This is the final draft version of the report. Some editing occurred during layout prior to going to press.

> "As our population continues to grow and stresses on our water resources increase, it is becoming imperative that the various components of the water resources programs be unified in philosophy and action to represent a cohesive and effective vision of how to protect these vital resources into the future."
>
> *--Albemarle County Comprehensive Plan 1999*

Water in the new Millennium

Meeting the Needs of People and the Environment

Contents

The community faces a challenge.

A public system run by the Rivanna Water and Sewer Authority (RWSA)[1] supplies water to all residents and businesses in the City of Charlottesville and those in Albemarle County□s designated development areas.

Numerous studies have warned that RWSA□s sources of raw water will be insufficient to meet demand in the future.

1997 projections show demand exceeding supply.

The latest estimates from RWSA□s consulting firm say that by the year 2050

- water demand will reach 18-21 million gallons per day (mgd),
- safe yield of water from existing facilities will be only 5 mgd, so
- actual demand will exceed the safe-yield supply by 13-16 mgd.

Who is responsible for addressing the projected water deficit?

The responsibility lies with the RWSA, as it is their mandate to provide water to meet the public□s demand.

In the water supplier□s decision-making, however, public participation is a required component of the permitting process for new water-supply facilities. It is also a desirable component of resource management within a community.

This booklet offers citizens basic information that is both pertinent to the evaluation process under way at the RWSA and necessary for informed decision-making on water issues in the new millennium.

What is the public□ s role?

As we go to press, we anticipate a televised public meeting on **April 20, 1999** where the various alternatives for addressing projected water demands through the year 2050 will be presented by the RWSA□s consultants. The 7:00 p.m. meeting will be held in the City Council Chamber, City Hall, Charlottesville, Virginia and will be videotaped and televised again at a later date. Public input will be heard at the meeting and afterward. A copy of the preliminary report describing the proposed list of water-supply alternatives will be made available by RWSA in advance of the meeting. Call 977-2970, extension 101.

In the 1980□ s, after studying various ways to impound additional water, the RWSA purchased land and easements along Buck Mountain Creek for a new reservoir.

What has been done to provide for future public water supply?

In 1995, the RWSA□s consulting firm, Black and Veatch, produced an *Urban Raw-Water Management Plan*.

- The plan indicated that local water demand could be expected to exceed supplies in the year 2015.

It recommended that "preliminary activities should begin immediately" for construction of a Buck Mountain Reservoir; the reservoir should be brought into service by 2012; and, design and construction should be under way by 2005.

Thus, a process began; however, permits for water collection systems are not a certainty. For guidance through the permitting maze, RWSA has hired the consulting firm of Vanasse Hangen Brustlin, Inc. (VHB) and its subcontractor O□Brien and Gere Engineers, Inc.

The Permitting Process

The federal government has regulatory requirements intended to minimize environmental damage by water-resource developments.

The steps entail acquisition of permits from the Army Corps of Engineers, the Virginia Marine Resources Commission and Departments of Environmental Quality and Conservation/Recreation, as well as reconsideration of all possible water supply alternatives and the effects of a water conservation program.

Other Virginia municipalities seeking to develop water resources have spent up to ten years in this permitting process. If at any point a permit is denied, another source of water must be identified and the process started over again.

In 1997, O□Brien/Gere produced two *Raw Water Supply Facility Permitting Analyses*□one for demand and one for supply. The reports, which are a required element of the permitting process, describe how the consultants arrived at their prediction for an impending water deficit. The next step, listing and re-analyzing all the supply possibilities is under way. The proposed Buck Mountain Reservoir is now only one of many alternatives.

What is our natural water supply?

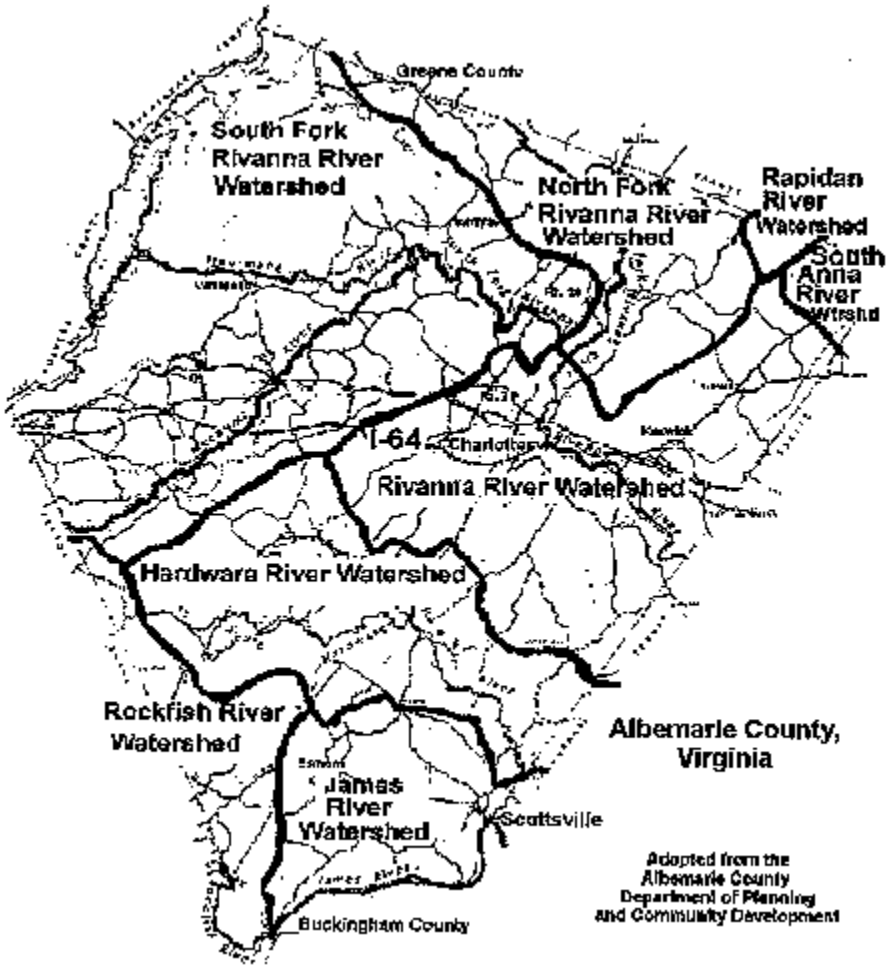
Precipitation. Our water supply is completely dependent upon Piedmont Virginia's mean annual precipitation of 45 inches of water. The most severe drought year for which there are local records, 1930, had precipitation totaling only 27 inches of water. The water supply system's safe yield is defined in terms of the drought of record.

In our location, beneath the eastern slopes of the Blue Ridge Mountains, water running down from the mountains or falling directly on our landscape travels a variety of pathways at different flow rates. It percolates through forest litter and into the soil and rock layers below. Moving at this slow rate, the water remains "stored." It also descends deep into the ground at one place and then emerges again at another as a spring, or drains swiftly into streams that lead to reservoirs and lakes, which spill away into rivers downstream.

Surface water flows in above-ground streams and rivers, and locally is collected by five dams and a river intake structure. These facilities are the sources for all the public water supply to the City of Charlottesville and the "designated development areas" of Albemarle County. The remainder of Albemarle County is served by ground water pumped from private wells.

Ground water in the central Piedmont moves in unpredictable patterns through underground spaces between particles of sand and gravel strata or through rock formations. Unlike other regions across the country, our area has no well-defined aquifer that can store large quantities of water.

Watersheds are regions in which all land drains to a common point, such as a river or reservoir. The common point might appear to be the "source" of water, but the source is actually a complex (eco)system of the interrelated parts making up the watershed itself. Eight watersheds comprise the local natural water supply.



Whether you are a customer of a public water service or pump water from a well, the source of your water is located in a watershed somewhere in Albemarle County.

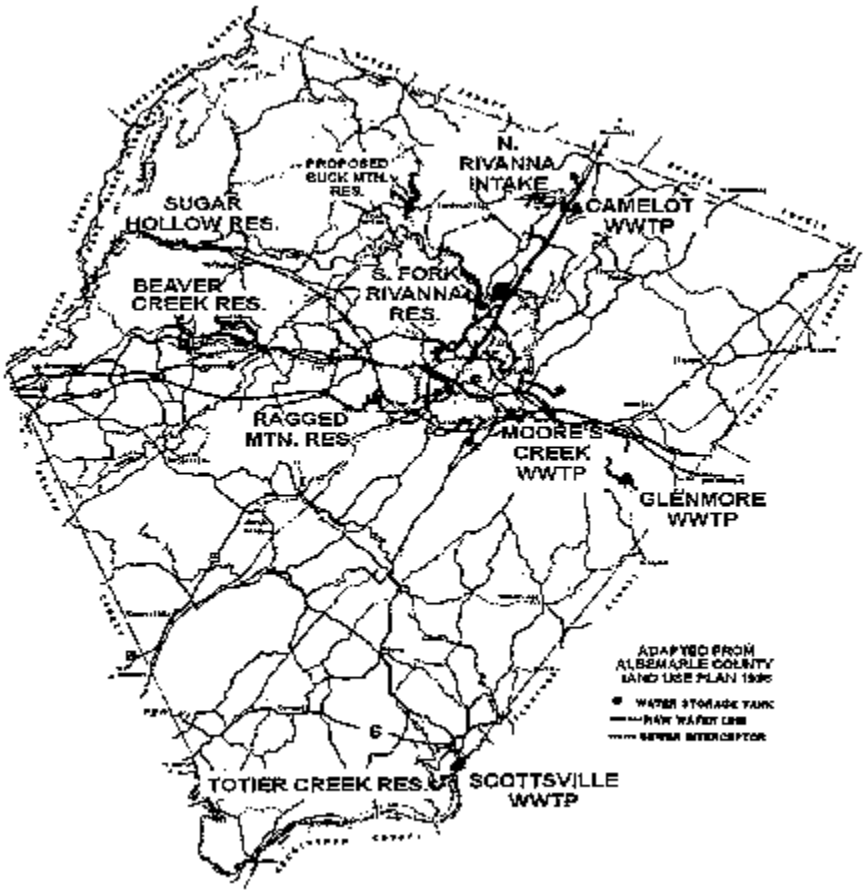
Where are the "supplies" of public water?

As the sole wholesaler of water, the Rivanna Water and Sewer Authority commands three distinct service areas, which are defined by different locations of major infrastructure:

- the "Urban Area" (includes Charlottesville, the University of Virginia, and the surrounding area of Albemarle County that is designated for development by the County□s Comprehensive Plan)
- Crozet
- Scottsville

To supply these service areas, surface water is captured, treated, and delivered to users, who may be at some distance from the contributing watershed.

Sources of supply for the Urban Area (4,135 million gallons used in 1998)



Sugar Hollow Reservoir in northwestern Albemarle fills from the Blue Ridge Mountains confluence of the Moormans River's North and South forks. (Watershed area, 18 square miles; usable storage volume, 360 million gallons).

Ragged Mountain Reservoir, which fills partially from its relatively small (1.8-square mile) surrounding drainage area, also fills from an 18" pipeline connected to the Sugar Hollow Reservoir. The usable volume is 514 million gallons.

Because of their pipeline connection, the reservoirs at Sugar Hollow and Ragged Mountain are managed as one system. The water is treated at Observatory Hill Plant.

Our largest storage area for water, the **South Fork Rivanna Reservoir** (watershed area, 243 square miles; current usable volume, 880 million gallons) north of Charlottesville fills from the overflow from Sugar Hollow Reservoir and other tributaries into the Moormans River, from Mechums River, and from the South Fork Rivanna River. This water is treated at the South Rivanna Treatment Plant.

A **North Fork Rivanna River Diversion** facility (watershed area, 121 square miles) diverts river flow into a North Fork Rivanna treatment plant. Chris Greene Lake could also supply this treatment plant.

Crozet supply (241 million gallons used in 1998*)

Water from the **Beaver Creek Reservoir** is treated at the Crozet Treatment Plant and supplies two Crozet areas: the area currently designated for development in the County s Comprehensive Plan and a small residential area outside the designated development area.

Scottsville supply (50 million gallons used in 1998)

Totier Creek Reservoir fills from southwestern Albemarle s James River Watershed and feeds into the

Scottsville Treatment Plant, which supplies that area of Scottsville designated for development in the County□s Comprehensive Plan.

Current supply and demand: Urban-Area public water

Estimated Water Supply 1997

Safe Yield [1] (million gallons per day)	
Rivanna Reservoir	**7.2**
Sugar Hollow/Ragged Mtn.	**4.1**
N. Rivanna River Intake	**0.6**
Total Urban Supply	**11.9**

[1] ***Safe yield is defined in appendix A.***

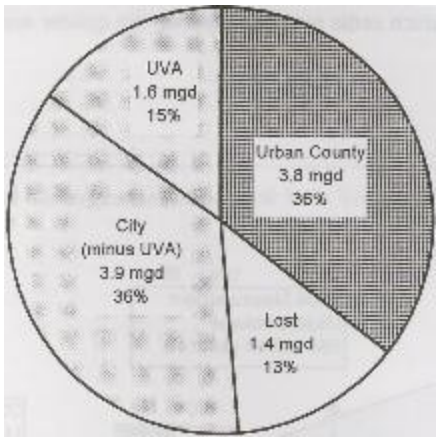
Previous supply estimates have been higher than those shown above. Three factors have changed.[2]

- Debris left in the Sugar Hollow Reservoir by the severe storm in 1995 reduced the storage volume by 71 million gallons.
- Previous calculations had not allowed for silting in Sugar Hollow Reservoir, which is more gradual than in the Rivanna, but is displacing 1.5 million gallons per year of storage capacity (~4,000 gallons per day).
- RWSA's current consultants used the 1930 drought as being amore likely model for demand than the less sever 1954 drought factored in by previous consultants.

[2] Source: VHB, Inc./O'Brien and Gere, Inc., *Raw Water supply Facility Permitting Supply analysis, October, 1997*.

Actual Daily Demand 1998
By Sector

mgd (million gallons per day) on average
and
percentage of the total urban wholesale volume averaging 10.7 mgd



Actual Annual Demand

Of 4,135 million gallons of treated water produced for the Urban Area in 1988 --

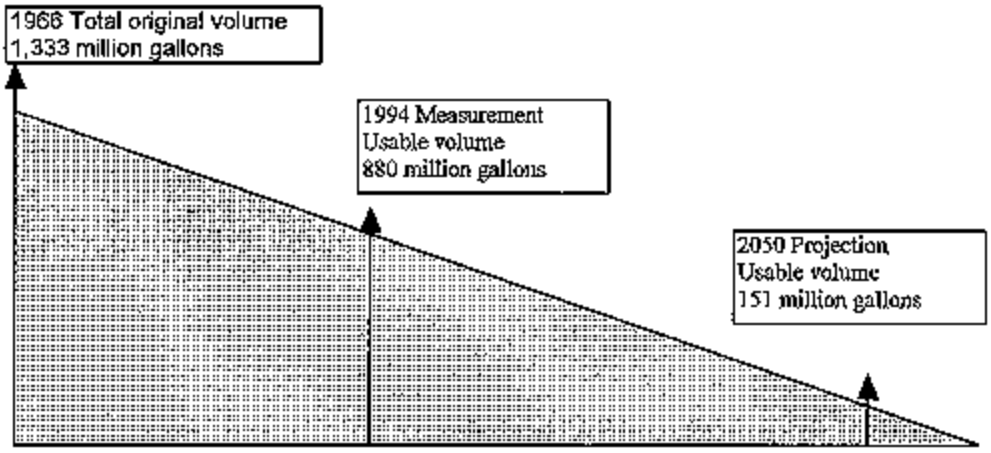
- 527 million gallons were lost between the RWSA metered intake of raw water and metered retain sale to consumers. (In appendix E, points of loss are listed.)
- 3,608 million gallons were sold at retail.

City retail sales
2,187 million gallons, including **625 million gallons** to the University of Virginia (the City's largest volume consumer).

County urban retail sales
1,420 million gallons, including **28 million gallons** sold to Farmington, Inc. (the County's largest volume Urban-Area customer).

Urban water supplies are diminishing over time. Why?

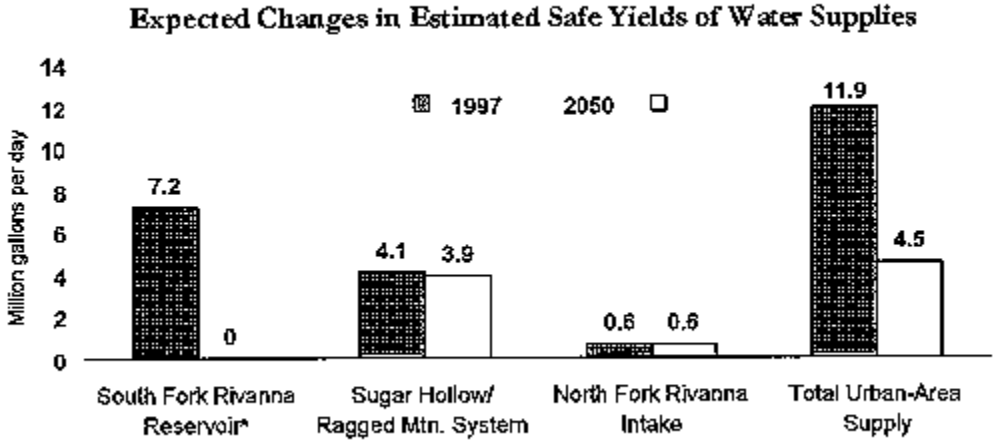
Silt deposits are rapidly reducing the storage capacity of the community□s largest reservoir. The streams and rivers that flow into the South Fork Rivanna Reservoir are carrying heavy loads of suspended silt particles, which settle out upon entering the quieter area of the reservoir.



Effect of silt deposits on the South Fork Rivanna Reservoir storage capacity

In 1994, RWSA consultants Black and Veatch made a depth analysis (bathymetric survey).
Based on the survey, the estimated loss of storage volume due to the silt flowing into the reservoir was 13.0 million gallons per year (~36,000 gallons per day).

The effect of the sediment loading over time is shown in the chart below.



Future demand for publicly supplied drinking water

"A comprehensive review of long-term water demand in the region...based on the best available data" is presented in the RWSA consultant□s 1997 *Raw Water Supply Facility Permitting Demand Analysis* ." The

report explains two methods that were used to prepare the estimates of future demand.

Analysis Method 1: One method simply plotted the trend in historic raw-water consumption and extended a line into the future. At year 2050, the line indicated water demand of 20.4 million gallons per day.

Analysis Method 2: Using a second method, the consultants separated out each sector of Urban-Area water demand□the Urban County, the City, and the University of Virginia□and, for each, analyzed **various combinations of the following information:**

- current water consumption per person per day (measured as total metered water sold in that sector / total population served),
- population growth projected to 2050 (the University estimate was based on student population size),
- homes not yet built, but allowed for by the current comprehensive plans of the City and County (no University plan was available), and
- historic demand

Results

For all combinations of the data, the estimates for the year 2050 fell into the range of 18-21 million gallons per day of water demand.

The estimates indicate that more than 70,000 *new* residents will require public water services by the year 2050.

What do these numbers assume?

The demand projections are a kind of "best guess.□ They assume that

- the current rates of population growth will continue,
- levels of water consumption, estimated per resident, will stay the same, and
- planned densities of residential development will remain unchanged over the next fifty years.

Other questions remain

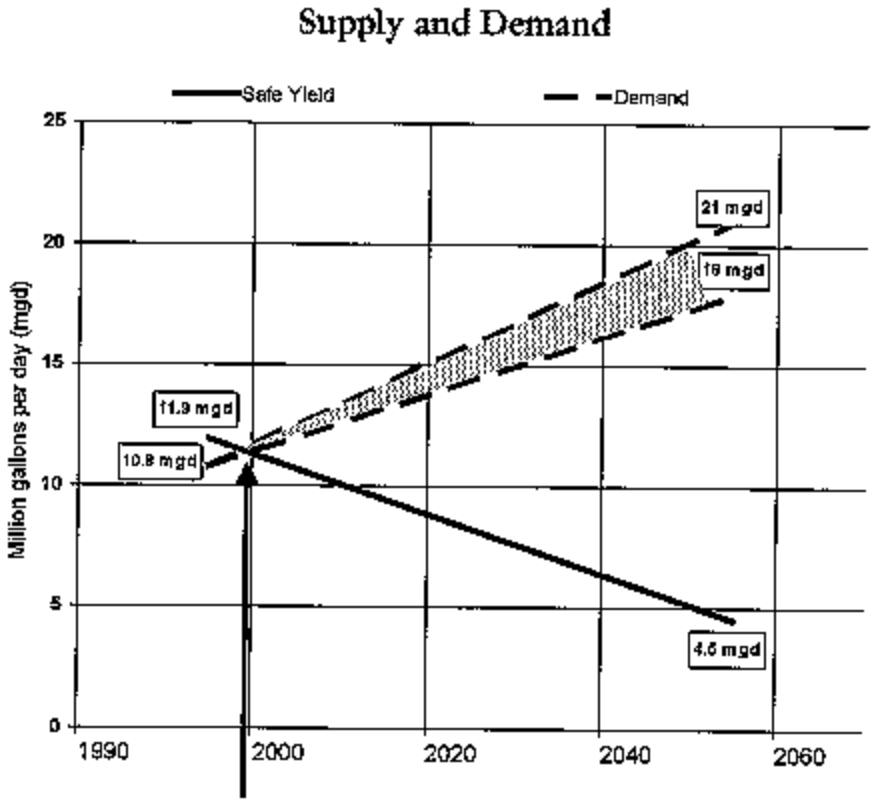
For example, future demand estimates for industrial/commercial uses of water have only been extrapolated from current levels of use. The impacts of changes in growth or demand management in those sectors have not been estimated.

A calculated deficit

Consultants to the Rivanna Water and Sewer Authority, calculating the year 2050 supplies of raw water and demand for treated water as described above, find a water deficit as follows.

Year 2050 demand	18-21 million gallons per day
Year 2050 supply (from the facilities that exist today)	4-5 million gallons per day

Year 2050 water deficit	12-17 million gallons per day



Arrow indicates the point when the safe yield of public water would equal demand if there were a drought equivalent to the 1930□s drought of record.

Note: Two lines are plotted for demand because the engineers□ projections for year 2050 range from 18 to 21 mgd.

Alternatives for new public water supplies

RWSA□s consultants currently are analyzing preliminary lists of resources to identify additional raw-water supplies for Charlottesville-Albemarle. It is important to remember that any alternative or combination of alternatives must meet the permitting process laid out [previously].

The Preliminary List of Alternatives

(As of 4/1/99. Prepared by VHB, Inc.)

At South Fork Rivanna Reservoir

Repeatedly dredge bottom sediments
Change downstream release practices to withhold water during severe drought conditions

Pump water back into from the reservoir from the downstream Rivanna River
Raise the dam with 4-foot or 8-foot crest controls
Reduce the incoming sediment load
Capture the treated water ordinarily discharged downstream from the Moore□s Creek Wastewater Treatment Plant and pump it to Mechums River for flow into the reservoir At Chris Greene Lake
During severe drought conditions, release water into the North Fork Rivanna to supplement supply to the intake facility, limiting the volume to either a 5-foot or 20-foot drop in water level at the lake.
During high flows, pump water from North Fork Rivanna to storage at Chris Greene Lake
Dredge Sugar Hollow Reservoir

Install ground water wells and pipe water to South Fork and North Fork treatment plants.

Store treated water in an aquifer for recovery during drought

Pump water from the James River to Charlottesville

Install new river intake and water treatment facility on the Rivanna River near Glenmore Country Club.

From Mechums River near Lake Albemarle, pump water to existing Ragged Mountain Reservoirs
At Ragged Mountain Reservoirs, raise the dam at the lower reservoir by 50 feet and store water pumped in from Mechums River during high flows

Construct a dam and reservoir on

Buck Mountain Creek, including alternate dam locations
Preddy Creek
Moormans River
North Fork Rivanna River
Mechums River 0.5 miles northeast of Batesville
Mechums River one mile upstream of I-64 near Midway
Buck Island Creek
Implement long-term water conservation program

Develop and implement a drought management plan

Detect leaks in water distribution systems and calibrate meters

Criteria for Evaluating Water Supply Alternatives

- Practicability (includes costs, feasibility, logistics)
- Environmental impacts
- Ability to satisfy water supply needs

- In choosing solutions, how will the criteria be weighted?
- What will make certain solutions more practicable than others?
- Since conservation must be a part of any water supply solution, who will set goals and have responsibility for coordinating a plan for the whole community?

Who's in charge?

The Local Suppliers of Public Water

For residents of the City of Charlottesville, water delivery and sewage treatment services are provided by the City□s **Public Utilities Division of the Department of Public Works.**

In Albemarle County, designated urban areas are served by public water and sewer services provided by the **Albemarle County Service Authority**

In addition, by the terms of a 1973 "Four-Party Agreement," the City Council, Albemarle County Board of Supervisors, and Albemarle County Service Authority designated another major player in the provision of public water: the **Rivanna Water and Sewer Authority.**

According to the Agreement, the Rivanna Water and Sewer Authority (RWSA) is required to provide at wholesale the water and the sewage treatment demanded by the Albemarle County Service Authority and the Charlottesville Department of Public Works for retail sale to the community. The RWSA is authorized to issue revenue bonds, to fix, charge and collect fees for services, and to enter into service contracts with other governmental units.

Water consumers are customers of the Albemarle County Service Authority or the Charlottesville Department of Public Works. **These two agencies are customers of** the RWSA.

Who governs the suppliers?

A five-member Board of Directors governs the RWSA. It includes the City Manager, the Director of Public Works of the City, the County Executive, the Executive Director of the Albemarle County Service Authority, and a private citizen, who is appointed by the City Council and the County Board of Supervisors and serves as Chair. The RWSA Board appoints for itself a Citizen Advisory Committee.

The Albemarle County Service Authority was established in 1964 pursuant to the Virginia *Water and Sewer Authorities Act* and is governed by a six-member Board of Directors appointed by the Albemarle County Board of Supervisors. The Directors serve four-year renewable terms; they appoint the Executive Director of the Authority and govern operations.

The Charlottesville Department of Public Works is a department of the City of Charlottesville. The Director of the Department of Public Works reports to the City Manager, who serves at the pleasure of the City Council.

Rethinking our use of water

Traditionally, meeting increased water demands in a community have involved developing new facilities to collect more water (building reservoirs or tapping rivers). There are less traditional approaches gaining popularity around the country. These adjust the ways we use and manage our existing supply of water in order to make that supply go further. They have to do with increasing efficiency, reducing waste, and reusing water. Some of the alternatives cited on the preceding pages reflect these methods. Consider the following.

Water Efficiency and Conservation

In 1997, the RWSA□s consulting engineers made a rough calculation for the average daily water consumption per person in the urban service areas. To do this, they simply divided the total retail volume of water by the number of persons residing in the area of interest.

Estimated volume of water used per person in the Urban-Area sectors	
	gallons per person per day
City of Charlottesville	111
University of Virginia	77
Urban Albemarle County	99

When a consumer uses water, that person often seeks clean dishes, a shower, or a flushed toilet□not the water per se, rather the service it provides. There are many ways more efficient service can be achieved.

Pipes that transport water can be carefully inspected for leaks. The pressure at which water is piped to customers can be lowered. Through public education, customers can be asked to water lawns and gardens at specified times when the evaporation level is lowest, to landscape with indigenous plants that survive under natural rainfall conditions, and to retrofit with water-saving fixtures and appliances.

By managing demand in these ways, we□individually and as a community□can maintain or even improve our quality of water service while also lowering utility bills and system-wide water consumption. With lower consumption, the need for costly supply-side improvements may be postponed or reduced.

Another community□ s solution

Increasingly, when faced with the high costs of developing new sources of water, such as constructing expensive reservoir communities are opting for a comprehensive water efficiency program as an alternative means of meeting demand. In 198 officials in Ashland, Oregon started discussing what to do when a key water right expired. Consultants advised them to dar Ashland Creek. The $11 million-dollar cost was a price no one wanted to pay.

On the advice of a second consultant, Ashland instituted a community-wide water efficiency program designed to save 500 gallons of water a day□the same amount of water that would have been provided by the dam. The efficiency program cost $825,000. In addition to saving water and more than $10 million dollars, Ashland's residents began to save more than 500, kilowatt-hours a year on heating water, and the annual volume of wastewater treatment was reduced by 43 million gallons.

Water pricing

Unlike ground water which is used straight from a well, publicly supplied water is a manufactured product, and it is "manufactured" to drinking-water standards, even though 98-99% of it is used for purposes other than drinking. At a current wholesale cost within the Charlottesville-Albemarle urban area of ten cents per one hundred gallons, treated water has no reputation as a precious commodity.

It might seem obvious that water efficiency could be achieved simply by increasing the price of water; however, changing the rate structure in some communities merely resulted in the customer readjusting to

new higher rates and returning to old use patterns. To influence water consumption, it was necessary to change from a flat rate to an increasing rate for each "block" of water used

Peak-load pricing, seasonal pricing, summer surcharges, and excess-use surcharges are examples of pricing that can reduce waste, extend the life of the water source, and cure many "water shortages."

Water re-use

One of the items on the RWSA□s list of alternative water sources points to the possibility for making use of treated wastewater. Currently, this water flows unused downstream. In 1998, f approximately 12 millions gallons per day of treated water were discharged from the Moore□s Creek Wastewater Treatment Plant. The plant has a permit to release up to 15 mgd of treated water. The wastewater comes from homes and businesses in the RWSA□s Urban and Crozet service areas. (Four smaller wastewater treatment plants in Albemarle County serve Scottsville, Glenmore, the area of Camelot subdivision, and Stone Robinson Elementary School. The combined total for effluent from these four facilities averaged less than 0.3 mgd in 1998.)

How far would the projected water-supply deficit move into the future if the community were to begin re-using the water supply it already has? How do the costs and benefits compare to other solutions?

Rethinking our Philosophy of Water

Keeping in mind the ecosystem

The capacity of a watershed to maintain its highest potential as a water holding and release system depends on its remaining a naturally functioning, healthy ecosystem. Charlottesville and Albemarle County now face a problem similar to that of many other communities across the country: *How can we find a way to preserve unique aquatic ecosystems along with their imperiled inhabitants while meeting increased water demands?*

Effects on ecosystems

We can foresee no gross changes in our weather patterns that would alter our basic climate. Therefore, the most intense impacts on the natural water supply to our ecosystems can be expected from acute severe weather□droughts and floods□and from human activity.

Human activities impact natural water flows both on a day-to-day basis and in relation to our management of drought and flood effects.

Two severely negative human impacts related to flood and drought have been highlighted recently.

Accelerated run-off after flood events (winter rain/snowmelt, summer storm)

The Rivanna River Round table□s *State of the Basin Report 1998* documented many negative effects on waterways as a result of floodwater running off impervious surfaces (parking lots, roofs, etc.) and areas otherwise stripped of vegetation. The negative impacts include:

- sudden heavy flows that gouge streambeds and undercut stream banks, causing loss of plant life and lower flows in an enlarged bed, and
- loading streams with pollutants (including fecal coliform) and suspended sediment in amounts that exceed various Virginia Department of Environmental Quality safety standards for humans and wildlife.

A river runs dry

In the past year, Sugar Hollow residents have raised community awareness about the lack of water in the Moormans River below Sugar Hollow Dam for as many as six months of the year.

This situation points out several features of the public water system.

First, to date, management practices have not been designed around guaranteeing a minimum flow back into the riverbeds below dams.

Second, because of its mandate and contractual obligations, the RWSA focuses on managing raw-water supplies for the purpose of meeting the public demand for tap water.

In order to meet these obligations as reliably as possible over time, RWSA keeps its facilities filled at all times, and manages release of reservoir waters to treatment plants to yield the greatest efficiencies, and thus economies, in plant operations.

The Four-Party Agreement which put the RWSA in the business of meeting demand for treated tap water did not at the same time charge any entity with meeting the demands from other dependents on the natural water supply. This arrangement may have had no obviously negative consequences when it was created back in 1973; the public demand for water was drastically lower at that time. Demand levels of the 1990□s create a significantly different situation.

The dry Moormans Riverbed may be a warning for the community on the effects of a water-management approach aimed only at meeting human demand.

Acknowledging the interrelationship of Ground Water and Surface Water

Historically, ground water has not been a reliable, long-term source for drinking water as population density increases. Charlottesville abandoned its wells over 100 years ago, when a combination of over-pumping and over-flowing privies, caused by increased population, sent City fathers into Albemarle County to buy land for impoundment of surface water. The first mountain stream reservoir at Ragged Mountain was followed later by the Sugar Hollow Reservoir on the Moormans River and the Rivanna Reservoir on the South Fork Rivanna.

Nevertheless, because ground water and surface water recharge one another (and the polluted water of one can pollute the other), urban consumers of treated surface water should be just as concerned about what happens to ground water as the County residents who depend on wells.

Currently one-half of the County□s population depends directly on this fragile source for water. We do not know how much ground water is available, how much is pumped out daily from the hundreds of domestic wells, or whether all of it is safe to drink. We also do not know whether over-pumping is depleting the supply, and thus not only risking dry wells, but also diminishing the reemergence of groundwater in natural springs, which contribute to the volume of surface waters.

By and large, the responsibility to protect ground water is left to local jurisdictions; it is a community□s responsibility to prevent its contamination, depletion, or misuse. A basic tool needed is a hydrogeologic report, which would provide, among other things, data to assure water quality and quantity. There is potential danger if development depending on ground water is pursued without regard to hydrogeological factors.

Reviewing our Goals and Aspirations

"Total water management" principles of the American Waterworks Association

For a "total water management" approach, a community must begin at the local level and integrate the following principles articulated by the American Water Works Association.

Stewardship The water utility industry cannot be concerned only with providing potable water. The role of the utility must be expanded to include stewardship of good water policy. Water utilities must position themselves to effect change in the way land and water resources are currently managed.

Government There is an urgent need for a unified water resources policy. Land and water-resources planning and management must be integrated under a watershed framework. The policy must be based on the principles of pollution prevention, resource conservation, and development strategies that are sustainable.

Water conservation Because water is a renewable, but finite resource, water conservation considerations should be a part of any utility's water resources planning. Conservation, encompassing supply and demand management, is appropriate to some degree for all utilities and not just those in water-short areas

Water resource management The water industry must consider the total interaction of water with the environment, including the balances of human and ecological risk and the preservation and restoration of ecosystems.

United States League of Women Voters Positions

The following statements are excerpts from the formal position statements of The League of Women Voters of the United States.

Natural Resources: Promote an environment beneficial to life through the protections and wise management of natural resources in the public interest by recognizing the interrelationships of air quality, energy, land use, waste management, and water resources.

The League of Women Voters of the United States believes that natural resources should be managed as interrelated parts of life-supporting ecosystems. Resources should be conserved and protected to assure their future availability. Pollution of these resources should be controlled in order to preserve the physical, chemical., and biological integrity of ecosystems and to protect public health.

Resource management: Promote resource conservation, stewardship, and long-range planning, with the responsibility for managing natural resource shared by all levels of government.

Resource management decisions must be based on a through assessment of population growth and of current and future needs. The inherent characteristics and carrying capacities of each area□s natural resources must be considered in the planning process.

To assure the future availability of essential resources, government policies must promote stewardship of natural resources. Policies that promote resource conservation are a fundamental part of such stewardship. Resources such as water and soil should be protected. Beneficiaries should pay the costs for water, land, and energy development projects. Reclamation and reuse of natural resources should be encouraged.

From the Rivanna River Basin Roundtable Principles 1998

- "All living things within the basin are interconnected in complex and interdependent systems, and are dependent on the quality and quantity of the basin□s waters."
- "All human activities should be considered in terms of their potential impacts on the waters of the basin."

From 1998 Sustainability Accords of the Thomas Jefferson Sustainability Council

- "Ensure that water quality and quantity in the Region are sufficient to support the human population and the ecosystems."

From the Albemarle County Comprehensive Plan Water Resources Section 1999

- "As our populations grows and stresses on water resources increase, we must increasingly strive to use these resources in an efficient manner. The more use we get out of every gallon of water leaves more in streams and ground water for the maintenance and health of natural ecosystems."

  "All land uses, landowners and residents (urban, suburban, agricultural, forestal) share the responsibility for preserving, protecting, and enhancing water resources in the community for current and future generations and the biological communities with whom we share the landscape."

APPENDICES

Appendix A. The meaning of *safe yield*

In our water industry, the term ***raw-water supply*** refers to surface water that has been collected for supply to a water treatment plant. (The treatment plant□s output of water clean enough to drink is referred to as *finished* or *potable* water.)

To describe the amount of raw-water provided by a reservoir (or a river diversion facility), a calculation is made regarding the maximum volume that can be consistently supplied to a treatment plant over a designated period of time.

The estimate takes into account

- the physical size of the reservoir or diversion facility, and the size of its watershed,
- the maximum volume of natural water that can be expected to flow into the system under conditions similar to the worst drought on record, and
- the duration of the worst drought on record**.**

The result of this calculation describes the *safe yield* of the system.

Safe-yield estimates typically do not include an amount set aside for consistently allowing water to flow past the dam or diversion and into the riverbed beyond.

In other words, yield calculations for local facilities assume that the entire basin flow may be diverted by the RWSA to meet demand from customers.

Appendix B. Formation of the Rivanna Water and Sewer Authority

Prior to the early 1970's, the City of Charlottesville and Albemarle County independently owned and operated water-output and sewage treatment facilities. In the early 1970's, each decided it needed additional facilities and applied to the State Water Control Board and the Environmental Protection Agency for federal grants to partially fund planning and construction. The Board approved these applications on the condition that the City and County establish a single political entity to address the severe water and sewage problems that plagued both communities.

There were good reasons for the State Water Control Board to place this condition on the City and County. Each needed to seek water within the same region: the Rivanna River Basin. Each needed to discharge effluent from sewage treatment plants back into the same basin. Thus, it made sense to place the responsibility for water supply and sewage treatment in the hands of a single entity that would have authority over the entire region.

Together, the City and County commissioned advice from Malcolm Pirnie, a consulting firm. The firm recommended creation of a Rivanna Water and Sewer Authority; the Authority was constituted in 1972.

The new Rivanna Water and Sewer Authority was charged with providing potable water and wastewater treatment to the City of Charlottesville and to those portions of the County served by the Albemarle County Service Authority.

Appendix C. RWSA Rates

Each year the RWSA sets its wholesale prices for treated water according to their costs for operation and maintenance, plus principal and interest on the bonds issued to build facilities. RWSA lumps all the Urban-Area facilities together to determine costs for that sector. Charges are allocated between the City of Charlottesville and the Albemarle County Service Authority on the basis of the volumes of retail water flows to those areas.

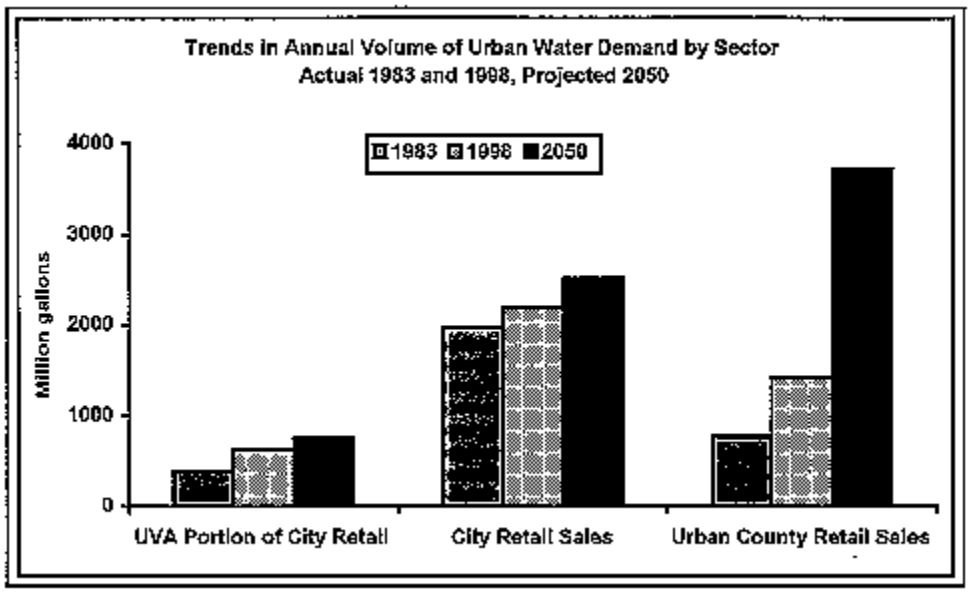
RWSA rates for fiscal year 1999	
Urban area City County	$1.015 per thousand gallons $1.134 per thousand gallons
Crozet	$43,078 per month
Scottsville	$17,130 per month

Water consumers pay a retail rate that reflects both the wholesale charge for water, plus the costs for operations and debt service on the distribution systems owned and operated by the City of Charlottesville and the Albemarle County Service Authority. Even though the Albemarle County Service Authority is charged different wholesale rates for the water treated in its three different service areas, as shown on

the schedule above, its retail policy is to charge all County customers the same rate regardless of where they live.

Appendix D. The trends in Urban-Area Water Demand

Data from the RWSA's compilation of "Urban Water Wholesale and Retain Flows by Fiscal Year" shows the following trends in Urban-Area water consumption.



Documented demand figures were taken from the RWSA's report, "Urban Water Wholesale and Retail Flows by Fiscal Year July 1982 - June 1998."

Estimated annual numbers for 2050 are based on projections for daily water consumption given the RWSA consultants' *Raw Water Supply Facility Permitting Demand Analysis Albemarle County and City of Charlottesville, October 1997.* The consultants estimated daily consumption in four ways. An average of their daily estimates for each sector was multiplied by 365 days to arrive at the annual figures given for year 2050 in the table.

Appendix E. "Lost" water described

Water is "lost" when unmetered uses and system losses occur between the raw water metering process and the final delivery of finished water to the end customer. The following is a partial list of points of loss:

- Plant losses in the finished water production process
- System losses during water transmission or distribution (line breaks and leakage)
- Distribution system maintenance and flushing
- Fire fighting
- Unmetered connections
- Meter inefficiencies
- Street washing

Appendix F. More on ground water

While public water service relies on collection, treatment, and piped delivery of *surface* waters, the

majority of Albemarle County residents live in areas that lie beyond the public system and depend on direct withdrawal of *underground* water.

Likewise, in urban areas, sewer systems pipe wastewater to central treatment plants, whereas in county areas outside these systems, wastewater is released into the ground near its source via individual septic systems.

In addition to the private well-and-septic systems serving approximately 12,500 Albemarle homes outside the urban area, there are 16 subdivisions with private, community water supplies and 49 non-community-based private systems serving facilities such as schools, motels, and restaurants.

Ground water is recharged through precipitation and septic field drainage. The amount of recharge from precipitation is estimated to be about 8 to 11 inches per year; the amount of septic recharge is unknown.

The Virginia Public Health Department is mandated by Title 32.1 of the State Code of Virginia to regulate the design and installation of well-and-septic systems in a way that minimizes the risk of contaminating ground water with septic drainage. Permits must be obtained from the Health Department for installation of new systems.

Thereafter, instead of being operated and maintained by trained staffs as public water systems are, a private well and its accompanying septic system, once installed, become the responsibility of the individual property owner.

Owners of private well-and-septic systems pay for permits, design and installation of the systems, and maintenance. As there is no metered measurement of the volume of ground water withdrawn or wastewater discharged, usage is subject to no fees and no record keeping.

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