



BY BRIAN RICHTER

## Meeting urban water demands while protecting rivers: A case study from the Rivanna River in Virginia

**I**n Summer 2002, many cities along the Atlantic seaboard found themselves running out of water. The region was experiencing its most severe drought in a century, and rivers throughout the East were experiencing their lowest recorded flows on record. As river levels dropped below water intakes and water supply reservoirs dropped to dangerously low levels, anxiety levels were high.

### NEAR-DISASTER UNDERSCORES NEED FOR 50-YEAR WATER SUPPLY PLAN

The city of Charlottesville, Va., was one of many communities wondering if its water supply was going to run dry. The city and

outlying areas in Albemarle County are supplied with water from the Rivanna Water and Sewer Authority (RWSA), which operates three reservoirs in the Rivanna River Basin. By October 2002, RWSA's usable storage in these reservoirs had dropped below 50%, representing only 71 days of storage.

Fortunately, by implementing stringent, mandatory water conservation measures, the community was able to survive the drought before its reservoirs bottomed out. As the rains returned, political leaders in the community and RWSA staff agreed that it was time to redouble efforts to develop a new 50-year water supply plan. Given rapid population growth in the area, RWSA faces some substantial challenges in trying to provide a reliable water supply with demand projections growing from 11 mgd in 2000 to 18.7 mgd in 2055. At the same time, RWSA's largest reservoir is expected to lose 75% of its storage capacity to sedimentation over the 50-year planning horizon.

More than 30 water supply alternatives were considered, including extending a pipeline 23



PHOTOS: COURTESY OF THE NATURE CONSERVANCY

**This reservoir on the south fork of the Rivanna River is one of three storage facilities used in the RWSA water supply system.**

mi to the James River. The selected option involved substantially enlarging an existing, off-channel storage reservoir to increase its usable storage capacity from 463 to 2,192 mil gal.

### MAINTAINING RIVER FLOWS IMPORTANT TO MANY INTERESTS

Throughout the planning process, local environmental interests argued strongly for better protection of the rivers being tapped by RWSA. These rivers are highly valued for their natural beauty and recreational benefits, including fishing, canoeing, and wildlife viewing. Maintaining adequate river flows is essential to the health of these rivers. When the storage reservoirs on the Moormans River and south fork of the Rivanna River are full, inflowing water simply pours over the dam spillways, which maintains close-to-natural river flows. However, when reservoir levels drop below the spillways, only minimum flows are released from the reservoirs. At this time, environmental flow releases are set at 0.4 mgd (0.6 cfs) on the Moormans River and 8 mgd (12 cfs) on the south fork of the Rivanna River. These reservoir releases equal less than 20% of the nondepleted summer flows in these rivers under normal conditions.

During the past two years, The Nature Conservancy has facilitated a comprehensive scientific assessment of the Rivanna River Basin, including evaluating the environmental flows needed to sustain a healthy river ecosystem. More than 40 regional scientists have been involved in this process, which has generated flow targets for normal flows during each month, as well as higher flows needed during wet periods and minimum allowable flows that must be maintained during extreme drought. An overarching recommendation from the scientists is to manage reservoir releases to mimic natural, non-depleted flows to the greatest extent

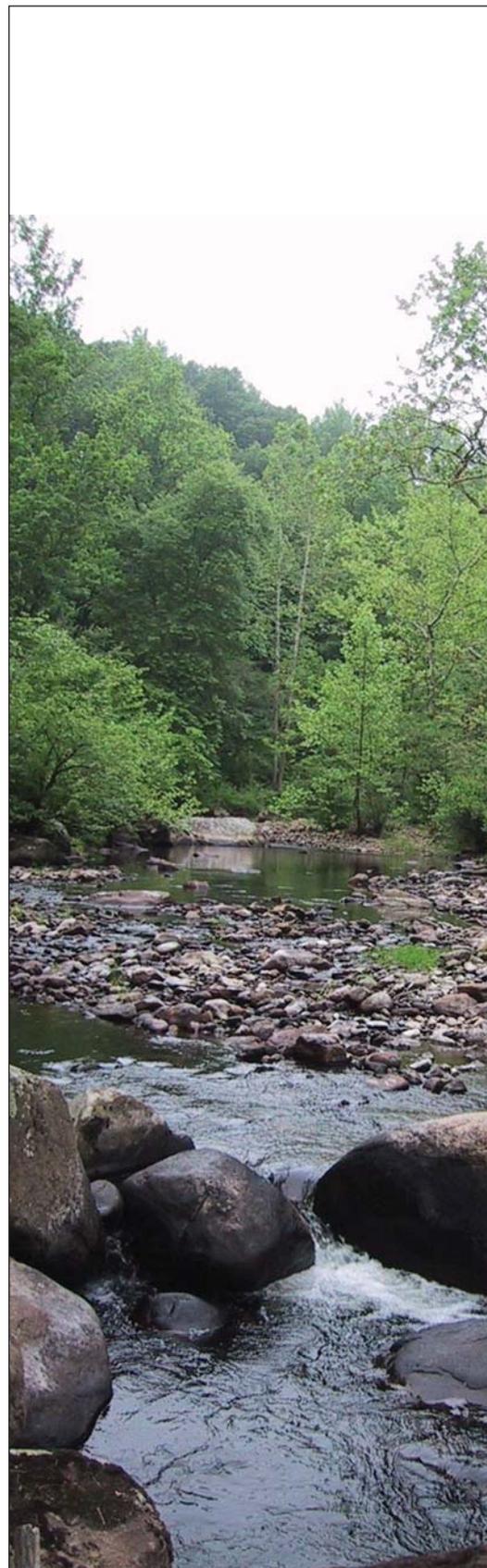
possible. More information about the scientific process used in the Rivanna River Basin can be obtained from The Nature Conservancy's website at: [www.nature.org/freshwater](http://www.nature.org/freshwater).

### FLOW RELEASE PLAN MIMICS NATURE

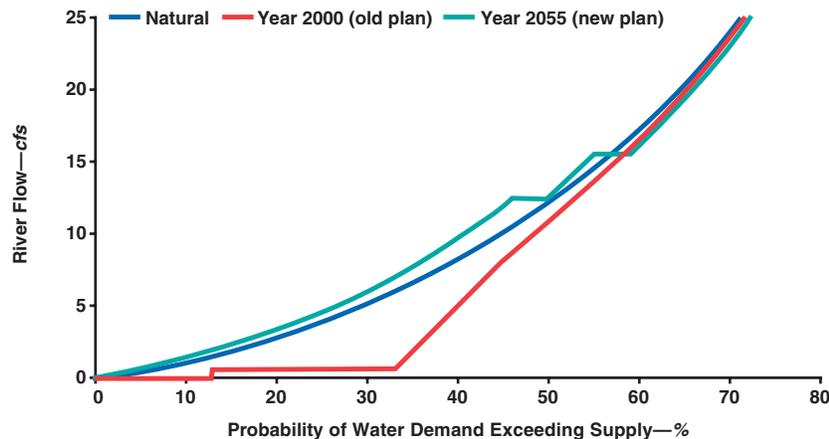
RWSA has worked closely with the conservancy and other environmental interests in developing a new water supply plan that will meet growing water demands and improve river ecosystem health. The new plan will improve river flows substantially. Based on the scientific recommendation to mimic natural flows to the extent possible, a reservoir operating plan was devised that sets environmental flow releases according to a varying percentage of the inflows to the reservoir. The inflow percentage to be released depends on cumulative storage in the reservoirs; when storage is lower, the percentage of inflows to be released is lower. The reservoir on the Moormans River will release natural inflows under most conditions, and releases on the south fork will range from 30 to 70% of natural inflow depending on reservoir storage. This operating plan will go a long way toward restoring natural flow variability in these rivers.

Figure 1 illustrates the simulated benefits of the proposed environmental flow-release plan for the reservoir on the Moormans River, comparing

**Instream flows in the Moormans River outside of Charlottesville, Va., will be improved substantially under the new RWSA plan.**



**FIGURE 1** Managing for improved environmental flows



*By basing environmental flow releases from water supply reservoirs on a percentage of inflow, water managers in the Rivanna River Basin will be able to restore much of the natural variability in river flows while meeting growing human demands.*

the operations plan from 2000 with the proposed 2055 plan. Instead of providing only a minimum static release of 0.4 mgd, reservoir releases are now designed to closely mimic natural flows. During drought periods, a portion of the storage in the reservoir on the Moormans will be transferred downstream to the larger reservoir on the south fork of the Rivanna River, thereby causing an

The improved environmental flows will be made possible through a number of strategies. Obviously, the substantial enlargement of the off-channel storage reservoir adds considerable flexibility in meeting both human and environmental water needs. An important aspect of the proposed operations is the intent to fill this reservoir largely by skimming water during high-flow events. By

**A** reservoir operating plan was devised that sets environmental flow releases according to a varying percentage of the inflows to the reservoir.

artificial increase in Moormans flows. Because these pulses of supplementary water will be released from the upstream reservoir in a manner that resembles natural floods, the scientists advising the project do not anticipate adverse ecological consequences in the Moormans River.

extracting water primarily during times when flows are naturally high, the impact of water withdrawals on the ecosystem can be minimized. This high-flow skimming is facilitated by sizing the off-take pipe appropriately so that a large volume of water can be extracted when it is available.

Another important part of the new plan is implementation of a drought management program. This program will include three levels of demand restriction, modeled conservatively on the assumption that there would be growing public awareness but little to no demand reduction during the first voluntary stage, progressing to a minimum of 5% reduction during the first mandatory stage, and at least 20% reduction during the second mandatory stage. This drought management program enables RWSA and its retail clients to preserve water supplies during risky dry periods and helps to keep the necessary enlargement of the off-channel reservoir to a minimum.

Finally, during drought periods, RWSA plans to use a simple forecasting approach to help them implement the various stages of the drought management plan. This risk-based approach enables RWSA managers to evaluate the probability of reservoir levels falling to critical levels during the near-term future, depending on probabilities derived from the historical streamflow record. Model simulations suggest that the decision of whether to initiate drought management and the timing of transitions to increasing levels of demand management might be improved substantially by using the forecasting approach.

For more information about this case study, contact the Rivanna Water and Sewer Authority at [info@rivanna.org](mailto:info@rivanna.org). For more information about the forecasting approach, contact Hydrologics Inc. at [bmccrodden@hydrologics.net](mailto:bmccrodden@hydrologics.net)

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