Evaluation of Household Water Quality in Bland and Giles Counties, Virginia

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EVALUATION OF HOUSEHOLD WATER QUALITY IN BLAND AND GILES COUNTIES, VIRGINIA

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ABSTRACT

During Spring 1999 in Bland and Giles Counties, Virginia, programs of household water quality education, which included water sampling, testing, and diagnosis, were conducted. Participation in the water quality programs was made available to any resident of these two counties who utilized a private, individual water supply. During the course of the projects, 153 households submitted water samples which were analyzed for iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index, copper, sodium, nitrate, and total coliform and E. coli bacteria. These analyses identified the major household water quality problems in these two counties as iron/manganese, hardness, and bacteria. Additionally, a number of samples were determined to have concentrations of sodium and nitrate high enough to possibly lead to health complications for at-risk segments of the population.

Following completion of the programs, a survey was mailed to the 153 participants. Seventy-two participants returned survey forms on which they identified their reason(s) for participating in such a program; the primary reason was concern about safety of their water supply. Returned survey forms also provided insight into measures participants had already taken, or planned to take, to improve the quality of their water supply. Nearly three-fifths of the households who reported having at least one water quality problem had taken, or planned to take, at least one measure to improve the quality of their water supply. Ten percent or more of all participants had, or planned to, take one or more of the following actions: shock chlorinate the water system, purchase or rent water treatment equipment, and contact a state agency for further assistance.

ACKNOWLEDGMENTS

Many thanks are due the residents of Bland and Giles Counties who participated in the educational program. Without their enthusiasm and cooperation, the program could not have succeeded. Special thanks are extended to local media, agency personnel, volunteers, and others who provided support in terms of publicity, encouragement, and interest, thus contributing to the success of the household water quality educational program. Personnel of the Virginia Department of Health, who spoke at the public meetings, are appreciated for their contributions. The Bland and Giles County Cooperative Extension secretaries, Kathryn Dunn and Dianne Rader, respectively, were instrumental in handling mailings, addressing phone requests for information, and assisting in preparation of sample kits.

The Southeast Rural Community Assistance Project, Inc. of Roanoke, Virginia provided funding to offset the cost of testing that was assessed to all participants. CSREES/USDA Water Quality Program Support 3-d funds were also made available for this program.

The Water Quality Laboratory of the Department of Biological Systems Engineering at Virginia Tech was responsible for the majority of the water quality analyses, as well as coordination among the various labs and for much of the data management. Julie Jordan, Laboratory Supervisor, and her staff are especially acknowledged for their efforts. Assisting with the general water chemistry analysis was the Soils Testing Laboratory of the Department of Crop and Soil Environmental Sciences at Virginia Tech.

Additional support from Virginia Tech should also be noted. Judy Poff, of the Virginia Water Resources Research Center, was instrumental in providing educational publications for participants at the public meetings. Joe Gray, of the Virginia Cooperative Extension Distribution Center, is appreciated for his assistance in preparing and mailing the evaluation survey packets to participants. Appreciation is due Diane Mahaffey for her efforts in preparing project forms and in typing this manuscript, and to Liz Epley for her assistance in data management. In addition, Bev Brinlee and Tim FisherPoff are acknowledged for their editorial and design contributions.

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INTRODUCTION

The water supply and wastewater disposal requirements of the vast majority of rural homes and farms throughout Virginia are met by individual water supply and wastewater disposal systems. In Bland and Giles Counties, for example, the majority of housing units (56%) are served by individual water systems (Koebel et al., 1993). Virtually all of these homes depend on groundwater sources.

Throughout these two counties, most wells were drilled only for farm or domestic water supply. George and Gray (1988) have estimated that more than half of the drilled wells are inadequately constructed, while nearly all dug/bored wells are inadequate. Six percent of households were also estimated to have failing or inadequate waste disposal systems.

Bland and Giles Counties have a combined land area of 717 square miles. Both counties are in Southwest Virginia, border West Virginia, and lie predominantly within the Valley and Ridge physiographic province. Most of the surface drainage of both counties is contained within the New River Watershed. A small portion of northeastern Giles County drains into the James River Watershed. Similarly, the southwesternmost part of Bland County contributes to the Holston/Tennessee River Watershed.

The population of the two-county area decreased by more than 5% during the period 1980-90. Despite this population decline, the total number of housing units increased by 11%, and many new homesites are rural-based without public water and sewage services. As rural home sites encroach on agricultural land, the water supply becomes suspect to residents. Of equal importance is the potential failure of septic systems, since many home sites are on land less than ideal for a properly functioning septic system.

In addressing similar concerns, Ross et al. (1991) initiated a pilot program of household water quality education in Warren County, Virginia, which included water sampling, testing, and diagnosis. Based on requests and support from local interests, subsequent programs have been conducted in 53 additional counties. During the course of these projects, more than 8000 households submitted water samples through local Virginia Cooperative Extension Offices to be analyzed for the following: iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index, copper, sodium, nitrate, and total coliform and fecal coliform/E. coli bacteria.

Major household water quality problems identified, as a result of these previous analyses, were determined to be iron/manganese, hardness, fluoride, and total dissolved solids, and because of their potential health significance, corrosivity, bacteria, and to a lesser extent, sodium and nitrate, although the occurrence and extent of these problems varied across counties. In most county programs, a limited number of additional samples from "high-risk" households were tested for over two dozen pesticides and other chemical compounds. Most of these compounds have been detected in measurable quantities in one or more samples, with several values exceeding a corresponding U.S. Environmental Protection Agency Health Advisory Level (HAL) or Maximum Contaminant Level (MCL). It was the need to assess the current state of rural household water supplies in Bland and Giles Counties, in addressing the above water quality issues, that led to the implementation of the Household Water Quality Education Program in both counties.

OBJECTIVES

The primary goal of this project was to conduct educational programs on household water quality to include water testing/diagnosis in Bland and Giles Counties. The general program objectives were to: (1) improve the quality of life of rural homeowners by increasing awareness and understanding of water quality problems, protection strategies, and treatment alternatives; and (2) create a groundwater quality data inventory to assist local governments in land use and groundwater management planning.

METHODS

Household water quality educational programs were offered through the local Virginia Cooperative Extension Offices in Bland and Giles Counties during Spring 1999. Any household resident of these counties who utilized a private, individual water supply was eligible to participate. The programs were patterned after the model developed under the pilot educational program completed in 1989 in Warren County (Ross et al., 1991). Local news media and agency newsletters publicized the program in each county, and program fact sheets were prepared (see Appendix).

The programs were launched through local meetings held in Bland County (Bland and Rocky Gap) and Giles County (Narrows and Newport) in mid-late March. Attendees of these initial meetings were presented with information on local hydrogeologic characteristics in relation to groundwater pollution, likely sources of, and activities contributing to, groundwater contamination, the nature of household water quality problems (both nuisance and health-related), and specifics of the water testing program to follow. At these meetings, individuals were invited to sign up to participate in the testing program at a basic cost of $20 per household water sample submitted.

Provisions were made to analyze up to 150 household water samples per county. Water sampling kits, for use by the participants themselves, were made available at the meetings and at the county Cooperative Extension offices after the meetings for late registrants. Two types of water sampling kits were distributed: (1) general water chemistry analysis for iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index (Langlier), copper, sodium, and nitrate; and (2) bacteriological analysis (total coliform and E. coli).

The sampling kits included a 250 ml plastic bottle for general water chemistry samples and a sample identification form (see Appendix). The form included sampling instructions and a questionnaire on which participants were asked to describe the characteristics of their water supply. Also included in the kits was a 125 ml sterilized plastic bottle for bacteriological samples. Instructions called for sampling from a drinking water tap and for flushing water systems prior to sampling to minimize contaminants contributed by the plumbing system. Persons who already had a water treatment device, such as a water softener, were requested to provide information about the type of equipment so that effective evaluation of their water quality and proper interpretation of results could be obtained, as further explained below.

Water samples were collected on March 22 (Giles) and 30 (Bland), and April 7 (Giles) at various locations in the two counties. At the close of each collection day, all samples were packed in ice and immediately delivered to Virginia Tech in Blacksburg for analysis.

The general water chemistry and bacteriological analysis was coordinated by the Department of Biological Systems Engineering Water Quality Laboratory at Virginia Tech. The Soils Testing Laboratory of the Department of Crop and Soil Environmental Sciences at Virginia Tech was subcontracted to analyze samples for several of the constituents. Water quality analyses were performed using standard analytical procedures (USEPA, 1979).

After the analysis had been completed for each county, participants were reminded by mail to attend subsequent meetings in either Bland, Rocky Gap, or Pearisburg (Giles County) to obtain and discuss the test results and management practices to reduce or prevent water contamination. Complete test results were ultimately mailed to those participants who could not attend any of the meetings. A sample report form and accompanying report interpretation are shown in the Appendix.

At the conclusion of the programs, an evaluation survey was mailed to participants (see Appendix). The objectives of the survey were to determine (1) the reasons for participation in the educational programs and for having household water tested, and (2) the actions to correct water quality problems the participants had taken, or planned to take, as a result of participation in the programs. Limited socio-economic information was also requested to obtain a profile of the total audience reached by the programs.

In addressing overall project objective 2, local government and public officials were kept apprised of water quality test results, during the course of the programs and at their completion. While the project was designed to involve voluntary participation, and quality control in sampling was not assured, the information gathered was nevertheless deemed useful for water quality assessment and planning at county and regional levels.

FINDINGS AND RESULTS

During the course of the projects, 153 individual household water samples were returned for general water chemistry and bacteriological analysis from all areas of the two counties. Two surveys were distributed to all water testing participants: One, the questionnaire with the water sampling kit, to be completed and returned by all participants with the sample submitted for analysis; and the other, an evaluation of the completed programs (see Appendix). For the latter, of the 153 forms mailed, 72 were returned (a 47% response rate). Both surveys provided insight into the characteristics of the households and their water supplies.

Profile of Participant Households

The average length of the respondents' residence in Bland or Giles Counties was 19 years. The length of residence reported ranged from 1 to 75 years. Twenty-five percent of those responding had lived in their present county for 5 years or less. The size of the respondents' households ranged from one to seven members; average household size was 2.52. It can, therefore, be estimated that nearly 400 residents of the two counties were directly impacted by the water analysis/diagnosis aspect of the programs.

Nearly one-half (44%) of the respondents were college graduates and 89% had at least a complete high school education (see Figure 1); facts that are not surprising, since it is likely that such individuals would have a greater awareness and understanding of water quality issues and be more likely to participate in such a program.

Participation in the program was on the high end of income distribution. Figure 2, which shows the family income (before taxes) of the respondents, indicates that a likely majority of the respondents exceeded the median family income ($29,232 averaged for the two counties and according to the 1990 Census) (Koebel et al., 1993). Eight percent of respondents declined to indicate family income.

Profile of Household Water Supplies

The initial survey answers, provided by all 153 participants in the water testing programs, helped to characterize their water supplies (see Appendix). One set of questions dealt with the proximity of the household water supply to potential sources of groundwater contamination. One such question sought to define housing density, which may have an impact primarily from the standpoint of contamination from septic systems and related water quality problems. Participants were asked to classify their household environs as one of the following four categories, ranging from low to high density: (1) on a farm, (2) on a remote, rural lot, (3) in a rural community, and (4) in a housing subdivision. As shown in Figure 3, farm and rural community were the most common at 36%, while subdivision (4%) was the least common.

Participants were also asked to identify potential contamination sources within 100 feet of their water supply. The major sources identified were streams, septic system drainfields, and home heating oil storage tanks, noted by 13%, 12% and 10% of all households, respectively. Indications of proximity (within one-half mile) to larger activities which could potentially contribute to groundwater pollution were also sought. Agricultural activities were the most commonly identified; 20% of the participants indicated that their water supply was located within one-half mile of field crop production and 46% within one-half mile of a major farm animal operation.

Information was also obtained regarding characteristics of the participants' water supply systems. Regarding the type of water source supplying the household, 75% of the participants reported that they rely on a well, while the remaining 25% use a spring. Participants relying on a well were asked to provide an estimate of the well depth, if known. Of those participants indicating well depths, 98% reported depths of more than 50 feet, while only 2% reported less than or equal to 50 feet. The maximum well depth reported was 720 feet; the average well depth was 220 feet. Fourteen percent of the wells were constructed in or prior to 1970. The earliest reported well construction date was 1919.

Household water systems were further identified with respect to the type of material used in the piping network for water distribution throughout the dwellings. The most widely used material was plastic (43%), while copper was reported by 41% of the participants. Three percent of participants reported, "Don't know."

To properly evaluate the quality of water supplies in relation to the point of sampling, participants were asked if their household water systems had water treatment devices currently installed, and if so, the type of device. The results of the inquiry are presented in Figure 4. Thirty-five percent of the participants reported at least one treatment device installed, with the most common type of treatment device in use being a sediment filter (48%) followed closely by water softener (43%).

Figure 1. Educational Level Achieved by Participants

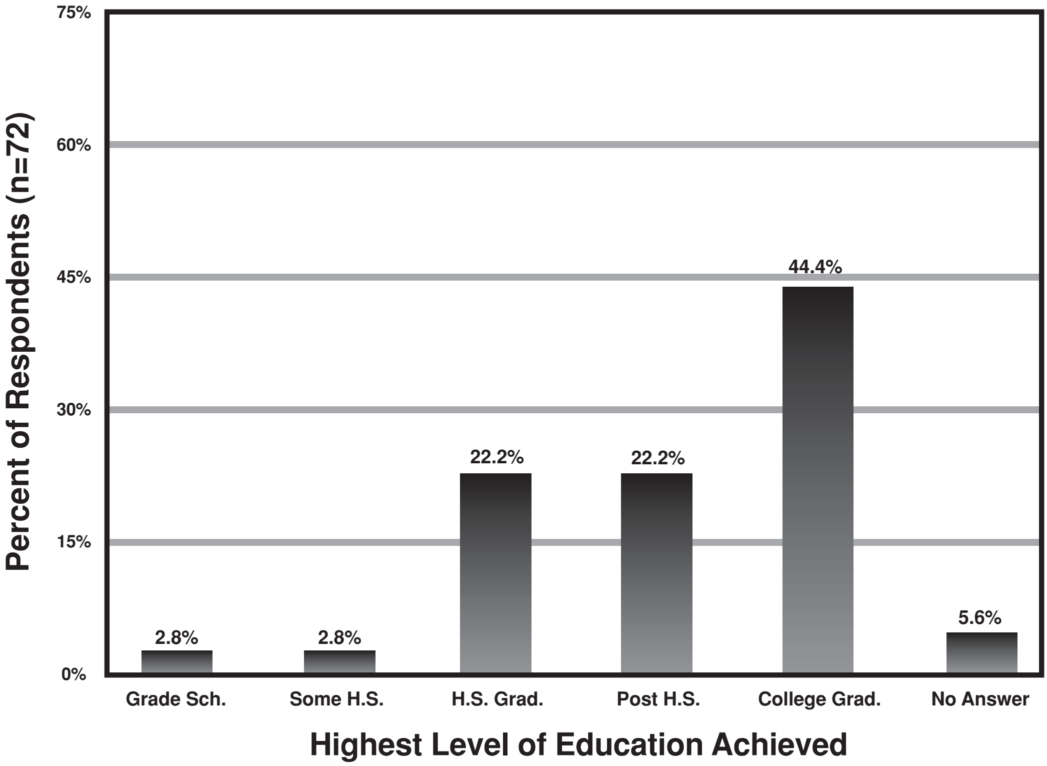


Figure 2. Family Income of Participants

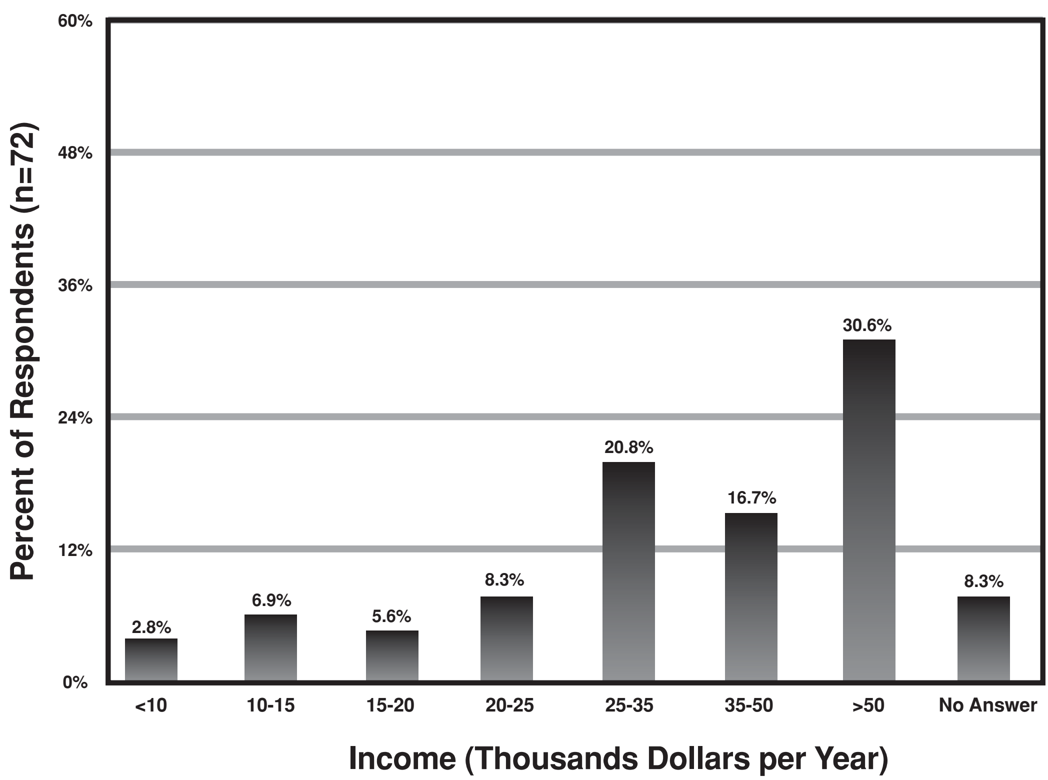
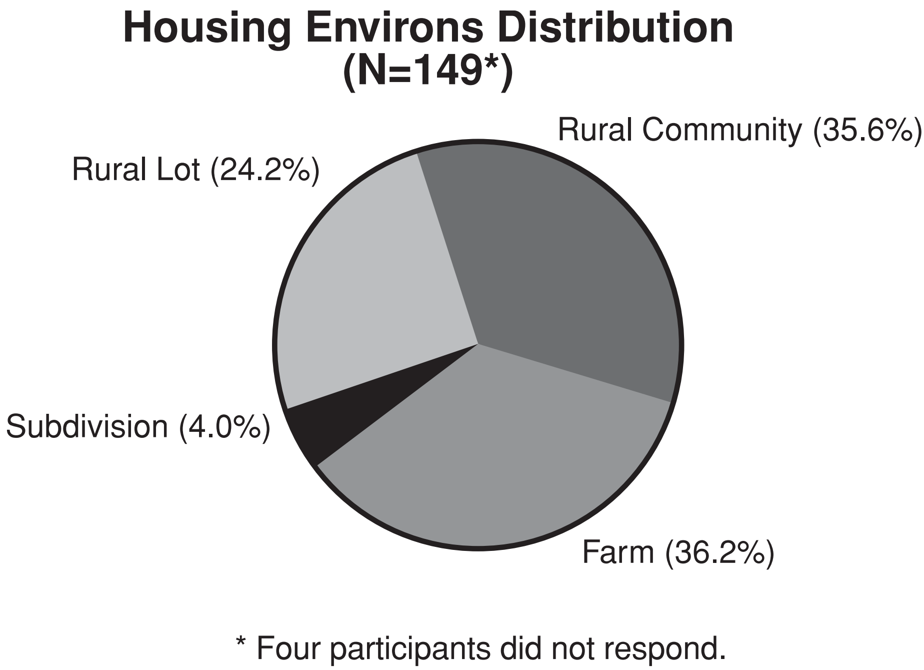


Figure 3. Housing Environs of Participants



Participants' Perceptions of Household Water Quality

Participants were also asked about problems they were experiencing in their household water systems (see Appendix). They were asked initially whether or not they experienced one or more of the following conditions: (1) corrosion of 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. With the exception of (1) above, with which 11% of the participants identified, participants were given several more specific descriptions from which to choose if answering positively.

Fourteen percent of the participants responded that their water had an unpleasant taste. For these participants, the identification of tastes is presented in Figure 5. “Sulfur” taste was the most common problem (48%), followed by “metallic”, identified by 38% of those who reported taste problems.

An objectionable odor was reported by 15% of the participants. Of these, the description of odors selected is shown in Figure 6. The most prevalent odor described was “rotten egg,” or sulfur, identified by 74% of those reporting odor problems.

Fourteen percent of the participants affirmed their water had an unnatural color or appearance. "Muddy" was identified by 43% of those who reported appearance problems (Figure 7), followed by both “milky” and “yellow” at 29%. Twenty-four percent offered their own descriptions by selecting “other” to include rusty.

A related question sought to identify the presence of solid particles in participants' water supplies. Twenty-four percent described such a condition; more than one-half of these (58%) reported that they noticed "white flakes" in their water (Figure 8). Fourteen percent indicated "other," indicating such a description as tiny twigs.

Staining problems on plumbing fixtures, cooking appliances/utensils, and/or laundry were reported by 37% of the participants. As presented in Figure 9, the major problem was that of "rusty" identified by 59% of those with staining problems, followed by "white/chalky" stains, reported by 36%.

Household Water Quality Analysis

Ultimately, two sample groups resulted: the "tap water" and "raw water" samples. The "tap water" group consisted of the 153 individual household water supplies analyzed to represent the actual water quality at the drinking water tap (including treated water). The "raw water" group consisted of samples from untreated systems only - a total of 99 samples.

The raw water sample results presented below may not be entirely indicative of the status of raw groundwater quality in Bland and Giles Counties. This may be particularly true for many of the nuisance contaminants for which treatment systems have been installed, since many of the already treated supplies likely represented the worst cases for specific contaminants correctable by treatment devices. Therefore, the inclusion of actual raw water (before treatment) analyses, if they had been available from those households with treatment devices installed, would likely have tended to worsen the overall assessment of raw water quality in the two counties.

General Water Chemistry Analysis

The tests included in the general water chemistry analysis are listed in Table 1, along with the detection limits, where appropriate, for each test as determined by laboratory equipment and testing procedure constraints. Also presented are the averages and ranges for each sample group defined for both counties combined. Table 2 provides, for both sample groups and each county, as well as both counties combined, the percentage of constituent values exceeding a given water quality standard or guideline. The results and importance of each test for both of the sample groups are individually discussed below.

Iron. Iron in water does not usually present a health risk. It can, however, be very objectionable if present in amounts greater than 0.3 mg/L. Excessive iron can leave brown-orange stains on plumbing fixtures and laundry. It may give water and/or beverages a bitter metallic taste and may also discolor beverages.

Overall, 7% of samples in both the tap water and raw water sample groups had iron concentrations exceeding the U.S. Environmental Protection Agency (EPA) Secondary Maximum Contaminant Level (SMCL) of 0.3 mg/L. It should be noted that the occurrence of excessive iron was substantially greater for Bland County as compared to Giles County (Table 2). The presence of iron was not surprising in view of the generally accepted notion that excessive iron is prevalent in rural water supplies throughout much of Virginia. Only 7% of the participants reported the installation of an iron removal filter, however, water softeners, which can remove small amounts of iron, as well as manganese, had been installed in 15% of the households. Despite the treatment equipment in place, the results of the sample questionnaire (see Appendix) revealed that 59% of the 56 who reported staining problems, or 22% of all participants, classified the color of those stains as "rusty" (red/orange/brown). Stains of this color on plumbing fixtures, cooking appliances/utensils, and/or laundry are usually attributed to excessive iron concentrations.

It should be noted that the SMCL for iron is likely based more on taste considerations than long-term staining tendencies, particularly on plumbing fixtures. It has been suggested that concentrations below 0.1 mg/L are preferred, when stain prevention is of concern. When a value of 0.1 mg/L was used as the threshold concentration, an additional 10% of samples in both the tap water and raw water sample groups of both counties combined exceeded this limit.

Manganese. Manganese does not present a health risk. However, if present in amounts greater than 0.05 mg/L, it may give water a bitter taste and produce black stains on laundry, cooking utensils, and plumbing fixtures.

The results of these analyses indicated that the extent of manganese problems in the two counties was slightly less than that of iron, with 6% of both the tap water and raw water samples exceeding the SMCL. It should be noted that none of these samples were from Giles County (Table 2). While manganese stains are generally dark and only 3% of all participants indicated "black" stains, the "particles in water" description of "black specks," reported by 3% of all participants, may also provide evidence of excessive manganese concentrations.

Hardness. Hardness is a measure of calcium and magnesium in water. Hard water does not present a health risk. However, it keeps soap from lathering, decreases the cleaning action of soaps and detergents, and leaves soap "scum" on plumbing fixtures, and scale deposits in water pipes and hot water heaters. Softening treatment is highly recommended for very hard water (above 180 mg/L). Water with a hardness of about 60 mg/L or less does not need softening.

Hardness is an additional "natural" parameter usually linked to karst terrain and limestone formations that are prevalent in this region of Virginia. As mentioned above, 15% of all participants had installed a water softener (Figure 4), and 36% of samples in the tap water and 43% of samples in the raw water groups exceeded the maximum recommended hardness level of 180 mg/L. Giles County appears to have substantially harder water than Bland County (Table 2), however, it should be noted more than three-fourths of all water softeners in use were in Bland County.

Hardness tolerance, like that of many nuisance contaminants, is somewhat relative to individual preferences. For example, water with total hardness between 60 mg/L and 180 mg/L may warrant the installation of a commercial water softener in the view of some household water users while others are satisfied with untreated water. Forty-two percent of the tap water samples and 48% of the raw water samples of both counties combined were in the range of 60 mg/L to 180 mg/L total hardness, indicating that more than three-fourths of all samples could be classified as "moderately hard" or harder.

Sulfate. High sulfate concentrations may result in adverse taste or may cause a laxative effect. The SMCL for sulfate is 250 mg/L. Sulfates are generally naturally present in groundwater and may be associated with other sulfur-related problems, such as hydrogen sulfide gas. This gas may be caused by the action of sulfate-reducing bacteria, as well as by other types of bacteria (possibly disease-causing bacteria) on decaying organic matter. While it is difficult to test for the presence of this gas in water, it can be easily detected by its characteristic "rotten egg" odor, which may be more noticeable in hot water. Water containing this gas may also corrode iron and other metals in the water system and may stain plumbing fixtures and cooking utensils.

Sulfate concentrations were relatively low for both the raw water and tap water sample groups. None of the raw water or tap water samples exceeded 250 mg/L. The complaints of a "rotten egg/sulfur" odor by nearly two-thirds of those reporting odor problems indicate that hydrogen sulfide gas may be a somewhat widespread problem in household water systems in the two counties; a conclusion that can not be confirmed by the presence of sulfate.

Figure 4. Household Water Treatment Devices Installed

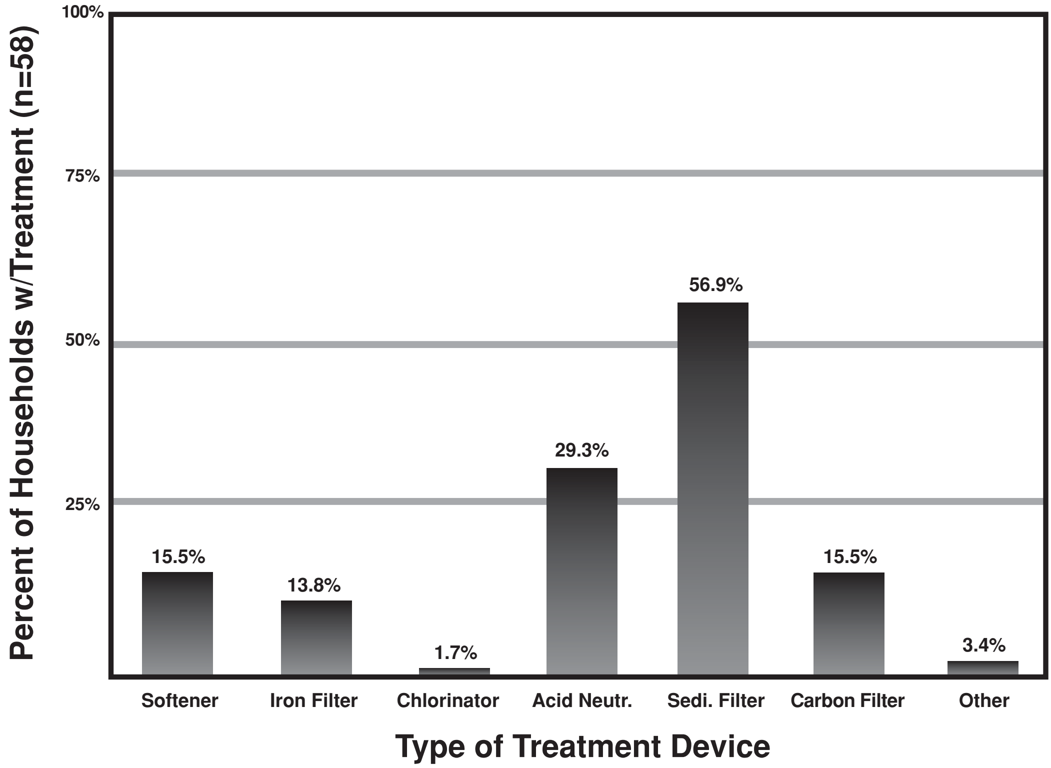


Figure 5. Unpleasant Tastes Reported by Participants

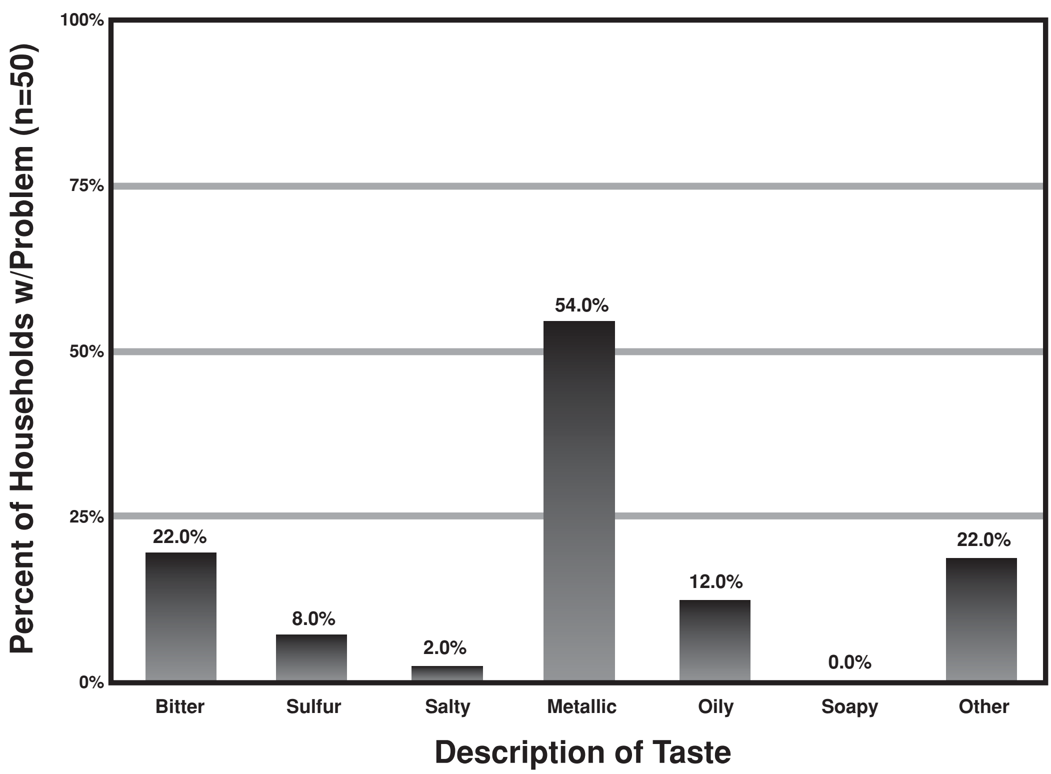


Figure 6. Objectionable Odors Reported by Participants

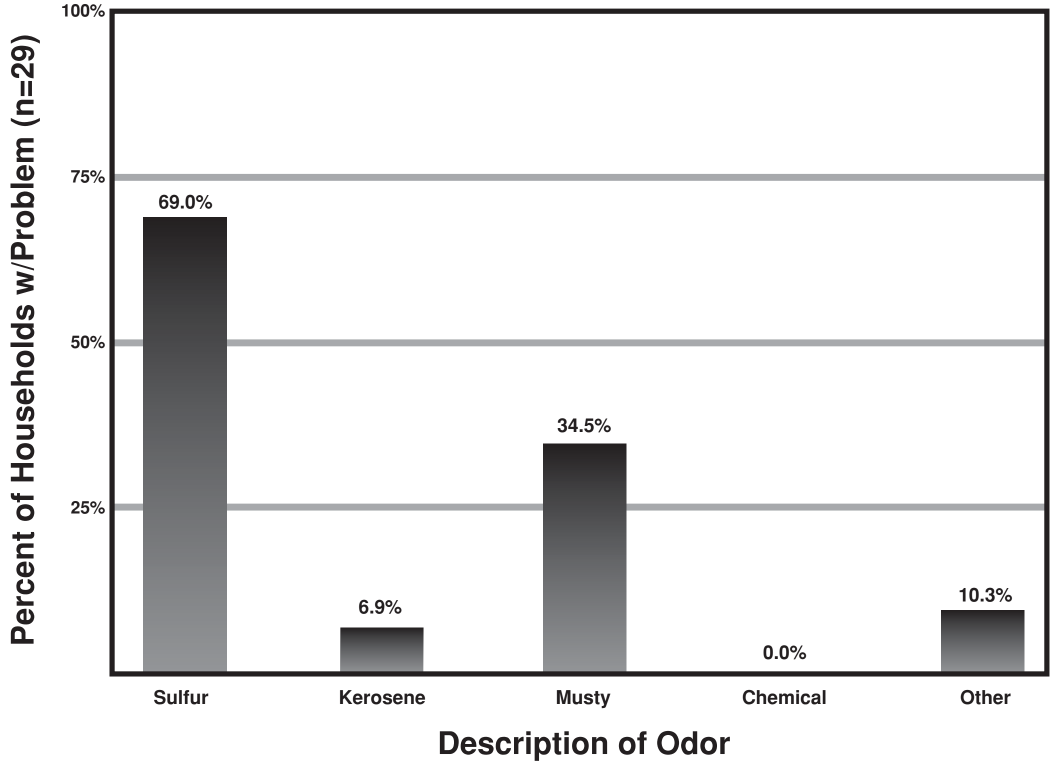


Figure 7. Unnatural Appearance Reported by Participants

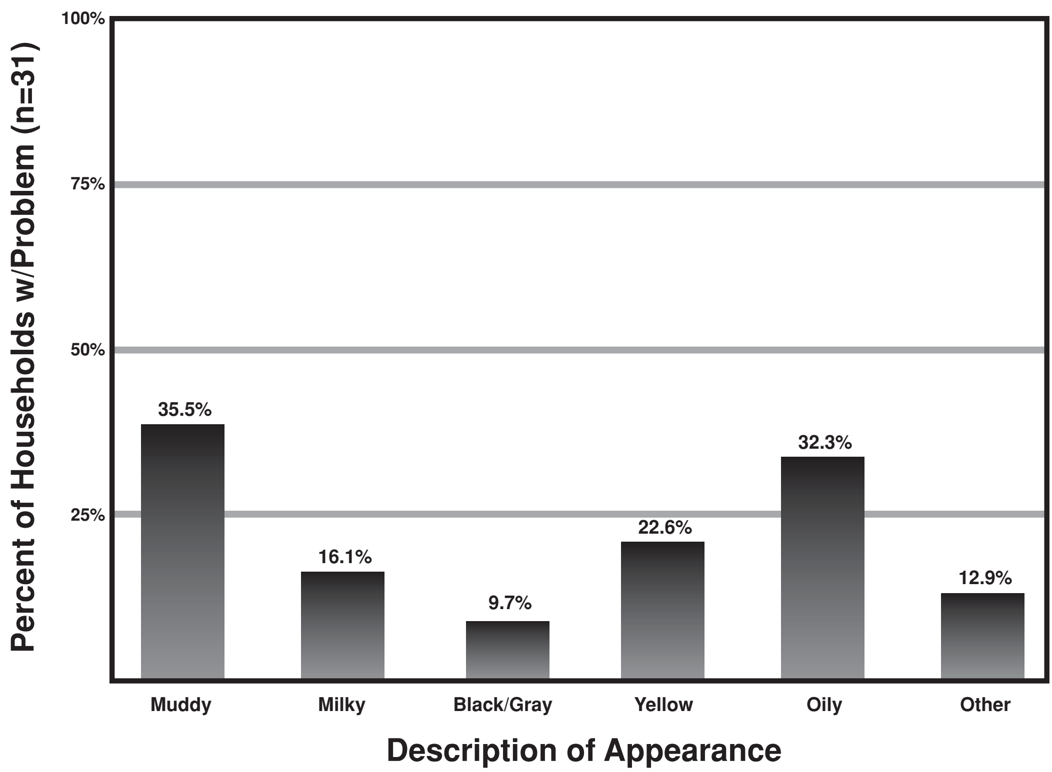


Figure 8. Particles in Water Reported by Participants

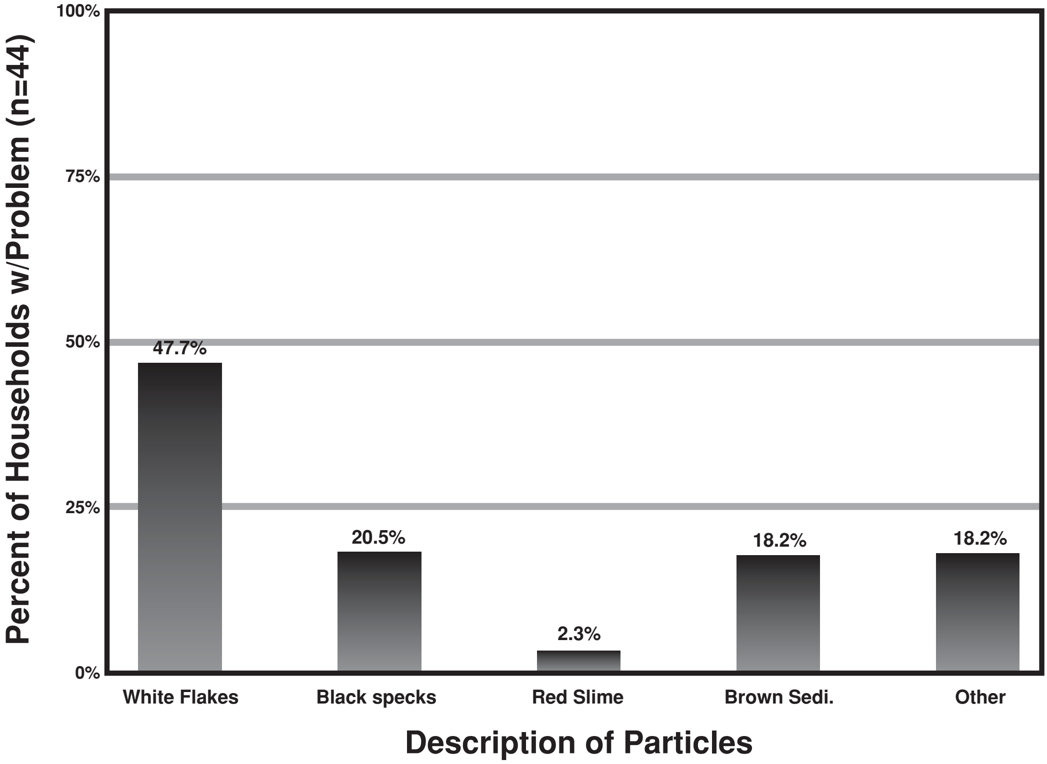
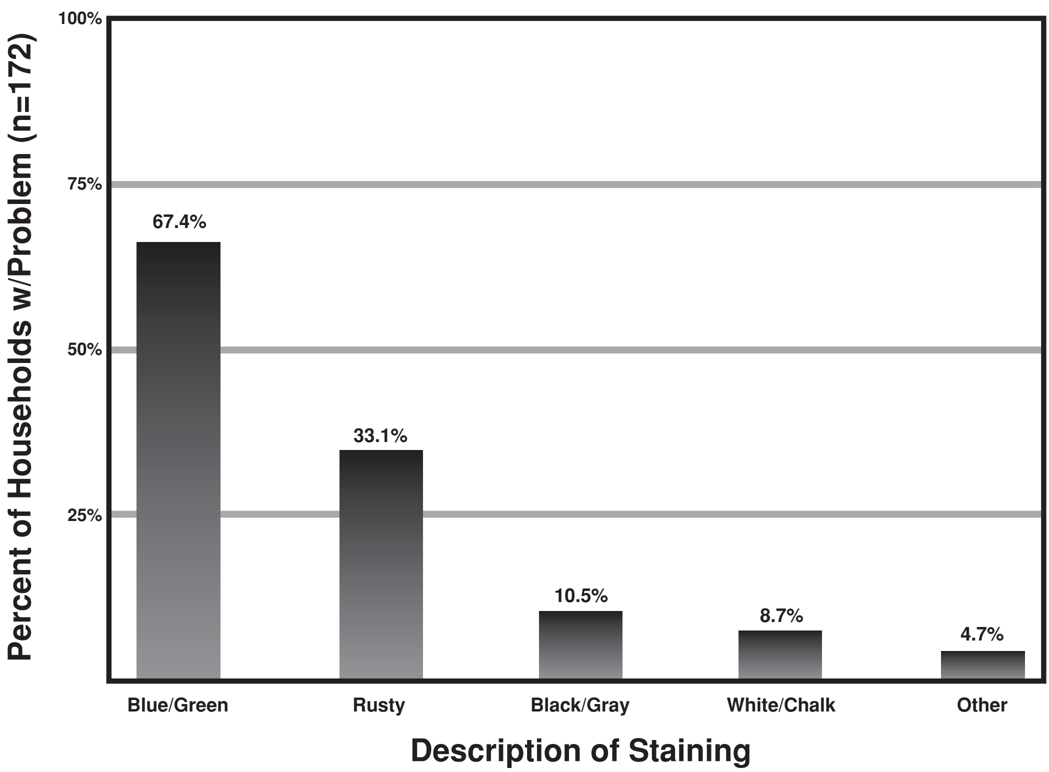


Figure 9. Staining Problems Reported by Participants



Chloride. Chloride in drinking water is not a health risk. Natural levels of chloride are generally low, and high levels in drinking water usually indicate contamination from a septic system, road salts, fertilizers, industry, or animal wastes. High levels of chloride may speed corrosion rates of metal pipes and cause pitting and darkening of stainless steel. The EPA has set an SMCL for chloride of 250 mg/L. One of the tap water and raw water samples in Bland County exceeded the SMCL for chloride.

Fluoride. Fluoride is of concern primarily from the standpoint of its effect on teeth and gums. Small concentrations of fluoride are considered to be beneficial in preventing tooth decay, whereas moderate amounts can cause brownish discoloration of teeth, and high fluoride concentrations can lead to tooth and bone damage. For these reasons, the EPA has set both a SMCL of 2 mg/L and a Maximum Contaminant Level (MCL) of 4 mg/L. None of the samples in the tap water and raw water sample groups exceeded either standard.

Total Dissolved Solids (TDS). High concentrations of dissolved solids may cause adverse taste effects and may also deteriorate household plumbing and appliances. The EPA SMCL is 500 mg/L total dissolved solids. Average TDS concentrations were 209 mg/L and 193 mg/L for the raw water and tap water sample groups, respectively. One Bland County sample in each sample group exceeded the standard. The maximum TDS concentration among both the raw water and tap water samples was 722 mg/L.

pH. The pH indicates whether water is acidic or alkaline. Acidic water can cause corrosion in pipes and may cause toxic metals from the plumbing system to be dissolved in drinking water. The life of plumbing systems may be shortened due to corrosion, requiring expensive repair and replacement of water pipes and plumbing fixtures. Treatment is generally recommended for water with a pH below 6.5. Alkaline water with a pH above 8.5 is seldom found naturally and may indicate contamination by alkaline industrial wastes. The EPA has set a suggested range of between 6.5 and 8.5 on the pH scale for drinking water.

The average pH reading was 7.5 for both the tap water and raw water samples. None of the samples in either sample group exceeded a pH of 8.5, with a maximum pH value of 8.3. Only two tap water samples (both from Bland County) had a pH value of less than 6.5. While the remaining samples had a pH above 6.5, slightly acidic water with a pH between 6.5 and 7.0 can lead to less immediate staining and corrosion problems. An additional three samples in both the tap water and raw water sample groups of Bland County fell into this category.

Saturation Index. The saturation index (Langlier) is used, in addition to pH, to evaluate the extent of potential corrosion of metal pipes, plumbing fixtures, etc. It is a calculated value based on the calcium concentration, total dissolved solids concentration, measured pH, and alkalinity. A saturation index greater than zero indicates that protective calcium carbonate deposits may readily form on pipe walls. A saturation index less than zero indicates that the water does not have scale-forming properties and pipes may be subject to corrosion. Saturation index values between -1 and +1 are considered acceptable for household water supplies.

No saturation index values were determined to be above +1 in either sample group. Values of less than -1, however, were determined for 28% of the tap water samples and 14% of the raw water samples. Average saturation index values were -0.89 for the former and -0.65 for the latter sample group with minimum values of -3.43 for the tap water samples and -3.06 for the raw water samples. There is an apparent partial explanation for this discrepancy. It is well documented that water softeners, which impacted 15% of the tap water samples, tend to enhance corrosion potential by removing scale-forming calcium from the water. For this reason, as well as the additional sodium imparted to the water (see below), it is sometimes recommended that water softeners be installed for hot water only or, in the case of extremely hard water, that at least drinking water lines bypass the softening equipment.

Copper. The EPA health standard for copper in public drinking water supplies is 1.3 mg/L, the maximum level recommended to protect people from acute gastrointestinal illness. Even lower levels of dissolved copper may give water a bitter or metallic taste and produce blue-green stains on plumbing fixtures. Consequently, EPA has established an SMCL for copper of 1.0 mg/L in household water.

None of the tap or raw water samples exceeded the recommended health level of 1.3 mg/L or the SMCL of 1.0 mg/L. The maximum copper concentration measured was 0.4 mg/L. Since natural levels of copper in groundwater are low, and the primary contributor of copper in drinking water is corrosion of copper water pipes and fittings, low copper levels were expected, even in the case of tap water samples, assuming that water lines were flushed properly prior to sampling.

Sodium. Sodium may be a health hazard to people suffering from high blood pressure or cardiovascular or kidney diseases. For those on low-sodium diets, 20 mg/L is suggested as a maximum level for sodium in drinking water, although a physician should be consulted in individual cases. Average sodium concentrations were 14 mg/L and 7 mg/L for the tap water and raw water sample groups, respectively, while the maximum concentration was 132 mg/L in the former case and 125 mg/L in the latter case. For the tap water and raw water samples, respectively, 22% and 10% exceeded 20 mg/L with a majority of these samples from Bland County (Table 2). These discrepancies were likely primarily due to the impact of installed water softeners on the tap water sample group (15% of all participants reported the use of a water softener with more than three-fourths of these in Bland County).

It should be reemphasized, however, that the suggested threshold of 20 mg/L for sodium is relatively low and applicable only to individuals suffering from health problems, such as heart disease or high blood pressure. To evaluate the presence of high sodium levels in the context of an otherwise healthy individual, a threshold value of 100 mg/L sodium has been suggested. Only one raw and five tap water samples exceeded this 100 mg/L threshold. Again, the likely influence of water softeners on sodium concentrations can be seen, even under higher threshold value.

Nitrate. High levels of nitrate may cause methemoglobinemia or "blue-baby" disease in infants. Though the EPA has set a MCL for nitrate (as N) of 10 mg/L, it suggests that water with greater than 1 mg/L not be used for feeding infants. Levels of 3 mg/L or higher may indicate excessive contamination of the water supply by commercial fertilizers and/or organic wastes from septic systems or farm animal operations, which may be subject to seasonal and climatic influences.

The maximum concentration of nitrate obtained was 11.8 mg/L for both the tap water and raw water sample groups, the only sample in either sample group to exceed the MCL of 10 mg/L. Thus, serious nitrate contamination does not appear to be a widespread problem in either county. When a 1 mg/L threshold value was selected, however, a much higher occurrence of nitrate was determined. In this case, 35% of the tap water and 41% of the raw water samples exceeded the level of potential concern to infant health. Furthermore, 9% of the tap water and 13% of the raw water samples had nitrate concentrations exceeding 3 mg/L, indicating that health-impacting levels would likely be approached in a number of cases in both counties. In both of the non-standard threshold cases, incidences of excessive nitrate were slightly higher for Giles County than for Bland County.

Table 1. Average and range of concentration of contaminants comprising general water chemistry analysis for Bland and Giles Counties.

Test	Detection Limit	Measured Concentrations					
		Raw Water (n=99)			Tap Water (n=153)		
		Avg.[1]	Min.	Max.	Avg.	Min.	Max.
Iron (mg/L)	0.005	0.298	DL[2]	12.420	0.250	DL	12.420
Manganese (mg/L)	0.001	0.021	DL	0.947	0.018	DL	0.947
Hardness (mg/L)	0.3	181.0	DL	468.5	149.5	DL	468.5
Sulfate (mg/L)	0.3	9.3	DL	59.5	9.3	DL	59.5
Chloride (mg/L)	40.0	64.0	DL	630.0	63.0	DL	630.0
Fluoride (mg/L)	0.5	0.51	DL	0.86	0.50	DL	0.86
TDS (mg/L)	1.0	209.0	7.0	722.0	193.0	6.0	722.0
pH	-	7.53	6.56	8.24	7.54	6.33	8.28
Saturation Index	-	-0.65	-3.06	0.41	-0.89	-3.43	0.41
Copper (mg/L)	0.002	0.015	DL	0.367	0.014	DL	0.367
Sodium (mg/L)	0.01	6.71	0.13	124.50	13.61	0.13	131.80
Nitrate (mg/L)	0.005	1.370	0.031	11.773	1.096	0.015	11.773

[1]*Averages calculated on the basis of below detection limit (DL) values set equal to the DL.*

[2]*Sample concentration non-detectable, i.e., below the detection limit for the given contaminant.*

Table 2. Percent of concentrations exceeding established standards for contaminants comprising general water chemistry and bacteriological analysis for Bland and Giles Counties.

Test	Standard	Percent of Values Exceeding Standard					
		Raw Water			Tap Water		
		Total n=99	Bland n=60	Giles n=39	Total n=153	Bland n=93	Giles n=60
Iron (mg/L)	0.3	7.1	10.0	2.6	7.2	10.8	1.7
Manganese (mg/L)	0.05	6.1	10.0	0	5.9	9.7	0
Hardness (mg/L)	180.0	43.4	31.7	61.5	35.9	22.6	56.7
Sulfate (mg/L)	250.0	0	0	0	0	0	0
Chloride (mg/L)	250.0	1.0	1.7	0	0.7	1.1	0
Fluoride (mg/L)	2/4	0/0	0/0	0/0	0/0	0/0	0/0
TDS (mg/L)	500.0	1.0	1.7	0	0.7	1.1	0
pH - Low	6.5	0	0	0	1.3	2.2	0
pH - High	8.5	0	0	0	0	0	0
Saturation Index - Low	-1.0	14.1	16.7	10.3	28.1	35.5	16.7
Saturation Index - High	+1.0	0	0	0	0	0	0
Copper (mg/L)	1.0/1.3	0/0	0/0	0/0	0/0	0/0	0/0
Sodium (mg/L)	20.0	10.1	15.0	2.6	21.6	28.0	11.7
Nitrate (mg/L)	10.0	1.0	1.7	0	0.7	1.1	0
Total Coliform	ABSENT	60.6	63.3	56.4	51.0	53.8	46.7
E. coli	ABSENT	22.2	23.3	20.5	16.3	16.1	16.7

Bacteriological Analysis

A common hazard of private household water supplies is contamination by 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. Of the non-gastrointestinal disorders, one particularly important disease transmissible through drinking water is Viral Hepatitis A. Other diseases include salmonella infections, dysentery, typhoid fever, and cholera.

Coliform bacterial detection is simply an indication of the possible presence of pathogenic, or disease-causing organisms. Detection of coliform bacteria is confirmed by a total coliform analysis result above zero. Coliforms are always present in the digestive systems of all warm-blooded animals and can be found in their wastes. Coliforms are also present in the soil and in plant material. While a water sample with total coliform bacteria present may have been inadvertently contaminated during sampling, other possibilities include surface water contamination due to poor well construction, contamination of the household plumbing system, or water table contamination. To determine whether or not the bacteria were from human and/or animal waste, positive total coliform tests were followed up by an analysis for E. coli bacteria.

Of the 153 household water samples from the two counties analyzed for total coliform bacteria, 78 (51%) tested positive (present). Subsequent E. coli analysis for these total coliform positive samples resulted in 25, or 32%, positive results, or 16% of all household water samples undergoing bacteriological analysis. The percentages of positive total coliform and E. coli results for the raw water sample group were 61 and 22, respectively.

The susceptibility of household water supplies to bacteriological contamination has often been associated with the type of water source. For example, it is generally accepted that the likelihood of bacteriological contamination of springs is greater than that of well water supplies, which usually offer better protection from surface, or near surface, contaminants. This contention is clearly borne out by the results of this program, which indicated that the incidence of total coliform and E. coli contamination of springs was 92% and 34%, respectively, while for wells, positive total coliform and E. coli results were obtained for only 37% and 10% of the samples.

The age of a water source/system is an additional factor which may have an influence on contamination susceptibility. With respect to wells in particular, deterioration of the well structure over time, cumulative damage caused by equipment traffic, etc., and prolonged exposure of the wellhead area to potentially harmful pollutants may all contribute to the eventual contamination of the well. A major age-related impact could relate to the development of, and conformance with, well construction standards through the years. Major legislation in Virginia to address such issues has been enacted in recent years, most notably in the early 1970's and early 1990's. Therefore, for the purpose of examining the occurrence of bacteriological contamination with well age, the sample results were evaluated for the following three construction date categories: (1) pre-1970, (2)1970-1989, and (3) 1990 to date. With respect to total coliform bacteria, for each of the above categories, the percentages of well water samples determined to be positive were as follows: (1) 46, (2) 33, and (3) 36. For E. coli bacteria, the corresponding percentages were: (1) 23, (2) 8, and (3) 7. An overall improvement was noted with time, likely influenced not only by the newness of the wells, but also recent legislation. Perhaps not surprisingly, however the extent of this reduction may have been somewhat tempered by the influence of the karst topography of the region.

Fecal bacteria present in household water supplies may have originated from animal waste generation or human waste from septic systems. Although, positive results should be viewed with concern, they are not a cause for panic. Individuals have probably been drinking this

Table 3. Measures taken or planned by respondents, since water quality analysis, to improve water supply (Bland and Giles Counties)

Measure	Percent of All Respondents (n=72)	Percent of Respondents who Reported the Following Problems			
		Health Only (n=24)	Nuisance Only (n=17)	Health & Nuisance (n=9)	None (n=22)
Contact an Agency, such as the Health Department	11.1	8.3	11.8	44.4	0
Seek Additional Water Testing from Another Lab	6.9	4.2	17.6	11.1	0
Determine Source of Undesirable Condition	2.8	0	0	22.2	0
Pump Out Septic System	0	0	0	0	0
Improve Physical Condition of Water Source	8.3	16.7	0	22.2	0
Shock-Chlorinate Water System	19.4	29.2	17.6	44.4	0
Obtain New Water Source	1.4	0	0	11.1	0
Use Bottled Water for Drinking/Cooking	5.6	4.2	5.9	22.2	0
Temporary Disinfection, such as Boiling Water	1.4	4.2	0	0	0
Purchase or Rent Water Treatment Equipment	11.1	4.2	29.4	11.1	4.5
Improve Existing Water Treatment Equipment	2.8	4.2	0	11.1	0
Take Other Measures to Eliminate/Reduce Contaminant(s)	2.8	8.3	0	0	0
Have Not Done Anything	59.7	45.8	52.9	22.2	95.5

water for some time with no ill effects and could possibly continue to do so. Nevertheless, such problems should be further investigated and remedied, if possible. Program participants whose water tested positive were given information regarding emergency disinfection, well improvements, septic system maintenance and other steps to correct the source of contamination. After taking initial corrective measures, they were advised to have the water retested for total coliform, followed by E. coli tests, if warranted.

Post-Program Survey

Following the completion of the educational program, a survey form (see Appendix) was mailed to the 153 households whose water supply had been tested. The objectives of the survey were to determine: 1) reasons for program participation and for having water tested, and 2) what the respondents had done to correct water quality problems as a result of participation in the educational program. Seventy-two (47%) had returned the survey forms by the deadline.

Household Water Testing History

Participants were asked to indicate their previous experience with water testing and, specifically, if and when they had last had a laboratory analysis of their present household water supply. Forty-two percent of the respondents indicated that they had previously obtained water test results. Of those reporting a prior testing date, 53% had done so within the past five years and 17% within the past two years.

Reasons for Program Participation

People participated in the water quality program for one or more reasons. Eighty-six percent of the respondents were prompted to participate by concern about the safety of their water supply. Eighteen percent of the respondents were prompted by nuisance problems, such as staining, objectionable taste and odor, etc. Eighteen percent wanted to follow up on previous tests of their household water. Eleven percent cited other reasons, such as general curiosity and low-cost opportunity.

Follow-up Activities Taken or Planned

Participants were asked to indicate the measures they planned to take, or had already taken, to improve the quality of their water supply, since receiving the results of their water quality analysis. Table 3 presents the results of this inquiry, with the greatest number of households indicating that they had already, or planned to, shock chlorinate the water system.

Participants were asked if the water analysis showed that their water was unsatisfactory for one or more of the following: bacteria, nitrate, sodium, iron, manganese, hardness, and pH. Responses were grouped in four categories: 1) households with potential health problems (positive bacteria test results and/or unsatisfactory levels of nitrate or sodium in their water samples), 2) households with unsatisfactory levels of nuisance contaminants (one or more of the following: iron, manganese, hardness, and pH), 3) households with potential health problems and unsatisfactory levels of nuisance contaminants, and 4) households with neither potential health problems nor unsatisfactory levels of nuisance contaminants.

The measures planned or already taken to improve household water as follow-up to the water quality analysis were generally in agreement with the water quality problems identified by the testing. Of the households with potential health problems only, and those with health problems in combination with unsatisfactory levels of nuisance contaminants, 61% had taken, or planned to take, at least one measure to improve their water supply. The measure taken by the greatest number of households in these two categories was shock chlorinate the water system.

Respondents were slightly more likely to address health-related problems than nuisance problems. Of the households with unsatisfactory levels of one or more nuisance contaminants only and those with nuisance problems in combination with potential health problems, 58% had taken, or planned to take, at least one measure to improve their water supply. Only 5% of the households with neither potential health problems nor unsatisfactory levels of nuisance contaminants reported taking follow-up measures.

CONCLUSIONS

The Household Water Quality Educational Programs conducted in Bland and Giles Counties were considered to be successful. The opportunity to participate in the programs was well-received by those residents who chose to do so. Individuals participated in the programs primarily because of concern about the safety of their water supply. Despite being voluntary programs, a geographically distributed sample representing diverse household and water supply characteristics was obtained. While the project was designed for voluntary participation and quality control in sampling was not assured, the type of information gathered and summarized was, nevertheless, deemed useful for water quality assessment at county and regional levels.

Water quality analysis, for many nuisance constituents, generally supported the participants' descriptions of their water supplies regarding such problems as staining, taste and odor, and appearance. The severity of these symptoms is confirmed by the high incidence of water treatment devices installed – 35% of all households participating had one or more water treatment devices installed.

Considering the results for both the raw and tap water sample groups, and the influence of the water treatment devices in use, the major remaining household water quality problems in Bland and Giles Counties, existing from a nuisance standpoint, were iron/manganese and hardness. The major health-related concern was bacteria. Furthermore, elevated nitrate and sodium concentrations may present a health risk to infants and some adults, respectively, in a number of cases. Fifty-one percent of the samples tested positive for total coliform and 16% were positive for E. coli bacteria. In these positive cases, participants were advised of ways to improve water supply conditions and were encouraged to pursue retesting for coliform bacteria.

Fifty-six percent of the households that reported having at least one water quality problem had taken, or planned to take, at least one measure to improve the quality of their water supply. Ten percent or more of all respondents had, or planned to, take one or more of the following actions: shock chlorinate the water system, purchase or rent water treatment equipment, and contact a state agency for further assistance.

REFERENCES

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USEPA. 1979. Methods for Chemical Analysis of Water and Wastes. Report No. EPA 600/4-79-020. Washington, D.C.: U.S. Environmental Protection Agency.

APPENDIX *

(1) Program Fact Sheets

(2) Sample Identification and Questionnaire Form

(3) Sample Water Quality Analysis Report

(4) Report Interpretation

(5) Post-Program Survey

* *The following examples (2) – (5) represent forms, reports, etc. used in the Bland County Program only. Paperwork for Giles County was similar, except for the information that was county-specific.*

(1) Program Fact Sheets

HOUSEHOLD WATER TESTING PROGRAMS

BLAND COUNTY

<u>Fact Sheet</u>

Purpose: Improve the quality of life of private water system users by increasing awareness and understanding of groundwater quality problems, protection strategies and treatment alternatives: and to create a groundwater quality data inventory to assist local government decision making for groundwater protection purposes.

Who is eligible?
150 Bland County residents who are served by a private water system are eligible.

Total Cost:
Total cost for the test is $20.00 and is due at the time the sampling kits are distributed.
Please make checks payable to <u>VCE-Bland Office.</u>

What will we test for?

1. General Water Analysis:

Nitrate	Iron	Hardness (Ca & Mg)
Chloride	Sodium	pH (acidity)
Fluoride	Copper	Corrosion Index
Sulfate	Manganese	Total Dissolved Solids

2. Bacteria: Total coliform and E. Coli Test.

Information Meetings:
Participants must attend **one** of the following sessions to receive the sampling kit. You will also learn how to take the sample at this meeting. Remember to bring payment, cash or check is acceptable

- Monday, <u>March 22, 1999</u> at 7:00 p.m. at the Laurel Fork Baptist Church Fellowship Hall in Rocky Gap
- Tuesday, <u>March 23, 1999</u> at 7:00 p.m. at the Bland County Library

Water Sample Delivery:
On ***<u>Tuesday, March 30, 1999</u>*** water samples must be taken by someone in the household and delivered between 7:00 a.m. and 10:00 a.m. to either the Laurel Fork Baptist Church or the Bland Extension Office (beside Scott's IGA).

Results of the water test will be returned on either of these dates. Dr. Blake Ross will be available to interpret results.

- Monday, <u>April 26, 1999</u> at 7:00 p.m. at the Laurel Fork Baptist Church
- Tuesday, <u>April 27, 1999</u> p.m. 7:00 p.m. at the Bland County Library

Confidentially: *All results will be kept confidential. Information gathered will have no names and will not be of sufficient detail to determine a particular water supply.*

Virginia Cooperative Extension

HOUSEHOLD WATER TESTING
for
Wells, Springs, & Cisterns in Giles County

Testing for: E. coli bacteria, Total Coliform bacteria, Iron, Manganese, Hardness, Sulfate, Chloride, Fluoride, Total Dissolved Solids, pH, Corrosion Index, Copper, Sodium, and Nitrate.

sponsored by:
Virginia Cooperative Extension – Giles County Office
Department of Biological Systems Engineering, Virginia Tech
Southeast Rural Community Assistance Project, Inc.

PUBLIC EDUCATIONAL MEETINGS: Meetings will describe this program and water sample kits will be available. Learn why and how to take water samples.

March 15 - 7 p.m. - at the Newport Community Center, Cafeteria
March 18 - 7 p.m. - at the Narrows Town Hall, Council Chambers

COST: **$20 per sample for the first 150 participants; $30 over 150.** Cash or check payable to **VCE – Giles County Office** on March 15 or March 18.

REGISTRATION:
For further information and to register, please call the **Giles County Extension Office at 921-3455; or e-mail to scottja@vt.edu**

WATER SAMPLE COLLECTION SITES:
March 22 – Narrows and Newport Post Offices Parking Lots – 7 a.m. to 12 noon
April 7 - Narrows and Newport Post Offices Parking Lots – 7 a.m. to 12 noon

FINAL MEETING: Receive your **confidential** water analysis results and discuss recommended treatments.

April 29 - 7 p.m. - at the Giles Lifesaving & Rescue Squad Building.

Ms. Dawn Barnes, Extension Agent, Family and Consumer Sciences
Dr. B. Blake Ross, Extension Agricultural Engineer
Mr. John A. Scott, Jr., Extension Agent, ANR/Animal Science

If you are a person with a disability and desire any assistive devices, services or other accommodations to participate in this activity, please contact Dianne Rader in the Giles County Extension Office at 921-3455 between the hours of 8:00 a.m. and4:30p.m. at least 5 days prior to the activity.

(2) Sample Identification and Questionnaire Form

BLAND COUNTY HOUSEHOLD WATER QUALITY PROGRAM

Bland County Cooperative Extension
P.O. Box 69
Bland, VA 24315-0069
(504) 688-3542

SAMPLE IDENTIFICATION (Please **print** clearly and provide complete information on both sides of form.)

Sample No.:________________ Date collected:____________________

Sample submitted by:

Name:____

Mailing address:____

____

Telephone:____

FOR OFFICE USE ONLY
Map Grid No.____________________
Lab Sample No.____________________

Household water supply source **drawn for sample** (check one):

___*well* ___*spring* ___*cistern* ___*other (Specify: ________________________)*

If *well* is checked above: (*a*) is it a ____ *dug or bored well,* ____ *drilled well,* ____ *don't know;*

(*b*) what is its approximate depth, if known? __________*feet*

(*c*) what year was well constructed, if known? ________

Do other households share the same water supply? ___*yes* ___ *no* **If** *yes*, approximately how many? ________

Water treatment devices currently installed and affecting **cold water only** drawn at faucet for sample (check **all** that apply):

_____*none* _____*acid water neutralizer*

_____*water softener (conditioner)* _____*sediment filter (screen or sand type)*

_____*iron removal filter* _____*activated carbon (charcoal) filter*

_____*automatic chlorinator* _____*other (specify: ____________________________)*

SAMPLING INSTRUCTIONS: You must take your water samples only on the collection day you have been assigned. For the general water analysis sample, use the larger plastic bottle as described below. A separate, smaller bottle is provided for bacteriological samples which should be taken last. If you have any questions about sampling procedures, call the Extension Office at 688-3542.

1. Do not remove caps from sample bottles until you are ready to take each sample. Do not touch inside of cap or mouth of either bottle.
2. Turn on the cold water faucet in the kitchen or bathroom (select a stationary, non-swivel faucet, if possible) and allow the water to run until it becomes as cold as it will get; then let it run for one more minute.
3. Slowly and carefully fill the larger bottle to avoid splashing or overflowing. Pour out this rinse water and then refill bottle completely. Tighten cap on bottle securely.
4. Let the water run for an additional two or three minutes. Reduce flow to prevent splashing and carefully fill the smaller bottle only once to the shoulder (just below the threaded top). DO NOT RINSE BOTTLE. Replace cap tightly.
5. Do not write anything on the bottle labels. If samples are not to be delivered immediately, store in refrigerator or on ice until ready to deliver later that day.
6. Fill out this Sample Identification Form and Questionnaire (on reverse side) completely and bring it, along with both water sample bottles, to the designated collection site on your assigned collection day.

Sample Identification and Questionnaire Form (cont.)

QUESTIONNAIRE (Please answer the following questions as completely as possible, considering how you view the **present** condition of the water sampled, including improvements due to any treatment devices identified on other side of form.)

1. Describe the location of your home. (Check **one**)
_____*on a farm* _____*on a remote, rural lot* _____*in a rural community* _____*in a housing subdivision*

2. What pipe material is primarily used throughout your house for water distribution? (Check **one**)
___*copper* __*lead* __*galvanized steel* _*plastic (PVC, PE, etc.)* __*other (specify: ______________________)* __ *don't know*

3. Do you have problems with corrosion or pitting of pipes or plumbing fixtures? _____*yes* _____*no*

4. Does your water have an unpleasant taste? _____*yes* _____*no*

5. If *yes*, how would you describe the taste? (Check **all** that apply)
___*bitter* ___*sulfur* ___*salty* ___*metallic* ___*oily* ___*soapy* ___*other (specify: ______________________)*

6. Does your water have an objectionable odor? _____*yes* _____*no*

7. If *yes*, how would you describe the odor? (Check **all** that apply)
___*"rotten egg" or sulfur* ___*kerosene* ___*musty* ___*chemical* ___*other (specify: ______________________)*

8. Does your water have an unnatural color or appearance? _____*yes* _____*no*

9. If *yes*, how would you describe the color or appearance? (Check **all** that apply)
___*muddy* ___*milky* ___*black/gray tint* ___*yellow tint* ___ *oily film* ___ *other (specify: ______________________)*

10. Do you have problems with staining of plumbing fixtures, cooking appliances/utensils, or laundry? ___*yes* ___*no*

11. If *yes*, how would you describe the color of stains? (Check **all** that apply)
___*blue-green* ___*rusty (red/orange/brown)* ___*black or gray* ___*white or chalk* ___*other (specify: ______________________)*

12. In a standing glass of water, do you notice floating, suspended, or settled particles? _____*yes* _____*no*

13. If *yes*, how would you describe this material? (Check **all** that apply)
___*white flakes* ___*black specks* ___*reddish-orange slime* ___*brown sediment* ___*other (specify: ______________________)*

14. If your water supply is located **100 feet or less** from any of the following, please indicate. (Check **all** that apply)
_____*septic system drain field* _____*home heating oil storage tank (above or below ground)*
_____*pit privy or outhouse* _____*stream, pond, or lake*
_____*cemetery* _____*sinkhole*

15. If your water supply is located **½ mile or closer** to any of the following, please indicate. (Check **all** that apply)
_____*landfill* _____*golf course*
_____*illegal dump* _____*field crop/orchard*
_____*active quarry* _____*farm animal operation*
_____*abandoned quarry, industry, etc.* _____*manufacturing/processing operation (specify: ______________________)*
_____*commercial underground storage tank or supply lines (gasoline service station, heating oil supplier, etc.)*

This material is based upon work supported by the U.S. Department of Agriculture, Extension Service.

(3) Sample Water Quality Analysis Report

Bland County
Household Water Quality Program

Bland County Cooperative Extension
P.O. Box 69
Bland, VA 24315
(540) 688-3542

Sample No: B

P.O. Box
Rocky Gap, VA 24366
(540) 928-

Source: Unknown_Well

Treatment: Iron Filter
Water Softener

Water Quality Results
Date of Sample: 3/30/99

Test	Household Water Sample	Maximum Recommended Level or Range
Iron (mg/l)	0.1369	0.3
Manganese (mg/l)	< 0.001	0.05
Hardness (mg/l)	< 0.3	180
Sulfate (mg/l)	5.467	250
Chloride (mg/l)	40	250
Fluoride (mg/l)	< 0.5	2
Total Dissolved Solids (mg/l)	98	500
pH	8	6.5 to 8.5
Saturation Index	-1.95**	-1 to 1
Copper (mg/l)	< 0.002	1.0
Sodium (mg/l)	40.26**	20
Nitrate-N (mg/l)	0.087	10
Total Coliform Bacteria	PRESENT**	ABSENT
E Coli Bacteria	ABSENT	ABSENT

** Measured Value exceeds recommendation for household water.

Analysis coordinated by Water Quality Laboratory, Dept. of Biological Systems Engineering, Virginia Tech, Blacksburg, VA. The information provided is for the exclusive use of the homeowner and should not be used as official documentation of water quality. The material is based upon work supported by the U.S. Department of Agriculture, Extension Service.

(4) Report Interpretation

Bland County Household Water Quality Program

INTERPRETING YOUR HOUSEHOLD WATER QUALITY ANALYSIS REPORT

IRON
Iron in water does not usually present a health risk. It can, however, be very objectional if present in amounts greater than 0.3 mg/l. Excessive iron can leave red-orange-brown stains on plumbing fixtures and laundry. It may give water and/or beverages a bitter, metallic taste and discolor beverages.

MANGANESE
Manganese does not present a health risk. However, if present in amounts greater than 0.05 mg/l it may give water a bitter taste and produce black stains on laundry, cooking utensils, and plumbing fixtures.

HARDNESS
Hardness is a measure of calcium and magnesium in water. Hard water does not present a health risk. However, it keeps soap from lathering, decreases cleaning action of soaps and detergents, leaves soap "scum" on plumbing fixtures, and leaves scale deposits on water pipes and hot water heaters. Softening treatment is highly recommended for very hard water (above 180 mg/l). Water with a hardness of about 50 mg/l or less does not need softening. Water hardness may also be reported in units of grains per gallon, or gpg (1 gpg = 17.1 mg/l hardness). In all but extremely hard water situations, it may be desirable to soften only the hot water.

SULFATE
High sulfate concentrations may result in adverse taste as well as cause a laxative effect. The Secondary Maximum Contaminant Level for sulfate is 250 mg/l. Sulfates are generally naturally present in groundwater and be linked to other sulfur-related problems, such as hydrogen sulfide gas. This gas may be caused by the action of sulfate reducing bacteria as well as other types of bacteria on decaying organic matter. While it is difficult to test for the presence of hydrogen sulfide gas in water, it can be easily detected by its characteristic "rotten egg" odor which may be more noticeable in hot water. Water containing this gas may also corrode iron and other metals in the water system as well as stain plumbing fixtures and cooking utensils.

CHLORIDE
Chloride in drinking water is not a health risk. Natural levels of chlorides are low; high levels in drinking water usually indicate contamination from a septic system, road salts, fertilizers, industry, or animal wastes. High levels of chloride may speed corrosion rates of metal pipes, and causing pitting and darkening of stainless steel. The EPA has set a Secondary Maximum Contaminant Level for chloride of 250 mg/l.

FLUORIDE
Fluoride is of concern primarily from the standpoint of its effect on teeth and gums. Small concentrations of fluoride are considered to be beneficial in preventing tooth decay while moderate amounts can cause brownish discoloration of teeth and high fluoride concentrations can lead to tooth and bone damage. For these reasons, the EPA has set both a Secondary Maximum Contaminant Level and a Maximum Contaminant Level of 2 and 4 mg/l, respectively.

TOTAL DISSOLVED SOLIDS (TDS)
High concentrations of dissolved solids may cause adverse taste effects and may also lead to increased deterioration of household plumbing and appliances. The EPA Secondary Maximum Contaminant Level is 500 mg/l total dissolved solids.

pH
The pH of water indicates whether it is acidic (below 7.0) or alkaline (above 7.0). Acidic water can cause corrosion in pipes, and may cause toxic metals from plumbing systems, such as copper and lead, to be dissolved in drinking water. Dissolved copper may give water a bitter or metallic taste, and produce blue-green stains on plumbing fixtures. The life of plumbing systems may be shortened due to corrosion requiring expensive repair and replacement of water pipes and plumbing fixtures. The use of plastic pipes throughout the water distribution system should lessen these concerns. Water with a pH below 6.5 is considered to be acidic enough to require treatment. Alkaline water with a pH above 8.5 is seldom found naturally, and may indicate contamination by alkaline industrial wastes. The EPA has set a suggested range of between 6.5 and 8.5 on the pH scale for drinking water.

SATURATION INDEX
The saturation (Langlier) index, in addition to pH, is used to evaluate the extent of potential corrosion of metal pipes, plumbing fixtures, etc. It is a calculated value based on the calcium concentration, total dissolved solids concentration, measured pH, and alkalinity, and is a measure of the scale formation potential of the water. A saturation index greater than zero indicates that protective calcium carbonate deposits may readily form on pipe walls. A saturation index less than zero indicates that the water does not have scale-forming properties and pipes may be subject to corrosion. Saturation index values between -1 and +1 are considered acceptable for household water supplies. NOTE: **Values of less than -1 need not be of concern if the water is not acidic (indicated by a pH of 7.0 or above).** Water softener owners may note a saturation index reading lower than desired. While these treatment devices correct hardness, they may enhance the corrosion potential of the water. Concerns about resulting drinking water quality may be lessened by softening only the hot water or bypassing drinking water lines.

COPPER
The EPA drinking water standard for copper is 1.3 mg/l, based on concerns about acute gastrointestinal illness. Since dissolved copper also leaves blue-green stains on plumbing fixtures, a Secondary Maximum Contaminant Level of 1.0 mg/l is also provided for copper. While copper in household water most often comes from the corrosion of brass and copper plumbing materials, this type of contamination is not likely to be detected under the sampling procedure followed in this program which called for flushing the water lines. Therefore, any excessive amounts of copper from the water source itself may indicate contamination from industrial wastes or dumps/landfills.

SODIUM
Excessive sodium has been linked to problems with high blood pressure, and heart and kidney diseases. Moderate quantities of sodium in drinking water are not considered harmful since an individual normally receives most (over 90%) of his/her sodium intake from food. For those on low-sodium diets, both the American Heart Association and EPA suggest 20 mg/l as a maximum level for sodium in drinking water; a physician should be consulted in individual cases. Water softening by ion-exchange will increase sodium levels in water. To reduce sodium in drinking water requiring such treatment, soften only the hot water or bypass drinking water lines.

NITRATE
High levels of nitrate may cause methemoglobinemia or "blue-baby" disease in infants. Though the EPA has set a Maximum Contaminant Level for nitrate-nitrogen of 10 mg/l, they suggest that water with greater than 1 mg/l be used with caution for feeding infants. Levels of higher than 3 mg/l may indicate excessive contamination of water supply by commercial fertilizers as well as organic wastes from septic systems or farm animal operations.

TOTAL COLIFORM BACTERIA
Microbiological contamination of drinking water can cause short term gastrointestinal disorders, resulting in cramps and diarrhea that may be mild to very severe. Other diseases of concern are Viral Hepatitis A, salmonella infections, dysentery, typhoid fever, and cholera. While coliform bacteria do not cause disease, they serve as indicators of the possible presence of disease bacteria. Coliform bacteria are always present in the digestive systems of humans and animals and could also come from natural sources such as soil or decaying vegetation. Analysis for total coliform bacteria is the EPA standard test for microbiological contamination of a water supply. A positive test result reported as "present" indicates the presence of coliform bacteria and is followed by a test for fecal coliform bacteria.

E COLI
A test for fecal coliform bacteria is necessary to determine whether or not any coliform bacteria present are from human and/or animal waste. A positive E. coli test result reported as "present" indicates that waste from a septic system or nearby animals is likely contaminating the water supply.

Glossary

EPA - U. S. Environmental Protection Agency

mg/l - Concentration unit of milligrams per liter in water, equivalent to one part per million (ppm).

Maximum Contaminant Level (MCL) - Legally enforceable national standard set by the EPA to protect the public from exposure to water hazards. Standards only apply to public drinking water systems, but, they also serve as a guide for individual water supplies.

Secondary Maximum Contaminant Level (SMCL) - Concentration limits for nuisance contaminants and physical problems. These standards are not enforced by governments. However, they are useful guidelines for individual water supplies.

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(5) Post-Program Survey

Bland County

HOUSEHOLD WATER QUALITY PROGRAM EVALUATION SURVEY

Please answer each question below as instructed in reference to your **household** water supply only. **Your answers are completely confidential and cannot be identified with any individual participant.**

1. Have you had a laboratory test of your water supply before this Household Water Quality Education Program? Yes _____ No _____

   If Yes, about what year was your last test? __________

2. What prompted you to participate in this program? (Check **all** that apply.)

   _____ Concern about safety of my water supply
   _____ Nuisance problems such as staining, objectionable taste or odor, corrosion, etc.
   _____ Follow-up to previous test of my water supply
   _____ Other (explain) ____

3. Did your household water analysis in this program show that your water was unsatisfactory for **any** of the following tests? (Check **one** response for each test.)

Nitrate	Yes _____	No _____
Sodium	Yes _____	No _____
Iron	Yes _____	No _____
Manganese	Yes _____	No _____
Hardness	Yes _____	No _____
pH	Yes _____	No _____

4. What were the results of the tests for the following? (Check **one** response for each test.)

Total coliform bacteria	Present _____	Absent _____
E. coli bacteria	Present _____	Absent _____

5. Since receiving the results of your water quality analysis, which of the following measures do you plan to take, or have already taken, to improve the quality of your water supply? (Check **all** that apply.)

   _____ Contact a state agency such as the Health Dept., Dept. of Environmental Quality, etc. for assistance or additional information
   _____ Seek additional water testing from a laboratory
   _____ Determine source of undesirable condition
   _____ Pump out septic system
   _____ Improve physical condition of water source (well, spring, or cistern)
   _____ Shock chlorinate water system
   _____ Obtain new water source
   _____ Use bottled water for drinking/cooking
   _____ Temporary disinfection, such as boiling water
   _____ Purchase or rent water treatment equipment
   _____ Improve functioning of existing water treatment equipment
   _____ Take other measures to eliminate or reduce contaminant(s) in your water (explain)

____

____

Haven't done anything because ____________________________________

____

Post-Program Survey (cont,)

The following questions are designed to provide us with a profile of the total audience we've reached with this program. **Be assured that answers cannot be identified with individual participants.**

6. How many years have you lived at your present location? _____

7. Number of persons in your household. _____

8. What is the highest grade in school you've completed? (Check **one.**)

_____ Grade school
_____ Some high school
_____ High school graduate
_____ Some education after high school
_____ College graduate

9. What is your **family** income before taxes? (Check **one.**)

_____ Less than $10,000
_____ $10,000 to $14,999
_____ $15,000 to $19,999
_____ $20,000 to $24,999
_____ $25,000 to $34,999
_____ $35,000 to $49,000
_____ $50,000 or more

10. Other comments about the Household Water Quality Education Program:

____

____

____

11. Are there other educational programs that you would like to see offered by the Bland County Extension Office?

____

____

12. How did you hear about this Household Water Quality Education Program? (Check **all** that apply.)

_____ Newspaper
_____ Radio
_____ Television
_____ Extension Newsletter
_____ Flyer from child's school
_____ Friend or Neighbor
_____ Other (explain)

____

Thank you for your participation. Please return this survey form by **June 25, 1999.** A postage-paid envelope has been provided for your use in returning this form to:

David Danner, Bland County
Virginia Cooperative Extension
Extension Distribution Center
112 Landsdowne Street
Blacksburg, VA 24060-9984

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