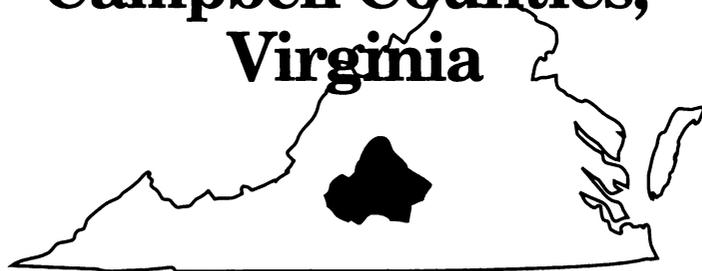


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Evaluation of Household Water Quality in Amherst, Appomattox, Bedford and Campbell Counties, Virginia



May 1999

Household Water Quality Series 37
Department of Biological Systems Engineering
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EVALUATION OF HOUSEHOLD WATER QUALITY IN AMHERST, APPOMATTOX, BEDFORD, AND CAMPBELL COUNTIES, VIRGINIA

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Evaluation of Household Water Quality in Amherst, Appomattox, Bedford and Campbell Counties Virginia

ABSTRACT

During Spring/Summer 1998 in Amherst, Appomattox, Bedford, and Campbell 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 four counties who utilized a private, individual water supply. During the course of the project, 490 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 four counties as iron/manganese, corrosivity, and bacteria.

After the completion of the general water testing program, water supplies from 12 households were resampled for the testing of 16 pesticides and other chemical compounds. None of the samples had a concentration of any of these contaminants exceeding EPA Health Advisory of Maximum Contaminant Levels. Furthermore, there were no detections of any compound observed.

Following completion of the programs, a survey was mailed to the 490 participants. Two hundred and fifty-six 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. More than two-thirds 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. Fifteen percent or more of all participants had taken, or planned to take, one or both of the following actions: shock chlorinate the water system and purchase or rent water treatment equipment.

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ACKNOWLEDGMENTS

Many thanks are due the residents of Amherst, Appomattox, Bedford, and Campbell Counties who participated in the educational program. Without their enthusiasm and cooperation, the program could not have succeeded. Special thanks are extended to all others who provided support in terms of publicity, encouragement, and interest, thus contributing to the success of the household water quality educational program. Public officials and other from the four counties, who spoke at the public meetings, are greatly appreciated. Jim Bowles, District Environmental Health Manager, Virginia Department of Health, participated in most of these meetings by sharing his expertise and advice. CSREES/USDA Water Quality Program Support 3-d funds were 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. Carol Newell, 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. The Pesticide Research Laboratory, of the Biochemistry and Anaerobic Microbiology Department of Virginia Tech, performed the pesticide analysis.

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. 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 Amherst, Appomattox, Bedford, and Campbell Counties, for example, nearly two-thirds (64%) of all housing units are served by individual water systems (Koebel et al., 1993). Virtually all of these homes depend on groundwater sources.

In the rural areas of these four counties, most wells were drilled only for farm or domestic water supply. George and Gray (1988) have estimated that nearly one-half of the drilled wells are inadequately constructed, while more than 80% of all dug/bored wells are inadequate. Nearly 5% percent of households were also estimated to have failing or inadequate waste disposal systems.

Amherst, Appomattox, Bedford, and Campbell Counties surround the city of Lynchburg and have a combined land area of 2,068 square miles. All of Appomattox and Campbell, and most of Amherst and Bedford, lie within the Piedmont physiographic province. The western areas of the latter two counties are part of the Blue Ridge physiographic province. The four-county area drains into two major Virginia basins: the James and Roanoke Rivers, which along with their major tributaries, are the primary sources of surface water. All of Amherst County drains into the James River, while the remaining three counties provide drainage into both the James and Roanoke Rivers.

The population of the four counties increased by 10% during the period 1980-90, with the vast majority of this growth taking place in Bedford County which grew by 31% during this same period. Most of this new development occurred in the Smith Mountain Lake area of Bedford as well as in areas of all four counties near Lynchburg. Some new home sites 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 42 additional counties. During the course of these projects, more than 6,400 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 Amherst, Appomattox, Bedford, and Campbell Counties, in addressing the above water quality issues, that led to the implementation of the Household Water Quality Education Program in these four counties.

OBJECTIVES

The primary goal of this project was to conduct educational programs on household water quality to include water testing/diagnosis in Amherst, Appomattox, Bedford, and Campbell Counties, Virginia. 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 Campbell and Bedford Counties back-to-back during Spring 1998 and in Amherst and Appomattox Counties concurrently during late Spring/early Summer 1998. 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 a program fact sheet was prepared (see Appendix).

The programs were launched through meetings held in Rustburg and Bedford in late March and late April, respectively, and in Amherst and Appomattox in late May. 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 cost of \$30 per household water sample submitted.

Provisions were made to analyze from 150 to 300 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 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. Participants were also provided with sampling instructions which 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 April 14 and 28 in Campbell, May 12 and 26 in Bedford, and on June 9 and 23 in both Amherst and Appomattox 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 late-May and late-June in Campbell and Bedford Counties, respectively, and in late-July in both Amherst and Appomattox Counties 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 general water testing program described above, participating households were given the opportunity to have their water further tested, for the presence of pesticides and other chemical compounds, at a cost of \$75 per sample. The Pesticide Research Laboratory of the Biochemistry and Anaerobic Microbiology Department at Virginia Tech performed the analyses. Sample jars and forms (see Appendix) were provided, whereby local project personnel collected the samples from August 17 – September 1, 1998.

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, 490 individual household water samples were returned for general water chemistry and bacteriological analysis from all areas of the four 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 490 forms mailed, 256 were returned (a 52% 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 Amherst, Appomattox, Bedford, or Campbell Counties was 16 years. The length of residence reported ranged from 1 to 80 years. Twenty-four 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 eight members; average household size was 2.40. It can, therefore, be estimated that nearly 1200 residents of the four counties were directly impacted by the water analysis/diagnosis aspect of the programs.

Almost one-half (46%) 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 majority of the respondents exceeded the median family income (\$32,579 averaged for the four counties and according to the 1990 Census) (Koebel et al., 1993). Seventeen percent of respondents declined to indicate family income.

Profile of Household Water Supplies

The initial survey answers, provided by all participants in the water testing programs (n=490), 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, rural community (39%) was the most common and subdivision (13%) the least common.

Participants were also asked to identify potential contamination sources within 100 feet of their water supply. The major sources identified were home heating oil storage tanks (13%) and septic system drainfields (11%). 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; 37% of the participants indicated that their water supply was located within one-half mile of major farm animal operation and 10% within one-half mile of a fruit orchard.

Information was also obtained regarding characteristics of the participants' water supply systems. Regarding the type of water source supplying the household, the vast majority of the participants (94.1%) reported that they rely on a well. Use of a spring was reported by 5.7% of participant households. One participant indicated that his/her household water source was a cistern. Participants who indicated their water supply source was a well were asked to provide an estimate of the well depth, if known. Of those participants indicating well depths, 94% reported depths of

Figure 1. Educational Level Achieved by Participants

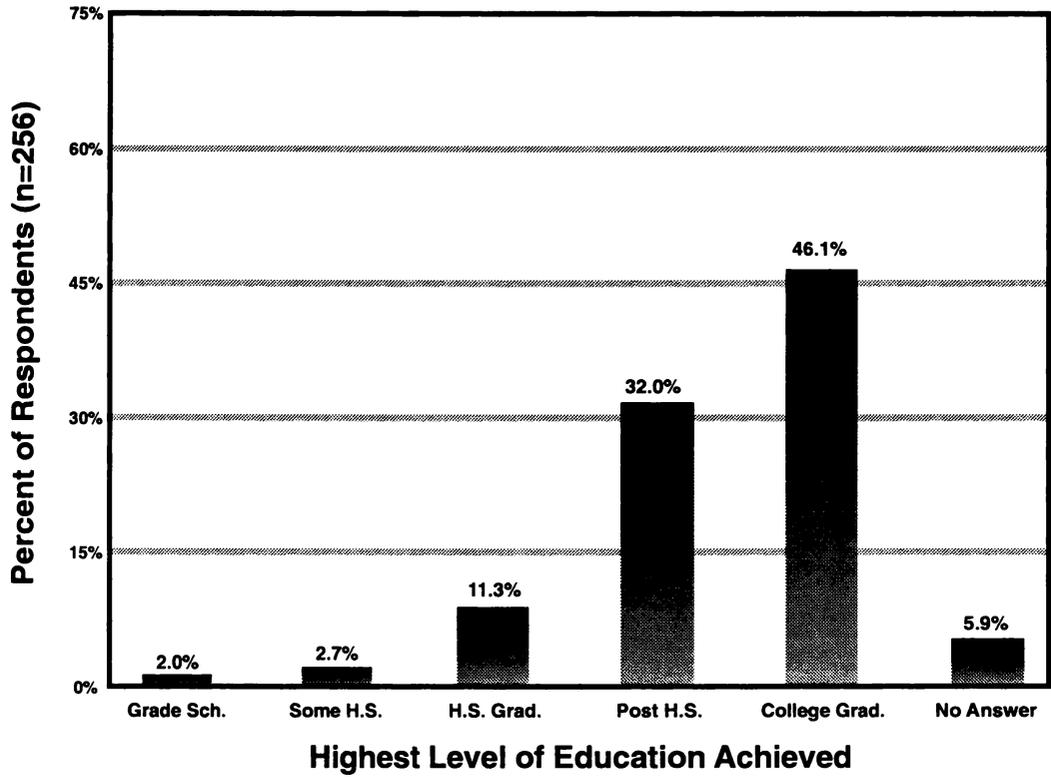


Figure 2. Family Income of Participants

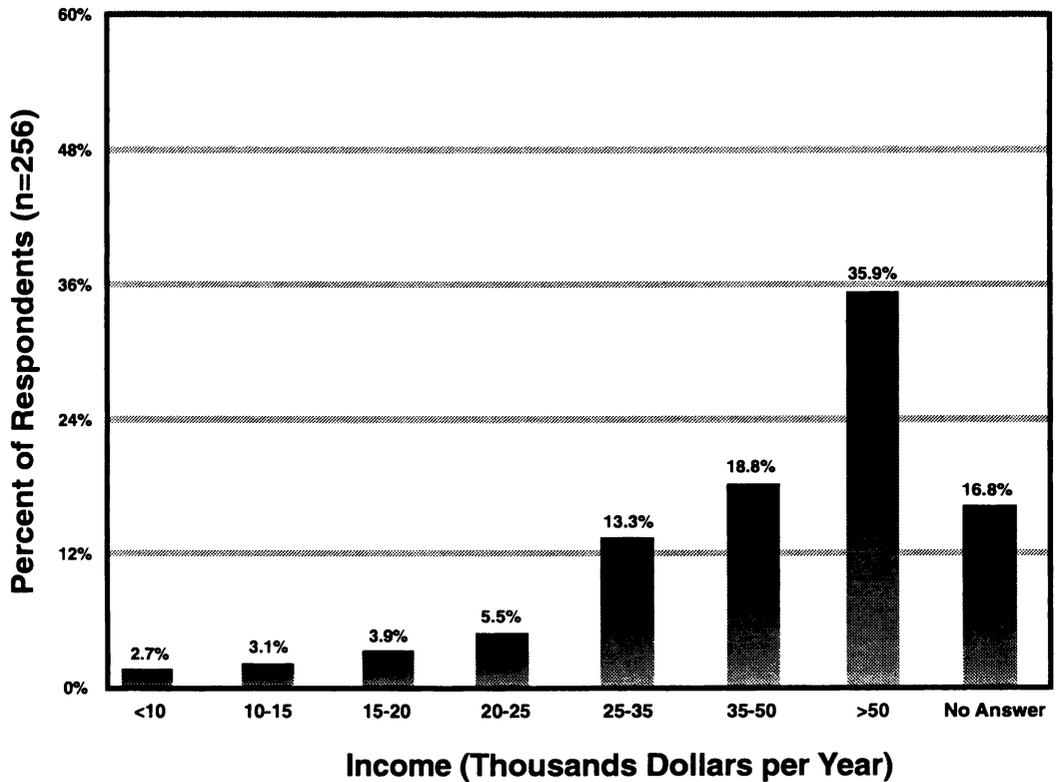
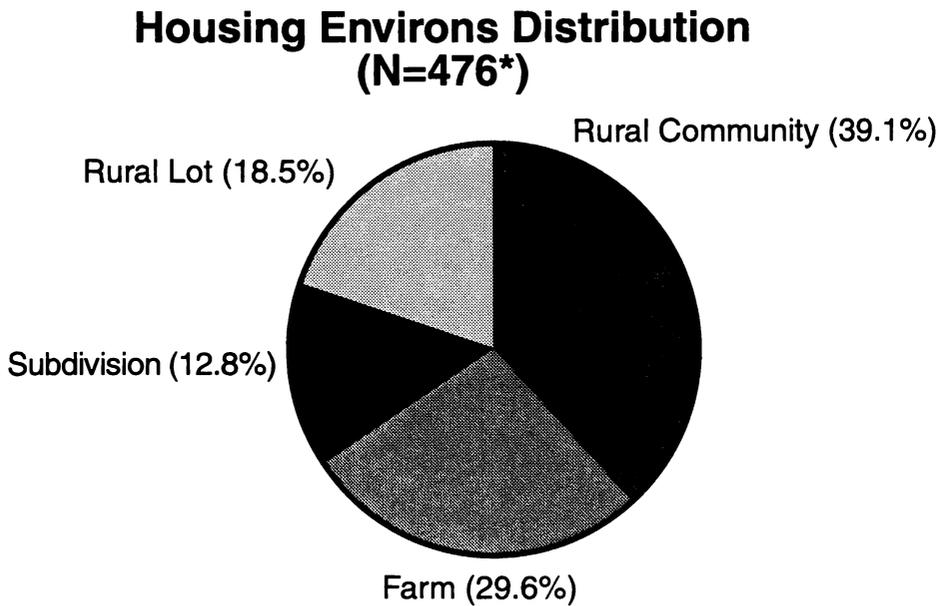


Figure 3. Housing Environs of Participants



* Fourteen participants did not respond.

more than 50 feet, while 6% reported less than or equal to 50 feet. The maximum well depth reported was 575 feet; the average well depth was 180 feet. Twenty-four percent of the wells were constructed in or prior to 1970. The earliest reported well construction date was 1876.

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 copper (48%), while plastic was reported by nearly as many participants (45%). Four 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-four percent of the participants reported at least one treatment device installed, with the most common type of treatment device in use being sediment filters (75%),

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 18% of the participants identified, participants were given several more specific descriptions from which to choose if answering positively.

Twenty-one percent of the participants responded that their water had an unpleasant taste. For these participants, the identification of tastes is presented in Figure 5. "Metallic" taste was

the most common problem (54%), followed by "bitter" and "sulfur," identified by 23% and 15%, respectively, of those who reported taste problems. Twelve percent of these reported "other" tastes, such as musty.

An objectionable odor was reported by 13% 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 59% of those reporting odor problems. Sixteen percent provided "other" odors, such as metallic.

Eleven percent of the participants affirmed their water had an unnatural color or appearance. "Muddy" was identified by 42% of those who reported appearance problems (Figure 7), followed by 20% indicating "oily film" and 18% "yellow." Twenty-six 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 percent described such a condition; two-fifths (40%) of these reported that they noticed "black specks" in their water followed by 28% reporting "brown sediment" (Figure 8). Nineteen percent indicated "other," which included a description of gray sediment.

Staining problems on plumbing fixtures, cooking appliances/utensils, and/or laundry were reported by 58% of the participants. As presented in Figure 9, the major problem was that of "blue-green" identified by 56% of those with staining problems, followed by "rusty" stains, reported by 41%.

Household Water Quality Analysis

Ultimately, two sample groups resulted: the "tap water" and "raw water" samples. The "tap water" group consisted of the 490 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, groundwater (wells and springs) systems only - a total of 324 samples.

The raw water sample results presented below may not be entirely indicative of the status of raw groundwater quality in Amherst, Appomattox, Bedford, and Campbell 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 four 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 all counties combined. Table 2 provides, for both sample groups and each county as well as all 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, 12% of samples in the tap water and 14% in the 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 varied greatly across counties (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. While only 5% of all participants reported the installation of an iron removal filter, the results of the sample questionnaire (see Appendix) revealed that 41% of the 283 who reported staining problems, or 24% 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.

This observation, however, is not unusual in 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 8% of samples in the tap water and 9% of samples in the raw water sample groups of all four counties 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 four counties exceeded that of iron, particularly in Amherst and Appomattox Counties. While manganese stains are generally dark and 4% of all participants indicated “black” stains, 20% of the tap water and 23% of the raw water samples exceeded the SMCL for manganese of 0.05 mg/L. The “particles in water” description of “black specks,” reported by 8% 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 not prevalent in central and eastern Virginia. Extensive use of water softeners is not warranted, although 4% of all participants had installed water softeners (Figure 4). Only four samples in the tap water (one sample from each county) and two samples in the raw water groups exceeded the maximum recommended hardness level of 180 mg/L.

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. Twenty-one percent of the tap water and 18% of raw water samples of all four counties were in the range of 60 mg/L to 180 mg/L total

Figure 4. Household Water Treatment Devices Installed

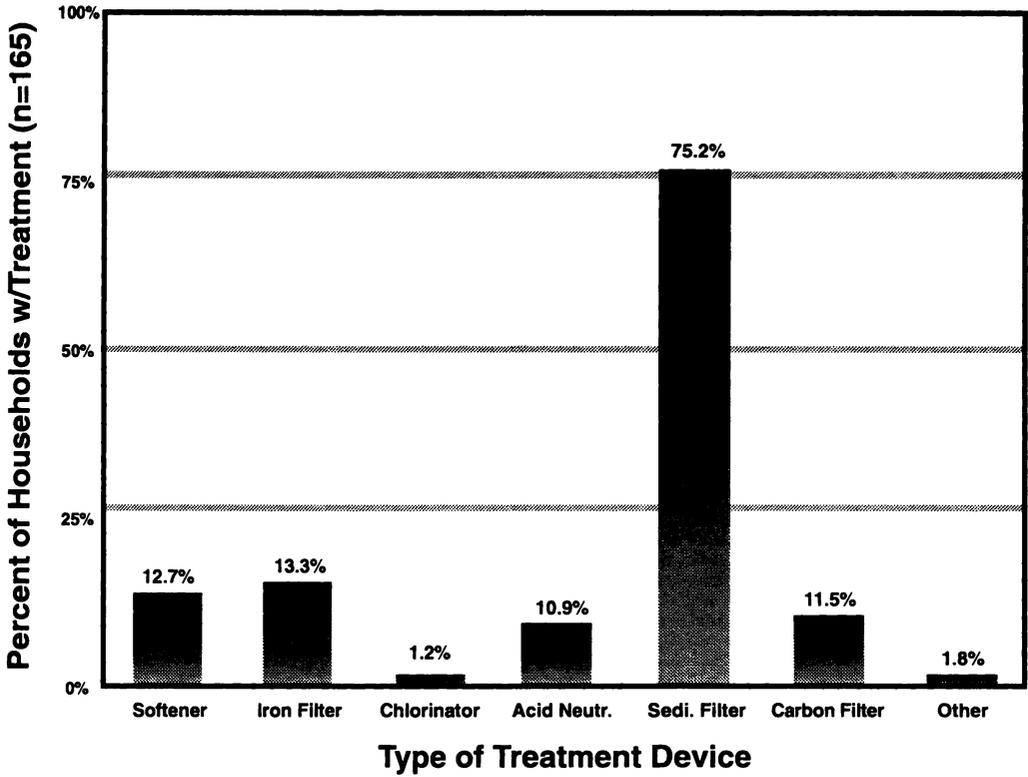


Figure 5. Unpleasant Tastes Reported by Participants

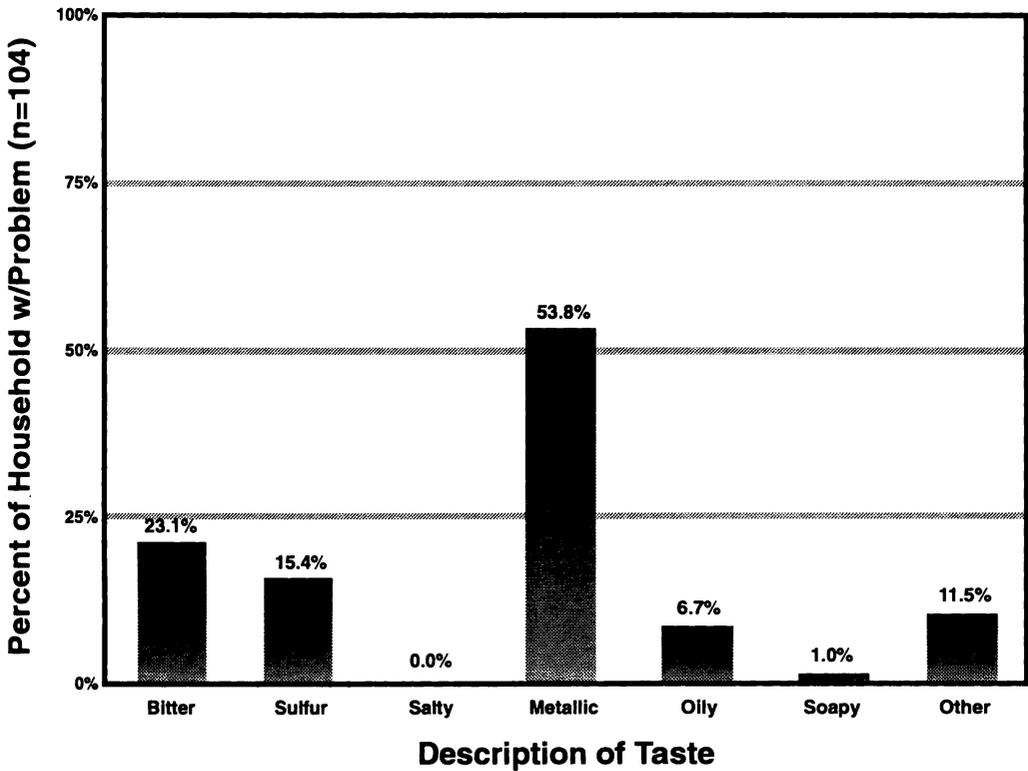


Figure 6. Objectionable Odors Reported by Participants

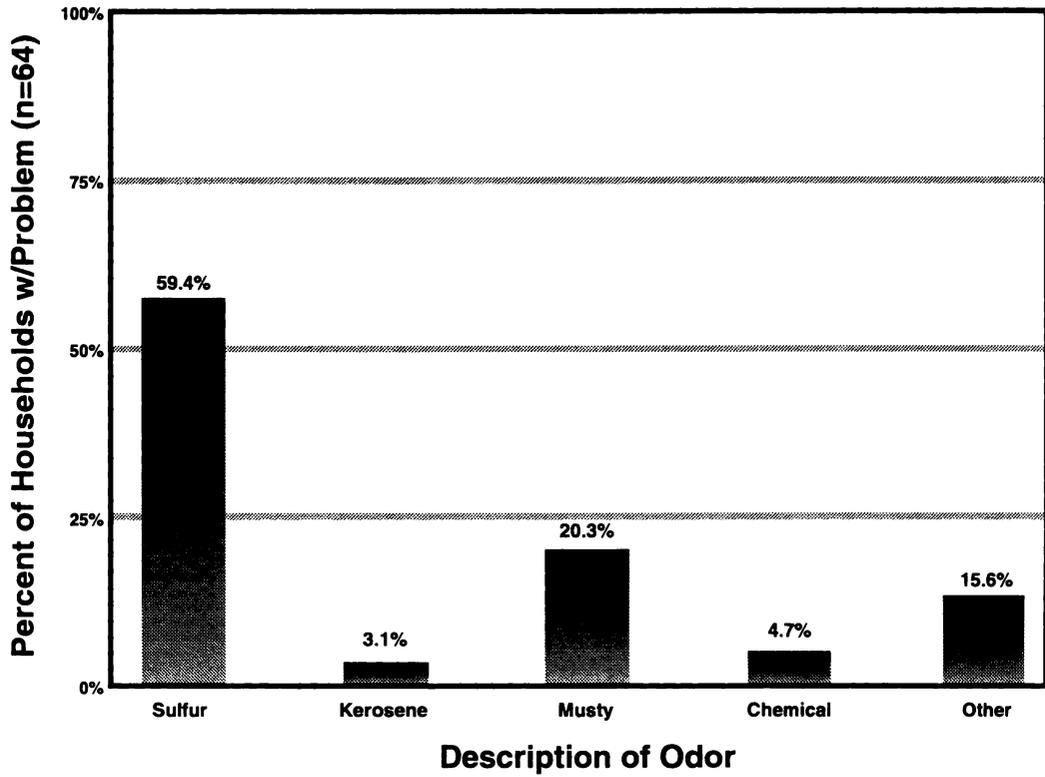


Figure 7. Unnatural Appearance Reported by Participants

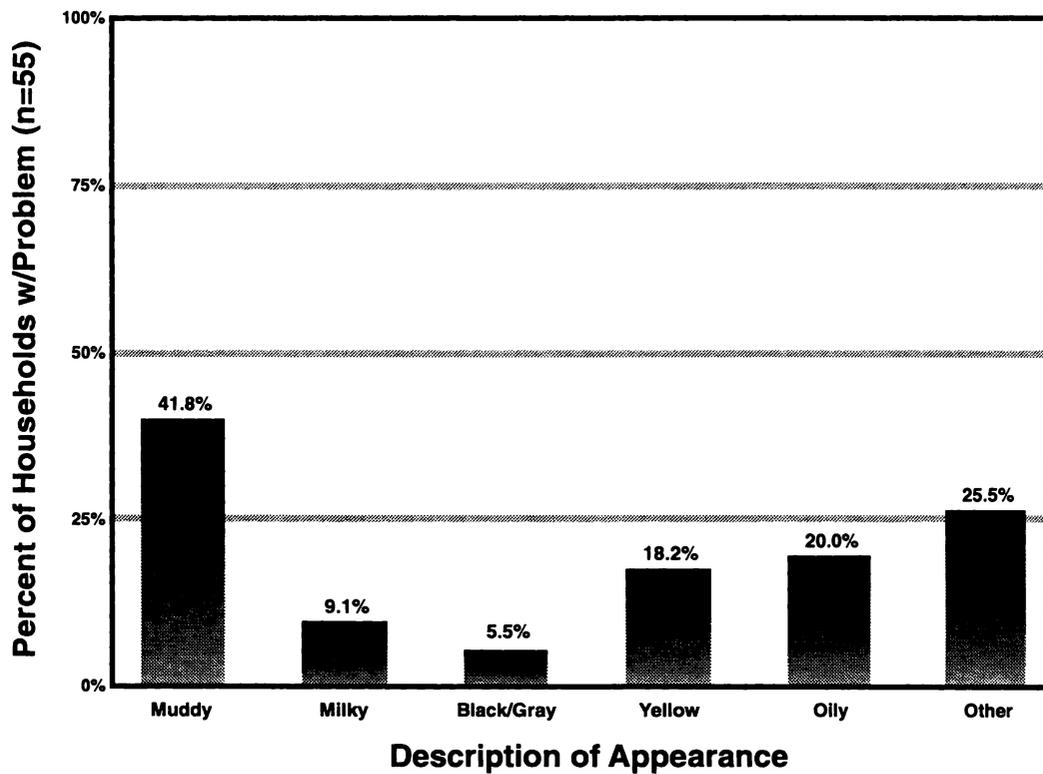


Figure 8. Particles in Water Reported by Participants

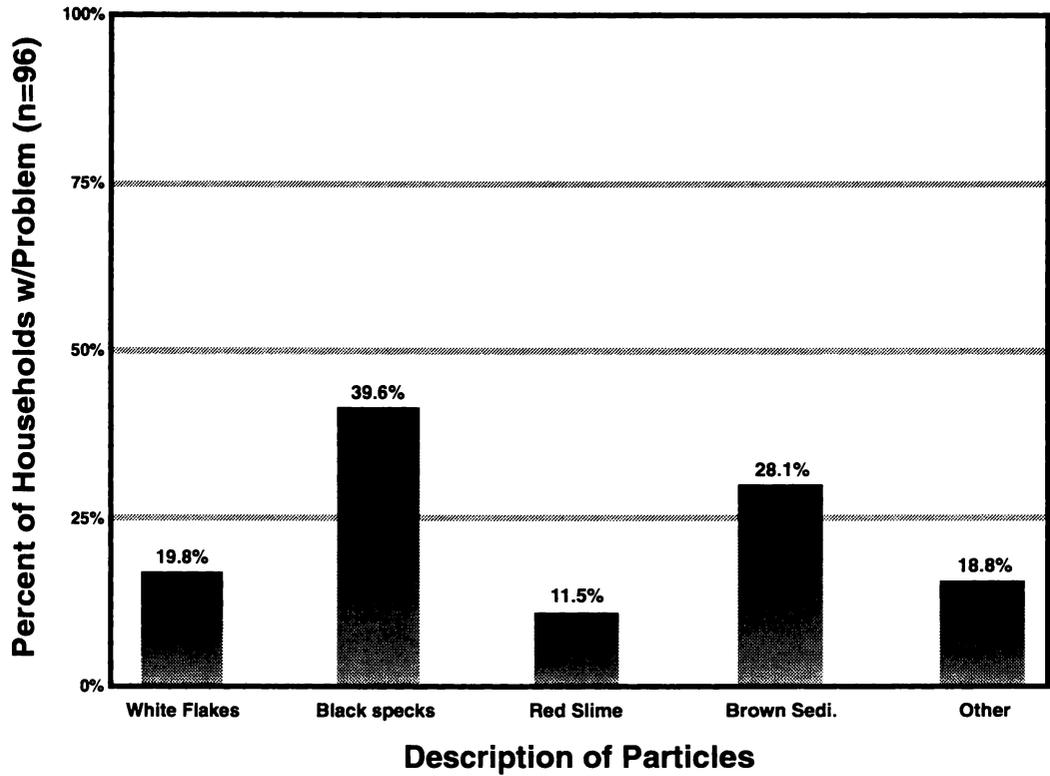
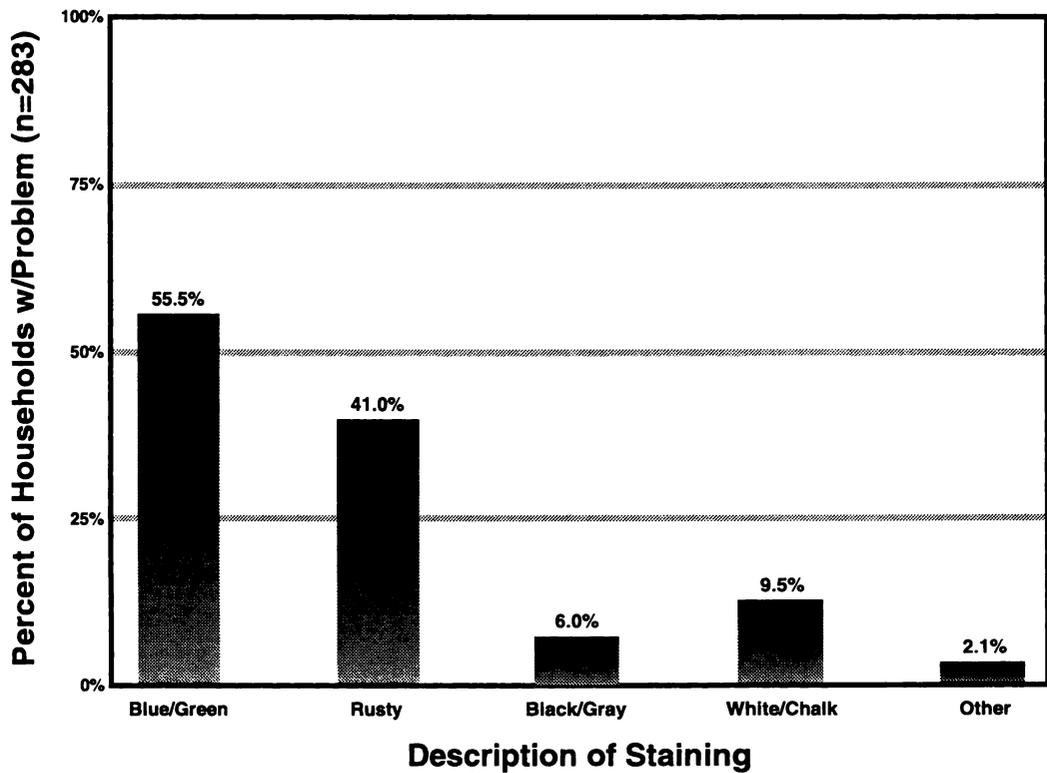


Figure 9. Staining Problems Reported by Participants



hardness, indicating that more than one-fifth 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 more than one-half of those reporting odor problems indicate that hydrogen sulfide gas may be a somewhat widespread problem in household water systems in the four counties; a conclusion that can not be confirmed by the presence of sulfate.

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. Only one sample at 260 mg/L (located in Appomattox County) in the tap water and raw water groups 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. No samples in the tap water or raw water groups exceeded the MCL or the SMCL. Furthermore, none exceeded the laboratory detection limit for fluoride of 0.5 mg/L.

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 72 mg/L and 78 mg/L for the raw water and tap water sample groups, respectively. None of the samples in either sample group exceeded the standard. The maximum TDS concentrations among both the raw water and tap water samples was 469 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 6.6 for the tap water sample group and 6.5 for the raw water sample group. Two of the samples in the tap water sample group only exceeded a pH of 8.5, with a maximum pH value of 9.6. For the tap water and raw water sample groups, 49% and 54%, respectively, were less than 6.5. (Amherst County had the greatest incidence of excessive

acidity at 62% of tap water samples while Campbell County experienced the least at 35%.) 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 28% of both the tap water and raw water samples of all four counties 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 93% of the tap water and 94% of the raw water samples. Average saturation index values were -2.83 and -2.92 for the tap water and raw water sample groups, respectively, with a minimum value of -5.73 in both groups.

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.

Less than 1% of samples in the tap water group and only one sample in the raw water group exceeded the recommended health level of 1.3 mg/L. An additional three samples in the tap water and raw water sample groups exceeded the SMCL of 1.0 mg/L. The maximum copper concentration measured was 2.3 mg/L for both sample groups. 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 7.9 mg/L and 5.8 mg/L for the tap water and raw water sample groups, respectively, while the maximum concentration was 71 mg/L for the former and 66 mg/L for the latter groups. For the tap water samples, 7% exceeded 20 mg/L, while only 1% exceeded 20 mg/L for the raw water samples. All of the reported water softeners were in Bedford and Campbell Counties only, consequently, these counties experienced comparatively more excessive sodium in the tap water samples than Amherst and Appomattox Counties.

While sodium concentrations were likely impacted by water softeners to some extent, it should be reemphasized, 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. As is evident from the maximum sodium concentrations presented above, none of the samples exceeded 100 mg/L.

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

Table 1. Average and range of concentration of contaminants comprising general water chemistry analysis for Amherst, Appomattox, Bedford, and Campbell Counties.

Test	Detection Limit	Measured Concentrations					
		Raw Water (n=324)			Tap Water (n=490)		
		Avg. ¹	Min.	Max.	Avg.	Min.	Max.
Iron (mg/L)	0.005	0.244	DL ²	10.460	0.209	DL	10.460
Manganese (mg/L)	0.001	0.094	DL	6.298	0.074	DL	6.298
Hardness (mg/L)	0.3	39.7	0.7	307.8	40.3	DL	307.8
Sulfate (mg/L)	0.3	3.3	DL	40.4	3.6	DL	59.1
Chloride (mg/L)	40.0	43.0	DL	260.0	43.0	DL	260.0
Fluoride (mg/L)	0.5	0.50	DL	DL	0.50	DL	DL
TDS (mg/L)	1.0	72.0	7.0	469.0	78.0	7.0	469.0
pH	-	6.53	5.40	7.98	6.60	5.40	9.57
Saturation Index	-	-2.92	-5.73	-0.09	-2.83	-5.73	0.85
Copper (mg/L)	0.002	0.128	DL	2.283	0.129	DL	2.283
Sodium (mg/L)	0.01	5.79	0.65	66.03	7.88	0.65	70.89
Nitrate (mg/L)	0.005	0.819	DL	11.180	0.696	DL	11.180

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

²Sample 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 Amherst, Appomattox, Bedford, and Campbell Counties.

Test	Standard	Percent of Values Exceeding Standard									
		Raw Water					Tap Water				
		Total n=324	Amh. n=75	App. n=42	Bed. n=148	Cam. n=59	Total n=490	Amh. n=113	App. n=49	Bed. n=248	Cam. n=80
Iron (mg/L)	0.3	13.9	5.3	9.6	18.3	17.0	12.1	3.5	8.2	15.3	16.3
Manganese (mg/L)	0.05	22.8	6.7	30.9	20.3	20.3	20.4	25.7	26.6	17.0	20.0
Hardness (mg/L)	180.0	0.6	0	2.4	0	1.7	0.8	0.9	2.0	0.4	1.3
Sulfate (mg/L)	250.0	0	0	0	0	0	0	0	0	0	0
Chloride (mg/L)	250.0	0.3	0	2.4	0	0	0.2	0	2.0	0	0
Fluoride (mg/L)	$\frac{2}{4}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
TDS (mg/L)	500.0	0	0	0	0	0	0	0	0	0	0
pH - Low	6.5	54.0	65.3	61.9	52.7	37.3	49.0	61.9	57.1	46.0	35.0
pH - High	8.5	0	0	0	0	0	0.4	0	0	0.8	0
Saturation Index - Low	-1.0	94.1	100.0	97.6	92.6	88.1	93.3	97.3	98.0	92.7	86.3
Saturation Index - High	+1.0	0	0	0	0	0	0	0	0	0	0
Copper (mg/L)	$\frac{1.0}{1.3}$	$\frac{1.2}{0.3}$	$\frac{1.3}{0}$	$\frac{2.4}{0}$	$\frac{0.7}{0.7}$	$\frac{1.7}{0}$	$\frac{1.4}{0.8}$	$\frac{2.7}{1.8}$	$\frac{2.0}{0}$	$\frac{0.8}{0.8}$	$\frac{1.3}{0}$
Sodium (mg/L)	20.0	1.2	1.3	2.4	0.7	1.7	6.5	2.7	2.0	9.7	5.0
Nitrate (mg/L)	10.0	0.3	0	0	0.7	0	0.2	0	0	0.4	0
Total Coliform	ABSENT	36.1	26.7	42.9	37.2	40.7	31.6	27.4	44.9	29.4	36.3
E. coli	ABSENT	10.2	14.7	9.5	8.8	8.5	8.6	14.2	8.2	6.5	7.5

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 11.2 mg/L for both the tap water and raw water sample groups. This value represented the only sample in each sample group which exceeded the MCL of 10 mg/L (found in Bedford County). Thus, serious nitrate contamination does not appear to be a widespread problem in any of the four counties. When a 1 mg/L threshold value was selected, however, a much higher occurrence of nitrate was determined. In this case, nearly one-fourth of the samples, 22% of the tap water and 26% of the raw water samples, exceeded the level of potential concern to infant health. Furthermore, 7% of both the tap water and the raw water samples had nitrate concentrations exceeding 3 mg/L, indicating that health-impacting levels would likely be approached in a few cases in all four counties.

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 490 household water samples from the four counties analyzed for total coliform bacteria, 155 (32%) tested positive (present). Subsequent *E. coli* analysis for these total coliform positive samples resulted in 42, or 27%, positive results, or 9% 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 36 and 10, respectively. It is interesting to note that Amherst County had both the lowest incidence of total coliform contamination and the greatest occurrence of *E. coli* bacteria.

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. Furthermore, deep drilled wells are better protected than shallow dug and bored wells. 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 71% and 46%, respectively, for dug/bored wells, 52% and 14%, respectively, while for drilled wells, positive total coliform and *E. coli* results were obtained for 27% and 5% of all samples.

Table 3. Pesticides and other chemical compounds analyzed in 12 household water supplies (Amherst, Appomattox, Bedford, and Campbell Counties).

Common Name	Trade name	Maximum Desired Concentration ¹ (ppb) ²	Maximum Measured Concentration (ppb)	Frequency of Sample Detection
Alachlor	Lasso	2.0	ND ³	0
Aldicarb	Temik	7.0	ND	0
Atrazine	Aatrex	3.0	ND	0
Azinphos-methyl	Guthion	–	ND	0
Captan	Orthocide	–	ND	0
Carbaryl	Sevin	700.0	ND	0
Chlordane	–	2.0	ND	0
Chlorpyrifos	Dursban	20.0	ND	0
DDTs	–	–	ND	0
Diazinon	Spectracide	0.6	ND	0
Dicamba	Banvel	200.0	ND	0
Isofenphos	Oftanol	–	ND	0
Lindane	–	0.2	ND	0
Methoxychlor	Marlate	40.0	ND	0
Metolachlor	Dual	70.0	ND	0
PCB's	–	0.5	ND	0

¹ U.S. EPA MCL or HAL, if available

² ppb - parts per billion, equivalent to micrograms per liter in water

³ ND - Non-detectable (below laboratory detection limit of 0.01 ppb)

Table 4. Measures taken or planned by respondents, since water quality analysis, to improve water supply (Amherst, Appomattox, Bedford, and Campbell Counties)

Measure	Percent of All Respondents (n=256)	Percent of Respondents who Reported the Following Problems			
		Health Only (n=41)	Nuisance Only (n=81)	Health & Nuisance (n=44)	None (n=90)
Contact an Agency, such as the Health Department	7.8	29.3	1.2	13.6	1.1
Seek Additional Water Testing from Another Lab	10.2	24.4	1.2	34.1	0
Determine Source of Undesirable Condition	9.0	24.4	0	29.5	0
Pump Out Septic System	2.7	4.9	0	11.4	0
Improve Physical Condition of Water Source	6.3	19.5	1.2	15.9	0
Shock-Chlorinate Water System	16.8	48.8	1.2	43.2	3.3
Obtain New Water Source	0.8	2.4	0	2.3	0
Use Bottled Water for Drinking/Cooking	6.3	12.2	3.7	13.6	2.2
Temporary Disinfection, such as Boiling Water	2.0	7.3	0	4.5	0
Purchase or Rent Water Treatment Equipment	15.2	0	32.1	20.5	4.4
Improve Existing Water Treatment Equipment	7.0	7.3	12.3	11.4	0
Take Other Measures to Eliminate/Reduce Contaminant(s)	7.0	4.9	12.3	6.8	3.3
Have Not Done Anything	51.2	24.4	44.4	13.6	87.8

While fecal bacteria in household water supplies may have originated from animal waste generation in some cases, it is likely that, considering the wide geographic distribution of positive results and the proximity of water supplies to specific pollution sources, many fecal coliforms present in water were due to 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 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 respondents 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.

Pesticide Analysis

As mentioned earlier, several of the original participating households opted to pay for additional testing of pesticides and other chemical compounds. Ultimately, 12 household water supplies, of the original total of 490, were resampled. The 16 constituents analyzed were considered to be the most likely to be found in groundwater partly because they are currently, or were recently, in common use in the four-county area. These pesticides and other compounds are listed in Table 3.

Analysis for these constituents revealed no evidence of excessive contamination in terms of human health implications. Out of a total of 192 test results, all resulted in concentrations below the laboratory detection limit (considered to be approximately 0.01 parts per billion, or ppb).

Post-Program Survey

Following the completion of the basic educational program, a survey form (see Appendix) was mailed to the 490 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. Two hundred and fifty-six (52%) 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. Thirty-one percent of the respondents indicated that they had previously obtained water test results. Of those reporting a prior testing date, 43% had done so within the past five years and 20% within the past two years.

Reasons for Program Participation

People participated in the water quality program for one or more reasons. Seventy-four percent of the respondents were prompted to participate by concern about the safety of their water supply. Thirty-seven percent of the respondents were prompted by nuisance problems, such as staining, objectionable taste and odor, etc. Nine percent wanted to follow up on previous tests of their household water. Sixteen 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 4 presents the results of this inquiry, with the greatest number of households (15% or more) indicating one or both of the following actions: shock chlorinate the water system and purchase or rent water treatment equipment.

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 coliform 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, 81% had taken, or planned to take, at least one measure to improve their water supply. The measures taken by the greatest number of households in these two categories were: shock chlorinate the water system, seek additional testing from a laboratory, and determine the source of undesirable condition.

As expected, respondents were more likely to address health-related problems than nuisance problems. Of the households with unsatisfactory levels of one or more nuisance contaminants only, 56% had taken, or planned to take, at least one measure to improve their water supply. Not unexpectedly, the group of households that reported the fewest follow-up measures (12%) were the households with neither potential health problems nor unsatisfactory levels of nuisance contaminants.

CONCLUSIONS

The Household Water Quality Educational Programs conducted in Amherst, Appomattox, Bedford, and Campbell 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 -- 34% 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 water treatment devices, the major remaining household water quality problems in Amherst, Appomattox, Bedford, and Campbell Counties, existing from a nuisance standpoint, were iron/manganese and corrosivity. The major health-related concerns were corrosivity (because of the potential to raise dissolved copper and lead levels in household water) and bacteria. Thirty-two percent of the samples tested positive for total coliform and 9% 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.

The limited analysis for pesticides and other chemical compounds revealed no problems with such contamination. All concentrations were nondetectable at levels below 0.01 ppb, therefore none of the 12 tested samples had a contamination of any of the 16 pesticides and other chemical compounds analyzed present in a concentration exceeding the corresponding EPA MCL or HAL.

Sixty-nine 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. Fifteen percent or more of all respondents had taken, or planned to take, one or both of the following actions: shock chlorinate the water system, and purchase or rent water treatment equipment.

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APPENDIX *

- (1) Program Fact Sheet
- (2) Sample Identification and Questionnaire Form
- (3) Sample Water Quality Analysis Report
- (4) Report Interpretation
- (5) Pesticide Analysis Sample Form
- (6) Post-Program Survey

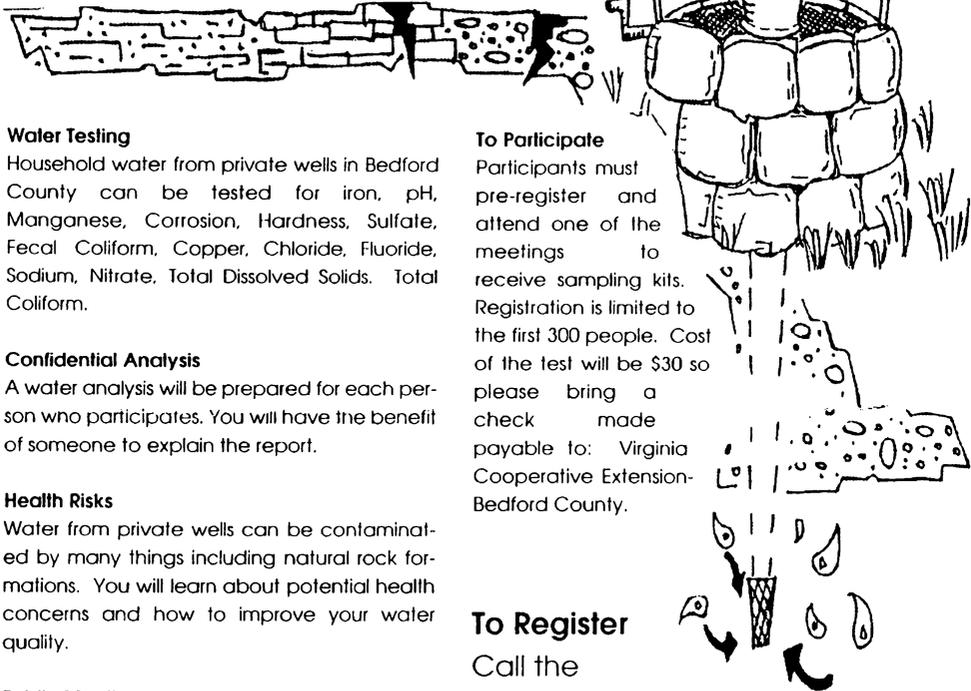
** The following examples represent forms, reports, etc. used in the Bedford County Program only. Paperwork for Amherst, Appomattox, and Campbell Counties was similar, except for the information that was county-specific.*

Virginia Cooperative Extension & Bedford County are offering:

GROUNDWATER EDUCATION



WATER TESTING PROGRAM



Water Testing

Household water from private wells in Bedford County can be tested for iron, pH, Manganese, Corrosion, Hardness, Sulfate, Fecal Coliform, Copper, Chloride, Fluoride, Sodium, Nitrate, Total Dissolved Solids. Total Coliform.

Confidential Analysis

A water analysis will be prepared for each person who participates. You will have the benefit of someone to explain the report.

Health Risks

Water from private wells can be contaminated by many things including natural rock formations. You will learn about potential health concerns and how to improve your water quality.

Public Meetings

We will hold two informational meetings at which time you will have the chance to pay for and receive your sampling kits. Meetings will be in the Public Meeting Room at the County Administration Building on Tuesday, April 28. Select to come at 2:00 or 7:00 p.m. hours.

To Participate

Participants must pre-register and attend one of the meetings to receive sampling kits. Registration is limited to the first 300 people. Cost of the test will be \$30 so please bring a check made payable to: Virginia Cooperative Extension-Bedford County.

To Register

Call the Bedford Extension Office at **586-7675** to register

This is an information & educational meeting. For more information, call the Bedford Extension Office.

586-7675

If you are a person with a disability and require any auxiliary aids, services, or other accommodations for this event/activity, please contact the Virginia Cooperative Extension Local Office five days prior to event/activity at 540 586-7675, Monday-Friday, 8 a.m. to 4:30 p.m.

FACT SHEET

BEDFORD COUNTY WATER TESTING PROGRAM

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

WHOSE WATER SUPPLY WILL BE TESTED?

- A. Private household water supplies; wells, springs, cisterns
- B. 300 water supplies (given on first-come, first-serve basis)
- C. Priority given to those persons attending April Informational Meetings

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 tests (present/absent).
Both tests have commercial cost of approximately \$150. Through this program, the homeowner cost will be **\$30**.

INFORMATIONAL MEETING AND WATER SAMPLE KITS: Persons attending the April Meetings will be given first priority for water testing. Water sample kits will be available at the meeting for May delivery dates.

PLACE:

**Bedford Co. Administration Building, 2nd Floor April 28, 2:00 P.M. or
Bedford Co. Administration Building 2nd Floor April 28, 7:00 P.M.**

For persons not attending one of these meetings, any remaining kits will be available beginning April 29, at the Bedford County Extension Office.

DELIVER WATER SAMPLE: May 12 & 26 to the Bedford County Extension Office from 7:30 a.m. to 1:00 p.m. Delivery dates will be assigned.

TEST RESULTS AND EXPLANATION OF ANALYSIS: June 23 at 2:00 p.m. or 7:00 p.m. at the Meeting Room of the Bedford County Administration Building.

Individual water test reports will be available at either of these meeting times with specialists available to explain results and any necessary treatment strategies.

CONFIDENTIALITY: All results will be kept confidential.

For more information, contact:

**BEDFORD COUNTY EXTENSION OFFICE
122 EAST MAIN ST.—STE 102
BEDFORD VA 24523-2035
540-586-7675**

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(2) Sample Identification and Questionnaire Form

BEDFORD COUNTY HOUSEHOLD WATER QUALITY PROGRAM

Bedford County Cooperative Extension
122 East Main St., Suite 102
Bedford, Virginia 24523-2305
(540) 586-7675

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):

- | | |
|---|--|
| <input type="checkbox"/> none | <input type="checkbox"/> acid water neutralizer |
| <input type="checkbox"/> water softener (conditioner) | <input type="checkbox"/> sediment filter (screen or sand type) |
| <input type="checkbox"/> iron removal filter | <input type="checkbox"/> activated carbon (charcoal) filter |
| <input type="checkbox"/> automatic chlorinator | <input type="checkbox"/> other (specify): _____ |

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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 compost/trash pile
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 fruit orchard/crop production
 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

BEDFORD COUNTY HOUSEHOLD WATER QUALITY PROGRAM

Bedford County Cooperative Extension
122 East Main St., Suite 102
Bedford, Virginia 24523-2305
(540) 586-7675

Sample No. B-

Blue Ridge, Va 24064

540 -947-

Source: drilled well 150 ft deep
Treatment: none

Water Quality Results Date of sample: 05/26/98

Test	Household Water Sample	Maximum Recommended Level or Range
Iron (mg/l)	0.1429	0.3
Manganese (mg/l)	< 0.001	0.05
Hardness (mg/l)	16	180
Sulfate (mg/l)	0.574	250
Chloride (mg/l)	< 40	250
Fluoride (mg/l)	< 0.5	2
TDS (mg/l)	31	500
pH	7.0	6.5 to 8.5
Saturation Index	-3.00 **	-1 to 1
Copper (mg/l)	0.026	1.0
Sodium (mg/l)	4.43	20
Nitrate-N (mg/l)	0.691	10
Total Coliform Bacteria	PRESENT**	ABSENT
E. Coli Bacteria	ABSENT	ABSENT

** Measured value exceeds recommendation for household water.

Analysis coordinated by Water Quality Laboratory, Department 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.

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Lorena W. Lyone, Administrator, 1890 Extension Program, Virginia State, Petersburg.

(4) Report Interpretation

Bedford 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.

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Report Interpretation (cont.)

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.

Compiled by Blake Ross, Extension Agricultural Engineer, and Kathy Parrott, Extension Specialist, Housing, Virginia Tech, Blacksburg, VA

June 1998

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

(5) Pesticide Analysis Sample Form

**BEDFORD COUNTY
HOUSEHOLD WATER QUALITY PROGRAM
CHEMICAL COMPOUND ANALYSIS**

Department of Biological Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0303

SAMPLE NUMBER: _____ DATE COLLECTED: _____

SAMPLE SUBMITTED BY:

NAME: _____

MAILING ADDRESS: _____

TELEPHONE: _____

WAS THE WATER TREATED BEFORE SAMPLING? _____YES _____NO (IF AT ALL POSSIBLE, SAMPLE WATER **BEFORE** TREATMENT)

IF YES, WHAT TREATMENT DEVICE(S) DID THE WATER PASS THROUGH PRIOR TO SAMPLING?

COMMENTS REGARDING LIKELIHOOD OF CHEMICAL CONTAMINATION (SPILLS, NEARBY USE, STORAGE, ETC.):

SAMPLING INSTRUCTIONS:

1. Do not remove cap from Sample Jar until you are ready to take sample. Do not touch inside of cap or mouth of the jar.
2. Take the sample as close to the water source (well or spring) as possible. If there are no water treatment devices in use, the sample may be taken from a kitchen or bathroom tap. If there is a treatment device in the house, the sample should be taken from a spigot not affected by a treatment device.
3. Turn on the Cold Water and allow it to run until it is as cold as it will get. Then allow it to run one minute more.
4. Slowly and carefully fill the jar to avoid splashing and overflowing. Pour out this water and refill the jar completely.
5. Place the Aluminum Foil Sheet over the mouth of the jar with the Dull Side down. Tighten cap on the jar securely.
6. If sample is not to be delivered immediately, store on ice until ready to deliver.

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(6) Post-Program Survey

Bedford 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.)

Table with 3 columns: Test Name, Yes, No. Rows include Nitrate, Sodium, Iron, Manganese, Hardness, and pH.

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

Table with 3 columns: Test Name, Present, Absent. Rows include Total coliform bacteria and E. coli bacteria.

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 _____

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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 Bedford 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 **August 21, 1998**. A postage-paid envelope has been provided for your use in returning this form to:

Helen Smith, Bedford County
Virginia Cooperative Extension
Extension Distribution Center
112 Landsdowne Street
Blacksburg, VA 24060-9984

Notes

Notes

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