ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BEDFORD
BEDFORD, MASSACHUSETTS
EPA FACILITY ID: MA6170023570
APRIL 25, 2005

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

Comment Period Ends:

MAY 25, 2005

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release 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. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude 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.

Please address comments regarding this report to:

Agency for Toxic Substances and Disease Registry
Attn: Division of Health Assessment and Consultation (E-60)
1600 Clifton Road, N.E., Atlanta, Georgia 30333

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PUBLIC HEALTH ASSESSMENT

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BEDFORD
BEDFORD, MASSACHUSETTS

EPA FACILITY ID: MA6170023570

Prepared by:

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

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 cleanup 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. Whatever the form of the public health assessment, the 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 than adults. 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 it touches on cases in which this is so, this report suggests what further public health actions are needed.

Conclusions

This report presents conclusions about the public health threat, if any, posed by a site. Any health threats that have been determined for high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices) are summarized in the Conclusions section of the report. Ways to stop or reduce exposure are recommended in the Public Health Action Plan section.

ATSDR is primarily an advisory agency, so its reports usually 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-60)
Atlanta, GA 30333

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List of Abbreviations

AFB	Air Force Base
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BMD	benchmark dose modeling
BTEX	benzene, toluene, ethylbenzene, and xylene
BW	body weight
CEL	cancer effect level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CREG	ATSDR's cancer risk evaluation guide
CRP	community response plan
CSF	EPA's cancer slope factor
CV	comparison value
DCE	dichloroethylene
DOD	Department of Defense
ED	exposure duration
EF	exposure frequency
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
ERH	electrical resistive heating
FDA	Food and Drug Administration
FFA	Federal Facilities Agreement
FR	flow rate
FS	feasibility study
FTF	flight test facility
gpm	gallons per minute
IR	ingestion rate
IRP	Installation Restoration Program
LF	landfill
LOAEL	lowest-observed-adverse-effect level
MCL	EPA's maximum contaminant level
µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter
mg/kg/day	milligrams per kilogram per day
MADEP	Massachusetts Department of Environmental Protection
MRL	ATSDR's minimum risk level
MT	mass transfer

List of Abbreviations (continued)

Navy	Department of the Navy
NFA	no further action
NOAEL	no-observed-adverse-effect level
NPL	EPA's National Priorities List
NWIRP	Naval Weapons Industrial Reserve Plant
O/W	oil/water
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	public health assessment
PHAP	Public Health Action Plan
ppb	parts per billion
ppm	parts per million
RAB	restoration advisory board
RBC	EPA's risk-based concentration
RfD	EPA's reference dose
RI	remedial investigation
RMEG	ATSDR's reference dose media evaluation guide
ROD	record of decision
SFTA	Southern Flight Test Area
SVOCs	semi-volatile organic compounds
T	time
TCE	trichloroethylene
TWA	time-weighted average
USAF	U.S. Air Force
UST	underground storage tank
V	volume
VOCs	volatile organic compounds

I. Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate potential health hazards from past, current, and future exposures to contaminants originating from the Naval Weapons Industrial Reserve Plant (NWIRP)–Bedford. Following a detailed review, ATSDR finds that people exposed to contaminants from the NWIRP Bedford site would not have harmful health effects.

NWIRP Bedford is located on 46 acres in Bedford, Middlesex County, Massachusetts, about 14 miles northwest of Boston, Massachusetts. The NWIRP Bedford property was owned by the U.S. Department of the Navy (Navy) and operated by the Raytheon Corporation beginning in 1952 for missile and radar development. Operations were expanded to design, fabrication, and testing of prototype equipment, such as missile guidance and controls systems. The site consists of two sections divided by Hartwell Road. The northern section is located on Hartwell's Hill; it contains the Components Laboratory and its auxiliary buildings, the compact test range, the facility's Storage Building, the Antenna Range Facility, the Transportation Buildings, a former incinerator, and the Vitro Tower. The southern section, the Southern Flight Test area (SFTA), is immediately south of Hartwell's Hill; it contains the Flight Test Facility (FTF), the Deluge Pump Station, the Guard House, a parking lot, a small storage building, and a concrete apron surrounding three quarters of the FTF. The entire site is bounded to the south by Lawrence G. Hanscom Field and Hanscom Air Force Base; to the west by Raytheon Electronic Systems Facility, wetlands, and a U.S. Air Force trailer park; to the north by woods and wetlands; and to the east by woods, wetlands, and private residences. Raytheon ceased operations at the facility in December 2000, and the land is now vacant as future use is being determined.

ATSDR conducted a public health assessment to evaluate potential hazards at NWIRP Bedford. ATSDR's public health assessment process is designed to identify populations who may have been exposed to hazardous substances and determine the public health implications of the exposure. As part of this process, ATSDR conducted a site visit and met with representatives from the Navy and NWIRP Bedford in July 2003. Information was gathered on the nature and extent of contamination associated with the site. ATSDR considered past, current, and potential future exposure situations.

Based on this evaluation, ATSDR determined that exposures to hazardous substances in soil do not pose a public health hazard because either (1) the area where the contamination is located is not widely used or accessible to the public, (2) contamination was detected only at low levels, or (3) the contamination has been removed from the site. ATSDR did identify several situations in which the public may be coming in contact with site-related contaminants. ATSDR studied possible hazards associated with these exposures and concluded the following:

- **Groundwater contamination and private well use near NWIRP Bedford.** *ATSDR has determined that use of local private wells has not posed a past, current or potential future public health hazard with respect to groundwater contamination from the NWIRP Bedford site.* Although contaminants have leached into the groundwater beneath NWIRP Bedford, levels are being reduced through pump and treat systems and removals of contaminated soil and sources. Some contaminants have migrated with groundwater flow north of the site. There are thirteen residences within half a mile east/northeast of NWIRP Bedford which have private wells. These wells are permitted for irrigation and the residences are connected to Bedford's municipal water supply. Because contaminant levels are being reduced and nearby households are connected to the municipal water supply, we do not anticipate future public health hazards. ATSDR recommends, as a prudent public health action, that residents continue to use municipal water for household uses due to multiple sources of area groundwater contamination.

- **Contaminants in the Hartwell Road well field between 1983 and 1984.** *ATSDR determined that no harmful exposures have occurred in the past from consuming water from the off-site municipal drinking water wells in the Hartwell Road well field. ATSDR recommends water quality testing and treating the affected groundwater to safe levels required by EPA and MADEP before restoring it to public use.* In the fall and winter of 1983, the town of Bedford discovered volatile organic compounds (VOCs) and dissolved iron in their Hartwell Road municipal well field, about ½ mile northwest of the NWIRP Bedford site. After further testing showed unacceptable levels of VOCs and dissolved iron, the town closed the well field in April 1984. ATSDR examined exposures to the detected levels of contaminants in the well field and determined that no health effects would have occurred for people who drank the water or used it for other domestic uses in the past. Since 1984, no exposure has occurred because the wells are no longer used. Because there are multiple sources of contamination in the area and contamination in fractured bedrock, ATSDR recommends that this well field not be reopened until groundwater remediation in the area is complete, potential sources of contamination have been investigated, and groundwater has been verified to be safe for use as drinking water.

- **Contaminants in Elm Brook.** *Contaminants from NWIRP Bedford have entered Elm Brook, but ATSDR determined that the levels are too low to pose harm to people who might visit the brook.* NWIRP Bedford contaminants have reached Elm Brook, a small, shallow stream that runs within 300 to 600 feet of the site's northern boundary. People are not expected to come in contact with contaminants in the brook often or for long periods of time, since Elm Brook is not used for drinking water or widely used for recreation. Any limited past, current, or future exposure to contaminants at the levels detected in surface water or sediment is not expected to result in adverse health effects. The already low contaminant concentrations are expected to further decrease before they reach the downstream Shawsheen River.

- **Possible vapors in on-site buildings located above the groundwater plumes.** *ATSDR determined that people who worked in or visited buildings above on-site groundwater contamination were not likely to encounter harmful levels of indoor air contaminants or suffer adverse health effects.* Some buildings at NWIRP Bedford sit above contaminated groundwater, which could release VOCs into building foundations. Conservative indoor modeling of potentially affected buildings units showed that VOC contaminants could be present in the air inside of certain buildings, but at levels below those associated with known adverse health effects.

II. Background

A. Site Description and Operational History

The Naval Weapons Industrial Reserve Plant (NWIRP)–Bedford is located on 46 acres in Bedford, Middlesex County, Massachusetts, approximately 14 miles northwest of Boston. The NWIRP Bedford property was owned by the Navy and operated by Raytheon Corporation. The site consists of two sections divided by Hartwell Road. The northern section is located on Hartwell's Hill; it contains the Components Laboratory and its auxiliary buildings, the compact test range, the facility's Storage Building, the Antenna Range Facility, the Transportation Buildings, a former incinerator, and the Vitro Tower. The southern section abuts Hanscom Field immediately south of Hartwell's Hill and contains the Southern Flight Test Area (SFTA): the Flight Test Facility (FTF), the Deluge Pump Station, the Guard House, a parking lot, a small storage building, and a concrete apron surrounding three quarters of the FTF (NUS Inc. 2001). The entire site is bounded to the south by Lawrence G. Hanscom Field and Hanscom Air Force Base; to the west by Raytheon Electronic Systems Facility, wetlands, and a U.S. Air Force (USAF) trailer park; to the north by woods and wetlands; and to the east by woods, wetlands, and private residences (Figure 1).

NWIRP Bedford was created in October 1952, when the Components Laboratory (then known as the Naval Industrial Research Aircraft Center) was constructed as a missile and radar development facility for Raytheon (see Figure 2). By 1959, the Navy had added flight test areas on the southern portion of the site. The facility expanded between 1959 and 1977, adding an additional 43 acres and the large facility storage and government buildings near the northern property boundary, an Antenna Range Building, air conditioning and incineration facilities, and the Advanced Medium Range Air to Air Missile Development (AMRAD) Building (EPA 2003). About 20 buildings were located on the NWIRP property, most of which supported work at the Components Laboratory and the FTF. Most recently, the facility was used for design, fabrication, and testing of prototype equipment, such as missile guidance and controls systems (ENSR 1992,

EPA 2003). Raytheon operations at the site ceased in December 2000 and the site, with the exception of a few buildings, is now vacant as future use is being determined.

B. Remedial and Regulatory History

Routine activities and waste disposal practices at NWIRP Bedford in the past have resulted in accidental spills or releases of chemicals to the environment. Some examples of these activities include the on-site storage of waste ash from the Old Incinerator (Site 1) and use and storage of fuels. Contaminants released to surrounding soil as a result of these activities include heavy metals in the waste ash (such as silver from classified film and lead, chromium, and zinc from paint wastes) and petroleum hydrocarbons and benzene, toluene, ethylbenzene, and xylene (BTEX) compounds associated with fuels (Roger, Golden, & Halpern 1986). Some of the contamination released to the soil seeped through it and, eventually, reached the underlying groundwater or was carried toward Elm Brook.

Environmental investigations began at NWIRP Bedford under the Department of Defense's Installation Restoration Program (IRP) in 1985. At that time, the Navy initiated a preliminary assessment (then known as an initial assessment study) and records review. The Navy continued environmental investigations at NWIRP Bedford in 1988 with the start of a remedial investigation (RI). The RI was undertaken to determine the nature and extent of contamination at NWIRP Bedford. Through the RI, the Navy found contaminants, including solvents and metals, in groundwater and/or soil at on-site locations (Tetra Tech NUS Inc. 2001). Data collected through this process were then used to evaluate potential risks to human health. In cases where risks exceeded regulatory guidelines (such as those of the U.S. Environmental Protection Agency, or EPA, and the Massachusetts Department of Environmental Protection, or MADEP), a feasibility study was conducted to identify and test alternative remedial actions.

On May 31, 1994, EPA added NWIRP Bedford to the National Priorities List (NPL) of sites to be investigated. (The NPL is part of EPA's Comprehensive Environmental Response,

Compensation, and Liability Act, or CERCLA, which is commonly known as "Superfund.") The Navy then entered into a Federal Facility Agreement (FFA) with EPA's Region I and MADEP to outline a comprehensive strategy for conducting environmental investigations and completing remedial actions on NWIRP property where hazardous materials might have been disposed of, spilled, or stored (EPA 2003).

The Navy continued to evaluate environmental conditions at NWIRP Bedford through a number of environmental investigations. Those investigations included the 1992–1993 Phase II RI and an RI Phase II supplemental study in 1998 that further defined the limits of groundwater plumes and possible source areas on site. Through this work, they investigated four IRP sites identified as having (or potentially having) hazardous contamination (Brown & Root Environmental 1997). The four sites, shown in Figure 2 and described in detail in Table 1, are:

- Site 1: Old Incinerator Ash Disposal Area
- Site 2: Components Laboratory (Fuel Oil Tank release)
- Site 3: Northwest Groundwater Plume of chlorinated VOCs
- Site 4: BTEX Fuel Area

For some on-site locations, the Navy has undertaken the following measures to control the spread of contamination:

- Operation of a row of extraction wells at the base of Hartwell's Hill since 1997. The wells contain contamination associated with the chlorinated plume from Site 3 and prevent it from migrating north toward Elm Brook. Water captured by the wells is pumped to a treatment system that removes the chlorinated VOCs and metals. The Navy continues to monitor the system on a quarterly basis.
- Excavation and removal of the contaminated soil from the Components Laboratory Fuel Oil Tank (Site 2).
- Removal of the 7,600-gallon gasoline underground storage tank (UST) and 75 to 100 cubic yards of gasoline-contaminated soil from Site 4.

Records of decision (RODs) for no further action at Sites 1 and 2 were selected by the Navy and EPA with concurrence of the Massachusetts Department of Environmental Protection. The September 2000 RODs indicate these sites pose no threat to humans or the environment (U.S. EPA. 2000a, 2000b).

Further remedial actions are underway at Sites 3 and 4. Currently, the Navy is conducting a pilot study to test whether they can use electrical resistive heating (ERH) to reduce total chlorinated volatile organic compounds (VOCs) at Site 3 by 95% to 99%. The Navy also plans to supplement the cleanup process at Site 4 with the ERH technology to reduce benzene concentrations in groundwater to 50 parts per billion (ppb) or below in the most contaminated areas (ENSR 2003).

The Navy also investigated the Southern Flight Test Area (SFTA) during RI activities for Site 3 (Tetra Tech NUS Inc. 2001). The investigation showed that the sources of contamination in the SFTA were likely related to the neighboring Hanscom Air Force Base, not NWIRP Bedford operations. Hanscom Air Force Base has operated a groundwater extraction system since 1997 to control the migration of contaminants from the site; as a result, the SFTA has not been addressed under the FFA for NWIRP Bedford. A Memorandum of Understanding regarding the containment and the cleanup of contamination at the SFTA was submitted to the Air Force in May 2001.

C. ATSDR Activities

Through the public health assessment (PHA) process, ATSDR assesses conditions at a site from a public health perspective to determine whether people can be exposed to site-related contaminants through contact with the site's groundwater/drinking water, surface water, soil, biota, or air. As part of the PHA process, ATSDR visited NWIRP Bedford in July 2003. The purpose of the visit was to collect information necessary to examine public health issues related to environmental contamination at the facility and to identify community health concerns.

During the visit, staff met with Navy and NWIRP Bedford personnel and representatives from federal and state agencies. Based on discussions, the site visit, and data reviews, ATSDR concluded at the time that there was little potential for immediate threats to human health. ATSDR did, however, identify several exposure pathways that required further evaluation. ATSDR prepared this PHA to further evaluate those pathways.

D. Demographics

ATSDR examines demographic information, or population information, to identify the presence of sensitive populations, such as young children (age 6 and under), the elderly (age 65 and older), and women of childbearing age (age 15 to 44). Demographics also provide details on population mobility and residential history in a particular area. This information helps ATSDR evaluate how long residents might have been exposed to environmental contaminants.

No one has ever lived at the site. The closest residents live in private residences in the Hartwell Acres housing subdivision and at the USAF trailer park. According to U.S. census data, about 3,523 people live within 1 mile of the site (Figure 3), including 395 children aged 6 and under and 361 adults aged 65 and older. The town of Bedford, overall, accounts for 13,000 residents (MADHCD 2003). Other towns near Bedford include Billerica (population 39,000) to the north, Lexington (population 30,000) to the east, Lincoln (population 8,000) to the south, and Concord (population 17,000) to west (MADHCD 2003).

E. Land Use

ATSDR examines land use to determine what activities might put people at risk for exposure to contaminants related to NWIRP Bedford. Land at NWIRP Bedford is mostly paved and was used to house metal-sided or reinforced concrete buildings that supported research and development of radar and missile guidance systems. All testing occurred in enclosed buildings; no testing was conducted outside (Brown and Root Environmental 1997). While the site was in full operation,

access was controlled by a partial fence and guard houses. Today, the site is no longer operational and the property is completely enclosed by a 6-foot-high chain-link fence.

Land surrounding NWIRP Bedford is zoned for residential and industrial use, and there are also large tracts of open land. Residential areas are located to the east/northeast (private homes) and west/southwest, including a trailer park for Hanscom staff located between the north and south sides of NWIRP Bedford. The next nearest residence to the site is about 200 yards to the northwest (Roger, Golden, & Halpern 1986). Hanscom Field and Raytheon Missile Systems Division Facilities are south and west of the site, respectively. Undeveloped wetlands, woods, and meadows border the site to the north/northwest (Halliburton NUS 1994).

Groundwater is the primary source of drinking water and irrigation water for Bedford residents (including residents of the Hanscom AFB trailer park adjacent to NWIRP Bedford) (Roger, Golden, & Halpern 1986). In 1983, the town of Bedford began drawing drinking water from the Hartwell Road well field, located less than ½ mile from the northwest corner of the NWIRP Bedford site. The well field was closed in 1984 after elevated levels of VOCs and dissolved iron were detected in the wells (Roger, Golden, & Halpern 1986). Today, about 85 percent of the drinking water for the town of Bedford comes from the Massachusetts Water Resources Authority (MWRA) via the town of Lexington municipal system. This water is augmented with water from the Shawsheen well field, located about 1.5 miles northeast of NWIRP Bedford. Only one of the three wells at the Shawsheen well field is currently operational (Bedford DPW 2003). Some residences connected to the municipal water system in the area of NWIRP Bedford also have private wells. A survey completed by the town of Bedford identified 12 private wells within 1 mile of the NWIRP Bedford site boundaries, the closest being 700 feet north-northeast of the site.

F. Natural Resources

Natural resources used in the vicinity of NWIRP Bedford include groundwater for drinking water and surface-water bodies for recreational uses (Shawsheen River). Some of the key exposure concerns associated with NWIRP Bedford pertain to chemical contamination in the shallow aquifer (groundwater) and releases to the Elm Brook, which is a tributary of the Shawsheen River. For information on how contaminants might migrate to and/or accumulate in these media, ATSDR obtained background information on the local topography, climatology, groundwater hydrogeology, and surface-water hydrology.

Geology and Hydrogeology

The northern section of NWIRP Bedford sits on the 40-acre Hartwell's Hill, which rises about 70 feet above the surrounding ground surface (or 205 feet above sea level). The hill is composed of glacial till overlying a bedrock base (Halliburton NUS 1992, Tetra Tech NUS Inc 2000; Dames & Moore 1992b; Brown and Root 1997)); with additional fill on top of the deposits. Extensive wetlands and flat to gently rolling wooded land dominate the land around the hill. NWIRP Bedford's lowest point occurs at its southern portion in the SFTA, near Hanscom Field (Roger, Golden, & Halpern 1986). In order of descending depth, the key subsurface layers are further described below:

- **Fill.** Manmade fill of sands and gravel, added to the property during its construction, covers a major portion of the hill. This fill ranges in thickness from about 10 to 23 feet on the hill, thins out in all directions from the hill and eventually disappears at the southern end of the site.

- **Glacial Deposits.** The fill is largely underlain by glacial deposits consisting of a sandy and clayey till layer. The till ranges in thickness from about 125 feet on the northwest portion of the hill to about 10 feet in the low-lying areas around the hill, and disappears at the southern end of the SFTA. The till is the only unit of glacial deposits present on the hill. Other glacial deposits surrounding the hill include outwash, located near Elm Brook and in the southern portion of the site, and a few areas of fine-grained lake deposits sandwiched between the till and outwash deposits.

- **Bedrock.** The weathered bedrock beneath the till layer is fractured, and ranges in depths from 135 feet in the northwest portion of the site to 26 feet in the southern end of the site.

Groundwater at NWIRP Bedford is primarily found in the surface layers and in the underlying fractured bedrock (Halliburton NUS 1992, 1993). The depth at which the groundwater is encountered varies, however, with the season and the amount of precipitation. The water table aquifer, or shallow aquifer, is typically encountered 15 to 30 feet below the ground surface, and roughly corresponds to the ground surface topography. From its high of 185 feet above mean sea level near the top of the hill, the shallow aquifer slopes steeply to the north, south, and east, and less steeply to the west. Given the fairly steep gradients on the hill, shallow groundwater would be expected to move vertically, or downward. However, the underlying glacial till is densely packed and acts as a low-permeability confining layer, or aquitard. This aquitard limits flow from the shallow aquifer to the bedrock aquifer (Halliburton NUS 1993). Consequently, groundwater flow in the shallow aquifer appears to move radially from Hartwells Hill and is strongly controlled by ground surface topography until it reaches the more permeable glacial deposits at the base of the hill (Dames & Moore 1992b). (This is important because contaminants in the shallow groundwater would be expected to move laterally in the shallow flow rather than migrate in significant concentrations to the deeper bedrock aquifer.) As the groundwater from the northern and western portions moves from the hill and toward Elm Brook, it is influenced more by the brook's surface hydrology.[1] Groundwater flow in the southern portion of the site near the SFTA is predominantly south and southeast, except when it is influenced and captured by the USAF's groundwater extraction system (Halliburton NUS 1993; Tetra Tech NUS Inc. 2002).

Groundwater flow in the bedrock aquifer is influenced by bedrock topography, but is similar to the direction in the shallow aquifer. Therefore, groundwater in the bedrock from the northern and western portions of the hill flows radially from the top of the hill and, like water in the shallow aquifer, ultimately discharges to Elm Brook (Tetra Tech NUS Inc. 2002a).

[1] Groundwater in the shallow aquifer on the western edge of the site might be drawn into a recovery well operated at the Raytheon Missile Systems Building rather than discharging to Elm Brook.

Surface Water Hydrology

Storm drains on the northern portion of the site collect rain and snow melt from paved areas atop Hartwell's Hill and empty out at several points at the edge of the slope (Halliburton NUS 1992). Other storm drains near the SFTA discharge to a drainage ditch southwest of the SFTA and toward one of the Hanscom Field runways. Runoff not collected by the drainage system likely enters the wetlands bordering Elm Brook (Roger, Golden, & Halpern 1986). Elm Brook, a tributary of the Shawsheen River, is the predominant natural surface water system near NWIRP Bedford. Elm Brook originates in a wetland about 4 miles southwest of the NWIRP Bedford site, and flows past the northern site boundary before joining the Shawsheen River, about 1.2 miles northeast of the NWIRP site (Halliburton NUS 1994). Elm Brook is typically a shallow, low-flow brook, except during the spring when heavy runoff increases its size (Roger, Golden, & Halpern 1986). As its limited size suggests, Elm Brook is not used as a source of potable or irrigation water, nor can it support a permanent fish population. The downstream Shawsheen River, however, has been used for both drinking water and recreation, and the town of Burlington continues to use the river as a source of potable water (Burlington DPW 2004). Surface water was pumped from the river into the Mill Pond Reservoir (about 10 miles downstream of NWIRP Bedford) and treated before use (Roger, Golden, & Halpern 1986). Sport fishing is popular at the Shawsheen River, but the Massachusetts Department of Public Health has posted a fish consumption advisory at the river due to elevated mercury concentrations in its fish (MADPH 2003).

G. Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the CERCLA program must meet standards for quality assurance and control measures for chain of custody, laboratory procedures, and data reporting. The environmental data presented in this PHA come from remedial investigations and other site reports. ATSDR has determined that the data's quality is adequate for making public health decisions.

III. Evaluation of Environmental Contamination and Exposure Pathways

A. Introduction

Identifying Exposure

ATSDR's PHAs are exposure (or contact) driven. People who work or live in an area of environmental release can only be exposed to a contaminant if they come in contact with it. A person might be exposed by breathing, eating, or drinking a substance containing the contaminant, or by skin contact with a substance containing the contaminant. But contact does not always happen when contaminants are released into the environment—*a release does not always result in exposure*.

ATSDR evaluates site conditions to determine if people could have been (a past scenario), are (a current scenario), or could be (a future scenario) exposed to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, water, air, waste, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation. ATSDR also identifies an exposure pathway as *completed* or *potential*, or *eliminates the pathway from further evaluation*. Completed exposure pathways exist if all elements of a human exposure are present. (See "Exposure Pathway" in Appendix A for a description of the elements of a completed exposure pathway.) A potential pathway is one that ATSDR cannot rule out, because one or more of its elements cannot be definitely proved or disproved. A pathway is eliminated if one or more of its elements is definitely absent.

More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/ or by contacting ATSDR at 1-888-42ATSDR. ATSDR also provides community web-based training at http://www.atsdr.cdc.gov/COM.

Exposure and Health Effects

Given sufficient exposure levels, chemical contaminants disposed of or released into the environment can cause adverse health effects. The type and severity of health effects that an individual can suffer after contacting a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (the combination of contaminants). Once exposure occurs, characteristics such as the exposed person's age, sex, nutritional status, genetics, lifestyle, and health status influence how he or she absorbs, distributes, metabolizes, and excretes the contaminant.

ATSDR selects contaminants for further evaluation by comparing their detected levels to health-based comparison values, or CVs. CVs are developed from the available scientific literature on exposure and health effects. Derived for a particular medium in which a contaminant can be present, a CV reflects the estimated concentration of that contaminant in that medium that is *not expected* to cause adverse health effects, assuming a standard daily contact rate (e.g., amount of water or soil consumed or amount of air breathed) and body weight. In order to be conservative and protective of public health, ATSDR CVs are generally based on contaminant concentrations *many times lower than levels at which no effects were observed* in experimental animals or human epidemiologic studies. They are not used to predict the occurrence of adverse health effects. Rather, they serve as a protective screen and first step in the evaluation of public health implications.

CVs used in this PHA are the environmental media evaluation guides (EMEGs), reference dose media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). EMEGs, RMEGs, and CREGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. In addition, ATSDR uses EPA's maximum contaminant levels (MCLs). MCLs are enforceable drinking water regulations developed to protect public health. (See Appendix B for a description of the CVs.)

If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for possible health effects. Figure 4 provides an overview of ATSDR's exposure evaluation process.

Possible Exposure Situations at NWIRP Bedford

ATSDR reviewed data for NWIRP's four IRP sites and the SFTA to determine if they are associated with past, current, or future public health hazards. (Table 1 describes each site and briefly summarizes our evaluation.) When evaluating these areas, ATSDR assesses the level of contamination present or degree of physical hazard, the extent to which individuals come into contact with the contamination or hazard, and whether this contact would result in a public health hazard. The review indicates that contamination from at NWIRP Bedford is not associated with any known public health hazards because the contaminant concentrations detected are too low to pose a health hazard or past and current exposure to the general public has been prevented.

In this review, however, ATSDR identified the following possible exposure situations at NWIRP Bedford that required further evaluation:

- Past, current, or future exposure to groundwater contamination via off-site private wells
- Past exposure to contaminants in the town of Bedford's Hartwell Road Well Field
- Past, current, or future exposure to contaminants in Elm Brook
- Past exposure to indoor air contaminants in on-site buildings above groundwater plumes

Of these possible exposure situations, the only completed exposure pathway is the past exposure to contaminants in the Hartwell Road well field. Exposure situations at NWIRP Bedford are evaluated in detail in the following discussion and summarized in Table 2. To acquaint the reader with terminology and methods used in this PHA, Appendix A provides a glossary of environmental and health terms presented in the discussion, Appendix B describes the CVs

ATSDR used in screening contaminants for further evaluation, and Appendix C describes the methods ATSDR used to evaluate whether health hazards exist.

B. Concern: Potential for Contamination to Reach Private Wells

Groundwater beneath the NWIRP Bedford site has become contaminated with VOCs and metals. Contamination in the northern portion of the site has been linked to former operations and waste disposal practices. Groundwater from the northern portion of the site flows toward and discharges into Elm Brook. VOC contamination in the southern portion of the site, at the SFTA, has not been linked to an on-site source. This contamination flows toward and is captured by the Hanscom Air Force Base groundwater treatment system located at the adjacent Hanscom Field. There are no wells serving private residents that are located near site contamination. Navy investigations show that contaminant concentrations in the groundwater at both the northern and southern portions of the site have over time have decreased substantially.

Discussion

Area Private Wells

Surveys were undertaken by the Bedford Board of Health and Department of Public Works to determine whether any private drinking water wells were located near the NWIRP Bedford site (Halliburton NUS 1992, 1994). The survey results indicated that 12 residences within 1 mile east and northeast of the site (in the Hartwell Acres neighborhood) had private wells. The closest of the residences is located 700 feet from the northeast property line. All the homes are connected to the town of Bedford's municipal water supply. Some of the private well owners reported using well water for watering lawns (Roger, Golden, & Halpern 1986). Although we have no way of knowing the full extent to which residents use their private wells, information gathered through the survey indicates that it was unlikely that these private wells have been used for drinking water or other domestic uses. Furthermore, ten of the twelve residences registered average municipal water use. Although two residences had average-to-low or low municipal water use,

they are located more than 2,000 feet from the northeast corner of NWIRP Bedford and therefore, are unlikely to be impacted by site contamination (Halliburton NUS 1992, 1994).

Groundwater Investigations

The Navy investigated the groundwater beneath the NWIRP Bedford site during several environmental studies: the 1989 Phase I RI, the 1990 Supplemental Investigation, the 1992–1993 Phase II RI, the 1997 Environmental Baseline Study, and the 1998 Supplemental Investigation. Groundwater investigations indicate that groundwater flow from Hartwell's Hill is largely influenced by topography: groundwater in the till flows outward in all directions from the top of the hill into the more permeable glacial outwash sands at the base of the hill (Halliburton NUS 1992). Once in the flat area at the base of the hill in the northern section, groundwater slowly discharges further northward into the Elm Brook (Roger, Golden, & Halpern 1986). Groundwater contamination in the southern section of the site is believed to be coming from the Hanscom Air Force Base site. The results of these groundwater investigations are summarized in Table 3 and in the discussions below.

Northern Section of the NWIRP Bedford Site

Volatile Organic Contamination

The Navy collected 22 shallow and deep groundwater samples as part of the initial phase of its RI at the NWIRP Bedford site. Sixteen of these samples (eight shallow and eight bedrock) were collected from the northern portion of the site, then analyzed for VOCs and metals. This analysis identified VOCs as the primary contaminant of the northern section. Although groundwater contaminants have migrated primarily to the northwest, some northeasterly migration has also occurred.

VOCs were detected in the groundwater of the northern section of the NWIRP Bedford site. Contamination has migrated primarily to the northwest and to a much lesser degree to the northeast. The closest private wells, to the east/northeast of the site, are permitted for irrigation. The Hartwell Road Well Field, to the northwest, was closed in April 1984. There are currently no known exposures to groundwater contaminants.

Most of the VOCs migrated off Hartwell's Hill to the west and then to the northwest towards Elm Brook. VOCs in the northwestern portion of the northern section appeared to be limited to the shallow aquifer (MW1S, MW2S, and MW11S). The highest VOC concentrations were discovered in a shallow well (MW11S) near the former Print Shop within the Factory Storage Building. At this location, the maximum trichloroethylene (TCE) and benzene concentrations were 2,300 ppb and 75 ppb, respectively. A breakdown product of TCE, 1,1-dichloroethylene (1,1-DCE), was also detected in the shallow aquifer at the same location at a maximum concentration of 1,200 ppb. Lower VOC concentrations (up to 210 ppb for TCE and nondetect for benzene) were discovered in the shallow well (MW2) just down-gradient of the Old Incinerator Ash Disposal piles. No VOCs were detected in the bedrock wells at either the Print Shop or the Ash Disposal piles (Dames & Moore Inc. 1992 a, b).

Along the northeast corner of the northern section, near the Component Laboratory (approximately 500 feet from the Facility Storage Building), VOCs were again detected, but at lower concentrations and over much smaller distances than contaminants migrating northwesterly from the Print Shop area. The Print Shop area in the northeastern corner of the Components Laboratory is also the suspected source area for this northeasterly contamination (Dames & Moore Inc. 1992a, b).TCE was found in both shallow and deep groundwater, indicating that contamination at this location, while lower in concentration, had reached the deeper bedrock aquifer. However, the extent of bedrock contamination was limited. TCE was detected at a maximum concentration of 110 ppb in the shallow aquifer. Other VOCs included 1,1-dichloroethane (1,1-DCA) (14 ppb), 1,2-DCA (1,2-dichloroethane) (44 ppb), 1,1-DCE (28 ppb), methylene chloride (10 ppb), and tetrachloroethylene (PCE) (11 ppb), all at levels just above their CVs. The deeper groundwater samples contained similar constituents, but at reduced concentrations (up to 42 ppb for TCE).

As noted, several private wells are located north of the site but are apparently not used for drinking water. It is not known whether contaminated groundwater from NWIRP Bedford has traveled northward far enough to reach these wells.

BTEX Contamination

High concentrations of BTEX (benzene, toluene, ethylbenzene, and xylene) compounds were identified in the unconsolidated deposits along the northern portion of the site and north-northwest into the low-lying area and wetlands. This area is known as Site 4. The BTEX contamination is believed to have originated from the pump of a former gasoline underground storage tank (UST) once located near the Transportation Building. Although the time over which the gasoline release occurred in the past is not known, evidence of the release was not confirmed until the suspect tank and associated pumping equipment were removed between December 1988 and January 1989 (Tetra Tech NUS 2000a).

BTEX is an acronym for benzene, toluene, ethylbenzene, and xylene, a group of volatile organic compounds found in petroleum hydrocarbons such as gasoline. These compounds were found in the groundwater in the northern section of the NWIRP Bedford site likely from gasoline released from a former UST. BTEX can dissolve in and move in groundwater, but because it sticks to soil particles, it moves slower than groundwater.

BTEX compounds contaminate the groundwater beneath the Transportation and Antennae Range Buildings of the site. The highest concentrations of these contaminants were detected during 1993 Phase II sampling in monitoring well (MW) 18, where total BTEX compounds reached 99,800 parts per billion (ppb). Concentrations of the individual constituents (benzene at 3,000 ppb, ethylbenzene at 7,800 ppb, toluene at 49,000 ppb, and total xylenes at 40,000 ppb) exceeded ATSDR's CVs for drinking water. Table 8 presents the maximum concentration of BTEX compounds detected at the site. Polycyclic aromatic hydrocarbons (PAHs) such as napthalene (up to 130 ppb) and 2-methylnapthalene (up to 38 ppb)—also constituents of gasoline—were detected in the overburden samples at concentrations above ATSDR's CV for drinking water. Findings of BTEX and PAHs together provide further evidence that the plume most likely originated from the gasoline release at the former UST. Neither BTEX constituents nor PAHs were measured in samples collected from the bedrock aquifer (Tetra Tech NUS 1999, 2000a).

The BTEX compounds were also detected in down-gradient overburden monitoring wells, so they appear to migrate northward in a narrow groundwater plume (about 50 feet wide by 720 feet long). Concentrations detected in the down-gradient wells are lower than those measured at the source area, suggesting that contaminant concentrations diminish with distance from the former release area. Total BTEX concentrations at the down-gradient wells were 51 to 6,530 ppb for MW15S and 200 to 1,400 ppb for GEI107U during supplement investigations in 1998 (Tetra Tech NUS 1999). Further down-gradient, in an area roughly estimated to be the lateral extent of the plume, benzene was detected in MW35S at 14.4 ppb and in MW36S at 1.6 ppb. Detections of BTEX compounds further down-gradient (near Elm Brook) were reported only during a 1996 sampling. During that event, benzene was estimated at 3 ppb in monitoring well ELM2 adjacent to the brook. Since then, BTEX has not been observed in that well during supplemental investigations and quarterly monitoring for the IRA system. According to all the monitoring data collected during the RI, the supplemental investigation, and quarterly monitoring events, the concentrations of the BTEX compounds in the groundwater within the overburden (shallow aquifer) have decreased over time, even though the plume's size and shape have stayed relatively the same (Tetra Tech NUS 1999, 2000a).

The Navy began evaluating an *in situ* chemical oxidation system in 2000 to address contamination in the source area at the Transportation and Antennae Range Buildings. (To further reduce contaminant source contributions, the Navy had removed an additional 35 cubic yards of contaminated soil from the former UST area and placed a liner over the area before backfilling soil.) The goal of the treatment system was to restore the groundwater beneath the site to drinking water quality; reducing BTEX concentrations in the source areas would also be expected to decrease the contamination in the groundwater plume over time. Chemical oxidation was selected because it has been shown to destroy chemicals such as those found in gasoline. The process works by injecting oxygen-containing compounds, such as hydrogen peroxide, into the ground so as to convert groundwater contaminants into harmless carbon dioxide and water.

The Navy evaluated the process in three treatment phases between November 2000 and January 2001. In total, the Navy injected over 6,000 gallons of 50% hydrogen peroxide (plus a catalyst) using 20 injectors and 9 vent wells over the extent of the source area during three separate 5-day treatment events. After the third round of injections in January 2001, only two wells remained above the interim cleanup objective of 300 ppb for BTEX, with a maximum total BTEX concentration of 1,880 ppb—a greater than 90% reduction in BTEX concentration (Krivansky et al. 2001).

The Navy reported that while the chemical oxidation treatment system had reduced contaminant levels, it had not adequately achieved the cleanup goal of 300 ppb for BTEX. As a next step, the Navy selected an *in situ* thermal treatment system using electrical resistance to further clean up the residual contamination in soil and groundwater. This time they selected a removal action goal for the source areas of 300 ppb for benzene. (Modeling conducted by the Navy indicated that a benzene concentration of 300 ppb at Site 4 would allow them to reach cleanup goals for safe drinking water in the area of the plume. This, as well as benzene's long cleanup time and low drinking water standard, is why the Navy chose benzene concentrations to indicate the thermal system's overall effectiveness.) Groundwater monitoring results indicated that by April 2004 the removal action goal had been achieved (Navy 2004).

After the thermal treatment system was used, the Navy monitored groundwater quality at 10 wells (3 in the source area and 7 down-gradient) in June 2004. This sampling showed that conditions were favorable for natural attenuation (see text box) —and that it was occurring in the area of the groundwater plume. Model analysis of the plume area predicted that, through natural attenuation, cleanup goals (drinking water standards for the individual constituents) in the area of the plume would be achieved in 20 years (Navy 2004).

Natural attenuation is the process by which naturally occurring microorganisms in the soil and groundwater help reduce chemical contaminant concentrations.

Southern Portion of the NWIRP Bedford Site

The southern portion of the site primarily consists of the SFTA. Contamination in the SFTA was identified and investigated during RI activities, in coordination with Site 3. The VOCs TCE, 1,1-DCE, and 1,2-DCE were detected in groundwater, but only TCE exceeded its current ATSDR CV of 5 ppb. The highest TCE concentrations were measured in the bedrock wells, particularly MW24R, in which concentrations reached 250 ppb in 1993. (MW24R and MW25R were not sampled in 1989.) By 1998, TCE concentrations in the bedrock had decreased, though the TCE concentrations still exceeded ATSDR's CV. Concentrations of TCE (estimated maximum of 71 ppb in 1989) in the overburden wells, which were lower than concentrations in the bedrock wells, had also decreased by the 1998 sampling.

Groundwater contamination in the **SFTA** bedrock likely comes from sources associated with Hanscom AFB. This contamination is captured and treated by the groundwater treatment system at Hanscom Field. Groundwater contaminants beneath the SFTA are not reaching area groundwater users.

Findings of the Phase II RI in the early 1990s and of the 1990 Supplemental Investigation, show no on-site source for the chlorinated solvents in the SFTA (Tetra Tech NUS Inc. 2002). Groundwater flow in the SFTA is predominantly south and southeast, but no VOCs were detected up-gradient (and north) of well MW24R. Furthermore, lower concentrations of TCE (less than 71 ppb) were detected in the overburden in the SFTA. Together, these findings suggest that sources other than SFTA may be contributing to the bedrock contamination, including off-site sources associated with neighboring Hanscom Air Force Base (AFB) (Tetra Tech NUS Inc. 2001). The groundwater treatment system at Hanscom AFB has a radius of influence that includes the SFTA of the NWIRP Bedford site. Therefore, groundwater and associated contaminants from SFTA are not expected to travel north toward area production wells, Elm Brook, the Hartwell Road well field, or to private wells north or northeast of the site.

The USAF operates a groundwater extraction system on Hanscom Field that controls the migration of contaminated groundwater in the SFTA. Because the contamination is not from

NWIRP Bedford operations and the USAF system is effectively controlling its migration, the Navy has not listed SFTA as an area of concern in the FFA with the USAF (Tetra Tech NUS Inc. 2001; ATSDR 2004).

Public Health Implications of Contaminants in Off-Site Groundwater

There is no past, current, or potential future exposure to or health hazards from contaminants in groundwater via private wells. ATSDR examined whether private well owners who live near NWIRP Bedford have been or could be exposed to the contaminants in groundwater. Some residents with private wells live north or northeast of known groundwater contamination at the northern portion of NWIRP Bedford. The potential for contaminants to reach private wells from NWIRP Bedford, however, is considered to be low. Few private wells exist in the direct path of typical groundwater flow in the area and none are close enough that they are likely to be contaminated by NWIRP Bedford. The closest private drinking water well in the path of typical groundwater flow direction is approximately 700 feet from the site.

Even if contaminants reached the residential area, local residents should not come in direct contact with contaminants in private well water frequently or for long periods of time. This is because the residences are connected to the municipal water supply and the private well water is permitted for irrigation. Some residents who use these wells for irrigation may contact contaminants in the water through skin contact or incidental ingestion of water. Nonetheless, the potential exposure via this exposure pathway is expected to be limited and not of health consequence. No harmful exposures to groundwater contaminants via private wells are anticipated in the near future if the residents continue to use municipal water for consumption and household use.

C. Concern: Past Contamination of the Hartwell Road Well Field

In April 1983, the town of Bedford began operating three water wells at the Hartwell Road well field to supply the town's drinking water. The well field is less than ½ mile from the northwest

corner of the NWIRP Bedford site. Sampling of the well water in October 1983 identified organic solvents and dissolved iron at levels above current drinking water standards. Following further sampling, the town of Bedford closed the municipal well field in April 1984 and provided Bedford residents with a safe alternate water supply. The town government believed that groundwater pumped at the Hartwell Road well field had become contaminated with VOCs from NWIRP Bedford and other neighboring properties.

Residents who used water from the well field during its operation were possibly exposed to the contaminants when they drank the water or used it for other domestic purposes. ATSDR reviewed the environmental data and possible exposures to the well water for Bedford users. Through this review, ATSDR determined that no ill effects would be expected for people who used the water until the wells were closed in April 1984, a period of about 1 year. Because the town has not used the wells since 1984 and has not developed plans for future use, no exposure is occurring now or expected to occur in the future. Wells that currently supply Bedford residents with drinking water have not been affected by site releases.

Discussion

Hartwell Road Well Field History

Because of closure of the Hartwell Road well field in April 1984, no exposures to contaminated groundwater have occurred since then. Past exposures were not sufficient to result in adverse health effects. A groundwater extraction system on NWIRP captures site contamination that heads north/northwestward.

By the spring of 1983, the town of Bedford completed construction of the Hartwell Road municipal well field and treatment plant. The town intended to use the new well field as its primary water supply source and to partially replace other municipal wells lost in 1978 to industrial contamination (CDM 1984a). The new well field housed three production wells (wells 10, 11, and 12, which were completed in 1981) and was equipped with an iron and manganese treatment system. The well field is located less than ½ mile from the northwest corner of the NWIRP Bedford site (Figure 5). Water quality analyses conducted prior to startup indicated that the finished water from the well field was acceptable for

public consumption and was free of VOCs (CDM 1984a, ENSR 1992). Bedford officials began operations of the treatment system in April 1983.

By October 1983—after only 6 months of operation—VOCs were discovered in a tap at the Town Hall during routine sampling, and an investigation was undertaken by the town to determine the source of the contamination. (Table 4 presents the chronological summary of monitoring activities at the Hartwell Road well field.) The investigation indicated that VOCs were present in each of the three new production wells (CDM 1984a, 1984b, 1984c), thus confirming contamination of the new Hartwell Road well field. TCE, an industrial solvent, was detected at concentrations up to 33 ppb and above ATSDR's CV of 5 ppb in one of the wells. Following the discovery of VOCs in the Hartwell Road wells, the town closed Well 11—the most contaminated well—while keeping Wells 10 and 12 online. By mid-December 1983, the town began a formal sampling program to monitor VOC concentrations in the well water (including Well 11). Through that sampling, the town detected benzene at levels up to 30 ppb. Table 5 presents the maximum concentrations of contaminants detected in the production wells.

Also in mid-December 1983, iron levels in the treatment plant's finished water began to rise. Sampling of the water at each well that month showed that most of the iron came from Well 10, which contained iron at 11,000 ppb. Iron levels in Well 10 continued to rise, jumping to a high of 31,000 ppb by early January, and then fluctuated between 25,000 ppb and 31,000 ppb through the end of the month.[2] Iron levels in Well 12 remained stable at less than 5,000 ppb during the same time period.

Iron was detected in the water from the Hartwell Road well field in the past. Iron is a naturally occurring metal that is present in all groundwater in New England to some extent. The iron discovered in the well water was predominantly in the form of ferrous iron—that is, dissolved or reduced iron. Ferrous iron tends to remain in solution until it is oxidized by either chlorine or oxygen (from bacteria), so water containing ferrous iron appears totally clear (CDM 1984a).

[2] Water quality results from early pump tests in October 1980 showed iron concentrations at only 3 ppm. Iron up to 50 ppb was detected in Well 11, which was closed at the time of detection.

Because of the unacceptable iron levels in Well 10's raw water, town officials closed that well and kept only Well 12 in operation. Well 12 continued to produce up to 260 gallons per minute of raw water into the treatment system. Then, in March 1984, elevated benzene concentrations (7 ppb) began to show up in samples of finished water from Well 12 (CDM 1984c, ENSR 1992). Town officials shut down the entire well field on April 3, 1984; they ultimately came to rely on MWRA water via the town of Lexington, and to a lesser extent on the Shawsheen well field, for public drinking water (CDM 1984c).

Groundwater Monitoring

Hartwell Road Well Field

Environmental investigations conducted in 1984 by the town of Bedford found VOCs and iron in the groundwater in the area of the Hartwell Road well field. The well field is located in a complex aquifer made up of five geologic units: the upper aquifer, the middle silt layer, the lower aquifer, the glacial till layer, and the bedrock. The primary water-bearing units are the upper and lower aquifers, which are thickest at the well field and thin out in all directions with distance from the wells. In fact, the lower aquifer is only 800 feet wide within the well field area, disappears to the west, east, and south, and does not appear to extend to Elm Brook (CDM 1984c). Under non-operating conditions, groundwater typically did not flow from the upper aquifer to the lower aquifer beneath the well field (CDM 1984c). In contrast, when the wells were pumping, groundwater leaked through the middle silt layer to the lower aquifer and the groundwater flow in the lower aquifer was diverted to the Hartwell Road well field production wells from its natural flow path toward the Elm Brook (CDM 1984c).

VOCs were discovered in the groundwater within the well field, but only in the lower aquifer. They included benzene, 1,1- DCE, trans1,2-DCE, TCE, 1,1,2,2-tetrachloroethylene, and toluene. Table 6 presents the maximum concentration of contaminants detected above ATSDR's CV. Of the VOCs detected, benzene, TCE, and 1,1-DCE appeared most consistently and in the highest concentrations (CDM 1984c). Apparently, the contamination was drawn into the Hartwell Road

well field from an off-site location when the wells were pumping. The contaminants likely entered the lower aquifer from either solvents that had moved along the glacial sediment from a nearby source or that had traveled within the fractured bedrock zone from an undetermined location. In either case, the sources were believed to be from properties located south-southeast of the well field (CDM 1984c).

In addition to VOCs, elevated concentrations of iron were widespread in both the upper and lower aquifers within the well field (CDM 1984c). The highest detected iron concentrations (up to 310,000 ppb) were more than 40 times higher than background concentrations (430 to 7,200 ppb) typical for the area and higher than the secondary MCL for iron in drinking water of 300,000 ppb. The study indicated that the iron in the groundwater likely originated from minerals in soil, and reached high concentrations due to chemical and biological reactions brought about by low pH conditions and high levels of sulfate (possibly from a sulfuric acid release to the west of Hartwell Road) (CDM 1984c).

NWIRP Bedford

The results gathered from the RI sampling identified that groundwater beneath the site had been contaminated by solvents and metals. The principal contaminants were benzene, TCE, PCE, and 1,2-DCE. Information on VOC contamination at the site is discussed in section III.B above.

Iron concentrations at NWIRP Bedford were detected at concentrations up to 2,840 ppb in a shallow groundwater well (MW11) located near the Facility Storage Building and up to 225 ppb in a deep (bedrock) groundwater well (MW2) situated near the Antenna Range Building (Dames & Moore Inc. 1992a, b). Despite these findings, the levels are well below the maximum concentration detected at the off-site Hartwell Road well field of 31,000 ppb and within the range of values typically observed in the groundwater for the Bedford area (430 ppb to 7,200 ppb) (CDM 1984a).

Following the RI, the town of Bedford came to the conclusion that groundwater pumped at the Hartwell Road well field had become contaminated with VOCs that originated from the NWIRP Bedford site and other neighboring properties (Dames & Moore Inc. 1992a). The town of Bedford then filed a civil action naming the Raytheon Company, Massachusetts Port Authority (operators of the Hanscom Field), the USAF, and the Navy as defendants with regard to contamination of Hartwell Road well field (Dames & Moore Inc. 1992a).

The Navy has conducted many investigations at NWIRP Bedford to characterize the hydrogeology and nature and extent of groundwater contamination at the site: the Phase I RI in 1989, the 1990 Supplemental Investigation, the 1992–1993 Phase II RI, the 1997 Environmental Baseline Survey, the 1998 Former Underground Storage Tank (UST) Assessment, the 1998 Supplemental Investigation for the SFTA, and the September 2000 Final Report for the Phase II RI for NWIRP. These investigations have not tied past Hartwell Road well field contamination with activities at the NWIRP Bedford site.

Public Health Implications of VOCs and Dissolved Iron in the Hartwell Road Well Field

There are no public health hazards from past exposure to contaminants in the Hartwell Road well field. Sampling in 1983 and 1984 found VOCs and iron in the municipal water supply wells at the Hartwell Road well field, which served the town of Bedford in the past. The contaminants benzene, TCE, and dissolved iron exceeded ATSDR comparison values. Surrounding properties including NWIRP Bedford might have contributed to the contamination in the affected wells, even though environmental investigations have not directly linked the contamination to the Navy site. Regardless of the source, ATSDR examined the possibility of harmful effects on people who used water from the well field in the past. Exposure to VOCs could have occurred when residents drank the water or used the water for other domestic purposes (e.g., showering) between the time the well field was opened (April 1983) and when it was closed (April 1984)—approximately 1 year. ***No exposure has occurred since April 1984.*** Bedford residents have since

received most of their drinking water from the MWRA via the town of Lexington. ATSDR focused its public health evaluation, therefore, on possible *past* exposures to contaminants in the Hartwell Road well field.

Past Exposure to TCE, Benzene, and Dissolved Iron in Drinking Water

ATSDR estimated the potential exposure dose for adults and children who drank water originating from the Hartwell Road well field to determine if a health hazard existed. ATSDR estimated doses for exposure to the contaminants that exceeded CVs or other screening values: benzene, TCE, and dissolved iron. In deriving human exposure doses, ATSDR incorporated information about the frequency and duration of potential contaminant exposure. For example, because it is not known when VOCs first reached the Hartwell Road wells, ATSDR used an exposure period of 1 year (the full amount of time the well field was operating) for adults and children to calculate a *theoretical* maximum exposure dose. To be protective, ATSDR also assumed that all drinking water pumped to residential taps contained the highest detected concentrations of benzene, TCE, and dissolved iron measured in the affected wells. ATSDR recognizes that, in most exposure situations, it is highly unlikely that a person will be continuously exposed to the highest concentration detected over time. ATSDR's approach is a conservative way to evaluate whether a contaminant is likely to pose a health concern. Appendix C describes ATSDR's approach in detail.

ATSDR compared the estimated exposure doses with standard health guidelines, such as ATSDR's oral minimal risk levels (MRLs) and EPA's reference doses (RfDs), if available. The MRLs and RfDs provide a protective estimate of daily exposures to noncancer agents that are not likely to result in adverse health effects, even for the most sensitive members of a community (e.g., pregnant women, children). The estimated exposure doses for ingestion of water from the Hartwell Road well field are provided in Appendix C, Table C-1.

Estimated exposure doses for adults and children are below MRLs/RfDs or several times lower than the levels at which effects were observed in laboratory animal studies. Current toxicologic

literature suggests that the detected levels of TCE and benzene are also below levels thought to cause cancer via the oral route of exposure (ATSDR 1997a, 1997b). *Considering this information, exposure to detected levels of contaminants from past ingestion of drinking water from the Hartwell Road well field are not expected to cause adverse health effects.*

Past Exposure From Breathing in VOCs Released From Household Use

Vapors, from water contaminated with detected levels of VOCs, might be released during normal household use, such as washing and bathing. The primary route for VOCs to enter the body is through inhalation of contaminated air. Persons who drank water from the Hartwell Road well field between April 1983 and April 1984 in the past, therefore, might have been additionally exposed to VOCs when they used the municipal water for household purposes. Some information suggests that the highest level of inhalation exposure to VOCs in the home occurs during showering (Lindstrom 1994). Consequently, ATSDR assessed exposures to VOCs moving from the water to air during showering. To be protective, ATSDR used a screening-level model to predict air concentrations based on the maximum detected VOCs in water. ATSDR also assumed that 100% of the VOCs volitalized to air and that no dissipation occurred. ATSDR's assumptions and methods, as well as the estimated doses, are further described in Appendix C. *Using these assumptions, ATSDR found no evidence that VOCs would reach levels in indoor air associated with adverse health effects from breathing in contaminants released during washing and bathing.*

D. Concern: Contamination Reaching Elm Brook

NWIRP Bedford is located in the Shawsheen River surface water drainage basin. While no surface water body flows through the site, Elm Brook runs within 300 to 600 feet north of the site's northern boundary. Relatively low concentrations of contaminants from NWIRP Bedford have reached the surface water and sediment of the brook. Even so, no public health hazards are expected from limited past, current, or future contact with the levels of contaminants measured in this brook. Elm Brook is not known to be used for drinking water or widely used for

recreation, and the levels of contaminants in the brook are too low to harm people who might come in contact with the brook infrequently or for brief periods of time. The already low concentrations of contaminants are expected to further decrease before the water reaches the downstream Shawsheen River.

Discussion

Elm Brook Hydrology

NWIRP Bedford sits in the drainage basin of the Shawsheen River. The site does not contain any natural surface water bodies. The closest water body to the site is Elm Brook, which flows within 300 to 600 feet of the northern boundary of NWIRP Bedford. Elm Brook flows year-round, but is greatly diminished in the warmer months. No surface water runoff from the NWIRP Bedford is believed to reach the brook or the Shawsheen River directly, because the area northwest, north, and east of the site is dominated by wetlands (Roger, Golden, & Halpern 1986). These extensive wetlands likely intercept any surface water runoff from the site before it can reach the brook. Groundwater at NWIRP Bedford migrates radially off the Hartwell Hill toward the surrounding wetland area. In the immediate area of NWIRP Bedford, groundwater in the till layer (shallow aquifer) discharges to Elm Brook, and possibly also to the Shawsheen River (Roger, Golden, & Halpern 1986). Elm Brook eventually flows into the Shawsheen River, about 1.4 miles to the east of the NWIRP Bedford site. The river is used for recreational activities and drinking water for the town of Burlington (e.g., fishing and boating), although not typically for swimming.

Surface Water and Sediment Monitoring Data

Surface Water Data

During the RI activities, the Navy collected four surface samples from Elm Brook and one sample from the drainage ditch in the SFTA that feeds into Elm Brook. All of the samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), and metals using EPA's

methodology. One sample was also analyzed for cyanide, pesticides, and PCBs (Tetra Tech NUS Inc. 2000a, 2000b).

Table 7 presents the range of contaminant concentrations in surface water that exceed ATSDR's CVs. Most contaminants were either not detected or detected at levels below health screening values. Only TCE and arsenic were found at concentrations above their CVs. TCE was discovered in two of the five samples at estimated concentrations of 1 ppb and 7 ppb, with the highest concentration reported for the sample taken from the drainage ditch. Arsenic was consistently detected in all five samples at concentrations between 3 and 5.2 ppb—above the arsenic CV for drinking water of 0.2 ppb. Arsenic concentrations were, however, within concentrations typical for the area.

Sediment Data

The Navy collected seven sediment samples from the top 5 inches of Elm Brook substrate and one sample from the SFTA drainage ditch during the 1992 RI. All of the samples were analyzed for VOCs, SVOCs, and metals using EPA methodology. One sample was also analyzed for cyanide, pesticides, and PCBs (Tetra Tech NUS Inc. 2000a, 2000b).

Of the contaminants assessed in the sediment, only arsenic and the SVOC benzo(a)pyrene were detected at concentrations above their CVs for soil. As Table 7 shows, the highest arsenic concentration (47.4 ppm, above ATSDR's CV of 20 ppm for arsenic in soil) was measured in the sample collected from the drainage ditch. Arsenic concentrations in other samples collected along the brook were lower (ranging from 3.9 ppm to 35.7 ppm), but there were still some samples above ATSDR's CV for arsenic in soil.

Public Health Implications of Contaminants in Elm Brook Surface Water and Sediment

No public health hazards are associated with past, current or future exposure to contaminants from NWIRP Bedford that have reached Elm Brook. Although VOCs, metals, and SVOCs have

been detected at levels above ATSDR's CVs in the surface water or sediment of Elm Brook that flows near NWIRP Bedford, people are not expected to come in contact with harmful levels of these contaminants. There are no indications that people use or will use Elm Brook in ways that would result in appreciable skin contact with surface water or sediment. Any skin contact with contaminants in surface water or sediment is expected to be limited in frequency and duration, and not of health consequence. Furthermore, the Navy has taken and continues to take measures to prevent groundwater contaminants at the NWIRP Bedford site from reaching the brook. Natural processes, such as dilution and mixing, would likely further reduce concentrations of any migrating contaminants before they reach the Shawsheen River, thus precluding the buildup of harmful levels of site-related contaminants in Shawsheen River surface water, sediment, or fish. ATSDR does not expect incidental exposure to contaminants in surface water and sediment to pose a public health hazard.

E. Concern: Vapor Intrusion From Groundwater Plumes Beneath On-Site Buildings

Groundwater beneath certain sections of the NWIRP Bedford site is contaminated with VOCs. Under some conditions, the VOCs can travel up from the groundwater, through the soils, and into the air of buildings. People in affected buildings could then breathe in air containing VOCs. However, no indoor air sampling has been conducted to determine whether contaminants associated with the groundwater plumes have entered the buildings and adversely affected indoor air quality.

Many of the buildings at the NWIRP Bedford site were used for industrial processes or storage. Even so, ATSDR estimated indoor air concentrations for vapor intrusion above or near the highest levels of groundwater contamination. The estimated maximum indoor air level of VOCs is much lower than the level at which we would expect to see adverse health effects. Therefore, contaminants associated with groundwater plumes probably did not seep into and accumulate to harmful levels inside NWIRP Bedford buildings located above groundwater contamination.

Discussion

NWIRP Bedford Groundwater Contamination

As discussed in a previous section, Section III.B., contamination is present in groundwater at discontinuous, isolated locations beneath the NWRIP Bedford site. The groundwater contamination contains mostly VOCs, with the highest concentrations discovered in the shallow groundwater next to the former Print Shop within the Factory Storage Building, where TCE, benzene, and 1,1-DCE concentrations reached 2,300 ppb, 75 ppb, and 1,200 ppb, respectively. Lower VOC concentrations (up to 210 ppb for TCE and nondetect for benzene) were discovered in the shallow groundwater just down-gradient of the Old Incinerators Ash Disposal piles. No VOCs were detected in the bedrock aquifer at either the Print Shop or the Old Incinerators Ash Disposal piles (Dames & Moore Inc. 1992a, b).

More widespread VOC contamination—but with far lower contaminant concentrations—was observed at the northeast and southern corners of the Components Laboratory. At these locations, VOCs were measured in both the shallow and deep groundwater aquifer. The contaminants likely came from the paint shop in the northeastern corner of the Components Laboratory, about 200 feet from MW5.

Public Health Implications of Exposures to Estimated Indoor Air Contaminants

No public health hazards associated with exposure from contaminants seeping into on-site buildings likely existed in the past. The groundwater beneath NWIRP Bedford is contaminated with VOCs, which can move from the groundwater through soil, and eventually seep into basements and affect the indoor air. If this occurred, people could have been exposed to contaminants in the air inside the on-site buildings.

Indoor air sampling data are not available for buildings at the NWIRP Bedford site above the VOC groundwater contamination. ATSDR, therefore, applied EPA's Johnson and Ettinger

(1991) model to estimate indoor air concentration. The model is a *screening-level* model that estimates the transport of contaminated vapors from either subsurface soils or groundwater into the spaces directly above the source of contamination (EPA 2003).

ATSDR estimated indoor air concentrations for benzene, TCE, and 1,1-DCE from vapor intrusion. ATSDR selected these three contaminants for review because they were detected frequently in the groundwater beneath the site in high concentrations. ATSDR then compared the concentrations to health based screening values, such as inhalation MRLs, and to information in the toxicological literature to determine whether indoor air contaminants could be associated with any adverse health effects. An estimated indoor air concentration less than the inhalation MRL is not expected to cause adverse health effects. Table C-5 lists the estimated indoor air concentrations for benzene, TCE, and 1,1-DCE, along with available health-based screening values.

ATSDR estimated benzene, TCE, and 1,1-DCE indoor air concentrations at 11.54 ppb, 8.5 ppb, and 24 ppb, respectively, based on the highest detected groundwater concentrations. The estimated exposure concentrations are lower than their intermediate inhalation MRLs or levels at which health effects have been reported. In fact, the estimated indoor air concentrations are more than 200 to 1,000 times lower than levels shown to elicit adverse health (ATSDR 1996, 1997a; EPA 2003b).

IV. Community Health Concerns

Throughout the PHA process, ATSDR gathers information about community health concerns. At the NWIRP Bedford site, ATSDR inquired about concerns through meetings with state, local, and Navy officials and review of site documents, including the Community Relations Plan (CRP). The CRP provides guidance for involving the community and other interested parties in the remedial decision-making process and for distributing information to these parties (Halliburton NUS 1992). While preparing the CRP, the Navy interviewed community members who are or potentially are affected by contamination at NWIRP Bedford. As part of its community relations activities, the Navy formed a restoration advisory board (RAB). The RAB, which is represented largely by local community members, meets to periodically review site documents and comment on actions and proposed actions taken by NWIRP Bedford.

No specific health concerns have been brought to ATSDR's attention, although general concerns about potential health hazards associated with the site and off-site migration of contaminants are identified in the CRP. ATSDR addresses these concerns in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section of this PHA.

V. Child Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain exposures to hazardous substances emitted from waste sites and emergency events involving hazardous chemicals. In general, children are more likely to be exposed because they play outdoors, have more hand-to-mouth behavior, and often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors that are close to the ground. Children are also smaller, so they receive higher doses of chemical exposure proportional to their body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

ATSDR has attempted to identify populations of children in the vicinity of NWIRP Bedford and any public health hazards associated with NWIRP Bedford that have or could threaten these children. According to U.S. census data, about 395 children aged 6 and under live within 1 mile of the site. ATSDR determined, however, that no harmful exposures to children living in the area have occurred in the past, nor are they expected to occur now or in the future. Although contaminants have been detected at NWIRP Bedford site, children cannot access the site or locations of contamination at NWIRP Bedford and no harmful exposures associated with the site are specific to children in the vicinity of the site. Children could visit Elm Brook, adjacent to and downgradient of the NWIRP Bedford site. Contaminants that have entered the surface water and sediment of the brook are low and below levels that could cause harmful health effects for these children. (Exposure pathways are discussed in the “Evaluation of Contamination and Exposure Pathways” section of this public health assessment.)

VI. Conclusions

Conclusions regarding potential past, current, and future exposure situations on and in the communities near NWIRP Bedford are based on an evaluation of site investigation data and observations made during site visits. Conclusions about exposures are described below. (The public health hazard conclusion categories are described in the glossary.)

- **Contaminated groundwater and private well use.** Contaminants have leached into the groundwater beneath NWIRP Bedford. Some contaminants have migrated with groundwater flow north of the site. There are thirteen residences within half a mile east/northeast of NWIRP Bedford which have private wells. These wells are permitted for irrigation and the residences are connected to Bedford's municipal water supply. Because contaminant levels are being reduced and nearby households are connected to the municipal water supply, we do not anticipate future public health hazards. ATSDR recommends that residents continue to use municipal water for household uses due to multiple sources of area groundwater contamination. ATSDR concludes that there is *no past, current, or future apparent public health hazard* associated with groundwater contamination from NWIRP Bedford and local private well use.

- **Contaminants in drinking water from the Hartwell Road well field in 1983 through 1984.** VOCs and iron were detected in the Hartwell Road well field, which supplied the town of Bedford with drinking water between 1983 and 1984. The amount of contaminants detected in the wells would not be expected to cause illness or health effects for people who drank water from the wells in the past. This past exposure, occurring during the short time period of well operation, posed *no apparent public health hazard.* Information indicates that other, non–NWIRP Bedford sources may be partially or primarily responsible for the contamination. The town of Bedford has supplied the residents with an alternate water supply since 1984. Because no exposures are currently occurring or are likely to occur in the future, there is *no apparent public health hazard.*

- **Contaminants in Elm Brook near NWIRP Bedford**. NWIRP Bedford contaminants have reached Elm Brook, a small, shallow stream that runs within 300 to 600 feet of the site's northern boundary. Elm Brook is not used for drinking water or widely used for recreation. Incidental exposures (via dermal contact) during occasional visits to the brook are the only types of exposures that likely occur. Given this, it is not expected that people would come in contact with contaminants in Elm Brook surface water and sediment often enough or at high enough levels for a health concern to exist. The already relatively low contaminant concentrations are expected to further decrease before the water reaches the downstream Shawsheen River. Thus, past, current, and future exposures pose *no apparent public health hazard.*

- **Possible vapors from on-site groundwater plumes.** Some buildings at NWIRP Bedford sit above groundwater contamination released from former site activities. Conservative indoor modeling showed that VOC contaminants could be present in the air inside of certain buildings, but at levels below those associated with known adverse health effects. Therefore, ATSDR believes that people who worked in or visited buildings above on-site groundwater contamination did not encounter harmful levels of indoor air contaminants. Given these findings, ATSDR concludes that there is *no apparent past public health hazard* associated with vapor intrusion. Since the buildings are now closed, no public health hazard is occurring.

VII. Recommendations

Its assessment of environmental data and potential exposure scenarios leads ATSDR to make the following recommendations:

1. If new information becomes available suggesting exposure at levels of health concern from contamination at NWIRP Bedford, ATSDR will evaluate the data and make appropriate public health recommendations.

2. ATSDR recommends water quality testing and treating the affected groundwater to safe levels required by EPA and MADEP before restoring the Hartwell Well Field to public use. *Note that ATSDR has verified with the Bedford Department of Public Works that the Town of Bedford currently plans to continue its use of water from the Massachusetts Water Resources Authority. However, the town of Bedford, under agreement with the Massachusetts Water Resources Authority, plans to continue considering this aquifer for future use as a public water supply. ATSDR was assured that, before the wells are put back into production, a complete chemical analysis of the water will be conducted to ensure that the water, treated if necessary, will meet all Safe Drinking Water requirements set by EPA and will be safe for human consumption.*

3. Due to multiple sources of groundwater contamination in the area, ATSDR recommends, as a prudent public health action, that private wells not be used for drinking water or other household uses and residents continue to use municipal water.

VIII. Public Health Action Plan

The public health action plan (PHAP) for NWIRP Bedford describes actions taken and to be taken by the Navy, ATSDR, EPA, MADEP, and the town of Bedford at and in the vicinity of the site once this PHA is completed. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing 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, ongoing/planned, or recommended are as follows.

Completed Actions

1. The town of Bedford closed wells at the Hartwell Road well field, located less than ½ mile northwest of NWIRP Bedford, in 1984 after elevated levels of VOCs and dissolved iron were detected in three of the water supply wells following a few months of operation.

2. A town of Bedford investigation determined that NWIRP Bedford and Hanscom Air Force Base were potential contributors to the groundwater contamination in the area.

3. Partly in response to the contamination in the municipal wells, the Navy began an investigation of the site in 1986 to identify possible contaminant sources. That investigation—and subsequent Navy investigations—did confirm the presence of contamination at NWIRP Bedford. Through the various investigations, the Navy identified and investigated four IRP sites. The Navy also investigated the SFTA under Site 3's RI activities. To date, the Navy has collected no data that confirm that NWIRP Bedford contributed to the Hartwell Road well water contamination.

4. EPA placed NWIRP Bedford on the NPL on February 2, 2000.

5. The town of Bedford has designated the aquifer beneath NWIRP Bedford an aquifer protection district. This is the most protective classification; the aquifer earns this designation because of its high use values as a potential drinking water source area.

6. The Navy has undertaken measures to reduce the sources of contamination at NWIRP Bedford. These measures include implementation of an immediate response action (formerly known as a short term measure investigation) that used a groundwater extraction and treatment system at Site 3 to remove chlorinated volatile organic

contaminants and metals. Additional measures include removal of a 7,600-gallon UST and 75 to 100 cubic yards of contaminated soil at Site 4 as well as removal of a fuel oil tank at Site 2.

7. The Navy has recommended Site 1 and Site 2 for no further action because they pose no risk to human health or they have been remediated to cleanup standards. No further action RODs were signed for these sites in September 2000.

8. ATSDR visited NWIRP Bedford in July 2003 to tour the site, meet with site representatives, and gather environmental and exposure information to complete this public health assessment.

Ongoing and Planned Actions

1. The Navy continues to construct a thermal treatment system as part of a pilot study at Site 3. This study's goal is to reduce the total chlorinated VOCs in the groundwater by 95% to 99% within the pilot test area on site. The Navy will monitor the groundwater during the treatment phase, and then again (possibly at 90 days and 150 days) after treatment.

2. The Navy plans to use the thermal treatment process to accelerate cleanup at Site 4 to reduce benzene concentrations in groundwater to 50 ppb in the area of highest contamination.

3. The Navy has agreed to conduct semi-annual groundwater monitoring of the SFTA.

4. The USAF operates a groundwater extraction system on Hanscom Field, near the SFTA. The system controls the migration of contaminated groundwater in the SFTA. (The suspected source of contamination is located on Hansom Field and is probably associated with HAFB activities, not the NWIRP Bedford site. Because the NWIRP site is not the suspect source of SFTA contamination and the USAF system is controlling the contaminant migration, the SFTA is not listed as an area of concern in the FFA. It is still included in the site's management plan.)

5. The Navy will pursue an agreement with the USAF to ensure the ongoing operation of the groundwater treatment system at Hanscom Field until groundwater contamination at the SFTA is fully addressed.

6. The Navy will continue to operate, maintain, monitor, and if necessary modify, the remedies for Sites 3 and 4 in accordance with the RODs and all other relevant US EPA, MA DEP and Navy decision documents.

7. Institutional controls should be implemented preventing private or public use of groundwater beneath NWIRP until site remediation is complete and the regulatory agencies have deemed the water safe for drinking.

IX. Preparers of Report

Laura Frazier
Environmental Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Gary Campbell, Ph.D.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

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