

# What's in Your Water?

## Development and Evaluation of the Virginia Household Water Quality Program and Virginia Master Well Owner Network

**Brian Benham**

**Erin Ling**

**Peter Ziegler**

**Leigh Anne Krometis**

*Virginia Tech*

*Approximately one-fifth of Virginians (about 1.7 million people) rely on private water supplies (e.g., wells, springs, cisterns) for their household water. Unlike public water systems, the Environmental Protection Agency (EPA) does not regulate private systems. As a result, private water system owners are solely responsible for system maintenance and water quality but are often unaware of common issues and lack access to objective information. We report on the development and evaluation of the Virginia Household Water Quality Program (VAHWQP), an ongoing Virginia Cooperative Extension (VCE) program that provides affordable water testing and education about private water supply system maintenance and groundwater protection. A companion capacity-building program, the Virginia Master Well Owner Network (VAMWON), provides training to volunteers, agency collaborators, and VCE agents who support the goals and objectives of the VAHWQP by conducting VAHWQP drinking water clinics and other outreach efforts. Program assessment findings indicate that VAHWQP drinking water clinic participants regard this programming favorably and are taking recommended actions. We discuss the program assessment framework and continued efforts to improve these programs to achieve long-term behavioral changes regarding water testing and system maintenance, which will yield safer private water supplies and improved environmental stewardship.*

**Keywords:** Cooperative Extension, outreach, volunteer, assessment, evaluation, groundwater, water quality, well water, domestic water supply, private water supply

### **Introduction**

In 2005, the United States Geological Survey (USGS) estimated that approximately 3 out of 10 Virginians (2.2 million) depend on groundwater for their domestic water supply; 1.7 million of

---

Direct correspondence to Brian Benham at [benham@vt.edu](mailto:benham@vt.edu)

these use private water supplies, such as wells, springs, and cisterns (Kenny et al., 2009). The majority of households in 60 of Virginia's 95 counties rely on private water supplies. During 2013-2014 the Virginia Department of Health issued permits for 14,791 wells (Lance Gregory, personal communication, April 19, 2015). The heaviest reliance on private water supply systems is outside urban centers in rural areas, where new growth occurs beyond the availability of public water or sewer lines.

Of the homes in Virginia using private water supply systems, the vast majority also use septic systems—a combination that can result in water quality problems unless both the water supply and septic systems are properly designed, constructed, and maintained (U.S. Environmental Protection Agency [EPA], 2015a; 2015b). Thirty-one percent of Virginia's private water supply users report they live on lots of 0.4 hectare or less, which may make the proper siting of water supply and wastewater disposal systems difficult. Thirty-five percent of those with wells use fuel oil as their heat source, presenting another potential threat to the groundwater supply (Groundwater Protection Steering Committee [GWPSC], 2014). A clean, reliable water supply is essential to the maintenance of property values. Eighty-three percent of families using a private water supply system own their homes, and more than half have a mortgage (GWPSC, 2014). Poorly-constructed or maintained private wells have the potential to become direct conduits for groundwater contamination. Groundwater is a shared resource, and contamination can affect both private and public water supplies.

Ensuring safe drinking water is a particular challenge in rural areas. Unlike households served by public water systems, homeowners using a private water supply are responsible for all aspects of their water system management, including routine maintenance, regular water testing (monitoring), interpretation of test results, and addressing water quality or quantity problems. Lack of knowledge about private water supply management and water quality issues may lead to system neglect and the absence of regular water testing, which may render occupants of these households more vulnerable to exposure to waterborne contaminants. According to Craun et al. (2010) in their examination of reported drinking water disease outbreaks from 1971 to 2006 in the U.S., the number of outbreaks associated with public water supplies decreased considerably after 1980. However, the annual proportion of drinking water outbreaks associated with individual, or private, water systems increased during the same period.

To increase the awareness about household water quality issues and the inherent care and maintenance responsibility that those who rely on private water supply systems bear, the Virginia Household Water Quality Program (VAHWQP) was created in 1991. The VAHWQP is a Virginia Cooperative Extension (VCE) effort that is organized and operated by faculty in the Biological Systems Engineering (BSE) department at Virginia Tech. The VAHWQP began with a pilot drinking water clinic program in Warren County, Virginia (Ross et al., 1991). The purpose of the clinic was to inform participants about the quality of their household water and to

increase their understanding about how to care for and maintain private water supply systems. Since its inception, the VAHWQP has sought to build participant awareness by providing affordable, confidential water quality analysis, interpretation of those water quality test results, recommendations about system care and maintenance, and guidance in dealing with water quality problems, should they exist. The VAHWQP clinics focus solely on those Virginians reliant on private water supplies. Clinics involve extensive collaboration between on-campus BSE Cooperative Extension specialists and county-based Extension agents. Through several iterations of the VAHWQP program, clinics have been held in nearly all Virginia counties.

The Virginia Master Well Owner Network (VAMWON) was created in 2007 as a bolstering, capacity-building program to support the VAHWQP. VAMWON provides training to Extension agents, agency collaborators, and volunteers who assist in accomplishing the VAHWQP goals, shifting it from a program almost completely reliant on a campus-based Extension specialist to a diffuse network of local individuals who are able to effectively deliver VAHWQP drinking water clinics and other outreach programming focused on private water supplies across the state.

### **Drinking Water Clinics: Process and Delivery**

The number of VAHWQP drinking water clinics conducted each year has varied. Since 2008, the number of clinics conducted annually has increased from 12 to about 45, with some clinics serving multiple counties. This increase is due in part to improvements in the clinic process (i.e., increased efficiency and staffing) and in part to the development of a group of trained and motivated VAMWON members, including volunteers, Extension agents, and agency collaborators. County Extension agents work with the VAHWQP coordinator to schedule clinics. The coordinator (a BSE Extension faculty member) provides resources to guide and assist the agent through the clinic delivery process, including a timeline; summary of frequently asked questions about the process of conducting a clinic; and templates for creating advertising fliers, press releases, and radio announcements (<http://www.wellwater.bse.vt.edu/>).

The drinking water clinic begins with advertising about 8-12 weeks prior to the clinic through local media outlets. Clinics are open to all residents who rely on a private water supply, and pre-registration is encouraged. Clinics are operated on a cost-recovery basis. The cost of participation has varied depending on laboratory operating costs and whether or not local financial support was secured to subsidize the cost of analysis (e.g., from county boards of supervisors, small local grants, or private organizations). In 2015, the cost for one sample kit, which includes testing for 14 parameters, was \$49. The process of delivering a VAHWQP drinking water clinic is outlined in Table 1.

**Table 1. VAHWQP Drinking Water Clinic Process**

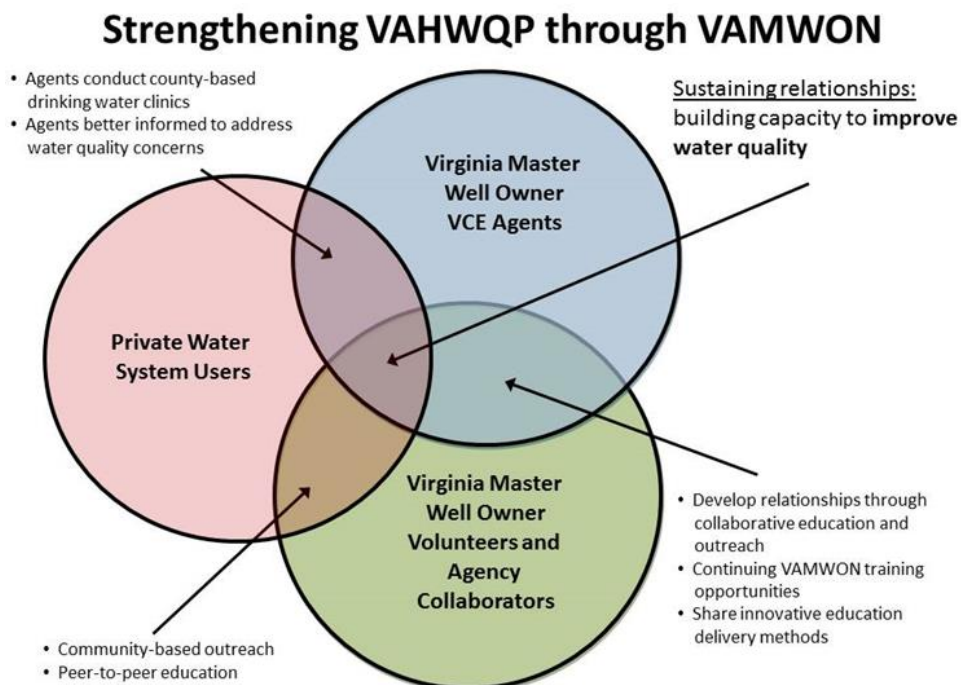
<b>Kickoff meeting</b>	An initial, brief evening meeting where homeowners receive basic information about the VAHWQP program, instructions for collecting a sample, and the opportunity to purchase sample test kits.
<b>Sample collection and transport</b>	After receiving their test kits, on a pre-determined morning, all homeowners collect samples and drop them off at a convenient location in the county. Samples are stored in coolers provided by VAHWQP. Participants also complete a short questionnaire enclosed in each sample kit that contains questions about water system characteristics, perceived water quality problems, and household demographic information. Sample transport back to campus is coordinated between the VAHWQP coordinator and the agent. On the morning when samples are collected, the agent meets a VAHWQP representative halfway, and the samples are transferred to the VAHWQP representative to complete the journey to the on-campus lab.
<b>Sample analysis and report preparation</b>	After arriving on campus, samples are analyzed for 14 parameters (total coliform bacteria, <i>Escherichia coli</i> bacteria, nitrate-nitrogen, sodium, iron, manganese, pH, copper, total dissolved solids [TDS], hardness, sulfate, lead, arsenic, and fluoride) using standard analytical procedures (Standard Methods for the Examination of Water & Wastewater, 2006). Sample analysis results and questionnaire data are entered into an Access database. The EPA (2015a) Safe Drinking Water Standards, which are enforced for public water systems, are used as guidelines for VAHWQP reporting. Water quality parameters out of range of the EPA (2015a) guidelines are identified on each sample analysis report. The reports are printed and sealed in envelopes with a sheet explaining each parameter tested, possible sources of contamination, health or nuisance effects, and suggestions for preventing contamination or water treatment, if needed.
<b>Interpretation meeting</b>	Three to four weeks after sample collection, an “interpretation meeting” is held in the county. At this meeting, participants receive their confidential water sample analysis results, and the coordinating Extension agent presents an approximately hour-long program that covers basic private water system care and maintenance and summarizes the sample data for the group, including chemistry and bacteriological analysis and sample questionnaire data. Additional information is provided concerning the most common water quality parameters out of range of the EPA (2015a) guidelines for that clinic. Potential sources of these contaminants, characteristics of water containing these contaminants, and possible health or aesthetic effects are covered, as well as general recommendations for addressing problems. Drinking water clinic participants often ask questions and generate discussion about the results, many of which are common issues or concerns in the group. An “intent to act” evaluation is administered at the close of each interpretation meeting which includes questions about actions participants plan to take (e.g., pursue additional testing, perform maintenance on their water system, pump out their septic system, install treatment devices). The agent conducting the clinic is also asked to evaluate the clinic process and provide feedback.

### **Building Program Capacity: Creating VAMWON**

From the initial clinic in 1991, until budget-driven retirements significantly limited program activity in 2003, VAHWQP drinking water clinics were delivered almost exclusively by an on-campus BSE Extension specialist, who traveled to about 12 counties per year to deliver clinic programming. This model, while effective, was inefficient. In addition to time and travel costs, one issue with on-campus faculty delivering each clinic was that it made the program dependent on an “external” expert for information—little lasting local capacity was developed to assist participants after the clinic or between clinics. With a 2007 USDA-Cooperative State Research, Education and Extension grant (USDA-CSREES Competitive Grant No. 2007-51130-03877), the VAHWQP was revitalized, and a new companion, capacity-building program, the Virginia Master Well Owner Network (VAMWON) was established. Based upon the successful Pennsylvania Master Well Owner (MWON) program (Clemens, Swistock, & Sharpe, 2007), the VAMWON sought to build upon the historical successes of VAHWQP, by offering more intensive educational programming designed to build local knowledge and capacity within communities across the state. With the support of the USDA grant funds, a part-time VAHWQP/VAMWON Program Coordinator was hired in 2008 to organize drinking water clinics and VAMWON trainings; establish new partnerships; design educational programming; support VAMWON agents, volunteers, and agency collaborators; and develop an evaluation framework to continuously improve and expand VAHWQP/VAMWON programming.

VAMWON training workshops are open to county Extension agents, screened volunteers, and “agency collaborators” (i.e., employees of state agencies engaged in water resources programming, such as Departments of Health and Environmental Quality and Soil and Water Conservation Districts). Once trained, VAMWON Extension agents collaborate with on-campus faculty, the program coordinator, and willing agency collaborators to conduct drinking water clinics (see Figure 1 on the next page). After completing the VAMWON training and taking leadership to conduct a VAHWQP drinking water clinic, the county-based agent gains confidence and is seen as a trusted information resource to local clientele who rely on private water supplies.

*Figure 1. Diagram Illustrating How the VAHWQP and VAMWON Programs Collaborate to Address Needs of Private Water Supply Users*



VAMWON volunteers may not own or operate a business associated with private water supplies, such as a well drilling or water treatment company. VAMWON volunteers are considered “occasional volunteers” in the VCE system, meaning that a background check is not required. Volunteers do receive VCE-sanctioned training on risk management and liability. VAMWON-trained volunteers educate others locally and assist nearby VAMWON-trained Extension agents in conducting drinking water clinics. Volunteers share their knowledge in a range of ways, including having informal conversations with friends and neighbors, operating a booth at a home show or county fair, giving presentations to local churches or civic groups, or writing a story for their local newspaper.

VAMWON agency collaborators are essential for helping spread the word about VAHWQP drinking water clinics and resources, as many of them receive questions from the public pertaining to private water system management, water testing, and troubleshooting. Agency collaborators are also essential in assisting Extension agents with clientele questions during and after a VAHWQP drinking clinic interpretation meeting. The VAMWON/VAHWQP has resulted in more frequent and useful agency/Extension collaboration to help solve private water supply problems.

County-based VAMWON agents are recruited across all VCE programming areas: Agriculture and Natural Resources (ANR), Family and Consumer Sciences (FCS), and 4-H (youth development). VAMWON volunteers and agency collaborators are recruited in a variety of ways, through VAMWON-trained agents, from other Cooperative Extension volunteer programs (e.g., Master Gardener), as well as by advertising on the program listserv and website (<http://www.wellwater.bse.vt.edu>) and on other Virginia environmental and health group listservs. Interested VAMWON applicants complete a brief online application, where they provide contact information, reasons for interest in the program, and experience with water-related education. VAMWON training involves a day-long (i.e., seven contact hours) workshop. Workshops are held at venues across the state. Typically there are 1 to 4 VAMWON training workshops per year, depending on demand. VAMWON volunteer workshops typically take place on a Saturday. The structure of the volunteer and agent VAMWON workshops is very similar; however, the volunteer workshops include a session on outreach methods where current VAMWON volunteers share their experiences. The agent workshop includes information about the mechanics and logistics of conducting VAHWQP drinking water clinics (see Table 1). VAMWON-trained agents are expected to conduct a VAHWQP drinking water clinic within a year of becoming VAMWON certified. Agency collaborators tend to attend training workshops for Extension agents rather than volunteers. This can help agency collaborators develop relationships with nearby Extension agents and assist with future collaboration on VAHWQP drinking water clinics. The following topics are covered in VAMWON training workshops:

- Groundwater hydrology and Virginia physiographic provinces;
- Water quality testing and interpretation;
- Land use impacts and wellhead protection;
- Private well regulations, location, and maintenance;
- Homeowner maintenance of private water supplies;
- Water treatment and addressing water problems;
- Household water conservation;
- Springs and cisterns;
- Tips and strategies for outreach (volunteers only); and
- Conducting a VAHWQP drinking water clinic (Extension agent and agency collaborator only).

Each VAMWON trainee (agent, volunteer, or agency collaborator) receives a set of resource materials that includes publications from various sources (e.g., Cooperative Extension, EPA, USGS) that provide more depth about the topics covered during a VAMWON workshop. The resource materials also include the PowerPoint files from each training presentation. Each VAMWON training features guest speakers from organizations and agencies with significant real-world expertise on selected topics covered during the VAMWON training (e.g., well drillers and water treatment specialists from the Virginia Water Well Association, groundwater

hydrologists from the USGS or Virginia Department of Environmental Quality). On-campus faculty and the VAHWQP program coordinator present the remaining topics. VAMWON trainees are introduced to a physical, table-top groundwater model. Use of this model helps participants visualize concepts related to groundwater hydrology, aquifers, well construction, and groundwater contamination. VAHWQP has positioned several table-top groundwater models across the state. Trained VAMWON agents can check out these models to aid them in local program delivery.

VAMWON trainees are reminded throughout the training that their role is to provide basic information and recommendations and to always refer more technical questions to the program coordinator, on-campus faculty, or other qualified professional. In addition to the technical information in the VAMWON training, succinct “take-home messages” are emphasized for each topic. These “take-home messages” are reinforced with VAHWQP promotional materials, such as “Ten Tips” tri-fold brochure. The “Ten Tips” brochure and other promotional materials are provided to VAMWON trainees at no charge and are available for download via the program website. In addition to sharing basic recommendations for private water system maintenance and routine water quality testing, the VAHWQP and VAMWON programs seek to help homeowners be informed consumers so that they are prepared to ask appropriate questions and make informed decisions about any water system-related service or equipment purchases (e.g., new well pump, pressure tank, water softener, filtration system).

After completing the VAMWON workshop, trainees are given a post-test that includes 25 multiple choice questions. To become a VAMWON volunteer, agency collaborator, or agent, one must score at least 80% on the post-test. Trainees are also asked to complete an evaluation form. Analysis of the VAMWON workshop evaluation data enables continued adjustment and improvement of the workshop and related resources. Contact information for VAMWON volunteers and Extension agents is made available through the program website.

### **VAHWQP/VAMWON Supporting Resources**

A number of resources have been developed to support the VAHWQP and VAMWON programs as they seek to inform Virginia residents reliant on private water supplies about the care and maintenance of their systems. These include:

- *The Virginia Household Water Quality Program Website*: Maintained by the program coordinator, this site (<http://www.wellwater.bse.vt.edu/index.php>) provides a portal to detailed program information, such as links to various publications and notifications of upcoming events.
- *Virginia Cooperative Extension household water quality publications*: A suite of 15 peer-reviewed Virginia Cooperative Extension publications that address a range of topics from how to shock chlorinate a well to water quality treatment basics. There are publications



that address in detail the risks associated with common water quality contaminants and recommended treatments to address the contaminant. Additional publications cover topics like emergency supplies of water for drinking and food preparation and water conservation.

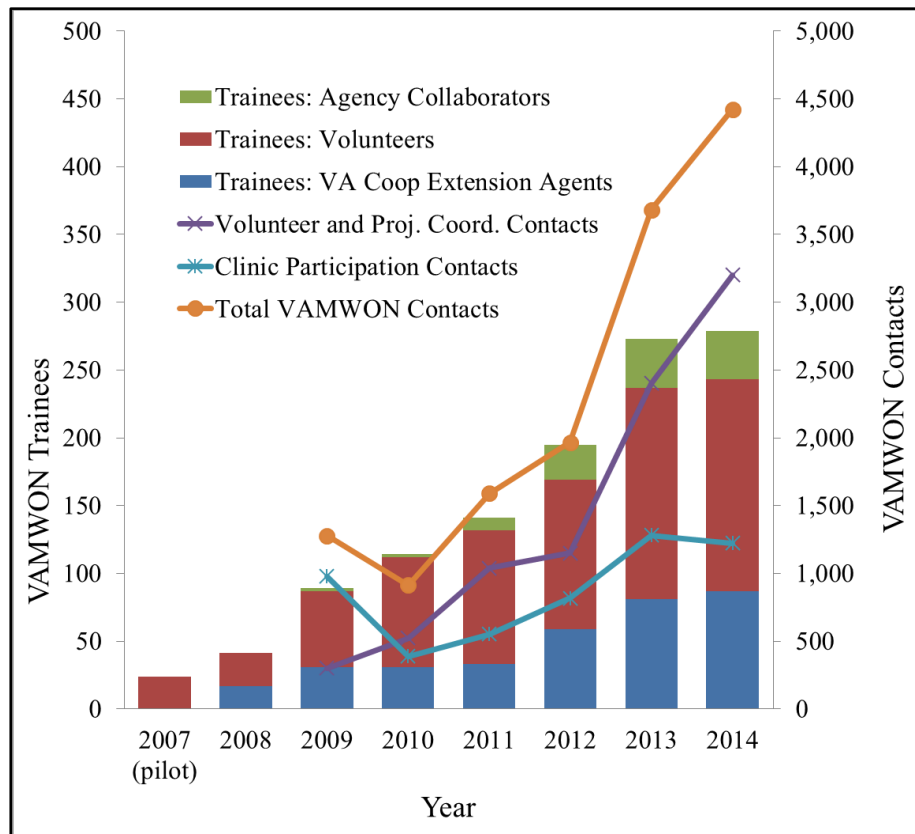
- *Drinking Water Clinic Summary Evaluation Reports*: Following each drinking water clinic, a summary of the water sample analysis and questionnaire results (i.e., water system characteristics, proximate sources of pollution, and perceptions of water quality) is made available via the program website. These reports are valuable to Extension agents and county officials as they provide useful reference material when addressing resident concerns.
- *3-D Table-top Groundwater Models*: As mentioned previously, these Envision™ (<http://www.envisionenviroed.net/>) groundwater models are used in VAMWON workshops to demonstrate groundwater hydrology concepts and land use impacts on water quality. The models may be checked out by VAMWON trainees.
- *Display Posters*: A “What’s in your Water?” poster was created to emphasize the VAHWQP “Ten Tips” discussed. Available for checkout by VAMWON trainees, this full-color, 3 ft by 4 ft laminated poster also describes VAMWON and VAHWQP programs in some detail.

### **VAMWON Impacts**

Since beginning in 2007 through March 2015, 19 VAMWON trainings have been held, educating 243 VAMWON trainees (see Figure 2 on the next page). One hundred and forty-six volunteers have become certified VAMWON volunteers; 76 are still actively involved. From 2009 through 2014, VAMWON trainees and the program coordinator combined have reported over 12,850 educational contacts. In addition to the volunteers, 105 VCE agents have completed the VAMWON training. Seventy-six of these agents were still employed with VCE as of December 2014. These agents are actively engaged in conducting VAHWQP drinking water clinics. VAMWON trainees also include 29 agency collaborators. The vast majority (94%) of those that have completed the VAMWON training have rated them as *Excellent* or *Very Good*, and report significant knowledge gains across all the topics covered in the training, particularly the more technical topics, such as groundwater hydrology, well construction, and water treatment. Participants also report having a good understanding of how the VAHWQP and VAMWON programs function. VAHWQP faculty have observed a pattern of VAMWON volunteers participating in the training, giving it high marks on the evaluation form, and doing well on the post-test. However, it appears that many volunteer participants do not end up staying involved and reporting volunteer contacts but use the information gained for the benefit of better managing their own private water supplies. After surveying volunteers in 2014, program staff are developing a homeowner well care and maintenance course that would be more in-depth than the information provided during the drinking water clinics but not have a volunteer requirement.

These trainings will be delivered online for maximum ease of participation and access to well owners across the state starting in 2016. The program coordinator and faculty believe this will address the volunteer turnover observed thus far.

**Figure 2. Virginia Master Well Owner Network Trainees and Associated Educational Contacts**



**VAMWON Volunteer, Agent, and Agency Collaborator Profile**

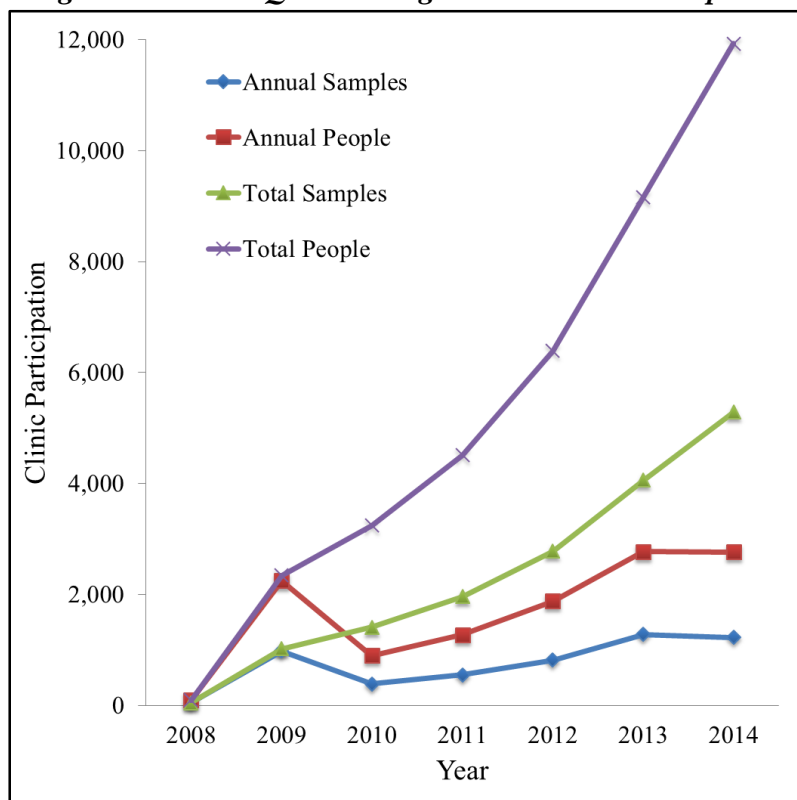
Twenty percent of VAMWON volunteers are retired; 34% have a professional background in engineering, science, geology, or water quality; 16% are teachers or outreach professionals; 6% are students; 6% are health/medical professionals; and 4% are realtors or home inspectors. VAMWON volunteers are slightly more likely to be female (54%) and average 52 years of age. Seventy-two percent report having some type of previous water quality educational experience, and 75% rely on a private water supply. VAMWON volunteers score an average of 95% on the training post-test. The program coordinator actively recruits both ANR and FCS educators to participate. Currently, 73% of VAMWON agents are ANR, 23% are FCS, and 4% are 4-H or other types of agents or assistants in Extension offices. Of the agency collaborators recruited for VAMWON thus far, about 80% are Virginia Department of Health employees (Environmental Health Specialists and Managers who administer the Virginia Private Well regulations), while

7% or less represent Soil and Water Conservation District, Department of Environmental Quality, or Department of Conservation and Recreation staff.

### VAHWQP Drinking Water Clinic Impacts

Since 1991, nearly 18,400 water samples have been collected and analyzed through the VAHWQP drinking water clinics. Between January 2008, when the most recent iteration of the VAHWQP began, and December 2014, there have been 99 drinking water clinics, serving 80 of Virginia's 95 counties, resulting in the analysis of approximately 5,200 samples. Based on demographic data collected with the sample kit questionnaires, these clinics have impacted some 12,000 Virginians (see Figure 3). The number of VAHWQP drinking water clinics conducted annually has increased fourfold since 2008. The eventual goal of the program is to conduct a VAHWQP drinking water clinic in every Virginia County every other year.

**Figure 3. VAHWQP Drinking Water Clinic Participation**



### Actions Taken by Clinic Participants

Of the VAHWQP drinking water clinic participants, about one-third completed and returned an “intent to act” survey that was distributed and collected at each VAHWQP interpretation meeting. These surveys indicated that following participation in a drinking water clinic, many

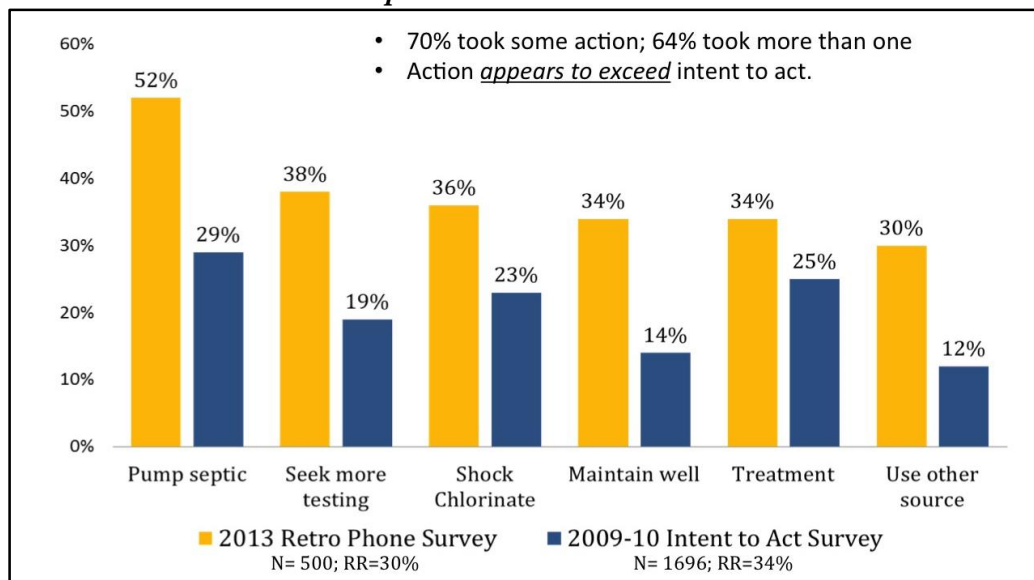
people planned to take some action to address issues with their private water supply system that were identified as a result of participating in the clinic. As a follow-up to these “intent to act” surveys, a retrospective phone survey was conducted in 2013 to ground-truth the “intent to act” data and gain a better understanding of actions drinking water clinic participants had actually taken. The follow-up phone survey work was partially supported through funding from USDA-NIFA Competitive Grant No. 2011-46100-31115.

Two groups of 250 participants were randomly selected from clinics conducted between 2008 and 2010. Group A consisted of well owners with test results that indicated no adverse findings. Group B were well owners with test results that indicated potential issues with either abnormal pH, the presence of *E. coli* bacteria, or both. Interviewers, blinded to the test results, asked six yes-no questions about possible actions recommended in interpretation meetings. Additionally, participants were asked three follow-up questions regarding their experience with the VAHWQP to further improve outreach.

Participants were contacted by phone during the evening hours between 5 and 8 pm EST over a period of several months during the summer and fall of 2013. Of the 500 participants contacted, 88 (18%) of calls were disconnected numbers, declined, or duplicate numbers; 264 (52%) were nonrespondents; and 148 (30%) completed surveys. Seventy-five percent of all respondents reported that they learned of upcoming clinics through VCE agents, either through direct Extension mailings (28%) or indirectly (47%) through newspaper advertisements placed by agents or articles written by the agent. Motivations for participation were overwhelmingly due to concerns about drinking water quality (69%). Overall satisfaction with the program was evaluated using a 4-point Likert scale with 1 = *Excellent*. The mean rating over the 148 surveyed participants was 1.3 (i.e., between *Excellent* and *Good*).

Of the completed surveys, 104 (70%) participants took some form of action following the clinic, and 64% took more than one form of action. The most common action taken was pumping the septic tank (52%), with each of the other actions taken by approximately 36% of participants (see Figure 4 on the next page). Forty-four (30%) of those that participated in the phone survey took no action. The most common reason given for taking no action was the perception that there were no problems with their private water supply system. The results of the retrospective phone survey indicated that VAHWQP drinking water clinic participants are taking more actions than they initially indicated, which is compelling.

**Figure 4. Retrospective Phone Survey Data and Post Drinking Water Clinic “Intent to Act” Responses: “Intent to Act” vs. Action Taken**



### Lessons Learned and Future Directions

Several important lessons may be gleaned from the VAHWQP/VAMWON programming experience to date:

- 1. Hire a dedicated program coordinator.** Having a dedicated program coordinator is key. The time and energy required to organize training workshops, develop resources, build relationships, seek additional funding, field questions generated from the website and other resources, and recruit and support a strong VAMWON volunteer, agency collaborator, and Extension agent network is significant. If at all possible, creating a mentoring relationship with an existing, similar, successful program is extremely beneficial. The VAMWON program benefited tremendously from the wisdom and experiences from those responsible for the Pennsylvania Master Well Owner Network and from the mentoring of the retired Virginia Tech Extension Specialist who originally initiated VAHWQP. Adapting materials from existing programs (with permission and appropriate citations) saves time and resources.
- 2. Methodically plan for impact assessment from the outset.** A logic model to expand VAHWQP and create VAMWON was created as part of the process of writing the 2007 USDA proposal that revitalized the VAHWQP and created the VAMWON. This provided a great roadmap for program development and assessment and has allowed us to continually look at our programs critically and adjust them to address challenges and meet new opportunities. For example, we know from our demographic data collected from drinking water clinic participants that we are primarily reaching

Caucasians older than 50 years with high levels of education and income, indicating we need to do a better job of engaging younger homeowners or renters, particularly young families. Ideas for how to reach this audience include offering clinics through schools, HeadStart or similar programs, and expanding our online advertising. We are also making efforts to collect additional qualitative data about our participants, as the ways in which our programs help people are most powerfully captured through their stories. Similarly, after noticing a decline in participation from VAMWON volunteers a year or so after completing the training, despite these participants doing well on their post-tests and evaluating the program highly, program faculty have decided to develop a homeowner training course to be offered online, which will cover topics included in VAMWON training but not have a volunteer requirement. Regarding the VAHWQP clinics, additional follow-up surveys will be conducted every few years to understand actions taken by homeowners who participate in drinking water clinics.

- 3. Developing mutually beneficial partnerships is critical for success.** Building capacity takes time. An important first step in building support for our program was to reach out to existing organizations and groups that have interest and expertise with private water supplies. We sought cooperation and support from the Virginia Department of Health, the agency responsible for permitting new well and septic systems and for closing abandoned wells. We also sought support from the Virginia Department of Environmental Quality, the state agency responsible for wellhead protection for public water supplies that rely on groundwater. While we have not received financial support from these state agencies, several staff members from each agency have become VAMWON agency collaborators, and now serve as invaluable references for help with questions and referrals. We also actively sought to work with the Virginia Water Well Association, a trade group whose membership includes well drillers and water treatment specialists throughout Virginia. This relationship has blossomed and now fosters shared programming, including a new initiative, *WellCheck*, kicked off in late 2014 (<http://www.wellwater.bse.vt.edu/wellcheck.php>). Through *WellCheck*, we seek to connect drinking water clinic participants with concerns about their wells to licensed well contractors for standardized, affordable, easy-to-understand well inspections. Building partnerships with these organizations has allowed our program to expand our pool of expertise available to VAHWQP drinking water clinic participants and VAMWON trainees and has lent additional credibility to the VAHWQP and VAMWON efforts. Our programs have also benefited from collaborations with existing VCE volunteer networks that have a similar focus and approach to nonformal education, primarily Master Gardeners and Master Naturalists. In many cases, mutual needs may be met through these collaborations, and working with experienced outreach volunteers who are well-connected and respected in their communities is a great way to get the word out about a new program.

- 4. Continue program development to engage new partners and resources.** We believe that our programs need to be continually evaluated and adjusted. We seek to build on our existing programs' successes in ways that can grow the scope of the program and produce additional impacts. Examples of this development include adapting our messages and resources to reach underserved audiences (e.g., translating publications into Spanish, ensuring that publications are written at an appropriate reading level). Plans include building in a youth component of programming to engage families through their children's experience in 4-H and expanding our relationship with well drillers across the state to provide additional technical support to clinic participants.

### Summary and Conclusions

The Virginia Household Water Quality Program (VAHWQP) and Virginia Master Well Owner Network (VAMWON) are two linked, capacity-building programs with the shared objective of improving the water quality and health of Virginians who rely on private water supplies. In 2008, using a 3-year grant from USDA, the VAHWQP was revived and the VAMWON was created. VAMWON-trained volunteers and VCE agents work with on-campus faculty to deliver county-based VAHWQP drinking water clinics. The capacity to deliver VAHWQP drinking water clinics has nearly quadrupled in 6 years with 44 clinics scheduled in 2015. The VAHWQP goal is to conduct a clinic in each of Virginia's 95 counties every other year. The VAHWQP clinics and supporting resources are having an impact. A retrospective phone survey of past clinic participants indicated that participants were actively executing VAHWQP-recommended actions to better care for their private water supply system. Both the VAHWQP and the VAMOWN are continually evaluated and modified. The plan is to expand the VAMWON training to additional curricula and to expand the programs to reach youth.

### References

- Clemens, S. S., Swistock, B. R., & Sharpe, W. E. (2007). The Master Well Owner Network: Volunteers educating Pennsylvania's well owners. *Journal of Extension*, 45(4), Article 4RIB7. Retrieved from <http://www.joe.org/joe/2007august/rb7.php>
- Craun, G. F., Brunkard, J. M., Yoder, J. S., Roberts, V. A., Carpenter, J., Wade, T., ... Roy, S. L. (2010). Causes of outbreaks associated with drinking water in the United States from 1971 to 2006. *Clinical Microbiology Reviews*, 23(3), 507–528. doi:10.1128/CMR.00077-09
- Groundwater Protection Steering Committee (GWPSC). (2014). *Groundwater protection steering committee*. Retrieved from <http://www.deq.virginia.gov/Programs/Water/WaterSupplyWaterQuantity/GroundwaterProtectionSteeringCommittee.aspx>

- Kenny, J. F., Barber, N. L., Hutson, S. S., Linsey, K. S., Lovelace, J. K., & Maupin, M. A. (2009). Estimated use of water in the United States in 2005. *U.S. Geological Survey, Circular 1344*. Retrieved from <http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf>
- Ross, B. B., Woodard, J. E., Dillaha, T. A., Orndorff, E. B., Hunnings, J. R., & Hanna, K. M. (1991). *Evaluating household water quality in Warren County, Virginia*. Virginia Agricultural Experiment Station Information Series 91-1. Blacksburg, VA: Virginia Polytechnic Institute and State University.
- Standard Methods for the Examination of Water & Wastewater. (2006). *Standard methods for the examination of water and wastewater*. Retrieved from <http://www.standardmethods.org/>
- U.S. Environmental Protection Agency (EPA). (2015a). *Drinking water contaminants – Standards and regulations*. Retrieved from <http://www.epa.gov/dwstandardsregulations>
- U.S. Environmental Protection Agency (EPA). (2015b). *Septic systems (Onsite/decentralized systems): Do your part, be septic smart!* Retrieved from <http://www.epa.gov/septic>

*Brian Benham* is a Professor and Extension Specialist in the Biological Systems Engineering Department at Virginia Tech, Blacksburg, VA.

*Erin Ling* is a Senior Extension Associate and VAHWQP/VAMWON Project Coordinator in the Biological Systems Engineering Department at Virginia Tech, Blacksburg, VA.

*Peter Ziegler* is a Research Assistant Professor in the College of Agriculture and Life Sciences at Virginia Tech, Blacksburg, VA.

*Leigh Anne Krometis* is an Assistant Professor in the Biological Systems Engineering Department at Virginia Tech, Blacksburg, VA.