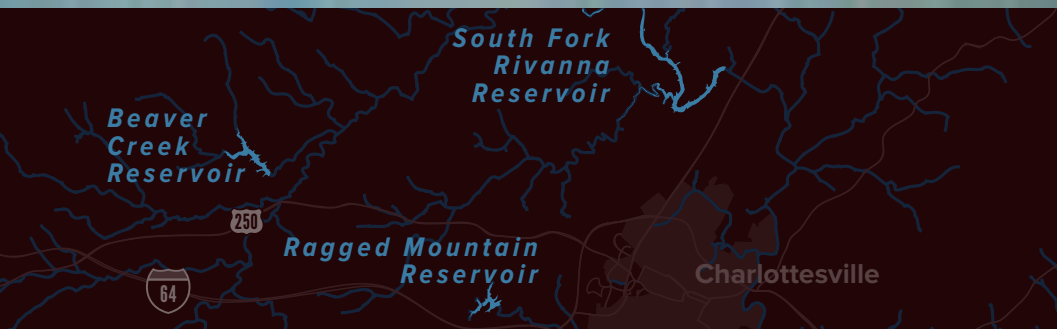


RESERVOIR WATER QUALITY AND MANAGEMENT STUDY A FIRST LOOK





IT ALL STARTS HERE

In the hills of Albemarle County lie five reservoirs that provide the source for clean, safe and reliable drinking water to our community. Rivanna Water and Sewer Authority's (RWSA) charge is to collect, store and treat this water which is then distributed throughout three service areas: the Urban Water System (consisting of the city of Charlottesville and surrounding county of Albemarle), the Crozet area, and the Scottsville area. These five reservoirs are key components in the process of delivering finished drinking water to area homes and businesses.

In 2014, RWSA enlisted DiNatale Water Consultants to study our water storage reservoirs as part of an effort to protect and improve the quality of these water bodies. This document provides you with a "First Look" at our monitoring and evaluation process, along with important information about how and why our reservoirs are susceptible to algal growth.

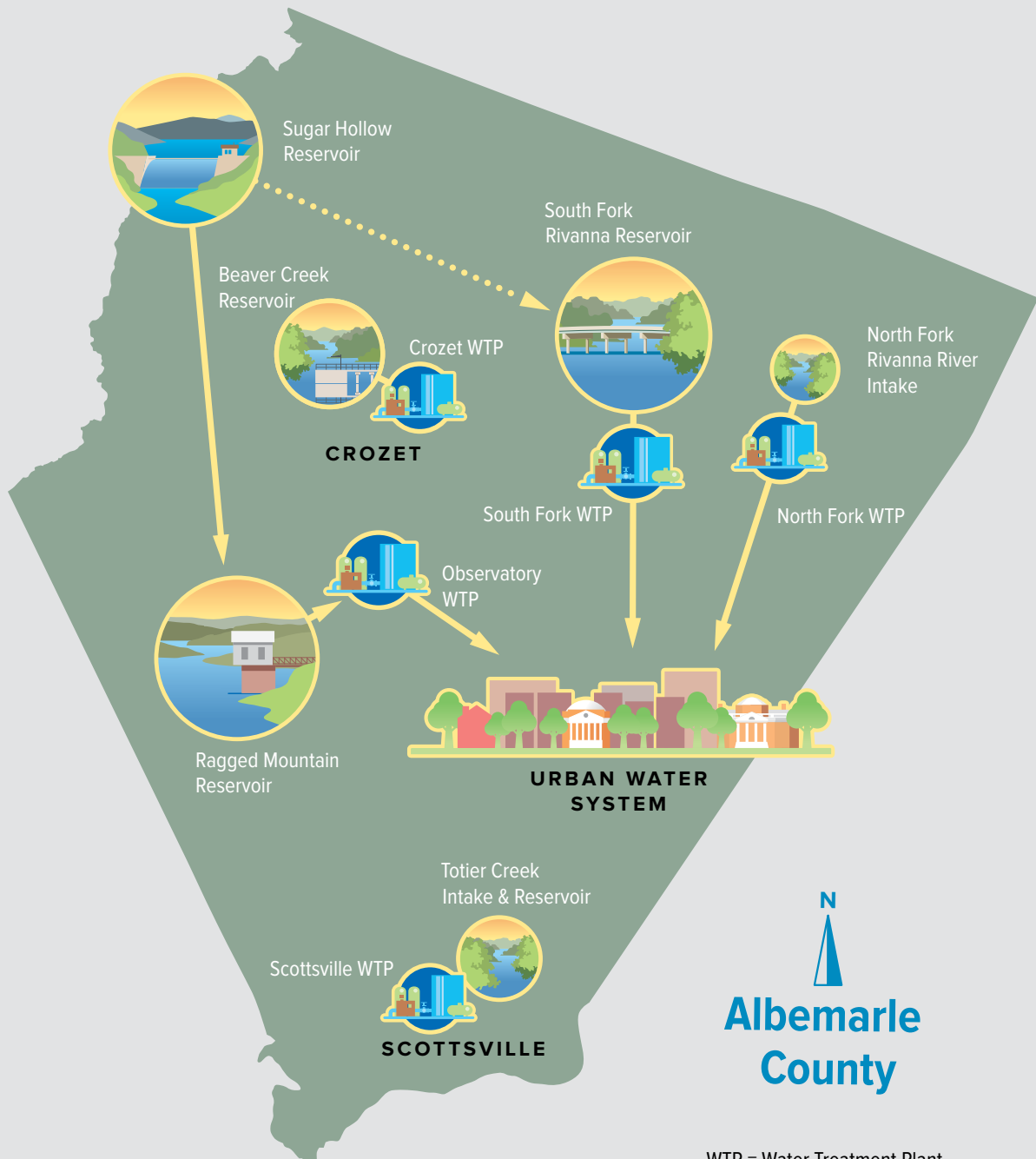
We invite you to learn more about the source of your drinking water and hope this document gives you a working knowledge of our reservoirs, as well as a closer look at the unique characteristics of each of these drinking water sources. We also explain what causes the characteristic greenish waters in our state's water bodies, and why we would like to see less algal growth in our reservoirs before this water reaches our treatment plants.

But we are not finished yet. We will be collecting additional water quality data, analyzing it, and sharing recommendations for improvement after the completion of additional water quality sampling and studies in 2016 and 2017.

We are committed to providing the highest quality drinking water to our customers: the City and the Albemarle County Service Authority, who then distribute the water to homes and businesses. We look forward to this ongoing study and recommendations, which will clarify viable alternatives that may improve our raw water quality in the future.

How water gets to your faucet

This figure depicts the RWSA water supply system. Sugar Hollow lies at the base of the mountains, and supplies water to Ragged Mountain Reservoir through a pipeline and to South Fork Rivanna Reservoir through streamflow in the Moormans River. The North Fork Rivanna River Intake, combined with Ragged Mountain and South Fork Rivanna reservoirs, supply water to three water treatment plants, forming the Urban Water System. Beaver Creek Reservoir water serves the Crozet area, and the Totier Creek Reservoir serves as a backup water supply to the Scottsville area.





RESERVOIRS: BEAUTIFUL LAKES STORING THE WATER WE WILL DRINK

The role of reservoirs

Reservoirs are man-made lakes created by building a dam. They store “raw” water that is later treated for domestic use. Like money in the bank they can be drawn upon in times of drought, ensuring a consistent supply. In wetter years they can also help reduce flooding.

Algae in Reservoirs

In the lush, hilly surroundings of Albemarle County, greenish reservoir waters may seem like an extension of the natural landscape. However, for a source of drinking water, this green-colored water can contribute to taste and odor issues and complicate the water treatment process.

Green-colored water is indicative of a state of eutrophication, where algae and other microorganisms grow excessively due to an abundance of “food” (or nutrients) that flows into the reservoirs from streams, groundwater, and runoff. Such nutrients exist naturally, but are increased in abundance with the addition of human contributions to the environment in a process termed **cultural eutrophication**.

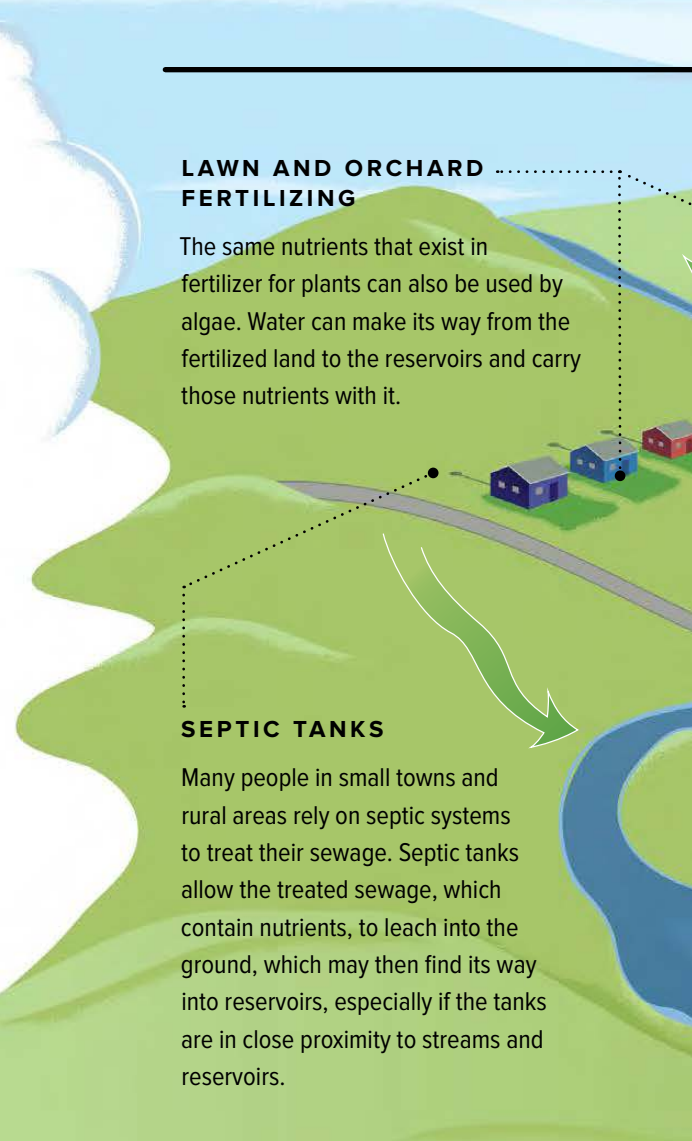
Eutrophication can result in the growth of blue-green algae, which are a special form of algae that can sometimes produce undesirable compounds, such as toxins, and taste and odor in the drinking water. Excessive algal growth is one reason RWSA decided to embark on this water quality study. We are collecting and analyzing data to identify possible methods to reduce algal growth and proactively address this issue.

LAWN AND ORCHARD FERTILIZING

The same nutrients that exist in fertilizer for plants can also be used by algae. Water can make its way from the fertilized land to the reservoirs and carry those nutrients with it.

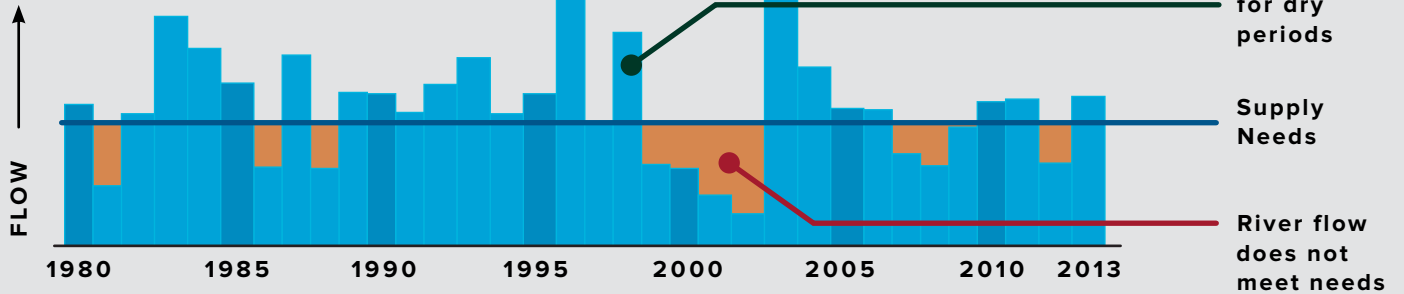
SEPTIC TANKS

Many people in small towns and rural areas rely on septic systems to treat their sewage. Septic tanks allow the treated sewage, which contain nutrients, to leach into the ground, which may then find its way into reservoirs, especially if the tanks are in close proximity to streams and reservoirs.

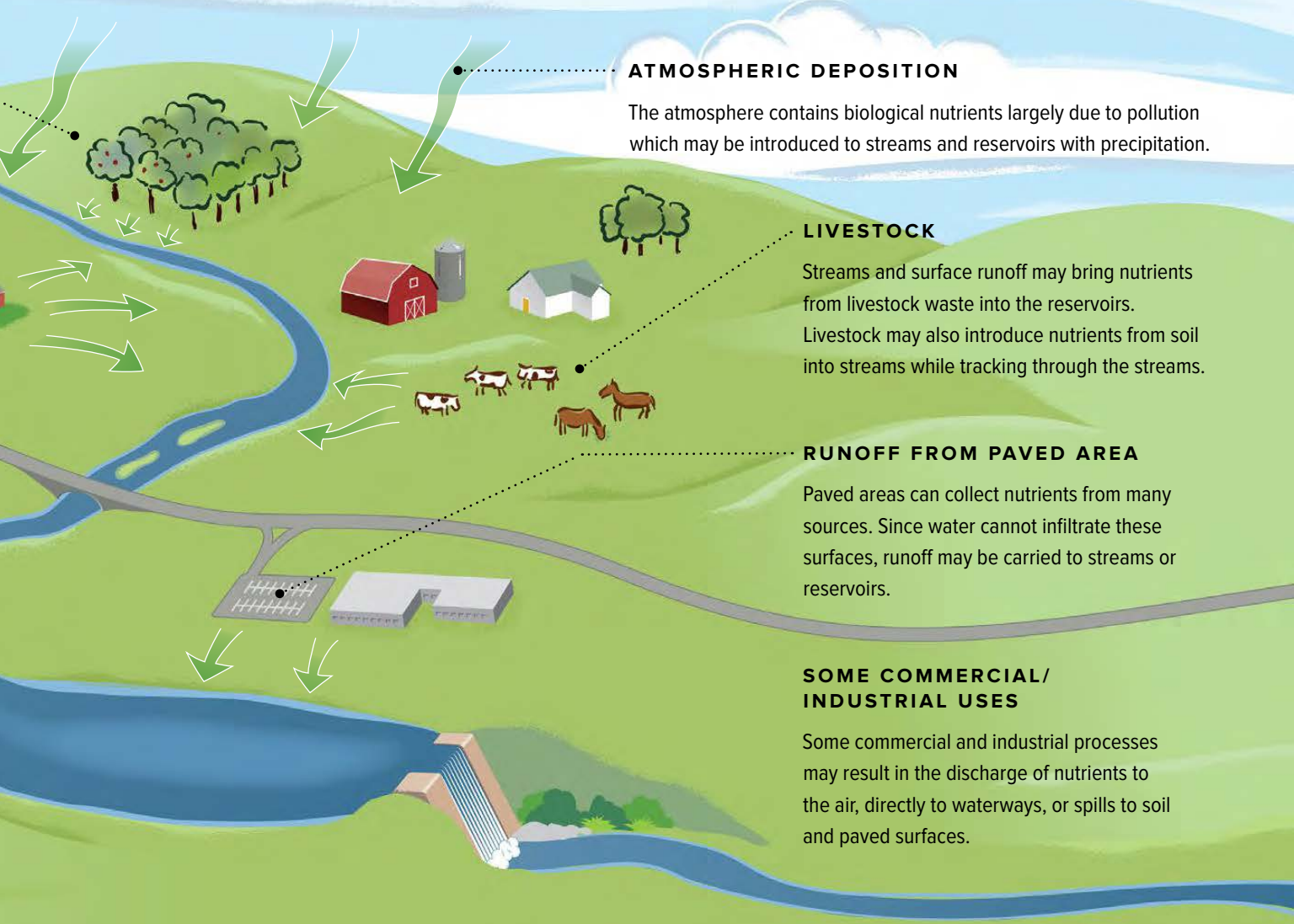


Why do we need reservoirs?

Water is essential to everything we do in life. During dry periods, there may not be enough water to meet the demand without the use of reservoirs. This chart represents the historical streamflow within Albemarle County watersheds. When streamflow exceeds the supply needs, a portion of the excess can be stored in reservoirs for later use.



SOURCES OF NUTRIENTS IN YOUR WATERSHED



RWSA staff testing the waters at South Fork Rivanna Reservoir



Reservoir Biology 101

Reservoir levels may fluctuate more than in natural lakes. Managing the growth of algae in this environment is an ongoing challenge, but necessary when the waters are ultimately destined for human consumption.

In the spring, algae begin to grow as the water warms and daylight increases. When the algae die, they sink to the bottom and begin to decompose, using up oxygen in the bottom of the reservoir.

During the summer, the upper part of the reservoir becomes warm while the bottom remains cooler, resulting in **thermal stratification**. The warm upper water and cold bottom water do not mix in deeper reservoirs, so oxygen is unable to be replenished at the bottom. The lack of oxygen at the bottom also causes accumulated nutrients in the sediment to be released into the bottom waters.

In the fall, the temperature of the reservoir becomes more uniform as the upper water cools, bringing some of the nutrients that were released from the sediment up to the surface, which then contribute to more algae growth. During the winter, biological processes slow significantly.

The cycle resumes in the spring, with more nutrients building up in the sediment and leading to the process of **eutrophication**. The **trophic state** is a measure of reservoir water quality. In Virginia, oligotrophic waters are not common given the nutrient-rich environment. However, increasing the quality of our reservoirs to a mesotrophic state may be possible with the use of certain management techniques.

In the natural environment, eutrophication will occur—but it can take centuries or thousands of years. In lakes and reservoirs impacted by human activities, this process can be accelerated so that it only takes decades, or even years. This human-accelerated process, called **cultural eutrophication**, is occurring in several of the RWSA reservoirs.

THERMAL STRATIFICATION:

The process where the warm upper waters and cool bottom waters do not mix, which can result in a lack of oxygen at the bottom of a body of water. In the fall as surface water temperatures cool, water mixes and “fall turnover” occurs.

EUTROPHICATION:

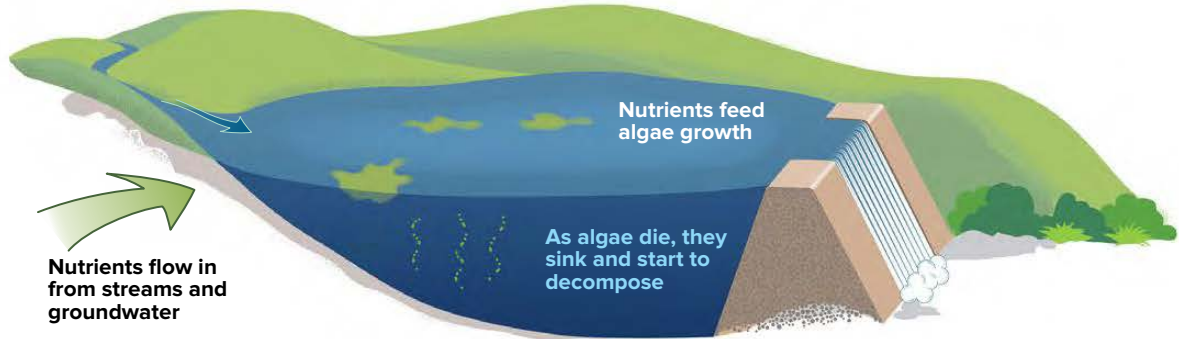
Excessive nutrients flowing into a water body and growing undesirable amounts of algae and other aquatic plants, which in turn have negative impacts, such as the depletion of oxygen in the water.



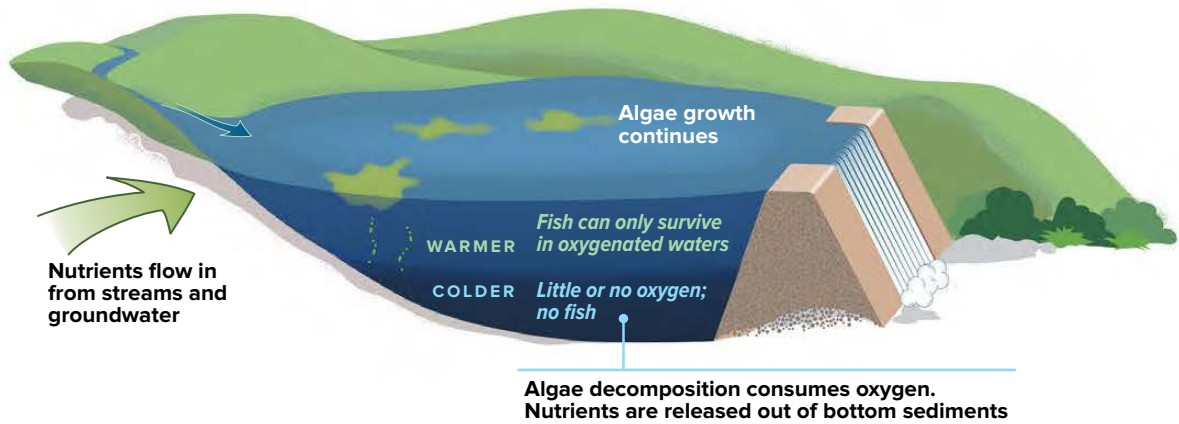
A reservoir's **trophic state** is a measure of the biologic productivity occurring within it. The trophic state of a reservoir can range from clear lakes with very little algae, called *oligotrophic*, to lakes with excessive aquatic plants and algae and poor water quality, called *hypereutrophic*. Oligotrophic lakes are not common in Virginia.

HOW A RESERVOIR CHANGES THROUGH THE SEASONS

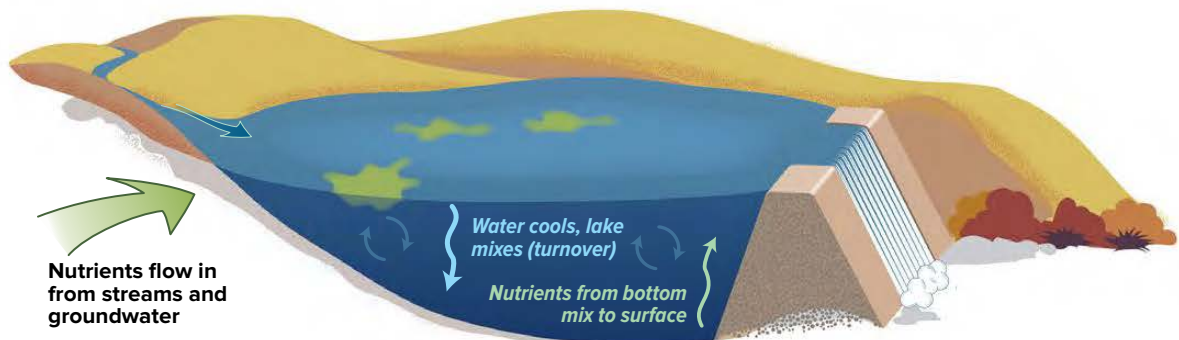
SPRING



SUMMER



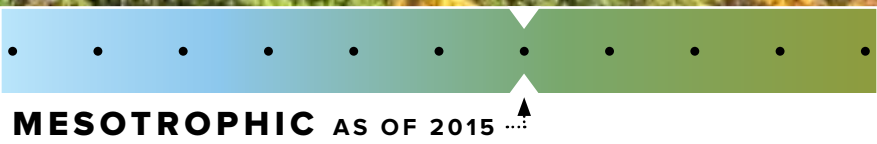
FALL

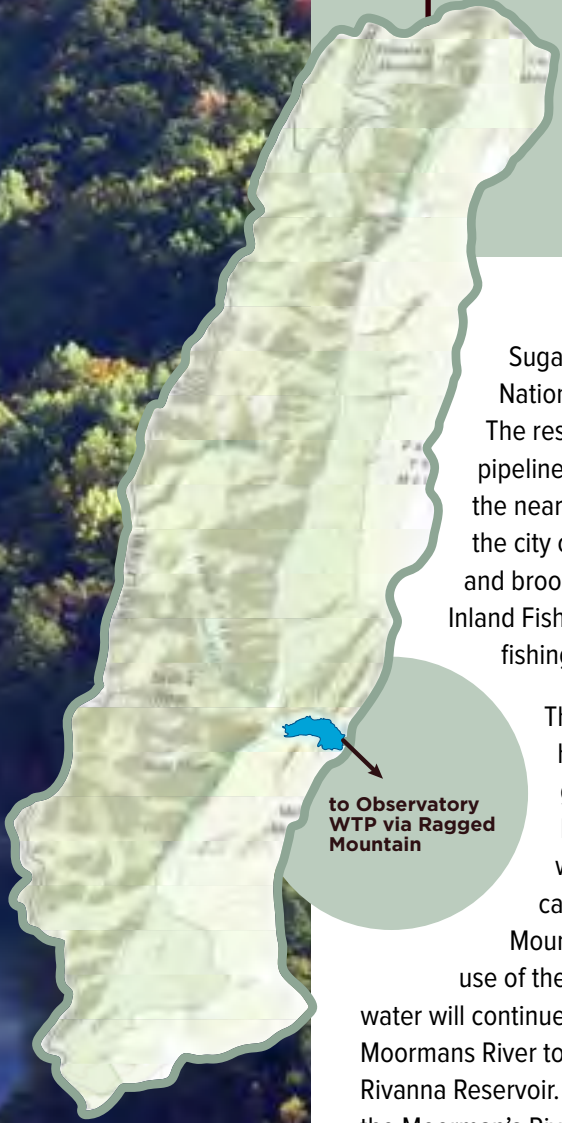
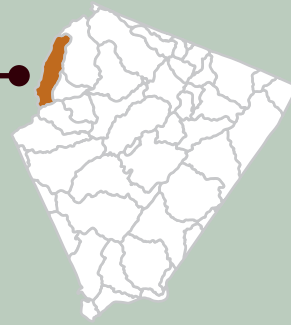
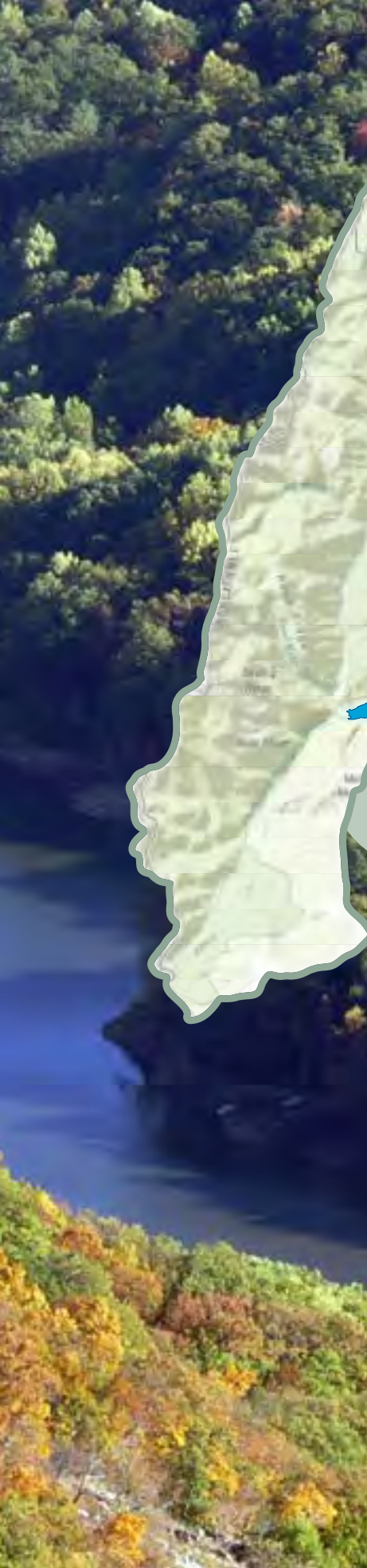




SUGAR HOLLOW RESERVOIR

YEAR BUILT 1947	USEABLE VOLUME 324 MILLION GALLONS	SURFACE AREA 47 ACRES
	MAX. DEPTH 58 FEET	WATERSHED AREA 18 SQUARE MILES
	ORIGINAL PURPOSE Water Supply	AREA SERVED Urban Water System





to Observatory WTP via Ragged Mountain

Sugar Hollow Reservoir lies just outside of Shenandoah National Park and much of the watershed lies within the park. The reservoir was built in 1947 and is connected by a 13-mile pipeline to Ragged Mountain Reservoir. Water is then treated at the nearby Observatory Water Treatment Plant and delivered to the city of Charlottesville. Sugar Hollow is stocked with rainbow and brook trout as part of the Virginia Department of Game and Inland Fisheries’ “put-and-take” trout program. There is bank fishing only and no boats are allowed.

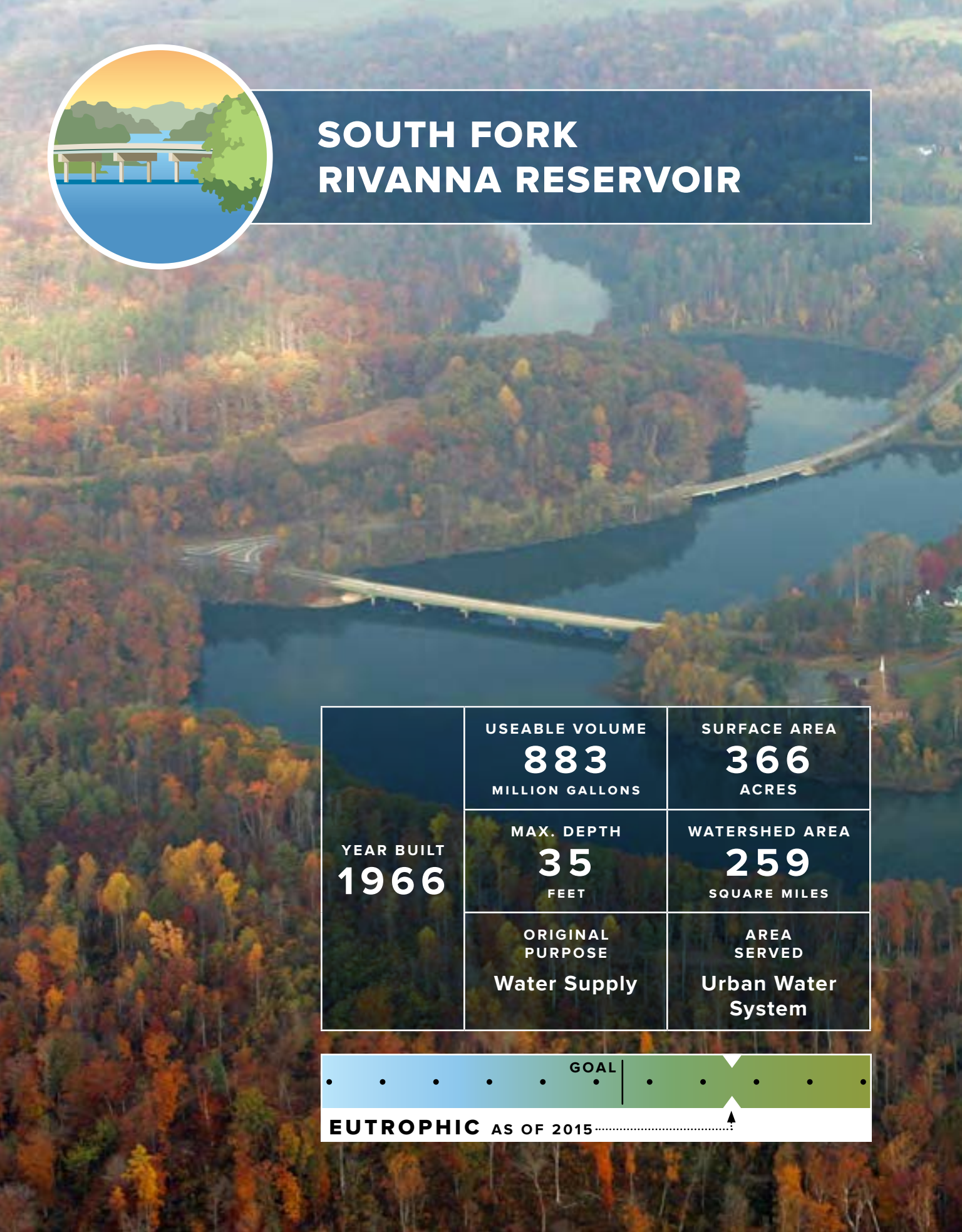
The watershed is secluded and minimally impacted by human activity. As a result, the reservoir typically has good water quality. A major storm in 1995 resulted in landslides in the immediate vicinity of the reservoir, washing soils into the reservoir and reducing storage capacity. Once the South Fork Rivanna to Ragged Mountain waterline is constructed, RWSA will discontinue use of the Sugar Hollow pipeline to fill Ragged Mountain and water will continue to be released from Sugar Hollow directly down the Moormans River to later be diverted to Ragged Mountain from South Fork Rivanna Reservoir. Water is released from Sugar Hollow ensuring flow into the Moorman’s River, even during drier months. This maintains a healthy aquatic ecosystem.

LAND USE IN THE SUGAR HOLLOW RESERVOIR WATERSHED

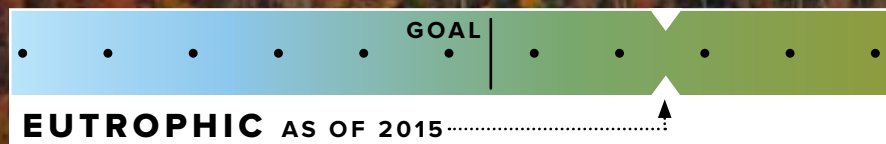


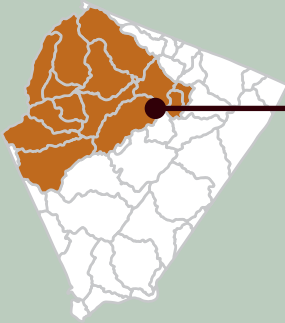


SOUTH FORK RIVANNA RESERVOIR



YEAR BUILT 1966	USEABLE VOLUME 883 MILLION GALLONS	SURFACE AREA 366 ACRES
	MAX. DEPTH 35 FEET	WATERSHED AREA 259 SQUARE MILES
	ORIGINAL PURPOSE Water Supply	AREA SERVED Urban Water System





South Fork Rivanna Reservoir has the largest watershed of the RWSA reservoirs, draining an area over 250 square miles. Though the majority of the watershed is heavily forested, 30% is impacted by humans as cropland, logging, roads, commercial and residential use.

The large area that is drained above the reservoir naturally contributes to sedimentation over time, with the rate accelerated by human activity. Despite a gradual loss of capacity since its construction, South Fork Rivanna Reservoir still holds almost 900 million gallons of water to serve the needs of the urban water system.

This reservoir, in combination with Sugar Hollow and Ragged Mountain reservoirs, provides water supply for the urban water system. The reservoir supplies the South Rivanna Water Treatment Plant with up to 12 million gallons of water per day.

In addition to being an invaluable source of raw water, the reservoir serves as a training area for the University of Virginia rowing teams, and is a popular fishing destination.

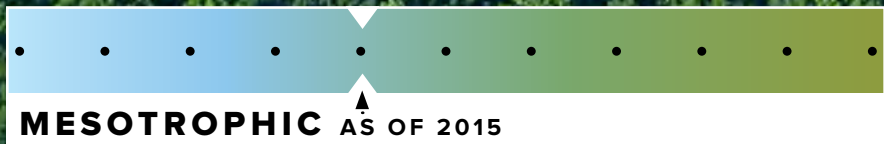
LAND USE IN THE SOUTH FORK RIVANNA RESERVOIR WATERSHED

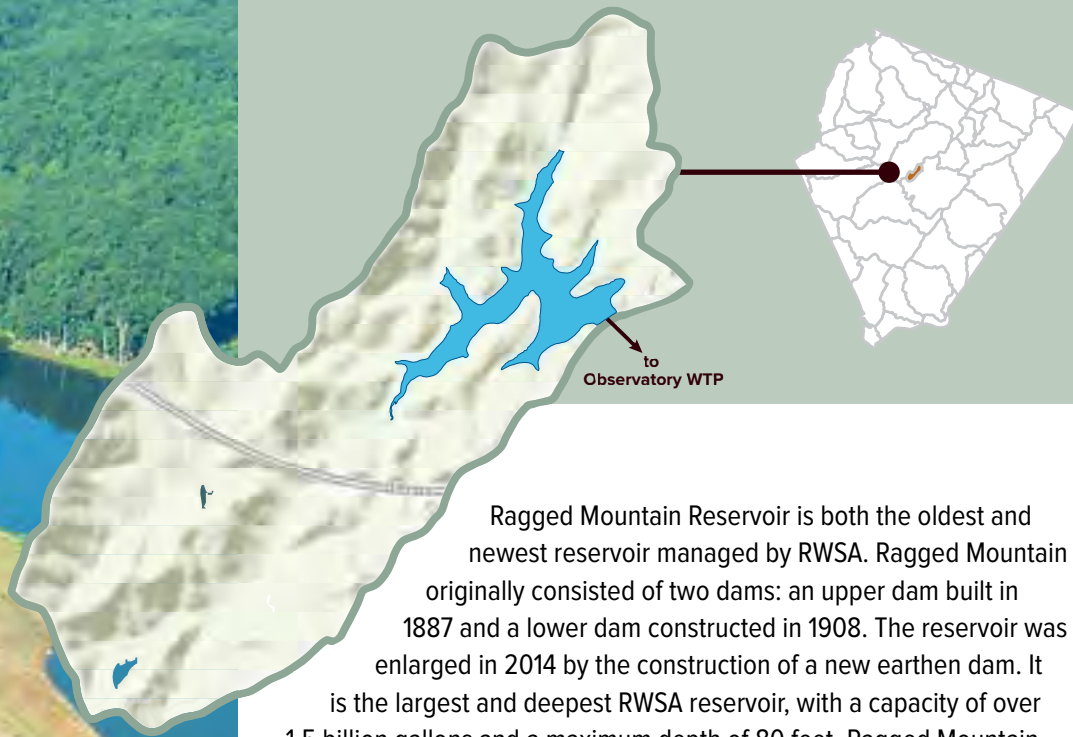




RAGGED MOUNTAIN RESERVOIR

YEARS BUILT UPPER: 1897 — LOWER: 1908 — ENLARGED 2014	USEABLE VOLUME 1,549 MILLION GALLONS	SURFACE AREA 170 ACRES
	MAX. DEPTH 80 FEET	WATERSHED AREA 2 SQUARE MILES
	ORIGINAL PURPOSE Water Supply	AREA SERVED Urban Water System



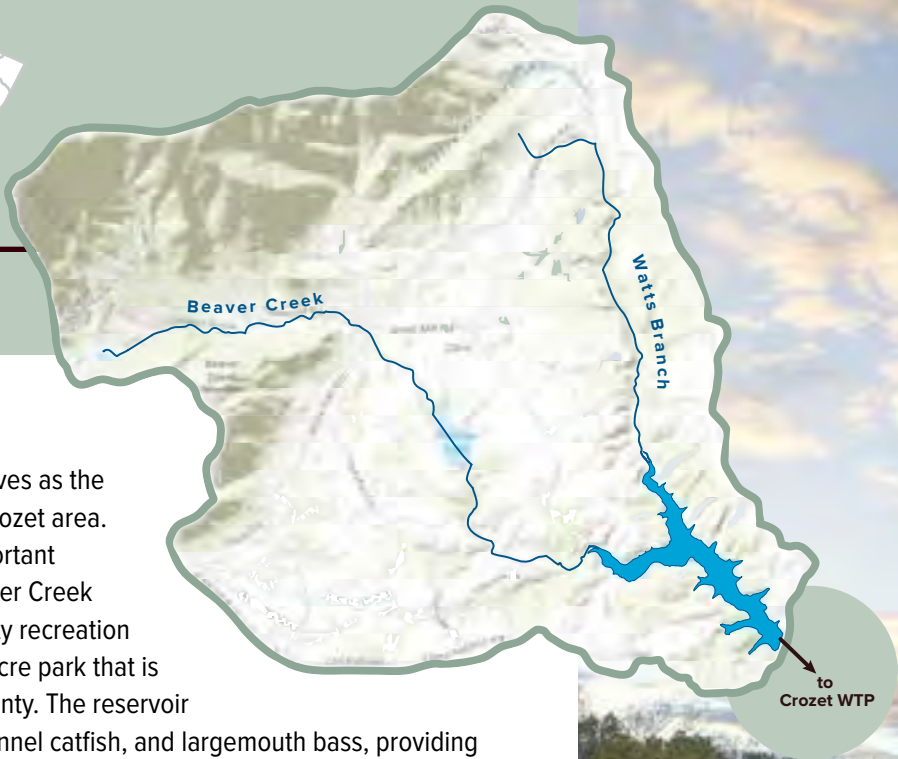
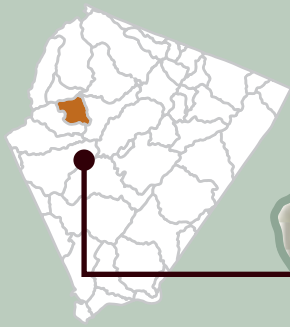


Ragged Mountain Reservoir is both the oldest and newest reservoir managed by RWSA. Ragged Mountain originally consisted of two dams: an upper dam built in 1887 and a lower dam constructed in 1908. The reservoir was enlarged in 2014 by the construction of a new earthen dam. It is the largest and deepest RWSA reservoir, with a capacity of over 1.5 billion gallons and a maximum depth of 80 feet. Ragged Mountain Reservoir has four miles of shoreline and is surrounded by the 980-acre Ragged Mountain Natural Area (RMNA) managed by the City of Charlottesville. There is not currently a public boat ramp, but smaller non-motorized boats are welcome. The RMNA provides ten miles of trails that lead through majestic forest, along rugged terrain, and through areas rich with wildlife. This offers a unique opportunity for wilderness hiking within minutes of town. The area is also rich in birdlife.

The newly enlarged Ragged Mountain Reservoir reached its full capacity in 2016, with water delivered from Sugar Hollow Reservoir. It does not currently have the same algae problems that exist in South Fork Rivanna and Beaver Creek reservoirs. With the planned delivery of water from nutrient-rich South Fork Rivanna Reservoir, it is likely that algae growth will increase in the future. Monitoring of water quality will be ongoing to better understand how the reservoir will respond to the change in water source and provide guidance on how best to maintain reservoir water quality.

LAND USE IN THE RAGGED MOUNTAIN RESERVOIR WATERSHED





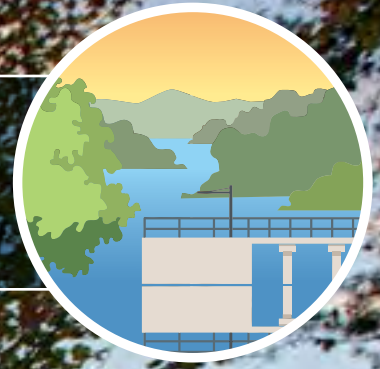
Beaver Creek Reservoir serves as the sole water supply for the Crozet area. In addition to being an important drinking water supply, Beaver Creek Reservoir is a favorite county recreation spot, surrounded by a 115-acre park that is managed by Albemarle County. The reservoir is stocked with sunfish, channel catfish, and largemouth bass, providing excellent fishing. Beaver Creek is home to the Western Albemarle High School rowing team and popular with canoers. No gas-powered boats are allowed on this reservoir.

Beaver Creek and Watts Creek supply this reservoir. Approximately half of the watershed is forested, with 38% in agricultural use. Some residences exist along the shoreline and throughout the watershed. Beaver Creek Reservoir often has algae blooms from spring through fall, which can lead to increased eutrophic conditions. This lack of oxygen at the bottom can potentially harm fish. Additionally, a lack of oxygen can cause nutrients to be released from the sediment and become available as food for algae. Because Beaver Creek Reservoir is both a source of drinking water and provides recreation opportunities, addressing water quality requires constant vigilance.

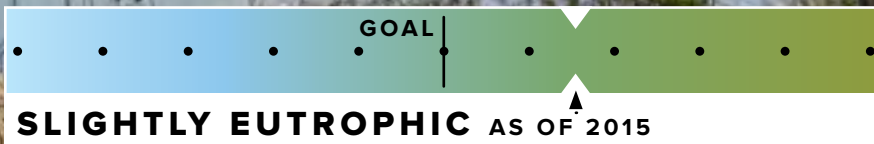
LAND USE IN THE BEAVER CREEK RESERVOIR WATERSHED



BEAVER CREEK RESERVOIR



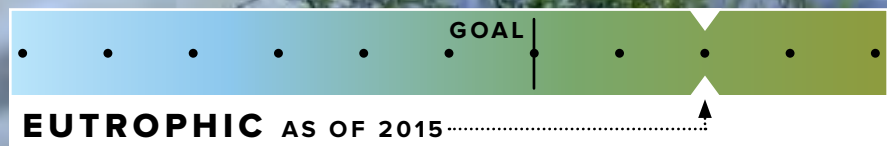
YEAR BUILT 1963	USEABLE VOLUME 521 MILLION GALLONS	SURFACE AREA 104 ACRES
	MAX. DEPTH 40 FEET	WATERSHED AREA 10 SQUARE MILES
	ORIGINAL PURPOSE Water Supply and Flood Control	AREA SERVED Crozet

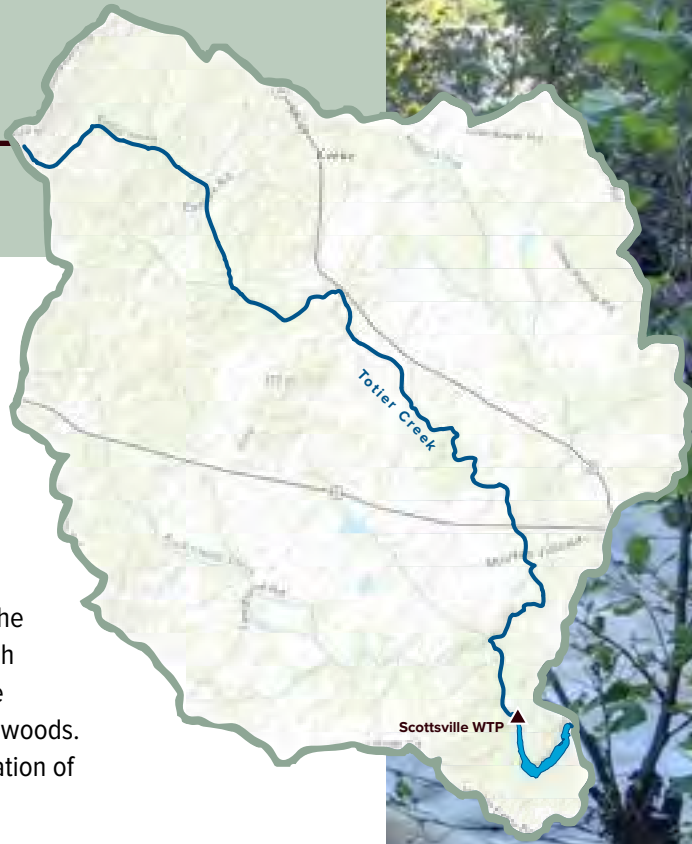
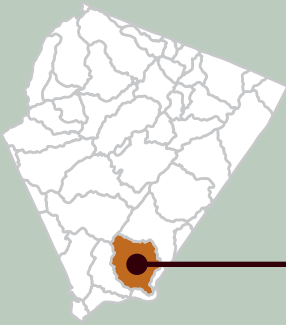




TOTIER CREEK RESERVOIR

YEARS BUILT 1971	USEABLE VOLUME 155 MILLION GALLONS	SURFACE AREA 66 ACRES
	MAX. DEPTH 25 FEET	WATERSHED AREA 29 SQUARE MILES
	ORIGINAL PURPOSE Water Supply and Flood Control	AREA SERVED Scottsville





Totier Creek Reservoir serves as a backup supply for the Scottsville area, primarily during dry periods when demand cannot be met directly from Totier Creek. The reservoir watershed is similar to that of Beaver Creek, consisting mainly of forest, but with a large component of agricultural use. Albemarle County manages the park at the reservoir, which is stocked with sunfish, catfish and largemouth bass. The park features three miles of trails along the lake shore and in the woods. Legend also has it that a signer of the Declaration of Independence once owned the property.

The reservoir can appear muddy at times, likely due to local soil conditions. The outlet tower is located off the main channel of the reservoir. The reservoir can experience water quality concerns such as algae blooms and low oxygen in the water.

LAND USE IN THE TOTIER CREEK RESERVOIR WATERSHED



OUR WATER: A MOST PRECIOUS RESOURCE



This “First Look” at our Reservoir Water Quality and Management Study has provided background on the RWSA watersheds and reservoirs, along with the biological factors that complicate our raw water quality. Since beginning the study in 2015, we have collected valuable data on each RWSA reservoir. We are now adding to that information with additional sampling in 2016 and 2017 in a comprehensive effort to clarify our understanding of raw water quality issues and our options to address them. The results will be released at the completion of the sampling and development of recommendations. Our goal is to:

- Continue the delivery of high quality drinking water
- Safeguard our reservoirs now and for the future
- Refine and affirm the rigorous water quality and algal monitoring program we have implemented
- Identify methods that help in the development of biologically healthier watersheds and reservoirs
- Utilize eco-friendly lake management practices where practicable

RWSA serves a region with a growing population which results in pressures on water demand and additional sources of nutrients in the reservoir watersheds. Though land use and development regulations in the watersheds are not within RWSA’s authority, we remain committed to environmental stewardship that enhances the quality of our raw water.

You can help by:

- Properly maintaining septic systems
- Minimally applying fertilizers, herbicides and pesticides
- Reducing livestock and pet wastes entering streams
- Engaging with local non-profits and government agencies like the Rivanna Conservation Alliance, the Thomas Jefferson Soil and Water Conservation District, and the Rivanna Stormwater Education Partnership



Learn more about our study
and view the full Phase 1 Report at
www.rivanna.org/reservoir-study



Above: South Fork Rivanna Reservoir in fall
Front cover: Sugar Hollow Reservoir



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Prepared by

