



## WHAT'S ON TAP?

*Grading Drinking  
Water in U.S. Cities*

June 2003

### CRYPTOSPORIDIUM

#### HIGH CONCERN

BOSTON  
HOUSTON  
PHILADELPHIA  
SEATTLE

#### SOME CONCERN

ATLANTA  
LOS ANGELES  
SAN DIEGO  
SAN FRANCISCO  
WASHINGTON, D.C.

# COMMON TAP WATER CONTAMINANTS

## *Health Effects, Treatment, and Recommendations*

NRDC's review of city tap water quality revealed that there are several contaminants that occur with surprising regularity in tap water throughout America's cities, regardless of location—such as chlorination by-products, lead, and total coliform bacteria. Other contaminants, such as industrial chemicals, may occur less frequently but still pose major health concerns. This chapter summarizes the health concerns for and sources of many of the most common tap water contaminants.

### MICROBIOLOGICAL CONTAMINANTS

#### ***Cryptosporidium***

##### **National Standard**

Treatment Technique (TT)

##### **National Health Goal (MCLG)**

0—no known fully safe level

*Cryptosporidium* (*Crypto*) is a microbial, waterborne protozoan. It has long been known to be a parasite in humans and animals, including cattle, and is shed in feces after reproducing by the millions in the host's intestines.<sup>1</sup> *Crypto* forms a particularly robust, hard-shelled cyst that can withstand temperature extremes and even survive a dousing with pure chlorine bleach.

##### **Health Effects**

*Crypto*'s health effects include severe diarrhea for up to two weeks in otherwise healthy people, nausea, abdominal cramps, and fever. Currently, no antibiotics or other medical treatments are available to kill *Crypto*.<sup>2</sup> *Crypto* poses significant public health concerns, especially to individuals whose immune systems are weakened, including people living with HIV/AIDS, the elderly, young children, chemotherapy patients, and organ transplant patients.<sup>3</sup> Indeed, individuals who are immunocompromised can and do die from *Crypto* infection.

In 1993, high levels of *Crypto* got through the filters and treatment process at a water treatment plant in Milwaukee, Wisconsin. The plant did use poorly operated filtration and chlorine disinfection and was apparently in full compliance with all

EPA rules then in place. More than 400,000 people in Milwaukee became sick, several thousand of whom were hospitalized and approximately 100 of whom eventually died. The outbreak was the largest documented waterborne disease occurrence in U.S. history, but it is not the only such experience on record.<sup>4</sup>

In the wake of the Milwaukee incident and several other *Crypto* outbreaks, the EPA negotiated a new set of rules with industry, NRDC, health groups, state and local governments, and others that will gradually reduce the risk of such outbreaks. The new rules require improved drinking water treatment and stricter controls on turbidity (cloudy water) that can indicate poor filter performance.

Many more waterborne *Crypto* outbreaks have occurred in the United States, England, and elsewhere in the world.<sup>5</sup> Tests of healthy adult human volunteers found that even a single *Crypto* cyst carries a risk of infection. The more cysts in a glass of drinking water, the higher the risk that people will become infected.<sup>6</sup> Because a single cyst may cause infection, the EPA has established a Maximum Contaminant Level Goal (MCLG, or health goal) for *Crypto* of 0.<sup>7</sup>

### **Occurrence and Treatment**

*Crypto* is found in most surface water supplies in the United States; surveys have found it in more than 80 percent of the U.S. surface waters tested.<sup>8</sup> However, *Crypto* is difficult to detect in water, and testing methods available cannot identify with certainty whether the *Crypto* that is detected is viable—that is, that it can actually make people ill.<sup>9</sup> In addition, the current testing methods are especially poor at detecting the kind of low-level *Crypto* concentrations that might be expected in finished, or treated, drinking water. Therefore, experts say it is incorrect to assume that *Crypto* is not present in treated drinking water simply because it has not been detected.<sup>10</sup>

All large- and medium-size water utilities that use surface water must monitor for *Crypto*, report results in their right-to-know reports and use advanced treatment if they find significant levels. Chlorine disinfection of drinking water is ineffective in killing *Crypto*. Indeed, only very finely tuned filtration or state-of-the-art disinfection using ozone or intense ultraviolet light will kill *Crypto* once it is in water supplies.<sup>11</sup> Of course, the best approach is to prevent *Crypto* from getting into drinking water sources in the first place, and that requires the adoption of strong source water protection programs. However, even cities with strong source water protection—including the use of completely undeveloped watersheds—find *Crypto* at low levels in their source water, possibly from wildlife or from humans using the watershed for recreation. Low levels of *Crypto* from protected watersheds pose far lower risks than high levels such as those found downstream from concentrated animal feeding operations or other major pollution sources. Nevertheless, they still pose a risk if not dealt with through treatment. However, if filtration is operating properly and is optimized, it will reduce *Crypto* levels.

In the wake of the above, EPA has adopted an “Interim Enhanced Surface Water Treatment Rule” for cities serving more than 10,000 people that filter surface water. The rules went into effect in January 2002, and they require water filtration plants to optimize the way they operate filters and to keep turbidity levels down, demonstrating filter efficiency (see turbidity section below).<sup>12</sup>

**Recommendations for People with Weakened Immune Systems**

People who are immunocompromised or are concerned about the possibility that *Crypto* may be in their water should consult with their health care provider about finding a safe source of drinking water. The Centers for Disease Control and Prevention (CDC) recommends that people with severely compromised immune systems may wish to avoid drinking tap water. The CDC has offered detailed recommendations specifically to people with HIV/AIDS, but they are equally applicable to anyone who is seriously immunocompromised. Those recommendations are quoted in full on page 13.

**TOTAL COLIFORM BACTERIA**

**HIGH CONCERN**

- BOSTON
- DETROIT
- WASHINGTON, D.C.

**SOME CONCERN**

- ALBUQUERQUE
- ATLANTA
- CHICAGO
- DENVER
- FRESNO
- HOUSTON

**LOS ANGELES**

- MANCHESTER
- NEW ORLEANS
- NEWARK
- PHOENIX
- SAN DIEGO

**SAN FRANCISCO**

**SEATTLE**

**LITTLE OR NO CONCERN**

- PHILADELPHIA

**Total Coliform Bacteria**

**National Standard (MCL)**

5% maximum in any month<sup>13</sup>

**National Health Goal (MCLG)**

0—no known fully safe level

Total coliform bacteria is a broad class of bacteria, many of which live in the intestines of humans and animals. It is a microbial contaminant whose presence is a potential indicator that disease-causing organisms may be in tap water.

**Health Effects**

While most coliform bacteria are themselves harmless, their presence is a sign that the water may contain fecal pathogens, including noncoliform pathogens such as other forms of bacteria, viruses, or protozoa. Exposure to disease-carrying pathogens potentially indicated by the presence of coliform bacteria may cause infection, resulting in diarrhea, cramps, nausea, jaundice, headaches, and fatigue.<sup>14</sup> Some coliform bacteria, such as *Escherichia coli* (*E. coli*), are dangerously infectious organisms that can cause serious infections in exposed people. It was this type of coliform that caused the infamous Jack in the Box hamburger poisoning incidents in 1999, in which four children were killed and 700 sickened.<sup>15</sup> In an *E. coli* disease outbreak in 1989 caused by contamination in the Cabool, Missouri, drinking water supply, four people died while 243 were sickened—but the incident generated virtually no publicity.<sup>16</sup> More recently, two people died, including a three-year-old girl, at least 65 were hospitalized, and an estimated 1,061 were confirmed to have become ill as a result of the same strain of *E. coli*, when drinking water was contaminated at a county fair in upstate New York in 1999.<sup>17</sup> Again, the incident generated some publicity, but hardly the nationwide attention caused by the hamburger incidents.

**Occurrence, Treatment, and the Total Coliform Rule**

The EPA says that “the presence of coliform bacteria in tap water suggests that the treatment system is not working properly or that there is a problem in the pipes.”<sup>18</sup> The EPA therefore has adopted the Total Coliform Rule (TCR), which set the health goal for total coliform at 0. The EPA found that “since there have been waterborne disease outbreaks in which researchers have found very low levels of coliform, any level indicates some health risk.”<sup>19</sup> To avoid or eliminate microbial

contamination, water systems may need to repair their disinfection or filtration processes, flush or upgrade pipes from treatment plants to customers (their distribution system), and adopt source water protection programs to prevent contamination. The EPA's TCR says that when water system tests reveal that more than 5 percent of monthly samples contain coliforms, system operators are required to report that violation to their state and the public.<sup>20</sup> If a water system finds that any sample contains total coliform, the TCR requires it to collect "repeat samples" within 24 hours.<sup>21</sup> When a sample tests positive for total coliforms, it must also be analyzed for fecal coliforms and *E. coli*.<sup>22</sup> If fecal coliform or *E. coli* are found, the incident is deemed an "acute violation," triggering a requirement that the system rapidly notify the state and the public, because such a violation "represents a direct health risk," according to the EPA.<sup>23</sup> Big city water systems are required to test for coliform far more often than small systems. Water suppliers serving fewer than 1,000 people may test once a month or less frequently, but systems with 50,000 customers must test 60 times per month, and those with 2.5 million customers must test at least 420 times per month.<sup>24</sup>

### **Recommendations for People with Weakened Immune Systems**

People with weak immune systems, including some infants, elderly people, organ transplant or cancer chemotherapy patients, and people living with HIV/AIDS, are at special risk from the pathogens whose presence may be indicated by total coliform.<sup>25</sup> In some cases, immunocompromised people can die from consuming water containing dangerous bacteria.<sup>26</sup>

Total coliform violations are a common trigger for boil-water orders issued in the United States. When total coliform levels are repeatedly high in a public water system, it is an indication that the system may pose serious risks, particularly to people with immune system problems. The CDC has offered detailed recommendations specifically to people with HIV/AIDS, but they are equally applicable to anyone who is seriously immunocompromised. The recommendations made by CDC regarding immunocompromised people taking action to avoid *Crypto* are equally applicable to water that has a high risk of *E. coli* or other pathogen contamination that may be indicated by boil-water alerts or total coliform violations. Those recommendations are quoted in full on page 13.

### **Turbidity (Cloudiness)**

#### **National Standards (TT) (in Nephelometric Turbidity Units, or NTU)**

##### *Filtered water*

0.5 NTU, 95% of the time (through 2001)

0.3 NTU, 95% of the time (as of 2002)

1 NTU, 100% of the time (as of 2002)

##### *Unfiltered water*

5 NTU maximum, 100% of the time

Turbidity is a measure of the cloudiness of water, often the result of suspended mud or organic matter, and may sometimes indicate that the water is contaminated

### **TURBIDITY**

#### **HIGH CONCERN**

ATLANTA  
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SEATTLE

with *Cryptosporidium* or other pathogens. In addition, turbidity can interfere with disinfection of the water because it can impede the effectiveness of chlorine or other chemical disinfectants.

### **Health Effects**

According to the EPA, “higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.”<sup>27</sup> Indeed, it was a spike in the level of turbidity at a Milwaukee treatment plant that indicated the city had a serious problem with its drinking water just before the 1993 *Crypto* outbreak that sickened 400,000 and killed approximately 100 people.<sup>28</sup> It is important, therefore, to remember that disease-carrying organisms that may be present during turbidity spikes can pose special, even mortal, threats to people with weakened immune systems.

### **Treatment and Regulation**

From 1989 until 2002, the EPA had a lax standard for turbidity in filtered drinking water, allowing up to 5 NTU as a maximum and requiring only that water systems maintain 0.5 NTU 95 percent of the time. (Most cities take samples every hour or every few hours.<sup>29</sup>) The laxity of this old standard was made all too clear by the Milwaukee outbreak. According to some investigators, although Milwaukee had a spike in turbidity, it reportedly did not violate the EPA standard during the outbreak.<sup>30</sup> In 1998, after an extensive set of regulatory negotiations among the EPA, the water industry, NRDC, health groups, and others, the EPA issued the Interim Enhanced Surface Water Treatment Rule, establishing a new turbidity standard for large filtered water systems serving more than 10,000 people. Under the new rules, which went into effect in 2002, large filtered systems can never exceed 1 NTU (down from the previous maximum of 5) and must achieve a limit of 0.3 NTU or less in at least 95 percent of its samples. In 2000, regulatory negotiators agreed to a rule to reduce *Crypto* and turbidity problems in smaller filtered systems; NRDC holds that this rule was legally required to have been issued, but the Bush administration has failed even to publish the proposal in *The Federal Register*.<sup>31</sup> Because the rules for unfiltered surface water systems have not been updated, unfiltered systems need only meet the old and outdated 5 NTU maximum limit, the Milwaukee experience notwithstanding.

### **Recommendations for People with Weakened Immune Systems**

Like coliform violations, turbidity violations often trigger boil-water orders. When turbidity levels are repeatedly high in a public water system, it is an indication that the system’s filters are not being well operated or maintained or, if the system is unfiltered, that its source water is not as well protected as it should be. Whichever is the case, the circumstance may pose serious risks, particularly to people with immune system problems. The recommendations made by CDC regarding immunocompromised people taking action to avoid *Crypto* are equally applicable to water

that has a high risk of significant turbidity spikes and violations. Those recommendations are quoted in full on page 13.

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## INORGANIC CONTAMINANTS

### Arsenic

#### National Standard (MCL)

50 ppb (average) through 2005

10 ppb (average) effective in 2006

#### National Health Goal (MCLG)

0—no known fully safe level

Arsenic in drinking water supplies comes from mining, industrial processes, past use of arsenic-containing pesticides, and natural leaching or erosion from rock. Recent studies indicate that heavy pumping of groundwater can actually increase arsenic levels in some cases, perhaps because the pumping allows oxygen to reach the arsenic source, permitting oxidization and mobilization of the poison.

#### Health Effects

Arsenic is toxic to humans and causes cancer, and for this reason, no amount of arsenic is considered fully safe. Many scientific studies, including no fewer than seven reviews of the problem by the National Academy of Sciences (NAS), have determined that arsenic in drinking water is known to cause cancer of the bladder, skin, and lungs; likely causes other cancers; and is responsible for a variety of other serious health ailments. The NAS reviews culminated in the important recent reports *Arsenic in Drinking Water* (issued in 1999) and *Arsenic in Drinking Water: 2001 Update*, which counter the long-standing water utility and industry arguments that arsenic in tap water poses no significant threat.<sup>32,33</sup> The NAS found in its 2001 report that a person who drinks two liters of water a day containing 10 ppb arsenic—the new EPA standard—has a lifetime total fatal cancer risk greater than 1 in 333 (that is, about 1 in 333 people who drink water containing this level of arsenic will die of arsenic-caused cancer).<sup>34</sup> The EPA traditionally has allowed no greater than a 1 in 10,000 lifetime fatal cancer risk for any drinking water contaminants. In other words, the risk level allowed by the new arsenic standard is more than 30 times higher than what the EPA traditionally allows in tap water. NAS's risk estimates were more than 10 times higher than the estimates the EPA used to justify its new January 2001 standard (see below). This 2001 NAS report's staggering findings likely would have been major news across the nation, but they were released on September 11, 2001.<sup>35</sup>

#### Treatment and Regulation

Arsenic can readily be removed from drinking water with off-the-shelf treatment technology, including activated alumina and membrane treatment.<sup>36</sup> According to the EPA, the cost of using current, easily available treatment for arsenic is less than \$2 per household per month for city water customers.<sup>37</sup> A working group of

### ARSENIC

#### HIGH CONCERN

ALBUQUERQUE

HOUSTON

PHOENIX

#### SOME CONCERN

FRESNO

LOS ANGELES

#### LITTLE OR NO CONCERN

DETROIT

NEW ORLEANS

the National Drinking Water Advisory Council, appointed by the Bush administration in 2001 to review these EPA estimates (in light of industry allegations that the EPA had grossly underestimated arsenic treatment costs), found the EPA's estimates "credible" and noted that newer technologies, such as granular ferric hydroxide and other cutting-edge treatments may bring even these already quite affordable costs of treatment down.<sup>38</sup> More than 60 years ago, in 1942, the Public Health Service issued a 50 ppb arsenic guideline. The EPA adopted that guideline in 1975, and this extremely lax tap water standard remains applicable today.<sup>39</sup> After the EPA missed at least three statutory deadlines to update the standard, and after NRDC sued the EPA to get the agency to move forward with issuing a new arsenic rule, the Clinton administration finally adopted the new arsenic standard (a Maximum Contaminant Level) of 10 ppb in January 2001.<sup>40</sup> That standard becomes effective in 2006.

However, upon taking office, the Bush administration suspended the EPA's new arsenic standard, responding to pleas from the mining industry and utilities and arguing that the EPA had overestimated arsenic's risks and underestimated the rule's costs. A public outcry ensued, and the NAS issued a study, at the Bush administration's behest, finding that the EPA had actually underestimated cancer risks tenfold.<sup>41</sup> The NAS's finding ought to have led to a standard lower than 10 ppb, but the Bush administration moved hurriedly to ratify the Clinton administration standard instead.

NRDC and many public health and medical group activists recommend a standard of 3 ppb because it is the lowest level deemed achievable by the EPA in using existing treatment technology. The NAS found that arsenic in tap water, even at 3 ppb, poses a cancer risk of about 1 in 1,000<sup>42</sup>—which is 10 times higher than what the EPA traditionally allows for any single tap water contaminant; this is a significant concern for human health.

**CHROMIUM**  
**SOME CONCERN**  
 LOS ANGELES  
 PHOENIX  
 SAN DIEGO

### ***Chromium***

#### **National Standard (MCL)**

100 ppb (average)

#### **National Health Goal (MCLG)**

100 ppb

Chromium is a naturally occurring metal used in industrial processes, including metal plating for chrome bumpers and making stainless steel, paint, rubber, and wood preservatives.<sup>43</sup>

### **Health Effects**

Health effects from human exposure to chromium range from skin irritation to damage to kidney, liver, and nerve tissues. A heated debate has taken shape recently over whether states and the EPA should adopt a separate standard for Chromium VI (hexavalent chromium), a form of chromium known to cause cancer when inhaled. The EPA has refused so far to consider it a carcinogen when it is consumed in tap water.<sup>44</sup>

### Treatment and Regulation

The EPA has found that chromium can be removed from drinking water through coagulation/filtration, ion exchange, reverse osmosis, and lime softening.<sup>45</sup>

### Cyanide

#### National Standard (MCL)

200 ppb (average)

#### National Health Goal (MCLG)

200 ppb

A well-known poison, cyanide is a nitrogen-carbon compound.<sup>46</sup> Cyanide is used in various forms in mining, steel and metal manufacturing, and to make resin, nylon, and other synthetic fibers.<sup>47</sup> Also, chlorination treatment of some wastewater can create cyanide, according to the EPA.<sup>48</sup>

### Health Effects

The EPA says short-term exposure to cyanide at levels above the standard can cause rapid breathing, tremors, and other neurological effects, and long-term exposure can cause weight loss, thyroid effects, and nerve damage.<sup>49</sup>

### Treatment and Regulation

Cyanide can be removed from drinking water with reverse osmosis membranes and ion exchange. In some cases, chlorine will assist in its removal.

### Lead

#### National Standard (TT)

15 ppb (action level, at 90th percentile)<sup>50</sup>

#### National Health Goal (MCLG)

0 ppb—no known fully safe level

Lead is a heavy metal that generally enters drinking water supplies from the corrosion of pipes, plumbing, or faucets.

### Health Effects

Lead is a major environmental threat and is often referred to as the number one environmental health threat to children in the United States. No amount of it is considered safe.<sup>51</sup> Infants, young children, and pregnant women's fetuses are particularly susceptible to the adverse health effects of lead. Lead poisoning can cause permanent brain damage in serious cases, and in less severe cases can cause children to suffer from decreased intelligence and problems with growth, development, and behavior. Lead can also increase blood pressure, harm kidney function, adversely affect the nervous system, and damage red blood cells.<sup>52</sup>

One way lead enters drinking water supplies is from the corrosion of water utility pipes in the distribution system—the system of pipes through which water reaches consumers' homes from the water utility, including water mains and their connectors, service lines (between the main and the home), goosenecks (which connect service

### CYANIDE

#### SOME CONCERN

WASHINGTON, D.C.

### LEAD

#### EXCEEDS ACTION LEVEL

BOSTON

NEWARK

SEATTLE

#### HIGH CONCERN

BALTIMORE

LOS ANGELES

MANCHESTER

PHILADELPHIA

WASHINGTON, D.C.

#### SOME CONCERN

ATLANTA

CHICAGO

DENVER

DETROIT

FRESNO

HOUSTON

PHOENIX

SAN DIEGO

SAN FRANCISCO

#### LITTLE OR NO CONCERN

NEW ORLEANS

lines to the main), and water meters. Lead can also leach from pipes or faucets in homes, schools, and businesses.

**Treatment and Regulation**

The easiest way for cities to reduce lead levels in tap water is to treat their water using corrosion control. This approach involves adjusting the water’s pH upward—that is, making it less acidic—by adding a chemical such as lime and thereby decreasing the likelihood of lead leaching from pipes. Many water utilities also add an orthophosphate, such as zinc orthophosphate, that forms a thin coating on the inside of utility and household pipes, thus reducing corrosion. The EPA’s lead and copper rule requires city water systems to reduce lead levels at the tap by optimizing corrosion control for their water, which reduces its ability to corrode pipes and therefore to leach lead into tap water.

The EPA has also adopted an action level standard for lead that is different from the standard for most other contaminants.<sup>53</sup> Water utilities are required to take many samples of lead in tap water, including some samples at identified high-risk homes—those that are likely to have high lead because they are old and have lead plumbing components, or in the case of homes built after 1982, because they have lead-soldered copper pipes likely to be heavy lead leachers.<sup>54</sup> The actual number of required samples is determined by system size; a large city generally must take at least 100 samples. If the amount of lead detected in the samples exceeds 15 ppb at the 90th percentile—which is to say that 10 percent or more of taps tested have 15 ppb or more of lead—then the amount is said to exceed the action level. A water system that exceeds the action level is not necessarily in violation, but additional measures are required, such as chemical treatment to reduce the water’s ability to corrode pipes and thus its ability to leach lead from pipes. If such chemical treatment does not work, the water system must then replace lead portions of its distribution system, including lead service lines and goose-necks owned by the water system, if they are still contributing to the lead problem.

In addition, Congress amended the Safe Drinking Water Act (SDWA) to ban high-lead solder (more than 0.2 percent lead) and high-lead plumbing (over 8 percent lead), but this plumbing can still contribute significantly to lead contamination of tap water.<sup>55</sup> An NSF standard for lead in plumbing, adopted by most states, is supposed to help on this front, but testing by NRDC and others has found lead leaching at high levels from faucets and water meters since Congress amended the SDWA. NRDC sued the faucet and water-meter manufacturers under a stricter California law (Proposition 65) and agreed to a settlement to phase out lead from faucets and water meters.

**NITRATE**  
**HIGH CONCERN**  
 FRESNO  
 PHOENIX  
**SOME CONCERN**  
 PHILADELPHIA  
**LITTLE OR NO CONCERN**  
 LOS ANGELES

***Nitrate***

**National Standard (MCL)**

10 ppm (two-sample average within 24 hours)

**National Health Goal (MCLG)**

10 ppm

Nitrates are the product of fertilizers and human or animal waste. Elevated levels of nitrates in water generally result from agricultural runoff from dairy and

cattle farms or concentrated animal feeding operations, and from fields heavily fertilized with inorganic nitrogen fertilizer or overfertilized with manure.<sup>56</sup> High levels of nitrate contamination also can come from septic tanks and sewage.<sup>57</sup>

### **Health Effects**

Infants who drink water containing excessive nitrates for even a short period of time can develop blue baby syndrome, in which nitrate poisoning prevents their blood from holding oxygen.<sup>58</sup> Shortness of breath, nausea, vomiting, diarrhea, lethargy, loss of consciousness, and even death can result from infants' exposure to high levels of nitrates in water.<sup>59</sup> Pregnant women are also particularly vulnerable to high nitrate levels in drinking water, again because it can affect the ability of their blood to carry oxygen.<sup>60</sup> The medical literature continues to report deaths and serious illnesses of infants fed formula made with nitrate-contaminated water.<sup>61</sup> In addition, recent literature suggests that pregnant women who drink nitrate-contaminated water can have miscarriages possibly caused by the contaminant.<sup>62</sup> Moreover, a comprehensive study conducted by the California Birth Defects Monitoring Program discovered an association between nitrate exposure and increased risk of neural tube defects.<sup>63</sup> The study found that pregnant women whose drinking water contained nitrates above the regulatory standard faced a fourfold increase in the risk of anencephaly—absence of the brain—in their developing fetus.

In addition to these short-term effects, several chronic effects of elevated nitrate levels have also been observed. According to the EPA, drinking water containing nitrates at levels above the Maximum Contaminant Level (MCL) for a prolonged period has “the potential to cause . . . diuresis, increased starchy deposits, and hemorrhaging of the spleen.”<sup>64</sup> In addition, indications are that breakdown products of nitrates called N-nitrosamines and compounds that form when nitrates react with pesticides with which they commonly co-occur (the nation's most used pesticide, the corn herbicide atrazine, among them) may cause cancer.<sup>65</sup>

### **Treatment and Standard**

The EPA set the MCLG and MCL for nitrate at 10 ppm. Because it is an acute toxin, no long-term averaging is allowed; one confirmation sample, taken within 24 hours of a sample showing a level over 10 parts per million, is allowed. The EPA's nitrate standard remains controversial. Many European and other nations have adopted a standard allowing less than half the nitrates the EPA permits.<sup>66</sup> While a National Academy of Sciences review conducted in 1995 concluded that the EPA's 10-parts-per-million health goal and standard were protective of health,<sup>67</sup> that conclusion may not be justified in light of emerging evidence of nitrates' possible reproductive and other toxicity and nitrosamines' potential cancer risks.<sup>68</sup> Clearly, the current EPA nitrate MCL and MCLG leave virtually no margin of safety, since blue baby syndrome has been observed in infants who drink water containing nitrates at 12 parts per million or possibly lower concentrations.<sup>69</sup>

**PERCHLORATE****HIGH CONCERN**

LOS ANGELES  
PHOENIX  
SAN DIEGO

**Perchlorate****National Standard (MCL)**

None established

**National Draft Safe Level (“Drinking Water Equivalent Level” or DWEL)<sup>70</sup>**

1 ppb

Perchlorate is an inorganic contaminant that usually comes from rocket fuel spills or leaks at military facilities. Perchlorate contaminates the tap water of much of southern California via the Metropolitan Water District’s Colorado River Aqueduct. It also is in the water of Phoenix, Las Vegas, and many other cities and towns reliant upon the Colorado River for their water. The source of the Colorado’s contamination is reportedly a Kerr-McGee site in Henderson, Nevada, where perchlorate was manufactured and whose waste leaks into the Colorado River.<sup>71</sup> Perchlorate also contaminated water sources for many other towns and cities across the nation, where it has been manufactured or used at military bases or in commercial applications. In addition to its heavy use in rocket fuel, perchlorate is also used, in far lower quantities, in a variety of products and applications, including electronic tubes, automobile air bags, leather tanning, and fireworks.<sup>72</sup>

**Health Effects**

Perchlorate harms the thyroid and may cause cancer.<sup>73</sup> According to the EPA, perchlorate:

*disrupts how the thyroid functions. In adults, the thyroid helps to regulate metabolism. In children, the thyroid plays a major role in proper development in addition to metabolism. Impairment of thyroid function in expectant mothers may impact the fetus and newborn and result in effects including changes in behavior, delayed development, and decreased learning capability. Changes in thyroid hormone levels may also result in thyroid gland tumors. [The EPA finds that] perchlorate’s disruption of iodide uptake is the key event leading to changes in development or tumor formation.<sup>74</sup>*

**Standard**

There is no national standard for perchlorate. In early 2002, the EPA proposed a reference dose, (a level the EPA says is safe) and with that as a basis, estimated that the “drinking water equivalent level” (DWEL)—essentially the highest safe dose in tap water—should be 1 ppb. The EPA appears reluctant to establish a permanent standard of any sort, however. It now maintains that it does not yet know enough to warrant establishing a standard and will continue studying the problem.<sup>75,76</sup> In the meantime, as many as 20 million Americans (or more) have perchlorate in their tap water, a circumstance that the EPA’s own draft risk assessment acknowledges is an unacceptable risk.

**THALLIUM****SOME CONCERN**

ALBUQUERQUE

**Thallium****National Standard (MCL)**

2 ppb (average)

**National Health Goal (MCLG)**

0.5 ppb

Thallium is a trace metal often associated with copper, gold, zinc, and cadmium and is found in rock and in ores containing these other commercially used metals.<sup>77</sup> Thallium is used principally in electronic research equipment.<sup>78</sup> The EPA reports that thallium pollution sources include gaseous emissions from cement factories, coal burning power plants, and metal sewers.<sup>79</sup> The chief source of thallium in water is ore processing—the metal leaches out during processing.<sup>80</sup>

#### **Health Effects**

High exposure to thallium for a short period can cause gastrointestinal irritation and nerve damage.<sup>81</sup> Of even greater concern are the long-term effects of exposure over time, even at lower levels (but still above the EPA standard): changes in blood chemistry; damage to the liver, kidney, intestines, and testicles; and hair loss.<sup>82</sup>

#### **Treatment**

Thallium can be removed from tap water with activated alumina, ion exchange, or reverse osmosis.

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## **ORGANIC CONTAMINANTS**

### **Atrazine**

#### **National Standard (MCL)**

3 ppb (average)

#### **National Health Goal (MCLG)**

3 ppb

Atrazine is among the most widely used pesticides in this country, applied to corn and other crops to protect from broad-leaved and grassy weeds.<sup>83</sup> Atrazine enters source waters through agricultural runoff, and also volatilizes, or evaporates, and is then redeposited with rain.<sup>84</sup> It is among the most commonly detected pesticide in drinking water, particularly during spring runoff season throughout most of the Mississippi River basin and virtually anywhere else that corn is grown.<sup>85</sup>

#### **Health Effects**

Atrazine is an animal carcinogen.<sup>86</sup> According to the EPA, short-term human exposure to atrazine may cause prostate cancer; congestion of the heart, lungs, and kidneys; low blood pressure; muscle spasms; weight loss; and damage to the adrenal glands.<sup>87</sup> Over the long term, the EPA reports, atrazine may cause weight loss, cardiovascular damage, retinal and some muscle degeneration, and possibly cancer.<sup>88</sup> In addition, as noted above, atrazine is a known endocrine disrupter, meaning that it interferes with the body's hormonal development and may cause cancer of the mammary gland.<sup>89</sup>

#### **Treatment and Standard**

Atrazine can be removed from tap water through the use of granular activated carbon, powdered activated carbon, or reverse osmosis.

**ATRAZINE**  
**SOME CONCERN**  
NEW ORLEANS  
PHILADELPHIA

The EPA recently reversed its previous judgment of atrazine's hazards and downgraded it from a "probable" to a "possible" carcinogen in humans, but new evidence collected about its link to prostate cancer in workers and its ability to harm the reproductive system as an endocrine disrupter have called the EPA's actions into question.<sup>90</sup> The EPA determined in 2002 that the chemical cousins triazine pesticides— atrazine, simazine, and propazine, and several of their degradates—all share a "common mechanism of toxicity," which is to say that they all poison the body in the same way.<sup>91</sup> However, the EPA has yet to take action to reduce allowable tap water or other exposure levels to these chemicals in combination. Moreover, in an early 2003 EPA announcement, the agency said that it would continue to allow atrazine to be used even if it causes serious drinking water contamination, well above EPA tap water standards.

**CIS-1,2-DICHLOROETHYLENE**  
LITTLE OR NO CONCERN  
FRESNO

***Cis-1,2-Dichloroethylene***

**National Standard (MCL)**

70 ppb (average)

**National Health Goal (MCLG)**

70 ppb

Cis-1,2-Dichloroethylene is a volatile organic chemical that reaches drinking water supplies as discharge from industrial chemical factories.

**Health Effects**

Cis-1,2-Dichloroethylene is linked with liver and nervous system problems.<sup>92</sup>

**Treatment and Standard**

The federal Maximum Contaminant Level (MCL) and health goal for the chemical are both 70 ppb, with averaging allowed.

**DBCP**  
SOME CONCERN  
FRESNO

***Dibromochloropropane (DBCP)***

**National Standard (MCL)**

200 ppt (average)

**National Health Goal (MCLG)**

0—no known fully safe level

DBCP is a banned pesticide still detected in some cities' tap water.

**Health Effects**

DBCP has been shown to cause cancer, kidney and liver damage, and atrophy of the testes leading to sterility.<sup>93</sup>

**Treatment and Standard**

DBCP can be removed from water with granular activated carbon, reverse osmosis, and certain other treatments. The enforceable standard is an average of 200 parts per trillion. DBCP has been shown to cause cancer, kidney and liver damage, and atrophy of the testes leading to sterility.

### **Dichloromethane (DCM)**

#### **National Standard (MCL)**

5 ppb (average)

#### **National Health Goal (MCLG)**

0—no known fully safe level

Dichloromethane (DCM) is an industrial chemical used as a paint remover, solvent, and cleaning agent; as a fumigant for strawberries and grains; and to extract substances from food.<sup>94</sup> It is sometimes discharged by the pharmaceutical and chemical industries.<sup>95</sup>

#### **Health Effects**

The EPA has found that exposure to dichloromethane over a relatively short term at levels exceeding the EPA's standard potentially causes damage to the nervous system and to blood.<sup>96</sup> Over the long term, the EPA says, dichloromethane has the potential to cause liver damage and cancer.<sup>97</sup>

#### **Treatment**

DCM can be removed from drinking water by granular activated carbon in combination with packed tower aeration or by reverse osmosis.

### **2,2-Dichloropropane (2,2-DCP)**

#### **National Standard (MCL)**

None

#### **National Health Goal (MCLG)**

None

2,2-Dichloropropane (2,2-DCP) is a volatile organic chemical that evaporates at room temperature and is found in a few drinking water supplies, most of which are reliant on groundwater sources. It was once used as a soil fumigant by the farming industry.

#### **Health Effects**

Although its isomer 1,2-dichloropropane is linked to liver problems and cancer, NRDC has been unable to find specific studies on the health effects of low level exposure to the chemical.

#### **Treatment and Standard**

2,2-DCP can be removed from water with activated carbon in combination with packed tower aeration.

### **Di-(2-Ethylhexyl)phthalate (DEHP or Phthalate)**

#### **National Standard (MCL)**

6 ppb (average)

#### **National Health Goal (MCLG)**

0—no known fully safe level

#### **DCM**

**SOME CONCERN**  
PHILADELPHIA

#### **2,2-DCP**

**LITTLE OR NO CONCERN**  
FRESNO

#### **DEHP**

**SOME CONCERN**  
PHILADELPHIA  
PHOENIX  
WASHINGTON, D.C.

Di-(2-Ethylhexyl)Phthalate (DEHP) is a plasticizing agent used widely in the chemical and rubber industries. It is also contained in many plastics.<sup>98</sup>

### Health Effects

The EPA has listed it as a probable human carcinogen, but it also causes damage to the liver and testes. As a result, the agency set a health goal of 0 for DEHP.<sup>99</sup>

### Treatment and Standard

DEHP can be removed from drinking water with granular activated carbon or reverse osmosis.

## EDB

### SOME CONCERN

FRESNO  
SAN DIEGO

## HAAs

### HIGH CONCERN

ATLANTA  
BALTIMORE  
BOSTON  
HOUSTON  
LOS ANGELES  
NEWARK  
PHILADELPHIA  
SAN DIEGO  
WASHINGTON, D.C.

### SOME CONCERN

ALBUQUERQUE  
CHICAGO  
DETROIT  
MANCHESTER  
NEW ORLEANS  
PHOENIX  
SAN FRANCISCO  
SEATTLE

### LITTLE OR NO CONCERN

CHICAGO  
DENVER

### Ethylene Dibromide (EDB)

#### National Standard (MCL)

50 ppt (average)

#### National Health Goal (MCLG)

0—no known fully safe level

Ethylene Dibromide (EDB) is used as an additive in gasoline, as a pesticide, in waterproofing preparations, and as a solvent in resins, gums, and waxes.<sup>100</sup>

### Health Effects

The EPA has found EDB to “potentially cause the following health effects when people are exposed to it at levels above the MCL for relatively short periods of time: damage to the liver, stomach, and adrenal glands, along with significant reproductive system toxicity, particularly the testes.”<sup>101</sup> The EPA also says that “EDB has the potential to cause the following effects from a lifetime exposure at levels above the MCL: damage to the respiratory system, nervous system, liver, heart, and kidneys; cancer.”<sup>102</sup>

### Treatment

EDB can be removed from water with granular activated carbon or reverse osmosis.

### Haloacetic Acids (HAAs)/Total Trihalomethanes (TTHMs)

#### HAAs National Standard (MCL)

60 ppb (average) (effective 2002; no previous standard)

#### HAAs National Health Goal (MCLG)

0—no known fully safe level<sup>103</sup>

#### TTHMs National Standard (MCL)

80 ppb (average) (effective 2002)

100 ppb (average) (effective through 2001)

#### TTHMs National Health Goal (MCLG)

0—no known fully safe level<sup>104</sup>

Total trihalomethanes (TTHMs) and haloacetic acids (HAAs) are volatile organic contaminants often referred to as disinfection by-products, or DBPs. TTHMs and HAAs are chemical contaminants that result when chlorine used to disinfect drinking

## TTHMs

### VIOLATION

SAN FRANCISCO

### HIGH CONCERN

BOSTON  
HOUSTON  
LOS ANGELES  
MANCHESTER  
NEWARK  
PHILADELPHIA  
PHOENIX  
SAN DIEGO  
SEATTLE  
WASHINGTON, D.C.

### SOME CONCERN

ALBUQUERQUE  
ATLANTA  
BALTIMORE  
DENVER  
DETROIT  
NEW ORLEANS

### LITTLE OR NO CONCERN

CHICAGO  
FRESNO

water interacts with organic matter in the water. TTHMs consist of a sum of the levels of four closely related chemicals—chloroform, dibromochloromethane, bromoform, and bromodichloromethane—which occur together at varying ratios when water is chlorinated. HAAs regulated by the EPA include five related chemicals: mono-chloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. TTHMs are used as an indicator of a complex soup of other potentially risky DBPs or “chlorination by-products.”

### **Health Effects**

More than a dozen epidemiological studies of people who drank water containing chlorination by-products have linked the chemicals to bladder cancer, and several studies indicate likely links to colorectal, pancreatic, and other cancers.<sup>105</sup> National Cancer Institute epidemiologists found links to brain cancer recently, and a link to childhood leukemia has been noted in a recent Canadian epidemiological study.<sup>106,107</sup> The EPA has classified some individual TTHMs as probable human carcinogens.

Recent studies have also found that some pregnant women exposed to DBPs in tap water may have a higher risk of problems with their babies, even after relatively brief periods of exposure to spikes of the chemicals. The most significant concerns raised by studies of pregnant women have been about findings of associations between elevated levels of chlorination by-products (including TTHMs) and low birth weight, preterm delivery, spontaneous abortions (miscarriages), stillbirths, and birth defects (central nervous system, major cardiac, oral cleft, respiratory, and neural tube defects).<sup>108</sup> For example, one study in California found a significant association between women who drank more than six glasses of water a day containing more than 75 ppb TTHMs and miscarriages by those women.<sup>109</sup> Lab studies on animals and studies of pregnant women exposed to chlorination by-products have also found an association between TTHMs and low birth weight.<sup>110</sup> The evidence that chlorination by-products cause miscarriages, birth defects, low birth weight, or other reproductive problems is not conclusive but raises major concerns worthy of preventative action to reduce or eliminate exposure to these chemicals. As one recent scientific review concluded, several studies have “shown associations for DBPs and other outcomes such as spontaneous abortions, stillbirth, and birth defects, and although the evidence for these associations is weaker, it is gaining weight.”<sup>111</sup>

### **Treatment and Standard**

Two TTHMs (bromoform and bromodichloromethane) and dichloroacetic acid have health goals of 0 because of cancer risks. In addition, the EPA promulgated and then withdrew after a court decision a 0 health goal for chloroform. It has not yet issued a new goal for chloroform. Since water systems generally report only the combined TTHM level, and since it is essentially chemically impossible to create one trihalomethane or one haloacetic acid in tap water without some level of the others, NRDC lists the health goal for TTHMs and HAAs as 0. In 1979, the EPA announced an “interim” tap water standard for TTHMs of 100 ppb that allows systems to test across their distribution systems every quarter, averaging the levels

across time and across the distribution system, and that exempts systems serving fewer than 10,000 people.<sup>112</sup> After complaints that the interim standard was too lax, the EPA said it would promptly review it. After many years of debate, and a 1994 agreement in a regulatory negotiation among the EPA, the water industry, NRDC, other health and consumer groups, states, and others, the EPA agreed to issue a “Stage 1 DBP Rule” that would strengthen the standard to 80 ppb and set a 60 ppb standard for HAAs.<sup>113</sup> The EPA published the final rule embodying that agreement in 1998. The EPA also agreed in the regulatory negotiations to propose a reduction to 40 ppb TTHMs and 30 ppb HAAs as a “Stage 2 DBP Rule,” which is legally overdue.<sup>114</sup>

Following a subsequent regulatory negotiation among most of the same parties, the EPA agreed to rework how the standards would be measured, putting much more emphasis on reducing peak TTHM and HAA levels, due to concerns about reproductive hazards, but left the actual MCL numbers in place.<sup>115</sup> The new standard would have the effect of substantially reducing the highest peaks in DBPs, and would also, the technical experts agreed, substantially reduce the average levels of DBPs in those systems, smoothing out their peak levels.<sup>116</sup> The EPA has missed the deadline for issuing that new standard, and in fact has not even published the proposal in *The Federal Register*.

**HEX**  
LITTLE OR NO CONCERN  
PHILADELPHIA

### **Hexachlorocyclopentadiene (HEX)**

#### **National Standard (MCL)**

50 ppb (average)

#### **National Health Goal (MCLG)**

50 ppb

Hexachlorocyclopentadiene is an industrial chemical used to make other chemicals, including pesticides, flame retardants, resins, dyes, pharmaceuticals, and plastics.<sup>117</sup>

#### **Health Effects**

According to the EPA, short-term exposure to high levels of HEX causes gastrointestinal distress and liver, kidney, and heart damage. Prolonged exposure, again according to the EPA, has the potential to cause long-term damage to the stomach and kidneys.<sup>118</sup>

#### **Treatment and Standard**

HEX can be removed from tap water with granular activated carbon combined with packed tower aeration or by reverse osmosis.

**MTBE**  
SOME CONCERN  
MANCHESTER  
LITTLE OR NO CONCERN  
SAN DIEGO

### **Methyl Tertiary-Butyl Ether (MTBE)**

#### **National Standard (MCL)**

None

#### **National Health Goal (MCLG)**

None

### **EPA Health Advisory**

20–40 ppb (based on taste and odor concerns; the EPA says safe health level is higher)

MTBE is a fuel additive, commonly used in the United States to reduce carbon monoxide and ozone levels caused by auto emissions.<sup>119</sup> Because of its widespread use, reports of MTBE detections in the nation's groundwater and surface water supplies are increasing.<sup>120</sup> MTBE gets into water supplies from leaking underground or aboveground storage tanks, spills, pipeline leaks, refineries, inefficient boat and other watercraft engines, runoff from streets, and even atmospheric deposition.<sup>121</sup>

### **Health Effects**

For several years running, the EPA has maintained that it is currently studying the implications of setting a drinking water standard for MTBE. There are numerous animal studies showing possible cancer and other adverse health effects of MTBE.<sup>122</sup>

### **Treatment and Standard**

The EPA has yet to make a commitment to issue a standard and has not promised to make a decision on a standard at any specific date. The EPA says that concentrations in the range of 20 to 40 micrograms per liter (or ppb) are the most people can tolerate because of the very bad turpentine-like or gasoline-like taste and odor of the water.<sup>123</sup> The health effects of these low levels are uncertain, according to the agency, since the limited testing of the chemical has shown that the taste and odor threshold "is lower than the range of exposure levels in which cancer or noncancer effects were observed in animal tests, though low doses may pose a cancer risk."<sup>124</sup>

### ***Pentachlorophenol (Penta)***

#### **National Standard (MCL)**

1 ppb (average)

#### **National Health Goal (MCLG)**

0—no known fully safe level

Pentachlorophenol is a common preservative used on telephone poles, railroad ties, and other wood.<sup>125</sup>

### **Health Effects**

The EPA reports that short-term exposure to high levels may cause central nervous system problems, while long-term exposure has the potential to cause reproductive problems and damage to liver and kidneys, in addition to cancer.<sup>126</sup>

### **Treatment and Standard**

Penta can be removed from tap water with granular activated carbon or reverse osmosis. Because it is a probable carcinogen, the health goal for penta is 0.<sup>127</sup>

### ***Simazine***

#### **National Standard (MCL)**

4 ppb (average)

**PENTA**  
**SOME CONCERN**  
PHILADELPHIA

**SIMAZINE**  
**SOME CONCERN**  
PHILADELPHIA

**National Health Goal (MCLG)**

4 ppb

A chemical cousin of atrazine, simazine is widely used in agriculture as a pre-emergence herbicide for control of broad-leaved and grassy weeds.<sup>128</sup> Its major use is on corn, where it is often combined with atrazine.<sup>129</sup> It is also used on a variety of deep-rooted crops, including artichokes, asparagus, berries, broad beans, and citrus, and on noncrop areas such as farm ponds and fish hatcheries.<sup>130</sup>

**Health Effects**

The EPA says that high levels of simazine exposure over a short term can cause weight loss and changes in blood. The EPA determined in 2002 that the chemical cousins triazine pesticides—simazine, atrazine, and propazine, as well as several of their degradates—all share a “common mechanism of toxicity,” which is to say that they all poison the body the same way<sup>131</sup>

**Treatment and Standard**

The EPA says that prolonged exposure to elevated levels of simazine above the MCL have the potential to cause tremors; damage to the testes, kidneys, liver, and thyroid; gene mutations; and cancer.<sup>132</sup> The EPA has yet to take action to reduce the allowable levels of simazine in tap water or elsewhere. Simazine can be removed from tap water with granular activated carbon or reverse osmosis.

**PERC**  
**SOME CONCERN**  
 FRESNO

***Tetrachloroethylene (Also Called Perchloroethylene, PCE, or PERC)*****National Standard (MCL)**

5 ppb (average)

**National Health Goal (MCLG)**

0—no known fully safe level

Tetrachloroethylene is used in dry cleaning and industrial metal cleaning or finishing.<sup>133</sup> It enters the water system via spills or releases from dry cleaners or industrial users, waste dumps, leaching from vinyl liners in some types of pipelines used for water distribution, and in some cases during chlorination water treatment.<sup>134</sup>

**Health Effects**

Prolonged consumption of water contaminated by PERC can cause liver problems and may cause cancer.<sup>135</sup>

**Treatment and Standard**

PERC can be removed from tap water with granular activated carbon in combination with packed tower aeration.

**TOLUENE**  
**SOME CONCERN**  
 PHILADELPHIA

***Toluene*****National Standard (MCL)**

1 ppm (1,000 ppb) (average)

### **National Health Goal (MCLG)**

1 ppm (1,000 ppb)

Toluene is a volatile organic chemical with a sweet odor.<sup>136</sup> A component of gasoline and other petroleum fuels, it is used to produce benzene and urethane, as well as in solvents and thinners, and is released in wastewaters or by spills on land during the storage, transport, and disposal of fuels and oils.<sup>137</sup> According to the EPA's Toxic Chemical Release Inventory, toluene releases to land and water totaled more than 4 million pounds from 1987 to 1993, primarily from petroleum refining.<sup>138</sup>

### **Health Effects**

Short-term exposure to toluene at high doses can cause minor nervous system disorders such as fatigue, nausea, weakness, and confusion.<sup>139</sup> Longer-term exposure to lower levels (but over the MCL) can cause more pronounced nervous disorders such as spasms, tremors, liver and kidney damage, and impairment of speech, hearing, vision, memory, and coordination.<sup>140</sup>

### **Treatment and Standard**

Toluene can be removed from tap water with granular activated carbon in combination with packed tower aeration.

### **Trichloroethylene (TCE)**

#### **National Standard (MCL)**

5 ppb (average)

#### **National Health Goal (MCLG)**

0—no known fully safe level

Trichloroethylene (TCE) is a colorless liquid used as a solvent to remove grease from metal parts. It is present in many underground water sources and surface waters as a result of the manufacture, use, and disposal of TCE at industrial facilities across the nation.<sup>141</sup>

### **Health Effects**

TCE is a likely carcinogen, and people exposed to high levels of trichloroethylene in their drinking water may experience harmful effects to their nervous system, liver and lung damage, abnormal heartbeat, coma, and possibly death.<sup>142</sup>

### **Treatment and Standard**

TCE can be removed from tap water with granular activated carbon in combination with packed tower aeration.

### **Trihalomethanes: See Haloacetic Acids, Above**

### **Vinyl Chloride**

#### **National Standard (MCL)**

2 ppb (average)

### **TCE**

**SOME CONCERN**

FRESNO

MANCHESTER

### **VINYL CHLORIDE**

**HIGH CONCERN**

PHILADELPHIA

**National Health Goal (MCLG)**

0—no known fully safe level

Vinyl chloride is used in the manufacture of cars, electrical wire insulation and cables, piping, industrial and household equipment, and medical supplies, and is also heavily used by the rubber, paper, and glass industries.<sup>143</sup>

**Health Effects**

Long-term exposure, according to the EPA, can cause cancer and liver and nervous system damage.<sup>144</sup>

**Treatment and Standard**

Vinyl chloride can be removed from drinking water with granular activated carbon in combination with packed tower aeration, or by reverse osmosis. The EPA has found that relatively short-term exposure to vinyl chloride at levels above the current standard of 2 ppb potentially causes damage to the nervous system.

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**RADIOACTIVE CONTAMINANTS**

**Gross Alpha Radiation**

**National Standard (MCL)**

15 pCi/L (average)

**National Health Goal (MCLG)**

0—no known fully safe level

Alpha particle radiation generally results from the decay of radioactive minerals in underground rocks and is sometimes a by-product of the mining or nuclear industries.

**Health Effects**

Alpha particle radiation causes cancer.<sup>145</sup>

**Treatment and Standard**

The best available treatment for alpha emitters other than radon or uranium is reverse osmosis membrane filtration (RO).<sup>146</sup> The RO membrane removes virtually all contaminants, including *Crypto* and other microbes, most industrial or agricultural synthetic chemicals, radioactive contaminants, and even most inorganic contaminants, including arsenic. The resulting water is almost entirely pure.

**Gross Beta Radiation**

**National Standard (MCL)**

50 pCi/L (average)

**National Health Goal (MCLG)**

0—no known fully safe level

Beta particle and photon emitter radiation generally results from the decay of radioactive minerals in underground rocks and is sometimes a by-product of nuclear testing or the nuclear industry.

**GROSS ALPHA RADIATION**

**SOME CONCERN**

- ALBUQUERQUE
- FRESNO
- LOS ANGELES
- SAN DIEGO
- WASHINGTON, D.C.

**GROSS BETA RADIATION**

**SOME CONCERN**

- LOS ANGELES
- SAN DIEGO
- WASHINGTON, D.C.

### Health Effects

Beta particle and photon emitter radiation causes cancer.<sup>147</sup>

### Treatment and Standard

The best available technologies for removing beta radiation or photon emitters is ion exchange or reverse osmosis (RO). As noted above, RO removes virtually all other contaminants as well.

### Radon

#### National Standard (MCL) (proposed)

300 pCi/L (averages)

alternate MCL of 4,000 pCi/L where approved multimedia program is in place (average)

#### National Health Goal (MCLG) (proposed)

0—no known fully safe level

Radon is a radioactive gas that results from the natural radioactive breakdown of uranium in the ground. Communities that depend on groundwater can often encounter radon gas in their drinking water, and in the United States, more than 81 million people's drinking water comes from groundwater.

### Health Effects

Radon is known to cause lung cancer. No amount of it is considered fully safe in tap water; indeed, a single particle of radon can cause cancer.<sup>148</sup> The EPA estimates that radon in drinking water causes approximately 168 deaths from lung and stomach cancers each year—89 percent from lung cancer caused by breathing radon released to the indoor air from water and 11 percent from stomach cancer caused by consuming water that contains radon.<sup>149</sup> In fact, radon is the second leading cause of lung cancer deaths in the United States after smoking, causing what the NAS has estimated is a total of 20,000 lung cancer deaths per year. Most of these lung cancers are due to radon seepage from soil into basements and through floor slabs, underscoring the importance of radon testing for basements.<sup>150</sup> But radon in tap water is a threat as well.

### Treatment and Standard

Radon is easily removed from tap water through simple aeration of the water—bubbling air through water in a packed tower. The EPA's estimated cost per household for customers living in a big city for this simple but life-preserving step: \$9.50 per year.<sup>151</sup> Some water industry representatives argue that since more people die from basement seepage of radon, worries about radon in tap water are misplaced. Congress relied on this argument in establishing a new radon provision in the 1996 Safe Drinking Water Act amendments. That provision requires the EPA to set a new radon MCL, using the usual standard-setting approach, by August 2001. However, acceding to the industry argument that basement seepage is worse than tap water radon, Congress also adopted a provision in the 1996 law that allows the EPA to set an alternate, weaker MCL applicable in cities or entire states that adopt a multimedia mitigation program (MMM)

### RADON

#### VIOLATION (PROPOSED STANDARD)

ALBUQUERQUE

HOUSTON

FRESNO

#### HIGH CONCERN

LOS ANGELES

designed to reduce exposure to radon from seepage into basements or across building slabs. In November 2000, the EPA proposed a radon rule that included a 300 pCi/L MCL and an “alternate” MCL of 4,000 pCi/L. But more than a year after the August 2001 deadline, the EPA still has not issued a final radon rule.

At the EPA’s proposed 300 picocuries-per-liter (pCi/L) maximum contaminant level (MCL), the lifetime risk of contracting fatal cancer is about 1 in 5,000—twice what the EPA traditionally says is the highest allowable cancer risk for any drinking water contaminant.<sup>152</sup> At 4,000 pCi/L, an “alternate” MCL that the EPA proposes to apply to some communities’ water, the fatal cancer risk is about 1 in 370—a cancer risk that is 27 times higher than what the EPA usually says is acceptable in tap water. NRDC is concerned that even at 300 pCi/L in tap water, the NAS and the EPA both agree that the cancer risks are larger than what the EPA traditionally allows. It is true that radon also seeps into some people’s basements and that more people die from that source than from radon in tap water. That is no argument for compounding the problem by permitting unacceptable levels of radon in tap water, particularly when fixing the tap water problem is readily within the capacities of water utilities (unlike basement radon) at a modest cost.

**TRITIUM**  
**SOME CONCERN**  
 WASHINGTON, D.C.

### **Tritium**

#### **National Standard (MCL)**

20,000 pCi/L (average) (Part of 4 millirem beta and photon emitter standard)

#### **National Health Goal (MCLG)**

0—no known fully safe level

The EPA says tritium:

*forms in the upper atmosphere through interactions between cosmic rays (nuclear particles coming from outer space) and the gases composing the atmosphere. Tritium can be deposited from the atmosphere onto surface waters via rain or snow and can accumulate in groundwater via seepage. Tritium is also formed from human activities. . . . Natural tritium tends not to occur at levels of concern, but contamination from human activities can result in relatively high levels. The man-made radionuclides, which are primarily beta and photon emitters, are produced by any of a number of activities that involve the use of concentrated radioactive materials.*

These radioactive materials are used in various ways in the production of electricity, nuclear weapons, nuclear medicines used in therapy and diagnosis, and various commercial products (such as televisions or smoke detectors), as well as in various academic and government research activities. Release of man-made radionuclides to the environment, which may include drinking water sources, are primarily the result of improper waste storage, leaks, or transportation accidents.<sup>153</sup>

#### **Health Effects**

Tritium is a radioactive form of hydrogen that causes cancer. A beta particle emitter, no level of exposure to it is considered safe.

### Treatment and Standard

The EPA says that beta emitters (such as tritium) are removed using ion exchange and reverse osmosis.

### Uranium

#### National Standard (MCL)

30 micrograms/liter (which EPA assumes to be equivalent to 30 pCi/L) (enforceable December 2003)

#### National Health Goal (MCLG)

0—no known fully safe level

Uranium is released from minerals in the ground, often as the result of mining or as a by-product of the nuclear industry.

### Health Effects

Uranium is radioactive and causes cancer when ingested.<sup>154</sup> In addition, the EPA has determined that uranium also causes serious kidney damage at levels above the MCL.

### Treatment and Standard

The EPA acknowledges that uranium poses a cancer risk at levels below its established MCL of 30 pCi/L, but the agency argues that the benefits of reducing uranium contamination of water are outweighed by the costs. That, at least, was the conclusion of the EPA's cost-benefit analysis, in which it calculated costs to all U.S. water systems, including small systems where per-customer costs can be considerably higher than for larger systems. The cancer risk at 30 pCi/L is about 1 in 10,000, the highest cancer risk the EPA usually allows in drinking water, and about 100 times higher than the 1 in 1,000,000 risk the EPA allows for carcinogens under the Superfund or pesticide programs.<sup>155</sup> Uranium is removed from water by many technologies, according to the EPA, including ion exchange, lime softening, reverse osmosis, and enhanced coagulation followed by filtration.

### URANIUM

SOME CONCERN

LOS ANGELES

LITTLE OR NO CONCERN

SAN DIEGO

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## NOTES

1 For general background information on *Crypto*, see Centers for Disease Control, "Parasitic Disease Information: *Cryptosporidiosis*," available online at [www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht\\_cryptosporidiosis.htm](http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm). For more detailed information, see, "*Cryptosporidium* and Water: A Public Health Handbook," (CDC, 1997). Available online at [www.cdc.gov/ncidod/diseases/crypto/crypto.pdf](http://www.cdc.gov/ncidod/diseases/crypto/crypto.pdf).

2 Ibid.

3 See CDC, "Parasitic Disease Information: *Cryptosporidiosis*," available online at [www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht\\_cryptosporidiosis.htm](http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm). See also, CDC, "*Cryptosporidiosis*: A Guide for People with HIV/AIDS," available online at [www.cdc.gov/ncidod/diseases/crypto/hiv aids.htm](http://www.cdc.gov/ncidod/diseases/crypto/hiv aids.htm).

4 W. R. MacKenzie, et al., "A Massive Outbreak in Milwaukee of *Cryptosporidium* Infection Transmitted Through the Public Water Supply," *New England Journal of Medicine* (1994), 331: 161–167. The precise number of people killed by the Milwaukee outbreak is not known with certainty. Account by the *Milwaukee Journal* puts the number at more than 100, although the "official" state and local health department count was "a minimum of 50 deaths." See Marilyn Marchione, "Deaths continued after *Crypto* outbreak: State report attributes a minimum of 50 deaths from '93 to '95." *The Milwaukee Journal Sentinel*, (May 27, 1996).

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- 8 See EPA, "National Primary Drinking Water Regulation: Long Term 2 Enhanced Surface Water Treatment Rule, Draft," page 75 Table III-5, available online at [www.epa.gov/safewater/lt2/lt2\\_preamble.pdf](http://www.epa.gov/safewater/lt2/lt2_preamble.pdf); M. W. LeChevallier and W. D. Norton, "Giardia and Cryptosporidium in Raw and Finished Water," *Journal AWWA* (1995), 87: 54–68.
- 9 Ibid.
- 10 See, e.g., EPA, "National Primary Drinking Water Regulation: Long Term 2 Enhanced Surface Water Treatment Rule, Draft," pg. 73 ("... it is expected that *Cryptosporidium* oocysts were present in many more samples and were not detected due to poor recovery rates and low volumes analyzed. The observed data do not account for the ICR Method's low recovery efficiencies. Adjusting for recovery would increase the estimated occurrence several-fold"), available online at [www.epa.gov/safewater/lt2/lt2\\_preamble.pdf](http://www.epa.gov/safewater/lt2/lt2_preamble.pdf).
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- 12 EPA, "National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment Rule," 63 Fed. Reg. 69477–69521 (December 16, 1998).
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- 14 The information on health effects of coliform is derived from EPA, "Total Coliform Rule," 54 Fed. Reg. 27544–27568, (June 29, 1989); EPA, "Total Coliform Rule," available online at [www.epa.gov/safewater/source/therule.html#Total](http://www.epa.gov/safewater/source/therule.html#Total), and EPA, "Total Coliform Rule: A Quick Reference Guide," available online at *Total Coliform Rule: A Quick Reference Guide* PDF file (816-F-01-035, September 2001).
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- 20 40 C.F.R. 141.21 & 141.63.
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- 22 See note 18.
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- 24 40 C.F.R. 141.21.
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- 27 EPA, "Fact Sheet: National Primary Drinking Water Regulations" (2002), available online at [www.epa.gov/safewater/mcl.html](http://www.epa.gov/safewater/mcl.html).
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- 29 EPA, "National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment Rule," 63 Fed. Reg. 69477–69521 (December 16, 1998).
- 30 See W. R. MacKenzie, et al., "A Massive Outbreak in Milwaukee of *Cryptosporidium* Infection Transmitted Through the Public Water Supply," *New England Journal of Medicine*, 1994, 331:161–167.

- 31 See EPA, "National Primary Drinking Water Regulation: Long Term 2 Enhanced Surface Water Treatment Rule, Draft," page 75 Table III-5, available online at [www.epa.gov/safewater/lt2/lt2\\_preamble.pdf](http://www.epa.gov/safewater/lt2/lt2_preamble.pdf).
- 32 Available online at [www.nap.edu/catalog/6444.html](http://www.nap.edu/catalog/6444.html).
- 33 National Academy of Sciences, National Research Council, *Arsenic in Drinking Water: 2001 Update* (National Academy Press, 2001), available online at [www.nap.edu/catalog/10194.html](http://www.nap.edu/catalog/10194.html).
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- 42 *Ibid.*; see also NAS's September 11, 2002, press release, available online at [www4.nationalacademies.org/news.nsf/isbn/0309076293?OpenDocument](http://www4.nationalacademies.org/news.nsf/isbn/0309076293?OpenDocument).
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- 45 See note 43.
- 46 EPA, "Consumer Fact Sheet: Cyanide," available online at [www.epa.gov/safewater/dwh/c-ioc/cyanide.html](http://www.epa.gov/safewater/dwh/c-ioc/cyanide.html).
- 47 *Ibid.*
- 48 *Ibid.*
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- 51 See EPA, "Consumer Fact Sheets on Lead," [www.epa.gov/safewater/Pubs/lead1.html](http://www.epa.gov/safewater/Pubs/lead1.html) and [www.epa.gov/safewater/standard/lead&co1.html](http://www.epa.gov/safewater/standard/lead&co1.html), and IRIS summary for lead available online at [www.epa.gov/iris/subst/0277.htm](http://www.epa.gov/iris/subst/0277.htm).
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- 53 40 C.F.R. §141.80-141.91.
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- 57 *Ibid.*
- 58 The information regarding the health effects of nitrate are derived from NAS, National Research Council, *Nitrate and Nitrite in Drinking Water*, 1995, available online at [www.nap.edu/catalog/9038.html](http://www.nap.edu/catalog/9038.html), and EPA, "Nitrates." Fact sheet available online at [www.epa.gov/safewater/dwh/c-ioc/nitrates.html](http://www.epa.gov/safewater/dwh/c-ioc/nitrates.html).
- 59 *Ibid.*
- 60 *Ibid.*
- 61 See, e.g., L. Knobeloch, B. Salna, A. Hogan, J. Postle, H. Anderson, "Blue babies and nitrate-contaminated well water," *Environmental Health Perspectives* (July 2000), 108(7): 675-8.

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- 63 L. A. Croen, K. Todoroff, G. M. Shaw, "Maternal exposure to nitrate from drinking water and diet and risk for neural tube defects," *American Journal of Epidemiology*, 2001, 153(4).
- 64 EPA, "Nitrates." Fact sheet available online at [www.epa.gov/safewater/dwh/c-ioc/nitrates.html](http://www.epa.gov/safewater/dwh/c-ioc/nitrates.html).
- 65 See L. Knobeloch, B. Salna, A. Hogan, J. Postle, H. Anderson, "Blue babies and nitrate-contaminated well water," *Environmental Health Perspectives*, July 2000, 108(7): 675-8; see also EWG, *Pouring It On: Nitrate Contamination of Drinking Water* (1995), available online at [www.ewg.org/reports/Nitrate/NitrateHealth.html](http://www.ewg.org/reports/Nitrate/NitrateHealth.html).
- 66 For a list of stricter standards overseas, see EWG, *Pouring It On: Nitrate Contamination of Drinking Water* (1995), available online at [www.ewg.org/reports/Nitrate/NitrateHealth.html](http://www.ewg.org/reports/Nitrate/NitrateHealth.html).
- 67 NAS, National Research Council, *Nitrate and Nitrite in Drinking Water* (1995), available online at [www.nap.edu/catalog/9038.html](http://www.nap.edu/catalog/9038.html).
- 68 See note 56 (noting emerging evidence that nitrate exposure may pose miscarriage and reproductive risks, cancer risks, thyroid risks, and diabetes risks, and that even exposure as low as 12 ppm has been linked to blue baby syndrome); EWG, *Pouring It On: Nitrate Contamination of Drinking Water* (1995), available online at [www.ewg.org/reports/Nitrate/NitrateHealth.html](http://www.ewg.org/reports/Nitrate/NitrateHealth.html) (noting evidence of chronic risks not considered by NAS).
- 69 Ibid.
- 70 A drinking water equivalent level is the presumed level of perchlorate that one would need to consume in tap water to reach the Reference Dose—the maximum safe level. See EPA, "Perchlorate," fact sheet available online at [www.epa.gov/safewater/ccl/perchlor/perchlo.html](http://www.epa.gov/safewater/ccl/perchlor/perchlo.html).
- 71 MWD is well aware that this Henderson facility is the source of this perchlorate. See MWD, "In the News: Perchlorate," available online at [www.mwdh2o.com/mwdh2o/pages/yourwater/ccr02/ccr03.html](http://www.mwdh2o.com/mwdh2o/pages/yourwater/ccr02/ccr03.html); MWD press release, "Water Officials Report Significant Progress in Perchlorate Removal," April 17, 2002. This release puts an unduly optimistic face on the problem, since MWD is well aware that the cleanup of the facility remains problematic and partially unsuccessful. See also Environmental Working Group, *Rocket Science* (2001), available online at [www.ewg.org/reports/rocketscience](http://www.ewg.org/reports/rocketscience).
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- 77 EPA, "Consumer Fact Sheet: Thallium," available online at [www.epa.gov/safewater/dwh/c-ioc/thallium.html](http://www.epa.gov/safewater/dwh/c-ioc/thallium.html).
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- 83 EPA, "Consumer Fact Sheet: Atrazine," available online at [www.epa.gov/safewater/dwh/c-soc/atrazine.html](http://www.epa.gov/safewater/dwh/c-soc/atrazine.html).
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- 86 Ibid.; see also note 84.
- 87 See note 83.
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- 100 EPA, "Consumer Fact Sheet on Ethylene Dibromide," available online at [www.epa.gov/safewater/dwh/csoc/ethylene.html](http://www.epa.gov/safewater/dwh/csoc/ethylene.html).
- 101 Ibid.
- 102 Ibid.
- 103 Some of the haloacetic acids have national health goals of 0 and others have nonzero goals. For the sake of simplicity and understandability, since there is a single haloacetic acid standard, and because it is essentially chemically impossible under normal conditions in tap water to create one regulated haloacetic acid without creating the others at some level, we have listed the national health goal as 0.
- 104 Total trihalomethanes (TTHMs) consist of a sum of the levels of four closely related chemicals—chloroform, dibromochloromethane, bromoform, and bromodichloromethane—which occur together at varying ratios when water is chlorinated. The latter two TTHMs have health goals of 0. The EPA promulgated and then withdrew (after a court decision) a 0 health goal for chloroform and has not yet issued a new goal for chloroform. Dibromochloromethane has a health goal of 60 ppb. Since water systems generally report only the combined TTHM level, and since it is essentially chemically impossible to create one trihalomethane in tap water without some level of the others, we list the health goal for TTHMs as 0.
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- 106 K. P. Cantor, C. F. Lynch, M. E. Hildesheim, M. Dosemeci, J. Lubin, M. Alavanja, G. Craun, "Drinking water source and chlorination by-products in Iowa. III. Risk of brain cancer," *Am. J. Epidemiol.* (September 15, 1999), 150(6): 552–60.
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- 108 See M. J. Nieuwenhuijsen, M. B. Toledano, N. E. Eaton, J. Fawell, P. Elliott, "Chlorination disinfection by-products in water and their association with adverse reproductive outcomes: a review." *Occupational and Environmental Medicine* (February 2000), 57(2): 73-85; F. Bove, Y. Shim, P. Zeitz, "Drinking water contaminants and adverse pregnancy outcomes: a review," *Environmental Health Perspectives* (February 2002), (110 Suppl. 1):61–74.
- 109 K. Waller, S. H. Swan, et al., "Trihalomethanes in drinking water and spontaneous abortion," *Epidemiology*, (March 1998), 9(2): 134–140; S. H. Swan, K. Waller, et al., "A prospective study of spontaneous abortion: relation to amount and source of drinking water consumed in early pregnancy," *Epidemiology* (March 1998), 9(2): 126–133.
- 110 M. J. Nieuwenhuijsen, M. B. Toledano, N. E. Eaton, J. Fawell, P. Elliott, "Chlorination disinfection by-products in water and their association with adverse reproductive outcomes: a review," *Occupational and Environmental Medicine* (February 2000), 57(2): 73–85.
- 111 Ibid.
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- 113 EPA, "National Primary Drinking Water Regulations: Disinfectants and Disinfection By-products," 63 Fed. Reg. 69389 (December 16, 1998).
- 114 Ibid.
- 115 EPA draft, "Preamble for Stage 2 Disinfection By-products Regulation," available online at [www.epa.gov/safewater/mdbp/st2dis-preamble.pdf](http://www.epa.gov/safewater/mdbp/st2dis-preamble.pdf).
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152 See note 147, at 59270 Table VII.1.

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