Pathogen Control

Adapted from: *Bulletin 160-98: California Water Plan*, California Department of Water Resources

Cryptosporidium parvum outbreaks have been documented in many places throughout the world. Table 1 lists some of the most significant outbreaks documented in recent years. In 1993, approximately 403,000 persons in Milwaukee, Wisconsin, became ill from cryptosporidiosis (the disease caused by *Cryptosporidium*) in their water supply. Approximately 100 deaths resulted from this outbreak. The suspected sources of *Cryptosporidium* were cattle wastes, slaughterhouse wastes, and sewage carried by rivers tributary to Lake Michigan, the drinking water source. This outbreak was associated with operational deficiencies in the water treatment plant and presents a compelling example of the importance of maintaining the quality of source waters.

More significantly, the 1994 *Cryptosporidium* outbreak in Las Vegas, Nevada was the first documented epidemiologically-confirmed waterborne outbreak from a water system with no associated treatment deficiencies or breakdowns. During this outbreak, 78 immunocompromised persons became ill of cryptosporidiosis, even when no *Cryptosporidium* was detected in the treated drinking water.

Table 1. Significant *Cryptosporidium* Outbreaks

Year	Location	Reported Cases	Reported Deaths
1984	Braun Station, Texas	2,000	
1987	Carrollton, Georgia	13,000	
1989	Thames River area, England	100,000	
1992	Jackson County, Oregon	15,000	
1993	Milwaukee, Wisconsin	403,000	100
1994	Las Vegas, Nevada	78	16

State and federal surface water treatment rules require that all surface water supplied for drinking receive filtration, high level disinfection, or both, to inactivate or remove viruses and protozoan cysts such as *Giardia lamblia*. However, if a water supply meets certain source water quality criteria and a watershed management program exists to provide protection against these pathogens, the public water purveyor may receive an exemption from filtration requirements. The City and County of San Francisco is currently the only California water retailer exempted from filtration requirements.

Besides *Giardia* and *Cryptosporidium*, there are many other disease-causing viruses, bacteria, and protozoans. Table 2 lists some waterborne diseases of concern in the United States.

Table 2. Some Waterborne Diseases of Concern in the United States

Disease	Microbial Agent
Amebiasis	Protozoan (*Entamoeba histolytica*)
Campylobacteriosis	Bacterium (*Campylobacter jejuni*)
Cholera	Bacterium (*Vibrio cholerae*)
Cryptosporidiosis	Protozoan (*Cryptosporidium parvum*)
Giardiasis	Protozoan (*Giardia lamblia*)
Hepatitis	Virus (hepatitis A)
Shigellosis	Bacterium (*Shigella* species)
Typhoid Fever	Bacterium (*Salmonella typhi*)
Viral Gastroenteritis	Viruses (Norwalk, rotavirus, and other types)

Disinfection By-Products. As water passes over and through soils, it also dissolves organic compounds (including humic and fulvic acids) present in the soil as a result of plant decay. High levels of these compounds can be present in drainage from wooded or heavily vegetated areas and from soils high in organic content. Chlorine, when used as a disinfectant in drinking water treatment, reacts with these organic compounds to form DBPs such as trihalomethanes and haloacetic acids. Where present, bromide enters the reaction to produce bromine-containing DBPs. Table 3 lists some potential DBPs, or chemical classes of DBPs, which may be produced during disinfection of drinking water. A maximum contaminant level for total THMs for drinking water has been established by EPA and by DHS, in accordance with the federal and State Safe Drinking Water Acts. The current MCL for total THMs in drinking water is 0.10 mg/L; no MCL for haloacetic acids is currently in effect.

Under EPA's proposed Disinfectant/Disinfection By-Product Rule, the maximum contaminant level for THMs will be lowered from 0.1 to 0.08 mg/L in Stage 1 and to 0.04 mg/L in Stage 2. Stage 1 and Stage 2 of the rule are to be promulgated in November 1998 and May 2002, respectively. Stage 1 of the rule also requires conventional surface water treatment systems to remove a percentage of the DBP precursors in the influent (as measured by TOC). A new MCL of 0.06 mg/L for haloacetic acids is also expected to become effective in late 1998.

Ozone is a powerful oxidant widely used for drinking water disinfection. Its advantages are that it efficiently kills pathogens such as *Giardia* and *Cryptosporidium*, destroys tastes and odors, and minimizes production of THMs and most other unwanted DBPs. However, bromate is formed during ozone disinfection of waters containing bromide. EPA estimates that bromate may be a more potent carcinogen than THMs and haloacetic acids. A new MCL of 0.01 mg/L for bromate is expected to be effective in late 1998.

Table 3. Disinfectants and Disinfection By-Products

Disinfectant	Potential DBPs or Classes of DBPs
Chlorine	Trihalomethanes
	Halogenated acids
	Haloacetonitriles
	Halogenated aldehydes
	Halogenated ketones
	Chloropicrin
	Chlorinated phenols
Chloramine	Trihalomethanes
	Halogenated acids
	Haloacetonitriles
	Halogenated aldehydes
	Halogenated ketones
	Chloropicrin
	Chlorinated phenols
	Cyanogen chloride
Ozone	Bromate
	Brominated acids
	Formaldehyde
	Acetaldehyde
	Other aldehydes
	Carboxylic acids
	Hydrogen peroxide
Chlorine dioxide	Chlorite