House Fish, Wildlife and Water Resources Committee
Testimony on H.80
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My name is Annette Smith. I am executive director of Vermonters for a Clean Environment. I would like to thank the chair and the committee for hearing my testimony today on this very serious and complex subject.

My testimony will focus on the science surrounding the use of monochloramine as a secondary drinking water disinfectant in the Champlain Water District. My written testimony contains numerous citations to studies, reports, and other documents that support the position that there is sufficient scientific evidence to show that monochloramine poses a threat to public health and the environment, and Vermont should take a time out from the use of monochloramine in drinking water, as called for in H.80.

I will also respond to some of the points made in last week's testimony by the Department of Health, the Department of Environmental Conservation and the Champlain Water District.

The science surrounding monochloramine in drinking water can best be divided into two categories: what we know and what we don't know. I will begin with what we don't know, and then turn our attention to what we know about monochloramine.

In the 1970s, the first link between consumption of chlorinated water and cancers was made. During the same decade, THMs became the first class of halogenated Disinfection ByProducts to be identified and regulated in treated drinking water.[1]

The first literature review of studies of chloramine that I could find was conducted in 1980 by two scientists at the University of Massachusetts, and was published in the Journal of Environmental Pathology and Toxicology. The authors noted that in 1978, the EPA recognized that chlorinated water's potential risk to human health was likely to "cause many water suppliers to turn to alternative disinfectants" (EPA, 1978), and that chloramine disinfection may increase (Kjellstrand et al., 1974).

The authors wrote,

> The primary unresolved question is, what are the health effects of chloramines? This concern was recently reiterated in the Federal Register (EPA, 1978). Certainly more should be known concerning the potential toxicity of chloramines and by-products before chloramine generation becomes adopted as a standard procedure for a majority of community water supplies where THM formation and/or maintenance of chlorine residuals is a problem… Research should be directed to the health effects of chloramines since it is recognized that additional information is required for more quantitative risk assessment (EPA 1978).[2]

There is no evidence that efforts were made to fill this data gap. The U.S. Environmental Protection Agency's Integrated Risk Information System (IRIS) for Monochloramine was last revised in 1994. At that time,

- there were no epidemiological studies of monochloramine itself;
- no data existed for Inhalation Exposure;
- monochloramine was not classifiable as to human carcinogenicity based on inadequate human data.[3]

In 2006, twenty-six years after authors of that 1980 literature review recommended that research should be directed to the health effects of monochloramine, Art Jensen, general manager of the San Francisco Bay Area Water Supply and Conservation Agency, or BAWSCA, wrote to several key public health agencies, asking about past, future and ongoing studies on the epidemiological, dermatological and respiratory effects on humans of chloraminated water. His inquiry was in response to complaints about health effects after San Francisco-area systems changed from chlorine to chloramine for secondary disinfection in 2004. The responses were, according to the Jensen, not satisfactory and were, in some cases, "spurious." After contacting several agencies by phone later, he concluded that the agencies were unable to cite studies of human health impacts. [4]

In 2007, Congresswoman Anna Eshoo of California requested a literature review be done by the Congressional Research Service of human health studies for dermal, respiratory and gastrointestinal effects of monochloramine. No results have ever been disclosed, presumably because no studies were found.

On September 26, 2007, Lorraine Backer, PhD, MPH, from the National Center for Environmental Health, of the Centers for Disease Control and Prevention, was in Vermont on a fact-finding trip investigating health complaints after the CWD made the switch to chloramine. Dr. Backer said on Burlington's WCAX-TV, "In terms of the kinds of health effects that people are complaining about, there really haven't been any studies to really address that issue in a statistically significant way."[5]

The CDC's report about their trip to Vermont, released in January 2008 said, "Chloramine has been approved for use by the EPA; however, data gaps remain about the potential health effects of using chloramine for large scale water disinfection."[6]

In 2009, we still do not have what the EPA recognized in 1978 was needed: results of research directed to the health effects of monochloramine on humans. It is critical to note that not only does this mean that EPA approval was awarded without sufficient investigation, it also hampers the ability of health professionals to understand and analyze symptoms. Doctors will only make diagnoses with formal studies to support them. The absence of these studies means that doctors are unable to make diagnoses connecting rashes, breathing and gastrointestinal problems with monochloramine in tap water.

This does not mean that there are no studies on monochloramine. In fact, there are quite a few studies that, when taken together, point to the conclusion that monochloramine poses a risk to human health.

The 1980 UMass literature review noted monochloramine's environmental and health effects:

> The results of…studies on aquatic life indicate the ability of monochloramine to interfere with energy metabolism and produce methemoglobinemia. Similar effects are seen under special conditions in humans exposed to monochloramine.
>
> Eichelsdoerfer et al. (1975) reported that dermal exposure with chloramine (4 mg/L) was more irritating than free chlorine (20 mg/L) to the conjunctiva of rabbits.[7]

Subsequent scientific studies provide evidence that monochloramine is irritating to mucous membranes:

- A 1997 study shows that rats experienced severe hemorrhages in stomachs after drinking monochloramine, suggesting that monochloramine damages the gastric mucosa (Hidekazu Nishiwaki, Shinichi Kato and Koji Takeuchi, 1997).

- A 1999 study found that chloramines are very strong irritants, causing inflammation of subcutaneous tissue and mucous membranes when exposed to the skin of rats, and vomiting when ingested (Fantus, Bernard and Smith M.I., 1999).

- In a 2005 study, an intense inflammatory reaction occurred in rectums of rats when monochloramine was administered one time at concentrations below the EPA acceptable limit of 4 PPM for 24 hours. This suggests that prolonged or continual exposure to chloraminated water may contribute to increased inflammatory bowel disease (Ballester I, Gonzalez R, Nieto A, Zarzuelo A and de Medina FS, 2005).[8]

Evidence of chloramine's respiratory effects are identified in a 2006 study[9] by Belgian researchers, which says:

> Hypochlorus acid and chloramines are known to be powerful membrane penetrating oxidants …These effects are induced by concentrations of hypochlorous acid and monochloramine as low as ... (.5 mg/L)

Note that these levels are approximately 1/4 of the dosage people in the CWD are being exposed to in their tap water.

These studies were not done on humans, but all showed health impacts similar or even identical to symptoms people in the CWD are experiencing. All of these studies can be found in routine searches of the available literature.

On Nov. 1, 2007, the DEC held a conference in Montpelier on disinfection and disinfection byproducts for water system operators. Toxicologist Dr. Richard Bull, one of the country's foremost experts in disinfection byproducts, told the audience:

> What people in the water industry don't seem to recognize is chloramines are really much more potent respiratory irritants, and this again is not addressed in regulation…It's an issue that really should be followed up on.

Dr. Bull went on to describe a skin study he designed that had an unexpected result:

> …we had a specially designed exposure method. We were originally going to have the mice swimming in the water. And for 10 minutes. And we had to put a collar around

> them so their head was held way out of the water out of the beaker. They died of respiratory irritation, acute respiratory irritation if they were either exposed to chlorine dioxide or chloramine. Chlorine had no problem... So there are respiratory irritants and there's some possibility that off-gassing in the shower and so forth might create a problem if the chloramine speciation is not controlled. And chlorine dioxide could also be a bit of a problem but in neither case has anybody looked at trying to establish a threshold.

Other indirect but telling evidence can be found in workplace safety investigations. Indications that chloramine is a respiratory irritant is found in a study of poultry workers done by NIOSH published in 2007, who had repeatedly reported eye and upper respiratory irritation.[10] The reported symptoms are identical to those being experienced in the Champlain Water District.

Similar symptoms were associated with chloramines in a recently released study of workers at an indoor water park in Ohio, who reported respiratory symptoms, cough, wheezing, shortness of breath, eye and nose irritation, and skin rashes.[11]

We do know the difference between trichloramine and monochloramine, and we are not confusing the issue by referring to studies about poultry workers and water park employees. The point of referencing those situations is to note that the types of symptoms being experienced by people who are exposed to combined chlorine and ammonia are identical to those experienced by chloraminated water users.

The health effects being reported in the Champlain Water District are consistent with monochloramine's action as an irritant of mucous membranes. The symptoms people are reporting, including burning eyes, skin rashes, respiratory problems, and gastrointestinal inflammation are, in fact, what should be expected, based on scientific studies of monochloramine in currently available literature. These studies support the conclusion that something has gone terribly wrong with this drinking water chemistry experiment.

Beyond the indirect studies available regarding health impacts, there are many other reasons to be very concerned about the use of monochloramine in drinking water.

- Monochloramine was found to increase DNA aberration.[12]
- Monochloramine's disinfection byproducts, which are not regulated except those that are in common with chlorine's DBPs, are being found to be more toxic than those of chlorine's.[13],[14] [reference to Plewa]
- Monochloramine can speciate to di-chloramine and tri-chloramine depending on pH, temperature, and aerosolization in people's homes.
- The use of chloramine in Washington DC and other cities has resulted in dangerously high lead levels in drinking water.[15]
- Because it is corrosive, chloramine has been found to degrade plumbing infrastructure, including rubber fittings in toilets.
- Build-up of nitrogen-containing compounds can occur at the ends of long lines in chloraminated systems.
- Chloramine is known to be an inferior disinfectant. According to the World Health Organization, "monochloramine is about 2000 and 100,000 times less effective than free

chlorine for the inactivation of E. coli and rotaviruses, respectively."[16]

- Chloramine requires the use of zinc orthophosphate to inhibit corrosion, adding to Lake Champlain's phosphorus loading.

Additional concerns that have so far not been discussed in testimony are environmental impacts. In the environment, chloramine is toxic to fish, frogs and invertebrates.

In Vancouver, British Columbia, two fish kills in a chloramination test area, where thousands of fish and frogs were killed from one water main break in the early 1990's, (Nikl and Nikl 1992) resulted in a re-evaluation of the use of chloramine by the City's water district, as well as the overall water treatment strategy for the region (Ferguson and Neden 1992). Vancouver decided in 1994 not to use chloramine because of its greater risk to the environment (Ferguson and Neden 1994).[17]

In 1999, Health Canada assessed chloramine's toxicity to the environment and found:

> Based on the available data, it is concluded that inorganic chloramines are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. …Therefore, inorganic chloramines are considered to be "toxic" as defined in Section 64 of the *Canadian Environmental Protection Act*, 1999 (CEPA 1999) [18]

In 2002, two professors of biological sciences at Simon Fraser University in Canada evaluated chloramine's toxicity for Environment Canada. They found that "the use of chloramine is an unacceptable tradeoff in B.C., where sensitive and biologically productive waterways abound." They were the first to investigate how the combination of chloramine concentration and exposure time affects toxin-sensitive freshwater organisms. Their data prove that low chloramine concentrations, even ones well below those used for disinfecting water, kill sensitive species when exposure lasts longer than several hours or days (as associated with continuous effluent release or water main breaks).

Evidence of fish kills from water main breaks in the US is growing:

- July 2006 – Berkeley, California, "Water-main breaks proving deadly to fish," "…Chloramine is worse for fish because it lasts longer in the environment…." Workers became concerned about chloramine after a series of East Bay Municipal Utility District water-main breaks sent hundreds of thousands of gallons of chloraminated water into three creeks, killing fish on at least two occasions in Berkeley

- October 2007 -- Water toxic to fish – West Marin Citizen, California

- April 2008 -- Water spill kills McLean fish – Fairfax, Virginia

  A broken Falls Church City water main is believed to have killed virtually the entire fish population in several miles of the Pimmit Run stream where it runs through McLean. "It killed practically everything. At least 90 percent of the fish are dead," said Ed Pickens, of Fairfax Trails and Streams….The water contained chloramine, a standard disinfectant for municipal drinking water. Chloramine is added to water to kill bacteria, but it is also toxic to fish.

Last week we heard the Champlain Water District point to Portland, Maine as a place that has used chloramine for a long time with no problems. But Portland's 2008 Water Quality Report[19] (Chloramine 1.88 ppm) indicates that in 2007 the district repaired 189 leaks on water mains and fire hydrants. That means a lot of chloraminated water could have entered the environment.

Unfortunately, the United States has not taken precautions similar to those taken by Canada to protect aquatic life from chloramine's effects.

Finally, I would like to respond to some of the statements made in last week's hearings:

You asked if the CWD is aware of similar health problems associated with chloraminated water in other states. We have heard health complaints identical to those we have heard from people in the CWD from people in chloraminated water districts in Massachusetts, New Hampshire, New York, South Carolina, Oklahoma, Colorado, California, Florida and numerous other states. Thousands of people are looking for solutions to the realization that their tap water is making them sick.

The most disturbing statement that we hear repeated by state regulators and the Champlain Water District is about the health effects of chlorinated water. We recognize that chlorine is a toxic substance. However, we believe it is important to be accurate about the current status of the science.

In particular, we heard Commissioner Pelosi and Jim Fay of the CWD refer to reproductive health issues and potential liability issues associated with acute short-term risks. The implication is that if the CWD returns to using chlorine as a secondary disinfectant, there will be an immediate risk of an increase in birth defects.

A definitive study by researchers at the University of North Carolina in 2008 made it clear that there is no connection between chlorination disinfection byproducts and fetal growth.[20] A study from 2005 "found that women with higher exposure to trihalomethanes through drinking water had no greater risk of pregnancy loss than other women."[21] Dr. Bull told the Vermont conference in 2007 that the science surrounding reproductive health has not really been that consistent. In fact, the scientific evidence is clear that the studies used by the EPA to support their claim of a connection between chlorine DBPs and reproductive health are of questionable value, at best. Current science does not support the CWD's or DEC's exaggerated warnings of the potential impacts of changing back to chlorine.

We heard Mike Barsotti of the CWD say that chloramine is easy to remove with Vitamin C, and at low cost. We have seen no scientific documents to support this claim. Consumers in Vermont, New York and California who have purchased and installed Vitamin C filters report poor to no results compared to manufacturer's claims. Some people find the filters work for a few days, weeks, or months, or not at all, but do not last 6 months as advertised. People figure out their filters are no longer working when they get sick again. Vitamin C filters are not a solution. Nor is shaking Ascorbic Acid in drinking, cooking and bath water.

Chloramine permeates the CWD's service area. It is not realistic to expect people to avoid

exposure to CWD water if they find they must avoid the community's tap water in order to maintain their health. We have heard similar reports about the inadequacies and expense of whole house filters. Advising consumers to invest in their own filtration systems amounts to an enormous cost-shifting, and is a social justice issue because only people who have sufficient resources can afford to buy health protection, inadequate though it may be.

We note that the National Sanitation Foundation (NSF) certifies water filtration devices, but only certifies for taste and odor control, not for health protection. NSF does not certify any filters for 100% chloramine removal.

In contrast, chlorine can be cheaply and easily filtered out from drinking water, and consumers are used to using Brita and PUR filters. Inexpensive carbon shower filters are readily available for chlorine filtration. There is no question we could do more to educate the public about how to protect themselves from the potential risks of chlorinated water, and at a societal cost much lower than what we see happening with the use of monochloramine.

We recognize that water system operators are facing significant regulatory challenges. But the fact remains that many options exist to meet the Stage 2 rule without using chloramine. In our contact with water system operations around the country, we have confirmed that as of this month chloramine is not used at all in at least eight states in the U.S. Chloramine is not used in CT, RI, DE, UT, MN, ID, TN or WV.

In our attempts to collaborate with the CWD and state regulators, we have repeatedly requested information about alternatives and encouraged the CWD to engage in an investigation of engineering solutions to meet the Stage 2 rule without using chloramine. The CWD's response to each and every one of our suggestions has been "no," and they point to their 20 year master plan which we note is 7 years old and contains out of date statements such as "Ultraviolet (UV) light is not an accepted method of treating drinking water." Engineers I have consulted assure me that it is not difficult to engineer the CWD's system to meet current and future EPA regulations without using chloramine – if only they wanted to investigate those options.

Dr. Schwarz said that from the VDH's perspective, there is enough science to assure the public that chloramine is safe and the case is closed – the problem is that people are not reassured by the evidence. If there is scientific, peer-reviewed evidence that chloramine is safe for use in tap water, I have not seen it. The fact that chloramine has been used in drinking water for decades does not prove it is safe. If monochloramine was proposed for use in drinking water today as a new substance, would it be approved? I think not – at least not without substantial new investigation and research.

Water system operators and state regulators are putting compliance with well-intentioned but misguided regulations ahead of public health and environmental protection, and even ahead of science itself. Please protect Vermonters by passing H.80.

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[3] http://www.epa.gov/iris/subst/0644.htm
[4] "How's the Water?", The Almanac, Cover Story - Wednesday, May 17, 2006
[5] http://www.wcax.com/Global/story.asp?S=7135973
[6] Epi-Aid Trip Report: An assessment of health concerns in a community exposed to chloramine treated tap water in Vermont,2006–2007, Public Health Service, Department of Health and Human Services Centers for Disease Control and Prevention (CDC), January 16, 2008, Leslie Hausman, RN, MPH, EIS Officer, Health Studies Branch (HSB), Division of Environmental Hazards and Health Effects (EHHE), National Center for Environmental Health (NCEH), Lorraine Backer, PhD, Team Lead, HSB, EHHE, NCEH
[7] Op. Cit. 2
[8] http://www.vce.org/ChloramineScience/Monochloramine-colitis-rats.pdf
[9] "The determinants of prevalence of health complaints among young competitive swimmers," Benoit Levesque, Jean-Francois Duchesne, Suzanne Gingras, Robert Lavoie, Denis Prud'Homme, Emmanuelle Bernard, Louis-Philippe Boulet, Pierre Ernst, Int Arch Occup Environ Health 2006
[10] Health Hazard Evaluation Report 2004-0337-3051,US Department of Agriculture, Food Safety and Inspection Service, Natchitoches, Louisiana, November 2007, Bradley King, MPH, CIH, Angela Warren, MPH, Charles Mueller, MS
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[14] Occurrence and Mammalian Cell Toxicity of Iodinated Disinfection Byproducts in Drinking Water, Susan D. Richardson et. al., August 11, 2008.
[15] Evidence that Monochloramine Disinfectant Could Lead to Elevated Pb Levels in Drinking Water Jay A. Switzer ,et. al., 2006.
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