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## Evaluation of Household Water Quality in Buckingham County, Virginia SEPTEMBER 2011 VIRGINIA HOUSEHOLD WATER QUALITY PROGRAM

### Background

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More than 1.7 million Virginia households use private water supplies such as wells, springs, and cisterns. The Virginia Household Water Quality Program (VAHWQP) began in 1989 with the purpose of improving the water quality of Virginians reliant on private water supplies. Since then drinking water clinics have been conducted in 86 counties across Virginia and samples analyzed from more than 14,500 households. In 2007, the Virginia Master Well Owner Network (VAMWON) was formed to support the VAHWQP. Virginia Cooperative Extension agents and volunteers participate in a 1 day VAMWON training workshop that covers private water system maintenance and protection, routine water testing, and water treatment basics. They are then able to educate others about their private water supplies. More information about these programs may be found at our website: [www.wellwater.bse.vt.edu](http://www.wellwater.bse.vt.edu).

Private water sources, such as wells and springs, are not regulated by the U.S. Environmental Protection Agency (EPA). Although private well construction regulations exist in Virginia, private water supply owners are responsible for maintaining their water systems, for monitoring water quality, and for taking appropriate steps to address problems should they arise. The EPA Safe Drinking Water Standards are good guidelines for assessing water quality. *Primary drinking water standards* apply to contaminants that can adversely affect health and are legally enforceable for public water systems. *Secondary drinking water standards* are non-regulatory guidelines for contaminants that may cause nuisance problems such as bad taste, foul odor, or staining. Testing water annually, and routinely inspecting and maintaining a water supply system will help keep water safe.

### Geology

Buckingham County lies in the *Piedmont* physiographic province, the largest in Virginia, extending west of the Fall Line to the Blue Ridge Mountains. The diversity of geology results in wide variations in groundwater quality and well yields. Groundwater use at many locations is limited. For example, a few areas have problems with high iron concentrations and low pH. Hard crystalline igneous and metamorphic formations dominate this region. A few areas contain sedimentary rocks. The size and number of fractures and faults, which store and transmit groundwater in the bedrock, decrease with depth, so the most significant water supplies are found within a few hundred feet of the surface. Large yields of water can be obtained where fracture and fault systems are extensive, as in the western Piedmont Province along the base of the Blue Ridge Mountains. Because of the range in groundwater quality and quantity in this region, as well as the varying potential for contamination, well site evaluation and well monitoring is very important. (GWPC, 2008).

### Overview

In September 2011, 18 residents from Buckingham County participated in a drinking water clinic sponsored by the local Virginia Cooperative Extension (VCE) offices and the Virginia Household Water Quality Program. Clinic participants received a confidential water sample analysis and attended educational meetings where they learned how to interpret their water test results and address potential issues. The most common household water quality issues identified as a result of the analyses for the participants were high levels of iron and manganese, low pH, and the presence of total coliform bacteria. *Figure 1*, found at the end of this report, shows these common water

quality issues along with basic information on standards, causes, and treatment options.

### **Drinking Water Clinic Process**

Any Buckingham County resident relying on a well, spring, or cistern was welcome to participate in the clinic. Advertising began 8 weeks prior to the first meeting and utilized local media outlets, announcements at other VCE meetings, and word of mouth. Pre-registration was encouraged.

**Kickoff meeting:** Participants were given a brief presentation that addressed common water quality issues in the area, an introduction to parameters included in the analysis, and instructions for collecting their sample. Sample kits with sampling instructions and a short questionnaire were distributed. The questionnaire was designed to collect information about characteristics of the water supply (e.g. age, depth, and location), the home (e.g. age, plumbing materials, existing water treatment), and any existing perceived water quality issues. The purpose of the clinic was to build awareness among private water supply users about protection, maintenance, and routine testing of their water supply.

Participants were instructed to drop off their samples and completed questionnaires at a predetermined location on a specific date and time.

**Sample collection:** Following collection at a central location, all samples were iced in coolers and promptly transported to Virginia Tech for analysis.

**Analysis:** Samples were analyzed for the following water quality parameters: iron, manganese, nitrate, chloride, fluoride, sulfate, pH, total dissolved solids (TDS), hardness, sodium, copper, total coliform bacteria, and *E. coli*. General water chemistry and bacteriological analyses were performed by the Department of Biological Systems Engineering Water Quality Laboratory at Virginia Tech. The Virginia Tech Soils Testing Laboratory performed the elemental constituent analyses. All water quality analyses were performed using standard analytical procedures.

The Environmental Protection Agency (EPA) Safe Drinking Water Standards, which are enforced for public water systems in the U.S., were used as guidelines for this program. Water quality parameters not within range of these guidelines were identified on each test report. Test reports were prepared and sealed in envelopes for confidential distribution to clinic participants.

**Interpretation meeting:** At the interpretation meeting, participants received their confidential water test reports, and VCE personnel made a presentation providing a general explanation of what the numbers on the reports indicated. In addition, general tips for maintenance and care of private water supply systems, routine water quality testing recommendations, and possible options for correcting water problems were discussed. Participants were encouraged to ask questions and discuss findings either with the rest of the group or one-on-one with VCE personnel after the meeting.

## **Findings and Results**

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### **Profile of Household Water Supplies**

The questionnaire responses, provided by all 18 participants at the clinic, helped to characterize the tested water supplies. One hundred percent of participants in the clinic indicated their water supply was a well.

Participants were asked to classify their housing location as one of four categories. The choices, ranging from low to high density development, are: (1) on a farm, (2) on a remote, rural lot, (3) in a rural community, and (4) in a housing subdivision.

For the Buckingham clinic, a farm and a rural lot were the most common household setting (33% each) followed by a rural community (22%).

Major sources of potential contamination near the home (within 100 feet of the well) were identified as an oil tank (17%) and a septic tank (6%). According to participants, larger, more significant potential pollutant sources were also proximate (within one-half mile) to water supplies. Fifty-six percent of respondents indicated that their water supply was located within one-half mile of a major farm animal operation while 28% indicated that their supply was within one half-mile of a field crop operation.

On the questionnaire, participants also described the type of material used for water distribution in each home. The two most common pipe materials were plastic (78%) and copper (22%).

To properly evaluate the quality of water supplies in relation to the sampling point, participants were asked if their water systems had water treatment devices currently installed, and if so, the type of device. Seventeen percent of participants reported at least one treatment

device installed. Six percent indicated having a sediment filter or carbon filter.

### **Participants' Perceptions of Household Water Quality**

Participants were asked whether they perceived their water supply to have any of the following characteristics: (1) corrosive to pipes or plumbing fixtures; (2) unpleasant taste; (3) objectionable odor; (4) unnatural color or appearance; (5) floating, suspended, or settled particles in the water; and (6) staining of plumbing fixtures, cooking appliances/utensils, or laundry.

Staining problems were reported by 50% of clinic participants. Rusty (22%) and blue-green (17%) were the most commonly reported stains. An objectionable odor was reported by 28% of clinic participants who cited a rotten egg smell in their water. Eleven percent reported unpleasant tastes, indicating a metallic taste. Twenty-two percent reported having particles in their water, the most common being *other* (11%). Finally, 17% reported an unnatural appearance in their water, observed as muddy.

### **Bacteriological Analysis**

Private water supply systems can become contaminated with potentially harmful bacteria and other microorganisms. Microbiological contamination of drinking water can cause short-term gastrointestinal disorders, such as cramps and diarrhea that may be mild to very severe. Other diseases that may be contracted from drinking contaminated water include viral hepatitis A, salmonella infections, dysentery, typhoid fever, and cholera.

Microbiological contamination of a water supply is typically detected with a test for total coliform bacteria. Coliform bacteria are present in the digestive systems of humans and animals and can be found in the soil and in decaying vegetation. While coliform bacteria do not cause disease, they are indicators of the possible presence of disease causing bacteria, so their presence in drinking water warrants additional testing.

Positive total coliform bacteria tests are often confirmed with a retest. If coliform bacteria are present in a water supply, possible pathways or sources include: (1) improper well location or inadequate construction or maintenance (e.g. well too close to septic, well not fitted with sanitary cap); (2) contamination of the household plumbing system (e.g. contaminated faucet, water heater); and (3) contamination of the groundwater itself (perhaps due to surface water/groundwater interaction).

The presence of total coliform bacteria in a water sample triggers testing for the presence of *E. coli* bacteria. If *E. coli* are present, it indicates that human or animal waste is entering the water supply.

Of the 18 samples collected, 72% tested positive (present) for total coliform bacteria. Subsequent *E. coli* analyses for all of these samples showed that 6% of the samples tested positive for *E. coli* bacteria.

Program participants whose water tested positive (present) for total coliform bacteria were encouraged to retest their water to rule out possible cross contamination, and were given information regarding emergency disinfection, well improvements, and septic system maintenance. Any participant with a sample that tested positive for *E. coli*, was encouraged to take more immediate action, such as boiling water or using another source of water known to be safe until the source of contamination could be addressed and the water supply system disinfected. After taking initial corrective measures, participants were advised to have their water retested for total coliform, followed by testing for *E. coli*, if warranted. In addition, participants were provided with resources that discussed continuous disinfection treatment options.

*Table 1*, found at the end of this report, shows the general water chemistry and bacteriological analysis contaminant levels for the Buckingham drinking water clinic participants.

### **Chemical Analysis**

As mentioned previously, all samples were tested for the following parameters: iron, manganese, nitrate, chloride, fluoride, sulfate, pH, total dissolved solids (TDS), hardness, sodium, and copper. Selected parameters of particular interest for the Buckingham drinking water clinic samples are discussed below.

#### **pH**

pH is a measure of the acidity or alkalinity of a substance. The EPA suggests the pH for public drinking water be between 6.5 and 8.5. Of the 18 Buckingham County clinic samples, 83% were below the recommended pH of 6.5, indicating acidic water. Although not a health concern in itself, acidic water may be corrosive and can potentially leach metals like copper and lead from plumbing components. An option for dealing with low pH water is to install an acid neutralizing filter, which raises pH by passing

the water through a medium of calcite and/or magnesium oxide.

If the age of a home or the plumbing materials present in a home pointed to potential health problems associated with metals leaching into water, participants were encouraged to pursue lead testing, which is not currently available through the VAHWQP.

### **Iron**

Iron in water is considered a nuisance and does not usually present a health concern. The EPA recommended secondary maximum contaminant level for iron is 0.3 mg/L. Excessive iron can cause brown-orange stains on plumbing fixtures, and laundry, and may produce a bitter, metallic taste.

Twenty-two percent of Buckingham clinic samples had iron concentrations exceeding 0.3 mg/L. Depending on whether the iron is in solution (dissolved) or in particulate form, treatment options for excessive iron include a water softener, aeration and filtration, ozonation, and distillation.

### **Manganese**

Manganese is a nuisance contaminant and does not present a health risk. The EPA recommended secondary maximum contaminant level is 0.05 mg/L. Excessive manganese concentrations may give water a bitter taste and can produce black stains on laundry, cooking utensils, and plumbing fixtures.

Seventeen percent of clinic samples tested above 0.05mg/L. Treatment options for manganese include a water softener, reverse osmosis, or distillation.

### **Conclusions**

Participants were asked to complete a program evaluation survey following the interpretation meeting. Sixty percent of respondents said they would work to determine the source of pollution, 50% plan to seek additional testing, 30% will take steps to maintain their well, and 60% report that they will shock chlorinate their water systems.

### **References**

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### **Additional Resources**

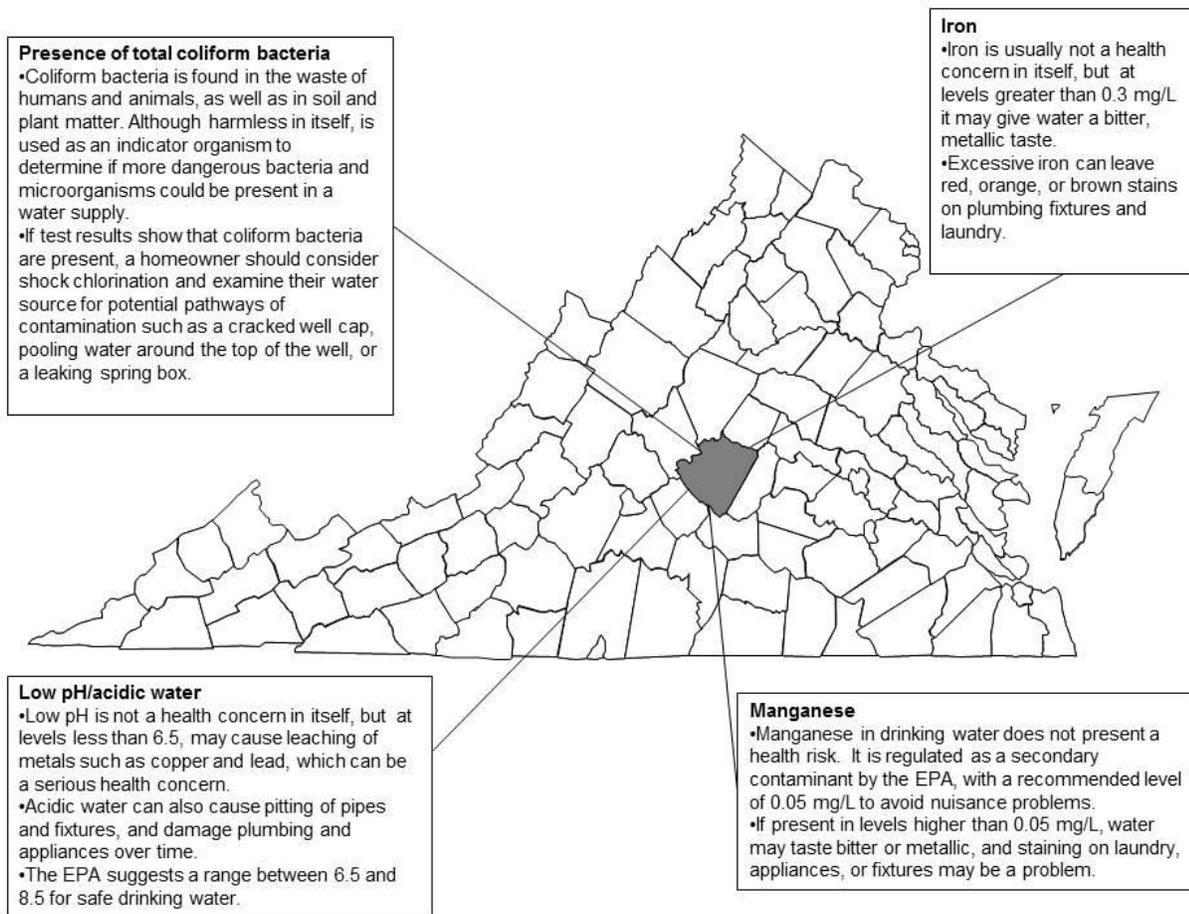
For more information about the water quality problems described in this document, please refer to our website. Here you will find resources for household water testing and interpretation, water quality problems, and solutions:  
[www.wellwater.bse.vt.edu/resources.php](http://www.wellwater.bse.vt.edu/resources.php)

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**Figure 1.** The most common household water quality issues found in the 18 Buckingham clinic participant samples were high levels of iron and manganese, low pH, and the presence of total coliform bacteria.

**2011 Buckingham County  
VAHWQP Drinking Water Clinic Results  
N = 18 samples**

| Test                    | EPA Standard | Average | Maximum Value            | % Exceeding Standard    |
|-------------------------|--------------|---------|--------------------------|-------------------------|
| Iron (mg/L)             | 0.3          | 1.359   | 18.440                   | 22.2                    |
| Manganese (mg/L)        | 0.05         | 0.043   | 0.366                    | 16.7                    |
| Hardness (mg/L)         | 180          | 59.7    | 173.0                    | 0                       |
| Sulfate (mg/L)          | 250          | 3.7     | 15.2                     | 0                       |
| Chloride (mg/L)         | 250          | 6       | 23                       | 0                       |
| Fluoride (mg/L)         | 2.0/4.0      | 0.11    | 0.22                     | 0                       |
| Total Dissolved Solids  | 500          | 124     | 342                      | 0                       |
| pH                      | 6.5 to 8.5   | 6.06    | 5.42 (min)<br>7.32 (max) | 83.3 (<6.5)<br>0 (>8.5) |
| Copper (mg/L)           | 1.0/1.3      | 0.060   | 0.324                    | 0                       |
| Sodium (mg/L)           | 20           | 6.41    | 12.20                    | 0                       |
| Nitrate - N (mg/L)      | 10           | 0.669   | 3.640                    | 0                       |
| Total Coliform Bacteria | ABSENT       | --      | --                       | 72.2                    |
| E. coli Bacteria        | ABSENT       | --      | --                       | 5.6                     |

**Table 1.** General water chemistry and bacteriological analysis contaminant levels for Buckingham drinking water clinic participants (N=18). This program uses the EPA primary and secondary standards of the Safe Drinking Water Act, which are enforced for public systems, as guidelines for private water supplies.