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ARIZONA DRINKING WATER WELL CONTAMINANTS

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> *If you own a well in Arizona, you have the sole responsibility for checking to see if your drinking water is contaminated. Arizona state law does not require private well owners to test or treat their water for purity.*

The most common contaminants found in Arizona groundwater in concentrations above health-based drinking water standards are arsenic, fluoride, radioactive elements (responsible for gross alpha radiation), and nitrate. Nitrate contamination, although it can be natural, is usually due to either agricultural practices (excessive fertilizer use and/or poor irrigation practices), or failing septic systems that allow contaminated waters to drain into the aquifer. Naturally occurring groundwater contaminants are dependent on aquifer geology and are discussed below.

Geologic forces have influenced the quality of water held within Arizona aquifers. The groundwater basins in the geologic past included river drainage systems that could not reach the sea, generating large inland lakes—such as the Great Salt Lake in Utah—that concentrated the salts as water evaporated. Large deposits of salt[1] are common across the state. These natural deposits are often associated with elevated groundwater concentrations of sodium, chloride, calcium, magnesium, sulfates, and carbonates.

In the Gila River Valley, deep petroleum exploration boreholes were drilled during the early 1900's through the thick layers of gypsum and salty clay found throughout the valley. Although oil was not found, salt brines are now discharging to the land surface through improperly sealed abandoned boreholes, and the local water quality has been degraded.

Figure 1 shows those portions of the state where groundwater has been reported to be saline, either due to deep layers of salt originating from geologic deposition or due to agricultural practices where evaporation of irrigation water concentrates naturally occurring salts.

Arsenic

Three significant geologic sources of arsenic are found in Arizona, and because of this elevated concentrations of arsenic occur in groundwater across the state. Regions of granite bedrock with valuable gold ore often contain elevated concentrations of arsenic. Gold prospectors have found new mine sites by measuring the concentration of arsenic in rivers and streams, using arsenic as a pathfinder as they move upstream following greater and greater concentrations of arsenic until the source is found – and gold is discovered. In addition, aquifers consisting of alluvium eroded from granite bedrock may also contain arsenic.

Major Aquifers and High Salinity Areas

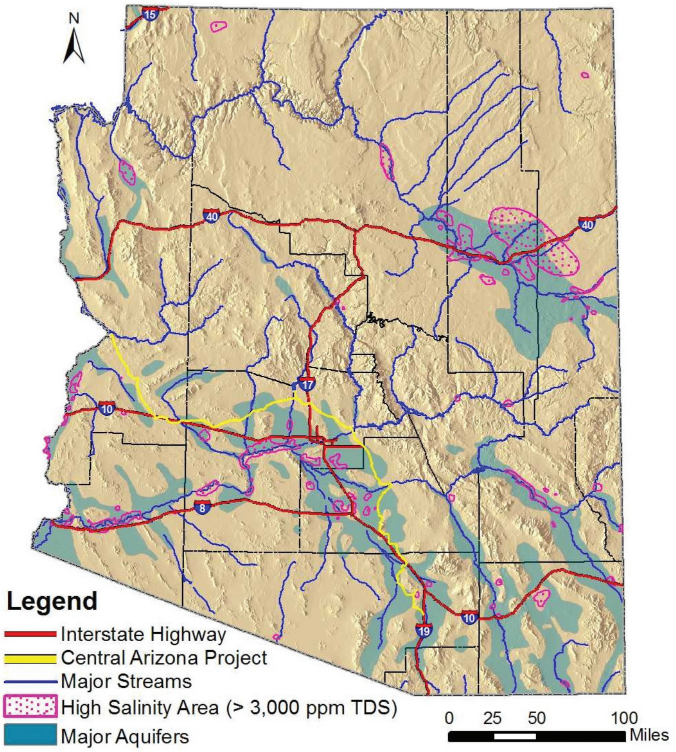

Figure 1. Major aquifers and regions of saline groundwater (modified from WRRC, 2002)

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[1] Salt deposits consist of common 'table' salt (sodium chloride), but can also contain gypsum (a calcium sulfate mineral), calcite (a calcium carbonate mineral), and other minerals.

The Colorado Plateau of northern Arizona and southern Utah consists of layers of ancient sedimentary rock that can be seen exposed in the cliffs of the Grand Canyon. Many water supply wells on the Colorado Plateau tap these formations. Arsenic, various metals, and uranium were deposited and concentrated within these sediments (Kenny, 2003). Wells constructed within the Supai Sandstone in the Colorado Plateau have elevated levels of dissolved arsenic in the groundwater, as well as uranium and other radioactive elements.

The arsenic-rich Supai Sandstone formation was eroded and re-deposited over the past 2 to 5 million years into the Verde Alluvium Formation, which now forms the aquifer of the Big Chino and Verde Valley. The highest concentration of arsenic in groundwater in Arizona was found near Paulden in the Verde Valley, with a concentration of 2,900 parts per billion in a private, domestic well. The Environmental Protection Agency (EPA) drinking water Maximum Contaminant Level (MCL) for arsenic is 0.010 mg/L, or 10 parts-per-billion. For more information about arsenic in Arizona groundwater see *Arsenic in Arizona Ground Water—Source and Transport Characteristics,* **http://cals.arizona.edu/pubs/water/az1453.pdf.**

Radioactive Elements

In Arizona, the most common source of radioactivity is dissolved uranium and dissolved radon gas. Uranium mines are found throughout the Supai Sandstone Formation (Kenny, 2003) in northeast Arizona. The water from wells within the Supai Sandstone in the Colorado Plateau show elevated concentrations of uranium, sometimes exceeding the MCL of 0.030 mg/L or 30 parts-per-billion.

Radioactive elements are unstable and break down (decay) releasing energy particles. For example, uranium eventually becomes a new element called radium, which then decays to the element radon. Radon is strongly radioactive as it emits high energy alpha particles. Unfortunately, the radon element is an odorless, colorless, tasteless gas that dissolves in groundwater and may migrate upward though the soil or your well borehole, eventually dissipating into the atmosphere. If radon gas is trapped within a structure, such as a basement or shed, the concentration of radon gas within the closed structure may exceed health standards. The EPA estimates that 1 in 15 U.S. homes contains a high level of the gas and it is considered to be the second leading cause of lung cancer in the country (**epa.gov/rado/radontest.html**).

'Gross alpha' is an indicator of radioactivity in water whether it is due to the decay of uranium, radium, or radon, and is a gross measurement of the amount of overall radioactivity. 'Gross alpha' is a common naturally occurring "contaminant" in Arizona bedrock aquifers.

Fluoride and other Constituents

Fluoride is a common mineral that is concentrated in volcanic materials, and mineral particles that contain fluoride are common in some sedimentary rocks. In Arizona, the highest fluoride concentrations are found in Cochise County (Hem, 1985); Mohave, Graham, and Greenlee Counties (ADEQ, 2005); and along the lower Gila River in Yuma County. Although fluoride at high concentrations may be harmful, it is essential for strong teeth and bones; many municipal water supply systems add fluoride to the water in a process called fluoridation. Excessive concentrations in drinking water results in tooth mottling and discoloration. The MCL for fluoride is 4.0 mg/L.

Elevated levels of other naturally occurring constituents have been found in wells across Arizona. For example, naturally occurring hexavalent chromium (CrVI), known to cause cancer, has been found in Paradise Valley north of Phoenix and in the Detrital Valley near Kingman (Robertson, 1975). Lithium is found in the groundwater of the Gila Valley near Safford. Selenium and boron are also detected in groundwaters near Yuma and within Pinal County, as well as near Kingman. Each of these constituents has known health impacts and should be avoided in high concentrations. The mineral-rich geology of our state results in elevated levels of elements such as copper, zinc, manganese, and sulfate minerals occasionally being encountered in groundwater near mining districts. Iron is found in nearly all groundwater and is responsible for iron-bacterial fouling and rotten egg smell of some well water.

Anthropogenic Contaminants

Anthropogenic contaminants are those chemicals that have been introduced to the environment by the activity of man. These contaminants include industrial chemicals inadvertently released into the environment, those derived from land use activities such as oils and grease flushed off roadways and agricultural chemicals applied to crops. In early June of 2003, the cause of the death of aquarium fish in a home in Tucson was traced to mercury in the water supply. The single source of mercury was a broken water-level indicator, a mercury switch, within one of the wells of the water provider for the neighborhood. This isolated incident points to the fact that water contaminants can be found very close to home.

A neighborhood of recently installed private domestic wells in a new subdivision in New York was tested for contaminants after concern was expressed about the proximity of a nearby landfill. All wells failed water quality testing because a dissolved industrial solvent was found. Since the solvent is also a common contaminant associated with landfills, an extensive investigation was conducted to tie the pollution to the landfill, but no link could be found. The source of water contamination was discovered to be the solvent used to glue the plastic polyvinyl chloride (PVC) pipe used to construct the wells and plumbing.

Chemical plants, manufacturing facilities, gas stations, repair shops, landfills, and mining activities all have the potential to release contaminants into the environment. Many Superfund Sites (EPA mandated environmental clean-up sites) were first discovered because domestic well owners noticed an unusual odor as they showered or an odd taste to their well water. In some cases groundwater contamination has extended miles beyond the original source. Although most major sources of groundwater in Arizona are deep (>50 feet), industrial solvents like Trichloroethylene (TCE) have contaminated several aquifers in our state. The US EPA has identified at least 10 Superfund sites with groundwater contaminated by TCE in Arizona. There are also 35 Water Quality Assurance Revolving Fund (WQARF) listed sites in Arizona and most contain toxic chlorinated solvents (Artiola & Ramirez, 2006) Both Superfund Sites and WQARF sites can be found at **http://www.azdeq.gov/environ/waste/sps/index.html.**

If there is a site in your neighborhood, you may want to follow up with the Arizona Department of Environmental Quality (ADEQ) to obtain information to determine if your water supply is at risk of contamination.

The gasoline additive MTBE (Methyl tertiary-butyl ether) was added to gasoline in the late 1970's to boost octane, to replace the toxic metal lead, and to reduce air pollution. Unfortunately, the fate of this chemical in the water environment was not fully tested before it was approved as a gasoline additive and has since been tied to respiratory problems. This chemical is very soluble and stable (degrades slowly) and has contaminated numerous groundwater supplies due to leaky underground gasoline tanks. Today, the fate and transport of MTBE in the subsurface is the subject of ongoing research studies. It is now banned in California, and EPA is taking actions to reduce and eventually eliminate MTBE use (**http://www.epa.gov/mtbe/faq.htm#actions**).

Often, the most likely source of groundwater pollution in a domestic well is found near the well-head (Figure 2). Stored pesticides, lawn amendments, oil and grease, and failing septic systems are the most likely sources of domestic water supply pollution. Septic tank de-greasers are banned in many states because the chemicals, industrial solvents, rapidly percolate through the soils and contaminate the aquifer.

It is worthwhile to note that the odor threshold (the concentration at which the human nose can detect an odor) of some natural and industrial chemicals is lower than the detection capacity of a testing laboratory. What this means is that sometimes we can be alerted to the presence of contaminants in water by their smell. However, one should not rely on the sense of smell only to determine the possible presence of contaminants in well water.

Pathogens

Drinking water supplies that depend on groundwater are subject to contamination by waterborne pathogens. The

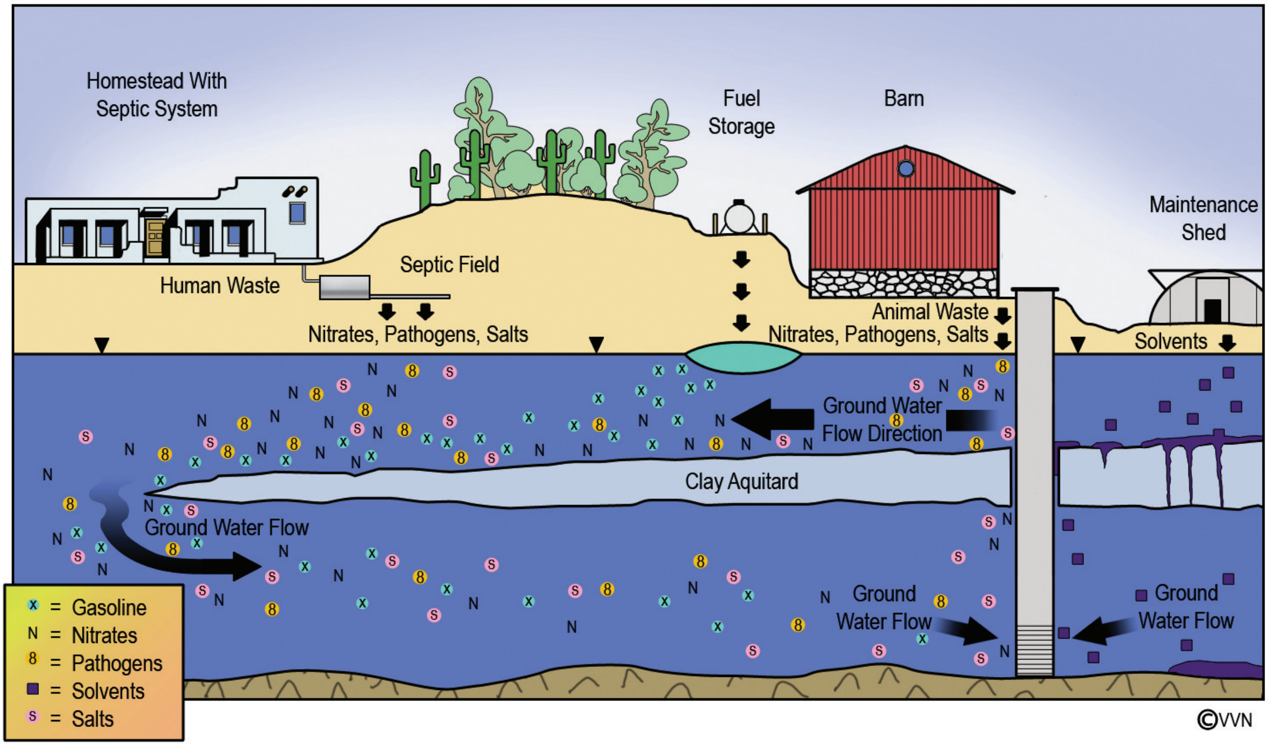

Figure 2. Typical Sources of Pollution near domestic wells (modified from Ontario, 2003)

detection of these pathogens (and other indicator organisms) may indicate fecal contamination of the groundwater. These pathogens can originate from leaking sewer lines, septic systems, or improperly protected well heads that allow contaminated surface water to drain into the aquifer along the outer well casing. Contaminated groundwater represents approximately half of the waterborne disease outbreaks documented in the United States every year. Typical symptoms associated with an infection include severe cramping, abdominal pain, dehydration, and diarrhea.

Iron bacteria thrive in groundwater with high concentrations of naturally occurring dissolved iron but are non-injurious to health. Iron bacteria are nuisance organisms that cause plugging of the pores in the aquifer and the openings of the well screen. The bacteria produce accumulations of slime within the well, and precipitate iron and manganese. The combined effect of the growth of the organisms and precipitated mineral has been reported to reduce well yield by 75% within a year in some locations (Johnson Division, 1972).

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This 'Fact Sheet' is a companion publication to the "Arizona Well Owner's Guide to Water Supply" CALs publication # AZ1485

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This information has been reviewed by University faculty.
cals.arizona.edu/pubs/water/az1503.pdf

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