

# Health Consultation

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PRESCOTT VALLEY WATER COMPANY

EVALUATION OF VOLATILE ORGANIC COMPOUNDS IN  
RESIDENTIAL DRINKING WATER

PRESCOTT VALLEY, YAVAPAI COUNTY, ARIZONA

SEPTEMBER 26, 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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HEALTH CONSULTATION

PRESCOTT VALLEY WATER COMPANY  
EVALUATION OF VOLATILE ORGANIC COMPOUNDS IN RESIDENTIAL DRINKING  
WATER

PRESCOTT VALLEY, YAVAPAI COUNTY, ARIZONA

Prepared by:

Arizona Department of Health Services  
Office of Environmental Health  
Environmental Health Consultation Services  
Under Cooperative Agreement with the  
U.S. Department of Health and Human Services  
Agency for Toxic Substances and Disease Registry

## **Background and Statement of Issues**

The Stoneridge subdivision is a growing rural community (approximately 100 miles north of downtown Phoenix, Arizona) with approximately 5,000 residents. The Prescott Valley Water Company (Prescott Valley, AZ) provides drinking water for residents in this area. A resident in the community indicated that there is a “paint thinner” type odor coming from the tap water. The Prescott Valley Water Company sampled the water due to request of the resident.

On July 27, 2004, the resident called the Arizona Department of Health Services to express his/her concern regarding the analytical results of benzene in tap water samples collected from faucets inside the house. As a result, the Arizona Department of Health Services completed a health consultation to evaluate if benzene and other volatile organic compounds (VOCs) in the water supplied by the Prescott Valley Water Company pose any adverse health effects.

## **Discussion**

### **Tap Water Data**

#### **(1) Tap Water Samples Collected from the Resident’s House**

On June 24, 2004, three tap water samples were collected from faucets in guest bath, master bath and kitchen of the resident’s house. Legend Technical Services of Arizona (Phoenix, AZ) tested the tap water samples for odor and VOCs. The laboratory report indicated that the submitted tap water samples were odor-free by using the United States Environmental Protection Agency (U.S. EPA) Method 140.1.

The concentrations of VOCs in the tap water samples were determined by the U.S. EPA Method 8260B. This method utilizes gas chromatography/mass spectrometry (GC/MS) technology to identify and quantify organic compounds with specific quality control requirements. This method tested for 62 VOCs. The results showed that all VOCs, except bromoform, in the tap water samples are below the practical quantitation limits. That is, this method was not able to determine the exact amount of VOCs in the tap water samples. Benzene and its derivatives were included in the 62 VOCs.

Practical quantitation limits are a guide for the “expected” concentrations that can be reliably achieved within specific limits of precision and accuracy during routine sample analyses. The only one exception is bromoform. The measured bromoform concentrations in the tap water samples are 3.7, 4.0 and 11.1 micrograms per liter ( $\mu\text{g/L}$ ) for the faucet in guest bath, master bath and kitchen, respectively. The practical quantitation limit is 2  $\mu\text{g/L}$  for bromoform, benzene and its derivatives.

In addition, Legend Technical Services of Arizona performed an open scan for organic compounds of the three tap water samples using the GC/MS instrument. The instrument and associated software attempts to identify and quantify organic compounds present in the samples. The scan results showed the present of several benzene derivatives. They were 1,2-diethylbenzene, 1-methyl-4-(1-methylethyl)benzene, 1-ethyl-2,3-dimethylbenzene, 4-ethyl-1,2-dimethylbenzene, 1,2,3,4-tetramethylbenzene, 1,2,3,5-tetramethylbenzene, and 2,3-dihydro-1-methylindene. However, Legend Technical Services of Arizona’s laboratory report indicated that

*“The data from this scan is considered non-compliance, as there is no associated quality control maintained for this analysis and the detected compounds are not confirmed by the analyst.”*

The above statement suggests that the open scan data have not been validated and did not meet data quality objectives. Thus, the Arizona Department of Health Services determined that the laboratory results from the open scan are not suitable for any health effects evaluation and will not be used in the health effects evaluation.

(2) 2003 Water Quality Report of the Prescott Valley Water Company (Town of Prescott Valley 2004)

The water source for Prescott Valley is groundwater, which is pumped into the distribution system by any one of its 11 wells. Chlorine is added to the water maintaining a residual 0.2 to 0.4 milligrams per liter (mg/L). Benzene and its derivatives were not included in the 2003 Water Quality Report because they were not detected in the water system from previous monitoring events. The 2003 Prescott Valley Water Quality Report indicated that the total trihalomethanes (TTHM) concentration in the water system ranged from 8 to 109 µg/L, with an average of 28 µg/L (Town of Prescott Valley 2004). The concentration of TTHM is a combined concentration of bromoform, chloroform, dibromochloromethane (DBCM), and dichlorobromomethane (DCBM).

(3) Tap Water Samples Collected by the Arizona Department of Environmental Quality

The concentrations of benzene and its derivatives in tap water sampled from the resident’s house were below the practical quantitation limit. To confirm the results of the first sampling event, the Arizona Department of Environmental Quality (ADEQ) collected more tap water samples at the Stoneridge subdivision.

On July 28, 2004, the Northern Region Office of ADEQ collected 4 tap water samples, including a travel blank, from three different residences in the Stoneridge subdivision. Legend Technical Services of Arizona analyzed the water samples for 43 VOCs, including benzene and its derivatives, by using U.S. EPA Method 524.2. This method utilizes GC/MS technology to identify and quantify organic compounds with specific quality control requirements.

The results showed that benzene and its derivatives were below the practical quantitation limits in all tap water samples. However, low levels of methyl *tert*-butyl ether (MTBE), bromoform, DBCM, and DCBM were detected in the tap water samples. None of the above chemicals were detected in the travel blank. Table 1 lists the analytical results of the selected chemicals in tap water samples.

**Table 1. Measured chemical concentrations in micrograms per liter (µg/L) in tap water samples collected from the Stoneridge subdivision by the Arizona Department of Environmental Quality (ADEQ)**

Sample ID	Measured chemical concentrations in tap water samples (µg/L)					
	Benzene	MTBE <sup>a</sup>	TTHM <sup>b</sup>			
			Bromoform	Chloroform	DCBM <sup>c</sup>	DCM <sup>d</sup>
House # 1	< 0.5 <sup>e</sup>	1.0	3.8	< 0.5	0.6	1.7
House # 2	< 0.5	< 0.5	3.0	< 0.5	< 0.5	1.5
House # 3	< 0.5	1.2	2.3	< 0.5	< 0.5	1.1

<sup>a</sup> MTBE: methyl *tert*-butyl ether

<sup>b</sup> TTHM: total trihalomethanes; TTHM is a combined concentration of bromoform, chloroform, dichlorobromomethane, and dibromochloromethane.

<sup>c</sup> DCBM: dichlorobromomethane

<sup>d</sup> DBCM: dibromochloromethane

<sup>e</sup> < 0.5 µg/L, which is the practical quantitation limit for benzene, MTBE, chloroform, DCM.

### Exposure Pathway Evaluation

The Arizona Department of Health Services 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 tap 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 2 lists the completed and potential exposure pathway elements.

**Table 2. Complete and Potential Exposure Pathways**

Exposure Pathway Elements					Time	Type of Exposure Pathway
Source	Media	Point of Exposure	Route of Exposure	Estimated Population		
Tap Water Supply	Tap Water	Resident: Tap	Ingestion Skin contact Inhalation	Approximately 15 Residents	Past	Potential
					Current	Completed
					Future	Potential

### Health Effects Evaluation

The Arizona Department of Health Services 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 that may 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 receptors (e.g. children).

If public exposure concentrations related to a site are below the appropriate CV, then the exposures are not 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 Arizona Department of Health Services used average concentrations to evaluate the potential health effects because they are most representative of the concentration that would be contacted at a site. If the detected chemical concentration is below the practical quantitation limit, the concentration of such chemical was assumed to be ½ of its practical quantitation limit. This is “a middle-of-the-road approach” where it is possible that the chemical would be detected in the sample and it “could be” as high as ½ of the practical quantitation limit.

The average chemical concentrations were compared to available health-based CVs. These CVs include Environmental Media Evaluation Guides (EMEGs), the Cancer Risk Evaluation Guide for 10<sup>-6</sup> (i.e. one in a million) Excess Cancer Risks (CREGs), Reference Dose Media Evaluation Guides (RMEGs), and Maximum Contamination Level (MCLs). The Agency for Toxic Substances and Disease Registry (ATSDR) develops EMEGs, CREGs, and RMEGs. EMEGs and RMEGs which represent concentrations of substances in water, soil, or air to which humans may be exposed without experiencing adverse health effects, over a lifetime. CREGs are CVs

used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

The U.S. EPA develops the MCLs, which are enforceable standards for public drinking water supplies that are protective of human health, over a lifetime. Table 3 indicates that the average chemical concentrations of MTBE, chloroform, DBCM, DCBM, and TTHM in water samples do not exceed the ATSDR's EMEG, CREG, RMEG, and MCL. Thus, these chemicals do not require further analysis.

**Table 3. Average chemical concentrations of tap water samples in micrograms per liter (µg/L) compared to health-based comparison values (CVs)**

Chemicals	Number of Samples	Average chemical concentration of tap water samples (µg/L)	Health-based CVs (µg/L)	Type of CV	Source of CV	Does it exceed the health-based CV?
Benzene	6	0.6	0.6 40 5	CREG <sup>a</sup> RMEG-c <sup>b</sup> MCL <sup>c</sup>	ATSDR ATSDR U.S. EPA	No No No
Methyl <i>tert</i> -butyl ether (MTBE)	3	0.8	3000	EMEG-c <sup>d</sup>	ATSDR	No
Bromoform	6	4.7	4 2000 80 <sup>e</sup>	CREG EMEG-c MCL	ATSDR ATSDR U.S. EPA	Yes No No
Chloroform	6	0.6	100 80 <sup>e</sup>	EMEG-c MCL	ATSDR U.S. EPA	No No
Dibromochloro methane (DBCM)	6	1.2	80 <sup>e</sup>	MCL	U.S. EPA	No
Dichlorobromo methane (DCBM)	6	0.7	200 80 <sup>e</sup>	EMEG-c MCL	ATSDR U.S. EPA	No No
Total trihalomethanes (TTHM)	—	28	80	MCL	U.S. EPA	No

<sup>a</sup> CREG: Cancer Risk Evaluation Guide for 10<sup>-6</sup> Excess Cancer Risk

<sup>b</sup> RMEG-c: Reference Dose Media Evaluation Guide for children's exposure

<sup>c</sup> MCL: maximum contamination level

<sup>d</sup> EMEG-c: Environmental Media Evaluation Guide for children's exposure

<sup>e</sup> The U.S. EPA has established a MCL of 80 µg/L for TTHM, which is a group of 4 chemicals (i.e., bromoform, chloroform, DBCM, and DCBM)

## (1) Benzene

In Table 3, the average benzene concentration in tap water samples is equal to the ATSDR's CREG for benzene. The Arizona Department of Health Services determined that benzene is not a chemical of interest and does not require further evaluation because both laboratory reports indicated that benzene levels in the tap water samples were below the practical quantitation limits.

Two different analytical methods (i.e., U.S. EPA Method 8260B and U.S. EPA Method 524.2) were used to determine the amount of benzene in drinking water samples. The practical quantitation limits are 2 µg/L and 0.5 µg/L for U.S. EPA Method 8260B and U.S. EPA Method 524.2, respectively. To estimate the average concentration of benzene in tap water samples, the Arizona Department of Health Services assumed that the benzene concentrations in the tap water samples are equal to ½ of the practical quantitation limits (i.e. 1 µg/L for tap water samples were analyzed by U.S. EPA Method 8260B, and 0.25 µg/L for tap water samples were analyzed by U.S. EPA Method 524.2). This estimated average benzene concentration in tap water is conservative since no history of benzene was detected in the water supply system. Furthermore, the estimated average benzene concentration in tap water can be at least 2 times higher than the actual benzene concentration in tap water due to the differences in quantitation limits alone. Based on the above, the Arizona Department of Health Services determined that benzene does not need further analysis.

## (2) Bromoform

The Arizona Department of Health Services determined that bromoform is a chemical of interest for cancer because the average bromoform concentration exceeded the ATSDR's CREG. Bromoform is colorless to yellow, heavy, nonflammable, liquids with a sweet odor. Small amounts are formed naturally by plants in the ocean. It is somewhat soluble in water and readily evaporate into the air. Animals exposed to high amounts of bromoform developed liver and kidney injuries. Exposure to low levels of bromoform do not appear to seriously affect the brain, liver, or kidneys. The U.S. EPA has classified bromoform as a probable human carcinogen (U.S. EPA 1991).

The Arizona Department of Health Services estimated the lifetime cancer risk by evaluating the potential exposure pathways, estimating exposure concentrations and intake, and combining exposure estimates with toxicology information (U.S. EPA 1991). The cancer risk was estimated by the following equations:

$$CancerRisk = CDI \times SF$$

$$CDI = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where, *CDI* = chronic daily intake (mg/kg/day)  
*SF* = slope factor (0.0079 1/(mg/kg/day)) (U.S. EPA 1991)  
*CW* = chemical concentration in tap water (mg/L, 1 mg/L = 1000 µg/L)  
*IR* = ingestion rate of tap water (L/day)  
*EF* = exposure frequency (days/year)  
*ED* = exposure duration (years)  
*BW* = body weight (kg)  
*AT* = averaging time (period over which exposure is averaged, days)

Studies have shown that inhalation exposure from residential uses of volatile organic compounds may equal to or exceed those of ingestion (Galber 1988). The Arizona Department of Health Services assumed that the use of bromoform-contaminated tap water in home would result in exposure equivalent to an intake of 4.7 L, which accounts for direct ingestion (2L), dermal exposure (1L), and inhalation of bromoform (1.7L) transferred to indoor air (e.g. from showering) (CalEPA 2001). The other values used to estimate the chronic daily intake of bromoform from tap water were based on the values for carcinogens listed in the Arizona Department of Health Services Deterministic Risk Assessment Guidance (ADHS 2003). The estimated excess lifetime cancer risk estimate of 0.000001 or one-in-one million represents the increased risk of developing cancer.

There is a general consensus among the scientific and regulatory communities on what level of estimated excess cancer risk is acceptable. An increased lifetime cancer risk of one-in-one million or less is general considered negligible. According to the U.S. EPA National Contingency Plan and subsequent guidance, an estimate of excess cancer risk between one in a million to less and one in ten thousand is within a range of acceptable risk (USEPA 1990, 1991). Risks greater than one in ten thousand do not necessarily pose a significant cancer risk, but require additional in-depth analysis in order to draw conclusions about potential cancer risk. The estimated cancer risk due to bromoform exposure is within the range of negligible risk and poses no apparent public health hazard to neighborhood residents.

### **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 not be adversely affected by the levels of benzene, MTBE and TTHM found in tap water at the residence.

## Conclusions

The Arizona Department of Health Services has classified the study sites as “No Apparent Public Health Hazard.” This classification is based upon the following:

- Very low levels of benzene, MTBE, and TTHM are present in the tap water samples taken from the residence.
- Exposures to benzene, MTBE, and TTHM are not at levels that are likely to cause adverse health effects, even to children and sensitive populations.
- The site does not pose a public health hazard because exposure concentrations are low.

## Recommendations

The Arizona Department of Health Services does not have any recommendation at this time.

## Public Health Action Plan

The Arizona Department of Health Services will (1) provide area residents with the completed health consultation, and (2) gather community concerns and answer any additional questions that community members have.

## References

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## **Certification**

The Prescott Valley Health Consultation 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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