Health Consultation

1, 4 – DIOXANE IN PRIVATE DRINKING WATER NEAR

NAVAL AIR STATION WHIDBEY ISLAND, AULT FIELD

OAK HARBOR, WASHINGTON

EPA FACILITY ID: WA5170090059

OCTOBER 21, 2005

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.

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Prepared by:

U.S. Department of Health and Human Services
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Statement of Issues

Purpose

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this health consultation in response to a request made in September 2005 by Navy officials associated with Naval Air Station (NAS), Whidbey Island to evaluate the safety of drinking water from off-base private wells. The Navy has been closely monitoring groundwater contamination plumes within NAS Whidbey Island and has been operating an air-stripping groundwater treatment system to remove volatile organic compounds (VOCs) at this site since 1995.

Background

The contamination source, referred to as Site 6 Landfill and Liquid Disposal Pit, is a 260-acre tract that received industrial waste and liquid waste from NAS Whidbey Island from the 1940s until the 1970s. Liquid waste was poured into unlined soil pits dug into the sandy soil and allowed to percolate down to the shallow water table.

The Navy has been monitoring groundwater at Area 6 since 1978. Contaminant plumes were initially detected on-base in the late 1980s and have been monitored since (URS 1993). VOCs detected in groundwater near the landfill include vinyl chloride (VC), trichloroethene (TCE), trichloroethane (TCA), dichloroethene (DCE), and dichloroethane (DCA). 1, 4, Dioxane is an additive found in some solvents and a solvent itself. Based on a recommendation from the U.S. Environmental Protection Agency (EPA) in 2003, the Navy began including 1,4-dioxane in the analyte list for sampling. 1,4-Dioxane was found in on-base monitoring wells in 2003.

The nearest homes are off base, less than one-half mile (1/2) away from the landfill. Concerned that groundwater contamination may be moving off base, the Navy collected water samples from the well pump head at homes (including a trailer park and apartment) that use well water as their drinking water source. Samples were collected from 13 off-base residential wells in May 2005. These wells were selected as the most likely to receive contamination based on the results from on-base groundwater monitoring. Although other VOCs were being monitored on-base, current levels at the southern base boundary are below drinking water standards. 1,4-Dioxane was the only chemical sampled in off-base wells; it was detected in 1 of 13 wells at 2.1 parts per billion (ppb). In August 2005, nine of the original 13 wells were resampled. Quantifiable contamination was found in 3 of the 9 wells retested. Levels of 1,4-dioxane were 2.7 ppb, 1.2 ppb, and 1.1 ppb. Five wells showed trace amounts of 1, 4-dioxane less than 1 ppb and in one well, 1,4-dioxane was not detected (EFA-NW 2005a and 2005b).

Discussion

Potentially Affected Population

Adjacent to the base boundary, in addition to the homes tested, there are additional homes within the local area near the City of Oak Harbor using well water that has not been tested by the Navy. There is a trailer park that uses well water to serve approximately 20 homes and an apartment complex that uses well water to serve about 10 apartment homes. These two community wells were included in the 13 sampled in May 2005. The local population is mixed with children, young adults, and older adults. Also potentially affected is a farm that grows organic vegetables, fruits, meat, and poultry. Many of these off-base wells are older and have no record of the depth to water or screen depth where the water is being pumped. Reportedly on one property, at certain times of year, groundwater acts like a spring, where free flowing water comes up from the ground without being pumped.

Perspective on 1,4-Dioxane

Levels of 1,4-dioxane detected in the privately owned wells just outside the NAS Whidbey Island border reviewed for this health consultation are currently nearly 50,000 times lower than levels reported to show adverse health effects.

1,4-Dioxane is a stable, clear liquid at ambient temperatures and dissolves almost completely in water. 1, 4-Dioxane is used as an additive to stabilize various compounds and as a solvent for chemical processing and manufacture of adhesives, cleaning and detergent preparations, cosmetics, deodorant fumigants, emulsions and polishing compositions, varnishes, and waxes. It has also been used as a laboratory reagent and is found in plastic, rubber, insecticides, and herbicides (ATSDR 2004).

People are exposed to 1,4-dioxane every day because of its widespread use in medicines, shampoo, cosmetics, detergents, and household items. In 2000, FDA instituted a formal policy that cosmetic products should not contain 1,4-dioxane at concentrations greater than10 parts per million (ppm) (10,000 ppb). However, in products (e.g., children's shampoos and bubble baths) analyzed since 1994, the FDA observed between the years 1992 and 1997, the average concentration of 1,4-dioxane in cosmetic finished products was reported to fluctuate from 14 to 79 ppm (14,000 to 79,000 ppb). Current levels of 1,4-dioxane in consumer products are much lower since that time because manufacturers are once again taking action to remove much of the 1,4-dioxane (ATSDR 2004, FDA 2005).

1,4-Dioxane can be released into the air, water, and soil at places where it is produced or used as a solvent. If released to the air, 1,4-dioxane would be present as a vapor. In water, 1,4-dioxane is stable and does not take on oxygen; therefore, it does not degrade (EPA 1995). However, in the body, it is metabolized to β-hydroxyethoxyacetic acid (HEAA) before being extensively eliminated in the urine. Because 1,4-dioxane is so soluble in water, it is easily flushed out of the body; it does not build up in the tissues of humans, mammals, fish or plants. In soil, 1,4-dioxane does not stick to soil particles, so when rain or water is present in the soil, it moves readily from soil into groundwater.

Because 1,4-Dioxane is more soluble in water than other volatile organic chemicals it disperses widely and completely in groundwater. It maintains an aqueous state without forming a non-aqueous phase like many VOCs. In groundwater, 1,4-dioxane forms the leading edge of a contaminant plume, traveling much faster, farther, and wider than other volatile organic compounds such as TCE, TCA, DCE, DCA, and vinyl chloride (ATSDR 2004). Its solubility and low volatility does not allow for its removal from groundwater by the Navy's currently used air stripping method for groundwater treatment, or by other common treatment methods such as carbon adsorption or air sparging, unless adequate temperature increase is achieved. The reported treatment technology of choice for this compound is UV oxidation with hydrogen peroxide (Geo Insight 2005).

1,4-Dioxane was primarily used as a stabilizing agent in TCA with an average concentration of 5% that of TCA. However, if TCA containing 5% 1,4-dioxane was used in a vapor degreasing process, 1,4-dioxane could become concentrated to an estimated maximum of 15% (Mohr, 2005).

Groundwater Investigations

ATSDR reviewed OU 1 Remedial Investigation information about groundwater conditions before groundwater treatment began to determine if groundwater contamination moved off-base and impacted drinking water wells. The Navy has been monitoring groundwater conditions at Area 6 since 1978 when five monitoring wells were first installed. Since 1978, there have been several investigations that included groundwater assessments of the various groundwater containing aquifers. Contaminant plumes were initially detected on-base in the late1980s and have been monitored since (URS 1993). In 1991, six off-base private and public water supply wells were tested for VOCs. No contamination was detected. Also in 1991, Island County Department of Health sampled 18 drinking water wells northwest, west, and south of Area 6 for lead and chromium. Low levels of lead were detected in 5 wells, but were not attributable to NAS Whidbey Island Area 6. Lead levels were not of health concern. The groundwater treatment system has been operational since 1995. Levels of VOCs have decreased significantly in the last ten years.

From the information reviewed, it is evident that groundwater treatment efforts have contained groundwater contamination reducing the likelihood of off-base well users to be impacted by contamination from Area 6. Information from past groundwater investigations show that off-base drinking water wells did not contain the VOCs: TCA, TCE, DCA, DCE, or VC.

ATSDR used information on the solubility of 1,4-dioxane, groundwater flow direction, speed, and pumping rates of on-base wells, and the Analytical Contaminant Transport Analysis System software to determine if exposures to 1,4-dioxane could have occurred in the past prior to the 2005 sampling. ATSDR concludes that it is likely for people to have been exposed to 1,4-dioxane prior to 2005 at concentrations not expected to result in adverse health effects.

Public Health Implications

People drinking water at the locations sampled are not expected to experience adverse health effects from their exposure. The liver and kidneys are targets for 1,4-dioxane effects in humans and animals. The maximum detected level of 1,4-dioxane in drinking water from privately owned wells is nearly 50,000 times lower than levels reported to show adverse health effects.

In animal studies where 1,4-dioxane was administered at extremely high levels, (124,000 times higher than in private wells) animals developed tumors of the liver, kidneys and nasal tracts. Exposure of workers who use 1,4-dioxane in the manufacturing of products has not been shown to result in human cancers. Based on sufficient information in animal, and limited information on humans, 1,4-dioxane is considered to be possibly carcinogenic to humans by the International Agency for Research on Cancer. To be protective of public health, ATSDR treats 1,4-dioxane as a cancer causing chemical and bases public health decision on its ability to cause cancer and non-cancer health effects.

Studies in human volunteers have shown that after inhalation of vapors of 1,4-dioxane, almost all of the 1,4-dioxane that enters the lungs can pass to the blood stream. Studies in animals have shown that 1,4-dioxane that is swallowed, reaches the stomach and moves into the blood stream. Once in the blood stream, 1,4-dioxane is distributed throughout the body and is rapidly converted into other chemicals or metabolites which quickly leave the body in the urine. Neither 1,4-dioxane nor its metabolites build up in the body (ATSDR 2004).

Regulatory Standards

ATSDR is not a regulatory agency like EPA or the Washington Department of Ecology. ATSDR acts an advisor to all parties regarding public health and makes recommendations to members of the pubic as well as local, state, and federal agencies about health. ATSDR has reviewed the health information cited in this report to evaluate the health implications of human exposure to contaminants found in drinking water around NAS Whidbey.

EPA sets drinking water standards as part of their role in the Safe Drinking Water Act, but at this time, has not established a drinking water standard (Maximum Contaminant Level, MCL) for 1,4-dioxane. However, they have determined a cancer slope factor based on the animal cancer studies. Using the cancer slope factor, drinking water containing 3 ppb 1,4-dioxane would not be expected to result in an increased cancer risk greater than one in one million (10^{-6}) (EPA IRIS Database September 2005). Concentrations lower than EPA's 10^{-6} risk levels are considered safe. Levels greater than EPA risk levels are considered by ATSDR for additional evaluation to determine if cancer health effects are likely. Since drinking water levels of 1,4-dioxane in off-base wells near NAS Whidbey are below 3 ppb, cancer is not expected to occur.

The state of Washington has not established a drinking water standard for 1,4-dioxane. However, a few states have drinking water recommendations, guidelines, or cleanup goals for 1,4-dioxane. California has established a drinking water action or notification level of 3 ppb as an advisory level which is not enforceable. In California, drinking water systems that contain as much as 3 ppb 1,4-dioxane are not required to treat the water or notify water recipients unless the level of 1,4-dioxane is greater than 3 ppb. Massachusetts and New Hampshire have also established drinking water guidelines of 3 ppb.

Although not regulatory, ATSDR has established a Minimum Risk Level (MRL) dose of 0.1 mg/kg/day as a screening value. A dose refers to the amount of substance that enters the body relative to a person's weight over a specified time. Doses below the MRL are safe to even sensitive people such as children or the elderly. Doses more than 200 times the MRL are typically considered to be of health concern at which action should be taken to stop, reduce, or prevent exposure. Cases that estimate doses between the MRL to 200 times the MRL are evaluated based on the specifics of the exposure situation.

To compare levels in drinking water to the MRL, ATSDR used mathematical calculations to estimate exposure doses for the people whose wells were tested. ATSDR used the maximum level found in the private well of 2.7 ppb. These calculations use a set of assumptions to determine how likely people are to have adverse health effects from their exposure to 1,4-dioxane. ATSDR estimated an exposure dose for adults and children that combined exposures from drinking water, inhaling vapors, and skin absorption during bathing.

ATSDR used the following information to estimate doses for adults and children: drinking water consumption of 2 Liters per day for adults and 1 Liter per day for children. Body weights for adults are 70 kg or 165 pounds and 16 kg or 23 pounds for children. Exposure durations were evaluated for 30 years for adults and 6 years for children. Showering times were estimated to be 15 minutes per day. All exposure durations were estimated to be daily. ATSDR assumed an equal amount of vapor was inhaled as was ingested. Skin absorption was based on factor of 0.1 with skin area of 19,200 cm2 for adult and 7,100 cm2 for child.

ATSDR estimated doses for adults (0.00017 mg/kg/day) and children (0.0032 mg/kg/day) based on combined exposure to 1,4-dioxane by way of drinking water and bathing/shower. A dose of 100 mg/kg/day has been reported as producing no adverse effects. A dose of 150 mg/kg/day has shown to result in “less serious” adverse health effects such as swelling of the liver and kidneys.

Because the levels present in drinking water are lower (more than 30 times lower) than the screening value MRL (0.1 mg./kg/day) and much lower (nearly 50,000 times lower) than levels reported in the literature as resulting in adverse health effects, ATSDR concludes that adverse health effects are not expected to occur in adults or children exposed to 2.7 ppb 1,4-dioxane.

Conclusions and Recommendations

1. Current levels of 1,4-dioxane have been detected at low concentrations in private wells, much lower (nearly 50,000 times lower) than levels shown to cause adverse health effects. Therefore, adverse health effects are not expected to occur in adults or children exposed to drinking water containing the maximum detected 2.7 ppb 1,4-dioxane. Because current 1,4-dioxane levels are not a health concern and are lower than established regulatory levels in other states, ATSDR believes that public health actions to stop exposure are currently not warranted. However, since the current groundwater treatment system is not effective for 1,4-dioxane, ATSDR recommends the Navy continue to closely monitor the levels of contaminants in groundwater including 1,4-dioxane that could impact off-base drinking water wells.

2. Since 1,4-dioxane is soluble in water, it is quickly diluted as it moves with groundwater. ATSDR concludes that, based on previous groundwater investigations, groundwater flow direction, groundwater speed, pumping rates of on-base wells, and computer modeling, if any exposures occurred to 1,4-dioxane prior to 2005, it is likely they would have been at concentrations not expected to result in adverse health effects.

3. It appears that off-base contamination was caught at an early stage before any health impact occurred. The groundwater treatment system is containing the major volatile organic compounds of groundwater contamination to the base in Area 6. Current treatment does not reduce 1,4-dioxane levels. However, since suspected source area concentrations are also low, treatment to reduce 1,4-dioxane levels is not warranted at this time.

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