Understanding Water Quality

Drinking Water Standards

Drinking water from a local public supply must meet federal and state standards for safe drinking water. Two sets of standards-primary drinking water and secondary drinking water-establish Maximum Contaminant Levels (MCLs) for a variety of contaminants. If the water supply exceeds MCLs for primary drinking water standards, it must be treated to eliminate the contaminant.

Primary drinking water standards establish concentration limits for contaminants affecting human health. Public water systems must meet the standards for microbes (coliform bacteria), inorganic contaminants (lead, arsenic, nitrates), synthetic organic chemicals (such as those in pesticides), and radionuclides (like radium 226).

Secondary drinking water standards set concentration limits for nuisance contaminants that affect color, odor, pH, clarity, and taste. Although it is desirable for drinking water to meet these secondary standards, it is not required by law.

A Century of Water Protection

In the early 1900s, good water quality meant water was free from the microorganisms that make people ill. Typhoid fever was rampant in Montana because many towns released untreated sewage into the streams and irrigation ditches that supplied their drinking water. The Montana legislature responded to this health hazard by passing the state's first stream pollution law in 1907. The law prohibited the release of raw sewage and other pollutants into surface waters used for drinking, ice supply, and other domestic purposes. It also required every city to construct a sewage treatment works. Amendments in 1929 set out to improve water quality for gardening, crop production, and domestic animals.

In the following decades, many other important acts expanded water quality protection. The Montana Water Pollution Control Act of 1955 established a stream classification system based on actual and anticipated uses. The 1972 Montana Water Quality Act set goals to:

> . .conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry, recreation and other beneficial uses and provide a comprehensive program for prevention, abatement, and control of water pollution.

With this landmark legislation, Montana's concept of water quality expanded to support other uses of water, including healthy habitats for plants and animals in lakes and streams.

Water Quality Today

Today we can define water quality according to the amount and kind of substances present in water, by water's ability to support beneficial uses such as irrigation and recreation, and by the overall health of the aquatic ecosystem.

One way that we assess water quality is by measuring contaminants that originate from natural or human-made sources. Some of these contaminants often escape detection except through laboratory tests. The list includes:

- **chemical** contaminants such as petroleum products from fuel leaks; metals like copper, zinc, cadmium, lead, and arsenic from mine wastes and natural sources; and phosphorus and nitrogen from fertilizers and sewage;
- **physical** contaminants such as turbidity, taste, temperature, sediment, color, and odor;
- **biological** contaminants such as fecal coliform bacteria from human or animal wastes;
- **radiological contaminants such as radon or uranium mill wastes**

To assure that our drinking water is safe, federal and state governments established standards that regulate contaminants affecting public health and the aesthetic quality of water.

We can also assess water quality by its ability to support its intended beneficial use, such as irrigation, industrial use, fish propagation, or recreation. For example, low instream flows can be considered a water quality problem if they impact trout spawning or survival. Laws have been passed in Montana to protect these beneficial uses.

Water quality also reflects the overall health of aquatic ecosystems. The health of lakes, streams, and wetlands is measured by the constituents dissolved in the water, the condition of the banks, shoreline, and riparian zones (habitat), and the composition of the plants and animals living in the water (*biological integrity*). As a rule, healthy aquatic ecosystems produce good quality waters unless compromised by habitat modification.

How Clean is Montana's Water?

Montana's waters exhibit natural extremes in quality, ranging from near pure water in some western headwater lakes and streams to the salinity of sea water in a few seeps and ponds in eastern Montana. We impair the quality of these waters through our daily activities, which can cause pollution from a variety of point sources or nonpoint sources.

Point source pollution comes from a localized discharge into a lake, stream, or ground water. This type of pollution accounts for ten percent of water impairment in Montana. Common point sources for surface water pollution include industrial and municipal wastewater discharges. Municipal discharges often contain contaminants that we flush down the toilet or dump down the drain. Point sources such as leaking underground fuel storage tanks and landfills contribute to ground water pollution. Most point sources of pollution are regulated by discharge permits mandated by federal and state law.

Nonpoint source pollution originates from activities over a broad area of land. Nonpoint sources include agricultural and forest practices, river channel modification, urban development, and mining. These sources contribute pollutants such as

A point source of pollution. Photo courtesy Montana Department of Environmental Quality.

Habitat Modification and Water Quality

When we modify habitats by activities such as bulldozing streambeds to divert water, we are affecting the riparian zone and the integrity of the stream channel. These modifications can cause erosion, destroy aquatic habitats, increase water temperature, and alter stream flows and lake levels. Habitat modification also promotes nuisance plant growth, degrades aesthetics and fish production, and generates byproducts that make water unfit for use and more expensive to treat. Because of the drastic effects caused by habitat modification, many such practices are no longer allowed on Montana's waterways. Before you attempt to modify riparian habitat, be sure to consult with your local Conservation District.

Nuisance plant growth in Ashley Creek. Photo courtesy Montana Department of Environmental Quality.

Runoff

Runoff flows to streams and lakes, or infiltrates to ground water during a storm event or spring thaw. As it races across the land, runoff collects pollutants such as sediment, trace metals, bacteria, and nutrients. In cities and towns, drains capture storm water and often carry it directly to nearby waterways.

Superfund

Motivated by the contamination of ground water at Love Canal in Buffalo, New York, Congress passed the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980. CERCLA makes polluters responsible and liable for damages to the environment and human health. It creates measures to clean up uncontrolled hazardous waste sites such as landfills, hard rock mines, wood treatment plants.

The "Superfund" is a trust fund that makes money available for clean-up of hazardous waste, where there is no responsible party. The Superfund National Priority sites list includes eight sites in Montana. The largest complex of sites-both in Montana and in the nation-is along The Clark Fork of the Columbia River, from Silver Bow Creek at Butte to Milltown Dam near Missoula. Seepage from old tailings and discharge from inactive and abandoned mines contaminates streams and aquifers in this area of Montana.

Montana's counterpart to the federal CERCLA law, the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA). was passed in 1989. It mandates cleanup for 250 sites not on the federal priority list.

sediments, metals, nutrients, mineral salts, and pesticides. Stormwater runoff collects nonpoint source contaminants as it flows down streets and across other impermeable surfaces.

When you add up the amount of all of the nonpoint sources, they account for 90 percent of Montana's water impairment. The state takes a non-regulatory approach to solving these problems by relying on land owners and managers to voluntarily implement *best management practices* (BMPs).

Not all water quality impairment is caused by human activity. Materials released naturally from geologic materials can also influence water quality. For example, arsenic occurs naturally in the geothermal features of Yellowstone National Park and affects water quality downstream in the Yellowstone, Madison, and Missouri rivers.

To better protect water from all types of pollutants, the state of Montana established a classification system for its waters. Surface waters were classified in 1955 according to actual and anticipated uses into four categories (A, B, C, and I) based on water temperature, ability to sustain fish and aquatic life, and suitability for other uses. Map E in the center section locates waters in these categories. Ground water was classified into four groups based on quality and use as of October, 1982: Class I, suitable for public and private water supply with little or no treatment; Class IV, suitable only for some industrial and commercial uses.

How Clean Are Streams?

Based on a study by the Montana Department of Environmental Quality, in 1994 more than 14,000 miles of streams in Montana were assessed as threatened or impaired. This represents almost one quarter of the 53,000 *perennial* stream miles in the state-and it is not a complete assessment. Reliable information exists only for major streams and those with known or suspected problems.

The major sources of stream impairment include:

- irrigation return flows
- dewatering
- mismanagement of stream banks and riparian zones through overgrazing, logging, and road construction
- discharges from municipal wastewater treatment plants
- mining

How Clean Are Lakes?

About 800,000 of Montana's 833,964 lake and reservoir acres have been assessed. Due to water level fluctuations, only 14 percent of lake acres assessed in Montana fully support fish and aquatic life. More than half support swimming and drinking water uses.

The main sources of lake impairment are:

- agricultural practices
- natural chemicals such as arsenic
- dam operations that can lead to fluctuating water levels
- municipal sewage plants
- septic systems
- air pollution
- forest practices

Contamination of lake waters can elevate salinity, nutrients, suspended solids, siltation, organic enrichment, metals, and promote noxious aquatic plant growth. To begin repairing the impairment of lakes, communities-particularly Flathead and Missoula counties-have passed local shore-line protection ordinances and phosphate bans.

How Clean Is Ground Water?

Human activities contribute the major sources of ground water contamination, especially in urban areas. These sources include:

- petroleum spills and leaking underground storage tanks. About 22,500 underground storage tanks are registered with the state. A pinhole leak from just one of these tanks can spill 500 gallons of fuel each year. Thousands of gallons of diesel fuel have spilled beneath major fueling facilities over a 75-year period.
- injection wells and runoff from storm drains, which add organic contaminants to ground water. About 900 oil field injection wells and thousands of shallow injection wells (like those in car washes and auto shops) exist in Montana.
- improperly designed sewage disposal and septic systems, which can contaminate ground water with coliform and other bacteria, viruses, and nutrients.
- leaching of contaminants from solid waste landfills and hazardous waste storage and disposal sites. Thirty years ago, 500 landfills were scattered around Montana. Today, landfills centralize waste disposal under highly regulated conditions. About 32 active Class II municipal solid waste landfills accept mixed wastes, including certain household hazardous wastes; 50 Class III landfills accept non-water soluble items such as tires, brush, and brick; and 12 privately-operated Treatment, Storage, and Disposal (TSDs) facilities handle hazardous waste. Substances that can pollute ground water at all of these landfill sites include metals, solvents, refrigerants, and petroleum derivatives.
- sludges from petroleum refining, creosote and solvents from wood treatment, and pesticides from agricultural and domestic insect control.
- contamination at hard rock mining operations from disposed tailings, cyanide heap leach facilities, and spills and leaks. Fluids from these sources may contain cyanide, heavy metals, inorganic chemicals, and very acidic water.
- oil and gas exploration, which uses drilling fluids containing diesel fuel and salts, has contaminated some domestic water supplies and surface soils in eastern Montana.
- agricultural practices, resulting sometimes in saline seep and nutrient-rich runoff.
- geology and natural substances. Ground water that migrates through rock formations can dissolve some minerals present in the rocks. The ground water near mineral deposits in western mining districts often contains heavy metals. Ground water that flows through fine-grained rocks in eastern Montana often exceeds the standard of 500 mg/L for total dissolved solids because salts and minerals dissolve in the water.

How You Can Protect Water Quality

Ground and surface waters are closely connected. When we pollute or deplete one, it affects the other, despite the fact that we are often unaware of the impacts. That's why individuals are becoming personally involved in pollution abatement and prevention, far beyond what a myriad of laws require of us. (These laws are described in Chapter 6.) Individually we can arrest the pollution problem by simply reducing the number of pollutants we pour down the drain, conserving water in our homes and

Saline Seep

Soil salinity is a problem that has intensified with agricultural development during the last 40 years. About 300,000 acres of formerly productive cropland in Montana are no longer able to produce crops because of salinity.

The problem can be linked to crop/fallow dry land farming practices that have replaced native range-land. How has this occurred? More water is received from rain and snow in the 14 to 21 month fallow period than can be stored in the rooting zone. Consequently, downward movement of natural salts, nitrates, and trace elements occurs through the soil. This movement increases during wet periods when no crop is actively growing. As the salty water approaches seepage spots on the soil surface at lower elevations, it evaporates and leaves salt that can kill crops and render the soil and water unusable.

Saline ground water is dominated by calcium, magnesium, and sodium sulfate salts, ranging from 500 to 72,000 mg/L total dissolved solids (TDS). The recommended upper levels for TDS are 500 mg/L for domestic uses, 1.000 mg/L for irrigation, and 3,000 mg/L for livestock water. Sea water is about 35,000 mg/L TDS.

If saline seep is a problem, the Montana Salinity Control Association or other groups conduct agronomic and hydro-geologic assessments, then develop management strategies such as planting deep-rooted crops and using intensive annual cropping practices in upslope recharge areas.

Alfalfa planted for seep control. Photo courtesy Montana Salinity Control Association.

When I Test My **Well,** Spring, or Tap Water, What Will I Learn?

When you have your water tested, you ore paying for an analysis that includes information about:

Total dissolved solids (TDS)
A measure of all dissolved minerals in solution (also called salinity, salt content, total mineral content, or alkali content). TDS typically ranges from fewer than 2 mg/L for distilled water to more than 20,000 mg/L **for highly saline waters.** TDS affects **taste, clarity of water, and pipe corrosion. (The Maximum Contaminant** Level is 500 mg/L.)

Nitrates
Levels greater than 10 mg/L pose an immediate threat of blood poisoning (methemoglobinemia) to infants under six months of age. Nitrate in well water may indicate contamination from agricultural practices or septic systems.

Hardness
The presence of calcium and magnesium ions that react with soap to form precipitates such as bathtub rings. A value of less than 25 mg/L is considered soft (rainwater); and values above 250 mg/L are considered very hard and require large amounts of soap to produce suds.

Alkalinity (pH)
The measure of water's capacity to neutralize acids. The acceptable alkalinity for municipal supplies is between 30 and 500 mg/L $CaCO_3$. Taste may be objectionable above 500 mg/L.

Lead
Drinking water may contain lead from soldered joints or old lead pipes. The current acceptable level is 0.015 mg/L.

Arsenic
Frequently found near mineralized areas and hot springs. The Environmental Protection Agency has set a limit of 0.050 mg/L in public drinking water supplies.

Iron
More than about 0.3 mg/L stains laundry and utensils reddish brown. Higher levels can cause unpleasant taste and aid growth of iron bacteria. Excessive iron may interfere with effectiveness of certain water softeners.

Coliform ***bacteria***
Generally are not harmful themselves but indicate that other harmful organisms may be present in water-typhoid, cholera, infectious hepatitis, parasitic protozoans.

businesses, and decreasing toxic chemical use in gardens and lawns. Other simple things that you can do to protect the integrity of water include the following.

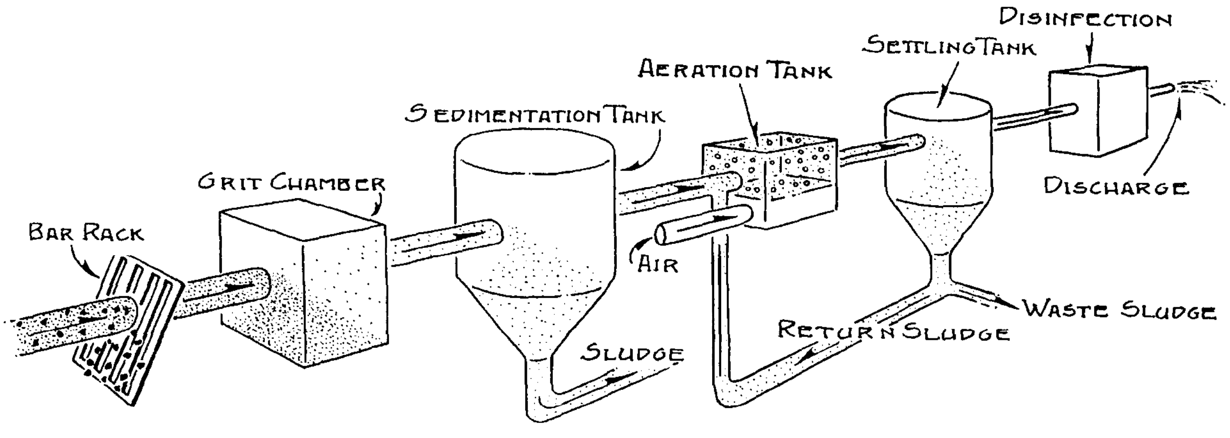
1. **Use best management practices (BMPs) at the ranch** or in small industry. For example, establish vegetation along stream banks to trap pollution from runoff; locate corrals, septic systems, and areas of heavy irrigation, pesticide use, and herbicide use away from streams, lakes, and wells.
2. **Properly dispose of chemicals** (pesticides, solvents, fertilizers, paint), and other toxic substances-and **use less.** Do not dump these substances on the ground outside homes or down the drain for treatment by a septic system or municipal wastewater treatment facility. Dispose of them at a TSD facility (a permitted hazardous waste disposal site), at a Class II landfill that can accept household hazardous wastes, or at an appropriate recycling facility. Better still, purchase only the amount of these substances needed or give the remainder to a friend who can use them up. Some towns have conducted household hazardous waste collections and paint swaps. These simple procedures save tax dollars that might be needed to clean up a bigger problem later.
3. **Use phosphate-free products** whenever possible. Build-up of phosphorus in lakes and streams can lead to overgrowth of algae and eutrophication (aquatic plant overgrowth).
4. **Conserve water** wherever possible. For example, plant native species that are naturally drought-resistant in your lawn and garden. (This is known as xeriscaping.) Conservation saves water and reduces the amount of wastewater you produce. This, in turn, prevents wear and tear on septic systems and municipal wastewater treatment plants. Conservation also reduces your water bill and can help ensure availability of water for other uses.
5. **Recycle** everything you can. Thirty-four community recycling centers across Montana accept newspaper, cardboard, aluminum, glass, plastics, and reuseables. Recycling places less stress on landfills and, in the long run, promotes the sustainable use of natural resources (trees, water, minerals). You can help further by purchasing products with minimum packaging that consume fewer resources.
6. **Analyze the water.** If your drinking water comes from a private well or if your home is old or has deteriorating pipes, you may want to have your water tested to be sure that it is suitable for drinking, bathing, washing, and cooking. Types of tests and costs vary.

Photo courtesy Mary Ellen Wolfe.

Wastewater Treatment: From Flush to Streamflow

Most of the water that we use reenters the environment, either by direct discharge to streams or by introduction into the ground water. Each person who draws water from the public water supplies uses an average of about 140 gallons of water per day (including commercial and parkland uses). Approximately 126 of those gallons ***wind up back*** *in ground or surface waters as industrial or domestic wastewater.*

Montana communities collect and treat wastewater from residences and businesses at centralized municipal treatment facilities. Of Montana's 165 wastewater treatment plants, 143 are lagoon plants. The rest are mechanical plants, requiring special equipment to treat the wastes prior to discharge. Homes not served by wastewater treatment plants have on-site disposal such as septic tanks with drain fields.

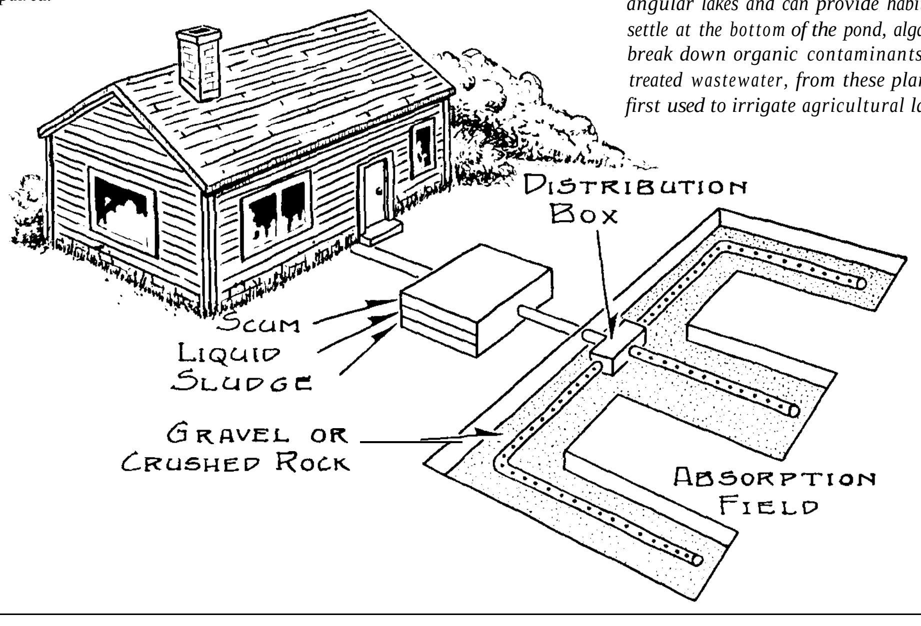


Septic Systems

Rural *residents usually have on-site septic tanks. Septic systems typically consist of a septic tank and a soil drain field. The septic tank breaks down and liquifies organic material and stores non-biodegradables. The drainfield treats the liquid effluent by further filtering out particles and breaking them down with soil bacteria.*

Approximately 120,000 individual, on-site septic systems are used by 300,000 people in Montana. When maintained properly, septic tanks provide adequate treatment. However, if too many septic systems are sited in one area, they can contaminate surface and ground water with bacteria and nutrients.

Nitrate is a common contaminant originating from septic systems. Nitrates can also come from fertilizers used on residential lawns and farmlands. When infants drink water with nitrate concentration exceeding the Maximum Contaminant Level of 10 mg/L, their circulatory system's ability to transport oxygen is impaired.



Mechanical Treatment

Larger communities treat wastewater in mechanical treatment plants that use biological processes to maximize treatment. The process typically begins with primary treatment to settle out large materials. Secondary treatment uses microorganisms to convert the remaining dissolved and suspended biodegradable organic wastes into a sludge. This stage usually includes trickling filters, activated sludge, and clarification, often followed by disinfection (ultraviolet or chlorination). Advanced treatment is more expensive but removes most additional nutrients. The Flathead basin is the only drainage in Montana **where** *advanced treatment is required of all municipal wastewater discharges. Water quality standards determine the degree oftrcaatment needed to insure adequate protection of public health and the environment before a waste is discharged.*

Lagoon Treatment

Smaller communities use lagoon treatment systems, which often look like rectangular lakes and can provide habitat for ducks and other wildlife. While solids settle at the bottom of the pond, algae produce the oxygen needed by bacteria to break down organic contaminants in the wastewater. Most of the effluent, or treated wastewater, from these plants is returned to the environment, or it is first used to irrigate agricultural land, golf courses, parks, and other areas.

For More Information

- Contact:

  -Montana Department of Environmental Quality.
  -U. S. Environmental Protection Agency.
  -Montana State University Extension or your local Extension agent.
  -Your local conservation **district office,** health department, or landfill.
  -Montana Department of Environmental Quality Waste Management Division, the Montana State University Extension Service Pollution Prevention Control Program, the Montana Material Exchange, or your county sanitarian for more information on proper disposal of hazardous wastes.
  -Department of Environmental Quality or a reputable local water testing lab to find out how to collect and submit a water sample.
- Water **Quality:** A Matter *of Choice,* Montana State University Extension Service, Pub. EB48A, 48B
- Montana *Water Quality 1994.* Montana Department of Environmental Quality.
- *Common Sense and Water Quality: A Handbook For Livestock Producers. 1994.* Montana Department of Environmental Quality.
- *Tips on Land and Water Management for Small Farms and Ranches in Montana,* Montana Department of Natural Resources and Conservation.
- *1995 Montana Recycling Directory.* Keep Montana Clean and Beautiful.
- *Onsite Wastewater Management Options for Montana Businesses.* MSU Extension Service.
- *A Catalog of Water Conservation Resources.* The Montana Watercourse, MSU-Bozeman.
- *Who Does What With Montana's Water: A Directory. 1995.* The Montana University System Water Resources Center and The Montana Watercourse.