Virginia Water Central

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FEATURE ARTICLE

From Ravensden Rock to Stingray Point, The Rappahannock River Draws Attention

Occasionally acts of policy have results that even the policy makers may not have envisioned. One such occasion was the creation of the Rappahannock River Basin Commission by the Virginia General Assembly in 1998. Established primarily to focus on water-*quality* issues in the Rappahannock basin and their effect on the Chesapeake Bay, the Commission is now studying water *quantity* throughout the Rappahannock basin in a process that may serve as a statewide model. This somewhat unanticipated work by the Commission is helping shed light on a water-resources policy area that has received relatively little state government attention.

INSIDE THIS ISSUE

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Origin of the Rappahannock Basin Commission

Made up of 25 local and state elected officials from communities throughout the basin, the Commission was created by SB 598, sponsored by Senator Edd Houck (D-Spotsylvania) (the bill is incorporated in the *Virginia Code* as Sections 62.1-69.25 to 62.1-69.33). Creation of the Commission resulted from a Rappahannock basin study panel established by the 1996 General Assembly. According to SB 598, that panel recommended a "continuing commission" to meet the need for "a mechanism for coordination and communication for the multitude of…activities that influence the Basin's natural resources" [and for] "easily accessible information for decision making at the public policy level as well as the individual level…." In 1999, state lawmakers agreed to fund the commission with an appropriation of $60,000 per biennium within the Department of Conservation and Recreation's budget, and the 2002 General Assembly maintained that funding level.

Accordingly, the Commission's functions include assembling information about the Rappahannock for the General Assembly; recommending policy changes; sponsoring studies; and seeking grants and other funding to support its activities. It has no regulatory authority. Commission funds have come from the $60,000 state appropriations in 1999 and 2000, an additional $14,000 each year from participating local governments in the basin, some state and federal grants, and a few private donations. City and county governments in the basin are not required to participate in or support the Commission's activities, and indeed neither Greene nor Madison counties are part of its efforts.

Expanding the Agenda

The Commission's original task was to examine ways of improving water quality in the basin. Part of the impetus for such work was the state's commitment to the water-quality goals of the Chesapeake Bay Agreement among Virginia, Delaware, Maryland, Pennsylvania, the District of Columbia, and the U. S. Environmental Protection Agency.[1] As a major Bay tributary, the Rappahannock carries a significant load of sediment and nutrients into the Bay, and the appointment of a commission was seen as a way to help identify sources of these pollutants and devise methods for reducing them.

Water quality could have been the extent of the story, if the Commission had not begun to evolve and take on a mandate of its own. Very soon after its inception, the Commission was involved in much more than water-quality issues. As Commission Coordinator Eldon James put it in an interview for this article, "We just seemed to fill all kinds of needs for people from the start."

One of the most important new tasks the Commission has taken on is water supply planning for a rapidly growing population. "It's a natural consequence," Mr. James suggested. "The Commission is made up of local office holders as well as delegates and senators, and they get pretty steady direct contact with their constituents. They hear what people are concerned about, and it's not just the quality of the water, but deciding how we're going to allocate it and whether there's going to be enough to support the river itself, along with all the activities that depend on water from the Rappahannock."

Local and regional agencies already existed to address some of these concerns. For example, four soil and water conservation districts lie within the river's watershed, and several citizens' organizations exist that sponsor river clean-up efforts, monitor water quality, and lobby to protect the river from various potential threats. But according to Mr. James, not until the Commission

[1] The legislation creating the Rappahannock River Basin Commission noted that "the creation of such a commission will be of great benefit to the Commonwealth…[in] meeting its commitments under the Chesapeake Bay Agreement." This referred to the Bay agreement first signed in 1983 and revised in 1987. The agreement was also revised and resigned in 2000.

was established did the communities and agencies concerned with different geographic areas or different uses of the river have one central place to take their concerns. "And because of that," he said, "there was just a backlog of issues that struck the members of the commission as very important, even if they weren't exactly on the topic of monitoring and improving water quality."

Although water quality was the original intent of the legislation, the bill's language was flexible enough that the Commission felt free to respond to guidance both from policy and from the basin's people. "We're being driven by what the people in the basin tell us they want," Mr. James said. "And in meetings we conduct all around the basin, they say they want water quality improved, but they also say we've got to protect the natural, unspoiled areas along the river, and that we've got to come up with a long-term plan for using the water in the basin in ways that won't deplete the river, drive people off the land, or strangle the communities and cities that depend on the Rappahannock."

Basin-wide Water Supply and Use Study

The Commission's attempt to respond to citizens' concerns about water supply, along with other events at the state level (please see the accompanying box below) led to the current comprehensive study of the dynamics of water flow in the entire Rappahannock Basin. Initiated through the Water Center, and being led by Virginia Tech faculty members William Cox, Jeffrey Connor, G.V. Loganathan, and Kurt Stephenson, the yearlong study (scheduled to be completed in June 2002) targets only the Rappahannock basin. The study is intended to be general and "user friendly" enough, however, to serve as a basis for water-supply planning for other parts of the state.

Planning in the Rappahannock Basin for Statewide Application

The decisions to study water-supply planning in the Rappahannock River Basin came amidst attempts to examine water supply and use on a statewide basis. Over the past three decades, the State Water Control Board (SWCB) and the General Assembly's State Water Commission (SWC) have studied ways to generate systematic, ongoing assessments of water-supply needs in each of Virginia's river basins. The SWCB and SWC have also examined possible changes to the state's water laws and regulations that would facilitate such assessments. The Water Center has published numerous studies on these issues (these are listed chronologically, along with reports on other topics, on the Center's Web-site, www.vwrrc.vt.edu, under "Research Bulletins" and "Special Reports").

Virginia has not yet developed a state water policy, but attention to the issue continues. Among recent initiatives, in 2000 the SWC requested, and the 2000 General Assembly approved, funds for the Virginia Department of Environmental Quality (DEQ) to conduct an assessment of the barriers to, and opportunities for, expanded state leadership in regional water-supply planning. The department's then-director, Dennis Treacy, contacted the Water Center to request assistance in doing the study. Virginia Tech Civil Engineering Professor William Cox at Virginia Tech agreed to take the lead in that effort. Those seeking a statewide approach to water supply saw this as a significant development, because, as Dr. Cox said in a recent interview, "The state has never paid much attention to…water-resource planning."

A two-year plan of work was approved and the work was begun, but budget reductions required of the DEQ in the second year of that biennium (2001) caused the project to be terminated. Using funds from within the Water Center, from other departments on campus, and from local governments, a new initiative on water supply planning was begun for just the Rappahannock basin, in cooperation with the Rappahannock River Basin Commission's Water Allocation Group. Why did the Rappahannock River basin get the nod over other major rivers? Commission Coordinator Eldon James said, "I think for one thing, Senator [Edd] Houck realized

[that a] larger proposed effort was just not going to get funded, so he started working on scaling it back without completely erasing it. For another, he knew there were already a lot of local governments and citizen's groups paying attention to these kinds of issues all along the Rappahannock, so he felt it wouldn't take a lot of effort or money to bring them together and get them to focus."

Dr. Cox is again leading the initiative with assistance from the Water Center and others, including the involvement of the U. S. Army Corps of Engineers and Virginia regulatory agencies in discussions. The participants intend that this effort serve as a model for other watersheds, and in so doing provide lessons for a state water supply planning effort—the intent of the original SWC charge to the DEQ in 2000.

A description of the study is available on the Commission's Web-site at www.rappriverbasin.state.va.us. In the description, Dr. Cox and his colleagues cite the following goals for the study:

- Assess water availability within the region's hydrologic systems;
- Determine the safe yield of water-supply reservoir systems;

[**Ed. note**: An article by Dr. Cox on safe yield appears in this issue's Science Behind the News, starting on page 5.]

- Project the growth in demand over the planning period (50 years) under alternative development and demand-management scenarios;
- Develop a computer model (a computer-based simulation) of the Rappahannock River above the stream-gaging station near Fredericksburg; and
- Facilitate a "shared-vision approach to planning that involves participation in the process by persons with…perspectives [different from]…that of the public water supply provider."

The latter point distinguishes the Rappahannock effort from much of the water-supply planning that has occurred previously in Virginia. Shared-vision planning directly engages citizens, state and federal agencies, county governments, and public water-supply providers in modeling the interactions of river flows and habitat needs, water-storage facilities, and water conservation and demand. The hope in the Rappahannock planning effort is that the shared-vision approach can result in a broad consensus on a water-supply plan and so avoid the kinds of conflicts and disagreements over water-supply proposals that have arisen elsewhere in the state.

In an interview for this article, Dr. Cox stressed that a comprehensive plan for water use in a river basin as large as the Rappahannock can't be done in a year; moreover, that's not the goal of his current work for the Commission. "This is all about *preliminary* planning," he said. "What we hope to do by June is develop some of the techniques and tools the communities in that basin can use to begin projecting the amounts of water they can expect to have, and how best to conserve and allocate it.

"It's a very limited initial effort," Cox continued, "and everybody knows that. But the Commission was willing to offer the Rappahannock as a case study, and it provided the funding necessary to spend at least one year figuring out how to collect the right kinds of data and how to begin making projections for a whole river basin…. What we learn in the process will not only benefit the people who depend on the Rappahannock, it will also give us a lot to work with [in other river basins around the state]."

Conclusion

Applying the process and results of the Rappahannock River Basin study to Virginia's other river basins may be one of the unanticipated benefits of the legislation that gave rise to the Rappahannock River Basin Commission in 1998. Intended to deal primarily with the problem of water quality, the Commission and basin citizens may be leading the way on a full slate of water-related problems that people throughout Virginia are facing now or may be facing in the future.

"The big question now is whether we can keep it up," said Eldon James. The Commission has secured enough funding to support the planning effort until June 30, but it's not clear whether any money will be available to continue beyond that date and then begin implementing aspects of the long-term plan in Rappahannock communities.

"A lot of that depends on what the administration and the legislature give us in this year's [2002-2003] budget," said Mr. James, "and I have to say right now it looks pretty scary—not just for us, but for every agency." He suggested that, without state funding, the Commission might be able to maintain itself on contributions from local governments in the basin and from grants but its pioneering effort in comprehensive, basin-wide water planning might slow to a crawl.

—By David Mudd

SCIENCE BEHIND THE NEWS

Measuring Safe Yield, and Other Issues of Water Supply

"City Exploring Options to Ease Water Shortage—Solutions May Help Lift Building Moratorium"

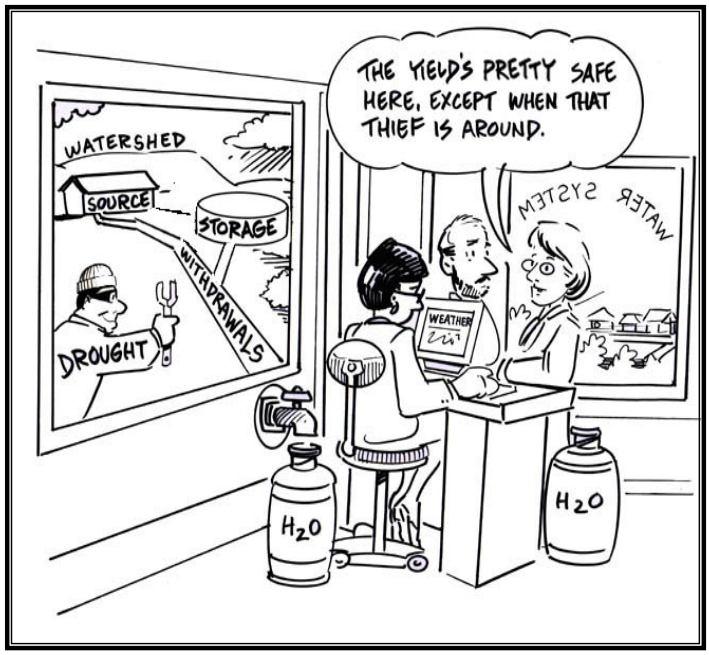
Frederick, Maryland, currently can produce almost seven million gallons per day (MGD) of public water. The average daily demand is only 1.4 MGD, but the single-day peak demands can go much higher during the summer. Until 1999, the city assumed it could take as much as 3 MGD additional water from the Monacacy River during high-demand periods. But in that year the city learned that, during a drought, the Monacacy water would not be available. That development contributed to the city's placing a moratorium in March 2001 on new plat recordations in the city.

–*Washington Post*, Feb. 7, 2002, p. GZ12.

Overview

Adequacy of public water supplies is a fundamental public policy issue. Water is closely related to most human activities, and an inadequate supply can have serious consequences for a community, as shown by the example from Frederick, Md., cited above. On the other hand, excessive water supply development can produce unnecessary environmental disruption and other undesirable effects. One of the basic tasks in assessing adequacy is estimating the capacity of the existing supply system. By comparing existing capacity to current and projected demands on the system, surpluses or deficits can be identified and necessary corrective actions planned.

A public water system is in effect an artificial river that flows through water conveyance facilities—pipes, household plumbing, etc.—until discharged in such forms as sewage effluent, industrial wastewater, or water to irrigate lawns. A water system typically consists of wells or surface water **intakes** to extract water from natural sources, **treatment** facilities, **distribution** networks, and **storage**. Any of these components can limit the system's **capacity**; for example, inadequate treatment capacity may limit the available supply even when water is naturally abundant. But the *ultimate* limitation on capacity is the potential of the source to deliver water on a continuous basis.



Delivery on a continuous basis is made necessary by the traditional view that a public water supply should be highly dependable with only infrequent disruption in normal service. This requirement of continuous availability has significant consequences for determining a system's yield. Because natural sources vary in their capability to supply water over time, the dependable yield, or "**safe yield**," traditionally has been defined as the *maximum output that the system can maintain throughout the most restrictive supply condition likely to occur*. The most restrictive or limiting condition is usually defined, in turn, as a drought

that recurs infrequently at the location in question. This approach, therefore, results in a safe yield determination substantially *lower* than the system's potential output during *non-drought* periods. In addition, the yield determined "safe" by this process would *not* be available during droughts more extreme than the one selected from the historical record for use in the safe-yield determination.

To maintain system output, some public water-supply systems depend almost entirely on taking water continuously from natural sources. But most water systems include **reservoirs** to store water for supplementing the supply available from natural flows during droughts. The primary purpose of reservoir construction, therefore, is to *increase safe yield* by providing a water supply to augment naturally available supplies. Much of the water in storage may be needed relatively infrequently, however (at times when rare droughts actually occur).

Selecting the Limiting Low-flow Condition

Selecting the limiting condition to be used in determining a safe yield requires considerable knowledge of the water-supply resource. When surface water is the source of supply, critical information needed includes the minimum flow to be expected, the length of time over which that minimum may occur, and the frequency of occurrence of the event. Statistical analysis of streamflow records provides this information. Note, however, that this approach is based on the assumption that flow variation observed in the past accurately indicates variability in the future; significant climate change and the resulting changes in rainfall patterns could make this assumption less valid. Using historical records to determine expected low flows also assumes, of course, that adequate and reliable data actually exist for a particular location to show the possible variation of flow. The following chart is an example of the type of historical flow data compiled for many water-gaging stations by the U. S. Geological Survey in cooperation with state water management agencies.

Historical Flow Data for the Potomac River near Washington, D.C.[1], 1959—2000.

Flow Statistic	Flow in cubic feet per second (cfs)	Flow in million gallons per day (MGD)
Annual mean (mean = average) over all years	11,740	7584
Highest annual mean	23,760	15,349
Lowest annual mean	4900	3165
Highest daily mean	334,000	215,764
Lowest daily mean	121	78
Instantaneous peak flow	359,000	231,914
Instantaneous low flow	66	43
10 percent exceeds[2]	26,700	17,248
50 percent exceeds[2]	6450	4167
90 percent exceeds[2]	1570	1014

[1]Location is approximately one mile upstream from Chain Bridge.
[2]The flow value exceeded by 10 percent of the recorded data; similar interpretation for "50 percent exceeds" and "90 percent exceeds."
Source: U. S. Geological Survey, *Water Resources Data—Virginia, Water Year 2000*, Vol. 1, p. 97.

Assuming that adequate information on flow is available, selecting an appropriate low-flow condition for determining safe yield next depends on whether or not the system includes stored water. On one hand, where there is no storage, a conservative approach is typically taken to select

a flow with an extremely low probability of occurrence (because the water system's output cannot be enhanced above this value). In Virginia, this flow is specified by Virginia Department of Health (VDH) regulations for waterworks[2] as the **$1Q_{30}$**—the lowest average daily flow expected to occur in a 30-year period. This daily flow has a 3.3-percent chance of occurring in any given year, which translates into a 96.7-percent probability that flows in the source will be *greater* than this amount. The proportion of this flow deemed available for use in the water system depends on policies or regulations that affect withdrawals, which vary with location.

On the other hand, where a storage reservoir does exist, safe yield is based both on inflows from the source of supply and on water taken from storage. VDH regulations specify that the appropriate critical low flow in this case is that which occurred during the worst drought condition recorded at the location in question since 1930. Due to variation in the periods of record at different locations and to the random nature of extreme low flows, this approach will result in selection of low flows of *different probabilities* of occurrence for *different locations*. For larger water systems, which typically have multiple water sources, the process of determining the limiting system inflow increases in complexity, requiring consideration of additional factors, such as the joint probability of low-flow occurrence in different sources of supply.

The Role of Stored Water in Defining Safe Yield

Determining the contribution of stored water to safe yield requires assumptions about two things: 1) the availability of water at the beginning of the critical low-flow period; and 2) the willingness of water-system managers actually to *use* the stored water during the critical period. Obviously, the theoretical maximum amount of water available for use from a reservoir is the total reservoir volume. But *available* volume may be less than *total* storage volume, for several reasons: intakes may not be capable of withdrawing from the lowest elevations of the storage pool; water-quality problems may arise; or water may be reserved for other purposes. In the most common approach, therefore, only 75 percent of reservoir volume is assumed available for water-supply use in order to account for various limitations on withdrawal.[3] This operational scheme assumes that reservoir capacity reaches the 25 percent storage level just as the drought of record (the worst-known drought and the one used in planning the reservoir capacity) ends and normal rainfall resumes.

Water managers who are less willing to accept the risk of depleting stored water may choose to adopt more conservative approaches (that is, to leave more water in storage). The city of Virginia Beach provides an example. There, the water-supply planning that ultimately resulted in the Lake Gaston transfer proposal rejected the standard approach to safe yield determination and assessed the capacity of the Norfolk water system (which served as the existing source of supply for Virginia Beach) by application of the concept of "*safe yield under prudent management*." In this approach, the safe yield was taken to be the actual flow rate produced by the system during a recent drought.[4] Water deliveries at the time in question had resulted in substantially less depletion of reservoir storage than allowed under the standard safe yield calculation, in turn resulting in a lower safe yield value (i.e., lower than would have been determined using the standard safe yield calculation). This value ultimately became irrelevant with Virginia Beach's decision to develop water supply independent of the Norfolk supply, but the example illustrates the flexibility planners often exercise in calculating safe yield.

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[2] Virginia Department of Health, Waterworks Regulations, 12 VAC 5-590-830.

[3] See, for example, "Safe Yield of Municipal Surface Water Supply Systems in Virginia," Virginia Water Control Board Planning Bulletin 335, 1985.

[4] Discussion of, and concurrence with, the approach taken by Virginia Beach is in "Water Supply Study—Hampton Roads, Virginia," 1984, pp. 141-46, by the U. S. Army Corps of Engineers, Norfolk District. The report, unfortunately, is out of print, nor is it available on-line.

Evolving Views of Water-supply Adequacy

The concept of water-supply adequacy has evolved in response to greater recognition of environmental and social values that are often adversely affected by water development.[5] Over much of the history of the United States, the focus in water supply management was on increasing safe yield through additions to storage capacity to keep pace with projected increases in demand. This approach has been replaced by one in which consideration of **demand management** is standard procedure. In the current regulatory climate, expansion of safe yield is acceptable *only after* adoption of demand-reduction measures, at least in situations where water-development projects would produce adverse environmental or social effects. If demand reduction is permanent—as in the case of implementing flow-reducing plumbing—the traditional concept of safe yield continues in effect, although the amount of system capacity presumed to be needed decreases in concert with the reduction in demand.

An alternative use of demand reduction, known generally as **drought management**, applies *temporary* demand-reduction measures during planned, or predicted, periods of water shortage. Drought management, in effect, rejects the traditional view that safe yield should represent a system's capacity available on a *continuous* basis, including during predictable low flow periods. Instead, the drought-management approach maintains system capacity at a level adequate during non-drought periods yet *inadequate* during the recurrence of certain predictable drought events. Drought management, developed as a means to avoid adding storage capacity needed only for relatively short times during droughts, incorporates planning to control the negative aspects of these predictable shortages. In contrast, planning for shortage in the traditional approach to determining safe yield is more limited in scope, because it focuses only on relatively rare events — such as unprecedented droughts—and would be implemented infrequently. In drought management, shortages occur more frequently because they occur during *anticipated* low flow events.

The traditional flexibility in safe yield determinations (described above) is likely to decrease because of constraints imposed by environmental protection programs. An example of this tendency is the permit deliberations of the Norfolk District of the U. S. Army Corps of Engineers in the case of the King William reservoir proposed by the city of Newport News.[6] The city's safe yield analysis assumed that 67 percent of certain reservoir storage was available for use during drought. The Corps' decision document reflects the view that a greater proportion of storage should be considered available for use.[7] Assuming that a higher percentage of storage could be used *increased* the existing safe yield calculation, thereby reducing the potential water-supply deficit and the presumed need for the proposed project. This example illustrates that regulations and regulatory proceedings increase the incentive to use *standardized* safe yield determinations.

Conclusion

The safe yield of a water system is a function of natural processes (e.g., streamflow) and system characteristics (e.g., reservoir storage volume), but it is also a function of operational decisions that involve value judgments. Water-system planners and managers make judgments,

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[5] Water projects can have a wide range of environmental and social impacts, including habitat destruction or alteration, water-quality changes, and displacement of people.

[6] In the case of the proposed King William reservoir, potential environmental impacts include wetlands destruction and changes in the salinity of the river downstream (with related fisheries impacts).

[7] U. S. Army Corps of Engineers, Norfolk District: "Final Recommended Decision of the District Commander on Permit Application Number 93-0902-12," July 2, 2001, p. 35. A copy of this report is available on-line at www.nad.usace.army.mil/kwr/.

for example, about the appropriate low-flow condition to apply and the decision of what proportion of reservoir storage to be used in responding to a drought. Such decisions reflect attitudes towards risk and other subjective factors, making the safe yield determination as much a policy decision as a technical calculation. Differences among planners—such as different perceptions of acceptable risk—can result in significantly different safe yield determinations for a given water system.

The current approach to water-supply planning creates substantial opportunity for disagreement during regulatory proceedings over safe yield determinations and other decisions. Water suppliers inherently tend to minimize the risk of water shortages through conservative assumptions when calculating safe yield, but this approach has met increasing opposition from federal regulators charged with evaluating the potential environmental and social impacts of water-storage projects.

While some people continue to advocate a fail-safe water supply, others promote planned shortages as a means to limit adverse impacts on environmental and social values. Conflicts resulting from these clashes suggest the need for *development of more comprehensive guidelines* on the dependability of water supply service and associated determinations, such as calculation of safe yield. Such guidelines should reflect climatic, environmental, and other factors that vary geographically. State government appears to possess the most appropriate perspective to create the suggested guidelines after substantial public debate. Flexibility for local governments to accommodate local objectives should be provided to the extent possible.

Development of guidelines for safe yield determinations and other decisions regarding water-supply planning would increase the consistency and acceptability of resulting plans. In turn, related regulatory proceedings would involve less conflict. Application of such guidelines, while not requiring major changes in current approaches to safe yield determination, has the potential to ease at least some of the difficult issues in water-supply management.

—By William E. Cox

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TEACHING WATER
Especially for Virginia's K-12 teachers

This Issue and the Virginia Standards of Learning

Below are suggested Virginia Standards of Learning (SOLs) supported by this issue's Feature (pp. 1-5), Science Behind the News (pp. 6-11), and For the Record (p. 20) sections. Abbreviations: BIO=biology; C/T=computer technology; ES=earth science; LS=life science.

Feature Article—Rappahannock River Basin Commission
Science SOLs: 6.11, LS.12, ES.7.
Social Studies SOLs: 7.4, 7.9, 10.2, 10.3, 10.9, 10.15, 12.8, 12.9, 12.10.

Science Article—Safe Yield and Water Supply
Science SOLs: 6.11, LS.12, ES.7, ES.9, BI O.9.
Social Studies SOLs: 10.2, 10.5, 10.9, 10.10, 10.15, 12.9.
Math SOLs: 8.13.

For the Record—Hydrology and Water-quantity Information Sources
Science SOLs: 4.8, 6.11, LS.12, ES.3, ES.7, ES.9.
Social Studies SOLs: 7.4, 10.1, 10.8, 10.9, 10.15.
Computer Technology SOLs: C/T5.3, C/T8.4.

IN AND *OUT OF* THE NEWS
Newsworthy Items You May Have Missed

The following summaries are based on information in the source(s) indicated at the end of each item. Selection of this issue's items ended February 15, 2002. Unless otherwise noted, all localities mentioned are in Virginia and all dates are in the year 2002.

Drought-Related News

As of February 2002, drought conditions were widespread throughout the eastern United States. New York City, the Delaware River Basin Commission in New Jersey, and parts of Maryland issued drought warnings in late January. Maryland's precipitation was seven inches below normal from October 2001 through January 2002, and Baltimore's reservoir levels as of January 31 were 61 percent of capacity, a record low for this time of year. In North Carolina, the state's Water Sources Task Force was reestablished in December 2001 to provide drought-related advice to communities. (*Washington Post*, 1/31/02; *Raleigh News & Observer*, 12/11/01)

Further west, parts of Idaho, Montana, New Mexico, Oklahoma, Texas, and Wyoming were all experiencing severe or extreme droughts as of early February. (*USA Today*, 2/5/02)

Between September 2000 and February 2002, **precipitation** was 33 percent of normal at Reagan National Airport in Washington, D.C., and 49 percent of normal at Dulles International Airport in northern Virginia. **Flow in the Potomac River** recently hit several single-day record lows, but three area reservoirs had adequate supplies as of February 14. (*Washington Post*, 2/15/02)

As of early February, varying drought conditions existed throughout Virginia but conditions were the worst in the northwestern part. The **Winchester area**, for example, would need 15—18 inches of precipitation through April to remedy the drought. (*Winchester Star*, 2/1/02)

The **city of Roanoke** imposed the first stage of mandatory water-conservation measures on February 14 when the city's main water-supply reservoir reached 22 feet below capacity. Carvin's Cove Reservoir was at its lowest February level in 15 years. (*Roanoke Times*, 2/15/02)

Other News in Virginia…

•In January the Virginia Institute of Marine Science (VIMS) began placing in the lower Chesapeake Bay **buoys equipped with instruments to measure winds, waves, currents, fish stocks, and various other physical and chemical features**. The instruments will be connected to the Internet so "real-time" data will be available to researchers, the military, shippers, commercial fishers, boaters, and other Bay users. The data will also help researchers improve computer models of Bay processes, potentially improving predictions of such phenomena as the movement of a toxic spill or the location of schools of fish. (*The Crest*, College of William and Mary/VIMS, Fall 2001)

•In 2000, **Virginia's Hampton Roads area ranked 7th among all U. S. ports in the value of commercial fish landed**, according to the 2000 report, *Fisheries of the U.S.*, by the National Marine Fisheries Service. Virginia's commercial fishers brought in almost 82 million pounds of fish and shellfish, worth over $89 million. Sea scallops accounted for 9.4 million pounds, worth $39.8 million. Scallops have constituted an increasing percentage of commercial fishery landings in Virginia since the 1990s. (*The Crest*, College of William and Mary/VIMS, Fall 2001)

•The Wise County Clerk's Office and the Digital Earth Virtual Environment and Learning Outreach Project will use a **$150,000 National Aeronautics and Space Agency (NASA) grant to map coal-sludge ponds in mining areas of Virginia**, Kentucky, Tennessee, and West Virginia. Damaging floods can occur when sludge ponds are overtopped or when the sludge seeps into and "blows out" abandoned mines. High school and college students will locate the ponds, mines, waterways, and potential pollution sources. (*Bristol Herald-Courier*, 11/29/01)

•**A test-marketing period for "Chesapeake Milk" ended** with relatively few sales but a large amount of learning by the product's sponsoring organizations. The milk came from farms that scored high on Pennsylvania Cooperative Extension's assessment of practices to protect local waterways from pollution; these farms were eligible for a premium of five cents per half-gallon. Farmers and consumers showed

interest in the product, but the additional costs of the milk were higher than expected (18 to 40 percent more in parts of Maryland, Pennsylvania, and Virginia). Surveys revealed the importance of a clear connection between higher price and environmental benefit, plus other challenges for such a product. (*Bay Journal*, Dec. 2001; please see the April 1999 *Water Central*, p. 12, for a previous item on Chesapeake Milk.)

•The Chesapeake Bay Program partners—Virginia, Maryland, Pennsylvania, the District of Columbia, and the federal government—have achieved **65 percent of their goal of planting 2010 miles of riparian forest by the year 2010**. Riparian (streamside) buffers provide various water-quality benefits, including reducing the amount of sediments and nutrients reaching waterways. In 2001, Virginia planted 102 miles of buffer, for a total of 312 since 1996 (Virginia's 2010 goal is 610 miles). Maryland planted 255 miles in 2001 (total so far is 578 miles; 2010 goal is 600 miles); Pennsylvania planted 266 miles (total so far is 400 miles; 2010 total is 600 miles); and on federal lands, 5 miles were planted (total so far is 8 miles; 2010 goal is 200 miles). (*Bay Journal*, December 2001)

•A **comprehensive revision of state water-quality standards for the Chesapeake Bay is proceeding**, with important developments and decisions scheduled for 2002. State standards consist of *designated uses* for a water resource and numeric *criteria* for measurements that indicate whether or not the designated uses are being supported. The Bay Program is developing a set of designated uses and accompanying criteria that would correspond to the different parts, habitats, and capabilities of the Bay. The first set of draft designated uses and criteria was released for public review in 2001. By this summer, the U. S. Environmental Protection Agency (EPA) will issue a second set for public comment, receive and review comments, and publish a final version. After that, states will begin establishing standards based on the uses and criteria. Ultimately the new standards will guide adoption of revised nutrient- and sediment-reduction goals for Bay tributaries. (*Bay Journal*, Dec. 2001)

•The **population of breeding Blue Crabs in the Chesapeake Bay was 40 percent higher in 2001** than the average from 1998-2000. Despite the improvement, the breeding population remains low compared to historic levels. Meanwhile, the *overall* Blue Crab population was between 15 and 20 percent of the level seen prior to 1992, when a dramatic decline began. (*Hampton Roads Daily Press*, 12/13/01)

Meanwhile**, oyster "spat sets," an assessment of oyster reproduction, were poor** in almost all areas of the Chesapeake in 2001. Maryland reported good spat sets in some areas, but this was not the case in Virginia. In addition, MSX and Dermo—diseases that have dramatically reduced Bay oyster populations—infected oysters farther upstream than is normally seen. Both diseases thrive in higher salinities, and the upper Bay has been more saline during the past three years of dry conditions. (*Bay Journal*, Jan.-Feb. 2002)

•At stream and river crossings along major roads in Virginia, **signs identifying the surrounding watershed will soon begin appearing.** An initial set of 20 signs will be placed along interstates and primary roads; other locations will receive the combination signs as current signs need replacing. Combination signs will also be used for replacements along secondary roads where local governments pass a resolution requesting the change. The signs are a joint project of the Va. departments of Transportation and of Conservation/Recreation, with funding from the Chesapeake Bay Program. (*Lynchburg News & Advance*, 12/18/01)

•**Loudoun County Circuit Court Judge James H. Chamblin** ruled on December 20, 2001, against a claim by county residents that plans for nearby subdivisions should not be approved because the State Water Control Board's **groundwater-nitrate standard** of 5 parts per million (ppm) might be exceeded. Nitrate is regulated in groundwater and drinking water because excessive nitrate can be a health hazard, especially for infants. Tests predicted that on-site wastewater treatment in the subdivisions would not cause groundwater nitrate levels to exceed the county's *drinking-water* standard of *10* ppm, which meets Virginia Department of Health requirements. Chamblin ruled that the county was not in conflict with the SWCB standards because the county had "not elected to go into the field of groundwater protection," as it is *allowed* but *not required* to do under the state's grant of zoning authority to localities. Acknowledging that the two state standards can be in conflict, Chamblin maintained that the "area…is best left to the state regulatory agencies unless and until [Loudoun] County decides to go specifically into the field of groundwater protection." Chamblin has said the case may end up before the Virginia Supreme Court. (*Leesburg Today*, 11/21/01, and text of judge's ruling)

•**Hundreds of low-income households in the cities of Franklin and Hampton and in James City County received water-conserving fixtures** through a program coordinated by the Hampton Roads Planning District Commission. The Commission predicts annual water-savings of over three million gallons, along with reduced water and sewer expenses for the residents. The U. S. EPA's "Environmental Justice Through Pollution Prevention" grant program funded the project. (*Hampton Roads Review,* Winter 2002)

•Nine federal, state, and local agencies and governments have signed a memorandum of agreement to **protect the North Landing River in Virginia Beach and Chesapeake**, a state Scenic River that is bordered by extensive wetlands and is part of the Intracoastal Waterway. The agreement identifies activities that support river protection and outlines a cooperative public-education program. (*Hampton Roads Review*, Winter 2002)

•**Fairfax County officials have temporarily halted the construction of large ponds to manage stormwater runoff**, while county engineers research other options. Fairfax County has 46 large regional ponds and about 900 smaller ones, while private citizens own about 1,400 ponds. Some citizens and county officials have been advocating smaller options involving less construction, such as "bio-retention" basins consisting of water-tolerant plants on permeable soils. (*Washington Post*, 1/17/02)

•**Cost estimates continue to come in for the agenda detailed in the Chesapeake 2000 agreement** among Bay states, the District of Columbia, and the federal government. In Fall 2001, Virginia officials estimated a cost of $328 million to $3.9 billion to meet the state's major Bay goals. A recently completed analysis by Maryland estimates that state's commitments under the agreement will cost about $7 billion, or about $1 billion annually until 2010. Last year the Chesapeake Bay Foundation estimated that the agreement's goals would cost $8.5 billion for the entire watershed. That estimate reportedly covered only certain large items, while Maryland's analysis attempted to look at all the state's commitments. (*Bay Journal*, Jan.-Feb. 2002)

•**Culpeper and Culpeper** (the county and the town, that is) have reached a Memorandum of Understanding for the **county to buy water and sewer service from the town**. The memorandum, which is one step toward an eventual legal agreement, is a milestone in a sometimes argumentative process dating back to the 1950s, according to members of the county Board of Supervisors and the Town Council. Under the agreement, the county will be able to purchase 3,120 water and sewer taps, up to a capacity of 600,000 gallons per day. The agreement also calls for the final document to address a technology-zone overlay, land-use classifications, and residential densities. (*Culpeper Star-Exponent*, 2/6/02)

…and Outside of Virginia

•Scientists from the National Oceanic and Atmospheric Administration (NOAA) found **at least five Northern Pacific Right Whales in the southeastern Bering Sea,** far from their known breeding grounds. Scientists have also found evidence that the animals may be feeding upon a species of crustacean not previously known as a food source for this whale. The discoveries are encouraging because known populations of these mammals—the most endangered whale species—remain so low that extinction is a serious threat. (*Washington Post*, 12/3/01)

•In December 2001, scientists at the annual meeting of the American Geophysical Union reported that **three of Antarctica's largest glaciers lost up to 150 feet in diameter between 1991 and 2001**. Data from European satellites showed ice thinning near the Amundsen Sea, where researchers had thought ice was *accumulating*. Such findings are of concern because a reduction in glacial ice could lead to rising sea levels, with serious consequences worldwide. (*Roanoke Times*, 12/12/01)

•Due to potentially unsafe levels of mercury, polychlorinated biphenyls (PCBs), and pesticides in 13 species of fish, the **Maryland Department of the Environment (MDE) issued an advisory in December 2001** warning consumers, especially pregnant women and children, to **limit their consumption of the fish species from 14 tidal waters**. No advisories are in effect for fish, crab, or oysters from the Chesapeake Bay. The MDE Web-site, www.mde.state.md.us, has details about the fish species covered and the suggested consumption limits. (*Washington Post*, 12/13/01)

•**Expected water-related agenda items for the EPA** in 2002 include the following regulations:
**proposals dealing with pathogens at water systems of all sizes and with potentially harmful by-products of disinfection processes (the "LT2" and "DBP" rules, respectively; an item about the "LT1" drinking-water rule, issued January 14, appears later in this section);

**proposal of a "multimedia" rule concerning radon in drinking water;
**further development of a groundwater rule proposed in May 2000, concerning bacteria and viruses in groundwater sources of drinking water;
**revision and proposal of the Total Maximum Daily Load (TDML) rule;
**revision and proposal of a Sanitary Sewer Overflow (SSO) rule;
**development of effluent-limitation guidelines for industry sectors the agency is required to address (according to a 1992 consent decree), including the metal products and machinery, construction, and iron and steel.
**in cooperation with the Corps of Engineers, development of guidance defining federal jurisdiction over wetlands, in the wake of the 2001 U. S. Supreme Court decision limiting the government's jurisdiction over isolated wetlands;
**proposal of regulations for cooling-water intake structures in power-generating plants.
(*Inside EPA's Water Policy Report*, 12/31/01)

•A **November 2001 report by the General Accounting Office** (GAO) of Congress detailed the **money that federal agencies and state governments spent on water-infrastructure projects** between 1991 and 2000. During that period, federal agencies—primarily the EPA and the departments of Agriculture, Commerce, and Housing and Urban Development—provided $44 billion in grants, loans, and loan guarantees. Five other federal agencies provided another $1.1 billion. State governments contributed about $25 billion in matching funds, grants, loans, and financing of state projects. The report notes that estimates of infrastructure costs over the next 20 years range from $300 billion to $1 trillion. The GAO report is available on-line at www.gao.gov; printed copies are available from the GAO by calling (202) 512-6000. (*Inside EPA's Water Policy Report*, 1/14/02, and the GAO report summary)

•The EPA is beginning **a complete review of drinking-water regulations**, as required by the 1996 Safe Drinking Water Act amendments. The review could result in proposal of revised rules for some contaminants; EPA has already indicated that it will revise the total coliform bacteria rule. Sometime within the next two months EPA is to publish in the *Federal Register* a list of the rules the agency proposes to change, but a *schedule* of proposed changes is not expected before August. (*Inside EPA's Water Policy Report*, 1/14/02)

•In the January 14 issue of the *Federal Register*, the Corps of Engineers announced the **Nationwide Wetlands Permits Program** that regulates **general permits** for activities impacting wetlands. The changes become effective March 16. The program has faced opposition from environmental groups and two federal agencies, the EPA and the U. S. Fish and Wildlife Service. Two key concerns for environmentalists are the following: a change from an acre-for-acre standard for mitigation of wetlands acreage lost by development, to a requirement that each Corps district office show in yearly surveys that no net wetland acreage is lost; and the Corps' decision that surface mining will continue to be eligible for permits if the operations are reviewed by a Corps district manager. The Bush Administration has characterized the new program as a compromise between a more-restrictive plan proposed by the Clinton Administration and a less-restrictive one originally proposed by the Corps in 2001. (*Washington Post*, 1/15/02; and *Inside EPA's Water Policy Report*, 1/28/02)

•In the January 14 issue of the *Federal Register*, the U. S. EPA published the final version of the **Long Term One Enhanced Water Treatment Rule** (LT1), primarily addressing filtration to control the **microbial pathogen *Cryptosporidium*** in drinking-water systems that serve 10,000 or fewer customers. (*Inside EPA's Water Policy Report*, 1/28/02)

•In January, **several environmental groups filed suit** against the U. S. EPA in West Virginia, **claiming that West Virginia's implementation of its anti-degradation policy violates of the Clean Water Act** (CWA). The CWA requires states to have anti-degradation policies to protect high-quality waters; specifically, a state must conduct a review of any proposed discharge to a high-quality water to determine whether the discharge is justified by significant economic or social benefits. The plaintiffs claim that West Virginia's policy, adopted in 2001 and approved by EPA, allows an unacceptable number of exemptions to the anti-degradation review process. (*Inside EPA's Water Policy Report*, 1/28/02)

—By Alan Raflo and Rebecca Ratliff

Rebecca Ratliff, a junior English major at Virginia Tech, is an intern at the Water Center for the Spring 2002 semester.

N O T I C E S

On the DEQ Public Calendar

The Va. Dept. of Environmental Quality's "Public Calendar" is located at www.deq.state.va.us/info/.

•**March 18**—Public meeting on proposed fecal coliform total maximum daily load (TMDL) for Gills Creek in Franklin County. Trinity Ecumenical Parish, Moneta, 7 p.m. For more information, contact Jay Roberts, e-mail: jaroberts@deq.state.va.us, or by phone at the DEQ Central Office in Richmond, toll-free in Virginia, (800) 592-5482.
•**March 19**—Ground Water Protection Steering Committee meeting. DEQ Central Office, Richmond, 9 a.m. For more information contact Mary Ann Massie, e-mail: mamassie@deq.state.va.us, or by phone at the DEQ Central Office in Richmond (see phone number listed above).
•**March 28**—State Water Control Board meeting. DEQ Central Office, Richmond, 9 a.m. For more information contact Cindy Berndt, e-mail: cmberndt@deq.state.va.us, or by phone at the DEQ Central Office in Richmond (see phone number listed above).

Washington Briefing 2002: Innovations in Water Quality

The Water Environment Federation and the American Society of Civil Engineers sponsor this opportunity to hear from members of Congress and other federal officials. April 16—17 in Washington, D.C. For more information, phone (703) 684-2400, ext. 7741; e-mail: lscott@wef.org.

Water Quality Monitoring in 2002: Building a Framework for the Future

This is the third annual conference sponsored by the National Water Quality Monitoring Council in cooperation with its state affiliates (including the Virginia council, on which the Water Center plays a key role). May 20—23, in Madison, Wisc. For more information, contact the Council at (405) 516-4972; FAX (405) 516-4973; e-mail: dan@nwqmc.org; Web-site: www.nwqmc.org.

SW Va. Stormwater Ordinance Project

The New River Highlands and Black Diamond Resource Conservation and Development Councils are sponsoring a project for communities to draft model stormwater-management ordinances, tailored to the needs of southwestern Virginia. Meetings to develop the model ordinances are planned for the spring and summer of 2002. All local governments in the area are invited to participate, as are private consultants and citizens. To participate, or for further information, contact Brian F. Schmidt, New River Highlands RC&D in Wytheville, (276) 228-2879; e-mail: bschmidt@smyth.net.

Potomac River Boating Maps

Virginia and Maryland agencies have produced a set of six maps to help boaters navigate and enjoy the Potomac River from Great Falls to the Chesapeake Bay. Along with river features, the maps include the locations of services and attractions. Available for purchase ($5) at Virginia and Maryland state parks along the Potomac, or by calling (800) 933-PARK (Virginia) or (410) 260-8780 (Maryland).

USGS Reports on Virginia's Waters

The U. S. Geological Survey (USGS) has recently issued a number of reports on Virginia's water resources. Unless otherwise noted, phone toll-free (888) ASK-USGS for ordering information.

Groundwater

•*Ground-Water Quality and Geohydrology of the Blue Ridge Physiographic Province, New River Basin, Virginia and North Carolina*. Available from the USGS office in Charleston, W.Va., phone (304) 347-5130.
•*Characteristics of Water-well Yields in the Blue Ridge of Loudoun County, Virginia*. $32. Open-file Rep. 00-0280. Available on-line at pubs.usgs.gov/openfile/of00-280/.
•*Chemical and Isotopic Composition of Water from Springs, Wells, and Springs in Parts of Shenandoah National Park, Virginia, and Vicinity, 1995-1999*. $4. Open-file Rep. 00-0373.

•*A Ground Electromagnetic Survey Used to Map Sulfides and Acid Sulfate Ground Waters at the Abandoned Cabin Branch Mine, Prince William Forest Park, Northern Virginia Pyrite Belt*. $17.75. Open-file Rep. 00-0360. Available on-line at pubs.usgs.gov/openfile/of00-360.

•*Shallow Ground-water Quality Adjacent to Burley Tobacco Fields in Northeastern Tennessee and Southwestern Virginia, Spring 1997*. $4. Water Res. Investigation 01-4009.

Surface Water

•*A Comparative Analysis of Hazard Models for Predicting Debris Flows in Madison County, Va.* (one CD-ROM). $32. Open-file Rep. 01-0067. Available from Va. Div. of Mineral Resources, Charlottesville, (434) 951-6341.

•*Summary of Trends and Status Analysis for Flow, Nutrients, and Sediments at Selected Nontidal Sites, Chesapeake Bay Basin, 1985-99*. $30. Open-file Rep. 01-0073. Available on-line at pa.water.usgs.gov/reports/ofr01-73.pdf.

Reducing Watershed Impacts

The Center for Watershed Protection in Maryland has developed 22 model development principles to promote "economically viable, yet environmentally sensitive" development. The principles identify areas where existing codes and standards can be changed to reduce the impact of development on watersheds. For a copy of the principles or for more information, contact the Center at 8391 Main Street, Ellicott City, MD 21043-4605; phone (410) 461-8323; e-mail: center@cwp.org; Web-site: www.cwp.org.

Looking for a Coral Reef?

The World Atlas of Coral Reefs, a project of the United Nations Environment Programme, was released in September 2001. Coral reefs provide habitat for thousands of marine plants and animals, but various human and natural factors have reduced the area of reefs in spots around the world. The *Atlas* contains information on the geography, biology, and human uses of coral reefs, as well as about threats to the reefs' existence. Available for sale from University of California Press by calling toll-free (800) 777-4726; on-line ordering information at www.ucpress.edu.

Guide for Natural Hazards Planning

Understanding Your Risks—Identifying Hazards and Estimating Losses is the first in a new series of hazard-mitigation guides published by the Federal Emergency Management Agency (FEMA). Floods, tsunamis, and coastal storms are among the seven hazards covered. Free copies are available from the FEMA Publications Warehouse, phone (800) 480-2520 (request publication FEMA 386-2).

Water On the Air

"Watershed Radio" provides one-minute spots on cultural, historic, and scientific aspects of the Chesapeake Bay to various stations in the Bay area. Watershed Radio is a project of the Smithsonian Environmental Research Center and the Sierra Club. The project's Web-site, www.watershedradio.org, offers the spots' text and audio, additional Bay information, and a list of stations broadcasting the spots (plus a terrific drawing of a duck at the microphone!). For more information, contact Anna van der Heijden, phone (301) 261-3368, e-mail: watershedradio@serc.si.edu.

CALL FOR PAPERS

Virginia Water Research Symposium 2002

For more information, contact Judy Poff at jupoff@vt.edu, phone: (540)231-8030, or go to the VWRRC's website: www.vwrrc.vt.edu.

Drinking Water News On-line

"Safedrinkingwater.com NEWS" is a free, weekly, electronic newsletter bringing subscribers links to news stories on drinking-water quality (specifically source water quality and protection, water treatment

plants and processes, and the water-distribution system). The newsletter is produced by McGuire Environmental Consultants, Inc., of Santa Monica, California. To subscribe, go to safedrinkingwater.com.

At the Water Center

To reach the Water Center, phone (540) 231-5624; e-mail: water@vt.edu; or visit www.vwrrc.vt.edu.

•Grant Received

The Water Center has received a grant from the Powell River Project to sponsor a symposium that will address water-resource quality and protection in seven coalfield counties of Virginia. For more information, contact Tamim Younos at the Water Center phone number or address;
e-mail: tyounos@vt.edu.

SPECIAL NOTICE

As a service to the Virginia Department of Housing and Community Development, *Water Central* presents the following item on a department program to provide drinking water to small communities.

Self-Help Virginia – Helping Communities Help Themselves to Water

Water is one our most precious natural resources. Many of us who have running water take the convenience for granted as we use it for drinking, cooking, cleaning, and sewage disposal.

Unfortunately, some communities in Virginia still lack running water in their homes. Every day people in those communities must rely on dilapidated wells or cisterns or collect water from relatives, neighbors, or public springs and haul it back to their homes in jugs or plastic containers. To combat this problem for Virginia's low-income citizens, the Virginia Department of Housing and Community Development (DHCD) started the **Self-Help Virginia Program** in 1998.

Self-Help Virginia is designed to help smaller communities meet the challenge of installing affordable water and wastewater systems. This unique program uses a community problem-solving, dollar-saving approach to bring running water to localities. The DHCD Community Development Block Grant and Appalachian Regional Commission programs provide funding for Self-Help Virginia. The program relies on neighborhood talent, creativity, and dedication to provide services that communities could not attain through conventional means.

For Self-Help Virginia projects, neighborhood residents act as their own project managers. Residents volunteer to lay water and sewer lines, cook for workers, control traffic, shovel, or solicit donations of money and materials. Self-Help Virginia projects cost about half as much as privately contracted projects and inspire communities to come together to achieve a common goal.

One community that achieved commendable success was Smith Ridge in Tazewell County, a pilot community for the program in 1998. The citizens laid 36,350 feet of pipe in only three months. In the process they set a record for Self-Help projects at that time by installing 2,440 feet of pipe in a single day.

The oldest resident of Smith Ridge is Narcie Smith. The 98 year-old "ball of energy" said, "Getting water from a faucet makes a world of difference. No longer will we have to go down and wonder if the cistern is dry before we can get the washing out." One of Narcie's daughters, Ann Shreve, commented on another unexpected benefit of the community's hard work. "You got to know everybody. Before, you just knew their names and that was it. "

Self-Help Virginia has assisted 18 communities to serve over 1,500 people with running water and wastewater systems. Although these projects have been successes, Self-Help may not be appropriate for *some* communities. Communities must meet the following program eligibility requirements:

- projects must use more volunteers than paid workers;
- projects must demonstrate a minimum cost savings of 40 percent compared to a conventional contracted approach;
- at least one well-attended community meeting must occur early in the process and demonstrate strong support for the project; and
- at least 51 percent of the proposed beneficiaries must meet low- or moderate-income guidelines, and signed user agreements are required. DHCD will assist any interested community in assessing its capacity and readiness to participate in the program.

The Self-Help Virginia Program has provided quality leadership and innovative thinking to help communities attain water and wastewater services. If you believe your community could benefit from the Self-Help Virginia program, contact Chris Sterling at (804) 371-7061 or visit the Web-site at www.dhcd.state.va.us.

—By Tamra Talmadge-Anderson and Jimmy Wallace, Virginia Department of Housing and Community Development.

FOR THE RECORD
Sources for Selected Water Resources Topics

Hydrologic and Water-quantity Information Sources

(Please see the December 1998 *Water Central*, p. 15, for a previous article on sources of hydrologic and water-quantity information.)

U. S. Geological Survey

The U. S. Geological Survey (USGS), Water Resources Division, provides data and reports on stream flows, watershed features, water use, and groundwater characteristics. For any data, publication, or information request for which you have no specific contact, call 1-888-ASK USGS.

The annual publication *Water Resources Data—Virginia* (one volume for surface water and one for groundwater) contains data on streamflows and groundwater levels. The publication is available at many libraries; to request a printed copy (supplies limited; current year only), contact Roger White at the USGS' Virginia District office at 1730 E. Parham Road, Richmond 23228; (804) 261-2600; e-mail: rkwhite@usgs.gov. The Web-site for the Virginia office is www-va.usgs.gov/. Along with access to the Water Resources Data report, this site has data on current streamflow and groundwater conditions, historic flow data, and other features.

Another USGS resource in Virginia and Maryland is the Chesapeake Bay River Input Monitoring Program. This program provides streamflow data specifically related to the water-quality impacts of Bay tributaries. The Virginia contact is Doug Moyer at the USGS office in Richmond (see phone number above); e-mail: dlmoyer@usgs.gov. The Web-site for this program is va.water.usgs.gov/chesbay/RIMP/.

For Internet users seeking information beyond Virginia, the "Water Resources of the United States" Web-site, water.usgs.gov/, provides access to data (including real-time data), publications, technical resources, programs, and state USGS contacts. From that Web address, you can reach the National Water Information System, which has data from approximately 19,000 streamflow sites and 1.2 million wells across the nation (with some records as far back as 1857); and the Hydro-climatic Data Network, with a streamflow data set from 1974 to 1988.

National Weather Service

The National Weather Service's Hydrologic Information Center (HIC) has information on current hydrologic conditions (such as river levels), current flooding, past floods, and water-supply outlooks. The HIC is located at 1325 East-West Highway, Silver Spring, MD 20910; (301) 713-1658; e-mail: HIC@noaa; Web-site: www.nws.noaa.gov/oh/hic/index.html. The HIC provides a biweekly water-supply statement for the Susquehanna, Delaware, and Potomac river basins; this statement is available on-line at marfcws1.met.psu.edu/Water/ESP.html.

Useful Publications

Virginia Water Atlas (1993) contains basic facts, maps, and graphs on Virginia's waters. Part II, "Hydrology," includes sections on river flows, reservoirs, aquifers, and several other topics. Some of this information is also in the *Environmental Almanac of Virginia* (1998). Both publications are available for sale from Tennyson Press, P. O. Box 1599, Lexington, VA 24450; (540) 463-2599.

A nice introduction to Virginia's water resources is included in the Winter 2000 issue of *Virginia Explorer*, published by the Virginia Museum of Natural History, 1001 Douglas Avenue, Martinsville, Virginia 24112; (276) 666-8600; e-mail: books@vmnh.org. The Museum's Web-site is www.vmnh.org.

Upcoming "For the Record" Schedule

April 2002 (Issue 21): Drinking Water
June 2002 (Issue 22): Weather and Climate
Aug. 2002 (Issue 23): Water Use
Oct. 2002 (Issue 24): Wetlands
Dec. 2002 (Issue 25): Water Law and Rights

Guide to *Water Central* articles, June 1998—December 2001

The following lists the main articles and features included in *Water Central* issues from June 1998 (the first issue) through December 2001 (issue #19). Titles are grouped by topic and listed alphabetically. The list does not include items from the "In and Out of the News" or "Notices" sections of the newsletter.

Aquatic Life

A "Fish-eye" View of Water Quality	Oct. 1998, p. 6
Dolly the Sheep and Dolly Varden the Trout (genetics)	Apr. 1999, p. 8
Don't Panic, But There's a Huge Crowd of Bacteria Outside…	Aug. 1998, p. 5
Loch, Lac, or Reservoir: There's More to Lakes than Water	June 1999, p. 5
Out of the Water, But Not Forever (amphibians)	April 2001, p. 6
Pfiesteria or Not, There's Always Algae	June 1998, p. 9
Plants Don't Stop at the Water's Edge	Nov. 2000, p. 7
Tracking the Wild—and Domestic—Bacteria	Oct. 1999, p. 8
When Aquatic Visitors Become Unwelcome Residents (nonnative species)	Aug.-Sept. 2001, p. 7

Information Sources

Aquatic-life Information Sources	Nov. 2000, p. 19
Coastal and Marine Resources Information	June 2001, p. 19
Federal Water Regulations	June-Aug. 2000, p. 19
Finding Drinking Water Information	Aug. 1998, p. 14
Finding Water Quality Information	Oct. 1998, p. 15; and Dec. 2001, p. 19
Following State Water Regulations	Apr. 2000, p. 15
Following the Virginia General Assembly	Feb. 2000, p. 15; and Dec. 2001, p. 18
Groundwater Information Sources	Feb. 1999, p. 15; and April 2001, p. 19
Hydrologic Information Sources	Dec. 1998, p. 15
Maps for Water Resources	Jan. 2001, p. 18
Tracking Federal Legislation and EPA Regulations	June 1998, p. 15
Water Law and Water Rights	Dec. 1999, p. 10
Water Use	June 1999, p. 15
Weather and Climate	Apr. 1999, p. 15
Wetlands Information Sources	Oct. 1999, p. 15

Law and Policy

1998 General Assembly Legislation Related to Water	June 1998, p. 3
2000 Virginia General Assembly	Apr. 2000, p. 1
Expanding the "Viewshed" on State Water Legislation	June 1999, p. 1
Finding the Path to No Net Loss of Virginia's Non-tidal Wetlands	Nov. 2000, p. 1
Fitting Drinking Water Amendments into Place	Dec. 1998, p. 1
Inside Virginia's State Budget for Water	April 2001, p. 1

Navigating the Currents of Water Quality Law (TMDL-related)	Oct. 1998, p. 1

Law and Policy, cont.

Reflections on the Water in the 2000 Virginia General Assembly	June-Aug. 2000, p. 2
Revisiting that Pesky Acronym, TMDLs	Oct. 1999, p. 1
The Flow of Federal Water Laws	Feb. 1999, p. 1
The Volume of Bills in the 1999 Virginia General Assembly	Apr. 1999, p. 1
TMDLs Past, Present, and Future	Dec. 2001, p. 1
Virginia Water Legislation in the Wake and on the Horizon	Aug. 1998, p. 1
Views of the Virginia Impaired-waters List	Dec. 1999, p. 1
Water in the 2001 General Assembly	June 2001, p. 1
Water Issues at a Sample of Virginia Newspapers	June 2001, p. 10

Research on Water in Virginia

Research on Small Water Systems and Community Drinking Water	Aug. 1999, p. 2
VWRRC Research Program Documentation for 1996-1999	Aug. 1999, p. 8
Water Science and Water Quality Management	Aug. 1999, p. 5

Teaching Resources

Benthic Macroinvertebrates Poster Source	Dec. 1999, p. 11
Dragonflies Poster Source	Apr. 2000, p. 8
Federal Agency Educational Resources for Schools	Jan. 2001, p. 15
National Park Service Earth Science Explorers	Nov. 2000, p. 6
Teach'n Fishing Workshops	June-Aug. 2000, p. 13
Virginia Standards of Learning for selected newsletter articles	Each issue, page varies
Virginia Watersheds Poster Source	Feb. 2000, p. 11

Watersheds and Water Movement

An Introduction to Urban Stormwater	Feb. 2000, p. 1
Divide and Confluence	Feb. 2000, p. 8
Hydrology Shows Where the Water Goes	Dec. 1998, p. 7

Miscellaneous

An Introduction to Water-related Sciences	Feb. 1999, p. 6
At Mid-season for Hurricanes, Southeastern Virginia Water Utilities Remember Floyd	Aug.-Sept. 2001, p. 2
The Virginia STEP Program in Summer 2001	Dec. 2001, p. 17
Water-related Responses to September 11, 2001	Dec. 2001, p. 8
What's New—and Old—in Drinking-water Treatment	Jan. 2001, p. 1
What's the Meaning of this…Data?! (statistics)	Jan. 2001, p. 6
When Numbers Talk, They Speak Statistics	June-Aug. 2000, p. 8

Virginia Water Central

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Water Central staff: Alan Raflo, editor; David Mudd, writer; George Wills, illustrator.

Sort through the cobwebs...

…to find *Virginia Water Central* on the Water Center's Web-site, **www.vwrrc.vt.edu**. If you prefer to read the newsletter there, *instead of* receiving a paper copy, please send your e-mail address to water@vt.edu, and we will notify you when a new issue is posted.

YOU GET THE LAST WORD

Please answer the following questions to let us know whether the newsletter is meeting your needs. Please mail this page to the Water Center address listed in the box to the left, or e-mail your responses to water @vt.edu. Thank you.

1. Would you rate the content of this issue as good, fair, or poor?

2. Would you rate the appearance as good, fair, or poor?

3. Would you rate the readability of the articles as good, fair, or poor?

4. Is the newsletter too long, too short, or about right?

5. Do the issues come too frequently, too seldom, or about right?

6. Please add any other **comments** you wish to make.

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