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WATER Quality

K-STATE Kansas State University

Organic Chemicals and Radionuclides in Drinking Water

It is not unusual for a local or national news story to report chemical spills, leaking fuel tanks, or pesticide contamination. These reports cause us to wonder if chemicals may be entering the water we drink. Door-to-door sales pitches capitalize on these news headlines and heighten the concern about the safety of our drinking water. This publication addresses drinking water standards and other health information for organic chemicals and radionuclides. A companion publication *Understanding Your Water Test Report*, MF-912, addresses inorganic chemicals and bacteria.

Most of us have grown up believing that water is made up of two hydrogen atoms and one oxygen atom. A closer look at our drinking water reveals that there is much more to it than just water molecules. Water acts as a universal solvent. Some of almost everything water touches is dissolved into it. As water moves from object to object, it picks up other molecules. As it passes through the environment, substances – minerals, salts, bacteria, and organic chemicals – dissolve into it.

Most of the time the materials that accompany the water molecules are unnoticed in our water supply. We become concerned when these extra substances affect physical properties like taste, odor, or color. Most of us call the water "contaminated" when it is not pleasant to our senses or no longer meets drinking water standards. These standards are based on physical, chemical, biological, or radionuclide substances in our water.

Where Organic Chemicals Occur

Organic chemicals are those compounds that contain carbon. Organic chemicals are being found in more places and continue to generate public concern. They can be natural sources, from plant or animal matter, or synthetic, man-made, with no natural source in the environment. The focus of public concern is usually over petroleum products and manufactured chemicals that may cause cancer or other serious long-term health problems.

Public concerns are heightened with each report of an industrial spill, leachate (garbage juices) from landfills and illegal dumps, leaking storage tanks, or waste water from factories. Runoff from industrial sites, city streets, agricultural land, highways, and lawns, is also the source of pollutants in our water.

More than 3 million chemicals (mostly organic) have been developed, and the number reportedly expands by a hundred thousand each year. But only a few hundred have been produced and used in significant amounts.

Exposure Route

People are most often exposed to organic chemicals through ingestion. The chemical enters the body in the beverages we drink or foods we eat. The skin readily absorbs some organic chemicals. When these chemicals are in the water, we are exposed as we shower or bathe. Volatile organics released into the air during showering, laundering, and dish washing may enter the body through inhalation. We are exposed to these chemicals through the air we breathe.

The risk to human health of organic chemicals depends on the exposure, which includes several factors:

- The toxicity of the contaminant to people
- Contaminant concentration in the water and food
- The amounts of water a person drinks or is exposed to
- The absorption efficiency of ingestion, skin contact, breathing or a combination of these

What Happens to Chemicals in the Body?

When a person is exposed to a dose of chemical, regardless of how it enters the body, several different things may occur depending on the dose, the chemical, the sensitivity of the person, and the length of exposure. Chemicals are broken down in body organs such as the liver, kidneys, or other tissues. A small dose is harmlessly converted to breakdown products and expelled. But some classes of organic chemicals may accumulate in fat or tissue of specific organs.

Dichlorodiphenyltrichloroethane (DDT) is probably the best known of the products that accumulates in tissue and persists in the body. Even at very low concentrations in the environment, it accumulated in fish tissue. It causes little or no direct impact on fish or lower animals. However, when other animals or larger fish eat those containing DDT, they accumulate DDT at higher levels in some tissues. In some cases, chemicals may move up the food chain through several steps with no impact. However, in the case of DDT, eagles were affected because concentrations interfered with reproduction.

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As the dose increases, at some point there is a very small effect on some body tissue. If the person is exposed repeatedly over years, there may be changes or damage to tissue of some organs or increase in the susceptibility to cancer or other impacts.

People differ in sensitivity to all kinds of exposures, including doses of chemicals. Standards are set in an effort to provide some reasonable margin of safety for the most sensitive people. Each chemical is generally tested on laboratory animals independent of other chemicals.

In the world outside of the laboratory, exposure to combinations of some contaminants, such as smoking and radon, can greatly increase the risk of either independently. It is likely that there are combinations of chemicals that will cause an undesirable effect, while no effect would occur with each chemical independently.

At larger doses, a point will finally be reached where the body cannot handle the contaminant even for a short period and there is an acute reaction. Death may result with increases in exposure.

The effect of small doses over many years may finally exceed the body's capability to deal with the contaminant, and a chronic effect results. This publication addresses low levels of exposure that may cause chronic effects after long term – decades – exposure.

Chronic effects may involve reproduction, mutation, damage to organ tissue, disruption of body chemical balance, immune system disruption, nervous system damage, and cancer. The Environmental Protection Agency (EPA) has established a procedure called risk assessment to protect people from these effects.

Table 1. *EPA Classification of Carcinogens*

Group	Evidence of Carcinogenicity
A	Known human carcinogen – sufficient evidence from epidemiologic studies
B	Probable human carcinogen
B1	At least limited evidence of carcinogenicity to humans
B2	Usually a combination of sufficient evidence in animals and inadequate data in humans
C	Possible human carcinogen – limited evidence of carcinogenicity in animals in the absence of human data
D	Not classified – inadequate animal or human evidence of carcinogenicity
E	No evidence of carcinogenicity in humans, in at least two animal species, or in both epidemiologic and animal studies

Risk Assessment

Risk assessment is the estimation of the probability and magnitude of adverse human effects resulting from exposure to a hazard. The National Research Council has identified risk assessment as consisting of four distinct steps. These are hazard identification, dose-response assessment, exposure assessment, and risk characterization.

Hazard identification is the process of establishing that a substance may have adverse effects on human health. Health consequences of concern include cancer and other chronic diseases, reproductive problems such as sterility or miscarriage, neurobehavioral problems, acute and chronic damage to specific organs of the body, birth defects, and other effects mentioned previously. Concern centers on establishing a causal link between exposure to a hazard and an adverse health effect.

Dose-response assessment is the determination of the relation between the magnitude of exposure and the probability of adverse health effects. This step often includes the determination of the extent to which various subpopulations experience different exposure levels and other factors that may affect response to the hazard. This step is essentially one of estimating the nature and magnitude of health effects for humans under different conditions of hazard exposure.

Exposure assessment is the determination of the nature and degree of human exposure to a hazard. Exposure to chemicals occurs by ingestion, skin absorption, inhalation, and often, a combination of these routes. Standards for drinking water are based on ingestion, but when skin or inhalation factors are known to be important routes of exposure a larger safety factor is used.

Risk characterization is the overall summary of what is known about the likelihood and magnitude of adverse health consequences. It represents a summary of the other three steps. It includes a quantitative estimate of the nature and degree of risk associated with hazard exposure and a statement of the uncertainty associated with the risk estimate. Adapted from *Assessing and Communicating Health Risks*, KSU Agricultural Experiment Station, Bulletin 658.

A common procedure in determining risk assessment, is to look at the health effects produced when contaminant doses that produce observable effects are administered to laboratory animals. Using a safety factor of 10, 100, or more, scientists then estimate the daily doses in humans that would produce no observable effect over a lifetime (70 years). Industrial exposure is the source of risk assessment data for people for some chemicals.

The EPA has developed guidelines that weigh the evidence that a chemical is a carcinogen and classify chemicals into one of five groups (See Table 1). Chemicals believed to cause cancer (groups A and B) are treated differently. Scientists assume that no concentration is safe and the Maximum Contaminant Level Goal (MCLG) is set

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at zero. However, measurements at very low concentrations are very expensive and treatment is also expensive. It is thus impractical to establish a Maximum Contaminant Level (MCL) at zero. The MCL is set as close to the MCLG as feasible, considering the effect of current monitoring cost and capabilities, and treatment cost.

How to Determine if Organic Chemicals are in Your Water

You can smell petroleum products, even at very low concentrations, in water, alerting you to a problem. However, the most reliable way to detect organic chemicals is water testing. Public water supplies are required to test water for more than 90 chemicals and report to the public in the annual consumer confidence report.

Private well owners are responsible for their water quality. They often have some reason to suspect contamination before they order tests. Users should test for specific chemicals, such as a chemical spilled near the well, that they suspect may have caused contamination. Tests for organics in drinking water may cost as much as $100 per test. Sometimes a scan or broader test can check for a family or class of chemicals.

Selecting a Laboratory

K-State Research and Extension publication *Testing to Help Ensure Safe Drinking Water*, MF-951, lists laboratories certified for broad categories, including organic chemicals, trihalomethanes, and radionuclides. The Kansas Department of Health and Environment web site has a searchable database for laboratory certification. Contact the laboratory for specific sampling procedures, sample containers, and costs for the test you want.

Understanding the Contaminant Concentration in Your Water

The Environmental Protection Agency (EPA) follows established procedures for determining the allowable amount of organic chemicals in your water. The amount of a specific contaminant in your water sample will be expressed as a concentration – a specific weight of the substance in a specific volume of water. Commonly used concentration units for drinking water are shown in Table 2.

Table 2

- Milligrams per liter (mg/L) – equivalent to parts per million or ppm, which means one part of the contaminant for every million parts of water, both by weight.
- Micrograms per liter (µg/L) – equivalent to parts per billion or ppb means one part of chemical per billion parts of water, both by weight.

Drinking Water Standards

The EPA has two main categories for drinking water standards – Primary and Secondary. Primary standards or Maximum Contaminant Level (MCL) is the enforceable standard for a public water supply. These standards are based on health considerations and are enforced by the state and EPA. Primary standards protect the public from pathogens, toxic chemicals, radionuclides, and other health effects. Laws and regulations require that consumers be notified if chemicals appear at levels above the standard, and action must be taken to reduce the contaminant. Kansas also has drinking water standards that generally follow the EPA standards, but may be more restrictive.

The MCL is set as close as feasible to the Maximum Contaminant Level Goal (MCLG) the level at which no known or anticipated adverse health effects occur. However, in addition to health effects, the EPA considers the feasibility and combined cost of analyzing water for a contaminant and for treating water to remove the contaminant. Therefore, the MCL may be less stringent than the MCLG.

Secondary standards apply to contaminants that cause offensive taste, odor, color, corrosiveness, foaming, and staining. The concentration limit for these objectionable contaminants is called the Secondary Maximum Contaminant Level (SMCL). Secondary Standards are not enforceable, so they serve as guidelines. The SMCLs may be exceeded at times. Water suppliers are not required to notify consumers if these standards are exceeded.

Other Standards and Guidelines

Other standards or guidelines for drinking water include Maximum Contaminant Level Goal (MCLG) and Health Advisories (HA).

The Maximum Contaminant Level Goal (MCLG) is a health-based guide that serves as the goal in setting the legally enforceable standards. The only enforceable standard is the Maximum Containment Level or MCL. Data from experiments on laboratory animals allow scientists to determine how toxic the chemical is and to estimate the concentration that will be harmful to humans. Formulas are applied to the data to estimate the effects of chemical concentrations in drinking water on health of humans over a lifetime of exposure. In other words, people drinking two liters of water per day over their whole lifetime (70 years) should not be affected by the contaminant.

Health Advisories (HA) provide information on health effects, analytical methods, and treatment technology for some chemicals when there is not enough data to develop a standard. To prepare Health Advisories, EPA reviews available human data and experimental animal studies to evaluate potential human health effects.

Health Advisories are calculated for water contaminants based on animal and other exposure data. The pro-

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cess of establishing lifetime Health Advisories (HA) is complicated and involves setting a reference dose, a daily exposure that is likely to be without appreciable risk of adverse effects over a lifetime. This dose is then converted to a Drinking Water Equivalent Level (DWEL) assuming the average body weight is 70 Kg (155 lbs) and two liters of water are consumed daily for a 70-year life span.

The DWEL represents a lifetime exposure concentration protective of adverse, noncancer health effects assuming all exposure for a contaminant comes from the water ingested. The lifetime Health Advisory allows for 20 percent of the reference dose or DWEL to be in drinking water. People also may be exposed by bathing and breathing chemicals vaporized from water.

Cancer risk is calculated separately from other health effects and is based on criteria that the increase in cancer risk should not exceed more than one additional cancer death in 10,000 or more people. All other lifetime health advisories include a safety margin of 10 to 1,000 based on the uncertainty involved when utilizing the available research data.

Using Table of Organic Chemical Standards

The list of chemicals in this publication on pages 5 through 11 is limited to those that have a standard or health advisory either draft or final. The MCL, MCLG, HA, or DHA will likely be changed over time as new information becomes available. Health Advisories are in various stages of development for many more chemicals.

More information is available by contacting the EPA Drinking Water Hot Line 800-426-4791. For current information about chemicals not covered in this publication and new information about chemicals that have health advisories, contact the Agency for Toxic Substance and Disease Registry, ATSDR. This is within Centers for Disease Control. Web site is, *www.atsdr.cdc.gov.* Telephone: 888-422-8737.

Radionuclide Standards

The table showing MCLs and MCLGs for radionuclides is shown on page 12. These materials may enter water from naturally occurring or man-made sources. They may be found in rainfall, runoff, and water-bearing rocks and soils. Nuclear tests, power plants, medical uses, and scientific studies add to the nuclear sources that may find their way into our drinking water.

Acute effects in the form of kidney injury may appear several days after exposure to radioactive material. Chronic effects from long-term low levels of exposure have produced kidney damage in animals. Studies have not demonstrated cancer from low levels of natural uranium exposure. However, EPA has classified all of the radionuclide contaminants as known human carcinogens.

Terms Used for Safe Drinking Water

DHA	Draft Health Advisory
HA	Health Advisory is a brief description of a chemical's effect upon human health
MCL	Maximum Contaminant Level (Primary standard, health effects)
KS MCL	Maximum Contaminant Level for the state of Kansas
MCLG	Maximum Contaminant Level Goal to protect from adverse health effects and allow an adequate margin of safety
SMCL	Secondary Maximum Contaminant Level (Nonhealth effects)
TT	Specifies a mandatory treatment technique that must be followed for public water supplies
µg/L	Micrograms per liter = 0.001 mg/L or parts per billion (ppb)
mg/L	Milligrams per liter = parts per million (ppm)
mrem/yr	Millirems per year
pCi	Picocuries – common unit for measuring radioactivity level
pCi/L	Picocuries per liter
rem	Equivalent unit of radiation a body or organ receives

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Related Research and Extension Publications

- *Activated Carbon Filters*, MF-883
- *Assessing and Communicating Health Risks: The Case of Meat/Fat Consumption*, SB-658
- *Distillation*, MF-885
- *Obtaining Safe Water from Private Wells*, MF-2345
- *Private Water Well – Owner/Operator Manual*, MF-2409
- *Private Well Maintenance and Protection*, MF-2396
- *Private Wells – Safe Locations and Construction*, MF-970
- *Quality Water, Man-Made Chemicals*, EP-28
- *Recommended Water Tests for Private Wells*, MF-871
- *Reverse Osmosis*, MF-884
- *The River Friendly Farm – Environmental Assessment Tool*, S-138
- *Testing to Help Ensure Safety of Drinking Water*, MF-951
- *Understanding Your Water Test Report*, MF-912

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Organic Contaminants	Standard MCLG (mg/L)	Standard MCL (mg/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Acifluorfen (Blazer, Tackle)		HA 0.1	herbicide (soybeans and peanuts)	probable cancer (B2)
Acrylamide	zero	TT HA 0.001	municipal drinking water and wastewater treatment; well drilling; food production and processing; paper making; textile manufacturing	probable cancer (B2); nervous system effects
Acrylonitrile		HA 0.006	chemical intermediate (fiber production, plastic bottles), pesticide, fumigant	probable cancer (B1)
Alachlor (Lasso) SOC	zero	0.002	agricultural and horticultural herbicide	probable cancer (B2); damage to liver, kidney, spleen, nasal passage, and eyes
Aldicarb (Temik) SOC	0.007	0.007	agricultural insecticide	(D); cholinesterase inhibition*
Aldicarb sulfone SOC	0.007	0.007 KS MCL 0.003	formed by plants and animals after exposure to aldicarb	(D); cholinesterase inhibition*
Aldicarb sulfoxide SOC	0.007	0.007 KS MCL 0.003	formed by plants and animals after exposure to aldicarb	(D); cholinesterase inhibition*
Aldrin SOC		HA 0.0002	insecticide	probable cancer (B2)
Atrazine (Aatrex, Crisazina)	0.003	0.003	agricultural herbicide most widely used in U.S. food; general weed control purposes	possible cancer (C); anorexia, organ weight changes, blood, heart, lungs, and kidney
Baygon		HA 0.003		possible cancer (C)
Bentazon (Basagran)		HA 0.2	herbicide (soybeans, rice, corn, peanuts)	(E); weight loss and ill health is seen in research dogs
Benzene (VOC)	zero	0.005	leaking underground fuel storage tanks; industrial wastes; manufacture of pesticides, detergents, and solvents; petroleum refining; coal processing	cancer (A); mutagen; blood disorders; reproductive damage; immune system depression; leukemia
Benzo[a]pyrene (PAH)	zero	0.002	fossil fuel burning; wood burning; coal tar; forest fires	probable cancer (B2)
Bis-2-chloroisopropyl ether		HA 0.3		(D)
Bromacil (Borea, Hyvan, Uragan)		HA 0.09	noncrop general herbicide	possible cancer (C); decreased weight gain; changes in liver and testes
Bromochloromethane		HA 0.09		(D)
Bromodichloromethane (THM) MCL is for total THM, see page 11	zero	0.08 DHA 0.06	disinfection by-product; fire retardant; solvent; chemical intermediate	probable cancer (B2)
Bromoform (THM) MCL is for total THM, see page 11	zero	0.08	disinfection by-product; solvent for waxes	probable cancer (B2)
Bromomethane		DHA 0.01		(D)
Butylate		HA 0.4		(D)
Carbaryl		HA 0.7		(D)

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Organic Contaminants	Standard MCLG (mg/L)	Standard MCL (mg/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Carboxin		HA 0.7		(D)
Carbofuran (Furadan, Curaterr)	0.04	0.04	agricultural and horticultural insecticide; fumigant	(E); cholinesterase inhibition*; weight loss; reproductive system damage
Carbon tetrachloride (VOC)	zero	0.005	manufacture of chlorofluorocarbons; paints and plastics; grain fumigants; fire extinguishers; solvent; metal cleaner; dry cleaning operations; chemical disposal sites	probable cancer (B2); liver, kidney, and lung damage; central nervous system depression and death
Chloramben		HA 0.1		(D)
Chlordane	zero	0.002	insecticide; termite treatment; hazardous waste sites	probable cancer (B2); central nervous system, reproductive system, and blood system effects
Chloroform (THM) see total THM	zero	0.08	disinfection by-product; industrial solvent; extractant; chemical intermediate	probable cancer (B2)
Chloromethane		HA 0.003	chemical intermediate	possible cancer (C)
Chlorophenol (2-)		DHA 0.04		(D)
Chlorothalonil		HA 0.15		probable cancer (B2)
Chlorotoluene o-		HA 0.1	solvent; chemical intermediate	(D); developmental effects; adrenal, heart, and testes organ weight gains
Chlorotoluene p-		HA 0.1	solvent; chemical intermediate	(D); affects blood cell formation; liver, kidney, brain, and central nervous system
Chlorpyrifos		HA 0.02		(D)
Cyanazine (Bladex)		DHA 0.001	herbicide (grasses and broadleaf weeds)	no cancer rating; reduced body weight gain; developmental toxicant
2,4-D (2,4-dichlorophenoxyacetic acid) (Aqua Kleen)	0.07	0.07	agricultural, horticultural, and industrial herbicide; aquatic weed control	(D); liver, nervous system, and kidney damage; fetotoxic effects; weakly teratogenic
Dalapon (Dowpon, Ded-weed)	0.2	0.2	herbicide for fruit trees, corn, cotton	(D); kidney and liver effects
DCPA (Dacthal)		HA 0.07	herbicide (turf, ornamentals, strawberries, vegetables)	(D); thyroid hyperplasia; liver and kidney effects
Di(2-ethylhexyl)adipate	0.4	0.4	plastics	possible cancer (C); liver and reproductive system effects
Di(2-ethylhexyl)phthalate (PAE)	zero	0.006		(B2)
Diazinon		HA 0.0006		(E)
Dibromochloromethane (THM) see total THM	0.06	0.08 DHA 0.04	disinfection by-product	possible cancer (C)
Dibromochloropropane (DBCP, Nemofume)	zero	0.0002	soil fumigant; nematocide	probable cancer (B2); kidney, stomach, and upper respiratory damage; infertility; fetotoxic
Dicamba (Bamzel)		HA 0.2	herbicide (corn, sorghum) noncropland, rangeland applications	(D); central nervous system effects; suspected human teratogen

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Organic Contaminants	Standard MCLG (mg/L)	Standard MCL (mg/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Dichloroacetic acid	zero	0.06	disinfection by-product	probable cancer (B2)
Dichlorobenzene m-		HA 0.6	fumigant; insecticide	(D); liver and blood effects; appetite loss
Dichlorobenzene o-	0.6	0.6	industrial solvent; deodorizer	(D); liver and blood effects; appetite loss
Dichlorobenzene p- (VOC)	0.075	0.075	deodorizer; insecticide	possible cancer (C); liver, kidney, spleen, and thymus damage
Dichorodifluoromethane		HA 1.0	refrigerant; blowing agent	(D); decreased body weight
Dichloroethane (1,2-)	zero	0.005	vinyl chloride and solvent manufacturing; metal degreasers; additive to adhesives, gasoline, and paint; tobacco flavorings	probable cancer (B2); lung, adrenal, heart, kidney, and liver damage; possible mutagen
Dichloroethylene (1,1-)	0.007	0.007	food packaging films and coatings; manufacture of 1,1,1-trichloroethane	possible cancer (C); liver and kidney damage; mutagen; fetotoxic
Dichloroethylene (cis-1,2-)	0.07	0.07	industrial solvents; transformed in drinking water from other chlorinated hydrocarbons; manufacture of chlorinated solvents	(D); liver and circulatory system effects; central nervous system depressant
Dichloroethylene (trans-1,2-)	0.1	0.1	industrial solvents; transformed in drinking water from other chlorinated hydrocarbons; manufacture of chlorinated solvents	(D); liver, immunological, and circulatory system effects; central nervous system depressant
Dichlorophenol (2,4-)		DHA 0.02		(E)
Dichloromethane (methylene chloride)	zero	0.005	solvent	probable cancer (B2)
Dichloropropane (1,2-) (DCP)	zero	0.005	industrial solvent; dry cleaning and degreasing; soil fumigant; organic chemical production	probable cancer (B2); liver, kidney, adrenal glands, bladder, gastrointestinal, and respiratory tract effects
Dichloropropene (1,3-) (DCP, Telone)		HA 0.04	soil fumigant	probable cancer (B2)
Dieldrin		HA 0.0002	insecticide	(B2)
Diethylhexyl phthalate (PAE)	zero	0.006	plastics	probable cancer (B2)
Diisopropyl methylphosphonate		HA 0.6		(D)
Dimethrin		HA 2.0		(D)
Dimethyl methylphosphonate		HA 0.7		possible cancer (C)
Dinitrobenzene (1,3-)		HA 0.001		(D)
Dinitrotoluene (2,4-)		HA 0.005	munitions manufacturing and disposal	probable cancer (B2); central nervous system depression; cardiovascular effects
Dinitrotoluene (2,6-)		HA 0.005	munitions manufacturing and disposal	probable cancer (B2); central nervous system depression; cardiovascular effects

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Dinitrotoluene (2,6- plus 2,4-)		HA 0.005		probable cancer (B2)
Dinoseb (DNBP, Dnitro)	0.007	0.007	herbicide (soybeans, vegetables, corn, and other field crops)	(D); liver, thyroid and reproductive effects; birth defects; possible teratogen
Dioxane p-		HA 0.3		probable cancer (B2)
Diphenamid		HA 0.2		(D)
Diquat	0.02	0.02	herbicide; defoliant	(D); liver, kidney, GI tract effects; cataract formation
Disulfoton		HA 0.0003		(E)
Dithiane (1,4-)		HA 0.08		(D)
Diuron		HA 0.01		(D)
Endothall (Aquathol)	0.1	0.1	herbicide; defoliant	(D); liver, kidney, GI tract, and reproductive system effects
Endrin	0.002	0.002	insecticide; rodenticide; bird perch treatment	(D); liver damage; convulsions; central nervous system effects
Epichlorohydrin	zero	TT HA 0.4	epoxy resin, glycerol, pharmaceuticals, pesticides, dye, adhesive, polymers, plasticizers; paper sizing; rubber manufacturing; flocculants for water treatment	probable cancer (B2); blood, stomach, and respiratory track damage; infertility; mutagenic
Ethylbenzene	0.7	0.7	solvents, naphtha, gasoline, and asphalt	(D); central nervous system, eye, liver and kidney effects
Ethylene dibromide (EDB, DowFume, Peftmaster)	zero	0.00005	food and soil fumigants	probable cancer (B2); liver, stomach, adrenal, and reproductive effects; mutagen
Ethylene glycol		HA 14.0	antifreeze	(D)
Ethylene thiourea (ETU)		HA 0.02	degradate of EBDC pesticide	probable cancer (B2)
Fenamiphos		HA 0.002		(D)
Fluometuron		HA 0.09		(D)
Fluorotrichoromethane		HA 2.0	plastic foam-blowing agent; refrigerant; degreaser	(D); possible immune system suppressor
Fonofos		HA 0.01		(D)
Formaldehyde		DHA 1.0		probable cancer (B1)
Glyphosate (Rodeo, Roundup)	0.7	0.7	herbicide	(D); liver and kidney effects
Heptachlor (H-34, Heptox)	zero	0.0004	insecticide; hazardous waste sites	probable cancer (B2); liver, blood, and chromosome damage
Heptachlor epoxide	zero	0.0002	formed by plants and animals after exposure to heptachlor	probable cancer (B2); liver and chromosome damage

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Hexachlorobenzene (HCB)	zero	0.001	waste by-product in manufacture of chlorinated pesticide	probable cancer (B2); liver, kidney ovary, skin, and nervous system damage
Hexachlorobutadiene		HA 0.001	waste by-product in manufacture of chlorinated pesticide	possible cancer (C)
Hexachloro-cyclopentadiene (HEX)	0.05	0.05	intermediate in production of pesticides and flame retardants	(D); kidney and stomach effects
Hexachloroethane (HCB, Perchlonobenzene)		HA 0.001	lubricant, fluorocarbons, rubber, insecticide, paint, smoke and fireworks, and fire extinguishing	possible cancer (C); liver, kidney, and reproductive effects
Hexazinoue		HA 0.4		(D)
HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)		HA 0.4		(D)
Isophorone		HA 0.1	solvent for lacquers, resins, pesticides, etc.	possible cancer (C); decrease in body weight; central nervous system and kidney effects
Isopropyl methylphosphonate		HA 0.7		(D)
Lindane	0.0002	0.0002	agricultural, horticultural, and silvicultural insecticide	possible cancer (C); liver and kidney damage; possible mutagen
Malathion		HA 0.1	insecticide	(D)
Maleic hydrazide		HA 4.0		(D)
MCPA 4(chloro-2-methoxyphenoxy) acetic acid		HA 0.004		(D)
Methomyl (Lannate, Nudrin)		HA 0.2	insecticide for agricultural and ornamental crops	(E); kidney and central nervous system toxicity; spleen, liver, and bone marrow effects
Methoxychlor (DMDT, Malate, Methoxy-DDT)	0.04	0.04	agricultural, home, horticultural, and silvicultural insecticide	(D); growth inhibition; weight loss; possible mutagen
Methyl parathion		HA 0.002		(D)
Metolachlor (Dual, Primextra)		HA 0.1	herbicide (cropland, sunflowers, corn, soybeans, and woody ornamentals)	possible cancer (C); testes damage; blood conditions
Metribuzin (Lexone, Sencor)		HA 0.2	broad range agricultural herbicide	(D); kidney damage
Monochloroacetic acid		0.06		no cancer rating
Monochlorobenzene	0.1	0.1	solvent; pesticide and other chemical manufacture; dry cleaning and degreasing	(D); liver, kidney, adrenal glands, and lymph node effects; mutagen
Naphthalene		HA 0.1		possible cancer (C)
Nitroguanidine		HA 0.7		(D)
Nitrophenol p-4-nitrophenol 4-hydroxynitrobenzene		HA 0.06		(D)

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Organic Contaminants	Standard MCLG (mg/L)	Standard MCL (mg/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Oxamyl (Vydate)	0.2	0.2	pesticide for potatoes and tomatoes	(E); cholinesterase inhibition*; decreased body and organ weight; decreased fetal survival
Parquat		HA 0.03		possible cancer (C)
Pentachlorophenol (PCP, Penta)	zero	0.001	previously used as broad-spectrum fungicide and bactericide; wood preservative; industrial waste sites	probable cancer (B2); liver, immune system, and kidney damage; reproductive effects; possible mutagen
Phenol		HA 4.0		(D)
Picloram (Tordon)	0.5	0.5	herbicide	(D); liver, thyroid, testes, and artery damage
Polychlorinated biphenyls (PCBs)	zero	0.0005	hazardous waste sites; disposal of electrical transformers, capacitors, and electrical industry	probable cancer (B2); liver, and kidney damage; skin effects; reproductive effects
Prometon (Gesafram, Pramitol)		HA 0.1	herbicide (perennial weeds and grasses)	(D); growth effects
Pronamide		HA 0.05		possible cancer (C)
Propachlor		HA 0.09		(D)
Propazine		HA 0.01		possible cancer (C)
Propham		HA 0.1		(D)
RDX hexahydro-1,3,5-trinitro-1,3,5-triazine		HA 0.002		possible cancer(C)
Simazine (Princep, Aquazine)	0.004	0.004	herbicide (broad leaf weeds; cropland and industrial areas; algae control)	possible cancer (C); testes, liver, kidney, and thyroid damage; mutation
Styrene	0.1	0.1	manufacture of styrene plastics, synthetic rubbers, resins, insulators, polyesters, and pharmaceuticals	possible cancer (C); liver damage; central nervous system effects
2,3,7,8-TCDD (Dioxin)	zero	0.00000003 or $3x10^{-8}$	by-product in manufacturing process of some chlorinated herbicides; pulp and paper mill effluent	probable cancer (B2)
Tebuthiuron		HA 0.5		(D)
Terbacil		HA 0.09		(E)
Terbufos		HA 0.0009		(D)
Tetrachloroethane, (1,1,1,2-)		HA 0.07	solvent; used in pesticides, bleaches, paints, and varnishes; chemical intermediate	possible cancer (C); kidney damage
Tetrachloroethane, (1,1,2,2-)		HA 0.0003		possible cancer (C)
Tetrachloroethylene	zero	0.005	industrial metal and textile cleaning solvent; manufacture of fluorocarbons	no cancer rating; liver, kidney, and central nervous system effects

PAH = Polycyclic Aromatic Hydrocarbon; SOC = Synthetic Organic Chemicals; THM = Trihalomethanes; VOC = Volatile Organic Chemical; DHA = draft health advisory; HA = health advisory, long term; TT = Mandatory Treatment Technique applies

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Organic Contaminants	Standard MCLG (mg/L)	Standard MCL (mg/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Toluene	1	1	solvents; gasoline additive (leaking fuel storage tanks)	(D); central nervous system, blood, kidney, lung, and liver damage; possible reproductive effect
Toxaphene	zero	0.003	insecticide for animals; before 1982, widely used pesticide for food and nonfood crops	probable cancer (B2); liver and kidney damage; central nervous system effects; immune system depression; possible mutagen
2,4,5-TP (Silvex)	0.05	0.05	broad-spectrum herbicide prior to 1983	(D); liver and kidney effects
Trichloroacetic acid	0.3	0.06	disinfection by-product	possible cancer (C)
Trichlorobenzene (1,2,4-)	0.07	0.07	manufacture of herbicides; dye carrier	(D); kidney and liver effects
Trichlorobenzene (1,3,5-)		HA 0.04		(D)
Trichloroethane (1,1,1-)	0.2	0.2	hazardous waste sites, industrial solvents and degreasers; dry cleaning solvents; manufacture of organic chemical	(D); diminished weight gain; liver damage
Trichloroethane (1,1,2-)	0.003	0.005	solvent; manufacture of vinylidene chloride	possible cancer (C); kidney and liver effects
Trichloroethylene (TCE)	zero	0.005	hazardous waste sites; home and industrial solvent; metal degreasers; anesthetic; extracting agent for food	probable cancer (B2); liver damage; possible mutagen
Trichlorofluoromethane		HA 2.0		(D)
Trichlorophenol, (2,4,6-)		0.3	herbicide, preservative, disinfectant, fungicide ingredient	probable cancer (B2)
2,4,5-Trichloro-phenoxy-acetic acid		HA 0.07	herbicide (industrial sites and rangeland)	(D)
Trichloropropane (1,2,3-)		HA 0.04	polymer production chemical; degreasing agent	no cancer rating
Trifluralin		HA 0.005	herbicide (soybeans, right of way, and turf)	possible cancer (C); liver and kidney damage; fetal effects; decreased red blood cell count and increased methemoglobin
Trihalomethanes (THMs) total	zero	0.08	formed when residual chlorine combines with naturally occurring organic matter in drinking water treatment	probable cancer (B2)
Trinitroglycerol		HA 0.005		no cancer rating
Trinitrotoluene (2,4,6-)		HA 0.002		possible cancer (C)
Vinyl chloride	zero	0.002	raw material in plastic, rubber, paper, glass, and auto industries; corrosion of plastic pipes; manufacture of electrical insulation, cable, pipe, industrial and household equipment	cancer (A); birth defects
Xylenes	10	10	manufacture of chemicals and drugs; solvent; component of gasoline (leaking underground fuel storage tanks)	(D); nervous system effects; liver and kidney effects

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Radionuclide Contaminants	MCLG (pCi/L)	MCL (pCi/L)	Uses and/or Sources	Cancer Risk (Cancer Group) Possible Chronic Health Effects
Beta particles and photon activity	P zero	4 mrem/yr	natural decay of uranium in rocks and soil; natural cosmic ray bombardment in the atmosphere; nuclear weapons testing; radiopharmaceuticals; nuclear fuel processing and use	cancer (A); birth defects; miscarriages; chromosome damage
Gross alpha particles	P zero	15	natural decay of uranium in rocks and soil; natural cosmic ray bombardment in the atmosphere	cancer (A); bone and kidney damage
Radium 226 and/or 228	P zero	5	natural decay of uranium in rocks and soil	cancer (A); bone cancer; bone and kidney damage; head carcinoma; birth defects
Radon	zero	P 300	degradate of naturally occurring radium in soil	cancer (A)
Uranium	zero	P 0.02 mg/L	naturally occurring in many minerals; by-product of uranium enrichment processing	cancer (A)

P = proposed

* Cholinesterase inhibition may cause nausea, blurred vision, stomach cramps, excessive salivation, dehydration, muscle weakness, headaches, irregular heartbeat, unconsciousness, and sometimes death.

Source: US EPA Primary drinking water contaminants, their potential sources, possible chronic health effects, and maximum contaminant levels (MCLs) as of 2001. In a very few cases, Kansas standards are more restrictive than EPA and are marked KS MCL.

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