



Public Health Assessment for

**NAVAL AIR ENGINEERING CENTER, LAKEHURST
(a/k/a NAVAL AIR ENGINEERING STATION, LAKEHURST)
LAKEHURST, OCEAN COUNTY, NEW JERSEY
EPA FACILITY ID: NJ7170023744
JULY 7, 2003**

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

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Naval Air Engineering Center, Lakehurst
(a/k/a Naval Air Engineering Station, Lakehurst)

Final Release

PUBLIC HEALTH ASSESSMENT

NAVAL AIR ENGINEERING CENTER, LAKEHURST
(a/k/a NAVAL AIR ENGINEERING STATION, LAKEHURST)

LAKEHURST, OCEAN COUNTY, NEW JERSEY

EPA FACILITY ID: NJ7170023744

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 clean up of the sites.

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

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

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

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

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

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, fullscale 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 (E60), Atlanta, GA 30333.

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List of Acronyms

AIRS	Aerometric Information Retrieval System
ATSDR	Agency for Toxic Substances and Disease Registry
BOMARC	Boeing Michigan Aeronautical Research Center
CEA	Classification Exception Area
CREG	cancer risk evaluation guide
CWM	chemical warfare materiel
DOD	US Department of Defense
EMEG	environmental media evaluation guide
EPA	US Environmental Protection Agency
°F	degrees Fahrenheit
IAS	Initial Assessment Study
IRP	Installation Restoration Program
LTA	Lighter Than Air
MCL	Maximum Contaminant Level
MRL	minimal risk level
MUA	Municipal Utilities Authority
NAAQS	National Ambient Air Quality Standard
NEHC	Navy Environmental Health Center
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
OCHD	Ocean County Health Department
NPL	National Priorities List
PCB	polychlorinated biphenyl
pCi/L	picocurie per liter
PHA	public health assessment
PM10	particulate matter having aerodynamic diameters less than or equal to 10 microns
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RMEG	reference dose media evaluation guide
TRI	Toxic Release Inventory
UXO	unexploded ordnance
US	United States
USGS	United States Geological Survey
VOC	volatile organic compound

For reference, Appendix A defines several technical terms used in this public health assessment.

Summary

Naval Air Engineering Station (NAES) Lakehurst is a 7,400-acre U.S. Navy (Navy) base located in central New Jersey's Jackson and Manchester Townships, adjacent to the Borough of Lakehurst. The base conducts research, development, and engineering activities to support the interface between aircraft and marine vessels. NAES Lakehurst's routine operations generate various wastes which are either managed on base, transferred to off-base waste facilities, or discharged according to the terms of the facility's operating permits. Some past waste disposal practices, some accidental spills, and other activities on the base released contamination directly into the environment. NAES Lakehurst has made extensive efforts to clean up or otherwise address the resulting contamination.

This public health assessment (PHA) evaluates exposure pathways and community concerns related to NAES Lakehurst's past, current, and future releases. The evaluations are intended to determine whether these releases have caused base residents, community members, or both to be exposed to unhealthy levels of environmental contamination. To prepare this PHA, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed data from many sources. The agency also consulted with representatives from the local community, the U.S. Environmental Protection Agency (USEPA), the U.S. Geological Survey (USGS), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Health and Senior Services (NJDHSS), the Ocean County Health Department (OCHD), NAES Lakehurst, and other parties.

This assessment also discusses four health concerns communicated to ATSDR by community members, base personnel, and public officials in relation to NAES Lakehurst:

1) Drinking or contacting contaminated groundwater, either on or off base

Past operations at NAES Lakehurst have contaminated the groundwater at several locations on and near base property. This contamination has been extensively studied and is closely monitored. In the past and at this time, no one is exposed to the groundwater contamination at NAES Lakehurst—the local private and public water supplies do not pump drinking water from the contaminated areas. Also, several measures are in place to ensure that the groundwater contamination does not become a hazard in the future, including perimeter wells that would detect that contamination *before* it enters drinking water supplies. Therefore, the groundwater contamination at NAES Lakehurst did not pose a public health hazard in the past, does not currently pose a public health hazard, and is not likely to in the future.

2) Contacting unexploded ordnance (UXO) or chemical warfare materiel (CWM) while hunting, hiking, or playing on base

An unknown amount of unexploded ordnance (UXO) and chemical warfare materiel (CWM) remain on NAES Lakehurst property from past munitions testing operations and military training exercises. (The term materiel is defined as the equipment, apparatus, and supplies of a military force or other organization.) Most UXO/CWM are believed to be located in the more remote, western part of NAES Lakehurst, far from base housing. However, these areas are accessible by hunters and others, including children living on base. NAES has taken measures to prevent contact with UXO/CWM, including posting warning signs in areas believed to have the greatest amount of UXO/CWM, requiring hunters to take an annual training course about the dangers of UXO/CWM, and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose. An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions and emergency response teams are on hand to respond to chemical releases, explosions, or fires. In addition, NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release of chemicals either on base or in the community. This includes coordination with local, state, and federal agencies dealing with emergency response.

ATSDR believes that there is insufficient data to evaluate potential levels of exposure in and around the proving ground and test facilities during 1918-1921. However, there is no indication that past releases or exposures have occurred since chemical warfare testing ended in 1921. For example, there have been no reported or unexplained deaths or injuries to a wide variety of fish and wildlife, nor unexplained vegetation stress or obvious changes in the numbers and types of insects.

ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared for safe and unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

3) Eating deer possibly containing radiologic contamination from BOMARC

Some base personnel and base residents have expressed concern that radioactive materials might be present in deer hunted on NAES Lakehurst property. The concern is based on an explosion and fire that occurred on June 7, 1960 at the nearby BOMARC (Boeing Michigan Aeronautical Research Center) guided missile site. This accidental explosion and missile meltdown released

trace levels of radiological materials into the environment. ATSDR reviewed information on the trace levels of radioactive chemicals that remain on and near the BOMARC site and the extent to which these contaminants are expected to accumulate in plants and animals, including deer on NAES Lakehurst property. Because deer retain a very small fraction of radioactive materials that they might eat, and amounts that are retained occur primarily in body parts that people do not eat, ATSDR does not consider that deer meat harvested from NAES Lakehurst poses a public health hazard in the past, currently, or in the future.

4) Air pollution

In response to community concerns regarding air quality, ATSDR obtained data on the amount of chemicals NAES Lakehurst releases to the air. ATSDR used an air modeling analysis to evaluate this concern. The results of the model suggest that emissions from NAES Lakehurst both in the past and currently do not cause off-base air pollution to reach unhealthy levels and are therefore a no apparent public health hazard.

However, general air quality in Ocean County is sometimes poor, given the high levels of ozone that occur during the summer months. The ozone problem is regional in nature and is from industrial and motor vehicle emissions over a broad geographic area. Some people exposed to elevated ozone levels could experience health effects such as lung irritation and difficulty breathing. On days when ozone levels are expected to be high, NJDEP issues warnings that explain how people can reduce their exposure and avoid these and other ozone-related health effects. ATSDR agrees with NAES Lakehurst's recommendation that the base day care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels. It is especially important for adults to convey these warnings to their children, particularly children with asthma.

I. Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is required by law to conduct public health assessments (PHAs) for all sites on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List (NPL). USEPA placed Naval Air Engineering Station (NAES) Lakehurst on the NPL in 1987. This led to the Navy conducting extensive remediation activities to reduce levels of environmental contamination on base property. This PHA evaluates whether the contamination levels at NAES Lakehurst were health hazards to base personnel, base residents, and local community members in the past, currently, or in the future.

After reviewing numerous base documents, discussing health concerns with community members, and meeting with base personnel, ATSDR identified four key concerns regarding how people might be exposed to contamination at NAES Lakehurst. These concerns are 1) groundwater contamination, 2) the presence of unexploded ordnance (UXO) and chemical warfare materiel (CWM) on base property, 3) potential radiological contamination in deer meat, and 4) air contamination. This PHA focuses on these four health concerns and also evaluates other environmental contamination in soils, surface water, sediments, and fish (see Appendix C).

Table 1 describes the exposure situations for NAES Lakehurst, ATSDR's health conclusion category for those situations, and the actions taken to limit exposure from them. ATSDR assigns conclusion categories to sites based on their level of public health hazard. Also, ATSDR has further clarified the "No Apparent Public Health Hazard" conclusion category by stating whether it is a past, current, or a future hazard. ATSDR's conclusion categories are explained in the Glossary (Appendix A).

Although ATSDR completed this PHA specifically to assess how contamination released from NAES Lakehurst might affect public health, the agency is aware that local community members have concerns about several sites throughout Ocean County and in neighboring counties. ATSDR and the New Jersey Department of Health and Senior Services (NJDHSS) have already completed PHAs for many of these other sites. Community members who would like to learn more about the public health implications of other sites near NAES Lakehurst should refer to the text box below.

What are some of the other sites and issues that ATSDR and NJDHSS have evaluated for areas near NAES Lakehurst?

Autism among children in Brick Township
Boeing Michigan Aeronautical Research Center (BOMARC) site
Cancers among children in Dover Township
Ciba-Geigy Corporation in Dover Township
Dover Township Municipal Landfill in Dover Township
Fort Dix's landfill site in Wrightstown
Jackson Township Landfill in Jackson Township
McGuire Air Force Base in Wrightstown
Reich Farm in Dover Township

Where can one obtain more information on ATSDR and NJDHSS's evaluations?

Copies of the some of the agencies' reports should be available at the Toms River Branch of the Ocean County Library: 101 Washington Street, Toms River, NJ 08753, 732- 349-6200.

Several reports are posted on ATSDR's Web site (www.atsdr.cdc.gov) and the Web site for the NJDHSS Hazardous Site Health Evaluation Program (www.state.nj.us/health/eoh/hhazweb).

Residents can contact ATSDR representatives by dialing the agency's toll free number, 1-888-42ATSDR (or 1-888-422-8737), and NJDHSS's Hazardous Site Health Evaluation Program representatives by dialing 609-584-5367.

II. Background

ATSDR obtained background information on NAES Lakehurst to understand what contaminants might have been released to the environment, where these contaminants might be found today, and whether anyone might come into contact with them. ATSDR reviewed data from many sources, including local community members, USEPA, the U.S. Geological Survey (USGS), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Health and Senior Services (NJDHSS), the Ocean County Health Department (OCHD), NAES Lakehurst, and other parties. This section summarizes the relevant background information by presenting facts and observations about NAES Lakehurst and its surroundings. Later sections document how these facts and observations factored into ATSDR's public health evaluations for this base.

A. Base Description and Operational History

NAES Lakehurst is located in central New Jersey, approximately 60 miles south of New York City, 50 miles east of Philadelphia, and 15 miles inland from the Atlantic Ocean (Figure 1). The base spans roughly 7,400 acres in Jackson and Manchester Townships of Ocean County. The base also falls entirely within the New Jersey Pinelands—a National Reserve covering more than 1 million acres.

Private industry, the U.S. Army, and the Navy have all operated on the lands that currently are NAES Lakehurst property. The following time line highlights notable past operations:

- *1915–1917: Eddystone Munitions Company.*¹ In 1915, Eddystone Munitions Company acquired lands in central New Jersey for establishing a proving ground where munitions were tested for the Russian military. Most operations occurred on what is now the western half of NAES Lakehurst property. Though limited information is available on the specific munitions that were tested, base historians believe most testing involved 3-inch shrapnel shells (Navy Environmental Support Office 1982).
- *1917–1921: US Army.* In 1917, the US Army acquired the lands previously owned by Eddystone Munitions Company, and the installation became known as Camp Kendrick. From 1918 through 1921, the U.S. Army Chemical Warfare Service operated an experimental proving ground for testing chemical warfare materiel (CWM), though testing of shrapnel shells and high explosive shells also occurred. The term materiel is

¹ The base documents use many different names when referring to the company that operated at NAES Lakehurst from 1915 to 1917. These names include Eddystone Munitions Company (the name ATSDR uses in this PHA), Eddystone Chemical Company, Eddystone Ammunition Company, and Eddystone Ammunition Corporation.

defined as the equipment, apparatus, and supplies of a military force or other organization. The total amount of chemical shells tested is not known, but the available range utilization statistics indicate that 1,841 shells were tested in 1920 alone (Navy Environmental Support Office 1982). The U.S. Army's testing also occurred at locations that are now part of the western half of NAES Lakehurst property (Navy Environmental Support Office 1982).

- *1921–Present: Navy.* In 1921, Camp Kendrick was turned over to the Navy, which purchased additional parcels of land over the following decades. The base was referred to by many different names between 1921 and today. Some of these names include Naval Air Station Lakehurst, Naval Air Engineering Center, Naval Air Warfare Center, and Naval Air Systems Command. This PHA refers to the base by its current name, NAES Lakehurst.

Since 1921 many different military support operations have taken place at NAES Lakehurst. From 1921 to 1961, NAES Lakehurst primarily supported the Navy's Lighter-Than-Air (LTA) program, by conducting research and development activities for dirigibles and blimps. After the LTA program ended in 1961, research and development activities at NAES Lakehurst shifted to supporting the Aircraft Platform Interface, or the interface between aircraft and marine vessels. Specific research activities include developing and testing catapults and arresting gear for aircraft carriers, designing visual landing aids and flight deck lighting systems, and manufacturing prototype equipment for production at other installations. When conducting these and other research and development activities, NAES Lakehurst has used many different chemicals and formulations, including fuels, lubricating oils, hydraulic fluids, solvents, and metals (Dames and Moore 1992).

Though NAES Lakehurst's research and development activities primarily supported aircraft, between 1921 and the late 1940s the Navy and its contractors also used base property as a proving ground and a bombing range. The proving ground operations took place between 1940 and 1941, when a private company tested tank guns and anti-aircraft weapons on the western part of base property. The sizes of projectiles fired on the proving ground typically ranged from 20 millimeters to 5 inches (Navy Environmental Support Office 1982).

Further, two bombing ranges periodically operated at NAES Lakehurst. One was located near the southern border of the facility, where airplanes dropped "practice bombs" on targets shaped like submarines. Practice bombs are bombs in which the main explosive contents are replaced with inert materials, such as sand or concrete. For spotting purposes, some practice bombs include small amounts of explosives. The second bombing range was located in what is currently the parachute jump circle (see Figure 2).

Here, aircraft dropped both practice and “live” bombs (i.e., high explosive bombs) during military training exercises. The Navy has attempted to recover all unexploded live bombs from this area.

- *Current uses and access: Navy.* NAES Lakehurst currently supports the Naval Air Systems Command. About 80% of the base lands are still undeveloped and unimproved. The developed and improved lands include more than 300 buildings, two aircraft runways, five tracks for testing jet propulsion with catapults, base housing, a day care center, and a golf course. Access to the base is limited to base personnel (both military and civilian), military retirees and personnel from other installations, and base residents (Michael Figura, NAES, personal communication, 2002). Visitors may access NAES Lakehurst property, but they must have an escort. On some occasions NAES Lakehurst invites large numbers of community members on base for special events (e.g., air shows), but the visitors in such cases are given access to only certain parts of the base.

B. Remedial and Regulatory History

Over the last 20 years, as part of the US Department of Defense’s (DOD) Installation Restoration Program (IRP), the Navy has conducted several environmental investigations at NAES Lakehurst. IRP was designed to identify, evaluate, and clean up contamination resulting from past operations.

In 1985 EPA proposed adding NAES Lakehurst to the National Priorities List (NPL), and the base was officially listed in 1987. From 1985 to 1987 NAES Lakehurst conducted a Phase I Remedial Investigation (RI). During this initial phase, base personnel measured levels of contamination at or near 42 areas identified in an Initial Assessment Study (IAS). NAES Lakehurst used the results of these and other investigations to make decisions on how to clean up contamination in the groundwater, soil, and sediments. These decisions include excavating areas with contaminated soils and sediments, removing or abandoning underground storage tanks, and pumping and treating contaminated groundwater.

NAES Lakehurst’s environmental investigations generated much of the sampling data that ATSDR reviewed before preparing this PHA. For detailed information on the Navy’s continuing environmental investigation and remediation plans at NAES Lakehurst, refer to documents located at the public repository: Ocean County Library, Toms River Branch, 101 Washington St., Toms River, NJ.

C. Land Use and Natural Resource Use

People use land and natural resources in many ways. ATSDR examines land and natural resource uses to determine what activities might put people at risk for exposure. This information is

important; controlling the types and frequencies of activities in those areas affects exposure to contamination. ATSDR uses the information as part of its evaluation of contamination and exposure.

Land Use

The general land use in the immediate vicinity of NAES Lakehurst is shown in Figure 2. Most of the adjacent lands are undeveloped. Colliers Mills Wildlife Management Area and wetlands are located along Ridgeway Branch, and border NAES Lakehurst to the north. The land immediately east of NAES Lakehurst is largely undeveloped, but several residential developments are less than 1 mile east of the NAES Lakehurst property. Neighboring property to the south of NAES Lakehurst includes the Manchester Wildlife Management Area, private land holders, and the Borough of Lakehurst. The Fort Dix Military Reservation borders NAES Lakehurst to the west.

Natural Resource Use

The natural resources used in this area include groundwater and biota. Two of the four main health concerns pertain to chemical or radiological contamination in groundwater and deer. For information on how contaminants might migrate in these media, ATSDR obtained background information on the local hydrogeology, terrestrial wildlife, and meteorology.

- *Hydrogeology.* Groundwater near NAES Lakehurst is found in two major aquifer systems: the shallower Kirkwood-Cohansey aquifer, and the deeper Potomac-Raritan-Magothy aquifer. Public and private water supplies throughout Ocean County pump drinking water from both aquifers. The thickness of the Kirkwood-Cohansey aquifer varies with location in Ocean County (Navy Environmental Support Office 1982). At NAES Lakehurst, the aquifer extends from near the surface (depths as low as 3 feet) to more than 100 feet. Although groundwater in this aquifer system generally flows from west to east, flow characteristics are known to vary with location and depth. At NAES Lakehurst, for example, the shallow groundwater typically flows toward streams and wetlands. Specifically, shallow groundwater in the northeastern part of the base flows north-northeast toward the Ridgeway Branch (NAES 2002a), while shallow groundwater in the southern part of the base flows southeast toward the Ruckles Branch (NAES 1999).

In the vicinity of NAES Lakehurst, the deeper Potomac-Raritan-Magothy aquifer extends from approximately 1,000 feet below ground surface down to bedrock—which occurs at depths of roughly 1,800 feet. Multiple confining units separate the deeper from the shallower aquifer (Navy Environmental Support Office 1982). Because these multiple confining units are less permeable than the shallower and deeper aquifers, groundwater in the area likely flows largely within the aquifers, rather than between them (Dames and Moore 1992).

- *Terrestrial wildlife (deer).* White-tailed deer live throughout the New Jersey Pinelands, including at NAES Lakehurst. Base surveys estimate that roughly 300 deer can be found on base property at any time (NAES 1997), with most observed in the western, more remote areas of the base. Deer have relatively broad home ranges, except during severe winters with deep snow when their movements are more limited. Because the western portions of the base are not fenced, deer in this area move freely between NAES Lakehurst, the Fort Dix Military Reservation, the Colliers Mills Wildlife Management Area, and other neighboring properties. Deer are not expected to forage on the BOMARC site; that site is completely fenced and much of its grounds are paved.

Deer hunting is permitted on NAES Lakehurst, but only base residents, base personnel, and selected other individuals (e.g., military retirees) can apply for hunting permits. Between 1991 and 1997 hunters harvested an average of 66 deer per year on base property; an additional 15 deer are killed per year from other causes, such as motor vehicle accidents (NAES 1997).

- *Climate and Meteorology.* Weather conditions and prevailing wind patterns at NAES Lakehurst vary considerably from season to season. For example, according to 30 years of weather observations made at Atlantic City, the monthly average temperature in the area ranges from 33 degrees Fahrenheit (°F) in January to 74 °F in July. The area receives roughly 40 inches of precipitation a year, primarily in the form of rain. Snowfall is most common in January and February, but the average snowfall amounts for these months is only 5 inches.

Several base documents indicate that wind patterns near NAES Lakehurst are variable and shift across the seasons (Dames and Moore 1992, Navy Environmental Support Office 1982, NAES 1997). The prevailing wind direction during the winter and early spring is from the northwest (Dames and Moore 1992), while winds tend to blow out of the southwest most commonly in the summer (NAES 1997). However, the base's close proximity to the Atlantic Ocean results in wind directions that change over the course of the day, from sea breezes during the afternoon to land breezes at night. The land and sea breeze effect is most pronounced on calm summer days. Though the wind direction varies considerably with time of year, the average wind speed is more constant; the annual average wind speed in the area is roughly 10 miles per hour, with modest changes from month to month.

ATSDR also obtained data on surface water runoff, aquatic wildlife, and geology. This data is not presented here, but was considered when evaluating levels of contamination in surface water, sediments, soils, and biota (other than deer). Appendix C summarizes ATSDR's evaluations for those media.

D. Demographics

ATSDR examines demographic data (i.e., population information) to determine the number of people potentially exposed to environmental chemicals and to determine the presence of sensitive populations, such as children (age 6 and younger), women of childbearing age (age 15–44), and the elderly (age 65 and older). Demographic data also provide details on population mobility which, in turn, helps ATSDR evaluate how long residents might have been exposed to environmental chemicals.

Figure 3 summarizes demographic data for the NAES Lakehurst vicinity, based on data compiled from the 2000 U.S. Census. According to the figure, 6,545 persons live within 1 mile of the base property line, and all are within the limits of Manchester Township, Jackson Township, or the Borough of Lakehurst.

Figure 3 also specifies the number of residents who fall into three potentially sensitive populations for environmental exposures: children, women of childbearing age, and the elderly. The proportion of people who are age 65 and older in the Lakehurst vicinity (38%) is considerably higher than that which is observed in the state of New Jersey (13%) and across the country (12%). In other words, a relatively greater number of senior citizens live in the vicinity of NAES Lakehurst than in most parts of New Jersey and the country.

Some of the environmental health issues ATSDR evaluated (e.g., the presence of UXO/CWM) may only affect those who access or work at specific locations on the base. As a result, ATSDR obtained data on the number of individuals with routine access to base property. Currently, the base employs 2,700 persons, including military, contractor, and civilian employees. Additionally, 91 persons (including 38 children) reside in on-base housing full time.² This housing, along with a day care facility, is located in the easternmost portion of base property.

E. ATSDR's Involvement

In 1991 ATSDR visited all military facilities on the NPL and ranked them in order of possible health or exposure significance. On August 12 and August 15, 1991, ATSDR conducted an initial base visit to NAES Lakehurst for a site survey. ATSDR toured the base, briefed the base commander, and met with various base activities and Ocean County Health officials to obtain health outcome and community concern information. Because ATSDR found few environmental exposure situations at NAES Lakehurst, the base was ranked as a very low priority.

² These residence figures are based on the number of people who live within the property line shown in Figures 1 and 2. NAES Lakehurst also owns and operates a housing unit, Pinehurst Estates, that is located within the Borough of Lakehurst, where 251 people live (including 91 children).

In December 2001 the Navy asked ATSDR to expedite and complete a public health assessment for NAES Lakehurst in preparation for its proposal to be removed from the NPL. From January 29 to February 1, 2002, ATSDR conducted a site visit of NAES Lakehurst. Included in this visit were meetings with base personnel from various departments, including environmental, housing, medical, health and safety, natural resources, hazardous waste management, pesticide management, and water supply. ATSDR also met with the superintendent of the Lakehurst Public Works Department and the community co-chair of the NAES Lakehurst Restoration Advisory Board (RAB). In addition, ATSDR reviewed documents at the base and at the Ocean County Library's records repository. ATSDR continues to work with base personnel and consults with public health and regulatory agencies on specific issues.

F. Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated environmental data provided in various reports prepared by NAES Lakehurst and other parties. Documents prepared for the Navy's IRP sites have Navy, NJDEP, and EPA oversight to verify that the data meets specific quality assurance and quality control measures for chain-of-custody procedures, laboratory procedures, and data reporting. These reports note any limitations to the sampling data. ATSDR evaluation of the data included looking for inconsistencies and data gaps. The validity of analyses and conclusions drawn in this PHA are based on the reliability of the information referenced in reports related to NAES Lakehurst. ATSDR believes that the quality of environmental data available in documents relating to NAES Lakehurst is sufficient for public health decisions.

III. Evaluation of Environmental Contamination, Exposure Pathways, and Public Health Implications

ATSDR reviewed the environmental data from the Navy's reports—as well as information from other sources—and used this information to determine any associated public health hazards. Four issues that people are concerned about were identified. When addressing these issues ATSDR evaluated the levels of contamination present, the extent to which individuals come into contact with the contamination, and whether this contact would result in a past, current, or future public health hazard. The four issues are discussed in the following section and summarized in Table 1. In addition, ATSDR evaluated the public health implications of environmental contamination in other media, including surface water, sediment, soil, and biota other than deer (see Appendix C).

A. Drinking or contacting contaminated groundwater on and off base

Past operations at NAES Lakehurst have contaminated the groundwater at several locations on base property. The main contaminants are chemicals found in chlorinated solvents and petroleum hydrocarbons. The groundwater contamination lies primarily within the base boundary, except in one area where it extends up to 1 mile south of the property line. NAES Lakehurst has taken steps to address this contamination, including collecting several thousand groundwater samples, delineating areas where contamination exists, and removing contamination from some plumes.

There is no indication that base residents or community members were exposed in the past or are currently being exposed to the contaminants in the groundwater plumes at NAES Lakehurst—none of the local water supplies or private wells supply drinking water from the areas with contaminated groundwater. As evidence of this, sampling data indicate that water from the base water supply, the Borough of Lakehurst Water Department, and selected nearby private wells is safe to drink.

Further, ATSDR notes that several measures are in place to ensure that groundwater contamination at NAES Lakehurst will not affect water supplies in the future. These measures include ongoing monitoring of the groundwater in several areas, establishing institutional controls (Classification Exception Areas) that restrict groundwater uses in the most contaminated areas, and routine testing of the public water supplies. Based on these observations, ATSDR concludes that groundwater contamination at NAES Lakehurst does not pose a health hazard now and likely will not pose a health hazard in the future.

Several past activities at NAES Lakehurst released contaminants to soils. Examples include leaking underground storage tanks and pipelines, fire fighting training pits where fuels were ignited, and direct release of contaminants onto the ground surface. The contaminants that were

most commonly released to the soils included jet fuels, hydraulic fluids, lubricants, and chlorinated solvents. Once released to the soils, a portion of these contaminants dissolve into the rain water and snow melt that seeps through the ground and eventually flows into groundwater resources.

People can come into contact with contaminants in groundwater different ways, but the most common route of exposure is through drinking from wells that draw from contaminated water. To evaluate this exposure pathway, ATSDR considered three separate issues: the current nature and extent of contamination, locations where groundwater wells provide drinking water to public utilities and private residences, and measures in place to prevent exposures to groundwater contamination. Each of these issues is discussed below:

What is the nature and extent of groundwater contamination at NAES Lakehurst?

NAES Lakehurst's Initial Assessment Survey identified 12 areas of potential groundwater contamination on base property. These areas are referred to by letters "A" to "L." Table 3 describes key features of these areas, such as the sources and levels of contamination and the history of how regulatory agencies and NAES Lakehurst have addressed remedial options for contaminated groundwater. Site documents suggest that groundwater contamination could have begun in the late 1950s. Contaminants continued to enter groundwater periodically until the early 1980s, when NAES Lakehurst implemented an environmental program to address groundwater contamination and other issues at the base.

NAES Lakehurst has studied the nature and extent of groundwater contamination. Currently, the base has approximately 420 groundwater wells (approximately 370 monitoring wells, 26 recovery wells, and 24 supply wells). Over the last 20 years several thousand groundwater samples have been collected from these wells. Two groundwater contamination areas—Areas A/B and I/J—have received extensive attention due to the contamination and their proximity to the base boundary. Figures 4 and 5 summarize recent data compiled by NAES Lakehurst for these areas, as do the following paragraphs:

- **Area A/B.** As Figures 2 and 4 show, Area A/B is located in the northeastern corner of NAES Lakehurst. Though several groundwater wells in this area continue to record concentrations of total volatile organic compounds (VOCs) greater than 10 parts per billion at depths up to 30 feet below the groundwater table, NAES Lakehurst has implemented aggressive treatment strategies to keep these elevated contamination levels from moving across the base boundary. For instance, NAES Lakehurst has removed soil contamination and underground storage tanks from several IRP sites within Area A/B and since 1993 has been pumping contaminated groundwater through a treatment plant. As much as 250 million gallons of groundwater are being treated per year from Area A/B (NAES 2001a, 2002a). Specifically, contaminated groundwater is pumped from the

ground through a process that removes VOCs, and the treated groundwater is pumped back into the aquifer. Monthly sampling data of the water being returned to the ground has shown that the treatment operation is highly effective at removing VOC contamination (NAES 2001a, 2002a).

- *Area I/J.* Figures 2 and 5 show the location of groundwater contamination in Area I/J, which contains the only groundwater contamination plume known to extend outside of the base property line. Groundwater in this area contains elevated levels of chlorinated solvents at depths up to 90 feet below the groundwater table. NAES Lakehurst has studied groundwater contamination in Area I/J for the last 20 years and investigated several treatment options. With concurrence from state and federal environmental regulators (NAES 1999), NAES Lakehurst is addressing the groundwater contamination in Area I/J with ongoing monitoring and natural restoration, along with the implementation of innovative treatment technologies.
- *All other groundwater contamination areas.* Table 3 summarizes current information for groundwater contamination in areas other than Areas A/B and I/J. More detailed information on these areas is not provided in this text because they have already been addressed to the satisfaction of environmental regulators (i.e., they have “no further action” selected as the site remedy) or they are located further from the base boundary than areas A/B and I/J.

In summary, although the chemicals and concentrations detected in the groundwater can vary from area to area, some key observations apply to all areas: NAES Lakehurst has thoroughly characterized levels of contamination, removed the sources of contamination in most areas, and implemented remedial actions (with concurrence from environmental regulators) to reduce levels of existing contamination.

Where do people who live at or near NAES Lakehurst get their drinking water?

In addition to evaluating the nature and extent of groundwater contamination, ATSDR also examined whether anyone who lives at or near the base is currently being exposed to the contaminants. This evaluation found that no drinking water wells draw from the groundwater contamination plumes emanating from NAES Lakehurst. Because no exposure is occurring, the contamination is not a public health hazard. For reference, the following paragraphs provide additional information on the base water supply, nearby public water supplies, and private well owners:

- *Base water supply.* NAES Lakehurst supplies drinking water to base residents and base personnel primarily from groundwater wells—but some buildings are supplied with bottled water because they are not connected to the base’s water supply. The water supply

draws from three groundwater well systems: the Helo System, the Test System, and the Hill System. Water from all three systems is treated before distribution. More information on these three water supply systems follows.

The Helo System consists of a single groundwater well that pumps water from a depth of 80 feet. This system provides drinking water to a few buildings in the western half of the base and does not serve the base residents. The well is located upgradient from the groundwater contamination plume at Area I/J (see Figure 8).

The Test System includes two deep wells that pump groundwater from depths greater than 1,500 feet below the ground surface. These wells provide drinking water to buildings near the Catapult Test Site in the western half of the base—they do not provide drinking water to base residents. Although the two wells are located near the groundwater contamination plume for Area I/J (see Figure 8), they pump from an aquifer far deeper than the depths at which the groundwater contamination is found.

Finally, the five Hill System groundwater wells supply drinking water to base residents and to most of the buildings on the eastern half of the base. These wells pump from depths between 50 and 120 feet below the ground surface. As Figure 8 shows, the five wells are located in the eastern half of the base, and two wells are adjacent to the Classification Exception Area (CEA) for Area A/B. Although the proximity of the two wells to the CEA might raise concerns about groundwater quality, ATSDR notes that the CEA shows the greatest potential area of contamination—not the area where contamination is currently found. Two other observations reassure ATSDR that the wells in the Hill System are not drawing contaminated groundwater: (1) the well depths are at least 50 feet below ground surface and the groundwater contamination is believed to occur at depths only up to 30 feet, and (2) groundwater modeling conducted in support of the base's 5-year and 12-year wellhead protection study found that the two water supply wells would draw water only from upgradient areas (NJDEP 1997).

In addition to these observations, which suggest that groundwater contamination is not affecting any of the base water supply systems, ATSDR reviewed the two most recent "Consumer Confidence Reports" to assess the quality of the base's drinking water (NAES 2001f, 2001g, 2001h, 2002f, 2002g, 2002h). These reports show that recent water samples collected from all three supply systems do not contain any contaminants at levels that would trigger corrective action by EPA's Safe Drinking Water Act. More simply, the best information available indicates that drinking water provided by the base is safe to drink.

- *Water supply utilities in neighboring communities.* Although groundwater contamination at NAES Lakehurst extends to off-base property only in Area I/J, ATSDR accessed

information on water supply utilities in the nearby communities to evaluate potential future exposures. ATSDR found the following:

- ▶ The Borough of Lakehurst Water Department provides drinking water to the entire Borough from a well nearly 1,000 feet deep, whereas the contaminated groundwater at and near NAES Lakehurst does not appear to occur deeper than 100 feet below the surface. In addition, the most recent water quality report for this system indicates that the “drinking water meets all federal and state safety requirements” (Borough of Lakehurst 2001).
- ▶ ATSDR contacted a representative from the Manchester Township Municipal Utilities Authority (MUA), who indicated that city residents either obtain their drinking water from private wells or from the city supply. According to NJDEP’s most recent drinking water quality summary report, the Manchester Township MUA did not have any Safe Drinking Water Act violations in calendar year 2000—an observation that suggests that the drinking water from this supply meets current health-based standards (NJDEP 2001a).

In short, ATSDR’s search found that the local public water supply utilities do not pump groundwater from the contamination plumes at NAES Lakehurst. Further, these utilities provide drinking water that meets state and federal water quality requirements. These utilities do not, however, supply drinking water to every resident in the area, as the next paragraphs explain.

- *Private wells.* ATSDR consulted with NJDEP’s Bureau of Water Allocation to estimate the number of residents in Jackson Township and Manchester Township who get drinking water from their own private groundwater wells. This bureau was consulted because it has copies of all groundwater-well construction permits, organized by location, that have been approved since the 1940s. Though extensive, the information available from NJDEP only allows for estimates of the actual number of private wells. Some wells previously constructed could now be out of service and the well locations are based on geographic data provided by the installation contractors, which are subject to error.³

According to the data compiled by NJDEP, 158 well-construction permits were issued for locations within 2 miles of a central point in the groundwater contamination plume of

³ As evidence of this data quality concern, a well construction permit for East Brunswick, New Jersey, was among the records that ATSDR was provided for being located within 1 mile of the NAES Lakehurst property boundary, even though East Brunswick is approximately 20 miles from the base. Because some of the data in NJDEP’s well construction database is inaccurate, this section should be viewed as providing approximate numbers of private wells near NAES Lakehurst property.

Area I/J. NAES Lakehurst obtained 65 of these permits for groundwater monitoring wells, while 26 of the permits were for construction of residential drinking water wells. It is not known how many of these residential wells are still being used to provide drinking water, but ATSDR notes that 18 of the well construction permits are more than 25 years old. The eight newly constructed wells (i.e., those installed within the last 15 years) all draw groundwater from at least 60 feet beneath the surface and their water should have been tested for contamination prior to operation.

ATSDR contacted a representative from the Jackson Township Water Department to inquire about drinking water sources for residents who live near the northeast corner of NAES Lakehurst (or near Area A/B). The representative noted that most residents in this part of Jackson Township obtain drinking water from private wells that the city does not test. However, the contamination from Area A/B remains largely on base and monitoring wells around the perimeter of the plume would detect significant off-base migration of contaminants.

ATSDR also searched NJDEP's permit records for all private wells constructed within 1 mile of the northeast corner of NAES Lakehurst property, or within 1 mile of the perimeter monitoring wells for Area A/B. Overall, 387 well construction permits were issued for this area, of which 263 were issued to NAES Lakehurst, primarily for groundwater monitoring and treatment activities. The permit records indicate that 65 of the wells were constructed to supply potable water to private well owners. The 23 wells that were constructed in the last 15 years all pump water from at least 60 feet beneath the surface. Also, before their initial installation they should all have been tested for groundwater quality.

Virtually all drinking water supplied in the vicinity of NAES Lakehurst comes from groundwater resources. However, ATSDR's review of the base water supply, municipal water supply utilities, and private wells indicates that none of the drinking water wells draw from areas with groundwater contamination from NAES Lakehurst. Because no one was or is exposed to contaminated groundwater from NAES Lakehurst, it not a public health hazard.

Are there any regional problems with groundwater?

When reviewing this issue, ATSDR found data indicating that groundwater supplies throughout central and southern New Jersey contain elevated levels of radium contamination. This is a regional issue which is closely monitored by drinking water providers. The text box below provides additional information on this contamination. The most recent sampling results indicate that the radiological contamination in drinking water provided by the base water supply and n nearby public water supplies is not a public health hazard.

Radium Contamination of Groundwater in Central and Southern New Jersey: A Regional Issue

Elevated levels of radium contamination have been detected in groundwater throughout central and southern New Jersey (e.g., USGS 1998). The radium appears to originate from the decay of other elements naturally found in the local geologic formations and is not the result of operations at NAES Lakehurst. The forms of radium detected release alpha and beta radiation during their natural decay process. Consequently, alpha radiation also has been found at elevated levels in groundwater in central and southern New Jersey. The radium and alpha radiation contamination occurs primarily in the shallow Kirkwood-Cohansey aquifer.

This groundwater contamination has been extensively studied. For instance, USGS reported that groundwater from 1/3 of the wells it sampled in southern New Jersey contained total radium at concentrations higher than EPA's Maximum Contaminant Level (MCL) of 5 picocuries per liter (pCi/L) (USGS 1998). Further, NJDEP reported in 1998 that during a then-recent round of sampling 29 drinking water supply systems in the state had elevated levels of radium contamination. The water supplies of concern included those operated by NAES Lakehurst, Toms River, Manchester Township, and Lakewood Township (NJDEP 1998). Follow-up testing at the base water supply, however, has shown that average concentrations of radium and alpha radiation in the drinking water are lower than EPA's MCLs.

Will groundwater contamination from NAES Lakehurst affect drinking water supplies in the future?

ATSDR also considered the likelihood that people could be exposed to the contamination from NAES Lakehurst in the future. Though ATSDR cannot predict future conditions with certainty, several measures are in place to ensure that the groundwater contamination currently at the base will not affect water supplies in the future. These measures include:

- *Ongoing groundwater monitoring and treatment.* NAES Lakehurst plans to continue to monitor the spatial extent of groundwater plumes, including at locations along the perimeter of the plumes, until relevant requirements are met or until USEPA designates that no further action is needed. Figures 4 and 5 show the locations of perimeter wells for Areas A/B and I/J, which are located furthest from the source of contamination; ongoing sampling of these wells will detect unexpected migration of groundwater plumes. Further, NAES Lakehurst will continue to pump and treat contaminated groundwater in Area A/B

and investigate use of other treatment technologies in Area I/J. These measures will help reduce existing levels of environmental contamination.

- *Required testing of public water supplies.* The Safe Drinking Water Act requires every public water supply system to test drinking water routinely for contamination. The water supply systems in the vicinity of NAES Lakehurst all test the drinking water for bacterial, chemical, and radiological contamination, and this testing will continue into the future. Compliance with the Safe Drinking Water Act will help ensure that authorities detect and promptly address environmental contamination that could enter drinking water supplies, thus reducing any exposures that might occur in the future.
- *Institutional controls at groundwater plumes.* NAES Lakehurst requested that NJDEP designate several Classification Exception Areas (CEAs) that delineate areas on and near base property where groundwater contamination exceeds health-based drinking water standards or could do so in the future. NJDEP has accepted this request and established CEAs at the base's groundwater plumes, most notably in Areas A/B and I/J (see Figures 4 and 5, respectively). A CEA is required pursuant to the state of New Jersey's Groundwater Quality Standards whenever an approved remedy will not meet constituent standards for the term of the remediation. The CEA is the state's method of ensuring that the uses of the aquifer are restricted and human health is protected until standards are achieved.
- *Testing and installation requirements for private wells.* Several additional measures are in place to ensure that contamination does not affect drinking water drawn from private wells. For instance, Ocean County Health Department regulations require that no new potable wells can be constructed without having a permit approved by the Ocean County Board of Health. Also, any wells located on or adjacent to properties with private sewage disposal systems or public sanitary sewage disposal systems must be installed by licensed well drillers. All new wells must be tested for chemical contamination, and the list of chemicals that must be evaluated include many of the groundwater contaminants at NAES Lakehurst (e.g., benzene, xylene, trichloroethylene). Private wells must also be tested for chemical contamination when a property is sold (OCHD 1990). Further, for the last 5 years, NAES Lakehurst has been testing monitoring wells which are located immediately northeast of the base boundary. None of these sampling results have shown evidence of base-related contamination. NAES Lakehurst plans to continue sampling this well.

The measures listed above will help ensure that base personnel and environmental regulators know where groundwater contamination exists and whether this contamination has entered drinking water supplies. These measures will therefore ensure that groundwater contamination from NAES Lakehurst will not be a health hazard in the future.

B. Contacting Unexploded Ordnance and Chemical Warfare Materiel While Hunting or Playing On Base

From 1915 to 1921 a private company and the U.S. Army operated ammunition proving grounds on parts of the land that is now NAES Lakehurst property. Between 1921 and the late 1940s, NAES Lakehurst, known at that time as Camp Kendrick, also operated a proving ground and conducted military training exercises with aircraft dropping bombs on targets. These past operations left unexploded ordnance (UXO) and chemical warfare materiel (CWM) at various locations on the base. Past base surveys suggest that UXO/CWM are most commonly found in the western, and more remote, part of NAES Lakehurst, far from base housing; however base personnel and base residents do have access to the areas where UXO/CWM are most likely to be present.

Recognizing that disturbing UXO/CWM can have serious consequences, NAES Lakehurst has implemented several measures to help base residents and base personnel avoid the hazards posed by these items. These measures include posting warning signs in areas believed to have the greatest amount of UXO/CWM, requiring hunters to take an annual training course on the dangers of UXO/CWM, and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose. An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions. Emergency response teams that have been trained to respond to large chemical releases are also on hand to respond to chemical releases, explosions, or fires. In addition, NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release from transportation and/or storage of industrial chemicals either on base or in the community. These plans and procedures are also appropriate for use in the event of a chemical munitions release and are reviewed frequently. These measures have been effective—even though base personnel and base residents continue to locate UXO items periodically. No accidents, injuries, or other adverse outcomes have resulted from individuals disturbing UXO/CWM at NAES Lakehurst.

NAES Lakehurst has taken steps to address the dangers of UXO/CWM. However, UXO/CWM are inherently dangerous materials and pose a hazard to anyone who contacts or disturbs them. To avoid hazards in the future, NAES Lakehurst should continue to inform all hunters and base personnel of the dangers posed by UXO/CWM. ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared for safe and unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

What did ATSDR consider when assessing the hazards of UXO/CWM?

To assess potential hazards associated with UXO/CWM at NAES Lakehurst, ATSDR considered several factors, such as the types of munitions and weapons used, where the remnants from the past operations lie, who has access to these areas, and what measures are in place to educate people about the dangerous properties of UXO/CWM.

What types of munitions and weapons were used?

In making its evaluation, ATSDR considered the types of material that were produced by the U.S. Chemical Warfare Services. ATSDR also considered the types of chemical warfare agents known to have been tested or used by other countries during World War because they may have also been tested by the U.S. Chemical Warfare service at the Lakehurst proving grounds. In addition, ATSDR looked at the types of weapons, containers, and mortar and artillery shells that were used to identify that the range of amounts of chemicals in containers and shells (1 to 100 pounds of compound).

Both the Eddystone Munitions Company and the U.S. Army operated proving grounds on what is now the western portion of NAES Lakehurst. These past activities involved testing both high-explosive ordnance and CWM. An inventory of all ordnance suspected by the Navy to remain at NAES Lakehurst was compiled and included in the Focused Feasibility Study for Site 41 (NAES 1996). This list may be updated based on the results of additional investigations to be conducted in the next few years. In the next few years the DOD will be reevaluating the potential to encounter chemical munitions and unexploded ordnance, as well as site conditions and archival material relating to NAES Lakehurst. Between 1940 and 1941, the Navy and its contractors also operated an anti-tank proving ground on this part of the base and although conventional munition compounds may be present around areas of historical targets, the presence of chemical agents is very unlikely. Additionally, the Navy conducted air-to-ground military training exercises using both high-explosive bombs and practice bombs, or bombs whose explosive charge is replaced

**What is unexploded ordnance?
When is it a hazard?**

Unexploded ordnance (UXO) is explosive (i.e., so-called "live") ordnance that has been armed or prepared for action, has been fired, dropped, launched, or buried in a manner that can cause a hazard, and remains unexploded, whether by design or by malfunction.

For UXO to be a hazard, three conditions must be met: (1) UXO must be present, (2) people must have access to the areas where UXO is present, and (3) people's actions must detonate the ordnance.

The first two conditions are clearly met at NAES Lakehurst. The third condition can potentially occur, but the base's efforts to educate individuals on the hazards of UXO have greatly reduced that potential.

with an inert material, such as sand or concrete.⁴ Use of high-explosive bombs occurred only at the Parachute Jump Circle. Efforts have been made to retrieve bombs that did not explode (NAES 1996), but the nature of these recovery efforts is not thoroughly documented. Air-to-ground exercises were also conducted over the southern portion of the base, but the overwhelming majority of those exercises were conducted with practice bombs. Thus many different munitions and weapons have been used on the land that is now NAES Lakehurst.

A review of base records suggests, however, that the UXO are usually less than a foot in length and CWM that remain on base would contain 100 pounds or less of chemicals. An issue to consider when assessing these materials is their sensitivity to detonation. Because most of the UXO and CWM were fired more than 50 years ago, little information is available on their current sensitivities. The fact that many UXO and CWM items have been located, and some even handled, without incident implies that the original materials might not be extremely sensitive to detonation. However, as munitions age and corrode, the potential for explosion or chemical release becomes more indeterminate. Current technology cannot assure that all munitions can be found and removed.

What can happen to buried UXO/CWM?

ATSDR believes that the greatest potential for a munition to explode or release its contents would be if the munition is moved or tampered with or encountered during excavation. It can not be determined why the munitions did not explode and consequently it cannot be predicted how many times, if any, munitions can be moved or tampered with without exploding. However, chemical changes or corrosion of metal components may make the munitions unstable and subject to detonation by vibrations, shock, friction, changes in temperature/heat, or electrical fields. For example, munitions that have been exposed by freeze and thaw or erosion may also explode during brush or forest fires. It is noteworthy that corrosion of munitions that does not lead to detonation may continue to the point where the contents of the munitions are released. ATSDR has no indication that underground explosions or chemical releases from corrosion of munitions has occurred. ATSDR considers unexploded ordnance inherently dangerous and administrative controls, standard procedures, and contingency plans to protect public health and safety appear to have been effective to this point in time.

Were people injured by UXO in the past?

There are no reports of people being injured by detonations of UXO in the past.

⁴ Practice bombs can contain small amounts of explosives for purposes of spotting. Such amounts, however, are substantially lower than the amounts in high-explosive bombs.