# Health Consultation

## Exposure Investigation of Private Drinking Water Wells

## Cities: New River, Desert Hills, and Cave Creek
## Maricopa County, Arizona

## March 19, 2004

**Prepared by**

**Arizona Department of Health Services**
**Office of Environmental Health**
**Environmental Health Consultation Services**

**Under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR)**

## Introduction

New River, Desert Hills, and Cave Creek, Arizona is rapidly growing unincorporated rural communities in northern Maricopa County, approximately 50 miles north of downtown Phoenix, Arizona. The estimated population is 30,000. Residents rely almost exclusively on private domestic wells for potable water. Some residents share wells between households. Virtually all residents' well water contains some arsenic, which occurs naturally in rock formations in the New River area as well as the Agua Fria Basin to the North, and the Cave Creek Basin to the East.

In August 2001, a resident of New River contacted the Arizona Department of Health Services (ADHS) Office of Environmental Health to request information on the health risks of arsenic in drinking water. The resident collected two well water samples and submitted them to a private laboratory for arsenic analysis. The analyses detected arsenic at 560 and 600 µg/L. To confirm these very high arsenic results, ADHS staff sampled the well for arsenic and submitted the samples for analysis by the ADHS State Laboratory. Arsenic was detected at 340 µg/L. Staff advised the well owner of potential health effects from this exposure and advised them to discontinue using the water for drinking and cooking. ADHS issued a health consultation through the Agency for Toxic Substances and Disease Registry documenting the advice given to the community member. After that, a large number of people requested health advice on arsenic in their well water. This public health consultation primarily evaluates arsenic levels found in private wells and documents health advice provided to well owners. When other metals were found at levels of concern, health advice was provided to well owners regarding exposure to those metals too.

## Background

Following the discovery of the arsenic levels in the well water, ADHS was concerned about the exclusive reliance of area residents on private wells for their drinking water supply. Initial conversations with the well owner and New River/ Desert Hills Community Association members revealed that many people had concerns about potential health effects from arsenic exposure. Also, many residents had not had their private wells tested. Consequently ADHS

initiated a private well sampling program to determine if arsenic contamination of private wells was a widespread problem in the New River area. An investigation, with sampling limited to 21 wells, was conducted in September and October 2001. The results of that investigation are contained in the Health Consultation dated September 24, 2002 (ADHS, 2002). The results of the Health Consultation were presented to the community at a public meeting in early 2003. Based upon the findings of that document, and the response from the public at the meeting, ADHS determined a wider reaching sampling program was warranted. A second exposure investigation was undertaken beginning in August 2003. This report focuses on the results of the August 2003 investigation.

## Methods

Between August 8 and September 15, 2003, ADHS obtained 83 water samples in the New River, Desert Hills, and Cave Creek areas. A map of the well locations is included in the Appendix. Samples were collected from mostly outside faucets.

Water samples were submitted to the ADHS State Laboratory for analysis of metals as determined by the Safe Drinking Water Act. These metals included arsenic, antimony, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Samples were also analyzed for sulfates, fluoride, bromide, chloride, nitrates, nitrites, and orthophosphates. Additional samples were collected to determine if radioactive decay products, as measured by gross alpha emissions, were present. A total of 13 samples were submitted to the Arizona Radiation Regulatory Agency (ARRA) laboratory for analysis.

Well owners were asked to sign a sampling consent form prior to drawing a water sample. Owners were also asked about any information they had on the depth of the well, depth to water, well casing size, and when the well was installed. Additional information on the wells was obtained from Arizona Department of Water Resources records.

ADHS selected a contaminant for toxicological evaluation if that contaminant was detected in excess of the ATSDR chronic exposure comparison value for children. Comparison values are screening values used to determine whether further investigation of a contaminant is necessary.

Concentrations of contaminants less than the comparison values are unlikely to cause health effects.

## Results

Arsenic, copper, and lead were detected in water samples in excess of the ATSDR chronic exposure comparison value for children. Of the 83 water samples**,** 54 contained arsenic at levels exceeding the comparison value, 24 exceeded the EPA action limit for lead, and 17 exceeded the comparison value for copper. The following table summarizes the analytical results.

**Table 1. Private Well Sampling Results for Metals**

| Chemical | Frequency of Detection | Range (µg/L) | ATSDR Child Comparison Value (µg/L) | Frequency of Detection Above Comparison Value | Contaminant of Concern? |
|---|---|---|---|---|---|
| Antimony | 0/83 | ND | 15* | 0/83 | No |
| **Arsenic** | 54/83 | ND-1800 | 3 | 54/83 | **Yes** |
| Beryllium | 0/83 | ND | 10 | 0/83 | No |
| Cadmium | 1/83 | ND-1 | 2 | 0/83 | No |
| Chromium | 17/83 | ND-61 | 100 | 0/83 | No |
| **Copper** | 78/83 | ND-1700 | 300 | 17/83 | **Yes** |
| **Lead** | 44/83 | ND-510 | ** | 24/83 | **Yes** |
| Mercury | 0/83 | ND | NA | 0/83 | No |
| Nickel | 0/83 | ND | 200 | 0/83 | No |
| Selenium | 0/83 | ND | 50 | 0/83 | No |
| Silver | 0/83 | ND | 50 | 0/83 | No |
| Thallium | 0/83 | ND | 0.5 | 0/83 | No |
| Zinc | 63/83 | ND-1200 | 3000 | 0/83 | No |

*USEPA Region 9 Preliminary Remediation Goal. No ATSDR Comparison Value Available

** USEPA Action level for lead in drinking water is 15 ug/L (micrograms per liter) No ATSDR Comparison Value available

ND= No Detectection

**Table 2. Private Well Sampling Results for Anions**

| Chemical | Frequency of Detection | Range (µg/L) | ATSDR Child Comparison Value (µg/L) | Frequency of Detection Above Comparison Value** | Contaminant of Concern? |
|---|---|---|---|---|---|
| Bromide | 78/79 | ND-1300 | | 0/79 | No |
| Chloride | 79/79 | ND-290,000 | | 0/79 | No |
| Fluoride | 77/79 | ND-12,000 | | 0/79 | No |
| **Nitrate** | 77/79 | ND-38,000 | 20,000 | 1/79 | **Yes** |
| Nitrite | 2/79 | 69- 300 | 1,000 | 0/79 | No |
| Orthophosphate | ND | ND | | 0/79 | No |
| **Sulfate** | 76/79 | ND-640,000 | ** | 1/79 | **Yes** |

µg/L = micrograms per liter

*** 250,000 part per billion based upon USEPA advisory*

**Table 3. Gross Alpha Radioactivity in New River/Desert Hills/Cave Creek**

| Chemical | Frequency of Detection | Range (pCi/L) | Frequency above the ATSDR Minimal Risk Level (5 pCi/L) | Frequency of Detection Above the Maximum Contaminant Level (15 pCi/L) | Contaminant of Concern? |
|---|---|---|---|---|---|
| **Gross Alpha** | 13/13 | 1.3 - 12 | 3/13 | 0/13 | **Yes** |

## Discussion

To evaluate the health effects of exposure to contaminants in specific environmental media, including water, soil, and air, ATSDR has developed a Minimal Risk Level (MRL) comparison value for common chemical contaminants. The MRL is an estimate of daily human exposure to a contaminant below which non-cancerous, adverse health effects are unlikely to occur. MRLs are developed for acute (less than 14 days), intermediate (14 to 365 days), and chronic (greater than 365 days) exposure.

That health guidance values such as MRLs represent a level above which toxicity is likely to occur is a common misconception. The MRL is neither a threshold for toxicity nor a level beyond which toxicity is likely to occur. MRLs are established solely as screening tools to determine whether further evaluation of the contaminant is necessary. Toxicological information used to derive MRLs and to evaluate the likelihood of health effects resulting from exposures to contaminants are contained in documents known as toxicological profiles, published by ATSDR. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status.

When exposure estimates exceed MRLs additional evaluation is necessary to determine whether a health hazard exists. Literature sources are reviewed to determine what exposure doses through different routes of exposure (ingestion, inhalation, or dermal contact) have been documented to actually cause a health problem. The No Observed Adverse Effect Level (NOAEL) is the highest exposure dose at which no effect was observed on the animal or human population in a study. The Lowest Observed Effect Level (LOAEL) for a chemical is the lowest exposure dose at which a measurable adverse health effect is observed in a human or animal study population. Whenever possible, when evaluating possible health effects from exposure to the contaminant, NOAELs and LOAELs from studies in humans are reviewed. If, however, no human studies exist, studies on laboratory animals are reviewed. Also, the health assessor might include safety factors to address human differences when evaluating whether health effects might be possible. The Appendix contains a discussion of potential health effects from chronic oral arsenic exposure.

To quantify exposures, the ADHS made several assumptions regarding dose intake: Adults residing in the area are assumed to drink 2 liters of water per day for 30 years from their private wells. Children are assumed to drink 1 liter of water per day from the well throughout childhood, defined as 0-6 years of age.

Bathing and oral hygiene are not considered to contribute to exposure, as only a negligible amount of the chemicals tested are absorbed through dermal contact with contaminated water (ATSDR, 2000). Likewise, the skin forms a protective barrier against alpha radiation.

**Health Hazard Analysis**

***Arsenic***

ADHS calculated the estimated daily exposure doses of arsenic for each well in which the arsenic concentration exceeded the ATSDR chronic childhood comparison value of 3 µg/L. The range of arsenic exposure from this set of samples reflects the wide range of arsenic groundwater concentrations. Fifty-five of the 83 samples contained detectable concentrations of arsenic exceeding the comparison value. Arsenic was not detected in 28 of 83 samples. The estimated daily dose of arsenic for children ranged from 0.0006 milligrams per kilogram a day (mg/kg-day) at the lowest detected concentration of 10 µg/L to 0.115 mg/kg-day for the sample with 1800 µg/L.

The NOAEL for chronic exposure to arsenic is 0.0004 mg/kg-day (6 µg/L in water). Exposures lower than this level would not be expected to result in adverse health effects in exposed persons. The health effects observed at the LOAEL of 0.015 mg/kg-day (23 µg/L) include reports of fatigue, headache, dizziness and numbness (ATSDR 2000). Health effects at slightly higher doses than the LOAEL include scaling of the skin and slight changes in skin pigmentation (ATSDR 2000). More significant health effects such as significant changes in skin pigmentation (hyperkeratosis), increased blood pressure, kidney problems, and lung problems have been observed at doses in the 0.05 mg/kg-day range (790 µg/L).

To evaluate the potential for adverse health effects, estimated arsenic exposure doses were compared to the chronic MRL, NOAEL, and LOAEL for each category. Table 4 summarizes the results of the sampling information.

**Table 4. Frequency of wells exceeding health standards for Arsenic**

| Category 1 | Category 2 | Category 3 | Category 4 |
|---|---|---|---|
| Frequency less than 10 µg/L | Frequency between 11 µg/L and 50 µg/L | Frequency between 50 µg/L and 780 µg/L | Frequency exceeding 780 µg/L |
| **29/83** | **41/83** | **13/83** | **4/ 83** |

*Category 1 (ND to 10 µg/L)*

No adverse health effects would be expected in children or adults who use water for domestic purposes including drinking water containing arsenic concentrations less than the new USEPA Maximum Contaminant Level of 10 µg/L. Drinking water from these wells would result in exposure doses within the NOAEL range of between 0.0004 mg/kg-day (6 µg/L) and 0.0014 mg/kg-day.

*Category 2 (11 µg/L to 50 µg/L)*

Minor adverse health effects including fatigue, headache, dizziness, and numbness, are possible in children or adults who drink water containing arsenic between 11 µg/L to 50 µg/L. Estimated exposure doses for children range from 0.0007 mg/kg-day (11µg/L) to 0.003 mg/kg-day (50 µg/L). Because of the uncertainty associated with the development of the NOAEL and LOAEL, the Arizona Department of Health Services recommends that persons with arsenic concentrations in this range limit the amount of untreated water that they use for drinking and cooking. Forty-one of the wells had arsenic concentrations from 11 to 50 µg/L. Well owners have been advised of this recommendation.

*Category 3(51 µg/L to 780 µg/L)*

Adverse health effects including fatigue, headache, dizziness and numbness are possible for children or adults who consume water that contains between 50 µg/L and 780 µg/L of arsenic. Using water for domestic purposes including drinking and cooking in this range can result in doses ranging from 0.0032 to 0.049 mg/kg-day. The health effects observed at the LOAEL of 0.005 mg/kg-day include reports of fatigue, headache, dizziness and numbness (ATSDR 2000). Health effects at slightly higher doses than the LOAEL include scaling of the skin and slight changes in skin pigmentation (ATSDR 2000). Arsenic concentrations greater than 78 µg/L (0.005 mg/kg-day) could result in health effects such as significant changes in skin pigmentation

(hyperkeratosis), increased blood pressure, kidney problems, and lung problems. Thirteen wells had arsenic concentrations between 50 and 780 µg/L. ADHS recommends no drinking of water with arsenic concentrations above 50 µg/L.

Well owners in Category 3 have been advised to avoid using untreated water for domestic purposes including drinking and cooking. Using water from Category 3 wells for other domestic purposes such as bathing, personal hygiene, and other domestic purposes does not pose a health threat.

*Category 4 (More than 780 µg/L)*
Adverse health effects including fatigue, headache, dizziness, numbness, changes in skin pigmentation including hyperkerototic warts and precancerous skin lesions, increased blood pressure, kidney problems, and lung problems are possible in children or adults who consume water that contains more than 780 µg/L of arsenic (0.05 mg/kg-day).

Well owners in Category 4 have been advised to avoid using untreated water for domestic purposes including drinking and cooking. Using water from Category 4 wells for other domestic purposes such as bathing, personal hygiene, and other domestic purposes does not pose a health threat.

***Lead***
Lead was detected in 45 of the 83 water samples, with 24 exceeding the EPA recommended level of 15 µg/L. Because of the elevated levels observed in so many of the samples, a second round of samples were taken from 12 of the homes. Of those 12 homes, two were equipped with reverse osmosis filters that are effective in removing lead from the water if they are maintained. Twelve of the homes were not sampled due to the inability to contact the owners on short notice or other scheduling difficulties. No discernible pattern was evident as to the distribution of the homes with the elevated lead levels. The second sample taken from the homes resulted in 7 samples exceeding the standard of 15µg/L.

**Table 5. Frequency of Lead in water samples**

| Frequency of samples with Lead | Frequency of samples with Lead above 15µg/L |
|---|---|
| **45/83** | **24/83** |

Most of the first samples were taken from exterior faucets, which may have resulted in the contamination of the water through lead based solder used during construction. The second samples were taken from actual drinking water sources such as the kitchen faucet if possible. In some of the samples, the second sample was actually higher than the first, but in most cases the second sample results showed lower levels, but still above the EPA action level. Four of the second samples collected were below the EPA action level. Two of those five samples were from homes equipped with reverse osmosis filters, which indicates the filters were working as expected. Six of the 12 had lead levels above the EPA action level of 15 µg/L.

Elevated blood lead levels affect children's mental and physical health. Children under 6 years of age are most sensitive to lead. Lead harms every organ in the body and is particularly harmful to the developing brain and central nervous system of young children. Severe lead poisoning, blood lead levels over 80 micrograms per deciliter (µg/dL), can cause coma, convulsions, and death. Blood lead levels as low as 10 µg/dL cause learning disabilities, lowered intelligence, hearing deficits, and behavior problems.

Symptoms of childhood lead poisoning are general in nature and may include lack of appetite, vomiting, fatigue, and anemia. However, most lead-poisoned children have no symptoms. Elevated blood lead levels can only be determined by blood lead testing.

The EPA has indicated the lead levels in new homes may be elevated for a period of several years, due to the residual lead in solder used to join the copper piping. Water chemistry may also have some effect on the amount of lead leaching from the solder.

Based upon the number of homes testing positive for lead, along with the EPA information on new homes containing some lead in the interior plumbing, the number of homes having elevated

levels does not appear to be unusual. Seven of the homes had levels above the EPA action level, prompting a suggestion to use other drinking water sources as a means to minimize lead exposure. Due to the sporadic follow-up testing of the homes with initial elevated lead levels, an additional 9 homes would also be considered to have water with unhealthful levels of lead. These homes, too, should seek alternative drinking water sources. The water can still be used for all other household uses such as laundry, bathing, plant watering, etc.

All homes with levels greater than the 15 µg/L were notified regarding the hazards associated with the water. In some instances, the water can be thoroughly flushed before use to lower the lead levels. Owners of wells in with elevated lead have been advised to avoid using untreated water for domestic purposes including drinking and cooking. Information on properly flushing the water prior to use has been provided. However, prior to using the water, well owners need to be sure that flushing has the desired results. Using water for other domestic purposes such as bathing, personal hygiene, and other domestic purposes does not pose a health threat. Using water for domestic purposes in the remaining 59 homes poses no health hazard.

***Copper***

Copper is an essential mineral for humans and the Food and Drug Administration recommends the daily intake of 900 micrograms per day. Higher intake rates of copper (> 10mg/day) can result in gastrointestinal disturbances.

The MRL for copper is 0.02 mg/kg-day which is equivalent to drinking water containing 310 µg/L of copper. Fifty-nine wells had copper concentrations up to 310 µg/L. No adverse health effects would be expected in children who drink water containing copper concentrations from 0 to 310 µg/L. Six additional wells had copper concentrations above the MRL (310 µg/L) but below the NOAEL of between 310 and 425 µg/L. Exposures in this range would not be expected to result in any adverse health effects, and all wells containing copper at less than 425 µg/L pose no apparent health hazard. If water is corrosive, then copper plumbing pipes and brass fixtures can corrode and release copper. Most levels of copper from home plumbing ranges from about 20 to 75 µg/L; however, levels have been found at over 1,000 µg/L. Levels are usually highest after the water has sat in the pipes over night. Flushing the water before using it can reduce copper levels if the copper is present because of copper plumbing pipes.

**Table 6. Frequency of exceeding effect levels for Copper**

| Frequency of wells less than the MRL (0.02 mg/kg-day) | Frequency of wells exceeding the MRL, but below the NOAEL (0.02 mg/kg-day to 0.0272 mg/kg-day) | Frequency exceeding the NOAEL, but below the LOAEL (0.0272 mg/kg-day to 0.073 mg/kg-day) | Frequency exceeding the LOAEL (0.0731 mg/kg-day) |
|---|---|---|---|
| **59/83** | **6/83** | **10/83** | **1/83** |

The NOAEL for copper is 0.0272 mg/kg-day (425 µg/L). The LOAEL for copper is 0.0731 mg/kg-day (1145 µg/L). Ten wells had copper concentrations exceeding 425 µg/L and less than 1145 µg/L, and no adverse health effects would be expected from drinking this water.

The LOAEL for copper is 0.0731 mg/kg-day. Gastrointestinal disturbances are associated with drinking water with more than 1145 µg/L of copper. Children drinking water with copper concentrations greater than 1145 µg/L, would receive a dose equivalent to the LOAEL. One well had copper concentrations higher than 1145 µg/L. This well owner has been advised to avoid using untreated water for domestic purposes including drinking and cooking. If copper plumbing is in the home, the owner might consider testing the water after flushing it thoroughly. Using water for other domestic purposes such as bathing, personal hygiene, and other domestic purposes does not pose a health threat

***Anions***

Water samples were also tested for anions including bromide, chloride, fluoride, nitrates, nitrates, phosphorous, and sulfates. One well exceeded the MCL for nitrates, and at levels that could cause problems in infants. No health problems have been found at levels at or below the MCL, but at least one report of blue baby syndrom was reported in a baby whose formula was mixed with water containing a little over 13,000 µg/L. Using this water for drinking water purposes may result in gastrointestinal distress, and could result in exposure to nitrate that could be unhealthy for children less than 1 year old. The ADHS recommends limiting the use of this

water for drinking water purposes and specifically recommended that it nor be used to make infant formula. This well owner has been advised to limit the use of this water for drinking.

One well exceeded the guideline of 250,000 µg/L for sulfates, using this water for drinking water may result in gastrointestinal distress, which has been reported in people drinking water containing 500,000 µg/L. ADHS recommends limiting the use of this water for drinking water purposes. This well owner has been advised to limit the use of this water for drinking.

***Radionucleides***

Water can contain naturally occurring radiological materials that have dissolved from soil and rocks. If groundwater is used as a primary drinking water source it is possible that radiological contaminants could be present in drinking water. Most radiological contaminants in groundwater decay when the nucleus of the chemical emits a subatomic particle called an alpha particle. The radiation from this process can be measured and reported as Gross Alpha Radioactivity. Some radioactive materials decay by emission of beta particles, gamma rays or photons, but they usually have an associated alpha particle emission as well. A measure of Gross Alpha Radioactivity is a good screening tool for measuring the amount of radio-chemicals in drinking water for these reasons.

The USEPA has established a Maximum Contaminant Level (MCL) for Gross Alpha Radioactivity in water of 15 pico-Curies per liter of water (pCi/L). The MCL for the radium species part of the Gross Alpha Radioactivity is 5 pCi/L. Likewise, the Agency for Toxic Substances and Disease Registry Minimal Risk Level is 5 pCi/L.

**Table 7. Frequency of measurable gross alpha**

| **Frequency of Measurable Gross Alpha** | **Frequency Exceeding the Minimum Risk Level** (5pCi/L) | **Frequency Exceeding the EPA Maximum Contaminant Level** (15pCi/L) |
|---|---|---|
| 13/13 | 3/13 | 0/13 |

The majority of measured Gross Alpha Radioactivity Levels in the wells are less than the Minimum Risk Levels (5pCi/L) and all are below USEPA Maximum Contaminant Level of 15 pCi/L. Lifetime exposure to the range of radioactivity in the water in New River/Desert Hills/Cave Creek area represents an additional theoretical cancer risk of three in one hundred thousand, nor do these chemicals pose a non-cancer health threat, suggesting that radio-chemicals in the water are not a cause for concern in the wells tested.

## Child Health Considerations

All exposure dose estimates were calculated assuming childhood exposure, thus incorporating exposure assumptions that reflect a child's greater intake of water relative to body weight. All conclusions and recommendations about using water from these wells were based on this sensitive population. Of all the metals found at elevated levels, lead is of most concern for children because it can affect a child's developing brain and central nervous system. Exposure to lead in drinking water can be reduced or eliminated. Nitrate exposure is also of particular concern for infants. It can cause a condition called blue baby syndrome or methemoglobanemia, a condition in which blood lacks the ability to carry sufficient oxygen to individual cells throughout the body.

## Conclusions

- Twenty-nine (29) of the 83 wells pose no health hazard when used for domestic purposes including drinking and cooking.

- Fifty eight (58) of the 83 wells (70%) pose a **health hazard for children and adults** if the water is used for drinking or cooking because of the presence of arsenic at levels above the pending MCL of 10 µg/L. Prudent public health practices suggest that drinking water with those levels of arsenic should be minimized. Using water from these wells for personal and household hygiene poses no health hazard.

- Seventeen (17) of the 54 wells have very high concentrations of arsenic in the water. These wells pose a **serious health threat** for children and adults if the water is used for drinking and cooking. Water from these wells might cause more health effects, such as diarrhea, nausea, changes in skin pigmentation, and growth of corns or warts on palms,

soles of feet, and torso. Using water from these wells for personal and household hygiene poses no health hazard.

- **Lead** present in the water, from unidentified sources, was above the EPA action level of 15µg/L in 24 of the 83 wells (29%). All lead exposure should be minimized and eliminated when possible because of its toxicity, especially in children. Using water from these wells for personal and household hygiene poses no health hazard.

- **Copper** was present in 1 well at a concentration high enough to cause gastrointestinal disturbances if the water is used for drinking water purposes. Using water from this well for personal and household hygiene poses no health hazard.

- **Sulfates** were present in 1 well at a concentration high enough to cause gastrointestinal disturbances if used for drinking water purposes. Using water from this well for personal and household hygiene poses no health hazard.

- **Nitrates** were present in 1 well at a concentration high enough to cause gastrointestinal disturbances and may pose a **health hazard** if used for making infant formula. Using water from this well for personal and household hygiene poses no health hazard. People with infants can reduce the possibility of exposing their children to harmful nitrate levels by testing their well water before using the water for drinking or mixing formula.

- All of the wells tested pose **no apparent health hazard** if the water is used only for bathing, washing dishes, tooth brushing and general sanitary purposes.

- Other private wells in the area were not tested. Some of these wells could contain contaminants at levels that might cause adverse health effects.

## Recommendations

- Residents of homes whose drinking water is supplied from wells with arsenic greater than 10 µg/L should either install a treatment system that effectively removes arsenic, find an alternative source of drinking water, or use bottled water for drinking and cooking. If well water contained other metals or nitrates at levels high enough to cause health effects, similar precautions should be considered. Thoroughly flushing water lines before use might effectively reduce levels of some metals.

- All residents in the New River/Cave Creek/Desert Hills area who use well water for drinking or beverage preparation should test their well water for arsenic and lead.

- All wells should be tested yearly for bacteriological and nitrate contamination from septic systems.

## Public Health Action Plan

- ADHS has previously notified well owners whose wells were determined to be a health hazard in this study.

- ADHS will present the findings of this investigation at a 2004 New River/ Desert Hills Community Association meeting.

- ADHS will work with the Arizona Department of Water Resources to notify private well owners in the New River/ Desert Hills area and recommend having their well water tested for arsenic.

- ADHS will provide information to any community member or health care provider regarding arsenic exposure and health effects.

**References**

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## Certification

This Exposure Investigation of Private Drinking Water Wells, New River, Arizona, was prepared by the Arizona Department of Health Services under cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the exposure investigation report was begun.

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Technical Project Officer
CAT, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this exposure investigation report and concurs with the findings.

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Team Leader-Cooperative Agreement Program
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## Appendix

1. Health effects from chronic arsenic ingestion.
2. Arsenic exposure dose equations
3. Sampling Consent Form

## Health Effects from Chronic Arsenic Ingestion

One of the most common effects of both acute and long-term arsenic ingestion is a pattern of skin changes, including changes in skin pigmentation (hyperpigmentation, interspersed with small areas of hypopigmentation of the face, neck, and back), generalized hyperkeratosis, or thickening of the skin, and formation of hyperkeratotic warts on the palms and soles. These effects are most often reported at chronic dose levels ranging from about 0.01 to 0.1 mg/kg-day.

Human studies document gastrointestinal irritation from chronic oral exposure to arsenic at dose levels of about 0.01 mg/kg-day and above. Symptoms include nausea, diarrhea, and vomiting. Damage to the liver and elevated levels of hepatic enzymes are reported at dose levels of 0.01 to 0.01 mg/kg-day. Hematological effects, including anemia and, have been documented at chronic oral exposures of 0.05 mg/kg-day and above. Neurological effects are reported at chronic oral doses of 0.03-0.01 mg/kg-day, including peripheral neuropathy and numbness in hands and feet, possibly developing into a painful “pins and needles” sensation.

Cardiovascular effects include cardiac arrhythmia and myocardial depolarization. A serious vascular condition called Blackfoot disease is endemic in an area of Taiwan where residents are exposed to arsenic in drinking water from about 0.014-0.065 mg/kg-day. Studies in Chile report indicate that consumption of drinking water doses of 0.02-0.06 mg/kg-day increases in the incidence of Raynaud’s disease and cyanosis of the fingers and toes (ATSDR 2000).

Arsenic has been classified as a human carcinogen by the U.S. Environmental Protection Agency (USEPA), the National Toxicology Program (NTP), and the International Agency for Research on Cancer (IARC). Reports indicate that arsenic in drinking water increases the risk of skin, liver, bladder, kidney, lung, and prostate cancer. Studies suggest that cancer effects might occur following long-term exposure (ATSDR 2000).

## Exposure Dose Equations

ADHS used the ATSDR exposure assessment documents to calculate an exposure dose for persons living in the New River area. The doses were calculated using the following equations:

***Ingestion of chemicals in water:***

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

CDI: chronic daily intake (mg/kg-day)

CW: concentration in water (mg/L)

IR: intake rate (L/day)

EF: exposure frequency (days/yr)

ED: exposure duration (yrs)

BW: body weight (kg)

AT: Averaging time (days)

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| Variable Assumptions | Adults | Children |
|---|---|---|
| IR (ingestion, water): | 2 | 1 |
| EF: | 350 | 350 |
| ED: | 30 | 6 |
| BW: | 70 | 15 |
| AT: | 10950 | 2190 |

Water Intake Rate for Tooth brushing

Fluoride concentration: 1 mg/ ml water*

Estimated fluoride ingestion: 0.3 mg/ brushing*

Estimated water intake: 0.3 ml/ brushing x 2 brushings = 0.6ml/day

Barnhart et al. 1974

# Consent Form for Water Sampling
# New River/Cave creek area

We would like to invite you to help in a study to find out if you have been exposed to arsenic. The Arizona Department of Health Services (ADHS) is offering free well water testing. Testing is free for residents living in the areas with high arsenic levels in water. By joining in this testing you will know the amount of arsenic or other materials in your well. This will help ADHS to determine if any help is needed. The time it will take for ADHS to do the testing will about 30 minutes.

Benefits

I understand that I will benefit by learning if there is arsenic or other materials in my well water. If high levels of arsenic or other materials are found in my well water, I will receive information on how to reduce exposure.

Risks

There are no risks in joining in the testing portion of this study.

Procedure/Tests:

A member of ADHS will take water samples from the faucet that I choose.

Participation

I understand that my giving a water sample is not required. Giving any information is voluntary and even if I agree to participate and sign this form, I can stop at any time. I understand that I must sign this form to have my water tested.

Results

I understand every effort will be made to send the results of my tests in writing to me within 2 months. Results that are of importance will be reported to me as soon as they are available.

Confidentiality

All personal information will be protected by law. Any reports will give only group information and not identify individuals. I understand that if I have my water tested, any forms with my name or address will be kept locked in cabinets at ADHS. Test results may be shared with other federal, state, and local public health and environmental agencies. These agencies must also protect this confidential information.

Contact

If I have any additional questions or if I feel I have been harmed by this investigation or the testing, I may contact: Brian Hasty of ADHS at (602) 230 5801

**Consent**

The risks and benefits of this investigation have been explained to me. All of my questions have been answered. I give my signed consent for participating in the testing described above.

I, (print)_____, agree to have my well water sampled for arsenic and other materials.

Signature: _____

Date: _____

Address: _____
**Street**

_____
City State Zip code

Phone #: _____

**Witness:** _____ _____
**(Print name)** **(Signature)**