Health Consultation

MARINE CORPS AIR STATION (MCAS) YUMA
YUMA, YUMA COUNTY, ARIZONA

EPA FACILITY ID: AZ0971590062

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

Health Consultation: A Note of Explanation

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

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

HEALTH CONSULTATION

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Prepared By:

Site and Radiological 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)**,** based in Atlanta, Georgia, is a federal public health agency of the U.S. Department of Health and Human Services**.** ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. This information is often provided in the form of public health assessments, health consultations, letter consultations, or could be technical assists. These health evaluations indicate if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced or prevented.

ATSDR and the Department of Defense (DoD) services have discussed ways in which to review previous recommendations made in health evaluations to ensure that the public health recommendations have been completed or are compatible with potential changes in current site use. Upon request, ATSDR performs follow-up evaluations on locations where health evaluations have been completed. ATSDR performs the follow-up evaluation by reviewing previous conclusions and recommendations; evaluating current site conditions and environmental remediation as necessary; and determining if there is a need for further review of environmental data.

Selection of a site for follow-up evaluation may be initiated for reasons such as: Site clean-up and mitigation measures may have reduced or eliminated contamination and/or exposures; an incident or exercise may produce an immediate need to evaluate a pathway; a new method may be developed that allows us to measure chemicals or markers of exposure in a new way; new statistical tools or procedures may facilitate the investigation of a pathway in a new way; or new biomedical or toxicological studies may change the way we assess risks.

Findings on the follow-up efforts will be discussed with the services on a site by site basis. If further evaluation efforts are determined to be needed by ATSDR and the respective DOD service, a timeline to address this follow-up will be agreed upon by these parties. Should ATSDR decide that a public health evaluation is necessary and the DOD service does not concur, the agency may conduct the follow-up evaluation using other resources.

Exposure

As the first step in the evaluation, ATSDR scientists review environmental data to see what chemicals are present, where the chemicals were found, and how people might come into contact with the chemicals. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When environmental data does not allow ATSDR to fully evaluate exposure, the report will indicate what further sampling data is needed.

Health Based Screening/Data Reduction

ATSDR uses several screening values that are derived from human and animal exposure studies. The screening values are meant to be protective of health and to allow scientists to eliminate further analysis of those chemicals that could not pose a hazard. Further analysis of the pathway is necessary when a chemical exceeds a health-based screening value. The pathway analysis may use other situation-specific screening values or may involve actual health effects data.

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 exposures may result in harmful effects. ATSDR recognizes that developing fetuses, infants, and children can be more sensitive to exposures than are adults. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable than adults. Thus, the health impact to the children is considered first when evaluating exposure and the potential adverse effects to a community. The health impacts to other groups within the community (such as the elderly, chronically ill, and people engaging in high-exposure practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies, to determine the likelihood of 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. In this case, this report suggests what further public health actions are needed.

Conclusions

This report evaluates the current status of a previously assessed site and presents conclusions about the public health threat, if any, posed by the site. These conclusions will include threats from individual pathways and a general conclusion of the health status of the site for the follow-up evaluation. Any health threats that have been determined for the general public as a result of this follow-up evaluation, including high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices), are summarized in the Conclusions section of the report. ATSDR has agreed to work with DoD and any other responsible parties to develop appropriate ways to stop or reduce exposure.

ATSDR is primarily an advisory agency, so its reports usually identify what actions are appropriate to be undertaken by DoD, 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.

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Summary and Statement of Issues

In 1998, the Agency for Toxic Substances and Disease Registry (ATSDR) prepared a public health assessment (PHA) for Marine Corps Air Station (MCAS) Yuma to determine if past, current, and future exposure to site contamination posed a potential public health hazard (ATSDR 1998). In 2007, ATSDR prepared this health consultation to update the Agency's conclusions from the 1998 PHA, and to evaluate any additional current or future exposure pathways associated with the station. (For more information on terms used in this document, please see ATSDR's online glossary at http://www.atsdr.cdc.gov/glossary.html.)

MCAS Yuma, encompassing 4,791 acres in the southwest corner of Arizona, lies about 1 mile southeast of the City of Yuma in Yuma County. The station is on the northern portion of the Yuma Mesa, with the cities of Phoenix and Tucson about 185 miles to the northeast and 235 miles to the east, respectively, and the Mexican border 21 miles to the south. The US Navy (Navy) has used MCAS Yuma to support the Marine Aircraft Wing and its subordinate units' operations since 1959. MCAS Yuma also operates an on-station airport. Daily, an estimated 4,000 military personnel and 600 civilians work at MCAS Yuma.

Throughout MCAS Yuma's history, aircraft refueling and maintenance, fire training, waste disposal, and other on-station activities released wastes into the environment. Wastes generated from these activities include acids, oils, herbicides, solvents, polychlorinated biphenyls (PCBs), paint residues, and pesticides. Remedial investigations, beginning in 1985, identified chlorinated solvents in station groundwater. As a result, in February 1990 the US Environmental Protection Agency (EPA) placed MCAS Yuma on the National Priorities List (NPL) of sites requiring further environmental investigation. To date, investigations have been conducted at four contaminated groundwater plumes, five federal facility agreement assessment program (FFAAP) sites, and 18 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) areas of concern (CAOCs). No contaminants of concern were found at some of these sites, but others have undergone extensive remediation. All sites received clean closure status under CERCLA (i.e., require no further action) except for one site—the Area 1 Hot Spot groundwater plume—which continues to undergo remediation. Full-scale air sparge/soil vapor extraction has significantly reduced contamination such that natural attenuation is expected to reduce concentrations to at or below EPA's maximum contaminant levels (MCLs) at this site in the near future.

In 1998, ATSDR identified three potential exposure pathways at MCAS Yuma: exposure to contaminated groundwater, exposure to asbestos-containing material (ACM) at the Radar Disposal Area, and exposure to organic lead in surface soil at the Flight Line, Shops Area, and Fire School Area sites (ATSDR 1998). In preparing this health consultation, ATSDR reevaluated these pathways and determined the potential for additional current and future exposures (i.e., drinking water, lead-based paint on equipment at on-station housing areas, and vapor intrusion) at MCAS Yuma. ATSDR's conclusions regarding each exposure scenario evaluated are listed below.

- *Contaminated groundwater is not a public health hazard.* No one has been exposed to the contaminated groundwater underlying MCAS Yuma and contamination has not migrated off site at levels above federal drinking water standards. Remedial activities reduced chlorinated hydrocarbon concentrations in groundwater plumes to at or below MCLs in all but one groundwater plume (Area 1 Hot Spot), but groundwater modeling suggests natural attenuation will reduce contaminant levels to MCLs in the near future.

- *Asbestos-containing material at the Radar Hill Disposal Area is not a public health hazard.* Remediation of the Radar Hill Disposal Area (CAOC 4), including removal of ACM, was completed in June 1999. No current or future hazards remain at the site.

- *Organic lead in surface soil is not a public health hazard.* Organic lead in surface soil at the Flight Line (CAOC 1), Shops Area (CAOC 2), and Fire School Area (CAOC 7) continues to be inaccessible due to the location of the organic lead (e.g., under a paved surface) and the use of access restrictions (e.g., fencing). As long as site conditions do not change, no current or future health hazards are expected.

- *On-station drinking water is not a public health hazard.* In 2004, the station began blending the surface water obtained from the Colorado River with well water to improve drinking water quality and maintain the necessary volumes. MCAS Yuma owns the land around the well and restricts activities that could impact this well. A review of MCAS Yuma drinking water quality reports for 2002–2006 indicates that no substances exceeded their MCLs. The *maximum* detected level of total trihalomethanes (TTHM; a group of volatile organic compounds including chloroform, bromodichloromethane, dibromochloromethane, and bromoform) exceeded the MCL in 2004–2006. However, the EPA requires water quality systems to maintain a maximum allowable *annual average* level of TTHM of 0.080 milligram/liter (mg/L)—which the station never exceeded. Nonetheless, as a precautionary measure, MCAS Yuma increased its sampling frequency (from four times a year to monthly), began regular flushing of the distribution system, and reduced the amount of chlorine added to the water. Based on the current levels and the recent downward trends of drinking water contaminants, current and future health hazards are not expected.

- *Lead-based paint on equipment at on-station housing areas is not a public health hazard.* Since at least 1997, MCAS Yuma has sampled for lead-based paint on playground equipment at on-station housing areas. Environmental investigations have detected lead-based paint on equipment at on-station housing areas, including a tennis court (on metal net poles), a basketball court (on metal backboard poles and metal light poles), and several playgrounds (on ladder bars, monkey bars, merry-go-rounds, swings, benches, slides, and other equipment). A MCAS Yuma Lead-Based Paint Operations and Maintenance Program is in place to identify lead-based hazards and to implement measures to control these hazards. To date, all of the play structures with lead paint have been removed or the lead has been encapsulated. Furthermore, the station's Housing Maintenance Contractor conducts monthly inspections of the playground equipment to ensure control measures remain protective of public health. Accordingly, no adverse health effects would be expected from current or future exposures to lead-based paint on the equipment in these on-station housing areas.

- *Chlorinated organic hydrocarbons emitted from underlying groundwater into indoor air are not a public health hazard.* Chlorinated hydrocarbons—1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and trichloroethene (TCE)—have been identified in the past in groundwater at the Area 1 Hot Spot at levels above federal drinking water standards and are of sufficient volatility to warrant further evaluation of potential health effects from vapor intrusion. ATSDR conducted modeling to evaluate the potential exposure to these contaminants via indoor air for occupants (i.e., workers) of the buildings overlaying this plume. As a health protective measure, ATSDR used the maximum concentrations detected in groundwater and assumed conditions (e.g., soil type) that estimated the highest possible indoor air concentrations. The estimated indoor air concentrations of PCE and TCE from the past are below health-based screening comparison values, and would not be expected to cause adverse health effects. The past maximum estimated indoor air concentration of 1,1-DCE (906.1 micrograms per cubic meter [$\mu g/m^3$]), however, exceeds the health-based screening comparison value of 80 $\mu g/m^3$. As such, ATSDR further assessed possible health effects by comparing this concentration to levels reported in the scientific literature to cause no adverse effects, or no observed adverse effects levels (NOAELs), and to the lowest levels shown to cause effects, or lowest observed adverse effect levels (LOAELs). The estimated maximum indoor air concentration of 1,1-DCE is nearly 20 times less than these NOAELs, and nearly 60 times less than these LOAELs. Therefore, past exposure would not be expected to cause adverse health effects.

  No adverse health effects are expected to occur in the present or future from the vapor intrusion pathway. Using parameters to model the worst-case current scenario, the indoor air concentration of 1,1-DCE is 35.4 $\mu g/m^3$, much lower than ATSDR's health-based screening value and adverse effect levels in the scientific literature. Further, because contaminant concentrations continue to decrease and are expected to reach federal drinking water standards through natural attenuation, no adverse health effects would be expected in the future. In addition, ATSDR recommends that MCAS Yuma continue its precautionary groundwater monitoring to identify any increases in cis-1,2-DCE, trans-1,2-DCE, or vinyl chloride that may occur due to degradation of 1,1-DCE, PCE, or TCE. Health effects from combined exposures to these chemicals would not be expected, as is the case for the past and present, if only one chemical is found to exceed ATSDR's health-based screening comparison values.

Background

Site Description and History

MCAS Yuma encompasses 4,791 acres in the southwest corner of Arizona about 1 mile southeast of the City of Yuma in Yuma County (EPA 2000; NAVFAC Southwest 2004). The station lies on the northern portion of the Yuma Mesa, approximately 4 miles west of the confluence of the Colorado and Gila Rivers (ADEQ, date unknown; EPA 2000; HLM 2000; NAVFAC Southwest 2004). The cities of Phoenix and Tucson are approximately 185 miles northeast and 235 miles east of MCAS Yuma, respectively, and the Mexican border is 21 miles south of the station (Figure 1) (HLM 2000; Military.com 2007).

Land bordering MCAS Yuma is primarily used for agricultural purposes, with adjacent properties to the south and east consisting of irrigated farmland (mainly citrus groves). Developed and undeveloped City of Yuma land lies to the north and west, with residential, light industrial, and commercial properties bordering to the north and northeast (HLM 2000; OHM 1999). Yuma International Airport borders the station along its northernmost east-west runway (NAVFAC Southwest 1994). A fence surrounds the station perimeter, and public access to MCAS Yuma is restricted (ATSDR 1998).

Operations began at the station in 1928 when the County of Yuma leased 640 acres of land from the US government for use as an airfield (OHM 1999). The US Army Corps used the station for bomber crew and pilot training from 1941 to 1946; flight activity ceased following the end of World War II (MCAS Yuma 2007a; NAVFAC Southwest 2004). Yuma County obtained rights to use the station as a civilian airfield from 1948 to 1951, when the US Air Force reactivated the station for use as a Weapons Proficiency Center for fighter-inceptor units (EPA 2000; NAVFAC Southwest 2004; Uribe & Associates 1997).

In 1959, MCAS Yuma was transferred to the Navy to support the Marine Aircraft Wing and its subordinate units' operations (NAVFAC Southwest 2004). In addition to these support activities, MCAS Yuma operates the on-station airport as a joint military/civilian facility with Yuma County Airport Authority (EPA 2000; NAVFAC Southwest 2004). MCAS Yuma is considered the busiest air station in the US Marine Corps; it is the third busiest among the Navy facilities (ADEQ, date unknown). An estimated 4,000 military personnel and 600 civilians work at MCAS Yuma on a daily basis (OHM 1999).

Aircraft refueling and maintenance, fire training, waste disposal, and other activities conducted throughout the station's 70-year history have generated a variety of wastes, including acids, waste oils, herbicides, solvents, PCBs, paint residues, and pesticides. Remedial investigations began at MCAS Yuma in 1985, and early results identified chlorinated solvents present in station groundwater. As a result of these findings, in February 1990 the EPA placed MCAS Yuma on the NPL to investigate potential risks to human health and the environment associated with the station's release of hazardous wastes (EPA 2000; NAVFAC Southwest 1994; Uribe & Associates 1997).

In 1992, the Navy, the EPA, and the Arizona Department of Environmental Quality (ADEQ) signed a final federal facility agreement to manage environmental investigations and potential remedial actions. Before remedial activities began, the station was divided into two areas for investigating CAOCs. Operable unit 1 (OU1) contained contaminated groundwater and contaminated soil deeper than 10 feet below ground surface (bgs), and OU2 contained contaminated soil above 10 feet bgs (EPA 2000; Uribe & Associates 1997). The 1996 OU1 remedial investigation (RI) identified six groundwater contaminated areas exceeding drinking water standards (Areas 1 through 6); two of these areas (Areas 4 and 5), however, were transferred to the underground storage tank (UST) program due to contamination by fuel constituents (EPA 2000). The 1995 RI for OU2 investigated 18 CAOCs; no action was recommended for 12 sites whereas remedial actions were recommended for 6 sites (1, 4, 7, 8A, 9, and 10) due to asbestos, metals, or organic compounds in soil (NAVFAC Southwest 2004; Uribe & Associates 1997). In addition, MCAS Yuma contained five FFAAP sites requiring investigation and/or remediation (GEOFON, Inc. 2002).

In 1998, ATSDR prepared a PHA that identified three potential exposure pathways at MCAS Yuma: exposure to contaminated groundwater, exposure to ACM at the Radar Hill Disposal Area, and exposure to organic lead in surface soil at three sites—Flight Line, Shops Area, and Fire School Area (ATSDR 1998; see the PHA at: http://www.atsdr.cdc.gov/HAC/PHA/yuma/ymc_toc.html). In this health consultation, ATSDR reevaluated these three exposure pathways and assessed three additional pathways: drinking water, lead-based paint on equipment at on-station housing areas, and vapor intrusion. Since the PHA was prepared, cleanup activities at MCAS Yuma have included removal of contaminated soil and extensive groundwater treatment. As of 2007, all CAOCs and FFAAP sites received clean closure status under CERCLA following investigations, remediation, and/or implementations of land use restrictions (GEOFON, Inc. 2002). The one site still requiring action—the groundwater plume in the Area 1 Hot Spot at OU1—continues to undergo monitoring and remediation as natural attenuation is expected to reduce concentrations to at or below EPA's MCLs in the near future (Dan Nail, Installation Restoration Program Manager, MCAS Yuma, personal communication, August 14, 2007).

Demographics

ATSDR assesses demographic data to identify the population(s) possibly exposed to contaminants associated with a site, such as MCAS Yuma. ATSDR can also use these data to determine if people who are more sensitive to the effects of potential contamination live in the area, including children (birth to 6-years-old), women of childbearing age (15- to 44-years-old), and elderly persons (65 years of age and older). In addition, ATSDR evaluates demographic data to examine how often people in the population move to another area, in an attempt to assess the time period that residents could have been exposed to site contaminants.

Daily, about 4,000 military personnel and 600 civilians work at MCAS Yuma (OHM 1999). In August 2007, approximately 2,290 people lived in station-owned housing. MCAS Yuma has one on-station housing area with 693 units in the southern corner of the station, and maintains 128 off-station housing units located about 5 miles northwest of the station. Residents live in MCAS Yuma housing for an average of 2.5 to 3 years (CDM Federal Programs Corporation.2003; Mark Smith, Housing Manager, MCAS Yuma, personal communication, August 14, 2007; MCAS Yuma Housing 2007).

According to 2000 census data, approximately 14,353 people live within a 1-mile radius of MCAS Yuma. Figure 2 presents population information for people living at and near the station. As the figure shows, 1,672 children aged 6 and younger, 2,741 women of childbearing age (aged 15–44), and 2,060 adults aged 65 and older live within 1 mile of MCAS Yuma. In August 2007, 462 residents of station-owned housing were 6 years of age and younger, while no residents were 65 years of age and older (Mark Smith, Housing Manager, MCAS Yuma, personal communication, August 14, 2007; MCAS Yuma Housing 2007).

Community Health Concerns

In 1994, MCAS Yuma implemented a Community Relations Program to facilitate public participation in environmental restoration at the station. Through this program, MCAS Yuma informs the public about environmental clean-up activities and encourages members of the public to participate in the remedial decision-making process. A Restoration Advisory Board (RAB), comprised of local community members and representatives of the Navy, the EPA, and ADEQ, meets periodically to discuss and to make decisions regarding investigation results, proposed future clean-up activities, and remediation alternatives (EPA 2000; Uribe & Associates 1997).

For the 1998 PHA, ATSDR identified community health topics of concern through the station's Community Relations Plan (CRP), which has been implemented since 1994 (NAVFAC Southwest 1994). These concerns, as well as ATSDR's responses, are presented below. In 2007, representatives from the Public Affairs and Environmental Department offices at MCAS Yuma, as well as EPA Region 9, identified no additional concerns expressed by station residents or workers regarding environmental issues.

Groundwater Contamination and Off-site Migration

No one has ever been exposed to the contaminated groundwater underlying MCAS Yuma and no contamination has migrated off site at levels above federal drinking water standards (Coonfare 2007; NAVFAC Southwest 2004). The station supplies drinking water to residents and workers through a canal system that obtains water from the Colorado River (EPA 2000). On an as needed basis, the station blends water from a groundwater well with the surface water to improve drinking water quality. MCAS Yuma owns the land surrounding this well and restricts activities that could impact the well (MCAS Yuma 2005–2007).

MCAS Yuma is using various remedial techniques to reduce chlorinated hydrocarbon concentrations in on-station groundwater plumes in OU1 Areas 1, 2, 3, and 6. Remedial measures include full-scale air sparge/soil vapor extraction in the Area 1 Hot Spot and Central/Interior plumes; a vertical circulation treatment system in the leading edge of the plume area (LEPA) of Area 1; monitored natural attenuation in all areas; and institutional controls (i.e., groundwater use restrictions at all sites) (MCAS Yuma 2001; NAVFAC Southwest 2004). Groundwater monitoring, conducted quarterly, indicates that all plumes are shrinking in size and concentrations as a result of remedial actions and no plumes are migrating off site. Areas 1 (LEPA and Central/Interior plumes), 2, 3, and 6 achieved EPA MCLs and have received clean closure status under CERCLA (Dan Nail, Installation Restoration Program Manager, MCAS Yuma, personal communication, August 14, 2007; NAVFAC Southwest 2004). The air sparge/soil vapor extraction system reduced contamination significantly in the Area 1 Hot Spot such that groundwater modeling indicates this plume will be reduced below MCLs through natural attenuation processes in the near future (NAVFAC Southwest 2004). In addition, precautionary groundwater monitoring conducted by MCAS Yuma will identify any increases in cis-1,2-DCE, trans-1,2-DCE, or vinyl chloride that may occur due to degradation of 1,1-DCE, PCE, or TCE.

Storage, Handling, and Disposal of Hazardous Waste

MCAS Yuma follows and complies with all Federal, State, and local requirements for hazardous waste storage, handling, and disposal. The station adheres to all Federal and State laws, which prohibit the release of any hazardous waste into the environment (i.e., via land, water, or air). The Environmental Department conducts daily inspections of hazardous waste accumulated at all MCAS Yuma areas. Details of these operating procedures are in MCAS Yuma's Environmental Compliance and Protection Standard Operating Procedures (ECPSOP) at http://www.yuma.usmc.mil/services/environmental/orders/P6280_3f01.pdf (MCAS Yuma, date unknown).

Windblown Contamination

Weather conditions and soil properties determine the amounts of dust that are blown into the air. Surface soil particles, and contaminants within these particles, can become airborne on windy days and blow in downwind directions. The EPA indicates that the amounts of dust generated by winds will depend on the soil particle size, the wind speed, the portion of soil that is covered by vegetation, and other variables (EPA 1985). Remedial actions at MCAS Yuma have removed contaminants from on-site surface soil. Therefore, current or future exposures would not be expected because there are no contaminants in surface soil to be carried via windblown dusts.

Health of Family Members, Especially Small Children

In 1998, ATSDR's PHA concluded that potential exposures at MCAS Yuma presented no public health hazard. Based on a review of information from 1998–2007, ATSDR concludes that current and future exposures at MCAS Yuma continue to present no public health hazard. ATSDR uses the *no public health hazard* category for sites where people have never and will never come into contact with harmful amounts of site-related substances. Accordingly, as long as conditions at the station do not change, no adverse health effects would be expected from exposures at MCAS Yuma in the present or future.

Buried Containers of Hazardous Waste Including Pesticides and Insecticides

A remedial investigation conducted in 1995 consisted of various activities at all 18 CAOCs in OU2, including geophysical surveys at CAOCs 4, 8, 9, 10, 14, 16, and 17 to search for drums, buried tanks, and other underground objects possibly containing hazardous substances. Based on these geophysical surveys, the remedial investigation concluded that asbestos-containing material (ACM) at the Radar Hill Disposal Area (CAOC 4), the Fire School Area (CAOC 7), and the Southeast Sewage Lagoon (CAOC 9) required removal (Uribe & Associates 1997). In June 1999, the removal of asbestos-containing material was completed at CAOCs 4, 7, and 9 (GEOFON, Inc. 1999; NAVFAC Southwest 2004). In addition, the geophysical survey identified metallic debris buried at CAOC 8A, the former Southeast Station Landfill where predominantly municipal wastes were burned and then disposed of (Uribe & Associates 1997). Based on these findings, institutional controls (e.g., land use restrictions), fencing, and locked gates were implemented to restrict exposures to contaminants at CAOC 8A (MCAS Yuma 2004a; NAVFAC Southwest 2004).

A possible concern would be if substances had leaked from these areas and entered on-station groundwater. As discussed previously, however, no one has or continues to be exposed to contaminated groundwater underlying MCAS Yuma. Removals of buried waste (i.e., asbestos) have occurred, but strict safety guidelines and precautions were followed to ensure no exposures occurred as a result of these removals.

Discussion

ATSDR prepared this health consultation to provide updated information regarding current and future exposure pathways identified in the Agency’s 1998 PHA (ATSDR 1998). ATSDR conducted interviews and reviewed site documents to evaluate whether the conclusions determined by ATSDR in 1998 were still appropriate for these potential pathways, and to determine whether additional current and future pathways exist that could pose a public health hazard. Detailed below are the conclusions from the 1998 PHA, as well as ATSDR’s updated findings.

What exposure pathways did ATSDR identify in its 1998 PHA?

Based on information collected from two site visits, interviews with knowledgeable parties, and relevant site documents, ATSDR identified three potential current and future exposure pathways:

- Exposure to contaminated groundwater.
- Exposure to ACM at the Radar Hill Disposal Area (CAOC 4).
- Exposure to organic lead in surface soil at the Flight Line (CAOC 1), Shops Area (CAOC 2), and Fire School Area (CAOC 7).

What did ATSDR conclude about each of these pathways in 1998?

ATSDR concluded that *current exposure to contaminated groundwater posed no public health hazard.* In 1998, no on-site wells were used for drinking water and contaminated plumes had not moved beyond the station perimeter. ATSDR also determined that *future exposure to contaminated groundwater was not a public health hazard* because the station was remediating and monitoring the contaminated plumes. Also, the Navy planned to implement a containment policy to prevent future contaminant migration beyond the station's perimeter, and off-site wells were sufficiently distant to eliminate the likelihood of future exposure.

In 1998, ATSDR concluded that *current exposure to asbestos-containing material at the Radar Hill Disposal Area (CAOC 4) presented no public health hazard* because the site was fairly isolated, ACM was not present in large quantities, and most of the ACM was buried underground. ATSDR also found that *future exposure to asbestos-containing material at the Radar Hill Disposal Area (CAOC 4) was no public health hazard* because of planned remedial activities that should eliminate any potential exposures

ATSDR concluded that *current and future exposure to organic lead in surface soil at the Flight Line (CAOC 1), Shops Area (CAOC 2), and Fire School Area (CAOC 7) presented no public health hazard.* The Flight Line Area is paved, preventing access to contaminated surface soil. The sampling area at the Shops Area is covered with dirt, and separated and fenced off from nearby single enlisted barracks and dining facilities. The surface sample from the Fire School Area was collected from an area between two runways that has been covered with sealant since the early 1980s, and the subsurface sample was collected from an area that is fenced with warning signs posted.

What does ATSDR conclude about the pathways identified in 1998 based on 2007 data?

Information collected in 2007 suggests that *exposure to groundwater continues to pose no current and future public health hazard.* No one has been exposed to the contaminated groundwater underlying MCAS Yuma and contamination has not migrated off site at levels above federal drinking water standards. The station supplies drinking water to residents and workers through a canal system that obtains its water from the Colorado River (EPA 2000; NAVFAC Southwest 2004). Beginning in 2004, on an as needed basis, the station started blending water from a groundwater well with the surface water to improve drinking water quality. MCAS Yuma owns the land surrounding this well and restricts activities that could impact the well (MCAS Yuma 2005–2007).

Remedial activities have reduced chlorinated hydrocarbon concentrations in groundwater plumes in OU1 Areas 1 (LEPA and Central/Interior plumes), 2, 3, and 6 to at or below EPA MCLs. Groundwater modeling at the Area 1 Hot Spot suggests this plume will be reduced below MCLs through natural attenuation in the near future (NAVFAC Southwest 2004). As long as site conditions do not change, future public health hazards would not be expected.

Based on a review of recent data, ATSDR concludes that *asbestos-containing material at the Radar Hill Disposal Area (CAOC 4) still poses no current or future public health hazard*. Remediation of CAOC 4, including removal of ACM, was completed in June 1999 (NAVFAC Southwest 2004).

Information available in 2007 indicates that current and future exposure to organic lead in surface soil at the Flight Line (CAOC 1), Shops Area (CAOC 2), and Fire School Area (CAOC 7) still presents no public health hazard because these contaminants continue to be inaccessible due to the location of the organic lead (e.g., under a paved surface) and the implementation of access restrictions (e.g., fencing).

Did ATSDR discuss other issues in the 1998 PHA? If so, what is the current status?

In 1998, ATSDR stated that the Navy planned to remediate and/or further investigate CAOC 7 (Fire School Area), CAOC 9 (Southeast Sewage Lagoon), FFAAP Unit 855.04 (Battery Shop), and FFAAP Unit 855.19 (Hydraulic Lift). ATSDR indicated that the Navy would place future use restrictions on CAOC 1 (Flight Line), CAOC 8A (Southeast Station Landfill), CAOC 10 (Ordnance Munitions Disposal Area), FFAPP Unit 327.03 (Drum Storage Area), FFAAP Unit 9005.00 (Transformer Storage Yard), and FFAAP Unit F808.00 (Former Pesticide Control Shop).

The Navy has completed remedial activities at all of these sites. Based on information collected in 2007, institutional controls (e.g., land use restrictions) restrict exposures to soil contaminants (e.g., PCBs, pesticides, asbestos, and metals) at CAOCs 1, 8A, and 10 (MCAS Yuma 2004a; NAVFAC Southwest 2004). Fencing and locked gates also restrict access to CAOC 8A. Remediation, including removal of ACM, was completed in June 1999 at CAOCs 7 and 9 (GEOFON, Inc. 1999; NAVFAC Southwest 2004). FFAAP Units 327.03, F808.00, 855.04, 855.19, and 9005.00 were closed following investigations, remediation, and/or implementations of land use restrictions (GEOFON, Inc. 2002).

Did ATSDR consider other exposures, such as surface water contact and fish ingestion?

In 1998, ATSDR evaluated land uses at MCAS Yuma to determine whether people could be exposed to any site contamination via surface water (e.g., dermal contact or incidental ingestion when swimming), fish ingestion, or hunting. ATSDR concluded that no exposures occurred through surface water because no natural surface water body exists at MCAS Yuma, and accordingly, no fishing occurs at the station. In addition, no hunting takes place. The public health assessment noted, however, that residents were possibly eating rabbits.

In 2007, ATSDR contacted the Natural Resources Department at MCAS Yuma to update the findings of the 1998 PHA. The station confirmed that no surface water bodies exist at MCAS Yuma; therefore, no swimming and no fishing occur on station. Furthermore, there are no reports of rabbit consumption at MCAS Yuma (Wylie Homesley, Natural Resources Manager, MCAS Yuma, personal communication, August 14, 2007).

Were exposure pathways not evaluated in the 1998 PHA evaluated in 2007?

Yes. In 2007, ATSDR evaluated potential exposures to on-station drinking water, lead-based paint on recreational equipment (e.g., playgrounds) in on-station housing areas, and chlorinated organic hydrocarbons emitted from underlying groundwater into indoor air spaces (i.e., vapor intrusion). The reasons these were included, as well as ATSDR's evaluation of these pathways, are presented below.

On-station drinking water: At the time ATSDR prepared its PHA in 1998, the MCAS Yuma drinking water system relied solely on surface water obtained from the Colorado River; no water from groundwater beneath the station was used. In 2004, the station began blending the surface water with water from a groundwater well as needed to improve drinking water quality (EPA 2000; NAVFAC Southwest 2004). MCAS Yuma owns the land surrounding the well, however, and restricts activities that could impact the well (MCAS Yuma 2005–2007). Nonetheless, ATSDR reviewed a 5-year (2002–2006) sample of drinking water quality reports for the station (MCAS Yuma 2003, 2004b, 2005, 2006, and 2007b), with years prior to and after 2004 included, to determine whether MCAS Yuma drinking water has been adversely impacted by the use of this groundwater well.

In accordance with EPA and ADEQ guidelines, MCAS Yuma regularly tests drinking water for nearly 90 substances (see the list at http://www.epa.gov/safewater/consumer/pdf/mcl.pdf) and compares detected concentrations to MCLs. MCLs are enforceable drinking water regulations developed to protect public health over a lifetime at an exposure rate of 2 liters of water per day. The station reports drinking water results annually in Consumer Confidence Reports, which can be obtained from the MCAS Yuma Base Services Department Water Plant Lead Operator (MCAS Yuma 2003–2007). More information on these drinking water regulations is available at http://www.epa.gov/safewater/index.html or http://www.azdeq.gov/environ/water/dw/index.html.

Based on ATSDR's review of MCAS Yuma drinking water data for 2002–2006, no substances exceeded their respective MCLs. More discussion is warranted, however, to describe the results regarding TTHM. TTHM refers to a group of volatile organic compounds including chloroform, bromodichloromethane, dibromochloromethane, and bromoform. TTHM is a byproduct of drinking water disinfection that forms when chlorine or other drinking water disinfectants react with natural organic matter in water (EPA 2006a, 2006b; MCAS Yuma 2006). The MCL requires water quality systems to maintain a maximum *annual average* level of TTHM of 0.080 mg/L (EPA 2006a, 2006b). As shown below, although the *maximum* detected levels of TTHM were above the MCL in 2004–2006, the maximum *annual average* level of TTHM never exceeded the MCL (MCAS Yuma 2005, 2006, 2007b).

- 2004: range of 0.0568–0.1 mg/L, with a running annual average of 0.0726 mg/L
- 2005: range of 0.0180–0.138 mg/L, with a running annual average of 0.07455 mg/L

- 2006: range of 0.0180–0.138 mg/L, with a running annual average of 0.0748 mg/L

As a precautionary measure, MCAS Yuma increased its sampling frequency from four times a year to monthly. In addition, the station began regular flushing of the distribution system and reduced the amount of chlorine added to the water (MCAS Yuma 2006). Because the maximum annual average levels of TTHM never exceeded the MCL, ATSDR does not expect adverse health effects to result from consumption of on-station drinking water. In addition, future health hazards would not be expected as long as drinking water contaminant levels remain the same or decrease.

<u>Lead-based paint in on-station housing areas:</u> An environmental investigation of MCAS Yuma military family housing areas was completed in 2003. The investigation summarized findings from lead-based paint surveys conducted on playground and other equipment in 1997, 2002, and 2003 at MCAS Yuma housing areas, and also evaluated whether various contaminants (e.g., pesticides, ordnance, radioactive waste, solid waste, and storage tanks) were of concern at on-station and off-station housing areas. Based on this evaluation, sampling in housing areas indicated lead-based paint as a potential concern. No soil lead or dust hazards were identified in on-station or off-station housing areas, but lead-based paint was detected in equipment at on-station housing areas, including a tennis court (on metal net poles), a basketball court (on metal backboard poles and metal light poles), and several playgrounds (on ladder bars, monkey bars, merry-go-rounds, swings, benches, slides, and other equipment). No lead-based paint, however, was detected on playground equipment at off-station housing areas (CDM Federal Programs Corporation 2003).

The station has a Lead-Based Paint Operations and Maintenance Program to identify lead-based hazards and to implement measures to control these hazards. According to the MCAS Yuma Housing Manager, subsequent to the findings of this 2003 investigation, all of the play structures were either removed or procedures were conducted to encapsulate the lead (Mark Smith, Housing Manager, MCAS Yuma, personal communication, August 14, 2007). Also, MCAS Yuma’s Housing Maintenance Contractor inspects the playground equipment on a monthly basis to ensure the control measures remain protective of public health (CDM Federal Programs Corporation 2003; Vivian Blevins, Asbestos and Lead Program Manager, MCAS Yuma, personal communication, August 29, 2007).

Accordingly, ATSDR does not expect adverse health effects to result in the present or future from lead-based paint exposures at equipment in on-station housing areas for the following reasons: a) MCAS Yuma has been sampling lead-based paint on equipment at on-station housing areas since at least 1997, b) the station used interim controls to prevent potential exposures prior to completion of lead-based paint abatement activities, c) the lead-based paint has been removed from the equipment or encapsulated, and d) the station conducts monthly monitoring of equipment in these areas to ensure control measures remain protective of human health.

Chlorinated organic hydrocarbons emitted from underlying groundwater into indoor air spaces: ATSDR evaluated the potential for chlorinated organic hydrocarbons in underlying groundwater at MCAS Yuma to enter indoor air, referred to as the *vapor intrusion pathway*. Vapor intrusion is the migration of volatile chemicals from subsurface soil or groundwater into overlying buildings (EPA 2002). Specifically for MCAS Yuma, this refers to the possible migration of vapors from the chlorinated hydrocarbons in on-site groundwater, through subsurface soils, into indoor air present in overlying on-site industrial buildings, and then being inhaled by individuals working in these on-station buildings. When the PHA was prepared in 1998, it was not standard public health practice to consider the vapor intrusion pathway. However, in recent years, this has emerged as a concern for sites containing volatile organic compounds in groundwater and/or subsurface soil. As such, ATSDR evaluated this pathway in 2007.

To evaluate the vapor intrusion pathway, ATSDR used EPA's Office of Solid Waste and Emergency Response (OSWER) guidance that outlines screening steps for determining whether this exposure applies to a site (see http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor.htm). EPA's OSWER recommends considering the vapor intrusion pathway when volatile chemicals (e.g., chlorinated hydrocarbons) are suspected to be in groundwater at 100 feet or less depth, and the contaminant plume is located within 100 feet of existing or future buildings (EPA 2002). Based on a review of site contamination and potential exposure scenarios at MCAS Yuma, no buildings were identified within 100 feet of the chlorinated hydrocarbon plumes in Areas 2, 3, or 6. The Area 1 Hot Spot plume, however, has contaminated groundwater within 100 feet and is located within 100 feet of two buildings—Building 220 and Building 230 (Coonfare 2007). Accordingly, ATSDR evaluated the vapor intrusion pathway for the Area 1 Hot Spot plume.

Chlorinated hydrocarbons—1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and trichloroethene (TCE)—have been identified in the past in groundwater at the Area 1 Hot Spot at levels above federal drinking water standards (i.e., MCLs) and are of sufficient volatility to warrant further evaluation of potential health effects for vapor intrusion. Current groundwater modeling indicates that levels of chlorinated hydrocarbons in this plume will be reduced to MCLs through natural attenuation processes in the near future (NAVFAC Southwest 2004). However, to evaluate possible past exposures via vapor intrusion, ATSDR identified the maximum detected groundwater concentrations of volatile organic compounds from 1995, when sampling began, to 2004, when decreased concentrations due to remedial activities were documented, and assumed that these contaminants could reach indoor air. This approach is extremely protective of public health because actual exposures would have been to an average concentration. Current exposures would be much lower due to continuing decreases in contaminant concentrations as a result of remedial activities and natural attenuation.

For this evaluation, ATSDR reviewed groundwater data for the Area 1 Hot Spot groundwater contaminant plume, considered groundwater hydrogeology, and employed the Johnson-Ettinger Model (JEM) (GW-SCREEN Version 3.1; EPA 2004) to evaluate vapor intrusion as a potential exposure pathway for occupants of the buildings overlaying the Area 1 Hot Spot plume. The JEM is a screening level model that incorporates site-specific data (e.g., groundwater temperature, soil type, and building construction) with several conservative default parameters and assumptions (see Table 1). ATSDR used the JEM to estimate vapor intrusion of the volatile compounds 1,1-DCE, PCE, and TCE into the occupational buildings that overlay the Area 1 Hot Spot contaminant plume (see Table 2). The JEM considered several variables, such as slab building construction and soil type. Because ATSDR was unable to specifically define the soil type overlaying the Area 1 Hot Spot plume and underneath the buildings, all soil types potentially present in the plume area were considered in the model (loam, loamy sand, sand, sandy loam, and silt loam) (EPA 2004).

As shown in Table 2, based on the maximum concentration detected in groundwater at the Area 1 Hot Spot plume, the highest estimated vapor concentrations in air for all three contaminants are for buildings overlaying sand. Using these highest results, the estimated vapor concentrations in air are 906.1 μg/m^3 for 1,1-DCE, 18.5 μg/m^3 for PCE, and 303.1 μg/m^3 for TCE. ATSDR compared these estimated concentrations to health-based screening comparison values (see text box) for these contaminants in air—environmental media evaluation guide (EMEG) levels—which are screening values that enable ATSDR to identify contaminants requiring further evaluation. To be protective of public health, screening values are generally based on contaminant concentrations *many times lower than levels at which no effects were observed* in experimental animals or human epidemiologic studies.

> ATSDR defines a comparison value (CV) as a calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Considering the maximum estimated concentrations for buildings overlaying sand, estimated vapor concentrations in air for PCE of 18.5 μg/m^3 and TCE of 303.1 μg/m^3 are below the health-based screening comparison values of 300 μg/m^3 and 500 μg/m^3, respectively. Therefore, exposure to the estimated concentrations of PCE and TCE in indoor air is not expected to result in adverse health effects, and requires no further evaluation. The maximum estimated past vapor concentration of 1,1-DCE of 906.1 μg/m^3, however, exceeds the corresponding health-based screening comparison value of 80 μg/m^3 (see Table 2), and requires further evaluation and discussion.

1,1-DCE: It is very important to emphasize the extremely health-protective aspects of this evaluation. First, the estimated vapor concentration for 1,1-DCE is based on the maximum concentration detected in the Area 1 Hot Spot groundwater plume since 1995 (512 micrograms per liter [μg/L]; Jacobs Engineering Group 1996), prior to any remedial activities. The average concentration of 1,1-DCE would be expected to be substantially less than the maximum concentration used in the modeling. Current concentrations are near MCLs and expected to decrease to federal drinking water standards through natural attenuation in the near future. In fact, in 2004 the maximum reported concentration of 1,1-DCE in groundwater at the Area 1 Hot Spot plume was 20 μg/L (NAVFAC Southwest 2004), more than 25 times lower than the maximum concentration of 512 μg/L detected in 1995. Second, the intermediate EMEG used for inhalation exposure to 1,1-

DCE is based on ATSDR's intermediate inhalation minimal risk level (MRL), which is calculated using a concentration of 1,1-DCE that caused no adverse effects in exposed animals (ATSDR 1994). Third, default parameters and assumption variables were entered into the model due to lack of information regarding the exact soil type overlaying the Area 1 Hot Spot and the specific depth of the groundwater plume. Generally, the use of default parameters rather than site-specific factors for input variables results in higher indoor air concentrations (EPA 2004). Further, ATSDR is considering a worst-case scenario because, in addition to using the maximum concentration of 1,1-DCE detected, the soil type (i.e., sand) resulting in the highest maximum indoor air concentration (906.1 $\mu g/m^3$) was being evaluated further. As Table 2 shows, estimated vapor concentrations for all other soil types were much less than for sand, ranging from 70.9–320.6 $\mu g/m^3$.

Because the estimated vapor concentration of 1,1-DCE exceeded its health-based screening comparison value for air, ATSDR reviewed available scientific data in the agency's *Toxicological Profile for 1,1-Dichloroethene* (see http://www.atsdr.cdc.gov/toxprofiles/tp39.pdf; ATSDR 1994) to identify exposure concentrations that have led to adverse health effects. Of all of the intermediate (15–364 days) and chronic (365 days or longer) duration inhalation studies reviewed, the highest level found to produce no adverse health effects, referred to as a no observed adverse effect level (NOAEL), was 5 ppm (5,000 ppb) or 19,826 $\mu g/m^3$. This NOAEL (used to derive an intermediate duration inhalation exposure MRL of 0.2 ppm) is based on a study where guinea pigs had no hepatic effects following continuous exposure to 1,1-DCE for 24 hours a day for 90 days (Prendergast et al. 1967). In addition, EPA has calculated a NOAEL human equivalent concentration (HEC) for chronic exposure to 1,1-DCE of 17,700 $\mu g/m^3$ (17.7 mg/m^3) based on studies where no adverse effects were seen in rats exposed via inhalation to 25 ppm 1,1-DCE 6 hours a day, 5 days a week, for up to 18 months (EPA 2007). In addition, toxicological studies on animals exposed to 1,1-DCE via inhalation have identified lowest observed adverse effect levels (LOAELs) ranging from 15–500 ppm (15,000–500,000 ppb) or 59,479–1,982,618 $\mu g/m^3$ for less serious effects (e.g., slight nasal irritation, fatty change in liver) and serious effects (e.g., renal adenocarcinoma, death) (ATSDR 1994). Further, EPA has calculated a $LOAEL_{HEC}$ for chronic exposure to 1,1-DCE of 53,200 $\mu g/m^3$ based on studies where the critical effect in rats exposed to 1,1-DCE via inhalation was liver toxicity (i.e., fatty change) (EPA 2007). The highest estimated indoor air concentration from the past for 1,1-DCE at MCAS Yuma—906.1 $\mu g/m^3$—is nearly 20 times less than these NOAELs and nearly 60 times less than these LOAELs. NOAELs are levels below which no adverse health effects have been observed. Therefore, exposure to concentrations of 1,1-DCE below the NOAELs would not be expected to cause adverse health effects from past exposures.

No adverse health effects are also expected from present or future exposures by the vapor intrusion pathway. ATSDR conducted modeling to estimate the indoor air concentration based on present-day groundwater concentrations of 1,1-DCE in the Area 1 Hot Spot plume. ATSDR assumed the buildings were overlaying sand, which results in the highest possible indoor air concentrations, and used the maximum detected concentration of 1,1-DCE in 2004 (20 $\mu g/L$; NAVFAC Southwest 2004). Using these input parameters and the same default values used previously (see Table 1), the current worst-case estimated indoor concentration of 1,1-DCE is 35.4 μg/m^3, much lower than ATSDR's screening value and adverse effect levels in the scientific literature . Further, no adverse health effects would be expected in the future because contaminant concentrations in the Area 1 Hot Spot plume continue to decrease and are expected to reach federal drinking water standards through natural attenuation over the next few years. In addition, precautionary groundwater monitoring conducted by MCAS Yuma will identify any increases in cis-1,2-DCE, trans-1,2-DCE, or vinyl chloride that may occur due to degradation of 1,1-DCE, PCE, or TCE. Studies show that there is no effect after exposure to mixtures of chemicals that are each below the NOAEL (ATSDR 2004). Therefore, health effects from combined exposures at Yuma are not expected.

Children's Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

As part of the child health considerations, ATSDR located the populations of children who live at MCAS Yuma and in the station's vicinity. According to 2000 census data, 1,672 children aged 6 and younger live within 1 mile of MCAS Yuma. In August 2007, a total of 462 children aged 6 years or younger lived in on- and off-station housing (Mark Smith, Housing Manager, MCAS Yuma, personal communication, August 14, 2007; MCAS Yuma Housing 2007).

Sampling conducted at MCAS Yuma has identified lead-based paint on playground equipment on-station. The station has removed all of the play structures or conducted activities to encapsulate the lead to prevent any exposures (Mark Smith, Housing Manager, MCAS Yuma, personal communication, August 14, 2007). Not only has MCAS Yuma implemented measures to control these hazards, but the station also inspects the playground equipment monthly to ensure control measures remain protective of public health (CDM Federal Programs Corporation 2003; Vivian Blevins, Asbestos and Lead Program Manager, MCAS Yuma, personal communication, August 29, 2007). Therefore, ATSDR does not expect adverse health effects to result for children using the on-station playground equipment. For additional details about the potential exposure pathways evaluated by ATSDR, refer to the *Discussion* section of this health consultation.

Conclusions

Based on available information for 1998–2007, discussions with MCAS Yuma representatives, and an evaluation of potential exposure pathways, ATSDR has reached the conclusions presented below. This section includes an update to the conclusions in ATSDR's 1998 PHA, as well as conclusions regarding additional exposure pathways evaluated by ATSDR in 2007. ATSDR concludes in each of the pathways below that the site poses no public health hazard.

1. *Contaminated groundwater poses no public health hazard.* No one has been exposed to the contaminated groundwater underlying MCAS Yuma and contamination has not migrated off site at levels above federal drinking water standards. Remedial activities have reduced chlorinated hydrocarbon concentrations in groundwater plumes in OU1 Areas 1 (LEPA and Central/Interior plumes), 2, 3, and 6 to at or below MCLs. Only one plume (Area 1 Hot Spot) still requires remediation at MCAS Yuma, but groundwater modeling suggests natural attenuation will reduce this plume to below MCLs in the near future.

2. *Asbestos-containing material at the Radar Hill Disposal Area poses no public health hazard.* Recent data indicate that remediation of the Radar Hill Disposal Area (CAOC 4), including removal of ACM, was completed in June 1999. No current or future public health hazards remain at the site.

3. *Organic lead in surface soil presents no public health hazard.* Organic lead in surface soil at the Flight Line (CAOC 1), Shops Area (CAOC 2), and Fire School Area (CAOC 7) continues to be inaccessible due to the location of the organic lead (e.g., under a paved surface) and as a result of access restrictions (e.g., fencing). No current or future health hazards are expected as long as site conditions do not change.

4. *On-station drinking water poses no public health hazard.* When ATSDR prepared the 1998 PHA, the MCAS Yuma drinking water system relied solely on surface water from the Colorado River. Since that time, the station began blending the surface water with water from a groundwater well as needed to improve drinking water quality. MCAS Yuma owns the land around the well, however, and restricts activities that could impact the well. Based on a review of drinking water quality reports for the station for 2002–2006, no substances exceeded their respective MCLs.

   Although the *maximum* detected level of TTHM exceeded the MCL during this time period, the EPA requires water quality systems to maintain a maximum allowable *annual average* level of TTHM of 0.080 mg/L—which the station never exceeded. Nonetheless, as a precautionary measure, MCAS Yuma increased its sampling frequency from four times a year to monthly. In addition, the station began regular flushing of the distribution system and reduced the amount of chlorine added to the water. No adverse health effects are expected based on the current levels of drinking water contaminants and as long as these levels remain the same or decrease.

5. *Lead-based paint on equipment at on-station housing areas presents no public health hazard.* MCAS Yuma has been sampling lead-based paint on equipment at on-station housing areas since at least 1997, and environmental investigations have detected lead-based paint on equipment, including a tennis court (on metal net poles), a basketball court (on metal backboard poles and metal light poles), and several playgrounds (on ladder bars, monkey bars, merry-go-rounds, swings, benches, slides, and other equipment). MCAS Yuma has a Lead-Based Paint Operations and Maintenance Program to identify lead-based hazards and to implement measures to control these hazards. To date all of the play structures with lead paint have been removed or the lead has been encapsulated. Furthermore, MCAS Yuma's Housing Maintenance Contractor inspects the playground equipment on a monthly basis to ensure control measures remain protective of public health. Accordingly, no adverse health effects would be expected from current or future exposures to lead-based paint on the equipment in these on-station housing areas.

6. *Chlorinated organic hydrocarbons emitted from underlying groundwater into indoor air are not a public health hazard.* Chlorinated hydrocarbons—1,1-DCE, PCE, and TCE—have been identified in the past in groundwater at the Area 1 Hot Spot at levels above federal drinking water standards and are of sufficient volatility to warrant further evaluation of potential health effects from vapor intrusion. ATSDR used modeling to evaluate the potential exposure to 1,1-DCE, PCE, and TCE via indoor air for occupants (i.e., workers) of the buildings overlaying this plume. To be health protective, ATSDR used the maximum detected concentrations and assumed soil conditions that would result in the highest possible indoor air concentrations. Estimated indoor air concentrations of PCE and TCE from the past are below health-based screening comparison values, and would not be expected to cause adverse effects. However, because the past maximum estimated indoor air concentration of 1,1-DCE (906.1 $\mu g/m^3$) exceeds the screening comparison value, ATSDR compared this concentration to levels reported in the scientific literature to cause no adverse effects, or no observed adverse effect levels (NOAELs), and to the lowest levels shown to cause effects, or lowest observed adverse effect levels (LOAELs). The past maximum estimated indoor air concentration of 1,1-DCE is nearly 20 times less than these NOAELs and nearly 60 times less than these LOAELs, and therefore, past exposure would not be expected to cause adverse health effects.

   No adverse health effects are expected to occur in the present or future from the vapor intrusion pathway. Using parameters to model the worst-case current scenario, the indoor air concentration of 1,1-DCE is 35.4 $\mu g/m^3$, which is much lower than ATSDR's health-protective screening value and adverse effect levels from the scientific literature. Further, because contaminant concentrations continue to decrease and are expected to reach federal drinking water standards through natural attenuation, no adverse health effects would be expected in the future. In addition, precautionary groundwater monitoring will identify any increases in cis-1,2-DCE, trans-1,2-DCE, or vinyl chloride that may occur due to degradation of

1,1-DCE, PCE, or TCE. Health effects from combined exposures to these chemicals are not expected from past or present exposures at the site.

Recommendations

1. ATSDR recommends that MCAS Yuma test any groundwater underlying the station in accordance with CERCLA requirements prior to its consideration as a drinking water source.
2. ATSDR recommends that MCAS Yuma continue its regular monitoring to ensure contaminated groundwater does not travel off site at levels above federal drinking water standards. In addition, ATSDR recommends that the station continue its monitoring of cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride—breakdown products of 1,1-DCE, PCE, and TCE—to prevent their accumulation at levels of concern for indoor air vapor intrusion.
3. ATSDR recommends MCAS Yuma reevaluate organic lead in surface soil at the Flight Line (CAOC1), Shops Area (CAOC 2), and Fire School Area (CAOC 7) if there is a change in site conditions or access restrictions.

Public Health Action Plan

The public health action plan (PHAP) for MCAS Yuma describes completed, ongoing, and future public health actions for the station. ATSDR prepares a PHAP to ensure that this health consultation outlines a plan of action to reduce and prevent harmful health effects that could potentially result from exposure to site-related contaminants in the environment. Because this health consultation is an update to ATSDR's 1998 public health assessment, the completed, ongoing, and planned public health actions listed below are relevant for 1998 to the present and future and provide updates to the information presented by the Agency in 1998 (see the 1998 PHAP at http://www.atsdr.cdc.gov/HAC/pha/yuma/ymc_p3.html).

Completed Actions

1. In October 2000, a record of decision was completed and finalized for OU1 (EPA 2000; NAVFAC Southwest 2004).
2. Five-year site reviews were completed at OU1 (August 2004) and OU2 (December 2002) (NAVFAC Southwest 2004).
3. Remedial techniques reduced chlorinated hydrocarbon concentrations in groundwater plumes in OU1 Areas 1 (LEPA and Central/Interior plumes), 2, 3, and 6 to or less than MCLs. These sites require no further action, and have been closed (NAVFAC Southwest 2004).
4. Institutional controls restrict (e.g., land use restrictions) exposures to soil contaminants at CAOCs 1 (Flight Line), 8A (Southeast Station Landfill), and 10 (Ordnance Munitions Disposal Area) in OU2. Fencing and locked gates also restrict access to CAOC 8A (NAVFAC Southwest 2004).
5. Remediation, including removal of asbestos-containing material, was completed in June 1999 at CAOCs 4, 7, and 9 in OU2 (GEOFON, Inc. 1999; NAVFAC Southwest 2004).

6. FFAAP Units 327.03 (Drum Storage Area), F808.00 (Former Pesticide Control Shop), 855.04 (Battery Shop), 855.19 (Hydraulic Lift), and 9005.00 (Transformer Storage Yard) were closed following investigations, remediation, and/or implementations of land use restrictions (GEOFON, Inc. 2002).

Ongoing Actions

1. Quarterly groundwater monitoring continues at MCAS Yuma (NAVFAC Southwest 2004).
2. The Area 1 Hot Spot in OU1 remains open, but groundwater modeling indicates this plume will be reduced to MCLs through natural attenuation (NAVFAC Southwest 2004).

Planned Actions

1. Once chlorinated hydrocarbon levels in groundwater are at or below MCLs in the Area 1 Hot Spot in OU1, this site will be closed.

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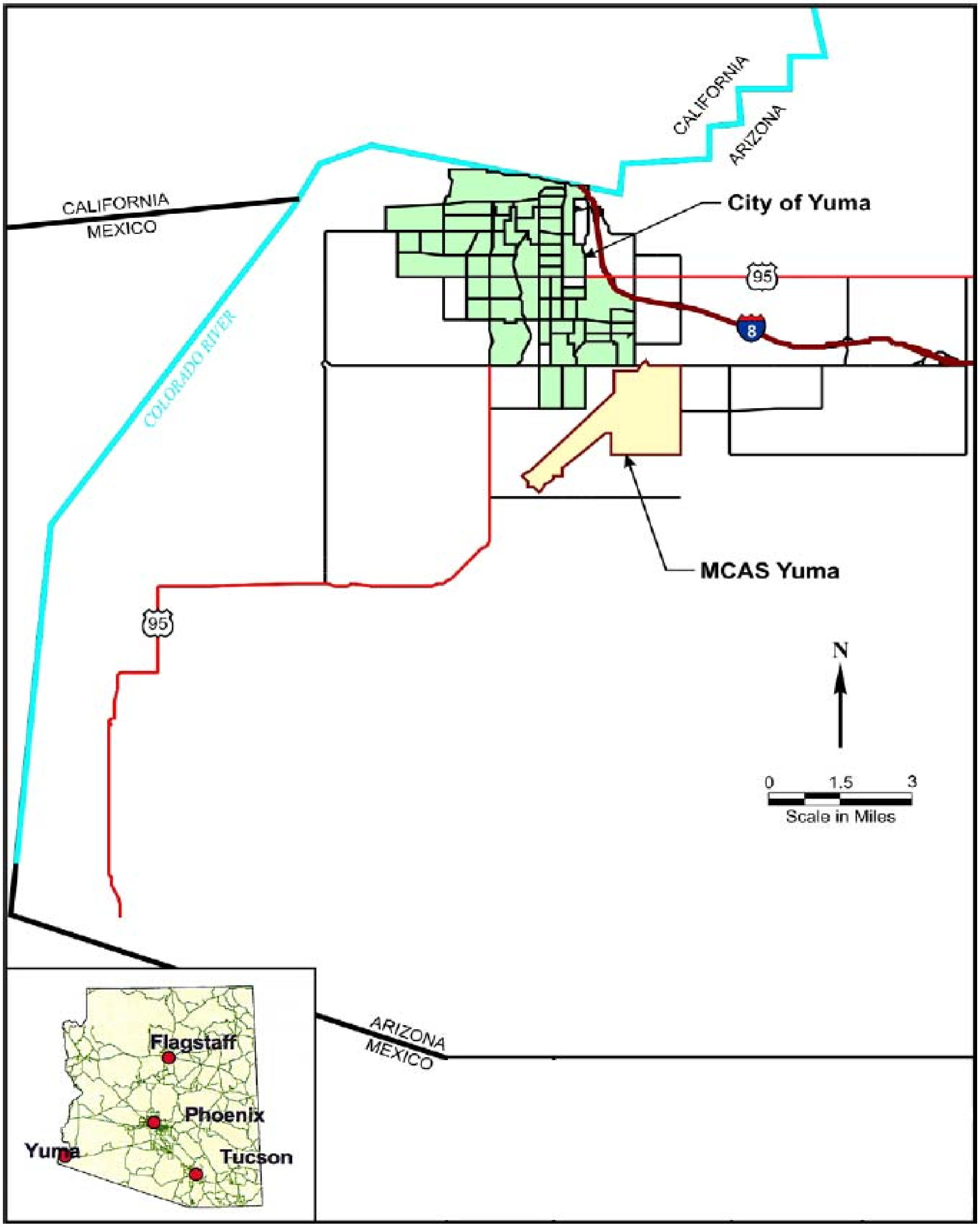
Figure 1. Location of MCAS Yuma



Source: NAVFAC Southwest 2004

Figure 2. Population Demographics Within 1 Mile of MCAS Yuma

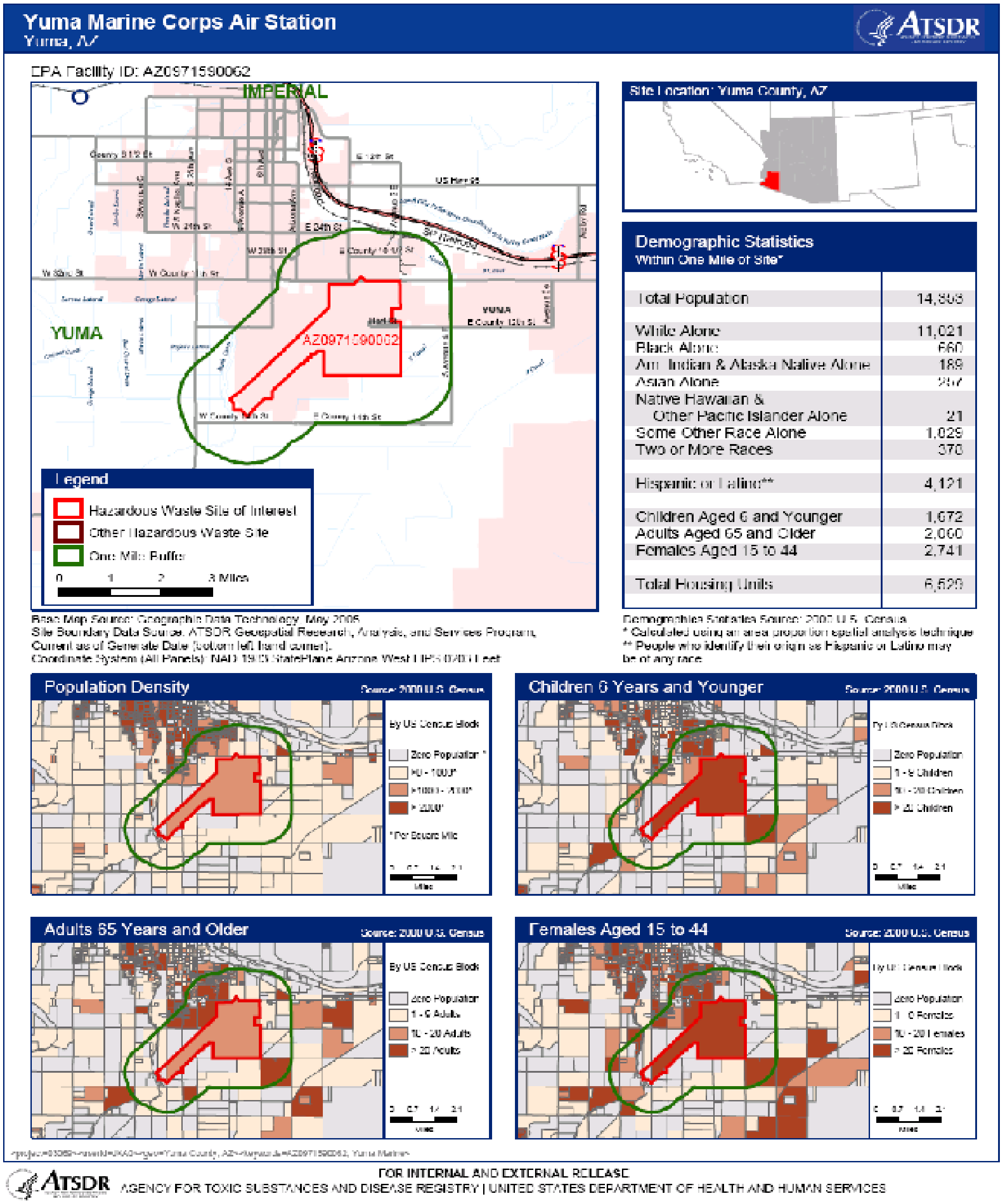


Table 1. JEM Groundwater Screening Model Variables for Vapor Intrusion into the Buildings Overlying the Area 1 Hot Spot Groundwater Plume

JEM Variable	*Model Input Parameters*	*Notes*
Depth below grade to bottom of enclosed space floor	15 cm	Default parameters were used to consider a building constructed on a slab (page 47; EPA 2004).
Depth below grade to water table	Loam: 32.5 cm (15 + 37.5) Loamy Sand: 33.75 cm (15 + 18.75) Sand: 32.05 cm (15 +17.05) Sandy Loam: 40 cm (15+25) Silt Loam: 83.2 cm (15+68.2)	Regardless of the depth to water, the JEM requires a minimum depth to account for capillary fringe. To calculate the depth below grade to water table, the capillary fringe for buildings overlaying each type of soil were added to the depth below grade to bottom of enclosed space floor (15 cm). The shallowest depth allowed by the model was utilized (see soil-specific height cap zone fetter values in Table 10; EPA 2004).
Soil type directly above the water table	Loam Loamy Sand Sand Sandy Loam Silt Loam	The soil beneath the buildings overlying the Area 1 Hot Spot consists of fine to medium sands with intervals of gravel sand, containing silty clay and/or clayey silt lenses (OHM 1999). Because the soil type could not be defined further, as a protective measure, ATSDR considered all potentially relevant soil types according to the JEM.
Average groundwater temperature	30ºC	Average groundwater temperature ranges from 22.6 to 30 degrees Celsius at MCAS Yuma (NAVFAC Southwest 1998). Using higher temperatures in the JEM results in higher indoor air concentrations. Thus, ATSDR used the more conservative value of 30 degrees Celsius.
Vadose zone soil type	Loam Loamy Sand Sand Sandy Loam Silt Loam	The JEM was utilized to consider vapor intrusion into an occupational building constructed on a slab, which overlays five types of soil (loam, loamy sandy, sand, sandy loam, and silt loam). ATSDR was unable to narrow the soil type in the area of the overlying buildings further. Thus, all five types of soil were evaluated and the soil yielding the highest estimated vapor concentrations were investigated in more detail.
Vadose zone soil dry bulk density	1.50 g/cm^3	The universal default parameter for subsurface soils (Table 7; EPA 2004).
Vadose zone soil total porosity	0.43 cm^3/cm^3	The universal default parameter for subsurface soils (Table 7; EPA 2004).
Vadose zone soil water-filled porosity	Loam: 0.061 cm^3/cm^3 Loamy Sand: 0.049 cm^3/cm^3 Sand: 0.053 cm^3/cm^3 Sandy Loam: 0.039 cm^3/cm^3 Silt Loam: 0.065 cm^3/cm^3	Conservative default parameters for the vadose zone loam, loamy sand, sand, sandy loam, and silt loam water-filled porosity (Table 10; EPA 2004).

Table 2. Estimated Vapor Concentrations in the Buildings Overlying the Area 1 Hot Spot Groundwater Plume Based on Maximum Concentrations Detected From 1995–2004*

Contaminant	*Maximum Detected Concentration in Groundwater (µg/L)*	*Estimated Vapor Concentration in Air by Soil Type (µg/m³)*	*ATSDR CVs (µg/m³)†*	*Is Estimated Vapor Concentration Above ATSDR's CV?*
1,1-Dichloroethene (1,1-DCE)‡	512	Loam: 70.9 Loamy Sand: 320.6 Sand: 906.1 Sandy Loam: 110.8 Silt Loam: 84.3	80	Yes (for all soil types except loam)
Tetrachloroethene (PCE)§	16	Loam: 1.4 Loamy Sand: 6.3 Sand: 18.5 Sandy Loam: 2.2 Silt Loam: 1.6	300	No
Trichloroethene (TCE)§	450	Loam: 23.5 Loamy Sand: 105.4 Sand: 303.1 Sandy Loam: 36.7 Silt Loam: 27.6	500	No

Notes:
*ATSDR considered groundwater concentrations detected from when initial sampling efforts at the Area 1 Hot Spot Area began in 1995 (Arizona Department of Water Resources 2002; NAVFAC Southwest 1998) until monitoring was conducted during the 5-year review in 2004 (NAVFAC Southwest 2004). ATSDR evaluated concentrations through 2004 because the 5-year review reported that groundwater concentrations in the Area 1 Hot Spot were near MCLs due to remedial activities and expected to decrease to levels below MCLs via natural attenuation in the near future. Thus, concentrations detected during sampling conducted after the 5-year review would be expected to be lower than those detected in 2004.
†All health-based comparison values are environmental media evaluation guide (EMEG) values for air. Intermediate EMEGs are available for 1,1-DCE and TCE, and a chronic EMEG is available for PCE.
‡Maximum detected concentration reported in Jacobs Engineering Group 1996.
§Maximum detected concentration reported in NAVFAC Southwest 1998.

Abbreviations:
CV is comparison value.
µg/L is micrograms per liter of water.
µg/m³ is micrograms per cubic meter of air.