

# **PUBLIC HEALTH ASSESSMENT**

**Willow Grove Naval Air Station/Air Reserve Station  
(a.k.a. Naval Air Station Joint Reserve Base and Air Force Reserve Station)  
Montgomery County, Pennsylvania**

**CERCLIS NO. PAD987277837**

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U.S. Department of Health and Human Services

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## FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 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. (The legal definition of a health assessment is included on the inside front cover.) 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.

**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 then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. 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 research studies are needed.

**Conclusions:** The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

**Interactive Process:** The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the parties responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

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

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

Letters should be addressed as follows:

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

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<b>ABBREVIATIONS</b>	
ARF-#3	Air Force Well #3
ARS	Air Reserve Station at Willow Grove
ATSDR	Agency for Toxic Substances and Disease Registry
AW	Airlift Wing
BEHP	bis(2-ethylhexyl)phthalate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPF	cancer potency factor
CREG	ATSDR's cancer risk evaluation guide
CV	comparison value
1,1-DCE	1,1-dichloroethylene
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HWSA	Horsham Water and Sewer Authority
IRP	Installation Restoration Program
JP-4	jet petroleum No. 4
LNAPL	light non-aqueous phase liquid
MCL	EPA's maximum contaminant level
mg/kg/day	milligram of chemical per kilogram of body weight per day
MRL	ATSDR's minimal risk level
NASJRB	Naval Air Station Joint Reserve Base at Willow Grove
Navy	U.S. Navy
NW-1; NW-2	Navy Wells #1 and #2, respectively
PA	preliminary assessment
PADEP	Pennsylvania Department of Environmental Protection
PAH	polycyclic aromatic hydrocarbon
PFBC	Pennsylvania Fish and Boat Commission
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene, also know as perchloroethene
PHA	public health assessment
PHAP	public health action plan
POL	petroleum, oil, and lubricant
ppb	parts per billion
ppm	parts per million
RBC	EPA Region III risk-based concentration
RfD	reference dose
RI	remedial investigation

*Willow Grove Naval Air Station/Air Reserve Station Public Health Assessment*

ROD	record of decision
SI	site inspection
SSL	EPA's soil screening level
SVE	soil-vapor extraction
SVOC	semivolatile organic compound
TCE	trichloroethylene
USAF	U.S. Air Force
UST	underground storage tank
VOC	volatile organic compound
WMA	Warrington Municipal Authority



## SUMMARY

The Naval Air Station Joint Reserve Base (NASJRB) and Air Reserve Station (ARS) at Willow Grove are two separate, but adjacent, military facilities that cover 1,015 acres in Montgomery County, Pennsylvania, approximately 20 miles north of Philadelphia. NASJRB and ARS are operating U.S. Navy (Navy) and U.S. Air Force (USAF) installations, respectively.

NASJRB, originally named Pitcairn Airfield, began operation in the 1920s. In 1942, the Navy acquired the airfield and established a classified anti-submarine program at NASJRB. Jet training began in 1949. After World War II, the Navy used NASJRB for reserve training. In 1958, the USAF established ARS on land adjacent to NASJRB. ARS has primarily served to train personnel for various air transport and air evacuation activities, to operate station facilities and air terminals, and to provide overall support to assigned units. Navy and USAF training operations continue as the primary function of NASJRB and ARS. As a result of training activities and associated facility operations, such as aircraft maintenance, hazardous materials have been generated, stored, and disposed of at NASJRB and ARS.

In preparing this public health assessment, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed available data from the Navy, USAF, and local water suppliers. Community concerns were gathered during discussions with Navy and USAF personnel and review of station documents. As a result, ATSDR identified exposure to contaminants in drinking water, surface soil, surface water and sediment, and fish as the principal possible exposure pathways of concern. After reviewing available environmental information, potential exposure situations, and contaminant toxicology information, ATSDR categorized NASJRB and ARS as posing no apparent public health hazard. Potential contact with site contaminants are not expected to result in illnesses or adverse health effects. (A description of ATSDR's hazards categories is provided in the Glossary, Appendix B.)

### Drinking Water

Past, current, and future exposure to contaminants in drinking water is not expected to result in illness or adverse health affects. Station supply wells contain low-levels of volatile organic compounds (VOC) and metals. ATSDR evaluated potential past exposures to these contaminants and found that concentrations were below levels expected to result in harm. To prevent current and future exposures, the Navy operates an air stripping unit to remove VOCs from the water supply prior to distribution. No remedial actions have been taken to address metal concentrations. However, metal concentrations have not exceeded drinking water standards during regular sampling conducted to determine compliance with state and federal regulations. The Navy suspects that the source of VOCs in the station supply is located off station to the north. No contamination attributable to NASJRB or ARS operations has been found in community supply wells. Community water suppliers operate air strippers to remove VOCs, resulting from off-station sources, in their water supply and conduct regular monitoring to ensure the safety of the water supply. One VOC—1,1-dichloroethene [1,1-DCE]—was found in two

private wells south of NASJRB. Because evidence indicates an off-station source, the Navy notified the Pennsylvania Department of Environmental Protection and the local Board of Health about the contamination in the private wells. Nonetheless, ATSDR evaluated possible exposures and found that use of private wells containing low-levels of 1,1-DCE was not expected to result in illness or adverse health effects. The Navy and USAF are conducting or investigating remediation measures to address groundwater contamination at NASJRB and ARS and to prevent current and future impacts to drinking water supplies from Navy or USAF sources.

#### Surface Soil

Past, current, and future exposure to contaminants in surface soil is not expected to result in illness or adverse health effects. Most areas of surface soil contamination are inaccessible to the public, therefore, no exposures occur at these locations. Station residents and/or the public may contact surface soil contamination at recreational areas near the Ninth Street Landfill. In these areas, however, contaminant concentrations are below state and federal regulatory limits and below levels expected to result in illness or harm from exposures during recreational activities. The public may also contact low-levels of contaminants found at the off-station Aircraft Mishap Site. After an F-14 Tomcat crash, the Navy conducted remedial actions and backfilled the area with topsoil. Sampling of the topsoil found three contaminants at levels below state and federal regulatory limits, but above ATSDR's conservative screening values. These contaminants are likely naturally occurring in the soil and are not a result of releases from the F-14 Tomcat crash. Although above screening levels, contaminant concentrations at the Aircraft Mishap Site are below levels expected to result in illness or harm from exposures during recreational activities.

#### Surface Water and Sediment

Past, current, and future exposure to contaminants in surface water and sediment is not expected to result in illness or adverse health effects. Similar to surface soil contamination, most areas of surface water and sediment contamination are inaccessible and no exposures are occurring. Exposures may occur at the recreational pond located near the Ninth Street Landfill and at off-station streams. Surface water and sediment contamination levels found in the recreational pond and at the station boundaries are below levels expected to result in illness or harm from exposures during recreational activities. Since sampling at the station found contaminants at levels below regulatory or health concern, possible exposures in off-station streams would not be expected to result in illness or harm during recreational activities.

#### Fish

Past, current, and future exposure to contaminants in fish is not expected to result in illness or adverse health effects. Streams within the station boundaries are intermittent and, therefore, do not support an edible fish population. Fishing is permitted in the recreational pond by the Ninth Street Landfill, however, consumption of fish caught in this pond is prohibited. Little Neshaminy Creek and Pennypack Creek, downstream of the station, are used for fishing. The low levels of surface water and sediment contaminants originating at the station are expected to disperse and be diluted to concentrations too low to accumulate to levels of concern in fish in these creeks. Sampling indicates that contaminant concentrations have decreased to levels below regulatory concern at the edge of the station. Fish consumption advisories are also in place for all water bodies in Pennsylvania based on a statewide

concern about mercury in fish, and for Little Neshaminay Creek based on a watershed concern about polychlorinated biphenyls (PCBs) in fish. Although very low levels of mercury and PCBs have been found in media at NASJRB and ARS, their presence was not the cause for these fish advisories. To prevent future migration of contamination beyond station boundaries, the Navy and USAF are planning or conducting remediation, as necessary, at sites at NASJRB and ARS.

## **BACKGROUND**

### **Site Description and Operational History**

The Naval Air Station Joint Reserve Base (NASJRB) at Willow Grove and the Air Reserve Station (ARS) at Willow Grove cover 1,015 acres in Horsham Township in Montgomery County, Pennsylvania (Figures 1 and 2). NASJRB and ARS are operating U.S. Navy (Navy) and U.S. Air Force (USAF) installations, respectively. The installations are adjacent to one another and are located approximately 20 miles north of Philadelphia.

NASJRB and ARS are bordered on the north by the Graeme Historical Site, open agricultural land, and residential development. Land west of the station primarily consists of open agricultural areas, residential areas, and a private golf course. Areas south and east of the station are used for residential, commercial, and industrial uses.

NASJRB was first activated during the 1920s, when the facility was called Pitcairn Airfield. The Navy acquired the airfield in 1942. After World War II, NASJRB was designated a reserve training station. Jet training began at NASJRB in 1949.

ARS has been in operation since 1958, occupying 210 acres adjacent to the northern portion border of NASJRB. Originally called the 512<sup>th</sup> Troop Carrier Wing, the name was later changed to the 913<sup>th</sup> Airlift Wing (AW). The 913<sup>th</sup> AW trains personnel for various air transport and air evacuation activities, operates station facilities and air terminals, and provides overall support to assigned units (Montgomery Watson 1998).

Currently, NASJRB and ARS provide materials, facilities, services, and training in direct support of the Navy and USAF. Other units that currently reside at these facilities include Patrol Squadrons 64 and 66, Fleet Logistic Support Squadron 52, Marine Air Group 49, 111<sup>th</sup> Pennsylvania Air Guard, and the Reserve Anti-Submarine Warfare Training Center (Brown and Root 1998).

Activities that generate, store, or dispose of hazardous waste at these two stations fall into these categories: aircraft maintenance, fuel operation, civil engineering, and personnel training (EPA Region III 2001).

### **Remedial and Regulatory History**

The Department of Defense's installation restoration program (IRP) at NASJRB and ARS commenced in 1984 to identify locations where hazardous substances may have been released into the environment (EA 1990). After investigations at NASJRB and ARS confirmed the

presence of contaminants at several locations, these stations were added to the U.S. Environmental Protection Agency's (EPA) National Priorities List in October 1995 (Montgomery Watson 1998).

Sites at NASJRB and ARS were grouped into 16 IRP sites in 1984, based on type of site and plans for remediation: nine at NASJRB and seven at ARS. The Navy Fuel Farm was added to the IRP in 1988 and the Aircraft Apron Parking in the mid-1990s. The sites are named as follows:

*NASJRB*

- Site 1 -- Privet Road Compound
- Site 2 -- Antenna Field Landfill
- Site 3 -- Ninth Street Landfill
- Site 4 -- North End Landfill
- Site 5 -- Fire Training Area
- Site 6 -- Abandoned Rifle Range #1
- Site 7 -- Abandoned Rifle Range #2
- Site 8 -- Building #118 Abandoned Fuel Tank
- Site 9 -- Steam Plant Building #6, Tank Overfill
- Site 10 -- Navy Fuel Farm
- Site 11 -- Aircraft Apron Parking

*ARS*

- Site 1 -- Petroleum, Oil, and Lubricant (POL) Area
- Site 2 -- Open Storage Area
- Site 3 -- Ponding Basin
- Site 4 -- Washrack Area
- Site 5 -- Waste Oil Storage Area
- Site 6 -- Heating Plant
- Site 7 -- Old Well House

In addition to the sites within station boundaries, an F-14 Tomcat crashed in an isolated 10-acre area north of the station in June 2000. This area is referred to as the Aircraft Mishap Site. The Navy investigated the crash area as a site where fuel and oil may have been released to the environment. The Navy conducted remedial actions at the site to address these possible releases. This site was not considered an IRP site, so investigations and remediation were conducted under Pennsylvania environmental regulations (Foster Wheeler 2000).

In 1993, the USAF removed a 300-gallon underground storage tank (UST) at Building 209 and discovered that the UST had leaked. As a result the area was designated non-IRP site contamination. Sampling and remediation were conducted following Pennsylvania Department of Environmental Protection (PADEP) and federal UST regulations. To address elevated levels of benzene in one groundwater monitoring well, the USAF injected an oxygen-releasing compound to encourage biodegradation of the benzene. After this action, benzene concentrations

in this well have been below drinking water standards. The USAF expects to close this site in 2001. The USAF has replaced USTs at ARS and manages potential leaks and spills under their environmental compliance program (ARS 1995, USAF 2001a). The Navy also managed their USTs under an environmental compliance program. The last two USTs located at NASJRB were removed in the early 1990s (Navy 2001a).

Site Investigations (SIs) and/or Remedial Investigations (RIs) have been performed for each site. The Navy has conducted Interim Removal Actions when necessary and is in the process of conducting Feasibility Studies (FSs) for sites at NASJRB. The USAF has completed or is in the process of implementing remedial actions selected under Records of Decision (RODs) for ARS.

Table 1 describes the IRP sites and Aircraft Mishap Site, past investigations, and completed or planned remedial investigations. The table also provides an evaluation of potential public health hazards associated with each site.

## **ATSDR Involvement**

In June 1996, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a site visit at NASJRB and ARS to collect and evaluate information for ranking these facilities according to potential public health hazards. ATSDR identified potential public health issues related to environmental contamination from NASJRB and ARS activities during this time, but no immediate public health hazards.

ATSDR reviewed past and current exposures documented for the facilities and completed a site summary in October 1996. Past exposures reviewed included the trichloroethylene (TCE) and tetrachloroethylene (PCE) contamination of on-station drinking water. Based on screening-level analyses, ATSDR concluded that past on-site exposures to TCE and PCE in drinking water were not expected to result in adverse health effects. ATSDR also concluded in the 1996 Site Summary that there were insufficient data to determine whether there was human contact with site contaminants originating from some areas at NASJRB and ARS.

ATSDR conducted a follow-up site visit in November 2000, to obtain updated information and evaluate site conditions for this Public Health Assessment (PHA). During the site visit, ATSDR met with representatives from the Navy and USAF. Issues identified by ATSDR or concerns expressed during the site visit are discussed in the “Evaluation of Environmental Contamination and Potential Exposure Situations” and the “Community Health Concern” sections of this PHA.

## **Demographics and Land Use**

NASJRB and ARS are adjacent military facilities located in southeastern Pennsylvania in Horsham Township in Montgomery County, approximately 20 miles north of Philadelphia and 70 miles west of the Atlantic Ocean. Horsham Township has a population of approximately 24,000 (U.S. Census 2001). Land north and west of the station is primarily open agricultural land, with some scattered residences, low-level commercial activities, and a private golf course. Farms and the Graeme Historical Site border ARS on the northern side. An industrial complex about 1,000 feet northwest of the station includes some small businesses and warehouses. Areas south and east of NASJRB and ARS are used for residential, commercial, and industrial uses. A cemetery is also located east of NASJRB, and a school is located approximately 1.5 miles to the southwest.

Access to both facilities is restricted to military personnel, station residents, and civilian employees. The public and contractors may only enter by passing a security guard station, registering their vehicle, and obtaining a pass. The station is surrounded by a perimeter fence that is regularly patrolled. Except for areas separately fenced, access to contaminated areas is not limited once within NASJRB or ARS boundaries.

NASJRB and ARS employ 1,571 active-duty individuals, 993 National Guard, 3,500 Reserves, and 778 civilians. On-station daily staff is approximately 1,700 (NASJRB 2001).

About 230 people live at the station year-round, with less than 30 people residing in single family dwellings and less than 200 in barracks (ATSDR 1996). NASJRB and ARS have five officer family units, 200 enlisted family units, and 250 unaccompanied enlisted units (NASJRB 2001). Housing units are located in the northeastern portion of the station, near the main gate.

There is a day-care center on station for 96 children from military families stationed at NASJRB and ARS. The Willow Grove Branch Medical Clinic is also located on the station, providing primary care, medical support, preventive medicine, and occupational health services to 20,000 active duty, reserve, retired personnel, and their family members (NASJRB 2001; Navy 2001b).

Recreational facilities, including a pavilion, playground, pond, and baseball diamond are located on the Ninth Street Landfill.

## **Quality Assurance and Quality Control**

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the Comprehensive Environmental Response, Compensation, and Liability Act (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 are from Navy and USAF SIs, RIs, and site

investigations. Based on our evaluation, ATSDR determined that the quality of environmental data available for NASJRB and ARS were adequate for making public health decisions.

## EVALUATION OF ENVIRONMENTAL CONTAMINATION AND EXPOSURE SITUATIONS

### Introduction

In this section, ATSDR evaluates whether community members have been, are, or could be exposed to harmful levels of contaminants in the environment. The conservative exposure evaluation process used by ATSDR is illustrated in Figure 3. ATSDR considers how individuals might come into contact with contaminated media, as well as the duration and frequency of exposure.

If it is possible that exposure has occurred or does occur, ATSDR then considers whether contaminants were or are present at harmful levels. This is accomplished by screening the concentration of each contaminant in an environmental medium (e.g., soil or groundwater) against its health-based comparison value (CV). CVs are contaminant concentrations that are not likely to cause adverse effects, even when very conservative exposure scenarios are assumed. However, environmental levels that exceed CVs will not necessarily produce adverse health effects. If a contaminant is found in the environment at levels exceeding its corresponding CV, ATSDR examines potential exposure variables and the toxicology of the contaminant. ATSDR emphasizes that regardless of the level of contamination, *a public health hazard exists only if people come into contact with, or are otherwise exposed to, harmful levels of contaminants in site media.*

ATSDR identified the groundwater, surface soil, surface water and sediment, and fish pathways as requiring further investigation. ATSDR then examined whether human exposure to harmful levels of contaminants via these pathways has occurred or does occur. The evaluation process for potential exposure pathways is illustrated in Figure 3, and is described in more detail in Table 2 and the following discussion. A list of CVs and a glossary are included in Appendices A and B. In addition, 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/>.

### Exposure to Contaminants in Drinking Water

Past activities at ARS have resulted in groundwater contamination with petroleum products. Petroleum products have been detected in monitoring wells located beyond ARS boundaries. Chlorinated solvents, specifically TCE and PCE, have been found in station drinking water production wells located at NASJRB. *Could past, current, or future use of groundwater from station, community, or private drinking water supplies pose potential health hazards?*

## ***Conclusion***

No apparent public health hazards were found associated with drinking water from station supply wells, community supply wells, or private wells. Sampling has found volatile organic compounds (VOCs), specifically PCE, TCE, and 1,1-dichloroethene (1,1-DCE), arsenic, barium, and lead in station supply wells or private wells. No contaminants attributable to NASJRB and ARS have been found in community supply wells located near NASJRB and ARS. Exposures to these site-related contaminants were possible in station supply wells and private wells, however, no direct evidence indicates that exposures actually occurred. Nonetheless, ATSDR reviewed environmental data, potential exposure situations, and contaminant toxicology information and concluded that no apparent public health hazards are posed by contaminants found in groundwater at NASJRB and ARS. Potential exposures were below levels expected to result in illness or other adverse health effects and measures are in place to prevent current and future impacts to drinking water supplies.

## ***Discussion***

### *Hydrogeology*

NASJRB and ARS are situated on the late Triassic age Stockton Formation, which is composed of fine- to medium-grained sandstone, shale, and siltstone (Brown and Root 1998). The different hydraulic properties found in this rock combination create a complex, heterogeneous, multiaquifer system. Groundwater moves through the network of interconnecting fractures, joints, and bedding plans. Nearly all deep wells in the Stockton Formation are open to several water-bearing zones and are multiaquifer wells (Sloto et al. 1996). Water from the Stockton Formation is the sole source of potable water to the station, and provides water to most community supplies and private wells in the area (Montgomery Watson 1998).

### *Groundwater Use*

Drinking water is supplied to the station from station supply wells and to off-station communities from off-station community supply systems and off-station private wells.

#### *Station Supply Systems*

NASJRB and ARS currently obtain water from two production wells, which have been in existence since the 1930s. Navy Wells #1 and #2 (NW-1 and NW-2, respectively) are located in the northeastern portion of NASJRB. A third well, Air Force Well #3 (ARF-3), is located in the southeastern portion of ARS. This well has not been used for at least the past 10 years because too few personnel are stationed at ARS to necessitate well operation. Pumps are operated monthly for maintenance (USAF 2001a). Locations of the wells are shown in Figure 2.

NASJRB and ARS also have reservoirs. NW-1 and NW-2 pump into Reservoir #1, which has a capacity of over 500,000 gallons and serves the north and central portions of two stations, and Reservoir #2, which serves the south end of the stations. Potable water is mixed and pumped from the reservoirs into the main distribution system (Earth Data 1985). Water is treated for VOCs by an air stripper prior to distribution (Brown and Root 1998; Navy 2001a).

#### Community Supply Systems and Private Wells

Community supply systems are operated by the Hatboro Borough Authority, Horsham Water and Sewer Authority (HWSA), Warminster Township Municipal Authority, Warrington Municipal Authority (WMA), and Warminster Heights Water Company, which meet all federal and state drinking water standards. These community supply systems were established in 1952. The municipalities collectively operate approximately 49 drinking water production wells. HWSA and WMA operate wells located closest to NASJRB and ARS (Earth Data 1985).

Private wells are located near the southern portion of NASJRB. In investigating groundwater contamination, the Navy identified approximately 160 private wells within 0.5 miles of the southern portion of the base. The Navy located private wells by reviewing HWSA records and identifying addresses which were billed for sewer use, but not for water use. The depths of most of these wells is unknown. Five private wells were sampled by the Navy, as described in the next section of this PHA (GLA 1996; Navy 2001a). Off-station private wells are shown in Figure 4.

#### *Nature and Extent of Contamination*

Past activities and waste disposal practices at NASJRB and ARS have resulted in groundwater contamination. VOCs, primarily PCE and TCE, bis(2-ethylhexyl)phthalate (BEHP), dieldrin, Aroclor-1260, and metals contaminated the groundwater at levels above ATSDR CVs. ATSDR identified groundwater contamination at the Privet Road Compound, the Fire Training Area, the ARS POL Area, and the Aircraft Mishap Site as possibly impacting drinking water wells. Review of the data generated during investigations of these sites, as detailed in the following text, found that none of these sites have actually impacted drinking water wells.

#### Station Supply Systems

Station supply wells are located in the northeastern corner of NASJRB. Based on site investigations, the Navy identified the Privet Road Compound as a potential source of contaminants found in station supply wells. Groundwater sampling at this site began during the 1990 SI and continued through the 1993 and 1998 Phase I and II RIs. Groundwater monitoring is ongoing. Monitoring wells at the Privet Road Compound have contained VOCs, including PCE and TCE, dieldrin, Aroclor-1260, and metals at concentrations above CVs (EA 1990; Brown and Root 1998). Later investigations, however, found that the Privet Road Compound was not the probable source of

contamination in the supply wells. The supply wells are fed by water carried in a bedrock fracture upgradient of the Privet Road Compound. Where the fracture originates and the source of contamination in this fracture is unknown, but is suspected to originate off station. The Navy will continue attempts to determine the origin of the fracture and source of contamination. The Navy believes that the Privet Road Compound is not responsible for contamination found in the supply wells, however, this finding has not yet been submitted to state and federal regulators for agreement (Navy 2001a, 2001c).

Sampling of station supply wells began in 1979, when groundwater contamination was found in areas throughout the region. Data from 1979, when contamination was discovered, to 1984 reported maximum detected concentrations of 300 part per billion (ppb) of TCE and 91 ppb of PCE in on-site supply wells. The second highest detected levels in this time period were 68 ppb of TCE and 79 ppb of PCE. The highest levels of both TCE and PCE were found in NW-1. After contamination was detected, this well was used mainly for fire protection, and not drinking water. Monitoring in 1985 also found arsenic (to 22 ppb), barium (to 1,190 ppb), and lead (to 20 ppb) above CVs in the drinking water wells (EA 1980; NASJRB 1980; Earth Data 1985; ATSDR 1996). As a result of detected contamination, the Navy installed an air stripper to treat groundwater prior to distribution (Brown and Root 1998). Monitoring of treated water between 1996 and 1998 found no contaminants above EPA's Maximum Contaminant Levels (MCLs), and only arsenic (to 2.5 ppb) above ATSDR's CVs (NASJRB 1999). A summary of contaminants found in the station supply wells is provided in Table 3.

#### *Community Supply Systems and Private Wells*

Groundwater at the Fire Training Area at NASJRB and the POL Area at ARS was identified as a potential source mostly likely to impact off-station drinking water supplies. The Navy installed and sampled monitoring wells at the Fire Training Area during the 1990 SI and 1993 and 1998 Phase I and II RIs. These wells contained VOCs, dieldrin, and arsenic above CVs.

The HWSA production well #17 and private wells are located west of the Fire Training Area. HWSA provides drinking water with a system of 15 groundwater supply wells. These wells feed into elevated water tanks before discharging water to the distribution system. HWSA annually inspects each well in the system and conducts regular monitoring to insure that state and federal drinking water standards are met. Although VOC contamination has been found in some of the wells in the supply system, none of the wells located closest to NASJRB and ARS (well #17 to the northwest and wells #1 and #10 to the east) have contained contamination. HWSA treats the water supply prior to distribution to prevent exposures to VOCs (HWSA 2000, 2001).

In 1996, the Navy sampled five private wells located along Horsham Road adjacent to the western station boundary. One well contained 1,1-DCE (2.8 ppb) above its CV, but below its MCL. The other four wells were free of contamination (GLA 1996). During

investigations of the Fire Training Area, the Navy found that the extent of a groundwater plume originating at the site was contained within NASJRB's boundaries. This plume, therefore, is not the source of 1,1-DCE found in private wells. Table 3 provides detailed information about the contamination found in the private well.

WMA also operates community drinking water supply wells near NASJRB and ARS. Residents in the western portion of Warrington receive drinking water from the North Wales Water Authority, which is provided by a surface water supply. Approximately 2,000 residents in the eastern portion of Warrington receive drinking water from the WMA system of nine groundwater wells. Of the nine wells operated by WMA, wells #1, #2, #6, and #8 are located nearest NASJRB and ARS—to the north along Easton Road. These wells, therefore, are not located near possible off-station contaminant migration areas associated with the Fire Training Area at NASJRB (southwest of the station) and the POL Area at ARS (northwest of the station). Regardless, WMA conducts annual monitoring under state and federal regulations to ensure the safety of the public water supply. In the past, VOC contamination has been reported in some of the supply wells. However, the presence of VOCs has not been attributed to NASJRB or ARS and WMA operates an air stripping system to remove these VOCs before distribution (WMA 2001, 2001b).

A jet petroleum No. 4 (JP-4) contaminant plume and free-phase JP-4 (fuel floating on the groundwater) were discovered at the POL Area at ARS in 1988 during RI investigations. At that time, groundwater sampling detected benzene, ethylbenzene, and toluene—components of JP-4—extending 1,400 feet to the northwest and free-phase JP-4 extending 900 feet northwest of the site. No drinking water supply wells, however, were found within the footprint of the groundwater plume or free-phase product. Groundwater monitoring completed in 1994 found that the extent of the groundwater plume and free-phase JP-4 had decreased. The groundwater plume extended only 575 feet to the northwest and the free-phase JP-4 extended only 380 feet northwest of the site (Montgomery Watson 1998).

Remediation efforts conducted at the ARS POL Area to date have had limited success. A passive recovery trench and soil vapor extraction (SVE) wells were installed and operated from 1993 to 1994. Changes in the groundwater levels, however, submerged the SVE wells, rendering them ineffective. In 1997, the USAF investigated implementing an SVE/groundwater extraction system. Pilot studies, however, indicated that this technology would also have limited use. A passive aerobic bioremediation technology was tested in 1998. Although analyses of the test results are ongoing, this technology (use of an oxygen releasing compound) will likely be deemed ineffective. The USAF is continuing to investigate remedial alternatives and is currently recommending a three-phase approach. Phase I includes baseline sampling to provide a picture of the current extent of contamination. Phase II includes implementation of in-situ chemical oxidation combined with enhanced in situ bioremediation in areas with shallow groundwater. Phase

III will include additional remediation, as necessary, based on monitoring conducted after Phase II. Phase III would consist of enhanced in situ bioremediation. Regardless of the methods used, the USAF will strive to clean the site to a set of standards in Pennsylvania's Land Recycling Program (Montgomery Watson 1998; USAF 2001a, 2001c).

The Graeme Historical Site, which obtains drinking water from a spring, is located northwest of the station and downgradient of the POL Area at ARS. Groundwater flow and contamination data gathered during the 1988 RI indicated that groundwater from the JP-4 plume flowed in the direction of the Graeme Historical Site. However, the 1988 RI indicated that the geologic conditions feeding the spring would be unaffected by the groundwater plume from the POL Area at ARS. Since the 1990s, the USAF has sampled the Graeme Historical Site well for benzene, toluene, ethylbenzene, xylenes, and naphthalene (JP-4 components). None of these contaminants were found when sampling began, or have been found in recent sampling events. Fuel components have been found at low-levels on several occasions when a nearby pond floods. The specific chemicals and concentrations found are unknown. During flooding events, the spring, which is located in the basement of a caretaker house, is covered by surface water runoff. The likely source of the infrequent and low-level detections found in the spring is migration, via surface water during spring flooding, of fuel components from vehicle maintenance areas at the caretaker house (Dames & Moore 1988; Montgomery Watson 1998; USAF 2001).

In June 2000, an accident involving a F-14 Tomcat occurred west of the station at the intersections of Horsham Road and Norristown Road. To assess whether fuel or hydraulic fluids potentially released during the crash impacted groundwater, the Navy sampled six nearby private wells in June and August 2000. Some of these wells had been sampled during the 1996 private well sampling event. One private well contained 1,1-DCE (0.27 ppb) above ATSDR CVs, but below EPA's MCL. The other five wells were free of contamination. 1,1-DCE is not a component of fuel or hydraulic fluid, therefore, the presence of this contaminant was not attributed to the F-14 Tomcat accident (Foster Wheeler 2000). Table 3 provides additional information about the contamination found in the private well.

### *Evaluation of Potential Public Health Hazards*

After reviewing the environmental data, potential exposure situations, and contaminant toxicology information, ATSDR concluded that the contaminants found in groundwater at NASJRB and ARS pose no apparent public health hazards. Although exposures may have occurred, no direct evidence indicates whether exposures actually occurred. Nonetheless, any possible exposures were below levels expected to result in illness or other adverse health effects and measures are in place to prevent current and future impacts to drinking water supplies. The following text and Appendix C describe how ATSDR reached this conclusion.

### Station Supply Systems

In the past, TCE, PCE, arsenic, barium, and lead were found in station supply wells at concentrations above CVs. When these contaminants were detected, the Navy implemented measures to prevent exposures. ATSDR assumed that people living and working at NASJRB and ARS in the past could have been exposed to these contaminants, although no direct evidence indicates that exposures actually occurred. ATSDR evaluated possible health effects from this exposure by assuming that people drank water with the highest levels of contamination while they were stationed at NASJRB and ARS—30 years for employees and 6 years for residents.<sup>1, 2</sup> Employees were assumed to drink 1 liter (a medium size soda bottle) of water from the station supply system each day for 250 days each year (5 days a week for 50 weeks a year). Adults living at NASJRB and ARS were assumed to drink 2 liters (a large soda bottle) and children 1 liter of water every day of the year.<sup>3</sup> Using these conservative assumptions, ATSDR found that the amount of contaminants that a person would drink would be below levels expected to result in health effects.

Measures to intercept contaminant migration and prevent current and future exposures have been implemented. Drinking water from station wells is treated prior to distribution and the Navy regularly monitors water quality under state and federal regulations to ensure that all drinking water standards are met. The Navy will also continue attempts to determine the source of contamination.

### Community Supply Systems and Private Wells

The HWSA supply wells, WMA supply wells, Graeme Historical Site supply well, and private wells along Horsham Road were identified as the water supplies most likely to be affected by station contamination. Although VOCs have been found in some of the wells serving HWSA, this contamination cannot be attributed to NASJRB and ARS. None of the supply wells nearest the station have contained elevated levels of VOCs. To prevent current and future contamination of the HWSA water supply, regular monitoring is conducted and water containing VOCs is treated before distribution.

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<sup>1</sup> The exposure duration of 30 years for a worker is based on a 1988 study that showed that men age 70 and older spend an average of 30 years in a single job. Women and younger men spend less time, on average, in a single job (EPA 1997).

<sup>2</sup> The exposure duration of 6 years for NASJRB and ARS residents is based on conservative assumptions. Most military personnel are stationed at NASJRB and ARS for 2 to 4 years before transfer (ATSDR 1996).

<sup>3</sup> The average adult drinks 1.4 liters of water a day and the average child, age 3 or younger, drinks 0.61 liters of liquid each day. A full-time employee is assumed to drink half of their daily intake while at work (EPA 1997).

VOC contamination has been found in some of the WMA drinking water supply wells, however, this contamination is not attributed to NASJRB and ARS. To prevent exposure to VOCs, the WMA operates air strippers to remove VOCs before water distribution and conducts regular monitoring to ensure that drinking water regulations are met.

The Graeme Historical Site receives water from a spring, which was located beyond areas of site contamination during the 1988 RI sampling. The USAF has detected low-levels of fuel components in this spring during flooding events. No contaminants were detected when sampling began in the early 1990s or in recent sampling events. Contamination found during flooding has been attributed to surface water runoff of fuel components released during vehicle maintenance at the caretaker house located on property adjacent to the Graeme Historical Site. Currently, the local Board of Health bans use of this spring as a drinking water supply due to concerns about bacteriological contamination (USAF 2001b). Past use of the well and possible infrequent exposure to low-levels of fuel components is not expected to result in illness or adverse health effects. The well is no longer being used as a drinking water supply and remediation efforts in place at the POL Area at ARS will prevent future impacts to this water supply.

Most local residents receive water from community water supply systems, which meet all federal and state drinking water standards. Private wells, however, are found along Horsham Road. Sampling has found 1,1-DCE above its CV in two of these private wells. The source of this VOC is not known, however, the Navy has used groundwater investigations and modeling to determine that the source of 1,1-DCE is not related to NASJRB and ARS activities or the Aircraft Mishap Site. Nonetheless, ATSDR evaluated possible exposures to residents drinking from these wells. Similar to the evaluation of the station water supply, ATSDR considered that residents drank water containing the highest levels of 1,1-DCE every day for 30 years as adults and 6 years as children.<sup>4</sup> Adults were assumed to consume 2 liters of water and children 1 liter of water each day. Using these conservative assumptions, ATSDR found that 1,1-DCE concentrations were below levels expected to result in illness or adverse health effects. Although the source of 1,1-DCE found in the two private wells has not been attributed to NASJRB and ARS, the Navy and USAF are addressing station contamination in accordance with state and federal regulations to ensure that private wells are not impacted by contaminants originating at NASJRB and ARS in the future. The Navy also notified PADEP and the local Board of Health about the contamination found in the private wells.

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<sup>4</sup> Based on several studies, a residence time of 30 years in a single home represents the 95<sup>th</sup> percentile of the population. An exposure duration of 6 years for a child is assumed to represent the time from toddler to young child when exposures may be at their highest (EPA 1997).

## Exposure to Contaminants in Surface Soil

Past activities resulted in areas of surface soil contamination located in several areas of the station. *Could past, current, or future use of these sites pose potential public health hazards?*

### *Conclusion*

No apparent public health hazards are associated with recreational use of facilities located adjacent to the Ninth Street Landfill or adjacent to the Aircraft Mishap Site. Although surface soil contamination has been found in several locations at the station, most areas of surface soil contamination are inaccessible to members of the public. At recreational areas near the Ninth Street Landfill, station residents and/or the public may contact surface soil contamination. Contamination, however, is below levels expected to result in illness or harm from exposures during past, current, or future recreational activities. Because only low-levels of surface soil contamination have been found in these areas, the Navy plans no further action. Low-levels of contaminants, which may be contacted by the public, have been found at the off-station Aircraft Mishap Site. The Navy conducted remedial actions at this site and backfilled the area with topsoil. Sampling of the topsoil found three contaminants at levels below state and federal regulatory limits, but above ATSDR's conservative screening values. These contaminants are likely naturally occurring in the soil and are not a result of releases from the F-14 Tomcat crash. Although above CVs, contaminant concentrations are below levels expected to result in illness or harm from exposures during past, current, or future recreational activities.

### *Discussion*

#### *Land Use*

Military housing areas are located in the northeastern portion of the stations, near the main gate. No areas of contamination have been identified near the on-site housing. Recreational areas available at NASJRB and ARS include a pavilion, playground, pond, and baseball diamond. These facilities are located in the southwest portion of the site on and near the Ninth Street Landfill. A private country club and golf course is near the station boundary, by the Ninth Street Landfill.

In June 2000, an F-14 Tomcat crashed southwest of NASJRB's southern boundary. The crash occurred in an isolated 10-acre area, referred to as the Aircraft Mishap Site, surrounded by residential homes and commercial businesses (Foster Wheeler 2000).

### *Nature and Extent of Contamination*

To characterize possible surface soil contamination at the Ninth Street Landfill, the Navy conducted site investigations under a 1984 Preliminary Assessment (PA), the 1990 SI, 1993 Phase I RI, and 1998 Phase II RI. As part of the SI, six surface soil samples were collected and analyzed for semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. Benzo(a)pyrene (0.47 parts per million [ppm]), dieldrin (0.11 ppm), and arsenic (19 ppm) were found above ATSDR's CVs (EA 1990). During the Phase I and II RIs, 28 surface soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and/or metals. Benzo(a)pyrene (to 1.1 ppm), benzo(b)fluoranthene (to 1.4 ppm), dibenz(a,h)anthracene (to 0.15 ppm), dieldrin (to 0.62 ppm), arsenic (to 8.6 ppm), cadmium (to 18.4 ppm), and iron (to 27,200 ppm) were found above ATSDR's CVs (Brown and Root Environmental 1998).

As a result of the F-14 Tomcat crash, on-board fuel and hydraulic fluids were released into the environment. Based on the nature of the crash and burn area, most of the on-board fuels and oils were likely consumed in the crash fire. The Navy gathered surface soil samples in the crash area to characterize possible fuel releases to the ground. Trace amounts of chemicals associated with fuel and oil were found, but no concentrations exceeded ATSDR's CVs. Topsoil imported from an off-station location to cover the crash site contained benzo(a)pyrene (0.35 ppm), which in some cases may be a natural component of soil, above ATSDR's CV. Arsenic (7.6 ppm) and iron (23,300) were also found above CVs, however these two metals are natural parts of the soil and are not found in fuel or oil (Foster Wheeler 2000).

Details regarding contaminants found above their CVs are provided in Table 4.

### *Evaluation of Potential Public Health Hazards*

No apparent past, current, or future public health hazards are associated with recreational use of facilities near the Ninth Street Landfill or the Aircraft Mishap Site. Several chemicals were found above ATSDR's health-based CVs. These CVs, however, were developed by ATSDR assuming that a person contacts, by accidentally eating, soil every day. Accidentally eating soil—also called incidental ingestion—can happen when a person gets soil on their hands, such as when gardening or playing baseball, and then eats food without washing their hands. Dust generated from the soil during activities such as digging or gardening may also settle on food that is then eaten without being washed first.

In conducting investigations of the Ninth Street Landfill, the Navy found only low-levels of contamination and has proposed that no further actions are required to address surface soil contamination at these sites (Navy 2001a). In evaluating exposures to surface soil contamination at the Ninth Street Landfill, ATSDR found that daily exposures are not expected to occur. Recreational areas near the Ninth Street Landfill are not expected to be accessed by residents at NASJRB and ARS or the public on a regular and frequent (daily) basis.

After the F-14 Tomcat crash at the Aircraft Mishap Site, the Navy conducted investigations and remedial actions to assess possible fuel releases and prevent contact with possible contamination. Remedial actions included backfilling the area with topsoil. Sampling of the topsoil found three contaminants at levels below state and federal regulatory limits, but above ATSDR's conservative screening values. These contaminants are likely naturally occurring in the soil and are not a result of releases from the F-14 Tomcat crash. Nonetheless, ATSDR evaluated potential exposures to these contaminants. As with the Ninth Street Landfill, daily exposures are not expected to occur. The Aircraft Mishap Site is located in an isolated area which is not expected to be accessed by the public on a regular and frequent, daily, basis..

## **Exposure to Contaminants in Surface Water and Sediment**

*Could exposure to contaminants in surface water and sediment adversely affect members of the NASJRB and ARS and surrounding communities?*

### ***Conclusion***

No apparent public health hazards are associated with recreational use of the on-station pond near the Ninth Street Landfill or streams flowing off station. No public health hazards are associated with surface water and sediment contamination possibly present at other sites at NASJRB and ARS. Most on-station areas of surface water and sediment are inaccessible to the public. The recreational pond located near the Ninth Street Landfill can only be accessed by people within NASJRB and ARS. However, off-station streams can be accessed by the public.

Sampling has found contamination in the recreational pond and on-station streams. Off-station sampling of two streams found no contamination in the tributary to Park Creek fed by runoff from the Ponding Basin and only low-level sediment contamination in the tributary to Pennypack Creek fed by runoff from the Antenna Field Landfill. Contaminant concentrations found in on- and off-station water bodies are below levels expected to result in illness or harm from exposures during past, current, or future recreational activities at the pond near Ninth Street Landfill or off-station streams. The Navy and USAF are planning no further action to address possible off-station stream contamination because only low-levels of contamination (below levels of health concern) were found in on- and off-station areas accessible to the public. The Navy and USAF, however, are conducting remediation as needed to address contamination sources.

## ***Discussion***

### *Surface Water Hydrology*

NASJRB and ARS lie on a topographic high, therefore, most surface water flows from the station to surrounding areas. Only minimal surface water flow from surrounding areas to the station is likely. Surface elevations range from approximately 370 feet above sea level in the southern portion of the station to 240 feet above sea level in the northern portion. Most land slopes are less than three percent, though regrading has resulted in some steeper areas.

NASJRB and ARS have two drainage basins—Little Neshaminy Creek in the north and Pennypack Creek in the south. Most surface water flows north into Park Creek, a tributary of Little Neshaminy Creek. Antenna Field Landfill and a portion of the Fire Training Area lie within the Pennypack Creek drainage basin. Both creeks eventually discharge to the Delaware River. No perennial streams have been identified at NASJRB and ARS. During heavy rainfalls runoff is channeled into swales and man-made drainage ditches. These swales and ditches are channeled to five primary outfall areas. Of the five outfalls, three drain to Park Creek, one drains into Pennypack Creek, and one directly connects to the Northern Storm Sewer System (Brown and Root 1998).

Surface water runoff from the Ninth Street Landfill collects in the recreational pond adjacent to the landfill. The outlet to the recreational pond discharges to an unnamed tributary of Park Creek, which passes through the golf course located adjacent to the station boundary (Brown and Root 1998).

### *Land Use*

Within NASJRB and ARS boundaries, the pond located north of the landfill and recreational areas at the Ninth Street Landfill may be used for recreation. Signs prohibiting swimming, fishing, and boating, however, are posted. Beyond station boundaries, streams carrying surface water runoff from the station may be used for recreation, including fishing. PADEP designated Pennypack Creek as a warm-water fishery. The Pennsylvania Fish and Boat Commission (PFBC) stocks Little Neshaminy Creek and Pennypack Creek with trout during the spring (Brown and Root 1998; PFBC 2001a).

### *Nature and Extent of Contamination*

Several on-site surface water bodies contain contaminated sediment and surface water (e.g., Antenna Field Landfill creek, recreational pond near Ninth Street Landfill, and Privet Road Compound drainage swales). Surface water and sediment contamination may result from direct release of contaminants to a surface water body or transport of contaminants in surface water runoff. Contaminants detected above CVs in surface water and/or sediment include VOCs,

BEHP, polycyclic aromatic hydrocarbons (PAHs), dieldrin, PCBs, and metals (Dames & Moore 1988; EA 1990, 1992; Brown and Root 1998).

Most areas of surface water and sediment contamination are located in remote portions of the station or are fenced to limit access, which minimizes contact with contaminants by the public, on-station residents, and on-station workers. Exposures, however, are possible at the recreational pond near the Ninth Street Landfill. During the 1990 SI sampling, four surface water and sediment samples were collected from the recreational pond. The Navy collected four surface water samples from the wetlands around the pond, and the downstream drainage swale during the 1993 Phase I RI and two samples from a ditch draining into the pond during the 1998 Phase II RI. Sediment samples collected by the Navy include six samples gathered during the 1993 Phase I RI and three samples gathered during the 1998 Phase II RI (EA 1990; Brown and Root 1998).

Results from these sampling events reported surface water containing dieldrin (0.06 ppb), antimony (to 73.3 ppb), arsenic (to 2 ppb), chromium (245 ppb), lead (to 83.5 ppb), manganese (to 5,710 ppb), and zinc (to 11,700 ppb) above CVs for drinking water. Drinking water CVs were used to evaluate contaminant concentrations in surface water because no surface water CVs are available. These CVs are very conservative estimates for exposure to surface water because they consider regular (e.g., daily) ingestion for extended periods of time (e.g., years).

Methylene chloride (10 ppb) and BEHP (6 ppb) were each found above their CVs in one sample collected in 1989. These contaminants, however, are commonly used in laboratory analysis methods and their presence was attributed to laboratory contamination. Sediment samples contained benzo(a)anthracene (to 14 ppm), benzo(a)pyrene (to 12 ppm), benzo(b)fluoranthene (to 12 ppm), benzo(k)fluoranthene (to 10 ppm), dibenz(a,h)anthracene (at 0.41 ppm), indeno(1,2,3-c,d)pyrene (to 8 ppm), aldrin (to 0.12 ppm), dieldrin (to 1.4 ppm), antimony (to 30.9 ppm), arsenic (to 7.4 ppm), cadmium (to 24 ppm), chromium (to 256 ppm), cyanide (at 30,700 ppm), iron (to 30,100 ppm), lead (to 3,690 ppm), mercury (to 30.2 ppm), thallium (to 61.2 ppm), and vanadium (to 208 ppm) above their surface soil CVs (EA 1990; Brown and Root 1998). Surface soil CVs were used to assess sediment contaminant concentrations because no sediment CVs are available. These CVs are very conservative estimates for exposure to sediment because they consider regular (e.g., daily) contact with surface soil for extended periods of time (e.g., years). Table 5 summarizes the contaminants found above CVs during these sampling events.

Off-station surface water and sediment samples were collected where runoff from the Ponding Basin and Antenna Field Landfill leaves the station. Runoff from the Ponding Basin flows into a tributary of Park Creek and runoff from the Antenna Field Landfill flows into a tributary of Pennypack Creek. No contaminants were found above CVs in off-station surface water or sediment samples collected near the Ponding Basin (Dames & Moore 1988). Arsenic and benzo(a)pyrene were found above CVs in off-station sediment samples collected both upstream and downstream of the Antenna Field Landfill. Upstream samples contained arsenic to 3.1 ppm

and benzo(a)pyrene to 330 ppb. The downstream sample contained arsenic at 3.2 ppm and benzo(a)pyrene at 160 ppb. No contaminants were found above CVs in surface water. Details regarding contaminants found above their CVs in surface water and sediment are provided in Table 5.

A review of results from samples collected from streams and drainage swales at the edge of the station found that most contaminants were at levels equal to or less than contaminant levels found at the recreational pond near the Ninth Street Landfill. Only dieldrin (0.11 ppb) in surface water at the Antenna Field Landfill and arsenic (23 ppm) and iron (42,700 ppm) in sediment at the North End Landfill were found at higher concentrations (Dames & Moore 1988; EA 1990, 1992; Brown and Root 1998).

#### *Evaluation of Potential Public Health Hazards*

No apparent past, current, or future public health hazards were identified associated with recreational use of the pond at the Ninth Street Landfill or off-station streams. Although people may contact contaminants in surface water and sediment in the recreational pond or off-station streams, the levels of contamination are below those associated with health concerns. Because no CVs are available for surface water and sediment, ATSDR conservatively compared contaminant levels found in surface water against drinking water CVs and sediment against surface soil CVs. Both groundwater and surface soil CVs are developed assuming daily contact. Recreational use of the pond and streams is expected to occur less frequently based on signs prohibiting swimming, boating, and fishing in the recreational pond; climate restrictions of Pennsylvania; and the intermittent flow of off-station streams adjacent to NASJRB and ARS. In addition, contaminants were found above the conservative drinking water and surface soil CVs in only a portion of the samples collected. As such, contact with contaminants at concentrations above CVs was expected to be infrequent and of short duration. No further actions are planned to address low-level contaminant concentrations (below levels of health concern) in surface water and sediment. The Navy and USAF, however, continue to undertake investigation and remediation efforts to address site contamination throughout NASJRB and ARS.

### **Exposure to Contaminants in Fish**

Past activities at NASJRB and ARS have resulted in surface water and sediment contamination. Recreational fishing occurs in streams and ponds receiving runoff from NASJRB and ARS. *Could consumption of fish from station and/or downstream water bodies pose potential health hazards?*

## ***Conclusion***

No apparent public health hazards were identified from consuming fish caught at NASJRB and ARS or downstream water bodies. Streams within the station boundaries are intermittent and, therefore, do not support a fish population suitable for eating. Little Neshaminy Creek and Pennypack Creek, downstream of the station, are used for fishing. Pesticides and mercury were found in surface water and sediment at NASJRB and ARS and are contaminants that can accumulate in fish. Contaminant concentrations, however, are expected to decrease below levels of health concern as the contaminants are transported downstream. In addition, PFBC has implemented consumption advisories to limit the potential for consumption of fish by the public. These advisories are not based on specific concerns about NASJRB and ARS, rather the advisory for mercury contamination is based on a statewide fish consumption advisory and the advisory for PCBs is based on concerns for the Little Neshaminy Creek watershed.

## ***Discussion***

Fishing occurs in water bodies receiving storm water runoff from the station. Little Neshaminy Creek, located about 1.5 miles downstream of NASJRB and ARS, and Pennypack Creek, located about 0.6 miles downstream, are stocked with trout for sport fishermen (PFBC 2001a). Pennypack Creek also is designated as a warm-water fishery by PADEP (Brown and Root 1998).

Although these creeks are stocked and fished, PFBC has issued fish-consumption advisories for mercury and PCBs. These advisories are in place because of statewide or watershed-wide concerns, not because of specific concerns about NASJRB and ARS. The mercury advisory applies to the entire state and recommends that people eat one meal per week, or less, of any fish caught in Pennsylvania. This advisory is consistent with the nationwide fish-consumption advisory developed to protect populations particularly susceptible to mercury toxicity, including pregnant and nursing women, women of childbearing age, and young children. The PCB advisory applies to designated water bodies. Under this advisory, people catching fish in the Little Neshaminy Creek basin are advised to eat one fish meal per week, or less, of all species, except carp. Carp should only be eaten once a month. Proper cleaning and cooking techniques should be used to reduce the amount of PCBs eaten (PFBC 2001b, 2001c).

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

Transport of contaminants may occur through surface water runoff in several small creeks flowing off station. Access to these off-station creeks is not restricted. A review of results from one sample collected off station from the Ponding Basin, two samples collected off station from the Antenna Field Landfill, and samples collected from streams and drainage swales at the edge of the station found PAHs, metals, and pesticides at concentrations above drinking water and surface soil CVs, as described in the “Exposure to Surface Water and Sediment” section of this PHA, but below levels of regulatory concern. Of the contaminants found in surface water and

sediment, pesticides and mercury are typically a concern for bioaccumulation in fish. No fish sampling, however, has been conducted.

The pesticide aldrin was found in sediment (0.08 ppm), but not surface water, collected near the station boundary at the Ninth Street Landfill. Sediment samples collected near the station boundary at the Antenna Field Landfill (0.71 ppm), Ninth Street Landfill (0.09 ppm), and North End Landfill (0.23 ppm) contained the pesticide dieldrin. Surface water at these sites contained dieldrin at 0.11 ppb, 0.03 ppb, and 0.06 ppb, respectively. In samples collected near the station boundary, mercury was found in sediment at 0.42 ppm near the Ninth Street Landfill and at 0.18 ppm at the North End Landfill. Mercury was found in surface water at 0.24 ppb at the North End Landfill (Dames & Moore 1988; EA 1990, 1992; Brown and Root 1998).

#### *Evaluation of Potential Public Health Hazards*

No apparent public health hazards have been identified from fishing in streams at NASJRB and ARS or downstream of the station. Streams within NASJRB and ARS boundaries are intermittent and do not support a fish population suitable for consumption. The surface water and sediment samples collected at the edge of the station reflect contaminant concentrations in intermittent streams and do not represent concentrations available for bioaccumulation in fish. As chemicals are transported downstream in surface water and sediment, their concentrations are expected to be reduced by the physical processes of dispersion. Fishable waters—Little Neshaminy Creek and Pennypack Creek—are located 1.5 and 0.6 miles downstream of NASJRB and ARS, respectively. In addition, PFBC has implemented fish consumption advisories. These advisories are not based on specific concerns about NASJRB and ARS, rather these advisories (consumption of one fish meal per week) are based on statewide and nationwide mercury concerns and a watershed-wide concern about PCBs. PFBC has implemented more stringent fish consumption advisories for mercury in a number of waterbodies; neither Little Neshaminy Creek or Pennypack Creek were identified as needing more stringent restrictions. PFBC has also implemented a fish consumption advisory based on PCBs in Little Neshaminy Creek. Trout that are stocked in Little Neshaminy Creek and Pennypack Creek are stocked at their legal catch size. The need for annual re-stocking indicates that the fish remain resident in these creeks for a short period, during which time bioaccumulation would be minimal.

## COMMUNITY HEALTH CONCERNS

ATSDR identified community health concerns through meetings with Navy and USAF personnel and review of site documents, including RODs and Community Relations Plans. The following concerns were identified:

***Have exposures occurred or could they be occurring from contaminated water drawn from shallow private wells near the Fire Training Area or Antenna Field Landfill?***

The Fire Training Area and Antenna Field Landfill are located in the southern portion of NASJRB. Groundwater contamination from the Fire Training Area was identified as possibly affecting drinking water wells located along Horsham Road to the west. To address concerns about exposures to contaminants in private wells, the Navy collected samples from five private wells located along Horsham Road in 1996. These samples were analyzed for VOCs. One sampled contained 1,1-DCE at 2.8 ppb. In June 2000, a F-14 Tomcat crashed near the intersection of Horsham and Norristown Roads. Some of the wells sampled in 1996 were resampled in an effort to determine if fuels released during the F-14 Tomcat accident affected six nearby private wells. One sample contained 1,1-DCE at 0.27 ppb. 1,1-DCE was found in two different wells during the two sampling events. In both wells, the detected concentrations were above the CV for cancer effects (0.06 ppb), but below the CV for noncancer effects (90 ppb) and EPA's MCL (7 ppb) (GLA 1996; Foster Wheeler 2000).

The source of the 1,1-DCE is unknown. During the F-14 Tomcat crash, only fuels, which contain no 1,1-DCE, were released. In conducting evaluations of the Fire Training Area, the Navy found that the aerial extent of a groundwater plume originating at the site was contained within NASJRB's boundaries. This plume, therefore, is not the source of 1,1-DCE found in private wells (Navy 2001a).

As described in the "Exposure to Contaminants in Drinking Water" section of this PHA, ATSDR reviewed information on detected concentrations, potential exposure situations, and contaminant toxicology. Based on an evaluation of this information, ATSDR concluded that no apparent public health hazards are posed by exposure to contaminants found in private wells. Although exposures may have occurred, they were below levels expected to result in illness or other adverse health effects. The Navy is also continuing to investigate groundwater contamination found at the Fire Training Area. A FS, which outlines proposed remediation measures, is under development. The Navy will conduct remediation once remedial measures are approved by state and federal environmental protection agencies to prevent exposures to contaminants originating at the Fire Training Area (Navy 2001a).

***Could lead from the Water Tower Demolition project affect members of the town or workers on the station?***

In 1997, the Navy demolished a water tower located in the eastern portion of the station. Community members are concerned that lead released from the lead paint coating the water tower may harm the public and workers at NASJRB and ARS. After demolishing the water tower, the Navy excavated approximately 52 tons of surface soil (0 to 6 inches) located near the water tower to remove possible soil contamination. The Navy collected five soil samples and analyzed them for metals, including lead, to confirm that possible contamination was removed. No metals were found at levels of concern. The excavated soil was disposed off station at Waste Management Landfill in Morristown, Pennsylvania (Navy 2001b). The public and workers at NASJRB and ARS are not expected to be affected by lead paint from the water tower because the water tower and potentially contaminated soil have been removed from the station.

## ATSDR CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity results from a number of factors. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, potentially resulting in higher doses of chemical exposure per unit 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. Therefore, ATSDR is committed to evaluating their special interests at sites such as NASJRB and ARS as part of the ATSDR Child Health Initiative.

ATSDR has attempted to identify populations of children near NASJRB and ARS. Horsham Township, in which NASJRB and ARS are located, has a population of approximately 5,500 children ages 14 and younger. Warrington Township, which is located adjacent to NASJRB and ARS to the northeast, has a population of approximately 4,400 children ages 14 and under (U.S. Census Bureau 2001).

Like other people living or working at or near NASJRB and ARS, children may contact contaminated site media. As discussed in the “Evaluation of Environmental Contamination and Potential Exposure Situations” section of this PHA, past, current, and future exposures for children include contact with contaminants in drinking water, surface soil, surface water and sediment, and fish. After reviewing information for each of these potential exposures, **ATSDR concluded that exposure to site contamination does not pose unique health hazards for children.** This conclusion is based on ATSDR’s exposure evaluation and the following information:

- Although groundwater contamination is present at NASJRB and ARS, impacts to drinking water supply wells has been minimal. In the past, station supply wells contained TCE, PCE, arsenic, barium, and lead, but at levels below those expected to cause adverse health effects in adults or children. To prevent current and future exposures, a treatment system was installed and wells are tested regularly to ensure that state and federal drinking water standards are met. Community water supplies are operated by HWSA and WMA. HWSA wells nearest the station have been free of contamination. WMA wells nearest the station have contained low-levels of VOCs, however, this contamination is not attributable to NASJRB and ARS. As required under state and federal regulations, regular monitoring is conducted to ensure that drinking water standards are met. A caretaker house located on property adjacent to the Graeme Historic Site has a spring-fed well, which has infrequently been contaminated with fuel components. The source of this contamination was identified as surface water runoff containing fuel components from

vehicle maintenance areas on the property. The well is no longer used as a drinking water supply and the USAF is investigating remedial alternatives to prevent possible future impacts from the POL Area at ARS. Sampling of private wells along Horsham Road found two wells that contained 1,1-DCE at concentrations below health concern. The source of the 1,1-DCE is unknown. The Navy has found that groundwater contamination associated with the Fire Training Area, the nearest on-station source to these wells, is confined within station boundaries. The Navy is developing remedial actions to prevent off-station migration of this groundwater contamination plume.

- Surface soil contamination is located in several areas at the station, however, access to most of these areas is restricted. Children playing in the recreational areas near the Ninth Street Landfill may contact PAHs, dieldrin, arsenic, cadmium, and iron. An F-14 Tomcat crash released fuels to surface soil in an isolated off-station location. Children who may enter this area would contact benzo(a)pyrene, arsenic, and iron, which were found at levels below regulatory limits in topsoil used to backfill the crash site. At both the Ninth Street Landfill and the Aircraft Mishap Site, however, contaminant concentrations are below levels expected to cause adverse health effects during recreational use for both adults and children. No remediation at the Ninth Street Landfill or further actions at the Aircraft Mishap Site are planned because contaminant levels were below levels of concern.
- Contaminants were found in surface water and sediment in several locations at NASJRB and ARS, but like surface soil contamination, most contaminants were found in areas inaccessible to the public. Children playing at the recreational pond near the Ninth Street Landfill and in off-station streams may be exposed to PAHs, aldrin, dieldrin, and metals in surface water and/or sediment. Concentrations of these contaminants, however, are below levels expected to cause adverse health effects during recreational use. No remediation, therefore, is planned by the Navy or USAF.
- Children may also be exposed to contaminants accumulated in fish. Streams at NASJRB and ARS contain sediment and surface water contamination, but these streams are intermittent and support no edible fish population. When surface water is flowing, contaminants may move downstream of the station to fishing areas. Little Neshaminy Creek and Pennypack Creek are located 1.5 and 0.6 miles downstream of NASJRB and ARS, respectively, and are used for fishing. Only low levels of aldrin, dieldrin, and mercury, however, were found in surface water and sediment samples collected at the station boundaries. As these contaminants move downstream, concentrations would decrease further based on dispersion mechanisms. Contaminant levels in fishable streams would be expected to be at levels too low to collect in fish at harmful levels. In addition, fish consumption advisories for mercury and PCBs are in place. Although very low levels of mercury and PCBs have been found in media at NASJRB and ARS, their presence at NASJRB and ARS was not the cause for these fish advisories. These advisories are based

on the nationwide concern about mercury in fish and a watershed concern about PCBs in fish from Little Neshaminy Creek.

## **CONCLUSIONS**

Based on a review of available environmental information, ATSDR concludes that the exposure situations at NASJRB and ARS pose **no apparent public health hazards**. (For a description of ATSDR's hazard categories, see the Glossary, Appendix B.) Conclusions regarding media-specific exposures are as follows:

1. No apparent public health hazards are posed by contaminants found in groundwater at NASJRB and ARS. Levels of PCE, TCE, 1,1-DCE, arsenic, barium, and lead detected in station supply wells or off-station private wells were below levels associated with adverse health effects. Low-levels of fuel components were infrequently detected in the Graeme Historic Site well. No contaminants attributable to NASJRB and ARS have been found in community supply wells located near NASJRB and ARS. The Navy and USAF are conducting or investigating remediation measures to prevent current and future impacts to drinking water supplies.
2. No apparent public health hazards are associated with contaminants found in surface soil. Most areas of surface soil contamination are inaccessible to the public, therefore, no exposures occur at these locations. Station residents and/or the public may contact surface soil contamination at recreational areas near the Ninth Street Landfill and at the off-station Aircraft Mishap Site. In these locations, however, contaminant concentrations are below levels expected to result in illness or harm from exposures during past, current, or future recreational activities. No remediation at the Ninth Street Landfill or further actions at the Aircraft Mishap Site, therefore, are planned by the Navy.
3. No apparent public health hazards are associated with contaminants found in surface water or sediment. Similar to surface soil contamination, most areas of surface water and sediment contamination are inaccessible and no exposures are occurring. Exposures may occur at the recreational pond located near the Ninth Street Landfill and off-station streams. Surface water and sediment contamination levels found in the recreational pond, in off-station streams, and at the station boundaries, however, are below levels expected to result in illness or harm from exposures during past, current, or future recreational activities. No remediation, therefore, is planned by the Navy or USAF. The Navy and USAF, however, are planning or conducting remediation as necessary to address sources of contamination throughout NASJRB and ARS.
4. No apparent public health hazards were identified from consuming fish caught at NASJRB and ARS or downstream water bodies. Streams within the station boundaries are intermittent and, therefore, do not support an edible fish population. Little Neshaminy Creek and Pennypack Creek, downstream of the station, are used for fishing. Pesticides and mercury concentrations found at the station, however, are expected to disperse to concentrations too low to accumulate at levels of concern in fish in these creeks. Fish

consumption advisories are also in place, not because of concern about contaminants originating from NASJRB and ARS, but because of a nationwide concern about mercury in fish and a watershed concern about PCBs in fish. To prevent future migration of contamination beyond station boundaries, the Navy and USAF are planning or conducting remediation as necessary to address sources of contamination throughout NASJRB and ARS.

## **PUBLIC HEALTH ACTION PLAN**

The Public Health Action Plan (PHAP) for NASJRB and ARS describes actions taken and those to be taken by ATSDR, the Navy, and USAF subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards, but 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 or planned, and recommended are listed below.

### **Completed Actions**

1. The Navy and USAF have conducted environmental investigations to identify possible areas of contamination and to characterize the nature and extent of contamination at these areas. Investigation results have been reported in the 1988 RI for ARS, 1990 SI, 1992 Extended Site Inspection, and 1993 Phase I and 1998 Phase II RIs for NASJRB. Based on the results of these investigations, the Navy and USAF have recommended FSs to assess possible remediation, implemented remedial actions, or prepared no further response action documents.
1. PCB-containing soils were found at the Privet Road Landfill during site investigations. Although this site is inaccessible to the public, the Navy excavated and removed approximately 1,200 tons of soil from the site in 1999. Contaminated soils were disposed of off station. Excavation and removal activities were documented in the 1999 Close-out Report for PCB Removals at the Privet Road Landfill.
2. To address possible fuel and oil releases during the F-14 Tomcat crash, the Navy cleared damaged vegetation, covered the area with topsoil, reseeded and replanted disturbed areas, and repaired a fence damaged by the crash and remediation efforts. A Remedial Action Completion Report documenting these actions was issued in September 2000.

## **Ongoing or Planned Actions**

1. To address contamination found in station supply wells, the Navy operates an air stripping unit to remove contaminants from the water supply prior to distribution. As the Navy receives and allocates funding, ongoing investigations and proposed remediation activities are occurring or will occur at the Privet Road Compound, Fire Training Area, Ninth Street Landfill, and other sites as necessary. Groundwater monitoring is also conducted at areas of concern—where contamination may impact drinking water supplies—throughout the station. At the Navy Fuel Farm, a vacuum-enhanced light non-aqueous phase liquid (LNAPL) and groundwater recovery and treatment system has operated since 1998. This system removes LNAPL floating on the surface of the groundwater and treats groundwater to remove dissolved chemicals (EA 2001). The USAF is continuing to address groundwater contamination associated with the POL Area. Past remediation efforts have had limited success. Currently, the USAF is proposing remediation in three phases. Phase I includes additional sampling to characterize current groundwater conditions, Phase II includes in-situ chemical oxidation and enhanced in-situ bioremediation, and Phase III includes expanded enhanced in-situ bioremediation, if needed.
  
1. The USAF installed absorbent booms in the Ponding Basin at the outfall to off-station streams to capture fuel contamination that may enter the basin with surface water runoff. These booms are replaced twice a year, or more frequently if needed. In addition, the USAF conducts monthly sampling and monitoring of the Ponding Basin outfall to ensure that parameters set forth in a National Pollution Discharge Elimination System permit are met (USAF 2001a).
  
1. The Navy is in the process of developing an FS to address contamination found at the Fire Training Area. The preferred remediation measures outlined in the FS will be reviewed and approved by state and federal environmental protection agencies.

## **Recommended Actions**

1. If new information from monitoring or future site investigations identifies pathways of contaminant exposure that may result in adverse effects on public health, ATSDR can, if requested, review the additional information and make recommendations for the protection of public health. ATSDR will also re-evaluate the potential for public health hazards if changes in station land uses or remedial activities may lead to future exposures that result in adverse effects on public health.
  
2. ATSDR supports Navy and USAF efforts to implement groundwater treatment technologies, operate the treatment system serving the station water supply system, and

conduct ongoing monitoring. These efforts will minimize or prevent current and future exposures to contaminants originating at NASJRB and ARS.

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## **TABLES**

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
Naval Air Station Joint Reserve Base (NASJRB) Site 1- Privet Road Compound	The Privet Road compound is located west of Building No. 6, in the northern corner of the station. The compound was used as a transfer station for wastes after the closure of the Ninth Street Landfill in 1967. The Privet Road Compound operated between 1967 and 1975 and was used as an open disposal area where appreciable quantities of waste were burned and buried.	<p>Sampling was conducted as part of the 1990 Site Inspection (SI), 1993 Phase I Remedial Investigation (RI), and 1998 Phase II RI. The following contaminants were found above comparison values (CVs):</p> <p><b>Surface Soil:</b> Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dieldrin, polychlorinated biphenyls (PCBs), arsenic, and iron.</p> <p><b>Groundwater:</b> Carbon tetrachloride, 1,1-dichloroethene (1,1-DCE), methylene chloride, tetrachloroethylene (PCE), trichloroethene (TCE), bis(2-ethylhexyl)phthalate (BEHP), dieldrin, Aroclor-1260, aluminum, arsenic, chromium, cadmium, iron, lead, manganese, and vanadium.</p> <p><b>Surface Water:</b> Acetone, 4-methyl-2-pentanone, and antimony.</p> <p><b>Sediment:</b> Benzo(a)pyrene, dieldrin, Aroclor-1260, arsenic, chromium, and iron.</p>	<p>The compound is currently fenced. PCB-containing soils were removed and disposed off site in 1999. Approximately 1,200 tons of soil were removed to achieve cleanup levels of 1 part per million (ppm). This site was initially identified as a potential source of volatile organic compounds (VOCs) found in station water supply wells. As such, the Phase II RI recommended completion of a Feasibility Study (FS) to address contamination. Later studies found that the Privet Road Compound is not a source of station well contamination. Regardless, an FS is currently under development. Groundwater monitoring is ongoing, and an air stripper removes VOCs from the station's drinking water supply.</p>	<p><b>Surface Soil:</b> No apparent public health hazard is associated with soil. Access restrictions have been implemented to prevent current and future exposures.</p> <p><b>Groundwater:</b> No apparent public health hazard is associated with groundwater contamination. Past exposures to VOCs in drinking water were below levels of health concern and treatment systems are in place to prevent current and future exposures.</p> <p><b>Surface Water/Sediment:</b> No apparent health hazard was identified. Contaminants were detected infrequently and exposures are expected to be infrequent and of short duration.</p>

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 2- Antenna Field Landfill	The Antenna Field Landfill, located in the southern portion of NASJRB, was used between 1948 and 1960 as the principal area of disposal for solid waste generated by the station. Landfilling procedures consisted of trench excavation, followed by burning and burial of waste. After landfilling operations ceased, the area was regraded with a soil cover and vegetated with grass.	An SI was completed in 1990 and Phase I and II RIs were completed in 1993 and 1998, respectively. The following contaminants were found above CVs: <b>Surface Soil:</b> Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dieldrin, arsenic and iron. <b>Groundwater:</b> Benzene, methylene chloride, 1,1-dichloroethene, PCE, BEHP, dieldrin, arsenic, barium, beryllium, cadmium, iron, lead, manganese, and thallium. <b>Surface Water:</b> Methylene chloride, BEHP, dieldrin, arsenic, cadmium, and manganese. <b>Sediment:</b> Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dieldrin, arsenic, iron, lead, and manganese.	Based on sampling results and evaluations conducted under the Phase I and II RIs, the U.S. Navy (Navy) determined that no remedial actions are necessary at the Antenna Field Landfill. Only low-levels of contaminants were found in soil, surface water, and sediment and no exposure routes were identified for groundwater contamination.	<b>Surface Soil:</b> No public health hazard was identified because access to this site was and is restricted. <b>Groundwater:</b> No public health hazards are associated with groundwater contamination. Groundwater in this area is not used as a drinking water supply. <b>Surface Water/ Sediment:</b> No apparent public health hazard from exposure to surface water and sediment was identified because contaminants were detected infrequently and access to the site was and is restricted.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 3- Ninth Street Landfill	The Ninth Street Landfill is located along the western side of NASJRB, north of Ninth Street. The landfill was used as a disposal area after the Antenna Field Landfill closed in 1960. Wastes disposed in the landfill include TCE, paint wastes, asbestos, PCB fluids, general refuse, metal scrap, sewage sludge, and industrial paint sludge. Landfill operations included dumping and burning the waste, then covering the trench. This area is currently used as a recreational area for station personnel.	An SI was completed in 1990. Phase I RI monitoring of surface soil, groundwater, surface water, and sediment began in 1991. Phase II RI monitoring was conducted in 1997. The following contaminants were found above CVs: <b>Surface Soil:</b> Benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, dieldrin, arsenic, cadmium, and iron. <b>Groundwater:</b> Methylene chloride, PCE, 1,1,2,2-tetrachloroethane, TCE, BEHP, arsenic, barium, cadmium, chromium, iron, lead, and manganese. <b>Surface Water:</b> Methylene chloride, BEHP, dieldrin, antimony, arsenic, cadmium, chromium, iron, lead, manganese, and zinc. <b>Sediment:</b> Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, aldrin, dieldrin, antimony, arsenic, cadmium, chromium, cyanide, iron, lead, mercury, thallium, and vanadium.	The Navy determined, based on sampling data generated during the Phase I and II RIs, that no further remedial actions were necessary to address contamination in soil. Additional investigations were necessary to address possible ecological impacts of sediment contamination. Development of an FS addressing groundwater contamination above the U.S. Environmental Protection Agency's (EPA) Maximum Contaminant Levels (MCLs) was also recommended. This FS will be prepared when funding is allocated, likely after the completion of an FS for the Fire Training Area.	<b>Surface Soil:</b> No apparent public health hazards were identified. Contaminant concentrations were below levels expected to cause health effects during recreational use of the site. <b>Groundwater:</b> No public health hazards are associated with groundwater contamination. Groundwater in this area is not used as a drinking water supply. <b>Surface Water/Sediment:</b> No apparent public health hazard was identified because exposures are expected to be infrequent during recreational use of the site.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 4- North End Landfill	The North End Landfill lies on 3.5 acres on the north end of Runway 15/33. The landfill was active from 1967 to 1969, and was used to dispose of overflow from Privet Road Compound.	<p>Sampling was conducted at North End Landfill as part of the 1990 SI. The following contaminants were found above CVs:</p> <p><b>Surface Soil:</b> Arsenic, thallium, and vanadium.</p> <p><b>Groundwater:</b> Methylene chloride, BEHP, dieldrin, antimony, arsenic, barium, cadmium, iron, and manganese.</p> <p><b>Surface Water:</b> Dieldrin, antimony, arsenic, and lead.</p> <p><b>Sediment:</b> Dieldrin, arsenic, and iron.</p>	No further action was proposed for this site. Contaminants were determined to originate from sources other than the landfill. Groundwater concentrations of dieldrin were attributed to surface water infiltration during flooding.	<p><b>Surface Soil:</b> No public health hazard was identified. The site is located in a remote portion of the station and landfill capping has limited current and future exposures.</p> <p><b>Groundwater:</b> No public health hazard was identified. Groundwater contamination is the result of up gradient sources and groundwater in this area is not used as a drinking water supply.</p> <p><b>Surface Water/Sediment:</b> No public health hazard was identified. This site is located in a remote area not expected to be accessed by the public.</p>

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 5- Fire Training Area	The Fire Training Area is located in the south-central area of NASJRB, between Runway 10/28 and State Route 463. The area was used from 1942 to 1975 for firefighting exercises, including the disposal and burning of flammable liquid wastes. Wastes were generated by NASJRB and included solvents, paint chemicals, xylenes, toluene, and various petroleum compounds. At least 4,000 gallons of these compounds were burned per year.	This area was evaluated during the 1990 SI and the 1993 and 1998 RIs. The following contaminants were found above CVs: <b>Surface Soil:</b> Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dieldrin, arsenic, and lead. <b>Groundwater:</b> Benzene, 1,1-dichloroethene, 1,2-dichloroethane, PCE, 1,1,1-trichloroethane, 1,1,2-trichloroethane, TCE, dieldrin, arsenic, barium, and chromium. <b>Surface Water:</b> Arsenic and dieldrin. <b>Sediment:</b> Arsenic, dieldrin, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.	An FS was recommended in 1998 to evaluate removal and treatment options for polycyclic aromatic hydrocarbon (PAH) hot spots in soil and contaminants in groundwater. This FS is currently under development. The Navy will select and complete remedial actions with oversight of state and federal environmental protection agencies. No further action was recommended for surface water and sediment.	<b>Surface Soil:</b> No public health hazards were identified because this site is located in a remote part of the station and access by the public is not expected. <b>Groundwater:</b> No public health hazards are associated with groundwater contamination. Studies indicate that the groundwater plume has not affected drinking water wells and the Navy is investigating remediation options to prevent future well impacts. <b>Surface Water/Sediment:</b> No public health hazard was identified because the site is located in a remote part of the station and contaminants were infrequently detected.
NASJRB Site 6- Abandoned Rifle Range #1	This rifle range was constructed when NASJRB was commissioned in 1942 and operated until 1953. The rifle range occupies 1 acre and is located west of the Marine Compound and immediately adjacent to Horsham Road.	<b>Soil:</b> Investigations during the 1990 SI estimated that approximately 345 pounds of lead remained. Soil samples were collected near the Abandoned Rifle Range #1 during construction of the Marine Compound. These samples were analyzed for lead, which was found at levels below CVs.	No further action was proposed for this site.	<b>Soil:</b> No apparent public health hazard was identified. No lead contamination was found during sampling. Past exposure during use of the range was expected to be infrequent and of short duration.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 7- Abandoned Rifle Range #2	Abandoned Rifle Range #2 is located west of the north end of Runway 15/33. The site occupies 1 acre and was used from 1965 to 1977. After closure of the firing range, the site was used as a landfill for inert construction and demolition debris, as well as wastewater treatment sludge and emulsified oil and grease.	SI sampling was completed in 1990 and a Extended Site Investigation (ESI) was completed in 1992. <b>Surface Soil:</b> Arsenic and iron were found above CVs. Sampling found lead at levels below its CV. <b>Groundwater:</b> Methylene chloride, BEHP, arsenic, barium, beryllium, cadmium, iron, lead, manganese, nickel, and vanadium were detected above CVs.	Based on the results of the ESI, no further investigation was recommended. Approximately 180 pounds of lead may lie buried in soil less than 12 inches from the surface.	<b>Surface Soil:</b> No apparent public health hazard was identified. Exposure is expected to be infrequent and of short duration. <b>Groundwater:</b> No public health hazard was identified; contaminants were detected infrequently and groundwater at the site is not used as drinking water supply.
NASJRB Site 8- Building #118 Abandoned Fuel Tank	Building #118 and its 500-gallon underground storage tank (UST) are located in the northeast area of NASJRB. The tank was constructed in 1959. Oil seepage from the tank was discovered in 1980. In 1980, the UST was replaced with a 290-gallon above ground storage tank (AST).	A soil vapor survey was conducted in 1988. No detectable levels of contaminants were found.	No further action at this site was proposed since no contamination above levels of concern was found.	No contamination has been found at this site, therefore, no health hazards were identified.
NASJRB Site 9- Steam Plant Building #6, Tank Overfill	In 1978, a supplier delivering a load of fuel oil mistakenly hooked up to a full above ground storage tank. Between 3,000 and 5,000 gallons of No.2 fuel oil spilled on the ground.	A soil vapor survey was conducted in 1988. No detectable levels of contaminants were found.	No further action was proposed at this site since no contamination above levels of concern was identified.	No contamination has been found at this site, therefore, no health hazards were identified.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
NASJRB Site 10- Navy Fuel Farm	The Navy Fuel Farm is located along the north side of Privet Road and south of the Air Reserve Station (ARS). Two partially buried 210,000 gallon fuel tanks were located at this site from 1950 to 1991. ASTs were installed in 1991 to replace the removed tanks.	A soil vapor survey was conducted in 1988 and led to subsurface soil and groundwater sampling in 1989. <b>Surface Soil:</b> No surface soil sampling has been conducted. No contaminants were found above CVs in subsurface soil samples. <b>Groundwater:</b> Acetone, benzene, methylene chloride, and TCE were detected above CVs.	The Navy conducted pilot studies between 1994 and 1996 to identify means of remediating fuel oils floating on the groundwater table. As a result, a vacuum-enhanced fuel oil and groundwater recovery and treatment system was installed and has been operating since 1998.	<b>Surface Soil:</b> No apparent health hazard was identified. The Fuel Farm is not expected to be accessed by the public and contamination is mainly limited to the subsurface. <b>Groundwater:</b> No apparent public health hazards were identified. Groundwater remediation is underway and no impacts to drinking water supplies were reported in the past.
NASJRB Site 11- Aircraft Apron Parking	The Aircraft Apron Parking site was identified in the mid-1990s during a construction project along the runway apron in the northeastern portion of NASJRB (north of the Navy Fuel Farm). Markings on the concrete suggest that aircraft defueling occurred in this area.	<b>Soil:</b> Soil samples were collected during construction in the mid-1990s. Analysis of these samples found fuel products.	Soil excavation was conducted as part of the construction project. No other remedial actions have been completed. This site was assigned a low-priority.	<b>Soil:</b> No apparent public health hazards were identified because the area is not accessible to the public. No exposures are expected to occur.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
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Aircraft Mishap Site	In June 2000, an F-14 Tomcat crashed in an isolated 10-acre area located northwest of NASJRB and ARS. The plane was carrying approximately 1,300 gallons of fuel oil and 20 gallons of hydraulic fluid at the time of the crash. Although most of the fuel and oil was expected to burn during the crash, some may have been released to the environment.	The Navy collected surface soil, private well water, and standing water when characterizing environmental impacts of the crash. <b>Surface Soil:</b> No contaminants were found above CVs. Topsoil used to cover the crash area contained benzo(a)pyrene, arsenic, and iron slightly above CVs. <b>Private Well:</b> One well contained 1,1-DCE above its CV. 1,1-DCE is not a component of fuel or hydraulic fluid. Its presence, therefore, is not a result of the aircraft crash. <b>Standing Water:</b> Benzene was found above its CV.	To address possible fuel and oil releases, the Navy cleared damaged vegetation, covered the area with topsoil, reseeded and replanted disturbed areas, and repaired a fence damaged by the crash and remediation efforts. A Remedial Action Completion Report was issued in September 2000.	<b>Surface Soil:</b> No apparent health hazard was identified because the site is located in an isolated area. Exposures to contaminants in the topsoil are expected to be infrequent. <b>Private Well:</b> No apparent health hazards were found from use of nearby private wells. Only one well contained contamination, which was found at levels below health concerns. <b>Standing Water:</b> No apparent health hazard was identified because standing water was only present due to heavy rainfall. Exposures are expected to be infrequent.

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ARS Site 1- Petroleum, Oil, and Lubricant (POL) Area	The POL Area is located in the northern section of the station, between the Open Storage Area and the Ponding Basin. Four ASTs are present at the site. They have been used to store jet petroleum No. 4 (JP-4), JP-8, aviation oil, and No. 6 fuel oil. It is estimated that tens of thousands of gallons of JP-4 may have been spilled throughout its history; one spill of 9,000 gallons has been recorded.	<p>A 1988 RI confirmed groundwater contamination resulting from JP-4 leaks.</p> <p><b>Surface Soil:</b> Arsenic was found above its CV.</p> <p><b>Groundwater:</b> RI sampling found benzene, ethylbenzene, methylene chloride, toluene, naphthalene, and arsenic above CVs. In 1992, free-phase JP-4 was discovered floating on groundwater.</p> <p><b>Surface Water/Sediment:</b> Naphthalene was detected above its CV. However, no contaminants were found above CVs in samples collected beyond station boundaries. In 1992, free product was found floating on surface water in Park Creek, outside the station boundary.</p> <p><b>Drinking Water:</b> Monthly sampling, beginning in the 1990s and continuing today, has found only low-levels of fuel components in a well at the caretaker house adjacent to the Graeme Historic Site. Detections occurred only during flooding events.</p>	Remediation efforts conducted at the POL Area to date have had limited success. Based on the 1988 RI, the U.S. Air Force (USAF) completed a FS in March 1989 and Record of Decision (ROD) in 1990. The ROD was not implemented because contamination was later found to be more extensive than defined by the RI. In response to the free product discovery, a soil vapor extraction (SVE) system and passive recovery trench were implemented, but were ineffective. A SVE/ groundwater extraction system and passive aerobic bioremediation technology (oxygen release compound) have also been tested with limited success. The USAF is currently planning additional sampling followed by in-situ chemical oxidation and enhanced in situ bioremediation.	<p><b>Surface Soil:</b> No apparent public health hazards were identified. The public is not expected to this area.</p> <p><b>Groundwater:</b> No apparent public health hazards are associated with groundwater contamination. Other than the Graeme Historical Site well, no drinking water wells are located in this area. The USAF is investigating remedial alternatives to prevent future exposures.</p> <p><b>Surface Water/Sediment:</b> No contaminants were found in surface water and sediment collected beyond station boundaries, where exposure would occur. As such, no apparent public health hazards were identified.</p> <p><b>Drinking Water:</b> The spring at the caretaker house on land adjacent to the Graeme Historic Site is no longer used as a drinking water. Infrequent exposure to past contamination is not expected to result in adverse health effects.</p>

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
ARS Site 2- Open Storage Area	The Open Storage Area is located along the northern boundary of the station. This 150 foot by 200 foot area was used from 1957 to the 1970s to store equipment and drums of hazardous substances, including oils, fluids, solvents, and batteries. Approximately every three months, materials stored at the site were removed.	An RI was completed in 1988. The following contaminants were found above CVs: <b>Surface Soil:</b> Arsenic. <b>Groundwater:</b> Benzene, ethylbenzene, methylene chloride, and arsenic.	Sampling during the 1988 RI indicated that contamination at the Open Storage Area was a result of POL Area contaminant migration. A no further response action plan (NFRAP) was written in August 1988, but was never approved. Results from more recent data collection efforts will be used to update the NFRAP.	<b>Surface Soil:</b> No apparent public health hazard was identified because access to the site is limited. <b>Groundwater:</b> See the POL Area (ARS Site 1).
ARS Site 3- Ponding Basin	The Ponding Basin, a man-made catchment pond, was created in 1957 and enlarged in 1979 to 5.8 million gallons. Contaminants associated with the area include petroleum, oils, lubricants, solvents, heavy metals, and PCBs.	A RI was completed in 1988. The following contaminants were found above CVs: <b>Groundwater:</b> Benzene, benzidine, ethylbenzene, toluene, naphthalene, and arsenic. <b>Surface Water:</b> Methylene chloride. <b>Sediment:</b> Benzidine, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and arsenic.	Absorbent booms are in place at the outfall of the Ponding Basin to capture floating fuel products entering the basin in surface water runoff. These booms are replaced at least twice a year. Monthly sampling and monitoring is conducted as well to ensure compliance with discharge permits. An NFRAP was written in August 1988, but was never approved. A removal action was completed in October 2000. Results from more recent data collection efforts will be used to update the NFRAP.	<b>Groundwater:</b> See the POL Area (ARS Site 1). <b>Surface Water/Sediment:</b> No apparent public health hazards were identified. The area is inaccessible to the public and off-station samples contained no contaminants above CVs.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
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ARS Site 4- Washrack Area	The Washrack Area is located southeast of Hangar 201 and is used to wash aircraft and strip paint. Detergent, solvent, and paint strippers have been discharged to the disposal system.	SI sampling was completed in 1990; ESI sampling in 1992. <b>Surface Soil:</b> No contaminants were found above CVs. <b>Groundwater:</b> TCE and 1,1-DCE were detected above CVs.	Based on the results of the 1992 ESI, an NFRAP was written in January 1993. Under the direction of EPA, the USAF completed a Source Identification Study at this site in 1999. Result of this study are undergoing EPA review.	<b>Surface Soil:</b> No apparent public health hazard was identified. Site access to the public is limited. <b>Groundwater:</b> No apparent public health hazards were identified. The Washrack Area was not identified as the source of TCE in groundwater found in the intermediate depth aquifer. In addition, groundwater in this area is not used as drinking water.
ARS Site 5- Building No. 330 Waste Oil Storage Area	The Waste Oil Storage Area is a small area behind Building No. 330, with an AST that was used between 1970 and 1980. Overfilling and spills associated with the AST have resulted in releases of contamination.	SI sampling was completed in 1990. <b>Soil:</b> Composite soil samples were collected and contained no contaminants above CVs.	Based on the results of the SI, a NFRAP decision was written in August 1990.	<b>Surface Soil:</b> No apparent public health hazard was identified. Access to the site was and is limited.
ARS Site 6- Heating Plant	Two ASTs are located in this area, one 15,000 gallons and one 600 gallons. In 1984, a 50-gallon fuel oil spill occurred when one of the ASTs was overfilled. Other chemicals have been stored in miscellaneous drums in and around the area. It was concluded that spills or leaks could have occurred.	Soil vapor sampling completed as part of the 1990 SI found no detectable levels of VOCs.	Based on the results of the SI, an NFRAP decision was written in June 1990, but was never approved. Results from more recent data collection efforts will be used to update the NFRAP.	No apparent public health hazard was identified. No contaminants have been found during investigations and spill containment walls control any discharge.

<b>Table 1. Evaluation of Public Health Hazards at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>				
<b>Site</b>	<b>Site Description/Waste Disposal History</b>	<b>Investigation Results/ Environmental Monitoring Results</b>	<b>Corrective Activities and/or Current Status</b>	<b>Evaluation of Public Health Hazard</b>
ARS Site 7-Old Well House	The Old Well House is a building located in the northern portion of the station. Beginning in 1972, the building was used for storing wastes, including paint, paint thinner, laquer thinner, and paint wastes. A well was installed in 1962, but was never used and was closed by capping and sealing soon after installation.	The former supply well was sampled during the December 2000 SI. Several metals were found above CVs, but no elevated levels of VOCs or SVOCs were found.	The pump was removed and the well was capped in 1962. Based on the results of the SI, an NFRAP decision was written in June 1990, but was never approved. Results from more recent data collection efforts will be used to update the NFRAP.	No public health hazards were identified because the well at this site was never used to supply water and the building is inaccessible to the public.

Sources: ATSDR 1996; Brown and Root 1998; Dames & Moore 1988; EA 1990, 1992, 2001; Foster Wheeler 1999, 2000; Halliburton NUS 1992, 1993; USAF 2000, 2001a, 2001b, 2001c; Navy 2000, 2001a, 2001b, 2001c; Montgomery Watson 1998; WGARS 1995; WrightLab 1994

Notes:

ARS	Air Reserve Station	PAH	polycyclic aromatic hydrocarbon
AST	above ground storage tank	ppm	parts per million
BEHP	bis(2-ethylhexyl)phthalate	PCB	polychlorinated biphenyl
CV	comparison value	PCE	tetrachloroethylene
1,1-DCE	1,1-dichloroethene	POL	petroleum, oil, and lubricant
EPA	U. S. Environmental Protection Agency	RI	remedial investigation
ESI	extended site investigation	ROD	record of decision
FS	feasibility study	SI	site investigation
JP-4	jet petroleum No. 4	SVE	soil vapor extraction
MCL	maximum contaminant level	TCE	trichloroethylene
NASJRB	Naval Air Station Joint Reserve Base	USAF	U. S. Air Force
Navy	U.S. Navy	UST	underground storage tank
NFRAP	No further response action planned	VOC	volatile organic compound

**Table 2: Potential Exposure Situations at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove**

Pathway Name	Exposure Pathway Elements						Comments
	Contaminant	Environmental Medium	Point of Exposure	Route of Exposure	Time of Exposure	Exposed Population	
Exposure to Contaminants in Drinking Water	Trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1-dichloroethene (1,1-DCE), arsenic, barium, and lead	Groundwater	Station supply wells, community supply wells, and private wells	Ingestion, dermal contact, and inhalation of volatiles	Past (all wells) and current and future (private wells only)	Station and local residents	No apparent public health hazards were identified. Concentrations of TCE, PCE, arsenic, barium, and lead detected in the past at station water supply wells were below levels expected to cause adverse health effects in adults or children. A treatment system was installed to address this contamination. Community water supply wells operated by the Horsham Water and Sewer Authority and Warrington Municipal Authority and located proximate to the Naval Air Station Joint Reserve Base (NASJRB) and Air Reserve Station (ARS) have not been impacted by NASJRB and ARS. As required under state and federal regulations, station and community water supplies are monitored regularly to ensure that safe drinking water standards are met. Sampling of private wells along Horsham Road found two wells that contained 1,1-DCE at concentrations below health concern.

<b>Table 2: Potential Exposure Situations at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove</b>							
	<b>Exposure Pathway Elements</b>						
<b>Pathway Name</b>	<b>Contaminant</b>	<b>Environmental Medium</b>	<b>Point of Exposure</b>	<b>Route of Exposure</b>	<b>Time of Exposure</b>	<b>Exposed Population</b>	<b>Comments</b>
Exposure to Contaminants in Surface Soil	Polycyclic aromatic hydrocarbons (PAHs), dieldrin, arsenic, and iron	Surface soil	Ninth Street Landfill and Aircraft Mishap Site	Incidental ingestion and dermal contact	Past, current, and future	Station and local residents	No apparent public health hazards were identified. Chemical concentrations are slightly higher than the Agency for Toxic Substances and Disease Registry's (ATSDR's) comparison values (CVs), which are developed assuming daily contact. Contact with surface soil contamination during recreational use of these sites is expected to be much less frequent and is not expected to result in adverse health effects.
Exposure to Contaminants in Surface Water and Sediment	PAHs, aldrin, dieldrin, and metals	Surface water and sediment	Recreational pond at the Ninth Street Landfill and off-station streams	Incidental ingestion and dermal contact	Past, current, and future	Station and local residents	No apparent public health hazards were identified. Most contaminants were found in areas inaccessible to the public. Contaminants found at the recreational pond near the Ninth Street Landfill and in off-station streams are below levels expected to cause adverse health effects during recreational use.

Table 2: Potential Exposure Situations at the Naval Air Station Joint Reserve Base and Air Force Reserve Station at Willow Grove							
Pathway Name	Exposure Pathway Elements						Comments
	Contaminant	Environmental Medium	Point of Exposure	Route of Exposure	Time of Exposure	Exposed Population	
Exposure to Contaminants in Fish	Aldrin, dieldrin, and mercury	Fish tissue	Little Neshaminy Creek and Pennypack Creek	Ingestion	Past, current, and future	Fishers and their families	No apparent public health hazards were identified. Flow in on-station streams is too low to support an edible fish population. Consumption of fish caught in the recreational pond near the Ninth Street Landfill is prohibited. Pesticides and mercury transported off station to Little Neshaminy Creek and Pennypack Creek, downstream of the station, are expected to disperse to concentrations too low to accumulate at levels of concern in fish in these creeks. Fish consumption advisories are also in place based on a nationwide concern about mercury in fish and a watershed concern about polychlorinated biphenyls in fish, and not because of specific concerns about sources at NASJRB and ARS.

Notes:

ARS Air Reserve Station  
 ATSDR Agency for Toxic Substances and Disease Registry  
 CV comparison value  
 1,1-DCE1,1-dichloroethene  
 NASJRB Naval Air Station Joint Reserve Base  
 PAH polycyclic aromatic hydrocarbon  
 PCE tetrachloroethylene

TCE trichloroethylene

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**Table 3: Summary of Drinking Water Supply Data that Exceed Comparison Values**

Contaminant	Impacted Well	Source of Contamination Impacting Well	Maximum Detected Concentration (ppb)	Comparison Values	
				Value (ppb)	Source
<i>Station Supply Wells</i>					
Tetrachloroethylene	Navy Wells #1 and #2, Air Force Well #3	unknown, suspected source is located off station to the north	91.1	5	MCL
Trichloroethylene			300	5	MCL
Arsenic			22	0.02 3	CREG EMEG-child

**Table 3: Summary of Drinking Water Supply Data that Exceed Comparison Values**

Contaminant	Impacted Well	Source of Contamination Impacting Well	Maximum Detected Concentration (ppb)	Comparison Values	
				Value (ppb)	Source
Barium			1,190	700	RMEG-child
Lead			20	15	MCL action level
<i>Off-site Private Wells</i>					
Fuel components	Graeme Historic Site		unknown	not applicable	not applicable
1,1-Dichloroethene	Horsham Road	unknown	2.8	0.06 90	CREG EMEG-child

**Table 3: Summary of Drinking Water Supply Data that Exceed Comparison Values**

Contaminant	Impacted Well	Source of Contamination Impacting Well	Maximum Detected Concentration (ppb)	Comparison Values	
				Value (ppb)	Source
1,1-Dichloroethene	Near Aircraft Mishap Site, Horsham Road	unknown	0.27	0.06 90	CREG EMEG-child

Source: Dames & Moore, 1988; Montgomery Watson 1998; Foster Wheeler 2000; GLA 1996; HWSA 2000, 2001; Earth Data 1985; WGNAS 1980; ATSDR 1996; Brown and Root 1998; WGNAS 1999

Notes:

-child comparison value for exposure to a child  
 CREG Cancer Risk Evaluation Guide  
 EMEG Environmental Media Evaluation Guide  
 MCL U.S. Environmental Protection Agency's Maximum Contaminant Level  
 ppb parts per billion  
 RMEG Reference Dose Media Evaluation Guide

<b>Table 4: Summary of Surface Soil Sampling Data That Exceed Comparison Values</b>				
<b>Chemical</b>	<b>Frequency of Detection*</b>	<b>Range of Detected Concentrations (ppm)</b>	<b>Comparison Value (ppm)</b>	<b>Source</b>
<i>NAS Site 3 - Ninth Street Landfill</i>				
Benzo(a)pyrene	16/28	0.043 - 1.1	0.1 0.087	CREG RBC
Benzo(b)fluoranthene	21/28	0.045 - 1.4	0.87	RBC
Dibenz(a,h)anthracene	1/28	0.15	0.087	RBC
Dieldrin	22/27	0.0045 - 0.62	0.04 3	CREG EMEG-child
Arsenic	21/21	0.37 - 8.6	0.5 20	CREG EMEG-child
Cadmium	2/26	1.9 - 18.4	10	EMEG-child
Iron	28/28	14,300 - 27,200	23,000	RBC
<i>Aircraft Mishap Site (topsoil)</i>				
Benzo(a) pyrene	1/1	0.35	0.1 0.087	CREG RBC
Arsenic	1/1	7.6	0.5 20	CREG EMEG-child
Iron	1/1	23,300	23,000	RBC

Source: Brown and Root 1998; Foster Wheeler 2000

Notes:

-child comparison value for exposure to a child

CREG Cancer Risk Evaluation Guide

EMEG Environmental Medial Evaluation Guide

ppm parts per million

RBC U.S. Environmental Protection Agency (EPA) Region III Risk-Based Concentration

\* Frequency of detection is the times detected / times sought

**Table 5: Summary of Surface Water and Sediment Sampling Data from the Recreational Pond that Exceed Comparison Values**

Chemical	Frequency of Detection*	Range of Detected Concentrations	Comparison Value <sup>+</sup>	Source
<i>Surface Water (parts per billion)</i>				
Dieldrin	3/16	0.02 - 0.06	0.002 0.5	CREG EMEG-child
Antimony	3/16	44.8 - 73.3	4	RMEG-child
Arsenic	3/15	1.6 - 2	0.02 3	CREG EMEG-child
Chromium	2/16	3.2 - 245	30	RMEG-child
Lead	15/16	1.1 - 83.5	15	MCL action level
Manganese	16/16	37.8 - 5,710	500	RMEG-child
Zinc	15/16	6.5 - 11,700	3,000	RMEG-child
<i>Sediment (parts per million)</i>				
Benzo(a)anthracene	11/19	0.13 - 14	0.87	RBC
Benzo(a)pyrene	11/19	0.18 - 12	0.1 0.087	CREG RBC
Benzo(b)fluoranthene	13/19	0.049 - 12	0.87	RBC
Benzo(k)fluoranthene	7/10	0.13 - 10	8.7	RBC
Dibenz(a,h)anthracene	3/19	0.136 - 0.41	0.087	RBC
Indeno(1,2,3-c,d)pyrene	11/19	0.014 - 8	0.87	RBC
Aldrin	3/9	0.0064 - 0.12	0.04 2	CREG EMEG-child
Dieldrin	12/17	0.031 - 1.4	0.04 3	CREG EMEG-child
Antimony	5/18	5.7 - 30.9	20	RMEG-child
Arsenic	15/15	1.1 - 7.4	0.5 20	CREG EMEG-child
Cadmium	14/19	0.61 - 24	10	EMEG-child
Chromium	17/17	8.5 - 256	200	RMEG-child
Cyanide	2/19	0.17 - 30,700	1,000	RMEG-child
Iron	19/19	279 - 30,100	23,000	RBC
Lead	19/19	5.4 - 3,690	400	SSL
Mercury	4/19	0.11 - 30.2	23	SSL
Thallium	6/19	0.15 - 61.2	5.5	RBC
Vanadium	19/19	11.9 - 208	200	iEMEG-child

Source: EA 1990; Brown and Root 1998

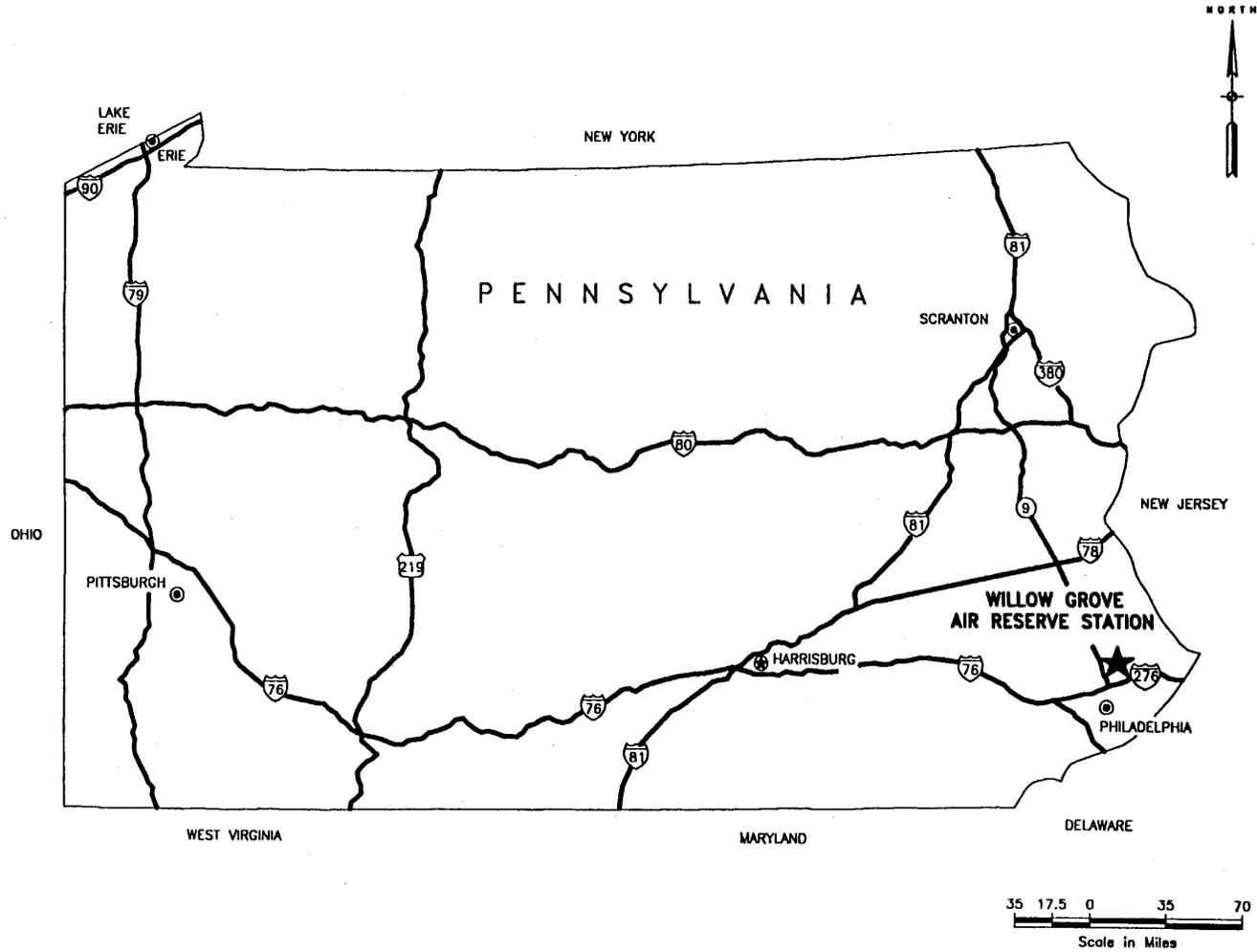
Notes:

-child comparison value for exposure to a child  
CREG Cancer Risk Evaluation Guide  
EMEG Environmental Media Evaluation Guide  
i intermediate  
ppb parts per billion  
ppm parts per million  
RBC Environmental Protection Agency (EPA) Region III Risk-Based Concentration  
RMEG Reference Dose Media Evaluation Guide  
SSL Soil Screening Level

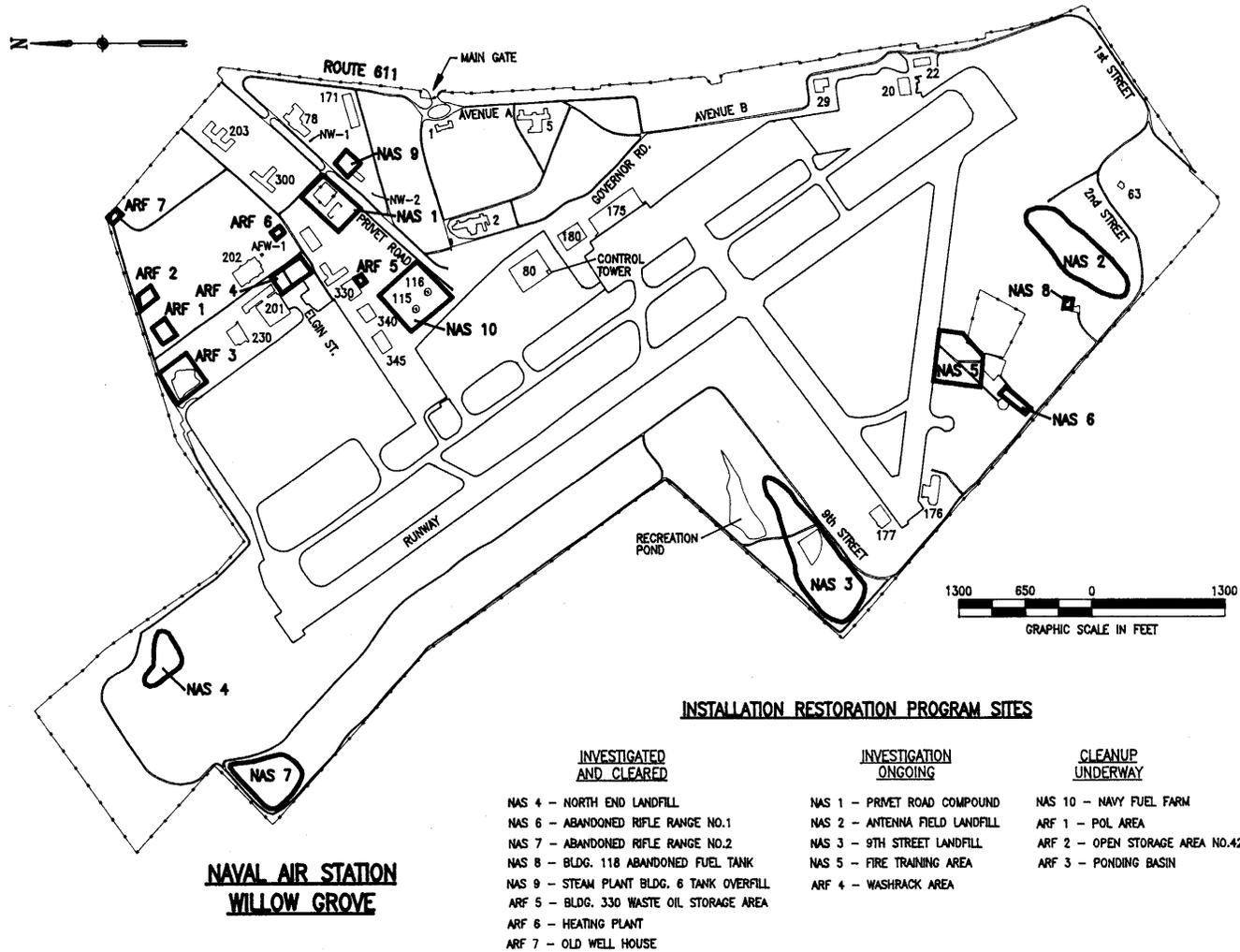
\* Frequency of detection is the times detected / times sought.

+ Contaminant concentrations in surface water were compared to drinking water comparison values and contaminant concentrations in sediment were compared to surface soil comparison values. Drinking water and surface soil comparison values are very conservative estimates for exposure to surface water and sediment, respectively, because these comparison values are developed considering regular (e.g., daily) contact with contaminants for extended periods of time (e.g., years).

## **FIGURES**

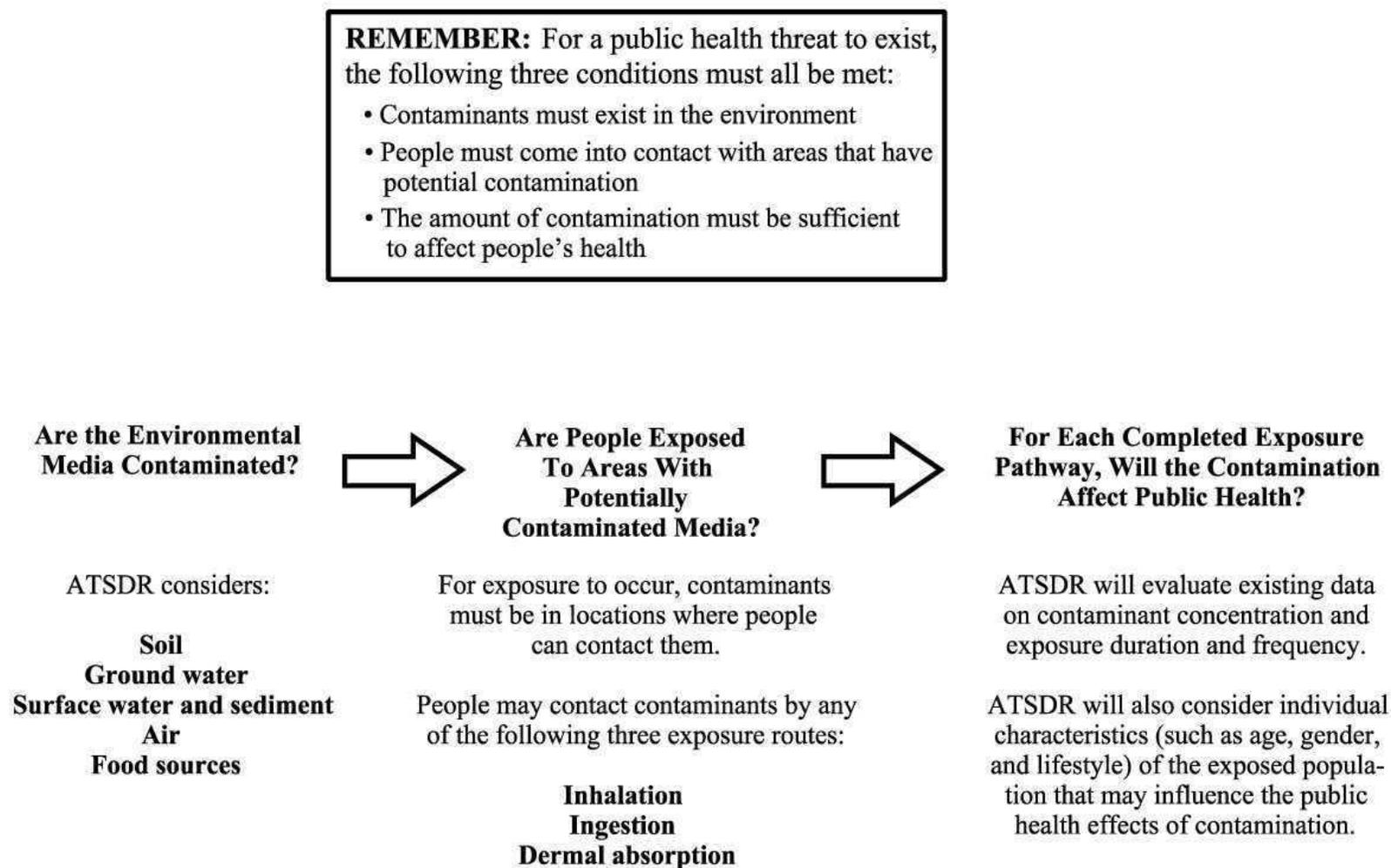


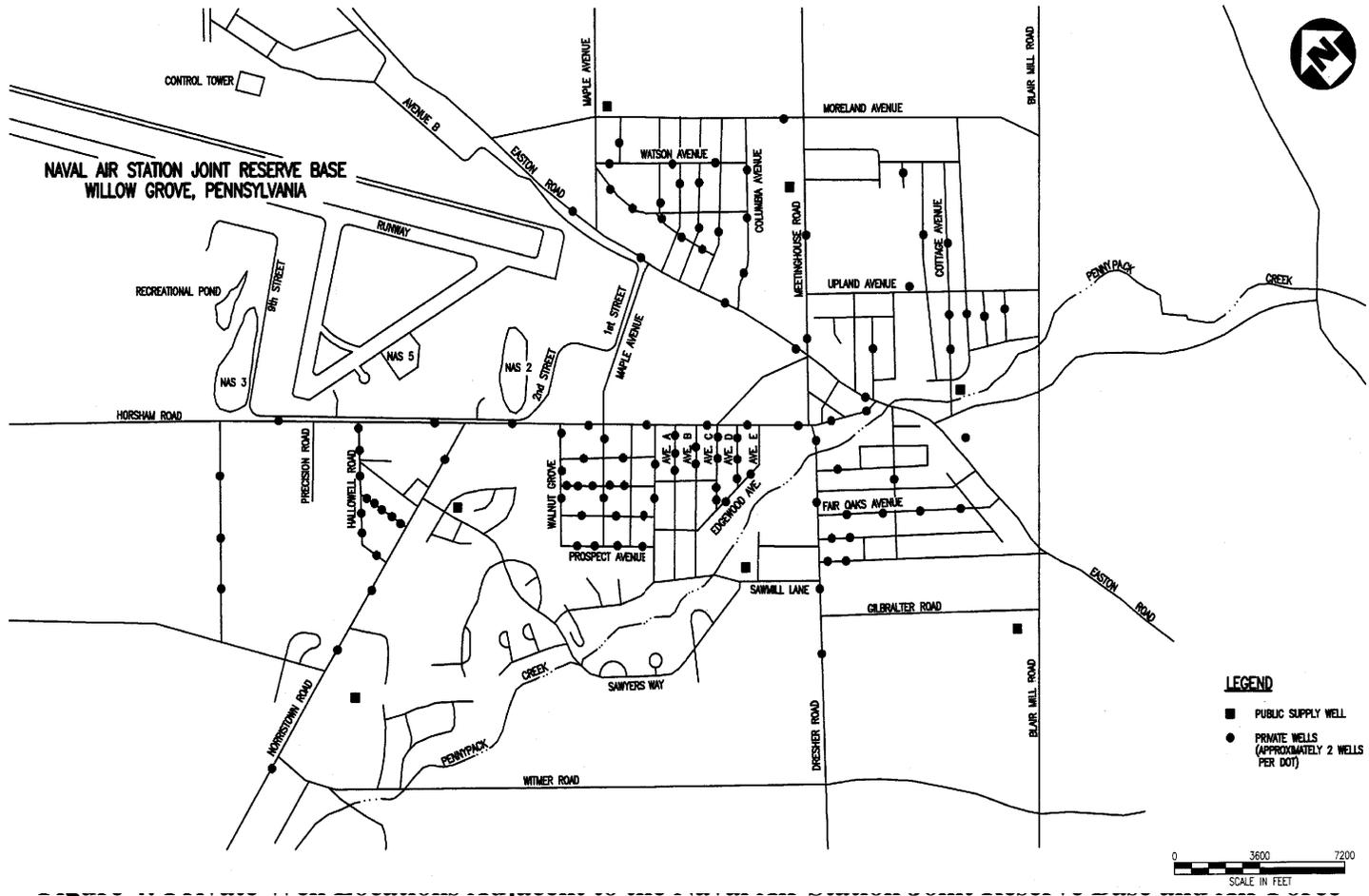
Source: Montgomery Watson 1998



Source: Navy 2000

Figure 3. ATSDR's Exposure Evaluation Process





Reserve Station at Willow Grove

Source: Brown and Root 1998

## **APPENDICES**

## **APPENDIX A: Comparison Values**

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

### **Cancer Risk Evaluation Guides (CREGs)**

Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million ( $10^{-6}$ ) persons exposed over a 70-year life span. The Agency for Toxic Substances and Disease Registry's (ATSDR's) CREGs are calculated from the U. S. Environmental Protection Agency's (EPA's) cancer potency factors (CPFs).

### **Environmental Media Evaluation Guides (EMEGs)**

EMEGs are based on ATSDR minimal risk levels (MRLs) and factor in body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in milligrams of chemical per kilogram of body weight per day [mg/kg/day]) that is likely to be without noncarcinogenic health effects over a specified duration of exposure.

### **Maximum Contaminant Level (MCL)**

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of an individual contaminant in water that is delivered to a free-flowing water supply. MCLs are derived for individual contaminants based on toxicity. MCLs are considered protective of public health over a lifetime (70 years) for people consuming 2 liters of water per day.

### **Reference Dose Media Evaluation Guides (RMEGs)**

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

### **Soil Screening Level (SSL)**

Generic SSLs were derived by EPA for nation-wide application to sites used for residential areas. SSLs are estimates of contaminant concentrations that would be expected to be without noncancer health effects over a specified duration of exposure or to cause no more than one excess cancer in a million ( $10^{-6}$ ) persons exposed over a 70-year life span.

### **Risk-Based Concentration (RBC)**

The RBCs were developed by EPA Region III. RBCs for tap water, air, and soil were derived using EPA RfDs and cancer potency factors combined with standard exposure scenarios, such as ingestion of 2 liters of water per day, over a 70-year life span. RBCs are contaminant concentrations that are not expected to cause adverse health effects over long-term exposures.

## **APPENDIX B: ATSDR Plain Language Glossary of Environmental Health Terms (Revised December 15 1999)**

### **Adverse Health**

**Effect:** A change in body function or the structures of cells that can lead to disease or health problems.

**ATSDR:** The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

**Background Level:** An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

**Cancer:** A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control.

**Carcinogen:** Any substance shown to cause tumors or cancer in experimental studies.

**CERCLA:** See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

### **Completed Exposure**

**Pathway:** See **E**xposure **P**athway.

### **Comparison Value**

**(CVs):** Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

## **Comprehensive Environmental Response, Compensation, and Liability**

**Act (CERCLA):** CERCLA was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

**Concern:** A belief or worry that chemicals in the environment might cause harm to people.

**Concentration:** How much or the amount of a substance present in a certain amount of soil, water, air, or food.

**Contaminant:** See **Environmental Contaminant**.

**Dermal Contact:** A chemical getting onto your skin. (see **Route of Exposure**).

**Dose:** The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.

**Duration:** The amount of time (days, months, years) that a person is exposed to a chemical.

## **Environmental Contaminant:**

A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

## **Environmental**

**Media:** Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

## **U.S. Environmental Protection**

**Agency (EPA):** The federal agency that develops and enforces environmental laws to protect the environment and the public’s health.

**Exposure:** Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

**Exposure Pathway:** A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
2. Point of Exposure,
3. Route of Exposure, and
4. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

**Frequency:** How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

**Hazardous Waste:** Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

**Health Effect:** ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

#### **Indeterminate Public**

**Health Hazard:** The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

**Ingestion:** Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

**Inhalation:** Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

**NPL:** The **National Priorities List**. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

**No Apparent Public**

**Health Hazard:** The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

**No Public**

**Health Hazard:** The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

**PHA:** **Public Health Assessment.** A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

**Plume:** A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

**Point of Exposure:** The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For example:  
the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

**Population:** A group of people living in a certain area; or the number of people in a certain area.

**Public Health Assessment(s):** See **PHA**.

**Public Health Hazard:** The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

**Public Health Hazard Criteria:** PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:

1. Urgent Public Health Hazard
2. Public Health Hazard
3. Indeterminate Public Health Hazard
4. No Apparent Public Health Hazard
5. No Public Health Hazard

**Receptor**

**Population:** People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

**Route of Exposure:** The way a chemical can get into a person's body. There are three exposure routes:

- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

**SARA:** The Superfund Amendments and Reauthorization Act in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

**Source**

**(of Contamination):** The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

**Special**

**Populations:** People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

**Superfund Site:** See **NPL**.

**Urgent Public Health Hazard:** This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

## APPENDIX C: Exposure Evaluation

To evaluate the potential for adverse health effects from consuming drinking water from station, community, and private wells, the Agency for Toxic Substances and Disease Registry (ATSDR) estimated potential exposure doses. ATSDR estimated exposure doses using information about substance concentrations and how often and how long a person could have contacted these substances. In the absence of site-specific information, ATSDR applied several conservative assumptions.

Applying conservative assumptions allows ATSDR to estimate the highest possible exposure dose and determine the corresponding health effects. Although ATSDR expects that few, if any, residents were exposed to the highest contaminant concentrations, the “conservative” estimates are used to protect public health. ATSDR used the following equation and assumptions to estimate exposure doses:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C = Maximum concentration (milligrams of chemical per liter water [mg/L]).

Although contaminants were found in water supply wells at a range of concentrations, ATSDR assumed that people ingested water containing the highest levels of 1,1-dichloroethylene (2.8 parts per billion [ppb], which equals 0.0028 mg/L) tetrachloroethylene (91.1 ppb or 0.0911 mg/L), trichloroethylene (300 ppb or 0.3 mg/L), arsenic (22 ppb or 0.022 mg/L), barium (1,190 ppb or 1.19 mg/L), and lead (20 ppb or 0.02 mg/L). This assumption is designed to overestimate exposures. These substances were found in only some of the samples collected and analyzed and were found at a range of concentrations. Concentrations fluctuate over time and the Navy implemented measures to prevent exposures as soon as contaminants were detected. As such, people may have been exposed to water that contained the maximum detected concentrations, but they also may have been exposed to water with lower contaminant concentrations or may have consumed water free of contamination.

IR = Intake rate: 2 liters per day (L/day) for adults, 1 L/day for children, and 1 L/day for workers

The intake rate represents the amount of liquids that a person would drink in a single day. The average adult drinks 1.4 liters of water a day and the average child, age 3 or younger, drinks 0.6 liters of liquid each day. Workers were assumed to drink half of their daily intake while at work (EPA 1997). This assumption overestimates exposures because people likely obtain water from

sources other than their drinking water wells (e.g., prepackaged soda or juice; bottled water; or wells serving stores, businesses, or schools).

EF = Exposure frequency: 365 days per year (day/yr) for residents and 250 days/yr for workers.

For residents, ATSDR assumed that exposures occurred every day, although daily exposures are unlikely because people are expected to travel or vacation away from their homes. For workers, ATSDR assumed workers would be at their jobs 5 days a week for 50 weeks per year.

ED = Exposure duration: 6 years (yrs) for adults living at the Naval Air Station Joint Reserve Base (NASJRB) or Air Reserve Station (ARS), 30 yrs for adults living in the community, 6 yrs for children, and 30 yrs for workers

The exposure duration for people living at NASJRB or ARS was assumed to be 6 years, a conservative estimate based on an average residence at the facility for 2 to 4 years. An exposure duration of 6 years for children represents the time from toddler to young child when exposures may be at their highest. The exposure duration of 30 years for community residents and workers is based on studies of how long people will live in their homes or remain at a single occupation (EPA 1997).

BW = Body weight: 70 kilograms (kg), which equals 154 pounds, for adults and 10 kg, which equals 22 pounds, for children

No site-specific information is available to characterize the average weight of people living at or near NASJRB and ARS. ATSDR reviewed the scientific literature and used the U.S. Environmental Protection Agency's (EPA) recommended default weight for an adult (70 kg) and child (10 kg) (EPA 1997).

AT = Averaging time: 2,190 days (6 yrs x 365 days/yr) for non-cancer effects to NASJRB residents and children, 10,950 days (30 yrs x 365 days/yr) for non-cancer effects to community residents and workers, and 25,550 days (70 yrs x 365 days/yr) for cancer effects

In assessing non-cancer effects, the averaging time is equal to the exposure duration. In assessing cancer effects, the averaging time is equal to a person's life span. No site-specific information is available to characterize the average life span of people living at or near NASJRB and ARS. ATSDR reviewed the scientific literature and used EPA's recommended default life span of 25,550 days (365 days per year x 70 years) (EPA 1997).

ATSDR compared the estimated exposure doses to dose-based CVs to assess potential non-cancer effects. Dose-based CVs (referred to as minimal risk levels [MRLs] by ATSDR and reference doses [RfDs] by EPA) are contaminant-specific doses that are conservatively derived based on the health effects literature and are below the levels associated with adverse health effects. Doses for people drinking water from community supply wells or private wells and workers at NASJRB and ARS were below dose-based CVs. Doses for adults and/or children living at NASJRB were slightly above the MRL for arsenic and RfD for barium. Because of the conservative assumptions used to estimate a dose, the true dose is expected to be much lower than the estimated dose. For arsenic, the dose-based CV was derived based on several epidemiologic investigations. These studies found health effects from prolonged (e.g., 45 years) exposure to arsenic at a dose of 0.014 milligrams of chemical per kilogram body weight per day (mg/kg/day) and higher. This dose is higher than the conservative doses estimated for adults and children consuming drinking water from station supplies. The estimated dose for children consuming water containing the highest levels of barium was below the dose shown to cause no health effects in laboratory studies (0.21 mg/kg/day). Table C-1 summarizes the conservative doses estimated for consumption of station water and the dose-based CVs (ATSDR 2001; EPA 2001). As such, possible past exposures to arsenic and barium are not expected to result in adverse health effects for adults or children using station supply wells.

**Table C-1: Estimated Non-Cancer Exposure Doses**

<b>Contaminant</b>	<b>Adult NASJRB Resident (mg/kg/day)</b>	<b>Child NASJRB Resident (mg/kg/day)</b>	<b>Minimal Risk Level (mg/kg/day)</b>
Arsenic	0.00063	0.0022	0.0003
Barium	0.034	0.12	0.07

ATSDR estimated a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime of exposure. In assessing cancer risks, scientists assume that any exposure to a carcinogen could result in a possible cancer case. However, information about the likelihood of developing cancer is based on studies where animals or humans have been exposed to high concentrations of a contaminants, levels much higher than would occur as a result of environmental releases. This assumption that any contact with a carcinogen could lead to cancer is extremely conservative. Scientists assume that the theoretical cancer risk can never be zero, whereas the true or actual risk is unknown and could be as low as zero (EPA 1996).

At NASJRB and NAS, the theoretical cancer risk for exposures to carcinogens were below  $10^{-4}$  (1 additional cancer over background in a population of 10,000)—a level used as a guideline for exposure doses that are below levels of concern. Only workers exposed to arsenic had a theoretical cancer risk above this level ( $1.4 \times 10^{-4}$  or 1.4 additional cancers over background in a population of 10,000). Because of the conservative assumptions used to estimate a dose, the true dose is expected to be much lower than the estimated dose. EPA classified arsenic as a carcinogen based on epidemiological studies where people consumed water containing 170 to

800 ppb arsenic for a 45-year exposure period. The maximum detected arsenic concentration in station wells was 22 ppb. Although the study demonstrated an association between arsenic in drinking water and skin cancer, the study failed to account for a number of complicating factors, including exposure to other non-water sources of arsenic, genetic susceptibility to arsenic, and poor nutritional status of the exposed population. In addition, unlike other carcinogens, arsenic does not cause cancer in laboratory animals when administered orally (ATSDR 2000). As such, possible past exposures to arsenic are not expected to result in an increased risk of developing cancer in workers using station supply wells.

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