# Human health and water quality in the Arizona

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The State of Arizona sets water quality standards for three classes of human health hazards:

## Non-carcinogenic toxic substances:

Examples: Mercury, Bromomethane – These are elements or compounds that do not cause or promote cancer but have other modes of toxicity which may range from subtle developmental/neuro toxicants such as mercury and lead to frankly acute toxicants such as cyanide salts. Some of these toxic substances may bioaccumulate, or build up in tissues over time and some are easily metabolized and excreted.

## Carcinogenic or cancer causing toxins or toxicants:

Examples: Arsenic, Dioxins – These are elements or compounds that may, or have been shown to, cause or promote cancer. The USEPA categorizes carcinogens in the following way:

**Class A:** A demonstrated human carcinogen
**Class B1:** Some human data and sufficient animal data to indicate its potential to cause cancer.
**Class B2:** Limited to no human data, but sufficient animal data to indicate its potential to cause cancer
**Class C:** Limited evidence of carcinogenicity in animals with inadequate human data
**Class D:** Not classifiable as a human carcinogen due to inadequate or no evidence of carcinogenicity in humans or animals.

## Pathogens:

Example: *E. coli* - Pathogens are micro-organisms that cause disease. They include a few types of bacteria, viruses, protozoa, and other organisms. Some pathogens are often found in water, frequently as a result of fecal matter from sewage discharges, leaking septic tanks, and runoff from animal feedlots.
A subset of this category that is emerging as a possible human health threat are aquatic organisms such as blue green or golden algae that produce toxins. Some of the toxins produced by these organisms are among the most toxic substances produced in nature. Anatoxin A, which is produced by the blue green alga Cylindrospermopsis, is listed as a possible bioweapon!

## Toxicology basics:

The State of Arizona addresses the risk posed by non carcinogenic and carcinogenic toxins using the following methods/formulas:

### All standards:

All standards are based on an estimation of the risk posed by an individual toxicant and estimated consumption rates and bodyweights based on national averages.

**Risk estimations:**

- Reference doses (**RfD**: an estimate of a daily oral exposure to the human population that is likely to be without an appreciable non-cancer risk during a lifetime.) taken from EPA's Integrated Risk Information System (IRIS) website (except as noted below).

- Oral cancer slope factors (**OCSF**: a quantitative estimate of carcinogenic risk from oral exposure presented as the risk per (mg/kg)/day) are taken from EPA's Integrated Risk Information System (IRIS) website (except as noted below).

- The maximum acceptable individual lifetime risk level (**MALR**: the absolute measure of the excess risk attributed to exposure to a carcinogen) was set at one in one million.

**Consumption and body weight defaults.**

- Water consumption (**WC**) was set at either two liters per day for Domestic Water Source (**DWS**) or 50 milliliters per day for Full Body Contact (**FBC**) and Partial Body Contact (**PBC**).

- Where applicable, fish consumption (**FC**) was set at the national default rate of 17.5 grams per day.

- A consumer body weight (**BW**) of 70 Kg ( average body weight of a human adult (154 lbs))

- A Relative Source Contribution (**RSC**) multiplier of 0.20 (20%) was used to calculate DWS, FBC, PBC and Fish Consumption (FC) water column standards for non-carcinogens. This multiplier is used to account for other exposures to toxins (diet, workplace exposure, etc.) that may occur to consumers.

**Individual standards:**

**Domestic Water Source (DWS):** Where available, EPA's maximum contaminant levels (MCL) were used to determine the standard to protect the DWS designated use. Where MCLs were not available the DWS standard was determined using the default consumption rate of two liters of water per day, the default adult body weight and the OCSF for carcinogens or the RfD for non-carcinogens for each individual pollutant. The formulas are as follows:

For carcinogens:

$$\frac{BW * MALR}{OCSF * WC_{DWS}}$$

For non-carcinogens:

$$\frac{RfD * RSC * BW}{WC_{DWS}}$$

**Full Body Contact (FBC):** FBC standards assume long term, regular exposures and are determined using a default consumption rate of 50 milliliters of water per day, the national default adult body weight and the OCSF for carcinogens or the RfD for non-carcinogens for each

individual pollutant. Where the MCL is a greater concentration than the calculated standard, the MCL will be used. The formulas are as follows:

For carcinogens:

$$\frac{BW * MALR}{OCSF * WC_{FBC}}$$

For non-carcinogens:

$$\frac{RfD * RSC * BW}{WC_{FBC}}$$

## Human Health issues in the Grand Canyon

In 2005 the Arizona Department of Environmental Quality (ADEQ) sampled 18 tributaries to the Colorado River in the Grand Canyon as a part of the statewide water monitoring program. Of the pollutants found, two stand out as possible significant human health risks; Arsenic and *E. coli*. Arsenic is a Class A or demonstrated human carcinogen (see accompanying article) and was found at concentrations above the proposed Domestic Water Source (DWS) and Full Body Contact (FBC) standards in four tributaries (Monument, Hermit, Crystal and Diamond Creeks). Of these creeks, Crystal stands out, in that, concentrations of arsenic were found at up to 12 times the human health standard! These data, coupled with National Park Service data for arsenic in Lava Creek (Lava Chuar) and Pumpkin Spring indicate a potential carcinogenic threat to those who may regularly consume water from these sources.

*Escherichia coli* or *E. coli* was found above the Arizona acute standard in two tributaries (Paria River, Little Colorado River) and above the chronic standard in Diamond Creek. *E. coli* is a class of bacteria that has been correlated with human gastroenteritis. Although most strains are harmless and live in the intestines of healthy humans and animals, this strain produces a powerful toxin and can cause severe illness. *E. coli* was first recognized as a cause of illness in 1982 during an outbreak of severe bloody diarrhea; the outbreak was traced to contaminated hamburgers. In Arizona, *E. coli* is not only a pathogen in its own right, but is used as a surrogate indicator of human fecal contamination.

Of the three significant occurrences of *E. coli,* all appear to be due to recreational and/or other human uses within the watershed rather than due to boater recreation at the mouth of the tributary. As an indicator of fecal contamination, the fact that 15 of 18 sites showed little or no E. coli contamination through four quarters of sampling is evidence that sanitation measures exercised by boaters within the Canyon are having the desired effect.