Health Consultation

Exposure Investigation of Private Drinking Water Wells

New River, Maricopa County, Arizona

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)

Background

New River, Arizona is a rapidly growing but still predominately rural community in northern Maricopa County—approximately 20 miles north of Phoenix, Arizona. The 2000 census estimated a population of 10,740. Residents rely exclusively on private domestic wells for potable water. Some residents share wells between households. All residents' well water contains some arsenic, which occurs naturally in rock formations in New River area as well as the Agua Fria Basin and the Verde River Basin areas to the north.

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 discontinuance of domestic well water use.

ADHS determined that the health risk posed by arsenic levels in this range and the exclusive reliance of area residents on private wells warranted further investigation. Initial conversations with the well owner and New River/ Desert Hills Community Association members revealed 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.

The objective of this public health consultation is to evaluate the potential health effects from exposure to arsenic in private drinking water wells in the New River, Arizona area.

Methods

On October 7, 2001, in a presentation to the New River / Desert Hills Community Association by ADHS staff, community members were informed of the detection of elevated arsenic levels in a local well. They were also offered free arsenic testing of their drinking water wells. Nearly all attendees requested that their wells be sampled. ADHS provided to the attendees fliers describing the sampling program, and asked that they distribute the fliers throughout the community.

Between October and December 2001 ADHS sampled a total of 21 private wells in the New River area. A map of the well locations is included in the Appendix. Samples were submitted to the ADHS State Laboratory for arsenic analysis, as well as for analyses for antimony, barium, beryllium, cadmium, chromium, selenium, thallium, and nickel. The additional metals were selected due to their common occurrence in ore deposits in mineralized areas.

ADHS selected a chemical for further toxicological evaluation if that chemical 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 chemicals less than the comparison values are unlikely to cause health effects.

Results

Arsenic was the only chemical detected in any well in excess of the ATSDR chronic exposure comparison value for children. Of the 21 wells sampled, 16 contained arsenic at levels exceeding the comparison value. The following table summarizes the analytical results.

Table 1. Private Well Sampling Results

Chemical	Frequency of Detection	Range (µg/L)	ATSDR Child Comparison Value (µg/L)	Frequency of Detection Above Comparison Value	Contaminant of Concern?
Antimony	0/21	-	15*	0/21	No
Arsenic	16/21	ND-580	3	16/21	**Yes**
Barium	0/21	-	700	0/21	No
Beryllium	0/21	-	10	0/21	No
Cadmium	0/21	-	2	0/21	No
Chromium	3/21	ND-98	100	0/21	No
Selenium	0/21	-	50	0/21	No
Thallium	0/21	-	0.5	0/21	No
Nickel	0/21	-	200	0/21	No

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

Discussion

Exposure Quantification

To quantify exposures, 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.

Also, adults and children are assumed to ingest 0.6 ml of water daily from brushing their teeth twice a day (Barnhart et al.1974). Bathing was not considered to contribute to exposure, as only a negligible amount of arsenic is absorbed through dermal contact with contaminated water (ATSDR 2000). The dose calculations assume an adult body weight of 70 kilograms (kg) and a child bodyweight of 15 kg. The exposure variables and equations used to determine exposure can be found in the Appendix.

Exposure Analysis

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 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.

Private Well Health Hazard Analysis

ADHS calculated the estimated daily exposure doses of arsenic for each well in which the arsenic concentration exceeded the ATSDR chronic childhood comparison value, as displayed in Table 2. Sixteen of 21 wells sampled contained arsenic levels exceeding the comparison value. Arsenic was not detected in the other five wells. To evaluate the potential for adverse health effects, estimated arsenic exposure doses were compared to the chronic MRL, NOAEL, and LOAEL. Both cancer and non-cancer health effects were evaluated. Fourteen of the 16 wells contained arsenic at a concentration that might cause an adverse health effect in children. Five of the 16 wells contained arsenic at a concentration that might cause an adverse health effect in adults. No geographic pattern was evident in the locations of the wells with elevated arsenic levels.

Table 2. Well Arsenic Dose Estimates and Comparison Values

Well Number	Child's Estimated Daily Dose (mg/kg/day)	Child Dose Exceeds MRL?	Child Dose Exceeds NOAEL?	Child Dose Exceeds LOAEL?
1	0.0013	**Yes**	**Yes**	No
2	0.0015	**Yes**	**Yes**	No
3	0.0020	**Yes**	**Yes**	No
4	0.0021	**Yes**	**Yes**	No
5	0.0019	**Yes**	**Yes**	No
6	0.0073	**Yes**	**Yes**	**Yes**
7	0.0035	**Yes**	**Yes**	No
8	0.0016	**Yes**	**Yes**	No
11	0.0008	**Yes**	No	No
13	0.0011	**Yes**	**Yes**	No
15	0.0227	**Yes**	**Yes**	**Yes**
16	0.0387	**Yes**	**Yes**	**Yes**
17	0.0013	**Yes**	**Yes**	No
18	0.0011	**Yes**	**Yes**	No
19	0.0007	**Yes**	No	No
20	0.0041	**Yes**	**Yes**	No

Arsenic Health Effect Thresholds

The NOAEL range for chronic exposure to arsenic ranges from 0.0004 to 0.0009 mg/kg/day. Exposures in this range would not be expected to result in adverse health effects in exposed persons. Health effects from exposure to arsenic have been observed at doses as low as 0.005 mg/kg/day. The health effects observed at the LOAEL include reports of fatigue, headache, dizziness and numbness (ATSDR 2000). Health effects at slightly higher doses than the LOAEL (0.0015 mg/kg/day) 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.

Well 1

The estimated arsenic exposure dose for children of 0.0013 mg/kg/day exceeds the MRL (0.0003 mg/kg/day) and the NOAEL range (0.0004 to 0.0009 mg/kg/day). The dose is only 4 times lower than the LOAEL (0.005 mg/kg/day), ~~. This~~ suggest~~ings~~ that exposure to arsenic from this well might cause subtle health effects in children, such as fatigue, numbness or changes in skin pigmentation.

The estimated adult exposure dose of 0.0005 is within the NOAEL range, and is 10 times lower than the LOAEL, suggesting that arsenic in this well should not pose even a non-cancer health hazard to adults.

The arsenic concentration in Well 1 was 19 µg/L; lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 19 µg/L would pose a cancer risk of less than 1 in 3,000.

As a precaution, ADHS recommends that due to elevated arsenic levels, this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 2

The estimated child exposure dose of 0.0015 mg/kg/day exceeds the NOAEL range and is only 3 times lower than the LOAEL, suggesting that exposure to arsenic from this well might cause subtle health effects in children, such ~~as~~ as fatigue, numbness or changes in skin pigmentation. The estimated exposure dose for adults of 0.0006 mg/kg/day is within the NOAEL range and is almost 10 times lower than the LOAEL, suggesting that arsenic in this well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 2 was 23 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 23 µg/L in drinking water would pose a cancer risk of less than 1 in 3,000.

As a precaution, ADHS recommends that this well not be used for drinking water, cooking, or preparing items such as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 3

The estimated child exposure dose of 0.002 mg/kg/day is close to the LOAEL of 0.005 mg/kg/day, suggesting that exposure to arsenic from this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure dose of 0.0008 mg/kg/day is within the NOAEL range and is more than 6 times lower than the LOAEL, suggesting that to adults, arsenic in this well should not even pose a non-cancer health hazard.

The arsenic concentration in Well 3 was 30 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 30 µg/L in drinking water would pose a cancer risk of less than 1 in 2,000.

As a precaution, ADHS recommends that this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 4
The estimated child exposure dose of 0.0021 mg/kg /day is close to the LOAEL of 0.005 mg/kg/day, suggesting that arsenic in this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure dose of 0.0009 mg/kg/day is equivalent to the highest NOAEL~~. and is 6 times lower than the LOAEL.~~ This suggests that arsenic in this well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 4 was 32 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 32 µg/L in drinking water would pose a cancer risk of less than 1 in 2,000.

As a precaution, ADHS recommends that this well not be used for drinking water, cooking, or preparing items such as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 5
The estimated child exposure dose of 0.0019 mg/kg/day is close to the LOAEL of 0.005 mg/kg/day. This suggests that exposure to arsenic from this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure dose of 0.0008 mg/kg/day is within the NOAEL range ~~and is more than 6 times lower than the LOAEL,~~ suggesting that ~~to adults,~~ arsenic in this well should not even pose a non-cancer health hazard.

The arsenic concentration in Well 5 was 29 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 29 µg/L in drinking water would pose a cancer risk of less than 1 in 2,000.

As a precaution, ADHS recommends that this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 6
The estimated child exposure dose of 0.0073 mg/kg/day exceeds the LOAEL, suggesting that arsenic in the well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin texture and pigmentation. An adult's estimated exposure dose of 0.0031 is close to the LOAEL, suggesting that arsenic in the well might also cause health effects in adults, such as fatigue, numbness, or changes in skin pigmentation and texture.

The arsenic concentration in Well 6 was 110 µg/L—higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 110 µg/L in drinking water presents a cancer risk of approximately 1 in 500.

ADHS recommends that this well not be used for drinking water, cooking, or preparing items such as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 7
The estimated child exposure dose of 0.0035 is close to the LOAEL, suggesting that arsenic in the well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The adult estimated exposure dose of 0.0015 exceeds the NOAEL range and is only 3 times lower than the LOAEL, suggesting that arsenic in the well might also cause health effects in adults, such as changes in skin pigmentation and texture.

Arsenic was detected in Well 7 at 53 µg/L—higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 53 µg/L in drinking water presents a cancer risk of approximately 1 in 1,000.

ADHS recommends that this well not be used for drinking water, cooking, or preparing items such as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 8
The estimated child exposure dose of 0.0016 exceeds the NOAEL range, and is only 3 times lower than the LOAEL, suggesting that arsenic in the well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The adult estimated exposure dose of 0.0007 is in the NOAEL range, and is almost 10 times lower than the LOAEL, suggesting that arsenic in the well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 8 was 24 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 24 µg/L in drinking water would pose a cancer risk of less than 1 in 2,000.

As a precaution, ADHS recommends that this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water, such as bathing and brushing teeth, pose no apparent health hazard.

Well 9
No arsenic was detected in this well, so use of the water poses no apparent health hazard.

Well 10
No arsenic was detected in this well, so use of the water poses no apparent health hazard.

Well 11
The estimated child exposure dose of 0.0008 is within the NOAEL range, and is more than 6 times lower than the LOAEL, suggesting that arsenic in the well should not pose a non-cancer health hazard to children. The adult estimated exposure dose of 0.0003 is lower than the NOAEL and is 17 times lower than the LOAEL, suggesting that arsenic in the well does not present a non-cancer health hazard for adults.

The arsenic concentration in Well 11 was 12 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 12 µg/L in drinking water would pose a cancer risk of less than 1 in 5,000.

This well poses no apparent health hazard.

Well 12
No arsenic was detected in this well, so use of the water poses no apparent health hazard.

Well 13
The estimated child exposure dose of 0.0011 mg/kg/day exceeds the NOAEL range and is slightly ~~only 4 times~~ lower than the LOAEL. This suggests that arsenic in this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult dose of 0.0005 is within the NOAEL range, and is 10 times lower than the LOAEL. This suggests that arsenic in this well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 13 was 17 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 17 µg/L would pose a cancer risk of less than 1 in 3,000.

As a precaution, ADHS recommends that due to elevated arsenic levels this well not be used for drinking water, cooking, or preparing items such as infant formula. Other residential uses of the water such as bathing and brushing teeth pose no apparent health hazard.

Well 14
No arsenic was detected in this well, so use of the water poses no apparent health hazard.

Well 15
The estimated child exposure dose of 0.0227 is over 4 times higher than the LOAEL, indicating that arsenic in this well might cause health effects in children, such as diarrhea, nausea, changes in skin pigmentation, and growth of corns or warts on palms, soles of feet, and torso. The estimated adult exposure dose of 0.0097 exceeds the LOAEL, indicating that arsenic in the well might cause health effects in adults, such as diarrhea, nausea, changes in skin pigmentation, and growth of corns or warts on palms, soles of feet, and torso.

The arsenic concentration in Well 15 was 340 µg/L—much higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure to arsenic in drinking water at 340 µg/L would pose a cancer risk of approximately 1 in 200.

If any family members are experiencing symptoms that they believe might be related to arsenic exposure, they should see their health care provider.

ADHS recommends that due to elevated arsenic levels this well not be used for drinking water, cooking, or preparing any food items, including infant formula. Other residential uses of the water, such as bathing and brushing teeth pose no apparent health hazard.

Well 16
The estimated child exposure dose of 0.0387 mg/kg/day is nearly 8 times higher than the LOAEL, indicating that arsenic in this well might cause health effects in children, such as diarrhea, nausea, changes in skin pigmentation, and growth of corns or warts on palms, soles of feet, and torso. The adult estimated exposure dose of 0.0166 is more than 3 times higher than the LOAEL, indicating that arsenic in this well might cause health effects in adults, such as diarrhea, nausea, changes in skin pigmentation, and growth of corns or warts on palms, soles of feet, and torso.

The arsenic concentration in Well 16 was 580 µg/L— much higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure to arsenic in drinking water at 580 µg/L would pose a cancer risk of approximately 1 in 100.

If any family members are experiencing symptoms that they believe might be related to arsenic exposure, they should see their health care provider.

ADHS recommends that due to elevated arsenic levels this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water, such as bathing and brushing teeth pose no apparent health hazard.

Well 17
The estimated child exposure dose of 0.0013 mg/kg/day exceeds the NOAEL range and is only 4 times lower than the LOAEL, suggesting that arsenic in this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure dose of 0.0006 mg/kg/day is within the NOAEL range and is almost 10 times lower than the LOAEL, suggesting that that arsenic in this well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 17 was 20 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 20 µg/L would pose a cancer risk of less than 1 in 3,000.

As a precaution, ADHS recommends that due to elevated arsenic levels this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water, such as bathing and brushing teeth, pose no apparent health hazard.

Well 18
The estimated child exposure dose of 0.0011 mg/kg/day exceeds the NOAEL range and is only 4 times lower than the LOAEL, suggesting that arsenic in this well water might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure dose of 0.0005 mg/kg/day is within the NOAEL range and is 10 times lower than the LOAEL, suggesting that arsenic in the well should not pose a non-cancer health hazard to adults.

The arsenic concentration in Well 18 was 16 µg/L—lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 16 µg/L would pose a cancer risk of less than 1 in 3,000.

As a precaution, ADHS recommends that due to elevated arsenic levels this well not be used for drinking water, cooking, or preparing such items as infant formula. Other residential uses of the water, such as bathing and brushing teeth, pose no apparent health hazard.

Well 19

The estimated child exposure dose of 0.0007 mg/kg/day is within the NOAEL range and is almost 10 times lower than the LOAEL, suggesting that this well should not pose a non-cancer health hazard to children. The estimated adult arsenic dose of 0.0003 is below the NOAEL, and is 16 times lower than the LOAEL, indicating that arsenic in this well should not pose a non-cancer health threat to adults.

Arsenic was detected in Well 19 at 11 µg/L—lower than the current drinking water standard of 50 µg/L, but just higher than the 2006 standard of 10 µg/L**.** Lifetime exposure to arsenic at 11 µg/L in drinking water presents a cancer risk of less than 1 in 5,000.

This well poses no apparent health hazard.

Well 20

The estimated child exposure dose of 0.0041 mg/kg/day is close to the LOAEL, suggesting that arsenic in this well might cause subtle health effects in children, such as fatigue, numbness, or changes in skin pigmentation. The estimated adult exposure of 0.0017 mg/kg/day exceeds the NOAEL range and is only 3 times lower than the LOAEL, suggesting that arsenic in the well might also cause subtle health effects in adults, such as fatigue, numbness, or changes in skin pigmentation.

Arsenic was detected in Well 20 at 62 µg/L—higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure to arsenic at 62 µg/L in drinking water presents a cancer risk of less than 1 in 1,000.

ADHS recommends that this well not be used for drinking water, cooking, or preparing beverages, including infant formula. Other residential uses of the water, such as bathing and brushing teeth, present no apparent health hazard.

Well 21

No arsenic was detected in this well, so use of the water poses no apparent health hazard.

Child Health Initiative

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.

Conclusions

- Seven of the 21 wells (9-12, 14, 19, and 21) pose **no apparent health hazard**.

? Fourteen of the wells (1-8, 13, 15-18 and 20) pose a **health hazard for children** if the water is used for drinking; arsenic is present in the water at levels that might cause subtle adverse health effects in children, such as fatigue, numbness, or changes in skin pigmentation.

- Five of the wells (6, 7, 15, 16, and 20) pose a **health hazard for children and adults** if the water is used for drinking; arsenic is present in the water at levels that might cause adverse health effects in adults such as fatigue, numbness, or changes in skin pigmentation.

- Two of the wells (15 and 16) have very high concentrations of arsenic in the water. These wells pose a health hazard for children and adults if the water is used for drinking. 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.

- 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 1-8, 13, 15-18, and 20 should either install a treatment system that effectively removes arsenic or find an alternative source of drinking water.

- All residents in the New River area who use well water for drinking or beverage preparation should test their well water for arsenic.

Public Health Action Plan

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

- ADHS will offer to present the findings of this investigation at a 2002 New River/ Desert Hills Community Association meeting.

- ADHS will mail a letter to all registered private well owners in the New River/ Desert Hills area, including investigation findings and a recommendation to have their well water tested for arsenic. The mailing will be completed by September 2002.

- If any community member would like their health care provider to have additional information on arsenic exposure and health effects, ADHS will provide that information.

References

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Appendix

1. Map showing locations of sampled wells.
2. Health effects from chronic arsenic ingestion.
3. Arsenic exposure dose equations.

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:

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

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)

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