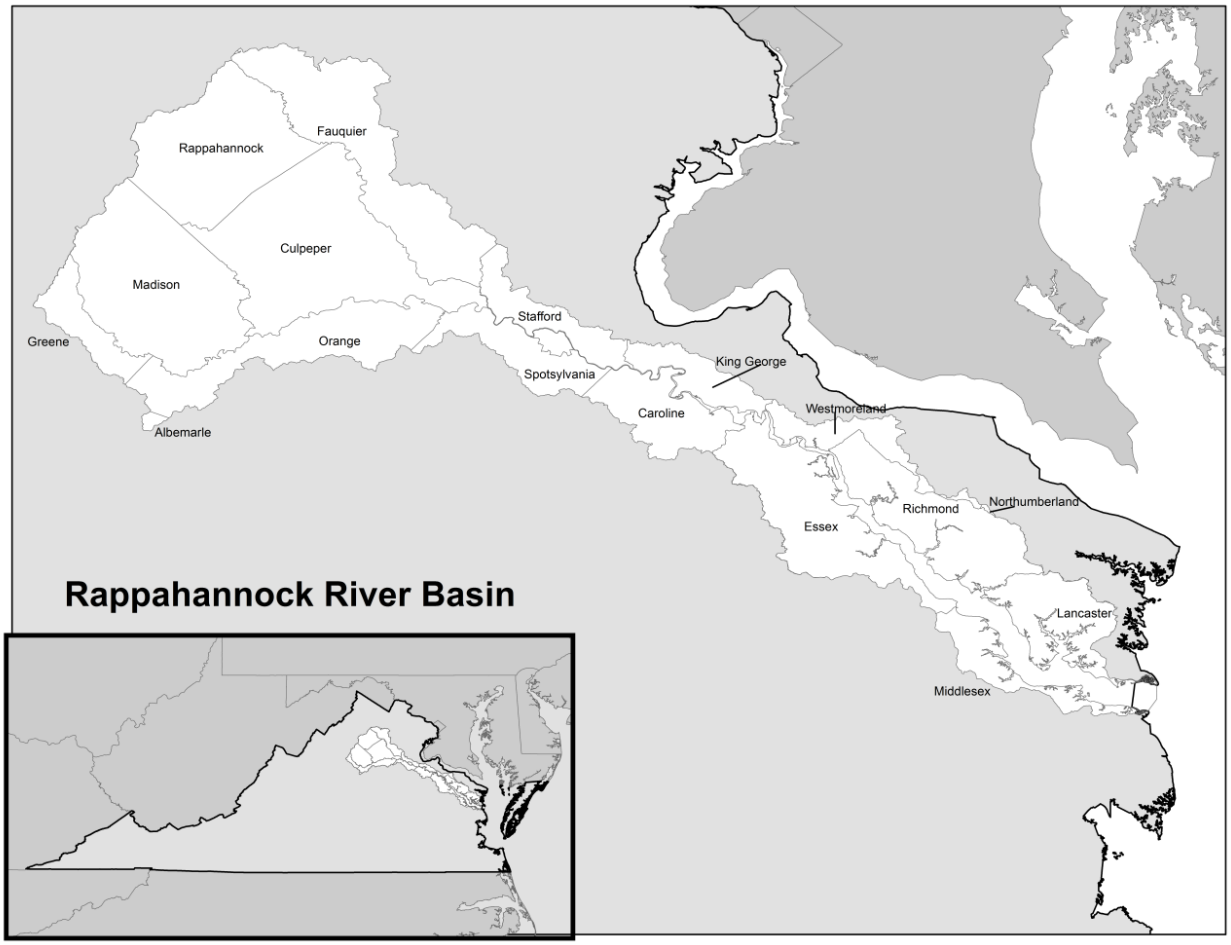
# Rappahannock River Basin Summary

For a full description of localities included in the water supply plans, as well as explanations of various terms and concepts used throughout this summary, please review the Introduction to the State Plan Appendices.

The Rappahannock River Basin drains an area of 2,715 square miles, approximately 6% of the Commonwealth's total area, and is 184 miles in length, varying in width from 20 to 50 miles. The Basin is bordered by the Potomac-Shenandoah River Basin to the north, and the York River Basin and Chesapeake Bay/Small Coastal Basin to the south and east.

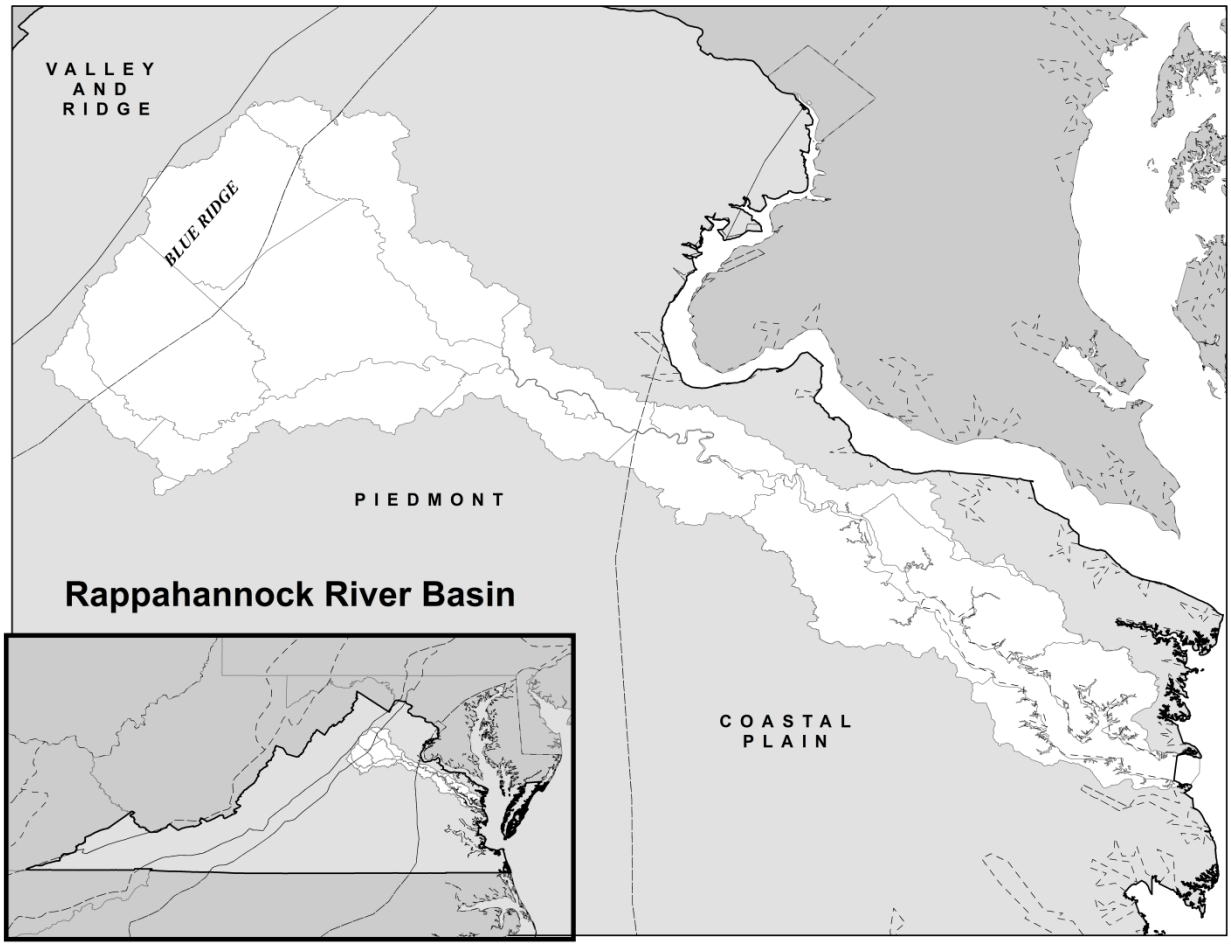
All or part of the following jurisdictions lie within the basin: the Counties of Albemarle, Caroline, Culpeper, Essex, Fauquier, Greene, King George, Lancaster, Madison, Middlesex, Northumberland, Orange, Rappahannock, Richmond, Spotsylvania, Stafford, and Westmoreland; City of Fredericksburg. These jurisdictions are represented within eleven regional water supply plans (Albemarle-Charlottesville-Scottsville, Rappahannock County and the Town, Fauquier County and Towns, Greene County and Town, Orange County and Towns, Middle Peninsula, the County and Town of Madison, the County and Town of Culpeper, Caroline County and the Town of Bowling Green, Spotsylvania County and the City of Fredericksburg, and the Northern Neck) and three local water supply plans (Stafford County, King George County, the Town of Port Royal).




Rappahannock River Basin Localities

Approximately 51% of the basin is forested and supports a variety of land uses, many of which are rural or conservation in nature: forestry, agriculture, and low density residential. Pockets of mixed use development account for approximately 36% of the land area. Areas with higher population densities are centered around Fredericksburg, the Town of Culpeper, and near the mouth of the river along the Lancaster County and Middlesex County shorelines. Only 6% of the basin is considered urban in character, although development pressure from metropolitan Washington continues to influence areas around the City of Fredericksburg and the Counties of Stafford and Fauquier. Military uses in the basin are represented in Caroline County, where a large portion of the land area is home to Fort A. P. Hill.

Most of the Rappahannock River Basin lies in the eastern Piedmont and Coastal Plain provinces, while the headwaters, located on the eastern slopes of the Blue Ridge, are considered to be in the Blue Ridge province.



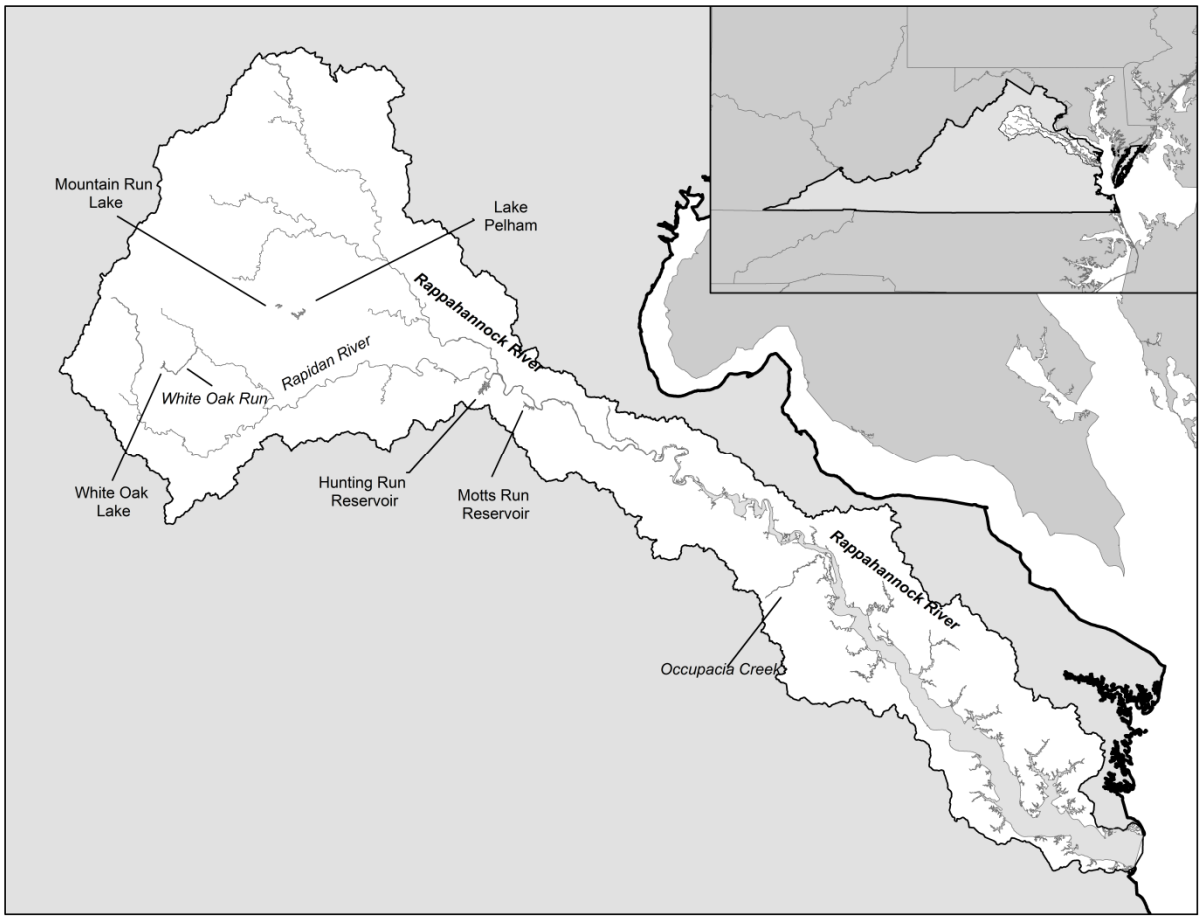
Rappahannock River Basin Physiographic Provinces

The headwaters of Rappahannock River are formed at Chester Gap (Rappahannock County) on the eastern slope of the Blue Ridge Mountains and in the Blue Ridge physiographic province. The river traverses the northern portion of the Commonwealth southeastward across the Piedmont Province, through the rocky fall line in the Fredericksburg area, the flat lands of the Coastal Plain Province in the east, and ultimately enters the Chesapeake Bay 20 miles south of the Potomac River. The Rapidan River, the Rappahannock's largest tributary, converges with the Rappahannock just west of Fredericksburg, at the fall line, which is characterized by rocks and Class I and II rapids. Southeast of Fredericksburg, the Rappahannock enters the Coastal Plain province and begins to slow and widen into a brackish, tidal estuary. When it flows past Tappahannock, the Rappahannock is well over a mile wide; at the point where the Rappahannock enters the Chesapeake Bay, between Windmill Point on the north and Stingray Point on the south, it is more than 3.5 miles wide. Other tributaries located within the basin include the Hazel River, Thornton River, Mountain Run, Robinson River, Cat Point Creek, and the Corrotoman River. The Rappahannock River Basin is divided into two USGS hydrologic units as follows: HUC 02080103 –

Rapidan – Upper Rappahannock; and HUC 02080104 – Lower Rappahannock. The two hydrologic units are further divided into 26 water bodies or watersheds and 74 sixth order sub-watersheds.

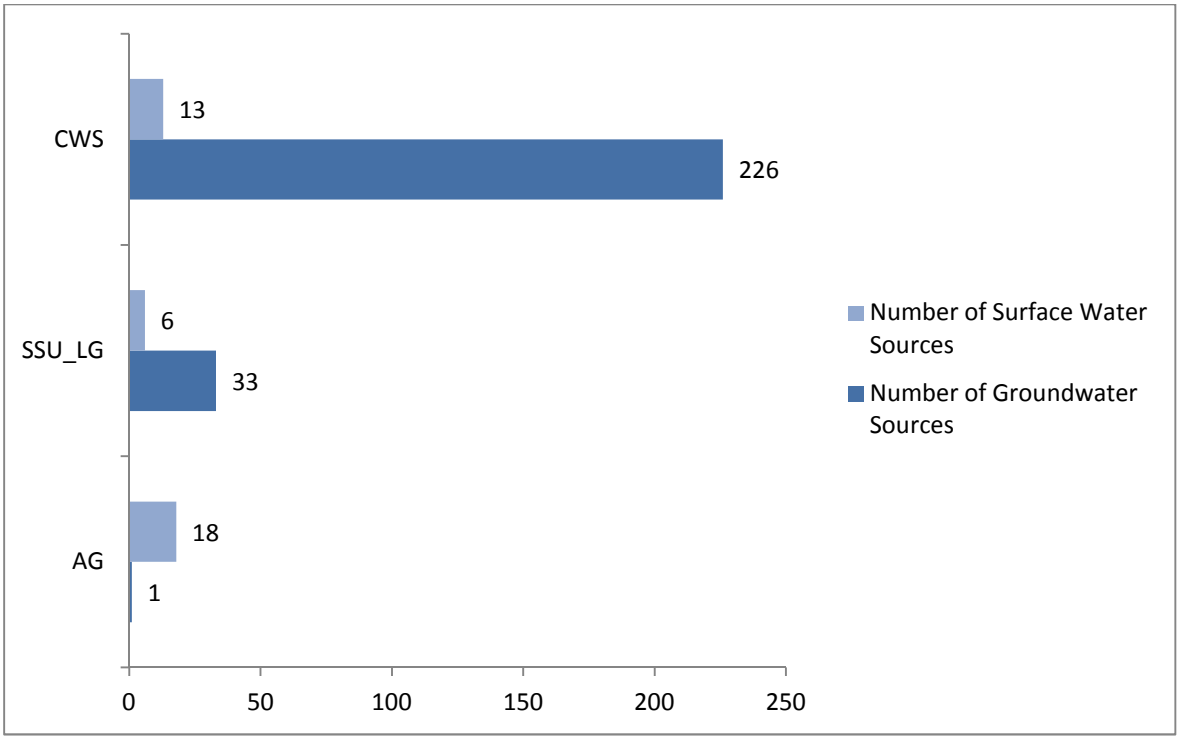
Existing Water Sources

Water sources utilized in the basin include stream intakes, reservoirs, springs, and groundwater. Surface water sources (reservoirs, springs, and streams) account for 37 withdrawals. Additionally, there are 260 groundwater withdrawals currently identified in the Rappahannock River Basin. Source water reservoirs include Mountain Run Lake, Lake Pelham, White Oak Lake, Town of Orange Reservoir, Hunting Run Reservoir, Motts Run Reservoir, and Lake Irvington. Stream intakes and spring sources used in the basin include the Rappahannock River, Rapidan River, White Oak Run, Lodge Creek, Cockrell Creek, Occupacia Creek, and Lydia Spring.




Rappahannock River Basin Major Reservoir and Stream Sources

Reported groundwater sources outnumber surface water sources in all use types except for agriculture. As estimated for the year 2010, approximately 241,382 people in the basin use private groundwater wells for residential water supply.




Rappahannock River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, are generated by Fauquier County Water and Sanitation Authority at the Remington Wastewater Treatment Facility. The treatment facility is permitted to discharge up to 2.5 MGD of treated effluent to the Rappahannock River. They currently provided 0.5 MGD to a natural gas, power generation facility owned by Old Dominion Electric Cooperative for cooling, stack scrubbing, turbine washing, and non-residential fire suppression.

Transfers

Water withdrawn in the basin may be used by the withdrawing user, or it may be transferred to another user. The transfer of water within and between river basins is a demand management practice that can address water supply and/or water quality needs by moving water from a basin or sub-basin with surplus supply to a basin or sub-basin with a supply deficit. Most often this practice of transferring water across sub-basin boundaries within a river basin - intrabasin transfers - occurs within a single county, but they can occur across county lines. Water movement that occurs when water is withdrawn from one major basin and transferred to a user in another major basin is called an interbasin transfer. Interbasin transfers

of water are less common in Virginia. There are no reported interbasin transfers in the Rappahannock River Basin.

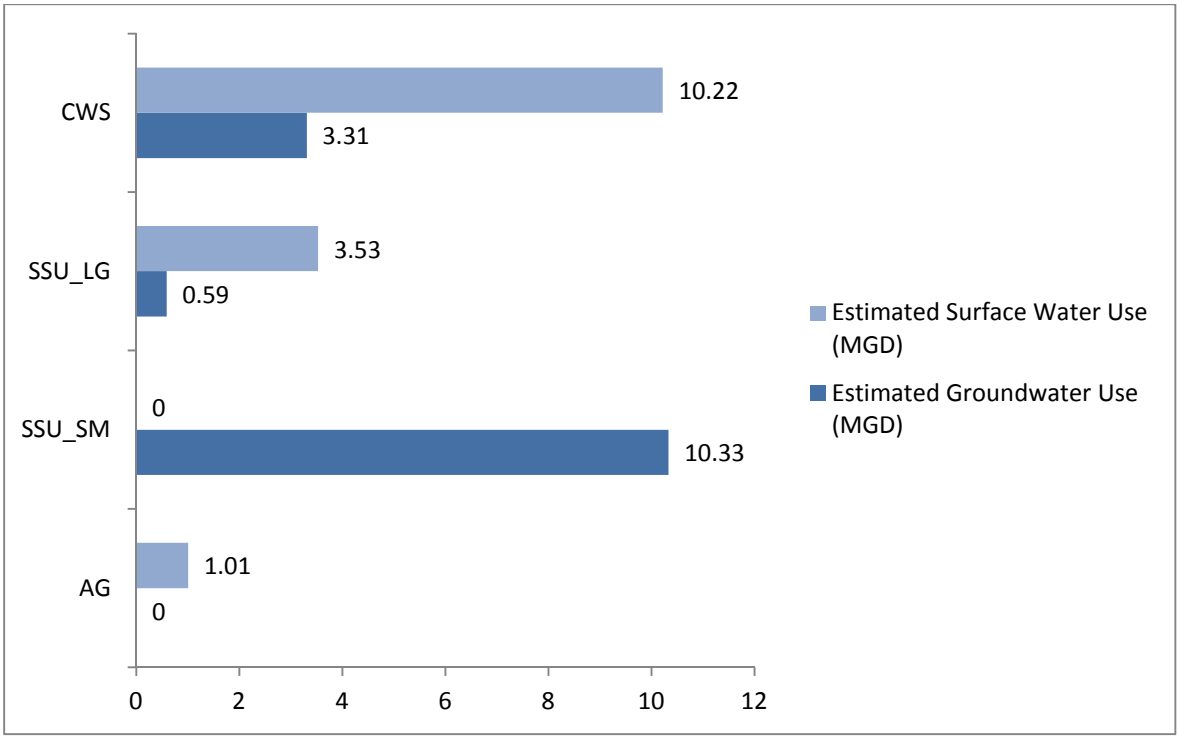
The following table lists intrabasin transfers between water providers and the municipalities to which they sell water (water purchaser).

| User Type | Water Purchaser and System(s) Name | Water Provider |
|---|---|---|
| CWS | County Club Estates | Spotsylvania County |
| CWS | City of Fredericksburg | Spotsylvania County |
| CWS | Rapidan Service Authority, Route 15 Service Area | Town of Orange |

Rappahannock River Basin Intrabasin Water Transfers

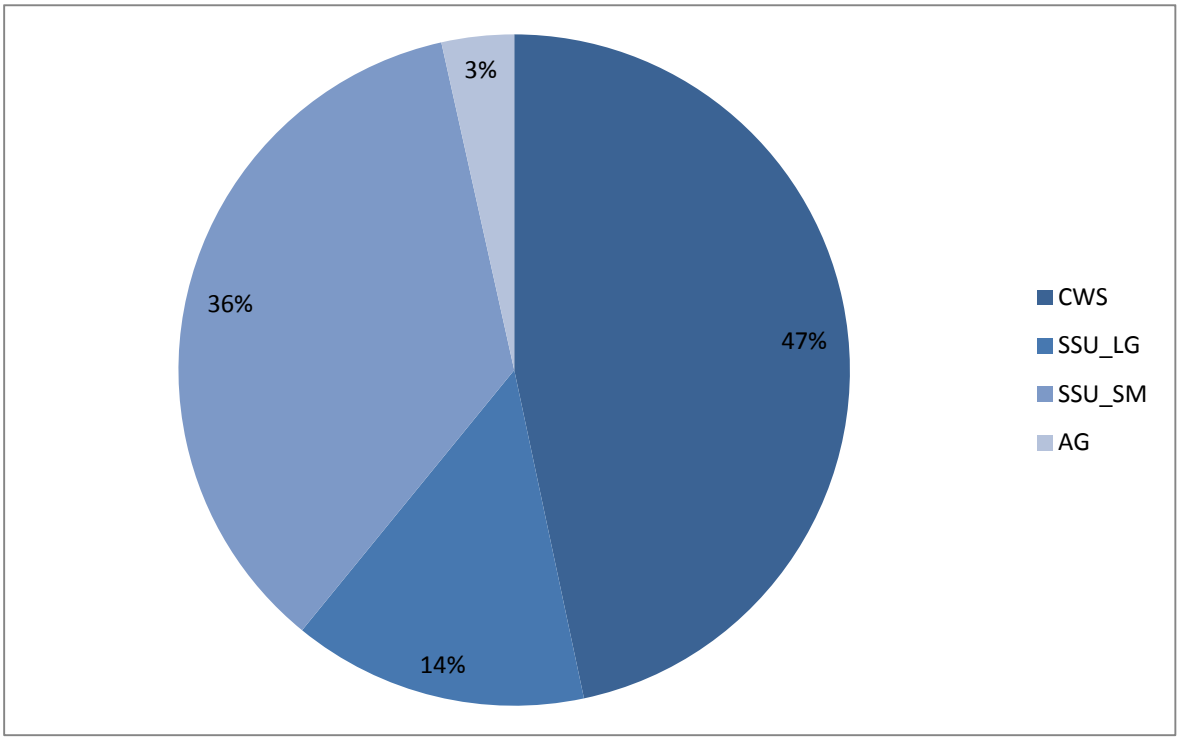
Existing Water Use

The total estimated water use provided in the regional water supply plans is summarized below in the following figure. The total estimated water use was approximately 29 MGD with 15 MGD withdrawn from surface water sources and 14 MGD from groundwater sources.




Rappahannock River Basin Estimated Water Use by Source and User Type (2010)

CWS used an estimated 47% of the total water in the basin followed by SSU_SM (36%), SSU_LG (14%), and AG (3%).

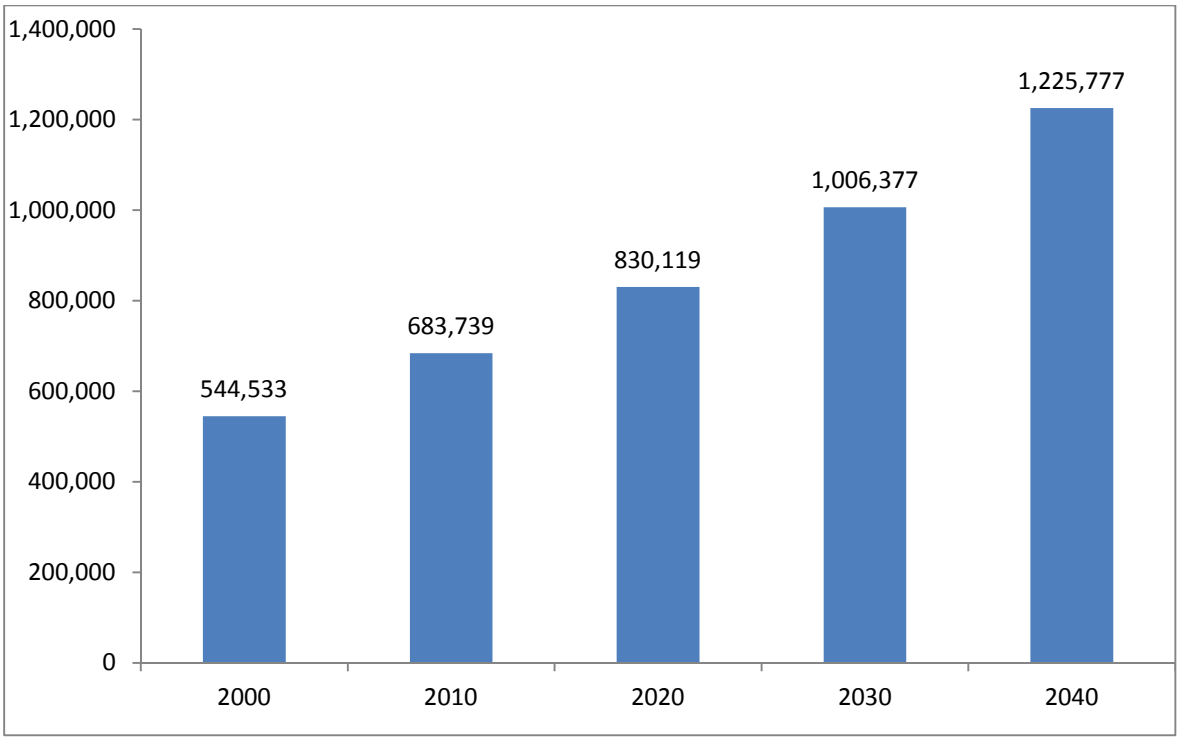



Rappahannock River Basin Percentage of 2010 Estimated Use by User Type

CWS reported their water use disaggregated into categories of use appropriate for the system. Categories commonly used included Residential, Commercial/Institutional/Light Industrial (CIL), Heavy Industrial, Military, Unaccounted for Water Losses, Production Processes, and Sales to other CWS. In addition, some CWS chose to include a category for "Other" use. Many smaller CWSs did not report disaggregated use as required. No assumption of disaggregated use was made for these systems; they are not included in this chart. The majority of water used by CWS is for residential supply.

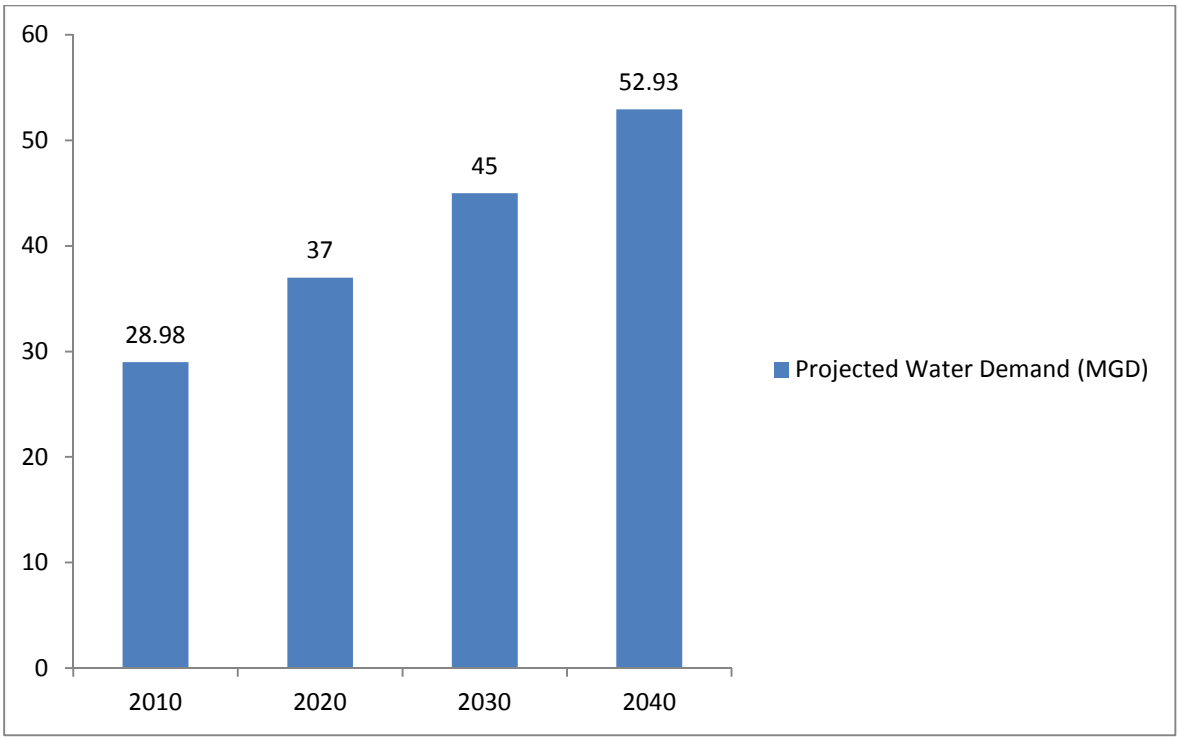
Projected Water Demand

The projected population of the localities with at least a portion of their area in the Rappahannock River Basin is displayed in the following figure. Population data was obtained from the Virginia Employment Commission's population estimates, which rely on data produced by the United States Census Bureau. The overall population of the localities is projected to increase through the year 2040. By the year 2040 the estimated basin wide population is projected at 1,225,777. The percent change in population from the years 2000 through 2040 is estimated at 79%.



Rappahannock River Basin Population Projections by Decade (2000-2040)

A 30- to 50-year projection of future water demand is required by the WSP Regulation. Thirty Years is the period of time common to all plans, so data is analyzed here for the timeframe of 2010 through 2040. The total projected water demand in the Rappahannock River Basin, as reported in the local and regional water supply plans, is estimated to increase from approximately 29 MGD in 2010 to 53 MGD in 2040. The percentage change in water use during the 30-year timeframe is estimated at 82.6%.



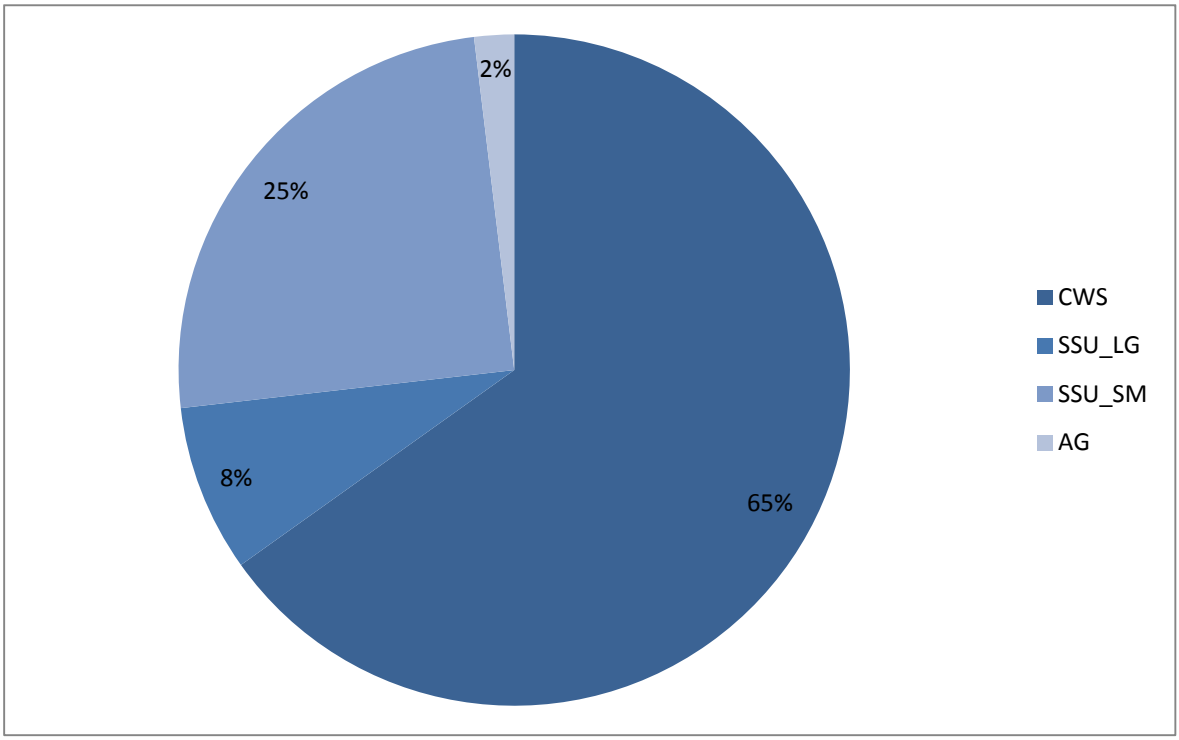
Rappahannock River Basin Projected Water Demand (MGD)

As depicted in the following table, the majority of the Basin's growth is expected to occur within CWS service areas, with a projected 153.4% increase in water demand over the 30-year period. Projected water demand for SSU_SM has the next highest percentage growth at 27%, followed by SSU_LG at 9.8%. AG use is projected to remain steady throughout the planning period. The anticipated steady state of AG water demand is a best guess on the part of the planning partners, as withdrawal data is limited and water use on an annual basis (in particular for crop irrigation) may change depending upon precipitation.

| User Type | Reported Use 2010 MGD | Projected Demand 2020 MGD | Projected Demand 2030 MGD | Projected Demand 2040 MGD | Percent Change (2010-2040) |
|---|---|---|---|---|---|
| CWS | 13.54 | 20.46 | 27.4 | 34.3 | 153.4% |
| SSU_LG | 4.11 | 4.26 | 4.4 | 4.52 | 9.8% |
| SSU_SM | 10.33 | 11.26 | 12.2 | 13.11 | 27.0% |
| AG | 1.01 | 1.01 | 1.01 | 1.01 | 0.0% |

Rappahannock River Basin Projected Water Demand by User Type (2010-2040)

In the year 2040, CWS demand is estimated to be 65% of total water demand in the Rappahannock River Basin, followed by SSU_SM (25%), SSU_LG (8%), and AG (2%).




Rappahannock River Basin Percentage of 2040 Projected Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs and alternative sources is obtained from the eleven regional and three local water supply plans represented in the Rappahannock River Basin. The information is presented for all those localities with at least a portion of land area located within the Rappahannock River Basin. The following lists the projected deficits in the basin.

**Albemarle County, the City of Charlottesville and the Town of Scottsville Regional Water Supply Plan**

A deficit of 0.41 MGD is estimated by 2035 in the urban areas of the planning region due to future demands. The region's plan to address the projected shortfall of municipal supply includes the expansion of the existing Ragged Mountain Reservoir in two phases. The first phase, known as the intermediate-expanded height phase, is scheduled to be operational in March 2014. The region will continue water conservation as a way to reduce demands.

**Caroline County and the Town of Bowling Green Regional Water Supply Plan**

The average daily demands of the municipal community water systems are estimated to exceed VDH permit capacities between 2020 and 2025, with a combined average daily deficit of 0.256 MGD by the year 2030. By the year 2050, six community water systems (municipal and private) are estimated to experience a combined average daily deficit of 1.53 MGD. Alternative water supply sources listed in the plan include groundwater development, interconnection with other localities, and an intake on the Rappahannock River.

**Culpeper County and the Town of Culpeper Regional Water Supply Plan**

The County's population (inclusive of the Town) is projected to increase from 46,689 in 2010 to 115,004 by 2050, an increase of 146%. The Plan anticipates that current supply will not be sufficient to meet projected water demand, and a deficit of 0.4 MGD is anticipated by 2050. Potential alternatives discussed in the plan include implementation of water demand management practices, verification of current safe yield studies, development of additional groundwater supply sources, and the development of an additional surface water supply source.

**Fauquier County Regional Water Supply Plan**

Fauquier County and the Towns of Remington and The Plains

Regional water supplies appear to be adequate to meet current and future demands through the planning period.

**Greene County and the Town of Stanardsville Regional Water Supply Plan**

The planning area is transitioning from rural farming to a residential community due to growth pressures from Albemarle County, the City of Charlottesville, and the Washington D.C. metro area. The Greene County municipal CWS anticipates an average day deficit of 0.54 MGD by 2030 and a peak day deficit of 0.07 MGD by 2010; Mountain Lakes CWS anticipates that, although average day demands are met through 2050, a peak day deficit of 0.031 MGD is anticipated by 2010. Short-term alternatives for additional supply include implementation of water conservation measures and development of new groundwater sources. Reservoir development is anticipated to satisfy long-term supply needs.

**King George County Water Supply Plan**

A water supply deficit of 1.5 to 2.0 MGD is estimated in the year 2030 for the King George County community water systems. A water supply deficit of 1.0 to 1.5 MGD is estimated in the year 2030 for self-supplied residential users in King George County. Alternative water sources identified include wastewater reuse, interconnection with a neighboring locality, reservoir development, and an intake on the Rappahannock River.

**Madison County and the Town of Madison Regional Water Supply Plan**

Existing water sources appear adequate to meet current and projected demands.

**Middle Peninsula of Virginia Regional Water Supply Plan**

Essex County and the Town of Tappahannock; Middlesex County and the Town of Urbanna

Water sources appear adequate to meet current and projected demands through the planning period.

**Northern Neck Regional Water Supply Plan**

Lancaster County and the Towns of Irvington, Kilmarnock and White Stone; Northumberland County; Richmond County and the Town of Warsaw; Westmoreland County and the Towns of Colonial Beach and Montross

Regional water supply appears to be adequate to meet demand through the planning period.

**Orange County Regional Water Supply Plan**

Orange County and the Towns of Orange and Gordonsville

Existing sources for each of the service areas may not be adequate to meet the projected maximum day demands. Depending on the source of the system (surface water impoundments, run-of-river intakes, groundwater), the deficit will be between 0.45 MGD and 4.61 MGD and with a range of years from 2010 to 2050. The Rapidan River/Orange Water Treatment Plant serving the Town of Gordonsville, Rapidan Service Area Rt. 15, and Town of Orange may experience a deficit of 2.61 MGD in 2050. Rapidan River/Wilderness Water Treatment Plant and the wells serving the Rapidan Service Area Rt. 20 may experience a deficit of 2.0 MGD in 2050. The region's plan to address the projected shortfall of municipal supply includes increasing the existing, permitted surface water withdrawal, developing new raw water storage, and developing new groundwater supplies, as well as continuing the existing water conservation policies or developing new ones.

**Town of Port Royal Water Supply Plan**

Average annual demands are estimated to be met by current sources during the 2010 to 2040 planning period; however, there are concerns over meeting peak demand as early as 2030. Peak demand is estimated at 0.049 MGD in 2030; the VDH permitted capacity of the system is 0.042 MGD. A limited customer base and financial issues limit the Town's options for meeting this demand. The Town is working with VDH Culpeper Field Office to secure funds to upgrade their system. Alternatives presented include improvements to the existing wells, a cooperative agreement with Caroline County to increase the Town's customer base or taking over the operation of two small community water systems outside of the town limits to increase customer base.

**Rappahannock County and the Town of Washington Regional Water Supply Plan**

Existing water sources are adequate to meet current and projected demand through the planning period.

**Spotsylvania County - City of Fredericksburg Regional Water Supply Plan**

Existing water sources are adequate to meet current and projected demand.

**Stafford County Water Supply Plan:**

Stafford County is projected to experience a water supply deficit sometime between 2010 and 2015. Based on this analysis, new water supplies capable of providing at least 14.7 MGD of additional treated water safe yield are needed to meet the County's projected 2050 demand of 27.7 MGD (with additional conservation). Accounting for estimated raw water transmission and treatment losses of 6%, at least 15.6 MGD of additional raw water safe yield is needed to meet projected 2050 demand. The region plans to address a projected shortfall of municipal supply by completing the construction of the Rocky Pen Run Reservoir project and pursuing other surface and groundwater alternatives as needed. Additional alternatives listed in the plan include expansion of existing Abel Lake; increase dam height at Rocky Pen Run facility, development of Potomac River and Rappahannock River tributaries for surface water reservoirs (Austin Run, Aquia Creek, Potomac Run, Long Branch Creek, Alcotti Run), development of off-stream pumped storage reservoirs adjacent to the Rappahannock River (Alcotti Run, Horsepen Run, Richland Run, increase to Rocky Pen Run facility), development of Vulcan Quarry offline storage reservoir adjacent to Aquia Creek, desalination of Potomac River water, and groundwater development.

| Locality | Estimated Year of Deficit | Estimated Deficit Amount (MGD) |
|---|---|---|
| Orange County | 2050 | 4.61 |
| Culpeper County & Town | 2050 | 0.4 |
| Caroline County | 2030 | 0.256 |
| Stafford County | 2015 (Rocky Pen Run Reservoir completion date) | 14.7 |
| King George County | 2030 | 1.0 – 1.5 |
| Greene County | 2030 | 0.54 |
| Albemarle County | 2035 | 0.41 |

Rappahannock River Basin Projected Water Deficits