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TREATED VS. UNTREATED DRINKING WATER:

CONSUMPTION MOTIVES IN SOUTHWESTERN ALASKA NATIVE COMMUNITIES AND INTERVENTION STRATEGIES

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ABOUT THE COVER

In southwest Alaska, 82% of Alaska Native residents reported that at least some of their drinking water comes from untreated sources, even though their villages have treated drinking water available from a centralized source. The authors of this month's cover feature, "Consuming Untreated Water in Four Southwestern Alaska Native Communities: Reasons Revealed and Recommendations for Change," sought to find out why residents choose to drink untreated water when treated water is available. The authors then recommend specific interventions—based on reasons given by residents—focusing on both the benefits of drinking treated water and risks from drinking untreated water.

See page 8.

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PRESIDENT'S MESSAGE

Carolyn Hester Harvey,
PhD, CIH, RS, DAAS, CHMM

Prestigious Recognition for Environmental Health Professionals

How many of NEHA's over 5,000 members are Registered Sanitarians (RS) or Registered Environmental Health Specialists (REHS) or both? How many of you know about and are members of the American Academy of Sanitarians (AAS)? If you are one of the above with an RS or REHS and not a member of AAS, allow me tell you about the organization and how you can become an active and sustaining Diplomate.

Like most professionals with letters after their name, environmental health professionals have an organization that recognizes their work, service, lifelong learning, and dedication to being the best environmental health professional in the field. AAS is an organization that elevates the standards, improves the practice, advances the professional proficiency, and promotes the highest levels of ethical conduct among professional sanitarians in every field of environmental health. AAS members exhibit every one of these characteristics on a daily basis. Their jobs may be focused on food protection through employment with a government agency at the federal, state, or local level or through employment in the private sector. If so, their responsibility is to protect the public from foodborne diseases. In order to do this effectively, they perform to every one of the standards: they take courses as the criteria and rules change; they improve the way they inspect; they use new tools and software to insure accurate and timely information; they utilize improved inspection techniques; and most of all, they are ethical people when conducting inspections and performing overall duties. The same standards and criteria cover all of the dozens of different jobs performed every day by environmental health professionals. They are an example of what an AAS membership represents.

You will experience a new camaraderie and expand your professional network.

AAS wants you as a member as you demonstrate the characteristics and the lifelong commitment to the profession of environmental health. AAS invites and encourages professionally credentialed environmental health practitioners with qualities of outstanding competence and leadership to become certified as Diplomates. The certification process is unique and differentiates a professional sanitarian registered by examination and one who is qualified under demanding standards such as academic achievement, publication, credentialing, and the demonstration of leadership.

The requirements for AAS membership are contained in the Diplomate Criteria. The applicant shall achieve the following:

(a) provide evidence of good moral character and high ethical and professional reputation;
(b) possess a baccalaureate degree from an accredited college or university and provide transcripts indicating the successful completion of at least 30 semester credit hours in the physical and biological sciences;
(c) possess a master's or higher degree awarded by an accredited institution in public health, the environmental health sciences, or in an area of scientific or administrative specialization related to environmental health;
(d) be legally registered as a professionally credentialed environmental health practitioner in the state in which he/she is employed, or, if no legal registration is in effect in that state, be registered in good standing as a sanitarian or environmental health specialist by NEHA;
(e) have had at least seven years' acceptable experience in environmental health including at least two years in charge of work at or above the staff level (time spent in course time in earning degrees below the doctoral level shall not be counted in the experience requirement); and
(f) certify his/her professional dedication to protecting and promoting the health and quality of life of mankind.

The criteria above may look daunting but if you take the time to review your career and document all the things you have accomplished, many of you will qualify. Since the inception of AAS in November 1956, fewer than 600 members have joined. That is 58

years with an average of fewer than 11 members per year.

If accepted, you become a Diplomate member and you are in exalted company. We should all strive for this prestigious recognition and become a strong member and supporter so AAS can persevere with its functions of 1) maintaining the highest level of environmental health standards, 2) granting academic scholarships through NEHA to future sanitarians, 3) awarding the Davis Calvin Wagner Award each year to a very deserving member of the Academy, and 4) funding environmental health students to attend NEHA's Annual Educational Conference (AEC) & Exhibition mentoring sessions of which many of you support with your time, money, and talents.

My membership status as a Diplomate of AAS is an honor and a privilege that I hold close to my heart. I urge every environmental health professional with the criteria necessary to take the time to apply for membership. You will experience a new camaraderie and expand your professional network with a very interesting and dedicated group of your peers. We can all look forward to hearing from AAS regularly in the *Journal of Environmental Health* through a tri-annual column beginning in the April 2015 issue. Additionally, I look forward to seeing many of you at the next in-person AAS meeting at the NEHA AEC in Orlando, Florida, the week of July 13–15, 2015.

We will each have more challenges in the coming year but as a group of environmental health professionals who perform best under pressure, we will survive and persevere. I feel fortunate to have a strong support system of friends and colleagues through my memberships with NEHA and AAS. I deeply appreciate your friendship, expert guidance, and support throughout the year and look forward to many positive changes for NEHA in the coming year. I should like to wish everyone a very happy, safe, and prosperous holiday season and new year.

Dr Carolyn Harvey
carolyn.harvey@eku.edu

Did You Know?

Waters & Company has been selected to recruit for NEHA's next executive director. They have more than 30 years of experience helping organizations identify, recruit, and promote key staff for complex organizations. NEHA's board hopes to announce the new executive director by early winter.

Consuming Untreated Water in Four Southwestern Alaska Native Communities: Reasons Revealed and Recommendations for Change

Troy L. Ritter, PhD, REHS, DAAS
Alaska Native Tribal Health Consortium, Division of Environmental Health and Engineering
National Tribal Water Center

Ellen D. S. Lopez, MPH, PhD
Center for Alaska Native Health Research
University of Alaska at Fairbanks

Rachel Goldberger
Division of Environmental Health and Engineering
Alaska Native Tribal Health Consortium

Jennifer Dobson, MPH, REHS
Office of Environmental Health and Engineering
Yukon Kuskokwim Health Corporation

Korie Hickel, MPH, REHS, CHES
Jeffrey Smith, MS, RS
Alaska Native Tribal Health Consortium
National Tribal Water Center

Rhonda M. Johnson, MPH, DrPH
Department of Health Sciences
University of Alaska at Anchorage

Andrea Bersamin, PhD
Center for Alaska Native Health Research
University of Alaska at Fairbanks

Abstract **In this article, the authors provide the first in-depth account of why some Alaska Native people drink untreated water when treated water is available. Their qualitative research was conducted in four Alaska Native village communities that have treated water available from a centralized distribution point. Most respondents (*n* = 172; 82%) reported that some of their household's drinking water came from an untreated source. Motives for drinking untreated water emerged from analysis of open-ended questions about drinking water practice and could be categorized into six themes: chemicals, taste, health, access, tradition, and cost. Importantly, some residents reported consuming untreated water because they both liked untreated water and disliked treated water. As such, interventions to increase safe water consumption should address this dichotomy by providing education about the benefits of treated water alongside the risks involved with drinking untreated water. Based on the findings, the authors provide specific recommendations for developing behavior change interventions that address influences at multiple social-ecological levels.**

Introduction

Drinking contaminated water is a well-documented risk factor for infectious disease. Currently, more than half of the hospital beds in the world are occupied by persons affected by inadequate water supply and sanitation (Bartram, Lewis, Lenton, & Wright, 2005). While the highest burden of water-related disease is found in developing countries, unsafe water consumption continues to affect U.S. populations (Centers for Disease Control and Prevention [CDC], 2008). Waterborne diseases cost the U.S. health care system an estimated $900 million each year (Collier et al., 2012).

The treatment of drinking water is an important preventive measure for waterborne disease. Water treatment is the purification of water to make it suitable for drinking or other domestic use. The most common water treatment processes are addition of chlorine to denature pathogens and filtration to remove particles. Most major U.S. cities began providing treated drinking water in the early 1900s. This increased availability of treated water in the U.S. contributed to the dramatic decline in the crude death rate from infectious disease that occurred during the first part of the 20th century (CDC, 1999). Construction of water treatment systems in Alaska Native communities, however, did not begin until the 1960s. Water system construction in Alaska's Native village communities falls under the jurisdiction of either the Alaska Native Tribal Health Consortium (ANTHC), a nonprofit tribal organization that provides water, sanitation, and health services to Alaska Native people and communities across the state (see ANTHC's Web site, http://anthctoday.org/about/index.html, for more information), or the state of Alaska's Village Safe Water program. Funding for water infrastructure in rural Alaska is limited and communities must demonstrate strong support and capacity for their proposed projects to be funded. Once in place, ownership and operation of the infrastructure is transferred to a governing entity

within the community, typically the tribal or city council. Sustainability can be a challenge. Local communities take on responsibility for daily operation and maintenance with training and limited on-site technical assistance provided through external programs. Revenue to pay for water system operation and maintenance is generated through user fees, but this does not always cover costs. Most village water utilities have no formal process for receiving and resolving consumer complaints or for educating consumers about water safety.

Currently, almost all residents of Alaska Native villages have access to treated drinking water. Yet for about one in four rural residents, treated water must be packed, or "self-hauled," to their homes from a centralized water point. Self-haul water systems require residents to fill and carry several small containers of water from a central water point to their homes using sleds, snow machines, or four-wheel-drive vehicles.

Despite the availability of treated drinking water in Alaska Native communities, it is widely recognized that many residents drink untreated river water and rain. This is of particular concern because microbiological sampling of untreated water found numerous pathogens, including *E. coli*, *Cryptosporidium*, and *Campylobacter*, and that rooftop-harvested rainwater contained *E. coli* (Alaska Native Tribal Health Consortium & CDC, unpublished data). Two studies provide insight on why Alaska Native people with access to treated water continue to drink untreated water (Cassady, 2008; Marino, White, Scheitzer, Chambers, & Wisniewski, 2009). One study conducted in Alaska's northwest Arctic region found that residents associated chlorine in treated water with the onset of cancer (Cassady, 2008). A 2009 study by Marino and co-authors revealed that residents in two Norton Sound region villages preferred the taste of untreated water to treated water and that they believed their untreated sources were superior in terms of health and safety. Study participants were wary of chemicals used in the water treatment process and preferred untreated water because they thought it was "more natural."

Our study builds on the previous research in three ways. First, we use thematic analysis to identify and analyze participant-reported motives for drinking untreated water and describe the interconnections among them. Second, based on our analysis, we provide recommendations for encouraging consumption of treated water only. Third, our research was conducted in Alaska's southwest region, exploring perspectives that may differ from those found in previous studies in northwest Alaska, where residents may espouse different cultural and health-related values.

Methods

Setting

We conducted our research in four small remote southwest Alaska village communities. Each community was selected because of its participation in a larger study exploring the impact of inadequate water and sanitation on rates of infections. In 2010, the combined population was 1,403, with the vast majority of residents (93.9%) identifying with Alaska Native heritage (U.S. Census Bureau, 2010). These village communities ranked among the most remote in Alaska. With no external road system, access between communities and urban centers is possible only by small airplane, snow machine, and the occasional summer barge. The selected communities also experience extreme weather conditions, with winter temperatures dropping to -40°F. Subsistence activities, such as hunting, fishing, and gathering (berries and greens) hold cultural, social, and economic significance to these communities, where employment opportunities are limited and more than 40% of residents over age 16 are not in the workforce (U.S. Census Bureau, 2010).

Participant Eligibility and Recruitment

The study materials and processes were approved by the Alaska area institutional review board, the human subjects review committee of the regional tribal health consortium, and the four representative village councils. The research focused on the estimated 250 households with only self-haul water distribution. Recruitment comprised announcements made over VHF radio (a simple transmitting device used as a primary method of communication in this region), recruitment flyers, and other word-of-mouth methods.

Data Collection and Questions

The data presented here were collected as part of a larger semistructured, in-person survey focused on assessing the change in health status following provision of in-house piped water and healthy water use promotion. In some cases, residents heard the VHF announcements and traveled to a community building to complete the survey. A majority of the surveys, however, were conducted in respondents' homes. To facilitate this, a paid village resident field worker accompanied a research team member on visits to each eligible household. Surveys were primarily conducted in English. For participants who preferred to use their local language, Yup'ik, the field worker helped to translate questions and responses. Because our previous experience working in this region indicated that the presence of a tape recorder often negatively impacted participation and the quality of responses, surveys were not audio recorded. Instead, the researcher strived to transcribe participants' responses to the open-ended questions as they were provided. Each household chose one member to complete the survey, and was offered $40 in compensation for the time.

The survey interview opened with the question, "How much of your household's drinking water comes from the (treated) water point?" Response options included "none," "some," "most," and "all." Participants who chose responses other than "all" were asked to elaborate by explaining their motives for consuming untreated drinking water. Data collected from this series of questions are the focus of this article.

Data Management and Analysis

Interview responses (both closed- and open-ended) were transcribed into an Excel spreadsheet. Qualitative data were analyzed using a four-phase process. Phase I involved having six individuals trained in environmental health review all of the transcribed statements from the open-ended survey questions. Two of these individuals had also been involved in data collection. They were asked to identify themes related to respondents' reported motives for drinking untreated water. The reviewers collectively identified six motive themes. During Phase II, two researchers who had participated in Phase I worked collaboratively to develop a codebook that included the six motive themes and their operational definitions. During Phase III, the same two researchers independently coded each response to one or more of the six motive themes. Finally, during Phase IV, the researchers compared their coding and discussed any coding disagreements. This pro-

cess resulted in inter-coder agreement on 230 of 234 code assignments (98.3%). In the four instances where agreement was not achieved, data for the entire household were excluded from the data set.

Results

Sample Characteristics

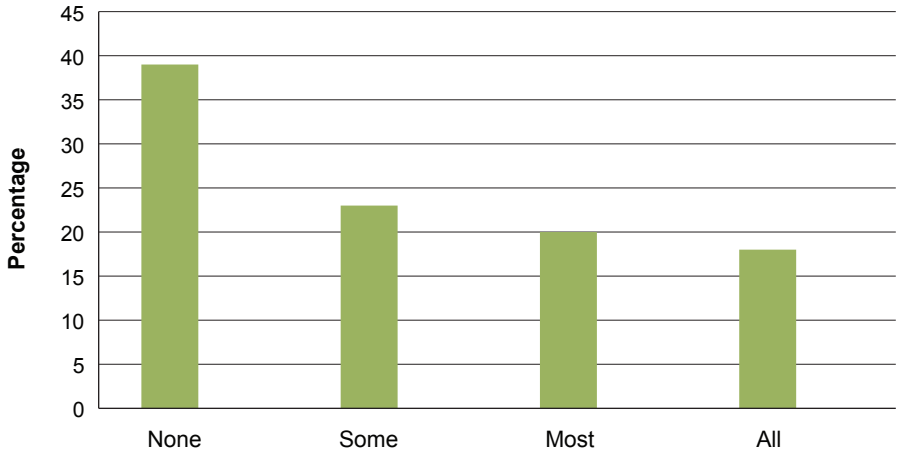
Of the 250 eligible households, 210 (84%) completed the questions relevant to this report. Participating households comprised an average of 3.9 occupants (range = 1–10). Sixty percent of the surveys (n = 126) were completed by a male household member. The average age of the respondent was 48 years (range = 19–83).

Proportion of Drinking Water Obtained From an Untreated Source

A majority of participants (82%; n = 172) reported that at least some proportion of their household's drinking water came from an untreated source. Untreated sources included river and rain water. The highest percentage of participants (39%; n = 82) reported their household obtained "none" of their drinking water from the water point while the lowest percentage (18%; n = 38) reported that "all" their drinking water came from the water point (Figure 1).

FIGURE **1**

Reported Proportion of Drinking Water From the Treated Source, Alaska (*N* = 210)



Motives for Drinking Untreated Water

Of the 172 participants reporting that any of their household's drinking water came from an untreated source, 153 (90%) answered the open-ended question to explain their motives for drinking untreated water. Data from four households were excluded during the coding process, leaving 149 respondents. Respondents offered multiple reasons for drinking untreated water, with a total of 204 separate explanations provided. The six identified motive themes include chemicals, taste, health, access to water, tradition, and cost and are discussed in detail below. Table 1 provides the number and percentage of households reporting each of the six motive themes along with illustrative quotations.

Chemicals

The use of chemicals in the water treatment process was the most common reason provided for choosing to consume untreated water (Table 1). Most respondents who expressed concerns about chemicals specifically named chlorine as the source of their opposition. Respondents explained that people disliked the taste and smell of chlorinated water, were concerned about the potential negative health effects caused by chlorine, and viewed chemical water treatment as a western practice that conflicted with the widely held preference for things produced naturally. Some respondents associated chlorine taste and smell with poor water treatment system operation and maintenance. Even though fluoride is not added to the treated water in any of the four villages, a few participants expressed concern that fluoride in their treated water may produce negative side effects.

Taste

Many respondents explained that they simply disliked the taste of treated water. According to participants, treated water tasted "weird," "salty," "yucky," and even "slimy." The themes taste and chemicals overlapped substantially, with 31 of the 67 respondents (46%) reporting both as reasons for consuming untreated water. Most respondents who mentioned taste emphasized their dislike of chlorine. Six respondents specifically noted that "chlorine doesn't go good with coffee," an observation also made in Marino's study (2009). Respondents also characterized treated water as unpalatable due to high iron content, which gives the water a rusty taste. Dislike of the taste of treated water was not the only taste-related motive, however. Many respondents explained that they enjoyed the taste of untreated rain and river water, describing it as "crisp," "clean," "sweet," and "fresh."

Health

Health emerged as a motive for consuming untreated water. While a few respondents believed that untreated water offered health benefits, more than a quarter of respondents, or 40 of 149, associated treated water with health problems such as stomachaches, diarrhea, headaches, allergic reactions, dry skin, and even death. Most common were concerns regarding gastrointestinal problems experienced by young children, older residents, and honored Elders. Of the 40 respondents who mentioned health as a motivator, 18 (45%) also discussed their negative opinions of chemicals, so there was frequent overlap in the first three categories. Chlorine was the chemical that participants most commonly associated with their health concerns. Respondents also associated the yellow, brown, and rust color that often results from iron in treated water with health problems, even though ingesting iron at levels found in drinking water is not a known health risk.

Concerns related to improper or inadequate water system operation and maintenance influ-

TABLE **1**

Motives for Drinking Untreated Water When Treated Water Is Available, Alaska, 2008

Motives (# and Percentage of Households Reporting Motive)	Illustrative Participant Quotations
Chemicals (*n* = 69; 46%)	"If pump water has too much chlorine we go to the creek." "We don't like chemical water." "I don't like chlorine." "I don't trust the chlorine that much."
Taste (*n* = 67; 45%)	"Chlorine doesn't go good with coffee. Creek water tastes sweeter." "Sometimes water at the water point tastes too much like chlorine." "Sometimes [treated water] tastes like rust." "[Untreated water] doesn't have a taste like slimy treated water."
Health (*n* = 40; 27%)	"River water builds immunity." "Too much [treated water] will kill anybody." "Treated water has chlorine and fluoride so it might have side effects." "Chlorine makes my dad sick in his stomach."
Access (*n* = 25; 17%)	"No transportation to haul [treated] water." "[Rain] is right outside." "Water points are too far from home." "Rain falls from the sky to my bucket."
Tradition (*n* = 13; 9%)	"I grew up with river water." "That's what we've always had." "I've never tried treated water." "That's how we were born and raised."
Cost (*n* = 12; 8%)* (*n* = 12; 18%)**	"You have to have money to buy treated water." "Can't afford [treated water]." "Water from the river is free." "[Drinking rain] saves money."

*Includes all households (*n* = 149).

**Includes only households in two villages where a charge for water existed (*n* = 65).

enced participants' drinking water choices. Several participants blamed faulty operation and maintenance for the taste and smell of chlorine, the color associated with iron in their treated water, and the potential for health problems. As one respondent stated, "I've seen the water tank. I think it needs to be cleaned."

Access to Water

Self-hauling treated water from the water point, a difficult and time-consuming process, was described as a barrier to consuming treated water when untreated water could be obtained in closer proximity to the residence. Respondents noted that rainwater was particularly accessible because it could be harvested on site with no need for packing and hauling. Lack of transportation to haul treated water was reported as another barrier. In addition, having to obtain tokens for the coin-operated water points was described as a "hassle" that further deterred treated water consumption.

Not surprisingly, accessing treated water was a barrier for residents with physical- or age-related limitations. One older respondent offered that she drank treated water in the winter and rainwater in the summer. When asked to elaborate, she explained that her son hauled treated water for her in the winter, but during summer he was away from the village at fish camp, leaving her to consume the more easily obtained rainwater. A respondent living with paraplegia described a similar reliance on others to fetch his water.

Tradition

Treated drinking water became available in the four villages in 1962, 1968, 1981, and 1985, well after most U.S. communities. Until then, residents had no choice but to consume untreated water. Many respondents described consuming untreated water as the social norm. In fact, a few participants admitted that they had never even tried the treated water available to them. Those who attributed their use of untreated water to tradition tended to be older (average age = 55).

Cost

The cost of treated water emerged as a motive among respondents in the two communities that charged a fee for treated water. Respondents in those communities noted that untreated river water and rain are free but that treated water incurs a charge. These respondents further explained that for some people with limited economic means, drinking untreated water is not a choice, but a necessity brought about by inability to pay.

Discussion

Understanding why Alaska Native people continue to drink untreated water when treated water is available is essential to designing effective and culturally responsive behavior change strategies toward waterborne disease prevention. In our study, we explored motivations for drinking untreated water in four southwest Alaska Native village communities that had access to treated water via a self-haul water system.

Qualitative analysis of data revealed six motivation themes for drinking untreated water: chemicals, taste, health, access to water, tradition, and cost. Among those six motivations, chemicals, taste, and health stood out in terms of the frequency at which they were reported; together, they accounted for 117 of the 204 (57%) statements provided by respondents, and those who cited one of them often cited the others. Further, these three motivation themes were related to the presence of chlorine in treated water. Most respondents who mentioned taste as a motivation focused on their dislike of chlorine, while respondents who mentioned health were concerned about the safety of chlorine in treated water. These concerns about chemicals, taste, and health are similar to those reported in a study conducted in northwest Alaska (Marino et al., 2009) as well as in studies conducted with non-Alaskan populations (Doria, Pidgeon, & Hunter, 2009; Patel, Bogart, Uyeda, Rabin, & Schuster, 2010; Saylor, Prokopy, & Amberg, 2011; Turgeon, Rodriguez, Theriault, & Levallois, 2004).

The motives described by participants in our study highlight the relationship between individuals and their environments (social, built, and policy). These findings attest

to the need for strategies that respond to issues and concerns occurring at multiple levels of the social-ecological framework. Public health interventions that take a social-ecological approach are particularly relevant to the environmental health profession because this approach acknowledges the importance of the environment in shaping individual behavior (Glanz, Rimer, & Viswanath, 2008). The three supra-individual levels of the social-ecological framework (family, community, and policy) are directly applicable to at least three different kinds of environments (social, built and policy), as will be illustrated below.

Structural modifications to the built environment, such as providing houses with piped water service, are often beyond the capacity of public health interventions. Nevertheless, such strategies fall within the scope of environmental health practice. Social ecology provides a framework for taking full advantage of the unique capacity held within the environmental health profession. Here, we use the social-ecological framework to suggest intervention strategies that are specific to the findings from this research and possibly transferrable to other populations, settings, and topics. Specifically, we discuss recommendations for the individual and the social, built, and policy environments. The individual and the social, built, and policy environments were deemed relevant to our study because our data suggested that they were areas where interventions could bring about the desired changes in behavior.

Individual Level

In our study, personal factors such as knowledge, attitudes, beliefs, and perceived barriers influenced residents' decisions to drink either treated or untreated water. For example, respondents expressed their concern about the taste and health consequences associated with chlorine (motive themes: chemical, taste, health). A strategy for addressing this concern would be to develop an education campaign. While health promotion materials may be available, it is important that the processes and materials of the campaign are adapted and contextually tailored to the specific circumstances, culture, and setting of the target population (Figueroa & Kincaid, 2010).

Social Environment

The social environment includes the individual's family, community, culture, and social norms. In our study, respondents described drinking untreated water as a long-standing traditional practice (motive theme: tradition). Activities to intervene must honor traditional practices while bringing forth new evidence-based health information. One strategy is to use participatory methods, such as those suggested by Fisher and Ball, where respected Elders and others are invited to be involved in all phases of community-level intervention, including development, implementation, and evaluation; this would help to ensure community acceptance, cultural sensitivity, and credible avenues of information diffusion (such as through community presentations, school classroom projects, and water treatment facility tours) (Fisher & Ball, 2002).

Built Environment

The physical environment comprises surroundings that are natural and built. Together they provide the setting for water source decision making and opportunities for intervention. In our study, participants reported limited access to treated water (motive theme: access). In the case of these four communities, this could be addressed by constructing piped water distribution systems that provide a convenient and plentiful supply of treated water to the home. Modifying the built environment offers the best solution for those who drink untreated water due to physical- or age-related disabilities and live in communities where construction of a piped water system is feasible. Marino and co-authors (2009) observed that residents with piped water service were more likely to drink treated water than those who self-hauled water. This was true even though both groups preferred untreated sources. Unfortunately, piped water systems may not be constructed in every community due to engineering and economic limitations. Environmental health practitioners are uniquely positioned to collaborate with colleagues from other disciplines to develop alternatives to piped water systems. In fact, at the writing of this article, the state of Alaska had called for the formation of multidisciplinary teams that pair environmental health professionals with experts from other fields such as engineering, health education, and economics to come up with innovative alternatives (http://watersewerchallenge.alaska.gov/).

Policy Environment

The policy environment includes legislative, regulatory, policy making, and ordinance actions that affect water source decisions. The policies most relevant are those that determine the fees that grant residents access to treated water, along with the payment structures developed to cover these fees. Two common methods of charging for water include metered rates and flat rates. With metered rate structures, households pay for water on a per-unit basis. With flat rate structures, households pay a set monthly fee for unlimited water use. Metered rate structures are widely used to promote water conservation while flat rate structures promote liberal use (Gaudin, 2006). As long as paying for water poses a continuing challenge for residents in these economically limited village communities, flat rate structures should be adopted to address the motive theme of cost. Implementing payment systems to incentivize consumption of treated water is important and possible.

These recommendations are provided to inform the design and implementation of a behavior change program to reduce consumption of untreated water in these four village communities. The recommendations are based on a social ecological framework and sound principles and longstanding standards of environmental health practice.

Conclusion

Consuming untreated water is a universally recognized risk factor for infectious disease. As such, strategies for encouraging and supporting consumption of only treated water are critical. This study found that 82% of surveyed households were drinking at least some untreated water even though treated water was available in their community. Interventions addressing the motives described by respondents have the potential to decrease the use of untreated water and increase the use of treated water in these village communities. While our findings are specific to a unique population and setting, they corroborate those from studies conducted in other regions of Alaska and outside of Alaska.

While this article reported on the motives causing residents of four small, predomi-

nantly Alaska Native communities to consume treated or untreated water, we suggest that usefulness of this research extends beyond the topic, population, and setting in two ways. First, we use qualitative data collection and analysis, an approach that is underutilized in the field of environmental health. In fact, a review of 3,155 articles published between 1991 and 2008 found that even though qualitative data are rarely published in traditional environmental health journals, nearly all studies that did include these data reported increased scientific understanding (Scammell, 2010). Environmental health professionals may want to consider a qualitative approach as presented here in designing their future targeted intervention strategies. Second, our recommendations for behavior change are based on a social-ecological framework, a framework that we suggest has particular applicability within the environmental health profession because of how it acknowledges and applies the role of the environment in shaping individual behavior. While we provide recommendations to address the risks associated with consuming untreated water, the social-ecological model could be applied to a range of topics in environmental health, such as encouraging food service workers to wash hands, promoting seatbelt usage among drivers, and increasing compliance with environmental regulations, or any issue that acknowledges the important role of multiple environments on human behavior.

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Corresponding Author: Troy L. Ritter, Applied Sciences Manager, Alaska Native Tribal Health Consortium, 3900 Ambassador Drive, Suite 301, Anchorage, AK 99508.
E-mail: tlritter@anthc.org.

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Biomonitoring for Perfluorochemicals in a Minnesota Community With Known Drinking Water Contamination

Adrienne Landsteiner, MPH
Chronic Disease and Environmental Epidemiology
Minnesota Department of Health

Carin Huset, PhD
Environmental Division
Minnesota Public Health Laboratory

Allan Williams, MPH, PhD
Jean Johnson, MPH, PhD
Chronic Disease and Environmental Epidemiology
Minnesota Department of Health

Abstract **Perfluorochemicals (PFCs) are pervasive and persistent environmental contaminants with uncertain public health implications. Following the discovery of PFC contamination in public and private drinking water supplies in Washington County, Minnesota, the authors conducted a pilot biomonitoring study. Serum samples from 196 residents of two communities were analyzed for seven PFCs. Perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorohexanesulfonate (PFHxS) were detected in all serum samples collected. Perfluorobutanoic acid (PFBA) and perfluorobutane sulfonate (PFBS) were found in 28% and 3% of the samples, respectively. The geometric mean for PFOA was 15.4 ng/mL (range: 1.6–177 ng/mL), PFOS was 35.9 ng/mL (range: 3.2–448 ng/mL), and PFHxS was 8.4 ng/mL (range 0.32–316 ng/mL). Mean levels for PFOA, PFOS, and PFHxS were higher in males and increased with age. Mean PFC serum levels for three PFCs were significantly elevated when compared to levels found in the U.S. population.**

Introduction

Background

Perfluorochemicals (PFCs) are a class of compounds that have been used widely in commercial and industrial products, including surfactants, stain-resistant fabric coatings, and nonstick products used in cookware and food container linings (Minnesota Department of Health [MDH], 2013). Due to the long-term production, widespread use in consumer products, and persistence of PFCs in the environment, measurable concentrations of some PFCs are found in serum samples of 98% of the general U.S. population (Calafat, Wong, Kuklenyik, Reidy, & Needham, 2007; Kato, Wong, Jia, Kuklenyik, & Calafat, 2011). Occupational exposures as well as community exposure through industrial contamination of drinking water, surface water, sediments, and soils have also been reported (Emmett et al., 2006; Holzer et al., 2008; Olsen, Church, et al., 2003; Olsen, Burris, et al., 2007; Olsen et al., 2008; Steenland, Fletcher, & Savitz, 2009; Wilhelm et al., 2009).

The 3M Company was a major manufacturer of perfluorooctanyl chemistry for more than 40 years that involved the manufacture of perfluorooctane sulfonate (PFOS) and related compounds, as well as perfluorooctanoic acid (PFOA; ammonium salt), with their manufacture mostly discontinued by the end of 2002 (Butenhoff, Olsen, & Pfahles-Hutchens, 2006). Studies of 3M employees have reported significantly elevated PFC levels (Olsen, Buehrer, Cox, Nunnally, & Ramm, 2007; Olsen, Burlew, Marshall, Burris, & Mandel, 2004; Olsen, Burris, et al., 2003; Olsen, Burris, et al., 2007). In 2004, during an assessment of ground water contamination from a nearby historical 3M disposal facility, state agencies discovered PFC contamination in groundwater and private drinking water wells in Washington County, Minnesota (MDH, 2012), on the eastern side of the Minneapolis-St. Paul metropolitan area.

Further investigation of drinking water contamination in 2005 measured PFOA and PFOS levels in several municipal wells serving the city of Oakdale, Minnesota, and the city began to limit the use of the most contaminated wells. Concentrations in the municipal wells tested between 2005 and 2008 ranged from 0.05 to 1.0 µg/L for PFOA and from nondetectable to 1.4 µg/L for PFOS (MDH, 2008). In 2006, granular activated carbon filters were installed on the Oakdale municipal water system to prevent further exposure to those who were receiving drinking water from the system.

Expanded monitoring of neighboring community wells was implemented and, as of July 2007, 455 private and noncommunity wells were tested for seven PFC chemicals. Bottled water, granular activated carbon home filters, and access to municipal water were provided to 160 households with contaminated private wells that exceeded the MDH health risk level (0.3 µg/L) for PFOS or PFOA, or 7 µg/L for perfluorobutanoic acid (PFBA) (MDH, 2008).

Due in part to the discovery of contaminated drinking water in Washington County, the Minnesota State Legislature created the

Environmental Health Tracking and Biomonitoring Program in 2007 (Minnesota Statute 144.995-144.998) and directed MDH to conduct biomonitoring for PFCs. The purpose of the project was to characterize PFC exposure in the affected communities and to inform the development of an ongoing state biomonitoring program. MDH selected two Washington County communities likely to have elevated exposure based on their drinking water source: 1) the community supplied by the Oakdale municipal water system and 2) the community of 169 households served by contaminated private wells discovered from 2005 to 2008.

Seven PFCs were selected for measurement in serum to coincide with groundwater and drinking water monitoring: PFOA, PFOS, PFBA, perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonate (PFHxS), perfluorohexanoic acid (PFHxA), and perfluoro-n-pentanoic acid (PFPeA). Although the contaminated drinking water had been treated or replaced to significantly reduce PFC exposure prior to our study, measurable levels in the blood of community residents were expected due to the long half-lives of several PFCs in the body (3–8 years) (Olsen, Burris, et al., 2007).

Methods

Population Selection

All study protocols and materials were reviewed and approved by MDH and Health East institutional review boards. In accordance with the Minnesota legislation, 100 subjects were selected from households in each community and invited to participate. In the municipal well community, a sampling frame was established using billing addresses of all households receiving municipal water service prior to January 1, 2005 (6,655 households). For the private well water community, well sampling records were used to identify 169 households served by a private well with a PFOS or PFOA contamination level above trace levels (≥0.01 parts per billion) in at least one well water sample.

A survey was sent to a random sample of 500 households from the municipal water billing list and to all 169 households in the private well population. The survey asked one individual in the home to identify all eligible adults over the age of 20, currently living in the home and who had lived there prior to January 1, 2005 (prior to the remediation). From the returned surveys a list was compiled of all eligible adults, from which 100 individuals from the municipal community and 100 individuals from the well water community were randomly selected and invited to participate.

Exposure History and Demographic Data Collection

All participants who consented completed a questionnaire about current drinking water habits, years of residence in their current home, pregnancy status if female, general health, age, gender, and current or previous employment at 3M, including prior involvement with PFC research or production.

Serum Collection and Extraction

Blood specimens were collected at a local health clinic contracted by MDH. Blood samples were collected with venipuncture into serum tubes. The blood was allowed to clot and centrifuged to separate serum and red blood cells. Serum was aliquoted into cryogenic vials and then frozen. Samples were delivered to the MDH Public Health Laboratory, frozen and stored in a locked, ultralow (-80ºC) freezer until analysis.

Serum samples (1 mL) were prepared using solid phase extraction and seven PFCs were analyzed by liquid chromatography tandem mass spectrometry as described elsewhere (Kuklenyik, Reich, Tully, Needham, & Calafat, 2004). Standards of PFBA, PFPeA, PFHxA, PFOA, PFBS, PFHxS, and PFOS were purchased, as were the stable isotope labeled internal standards for PFBA, PFHxA, PFOA, PFHxS, and PFOS. Matrix matched calibration curves were prepared daily using bovine calf serum. The limit of detection (LOD) for all analytes in the method was 0.1 ng/mL. Analytical precision and accuracy varied by analyte but ranged from 2% to 8% relative standard deviation and 100%–115%, respectively.

Data Analysis

All statistical analysis was completed using SAS 9.1. Log transformations and geometric means were calculated for concentrations of PFOA, PFOS, and PFHxS in serum and water to account for the log normal distributions and in accordance with prior literature (Calafat, Kuklenyik, Caudill, Reidy, & Needham, 2006; Calafat, Kuklenyik, et al., 2007; Calafat, Wong, et al., 2007; Steenland, Jin, et al., 2009).

Stratified analyses of the distributions of log transformed PFC analyte serum levels by gender, age, length of residence, and employer status were performed. A *t*-test statistic was used to examine differences between groups.

Among the 98 participants with known private well water concentrations, an analysis of variance was used to assess the correlation between PFOA and PFOS serum levels and past drinking water PFC concentrations. For this analysis, the available private well testing data collected from 2005 to 2008 was used to calculate an average concentration of past PFCs in the drinking water for each subject. For concentrations of water PFC levels below the LOD, a concentration equal to ½ √LOD was used in the aggregate analyses consistent with previous studies (Centers for Disease Control and Prevention [CDC], 2009). The appropriate LOD was selected based upon the analyte and sample period as improvement of the LOD occurred over the sampling time frame. Age, gender, and length of residence in the home were tested in the models as covariates for partially explaining the variability observed in serum PFC levels.

Results

Demographic characteristics for all 196 study participants are shown in Table 1 for each community (municipal, private well) and for the combined study population. The two communities were found to be statistically similar in their characteristics by average age and length of residence in the home. Among all participants, the average age was 53 years (range: 20–86) and average length of residence was 18.8 years (range: 4–62). In both communities, more females than males (108 females, 88 males) participated, and a large majority (n = 187) identified themselves as white non-Hispanic. PFOA, PFOS, and PFHxS were detected in the blood serum of all 196 participants (Table 1), whereas PFBA and PFBS were detected in 28% and 3% of the participants, respectively. PFPeA and PFHxA were below the LOD (0.1 ng/mL) in all 196 samples. The geometric mean PFOA, PFOS, and PFHxS serum concentrations were all higher in the municipal water community (17.3 ng/mL, 39.3 ng/mL, and 8.6 ng/mL, respectively) than in the private well water community (13.6 ng/mL, 32.9 ng/

mL, and 8.3 ng/mL, respectively), though the differences were not statistically significant. The highest individual concentrations were found, however, in the private well water community for all three chemicals.

Serum PFC levels were significantly higher in males than females for PFOS (p = .001) and PFHxS (p = .004) (Table 2), consistent with findings in other studies (Calafat, Wong, et al., 2007; Kato et al., 2011). No significant gender difference was detected for PFOA serum levels.

Participants were grouped into three age strata: 20–39 years, 40–59 years, and ≥60 years, consistent with a recent National Health and Nutrition Examination Survey biomonitoring report (Kato et al., 2011). PFOA and PFHxS were found to be significantly different from each other across all three age strata, while PFOS concentrations were found to be nonsignificant across age strata (Table 2). Those in the age category ≥60 years had the highest mean PFOA, PFOS, and PFHxS levels.

Length of residence at their current home was divided into four categories: 4–9 years, 10–19 years, 20–29 years, and ≥30 years of residence. Significant associations were found between length of residence and PFOA and PFHxS, but not for PFOS (Table 2). Individuals in the ≥30 years of residence category had the highest mean PFOA, PFOS, and PFHxS measures.

Of the 196 participants, 30 self-reported to be current or former 3M employees. Participants with current/former 3M employment were significantly older, with an average age of 59 (p = .001). Length of residence was not significantly different between current/former 3M employees and nonemployees. PFOA and PFOS serum levels were not significantly different between those who reported past 3M employment and those who did not. The geometric mean serum PFOA level for former/current 3M employees was 17.0 ng/mL, compared to 15.1 ng/mL for non-3M employees. The geometric mean serum PFOS level for former/current 3M employees was 45.5 ng/mL, compared to 34.5 ng/mL for non-3M employees. A significant difference existed, however, between 3M and non-3M study participants for PFHxS serum levels (p = .0003). The PFHxS geometric mean serum level for former/current 3M employees was 12.4 ng/mL, compared to 7.9 ng/mL for nonemployees.

TABLE **1**

Community Demographics and Serum Perfluorochemical Concentrations (ng/mL)

Category	Municipal Well Community (*n* = 98)	Private Well Community (*n* = 98)	Combined Community (*n* = 196)
Gender (male/female)	44/54	44/54	88/108
Average age, years (range)	53 (25–85)	53 (20–86)	53 (20–86)
Average length of residence, years (range)	17.8 (4–62)	19.8 (4–60)	18.8 (4–62)
PFOA			
Geometric mean (95% *CI*[a])	17.3 (14.7–20.4)	13.6 (11.3–16.4)	15.4 (13.6–17.4)
Median	21	13	16
Range	2–79	1.6–177	1.6–177
PFOS			
Geometric mean (95% *CI*)	39.3 (34.2–45.1)	32.9 (27.7–39.0)	35.9 (32.2–40.1)
Median	43	35	41
Range	3.9–166	3.2–448	3.2–448
PFHxS			
Geometric mean (95% *CI*)	8.6 (7.1–10.4)	8.3 (6.7–10.2)	8.4 (7.3–9.7)
Median	9.8	7.5	8.9
Range	0.3–72	0.4–316	0.3–316

[a]*CI* = confidence interval.

TABLE **2**

Serum Perfluorochemical Concentrations (ng/mL) by Gender, Age, and Length of Residence for the Combined Community

Category	*n*	PFOA GM (95% *CI*)[a]	PFOS GM (95% *CI*)	PFHxS GM (95% *CI*)
By gender				
Male	88	16.6 (13.9–19.8)	43.9 (38.1–50.7)	10.6 (8.8–12.6)
Female	108	14.4 (12.1–17.2)	30.5 (26.1–35.7)	7.0 (5.7–8.6)
By age (years)				
20–39	19	8.1 (6.4–10.2)	21.9 (16.0–30.1)	4.2 (2.9–6.1)
40–59	106	14.4 (12.3–16.9)	34.7 (30.1–39.9)	7.6 (6.3–9.1)
≥60	71	20.1 (16.1–25.1)	43.4 (35.6–52.8)	12.0 (9.5–15.1)
By length of residence (years)				
4–9	49	9.9 (7.7–12.7)	29.3 (23.4–36.6)	5.9 (4.3–7.9)
10–19	71	16.7 (14.0–20.0)	38.6 (32.3–46.2)	8.8 (7.1–10.9)
20–29	36	15.9 (11.8–21.4)	36.3 (28.3–46.6)	8.0 (5.9–10.8)
≥30	30	22.0 (16.4–29.4)	40.4 (30.9–52.8)	12.8 (9.2–17.8)

[a]GM = geometric mean; *CI* = confidence interval.

Table 3 presents the multivariate regression results for the 98 participants with contaminated private wells. The regression showed that, controlling for age, average PFOA concentrations in private drinking water wells were significantly associated

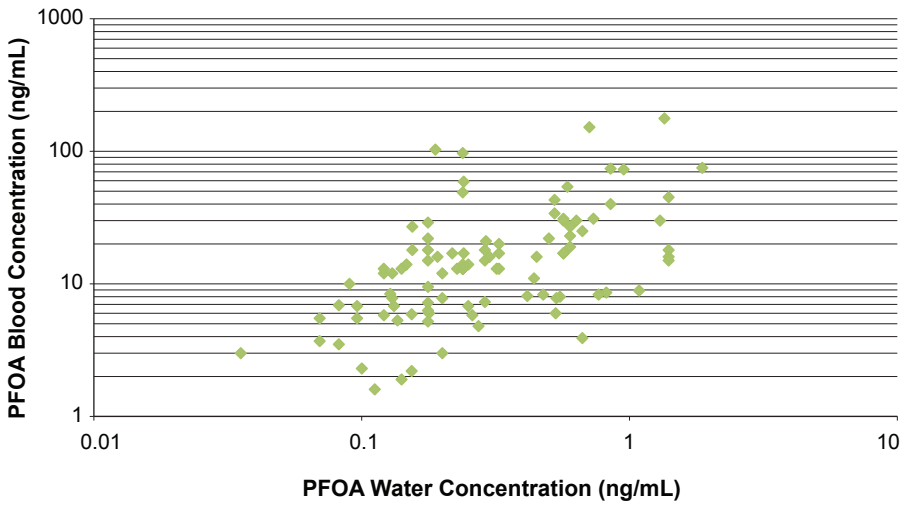
TABLE **3**

Results of Multiple Regression Analysis of Perfluorochemical Serum Concentrations

Factor	Log_{10} PFOA Serum Level (ng/mL)			Log_{10} PFOS Serum Level (ng/mL)		
	β	*SE*	*p*-Value	β	*SE*	*p*-Value
Age (years)	0.03	0.01	<.0001	0.02	0.01	.0035
Gender (male)	–	–	–	0.39	0.14	.0046
Log_{10} PFOS water (ng/mL)	–	–	–	0.42	0.06	<.0001
Log_{10} PFOA water (ng/mL)	0.66	0.09	<.0001	–	–	–

FIGURE **1**

PFOA Concentrations in Blood and Drinking Water for Private Well Community Participants (*n* = 98)



with serum concentrations (Figure 1), and 42% of the variability in serum level could be explained by variability in the water concentration and age (adjusted R^2 = .42, p < .0001). Controlling for both age and male gender in the model, average PFOS well water concentrations were also significantly associated with serum concentrations (Figure 2) (adjusted R^2 = .40, p < .0001). The average well water concentration calculated for estimating participants past exposure from the available 2005–2008 sampling records ranged from 0.04 to 1.9 ng/mL PFOA (GM = 0.29 ng/mL) and from 0.04 to 2.5 ng/mL PFOS (GM = 0.22 ng/mL).

Discussion

Our study confirmed that mean PFOA, PFOS, and PFHxS serum levels in Washington County, Minnesota, residents previously exposed to PFC-contaminated drinking water were elevated in comparison to levels reported by the Centers for Disease Control and Prevention National Biomonitoring Program's monitoring of the U.S. population during the same time frame (Calafat et al., 2006; Calafat, Kuklenyik, et al., 2007; Calafat, Wong, et al., 2007; Kato et al., 2011). The U.S. geometric mean PFOA serum concentration during 2007–2008 was 4.1 ng/mL, approximately one-third the level found in our study (15.4 ng/mL). The U.S. geometric mean PFOS serum concentration was 13.2 ng/mL, less than half the Washington County geometric mean of 35.9 ng/mL. The U.S. geometric mean PFHxS serum concentration was 1.9 ng/mL, one-fourth the Washington County geometric mean of 8.4 ng/mL. These findings are consistent with similar studies of communities with PFC-contaminated drinking water (Emmett et al., 2006; Hoffman et al., 2011; Holzer et al., 2008).

The elevated levels observed in the study communities may also be partially explained by the fact that study eligibility was limited to adult residents who had lived at their current home prior to 2005, thus increasing the likelihood that the study group represents older (average age 53 in 2008), more stable (average number of years in their current home being nearly 19 years) residents in the community, and excludes newer residents.

Consistent with other general population studies, males were found to have significantly higher levels of PFOS and PFHxS than females (Kato et al., 2011). This gender difference was not significant, however, when comparing PFOA serum levels between males and females. Gender difference in PFC serum levels have not been explained but may be due to differences in intake, metabolism, or clearance rates.

Elevations of PFHxS serum levels observed in the study communities compared to general U.S. population levels were unexpected since PFHxS levels were often very low or below the LOD when found in the drinking water samples (MDH, 2008). Even at these very low levels in the drinking water, the long half-life of PFHxS may have led to the bioaccumulation of serum concentrations over the extended period of exposure (Olsen, Burris, et al., 2007). Elevated PFHxS exposure may also be attributable to consumer product use and has been shown to increase with income levels (Kato et al., 2011). Thus the observed elevations may in part be explained by demographic and socioeconomic characteristics in this suburban community sample, which includes current and past employees of 3M. We observed that increased average age and 3M employment were positively associated with PFHxS serum levels in this population.

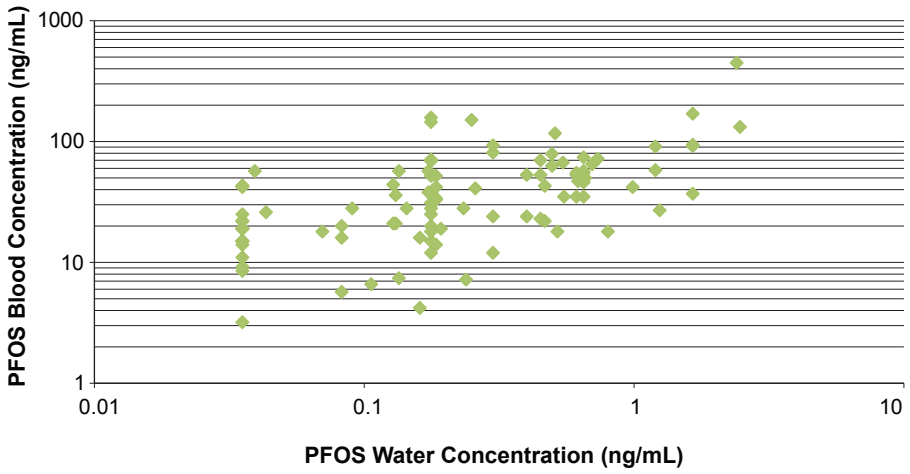
Average serum levels of PFOS, PFOA, and PFHxS in the U.S. population declined between the initial PFC measurements in 1999 and 2004, likely due to changes in the manufacturing and use of PFCs in con-

sumer products (Calafat et al., 2007; Post, Cohn, & Cooper, 2012). Serum PFC levels have also declined in Red Cross blood donor samples and in the Ohio River Valley population (Bartell et al., 2010; Olsen et al., 2008). Data from the U.S. national biomonitoring survey for the period 1999–2008 indicated that PFOS serum levels have continued to decline, while PFOA and PFHxS serum levels, which initially declined, remained constant or increased slightly for sample years 2007 and 2008 (Kato et al., 2011).

In light of the significant correlation between PFOA and PFOS concentrations in water and serum in our study and the significant reduction in exposure via drinking water following public health interventions, PFC levels in serum in these exposed Washington County communities are expected to decline in subsequent years. Further research to monitor this trend is warranted. A limitation of this pilot project is the small sample size, which was determined by the Minnesota law and associated funding. The sample described in this article is representative of an adult population with a likely history of past drinking water exposure in their current home over many years (18 years on average), and does not reflect general population exposure for all Washington County residents. Also, this project collected specimens starting in 2008, three years after the discovery of the contamination when the first drinking water advisories were issued and nearly all participants had stopped using untreated water. Serum concentrations measured in our study likely do not capture the peak exposures that may have occurred in the past.

FIGURE **2**

PFOS Concentrations in Blood and Drinking Water for Private Well Community Participants (*n* = 98)



Conclusion

Our study documented that adult Washington County residents with a past history of household exposure to contaminated public and private drinking water supplies had elevated serum levels of PFCs, specifically PFOA, PFOS, and PFHxS, compared to 2007–2008 U.S. population levels. Serum PFC levels increased with age and length of residence in the home. Among participants with private wells, serum levels were significantly associated with past well water concentrations.

Further study is in progress to document the expected decline in PFC serum levels as a result of public health interventions to reduce exposure from contaminated drinking water. Further study should also explore other exposure routes to PFCs in the community, in addition to the drinking water, that are contributing to population exposure. Product use, household dust, and diet are suspected to be important contributors to exposure in the general population (Trudel et al., 2008).

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Corresponding Author: Adrienne Landsteiner, Minnesota Department of Health, P.O. Box 64882, St. Paul, MN 55164-0882.
E-mail: Adrienne.Landsteiner@state.mn.us.

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Communicating About Biomonitoring and the Results of a Community-Based Project: A Case Study on One State's Experience

Claudia L. Vousden, MPH, RN
National Center for Environmental Health
Centers for Disease
Control and Prevention

Saloni Sapru, PhD
Westat

Jean E. Johnson, PhD
Health Promotion and
Chronic Disease Division
Minnesota Department of Health

Abstract **Communicating biomonitoring results is a challenge. This article describes the communication strategies used by the Minnesota Department of Health (MDH) to support a biomonitoring project in communities exposed to perfluorochemicals through contamination of their drinking water. Using archival documents, media reports, and informant interviews, the case study described here elucidates MDH's successes, challenges, and lessons learned with communicating biomonitoring results characterized by uncertainty about health effects and risk levels. MDH's communication approach focused on engaging audiences and repeating key messages. Despite the repeated message that the biomonitoring project was an exposure study and not a health study, lay audiences generally expressed lingering discontent with the results while others expressed satisfaction and understanding. This outcome highlights the importance of implementing carefully developed communication plans with well-defined goals, objectives, and intended audiences, and with evaluation guiding the entire process.**

Introduction

The Centers for Disease Control and Prevention (CDC) have conducted biomonitoring studies to identify environmental chemical exposures and measure chemical levels in people's bodies for over 30 years. Communicating biomonitoring results is a vexing challenge, yet critical to the accurate interpretation and use of biomonitoring data (National Research Council [NRC], 2006). Alone, biomonitoring data lack information on sources, routes of exposure, toxicity levels, and health risks. While these factors impose uncertainties that increase the complexity of communication, especially with nonscientific audiences, application of the known principles and practices for effective health and risk communication can increase knowledge and understanding, refute misconceptions, calm fears and anger, and strengthen organizational relationships (Covello & Allen, 1988; Food and Drug Administration [FDA], 2011; National Cancer Institute [NCI], 2002).

This article presents a case study on the communication practices and outcomes for a community-based biomonitoring project characterized by some of the uncertainties classically associated with biomonitoring. In 2008, the Minnesota Department of Health (MDH) began the project among residents of two communities in east metropolitan (East Metro) Minneapolis-St. Paul. These residents were exposed to perfluorochemicals (PFCs) through contamination of their drinking water caused by the waste product disposal practices of an industry that locally manufactured PFCs from the late 1940s to 2002 (Minnesota Department of Health [MDH], 2008). The purpose of the PFC Biomonitoring Project conducted by MDH was to measure the magnitude and range of community exposure. Additional details about the project are described in "Biomonitoring for Perfluorochemicals in a Minnesota Community With Known Drinking Water Contamination," published in this issue on page 14.

PFCs are a group of chemicals used to make a wide variety of household and industrial products that resist heat, oil, stains, grease, and water. Studies of animals given large amounts of PFCs have found that some may affect growth, development, and reproduction and may damage the liver (CDC, 2009). The uncertainty about human health effects from PFC exposure provides the opportunity for our case study and other empirical studies to advance effective use of health and risk communication practices for biomonitoring.

Methods

Our case study used qualitative research methods to describe a phenomenon within its real-life context (Flyvberg, 2011; Ulin, Robinson, & Tolley, 2005; Yin, 2003). We defined the case as the communication component of the PFC Biomonitoring Project. Data collection methods included review of archival documents identified through LexisNexis, MDH referral, and Internet searches. We also conducted telephone or in-person interviews with a convenience sample of key informants from select groups vested in the project. The groups were state legislators, industry officials, environmental advocates, biomonitoring participants, and state public health officials.

We identified potential informants from the advocacy, industry, state policy making, and public health groups through the review of archival documents and from lists provided by MDH. After contact by letter or e-mail and follow up by telephone, we selected two to four individuals from each of these groups based on their willingness and availability to participate.

We defined biomonitoring participants as residents of the communities affected by contamination of the municipal water supply or private wells that provided their drinking water who had also contributed blood samples for measurement of their PFC levels in the MDH PFC Biomonitoring Project. While recruiting for a follow-up biomonitoring study among those who previously had agreed to be contacted for future research projects, MDH sought consent to provide the names and contact information of candidates for participation in the interviews for our case study in the fall of 2010. Those who consented received a letter from CDC inviting them to participate and informing them of follow up by telephone to confirm participation and schedule an in-person interview. Additional criteria included selection of an approximately equal number by gender and age under and above 50 years. For this group, temporal and resource constraints restricted us to a maximum of nine interviews, and participants received a $30 gift card as compensation for their time.

The interviews were conducted using semistructured interview guides. Although we tailored the guides for each informant group, the questions for all were based on the following broad topic areas: (1) role and experience with the PFC Biomonitoring Study; (2) understanding of issues about biomonitoring and health risks; (3) perceptions of the communications about biomonitoring; (4) communication challenges related to the PFC Biomonitoring Study; (5) impact of the communication experience; and (6) lessons learned.

Analysis of the data was an iterative process with initial examination of the archival documents to understand the historical and situational context, facilitate identification and characterization of stakeholders and interview candidates, and inform the design of the interview guides. For each informant group, the data were categorized first by the topic areas and then analyzed to identify key themes and patterns. In addition, this analysis supplemented and validated the archival data, informed understanding of how contextual factors influenced communication efforts, and enriched the chronology of events by illustrating personal experiences and perceptions.

Results

The document search yielded 44 reports, presentations, web postings, and media stories about the PFC contamination of drinking water sources in the affected communities. The archival data informed the chronology of events outlined in Table 1, provided context for the public discourse and concern, and highlighted some communication needs associated with the PFC Biomonitoring Project. We completed 23 interviews ranging from 25 to 60 minutes in length (Table 2).

The data showed that following the initial 2004 discovery of PFCs in some sources of drinking water, MDH, the Minnesota Pollution Control Agency (MPCA), and local government agencies used media interviews, written materials, Web sites, and public meetings to explain actions underway and get community input. Continued public discourse and perceptions of the potential for adverse health effects, however, prompted residents of the affected communities and environmental advocates to contact state legislators. Those representing the communities became interested in biomonitoring, and some legislators thought a study measuring the PFC levels in community residents would help alleviate concerns.

Subsequently, state legislation established a pilot biomonitoring program at MDH (Minnesota Statute, 2007a) and directed the agency to convene an advisory panel of experts to provide recommendations and guidance (Minnesota Statute, 2007b). The legislation called for biomonitoring of designated chemicals, including PFCs, in likely exposed communities. Furthermore, the legislation directed MDH to provide the community biomonitoring results to participants, give participants the opportunity to receive their individual results, offer information on relevant scientific findings, and apply a method to receive citizen comments.

Initial Communication Approach

MDH began preparing for communication about the PFC Biomonitoring Project with a search of published literature, some of which informed their activities but yielded nothing specific to communicating about biomonitoring for a community-based project. Finding little guidance, the agency drew on its experience with risk communication and general knowledge of the communication needs across the vested groups as they became audiences for the project.

Although MDH did not develop a written communication plan, our case study data showed that early efforts focused on communicating the project purpose and proposed activities, and soliciting input and acceptance of vested audiences. The findings also identified two key messages: 1) the purpose of the project was to characterize the communities' PFC exposure, and 2) the results would not provide information about relationships between PFC levels and current or future health effects. Expectation management was an early communication theme as described by a public health official:

> *We always took the approach that we were managing expectations. We tried to be really clear about what we could and couldn't do with this project and what the purpose was. We explained … that the purpose was to characterize exposure in the population but that we were not doing a health study.*

To introduce the project and facilitate dissemination of the key messages, MDH conducted three public meetings in the affected communities. These meetings were announced through press releases, direct

TABLE **1**

Timeline of Key Events and Activities Leading to and Encompassing the East Metro Perfluorochemicals (PFC) Biomonitoring Project

1948 (est.)	Industry begins manufacturing PFCs in an East Metro community and disposing waste on industry property.
1956	Industry begins using East Metro landfills for PFC waste.
1974	Industry begins using an incinerator to dispose of all PFC waste.
2000	Industry begins phase out of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) production.
2002	Minnesota Pollution Control Agency (MPCA) learns of PFC-contaminated drinking water at the industry's production facility and begins an investigation. Industry completes its phase out of PFOS and PFOA production.
Late 2003	MPCA discovers PFCs in groundwater at and near former waste disposal sites.
2004	MPCA and Minnesota Department of Health (MDH) discover PFC contamination of East Metro drinking water sources and begin investigating the extent of the contamination.
December 2004	A municipal water supply tests positive for trace amounts of PFOS and PFOA.
2005	MDH begins frequent measurement of PFC levels in the municipal water supply and holds two public meetings to update the affected communities on the groundwater investigation and address concerns. MPCA provides bottled water and granular activated carbon filter units to residents with contaminated wells.
2006	Industry funds and begins operation of a filtration system for the affected municipal water supply and hookups for households with contaminated private wells. In September, MDH, MPCA, and local officials hold a public meeting to update residents on the PFC groundwater investigation and address concerns.
2007	MDH issues revised health-based guidance for drinking water advisories that affects more residents and holds another series of public meetings in the affected communities.
June 2007	MDH reports cancer rates in the affected communities are comparable or slightly lower than statewide rates.
July 2007	Legislation establishing the Biomonitoring Program at MDH takes effect.
October 2007	The legislatively established Advisory Panel begins meeting quarterly.
2008	MDH holds three public meetings in the affected communities to introduce the PFC Biomonitoring Project and get community input.
January 2008	
October 2008	Blood sample collection for the PFC Biomonitoring Project begins.
2009	Blood sample collection from 198 randomly selected participants is completed.
January 2009	
February 2009	MDH mails individual biomonitoring results and an information booklet to biomonitoring participants.
June 2009	The advisory panel reviews the results and recommends further biomonitoring later to measure change over time.
July 2009	MDH shares the biomonitoring results at two community meetings; results show that average blood levels of PFCs are elevated in the study communities compared to national averages in the U.S. population.

mailings that included letters to legislators representing the affected communities, postings on city and county Web sites, posters in city buildings, and announcements on local cable television stations and digital message boards.

MDH made contact information for the project coordinator widely available for those seeking additional information. MDH also developed introductory and follow-up letters to recruit the biomonitoring participants and obtain informed consent, along with support materials that participants received by mail.

Communication materials (Table 3) varied in technicality in an effort to accommodate the needs of different audiences, but many were available to all through the MDH Web site. The messages and materials received expert review through the advisory panel, and MDH staff with communication expertise revised those intended for community residents and biomonitoring participants to enhance readability. The development process, however, drew short of pretesting or use of other evaluation methods to optimize the likelihood that the messages and materials would be received and understood as intended.

Communication of the Biomonitoring Results

A new phase of communication began in February 2009 when MDH mailed individual results to the biomonitoring participants along with the most recently available PFC levels of the U.S. population for comparison (Figure 1). The participants also received a booklet written in question-and-answer format with supplemental information about interpretation of the biomonitoring results, relationships to health problems, other studies, and avoiding exposure.

MDH completed technical and community reports summarizing the biomonitoring results. The reports also described the average blood levels of three PFCs in exposed residents as moderately elevated in comparison to the U.S. population (MDH, 2009a, 2009b). MDH issued a press release announcing two public meetings to present the results and mailed the community report to the biomonitoring participants with an invitation to join the meetings. State legislators from the affected communities, local government officials, environmental

TABLE **2**

Mode and Number of Interviews by Informant Group

Group	Mode	# Interviewed (Total of 23)
State legislators	Telephone	4
Industry officials	Telephone	3
Environmental advocates	Telephone	2
Biomonitoring participants	In person	9
State public health officials	Telephone	5

TABLE **3**

Key Communication Materials, Dissemination Channels, and Intended Audiences

Materials	Channels	Intended Audiences
Background summaries and updates	MDH[a] Web site Print and broadcast media	All
Community briefs/reports	MDH Web site Public meetings	Community residents
Questions and answers	MDH Web site Public meetings	Community residents
Technical reports	MDH Web site	All
	Advisory panel meetings	Advisory panel
	Legislative meetings	Legislators
Legislative briefs	Legislative meetings	Legislators
Press releases	MDH Web site	All
Project implementation materials (e.g., recruitment letter, consent forms, procedural instructions, results, *PFCs and Health* booklet)	Mail Telephone	Biomonitoring participants

[a]MDH = Minnesota Department of Health.

advocates, and industry representatives also attended the meetings. During these meetings, attendees raised three issues of primary interest:

- future biomonitoring to verify decreases in PFC levels;
- a health study to examine the effects of PFCs, especially about cancer; and
- more information about how PFC exposure occurs.

Based on the project results and community response, the advisory panel recommended follow-up biomonitoring and surveys in the same communities "at a later date" to measure changes in PFC levels over time, assess efficacy of mitigation efforts, and learn more about exposure sources.

Responses to the Biomonitoring Communication

The individual interviews provided insight into perceptions of the PFC Biomonitoring Project and its results based on exposure to the communication messages and materials. Our interview results indicated that the communication activities fostered favorable perceptions of the project in general but showed variation in comfort and satisfaction with the communication of the biomonitoring results.

Legislators

All interviewed legislators supported the biomonitoring legislation, had constituents in the affected communities, and thought the biomonitoring project was worthwhile. They were united less, however, in their satisfaction with the results. While all knew that biomonitoring measures the levels of environmental chemicals in people's bodies, only one understood that the project would not yield "information on how the chemicals might be affecting people." The others' reactions to the lingering uncertainties ranged from frustration to relative tolerance and resignation that "the [project] produced some findings, but still left so many questions."

Nevertheless, most of these informants noted that contact from their constituents with concerns about PFC exposure gradually discontinued after MDH introduced the project to the public and became a resource for information. One legislator described this as "one indicator that people have been satisfied [with the information they have]." This outcome diminished legislators' concerns about how the communities would react to the project results.

Industry Officials

The three industry officials considered the biomonitoring project to be valuable and described it as "independent" and "good science." As scientists and others with biomonitoring expertise, the results aligned with their expectations.

These informants received information about the project through advisory panel materials, the MDH Web site, and the public meetings. They perceived MDH as effective in answering questions and responding to challenges during the meetings but believed other public meetings on PFCs held during the same period obscured the purpose of the introductory meetings about the biomonitoring project. They also described those attending as having "varying agendas—some were curious because they didn't know much about the [project]," and others "wanted clarification or additional information." These informants perceived that some attendees thought the meetings were helpful while others challenged MDH by asking, "Why aren't you doing more?"

According to one industry informant, the later meetings about the biomonitoring results seemed clearer to attendees. These informants agreed that a salient challenge to communicating the results was keeping the discussion framed as an exposure rather than a health issue, but they believed that MDH "did a good job" communicating the biomonitoring results.

Environmental Advocates

Although both environmental advocates worked with organizations interested in biomonitoring and were aware of the PFC Biomonitoring Project and its findings, only one closely followed its progress and attended the public meetings. Both expected MDH to present the results with information about possible health effects and noted that this expectation was not met.

> *I think it was important for there to be a [project] showing that these chemicals are in people's bodies, and from that, to lead to a discussion about "what does that imply for health?" The department of health sets health risk levels—for the safe levels of these chemicals that can be in water because they were trying to protect public health. I just feel like that should have also been reflected in this [project]… I think there should have been a conversation with the public about "what does this mean for your health?"*

Despite their unmet expectations, both advocates were pleased that the project provided "accurate information" and believed their organizations could use the findings to support activities such as advocating for reform of the Toxic Substances Control Act.

Biomonitoring Participants

Many of the biomonitoring participants interviewed for our case study had difficulty recalling how they first heard about the project, but most thought it was through mail from MDH. Only two recalled attending one of the introductory public meetings but did not clearly recall its content, as they had attended multiple public meetings about the PFC contamination around that time. Both believed that either they or a family member had experienced a severe health condition caused by PFC exposure.

For most, curiosity about their PFC levels was the primary motivation for participating in the project. Those experiencing health conditions themselves or in family members were interested in gaining insight into possible explanations. In addition, several cited the ease and convenience of getting their blood drawn and tested as influencing their decision to participate.

These informants thought their participation was "a positive experience" in a well-conducted study with friendly and responsive MDH staff. None sought additional information from Web sites. All understood that their participation enabled them to learn their individual PFC levels and contributed to knowledge about the exposure of their communities.

Nonetheless, they also expressed varying degrees of discontent with the biomonitoring results and supplemental communication materials. While these informants could identify their personal PFC levels from the results letter, most described the information as overly technical, unclear, incomplete, or of limited usefulness. Some recalled reading the booklet, but most thought they had only skimmed it before filing it with the other information they had about the project.

> *…I remember this because it's so overly technical…it doesn't tell anybody anything.… It strikes me that these are things that are written by very well-meaning people who talk about this everyday with other people who understand it, and then, when they try to write it for the general public, they write it like they are writing to their coworkers, and that's the problem.*

Other perceptions reflected a persistent interest—spoken or unspoken—in what the results meant for one's health.

> *I remember looking at this [letter], and I still don't know what this means other than my numbers are much higher. I remember that being somewhat disappointing—not that the numbers are higher—it's just that I didn't have context within what that means.*

There were mixed responses to the U.S. population data provided for comparison with one informant saying, "Comparing me to the U.S. population…that just seemed too broad," while another said she thought it was important "because I know it's a start—you have to have something to compare it to."

Even those most understanding and accepting of the biomonitoring results expressed a sense that something was missing. One informant articulated a recurring theme: "Ultimately, people want to know how things like this affected them—individually, and that's where the link needs to be made."

In spite of some discontent, most of these informants thought biomonitoring should continue and anticipated that MDH would

FIGURE **1**

Excerpt From the Letter Template Used to Inform Perfluorochemical (PFC) Biomonitoring Participants of Their Results

This letter is to give you your results. The table below shows the levels of PFCs found in your blood. The table also shows the average levels and ranges for the United States, when known.

Perfluorochemical (PFC)	Your Level (µg/L)	U.S. Population* Average Level (µg/L)	U.S. Population* Range (µg/L) 10th to the 95th Percentile
PFOA		3.9	1.9–9.8
PFOS		20.7	9.8–54.6
PFBA		**	**
PFHxS		1.9	0.7–8.3
PFBS		**	**
PFHxA		**	**
PFPeA		**	**

*The levels for the U.S. population are based on results from the National Health and Nutrition Examination Survey (NHANES). NHANES results are from a random sample of the U.S. population (age 12 and greater) taken in years 2003–2004.

**NHANES does not report an average or range for this chemical.

Just because people have a chemical in their blood does not mean that the chemical causes disease. Research on PFCs and people's health is new. So far, research has not shown an increase in the risk for disease from being exposed to PFCs. (Please see the enclosed booklet for more information about PFCs and health.)

regularly monitor PFC blood levels in their communities. Most acknowledged awareness that evidence linking PFCs and health risks was inconclusive but thought biomonitoring was important for increasing scientific knowledge and staying abreast of the conditions attributed as the cause of PFC exposure in the affected communities.

> *I have an elevated level of PFCs in my blood. It's something I want to pay attention to and track over time …. I look forward to communications from the state of Minnesota on any updates …. I feel some level of comfort knowing that the state has an eye on what's happening with [the industry].*

State Public Health Officials

All five public health officials were involved in the PFC Biomonitoring Project but had varying roles and responsibilities. These informants said the public meetings provided opportunities for them to address questions and concerns and to garner community input for use in subsequent plans. They also believed that the meetings helped allay the fear and anger felt by some attendees.

All recognized the persistent communication challenges, including confusion over comparisons with national data and lack of understanding that biomonitoring results did not distinguish exposure sources. The challenge they considered greatest, however, was communicating effectively about the limitations of biomonitoring results regarding risk of health effects. One informant stated, "We didn't fully anticipate the frustration people had with not knowing the personal implications of the results."

Other lessons cited by these informants included the importance of engaging the community and acknowledging anxiety, fear, and anger; allocating sufficient time and resources for communication planning and implementation; and anticipating community interest in subsequent biomonitoring to determine how exposure changes over time. Finally, uncertainty about health effects as a persistent communication challenge prompted these informants to consider the possibilities that "chemical choice makes a difference" in the ease of interpreting results and communication may be less challenging for chemicals, such as arsenic or mercury, about which more is known regarding health effects, risk estimates, and prevention.

Discussion

Our case study shows that integration of communication as a distinct component of a biomonitoring study can mitigate challenges to communicating results. This case also shows, however, that the challenges, especially those involving uncertainty about health risks, can be persistent and merit more comprehensive use of the health and risk communication principles known to influence effectiveness (Keune, Morrens, & Loots, 2008; Nelson, Scammel, Altman, Webster, & Ozonoff, 2008; NRC, 2006). These principles and related practices are documented extensively in the literature (Covello & Allen, 1988; FDA, 2011; NCI, 2002), but here we offer brief discussion of some of the key principles with germane insights offered by this case that can inform communication planning and intervention for future biomonitoring studies.

Plan Carefully

A carefully developed plan documents and defines the communication goal, objectives, intended audiences, and strategies to accomplish the goal and objectives. Careful planning helps to organize and steer activities, set priorities, and maximize resources. While we identified many elements that would be part of a communication plan, omitting development of a distinct communication plan for the PFC Biomonitoring Project likely hindered recognition of some needs for refinement and other benefits such planning offers.

Define the Goals and Objectives

Identifying the goal of communication and defining supportive, specific, and measureable objectives provides the basis for evaluating effectiveness. Management of expectations about what could be learned from the biomonitoring results emerged as the implied communication goal for the PFC Biomonitoring Project, but no defined objectives existed to support and direct how this goal would be accomplished. Consequently, the lack of objectives also hindered measurements of and conclusions about success.

Define and Learn About Each Intended Audience

Identifying intended audiences and determining the need for segmentation based on shared characteristics informs development of messages, materials, and dissemination strategies. In addition to the variety of behavioral, demographic, physical, and psychosocial characteristics that may need consideration, literacy and numeracy skills are likely to influence effectiveness of communication about biomonitoring. This information can be collected through a variety of formative evaluation methods including observation and one-on-one or group interaction, which are feasible even for programs with small budgets. MDH identified and segmented the audiences based largely and appropriately on their relationship to the biomonitoring project. In addition to using knowledge of the audiences based on past experience, MDH used new knowledge about the audiences acquired through group interactions such as the meetings with the public and legislators.

Create Messages and Materials Effectively

Message and material development is a critical step in the communication process that is based on what information has the greatest value in supporting achievement of the communication goal and objectives. Pretesting messages and materials and using the results to guide revisions reduces the risk of discrepancies between the communication objectives and actual communication performance. MDH applied expert review and readability assessments appropriately during the message development process but did not consider pretesting with individuals sharing key characteristics of the intended audiences. Although the public health informants repeatedly stated their intent to be clear about the purpose of the study and limitations on the interpretation of results, there was no evidence of their recognition that clarity is judged by message recipients and can only be confirmed with their feedback.

Evaluate

Evaluation throughout the communication process is vital to its success. Yet, often it is seen as too expensive and unnecessary as program staff and communicators choose to rely on their own knowledge, intuition, and experience. Intuition and even the most experience-based beliefs, however, are not substitutes for scientific evidence of effectiveness. Formal evaluation provides objectivity, enhances credibility, helps build the evidence

base for what does and does not work, and does not have to be costly. Even with minimal budgets, evaluation opportunities exist. The expert reviews and readability assessments for the PFC Biomonitoring Project materials developed for the lay audiences could have been followed by evaluation for clarity and comprehension by asking friends, family, or colleagues outside the field to review the materials and provide feedback to predetermined questions at little or no cost. Such evaluation during development of the letter informing the biomonitoring participants of their results may have provided valuable input and guided changes that increased the recipients' understanding of and satisfaction with the content.

Communication cannot banish the uncertainties inherent to biomonitoring, particularly for emerging environmental chemicals for which health study results remain inconclusive. The multiple points of uncertainty will continue to impede some fundamentals of risk management and communication practice such as assessments of risk, determinations of reliable risk reduction measures, and opportunities for individuals and groups to make decisions that affect their health and well-being. Still, comprehensive application of evidence-based communication principles provides the means to reduce uncertainty about what makes effective communication for interpretation and use of biomonitoring data.

Conclusion

The communication experience of Minnesota's PFC Biomonitoring Project provides a practical example from which biomonitoring programs can learn. Notwithstanding some of the limitations (e.g., retrospective reporting of events that occurred some time ago; a small convenience sample; inability to generalize findings), case studies such as this offer meaningful contribution to the evidence-based practices needed to address the challenges of communicating about biomonitoring with lay audiences and others outside the field.

Corresponding Author: Claudia Vousden, Health Communication Specialist, Division of Laboratory Sciences, National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Highway, MS F-10, Atlanta, GA 30341.
E-mail: cbv5@cdc.gov.

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GUEST COMMENTARY

The Environmental Health Workforce in the 21st Century

Bailus Walker, Jr., MPH, PhD, FACE
Howard University College of Medicine

Stephanie Miles-Richardson, DVM, PhD
Morehouse School of Medicine

Rueben Warren, MPH, DDS, DrPH
Tuskegee University

These challenges are not unique to environmental health, they cause us to look for creative ways to continue to achieve greater environmental health protection.
— Alicia Enriquez-Collins, REHS, Immediate Past President, NEHA

Introduction

Recognition is growing that although significant progress has been made in improving the health status of the U.S. population, challenges remain. At the same time efforts are underway to reform the health care system and to improve social and economic conditions of local, national, and global communities. These developments have directed attention to the role of the health workforce. In this context concerns have been raised specifically about the environmental health workforce, including the challenge of enumerating this key group of public health professionals. In this guest commentary, we argue that the sheer number of environmental health professionals in the 21st century, with its rapid advances in science and technology, may not be nearly as high a priority as quality, knowledge, and skills of the workforce.

Effective efforts to derive continuous human health benefits from the application of advances in science and technology require a highly trained workforce. This workforce must have a steady infusion of people with new ideas, diversity of perspectives, and approaches if it is to be successful. Clearly, support for training this health workforce is an investment in the health of the population, with high potential for the significant yields in humans.

Recent developments in health, social, and economic policies have driven attention to quantitative assessment of the health workforce and to related attempts to balance supply and demand. For instance, concerns about the size of health workforce needed for the effective implementation of the Affordable Care Act (ACA) prompted an analysis of the nursing workforce. That study concluded that the nursing shortage projected a decade ago has not materialized (Auerbach, Staiger, & Muench, 2013). Other studies have examined physician supply and needs also to address health care issues that may be influenced by ACA and other changes in health services (Colbert, 2013; Iglehart, 2013).

The Public Health Workforce

Recently, the Committee on Microbial Threats to Health in the 21st Century called attention to the inadequate number of infectious disease specialists (Institute of Medicine, 2010). The committee said that the number of *qualified* individuals in the workforce for microbial threat preparedness is dangerously low. One of the most recent (2009) counts of the public health workforce determined that approximately 500,000 public health professionals are in the U.S. (Association of Schools of Public Health, 2009). That study estimated that in the coming years substantial shortages will arise, especially in federal and state health departments. Of course federal and state health agencies are not the only settings in which public health professionals are employed.

Environmental Health Workforce

The preceding examples and numerous others suggest that it would be useful to address the full range of issues and challenges of assessing and predicting the status of public health professionals over the entire spectrum of the health sciences because they are interrelated. The objective here is a more limited one, however: a focus on the environmental health workforce. Why? A number of compelling reasons exist. Perhaps the most important is that one observation that has remained sturdy over centuries is that virtually all human disease can be caused, modified, or altered by environmental agents/conditions/factors. This observation has withstood advances in the sciences, alterations of theories, and related types of scientific progress that constantly fuel reevaluation of concepts and ideas. In fact, unless environmental factors are considered, a complete epidemiology of disease cannot be achieved. Moreover, in the current approach to advancing population health, environmental health services are part of a triumvirate, along with personal health care and health education. These three means of health promotion and disease prevention are complementary. Thus, activities aimed at the preservation and improvement of the environment have represented and will always represent a major part of community health programs, the foundation of which is the quality of its workforce.

A unique feature of environmental health is its grounding in a multitude of sciences including a wide range of physical, biological, and social sciences, which make for a daunting enumeration task.

The environmental health workforce consists of, in its simplest classification, professionals who are concerned with environmental health effects research, with environmental health effects technology, with environmental health policy, and with applied environmental health. This last group comprises individuals

employed by public health or environmental protection agencies. Many members of this latter group are working at the state and local levels of government where environmental health and protection services actually come in contact with people; this is the real firing line where community environment and health issues first come to the attention of environmental health and protection authorities. After all the federal aid has been provided, standards (e.g., air, water, food) and national policy have been set, and periodic training offered, it is the state and local levels of government that provide environmental health services, often translating and applying advances in science and technology. As such they are usually in the best position to define the environmental health needs of the local community and how best to meet them, including awareness of the political, social, economic, cultural, and other factors that may play a role in defining priorities and setting and meeting environmental health goals and objectives for neighborhoods or the community at large.

It is in this context that a desire for an accurate enumeration, a count, of the environmental health workforce has prompted concerns and published papers on issues of counting who is and who is not in the workforce (Massoudi, Blake, & Marcum, 2012; Roberts, 2009).

Workforce Quantity or Quality

An accurate enumeration of the environmental health workforce is a laudable and challenging goal.

This review, however, argues that no assessment of the supply and demand for environmental health professionals in the 21st century and beyond can ignore or even blur the important issue of quality. That is, the scientific and technological knowledge and skills of the workforce are of paramount importance. The scientific and technological accuracy, reliability, and validity of decisions by environmental health professionals must be as high as possible because they can have far-reaching impacts, affecting large segments of the population. Nine factors lend support to the quality-of-the-workforce argument.

In Retrospect

First, a glance backward to see when and how the environmental health workforce "movement" originated reveals that when environmental health was in its infancy the need for professional skills and scientific and technical training was far less critical than today. The archives of public health note that when the American Public Health Association was organized in 1872, many hundreds of persons were engaged in public health work, including environmental sanitation. But none of them had formal training in this field (Rosen, 1958). Moreover, the often-quoted 1849 report of Lemuel Shattuck (a name familiar to most students of public health history) recommended "that persons be specially educated in sanitary science as preventive and curative advisors." Shattuck continued, "The science of preserving health and preventing disease should be taught as one of the most important sciences (Shattuck, 1850)." Unfortunately, Shattuck's farsighted recommendations were destined to lie dormant for nearly a quarter of a century. This may have slowed the early development of a comprehensively trained environmental health workforce.

The 21st Century

Second, in the 21st century environmental epidemiology has flourished, and detailed studies have demonstrated many heretofore unrecognized associations between environmental exposures and certain adverse health effects. Moreover, the body of environmental health literature has increased greatly and research in all areas of the environmental health sciences continues to grow. At the same time advancing edges of research have resulted in the constant emergence of new fields with broad implications for the practice of environmental health. Some come and go, others develop into new entities. Examples include genomics, proteomics, and nanotechnology. All of these developments, and many more, require a high degree of scientific and technological knowledge on the part of those who seek to carry out programs of prevention and protection.

Third, sentiment is growing that erosion of the workforce is threatened daily by economic adversity and ill-advised policy decisions. This is reflected in a survey by the Association of State and Territorial Health Officials (ASTHO). The analysis found that 67% of responding health directors reported that funding decreases resulted in staff layoff or staff reduction in full time responsibilities (Association of State and Territorial Health Officials, 2006).

New Tools

Fourth, this trend suggests that a need exists to fully support and encourage the early diffusion of innovations, which have the potential to compensate for reductions in human resources for environmental health services. The following list of such innovations is significant but incomplete.

- New technologies are improving capabilities to predict and effectively manage environmental health challenges (e.g., water and air quality) (Bare, 2011; National Research Council, 2012).
- A risk model has been developed that classifies safe and unsafe areas of groundwater. The significance of this development is that approximately 140 million people worldwide drink groundwater containing unsafe level of arsenic, increasing their risk of cancers and skin lesions (Rodríguez-Lado et al., 2013). In the past arsenic in groundwater had been detected only after diagnosis of health effects. Using this model has the potential to facilitate the construction of risk maps, which may bolster private well-testing programs in addition to demands for corrective action for affected areas.
- Equally important are the application of advances in science and technologies to the initial design of products and changes in manufacturing processes so as to minimize or prevent emissions that pose potential environmental health risks to the population.
- Green chemists are designing products and processes that are "environmentally friendly" and that should reduce the incidence of illnesses attributable to worker or consumer toxic exposures. These chemists not only create new molecules but take into account how they behave in the environment, whether they will be toxic or otherwise undesirable (Hogue, 2013).
- A new generation of genetically modified crops uses RNA interference that will kill insects by silencing their genes and thereby reduce the incidence of pesticide-induced neurotoxicity in humans (pesticides are manufactured to be neurotoxic) (Kupferschmidt, 2013). Another benefit of this technology is the prevention of world's suicides, (e.g., one million cases annually) of which one-third are attributed to pesticide ingestion. Moreover, studies of the effects of pesticides on the very young brain are resulting in some worrisome findings (e.g.,

abnormal reflexes, lower birth weight, misdirected assembly of the brain in prenatal development) (Mascarelli, 2013).

- The potential implications of pesticide use reduction technology are significant for the person hours devoted to the investigation of pesticide illnesses, which is the most common type of activity in state and local pesticide regulatory and control programs, according to the ASTHO survey cited previously.

These and other innovations are gaining more traction as advances in science and technology are tested and translated into real-world applications, a process that requires environmental health professionals who have an understanding of the scientific principles, concepts, and mechanisms involved.

Fifth, another prominent illustration of the need for emphasis on quality of the workforce with the skills to capture and apply the breadth and depth of advances in science and technology to environmental health challenges was in 2011. The U.S. Environmental Protection Agency (U.S. EPA), looking to position itself in the best possible place scientifically and technologically to achieve its mission, asked the National Research Council (NRC) of the National Academy of Sciences to "assess independently the overall capability of the agency to develop, obtain, and use the best available scientific and technologic information and tools to meet persistent, emerging, and future challenges and opportunities (NRC, 2012)." The NRC's response was a 233-page report. Its analysis and recommendations are not only key for environmental health and protection professionals but all professions in fields that touch upon environmental health. Parenthetically: the NRC's response is consistent with the National Academy of Sciences' mandate granted by Congress in 1863 to advise the federal government on scientific and technical matters.

Sixth, advances in science and technology arrive at such a rapid clip that last year's knowledge barely scratches the surface of what is needed next year. Thus, it becomes important for the environmental health workforce to continue to evolve as science evolves. Of course scientific data represent only one input into the decision making/problem solving process and by themselves cannot resolve complex environmental health problems.

Seventh, the knowledge and skills of the environmental health workforce can play an important role in propelling the current thrust toward collaboration and integration of the biological sciences with physical and computational sciences, mathematics, and engineering, which promises to build an enterprise with the scope and expertise to address a broad range of highly complex societal problems, including environmental and human health challenges. (NRC, 2009a).

More collaboration is already taking place than in the past between biological scientists and social scientists consistent with new thinking on environmental health, including for example the health implications of the built and socioeconomic environments (King, 2011). As the social and behavioral sciences have been maturing, society has come to realize the absolute necessity of their research findings for the understanding of the determinants and prevention of environmental health problems. So it was no surprise when a committee of scientists recently called for more people with training in the social and behavioral sciences be added to the environmental health workforce (NRC, 2012).

Eighth, another development that supports the argument for attention to quality of the environmental health workforce is the momentum toward consumer-driven health care. This movement has empowered the public to seek health information through the Internet or similar avenues. These searches have focused not only on genetic factors but environmental risk factors for disease and disability (e.g., the often-cited example: patient says to doctor, "Is it my genes or is it the environment?"). The concern here is that having information is not enough. Without a knowledgeable environmental health professional to help individuals with the interpretation of environmental risk information, misinterpretation by the individuals may cause unnecessary anxiety and financial impacts because of incorrect conclusions about the data available.

Ninth and finally, further evidence that lends support to the argument that quality of the workforce is an essential ingredient for the effective application of the theory and practice of assessing, correcting, and preventing those factors in the environment that can potentially adversely affect the health of present and future generations comes from the Committee on Educating Public Health Professionals in the 21st Century (NRC, 2009b). Responding to a clearly defined list of major challenges confronting public health (e.g., globalization and scientific and technological advances) the committee emphasized that these require public health professionals not only educated in the long-recognized and agreed-upon five core components of public health (i.e., epidemiology, biostatistics, environmental health, health services administration, and social and behavioral science), but also educated in eight critical new areas: informatics, genomics, communication, cultural competence, community-based participatory research, policy, law, and global health. What is clear from the committee's study is that in the 21st century, the U.S. needs high *quality* public health professionals contributing through practice, teaching, and research to improve health in our communities. This conclusion is unlikely to be debated about intensely.

Concluding Comments

The sum of the preceding paragraphs is a clear indication that increasing emphasis should be given to qualitative dimensions of the environmental health workforce. Our view grows from the convergence of several experiences: an extensive review of the relevant literature and of our experiences, including service as staff and ranking officials in federal, state, and local public health programs and our work as officers of instruction in academic institutions. We have also invested considerable efforts aimed to increase the preparation and motivation of underrepresented minority students to enter the environmental health profession. These services, involving a broad array of activities, are pursued against a background of evolving demographic data, documenting that the U.S. is rapidly transforming into one of the most racially and ethnically diverse nations in the world. In both the private and public sectors well-publicized efforts are well underway toward the goal of ensuring that the workforce reflects this demographic transformation.

Corresponding Author: Bailus Walker, Jr., Department of Community and Family Medicine, Howard University. 520 W St., NW, Suite 2400, Washington, DC 20001.
E-mail: bwalker@howard.edu.

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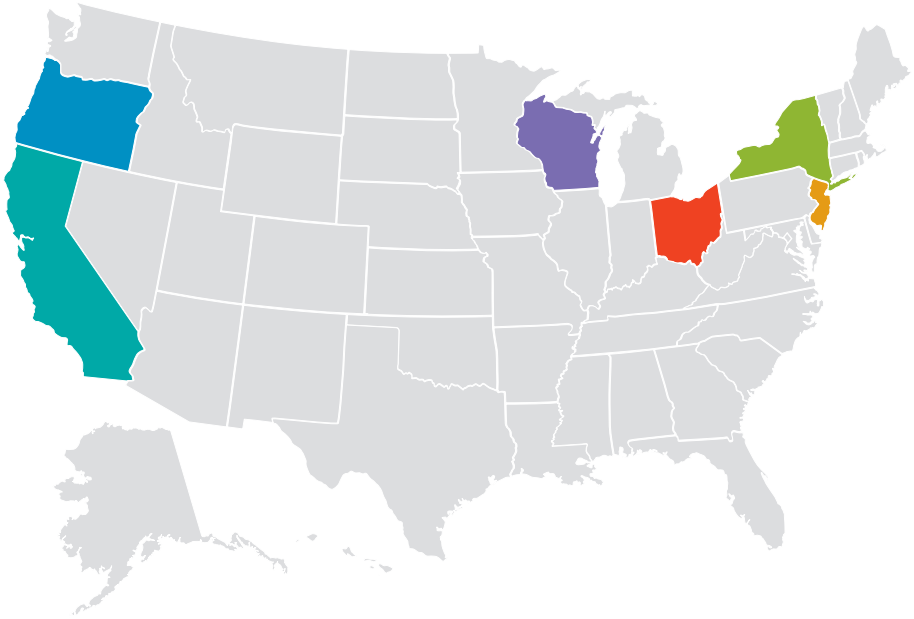
ACROSS THE COUNTRY WHAT'S HAPPENING IN ENVIRONMENTAL HEALTH



Editor's Note: **This feature in the *Journal* is intended to provide readers with interesting and novel stories of environmental health being practiced across the country. This month's installment features stories of children's environmental health issues being addressed in several different states.**

CALIFORNIA

Keeping Children Safe From Environmental Hazards

Children are often more heavily exposed to toxins in the environment. Pound for pound, children breathe more air, drink more water, and eat more food than adults. Their behavior patterns, such as playing close to the ground and hand-to-mouth activity, increase their exposure to potential toxins. In addition, their systems are still developing, often making them less able than adults to metabolize, detoxify, and excrete toxins.

Children spend a substantial amount of time in schools or child-care centers. The U.S. Environmental Protection Agency's Children's Environmental Health Program supported a special project with the Pediatric Environmental Health Specialty Units of the University of California to provide healthy child care and school environments training in the San Joaquin Valley and U.S.-Mexico border region. Both areas must contend with some of the poorest air quality in the country.

Offered in Fresno and Imperial counties, over 200 people attended training sessions that focused on addressing environmental challenges in school and child care environments. Participants included school nurses, child care providers, health promoters, and others. Training focused on how environmental factors can affect child development; what environmental hazards may be present in schools, child-care centers, and homes; and what steps can be taken to prevent, eliminate, or reduce these hazards. Training topics included outdoor and indoor air quality, asthma, lead, mercury, pesticides and integrated pest management, and green cleaning and sanitizing.

Source: www.epa.gov/region9/childhealth.

NEW JERSEY

Chemical Facility Poses Vulnerability Zone to High Number of Students

A recent study released by the Center for Effective Government showed that one in three children attend schools in areas vulnerable to chemical accidents from nearby facilities. The study provides a map that compares the locations of 122,968 public and private schools against areas susceptible to contamination from over 3,400 high-risk chemical facilities is the U.S. California, Texas, Florida, Illinois, and New York have the largest number of students at risk.

New Jersey houses a chemical company facility that places the highest number of schools and students at risk. The facility's vulnerability zone encompasses nearly all of Manhattan, as well as all of Jersey City and Newark. The report calculates that over 860,000 students are situated within this vulnerability zone. The chemical facility houses up to two million pounds of chlorine gas for the manufacturing of bleach. Chlorine gas causes the burning of skin and eyes, respiratory damage, and even death.

Source: www.foreffectivegov.org/kids-in-danger-zones.

NEW YORK

Terminating Toxic Toys

A New York state bill that would ban certain chemicals in children's toys continues to gain support in the state Senate, leaving advocates hopeful the legislation will be passed before the end of session. The Child Safe Products Act has been approved by the Assembly in the past, and now has 40 sponsors from both sides of the aisle in the Senate, where just 32 votes are needed to pass.

The bill (S.04614) would establish 10 priority chemicals including lead, mercury, and arsenic. In the first year, companies would be required to test their products for those chemicals, and alert consumers of their presence. In subsequent years, an outright ban on the sale of toys containing any of the toxins would be imposed. Additional toxins can be added to the list every three years.

The bill was being reviewed in the Senate Finance Committee. Phil Boyle, sponsor of the legislation, said he is hopeful that the committee will sign off on the legislation before the end of session, bringing it one step closer to a floor vote. "When it comes to the floor, I think we're going to see unanimous, or nearly unanimous, approval," Boyle said. As of print, the bill had not gone to the floor for a vote.

Source: www.legislativegazette.com/Articles-Top-Stories-c-2014-06-17-88315.113122-Child-Safe-Products-Act-gains-momentum.html.

OHIO

Granting Freedom From Lead

Children under the age of six are most likely to be affected by lead and low levels of lead poisoning have been linked to lower IQs, delayed growth, poor hearing, and attention deficit hyperactivity disorder. High levels of lead poisoning have been linked to mental retardation, comas, convulsions, and death. In Ohio, around 8,000 children are diagnosed with elevated lead levels every year.

Ohio residents who discover they have high levels of lead in their homes, however, are not without support in remediating the issues and making their homes safer for their children. Through the Ohio Department of Health's Lead Hazard Control Program, qualifying homeowners can apply for grants to assist with lead remediation. The grants are part of a $4.6 million effort by the state to eliminate lead-based paint in existing homes. In the past three years, $2.5 million has been spent fixing 215 properties. For many homeowners, the cost of remediating lead paint issues in their homes is not affordable and this program provides a means in which to ensure a safe environment for their children.

Source: www.zanesvilletimesrecorder.com/story/news/local/2014/09/30/grant-saves-family-dangers-lead/16503057/.

OREGON

Gas Stoves and Asthma

A recent study conducted by researchers from Oregon State University (OSU) showed an association between gas kitchen stove ventilation and asthma, asthma symptoms, and chronic bronchitis. "In homes where a gas stove was used without venting, the prevalence of asthma and wheezing is higher than in homes where a gas stove was used with ventilation," said Ellen Smit, OSU associate professor and one of the study's authors.

The study showed that children who lived in homes where ventilation such as an exhaust fan was used when cooking with gas stoves were 32% less likely to have asthma than children who lived in homes where ventilation was not used. Children in homes where ventilation was used while cooking with a gas stove were 38% less likely to have bronchitis and 39% less likely to have wheezing.

The research is limited and it cannot be inferred that using a gas stove without ventilation will cause respiratory issues. The study does, however, show an association between having asthma and using ventilation. "More research is definitely needed," said Eric Coker, a doctoral student and coauthor of the study. "But we know using an effective ventilation system will reduce air pollution levels in a home."

Source: www.news-medical.net/news/20140930/New-OSU-study-shows-association-between-gas-kitchen-stove-ventilation-and-asthma.aspx.

WISCONSIN

Lead Poisoning Prevention

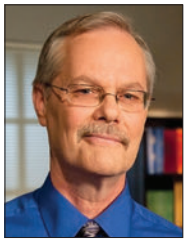
Sixteenth Street Community Health Centers (SSCHC) in Milwaukee is working to address the risk of lead poisoning among its patient population through proactive testing and prevention steps. SSCHC's Childhood Lead Poisoning Project integrates clinical blood lead screenings for children with comprehensive in-home bilingual lead education and visual environmental risk surveys to identify lead hazards.

The clinic also is championing childhood lead poisoning awareness in the community by educating parents and homeowners on practical cost-free solutions to improve the environmental safety of their home—like moving furniture in front of window ledges to block children from reaching lead paint–prone areas and using duct tape to cover questionable surfaces. For the past 17 years, the Lead Outreach Program has worked directly with more than 6,000 families to prevent and manage childhood lead poisoning. In 2013, SSCHC conducted a total of 8,261 blood lead screening tests. SSCHC has successfully reduced the rate of lead poisoning among children in its service area from 36% in 1997 to approximately 1.9% in 2013.

Source: SSCHC.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH

CDR Jasen Kunz, MPH, REHS



Michael Beach, PhD

The First Edition of the Model Aquatic Health Code Is Now Available: What's Next?

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In this column, EHSB and guest authors from across CDC will highlight a variety of concerns, opportunities, challenges, and successes that we all share in environmental public health. EHSB's objective is to strengthen the role of state, local, tribal, and national environmental health programs and professionals to anticipate, identify, and respond to adverse environmental exposures and the consequences of these exposures for human health.

The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

CDR Jasen Kunz is a commissioned officer in the U.S. Public Health Service. CDR Kunz serves as the Model Aquatic Health Code (MAHC) coordinator from CDC's National Center for Environmental Health. Michael Beach is associate director for Healthy Water at CDC's National Center for Emerging Zoonotic and Infectious Diseases and is a member of the MAHC steering committee.

The first edition of the Model Aquatic Health Code (MAHC) was released on August 29, 2014, and is now available on the Centers for Disease Control and Prevention's (CDC's) Web site (www.cdc.gov/mahc, see Figure 1). The MAHC is a set of free guidelines based on science and best practices to help jurisdictions reduce outbreaks, drowning, and chemical injuries at public aquatic facilities. The MAHC is a model—not a federal law—that local and state agencies can use to update or implement aquatic facility codes, rules, regulations, guidance, laws, or standards. The MAHC is inclusive; it covers all health and safety issues by providing sample code language and explanatory text addressing design and construction, operation and maintenance, and policies and management. The MAHC is voluntary; jurisdictions can use some, all, or none of the MAHC, and they can change any part of it to suit their needs (see Figure 2).

MAHC development was a collaborative effort, stemming from a 2005 national workshop recommendation, between CDC and more than 140 volunteer experts from across the U.S. These experts included federal, state, and local public health officials; researchers; aquatics sector representatives and associations; building code officials; and certification organizations. The MAHC also went through two rounds of public comment and received more than 4,400 comments from stakeholders.

In the U.S., no federal regulatory agency is responsible for aquatic facilities. Swimming pool programs have long been considered a core function of state or local health departments; 68% have programs that regulate, inspect, or license public swimming pools (National Association of County and City Health Officials, 2013). This has led to significant variability in standards and requirements, as well as time and resources spent in individual jurisdictions as they create and update codes. The MAHC will help local and state agencies to incorporate science and best practices into their codes and pool programs and prevent the duplication of effort.

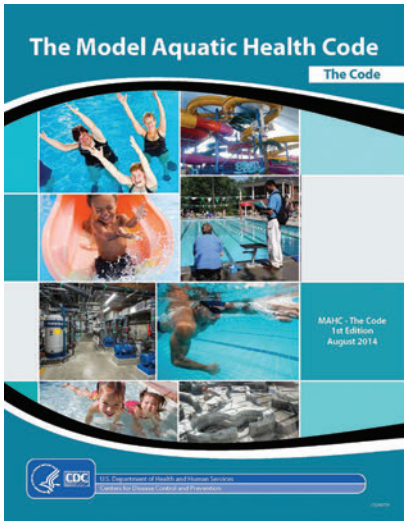
Expected Impact

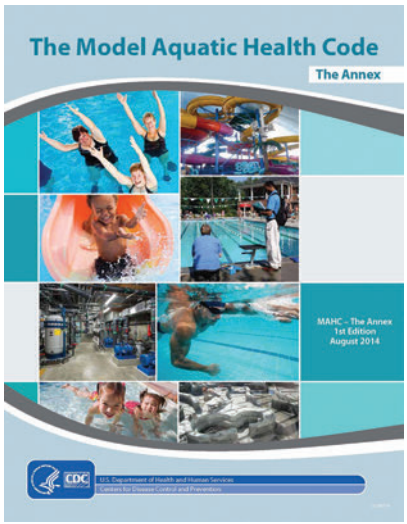
Local and state agencies voluntarily adopting key elements of the MAHC are expected to

- prevent injuries, disease transmission, outbreaks, and associated costs;
- reduce pool code violations and imminent health hazard–related closures;
- facilitate use of a systems-based, risk-reduction approach to pool design and operation;
- incorporate science and best practices into pool inspection programs;
- improve data collection through standardized inspection forms and inspector training;
- expand the use of inspection data to improve surveillance and decision making; and
- decrease resources needed for creating and regularly updating pool codes.

FIGURE **1**

Cover Images for the 1st Edition of the Model Aquatic Health Code (Code and Annex), Released August 2014

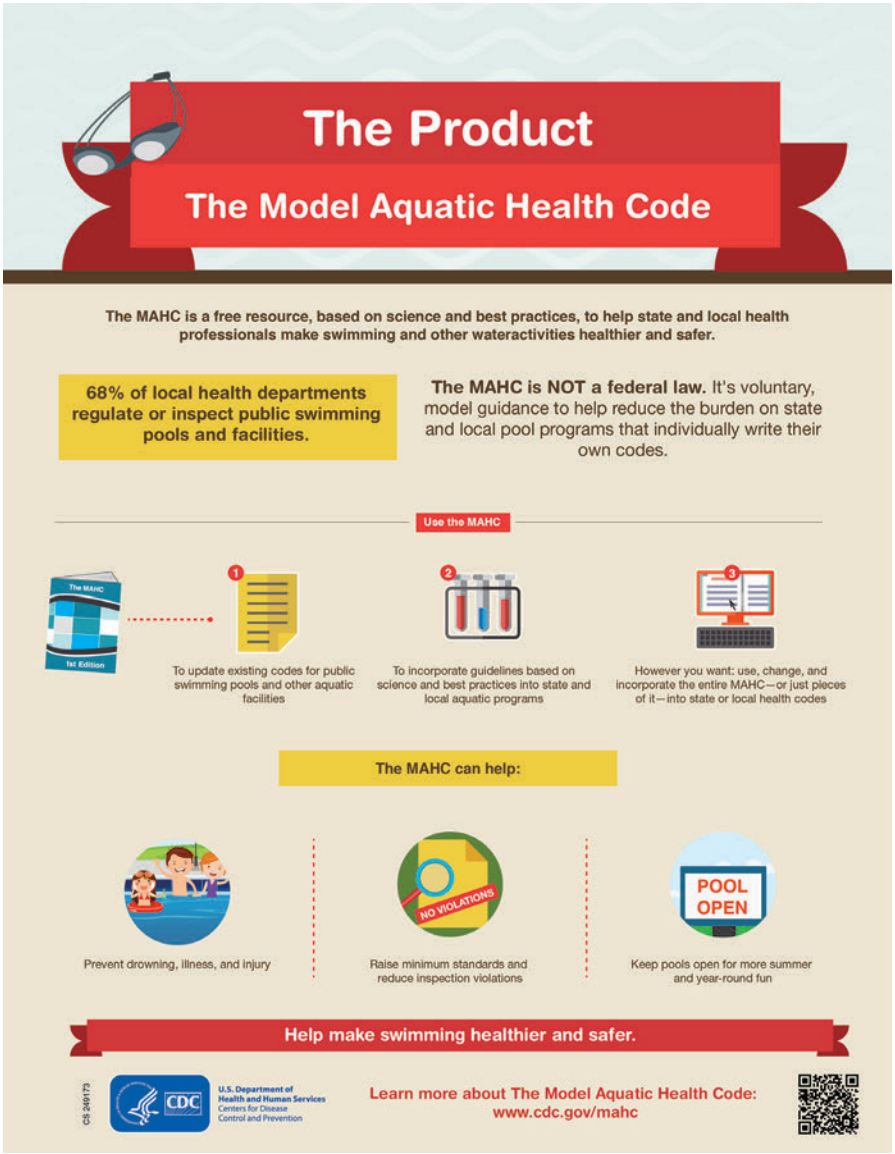




The code provides guidelines based on science and best practices. The annex provides references and rationale for the guidelines.

FIGURE **2**

Section of the Model Aquatic Health Code (MAHC) Infographic Available From the MAHC Web Site



What's Next?

CDC recognizes that the MAHC must remain relevant and respond to the latest industry trends and research. To keep the MAHC up to date, an independent 501c3 nonprofit organization, the Conference for the Model Aquatic Health Code (CMAHC), was created in 2013 by MAHC stakeholders to manage future MAHC updates. The CMAHC will partner with CDC to collect, assess, and relay national input on MAHC revisions back to CDC for final acceptance. This will keep the MAHC current and up to date with the latest public health issues and aquatics sector advances. CDC encourages people to join and help build the CMAHC into a driving force for improved health, safety, and fun at the nation's public swimming facilities. More information about the CMAHC can be found at www.cmahc.org.

Building Partnerships with Building Officials

To prevent recreational water injury and illnesses, strong codes built on a foundation of science and best practices that avoid conflict with other complementary codes are needed

by both public health professionals and building code officials. Recognizing this need, in 2012 representatives from the International Association of Plumbing and Mechanical Officials, International Code Council, NEHA, and CDC entered into historic memorandums of understanding (MOUs) intended to bring enhanced public health, safety, and code alignment to design, installation, operation, and maintenance of public aquatic facilities.

These MOUs built on the overriding principle that public health professionals and building officials must work together closely. Coordination is key to preventing recreational injury and illnesses, because an improperly designed or constructed pool will result in potential health, safety, and cost issues for both building and public health officials and the communities they serve. The MOU partners sought to eliminate all conflict among their respective codes, use evidenced-based principles to further align the codes, and agree to continued partnership to ensure alignment in future code editions.

Who will benefit from building and public health officials working together? The answer is the general public, pool owners, code officials, plan examiners, inspectors, health officials, design professionals, pool contractors, and others.

The future of aquatic health and safety is bright, and in the coming years increased emphasis will be put on strengthening partnerships with all stakeholders to make the MAHC release just the first step towards redefining aquatic health and safety in this country. Explore the MAHC as a resource for reducing risk in your jurisdiction, and get involved in the national CMAHC effort to guide improvement in future MAHC editions.

Corresponding Author: Jasen Kunz, Environmental Health Officer, Division of Emergency and Environmental Health Services, National Center for Environmental Health, CDC, 4770 Buford Highway NE, MS F-58, Atlanta, GA 30341. E-mail: izk0@cdc.gov.

Reference

National Association of County and City Health Officials (2013). *National profile of local health departments*. Retrieved from http://nacchoprofilestudy.org/wp-content/uploads/2014/02/2013_National_Profile021014.pdf

Did You Know?

National Handwashing Awareness Week is December 7–13. Its goal is to decrease the spread of infectious diseases through community education on proper hand washing and hygiene behaviors.

DIRECT FROM CDC ENVIRONMENTAL PUBLIC HEALTH TRACKING NETWORK

Ethan Fechter-Leggett, MPVM, DVM

Disease Detective Applies Skills to Surveillance Evaluation

Editor's Note: As part of our continuing effort to highlight innovative approaches and tools to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Centers for Disease Control and Prevention's (CDC's) Environmental Public Health Tracking Network (Tracking Network). The Tracking Network is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. The Tracking Network brings together data concerning health and environmental problems with the goal of providing information to help improve where we live, work, and play.

Environmental causes of chronic diseases are hard to identify. Measuring amounts of hazardous substances in our environment in a standard way, tracing the spread of these over time and area, seeing how they show up in human tissues, and understanding how they may cause illness is critical. The Tracking Network is a tool that can help connect these efforts. Through these columns, readers will learn about the program and the resources, tools, and information available from CDC's Tracking Network.

The conclusions of this article are those of the author(s) and do not necessarily represent the views of CDC.

Ethan Fechter-Leggett is a second-year Epidemic Intelligence Service (EIS) officer in CDC's Environmental Health Tracking Branch at the National Center for Environmental Health. Prior to becoming an EIS officer, Dr. Fechter-Leggett worked in vectorborne diseases at the California Department of Public Health.

I am a second-year Epidemic Intelligence Service (EIS) officer assigned to the Centers for Disease Control and Prevention's (CDC's) National Environmental Public Health Tracking Program (Tracking Program). EIS officers, commonly referred to as "disease detectives," have opportunities to apply our skills to many public health activities beyond outbreak investigations and emergency response. One of the projects I worked on for the Tracking Program was assessing the utility of the hospital discharge data in the National Environmental Public Health Tracking Network (Tracking Network).

CDC's Tracking Program funds health departments in 25 states and 1 city (grantees) to build local tracking networks that integrate health and environmental data (National Environmental Public Health Tracking Program, 2010). These state and local networks feed into the Tracking Network where data can be used to observe trends of exposures and health outcomes, identify populations at risk, plan and evaluate protective and preventive measures, and facilitate research. One of the main sources of data from the Tracking Network grantees is hospital discharge data (HDD). HDD are created and maintained at hospitals for billing and payment purposes (Love, Rudolph, & Shah, 2008). Every year, Tracking Program grantees submit de-identified HDD for display on the Tracking Network. Currently, HDD on the Tracking Network provide information on asthma, heart attack, carbon monoxide poisoning, and heat stress health effects dating back to 2000. Currently, these data are available for 23 states.

We consistently use surveillance data to evaluate programs and interventions in public health, but many of us may not think about the need to evaluate surveillance data and systems. Periodic evaluation is necessary to ensure systems are operating efficiently and effectively. An opportunity for this type of evaluation presented itself in 2012 after the Tracking Network's data file structure changed.

Because of the file-structure change, we asked our Tracking grantees to resubmit all previous years' HDD (2000–2010). That gave us two sets of 2000–2010 data: the original submissions with the old file structure (old submission) and the resubmitted data with the new file structure (new sub-

FIGURE **1**

Formula

$$\text{Absolute Percent Change} = \left| \frac{\text{New} - \text{Old}}{\text{Old}} \times 100\% \right|$$

mission) for 21 grantees, which allowed us to evaluate HDD quality by comparing the old and new submissions.

We used CDC-recommended guidelines to evaluate public health surveillance systems to assess the utility of HDD in the Tracking Network (Centers for Disease Control and Prevention, 2001). Our evaluation focused on the following attributes: usefulness, simplicity, flexibility, data standards, data quality, completeness of reporting, acceptability, representativeness, timeliness, and stability. We assessed these attributes by calculating the absolute percentage change between the old submission and the new submission. We determined the absolute percentage change by using the following steps (Figure 1):

1) Subtracted the value of the old submission from the value of the new submission.
2) Divided the number value from step one by the value of the old submission.
3) Multiplied the number value from step two by 100%.
4) Determined the absolute value of the number value from step three.

Evaluation Highlights Two Main Challenges

The evaluation results indicated that the following attributes of HDD were satisfactory for use in the Tracking Network: usefulness, simplicity, flexibility, data standards, data quality, acceptability, representativeness, timeliness, and stability. The main challenges were with timeliness and completeness of reporting, two critical elements in the Tracking Network.

Timeliness

Timeliness describes the amount of time at and between steps in data collection and processing. Figure 2 describes data flow of state HDD. Data flow begins in hospitals where patient transaction information is created and maintained. In most states, hospitals submit HDD for records that have closed (i.e., charges have been paid) to state data stewards. Data stewards are health data agencies within a state; they can be public organizations (such as part of the state government) or a delegated authority (such as a hospital association or private entity). HDD are submitted usually to

FIGURE **2**

Hospital Discharge Data Flow

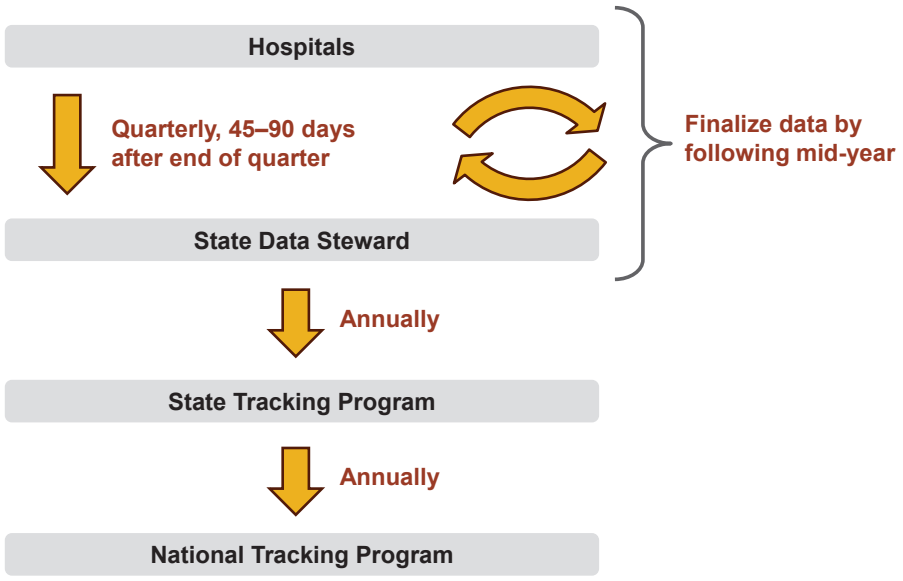
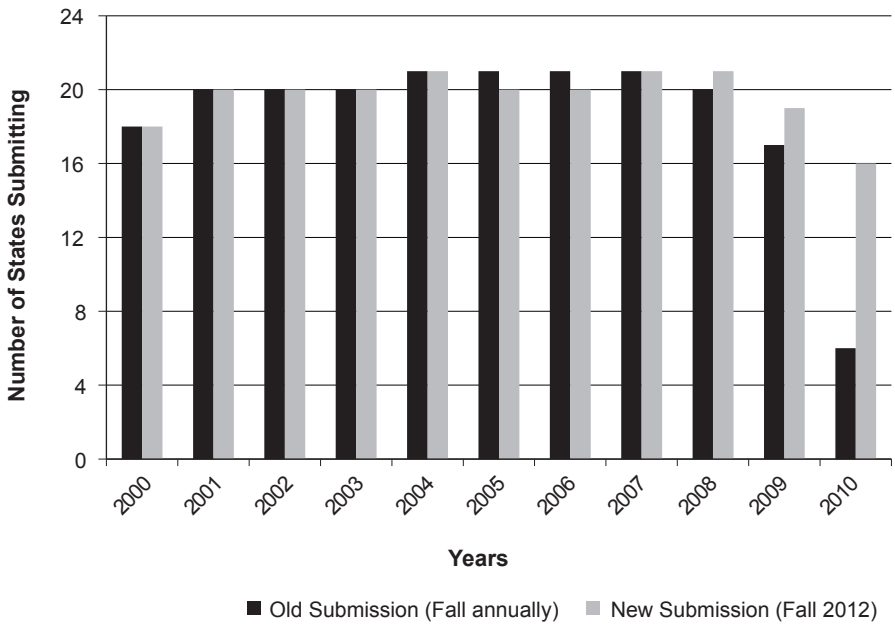


FIGURE **3**

Timeliness



data stewards quarterly, 45–90 days after the end of the quarter. State data stewards then provide HDD to state tracking programs, usually annually, for surveillance purposes. State tracking programs then submit de-identified HDD as monthly aggregates per year to the national Tracking Program every fall. De-identified data are available on the Tracking Network the following spring.

Although the delay between patient discharge and HDD submission to the data steward is 45–90 days, a complete calendar year's HDD may not be available until mid-year of the following calendar year. This circumstance is due to an iterative updating and validating process between the data stewards and hospitals. For example, most data stewards will finalize 2012 calendar year HDD by mid-2013. Because the Tracking Network receives HDD in the early fall, in some states, a short time period may occur between the data steward finalizing the previous year's HDD and when the state tracking programs need to submit HDD to the Tracking Network. Our evaluation showed that not all states were able to submit HDD every year during fall annual data submissions (Figure 3), especially for the most recent year; this may be partially due to this compressed timeline.

Completeness

Completeness describes how well data submitted to the Tracking Program represent the total numbers of known hospitalizations for a health outcome at the time of data submission. Our evaluation found that when HDD were resubmitted during the new submission, the data generated most recently before submission to the Tracking Network changed by a larger percentage when compared to the earliest data generated. This finding is evident in the increasing absolute average percentage change over time (Figures 4 and 5). In addition, the most current five years of data showed the most change. This situation likely occurs because data stewards only receive patient files that have closed, a process that can take multiple years with hospital billing and payment systems.

Recommendations to Balance Timeliness and Completeness

After analyzing the results, we devised two proposed strategies to improve timeliness and completeness of the HDD submitted to the Tracking Network. The first strategy is

FIGURE **4**

Completeness of Reporting: Number of Asthma Hospitalizations

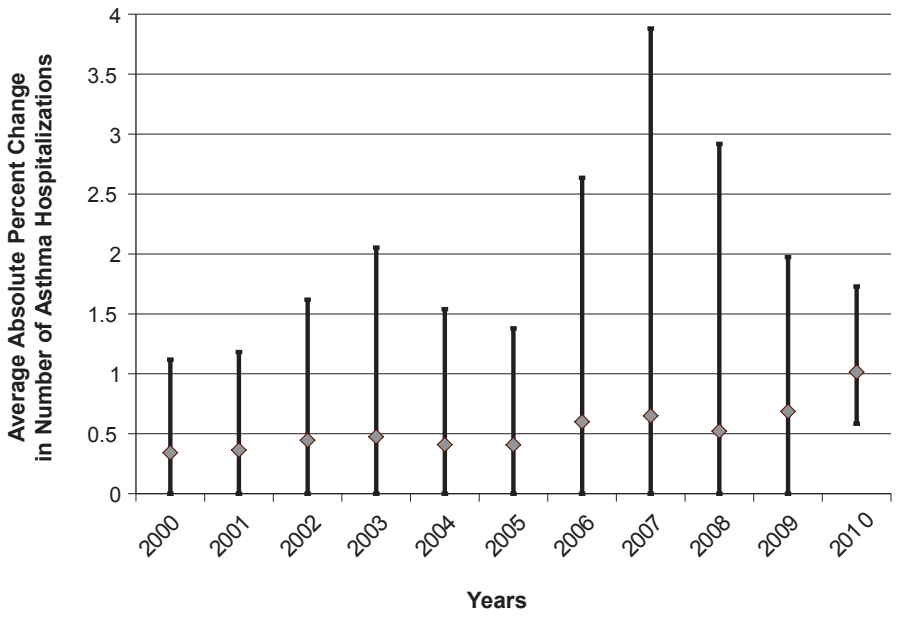
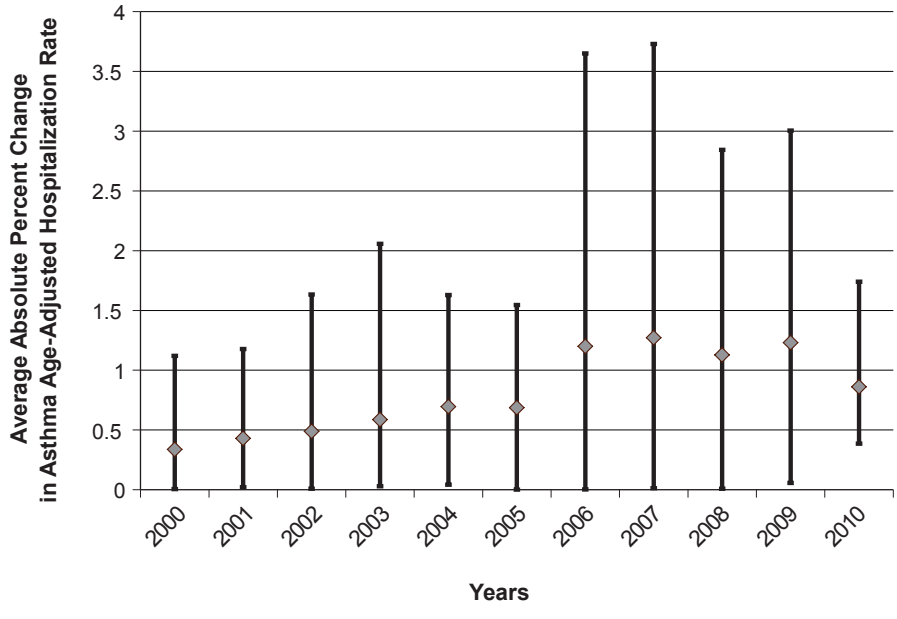


FIGURE **5**

Completeness of Reporting: Age-Adjusted Asthma Hospitalizations Rate



to consider receiving HDD from grantees in the following spring instead of the fall. This change could give grantees more time between data steward finalization and state tracking programs HDD submission to the Tracking Network. Grantees would gain an additional six months to receive and process the most recently completed calendar year's HDD before submission to the Tracking Network. While this would mean that data are published to the Tracking Network six months later, it would potentially increase the number of grantees that submit the most recent year's HDD. In addition, shifting HDD submission to the following spring actually may allow more states to have their HDD published as much as six months earlier than it when it would have otherwise been published the following year.

The second strategy is to consider a three-year HDD resubmission policy. This strategy would have grantees resubmit the previous three years of HDD annually to maximize completeness of reporting. A three-year data resubmission policy would standardize timing and volume of data resubmission for all grantees to balance the needs for both timeliness and completeness.

As "disease detectives," EIS officers are most well known for participating in outbreak investigations and emergency responses, but my experience as an EIS officer in CDC's Tracking Program is a good example of the wide range of responsibilities we might have. Data are at the heart of every public health action, and having quality data makes it possible to deliver quality public health service. HDD remain a useful health outcomes source for the Tracking Network that can be joined with environmental exposure data and used to observe trends that guide public health decisions. Targeting improvements to timeliness and completeness of reporting will help the Tracking Network provide the most accurate and up-to-date data for the public.

Corresponding Author: Ethan Fechter-Leggett, Epidemic Intelligence Service Officer, Environmental Health Tracking Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health, CDC, 4770 Buford Highway NE, MS F-60, Chamblee, GA 30341. E-mail: iun8@cdc.gov.

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DEMYSTIFYING THE FUTURE

Thomas Frey

The Great Barrier Backlash

Editor's Note: Significant and fast-paced change is occurring across society in general and our profession in particular. The clearer our sense for the future is, the more able we are to both understand and take advantage of trends working their way through virtually every aspect of our lives today. To help us see what these trends are and where they appear to be taking us, NEHA has made arrangements to publish the critical thinking of the highly regarded futurist, Thomas Frey.

The opinions expressed in this column are solely that of the author and do not in any way reflect the policies and positions of NEHA and the *Journal of Environmental Health*.

Thomas Frey is Google's top-rated futurist speaker and the executive director of the DaVinci Institute®. At the Institute, he has developed original research studies enabling him to speak on unusual topics, translating trends into unique opportunities. Frey is a powerful visionary who is revolutionizing our thinking about the future.

My wife Deb and I recently returned from a weeklong trip to South Korea where much of our travel inside the country involved riding on the high-speed KTX (Korean Transit eXpress) train from city to city.

The train is designed for speeds up to 350 km/h (217 mph), but currently tops out at 190 mph. Our final trip from Changwon City in the southern tip of Korea to Seoul in the far north took just three hours.

The entire country is 20% smaller than my home state of Colorado, but has a population of over 50 million people, greater than California, Arizona, and Colorado combined.

KTX trains are amazingly efficient with each stop lasting only three to five minutes and hundreds of people getting on and off at each stop. Compared to the nightmare that airports have become, where the minimum time between a plane landing and takeoff is well over an hour, and highways that slow to a crawl during most of the day, these trains are breaking down barriers of time and distance all across Korea.

KTX will soon connect Seoul's Incheon Airport with the rest of its network.

Their system works because it has broken down all the barriers: no security lines, no stoplights, no traffic cops, no passport checks or customs stations, just lightning fast trains.

In addition to high-speed trains, they are known for their high-speed networks. South Korea is also rolling out a 5G network in 2017, which is 1,000 times faster than today's 4G LTE networks.

Yes, it helps to be a small country geographically. But pushing the limits on both transportation and Internet speeds, combined with reducing barriers along the way, makes for a potent combination.

Here's why global competitiveness and emerging technology are forcing the hands of nearly every country to rid themselves of unnecessary barriers, something I call the Great Barrier Backlash.

Waging War Against Traps

In 1997 Reed Hastings returned his copy of "Apollo 13" to the video store and was hit with a late fee so big that he was embarrassed to tell his wife about it. Out of this moment of humiliation the idea for Netflix was born, a business that would eventually take down the entire video rental industry, and its excessive fee-charging practices in the process.

If I'm staying in a hotel room, I don't mind paying minibar rates for water and snacks if I know what they cost. I do mind if I drink a bottle of water that I assumed was complementary, only to be tagged with an $8 fee upon checkout.

Most hotels have eliminated sneaky little traps like this in favor of well-posted menus listing all the prices, but many other industries have not.

Credit card companies and banks are notorious for their late-payment fees, over-limit fees, overdraft fees, and anything else they can find to stack the deck in their favor.

Telecom companies have long hidden sinister fee traps throughout their networks with the most egregious being the roaming charges that get imposed when traveling abroad.

Even government agencies have bought into this line of thinking, imposing penalties on everything from late tax filings, to wrong-

day watering fines, to late utility fees, to parking fines.

In the U.S., penalty traps have become a form of debtor prisons for those unable to comply with the demands of the system. With much of their income being taken from them, they have been reduced to a life of poverty.

The Great Awareness Shift

Today, many young entrepreneurs are looking at the excessive fee-charging practices of business and government with the same kind of righteous anger and opportunistic eyes that motivated Reed Hastings.

As our online communities continue to raise awareness all around the world, those operating within what is considered a legal but ethical gray zone will find themselves increasingly exposed to public angst.

Here are a few examples that come to mind:

- Cities that are overly aggressive in issuing speeding and parking tickets will find themselves cast into a social media "no-travel zone." Both shoppers and travelers will go out of their way to avoid what they construe as a form of visitor harassment. Overall cost to the city in the form of lost revenue will be far greater than what is charged through its penalties.
- Businesses that employ the use of fee traps, legal shenanigans, or anything construed as customer abuse will have their tactics bared to the public with a hacker's bullseye painted squarely on their executive officers.
- Communities that make it hard to do business will be publicly exposed. Excessive fees, filings, forms, and reporting will be publicly berated, castigated, and red flagged. Businesses will go elsewhere.
- Government agencies that still require forms be typed on a typewriter will not only be avoided but may even receive death threats for their stupidity.

It's no longer possible to hide behind a cloak of secrecy when every person you interact with has the ability to write their own headlines on social media, text a friend, or capture the problem on video.

The New Age of Global Competitiveness

The people of South Korea are very aggressive. They are highly educated, tech savvy, and determined to make a name for themselves.

They have risen from a poverty-stricken, destitute nation to one of the most influential world-class countries in the world today.

In 1957 South Korea had a lower per capita GDP than Ghana, the poorest country in the world, but today theirs is over three times that of China, and over 18 times those living in the penniless squalors of North Korea.

Companies in Japan, China, Singapore, and South Korea are aggressively competing for the same money as businesses in North and South America and Europe.

Competitiveness is not just about being smarter or more aggressive, however; it's also about having fewer barriers to contend with.

1. Executives who can squeeze in eight meetings a day rather than five because of fewer traffic problems will be more competitive.
2. Companies that are required to fill out five fewer government forms a year will be more competitive.
3. People who spend 100 hours less each year resolving accounting issues as a result of questionable fees and erroneous charges will also be far more competitive.
4. Travelers who are able to circumvent security and passport checks will have far more time to pay attention to other things.
5. Both people and businesses that spend 40% fewer hours a year doing their taxes will have far more resources to dedicate towards more important issues.

Final Thoughts

In our increasingly fluid society, people and businesses that don't feel welcome will leave. And they may not just leave the local community, they may move to an entirely different country. Most countries are actively recruiting talented people.

Global power is constantly shifting. The 1800s were dominated by the British. America dominated the 1900s. The 2000s are showing major signs of shifting towards Asia.

One of the major factors in this power shift will be personal effectiveness, and our effectiveness gets far better when we are able to strip away at all the numerous barriers we all have to contend with.

On a recent trip to Amsterdam, I texted two photos to Deb, only to get tagged with a $24 charge. Normal texts only cost $.50 but texting photos, unbeknownst to me, costs far more.

Sneaky charges like this are very disruptive. They disrupt our normal thinking, divert attention, and create a painful wariness about using online services in an era where online services can be the critical difference between success and failure.

When it comes to fee traps, fines, and penalties, the monetary gains of the few create losses for the many. They represent unnecessary barriers to progress, and unnecessary challenges at a time where only the most resilient will survive.

Interested in sharing your thoughts? Go to www.FuturistSpeaker.com.

Corresponding Author: Thomas Frey, Senior Futurist and Executive Director, DaVinci Institute®, 511 East South Boulder Road, Louisville, CO 80027.
E-mail: dr2tom@davinciinstitute.com.

Did You Know?

The Integrated Foodborne Outbreak Response and Management (InFORM) meeting will be held in Phoenix, Arizona, November 17–20, 2015. This meeting brings together laboratory, epidemiology, and environmental health professionals involved with foodborne and enteric disease outbreak response. Mark your calendars and visit www.aphl.org/conferences/Pages/InFORM.aspx for more information.

IN MEMORIAM

Joe Beck

NEHA was saddened to learn that Joe Beck passed away on August 9, 2014. Beck will be remembered for his many contributions to the environmental health profession—from his love of teaching and his devotion to students, to all the textbooks and papers he authored, to his kind and generous spirit.

Beck graduated from Paducah Junior College with an associate degree in chemistry and the physical sciences, received a bachelor of science degree from Murray State University in biology and geology, and a master of public administration and political science degree from the University of Illinois at Champaign-Urbana. He served proudly in the U.S. Army during the Vietnam War and was stationed at Fort Campbell (Kentucky) with the 101st Airborne. He served as a preventive medicine officer and combat medic and received his medical training from the Fort Sam Houston Medical Field Service School.

From 1984 to 1988, Beck served as co-chair with then-Vice President George H.W. Bush on his Task Force on Environment and Health. He also worked extensively with Native American tribes as a consultant on public policy and environmental issues and played a major role in the creation of the National Council on Diversity in Environmental Health.

Beck also held past positions as a senior research staff scientist and project manager at the Pacific Northwest Laboratory, Battelle Memorial Institute; a visiting professor at Washington State University and as a faculty member at Illinois State University, Bloomington-Normal; department head of environmental sciences and health at Western Carolina University; and field practice positions with the Illinois State Department of Public Health and the McCracken County Health Department in Paducah, Kentucky.

Beck generously gave of his time to NEHA and numerous environmental health organizations. He was a member of NEHA and received the Past Presidents Award in 2012. He was a chair for NEHA's institutional environmental health technical section for nearly a decade and served as an advisor to the Student National Environmental Health Organization. He also served as a subject-matter expert for NEHA on the development of the Registered Environmental Health Specialist/Registered Sanitarian exams starting in the early 1980s.

In addition, Beck served several terms on the National Environmental Health Science and Protection Accreditation Council and as its past chair. He had been a member of the American Academy of Sanitarians (AAS) since 1982 and also served as its chair. In 2013 he was awarded Diplomat Emeritus status by AAS. He was a member and past president of Phi Kappa Phi and a member of Nu Etta Epsilon. Beck served as an associate editor for the *Illinois Environmental Health Journal* and the *Kentucky Journal*. He was also on the editorial board of the *Occupational Health and Safety Magazine*.

Beck joined the environmental health science faculty at Eastern Kentucky University (EKU) in 1995. He played a key role in the rapid growth and lofty national reputation of the program. A gifted storyteller in the classroom, he was always available outside of class to help his students in any way possible. Students never forgot Beck's advocacy and acts of kindness, typically staying in touch with him long after graduation.

His talents were highly regarded well beyond the EKU campus. He was a prolific writer and co-authored with EKU colleagues several textbooks as well as the Centers for Disease Control and Prevention's housing manual. Because of his expertise, he was a frequently sought speaker, invited annually to present at dozens of meetings across the U.S. and in many foreign countries.

Beck's lasting impact on environmental health and the people he touched can be seen in the following comments.

"I had the privilege of knowing Joe Beck for over 20 years. First as a colleague at NEHA functions and later as a faculty colleague. Joe was one of the most proliferative readers and writers of environmental health I have ever known. He had books older than himself and quoted them frequently. As a colleague, Joe was the best person to go to for help with a class, with historical information on environmental health, or if you needed help writing a professional paper, he was there for you. Joe was an idea man and was constantly coming up with new ones to run past you. Saying no never stopped him from continuing his ideas. Joe was a great asset to our environmental health program as students loved his stories and ideas. I will personally miss him very much, as will our students."—Carolyn Harvey, PhD, CIH, RS, DAAS, CHMM, NEHA president and EKU professor

"I was an aquatic biology major when I first met Joe Beck. Within an hour he had talked me into switching my major to environmental health science, a decision that would turn out to be one of the best of my life. Like so many others, I credit Professor Beck with getting me started in this incredible profession."—CDR Troy Ritter, PhD, DAAS, REHS, U.S. Public Health Service

"I loved Joe's capacity for inspiring those around him. He built a successful environmental health degree program when challenges were bedeviling others. He taught when he could barely see. He consistently tuned into the good possessed by others. No matter his condition, he always approached others with a cheerfulness that instantly made you his friend. Joe never stopped believing. Shortly before his passing, he shared one of his book manuscripts with me anticipating that it would soon be published. And, the man never knew fatigue! I really miss Joe. He and his example have been a huge positive influence on my life and even my world view."—Nelson Fabian, former NEHA executive director (1983–2014)

"I always referred to Joe as 'My friend Joe,' rather than 'Professor Beck.' It was my privilege to know Joe for many decades and to know of some of his numerous contributions. Graduates of the EKU Environmental Health Program were proud to assert that they 'studied under Joe Beck,' rather than 'attended the EKU program.'

IN MEMORIAM

I always admired Joe for continuing to contribute professionally even while overcoming his various serious health problems. I wish I could attend the celebration of life service in honor of my friend Joe, but I will be thinking of Joe and his many contributions, as well as our long friendship."—Larry Gordon

"Joe Beck was my great friend and mentor in the environmental health profession for over 30 years. He always had a kind word, a wide smile, a relevant anecdote, and rousing encouragement for everyone. No issue, personal or professional, was ever too small or too large for Joe's big heart to care about. His encouragement and mentorship has kept me active and engaged in the environmental health profession throughout my career. Many lives have been touched by Joe, and we should all try our best to pass it on." —David Breeding, PhD, Texas A&M University

"I was saddened to hear the news of the passing of Professor Joe Beck. We lost a great colleague and a good friend. He will be missed. But, he will also be long remembered for his major contributions to academia and the field of environmental health practice. For me, he represented a very good reason for attending NEHA's educational conferences. I have always enjoyed the time we spent together at those meetings. Such a memory will always be cherished."—Amer El-Ahraf, PhD, REHS, NEHA past president

NEHA wishes to express its deepest sympathies to Beck's family, colleagues, and friends. He was an exemplary teacher and mentor in environmental health and will be greatly missed.

Editor's Note: The *Journal* will publish the In Memoriam section twice a year in the June and December issues. If you would like to share information on the passing of a noteworthy environmental health professional, please contact Kristen Ruby-Cisneros at kruby@neha.org.

Did You Know?

Joe Beck's family is setting up a scholarship fund in his memory. Contributions can be mailed to C/O EKU Foundation, 521 Lancaster Ave., CPO 19, Richmond, KY 40475.

AEHAP
ASSOCIATION OF ENVIRONMENTAL HEALTH ACADEMIC PROGRAMS

Announces

THE 2015 AEHAP/NCEH STUDENT RESEARCH COMPETITION

for undergraduate and graduate students enrolled in a National Environmental Health Science and Protection Accreditation Council (EHAC)-accredited program or an environmental health program that is an institutional member of AEHAP

Win a $1,000 Award

and up to $1,000 in travel expenses

Students will be selected to present a 20-minute platform presentation at the National Environmental Health Association's Annual Educational Conference & Exhibition in Orlando, FL, July 13–15, 2015.

Entries must be submitted by Monday, April 6, 2015, to
Dr. David Gilkey
Colorado State University
146 EH Building
Fort Collins, CO 80523-1681
E-mail: dgilkey@colostate.edu

For additional information and research submission guidelines, please visit www.aehap.org.

AEHAP gratefully acknowledges the support of the National Center for Environmental Health, Centers for Disease Control and Prevention, for this competition.

CAREER **OPPORTUNITIES**

Food Safety Inspector

UL Everclean Services is the leader in the restaurant inspections market. We offer opportunities throughout the country. We currently have openings for professionals to conduct Q.A. audits of restaurants.

Past or current food safety inspecting is required.

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Cleveland, OH
Colorado Springs, CO
Grand Junction, CO
Hartford, CT
Jackson, MS
Jacksonville, FL
Little Rock, AR
McAllen, TX
Milwaukee, WI
Minneapolis, MN
New Orleans, LA
Oklahoma City, OK
Owatonna, MN
Pittsburgh, PA
Pocatello, ID
Puerto Rico
Rapid City, SD
Roanoke, VA
Rochester, NY
Shreveport, LA
Sioux Falls, SD
Spearfish, SD
St. Louis, MO
St. Paul, MN
Syracuse, NY
Tulsa, OK
Yuma, AZ

Canada Listings
Edmonton, AB
Kamloops, BC
Mississauga, ON
Ontario
Ottawa, ON

Interested applicants can send their resume to: Bill Flynn at Fax: 818-865-0465. E-mail: Bill.Flynn@ul.com.

Assistant/Associate Professor

Environmental & Occupational Health (EOH)
Tenure Track
California State University, Northridge

Effective Date of Appointment: AY 2015–2016
General Information: The Department of EOH is one of the oldest accredited programs of its kind in the nation and is widely known for its commitment to academic excellence and practical career training.

Qualifications and Responsibilities: Doctoral degree in EOH or a closely related field. ABD candidates will be considered, but doctorate must be completed by time of appointment. REHS, CIH, strongly preferred. Teaching and professional experience are criteria in evaluating candidates. Experience in student advisement is desirable.

Teaching areas may include: Administration, air quality, food safety, industrial hygiene, microbiology, hazardous waste management, EOH program management, research design, risk analysis, toxicology, vector control, and water quality.

Inquiries and applications: To apply: www.csun.edu/faculty-affairs/health-and-human-development/ or for more information contact Dr. Michael Sullivan, chair of the Search and Screen Committee at (818) 677-6325 or michael.sullivan@csun.edu. Department Web site: www.csun.edu/hhd/eoh/.

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EH CALENDAR

UPCOMING NEHA CONFERENCE

July 13–15, 2015: NEHA's 79th Annual Educational Conference & Exhibition, Renaissance Orlando at SeaWorld, Orlando, FL. For more information, visit www.neha2015aec.org.

NEHA AFFILIATE AND REGIONAL LISTINGS

California
April 13–16, 2015: Annual Educational Symposium, hosted by the California Environmental Health Association, San Diego, CA. For more information, visit www.ceha.org.

Michigan
March 17–20, 2015: Annual Educational Conference, hosted by the Michigan Environmental Health Association, Traverse City, MI. For more information, visit www.meha.net.

Ohio
April 22–24, 2015: Annual Education Conference, hosted by the Ohio Environmental Health Association, Dublin, OH. For more information, visit www.ohioeha.org.

Texas
December 3–5, 2014: Annual Educational Conference, hosted by the South Texas Chapter of the Texas Environmental Health Association, South Padre Island, TX. For more information, visit www.facebook.com/TEHASTC.

TOPICAL LISTINGS

Children's Environmental Health
February 4–6, 2015: 2015 Research Conference—Children: Food and Environment, hosted by the Children's Environmental Health Network, Austin, TX. For more information, visit www.cehn.org/2015_research_conference.

Food Safety
December 4–5, 2014: Consumer Food Safety Education Conference, hosted by the Partnership for Food Safety Education, Arlington, VA. For more information, visit www.teamfoodsafety.org/2014.

Onsite Wastewater
January 15–16, 2015: 33rd Annual Onsite Wastewater Treatment Conference, hosted by the Illinois Association of Local Environmental Health Administrators, East Peoria, IL. For more information, visit http://ieha.coffeecup.com/calendar.html.

neha.org

- Journal of Environmental Health
- e-Learning
- **R&D Programs**
- NEHA in Action
- Credentials
- Continuing Education
- NEHA Food Safety Training
- Awards & Sabbaticals
- Endowment Fund
- Scholarships
- Position Papers
- Affiliated Organizations
- Links
- Students Section

Information and opportunities abound behind the research and development (R&D) button on NEHA's homepage. Visit neha.org/research to obtain the latest on the following NEHA federally funded programs, many of which include free or low-cost training and educational opportunities:

- Biology and Control of Vectors and Public Health Pests Program
- Environmental Public Health Tracking Program
- Epi-Ready Team Training Program
- Food-Safe Schools Program
- Industry-Foodborne Illness Investigation Training and Recall Response (I-FIIT-RR) Program
- Land Use Planning and Design Program
- Onsite Wastewater Treatment Systems Program
- Radon/Indoor Air Quality Program
- Workforce Development Program

Did You Know?

New NEHA membership options started in October! Members can choose from hard copy, electronic delivery of the *Journal of Environmental Health*, or both! Go to www.neha.org/member for details.

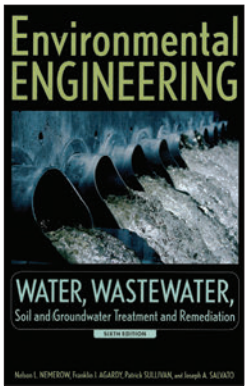
RESOURCE CORNER

Resource Corner highlights different resources that NEHA has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these, and many other, pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation (Sixth Edition)

Edited by Nelson L. Nemerow, PhD; Franklin J. Agardy, PhD; Patrick Sullivan, PhD; and Joseph A. Salvato (2009)

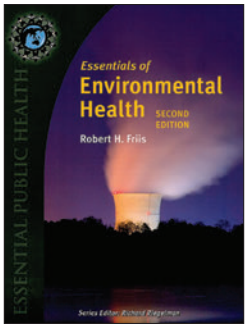


First published in 1958, Salvato's *Environmental Engineering* has long been the definitive reference for generations of sanitation and environmental engineers. This sixth edition has been completely rewritten by leading experts in the field and offers succinct new case studies, new process and plant design examples, and added coverage of such subjects as urban and rural systems. This volume covers water and wastewater treatment, water supply, soil and groundwater remediation and protection, and industrial waste management. Study reference for NEHA's REHS/RS exam.

384 pages / Hardback / Catalog #709
Member: $130 / Nonmember: $140

Essentials of Environmental Health (Second Edition)

Robert H. Friis (2010)

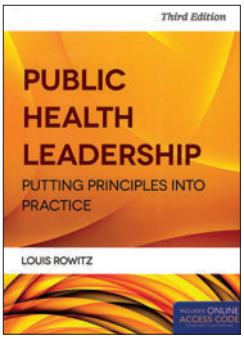


This book provides a clear and comprehensive study of the major topics in environmental health including 1) background on the field and tools of the trade (environmental epidemiology, environmental toxicology, and environmental policy and regulation); 2) environmental diseases (microbial agents and ionizing and nonionizing radiation); and 3) applications and domains of environmental health (water and air quality, food safety, waste disposal, and occupational health). The second edition is a thorough revision that includes new material such as a chapter on injuries, an expanded discussion of the history of environmental health, a case study on pandemic influenza (H1N1) 2009, and coverage of environmental controversies.

442 pages / Paperback / Catalog #1115
Member: $97 / Nonmember: $102

Public Health Leadership: Putting Principles into Practice (Third Edition)

Louis Rowitz (2014)

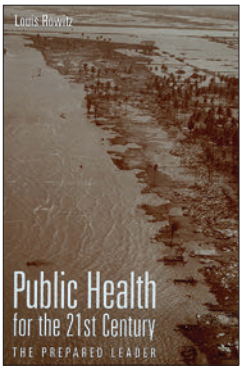


New edition! The importance of leadership in public health has steadily increased over the last 20 years. This text has become a standard reference for future and practicing public health leaders. The new third edition is an exhaustive revision that includes extensive coverage of the leadership skills and tools that are critical to managing public health emergencies. In five parts, it explores the basic theories and principles of leadership and describes how they may be applied in the public health setting. Leadership skills and competencies, as well as methods for measuring and evaluating leaders, are thoroughly covered. The book includes an online access code to the companion Web site. It also offers updated exercises and case studies throughout and new chapters on building infrastructure, accreditation, and the global public health leader.

738 pages / Paperback / Catalog #931
Member: $93 / Nonmember: $99

Public Health for the 21st Century: The Prepared Leader

Louis Rowitz (2006)



Public health has moved to the forefront of national interest and scrutiny in the light of present day events. Public health professionals are now regulars in all forms of media, something unheard of just a few years ago. The issues are well known—bioterrorism, SARS, West Nile virus—and they are enough to panic a population without skillful leadership. The book examines public health leadership in terms of emergency preparedness and specific skills and tools. As modern-day threats force leaders to look at how they address disasters and drive communities to prepare themselves, this book provides tools and real-life cases to hone management skills to prepare agencies to deal with large-scale events.

521 pages / Paperback / Catalog #932
Member: $104 / Nonmember: $109

Students Don't Miss This Opportunity!

Applications for the 2015 National Environmental Health Association/American Academy of Sanitarians (NEHA/AAS) Scholarship Program are now available. Last year, $4,000 was awarded to two students who demonstrated the highest levels of achievement in their respective environmental public health degree programs. If you would like an application or information about the NEHA/AAS Scholarship, do one of the following before the deadline:

Visit

www.neha.org/scholarship/scholarship.html.

Application and qualification information is available to download from NEHA's scholarship Web page.

Contact

Cindy Dimmitt
with a request for
an application and information.
E-mail: cdimmitt@neha.org
Phone: 303.756.9090, ext. 300
Write: NEHA/AAS Scholarship
720 S. Colorado Blvd.,
Ste.1000-N
Denver, CO 80246-1926

Deadline: February 1, 2015

JEH QUIZ

FEATURED ARTICLE QUIZ #3

Consuming Untreated Water in Four Southwestern Alaska Native Communities: Reasons Revealed and Recommendations for Change

Available to those holding an Individual NEHA membership only, the *JEH* Quiz, offered six times per calendar year through the *Journal of Environmental Health,* is a convenient tool for self-assessment and an easily accessible means to accumulate continuing-education (CE) credits toward maintaining your NEHA credentials.

1. Read the featured article carefully.
2. Select the correct answer to each *JEH* Quiz question.
3. a) Complete the online quiz at www.neha.org (click on "Continuing Education"),
   b) Fax the quiz to (303) 691-9490, or
   c) Mail the completed quiz to
   JEH Quiz, NEHA
   720 S. Colorado Blvd., Suite 1000-N
   Denver, CO 80246.
   Be sure to include your name and membership number!
4. One CE credit will be applied to your account with an effective date of December 1, 2014 (first day of issue).
5. Check your continuing education account online at www.neha.org.
6. You're on your way to earning CE hours!

Quiz Registration

Name

NEHA Member No.

Home phone

Work phone

E-mail

Quiz deadline: March 1, 2015

1. Waterborne diseases cost the U.S. health care system an estimated __ each year.
   a. $100 million
   b. $300 million
   c. $600 million
   d $900 million

2. About __ of the world's hospital beds are occupied by persons affected by inadequate water supply and sanitation.
   a. three-fourths
   b. half
   c. one-third
   d. one-fourth

3. Although most residents of Alaska Native villages have access to treated drinking water, about __ in __ rural residents must haul treated water to their homes from a centralized water point.
   a. one; four
   b. one; five
   c. one; six
   d. one; eight

4. The study uses thematic analysis to identify and analyze participant-reported motives for drinking untreated water and to describe the interconnections among them.
   a. True.
   b. False.

5. Recruitment for the study comprised of all of the following except
   a. VHF radio announcements.
   b. recruitment flyers.
   c. e-mail announcements.
   d. word-of-mouth methods.

6. Of the households eligible for the study, __ completed the questions relevant to this article.
   a. 70%
   b. 74%
   c. 80%
   d. 84%

7. __ of the surveys were completed by a male household member.
   a. Forty-eight percent
   b. Sixty percent
   c. Eighty-two percent
   d. Eighty-four percent

8. __ and __ of participants reported their household obtained none and all of their drinking water from a treated water point, respectively.
   a. Thirty-nine percent; 18%
   b. Thirty-nine percent; 38%
   c. Eighteen percent; 38%
   d. Eighteen percent; 39%

9. The six identified motive themes for drinking untreated water include
   a. chemicals, appearance, health, access to water, tradition, and cost.
   b. chemicals, taste, appearance, access to water, tradition, and cost.
   c. chemicals, taste, health, access to water, tradition, and cost.
   d. chemicals, taste, health, appearance, tradition, and cost.

10. Which two themes overlapped substantially with 46% of participants reporting both as reasons for consuming treated water?
    a. Taste and health.
    b. Access to water and chemicals.
    c. Chemicals and appearance.
    d. Chemicals and taste.

11. The use of chemicals in the water treatment process was the most common reason provided for choosing to consume untreated water.
    a. True.
    b. False.

12. __ is not one of the three supra-individual levels of the socio-ecological framework.
    a. Policy
    b. Community
    c. Individuality
    d. Family

JEH Quiz #1 Answers
July/August 2014

1. a	4. d	7. e	10. a
2. c	5. c	8. c	11. b
3. e	6. d	9. d	12. c

SUPPORT THE NEHA ENDOWMENT FOUNDATION

The NEHA Endowment Foundation was established to enable NEHA to do more for the environmental health profession than its annual budget might allow. Special projects and programs supported by the foundation will be carried out for the sole purpose of advancing the profession and its practitioners.

Individuals who have contributed to the foundation are listed below by club category. These listings are based on what people have actually donated to the foundation—not what they have pledged. Names will be published under the appropriate category for one year; additional contributions will move individuals to a different category in the following year(s). For each of the categories, there are a number of ways NEHA recognizes and thanks contributors to the foundation. If you are interested in contributing to the Endowment Foundation, please fill out the pledge card or call NEHA at 303.756.9090.

Thank you.

DELEGATE CLUB ($25–$99)

Name in the Journal *for one year and endowment pin.*

Freda W. Bredy
Alexandria, VA

HONORARY MEMBERS CLUB ($100–$499)

Letter from the NEHA president, name in the Journal *for one year, and endowment pin.*

Michele R. DiMaggio
Martinez, CA

B. Robert Rothenhoefer, RS, REHS, CP-FS
Falls Church, VA

James M. Speckhart, MS
Norfolk, VA

21st CENTURY CLUB ($500–$999)

Name in AEC program book, name submitted in drawing for a free one-year NEHA membership, name in the Journal *for one year, and endowment pin.*

Bette J. Packer
Ham Lake, MN

Peter M. Schmitt
Shakopee, MN

Dr. Bailus Walker, Jr.
Arlington, VA

SUSTAINING MEMBERS CLUB ($1,000–$2,499)

Name in AEC program book, name submitted in drawing for a free two-year NEHA membership, name in the Journal *for one year, and endowment pin.*

James J. Balsamo, Jr., MS, MPH, MHA, RS, CP-FS
Metairie, LA

George A. Morris, RS
Dousman, WI

Welford C. Roberts, PhD, RS, REHS, DAAS
South Riding, VA

Walter P. Saraniecki, MS, LDN, LEHP, REHS/RS
La Grange, IL

AFFILIATES CLUB ($2,500–$4,999)

Name in AEC program book, name submitted in drawing for a free AEC registration, name in the Journal *for one year, and endowment pin.*

EXECUTIVE CLUB AND ABOVE ($5,000–$100,000)

Name in AEC program book, special invitation to the AEC President's Reception, name in the Journal *for one year, and endowment pin.*

NEHA ENDOWMENT FOUNDATION PLEDGE CARD

I pledge to be a NEHA Endowment Foundation Contributor in the following category:

- ❍ Delegate Club ($25)
- ❍ Honorary Members Club ($100)
- ❍ 21st Century Club ($500)
- ❍ Sustaining Members Club ($1,000)
- ❍ Affiliates Club ($2,500)
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- ❍ President's Club ($10,000)
- ❍ Endowment Trustee Society ($25,000)
- ❍ Visionary Society ($50,000)
- ❍ Futurists Society ($100,000)
- ❍ **You have my permission to disclose the fact and amount (by category) of my contribution and pledge.**

I plan to make annual contributions to attain the club level of _____ over the next _____ years.

Signature _____ Print Name _____

Organization _____ Phone _____

Street Address _____ City _____ State _____ Zip _____

❍ Enclosed is my check in the amount of $_____ payable to **NEHA Endowment Foundation**.

❍ Please bill my: MasterCard/Visa Card #_____ Exp. Date _____

Signature _____

MAIL TO: NEHA, 720 S. Colorado Blvd., Suite 1000-N, Denver, CO 80246, or FAX to: 303.691.9490. 1412JEHEND

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Albuquerque Environmental Health Department
www.cabq.gov/environmentalhealth

Allegheny County Health Department
www.county.allegheny.pa.us

American Academy of Sanitarians (AAS)
Gary P. Noonan
www.sanitarians.org

American Chemistry Council
www.americanchemistry.com

Anua
www.anua-us.com

Ashland-Boyd County Health
hollyj.west@ky.gov

Association of Environmental Health Academic Programs
www.aehap.org

ATSDR/DCHI
www.atsdr.cdc.gov/hac

Camelot International Health Organization
www.camelot.gr

CDP, Inc.
www.cdpehs.com

Chemstar Corporation
www.chemstarcorp.com

City of Bloomington
www.ci.bloomington.mn.us

City of Fall River Health & Human Services
(508) 324-2410

City of Houston Environmental Health
www.houstontx.gov/health/Environmental

City of Milwaukee Health Department, Consumer Environmental Health
http://city.milwaukee.gov/Health

City of San Diego Environmental Services Department
www.sandiego.gov/environmental-services

City of St. Louis Department of Health
www.stlouis-mo.gov/government/departments/health

Coconino County Public Health
www.coconino.az.gov

Colorado Department of Public Health and Environment, Division of Environmental Health, Delegated Programs Unit
Therese Pilonetti
therese.pilonetti@state.co.us

Decade Software Company, LLC
Darryl Booth
www.decadesoftware.com

DEH Child Care
www.denvergov.org/DEH

DeltaTrak, Inc.
Vallierie Cureton
www.deltatrak.com

Digital Health Department, Inc.
www.dhdinspections.com

Diversey, Inc.
Steve Hails
www.diversey.com

DuPage County Health Department
www.dupagehealth.org

Eastern Idaho Public Health District
www.phd7.idaho.gov

Ecobeco
www.ecobeco.com

Ecolab
robert.casey@ecolab.com
www.ecolab.com

EcoSure
charlesa.arnold@ecolab.com

Elite Food Safety Training
www.elitefoodsafety.com

English Sewage Disposal, Inc.
(756) 358-4771

Florida Department of Health
www.doh.state.fl.us

Gila River Indian Community, Environmental Health Services
www.gilariver.org

GLO GERM/Food Safety First
Joe D. Kingsley
www.glogerm.com

HealthSpace USA Inc.
Joseph Willmott
www.healthspace.com

Industrial Test Systems, Inc.
www.sensafe.com

Inspect2Go
www.inspect2go.com

InspekPro LLC
www.inspekpro.com

International Association of Plumbing and Mechanical Officials
www.iapmo.org

Jefferson County Health Department (Missouri)
Joe Hainline
www.jeffcohealth.org

Jefferson County Public Health (Colorado)
csanders@jeffco.us
http://jeffco.us/health

Kansas Department of Health & Environmental
jrhoads@kdheks.gov

Linn County Public Health
health@linncounty.org

Maricopa County Environmental Services
jkolman@mail.maricopa.gov

Mars Air Doors
www.marsair.com

Merced County Public Health, Division of Environmental Health
rrowe@co.merced.ca.us

Mesothelioma Lawyer Center
www.mesotheliomalawyercenter.org

Mid-Iowa Community Action
www.micaonline.org

Mid-Ohio Valley Health Department
tim.l.miller@wv.gov
www.movhd.com

Mitchell Humphrey
www.mitchellhumphrey.com

Mycometer
www.mycometer.com

National Environmental Health Science and Protection Accreditation Council
www.ehacoffice.org

National Registry of Food Safety Professionals
Lawrence Lynch
www.nrfsp.com

National Restaurant Association
www.restaurant.org

National Swimming Pool Foundation
Michelle Kavanaugh
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Neogen Corporation
www.neogen.com

New Mexico Environment Department
www.nmenv.state.nm.us

New York City Department of Health & Mental Hygiene
www.nyc.gov/health

North Bay Parry Sound District Health Unit
www.healthunit.biz

Nova Scotia Department of Agriculture
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NSF International
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PerkinElmer, Inc.
www.perkinelmer.com

Polk County Public Works
www.polkcountyiowa.gov/publicworks

Presby Environmental, Inc.
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Prometric
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Racine City Department of Health
www.cityofracine.org/Health.aspx

Remco Products
www.remcoproducts.com

Sacramento County Environmental Management Department
www.emd.saccounty.net

San Jamar
www.sanjamar.com

Seattle & King County Public Health
Michelle Pederson
michelle.pederson@kingcounty.gov

Shat-R-Shield Inc.
Anita Yost
www.shat-r-shield.com

Skillsoft
www.skillsoft.com

www.sneezeguard-solutions.com

Sonoma County Permit and Resource Management Department, Wells and Septic Section
www.sonoma-county.org/prmd

Starbucks Coffee Company
www.starbucks.com

StateFoodSafety.com
www.StateFoodSafety.com

Stater Brothers Market
www.stater.com

Sweeps Software, Inc.
Kevin Thrasher
www.sweepssoftware.com

Taylor Technologies, Inc.
www.taylortechnologies.com

Texas Roadhouse
www.texasroadhouse.com

The Steritech Group, Inc.
www.steritech.com

Tri-County Health Department
www.tchd.org

Underwriters Laboratories, Inc.
Gus Schaeffer
www.ul.com

Waco-McLennan County Public Health District
davidl@ci.waco.tx.us

Washington County Environmental Health (Oregon)
environmentalhealth@co.washington.or.us
www.co.washington.or.us/HHS/EnvironmentalHealth

Waukesha County Public Health Division
sward@waukeshacounty.gov
www.oeo.wv.gov

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Educational Institution Members

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www.colostate.edu

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Michigan State University, Online Master of Science in Food Safety
www.online.foodsafety.msu.edu

Ponce School of Medicine, Public Health Program
www.psm.edu/php

The University of Findlay
www.findlay.edu

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Sharron LaFollette
www.uis.edu/publichealth

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SPECIAL **LISTING**

The board of directors includes NEHA's nationally elected officers and regional vice presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

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National Officers

President—Carolyn Hester Harvey, PhD, CIH, RS, DAAS, CHMM, Professor, Director of MPH Program, Department of Environmental Health, Eastern Kentucky University, Dizney 220, 521 Lancaster Avenue, Richmond, KY 40475.
Phone: (859) 622-6342
carolyn.harvey@eku.edu

President Elect—Bob Custard, REHS, CP-FS, 29 Hammond Drive, Lovettsville, VA 20180. Phone: (571) 221-7086
BobCustard@comcast.net

First Vice President—David E. Riggs, REHS/RS, MS, 2535 Hickory Avenue, Longview, WA 98632. Phone: (360) 430-0241
davideriggs@comcast.net

Second Vice President—Adam London, RS, MPA, Environmental Health Director, Kent County Health Department, 700 Fuller NE, Grand Rapids, MI 49503.
Phone: (616) 632-7266
adam.london@kentcountymi.gov

Immediate Past President—Alicia Enriquez Collins, REHS
enriqueza@comcast.net

Regional Vice Presidents

Region 1—Ned Therien, MPH,
Olympia, WA.
nedinoly@juno.com
Alaska, Idaho, Oregon, and Washington.
Term expires 2017.

Region 2—Marcy A. Barnett, MA, MS, REHS, Emergency Preparedness Liaison, California Department of Public Health, Center for Environmental Health, Sacramento, CA. Phone: (916) 449-5686
marcy.barnett@cdph.ca.gov
Arizona, California, Hawaii, and Nevada.
Term expires 2015.

Region 3—Roy Kroeger, REHS,
Environmental Health Supervisor, Cheyenne/Laramie County Health Department, 100 Central Avenue, Cheyenne, WY 82008.
Phone: (307) 633-4090
roykehs@laramiecounty.com
Colorado, Montana, Utah, Wyoming, and members residing outside of the U.S. (except members of the U.S. armed forces).
Term expires 2015.

Region 4—Keith Johnson, RS, Administrator, Custer Health, 210 2nd Avenue NW, Mandan, ND 58554.
Phone: (701) 667-3370
keith.johnson@custerhealth.com
Iowa, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin.
Term expires 2016.

Region 5—Sandra Long, REHS, RS, Inspection Services Supervisor, City of Plano Health Department, 1520 K Avenue, Suite 210, Plano, TX 75074. Phone: (972) 941-7143 ext. 5282; Cell: (214) 500-8884
sandral@plano.gov
Arkansas, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas.
Term expires 2017.

Region 6—Lynne Madison, RS,
Environmental Health Division Director, Western UP Health Department, 540 Depot Street, Hancock, MI 49930.
Phone: (906) 482-7382, ext. 107
lmadison@hline.org
Illinois, Indiana, Kentucky, Michigan, and Ohio. Term expires 2016.

Region 7—Tim Hatch, MPA, REHS, Environmental Programs, Planning, and Logistics Director, Center for Emergency Preparedness, Alabama Department of Public Health, 201 Monroe Street, Suite 1310, Montgomery, AL 36104.
Phone: (334) 206-7935
tim.hatch@adph.state.al.us
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. Term expires 2017.

Region 8—LCDR James Speckhart, MS, USPHS, Health and Safety Officer, FDA, CDRH-Health and Safety Office, WO62 G103, 10903 New Hampshire Avenue, Silver Spring, MD 20993. Phone: (301) 796-3366
jamesmspeckhart@gmail.com
Delaware, Maryland, Pennsylvania, Virginia, Washington, DC, West Virginia, and members of the U.S. armed forces residing outside of the U.S. Term expires 2015.

Region 9—Edward L. Briggs, MPH, MS, REHS, Director of Health, Town of Ridgefield Department of Health, 66 Prospect Street, Ridgefield, CT 06877.
Phone: (203) 431-2745
eb.health@ridgefieldct.org
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Term expires 2016.

Affiliate Presidents

Alabama—Haskey Bryant, MPH, MPA, Environmental Health Specialist, Jefferson County Dept. of Health, Birmingham, AL.
haskey.bryant@jcdh.org

Alaska—Ryan Autenrieth, REHS, Environmental Health Officer, Yukon-Kuskokwim Health Corporation, Bethel, AK.
aeha.net@gmail.com

Arizona—Shikha Gupta, Environmental Operations Program Supervisor, Maricopa County, Phoenix, AZ.
sgupta@mail.maricopa.gov

Arkansas—Jeff Jackson, Camden, AR.
jeff.jackson@arkansas.gov

California—Sarah Crossman, REHS, Environmental Health Specialist IV, Riverside County Dept. of Environmental Health, Riverside, CA.
president@ceha.org

Colorado—Lane Drager, Consumer Protection Coordinator, Boulder County Public Health, Boulder, CO.
ldrager@bouldercounty.org

Connecticut—Marco Palmeri, RS, Chief Sanitarian, Plainville-Southington Regional Health District, Plainville, CT.
health@plainville-ct.gov

Florida—Jill Wallace, Winter Haven, FL.
knine trainer@aol.com

Georgia—Chris Rustin, MS, DrPH, REHS, Environmental Health Section Director, Georgia Dept. of Public Health, Atlanta, GA.
chris.rustin@dph.ga.gov

Hawaii—John Nakashima, Sanitarian IV, Food Safety Education Program, Hawaii Dept. of Health, Hilo, HI.
john.nakashima@doh.hawaii.gov

Idaho—Patrick Guzzle, MA, MPH, REHS, Food Protection Program Manager, Idaho Dept. of Health and Welfare, Boise, ID.
guzzlep@dhw.idaho.gov

Illinois—Lenore Killam, Clinical Instructor, University of Illinois Springfield, Springfield, IL.
lkill2@is.edu

Indiana—Michael Mettler, Indiana State Dept. of Health, Indianapolis, IN.
mmettler@isdh.in.gov

Iowa—Sandy Heinen, Environmental Health Officer, Black Hawk County Health Dept., Waterloo, IA.
sheinen@co.black-hawk.ia.us

Jamaica—Steve Morris, Chief Public Health Inspector, Ministry of Health, St. Catherine, Jamaica.
president@japhi.org.jm

Kansas—Bronson Farmer, RS, HHS, Salina-Saline County Health Dept., Salina, KS.
farmerduo@hotmail.com

Kentucky—Leslie Cobb, Technical Consultant, Kentucky Food Safety Branch, Frankfort, KY.
leslie.cobb@ky.gov

Louisiana—Bill Schramm, Louisiana Dept. of Environmental Quality, Baton Rouge, LA.
bill.schramm@la.gov

Maryland—James Lewis, Westminster, MD.
jlewis@mde.state.md.us

Massachusetts—Alan Perry, REHS/RS, Health Agent, City of Attleboro, Attleboro, MA.
healthagent@cityofattleboro.us

Michigan—Carolyn Kreiger, REHS, Environmental Quality Analyst, Michigan Dept. of Environmental Quality, Kalamazoo, MI.
chobbs@meha.net

Minnesota—Jim Topie, REHS, Planner Principal, Minnesota Dept. of Health, Duluth, MN.
james.topie@state.mn.us

Mississippi—Queen Swayze, Food Program Specialist, Mississippi State Dept. of Health, Jackson, MS.
elizabeth.swayze@msdh.state.ms.us

Missouri—Paul Taylor, Environmental Representative, St. Louis County Health Dept., Berkeley, MO.
ptaylor@stlouisco.com

Montana—Erik Leigh, RS, Public Health Sanitarian, State of Montana DPHHS, Helena, MT.
eleigh@mt.gov

National Capitol Area—Shannon McKeon, Environmental Health Specialist, Fairfax, VA.
smckeon@ncaeha.com

Nebraska—Kathy King, Environmental Health Specialist II, Lincoln-Lancaster Health Dept., Lincoln, NE.
kking@lincoln.ne.gov

Nevada—Tamara Giannini, Environmental Health Supervisor, Southern Nevada Health District, Las Vegas, NV.
giannini@snhdmail.org

New Jersey—Robert Uhrik, REHS, South Brunswick Township Health Dept., Monmouth Junction, NJ.
ruhrik@sbtnj.net

New Mexico—Michael Broussard, CP-FS, Program Specialist, NMED, Santa Fe, NM.
michael.broussard@state.nm.us

New York—Contact Region 9 Vice President Edward L. Briggs.
eb.health@ridgefieldct.org

North Carolina—Jesse Dail, Environmental Health Specialist, Morehead City, NC.
jessed@carteretcountygov.org

North Dakota—Jane Kangas, Environmental Scientist II, North Dakota Dept. of Health, Fargo, ND.
jkangas@nd.gov

Northern New England Environmental Health Association—Co-president Brian Lockard, Health Officer, Town of Salem Health Dept., Salem, NH.
blockard@ci.salem.nh.us
Co-president Thomas Sloan, RS, Agricultural Specialist, New Hampshire Dept. of Agriculture, Concord, NH.
tsloan@agr.state.nh.us

Ohio—Eric J. Zgodzinski, MPH, RS, CPH, Director of Community and Environmental Health, Toledo-Lucas

County Health Dept., Toledo, OH.
zgodzinski@co.lucas.oh.us

Oklahoma—James Splawn, RPS, RPES, Sanitarian, Tulsa City-County Health Dept., Tulsa, OK.
tsplawn@tulsa-health.org

Oregon—Delbert Bell, Klamath Falls, OR.
Dbell541@charter.net

Past Presidents—Mel Knight, REHS, Folsom, CA.
melknight@sbcglobal.net

Pennsylvania—TBD

Rhode Island—Dottie LeBeau, CP-FS, Food Safety Consultant and Educator, Dottie LeBeau Group, Hope, RI.
deejaylebeau@verizon.net

Saudi Arabia—Zubair M. Azizkhan, Environmental Scientist, Saudi Arabian Oil Company, Saudi Arabia.
Zubair.azizkhan@aramco.com.sa

South Carolina—Trey Reed, Regional Environmental Health Director, South Carolina Dept. of Health and Environmental Control, Aiken, SC.
reedhm@dhec.sc.gov

South Dakota—John Osburn, Pierre, SD.
john.osburn@state.sd.us

Tennessee—David Garner, Nashville, TN.
david.garner@tnenvironmentalhealth.org

Texas—Joanna Meyer, RS, Regional QA Manager, MBM, Ft. Worth, TX.
jmeyer@mbmfoodservice.com

Uniformed Services—MAJ Joseph Hout, MSPH, PhD, REHS, CPH, Industrial Hygiene Chief, Academy of the Health Sciences, Ft. Sam Houston, TX.
joseph.j.hout.mil@mail.mil

Utah—Michelle Cooke, LEHS, Program Manager, Weber-Morgan Health Dept., Ogden, UT.
mcooke@co.weber.ut.us

Virginia—Mark Cranford, REHS, CP-FS, Environmental Health Specialist, Virginia Dept. of Health, Charlottesville, VA.
mark.cranford@vdh.virginia.gov

Washington—Michael Baker, MS, PhD, Dept. of Environmental Health Director, Whitman County Public Health, Pullman, WA.
michael.baker@whitmancounty.net

West Virginia—Elizabeth Green, Parkersburg, WV.
elizabeth.s.green@wv.gov

Wisconsin—Laura Temke, REHS, CP-FS, HHS, Environmentalist, City of West Allis Health Dept., West Allis, WI.
ltemke@westalliswi.gov

Wyoming—Tiffany Gaertner, REHS, CP-FS, EHS II, Cheyenne-Laramie County Health Dept., Cheyenne, WY.
tgaertner@laramiecounty.com

NEHA Historian

Dick Pantages, NEHA Past President, Fremont, CA.
dickpantages@comcast.net

Technical Advisors

Air Quality—David Gilkey, PhD, Associate Professor, Colorado State University, Ft. Collins, CO.
dgilkey@colostate.edu

Aquatic Venues/Recreational Health—Tracynda Davis, MPH, President, Davis Strategic Consulting, LLC, Colorado Springs, CO.
tracynda@gmail.com

Aquatic Venues/Recreational Health—Colleen Maitoza, REHS, CPO, Supervising Environmental Specialist, Sacramento County Environmental Management Dept., Sacramento, CA.
maitozac@gmail.com

Children's Environmental Health—Anna Jeng, MS, ScD, Associate Professor and Graduate Program Director, Old Dominion University, Norfolk, VA.
hjeng@odu.edu

Drinking Water/Environmental Water Quality—Sharon Smith, REHS/RS, Sanitarian Supervisor, Minnesota Dept. of Health, Fergus Falls, MN.
sharon.l.smith@state.mn.us

Emergency Preparedness and Response—Martin Kalis, Public Health Advisor, CDC, Atlanta, GA.
mkalis@cdc.gov

Emergency Preparedness and Response—Vince Radke, MPH, RS, CP-FS, DAAS, CPH, Sanitarian, CDC, Atlanta, GA.
vradke@cdc.gov

Emerging Pathogens—Lois Maisel, RN, CP-FS, Environmental Health Specialist, Fairfax County Health Dept., Fairfax, VA.
lois.maisel@fairfaxcounty.gov

Environmental Justice—Welford Roberts, PhD, DAAS, RS, REHS, Subject Matter Expert, Office of the Air Force Surgeon General and ERP International, LLC, South Riding, VA.
welford@erols.com

Food (including Safety and Defense)—Eric Bradley, MPH, REHS, CP-FS, DAAS, Environmental Health Specialist, Scott County Health Dept., Davenport, IA.
eric.bradley@scottcountyiowa.com

Food (including Safety and Defense)—John Marcello, CP-FS, REHS, Regional Retail Food Specialist, FDA, Tempe, AZ.
john.marcello@fda.hhs.gov

General Environmental Health—Ron de Burger, CPHI(C), Retired Director, Toronto Public Health, Toronto, ON, Canada.
rdeburger@gmail.com

General Environmental Health—ML Tanner, HHS, Program Manager, South Carolina Dept. of Health and Environmental Control, Columbia, SC.
tannerml@dhec.sc.gov

Global Climate Change and Health—Norbert Campbell, Lecturer, University of the West Indies, Kingston, Jamaica.
norbert.campbell02@uwimona.edu.jm

Hazardous Materials/Toxic Substances—Priscilla Oliver, PhD, Life Scientist/Regional Program Manager, U.S. EPA, Atlanta, GA.
POliverMSM@aol.com

Hazardous Materials/Toxic Substances—Sarah Keyes, MS, Health, Safety, and Environmental Manager, Peter Cremer North America, LP, Cold Spring, KY.
skeyes@petercremerna.com

Healthy Homes and Healthy Communities—Sandra Whitehead, MPA, National Association of County and City Health Officials, Washington, DC.
whitehead.sandra.1@gmail.com

Injury Prevention—Alan Dellapenna, RS, Branch Head, Injury and Violence Prevention Branch, North Carolina Division of Public Health, Raleigh, NC.
alan.dellapenna@dhhs.nc.gov

International Environmental Health—Sylvanus Thompson, PhD, CPHI(C), Associate Director, Toronto Public Health, Toronto, ON, Canada.
sthomps@toronto.ca

Land Use Planning/Design—Felix Zemel, MCP, MPH, REHS/RS, CEHT, HHS, DAAS, Health Agent, Cohasset Board of Health, Cohasset, MA.
felix.zemel@gmail.com

Legal—TBD

Occupational Health/Safety—D. Gary Brown, DrPH, CIH, RS, DAAS, Professor and Graduate Program Coordinator, Eastern Kentucky University, Richmond, KY.
gary.brown@eku.edu

Onsite Wastewater—Craig Gilbertson, RS, Planner, TrackAssist-Online, Walker, MN.
cgilbertson@yaharasoftware.com

Radiation/Radon—TBD

Risk Assessment—Jason Marion, PhD, Assistant Professor, Eastern Kentucky University, Richmond, KY.
jason.marion@eku.edu

Schools/Institutions—Stephan Ruckman, Environmental Health Manager, Worthington City Schools, Dublin, OH.
mphosu@yahoo.com

Sustainability—Timothy Murphy, PhD, REHS/RS, DAAS, Associate Professor and Dept. Chair, The University of Findlay, Findlay, OH.
murphy@findlay.edu

Technology (including Computers, Software, GIS, and Management Applications)—Darryl Booth, MPA, President, Decade Software Company, Fresno, CA.
darrylbooth@decadesoftware.com

Vector Control & Zoonotic Diseases—Zia Siddiqi, PhD, BCE, Director of Quality Systems, Orkin/Rollins Pest Control, Atlanta, GA.
zsiddiqi@rollins.com

Workforce Development, Management, and Leadership—CAPT Michael Herring, MPH, REHS, Senior Environmental Health Specialist/Training and Technical Assistance Team Leader, CDC, Atlanta, GA.
mherring@cdc.gov

Workforce Development, Management, and Leadership—George Nakamura, MPA, REHS, RS, CP-FS, DAAS, CEO, Nakamura Leasing, Sunnyvale, CA.
gmlnaka@comcast.net

NEHA Staff: (303) 756-9090

Rance Baker, Program Administrator, NEHA Entrepreneurial Zone (EZ), ext. 306, rbaker@neha.org

Trisha Bramwell, Customer & Member Services Specialist, ext. 336, tbramwell@neha.org

Laura Brister, Customer & Member Services Specialist, AEC Registration Coordinator, ext. 309, lbrister@neha.org

Patricia Churpakovich, Credentialing Coordinator, ext. 317, pchurpakovich@neha.org

Brian Collins, Interim Executive Director, ext. 301, bcollins@neha.org

Ginny Coyle, Grants/Projects Specialist, Research and Development (R&D), ext. 346, gcoyle@neha.org

Vanessa DeArman, Project Coordinator, R&D, ext. 311, vdearman@neha.org

Cindy Dimmitt, Receptionist, Customer & Member Services Specialist, ext. 300, cdimmitt@neha.org

Elizabeth Donoghue-Armstrong, Copy Editor, *Journal of Environmental Health*, nehasmtp@gmail.com

Eric Fife, Learning Content Producer, NEHA EZ, ext. 344, efife@neha.org

Soni Fink, Strategic Sales Coordinator, ext. 314, sfink@neha.org

Michael Gallagher, IFSS Logistics and Training Coordinator, NEHA EZ, ext. 343, mgallagher@neha.org

TJay Gerber, Credentialing Specialist, ext. 328, tgerber@neha.org

Dawn Jordan, Customer Service Manager, Office Coordinator, HR and IT Liaison, ext. 312, djordan@neha.org

Erik Kosnar, Learning Content Production Assistant, NEHA EZ, ext. 318, ekosnar@neha.org

Elizabeth Landeen, Assistant Manager, R&D, (702) 802-3924, elandeen@neha.org

Matt Lieber, Marketing and Communications Assistant, ext. 338, mlieber@neha.org

Larry Marcum, Managing Director, R&D and Government Affairs, ext. 307, lmarcum@neha.org

Marissa Mills, Project Assistant, R&D, ext. 304, mmills@neha.org

Eileen Neison, Credential Department Customer Service Representative, ext. 310, eneison@neha.org

Carol Newlin, Credentialing Specialist, ext. 337, cnewlin@neha.org

Terry Osner, Administrative Coordinator, ext. 302, tosner@neha.org

Barry Porter, Financial Coordinator, ext. 308, bporter@neha.org

Kristen Ruby-Cisneros, Content Editor, *Journal of Environmental Health*, ext. 341, kruby@neha.org

Michael Salgado, Assistant Manager, NEHA EZ, ext. 315, msalgado@neha.org

Jill Schnipke, Education Coordinator, ext. 313, jschnipke@neha.org

Joshua Schrader, Sales & Training Support, NEHA EZ, ext. 340, jschrader@neha.org

Clare Sinacori, Marketing and Communications Manager, ext. 319, csinacori@neha.org

Christl Tate, Project Coordinator, R&D, ext. 305, ctate@neha.org

To update information, contact Terry Osner at tosner@neha.org.

2015 ACCEPTING NOMINATIONS NOW

Walter S. Mangold Award

The Walter S. Mangold Award recognizes an individual for extraordinary achievement in environmental health. Since 1956, this award acknowledges the brightest and the best in the profession. NEHA is currently accepting nominations for this award by an affiliate in good standing or by any five NEHA members, regardless of their affiliation.

The Mangold is NEHA's most prestigious award and while it recognizes an individual, it also honors an entire profession for its skill, knowledge, and commitment to public health.

Nominations are due in the NEHA office by Monday, March 16, 2015.

Visit www.neha.org/about/Awards/WalterSMangoldAward.html for application criteria. Please direct questions to Terry Osner, Mangold Award coordinator, at tosner@neha.org.

NEHA SABBATICAL EXCHANGE PROGRAM TO ENGLAND OR CANADA

NEHA offers wide-ranging opportunities for professional growth and the exchange of valuable information on the international level through its longtime Sabbatical Exchange Program.

The sabbatical may be taken in England, in cooperation with the Chartered Institute of Environmental Health, or in Canada, in cooperation with the Canadian Institute of Public Health Inspectors. The sabbatical can be from two to four weeks, as determined by the recipient. If selected, the sabbatical ambassador receives up to **$4,000** as a stipend, depending on the length of the sabbatical, and up to $1,000 for roundtrip transportation.

The application deadline is March 2, 2015.

Winners will be announced at the NEHA 2015 Annual Educational Conference (AEC) & Exhibition in Orlando, Florida, in July 2015. Recipients will complete the sabbatical between August 1, 2015, and June 1, 2016. The sabbatical ambassador will give a required report of their experience at the 2016 AEC in San Antonio, Texas.

For more information, contact Terry Osner at tosner@neha.org.

To access the online application, visit www.neha.org/about/awardinfo.html.

neha2015aec.org

AEC *JULY 13-15, 2015*

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NEHA **NEWS**

NEHA Regional Vice President Application Process and Dates

NEHA's membership is divided into nine different regions and each region elects a vice president to represent it on NEHA's board of directors. A current listing of NEHA's regional vice presidents (RVPs) and the states each region represents can be found on page 56. RVPs serve a three-year term.

Last year, NEHA's board of directors modified the submission date for RVP candidate nominations from February 1 to January 1. This was done to be in compliance with changes in California statutes as NEHA is incorporated in that state. All other dates related to NEHA's elections remain the same.

Terms for three RVP positions end in 2015—Region 2, Region 3, and Region 8. If interested in becoming an RVP for one of these regions, NEHA encourages you to review the nomination (www.neha.org/pdf/officers/rvp.pdf) and election (www.neha.org/about/elections.html) information posted on its Web site.

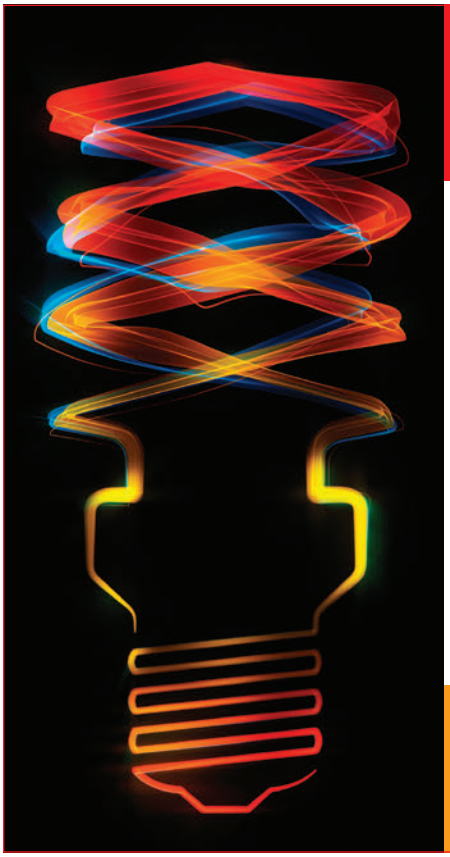
Below is a summary of critical dates to submit for one of these RVP positions.

- January 1, 2015: Completed nomination forms due to the NEHA office.
- February 15, 2015: Deadline to become a NEHA member for voting consideration.
- March 2, 2015: Election ballots mailed (or electronically activated).
- March 31, 2015: Election ballots must be received at NEHA office (or electronically deactivated).
- July 15, 2015: Newly elected RVPs will take office at the installation ceremonies on the last evening of NEHA's Annual Educational Conference (AEC) & Exhibition following the acceptance or verification of their election.

This is an opportunity to share your leadership skills and environmental health experience with current NEHA board members and to make a difference in your profession. For further information or to recommend a qualified individual, please contact Terry Osner at tosner@neha.org.

Did You Know?

A new exam is under development for the Healthy Homes Specialist (HHS) credential and will be launched in late winter 2015. NEHA is currently working with Professional Testing, Inc., and HHS credential holders to revise and update the HHS exam. Find information about the HHS exam at www.neha.org/credential/HHS.html.



2015 Nelson E. Fabian Environmental Health Innovation Award

This award recognizes a NEHA member or organization for creating a new idea, practice, or product that has had a positive impact on environmental health and the quality of life. Innovative change that promotes or improves environmental health protection is the foundation of this award.

Named in honor of former NEHA Executive Director Nelson Fabian, this annual award recognizes those who have made an innovative contribution to the field, as well as encourages others to search for creative solutions. Take this opportunity to submit a nomination to highlight the innovations being put into practice in the field of environmental health!

Nominations are due in the NEHA office by March 16, 2015.

For more information, please visit **www.neha.org/about/awardinfo.html.** Nomination materials can be obtained by e-mailing Terry Osner at **tosner@neha.org**.

2015 Educational Contribution Award

This award was established to recognize NEHA members, teams, or organizations for an outstanding educational contribution within the field of environmental health. This award provides a pathway for the sharing of creative methods and tools to educate one another and the public about environmental health principles and practices. Don't miss this opportunity to submit a nomination to highlight the great works of your colleagues!

Nominations are due in the NEHA office by March 16, 2015.

For more information, please visit **www.neha.org/about/awardinfo.html**. Nomination materials can be obtained by e-mailing Terry Osner at **tosner@neha.org**.

Holiday Environmental Health and Safety Tips

Another year is coming to an end and the month of December offers us the joys of gathering with family, friends, and colleagues to celebrate the various holidays and ring in the New Year. The *Journal* staff has compiled a few tips related to environmental health, safety, preparedness, and sustainability to keep you and yours healthy and safe during the holiday season.

NEHA wishes everyone a safe and healthy holiday season and a happy New Year!

Weather Safety Preparedness

Preparation is the key to dealing with winter weather, according the Federal Emergency Management Agency (FEMA). FEMA recently issued a news release on how to prepare for winter storms and cold weather.

Emergency supply kits: A kit for both home and in the car will prepare you for winter power outages and icy/impassible roads. For winter weather, add the following items: rock salt, sand or cat litter, snow shovels and other snow removal equipment, and adequate clothing and blankets. A complete list of kits for both home and in the car can be found at www.ready.gov/winter-weather.

Travel smart: Contact someone both before your departure and when you safely arrive. Travel with your cell phone and ensure the battery is charged. Keep a cell phone charger in your car. Watch weather reports and delay travel if bad weather is forecasted.

Understand winter storm terms: Familiarize yourself with terms used to identify a winter storm hazard and discuss with your family what to do if a winter storm watch or warning is issued. These terms include the following:

- *Freezing rain* creates a coating of ice on roads and walkways.
- *Sleet* is rain that turns into ice pellets before reaching the ground.
- *Winter weather advisory* means cold, ice, and snow are expected.
- *Winter storm watch* means severe weather such as heavy snow or ice is possible in the next day or two.
- *Winter storm warning* means severe winter conditions have begun or will begin very soon.

More information and winter preparedness tips can be found at www.ready.gov/winter-weather or www.nws.noaa.gov/om/winter/.

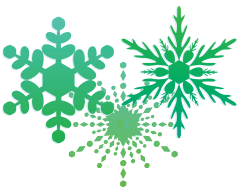
Children's Health

Parents should be aware of potential lead hazards associated with some holiday toys and jewelry. According to the U.S. Consumer Protection Agency, with a few limited exceptions, all children's products manufactured after August 14, 2011, must not contain more than 100 parts per million (ppm) of total lead content in accessible parts. The Centers for Disease Control and Prevention provide some important facts to keep your little ones safe this holiday season at www.cdc.gov/features/leadintoys/.

Food Safety

The holiday season offers us many culinary delights and events including office parties, cocktail parties, and family dinners. We want you to enjoy all the goodies the season has to offer without the agony of suffering from a foodborne illness. FoodSafety.gov offers information to help keep your food safe during the holiday season at www.foodsafety.gov/keep/events/holidays/, and here are a few holiday food safety tips.

- Refrigerate leftover and takeout foods within two hours.
- Allow enough time to properly thaw food. A 20-pound turkey needs four to five days to completely thaw in the refrigerator.
- Always use proper hand-washing techniques (warm water and soap for 20 seconds) before and after handling food.
- Avoid cross contamination. Do not rinse raw meat or chicken before cooking. Designate separate cutting boards for raw and cooked.
- For recipes that call for raw eggs such as eggnog and frostings, use pasteurized shell eggs, liquid or frozen pasteurized egg products, or powdered egg whites.
- Don't lick the spoon! Avoid eating uncooked cookie dough.
- Use a food thermometer to make sure meat, poultry, and fish are cooked to a safe internal temperature. For example, turkey is safe when the temperature reaches 165°F.



Sustainability

Bing Crosby crooned about having a white Christmas … get with the times and consider having a green one instead! Eartheasy.com (http://eartheasy.com/give_sustainchristmas.htm) offers these few simple tips to help make the holiday season more sustainable.

- Buy less.
- Buy smart—local products, products made from recycled materials, naturally powered toys, etc.
- Lower the impact of holiday lighting—reduce the number, use LED lights, put your holiday lighting on timers.
- Choose a live tree—live potted trees can be used for years, and many communities offer chip/mulch services for trees.
- Use homemade cards.
- Use alternatives to wrapping paper—avoid glossy foil or metallic paper, look for wrapping paper made from recycled materials, and reuse wrapping paper and ribbons.
- Reuse and recycle wrapping paper and ribbons, trees, bubble wrap, boxes, and old electronics.

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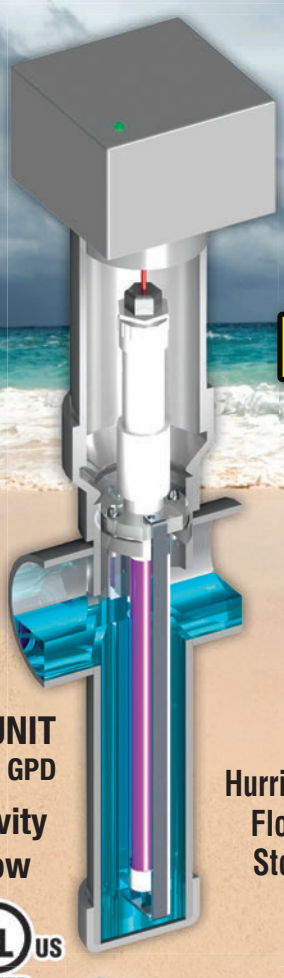

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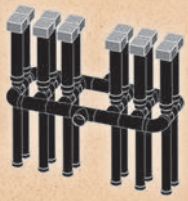

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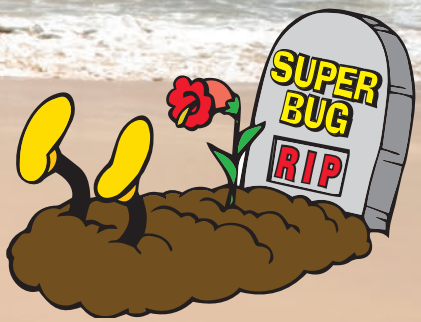

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