PUBLIC HEALTH ASSESSMENT

WURTSMITH AIR FORCE BASE

OSCODA, IOSCO COUNTY, MICHIGAN

EPA FACILITY ID: MI5570024278

Prepared by:

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

FOREWORD

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

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

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

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

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

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

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

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report respónds 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 (E56), Atlanta, GA 30333.

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LIST OF ABBREVIATIONS

ACC	Air Combat Command
AFFF	aqueous film forming foam
ASPTS	Arrow Street pump-and-treat system
ASR	Au Sable River
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and xylene
BPPTS	Benzene Plant pump-and-treat system
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLHA	child longer term health advisory
CPF	cancer potency factor
CREG	cancer risk evaluation guide
CV	comparison value
DRMO	Defense Reutilization Management Office
EMEG	environmental media evaluation guide
EPA	United States Environmental Protection Agency
IARC	International Agency for Research on Cancer
IRP	Installation Restoration Program
J	estimated concentration
JB	estimated due to blank contamination
KOC	Knights of Columbus
LNAPL	light nonaqueous phase liquid
LTHA	Lifetime Health Advisory
MCL	EPA's maximum contaminant levels
MCLG	EPA's maximum contaminant level goal
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MDPTS	Mission Drive pump-and-treat system
mg/kg/day	milligrams per kilogram per day
MOGAS	motor gasoline
MRL	ATSDR's minimal risk level
MTBE	methyl tert-butyl ether
MWSW	main water supply well
NA	not applicable
ND	nondetect
NTP	National Toxicology Program
OBW	off-base well
OWS	oil/water separator
PAHs	polycyclic aromatic hydrocarbons

PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	public health assessment
PHAP	Public Health Action Plan
PNA	polynuclear aromatics
POL	petroleum, oil, lubricant
ppb	parts per billion
ppm	parts per million
PTS	pump-and-treat system
RI	remedial investigation
RBC	risk-based concentration
RfD	EPA's reference dose
RMEG	reference dose media evaluation guide
SAFR	Small Arms Firing Range
SVOC	semivolatile organic compound
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
USAF	United States Air Force
UST	underground storage tank
VEL	Van Etten Lake
VESP	Van Etten State Park
VOC	volatile organic compound
WAFB	Wurtsmith Air Force Base
WSA	Weapons Storage Area
WSD	West Shore Drive
WWTP	waste water treatment plant

SUMMARY

Wurtsmith Air Force Base (WAFB) is in Oscoda (Iosco County), Michigan, approximately 170 miles north of Detroit. The base was closed in June 1993, following seven decades of service as an aviation support facility. While the base was operational, hazardous materials were released to the environment, resulting in environmental contamination at a number of locations. Contaminants from some of these areas have migrated beyond the base's boundaries.

To date, 58 areas of potential contamination have been evaluated under the U.S. Air Force (USAF) Installation Restoration Program. The Agency for Toxic Substances and Disease Registry (ATSDR) analyzed all 58 sites to determine whether past, current, or future public health hazards are associated with them. For the vast majority of sites, no public health hazards were identified because of one or more of the following reasons: (1) no site-related contaminants were present, (2) detected contaminant concentrations were too low to pose a hazard, (3) past, current, and future exposures to the contaminated media were very infrequent and/or conducted with personal protective gear, and (4) future exposures will be prevented by land use restrictions.

ATSDR visited WAFB in 1995 and 1998. During the visits, ATSDR identified two pathways by which on-base residents and the surrounding community might have come into contact with contaminants originating at WAFB: (1) exposures to drinking water from on-base and off-base water supply wells and (2) exposures to on-base and off-base surface water bodies. ATSDR evaluated these potential exposure pathways in this public health assessment and addressed community health concerns.

Exposures to On-base and Off-base Water Supplies

ATSDR concluded that past exposures to groundwater may have posed an increased risk of developing adverse health effects. Several on-base and off-base water supply wells were used in the past to service residential areas, facility buildings, and recreational areas. Contaminants were detected in some of these wells and in samples collected from building faucets. Although trichloroethylene (TCE) concentrations in on-base water supply wells and one off-base well were high enough to warrant concern, it is unknown whether the concentrations persisted at high enough levels for long enough durations to actually pose a public health hazard.

Current and potential future exposures to groundwater are not expected to pose a public health hazard. Today, the vast majority of on-base and off-base areas receive their drinking water supplies from the Huron Shores Regional Utility Authority, a source that is not located near WAFB, and which meets all federal and state safe drinking water standards. A few wells are still in service, but exposure to the water that they provide is not expected to pose current or future health hazards because the wells do not contain high contaminant concentrations, they are only rarely used, and/or exposure durations are expected to be short. Institutional controls are in place to prevent new wells from being installed in contaminated areas in the future.

Exposures to Surface Water and Sediment

ATSDR concluded that past, present, and future exposures to surface water and sediment are not expected to pose a public health hazard. Contaminants from WAFB have been released to Van Etten Lake, the Au Sable River, Duell Lake, and a wetland area located in the southern portion of the base. Although these surface water bodies have been and continue to be used for recreational activities, contaminant concentrations are low and/or exposure is too infrequent to result in health hazards.

Community Health Concerns

Health concerns expressed by community members included:

Concern that volatile contaminants in the groundwater could migrate into subsurface housing structures (e.g., basements). ATSDR concluded that it is improbable that exposures to volatilizing materials would pose public health hazards. In the absence of actual indoor air measurements, indoor air contaminant levels were estimated using conservative mathematical models. The results suggested that indoor air levels are too low to be of health concern.

Concern that exposures to vinyl chloride could cause cancer. A community member asked ATSDR whether vinyl chloride causes cancer, and whether this chemical was identified as a contaminant of concern in on-base water supply wells or Van Etten Lake. ATSDR concluded that it is true that some health studies suggest a link between occupational exposures to vinyl chloride and brain cancer. Data on vinyl chloride were collected from on-base drinking water wells and Van Etten Lake starting in 1983 and 1990, respectively. Based on these data, ATSDR concluded that vinyl chloride concentrations have not been high enough to pose health hazards to people exposed to on-base drinking water wells during or after 1983 or to Lake Van Etten during or after 1990.

Concern that there is an increased incidence of cancer in the community. No health outcome studies were available to address this community concern. Although ATSDR concluded that people exposed to TCE-contaminated drinking water wells in the past might have been at an increased risk of developing adverse health effects, it is unknown whether high TCE concentrations persisted for long enough durations to cause these health effects to manifest. Furthermore, there is much controversy in the scientific community regarding whether TCE causes cancer in human populations. The U.S. Environmental Protection Agency (EPA) is currently reviewing the scientific literature to determine its cancer classification.

Concern that miscarriage rates increased during the time period when on-base wells were contaminated. ATSDR reviewed available literature and found very few studies that evaluated whether exposures to chlorinated solvents in groundwater pose an increased risk

of miscarriage in humans. Thus, no definitive conclusions could be made about this concern. It should be noted, however, that studies in laboratory animals show some adverse reproductive outcomes (e.g., decreased survival rates), but at doses that are significantly higher than those expected to have occurred at WAFB.

Concern that community members could be eating contaminated fish. Community members use Van Etten Lake and the Au Sable River for recreational fishing. Based on available data, ATSDR does not believe that consuming fish from these water bodies will pose health hazards. This conclusion was made, however, based on limited data.

Concern that community members could be eating contaminated deer and turkey. Community members hunt and eat game animals that live in or near a wetland that has been impacted by the base's contaminants. No samples have been collected from the animals to determine whether contaminants have accumulated within their tissues. Thus, ATSDR cannot make any definitive conclusions about whether people could be eating contaminated game animals. It should be noted, however, that game animals are not expected to spend all of their time in the wetland. In addition, hunters probably do not eat large quantities of meat that comes from animals exposed to the wetland area.

Concern that enhanced bioremediation will not adequately remediate the Northern Landfill Plume. ATSDR learned that USAF no longer plans to use this remedial approach. Instead, a dual system, consisting of a pump-and-treat and an air sparging system, will be installed. (The public was allowed to comment on this selected remedy.)

Concern that seeps could cause public health hazards and aesthetic problems. The Northern Landfill Plume discharges into Van Etten Lake at Seep #1 and Seep #2. Because exposures to the seeps are extremely limited, ATSDR does not believe that these seeps pose a health hazard. The seeps have caused an aesthetic problem, but USAF plans to address this issue in the near future.

Concern that radioactive materials were stored on site, and that the public may have been exposed to these materials. Base representatives did not know if radioactive materials had been stored at WAFB. If they were, these materials would have been stored in secure igloos in the Weapons Storage Area. A radiologic survey was conducted in this area after the base closed; no radioactive contamination was detected.

BACKGROUND

Site Description and History

Site Description

Wurtsmith Air Force Base (WAFB) is in Oscoda (Iosco County), Michigan, approximately 170 miles north of Detroit (see Figure 1). The 5,221-acre site is located less than one mile from Lake Huron. It is bounded by Van Etten Lake (to the north and east), the Oscoda and Au Sable communities (to the east and south), the Huron National Forest (to the south) and the Alpena State Forest (to the west). A variety of hazardous substances (e.g., fuels, solvents, and pesticides) have been handled, stored, and disposed at WAFB. Some of these materials were released to the environment, resulting in soil, groundwater, sediment, and surface water contamination at a number of locations.

Operational Activities

WAFB supported aviation activities for seven decades. The base was established in 1923, under the name Camp Skeel, and operated as a landing field and gunnery range. Its name changed several times before it was officially named WAFB in 1953. During different points in its history, the base served as (1) an airfield—housing, maintaining, and refueling several types of planes; (2) a training facility—offering training in overseas fighting, gunnery and combat zone fighting, and fire survival; and (3) a weapons storage area—maintaining, processing, testing, and housing a wide variety of weapons (Air Force 1995). Throughout much of the 1960s, 70s, and 80s, WAFB was on Ground Alert (i.e., continuous alert for foreign attacks), but it was placed on a base closure list following the end of the "Cold War." Congress approved the closure in October 1991 and closing ceremonies were held on June 30, 1993 (Air Force 1995).

Remedial and Regulatory History

Contaminants were first discovered at WAFB in October 1977, when an on-base resident complained that the base's drinking water supply contained peculiar tastes and odors. In response to this complaint, a tap water sample was collected from an on-base housing unit and trichloroethylene (TCE) was detected. This discovery prompted several environmental investigations and it soon became evident that a groundwater plume had formed under the base and impacted on-base water supply wells. In the years to follow, WAFB discovered that several other environmental media (i.e., surface water, sediment, and soil) had been impacted by contaminants as well. The site was proposed for the U.S. Environmental Protection Agency's (EPA's) National Priority List in January 1994 (AFBCA 2000f).

Many of the initial environmental investigations performed at WAFB were conducted by the United States Geological Services in the late 1970s and early 1980s. More extensive investigational activities were initiated in 1984, when the U.S. Air Force (USAF) began evaluating WAFB through its Installation Restoration Program (IRP). (The IRP is designed to identify, evaluate, and clean up environmental contamination resulting from past management practices.) To date, 58 areas with potential contamination have been evaluated at WAFB under the IRP (see Figure 2). (AFBCA 1999a). At some of these areas, contamination was significant enough to warrant immediate cleanup activities. Some of these cleanup activities, such as tank or soil removal, were executed expediently and have already been completed. Other activities, such as remediating groundwater plumes via pump-and-treat systems, are still ongoing because they require longer durations to achieve cleanup goals. Appendix A provides a summary of the status of all of the sites that are being evaluated under the IRP.

Several different entities have influenced environmental decision-making at WAFB through the years. For example, the Michigan Attorney General was heavily involved at one time, resulting in the signing of a Consent Decree in November 1980 that required USAF to complete hydrogeological studies, create a groundwater remediation plan, increase the productivity of their pump-and-treat system, and cap some of their landfills. At another time in WAFB's history, the courts played an important role in deciding which remedial approaches should be taken.[1] Today, most of the decisions are made by the Base Realignment and Closure (BRAC) Cleanup Team, which consists of representatives from USAF, EPA, and the state of Michigan.

Local Demographics

About 8,000 people lived and/or worked at WAFB while the base was operational (AFCEE 1998a). According to the U.S. Census, for locations within 1 mile of WAFB, 7,700 people resided in 2,961 households in 1990.

As of fall 1999, about 397 people were still working at the base, and about 230 people were living on base (USAF 2000). The base's closure has had a profound impact on the demographics of the surrounding area. There are currently only about 5,200 people living in adjacent communities (AFCEE 1998a).

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1 The USAF and a state regulatory agency disagreed about whether aggressive treatment systems were required to prevent groundwater from impacting Van Etten Lake. In 1989, the issue was taken to the courts, which sided in favor of USAF (Bay City 1990).

Land Use and Natural Resources

Land Use

As indicated previously, WAFB was closed in June 1993. Today, the base is in a state of transition, with some areas being used for industrial and commercial purposes and others being left unused until environmental investigations or cleanups are completed. The BRAC Cleanup Team is trying to expedite cleanups so that the base property can be reused as quickly as possible. According to proposed reuse plans, the base will be used as an airfield, for aviation support, for industrial and commercial activities, and for medical, child care, and educational services. Some of the land will be designated for recreational use (Air Force 1993). Also, the on-base housing area, which is being sold to the community, will be used for residential purposes. In fact, some of the units are currently occupied by community members (USEPA 2000a).

The land beyond the base's boundaries is used mostly for residential and recreational purposes. Residential properties and camping areas abut the base to the east and northeast. Some of the residential properties serve as year-round residences, but others are only used on a seasonal basis. The camps located in close proximity to the base are Camp Nissokone and Van Etten State Park (see Figure 3). The former is operated by the YMCA and hosts several hundred children for short periods each summer (ATSDR 1998a). The latter is owned by the Michigan Department of Natural Resources (MDNR) and supports 40 rustic campsites (MDEQ 1999a).

Natural Resources

A groundwater aquifer lies below the base and extends beyond the base's boundaries. The principal aquifer in the region extends from the ground surface to a depth of approximately 65 feet (ATSDR 1996a; M&E 1987). Groundwater flow patterns have been studied and researchers concluded that a groundwater divide extends diagonally across the base, directing groundwater south of the divide toward the Au Sable River at a rate of about 0.3 feet/day and groundwater to the north of the divide toward Van Etten Lake at a rate of 0.8 feet/day (M&E 1987) (See Figure 4 for the locations of Van Etten Lake and the Au Sable River). Although subsurface geology influences flow patterns, pumping activities from several on-base purge wells have also influenced how groundwater flows under the base. For several years, the aquifer served as a drinking water source for WAFB and several nearby off-base properties. Today, nearly all of these areas receive their drinking water from municipal sources (AFBCA 1999b).

As depicted in Figure 4, lakes, rivers, and wetlands are located near WAFB. Some of these water bodies (i.e., Van Etten Lake, Au Sable River, Duell Lake, and a wetland area), which are used by residents and tourists for recreational activities, have been impacted by WAFB's contaminants.

The Agency for Toxic Substances and Disease Registry (ATSDR)'s Involvement

On December 3, 1993, the Citizen's Advisory Committee on Wurtsmith AFB Contamination, Inc., petitioned ATSDR to perform a public health assessment (PHA). One month later, the site was proposed for the National Priorities List. Once on the list, ATSDR was mandated to perform a PHA for the site. As a first step, ATSDR visited WAFB in June 1995 and met with Air Force personnel and representatives from the local community. The latter were asked to summarize their health concerns. Following the visit, ATSDR ranked the site according to its potential public health hazard and released a Site Summary. In this report, the agency concluded that WAFB posed no current public health hazards, but that past exposures to contaminated environmental media had occurred. The agency made no conclusions at this time about whether these past exposures could have caused adverse health effects (ATSDR 1996a).

In July 1998, ATSDR revisited WAFB to gather additional information for the PHA. During the second site visit, ATSDR met with Air Force personnel, community members, and representatives from Camp Nissokone. ATSDR talked at length with the latter two groups to learn more about their health concerns. In addition, after the site visit, ATSDR contacted representatives from the Michigan Department of Environmental Quality and the District Health Department to determine whether these agencies had health concerns or knew of any community concerns. Also, ATSDR was alerted to concerns that EPA had expressed about the site. All of the concerns expressed by community members or environmental agencies are addressed in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" and the "Community Health Concerns" sections of this PHA.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Many of the reports were prepared under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program and had to meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. Some of the environmental data presented in this PHA were not collected under the CERCLA program, and may not have been subjected to as rigorous quality control procedures. Nevertheless, ATSDR used these data because no other data were available to help reconstruct past contamination scenarios.

EVALUATION OF ENVIRONMENTAL CONTAMINATION AND POTENTIAL EXPOSURE PATHWAYS

Introduction

In this section, ATSDR evaluated whether people are, have been, or will be exposed to contaminants originating from WAFB. In evaluating exposure pathways, ATSDR determines whether exposure to contaminated media has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation of contaminants. When exposure to contaminated media occurs, the exposure pathway is regarded as "complete." To determine whether completed exposure pathways pose a potential health hazard, ATSDR compares contaminant concentrations to health-based comparison values (CVs). CVs are calculated from available scientific literature on exposure and health effects. These values, which are defined for each of the different media, reflect the estimated maximum contaminant concentration for a given chemical that is not expected to cause adverse health effects, given a standard daily ingestion rate and standard body weight. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency) and the toxicology of the contaminant. It should be noted that because CVs do not represent thresholds of toxicity, exposure to contaminant concentrations above CVs will not necessarily produce health effects. In fact, ATSDR CVs are designed to be many times lower than levels at which no adverse health effects were observed in experimental animals or epidemiological studies. A public health hazard exists only if people come in contact with, or are otherwise exposed to harmful levels of contaminated media. The exposure evaluation process is summarized in Figure 5. To acquaint readers with terminology used in this report, a glossary and a list of CVs are included in Appendices B and C, respectively.

ATSDR analyzed all 58 IRP sites at WAFB to determine whether past, current, or future public health hazards were associated with them. The Agency's conclusions are summarized in Appendix A. For the vast majority of sites, no public health hazards were identified because of one or more of the following reasons: (1) no site-related contaminants were present, (2) detected contaminant concentrations were too low to pose a hazard, (3) past, current, and future exposures to the contaminated media were very infrequent and/or conducted with personal protective gear, and (4) future exposures will be prevented by land use restrictions.

ATSDR identified four media that have been affected by WAFB's activities: soil, groundwater, surface water, and sediment. *As indicated in Appendix A, no health hazards are associated with past, current, or future exposures to soil.* (Access to contaminated areas was highly restricted in the past. As a result, exposure to contaminated soil was infrequent. Also, over the years, many cleanup efforts have been initiated to remediate areas with high soil contaminant concentrations. Some contaminated soils are still present, but exposure to them is not expected to pose health hazards because contaminant concentrations are low and/or people are not expected to contact the contaminated soils on a frequent enough basis to warrant concern.) ATSDR's analysis of the

other three media (i.e., groundwater, surface water, and sediment) is summarized in the text that follows, Table 1, and Appendix D.

Groundwater

Groundwater underlying WAFB has been impacted by site activities. Several groundwater plumes have been identified, some of which have migrated beyond the base's boundaries (see Figure 2). Detailed information about the groundwater conditions at all 58 IRP sites is provided in Appendix A. ATSDR focused on the following plumes because they contained some of the highest contaminant levels and/or have impacted on-base or off-base drinking water supply wells:

- *The Arrow Street Plume*. In 1962, an underground storage tank (UST) was installed to store waste TCE. It was removed in 1977 after base representatives discovered a leak (AFCEE 1997a). Sampling results indicated that the leaking TCE impacted subsurface soils and underlying groundwater. Remedial activities were initiated immediately, with purging activities starting in November 1977 and the Arrow Street pump-and-treat system (ASPTS) becoming operational in 1981. Before the ASPTS became operational, the Arrow Street Plume impacted USAF's on-base water supply wells and migrated off base, flowing toward Van Etten Lake. TCE concentrations were highest in the late 1970s, with TCE reaching a high of 46,800 parts per billion (ppb) in 1978 in one on-base monitoring well (ATSDR 1996a). Groundwater remediation efforts have removed much of the TCE, but the ASPTS' pumping activity has drawn contaminants from other on-base sources (i.e., SS-06, SS-08, and SS-47 [see Appendix A]) towards it. According to results obtained during a 1996 sampling event, several contaminants remain above ATSDR's health-based drinking water CVs, including benzene, tetrachloroethylene (PCE), toluene, and TCE (AFCEE 1997a). The ASPTS will remain operational until contaminant concentrations decrease below EPA's Maximum Contaminant Levels (MCLs).

- *Petroleum, Oil, Lubricant (POL) Bulk Storage Area Plume*. In the late 1970s, investigators identified the POL Bulk Storage Area Plume when benzene was detected in on-base monitoring wells at concentrations ranging from 197 ppb to 1,000 ppb (ATSDR 1996a). The plume is being captured and treated by the ASPTS and the Benzene Plant pump-and-treat system (BPPTS). Several contaminants remain at levels that exceed ATSDR's drinking water CVs, including benzene, ethylbenzene, methylene chloride, TCE, and xylene (AFCEE 1996a). Treatment efforts are ongoing.

- *Mission Drive Plume.* The Air Combat Command (ACC) Operational Apron (Site SS-08) has been identified as the probable source of the Mission Drive Plume (AFCEE 1996b).[2] The plume extends under the on-base housing area, migrating in a southerly direction. The Mission Drive pump-and-treat system (MDPTS) was installed to treat the plume in the mid-1980s. In recent years, investigators discovered that part of the plume is bypassing the treatment system and discharging to the 3-pipes drainage ditch—a conduit that discharges directly into the Au Sable River (AFCEE 1996b). The Air Force plans to install additional purge wells to remediate this situation in the near future (AFBCA 1999a). According to results obtained from a 1994 and 1995 sampling event, the plume still contains several constituents above ATSDR's CVs, including arsenic, benzene, dichlorobromomethane, cis-1,2-dichloroethene, 1,1-dichloroethene, manganese, and TCE (AFCEE 1996b, 1996c).

- *The Northern Landfill Plume.* Hazardous materials were disposed and stored at Landfills 30 and 31. For example, two 6,000-gallon tanker trailers were buried at Landfill 30 and used to store waste jet fuels, oils, solvents, thinners, and lubricants (AFCEE 1996d). Environmental investigations indicated that a chlorinated solvent plume has formed under the landfills, migrating under off-base residents and Camp Nissokone, and discharging into Van Etten Lake (see Figure 2). According to results obtained from a 1994 sampling event, several constituents in the plume are above ATSDR's CVs, including arsenic, benzene, cadmium, manganese, methylene chloride, TCE, and vinyl chloride (AFCEE 1996d). Much controversy has been generated about how the plume should be managed. Recently, a decision was made to install a dual system, consisting of pump-and-treat and air sparging, to address the plume. The remedial system will be installed by June 2001 (AFBCA 2000a, 2000b; USAF 2001).

- *Pierce Point Plume.* Wastes generated at the Weapons Storage Area (WSA) were released to the environment via a leachfield (AFCEE 1996e). These releases resulted in a groundwater contamination plume that stretches from the WSA, traveling under off-base residential areas, and discharging to Van Etten Lake. According to results obtained from 1994 and 1995 sampling events, several contaminants in the plume are present above ATSDR's CVs, including arsenic, cadmium, heptachlor epoxide, lead, methylene chloride, PCE, and TCE (AFCEE 1996e). The USAF has not installed an active groundwater remediation system at this site. Rather, they are relying on natural attenuation—a process in which microbes degrade constituents to nontoxic forms over time—to perform the remedial work.

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[2] Although the ACC Operational Apron (SS-08) is located north of WAFB's natural groundwater divide, it is suspected that well pumping activities caused the groundwater at this site to be drawn south of the divide (AFCEE, 1996b).

Several on-base and off-base drinking water wells have been impacted by the groundwater plumes beneath WAFB. ATSDR separated these wells into three categories based on the areas that they serviced:

- USAF's main water supply wells (i.e., wells AF1, AF2, AF3, AF4, AF5, AF18, AF19, AF30, AF31, and AF32) (see Figure 6).
- USAF's area-specific wells (i.e., wells AF7, AF8, AF14, AF15, AF16, AF22, AF25, and two unnumbered wells) (see Figure 6).
- Off-base wells (i.e., wells that are located on properties that are situated between WAFB and Van Etten Lake).

For all of these wells, ATSDR evaluated available well usage information and sampling data to determine whether exposures to the wells could have posed a public health hazard.

Exposures to On-Base Water Supplies

Past Exposures

USAF's Main Water Supply Wells

In the past, USAF's main water supply wells were used to supply water to on-base housing units and several base buildings. These wells were used for both potable (drinking and other household uses) and nonpotable (industrial activities) purposes. Base residents used the water supplied by these wells until June 1993, when WAFB officially closed and the housing units were vacated. Base representatives who continued to work in on-base buildings after closure continued to use the water supplied by USAF's main water supply wells until municipal hookups were established in 1997 (AFBCA 1999b).

Ten water supply wells served the base during different periods of the base's history (see Figure 6). Water from individual wells was pumped to a distribution center and mixed with water that was provided by other wells before being distributed for use. Wells AF1, AF2, AF3, AF4, AF5, AF18, and AF19 served as the original main water supply wells, but wells AF1 through AF5 were removed from service in November 1977 after high concentrations of TCE were detected in a tap water sample that was collected from an on-base housing unit (AFBCA 1999b, 1999c). Following their removal, wells AF18 and AF19 served as the only two main water supply wells. Their service was short-lived, however, and they were taken off line in 1978 after USAF representatives detected high levels of TCE in these wells (USGS 1983). (AF18 never returned to service, but AF19 was brought back on line during later years.) Between 1978 and 1984, AF2, AF4, and AF5 were brought back on line to serve as the main water supply wells. (Sampling

events indicated that these wells were safe to use.) In 1984, wells AF30, 31, and 32 were drilled and these took over as the main water supply wells until 1997 when the base started receiving municipal water. Once these new wells came on line, wells AF2, AF4, AF5, and AF19 were relegated to being used only on a supplemental basis when the base's water demands were very high (AFBCA 1999b; Ayres 1990). Table 2 provides more detailed information about well usage for all ten of USAF's main water supply wells.

Starting in 1977, several water samples were collected from the faucets of on-base housing units and facility buildings. These tap water samples were analyzed for a variety of contaminants. Table 3 summarizes the tap water sampling events that occurred between 1977 and 1997 and lists those contaminants that were detected above ATSDR's drinking water CVs (Air Force 1990; AFBCA 1993, 1999d, 1999e; MDEQ 1999b). ATSDR also evaluated the data that were collected from USAF's main water supply wells during the years that each was operating as a potable source (see Table 2). The well data were evaluated to ensure that ATSDR identified all potential contaminants that may have been present in on-base drinking water. In general, samples were collected from the wells more frequently than they were collected from faucets. Also, the samples collected from the wells were typically analyzed for a broader range of contaminants. Contaminants detected in the individual wells do not necessarily reflect the concentrations that people were exposed to at the tap because water from several wells was mixed prior to distribution to on-base buildings.

ATSDR's analysis indicated that eight contaminants were present in tap water and/or well samples at concentrations above ATSDR's drinking water CVs. ATSDR performed a thorough review of these contaminants to determine whether they could have posed health hazards to people who drank, bathed, or cooked with on-base water supplies in the past. Appendix D provides a detailed explanation of how ATSDR arrived at its conclusions for each chemical.

TCE was identified as the only contaminant that could have caused potential adverse health effects. This contaminant was detected at high concentrations (i.e., 1,100 ppb) in a tap water sample that was collected in October 1977 from an on-base housing unit (AFBCA 1993). ATSDR does not know how long TCE concentrations had been at this level prior to October 1977 because no samples were collected before that date. To be extremely conservative, ATSDR assumed that concentrations could have been that high since 1962, the year that Site 21's UST was installed. This UST is the suspected source of the Arrow Street Plume; investigators believe that this plume contaminated USAF's main water supply wells. High TCE concentrations were not sustained in the tap water long after October 1977. In fact, concentrations dropped very rapidly after the most contaminated wells were removed from service. For example, between November 1977 and December 1979, TCE concentrations detected in tap water samples varied between nondetect and 150 ppb, with many detections ranging between 20 ppb and 80 ppb. In the 1980s and 1990s, TCE was rarely detected above ATSDR's drinking water CVs in well or

tap water samples, and only reached a high of 25 ppb once between 1980 and 1997 (AFBCA 1993; Air Force 1990; MDEQ 1999b).

After evaluating sampling data and exposure information, ATSDR determined that it was highly improbable that exposures to TCE would have posed a public health hazard to anyone who started using USAF's main water supply wells after 1979. As for those populations that lived or worked on base prior to that time, ATSDR concluded that exposures could have posed an increased potential for developing adverse health effects. It should be noted, however, that this conclusion assumes that people were exposed to the highest TCE concentration that was detected in tap water samples for a long period of time. ATSDR cannot be certain that long-term exposures of this sort actually occurred. (While ATSDR assumed that exposures could have resulted as soon as the UST at Site 21 was installed, this assumption was probably overly conservative for several reasons. In actuality, the UST could have been in place for many years before it leaked and impacted USAF's main water supply wells. Also, ATSDR assumed that families and employees were exposed to contaminated water for nearly two decades. This probably overestimates the amount of time that most families lived at the base.) Also, it should be noted that there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans (see Appendix D). TCE has been shown to cause cancer in laboratory animals who receive large doses, but EPA is currently reviewing the scientific literature to determine its potential to cause cancer in humans (USEPA 2000b).

USAF's Area-Specific Wells

While water from USAF's main water supply wells was mixed together and used to service many on-base areas, some of WAFB's supply wells only serviced one particular area or building (AFBCA 1999b, 1999c, 1999d, 1999f; USGS 1983). These wells, which are referred to as USAF's area-specific wells, serviced the following buildings:

- AF7—North Cottage at Air Force Beach
- AF8—South Cottage at Air Force Beach
- AF14—Building 1135
- AF15—Procurement office
- AF16—Firing range
- AF22—Burkhart Lodge
- AF23—Air Force Beach
- AF25—Building 5098
- Unnamed well—Dog kennels
- Unnamed well—Defense Reutilization Management Office

Table 4 and Appendix D summarize available well usage information and sampling data for these wells. While much of the listed data were obtained from well samples, some were obtained from tap water samples that were collected from serviced buildings. Because each area-specific well only serviced one area and was not mixed with other water streams on its way to the faucet, ATSDR considered the contaminant concentration detected in the well to represent the level that

would have been detected in the faucet and vice versa. Contaminants were detected above ATSDR's drinking water CVs in eight of the 10 area-specific wells (Air Force 1990; AFBCA 1993).

ATSDR performed a thorough review of the contaminants detected in these eight wells. *After closely evaluating available data sets and information about the frequency and duration of potential past exposures, ATSDR concluded that exposures to these wells were not associated with public health hazards because contaminant concentrations were too low and/or exposures were too infrequent.* ATSDR's conclusions are summarized in Table 4 and described in detail in Appendix D.

Current Exposures

ATSDR concluded that on-base water poses no current public health hazards. In the spring of 1997, WAFB started receiving water from the Huron Shores Regional Utility Authority (AFBCA 1999b; District 1999a). This municipal water source, which is pumped from Lake Huron, is monitored on a regular basis to ensure that it meets all federal and state drinking water quality standards (District 1999a). All areas of the base are currently being serviced by this municipal water except for a portion of Building 5098, which is serviced by USAF's area-specific well AF25 (AFBCA 1999b). This well is the only USAF on-base water supply well that is still operational. (All of the other USAF area-specific wells and USAF main water supply wells were officially abandoned in 1998 [AFBCA 1999b].)

One IRP site, OT-16, is located relatively close to AF25. As indicated in Appendix A, groundwater contaminants associated with OT-16 are present at concentrations exceeding ATSDR's drinking water CVs. ATSDR collected information on well usage for AF25 to determine whether anyone is being exposed to the water provided by this well. AF25 services the bathroom at Building 5098, a building that does not have a permanent occupant but is being used to store equipment for base remediation efforts. The only people who might be using the building's restrooms are USAF employees or remediation contractors, and their exposure to the restrooms' water would be minimal (AFBCA 2001a). The water supplied to the restrooms is not used for drinking water purposes: signs are posted in the bathroom to advise people against drinking the water (AFBCA 1999g, 2001c).

AF25 is located crossgradient of site OT16 and lies outside of OT16's radius of impact (NCIBRD 1999a). Samples were collected from AF25 and analyzed for TCE in 1977; detected concentrations were below EPA's MCL (5 ppb) (See Table 4). Because water use in Building 5098 is restricted and TCE concentrations were low in the past, incidental exposures are not expected to cause public health hazards. Nevertheless, USAF has agreed to sample AF25 during the spring of 2001 and to analyze the sample for VOCs (AFBCA 2001b; USAF 2001).

Future Exposures

ATSDR concluded that on-base water poses no future public health hazards. As noted above, only one on-base water supply well (AF25) is currently being used. People use the water supplied by this well for nonpotable purposes and only on a sporadic basis. Even if usage is expanded in the future, exposures to AF25 are not expected to pose public health hazards: a base representative has indicated that the well would probably be abandoned if the 2001 sampling data reveal that VOCs are present at elevated levels in this well (AFBCA 2001c).

Potential future exposures to on-base groundwater are not expected to pose health hazards because (1) the groundwater under WAFB is being remediated and (2) land use restrictions will prevent new wells from being drilled in contaminated areas until contaminant levels are reduced to meet the state of Michigan's drinking water standards (AFBCA 1999b). (See Appendix A for more information about which sites will have restrictions written into their deed or lease agreements.)

Exposures to Off-Base Water Supplies

Past Exposures

As depicted in Figure 2, the Arrow Street Plume, Pierce Plume, and the Northern Landfill Plume have migrated off base, moving towards Van Etten Lake. Several parcels of private property are located between WAFB and Van Etten Lake, many of which had wells that serviced residences, campgrounds (e.g., Camp Nissokone and Van Etten State Park), and recreational buildings (e.g., the Knights of Columbus) in the past (see Figure 3).

Although the plumes at WAFB have been fairly well-defined in recent years, the shapes and extent of the plumes in past years is not as clear. At WAFB, the plumes have changed direction and size dramatically throughout its history because of the pumping activity of on-base wells. (For example, while Figure 2 suggests that the Arrow Street Plume extends off base, site representatives claim that the plume is now completely confined within the boundaries of the base.) Given the shifting directions of groundwater flow, ATSDR evaluated all of the available sampling data for nearby residential properties. Sampling data were available for 61 properties located on West Shore Drive and F-41 County Road—streets that are located between WAFB and Van Etten Lake. These data, along with available well usage information, are summarized in Table 5.

Contaminants were detected above ATSDR's drinking water CVs at nine of the 61 locations (Air Force 1990; AFBCA 1993; MDEQ 1999c, 1999d). ATSDR performed a thorough review of the contaminants detected at these nine locations. *After closely evaluating available data sets and information about the frequency and duration of potential past exposures, ATSDR concluded*

that only one of these wells—located at 6504 West Shore Drive—may have contained TCE at a high enough concentration to pose a public health hazard. This well, which serviced a residential property located at Pierce's Point, was used as a drinking water source until the late 1970s (see Figure 3). Sampling activities were initiated in May and June 1979, at which time TCE was detected at concentrations ranging from 500 to 837 ppb (AFCEE 1996e; AFBCA 1993). Immediately upon discovering the contamination, USAF started supplying bottled water to the residence. The well continued to be used for nonpotable purposes, however, until a municipal hookup was established in the early 1990s. Samples continued to be collected while the well was used for nonpotable purposes and TCE concentrations ranged from nondetect to 1,281 ppb (AFBCA 1993). Assuming that TCE concentrations had been high for an extended period of time before the 1979 sampling activities, ATSDR concluded that exposures may have posed a potential for adverse health effects. It should be noted, however, that it is unclear how long people were actually exposed to high TCE concentrations prior to 1979. Site documents did not indicate when the well was installed or when contaminants from SS-05 (the suspected source of the Pierce Plume) first migrated to the vicinity of 6504 West Shore Drive (District 1999b). (Releases at SS-05 may have been occurring as early as the mid-1950s.) If the TCE was only present in this well for a short duration before the 1979 sampling event, then exposures would not be expected to cause adverse health effects. Additionally, as noted previously, there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans (see Appendix D).

Current and Future Exposures

ATSDR concluded that exposures to off-base water supply wells pose no current or future public health hazards. Although many of the off-base wells located to the east of WAFB were used as potable sources in the past, the vast majority of the area now receives water from the Huron Shores Regional Utility Authority. In fact, only three properties (discussed below) are currently using their wells as potable water sources. Moreover, a system is in place to prevent new wells from being drilled in off-base areas that are impacted by contaminated groundwater. Individuals who want to install new wells must notify their District Health Department before doing so. According to health officials, the department issues advisories against installing new wells if the targeted area lies over contaminated groundwater plumes (District 1999a, 1999c).

The three properties that are currently using their wells as potable water sources are:

- *6092 F-41 County Road.* In the early 1990s, USAF offered to establish a hookup for municipal water at 6092 F-41 County Road (see Figure 3), but the offer was refused (Township Oscoda 1999). Therefore, ATSDR assumes that well water is still being used as a potable source at this property. ATSDR evaluated available data to determine whether exposures to the water from this well are expected to pose current health hazards. ATSDR concluded that no health hazards are expected because no contaminants were detected at this property during sampling events that were conducted in 1979, 1989, 1990, 1991, and 2000 (AFBCA 1993; MDEQ 1999c; Montgomery Watson 2000).

- *Van Etten State Park.* Well CG#1 is currently being used to provide potable water to Van Etten State Park, a recreational area that has 40 rustic campsites (District 1999d, 2000a). (The well services a pitcher pump.) Water extracted from the well is used for drinking, cooking, and sponge bathing, but it is not used for more extensive bathing purposes because the camp site does not have showers or plumbed bathroom facilities (MDEQ 1999a). Samples were collected from well CG#1 and tested for volatile organic compounds (VOCs) in April 2000 and more than once in 1999. No contaminants were detected during any of the sampling events (District 1999e, 2000a, 2000b). Thus, the water that is currently being supplied to campers does not appear to be impacted by plumes that are migrating from the base.

  Campers will continue to visit the Van Etten State Park for many years to come. As noted above, the entire campsite is currently being serviced by well CG#1. Samples will be collected from this well regularly to make sure that the well water remains safe to drink. (A District Health Department employee plans to recommend sampling the well annually and testing for VOCs [District 2000b].) MDNR, the park's owner, is making plans to increase the amount of water that is provided to the park.

A second well located on the property, referred to as CG#2, provided potable water to campers for many years before being removed from service in the spring of 1999. TCE was detected earlier that year at concentrations ranging from 2.4 ppb to 3.4 ppb [MDEQ 1999a; District 2000b]. Although MDNR removed the well from service immediately upon discovering TCE as a precautionary measure, MDNR does have the legal right to bring the well back into service since TCE concentrations have not exceeded Michigan's standard of 5.0 ppb [District 2000a].) At this time, MDNR has not decided whether to use CG#2 again. MDNR has started evaluating other alternatives, such as establishing a municipal hookup, to meet the camp site's water supply needs. Even if CG#2 is brought back into service, exposures are not expected to pose public health hazards. According to a representative from the District Health Department, if the well is used, MDNR would be required to sample the well monthly to make sure that TCE concentrations remain below Michigan's safe drinking water standards (District 2000a). Exposures to concentrations below the standards are not expected to pose health hazards to campers who visit Van Etten State Park.

- *A New Residence Near Pierce's Point.* In the summer of 1998, a new well was drilled at a property located on Pierce's Point (MDEQ 1999e). Although this well was installed without notifying the District Health Department, health officials have since been alerted of its presence. Based on available hydrogeological studies, health officials concluded that the well is located on the edge of a TCE and PCE plume (District 1999f). Because no samples have been collected from the homeowner's well, ATSDR could not determine whether the well is currently impacted by contaminants. ATSDR concluded, however, that it is improbable that adverse health effects could have resulted during the two years that the well has been in use. Groundwater concentrations in the Pierce's Point area are currently too low to pose health hazards over such short exposure periods.[3]

According to the District Health Department, contaminants are expected to migrate under the homeowner's property in the future (District 1999f). Thus, actions are being taken to ensure that the well is removed from service. In the summer of 1999, representatives from the District Health Department visited the homeowner and asked him to remove the well and establish a municipal hookup. The homeowner was not willing to do so. As a followup, the Department sent the homeowner a letter ordering abandonment of the well

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[3] ATSDR analyzed data that were collected in 1994 and 1995 from the private well at 6504 West Shore Drive and monitoring wells R27, R28, R29, R30, and R31 (see Figure 7). No contaminants were detected above ATSDR's drinking water CVs in the monitoring wells and only TCE (180 to 240 ppb) and methylene chloride (5 to 52 ppb) exceeded these guidelines in the private well. ATSDR assumed that the concentrations at 6504 West Shore Drive are representative of conditions in the newly-drilled well. Short-term exposures to these concentrations are not expected to cause adverse health effects.

(District 1999f). The letter explained that the homeowner had three options: (1) appeal the Department's decision, (2) hook up to the municipal water supply, or (3) drill a new well. If the latter option were chosen, the letter explained, the homeowner would be required to send the Department detailed data proving that the well would not be impacted by contaminants in the future and that drilling a new well would not significantly impact the plume's flow patterns (District 1999f). The homeowner failed to respond to this letter. Thus, the county prosecutor attorney has become involved in the case to force the homeowner to address the Department's concerns about the well (District 2000c, 2000d).

Surface Water and Sediment

Van Etten Lake

Van Etten Lake, a surface water body located to the east of WAFB, is used for recreational fishing, boating, and swimming. Diffuse impacts over large areas of the lake have resulted from surface water runoff draining from the northern portion of the base. In addition, more concentrated releases have occurred at three specific locations along the lake:

- *Areas Near Pierce's Point*. The Pierce Point Plume discharges into Van Etten Lake at Pierce's Point (see Figure 2). Several sampling efforts have been conducted to determine whether the lake has been adversely affected by these discharges. Surface water samples, collected between 1980 and 1997, have been analyzed for VOCs (AFBCA 1999h; AFCEE 1996e; M&E 1987; MDNR 1992; Radian 1985). Sediment samples, collected in 1990 and 1994, have been analyzed for VOCs, chlorinated hydrocarbons, and metals (AFCEE 1996e; MDNR 1992).

- *Areas Where the Northern Landfill Plume Discharges to Van Etten Lake*. The Northern Landfill Plume migrates under Camp Nissokone's property and discharges to Van Etten Lake (see Figures 2, 9, and 10). As shown on Figure 8, Camp Nissokone's old swim area was located on the Northern Landfill Plume's migratory path. Thus, in the past, campers who visited Camp Nissokone may have been swimming in the vicinity of the discharge area for about 2 hours a day for several weeks during the summer (ATSDR 1998a). Campers no longer swim in these areas; the camp moved its beach to a more northern section of the shore in the mid 1990s (Camp Nissokone 2000a). Other community members may still be swimming in the areas that are impacted by discharges, however. Several sampling efforts have been conducted to determine whether the lake has been adversely affected by these discharges. Surface water and sediment samples were collected from Van Etten Lake in the vicinity of the Northern Landfill Plume discharges (see Figure 9) in 1990, 1994, and 1995 (AFCEE 1996d; MDNR 1992). Additional

surface water samples were also collected in 1997 and 1998 (AFBCA 1999h, 2000c). The surface water samples have been analyzed for hydrocarbons and VOCs. Sediment samples have been analyzed for VOCs, chlorinated hydrocarbons, PCBs, and metals (AFCEE 1999d; MDNR 1992).

- *Air Force Beach.* In 1990, fuel from a ruptured dispensing line was released to the lake near Air Force Beach (see Figure 2). Ice fishermen identified the release, which occurred during the winter, and notified base representatives immediately. Corrective activities were initiated quickly. Holes were chopped into the ice and sorbent pads were used to capture the product (AFCEE 1995a). In 1995, sediment samples were collected in the vicinity of the Air Force Beach, and analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), polynuclear aromatics (PNAs), lead, and methyl tert-butyl ether (MTBE) (AFCEE 1995a). Sampling locations were chosen after site investigators determined the location where the distribution line ruptured.

ATSDR evaluated and summarized available surface water and sediment data that were collected from these three locations (see Tables 6 and 7 and Figure 9). To determine whether exposures to either of these media could pose health hazards, ATSDR compared surface water and sediment concentrations against ATSDR's drinking water and soil CVs, respectively. Most of the contaminants were detected at or below CVs and were not evaluated further.[4] For contaminants detected above CVs, ATSDR performed a more detailed analysis to determine whether swimmers, exposed via dermal contact and incidental ingestion, could be adversely affected by these media.

As indicated in Table 6, four VOCs have been detected above drinking water CVs in the surface waters of Van Etten Lake: benzene (nondetect to 9.2 ppb), methylene chloride (nondetect to 8 ppb), TCE (nondetect to 388 ppb), and vinyl chloride (nondetect to 1.0 ppb). TCE was the only contaminant that was detected significantly higher than its drinking water CV. It should be noted that high concentrations were not detected in all areas of the lake. The highest concentrations were detected in samples that were collected near Pierce's Point, an area that has some residences located upon it. TCE concentrations in samples that were collected further north (i.e., in the area where the Northern Landfill Plume discharges) never exceeded 11 ppb. It is unlikely that swimmers would be exposed to the maximum detected TCE concentration (i.e., 388 ppb) because such high values have only been detected in samples collected during the winter months.

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4 Drinking water and soil CVs were used to screen contaminant levels because no CVs exist for surface water or sediment. Using these CVs is a very conservative [or protective] approach because the drinking water and soil CVs assume that people will have daily exposure to these media for a lifetime. Obviously, exposures to surface water and sediments will be significantly less. It can be reasonably concluded, therefore, that surface water and sediment contaminants detected at or below the CVs do not pose health hazards.

Summertime TCE concentrations have never been recorded above 20 ppb. (TCE is a volatile chemical. During the winter, a layer of ice prevents the chemical from volatilizing from the water and dispersing in the air.) Ice fishermen are the only population expected to contact Van Etten Lake's surface waters during the winter, and their direct contact with the water is too infrequent to pose a health concern. As for summertime swimmers, the concentrations detected in surface waters are too low to pose health hazards even if a swimmer (adult or child) were exposed via incidental ingestion and dermal contact to 20 ppb of TCE, 9.2 ppb of benzene, 8 ppb of methylene chloride, and 1.0 ppb of vinyl chloride for 3 hours a day for 20 weeks a year over a period of 40 years.

As indicated in Table 7, arsenic (nondetect to 4.4 parts per million [ppm]) and iron (nondetect to 30,000 ppm) were detected in the lake's sediments at concentrations exceeding ATSDR's CVs. Given the limited contact that people are expected to have with sediment and the inability of these metals to be absorbed through the skin, ATSDR concluded that no adverse health effects are expected to result from swimming in Van Etten Lake.

Au Sable River

The Au Sable River, which is located 0.5 miles to the south of WAFB, has been impacted by the base's activities, primarily through discharges from the 3-pipes drainage ditch (see Figure 4). This ditch shuttles stormwater from WAFB's flightline area to the Au Sable River. (Much of the water passes through a retention pond, which acts as an oil/water separator, before entering the ditch.) In addition, some investigations suggest that a portion of the Mission Drive Plume discharges to the ditch. The ditch empties into the Au Sable River at a specific outfall location (See Figure 4). Between 1985 and 1993, TCE concentrations in the outfall ranged from 0.8 ppb to 77 ppb (AFCEE 1996b).

The Au Sable River is quite popular among recreational fishermen and swimmers (MDNR 1992; NCIBRD 1995). To determine whether these populations could be adversely impacted by contacting the water's surface water and sediment, ATSDR evaluated available data that have been collected from the river (AFCEE 1996b; MDNR 1992). Tables 6 and 7 separate these data into three categories, based on where the samples were collected (i.e., upstream of the 3-pipes drainage outfall, at the discharge point, or downstream of the outfall). Not surprisingly, the highest contaminant concentrations were detected at the discharge point and concentrations decreased downstream of that area. ATSDR used the same approach as described under the "Van Etten Lake" section to determine whether exposures to surface water and sediment could pose health hazards to swimmers. The analysis indicated that three contaminants have been detected in surface water samples at concentrations exceeding ATSDR's drinking water CVs: arsenic (2.0 ppb), 1,1,2,2-tetrachloroethane (nondetect to 0.6 ppb), and TCE (nondetect to 15 ppb). Additionally, one contaminant—arsenic (nondetect to 0.55 ppm)—exceeded ATSDR's soil CV in sediments. The contaminants detected in surface water were too low to pose a public health

hazard even if a person (adult or child) were exposed via incidental ingestion and dermal contact to the maximum detected concentrations for 3 hours a day for 20 weeks a year over a period of 40 years. Likewise, ATSDR concluded that the arsenic concentration in the sediment was too low to warrant concern. *ATSDR concluded that no adverse health effects are expected to result from swimming in the Au Sable River.*

Duell Lake

Duell Lake, which is located to the south of the on-base housing area, is accessed by duck hunters (see Figure 4). The lake has been impacted by the Mission Drive Plume. ATSDR evaluated available surface water and sediment data to determine whether exposure to these media could pose health hazards via dermal contact or incidental ingestion, to the hunters that use this area. As indicated in Tables 6 and 7, no contaminants were detected above ATSDR's drinking water or soil CVs (AFCEE 1996b, 1996c). *Therefore, ATSDR concluded that no adverse health effects are expected to result from hunting in the vicinity of Duell Lake.*

Wetland Area South of Site LF-27

As indicated in Figure 4, a wetland area is located to the south of Site LF-27. As described in Appendix A, this wetland may have been impacted by contaminants migrating from three IRP sites (i.e., FT-02, OT-16, and LF-27). The wetland is accessed on occasion by people who hunt for deer and turkey. ATSDR evaluated available surface water and sediment data to determine whether exposure to these media could pose health hazards, via dermal contact or incidental ingestion, to the hunters that use this area. As indicated in Tables 6 and 7, contaminants were detected in surface water and sediment samples above ATSDR's drinking water and soil CVs, respectively (AFCEE 1997b). *Given that visits to this area are sporadic and of short duration and that hunters wear clothing that prevents exposures, ATSDR concluded that the contaminant concentrations in the wetland area do not pose health hazards.*