Health Consultation

KANAKANAK HOSPITAL VAPOR INTRUSION

DILLINGHAM, ALASKA

SEPTMBER 8, 2008

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

KANAKANAK HOSPITAL VAPOR INTRUSION

DILLINGHAM, ALASKA

Prepared By:

Alaska Department of Health and Social Services
Division of Public Health, Epidemiology Section
Under cooperative agreement with
The Agency for Toxic Substances and Disease Registry

Introduction

In November 2007, the Indian Health Service (IHS) contacted the Alaska Division of Public Health (ADPH) to request an independent evaluation of subsurface vapor intrusion issues at Kanakanak Hospital, a 16-bed IHS facility in Dillingham, Alaska. Low levels of several volatile organic compounds (VOCs) have been detected in the crawl space under a hospital addition built in the 1980s. A maintenance garage and two large above ground fuel storage tanks were situated at that location in the 1950s (1). Much of the soil was removed when the addition was constructed, but contaminated groundwater may be a source of VOC vapors.

Dillingham is located in northern Bristol Bay, about 327 miles southwest of Anchorage. It is classified as large town/regional center, with a population of 2,405. Traditionally a Yupi'ik Eskimo area, Dillingham is now a highly mixed population that is about 61% Alaska-Native or part Native. Commercial fishing opportunities are the focus of the local culture, and about 11.7 percent of residents live below the federal poverty level (2).

ADPH was asked to evaluate data obtained from vapor monitoring of the hospital's crawl spaces and the basement of an adjacent building, and to explain the different comparison values for detected VOCs among the U.S. Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the U.S. Environmental Protection Agency (EPA), and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). Comparison values among these agencies vary by orders of magnitude, causing confusion regarding their interpretation and applicability to the specific circumstances of this site. The ADPH was asked to put the various comparison values into context and interpret the vapor monitoring data from a public health perspective, to determine whether detected VOCs pose a health risk to the hospital's staff or patients.

While the ADPH is qualified to comment on the health implications of the VOC data, we have neither the expertise nor the regulatory authority to require additional sampling, mandate specific remediation techniques, establish site clean-up standards, or make other regulatory decisions at any contaminated site. Our role is limited to an advisory capacity.

Data Evaluated

ADPH evaluated indoor monitoring data from four sampling events designed to assess seasonal variability, which occurred in August 2006, November 2006, March 2007, and June 2007 (3). During each quarterly sampling event four samples were collected from the crawl space of hospital Building 401, and one sample was collected from the electrical parts room in the basement of an adjacent hospital structure (Building 301). Air samples were collected in 6-liter Summa canisters, and analyzed via modified EPA Method TO-15 using GC/MS in full scan mode.

Benzene, trichloroethylene (TCE) and tetrachloroethylene (PCE) screening criteria from at least one agency were exceeded in at least one sample. Results for these chemicals are shown for all samples, along with each agency's screening criteria, in Table 1.

Table 1. Volatile Organic Compounds in Crawl Space Vapor, Kanakanak Hospital

Parts per Billion – Volume (ppbv)

Location	Date	Benzene	TCE	PCE
G1	8/25/2006	**1.50**	ND (0.15)	ND (0.15)
Crawlspace, Bldg 401	11/17/2006	**0.23**	ND (0.14)	ND (0.14)
(main hospital)	3/2/2007	**0.28**	ND (0.16)	ND (0.16)
	6/15/2007	ND (0.15)	ND (0.15)	ND (0.15)
G2	8/25/2006	**1.40**	ND (0.16)	ND (0.16)
Crawlspace, Bldg 401	11/17/2006	**0.23**	ND (0.15)	ND (0.15)
(main hospital)	3/2/2007	**0.27**	ND (0.17)	ND (0.17)
	6/15/2007	ND (0.15)	ND (0.16)	ND (0.16)
G3	8/25/2006	**0.56**	ND (0.14)	ND (0.14)
Electrical Parts Rm,	11/17/2006	**0.20**	**0.45**	**0.14**
Bldg 301	3/2/2007	**0.22**	**0.62**	**0.17**
	6/15/2007	ND (0.15)	ND (0.15)	ND (0.15)
G4	8/25/2006	**1.20**	ND (0.14)	ND (0.14)
Crawlspace, Bldg 401	11/17/2006	**0.25**	ND (0.15)	ND (0.15)
(main hospital)	3/2/2007	**0.30**	ND (0.17)	ND (0.17)
	6/15/2007	ND (0.15)	ND (0.15)	ND (0.15)
G5	8/25/2006	**0.44**	ND (0.16)	ND (0.16)
Crawlspace, Bldg 401	11/17/2006	**0.22**	ND (0.14)	ND (0.14)
(main hospital)	3/2/2007	**0.28**	ND (0.16)	ND (0.16)
	6/15/2007	ND (0.15)	ND (0.15)	ND (0.15)
COMPARISON VALUES				
		Benzene	**TCE**	**PCE**
EPA Generic Screening Criteria - residential[1]		0.098	0.0041	0.12
EPA-based screening criteria - occupational[2]		0.16	0.0069	0.2
Typical background (ADEC Appendix B)[3]		0.9 - 2	0.2 - 9	0.1 - 0.7
ATSDR Chronic EMEG/MRL[4]		3	100 (intermediate)	40
NIOSH REL (TWA)[5]		100	25,000	n/a (minimize exposure)
OSHA PEL (TWA)[6]		1000	100,000	100,000

1: Values are from Table 2C of the November 2002 OSWER Draft Guidance (7), using a residential exposure scenario and $1x10^{-6}$ cancer risk level

2: Values are calculated using Appendix D of the November 2002 OSWER Guidance (7), using an occupational exposure scenario assuming exposure occurs 250 days/year for 25 years with a cancer risk level of $1x10^{-6}$

3: Background levels are from Appendix B of Alaska Dept. of Environmental Conservation (ADEC) guidance (9) which reprints from Ettinger 2003 (8)

4: Minimal Risk Levels for chronic exposures (non-cancer effects), cited in Toxicological Profiles (4,5,6)

5: NIOSH Recommended Exposure Limits; time-weighted average for occupational exposures

6: OSHA Permissible Exposure Limits; time-weighted average for occupational exposures

(#) represent detection limits

Discussion

Differences among Comparison Values

Various government agencies establish screening or comparison values to assist in the interpretation of chemical concentrations in the environment, and the comparison values can differ significantly among agencies. Comparison value differences are related to each agency's mission, its objectives in interpreting the chemical values, and the nature of the resource or endpoint it is charged with protecting. In some cases the development of comparison values includes a risk/benefit component, or consideration of factors other than risk, such as logistics and cost.

In the case of Kanakanak Hospital, where vapor intrusion of benzene, TCE and PCE is of concern, the differences among each agency's screening criteria are substantial for each chemical. Screening criteria differences are most dramatic for the chemical TCE, as the EPA generic screening criteria for TCE is more than a million times more conservative than OSHA's Permissible Exposure Limit for TCE.

OSHA standards are designed to protect workers from health hazards resulting from chemical exposure. They are often the least conservative standards among the agencies, because their intention is often to prevent acute illness in workers. The establishment of OSHA standards often includes consideration of feasibility, cost, and the concerns of the regulated industry.

NIOSH Recommended Exposure Limits (RELs) are recommendations, not enforceable standards, developed to protect worker health. NIOSH evaluates all available information regarding chemical hazards as they develop RELS, which they then publish and transmit to OSHA for use in promulgating legal standards. NIOSH RELs are generally similar to or more protective than corresponding OSHA standards. NIOSH identifies numerous occupational carcinogens, but does not establish exposure thresholds to protect 100% of workers from carcinogenic effects. Instead, it recommends that occupational exposures to carcinogens be limited to the lowest feasible concentration. NIOSH recognizes benzene, TCE and PCE to be carcinogens. The U.S. EPA has categorized benzene as Category A (known human carcinogen). The International Agency for Research on Cancer (IARC) designates TCE and PCE as Group 2A, or probable carcinogens for humans.

While standards designed to protect workers in an occupational setting are often among the most lenient, the standards established by environmental regulatory agencies to protect the lay public are among the most conservative. Standards meant to protect the lay public must consider not only the healthy adult worker but also the most vulnerable members of the population, which depending on the chemical involved may include children, pregnant women and their growing fetuses, the elderly and/or the disabled. Agencies charged with protecting the environment from contamination, or with remediating contaminated sites, use a risk assessment process to define protective screening values. Risk assessments generally make a series of assumptions throughout the process, including the length of time a person might be exposed to a chemical, the amount of air inhaled at the site, the amount of soil or water ingested from the site, etc. Each assumption errs on the side of caution, so the overall assessment is usually very protective.

Using a similar but independent process, ATSDR also establishes health protection screening values using a series of conservative assumptions. ATSDR's Minimal Risk Values (MRLs) are based on the most sensitive non-cancer health endpoint for each chemical (that is, the health effect that occurs at the lowest chemical concentration). These sensitive non-cancer endpoints are a reduction in white blood cell count for benzene (4), impaired performance on neurobehavioral tests for PCE (5), and neurological effects such as decreased wakefulness for TCE (6).

U.S. EPA approaches risk assessment for benzene, TCE and PCE differently, by attempting to quantify the concentration of each chemical that would result in a defined increased risk of developing cancer. These different approaches may partially explain the different screening values derived by the two agencies.

The U.S. EPA generic screening value was based on a residential scenario, and assumed 350 days of occupancy a year for 30 years (7). A U.S. EPA-based screening value for carcinogenic risk from occupational exposure was calculated for this health consultation using the U.S. EPA's toxicity values and risk assessment approaches, assuming an occupational scenario of 250 days exposure per year for 25 years.

When evaluating the health implications of contaminants at a site, ATSDR health assessors consider all available information to develop a tailored evaluation for that site's conditions. ATSDR's approach begins with the various screening values and the basis for how each specific standard was derived. From there, other considerations, such as how the site was/is used, site-specific exposure parameters, and the specific question being asked are factored into the evaluation.

Building Uses – an Assessment of Typical Exposures

At Kanakanak Hospital, four of the five sampling locations occurred in the crawl space of the main hospital, Building 401. Sample G3 was taken from the adjacent basement (electrical parts room) of Building 301, which does not have a crawl space.

The Kanakanak Hospital serves the local population for their minor emergency health care needs. There are no long-term stays at the facility. Persons needing complex medical treatments or long-term care are referred to other facilities outside of Dillingham that offer more comprehensive services. Maintenance workers may work in the crawl space area for several days at a stretch.

Building 301 contains administrative offices, and also serves as an outpatient clinical area. Pregnant mothers stay in this building for thirty days prior to giving birth, and the building is used for a variety of other purposes that result in temporary occupancy. The electrical parts room of Building 301 is used mainly by maintenance personnel.

Given these building uses and the lack of permanent residential occupancy, the U.S. EPA's risk assessment methodology for carcinogenic risk from occupational exposures is sufficiently protective for this site. Those methods assume exposures occur for 250 days per year for 25 years. The U.S. EPA's residential scenario assumes that exposures would occur for 350 days per year for 30 years, which would be overly protective for this site.

Air samples taken from the crawl space (or from the basement in the case of sample G3) should be a worst-case scenario that would overestimate the concentrations found in the indoor air of the occupied facility, if vapor intrusion is the source of the VOCs. Some of the chemicals in the crawl space would be expected to dissipate to the environment outside the facility, while those rising to the main floor would be diluted by the large air volume in the facility. Indoor air samples were not collected for this investigation because it is often difficult to distinguish site-related VOCs (from vapor intrusion) from other sources of VOCs, such as off-gassing of dry-cleaned clothing, other chemicals such as cleaning solvents stored in the facility, or combustion byproducts in ambient air (7).

Drinking water for this facility comes from wells located about 0.25 miles upgradient from the site. The wells are 78 feet deep, and draw water from a confined aquifer (8). Since the drinking water wells are located upgradient from the site, there is no pathway of exposure to site-related contaminants via drinking water.

Health Implications of VOC Concentrations Detected

Benzene was found at all five sampling locations at concentrations above U.S. EPA-based screening values for occupational and residential exposures. Benzene levels were consistently highest during the late August sampling event. Benzene levels were lower in the November and March sampling events relative to the late August sampling event, but were still in exceedance of U.S. EPA-based screening values for residential or occupational scenarios. Benzene levels were below detection in June 2007. However, the benzene detection limit in June 2007 (0.15 ppbv) was above the U.S. EPA's generic screening criteria at a 1×10^{-6} cancer risk level (0.098 ppbv). In contrast, none of the crawl space samples exceeded ATSDR's MRL of 3 ppbv, which was established to protect chronically-exposed individuals from changes in blood cell levels. Furthermore, the benzene values detected in the crawl space vapors were within the range of typical indoor air background benzene concentrations reported by Ettinger (9) and reprinted in Alaska Department of Environmental Conservation (ADEC) vapor intrusion guidance, Appendix B (10).

These data indicate that even typical background concentrations of benzene pose some finite risk of causing cancer. Therefore, additional exposures should be avoided if possible. However, the benzene levels found in Kanakanak Hospital's crawl space do not add significantly to typical background benzene exposures, and do not pose a risk to the health of either workers or clients. This is particularly true because the vapors were measured in the crawl space, and would be significantly lower in the indoor air of the hospital's occupied space (due to dispersion and dilution) if subsurface vapor intrusion is the VOC source.

TCE and PCE vapors were only detected at sample location G3 (electrical parts room of Building 301, basement rather than crawl space), and only during the November and March sampling dates. The detection limit for TCE was over 30 times higher than the U.S. EPA screening level for residential exposures, and 20 times higher than the U.S. EPA-based screening level for occupational exposures, so the analytical technique used was not sufficient to assess whether TCE levels fell below these regulatory screening values. Detected TCE values (0.45 – 0.62 ppbv) were significantly higher than U.S. EPA-based screening values for residential (0.0041 ppbv) and occupational (0.0069 ppbv) exposures at location G3. ATSDR has not established an MRL to protect persons chronically exposed via inhalation to TCE (6). However, detected TCE concentrations in the basement (0.45 to 0.62 ppbv) were far below ATSDR's MRL for exposures of intermediate duration (100 ppbv). Detected TCE concentrations were within the range of indoor air background TCE concentrations reported by Ettinger (9) and reprinted in ADEC vapor intrusion guidance, Appendix B (10).

The detection limit for PCE was slightly higher than the U.S. EPA screening value, but was sufficient when compared to the U.S. EPA-based occupational screening value. Detected PCE concentrations in the basement were slightly higher than the U.S. EPA generic screening value for residential exposures, but did not exceed the U.S. EPA-based occupational scenario screening value. Detected PCE values were much lower than ATSDR's chronic MRL (5), and were at the low end of the range of typical indoor air background PCE concentrations reported by Ettinger (9) and reprinted in ADEC vapor intrusion guidance, Appendix B (10).

Taken together, ADPH finds that TCE and PCE concentrations measured in the basement of Building 301 do not add significantly to typical background exposure levels, and do not pose a risk to the health of either workers or clients.

Concerns Regarding Adequacy of Sampling and Analysis

While the benzene, TCE and PCE levels detected in crawl space and basement vapor samples did not pose a public health hazard, concerns remain that vapor sampling was not adequate to identify all potential hazards associated with the site.

One concern is that only a "short list" of chemicals was tested for in the vapor samples, rather than the full list of TO-15 analytes. It is unknown whether untested VOCs might be present at problematic levels.

Another concern is the paucity of sampling locations, particularly for building 301. It is well known that air concentrations of VOCs resulting from vapor intrusion can vary dramatically at different parts of a building. It is less than ideal to characterize a building with only one sample. It is possible that a "hot spot" may exist in the building which has not yet been detected or identified.

Child Health Issues

The most crucial route for benzene, TCE and PCE exposure is through inhalation. These substances can also be ingested by drinking contaminated water or food. Children may take up, through various routes, and rid the body of contaminants differently then adults. For instance, children eat more food and breathe more air per kilogram of body weight than do adults, and these differences sometimes result in a greater relative dose of a contaminant entering the body. Children's shorter stature leads them to breathe in dust, soil, and vapors that are closer to the ground than do adults. Additionally, children who engage in hand-to-mouth behaviors increase the possibility of ingesting substances. Benzene, TCE and PCE can also pass from the mother's blood to a fetus.

It is not known if children are more susceptible to benzene poisoning than adults. The developing fetus, children, and especially the developing nervous system may be particularly susceptible to the toxic effects of PCE. Several epidemiological studies have found associations between TCE and/or PCE exposure and leukemia in children (5,6).

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.

Conclusions

- Benzene is a contaminant of concern at all sampling locations. While it is present at levels above regulatory screening values, it does not add significantly to typical background benzene exposures and does not pose a risk to the health of either workers or clients.
- TCE and PCE concentrations measured thus far in the basement of Building 301 do not add significantly to typical background exposures, and do not pose a risk to the health of either workers or clients.
- Because benzene, TCE and PCE levels measured in crawl space and basement vapor are not adding significantly to typical background levels of these chemicals, they pose no apparent public health hazard at Kanakanak Hospital.
- Additional samples are needed to adequately characterize the extent of vapor intrusion in Building 301.
- Air samples were not analyzed for all TO-15 analytes. There is an indeterminate public health hazard present for the Kanakanak Hospital for the untested analytes.

Recommendations

- Conduct annual monitoring in crawl spaces and basements at Kanakanak Hospital buildings during the late summer to ensure that vapor intrusion contaminants are not increasing in concentration.
- Sample additional locations within Building 301 to more completely characterize the magnitude and extent of vapor intrusion, in accordance with an ADEC-approved plan.
- Conduct an additional round of sampling in August 2008 at these five sampling locations, using the complete TO-15 analyte list.

Public Health Action Plan

- Within three months following release of this health consultation, perform an informal needs assessment to determine what health education activities may be needed at the site.
- Participate in workgroups led by ADEC on request, to assist with sampling design or other issues needing public health involvement.
- Review future vapor intrusion sample data on request.

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Certification

This Health Consultation (Kanakanak Hospital Vapor Intrusion) was prepared by the Alaska Department of Health and Social Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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