COMMONWEALTH of VIRGINIA

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It is with great pleasure that I present the 2015 State Water Resources Plan ("Plan"), the culmination of a significant effort that began after the extended drought of 1998-2002. The Plan was developed based on information provided by Virginia's counties, cities, and towns in response to the Water Supply Planning Regulation (9 VAC 25-280). Forty-eight local and regional water supply plans covering every locality in the Commonwealth were developed with the significant efforts of planning districts, localities, water utilities, industries, agriculture, state agencies and interested citizens. The water supply plans include information about their existing water use and sources of supply, future projections of population and water demand, anticipated water supply deficits, potential sources of future water supply, and current efforts to use water efficiently.

In addition to information from the water supply plans, the Plan includes an analysis of how meeting future water needs may affect key water uses such as pollution assimilation, fish and wildlife habitat, and other existing downstream users. The main components of the Plan include an extensive look at surface water and groundwater sources, and an assessment of the capacity of these sources to meet the projected water demand in 2040. The Plan also outlines challenges faced by the Commonwealth in managing its water resources and identifies recommendations to address these challenges.

The Plan was advertised for public comment in the spring and 31 comments were received. DEQ appreciates the time and effort it took to provide comments, and while no changes were made to the Plan itself, the comments received and agency responses are included as Appendix E to the Plan to ensure consideration during near-term planning efforts and in developing future versions and updates of the Plan. The Plan is available on the DEQ State Water Resources Plan website.

DEQ is actively communicating the Plan's findings across the Commonwealth, and efforts are underway to meet with local and regional planning partners to discuss in more detail the potential risks associated with meeting projected water needs on local and regional beneficial uses. These meetings will be prioritized based upon areas where 2040 projected water needs are clustered, multiple potential risks are anticipated, and a deficit in water supply is predicted by 2040. Planning partners that believe they might benefit from a more detailed discussion of their Cumulative Impact Analysis or in the evaluation of water supply alternatives are encouraged to contact DEQ to express their interest in being included in the prioritization.

The Plan will be subject to incremental revision at five-year intervals as DEQ, localities, and other stakeholders provide input through ongoing water supply planning efforts. One aspect of Plan implementation currently under development is a web-based, interactive platform that will enable localities to enter water supply planning information directly into the system and to receive real-time, dynamic responses to inquiries regarding the sustainability of water resources. It is anticipated that this interface will provide the basis for more efficient data collection, which in turn, will improve DEQ's ability to provide localities and regions with analysis on water resource conflicts that could impact development of their future water supplies. This should add value to local decision making before significant resources are invested in particular water supply projects. DEQ anticipates the release of this interface as a pilot test in early 2016, with public release in October 2016.

DEQ would like to thank everyone who participated in the development of the local and regional water supply plans, members of the Water Supply Plan Advisory Committee, and other state agency staff from the Department of Health, Department of Conservation and Recreation, Marine Resources Commission, Department of Historic Resources, and Department of Game and Inland Fisheries.

This is a continuing planning process and I look forward to ongoing collaboration and communication with our local, regional and agency planning partners to ensure adequate water supplies and responsible, sustainable resource management for our citizens now and in the future.

Respectfully submitted,

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Commonwealth of Virginia

State Water Resources Plan

Preface

The State Water Resources Plan (State Plan) is the first document of its kind in the Commonwealth of Virginia. While Virginia has a history of planning for water resources, this is the first comprehensive plan that incorporates information from locally-developed water supply plans and includes basin-wide cumulative impact analyses of the information and the probable impact of future water demand on beneficial uses. The State Plan is a compilation and synthesis of the 48 local and regional water supply plans developed by local governments to assess their future water supply needs. The State Plan takes an extensive look at surface water and groundwater sources currently being used in the Commonwealth and assesses the capacity of these sources relative to all beneficial uses. All beneficial uses of water are examined, both current use and projected water demand to 2040, and an assessment of the ability of current sources to meet the future need is detailed. The State Plan also outlines challenges faced by the Commonwealth and identifies recommendations to address these challenges. The State Plan will be updated every five years following the review and update of all the local and regional plans.

Acknowledgements

The State Water Resources Plan (State Plan) is possible because of the time, effort, and expertise of many people and organizations throughout the Commonwealth of Virginia. The Virginia Department of Environmental Quality (DEQ) would like to thank everyone who participated in the development of the 48 local and regional water supply plans and the State Plan.

DEQ would also like to acknowledge the assistance from the Water Supply Plan Advisory Committee, which provided a final report that included guidance relevant to drafting this important document. Also, DEQ would like to thank the members of the original Water Policy Technical Advisory Committee (WP-TAC) that assisted in writing the Water Supply Planning Regulation.

Further appreciation goes to the following Virginia state agencies, which provided review and evaluation of the local and regional water supply plans: Department of Health, Department of Conservation and Recreation, Marine Resources Commission, Department of Historic Resources, and Department of Game and Inland Fisheries.

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Executive Summary

The Commonwealth of Virginia is rich in water resources; however, as the impacts of drought over the past two decades have demonstrated, we must work together to manage and protect water resources for future generations. Meeting long-term human and environmental needs can be accomplished most effectively by joint efforts of the Commonwealth and its localities. Comprehensive planning for the sustainability of the Commonwealth's water resources, as outlined in the Local and Regional Water Supply Planning Regulation (9VAC25-780) is designed to ensure the availability of adequate and safe drinking water to all citizens of the Commonwealth. Additionally, the planning process is established to encourage, promote, and protect all other beneficial uses of the Commonwealth's water resources, both in-stream and off-stream, and encourage, promote, and develop incentives for alternative water sources, including but not limited to desalinization. By Statute, all beneficial uses of our water resource, both in-stream and off-stream uses, which includes the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, cultural and aesthetic values, domestic (including public water supply), agricultural, electric power generation, and commercial and industrial uses, must be protected for the maximum benefit to all. Improved coordination of water resource management activities at the local, regional, and state levels will ensure adequate water resources will be available for water demand for present and future beneficial uses.

The State Water Resources Plan (State Plan) is a compilation and synthesis of the 48 local and regional water supply plans[1] developed by local governments to assess their water supply needs 2010 to 2040, as well as information from other sources. Each water supply plan includes information concerning community water systems and self-supplied users, existing and potential sources of water supply, existing use, and anticipated future water demand. This information was entered into the Virginia Department of Environmental Quality's (DEQ) content management system (VA Hydro) for use in the cumulative impact analysis.

The Commonwealth realized a more proactive approach to water resources planning was necessary following the 1999-2002 drought event. Following the 2002 drought, the Local and Regional Water Supply Planning Regulation[2] was established, which required each locality to develop and submit a plan, either alone or in collaboration with other localities, by 2011. These plans have been collected and analyzed, and the results and recommendations are included in this report. The State Plan is designed, as required by statute,[3] to encourage, promote, and secure the maximum beneficial use and control of the Commonwealth's water resources. In practice, the document will assist the DEQ in the efficient and effective regulation and management of water resources by examining projected water demand,

[1] See Appendix A
[2] §9VAC25-780
[3] http://lis.virginia.gov/cgi-bin/legp604.exe?000+cod+62.1-44.38

identifying water resources targeted to meet this demand, and analyzing potential impacts that may occur if the demand is met.

The State Plan takes a comprehensive look at the water sources currently being used in the Commonwealth and assesses the capacity of these sources relative to defined beneficial uses. An assessment of the ability of current sources to meet the projected water demand to 2040 is detailed.

This State Plan provides an opportunity to identify the likely challenges that will be faced by the many beneficial uses that depend on flow in Virginia's water resources. The information provided enables the identification of the probable location and types of impacts to beneficial uses and the various regulatory, infrastructure, and ecological challenges that these impacts might present. In addition to these areas of likely impact, the information in this plan can be used to target areas whose demands may jeopardize the sustainability of the water resource. These areas will require better understanding of aquatic resources, a more intense scrutiny to the accuracy of data, and a more thorough knowledge of water supply operations in those areas.

The cumulative impact analysis in the State Plan examined the data and information submitted during this water supply planning process and predicted a net increase of approximately 32% in mean daily water supply demand over the planning period 2010-2040. An estimated 450 million gallons per day (MGD) of additional water will be needed to meet the projected demands in 2040. This approximate 32% increase of water demands over the planning period is consistent with the Commonwealth's expected population increase for the same time period. Of this projected demand, about 77% is anticipated to come from surface water sources. The remaining estimated 23% demand is expected to come from groundwater sources.

During the drought of record simulation the challenge to the full range of beneficial uses will require greater attention in the follow up to this plan. The initial analysis indicated that in the future, there may be widespread areas of little to moderate impacts under normal conditions, punctuated by isolated areas with significant chronic impacts, and moving towards more widespread impacts under the driest conditions. For example, nearly 97% of the projected surface water demands in Virginia's streams are projected to come from approximately 25% of the stream reaches simulated. With 16% of streams predicted to see greater than 5% reduction in Drought of Record flows based on anticipated increases in use, drought-related impacts are likely to be more severe and last longer. This indicates a high probability that new management and/or infrastructure will be required to maintain safe yields at current levels. While systems that have built or are planning to build new storage will likely have adequate reserves to meet the predicted reduced drought inflows, systems without storage or with demands that are nearing existing safe yield may face challenges as the cumulative demands on streams increases.

Comprehensive water resources management includes planning, developing, distributing, and managing water resources for optimum use. These interrelated tasks can be accomplished by considering the competing demands of beneficial uses for water, allocating water resources, and satisfying all uses and demands. In searching for lasting solutions to the growing and competing demands for Virginia's water resources, a balance is needed between beneficial uses and long-term water availability. Industries and communities need reliable water to be available and profitable in both the short and long term.

The compilation of the water supply plans revealed that there are approximately 800 surface water withdrawals (reservoir, stream, and spring sources) and 2,900 groundwater well withdrawals (excluding private groundwater well estimates) statewide. Reported groundwater withdrawals outnumber surface water withdrawals for all use types (community water systems, large and small self-supplied users), except agriculture. Totals from the water supply plans indicate that an estimated 1.6 million people in the Commonwealth use private groundwater wells for residential water supply.

Appendix B of this State Plan includes summaries for nine major river basins, based on Virginia Code Section 62.1-44.38: Albemarle-Chowan River Basin, Chesapeake Bay-Small Coastal Basin, James River Basin, New River Basin, Potomac-Shenandoah River Basin, Rappahannock River Basin, Roanoke River Basin, Tennessee-Big Sandy River Basin, and York River Basin. The Major Basin Summaries include the following information, as summarized from the water supply plans:

- A description of the water supply planning units and localities included in each basin.
- A comparison of the surface water and groundwater sources used and withdrawals by source category
- Interbasin and intrabasin transfers identified in the water supply plans.
- Projected water demand and anticipated water supply deficits.
- A statement of need and a list of alternative water sources that may be considered to address deficits.

The State Plan will help focus the attention of decision makers on key issues and educate the public about the importance of managing Virginia's water supply. This State Plan gathers relevant water resource information in one location, laying the foundation for informed decision making at all levels concerning future water supply and use. For the first time in Virginia's history, the Commonwealth has a process in place to analyze the expected cumulative impacts of future water demands on streamflows and groundwater resources continually, as conditions change, to assist in decisions about the management and development of water resources.

State and local agencies, water purveyors, and consumers face a number of water supply challenges over the next 30-50 years, and even sooner in some areas. The challenges identified in managing the water resources and recommendations to address these challenges are outlined in the State Plan. The following issues are described:

1. **Challenge: Understanding the Impact of Unpermitted Water Withdrawals**

According to the 2014 Report on Virginia's Water Resources Management Activities[4], 82% of the total surface water withdrawn in 2013 was excluded from permitting, thus making it difficult to manage water resources, particularly during low flow periods. Unlike permitted withdrawals, excluded withdrawals are not subject to permit conditions that require conservation during times of low flow to reduce water use or to limits on withdrawal that require a certain volume of water to flow by the intake or to be released from a reservoir. These conditions help to ensure the existing beneficial uses of the water resource, including those of the withdrawal, are sustained at all times and, particularly, during dry periods, as well as conserving the resource for the long term.

Recommendation 1.1:

As resources allow, DEQ plans to coordinate with localities and other pertinent stakeholders to see if operational rules can be developed for those surface water withdrawals and impoundment releases currently excluded from VWP permitting. The areas that are predicted to result in negative impacts to beneficial uses during times of low flow will be prioritized. DEQ expects to meet with relevant parties in these areas to see if there are actions that can be agreed upon that would alleviate or reduce impacts on beneficial uses. Target stream reaches have been identified in the following river basins: Chowan-Albemarle, James, Potomac-Shenandoah, Rappahannock, Roanoke, and York. Future options may include, but are not limited to, the following: establishment of Surface Water Management Areas and Groundwater Management Areas; changes to pertinent statutes and/or regulations to capture unpermitted withdrawals.

2. **Challenge: Gaps in Water Withdrawal Reporting, Differences in Reporting Thresholds between WSP and VWWR Regulations, and Lack of Adequate Data**

As data submitted with the local and regional water supply plans was evaluated, it was noted that there are data gaps in groundwater and surface water information. While there is some information on the water use for agricultural and some commercial institutions, such as golf courses and nurseries, for example, additional outreach needs to be done to determine if there are water uses in these categories that have not been accounted for in Virginia's water budget.

[4] http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterSupplyPlanning/AWRP_090814FINAL.pdf

Recommendation 2.1:

DEQ will:

a) Coordinate with localities and regions to update the data set to continuously improve model results.

b) As resources allow, initiate a more systematic approach to registering those facilities that meet the threshold for VWWR reporting, but who are not currently registered and do not report.

c) Train localities and other water purveyors to directly input data into the content management system for more timely information.

3. Challenge: Quantifying Current and Future Risks to Groundwater Availability Outside of Current Groundwater Management Areas

The degree of interconnectedness of fractured rock groundwater systems and surface water features in western Virginia is significant, resulting in unique challenges to assessing water supply risk. These systems can be highly influenced by annual precipitation, can be storage limited, and can recharge or decline on short time scales. In most watersheds, groundwater discharge to streams constitutes a significant portion of the water in the stream. Droughts over the last two decades have demonstrated that below normal recharge over as little as two years can significantly reduce groundwater contribution to streamflow. Increases in groundwater withdrawals in these systems can have the same effect in reducing streamflow, increasing the risk of impacts to beneficial uses in a watershed. During times of low recharge, this effect can be compounded by increased withdrawals.

While the structural complexity of these groundwater/surface water systems creates some practical limitations, the Commonwealth and its localities need to begin at least some preliminary quantification of risk. Seventy-five percent of the groundwater demand for 2040 is expected to occur outside the coastal plain GWMAs. Therefore, it is important to start by creating some basic water budgets in these areas. These can start as simply as a comparison of rainfall volumes to expected withdrawal volumes.

As projections were gathered through the water supply planning effort, there is a better understanding of groundwater demands and reliance on this resource in the western half of Virginia. It was estimated that 137.81 MGD of water was used by small self-supplied users of private residences. Additionally, estimates of the projected future demand associated with these wells were made in the water supply plans. However, assumptions were made that groundwater resources could support this increased demand. This may or may not be the case; there is not enough information on the sustainability of groundwater wells in the western half of the Commonwealth to be sure.

To go beyond simple assessments, further investment is needed in targeted monitoring and model development to determine groundwater flow, relative storage in these systems, and the probable magnitude of impact under different meterological and water use conditions.

Recommendation 3.1:

DEQ may facilitate efforts with localities and regional stakeholders (e.g., planning district commissions, utilities, public service authorities) to expand groundwater monitoring wells in localities outside the Groundwater Management Area with expected significant increases in 2040 demands from groundwater and may be at high risk for negative beneficial use impacts. An increase in groundwater monitoring wells should improve our understanding of the groundwater resource and the impacts of pumping on the aquifer. State and local entities may coordinate efforts to identify financial resources to provide funding necessary for an expansion of the State Observation Well network. Additionally, DEQ plans to provide decision makers with all methodologies and analysis that DEQ has on the availability and sustainability of groundwater. DEQ may provide input and assistance if localities or regions conduct their own methodologies or analysis, including Recharge Analysis. As resources allow, DEQ staff will analyze data and provide outreach to localities and regions to ensure better management of the resources and water availability for all beneficial users. DEQ plans to target outreach efforts to localities that the cumulative impact analysis indicates groundwater uses exceed the annual recharge. These localities include the counties of Giles, Frederick, and Rockingham, and the cities of Martinsville, Radford, Roanoke, Salem, and Waynesboro.

4. Challenge: Reservoir Site Development

The process of identifying future reservoir sites can be difficult, potentially involving numerous competing interests, all of which can be the subject of much debate. Localities typically must consider planned projects, such as housing developments, major road, rail, or utility line construction, infrastructure development, and identification and protection of sites for future economic development. Federal, state, and local interests to protect natural ecosystems located within a reservoir footprint can also impact the viability of a site. Considerations such as cost, size, the distance to where water is needed, environmental and archaeological concerns, water quality and source water protection, and benefits beyond water supply (recreational uses and tourism) must also be considered. Maintenance of reservoirs to assure their storage capacity is another cost that should be considered. Any of these conditions can influence the viability of a new reservoir site and impact the ability of state or federal authorities to approve a proposed permit application.

Recommendation 4.1:

Based on the projected 2040 demand, localities and regions will need additional storage. DEQ will assist, as appropriate, in any efforts to optimize the use of the resource.

5. Challenge: Threats to Water Quality

Water supply plans listed a number of potential threats to water quality. The WSP Regulation section on "Existing Resource Information" requires all water supply plans to include "a description of existing environmental conditions that pertain to, or may affect, in-stream flow, in-stream uses, and sources that provide the current supply." Required conditions to be considered included state or federal threatened or endangered species or habitats of concern, river segments that have recreational significance, unusual geologic formations or soil types, wetlands, riparian buffers, land use including impervious surfaces, impaired streams, and point source discharge locations. Potential threats to water quality or quantity beyond this list were to be discussed in the plans.

Other potential threats listed in the water supply plans include contamination from septic tanks, fuel spills, industry, landfills, landslides, radon emission, mining excavations, logging, junkyards, septic system failures, and agricultural runoff. Improper application or inappropriate storage of lawn and garden chemicals, paints, synthetic detergents, solvents, oils, medicines, disinfectants, pool chemicals, pesticides, batteries, gasoline, and diesel fuel are also considered threats to water quality.

Recommendation 5.1:

DEQ will continue to evaluate August Low Flow (aquatic life impacts), and 7Q10 (waste assimilation) to assess the probable impacts to certain beneficial uses. As resources allow, DEQ will add conditions to be considered to assess the potential impacts to the water resources.

6. Challenge: Understanding the Impact of Consumptive Use on Water Supply

Consumptive use, that portion of the water withdrawn that is lost to evaporation, transpiration, or consumption by humans or animals and is not returned to the water system, has the greatest impact on water availability. The impact of consumptive uses on beneficial uses is and should continue to be evaluated in water supply planning and permitting. Current regulations (WSP Planning, Water Withdrawal Reporting) do not require information on consumptive use. One of the main objectives of the cumulative impact analysis and water supply planning process is to ensure against future water shortages and unforeseen negative impacts to in-stream beneficial uses. As such, consumptive use must be factored into the modeling equation. Assumptions about consumptive use are conservative, erring on the side of assuming a higher level of net consumption from water use activities. Reporting of actual data concerning consumptive use will provide more accurate projections on the availability of water during low flows.

Recommendation 6.1:

Request approval to revise the Virginia Water Withdrawal Reporting Regulation (9VAC25-200-10 et seq.) to require the annual reporting of consumptive use.

7. **Challenge: Promoting Increased Conservation to Reduce Long-Term and Short-Term Demand**

The goal of water conservation is to maximize the benefit gained from each gallon of water used. Water conservation is increasingly becoming important as part of local governments' overall water management strategy across the Commonwealth, particularly during drought events. Water conservation practices can extend the use of a system's available water supply, reduce the impacts of drought, delay expansion of treatment facilities, reduce operating costs, and reduce costs to consumers as their use of water declines. Use of water conservation practices are described in regional water supply plans and reflect that the more limited a region's water resources are or are expected to become, the more critical it is to have effective water conservation programs.

Water conservation can be an important component of water resource management. Although Virginia is rich in water resources, citizens must use water wisely to ensure the sustainability of the resource both during drought events and every day. As such, localities and other water purveyors are considering water conservation programs to ensure water is used as efficiently as practicable.

Recommendation 7.1:

DEQ will encourage localities and regions to place more emphasis on conservation efforts to reduce demand in their water supply plans.

8. **Challenge: Critical Infrastructure Deficiencies**

Water infrastructure in Virginia was built over many decades and, for many localities and systems, has not been maintained adequately due to insufficient funds and planning. The local and regional water supply plans reflect system losses from 4% to 50%, generally depending upon the age of the system. The American Society of Civil Engineers recently released the "New 2015 Report Card for Virginia's Infrastructure" **(**http://www.infrastructurereportcard.org/virginia/virginia-overview/) and gives Virginia a grade of 'C' based on the reported condition of existing assets, expected service life, current functionality and level of service, future growth needs, and anticipated level of funding required to maintain Virginia's infrastructure. The report continues that "Virginia reported $6.1 billion in drinking water infrastructure needs over the next 20 years." While all systems will not fail at the same time, water treatment facilities and related distribution systems need to be properly maintained or replaced to ensure proper water efficiency.

VDH has prioritized drinking water loss in their grant/loan program. In the "Commonwealth of Virginia Drinking Water State Revolved Fund Program Intended Use Plan For the DWSRF FY 2015 Capitalization Grant," http://www.vdh.state.va.us/ODW/financial/documents/pdf/2015%20IUP.pdf, draft dated January 5, 2015, VDH established the Drinking Water State Revolved Fund (DWSRF) Program in accordance with the federal Safe Drinking Water Act Amendments of 1996. The goals of this program include assisting "waterworks owners in protecting water supplies, ensuring the reliable operation of water systems, preparing for future waterworks challenges, and developing their technical, financial, and managerial capacity."

Recommendation 8.1:

DEQ will provide VDH with a list of localities whose water supply plans indicated that they have high water loss so VDH can consider them for funding to improve their infrastructure.

9. Challenge: Sea Level Rise, Changes in Precipitation Patterns, and Land Subsidence

Environmental issues such as sea level rise, changes in precipitation patterns, and land subsidence may have impacts on water resources in the Commonwealth. "The changing climate impacts society and ecosystems in a broad variety of ways. For example climate change can increase or decrease rainfall, influence agricultural crop yields, affect human health, cause changes to forests and other ecosystems, or even impact our energy supply. Climate-related impacts are occurring across regions of the country and across many sectors of our economy."[5]

Recommendation 9.1:

a) DEQ will conduct a Cumulative Impact Analysis annually and will evaluate the impacts on streamflow of the most recent climate change model scenarios available in time for each five-year review cycle for local and regional water supply plans.
b) DEQ will develop a subsidence monitoring plan to better characterize the amount of sea level rise due to land subsidence over time to inform water supply-related local adaptation strategies.

10. Challenge: Source Water Protection

Many local and regional water supply plans acknowledge that the VDH Source Water Assessment Program indicated high susceptibility for their sources of water supply, yet only 15 of the 48 water supply plans indicate a source water protection plan program has been completed or is under development. Completion of the Source Water Protection Plans process, using the same funding strategy mentioned above in coordination with VDH, should improve the long-term viability of storage and infrastructure in the Commonwealth.

Recommendation 10.1:

DEQ will coordinate with VDH and localities to urge localities to develop and implement Source Water Protection Plans. Localities can begin by reviewing the Source Water Assessment conducted by VDH and determining whether additional study of additional threats is needed. Land areas should be

[5] http://www.epa.gov/climatechange/impacts-adaptation/

defined that contribute water to the system. Localities can develop zoning ordinances and other tools to ensure these areas are protected from water quality threats.

11. Challenge: Conflict Resolution

As discussed in the 2012 Final Report for the Water Supply Plan Advisory Committee, the State Plan is used as an informational tool for future water supply decisions and not for conflict resolution. The information derived from local and regional plans can be used to evaluate alternative water sources and to determine the extent of hydrologic conflicts between localities, regions, existing users, and other in-stream and off-stream beneficial uses. When conflicts are identified, DEQ can provide informal facilitation if requested, but attempts to resolve the conflict should be at the local level. Should it not be practical or logical for issues to be resolved at the local level, there are other remedies available that may assist with resolving issues between stakeholders. DEQ does not currently have the authority necessary to resolve conflicts beyond identifying them and facilitating discussion between localities and regions.

Under the current regulatory framework, conflicts arising from planned implementation of local and regional water supply plan alternatives can be resolved through the following methods:

a) Issuance of Virginia Water Protection permits.
b) Creation or use of a legislative or voluntary body (such as a river basin commission).
c) Regulations, such as declaration of a Surface Water Management Area or Groundwater Management Area.
d) Litigation among parties.

Recommendation 11.1:

DEQ should continue to work within the current regulatory framework to resolve conflicts.

12. Challenge: Public Education and Outreach

All residents of the Commonwealth should understand the need for managing Virginia's water resources so state, regional, and local water supply planning will be more effective. When people understand that the Commonwealth's water resources are finite and that active management of existing resources is essential to meeting future demand, statewide educational efforts will likely be more successful, as localities may coordinate activities and inspire each other as they consider ways to reach more citizens. DEQ, other state agencies, and all localities must work in concert to provide accurate and useful information to ensure that citizens learn about the opportunities and benefits of improving water use efficiency. A comprehensive, statewide public education and outreach program can have a positive impact on Virginia's water resources.

Recommendation 12.1:

DEQ will engage localities and planning regions in water supply planning efforts, as follows:

1) Communicate the findings of the State Water Resources Plan, including the Cumulative Impact Analysis and probable impacts to water resources.

2) Assist localities with water supply planning compliance efforts as outlined in their condition of approval.

3) Improve modeling results by increasing the accuracy of the data, as follows:

    a.3.1 Partner with a locality willing to serve as a pilot for the direct input of data into the DEQ content management system, ensuring the system is user friendly and easily accessible

    a.3.2 Train localities and water purveyors to directly input data into the content management system

4) Expand public education and outreach efforts to impress upon citizens the importance of water supply planning and conservation during drought.

In summary, the State Plan presents relevant information for local communities and their consultants to use when planning for future water supply needs, such as projected demand, anticipated deficits, potential water supply alternatives, and addressing the various state regulations and programs that affect water supply planning. The water supply planning regulation anticipated that localities would use the information included in the State Plan in their planning. To that end, DEQ anticipates updating the State Plan at five-year intervals, with each update reflecting the most recent local and regional water supply plans, water withdrawal data, and demand projections. The State Plan is intended to be a dynamic, iterative document that will be updated as new data becomes available.

Acronyms and Abbreviations

ALF: August Low Flow

CBIC: Chesapeake Bay Impact Crater

CWA: Clean Water Act

CWS: Community Water System

DCR: Virginia Department of Conservation and Recreation

DEQ: Virginia Department of Environmental Quality

DGIF: Virginia Department of Game and Inland Fisheries

DHR: Virginia Department of Historic Resources

DMTF: Virginia Drought Monitoring Task Force

FERC: Federal Energy Regulatory Commission

GWMA: Groundwater Management Area

GWPP: Groundwater Withdrawal Permitting Program

HUC: Hydrologic Unit Code

ICPRB: Interstate Commission on the Potomac River Basin

MGD: Million Gallons per Day

MGY: Million Gallons per Year

NOAA: National Oceanic and Atmospheric Administration

NWS: National Weather Service

ORSANCO: Ohio River Valley Water Sanitation Commission

Rappahannock RBC: Rappahannock River Basin Commission

Rapidan RBC: Rapidan River Basin Commission

RRBBC: Roanoke River Bi-State Commission

SDWA: Safe Drinking Water Act

SSU: Self-Supplied Users

SWCB: State Water Control Board

SWMA: Surface Water Management Area

TMDL: Total Maximum Daily Load

USACE: United States Army Corp of Engineers

USEPA: United States Environmental Protection Agency

USFWS: United States Fish and Wildlife Service

USGS: United States Geological Survey

VDH: Virginia Department of Health

VDH-ODW: Virginia Department of Health Office of Drinking Water

VMRC: Virginia Marine Resources Commission

VPA: Virginia Pollution Abatement Program

VWPP: Virginia Water Protection Permit

VWUDS: Virginia Water Use Database System

VWWR: Virginia Water Withdrawal Reporting

WSP: Water Supply Plan

Glossary

7Q10 is the lowest seven-day average flow that occurs (on average) once every 10 years.

Aquifer as defined by 9VAC20-50-40 means a “water-bearing geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of groundwater to wells or springs. An aquifer is unconfined (water table) or confined (artesian) according to whether the upper surface of the water is at atmospheric pressure or at greater than atmospheric pressure.” Derived from the two Latin words *aqua*, or “water,” and *ferre*, meaning “to bear” or “to carry,” aquifers literally carry water underground. Aquifers may be comprised of a layer of sand or gravel, sandstone or cavernous limestone, a rubbly top or base of lava flows, or even a large body of massive rock such as fractured granite with sizable openings. Aquifers are replenished by the seepage or infiltration of precipitation falling on the land.

Assimilative capacity means the ability of a body of water to cleanse itself; its capacity to receive waste waters or toxic materials without harmful effects and without damage to aquatic life or humans.

August Low Flow (ALF) is a critical summer flow for fish. August is considered by aquatic biologists to be a critical month for many riverine species, with a high potential for negative impacts due to flow reductions during this time. Recent research support this hypothesis, showing evidence that decreases in flows as reflected in a stream’s ALF value may result in a measurable loss of biodiversity. The ALF statistic is a good metric for evaluating water supply impacts because it is sensitive to the most common water supply flow alteration: surface water withdrawals for off-stream consumptive use.

Baseflow, or groundwater seepage into a stream channel, means the portion of streamflow that comes from the sum of deep subsurface flow and delayed shallow subsurface flow. During most of the year, streamflow is composed of both groundwater discharge and surface water runoff. When groundwater provides the entire flow of a stream, baseflow conditions are said to exist. Perennial streams flow year-round because groundwater remains above the streambed throughout the year. Intermittent streams, those that flow only part of the year, generally from spring to mid-summer or only during wet periods, occur when the water table rises above or falls below the base of a stream channel in response to wet or dry weather conditions. The amount of baseflow a stream receives is closely linked to the permeability of rock or soil in the watershed.

Baseline Flow Budget is a critical tool in water supply engineering. This budget is estimated by constructing a model of flows through a river system without including withdrawals, discharges, or detainment of water by lakes or reservoirs. This budget reveals the quantity, quality, and timing of flows through river systems and allows the determination of total capacity of the stream, assesses system stress due to water supply activities, and sets reasonable expectations for potential beneficial uses.

Beneficial use as defined by 9VAC25-780-30 relates to both in-stream and off-stream uses. In-stream beneficial uses include, but are not limited to, the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. Off-stream beneficial uses include, but are not limited to, domestic (including public water supply), agricultural, electric power generation, and commercial and industrial uses.

Community water system (CWS) as defined by 9VAC25-780-30 means a waterworks that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents, and is regulated by the Virginia Department of Health Waterworks Regulation (12VAC5-590). This definition for CWS is identical to that of “community waterworks,” one of the three types of “waterworks” regulated by the VDH (12VAC5-590-10).

Consumptive use refers to water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

Cumulative impact analysis means an assessment of the environmental impacts resulting from the incremental actions when added to other past, present, and reasonably foreseeable future actions.

Desalination means the process of removing salts, minerals, and dissolved solids from brackish, saline, or seawater.

Dendritic drainage patterns are the most common form of drainage system. In a dendritic system there are many contributing streams similar in form to the twigs of a tree, which are then joined together into the tributaries of the main river (the branches and trunk of the tree). Dendritic drainage patterns develop where the river channel follows the slope of the terrain, typically in V-shaped valleys, in areas of impervious and non-porous rock such as in the Appalachian Plateau Physiographic Province.

Estuary means a partly enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea.

Evaporation is the process by which water changes from a liquid to a gas or vapor, representing the water loss from open bodies of water, such as lakes and reservoirs, wetlands, bare soil, and snow cover. Evaporation is the primary pathway water moves from a liquid state back into the water cycle as an atmospheric water vapor. Studies have shown that the oceans, seas, lakes, and rivers provide nearly 90 % of the moisture in the atmosphere via evaporation, with the remaining 10% being contributed by plant transpiration.

Evapotranspiration (ET) means the combined release of water from the earth's surface via evaporation plus transpiration from plants.

Groundwater as defined by 9VAC25-600-10 means "any water, except capillary moisture beneath the land surface in the zone of saturation or beneath the bed of any stream, lake, reservoir or other body of surface water within the boundaries of this state, whatever may be the subsurface geologic structure in which such water stands, flows, percolates or otherwise occurs."

Groundwater discharge means the movement of water out of an area of saturated soil. Groundwater discharges into streams when the water table, or the top of groundwater saturation, rises above the streambed.

Groundwater recharge is a hydrologic process where water moves downward from surface water to groundwater. This process occurs both naturally and through artificial processes where rainwater and/or reclaimed water is routed to the subsurface. Groundwater is recharged naturally by the infiltration of rain and snow melt and to a smaller extent by surface water. Recharge may be impeded by human activities such as paving, land development, or logging, which can result in loss of topsoil and reduced water infiltration.

Groundwater management area means a geographically defined groundwater area in which the Virginia State Water Control Board has deemed the levels, supply, or quality of groundwater to be adverse to public welfare, health, and safety.

Human consumption as defined by 9VAC25-610-10 means the use of water to support human survival and health, including drinking, bathing, showering, cooking, dishwashing, and maintaining hygiene.

Hydraulic fracturing means the fracturing of rock by a pressurized liquid, which can occur naturally, or be induced for other purposes including the release of natural gases contained in the rock. Induced hydraulic fracturing, known as hydrofracturing or fracking, is a technique in which water is mixed with sand and chemicals, and then injected at high pressure into a wellbore to create small fractures along which fluids such as gas, petroleum, uranium-bearing solution, and brine water may migrate to the well.

Hydrologic (or water) cycle means the natural sequence through which water is transferred across or beneath the earth's surface and between the earth and the atmosphere.

Hydrologic units are surface water drainage areas that are delineated so as to nest into a multi-level hierarchical drainage system. Aside from the surface waters that are collected within the boundary of a hydrologic unit, it may also accept water from one or more points outside of the unit's boundary. Hydrologic units may include associated surface areas whose drainages do not connect, thus resulting in multiple outlet points. This is usually the case with coastal units such as those containing multiple outlets to the Chesapeake Bay or Atlantic Ocean.

Hydrologic Unit Code (HUC) refers to a unique code assigned to hydrologic units in a hierarchical system initially created by the USGS to provide a standardized method of cataloging watersheds in the United States. In 2006, new hydrologic unit delineation standards officially expanded the hierarchy from four to six levels with HUCs 2 to 12 digits in length. A HUC8 is classified as a “subbasin” level whose average unit size is 703 square miles. The HUC8 classification is used in this State Plan, as it is a convenient, reasonably-sized, and widely understood unit of watershed division for the purpose of reporting the cumulative impact analysis results that summarize resource availability, challenges, and strategies.

Hydrology means the study of the waters of the earth on and below the surface of the planet. Hydrology also involves the study of the various properties of water and their relationship with the living and nonliving environment.

Hydrogeology is the area of geology that deals with the distribution and movement of groundwater in and through the soil and rocks of the earth’s crust.

Infiltration means the process by which water on the surface enters the soil.

In-stream flow means the state in which water remains in its natural course (e.g., streams, creeks, or rivers) as opposed to water that has been diverted artificially for other purposes (e.g., irrigation, reservoirs, drinking water, etc.).

Karst topography as defined by 9VAC20-50-40 means a type of topography that may form over limestone, dolomite, or gypsum formations by dissolving or solution, and that is characterized by closed depressions or sinkholes, caves, and underground drainage.

Local government as defined by 9VAC25-780-30 means a city, incorporated town, or county.

Local water supply plan means a water supply plan developed by and pertaining to a single local government.

Minimum in-stream flow means the amount of water flow necessary to preserve stream values.

Non-consumptive use as defined by 9VAC25-220-10 means the use of water withdrawn from a stream in such a manner that it is returned to the stream without substantial diminution in quantity at or near the point from which it was taken and would not result in or exacerbate low flow conditions.

Nonpoint source pollution as defined by 9VAC25-870-10 means pollution such as sediment, nitrogen, phosphorous, hydrocarbons, heavy metals, and toxics whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by stormwater runoff.

Off-stream use involves the withdrawal or diversion of water from a surface water or groundwater source for residential, industrial, agricultural, energy development, or other purposes.

Percolating water means water which seeps or filters through the ground without any definite channel and is not a part of the flow of any waterway.

Permeable refers to a rock or membrane that can be permeated, or penetrated, especially by liquids or gases.

Physiographic province means a region or area with similar landforms that are distinctly different from landforms found in adjacent areas. Virginia has five physiographic provinces: the Appalachian Plateau, Valley and Ridge, Blue Ridge, Piedmont, and the Coastal Plain.

Point source as defined by 9VAC25-31-10 means any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff.

Potable water as defined by 9VAC25-740-10 means water fit for human consumption and domestic use that is sanitary and normally free of minerals, organic substances, and toxic agents in excess of reasonable amounts for domestic usage in the area served and normally adequate in quantity and quality for the minimum health requirements of the persons served.

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. Precipitation is the primary connection in the water cycle providing for the delivery of atmospheric water to the earth.

Planning period as defined by 9VAC25-780-30 means the 30- to 50-year time frame used by the locality or region to project future water demand in accordance with 9VAC 25-780-100 B.

Reclaimed water as defined by 9VAC25-740-10 means water resulting from the treatment of domestic, municipal, or industrial wastewater that is suitable for water reuse that would not otherwise occur.

Regional water plan as defined by 9VAC25-780-30 means a water plan developed and submitted by two or more cities or counties or both. A town and an adjacent county may develop a regional water plan. Two or more towns may develop and submit a regional plan where the plan results in the proposed development of future water supply projects that supply the water supply demands of the affected towns. Such plans developed by two or more towns may be included in regional water plans developed and submitted by counties or cities. Regional water plans shall be developed and submitted in conjunction with all public service authorities operating community water systems within the regional planning unit, if applicable.

Reuse or water reuse as defined by 9VAC25-740-10 means the use of reclaimed water for a direct beneficial use, an indirect potable reuse, an indirect non-potable reuse, or a controlled use.

Riparian area or zone is that area of land immediately adjacent to streams, lakes, or other surface waters.

Riparian land as defined by §62.1-104 means land which is contiguous to and touches a watercourse.

Riparian owner or landowner as defined by §62.1-104 means an owner of riparian land.

Riparian (water) rights refer to a system for allocating water among those who possess land adjacent to a body of water. Having its origins in English common law, under the riparian principle, landowners whose property adjoins a body of water such as a navigable river, bay, creek, or ocean, have the right to make reasonable use of it as it flows through or over their property.

Safe yield of public water supply means the highest volumetric rate of water that can be withdrawn by a surface water withdrawal during the Drought of Record since 1930, including specific operational conditions established in a Virginia Water Protection permit, when applicable.[6]

Self-supplied user (SSU) as defined by 9VAC25-780-30 means any person making a withdrawal of surface water or groundwater from an original source (e.g., a river, stream, lake, aquifer, or reservoir fed by any such water body) for his own use. Self-supplied users do not receive water from a community water system. Self-supplied users are further described in Section 9VAC25-780-70 of the Water Supply Plan Regulation as follows:

> **Agricultural self-supplied users (AG)** are those agricultural operations that use more than 300,000 gallons of surface water or groundwater per month for irrigation or non-irrigation purposes.

[6] Proposed definition February 2015

Large self-supplied users (SSU_LG) are those self-supplied users of more than 300,000 gallons per month of surface water or groundwater for nonagricultural uses, including but not limited to commercial, manufacturing, mining, and hydropower.

Small self-supplied users (SSU_SM) are those residences and businesses that are self-supplied by individual wells withdrawing less than 300,000 gallons of water per month.

Service area as defined by 9VAC25-780-30 means the geographical area served by a community water system.

Springs are water resources formed when the side of a hill, valley bottom, or other excavation intersects a flowing body of groundwater at or below the water table. Although they can be formed in any type of rock, springs are more prevalent in limestone and dolomite formations because of their fractal nature and their propensity to dissolve in rainfall that is weakly acidic. As the rock dissolves and fractures, spaces can form that allow water to flow. If the water flow is horizontal, it can reach the land surface and result in a spring.

Stormwater as defined by §62.1-44.15 means precipitation that is discharged across the land surface or through conveyances to one or more waterways and that may include stormwater runoff, snow melt runoff, and surface runoff and drainage. Stormwater runoff is generated when precipitation from rain and snow melt flows over land or impervious surfaces (sidewalks, parking lots, rooftops) and does not percolate into the ground. Traditional definitions of stormwater have characterized it as non-point source runoff; however, a great deal of urban and industrial stormwater is discharged into surface waters through storm sewers, ditches, channels, or other conveyances which are considered point sources. As stormwater runoff flows overland, it accumulates debris, chemicals, sediment, or other pollutants that could adversely affect water quality if it is discharged into surface water bodies untreated.

Streamflow refers to the amount of water flowing in a river. Streamflow and the water quality of a river are affected by whatever is happening in the land area "above" the point where a river flows out of a watershed. Natural mechanisms that cause changes in streamflow include runoff from rainfall and snowmelt, evaporation from soil and surface water bodies, transpiration, groundwater discharge, and sedimentation of lakes and wetlands. Human-induced mechanisms include surface water withdrawals and inter- or intra-basin diversions; river flow regulation for hydropower and navigation, construction, removal, and sedimentation of reservoirs and stormwater detention ponds; stream channelization and levee construction; drainage or restoration of wetlands; land use changes such as urbanization that alter erosion, infiltration, overland flow, or evapotranspiration rates; wastewater outfalls; irrigation wastewater return flow, etc.

Surface water as defined by 9VAC25-210-10 means any water in the Commonwealth, except groundwater as defined in §62.1-254 of the Code of Virginia, which wholly or partially are within the Commonwealth or bordering the Commonwealth.

Surface water withdrawal as defined by 9VAC25-210-10 means a removal or diversion of surface water from a stream, spring, and/or lake/pond in Virginia or from the Potomac River.

Sustainability means using, developing, and protecting resources in a manner that enables people to meet current needs, and provides the ability for future generations to also meet future needs. Additionally, sustainability is defined in terms of maintaining the "beneficial uses" that are considered to be essential to the wellbeing of the Commonwealth's human and natural resources. These beneficial uses are protected by law and include the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, cultural and aesthetic values, public water supply, agricultural uses, electric power generation, and commercial and industrial uses.

Topography means the arrangement of the natural and artificial physical features of an area.

Transpiration is the release of water from living plant surfaces. Transpiration rates can vary widely depending upon weather conditions such as temperature, humidity, sunlight availability and intensity, precipitation, soil type and saturation, root depth, wind speed, density and type of vegetative cover, land slope, reflective land-surface characteristics, and the season of the year. During dry periods, transpiration can contribute to the loss of moisture in the upper soil zone which can effect vegetation and crops.

Water budget is an accounting of the flow of water into and out of a system. The water budget of a place or system, whether it is an agricultural field, a watershed, or a continent, can be determined by calculating the input, output, and storage changes of water at the earth's surface over a period of time.

Water demand management as defined by 9VAC25-780-30 means plans for water conservation, reuse, and reducing unaccounted for water losses contained in a local or regional water supply planning program.

Water resource management means the activity of planning, developing, distributing, and managing the optimum use of water resources.

Water sources as defined by 9VAC25-780-30 means wells, stream intakes, and reservoirs that serve as sources of water supplies.

Water supply planning area means the geographical area as defined by local government boundaries that is included in a local or regional water supply plan.

Watershed as defined by 4VAC5-15-10 means a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Waterworks as defined by 12VAC5-590-10 means a system that serves piped water for drinking or domestic use to (i) the public, (ii) at least 15 connections, or (iii) an average of 25 individuals for at least 60 days out of the year. The term "waterworks" shall include all structures, equipment and appurtenances used in the storage, collection, purification, treatment and distribution of pure water except the piping and fixtures inside the building where such water is delivered (see Article 2 (§ 32.1-167 et seq.) of Chapter 6 of Title 32.1 of the Code of Virginia).

Well as defined by 9VAC25-610-10 means any artificial opening or artificially altered natural opening, however made, by which groundwater is sought or through which groundwater flows under natural pressure or is intended to be withdrawn.

Wetland means a transitional area on the landscape between dry land and open water or streams, often exhibiting characteristics of both terrestrial and aquatic habitats. State Water Control Law (§ 62.1-44.3) and Virginia Water Protection Permit (VWP) Program regulations (9VAC25-210-10) define "State waters" as "all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction, including wetlands." Further, "wetlands" are defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The definition of "wetlands" in state law mirrors the definition in the federal Clean Water Act.

Chapter 1 Virginia's Water Resources Planning Process

Planning and Water Resources Management in Virginia

This Chapter discusses the history of water resources planning in Virginia, the interrelationship between this State Water Resources Plan (State Plan) and water use permitting, and current water supply planning efforts in Virginia. It also includes a brief overview of Virginia's population, economy, and anticipated growth as they relate to water resources management and planning.

Water resources management encompasses planning, developing, distributing, and managing water resources for their optimum use. These interrelated tasks can be accomplished by considering all of the competing demands for water, allocating water resources on an equitable basis, and satisfying all uses and demands.

Water supply planning in Virginia is designed, among other goals, to encourage, promote, and protect all beneficial uses of the Commonwealth's water resources. As defined by § 62.1-44.3 of the Code of Virginia:

> "Beneficial use" means both in-stream and off-stream uses. In-stream beneficial uses include, but are not limited to, the protection of fish and wildlife resources and habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. The preservation of in-stream flows for purposes of the protection of navigation, maintenance of waste assimilation capacity, the protection of fish and wildlife resources and habitat, recreation, cultural and aesthetic values is an in-stream beneficial use of Virginia's waters. Off-stream beneficial uses include, but are not limited to, domestic (including public water supply), agricultural uses, electric power generation, commercial, and industrial uses.

The Commonwealth of Virginia is rich in volume, type, and diversity of water resources. Precipitation averages almost 43 inches of rain per year, much more than many other states. However, as the impacts of the droughts of the last two decades demonstrated, this resource cannot be taken for granted. The Commonwealth and its localities must work together to manage and protect the water resources to meet long-term human and environmental needs. Improved coordination of drought response and water resources management activities at the local, regional, and state levels are essential to guaranteeing the adequacy of water supplies to meet current and future needs of Virginia's citizens in an environmentally sound manner. The challenge is to ensure sufficient water supplies are available to meet existing and future beneficial uses of water.

Water Resource Planning

Virginia has been involved in water resources management and water supply planning since 1927. Early efforts (between 1927 and 1968) involved the development of various "bulletins" developed periodically for major river basins. These early reports primarily examined surface water, with some effort to describe groundwater resources. The information in these plans was based upon streamflow data and water availability. Planning efforts expanded between 1968 and 1972, following an extended multi-year drought. Reports examining water availability were again developed by major river basin during this time. However, these plans differed from the early plans in that they contained the first inventory of local water use.

The authority[7] for these early plans and reports outlines the following principles and policies:

1) Existing water rights are to be protected and preserved subject to the principle that all of the state waters belong to the public for use by the people for beneficial purposes without waste;
2) Adequate and safe supplies should be preserved and protected for human consumption, while conserving maximum supplies for other beneficial uses. When proposed uses of water are in mutually exclusive conflict or when available supplies of water are insufficient for all who desire to use them, preference shall be given to human consumption purposes over all other uses;
3) It is in the public interest that integration and coordination of uses of water and augmentation of existing supplies for all beneficial purposes be achieved for maximum economic development thereof for the benefit of the Commonwealth as a whole;
4) In considering the benefits to be derived from drainage, consideration shall also be given to possible harmful effects upon groundwater supplies and protection of wildlife;
5) The maintenance of streamflows sufficient to support aquatic life and to minimize pollution shall be fostered and encouraged;
6) Watershed development policies shall be favored, whenever possible, for the preservation of balanced multiple uses, and project construction and planning with those ends in view shall be encouraged;
7) Due regard shall be given in the planning and development of water recreation facilities to safeguard against pollution.

Amended in 1981, Section 62.1-44.38 of the Code of Virginia required preparation and submission of a plan and programs for the management of the Commonwealth's water resources "to encourage, promote and secure the maximum beneficial use and control thereof." Plans were required for each major river basin of the Commonwealth, specifically naming the Potomac-Shenandoah, Rappahannock, York, James, Chowan, Roanoke, New, and the Tennessee-Big Sandy River Basins, and for those areas in the

[7] Code of Virginia §62.1-44.36

Tidewater and elsewhere in the Commonwealth not within these major river basins, and were to include the following information:

- An estimate of current water withdrawals and use for agriculture, industry, domestic use, and other significant categories of water users.
- A projection of water withdrawals and use by agriculture, industry, domestic water use, and other significant categories of water users.
- An estimate, for each major river and stream, of the minimum in-stream flows necessary to maintain water quality and avoid permanent damage to aquatic life in streams, bays, and estuaries during drought conditions.
- An evaluation, to the extent practicable, of the ability of existing subsurface and surface waters to meet current and future water uses, including minimum in-stream flows, during drought conditions.
- An evaluation, in cooperation with the Virginia Department of Health and local water supply managers, of the current and future capability of public water systems to provide adequate quantity and quality of water.
- An identification of water management problems and alternative water management plans to address such problems.
- An evaluation of the hydrologic, environmental, economic, social, legal, jurisdictional, and other aspects of each alternative management strategy identified.

Following the 1981 amendments to § 62.1-44.38, water supply planning efforts were undertaken as major river basin plans were developed between 1985 and 1988. For the first time, safe yield[8] and analysis of local demand were included in plans in addition to information on water availability and an inventory of local systems and use.

Establishment of a Comprehensive Water Supply Planning Process

Despite Virginia's early efforts to better manage water resources, during the drought of 1999-2002 some localities were unprepared for a dwindling water supply. The intensity of the drought impacts peaked in late August 2002. Wildfire indices were at levels previously unrecorded in Virginia, the vast majority of Virginia agricultural counties had applied for Federal drought disaster designation, streamflows reached a period of record lows, and thousands of individual private wells failed. Several public water supply systems across the Commonwealth were on the brink of failure and a number of large municipal systems had less than 60 days of water supply capacity remaining in reservoirs.

[8] See "Safe yield" in Glossary.

In response, the Virginia General Assembly amended the Code of Virginia[9] to require the establishment of a "comprehensive water supply planning process for the development of local, regional, and state water supply plans…designed to (i) ensure that adequate and safe drinking water is available to all citizens of the Commonwealth, (ii) encourage, promote, and protect all other beneficial uses of the Commonwealth's water resources, and (iii) encourage, promote, and develop incentives for alternative water sources, including, but not limited to desalination."

The distinction between this water supply planning effort and previous efforts is the establishment of a continuous, comprehensive, iterative, long range planning process. This planning process involved the development of local or regional plans by local governments; plans were to describe environmental resources, and existing and anticipated water sources, water use, and water demand. These plans, further described in the following sections, form the foundation of this State Plan. The data from the plans provides information necessary to determine the likely impacts on water resources if future demands are met. The planning process also provides information to be considered in the permitting process for future water supply withdrawals.

Local and Regional Water Supply Plans

At the heart of Virginia's comprehensive water supply planning process are the local and regional water supply plans, the content of which is defined by regulatory requirements. Virginia's water supply planning program is designed to be a statewide partnership, enabling local and regional partners, such as planning district commissions, water authorities, and other stakeholders, to take the lead in identifying their future water needs with the technical support and oversight of the State. The Local and Regional Water Supply Planning Regulation[10] (WSP Regulation) requires that all counties, cities, and towns in the Commonwealth of Virginia participate in the development of, and formally adopt, a local or regional water supply plan.

Virginia's Water Resources:

- are finite;
- have multiple uses, each protected by law; and
- are increasingly in demand.

Water Supply Plan Review Process

Ten "local" (individual locality) and 38 "regional" (two or more localities) water supply plans were developed and submitted to the Virginia Department of Environmental Quality (DEQ) by planning entities between 2008 and 2011. DEQ provided technical and financial assistance to facilitate development of the plans and aided localities and regions in acquiring information on existing resource conditions and existing water use and sources. DEQ also assisted with the

[9] Code of Virginia §62.1-44.38:1, 2003
[10] §9VAC 25-780, 2005

identification of methods for the projection of future water needs. As required by the WSP Regulation, all localities in the Commonwealth held public hearings during the development of the water supply plans and formally adopted the plans, and all plans were submitted to DEQ by the regulatory deadlines. DEQ carefully reviewed each plan for compliance with the WSP Regulation, coordinated with local governments to ensure that plans were as complete and accurate as possible, and entered submitted information into the content management system used for the cumulative impact analysis.

Development of the State Water Resources Plan

Information and data submitted in the local and regional water supply plans are included in this State Plan. In addition to the local data, the State Plan incorporates water withdrawal data submitted by water users[11] to DEQ. The State Plan includes a cumulative impact analysis based upon information contained in the local and regional water supply plans and other sources. This analysis is discussed in detail in Chapter 5 Assessing the Long Term Sustainability of Water Resources. In its entirety, this State Plan describes the major water supply issues facing state and local governments through 2040. DEQ anticipates updating the State Plan at five-year intervals, with each update reflecting the most recent local and regional water supply planning information.

The first document of its kind in Virginia, the State Plan is the primary mechanism available for achieving wise, long-term water use. Sustainability means maintaining the "beneficial uses" that are considered to be essential to the wellbeing of the Commonwealth's human and natural resources.

Pursuant to Virginia Code § 62.1-44.38, the purpose of the State Plan includes the following:

- Estimate current water withdrawals and use for agriculture, industry, domestic use, and other significant categories of water users;
- Project water withdrawals and use by agriculture, industry, domestic water use, and other significant categories of water users;
- Estimate, for each major river and stream, the minimum in-stream flows necessary during drought conditions to maintain water quality and avoid permanent damage to aquatic life in streams, bays, and estuaries;
- Evaluate, to the extent practicable, the ability of existing subsurface and surface waters to meet current and future water uses, including minimum in-stream flows, during drought conditions;
- Evaluate, in cooperation with the Virginia Department of Health and local water supply managers, the current and future capability of public water systems to provide adequate quantity and quality of water;

[11] §9VAC25-200

- Identify water management problems and alternative water management plans to address such problems; and
- Evaluate hydrologic, environmental, economic, social, legal, jurisdictional, and other aspects of each alternative management strategy identified.

Among other uses, the State Plan can be used to:

- Identify and prioritize water resource and water supply development projects.
- Provide information to public and private decision makers regarding water availability to help guide efficient investment and economic development.
- Identify opportunities for improving operation of existing water resources infrastructure.
- Guide the development and implementation of policies and programs to reduce the risk of water shortages from drought and conflicts between water users or uses.
- Guide policies on activities that directly and significantly affect the quantity and quality of water available with the objective of balancing and encouraging multiple uses of water resources.
- Educate the public about the sources and uses of water in the Commonwealth.

Interrelationship between Water Supply Planning and Water Use Permitting

Water supply plans are an important component of the evaluation process for both the Virginia Water Protection (VWP) and Groundwater Withdrawal (GW) permitting programs. Permitting staff in the DEQ VWP and GW permitting programs coordinate with water supply planning staff when evaluating permitting actions. Prior to the issuance of a VWP or GW permit, relevant information contained in water supply plans are given consideration for Virginia Water Protection Permitting[12] and for Groundwater Withdrawal Regulations[13].

Population, Economy, and Growth Depend upon Water

As Virginia's population and economy continue to grow, so does the need for good quality, reliable water supplies. The future of the economy depends upon having enough water for future needs.

Population

According to the most recent data from the U. S. Census Bureau, the population of the Commonwealth of Virginia is estimated to be 8,185,867, 2.6% of the total United States population. Virginia's population is estimated to have grown 2.5% since the 2010 Census estimate of 8,001,024 persons (Table 1-1).

[12] 9VAC25-210-80 B 2 g, and 9VAC25-210-115 B 2 and C 2
[13] 9VAC25-610-102

Approximately 86% of all Virginians live in 11 metropolitan areas: Washington-Arlington-Alexandria, Virginia Beach-Norfolk-Newport News, Richmond, Roanoke, Lynchburg, Charlottesville, Blacksburg, Bristol, Winchester, Harrisonburg, and Danville. Approximately 3% of the population lives in seven smaller urban areas (micropolitan areas) and 11% live in rural areas. The percentage of estimated population increase from 2010 to 2040 is 32%. As described later in this State Plan, this is consistent with the projected water use for the same time period.

Region	2010	2020	2030	2040
United States	308,745,538	335,605,444	360,978,449	382,152,235
Virginia	8,001,024	8,871,484	9,701,508	10,415,575

Table 1-1 Population Estimates for U.S. and Virginia: 2010–2040[14]

Economy and Growth

Water contributes to economic growth when used for hydroelectric power generation, navigation, and industrial, agricultural, and commercial purposes. Water also provides the streamflows, lakes, and reservoirs necessary to support fish and wildlife, boating, scenic attractions, and related recreation and tourism industries.

In seeking lasting solutions to the growing and competing demands for Virginia's water resources, the ultimate goal must be to create balance and sustainability. In this respect, a healthy natural environment as well as strong local economies will demonstrate the achievement of balance. Industries and communities must be sustainable and profitable in both the short and long term. Likewise, resource management programs must contribute positively to watershed health. Key to achieving these outcomes is finding practical, common sense ways to balance the economic and cultural needs of communities with the biological needs of natural resources.

[14] Figures updated August 2013 by Weldon Cooper Center for Public Service, Demographics & Workforce Group, www.coopercenter.org

Chapter 2 Virginia's Collaborative Water Management Framework

The Commonwealth of Virginia executes a variety of laws and regulations pertaining to water quality and supply. Meeting Virginia's environmental challenges is a cooperative effort that involves communities, businesses, educators, government agencies, and many more. This Chapter contains descriptions of programs implemented by state and federal agencies that impact some facet of water resources management and water supply planning. The DEQ programs do not address riparian rights, but seek to balance reasonable use by defined beneficial uses.

Natural Resources Policy

Article XI, Section 1[15]: Natural Resources and Historical Sites of the Commonwealth of the Virginia Constitution states the following:

> "To the end that the people have clean air, pure water, and the use and enjoyment for recreation of adequate public lands, waters, and other natural resources, it shall be the policy of the Commonwealth to conserve, develop, and utilize its natural resources, its public lands, and its historical sites and buildings.
>
> Further, it shall be the Commonwealth's policy to protect its atmosphere, lands, and waters from pollution, impairment, or destruction, for the benefit, enjoyment, and general welfare of the people of the Commonwealth."

State Water Resources Policy

On May 7, 1974 the State Water Control Board (SWCB) adopted a Water Resources Policy.[16] The creation of this policy supports the SWCB in fulfilling its statutory responsibilities under § 62.1-44.36 of the Code of Virginia. The policy begins with precepts or agreed upon statements which acknowledge the need to balance natural resource protection and economic growth. The document includes a number of policies that the SWCB observes when preparing Water Resource Management Plans, when advising on the adequacy and desirability of water resource projects, and in authorizing specific water resource projects or in commenting on projects which affect water resources. The policies are, generally, to:

- acknowledge and protect natural water sources,

[15] http://constitution.legis.virginia.gov/constitution.htm#11S1
[16] § 9VAC25-390 et seq

- understand and protect all beneficial uses and to ensure the public benefits from water resources projects,
- uphold long-term protection of the environment as a guiding criterion in decisions relating to water and related land resources,
- minimize pollution and the wasteful use of water,
- support water supply planning and encourage storage,
- promote awareness of flood plains and flood control,
- understand the financial factors associated with water resource projects, and
- preserve wetland ecosystems.

State Regulatory Controls Regarding Water Use

Water quantity and quality management occurs in a number of programs within DEQ. These programs are designed to improve and protect Virginia's streams, rivers, bays, wetlands, and groundwater for aquatic life, human health and other beneficial water uses. A brief description of each program follows.

Local and Regional Water Supply Planning

The WSP Regulation is discussed in Chapter 1 Virginia's Water Resources Planning Process. As mentioned, the WSP Regulation requires the DEQ to review the programs for compliance with the regulation. Local and regional water supply programs are also reviewed by the Virginia Department of Health (VDH), the Department of Conservation and Recreation (DCR), the Department of Historic Resources (DHR), the Virginia Marine Resources Commission (VMRC), and the Department of Game and Inland Fisheries (DGIF). The state agency review of the first water supply plans submittal was an integral part of the determination of compliance as noted in 9VAC25-780-140 and 150.

Virginia Water Withdrawal Reporting Regulation

The Virginia Water Withdrawal Reporting (VWWR) Regulation[17] requires reporting for any withdrawal whose daily average withdrawal exceeds 10,000 gallons per day, with the exception of crop irrigation. Reporting of crop irrigation applies to withdrawals exceeding one million gallons in any single month. Withdrawal reports for the previous calendar year are due on January 31. If a withdrawal meets the reporting threshold, reporting under the VWWR Regulation is required regardless of whether or not a withdrawal permit is held and regardless of whether or not the withdrawal is within a groundwater management area. Reporting is a statewide requirement.

[17] §9VAC25-200-10 et seq

The analysis of withdrawal information reported under this regulation contributes to a better understanding of pressure on the resource. Knowledge of how much water is withdrawn, for what purpose, and from what source (surface water, groundwater, or water transferred among users) allows the DEQ to consider these withdrawals in permitting decisions. Additionally, it provides the Commonwealth with a more accurate understanding of the full water budget in watersheds. Water withdrawal data is stored in the Virginia Water Use Database System (VWUDS). Data collected pursuant to the VWWR Regulation is summarized in the Annual Report on the Status of Virginia's Water Resources.[18]

In the VWUDS, withdrawal points are established by facility and by category of use. The categories of withdrawal are agriculture (including but not limited to livestock watering), commercial (includes golf course irrigation), power production (including nuclear, fossil, and hydro), irrigation (including but not limited to agricultural crop, sod, and nursery production), manufacturing, mining, public water supply, and other. Total monthly values and the maximum daily withdrawal for the year are reported. Monthly withdrawals are self-reported in hardcopy format or online. Approximately 80% of reporting is performed online.

Virginia Water Protection Permit Program

The DEQ's VWP Permit Program[19] regulates permanent and temporary impacts to surface waters to protect water quality and manages instream flows to balance on-stream and off-stream beneficial uses. Activities in surface waters that are regulated under the VWP Program include surface water withdrawals, non-agricultural impoundments, impacts to surface waters such as land clearing, dredging, filling, excavating, draining, flooding, or ditching in open water, streams, and wetlands. The VWP Program also serves as Virginia's Section 401 certification program for federal Section 404 permits issued under the authority of the Federal Clean Water Act[20] (CWA).

Surface waters are defined as all surface waters which are not groundwaters, which wholly or partially are within the Commonwealth or bordering the Commonwealth. Wetlands, stream channels, lakes, springs, and ponds are all surface waters and fall under the VWP Program's jurisdiction. A surface water withdrawal means a removal or diversion of surface water from a stream, spring, lake, or pond in Virginia or from the Potomac River. All surface water withdrawals, unless excluded,[21] require a VWP.

According to the 2014 Report on Virginia's Water Resources Management Activities, 82% of the total surface water withdrawn in 2013 was excluded from permitting, or 'grandfathered.' These grandfathered

[18] http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterSupplyPlanning/WRreportfinal2013.pdf
[19] Code of Virginia §62.1-44.15:20
[20] 33 U.S.C.§1251 et seq. (1972)
[21] §9 VAC 25-210-60.B

withdrawals are able to withdraw at an unspecified volume regardless of the flow in the stream, which could negatively affect other beneficial uses and cumulatively result in an unsustainable condition in the long term. DEQ has limited operational information on unpermitted withdrawals, information that would otherwise be obtained through the permitting process and used to assist in the management of the water resource and avoid impacts during low flow periods. Also, unpermitted withdrawals are not subject to periodic review as is the case for permitted withdrawals, which are associated with the 15-year permit term. The ability to regulate a larger percentage of unpermitted withdrawals could enable the Commonwealth to improve management of its water resources, especially in times of drought, to protect the beneficial uses of those resources, including downstream use. Unlike permitted withdrawals, excluded withdrawals are not subject to permit conditions that require conservation during times of low flow to reduce water use or place limits on the withdrawal that require a certain volume of water to flow by the intake or to be released from a reservoir. These conditions help to ensure the existing beneficial uses of the water resource, including those of the withdrawal, are sustained at all times and, particularly, during dry periods, as well as conserving the resource for the long term. This is further discussed in Chapter 5, Assessing the Long Term Sustainability of Water Resources, and Chapter 6, Water Supply Challenges and Recommendations.

Wetlands are transitional areas on the landscape between dry land and open water or streams, and often exhibit characteristics of both terrestrial and aquatic habitats. State Water Control Law[22] and VWP Program regulations[23] define “wetlands” as “those areas that are inundated or saturated by surface [water] or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.” The definition of “wetlands” in State law mirrors the definition in the CWA.

The VWP Regulation requires the evaluation of cumulative impacts of the withdrawal on beneficial uses during the review of permit applications for surface water withdrawals. DEQ developed and maintains an operational hydrologic model covering all streams and impoundments in the Commonwealth for the purpose of performing cumulative impact analyses. Each new or renewing VWP for a surface water withdrawal is analyzed with the modeling system for its potential to impact downstream beneficial uses and for its susceptibility to impacts from other water users located upstream. DEQ uses the output of these models to arrive at a set of operational rules that minimize impacts on all beneficial uses. The review of applications is closely coordinated with the U.S. Army Corps of Engineers (USACE), VMRC, VDH, DGIF, and DCR.

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[22] Code of Virginia §62.1-44.3
[23] §9VAC25-210-10

Surface Water Management Area Act

In 1989, the General Assembly enacted the Surface Water Management Area (SWMA) Act[24] for the purpose of protecting in-stream uses from excessive surface water withdrawals and to enable water users to develop plans for allocation of available surface water resources during low flow conditions. The legislation authorizes the SWCB to establish surface water management areas when there is evidence that 1) A stream has substantial instream values as indicated by evidence of fishery, recreation, habitat, cultural or aesthetic properties; 2) Historic records or current conditions indicate that a low flow condition could occur which would threaten important instream uses; and 3) Current or potential offstream uses contribute to or are likely to exacerbate natural low flow conditions to the detriment of instream values. The legislation also encourages the SWCB to promote voluntary agreements among surface water users within the same designated SWMA. The SWCB would, after sufficient public notice, approve and be a party to any such voluntary agreement, and the agreement would act in lieu of a permit issued by the SWCB to withdraw surface water. To date, no surface water management areas have been designated by the SWCB within the Commonwealth.

Ground Water Management Act

The Virginia General Assembly determined that the continued and unrestricted usage of groundwater is contributing and will continue to contribute to the degradation of groundwater quality and shortage of groundwater, thereby jeopardizing the public's welfare, safety and health. The Ground Water Management Act[25] of 1992 was adopted in order to conserve, protect, and beneficially utilize the groundwater of the Commonwealth and to ensure the public's welfare, safety, and health.

Groundwater is regulated under the Ground Water Management Act of 1992[26]. The Groundwater Withdrawal Regulations (GW Regulations)[27] regulates groundwater withdrawals in areas designated as Groundwater Management Areas (GWMA), which is defined by the regulation as "a geographically defined groundwater area in which the [State Water Control Board] has deemed the levels, supply or quality of groundwater to be adverse to public welfare, health and safety." Currently, there are two GWMA's in the Commonwealth (see Figure 2.1 below). On January 1, 2014 the Eastern Virginia Groundwater Management Area was expanded to include all areas east of Interstate 95. The Eastern Shore Groundwater Management Area covers Accomack and Northampton Counties. Permitting activities are processed in accordance with the GW Regulations. Any person or entity located within a declared GWMA must obtain a permit to withdraw 300,000 gallons or more in any one month for an

[24]Code of Virginia, Title 62.1, Chapter 24
[25] Code of Virginia, Title 62.1, Chapter 25
[26]Code of Virginia, Title 62.1, Chapter 25
[27] § 9VAC25-610-10 et seq.

individual well or well system. Localities that are part of the newly expanded GWMA will need to reference this change in their ten year water supply plan re-submittals.

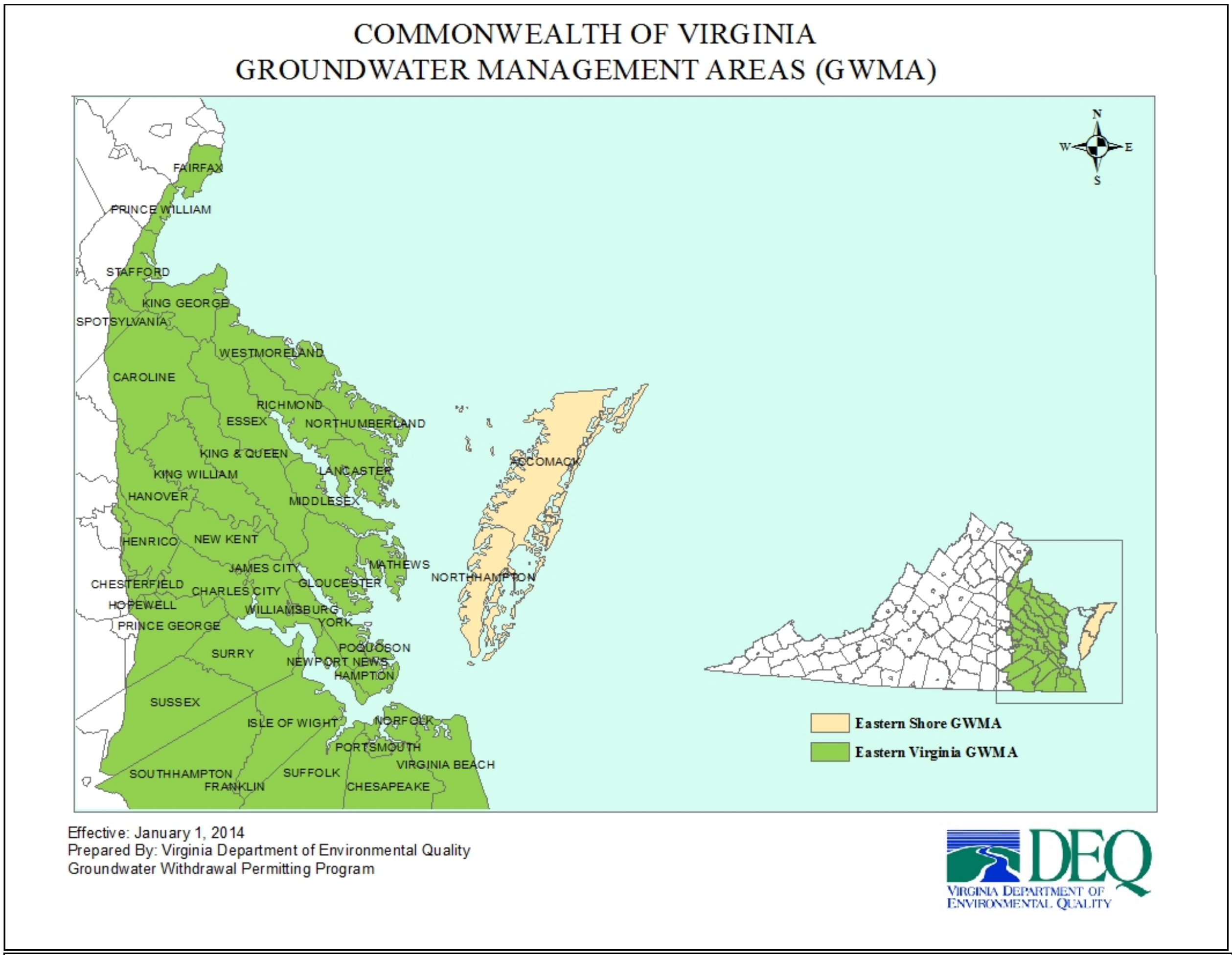

Figure 2-1 Virginia Groundwater Management Areas

Water Reclamation and Reuse Regulation

The reclamation of either municipal or industrial wastewater and reuse of the reclaimed water is regulated in accordance with the Water Reclamation and Reuse Regulation.[28] Facilities that typically require a permit for water reclamation and reuse include reclamation systems, satellite reclamation systems, and reclaimed water distributions systems. End users of the reclaimed water are rarely required to obtain a permit.

A reclamation system associated with wastewater treatment works that has or will have a surface water discharge is covered under the Virginia Pollutant Discharge Elimination System[29] (VPDES) individual

[28] § 9VAC25-740
[29] http://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination.aspx

permit issued to the wastewater treatment works. A reclamation system associated with wastewater treatment works that does not or will not have a surface water discharge is covered under the Virginia Pollution Abatement[30] (VPA) individual permit of the wastewater treatment works. Water reclamation systems independent of treatment works and reclaimed water distribution systems require a VPA individual permit.

Water reclamation and reuse can have a positive effect on water supply by reducing the amount of water needed to meet demand, as the reclaimed water is used to supplant other sources. On the other hand, water reuse can impact downstream users who previously benefited from the discharge of treated wastewater, as such discharges supplement surface water flow. When wastewater is reused, it is taken out of the water system and may affect beneficial uses downstream.

Virginia Drought Monitoring Task Force

The Virginia Drought Monitoring Task Force (DMTF) is an interagency group of technical representatives from state and federal agencies responsible for monitoring natural resource conditions and the effects of drought on various segments of society. The DMTF, which is coordinated by the DEQ, meets on a regular basis to assess hydrologic conditions and make recommendations to the Virginia Drought Coordinator regarding drought status as directed by the Virginia Drought Assessment and Response Plan.[31] State agencies with active representation on the DMTF include the DGIF, the Virginia Department of Agriculture and Consumer Services (VDACS), the Virginia Department of Emergency Management (VDEM), the Virginia Department of Forestry (VDOF), and VDH. Federal agencies include the National Weather Service (NWS), the USACE, the U. S. Department of Agriculture (USDA) and the U. S. Geological Survey (USGS). The DMTF periodically releases Drought Status Reports summarizing drought conditions in the Commonwealth. These Reports are posted to the DEQ's website.[32]

Drought monitoring is an important component of water resources management. Careful observation and analysis of groundwater levels and surface water flow is paramount to thoughtful and fair resource decisions. Planning for conservation during water shortages allows all users to share the responsibility.

Virginia River Commissions

Virginia River Commissions are established in federal and state codes to provide guidance and make recommendations to local, state, and federal legislative and administrative bodies regarding the use, stewardship, and enhancement of a river basin's water and other natural resources. The commissions promote communication, coordination, and education and may undertake studies and prepare, publish,

[30] http://www.deq.virginia.gov/Programs/Water/LandApplicationBeneficialReuse.aspx
[31] http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterResources/vadroughtresponseplan.pdf
[32] http://www.deq.virginia.gov/Programs/WaterSupply/WaterQuantity/Drought.aspx

and disseminate reports related to water quantity, quality, and other natural resources of their basins. Virginia has five river basin commissions with legislative representation. They are the Interstate Commission on the Potomac River Basin (ICPRB), the Ohio River Valley Water Sanitation Commission (ORSANCO), the Rappahannock River Basin Commission (Rappahannock RBC), The Rivanna River Basin Commission (Rivanna RBC), and the Roanoke River Basin Bi-State Commission (RRBBC). These are further discussed below.

- ICPRB: The ICPRB[33] was created by an interstate compact to enhance, protect, and conserve the water and associated land resources of the Potomac River Basin through regional and interstate cooperation. The ICPRB is represented by appointed Commissioners from the States of Maryland, Pennsylvania, Virginia, West Virginia, the District of Columbia, and the federal government.
- ORSANCO: The Ohio River Valley Water Sanitation Commission (ORSANCO[34]) was established on June 30, 1948 to control and abate pollution in the Ohio River Basin. ORSANCO is an interstate commission representing eight states and the federal government. Member states include: Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia. ORSANCO operates programs to improve water quality in the Ohio River and its tributaries, including: setting waste water discharge standards; performing biological assessments; monitoring for the chemical and physical properties of the waterways; and conducting special surveys and studies. ORSANCO also coordinates emergency response activities for spills or accidental discharges to the river, and promotes public participation in programs, such as the Ohio River Sweep and the RiverWatchers Volunteer Monitoring Program.[35]
- Rappahannock RBC: The Rappahannock RBC[36] was established to provide guidance for the stewardship and enhancement of water quality and natural resources in the Rappahannock River Basin. The RRBC is a forum for governments and citizens to discuss issues affecting the Basin's water quality and quantity, as well as other natural resources.
- Rivanna RBC: The Rapidan RBC was established to provide guidance for the stewardship and enhancement of the water and natural resources of the Rivanna River Basin. The Commission is a forum in which local governments and citizens can discuss issues affecting the Basin's water quality and quantity and other natural resources.[37]

[33] Code of Virginia §62.1-65
[34] Code of Virginia § 62.1-79.1
[35] http://www.orsanco.org/
[36] Code of Virginia §62.1-69.27
[37] Code of Virginia § 62.1-69.46

- RRBBC: The RRBBC[38] is composed of members from the Commonwealth of Virginia and the State of North Carolina. The purpose of the RRBBC is to, among other things, provide guidance and make recommendations to local, state, and federal legislative and administrative bodies, and to others as it deems necessary and appropriate, regarding the use, stewardship, and enhancement of the Basin's water and other natural resources. The Virginia Roanoke River Basin Advisory Committee (VRRBAC) was established in the executive branch of state government as an advisory committee to Virginia's RRBBC delegation.

Water Protection Source

The VDH authority and role in water supply is to ensure that all people in Virginia have access to an adequate supply of affordable, safe drinking water that meets federal and state drinking water standards. The VDH enforces drinking water regulations and standards of the Virginia Public Water Supply Law[39] and the federal Safe Drinking Water Act[40] (SDWA). The VDH also monitors drinking water quality, supports voluntary source water protection efforts, provides technical assistance and training with respect to all drinking water issues, and provides financial assistance to improve drinking water systems.

The 1986 Amendments to the SDWA established a federal Wellhead Protection Program to protect groundwater that supplies wells and wellfields contributing to public water supply systems. The legislation called on states to develop programs that would protect groundwater-based public water supplies from contaminants that may adversely affect human health. Ten years later, the SDWA Amendments of 1996[41] established a Drinking Water State Revolving Fund (DWSRF) Program and expanded the protection concept to include surface waters.

As a part of the DWSRF Program, funds have been set aside to enhance the ability of waterworks owners to ensure long-term capacity to produce safe drinking water and to protect source waters, including groundwater that supplies wells, wellfields, and surface-based systems. Protecting source water can benefit the environment, waterworks owners, and the public. The environment benefits from a reduced risk of contamination and impacts to ecosystems, the owner benefits from lower and/or sustainable operational costs in treating the water, and the public benefits from safer drinking water and a cleaner environment.

The 1996 Amendments to the SDWA also require states to develop a source water assessment program (SWAP) and complete assessments and susceptibility evaluations on all public water supply systems in

[38] Code of Virginia §62.1-69.37
[39] Title 32.1-167 through Title 32.1-176
[40] Title XIV of the Public Health Service Act, Safety of Public Water Systems (Safe Drinking Water Act)
[41] P.L.104-182

the Commonwealth. This effort was undertaken and completed in 2003. The VDH continues to perform new wellhead site approvals and routine sanitary surveys of existing wellheads.

The goal of the SWAP is to establish procedures and provide a foundation of support for protecting the Commonwealth's drinking water resources from degradation. This degradation can be the result of residential, industrial, commercial, agricultural, waste management, or transportation: accidental introduction of contaminants; improper land use practices; illegal material handling practices; and other conditions. The SWAP methodology includes delineating assessment boundaries of a drinking water source, performing an inventory of land use activities, and determining a relative susceptibility of the drinking water source to these activities. Many source waters in Virginia that were designated as highly susceptible have had source water protection plans (SWPP) developed. SWPPs are voluntary in the Commonwealth of Virginia. The VDH and the DEQ encourage and provide support, both financial and technical, to SWPP development efforts.

Chesapeake Bay Preservation Act

The Chesapeake Bay Preservation Act[42] (Bay Act) was enacted by the Virginia General Assembly in 1988 as a critical element of Virginia's non-point source management program. The Bay Act is designed to improve water quality in the Chesapeake Bay and other waters of the State by requiring the use of effective land management and land use planning, key elements to sustainable water resources. At the heart of the Bay Act is the concept that land can be used and developed to minimize negative impacts on water quality.

Virginia designed the Bay Act and the Chesapeake Bay Preservation Area Designation and Management Regulations (Bay Regulations) to enhance water quality and still allow reasonable development to continue. The Bay Act and Bay Regulations recognize local government responsibility for land use decisions and are designed to establish a framework for compliance without dictating local program development. Local governments have flexibility to develop water quality preservation programs that reflect unique local characteristics and embody other community goals. Such flexibility also facilitates innovative and creative approaches in achieving program objectives. The regulations address nonpoint source pollution by identifying and protecting certain lands called Chesapeake Bay Preservation Areas.

Each Tidewater locality must adopt a program based on the Bay Act and Bay Regulations. The Bay Regulations use a resource-based approach that recognizes differences between various land forms and treats them differently. The DEQ staff provides technical and financial assistance to the Tidewater local governments to ensure comprehensive plans, zoning ordinances, and subdivision ordinances are in

[42] Code of Virginia §62.1-44.15:74

compliance with the Bay Regulations. This ensures consistent land use decisions are implemented, thereby protecting water quality. The program is implemented by the DEQ's Office of Stormwater Management.

Impaired Streams

Virginia's goal is that all streams attain and maintain the quality necessary to support applicable designated uses to be made of the water. The DEQ's water quality assessment program staff and partners monitor Virginia's rivers, lakes, and tidal waters annually for over 130 pollutants to determine whether the Commonwealth's waters can support their applicable designated uses – basically swimming, fishing, and drinking – that have been identified for a particular water body. There are six designated uses applicable to water quality in surface water bodies:

- aquatic life – supports the propagation, growth, and protection of a balanced indigenous population of aquatic life which may be expected to inhabit a waterbody
- fish consumption – supports game and marketable fish species that are safe for human health
- shellfishing – supports the propagation and marketability of shellfish (clams, oysters, mussels)
- recreation – supports swimming, boating, and other recreational activities
- public water supply – supports safe drinking water
- wildlife – supports the propagation, growth, and protection of associated wildlife

Based upon the quality of water needed to support each of these uses, Virginia's water quality standards establish numeric criteria against which physical and chemical data are assessed. Virginia's surface waters are monitored annually to determine if they meet water quality standards. If a waterbody contains more contamination than allowed by water quality standards, it will not support one or more of the designated beneficial uses. Such waters are considered to have "impaired" quality or having an individual parameter or characteristic that violates a water quality standard. A surface water body fails to support a designated use when it has one or more impairments. In most cases, a cleanup plan based upon the "total maximum daily load" (TMDL), a term that represents the total pollutant a water body can assimilate and still meet water quality standards, must be developed and implemented to restore impaired waters.

Since 1992 and every even year since, DEQ has developed a list of waters that do not meet water quality standards. This list of impaired waters is reported to the citizens of Virginia and the U.S. Environmental Protection Agency (USEPA) as the Virginia Water Quality Assessment 305(b)/303(d) Integrated Report (Integrated Report). The Integrated Report, developed by DEQ's Office of Water Quality Monitoring and Assessment, describes segments of streams, lakes, and estuaries that violate water quality standards, details the pollutant responsible for the violations, and identifies the suspected cause and source of the pollutant. DEQ has developed TMDL implementation plans, with public input, since 1998 to restore and maintain the water quality for the impaired waters. The location of impaired waters and the types of impairment were provided as required in local and regional water supply plans. Improved water quality is critical to water supply management. Water quality often decreases as water quantity decreases, adversely affecting in-stream beneficial uses.

Virginia Pollution Discharge Elimination System Program

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) program to limit pollutant discharges into streams, rivers, and bays. The program is administered in Virginia as the VPDES Program. DEQ issues VPDES permits for all point source discharges to surface waters and to dischargers of stormwater from industrial activities, construction activities, and municipal separate storm sewer systems (MS4s). Requirements for VPDES permits authorizing discharges of stormwater from construction activities and MS4s are established in the Virginia Storm Water Management Program[43] (VSMP). DEQ issues individual permits to both municipal and industrial facilities. Permit requirements, special conditions, effluent limitations, and monitoring requirements are determined for each facility on a site-specific basis to meet applicable water quality standards.

DEQ issues general permits for a general class of dischargers. In Virginia, general permits must be written as permits and adopted as regulations. Classes of dischargers covered under general permits include but are not limited to:

- Domestic Sewage Discharges of Less Than or Equal to 1,000 Gallons Per Day (9VAC25-110)
- Seafood Processing Facilities (9VAC25-115)
- Petroleum Contaminated Sites and Hydrostatic Tests (9VAC25-120)
- Discharges of Storm Water Associated with Industrial Activity (9VAC25-151)
- Non-Metallic Mineral Mining (9VAC25-190)
- Concentrated Animal Feeding Operations (9VAC25-191)
- Concrete Products Facilities (9VAC25-193)
- Vehicle Wash and Laundry Facilities (9VAC25-194)
- Non-Contact Cooling Water Discharges (9VAC25-196)
- Pesticides Discharges (9VAC25-800)
- Potable Water Treatment Plants (9VAC25-860)
- Watershed Permit for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed (9VAC25-820)
- Stormwater Discharges from Construction Activities (9VAC25-80

[43] Code of Virginia §62.1-44.15:24

- Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (9VAC25-890).

The Storm Water Management Act and VSMP permit regulations provide DEQ the ability to manage the quantity and quality of stormwater runoff on construction sites as well as on a regional or watershed basis when the stormwater runoff is not confined to a single source, such as a wastewater treatment plant or industrial discharge pipe. During construction, a permit may also be required for erosion and sediment control. These permits are issued by localities as part of their erosion and sediment control programs. DEQ also conducts reviews of local erosion and sediment control programs.

There are 975 active VPDES Individual Permits.

Virginia Pollution Abatement Program

The treatment of sewage sludge, storage and land application of biosolids, industrial wastes (sludge and *w*astewater), municipal wastewater, and animal wastes (manure/litter from livestock and poultry) are regulated activities under the Virginia Pollution Abatement (VPA) Program[44]. Oversight of these potential contaminant sources protects water quality for all beneficial uses. DEQ may issue a VPA permit whenever waste or wastewater are managed in a manner that does not involve discharging to a sewage treatment work or to state waters pursuant to a valid VPDES permit. In general, land application of biosolids, industrial sludge, or spray irrigation of industrial and municipal wastewater is covered by a VPA individual permit. Animal Feeding Operations (AFO) are covered by a VPA individual or general permit. Livestock operations that confine more than 300 animal units and utilize liquid waste storage are typically covered by a general VPA permit[45]. Confined poultry feeding operations are typically covered by the VPA general permit for poultry waste management[46]. VPDES individual permits may be required for some Concentrated Animal Feeding Operations (CAFOs) in accordance with the VPDES Permit Regulation[47]. DEQ does not utilize a general permit for CAFOs that require a VPDES permit.

There are 147 active VPA Individual Permits. There are 140 active CAFO General Permits and 876 Poultry General Permits issued under the VPA.

[44]§9VAC25-32
[45]§9VAC25-192
[46]§9VAC25-630
[47]§9VAC25-31

Federal Regulatory Controls Regarding Water Use

U.S. Environmental Protection Agency

The DEQ has been granted primacy for authority of a number of water protection programs administered by the USEPA under the CWA and the Resource Conservation and Recovery Act[48]. Funding allocated to the states through these Acts enables states to implement programs that ensure safe and reliable sources of water for all beneficial uses.

In addition, the USEPA provides an oversight role as a commenting agency on applications requesting authorization to impact "waters of the United States, including wetlands," (WOUS). Section 404 of the CWA, which establishes a permitting program to regulate the discharge of dredge and fill material into waters of the United States, is delegated by USEPA to the USACE. USACE administers the day-to-day program, including individual permit decisions and jurisdictional determinations; develops policy and guidance; and enforces Section 404 provisions. EPA develops and interprets environmental criteria used in evaluating permit applications, identifies activities that are exempt from permitting, reviews/comments on individual permit applications, enforces Section 404 provisions, and has authority to veto USACE permit decisions.[49]

U.S. Army Corps of Engineers

Section 404 of the CWA is administered by the USACE with oversight from the USEPA. Section 404 requires that anyone interested in depositing dredged or fill material into WOUS must receive authorization for such activities. Areas that are regulated by the USACE include, but are not limited to, tidal marshes, seasonally saturated forested and non-forested wetlands, swamps, rivers, bays, and streams. Activities in WOUS for which permits may be required include, but are not limited to, fill, ditching activities when excavated material is sidecast, mechanized clearing, and land leveling. The USACE has authority to regulate and issue permits under Section 404 of the CWA and also under Section 10 of the Rivers and Harbors Act of 1899[50] for activities proposed in navigable waters.

The USACE also manages three multi-purpose reservoir projects located within the Commonwealth that serve the following uses: flood risk management, hydropower generation, water supply, water quality management, and recreation. These projects are the Gathright Dam/Lake Moomaw Reservoir in the Upper James River Basin and two projects within the Roanoke River Basin: the J. H. Kerr Dam and Reservoir on the lower Roanoke River and the Philpott Dam and Reservoir on the Smith River. The USACE also manages two dam and reservoir projects within the Upper Potomac River Basin (Jennings-

[48] Subtitle C of RCRA (40 CFR Parts 260-299)
[49] http://water.epa.gov/type/oceb/habitat/cwa404.cfm
[50] 33 U.S.C. 403; Chapter 425, March 3, 1899; 30 Stat. 1151

Randolph and Savage River), which act as water-supply storage reservoirs for the Washington DC metropolitan region. USACE operated hydropower projects do not require Federal Energy Regulatory Commission (FERC) licensing. The DEQ involvement in USACE projects includes participation in regular and periodic water management stakeholder meetings, participation in studies authorized by Section 216 of the River and Harbor and Flood Control Act of 1970[51], and representation on the Potomac River Basin Drinking Water Source Protection Partnership.

U.S. Geological Survey

In general, the USGS supports the nation in its management of water resources by providing scientific studies, publications, data, maps, and application software. In Virginia, DEQ enjoys an active collaborative relationship with the USGS Virginia Water Science Center. Staff members from both agencies work in tandem to investigate, collect samples, and analyze the waters of the Commonwealth. These efforts include monitoring of precipitation, stream discharge, groundwater levels, and quality of surface water and groundwater under contract to DEQ. Currently, the DEQ and USGS cooperatively operate a stream gage monitoring network for Virginia that consists of 195 stations at which streamflow and/or water quality are monitored on a real-time basis. The DEQ and USGS also cooperatively operate a groundwater monitoring network for Virginia that includes 131 real-time sites. Both networks also include dozens of additional stations at which discharge, water level, and/or water quality data are collected periodically. These stations also provide important ancillary data, including stream channel surveys, geologic logs, and hydrogeologic tests.

The data from these networks have formed the foundation for a large number of studies focused on estimating the availability of water for beneficial uses within the Commonwealth and gauging the impacts of water withdrawals upon streams, reservoirs, and aquifers. A number of these projects involved the development of statistical and numerical models that are used to better understand the relationships between local and regional hydrology, geology, and water use. Examples of these projects include a state-wide statistical analysis of the low-flow characteristics of Virginia streams, development of an updated hydrogeologic framework, and regional-scale numerical groundwater models of the Virginia Coastal Plain aquifer system and the Eastern Shore aquifer system to assist in evaluating groundwater availability, and the development of a groundwater flow model of the fractured rock aquifer system in the northern Shenandoah Valley that provided valuable information regarding the connection between the aquifer system and the Potomac River. The latter project, which was the first attempt to model a complex, fractured rock aquifer system in Virginia, was a cooperative effort initiated by local governments in the region. Other examples of applied collaborative research studies supported by the Commonwealth and local stakeholders include an evaluation of nutrient loading to the Chesapeake Bay and mercury

[51] Pub. L. 91-611, 84 Stat. 1818

loading to the South River and South Fork of the Shenandoah River. Data from ongoing monitoring are maintained by the USGS and available from the USGS website at http://waterdata.usgs.gov/va/nwis/nwis.

Federal Energy Regulatory Commission

The FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines, as well as licensing hydropower projects. FERC's hydropower licensing process includes provisions for stakeholder comments from state agencies, including DEQ as the agency providing Section 401 certification for federal Section 404 permits issued under the authority of the CWA. The VWPP Program serves as Virginia's Section 401 Certification program for federal Section 404 permits. Since the commencement of the VWPP Program, the DEQ and FERC have collaborated during the licensing process so that the conditions assigned to certifications have been incorporated into the corresponding FERC license articles whenever a hydropower license has been issued or reissued. Currently, there are 22 active FERC licenses for hydropower projects in Virginia. Ten of these projects have Section 401 certifications; the remaining projects predated Virginia's permitting requirements.

U.S. Fish and Wildlife Service

The USFWS is engaged in water-resource planning, management, and research that conserves, protects, and enhances the nation's fish, wildlife, and plants. The USFWS participates in the Section 404 of the CWA permitting process administered by the USACE by commenting on applications requesting authorization to impact WOUS.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) includes the National Weather Service (NWS), which collects, analyzes, and provides weather and climatological data, evaluations, and forecasts for use by state agencies and citizens of the Commonwealth. Using a combination of automated observation stations, a cooperative observer network and Doppler Weather Radar stations, the NWS collects and provides nearly continuous meteorological data. Weather data are made available via numerous services, including two Weather Forecast Offices (WFO) located within Virginia (Blacksburg and Wakefield), the Advanced Hydrologic Prediction Service, and the Middle Atlantic River Forecast Center. These sources provide critical information about current and recent weather conditions and provide flood forecasting. Longer-term climatic data and forecasts are made available by the NWS Climate Prediction Center and NOAA's National Climatic Data Center. In addition, the WFOs collect and disseminate precipitation, river, and rainfall data, and prepare local climatological data. This information is critical to understanding local and regional water supply issues and particularly important for anticipating and responding to drought declarations.

Chapter 3 Virginia's Environmental Resources

Virginia is a state defined by its natural resources. Unlike many western states that have boundaries based on latitude and longitude, most of the states founded initially by English colonists have boundaries defined by natural features. Most of Virginia's state and county boundaries are defined by a combination of natural features, especially rivers and divides, and straight survey lines. Even when straight survey lines were used to define Virginia's boundaries, natural features were used as a point of origin. Virginia's boundaries are marked by the Atlantic Ocean to the east; a non-natural, almost straight line based upon latitude to the south; the Potomac River (generally) to the north; and mountains that divide watersheds to the west.

This Chapter provides an overview of the Commonwealth's climatic characteristics and the relationship between climate and vital surface water and groundwater resources. Hydrology and water budgets are discussed along with a description of existing geologic conditions and their potential effects on the quality and quantity of groundwater.

Climate

Virginia's temperate climate is actually quite diverse. According to the Virginia State Climatology Office, the State has five different climate regions: Tidewater, Piedmont, Northern Virginia, Western Mountain, and Southwestern Mountain (see Table 3-1). Virginia's latitude, topography, prevailing westerly winds, and the influence of the Atlantic Ocean determine the climate. Average temperatures in the State generally decrease from southeast to northwest, with two particularly distinct areas. The Coastal Plain physiographic province, moderated by the Atlantic Ocean, has fewer hot and cold days, less snowfall, and a longer growing season than is typical for the rest of the Commonwealth. Because of its elevation, the Appalachian Plateau physiographic province has fewer hot days, more cold days, and more snowfall than the rest of the Commonwealth.

Most of Virginia is considered to have a "humid, sub-tropical" climate east of the Blue Ridge. West of the Blue Ridge in the southern part of the Shenandoah Valley and the Roanoke Valley, the climate is classified as "humid continental" and "maritime temperate" with lower humidity and cooler temperatures by an average of 5 to 10 degrees in all four seasons.

Climate Region	Average Temperature January (°F)	Average Temperature July (°F)
Tidewater (includes Tidewater & Hampton Roads, southern Chesapeake Bay and Eastern Shore)	35-48	71-85
Piedmont (includes Central Virginia)	27-47	68-88
Northern Virginia (includes Northern VA and northern Chesapeake Bay area)	19-42	61-86
Western Mountain (includes Shenandoah Valley)	27-45	65-87
Southwestern Mountain (includes southwest Blue Ridge Highlands and the Heart of Appalachia)	22-44	60-85

Table 3-1: Average Precipitation for the five climate regions within Virginia[52]

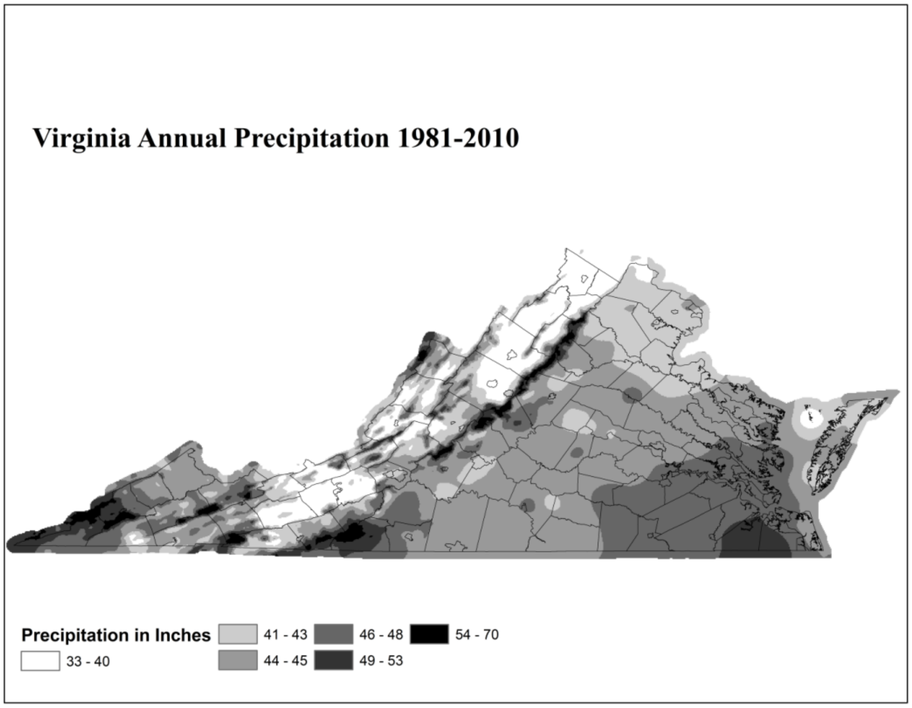

Figure 3-1 Average Annual Precipitation across Virginia

In addition to being temperate, Virginia is also a well-watered State, with frequent rainfall that is not normally severe enough to cause flooding. Between 1981 and 2010, the annual average for total precipitation in Richmond was 43.6 inches, and 46.5 inches in Virginia Beach[53]. Average annual precipitation varies across climate regions from approximately 38 inches in Northern Virginia to approximately 47 inches in the Southwestern Mountain region (see Figure 3-1). Despite typically generous rainfall, Virginia has experienced severe droughts in the past: significant multi-year drought events occurred in 1930-1932, 1962-1971, 1985-1988, and 1999-2002.

52 Southeast Regional Climate Center: http://www.sercc.com/
53 National Climatic Data Center, *NOAA's 1981-2010 Climate Normals*

Influences of Landscape, Rivers, and Streams on Climate

The landforms in these climate regions contribute to local climate in three ways. First is proximity to the coast and the warm waters of the Gulf Stream. As moisture-laden air crosses the coast of Virginia, storms grow in size and intensity, impacting the eastern slopes and foothills of the Blue Ridge Mountains. The great coastal storms of 1962, remembered primarily because of the high surf and storm surges along Virginia's coast, also produced record snowfalls along the northern section of the Blue Ridge Mountains.

The character of Virginia's streams is a direct reflection of the geologic and physiographic provinces over which they flow.

Secondly, the relatively high relief of the Appalachian and Blue Ridge mountain systems influence Virginia's climate by causing a rain shadow effect through which storms drop abundant precipitation on the windward side of the mountains and little precipitation on the leeward side. Along the southwest to northeast trending mountain chains of western Virginia, storm directions are sometimes from the west and sometimes from the east. When the flow is from the west, the New River and Shenandoah River Valleys are in the rain shadow of the Appalachian Mountains; when the airflow is from the east, they are in the shadow of the Blue Ridge Mountains. As a result, portions of the New River and Shenandoah River Valleys are among the driest portions of the Commonwealth.

Virginia's complex pattern of rivers and streams that drain precipitation and modify the pattern of moist airflow is the third important contribution to climate. Virginia's river systems drain the Commonwealth's terrain in all four geographical directions. In far southwestern Virginia, the Clinch and Holston Rivers drain south into North Carolina and Tennessee. The New River flows northwestward into the Ohio River, while the Shenandoah River drains northward into the Potomac River. Finally, the Chowan, James, Rappahannock, Roanoke, and York Rivers drain eastward through the Piedmont and into the Coastal Plain. The air moving across Virginia flows either up these river valleys or over the crests of the mountains and down into the valleys, and weather patterns change depending upon which way the river flows. As an example, a flow of moist air from the south would move up the Holston River Basin, increasing rainfall up river at higher elevations. However, this same southerly airflow would be downhill into the New River drainage, and on toward the Ohio River Basin, a phenomenon that is not conducive to rainfall.

Hydrology of Virginia

Hydrology is the study of the waters of the earth on and below the surface of the planet. Hydrology also involves the study of the various properties of water and its relationship with the living and nonliving environment. Over most of Virginia, abundant precipitation causes a significant amount of runoff to streams, lakes, and rivers. Consequently, the hydrologic system is dominated by surface water features.

Virginia has over 50,000 miles of streams and rivers which are part of nine major river basins: Albemarle-Chowan, Chesapeake Bay-Small Coastal, James, New, Potomac-Shenandoah, Rappahannock, Roanoke, Tennessee-Big Sandy, and York. A summary description of each of these major river basins is included in Appendix B, Major Basin Summaries.

The character of Virginia's streams is a direct reflection of the geologic and physiographic province over which they flow. Valley and Ridge streams flow briskly down linear valleys between parallel ridges. Northern Blue Ridge streams fall rapidly from ridge crests to the low country on either side of the range. Only the James, Potomac, and Roanoke Rivers breach the Blue Ridge. Streams meander across the Piedmont with low to moderate gradients, but drop swiftly to the Coastal Plain in the Fall Zone. Coastal Plain streams have low gradients and become wide estuaries as they approach the Chesapeake Bay.

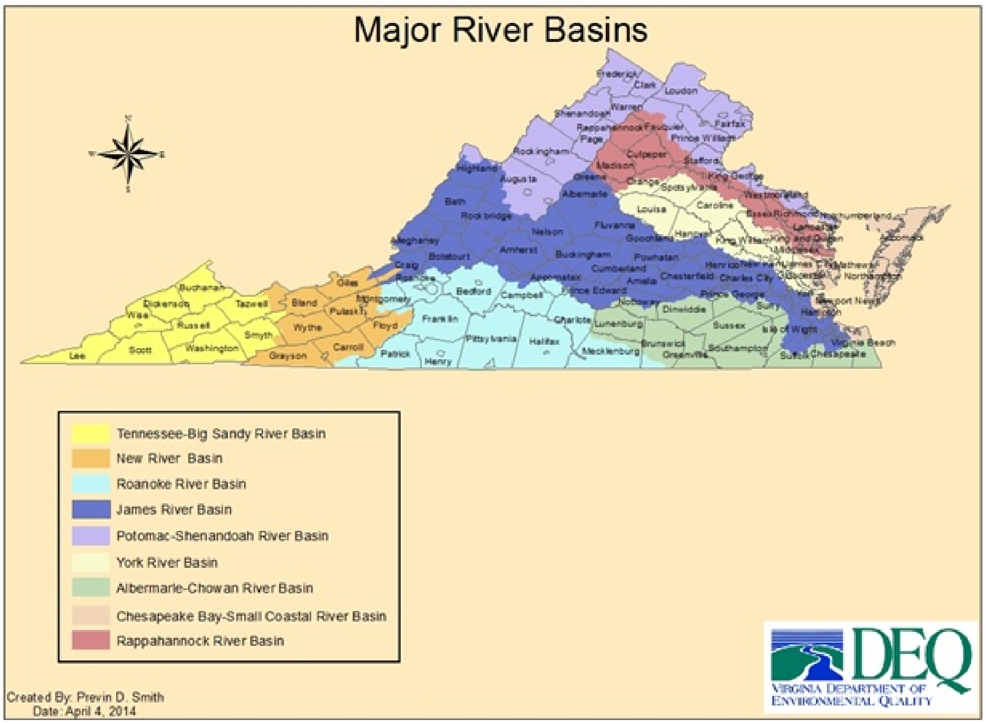

Figure 3-2: Virginia's Major River Basins

Virginia also contains a significant number of reservoirs formed by constructing dams across streams and rivers. The 248 publicly-owned lakes in the Commonwealth have a combined area of 130,344 acres. Three large impoundments (Lakes Gaston, Kerr, and Smith Mountain) account for two-thirds of this total. Many thousands of other smaller, publically and privately-held lakes, reservoirs, and ponds, some of significant size, dot the landscape. There are only two natural lakes in Virginia: Lake Drummond in Great Dismal Swamp and Mountain Lake in southwestern Virginia. Other significant water features of Virginia include approximately 236,900 acres of tidal and coastal wetlands, 808,000 acres of freshwater wetlands, 120 miles of Atlantic Ocean coastline, and over 2,300 square miles of estuaries. Virginia's highly indented shoreline, including the Chesapeake Bay and its sub-estuaries, is conservatively estimated to be 3,315 miles long. The total combined flow of all freshwater streams in the State is estimated at about 25 billion gallons per day. Maps of major rivers, streams, reservoirs, and lakes can be found in Appendix B, Major Basin Summaries.

Hydrologic Cycle and Virginia's Water Budget

The natural sequence through which water travels across or beneath the earth's surface and between the earth and the atmosphere is referred to as the hydrologic cycle. A water budget is an accounting of the input and output components of this cycle for a particular place and time. Ideally, input equals output minus any change in storage within surface water and groundwater reservoirs. With reasonable planning and informed decisions, a water budget can be a useful tool in water resource management.

For Virginia, a long-term water budget can be estimated by examining evaporation, precipitation, and streamflow data collected over several decades and assuming that 1) groundwater infiltration equals groundwater discharge to surface waters as baseflow, and 2) changes in storage over this period are negligible. Inputs include precipitation and surface water inflow. Evapo-transpiration, the combined release of water from the earth's surface via evaporation plus transpiration from plants, is the major output from the system. Surface water outflow from the major river basins, either westward to adjoining states or to the Chesapeake Bay, make up more than 25% of the total output. For comparison, statewide withdrawals of surface water and groundwater during 2012 (excluding those for power generation) totaled 1,221 million gallons per day, or approximately 1.4% of total outflow.

Virginia's Long-Term Water Budget:

Inflow:
Precipitation: 43 inches/year (87,172 mgd)
Surface water: 1 inch/year (2,974 mgd)
Inflow Total: 44 inches/year (90,146 mgd)

Outflow:
Evapotranspiration: 32 inches/year (65,146 mgd)
Surface water: 12 inches/year (25,000 mgd)
Outflow Total: 44 inches/year (90,146 mgd)

A statewide water budget based on long-term averages can be misleading. Although long-term average annual precipitation and evaporation do not vary by more than several inches across the State, the temporal variation at any particular location can vary tremendously month to month and year to year. Evapotranspiration has a significant seasonal variation, with the greatest amount occurring during the warm months of the growing season. Precipitation can range from well below normal over long periods during drought years to well above normal during wetter than average years. Figure 3-3 illustrates the variation in monthly precipitation at a station in central Virginia during the period from 1998 through 2004. During the drought years of 1999 through 2002, precipitation was below average during most months.

During the following wetter period of 2003 through 2004, monthly precipitation exceeded the long-term average during most months.

Because these largest input and output components of the water budget vary so much over short periods of time, the other components also change over relatively short periods. Over a time scale of a few years or less, groundwater and reservoir storage changes are significant and perhaps always in a state of flux, and there is a lag in time between groundwater recharge and the discharge of groundwater to streams as baseflow. During drought years when low precipitation results in low streamflow levels and decreased reservoir storage, the impact of water withdrawals becomes magnified, particularly during summer months when water withdrawal demands and evapotranspiration rates are at their maximum levels. During extended, multi-year droughts, low precipitation during winter months results in less recharge to the groundwater flow system. Consequently, the lower groundwater levels produce less baseflow to streams during the following summers, which further impacts streamflows and can also negatively affect the availability of water for off-stream beneficial uses.

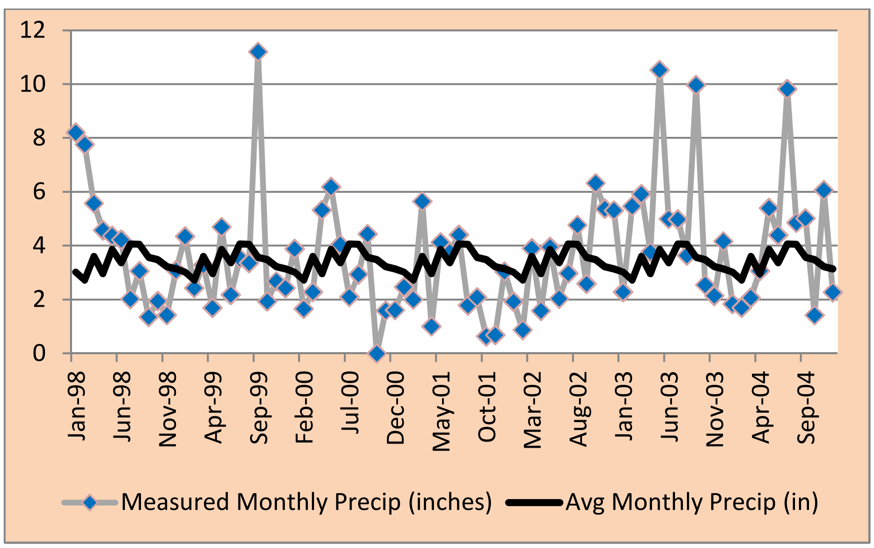

Figure 3-3: Measured monthly precipitation and long-term average precipitation at Bremo Bluff, Fluvanna County: 1998-2004

Geology and Groundwater

Virginia is over 400 miles wide along its southern boundary, reaching from the Atlantic Ocean in the east, crossing the eastern continental divide into the Mississippi Basin to the west. Much of the precipitation Virginia receives in any given period of time runs off into streams and rivers, while the rest returns to groundwater. Groundwater exists in underground pore spaces between rock particles and sediment grains, and in openings such as cracks, faults, fissures, and solution cavities within the rocks and unconsolidated sediments. The available quantity of groundwater depends on the number and size of the pore spaces and openings and the water permeability of the rocks.

Virginia crosses five physiographic provinces. The physiographic and geologic characteristics of each province are discussed in the following sections of this Chapter, as are the potential effects of those characteristics on the quality and quantity of groundwater.

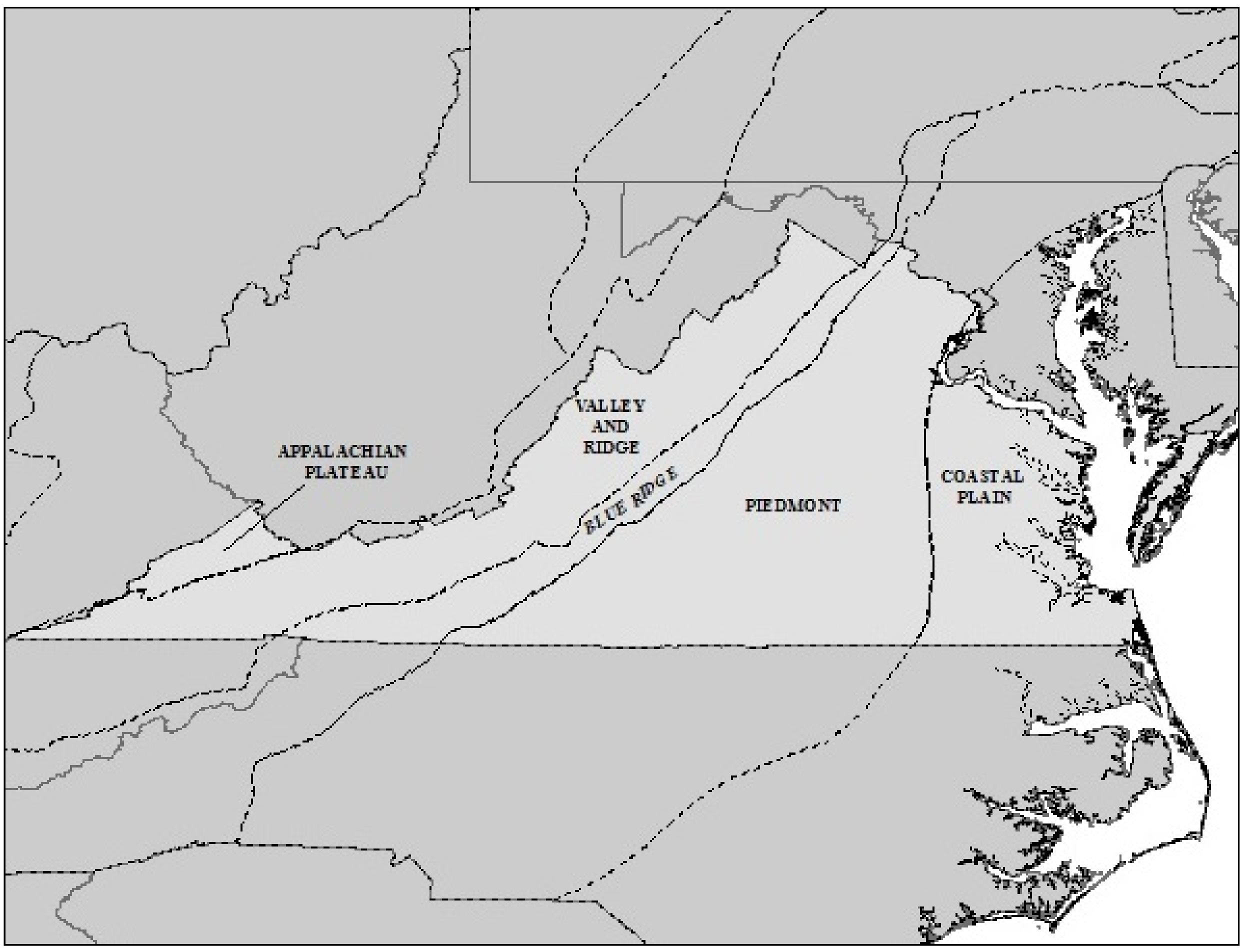

Figure 3-4: Physiographic Provinces of Virginia

Appalachian Plateau Physiographic Province

The Southwestern portion of Virginia lies in the Appalachian Plateau Physiographic Province, northwest of the Valley and Ridge Physiographic Province, characterized by rugged, well-dissected landscape with dendritic drainage patterns. Rocks in the Appalachian Plateau are sedimentary, horizontally lying or broadly and gently folded, with a dendritic drainage pattern (where stream valleys keep splitting in a random pattern). Older Cambrian rocks form basement layers, with younger Pennsylvanian rocks on top often exposed due to present day erosion. Commonly, the top-most Pennsylvanian rocks are composed of hard sandstone, forming mountain tops and containing coal. Rivers have eroded deep valleys into the sandstone to expose softer rocks below. Elevations in the Appalachian Plateau range from 1,000 feet to 3,000 feet above sea level, with High Knob near Norton, VA rising to over 4,000 feet. Average elevations range from 2,000 feet to 2,500 feet above sea level.

The Appalachian Plateau Province encompasses two sub-provinces, the Allegheny Plateau and the Cumberland Plateau. The boundary between the two sub-provinces is a feature known as the Allegheny Front, lying near the New River in West Virginia. The Allegheny Front is an area of transition between the upturned edges of the Appalachian Plateau, where the horizontal beds of the Plateau give way to the folded beds of the Valley and Ridge. The Appalachian Plateau is only structurally a plateau: some parts of the Plateau exhibit a low relief, plateau-like morphology; however, much of the Appalachian Plateau is strongly dissected by stream erosion. The resulting topography is rugged, with small, narrow valleys (or hollows) twisting through the resulting mountains. The older surface is evident in the pattern of hilltops, all tending to reach the same elevation.

Only a small portion of Virginia lies in the Appalachian Plateau Province and is located entirely in the Cumberland Plateau sub-province. The surface of the Cumberland Plateau is underlain by the same Paleozoic sedimentary rocks as the Valley and Ridge - principally sandstone, shale, and coal. While the sedimentary rocks are similar, in the Cumberland Plateau sub-province, these rocks have not been deformed and still occur in horizontal beds.

Groundwater quality in the Cumberland Plateau sub-province is generally poor due to high acidity and concentrations of iron, manganese, sulfates, and total dissolved solids. Quality varies with depth, with the first 100 feet of rock below stream level often being of poor quality, and naturally saline waters occurring at depths greater than 300 feet. Better quality water can be found at depths of 150 to 300 feet below stream level; however, in coalmining areas, some groundwater has become acidic due to mine drainage and is usually unsuitable for most uses. Because of these naturally occurring quality issues, establishing a well with dependable water quality and quantity can be an investment in time and money. Delineation of the source for implementation of protection practices is also a challenge.

Reported groundwater use is relatively low for this region. Groundwater extraction rates are likely higher due to the amount used for mining, which is generally exempt from annual withdrawal reporting (See Chapter 2 Virginia's Collaborative Water Management Framework). Well depths range from four to 1,738 feet, but median value is 150 feet below land surface.

Well-cemented sandstone is ubiquitous throughout plateau rock formation; therefore, secondary permeability features such as bedding-plane separations, open fractures, and cleats found in coal beds account for the majority of groundwater movement in the region. Downward groundwater gradients exploit stress-relief fractures along valley walls and result in localized, shallow flow systems that ultimately discharge near valley floors. Regional groundwater movement is likely dominated by enhanced secondary permeability along coal-bed cleats. Groundwater transmissivity along coal seams is of greater magnitude than all other rock types or lithologic contacts in the plateaus and, in general, transmissivity for all rock types decreased significantly at depths below 300 feet[54]. Harlow and Lecain also noted predominantly downward gradient flow within boreholes that intercepted multiple water bearing zones.

Valley and Ridge Physiographic Province

The geology of the Valley and Ridge Physiographic Province consists of Cambrian to Mississippian sedimentary rocks that were faulted, tilted, and folded during the Pennsylvanian and Permian periods. The rocks are found in thrust-fault bounded blocks that repeat the rock layers in parallel sandstone ridges and shale and carbonate valleys. This construction forms a trellis drainage pattern formed by rivers forced to run parallel to long ridges. Consolidated sedimentary rocks deposited beneath ancient seas underlie the Valley and Ridge Province and include limestone, sandstone, dolomite, and shale.

The western boundary of the Valley and Ridge Physiographic Province is the Alleghany Front, marking an abrupt change from the flat lying rocks of the Plateau to the folded/faulted rocks in the Valley and Ridge. In general, the more resistant sandstones and shale are the rock types often present in the ridges and upland areas, protecting the softer bedrock below from erosion, but yielding only enough water for rural and domestic supplies. In the lowlands, such as the Shenandoah Valley, limestone and dolomite occur beneath the surface forming the most productive aquifers in Virginia's consolidated rock formations. It is an area of well-developed karst topography created by the erosion of the limestone over thousands to millions of years, characterized by features such as sinkholes, caves, sinking streams, and large perennial springs. In many parts of the carbonate Valley and Ridge, springs remain extremely important water resources for individual, community, and industrial water supply. Spring discharges in this terrain commonly exceed several hundreds to thousands of gallons per minute (GPM) with a maximum recorded discharge of 16,646 GPM. Discrete spring discharges have been shown to account for between 65 and

[54] Harlow and Lecain, 1993

97% of surface streamflow in this terrain[55]. Sustained well yields of over 1,000 GPM have been demonstrated in portions of the carbonate valley and ridge, especially in areas overlain by unconsolidated siliciclastic overburden shed from the western slope of the Blue Ridge Mountains.

The connection between groundwater and surface water plays a major role in groundwater recharge in the Valley and Ridge Province, where streams often cross fault zones recharging aquifers. Wells in the fault zones have the greatest yields. Recharge also occurs through surface runoff into limestone sinkholes, bypassing filtration through the soil. This can cause serious water quality problems, because polluted surface water may be introduced directly into the groundwater system. Groundwater quality can also be adversely affected by private trash dumps located in sinkholes that receive surface run-off. In addition, carbonate formations contribute to the "hardness" of the groundwater. The karst limestone terrain in the valley poses difficult problems for wellhead protection area delineation, because underground conduits may act much like surface rivers. Some studies have suggested that surface water drainage patterns may be the best way to delineate wellhead protection areas in such circumstances.

Blue Ridge Physiographic Province

The Blue Ridge Physiographic Province is a relatively narrow zone, ranging from four to 25 miles wide, inclusive of both the Blue Ridge Mountains (the Shenandoah National Park and the Blue Ridge Parkway) and the strip of land to the east running through Galax, Charlottesville, Culpepper, and Warrenton. Located to the west of the Piedmont Province, the Blue Ridge Province contains mountains with some of the highest elevations in the State. Geologically, the Province is defined primarily by the rocks underlying it, course-grained igneous (granitic) and metamorphic Grenville basement rocks, with some late Proterozoic intrusive and sedimentary rocks present as well, rather than its topography. On the eastern flank of the Blue Ridge, the bedrock lies beneath a thin layer of soil and weathered rock. Largely impervious, these are the oldest rocks in the Commonwealth, ranging from approximately 1.1 billion to 1.9 billion years old, and resulting well yields are low. The bedrock contains water primarily in joints, fractures, and faults.

Although the occurrence of groundwater in the fractured rock of the Blue Ridge is ubiquitous, the ability of these groundwater systems to transmit and store groundwater is highly variable and dependent on the extent and orientation of the fractured network, as well as the source of groundwater recharge to the fractured-rock groundwater system.

There has been little residential or industrial development in the Blue Ridge Physiographic Province, with groundwater use developed mainly for private domestic needs rather than for public wells. Generally, the

[55] Harlow and other, 2005; Nelms and Moberg, 2010

Blue Ridge area provides a limited source of groundwater due to steep terrain, thin soil, and rapid run-off over impermeable rocks. This leads to low groundwater recharge and low well yields. The lower slopes of the mountains are the most favorable areas for groundwater accumulation. Springs are common and are often used for private water supplies. Because the rocks in the Blue Ridge are relatively insoluble, the groundwater is not severely mineralized, but iron content is high in some locations.

Obtaining good supplies of groundwater in the Blue Ridge for uses other than residential often entails site specific studies that incorporate surface geophysical and geological mapping methods to target and maximize well yields due to the localized nature of groundwater storage in fractured rock. More regional sources of groundwater in the Blue Ridge occur in a structurally complex zone in the Vinton/Roanoke area, where transverse faulting is suspected to play a role in the creation of high transmissivity groundwater systems. Higher well yields have been shown to occur along the western flank of the Blue Ridge Anticlinorium in the Buena Vista area. By contrast, the eastern flank of the Blue Ridge Anticlinorium is often a poor producer of water. This phenomenon is thought to be influenced by the topographic position and structural orientation of the quartzites in the Antietam Formation along Bull Run Mountain, and the presence of low transmissivity phyllites in the Candler Formation nearly along strike to the south. In the core of the Anticlinorium, well yields are highly variable, but site-specific targeting of groundwater in this area often proves to be fruitful.

Piedmont Physiographic Province

The largest of Virginia's physiographic provinces, the Piedmont Province extends from the Fall Zone or Fall Line in the east which separates the Piedmont Province from the Coastal Plain Province to the mountains of the Blue Ridge Province in the west. The province is characterized by gently rolling topography, deeply weathered bedrock, and a relative scarcity of solid outcrop. Hard, crystalline igneous and metamorphic formations dominate this region, with some areas of sedimentary rocks and saprolite (residual clay or silt) deposits overlying the bedrock. The size and number of fractures and faults in the bedrock which store and transmit groundwater decrease with depth, so most significant water supplies are found within a few hundred feet of the surface.

Fairly large yields of water can be obtained where fracture and fault systems are extensive such as the Western Piedmont along the base of the Blue Ridge Mountains. The diversity of subsurface geology of the Piedmont Province results in wide variations of groundwater quality and well yields, limiting the use of groundwater in many locations. For example, a few areas have problems with high iron concentrations and acidity. Dry holes are not uncommon in the Piedmont Province and groundwater is usually limited to fractures within 300 feet of the land surface. Because of the range in groundwater quality and quantity in this region, as well as the varying potential for contamination, well site evaluation and well monitoring is very important. From a wellhead protection standpoint, assumptions about the porosity and permeability of the overlying saprolite may have to be made so that reasonable estimates of wellhead protection areas can be calculated.

Although the occurrence of groundwater in the Piedmont Province is ubiquitous, the ability of fractured rock aquifers in the Piedmont to supply groundwater varies locally. Well yields in the Piedmont vary greatly and have been documented to yield less than one GPM to over 1,000 GPM.

Obtaining good supplies of groundwater in the Piedmont Province for uses other than residential often entails site-specific studies that incorporate surface geophysical and geological mapping methods to target and maximize well yields due to the localized nature of groundwater storage in fractured rock.

Coastal Plain Physiographic Province

The Coastal Plain is Virginia's easternmost province and is composed of flat landscapes with wide rivers that are easy to navigate. The Coastal Plain is a broad, low relief surface that slopes gently toward the ocean and is comprised of three sub-provinces: upland, lowland, and Barrier Island and salt marshes. The Coastal Plain is the youngest of Virginia's physiographic provinces, with rocks that were deposited after the Atlantic Ocean began to form early in the Mesozoic Period. Several low, wave-cut terraces punctuate the landscape where the softer sedimentary rocks of the Coastal Plain abut the more resistant metamorphic rocks of the Piedmont, creating a low escarpment visible on the landscape, known as the Fall Line. The Fall Line passes roughly through Fairfax County, Fredericksburg, Richmond, Petersburg, and Emporia, and is so named because where rivers cross the Fall Line, there are rapids or falls. On the Potomac River, a fairly broad "fall zone" extends from Great Falls downstream nearly to Alexandria. The falls were barriers to ocean-going vessels even in the Colonial period and had a major influence on early European settlement patterns in Virginia.

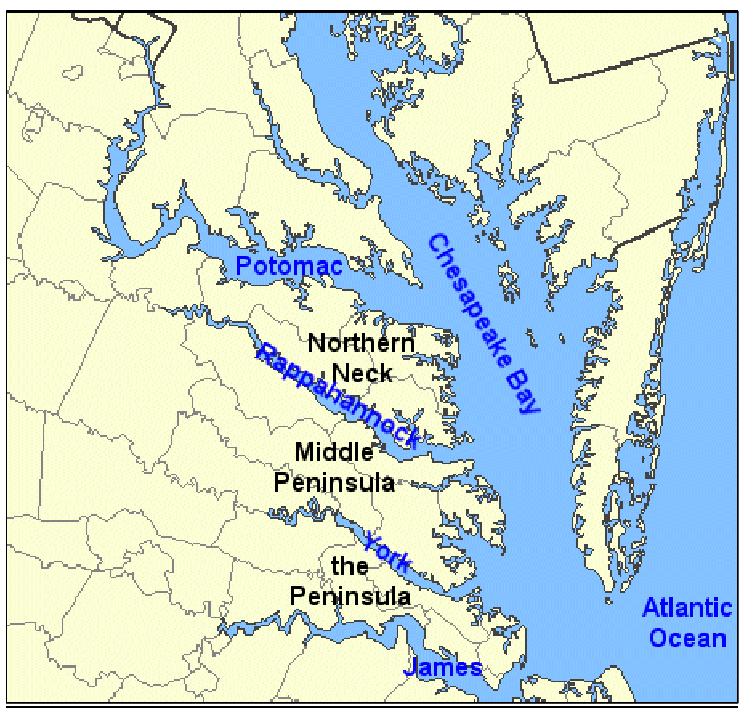

Figure 3-5 Three Peninsulas in the Coastal Plain

The topography of the Coastal Plain is that of a terraced landscape stepping down to the coast and to the major rivers: the Potomac, Rappahannock, York, and James - large, tidal rivers that flow southeastward across the Coastal Plain to the Chesapeake

Bay, which, in turn, empties into the Atlantic Ocean. The risers (scarps) are former shorelines and the treads are emergent bay and river bottoms. The higher, older plains in the western part of the Coastal Plain are more dissected by stream erosion than the lower, younger terrace treads. This landscape was formed over the last few million years as sea level rose and fell in response to the repeated melting and growth of large continental glaciers and as the Coastal Plain slowly uplifted. During the glacial maxima, much of the continental shelf was emergent and the Susquehanna flowed through the Chesapeake lowland and across the exposed shelf to the sea 80 kilometers or more to the east.

The stream-cutting of the Pleistocene Period also led to the dissection of the Coastal Plain into three peninsulas or “necks” known today by the names applied by Virginia's European settlers: Northern Neck, Middle Peninsula, and Virginia Peninsula, also known as “the Peninsula.”

The Northern Neck is the northern most of three peninsulas on the western shore of the Chesapeake Bay. Bounded by the Potomac River on the north and the Rappahannock River on the south, it encompasses Lancaster, Northumberland, Richmond, and Westmoreland Counties. The Middle Peninsula is the second of the three large peninsulas, lying between the Virginia Peninsula and the Northern Neck. The Middle Peninsula is bounded by the Rappahannock River on the north and the York River on the South, and encompasses Essex, Gloucester, King and Queen, King William, Mathews, and Middlesex Counties. Early settlement in Virginia focused on the Virginia Peninsula, bounded by the York River, James River, Hampton Roads, and the Chesapeake Bay. Today, the Virginia Peninsula encompasses the Counties of James City and York and the Cities of Williamsburg, Newport News, Hampton, and Poquoson.

The Coastal Plain region is the only one in Virginia that is composed mostly of unconsolidated deposits, primarily alternating layers of sand, gravel, shell rock, silt, and clay. More groundwater is stored in these very permeable materials than in any other province in the Commonwealth. Consequently, a large portion of Virginia’s groundwater use occurs in the Coastal Plan. In many cases, a shallow unconfined aquifer system lies above relatively impermeable clay beds and is the source of water for hundreds of domestic and other capacity wells. The pollution potential in the uppermost unconfined aquifer is high because of the permeability coupled with the high population density and agricultural activities in the area. Except for areas where saltwater, iron, and hydrogen sulfide occur, the natural water quality in the Coastal Plain aquifers is good. In aquifers near a saltwater interface, saltwater may migrate west as aquifers are pumped. As a result, water from the deep aquifers on much of the lower York-James Peninsula and the Norfolk-Virginia Beach area generally contains high chloride concentrations, rendering the water too salty for domestic use without treatment. However, the deeper system of confined aquifers is the principal source of major groundwater withdrawals in the region.

The Virginia Coastal Plain is part of an aquifer system reaching from New Jersey to Alabama. In Virginia, the multi-aquifer system is bounded on the west by the fall line and the east by a saline density boundary. The Coastal Plain aquifer system hydrogeologic framework is comprised of 19 units which include one unconfined aquifer, seven confined aquifers, and 11 confining units[56]. The Potomac, Virginia Beach, Pedee,and surficial aquiers are quartz/feldspathic sand and gravel; the Aquia, Piney Point, St. Marys, and Yorktown-Eastover aquifers are fossil shell material. Historically, the lower/middle/upper Potomac aquifer has the most withdrawal pressure. This aquifer is the most dominate hydrologic unit in the Coastal Plain and supplies the major industrial, commercial, agricultural, public water supply, and domestic residential users through the province. The Yorktown-Eastover aquifer and the Piney Point aquifer are the second and third most heavily used aquifers.

Confining layers that separate the aquifers restrict, but do not prevent, vertical flow between the aquifers. The recharge area to these aquifers occurs miles away from where the formations outcrop, but infiltration from the water table and shallower confined aquifer also recharge the deeper confined aquifers and could carry pollutants into these deeper reaches. The Coastal Plain presents a complex wellhead protection problem where the deep confined aquifers are concerned. The shallower aquifer, however, may have a more direct interaction with the surface and present a relatively straightforward challenge.

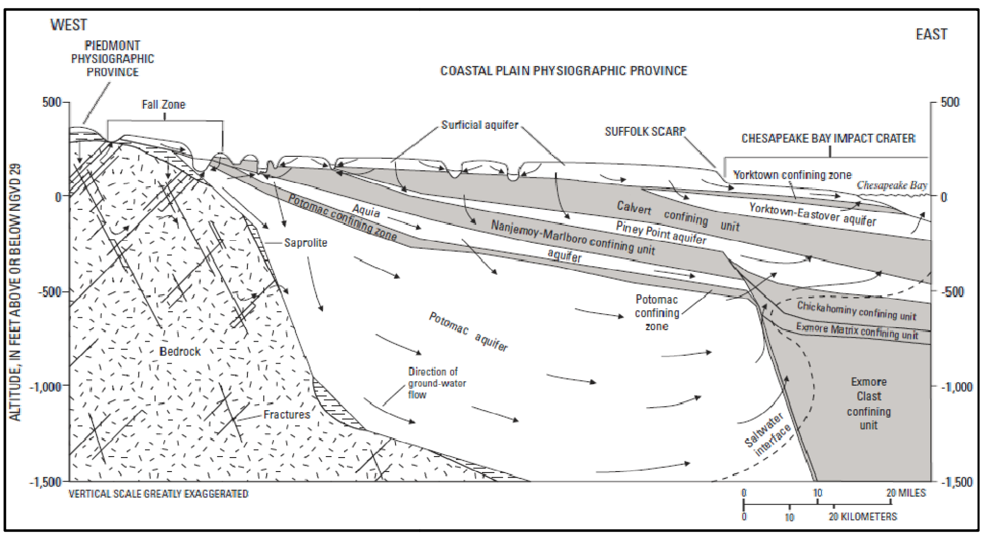

Figure 3-6: Vertical section through the Coastal Plain Physiographic Province

Chesapeake Bay Impact Crater

About 35 million years ago in the late Eocene Epoch, a bolide (comet or asteroid-like object from space) hit the earth, leaving behind a crater in the continental shelf near the Town of Cape Charles on Virginia's

[56] McFarland and Bruce USGS Professional Paper 1731-2006

Eastern Shore. The bolide created what geologists call the "Exmore Crater," or the Chesapeake Bay Impact Crater (CBIC). Geologists believe the bolide was as large as Rhode Island and as deep as the Grand Canyon. Although the bolide did not create the Chesapeake Bay, it helped determine that a bay would eventually be located there. The inner rim of the CBIC is 23 miles in diameter and the outer rim is 56 miles in diameter. The outer disruption boundary is approximately 80 miles in diameter.

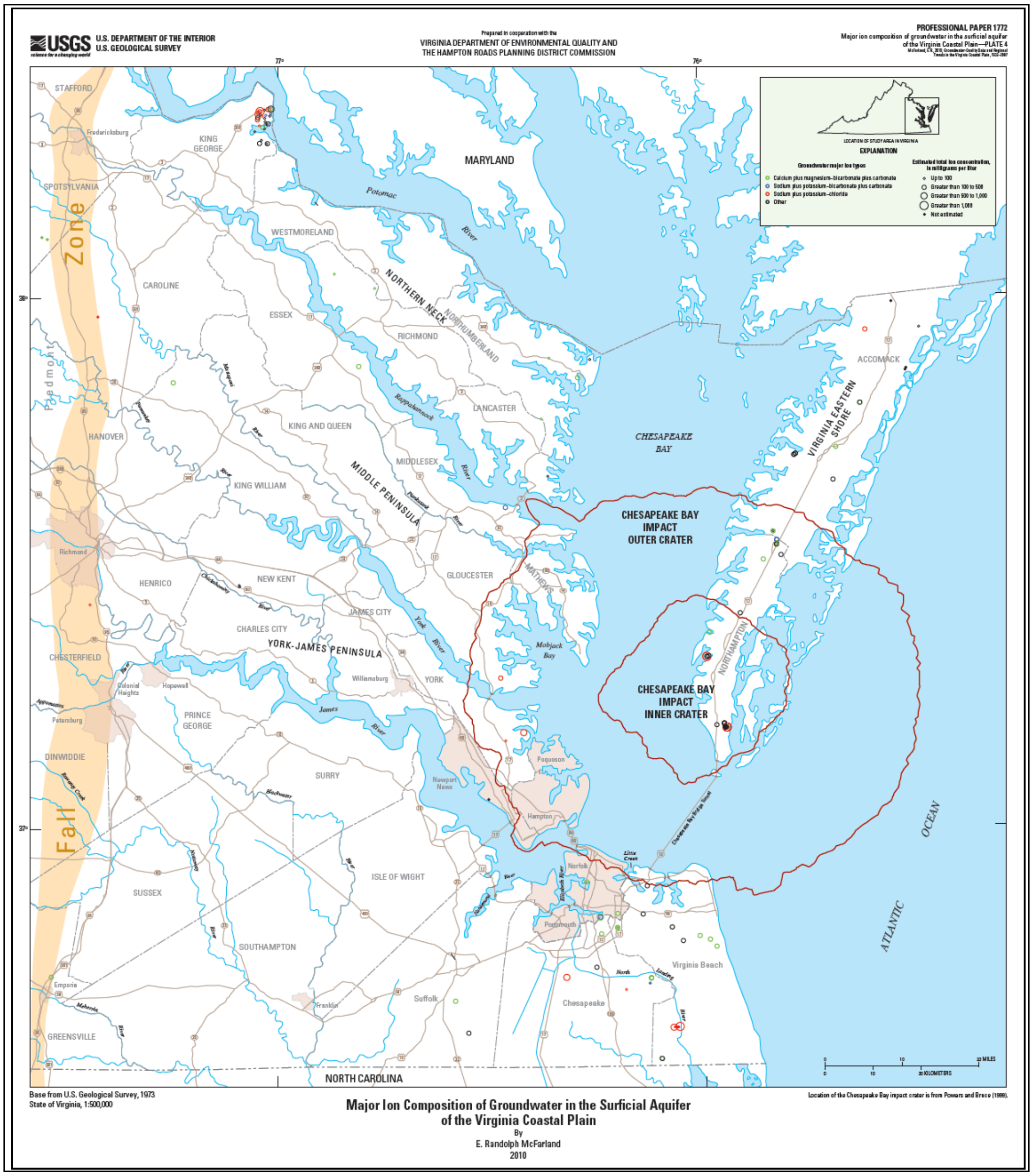

Figure 3-7: Chesapeake Bay Impact Crater

Since the CBIC discovery, studies have been done that have revised the understanding of Coastal Plain evolution. In particular, several consequences of the impact that still affect citizens around the Bay today have been revealed: land subsidence, river diversion, disruption of coastal aquifers, ground instability, and the location of the Chesapeake Bay. The CBIC truncates the Potomac and Aquia aquifers in eastern Virginia. Differential flushing of salty groundwater over geologic time has resulted in the Virginia inland saltwater wedge. The inland saltwater wedge is characterized by elevated chloride and sodium concentrations in the Potomac aquifer as far west as Williamsburg.

Chapter 4 A Comparison of Water Supply and Water Use across the Commonwealth

The WSP Regulation requires the compilation of information for existing water sources, uses, and projections of future water demand. This Chapter provides a view of the water sources, uses, and projected demand in the Commonwealth based upon information collected from local and regional water supply plans.

Identification of Water Planning Areas and Basin Assignments

Forty-eight local and regional water supply plans were developed and submitted to DEQ by planning entities between 2008 and 2011[57]. Of the 48, ten local governments elected to develop individual (local) water supply planning programs: the Counties of Amelia, Charles City, King George, New Kent, and Stafford, the City of Richmond, and the Towns of Chincoteague, Hillsboro, Port Royal, and Warrenton. The remaining localities committed to regional water supply planning with the development of 38 regional plans (Figure 4-1). Water supply planning areas are designated along county, city, and town boundaries and the water use data collected in plans is presented and summarized along these boundaries.

[57] See Appendix A

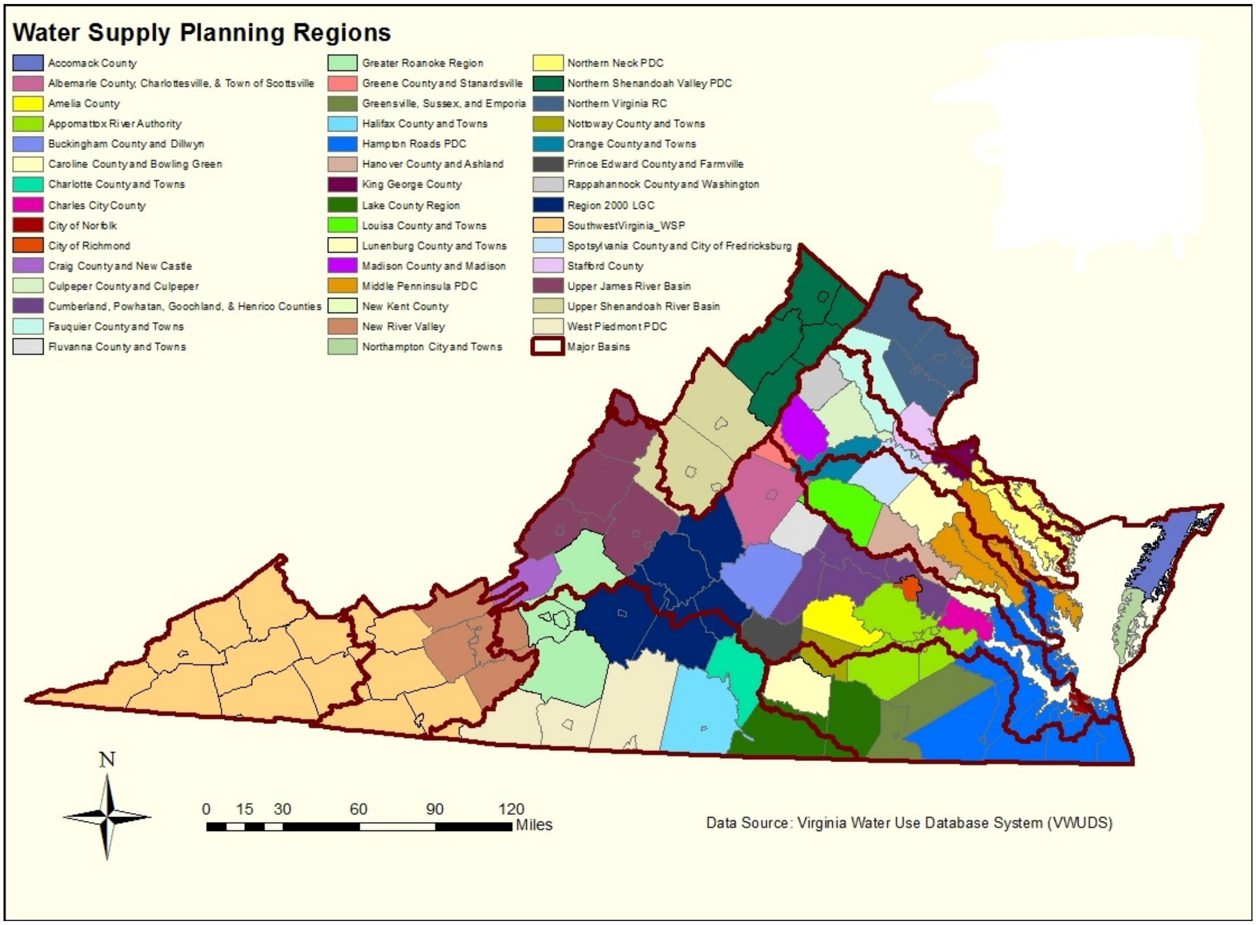

Figure 4-1: Local and Regional Water Supply Planning Areas in the Commonwealth

In Chapter 3, Figure 3-3 depicts the nine hydrologic (major basin) boundaries in the Commonwealth. Each basin includes a number of Hydrologic Unit Codes (HUC). In the State Plan, cumulative impact analysis, water use data from the local and regional plans is analyzed by the National Hydrography Database 8-digit Hydrologic Unit Code (HUC8) classification. There are 48 HUC8's in the Commonwealth.

Hydrologic units are drainage areas that are delineated so as to nest into a multi-level hierarchical drainage system. Aside from the surface waters that are collected within the boundary of a hydrologic unit, it may also accept water from one or more points outside of the unit's boundary. Hydrologic units may include associated surface areas whose drainages do not connect, thus resulting in multiple outlet points. This is usually the case with coastal units such as those containing multiple outlets to the Chesapeake Bay or Atlantic Ocean.

A HUC is a unique code assigned to hydrologic units in a hierarchical system initially created by the USGS. In 2006, new hydrologic unit delineation standards officially expanded the hierarchy from four to six levels with HUCs 2 to 12 digits in length. A HUC8 is classified as a "sub-basin" level with average unit size of 703 square miles. The HUC8 classification is used in this State Plan as it is a convenient, reasonably-sized, and widely understood unit of watershed division for the purpose of reporting results that summarize resource availability, challenges, and strategies. The following Figure 4-2 depicts current water use by HUC8 in millions of gallons per day (MGD).

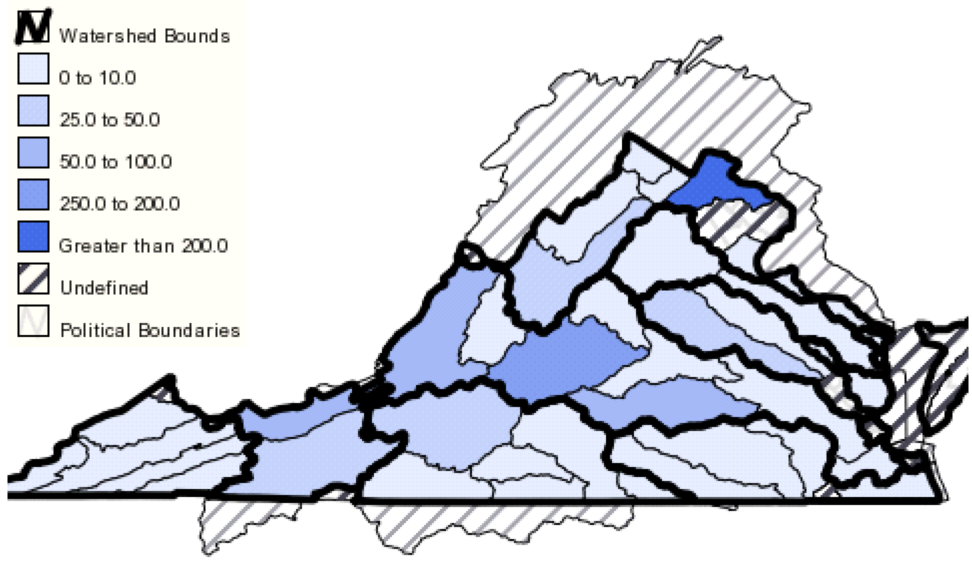

Figure 4-2 Current Water Use (MGD) in Virginia by HUC8

Water Source and Use Data Collection

Water users are sorted into four categories: community water systems, large and small self-supplied users, and agriculture. These are abbreviated CWS, SSU_LG, SSU_SM, and AG respectively and can use surface water or groundwater as sources. A CWS is a private or public waterworks that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents and is regulated by the VDH Waterworks Regulation.[58] Self-supplied users are defined as any person making a withdrawal of surface water or groundwater (e.g. a river, stream, lake, aquifer, or reservoir fed by any such waterbody) for his own use. Self-supplied users do not receive water from a community water system. SSU_LG are defined as those users of more than 300,000 gallons per month of surface water or groundwater for nonagricultural uses, including, but not limited to commercial (includes golf course irrigation), manufacturing, mining, and power. SSU_SM are defined as those users supplied by individual wells withdrawing less than 300,000 gallons of water per month. AG water use

[58] 12 VAC 5-590

data is collected for those agricultural operations withdrawing more than 300,000 gallons of water per month.

The data collected for the four category types in the local and regional water supply plans was obtained by local governments and planning entities through existing, readily available sources. Sources commonly used include local water purveyors, Virginia Department of Health Office of Drinking Water (VDH-ODW), and DEQ. As described in Chapter 2, Virginia's Collaborative Water Management Framework, DEQ collects water withdrawal data on an annual basis through the Virginia Water Withdrawal Reporting Regulation (VWWR). DEQ withdrawal data is stored in an online database, the Virginia Water Use Data System (VWUDS). The VDH-ODW collects monthly the raw water pumped and/or treated and the total water produced for CWS regulated under the VDH Waterworks Regulation. Data is stored at the local VDH-ODW field offices across the Commonwealth.

Through the water supply planning process, some planning entities determined that water source and use information was not always readily available for all users in a particular locality. Agriculture and golf course water use were two areas often lacking readily available data. When specific agricultural users were unknown in a locality or region, the United States Department of Agriculture's National Agricultural Statistics Service Census of Agriculture (NASS Census) data was often summarized in the plans. The NASS Census is confidential as required by law, collecting data from farm and ranch operations. NASS Census data is reported by county for total acres irrigated and total number of livestock. The plans using NASS Census used the data to estimate livestock and crop irrigation water use. The estimates based on the NASS Census are for all users in an entire county, not just the users of greater than 300,000 gallons per month. The amount of use derived from surface water versus groundwater is unknown. Although the data is not a best fit for what is required by the WSP Regulation, it does provide a basis for projections of future demand for the agricultural sector in a particular county and aids DEQ in understanding which counties reported the greatest number of irrigated acres.

The threshold for agricultural data outlined in the WSP Regulation differs from the threshold in the VWWR. The VWWR requires crop irrigation data for those withdrawing more than one million gallons in any single month. The WSP Regulation requires agricultural data (crop irrigation and all other agricultural uses) for those withdrawing more than 300,000 gallons per month. Therefore, it is possible the amount used for agricultural irrigation was underestimated by those planning entities using agricultural irrigation data collected by DEQ (VWWR) in the local and regional water supply plans. DEQ recognizes the need for compliance and is targeting nonreporters, including agriculture and golf course facilities, to increase the amount of data available for water supply planning.

Existing Water Sources

As reported in the local and regional water supply plans, approximately 800 surface water withdrawals (reservoir, stream, and spring sources) and 2,900 groundwater well withdrawals (excluding private groundwater wells) are used statewide (Figure 4-3). The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in Figure 4-3. As estimated for the year 2010 in the water supply plans, over 1.6 million people in the Commonwealth use private groundwater wells for residential water supply. Detailed source information is provided for each individual basin in Appendix B, Major Basin Summaries.

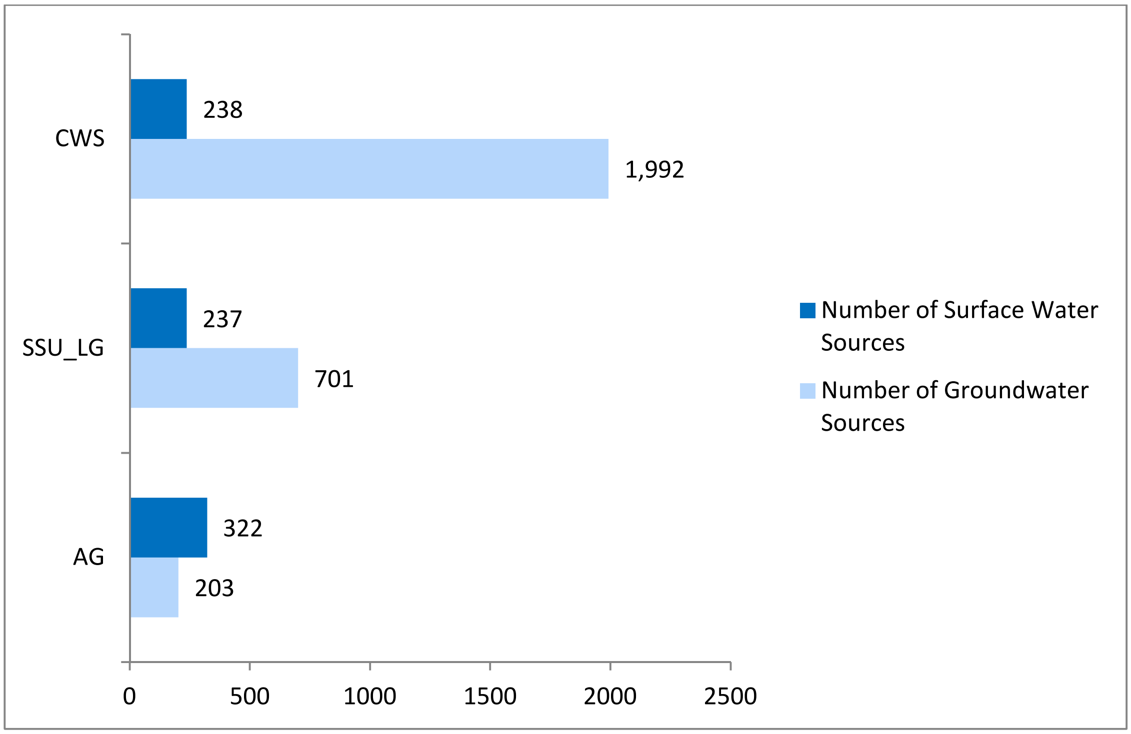

Figure 4-3: Statewide Source Type by User Type

The cumulative impact analysis in the State Plan predicts a net increase of over 30% in mean daily water supply demand over the planning period to 2040, which is consistent with the projected population increase within the Commonwealth. This increase in projected demand provides for special concern when dealing with groundwater withdrawals occurring in the Coastal Plain of Virginia and the associated GWMA, since groundwater resources are already oversubscribed, not sustainable for the long term at current use, and are contributing to increased land subsidence and saltwater intrusion potential. Therefore, localities will need to conduct a more in-depth alternative water sources analysis to allow for reduction of groundwater while still meeting their projected needs for water supply.

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly used by localities in the Commonwealth. However, there are a few localities taking advantage of these options. More information may be found in Appendix B, Major Basin Summaries.

Water withdrawn in the Commonwealth may be used by a withdrawing user or 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 major river basin - intrabasin transfers - occurs within a single county, but such transfers can occur across county lines. Intrabasin water transfers occur throughout the Commonwealth, primarily between CWS. Specific intrabasin transfer information is provided in Appendix B, Major Basin Summaries.

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. The interbasin transfer of water is less common in Virginia, but does take place. Specific interbasin transfer information is provided in Appendix B, Major Basin Summaries.

Current Trends in Off-stream Water Use

The categories of water withdrawals reported pursuant to the VWWR Regulation include agriculture, commercial, irrigation, manufacturing, mining, fossil fuel power, hydropower, nuclear power, and public water supply. The VWWR Regulation public water supply category correlates to the WSP Regulation's CWS category. The VWWR Regulation agriculture and crop irrigation categories are combined to represent the WSP Regulation's AG category. All remaining VWWR categories (commercial includes golf course irrigation), manufacturing, mining, fossil fuel power, hydropower, and nuclear power) are combined to represent the WSP Regulation category of SSU_LG.

The water use reported in the water supply plans exceeds the withdrawals reported to the VWWR in all three corresponding use categories by millions of gallons per day (MGD), as depicted in Figure 4-4. Data provided in the plans includes information for those users not currently required to report under the VWWR Regulation, such as CWS using less than 300,000 gallons per month, SSU_SM (< 300,000 gallons per month), and AG irrigation withdrawals of less than one million gallons per month. Although data collected by the VWWR Regulation is not as comprehensive as the data provided in the water supply plans, it does provide a historical reference for CWS, SSU_LG, and AG water use.

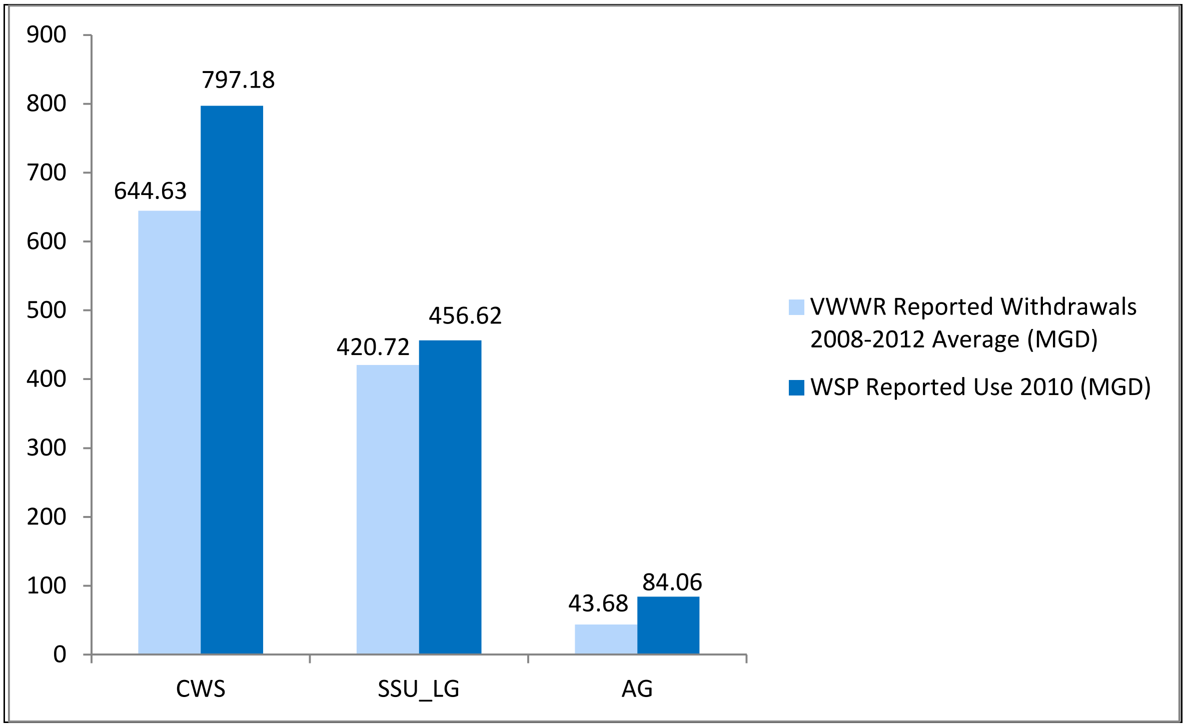

Figure 4-4: Statewide Water Withdrawal (VWWR) and Use (WSP) Comparison

It should be noted that a portion of the water reported as withdrawn by CWS and SSU_LG users with Virginia Pollutant Discharge Elimination System (VPDES) discharges is nonconsumptive, as some of the water is returned to the stream. Water diverted for hydropower use is essentially non-consumptive. These withdrawals are exempt from the VWWR Regulation and are generally not reported to the DEQ. A significant portion of water diverted for uses related to fossil fuel and nuclear power generation is also non-consumptive. For these reasons, the following summary of total statewide water withdrawals and use does not include water withdrawn for non-consumptive power cooling.

Figure 4-5 summarizes water withdrawals in Virginia as reported to the VWWR, averaged for the five-year time period of 2008 through 2012. The amount withdrawn was predominantly from surface water sources and totaled 1,109 MGD, with 931 MGD from surface water and 178 MGD from groundwater.

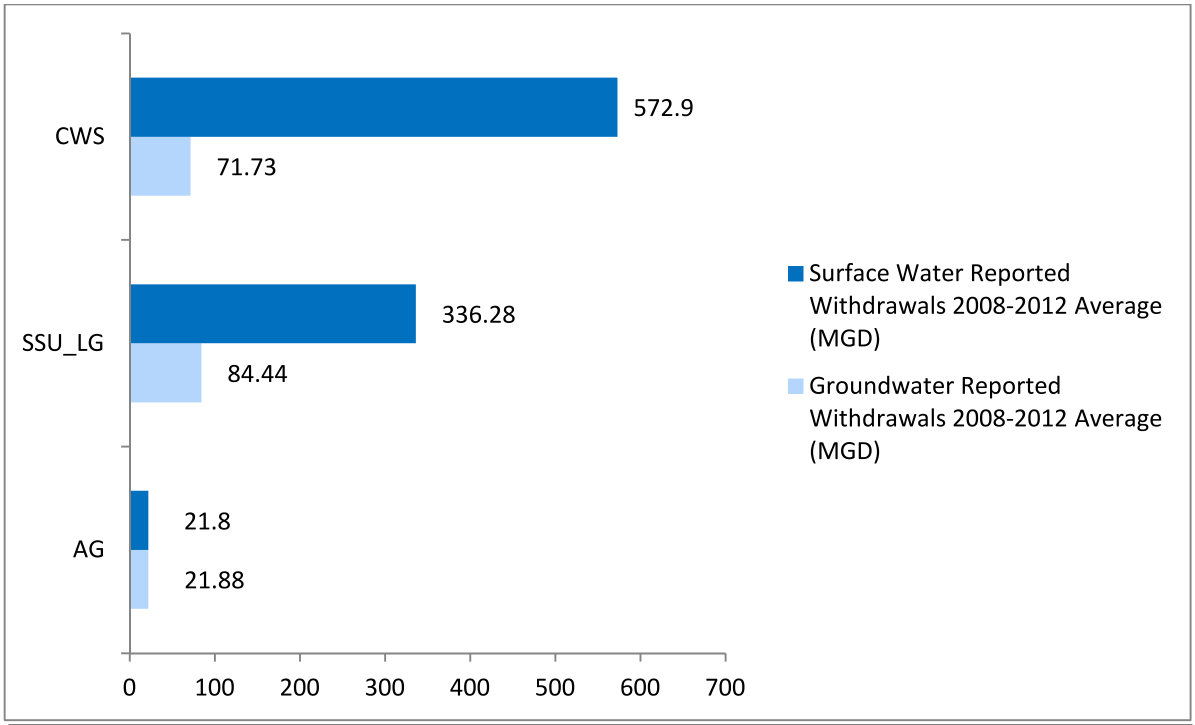

Figure 4-5: Statewide VWWR Average Reported Water Withdrawals by Source and Type

Water use reported in the local and regional water supply plans, excluding non-consumptive power cooling use, was predominantly from surface water sources. The total estimated water use was approximately 1,476 MGD, with 1,096 MGD from surface water and 380 MGD from groundwater (Figure 4-6). CWS, SSU_LG, and AG used more surface water than groundwater. SSU_SM uses solely groundwater. Statewide, totaling all use types and excluding non-consumptive power cooling, 74% of the 2010 water use was from surface water sources and 26% came from groundwater sources.

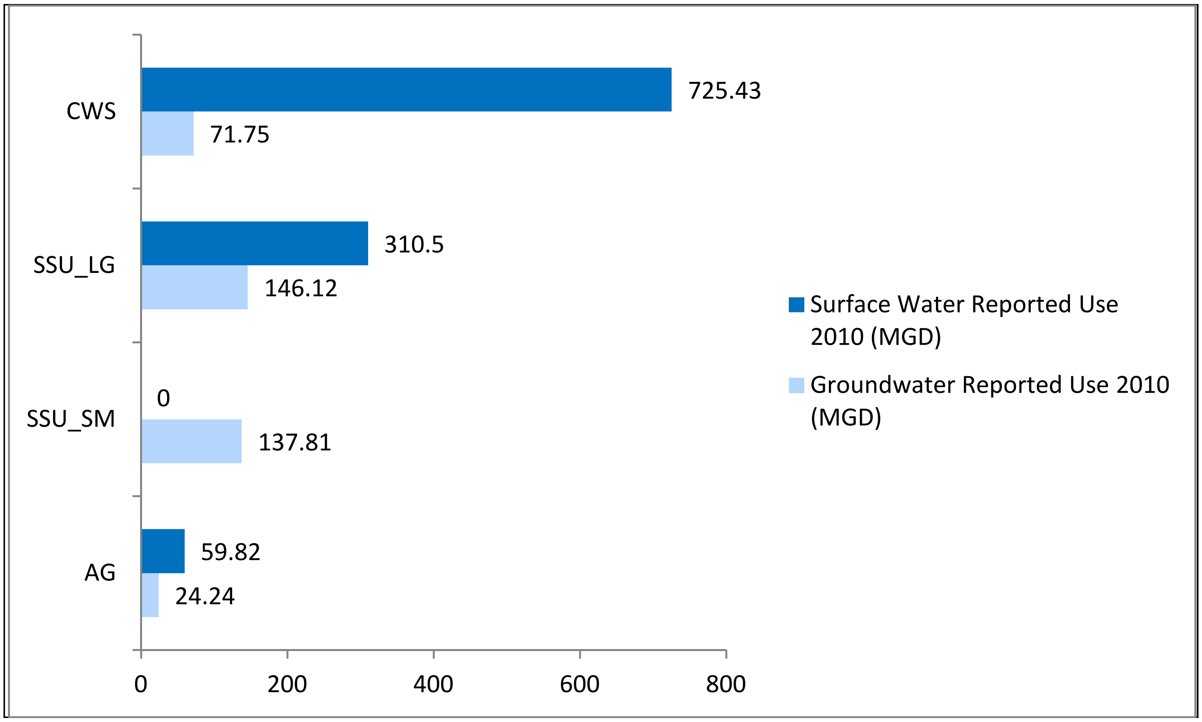

Figure 4-6: Statewide WSP Reported Water Use by Source and Type[59]

As shown in Figure 4-7, CWS used an estimated 54% of the total 2010 reported water use in the Commonwealth, followed by SSU_LG (31%), SSU_SM (9%), and AG with 6%.

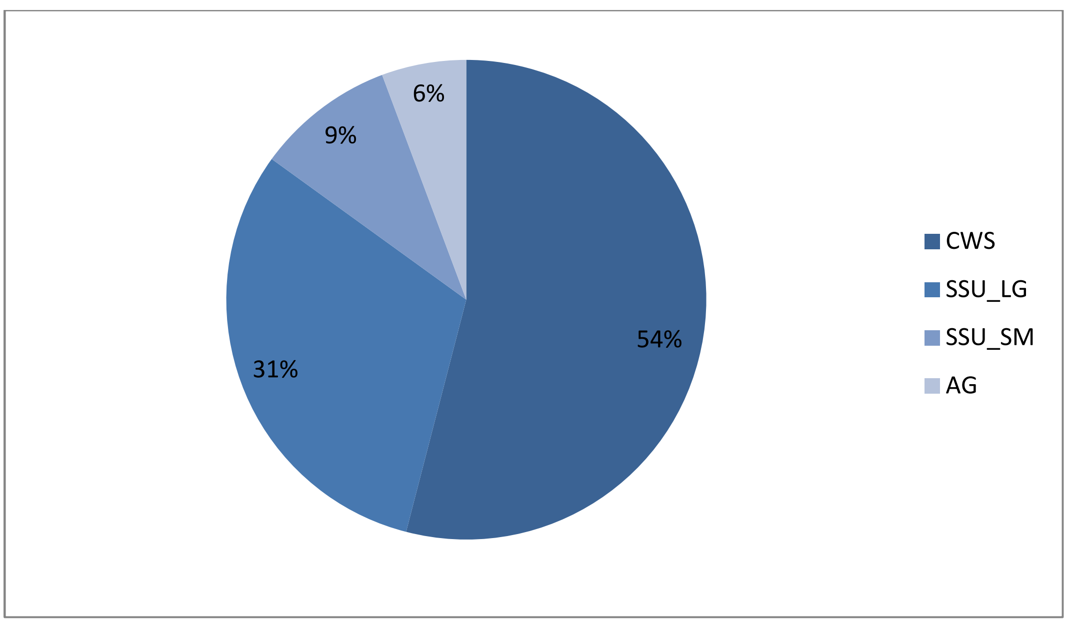

Figure 4-7: Statewide Percentage of WSP 2010 Reported Use by User Type

[59] Source: Local and Regional Water Supply Plans

The following tables provide an analysis of water use, excluding non-consumptive power cooling, for each of the four use category types as reported in the local and regional water supply plans. Water use is ranked from largest to smallest for each of the nine major basins.

The water use of CWS was approximately 797 MGD in 2010 (Table 4-1). The Potomac-Shenandoah River Basin reported the highest CWS use in the Commonwealth.

Basin	Reported CWS Use 2010 (MGD)
Potomac-Shenandoah	280.87
James	271.27
Roanoke	94.58
Albemarle-Chowan	36.57
Tennessee-Big Sandy	33.54
New	32.09
York	31.65
Rappahannock	13.54
Chesapeake Bay-Small Coastal	3.07
TOTAL	**797.18**

Table 4-1: Statewide WSP 2010 Reported CWS Use by Major Basin

The water use of SSU_LG (excluding non-consumptive power cooling) totaled approximately 457 MGD in 2010 (Table 4-2). The James River Basin reported the highest SSU_LG use in the Commonwealth.

Basin	Reported SSU_LG Use 2010 (MGD)
James	236.9
York	54.41
Albemarle-Chowan	48.97
New	39.51
Potomac-Shenandoah	34.4
Roanoke	25.41
Tennessee-Big Sandy	7.27
Chesapeake Bay-Small Coastal	5.64
Rappahannock	4.11
TOTAL	**456.62**

Table 4-2: Statewide WSP 2010 Reported SSU_LG Use by Major Basin

The water use of AG totaled approximately 84 MGD in 2010 (Table 4-3). The highest reported AG use occurred in the James River Basin.

Basin	Reported AG Use 2010 (MGD)
James	24.64
Roanoke	17.56
New	10.63
Potomac-Shenandoah	10.32
Tennessee-Big Sandy	5.71
Chesapeake Bay-Small Coastal	5.55
York	5.55
Albemarle-Chowan	3.09
Rappahannock	1.01
TOTAL	**84.06**

Table 4-3: Statewide WSP 2010 Reported AG Use by Major Basin

In 2010, approximately 138 MGD of groundwater was used for SSU_SM private residential supply statewide (Table 4-4). The James River Basin reported the highest SSU_SM residential use in the Commonwealth. The residential population served by private wells was estimated in the plans by taking the total population of a locality and subtracting the population served by CWS. The resulting population number was multiplied by a gallons per day (gpd) factor to determine the amount used on an annual average. The gpd factor varied depending on what was chosen by the planning entity and commonly measured between 75 and 100 gpd.

Basin	Reported SSU_SM Groundwater Use 2010 (MGD)
James	34.12
Potomac-Shenandoah	31.26
Roanoke	21.7
York	14.63
Rappahannock	10.33
Chesapeake Bay-Small Coastal	7.77
Albemarle-Chowan	7.38
New	6.55
Tennessee-Big Sandy	4.07
TOTAL	**137.81**

Table 4-4: Statewide WSP 2010 Reported SSU_SM Residential Groundwater Use by Major Basin

As noted above, non-consumptive power cooling use is excluded from the tables and figures. Table 4-5 reveals the amount of water used in each basin for non-consumptive power cooling. The 2010 statewide total was approximately 6,567 MGD, and the James River Basin reported the highest amount of non-consumptive water use for power cooling.

Basin	Non-Consumptive Power Cooling Use 2010 (MGD)
James	3,391.5
York	2,882.9
New	289.1
Roanoke	3.0
Chesapeake Bay-Small Coastal	0
Albemarle-Chowan	0
Potomac-Shenandoah	0
Rappahannock	0
Tennessee-Big Sandy	0
TOTAL	**6,566.5**

Table 4-5: Statewide WSP 2010 Reported Non-Consumptive Power Cooling Use by Major Basin

Projections of Future Off-stream Water Demand

The projected population by decade for the Commonwealth (2000 through 2040) is displayed in Figure 4-8. Population data is obtained from the Virginia Employment Commission's population estimates, which rely on data produced by the United States Census Bureau. The overall population is projected to increase through the year 2040. By the year 2040 the estimated population is projected to reach approximately 10,455,075, an approximate 32% increase, from 2010 to 2040.

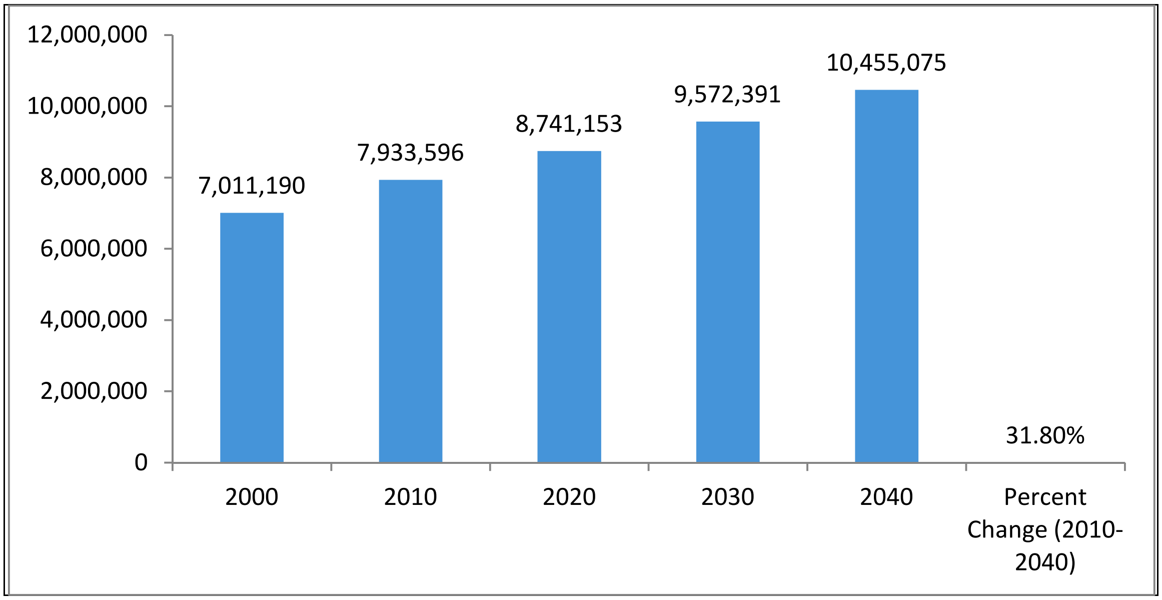

Figure 4-8: Statewide Projected Population by Decade (2000–2040)

The Commonwealth's projected water demand through the year 2040 is summarized in Figure 4-9. The total projected water demand as reported in the local and regional water supply plans is estimated to increase from 1,476 MGD to 1,935 MGD in 2040, or approximately 32% during the 30-year timeframe. Projections were derived using various methods selected by the planning entities, as outlined in each individual water supply plan. The methodologies applied, although varied, were reasonable and found to be consistent with the requirements of the WSP Regulation. Projections by major basin are described in Appendix B, Major Basin Summaries.

By 2040, an increase of approximately 450 MGD of water will be needed. This estimated 32% increase from 2010 is consistent with the percentage increase of population for the same time period.

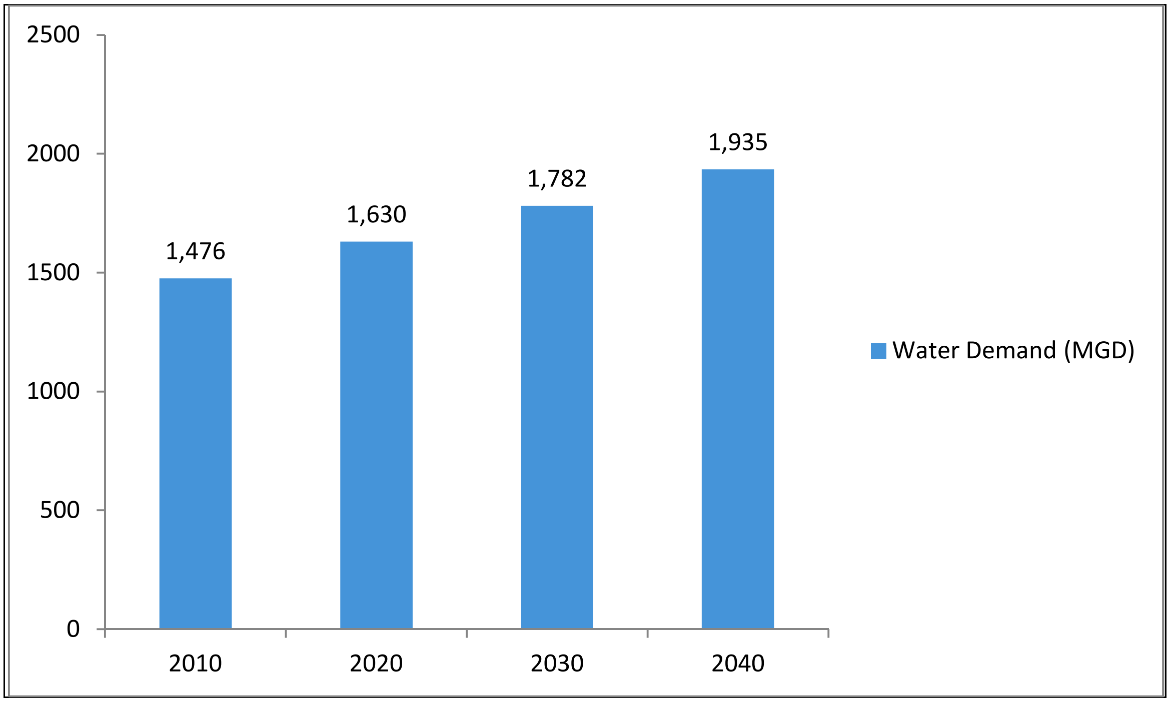

Figure 4-9: Statewide Projected Water Demand (2010 – 2040)

As viewed in Table 4-6, CWS show the largest percent change increase (38.7%) in water demand over the 30-year planning period, followed by SSU_SM (29.6%), SSU_LG (23.9 %) and AG (9. %).

User Type	Reported Use 2010 (MGD)	Projected Use 2020 (MGD)	Projected Use 2030 (MGD)	Projected Use 2040 (MGD)	Percent Change (2010-2040)
CWS	797.18	897.48	997.9	1,098.07	37.7%
SSU_LG	456.62	493.02	529.4	565.8	23.9%
SSU_SM	137.81	151.43	165.1	178.63	29.6%
AG	84.06	86.71	89.4	92.03	9.5%

Table 4-6: Statewide Projected Water Demand by User Type (2010-2040)

In 2040, the percentage of demand by user type shows an increase for CWS as compared to the percentage of current use. In 2040, CWS percentage of demand is estimated at 57%, an increase of 3% from the percentage of current use. SSU_LG follows with 29% of 2040 demand, a decrease of 2% when compared to the SSU_LG percentage of current use. The percentage of SSU_SM demand is projected to remain steady at 9% and the percentage of AG demands is projected to decrease to 5% of the total statewide demand (Figure 4-10).

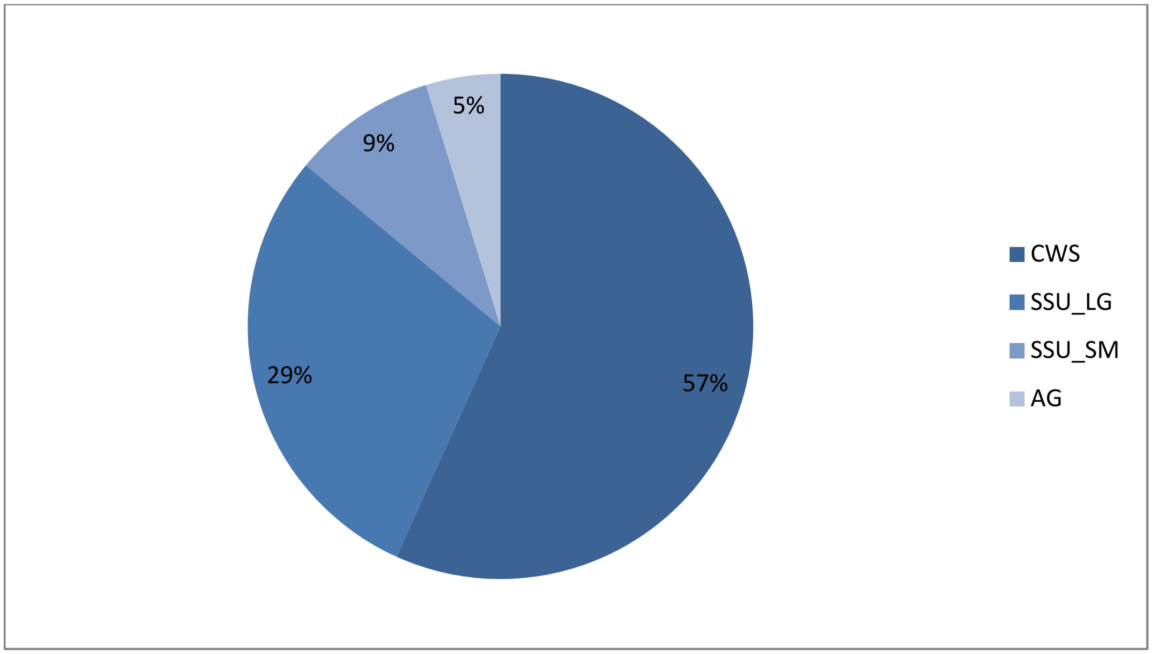

Figure 4-10: Statewide Percentage of 2040 Projected Demand by User Type

In 2040, 77% of the total projected water demand is estimated to come from surface water, an increase of 3% as compared to the percentage of 2010 reported use. The percentage of total 2040 water demand derived from groundwater sources is estimated at 23% which is a decrease of 3% when compared to the 2010 reported use. (Figure 4-11).

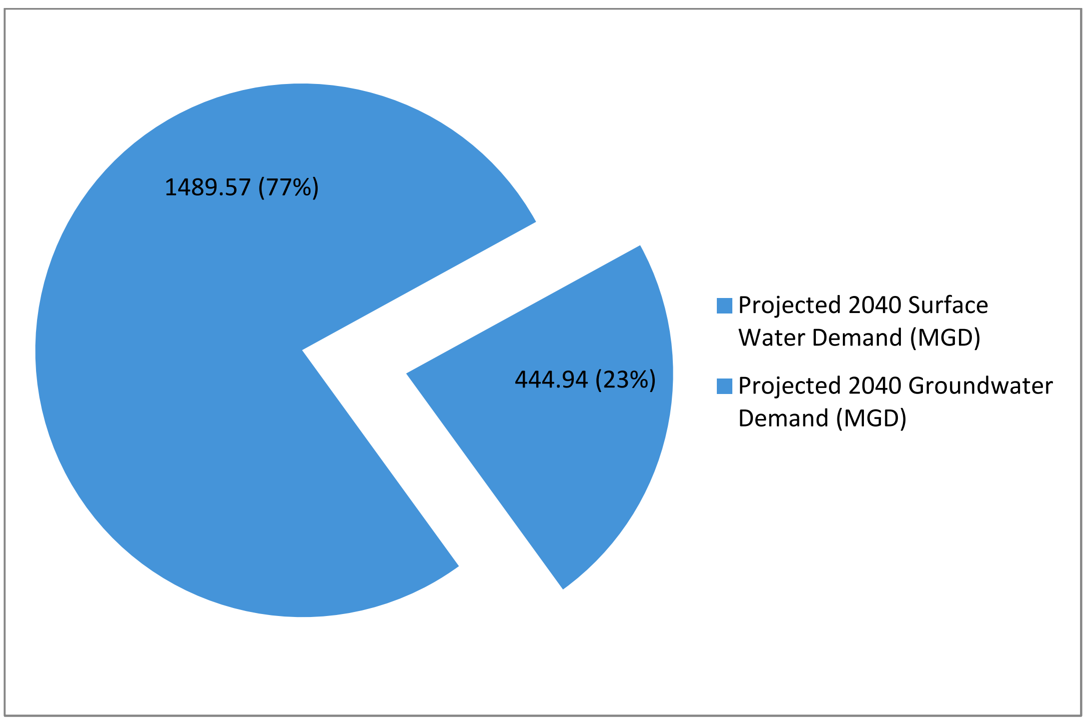

Figure 4-11: Statewide 2040 Projected Demand by Source Type

As shown in Figure 4-12, the total amount of surface water use is estimated to increase from approximately 1,096 MGD to 1,490 MGD in 2040. Groundwater use is estimated to increase from approximately 380 MGD to 445 MGD in 2040.

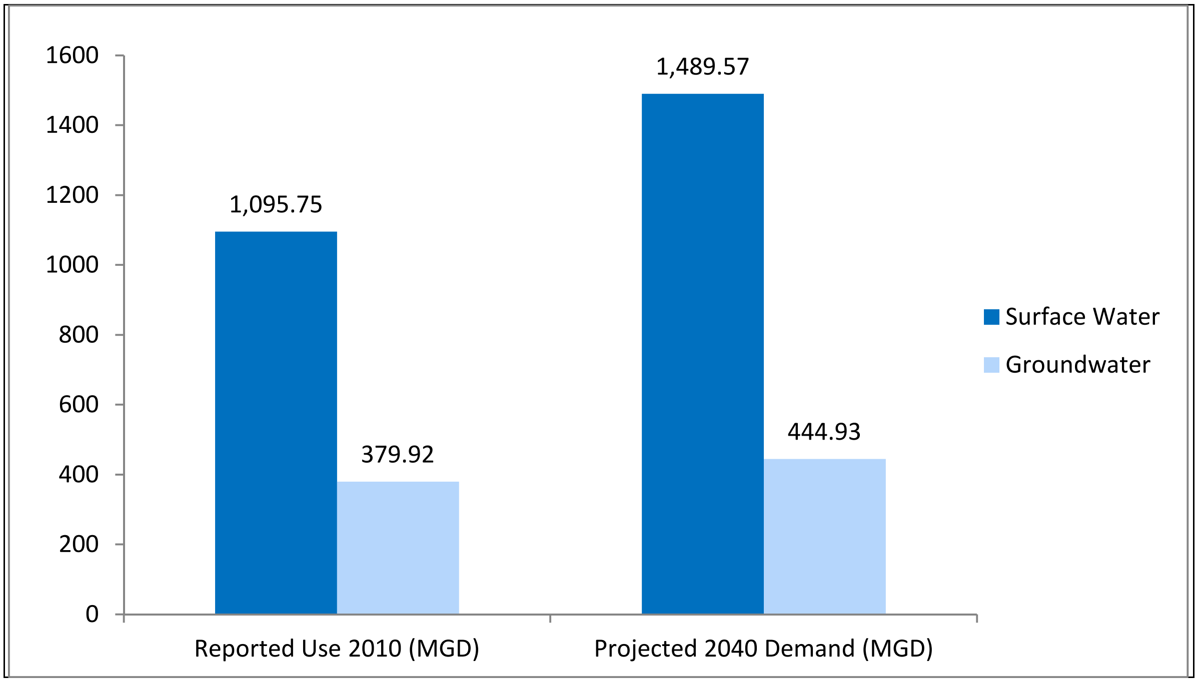

Figure 4-12: Statewide 2010 Reported Use and 2040 Projected Demand by Source Type

Chapter 5 Assessing the Long Term Sustainability of Water Resources

Introduction to Cumulative Impact Analysis

This Chapter contains an analysis which describes the expected cumulative impacts of future water demands on streamflows to assure the long-term sustainability of Virginia's water resources. Sustainability is defined in terms of maintaining the "beneficial uses" that are considered to be essential to the wellbeing of the Commonwealth's human and natural resources. These beneficial uses are protected by law, defined earlier in this State Plan, and include the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, cultural and aesthetic values, public water supply, agricultural uses, electric power generation, and commercial and industrial uses. The various beneficial uses are termed as such because they literally "use" water; however, the ways in which they use the water are varied. Beneficial uses which involve the pumping of water from the stream are considered "off-stream" uses, whereas uses such as recreation, waste assimilation, and aquatic life are considered "in-stream" uses. Different beneficial uses may require water in differing amounts, at different times, and of varying levels of quality. Nearly all uses have a specific set of conditions during which they are most vulnerable to flow alterations. This set of conditions during which a use is considered most vulnerable is referred to as a use's "critical condition." The potential for changes to streamflow under these critical conditions are described as "flow alterations." This analysis produces an assessment of risk to various beneficial uses resulting from alterations to critical flows induced by water supply activity.

Drought as Critical Condition

Although Virginia is generally considered to be a "water rich" state, the Commonwealth still faces infrequent but severe periods of water scarcity that prove stressful to both in-stream and off-stream beneficial uses. These periods of scarcity have their roots in the variations in seasonal and intra-annual meteorology that characterize the climate, as well as the need to rely on surface water to supply a substantial portion of annual water needs. During years with normal to high precipitation, Virginia's net water withdrawal from surface water in non-tidal streams is less than 5% of the median daily streamflow. However, due to seasonal and annual variation in flows, average demands make up an estimated 30% of the total mean flow in Virginia streams during September Drought Warning conditions, further described below. Figure 5-1 shows a map of projected increases in surface water demand for 327 non-tidal river segments simulated for this analysis. This map illustrates the large spatial variation in surface water demands, which results in an unequal distribution of impacts to Virginia's riverine system. This distribution results in some stream segments that are virtually untouched by the human water supply system, and others whose off-stream demand exceeds 100% of flows during periods of drought. During these times of drought, off-stream water demands rely largely on water stored in reservoirs and groundwater sources. Surface flows during this time are dominated by point source returns in many streams, linking the quantity and water quality of downstream flows with those point sources.

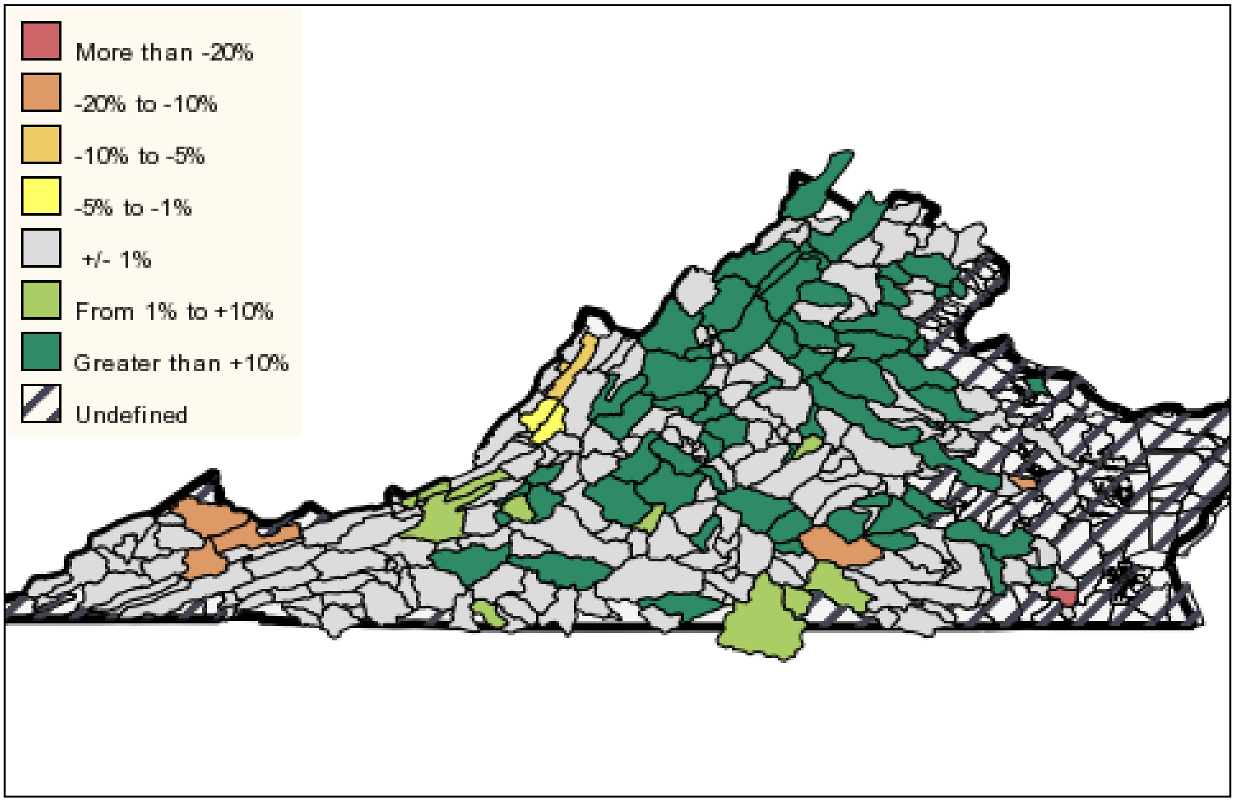

Figure 5-1: Map of the projected change in daily withdrawal from surface waters in non-tidal watersheds in the Commonwealth of Virginia.

Flow Metrics to Describe Risk to Critical Conditions

By integrating the locality-based predictions of future water demand with a process-based model of in-stream flows, this analysis characterizes the probable spatial distribution and likely extent of impacts to the full range of in-stream and off-stream beneficial uses. The increased demands projected by the year 2040 will result in a net decrease in streamflows as a result of consumptive uses and additional stress upon all beneficial uses. The most common critical conditions for beneficial uses in Virginia are periods of low flow, or drought. Therefore, a majority of the metrics selected for analysis will focus on these low flows. Because certain recreational uses require high flows and a growing realization of the positive effects of some storm flows on water quality in the riverine system, analysis was also performed to quantify the potential for reduction of high flows. Overall, four metrics were selected to characterize the extent to which future demands will affect the various critical conditions and beneficial uses in Virginia streams. Table 5-1 has a brief overview of these metrics. A full description of metrics can be found below in the section entitled “Method II: Metrics for Cumulative Impact Analysis.” The thresholds chosen for significant impacts are intended to be "screening thresholds" and are intentionally conservative. They are not a prediction of certain negative impacts, but rather an indication of a potential future impact deserving of greater scrutiny and planning.

Metric Name	Metric Purpose and Description	Screening Threshold
Changes in August Low Flow (ALF)	Watersheds that see substantial changes to ALF will face an increased probability of aquatic life impacts.	Decrease in ALF >=10%
Changes in 7Q10	Areas that suffer decreases in 7Q10 flows will have decreased estimated waste assimilative capacity as well as flows for off-stream uses.	Decrease in 7Q10>=5%
Withdrawals as percentage of September Drought Warning Flows	This measurement is an indicator of cumulative water supply system stress and indicates either substantial decrease in streamflows or reliance on stored water. Streams with withdrawals as a high percent of baseline drought warning flows are considered to have elevated risk of algal blooms due to storm flow capture and/or risk of water scarcity.	Withdrawal >=25% September Warning Flow
Changes in Drought of Record Flow	Drought of Record (DoR) flows are the ultimate limiting factor in safe yield. This estimates the change in flow under DoR meteorological conditions and 2040 projected demands.	Decrease in DoR Flow >5%

Table 5-1: Cumulative Impact Analysis indicators used in the 2014 State Plan; indicators reflect impacts on infrastructure, downstream uses, aquatic life, and assimilative capacity due to increased water use

Method I: Cumulative Impact Modeling

Modeling Objectives, Time-Scale, and Components

The ultimate goal of this modeling exercise was to be able to predict the approximate location, direction, and magnitude of impacts to the in-stream and off-stream water system from increasing water demand and water supply system management actions. The various beneficial uses that are identified in this analysis are impacted by flow variations on an annual, seasonal, and even daily time scale. Therefore, the model analyzed the cumulative impacts capable of simulating the water balance on a daily basis, as well as simulated the variation in conditions expected to occur on a seasonal and annual basis. The baseline flow budget can be greatly altered by the management of reservoirs, withdrawals, and point source discharges. Therefore, a suitable modeling system must be capable of simulating the flow altering effects of the sometimes complicated rule sets that govern these water supply activities. This requires a basic simulation of streamflows, including these fundamental components:

- A baseline flow time series – an estimate of the water entering the riverine system on a daily basis over a “representative” time period. A “representative” time period is generally considered to be one that shows the full range of seasonal and annual climatic variations including “average” years, “wet” years, and “drought” years.

- An inventory of current water withdrawals and discharges and a projection of future water withdrawals and discharges.
- A simulation of operational rules for water supply entities (withdrawals, reservoirs) with known operational triggers.
- Major reservoirs - Minimum flow releases were simulated for major reservoirs where operational rules were known. Operational rules for this simulation came from previously simulated VWP modeling evaluations and from information gathered during the water supply planning process.

Understanding the Water Budget

To understand the extent to which activities produce flow alterations, an assessment of basic components of the flow budget (natural inflows, withdrawals, and discharges) must occur, as well as a perception of the natural variability that exists in the riverine system. These basic components are then represented in a water supply system model that helps quantify the relative effects of complex management actions on the system. Once the means to quantify the basic driving forces of the water budget is developed, the assessment of flow alteration can occur.

Baseline Flow Budget

A critical tool in water supply management is the construction of what is often referred to as a "baseline flow budget." This budget is estimated by constructing a model of the flows through a river system *without* including withdrawals, discharges, or detainment of water by lakes or reservoirs. By considering the quantity, quality, and timing of flows into and through a river system, the baseline budget allows for the determination of total capacity, assessment of system stress due to water supply activities, and setting reasonable expectations for potential beneficial uses. In sum, the baseline flow budget allows for the creation of an accurate accounting of the ways a current or future beneficial use alters the quantity, quality, and timing of water flows throughout the system.

A baseline flow regime can also be used to set reasonable expectations of the beneficial uses that can be maintained in the watershed. For example, the baseline flow regime identifies the total water budget that is available for sharing amongst the beneficial uses during drought. By comparing a stream’s baseline drought flow values to the total water demand in the stream, a sense of the stress imposed on the stream and/or water supply system can be determined. If a stream’s demands are equal to a high percentage of its baseline flow at any time, this means that either downstream beneficial uses will see flow reductions, reservoir storage will be depleted, or off-stream demands must temporarily decrease due to conservation restrictions. Baseline flows can also be used to determine recreational potential since it would be unrealistic to expect that a slow moving Coastal Plain stream could be managed to produce frequent, high quality whitewater rafting flows. Similarly, a small, flashy mountain stream whose summer flows slow to a trickle would be hard pressed to meet the demands of a large community water system without a large storage reservoir to supplement demands during drought. In short, the baseline flow regime shows how much water can potentially flow into a reservoir during drought, the native flow conditions for aquatic organisms, the potential for recreational uses such as boating and rafting, and the potential variation in in-stream flows during wet and dry months, and normal and drought conditions.

In order to establish a baseline flow budget, a hydrologic model is employed to provide a simulation of rainfall, runoff, percolation into groundwater tables, and flow into streams.

Rainfall-Runoff Model Scale, Scope, and Accuracy

When attempting to quantify the status of a water supply system, the various components that play a role in governing water availability in the system must be identified, and the initial water budget that the system has to work within must be quantified. Rainfall-runoff models can be very useful tools in this endeavor since they allow the piecing together of the various elements in a way that shows the influence of the various impoundments, withdrawals, and discharges. Rainfall-runoff models also allow the quantification of the effects of reservoirs in evaporation. The baseline runoff flow and sub-watershed units used for simulation and analysis in this study came from a decision support system referred to as VAHydro.

VAHydro simulates complex reservoir and withdrawal operational rules, a physically-based channel routing methodology, and has a surface water hydrology and hydrography component built on the hydrologic framework established in the development of the Phase 5.3 Chesapeake Bay Watershed Model (CBP5), which was expanded to include areas of Virginia outside of the Chesapeake Bay watershed. The CBP5 model runs on an hourly time step (15 minutes in some areas), and has a 21-year simulation time period from 1984 to 2005, which is considered to adequately represent the range of meteorological conditions common to Virginia. This model was calibrated using flows from over 140 continuous flow gages and produces flows for 327 non-tidal stream reaches in Virginia. The only streams that are not modeled are those that are subject to significant tidal influence. While the un-modeled tidal streams represent a significant portion of the Commonwealth’s total area, water use in these areas is predominantly from groundwater sources, whose cumulative impacts are assessed in the Virginia Coastal Plain Model of groundwater aquifer pumping. Figure 5-2 shows a map of the VAHydro sub-watersheds modeled during this analysis.

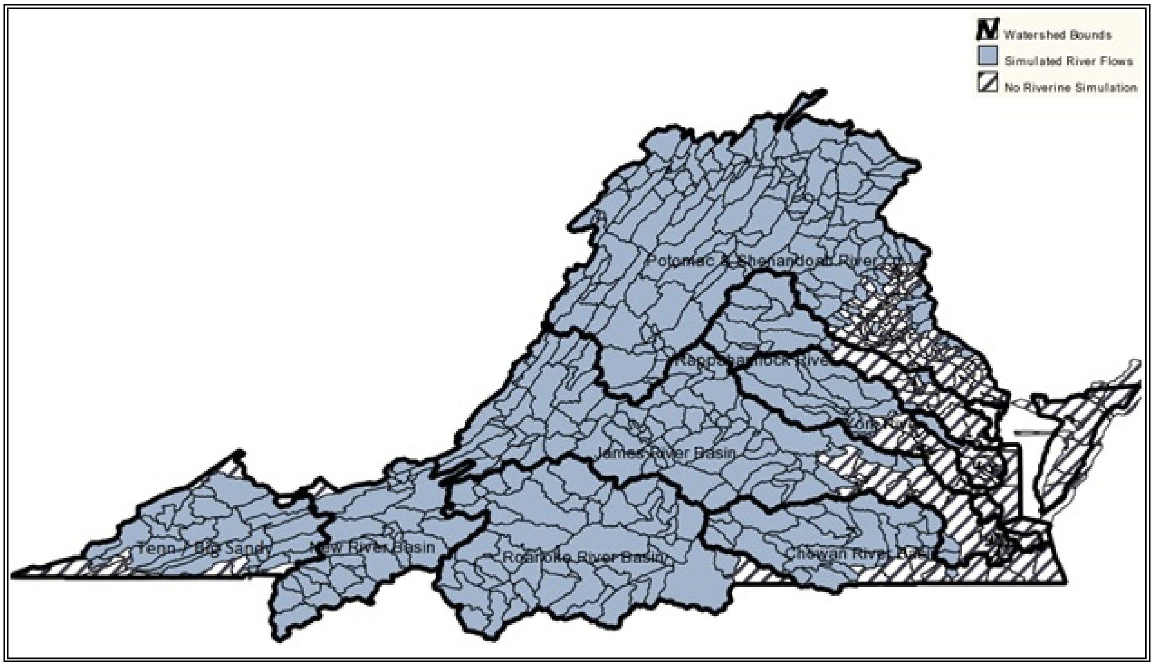

Figure 5-2: A map of the extent of the VAHydro rainfall-runoff model for simulation of the cumulative impacts of current and future water supply actions; cross-hatched areas are not simulated because of significant tidal influence or drain outside of Commonwealth boundaries

The CBP5 model was reviewed by DEQ in 2006 and determined to have a reasonable level of accuracy for total water budget: 82.9% of the 141 gaged streams were within 15% of total annual measured flows for a 16-year calibration/validation period, and 92.2% were within 20%. Of the largest 50% of basins, the results show 90.1% of modeled flows within 15%, and 97.2% within 20%. Reasons for hydrologic model error can be the result of simplifications in the modeled processes, errors in data input, and errors in the observed values of flow gages when estimating flow rates outside of the gages observed record. Sources of error in the CBP5 model may be the result of errors in the VWWR Regulation water withdrawal records, which suffered from gaps early in the record; precipitation variations; and failure of the assumption that groundwater boundaries conform to surface water boundaries (both of which become increasingly important in smaller basins).

For an investigation such as this, absolute model error is less critical than understanding the general direction of changes. By calculating the difference between current conditions and projected future conditions, model errors may impact the magnitude of predicted flow changes, but they will not affect the direction of those flow changes. For example, in a stream reach that is expected to see increased consumptive demands from direct withdrawals, seasonal low flows will decrease, and the numerical models used for this analysis will never predict an increase.

Data Sources and Assumptions

The water supply planning data set contains estimates of the water use in Virginia based on data gathered during Virginia's water supply planning effort. The values given in this dataset reflect the best assessments of water use as of 2010 and projected water use in the year 2040. The rates of current and future water withdrawal in this dataset are based entirely on data submitted to DEQ in the local and regional water supply plans and represent a more comprehensive picture of water supply activities in Virginia than has ever been assembled. Nevertheless, sources of uncertainty exist, most important of which are as follows:

- Monthly variation – 37% of systems included monthly variation information. Monthly use patterns can also vary considerably from year to year within a given system, especially in the case of CWS water withdrawals. Given this uncertainty, monthly variation was not considered in this simulation.
- Water withdrawal magnitude - Water withdrawals were estimated based on the data submitted during the water supply planning process from every locality in the Commonwealth. Demands in the Potomac River Basin outside of Virginia were obtained from estimates developed during the 2009 Middle Potomac River Watershed Assessment. Current and projected demands for areas in the Dan River in North Carolina were obtained from the North Carolina water supply planning website.
- Water withdrawal location – The WSP Regulation did not require the submission of precise location information for withdrawals. However, many of the systems report under the VWWR Regulation (VWUDS database), and significant efforts were made to link the location of these systems to entries in the VWUDS database for the purpose of more accurate spatial scale for simulation and analysis purposes. Locations of systems for which no VWUDS linkage was established were located according to the reported locality, or if lacking locality information, they were located at the center of their planning region. Overall, DEQ established links to the VWUDS database for 922 out of 2,836 water supply systems, roughly 33% of systems.
- Point source flows – Point source data was not required by the WSP Regulation, so estimates were made based on the VPDES database, with monthly varying flows based on the average reported discharge values from the years 2005-2009. Consumptive use fractions for future withdrawals are an area of high uncertainty. When looking at a small basin scale, water is often withdrawn from one stream only to be returned via point source discharge in another stream nearby. For areas of the Potomac River outside of Virginia, point source estimates developed during the 2009 Middle Potomac River Watershed Assessment were used. No point sources discharges were simulated for areas of the Dan River in North Carolina.

Consumptive Use Definition and Assumptions

"Consumptive use" describes the net loss of water from the riverine system as a result of evaporative losses due to off-stream use or due to detention in in-stream impoundments. The water removed from streams for off-stream uses is divided into a "consumptive" and "non-consumptive" fraction. The "non-consumptive fraction" is the portion of withdrawal that is returned to the stream via a point source discharge. An evaporative loss, or "consumptive use fraction," is that portion of a withdrawal that is not returned to the stream. One of the main objectives of this analysis and water supply planning process is to ensure against future water shortages and unforeseen negative impacts to in-stream beneficial uses. For this reason, it is important to make assumptions about consumptive use that are conservative, erring on the side of assuming a higher level of net consumption from water use activities. Because of the uncertainty in both consumptive use and monthly use pattern variation, no increase in point source discharge is modeled, but the mean reported rate of discharge was used, varying by month, for the years 2005-2009. This assumption will likely result in an underestimation of future discharges. Future withdrawals, on the other hand, were modeled without monthly variation due to the inconsistency in reporting of monthly variation amongst the water supply systems. This will have the effect of likely underestimating summertime withdrawals, particularly in July and August. The result of underestimating both point source discharges and withdrawals will result in a conservative estimate of flow reduction, but will preserve the spatial distribution of expected flow alterations.

Major Reservoirs under Construction or with New Operational Rules

Given that water supply infrastructure development and permitting changes are constantly under way, it can be challenging to select a point in time that represents "current" conditions. Major reservoirs have the greatest potential to make immediate changes to surface water hydrology. The following criteria were used to determine whether or not to model the presence of a new major water supply impoundment or major alteration to the management of an existing impoundment.

- Projects that have VWP permits issued as of fall 2013, but that have not yet been constructed, were not modeled as part of "Current Condition" model runs. These projects were included in "Projected 2040" model runs, allowing more understanding to the changes due to demand, as well as due to currently approved strategies to meet that demand.
- Projects with newly issued or re-issued VWP permits between winter 2010 and fall 2013 that require no change in infrastructure for operation were modeled in both current and projected 2040 scenarios.

Method II: Metrics for Cumulative Impact Analysis

Flow Statistics and Metrics

A common method in hydrologic analysis is the use of the "flow statistic" – a statistical calculation of the magnitude of flow that occurs at a specific frequency at a certain time of year. The Commonwealth's drought flow indicators are one example of flow statistics.[60] Water quality programs, such as the VPDES, also use flow statistics to characterize the capacity of a stream to assimilate waste products. Aquatic biologists also use flow metrics to describe critical conditions for living organisms in streams. For a study of the impacts of changes to water supply needs, it is important to select flows that are known to be readily impacted by common water supply activities. These flow statistics are used to characterize current and projected future streamflows as a result of water supply activities. The potential impacts of future water supply needs are estimated by calculating the percent change between current and future flow conditions as described by these flow statistics. The percent change that results is described as a "flow alteration metric" for this study.

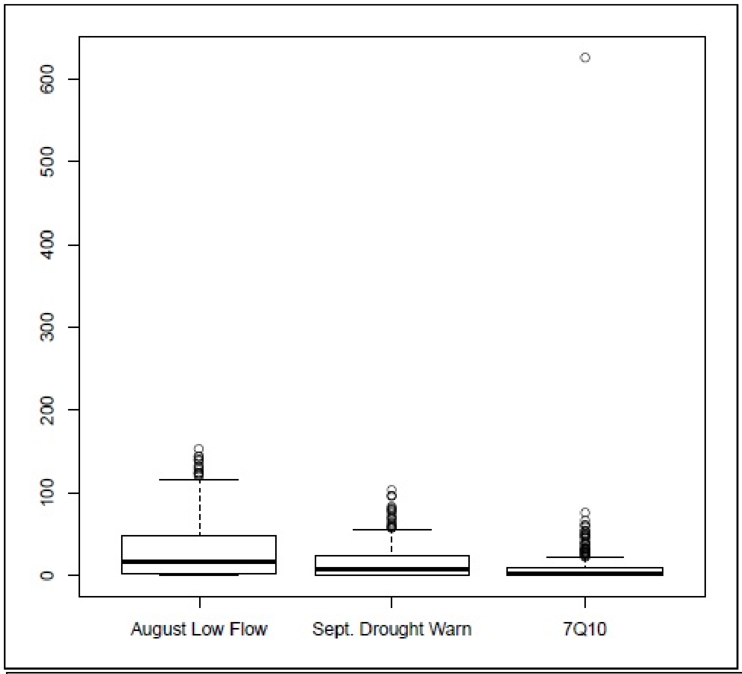

Figure 5-3: Box and whisker plot of the three flow statistics selected for this State Plan. These plots show relationships between the median, standard deviation, and outliers for small to medium sized streams within the Commonwealth.

To address the critical condition most susceptible to water supply management decisions, this study calculated a variety of alteration metrics based on the following three flow statistics which represent three separate beneficial uses:

- August Low Flow (ALF) – An indicator of the biological system carrying capacity as influenced by minimum flow volumes. ALF values tend to describe a moderately dry condition that falls outside of the drought ranges specified by the Virginia drought flow thresholds and are the highest flow statistics considered in this study (see Figure 5-3).
- September Drought Warning – The drought flows associated with voluntary water restrictions in the Virginia Drought Assessment and Response Plan.[61] September drought warning flows describe a condition of moderate drought, with a median value that falls in between the ALF and 7Q10 values found in Virginia streams (see Figure 5-3).

[60] http://www.deq.virginia.gov/Programs/Water/WaterSupplyWaterQuantity/Drought/DroughtMonitoring.aspx
[61] http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterResources/vadroughtresponseplan.pdf

- 7Q10 – A common flow metric used to establish point source discharge limits. This statistic describes a flow condition that is expected to occur only one time in a 10-year period, and is the lowest flow statistic used in this analysis, with the exception of the drought of record flow (see Figure 5-3).

In addition to these three basic flow statistics, an additional numerical indicator was developed to characterize the potential change to streamflows during a repeat of the meteorological conditions during the historical drought of record. The 2002 drought was the drought of record for a majority of the Commonwealth, and the month of September was the lowest flow month during this period. Therefore, the simulated mean daily flow for the month of September was selected as the Drought of Record (DoR) flow indicator for this analysis. Models were run to simulate the mean daily September flows that would result from 2002 meteorological conditions and current consumptive withdrawal values with projected 2040 consumptive withdrawal values. The percentage differences in streamflow between those two consumptive withdrawal scenarios was calculated as a representation of the potential for changes in future water supply demand to exacerbate the most critical drought flow conditions in the future.

This choice of flow statistics provides benefit beyond the specific beneficial use that they represent. They also describe a full range of the months (July through October), and flow ranges (moderately dry to extreme drought) that define the critical conditions common to a majority of beneficial uses. The calculation of flow-alteration metrics from these basic flow statistics are described in detail in Table 5-2.

Metric Name	Metric Purpose and Description
Change in August Low Flow (ALF)	Watersheds that see substantial changes to ALF will face an increased probability of aquatic life impacts. The potential for these impacts will present a challenge for the issuance of new or expanded withdrawal permits and may benefit from investment in increased biological monitoring to determine the real impacts at higher levels of flow alteration. While increased reservoir storage is one option to consider in alleviating these impacts, it is often difficult to maintain higher August releases and flow-bys given that the most significant droughts last through September and into October. Only reservoirs with very large amounts of storage relative to demand are able to sustain off-stream needs without reducing flows in the early months of drought. Stream segments with greater than a 10% reduction in ALF were considered to be of high risk.
Change in 7Q10 (7Q10)	Areas that suffer decreases in 7Q10 flows will face choices that involve reducing consumptive demands, increasing reliance on stored water during dry periods, or reducing the amount of

	waste discharged from point sources. These choices will involve weighing the cost-benefit associated with upgrading wastewater treatment equipment, water supply infrastructure, and creation and/or enforcement of drought ordinances. Because 7Q10 is a low flow that tends to occur in late September and early October, decreases in 7Q10 have implications for water supply operations. Stream segments whose 7Q10 decrease due to increased consumptive withdrawals are considered to be at risk for more severe drought impacts and should engage in a more in-depth analysis of non-permitted water users' capabilities and best practices. Stream segments with greater than a 5% reduction in 7Q10 were considered to be of high-risk.
Withdrawals as Percentage of September Drought Warning Flows (W9W)	This measurement is an indicator of cumulative water supply system stress. Because it is evaluated as a function of the baseline flow budget on a watershed basis, it is one of the best indicators of areas requiring collaborative solutions. It shows the potential for conflict amongst different off-stream uses, as well as the potential for impacts to in-stream beneficial uses. On- and off-stream storage reservoirs may be used to ease demand pressures during drought by capturing flows during high flow periods (summer and fall storms, winter and spring base flows). However, due to the growing realization of the role of storm flows in maintaining water quality and healthy aquatic communities, this approach may ultimately lead to the need for increased biological monitoring and investment in infrastructure needed to develop complex operational management tools and intra-system cooperative agreements. Streams with a high W9W are considered as having a heightened risk of algal blooms due to storm flow capture, as well as having a risk of water scarcity for off-stream uses. Stream segments with greater than a 25% W9W were considered to be of high-risk.
Changes in Drought of Record (DoR) Flow	DoR flows are the ultimate limiting factor in safe yield. This estimates the change in flow under DoR meteorological conditions and 2040 projected demands. Safe yields of withdrawals and reservoirs are directly impacted by reductions to the DoR flow; therefore, even small changes to the DoR flow are considered to be of critical concern. For this reason, river segments with greater than 5% reduction in DoR flow were considered to be of high-risk.

Table 5-2: The "flow metrics" used in this State Plan to indicate risk of negative impact to beneficial uses from flow alteration caused by cumulative water supply activities

Modeling, Characterizing Uncertainty and Managing Risk

Risk management is defined as "quantifying the effect of uncertainty on objectives." Given the considerable uncertainties in a forward projection exercise, it is extremely important to characterize the sources of uncertainty and the potential magnitude of uncertainty as accurately as possible. It is also important to identify strategies for managing that risk and responding to those uncertainties. In water supply projection, the greatest sources of uncertainty are those that are not subject to any form of regulation, such as population growth, economic development, geographic distribution of growth, and climatic variation. The regulated uncertainties, such as the acceptable level of alteration in a given stream, will all be bounded by the unregulated uncertainties in this case. For example, a regulation that requires no more than 20% decrease in ALF would be of concern only in areas where there was a high probability of demands growing beyond a certain finite level.

The effects due to uncertainties in geographic distribution can be analyzed by using a probabilistic approach to quantifying model results. By looking at the range of values of impacts that are predicted as a function of the given water supply plan projections, a sense of the range of predictions can be determined. An assumption can be made that some projections will fall short, and some will be exceeded by the actual growth in water supply demand that occurs by 2040. In other words, if the assumption is made that errors in prediction are randomly distributed in a normal, or "bell curve" shape, then the median predicted demand increase is a good estimate of the median demand change that will occur in 2040. If this assumption is true, then a prediction can be made that overall the median predicted flow alteration may represent a good estimate of the level of risk to streams in a given area.

Projection Uncertainty and Operational Rules

There are several sources of uncertainty in predicting the cumulative impacts to in-stream flows as a result of future water supply system change. The most common in this analysis are as follows:

- Projecting demand magnitude - Demand projections in the Commonwealth are highly linked to population growth; therefore, if population growth is greater or lesser than projected, demands will likewise be greater or lesser.
- Geographical distribution of growth - Localities used their best judgment as to where it was believed that future growth would be likely; however, it is believed that there could be considerable differences in the actual geographic distribution of new water demands. If demands occur in different watersheds than currently predicted, the source of the water needed to meet those demands will be expected to change as well.
- Operational uncertainty - Water withdrawals and reservoir operations may vary widely from day to day and season to season. Also, the level of knowledge of these operations differs widely depending

on the water system's permit status. There is a very strong understanding and ability to simulate the operations of systems that are covered by a VWP permit, 401 Certification, or some known voluntary management rule set (see Chapter 2, Virginia's Collaborative Management Framework). For other grandfathered or exempt operations, knowledge of these operations is incomplete. While the larger withdrawals fall into the category of known operations, in areas with a large number of small unknown operations could potentially result in significant model error.

For these reasons, the expected impacts will be examined as indicating a greater or lesser probability of some negative impact, rather than as an absolute prediction of an impact. While considering the streams with the greatest potential for impacts, statistical descriptions such as Median Projected Impact over a group of streams will be examined. The median impact over a group of streams will possibly represent a more likely consequence of the projected growth in demand, since the permitting process tends to encourage distributing demands to less impacted areas in order to minimize the incidence of high levels of degradation. Areas that are predicted to have either a large potential for demand growth or large potential for beneficial use impacts should be evaluated further, with emphasis placed on obtaining greater level of detail for operations as well as limits to growth.

To understand the extent to which activities produce flow alterations, an assessment of basic components of the flow budget (natural inflows, withdrawals, and discharges) must occur and understanding the natural variability that exists in the riverine system. These basic components are then represented in a water supply system model that allows the quantification of the relative effects of complex management actions on the system.

Annual and Monthly Flow Variability

Streamflows in Virginia are highly variable due to the substantial variation in rainfall (see Chapter 3, Virginia's Environmental Resources for a discussion of Virginia climate). There are significant variations from year to year and from month to month within a single year. For example, in the Big Otter River near Evington, Virginia, mean daily streamflows varied from a low of 67 cubic feet per second (cfs) in 2002 to a high of 570 cfs in 1987, a difference of over 900% (see Figure 5-4 for annual flow rates for this gage from 1984-2005). Streamflows also vary from month to month as a result of differences in evaporation and transpiration, with the highest streamflows usually occurring in cooler winter and spring months, and the driest months occurring when temperatures are highest in the summer and early fall. Figure 5-5 shows an example of this variation, in the Big Otter River at Evington Virginia. At this gage, the month with the highest median flow (March, 372 cfs) has more than three times the flow than the lowest flow month (September, 103 cfs). In addition to these temperature-driven variations, streams in Virginia can see some of their highest flows as a result of hurricanes in the late summer and early fall months. The years with high temperatures, low winter rainfall, and little to no tropical storm/hurricane activity produce the most severe droughts. Because of these wide variations in flows, planners, engineers, and permitting agencies commonly focus on the driest years and months when determining the amount of water that is available for withdrawal from streams.

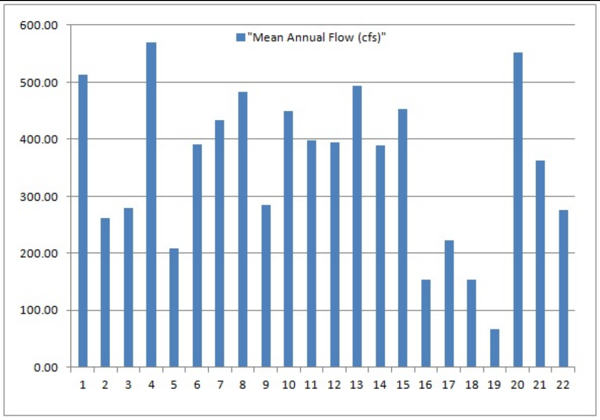

Figure 5-4: Observed average daily streamflows by year in the Big Otter River near Evington VA (USGS 02061500) from 1984-2005. This period saw a low of 67 cfs, an average of 354 cfs and a high of 570 cfs

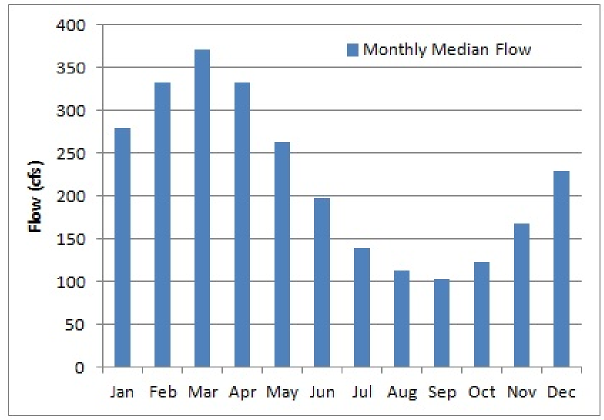

Figure 5-5: Observed median daily baseline streamflows by month in the Big Otter River near Evington VA from 1936-2013

Quantifying Hydrologic Drought

As a result of the severe drought in 1999-2002, the Commonwealth developed a set of measurements to define the occurrence and severity of drought conditions. The measurements used for this drought designation are based on rainfall, groundwater well levels, soil moisture, and streamflows. While the water supply activities that are covered in this State Plan cannot affect rainfall and soil moisture, they can have a substantial impact on both streamflows and groundwater well levels. Drought that is associated with only streamflows and groundwater levels is often referred to as "hydrologic drought." Because of the limitations of Virginia's current groundwater monitoring and modeling tools, and because streamflows are generally more sensitive to short-term changes than groundwater levels, this discussion is limited to those drought indicators that pertain to streamflows.

It is common to characterize the relative "dryness" or "wetness" of a stream according to its ranking relative to all other flows that have ever been recorded in that stream. This ranking formula is known as a "non-exceedance percentile," which literally answers the question "what percentage of flow measurement that has been taken at this location that is LESS than the current value?" In Virginia, a stream's drought status is considered to be either "Normal," "Drought Watch," "Drought Warning," or "Drought Emergency" based on a monthly "non-exceedance percentile." This ranks a given daily flow against all other flows that have been recorded at the site in a given month. Based on where a given daily flow reading is ranked in this table, the stream's drought status is determined as follows:

- Normal (>25%) - When streamflows in a given month are ranked at or above the 25th percentile, that gage is said to be in "normal" conditions.
- Watch (between 10-25%) - When the stream gage reads between the 10th and 25th percentile, the stream is said to be in a state of "drought watch."
- Warning (between %) - When the stream gage reads between the 5th and 10th percentile, the stream is said to be in a state of "drought warning."
- Emergency (less than 5%) - When the stream gage reads less than the 5th percentile, the stream is said to be in a state of "drought emergency."

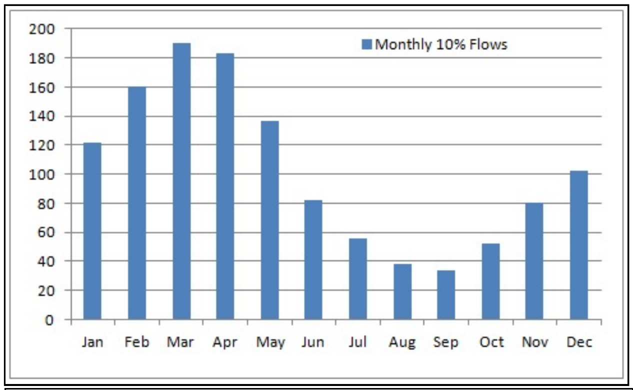

Figure 5-6: Observed monthly 10 percent non-exceedance flows average streamflows in the Big Otter River at Evington VA (USGS 02061500); the 10 percent flows correspond to a "drought watch" status according to the Virginia statewide drought indicators

For an example of "Drought Warning" flow levels, Figure 5-6 shows a plot of the monthly 10% flows in the Big Otter River. Based on this chart, in the month of August, an observed flow that is less than 38 cfs is considered to be below the 10th percentile, and, therefore, is categorized as a drought warning flow. Table 5-3 shows the full range of monthly historical flow non-exceedance percentiles for this same stream gage for all months of the year.

	Min	5%	10%	25%	50%	75%	90%	95%	Max
January	57	105	122	189	280	436	725	1,060	11,700
February	78	137	160	218	333	518	802	1,140	8,140
March	75	165	190	260	372	563	898	1,320	10,700
April	81	159	183	231	333	502	792	1,080	10,700
May	52	116	137	183	263	391	598	873	12,400
June	11	66	82	128	197	281	477	729	35,700
July	4.2	41	56	86	140	211	370	546	6,440
August	0.75	27	38	63	112	189	349	589	12,400
September	0.64	25	34	59	103	170	318	549	20,200
October	8.4	36	52	78.5	122	199	348	615	12,700
November	28	67	80	112	167	271	478	704	12,400
December	42	84	102	143	230	356	613	913	9,700

Table 5-3: Observed annual average streamflow in the Big Otter River at Evington VA (USGS 02061500) from 1984-2005; flow values for 5th, 10th and 25th percentile correspond to the drought Watch, Warning, and Emergency thresholds for a given month

Flow Alteration

In general, anything that affects the quantity, quality, or timing of streamflows can be said to be a "flow alteration." Flow alterations due to human activities are understood to varying degrees. The most common and powerful flow alterations, such as reservoir management, water withdrawal, wastewater discharge, stream channel engineering, evaporation of reservoir surfaces, and land use change are very well understood in terms of their effects on river flows. Engineers can predict the flow alterations due to changes in water supply operations with a high degree of accuracy. Other activities, such as the depletion of groundwater tables due to pumping and the subsequent effects on streamflows, are less understood. Table 5-4 shows the largest water supply system contributors to alteration and an indication of the understanding of the nature and extent of their effects. Because these activities can change the quantity, quality, and timing of flows, they can have significant impacts to other beneficial uses in their watershed.

Flow Alteration Activity	Average Flow	Low Flow	High Flow
Water Supply Dams	-	+	-
Surface Water Withdrawal	-	-	-
Groundwater Withdrawal	-?	-?	?
Point Sources	+	+	+
Flood Control Dams	*	?	-
Impervious Area	+	-	+

"+" an increase in the specified flow component is well captured by current modeling techniques.
"-" a decrease in the specified flow component is well captured by current modeling techniques.
"-?" a decrease in the flow component is NOT well captured by current modeling techniques.
"+?" an increase in the specified flow component is NOT well captured by current modeling techniques.
"?" indicates that changes vary on a case by case basis
"*" An asterisk indicates no appreciable change

Table 5-4: Water supply system activities and infrastructure that are the largest contributors to flow alteration in Virginia

Flow Altering Effects from Groundwater Pumping

While it is understood that some of the water that is pumped out of shallow wells "intercepts" flows bound for the stream channel, outside of the Coastal Plain the groundwater monitoring networks are too small to construct adequate predictive models over large geographic areas to say with any certainty what the likely impacts of continued and expanded pumping will be over the next 30-50 years. It can be inferred that flow alterations due to groundwater pumping effects are most likely to be noticed during low flows, making flow alterations a critical piece of information to have as pressure on the water resources grow. Also, it becomes clear that climate is not a static background variable, but one that may change substantially in a single lifetime. Therefore, as groundwater pumping within and outside of the Coastal Plain increases, monitoring networks need to expand and increase the availability of subsurface flow models to avoid being surprised by unforeseen changes to in-stream flows and groundwater system failures. In the course of the cumulative impact analysis conducted for this State Plan, areas outside of the Coastal Plain that are subject to the greatest current and future groundwater pumping will be determined, and simulations using next generation groundwater models inside of the Coastal Plain aquifers will be performed.

While great uncertainties do in fact exist, the first step in any analysis process is to collect available data for review. By examining the spatial trends in current and future groundwater pumping rates throughout the Commonwealth, an assessment of the probability that noticeable base flow impacts in a given area based on the magnitude of projected withdrawal over a given area can be developed.

Beneficial Uses and Flow Requirements

In order to assess the long-term viability of a given beneficial use, quantifying the ways in which streamflows affect that use is needed, termed generally as its "flow needs." For example, public drinking water supply requires a certain minimum amount of water each day to maintain human health. Therefore, during a drought event, there must be either sufficient "in-stream flow" to serve drinking needs, or sufficient "off-stream" or "in-stream" stored water (such as that in reservoirs). Another example would be certain migratory species that require high flows of cold water during the spring to trigger spawning runs. In general, a given beneficial uses' "flow needs" can be described in terms of the quantity, quality, and timing of water needed to maintain that use at some desired level of viability or productivity.

Critical Flow Conditions

One approach to defining flow needs is to identify the period in time, or general conditions, under which a given beneficial use is most vulnerable. This set of conditions of greatest vulnerability is often referred to as the "critical conditions" for that beneficial use. The flow needs of the various beneficial uses are understood to different degrees by scientists, with some needs being far more clearly understood than others. Given long experience with human water supply, it is relatively simple to quantify the minimum drinking water requirements for a known population of humans, with the critical condition obviously being drought. There is a good understanding of recreational flow needs and water quality needs. Additionally, there is a good understanding of the flow needs of a small number of aquatic species, but it is extremely difficult to determine the exact in-stream flow needs for all forms of aquatic life due to a lack of adequate data and targeted monitoring. As greater and greater levels of management are imposed on stream resources, an increase in both the understanding of the needs of each beneficial use and the impacts caused to other beneficial uses by water management decisions will be necessary.

Critical Periods for Beneficial Uses

Table 5-5 shows a list of eight general flow components corresponding to seasonal high and low flows, and five general beneficial uses or water supply infrastructure. An "X" indicates that the given beneficial use is susceptible to decreases in the corresponding seasonal flow component. The list of beneficial uses includes two different uses for human water supply, reservoir and direct withdrawal, because these two methods of providing off-stream water differ in terms of their critical condition. This is by no means an exhaustive list. However, it does describe the more common critical conditions faced by operations in the Commonwealth, given the historic pattern of seasonal climatic variations.

Season/Flow	Direct Withdrawals CWS/SSU/AG	Reservoir Storage CWS/SSU/AG	Aquatic Life	Waste Assimilation	Regulation of Algal Blooms
Winter High					
Winter Low		X			
Spring High			X		
Spring Low		X	X		
Summer High			X		X
Summer Low	X	X	X	X	
Fall High			X		X
Fall Low	X	X	X	X	

Table 5-5: Beneficial uses and their vulnerability to decreases in various seasonal flow conditions

Flow Needs and Cumulative Impacts

Evaluating System Stress during Drought Flows

The drought flow triggers established by the Commonwealth (see Table 5-1 and drought indicators in "Quantifying Hydrologic Drought") are useful because they represent flow values that have been shown to place stress upon the water supply system. The drought flow triggers established by the Commonwealth (see Table 5-1 and drought indicators in "Quantifying Hydrologic Drought") are useful because they represent flow values that have been shown to place stress upon the water supply system. They are a fairly common occurrence and, if stream withdrawals are high, they have a potential for ecological impact.

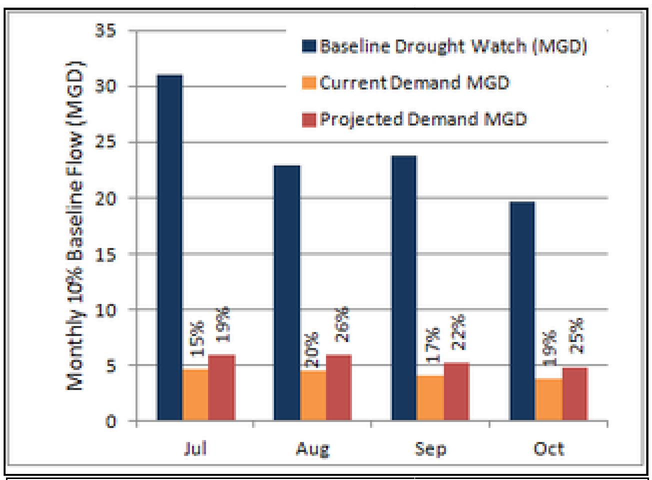

Figure 5-7: A plot of monthly 10% flows for July-October along with the current and projected mean daily surface water demands

By comparing a stream's baseline drought flow 10th percentage value to the total water demand in the stream at that time, a sense of the stress imposed on the stream and/or water supply system can be determined. For example, if a stream's demands are equal to a high percentage of its drought watch flow, this means that either downstream beneficial uses will suffer flow reductions, off-stream storage will be depleted, or demands must temporarily decrease due to drought restrictions. Figure 5-7 shows an example of this approach with current and projected surface water demand as compared to monthly baseline drought triggers in the Big Otter River for the months July-October. It can be seen that total demand in this stream is between 15-20% of the baseline drought watch value for all of these months. The projected demand is between 19-26% of the baseline water budget under drought watch conditions (the monthly 10% flow).

This metric is unique in this analysis because it aims to assess risk to multiple beneficial uses. As demands grow relative to drought flows, localities have invariably sought to augment their water supplies with stored sources of water. Aquatic biologists have long maintained that storage reservoirs may intercept storms that are critical for downstream water quality maintenance, and a recent study by the USACE at the Gathright Dam bolstered that understanding with scientific data. It was shown that harmful periphyton blooms were occurring downstream of the Gathright Dam and that these blooms could be nullified or prevented by moderately-sized storm flows being released from the Dam (for more information: http://www.nao.usace.army.mil/Portals/31/docs/regulatory/publicnotices/2012/Dec/GathrightDamLowFlowAugmentation_EA.pdf).

Impacts to Aquatic Life

Similar to flow needs for human uses, a given stream will tend to support specific types of aquatic and riparian life because of the quantity, quality, and timing of flows that naturally occur in that stream. Flow recommendations for protection of aquatic life have varied over the years as understanding of stream biology has evolved. Two major types of data-driven efforts have historically been undertaken to quantify critical conditions for aquatic organisms:

- "Flow-Habitat" analysis, such as the In-stream Flows Incremental Methodology (IFIM), which uses stream surveys and flow measurements to predict available habitat for aquatic organisms under varying flow conditions. Available habitat can identify conditions at specific locations in the stream under critical periods, but it is very data intensive and costly.
- "Flow-Ecology" analysis uses statistical analysis of flow regimes (distribution of high, medium, low, and hydrograph shape) that are found to coincide with the life-stage needs of specific types of aquatic organisms. This analysis characterizes risk to organisms from flow alteration in streams by the percentage deviation from the reference flow regime conditions. It is less data intensive than Flow-Habitat studies, but faces the challenge of finding appropriate reference conditions.

The models developed during this process can be useful for understanding the needs of fish, aquatic insects, and riparian vegetation from both a "flow-habitat" and a "flow-ecology" perspective. Because of the diversity of aquatic and riparian species and the complex interactions amongst the different elements, the flow needs of the aquatic ecosystem are much more difficult to define than human needs. However, by evaluating changes in flow-habitat and flow-ecology metrics from the standpoint of current conditions versus future conditions, a sense of where changes are likely to occur can be determined, as well as a means for characterizing relative change between different streams. While this does not provide definitive guidance on the absolute limits of allowable change, it enables the targeting of adaptive management approaches and monitoring based on areas of greater relative change.

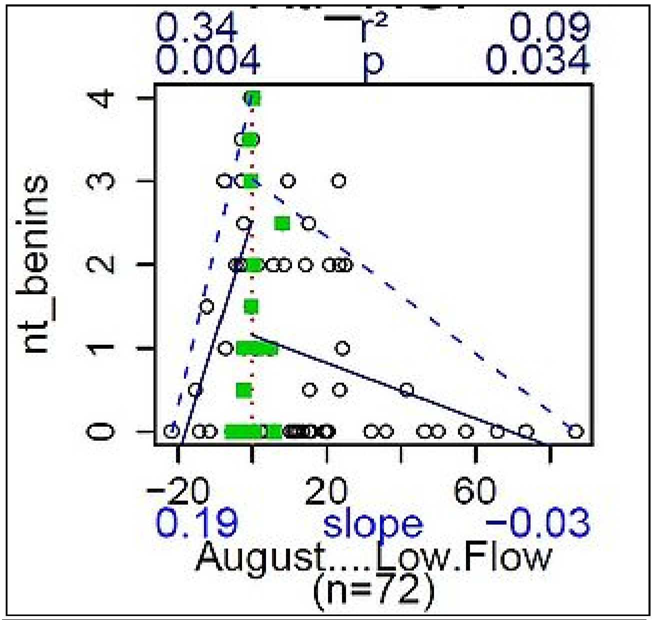

Figure 5-8: A plot of number of Taxa benthic insectivores as a function of alteration in August minimum flow in non-tidal Virginia streams (2011 USEPA sponsored Healthy Watersheds Initiative study)

Impacts to Aquatic Biology: Reductions in August Low Flow

August is considered by aquatic biologists to be a critical month for many riverine species, with a high potential for negative impacts due to flow reductions during this time. Recent research support this hypothesis, showing evidence that decreases in flows as reflected in a stream's ALF value may result in a measurable loss of biodiversity. The ALF statistic is a good addition to the suite of metrics used in this analysis because it represents a moderate flow value more similar to the 25% Drought Watch threshold, in contrast to the Virginia five and 10% drought thresholds and the 7Q10, which tend to represent more extreme low flow conditions. Because of historical recommendations to avoid flow alterations of greater than 10% and recent studies suggesting a substantial negative impact resulting from decreases in ALF of greater than 20%, 10 and 20% changes in ALF are used to classify the severity of potential risk in maps such as that shown in Figure 5-8.

The identification of ALF as a potential indicator of aquatic system flow needs is a preliminary step in understanding the dynamic interrelationships that govern the viability of the aquatic ecosystem. By targeted monitoring of streams with larger expected impacts to ALF and by continued research into aquatic life impacts and common water supply-related flow alterations, understanding of the relationship between flows and aquatic life will increase.

Flow Alteration and Aquatic Habitat Loss

One fundamental way in which flow alterations can impact aquatic life is by changing the amount and timing of specific aquatic habitats. Different aquatic species will require different types of habitat, and the availability of this habitat is largely governed by the water flows in the system at a given time. During non-drought conditions, variations in water flows tend to reduce and/or increase different types of habitat at any given time, resulting in a very complicated relationship. Some organisms gain habitat at the expense of other organisms as the streamflows vary naturally or as a result of water supply system-induced alterations. During drought flows, especially extreme drought, virtually all types of aquatic habitat are greatly reduced, resulting in detrimental effects to most organisms. Biologists can quantify the variation in habitat by performing detailed surveys of a segment of a stream, then constructing a mathematical relationship that predicts the amount of each different type of habitat available at a given range of streamflows. The IFIM studies described earlier are very powerful tools for showing potential impacts of water supply decisions, especially under low flows when habitat loss can become critical for a majority of aquatic organisms in a given stream. These studies, while very valuable, take a considerable amount of time and effort to construct; therefore, only a handful of stream sections in the Commonwealth have had these mapping projects performed. In recent years, extensive habitat mapping has been performed in select streams, which resulted in the ability to estimate the amount of habitat that is lost or gained as a result of a specific flow alteration. Table 5-6 shows a list of streams in Virginia that have had extensive habitat mapping performed.

Stream Name	Major Basin	Year Performed
Appomattox River	James River	2011
Lower James River near Richmond	James River	1991
North Anna River	Pamunkey River	2009
North Fork Shenandoah River	Potomac River	2004
Potomac River Between Great Fall and Little Falls Dam	Potomac River	1981, 2002
Roanoke River	Roanoke River	2004
South Fork Shenandoah River	Potomac River	2012

Table 5-6: Virginia streams with completed flow-habitat modeling studies as of February 2014

These habitat maps are constructed for multiple species or groups of organisms, allowing for a very complex picture of flow-habitat relationships with a given flow alteration having varying impacts on the species or groups evaluated. Sometimes, a flow alteration that decreased habitat for one species would increase habitat for another (see Figure 5-9).

This water supply modeling and analysis effort incorporated an assessment of habitat gains/losses due to future water demands in areas where habitat modeling studies were available, but these studies are few and only a small portion of Virginia streams benefits directly from these studies. The information provided by these studies also paints a complex picture of competing habitat gains/losses between species at different flow levels and flow-alteration levels. Despite the sparseness of habitat mapping projects in Virginia, biologists with DGIF began to see certain predictable patterns emerge in flow: habitat relationships. As a result, between 2005 and 2010, DGIF biologists began to recommend that flow alterations be limited to 10% of flow during times of low flow. This recommendation was based on a study of existing flow-habitat relationships that showed that at lower flows, a 10% flow loss resulted in less than or equal to 10% habitat loss.

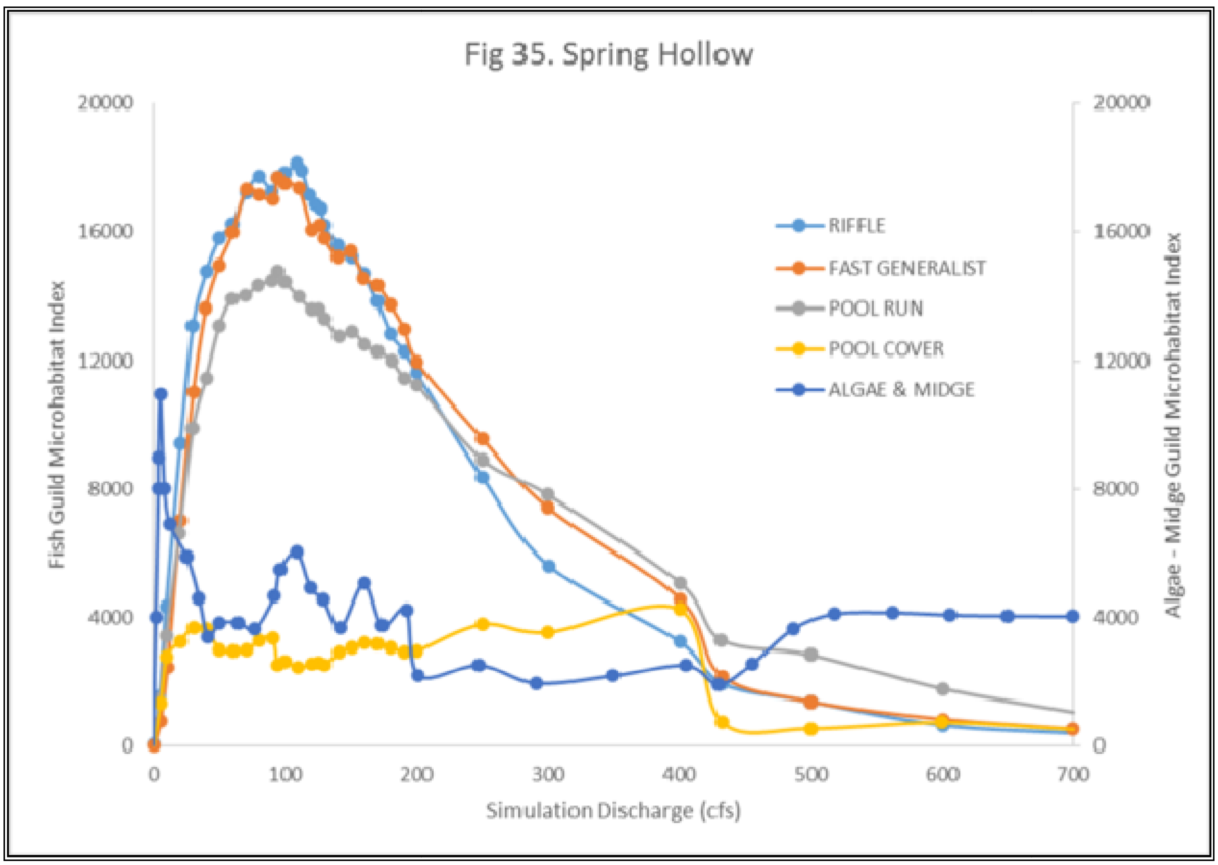

Figure 5-9: Flow-habitat relationship in the North Fork Shenandoah at the Spring Hollow sampling site from the 2004 study entitled “Stream Habitat Modeling to Support Water Management Decisions for the North Fork Shenandoah River, Virginia”

Impacts to Water Quality: Reduction in Assimilative Capacity

The "assimilative capacity" of a water body is defined as "the amount of contaminant load that can be discharged to a specific water body without exceeding water quality standards or criteria. Assimilative capacity is used to define the ability of a water body to naturally absorb and use a discharged substance without impairing water quality or harming aquatic life." Water supply activities can impact the assimilative capacity in streams in two main ways:

- When streamflows decrease as a result of withdrawal, the waste assimilative capacity of a stream is reduced.
- Point source discharges can augment flows in streams under dry conditions. Depending upon the level of various pollutants in the point source discharge, the resulting flow can either reduce or increase the waste assimilative capacity of the receiving stream.

The waste assimilative capacity of a receiving stream may be estimated in a variety of ways, depending on the type of stream, any flow altering features (such as dams), and based on the specific pollutant of interest. Many of these estimation techniques use what is called a "design flow." The design flow is typically a low drought flow that is considered to represent some worst case condition in the stream. Allowable pollutant loadings are then calculated based on the stream's capacity to assimilate waste during this worst-case flow. Table 5-7 shows the full list of design flow statistics used by the VPDES program for point source regulation.

Flow Metric	Seasonal Restriction	Use
7Q10	Annual and wet season* only	DO modeling, chronic Waste Load Allocations other than Ammonia-N
1Q10	Annual and wet season* only	Acute Waste Load Allocations
30Q10	Annual and wet season* only	Chronic Ammonia-N Waste Load Allocations
30Q5		Human Health, non-carcinogenic Waste Load Allocations
Harmonic Mean		Human Health, carcinogenic Waste Load Allocations
* Wet season is defined as the months with a long term average monthly flow is greater than the long term annual average flow.		

Table 5-7: Design flows for Point Source Discharge Regulation in Virginia[62]

For this analysis, the 7Q10 was chosen as the best indicator for describing potential impacts to waste assimilation from water supply activities. The 7Q10 is defined by the USEPA as "the critical receiving streamflow used to calculate chronic aquatic life standards. It is the low flow which, on a statistical basis, would occur for a seven consecutive day period once every 10 years." In recent years, water supply needs have grown to such an extent as to lower 7Q10 values in a number of Virginia streams. Future water supply needs will result in further decreases to the 7Q10 unless withdrawal limits are constructed in such a way as to avoid these decreases. In order to achieve this goal, withdrawals would have to be reduced at time of low flow, which would require either significant reductions in demand due to conservation, or reliance on sources of water stored in reservoirs.

Modeling Changes to 7Q10

Under currently accepted practice, the 7Q10 of a given stream is calculated by analyzing the historical flow record of that stream. While there are no explicit rules for including or excluding portions of a stream's historical record from 7Q10 calculation, it is generally understood that a stream's calculated 7Q10 can be subject to significant errors if there is a large variation in the amount of flow alteration occurring during the historical record. In other words, if a stream has recently seen an increase or decrease in low flows due to withdrawals, discharges, or a change in reservoir management, then data prior to the onset of these new alterations should no longer be used in estimating the 7Q10. In cases such as this, rainfall-runoff models and the baseline flow budget that they produce can be of use to help

[62] http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/VPDESPermitManual.pdf

distinguish the effects of flow alteration on the historical record. These models can then be run using the baseline flow budget subjected to current known flow altering effects to produce a more defensible data set for calculation of 7Q10 and other flow statistics. This approach is not without limitation since model error and model time span can introduce uncertainties into the resulting calculation. Nevertheless, as withdrawals and other flow altering factors distort the baseline flow budget to a greater extent, they can become more important than the model's own intrinsic error. Furthermore, despite the ability of model error to influence the magnitude of predicted 7Q10 changes, the models used in this study should accurately represent the direction of those changes and suffice as an indicator of the location of areas at high-risk of water-supply induced impacts to water quality.

Changes in Critical Flows Impacting Beneficial Uses

Aquatic Biology Impacts: Changes to August Low Flow

August flows are considered by biologists to represent a critical condition for many fish species, with various studies indicating declines in aquatic ecosystem health due to significant alterations in August flows. The ALF flow metric is ideal for characterizing changes in August base flows as a result of consumptive water supply demands and reservoir management rules. Projected 2040 demands are expected to affect ALF flows most significantly in the northern and eastern portions of the Commonwealth, with some small decreases in select streams in the western and southern portions of the state. For screening purposes, reaches with ALF decreases of at least 10% are considered to be at risk and need follow-up planning and monitoring. Figure 5-2 shows the median change in predicted ALF in modeled reaches for the 48 HUC's in Virginia, and Figure 5-3 shows the predicted decrease in the 10% most highly impacted reaches in each HUC. Basins with significant decreases in ALF are as follows:

- Potomac-Shenandoah River Basin
    - Shenandoah River North and South Fork: Reaches in this Basin are projected to have a median change in ALF of less than 5%, but with individual streams projected to experience reductions of 10-20%.
    - Middle and Lower Potomac River streams are predicted to have a median change of less than 1 %; however, reductions of 10-20% are predicted in select streams. The main stem of the Potomac River above the fall line has predicted decreases of less than or equal to 5%.
- James River Basin represents a diverse set of conditions with small increases, or no change in ALF predicted in much of the upper reaches of the watershed above Lynchburg, with median decreases of less than 5% in the non-tidal reaches in the middle and lower portion of the watershed. Approximately 10% of individual stream reaches are expected to see decreases of between 10-20%.

- York River Basin: Increased withdrawals from unregulated impoundments on the Ni River are expected to decrease downstream ALF by 10-20% in the reaches of the Mattaponi unless specific reservoir management rules and releases are in place to preserve in-stream flows.

Major basins that are predicted to have reaches with increasing ALF as a result of declining surface water demands or as a result of low flow augmentation from reservoirs are:

- James River Basin: The stretch of the James River below Cartersville/Cobbs Creek project[63] to the fall line are predicted to see increased ALF in the range of 1 -10% due to the low flow augmentation activities from the Cobb's Creek project. These low-flow augmentation releases are expected to increase ALF despite an increase of approximately 30-40 MGD above the Cobbs Creek intake.
- Albemarle-Chowan River Basin: Decreases in demand in the headwaters of the Nottoway River basin are predicted to result in small increases to ALF (less than 10%).
- Tennessee-Big Sandy River Basin: Select segments in the headwaters of the Clinch River Basin are predicted to have increasing August Low Flows as a result of declining surface water demands.

[63] The Cobbs Creek Reservoir project is a new regional pumped storage reservoir in northern Cumberland County near the James River that will provide 14.8 billion gallons of raw water storage within a 1,107 acre normal pool area. The reservoir's primary water source will be obtained from an intake on the James River, which will transfer water when flows in the river are adequate. The multi-purpose reservoir will serve to provide additional water storage in the James River watershed for Henrico County's and its regional partners' public water supply projects, provide a recreational amenity to visitors and citizens of Cumberland County, and provide flow augmentation releases to the James River during low flows and droughts. Flow augmentation releases from the Cobb Creek Reservoir to the James River are designed to supplement flows during low flows or droughts in the 45 mile stream reach between the release point to Henrico County's existing intake located downstream near Richmond. These releases are to offset the effect of new or increased withdrawals from the James River by Henrico County and its regional Partners to mitigate the withdrawal's impact on aquatic habitat and other existing beneficial uses. Releases will occur from June through November, which are the months with the statistically lowest flows in the James River. When flows at the USGS James River at Cartersville, VA stream gage (No. 02035000) are between the 5th and 30th percentile monthly flow levels, release will occur to offset new or existing withdrawals. When flows are below the 5th percentile monthly flow levels, releases will be provided to try to increase stream flows at the aforementioned UGSG gage to the 5th percentile, with a maximum release of 100 MGD.

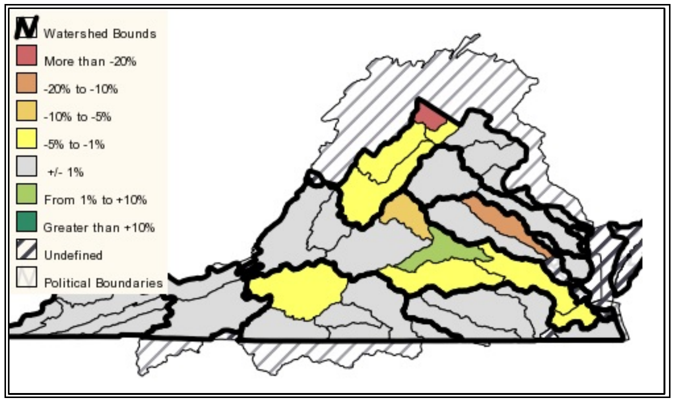

Figure 5-10 Median change in August Low Flow by HUC

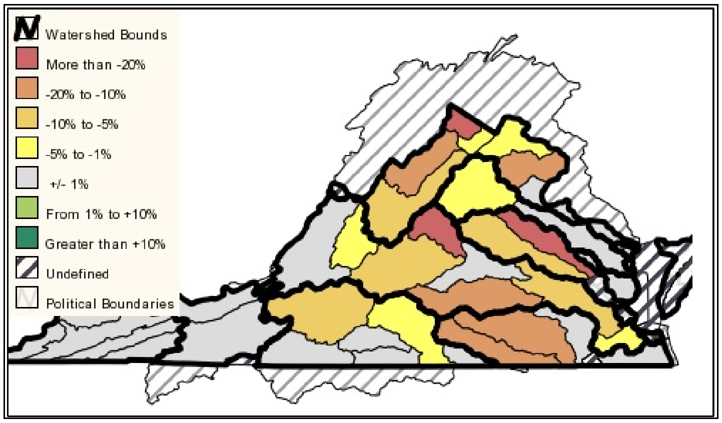

Figure 5-11 Projected changes in ALF for the most highly impacted 10% of watersheds in each HUC

Water Quality Impacts: Projected Changes to 7Q10

As described earlier, 7Q10 is one of a host of flow statistics that is used by regulatory agencies to estimate the waste assimilative capacity of rivers, and is used to set allowable effluent limits for point source discharges. Decreases to 7Q10 flows may result in decreased assimilative capacity, which may result in reduced effluent limits for regulated point sources to prevent water quality degradation. Margins of safety vary from permit to permit, so a 5% decrease in 7Q10 was set as a conservative screening threshold for recommending follow-up planning and monitoring. Figure 5-12 shows the median change in predicted 7Q10 in modeled reaches for the 48 HUC8's in Virginia, and Figure 5-13 shows the predicted decrease in the 10% most highly impacted reaches in each HUC. Basins with reaches that are predicted to see significant decreases in 7Q10 are as follows:

- James River Basin: Flows between Lynchburg and the confluence with the Rivanna River are predicted to see reductions between 5-10% in 7Q10, until flow augmentations from Cobbs Creek ameliorate these decreases. Flows in some headwater reaches of the Appomattox River are predicted to have 7Q10 flows that decrease by 5-20%, reducing 7Q10 inflows to Lake Chesdin. Due to release rules that are oriented towards preserving low flows, flow below Lake Chesdin is expected to decrease less than 5%, with the river soon becoming tidally influenced and no longer limited by 7Q10.

- Potomac-Shenandoah River Basin
  - Potomac – Median change of less than 1%; however, main stem Middle Potomac River through this segment from Point of Rocks to the fall line is expected to see a decrease of approximately 5%.
  - Shenandoah River Basin - Reductions of 10-20% in 7Q10 are possible in North and South Fork Shenandoah. Point sources augmentation may reduce much of this, especially since groundwater withdrawals are expected to supply approximately 50% of new withdrawals. In the short term, this groundwater pumping may result in flow augmentation as point source return flows, but in the long term, groundwater pumping may lead to reduced base flows in streams.
- Rappahannock River Basin – Mild reductions in 7Q10, with a mix of increases below the Greene County Reservoir and small decreases in Upper Rappahannock and near Fredericksburg.
- Roanoke River Basin - Select reaches in the Upper Roanoke HUC are predicted to see decreases of as much as 10%; however, overall the Roanoke drainage median decrease in 7Q10 is less than 1%.
- York River Basin – Due to increased energy production, draw downs in Lake Anna are expected to increase. Operational rules in Lake Anna require release to be tied in part to reservoir storage amounts and are predicted to decrease 7Q10 flows. Increased demands below Lake Anna are also expected to contribute further to this decrease. Increased withdrawals from unregulated impoundments on the Ni River are expected to decrease downstream flows unless specific reservoir management rules and releases are in place to preserve downstream assimilative capacity.

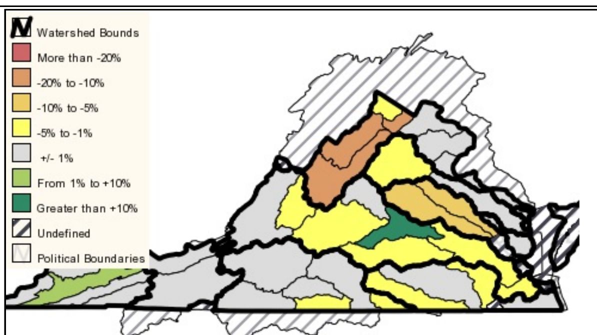

Figure 5-12: Median projected changes in 7Q10 by HUC

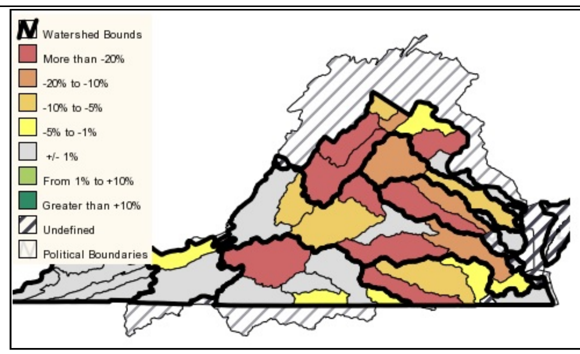

Figure 5-13: Projected changes in 7Q10 for the most highly impacted 10% of watersheds in each HUC

Major basins that are predicted to have reaches with increasing 7Q10 as a result of declining surface water demands or as a result of low flow augmentation from reservoirs are:

- James River Basin- The stretch of the James River below Cartersville to the fall line are predicted to see increased 7Q10 of greater than 10% due to the low flow augmentation activities from the Cobbs Creek project.
    - Lower James near Virginia Beach – probably statistical anomaly.
- Tennessee/Big Sandy River Basin- Select segments in the headwaters of the Clinch River basin are predicted to have increasing ALF as a result of declining surface water demands.

Water Availability: Changes in September Drought of Record Flow

The ability for water supply systems to meet off-stream demand is often referred to a “safe yield,” which is by definition the highest average annual volumetric rate of water that can be withdrawn by a surface water withdrawal during the worst DoR in Virginia since 1930. . Because cumulative consumptive withdrawals of surface water reduce streamflows, a future occurrence of the same meteorological conditions that led to DoR flows would produce even lower flows if consumptive demands were higher than those present during the DoR. A 5% decrease in September mean flow during the DoR was set as a conservative screening threshold for recommending follow-up planning and monitoring. Important variables to quantify to determine actual risk of reduced DoR flows will be consumptive fractions of new demands and the potential effectiveness of conservation ordinances and practices. Figure 5-14 shows the median predicted decrease in September DoR flow, and Figure 5-15 shows the decrease predicted for the 10% most highly impacted reaches by HUC. Basins with reaches that are predicted to see significant decreases in DoR flows as a result of increased consumptive withdrawals are as follows:

- James River Basin - Decrease in September DoR of between 5-10% were predicted for select reaches in the Middle James between Lynchburg and Cartersville and for areas of the Chickahominy River.
- Potomac-Shenandoah River Basin - The South Fork Shenandoah River is predicted to see median DoR flows decrease by at least 10%, with 10% of reaches in the North Fork Shenandoah, Upper Potomac, and Middle Potomac seeing decreases of 10-20%.
- Roanoke River Basin - 10% of reaches in the Upper Roanoke watershed are predicted to have DoR reductions of 10-20%; however, the median change is predicted to be less than 1%.
- York River Basin - The York is overall the most highly susceptible watershed, with median decreases of between 10-20% predicted and 10% of reaches predicted to see at least a 20 % decrease in DoR flow as a result of increased consumptive withdrawals.

Major basins that are predicted to have reaches with increasing DoR as a result of declining surface water demands, or as a result of low flow augmentation from reservoirs are:

- James River Basin - The stretch of the James River below Cartersville to the fall line are predicted to see increased DoR flows of greater than 10% due to the low flow augmentation activities from the Cobbs Creek project.

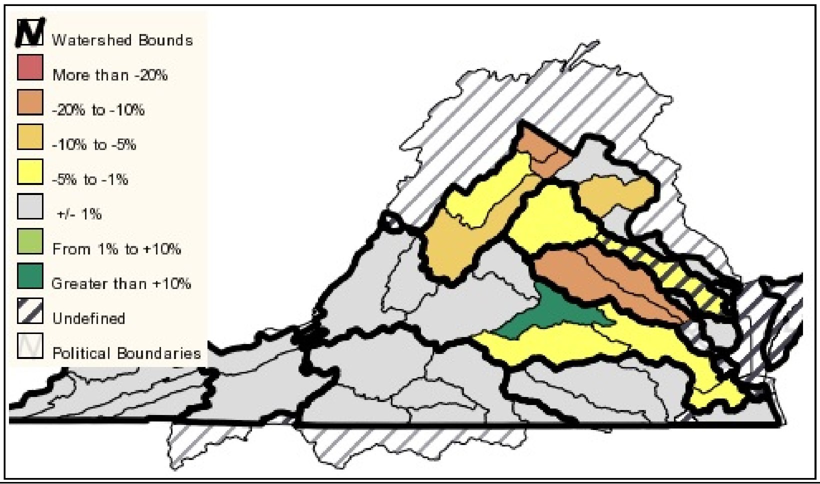

Figure 5-14: Median change in September drought of record flow by hydrologic boundaries

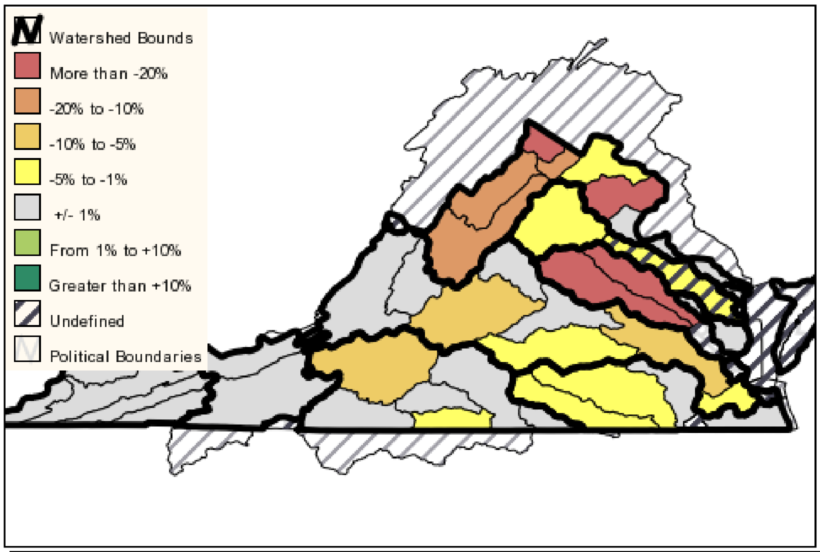

Figure 5-15: Projected changes in September drought of record flow for the most highly impacted 10% of watersheds in each HUC

System Stress: Withdrawals as Percentage of Baseline Drought Flow

By comparing a stream's baseline drought flow values to the total water demand in the stream, a sense of the stress imposed on the stream and/or water supply system can be obtained. If a stream's demands are equal to a high percentage of its baseline flow at any time, this means that either downstream beneficial uses will see flow reductions, reservoir storage will be depleted, or off-stream demands must temporarily decrease due to conservation restrictions. Reaches with cumulative projected demands greater than 25% of September drought warning flows are considered candidates for recommending follow-up planning and monitoring.

All major basins, even those with net declining withdrawals, are projected to have at least some stream reaches that are predicted to have mean withdrawals that are greater than 30% of September Drought Warning flow, indicating a moderate to high level of overall water system stress. Areas of the Potomac, York, Rappahannock, and James River Basins are projected to see median level of water system stress above the 30% level.

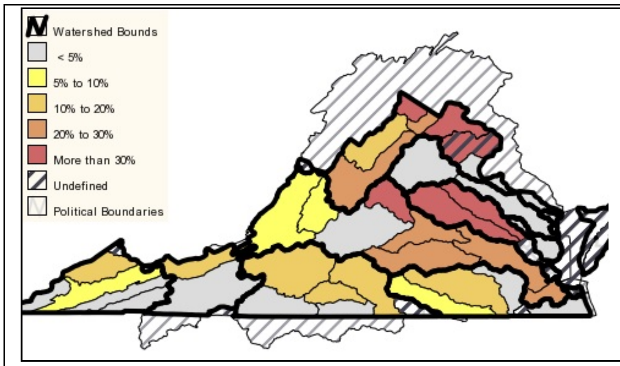

Figure 5-16: Median Cumulative withdrawals as a percentage of September Drought Warning flow in Virginia by 8-Digit NHD HUC

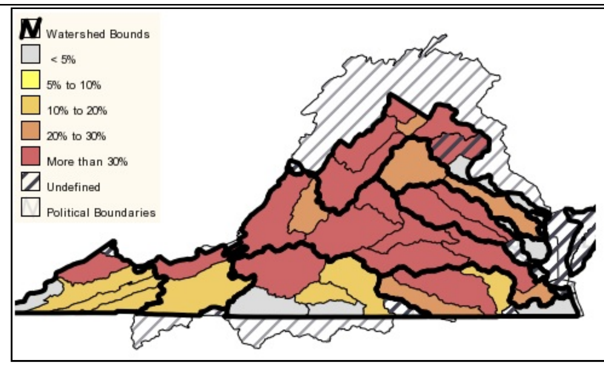

Figure 5-17: Cumulative withdrawals as a percentage of September Drought Warning flow for the most highly impacted 10% of watersheds in each HUC

Cumulative Effects of Groundwater Pumping

Groundwater is expected to provide approximately 23% of water demands by the year 2040. Approximately 75% of this groundwater demand is expected to occur outside of the Coastal Plain Groundwater Management Areas. While the area inside the Coastal Plain is capable of being modeled for cumulative groundwater impacts, understanding of the groundwater dynamics outside the Coastal Plain is hampered by a lack of monitoring wells and by the heterogeneity of the unconsolidated surficial aquifers that characterize this area. Also, the groundwater demands outside of the Coastal Plain are dominated by small residential users, so the spatial resolution of the data submitted limits understanding further to the locality scale. Despite these limitations, the data gathered during this water supply planning process gives a far more complete picture of the geographic distribution and magnitude of groundwater demands and their potential rates of change than was previously possible. Figure 5-19 shows a map of projected groundwater demands in 2040 in units of million gallons per year (MGY) per square mile, and Table 5-9 shows the statistical distribution of mean projected pumping rates in 2040 by locality. Given the lack of data outside of the Coastal Plain, it is difficult to provide any risk assessment based on an actual detailed physical understanding of the system. However, a comparative risk assessment which ranks individual localities according to their groundwater unit area pumping rates is within current capabilities. Areas with greater than approximately 0.3 MGY per square mile are considered to be in the upper 25 %

in terms of risk for negative impacts due to groundwater pumping. Outside of the Coastal Plain, 17 localities are projected to exceed this threshold in 2040.

When looking at projected demands for groundwater within the GWMA of Virginia, DEQ is able to use actual withdrawal data provided through VWWR and reporting required by Groundwater Withdrawal Permits, with the projected values based on the NASS Census data. Since private wells are not regulated unless withdrawals are above the 300,000 gallons per month value, the residential demand served by private wells was estimated.

The percentage of total 2040 water use derived from groundwater sources is estimated at 25%; therefore, the groundwater use is estimated to increase from 380 MGD in 2010 to 445 MGD in 2040.

Within the Coastal Plain, the affects of the projected demand for groundwater withdrawals can be modeled using VAHydro–GW. This is the same modeling tool used to complete the Technical Evaluations used for the Groundwater Withdrawal Permitting. The current model uses the 2006 updated framework (McFarland and Bruce, 2006[64]) along with reported and permitted withdrawal up through 2012.

Figure 5-18 depicts the simulation of the estimated domestic non-permitted wells in Virginia with the known permitted wells at their current estimated pumping rates, then increasing their pumping rates over the duration of the simulation to the projected 30-year pumping value for each well. The VAHydro-GW simulation was executed for a full 50 years, even though the water supply planning evaluations are projected out for 30 years. Table 5-8 outlines the pumping values involved in the planning simulation. The 2013 Total Permitted Simulation pumping values are also included in the following table for reference.

Permitted Wells					
	VAHydro-GW Simulation Year				
	2013-2022	2023-2032	2033-2042	2043-2052	2053-2062
30 Year Planning Scenario (MGD)	76	92.6	109.1	125.7	142.3
2013 Total Permitted Simulation (MGD)	120.2	120.2	120.2	120.2	120.2

[64] http://pubs.usgs.gov/pp/2006/1731/pp1731_download.htm

Domestic Wells					
	VAHydro-GW Simulation Year				
	2013-2022	2023-2032	2033-2042	2043-2052	2053-2062
30 Year Planning Scenario (MGD)	33.6	35.7	37.7	39.8	41.8
2013 Total Permitted Simulation (MGD)	25.2	25.2	25.2	25.2	25.2

Table 5-8 Pumping Values involved in planning simulation

The following figures show that if withdrawals were to occur at the projected water supply planning rates, the critical cells would increase over the projected period. The white squares show the projected critical cells from the current total permitted withdrawals. The orange squares illustrate the increase in those critical cells if the projected values were reached. This figure of the Potomac aquifer is an illustration of how critical cells would increase by over 500 cells, indicating that those areas in orange would be overdrawn in a non-sustainable way, resulting in reduced head and potentially irreversible damage to the aquifer system that may result in increases in saltwater intrusion and land subsidence.

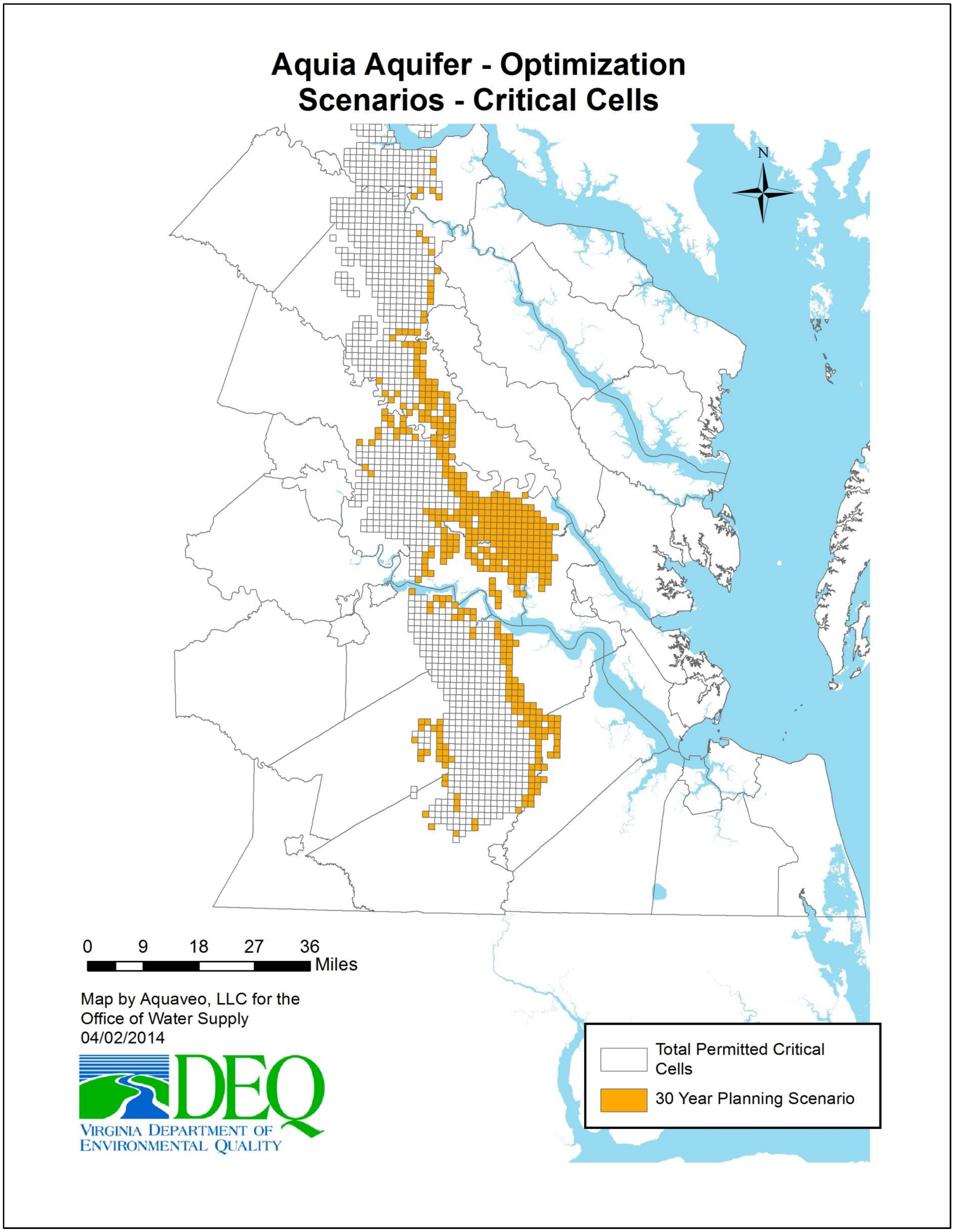

Figure 5-18 Aquia Aquifer

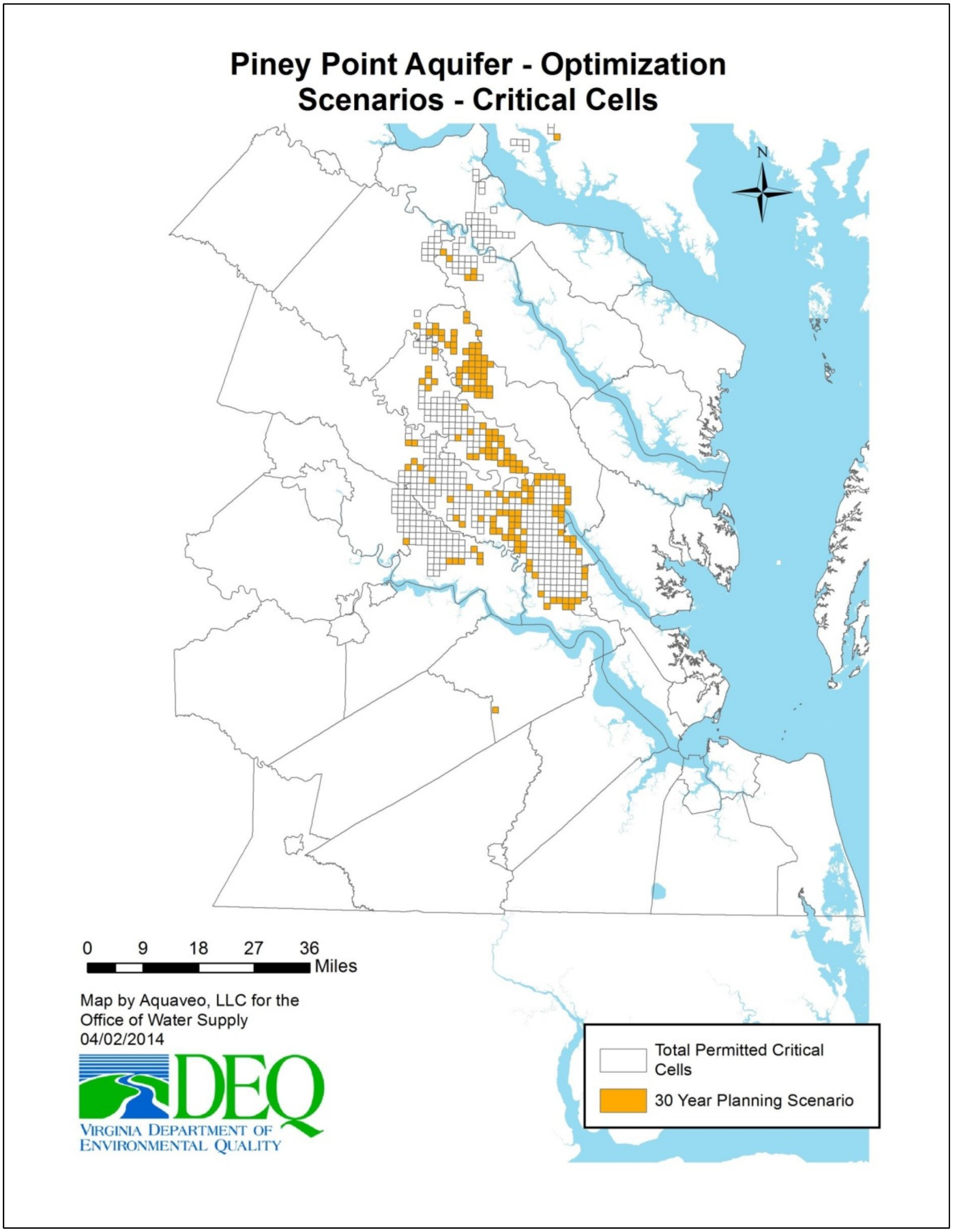

Figure 5-19 Piney Point Aquifer

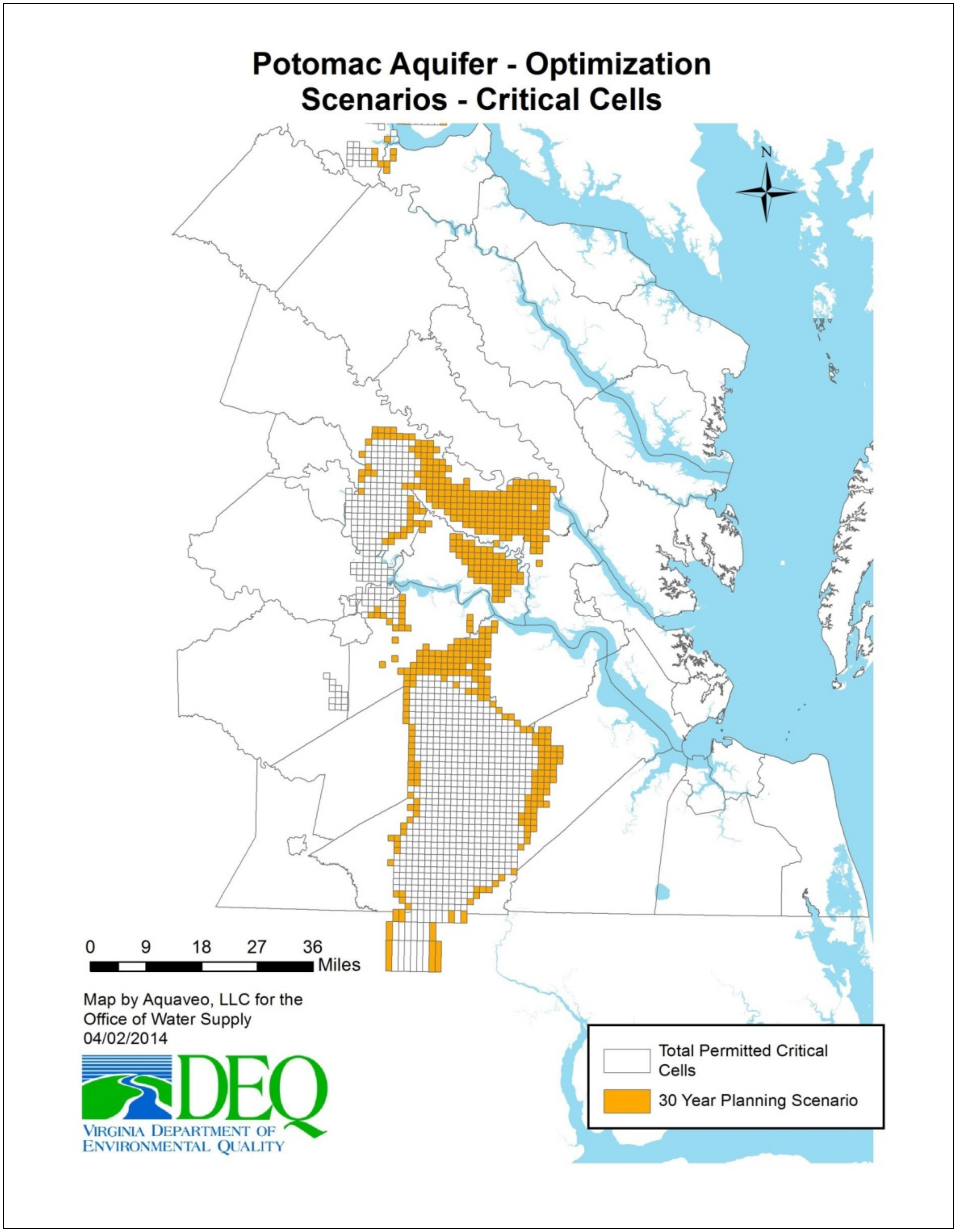

Figure 5-20 Potomac Aquifer

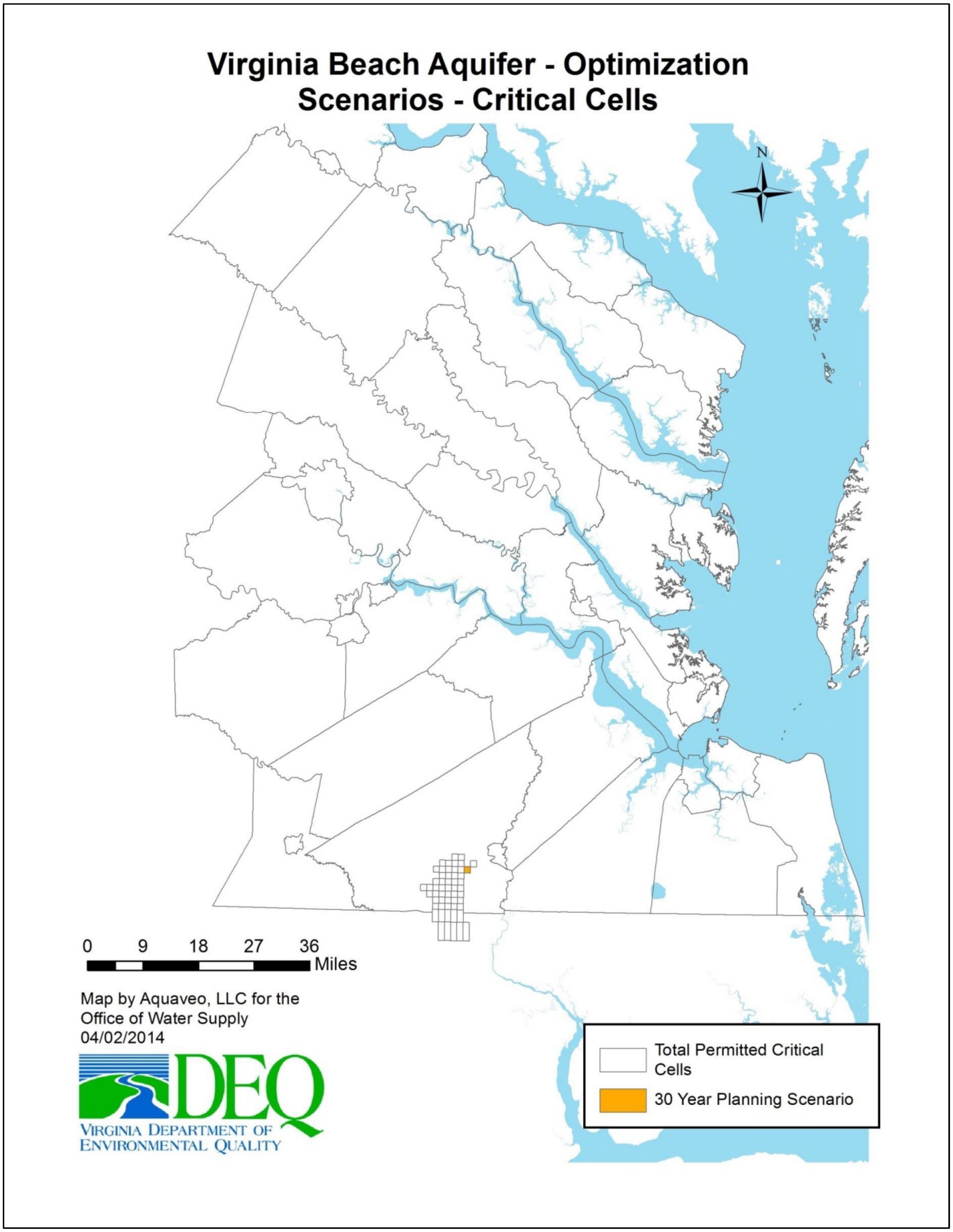

Figure 5-21 Virginia Beach Aquifer

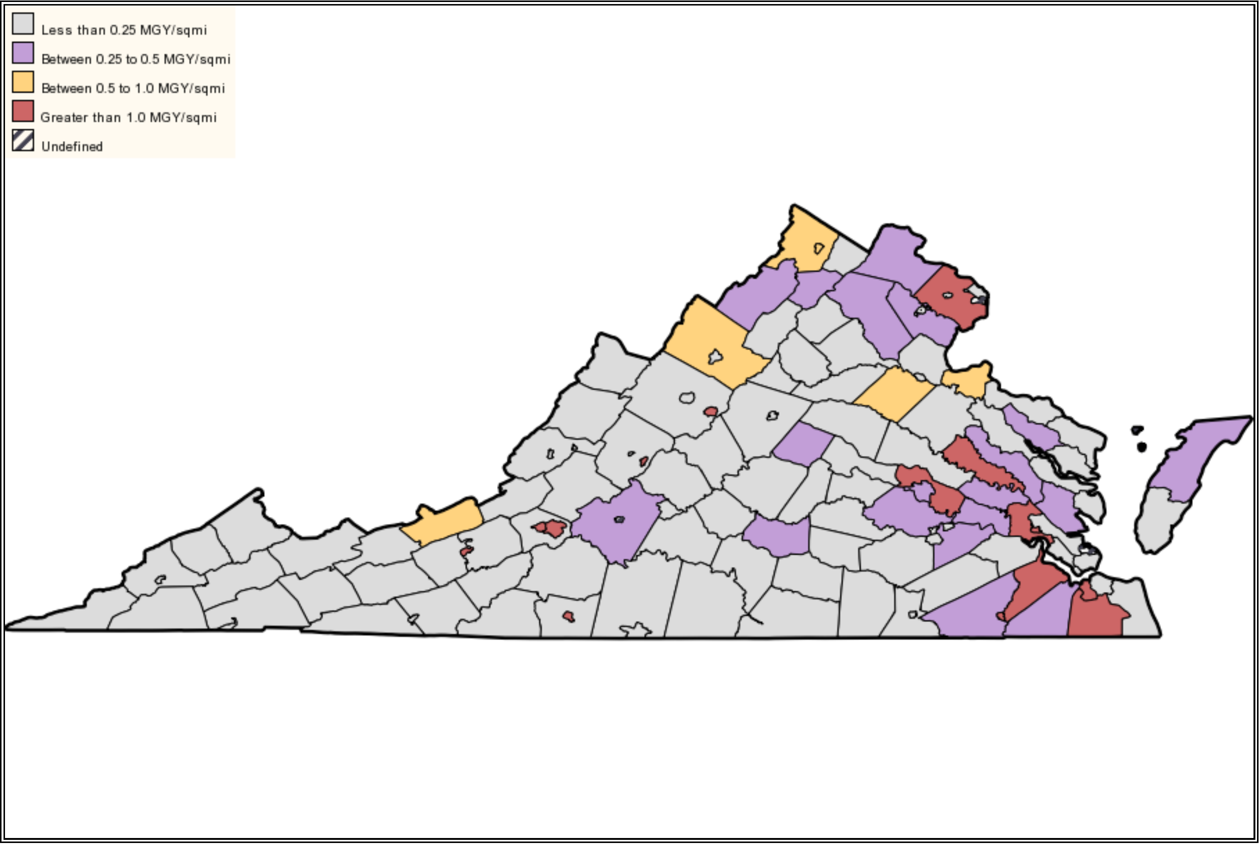

Figure 5-22: Projected groundwater demand in 2040 givein in MGY/square mile. This data is presented by Federal Information Processing Standards (FIPS) locality because the resolution of Water Supply Plan residential groundwater data is limited to the locality scale

Lowest 25 Percent Rate of Pumping (MGY / Square Mile)	Median Rate of Pumping (MGY / Square Mile)	Highest 25 Percent Rate of Pumping (MGY / Square Mile)
0.0445	0.1255	0.298

Table 5-9: 25th, 50th, and 75th Quantile values for total estimated 2040 groundwater pumping rates reported by localities. Rates were calculated in MGY/square miles, which is total water from groundwater in MGY in a locality divided by the locality's area in square miles.

Cumulative Impacts Analysis: Conclusions

The data and information submitted during this water supply planning process predicted a net increase of approximately 32% in mean daily water supply demand. Within this average overall increase, rates of change varied geographically, with a mixture of large, moderate, and small increases, as well as a small number of areas with a decreasing or static trend in water supply demand. Table 5-10 lists the percentage of streams, by major basin, that are predicted to suffer significant reductions in flow as a result of 2040 demand increases. A brief summary of impacts in the 327 non-tidal river reaches modeled Commonwealth-wide is as follows:

- 7 % are predicted to have a significant decrease in August Low Flows.
- 16% are predicted to see a significant decrease in September mean flow under historic drought of record conditions.
- 24% of reaches are predicted to see a potentially significant decrease in 7Q10 as a result of water supply activities.
- 26% are expected to represent a significant level of overall system stress as evaluated by withdrawals as a percent of September drought warning flows.

These summary statistics portray a future that may be marked by widespread areas of little to moderate impacts under normal conditions, punctuated by isolated areas with significant chronic impacts, and moving towards more widespread impacts under the driest conditions. Under moderately dry, but non-drought conditions such as those represented by the ALF, projected critical areas represent a small (7%), but significant portion of Commonwealth stream reaches. While these ALF impacts may in fact represent a serious concern for aquatic system health, the results of this modeling and analysis also suggest that this may not be an inevitable consequence. A number of areas were shown to be able to meet large demand increases while also preventing changes to ALF through carefully planned withdrawal rules and use of stored water. Similarly, management rules and use of storage was predicted to mitigate potential reductions to 7Q10 and drought warning flows. During the drought of record simulation, however, the challenge to the full range of beneficial uses will require greater attention in the follow-up to this plan. Nearly 97% of the projected surface water demands in Virginia's streams are projected to come from approximately 25% of the stream reaches simulated. With 16% of streams predicted to see greater than 5% reduction in drought of record flows, this indicates a high probability that new management and/or infrastructure will be required to maintain safe yields at current levels. While systems that have built or are planning to build new storage will likely have adequate reserves to meet the predicted reduced drought inflows, systems without storage or with demands that are nearing existing safe yield will face stiff challenges as the cumulative demands on streams increases.

Moving forward it should be noted that increased storage is not the only solution that can be implemented, nor is it a solution without its potential downsides. As understanding of the impacts of flow alteration from large impoundment activities improves, there may be a need to devote resources and management efforts to balancing the need for stored water with flushing flows to maintain downstream algal populations at desirable levels. Given the relatively modest flow impacts predicted in many areas, attention should be paid to the role of conservation and drought restrictions to reduce demands during critical periods. Similarly, understanding monthly demand trends and exploring ways to shift demands away from the driest months and towards wetter months may be one of the most powerful methods of securing stable safe yields in the future.

This plan provided an opportunity to see the likely challenges that will be faced by the many beneficial uses that depend on flow in Virginia's streams. The information provided enables the identification of the probable location and types of impacts and the various regulatory, infrastructure, and ecological challenges that these impacts might present. In addition to these areas of likely impact, the information in this plan can be used to target areas whose demands reach or exceed the plan projections. Areas whose growth exceeds predictions will require better understanding of aquatic resources, a more intense scrutiny to the accuracy of data, and a more thorough knowledge of water supply operations in that area.

Basin	% Increase Water Demand 2010-2040	2040 % Basin Decrease ALF >10%	2040 % Basin Decrease 7Q10 > 5%	2040% Basin Withdrawal >25% of September Drought Warning	2040 % Basin Decrease September DoR > 5%
Chesapeake Bay-Small Coastal	+14%	NA	NA	NA	NA
Chowan-Albemarle River Basin	+21%	12%	19%	19%	8%
James River Basin	+37%	10%	29%	41%	10%
New River Basin	+5%	0%	0%	3%	0%
Potomac-Shenandoah River Basin	+33%	12%	39%	31%	32%
Rappahannock River Basin	+83%	0%	29%	14%	7%
Roanoke River Basin	+24%	2%	11%	13%	7%
Tennessee-Big Sandy River Basin	-5%	0%	0%	12%	4%
York River Basin	+50%	18%	53%	65%	59%
Commonwealth of Virginia	+32%	7%	24%	26%	16%

Table 5-9: Modeled changes to key indicators for watersheds in Virginia based on projected demand changes from 2010-2040

Chapter 6 Water Supply Challenges and Recommendations

State and local agencies, water purveyors, and consumers face a number of water supply challenges over the next 30-50 years, and even sooner in some areas. Comprehensive water supply planning can assist state and local governments, as well as other stakeholders, monitor conditions and better respond to these challenges.

Virginia's future health and economic welfare is dependent upon an adequate supply of clean water. Review of local and regional water supply plans and the initial cumulative impact analysis of water use indicate that additional withdrawals from existing water sources will likely stress the sources and negatively impact beneficial uses. Drought events will further exacerbate the situation.

Information from the water supply plans and other sources were input into DEQ's content management system so cumulative impact modeling can be done. As described in Chapter 5, Assessing the Long Term Sustainability of Water Resources, DEQ has much information for the initial analysis of cumulative impacts of future water demands on the Commonwealth's streamflows. With an estimated 32% increase in water demands by the year 2040, it is critical that the best information be available to make water resources decisions. This Chapter identifies recommendations needed to improve the water supply planning process to ensure long-term sustainability of the Commonwealth's water resources.

Water Management Program Limitations

1. Challenge: Understanding the Impact of Unpermitted Water Withdrawals

According to the 2014 Report on Virginia's Water Resources Management Activities[65], 82% of the total surface water withdrawn in 2013 was excluded from permitting, thus making it difficult to manage water resources, particularly during low flow periods. Unlike permitted withdrawals, excluded withdrawals are not subject to permit conditions that require conservation during times of low flow to reduce water use or to limits on withdrawal that require a certain volume of water to flow by the intake or to be released from a reservoir. These conditions help to ensure the existing beneficial uses of the water resource, including those of the withdrawal, are sustained at all times and, particularly, during dry periods, as well as conserving the resource for the long term.

This State Plan reveals that approximately 450 MGD of additional water is needed to meet 2040 projected demands. Approximately 77% of the total water demand in 2040 is expected to come from surface water. Development of operational rules for unpermitted withdrawals and impoundment releases should facilitate better management of water during low flows.

[65] http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterSupplyPlanning/AWRP_090814FINAL.pdf

Of the 1,935 MGD of water needed to meet 2040 demand, 23% is expected to come from groundwater. Of that 23%, 75% of these withdrawals are expected to occur outside the Groundwater Management Areas (GWMA).

Recommendation 1.1:

As resources allow, DEQ plans to coordinate with localities and other pertinent stakeholders to see if operational rules can be developed for those surface water withdrawals and impoundment releases currently excluded from VWP permitting. The areas that are predicted to result in negative impacts to beneficial uses during times of low flow will be prioritized. DEQ expects to meet with relevant parties in these areas to see if there are actions that can be agreed upon that would alleviate or reduce impacts on beneficial uses. Target stream reaches have been identified in the following river basins: Chowan-Albemarle, James, Potomac-Shenandoah, Rappahannock, Roanoke, and York.

Future options may include, but are not limited to, the following:

a) Establishment of Surface Water Management Areas and Groundwater Management Areas.
b) Changes to pertinent statutes and/or regulations to capture unpermitted withdrawals.

2. Challenge: Gaps in Water Withdrawal Reporting, Differences in Reporting Thresholds between WSP and VWWR Regulations, and Lack of Adequate Data

As data submitted with the local and regional water supply plans was evaluated, it was noted that there are data gaps in groundwater and surface water information. While there is some information on the water use for agricultural and some commercial institutions, such as golf courses and nurseries, for example, additional outreach needs to be done to determine if there are water uses in these categories that have not been accounted for in Virginia's water budget. As discussed in Chapter 4 A Comparison of Water Supply and Water Use across the Commonwealth, agricultural and commercial use amounts and patterns appear to be underreported. Figure 4-4 indicates that considerably more water use was reported in the water supply plans for agricultural use than is reported annually in the VWWR process. Additionally, a number of golf courses and other facilities were identified in water supply plans, but are not reporting under the VWWR requirement. It is noted that some of these facilities may not withdraw water or may not meet the threshold established for annual reporting. Unlike water used for manufacturing processes or industrial purposes, agricultural and commercial water use typically occurs primarily during times of water scarcity, which can exacerbate the stress on a resource already experiencing low flows.

Recommendation 2.1:

DEQ will:

a. Coordinate with localities and regions to update the data set to continuously improve model results.
b. As resources allow, initiate a more systematic approach to registering those facilities that meet the threshold for VWWR reporting, but who are not currently registered and do not report.
c. Train localities and other water purveyors to directly input data into the content management system for more timely information.

Current and Potential Future Water Supply Challenges

3. Challenge: Quantifying Current and Future Risks to Groundwater Availability Outside of Current Groundwater Management Areas

The degree of interconnectedness of fractured rock groundwater systems and surface water features in western Virginia is significant, resulting in unique challenges to assessing water supply risk. These systems can be highly influenced by annual precipitation, can be storage limited, and can recharge or decline on short time scales. In most watersheds, groundwater discharge to streams constitutes a significant portion of the water in the stream. Droughts over the last two decades have demonstrated that below-normal recharge over as little as two years can significantly reduce groundwater contribution to streamflow. Increases in groundwater withdrawals in these systems can have the same effect in reducing streamflow, increasing the risk of impacts to beneficial uses in a watershed. During times of low recharge, this effect can be compounded by increased withdrawals.

While the structural complexity of these groundwater/surface water systems creates some practical limitations, the Commonwealth and its localities need to begin at least some preliminary quantification of risk. Seventy-five percent of the groundwater demand for 2040 is expected to occur outside the coastal plain GWMAs. Therefore, it is important to start by creating some basic water budgets in these areas. These can start as simply as a comparison of rainfall volumes to expected withdrawal volumes.

As projections were gathered through the water supply planning effort, there is a better understanding of groundwater demands and reliance on this resource in the western half of Virginia. It was estimated that 137.81 MGD of water was used by small self-supplied users of private residences in 2010. Additionally, estimates of the projected future demand associated with these wells were made in the water supply plans. However, assumptions were made that groundwater resources could support this increased demand. This may or may not be the case; there is not enough information on the sustainability of groundwater wells in the western half of the Commonwealth to be sure.

To go beyond simple assessments, further investment is needed in targeted monitoring and model development to determine groundwater flow, relative storage in these systems, and the probable magnitude of impact under different meterological and water use conditions.

Recommendation 3.1:

DEQ may facilitate efforts with localities and regional stakeholders (e.g., planning district commissions, utilities, public service authorities) to expand groundwater monitoring wells in localities outside the Groundwater Management Area with expected significant increases in 2040 demands from groundwater and may be at high risk for negative beneficial use impacts. An increase in groundwater monitoring wells should improve our understanding of the groundwater resource and the impacts of pumping on the aquifer. State and local entities may coordinate efforts to identify financial resources to provide funding necessary for an expansion of the State Observation Well network. Additionally, DEQ plans to provide decision makers with all methodologies and analyses that DEQ has on the availability and sustainability of groundwater. DEQ may provide input and assistance if localities or regions conduct their own methodologies or analysis, including Recharge Analysis. As resources allow, DEQ staff will analyze data and provide outreach to localities and regions to ensure better management of the resources and water availability for all beneficial users. DEQ plans to target outreach efforts to localities that the cumulative impact analysis indicates groundwater uses exceed the annual recharge. These localities include the counties of Giles, Frederick, and Rockingham, and the cities of Martinsville, Radford, Roanoke, Salem, and Waynesboro.

4. Challenge: Reservoir Site Development

The process of identifying future reservoir sites can be difficult, potentially involving numerous competing interests, all of which can be the subject of much debate. Localities typically consider planned projects, such as housing developments, major road, rail, or utility line construction, infrastructure development, and identification and protection of sites for future economic development. Federal, state, and local interests to protect natural ecosystems located within a reservoir footprint can also impact the viability of a site. Considerations such as cost, size, the distance to where water is needed, environmental and archaeological concerns, water quality/source water protection, and benefits beyond water supply (recreational uses and tourism) must also be considered. Maintenance of reservoirs to assure their storage capacity is another cost that should be considered. Any of these conditions can influence the viability of a new reservoir site and impact the ability of state or federal authorities to approve a proposed permit application.

Recommendation 4.1:

Based on the projected 2040 demand, localities and regions will need additional storage. DEQ will assist, as appropriate, in any efforts to optimize the use of the resource.

5. Challenge: Threats to Water Quality

Water supply plans listed a number of potential threats to water quality. The WSP Regulation section on "Existing Resource Information" requires all water supply plans to include "a description of existing environmental conditions that pertain to, or may affect, in-stream flow, in-stream uses, and sources that provide the current supply." Required conditions to be considered included state or federal threatened or endangered species or habitats of concern, river segments that have recreational significance, unusual geologic formations or soil types, wetlands, riparian buffers, land use including impervious surfaces, impaired streams, and point source discharge locations. Potential threats to water quality or quantity beyond this list were to be discussed in the plans.

Other potential threats listed in the water supply plans include contamination from septic tanks, fuel spills, industry, landfills, landslides, radon emission, mining excavations, logging, junkyards, septic system failures, and agricultural runoff. Improper application or inappropriate storage of lawn and garden chemicals, paints, synthetic detergents, solvents, oils, medicines, disinfectants, pool chemicals, pesticides, batteries, gasoline, and diesel fuel are also considered threats to water quality.

Recommendation 5.1:

DEQ will continue to evaluate August Low Flow (aquatic life impacts), and 7Q10 (waste assimilation) to assess the probable impacts to certain beneficial uses. As resources allow, DEQ will add conditions to be considered to assess the potential impacts to the water resources.

Management Strategies to Address Water Demand

6. Challenge: Understanding the Impact of Consumptive Use on Water Supply

Consumptive use, that portion of the water withdrawn that is lost to evaporation, transpiration, or consumption by humans or animals and is not returned to the water system, has the greatest impact on water availability. The impact of consumptive uses on beneficial uses is and should continue to be evaluated in water supply planning and permitting. Current regulations (WSP Planning, Water Withdrawal Reporting) do not require information on consumptive use. One of the main objectives of the cumulative impact analysis and water supply planning process is to ensure against future water shortages and unforeseen negative impacts to in-stream beneficial uses. As such, consumptive use must be factored into the modeling equation. Assumptions about consumptive use are conservative, erring on the side of assuming a higher level of net consumption from water use activities. Reporting of actual data concerning consumptive use will provide more accurate projections on the availability of water during low flows.

Recommendation 6.1:

Request approval to revise the Virginia Water Withdrawal Reporting Regulation (9VAC25-200-10 et seq.) to require the annual reporting of consumptive use.

7. Challenge: Promoting Increased Conservation to Reduce Long-Term and Short-Term Demand

The goal of water conservation is to maximize the benefit gained from each gallon of water used. Water conservation is increasingly becoming important as part of local governments' overall water management strategy across the Commonwealth, particularly during drought events. Water conservation practices can extend the use of a system's available water supply, reduce the impacts of drought, delay expansion of treatment facilities, reduce operating costs, and reduce costs to consumers as their use of water declines. Use of water conservation practices are described in regional water supply plans and reflect that the more limited a region's water resources are or are expected to become, the more critical it is to have effective water conservation programs.

Water conservation can be an important component of water resource management. Although Virginia is rich in water resources, citizens must use water wisely to ensure the sustainability of the resource both during drought events and every day. As such, localities and other water purveyors are considering water conservation programs to ensure water is used as efficiently as practicable.

Recommendation 7.1:

DEQ will encourage localities and regions to place more emphasis on conservation efforts to reduce demand in their water supply plans.

8. Challenge: Critical Infrastructure Deficiencies

Water infrastructure in Virginia was built over many decades and, for many localities and systems, has not been maintained adequately due to insufficient funds and planning. The local and regional water supply plans reflect system losses from 4% to 50%, generally depending upon the age of the system. The American Society of Civil Engineers recently released the "New 2015 Report Card for Virginia's Infrastructure" **(**http://www.infrastructurereportcard.org/virginia/virginia-overview/) and gives Virginia a grade of 'C' based on the reported condition of existing assets, expected service life, current functionality and level of service, future growth needs, and anticipated level of funding required to maintain Virginia's infrastructure. The report continues that "Virginia reported $6.1 billion in drinking water infrastructure needs over the next 20 years." While all systems will not fail at the same time, water treatment facilities and related distribution systems need to be properly maintained or replaced to ensure proper water efficiency.

VDH has prioritized drinking water loss in their grant/loan program. In the "Commonwealth of Virginia Drinking Water State Revolving Fund Program Intended Use Plan For the DWSRF FY 2015 Capitalization Grant," http://www.vdh.state.va.us/ODW/financial/documents/pdf/2015%20IUP.pdf, draft dated January 5, 2015, VDH established the Drinking Water State Revolving Fund (DWSRF) Program in accordance with the federal Safe Drinking Water Act Amendments of 1996. The goals of this program include assisting "waterworks owners in protecting water supplies, ensuring the reliable operation of water systems, preparing for future waterworks challenges, and developing their technical, financial, and managerial capacity."

Recommendation 8.1:

DEQ will provide VDH with a list of localities whose water supply plans indicated that they have high water loss so VDH can consider them for funding to improve their infrastructure.

Other Issues Impacting Water Supply

9. Challenge: Sea Level Rise, Changes in Precipitation Patterns, and Land Subsidence

Environmental issues such as sea level rise, changes in precipitation patterns, and land subsidence may have impacts on water resources in the Commonwealth. "The changing climate impacts society and ecosystems in a broad variety of ways. For example climate change can increase or decrease rainfall, influence agricultural crop yields, affect human health, cause changes to forests and other ecosystems, or even impact our energy supply. Climate-related impacts are occurring across regions of the country and across many sectors of our economy."[66]

Recommendation 9.1:

a) DEQ will conduct a Cumulative Impact Analysis annually and will evaluate the impacts on streamflow of the most recent climate change model scenarios available in time for each five-year review cycle for local and regional water supply plans.

b) DEQ will develop a subsidence monitoring plan to better characterize the amount of sea level rise due to land subsidence over time to inform water supply-related local adaptation strategies.

10. Challenge: Source Water Protection

Many local and regional water supply plans acknowledge that the VDH Source Water Assessment Program indicated high susceptibility for their sources of water supply, yet only 15 of the 48 water supply plans indicate a source water protection program has been completed or is under development. Completion of the Source Water Protection Plans process, using the same funding

[66] http://www.epa.gov/climatechange/impacts-adaptation/

strategy mentioned above in coordination with VDH, should improve the long-term viability of storage and infrastructure in the Commonwealth.

Recommendation 10.1:

DEQ will coordinate with VDH and localities to urge localities to develop and implement Source Water Protection Plans. Localities can begin by reviewing the Source Water Assessment conducted by VDH and determining whether additional study of additional threats is needed. Land areas should be defined that contribute water to the system. Localities can develop zoning ordinances and other tools to ensure these areas are protected from water quality threats.

11. Challenge: Conflict Resolution

As discussed in the 2012 Final Report for the Water Supply Plan Advisory Committee, the State Plan is used as an informational tool for future water supply decisions and not for conflict resolution. The information derived from local and regional plans can be used to evaluate alternative water sources and to determine the extent of hydrologic conflicts between localities, regions, existing users, and other in-stream and off-stream beneficial uses. When conflicts are identified, DEQ can provide informal facilitation if requested, but attempts to resolve the conflict should be at the local level. Should it not be practical or logical for issues to be resolved at the local level, there are other remedies available that may assist with resolving issues between stakeholders. DEQ does not currently have the authority necessary to resolve conflicts beyond identifying them and facilitating discussion between localities and regions.

Under the current regulatory framework, conflicts arising from planned implementation of local and regional water supply plan alternatives can be resolved through the following methods:

a) Issuance of Virginia Water Protection permits.

b) Creation or use of a legislative or voluntary body (such as a river basin commission).

c) Regulations, such as declaration of a Surface Water Management Area or Groundwater Management Area.

d) Litigation among parties.

Recommendation 11.1:

DEQ should continue to work within the current regulatory framework to resolve conflicts.

12. Challenge: Public Education and Outreach

All residents of the Commonwealth should understand the need for managing Virginia's water resources so state, regional, and local water supply planning will be more effective. When people understand that the Commonwealth's water resources are finite and that active management of existing resources is essential to meeting future demand, statewide educational efforts will likely be more successful, as localities may coordinate activities and inspire each other as they consider ways to reach more citizens. DEQ, other state agencies, and all localities must work in concert to provide accurate and useful information to ensure that citizens learn about the opportunities and benefits of improving water use efficiency. A comprehensive, statewide public education and outreach program can have a positive impact on Virginia's water resources.

Recommendation 12.1:

DEQ will engage localities and planning regions in water supply planning efforts, as follows:

5) Communicate the findings of the State Water Resources Plan, including the Cumulative Impact Analysis and probable impacts to water resources.

6) Assist localities with water supply planning compliance efforts as outlined in their condition of approval.

7) Improve modeling results by increasing the accuracy of the data, as follows:

   a.7.1 Partner with a locality willing to serve as a pilot for the direct input of data into the DEQ content management system, ensuring the system is user friendly and easily accessible

   a.7.2 Train localities and water purveyors to directly input data into the content management system

8) Expand public education and outreach efforts to impress upon citizens the importance of water supply planning and conservation during drought.

Introduction to Appendices

Appendix A is a list of the ten local and 38 regional water supply plans, including all participating localities.

The information found in Appendix B: Major Basin Summaries and Appendix D: Snapshots of Water Resources by Locality was obtained from the local and regional water supply plans and the DEQ analysis of the data provided in those plans. Water users have been divided into four categories: community water systems (CWS), agriculture (AG), large self-supplied users (SSU_LG), and small self-supplied users (SSU_SM). Water use information for SSU_LG excludes power plant cooling withdrawals, as this is largely a non-consumptive use.

A CWS is a private or public waterworks that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents and is regulated by the Virginia Department of Health Waterworks Regulation (12 VAC 5-590). Self-supplied users are defined as any person making a withdrawal of surface water or groundwater from a source (e.g. a river, stream, lake, aquifer, or reservoir fed by any such water body) for their own use. Self-supplied users do not receive water from a community water system. Large self-supplied users are defined as those users of more than 300,000 gallons per month of groundwater or surface water for nonagricultural uses, including but not limited to commercial, manufacturing, mining, and hydropower. Small self-supplied users are defined as those users supplied by individual wells withdrawing less than 300,000 gallons of water per month. Agricultural data is collected for those agricultural operations who utilize more than 300,000 gallons of water per month for crop irrigation and all other uses, such as livestock/poultry watering.

Through the water supply planning process, some planning units determined that water source and use information was not readily available for all users in a particular locality. Agriculture and golf course water use were two areas commonly lacking readily available data. When specific agricultural users were not known in a locality or region, the United States Department of Agriculture's National Agricultural Statistics Service's Census of Agriculture (NASS Census) data was often summarized in the plans. The NASS Census is confidential and required by law, collecting data from farm and ranch operations. NASS Census data is reported by County for total acres irrigated and total number of livestock. The plans using NASS Census took the data and used it to estimate water use associated with livestock and irrigation. The estimates that are based on the NASS Census are for the entire County and not just the users of greater than 300,000 gallons per month. A limiting factor of this data is that the amount of use derived from groundwater versus surface water is not specified. Although the data is not exactly what is required by the WSP Regulation, it does provide a basis for projections of future demand for the agricultural sector in a particular county and helps DEQ understand which counties reported the greatest amount of irrigated acres. It should be noted that the NASS Census data does not provide information for towns and cities. This information is captured in the respective counties' data.

In assigning water source and water use to basins, it should be noted that at this time it is not possible to identify the specific location of most groundwater sources. Groundwater source and use information is assigned to the basin which contains the largest part of the county's area. For example, Caroline County is in both the York River Basin and the Rappahannock River Basin. The majority of the County's land mass is in the York River Basin; therefore, all groundwater data for Caroline County will be summarized in the York River Basin summary.

Population figures are included for the counties associated with each basin. Many counties in the Commonwealth straddle two or more basins. Population figures are repeated in each appropriate basin summary for those counties spanning more than one basin. Repeating the population figures does not affect water source, water use, or water demand projections. Water source, water use, and water demand projections come directly from the local and regional water supply plans.

Using Caroline County as an example again, the Virginia Employment Commission (VEC) population figures for Caroline County are counted in the population total for both the York River Basin and the Rappahannock River Basin. The population growth trends, illustrated in a table in each basin summary, are projected by DEQ from the VEC data. These population growth trends track very closely with the water demand projections, which are based solely on information provided in the water supply plans.

The following is a list of the localities, by water supply plan, that are wholly or partially located in each major basin and discussed in the major basin summaries.

<u>Albemarle-Chowan River Basin</u>

Information from the following localities, as represented in eight regional water supply plans, contributed to the development of the State Water Resources Plan and the Albemarle-Chowan River Basin Summary:

- Appomattox River Water Authority: City of Petersburg, Counties of Prince George and Dinwiddie
- Charlotte County Regional Water Supply Plan: Charlotte County
- Greensville County, Sussex County and the City of Emporia Regional Water Supply Plan: Counties of Greensville and Sussex; City of Emporia
- Hampton Roads Regional Water Supply Plan: Counties of Isle Of Wight, Southampton, and Surry; Cities Of Chesapeake, Franklin, Suffolk, Virginia Beach
- Lake Country Regional Water Supply Plan: Counties of Brunswick and Mecklenburg
- Lunenburg County and the Towns of Kenbridge and Victoria Regional Water Supply Plan: County of

Lunenberg

- Nottoway Water Supply Plan: County of Nottoway
- Prince Edward County and the Town of Farmville Regional Water Supply Plan: County of Prince Edward

Chesapeake Bay-Small Coastal Basin

Information from the following localities, as represented in five regional water supply plans and one local water supply plan contributed to the development of the State Water Resources Plan and the Chesapeake Bay-Small Coastal Basin Summary:

- Accomack County Regional Water Supply Plan: County of Accomack
- Chincoteague (Town of) Water Supply Plan: Town of Chincoteague
- Hampton Roads Regional Water Supply Plan: Counties of Gloucester and York; Cities of Hampton, Newport News, Norfolk, Poquoson, Virginia Beach, and Williamsburg
- Middle Peninsula Regional Water Supply Plan: Counties of Essex, King and Queen, Mathews, and Middlesex
- Northampton County Regional Water Supply Plan: County of Northampton
- Northern Neck Regional Water Supply Plan: Counties of Lancaster, Northumberland

James River Basin

Information from the following localities, as represented in eighteen regional water supply plans and four local water supply plans contributed to the development of the State Water Resources Plan and the James River Basin Summary:

- Albemarle County and the City of Charlottesville and the Town Of Scottsville Regional Water Supply Plan: County of Albemarle; City of Charlottesville
- Amelia County Water Supply Plan: Amelia County
- Appomattox River Water Authority Regional Water Supply Plan: Counties of Chesterfield, Prince George, and Dinwiddie; Cities of Colonial Heights, Hopewell, and Petersburg
- Buckingham County and the Town of Dillwyn Regional Water Supply Plan: County of Buckingham
- Charles City County Water Supply Management Plan: County of Charles City
- Craig County and the Town of New Castle Regional Water Supply Plan: County of Craig
- Cumberland County, Goochland County, Henrico County, and Powhatan County Regional Water Supply Plan: Counties of Cumberland, Goochland, Henrico, and Powhatan
- Fluvanna County and the Town of Columbia Regional Water Supply Plan: County of Fluvanna
- Greene County and the Town of Stanardsville Regional Water Supply Plan: County of Greene
- Hanover County and the Town of Ashland Long Range Water Resources Plan: County of Hanover

- Hampton Roads Regional Water Supply Plan: Counties of Isle Of Wight, James City, Surry, and York; Cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, and Williamsburg
- Louisa County Long Range Water Supply Plan: County of Louisa
- New Kent County Water Supply Plan: County of Kent
- New River Valley Regional Water Supply Plan: Counties of Montgomery and Giles
- Nottoway Water Supply Plan: County of Nottoway
- Orange County Water Supply Plan: County of Orange
- Prince Edward County and the Town of Farmville Regional Water Supply Plan: County of Prince Edward
- Region 2000 Local Government Council Regional Water Supply Plan: Counties of Amherst, Appomattox, Bedford, Campbell, and Nelson; City of Lynchburg
- Richmond (City of) Water Supply Plan: City of Richmond
- Roanoke Valley Alleghany Regional Commission Regional Water Supply Plan: Counties of Bedford, Botetourt, and Roanoke
- Upper James River Basin Regional Water Supply Plan for the Counties of Alleghany, Bath, Highland, and Rockbridge; Cities of Buena Vista, Covington, and Lexington
- Upper Shenandoah River Basin Regional Water Supply Plan: County of Augusta

New River Basin

Information from the following localities, as represented in four regional water supply plans, contributed to the development of the State Water Resources Plan and the New River Basin Summary:

- The Towns of Blacksburg and Christiansburg Regional Water Supply Plan: Towns of Blacksburg and Christiansburg
- Craig County and the Town of New Castle Regional Water Supply Plan: County of Craig
- New River Valley Regional Water Supply Plan: Counties of Montgomery, Floyd, Pulaski, Giles; City of Radford
- Southwest Virginia Regional Water Supply Plan: Counties of Bland, Carroll, Grayson, Smyth, Tazewell, and Wythe; City of Galax

Potomac-Shenandoah River Basin

Information from the following localities, as represented in six regional water supply plans and four local water supply plans, contributed to the development of the State Water Resources Plan and the Potomac- Shenandoah River Basin Summary:

- Fauquier County Regional Water Supply Plan: County of Fauquier
- Hillsboro (Town of) Water Supply Plan: Town of Hillsboro

- King George County Water Supply Plan: County of King George
- Northern Neck Regional Water Supply Plan: Counties of Northumberland and Westmoreland
- Northern Shenandoah Regional Water Supply Plan: Counties of Clarke, Frederick, Page, Shenandoah, and Warren; City of Winchester
- Northern Virginia Regional Water Supply Plan: Counties of Arlington, Fairfax, Loudoun, and Prince William; Cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park
- Stafford County Water Supply Plan
- Upper James River Basin Regional Water Supply Plan: County of. Highland
- Upper Shenandoah River Basin Regional Water Supply Plan: Counties of Augusta and Rockingham; Cities of Harrisonburg, Staunton, and Waynesboro
- Warrenton (Town of) Water Supply Plan

<u>Rappahannock River Basin</u>

Information from the following localities, as represented in eleven regional water supply plans and three local water supply plans, contributed to the development of the State Water Resources Plan and the Rappahannock River Basin Summary:

- Albemarle County and the City of Charlottesville and the Town of Scottsville Regional Water Supply Plan: County of Albemarle
- Caroline County and the Town of Bowling Green Regional Water Supply Plan: County of Caroline
- Culpeper County and the Town of Culpeper Regional Water Supply Plan: County of Culpeper
- Fauquier County Regional Water Supply Plan: County of Fauquier
- Greene County and the Town of Stanardsville Regional Water Supply Plan: County of Greene
- King George County Water Supply Plan: County of King George
- Madison County and the Town of Madison Regional Water Supply Plan: County of Madison
- Middle Peninsula Regional Water Supply Plan: Counties of Essex and Middlesex
- Northern Neck Regional Water Supply Plan for the Counties of Lancaster, Northumberland, Richmond, and Westmoreland
- Orange County Water Supply Plan: County of Orange
- Town of Port Royal Water Supply Plan: Town of Port Royal
- Rappahannock County and the Town Of Washington Water Supply Plan: County of Rappahannock
- Spotsylvania County and the City Of Fredericksburg Regional Water Supply Plan: County of Spotsylvania; City of Fredericksburg
- Stafford County Water Supply Plan: County of Stafford

Roanoke River Basin

Information from the following localities, as represented in eight regional water supply plans, contributed to the development of the State Water Resources Plan and the Roanoke River Basin Summary:

- Charlotte County and the Towns of Charlotte Court House, Drakes Branch, Keysville, and Phenix Regional Water Supply Plan: County of Charlotte
- Halifax County Regional Water Supply Plan: County of Halifax
- Lake Country Regional Water Supply Plan: Counties of Brunswick and Mecklenburg
- New River Valley Regional Water Supply Plan: Counties of Montgomery and Floyd
- Roanoke Valley Alleghany Regional Commission Regional Water Supply Plan: Counties of Bedford, Botetourt, Franklin, And Roanoke; Cities of Roanoke and Salem
- Region 2000 Local Government Council Regional Water Supply Plan: Counties of Appomattox, Bedford, and Campbell
- West Piedmont Planning District Commission Regional Water Supply Plan: Counties of Henry, Patrick, and Pittsylvania; Cities of Danville and Martinsville
- Southwest Virginia Regional Water Supply Plan: Counties of Carroll and Grayson

Tennessee-Big Sandy River Basin

Information from the following localities as represented in the Southwest Virginia Regional Water Supply Plan contributed to the development of the State Water Resources Plan and the Tennessee-Big Sandy River Basin Summary:

- Southwest Virginia Regional Water Supply Plan: Counties Of Bland, Buchanan, Dickenson, Grayson, Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe; Cities of Bristol, and Norton

York River Basin

Information from the following localities, as represented in ten regional water supply plans and one local water supply plan, contributed to the development of the State Water Resources Plan and the York River Basin Summary:

- Albemarle County and the City Of Charlottesville and The Town Of Scottsville Regional Water Supply Plan: County of Albemarle
- Caroline County and the Town Of Bowling Green Regional Water Supply Plan: County of Caroline
- Cumberland County, Goochland County, Henrico County, and Powhatan County Regional Water Supply Plan: County of Goochland
- Fluvanna County and the Town Of Columbia Regional Water Supply Plan: County of Fluvanna

- Hanover County and the Town Of Ashland Long Range Water Resources Plan: County of Hanover
- Hampton Roads Regional Water Supply Plan: Counties Of Gloucester, James City, and York; City of Williamsburg
- Louisa County Long Range Water Supply Plan: County of Louisa
- Middle Peninsula Regional Water Supply Plan: Counties of King and Queen and King William
- New Kent County Water Supply Plan: County of New Kent
- Orange County Water Supply Plan: County of Orange
- Spotsylvania County and The City of Fredericksburg Regional Water Supply Plan: County of Spotsylvania

Appendix C lists the outstanding items needed for full compliance with the Local and Regional Water Supply Planning Regulation. The outstanding items are listed by local or regional water supply plan.

All of the water supply program compliance determinations included 'conditions' that must be addressed in time for the five-year review of all local and regional water supply plans. These conditions were outlined in a memorandum that accompanied a package including the notice of the compliance determination, a review of state agency comments (when appropriate), and a checklist document utilized by DEQ for the consistent review of programs.

Appendix A: Water Supply Plans and Participating Localities

Water Supply Plans and Participating Localities

Local Water Supply Plans

Amelia County

Charles City County

Town of Chincoteague

Town of Hillsboro

King George County

New Kent County

Town of Port Royal

City of Richmond

Stafford County

Town of Warrenton

Regional Water Supply Plans

Accomack County and Towns (County of Accomack and the Towns of Accomac, Belle Haven (partially), Bloxom, Hallwood, Keller, Melfa, Onancock, Onley, Painter, Parksley, Saxis, Tangier, and Wachapreague)

Albemarle, Charlottesville and Scottsville (County of Albemarle, the City of Charlottesville and the Town of Scottsville)

Appomattox River Water Authority and the City of Hopewell (Counties of Chesterfield, Dinwiddie and Prince George, Cities of Colonial Heights, Hopewell, and Petersburg, and the Town of McKenney)

Blacksburg/Christiansburg (Towns of Blacksburg and Christiansburg)

Buckingham County and Town (County of Buckingham and the Town of Dillwyn)

Caroline County and Town (County of Caroline and the Town of Bowling Green)

Charlotte County and Towns (County of Charlotte and the Towns of Charlotte Court House, Drakes Branch, Keysville, and Phenix)

Craig County and Town (County of Craig and the Town of New Castle)

Culpeper County and Town (County of Culpeper and the Town of Culpeper)

Cumberland, Goochland, Henrico, and Powhatan Counties

Fauquier County and Towns (County of Fauquier and the Towns of Remington and The Plains)

Fluvanna County and Town (County of Fluvanna and the Town of Columbia)

Greene County and Town (County of Greene and the Town of Stanardsville)

Greensville, Sussex and Emporia (Counties of Greensville and Sussex, the City of Emporia and the Towns of Jarratt, Stony Creek, Wakefield, and Waverly)

Halifax County and Towns (County of Halifax and the Towns of Halifax, South Boston, Scottsburg, and Virgilina)

Hampton Roads (Counties of Gloucester, Isle of Wight, James City, Southampton, Surry, and York, the Cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, and the Towns of Boykins, Branchville, Capron, Claremont, Courtland, Dendron, Ivor, Newsoms, Smithfield, Surry, and Windsor)

Hanover County and Town (County of Hanover and the Town of Ashland)

Lake Country (Counties of Mecklenburg and Brunswick, and the Towns of Alberta, Boydton, Brodnax, Charles City, Clarksville, La Crosse, Lawrenceville, and South Hill)

Louisa County and Towns (County of Louisa and the Towns of Louisa and Mineral)

Lunenburg County and Towns (County of Lunenburg and the Towns of Kenbridge and Victoria)

Madison County and Town (County of Madison and the Town of Madison)

Middle Peninsula (Counties of Essex, King and Queen, King William, Mathews, and Middlesex, and the Towns of Tappahannock, Urbanna, and West Point)

New River Valley (Counties of Floyd, Giles, Montgomery, and Pulaski, the City of Radford, and the Towns of Dublin, Floyd, Glen Lyn, Narrows, Pearisburg, Pembroke, Pulaski, and Rich Creek)

Northampton County and Towns (County of Northampton and the Towns of Cape Charles, Cheriton, Eastville, Exmore, Nassawadox, and Belle Haven (partially))

Northern Neck (Counties of Lancaster, Northumberland, Richmond, and Westmoreland, and the Towns of Colonial Beach, Irvington, Kilmarnock, Montross, Warsaw, and White Stone)

Northern Shenandoah Valley (Counties of Clarke, Frederick, Page, Shenandoah, and Warren, the City of Winchester, and the Towns of Berryville, Boyce, Edinburg, Front Royal, Luray, Middletown, Mount Jackson, New Market, Shenandoah, Stanley, Stephens City, Strasburg, Toms Brook, and Woodstock)

Northern Virginia (Counties of Arlington, Fairfax, Loudoun, and Prince William, the Cities of Alexandria, Fairfax, Falls Church, Manassas, Manassas Park, and the Towns of Clifton, Dumfries, Hamilton, Haymarket, Herndon, Leesburg, Lovettsville, Middleburg, Occoquan, Purcellville, Quantico, Round Hill, and Vienna)

Nottoway County and Towns (County of Nottoway and the Towns of Blackstone, Burkeville, and Crewe)

Orange County and Towns (County of Orange and the Towns of Gordonsville and Orange)

Prince Edward County and Town (County of Prince Edward and the Town of Farmville)

Rappahannock County and Town (County of Rappahannock and the Town of Washington)

Region 2000* (Counties of Amherst, Appomattox, Bedford, Campbell, and Nelson, the City of Lynchburg, and the Towns of Altavista, Amherst, Appomattox, Bedford, Brookneal, and Pamplin)

Roanoke Valley Alleghany Regional Commission*[67] (Counties of Bedford, Botetourt, Franklin, and Roanoke, the Cities of Roanoke and Salem, and the Towns of Boones Mill, Buchanan, Fincastle, Rocky Mount, Troutville, and Vinton)

Southwest Virginia (Counties of Bland, Buchanan, Carroll, Dickenson, Grayson, Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe, the Cities of Bristol, Galax, and Norton, and the Towns of Abingdon, Appalachia, Big Stone Gap, Bluefield, Cedar Bluff, Chilhowie, Cleveland, Clinchco, Clinchport, Clintwood, Coeburn, Damascus, Duffield, Dungannon, Fries, Gate City, Glade Spring, Grundy, Haysi, Hillsville, Honaker, Independence, Jonesville, Lebanon, Marion, Nickelsville, Pennington Gap, Pocahontas, Pound, Richlands, Rural Retreat, Saltville, St. Charles, St. Paul, Tazewell, Troutdale, Weber City, Wise, and Wytheville)

Spotsylvania County and the City of Fredericksburg

Upper James River Basin (Counties of Alleghany, Bath, Highland, and Rockbridge, the Cities of Buena Vista, Covington, and Lexington, and the Towns of Clifton Forge, Glasgow, Goshen, Iron Gate, and Monterey)

Upper Shenandoah River Basin (Counties of Augusta and Rockingham, the Cities of Harrisonburg, Staunton, and Waynesboro, and the Towns of Bridgewater, Broadway, Craigsville, Dayton, Elkton, Grottoes, Mount Crawford, and Timberville)

West Piedmont (Counties of Henry, Patrick, and Pittsylvania, the Cities of Danville and Martinsville, and the Towns of Chatham, Gretna, Hurt, Ridgeway, and Stuart)

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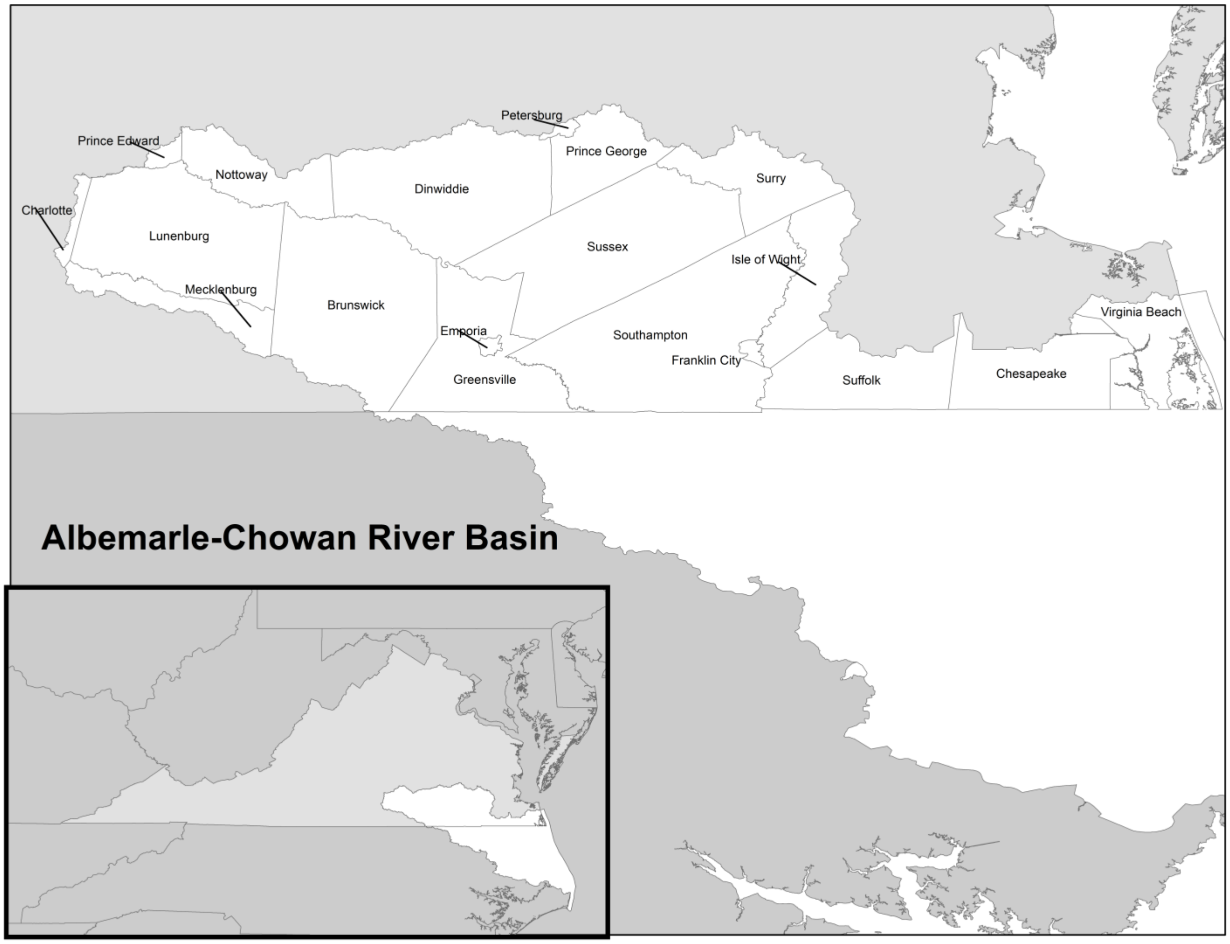
*Bedford County participated in water supply plans for Region 2000 and RVARC. The Town of Bedford was a City during the development of the water supply plans and participated in the Region 2000 plan only.

Albemarle-Chowan 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 Albemarle-Chowan River Basin is located in the southeastern portion of Virginia and covers 4,220 square miles, or approximately 10% of the Commonwealth's land area. The Basin is approximately 145 miles in length and varies from 10 to 50 miles in width. Virginia's portion of the Basin extends eastward from Charlotte County to the Chesapeake Bay. The Basin is bordered by the James River and the Chesapeake Bay-Small Coastal River Basins to the north, the Roanoke River Basin to the west and the Virginia/North Carolina State line to the south.

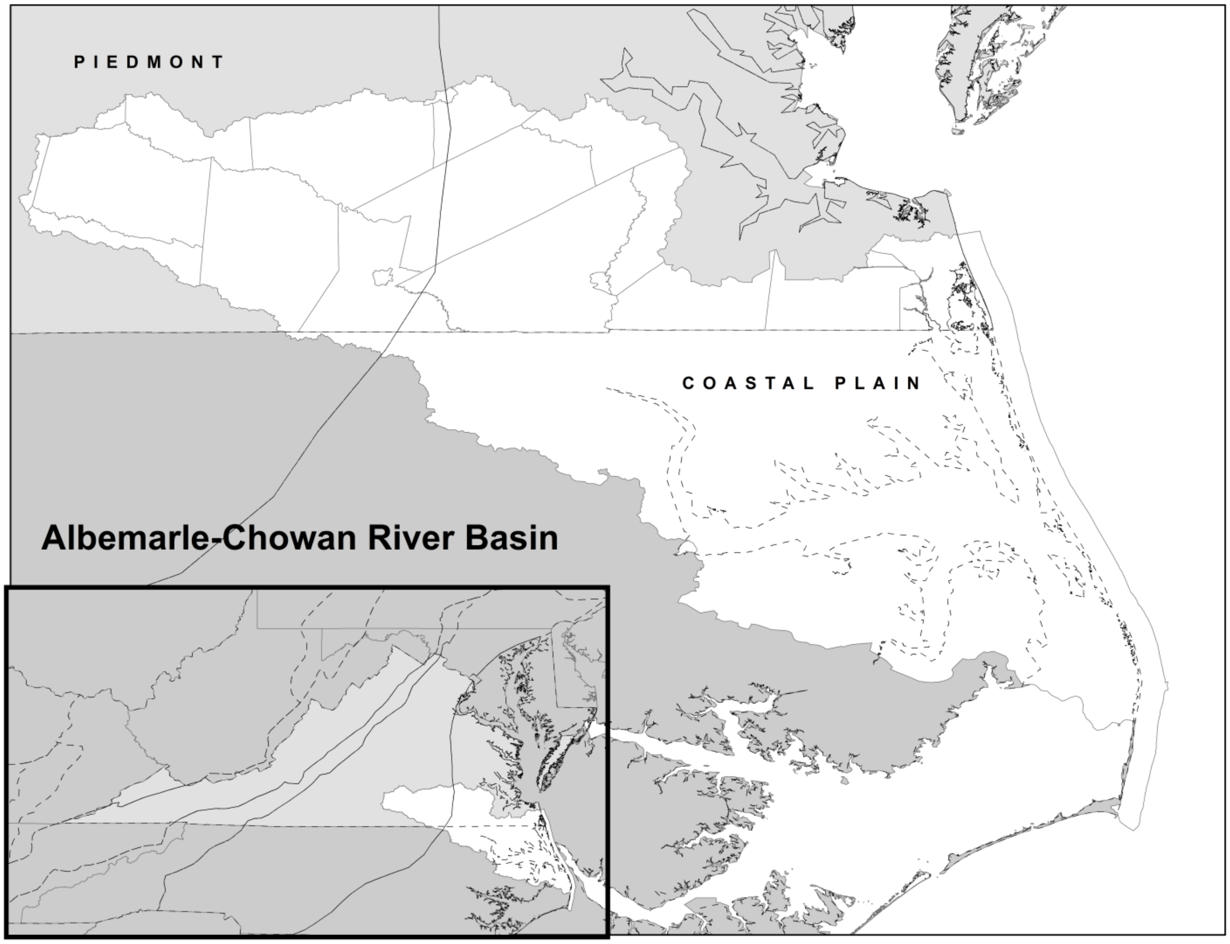
All or portions of the following 13 counties and six cities lie within the Basin: counties of Brunswick, Charlotte, Dinwiddie, Greensville, Isle of Wight, Lunenburg, Mecklenburg, Nottoway, Prince Edward, Prince George, Southampton, Surry, and Sussex; cities of Chesapeake, Emporia, Franklin, Petersburg, Suffolk, and Virginia Beach. These jurisdictions are represented within eight regional water supply plans: Greensville/Sussex/Emporia, Lunenburg County/Towns, Nottoway County/Towns, Hampton Roads, Lake Country, Charlotte/Town, Appomattox River Water Authority, and Prince Edward/Town.



Albemarle-Chowan River Basin Localities

Major tributaries of the Chowan River are the Meherrin, Nottoway and Blackwater Rivers. Approximately nine miles south of the City of Franklin, along the Southampton County and City of Suffolk border, the Nottoway and Blackwater Rivers combine to form the Chowan River. Virginia's portion of the Meherrin River crosses into North Carolina to join the Chowan as it travels south to the Albemarle Sound on North Carolina's coast. The far eastern section of the Basin encompasses the southern portions of the Cities of Suffolk, Chesapeake and Virginia Beach. The land here is mostly flat with many swamp and marshland areas and drains directly to the Albemarle Sound.

The Basin flows through the Piedmont and Coastal Plain Physiological Provinces. The Chowan portion flows 130 miles from west to east, crossing both the Piedmont and Coastal Plain, while the eastern portion of the Basin lies entirely within the Coastal Plain. The Piedmont is characterized by rolling hills, steeper slopes, and somewhat more pronounced stream valleys. The Coastal Plain, in contrast, is nearly flat with a descending series of terraces.



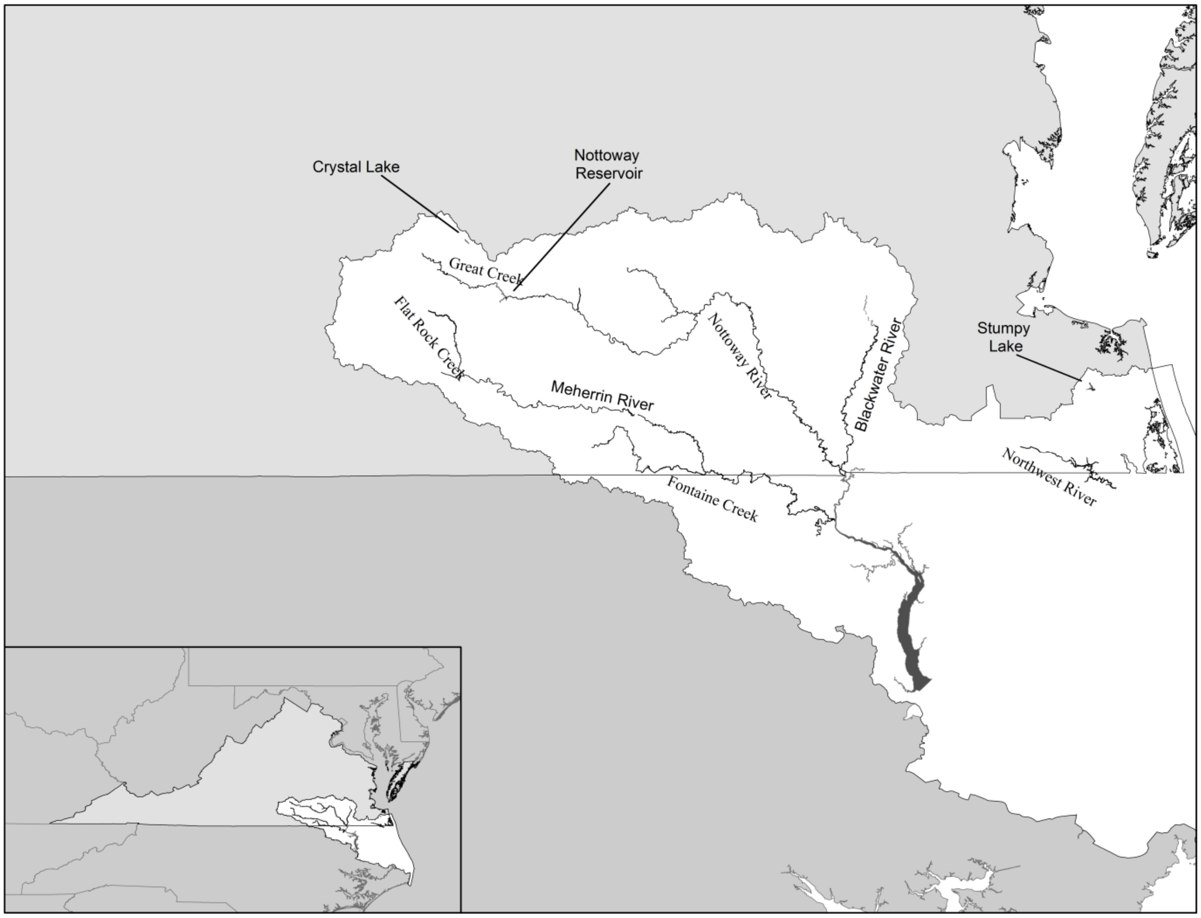
Albemarle-Chowan River Basin Physiographic Provinces

The Albemarle-Chowan River Basin is mostly rural with approximately 64% of its land covered by forest. Crop and pasture land make up another 28%, while only about 6% is classified as urban. The Basin is divided into five USGS hydrologic units as follows: HUC 03010201 Nottoway; HUC 03010202 Blackwater; HUC 03010203 Chowan; HUC 03010204 Meherrin; and HUC 03010205 Albemarle Sound. The five hydrologic units are further divided into 42 waterbodies or watersheds and 127 6th order sub-watersheds.

Existing Water Sources

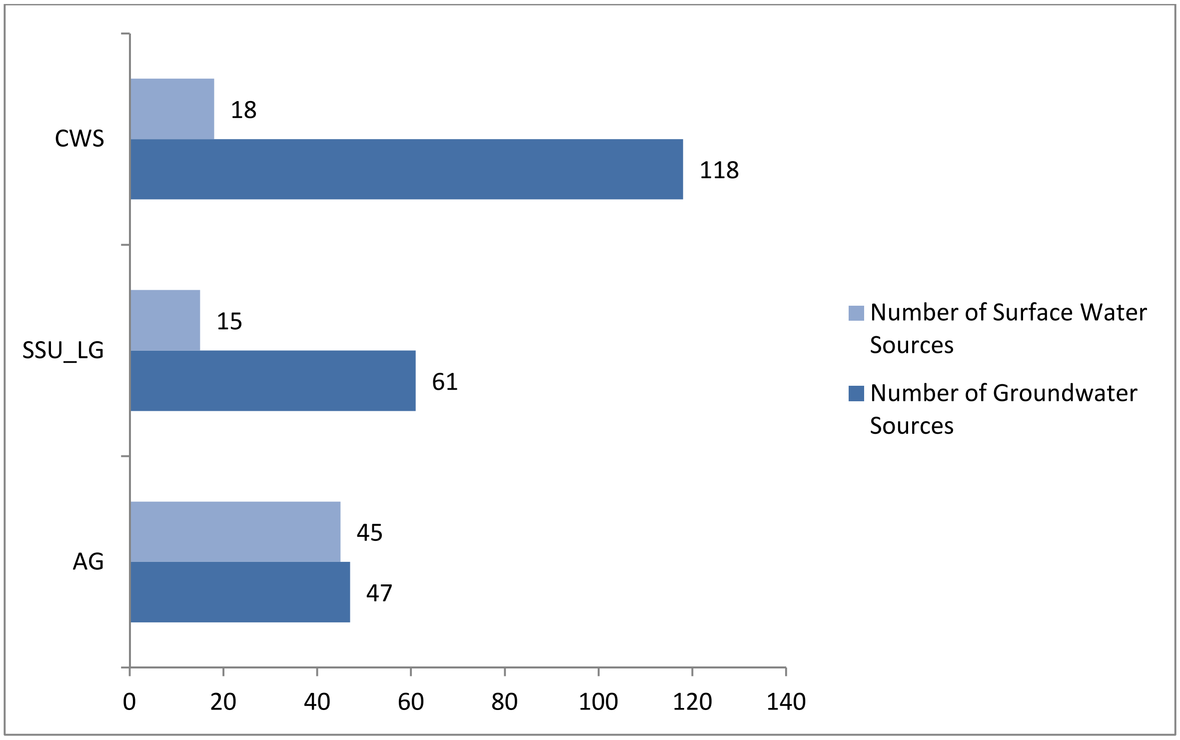
Water sources utilized in the Basin include stream intakes, reservoirs, private ponds, and groundwater wells. Surface water sources (reservoirs and streams) account for 78 withdrawals; additionally there are 226 groundwater withdrawals currently identified in the Albemarle-Chowan River Basin. Source water reservoirs used in the Basin include Lunenburg Lake, Nottoway Falls Reservoir, Emporia Reservoir, Crystal Lake, Fort Pickett Reservoir, and Stumpy Lake. Stream intakes used in the Basin include the Blackwater River, Great Creek, Meherrin River, Northwest River, Nottoway River, Flat Rock Creek, and

Fontaine Creek. Ponds and lakes on private property are used for irrigation on farms and golf courses in the Basin.



Albemarle-Chowan River Basin Major Reservoir and Stream Sources

Reported groundwater sources outnumber reported surface water sources in all use types. The number of residential groundwater sources (SSU_SM) is unknown and, therefore, is not included in the figure below.   As estimated for the year 2010, approximately 224,335 people in the Basin use private groundwater wells for residential water supply.



Albemarle-Chowan River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly utilized by localities in the Commonwealth. However, there are a few localities in the Basin taking advantage of these options. The City of Chesapeake treats brackish surface water at the Northwest River Reverse Osmosis Water Treatment Plant and uses an aquifer storage and recovery well for storage of treated water during peak demands. The City of Suffolk uses electro-dialysis reversal desalination at their water treatment plant to treat high fluoride groundwater.

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.

The following table lists the two reported Albemarle-Chowan intrabasin transfers between water providers and the Community Water System (CWS) to which they sell water (water purchaser).

User Type	Water Purchaser and System(s)	Water Provider
CWS	Town of Alberta	Town of Lawrenceville
CWS	Greensville County WSA - Jarratt system	Georgia Pacific Jarratt Plant

Albemarle-Chowan River Basin Intrabasin Transfers

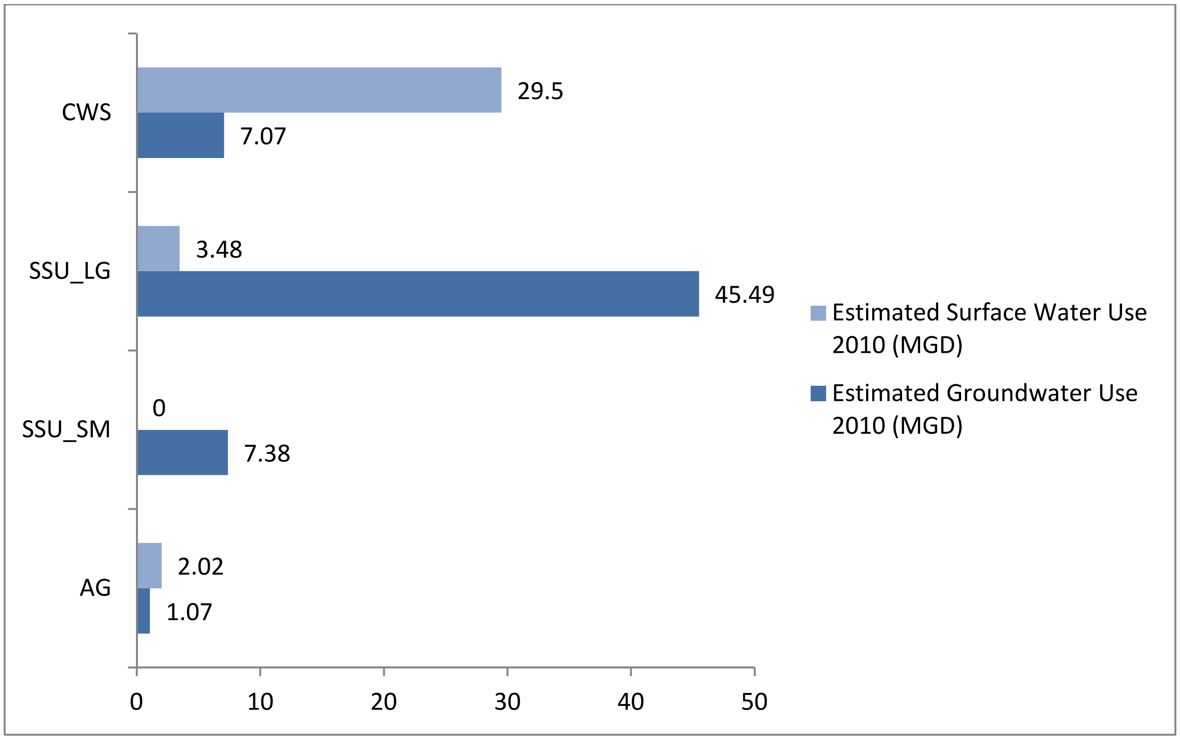
Interbasin transfers reported in the Albemarle-Chowan River Basin are found below.

User Type	Water Purchaser and System(s)	Water Provider
CWS	Chesapeake - Northwest River System	City of Norfolk
CWS	U. S. Navy - Dam Neck	City of Norfolk
CWS	U. S. Navy - Oceana	City of Norfolk
CWS	City of Virginia Beach	U. S. Army Corps of Engineers
CWS	Town of South Hill	Roanoke River Service Authority
CWS	Town of Brodnax	Roanoke River Service Authority
SSU_LG	Georgia Pacific Skippers Plant	Roanoke Rapids Sanitary District
SSU_LG	Interstate 95 Rest Area located in Greensville County	Roanoke Rapids Sanitary District

Albemarle-Chowan River Basin Interbasin Transfers

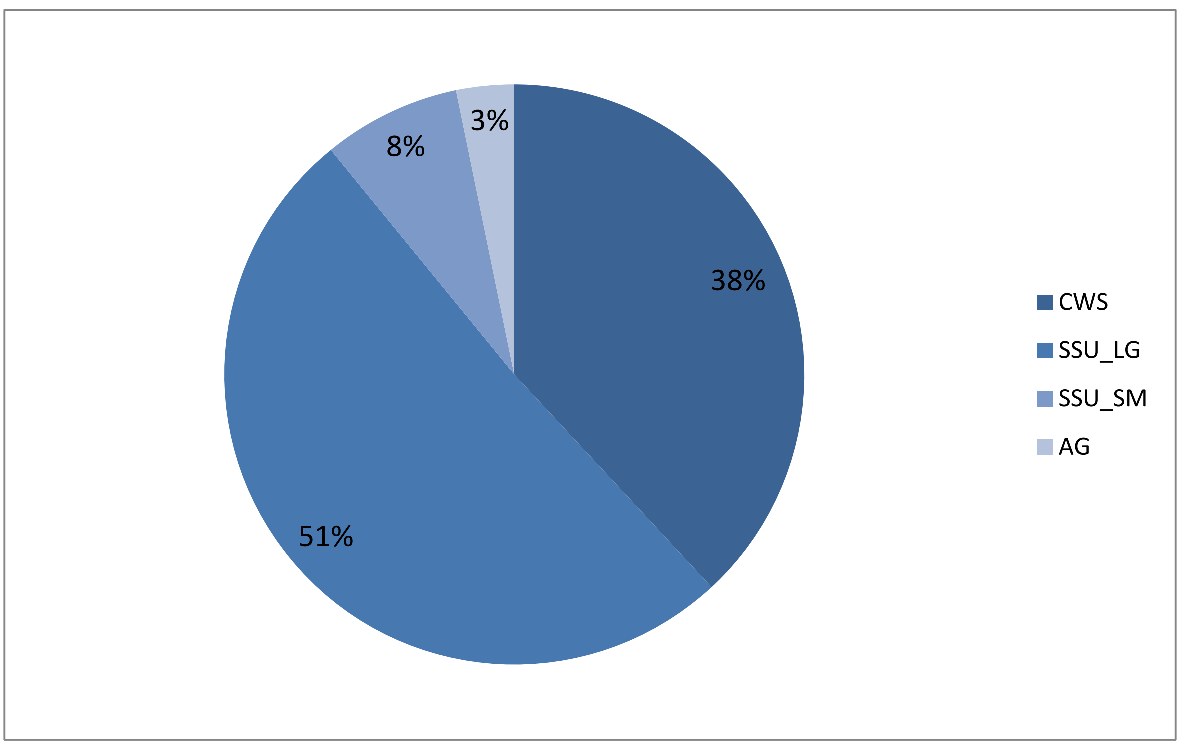
Existing Water Use

The estimated water use provided by the regional water supply plans is summarized below. The total estimated water use is approximately 96 MGD with 35 MGD of surface water use and 61 MGD of groundwater use.



Albemarle-Chowan River Basin Estimated Use by Source and Type

Large Self-Supplied Users (SSU_LG) use an estimated 51% of the total water used in the Basin followed by CWS (38 percent), Small Self-Supplied Users (SSU_SM) (8%) and Agriculture (AG) (3%).

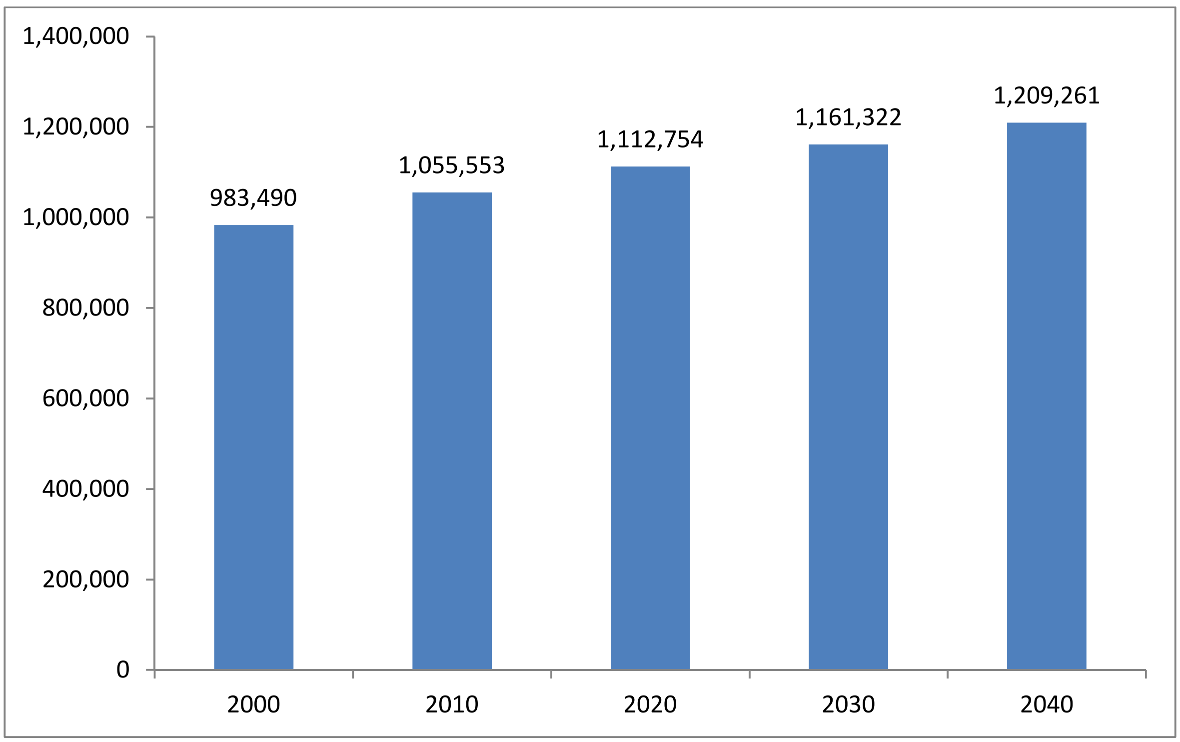


Albemarle-Chowan River Basin Percentage of 2010 Estimated Use by User Type

CWS reported their water use disaggregated into categories of use appropriate for the system. Categories commonly used included Residential, Commercial/Institutional/Light Industry (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 CWS 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.

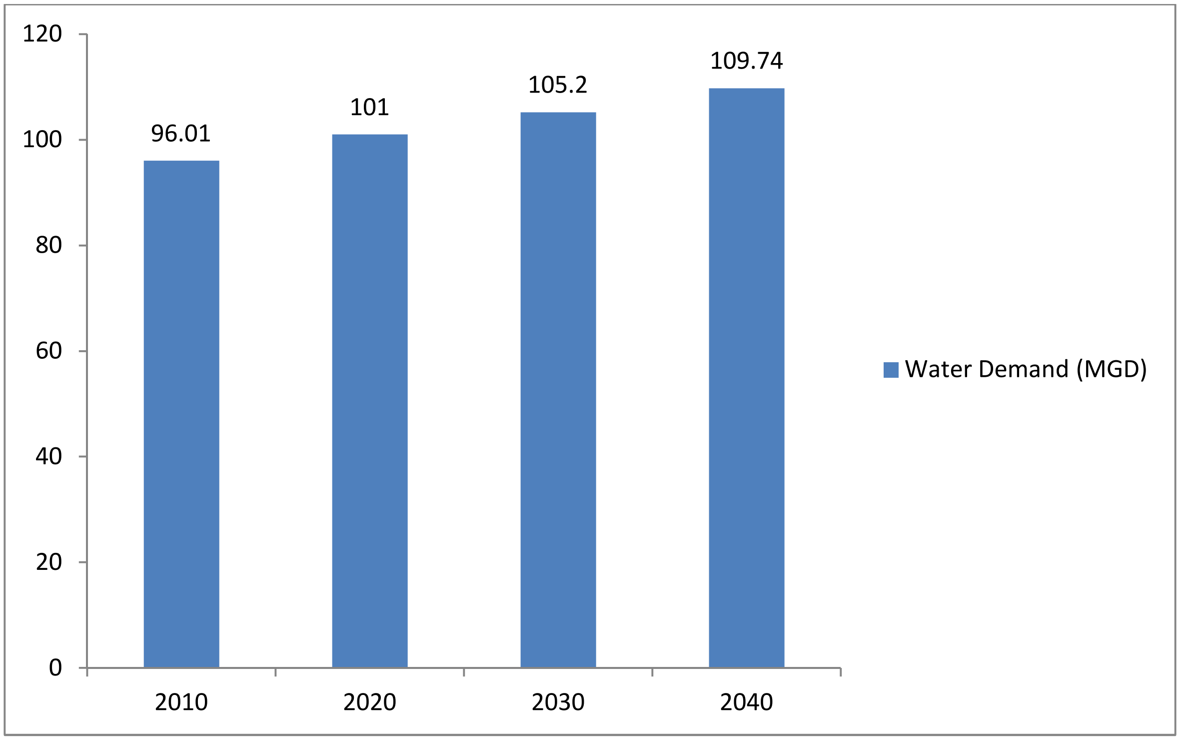
Projected Water Demand

The projected population of the localities with at least a portion of their land area in the Albemarle-Chowan River Basin is displayed in the figure below. Population data is 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 Basin is projected to increase through the year 2040. By the year 2040 the estimated basin-wide population is projected at 1,209,261. The percent change in population from the years 2010 through 2040 is estimated at 14.6%.



Albemarle-Chowan River Basin Projected Population

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 Albemarle-Chowan River Basin, as reported in the regional water supply plans, is estimated to increase from approximately 96 MGD to 110 MGD in 2040. The percent change in water use during the 30-year timeframe is estimated at 20.8%.



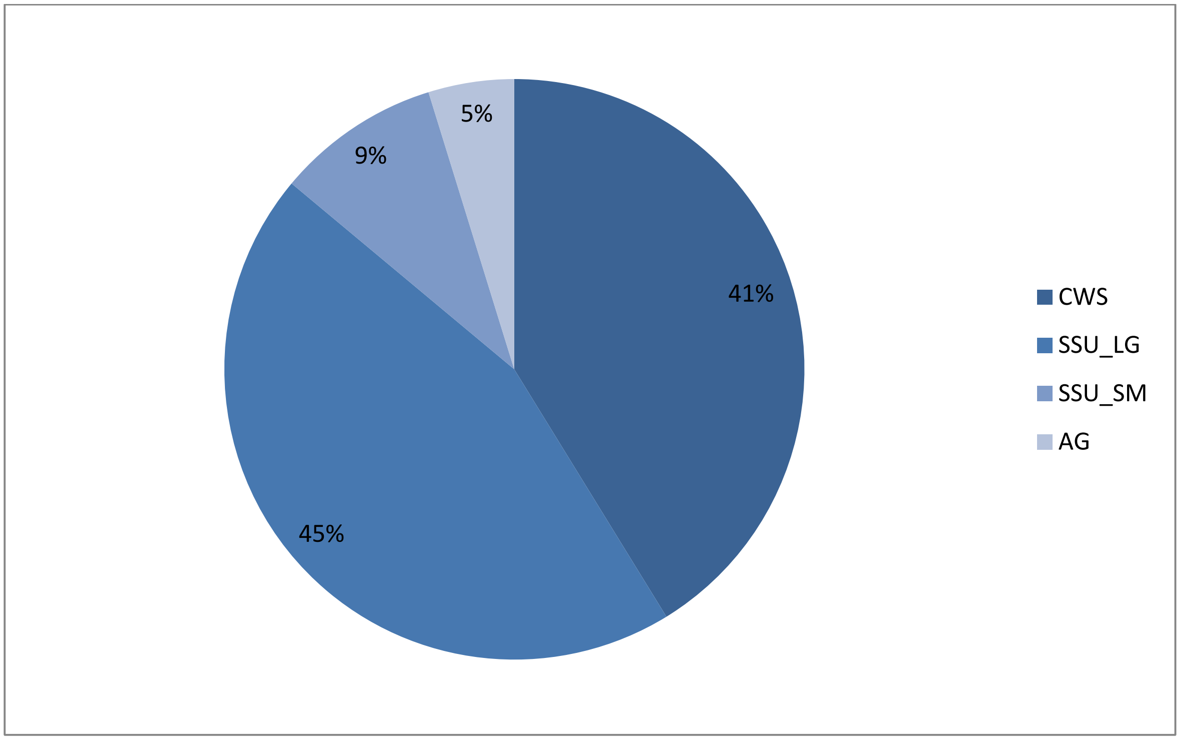
Albemarle-Chowan River Basin Projected Water Demand

As depicted in the following table, agricultural users show the largest increase (70%) in water demand over the 30-year period, followed by SSU_SM (36.2%), CWS (30.4%) and SSU_LG (0.5%).

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	36.57	39.46	42.3	45.24	30.4%
SSU_LG	48.97	49.04	49.1	49.20	0.5%
SSU_SM	7.38	8.28	9.2	10.06	36.2%
AG	3.09	3.81	4.5	5.25	70.0%

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

The percentage of total projected 2040 demand by user type is shown in the figure below. In the year 2040 SSU_LG demand is estimated at 45% of the total demand in the Basin followed by CWS with 41%, SSU_SM with 9% and AG at 5%.



Albemarle-Chowan 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 water sources is obtained from the eight regional water supply plans represented in the Albemarle-Chowan River Basin. The information is presented for all those localities with at least a portion of land area located within the Albemarle-Chowan River Basin. The following lists the projected deficits in the Basin.

Appomattox River Water Authority Regional Water Supply Plan

Dinwiddie County and the Town of McKenney, Prince George County and the City of Petersburg

By the year 2040, the Appomattox River Water Authority (ARWA) is expected to have an average day supply deficit of 9.4 MGD. Regional peak day supply deficit of 14.6 MGD is anticipated by 2050. Peak day deficits anticipated by locality are anticipated as follows:

Dinwiddie County anticipates a peak day deficit of 0.16 MGD by 2050

Prince George County anticipates a peak day deficit of 0.9 MGD by 2020

The City of Petersburg shows a decline in future water demand.

Several alternatives are recommended for meeting this additional demand in the future: increases in current water supply allocations, new sales/purchase agreements, development of water reuse capacity, increases in water demand management and conservation efforts, and development of additional supply through new groundwater sources, raising the water level of Lake Chesdin, building a river intake on the Appomattox River, and development of a new surface water reservoir.

The Virginia Water Protection (VWP) permit reissued to the ARWA on November 1, 2013 for operation and management of Chesdin Lake and the municipal water withdrawal requires the permittee to continue investigating options and to report on progress towards procurement of future storage augmentation. Funding was appropriated by the 2013 General Assembly for expanding capacity at Lake Chesdin. The ARWA is currently investigating increasing raw water supply through a seasonal increase of 18 inches in the water level of Lake Chesdin.

Charlotte County Regional Water Supply Plan

<u>Charlotte County the Towns of Charlotte Court House, Drakes Branch, Keysville and Phenix</u>

The regional plan provided 'upper level' and 'lower level' population and water demand projections. Using the upper level demand projections for community water systems found in the water supply plan, future deficits in water supply are anticipated in the four towns as follows:

Town of Drakes Branch: deficit of 0.153 MGD by 2020

Town of Phenix: deficit of 0.0002 MGD by 2010

Town of Charlotte Court House: deficit of 0.008 MGD by 2020

Town of Keysville: deficit of 0.207 MGD by 2050

Several alternatives are recommended for meeting this additional demand in the future: clarification of the safe yield for Keysville Reservoir; development of additional groundwater supply in the towns of Drakes Branch, Charlotte Court House, and Phenix; development of a water treatment plan at the Drakes Branch Lake; and system interconnection of Charlotte Court House with either Drakes Branch or Keysville, and system interconnection of Drakes Branch with Keysville.

Greensville-Sussex-Emporia Regional Water Supply Plan

<u>Greensville County and the Town of Jarratt, Sussex County and the Towns of Stony Creek, Wakefield and Waverly; City of Emporia</u>

The communities of Skippers, Jackson-field Home, Stony Creek, Northeast, and Wakefield have ample water supply for projected demands. The communities of Waverly, Birch Island, Greensville/Jarratt and Emporia may not meet peak demands in the planning period. Greensville County has concerns of the water source for the Greensville/Jarratt area, which is obtained from a Georgia-Pacific (G-P) owned intake, due to physical limitations of the existing withdrawal canal. The County proposes improvements to Greensville County Water Service Authority's (GCWSA) raw water supply system to create a stable and reliable system that will allow them to safely add customers to their water system to support growth in the County. The County informed DEQ during a meeting on October 22, 2013, that they are continuing negotiations with G-P regarding the intake in spite of receiving notification that G-P is closing the Jarratt Plant. It is still their intention that the water needs currently being met by the existing G-P intake, for both public water supply and potentially a new industrial user, be met through the new, County-owned, intake on the Nottoway River and construction of a pumped storage reservoir system. The GCWSA is seeking a VWP permit for this project (JPA No. 13-0957). The GCWSA also plans to deepen/refurbish groundwater wells and dredge/refurbish the Emporia Reservoir if the storage capacity is reduced to 500 acre feet.

Hampton Roads Regional Water Supply Plan

<u>Isle of Wight County and the Towns of Smithfield and Windsor; Southampton County and the Towns of Boykins, Branchville, Capron, Courtland, Ivor, and Newsoms; Surry County and the Towns of Claremont, Dendron, and Surry; Cities of Chesapeake, Franklin, Suffolk, and Virginia Beach</u>

Demand is expected to increase as population in the region continues to grow; however, projected supply is anticipated to meet projected demand for the region through 2050.

Lake Country Regional Water Supply Plan

<u>Brunswick County and the Towns of Alberta, Brodnax and Lawrenceville; Mecklenburg County and the Towns of Boydton, Chase City, Clarksville, La Crosse, and South Hill</u>

Total population for the planning area is projected to increase only slightly during the planning period. Regional water supply is plentiful, and it is estimated that there are adequate water sources to provide for the needs of the planning area now and in the foreseeable future; however, competition for water from fast growing metropolitan areas in neighboring North Carolina and Tidewater Virginia was cited in the Plan as a potential threat to water quantity.

Lunenburg County and the Towns of Kenbridge and Victoria Regional Water Supply Plan

A slight increase in regional population is anticipated from 13,146 in 2000 to 13,551 in 2040. Land use within the region is not predicted to change substantially. The water supply plan indicates that existing water sources are adequate to meet current and projected demand.

Nottoway Water Supply Plan

<u>Nottoway County and the Towns of Blackstone, Burkeville and Crewe, and the Fort Pickett Military Reservation</u>

The planning region expects current sources will meet projected demands through 2050.

Prince Edward County and the Town of Farmville Regional Water Supply Plan

Prince Edward County anticipates future growth in their northern sector and the Farmville CWS service area. 2060 high-range projected average daily demands (2.7 MGD) in Farmville are not anticipated to exceed the safe yield at the Appomattox River intake (3.04 MGD) or the VDH permitted capacity (3.0 MGD). However, the plan notes that during low-flow or drought conditions, additional source water may be needed. Plans to address the projected shortfall of municipal supply include developing a water intake structure and water treatment facility near the Sandy River Reservoir, extending existing waterlines, and expansion of groundwater wells, along with new and continuing water conservation efforts.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Town of Drakes Branch	2020	0.153
Town of Phenix	2010	0.0002
Town of Charlotte Court House	2020	0.008
Town of Keysville	2050	0.207
Dinwiddie County	2050	0.16
Prince George County	2020	0.9

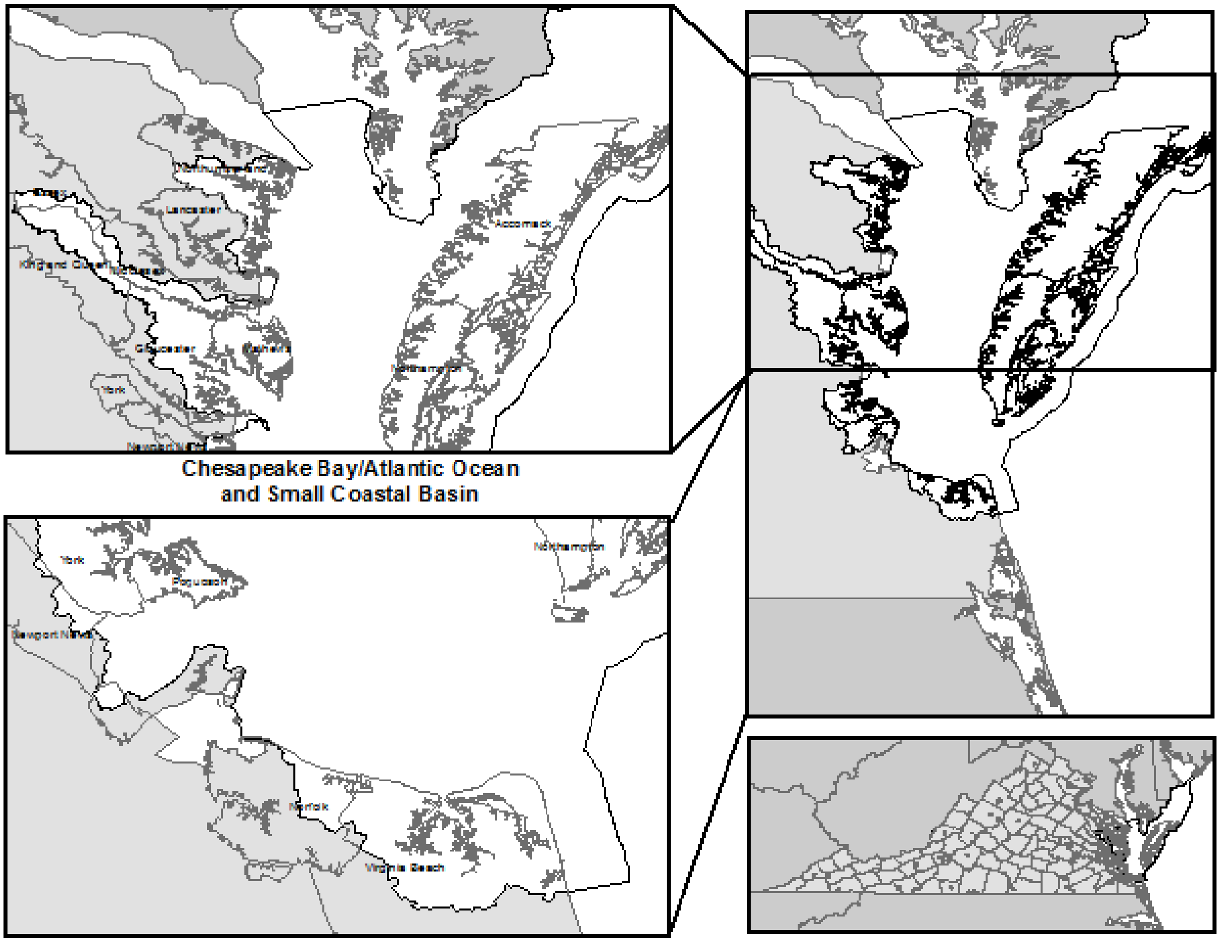
Albemarle-Chowan River Basin Projected Water Deficits

Chesapeake Bay-Small Coastal 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.

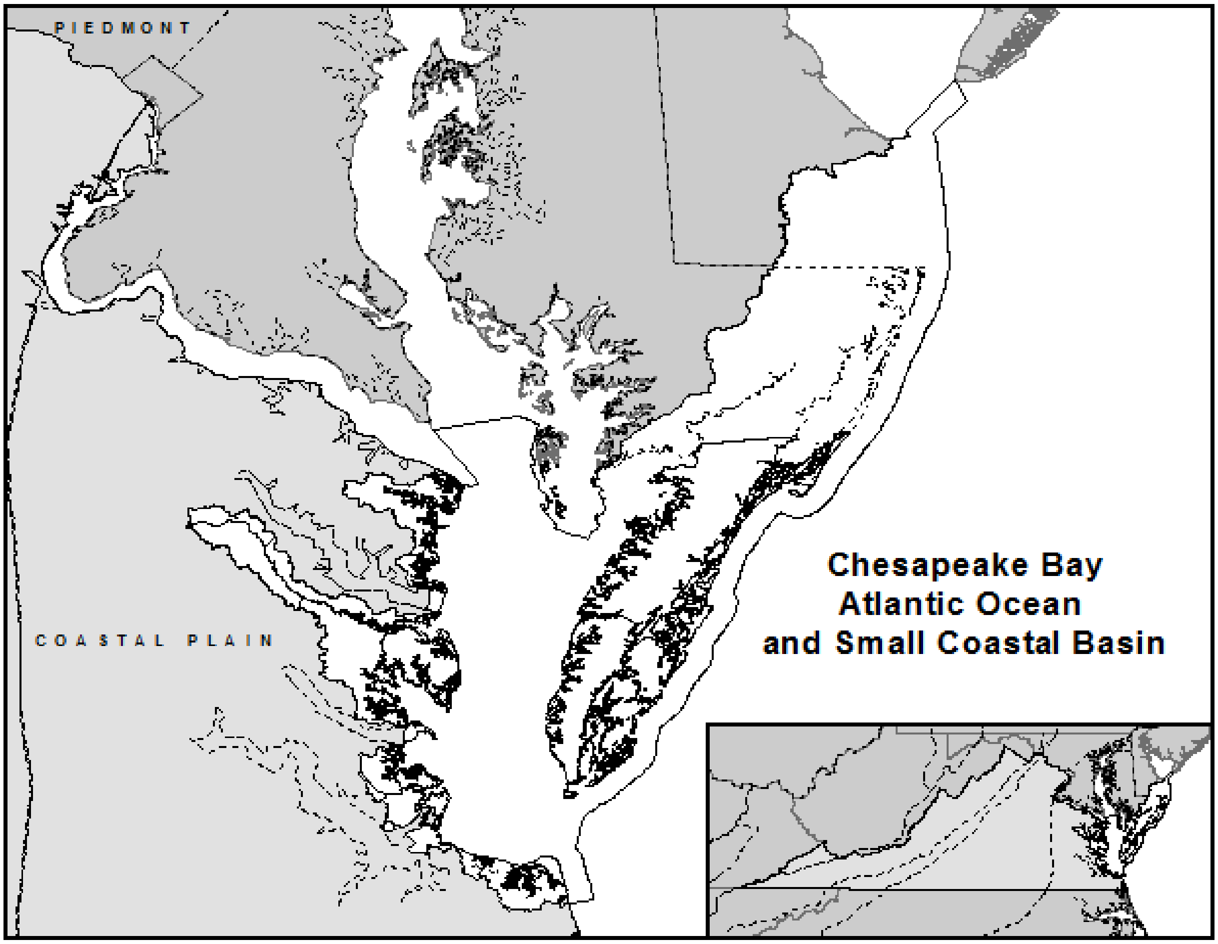
The Chesapeake Bay-Small Coastal Basin is located in the eastern part of Virginia, encompassing the small bays, river inlets, islands, and shoreline immediately surrounding the Chesapeake Bay, the southern portion of the Delmarva Peninsula, and the Chesapeake Bay itself. The Basin is defined by both hydrologic and political boundaries: the Potomac River, the Rappahannock River, the York River, the James River, and the Albemarle-Chowan River Basins border the small coastal basins to its west. The Eastern Shore portion is bordered on the west by the Chesapeake Bay, on the north by Maryland, and on the east by the Atlantic Ocean. The Basin covers 3,592 square miles, or approximately 8% of the Commonwealth's total land area.

The following ten counties and five cities are entirely or partially located within the Basin: counties of Accomack, Essex, Gloucester, King and Queen, Lancaster, Mathews, Middlesex, Northampton, Northumberland, and York; cities of Hampton, Newport News, Norfolk, Poquoson, and Virginia Beach. These jurisdictions are represented within five regional water supply plans (Middle Peninsula, Hampton Roads, Northern Neck, Accomack County and Towns, and Northampton County and Towns) and one local water supply plan (Town of Chincoteague).



Chesapeake Bay-Small Coastal Basin Localities

The topography of the Chesapeake Bay-Small Coastal Basin varies little. The Basin is within the Coastal Plain Physiographic Province where elevations average no more than a few feet above sea level. More significant elevation occurs along the central spine of the Eastern Shore portion, which forms a plateau about 45 feet above sea level. Much of this Basin consists of marshland.



Chesapeake Bay-Small Coastal Basin Physiographic Provinces

About 30% of the Chesapeake Bay-Small Coastal Basin is forested, while nearly 22% is in cropland and pasture. Approximately 24% is considered urban.

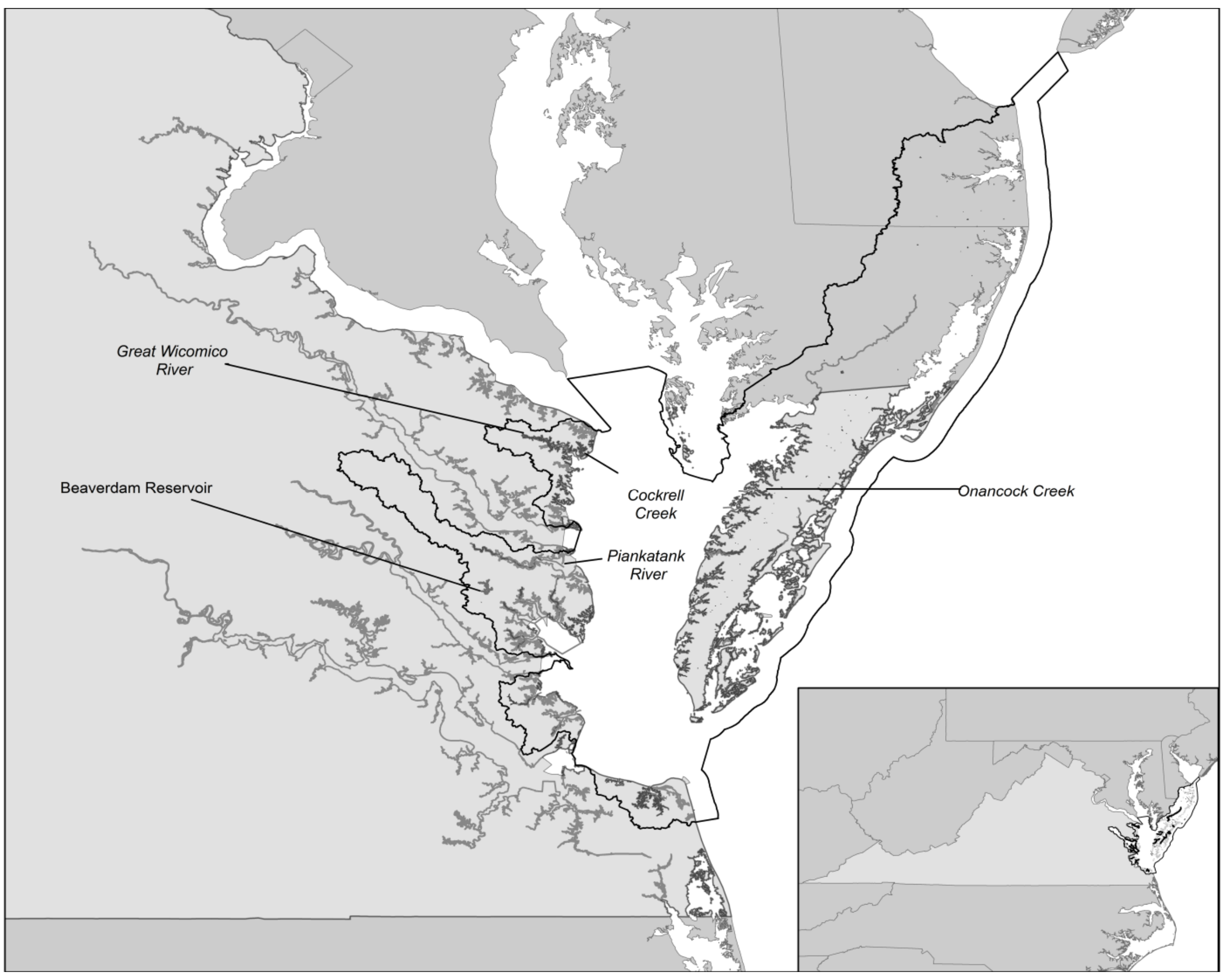
Tributaries in the Chesapeake Bay-Small Coastal Basin drain into the Chesapeake Bay or the Atlantic Ocean. Major tributaries flowing into the Chesapeake Bay from the western shore are the Great Wicomico River, Piankatank River, Fleets Bay, Mobjack Bay including the East, North, Ware, and Severn Rivers, Poquoson River, Back River, and Lynnhaven River. Tributaries in the Eastern Shore portion that drain into the Bay include the Pocomoke River, Onancock, Pungoteague, Occohannock, and Nassawadox Creeks. Machipongo River, Assawoman Creek, Parker Creek, Folly Creek, and Finney Creek drain east, directly into the Atlantic Ocean.

The Chesapeake Bay-Small Coastal Basin is divided into seven USGS hydrologic units as follows: HUC 02060009 – Pocomoke; HUC 02060010 – Chincoteague; HUC 02080101 – Lower Chesapeake Bay; HUC 02080102 – Great Wicomico-Piankatank; HUC 02080108 – Lower Lynnhaven-Poquoson; HUC

02080109 – Western Lower Delmarva; and HUC 02080110 – Tangier. The seven hydrologic units are further divided into 24 water bodies or watersheds and 73 6th order sub-watersheds.

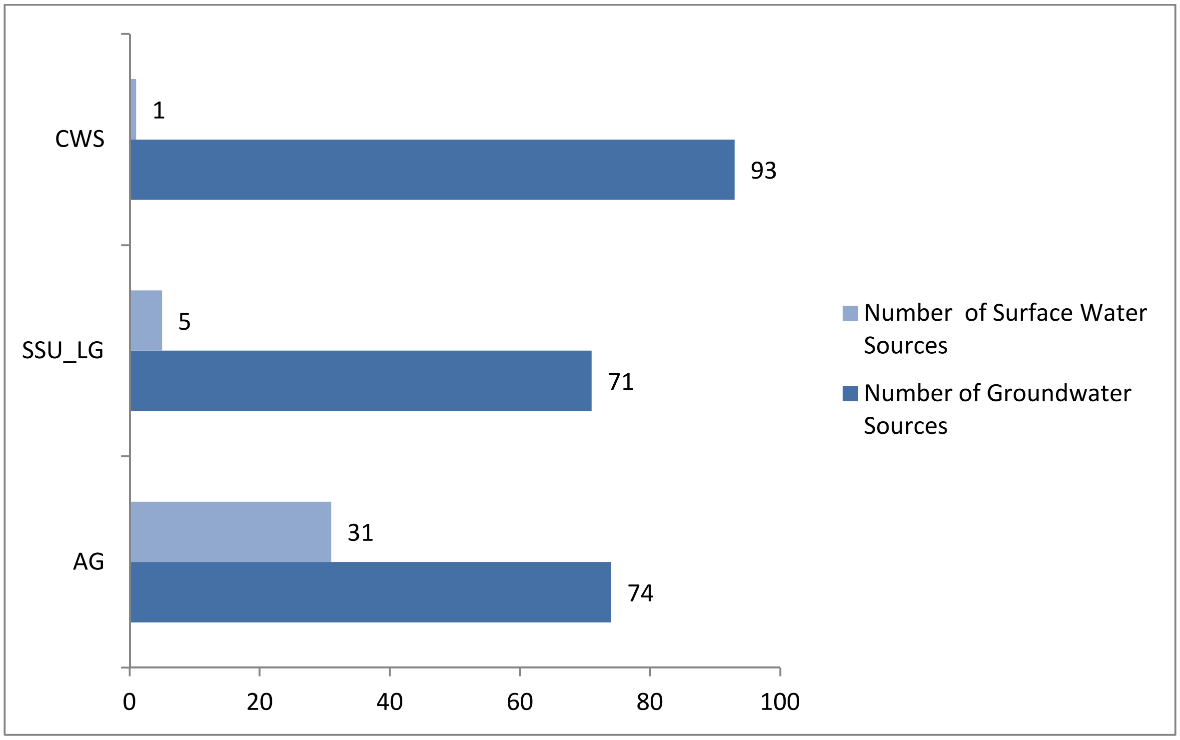
Existing Water Sources

Water sources utilized in the Basin include stream intakes, reservoirs, private ponds, and groundwater wells. Surface water sources account for 37 withdrawals. Additionally, there are 238 groundwater withdrawals currently identified in the Chesapeake Bay-Small Coastal Basin. One municipal CWS uses source water from the Beaverdam Reservoir. Stream intakes used in the Basin include those on the Great Wicomico River, Piankatank River, Cockrell Creek, and Onancock Creek. Ponds, lakes, and groundwater wells on private property are used for irrigation on farms and golf courses.



Chesapeake Bay-Small Coastal Basin Major Reservoir and Stream Sources

Reported groundwater sources outnumber surface water withdrawals in all use types. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 114,129 people in the Basin use private groundwater wells for residential water supply.



Chesapeake Bay-Small Coastal Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly utilized by localities in the Commonwealth. However, there are a few localities taking advantage of these options in this Basin. The first permitted industrial water reuse project in Virginia was a public-private partnership between Hampton Roads Sanitation District (HRSD) and Giant Industries, the former York River Western Refinery that was endorsed by Newport News Waterworks. The HRSD York River Treatment Plant began delivering 500,000 gallons a day of treated wastewater to the adjacent refinery in July 2002. Prior to closure of the refinery, the project received several awards, including the Water Reuse Association's 2003 "Outstanding Project of the Year," and the American Council of Engineering Companies of North Carolina's 2004 "Honors Award for Engineering Excellence." HRSD funded the $3 Million York River project using a 20-year, low-interest loan from the Virginia Water Facilities Revolving Fund. HRSD also provides 14 million gallons per day (mgd) of effluent to the closed-loop heating and cooling systems of Dam Neck Naval Annex. A 66-inch diameter HRSD line through the Dam Neck Naval Annex transported between 32 to 40 mgd of effluent into the Atlantic Ocean. Following ribbon cutting in October 2008, the Navy began reusing 14 mgd of effluent water as a single pass heat sink, providing more efficient service for about the same cost. HRSD continues to pursue markets for water reuse. HRSD evaluates potential water reuse projects on a case-by-case basis in order to reduce long-term demand. Water reuse projects are also implemented by the localities of Hampton Roads. For example, the City of Virginia Beach has a policy within the Comprehensive Plan to encourage city golf courses to maximize use of recycled water for irrigation instead of groundwater. The plan also seeks full Audubon certification for City golf courses that use recycled water, as a means to encourage private golf courses to do the same.

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.

The following table lists the Chesapeake Bay-Small Coastal intrabasin transfers between water provides and the entities to which they sell water (water purchases).

User Type	Water Purchaser and System(s)	Water Provider
CWS	Balford Langley Bolling Family Housing	Newport News Waterworks
CWS	U. S. Air Force – Langley	Newport News Waterworks

Chesapeake Bay-Small Coastal Intrabasin Transfers

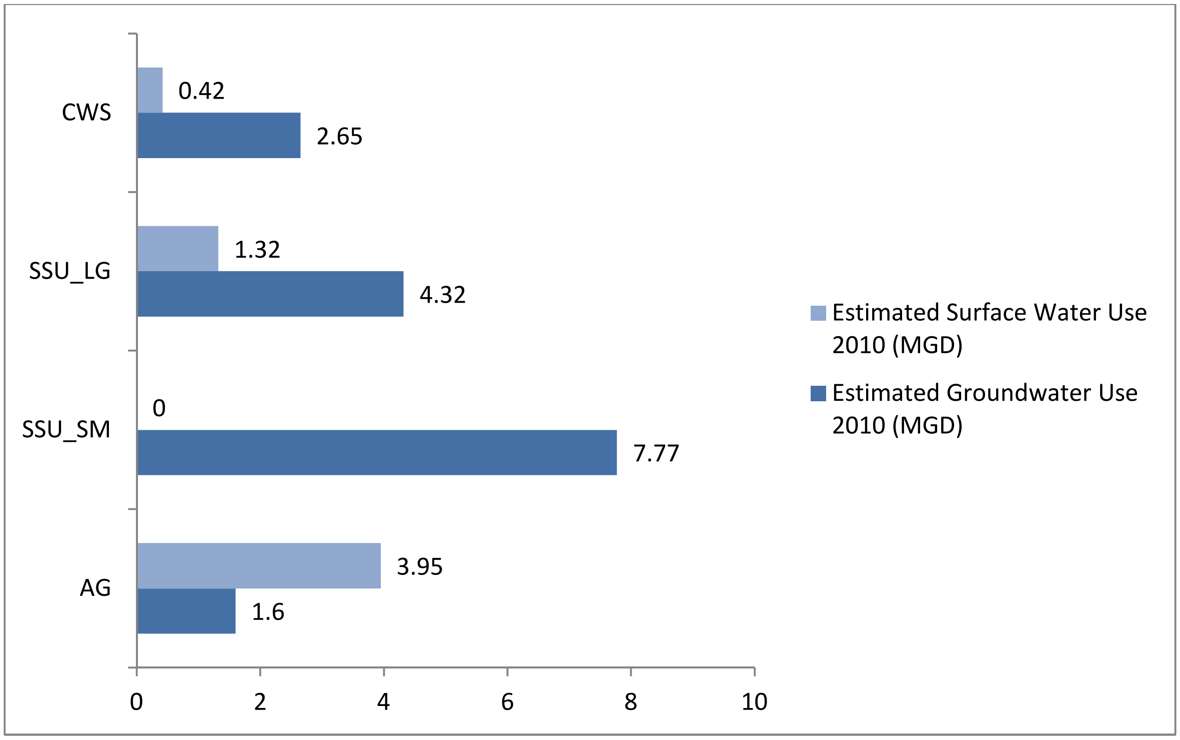
Interbasin transfers reported in the Chesapeake Bay-Small Coastal Basin are found in the table below.

User Type	Water Purchaser and System(s)	Water Provider
CWS	City of Virginia Beach	U. S. Army Corps of Engineers
CWS	U.S. Navy (Little Creek Amphibious Base and Oceana Naval Air Station) U.S. Army (Fort Story)	City of Norfolk

Chesapeake Bay-Small Coastal Interbasin Transfers

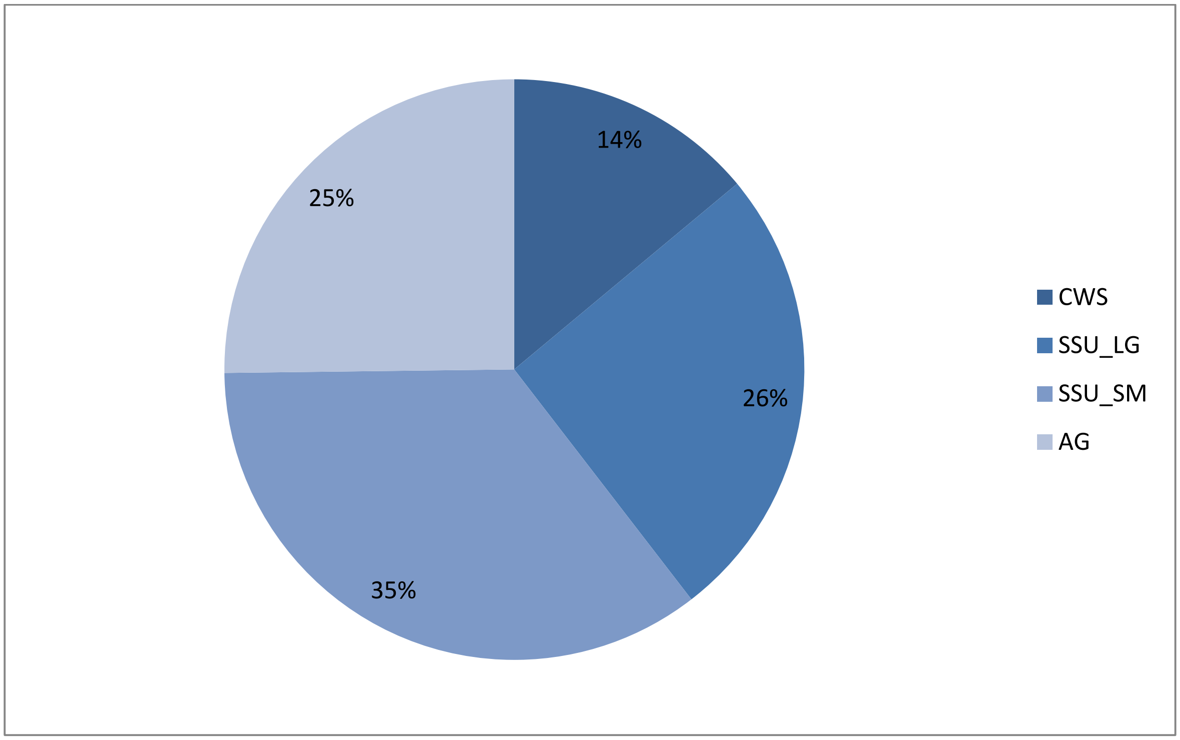
Existing Water Use

The total estimated water use provided in the six water supply plans is summarized in the figure below. The total estimated water use is 22 MGD, with approximately six MGD of surface water use and 16 MGD of groundwater use.



Chesapeake Bay-Small Coastal Basin Estimated Use by Source and Type

SSU_SM account for 35% of the 2010 estimated use followed by SSU_LG (26%) and AG (25%). CWS use accounts for 14% of estimated use.

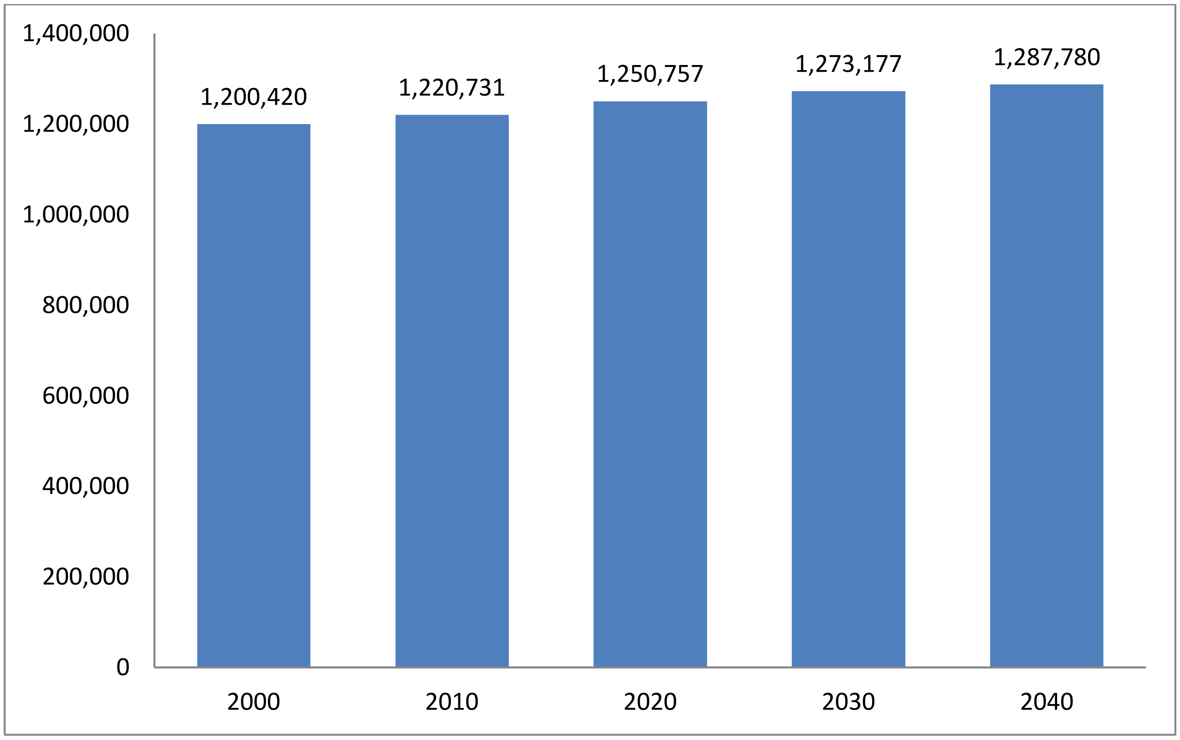


Chesapeake Bay-Small Coastal Basin Percentage of 2010 Estimated Use by User Type

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 CWS did not report disaggregated use. No assumption on 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.

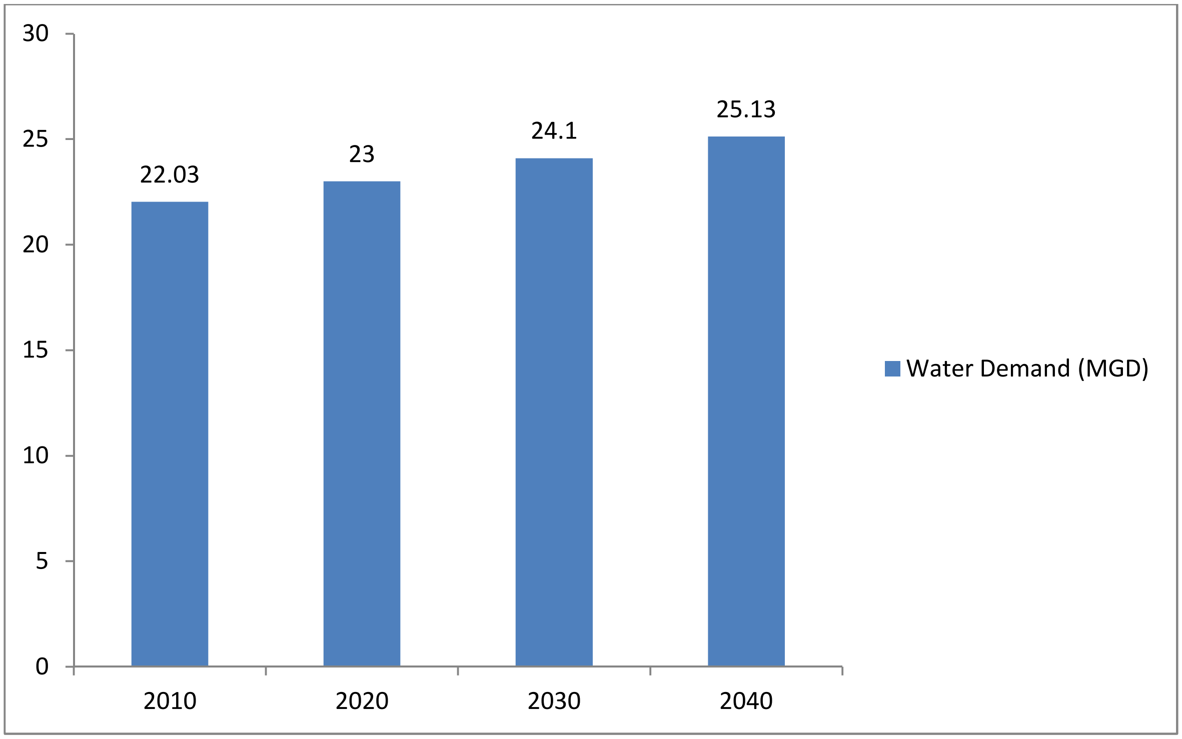
Projected Water Demand

The projected population of the localities with at least a portion of their area in the Chesapeake Bay-Small Coastal Basin is displayed in the figure below. Population data is 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 1,287,780. The percent change in population from the years 2000 through 2040 is estimated at 5.5%.



Chesapeake Bay-Small Coastal Basin Projected Population

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 Chesapeake Bay-Small Coastal Basin as reported in the water supply plans is estimated to increase from approximately 22 MGD to approximately 25 MGD in 2040. The percent change in water use during the 30-year timeframe is estimated at 14.1%.



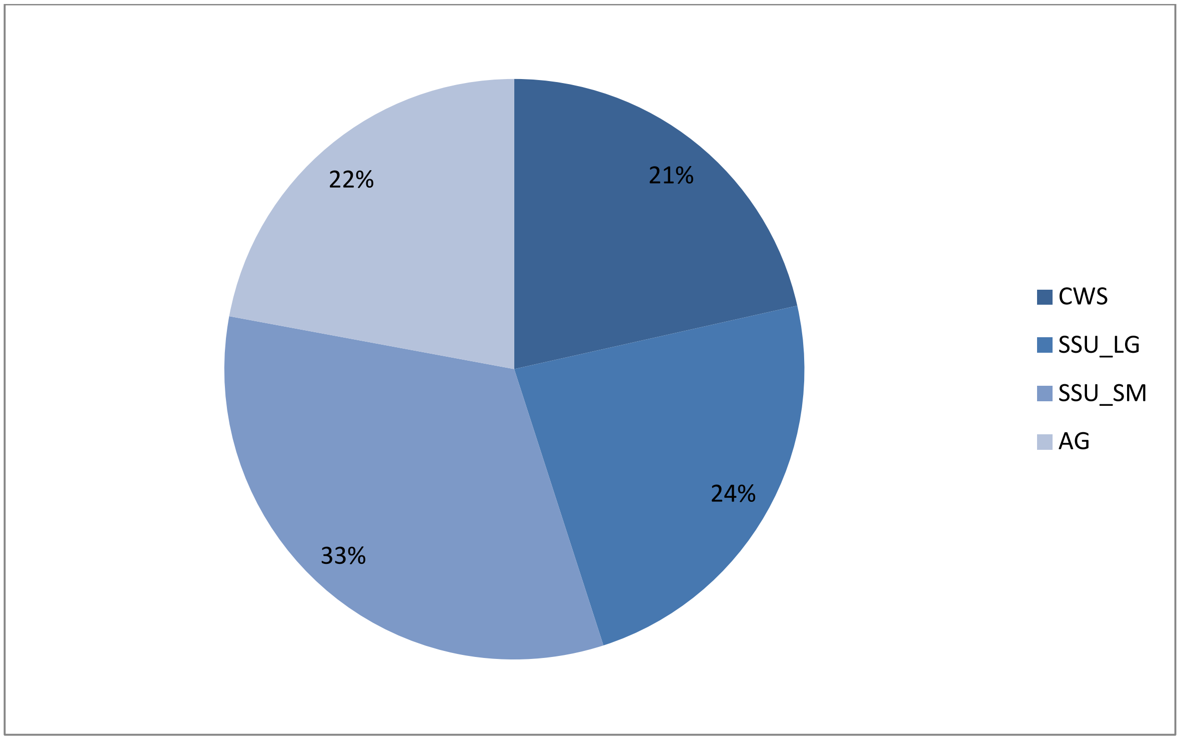
Chesapeake Bay-Small Coastal Basin Projected Water Demand

As depicted in the following table, CWS shows the greatest percentage of change (75.7%) in water demand over the 30-year planning period followed by SSU_SM (6.3%) and SSU_LG (5.10%). Agricultural demand is predicted to remain static over the thirty-year planning period.

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change 2010-2040
CWS	3.07	3.85	4.6	5.4	75.70%
SSU_LG	5.64	5.73	5.8	5.92	5.10%
SSU_SM	7.77	7.94	8.1	8.27	6.30%
AG	5.55	5.55	5.5	5.55	0.00%

Chesapeake Bay-Small Coastal Basin Projected Water Demand by User Type (2010-2040)

In the year 2040, the projected water demand by user type in the Chesapeake Bay-Small Coastal Basin is similar to the 2010 use in that SSU_SM are still projected to use the greatest percentage of water followed by SSU_LG, AG, and CWS.



Chesapeake Bay-Small Coastal Basin Percentage of 2040 Projected Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs is obtained from the six water supply plans represented in the Chesapeake Bay-Small Coastal Basin. The information is presented for all those localities with at least a portion of land area located within the Chesapeake Bay-Small Coastal River Basin. The following lists the projected deficits in the Basin.

Accomack County Regional Water Supply Plan

Accomack County and the towns of Accomac, Belle Haven, Bloxom, Hallwood, Keller, Melfa, Onancock, Onley, Painter, Parksley, Saxis, Tangier, and Wachapreague

Existing sources are anticipated to meet the current and projected demand in the planning period. No additional sources were examined; however, there is mention of the use of the Columbia aquifer over the confined Yorktown-Eastover aquifer for all withdrawals, including some for public water supply, as a potential alternative source.

Town of Chincoteague Water Supply Plan

Town of Chincoteague's CWS may experience a summertime water deficit of approximately 0.10 MGD in 2015, based on the projected average daily demands in the summer months as compared to the system's VDH permitted capacity. Alternatives listed in the Town's Water Master Plan include development of up to three new wells in the town's easement area at NASA, the purchase of water from NASA or another mainland source, and construction of a desalination facility to treat a well drilled on the Island. The plan describes short-term improvements to reduce water loss, improve efficiency, and increase storage capacity.

Hampton Roads Regional Water Supply Plan

Gloucester County; York County; Cities of Hampton, Newport News, Norfolk, Poquoson, and Virginia Beach

Demand is expected to increase as population in the region continues to grow; however, the projected supply is anticipated to meet projected demand for the region through 2050. There is potential for demand to exceed supply by 2040 in the York-James Peninsula sub-region as the projections are within a 10% margin of error and alteration of the assumptions could result in revised projections. Alternatives considered to meet the potential need in the Peninsula sub-region include additional surface water storage, additional groundwater withdrawals, desalination, aquifer storage and recovery, interconnection, reuse, and system optimization.

Middle Peninsula Regional Water Supply Plan

Essex County and the Town of Tappahannock; Middlesex County and the Town of Urbanna; King and Queen County; Mathews County

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

Northampton County Water Supply Plan

Northampton County and the Towns of Belle Haven, Cape Charles, Cheriton, Eastville, Exmore, and Nassawadox

Existing sources will provide adequate water supply through 2040. No additional sources were examined; however, there is mention of the use of the Columbia aquifer over the confined Yorktown-Eastover aquifer for all withdrawals, including some for public water supply, as a potential alternative source.

Northern Neck Regional Water Supply Plan

Lancaster County and the Towns of Irvington, Kilmarnock, and White Stone; Northumberland County

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

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Town of Chincoteague	2015	0.10

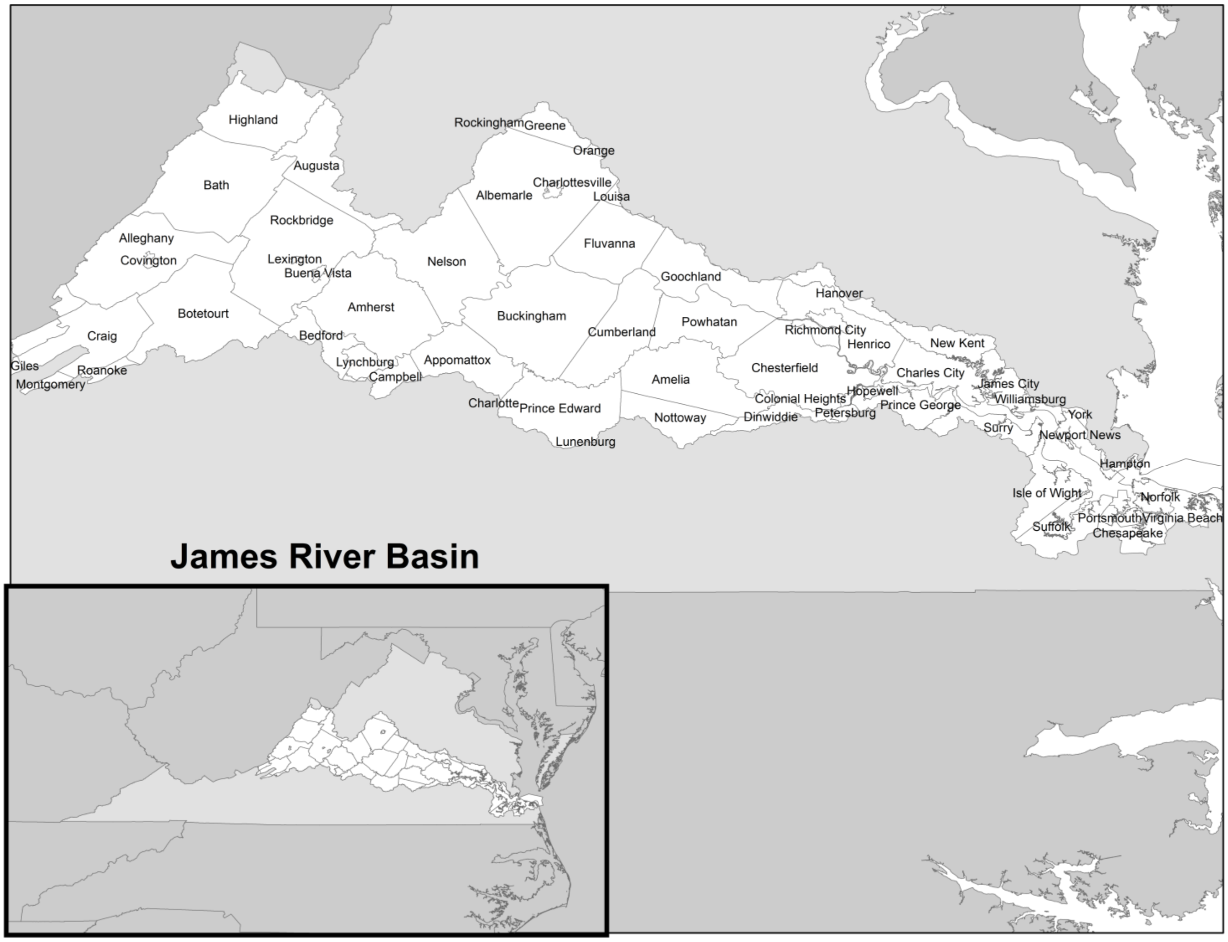
Chesapeake Bay-Small Coastal Basin Projected Deficits

James 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 James River Basin occupies the central portion of Virginia and covers 10,265 square miles, or approximately 24% of the Commonwealth's total land area. It is Virginia's largest river basin and is made up of the Upper, Middle, and Lower James River sub-basins as well as the Appomattox River sub-basin.

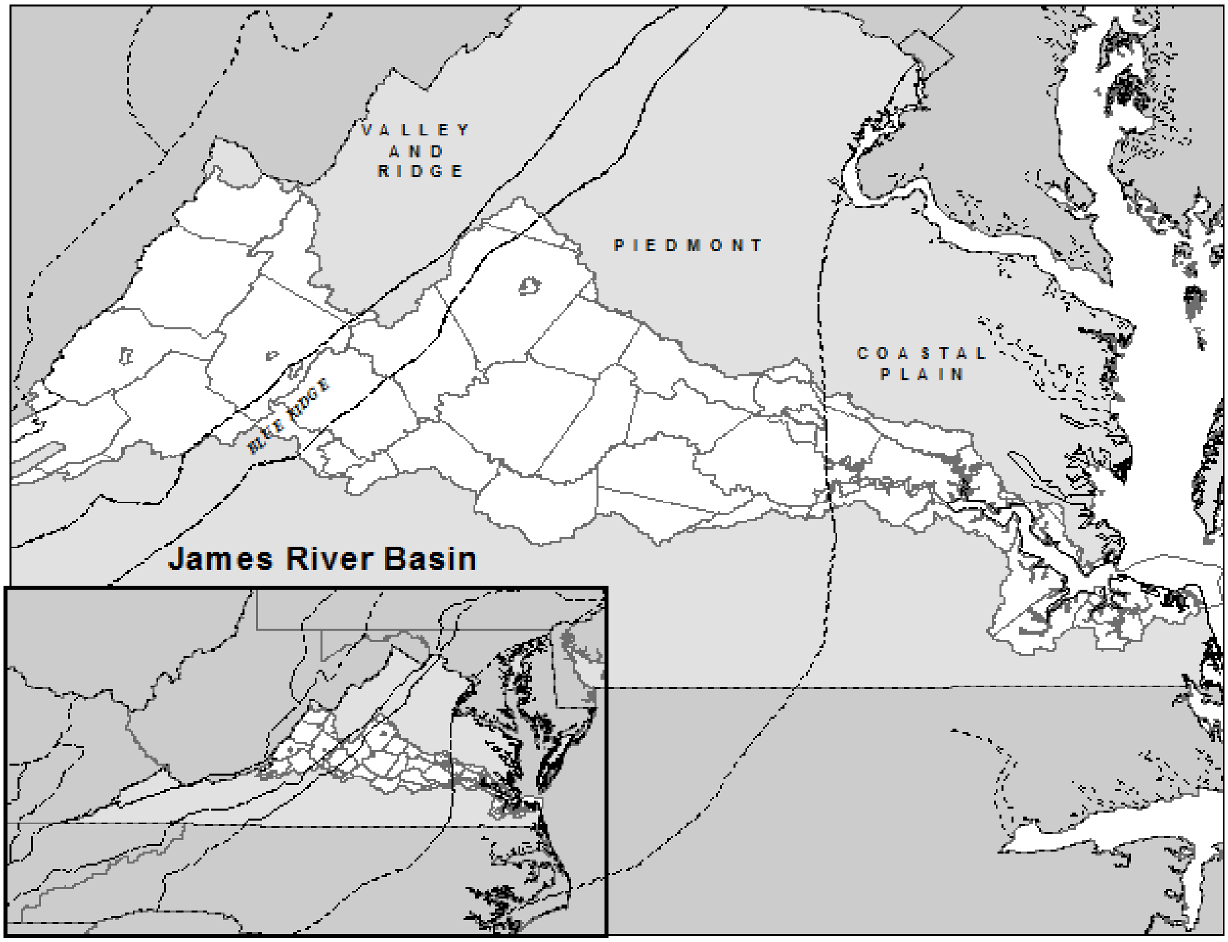
All or portions of the following 38 counties and 17 cities lie within the Basin: Counties: Albemarle, Alleghany, Amelia, Amherst, Appomattox, Augusta, Bath, Bedford, Botetourt, Buckingham, Campbell, Charles City, Chesterfield, Craig, Cumberland, Dinwiddie, Fluvanna, Giles, Goochland, Greene, Hanover, Henrico, Highland, Isle of Wight, James City, Louisa, Montgomery, Nelson, New Kent, Nottoway, Orange, Powhatan, Prince Edward, Prince George, Roanoke, Rockbridge, Surry, and York; Cities: Buena Vista, Charlottesville, Chesapeake, Colonial Heights, Covington, Hampton, Hopewell, Lexington, Lynchburg, Newport News, Norfolk, Petersburg, Portsmouth, Richmond, Suffolk, Williamsburg, and Virginia Beach. These jurisdictions are represented within eighteen regional water supply plans (Appomattox River Water Authority, Albemarle County/City of Charlottesville/Town of Scottsville, Craig County and Town, Fluvanna County and Town, Greene County and Town, Hampton Roads Planning District Commission, Upper James, Region 2000, Roanoke Valley-Alleghany Regional, New River Valley, Upper Shenandoah, Prince Edward County and Town, Buckingham County and Town, Louisa County and Town, Henrico/Goochland/Powhatan/Cumberland, Hanover County and Town, Nottoway County and Towns, and Orange County and Towns) and four local water supply plans (Amelia County, Charles City County, New Kent County, and the City of Richmond).



James River Basin Localities

The James River Basin is defined by both hydrologic and political boundaries. The Potomac-Shenandoah River Basin, the Rappahannock River Basin, and the York River Basin bound the Basin to the north. The southern boundary is made up of the New River Basin, the Roanoke River Basin, and the Albemarle-Chowan River Basin. Its headwaters originate along the Virginia/West Virginia state line. The James is formed by the confluence of the Jackson and Cowpasture Rivers in the Alleghany Mountains and flows 242 miles to the Fall Line at Richmond and another 106 miles where it enters the Chesapeake Bay.

The topography of the James River Basin varies throughout the four physiographic provinces that it spans. The Valley and Ridge Province extends from the Appalachian Plateau in West Virginia to the Blue Ridge Province. The Blue Ridge Province, a remnant of a former highland, differs from the Valley and Ridge Province. It is a province of rugged terrain with steep slopes and narrow ridges in the north and broad moderate slopes in the south. The Piedmont Province extends to the Fall Line and has scattered hills and small mountains, gradually turning into gently rolling slopes and lower elevation in the eastern portion of the province. The Fall Zone separates the Coastal Plain Province from the Piedmont. The Fall Zone is a three-mile stretch of river running through Richmond where the river descends 84 feet as it flows from the resistant rocks of the Piedmont to the softer sediments of the Coastal Plain.

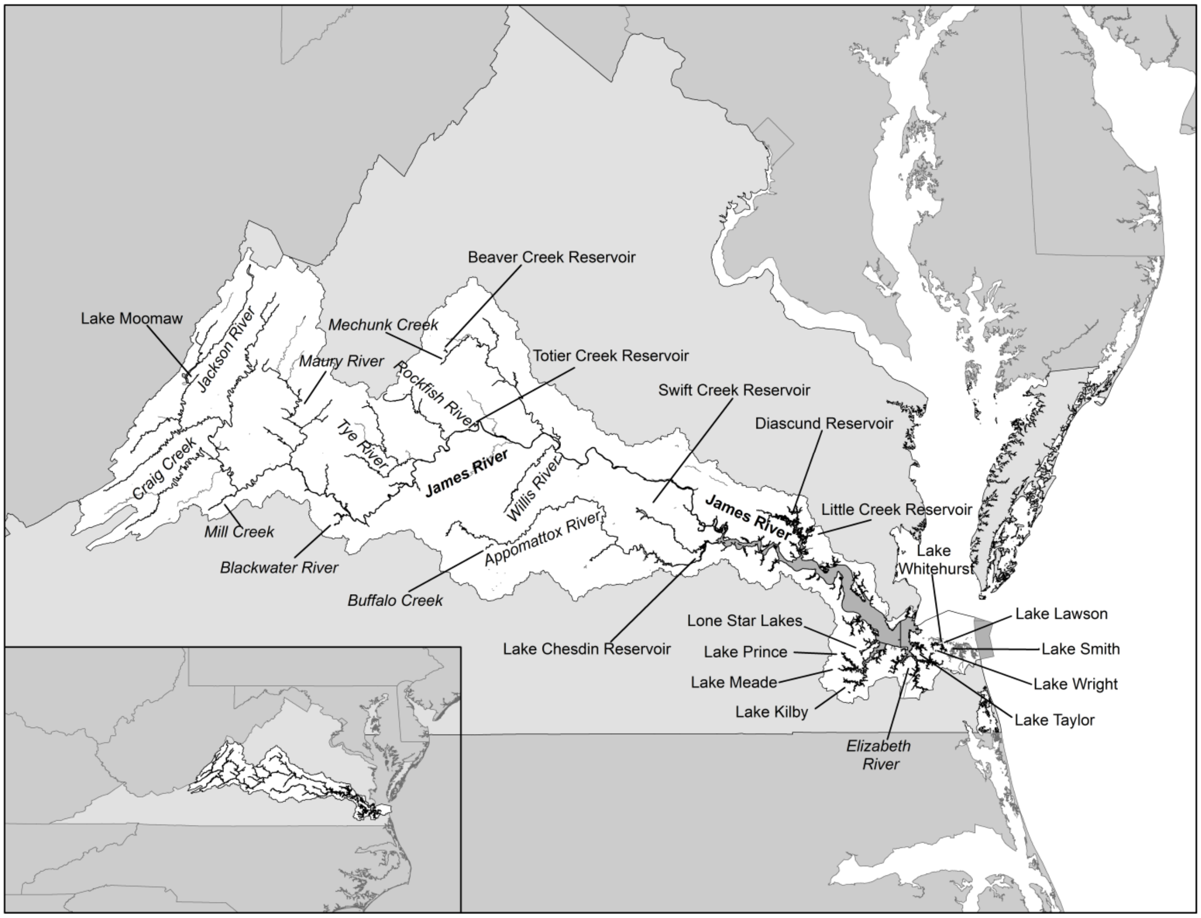


James River Basin Physiographic Provinces

Over 65% of the James River Basin is forested, with 19% in cropland and pasture. Approximately 12% is considered urban. Major tributaries to the James River are Jackson River, Cowpasture River, Craig Creek, Maury River, Tye River, Rockfish River, Slate River, Rivanna River, Willis River, Appomattox River, Chickahominy River, Pagan River, Nansemond River, and the Elizabeth River.
The James River Basin is divided into eight USGS hydrologic units as follows: HUC 02080201 –Upper James, HUC 02080202 – Maury, HUC 02080203 – Upper Middle James, HUC 02080204 – Rivanna, HUC 02080205 – Lower Middle James, HUC 02080206 – Lower James, HUC 02080207 – Appomattox, and HUC 02080208 – the Elizabeth. The eight hydrologic units are further divided into 109 waterbodies or watersheds and 298 6th order sub-watersheds.

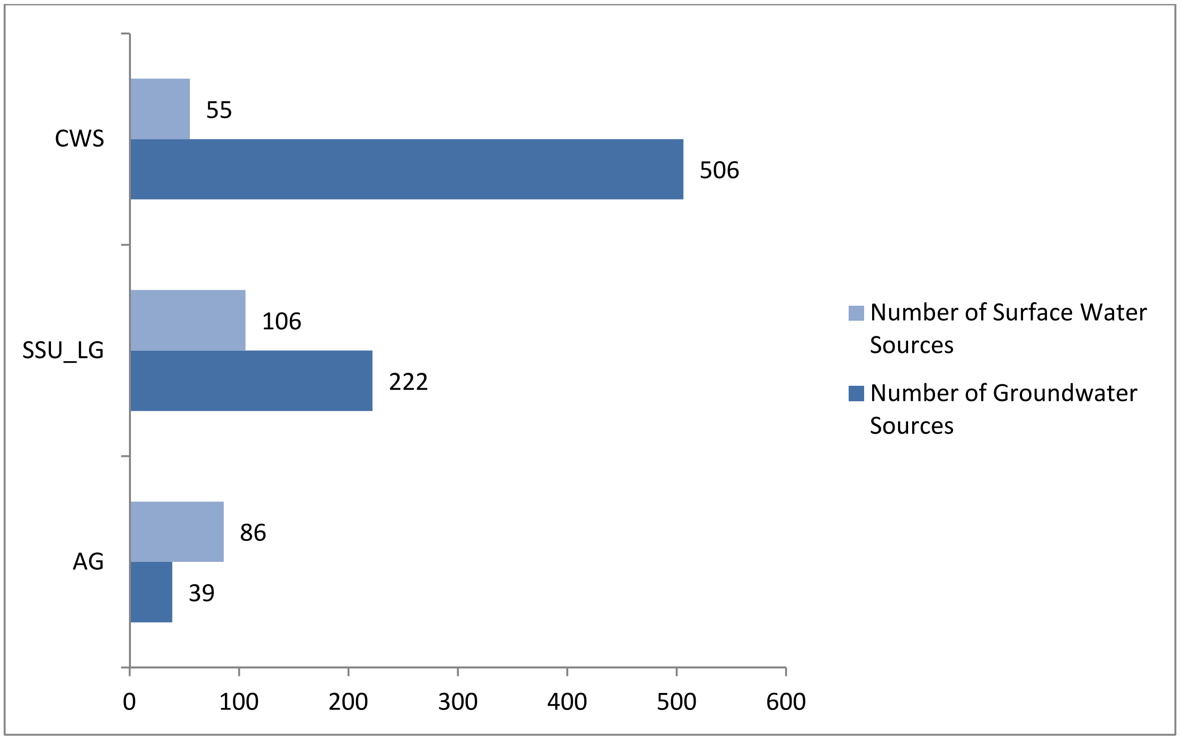
Existing Water Sources

Water sources utilized in the Basin include stream intakes, reservoirs, springs, and groundwater wells. Surface water sources (reservoirs, streams, and springs) account for 247 withdrawals. Additionally, there are 767 groundwater withdrawals currently identified in the James River Basin. Source water reservoirs used in the Basin include Beaver Creek Reservoir, Black Creek Reservoir, Diascund Reservoir, Graham Creek Reservoir, Harwood's Mill Reservoir, Judith Creek Reservoir, Lake Burnt Mills, Lake Chesdin Reservoir, Lake Cohoon, Lake Kilby, Lake Lawson, Lake Meade, Lake Monocan, Lake Prince, Lake Smith, Lake Taylor, Lake Whitehurst, Lake Wright, Lee Hall Reservoir, Little Creek Reservoir, Lone Star Lakes, Ragged Mountain Reservoir, Smith Creek Reservoir, Skiff's Creek Reservoir, South Fork Rivanna Reservoir, Sugar Hollow Reservoir, Swift Creek Reservoir, Totier Creek Reservoir, and Western Branch Reservoir. Stream intakes and spring sources used in the Basin include Allen Creek, Appomattox River, Buck Creek, Buffalo Creek, Collins Run of Chickahominy River, Craig Creek, Dillard Creek, Fighting Creek, Hat Creek, Jackson River, James River, Mill Creek, Newfound River, North Anna River, North Buckskin Creek, Paint Bank Branch, Pamunkey River, Reeds Creek, South Anna River, South Fork Rockfish River, Blackwater River, Montbello Springs, Tye River, Speights Run, Alvey Spring, Augusta Springs, Big Spring, Buffalo River, Cascades Spring, Chaplin Spring, Chickahominy River, Gladstone Springs, Hall Spring, Harris Creek, Jackson River, Johnson's Branch, Keyser-Jackson Springs, Klondike Spring, Maury River, McAllister Spring, Mechunk Creek, North Fork Rivanna River, Pounding Mill Spring, Queen Spring, Rivanna River, Smith Creek, and Stoney Creek. Ponds and lakes on private property are used for irrigation on farms and golf courses in the Basin.



James River Basin Major Reservoir and Stream Source Sources

Reported groundwater sources outnumber surface water withdrawals in all use types except agriculture. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 591,811people in the Basin use private groundwater wells for residential water supply.



James River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly utilized by localities in the Commonwealth. However, there are a few localities taking advantage of these options.

The City of Chesapeake treats brackish surface water at the Northwest River Reverse Osmosis Water Treatment Plant, and they use an Aquifer Storage and Recovery well for storage of treated water during peak demands. The City of Suffolk uses electrodialysis reversal desalination at their water treatment plant to treat high fluoride groundwater. New Kent County's Parham Landing Waste Water Treatment Plant is permitted to generate and distribute up to 2 MGD of reclaimed water to non-municipal facilities for bulk irrigation reuse and dust suppression and irrigation (bulk and non-bulk) use. Powhatan County's Dutoy Creek Waste Water Treatment Plant is permitted to generate and distribute up to 0.04 MGD of reclaimed water to a non-municipal facility for non-bulk irrigation reuse. Chesterfield County's Proctors Creek Waste Water Treatment Facility is permitted to discharge up to 27 MGD of reclaimed water into the James River. Additionally, they provide up to 7 MGD of effluent to a non-municipal facility for stack scrubbing.

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.

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

User Type	Water Purchaser and System(s)	Water Provider
CWS	Alleghany County Public Works (ACPW) - Selma/Low Moore/Valley Ridge Subdivision; Westgate; Cliftondale Park/Wilson Creek/Sharon	Town of Clifton Forge
CWS	ACPW - Pounding Mill; Intervale/Clearwater Park; Rosedale/Callaghan; Cherokee/Indian Valley/Oneida Trail	City of Covington
CWS	Albemarle County SA - Urban Area, Crozet, Scottsville, Red Hill	Rivanna Water and Sewer Authority
CWS	Amherst County SA - Henry L. Lanum, Jr. Water Filtration Plant	City of Lynchburg
CWS	Bath County Service Authority (BCSA) - Thomaston/Crowdertown/Switchback	Homestead Water
CWS	BCSA - Bath County Regional Water; Millboro Industrial Park	Millboro Water Association
CWS	Bedford County RWA - Forest & New London	City of Lynchburg
CWS	City of Charlottesville	Rivanna Water and Sewer Authority
CWS	City of Chesapeake - South Norfolk System	City of Norfolk
CWS	City of Chesapeake - Western Branch System	City of Portsmouth
CWS	Chesterfield County	Appomattox River Water Authority
CWS	Chesterfield County	City of Richmond
CWS	City of Colonial Heights	Appomattox River Water Authority
CWS	Eastern Goochland Water System	Henrico County
CWS	Goochland Courthouse	James River Correctional Center
CWS	Hanover Utilities - Overhill Estates-Holly Farms	Henrico County
CWS	Henrico County Water System	City of Richmond
CWS	Town of Iron Gate	Town of Clifton Forge

CWS	City of Lexington	Maury Service Authority
CWS	Norfolk Naval Base	City of Norfolk
CWS	Norfolk Naval Shipyard	City of Portsmouth
CWS	City of Petersburg	Appomattox River Water Authority
CWS	City of Portsmouth	City of Norfolk
CWS	Powhatan Correctional Facilities	James River Correctional Center
CWS	Powhatan County Flat Rock Water System	Chesterfield County
CWS	Founders Bridge (Powhatan)	Chesterfield County
CWS	Prince George County Department of Utilities	Appomattox River Water Authority
CWS	Prince George County Department of Utilities	City of Petersburg
CWS	Rockbridge County PSA (RCPSA) - Rt. 251 System	City of Lexington
CWS	RCPSA - Long Hollow Water Development Company	City of Buena Vista
CWS	RCPSA - North Lexington/Fairfield/Raphine	Maury Service Authority
CWS	RCPSA - Rivermont Heights	City of Buena Vista
CWS	York County Utilities - Hubbards Lane	Newport News Waterworks, Williamsburg/York County
CWS	Western Tidewater Water Authority - Suffolk Main System	City of Portsmouth
CWS	Galting Pointe Subdivision	Town of Smithfield
CWS	Newport Development Service District	Western Tidewater Water Authority/City of Suffolk, City of Portsmouth
CWS	Isle of Wight County	Western Tidewater Water Authority
CWS	Windsor Development Service District	Town of Windsor
CWS	Western Tidewater Water Authority	City of Suffolk
CWS	City of Virginia Beach	U. S. Army Corps of Engineers
CWS	Isle of Wight County	City of Franklin
SSU_LG	MeadWestVACO Corporation	City of Covington
SSU_LG	Applied Extrusion Technologies	City of Covington
SSU_LG	Lee's Carpets - Mohawk Industries	Town of Glasgow
SSU_LG	Fort Eustis, Fort Monroe	Newport News Waterworks
SSU_LG	Luck Stone - Route 6 Goochland	Manakin Farms

James River Basin Intrabasin Transfers

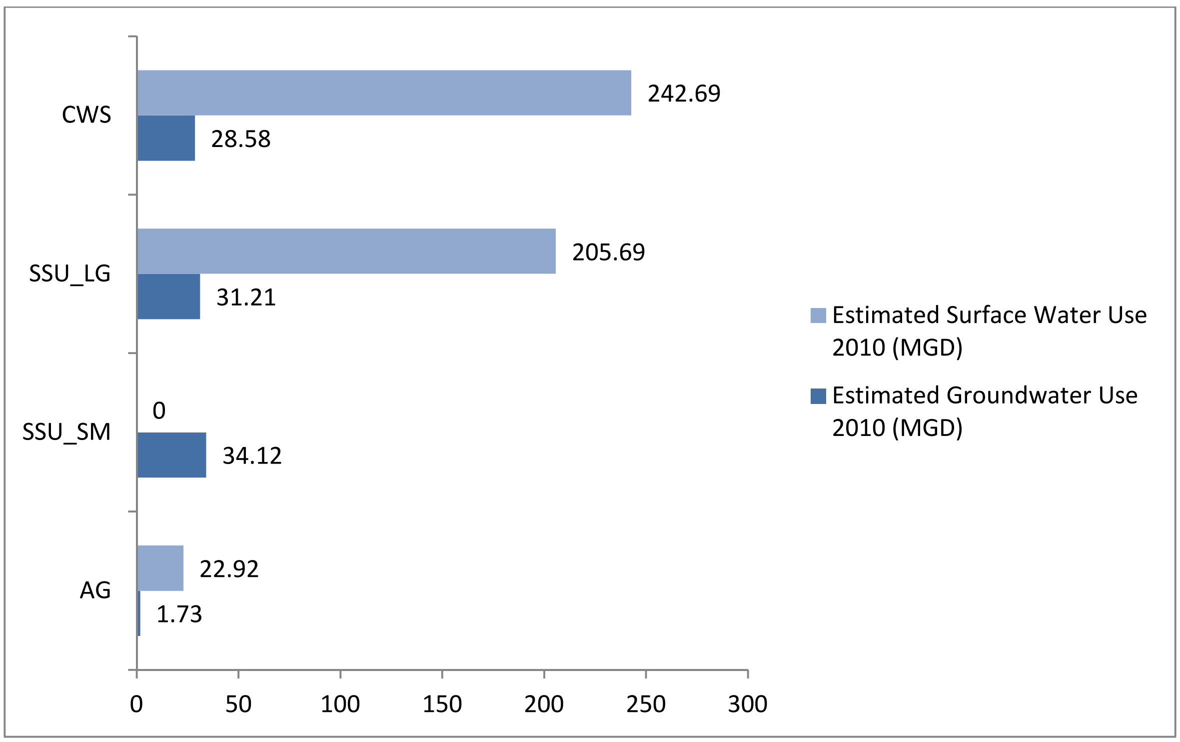
Interbasin transfer(s) reported in the James River Basin are listed in the following table.

User Type	Water Purchaser and System(s)	Water Provider
CWS	U.S. Navy (Little Creek Amphibious Base and Oceana Naval Air Station) and the U.S. Army (Fort Story)	City of Norfolk

James River Basin Interbasin Transfers

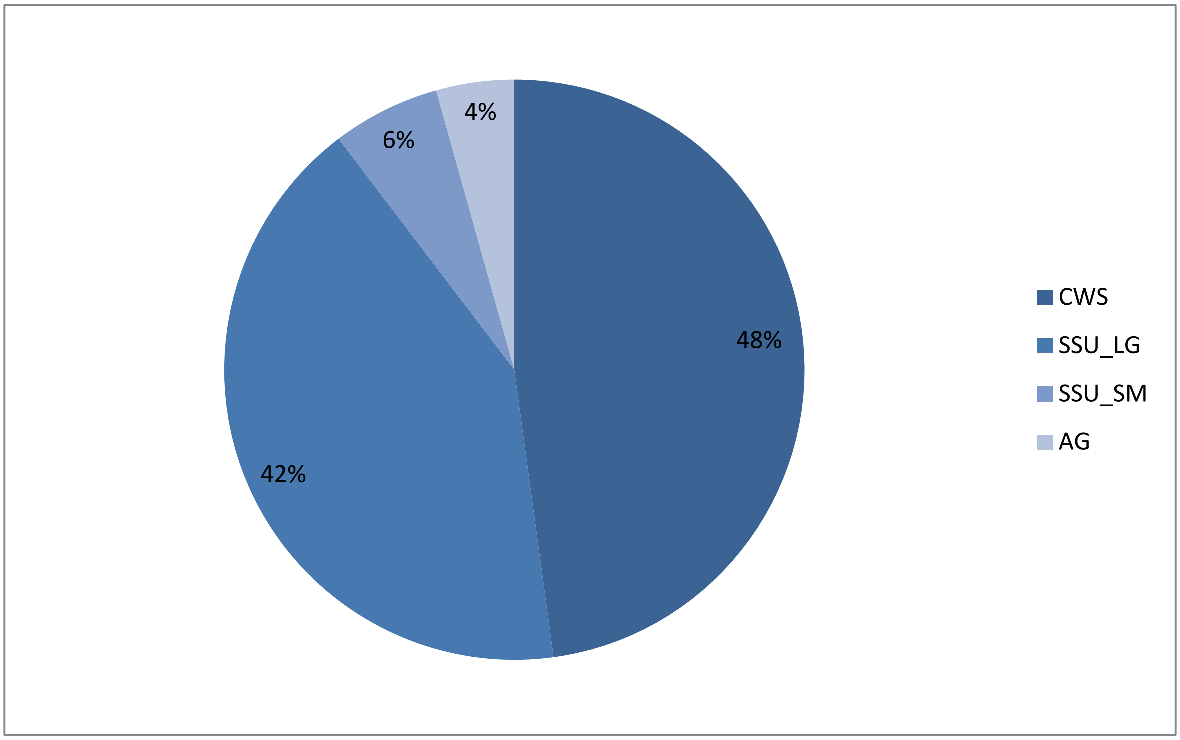
Existing Water Use

The total estimated water use provided in the twenty-two water supply plans is summarized in the following figure. The total estimated water use is 567 MGD, with approximately 475 MGD of surface water use and 92 MGD of groundwater use.



James River Basin Estimated Use by Source and Type

CWS use an estimated 48% of the total water used in the Basin followed by SSU_LG (42%), SSU_SM (6%), and AG (4%).

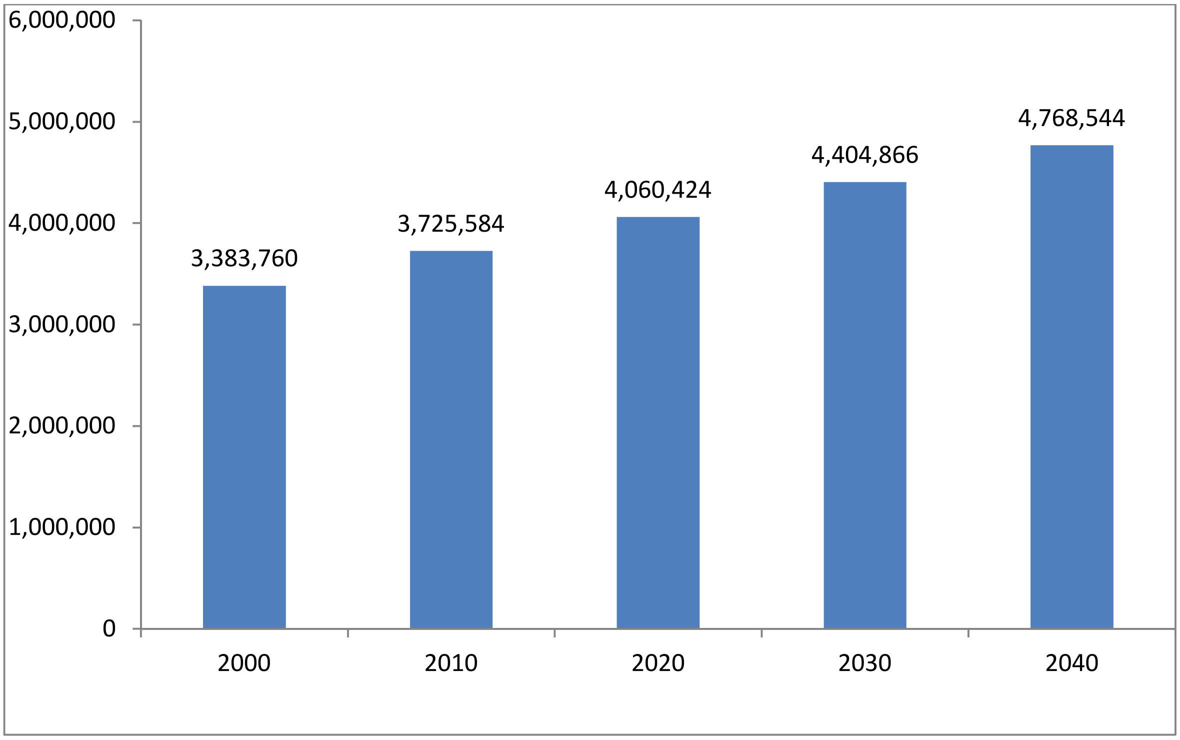


James River Basin Percentage of 2010 Estimated Use by User Type

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 CWS did not report disaggregated use as required. No assumption on 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.

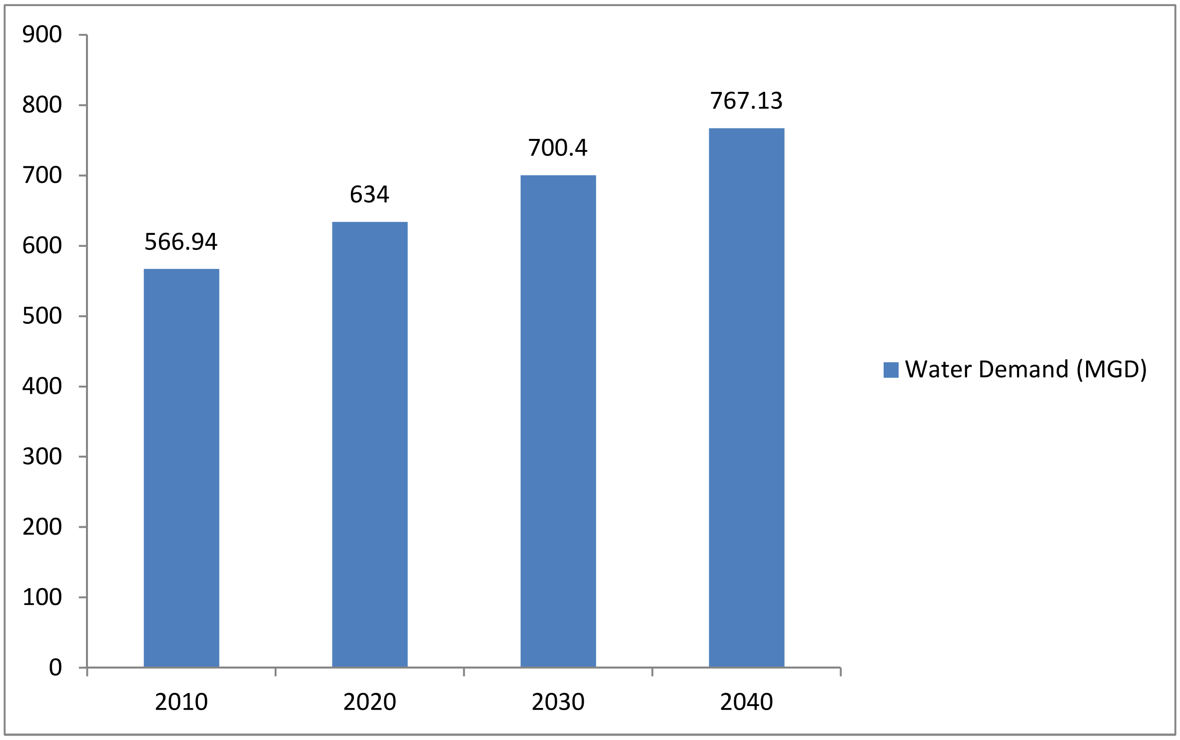
Projected Demand

The projected population of the localities with at least a portion of their area in the James River Basin is displayed in the following figure. Population data is 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 4,768,544. The percent change in population from the years 2000 through 2040 is estimated at 28%.



James River Basin Projected Population

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 James River Basin, as reported in the regional water supply plans, is estimated to increase from 567 MGD to approximately 767 MGD in 2040. The percentage change in water use during the 30-year timeframe is estimated at 37.3%.



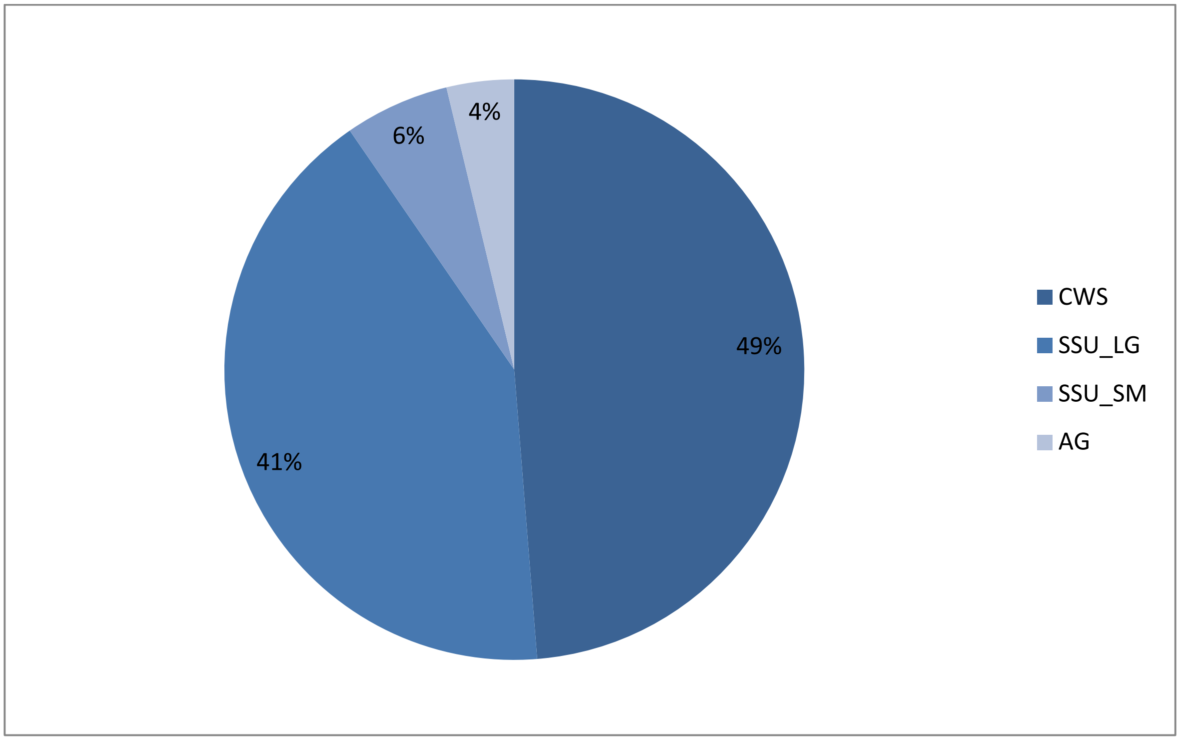
James River Basin Projected Water Demand

As depicted in the following table, CWS show the largest percent change (41%) in water demand over the 30-year period, followed by SSU_LG (34.8%), SSU_SM (31.5%), and AG (17.2%).

User Type	Reported 2010 Use MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	271.27	305.48	339.7	373.89	41.0%
SSU_LG	236.9	264.43	292	319.48	34.8%
SSU_SM	34.12	37.7	41.3	44.87	31.5%
AG	24.64	26.06	27.5	28.89	17.2%

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

In the year 2040 the projected water demand by user type in the James River Basin is similar to the 2010 use in that CWS are projected to use the greatest percentage of water followed by SSU_LG, SSU_SM, and AG.



James River Basin Percentage of 2040 Projected Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs is obtained from the eighteen regional and four local water supply plans represented in the James River Basin. The information is presented for all those localities with at least a portion of land area located within the James 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 water supply of 0.41 MGD is anticipated 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 also includes continuing water conservation as an alternative.

Amelia County, Virginia Water Supply Plan

Based on projections of future water demand and aquifer recharge and recovery assumptions, existing water sources are expected to meet projected 2060 water demands. Although current sources are deemed adequate, development of additional groundwater sources and the use of surface water (Appomattox River) were given as alternative sources.

Appomattox River Water Authority Regional Water Supply Plan

Chesterfield County; Dinwiddie County and the Town of McKenney; Prince George County; the Cities of Colonial Heights, Petersburg, and Hopewell

The City of Hopewell is not expected to require additional supply or treatment capacity to meet demand projections. Of the Appomattox River Water Authority member localities, Chesterfield County is the largest customer, and fluctuations in the Appomattox River Water Authority (ARWA) demand and supply result from demand peaks by Chesterfield customers. Chesterfield's demand has shown significant increases since the mid-1980's, while the remaining jurisdictions have seen demand remain flat, or even decline in the case of the City of Petersburg. By the year 2040, the ARWA is expected to have an average day supply deficit of 9.4 MGD. A regional peak day supply deficit of 14.6 MGD is anticipated by 2050. Peak day deficits anticipated by locality are anticipated as follows:

Chesterfield County anticipates a peak day deficit of 1.0 MGD by 2040
City of Colonial Heights anticipates a peak day deficit of 0.1 MGD by 2020
Dinwiddie County anticipates a peak day deficit of 0.16 MGD by 2050
Prince George County anticipates a peak day deficit of 0.9 MGD by 2020

Several alternatives are recommended for meeting this additional demand in the future: increases in current water supply allocations, new sales/purchase agreements, development of water reuse capacity, increases in water demand management and conservation efforts, development of additional supply through new groundwater sources, raising the water level of Lake Chesdin, building a river intake on the Appomattox River, and development of a new surface water reservoir.

The Virginia Water Protection permit reissued to ARWA on November 1, 2013 for operation and management of Chesdin Lake and the municipal water withdrawal requires the permittee to continue investigating options and to report on their progress towards procurement of future storage augmentation. Funding was appropriated by the 2013 General Assembly for expanding capacity at Lake Chesdin. The ARWA is currently investigating increasing raw water supply through a seasonal increase of 18 inches in the water level of Lake Chesdin.

Buckingham County and the Town of Dillwyn Regional Water Supply Plan

The Buckingham County water system's source water is adequate to meet future demands. Privately-owned community water systems and self-supplied user supplies are presumed adequate with no increase in demand projected.

Charles City County 2013 Water Supply Management Plan

Charles City County's demand is expected to exceed well capacity in 2040 at the Hideaway/Mt. Zion Rustic, the Schools Complex, Ruthville, and the Adkins Store neighborhood service areas. Additional groundwater sources are expected to meet demands in neighborhood service areas. Deficits in planned industrial areas (with no current source) may be met with interconnection to adjacent localities. Development in these areas has slowed due to the economy.

Craig County -Town of New Castle Regional Water Supply Plan

Based on projections of future water demand and the VDH permitted capacity of the Craig-New Castle Public Service Authority community water system, existing water sources are deemed adequate to meet projected 2040 community water system demands.

Cumberland, Goochland, Henrico, and Powhatan Regional Water Supply Plan

The Counties of Henrico, Goochland, Powhatan, and Cumberland conclude the greatest growth is anticipated by Goochland County (229%) and Powhatan County (123%). Cumberland and Goochland counties project that existing sources will meet future demand. Powhatan County anticipates a deficit of 0.56 MGD by 2030; Henrico County anticipates a deficit of 3.75 MGD by 2045. Several alternatives are recommended for meeting this additional demand in the future: the regional Cobbs Creek Reservoir project; continuing the existing water conservation policies or developing new ones; initiating discussions with Prince Edward County concerning the availability of water from the Sandy River Reservoir; regional coordination between the Department of Corrections and Goochland and Powhatan Counties to increase the withdrawal of water from an existing James River water withdrawal; developing and implementing groundwater management policies to manage the groundwater resources; and expanding existing water purchase contracts or developing new ones.

Fluvanna County and the Town of Columbia Regional Water Supply Plan

Water demands are projected through 2030 with a deficit anticipated in the Palmyra Community Water System. The other community water systems' sources are expected to be adequate for the next twenty years. The James River Water Authority is listed as one option to meet future demand. A reservoir site associated with the Rivanna River and the James River is also included. A specific site for a reservoir is not given.

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.

Hampton Roads Regional Water Supply Plan

Isle of Wight County and the Towns of Smithfield and Windsor; James City County; Surry County and the Towns of Claremont, Dendron, and Surry; York County; the Cities of Chesapeake, Hampton, Newport news, Norfolk, Portsmouth, Suffolk, Williamsburg, and Virginia Beach

Demand is expected to increase as population in the region continues to grow; however, projected supply is anticipated to meet projected demand for the region through 2050. There is potential for demand to exceed supply by 2040 in the York-James Peninsula sub-region as the projections are within a 10% margin of error and alteration of the assumptions could result in revised projections. Alternatives considered to meet the potential need in the Peninsula sub-region include additional surface water storage, additional groundwater withdrawals, desalination, aquifer storage and recovery, interconnection, reuse, and system optimization.

Hanover County and Town of Ashland Long Range Water Resources Plan

Hanover County CWS may experience a deficit of 0.34 MGD by the year 2032 based on total projected demands as compared to the current VDH permitted capacity for all CWS in the planning region. A single alternative is mentioned in the plan, the Verdon Quarry side storage reservoir project which includes: river intakes and raw water pumping stations on North Anna and Little Rivers, and a reservoir intake and raw water pumping station on Verdon Quarry. If completed in 2037 as scheduled, water resources will be adequate to meet the CWS needs through the planning period to 2042.

Louisa County Long Range Water Supply Plan

Louisa County and the Towns of Louisa and Mineral

Louisa County's Northeast Creek Reservoir Service Area's average day demands can be met through 2050; peak day water demand surpasses the permitted capacity in 2039. Water demand within the Zion Crossroads Service Area is expected to outpace the permitted supply by 2025. The small groundwater-based CWS and Blue Ridge Shores do not predict a deficit in the planning period. The Northeast Creek Reservoir Service Area will need improvements in the Town of Mineral well, and the Northeast Creek Water Treatment Plant would be required to meet this peak demand for the Northeast Creek Reservoir Service Area. If Northeast Creek Reservoir Service Area and Zion Crossroads Service Area were interconnected and all source capacity was developed, this deficit would be eliminated in the planning period (2050).

The County has partnered with Fluvanna County to create the James River Water Authority, which is authorized to withdrawal water from the James River under Virginia Water Protection Permit No. 04-0805. Louisa County Water Authority also has a pending application for an intake on Lake Anna to supply that area.

Six designated growth areas (Gum Spring, Ferncliff, Shannon Hill, Lake Anna, Boswells Tavern, and Gordonsville) do not currently have sources, but the Louisa County Water Authority is considering groundwater wells, surface water withdrawals, off-line reservoir, extension of water transmission lines from other growth areas, upgrades to the existing Northeast Creek Water Treatment Plant, a partnership with Fluvanna County, and an upgrade to Bowlers Mill Reservoir.

New Kent County Water Supply Plan

Portions of New Kent County may experience a water supply deficit as early as 2017, based on the current permitted withdrawal amount. Factoring in all available water sources and demand reduction goals, the projected 2060 water deficit for county-operated CWS is approximately 1.5 MGD. In the short term, a waterline extension is being designed to connect two county-operated CWS to alleviate the anticipated 2017 deficit. The two top ranked alternatives for future water supply listed in the plan are an intake on the Pamunkey River (reverse osmosis water treatment) and the purchase of water from the City of Richmond.

New River Valley Regional Water Supply Plan

<u>Giles County and the Towns of Glen Lyn, Narrows, Pearisburg, Pembroke, and Rich Creek; Montgomery County</u>

As a region, there is generally no deficit in the planning period. Some systems are already exploring options to increase system capacity. Alternatives considered include the installation of pressure reducing valves; interconnection of systems with the City of Radford across the planning area; increased educational efforts; water capacity expansion for the Giles County PSA and a pilot study on potential to withdraw from the New River; joining the Blacksburg-Christiansburg-VPI Water Authority for Montgomery County.

Nottoway Water Supply Plan

<u>Nottoway County and the Towns of Blackstone, Burkeville and Crewe, and the Fort Pickett Military Reservation</u>

The planning region expects current sources will meet projected demands through 2050.

Orange County Water Supply Plan

Orange County and the Towns of Orange and Gordonsville

The 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 with a range of years from 2010 to 2050. Rapidan River/Orange Water Treatment Plant serving the Town of Gordonsville, Rapidan Service Area Rt. 15, and the Town of Orange will 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 will experience a deficit of 2 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.

Prince Edward County and the Town of Farmville Regional Water Supply Plan

Prince Edward County anticipates future growth in their northern sector and the Farmville CWS service area. 2060 high-range projected average daily demands (2.7 MGD) in Farmville are not anticipated to exceed the safe yield at the Appomattox River intake (3.04 MGD) or the VDH permitted capacity (3.0 MGD). However, the plan notes that during low-flow or drought conditions, additional source water may be needed. Regional plans to address the projected shortfall of municipal supply include developing a water intake structure and water treatment facility near the Sandy River Reservoir, extending existing waterlines, and expansion of groundwater wells, along with new and continuing water conservation efforts.

Region 2000 Regional Water Supply Plan

Amherst County and the Town of Amherst; Appomattox County and the Towns of Appomattox and Pamplin City; Bedford County and the Town of Bedford (Bedford County participated in two regional water supply plans, Roanoke Valley-Alleghany Regional Commission and Region 2000); Campbell County and the Towns of Altavista and Brookneal; Nelson County; the City of Lynchburg

In a planning area as diverse as Region 2000, the ability to meet water demands may vary from one municipality to another. This may be due to population centers or system limitations. Because of these complexities, water supply is adequate for a portion of the planning area through the planning period of 2060. However, deficits are anticipated in the following CWS supplies:

Amherst County Service Authority/ACSA (deficit of 0.019 MGD by 2019, based on the current VDH permitted capacity of 2.0 MGD)

Town of Amherst (deficit of 0.14 MGD by 2060 if future water sales to other communities are factored into the projections, based on the VDH permitted capacity of 1.0 MGD)

Bedford County Regional Water Authority (deficit of 0.004 MGD by 2015, based on the VDH permitted capacity of 0.79 MGD plus the 1.4 MGD purchase from the City of Lynchburg)

Campbell County Utility and Service Authority/CCUSA (deficit of 0.03 MGD by 2057, based on the VDH permitted capacity of 4.4 MGD, if future water sales are factored into the projections)

Town of Altavista (deficit of 0.003 MGD by 2052, based on the VDH permitted capacity of 3.0 MGD)

Nelson County (deficit of 0.005 MGD by 2059, based on the VDH permitted capacity of 0.79 MGD)

Town of Appomattox (deficit of 0.0004 MGD by 2051, based on the VDH permitted capacity of 0.33 MGD).

Alternatives as presented: Amherst County plans an expansion of the Lanum Water Filtration Plant from 2.0 mgd to 4.0 mgd capacity to meet the projected 2019 deficit. In addition, in 2050 a replacement of ACSA's interconnecting mains with the City of Lynchburg is planned. The Town of Amherst is considering a recommendation to pursue an interconnection upgrade with ACSA. Alternatives described for Bedford County include the Lakes Regional Water Treatment Plant on Smith Mountain Lake and increased purchase from the City of Lynchburg. Campbell County and Town of Altavista alternatives listed in the plan include storage at Boxley Rock Quarry with a pump-over to Harvey Branch and a CCUSA-Altavista intake on the Roanoke River. Water purchase agreements with Lynchburg City or Bedford County may also be feasible alternatives. The Town of Appomattox is considering development of new groundwater wells or an intake on the James River as future alternatives. Nelson County's highest rated alternative is a Tye River withdrawal. Besides the alternatives listed above, the region considers the following as water supply alternatives: additional groundwater sources, reservoirs, intakes, interconnections, reuse and recycling, and demand management.

City of Richmond Water Supply Plan

The City of Richmond has sufficient water treatment and supply capacity to meet the city and its wholesale customers' water demand in the planning period, through 2060.

Roanoke Valley–Alleghany Regional Commission Water Supply Plan

<u>Bedford County and the Town of Bedford (Bedford County participated in two regional water supply plans, Roanoke Valley-Alleghany Regional Commission and Region 2000); Botetourt County and the Towns of Buchanan, Fincastle, Troutville; Roanoke County and the Town of Vinton; the cities of Roanoke and Salem</u>

Future deficits are anticipated in CWS for Bedford County (deficit of 0.004 MGD by 2015), and Botetourt County (deficit of 0.09 MGD by 2020). Two water supply alternatives are listed as the most economical for the region: the expansion of the Smith Mountain Lake Regional Water Treatment Plan in Bedford

County and a new intake on Smith Mountain Lake to supplement Western Virginia Water Authority's (WVWA) Carvins Cove reservoir system. Development of new groundwater sources is also mentioned by some of the localities with predicted future water supply deficits.

Upper James River Basin Water Supply Plan

Alleghany County and the Towns of Clifton Forge and Iron Gate; Bath County; Highland County and the Town of Monterey; Rockbridge County and the Towns of Glasgow and Goshen; the Cities of Buena Vista, Covington, and Lexington

Population and demand will remain constant through 2040; therefore, existing water sources are anticipated to be adequate.

Upper Shenandoah River Basin Regional Water Supply Plan

Augusta County and the Town of Craigsville

Water demand is anticipated to increase during the planning period (from 2010 to 2040) as is population. The plan concludes the County of Augusta may experience a deficit by the year 2040 compared to existing VDH permitted capacities. Augusta County Service Authority (ACSA) predicts a deficit of 0.83 MGD by 2027. Several alternatives are recommended for meeting this additional demand in the future: development of new wells and treatment facilities; plant upgrades to provide additional supply and treatment capacity; development of new stream intakes, pump stations, and pipelines; development of purchase water agreements with neighboring jurisdictions; and inter-jurisdictional collaboration on new infrastructure projects.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Albemarle County – Charlottesville - Scottsville	2035	0.41
Appomattox River Water Authority	2040	9.4
Charles City County	2040	1.0
Palmyra CWS (Aqua VA)	2030	0.067
Greene County	2030	0.54
Powhatan County	2030	0.56
Henrico County	2045	3.75

New Kent County	2060	1.5
Amherst County	2019	0.019
Town of Amherst	2060	0.14
Bedford County	2015	0.004
Campbell County	2057	0.03
Town of Altavista	2052	0.003
Nelson County	2059	0.005
Town of Appomattox	2051	0.0004
Botetourt County	2020	0.09
Orange County	2050	4.61
Augusta County	2027	0.83
Louisa County Water Authority - Zion Crossroads Service Area	2050	0.841
Hanover County	2032	0.34

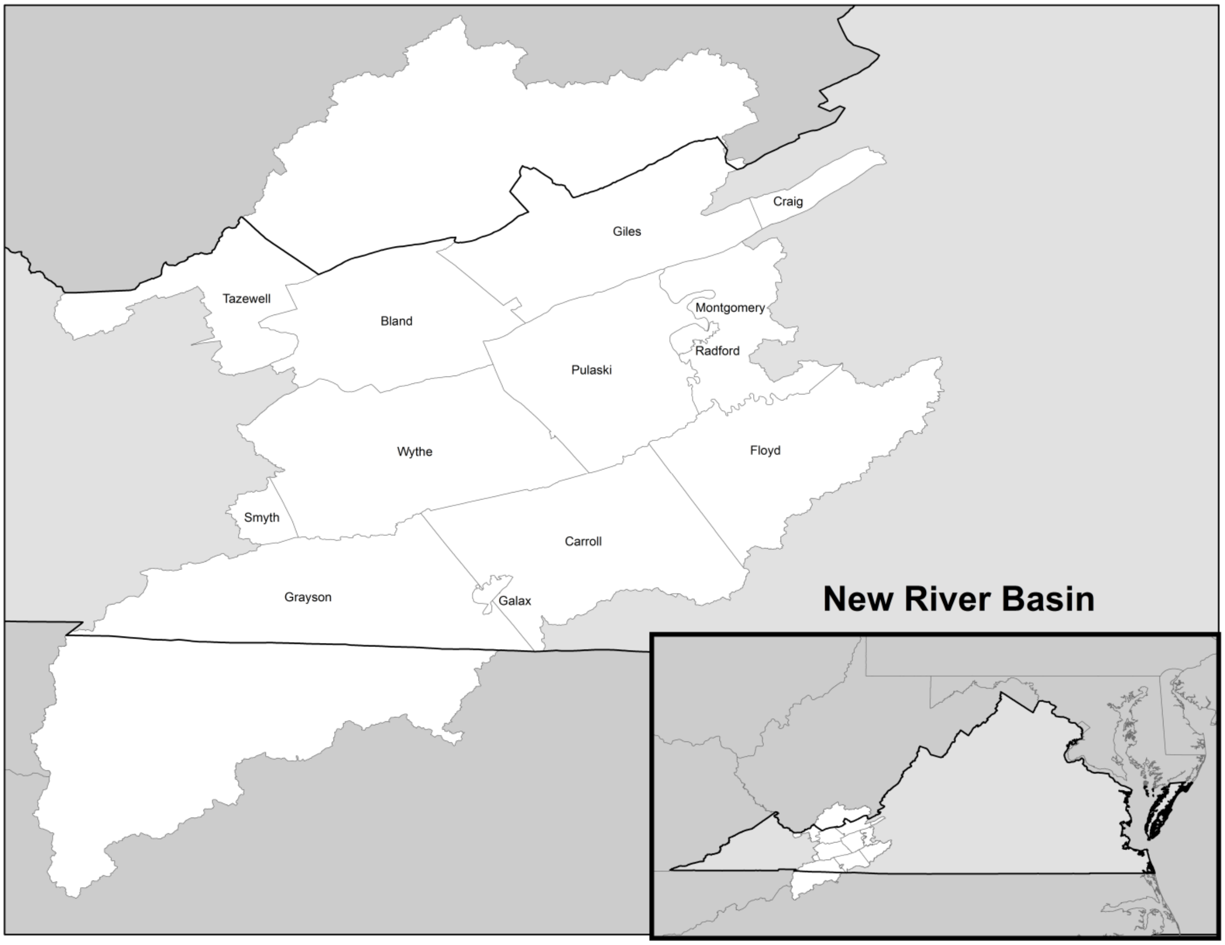
James River Basin Projected Water Deficits

New 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 New River Basin is located in southwest Virginia and covers 3,068 square miles, or approximately 7% of the Commonwealth's total land area. The New River flows from its headwaters in Watauga County, North Carolina in a northeasterly direction to Radford, Virginia, and then in a northwesterly direction to Glen Lyn, Virginia, where it exits into West Virginia. From there it flows to the confluence of the Gauley River forming the Kanawha River, a tributary to the Ohio River.

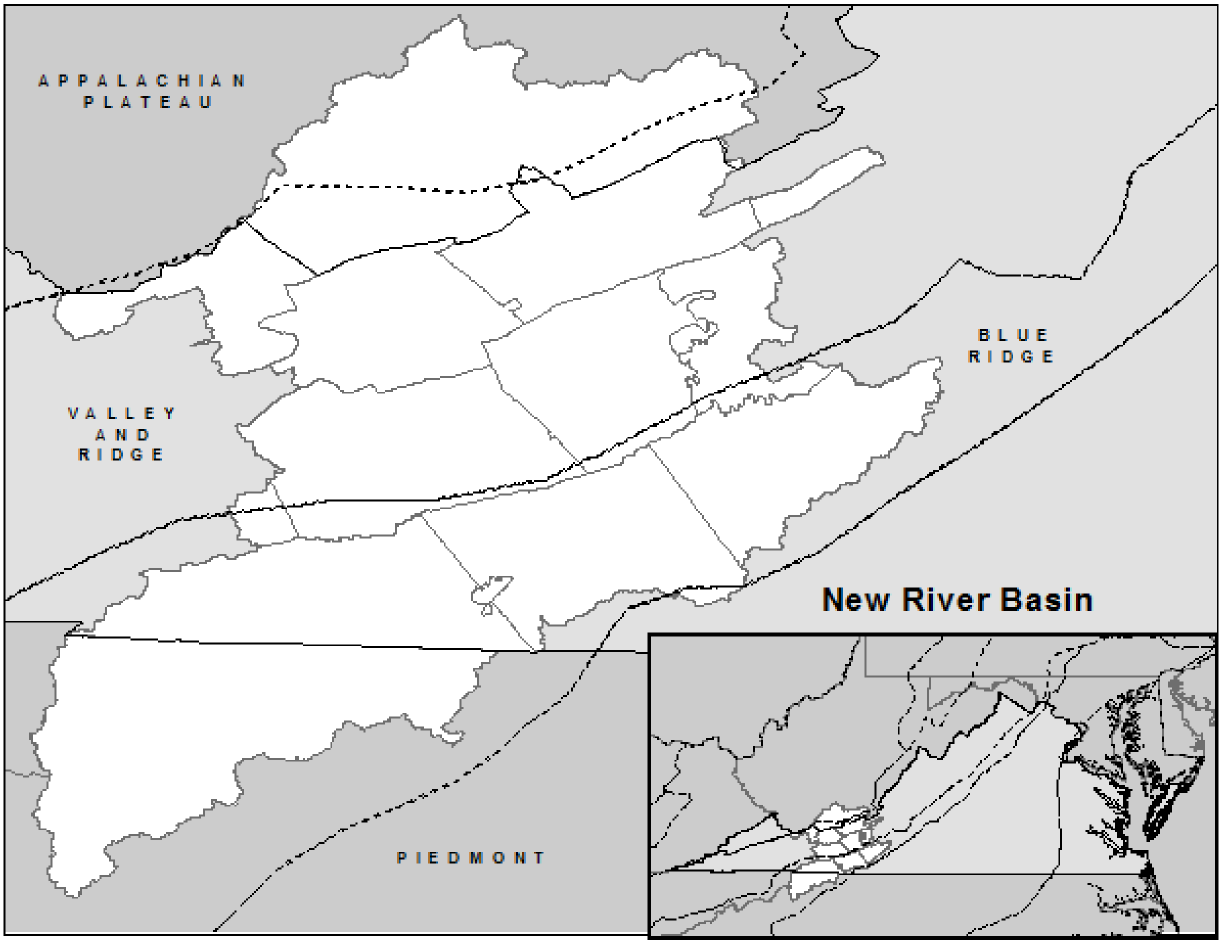
All or portions of the following jurisdictions lie within the Basin: Counties of Bland, Carroll, Craig, Floyd, Giles, Grayson, Montgomery, Pulaski, Smyth, Tazewell, and Wythe; Cities of Galax and Radford. These jurisdictions are represented within four regional water supply plans (Craig County and the Town of New Castle, Southwest Virginia, Blacksburg/Christiansburg, and the New River Valley).



New River Basin Localities

The New River Basin in Virginia is defined by both hydrologic and political boundaries. It is bordered by the James River Basin and Roanoke River Basin to the east, and the Tennessee-Big Sandy River Basin to the west. The southern boundary of the Virginia portion is the North Carolina state line and its northwest boundary is the West Virginia state line.

The topography of the New River Basin is generally rugged; the upper reaches of its tributaries are extremely steep. High mountains, narrow valleys, and steep ravines characterize the Basin. There are ten tributaries in the Upper New River Basin, each having more than 100 square miles in drainage area and many others with forty or more square miles. The New River Basin runs 115 miles in length from Blowing Rock, North Carolina to Bluestone Dam near Hinton, West Virginia with a maximum basin width of 70 miles near Rural Retreat, Virginia. The Virginia portion of the New River Basin is 87 miles in length.



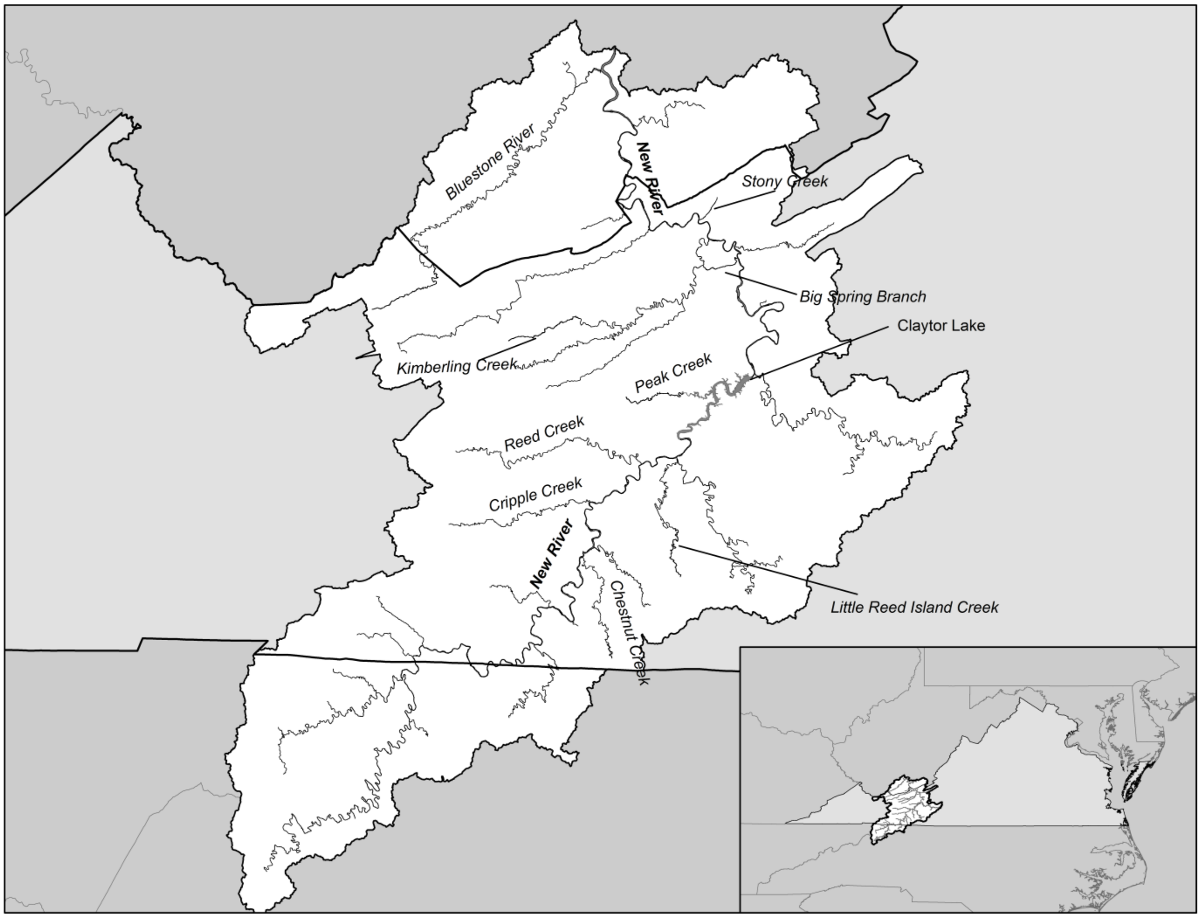
New River Basin Physiographic Provinces

The New River Basin is the least densely populated of the Commonwealth's major river basins. The higher elevations of the Basin have steep slopes and are thickly forested, while the mount bases are mostly used for agriculture. Approximately 59% of its land is forested. Cropland and pasture make up another 35%, with approximately 3% considered urban. The New River Basin is divided into two USGS hydrologic units as follows: HUC 05050001 – Upper New; and HUC 05050002 – Middle New. The two hydrologic units are further divided into 38 water bodies or watersheds and 88 6th order watersheds.

Existing Water Sources

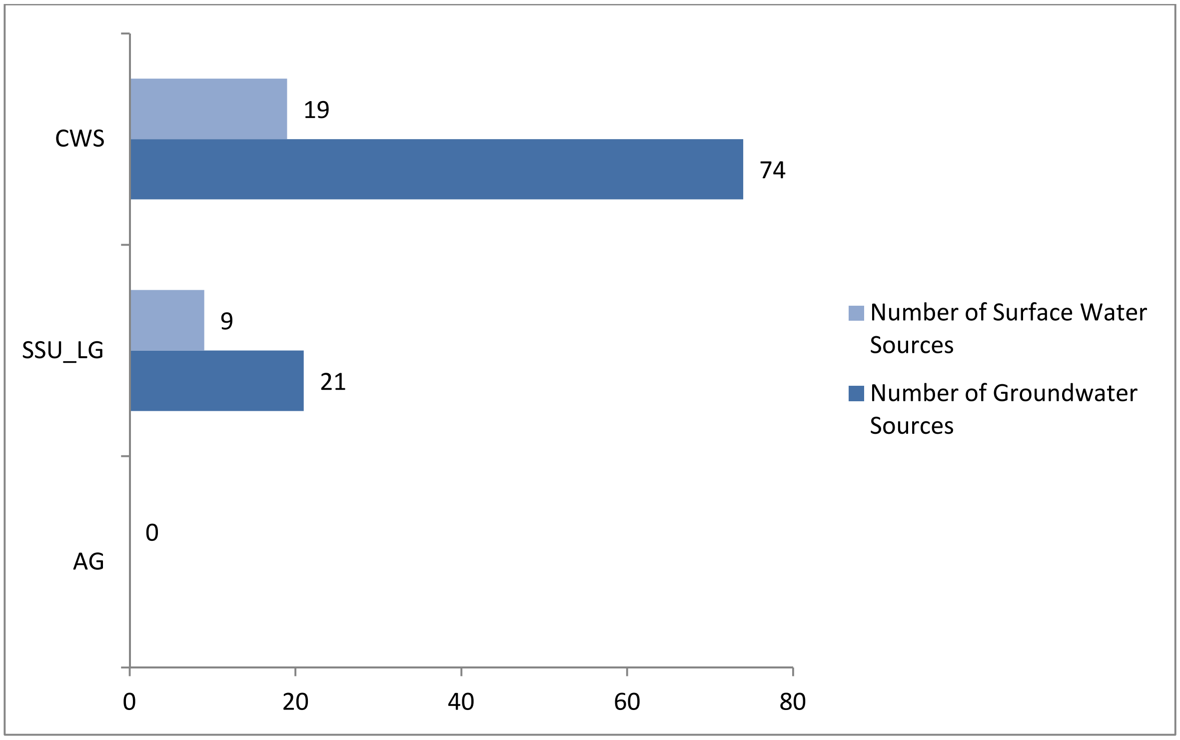
Water sources utilized in the Basin include stream intakes, reservoir, springs, and groundwater wells. Surface water sources account for 28 withdrawals. Additionally, there are 95 groundwater withdrawals currently identified in the New River Basin. Source water reservoirs used in the Basin include Claytor

Lake. Stream intakes and springs used in the Basin include the New River, Peak Creek, Phillippi Spring, Bluestone River, Big Spring, Abbs Creek, Butt Mountain Spring, Chestnut Creek, Dill Springs, Dulaney Spring, Eagle Bottom Creek, Kimberling Creek, Little Reed Island Creek, Boiling Springs, Stony Creek, and White Spring.



New River Basin Major Reservoir and Stream Sources

Reported groundwater sources outnumber surface water withdrawal types in CWS and SSU_LG. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 98,927 people in the Basin use private groundwater wells for residential water supply. Agricultural use was estimated through a combination of water withdrawal reporting and the USDA Census method; therefore, source was not available.



New River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not currently used by the localities in the region.

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 interbasin transfers reported in the four regional water supply plans in covering this Basin.

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

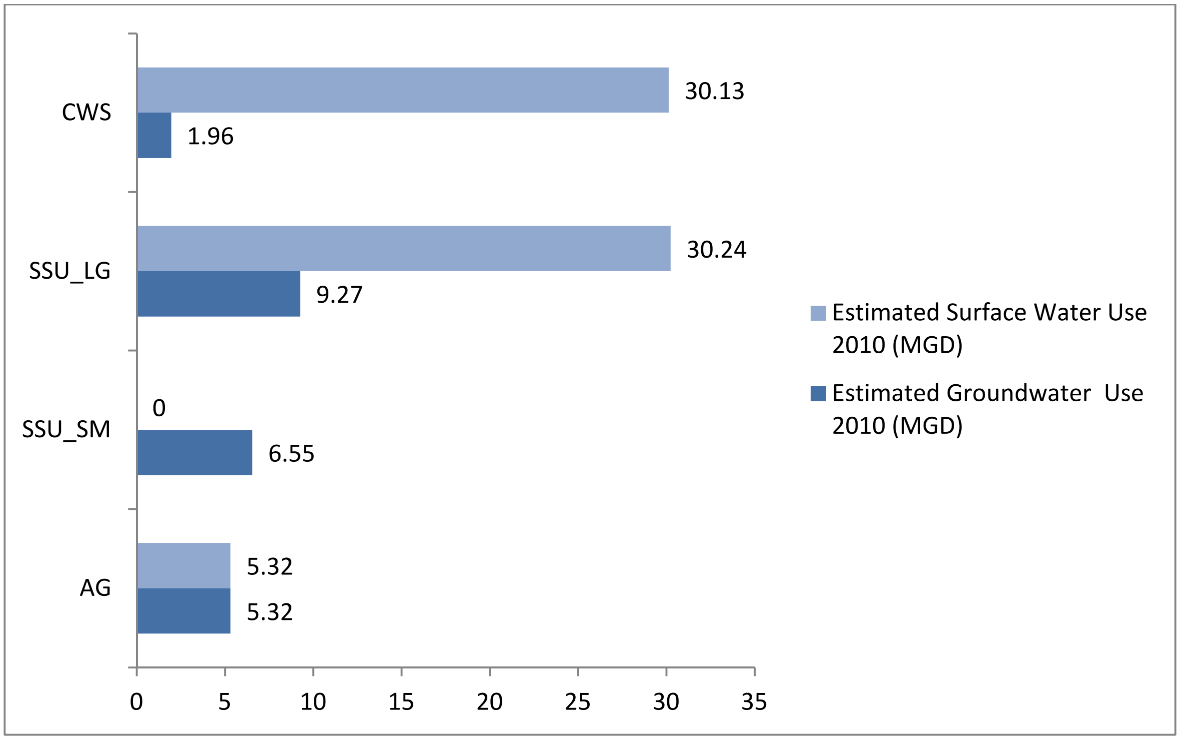
User	Water Purchases and System(s)	Water Provider
CWS	Giles County	Giles County PSA
CWS	Town of Glen Lyn	Giles County PSA
CWS	Town of Narrows	Giles County PSA
CWS	Town of Pearisburg	Giles County PSA
CWS	Town of Pembroke	Giles County PSA
CWS	Town of Rich Creek	Giles County PSA
CWS	Town of Dublin	Pulaski County PSA
CWS	Town of Pulaski	Pulaski County PSA
CWS	Montgomery County PSA-Belview, Warm Hearth, Rt. 144 Corridor, Jennell Road and Yellow Sulphur Road, Merrimac/Price Mountain, Coal Bank Ridge	Town of Blacksburg
CWS	Montgomery County PSA-Bethel Area, Rt. 177 Corridor, Plum Creek	City of Radford
CWS	Town of Blacksburg	VPI Water Authority
CWS	Montgomery County PSA-Midway/Merrimac, Christiansburg Elliston Waterline, Industrial Park-Price Mountain, Mudpike Road Waterline	Town of Christiansburg
CWS	Town of Christiansburg	VPI Water Authority
CWS	Montgomery County PSA-Prices Fork/Merrimac	Radford Army Ammunition Plant
CWS	Pulaski County PSA	Radford Army Ammunition Plant

CWS	Viewland Subdivision	Montgomery County PSA/New River Water Company
CWS	Pulaski County PSA - Brookmont Area	Town of Pulaski
CWS	Pulaski County PSA - Mt. Olivet	no information provided in the regional plan
CWS	New River Valley Planning District Commission (NRVPDC)	City of Radford
CWS	Pulaski County PSA	NRVPDC
CWS	Bland County SA - Rocky Gap/Bastian System	Bluefield Valley Water Works (WV)
CWS	Fairview Water System	City of Galax
CWS	Old Town Water System	City of Galax
CWS	Carroll County PSA - Carroll County Industrial Park, Tower Road	Town of Hillsville
CWS	Town of Tazewell	Tazewell County PSA
CWS	Tazewell County - Falls Mills	Town of Pocahontas

New River Intrabasin Water Transfers

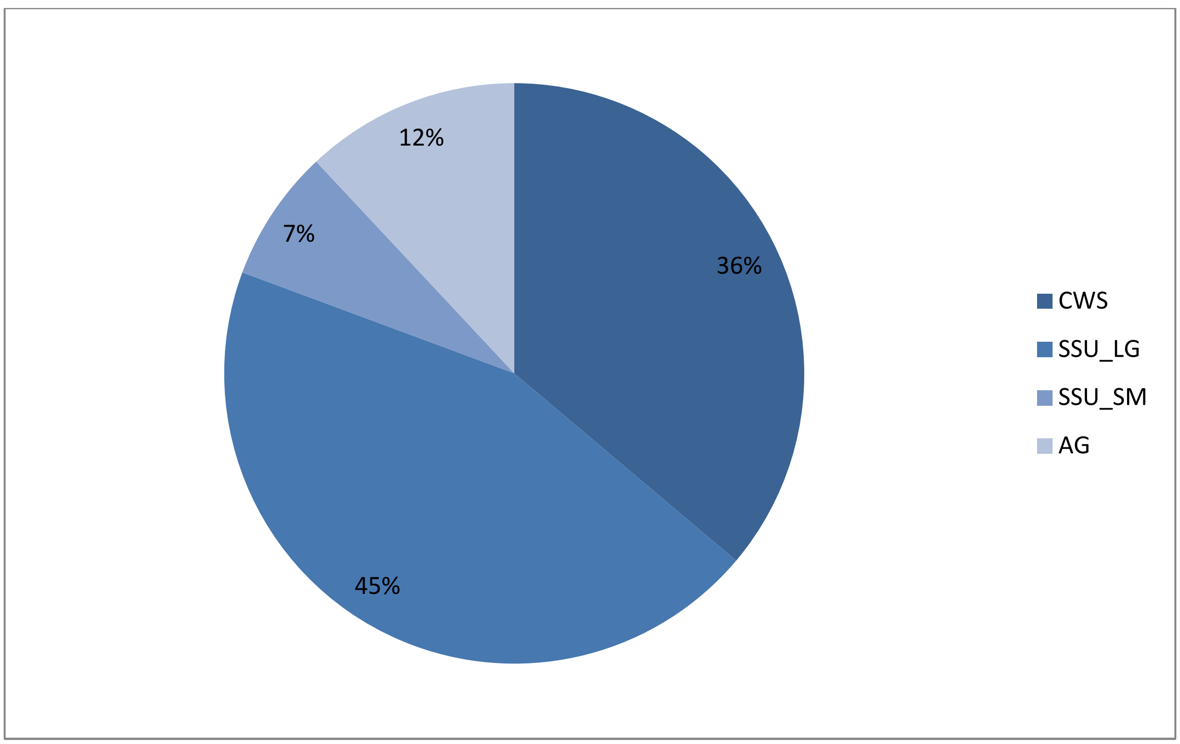
Existing Water Use

The total estimated water use provided in the four water supply plans is summarized in the following figure. The total estimated water use is 89 MGD with approximately 23 MGD of groundwater and approximately 66 MGD of surface water.



New River Basin Estimated Use by Source and Type

SSU_LG use an estimated 45% of the total water in the Basin followed by CWS (36 percent), AG (12%), and SSM_SM (7%).

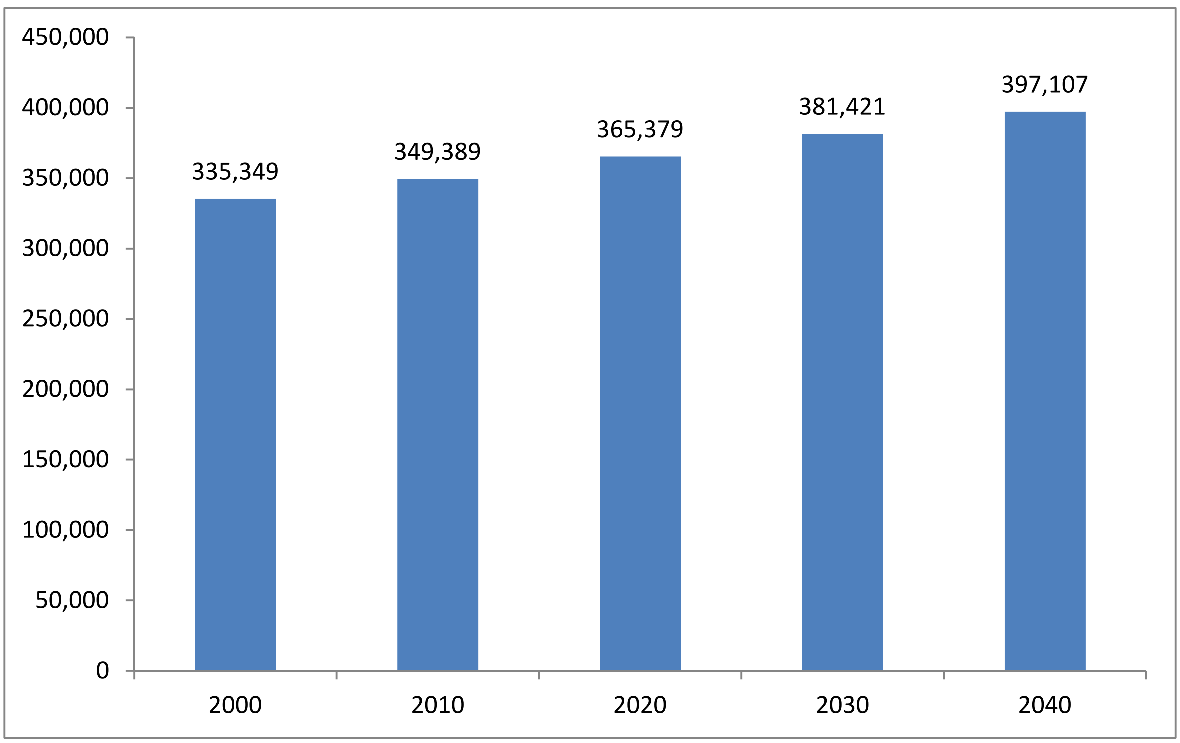


New River Basin Percentage of 2010 Estimated Use by User Type

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 CWS did not report disaggregated use as required. Therefore, the data set is not complete, but is evaluated as a percentage of those that reported. The majority of water used by CWS is for residential supply.

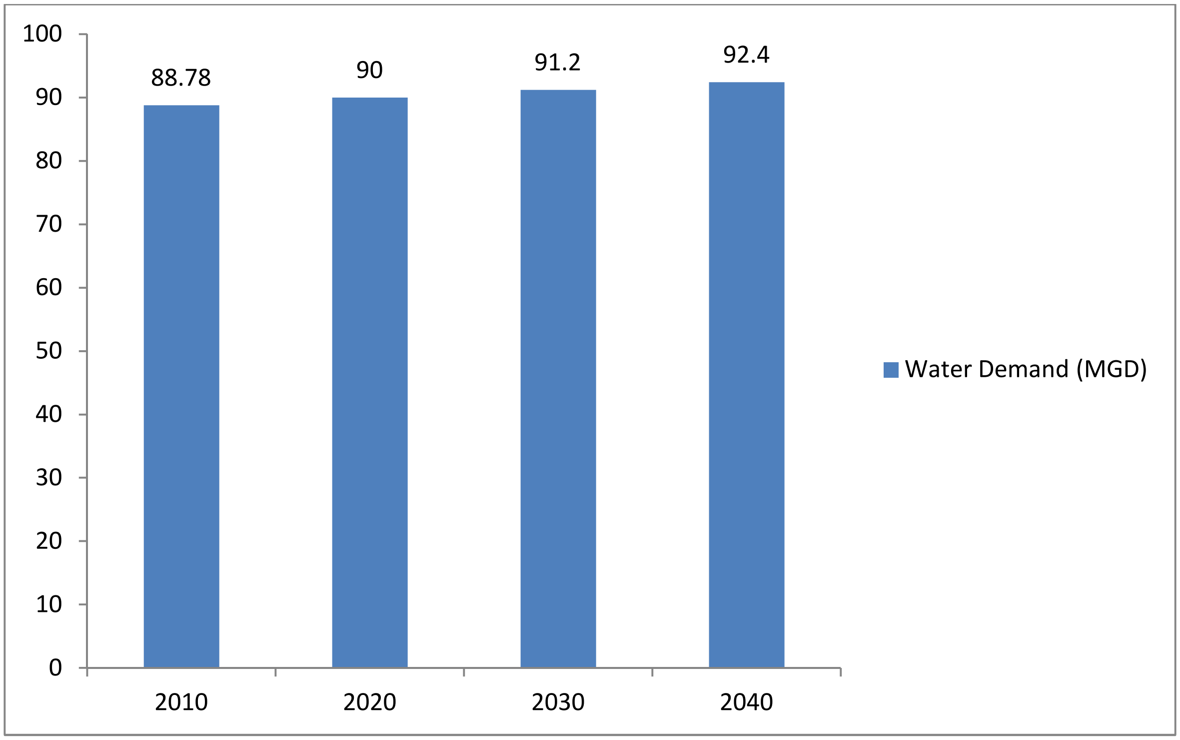
Projected Water Demand

The projected population of the localities with at least a portion of their area in the New River Basin is displayed in the following figure. Population data is obtained from the Virginia Employment Commission’s population estimates which rely on data produced by the United States Census Bureau. The overall population is projected to increase through the year 2040. By the year 2040 the estimated basin-wide population is projected at 397,107. The percent change in population from the years 2000 through 2040 is estimated at 13.7%.



New River Basin Projected Population

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 New River Basin, as reported in the regional water supply plans, is estimated to increase from approximately 89 MGD in 2010 to 92 MGD in 2040. The percent change in water use during the 30 year timeframe is estimated at 5.4%.



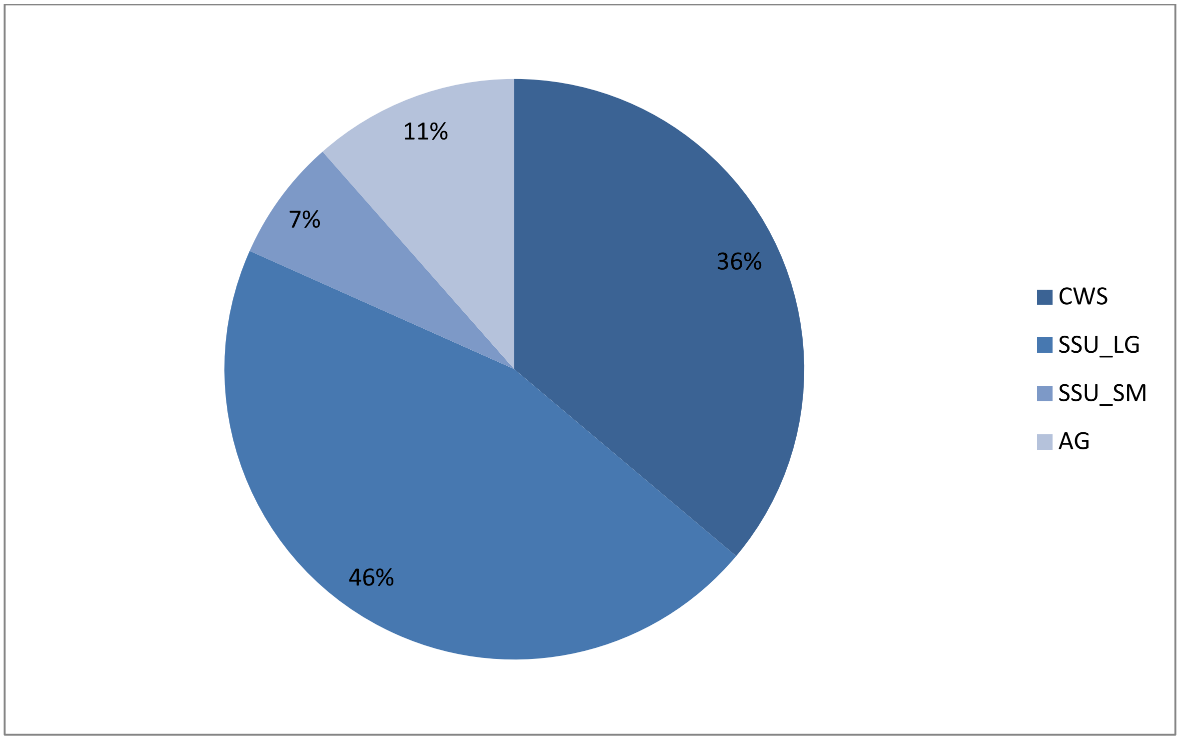
New River Basin Projected Water Demand

As depicted in the following table, the percentage change among users is slight, with CWS showing a 7.4 percent change in water demand over the 30 year planning period. SSU_LG show a 6.5% change and SSU_SM show a decrease in use with a -3.9% change in water demand. The AG use in the New River Basin remains unchanged over the planning period with initial figures based on water withdrawal reporting and USDA Census data.

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	32.09	32.52	33	33.39	7.4%
SSU_LG	39.51	40.37	41.2	42.08	6.5%
SSU_SM	6.55	6.46	6.4	6.29	-3.9%
AG	10.63	10.63	10.6	10.63	0.0%

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

In the year 2040 the percentage of water demand by user type in the New River Basin is similar to the 2010 use in that SSU_LG are projected to use the greatest percentage of water followed by CWS, AG, and SSU_SM.



New River Basin Percentage of 2040 Projected Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs is obtained from the four regional water supply plans represented in the New River Basin. The information is presented for all those localities with at least a portion of land area located within the New River Basin. The following lists the projected deficits in the Basin.

Town of Blacksburg and Town of Christiansburg Regional Water Supply Plan

Blacksburg and Christiansburg confirm that available resources and the permitted capacity of the treatment plant exceed current and future demand projections.

Craig County-Town of New Castle Regional Water Supply Plan

Based on projections of future water demand and the VDH permitted capacity of the Craig-New Castle Public Service Authority community water system, existing water sources are deemed adequate to meet projected 2040 community water system demands.

New River Valley Water Supply Plan

Montgomery County; Floyd County; Pulaski County and the Towns of Dublin and Pulaski; Giles County and the Towns of Glen Lyn, Narrows, Pearisburg, Pembroke, and Rich Creek; City of Radford

As a region, there is generally no deficit during the planning period. Some systems are already exploring options to increase system capacity. Alternatives considered include the installation of pressure reducing valves; interconnection of systems with the City of Radford across the planning area; increased educational efforts; additional well(s) in Floyd; water capacity expansion for the Giles County PSA and a pilot study on potential to withdraw from the New River; joining the Blacksburg-Christiansburg-VPI water authority for Montgomery County; Pulaski County is engaged in discussions with the City of Radford to increase capacity in an industrial park.

Southwest Virginia Regional Water Supply Plan

Bland County; Carroll County and the Town of Hillsville; Grayson County and the Towns of Fries, Independence, and Troutdale; Smyth County and the Towns of Chilhowie, Marion, and Saltville; Wythe County and the Towns of Rural Retreat and Wytheville; Tazewell County and the Towns of Bluefield, Cedar Bluff, Pocahontas, Richlands, and Tazewell; the City of Galax

The Town of Saltville may experience a water deficit as early as 2006 based on the current VDH permitted capacity. The deficit is projected to increase to approximately 0.68 MGD in 2060. The Town of Wytheville may experience a water deficit as early as 2041, based on the current VDH permitted capacity. The deficit may increase to approximately 0.85 MGD in 2060.

The region's plan to address the projected shortfall of municipal supply includes: maintaining, increasing, or initiating supply interconnections with neighboring localities, infrastructure upgrades, groundwater source development, increasing permitted surface water withdrawals, upgrading current VDH permitted capacities, and continuing existing water conservation policies or developing new ones.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Town of Saltville	2060	0.68
Town of Wytheville	2060	0.85

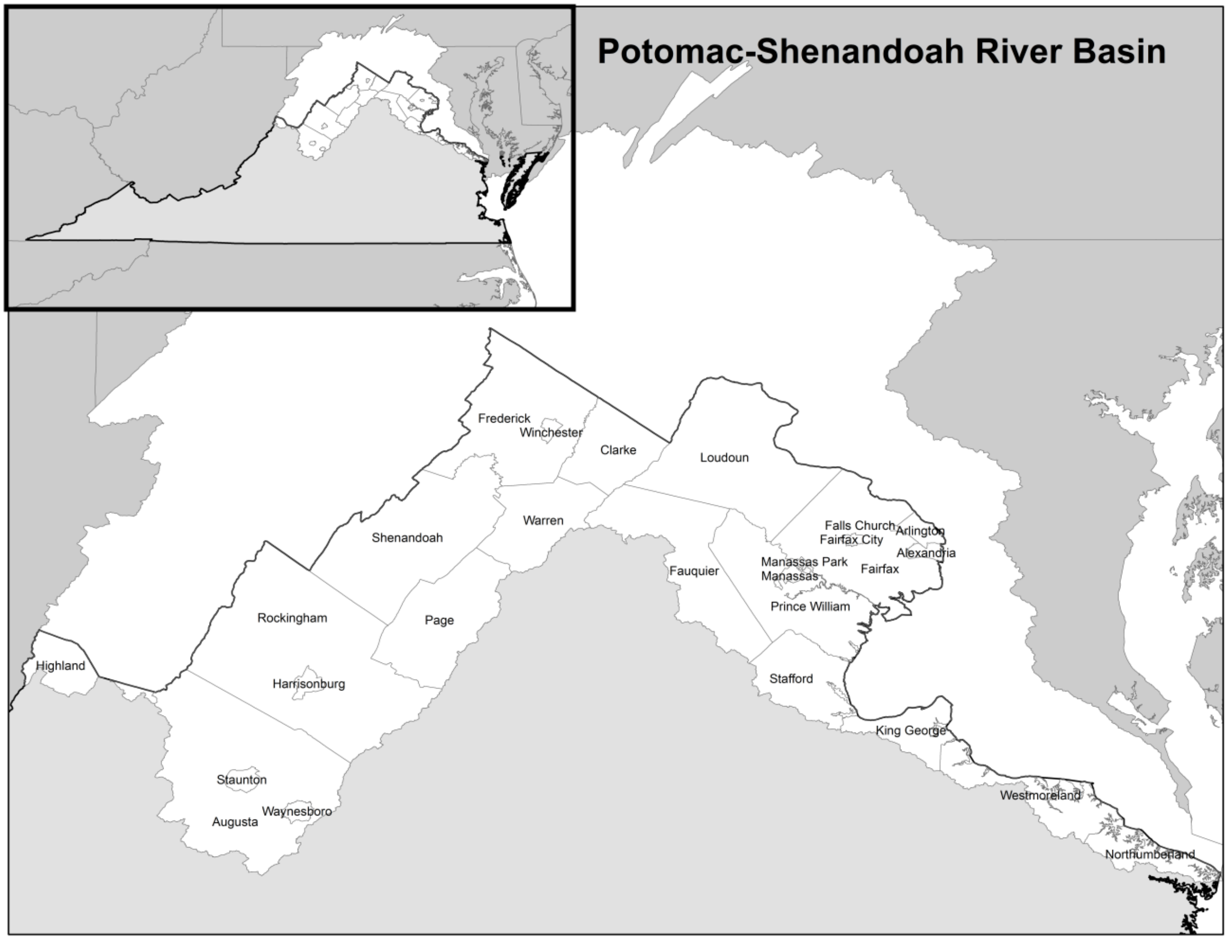
New River Basin Projected Water Deficits

Potomac-Shenandoah 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.

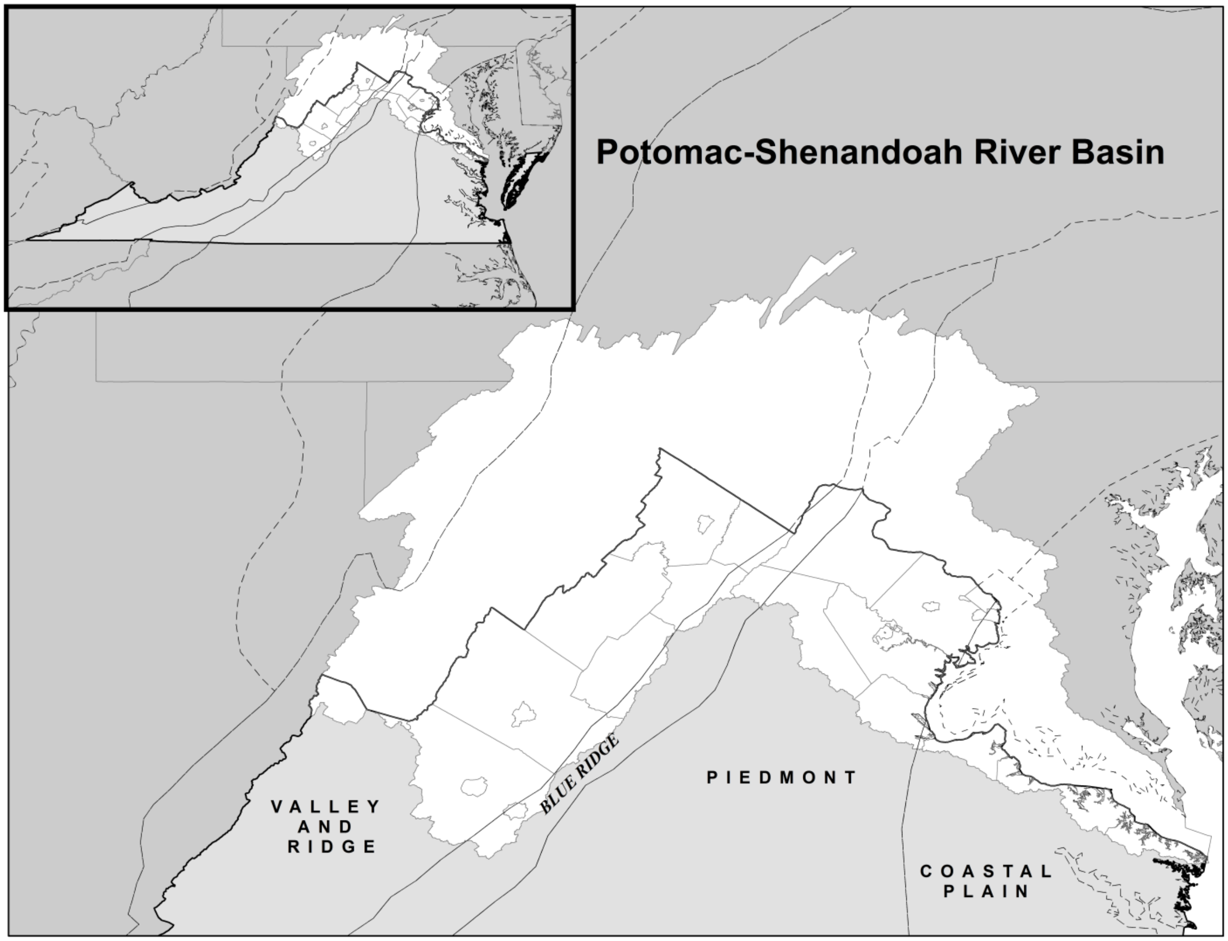
The Potomac-Shenandoah River Basin stretches across parts of four states (Maryland, Pennsylvania, Virginia, and West Virginia) as well as the District of Columbia. As its name implies, the Basin is made up of the Shenandoah River and the Potomac River sub-basins, occupying the northern portion of Virginia and covering 5,681 square miles, or approximately 13% of the Commonwealth's total area. In Virginia, the Potomac-Shenandoah River Basin is defined by both hydrologic and political boundaries. The James River and Rappahannock River Basins border the Basin to the south. The West Virginia and Maryland State lines and the District of Columbia border the northern and western perimeters of the Basin.

All or part of the following jurisdictions lie within the Basin: the Counties of Arlington, Augusta, Clarke, Fairfax, Fauquier, Frederick, Highland, King George, Loudoun, Northumberland, Page, Prince William, Rockingham, Shenandoah, Stafford, Warren, and Westmoreland; the Cities of Alexandria, Fairfax, Falls Church, Harrisonburg, Manassas, Manassas Park, Staunton, Waynesboro, and Winchester. These jurisdictions are represented within six regional water supply plans (Fauquier County and Towns, Northern Neck, Northern Shenandoah, Northern Virginia, Upper James, and Upper Shenandoah) and four local water supply plan (Town of Hillsboro, King George County, Stafford County, and the Town of Warrenton).



Potomac-Shenandoah River Basin Localities

The Basin lies in five geological provinces: the Appalachian Plateau, the Ridge and Valley, Blue Ridge, Piedmont Plateau, and the Coastal Plain.



Potomac-Shenandoah River Basin Physiographic Provinces

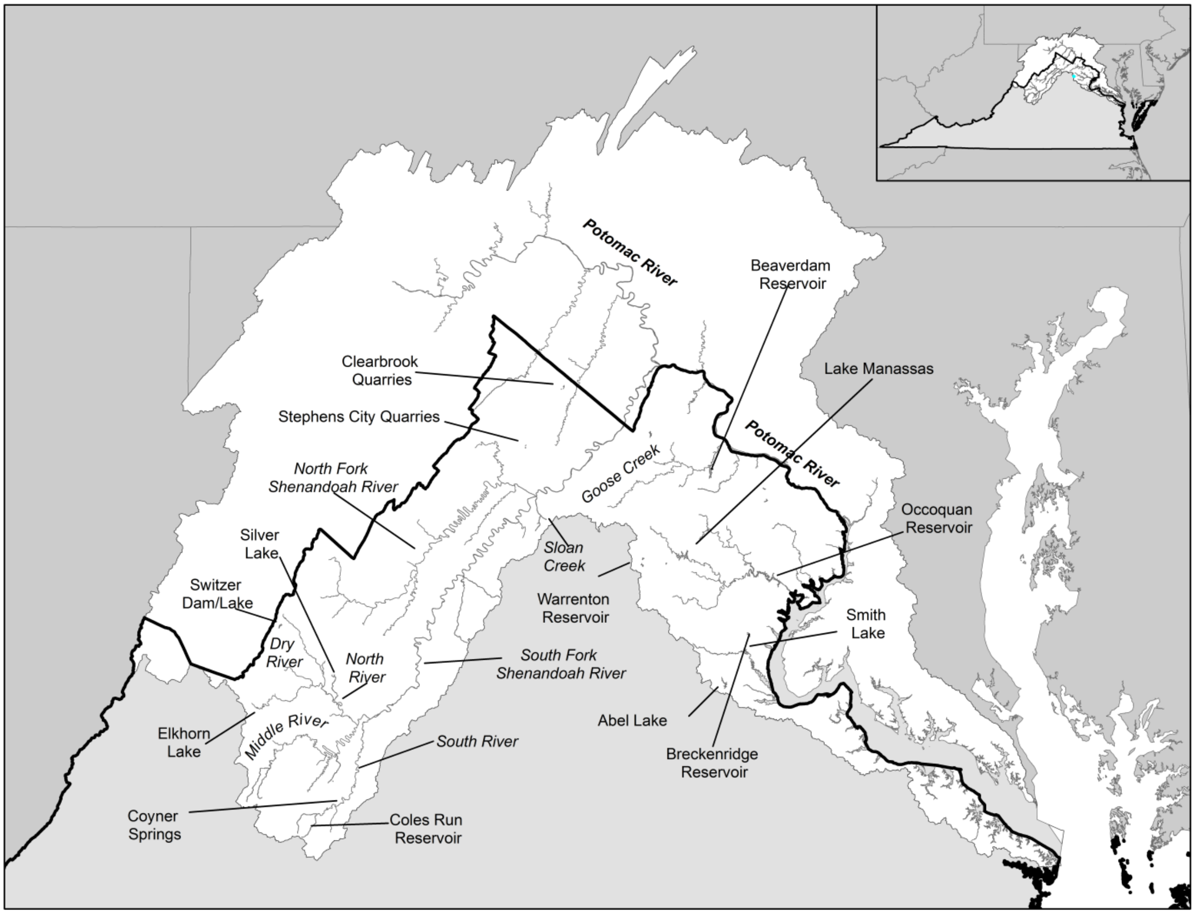
Approximately 2,298 of the 14,700 square miles of the Potomac River sub-basin drainage area lie in Virginia; the rest are found in three states (Maryland, Pennsylvania, and West Virginia) and the District of Columbia. About 40% of the Potomac River sub-basin's land area is forested, 33 percent is farmland and pasture, and an estimated 27% is urban. Similarly, approximately 45% of the land area in the Shenandoah River sub-basin is forested, due to a large amount of federally-owned land and the steep topography. Farmland and pasture account for 39% of the Shenandoah sub-basins land area, while 16% is urban. Major industries in the Basin include agriculture and forestry throughout the Basin; chemical production and agriculture in the Shenandoah Valley; high-tech service and light industry in northern Virginia; and fishing the lower Potomac estuary.

The Potomac-Shenandoah River Basin is divided into eight USGS hydrologic unit codes (HUC) as follows: HUC 02070001- South Branch Potomac; HUC 02070004 - Conococheague-Opequon; HUC 02070005 - South Fork Shenandoah; HUC 02070006 - North Fork Shenandoah; HUC 02070007 - Shenandoah; HUC 02070008 - Middle Potomac-Catoctin; HUC 02070010 - Middle Potomac-Anacostia-

Occoquan; HUC 02070011 - Lower Potomac.ac-Catoctin; HUC 02070010 - Middle Potomac-Anacostia-Occoquan; HUC 02070011 - Lower Potomac. The eight hydrologic units are further divided into 92 waterbodies or watersheds and 181 6th order sub-watersheds.

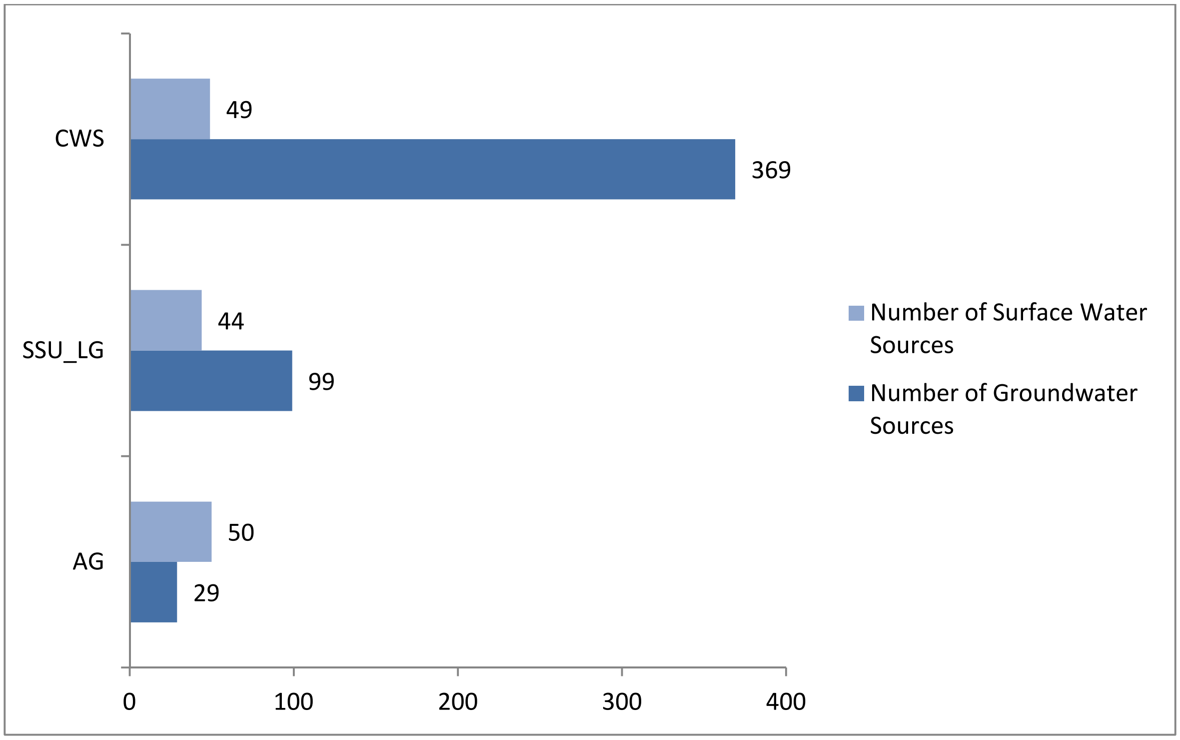
Existing Water Sources

Water sources in the Basin include stream intakes, reservoirs, springs, and groundwater. Surface water sources (reservoirs, streams, and springs) account for 143 withdrawals. Additionally, there are 497 groundwater withdrawals currently identified in the Potomac-Shenandoah River Basin. Source water reservoirs include Abel Lake, Airlie Reservoir, Beaverdam Creek Reservoir, Breckenridge-Lunga Reservoir, Clear Brook Quarry, Elkhorn Lake, Hirst Reservoir, Lake Manassas, Occoquan Reservoir, Rocky Pen Run Reservoir, Silver Lake, Smith Lake, Coles Run Reservoir, Stephens City Quarries, Switzer Lake, and Warrenton Reservoir. Stream intakes and spring sources used in the Basin include the Dry River , Middle River, North River, Potomac River, Shenandoah River, South River, Back Creek, Broad Run, Christian's Creek, Cook's Creek, Dam Creek, Daniel's Run, Goose Creek, Happy Creek, Hawksbill Creek, Jeb's Creek, Linville Creek, Lodge Creek, Meadow Run, Mill Creek, Mossy Creek, Pass Run, Passage Creek, Pogue Run, Potomac Creek, Sloan Creek, Smith Creek, Spring Creek, Stony Creek, Baker Spring, Coyner Spring, Elk Run Spring, Gardner Spring, Hite Spring, Quicks Spring, Rawley Spring, and Vandevender Spring.



Potomac-Shenandoah River Basin Reservoirs and Stream Sources

Reported groundwater sources outnumber surface water sources in all use types except for agriculture. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 500,630 people in the Basin use private groundwater wells for residential water supply.



Potomac-Shenandoah River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly utilized by localities in the Commonwealth. Four facilities located in the Potomac-Shenandoah River Basin are permitted to generate and distribute reclaimed water: Loudoun Water (Broad Run Water Reclamation Facility) is permitted to generate and distribute up to 11 MGD of reclaimed water to a data center for cooling and to the National Rural Water Utilities Cooperative Finance Corporation for indoor toilet/urinal flushing, commercial air conditioning, non-bulk irrigation use, and non-residential fire suppression. Loudoun Water (Courtland Farms WTP) is permitted to generate and distribute up to 0.08 MGD of reclaimed water to a golf course for irrigation. Fairfax County (Noman M. Cole Jr. Pollution Control Plant) is permitted to generate and distribute up to 6.6 MGD to a waste to energy facility for cooling and to a golf course and recreational ball fields owned by the county for irrigation. Fauquier County Water and Sanitation Authority (Remington WWTF) is permitted to discharge up to 2.5 MGD to the Rappahannock River. The treatment plant provides up to 0.5 MGD of effluent to a natural gas, power generation facility for cooling, stack scrubbing, turbine washing, and fire suppression. Upper Occoquan Service Authority is permitted to discharge up to 64 MGD of treated effluent into a tributary of the Occoquan Reservoir.

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 Potomac-Shenandoah River Basin.

The following table lists the Potomac-Shenandoah intrabasin transfers between water providers and the entities to which they sell water (water purchasers).

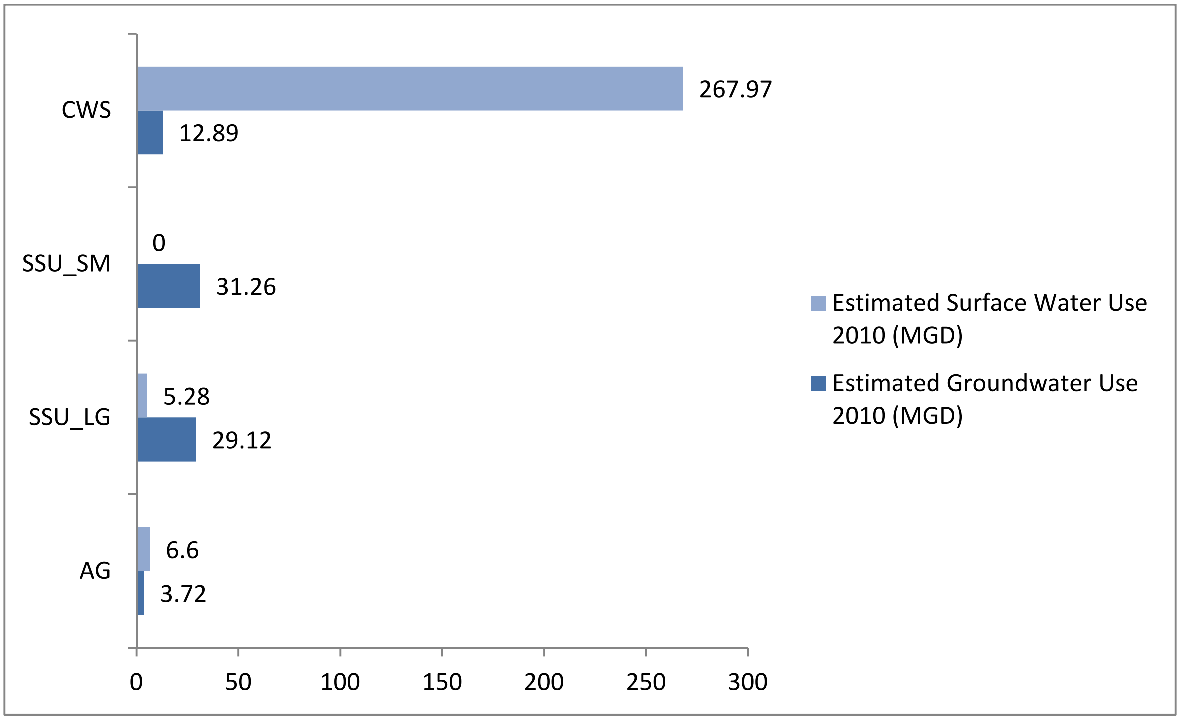
User Type	Water Purchaser and System(s)	Water Provider
CWS	Augusta County Service Authority (SA) – Blackburn, South River, Verona, Rt. 250 West	City of Staunton
CWS	Augusta County SA - Estaline Valley	Town of Craigsville
CWS	Fort Belvoir	Fairfax Water
CWS	City of Fairfax	Fairfax Water
CWS	Loudoun Water - Central System	Fairfax Water
CWS	Prince William County SA - Oak Ridge, OWDT	Fairfax Water
CWS	VA American Water Company - Dale City	Fairfax Water
CWS	Prince William County SA - Greater Manassas, Manassas Southside	Fairfax Water, City of Manassas
CWS	Fairfax Water	City of Fairfax
CWS	Loudoun Water - Central System	City of Fairfax
CWS	Fairfax Water	City of Falls Church
CWS	Town of Vienna	City of Falls Church
CWS	City of Manassas Park	City of Manassas
CWS	City of Manassas	Prince William County SA
CWS	City of Manassas Park	Prince William County SA

CWS	Town of Quantico	Quantico Marine Corps Base
CWS	Rockingham Co. - Countryside Sanitary District	Town of Bridgewater
CWS	Rockingham Co. - Harmony Hills, Rosedale Subdivision, RR Donnelly/Smith Creek	City of Harrisonburg
CWS	Fairfax Water	Town of Vienna
CWS	Arlington County	Washington Aqueduct
CWS	Town of Falls Church	Washington Aqueduct
SSU_LG	Reagan National Airport	Arlington County or Washington Aqueduct
SSU_LG	Federal Mogul Friction Product - Winchester Plant	City of Winchester
SSU_LG	Dulles International Airport	Fairfax Water or other

Potomac-Shenandoah River Basin Intrabasin Transfers

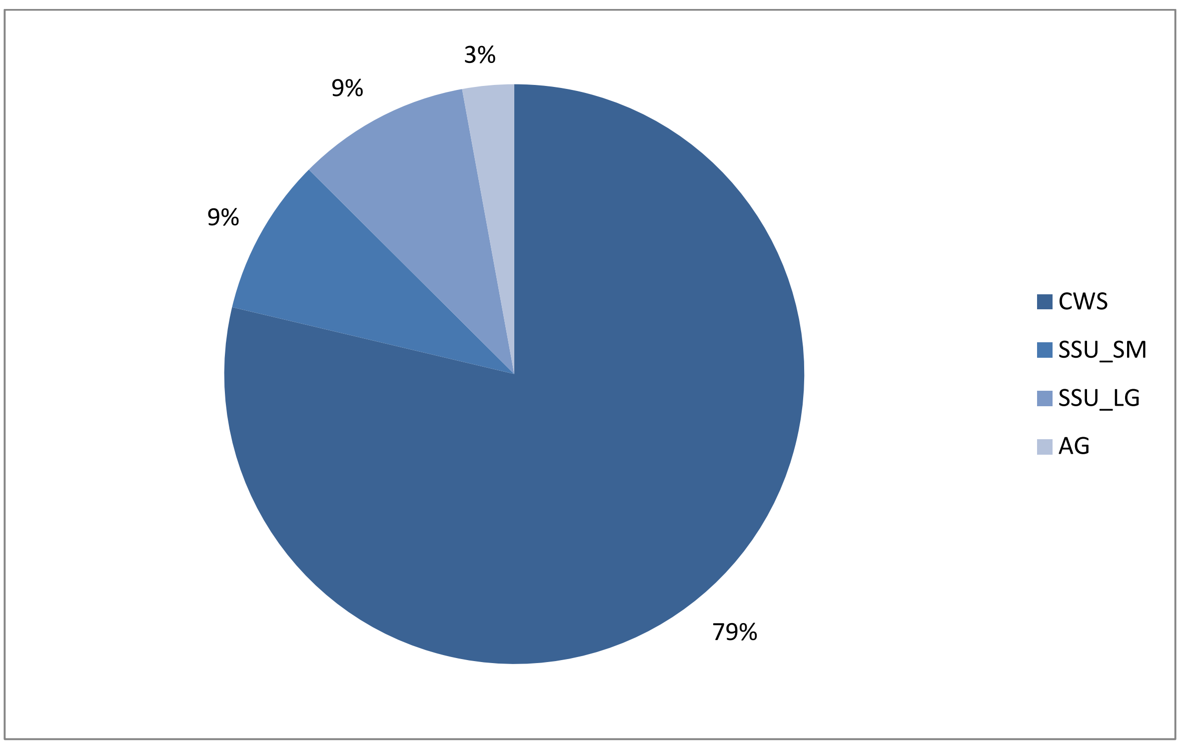
<u>Existing Water Use</u>

The total estimated water use by source and user type provided in the local and regional water supply plans is summarized in the following figure. The total estimated water use is approximately 357 MGD, with 280 MGD withdrawn from surface water sources and 77 MGD from groundwater sources. Although the number of groundwater withdrawals far exceeds surface water withdrawals in the Potomac-Shenandoah River Basin, the estimated existing use from surface water sources exceeds that of groundwater by a significant margin.



Potomac-Shenandoah River Basin Estimated Use by Source and Type

CWS used an estimated 79% of the total water in the Basin followed by SSU_LG and SSU_SM (both 9%), and AG (3%).

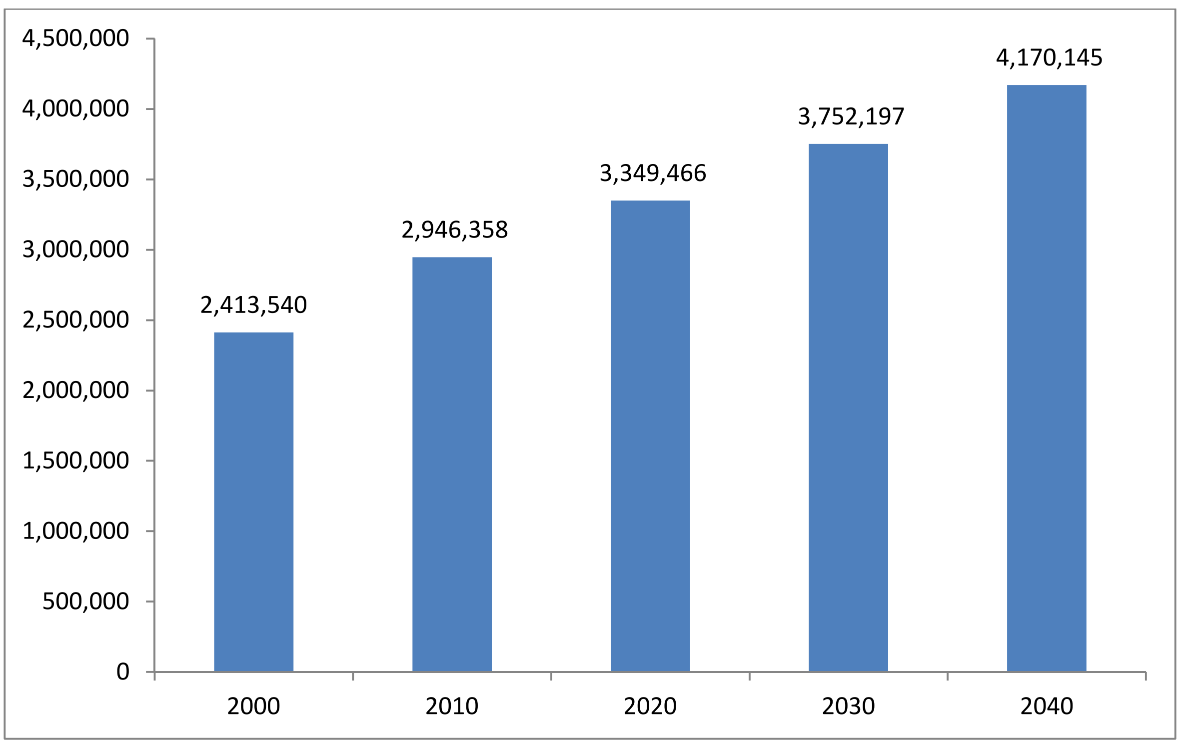


Potomac-Shenandoah River Basin 2010 Estimated Use by User Type

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 CWS did not report disaggregated use as required. No assumption on 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.

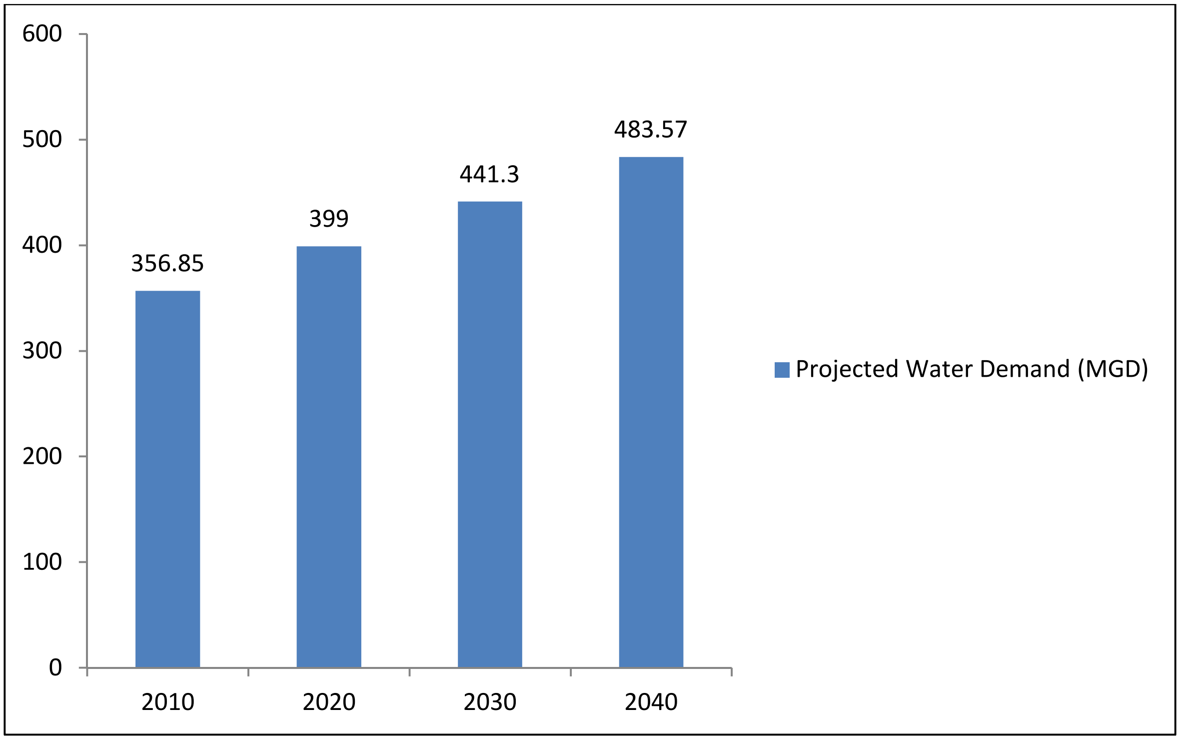
Projected Water Demand

The projected population of the localities with at least a portion of their area in the Potomac-Shenandoah 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 4,170,145. The percent increase in population from the years 2000 through 2040 is estimated at 41.5%.



Potomac-Shenandoah River Basin Projected Population by Decade

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 Potomac-Shenandoah River Basin, as reported in the regional water supply plans, is estimated to increase from approximately 357 MGD to 484 MGD in 2040. The percentage change in water use during the 30-year timeframe is estimated at 32.6%.



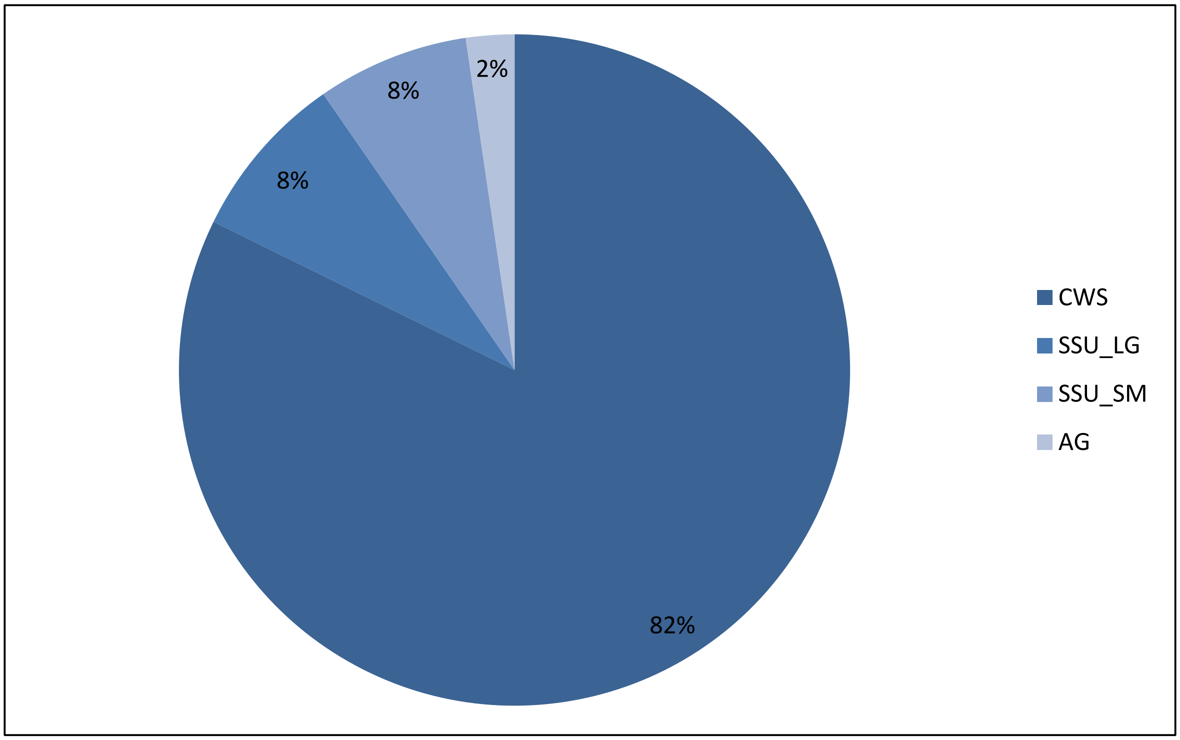
Potomac-Shenandoah River Basin Projected Water Demand

As depicted in the following table, the majority of the Basin's growth is expected to occur within CWS service areas, with a projected 35.7% increase in water demand over the 30-year period. Projected water demand for SSU_LG has the next highest percentage growth (13.6%), followed by SSU_SM (13.5%), and AG with 9%. The anticipated growth in 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	280.87	319.87	358.9	397.87	35.7%
SSU_LG	34.4	35.93	37.4	38.97	13.6%
SSU_SM	31.26	32.67	34.1	35.47	13.5%
AG	10.32	10.63	10.9	11.25	9.0%

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

In the year 2040, CWS demand is estimated at 82% of the total demand for the Basin, followed by SSU_LG and SSU_SM (both at 8%), and AG accounting for 2%.



Potomac-Shenandoah River Basin Percentage of Projected 2040 Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs is obtained from the six regional and four local water supply plans represented in the Potomac-Shenandoah River Basin. The information is presented for all those localities with at least a portion of land area located within the Potomac/Shenandoah River Basin. The following lists the projected deficits in the Basin.

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

Town of Hillsboro Water Supply Plan

The well and spring used by the town are inadequate, both from a quality and quantity standpoint. The Town has been under a VDH-imposed consent order and boil water notice since 2005, as the spring is under the influence of surface water. In March of 2012, Hillsboro submitted to the VDH-ODW a Grant Application for the Financial and Construction Assistance Programs to construct a new well, connect it to the existing system, and provide additional storage and infrastructure improvements to the system. In November 2012, VDH approved a total funding package of $1,200,000 for the project. It consists of a $720,000 DWSRF loan at 2.5% interest for a term of 30 years and $480,000 in grant funding from the Water Supply Assistance Grant Fund. Construction was projected to begin by late fall 2013.

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.

Northern Neck Regional Water Supply Plan

Northumberland County; Westmoreland County and the Towns of Colonial Beach and Montross

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

Northern Shenandoah Regional Water Supply Plan

Clarke County and the Towns of Berryville and Boyce; Frederick County and the Towns of Middletown and Stephens City; Page County and the Towns of Luray, Shenandoah, and Stanley; Shenandoah County and the Towns of Edinburg, Mt. Jackson, New Market, Strasburg, Toms Brook, and Woodstock; Warren County and the Town of Front Royal; City of Winchester

The plan states that, through careful planning and conservation efforts, there will be sufficient water to support the majority of needs through the year 2040. Based on current supply, a deficit of 0.81 MGD is anticipated to occur in Frederick County by 2030. Frederick County Sanitation Authority alternatives include quarry expansion and groundwater well improvements.

Northern Virginia Regional Water Supply Plan

Arlington County; Fairfax County and the Towns of Clifton, Herndon, and Vienna; Loudoun County and the Towns of Hamilton, Leesburg, Lovettsville, Middleburg, Purcellville, and Round Hill; Prince William County and the Towns of Dumfries, Haymarket, Occoquan, and Quantico; Cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park

The City of Fairfax is expected to experience a water deficit around 2038, with a total deficit of almost 0.20 MGD by 2040. The Town of Purcellville had a water supply deficit in 2007 until additional well sources were placed online later that year. The Town will maintain a water supply surplus until 2038 and, without additional water, a deficit of approximately 0.07 MGD may occur in 2040. The region's plan to address the projected shortfall of municipal supply includes constructing a stream intake/pumping station on the Potomac estuary below Little Falls (recently permitted by DEQ); utilizing a reverse osmosis membrane treatment plant on the Occoquan estuary, using quarries located in Fairfax County to augment Fairfax Water storage, and using Loudoun County quarries to augment system storage (recently permitted by DEQ).

Stafford County Regional 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.

Upper James River Basin Water Supply Plan

Highland County and the Town of Monterey

Population and demand will remain constant through 2040; therefore, existing water sources are anticipated to be adequate.

Upper Shenandoah Regional Water Supply Plan

Augusta County and the Town of Craigsville; Rockingham County and the Towns of Bridgewater, Broadway, Dayton, Elkton, Grottoes, Mount Crawford, and Timberville; Cities of Harrisonburg, Staunton, and Waynesboro

Water demand is anticipated to increase during the planning period, as is population, which is projected to increase by 3% in Rockingham and Augusta counties. Population is anticipated to increase far more significantly in the cities and towns: 175% in Harrisonburg, 37% in Waynesboro, and 20% in Staunton; and ranging from 49% to over 300% in the towns. The Plan concludes that although water sources overall within the region will be adequate to meet projected demand, when examined individually, the counties of Augusta and Rockingham and the towns of Bridgewater, Broadway, Grottoes, Mt. Crawford, and Timberville show potential deficits by the year 2040 compared to existing permitted sources.

Augusta County (August County Service Authority) deficit of 0.83 MGD by 2027

Rockingham County (includes the Town of Mount Crawford) deficit of 1.272 MGD by 2020

Town of Bridgewater deficit of 0.05 MGD by 2030

Town of Broadway deficit of 0.23 MGD by 2040

Town of Grottoes deficit of 0.01 MGD by 2040

Town of Timberville deficit of 0.04 MGD by 2040

Development of new wells and treatment facilities; plant upgrades to provide additional supply and treatment capacity; development of new stream intakes, pump stations, and pipelines to provide additional source water: and development of purchase water agreements from neighboring jurisdictions and inter-jurisdictional collaboration on new infrastructure projects.

Town of Warrenton Water Supply Plan

Existing service area build-out demand projections are in line with water supply resources, and a deficit is not anticipated during the planning period.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Augusta County	2027	0.83
Rockingham County	2020	1.27
Town of Bridgewater	2030	0.05
Town of Broadway	2040	0.23
Town of Grottoes	2040	0.01
Town of Timberville	2040	0.04
King George County	2030	1.0 – 1.5
City of Fairfax	2040	0.20
Town of Purcellville	2040	0.07
Stafford County	2015 (Rocky Pen Run Reservoir completion date)	14.7
Frederick County	2030	0.81

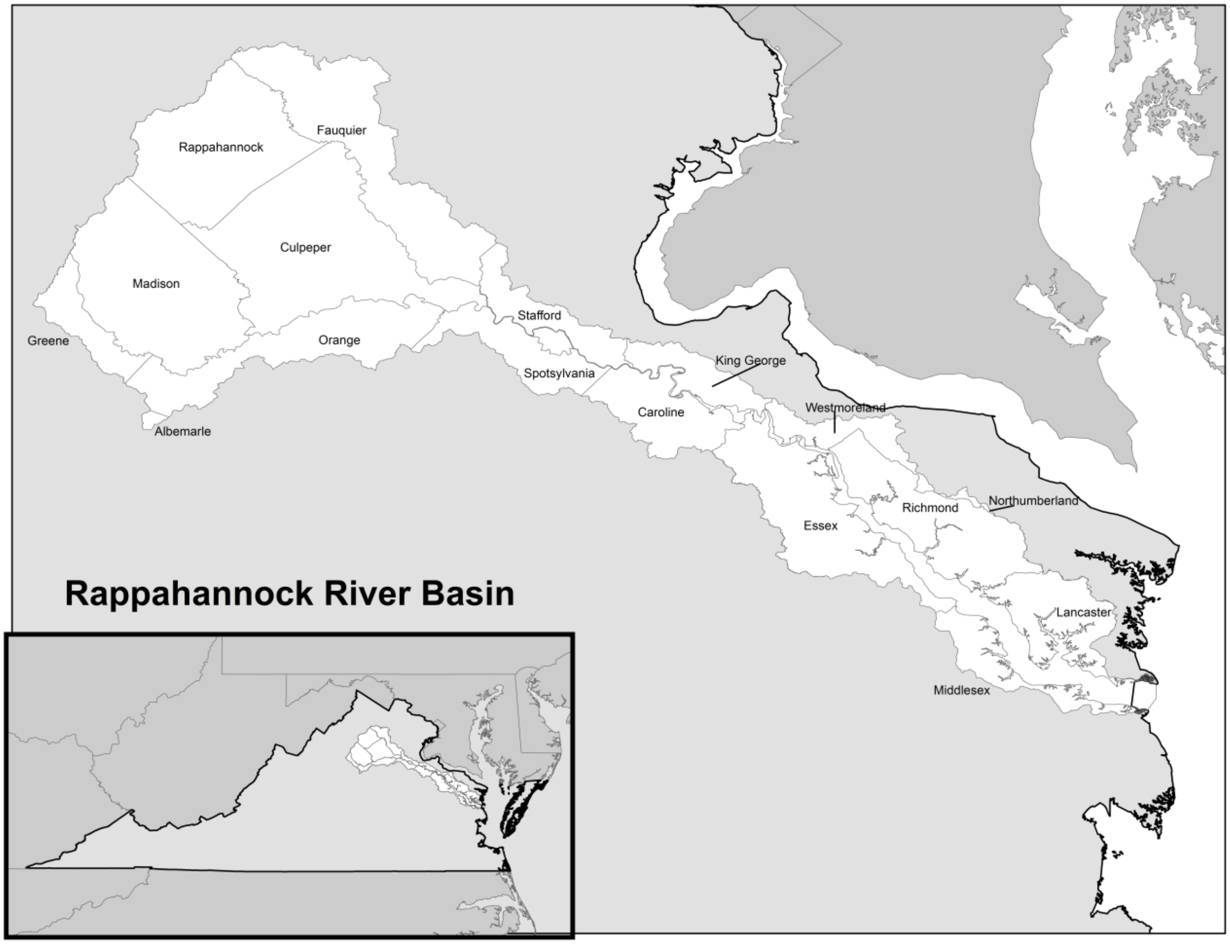
Potomac-Shenandoah River Basin Projected Water Deficits

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.

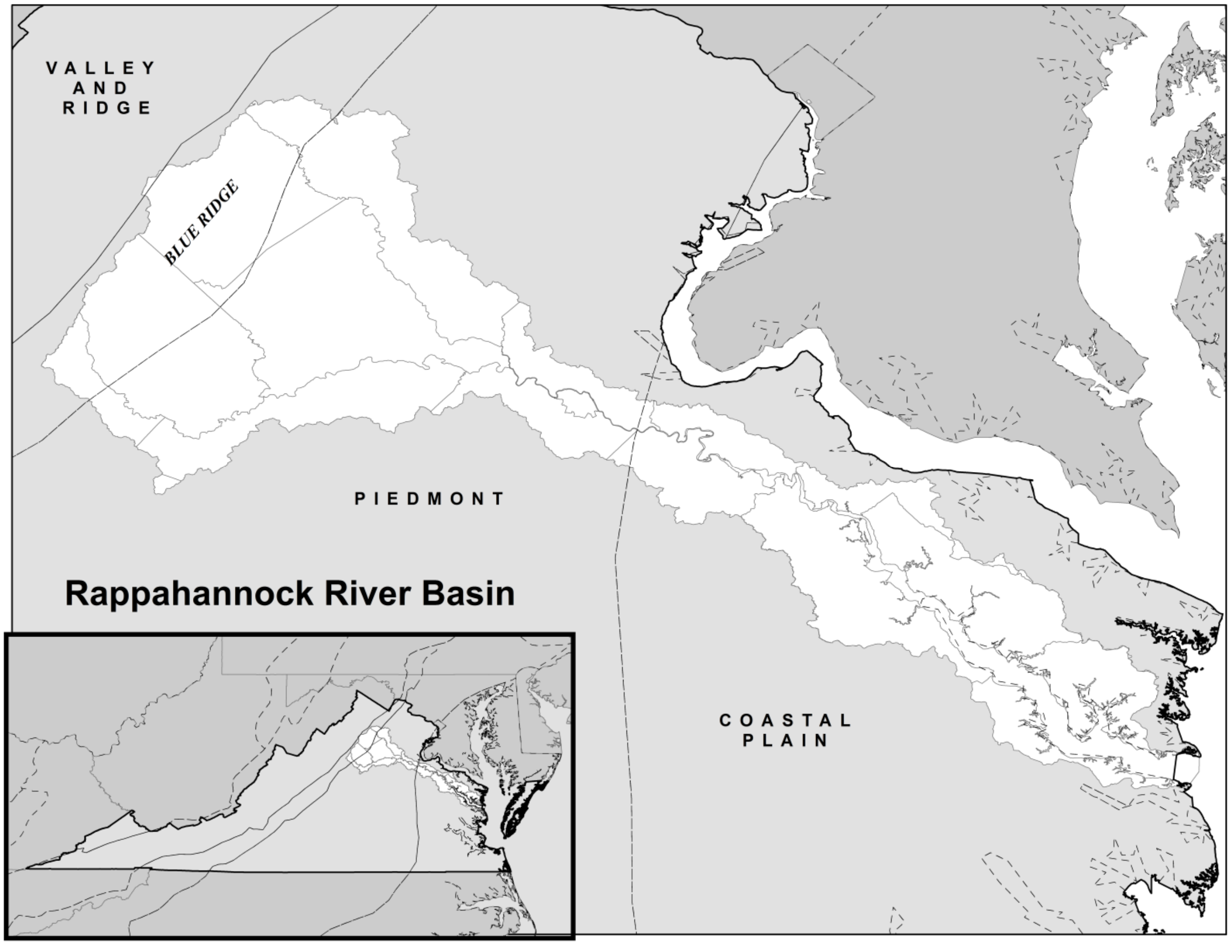
All or part of the following jurisdictions lie within the basin: the Counties of Albemarle, Caroline, Culpeper, Essex, Fauquier, Greene, King George, Lancaster, Madison, Middlesex, Northumberland, Orange, Rappahannock, Richmond, Spotsylvania, Stafford, and Westmoreland; City of Fredericksburg. These 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.



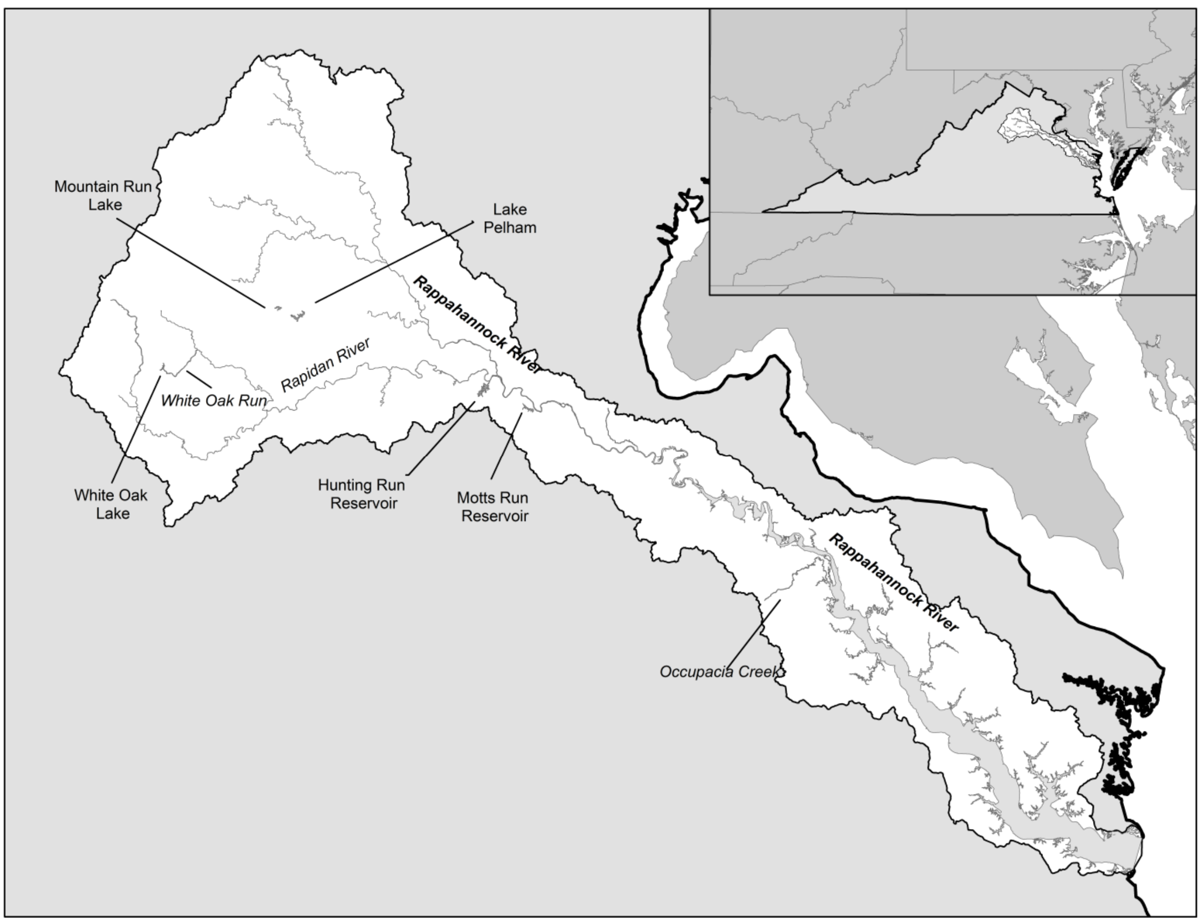
Rappahannock River Basin Physiographic Provinces

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.

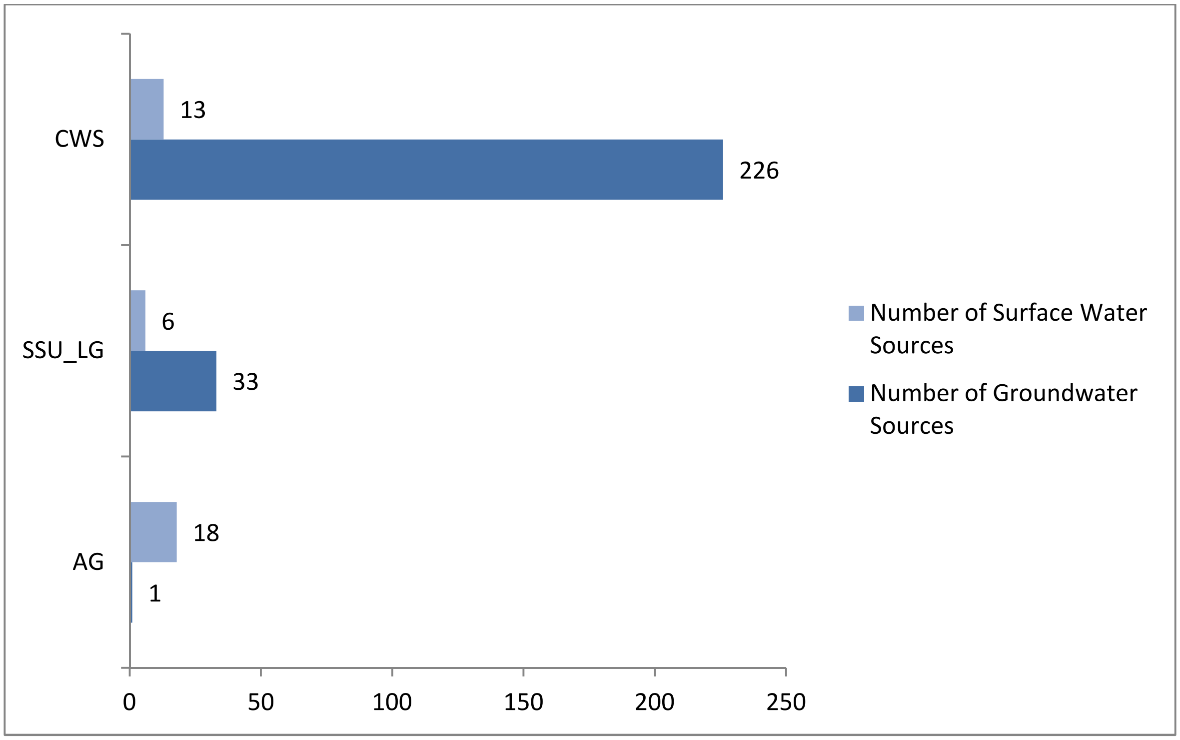
<u>Existing Water Sources</u>

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.

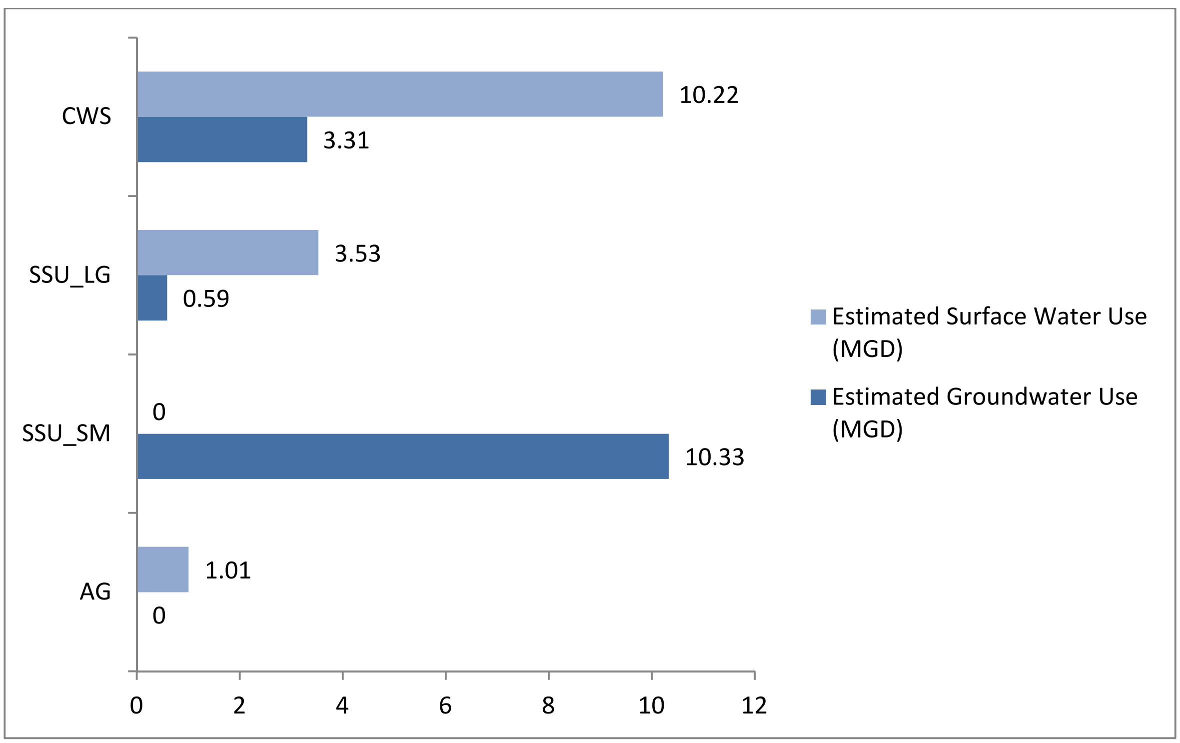
The following table lists intrabasin transfers between water providers and the municipalities to which they sell water (water purchaser).

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

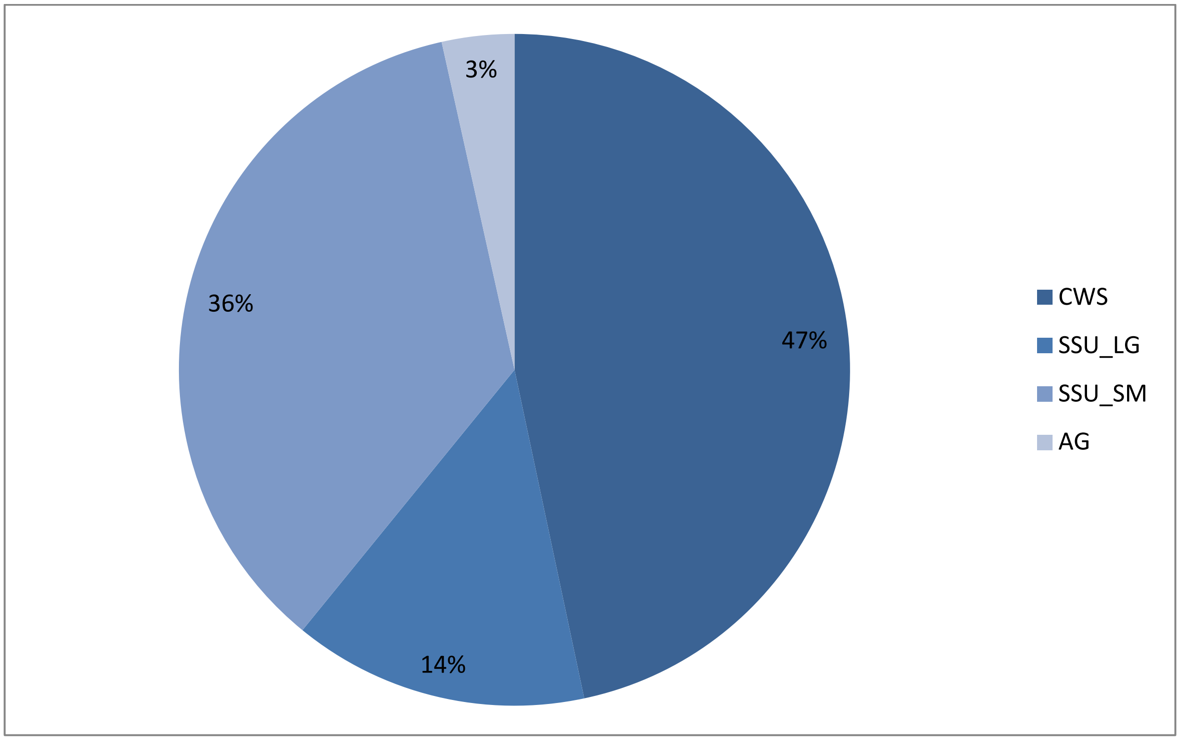
Existing Water Use

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%).

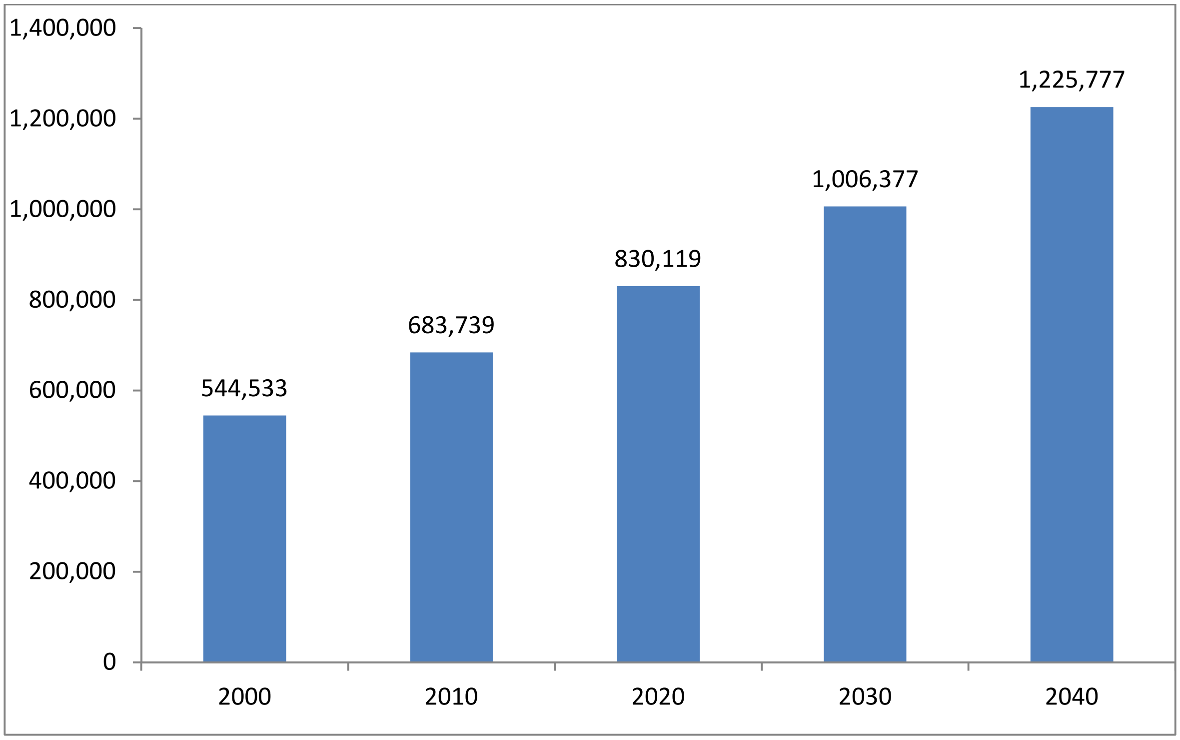


Rappahannock River Basin Percentage of 2010 Estimated Use by User Type

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.

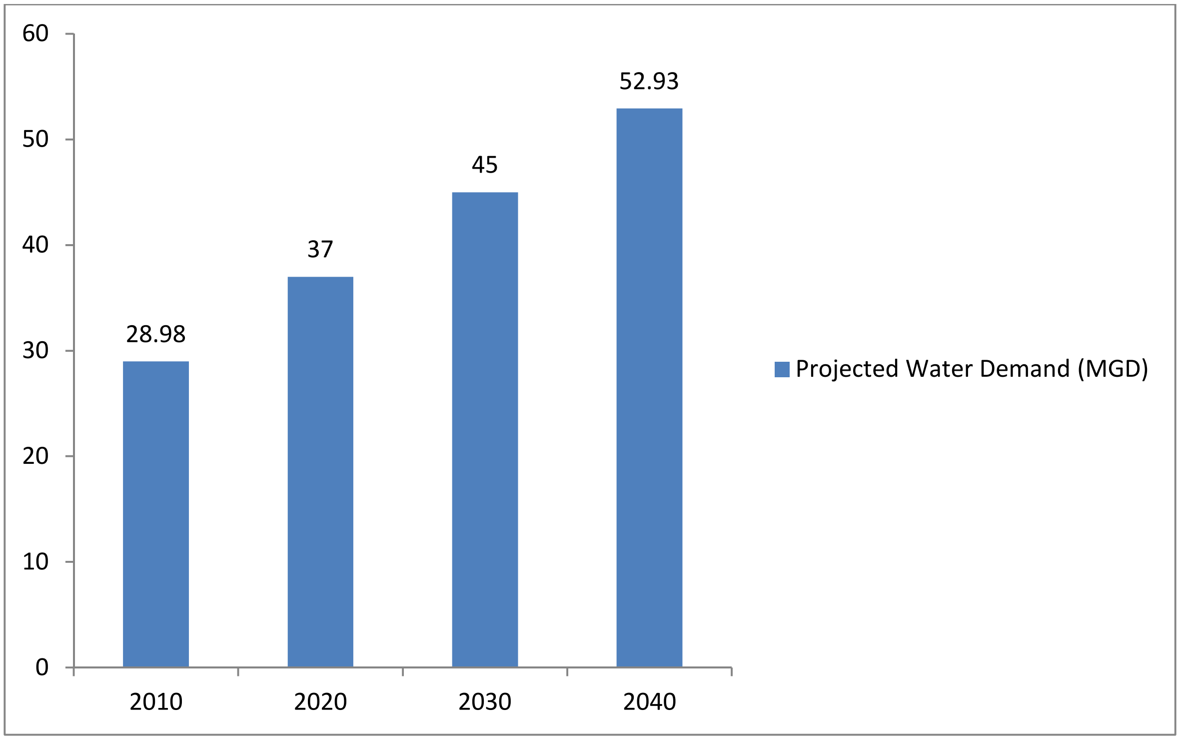
Projected Water Demand

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%.



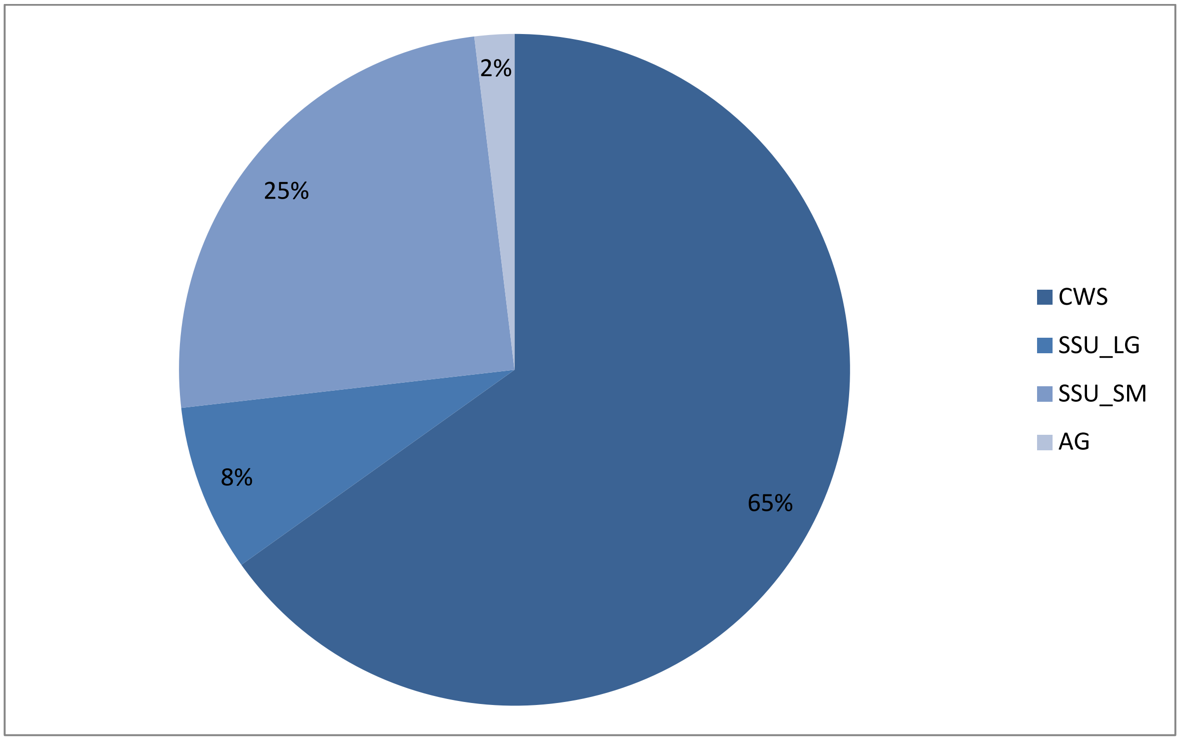
Rappahannock River Basin Projected Water Demand (MGD)

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

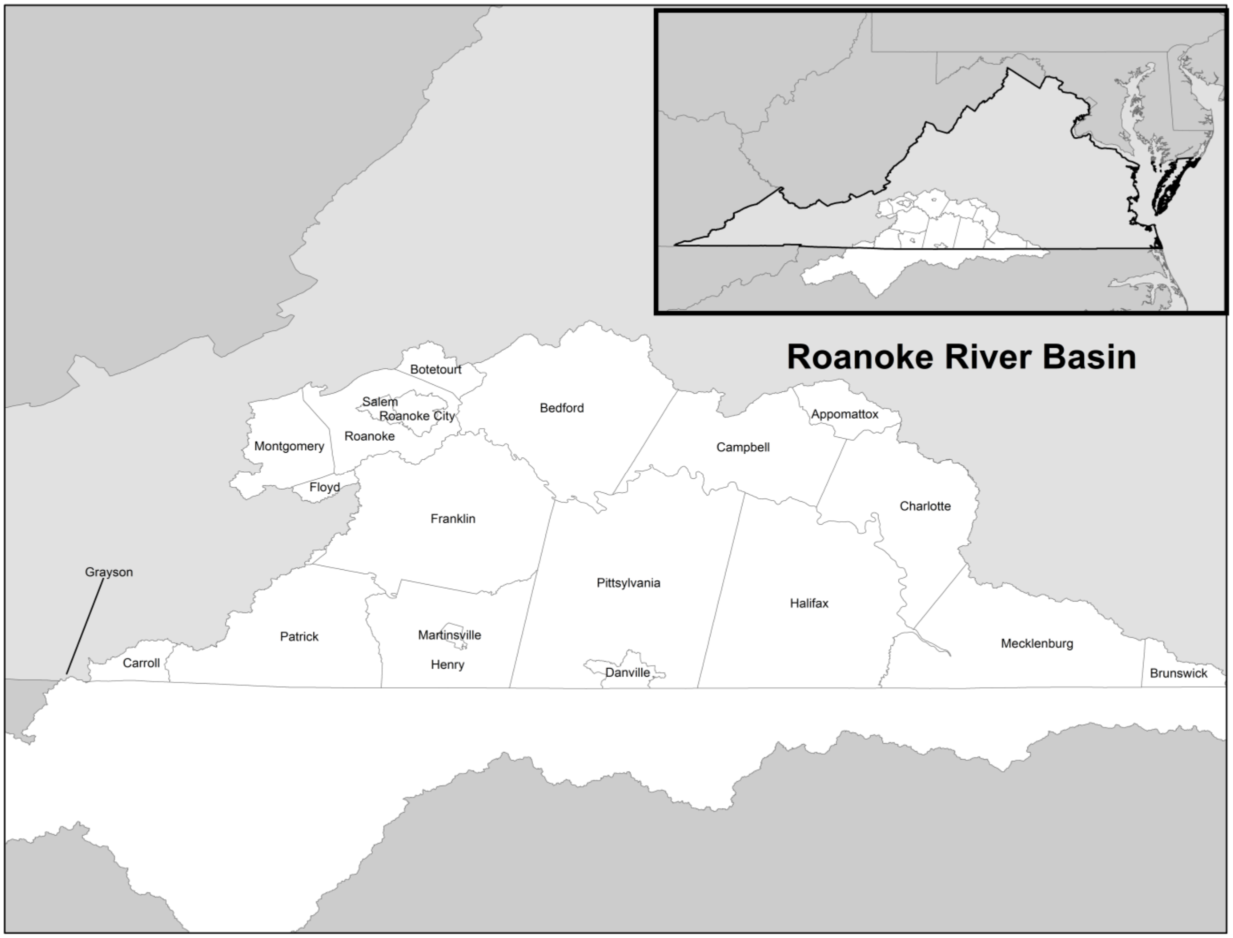
Roanoke River Basin Summary

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 Roanoke River Basin covers 6,393 square miles, or approximately 15% of the Commonwealth's total area. The basin is bordered by the James River Basin on the north, the Albemarle-Chowan River Basin to the east, and the New River Basin to the west. The southern boundary of the Basin is the Virginia/North Carolina state line. The Roanoke River headwaters begin in the Blue Ridge Mountains in eastern Montgomery County. Once through the City of Roanoke, the river generally flows east-southeast to the Virginia state line, exiting the Commonwealth near the Mecklenburg-Brunswick County line. The river travels southeast across North Carolina and enters the Albemarle Sound. In Virginia, the Roanoke River is often referred to as the Staunton River, particularly below Leesville Lake.

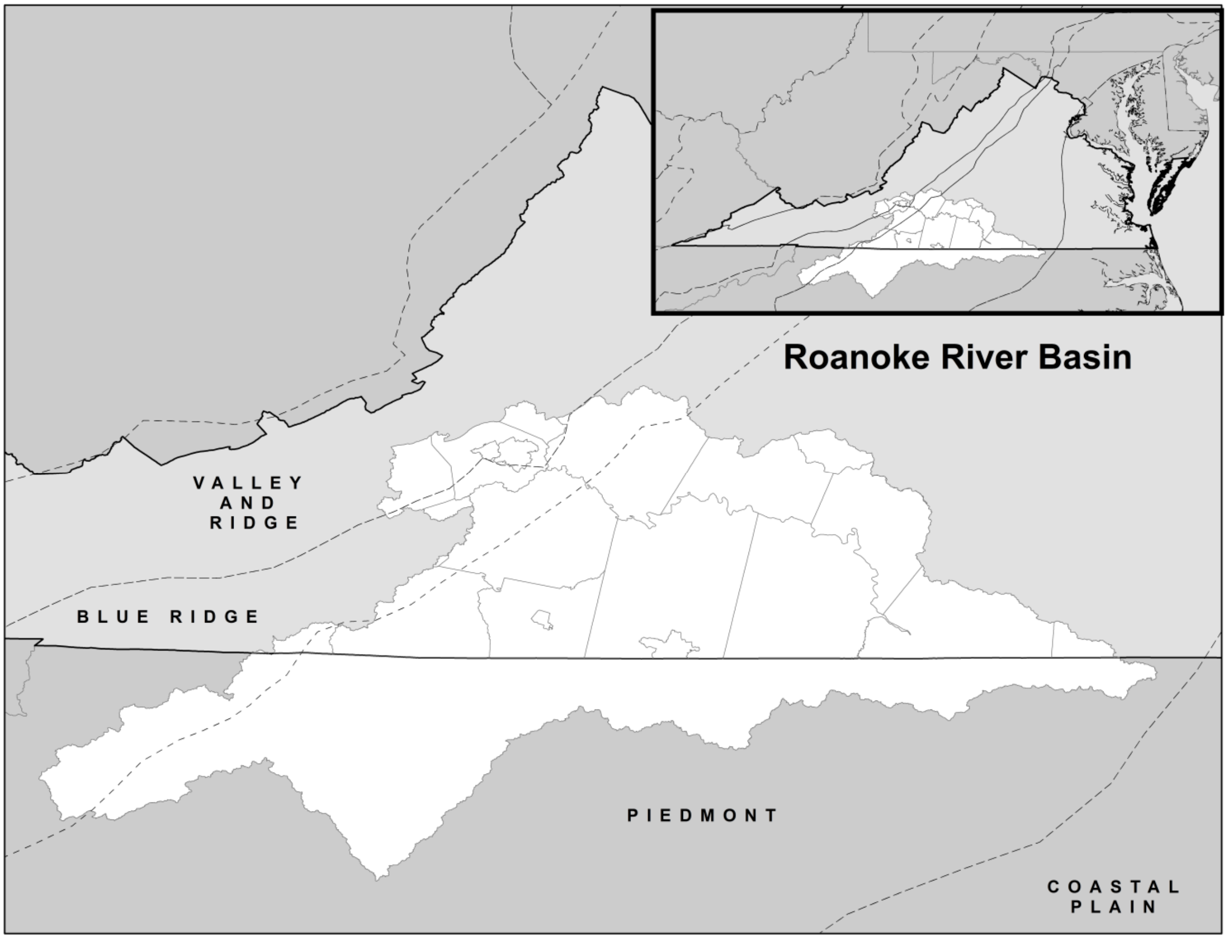
In addition to the Roanoke itself, the Basin also contains the Yadkin River sub-basin. The Yadkin River forms in North Carolina and is the northernmost part of the Pee Dee River drainage. The Pee Dee River flows south entering the Atlantic Ocean near Georgetown, South Carolina.

The following seventeen counties and four cities are entirely or partially located within the Basin: Counties of Appomattox, Bedford, Botetourt, Brunswick, Campbell, Carroll, Charlotte, Floyd, Franklin, Grayson, Halifax, Henry, Mecklenburg, Montgomery, Patrick, Pittsylvania, and Roanoke; Cities of Danville, Martinsville, Roanoke, and Salem. These jurisdictions are represented within eight regional water supply plans: Lake Country, Charlotte/Town, Halifax/Towns, Region 2000, Roanoke Valley, New River Valley, West Piedmont, and Southwest Virginia.



Roanoke River Basin Localities

Three physiographic provinces are represented in the Basin, the Valley and Ridge Province to the northwest and the Blue Ridge and Piedmont Provinces to the southeast. The topography of the Basin ranges from broad valleys and linear ridges in the Valley and Ridge Province followed by the moderate to steep slopes in the Blue Ridge and ending in the gently sloping terrain east of the mountains in the Piedmont Province.

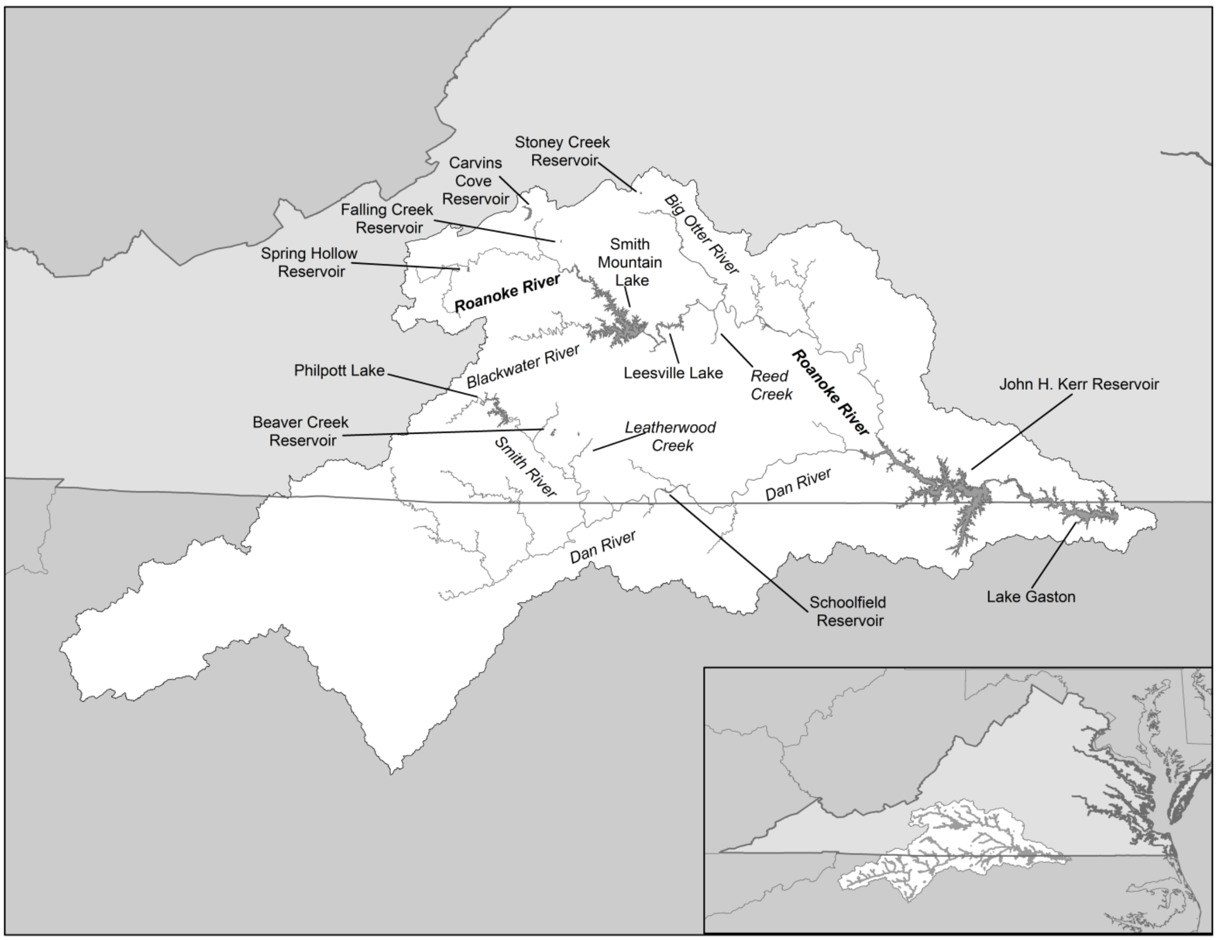


Roanoke River Basin Physiographic Provinces

Over 62% of the Roanoke River Basin is forested, while nearly 25% is in cropland and pasture. Approximately 10% is considered urban. The remainder is streams, lakes, ponds, wetlands, small barren/mixed uses, or quarries. The Roanoke River Basin is divided into seven USGS hydrologic unit codes (HUC) as follows: HUC 03010101 Upper Roanoke; HUC 03010102 Middle Roanoke; HUC 03010103 Upper Dan; HUC 03010104 Lower Dan; HUC 03010105 Banister; HUC 03010106 Roanoke Rapids and HUC 03040101 Upper Yadkin. The seven hydrologic units are further divided into 87 waterbodies or watersheds and 202 sixth order sub-watersheds.

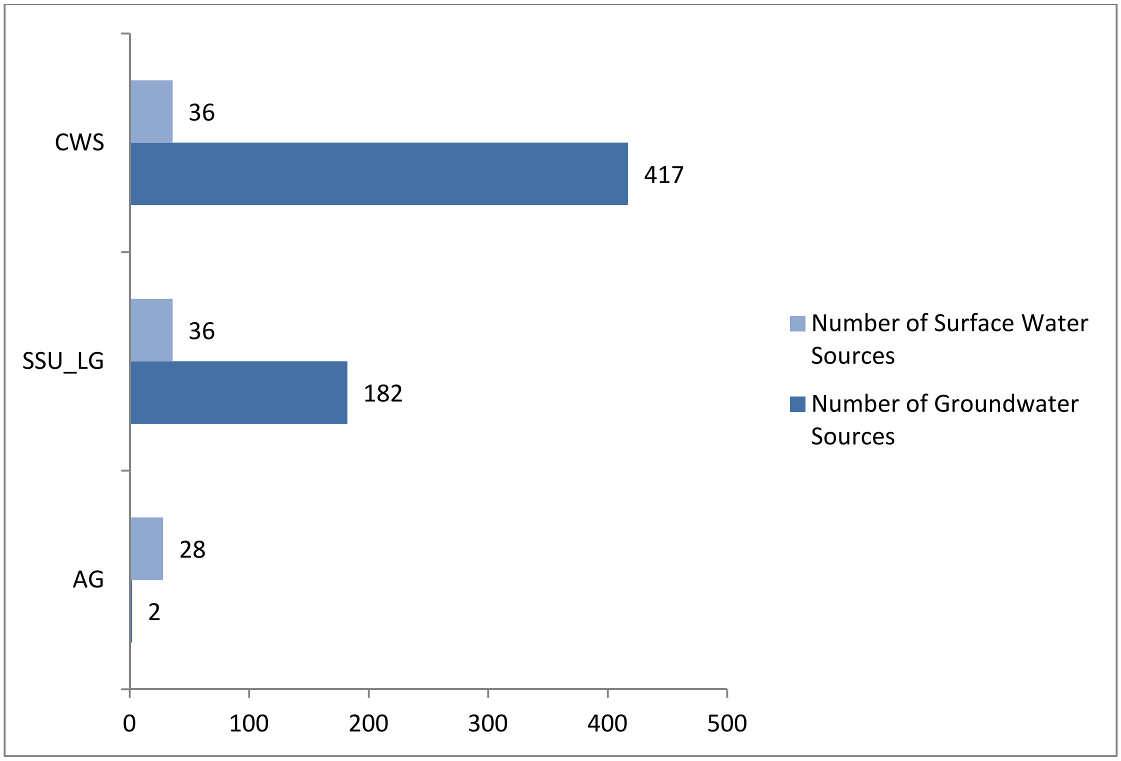
Existing Water Sources

Water sources utilized in the Basin include stream intakes, reservoirs, springs, and groundwater wells. Surface water sources (reservoirs, streams, and springs) account for 100 withdrawals; additionally there are 601 groundwater withdrawals currently identified in the Roanoke River Basin. Large source water reservoirs used include Smith Mountain Lake and Leesville Lake to the north and John H. Kerr Reservoir (known locally in Virginia as Buggs Island Lake), and Lake Gaston located along the North Carolina state line. These reservoirs range in size from the 33,300 acre Kerr Reservoir to the 2,600-acre Leesville Lake. Smaller reservoir sources used include Falling Creek Reservoir, Beaverdam Reservoir, Beaver Creek Reservoir, Carvins Cove Reservoir, Spring Hollow Reservoir, Keysville Reservoir, Georges Creek Reservoir, Stoney Creek Reservoir, Phelps Creek Reservoir, Schoolfield Reservoir, Hale Creek Reservoir, and Philpott Reservoir. Stream intakes and spring sources used in the Basin include the Dan River, Roanoke River, Big Otter River, Blackwater River, South Mayo River, Smith River; Reed Creek, Cherrystone Creek, Rutledge Creek, Sycamore Creek, Leatherwood Creek, Little Beaver Creek; Boones Mill Spring, and Crystal Springs.



Roanoke River Basin Major Reservoir and Stream Sources

Groundwater wells provide source water for most of the community water systems in the Basin. Groundwater sources outnumber surface water withdrawals in all use types except agriculture. The number of residential groundwater sources (SSU_SM) is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 345,880 people in the Basin use private groundwater wells for residential water supply.



Roanoke River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are used by two localities in the basin. The Bedford Regional Water Authority is permitted to generate and distribute up to 2.0 MGD of reclaimed water and Halifax County Service Authority is permitted to generate and distribute up to 4.0 MGD of reclaimed water. The water is currently provided to non-municipal facilities for use in cooling and boiler feed.

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.

In the Roanoke River Basin, intrabasin transfers primarily exist between municipal CWS. The following lists the reported intrabasin transfers between water providers and the entities to which they sell water (water purchaser).

User Type	Water Purchaser and System(s)	Water Provider
CWS	Botetourt County: Cloverdale/Vista Park	Town of Troutville
CWS	Bedford County RWA: Stewartsville Consecutive	Western Virginia Water Authority
CWS	Town of Boydton	Roanoke River Service Authority
CWS	Franklin County: Forest Hills	Blackwater River (Town of Rocky Mount)
CWS	Henry County PSA: Edgewood Village, Woodland Avenue	City of Martinsville
CWS	Henry County PSA: Sandy Level	City of Eden, North Carolina
CWS	Town of Hurt	Town of Altavista
CWS	Town of La Crosse	Roanoke River Service Authority
CWS	Pittsylvania County SA: Greenwood Drive, Route 58 West	Henry County PSA
CWS	Pittsylvania County SA: Grit	Town of Hurt
CWS	Pittsylvania County SA: Mount Cross Road, Mount Hermon, Ringgold Industrial Park, Route 29 North, Route 360	City of Danville
CWS	Pittsylvania County SA: Route 40 West Gretna Road	Town of Gretna
CWS	Pittsylvania County SA: Tightsqueeze	Town of Chatham
CWS	Western Virginia Water Authority: Andrew Lewis Place	City of Salem
SSU_LG	Goodyear-Danville Plant	City of Danville

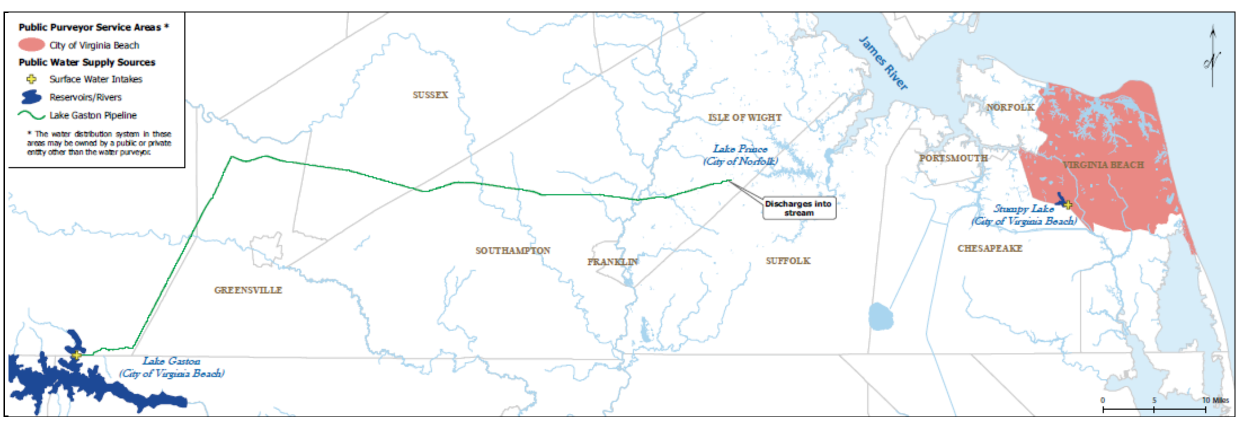
Roanoke River Basin Intrabasin Transfers

Interbasin transfers exist in the Roanoke River Basin with Roanoke water being sold to supply CWS and SSU_LG in other basins.

User Type	Water Purchaser and System(s)	Water Provider
CWS	City of Virginia Beach	U. S. Army Corps of Engineers
CWS	City of Chesapeake - Northwest River System	City of Norfolk
CWS	US Navy-Dam Neck	City of Norfolk
CWS	US Navy-Oceana	City of Norfolk
CWS	Town of South Hill	Roanoke River Service Authority
CWS	Town of Brodnax	Roanoke River Service Authority
SSU_LG	Georgia Pacific Skippers Plant	Roanoke Rapids Sanitary District
SSU_LG	Interstate 95 Rest Area located in Greensville County	Roanoke Rapids Sanitary District

Roanoke River Basin Interbasin Transfers

Since 1998, the City of Virginia Beach has pumped fresh water from an intake on Lake Gaston in Brunswick County to Lake Prince located in Isle of Wight County's portion of the James River Basin. Lake Prince is owned by the City of Norfolk and Lake Gaston is owned by the U.S. Army Corps of Engineers (USACE). Water is purchased by Virginia Beach from the USACE.

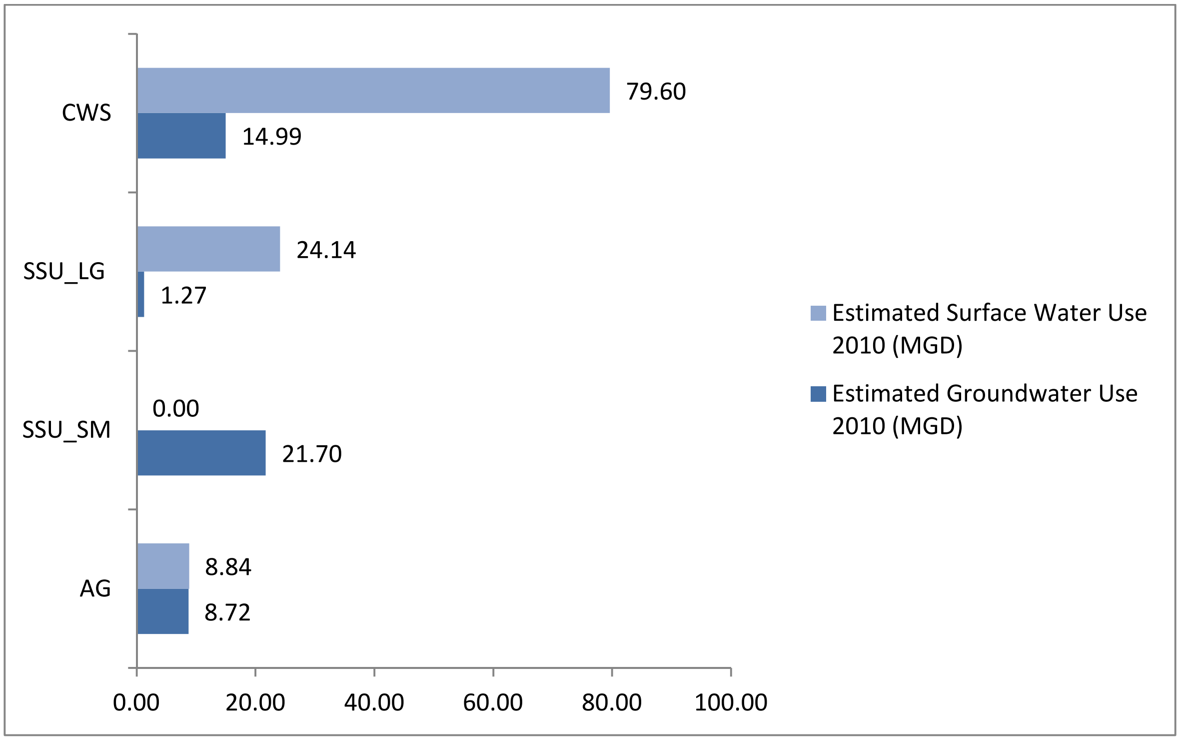


City of Virginia Beach Sources and Service Area[68]

[68] Hampton Roads Planning District Commission: Hampton Roads Regional Water Supply Plan

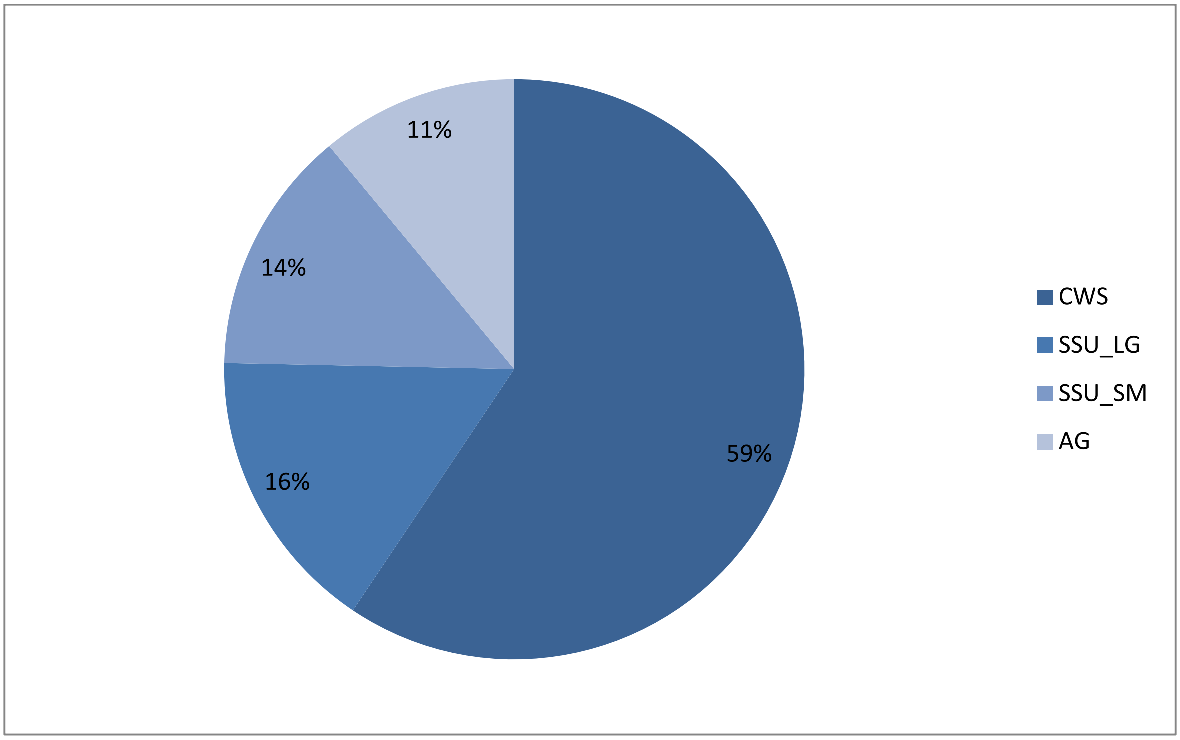
Existing Water Use

The total estimated water use provided in the regional water supply plans is summarized in the figure below. The total estimated water use is approximately 159 MGD, with 112 MGD of surface water use and 47 MGD of groundwater use. Although the number of groundwater withdrawals far exceeds the number of surface water withdrawals in the Roanoke River Basin, the estimated amount of use from surface water exceeds that from groundwater.



Roanoke River Basin Estimated Use by Source and Type

CWS use an estimated 59% of the total water in the Basin followed by SSU_LG (16%), SSU_SM (14%) and AG (11%).

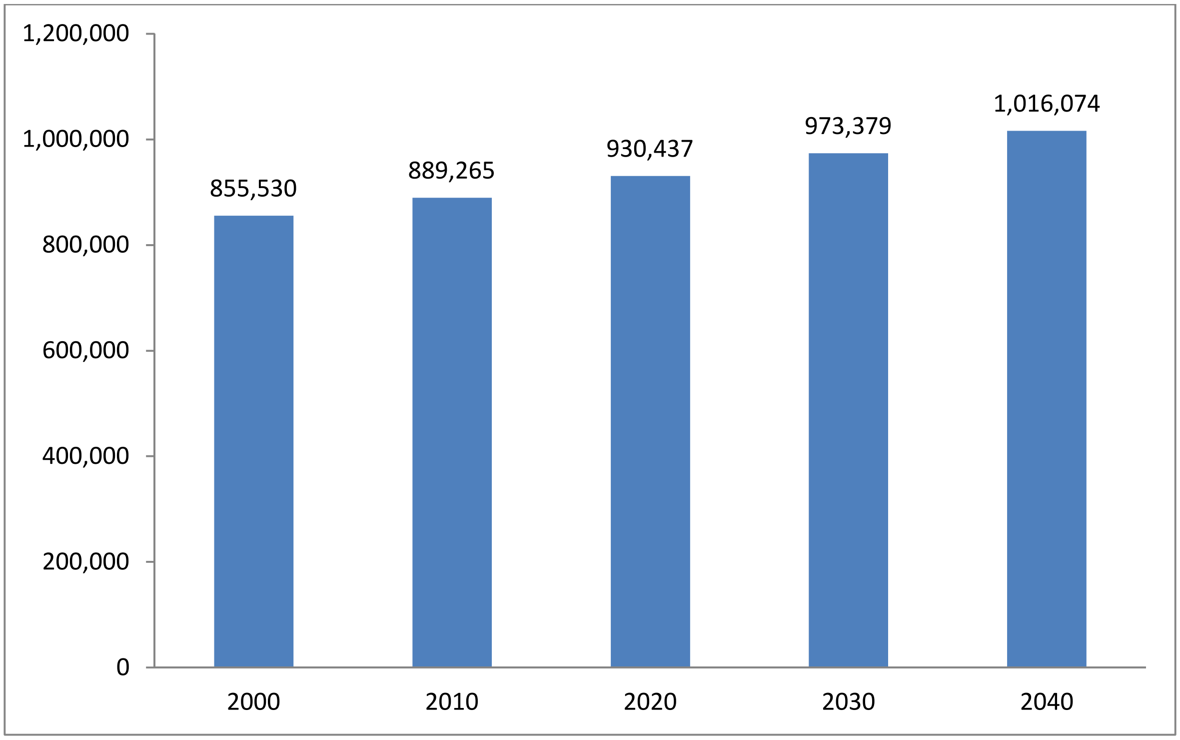


Roanoke River Basin Percentage of 2010 Estimated Use by User Type

CWS reported their water use disaggregated into categories of use appropriate for the system. Categories commonly used included Residential, Commercial, Institutional, and 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 CWS did not report disaggregated use as required. No assumption on 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.

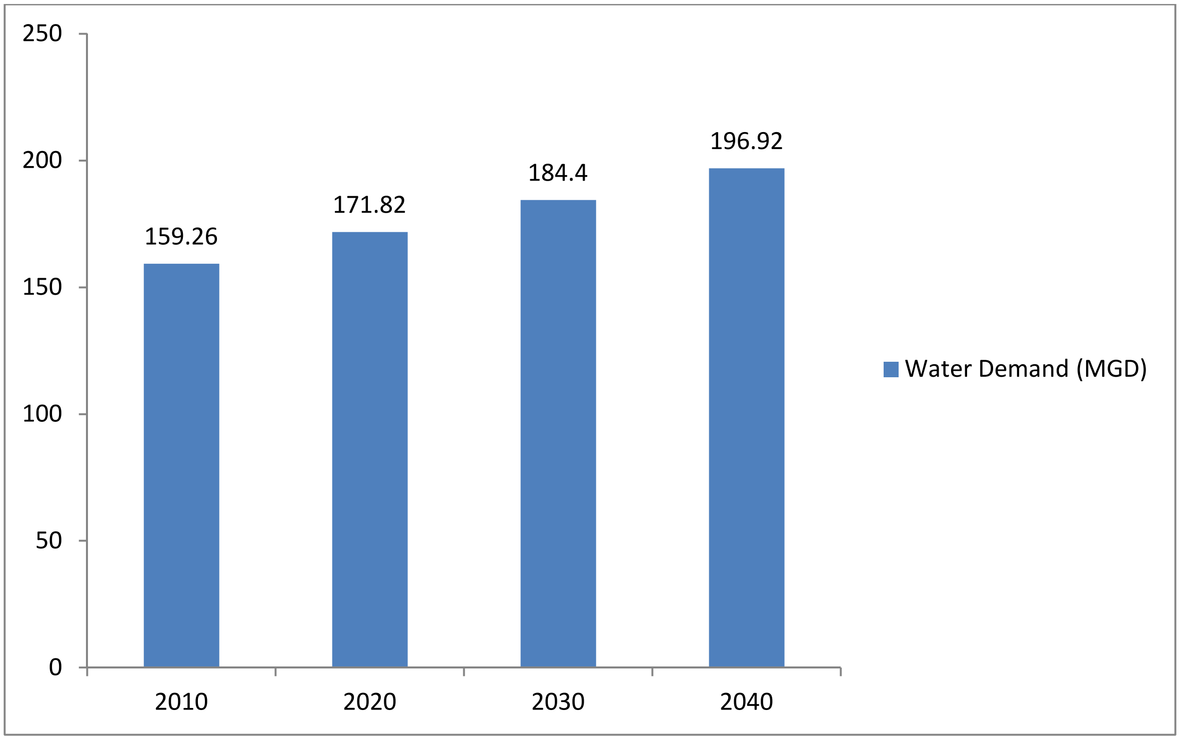
Projected Water Demand

The projected population of the localities with at least a portion of their area in the Roanoke River Basin is displayed in the figure below. Population data is obtained from the Virginia Employment Commission's population estimates which rely on data produced by the United States Census Bureau. The overall population is projected to increase through the year 2040. By the year 2040 the estimated basin-wide population is projected at 1,016,074. The percent change in population from the years 2000 through 2040 is estimated at 14.3%.



Roanoke River Basin Projected Population

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 Roanoke River Basin, as reported in the regional water supply plans, is estimated to increase from approximately 159 MGD in 2010 to 197 MGD in 2040. The percent change in water use during the 30-year timeframe is estimated at 23.5%.



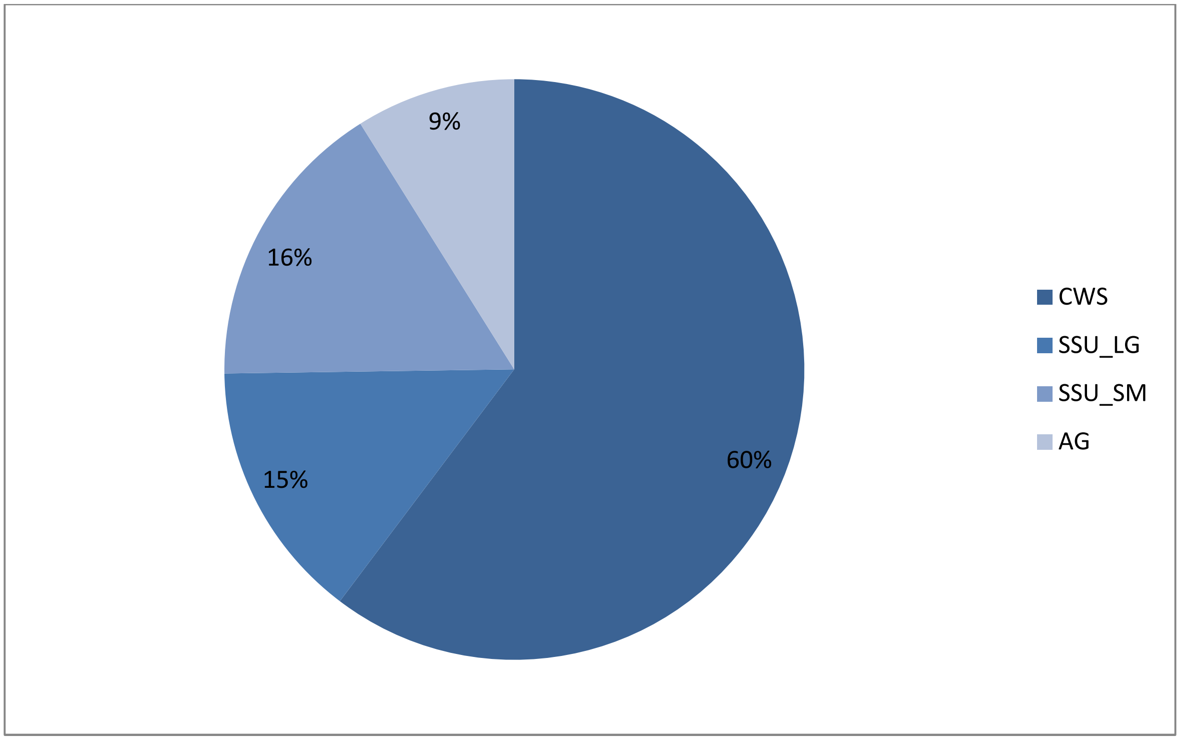
Roanoke River Basin Projected Water Demand

As depicted in the table below, SSU_SM show the largest percent change (47.9%) in water demand over the 30 year period. From this data, it appears the majority of population growth in the Basin may occur outside the CWS service areas. Projected water demand for CWS has the next highest percentage growth (25.3%) followed by SSU_LG (12.3%). The AG use in the Roanoke River Basin remains unchanged over the planning period as detailed in the regional water supply plans. The steady state of AG use is a best guess on the part of the planning entities, as the withdrawal data is limited and water use on an annual basis, in particular for crop irrigation, may change depending on precipitation.

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	94.58	102.63	110.7	118.72	25.3%
SSU_LG	25.41	26.46	27.5	28.55	12.3%
SSU_SM	21.70	25.17	28.6	32.10	47.9%
AG	17.56	17.56	17.56	17.56	-0.0%

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

The percentage by user type of total projected 2040 demand is shown in the following figure. In 2040 CWS demand is estimated at 60% of the total demand in the Roanoke River Basin followed by SSU_SM (16%), SSU_LG (15%), and AG (9%).



Roanoke 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 eight regional water supply plans represented in the Roanoke River Basin. The information is presented for all those localities with at least a portion of land area located within the Basin. The following lists the projected deficits in the Basin.

Charlotte County Regional Water Supply Plan

Charlotte County the Towns of Charlotte Court House, Drakes Branch, Keysville, and Phenix

The regional plan provided 'upper level' and 'lower level' population and water demand projections. Using the upper level demand projections for community water systems found in the water supply plan, future deficits in water supply are anticipated in the four towns as follows:

- Town of Drakes Branch: deficit of 0.153 MGD by 2020
- Town of Phenix: deficit of 0.0002 MGD by 2010
- Town of Charlotte Court House: deficit of 0.008 MGD by 2020

- Town of Keysville: deficit of 0.207 MGD by 2050

Several alternatives are recommended for meeting this additional demand in the future: clarification of the safe yield for Keysville Reservoir; development of additional groundwater supply in the towns of Drakes Branch, Charlotte Court House, and Phenix; development of a water treatment plan at the Drakes Branch Lake; and system interconnection of Charlotte Court House with either Drakes Branch or Keysville, and system interconnection of Drakes Branch with Keysville.

Halifax County Regional Water Supply Plan

Halifax County and the Towns of Halifax, South Boston, Scottsburg, and Virgilina

The Halifax County Service Authority CWS anticipates reaching 80% of its VDH permitted capacity (2.4 MGD) for a three-month period at the Leigh Street Water Treatment Plant on the Dan River around 2035. A deficit of 0.035 MGD may occur by the year 2050 based on the VDH permitted capacity. The Halifax County Service Authority plans to address the 2035 capacity issue by requesting an increase in the permitted withdrawal amount on the Dan River.

Lake Country Regional Water Supply Plan

Brunswick County and the Towns of Alberta, Brodnax, and Lawrenceville; Mecklenburg County and the Towns of Boydton, Chase City, Clarksville, La Crosse, and South Hill

Total population for the planning area is projected to increase only slightly during the planning period. Regional water supply is plentiful, and it is estimated that there are adequate water sources to provide for the needs of the planning area now and in the foreseeable future; however, competition for water from fast growing metropolitan areas in neighboring North Carolina and Tidewater Virginia was cited in the plan as a potential threat to water quantity.

New River Valley Regional Water Supply Plan

Floyd County and Montgomery County

As a region, there is generally no deficit during the planning period. Some systems are already exploring options to increase system capacity. Alternatives considered include the installation of pressure reducing valves and the interconnection of systems with the City of Radford across the planning area. Floyd County desires to increase educational efforts and develop additional well(s). Montgomery County mentions joining the Blacksburg-Christiansburg-VPI Water Authority as a possible alternative in the future.

Region 2000 Regional Water Supply Plan

Appomattox County and the Towns of Appomattox and Pamplin City; Campbell County and the Towns of Altavista and Brookneal; Bedford County and the Town of Bedford (Bedford County participated in two regional water supply plans, Region 2000 and the Roanoke Valley-Alleghany Regional Commission).

As stated in the plan, in a planning area as diverse as Region 2000, the ability to meet water demands may vary from one municipality to another. This may be due to population centers or system limitations. Because of these complexities, water supply is adequate for a portion of the planning area through the planning period of 2060. However, deficits are anticipated in the following community water system supplies.

- Bedford Regional Water Authority: deficit of 0.004 MGD by 2015, based on the VDH permitted capacity of 0.79 MGD plus the 1.4 MGD purchase from the City of Lynchburg.
- Campbell County Utility and Service Authority: deficit of 0.03 MGD by 2057, based on the VDH permitted capacity of 4.4 MGD, if future water sales are factored into the projections.
- Town of Altavista: deficit of 0.003 MGD by 2052, based on the VDH permitted capacity of 3.0 MGD.
- Town of Appomattox: deficit of 0.0004 MGD by 2051, based on the VDH permitted capacity of 0.33 MGD.

Alternatives described for Bedford County include the Lakes Regional Water Treatment Plant on Smith Mountain Lake and increased purchase from the City of Lynchburg. Campbell County and Town of Altavista alternatives listed in the regional plan include storage at Boxley Rock Quarry with a pump-over to Harvey Branch, a Campbell County Utility and Service Authority-Altavista intake on the Roanoke River and water purchase agreements with Lynchburg City or Bedford County. The Town of Appomattox is considering development of new groundwater wells or an intake on the James River as future alternatives. In addition to the alternatives listed above, the region considers the following as water supply alternatives: additional groundwater sources, reservoirs, intakes, inter-connections, reuse and recycling, and demand management.

Roanoke Valley-Alleghany Regional Commission Water Supply Plan

Bedford County and the Town of Bedford (Bedford County participated in two regional water supply plans, Roanoke Valley-Alleghany Regional Commission and Region 2000); Botetourt County and the Towns of Buchanan, Fincastle, Rocky Mount, and Troutville; Franklin County and the Towns of Boones Mill and Rocky Mount; Roanoke County; Cities of Roanoke and Salem; Town of Vinton

Current water sources are adequate to meet current and projected demand except for those supplying the following localities:

- Bedford County: deficit of 0.004 MGD by 2015
- Botetourt County: deficit of 0.09 MGD by 2020
- Franklin County: deficit of 0.03 MGD by 2020
- City of Salem: deficit of 0.11 MGD by 2046
- Town of Boones Mill: deficit of 0.002 MGD by 2018
- Town of Troutville: deficit of 0.009 MGD by 2027

Two water supply alternatives are listed as the most economical for the region: the expansion of the Smith Mountain Lake Regional Water Treatment Plan in Bedford County and a new intake on Smith Mountain Lake to supplement Western Virginia Water Authority's (WVWA) Carvins Cove reservoir system. Development of new groundwater sources is also mentioned by some of the localities with predicted water supply deficits.

Southwest Virginia Regional Water Supply Plan

Carroll County and the Town of Hillsville; Grayson County and the Towns of Fries, Independence, and Troutdale

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

West Piedmont Planning District Commission Regional Water Supply Plan

Henry County and the Town of Ridgeway; Patrick County and the Town of Stuart; Pittsylvania County and the Towns of Chatham, Gretna, and Hurt; Cities of Danville and Martinsville

Regional water supply is adequate to provide for the needs of the planning area through the planning period of 2060 except for Henry County and the Town of Gretna, as follows:

- Henry County: deficit of 0.01 MGD by 2049 based on the VDH permitted capacity
- Town of Gretna: demands may exceed reservoir safe yield by 2020

To address the deficit, Henry County Public Service Authority submitted a VWP permit application for an increased withdrawal from the Upper Smith River, under review by DEQ at the development of the plan. The Town of Gretna will likely pursue a new raw water intake on Whitethorn Creek and a pipeline to Georges Creek Reservoir.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Town of Drakes Branch	2020	0.153
Town of Phenix	2010	0.0002
Town of Charlotte Court House	2020	0.008
Town of Keysville	2050	0.207
Halifax County	2050	0.035
Bedford County	2015	0.004
Campbell County	2057	0.03
Town of Altavista	2052	0.003
Town of Appomattox	2051	0.0004
Henry County	2049	0.01
Town of Gretna	2020	Demands may exceed reservoir safe yield
Botetourt County	2020	0.09
Franklin County	2020	0.03
City of Salem	0.11	2046
Town of Boones Mill	2018	0.002
Town of Troutville	2027	0.009

Roanoke River Basin Projected Water Deficits

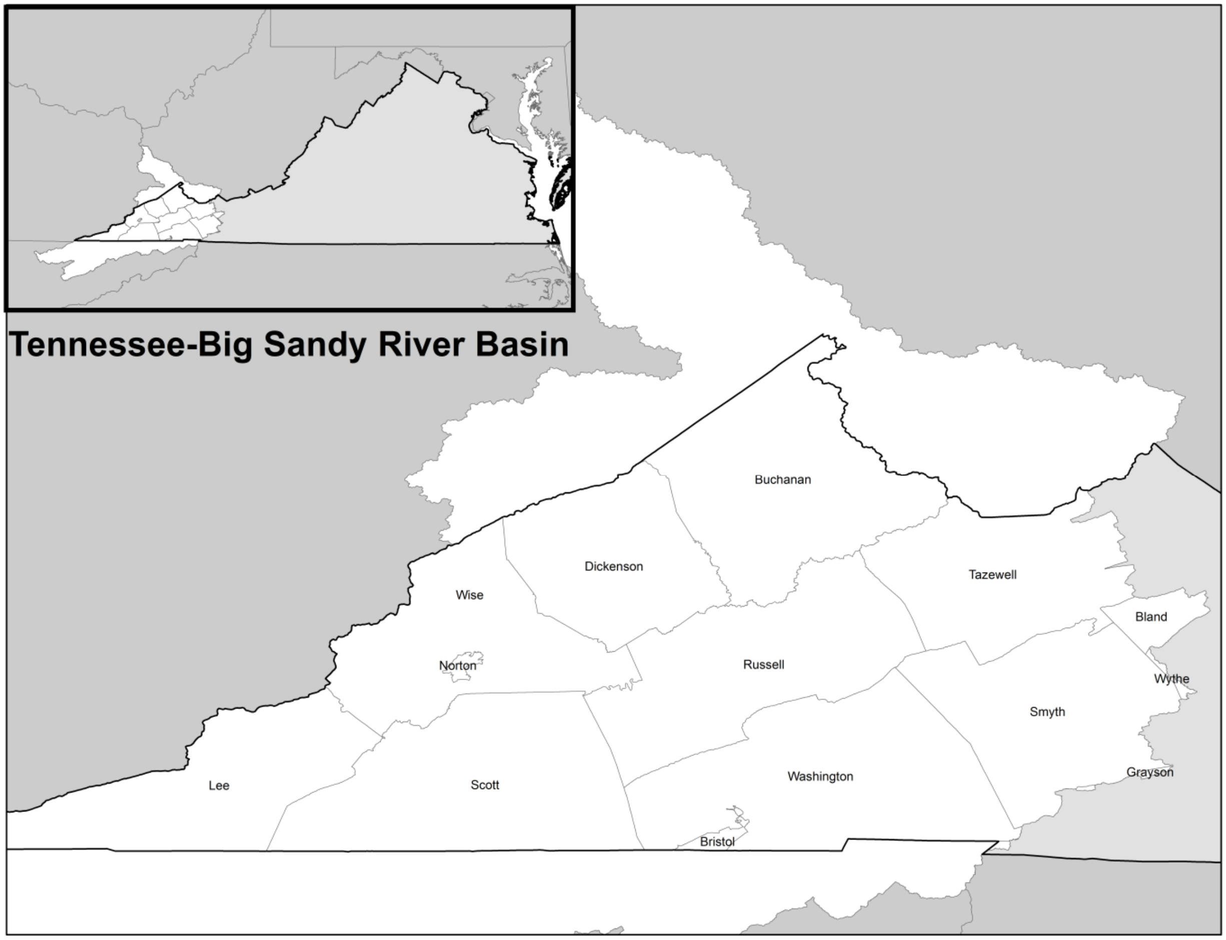
Tennessee-Big Sandy River Basin Summary

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 Virginia portion of the Tennessee-Big Sandy River Basin is comprised of the Holston, Clinch-Powell, and Big Sandy sub-basins. These sub-basins are located in the extreme southwest portion of Virginia and cover 4,132 square miles, or approximately 10% of the Commonwealth's land area. The Basin is bordered by the West Virginia state line to the north, Kentucky to the west, and Tennessee to the south. The New River Basin makes up the eastern boundary.

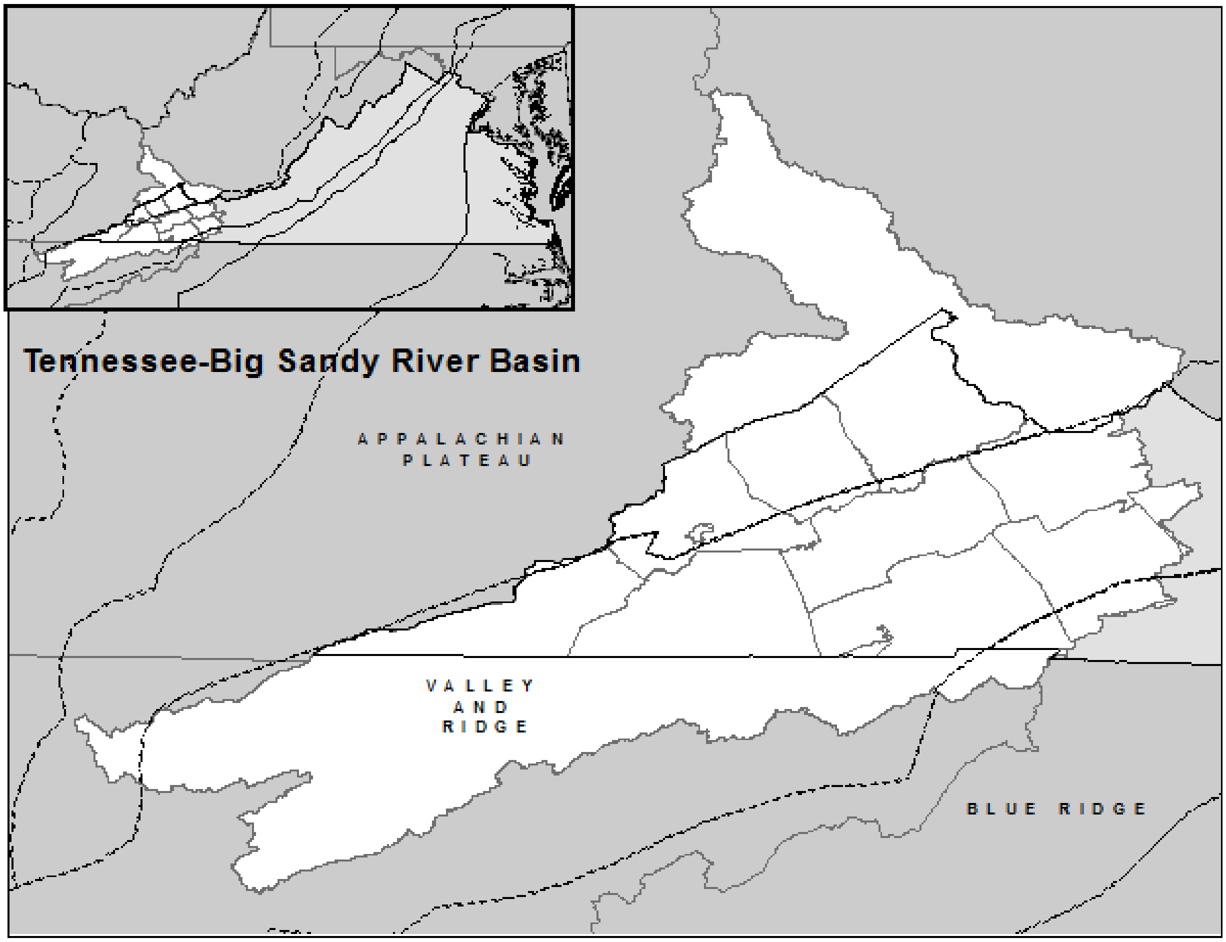
While numerous southwestern Virginia streams feed the Tennessee and Big Sandy Rivers, neither river has headwaters within the Commonwealth itself. In Virginia, the Russell, Levisa, and Tug Forks flow northward into Kentucky and combine to form the Big Sandy River. The Holston (North, Middle, and South Forks), Clinch, and Powell Rivers flow southwestward through Virginia and merge in Tennessee to form the Tennessee River. The Big Sandy and Tennessee Rivers eventually empty into the Gulf of Mexico via the Ohio and Mississippi Rivers.

The entire Virginia portion of the Tennessee-Big Sandy River Basin is contained within one water supply plan, the Southwest Virginia Regional Water Supply Plan. The following 12 counties and two cities are entirely or partially located within the Basin: Counties of Bland, Buchanan, Dickenson, Grayson, Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe; Cities of Bristol and Norton.



Tennessee-Big Sandy River Basin Localities

Three physiographic provinces are included in the Basin: the Appalachian Plateau, Valley and Ridge, and the Blue Ridge. The Big Sandy portion of the Basin lies within the Appalachian Plateau. This province is characterized as rugged, with mountainous terrain and steep valleys. Parallel valleys and ridges running in a northeast to southwest direction characterize the Tennessee portion, lying in the Valley and Ridge Province. A small portion of the Basin, located in the Blue Ridge Province, is more like a plateau with no single, prominent ridge that characterizes the province to the southeast.

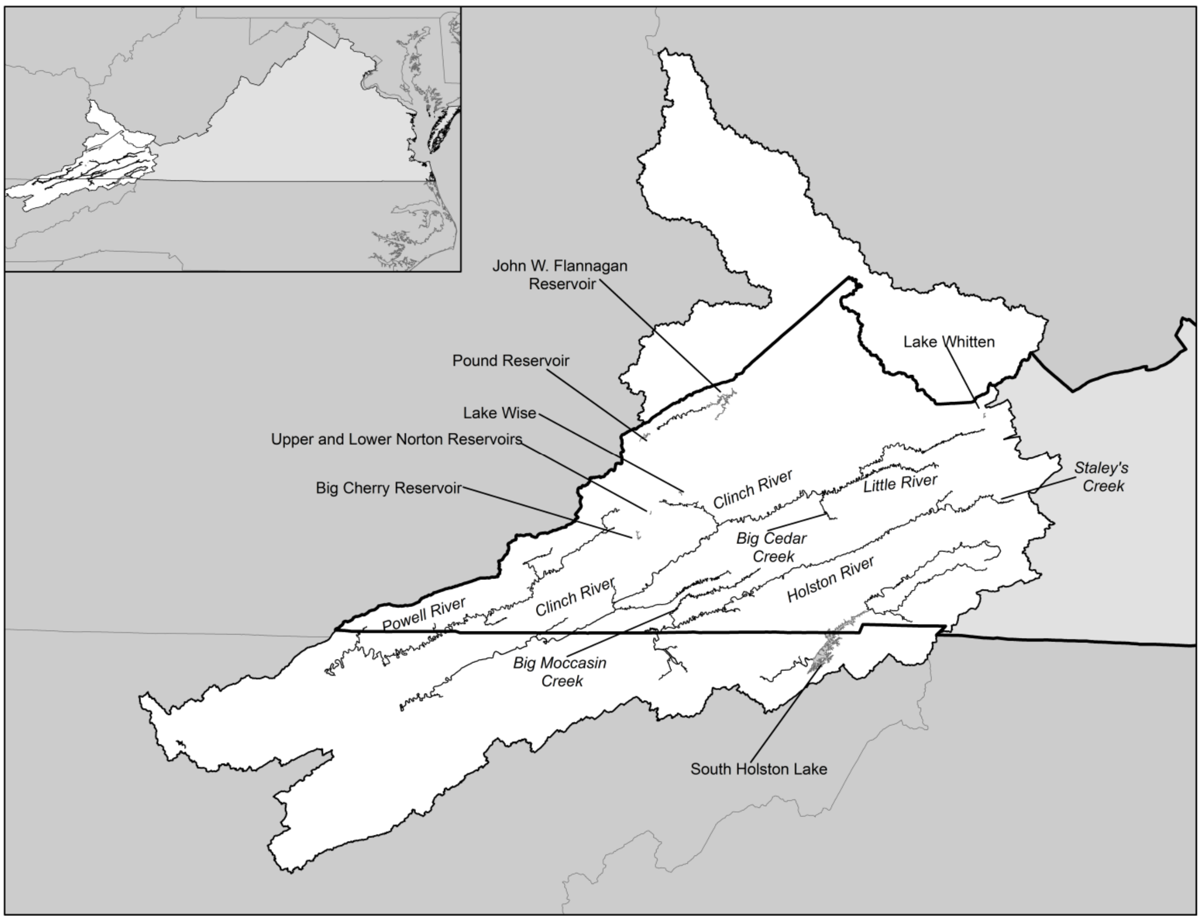


Tennessee-Big Sandy River Basin Physiographic Provinces

Within Virginia, approximately 48% of the Tennessee River sub-basin is forested, while cropland and pasture make up another 39.7%. The Big Sandy portion of the Basin is approximately 86% forest, with only about 5% in cropland and pasture. Urban areas make up only a small percentage of the total land area of the combined Tennessee-Big Sandy Basin. The Basin is divided into six USGS hydrologic units: HUC 05070201 Tug Fork; HUC 05070202 Upper Levisa; HUC 06010101 North Fork Holston; HUC 06010102 South and Middle Fork Holston; HUC 06010205 Upper Clinch; and HUC 06010206 Powell River. The six hydrologic units are further divided into 56 waterbodies or watersheds and 135 6th order sub-watersheds.

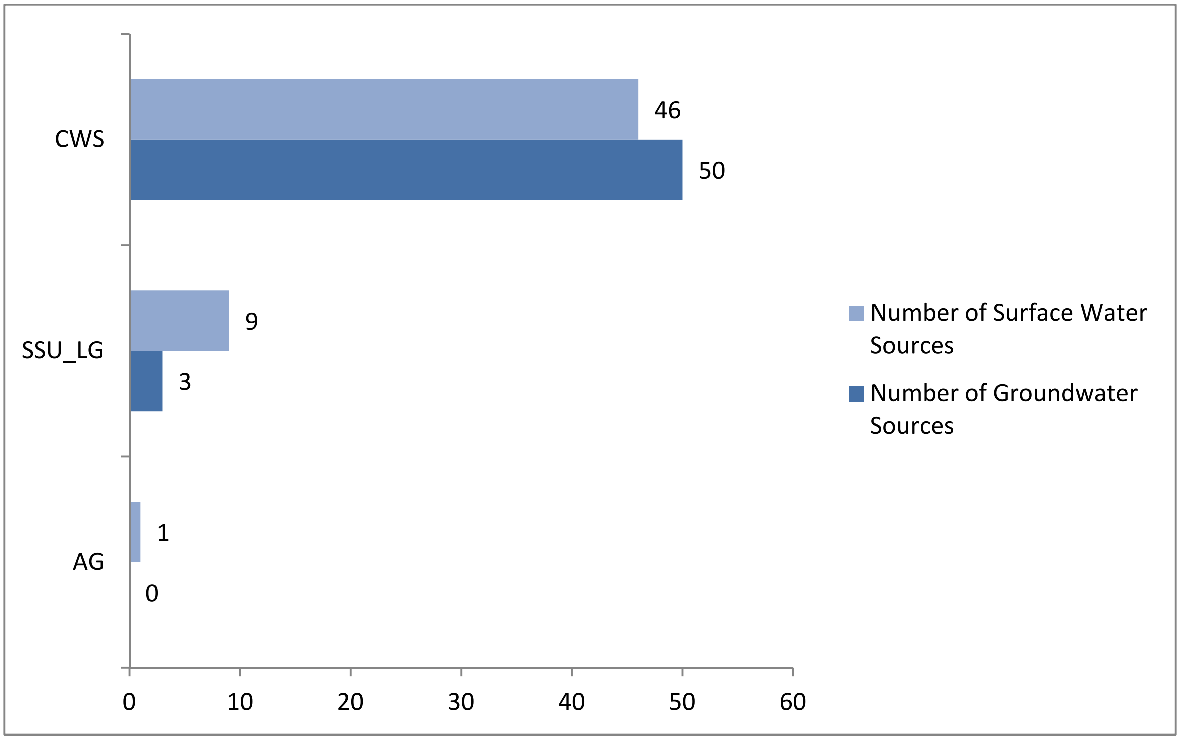
Existing Water Sources

Water sources utilized in the Basin include stream intakes, reservoirs, springs, and groundwater wells. Surface water sources (reservoirs, streams, and springs) account for 56 withdrawals. Additionally, there are 53 groundwater withdrawals currently identified in the Tennessee-Big Sandy River Basin. Source water reservoirs used in the Basin include the John Flannagan Reservoir, Lower Banner Seam (abandoned mine), Cox Reservoir, Lake Whitten, Ben's Branch Reservoir, Big Cherry Reservoir, KVS Quarry, Pound Reservoir, Upper and Lower Reservoirs in Norton, South Holston Lake, Tom's Creek Reservoir, and Wise Reservoir. Stream intakes and spring sources used in the Basin include the Clinch River, Little River, Big Cedar Creek, Big Moccasin Creek, Staley's Creek, Powell River, Spurlock Branch, Benges Branch, Robinette Branch, Chaney Creek, Holston River, Seven Springs, White Spring, Sargent Spring, Taylor Spring, Coles Spring, Reservation Spring, Millcreek Spring, Jones Spring, Widener Spring, and Wynn Spring.



Tennessee-Big Sandy River Basin Major Reservoir and Stream Sources

The number of reported surface water withdrawals narrowly outnumbers groundwater sources. Only one individual AG user is reported in the regional plan. Agricultural water withdrawal data collected by DEQ is limited for this area of the Commonwealth. It is possible agricultural users of greater than 300,000 gallons per month are limited in the Basin, or those that exist may not currently report their water withdrawals to DEQ as required by law through the VWWR. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 88,598 people in the Basin were reported as using private groundwater wells for residential water supply.



Tennessee-Big Sandy River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly utilized by localities in the Commonwealth. However, there is one non-municipal entity in the region generating reclaimed water. Primland Resort in Patrick County is permitted through DEQ to generate and distribute up to 0.087 MGD of reclaimed water. The water is currently provided to a golf course for irrigation reuse.

Water 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.

In the Tennessee-Big Sandy River Basin, all intrabasin transfers reported occur between municipal and private CWS. The following table lists Tennessee-Big Sandy River Basin intrabasin transfers between water providers and the CWS to which they sell water (water purchaser). Interbasin transfers were not reported in the Southwest Virginia regional water supply plan.

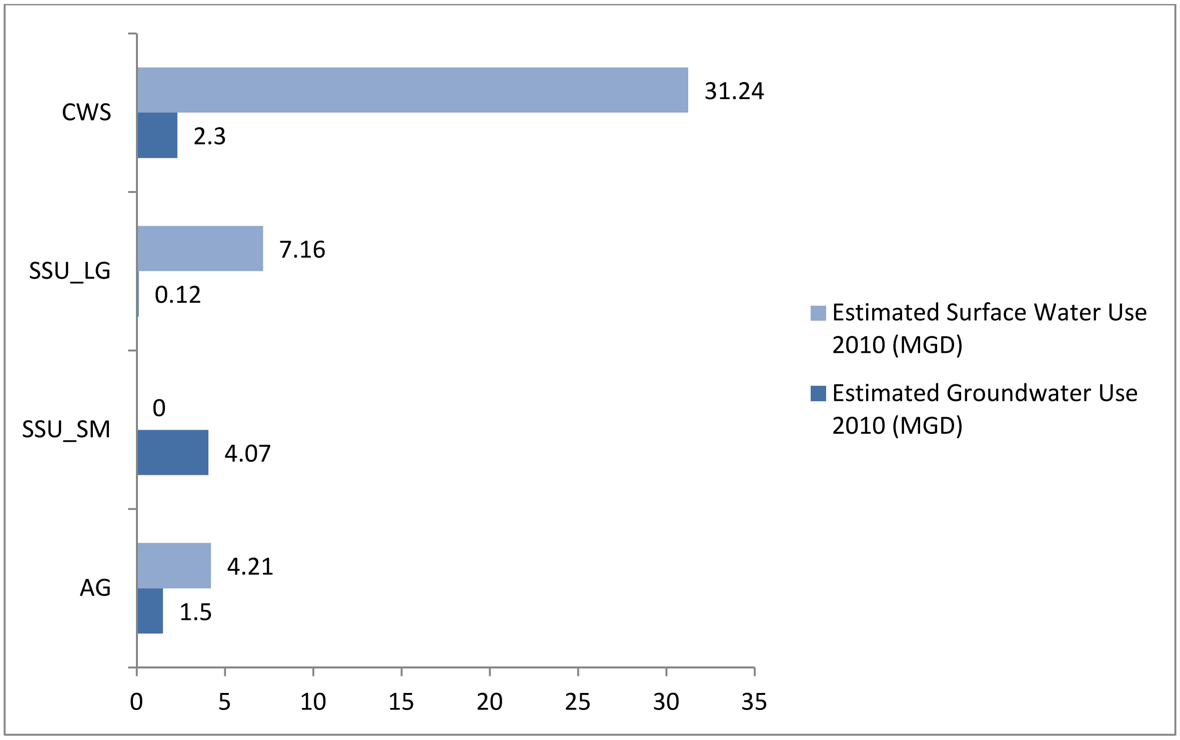
User Type	Water Purchaser and System(s)	Water Provider
CWS	Buchanan County PSA: Grassy Creek	Dickenson County PSA (Bartlick/Breaks CWS)
CWS	Town of Cedar Bluff	Town of Richlands
CWS	Town of Clintwood	John Flanagan Water Authority
CWS	Dickenson County PSA: Bartlick/Breaks, Crooked Branch, Fearls Branch, Honey Camp, Osborns Gap, Rakes Ridge, Route 80, Skeetrock, Wolf Pen Branch	No details in regional plan
CWS	Dickenson County PSA: Dickenson County Regional, Sandy Ridge	Wise County Public Service Authority
CWS	Dickenson County PSA: Doe Branch	Buchanan County PSA
CWS	Dickenson County PSA: Rush Creek	Town of Clintwood
CWS	Dryden Water Authority	Town of Pennington Gap
CWS	Lee County PSA: Eastern Lee, Jasper, Old Woodway Road	Town of Big Stone Gap
CWS	Lee County PSA: Keokee	Town of Appalachia
CWS	Lee County PSA: Lee County System	Arthur Shawanee Utility District (located in TN)
CWS	Lee County PSA: Big Hill, Miller/Smyth Chapel, Puckett and Ely Creek, Robbins Chapel	Town of Pennington Gap
CWS	Russell County PSA: Belfast/Rosedale, Swords Creek	Tazewell County PSA
CWS	Russell County WSA	Town of St. Paul
CWS	Scott County PSA: Boozy Creek, East Carters Valley	Bloomingdale Utility District (located in TN)
CWS	Scott County PSA: Cove Creek	Washington County SA
CWS	Scott County PSA: Daniel Boone	Town of Gate City

CWS	Smyth County SA: Atkins Extension, East Hungry Mother	Town of Marion
CWS	Smyth County SA: Poor Valley	Town of Saltville
CWS	Smyth County SA: South Fork	Thomas Bridge Water Company
CWS	Smyth County SA: St. Claires Creek, St. John's Crossing, Walker Creek	Town of Chilhowie
CWS	Smyth County SA: Walker Creek	Thomas Bridge Water Company
CWS	Spring Valley Subdivision	Bloomingdale Utility District (located in TN)
CWS	St. Charles Water Authority	Town of Pennington Gap
CWS	Tazewell County PSA: Baptist Valley, Eastern Tazewell, Fort Whitten, Gratton	Town of Tazewell
CWS	Tazewell County PSA: Jewell Ridge	Buchanan County PSA
CWS	Tazewell County PSA: Raven-Doran	Town of Richlands
CWS	Washington County SA: Hayter's Gap	Town of Saltville
CWS	Washington County SA: Clear Creek, Hayter's Gap, WCSA WTP	Bristol Virginia Utilities Board
CWS	Wise County PSA: Appalachia #1, Blackwood, Flatwoods, Mill Branch, Norton #1, South Mountain, Wise #2	Towns of Pound and Wise
CWS	Woodway Water Authority	Towns of Pennington Gap and Jonesville

Tennessee-Big Sandy River Basin Intrabasin Transfers

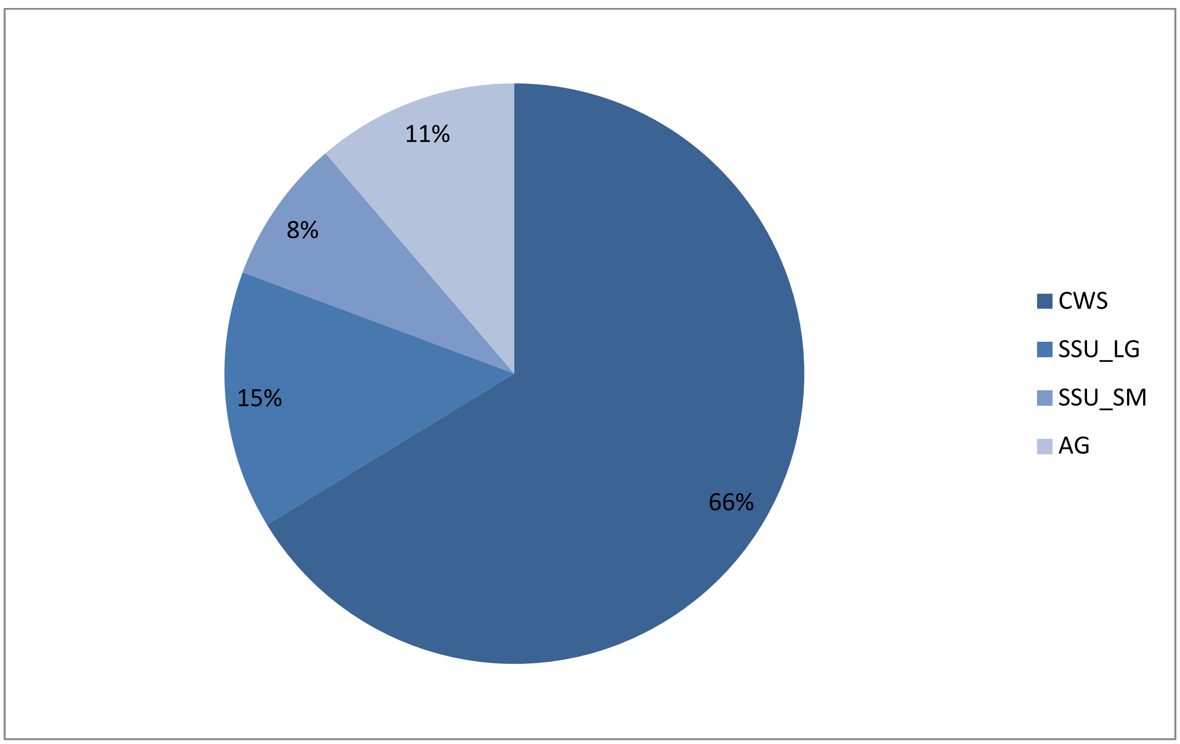
<u>Existing Water Use</u>

The estimated water use provided in the Southwest Virginia Regional Water Supply Plan is summarized in the following figure. The total estimated water use is approximately 51 million gallons per day (MGD). The estimated amount of use from surface water (43 MGD) exceeds that from groundwater (8 MGD) by a significant margin.



Tennessee-Big Sandy River Basin Estimated Use by Source and Type

CWS use an estimated 66% of the total water used in the Basin followed by SSU_LG (15%), AG (11%), and SSU_SM (8%).

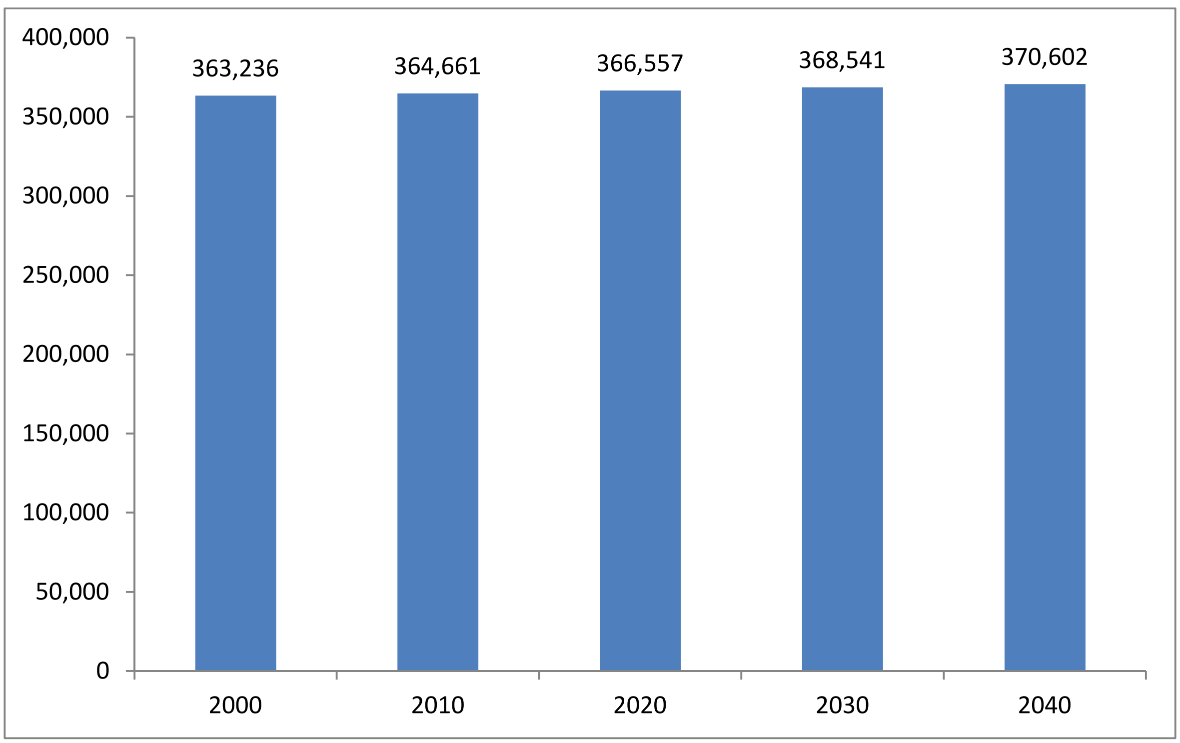


Tennessee-Big Sandy River Basin Percentage of 2010 Estimated Use by User Type

CWS reported their water use disaggregated into categories of use appropriate for the system. Categories commonly used included Residential, Commercial/Institutional/Light Industry (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 CWS 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.

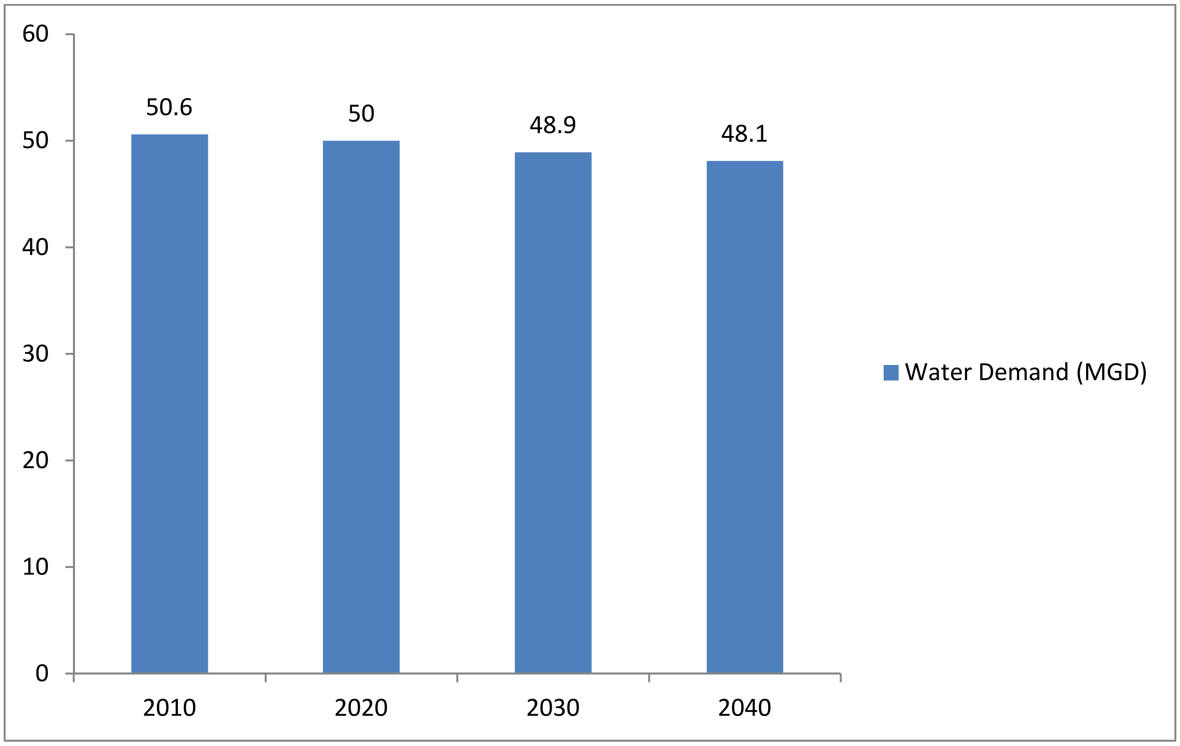
Projected Water Demand

The projected population of the localities with at least a portion of their land area in the Tennessee-Big Sandy River Basin is displayed in the following figure. Population data is 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 Basin is projected to increase only slightly through the year 2040. By the year 2040 the estimated basin-wide population is projected at 370,602. The percent change in population from the years 2000 through 2040 is estimated at 1.6%.



Tennessee-Big Sandy River Basin Projected Population

A 30- to 50-year projection of future water demand is required by 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 for the Basin is estimated to decrease from approximately 51 MGD to approximately 48 MGD in 2040. The percent change in water use during the 30-year timeframe is estimated at -4.9%.



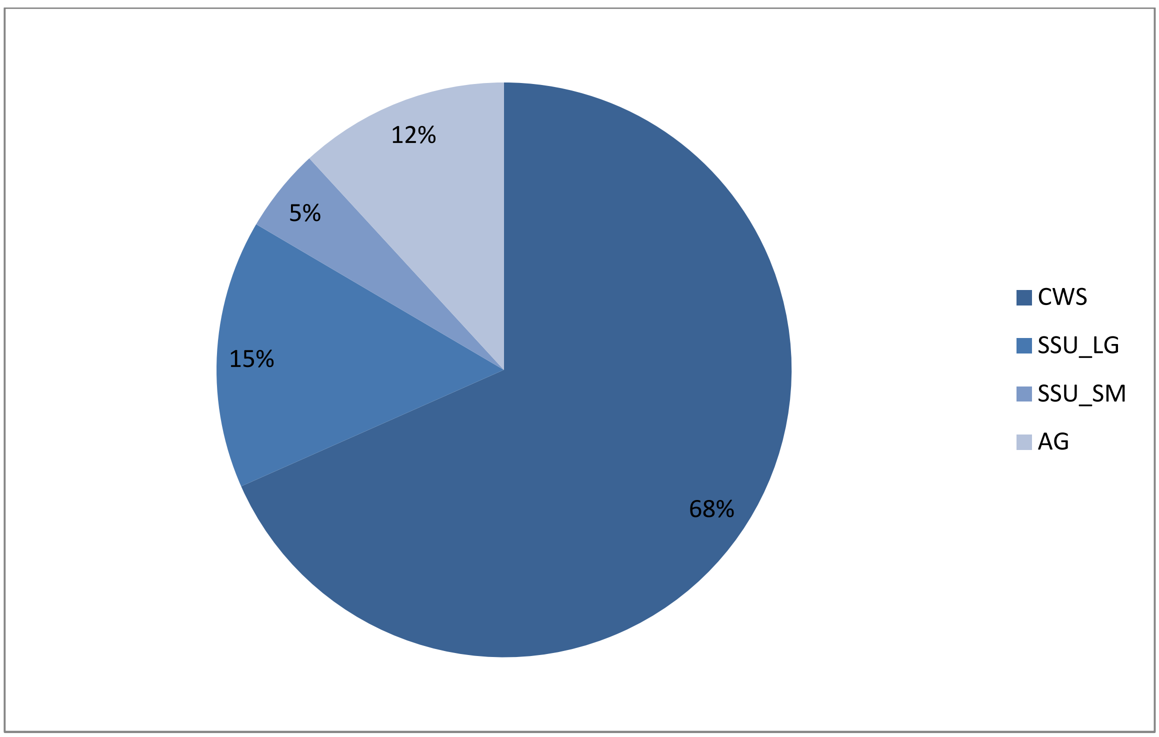
Tennessee-Big Sandy River Basin Projected Water Demand

As depicted in the following table, small self-supplied users of private groundwater wells show the largest decrease (-44.2%) in water demand over the 30 year period. Projected water demands also decrease (-2%) for CWS. The reported LG_SSU and AG use remains unchanged over the planning period as detailed in the regional plan. The steady state of agricultural use is a best guess on the part of the planning entities, as the withdrawal data is limited and water use on an annual basis, in particular for crop irrigation, may change depending on precipitation.

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	33.54	33.31	33.6	32.85	-2.00%
SSU_LG	7.27	7.27	7.27	7.27	0.0%
SSU_SM	4.07	3.47	2.9	2.27	- 44.2%
AG	5.71	5.71	5.71	5.71	0.0%

Tennessee-Big Sandy River Basin Projected Water Demand by User Type (2010-2040)

The 2040 projected water demand in the Tennessee-Big Sandy River Basin by user type is similar to the estimated 2010 use by user type in that CWS are projected to use the greatest percentage of water, followed by SSU_LG, AG, and SSU_SM. While three user types increase in percentage over the 30-year time frame, the percentage of water use by SSU_SM users is estimated to decrease by 3%.



Tennessee-Big Sandy 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 water sources is obtained from the regional water supply plan. The information is presented for all those localities with at least a portion of land area located within the Tennessee-Big Sandy River Basin. The following lists the projected deficits in the Basin.

Southwest Virginia Regional Water Supply Plan

Lee County and the Towns of Jonesville, Pennington Gap, and St. Charles; Scott County and the Towns of Clinchport, Duffield, Dungannon, Gate City, Nickelsville, and Weber City; Wise County and the Towns of Appalachia, Big Stone Gap, Coeburn, Pound, St. Paul, and Wise; City of Norton; Dickenson County and the Towns of Clinchco, Clintwood, and Haysi; Russell County and the Towns of Cleveland, Honaker, and Lebanon; Washington County and the Towns of Abingdon, Damascus, and Glade Spring; City of Bristol; Buchanan County and the Town of Grundy; Tazewell County and the Towns of Bluefield, Cedar Bluff, Pocahontas, Richlands, and Tazewell; Smyth County and the Towns of Chilhowie, Marion, and Saltville; Bland County; Wythe County and the Towns of Rural Retreat and Wytheville; Grayson County and the Towns of Fries, Independence, and Troutdale

Current sources are adequate for the needs of all localities in the planning region except for those localities listed below.

Russell County may experience deficits in two community water systems during the planning period. The Castlewood Water and Sewage Authority community water system is projected to experience a water deficit in 2010, based on the current VDH permitted capacity. The deficit is projected to increase to approximately 0.12 MGD in 2040. Russell County's Belfast/Rosedale CWS is also projected to experience a deficit in 2040 (amount unknown) based on future waterline extensions and the current capacity of the Tazewell County Water Treatment Plant that provides water to the system.

The Town of Saltville may experience a water deficit as early as 2006 based on the current VDH permitted capacity. The deficit is projected to increase to approximately 0.68 MGD in 2060.

Washington County may experience a water deficit as early as 2006 based on the current VDH permitted capacity. The deficit is projected to increase to approximately 4.75 MGD in 2060.

The Town of Wytheville may experience a water deficit as early as 2041, based on the current VDH permitted capacity. The deficit may increase to approximately 0.85 MGD in 2060.

To address the projected shortfall of municipal supply the regional plan includes the following alternatives: maintaining, increasing, or initiating supply interconnections with neighboring localities, infrastructure upgrades, groundwater source development, increasing permitted surface water withdrawals, upgrading current VDH permitted capacities, and continuing existing water conservation policies or developing new ones.

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Russell County	2040	0.12
Town of Saltville	2060	0.68
Washington County	2060	4.75
Town of Wytheville	2060	0.85

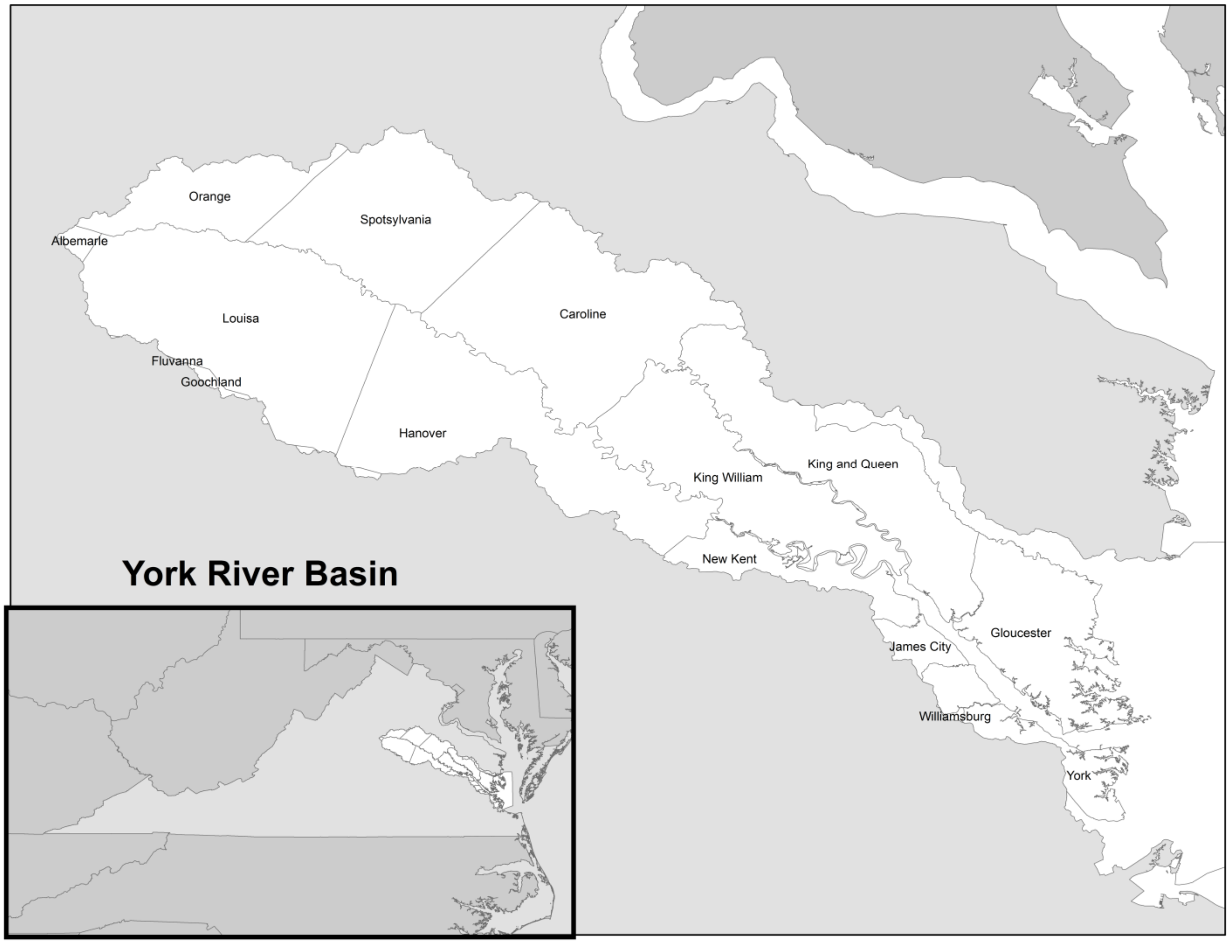
Tennessee-Big Sandy River Basin Projected Water Deficits

York 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.

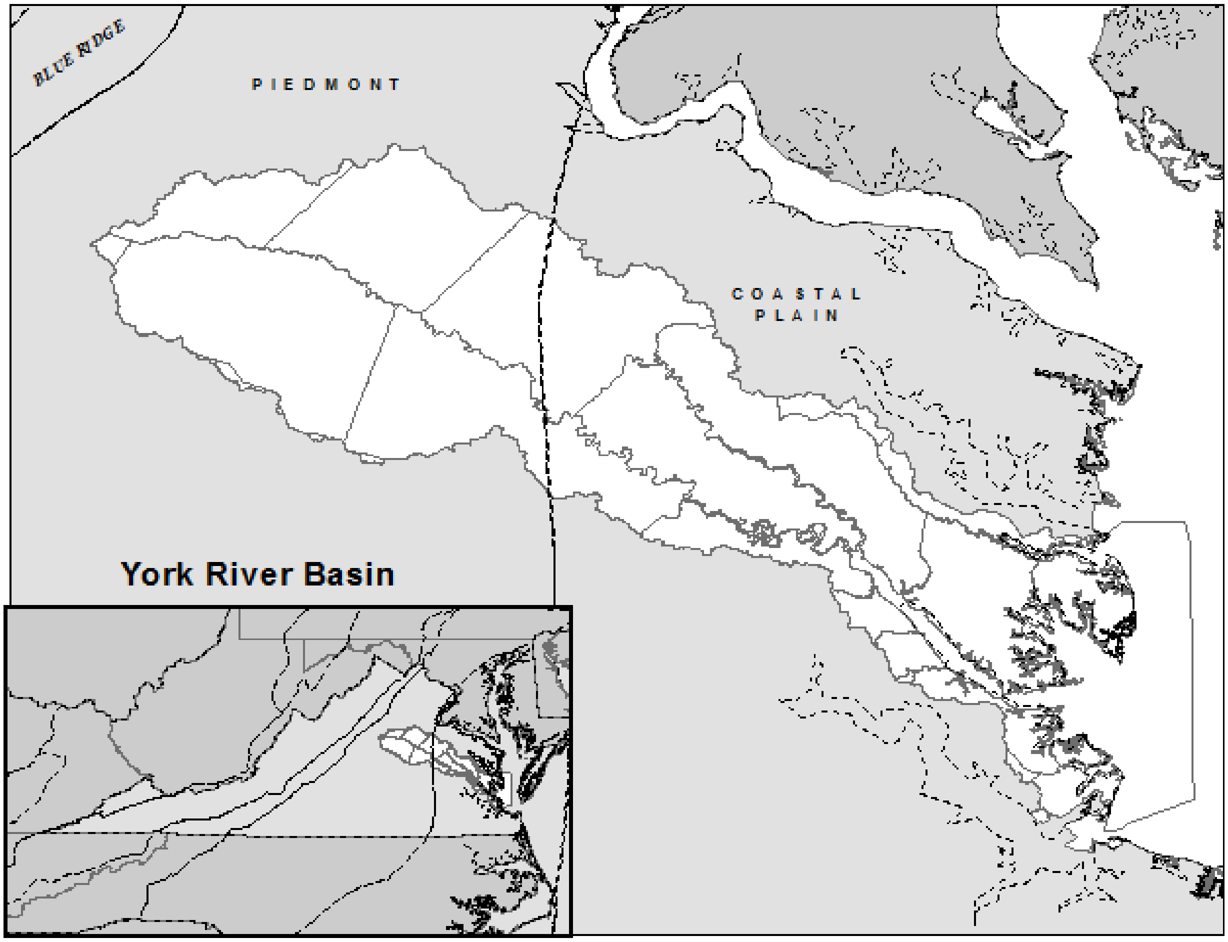
The York River Basin lies in the central and eastern section of Virginia and covers 2,674 square miles or 6% of the Commonwealth's total area. The Basin is bordered by the Rappahannock River Basin to the north, the James River Basin to the south and west, and the Chesapeake Bay-Small Coastal Basin to the east. The headwaters of the York River begin in Orange County and flow in a southeasterly direction for approximately 220 miles to its mouth at the Chesapeake Bay. The Basin's width varies from five miles at the mouth to 40 miles at its headwaters.

The following fourteen counties and one city are entirely or partially located within the Basin: Counties of Albemarle, Caroline, Fluvanna, Gloucester, Goochland, Hanover, James City, King and Queen, King William, Louisa, New Kent, Orange, Spotsylvania, and York; City of Williamsburg. These jurisdictions are represented within ten regional water supply plans (Hampton Roads, Hanover County and Town, Spotsylvania County and the City of Fredericksburg, Louisa County and Towns, Caroline County and Town, Orange County and Towns, Middle Peninsula, Goochland-Henrico-Cumberland-Powhatan, Albemarle County-Scottsville-Charlottesville, and Fluvanna County and Town) and one local water supply plan (New Kent County).



York River Basin Localities

The Basin is comprised of the York River and its two major tributaries, the Pamunkey and the Mattaponi Rivers. The York River itself is only about 30 miles in length. The Pamunkey River's major tributaries are the North and South Anna Rivers and the Little River, while the major Mattaponi tributaries are the Matta, Po, and Ni Rivers. Lying in the Piedmont and Coastal Plain physiographic provinces, the Basin's topography is characterized by slightly rolling hills at the headwaters or extreme western portion, to gently sloping hills and flat farmland near its mouth. Tributaries in the central Piedmont exhibit moderate and near constant profiles. Their flat slope largely characterizes streams in the Coastal Plain.



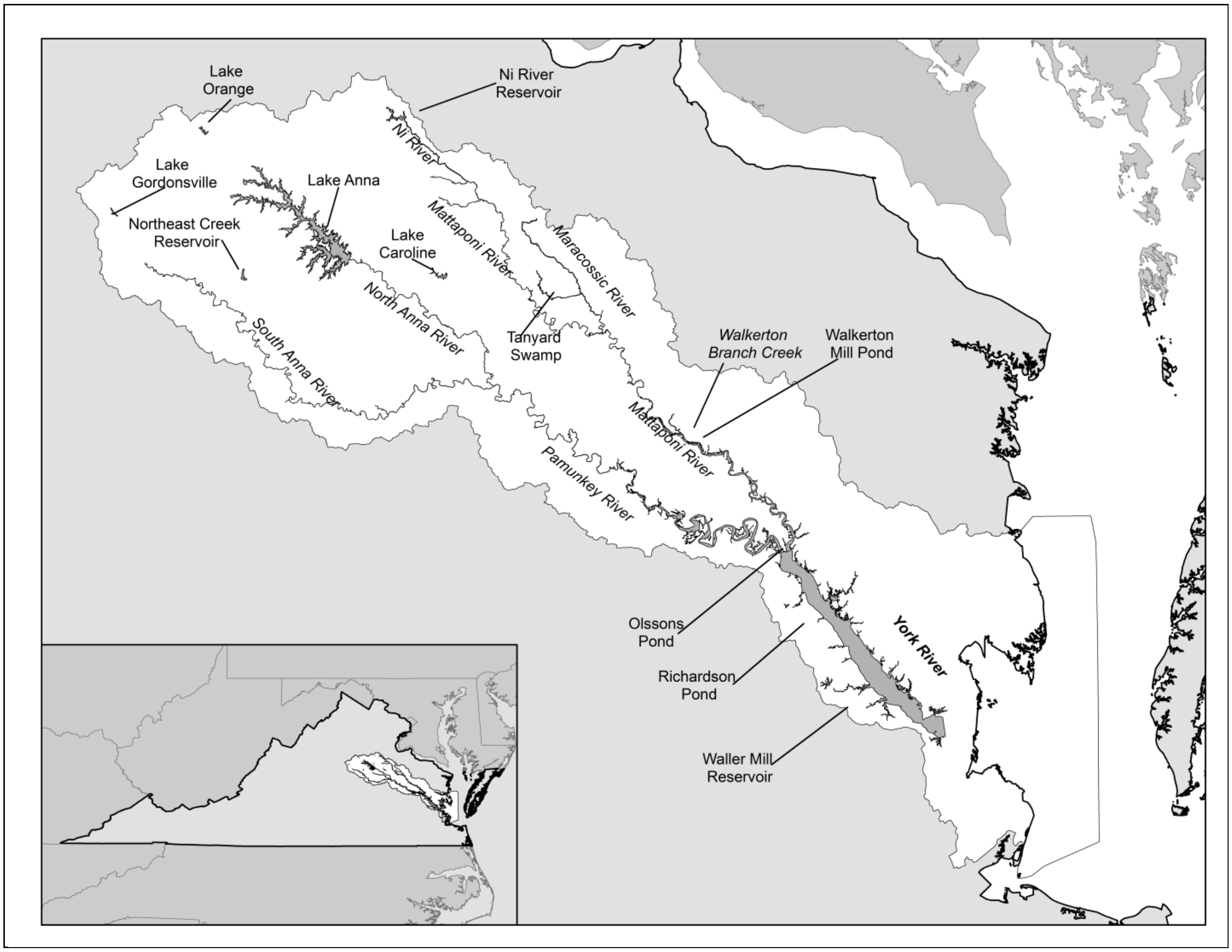
York River Basin Physiographic Provinces

Approximately 65% of the Basin's land area is forest, farmland, and pasture account for approximately 20%, and approximately 10% of the Basin land area is urban. The York River Basin is divided into three USGS hydrologic units: HUC 02080105 – Mattaponi; HUC 02080106 - Pamunkey and HUC 02080107 - York. The three hydrologic units are further divided into 27 water bodies or watersheds and 69 6th order sub-watersheds.

Existing Water Sources

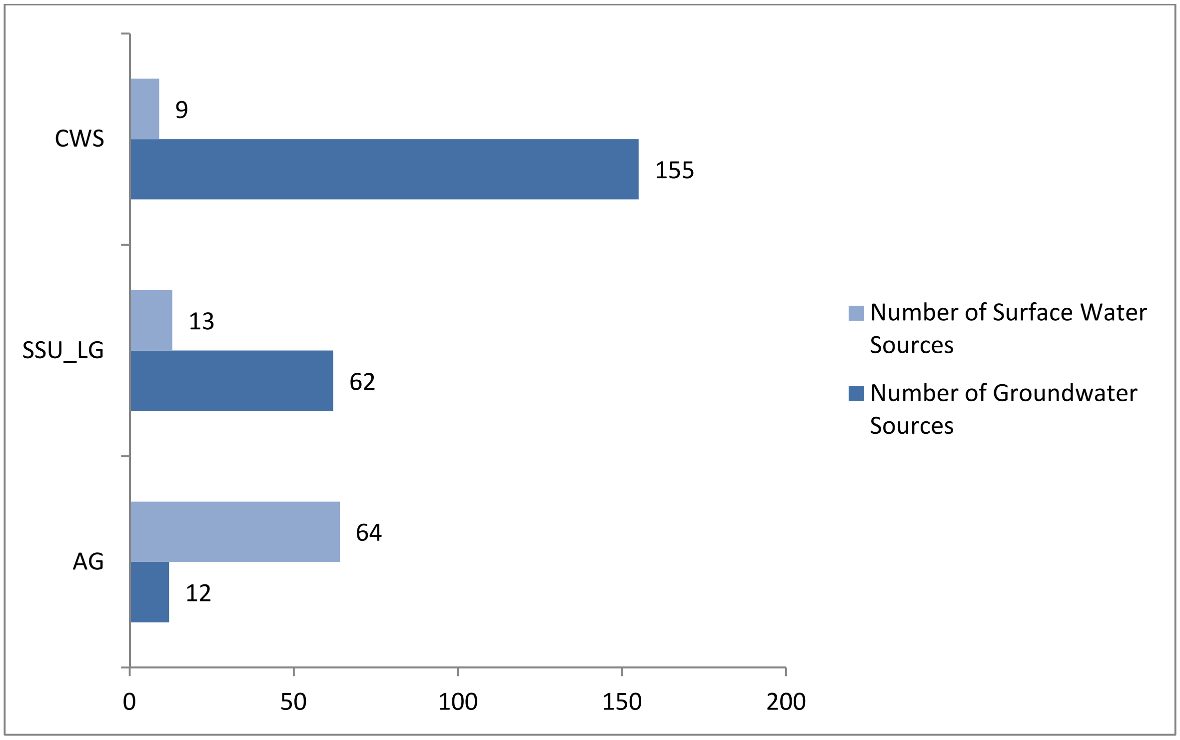
Water sources utilized in the Basin include stream intakes, reservoirs, private ponds, and groundwater wells. Surface water sources (stream intakes, reservoirs, private ponds) account for 86 withdrawals. Additionally, there are 229 groundwater withdrawals currently identified in the York River Basin. Source water reservoirs used in the Basin include Lake Anna, Lake Caroline, Beaverdam Reservoir, Northeast Creek Reservoir, Ni River Reservoir, Waller Mill Reservoir, Lake Gordonsville, Lake Orange, Richardson Pond, Walkerton Mill Pond, Glenwood Toddsberry Pond, Ruffens Pond, Bowlers Mill Reservoir, Olssons Pond, and the Gordonsville Quarry. Stream intakes used in the Basin include Lake Anna, Tanyard

Branch, Rappahannock River, Ni River, York River, Pamunkey River, Mattaponi River, North Anna River, Maracossic River, Dicks Creek, Courthouse Creek, Glenwood Chapel Creek, Walkerton Branch Creek, and Garnett's Mill Stream. Ponds and lakes on private property are used for irrigation on farms and golf courses in the Basin.



York River Basin Major Reservoir and Stream Sources

Reported groundwater sources outnumber surface water withdrawals in all use types except agriculture. The number of groundwater sources for the SSU_SM use type is unknown and, therefore, is not included in the figure below. As estimated for the year 2010, approximately 226,625 people in the Basin use groundwater wells for residential water supply.



York River Basin Source Type by User Type

Nontraditional water sources, such as water reclamation and reuse, are generated by New Kent County's Parham Landing Waste Water Treatment Plant (WTP). The WTP is permitted to generate and distribute up to 2 MGD of reclaimed water to non-municipal facilities for bulk irrigation reuse and dust suppression and irrigation.

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.

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

User Type	Water Purchaser and System(s)	Water Provider
CWS	Town of Louisa	Louisa County WA
CWS	Town of Mineral	Louisa County WA
CWS	Aqua VA - Queens Lake	City of Williamsburg and York County

York River Basin Intrabasin Water Transfers

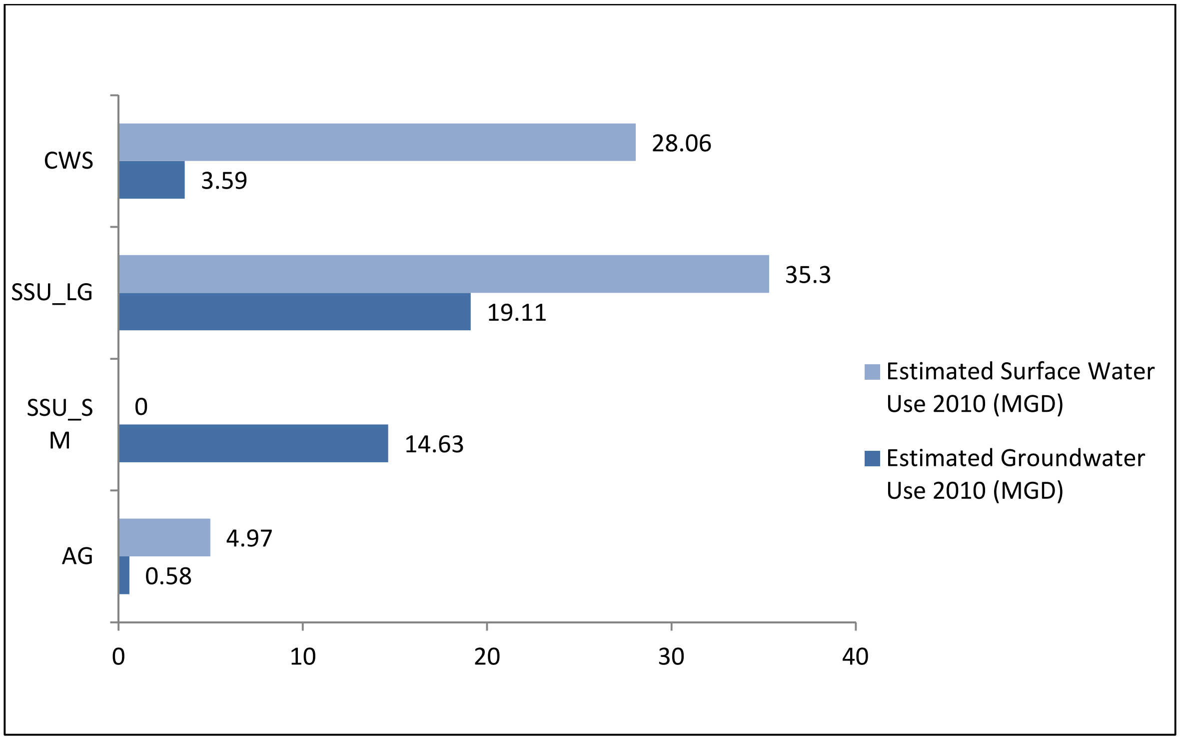
The following table lists interbasin transfers between water providers and the entities to which they sell water (water purchaser).

User Type	Water Purchaser and System(s)	Water Provider
CWS	Mountain Lake Company and Aqua Virginia (York Terrace, Nelson Park, Carver Gardens)	Newport News Waterworks and York County
CWS	Yorktown Naval Weapons Station - Cheatham Annex Naval Supply Center	Newport News Waterworks
CWS	Hanover Utilities - Overhill Estates-Holly Farms	Henrico County
CWS	Aqua VA - Holly Ridge	Henrico County
CWS	Town of Gordonsville	Rapidan Service Authority
CWS	Aqua VA - Country Club Estates	Spotsylvania County

York River Basin Interbasin Transfers

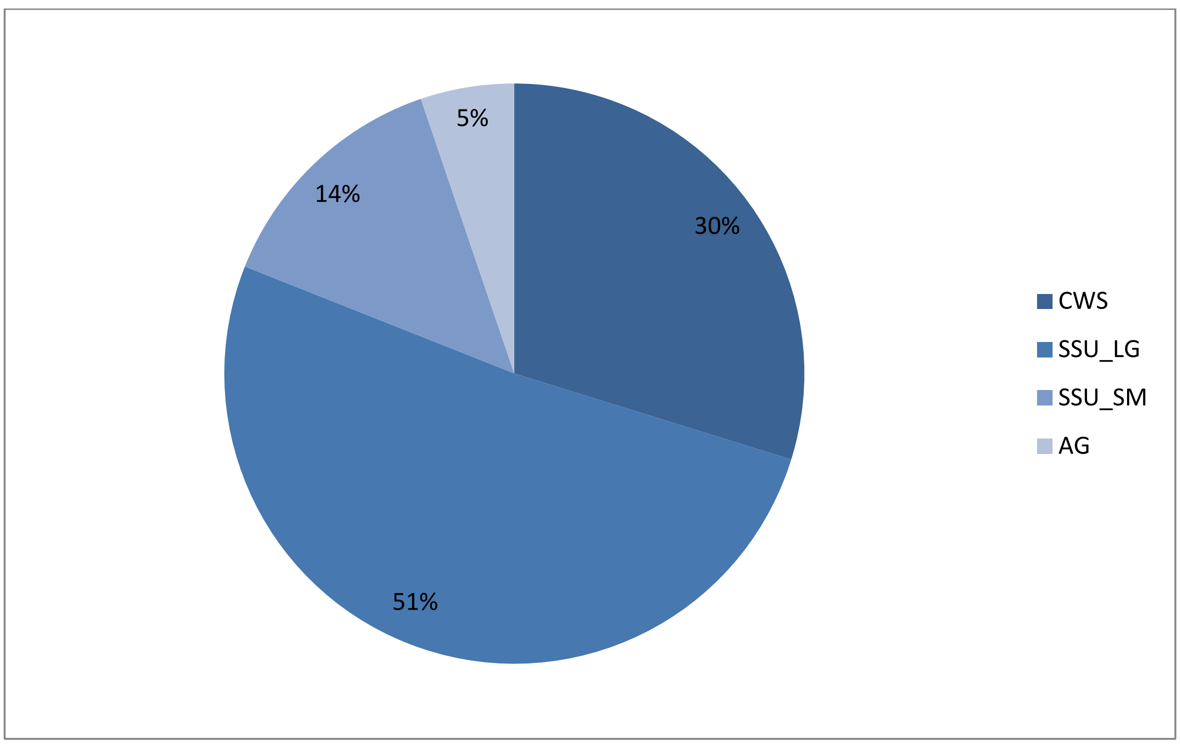
Existing Water Use

The total estimated water use provided in the water supply plans is summarized in the following figure. The total estimated water use is approximately 106 MGD with approximately 69 MGD of surface water use and 38 MGD of groundwater use.



York River Basin Estimated Use by Source and Type

SSU_LG use an estimated 51% of the total water in the Basin followed by CWS (30%), and SSU_SM (14%). AG use is the smallest at 5%.

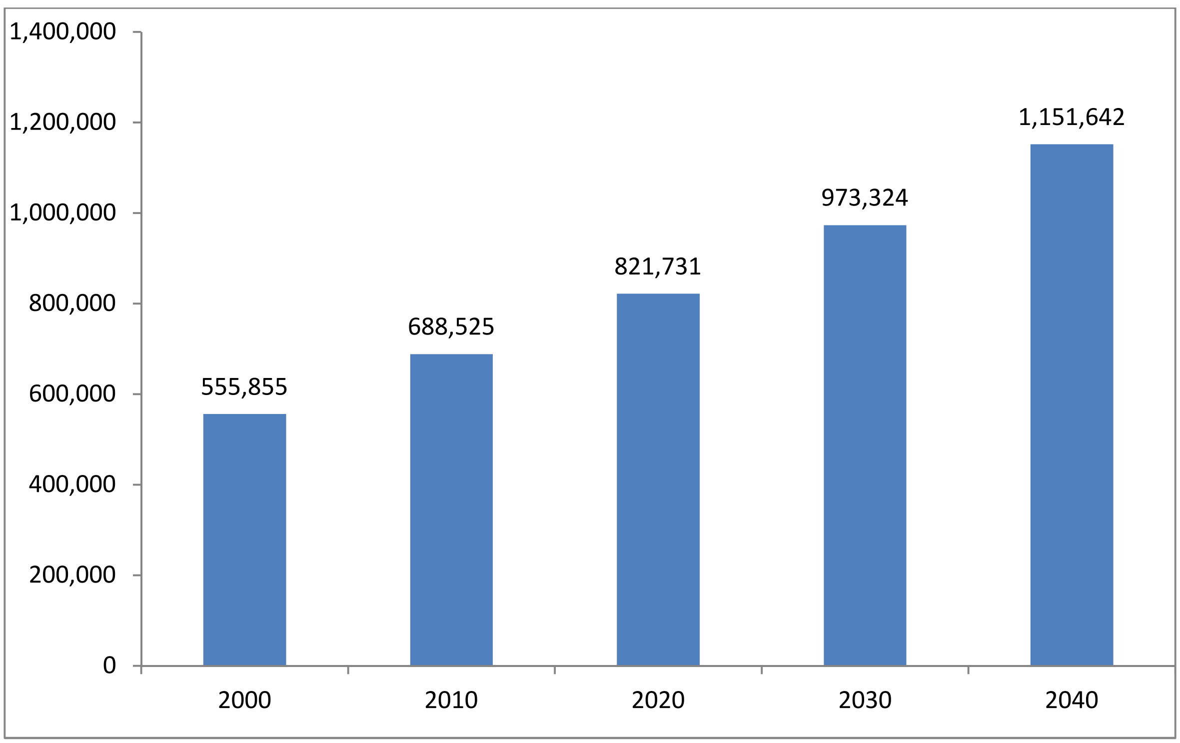


York River Basin Percentage of 2010 Estimated Use by User Type

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 CWS 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.

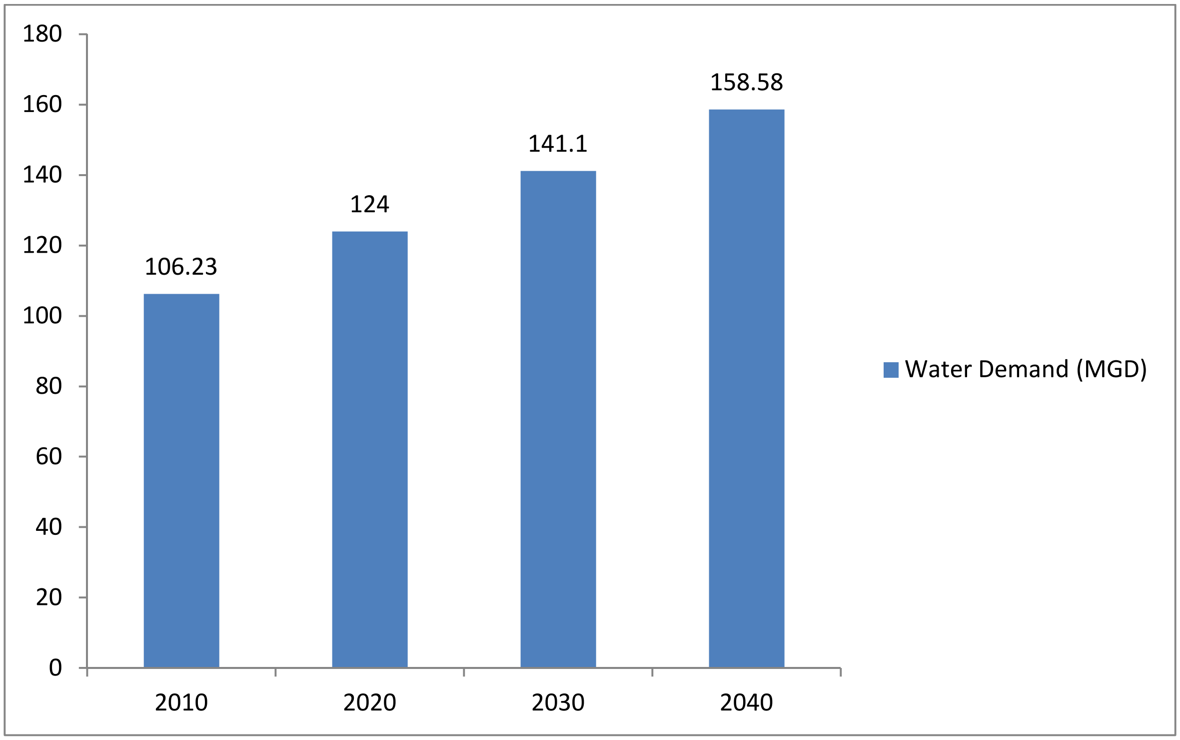
Projected Water Demand

The projected population of the localities with at least a portion of their area in the York River Basin is displayed in the following figure. Population data is 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 1,151,642. The percent change in population from the years 2000 through 2040 is estimated at 67.3%.



York River Basin Projected Population

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 York River Basin, as reported in the regional water supply plans, is estimated to increase from approximately 106 MGD to 159 MGD in 2040. The percent change in water use during the 30-year timeframe is estimated at 49.9%.



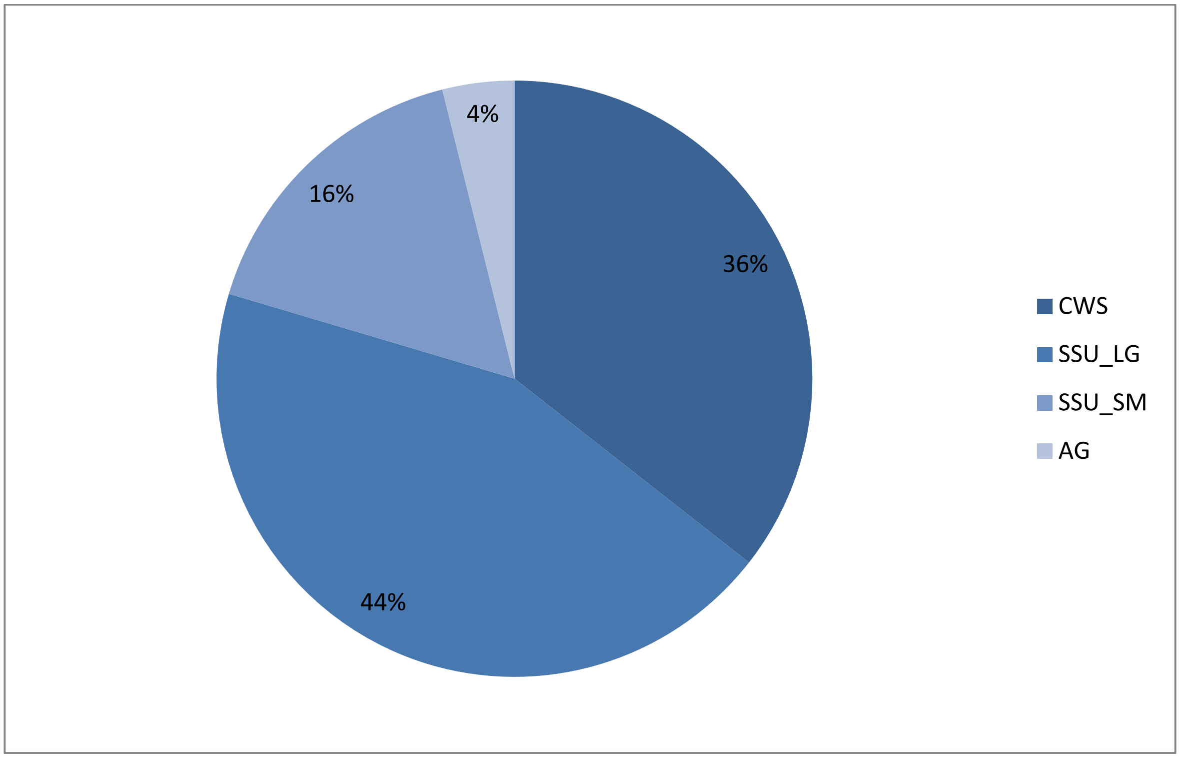
York River Basin Projected Water Demand

As depicted in the following table, CWS use shows the largest percent change (79.5%) in water demand over the 30-year period followed closely by SSU_SM (79%), SSU_LG (28.3%), and AG (11.4%).

User Type	Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
CWS	31.65	39.90	48.2	56.41	79.5%
SSU_LG	54.41	59.54	64.7	69.81	28.30%
SSU_SM	14.63	18.48	22.3	26.19	79.0%
AG	5.55	5.76	6	6.18	11.4%

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

In 2040, the projected demand by user type in the York River Basin is similar to the 2010 use in that SSU_LG are projected to use the greatest percentage of water followed by CWS, SSU_SM, and AG.



York River Basin Percentage of 2040 Projected Demand by User Type

Statement of Need and Alternative Water Sources

The following review of future water needs is obtained from the ten regional and one local water supply plans represented in the York River Basin. The information is presented below for all those localities with at least a portion of land area located within the York 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

Caroline County notes 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. Alternative water supply sources listed in the plan include groundwater development, interconnection with other localities, and an intake on the Rappahannock River.

Cumberland, Goochland, Henrico, and Powhatan Regional Water Supply Plan

Goochland County anticipates existing sources will meet future demand.

Fluvanna County and the Town of Palmyra Regional Water Supply Plan

Fluvanna County water demands are projected through 2030 with a deficit anticipated in the Palmyra Community Water System. The other community water systems' sources are adequate for the next twenty years. The James River Water Authority is listed as one option to meet future demand. A reservoir site associated with the Rivanna River and the James River is also included. A specific site for a reservoir is not given.

Hampton Roads Regional Water Supply Plan

City of Williamsburg, Gloucester County, James City County, York County

The localities anticipate an increase in population as the region continues to grow; however, projected supply is adequate to meet projected demand for the region through the planning period. There is potential for demand to exceed supply by 2040 in the York-James Peninsula sub-region as the projections are within a 10% margin of error and alteration of the assumptions could result in revised projections. Alternatives considered to meet the potential need in the Peninsula sub-region include additional surface water storage, additional groundwater withdrawals, desalination, aquifer storage and recovery, interconnection, reuse, and system optimization.

Hanover County and the Town of Ashland Long Range Water Resources Plan

Hanover County community water systems may experience a deficit of 0.34 MGD by the year 2032, based on total projected demands as compared to the current VDH permitted capacity for all community water systems in the planning region. A single alternative is mentioned in the plan, the Verdon Quarry side storage reservoir project, which includes: river intakes and raw water pumping stations on North Anna and Little Rivers and a reservoir intake and raw water pumping station on Verdon Quarry. If completed in 2037 as scheduled, water resources will be adequate to meet the community water system needs through the planning period.

Louisa County Long Range Water Supply Plan

Louisa County and the Towns of Mineral and Louisa

Louisa County's Northeast Creek Reservoir Service Area's average day demands can be met through the planning period; peak day water demand surpasses the permitted capacity in 2039. Water demand within the Zion Crossroads Service Area is expected to outpace the permitted supply by 2025. The small groundwater-based community water systems and Blue Ridge Shores do not predict a deficit in the planning period. The Northeast Creek Reservoir Service Area will need improvements in the Town of Mineral well and the Northeast Creek Water Treatment Plant would be required to meet this peak demand for the Northeast Creek Reservoir Service Area. If Northeast Creek Reservoir Service Area and Zion Crossroads Service Area were interconnected and all source capacity was developed, this deficit would be addressed

.

The County has partnered with Fluvanna County to create the James River Water Authority, which is authorized to withdrawal water from the James River under Virginia Water Protection Permit No. 04-0805. Louisa County Water Authority also has a pending application for an intake on Lake Anna to supply that area.

Six designated growth areas (Gum Spring, Ferncliff, Shannon Hill, Lake Anna, Boswells Tavern, and Gordonsville) do not currently have sources, but the Louisa County Water Authority is considering groundwater wells, surface water withdrawals, off-line reservoir, extension of water transmission lines from other growth areas, upgrades to the existing Northeast Creek Water Treatment Plant, a partnership with Fluvanna County, and an upgrade to Bowlers Mill Reservoir.

Middle Peninsula Regional Water Supply Plan

King and Queen County; King William County and the Town of West Point

King and Queen County anticipates existing sources to be adequate to meet current and projected demand in the planning period. King William County and the Town of West Point Water predict that demand projections will exceed current community water system supplies by 2020 for King William (deficit of 0.925 MGD) and 2030 for West Point (deficit of 0.036 MGD). Alternative sources listed for the Town of West Point include system upgrades and groundwater permit modifications that allow for greater use of existing wells. New well development and an intake on the Pamunkey River are King William County's preferred alternatives for source water.

New Kent County Water Supply Plan

Portions of the County may experience a water supply deficit as early as 2017, based on the current permitted withdrawal amount. In the short term, a waterline extension is being designed to connect two county-operated community water systems to alleviate the anticipated 2017 deficit. The two top ranked alternatives for future water supply listed in the plan are an intake on the Pamunkey River (reverse osmosis water treatment) and the purchase of water from the City of Richmond.

Orange County Regional Water Supply Plan

Orange County and the Towns of Gordonsville and Orange

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. 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.

Spotsylvania County and the City of Fredericksburg Regional Water Supply Plan

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

Locality	Estimated Year of Deficit	Estimated Deficit Amount (MGD)
Albemarle County - Charlottesville - Scottsville	2035	0.41
Caroline County	2030	0.256
Aqua VA – Palmyra	2030	0.067
Hanover County	2032	0.34
King William County	2020	0.925
Town of West Point	2030	0.036
Louisa County Water Authority	2050	0.841
Orange County	2050	4.61
New Kent County	2060	1.5

York River Basin Projected Water Deficits

Appendix C: Local/Regional Water Supply Plan Reviews and Conditions of Approval

Accomack County and Towns Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Accomack County and Towns Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Accomack County and towns need to clarify how the localities intend to implement and enforce mandatory restrictions and provide copies of enacted ordinances upon adoption.
2. For all community water systems and self-supplied users in all localities, provide all of the data required by 9 VAC 25-780-80 including water usage on an average monthly and annual basis, max day, peak day water use by month, and disaggregated use data.
3. For all community water systems and self-supplied users in all localities, provide all of the data required by 9 VAC 25-780-70.
4. Improve data collection for agricultural self-supplied users and provide additional detail on location and type (surface water or groundwater) sources as required by 9VAC 25-780-70.I.
5. Provide missing disaggregated demand data required by §9 VAC 25-780-100.D.4 for all community water systems in the planning region.
6. Provide a description of potential threats to existing water quantity and quality beyond those currently identified as required by 9 VAC 25-780-90B.11.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on March 4, 2013. General comments were received from the Virginia Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Marine Resources Commission, and the Department of Historic Resources.

The Department of Health provided the following specific comments:

1. "Significant waterworks that were excluded from the plan include Virginia Landing and Accomack Manor. Parts of the Captains Cove service area were also not included."

2. “There is some excess capacity in some systems in Accomack County. The Industrial Park and the two NASA systems are examples of systems utilizing below 30% of capacity. Northern and Central Accomack are expected to grow. Onancock is picking up demand (possibly a good bit of the Onley area).”

3. “Some of the newer sources (wells) have demonstrated high Secondary Maximum Contaminant Level parameters (color, TDS, iron) as well as some Primary Maximum Contaminant Levels (arsenic) items. Some of the sources have also indicated sufficient disinfection by-product precursors to cause elevated disinfection byproducts.”

4. “There will be about 60,000 gpd demand moving from Northampton County to Accomack County with the move of the hospital, and this is not reflected in the Water Supply Plan. Also, the projections for Onancock and Parksley don't make sense - the Plan shows slow population growth but fast (and very significant) demand growth, which is not explained (i.e., no discussion of industrial or commercial growth that would account for the demand increase).”

5. “There is discussion of a program for submission and review of annual production meter calibration reports, but no description of who will be responsible for the program.”

6. “The Plan mentions a demand center for the Dreamland Homes mobile home community in the section about Groundwater Withdrawal Permits. This community is a collection of 15 (or more) small separate and non-interconnected non-regulated water systems (each being too small to regulate as a waterworks), but does not address the water quality issues that have been reported at the community.”

7. “There are several references to waterworks that are not part of the Plan. The Town of Eastville is mentioned briefly (it's actually located in Northampton County), plus data from and information about the Town of Chincoteague is presented (the Town of Chincoteague has its own, separate Water Supply Plan).”

<u>The Virginia Marine Resources Commission provided the following comments:</u>

“While the plan characterizes the existing resources information in the region, we note that new water supplies will likely target ground water resources. As such, the need for any permits for encroachments over State-owned submerged land would likely only involve pipelines or infrastructure that would cross a waterway.”

Albemarle County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Albemarle County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Work with cooperative extension or soil and water conservation staff to better represent source, use, and projected demand information for agricultural users.
2. Provide one or more maps showing the boundary of the service area for each Community Water System service area. Where mapping is not readily available, it should be so noted in the narrative.
3. Update Section 8 of the plan to include the status of state and federal permit modifications issued for the Ragged Mountain Reservoir Expansion project.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, and the Department of Game and Inland Fisheries. The Marine Resources Commission did not provide comments on this plan.

Amelia County Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Amelia County Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 15, 2018, whichever comes first:

1. Provide the community water system peak day water use and projected demands on a peak monthly basis.
2. Provide information for the existing water resources not currently addressed in the plan including significant fisheries, impaired streams, and river segments with recreational significance.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on 12/03/2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comment:

"The plan indicates the Amelia Courthouse system is permitted for 546,000 gpd. The system is currently permitted for 207,200 gpd and is anticipated to be permitted for 310,400 gpd in the near future when the permit is revised."

Appomattox River Water Authority and the City of Hopewell Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Regional Water Supply Plan for the Appomattox River Water Authority (ARWA) and the City of Hopewell be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Virginia American Water Company should clarify implementation and enforcement of the Water Conservation Plan for its customers in the City of Hopewell.
2. Please provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users in all localities.
3. Improve documentation of the inclusion of Prince George County and the City of Hopewell in the Groundwater Management Area and the annual and monthly permitted amounts for each permittee, where applicable.
4. A source water assessment program for the region was completed by VDH and should be provided.
5. Work with privately owned community water systems to better represent water use information required by Section 9 VAC 25-780-80 of the Regulation for their systems.
6. Provide all of the data required in Projected Water Demand (§9 VAC 25-780-100), such as population with each locality served by a community water system, disaggregated demand data, and water demand projections for both large and small self-supplied users.
7. Provide a map for each community water system service area and any proposed expansion.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission. .

The Department of Health provided the following comments:

"There were some well yields and storage tank capacities that differed from those listed on description sheets or in our files. Some waterworks listed in the plan, like Browders HFA and Dinwiddie Unit 27, are now inactive, and new groundwater sources have been installed in other locations. Virginia American Water supplies water to a portion of Prince George County, but this was not clear in the plan. Technical memo #3 notes that the VAW – Hopewell plant capacity will increase to 38 MGD following plant upgrades but it is unclear how this value was generated. The treatment capacity of the potable train in the plant will be 18 MGD but the waterworks permit capacity will be less than that due to limited storage (approx. 14.4 MGD). VDH does not regulate the non-potable portion of the VAW – Hopewell system, and does not track capacity of that facility."

Blacksburg/Christiansburg Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Blacksburg/Christiansburg Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Provide a qualitative description of existing in-stream beneficial uses, either within or outside of the planning area, affected by the point of stream withdrawal for each community water system in the Plan that uses a stream intake.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

Buckingham County and the Town of Dillwyn Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Buckingham County and Town of Dillwyn Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 15, 2013, whichever comes first:

1. Existing Water Sources: Improve estimates of agricultural users by using U.S. Department of Agriculture census data.

2. Existing Water Resources: Provide percentage of impervious cover for the planning region.

3. Projected Water Demand: Provide explanation of how current conservation practices, techniques, and technologies were considered in the water demand projections.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

The Department of Health provided the following comments:

"The WSP includes information for Community GW systems that are currently inactive. To date, Buckingham County has three (3) active community waterworks which are: Buckingham County Water System, Discovery School of Virginia (boys facility), and Gold Hill Village. The Discovery School of Virginia is currently in the preliminary engineering phase of development of an additional community waterworks for a girls facility."

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

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Caroline County and the Town of Bowling Green Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 20, 2018, whichever comes first:

1. Evaluate factors used to establish drought stage levels. Sections 6.2.1 and 6.2.2 of the plan list precipitation and well drawdown as the two drought stage indicators. The precipitation evaluation described in the plan will benefit from specific ranges for each drought stage, similar to those used in the Virginia Drought Response and Assessment Plan. Groundwater production well levels for each drought stage should be established with monitoring. If production wells prove too variable, the region may use one or more USGS groundwater monitoring well(s) to establish specific drought stage levels.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

1. “Caroline County Utilities is continually looking for new sources as system takeovers and development plans continue to tax the current supply.
2. “New source considerations are additional wells, a new surface water facility, and consecutive connections with Hanover and/or Spotsylvania Counties.
3. “There is speculation that a private waterworks company will buy Lake Caroline waterworks and rebuild the surface water plant, which would revise the projected future demand for Caroline County Utilities.”

Charles City County Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Charles City County Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 15, 2018, whichever comes first:

1. Existing Water Use: Provide peak day use by month for each community water system.
2. Projected Water Demand: Include all nonagricultural self-supplied user(s) even if their use will remain static (Port Tobacco and Ingenco).
3. Statement of Need and Alternatives Analysis: Provide a description of potential water savings through demand management actions and include water demand management and conservation measures as an alternative.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. “Courthouse Complex system includes the old Courthouse Complex well and the old Gov’t/School administration Bldg. systems and wells.”
2. “The following are listed as community waterworks, but are noncommunity waterworks: Courthouse Complex, School Complex, Roxbury Industrial Park, Ruthville Recreation Center, and Ruthville Gym.”

Charlotte County and Towns Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Charlotte County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Include the source water assessment program for the region that was completed by VDH.
2. Provide the design capacity for the average daily withdrawal and maximum daily withdrawal for each community water system.
3. Provide peak day water use by month for each community water service within the planning area.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

Chincoteague (Town of) Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Town of Chincoteague Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 13, 2018, whichever comes first:

1. Provide an estimate of the amount of water used in production processes by the community water system.
2. Provide information on existing environmental conditions that pertain to, or may affect the sources that provide the current supply.
3. Estimate the water demand for each existing or proposed community water system disaggregated into categories of use appropriate for the system.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on March 4, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, and the Department of Game and Inland Fisheries. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"While not pin-pointed, the plan does indicate the probable locations for future water sources in a general nature (in existing easements) and the possibility of desalination (noted as still expensive).

1. Safe yield evaluation of the existing source(s) have not been provided. "It is known about what yields the new wells will have based on the existing wells."
2. "Given the availability of buildable lots, the growth rate discussed in the WSP may be aggressive."

Craig County and the Town of New Castle Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Craig County and the Town of New Castle Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide information regarding water "available to be purchased" and water "to be purchased" from sources outside the region's planning area, per §9 VAC 25-780-70 G & H.

2. The Drought Response and Contingency Plan defines a "primary drought indicator": precipitation deficits. The County and Town will use this single indicator to determine whether a drought stage is warranted. Establish a groundwater based indicator to enhance drought stage declarations.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, and the Department of Game and Inland Fisheries. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comment:
"One NTNC waterworks identified in the plan is no longer active (PWSID 2045090 Camp on Craig)."

Culpeper County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Culpeper County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 20, 2018, whichever comes first:

1. Provide all of the data requested by Section 9 VAC 25-780-70 for the region.
2. Clarify whether or not water is available for purchase from outside the geographic boundaries of the planning area (Section 9 VAC 25-780-70.G).
3. A source water assessment program for the region was completed by VDH and should be provided.
4. Provide a summary of the County's groundwater protection program.
5. Provide all of the data requested by Section 9 VAC 25-780-80 for the region.
6. Provide a service area map, including any proposed expansion area, for each community water system in the County (Section 9 VAC 25-780-100.D.2).
7. Provide all of the data requested by Section 9 VAC 25-780-100 for the region.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Health, the Department of Conservation and Recreation, and the Department of Game and Inland Fisheries. The Department of Historic Resources and the Marine Resources Commission did not comment on this plan.

Cumberland, Goochland, Henrico, and Powhatan Counties Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Regional Water Supply Plans for the Counties of Cumberland, Goochland, Henrico, and Powhatan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users in all localities, including well construction data.
2. Provide any applicable contract or agreement term (period) for the Founders Bridge system in Powhatan County.
3. Provide all of the data requested by 9 VAC 25-780-80 for all community water systems and self-supplied users, including peak day use by month for Cumberland County.
4. Provide all data requested by 9 VAC 25-780-100 including peak use by month for all community water systems and self-supplied users in Cumberland and Henrico counties, disaggregated demand data for Powhatan County, a clarification of large self-supplied users demand both inside and outside of community water system service areas for Goochland County.
5. Update the Drought Response and Contingency information for all localities to reflect updated local ordinances and/or applicable conditions issued under any Virginia Water Protection Permits.
6. Update appropriate sections of the plan narrative regarding permit applications and issuances for water supply projects, such as the Cobb Creek Reservoir and Henrico County's James River withdrawal.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

"If additional capacity is needed for the village area of Crozier in Goochland County, a safe yield evaluation will be needed for any new wells. Chesterfield County will probably not be able to increase its allocation to Powhatan County, because it will need the remainder of its available water supply for its own customers. The Henrico Regional WTP is currently undergoing an expansion from 58 MGD to 80 MGD. Two non-community waterworks in Henrico County need to be added to the plan – Cedar Fork and Elko Community Center. Three non-community waterworks in Henrico County need to be deleted from the plan – Deep Bottom Boat Ramp, Echo Lake Park, and Richmond Elks Lodge #45."

Fauquier County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Fauquier County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide a copy of the County's updated Drought Response and Contingency Plan (DRCP) with drought stage response and trigger updates. In addition, provide a description of the procedures adopted for implementation and enforcement of the DRCP measures in the Town of Remington and those portions of Fauquier County not served by the Fauquier County Water and Sanitation Authority.
2. Include well construction information for all non-agricultural, self-supplied users of more than 300,000 gallons per month of groundwater.
3. Provide information for water available to be purchased outside the planning area from any source with the capacity to withdraw more than 300,000 gallons per month of surface and groundwater.
4. Provide a projection of water demand on an annual average basis for each existing and any proposed self-supplied nonagricultural user of more than 300,000 gallons per month of surface and groundwater located outside the service areas of CWS.
5. Provide an explanation of how the projected needs of domestic consumption, in stream beneficial uses, and economic development have been accounted for in the projections of future demand is needed.
6. Submit a copy of the County's well monitoring program.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

Fluvanna County and the Town of Columbia Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Fluvanna County and Town of Columbia Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. As outlined in the Local and Regional Water Supply Planning Regulation, Section 9 VAC 25-780-50 D, please provide an update on activities associated with the James River Water Authority.

2. Work with other partners to improve the availability of data requested under the Water Supply Regulation. This includes data gaps in Section 9 VAC 25-780-80 Existing water use information for all public and private community water systems.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

The Department of Health provided the following comments:

"Recent political developments imply that the proposed James River Water Authority will likely not develop into a countywide system. Other alternatives are being considered to supply water to Zion Crossroads area. The new high school is not mentioned in the report, but water availability has become a concern for that facility."

Greene County and the Town of Stanardsville Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Greene County, Virginia and the Town of Stanardsville Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 15, 2018, whichever comes first:

1. Provide a discussion of the pump storage reservoir that was permitted in 2012.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

Greensville County/Sussex County/City of Emporia Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Greensville County/Sussex County/City of Emporia Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 6, 2018, whichever comes first:

1. Clarify annual water use for Georgia Pacific.
2. Clarify average day and max day withdrawals for Stony Creek.
3. Provide Virginia Department of Health Public Water System Identification (PWSID) numbers for applicable groundwater wells.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on February 4, 2013. General comments were received from the Department of Conservation and Recreation and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"The GCWSA-Skippers and Jackson-Field Home waterworks are non-community systems, but have been included in the analysis with the regional community systems. Birch Island is incorrectly listed as having only one well (pg. 41) – it actually has two wells. The Northeast Regional System in Sussex County serves both the prison and several residences, which is not reflected in the report. However, it is unclear whether the non-institutional, residential connections had been added to this system when this report was generated."

The Department of Game and Inland Fisheries provided the following comments:

"Plan is missing water use values for the Borden Plant and the Sussex County Courthouse well complex. Figures 3.1 and 3.2 are very confusing – discrepancy between legend values (mg/day) and table labeling as 'annual water withdrawals.' The colored points in Figure 3.1 do not seem to match up with the use values in associated Table 4.1. They do not appear to match up. We recommend clarifying/fixing that."

Halifax County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Halifax County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first

1. The Town of Scottsburg should provide a method to enforce the Drought Response and Contingency Plan.
2. Provide construction information for non-agricultural, self-supplied users of more than 300,000 gallons per month of ground water [ODEC Clover Power Station drinking water well].
3. The Towns of Scottsburg and Virgilina should address conservation methods.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 1, 2012. General comments were received from the Department of Health, the Department of Game and Inland Fisheries, the Department of Conservation and Recreation, the Department of Historic Resources, and the Marine Resources Commission.

Hanover County and the Town of Ashland Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Hanover County and the Town of Ashland Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 22, 2018, whichever comes first:

1. Verify the locality population figure, total population served by community water system figure, and the existing use data for self-supplied residences and businesses (inside and outside community water system service areas).
2. Provide the existing water used on an average monthly and annual basis for the Holly Ridge community water system.
3. Provide the projected population and estimated water demand for each individual community water system in the planning area, including: a) estimates of the projected population served within the locality for each community water system; b) estimated water demand on both an annual average and peak monthly basis for each community water system; and c) estimated water demand disaggregated by categories of use appropriate for each community water system.
4. Provide the missing source information for community water systems using groundwater.
5. Provide the missing source information for non-agricultural, self-supplied users of more than 300,000 gallons per month of surface water.
6. Include requested information on impaired streams, including the type of impairment.
7. Re-evaluate the adequacy of water resources and additional alternatives as demand is projected to exceed supply prior to completion of the Verdon Quarry water supply project in 2037.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on February 4, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"Many listed systems (Tables 4-1 and 4-2) use <300,000 gal/month. Two systems listed as 'community' are actually non-community (Hanover Courthouse & Taylor House). Richfood Holdings, Inc. may be the same system as Super Value Inc – Mechanicsville Warehouse."

Town of Hillsboro Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Town of Hillsboro Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide unaccounted for losses in the water system due to aging infrastructure.
2. Provide a map of the service area.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on September 26, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following:

1. "The historic water demands have been limited by inadequate water sources. The WSP acknowledged that water demand will increase after inadequate water sources are addressed; however, no attempt was made to quantify the increase. As a result, the WSP should be revised."
2. "The WSP does not call for expansion of the waterworks capacity. The waterworks capacity will need to increase to at least meet the design standards in the Waterworks Regulations; however, this was not discussed in the plan and it should be revised."
3. "The existing spring is likely to be abandoned; therefore a safe yield evaluation will not be needed. The existing well, if retained in service, will need a new safe yield evaluation. The water supply plan should be revised to include reasonable future water demand projections, including review of water demand data from the last decade of waterworks operations (only 2005 was presented) and evaluation of peak day demands based on actual data. Further, the minimum design capacity requirements in the Waterworks Regulations must be considered. The waterworks has completed a Preliminary Engineering Report that addresses much of this information and could be used as the basis for an updated and more useful WSP. The Town acknowledged that a PER was anticipated to be completed in 2011 and '…when more information on the Town's water system is available, a revised Water Supply Plan will be submitted.'"

Hampton Roads Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Hampton Roads Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users in all localities.

2. Provide all of the data requested by Section 9 VAC 25-780-80 of the Regulation, including for privately-owned community water systems.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. “The plan does not include Pooles MHP in Surry County. In Hampton, Langley AFB has spun off the old Bethel Housing area to a contractor, and it is now considered to be a separate waterworks, with a claimed population of 3,344. The total population in the city hasn’t changed, but the population is spread over more waterworks. The proposed water system in James City County (Liberty Ridge) is now permitted and in operation. Two other waterworks in James City County are in development: Fords Colony 35 (currently under construction) and Deer Lakes (construction plans pending). The plan does address the Liberty Ridge project (groundwater), but does not address either Ford’s Colony 35 or Deer Lakes.”

2. “The current VDH permit limit for the Town of Dendron is 125 ERC (0.05 MGD), not 0.02 MGD as listed in Table 1-28. The Scottland Riverview waterworks (formerly known as Scotland Heights) has two wells, but the report only lists one well for the system. DEQ has issued a Groundwater Withdrawal Permit to Chippokes State Park (covering the two separate waterworks in the park), but the park is not identified in the plan as a self-supplied user. The Tidewater Academy waterworks has been inactivated. New sources have been installed or activated at several waterworks since the drafting of this plan.”

3. “Gatling Pointe does receive water from the Town of Smithfield, as noted on page 1-48, but is NOT under a fluoride Consent Order. The Town of Smithfield waterworks is in fact limited by a DEQ Groundwater Withdrawal Permit. Isle of Wight County now owns Lawne's Point, however the system still does not qualify as a Community Waterworks. Ashby Subdivision, Brewer's Creek, Cannon Acres, and Queen Anne's Court have all been connected to Isle of Wight County's Northern Development Service District (NDSD), and their separate Waterworks Operation Permits have been revoked. Red Oaks Mobile Community is in the process of final connection to the NDSD and at that time will no longer be a Community Waterworks. Four waterworks remain on VDH Consent Order for high fluoride violations: Cherry Grove Acres, Deer Run, Longview Acres and Springfield Downs. Bob Steele, Edwards Trailer Park and James River Shores have each been physically separated into private, non-regulated well systems. International Paper's future water needs are unknown. It is unlikely that Smithfield Foods (withdrawing more than 300,000 gal/month) would connect to a publicly owned waterworks in the future.”

4. “Water quality data for the new Drewryville well has been submitted, but the well yield needs to be re-evaluated. The City of Chesapeake will increase their use of raw water from Lake Gaston, once the Red Top transmission facilities (pump station improvements and raw water main, currently under construction) are placed into service. The City of Suffolk is expected to begin purchasing raw water from Lake Gaston as early as 2015.The plan does not include well #6 serving the Holland waterworks in the City of Suffolk.”

5. “The plan noted that the Peninsula may be in a source water deficit situation during the 40-year design period of the plan, but doesn't really address any additional sources to be developed.”

King George County Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the King George County Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide water source data for all community water systems and self-supplied users.
2. Provide water use data for all community water systems and self-supplied users.
3. Provide projections by individual community water system, including projected future water demands on both an annual average and peak monthly basis, projections of population served, and future demands disaggregated into categories of use.
4. Evaluate potential savings through water demand management actions in the analysis of alternative water sources.
5. Describe practices to address water loss in the maintenance of systems to reduce unaccounted for water loss.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on November 20, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, and the Marine Resources Commission.

The Department of Game and Inland Fisheries provided the following comments:

“Federal Endangered Atlantic sturgeon and federal endangered shortnose sturgeon need to be added to the listed species discussion.” Additionally, the agency suggested that all water supply plans include the location and amount of return flows into the system.

Lake Country Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Lake Country Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Clarify the purpose of water withdrawals for SJB Farms, Inc. as being irrigation or non-irrigation, or both.
2. Provide a copy of the source water assessment program for the region that was completed by VDH.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. "WSP is consistent [with existing ODW information and previous planning reports for waterworks] for all systems except the Town of Lawrenceville. Lawrenceville will require an expanded waterworks capacity to serve a committed energy company. ODW has approved a PER that includes a proposed increase in the permitted capacity of the Lawrenceville WTP from 2.0 MGD to 3.0 MGD."
2. "Lake Country WSP should be updated to reflect that the Town of Chase City is now consecutive to the RRSA. The Town was supplied by groundwater wells until August 2012."

Louisa County Long Range Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Louisa County Long Range Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 22, 2018, whichever comes first:

1. Provide an update within the five year review period on activities associated with the James River Water Authority.
2. Work with other partners to improve the availability of data requested under the Water Supply Regulation.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on February 4, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comment:
"The Cutalong Development and New Bridge Landing were not included in the report. These are relatively new and of considerable size."

Lunenburg County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Lunenburg County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 6, 2018, whichever comes first:

1. Clarify the name of the future water source as either Victoria Lake or Modest Creek Reservoir. See Part II, Section A.6.g.
2. Provide a discussion concerning the amount of water available for purchase outside of the planning area from any source with the capacity to withdraw more than 300,000 gallons per month (§9 VAC 25-780-70.G). See Part II, Section A.11.c.
3. Reconcile discrepancies between §2.12 and §5.3.2.2 of the Plan concerning agricultural self-supplied users withdrawing more than 300,000 gallons per month. See Part II, Sections A.12.e and B.5.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on February 4, 2013. General comments were received from the Department of Conservation and Recreation and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Game and Inland Fisheries provided the following comment:
"We recommend that location maps for the sites of water sources be included in the plan."

The Department of Health provided the following comment:
"Safe yield analysis should be updated for Town of Kenbridge and the Town of Victoria."

Madison County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Madison County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 20, 2018, whichever comes first:

1. Provide well construction data requested for all community water systems using groundwater (§9 VAC 25-780-70.B).
2. Work with privately owned community water systems in the planning area to better represent water use information required by Section 9 VAC 25-780-80 of the Regulation for their systems.
3. Address production processes as a disaggregated use for the Rapidan Service Authority Community Water System existing water use and projected water demand (§9 VAC 25-780-80.B.9 and 100.D.4).
4. Provide population projections for all community water systems (§9 VAC 25-780-100.D.1).
5. Provide a service area map, including any proposed expansion area, for each existing community water system (§9 VAC 25-780-100.D.2).

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, and the Department of Game and Inland Fisheries. The Marine Resources Commission did not provide comments on this plan.

Middle Peninsula Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Middle Peninsula Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or December 20, 2018, whichever comes first:

1. Complete items marked as "to be addressed in the next plan revision" as noted in the "Response Matrix for DEQ Comments," submitted to DEQ with the regional plan in July 2011.
2. Include the annual and monthly permitted amounts contained in groundwater withdrawal permits for all the community water systems located within the Ground Water Management Areas.
3. Provide additional information for non-agricultural self-supplied users of >300,000 gallons per month of surface water including any limitations on withdrawals established by permits issued by the SWCB, VDH, or any other agency and the average and maximum daily withdrawal design capacities.
4. Provide peak day water use by month for community water systems in the planning region.
5. Provide the missing water demand projection data for the community water systems in the region including the estimated water demand in annual average and peak monthly basis for each existing or proposed CWS.
6. Evaluate the items currently missing from the alternative analysis, including a description of potential water savings through demand management, and a description of water demand management and conservation alternatives.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"In Table 4 on page 23, Essex County presently has 12 community water systems and Mathews County has 7 community water systems for a total of 46 community water systems. On Page 112, it was stated that the Town of West Point may exceed VDH permitted capacity by 2012. It has not exceeded and is well within the VDH permitted capacity."

New Kent County Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the New Kent County Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 15, 2013, whichever comes first:

1. Specify the number of self-supplied users less than 300,000 gallons per month of groundwater inside each community water system service area.
2. Provide all the information required by for all community water systems using groundwater, including those privately owned.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 12, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

New River Valley Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the New River Valley Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 8, 2018, whichever comes first:

1. Maps should include references to streams, rivers, counties, etc. in Existing Resource Information.
2. Provide summary table for disaggregated demand, including non-municipal (private) community water systems.
3. Provide peak day water use by month for all community water systems within the planning area.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

Northampton County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Northampton County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 13, 2018, whichever comes first:

1. Clarify how the region intends to implement and enforce the mandatory restrictions of the drought response and contingency plan prior to drought ordinance adoption, and provide copies of enacted ordinances upon adoption.

2. Please provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users and self-supplied users.

3. Work with community water systems and self-supplied users to develop the water use information required by Section 9 VAC 25-780-80 of the Regulation for their systems, particularly average daily and maximum daily withdrawals, and average monthly and average annual withdrawals.

4. Provide all of the data requested by §9 VAC 25-780-100 Projected Water Demand. Much of the data requested by the Regulation has been provided; however, certain necessary data is missing for a number of community water systems and self-supplied users such as population with each locality served by a community water system and self-supplied users, maps depicting proposed community water systems and self-supplied users service areas, disaggregated demand data, and water demand projections for both large and small self-supplied users..

5. Provide an update on use and demand for Kiptopeke Condominiums.

6. Provide a service area map for the Northampton County Complex.

7. Provide savings calculations, estimates, or a description of potential water savings through demand management actions.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on March 4, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Marine Resources Commission, and the Department of Historic Resources.

The Department of Health provided the following comments:

1. "The plan indicates growth in the Cape Charles and Exmore areas, based on past population projections, perhaps to the point where they exceed the current VDH permitted capacities. The plant does not address expansion of either waterworks' capacity."

   Responding to the need for future new or expanded waterworks - "although it would not take much to cause the projections to be off. Just about any minor positive correction in the economy could triple the growth rate."

2. "The plan mentions RO and ASR in general, but does not discuss their implementation with respect to any particular waterworks."

3. "The WSP does not address the scheduled move of the hospital (a significant user of the aquifer) from Northampton County to Accomack County. There is currently no established timeframe for the move, but current indications are that it will occur in the next three to five years."

4. "Section 6 of the WSP (Water Demand Management) is written as if for a single waterworks/town, rather than for the actual situation (multiple jurisdictions)."

5. "The service area for the Town of Eastville doesn't include the high school (which the Town serves) - the population given is only for the Town proper."

6. "The Plan talks about population growth in the Cheriton and Nassawadox areas, but there are currently no waterworks located in those areas. The Plan does not discuss creation of new waterworks in those areas."

The Virginia Marine Resources Commission provided the following comments:

"While the plan characterizes the existing resources information in the region, we note that new water supplies will likely target ground water resources. As such, the need for any permits for encroachments over State-owned submerged land would likely only involve pipelines or infrastructure that would cross a waterway."

Northern Neck Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Northern Neck Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide a map for each community water system service area.
2. Provide all of the data requested by the Existing Water Use (§9 VAC 25-780-80) and Projected Water Demand (§9 VAC 25-780-100) sections of the Regulation for all community water systems as well as for small self-supplied users. Provide water use data by community water systems for disaggregated use type and for unaccounted losses.
3. Provide additional information on existing water resource conditions including a description of impaired streams and the type of impairment and a description of conservation easements and riparian buffers.
4. Provide additional information on existing water resources, if available, including an indication of the percentage of impervious cover within the source watershed and where new development may impact source water quality.
5. Provide information on additional water demand management strategies to ensure the sustainability of water resources in the region, including efforts to improve compliance with the Uniform Statewide Building Code.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on 9/26/2012. General comments were received from the Department of Health, the Department of Historic Resources, and the Marine Resources Commission. The Department of Conservation and Recreation did not provide comments on this plan.

The Department of Game and Inland Fisheries provided the following comments:

1. “The following listed species are known from the counties covered by this plan but were not included in the plan. We recommend that the plan be updated to include these species:
   a. Westmoreland County – federal Endangered (FE) Atlantic sturgeon

b. Lancaster County – federal Endangered Kemp's Ridley sea turtles, federal Threatened (FT) loggerhead sea turtles, FT green sea turtles, FE Atlantic sturgeon, and FE shortnose sturgeon

c. Richmond County – FE shortnose sturgeon

d. Northumberland County - federal Endangered Kemp's Ridley sea turtles, federal Threatened (FT) loggerhead sea turtles, FT green sea turtles, Atlantic sturgeon, and FE shortnose sturgeon"

2. "Impoundments have been identified as possible drinking water supplies in case groundwater does not meet future demand or becomes unusable for some reason. It would be helpful if the potential sites were identified by information other than simply the physical address (maps, lat/long coordinates, stream name) and if the size and yield of the impoundments were included for each."

Northern Shenandoah Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Northern Shenandoah Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Town of Mount Jackson needs to provide documentation of how drought measure**s** will be enforced.
2. Projected Water Demand for City of Winchester should be presented for each decade in the planning horizon.
3. Work with cooperative extension or soil and water conservation staff to better represent source information for non irrigation, i.e. livestock watering.
4. Work with privately-owned community water systems to better represent use information for their systems.
5. Projected Water Demand: The following use categories should be incorporated into summary tables by county/city and by planning region, even if their use is expected to remain static.
    a. self supplied non agricultural users >300,000 gallons per month
    b. privately owned community water systems using >300,000 gallons per month
    c. self supplied agricultural users > 300,000 gallons per month
    d. small self supplied users on domestic wells (rural population) and small businesses using less than 300,000 gallons per month
6. Statement of Need and Alternatives Analysis: Additional detail is requested on Berryville's conservation predictions of 20% reduction; additional detail is requested on FCSA's planned quarry expansion or other alternatives, including potential issues and impacts; additional detail is requested on Middletown's conservation strategy.
7. Water Available to be Purchased: Elaborate on the opportunities for water purchases with localities that are not part of the NSRVC.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on November 20, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

"Two identified community waterworks – Battleground Trailer & Mountain Waterworks – are no longer active waterworks. George's Chicken permitted design capacity is 1.525 MGD, not 14.98 MGD."

Northern Virginia Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Northern Virginia Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide the design capacity for the average daily withdrawal for each of Loudoun County's six public groundwater-based community water systems.
2. Provide the storage capacity and/or safe yield of the Savage Reservoir.
3. Provide the following information on City of Fairfax's Goose Creek intake: drainage area above the intake, lowest daily flow of record, and design capacity of the pump station.
4. Provide information for agricultural self-supplied users of more than 300,000 gallons per month.
5. Provide the maximum daily withdrawal for Community Water Systems.
6. Provide usage on an average monthly and annual basis peak day use by each month for Arlington County.
7. Provide peak day use by each month for Cities of Alexandria and Fairfax and Towns of Hamilton, Lovettsville, and Middleburg.
8. Provide estimate of the water used on an average annual basis by self-supplied nonagricultural users of more than 300,000 gallons per month of surface and ground water for Arlington County and Fairfax County.
9. Provide the estimated average annual use for Festival Lake Farm in Loudoun County.
10. Provide the estimated average annual use for the Fairfax County Park Authority Burke Lake Golf Course.
11. Provide the estimated average annual use for Ticonderoga Farms and Wheatland Vegetable Farm in Loudoun County.
12. Provide total projected water demand for all existing or proposed community water systems, including privately owned, disaggregated into categories.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on November 20, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. “The Town of Round Hill is expected to require expansion, but the WSP does not identify this need.”

2. “No effort was made to evaluate the status and capacity of existing groundwater sources beyond a paperwork review of VDH ODW's permitted yields and waterworks capacities. Round Hill, Purcellville and Hamilton, for example, are known to have groundwater wells that have experienced declining yields and the most recent yield and drawdown tests (conducted decades ago) are no longer reasonable estimates of the source capacities (i.e., are overoptimistic). This introduces some uncertainty into the capacity of the waterworks. As part of the planning effort, these groundwater sources need to [be] reevaluated and this new yield information considered as part of the statement of need. At a minimum, the uncertainty in the capacity of the waterworks should be shown in the graphs in Section 8 of the report.”

3. “VDH ODW conducted a spot review of the calculations and assumptions used in the demand projections for the non-coop water system. We have the following comments:

   a. Table 5-5: Method 2 Total Projected Demand on page 5-10 contains incorrect information and needs to be updated. The values in this table do not match the values in Appendix D.

   b. The data in the graphs in Section 8.3, Statement of Need for the non-coop waterworks is incorrect. The supply surplus should [be] calculated as the water source capacity minus the peak monthly average rather than the annual average. Further, the peak day demand should be estimated to confirm that the waterworks can meet this demand.

   c. Generally, the assumptions used for modeling the demand need to be reviewed and validated by the water system owners. We feel some assumptions do not match reality or our knowledge of the water systems.

   d. The demand type percentages in Table 5-4 should be backed up with facts about the water systems, rather than assumed. For example, Towns of Lovettsville, Round Hill, Hamilton, and Middleburg do not have industrial parks (and this is unlikely to change) and the percentage of Heavy Industry Demand should be zero. Likewise, the percent commercial, institutional, and industrial demand should be obtained from the waterworks and not assumed.

e. Town of Quantico was assumed to have zero percent unaccounted for water, which is overoptimistic. The Town's unaccounted for water [was] 6.7% in 2010 and this assumption should be revised.

f. The 2007 annual average demand for Lovettsville is 113,313 gpd or 3.4 MG/month; however the calculations showed 0.11 MG/month. The calculations and Figure 8.3.6 need to be corrected.

g. The Town of Clifton water supply demand projection should be revisited because it was based principally on information from two noncommunity waterworks - one of which is located outside of the Town. There is no central or community waterworks serving Clifton. The demand projections should be updated to include the five noncommunity waterworks located inside Town plus the residential demand supplied by private wells.

h. Some water systems serve both customers inside the Town and in adjacent areas outside the Town in the County, for example, Hamilton, and Round Hill. Others still have significant undeveloped land in town such as Purcellville and Lovettsville. In addition to using census data and growth projections for the land inside the Town borders, the population served by the water system in 2040 should consider the expected increase in service area outside the existing service area. We understand the Round Hill and Lovettsville will experience significant growth through 2040, not reflected in the demand projections. As a result of this growth, expansion in source capacity may be required."

Nottoway Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Nottoway Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 6, 2018, whichever comes first:

1. Provide response to §9 VAC 25-780-70 G and 70 H regarding water available to be purchased from outside the planning area.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on February 4, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources provided general comments. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"Updated safe yield analysis should be completed for the Town of Crewe and Blackstone. The Town of Crewe has a SRF planning grant to identify possible additional sources of raw and finished water. A preliminary engineering conference was held in DFO on March 8, 2013. The Town is currently working with a consultant to develop a PER to be submitted to this Office for review."

Orange County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Orange County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 20, 2018, whichever comes first:

1. Provide the design capacity for average daily and maximum daily withdrawals from the Town of Orange Reservoir.
2. For all non-agricultural, self-supplied users of more than 300,000 gallons per month of surface water, provide the design capacity for the maximum daily withdrawal and any limitations on the withdrawals, as established by permits issued by the State Water Control Board (DEQ), the Virginia Department of Health, or any other agency.
3. For all non-agricultural, self-supplied users of more than 300,000 gallons per month of groundwater, provide the well construction data (well name/ID, well depth, casing depth, screen depth, well diameter); the design capacity for the maximum daily withdrawal; and any limitations on the withdrawal, as established by permits issued by the Virginia Department of Health.
4. Provide the well construction data.
5. Provide a summary of findings and recommendations from source water assessment plans and/or wellhead protection programs.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Conservation and Recreation and the Department of Game and Inland Fisheries. The Department of Historic Resources and the Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

“RSA Wilderness has submitted an application requesting a permitted withdrawal of 3.0 mgd.”

Town of Port Royal Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Town of Port Royal Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or December 20, 2018, whichever comes first:

1. With assistance as offered from the Virginia Department of Health, investigate loan opportunities for system improvements, and keep DEQ apprised of the efforts.
2. Investigate opportunities in demand management, including public outreach for conservation efforts.
3. Provide percentage of impervious cover within the Town limits.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 03, 2013. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

The Department of Health provided the following comments:

"Existing town growth negligible, but major infrastructure rehab is needed before any serious growth could occur. Tidewater mobile home park has two wells of unknown capacity or construction that could be considered [as additional sources] after well yield and draw down tests that could show respectable yields. Tidewater MHP to do yield and drawdown [tests] if considered [as new water sources]."

Prince Edward County and the Town of Farmville Regional Water Supply Plan Compliance Determination

<u>Proposed Action:</u>

As documented in the attached Compliance Checklist, staff recommends that the Prince Edward County and the Town of Farmville Regional Water Supply Plan be found to <u>comply</u> with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Because withdrawals from the Sandy River Reservoir are currently permitted under state (DEQ) and federal (Corps) regulations, provide the information required by -70 C (source information for community water systems using reservoirs) including the limitations on withdrawal established by the permits.

2. Update all applicable sections of the plan to reflect any new information regarding the Manor Golf Club.

3. Revise the statement found in Section 2.9 of the plan, as follows: "During times of drought, farmers in Prince Edward County may be ~~given the right to~~ authorized to withdraw water directly from the Appomattox River and the Sandy River Reservoir with tanker trucks~~. However, this right is given to local farmers~~ on a case by case basis after evaluation ~~of the water source and drought conditions~~ by applicable permitting agencies." DEQ, on behalf of the State Water Control Board, makes this determination at the state level [-70 I].

4. Clarify what the term "grandfathered" refers to on page 44 of the plan narrative ["Water use information concerning transient-non-community systems in Prince Edward County is scarce. Most systems are known as "grandfathered systems" and are not required to monitor or report their water usage."] Clarify which regulation is referenced such as the Virginia Water Protection Permit Program Regulation; the Virginia DEQ Water Use Reporting Regulation; Virginia Department of Health Regulations; or some other regulation.

5. Peak daily demand (gpd) projections were provided for each sector by decade. Provide the estimated water demand for each existing or proposed CWS on a peak monthly basis [Note: the Town reliance on upstream storage cannot occur without authorization by a VWP permit].

<u>State agency comments:</u>

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. "The WSP indicates that the Appomattox River has adequate capacity to meet the existing and future demands of the Farmville Community Waterworks; however, historically there is evidence that additionally source water is needed during low-flow or drought conditions."

2. "The WSP indicates that the Town of Farmville's consulting engineer has estimated the safe yield of the Buffalo Creek Watershed as approximately 2 MGD. To date, the Office of Drinking Water has not reviewed and approved a safe yield analysis, as required by the Waterworks Regulations, for withdraw of raw water from the Buffalo Creek Watershed. A preliminary engineering report will need to be developed and submitted to the Office of Drinking Water which evaluates water quality, safe yield, and design of proposed intake, control, and pumping facilities prior to proceeding with final design and construction."

3. "A DEQ withdrawal permit of 6.3 MGD has been issued to Prince Edward County for the existing Sandy Creek Reservoir. The Office of Drinking Water has approved a preliminary engineering report for a WTP for Prince Edward County with the Sandy Creek Reservoir as the water source. To date, neither an evaluation nor a formal review of the Buffalo Creek Watershed water quality has been performed by the Office of Drinking Water [one of the five alternatives discussed in the WSP to provide additional source water to the Farmville WTP]."

Roanoke Valley Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Roanoke Valley Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Provide well construction information for all groundwater-based community water systems and self-supplied users in the region.
2. Provide the disaggregation information for each individual community water system and the peak day water use by month for each individual community water system in the planning area.
3. Provide a qualitative description of existing in-stream beneficial uses within the planning area or outside the planning area that may be affected by the point of stream withdrawal.
4. Provide a summary of land use in the region and the aage of impervious cover. Also, provide a summation of the land use where new development may impact the quality of a water source.
5. Provide water use data for self-supplied agricultural users of more than 300,000 gallons per month of surface water and groundwater for agriculture.
6. Provide the estimated water demand for each existing or proposed community water system on both an annual average and peak monthly basis. In addition, estimate water demand for each existing or proposed community water system disaggregated into categories of use appropriate for the system.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on September 7, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. The WPS does not mention the 12-inch diameter US Route 220 waterline that extends from the Western Virginia Water Authority into Franklin County.

2. The WSP mentions Andrew Lewis Place as a consecutive waterworks to the City of Salem. Andrew Lewis Place is served by the Western Virginia Water Authority.

3. The WSP does not mention that the Western Virginia Water Authority provides some water to the Town of Vinton - mainly to a single manufacturing facility.

4. The WSP makes reference to a private community water sytem that utilizes groundwater within the City of Salem. This statement is incorrect.

5. Page 9 of the Executive Summary notes an existing capacity for the City of Salem as 10.5 MGD. The currently permitted capacity for the City of Salem waterworks is 10.0 MGD.

6. Page 9 of the Executive Summary states "…The City of Salem currently has a water supply surplus of 2.50 MGD based on a limiting capacity of 8.00 MGD". As noted the existing permitted capacity for the City of Salem waterworks is 10.0 MGD. This design capacity is source limited with 8 MGD capacity from the Roanoke River intake and an additional 2.0 MGD capacity from 3 drilled wells that provide additional source water to the WTP.

7. Page 10 of the Executive Summary indicates that the Town of Fincastle owns and operates the public community water system for the Town. Actually the Western Virginia Water Authority operates the waterworks.

8. Page 11 of the Executive Summary indicates that the Town of Troutville purchases some water from the Western Virginia Water Authority. Actually the Town of Troutville purchases water from Botetourt County.

9. Section 2-26 indicates BCPSA owns Woodhaven Nursing Home. Woodhaven Nursing Home is privately owned by Family Health Initiatives, Inc.

10. Section 2-27 Information for Hillcrest Subdivision (PWSID 5019425) is incorrect. It uses information from Hillcrest Mobile Home Park (PWSID 5019430).

11. Section 2-28 Meadow Run MHP has connected to City of Bedford water system.

12. Section 2-33 Waterways Subdivision has connected to Smith Mountain Lake Central Water System.

13. Plan does not mention the SR220 waterline owned by WVA that starts in Roanoke and follows SR220 through Boones Mill and terminates about a mile north of Rocky Mount.

Rappahannock County Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Rappahannock County Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 20, 2018, whichever comes first:

1. Improve data collection for self-supplied users and provide source data for those self-supplied, non-agricultural users that withdraw more than 300,000 gallons per month of surface water or groundwater (§9 VAC 25-780-70.E).

2. Provide an estimate of projected water demand for the system disaggregated into categories of use appropriate for the system, as required by 9 VAC 25-780-100 D.4.

3. The County should consider placing greater emphasis on water conservation and demand management practices, given the region's dependence upon groundwater sources and the concerns expressed in the Plan regarding future water supply quantity and quality.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

Region 2000 Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Region 2000 Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Per 70B, provide the Design Capacity-Max Daily for community water systems in Bedford and Campbell Counties.
2. Per 80B, provide the peak day water use by month (e.g., one value for each of the twelve months of the year in which data applies) for each community water system.
3. Provide the Maximum Daily Withdrawal (mgd) for the Town of Altavista.
4. Provide a qualitative description of existing in-stream beneficial uses either within or outside the planning area that may be affected by the point of stream withdrawal for each community water system using stream intakes.
5. Provide the break out of percentage of impervious cover for Amherst County and the Town of Amherst.
6. Address the information required by Sections 100 of the regulation, as noted in the checklist.
    a. Per Section 100D of the regulation, provide estimates of population within the locality served by each community water system.
    b. Per Section 100D, provide the estimated water demand for each existing or proposed private community water system on both an annual average and peak monthly basis, as well as the estimated water demand for each existing or proposed private community water system disaggregated into categories, for those jurisdictions where this information is not shown.
    c. Per Section 100D, revise Section 2 to show service area boundaries.
    d. The projected needs of economic development have been accounted for in the demand projections for Amherst County, Appomattox County, Bedford County, and the City of Lynchburg. As required by Section 100I of the regulation, explain how domestic consumption and the projected needs of economic development have been accounted for in the demand projections for the remaining jurisdictions. Also, elaborate on how domestic consumption has been

accounted for in the demand projections for Amherst County, Appomattox County, Bedford County, and the City of Lynchburg.

7. Provide a statement as to whether or not, and how, current conservation practices, techniques and technologies were considered in the water demand projections, as required by Section 110B of the regulation.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

<u>The Department of Health provided the following comments:</u>

1. For CCUSA, report states capacity of 4.4 MGD. WTP is only rated for 4.15 MGD. Current permit is 3.0 MGD due to raw water pump station.
2. NCSA Wintergreen's source has been previously impacted by drought and this waterworks will likely need additional source capacity well before the projected 2060 county-wide date.
3. Gladstone's source is NOT a "stream" it is a groundwater spring.
4. Johnson Senior Center is no longer regulated as a community waterworks.
5. In the Lovingston system, Bowling Well Nos. 2 and 3 no longer exist as they were interconnected with Bowling Well No. 1
6. Stoney Creek Village now has 4 wells (Well 26 is missing from the report)
7. Interconnection between CCUSA, Appomattox County, and Town of Appomattox has occurred.
8. Bedford County Public Service Authority High Point WTP uses surface water reservoir (Smith Mountain Lake), not stream.
9. Eagle Eyrie system is an “NTNC” not “C”.
10. Information for Hillcrest Subdivision (PWSID 5019425) is incorrect. It uses information from Hillcrest Mobile Home Park (PWSID 5019430).
11. The following waterworks are no longer regulated as community waterworks:

a. Serving less than 15 connections or 25 persons- Bedford Place #2, Hardy Road MHP Section I, Clearview Estates, Homestead MHP, Lake Forest, Landmark MHP, Liberty Apartments, Snidow

b. Connected to Forest Central Water System (PWSID 5019315)- Ashton Ridge, Cedar Hills, VDOT

c. Connected to City of Bedford (PWSID 5515050)- Meadow Run MHP

d. Connected to Smith Mountain Lake Central Water System (PWSID 5019400)- Waterways

e. Connected to Stewartsville Consecutive (PWSID 5019795)- Cherry Hill Estates

f. Never regulated as a community waterworks- Blue Ridge Heights, Edwards MHP, Harbour Heights

12. Amherst County Service Authority's James River intake is for emergency use only. Not approved as a regular source.

13. BCPSA High Point WTP now has a 1 MGD Capacity.

14. Water supply plan does not include Big Otter River as a water source (part 2.1.6) for City of Bedford.

15. The supply plan (part 8.2.7) also shows a capacity of 2.0 MGD for City of Bedford, actual permitted capacity is 3.45 MGD.

City of Richmond Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the City of Richmond Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. There is no information presented on written comments that may have been submitted as part of the public hearing process. Indicate whether or not comments were received. If written comments were received, a copy of the written comments and the locality's written response must be submitted.
2. Ordinances adopted to implement the Drought Response and Contingency Plan are not included. Confirm that Ordinance No. 2002-210-223 (adopted July 30, 2002) and Ordinance No. 220-238-256 (adopted September 23, 2002) are applicable for enforcing the City's drought responses.
3. Provide the value for safe yield for the James River intake rather than reference Army Corps of Engineers permit.
4. Provide the percentage of impervious cover in the city.
5. Provide projected water demand in disaggregated categories, including a line item for wholesale values to neighboring counties, with self-supplied user demand for the thirty- to fifty-year planning period. This cumulative table would promote a better understanding of all demands for the planning area.
6. Provide information regarding the Virginia Department of Health's Source Water Assessment Program results.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Marine Resources Commission.

Southwest Virginia Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Southwest Virginia Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or December 13, 2018, whichever comes first:

1. Provide copies of any adopted drought ordinances or clarify how Lee County, the City of Norton, and the Towns of Appalachia, Big Stone Gap, Clinchport, Coeburn, Dungannon, Gate City, Jonesville, Nickelsville, Pennington Gap, Pound, St. Paul, and Wise will implement and enforce the drought response and contingency plan.

2. Provide well, reservoir, and stream intake source information for community water systems in the planning region.

3. Provide the maximum daily and average annual purchase and the term of contract/agreement for the Bland County's Rocky Gap/Bastian system.

4. Clarify information regarding the Austinville community water system and the New River Water Authority, which appear to be discussing the same intake on the New River (permitted by DEQ under VWP No. 04-2106). If considered two separate community water systems as presented in the source section of the plan, provide water use data for the New River Water Authority.

5. Provide source information for self-supplied users of greater than 300,000 gallons per month of surface water and groundwater.

6. For the towns in Cumberland Plateau and LENOWISCO PDC areas, provide information for self-supplied residential and business users withdrawing less than 300,000 gallons per month.

7. Information needed to address Section 80 B is listed below:

   a. Provide water use information for each individual community water system in the following municipalities: Bland County (both municipal community water systems), Buchanan County (Osborne Mountain), Lee County (the nine community water systems that purchase water), Russell County (Castlewood community water system), Smyth County (all nine municipal community water systems), and Wise County (South Mountain, Mill Branch, Blackwood, Flatwoods, Appalachia #1, and Wise #2).

b. Provide the peak day use data for community water systems within the Mount Rogers Planning District.

c. Provide the disaggregated use for the Lee Co PSA- separate disaggregation for each of the nine community water systems that purchase water; Wise Co PSA- separate disaggregation for each of the nine systems that purchase water; and Mt Rogers PDC - separate disaggregation for all municipal community water systems.

d. For each community water system using stream intakes, provide a qualitative description of existing in-stream beneficial uses either within or outside the planning area that may be affected by the point of stream withdrawal.

8. To address Section 90 B, verify the primary land uses within the Cumberland Plateau and LENOWISCO PDCs, which is noted as being "primarily residential with limited agricultural and commercial activity," and provide a discussion of percentage of impervious cover for each of the PDC regions.

9. Provide a total projected water demand by disaggregate category for all existing or proposed community water systems in the Cumberland Plateau and Lenowisco PDCs. Provide projected demand information for the Castlewood Water and Sewer Authority.

<u>State agency comments:</u>

The plan was submitted to state agencies for their evaluation and comment on March 4, 2013. General comments were received from the Department of Conservation and Recreation, and the Department of Historic Resources. The Marine Resources Commission did not provide comments on this plan.

<u>The Department of Game and Inland Fisheries provided the following comments:</u>

"This plan was very confusion [sic]. It was poorly organized and inconsistent from one section to another. There were a number of inconsistencies documented on page 3-8. Some of the values appear incorrect, the math just doesn't work out. On page 3-8 Washington County use is described as about 2400 mg per year used for residential and commercial uses as well as unaccounted for loss. That works out to an average of above 6.575 mgd. However, on page 3-9 they say the average withdrawal is .6 mgd with a peak day demand of .72 mgd. For uses without info on peak demand they use a factor of 1.2 to predict peak demand but on page 3-9 they cite the Middle Fork Holston use with a documented peaking factor of 2.556. We recommend the authors of the plan use the information available based upon actual use rather than an arbitrary multiplier. In addition, they cite peak day demands that exceed permitted withdrawals. In Lee, Tazewell and Wise Counties they cite surface withdrawals that are either extremely close or exceed the permitted withdrawal but no documentation for expanded need for the future."

The Department of Health provided the following comment:

“Virginia Carolina Water Authority (1077825) and Fancy Gap (1035581) [are identified as significant waterworks that are excluded from the plan].

Spotsylvania County, VA and the City of Fredericksburg Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Spotsylvania County, VA and City of Fredericksburg Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five year review of the plan, or November 22, 2018, whichever comes first:

1. Provide the drainage area above each stream intake for those Community Water Systems that utilize intakes.
2. Provide the design capacity withdrawal (average daily and maximum daily) for each self-supplied user listed in Table 2-4, and provide any limitations on withdrawals established by permits issued by the SWCB, VDH, or any other agency.
3. Provide well construction data and design capacity average daily data for the ground water users listed in Table 2-3.
4. Clarify the number of self-supplied users of less than 300,000 gallons per month.
5. Provide the actual values in each disaggregated use category shown in Figures 5-4 and 5-5 (Section 5 of the plan), including the total projected water demand for all existing or proposed CWS disaggregated into the categories.
6. Verify whether or not the Ni River intake structure for GM Powertain, as noted on page 2-13 of the plan, has been abandoned and/or physically removed from the river.
7. Provide a discussion of the disaggregated category “sales to other community water systems” in projected demands section of the plan.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on January 3, 2013. General comments were received from the Department of Conservation and Recreation and the Department of Game and Inland Fisheries. The Department of Historic Resources and the Marine Resources Commission did not provide comments on this plan. The Department of Health provided the following comments:

1. "This report presents a number of different options to expand source capacity, but doesn't propose implementing any of them. The report indicates alternative C1, "New Intake on the Lower Rappahannock River," was deemed unfeasible due to water quality concerns, although it remains among the recommended options."

2. "Among the recommended options is wholesale purchase from Stafford Co, although Stafford Co Utilities has not included wholesale delivery of water to Spotsylvania Co in their planning."

3. "Figures used for safe yield in the report for existing reservoirs may not have included sediment or recreation volume. The County has performed more recent evaluations of safe yield that are currently under review by ODW."

4. "WSP projects a 2060 demand from the Spotsylvania Co municipal system and Fredericksburg of 24 MGD, compared with the current combined source capacity of 21.4 MGD. The report doesn't address this shortfall, but the projected demand in 2050 is 19.9 MGD and 2050 is beyond the 30 year WSP minimum required planning period."

5. "There is no discussion of the methodology employed in projecting commercial/industrial growth."

6. Some of the values in the report do not match VDH records: e.g. the design cap of Motts is listed as 13 MGD, with permitted cap of 15 MGD (which matches our records). Some of the values are errors, e.g. New Life for Youth yield is 32 gpm rather than the 320 gpm in the report. These errors are probably of less significance in terms of biasing the reports' conclusions than some of the other issues, namely the uncertainty regarding projecting commercial and industrial growth."

Stafford County Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Stafford County Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide a list of the agricultural users in the County.

2. Update the plan to reflect the status of the Stafford County, Spotsylvania County, and the City of Fredericksburg Regional Public Water and Sewer Mutual Aid and Assistance Agreement from February 2009. Piped emergency treated water connections were expected to increase the water transfer capacity to between 5 and 10 MGD.

3. Update plan data regarding the Rocky Pen Run Reservoir and intake, including any operational information and permit limitations.

4. Expand upon and update the discussion of the presence or absence of state threatened or endangered species is not discussed in the plan narrative.

5. Update the status of water purchase agreements between Stafford County and Quantico Marine Corps Base.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on September 26, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

1. "Plan discussed future transfer from Lunga (Quantico MCB) to Beaverdam Run (Smith Lake), but only as a short term measure, not to increase safe yield of Smith. The current agreement between Quantico MCB and Stafford allows for 0.75 MGD transfer to offset treated water sales to Quantico MCB — Camp Barrett, but Stafford has not historically requested that allowance."

2. "Even with Rocky Pen Run project, shortfall of 2.6 MGD is expected by 2050. Shortfall will be made up by water conservation and control of water loss. Plan doesn't address sedimentation of reservoirs or forecast a decrease in safe yield or need for dredging."

Upper James River Basin Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Upper James River Basin Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Section 9 VAC 25-780-50.C.1 of the Regulation requires "a description of existing water sources in accordance with the requirements of 9 VAC 25-780-70." Although an effort to provide this information has been made, data gaps exist for community water systems and self-supplied users in some localities. Provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users in all localities.
2. Planning partners should collaborate to present methodologies and data located within the Existing Water Usage and Projected Water Demands chapters in a consistent format to improve data collection, analysis, and presentation, and to provide a comprehensive representation of the entire region.
3. Work with privately-owned community water systems to better represent water use information required by Section 9 VAC 25-780-80 of the Regulation for their systems.
4. Provide a map for each community water system service area, including any proposed expansion areas, for each community water system in the planning region (§9 VAC 25-780-100.D.2).
5. Consider current conservation practices, techniques, and technologies in water demand projections (§9 VAC 25-780-110 B).
6. Update Table 8.1 to include all existing municipal water systems to provide a comprehensive picture of future demand for the region.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on December 3, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comment:

“Several waterworks are listed in the report that are no longer public water systems. Most have been incorporated into larger existing systems and some are no longer public due to size.”

Upper Shenandoah Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Upper Shenandoah Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide all of the data requested by 9 VAC 25-780-70 for all community water systems and self-supplied users in all localities.
2. Verification is needed from localities as to whether there is water available for purchase outside of the planning area.
3. Work with privately-owned community water systems to better represent water use information required by Section 9 VAC 25-780-50.C.2 of the Regulation for their systems.
4. Provide a map for each community water system service area.
5. Provide an estimate of future water use projected at the beginning of each decade for Augusta County.
6. Provide an explanation of how the projected needs of domestic consumption, in-stream uses, and economic development have been accounted for in the demand projection for the planning period.
7. Provide a more thorough analysis of potential alternatives to meet future demand shortfalls, including a description of potential water savings from water demand management actions and a description of potential resource impacts for each potential new source as called for in §9 VAC 25-780-130 B of the Regulation.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on August 15, 2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

Town of Warrenton Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the Warrenton Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 15, 2018, whichever comes first:

1. Provide well construction data: screen depth.
2. Provide all of the data requested by 9 VAC 25-780-80 for all community water systems and self-supplied users.
3. Provide documentation for the 700gpd/acre multiplier used to determine build-out water demand for commercial land uses.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on 9/26/2012. General comments were received from the Department of Health, the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

West Piedmont Regional Water Supply Plan Compliance Determination

Proposed Action:

As documented in the attached Compliance Checklist, staff recommends that the West Piedmont Regional Water Supply Plan be found to comply with 9 VAC 25-780-140.C and F, with the following conditions to be completed in time for the five-year review of the plan, or November 8, 2018, whichever comes first:

1. Provide peak day water use by month for the community water systems located in the Towns of Chatham, Danville, and Gretna.
2. Update all plan data regarding the following facilities, including the operational status and corresponding Virginia Water Protection (VWP) permit or permit exclusion status of each facility, as well as the effects of changes in the status of the facilities upon projected demands for the following:
    a. The Town of Gretna Whitethorn Creek Reservoir
    b. Henry County Upper Smith River intake (a VWP permit application for an increased withdrawal was under review by DEQ as of 2013)
    c. Pittsylvania County Leesville Lake intake (VWP permit 06-2325, not constructed as of 2013)
3. Expand on land cover and land use information to include percentage of impervious cover within a watershed and areas where new development may impact water quality of the source.

State agency comments:

The plan was submitted to state agencies for their evaluation and comment on September 7, 2012. General comments were received from the Department of Conservation and Recreation, the Department of Historic Resources, the Department of Game and Inland Fisheries, and the Marine Resources Commission.

The Department of Health provided the following comments:

“City of Martinsville sources (Beaver Creek Reservoir and Leatherwood Creek) safe yields have been reduced and reflected in Operation Permit dated January 31, 2012. The report indicates that the Patrick County Public Service Authority (PCPSA) operates a public community water system using two groundwater wells. This is incorrect. The PCPSA only consists of distribution piping, receives water from and is operated by the Town of Stuart. The Layman Water Supply Waterworks Operation Permit was revoked on July 5, 2011 because the system was connected to the Town of Stuart water system.”

Accomack County and the Towns of Accomac, Belle Haven, Bloxom, Chincoteague, Hallwood, Keller, Melfa, Onancock, Onley, Painter, Parksley, Saxis, Tangier, and Wachapreague

Water Source Overview

Major sources are groundwater wells.

***Table 1:** Reported (2010) and projected (2040) water use by system type for Accomack County in MGD

Type	Reported Use 2010 MGD	Projected Use 2040 MGD
Community Water System	0.423	0.784
Small Self-Supplied Users (under 300,000 gal/month)	3.090	2.861
Large Self-Supplied Users (over 300,000 gal/month)	2.878	3.142
Agricultural Self-Supplied Users	3.899	3.899

Water Use by System Type

Approximately 30,006 people use private groundwater wells for residential water supply. All tables and graphs represent reported water use including Sales to other localities, if applicable.

***Figure 1:** Percentage of reported water use by system type in 2010 *(No use data shown on graph if less than .01 MGD: Refer to Table 1)*

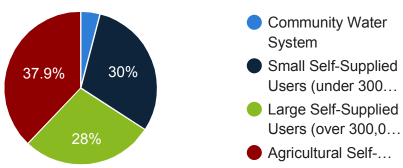
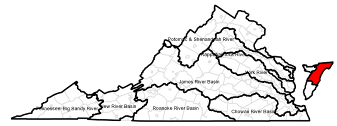


***Figure 2:** Disaggregated water use percentages for Community Water Systems in 2010 *(No graph shown if no disaggregated use data reported)*

***Table 2:** Reported (2010) and projected (2040) groundwater and surface water use for Accomack County in MGD

Reported 2010 Groundwater Use (MGD)	Reported 2010 Surface Water Use (MGD)	Projected 2040 Groundwater Use (MGD)	Projected 2040 Surface Water Use (MGD)
7.39	2.90	7.79	2.90

***Figure 3:** Accomack County highlighted in the Commonwealth of Virginia



Projected Water Demand

Population and demand are projected to increase through the planning period. Existing water sources in the County and most towns are expected to meet projected demands. The Town of Chincoteague may experience a summertime water deficit of approximately 0.10 MGD in 2015. Alternatives considered include development of up to three new wells in the Town's easement area at NASA, the purchase of water from NASA or another mainland source, and construction of a desalination facility to treat a well drilled on the Island.

***Table 3:** Accomack County population projections by decade from 2010 to 2040 (data gathered from VEC projections - 05/20/13)

2010	2020	2030	2040	% Change (2010-2040)
33,164	33,432	33,568	33,661	0.0%

***Figure 4:** Accomack County population projections by decade for 2010, 2020, 2030 & 2040

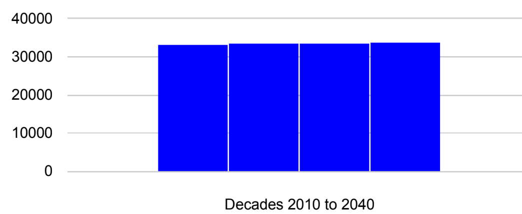
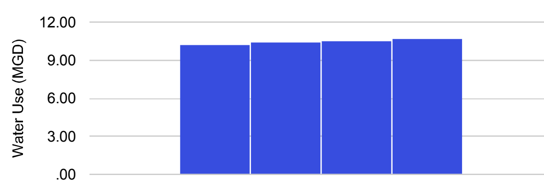


***Table 4 & Figure 5:** Accomack County water demand trends by decade for 2010, 2020, 2030 & 2040 in MGD

Reported Use 2010 MGD	Projected Use 2020 MGD	Projected Use 2030 MGD	Projected Use 2040 MGD	Percent Change (2010-2040)
10.29	10.42	10.55	10.69	3.8%



Drought Management Practices

The County and all Towns adopted the Drought Response and Contingency Plan (DRCP). The Town of Chincoteague adopted an ordinance to implement and enforce the DRCP. The status of implementation and enforcement of the DRCP in Accomack County and the remaining towns is pending, but will be resolved by the five-year update of the water supply plan. [Accomack County Regional WSP and the Town of Chincoteague Local WSP]

Appendix E: Public Comments and Next Steps

The State Water Resources Plan (the "Plan") is a collaborative effort among localities, regional partners, state agencies, water resource managers, businesses, the public, and other stakeholders to ensure the Commonwealth's water resources are managed and protected for future generations. The Plan takes a comprehensive look at water resources and water demand for all beneficial uses in Virginia. An important note is that DEQ is charged with both enabling adequate public water supplies and ensuring protection of in-stream flow and groundwater for all identified beneficial uses. Water supply planning has not been overlooked or de-emphasized; rather it is a subset of an overall water resources plan.

The data and information collected as part of the initial Plan development are housed in a content management system (VA Hydro, the Office of Water Supply Modeling and Analysis Database). The information is currently accessible only internally to DEQ staff. However, plans are in place and development underway to roll out an online interface to local and regional planning partners in support of their local and regional water supply planning efforts, and ultimately to the public. The anticipated timeline for establishing this interactive platform is attached as Table 1 to this document. DEQ is actively communicating the Plan's findings across the Commonwealth (schedule is attached as Table 2), and efforts are underway to meet with local and regional planning partners to explain the risks to beneficial uses when considering actions to meet future demand. These meetings will be prioritized based upon areas where 2040 projected demands are clustered, multiple critical indicators are anticipated to be met or exceeded by 2040, and a deficit in water supply is predicted. Initial outreach will focus on planning regions in the Potomac-Shenandoah River Basin, York River Basin, (Middle) James River Basin, and (Upper) Roanoke River Basin. Local and regional planning partners that believe they might benefit from a more detailed discussion of their Cumulative Impact Analysis or in the evaluation of water supply alternatives are encouraged to contact DEQ to ensure they are included in the prioritization.

A formal update of the Plan is anticipated following the submittal of the five-year local and regional water supply plan updates in December 2018. The statewide cumulative impact analysis (CIA) will be updated annually to reflect the most current information available. All water supply programs shall be reviewed, revised, and resubmitted to DEQ every 10 years beginning 2023. Formal compliance reviews of local and regional water supply programs will be reviewed in the context of the updated Plan.

Annual updates concerning activities in support of the Plan will be provided as part of DEQ's Annual Water Resources Report to the Governor and the General Assembly. However, the ultimate goal is to enable local government or other stakeholders to directly enter projected water use or other water supply planning inputs into an interactive, web-based platform (VA Hydro, currently available as read-only, interactive interface under development) and to receive real-time, dynamic responses.

Once the interactive platform has been finalized, the Plan will become a 'living document.' As such, it will be subject to incremental revision during its lifetime as DEQ, localities, and other stakeholders provide input regarding their ongoing water supply planning efforts. Information supplied by localities will provide the basis for more efficient data collection, which, in turn, will improve DEQ's and other resource managers' understanding of the Commonwealth's water resources. The interactive Plan will be available to all stakeholders as a tool to use as they identify solutions to meet future water demand, ensuring the water resources being considered are sustainable for their needs.

The 30-day public comment period for the draft Plan began on April 8, 2015. Thirty-one comments were received and are included as an attachment to this document (see Table 3). DEQ appreciates the time and effort it took to read the Plan and provide comments, and while no changes were made to the Plan itself, the comments and this document will be included as an addendum to the Plan to ensure consideration during near-term planning efforts and in developing future versions and updates of the Plan.

The comments submitted on the Plan reflect the diverse nature of the water use interests within the Commonwealth and are not unexpected. In general, there was recognition of the monumental endeavor it was to create the first plan to address the Commonwealth's future water needs, and it was noted that the Plan goes a long way in presenting the current state of water resources, anticipated growth, and potential impact of that growth on water supplies. It was also acknowledged that Virginia's water resources and demands are very complex, and there was appreciation that DEQ considered this in the Plan. Finally, it was noted that the Plan is an important tool for determining long-term water needs and how best to meet those needs, and there was support that the Plan be iterative and updated periodically to incorporate new information and to reflect changes.

The remaining comments are categorized as follows: Plan Structure and Development; Information from Water Supply Plans; Population Projections; Beneficial Uses; Cumulative Impact Analysis/Flow Metrics; Alternative Sources, Including Reuse; Safe Yield, Withdrawal Permits; and the twelve challenges identified in the Plan.   A summary of these comments and DEQ's general responses to comments are provided below.

Plan Structure and Development Comments

- A commenter suggested that DEQ should consider the success of the Metropolitan Washington Area Potomac River water supply agreements and plans as they contemplate a statewide water supply planning approach.
- There was concern that the document does not accomplish the requirements set forth in the Virginia Code to prepare basin-specific reports.
- There was concern that the document does not constitute a "plan," as there are no goals, objectives, milestones, or timeframes, and it does not discuss how the state will help localities with long range water supply issues (financially, technically, or otherwise).

- Challenges should be prioritized and more context and discussion should be provided on how to proceed.
- Lumping all of the local/regional water supply plans together to make a statewide conclusion about water needs is misleading; the conclusion that there will be an increase in water demand of 32% by 2040 without context (in Executive Summary) does not provide an accurate picture. Major Basin Summaries provide a better and more complete picture of future demand.

DEQ Response:
The basis of the State Plan is the data and resource information provided in local and regional water supply plans and an analysis of the potential beneficial use implications of meeting these local and regional needs. It is not clear how the DEQ could meet its statutory and regulatory obligations using the Metropolitan Washington Agreements. The Metropolitan Washington Agreements provide an example of local coordination of water supplies to meet demand that other jurisdictions could choose to replicate, but there is no clear authority for DEQ to mandate specific approaches beyond defining baseline planning methods. The State Plan satisfies statutory requirements as the information in the main Plan document is at a smaller scale than the basin analysis required by law. In addition, Appendix B includes the summary data and analysis at the mandated basin scale. The online tool will improve upon this by integrating both scales dynamically. The structure of the State Plan reflects its purpose of informing local water users and local and regional water supply planning units of resource limitations and fatal flaws to be avoided in developing supplies to meet local needs. Neither the Code nor the regulation set forth a requirement or a process for inclusion of goals, objectives, milestones, or timeframes because at the time of adoption and promulgation, there was no consensus among stakeholders with respect to the appropriate inclusion or process for developing these tools. With the technical basis that has been developed through this Plan, DEQ can provide greater detail over time on what specific issues a community may need to address and facilitate conversation about how best to address them. Within the next few months, DEQ staff will be initiating these conversations in the locations with the most immediate water supply deficits and greatest potential for beneficial use conflict. This is also how DEQ anticipates dealing with the prioritization of the recommendations as it is expected that the prioritization will vary across the state based on the issues unique to each locality and region. Finally, the total statewide demand number is the factual statewide aggregate total of future demands provided to DEQ in the local and regional plans. The State Plan requirement identified by regulation for the presentation of demand is that it be a "cumulative demand analysis." This is identified in 9VAC 780-140.G.1.

Information from Water Supply Plans Comments

- Water supply plans were submitted some time ago, and there have been significant developments that impact projections and water supply capacities. The Plan should reflect this updated information.

- Snapshots provided on localities served do not truly reflect the water uses by locality; these should be reviewed and updated.

DEQ's Response:

The Plan and snapshots include information from local/regional water supply plans that were developed with information collected from 2005 to 2011 in accordance with the phasing schedule required by the Local and Regional Water Supply Planning Regulation (WSP Regulation). This was unavoidable due to the staggered submission dates prescribed by the WSP Regulation. The initial delay in synchronizing local data collection with State Plan development was acknowledged as one of the consequences of state and local resource limitations, lack of local water supply planning data and experience, and the need to develop the data management and analytic tools to add value to the local planning processes. This will continue to improve with time. The regulations allow updated data to be submitted to DEQ at any time and if it is a change related to demand, it is required to be updated as part of the five-year review. If new data is submitted to DEQ, the State Plan will be updated in hard copy every five years. Once the online tool becomes available, it will allow for updating information in near real-time. It is important to note that the term "accuracy," when applied to predicted future water demand should be viewed much differently than other types of data. Future growth and development and its associated water use simply cannot be predicted with the same "accuracy" as a measured stream flow, or a measured volume of water withdrawn. Expectations of data accuracy and validity should be interpreted in this context. Water use, in terms of applicable state statute and regulation, is defined as water withdrawn from a source. Data are submitted and presented in the Plan consistent with this definition. Presenting the data in another way is inconsistent with the statute and regulations. Any particular data issues that are confirmed as erroneous will be revised.

Population and Demand Projections Comments

- The Plan should include information on water use and population growth in Virginia over the past several decades.
- Critical analysis of the statewide per capita demand projection methodology is needed, as national trends indicate that per capita water use has gradually declined in recent years.
- Validation of projected water demand, population projections, and per capita water use should be reviewed. The projected consumption rates appear to be overestimated, as data from the last 20 years does not support a strong correlation between population growth and water demand; this trend should be acknowledged.
- Regional analysis is suspect due to the reliance on demand predictions provided in the local/regional water supply plans. DEQ established no criteria for these local predictions, so putting much weight in analyzing their findings is suspect.

DEQ's Response:

The importance of the water supply planning process is that it establishes a baseline for future planning. It is inherently prospective in nature. The Water Policy Technical Advisory Committee that drafted the consensus-based regulation never reached consensus on criteria for look backs. The Plan process was designed to establish a baseline and then to look prospectively after that. While there may be some benefit for particular planning regions or localities to look at per capita use, it is not required. Each locality and region has unique planning capabilities and limitations. The objective of the regulation was to establish a common baseline for demand projection that could be used by large urban areas as well as rural towns that would use data that was readily available to all. In many cases, rural jurisdictions did not have per capita use data. While there may be benefits to be realized by using a per capita use analysis in some areas of the state, at this time it is not practicable. At some future point in the process it may become more practicable for more localities. By design, the WSP Regulation allows for flexibility in the type of demand methodology applied. There is no perfect methodology for predicting the future use of water. Every methodology has strengths and limitations based on the basis of its assumptions. In lieu of dictating a methodology in the regulations, the emphasis is on using accepted industry standard methods and being transparent about the assumptions used in each local or regional plan. All methodologies employed in the local and regional water supply plan submittals were reviewed by DEQ staff, as well as the Water Supply Plan Advisory Committee established by the General Assembly, and were found to be reasonable, consistent with industry standards, and consistent with the requirements of the WSP Regulation. DEQ and the State Water Supply Plan Advisory Committee vetted the demand methods used in each plan and found them to be consistent with standard methods. As predictions of the future, they are as reasonable as any other. If there are overestimates in some cases due to more optimism in some plans than others, the analysis of impact is not invalidated; it simply is an analysis of an impact that may occur at a later date when the projected amount of water need may be reached.

Beneficial Uses Comments

- The Plan should emphasize that preference shall be given to human consumption over all other uses.
- Concern that DEQ is not prioritizing human consumption in practice.
- The Plan seems to intentionally raise the emphasis on instream needs and all but dismisses the priority that has historically been given to human consumptive needs.
- The Plan should clarify that the term "beneficial use" has a distinct meaning for surface water and groundwater, and that references to beneficial uses that apply only to surface water be stated as such.

DEQ's Response:

The human consumption issue was highly debated in the Water Policy Technical Advisory Committee that developed the regulation from 2002-2005. It was made clear that DEQ is charged with looking at water supply to serve all beneficial uses of water, both in-stream and off-stream. DEQ must consider both the human needs for adequate water supply and the consequences of meeting those needs on in-stream flow and other downstream users. The State Plan reflects that DEQ must do both. The Local and Regional Water Supply Planning law and regulation and the Virginia Water Protection Permit law and regulation establish no presumptive preference for human consumption. For groundwater, the statute and regulations identify a preference for human consumption, but no direction on how to implement the preference. Conflicts regarding water withdrawals and beneficial uses typically arise and are dealt with during the permitting process. As defined in the WSP Regulation, in-stream beneficial uses include, but are not limited to, the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. Off-stream beneficial uses include, but are not limited to, domestic (including public water supply), agricultural, electric power generation, and commercial and industrial uses. The State Plan emphasis on in-stream needs referenced by commenters reflects the direction in 9 VAC 780-140.G.3 to evaluate conflicts among projected demand and estimates of requirements for in-stream flow. The value added by the State is identifying where permitting issues could result from such conflicts so that they could be addressed as water supply projects are developed. This was a goal for the State Plan when the regulations were developed. It is noted the comment on different beneficial uses of water for surface water and groundwater is correct and will be addressed when the plan is reissued.

Cumulative Impact Analysis/Flow Metrics Comments

- The four flow metrics selected for cumulative impact analysis do not accomplish the objectives required by the Code of Virginia. The graphical changes in flow by Hydrological Unit Code (HUC) presents a misleading picture of the potential impacts of cumulative withdrawals and need to be modified to reflect actual changes by linear river or stream segments rather than across entire HUC areas.
- Clarification is needed regarding the August Low Flow metric about its applicability to tidal freshwaters, and DEQ should develop minimum requirements for these waters.
- The Plan should add to the discussion of potential flows in the York River Basin a discussion of the regulation of releases from Lake Anna Dam so that readers are provided context of the associated issues.
- The Plan identifies a water shortfall under a drought critical condition, but fails to identify a strategy for addressing this shortfall.

DEQ's Response:

Early in the development of the WSP Regulation, it was concluded that the goal of this process was to put localities and the state in roles that they could perform best to add value to water supply planning. The consensus was that localities should maintain their traditional roles in identifying data unique to them and to take the lead in identifying their plan for future water supplies. DEQ then would take the lead in aggregating the information and conduct basin and statewide analyses of the conflicts or potential impacts to the resource that may be encountered in meeting these local water expectations. DEQ would then provide these analyses to localities to consider in their future planning and, when appropriate, facilitate dialogue on how to avoid the potential impacts or conflicts becoming future permitting problems. DEQs cumulative impact analyses use the most applicable peer-reviewed metrics that were available that could reasonably be used as surrogates for the beneficial uses to be evaluated. It is important to note that this is a large scale analysis that is limited by the readily available data that existed across the state. Without specific identification of local intakes that may be proposed to meet future needs (which was not available nor required by the WSP Regulation), a river segment or stream reach analyses would be misleading and would run the risk of presenting greater certainty than would be warranted given the data. DEQ expects that the metrics will evolve and improve over time, as will the local certainty of where projects may be located. In tidal fresh waters, the August Low Flow metric appears to have some validity and reliability for shad, but the data set is limited. DEQ has contracted with the United States Geological Survey to evaluate over seventy-five additional metrics over 2016-17. It is expected that there may be a better tidal metric in that data set that could improve the understanding of tidal living resource impacts. These improvements will be noted in annual cumulative impact analyses that will be published by DEQ in subsequent State Plans. Additional metrics, if found to be scientifically valid through peer review, will be added to the analysis in subsequent plans.

Alternative Sources, Including Reuse Comments

- The Plan should give greater consideration to reclaimed water, explain why this tool is not more commonly used in the Commonwealth, and make recommendations to remove or alleviate the existing regulatory barriers that exist, as well as articulate the benefits derived from reuse, per the Commonwealth's explicitly stated public policy.
- The Plan should facilitate the availability of reliable, safe, and cost-effective sources; disappointed that the Plan all but ignores existing barriers to wastewater reclamation and reuse.
- DEQ should take an active role in assisting public water supplies for the region and promoting the state funding for new sources and infrastructure.
- Policies should be adopted that incentivize water reuse.
- Although desalinization is mentioned as an alternative source, the Plan does not offer a solution to brine disposal, which is a major challenge for this alternative.

- The Plan should include an additional challenge and recommendation that states DEQ will coordinate with other agencies, including the Virginia Department of Health and Virginia Department of Housing and Community Development, to identify regulatory obstacles to the availability of wastewater reclamation and reuse as an attractive, reliable, and cost-effective water supply. At a minimum, any regulatory requirements that (1) substantially increase the cost of projects, (2) unnecessarily lengthen the process for obtaining approval for projects, or (3) lessen the reliability and usefulness of projects to the provider or user should be considered obstacles. DEQ and its coordinating agencies will work to modify or eliminate any identified regulatory obstacles that are not necessary for material and substantial protection of public health and safety or the environment.
- The Plan should describe how DEQ and other state agencies will advocate for funding and permitting for additional water sources.
- Indirect potable reuse (IPR) is a common, yet unrecognized practice, and the state must acknowledge this and seize the opportunity to broaden the use of treated wastewater as an alternative water supply.
- IPR through aquifer replenishment has the potential to sustain groundwater supplies throughout much of the Eastern Virginia Groundwater Management Area as opposed to the more localized benefits associated with reservoir augmentation.
- DEQ should recognize trading as a potential strategy for addressing water demand.
- DEQ should clearly identify where more storage is needed, include suggestion for creating incentives for companies willing to develop such sites, and ally in the federal permitting process.
- The Plan should suggest nontraditional sources to meet projected 2040 demand, such as water reclamation and reuse, desalination, and interconnection, and address/eliminate burdensome roadblocks.
- The Plan should include an analysis of potential alternative sources identified at the local level; it is necessary to highlight potential impediments to alternative sources identified in the local/regional plans.
- The Plan should identify and vet alternative water sources, as well as include concrete recommendations on how to further identify and implement alternative solutions - this should be primary goal of the Plan. Potential alternatives that should be included: stormwater; a water trading program, providing incentives for individual water use reductions. Instead, the Plan identifies the regulatory implications of predicted water demands without critically evaluating the legitimacy of those demand predictions.
- By focusing on the regulatory implications, the Plan further restricts water availability without identifying concrete alternative sources to offset those restrictions. While water quality and other

regulatory programs will impact the assessment of water needs, the Plan focuses too much on these other impacts and too little on water supply planning itself.

- The Plan should address groundwater as a resource to carry public water supplies through drought periods.

DEQ's Response:

Negative public perception and high infrastructure costs are most often cited in Virginia as limiting greater reuse. The Eastern Virginia Groundwater Advisory Committee (EVGWAC) is currently exploring the potential benefits and obstacles to the development of alternative sources of supply such as reclamation and reuse (including IPR), trading, aquifer replenishment, etc. as part of an effort to address groundwater declines and the implications of those declines on future water supplies from the coastal aquifer system. Any findings and recommendations from the EVGWAC will be considered in future planning efforts. DEQ agrees greater incentives could be provided for alternative sources including reuse. Other state agencies are on the EVGWAC and may recommend the changes reflected by these comments. DEQ has stated that to meet the future water supply need, the industry should consider creating greater diversification of supply sources and regional interdependence. DEQ anticipates that follow-up work with targeted communities will evolve into a conversation about alternative supply development and perhaps in realizing economies of scale through regional cooperation when resources may be limited. If a water purveyor is considering an alternative water source, a storage project, a water reuse project, or other methods to meet demand, DEQ staff can facilitate information sharing and discussion among localities, state and federal agencies, and other stakeholders to assist in this effort. This is the process that can help vet and analyze the pros and cons of local alternatives. DEQ does not make decisions of funding policy. Those decisions are made by each Administration and the General Assembly. It is important to note that the Plan is not a regulation and, therefore, does not restrict water availability. It does however provide an early opportunity to consider resource issues that could become challenges for projects being developed. A primary objective of the regulation was to provide early warning, at the planning stage, for water supply project designers of potential issues that may come up in permitting. To be clear, the State Plan was not intended to analyze local demands beyond whether the demand method was legitimate and appropriate data was used in the projection.

Safe Yield Comments

- The term “safe yield” is used throughout the State Plan, yet it is unclear what this term means and how it is being applied in this document.
- The proposed definition of “safe yield” cited in the report is of concern. The phrase “can be” is subjective and the time period/duration of the “volumetric rate” is not specified in the definition.

DEQ's Response:

Safe yield is defined in the Glossary of State the Plan as follows: Safe yield of public water supply means the highest volumetric rate of water that can be withdrawn by a surface water withdrawal during the Drought of Record since 1930, including specific operational conditions established in a Virginia Water Protection permit, when applicable. DEQ believes that this definition is consistent with how it has traditionally been used in practice. The use of the phrase "can be" reflects that this is but a snapshot in time, as the amount that can be withdrawn under a drought of record and changes based on the drought of record, which is not static, and the number of users in the watershed, which also is not static. The yield is good for the term of the permit and is re-evaluated each time the permit is renewed or modified based on the current data at that time.

Withdrawal Permits Comments

- The Plan should make every effort to maintain current permitted withdrawal amounts.
- Duration of permits should be reevaluated; ten or fifteen year permits are too short in the context of long range water supply planning and infrastructure investment.
- Requiring permittees to pay for monitoring wells is a cost shifting strategy that places additional burdens on the private sector, hindering economic development; grants or loans should be provided by the General Assembly.
- RockTenn in West Point should be required to reduce its permitted withdrawal and recycle processed water.

DEQ's Response:

The State Plan has no impact on permitted withdrawal amounts. Permitted amounts are tied to a permit and its period of applicability. Although water supply planning informs the permitting process, statutory permitting authority and implementing regulations are separate and have separate criteria for determining withdrawal limits. Any proposed changes to statutory permitting authorities must be made by the General Assembly, and any regulatory change must follow the applicable procedures for regulatory development, including public notice and comment. Changing permit terms would need to be done by the General Assembly and cannot be accomplished through the State Plan. The statute allows DEQ to require monitoring of groundwater levels by water users in their permits. These permit conditions were regularly used by the state from 1973 to the mid-1980s. In the 1980s, DEQ was able to develop its own drilling capabilities and did this work in lieu of permit conditions as a service until the program was eliminated a decade later. Reduction of water withdrawn by WestRock (RockTenn) is the subject of a permit renewal process currently underway.

Many responders provided comments on the specific challenges and recommendations found in the Plan as follows:

Challenge #1 Comments: Understanding the Impact of Unpermitted Water Withdrawals

- The Plan should acknowledge that, in all cases, grandfathered water withdrawals are limited to the specific volume of water that can be withdrawn through the capacity of the intake structure, and that large self-supplied users and community water systems are already required to adopt a Drought Response and Contingency Plan.
- Using the terms “grandfathered” and “unpermitted” interchangeably is misleading.
- The Plan incorrectly states that DEQ has limited information on unpermitted withdrawals, based on VWP exemption requirements for these users.
- DEQ should clarify that any future options contemplated by the Plan protect public water supply capacity.
- Changes to these statutory provisions have not been justified and are not warranted. Voluntary coordination with specific exempted withdrawals to identify options to reduce potential impacts to beneficial uses during low flow periods is supported.
- Unpermitted withdrawals continue to place stress on available water resources; permit parity is needed.
- DEQ must be provided adequate financial resources and staff to timely manage and issue permits.
- DEQ should be cautious establishing Surface Water Management Areas, but should favor cooperative agreements instead.
- Less regulated localities should be brought to a comparable level before additional regulations are applied to others.
- The establishment of Surface Water Management Areas seems to be the first step to develop a truly comprehensive water resources plan.
- The Plan should include a broad discussion of legal water rights that pertain to the withdrawal and use of surface waters in Virginia.

DEQ’s Response:
While many users may have drought contingency and response plans, they were not designed nor evaluated to see if they eliminate downstream impacts. Use of the terms “grandfathered” and “unpermitted” will be reviewed for appropriate application in the next State Plan. DEQ’s statement on the lack of information on unpermitted withdrawals is valid. The information submitted in the excluded user survey is not certified by a professional engineer nor is any evidence of accuracy of the information provided. The surveys did not request operation information, which is the critical component in assessing potential impacts to other users and key water uses during low flow events. There are also gaps in the number of known users responding to the survey. Relying on this data would not be technically defensible. DEQ cannot state that public water supply capacity will be protected without knowing if the

existing supply can meet demand and that proposed alternatives do not make the situation worse. In the case of the Coastal Plain aquifer and its associated declines, DEQ is making every effort to preserve existing capacity, but in some cases it may not be possible without investment by others to improve the water balance. DEQ has stated that it will exhaust voluntary efforts to address potential resource conflicts identified in the State Plan. While there are management benefits to permit parity, DEQ believes it needs further interaction with stakeholders through voluntary means before any final conclusions are made. The development of definitive information on the stresses attributed to unpermitted withdrawals is needed. DEQ believes that specific data to demonstrate the need for any potential use of Surface Water Management Areas would need to be developed to meet the regulatory requirements. At the present time, that information has not been developed and likely cannot be developed without working with willing localities in a cooperative manner. DEQ has indicated more work with stakeholders is needed to determine if any identified resource issues can be addressed through voluntary means. DEQ's initial follow-up efforts will concentrate on planning units where 2040 projected demands are clustered, multiple beneficial use metrics are anticipated to be exceeded by 2040, and a deficit in water supply is predicted. Should there be an unpermitted water withdrawal whose known operation (or unknown operation) led to the potential risk to beneficial uses identified, DEQ will coordinate with the localities and other stakeholders to collect information, clarify operation, or facilitate the development of low flow operational rules, if requested. Options, such as establishing Surface Water Management Areas, are tools available to DEQ if a problem exists that could be addressed with such a tool and voluntary efforts are unsuccessful. If the designation criteria for a Surface Water Management Area can be demonstrated, a proposal to take that regulatory action could be brought to the State Water Control Board as a result of a local petition or DEQ initiative. The assumption that the Surface Water Management Areas should be established as the basis for a comprehensive State Plan may miss opportunities to achieve similar results through non-regulatory means. However, it is too early in this effort to say how important the use of that tool may or may not be. DEQ is not clear which localities may be under-regulated, so is unable to respond. There is no requirement for a discussion of water rights in the Plan and, given the legal nature of water rights, it is unclear that such a discussion would be appropriately within the Plan scope or add value to the Plan.

Challenge #2 Comments: Gaps in Water Withdrawal Reporting, Differences in Reporting Thresholds between WSP and VWWR Regulations, and Lack of Adequate Data

- An interactive, real time, self entered database is a good idea.
- General Assembly must provide adequate resources to DEQ to partner with localities to provide this data.
- Any usages not reported should be recorded; direct input of data seems to be reasonable, but is already being done for surface water withdrawals.

- Obtaining accurate data should be a priority, as this data is needed to better manage water resources.
- Costs associated with state observation wells to obtain groundwater data should not be borne solely by groundwater users.

DEQ's Response:

DEQ appreciates the support for an online data system. DEQ agrees that the grant funding provided to localities and regions for plan development was instrumental in the successful completion of local and regional plans. The elimination of this funding may be detrimental to continued local efforts to develop data. On-line data entry of surface water withdrawals accounts for approximately 60-70 percent of a given year's withdrawals. Data needed to meet the objectives of all commenters is unlikely to be borne by any one entity. It is simply cost prohibitive. DEQ spends over $1.5 million a year to monitor the quantity of water resources. Nearly $500,000 goes to contract USGS to collect and maintain flow and water level data. Funding for data collection has declined over time. Areas where there has been underreporting have been targeted for improvement, and DEQ began efforts to improve water use data collection in late 2014 by contacting all golf courses in the Commonwealth not currently registered in the Virginia Water Withdrawal Reporting database. Additionally, DEQ is coordinating with the Virginia Golf Course Superintendents Association. To date, 280 of 320 known golf courses are registered in VA Hydro. DEQ also developed a work plan for outreach efforts to the agricultural community in late 2014. To date, explanatory materials have been developed for dissemination to farmers and other interested parties. The agency is coordinating with the Farm Bureau, Virginia Extension, and others to ensure success in improved data collection. In 2015, DEQ applied for federal funds to improve water withdrawal data collection and management capability.

Challenge #3 Comments: Quantifying Current and Future Risks to Groundwater Availability Outside of Current Groundwater Management Areas

- Expanding the monitoring capability and gaining a better understanding of groundwater resources outside GWMA is a reasonable goal.
- DEQ should work with USGS and other applicable state and federal agencies to establish well networks, as this is a statewide issue.
- Industrial and agricultural water users should be added to the list of stakeholders.

DEQ's Response:

DEQ appreciates the commenter's support for expanding groundwater monitoring outside of the Groundwater Management Areas. DEQ currently works with USGS on the State Observation Well Network. DEQ collects data on groundwater levels at 192 wells and the USGS collects data on groundwater levels at 218 wells, with periodic water quality samples taken at 19 of those wells. Sixty-six of the wells in the DEQ/USGS Observation Well Network have been converted to real time monitoring with measurements captured every 15 minutes and uploaded to the internet using satellite technology. Additional information about this program can be obtained on DEQ's website. The comment regarding industrial and agricultural stakeholders is noted and is being done in practice as outreach efforts are implemented.

Challenge #4 Comments: Reservoir Site Development

- DEQ (and other state agencies) should take a more active, declared, and advocacy role in support and development of water storage projects.
- The Plan should clearly identify areas in need of water and recommend alternatives and locations for new sources and storage.
- The state needs to provide sources of funding for new water supply storage projects;
- For those that have already funded and implemented water storage reservoirs, the effects of flow augmentation and the benefits during low instream flow should be credited to the purveyor.
- Recommendation should be revised to state that if a project receives its VWP and VMRC permits, DEQ will actively support the project with respect to any necessary federal funding.
- Challenge description should highlight the challenges Virginia will face if projects are not identified and advanced.

DEQ's Response:

DEQ acts within the limits of its statutory authority with respect to the development of water storage projects. An issue that was highly debated when the regulation was developed is that the water industry felt that the DEQ should be an "advocate" for local and regional water supply projects during the permitting process with other state and federal agencies. DEQ's interest in this issue is to permit projects that provide an adequate future water supply, meet a defined local need, and are the least environmentally damaging practicable alternative. When DEQ issues its permit, it defends the permitting decision and the project as environmentally protective. While caution is necessary when recommending specific impoundment sites to localities, regions, or other stakeholders, DEQ will consider identifying regions of the Commonwealth where additional storage is needed and be prepared to share any technical or scientific information that might assist localities and others to maximize available supply as they make these decisions. If a water purveyor is considering a storage project to meet demand, DEQ can facilitate information sharing and discussion among localities, state, and federal agencies and other stakeholders on regulatory issues. The creation of a state source of funding for new water supply projects is a matter for consideration by the General Assembly and State Water Commission rather than DEQ. It is not clear how any flow augmentation should be credited in the State Plan. In cases where this operation is defined by permit and known, it was taken into account by the cumulative impact analysis. DEQ defends its permits for projects in the federal permitting process in practice as part of the joint permit process. A recommendation is not needed to change what is already being done. DEQ appreciates the comment to highlight the impacts of not implementing a particular project or projects. The State Plan was intended to identify all potential alternatives for meeting future supply and to keep them “on the table” as demands, affordability, and resource constraints change over time. That is why there is not a required designation of a preferred alternative for each local or regional plan. Therefore, it would be impossible to truly assess what the impact of not implementing the alternatives would be in any detail. Certainly it would not be beneficial to the state or local economy if demand could not be met in the future.

Challenge #5 Comments: Threats to Water Quality

- The Plan should focus on water supply, not water quality as it concerns aquatic life.
- Recommendation does not correlate to the description of threats.
- Unclear how August Low Flow and 7Q10 numbers can be used to address identified threats; any flow metric considered by DEQ in water withdrawal permitting actions must be based on peer-reviewed scientific studies specific to a particular basin.

DEQ’s Response:

Water quality has a close, complex relationship with water quantity. DEQ is required to look at both water quality and water quantity in the State Plan and in the permitting process. Both must be considered when assessing the availability and sustainability of the resource in meeting demand. DEQ believes that the recommendation is consistent with the identification of possible threats to water quality, but will review this State Plan narrative and its associated rationale and revise, if necessary, in future plans. DEQ will continue to educate stakeholders on the relationship between the metrics used and the stated threats. The metrics used are the result of a significant peer review process and literature review. Study in each basin is not necessary for a metric to be statistically valid in describing a relationship that has been hypothesized.

Challenge #6 Comments: Understanding the Impact of Consumptive Use on Water Supply

- A methodology that can be easily used must be provided so consumptive use can be provided to DEQ.
- DEQ should evaluate all options available for improving estimates of water consumption prior to seeking a requirement for individual reporting of water consumption.
- Concern with the definition of consumptive use.
- DEQ possesses data that can be used to estimate consumptive use.
- The Plan does not clearly state the need for this info and how such would alter or benefit the recommendations or assessments.
- Supports the recommendation to strengthen the information base.

DEQ's Response:

DEQ made conservative estimates for the initial cumulative impact analysis, based on the information available. More accurate information on consumptive use will assist with developing a better understanding of the impacts on streamflow and impacts to downstream users, resulting in a more refined analysis. The process of adopting regulatory amendments is significant and would be expected to include the development of an advisory committee that would provide input on appropriate methods for measuring and reporting on consumptive use. If the Annual Water Withdrawal Regulation is amended to include reporting of consumptive use, reporting criteria/methodology will be provided. DEQ will look at available options for improving estimated consumptive use that are considered to be industry standards. The definition of consumptive use used in the State Plan reflects a search of the term in the regulations of other states and scientific literature. The same definition has been used in the permitting program. DEQ does have some information on consumptive use, but not for all users. This creates additional uncertainty in the conclusions that can be made and can improve with a consistent method that is not forced to combine measured data and literature values that may not reflect the consumptive use of individual users appropriately. DEQ appreciates the support of database improvements.

Challenge #7 Comments: Promoting Increased Conservation to Reduce Long-Term and Short-Term Demand

- Recommended conservation measures were submitted by one commenter.
- The Plan needs to address irrigation as a critical component of efforts to conserve water; better addressed at the state level.
- Recommendation is redundant with existing regulation and needs to be removed.
- Stating that "water conservation can reduce costs to consumers as use of water declines" is misleading and too simplistic; it fails to recognize the financial complexities and obligations associated with water utilities.
- A cost benefit analysis would be useful.
- The Plan must include water reuse as a specific recommended water conservation technique.
- There is no need to broadband conservation as a 24/7/365 requirement, but teach it and engage it when and where needed.
- Many water providers have increased conservation and awareness practices as much as possible; likely needed is better documentation from localities on what they have already done.
- Incentives are needed, and examples from other states would enhance the recommendation.

DEQ's Response:

State Plan recommendations regarding specific uses like irrigation were not made, as there is some uncertainty about the benefits statewide. It appears from the initial data that there may be some localities and regions where reducing outdoor irrigation through conservation initiatives would have a significant impact on water use. However, in a locality with little or no outdoor irrigation, a state-wide recommendation has no meaning. DEQ believes that these issues are best handled in the follow-up efforts that will be undertaken with stakeholders. As part of the ongoing planning process, increased conservation and planning efforts will be incorporated into the State Plan, and DEQ can facilitate as resources allow in the information exchange between water providers on best practices. Review of the local and regional water supply plans revealed significant diversity in the level of complexity of programs implemented throughout the Commonwealth. Many localities have no program in place with no data collection, no measures of success, or clear objectives, so DEQ does not believe the recommendation is redundant. The WSP Regulation simply requires that the local or regional plan report what existing efforts to conserve water are underway. The statement may be too simplistic, but is reasonable for a planning document as a general principal to reduce cost over the long term by reducing waste and conserving when appropriate. DEQ does not have funding for a cost benefit analysis and recommends that they be done locally to assess the reasonableness of water conservation efforts the particular locality may consider appropriate. DEQ agrees water reuse is an important means of conserving water, but it may not be the right tool for every system or locality. Therefore, DEQ has avoided recommending specific conservation techniques in the State Plan. DEQ does not question that some localities may be doing all that can be done in the area of conservation. DEQ agrees that better documentation of local efforts can only help reflect what is being achieved and that incentives would be useful. Future versions of the State Plan will consider adding examples of successful efforts from Virginia and other states on this topic.

Challenge #8 Comments: Critical Infrastructure Deficiencies

- Recommendation supported; assumption that emphasis will be on small water systems.
- DEQ should increase its efforts to obtain funding for critical infrastructure and expand its criteria for prioritizing funding beyond simply water loss.
- More concrete recommendations are needed, such as a fund established by the General Assembly recognizing the need to invest in infrastructure upgrades, sustainable planning, and revenue generation for water infrastructure.

DEQ's Response:

DEQ appreciates the support of this recommendation. DEQ does not believe that this issue is unique to small systems. Given resource constraints, however, the most likely initial focus will be on small systems. As noted in the recommendation, DEQ and VDH work together on issues related to water supply and would expect to work together on this effort. Conversations between the agencies regarding this topic have already begun. DEQ has no funding to aid in infrastructure replacement. At this time, such specific recommendations regarding infrastructure investments may be premature and are the purview of the General Assembly.

Challenge #9 Comments: Sea Level Rise, Changes in Precipitation Patterns, and Land Subsidence

- The significance of saltwater intrusion and sea level rise within the lower portion of the Coastal Plain and its impacts on groundwater should be enhanced to further exemplify the magnitude of the groundwater problem facing many coastal communities.
- Any work on modeling streamflow scenarios needs to be shared with localities early on.
- DEQ should assist as needed in understanding how any implications can be taken into account in local/regional water supply plan updates.
- Possible hydraulic fracturing activity is an emerging issue of concern, yet not addressed in the Plan.
- Recommendation is confusing; clarification about the purpose, intent, and implementation is needed.

DEQ's Response:
Water planners and providers have recognized that additional planning is needed to better understand the water supply implications of emerging issues such as sea level rise, changing precipitation patterns, and land subsidence. DEQ agrees with the commenters that further detail is needed in order to determine the extent and significance of each issue for localities. Some of this work is being contemplated now in conjunction with local or regional governments and federal agencies. DEQ anticipates assisting as resources allow and reflecting new information in subsequent versions of the State Plan. DEQ has maintained streamflow models since 2006, and they are the result of peer-reviewed models developed by the USGS. Access to the models can be made available to localities as they conduct continued water supply planning. DEQ's follow-up efforts are expected to assist localities and regions in understanding the implications of these issues as they continue to plan for their future water supply. Hydraulic fracturing was not addressed as a threat, as DEQ believes that the current programs in place and regulatory changes in the public comment process submitted by the Department of Mines, Minerals, and Energy are environmentally protective. DEQ will review the recommendation and modify as appropriate in the next version of the State Plan.

Challenge #10 Comments: Source Water Protection

- Good recommendation; assistance is needed at the state level to develop Source Water Protection Plans for sources that are either located in, or have watersheds in other jurisdictions.
- Other aspects, such as tracking hazardous materials handlers, should be considered.
- This is an unnecessary addition, given DEQ's limited resources and the fact that this program is already in place and working effectively.
- The Plan should include Best Management Practices related to agricultural runoff.

DEQ's Response:

DEQ appreciates the support of this recommendation. Public comments provided suggestions to be considered as this recommendation is implemented. Comments regarding resource limitations are noted. DEQ has no intention of duplicating efforts underway for source water protection, but to collaborate as necessary with state and local entities to protect the resources. DEQ believes that the recommendation is necessary due to the fact that many Source Water Protection Plans are not being implemented according the review of local and regional water supply plans. DEQ believes that individual best management plans are best developed and implemented in this context as a part of ongoing planning when the issue is applicable within the planning unit. DEQ will assist as it can to identify when these conditions are appropriate in follow-up efforts.

Challenge #11 Comments: Conflict Resolution

- The Plan should recognize that DEQ has the authority to resolve conflicts through existing regulations to establish Surface Water Management Areas.
- The state should act as a fair and unbiased arbiter, but this has never occurred.
- The Plan should provide a mechanism for dealing with conflicts before they become a problem. This recommendation is consistent with the recommendations of the Water Supply Plan Advisory Committee.

DEQ's Response:

This topic was vetted extensively by the Water Supply Plan Advisory Committee, which concluded in its Final Report that "DEQ does not currently have any authority to resolve conflicts within the context of the SWRP (State Plan) beyond identifying them and facilitating discussion between localities and regions. Under the current regulatory framework, conflict arising from efforts to implement the State Plan can be resolved through the following methods: issuance of Virginia Water Protection Permits, litigation among parties, creation or use of a legislative or voluntary body (such as a river basin commission), and regulations (such as declaration of a Surface Water Management Area or Ground Water Management Area). Because these procedures are available, the Committee recommends no additional authority be created to resolve conflict at this time." DEQ plans to facilitate dialogue on issue resolution as anticipated during the development of the regulation. DEQ appreciates the comment regarding the consistency of this recommendation with that made by the Water Supply Plan Advisory Committee.

Challenge #12 Comments: Public Education and Outreach

- Caution is offered on educating the public on the importance of conservation during droughts; assumptions should not be made that more conservation during droughts will help through temporary or long term droughts; many have already cut back on demand to such a degree that discretionary demand has been diminished.
- More robust public education is needed beyond concern with supply shortfalls, but also alternatives such as water reuse that are available.

- Public education is a critical component of both achieving water conservation goals and gaining public support for measures needed to effectively manage Virginia's water resources.
- Public education measures should be complementary of the existing communication plans of local governments and water providers.
- Development of the Plan in and of itself is an important tool for education and outreach.

DEQ's Response:
As reflected in the state Drought Assessment and Response Plan, DEQ anticipates promoting the concept of measured and graduated responses to drought consistent with their severity. DEQ agrees additional topics beyond supply and demand are appropriate and can be developed and implemented over time. DEQ agrees that public education is critical in achieving conservation and buy in by citizens. Suggestions submitted in the public comments are helpful in planning public education, and outreach. DEQ agrees with the importance of state and local coordination of public education messages. DEQ acknowledges that the State Plan can serve the stated purpose.

JLARC Study
In the 2015 Session, the Virginia General Assembly approved HJ 595, HJ 623, and SJ 272 directing the Joint Legislative Audit and Review Commission (JLARC) to study Virginia's water resource planning and management. JLARC is directed to (i) assess the extent to which ground and surface water consumption is unsustainable, the potential effects of any unsustainable consumption, and the risk of overconsumption in the future; (ii) assess the effectiveness of the state's permitting process for ground and surface water withdrawals; (iii) assess the effectiveness of state and local water resource planning, particularly with regard to groundwater, including the role state and local plans play in water withdrawal permitting; (iv) examine the adequacy of the funding and staff levels for managing Virginia's water resources; (v) consider the need for strategies and practices preserve or increase the amount of groundwater and surface water available for consumption; and (vi) review any other issues and make recommendations as appropriate. JLARC shall complete its meetings the first year by November 30, 2015, and for the second year by November 30, 2016, and the chairman shall submit to the Division of Legislative Automated Systems an executive summary of its findings and recommendations no later than the first day of the next Regular Session of the General Assembly for each year.

Table 1. State Plan as a Living Document Work Plan

Task	Description	Target Completion	Milestone
Review VA Hydro for functionality	Ensure tabs and other navigation are intuitive; Ensure maps are accurate and adequate; Review all pages for spelling, accuracy, etc.	10/31/2015	VA Hydro is ready for migration to new platform
Migrate to new VA Hydro platform	Ensure all information transferred; Ensure system is user-friendly, clear; Review all pages for accuracy	01/31/2016	VA Hydro is ready for internal testing and pilot preparation
Pilot project preparation	Develop protocol regarding access of VA Hydro (Water Supply Planning and Annual Water Withdrawal Reporting); Determine and document expectations of participants; Develop a schedule for review and completion of the pilot project	02/29/2016	Pilot project ready for external presentation and testing
Initiate Pilot Project	Identify interested stakeholders; Meet with pilot participants, provide training, review expectations	03/31/2016	Pilot project begins
Pilot project complete	Results and comments from participants reviewed; Changes made in VA Hydro as appropriate; Develop training webinar that incorporates suggestions and comments from pilot project	08/31/2016	VA Hydro ready for public release
Interactive Plan ready for public release	Localities, regions, and other stakeholders notified of living document release; Conduct training webinar and post to DEQ website; Provide regional training opportunities upon request; Provide and announce mechanism for receiving and responding to questions and input from stakeholders	10/31/2016	Plan used as a living document
Review and update of the Plan	Incorporate updated software and other tools as they become available to improve the Plan; Provide local and regional drought pages; Update and conduct webinar and other training as needed	Ongoing	Update, improve, and refresh the Plan for stakeholders' use
Provide periodic updates	Include Plan conclusions following annual Cumulative Impact Analysis; Explain any new tools available on VA Hydro; Update locality- or region-specific information as appropriate (electronic/part of Annual Water Resources Report)	At least annually	Public kept aware of Plan status and updates

Table 2. 2015 State Water Resources Plan Presentation Schedule		
March	4	Manassas Rotary Club
	16	Accomack-Northampton Planning District Commission
	19	Crater Planning District Commission
	20	Northern Neck Chief Administrative Officers
	26	West Piedmont Planning District Commission
April	2	Commonwealth Regional Council
	9	Richmond Regional Planning District Commission
	22	Middle Peninsula Planning District Commission
	28	Commonwealth Regional Council
May	6	Hampton Roads Planning District Commission - Utility Directors
	8	James River Basin Association
June	15	George Washington Regional Council
	25	Roanoke Valley-Alleghany Regional Commission
	25	New River Valley Regional Commission
July	16	Region 2000
	23	Southside Planning District Commission
August	19	Cumberland Plateau Planning District Commission
	26	Rappahannock-Rapidan Regional Council
September	2	Mount Rogers Planning District Commission
	16	Water Jam, Virginia Beach
October	5	DEQ Southwest Regional Office Presentation
	5	LENOWISCO Planning District Commission
	6	Virginia Municipal League Conference Richmond Marriott
	19	Central Shenandoah Planning District Commission
	27	Tentative For Northern Virginia Regional Commission
November	5	Thomas Jefferson Planning District Commission
November	12	Tentative for Upper James RC&D Council
December	11	VAPA Virginia Chapter Board of Directors

Table 3. 2015 State Plan Public Comments

General Comments
King William County Less regulated localities should be brought to a comparable level before counties such as King William see additional regulations applied.
Fairfax Water Consider the success of the Metropolitan Washington Area Potomac River water supply agreements and plans as it contemplates a statewide water supply planning approach.Concerned that the draft State Plan does not accomplish the requirements set forth in the Code to prepare basin-specific reports or meet the re State Plan requirement to prepare a State Water Supply Plan; concerned that the scope and content of the draft extends well beyond the authority given to DEQ through the Code. Full cognizance must be taken of water utilities' ongoing obligations, such as those of Fairfax Water.
Crater Planning District Commission Groundwater management is an issue that could affect this region. Please make sure we are informed of any future developments on this matter.
James City Service Authority State Plan good first step, but does not constitute a plan; there are no goals, objectives, milestones, or timeframes; does not discuss how the state will help localities with long range water supply issues (financially, technically, or otherwise).
Hampton Roads Planning District Commission State Plan provides a comprehensive summary of water supply sources and demands in VA.Does not support the submittal of the State Plan to the Governor, Senate Committee on Agriculture, conservation, and Natural Resources, and the State Water Commission.
Newport News Waterworks State Plan is an impressive undertaking by DEQ in both magnitude and scope.
West Piedmont Planning District Commission Inconsistent percentages for groundwater demand.Confusion with CWS and SSU_LG; request consideration of placing parentheses after each use of abbreviation or use different abbreviations.
City of Richmond DPU shares Mission H20's concern that the purpose and power of a state water supply plan not be lost within a state water resources plan. Both types of plan are critical, but DPU urges that more emphasis and clarity be given to the Plan's water supply elements.DPU applauds VA and DEQ for determining to assess and plan for future water needs and solutions, particularly with respect to the need for sustainable, cost-effective, reliable, clean, safe drinking water. State Plan marks a good collective start, and DPU pledges to work with DEQ and others in helping to ensure that VA's long-term water supply needs are met.Supports comments submitted by Mission H2O and VAMWA concerning draft State Plan.
Loudoun Water State Plan caution related to the effect of reuse on downstream users is incomplete and misleading. A more complete understanding of the effect of reuse considers the net water balance caused by the use of reclaimed water v. potable water.
Hampton Roads Sanitation District The state's first ever comprehensive water supply plan presents an opportunity to craft a visionary strategy that addresses many of the future challenges through holistic water resource management. This plan falls significantly short. Though a water shortfall is clearly identified under the drought critical condition, the plan fails to identify a strategy for addressing this shortfall. Though the State Plan identifies an over allocation of currently permitted withdrawals in the Potomac Aquifer independent of drought conditions; the plan fails to address this challenge.

Western Tidewater Water Authority DEQ should assist public water suppliers in EVGMA find and fund alternative sources. Groundwater must remain available as a drought resistant source. State Plan does not address groundwater as a resource to carry public water supplies through drought periods. The State Plan should expressly recognize that groundwater supplies should be a tool available to public water supplies to compensate for diminished surface water supplies during low flow and/or drought conditions.
Betty Lucas Virginia's proposed plan should identify large water users as the major source of consumption problems to concentrate on conservation controls on individual users; include protection for exemptions of private wells and make human needs a priority; concern with RockTenn Paper and Franklin Paper Mills withdrawal amounts.
Hanover County Executive summary: The "rich in water resources" statement in first sentence is subjective and should not be in a fact based report. Although much of the first paragraph is subjective.In last sentence remove the words "efficient and effective."Remove the words For the first time in Virginia's history.The approximate 32% increase in demand suggests that all additional demand will be from new withdrawals; edit as suggested.
Hanover County Chapter 4, water use tables 4-1 through 5-4 use MGD as an annual number. This could be clarified annual average day.
David Ek Ch 2 Waters sampled and thus reported on the list of impaired waters is not randomly selected, so statistical and spatial analysis is problematic. Quality of some figures when printed is blurred.Font size in legends is small.Ch 3 Two suggested changes to the text box that states “the character of Virginia’s streams is a direct reflection of the geologic and physiographic provinces over which theyflow.” ...it would be more accurate to state that streams are a reflection of geologic and physiographic “processes” rather than “provinces.” Several statements in this section appear to accept and repeat the common fallacy of the “water budget myth”.... Water budget calculations cannot form the basis of determining thesustainability of aquifers or to assess groundwater withdrawal’s affects upon the system....the degree of heterogeneity inherent in fracture-flow and conduit flow groundwater systems limits the amount and type of modeling that can beappropriately utilized. Basin Summaries could be strengthened by the inclusion of regional trends and spatial analysis, if there is data to support this.Definition of interbasin transfer needed?Concern about determination of 'headwaters." State Plan should include a clearly defined strategy in how to accomplish the recommendations complete with priorities and quantifiable metrics to gauge success.This should be a strategic plan.
Virginia Institute of Marine Sciences The Plan could be strengthened through the inclusion of a more robust educational presentation on the physical characteristics and ecosystem services of the tidal freshwater areas. These areas are candidates for the SWMA.Consider the protection of drinking water as a priority in TMDL implementation; its incorporation into the process could increase awareness of water supply issues and have added benefits to target waterways.Presentation of aquatic flora and important fisheries founding during all or part of their life cycle in tidal freshwaters would assist in framing the importance of these areas to VA and Ches Bay.
Mission H2O By converting the state water supply plan into a state water resources plan, DEQ has diluted the purpose and power of a water supply plan. Making conclusions that could potentially reduce water availability should not be done without first establishing the means for achieving the water necessary to meet those requirements.Instead, the Plan identifies the regulatory implications of predicted water demands without critically evaluating the legitimacy of those demand predictions. Moreover, by focusing on the regulatory implications, the Plan further restricts water availability without identifying concrete alternative sources to offset those restrictions. While water quality and other regulatory programs will impact the assessment of water needs, the Plan focuses too much on these other impacts and too little on water supply planning itself.

Mission H2O State Plan lacks a cost-benefit analysis. Evaluation of the cost impacts of the issues raised by the Plan must include the potential effects on a community, economic or otherwise, to put restrictions on them.
Mission H2O State Plan should prioritize the challenges and provide more context and discussion about how to proceed.The three most critical issues highlighted in the Plan to Mission H20 are the need for not only sufficient data and valid local/regional data; the need for additional water storagesites and recommendations for how to locate and develop such sites; and support for development of incentives, including funding, for improvements to water infrastructure (both upgrades to existing infrastructure and development of new infrastructure).
Mission H2O Making statewide conclusions about water needs is misleading. Statewide 32% increase in 2040 demand does not take into account reductions in water usage that have been achieved in the past, and that per capita demand is decreasing. App B provides a better picture of future demand.
Loudoun Water Agrees with need to update the State Plan at five-year intervals to reflect most recent plans, data, and projections; State Plan must be a dynamic and iterative planning tool for all beneficiaries of VA's water resources.

Information from Water Supply Plans
Loudoun Water State Plan should footnote significant changes that have occurred since information was provided in water supply plans.
Fairfax Water Water use info for Fairfax County is not consistent with information included in NVRWSP. DEQ needs to check the information, as it appears that both FW retail and wholesale water sales are reflected in the snapshot for Fairfax County.
James City Service Authority 30-day comment period for State Plan was too short, insufficient time for stakeholders to discuss the report with each other.
Chesterfield County Information from water supply plan was submitted in 2007 and there have been significant developments that impact projections and water supply capacities. Specific changes were requested.
Newport News Waterworks Snapshots provided on localities we serve do not truly reflect the water uses by locality. These should all be reviewed and updated. In addition, we also serve a section of James City County, but no mention is made of this on the James City County sheet.
Hanover County P 244 Update Hanover interbasin transfers to include Hanover's purchase from the City of Richmond which originates in the James River as identified on page 22 of Hanover-Ashland WSP. App D: CWS demands 2010 in the snapshot do not agree with the information submitted in the Hanover/Ashland plan. Also, SSU_SM population and demands for 2010 in snapshot do not agree with the information submitted in the Hanover/Ashland WSP. Also, snapshot info for people using private groundwater wells for residential water supply does not agree with WSP. Request inclusion of a new additional alternative not mentioned in the WSP: South Anna River and the Little River could be used to supply the Verndon Quarry.

Mission H2O Water supply is inherently local in nature, so lumping all of the local/regional plans together to make state-wide conclusions about water needs is misleading. The Plan reaches a conclusion, expressed in the Executive Summary (page xii), that there will be an increase in water demand of 32% by 2040. Including this statement without any context does not provide an accurate picture. Major Basin Summaries provide a better and more complete picture of future demand.
Rapidan Service Authority (RSA) RSA has numerous interbasin transfers in the Greene County system from the Rappahannock into the James. These interbasin transfers have existed since RSA's inception, the early 1970s. Interbasin transfers consist of numerous single house connections to a 10 inch water main serving thousands of connections. This comment is only to document this fact.
David Ek Page 186: this section speaks to the Potomac but there is mention of a 2.5 MGD discharge permit to the Rappahannock which is repeated in the Rappahannock River section.

Projections
Fairfax Water State Plan should include information on water use and population growth in VA over the past several decades. Critical analysis of statewide per capita demand projection is needed, as national trends indicate that per capita water use has gradually declined in recent years.
Hampton Roads Sanitation District Validation of projected water demand, population projections, and per capita water use should be reviewed. The projected consumption rates in the plan appear to be overestimated. Data from the last 20 years does not support a strong correlation between population growth and water demand; this trend should be acknowledged. There is inherent uncertainty with projecting population growth and per capita water use; this should be incorporated into the plan.
West Piedmont Planning District Commission VA population figures inconsistent.
Newport News Waterworks The water demand projections presented in the plan should be reviewed. We assume that the numbers are simply an agglomeration of the individual plans. However from our experience, despite growing population, per capita water demand is decreasing suggesting that a one to one correlation with population growth is not accurate.
David Ek Ch 5 ...regional analysis is suspect due to the reliance on demand predictions provided in local/regional water supply plans. DEQ established no criteria for these local predictions; putting much weight in analyzing their findings is suspect. VEC v Weldon Cooper population projections.

Beneficial Uses
Loudoun Water Emphasis that preference shall be given to human consumption over all other uses.
James City Service Authority Concerned that DEQ is not prioritizing human consumption in practice.
Hampton Roads Planning District Commission State Plan should clearly state that meeting water demands for human consumption is the highest priority and address how demands associated with population growth should be accomplished.

Newport News Waterworks State Plan seems to intentionally raise the emphasis on instream needs and all but dismisses the priority that has historically been given to human consumptive needs.
Western Tidewater Water Authority State Plan should clarify that the term “beneficial use” has a distinct meaning for surface water and groundwater and that references to beneficial uses that apply only to surface waters be stated as such.

Alternative Sources, including Reuse
VA Association of Municipal Wastewater Agencies Primary reason for commenting on the draft State Plan is to recommend greater consideration of reclaimed water as a resource and to recommend that the Commonwealth continue to work to remove barriers to water reuse. DEQ and the State Plan should facilitate the availability of reliable, safe, and cost-effective sources; disappointed that the State Plan all but ignores the existing regulatory barriers to wastewater reclamation and reuse. The State Plan observes that water reclamation and reuse is “not commonly used by localities in the Commonwealth.”However, the plan does not take the next step to address why this tool is not more commonly used.
Loudoun Water State Plan should be amended to strongly "promote ad encourage the reclamation and reuse of wastewater" and articulate the benefits derived from reuse, per the Commonwealth's explicitly stated public policy.
Newport News Waterworks The plan mentions consideration for desalinization for alternative sources of water but does not offer any potential answers for brine disposal, which is a major challenge with such a water supply.
Western Tidewater Water Authority DEQ should take an active role (1) assisting public water suppliers in developing alternative supplies for the region and (2) promoting the state funding for new sources and infrastructure.
VA Association of Municipal Wastewater Agencies Requests that DEQ add the following to the Water Supply Challenges and Recommendations in Chapter 6: “Challenge: Regulatory Barriers to the Use of Wastewater Reclamation and Reuse.” VAMWA further suggests that DEQ include a recommendation along the following lines:Recommendation: DEQ will coordinate with other agencies, including the VDH and DHCD, to identify regulatory obstacles to the availability of wastewater reclamation and reuse as an attractive, reliable, and cost-effective water supply. At a minimum, any regulatory requirements that (1) substantially increase the cost of projects, (2) unnecessarily lengthen the process for obtaining approval for projects, or (3) lessen the reliability and usefulness of projects to the provider or user should be considered obstacles. DEQ and its coordinating agencies will work to modify or eliminate any identified regulatory obstacles that are not necessary for material and substantial protection of public health and safety or the environment.
Hampton Roads Planning District Commission State Plan should describe how DEQ and other state agencies will advocate for funding and permitting for additional water sources.
Hampton Roads Sanitation District Water reuse must go beyond industrial and irrigation uses. Indirect potable reuse (IPR) is a common, yet unrecognized practice and the state must acknowledge this and seize the opportunity to broaden the use of treated wastewater as an alternative water supply. Much of the treated water in the HRSD service area is lost to downstream uses following discharge to the tidal James, York, and Atlantic. Reuse of this otherwise wasted water provides a significant opportunity.IPR through aquifer replenishment has the potential to sustain groundwater supplies throughout much of the EVGWMA as opposed to the more localized benefits associated with reservoir augmentation.VA must face water supply challenge head-on and adopt policies which strongly incentivize water reuse as a means to preserve this resource; remove barriers to reuse.

Ches Bay Nutrient Land Trust Encourages DEQ to recognize trading as a potential strategy for addressing water demand. In Challenge #4: "...assist as appropriate in any efforts to optimize use of the source." It is unclear what this means or how DEQ will assist. More detail is needed. DEQ should clearly identify where more storage is needed, include suggestions for creating incentives for companies willing to develop such sites, and serve as an advocate and ally in the federal permitting process.
Hanover County The State Plan is somewhat single dimensional focusing almost solely on surface and groundwater, generally discounting nontraditional sources to meet projected 2040 demand. Nontraditional water sources, such as water reclamation and reuse, desalination, and interconnection are not commonly used by localities in the Commonwealth and address/eliminate burdensome roadblocks.
Hanover County Supports the comments submitted by the Virginia Association of Municipal Wastewater Agencies regarding the suggested additional Chapter 6 Challenge and Recommendation pertaining to reclamation and reuse. VAMWA's comments align with the aforementioned general reclamation and reuse statements.
Mission H2O State Plan does not include any analysis of the potential alternative sources identified at the local level; it is necessary to highlight potential impediments to alternative sources identified in the local/regional plans.
Mission H2O Should identify and vet alternative water sources, as well as include concrete recommendations on how to further identify and implement alternative solutions - should be primary goal of the State Plan. Potential alternatives that should be included: stormwater; a water trading program, providing incentives for individual water use reductions. Instead, the Plan identifies the regulatory implications of predicted water demands without critically evaluating the legitimacy of those demand predictions. Moreover, by focusing on the regulatory implications, the Plan further restricts water availability without identifying concrete alternative sources to offset those restrictions. While water quality and other regulatory programs will impact the assessment of water needs, the Plan focuses too much on these other impacts and too little on water supply planning itself.

Safe Yield
Mission H2O The term "safe yield" is used throughout the Plan. It is unclear what this term means, and how it is being applied in this document. (explanation provided).
VA Department of Health Proposed definition of “safe yield” cited in the report is of concern. The phrase “can be” is subjective and the time period/duration of the “volumetric rate” is not specified in the definition. Provided language from the Waterworks Regulation.

Withdrawal Permits
King William County The State Plan should make every effort to maintain current permitted withdrawal amounts.
James City Service Authority Duration of permits should be re-evaluated. Ten year permits are quite short in the context of long range water supply planning.

Hampton Roads Planning District Commission The State Plan should acknowledge that the 10-year permit period does not align with the typical 30-year period needed to finance major water infrastructure projects.
Middle Peninsula Planning District Commission Requiring monitoring wells to be paid for by those requesting a permit is a cost shifting strategy that places additional burdens on the private sector thus further hindering economic development. The General Assembly should provide cost share grants or low interest loans to partner with the private sector for monitoring wells.
Western Tidewater Water Authority Permit periods do not align with reality of utility operation and finance. Utility decisions are generally made over a 30-year planning horizon. The State Plan should recognize this problem and recommend that the permitting periods be extended to greater align with the realities of utility planning and financing.
Bill Lucas RockTenn paper mill in West Point, VA should be required to reduce its permitted withdrawal and recycle processed water.

Cumulative Impact Analysis / Flow Metrics
Fairfax Water The four flow metrics selected for cumulative impact analysis by DEQ do not accomplish the objectives required by the Code of VA. The figures in the State Plan indicating graphical changes in flow by HUC present a misleading picture of the potential impacts of cumulative withdrawals and need to be modified to reflect actual changes by linear river or stream segments rather than across entire HUC areas.
Dominion Resources Services, Inc. Request that the discussion of potential flows in the York River Basin include a discussion of the regulation ofthe releases from Lake Anna Dam so that readers are provided context of the associated issues.
Virginia Institute of Marine Sciences Clarification within the Plan is needed regarding the August Low Flow metric regarding its applicability to tidal freshwaters. We recommend that DEQ consider the development of minimum requirements for tidal freshwaters.

Understanding the Impact of Unpermitted Water Withdrawals (Challenge #1)
Fairfax Water The State Plan should acknowledge that, in all cases, grandfathered water withdrawals are limited to the specific volume of water that can be withdrawn through the capacity of the intake structure. The State Plan needs to acknowledge that all SSU_LG and CWS are required to have DRCP.
Middle Peninsula Planning District Commission Unpermitted withdrawals continue to place stress on available water resources. Permit parity is needed. Economic development opportunities cannot wait 2+ years for permits, while those unregulated continue to consume water. DEQ must be provided adequate financial resources and staff to timely manage and issue permits.
Michael Collins Director of Public WorksCity of Harrisonburg (personal comments) Meeting with unpermitted withdrawers in prioritized areas of low instream flow is a good approach (provides a list of values). DEQ should be extremely cautious to enter into SWMA designation, but should favor cooperative agreements instead; provides explanation

Newport News Waterworks Leadership role is needed to assist localities with guaranteeing quality and quantity of their supplies in a concurrent effort while considering any operational rules for any un-managed water supply sources.
Western Tidewater Water Authority Any effort to regulate unpermitted surface water withdrawals must protect existing users and prioritize public water supplies WTWA staff request that DEQ clarify that any “future options” contemplated by the State Plan will protect public water supply capacity.
VA Water and Waste Authorities Association Does not believe DEQ should amend its regulations to encompass these grandfathered rights and that doing so would exceed its legislative authority; opposed to DEQ collecting information about these withdrawals, although most are already covered under the Virginia Water Reporting Regulation. Not opposed to truly voluntary agreements by grandfathered rights holders as to how they will manage their unpermitted withdrawals. Do not supportany governmental regulation of these rights beyond what is currently permissible by law.
City of Richmond DPU concerned with how the State Plan addresses "grandfathered withdrawals" from VA's surface waters and the suggested need for further controls on such withdrawals. The State Plan should include a broad discussion of legal rights that pertain to the withdrawal and use of surface waters in VA.
Dominion Resources Services, Inc. Consideration of changes to these statutory provisions have not been justified and are not warranted. However, we do support the discussion regarding DEQ's interest to voluntarily coordinate with specific exempted withdrawals to identify options to reduce potential impacts to beneficial uses during low flow periods.
Mission H2O Using the terms "grandfathered" and "unpermitted" interchangeably is misleading. Statement on P 11" DEQ has limited operational information on unpermitted withdrawals" is not accurate, based on VWP exemption requirements for these users. It is unclear what additional "control" or operational restrictions DEQ would be seeking as a part of the solution.
James City Service Authority The State Plan seems to imply that SWMA be created and permitted similar to GWMA; this would seem to be the first step to develop a truly comprehensive water resources plan.

Gaps in Water Withdrawal Reporting, Differences in Reporting Thresholds between WSP and VWWR Regulations, and Lack of Adequate Data (Challenge #2)
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) An interactive, real time, self entered database is a good idea versus the once per year reporting requirement now in effect.
Middle Peninsula Planning District Commission The General Assembly must provide adequate resources to DEQ to partner with local governments if mandated to provide this data to DEQ.
Newport News Waterworks Any usages that are not reported should be recorded; direct input of data seems to be a reasonable request, but is already being done for surface supply withdrawals.
Hanover County DEQ should do more than simply coordinate with localities; they should coordinate available state data and there should be no resubmitting of data to DEQ.
Mission H20 Accurate data is needed to better manage water resources. Obtaining this data should be a priority. Such data is readily available for surface water. Costs associated with development of SOW should not be borne solely by groundwater users.

Quantifying Current and Future Risks to Groundwater Availability Outside Groundwater Management Areas (GWMA) (Challenge #3)
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation
Newport News Waterworks Expanding the monitoring capability and gaining a better understanding of groundwater resources outside of the managed areas is a reasonable goal. For years GWMA permittees are required to perform expensive, targeted groundwater research efforts. This approach seems fair and should be expanded to areas and other basins where needed.
Hanover County The State should take the lead and work with USGS and other applicable state and federal agencies to establish the observation well networks, as this is a statewide issue.
Mission H2O Industrial and agricultural water users are not identified in the list of stakeholders referenced in the recommendation and should be.

Reservoir Site Development (Challenge #4)
Loudoun Water DEQ encouraged to take a more active and declared role in support and development of water storage projects.
Fairfax Water The State Plan needs to indicate that DEQ will promote and be a strong advocate for new water supply storage projects, and that the state needs to provide sources of funding for, and the means to facilitate the development of, new water supply storage projects.
Hampton Roads Planning District Commission The State Plan should describe how DEQ and other state agencies will advocate for funding and permitting for additional water sources.
Hampton Roads Planning District Commission The State Plan should clearly identify areas in need of water and recommend alternatives and locations for new sources and storage.
Middle Peninsula Planning District Commission Coordination between DEQ and ACOE needs to take place prior to inclusion in the State Plan.
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) DEQ should assist with efforts to construct new water storage projects. For those that have already funded and implemented water storage reservoirs, the effects flow augmentation and the benefits during low in stream flow should be credited to the purveyor.
Newport News Waterworks State should take a more active involvement and leadership role to preserve good sites for reservoirs.
Western Tidewater Water Authority Appreciates DEQ's commitment to assist with reservoir construction projects. Requests that DEQ further strengthen its commitment to supporting large-scale water supply projects by committing its willingness to become a partner in projects that will have a great public benefit.

VWWAA Recommendation does not take a strong enough position on what DEQ could do to support a reservoir project. What the State Plan does not do is strongly state how the state could be an advocate for a reservoir project once a project has received its VMRC and VWP permits. Revise recommendation to state that if a project has received its VWP and VMRC permits, DEQ would actively support the project with respect to any necessary federal permitting.
Chesapeake Bay Nutrient Land Trust, LLC DEQ's recommendation is that "DEQ will assist, as appropriate, in any efforts to optimize the use of the resource." It is unclear what this recommendation means or how DEQ will assist. More detail is needed in this recommendation. If thedata gathered through the water supply planning process demonstrates that new reservoir sites areneeded, the State Plan should more clearly identify where additional storage is needed thus creating an incentive and opportunity for the market to drive development of such sites. Additionally, DEQ'srecommendation could include suggestions for creating incentives for companies willing to develop such sites. Finally, DEQ must affirmatively commit to serve as an advocate and ally in the federal permitting process.
Hanover County Given the need for additional storage and the impact a storage project in an upstream river segment can have on a downstream segment, the State should take a key role in regional reservoir development, based upon the data contained in the State Plan. Key reservoir sites should be identified.
Mission H2O Challenge description should highlight the challenges VA will face if projects are not identified and advanced. Recommendation does not go far enough; DEQ should help identify or vet potential reservoir sites. DEQ should advocate for those projects, particularly through the federal regulatory process.

Threats to Water Quality **(Challenge #5)**
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation.
Newport News Waterworks The State Plan should focus on water supply, not on water quality as it concerns aquatic life.
Mission H2O Recommendation directly relates to water quantity, despite the heading description of water quality; does not correlate to the description of threats. Unclear how AFL and 7Q10 numbers can be used to address identified threats.
Fairfax Water It is imperative that any flow metric considered by DEQ in water withdrawal permitting actions be based on peer-reviewed scientific studies specific to a particular basin. The State Plan needs to clarify the derivation of the ALF and provide its quantity and reoccurrence interval for each river sub-basin in VA.
Understanding the Impact of Consumptive Use on Water Supply **(Challenge #6)**
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation.
Newport News Waterworks If required to report this number, a methodology must be provided that can be easily used to obtain this information.

Dominion Resources Services, Inc. Consumptive use of water is the primary issue facing VA's future water supply. Requiring individual operators to estimate and report consumptive use, without first establishing the most appropriate methods and scale to estimate consumptive use is likely to result in estimates of water consumption that range widely in accuracy. DEQ should evaluate all options available for improving estimates of water consumption prior to seeking a requirement for individual reporting of water consumption, including development of improved sector/industry-specific consumptive use factors that are appropriate for VA prior to individual reporting.
Hanover County Supports VAMWA suggestion to include a new Challenge/Recommendation re: reclamation and reuse.
VA Department of Health Concern with definition of "consumptive use" and the recommendation to require annual reporting of this use. Definition and recommendation should be revised to obtain a more accurate reported measurement.
Mission H2O It is unclear the purpose or need for performing such calculations (water lost to evaporation, transpiration, etc.). DEQ possesses data that can be used to estimate consumptive use. The State Plan does not clearly state the need for this info and how such would alter or benefit the recommendations or assessments already being performed.
Virginia Institute of Marine Sciences Agrees with the State Plan regarding the difficulties raised by a lack of comprehensive withdrawal and consumptive data; supports the recommended intentions to strengthen the information base for ongoing activities.

Promoting Increased Conservation to Reduce Long-Term and Short-Term Demand (Challenge #7)
Stuart Nixon Include ideas for conserving water (provided examples in two submittals).
James City Service Authority The State Plan needs to address irrigation as a critical component of efforts to conserve water; better addressed at the state level than the locality level.
Fairfax Water This recommendation is redundant with existing regulation and needs to be removed. The statement "Water conservation practices can...reduce costs to consumers as their use of water declines" is misleading.
Middle Peninsula Planning District Commission The State Plan must include water reuse as a specific recommended water conservation technique especially in the Coastal regions where saltwater intrusion is a threat to the aquifers.
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) At this time there is no need to broadband conservation as a 24/7/365 requirement, but teach it and then engage it when and where needed.
Newport News Waterworks Water demand has decreased sharply and not just locally, but across the nation. This is due to many factors, including, changes in the plumbing code, appropriate pricing of water, the establishment of a water conservation ethic among the public, and some other factors. Many water providers are "already there" regarding increased conservation awareness and practices. Any new VWPP and groundwater permits already require a plan be developed and implemented. What may be needed is better documentation from localities on what they have already done to give credit for progress already made.
Hanover County The statement is too simplistic and fails to recognize the financial complexities and obligations associated with water utilities. As conservation programs become more successful, the fixed costs will need to be shifted to the consumer, such as debt, bond covenants, maintenance and personnel.

Mission H2O Additional reductions in water demand through conservation efforts are not so readily achieved and are more costly. A cost benefit analysis would be useful for this challenge and recommendation. Incentives are needed and examples from other states would enhance the recommendation.

Critical Infrastructure Deficiencies (Challenge #8)_
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation.
Newport News Waterworks Determining the loss of water can be difficult for localities. Funding for infrastructure is a worthwhile goal; assumption that emphasis will be on small water systems.
Western Tidewater Water Authority Requests that the plan recommend that DEQ increase its efforts to obtain funding for critical infrastructure and expand its criteria for prioritizing funding beyond simply water loss.
Mission H2O More concrete recommendations are needed. Examples: General Assembly established fund recognizing the need to invest in infrastructure upgrades, sustainable planning and revenue generation for water infrastructure.

Sea Level Rise, Changes in Precipitation Patterns, Land Subsidence (Challenge #9)
Middle Peninsula Planning District Commission The significance of saltwater intrusion and sea level rise within the lower portion of the Coastal Plain and its impacts on groundwater should be enhanced in the State Plan to further exemplify the magnitude of the groundwater problem facing many coastal communities.
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation.
Newport News Waterworks Some water providers are already working to gain a better understanding of the possible implications of changes in precipitation and sea level conditions. Any work on modeling streamflow scenarios needs to be shared with localities early on and DEQ should assist as needed in understanding how any implications can be taken into account as updates are made to regional and individual water plans.
Middle Peninsula Planning District Commission Possible hydraulic fracturing activity in our region is an emerging issue of concern not addressed in local plans or considered in future demand projects. Future plan updates should recognize this potential new user and possible polluter of groundwater. Saltwater intrusion and sea level rise should be enhanced to further exemplify the magnitude of the groundwater problem facing many coastal communities.
Virginia Institute of Marine Sciences The effects of sea level rise and saltwater intrusion on the relationship between water supply and aquatic resources in tidal freshwater areas should be incorporated into the Plan to a greater degree (provides explanation).
Mission H2O Recommendation is confusing; clarification about the purpose, intent and implementation of this recommendation is needed.

Source Water Protection (Challenge #10)
Middle Peninsula Planning District Commission The State Plan should include BMPs related to AG water runoff into AG ponds and other water sources should be included in water resource plans to broaden opportunities for funding sources for implementation. Recognition that there is a disparity of regulatory burden between AG uses, legally recognized unpermitted users and permitted users. A level of uniformity is needed.
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation.
Newport News Waterworks Good recommendation, but many localities have sources that are either located in, or have watersheds in other jurisdictions. Assistance is needed at the State level to help localities to develop and implement SWPP for those areas for which they have no control. Other aspects, such as tracking hazardous materials handlers within watersheds, should be considered.
Mission H2O Unnecessary addition, given DEQ's limited resources and the fact that this program is already in place and working effectively.

Conflict Resolution (Challenge #11)
Fairfax Water The State Plan should recognize that DEQ has the authority to resolve conflicts through existing regulation to establish SWMA.
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Supports DEQ recommendation
Newport News Waterworks Most conflicts over water resources have traditionally been resolved by localities. State could act as a fair and unbiased arbiter, but that really has not occurred, and is not likely. The State Plan should provide a mechanism for dealing with conflicts before they become a problem, but does not appropriately address this issue.
Mission H2O Consistent with the recommendations of the WSPAC. Mission H20 members support its inclusion.

Public Education and Outreach (Challenge #12)
Michael Collins, Director of Public Works, City of Harrisonburg (personal comments) Public education should be in alignment with the purpose as stated under Challenge #7: At this time we do not need to broadband conservation as a 24/7/365 requirement, but teach it and then engage it when and where needed. Actual designated conservation periods may be one out of the box approach to begin education and practice.

Newport News Waterworks Caution is offered on educating the public on the importance of conservation during droughts. Assumptions should not be made that more conservation during droughts will help through temporary or long term drought conditions. The reality is that the public, businesses and industries have already cut back on their water demand to such a degree that most of the discretionary demand that could be cut back during a drought has been very much diminished. Future droughts, if worse than those in the recorded past, could have very detrimental effects on our citizens. The need for developing future water supply projects should be championed at the state and federal levels rather than putting up roadblocks. The State Plan should take on more of an advocacy role for water supply rather than an inventory and enforcement role.
Hampton Roads Sanitation District More robust public education is needed beyond concern with supply shortfalls, but also the alternatives such as water reuse that are available.
Mission H2O Public education is a critical component of both achieving water conservation goals and gaining public support for the measures needed to effectively manage Virginia's water resources. Such public education measures should be complementary of the existing communication plans of local governments and water providers that are already in place. The development of the Plan in and of itself is an important tool for education and outreach.