"Water quality" is a technical term that is based upon the characteristics of water in relation to guideline values of what is suitable for human consumption and for all usual domestic purposes, including personal hygiene. Components of water quality include microbial, biological, chemical, and physical aspects.

Microbial Aspects.

Drinking water should not include microorganisms that are known to be pathogenic. It should also not contain bacteria that would indicate excremental pollution, the primary indicator of which are coliform bacteria that are present in the feces of warm-blooded organisms. Chlorine is the usual disinfectant, as it is readily available and inexpensive. Unfortunately, it is not fully effective, as currently used, against all organisms.

Biological Aspects.

Parasitic protozoa and helminths are also indicators of water quality. Species of protozoa can be introduced into water supply through human or animal fecal contamination. Most common among the pathogenic protozoans are *Entamoeba* and *Giardia*. Coliforms are not appropriate direct indicators because of the greater resistance of these protozoans to inactivation by disinfection. Drinking water sources that are not likely to be contaminated by fecal matter should be used where possible due to the lack of good indicators for the presence or absence of pathogenic protozoa. A single mature larva or fertilized egg of parasitic roundworms and flatworms can cause infection when transmitted to humans through drinking water. The measures currently available for the detection of helminths in drinking water are not suitable for routine use.

Chemical Aspects.

Chemical contamination of water sources may be due to certain industries and agricultural practices, or from natural sources. When toxic chemicals are present in drinking water, there is the potential that they may cause either acute or chronic health effects. Chronic health effects are more common than acute effects because the levels of chemicals in drinking water are seldom high enough to cause acute health effects. Since there is limited evidence relating chronic human health conditions to specific drinking-water contaminants, laboratory animal studies and human data from clinical reports are used to predict adverse effects.

Physical Aspects.

The turbidity, color, taste, and odor of water can be monitored. Turbidity should always be low, especially where disinfection is practiced. High turbidity can inhibit the effects of disinfection against microorganisms and enable bacterial growth. Drinking water should be colorless, since drinking-water coloration may be due to the presence of colored organic matter. Organic substances also cause water odor, though odors may result from many factors, including biological activity and industrial pollution. Taste problems relating to water could be indicators of changes in water sources or treatment process. Inorganic compounds such as magnesium, calcium, sodium, copper, iron, and zinc are generally detected by the taste of water, and contamination with the oxygenated fuel additive MTBE has affected the taste of some waters.

The effects of urbanization on water quality: Waterborne pathogens

Waterborne pathogens are disease-causing bacteria, viruses, and protozoans that are transmitted to people when they consume untreated or inadequately treated water. Two protozoans in the news today are Giardia and Cryptosporidium. Their consumption can lead to severe problems of the digestive system, which can be life-threatening to the very young, very old, or those with damaged immune systems.

Many cities routinely monitor urban streams to measure the amounts of bacteria that, although harmless themselves, have similar sources (animal and human waste) as do the waterborne pathogens. The harmless bacteria therefore act as indicators of the possible presence of other bacteria that are not harmless. Treated water coming out of wastewater treatment plants is also monitored for bacteria. And in some larger cities additional monitoring of drinking water has begun. Overflow of sewage cause high bacteria levels in streams.

The effects of urbanization on water quality: Sewage overflows

Many sewer lines are constructed next to streams to take advantage of the continuous, gradual slopes of stream valleys. Blockages, inadequate carrying capacity, leaking pipes, and power outages at pumping stations often lead to sewage overflows into nearby streams. There are three types of sewer systems:

1. **Storm sewers** carry storm runoff from streets, parking lots, and roofs through pipes and ditches, and eventually into streams.
2. **Sanitary sewers** carry raw sewage from homes and businesses to wastewater-treatment facilities.

Combined sewers carry a combination of raw sewage and stormwater runoff

Sanitary sewer overflows occur when sewer pipes clog or pumping stations break down. As shown here, raw sewage overflows from manholes and leaking pipes into nearby streams rather than backing up into homes and businesses.

Combined sewer overflows occur during storms when there is more storm water flowing than the pipes leading to a treatment plant can handle. The excess runoff flushes human and industrial wastes, oil, toxic metals, pesticides, and litter into streams.

The effects of urbanization on water quality: Urban runoff

Much of the rainfall in watersheds having forests and pastures is absorbed into the porous soils (infiltration), is stored as ground water, and moves back into streams through seeps and springs. Thus, in many rural areas, much of the rainfall does not enter streams all at once, which helps prevent flooding.

When areas are urbanized, much of the vegetation and top soil is replaced by impervious surfaces such as roads, parking lots, and pavement (picture at left). When natural land is altered, rainfall that used to be absorbed into the ground now must be collected by storm sewers that send the water runoff into local streams. These streams were not "designed by nature" to handle large amounts of runoff, and, thus, they can flood.

Drainage ditches to carry stormwater runoff to storage ponds are often built to hold runoff and collect excess sediment in order to keep it out of streams.

So, how can excessive urban runoff harm streams?

- Water running off of impervious areas, such as roads and parking lots, can contain a lot of contaminants, such as oil and garbage. This runoff often goes directly into streams.

- Following summer storms, runoff from heated roads and parking lots causes rapid increases in stream temperatures that can produce thermal shock and death in many fish.

- Use of stormwater impoundments and porous paving materials can reduce stormwater runoff and the movement of contaminants from roads and other areas to streams.

- Regulations and controls on the location and amount of impervious area can lessen the damage that contaminants can do to streams.

- Runoff of sand and salt used to help remove snow from roads can contaminate streams.

The effects of urbanization and agriculture on water quality: Nitrogen

Nitrogen, in the forms of nitrate, nitrite, or ammonium, is a nutrient needed for plant growth. About 78% of the air that we breathe is composed of nitrogen gas, and in some areas of the United States, particularly the northeast, certain forms of nitrogen are commonly deposited in acid rain. Although nitrogen is abundant naturally in the environment, it is also introduced through sewage and fertilizers. Chemical fertilizers or animal manure is commonly applied to crops to add nutrients. It may be difficult or expensive to retain on site all nitrogen brought on to farms for feed or fertilizer and generated by animal manure. Unless specialized structures have been built on the farms, heavy rains can generate runoff containing these materials into nearby streams and lakes. Wastewater-treatment facilities that do not specifically remove nitrogen can also lead to excess levels of nitrogen in surface or ground water. Two of the major problems with excess levels of nitrogen in the environment are:

- Excess nitrogen can cause overstimulation of growth of aquatic plants and algae. Excessive growth of these organisms, in turn, can clog water intakes, use up dissolved oxygen as they decompose, and block light to deeper waters. This seriously affects the respiration of fish and aquatic invertebrates, leads to a decrease in animal and plant diversity, and affects our use of the water for fishing, swimming, and boating.
- Too much nitrate in drinking water can be harmful to young infants or young livestock.

For information on the status and trends of nitrogen and phosphorus in the nation's surface and ground water, visit the USGS site Nutrients in the Nation's Waters--Too Much of a Good Thing? (http://water.usgs.gov/nawqa/CIRC-1136.html). This USGS circular was produced by the National Water-Quality Assessment (NAWQA) Program, which was designed to describe the status and trends in the quality of the Nation's ground- and surface-water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources.

USGS Podcast: Too Much of a Good Thing: Increasing Nitrogen Deposition in Lakes

Increasing nitrogen emissions from motor vehicles, energy production, and agriculture are being deposited in lakes throughout the world, directly affecting lake biology and associated food webs. Alpine lake ecosystems are especially vulnerable to this deposition. USGS scientist Jill Baron, co-author of two new studies on how increased nitrogen pollution can affect lake ecosystems and water quality, discusses the issue