Hello Mudder, Hello Fadder, Can I drink the water at Camp Grenada?

by Kathy Jesperson
On Tap Editor

Last year, more than nine million children benefited from summer camp at an estimated 8,500 to 10,000 camps throughout the U.S., according to the American Camping Association (ACA). That means more kids went to camp last year than the total number of children enrolled in public schools in Connecticut, Illinois, New York, South Dakota, Tennessee, Texas, and West Virginia.

So what makes summer camps so popular? “Summer camp is a place where a child can explore values, talents, and interests,” notes ACA. “It’s also a place where a child can develop skills, self-reliance, and make life-long friends.”

Further, the association notes that there are more options than ever to keep a child busy during the summer. Yet summer camp enrollment rises approximately eight to 10 percent annually.

Parents Need Confidence

But even with everything that summer camps have going for them, parents want to be assured that their children are in good hands—and that the water their children will be drinking is as safe as it can possibly be.

“Every year, many parents send their children off to summer camp and entrust camp officials to keep their children safe and healthy,” says George Harakaly, vice president of the Atlantic States Rural Water and Wastewater Association (ASRWWA). He also is the facility manager of the Hole in the Wall Gang Camp.

Actor Paul Newman founded the Hole in the Wall Gang Camp as a nonprofit residential summer camp for children with cancer, sickle cell, or serious blood diseases. The camp is located in the hills of northeastern Connecticut. “We serve approximately 240 people a day from early June to late August,” says Harakaly. “But some days we have 1,000 campers here. Some camps have 5,000 a day on certain days.”

“We have 45 manuals on operating this camp,” notes Harakaly. “The drinking water and wastewater systems have eight manuals dedicated just to them so they can be professionally managed. The only treatment that we use is to sanitize on start-up or at system interruptions. But we test the water regularly to ensure that it is free from bacteria and a number of other chemical contaminants.”

“The water is a blend from three 600-foot-deep, rock-driven wells and is protected from surface water influence through required setbacks and a wellhead protection plan,” says Harakaly. “Providing only the purest water to the children who stay here and shielding them from any contamination is of critical importance.”

The Water Tastes Great

Hole in the Wall just won the best tasting water competition at the Atlantic States Rural Water conference, boasts Harakaly. The camp captured the “nondisinfected division” (water without chlorine) and in a final taste-off won the best tasting water in Connecticut overall. “We were the first water system in Connecticut to join ASRWWA, which continued on page 3
Two Long-Time NDWC TAs Say Good-bye

Well, this is it—the last issue of On Tap as a newsletter. In the Spring, we will publish our first edition of On Tap as a magazine and the topic will be distribution systems.

But first things first. You’ve probably noticed that this issue doesn’t contain a “Tech Brief.” It isn’t because we decided to stop writing them. It’s because Mohamed Lahlou, Ph.D., has finally gotten away from us. Lahlou accepted a job in Lynchburg, Virginia, where he is working as a consulting engineer. He will continue to work with small systems, and he will have the opportunity to work toward obtaining his professional engineer (P.E.) license.

Almost nine years ago, Lahlou was the first graduate engineering student that the National Drinking Water Clearinghouse (NDWC) hired. While he was here, he completed his masters degree in civil engineering as well as two more degrees: a master’s in business administration and a Ph.D. in resource economics. We relied on his experience and knowledge, and he was our senior technical assistance specialist.

“I know a little bit more than when I came here in 1992,” says Lahlou. “I am happy to be starting a new experience, but it’s with mixed feelings and some sadness.”

We will miss him as well. But we wish Lahlou all the best in his new life. We know he will do well in the world. However, we have talked him into sitting on our editorial advisory board for the magazine. And we look forward to talking him into sitting with people as wonderful as the ones here.”

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On another sad note, we also are losing Babu Madabhushi. He is on his way to Miami, Florida, where he will be working for an environmental consulting firm. The firm offers water, wastewater, and solid waste management services. Madabhushi will be working as a project engineer.

Madabhushi worked with the NDWC for four years as a technical assistance specialist, and he wrote the Q&A section of On Tap every quarter. Madabhushi holds a master’s in civil engineering and is working toward completing a Ph.D. in groundwater remediation.

“I have learned a lot working here,” says Madabhushi. “I will miss everyone and hope that I will work with people as wonderful as the ones here.”

We have also talked him into sitting on our editorial advisory board as we value his expertise. However, we are sorry to say good-bye, but we wish him much luck for his future.

Finally, I would also like to announce that Sanjay Saxena, the NDWC’s director, has once again been appointed as the Technical Section Chair for the National Environmental Health Association. Congratulations.

The next thing on my list is that I promised to tell you about the readership survey. There were 325 respondents to this year’s readership survey. Considering that we sent out more than 20,000 surveys, this translates to a little more than a one-percent return. We received responses from local, state, and federal governments; water board members; health officials; and even some private citizens.

When we asked what types of articles you are most likely to read in On Tap, 77 percent of you choose to read technical articles. The next highest rating is regulatory articles at 75 percent. The financial articles were the least popular at 40 percent. Other article types fell at the midpoint in popularity.

At least half of the respondents say that they read most of the articles. A little more than half say that they save On Tap, almost half say that they route the publication to others.

A large number of respondents, 77 percent, report that they have computer access at home and at work. And 83 percent of these say that they have Internet access.

We were really glad to hear that many of you use On Tap in training others. We are happy that you find our work useful.

Of the survey questions where we asked for a written answer, we received a lot of suggestions for future articles, including:

- how-to articles,
- solving taste and odor problems,
- wellhead protection programs,
- more about drought issues,
- point-of-use, point-of-entry equipment,
- regulatory issues facing small systems,
- public health issues,
- more about noncommunity water supplies, and
- too many suggestions to list here—but I’m sure you’ll see them as we research and write them.

Once again, I want thank all of you who answered the survey. All of your suggestions are taken into consideration and are very much appreciated. If there are topics you would like to see covered in On Tap, please let us know. You may call me at (800) 624-8301 or (304) 293-4191 extension 5533 or e-mail me at kjespers@wwu.edu. Thanks again. I look forward to hearing from you.
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serves the training needs of small water systems in Connecticut and Rhode Island,” he continues. “ASRWWA holds various workshops for camps and campgrounds on spring start-up and sanitizing. Often, state health department officials attend and present at these workshops. And the association issues continuing education units for training programs.

“We joined Rural Water to get the training that we need to properly and safely operate our water system,” says Harakaly. “We wanted to have this knowledge so that we would not lose control of our drinking water system.”

By 2001, all camps with a public water system must have a state certified Small Water System (SWS) operator and have a back-up certified SWS operator to cover in the absence of the primary operator, according to the Connecticut Department of Public Health (DPH), Water Supply Section.

Connecticut DPH defines an SWS as a community water system or a nontransient noncommunity (NTNC) water system that serves fewer than 1,000 people and that has no treatment or has only treatment that does not require an operator to provide any chemical treatment, process adjustment, back washing, or media regeneration.

What’s a NTNC or a TNC?

According to the U.S. Environmental Protection Agency’s (EPA) definitions, noncommunity water systems are classified as either transient noncommunity systems (TNC) or NTNC. TNC water systems typically serve travelers and other non-routine users at locations such as highway rest stops, restaurants, and public parks. These systems serve at least 25 people a day for at least 60 days per year, but not the same 25 people each day.

On the other hand, NTNC water systems serve the same 25 people for at least six months. Common examples of NTNC water systems are schools, factories, and other public places that have their own drinking water supply.

Knowing the System Makes Sense

Besides understanding what category their water system fits into and what mandatory testing requirements are for that classification, camp water system operators must be trained and totally familiar with the particular system they are operating. And knowing the system keeps a lot if you’re being inspected.

State officials conduct sanitary surveys of public water systems routinely to determine if systems are in compliance with state and federal regulations. According to an article that appeared in the April 1998 The Source Technical Bulletin, an ASRWWA publication, by law, camp drinking water systems must be inspected every five years if they are classified as community or NTNC. For those considered TNC, the inspection cycle is every 10 years.

A sanitary survey includes assessing potential pollution sources, the system’s equipment, and any other environmental factors that may impact the water system. The sanitary survey that the state conducts may result in immediate corrective action or simply making suggestions for improving the system. Operators are expected to know or have immediate access to test results and records as needed to answer any questions the state official may have.

Also, these surveys may provide camp water system operators with an overview of their camp water systems and what areas may require additional monitoring and maintenance.

A Different Way of Thinking

Harakaly says that residential summer camps have many small-town elements, including independent laundries, water systems, electrical services, such as generators, and several buildings that serve different functions. Because of this atmosphere, they should be thought of as small towns.
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“Summer camps should really fall under community drinking water regulations,” Harakaly says. “But most camps are TNC, for which Connecticut has not mandated any training requirements. Larger camps, such as the Hole in the Wall Camp, are NTNC, and Connecticut is in the process of finalizing the training mandates. “Hole in the Wall’s water system was a community system for many years,” he continues. “However, now it’s a NTNC water system.”

Facilities Must Be Safe

“One of the leading reasons for lawsuits against summer camps has to do with the facilities themselves,” explains Harakaly. “And that covers the grounds, buildings, equipment, and drinking water. “One camp that I know of had a squirrel floating in the well. The state told them they had to get the squirrel out of the water, but the person who runs the camp practically chased them off the property.” However the story didn’t end too badly. “The state did finally get its point across, and once the camp owner actually saw the squirrel in the well, he ‘saw the light’ so to speak,” according to Mark Sceery, Connecticut public water supplies coordinator for Region 1 EPA. “And this particular camp owner did make many renovations to the well to make certain it was safe.”

But the moral to the story is that residential summer camp drinking water system operators have the responsibility of ensuring that safe drinking water is delivered to all of the taps in camps.

Trying To Slip By

“There are a minority of people who try to avoid being regulated,” says Gerald Iwan, Ph.D., chief of water supplies, Connecticut Department of Public Health. “They try to slip in under the regulations—for example, saying they are only open 59 days a year rather than 60, which would mean that they would not be regulated. But parents want to make sure that they get their children back at least the way they sent them in. So our first role is to protect the public’s health. We have mechanisms to put these people out of business. We really try not to allow people to slip through the cracks.”

Harakaly agrees: “Fear is a tool that you have to use. Camp owners need to understand the consequences of having a squirrel in the water system.

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EPA Launches “Children First” Campaign in New England

On September 1, 2000, the U.S. Environmental Protection Agency’s (EPA) New England office launched a $1 million “Children First” initiative aimed at protecting children from environmental health threats in the places where they spend most of their time—in school, at home, and outdoors.

As a part of this campaign, EPA New England will cite community water suppliers that do not provide Consumer Confidence Reports to their customers. EPA New England will be the first region to do so. Every community water supplier in the nation is required to issue a public report so that families know the quality of the water flowing from their taps.

Citizens have the right to know about the chemicals used and released in the communities where their children live and grow. EPA will provide information to the public through real-time air monitors, expanded Web pages, and public reporting laws.

Child-Based Standards Created

EPA is committed to setting national standards for smog, soot, and water quality, as well as pesticides, at levels that protect children. EPA is now looking at all approved pesticides to ensure that children are protected. At Superfund sites, clean-up decisions are being made based upon the safety levels needed to protect children.

Environmental Justice Secured

All children, whether in rural areas or underserved urban areas, deserve the same environmental protection. EPA New England carries out its program with a basic belief in the right of all children to clean air, land, and water. This program provides financial assistance to eligible community groups (i.e., grassroots organizations, churches, or other nonprofit organizations) and federally recognized tribal governments that are working on projects to address environmental justice issues. Preference for awards is given to community-based/grassroots organizations that are working on local solutions to local environmental problems.

For more information about this initiative, visit EPA New England’s Web site at: www.epa.gov/region01/children/index.html.
Training Is Necessary

“Since we don’t have the manpower to offer training ourselves, we’re relying on the states to do it,” says Sceery. “We do, however, provide a lot of the money that enables other groups to conduct training in the state. The sanitary survey training is targeted toward small system inspections, and we offer this training to Rural Water Association personnel and local health officials, as well as state health department personnel.”

State health department officials emphasize the need to offer training programs.

“Every group should participate in specialized training,” says Iwan. “As part of our capacity development program, we put on workshops for noncommunity suppliers. Our role is to educate and follow up. The New England states are pretty aggressive with their outreach programs.

“The one thing we’ve realized is that you cannot run a program from a centralized location. You can’t just make pronouncements from the capital. You have to have the involvement of many different groups and that includes organizations like Rural Water Associations, health director’s associations, and others. Technical groups need to work together.”

ASRWWA is on top of camp drinking water operator training programs. “I have had the opportunity at camping conferences to provide some training for water systems operation for other camps,” says Harakaly. “We held an end-of-the-season workshop on October 5, where we talked about camps. We talked to owners and maintenance people about what they need to do to keep water supplies safe.

“On December 5, we held a symposium at the Hole in Wall Gang Camp to discuss training needs for 2001,” he continues. “We hope to find out what everyone thinks the needs are, such as well intrusions, interruptions in service, more OSHA [Occupational Health and Safety Association] safety training, and to get the word out to people that they need to sanitize the well and the entire system in the spring.

“I cannot stress enough how important it is to sanitize in the spring, so we also conduct a Spring Start-up Program,” he explains. “When people become aware of what they’re supposed to be doing, then they do it. We hold a workshop and then follow-up with participants after the workshop.

“Camps are becoming bigger and extending their season with activities, such as weekend reunions or adding conference centers. They all need to recognize the importance of their drinking water. Many camps fail because of the lack of maintenance. It’s a tough charge to keep it going. We’re here to support the camp. We want to raise the bar on water systems’ operation as well as program support and other various camp program needs,” he concludes.

For more information about the Spring Start-up Program or to contact Harakaly, call him at (860) 487-0574. You also may write to him at the Hole in the Wall Gang Camp, 565 Ashford Center Road, Ashford, CT 06278.

To contact Iwan, call (860) 509-7333. You also may write to him at Connecticut Department of Public Health, 410 Capitol Avenue, P.O. Box 340308, Hartford, CT 06134-0308.

To contact Sceery, call (617) 918-1559. You also may contact him by mail at New England, Region 1, One Congress Street, Suite 1100, Boston, MA 02114-2023.
Small water systems across the country are largely governed and operated by local people in the community. With water boards made up of school teachers, bankers, business folks, community activists, and others, the decisions happen locally. But local decisionmakers don’t always have all the answers to the problems that their drinking water systems face. So for many water systems, getting an objective, third party’s opinion, suggestion, or assistance is the key to getting problems solved.

One nonprofit group that helps small systems work out their issues and find solutions to financial, managerial, and technical problems is the Rural Community Assistance Corporation (RCAC). Headquartered in Sacramento, California, RCAC offers assistance to rural communities and disadvantaged people in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, and Washington.

**Helping Others Help Themselves**

Al West is a senior environmental specialist with RCAC and primarily offers technical assistance and training in Colorado. He says that some communities are a little hesitant to have outsiders come into their neighborhoods and tell them what to do. But, he says, the key to a good working relationship is to offer suggestions and let the decisionmakers do their job.

“I do not tell them what to do,” West says. “I give them options for solutions and let them decide for themselves what would work best for their community.” He says the strategy works well, especially for communities where outsiders are viewed with caution.

Another RCAC representative, George Chimiklis of the Sacramento office, agrees that RCAC’s aim is to give local communities information so they may make the decisions that affect their lives and their services.

“It may look like we have a hands-off approach, but that’s the farthest from the truth,” Chimiklis says. “We’re trained to work with communities and allow the community to find the answers. We give them options but allow them to decide. We do not work like a consultant who tells them what to do, but instead, we help the community determine what is best for them. “That takes longer to do, but it’s better in the long run,” he says. “It’s important for the decisionmakers to know what their roles are in the process. We like them to review the options and guidance we offer, but then make the decision for what meets the community’s needs. We help water boards do a better job and understand what their role is.”

**Staff Offer Environmental Services**

RCAC has staff trained in five major categories of assistance that they provide to small municipal and nonprofit water systems, wastewater systems, and solid waste management programs. The categories of assistance are:

- technical assistance,
- managerial assistance,
- financial assistance,
- networks, advocacy, and publications, and
- training.

In addition, RCAC has a loan fund that can provide other financing options to the communities that it serves.

RCAC has four goals for the environmental services they provide:

1) to develop the ability of local officials to manage their own problems and find cost-effective solutions;
2) to increase the visibility of rural community concerns in drinking water, wastewater, and solid waste;
3) to provide environmental education to the rural public; and
4) to help communities achieve compliance of their drinking water and wastewater systems by using diverse funding sources.

Chimiklis says that communities are pleased with the services RCAC provides.

“We’re just now completing a year-long process where we’re developing a five-year plan for community-based solutions to water issues in the West.”

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Helping Communities One at a Time

One small community RCAC has helped is Aristocrat Ranchettes in Colorado, a community with 306 drinking water system users. The town had a dilapidated distribution system and needed assistance in understanding the complicated process to secure funding for the project.

Al West worked with the community on the U.S. Department of Agriculture’s Rural Utilities Service (RUS) letter of conditions and provided them with training and a rate analysis to help them in choosing the proper rate to repay the loans on the new system.

“Because RUS was providing a loan/grant combination and it has a technical assistance contract with RCAC, they referred the community to us to assist and ensure they could complete the paperwork process and set water rates that would allow the community to repay the loan,” West says.

Over the course of 18 months, West worked with the water board to review their books, establish a fair rate, learn about loan repayment, and complete the more than 30 conditions of financing as set by RUS. One of his first jobs was to hold a training session on “How-to Set a Rate Structure.” For three days, six hours each day, West trained the unpaid water board members in what they needed to know.

“I wanted to teach them how-to set rates that could repay the loan they were going to receive,” he says. “Even though the training was 18 hours total, the community maintained interest and enthusiasm for getting the job done. We reviewed the expense budget for fixed and variable costs and devised three different rate structures that the community could vote on. After the community voted on the structure they wanted, the balance of the conditions were met and in a total time of two years the system was built. The community continues to pay for the financing just fine.”

West, who has five years under his belt at RCAC, says the rate structure the community and new members connecting to the system selected was set to payoff their loan in 40 years. But as 54 new users came into the system after construction was complete, the system was generating more income than necessary. Because of the rate-setting complexity and new board members, West returned to the community to review the structure again.

“The rate structure was made to fit the number of users the system had at the end of construction; however new users brought them excess revenue,” he says. “We then did an analysis of their rates and worked out two solutions for the community to vote on. The community was able to lower its minimum rate by $1 per year for the next four years and pay off some of their debt at a faster rate.

“Again, I don’t tell them what to do,” West says. “I give them options and let the decisions be made locally. In the case of Aristocrat Ranchettes, I will visit the community in six months to do a check-up on the new rates.

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plan. We talked with clients, partners, and others to determine how our services were appreciated and used. In general, our publications and direct technical assistance and training were highly received. We often receive requests to do more of the same and have more staff to work with communities.”

He says that in addition to self-referrals from communities, RCAC reaches clients through RCAC’s publications, other communities referrals, a Web site, and regulatory agencies that refer communities that are having compliance problems.

“Very frequently, a community comes to us asking for money,” he says, “but they also ask us ‘how do we go forward from here?’ We help an individual system clarify and prioritize what its needs are and develop an action plan that can draw support from the entire community.”
RCAC Helps Disadvantaged Communities

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“The community was very interactive,” he says. “I saw no strong resistance to my ideas, but rather an acceptance of the knowledge and experience I was able to give them. Some communities see RCAC technical assistance providers as outsiders and in this case, they were welcoming, willing to listen, and willing to question the ideas and the training. I am happy to hear that Aristocrat is doing well financially. I don’t always get to hear back.”

Total costs for the project were $2,443,000. Of that, $1,800,800 was a 60 percent grant, 40 percent loan from RUS with a 4.5 percent interest rate. The Colorado Water Conservation Board provided a loan of $600,000 to purchase water rights. The community provided $42,200 toward the project.

Other RCAC Projects

Since it was formed in 1978, RCAC has helped numerous communities in the western U.S. George Chimiklis says that RCAC has developed a good reputation for working cooperatively with other technical assistance providers, state agencies, and federal agencies. “If there is not a network of providers in a state, we work strongly to establish those ties among state officials, Rural Water folks, regional U.S. Environmental Protection Agency (EPA) staff, American Water Works Association (AWWA) members and others.

“It’s easy to get on a water board, and then the folks on the water board very quickly find themselves needing more information than they can get locally,” Chimiklis says. “Rural Water associations, AWWA chapters, and RCAC, as well as other fellow travelers and assistance providers, like environmental resource centers and state agencies, are great technical assistance resources. These groups are essential for helping small communities stay healthy. We really do have to work together.”

In June, Chimiklis says EPA’s Indian Programs office asked RCAC representatives to assist Indian Health Services who were putting together a two- and a-half-day training session for tribal operators in New Mexico. “Because EPA knows we help communities in this state, our representative there, Martin Lopez, did an entire day’s training for tribal operators at our expense. We were able to respond to their need through our program funding.”

Chimiklis says RCAC has also worked closely with EPA Region 6 Tribal Drinking Water Program in New Mexico. RCAC facilitates quarterly sessions with tribal technical assistance providers. Chimiklis says the sessions have led to tribes developing an interest in utility boards. Tribes also have asked for additional training in capacity development.

In addition to these projects, RCAC has been able to:

• produce Safe Drinking Water booklets in both Spanish and English.
• assist residents in the 40 homes and trailers at Poe Colonia, California, by responding to the immediate health threat of unsafe drinking water. The homeowners were receiving household water from an open irrigation canal. RCAC identified sources of financing for a new water system, wrote an application for funds, and acted as liaison between the city, county, and the residents to ensure that the residents’ needs were met.
• conduct Communicating Drinking Water Issues training for state and local drinking water regulatory officials.
• work with three communities in Tillamook County, Oregon, that had received notices to improve their water systems. RCAC developed educational tools and facilitated meetings to inform residents.
• conduct drinking water compliance workshops for small drinking water systems.
• publish Financing & Outreach for Small Systems—A Joint Effort funded by EPA’s Public Private Partnership Initiative.
• conduct clinics for small drinking water systems and rural communities about financial management, budgeting, and capital planning.
• help small water and wastewater systems obtain funding for engineering studies and to implement system upgrades and repairs, and
• train communities about how to set water rates and manage water system budgets.

You may write the RCAC at 3120 Freeboard Dr., Suite 201, West Sacramento, CA 95691. Their phone number is (916) 376-0507 and their fax number is (916) 447-2878. RCAC is online at www.rcac.org.

In other regions of the country, contact the Rural Community Assistance Program at RACAP INC., 722 East Market Street, Suite 105, Leesburg, VA 20176, or call them at (703) 771-8636. You also may e-mail them at racp@rcap.org.
**Perchlorate May Endanger Newborns, Fetuses**

Even low levels of ammonium perchlorate in drinking water may negatively affect fetuses and newborns. That’s according to a study recounted in the August issue of the *Journal of Occupational and Environmental Medicine*.

The study reported that perchlorate—a chemical that is used to manufacture rockets, missiles, and fireworks, among other products—may be the reason behind higher-than-normal thyroid stimulating hormone (TSH) levels, which points to hypothyroidism, identified in some newborns in Arizona. And because perchlorate crosses the placenta, it has the potential to cause hypothyroidism in fetuses.

According to the Magic Foundation for Children’s Growth, clinical hypothyroidism is marked by a deficiency in the secretion of the thyroid hormones thyroxine (T4) and triiodothyronine (T3). These hormones regulate metabolism and, in children, have some growth regulating functions.

A child with hypothyroidism may have an enlarged thyroid gland, also known as a goiter. But more likely, the child will fail to grow, particularly in height. At the time of birth, however, the symptoms and signs of hypothyroidism are minimal or absent. But, the most critical reason to test a newborn for hypothyroidism, the foundation warns, is that “the lack of adequate thyroid hormone from birth until approximately two years of age is associated with varying degrees of permanent mental retardation.”

Dr. Ross Brechner, lead author of the study and chief of the Arizona Department of Health Services, found that mothers who drink water with detectable levels of perchlorate gave birth to babies with elevated levels of TSH, an indicator of hypothyroidism.

Scientists with the Arizona Department of Health Services’ Bureau of Health Statistics compared newborn screening data for 1,542 infants born in Yuma and Flagstaff between 1994 and 1997. Researchers chose these cities because Yuma draws all of its drinking water from the Colorado River below Lake Mead, which is contaminated with perchlorate, while Flagstaff does not use any water from the Colorado River. Also, the cities are comparable in size and socioeconomic status, and conventional water treatment plants serve both communities.

The study found that infants born in Yuma had significantly higher levels of TSH than those born in Flagstaff which is indicative of a thyroid disorder. “Further, [this study] suggests that even low-level perchlorate contamination of drinking water may be associated with adverse health effects in neonates, and highlights the need for both further study and control of human low-level perchlorate exposure,” noted the study’s authors.

As much as 1,000 parts per billion (ppb) of perchlorate have been detected in the Las Vegas Wash, which feeds Lake Mead and the Colorado River. The chemical also has been detected in the river below the lake, which provides water to approximately 20 million people.

Currently, California is the only state that has a standard for perchlorate, which is set at 18 ppb. In 1999, the perchlorate level in Yuma’s treated water was 6 ppb; the chemical was not detected in Flagstaff’s water.

*For more information about perchlorate, contact the Safe Drinking Water Hotline at (800) 426-4791.*

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**Maintaining a Healthy Septic System**

Do water softeners affect the biological activity in a septic tank? Does the additional sodium in softener brine lead to drainfield failure?

If you’ve ever wondered whether a home water-softening unit might mean trouble for an onsite septic system, read the next issue of *Pipeline*, a National Small Flows Clearinghouse (NSFC) publication. The *Winter 2001 Pipeline* discusses water softeners and offers answers to common questions consumers ask.

 Experts have studied the effects of water softeners on septic system performance, and while not all the research is conclusive, the answers presented thus far can help consumers make informed choices about their own hard water problems.

To get this copy of *Pipeline*, Call the NSFC at (800) 624-8301 or (304) 293-4191.
One Man’s Dilemma
Operator Struggles To Provide Safe Water

by Jamie Knotts
On Tap Assistant Editor

Editor’s note: We’ve been sensitive to the operator in this article and chosen not to use his name or that of the utility he owned and operated.

His name is Tom and he didn’t ask to be a drinking water system owner and operator. He sort of fell into the role by accident.

When he bought some property in Missouri back in the ’70s, Tom didn’t know about all the problems he would face in the future. The property had a well on it that supplied several of the town’s residents. As more and more people moved to the area, they tapped into the well, until it became a public water system that ultimately served 83 households.

Over the years, the now 68-year-old Tom tried his best to keep the system operating. He often spent his own money to pay the electric bill, largely because he still charged rates set 17 years ago in 1983. He worried about the little old lady down the street who couldn’t afford a rate increase.

He was just being neighborly.

But things changed when the state’s Department of Natural Resources (DNR) cited his system for a number of maximum contaminant level (MCL) violations. He was injecting chlorine from a ground well and didn’t have enough detention time because the system had no storage. And his pumps were running all the time, resulting in some electric bills hitting $2,000 a month.

Aside from a long list of MCL violations, the system’s pipe wasn’t sufficiently covered. With maybe six inches of dirt resting on a layer of rock, it was hard for him to meet the standard.

On top of these problems, the system’s $10 a month rate for unlimited water often didn’t even cover the system’s routine costs. And even at that low rate, some people owed $300 or $400 in back payments. Any improvements would have to come out of Tom’s own pocket.

MAP Lends a Helping Hand

Tom needed help and got it from Chris Fierros, a rural development specialist with the Midwest Assistance Program (MAP). Headquartered in New Prague, Minnesota, MAP is one of six Rural Community Assistance Programs that strive to improve the delivery of water and waste disposal services to rural and low-income areas. Working out of her office in Mound City, Missouri, Fierros set out to help Tom.

“I knew there were problems. The plant facilities were put together makeshift and the system never really was in compliance,” Fierros says. “I helped review the rates and look over the system. Tom only actually owned the well location. He had no easements, no right-of-ways. He couldn’t even disconnect customers for nonpayment. It was a pretty bad situation when I got down there.

“Tom knew he needed a rate increase,” she says. “At that point, I had never worked on a private-side issue before. Most of the systems we work with are municipalities and they don’t fall under the PSC [Public Service Commission].” The PSC works differently for private and public water systems.

“I got a few lessons of how the PSC works in Missouri,” she says. “It’s just the opposite of a public system. On the private side you have to make all the improvements before you can get a rate increase. Small systems often don’t have the financial resources available to make improvements without the PSC guaranteeing they will get the increase and no bank will loan the money because there may not be any repayment ability.

“The PSC won’t even look at and approve a rate increase pending an agreement that the system will make the improvements,” says Fierros. “And we couldn’t go to a bank asking for a loan without the PSC’s rate approval. The PSC did acknowledge that the rates were too low and had not changed since 1983. The PSC knew that the $10 wasn’t even covering the electric bill.”

The PSC does not regulate public water systems in Missouri. Fierros says that funders somewhat regulate the public water systems. Funders are the organizations or agencies that provide the system’s funding. So when a system wants or needs a rate increase, it seeks approval from the funders who provided its grants or loans.

“Tom didn’t know where to go or what to do,” Fierros says. “Most small system operators don’t want to call an outside agency for help if there is something wrong. They think they will get in more trouble if they come forward with their problems. But Tom was already under a compliance agreement with state DNR. He needed assistance from our organization.”

Gathering the Facts

One of the first things the two had to do was collect all the necessary information to put a rate increase proposal together. They took an inventory of all the system’s equipment and put together financial reports detailing all assets and

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experts. “The report was as detailed as listing 200 feet of six-inch pipe and its cost,” Fierros says. “It took a lot of research to list what he put in the system.”

Once they started this fact gathering process, Fierros says, the PSC came down to the system and worked with them. “I knew I could eventually work things out,” she says. “All I had to do was call the PSC and they were really good about helping. It helped that they knew he was charging 1983 rates. A rate increase was easily justifiable for this system.”

With all the information gathered, the pair filled out a formal document 28 pages long. “It was real in-depth,” says Fierros. “It listed the year he made improvements, what the improvements were, and any debts against the system. It also included such things as how much money was invested in the system, and how much profit was taken from the system. They are allowed a 30 percent profit over their expenses in Missouri, and they’ll (the PSC) catch it (if it exceeds 30 percent.).

**New Rate Denied, Now What?**

They submitted the rate increase application in late June, and by September, they learned the increase had been denied. “The PSC pushed that through,” Fierros says. “Normally they say that it’s a six-month process once they receive it. He just didn’t have six months to wait.”

The application went through a review committee and eventually came before a three-member commission who had the authority to approve or disapprove.

“They found that he needed the increase, however because of the public comments, they said that he couldn’t enforce the rate until improvements were made,” Fierros says. “The comments were justifiable because some people didn’t even have water. How could he enforce a new rate on people who weren’t always getting what they were paying for?”

Fierros estimates that there were 20 comments out of the 83 connections to the system. She says most of the written comments were negative.

“He ended up giving the system to the city because he didn’t have the money to make the improvements and didn’t want the customers to suffer,” Fierros says. “The situation had gotten way past the typical help the system could get. The city could get the grant money and funding in order to put the system in working compliance.”

In Missouri, a Hancock Amendment prohibits cities from taking over systems and immediately raising rates. However, they found they could bypass this rule having completed the PSC rate process, which found that a rate increase was justifiable, but not enforceable until improvements had been made.

“Tom had to walk through the whole PSC process to get the system turned over to city,” Fierros says. “He wanted to get out of the water business. He was 68 and just wanted out.”

**Tips for Working with PSCs**

For systems wanting a rate increase, Fierros says they need to make sure that all system improvements are justified. “They can’t go out arbitrarily and make system changes and then say they need a rate increase,” she says. “The PSC needs to see that systems are making needed changes.

“Keep in contact with the PSC and let them know what is going on,” she urges. “They are more open to involvement then not knowing about something that is going on behind their backs. The PSC doesn’t like surprises. Let them know what you are doing.”

Fierros says that those going through the process need to make sure they know all the rules that apply with the PSC’s regulations. Most are posted on the internet. “Going into it, I didn’t know there would be so many things different between public and private systems.”

She says the biggest pitfall a system can get into is exaggeration of expenses. “The PSC is pretty good about knowing what the costs are,” she says. “If an operator has two 250-gallon-a-minute pumps, then the PSC should know what the electric costs would be.

“They questioned various parts of our application and we justified the situation,” says Fierros. “In this case, there were no holding tanks, so the pumps ran pretty much 24 hours a day, resulting in the higher than normal electric bills. The PSC understood this.”

To speak with Fierros, call her at (606) 552-3852. To contact the Midwest Assistance Program, call (800) 822-2981 or (612) 758-4334. MAP offers assistance to systems in Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming. If you have a story that you would like to share with On Tap readers, please contact Kathy Jesperson at (800) 624-8301 or (304) 293-4191 extension 5533 or e-mail at kjespers@wvu.edu.
In June 2000, the U.S. Environmental Protection Agency (EPA) proposed a rule that would lower the existing standard for arsenic from 50 parts per billion (ppb) to 5 ppb. According to the Safe Drinking Water Act (SDWA) Amendments of 1996, EPA must decide upon the final standard by June 22, 2001. The World Health Organization recommends a standard of 10 ppb and has stated that if health considerations were the only factor, the standard would be even lower.

**Study Concludes Limit Not Protective**

In a 1999 report, the National Research Council (NRC) concluded that the 50-ppb standard does not protect public health. Furthermore, the report said that long-term exposure to low concentrations of arsenic could cause skin, bladder, lung, and prostate cancer; cardiovascular disease; diabetes; and anemia. However, the NRC report does not recommend an arsenic standard. But it does state that the arsenic regulation must be strengthened, and calls for more research to support an appropriate standard.

**Lower Arsenic Limit Could Cost Billions**

The American Water Works Association (AWWA) estimated that the proposed limit of 5 ppb could cost water utilities $1.4 billion a year in operating expenses and $14 billion in capital expenses. A standard of 3 ppb would cost $2.8 billion a year with a capital cost of $28 billion. According to the EPA’s estimate, the cost for a 5 ppb standard would be $374 million per year.

All community water systems would be subject to the new standard. According to the EPA’s own estimate, 6,600 utilities would have to take corrective action. That’s about 12 percent of all water suppliers with the vast majority of them serving fewer than 10,000 people.

The burden would fall most heavily in the Southwest, where many communities have tap water with high levels of arsenic. Other communities in the West, Midwest, and New England would also be affected, especially those that rely on groundwater. According to EPA’s estimate, the cost per household may be about $28 per year in larger cities, and about $85 per household per year in communities of fewer than 10,000 people.

According to a U.S. Geological Survey study, as few as one percent of drinking water systems have arsenic levels above the existing federal standard of 50 ppb, eight percent exceed 10 ppb and just a little more than 13 percent of systems exceed five percent.

**EPA Proposes Lower Arsenic Limit**

EPA Proposes Lower Arsenic Limit

NTNC Water Systems Must Report Violations

Public water systems exceeding a new maximum contaminant level (MCL) will be required to either treat their water or find alternative sources. Although homeowners with private wells are not regulated, a lower drinking-water standard would mean that more homeowners would be consuming water with concentrations that exceed the standard.

At the same time, EPA is proposing that non-transient, noncommunity water systems (NTNCs) be required to notify people when arsenic levels exceed the drinking water standard.

**EPA Considers Treatment Costs**

The 50 ppb standard was originally established in 1942, and was adopted as an “interim” standard in 1975 and has not been updated since. The SDWA requires EPA to set the MCL as close as possible to the maximum contaminant level goal (MCLG). However, EPA is required to take into account the quantifiable and non-quantifiable costs based on Health Risk Reduction and Cost Analysis (HRRCA).

EPA would like to set the arsenic level at 3 ppb; however, it cannot justify setting the MCL at that level because of the uncertainties in costs and risk assessments. Until more is known, the agency is taking a traditional, public health conservative approach to considering the potential risks of drinking water containing inorganic arsenic.

**The Arsenic Research Plan**

The SDWA also requires EPA to develop an Arsenic Research Plan. This research plan was released in early 1998 and describes research needed to reduce uncertainties in the arsenic risk assessment and to support EPA’s development of a new arsenic drinking water standard. The research needs addressed are in the areas of exposure, health effects, risk assessment, and risk management for determining the most scientifically defensible and technically feasible revised MCL for arsenic in drinking water.

**Sources of Arsenic Contamination**

Arsenic is an element that occurs naturally in rocks and soil, water, air, plants, and animals. Volcanic activity, the erosion of rocks and minerals, and forest fires are natural sources that can release arsenic into the environment. About 90 percent of the arsenic that U.S. industry uses is for wood preservative purposes. Arsenic is also used in paints, drugs, dyes, soaps, metals, and...
semi-conductors. Burning fossil fuels and wastes, paper production, glass manufacturing, cement manufacturing, mining and smelting can also release arsenic.

**Treatment Technologies for Arsenic**

EPA has designated Ion Exchange, Activated Alumina, Reverse Osmosis, Modified Coagulation/Filtration (C/F), Modified Lime Softening (LS), and Electrodiagnosis as the Best Available Technologies (BATs) for treating arsenic from source water.

**Coagulation/Filtration (C/F)** is an effective method for treating arsenic, provided proper pH and coagulant are used. In pilot studies, ferric sulfate outperformed alum and other coagulants.

**Lime Softening (LS)** operated within the optimum pH range of greater than 10.5 is likely to provide a high percentage of arsenic removal. However, if removals greater than 80 percent are required, it may be difficult to remove consistently at that level by LS alone. Systems using LS may require secondary treatment to meet that goal (e.g., addition of an ion exchange unit as a polishing step). Both, LS and C/F have sludge disposal concerns to be addressed. Both these methods are primarily used for large systems. Package plants may be more affordable for small systems to employ these technologies.

**Activated Alumina (AA)** is effective in treating water with high total dissolved solids (TDS). However, the capacity of AA to remove arsenic is very pH sensitive. High removals can be achieved at high pHs, but at shorter run lengths. Selenium, fluoride, chloride, and sulfate, if present, compete for adsorption sites. AA is highly selective toward pentavalent arsenic; and this strong attraction results in regeneration problems.

**Ion Exchange (IX)** can effectively remove arsenic as well. It is primarily recommended as a BAT for small groundwater systems, with low sulfate and TDS as well as a polishing step after filtration. Selenium, fluoride, chloride, nitrate, and sulfate if present compete for adsorption sites and can affect run lengths. Column bed regeneration frequency is a key factor in calculating costs for this method. Passage through a series of columns could improve removal and decrease regeneration frequency.

**Reverse Osmosis (RO)** provides removal efficiencies of greater than 95 percent when operating pressure is ideal. However, water rejection may be an issue. Where scarcity is an issue, water recovery will need to be optimized.

**Electrodiagnosis Reversal (EDR)** can produce water quality comparable to reverse osmosis. EDR systems are fully automated, require little operator attention, and do not require chemical additives. A removal of about 85 percent can be achieved.

For general information about arsenic in drinking water, contact the Safe Drinking Water Hotline at (800) 426-4791, or visit the EPA Safewater Web site at www.epa.gov/safewater or the arsenic Web site at www.epa.gov/safewater/arsenic.html.

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**NSFC’s Updated Products Catalog Now Available on the Web**

The National Small Flows Clearinghouse (NSFC) announces the release of its new products’ catalog. The 2000-2001 Wastewater Products Catalog is now available and provides a complete listing of the 434 free and low-cost products NSFC offers. Materials range from educational products for the general public to technical manuals for the wastewater professional.

The products are listed according to type. Categories include case studies, computer searches, computer software, design manuals, fact sheets, finance and management, general information, operation and maintenance, public education, publications, regulations, research, technology packages, and videotapes.

The catalog offers a brief description of each product, including the year it was produced, its intended audience (e.g., engineers, state officials, etc.), the number of pages, item number, and price. In the back of the catalog, a keyword index allows readers to search for a product by topic and to find the page the product is located on.

Also included is an order form that can be downloaded and mailed or faxed to the NSFC. Orders may also be called in or sent via e-mail to the number and address below.

To order the 2000-2001 Wastewater Products Catalog, call the NSFC at (800) 624-8301 or (304) 293-4191 and request Item #WWCAT. Orders may also be placed via e-mail at nsfc_orders@mail.estd.wvu.edu.
What are chlorinated solvents?

Subsurface soils and groundwater contaminated with nonaqueous-phase organic liquids cause major environmental concerns. These pollutants, such as chlorinated solvents and their natural transformation products, represent the most prevalent organic groundwater contaminants in the country. And since they are quickly adsorbed, they are difficult to remove from subsurface environments.

These organic liquids act as a continuous source of dissolved organic pollutants to groundwater. Even at low levels, they can contaminate large quantities of groundwater. Nonchlorinated solvents and lightly chlorinated solvents are generally biodegradable in aerobic (in presence of oxygen) conditions. Highly chlorinated solvents are more recalcitrant (resistant to biodegradation) to aerobic degradation, but more susceptible under anaerobic (in absence of oxygen) conditions.

One chlorinated solvent, trichloroethylene (TCE), has been getting a lot of attention, and it is estimated to be present in 34 percent of the nation’s drinking water supplies. TCE possesses unique physical and chemical properties that pose serious health risks and make groundwater treatment expensive. Microbial degradation byproducts of TCE make its treatment even more difficult. The current discussion focuses on TCE, its effects on health, and its treatment.

How is TCE different from other contaminants?

TCE is a nonflammable liquid with a sweet odor that most people can smell, even at concentrations as low as 1 ppm [parts per million]. TCE is colorless at room temperature, less viscous than water (will sink in water), and a suspected carcinogen. Based on animal testing, TCE may cause cancer, birth defects, and genetic damage. TCE can decompose at high temperatures forming toxic gases, such as hydrogen chloride, chlorine, and phosgene. Due to its high volatility, it evaporates quickly from surface waters—but not from the soil. TCE can percolate quickly through soil along with rainwater to the groundwater. Once it reaches the groundwater, it adsorbs onto the soil and may attach itself to water particles, and then it travels until it reaches an impermeable surface. When groundwater is drawn from this TCE-contaminated region, it poses serious health risks.

Does TCE have other names?

TCE is also known as acetylene trichloride; 1-Chloro-2,2-dichloroethylene; 1,1-dichloro-2-chloroethylene; ethinyl trichloride; ethylene trichloride; trichloroethene; and 1,1,2-trichlorethylene. Its Chemical Abstracts Service (CAS) Registry Number is 79-01-6 (a number assigned by the CAS in the U.S. used as a unique identifying number worldwide).

What is TCE used for?

TCE is produced in the petrochemical industry and has many uses, such as in dry cleaning operations, paint and printing ink removal, fumigation of rodents, manufacturing fluorocarbons, and as an anesthetic. Trichloroethylene is used for degreasing metal parts (the automotive and metal industries are the primary users). TCE also is used for scouring cotton and other fabrics in the textile industry. It is used in the pharmaceutical industry as a solvent for waxes, fats, resins, and oils and in the aerospace industry for flushing liquid oxygen. Many consumer products, such as correction fluid, paint remover, adhesives, and spot removers, contain TCE. Its historical use in foods, beverages

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(decaflaision of coffee), pet foods, medicine, pharmaceuticals, and cosmetics has been banned because of its toxicity.

Is TCE regulated?
Due to its serious health effects, the U.S. Environmental Protection Agency (EPA) has set the Maximum Contaminant Level Goal (MCLG) for trichloroethylene at zero because EPA believes that at this level of protection, TCE will not cause any potential health problems. However, the Maximum Contaminant Level (MCL) has been set at five parts per billion (ppb) because EPA believes, given present technology and resources, this is the lowest level at which water systems can reasonably be required to remove it from drinking water.

How is one exposed to TCE?
One can be exposed to TCE by inhaling air contaminated with TCE vapors from water, and products made with it, such as spot removers and correction fluid. Other modes include drinking TCE-contaminated water, showering, or swimming in contaminated water. Coming into contact with soil contaminated with TCE also is a mode of exposure.

TCE is rapidly absorbed into the bloodstream following inhalation and ingestion, and it is rapidly distributed to organs, including the liver, kidneys, and cardiovascular and nervous systems. Also, small amounts can be absorbed through the skin. TCE is excreted from the body at a moderate rate, mostly in the urine.

What are TCE’s health effects?
Exposure to TCE can cause a variety of health problems ranging from minor irritation to death. The most serious effects are related to the central nervous system. Breathing large amounts of TCE may cause impaired heart function, coma, and ultimately death. If exposed for longer periods, TCE may cause nerve, lung, kidney, and liver damage. Breathing small amounts for shorter periods may cause headaches, dizziness, slowed reaction time, depression, insomnia, anorexia, and facial numbness.

Though TCE is noticeable by smell at lower concentrations in air (82 ppm), people can become accustomed to the odor and may not smell TCE until it reaches higher concentrations. At very high concentrations (2,000 ppm), the odor may cause irritation of the nose and throat, drowsiness, dizziness, and nausea within five minutes.

Drinking large quantities of water contaminated with TCE may cause nausea, convulsions, liver and kidney damage, impaired heart function, coma, or even death. Though inconclusive, some studies with mice and rats suggest that exposure to high TCE levels may cause liver and lung cancer.

Long-term exposure to high concentrations may cause facial numbness or discomfort as well as jaw weakness. TCE is a severe skin irritant, and prolonged contact with it may cause reddening of the skin, irritation, and blister formation. Though TCE can be absorbed through the skin, researchers do not expect this mode of transmission to cause significant, harmful effects. Contact with eyes may cause severe eye irritation, including temporary clouding of the cornea, disturbances in eyesight, reduced eyesight, and blurred, double, and tunnel vision. Ingestion may cause a burning sensation in the mouth and throat, followed by abdominal pain, severe lung irritation, and damage to the lung tissues.

Does TCE cause cancer?
The International Agency for Research on Cancer (IARC) concluded that there is limited evidence for the carcinogenicity (capability to cause cancer) of TCE in humans. However, IARC also concluded that there is sufficient evidence from animal studies that TCE may be carcinogenic.

How do I treat TCE-contaminated water?
Treatment of groundwater contaminated by chlorinated solvents is more difficult than cleaning groundwater contaminated with less dense liquids, such as gasoline and diesel fuel, which float on the surface of water. As these dense liquids (chlorinated solvents) travel and sink faster through water, larger quantities of water become contaminated in a shorter time period.

As TCE quickly evaporates, using irrigation sprinklers is one treatment option. These sprinklers diffuse water droplets through the air, removing the TCE. One research study indicates that the contaminated water can be pumped out, treated, and reinjected back into the subsurface below the actual contamination. This reinjected water helps prevent further contamination.

Airborne TCE can be removed using activated carbon filtration and resins. Air stripping is used to treat contaminated groundwater. Soil vapor extraction can be used to remove TCE present in the soil. Granular activated carbon (GAC) in combination with packed tower aeration has long been recognized as an effective method of removing TCE from water. As the cost of GAC is increasing, use of synthetic

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How does trichloroethylene affect drinking water?

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carbonaceous adsorbents has been on the rise. Carbonaceous adsorbents have better adsorption capacity and can easily be regenerated onsite.

Researchers have identified and isolated several species of bacteria that can remove halogens (e.g., chlorine) from TCE. Generally, a site’s environmental chemistry determines the rate of TCE biodegradation. TCE’s initial metabolism in groundwater involves a biochemical process described as sequential reductive dechlorination. (Reduction is any chemical reaction that adds electrons to an element. For reduction to occur, some other material must be oxidized.)

When sequential reductive dechlorination occurs, two electrons are transferred to the chlorinated compound being reduced. One of these electrons combines with a chlorine atom that is bonded with a carbon atom to become a negatively charged chloride ion. The second electron combines with a proton (hydrogen ion) to become a hydrogen atom that replaces the chlorine atom in the byproduct. One chlorine atom at a time is replaced with hydrogen, and each transfer occurs in sequence. As an example, tetrachloroethylene is reduced to TCE, then any of the three dichloroethylenes, then to monochloroethylene (commonly called vinyl chloride), then to the chlorine-free carbon skeleton ethylene, then finally to ethane.

References:
Basic Information on Trichloroethylene and Health Effects of TCE. www.ccohs.ca/oshanswers/chemicals/chem_profiles/trichloroethylene/trichloroethylene.htm.

Alternative Technologies Conference Set for March

The Nebraska Department of Environmental Quality’s Nebraska Environmental Partnerships program is teaming with the Nebraska Water Environment Association, regional chapters of the Solid Waste Association of North America, the National Drinking Water Clearinghouse, and many other sponsors to present two conferences: the 1st Alternative Water and Wastewater Technologies for Small Communities Conference and the 45th Annual Great Plains Waste Management Conference. These conferences will be held on March 28 and 29, 2001, at the Holiday Inn Convention Center in Omaha, Nebraska.

Providing safe drinking water and effective wastewater systems are key to protecting a community’s environmental health and are strongly linked to its social and economic development. Furthermore, because small systems’ managers and operators encounter special challenges when working with complex financial, technical, and regulatory information, the conference will highlight lower cost, alternative technologies that have been installed and used in communities with populations with fewer than 5,000. The conference includes a full day of alternative technology presentations. In many cases, community representatives will be available to explain the projects from the community’s perspective.

In addition, University of Nebraska students will display research posters.

The conference will target community leaders, community utility workers, engineers, contractors, technical assistance providers, state regulators, funding organizations, and national/regional researchers.

If you are interested in attending this conference or would like more information, please contact M.J. Rose at the Nebraska Environmental Partnerships program at (402) 471-3193, or Kirk Pfeffer at the Nebraska Environment Association at (402) 444-4923, or visit Nebraska Department of Environmental Quality’s Web site at www.deq.state.ne.us.
Synthetic membranes were first developed in the 1960s and have been a growing trend in the water industry ever since. Synthetic membranes are barriers that can permit the separation of select microbial pathogens, particulate matter, and organic or inorganic chemical species onto the membrane surface or into a separate stream through a combination of sieving and sorption/diffusion mechanisms.

Depending on the sizes of pores, membrane processes are further classified as microfiltration (MF), nanofiltration (NF), ultrafiltration (UF), reverse osmosis (RO), and electrodialysis (ED). Membranes also can be classified in other ways, depending on chemical nature (organic or inorganic), separation mechanism (size difference, solubility differences), or the differences in application pressures (high and low pressure).

This increased use of membranes can be attributed to several factors. Membrane filtration:
- provides an effective multiple barrier treatment for regulated pathogens for both drinking water and wastewater;
- can be used with a lower quality water;
- requires less space than conventional treatment technology and can often increase plant capacity;
- can be added to conventional plant treatment, ensuring compliance with impending regulations;
- is flexible, allowing easy placement within an existing plant;
- can be upgraded for increased capacity or to implement improvements is rapid and low cost;
- offers a broad range of water processing capabilities;
- has a long service life because they are typically strong, compatible with disinfecting and cleaning practices, and can be regenerated online; and
- can be tested by direct methods so that repair or replacement is timely and simple.

**Trend Begins in the 1980s**

In the 1980s, research showed that both MF and UF were highly capable of removing particulate matter (turbidity) and microorganisms from water.

Membrane processes, such as MF and UF, were used prior to 1980 in the food processing industry for non-chemical disinfection (sometimes referred to as “cold sterilization”). Nowadays, membranes can be used to filter drinking water and wastewater because researchers have a much better understanding of how they work. Further, researchers now know what clogs or fouls a membrane, making cleaning and maintenance a much easier process. And membranes no longer have to be taken off-line to monitor fouling or clogging.

Depending on the membrane type, there are other advantages, such as a smaller waste stream, lower chemical usage, greater pathogen reduction, no disinfection byproduct (DBP) formation, and more automation and control.

In addition, membranes are finding their niche in water treatment because of a better understanding of how water quality affects the performance of each type, the lower cost of multiple barrier treatment sequences, and the extent to which membranes replace or complement other treatment technologies.

**First Major MF Plant in California**

But membrane technologies have not always been accepted. First, during their early use, the cost of membrane treatment was prohibitively high. Second, membrane processes did not have regulatory approval, and third no data was available about membrane use for large-scale processes.

Despite these problems, the Department of Health Services and some water utilities in California, realized the benefits that low-pressure membranes provide, and decided to undergo the regulatory approval process to install these systems at small and cost-effective scales. In addition, a major factor that led to successful use at the full-scale level was that, since the early 1990s, the cost of low-pressure membranes has decreased dramatically.

Until 1994, all MF or UF plants had capacities of less than 3 million gallons per day (gpd). Since 1994, the application of low-pressure membrane filtration is on the rise. Capacities of plants are essentially unlimited with membrane system technology now available.

**Regulatory Pressures Create New Interest**

New regulations on filtration, disinfection, and DBPs have generated considerable interest in membrane technology.
Increasing use of membrane process

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processes. Low pressure MF and the lower pressure version of UF membranes are now being used to remove turbidity and pathogens.

Higher pressure UF, NF, and RO filters remove regulated organic and some inorganic waterborne substances. However, DBPs and virus problems warrant greater reliance on these technologies at some sites.

The passage of the Surface Water Treatment Rule (SWTR), developed in response to the Safe Drinking Water Act (SDWA), requires treatments that remove and inactivate specific protozoa, viruses, and bacteria. These requirements may be met by increasing the dosage of chemical disinfectants, such as chlorine, chlorine dioxide, ozone, or chloramines. However, higher doses of chlorine may also result in higher concentrations of DBPs, such as chloroform and other trihalomethanes (THMs). Moreover, the SDWA amendments required that a new set of maximum contaminant levels (MCLs) be established for THMs.

Thus, the effect of the SDWA has been to force water treatment professionals to consider non-conventional treatment processes, such as membrane technologies. There are many strategies for using different types of membranes with specialized technologies for disinfecting (i.e., advanced oxidation technologies). Special membrane materials that are resistant to the range of oxidants, such as Polyvinylidene fluoride (PVDF), are serving the need very well. Membrane manufacturers have a very large arsenal of membrane materials and system configurations to cope with fouling behaviors of different source waters and the needs for long-service life.

Groundwater and end-of-plant water quality are ideal places to implement membranes. For these “cleaner water” situations, the membrane system, especially MF systems, can offer peace of mind by adding an absolute barrier to chlorine resistant protozoan cyst and oocyst. These MF membranes offer protection in the event that the conventional plant suffers migration behaviors or when groundwater is under the influence of surface water.

Water Scarcity Encourages Membrane Use

Membrane treatment in Florida has increased because of regulatory pressure and water scarcity. Many municipalities throughout the state use shallow groundwater as a source of potable water. But this water contains high concentrations of natural organic matter (NOM) that may react with chlorine, forming unacceptable levels of THMs. Because of these factors, Florida is a leading state in the use of NF.

By 1996, the combined capacity of all the NF plants in the U.S. was 60 million gallons—and all of

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the plants were located in Florida. NF is now the second-largest application of membrane processes. Also, EPA has designated NF as one of best available technologies (BATs) for meeting Stage 2 of the Disinfection Byproducts Rule.

Membranes have a variety of uses. They can be used to treat wastewater before discharge to surface water. In addition, they are particularly useful in areas with scarce water supplies. RO units were air dropped during the Gulf War in Iraq so that troops could use them to filter their drinking water. Further, a process that combines UF and activated sludge treatment is used in Japan in more than 100 installations to flush toilets.

Desalination Offers Attractive Alternatives

In remote, arid regions, communities rely primarily on groundwater supplies that tend to have high mineral concentrations. Water supply problems in such areas can be alleviated by desalination of brackish water. RO and ED may be viable options. Although, the cost of these two processes is higher than the cost of treating fresh water by conventional methods, it may be more economical than hauling water over large distances.

Desalination of seawater for drinking water purposes is widely practiced in the Middle East, which boasts two-thirds of the world’s desalting capacity. However, the largest RO plant is in Yuma, Arizona, (66 million gpd) followed by a plant in Saudi Arabia. Distillation dominated the desalination market until about 1970. Since then, improvements in RO and ED have led to their increased use. RO and ED are now the preferred methods for desalting. In 1988, there were 1,742 RO plants—which is 49.4 percent of the total 3,527 desalination plants in the world.

Membrane Technology Has a Future

Membrane filtration technology is being widely accepted in the water industry. Utilities perceive cost as the main obstacle for widespread use of this technology. However, the difference in treatment costs between a conventional and membrane treatment is rapidly decreasing. The cost of new membrane plants, where no plant existed before, may show significant cost benefits over installing new conventional treatment trains since the preparations and foundations of membrane plants are much simpler and faster to construct.

With water resources becoming increasingly scarce and regulations increasingly stringent, traditional methods will not be sufficient to meet the standards in the future.

Moreover, membrane treatment processes are increasingly attractive due to further advances in research. Membrane processes provide solutions to previously difficult problems. And they represent an exciting development in water treatment. If the trend continues, membrane treatment may be the preferred water-treatment method.

References and Bibliography


Reviewers

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NDWC Assists Noncommunity Water Systems

Note: Call (800) 624-8301 or (304) 293-4191 to order products and verify prices. Please allow three to four weeks for delivery. Actual shipping charges are added to each order. These products also may be ordered via e-mail at ndwc_orders@mail.estd.wvu.edu. Products are subject to availability.

- Nontransient Noncommunity Drinking Water: Requirements for Suppliers
  Item #DWVTRG34
  This 1993 public education video provides general information about nontransient noncommunity water systems. It addresses standards, contaminants, monitoring and compliance, and sampling frequency.

- Transient Noncommunity Water Systems Regulations: Complying with the Safe Drinking Water Act
  Item #DVTTR08
  This 1993 video and accompanying learner’s guide address the regulatory requirements for transient noncommunity water systems. Presented in a newscast format, the video discusses the Surface Water Treatment Rule, the Total Coliform Rule, and nitrate monitoring requirements.

- Self-Assessment for Small Privately Owned Water Systems
  Item #DWBLMG01
  Intended to help water system managers and local officials identify financial and managerial problems, this 1989 guide includes a series of questionnaires that can help assess a system’s financial condition.

- Water System Self-Assessment for Homeowners’ Associations
  Item #DWBLMG03
  This 1989 booklet was developed to help homeowners’ associations—that regularly supply drinking water to 15 or more hookups or 25 or more people—understand the financial and managerial problems of small drinking water systems. The booklet includes worksheets and suggestions to help solve common problems.

- Water System Self-Assessment for Mobile Home Parks
  Item #DWBLMG02
  This 1989 guide contains worksheets that can help small system operators assess whether they need help with planning, financing, or operating. It also provides suggestions for solving common water system problems.

NDWC Mission Statement

The National Drinking Water Clearinghouse assists small communities by collecting, developing, and providing timely information relevant to drinking water issues.