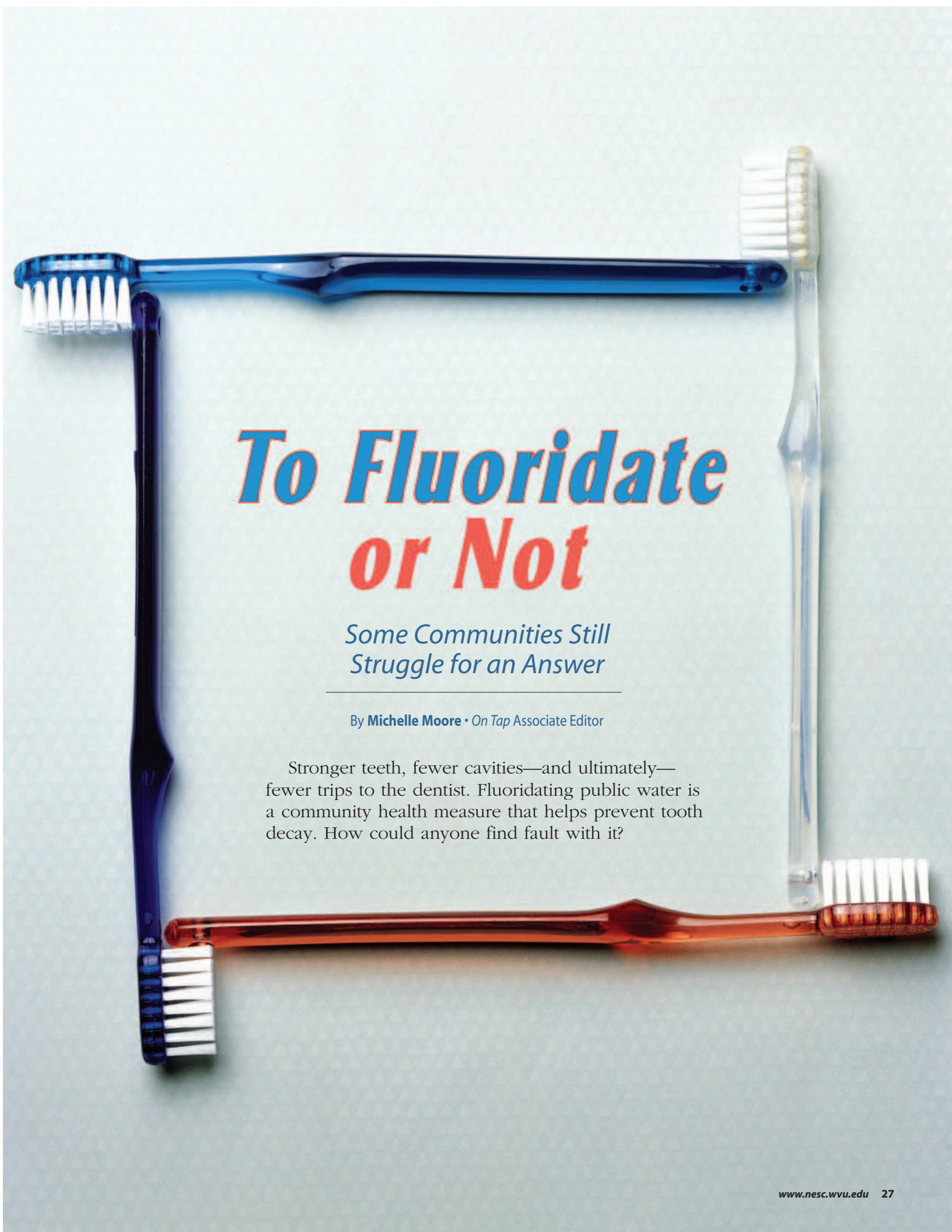


To Fluoridate or Not

Some Communities Still Struggle for an Answer

By **Michelle Moore** • *On Tap* Associate Editor

Stronger teeth, fewer cavities—and ultimately—fewer trips to the dentist. Fluoridating public water is a community health measure that helps prevent tooth decay. How could anyone find fault with it?

Those of us who live where water has been fluoridated for decades take it for granted. We drink it and cook with it, and for that matter, we brush our teeth with water whose fluoride level is adjusted so we can have healthier, brighter smiles. Like the other 40 or so chemicals that might be used in a water treatment facility, fluoride is just one of the behind-the-scenes ingredients in the drinking water mix.

But in other communities across the country, debates go on over continuing or even starting fluoridation. Arcata, California, city council wants voters to decide the fate of their fluoridation program. Clearwater, Florida, just started fluoridating following decades of opposition. Juneau, Alaska, fluoridated for years, but then stopped in 2003. Residents protested, and fluoridation resumed, but a task force is waiting for a National Academy of Sciences report before they make a final decision about how to proceed.

Fluoridation as a Public Health Measure

Water fluoridation is not only supported, it's encouraged by nearly 100 public health organizations, government agencies, and medical associations. The American Water Works Association (AWWA), the World Health Organization (WHO), the Centers for Disease Control (CDC), the U.S. Public Health Service (PHS), the American Cancer Society, the American Dental Association (ADA), and the Canadian Dental Association represent just a few of the respected organizations that recommend fluoridation as a simple, cost-effective means of promoting dental health.

It's not news to anyone that fluoride makes teeth stronger and more resistant to cavities; our dentists have been telling us that for years. We can buy fluoride toothpaste, rinses, drinks, and tablets. Fluoridating water is a public health strategy intended to add an additional safeguard for all people, young children especially, to help ensure that teeth grow strong. (Read about the history of fluoridation on page 30.)

Besides the topical effect fluoride has on the tooth surface, it also acts systemically to strengthen developing teeth, according to the ADA. When children ingest adequate amounts of fluoride before their teeth emerge, they have better resistance to tooth decay. Once teeth are full-sized, fluoride helps strengthen and repair the surfaces.

CDC statistics for the year 2000 show that approximately 162 million people, or 65.8 percent of the U.S. population who rely on public water supplies, receive fluoridated water. Still, 100 million people in the country do not.

Like many chemicals and simpler substances we encounter in life, fluoride in large doses or in a concentrated form can hurt us. Studies showing harm from ingesting excessive amounts of fluoride have helped fuel public fears. But large amounts of plenty of things can be toxic. The ADA lists normally innocent things like salt, iron, vitamins A and D, oxygen, and even plain water as being harmful in large quantities.

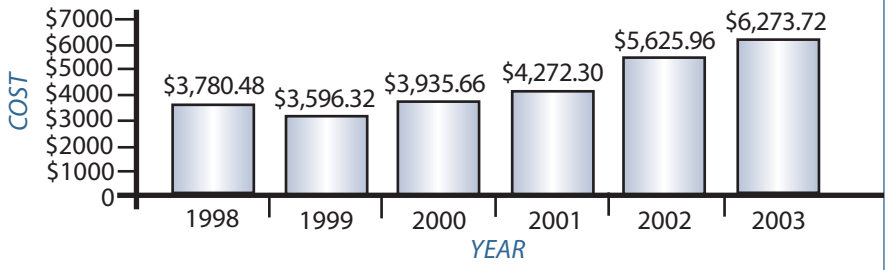
"Fluoridation is the most cost-effective, practical, and safe means for reducing the occurrence of tooth decay in a community." —Former Surgeon General David Satcher, 2001

Status of Water Fluoridation in the U. S. in 2000:

- Total U.S. Population 281,421,906
- U.S. Population on Public Water Supply Systems 246,301,290
- U.S. Population Not Served by Public Water Supply Systems 35,301,290
- Total U.S. Population on Fluoridated Drinking Water Systems 162,067,341
- Percentage of U.S. Population Receiving Fluoridated Water 57.6 percent
- Percentage of Total U.S. Population on Public Water Supply Systems Receiving Fluoridated Water 65.8 percent

Source: *Centers For Disease Control Oral Health Resources*

Total Cost of Fluoride Used Each Year from 1998 to 2003



Fluoride Costs

YEAR	Price for #	Price for 155# Drum
1998	$0.09	$14.26
1999	$0.09	$14.10
2000	$0.09	$14.26
2001	$0.10	$15.50
2002	$0.12	$18.60
2003	$0.14	$22.47
2004	$0.14	$22.47

= pound

- Average use of 135 to 140 pounds a day at a cost of $19.57 a day.
- Average use of 5.6 pounds an hour at a cost of $.81 an hour.
- Approximately 15 to 20 drums on hand due to storage restrictions.

Source: Weirton, West Virginia, Population 20,000, Weirton Water Treatment Plant, *Treatment Efficiency Report*

CDC Asserts Safety Fluoride

Some people worry that with all the potential fluoride sources that are available we might be overdosing on the stuff. Kip Duchon, the national fluoridation engineer with the CDC in Atlanta, says that is unlikely.

"We're not talking about a lot of fluoride in water," he says. "All the research shows that even with these other methods you're really not anywhere near overdosing."

According to the ADA, in 1993 the National Academy of Sciences' National Research Council reported to the U.S. Environmental Protection Agency (EPA) that adjusted drinking water fluoride levels posed no health risk and that the maximum level of 4 parts per million (ppm) "would protect against adverse health effects with an adequate margin of safety." (For more information about what parts per million measurements mean, read the article on page 38.)

To effectively prevent tooth decay, the U.S. PHS determined a range for fluoride of 0.7 to 1.2 ppm. EPA established standards for safe fluoride levels in drinking water with the optimal level at 1 ppm. One ppm is equivalent to 1 milligram of fluoride per liter of water. ADA compares this measure to "1 inch in 16 miles, one minute in two years, or one cent in $10,000."

As stated above, the agency set fluoride's primary maximum contaminant level at 4 ppm and the secondary contaminant level at 2 ppm—levels at which the agency believes fluoride will safely prevent cavities without chronic toxicity becoming an issue. (To read about how EPA determines safe contaminant levels, see the article on page 46.)

ADA says that it is impossible for someone to suffer from acute fluoride toxicity by drinking water fluoridated at optimal levels. The amount of fluoride necessary to cause the death of an adult 155-pound man has been estimated to be 5–10 grams of sodium fluoride ingested at one time. Because 1 gram is equal to 1,000 milligrams, this amount is more than 10,000–20,000 times as much fluoride as is consumed at one time in a single eight-ounce glass of optimally fluoridated water.

The association also notes that someone would need to drink water fluoridated at approximately 5 ppm for 10 years or more before showing clinical signs of osteosclerosis, a mild form of skeletal fluorosis (increased bone density with outgrowths).

ADA and CDC have both published statements on the safety and effectiveness of fluoridation, and they refute charges from opponents who say that fluoride is responsible for a list of ailments, such as cancer, lead poisoning, increased bone fractures, hormonal imbalance, and lowering of IQs. Fluoridation opponents cite articles that show problems with fluoride, despite the overwhelming number of peer-reviewed, scientific studies that demonstrate its safety.

These claims are posted on Web sites, arousing fear in many people. Statements on these sites are repeated on additional Web sites and by supposedly well-meaning individuals who have been frightened by what they've read. The misinformation is then passed from person to person and group to group until many of these statements are accepted as fact. The ADA's *Fluoridation Facts* book refers to a kind of "pseudo-scientific literature" that is based on misquoted material, partial truths, and outright fabrication.

"The public often sees scientific and technical information quoted in the press, printed in a letter to the editor, or distributed via an Internet Web page," says the ADA. "Often the public accepts such information as true simply because it is in print. Yet, the information is not always based on research conducted according to the scientific method, and the conclusions drawn from the research are not always scientifically justifiable. In the case of water fluoridation, an abundance of misinformation has been circulated."

Duchon says that about 6,000 fluoride research articles have been published in the last 30 years, and that nearly all of them support the safety of water fluoridation. "There's a handful—and it's literally a handful—that have had results not consistent with the rest," he says. "Almost all of those, when they were peer reviewed, have been found to have mistakes in epidemiology or some kind of faulty consideration.

"A perfect example is one study that showed communities that have been fluoridated have higher lead in the bloodstreams [of the residents] than communities that have not been fluoridated. When you go back and look at the epidemiology, they were comparing older cities that were fluoridated to newer cities that were not fluoridated. By an epi-

The Mystery of Colorado Brownstain

Back in 1901, a young fellow fresh from dental school in the East moved to Colorado Springs. Once he'd opened his dental practice, Frederick McKay began to notice that many of the people in the area had mottled, brown stains on their teeth. McKay was puzzled by the condition and set out to find what caused it. None of the journals he read indicated what this strange discoloration might be or what caused it. So, McKay took it upon himself to find an explanation.

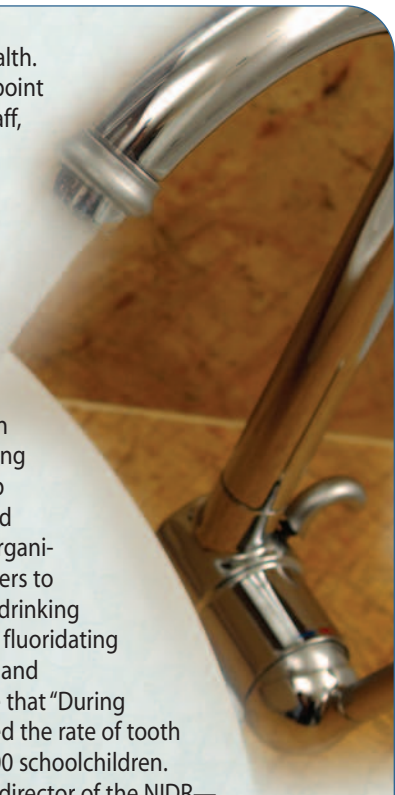
In 1909, McKay was joined by respected dental researcher Dr. G.V. Black in his investigation. Black became interested in the mystery when the Colorado Springs Dental Society reported that nearly 90 percent of children born in the area had the mottling, known as Colorado Brown Stain, on their teeth.

Over the next six years, Black and McKay learned two things about the disorder. They found that it resulted from problems during tooth development in children, meaning that adults whose teeth had no staining would not get the condition. And, teeth with the staining had much better decay resistence.

Some local theories for the staining were a little far-fetched, but one had to do with the possibility of it being related to the water. When McKay traveled to Oakley, Idaho, in 1923 to investigate staining on children's teeth there, he was reminded of the water theory. The staining began to show up after Oakley developed a public water supply. Although McKay couldn't find anything wrong with the water, he suggested that they use another source. The town made the change, and after a few years, the mottling no longer showed up on younger children's teeth.

Further investigation at other communities eventually led to the discovery that excess fluoride in water was causing the staining that today is called fluorosis.

In 1931, Dr. H. Trendley Dean with the National Institutes of Health furthered the investigation. He began studying the relationship between fluoride and dental health. Part of his focus was to find out at what point fluoride caused staining. Dean and his staff, along with chemist Elias Elvove, who devised a way to accurately measure the fluoride content of water, found that fluoride levels of 1 part per million did not cause fluorosis, whereas higher levels did.



McKay's and Black's earlier research showed that people with fluorosis also had unusually decay-resistent teeth. Dean wanted to see if adding fluoride to drinking water at that optimal amount would help prevent dental problems. In 1944 in Grand Rapids, Michigan, various public health organizations worked with the city commissioners to institute a fluoridation program for their drinking water. The next year Grand Rapids began fluoridating its water. The National Institute of Dental and Craniofacial Research says on its Web site that "During the 15-year project, researchers monitored the rate of tooth decay among Grand Rapids' almost 30,000 schoolchildren. After just 11 years, Dean—who was now director of the NIDR—announced an amazing finding. The caries rate among Grand Rapids children born after fluoride was added to the water supply dropped more than 60 percent. This finding, considering the thousands of participants in the study, amounted to a giant scientific breakthrough that promised to revolutionize dental care, making tooth decay for the first time in history a preventable disease for most people."

Condensed from "The Story of Fluoridation" National Institute of Dental and Craniofacial Research, a part of the National Institutes of Health located on the Web at www.nidcr.nih.gov/HealthInformation/OralHealthInformationIndex/Fluoride/StoryFlouride.htm.

demiological perspective, the big differentiator is that the older cities have lead paint and a lot of other lead sources. When they went back and tried to repeat that with old cities that were unfluoridated with old cities that were fluoridated and new cities that were unfluoridated with new cities that were fluoridated, there was absolutely no correlation. That pretty much debunked the study and showed it was based on poor controls."

Fluoridation opponents contend that other countries don't fluoridate, pointing to Western Europe, in particular, as having banned fluoridation. The ADA says that this is not true. Fluoridation is merely impractical in many European countries "because of complex water systems with numerous water sources." They also note that fluoridation is "available in approximately 60 countries benefiting over 360 million people." The list includes the U.S., Australia, Brazil, Canada, Hong Kong, Malaysia, United Kingdom, Singapore, Chile, New Zealand, Israel, Columbia, Costa Rica, and Ireland.

Duchon says that when countries choose not to fluoridate, even though it is recommended by WHO, they frequently promote salt fluoridation instead. Similar to iodized salt, fluoridated salt offers consumers an easy avenue for ingesting a nutrient they otherwise may have to do without.

"You've heard of going to places in Europe where they say don't drink the water?" Duchon asks. "It's the same way in South America. A lot of people drink bottled water, or they might drink very little water; they might drink a lot more wine or beer. Their beverages are different, and because of the inconsistent nature of the water quality in some of these countries, a lot of them have chosen to go to a salt fluoridation program."

In Switzerland, for instance, you can buy regular table salt, iodized table salt, fluoridated table salt, or you can buy salt

that is both fluoridated and iodized. "By law, fluoridated and iodized table salt cost the least, and just plain salt costs the most," Duchon says.

Where is fluoride found?

Fluoride is an ion of the element fluorine, a gas that readily combines with other elements to form fluoride compounds. These fluoride compounds exist in rocks and soil in the Earth's crust. Water dissolves some of the fluoride, carrying it along with other minerals in underground streams and rivers and in surface water. This process results in a tiny amount of dissolved fluoride occurring naturally in all waters, including the ocean.

The Agency for Toxic Substances and Disease Registry reports that fluoride levels in surface water are approximately 0.2 ppm and usually range in groundwater from 0.02 to 1.5 ppm. Groundwater fluoride levels may be higher in some parts of the country, especially in the Southwest.

Communities that have adequate fluoride already present in their drinking water obviously don't need to fluoridate. Those with too much fluoride have to remove the excess through their water systems' treatment processes. Much more common are communities with sub-optimal levels. When they choose to fluoridate, it is added either at the source or during treatment.

Three fluoride compounds are used in drinking water: sodium fluoride (NaF), fluorosilicic acid (H_2SiF_6), and sodium fluorosilicate (Na_2SiF_6). Depending upon which compound is used, the fluoride is added to water supplies directly as a liquid (H_2SiF_6) or as a solution of water mixed with the dry chemical powder (H_2SiF_6 or NaF).

Most of the fluoride comes from apatite rock, which is also the source of phosphorus for agricultural fertilizer. Nearly all fluoride for drinking water is a product of the phosphate extraction process in making the fertilizer.

Opponents say that these fluoride compounds contain toxic levels of impurities. AWWA sets safety standards for fluoride that water utilities obey. These standards say, in part, that the fluoride "shall contain no soluble materials or organic substances in quantities capable of producing deleterious or injurious effects . . ."

Jane McGinley, a spokesperson for ADA says "no chemical, even pharmaceutical grade chemicals, are 100 percent pure, so they do contain impurities. However, all the chemicals used in water fluoridation, as with all chemicals used in water treatment plants, meet [AWWA's] standards."

This is not to say that fluoride itself is not toxic. It is one of 11 or so chemicals used in water treatment that the CDC lists as a "very hazardous material for plant operators."

"Like many chemicals, fluoride in a concentrated form is dangerous," Duchon says. "But, chlorine also will really injure you. Alum—aluminum sulfate—will burn you. Lime will burn you. I mean there are all these chemicals that we deal with in water treatment and other places, which in a concentrated form need safe handling. If you have industrial exposure, you can have some negative consequences.

"Think of it this way: A doctor says to take two aspirin because it will be good for you. But what happens if you take 40? You might die. A little bit of something can be quite beneficial. A lot of something might not be. Fluoride's the same way. Are there cases where fluoride could be a poison? Yes. Are there cases where it could injure you? Yes. Will that happen at the concentration that we're talking about for optimal fluoridation? There's absolutely no evidence that that's the case."

CCR Tracks Flouride

A public water system's annual consumer confidence report gives residents a record of water quality, including information about fluoride. Operators are required by EPA to test the water's fluoride level at least once a day. Darle Setler with the Taylor County Public Service District (PSD) in Grafton, West Virginia, says that he checks more often if he feels it is warranted. He might seem to be extra cautious, but he says that fluctuations in the flow rate at the plant site will alter the dosage.

"The entire operation has to be watched carefully—turbidity levels, chlorine levels, disinfection byproducts, it goes on and on. If you're doing the job properly, you're going to be concerned about all those issues—not the least of which are the fluoride concentration levels."

Conscientious plant personnel play the greatest role in making sure fluoride in water is at a safe level for consumers. Setler, whose PSD was recognized by the CDC for maintaining the optimum fluoride level and meeting fluoridation requirements, says they've got a fail-safe plan for their fluoride feed system so that, no matter what might happen, no significant overdosing can occur.

"Our system here has an atmospheric drop, an air gap," Setler says. "The fluoride is introduced into our water system by a metering pump. We adjusted the metering belt setting to the lowest output on the chemical feed pump based on our average rate of flow of 3,100 gallons a minute. If the pump was accidentally left up at 100 percent, we couldn't overfeed more than 2ppm into the system."

West Virginia's operating range for acceptable fluoride levels is between 0.8 and 1.3 ppm with the optimum level set at 1ppm. Setler says the dilution is checked and monitored, not only through daily fluoride samples in the plant, but also through the distribution system. They keep a close watch on the accuracy of their scales and the metering pump output.

"We also have a partial barometric pressure loop," Setler says. "We have to pump up to a point about 30 feet and then it drops to a point where there is a physical air gap between the fluoride feed line and the filter effluent trough, making it impossible for a 55-gallon drum of HFS to accidentally be fed into our drinking water at one time.

"The two-foot air gap in place between our effluent trough and the fluoride feed line makes it impossible for any back-siphoning to occur as well. Our system has built-in redundancy checks from start up to shut down with a written plan of each phase of the operation. We take our responsibility very seriously."

Part of good treatment plant management is keeping accurate records and submitting them to the state regulatory agency. Copies have to be kept for at least 10 years. As noted in *Water Fluoridation: A Manual for Water Plant Operators*, these records should include:

- daily fluoride tests with date, place, time of sampling, and the name of the sample collector
- daily weight measurements
- make-up water used for saturators
- weekly/monthly fluoride check sample tests
- dosage rates
- identification of the sample (routine distribution systems sample, check, raw or processed water, or other)
- date of analysis
- analysis lab and technician's name
- analysis method
- results

(For more information about record keeping, see the Summer 2004 *On Tap*.)

Costs and Benefits

According to current cost information, a community with 5,000 residents will spend approximately $3 per person for water fluoridation. The ADA says that fluoridation is worth the price to the community, and for individuals, the "lifetime cost per person to fluoridate a water system is less than the cost of one dental filling."

A town can expect to spend $6,000 to $10,000 for a fluoridation system, says the CDC's Duchon, including the equipment (storage tank and metering pump for liquid H_2SiF_6 or a saturator and pump for the dried chemical) and installation. For a cash-strapped small town, which is the rule more than the exception, the cost, plus the potential for controversy, add up to a situation that many water boards and town councils may choose to avoid.

Phil Fishburn, who works with the Midwest Assistance Program (part of the Rural Community Assistance Partnership) in Kansas, says that getting small communities to incorporate water fluoridation into their water treatment process may be harder than one might expect. More than anything, local officials don't want to "rock the boat" when it comes to any kind of controversy or debate. Plus, towns are already trying to figure out how to finance the ever-growing load of regulatory requirements with tighter budgets, so an additional drain on their funds may be a tough sell.

"The bottom line," Fishburn says, "is that for most of the smaller communities, you're going to have a lot of difficulty in finding boards and councils with the political will to jump into such a controversial decision. And, the cost factor is a very legitimate concern. It's difficult enough to encourage people to look at the rates on a yearly basis and raise them to keep their systems viable financially and on a sustainable basis. Throwing in additional costs is another factor that I think would cause some communities to shy away from it."

A fluoridation debate was on the table in Hutchinson, Kansas, for a number of years. Influenced by claims (similar to those previously mentioned) from individuals in the community, the city council voted to not fluoridate five years ago. But, a new council is in office now, and they've recently decided to begin the practice.

Hutchinson would receive help from a local group, the Methodist Health Ministry Fund, who offered a $247,000 grant to get the fluoride process going and to support operating costs for the first two years. To get the matter settled, City Planner Joe Palacioz said that residents were given three-weeks notice that fluoridation would be on the agenda at an upcoming council meeting.

"People could express their viewpoints, both pro and con," Palacioz said. "Then, after we had about an hour and a half debate on each side of the issue, the decision [to fluoridate] was made."

Should people be concerned?

In 2001, Former U.S. Surgeon General David Satcher reported that "More than 50 years of scientific research has found that people living in communities with fluoridated water have healthier teeth and fewer cavities than those living where the water is not fluoridated. . . . A significant advantage of water fluoridation is that anyone, regardless of socioeconomic level, can enjoy these health benefits during their daily

Operator Jim Holmes checks the calibration of the fluoride metering pump at the Taylor County, West Virginia, water treatment plant.

Photos by Michelle Moore and Julie Black

lives—at home, work, or at school or play—simply by drinking fluoridated water or beverages prepared with fluoridated water."

The benefits appear to be obvious. But, as much as proponents of water fluoridation might want the controversy to be resolved, there is no sign that it will be. Commun-ities will continue to debate the issue as long as there are still questions being raised.

Groups who support water fluoridation have no agenda but to encourage better public health for everyone. "The CDC's opinion is that we're not here to promote things," Duchon says. "We're here to provide a scientific basis and a health perspective and to establish an overall framework so that when other people actually do something they've got some good scientific grounding. With the antifluoridation groups, there is plenty of passion but not much science."

Fluoridation opponents assert that they are only concerned for public health also. But one charge they put forth has nothing to do with science or safety, and many people agree with this one. They say that the practice disregards an individual's right to choose whether they want to have fluoride added to their water or not. They claim that water fluoridation is "mass medicating" a city's or smaller community's residents.

The Santa Cruz County Public Health Commission in California notes in their fluoridation position statement that many public health measures have been instituted for the "greater public good, including chlorinating water, pasteurization of milk and the addition of vitamin D, childhood immunizations, mandatory use of passenger restraints in cars, helmets for children bicycle riders and motocycle riders, and restriction of smoking in public places."

Fluoridating water, they say, is merely one in many instances where individual rights are foregone for the greater good of the community. As the health director of Manchester, New Hampshire, said in a *The Union Leader* newspaper article, "This is not really an issue debated at the local level. If we debated immunization or Vitamin D in milk or folic acid in bread, we wouldn't have them."

Still, the debate continues. Community leaders and water system managers will be with what to do for their residents. They need to educate themselves about fluoride and fluoridation, weed out the misinformation from the valid, and use that knowledge to make the best decision for the town.

To Learn More

You can order the 57-page book *Fluoridation Facts* from the ADA. Call them at (800) 947-4746 or visit their Web site at *www.ada.org* or write to American Dental Association Council on Access, Prevention, and Interprofessional Relations, 211 East Chicago Avenue, Chicago, IL 60611-2678.

The ADA also has several fact sheets available on their Web site at *www.ada.org/prof/resources/topics/fluoride.asp*.

Some states and private organizations offer grants to help communities with water fluoridation. Contact your state oral health department to see if any grants are available in your area.

Small systems may also use state revolving loan funds for fluoridation equipment and installation. Contact your state department of environmental protection for more information.

AWWA has an updated fluoridation manual, *Water Fluoridation Principles and Practices* (M4) 5th Edition, available at *www.awwa.org/bookstore/product.cfm?id=30004*.

The CDC offers *Engineering and Administrative Recommendations for Water Fluoridation, 1995* (MMWR Vol. 44, No. RR-13) available via download from their Web site or through the Division of Oral Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, e-mail: *oralhealth@cdc.gov*.

The CDC also posts fluoridation and oral health fact sheets on their Web site at *www.cdc.gov/OralHealth/factsheets/index.htm*.

Darle Setler can answer questions about the fluoridation system at the Taylor County Public Service District in Grafton, West Virginia. Call him at (304) 265-5569.

Michelle Moore, *On Tap* associate editor, welcomes reader feedback—both positive and negative—on her articles. Contact her at *michelle.moore@mail.wvu.edu*.