Health Consultation

WRIGHT GROUNDWATER CONTAMINATION SITE

WRIGHT, KANSAS

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
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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
Agency for Toxic Substances and Disease Registry
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Background and Statement of Issues

The Wright groundwater site is located in Wright, Kansas, an unincorporated town in Ford County. Private potable wells at the site were contaminated with nitrates, volatile organic compounds (VOCs), and herbicides. Because of the groundwater contamination, residents were connected to the Dodge City water supply in 1997. However, residents might choose to use the contaminated wells as a nonpotable water source to water lawns and gardens and fill pools. The U.S. Environmental Protection Agency (EPA) Region 7 office requested the Agency for Toxic Substances and Diseases Registry (ATSDR) review environmental data provided by EPA to determine the public health implications and provide recommendations.

The specific question to ATSDR was: *Does the groundwater with the reported contaminant concentrations pose a public health hazard for nonpotable outdoor use?*

Potential exposure pathways resulting from potential uses of this groundwater include

- inhalation of VOCs while watering lawns and gardens;
- inhalation of VOCs, incidental ingestion of contaminants, and direct skin contact while using small "kiddie" pools filled with well water (there are no known in-ground or permanent above-ground pools); and
- ingestion of contaminants in garden produce watered with local well water.

Environmental data

The Wright data package includes groundwater data from several private and monitoring wells. These samples were collected to define the extent of groundwater contamination. Table 1 displays the maximum contaminant values found in both the monitoring and private wells. The private wells are 80–100 feet below grade. The water table is located approximately 80 feet below grade.

Several of the samples exceeded health screening values, including EPA's maximum contaminant levels (MCLs) and ATSDR's environmental media evaluation guides (EMEG) (Table 1).

Discussion

In evaluating this site, the ATSDR Strike Team focused on the three activities that could lead to potential exposure:

1. Watering lawns and gardens
2. Using kiddie pools filled with well water
3. Consuming local garden produce

In addition to the three exposure activities related to the outdoor use of the nonpotable groundwater, ATSDR considered the potential for indoor air contamination from soil vapor intrusion. ATSDR believes there is no risk of vapor intrusion, however, because the water table in this area is reported to be approximately 80 feet below grade. Soil depths of more than 15 feet greatly resist the movement of air into homes.

Watering lawns and gardens

While watering lawns and gardens, residents could potentially inhale VOCs. To evaluate this pathway, ATSDR first used a protective screening method designed to evaluate the average concentration VOCs in the air from showering. This method assumes that the concentration of a volatile in the air is equal to the concentration in water multiplied by $5x10^{-4}$ (EPA 1988, EPA 1992). If the levels were below levels of concern, then there would be no inhalation hazard associated with inhaling the vapors from the water.

The results of this evaluation show that all the VOCs, with the exception of benzene, were either close to or below the inhalation health screening values, which are based on continuous exposures.

ATSDR further evaluated benzene by calculating an exposure dose for children and for adults. ATSDR assumed that a lawn would be watered 3 days per week for 2 hours per day during a 3-month summer period. These dose estimates, 0.0002 ppm for adults and 0.0006 ppm, are well below ATSDR's intermediate minimal risk level (MRL) of 0.004 ppm. ATSDR believes that the dose is likely to be even lower because the vapors will disperse very quickly outdoors. Therefore, using the groundwater for watering is not likely to be a health hazard.

Using kiddie pools filled with well water

This exposure activity has three possible exposure pathways:

1. inhalation from playing in the pool,
2. incidental ingestion of water, and
3. direct skin contact with water.

Inhalation

ATSDR evaluated this pathway in the same way as the watering lawns and gardens pathway (see previous section). Because benzene is the only VOC that was significantly above the inhalation health screening value, ATSDR further evaluated this contaminant by calculating an exposure dose for children and for adults. ATSDR assumed that a child would play in a kiddie pool 4 days per week for 2 hours per day during a 3-month summer period. To be protective, this also assumes that the pool is refilled with fresh water each use. (As volatiles disperse, less exposure would result the longer the water remains in the pool.) These estimates, 0.0003 ppm for adults and 0.0008 ppm for children, are both below ATSDR's MRL of 0.004 ppm.

In addition, the combination of estimated exposure doses for watering lawns and playing in the pool for adults and children are well below the MRL. The actual dose is likely much lower because of the conservative exposure assumptions and the fact that the vapors will disperse very quickly outdoors.

Filling a kiddie pool with water will probably take only 10 to 15 minutes. On the basis of the previous evaluation of potential exposure from watering the lawn, filling the pool is unlikely to result in significant exposure to VOCs.

Incidental ingestion

Local well water is not used for drinking, so the main concern is incidental ingestion. ATSDR reviewed the data and determined that samples that were within an order of magnitude of the appropriate health screening value would likely not pose a health hazard. After this screening, ATSDR further evaluated the potential for incidental ingestion of benzene, nitrates, lead, and thallium in local groundwater. Like the inhalation scenario above, ATSDR assumed that a child would play in a kiddie pool 4 days per week for 2 hours per day during a 3-month summer period. For that scenario, ATSDR used a conservative water intake rate of 50 mL per hour.

Oral MRLs are not available for benzene and nitrates, so ATSDR compared the estimated doses to EPA's oral references doses (RfDs). The estimated exposure doses for benzene, 0.00008 mg/kg/day for adults and 0.0003 mg/kg/day for children, were both well below the RfD of 0.004 mg/kg/day. The estimated exposure doses for nitrates, 0.04 mg/kg/day for adults and 0.19 mg/kg/day for children, were both well below the RfD of 1.6 mg/kg/day. Therefore, neither benzene nor nitrates pose a heath hazard from incidental ingestion.

The estimated exposure doses for lead are 0.00005 mg/kg/day for adults and 0.03 mg/kg/day for children. The bulk of human data on the health effects of lead are expressed in terms of internal exposure, or blood lead levels, rather than external exposure levels (i.e., mg/kg/day). However, animal studies have looked at external exposure levels and health effects. The estimated exposure doses are well below the no observed adverse effect levels found in several of these studies: 0.57 mg/kg/day and 0.64 mg/kg/day (monkeys); 0.9 mg/kg/day and 1.4 mg/kg/day (rats) (ATSDR 1999).

The estimated exposure doses for thallium are: 0.00001 mg/kg/day for adults and 0.007 mg/kg/day for children. The scientific literature on thallium is limited; most human studies involve accidental or intentional acute thallium ingestion. A 1986 study found a no-observed-adverse-effect level (NOAEL) when rats were administered 0.2 mg/kg/day of thallium by gavage over a 90-day period (Stoltz 1986). The estimated thallium exposure doses for adults and children using the water in this scenario are orders of magnitude below this value.

However, this scenario only takes into account incidental ingestion from splashing and playing in a small pool. Residents, particularly children, could ingest water other than by playing in the pool. They might, for example, drink water directly from the hose. This is a specific concern with thallium because it is one of the most toxic of the heavy metals. Therefore, to prevent exposure to thallium in the groundwater, ATSDR recommends that residents refrain from using the nonpotable water supply for drinking or consumption. In addition, for activities that have the potential for ingestion of the thallium-contaminated groundwater, ATSDR recommends that the city water be used instead.

Direct skin contact

Exposure from skin absorption is typically much less than the contribution from oral and inhalation routes. The inhalation and incidental ingestion exposure doses were well below the comparison values, therefore exposure from direct skin contact is unlikely to contribute significantly to the overall dose. In addition, the VOCs in the groundwater will disperse quickly in the outdoor atmosphere, so VOC levels in water in the pools likely will be much lower after a short period.

Consuming garden produce

ATSDR also looked into concerns that produce could absorb contaminants from the groundwater and residents could be exposed to those contaminants by eating the produce.

VOCs

Because VOCs would quickly volatilize in the outdoor atmosphere, it is unlikely that there would be significant levels of VOCs remaining for plant uptake either in the soil or on the plant. Therefore, VOCs will not pose a hazard to people eating produce from home gardens.

Nitrates

Most of the nitrate samples are within one order of magnitude of the MCL. In addition, the water is not used for drinking and gardens are only used part of the year. For those reasons, it is unlikely that produce would take up significant amounts of nitrates.

The nitrates in one sample, however, measured 475,000 µg/L, which is almost 50 times the MCL. Nitrates are essential for plant growth; nitrogen in fertilizer is converted to nitrate in the soil. Nitrate content of plants is determined by their inherited metabolic pattern (genetics) and the available nitrate of the soil. Applying fertilizer in amounts beyond the ability of the vegetable crop to use them may result in an accumulation of nitrate (University of Missouri Extension 2005). Fertilizers high in nitrogen discourage flowering and favor leafy growth, so vegetable production may be reduced.

The consumption of small amounts of nitrate is not harmful; nitrate is actually part of a normal diet. Health problems can occur in infants, however, if they ingest too much nitrate. When nitrates enter the body, stomach bacteria converts nitrate to nitrite. Adults have low pH (high acidity) stomach acid that destroys these bacteria. Infants (especially those younger than 3 months old) do not have developed digestive systems that can destroy the stomach bacteria. Infants with excess levels of nitrite in the body can to develop a condition called methemoglobinemia. This condition, also known as “blue baby syndrome,” reduces the ability of blood cells to transport oxygen through the body. For infants, the major source of nitrate exposure is nitrate-contaminated drinking water used to dilute formula (ATSDR 1991, Kross et al 1992). Once an infant's system is fully developed (normally 3 to 6 months), methemoglobinemia is a rarely a problem (EPA 2005).

Because the water in these wells is not being used for drinking, and babies younger than 3 months do not typically consume garden produce, ATSDR believes that consuming garden produce watered with these levels of nitrates will not pose a health hazard.

Lead

The maximum value of lead in groundwater from this site was measured at 485 µg/L. A recent study was conducted in which many different fruits and vegetables were grown in lead-contaminated soil. The results showed that all garden vegetable plants grown in contaminated soil accumulate lead to some level, and that the majority of the contamination is in the plant root. Smaller levels of lead were found in the plant shoot, with low to nondetectable levels in the edible fruit (e.g. tomatoes, peppers, beans, and zucchini) (Finster et al. 2004). Most lead compounds are relatively insoluble; therefore, natural plant uptake is minimal (Barcosi et al 2003). Although there may be lead in the soil from watering produce gardens with the contaminated well water, ATSDR believes that any plant uptake will be minimal and will not pose a health hazard.

Thallium

Thallium was measured in three wells at 121 µg/L, 118 µg/L, and 112 µg/L. Thallium and its oxide are insoluble in water, but the chloride, acetate, nitrate, and sulfate of thallium are water soluble (ATSDR 1992). These soluble salts could be leached out of the soil. Brassica plants (rutabaga, turnip, cabbage, mustard, etc.) are likely to be the main source of dietary exposure to thallium in food produced on contaminated land (Sherlock and Smart 1986). The thallium content of food depends directly on the thallium concentrations in the soil. Therefore, food grown in thallium-contaminated soils can be a significant source of thallium exposure (WHO 1996, Leonard and Gerber 1997).

Until 1972, thallium was used as a rat poison. A literature search turned up no evidence that thallium-related toxicity has ever occurred as a result of eating plants that have naturally accumulated this heavy metal. However, the literature on human exposure to thallium is limited and is mostly related to accidental or intentional poisonings.

Thallium leaves the body slowly. It can be found in the urine as long as 2 months after exposure. Thallium is one of the most toxic of the heavy metals, but it is not a very common environmental contaminant. ATSDR found no site-specific information about thallium in the soil of produce gardens watered with contaminated groundwater. Because of uncertainty about the potential for plants to uptake thallium and little information about the site-specific conditions of the soil, ATSDR cannot make a determination about the potential for health hazard from the thallium-contaminated water. Therefore, ATSDR recommends that people who have wells with thallium contamination at these levels do not use that water on their produce gardens.

In addition, because thallium is such an uncommon environmental contaminant, the values in the groundwater are high, and there is no indication of a contamination source, ATSDR is concerned about the possibility that the soil is the source of contamination. If this is the case, residents in this area could be further exposed to thallium if their gardens and play areas contain thallium-contaminated soil. ATSDR recommends that soil sampling be conducted in the area to characterize the source of the thallium.

ATSDR's Child Health Initiative

ATSDR recognizes that in communities faced with contamination of air, water, soil, or food, the unique vulnerabilities of infants and children demand special emphasis. As part of its Child Health Initiative, ATSDR is committed to evaluating the health impact of environmental contamination on children. The ATSDR believes there is minimal exposure risk to children from the activities associated with the contaminated well water at the Wright groundwater site.

Conclusions

1. Contaminants in the nonpotable well water do not pose a public health hazard from inhalation when used for watering lawns and gardens.
2. Contaminants in the nonpotable well water do not pose a public health hazard from inhalation, incidental ingestion, or direct skin contact when used to fill small kiddie pools. However, this does not take into account the possibility that residents, particularly children, could ingest water other than by playing in the pool, such as drinking water directly from the hose. This would increase exposure to contaminants in the water. This is a specific concern with thallium because it is one of the most toxic of the heavy metals.
3. Contaminants in the nonpotable well water used to water home gardens do not pose a public health hazard for VOCs, nitrates, or lead from consuming produce. However ATSDR is unable to make a determination about the risk from using the thallium-contaminated groundwater to water produce.

Recommendations

1. Restrict drilling of new wells in known contaminant plumes.
2. Restrict well water to outdoor nonpotable use only.
3. Use city water instead of the thallium-contaminated groundwater for activities in which the water may be ingested.
4. Do not us groundwater with high levels of thallium to water produce gardens.
5. Conduct soil sampling in the area to characterize the source of the thallium.

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Table 1: Maximum contaminant values in residential and monitoring wells Wright groundwater site			
Contaminant	**Max value (µg/L)**	**Health Screening Value (µg/L)**	**Type of Health Screening Value**
Alachlor	4.8	2	MCL
Atrazine	41	3	MCL
Benzene	850	5	MCL
Chloroform	3	0.1 – child 0.4 – adult	Chronic EMEG
1,2-Dichloropropane	7	5	MCL
Nitrates	475,000	10,000	MCL
Tetrachloroethylene	15	5	MCL
Trichloroethylene	72	5	MCL
Bromodichloromethane	0.4	0.2 – child 0.7 – adult	Chronic EMEG
1,2-Dichloroethane	7	5	MCL
Cyclohexane	5.5	12,000	RBC
1,2-Dibromomethane	0.064	0.00075	RBC
MTBE	100	2.6	RBC
Chloroethane	0.81	3.6	RBC
Chloromethane	0.51	190	RBC
Lead	485	15	NPDWS Action Level
Chromium	461	100	MCL
Copper	1,680	1,300	MCL
Thallium	121	2	MCL
MCL – maximum contaminant level (EPA National Primary Drinking Water Standard) EMEG – Environmental media evaluation guide (ATSDR) RBC – risk-based concentration (EPA Region 3) NPDWS – National Primary Drinking Water Standard			