Health Consultation

EVALUATION OF METALS IN PRIVATE DRINKING WATER WELLS

PAULDEN, YAVAPAI COUNTY, ARIZONA

JUNE 13, 2006

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

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HEALTH CONSULTATION

EVALUATION OF METALS IN PRIVATE DRINKING WATER WELLS

PAULDEN, YAVAPAI COUNTY, ARIZONA

Prepared By:

Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
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Purpose

A resident in Paulden, Arizona has expressed concerns regarding the levels of arsenic and other metals in their private well. As a result, the Arizona Department of Health Services (ADHS) completed a health consultation to evaluate if the levels of arsenic and other metals in the private wells in the neighborhood pose any adverse health effects.

Background and Statement of Issues

The town of Paulden, Arizona is a rapidly growing community in northern rural Yavapai County, approximately 110 miles north of downtown Phoenix, Arizona (Figure 1). The estimated population is 3,500 residents. They are scattered throughout rolling hills about five miles north of Chino Valley. Many of these residents rely on private domestic wells for potable water. Some residents share wells between households.

In July 2005, a resident of Paulden contacted the Arizona Department of Health Services, Office of Environmental Health to request information about groundwater quality in the Paulden area. The resident's well water had been sampled and analyzed by a private water treatment company. The company's laboratory reported to the resident that the levels of arsenic were unacceptable. In addition, the residents reported to the ADHS adverse health effects believed to be associated with drinking the well water, such as nausea and diarrhea. These residents were new to the area, and had only resided in the house for a short time. The groundwater wells are not located near any identified hazardous waste sites. There are no known background levels of metals in the groundwater in the area. The area's geology is known to be naturally rich in metals, and the surrounding area had been historically used for mining. The ADHS decided to collect water samples from the residence due to no prior knowledge of groundwater conditions in the Paulden area.

Figure 1. Map shows the location of Paulden, Arizona

Due to the great concerns from the residents, the Paulden Area Community Organization (PACO) invited the ADHS to its monthly meeting to (1) explain what are the acceptable levels of arsenic, (2) possible human health effects from consumption, and (3) answer questions that community members have. The PACO is formed by the residents in July 2001 with a board that meets the first Thursday of each month at 7 p.m. at the fire department building at 24050 Marblehead, just off Big Chino Road, to discuss community issues.

At the meeting on September 1, 2005, the ADHS gave a presentation about arsenic and possible human health effects due to water consumption. The ADHS handed out information sheets about arsenic and brochures entitled "*What you should know about arsenic in the groundwater?*" to the community members. The ADHS also provided an arsenic field test kit "Arsenic Econo-Quick, 481298" to the community members. The residents can screen the arsenic levels in their private wells with the help from two identified/qualified community members. If there is a need, the ADHS will provide an additional test kit to the residents.

To date, the ADHS has received numbers of phone calls from residents who have questions or concerns regarding the arsenic levels in the Paulden area. The ADHS will continue to answer questions and concerns from the community members.

Discussion

Sample Collection

The ADHS collected 7 water samples in July 2005 from 4 private wells in the Paulden area. Two samples, one from the kitchen faucet, and one from a water faucet outside near the wells were taken from 3 homes with private wells. The homes were located within a ½ mile of each other. The seventh sample was obtained from water drawn from the kitchen tap approximately 2 miles away from the first 3 homes. The water samples were stored in nitric-acid preserved water sample bottles provided by the Arizona Department of Health Services, Bureau of State Laboratory Services, Office of Environmental and Analytical Chemistry.

Sample Analysis

The Arizona State Laboratory analyzed the water samples for arsenic and other primary metals by the United States Environmental Protection Agency (U.S. EPA) Methods 200.7. The water samples were also analyzed by Metals2002Scrn, which is an Arizona State Laboratory developed method, based on the U.S. EPA methods. Arizona does not regulate drinking water quality from private wells, and compliance with the U.S. EPA methods is not required in this instance. The laboratory reports indicated, "All quality control data is within the laboratory's acceptance limits as indicated in the *Quality Assurance Plan for Analytical Chemical Services* and/or the individual standard operating procedure for the test performed".

Exposure Pathway Evaluation

The ADHS identified the exposure pathways to determine if and how residents might be exposed to chemicals in tap water. There are five elements are considered in the evaluation of exposure pathways:

- A source of contamination
- Transport through an environmental medium
- A point of exposure
- Route of exposure
- A receptor population

Exposure pathways are classified as completed, potential, or eliminated. Completed pathways exist when the five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring now. Potential pathways are those that may have occurred in the past or present, or could occur in the future. In eliminated pathways, at least one of the five elements is and was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

Completed and potential exposure pathways may result from people using the water for domestic purposes. Typical domestic water exposures to chemicals include inhalation and dermal exposures from bathing and showering, and ingestion exposures from drinking and using water for cooking. Table 1 shows the completed and potential exposure pathway elements.

Table 1. Complete and Potential Exposure Pathways

Exposure Pathway Elements					Time	Type of Exposure Pathway
Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Estimated Exposed Population**		
Groundwater Well	Groundwater	Resident: Tap	Ingestion Skin contact	Approximately 20 Residents	Past	Potential
					Current	Completed
					Future	Potential

Selecting Chemicals of Interest

The ADHS assesses a site by evaluating the level of exposure in exposure pathways to determine if residents are being exposed to chemicals at levels of public health concern. An exposure pathway defines how a chemical may enter a person's body and potentially cause adverse health effects. The evaluation includes use of comparison values (CVs), which are screening tools used with environmental data relevant to the exposure pathways. CVs are conservatively developed based on the available scientific data and the most sensitive groups (e.g. children).

If public exposure concentrations related to a site are below the corresponding CV, then the exposures are not considered of public health concern and no further analysis is conducted. However, while concentrations below the CV are not expected to lead to any observable adverse health effect, it should not be inferred that a concentration greater than the CV will necessarily lead to adverse health effects. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels above the comparison value may or may not lead to a health effect. Therefore, the CVs should not be used to predict the occurrence of adverse health effects.

The CVs used in screening analyses include (1) Environmental Media Evaluation Guides (EMEGs), (2) Reference Dose Media Evaluation Guides (RMEGs), (3) Maximum Contamination Levels (MCLs), and (4) Drinking Water Equivalent Level (DWEL). The Agency for Toxic Substances and Disease Registry (ATSDR) develops EMEGs and RMEGs based conservative assumptions about exposure. EMEGs and RMEGs which represent concentrations of substances in water, soil, or air to which daily human exposure is unlikely to result in adverse health effects.

The U.S. EPA develops the MCLs and DWELs. MCLs are enforceable standards for public drinking water supplies that are protective of human health, over a lifetime. DWELs are not enforceable legal standards. DWEL defines a lifetime exposure concentration protective of adverse, non-cancer health effects, assuming that all exposure to a contaminant is from drinking water.

Table 2. Groundwater sampling data in micrograms per liter (µg/L) of selected metals for the Paulden Area

Chemicals	Number of Samples	Ranges of detected concentration (µg/L)	Health-based CVs (µg/L)	Source of CV	Number of detections greater than CV	Is it a chemical of interest?
Arsenic	7	ND[a] − 3,400	10	MCL[b] U.S. EPA	6	**Yes**
Boron	7	ND − 76,000	100	EMEG-ci[c] ATSDR	6	**Yes**
Silicon	7	9,000 − 29,000	NA	NA	NA	**Yes**
Sodium	7	50,000 − saturated	20,000[d]	DWEL[e] U.S. EPA	7	**Yes**

[a] ND: non-detected (i.e., dissolved metal concentrations in groundwater samples were below the laboratory reporting limit)
[b] MCL: Maximum Contamination Level
[c] EMEG-ci: Environmental Media Evaluation Guide for children's intermediate exposure
[d] This health-based value is for individuals on a 500 mg/day restricted sodium diet
[e] DWEL: Drinking Water Equivalent Level

When no CVs are available, the chemical is generally retained for further evaluation. No CVs are available for some essential nutrients (e.g. calcium, iron and magnesium). However, these essential nutrients are typically not harmful to humans under most environmental exposure scenarios and are not retained for further analysis (ATSDR 2005). Table 2 shows analytical results of selected chemicals of interest. The complete screening results are shown in the Appendix. The identified chemicals of interest are arsenic, boron, silicon, and sodium.

Health Effects Evaluation

To further evaluate the selected chemicals of interest, the ADHS estimated the chronic daily intakes (CDIs) based on the site-specific conditions (e.g. duration and frequency). The estimated CDIs were then compared to health guideline values. The health guideline values are estimates of the daily human exposure to a chemical that is likely to be without appreciable risk of adverse health effects during a specified duration of exposure.

Chemicals of interest having CDIs below conservatively derived health guidelines likely pose no public health hazards. However, chemicals of interest having CDIs above the health guidelines does not mean that the chemicals of interest will cause adverse health effects, but rather there is a need for further toxicological evaluation by comparing the estimated CDI for residents to CDIs known to cause harmful effects.

Uptake chemicals through skin contact

As indicated in Table 1, residents can uptake chemicals through water ingestion and skin contact. The ADHS determined that uptake of metals through skin contact can be ignored because metals are not readily absorbed through the skin.

Exposure to metals through skin contact results in a much lower dose than the water ingestion pathway. For example, dermal exposure to arsenic is usually not of concern because only a small percentage will pass through skin and into the body (ATSDR 2000). Direct skin contact with arsenic could cause some irritation or swelling, but skin contact is not likely to result in any serious internal effects.

Uptake chemicals through water ingestion

The CDIs from water ingestion were estimated by following the Arizona Department of Health Services Deterministic Risk Assessment Guidance (ADHS 2003). For non-cancer health effects, the estimated CDIs were compared to the ATSDR's Minimal Risk Levels (MRLs) or the U.S. EPA's Reference Dose (RfD). For cancer health effects, the estimated CDIs were used to calculate the excess lifetime cancer risk.

The MRLs or RfDs are derived based on the non-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) and an uncertainty factor. A NOAEL is the highest exposure level of a chemical at which adverse health effects were not observed. A LOAEL is the lowest exposure level of a chemical at which adverse health effects were observed.

An MRL contains uncertainty that is due to the lack of knowledge about the data on which it is based. To account for this uncertainty, "safety factors" are used to set MRLs below actual toxic effect levels (i.e. NOAEL or LOAEL). This approach provides an added measure of protection against the potential for adverse health effects to occur.

Table 3 shows the estimated CDIs for arsenic, boron, sodium, and silicon for wells containing concentrations higher than the CVs. These values were used to evaluate the non-cancer health effects. The estimated CDIs for arsenic and boron exceeded the health guideline values, which indicate arsenic and boron require more careful examination (i.e. toxicological evaluation). Silicon was retained for further evaluation since no health guideline value was available.

Table 3. Estimated chronic daily intake (CDI) in milligrams per kilogram per day (mg/kg/day) compared to the health guidelines.

Chemical	Chemical concentration[a] (well name) (mg/L)	Chronic daily intake (mg/kg/day)		Health guideline (mg/kg/day)	Source	Does the child CDI exceed the health guideline ?	Does the adult CDI exceed the health guideline ?
		Child	Adult				
Arsenic	2.5 (Private well 1)	0.16	0.07	0.0003	MRL[b] ASTDR	**Yes**	**Yes**
	3.35 (Private well 2)	0.21	0.09			**Yes**	**Yes**
	2.00 (Private well 3)	0.13	0.05			**Yes**	**Yes**
Boron	49.0 (Private well 1)	3.13	1.34	0.2	RfD[c] U.S. EPA	**Yes**	**Yes**
	75.5 (Private well 2)	4.83	2.07			**Yes**	**Yes**
	28.0 (Private well 3)	1.79	0.77			**Yes**	**Yes**
Sodium	100[d] (Private well 1)	6.39	2.74	NA[e]	NA	NA	NA
	100[d] (Private well 2)	6.39	2.74			NA	NA
	100[d] (Private well 3)	6.39	2.74			NA	NA
	50 (Private well 4)	3.20	1.37			NA	NA
Silicon	14.5 (Private well 1)	0.93	0.40	NA	NA	NA	NA
	9.5 (Private well 2)	0.61	0.26			NA	NA
	20.5 (Private well 3)	1.31	0.56			NA	NA
	29 (Private well 4)	1.85	0.79			NA	NA

[a] Chemical concentration is the average concentration of water samples collected from the kitchen and outside faucets.
[b] MRL: minimal risk level
[c] RfD: reference dose
[d] Saturated concentration
[e] NA: not available

Toxicological Evaluation

(1) *Arsenic*

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds (ATSDR 2000).

Arsenic can be released to water from the natural weathering of soil and rocks and can also leach from soil and minerals into groundwater. In some western states with mineral deposits high in arsenic, groundwater levels of up to 3400 µg/L arsenic have been found. Most arsenic in natural waters is a mixture of arsenate (trivalent arsenic or As III) and arsenite (pentavalent arsenic or As V), with arsenate (As III) usually predominating (ATSDR 2000a).

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Ingestion of arsenic can increase the risk for skin cancer and internal cancers: liver, lung, bladder, and kidney (ATSDR 2000).

(A) Non-cancer Health Effects

As shown in Table 3, the estimated child and adult arsenic CDIs from water ingestion exceeded the arsenic MRL of 0.0003 mg/kg/day. The results indicated that there is a need for further toxicological evaluation. Thus, the Arizona Department of Health Services further evaluated the human studies on which the arsenic MRL was based.

The arsenic MRL was derived from the long-term arsenic NOAEL of 0.0008 mg/kg/day, obtained from human epidemiologic studies, and an uncertainty factor of three (ATSDR 2000). The long-term LOAEL associated with these epidemiologic studies is 0.014 mg/kg/day, where exposure to arsenic above this level resulted in keratosis (patches of hardened skin), hyperpigmentation of the skin, and possible vascular complication (ATSDR 2000). The results in Table 3 indicate that the estimated CDIs for child and adult exceeded the LOAEL of 0.014 mg/kg/day.

(B) Cancer Health Effect

The excess lifetime cancer risks due to arsenic from water ingestion were estimated based on the Arizona Department of Health Services Deterministic Risk Assessment Guidance (ADHS 2003) and the cancer slope factor of arsenic developed by the U.S. EPA. The estimated excess lifetime cancer risks ranged from 0.035 to 0.059, over a lifetime. It means that there is a potential increase in excess lifetime cancer of 3.5 to 5.9 cases per 100 persons.

The estimated excess lifetime cancer risks are greater than the upper bound of the acceptable risk, one-in-ten-thousand persons, defined by the U.S. EPA (U.S. EPA 1991). In a population of one million men in the United States, 333,000 (one in three) are expected to develop cancer from all causes in the lifetime (through 79 years of age) (ACS 1998). The estimated excess lifetime cancer risk of one-in-ten thousand means that if those one million men were exposed to this level of chemical for 30 years, 334,000 would be expected to develop cancer. That is, the chance for those one million men to develop cancer from all causes in their lifetime increases from 33.3 % to 33.4 %.

After a review of available exposure and health effect data, the Arizona Department of Health Services determined that detected arsenic levels in the Private well 1, 2, and 3 pose a health hazard to adults and children.

(2) *Boron*

Boron is a compound that occurs in nature. It is often found combined with other substances to form compounds called borates. Common borate compounds include boric acid, salts of borates, and boron oxide (ATSDR 1992).

There is little information on the health effects of long-term exposure to boron. Most of the studies are on short-term exposures. If humans eat large amounts of boron (4,161 parts per million) over short periods of time, it can affect the stomach, intestines, liver, kidney, and brain and can eventually lead to death. Developmental (decreased fetal weights in experimental animals) effects are the critical health effect due to long-term boron exposure (ATSDR 1992, U.S. EPA 2004).

The estimated CDIs of boron from the groundwater well ranged from 1.79 to 4.83 mg/kg/day for children and 0.77 to 2.1 mg/kg/day for adults. Even though these levels are above the RfD, they are lower than the benchmark response level (10.3mg/kg/day) and the NOAEL (9.6 mg/kg/day) established by the U.S. EPA (U.S. EPA 2004). The benchmark response level corresponds to a 5% decrease in the fetal weight of the experimental animals relative to the control animals. The NOAEL is the highest exposure level at which adverse health effects were not observed in the experimental animals.

After a review of available exposure and health effect data, the Arizona Department of Health Services determined that boron levels in the Private well 1, 2, and 3 do not pose a health hazard to adults and children.

(3) *Silicon*

Silicon is in human connective tissues, bones, teeth, skin, eyes, glands and organs. It is a major constituent of collagen that helps keep our skin elastic, and it helps calcium in maintaining bone strength. The results from animal studies indicated that exposure to high doses of silicon (> 270 parts per million) might reduce growth rates and organ weights. However, no significant adverse health effects have been observed. In addition, there is no evidence that silicon that occurs in food and water produces adverse health effects (IOM 2000).

The estimated chronic daily intakes of silicon from the groundwater well ranged from 0.61 to 1.85 mg/kg/day for children and 0.26 to 0.79 mg/kg/day for adults. These values are well

below the Safe Upper Level for Daily Consumption over a lifetime (12mg/kg/day) established by the Medical Defense Union in the United Kingdom (EVM 2003).

After a review of available exposure and health effect data, the Arizona Department of Health Services determined that silicon levels in the Private well 1, 2, and 3 do not pose a health hazard to adults and children.

(4) *Sodium*

Sodium in drinking water normally present no health risks, as about 99% of the daily salt intake is from food. However, elevated sodium in well water may be considered a health concern for people on salt-restricted diets. The treatment for certain heart conditions, circulatory or kidney disease, or cirrhosis of the liver may require a sodium-restricted diet (Brody 2002).

Sodium is an essential nutrient. The Food and Nutrition Board of the National Research Council recommends that most healthy adults need to consume at least 500 milligrams per day, and that sodium intake be limited to no more than 2,400 milligrams per day. A Food and Drug Administration publication, *Scouting for Sodium and Other Nutrients Important to Blood Pressure* (FDA 95-2284), indicates that most American adults tend to eat between 4,000 to 6,000 milligrams of sodium per day and sodium therapeutic sodium restricted diet can range from below 1,000 to 3,000 milligrams per day.

Since detection methods could not quantify concentrations greater than 100 milligrams sodium per liter of water (mg/L), the lowest possible concentration of sodium was 100 mg/L, which exceeded the Drinking Water Equivalent Level (DWEL) of 20 mg/L. The DWEL, is a health-based guidance level for individual on 500 milligrams sodium per day restricted sodium diet. At least two households are using their well water for drinking and cooking. The Arizona Department of Health Services is unable to determine the potential health effects to the general public (i.e. people are not on restricted sodium diet) due to the sodium in the groundwater well, since the exact amount of sodium in the groundwater well is not known.

ATSDR Child Health Concerns

ATSDR recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contaminants in environmental media. Children's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Children ingest a larger amount of water relative to body weight, resulting in higher burden of pollutants. Furthermore, children often engage in vigorous outdoor activities, making them more sensitive to pollution than healthy adults. All health analyses in this report take into consideration the unique vulnerability of children. Children will be adversely affected by the levels of arsenic found in private wells 1, 2, and 3 at the residence.

Conclusions

The Arizona Department of Health Services has classified the Private well 1, 2, and 3 as "Public Health Hazard". This classification is based upon the following:

- The estimated CDIs for children and adults exceeded the LOAEL of 0.14 mg/kg/day
- The estimated excess lifetime cancer risks are greater than the acceptable risk range of one-in-one-million to one-in-ten-thousand

If further information becomes available, the Arizona Department of Health Services will evaluate it and update conclusions as necessary.

Recommendations

- For groundwater wells containing arsenic levels above the new MCL of 10 μg/L, a treatment system that effectively removes arsenic should be installed. Meanwhile, residents should have an alternative water source, such as bottled water, for drinking or cooking.
- All residents in the Paulden area who use private well water for drinking or cooking should have their well water tested yearly for bacteria and nitrates, and at least once for primary metals, such as arsenic, copper, and lead, etc.
- Individuals on restricted sodium diet should consult their physician before using the well water for drinking or cooking.

Public Health Action Plan

1. On September 1, 2005, The ADHS attended the Paulden Area Community Organization (PACO) meeting to (1) explain what are the acceptable levels of arsenic, (2) possible human health effects from consumption, and (3) answer questions that community members have.
2. The ADHS handed out information about arsenic and brochures entitled "*What you should know about arsenic in the groundwater?*" to the community members at the PACO meeting on September 1, 2005.
3. The ADHS provided an arsenic field test kit "Arsenic Econo-Quick, 481298" to the community members to screen the arsenic levels in their private wells. If there is a need, the ADHS will provide an additional test kit for the residents.
4. The ADHS will attend another PACO meeting as a request of the community members.
5. The ADHS will continue to answer questions and concerns from the community members.
6. The ADHS will send a copy of the finalized health consultation to the residents and a flyer entitled "*Private Well Water and Your Health*", which contains information regarding private wells.

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Certification

This Health Consultation entitled *Evaluation of Metals in Private Drinking Water Wells, Paulden, Yavapai County, Arizona* was prepared by the Arizona Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, Agency for Toxic Substance and Disease Registry, has reviewed this health consultation and concurs with its findings.

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Appendix

Groundwater sampling data in micrograms per liter (µg/L) for selected metals from the Paulden area

Chemicals	Number of Samples	Ranges of detected concentration (µg/L)	Health-based CVs (µg/L)	Source of CV	Number of detections greater than CV	Is it a chemical of interest?
Aluminum	7	ND[a]	20,000	EMEG-ci[b] ATSDR	0	No
Antimony	7	ND	6	MCL[c] U.S. EPA	0	No
Arsenic	7	ND − 3,400	10[d]	MCL U.S. EPA	6	**Yes**
Barium	7	ND	2,000	MCL U.S. EPA	0	No
Beryllium	7	ND	4	MCL U.S. EPA	0	No
Boron	7	ND − 76,000	100	EMEG-ci ATSDR	6	**Yes**
Cadmium	7	ND	5	MCL U.S. EPA	0	No
Calcium	7	ND	NA	NA	0	No
Chromium	7	ND	100	MCL U.S. EPA	0	No
Cobalt	7	ND	100	EMEG-ci ATSDR	0	No
Copper	7	ND	100	EMEG-ci ATSDR	0	No
Iron	7	ND	NA	NA	0	No
Lithium	7	ND	NA	NA	0	No
Lead	7	ND	15	MCL U.S. EPA	0	No
Magnesium	7	ND	NA	NA	0	No
Manganese	7	ND	500	RMEG-c[e] ATSDR	0	No
Molybdenum	7	ND	50	RMEG-c ATSDR	0	No
Nickel	7	ND	200	RMEG-c ATSDR	0	No
Potassium	7	ND	NA	NA	0	No
Selenium	7	ND	50	MCL U.S. EPA	0	No
Silicon	7	9,000 − 29,000	NA	NA	NA	**Yes**
Silver	7	ND	50	RMEG-c ATSDR	0	No
Sodium	7	50,000 − saturated	20,000[f]	DWEL[g] U.S. EPA	7	**Yes**
Strontium	7	ND	20,000	EMEG-c ATSDR	0	No
Thallium	7	ND	2	MCL U.S. EPA	0	No
Tin	7	ND	3,000	EMEG-c ATSDR	0	No
Titanium	7	ND	NA	NA	0	No

[a] ND: non-detected (i.e., dissolved metal concentrations in groundwater samples were below the laboratory reporting limit)
[b] EMEG-ci: Environmental Media Evaluation Guide for children's intermediate exposure
[c] MCL: Maximum Contamination Level
[d] The current arsenic MCL is 50 μg/L; however, the new arsenic MCL of 10 μg/L becomes effective on January 23, 2006.
[e] RMEG-c: Reference Dose Media Evaluation Guide for children's exposure
[f] This health-based value is for individuals on a 500 mg/day restricted sodium diet
[g] DWEL: Drinking Water Equivalent Level