STATUS OF VIRGINIA'S WATER RESOURCES

A Report on Virginia's Water Resources Management Activities

A report to the Honorable Terence R. McAuliffe, Governor, and the General Assembly of Virginia

Virginia Department of Environmental Quality

Office of Water Supply

October, 2014

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ACRONYMS

CIA: Cumulative Impact Analysis

DEQ: Department of Environmental Quality

DMTF: Drought Monitoring Task Force

EPA: Environmental Protection Agency

FERC: Federal Energy Regulatory Commission

GWCP: Groundwater Characterization Program

GWPP: Groundwater Permit Program

GWMA: Groundwater Management Area

HWI: Healthy Waters Initiative

MGD: Million Gallons Per Day

NURE: National Uranium Resource Evaluation

OWS: Office of Water Supply

PDC: Planning District Commission

SWCB: State Water Control Board

SWIP: Surface Water Investigations Program

SWRP: State Water Resources Plan

TMDL: Total Maximum Daily Load

USACE: United States Army Corps of Engineers

USGS: United States Geological Survey

VDGMR: Virginia Department of Geology and Mineral Resources

VDH: Virginia Department of Health

VMRC: Virginia Marine Resources Commission

VWP: Virginia Water Protection (Permit Program)

VWUDS: Virginia Water Use Data System

EXECUTIVE SUMMARY

This annual report, submitted to the Governor and the Virginia General Assembly in accordance with § 62.1-44.40 of the *Code of Virginia*, describes the status of the Commonwealth's surface and groundwater resources, summarizes reported water withdrawals for the 2013 calendar year and provides an update on the Commonwealth's Water Resources Management Program. The report also provides an overview of current climatological conditions and impacts on water supplies in the Commonwealth. Water quantity is the focus of this report. Water quality issues are addressed in the most recent DEQ biennial Water Quality Assessment Integrated Report.

Virginia's estimated 52,232 miles of freshwater streams and rivers are part of nine major watersheds. Annual state-wide rainfall averages almost 43 inches. The total combined flow of all freshwater streams in the state is estimated at about 22.5 billion gallons per day. The 248 publicly owned lakes in the Commonwealth have a combined surface area of approximately 162,000 acres. Additionally, many hundreds of other small privately owned lakes and ponds are distributed throughout the state. 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 more than 2,300 square miles of estuaries. A summary of Virginia's surface water resources is provided in Appendix 1.

Precipitation during the 2013 water year has been generally normal to above normal across most of Virginia. Consequently, stream flows were generally within normal ranges and groundwater levels in Climate Response Network observation wells remained relatively high throughout the spring and summer. Water-supply storage reservoirs maintained water levels within or above normal ranges throughout the year. Southwestern Virginia, where abnormally dry to moderate drought conditions existed during the spring and summer months, was the exception to this pattern. Stream flows in parts of the Tennessee and New River basins were below normal ranges during the late spring and early summer months. However, reservoirs in these basins also maintained storage within normal ranges.

Management of the quantity of water resources across the Commonwealth of Virginia is coordinated by the Office of Water Supply within the Division of Land Protection and Revitalization of the Department of Environmental Quality (DEQ). The Office of Water Supply (OWS) consists of five programs: Ground Water Characterization, Water Supply Planning and Water Withdrawal Reporting, Groundwater Withdrawal Permitting, Surface Water Withdrawal Permitting, and Drought Assessment and Response. Additional information about the OWS programs can be found at Water Supply and Quantity on the DEQ webpage. Programmatic highlights of the Office of Water Supply during 2013 include:

- Monitoring of 68 real-time surface water discharge monitoring stations, 85 real-time groundwater stations and 140 additional wells, and 30 Total Maximum Daily Load (TMDL) surface-water data sites. (Real-time data are collected at 15-60 minute intervals and transmitted to viewable databases every 1-4 hours.)
- The Virginia Ambient Groundwater Monitoring Strategy document was developed in November of 2013. This document describes the current coverage of ambient (background) groundwater quality samples taken in Virginia and presents a strategy for collecting ambient groundwater quality data for the purpose of describing the current geochemical composition of groundwater throughout Virginia.
- Borehole logging was conducted at 25 wells using geophysical and/or camera logging tools. Data from these logs were used to help bring non-permitted wells into compliance, to help document and describe groundwater resource conditions within the Commonwealth, and for more effective management of groundwater supply wells.
- Public outreach and technical assistance activities regarding groundwater resources included teaching classes at the Virginia Water Well Association Annual Winter Driller Conference and Fall Field Day and the Virginia Department of Health Water Treatment Plant Operators Short Course, plus speaking engagements at numerous local groundwater related meetings.
- A relational database was constructed to compile, organize and analyze the data submitted with the 10 Local and 38 Regional Water Supply Plans submitted in accordance with the Local and Regional Water Supply Planning Regulation (9VAC 25-780). Information from the plans was used to assist in preparing a draft of the State Water Resources Plan (SWRP).
- Preparations were made to begin implementation of three new regulatory packages that became effective on January 1, 2014. These were: 1) the expansion of the Eastern Virginia Ground Water Management Area (9VAC25-600), 2) revision of the Ground Water Withdrawal Regulations (9VAC25-610) and (3) an Order Declaring the Eastern Shore of Virginia as a Critical Ground Water Area (9VAC25 - 620).
- Issuance of 41 groundwater withdrawal permits.
- Issuance of 8 Virginia Water Protection (VWP) Program permits (4 new, 3 modifications and 1 reissuance).
- Continued management of the annual water withdrawal reporting program. For 2013, non-zero withdrawals were reported by 955 user facilities for 2257 withdrawal measuring points. The reported 2013 withdrawals exceeded 7 billion gallons per day for all use types, including water used for cooling at nuclear and fossil fuel power generation facilities. Excluding power generation, the reported 2013 withdrawals totaled approximately 1.2 billion gallons per day.

I. INTRODUCTION

This annual report, submitted to the Governor and the Virginia General Assembly in accordance with § 62.1-44.40 of the *Code of Virginia*, describes the status of the Commonwealth's surface and groundwater resources, summarizes reported water withdrawals for the 2013 calendar year and provides an update on the Commonwealth's Water Resources Management Program. The report also provides an overview of current climatological conditions and impacts on water supplies in the Commonwealth. Water quantity is the focus of this report. Water quality issues are addressed in the most recent DEQ biennial Water Quality Assessment Integrated Report.

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II. CLIMATOLOGICAL CONDITIONS

This section provides an overview of the climatological conditions that have affected Virginia's Water Resources during the 2013-2014 water year (October 1, 2013 through September 30, 2014). Appendix 2 contains the most recent report from the Virginia Drought Monitoring Task Force (DMTF), which includes contributions from member agencies describing meteorological and hydrologic conditions during the previous twelve months.

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Southwestern Virginia, where abnormally dry to moderate drought conditions existed during the spring and early summer months, was the exception to this pattern. Stream flows in parts of the Tennessee and New River basins were below normal ranges and then rebounded during August 2014.. Reservoirs in these basins also maintained storage within normal ranges,

however. A current update on drought conditions in Virginia can be obtained from the DEQ Drought Monitoring website.

III. PROGRAM SUMMARIES

Management of the quantity of water resources across the Commonwealth of Virginia is coordinated by the Office of Water Supply within the Division of Land Protection and Revitalization of the Department of Environmental Quality (DEQ). The Office of Water Supply (OWS) consists of five programs: Ground Water Characterization, Water Supply Planning and Water Withdrawal Reporting, Groundwater Withdrawal Permitting, Surface Water Withdrawal Permitting, and Drought Assessment and Response. The Surface Water Investigations program is currently part of the DEQ Office of Wetlands and Stream Protection; however, this program will also be briefly described in this report because the collection and evaluation of adequate and accurate surface water discharge data is critical to the operation of all five OWS programs. Additional information about the OWS programs can be found at Water Supply and Quantity on the DEQ webpage.

Surface Water Investigations Program

DEQ and the United States Geological Survey (USGS) are the primary agencies responsible for collecting hydrologic data in Virginia. The two agencies work cooperatively to provide a comprehensive picture of real-time and historical hydrologic conditions in the Commonwealth. The mission of the Surface Water Investigations Program (SWIP) is to systematically collect reliable hydrologic data regarding the quantity of surface water in the Commonwealth using the same standards as the United States Geological Survey (USGS). This is accomplished through a network of real-time satellite telemetry gauging stations and is essential for the successful planning and management of the Commonwealth's water resources.

DEQ and the United States Geological Survey (USGS) are the primary agencies responsible for collecting hydrologic data in Virginia.

In 2013, DEQ personnel monitored and processed the data collected from 68 surface water discharge monitoring stations (Figure 1) on a six to eight week schedule, including extreme conditions of low and high water, servicing the real-time satellite equipment, maintaining the permanent stations and measuring stream flow (discharge). Over 500 discharge measurements were made by DEQ personnel for the gauging station network in 2013. Stream depth, width and velocity are measured in the waterway to determine discharge. From these measurements, a rating curve is developed by correlating discharge with water level (gage height) in the stream. The gage height is recorded every 15 minutes by a data logger located in a permanent gage

house, saved and transmitted to the USGS database hourly by satellite telemetry, converted into discharge, then updated on the USGS National Water Information System (NWIS) website .

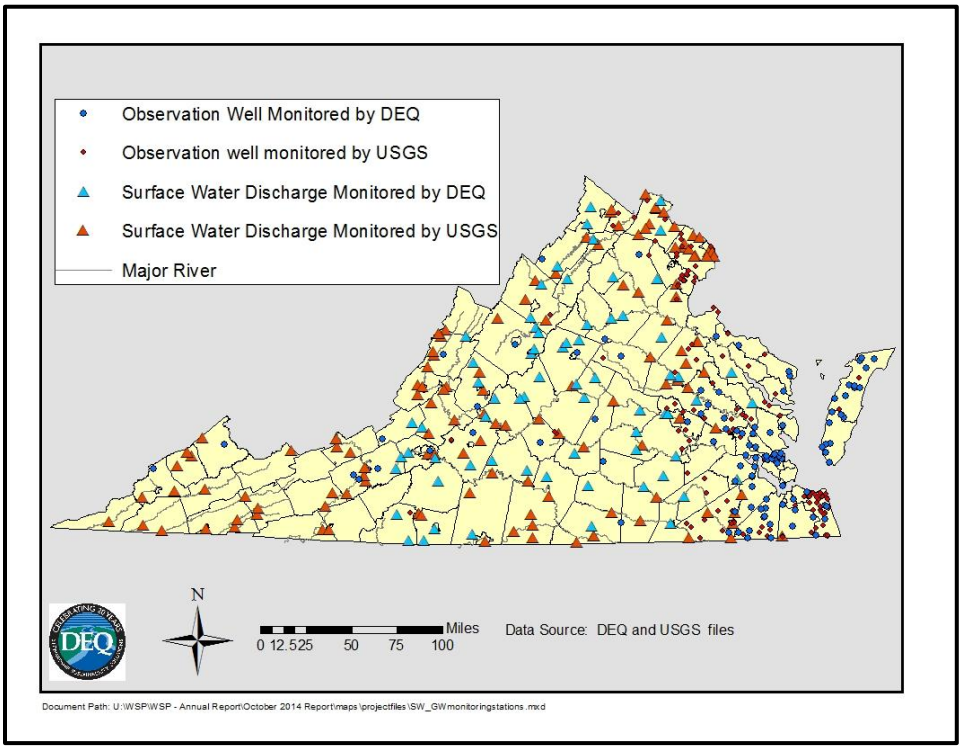


Figure 1: Locations of Groundwater and Surface Water Monitoring Stations. Monitoring at all of the USGS sites is performed by the USGS under contract for the DEQ.

Under the Clean Water Act the Environmental Protection Agency (EPA) requires that each state develop a list of impaired water bodies and TMDLs. A TMDL or "Total Maximum Daily Load" is the maximum amount of pollutant that a body of water can have and still meet water quality standards. A TMDL calculation must account for seasonal variation in water quality. The SWIP is a major component of the Commonwealth's TMDL program, supplying critical stream discharge and water quality data throughout Virginia. In 2013, the SWIP measured 30 miscellaneous TMDL sites with a total of 164 measurements located in the Upper Potomac, Lower Shenandoah, Upper Rappahannock, Upper and Middle James, Big Sandy and Tennessee Basins.

Groundwater Characterization Program

DEQ established the Groundwater Characterization Program (GWCP) in response to negative impacts experienced by many localities, businesses, and domestic well users during the drought of 2002. The organizational objective of the GWCP is to protect Virginia's environment and promote the health and well being of its citizens by collecting, evaluating, and interpreting technical information necessary to manage groundwater resources of the Commonwealth. The GWCP staff works to assure that necessary information is available to support resource

management decisions and water supply planning activities, assessment of groundwater availability, facilitate drought monitoring, and provide technical support for the expansion or creation of Groundwater Management Areas. Providing educational outreach to citizens of the Commonwealth is seen as one of the most important opportunities for developing awareness of the wide range of viewpoints and issues affecting the region. Long term goals for the GWCP include expansion of the State Observation Well Network west of Interstate 95 and in Virginia's Northern Neck peninsula and publication of regional groundwater resources reports.

State Observation Well Network

DEQ provides accurate groundwater elevation data by utilizing a state-wide groundwater level monitoring network in cooperation with the USGS. This network assists with determining the availability of the groundwater resource for water supply planning, groundwater withdrawal permitting and drought monitoring purposes. DEQ personnel monitor water levels at 85 real-time groundwater stations and 140 manually measured (taped) stations (Figure 1) on a quarterly schedule. The USGS provides water level data for an additional 193 wells and 3 springs. The groundwater data collected by both GWCP and the USGS are available online at the USGS GroundwaterWatch webpage. Both groundwater level data as well as stream discharge data are reviewed, approved and published digitally in an annual USGS Water Resources Data Report.

Network wells help to determine the magnitude and extent of the continuing long-term water-level declines in wells completed within the coastal plain's Potomac aquifer due to groundwater withdrawals.

Information obtained from the observation well network is used to help guide groundwater management decisions, and aid in the study of local and regional aquifer system responses to a variety of natural and anthropogenic stresses. Network wells help to determine the magnitude and extent of the continuing long-term water-level declines in wells completed within the coastal plain's Potomac aquifer due to groundwater withdrawals (Figure 2). Water-level monitoring at observation wells completed at different levels within fractured rock aquifers located west of the coastal plain provides insight regarding the timing and magnitude of groundwater recharge (Figure 3).

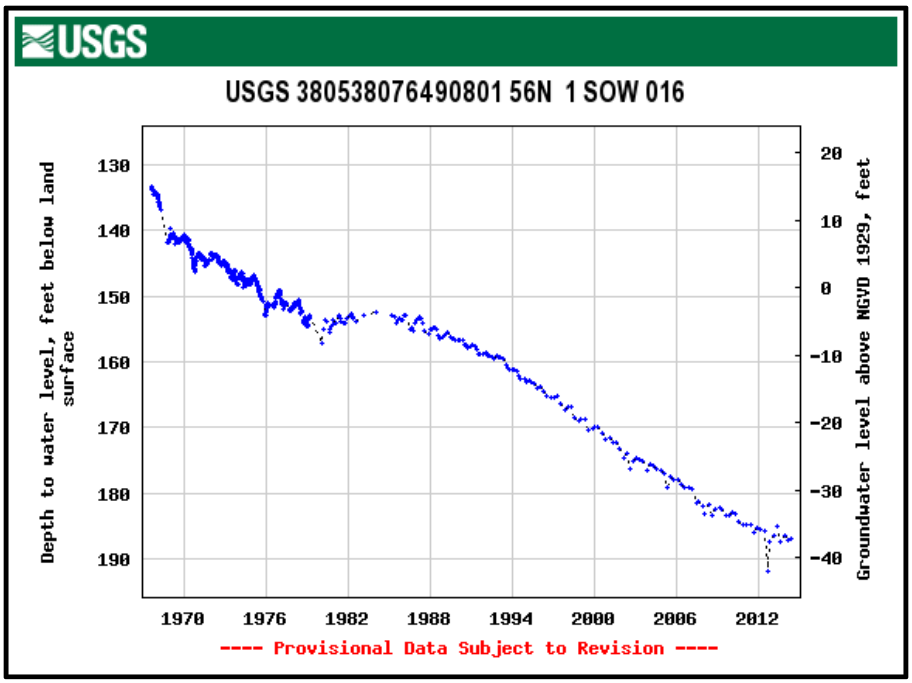


Figure 2: Groundwater level field measurements for State Observation Well 216 in Westmoreland County, Virginia - August 25, 1967 to April 28, 2014. This well is completed in the Potomac Aquifer.

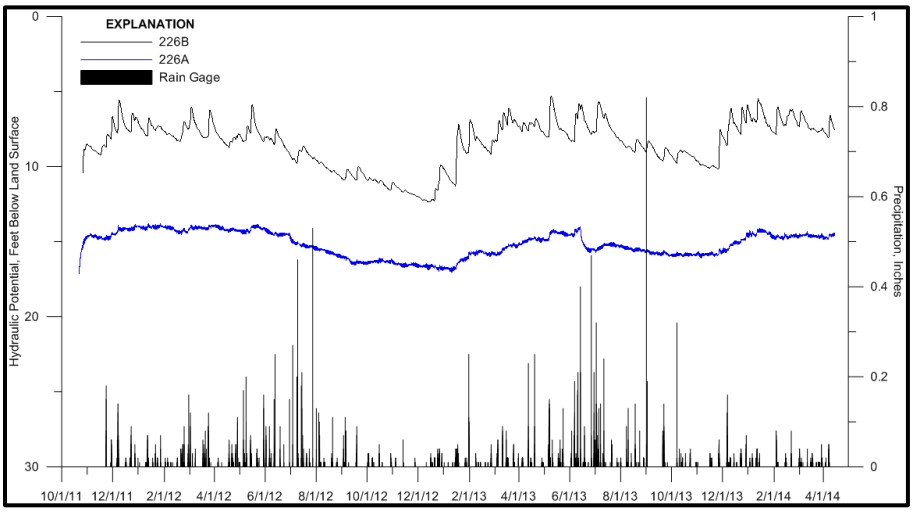


Figure 3: Depth to water in State Observation Wells 226Aand 226B and precipitation at Otterville rain gage from late 2011 through mid-April 2014, Bedford County, Va. Values of depth to water and precipitation reported in 15 minute increments. 226A open to fractured rock aquifer at 168 feet below land surface, 226B open to fractured rock aquifer 37 feet below land surface.

Groundwater Resource Reports and Groundwater Related Publications

Regional groundwater resource reports document and describe the geologic controls on the occurrence, movement, availability, and quality of groundwater as it occurs within the geologically distinct provinces and sub-provinces of Virginia, and summarize current groundwater withdrawal rates and trends.

The Virginia Ambient Groundwater Monitoring Strategy document was developed in November 2013. This document describes the current coverage of ambient (background) groundwater quality samples taken in Virginia and presents a strategy for collecting ambient groundwater quality data for the purpose of describing the current geochemical composition of groundwater throughout Virginia. This report, along with other recently published and historic groundwater publications is available for download at the Groundwater Characterization Reports and Publications webpage.

Statewide Water Well Construction and Geochemical Databases

Water well construction information is vital for understanding and describing local and regional groundwater systems. In 2007 and 2008, DEQ compiled a GIS database of approximately 35,000 historic well construction records. Each record describes in varying detail the location and physical properties of the well and the water-bearing properties of the geologic material in which the well is completed. These well records include information from the State Water Control Board (SWCB), Department of Environmental Quality (DEQ), The United States Geological Survey (USGS), The Virginia Department of Geology and Mineral Resources (VDGMR), the Virginia Department of Health (VDH), county governments, and well drillers. Considerable effort and time is being invested to cull duplicate records and to locate a substantial number of non-domestic water supply wells with questionable coordinate and incomplete construction information. Incorporation of new electronic well construction data from cooperating drillers into the dataset as well as the incorporation of new public water supply well records forwarded to the DEQ by VDH is ongoing. Currently, the well construction database houses well construction and location data for approximately 57,000 wells state wide. There are, however, a significant number of historic legacy well files that remain to be entered into the database. These records are located within the files of local health departments and more resources are needed to acquire and enter these data into the database.

Currently, the absence of accurate well-head location requirements (coordinates) for domestic water well completion reporting forms means that the thousands of residential wells drilled annually have no readily usable spatial representation. Consequently, there is no efficient way to analyze the impact of residential demands on local aquifers or of effectively analyzing the local geologic limitations on these systems. DEQ continues to educate private well drillers about the importance of voluntarily reporting well coordinate information, and by encouraging the electronic submittal of water well completion reports to VDH so that the data can be more easily converted into a database format. DEQ has also initiated an effort to actively pursue and

incorporate existing georeferenced well construction information that is currently stored and managed electronically by drillers within the Commonwealth.

In 2008, a geochemical database of groundwater samples was compiled and geo-referenced by DEQ staff. This database contains information about the natural groundwater quality throughout the Commonwealth from approximately 23,000 groundwater samples originating from approximately 12,400 wells. Sample data originated from SWCB, USGS, VDH, and National Uranium Resource Evaluation (NURE) data, and has been consolidated and normalized to standard concentrations and uniform reporting units. The geochemical database is also used to manage new groundwater quality information made available to or acquired by DEQ staff.

Virginia Spring Database

DEQ staff have initiated an effort to locate, characterize, and publish a database of springs throughout Virginia with an emphasis on the predominantly carbonate terrains of western Virginia. Springs are important water resources for municipalities, agriculture, and private landowners, particularly within the western portion of the Commonwealth. Locations and discharge measurements of springs are important components of any hydrogeologic analysis and are increasingly sought after by resource managers. This is the first comprehensive analysis of springs undertaken by the Commonwealth since 1930. A spring database structure was formalized in 2007 capable of integrating various historic datasets with more recent field measurements. The spring database contains site location information, field measurements such as spring discharge, pH, specific conductance, total dissolved solids, dissolved oxygen and temperature, laboratory water quality analyses, scanned images of historic documents, and site photos. Since its inception, the spring database has grown from a little over 200 springs to 971 spring locations associated with over 2900 field measurements, and analyses from 331 water quality sampling events (Figure 4). Data sharing agreements exist with sister agencies in the Virginia Department of Conservation and Recreation's Karst Program, Virginia Department of Mines Minerals and Energy, and the USGS in order to accelerate the acquisition of spring data and to prevent duplication of work. A quick and easy-to-use spring reporting form was developed by DEQ and is available for field personnel of sister agencies to inventory springs encountered during field work.

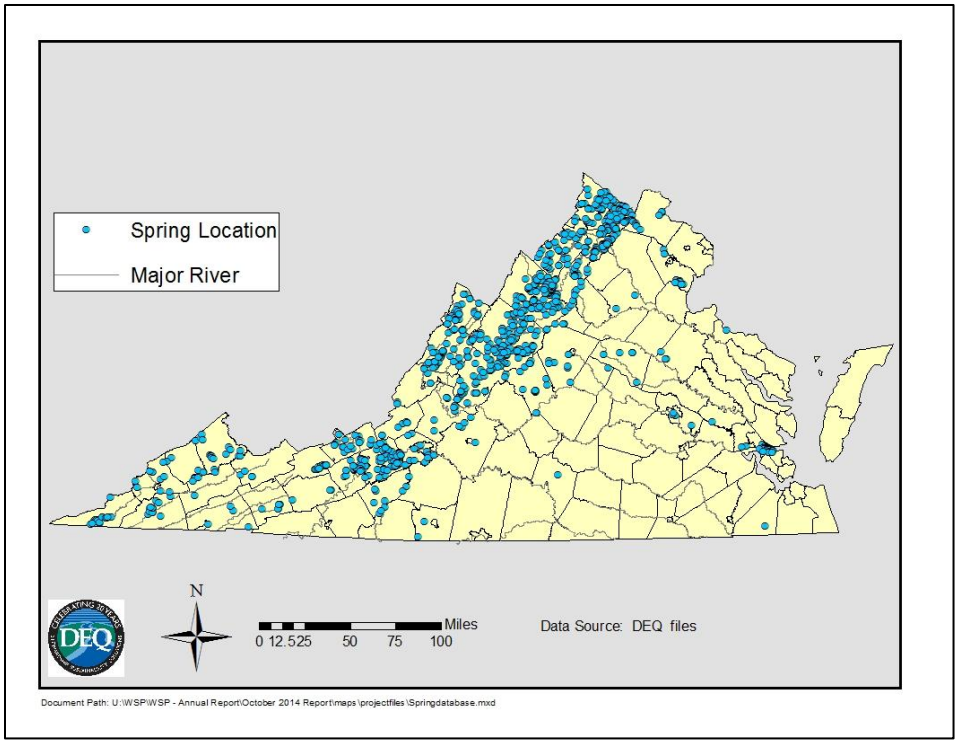


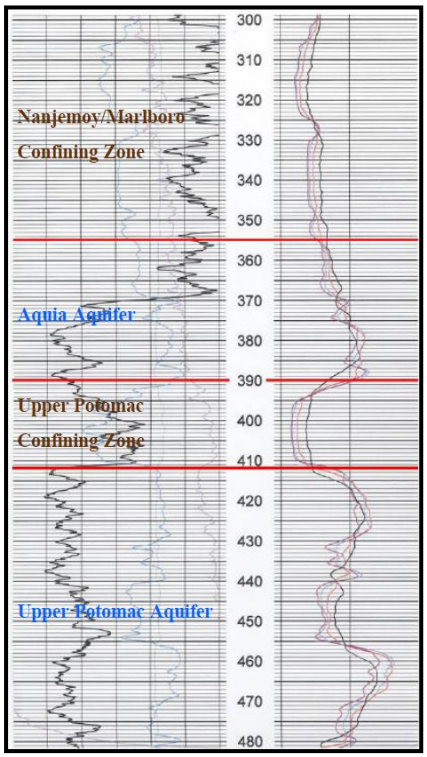
Figure 4: Locations of springs in the DEQ Spring Database.

Well Logging Activities

DEQ operates, in cooperation with the USGS, a geophysical logging truck used for evaluating wells throughout the Commonwealth. The truck is equipped with borehole geophysical probes used for analyzing the structural, hydrogeologic, and geophysical properties of the host geologic formation(s) penetrated by a well. Borehole geophysical logging provides a means for acquiring important information pertaining to well construction and condition, and is an effective technique for acquiring the geologic and hydrogeologic data required to better understand local and regional groundwater systems. In the 2013 calendar year, 25 wells were evaluated with geophysical and/or camera logs in the Commonwealth. Data from these logs were used to help bring non-permitted wells into compliance, to help document and describe groundwater resource conditions within the Commonwealth, and for more effective management of groundwater supply wells.

In the Ground Water Management Areas, DEQ staff utilizes geophysical logging techniques and analyzes mud rotary cuttings to assist water withdrawal permit applicants with completing permit applications. Geophysical and well cuttings logs help to identify and assign groundwater withdrawals to the proper aquifer and to further define the geologic and hydrogeologic conditions underlying the Virginia Coastal Plain physiographic province (Figure 5. In the 2013 calendar year, 6 wells were logged with either geophysical or mud rotary cuttings methods to assist with proper permit documentation.

Figure 5: Aquifer Picks determined from a geophysical log run in the Coastal Plain. Geophysical logging methods are utilized by GWCP staff to assist withdrawal permit applicants with locating target aquifers and for further defining and describing hydrogeologic conditions throughout Virginia.



Technical Assistance
DEQ staff members frequently participate as speakers at groundwater related events. Educational and speaking opportunities for the 2013 calendar year included teaching classes at the Virginia Water Well Association Annual Winter Driller Conference and Fall Field Day, the Virginia Department of Health Water Treatment Plant Operators Short Course, and numerous local groundwater related meetings and events. In addition to formal educational opportunities, DEQ staff provides data and technical assistance to citizens, private businesses, and municipalities with groundwater resource related questions and concerns.

Ambient Groundwater Quality Monitoring

Development of the Ambient Groundwater Quality Strategy document was completed in 2013 in conjunction with the FY 2014 Ambient Groundwater Quality Sampling Implementation Plan. During the 2013 calendar year, quarterly samples were taken at a coastal plain trend well site, and multiple spot samples were taken at wells and springs throughout the Commonwealth in accordance with the FY 2014 Ambient Groundwater Quality Sampling Implementation Plan. A copy of the FY 2014 Implementation Plan can be downloaded from the GWCP Reports and Publications webpage.

Water Supply Planning and Water Withdrawal Reporting Program

Water Supply Planning

The Local and Regional Water Supply Planning Regulation (9VAC 25-780) became effective November 2, 2005. The regulation requires all localities in the Commonwealth to prepare and adopt a water supply plan. Forty-eight water supply plans were submitted, 38 of which were regional and ten local programs. The water supply plans include comprehensive actions to manage water demands, sources of water supply, and the effects of drought. All plans include

a discussion of the current and future water supply need, current and anticipated sources of supply, current and future conservation measures, and future alternatives for meeting demands.

All plans were submitted to other state agencies (Department of Health, Department of Conservation and Recreation, Department of Game and Inland Fisheries, Department of Historic Resources, and Department of Marine Resources Commission) for evaluation and comments. DEQ reviewed all plans for consistency and compliance with the regulation. All 48 plans were found conditionally compliant. DEQ will work with all planning regions to address the conditions by the next iteration of the plans, which will be in 2018, five years following the compliance determination, pursuant to the regulation. Plans were posted to DEQ's website for a 30-day public comment period as required.

Water Supply Plan Advisory Committee

During the 2010 session, the Virginia General Assembly established the State Water Plan Advisory Committee to assist DEQ in developing, revising, and implementing the state water resources plan. The Committee is charged with examining: (i) procedures for incorporating local and regional water supply plans into the state water resources plan and minimizing potential conflicts among various submitted plans; (ii) the development of methodologies for calculating actual and anticipated future water demand; (iii) the funding necessary to ensure that the needed technical data for development of a statewide planning process; (iv) the effectiveness of the planning process in encouraging the aggregation of users into common planning areas based on watershed or geographic boundaries; (v) the impact of consumptive use and reuse on water resources; (vi) opportunities for use of alternative water sources, including water reuse and rainwater harvesting; (vii) environmental flows necessary for the protection of instream beneficial use of water for fish and wildlife habitat; (viii) the role of the SWCB in complying with the state water resources plan; and (iv) other policies and procedures that the Director of DEQ determines may enhance the effectiveness of water supply and water resources planning in Virginia. The Act establishing the committee sunset on December 31, 2012. The Water Supply Plan Advisory Committee issued a Final Report in December 2012.

Information from the local and regional water supply plans and from other sources, as well as discussions and recommendations from the WSPAC, were used in the development of the State Water Resources Plan.

State Water Resources Plan

A draft of the State Water Resources Plan (SWRP) was completed in 2013. This is the Commonwealth's first comprehensive water resources plan that incorporates information from locally-developed water supply plans. The SWRP includes an analysis describing the expected cumulative impacts of future demands on beneficial uses to assure the long term availability and productivity of the Commonwealth's water resources.

Data analysis predicted a net increase of approximately 32% percent in mean daily water supply demand over the planning period to 2040 (Figure 6). The estimated 32% increase in water demand between 2010 and 2040 is consistent with the Commonwealth's expected population increase for the same time period.

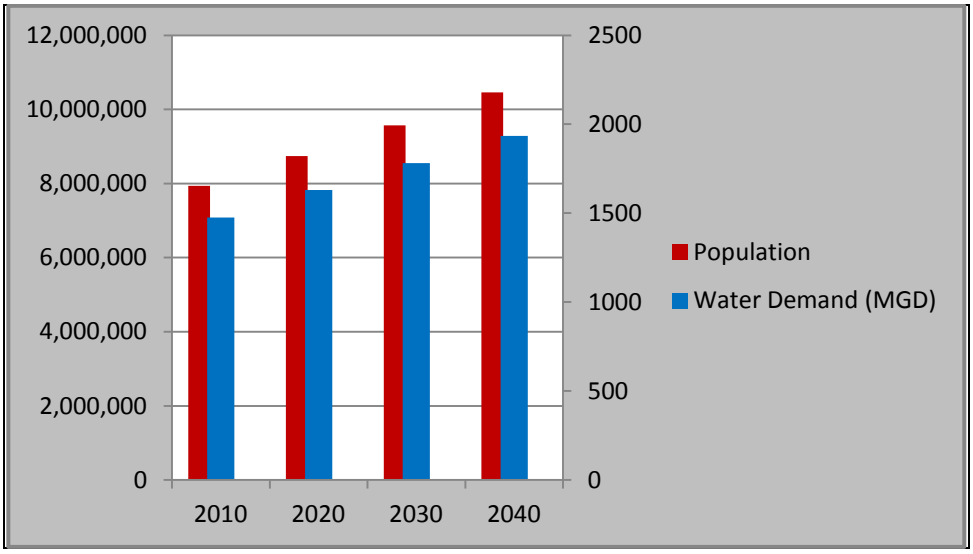


Figure 6: The estimated 32% increase in water demand between 2010 and 2040 is consistent with the Commonwealth's expected population increase for the same time period.

Data analysis also showed that approximately 450 million gallons a day (MGD) of additional water will be needed to meet the projected 2040 demand. Eighty-six percent of this increase in demand is expected to come from surface water (Figure 7). Twenty-three percent of the total 2040 demand is expected to come from groundwater resources, 75% of which will be outside Groundwater Management Areas (GWMA). Nearly 97% of the total projected 2040 surface water demand is proposed to come from approximately 25% of the stream reaches evaluated. With 16 percent of streams predicted to see greater than a five percent reduction in Drought of Record flows, there is 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 (DEQ, 2014).

Nearly 97% of the projected surface water demand is proposed to come from approximately 25% of the stream reaches evaluated.

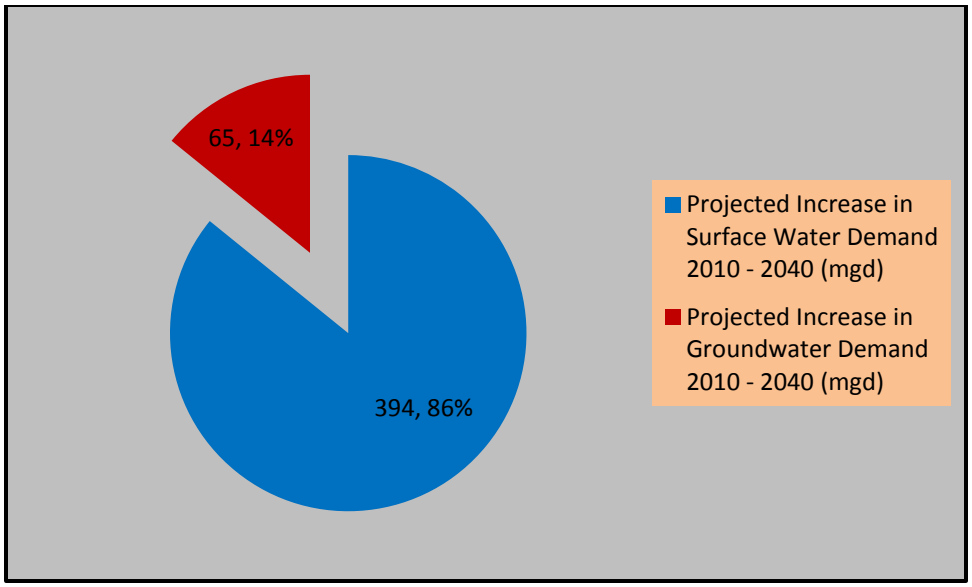


Figure 7: Most of the projected increase in 2040 annual average demand is expected to come from surface water.

The SWRP includes a discussion of water supply challenges facing the Commonwealth over the next 30-50 years, including some challenges that occur sooner in some areas. Continued comprehensive water supply planning is critical to understand and better respond to these challenges. Recommendations are identified in the SWRP to ensure the long-term availability and productivity of the water resources in the Commonwealth. The SWRP will be distributed in late 2014.

Water Withdrawal Reporting

The Virginia Water Withdrawal Reporting Regulation (9 VAC 25-200-10 *et seq*.) requires that individuals or facilities that withdraw water at volumes greater than 10,000 gallons per day (gpd) (one million gallons per month for crop irrigators) must measure and report annually to DEQ the monthly volume of water withdrawn. The purpose of withdrawal reporting is to enable appropriate planning for the Commonwealth's future water needs through the collection of water use information. This information is critical to the preparation of accurate water budgets of hydrologic inputs and outputs. These water budgets are used in cumulative impact analyses to ensure that withdrawals do not exceed the hydrologic system inputs.

The data reported are contained within the Virginia Water Use Data System (VWUDS) database, which stores withdrawal data collected since 1982. DEQ offers an electronic reporting option through a website that includes features to allow operators to input withdrawals as they occur throughout the year and to view withdrawal reporting information from previous years. The categories of water withdrawals identified in the VWUDS database include agriculture, commercial, irrigation, manufacturing, mining, fossil fuel power, hydropower, nuclear power, and public water supply.

Detailed information regarding reported water withdrawals for 2013 is provided in Section IV of this report. Comparisons between 2013 withdrawals and withdrawals reported for the previous five years can be found in Sections V and VI, along with detailed information about withdrawals for major water use categories.

Wellhead Protection Implementation Grants

Since December 2005, DEQ and VDH have collaborated to provide grants totaling $936,367 to fund wellhead protection implementation projects at thirteen municipalities with groundwater based community water supplies. Localities benefiting from this funding are Accomack-Northampton PDC, James City Service Authority, the Town of Lovettsville, the Town of Stanley, the Town of Middleburg, Wythe County, Rye Valley Service Authority, the Town of Burkeville, Augusta County Service Authority, Rockingham County, the Town of New Market, Fauquier County, and the Town of Dayton. The funding source has been a combination of Federal Clean Water Act and Safe Drinking Water Act dollars. Projects that were completed in 2013 received $130,390 in Safe Drinking Water Act funding and the projects were managed by DEQ. The VDH assumed full responsibility for recruiting and managing projects in 2014.

Water Withdrawal Permitting Programs

OWS administers two water withdrawal permitting programs: Groundwater Withdrawal Permitting and Surface Water Withdrawal Permitting. Under the Groundwater Management Act of 1992, Virginia manages groundwater through a program regulating groundwater withdrawals within Groundwater Management Areas. The Virginia Water Protection (VWP) Permit Program regulates surface water withdrawals from state waters and related permanent structures, fill, excavation, or back-flooding. Summaries of 2013 activities within each of these programs are set forth below.

Groundwater Withdrawal Permitting Program

The Virginia Well Capping Law of 1956 was established to control the unrestricted flow of artesian wells and secure availability of groundwater in eastern Virginia. As a result of increased industrial usage that was lowering water levels in the confined aquifer system and the reduced or inability to access groundwater from the artesian wells the Groundwater Management Act of 1973 was enacted.

The Virginia Groundwater Act of 1973 recognized the duty of the SWCB to manage groundwater resources and declare management areas. Subsequently, two Groundwater Management Areas (GWMAs) were declared in 1975-76; the Eastern Virginia GWMA and the Eastern Shore GWMA (Figure 8) comprising a majority of Virginia's Coastal Plain Physiographic Province and the Coastal Plain Aquifer system. Groundwater Withdrawal Permits are required in the GWMA's for any withdrawal in excess of the established regulatory and permitting threshold.

As a result of the Groundwater Management Act of 1973, permitting was applied to industrial and commercial use greater than 50,000 gallons per day (1.5 MG per month). In 1986 Amendments to Ground Water Management Act of 1973 added municipal withdrawals and reduced permitting threshold to 300,000 gallons per month. In 1992 the Ground Water Management Act of 1992 removed the ability of the permittee to be guaranteed the right to withdrawal at maximum daily values 365 days a year on a continuous basis and included agriculture to those regulated withdrawal types.

Groundwater Withdrawal and Resource Management

DEQ is required by the Ground Water Management Act of 1992 "to conserve, protect and beneficially utilize the groundwater of this Commonwealth and to ensure the public welfare, safety and health." (VA Code § 62.1-254) The confined aquifers of the Coastal Plain Aquifer System (Figure 9) have historically yielded high rates of groundwater satisfying much of the area's industrial, commercial, municipal, and agricultural demands. Large withdrawals from these aquifers produce overlapping cones of depression and some have resulted in interference among wells. In addition, decades of water level observations in these aquifers indicate a declining trend in water levels: water levels have fallen at a rate of about 2 feet per year in the Potomac aquifer. To assure that 1) existing groundwater users were protected from new or expanding withdrawals, 2) resource viability continues into the future, and 3) the resource is managed comprehensively, the SWCB had to consider expanding the Eastern Virginia Groundwater Management Area to include the Northern Neck and Middle Peninsula. As a result, DEQ began working on a regulatory package that included revisions to the Groundwater Withdrawal Regulations (9VAC25-610-10 *et seq*.) and a proposal to expand the Eastern Virginia GWMA to the remainder of the Coastal Plain Physiographic Province.

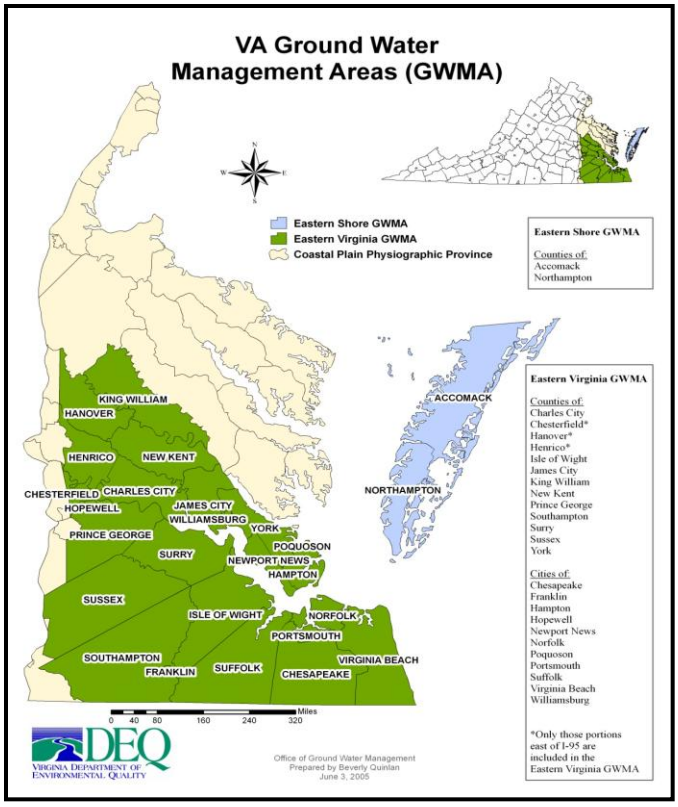


Figure 8: Groundwater Management Areas in Virginia resulting from the Groundwater Management Act of 1973.

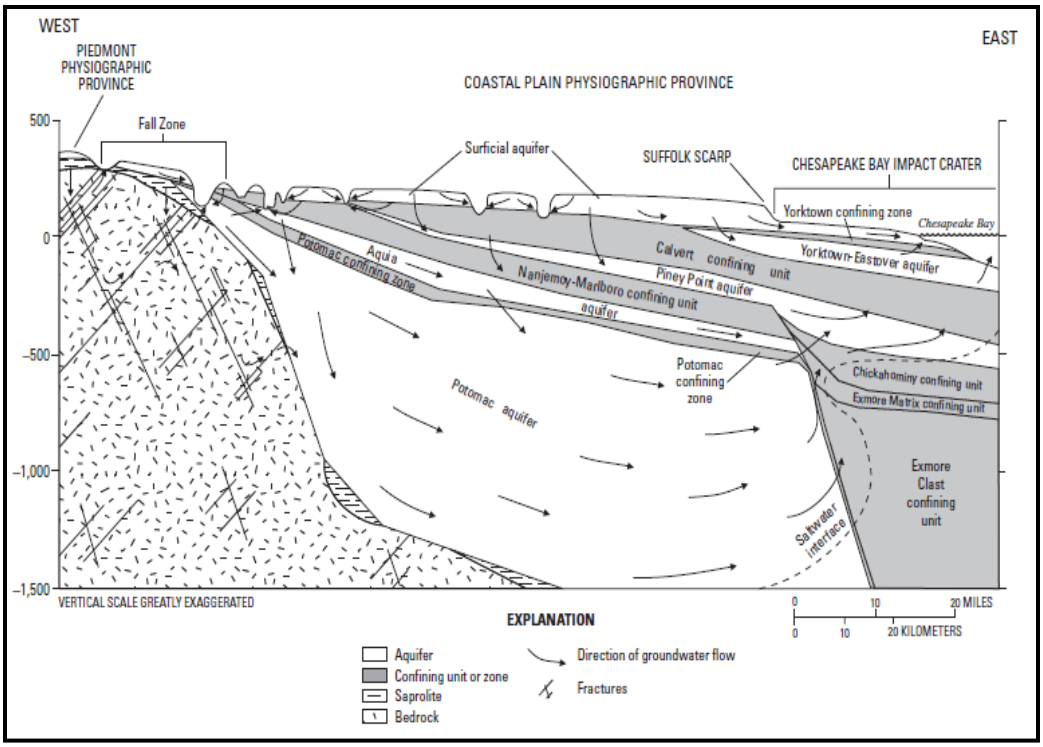


Figure 9: Generalized hydrogeologic section and directions of ground-water flow in the Virginia Coastal Plain (from Figure 2 of McFarland, E.R., and Bruce, T.S., 2006, The Virginia Coastal Plain Hydrogeologic Framework: U.S. Geological Survey Professional Paper 1731, 118 p., 25 pls.; altitudes relative to National Geodetic Vertical Datum of 1929).

In October 2013 the Governor completed the executive branch review process and released the following three regulatory packages to become effective on January 1, 2014. (1) Designated Groundwater Management Areas (9VAC25-600), which expanded the Eastern Virginia groundwater management area to include the Middle Peninsula and Northern Neck; (2) Groundwater Withdrawal Regulations (9VAC25-610); and (3) Repeal of the Order Declaring the Eastern Shore of Virginia - Accomack and Northampton Counties - as a Critical Ground Water Area (9VAC25 - 620).

The regulatory actions for 9VAC25-600 et seq. and 9VAC25-620 resulted in the expansion of the Eastern Virginia Groundwater Management Area to include the remaining portion of Virginia's coastal plain (Figure 10). This adds the following to the Eastern Virginia Groundwater Management Area - all of Essex, Gloucester, King George, King and Queen, Lancaster, Mathews, Middlesex, Northumberland, Richmond and Westmoreland counties and the areas east of Interstate 95 in Caroline, Fairfax, Prince William, Spotsylvania and Stafford counties. Additionally, the adopted amendments to the Groundwater Withdrawal Regulations are more consistent with other water permitting programs within the Agency and allow for improved administrative and application processing practices. Approximately 130 existing groundwater

withdrawal facilities are expected to come under the groundwater withdrawal regulation due to the expansion of the Eastern Virginia Groundwater Management Area.

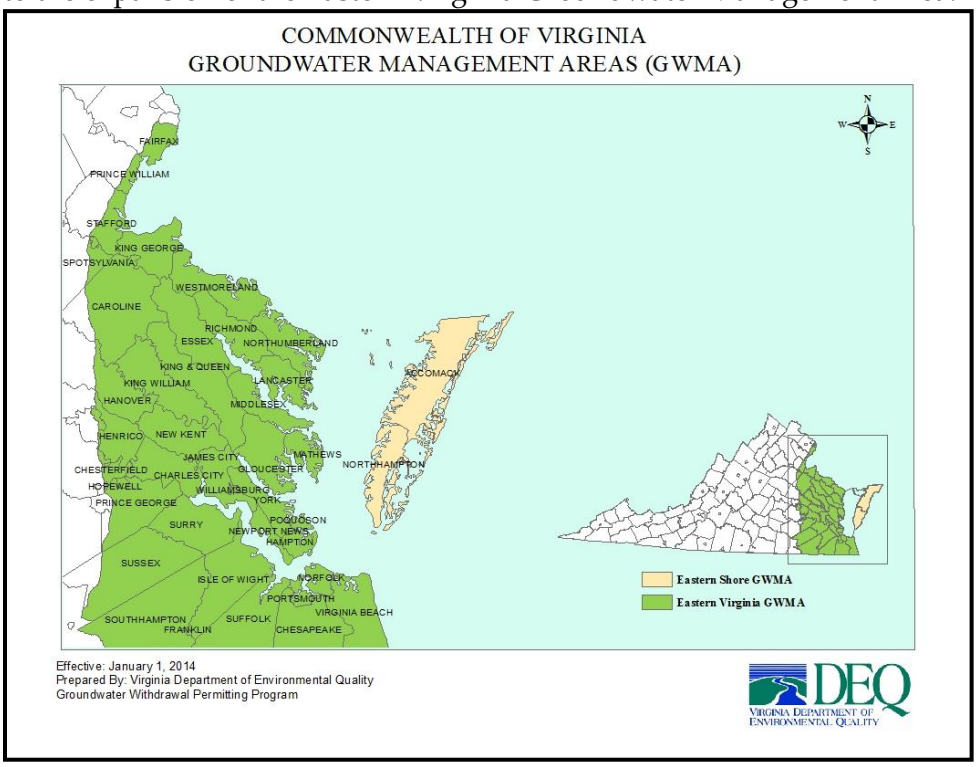


Figure 10: Groundwater Management Areas in 2014, showing expanded Eastern Virginia Groundwater Management Area.

Groundwater Withdrawal Permitting Efforts

The Ground Water Withdrawal Act of 1992 is the current statute and framework for the Groundwater Withdrawal Regulations that the program operates within to issue Groundwater Withdrawal Permits.

Permit applications for new or expanded (increase to existing withdrawal) withdrawals are evaluated for sustainability, considering the combined impacts from all existing lawful withdrawals. Existing lawful withdrawals include those permits issued under historic use conditions and current new or expanded use permits.

In areas where the groundwater resource is predicted or identified through monitoring to be below resource protection limits established by regulation, applications for new or expanded withdrawals are evaluated for denial. Applications that involve human consumptive uses receive priority in use.

DEQ staff meets with all prospective permit applicants to discuss the permitting process, administrative requirements and technical requirements prior to application submission.

Groundwater permit reissuances during 2013 resulted in a reduction of 2.18 mgd in permitted groundwater withdrawal volumes.

Technical evaluations of impacts and resource sustainability are conducted by groundwater modeling contractors. Modeling contractors work closely with DEQ staff on proposed withdrawals to discuss technical requirements. Through an ongoing collaborative effort with modeling contractors, permit program staff provide technical support to applicants by reviewing and providing comments on all proposals for field data collection in support of permit development.

Groundwater permit reissuances during 2013 resulted in a reduction of 2.18 mgd in permitted groundwater withdrawal volumes. This reduction was primarily due to downward adjustment of permitted withdrawal volumes to match historic withdrawal rates. Groundwater permits were issued to 39 facilities with a total of 134 permitted well locations (Table 1 and Figure 11). Sixty-eight of these wells are located within the Eastern Shore GWMA; the remaining wells (66) are located within the Eastern Virginia GWMA.

Table 1: Groundwater Withdrawal Permitting Actions in 2013.

2013 Permitting Activities	
Active and Administratively Continued Permits	247
Applications in Renewal	61
Permits Issued	41
Permits Modified	3
New Permit Applications	16
2013 Compliance / Enforcement Activities	
Onsite visits	11
Requests for corrective action	24
Alleged violations (Warning Letters and Notice of Violations)	17

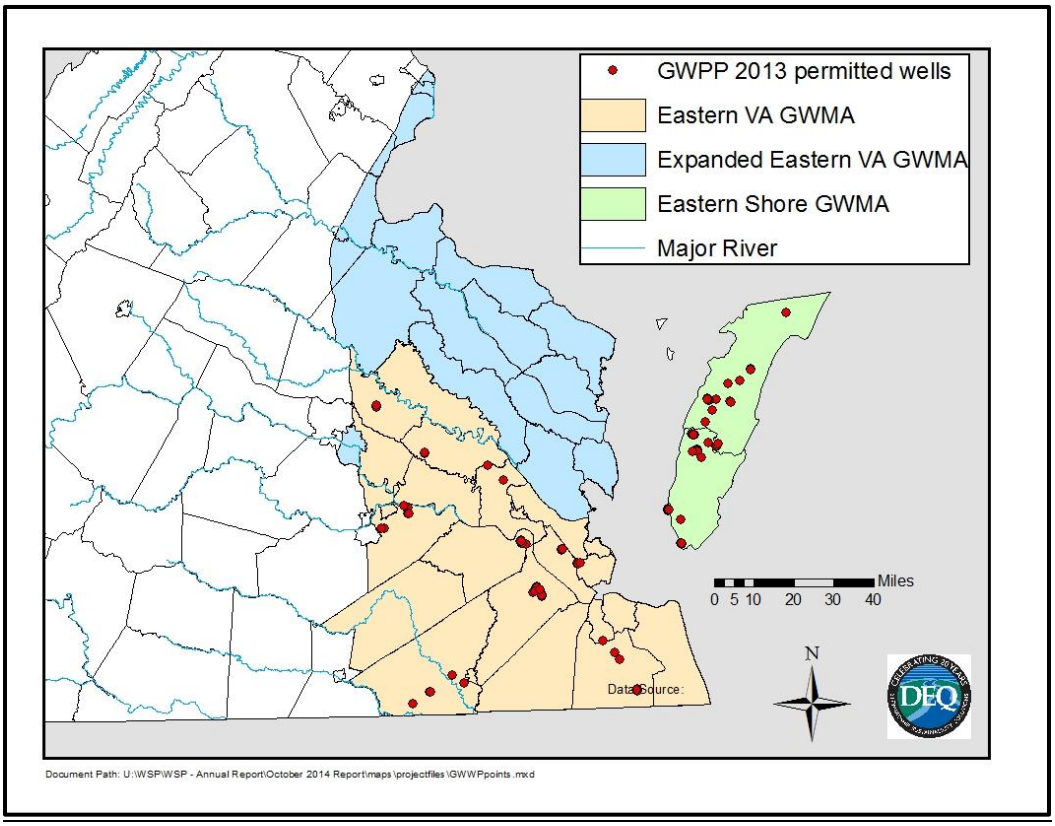


Figure 11: Groundwater permits were issued to 39 facilities with a total of 134 permitted well locations

Permitting Surface Water Withdrawals under the Virginia Water Protection (VWP) Permit Program

Surface water withdrawals are regulated under the VWP Permit Program, which also regulates excavation, filling, dredging or other activities impacting surface waters (streams, lakes and wetlands). VWP permits for surface water withdrawals are required for any withdrawals in excess of 10,000 gallons per day, unless otherwise excluded by 9VAC25-210-60.B of the VWP Permit Program regulations. The VWP Permit Program is administered by the DEQ Office of Wetland and Streams Protection, with the Office of Water Supply serving as lead for surface water withdrawal projects. The VWP Permit Program serves as the vehicle for Section 401 Certification for surface water withdrawals under the Clean Water Act. Authority to regulate surface water withdrawal activities under the VWP Permit Program is provided at §§62.1-44.15.20 and 62.1-44.15.22 of the Code of Virginia. The regulation encompassing the VWP Permit Program is 9VAC25-210 et seq. of the Virginia Administrative Code.

DEQ permits a variety of surface water withdrawal projects that obtain water through a withdrawal from a stream, lake or reservoir. These projects are for various use types such as industrial, commercial, agriculture, and public water supply. Typical uses for the water withdrawn are potable water, irrigation, cooling water, or power generation.

Application for a surface water withdrawal is made through submittal of a Joint Permit Application. The same application is also used by the Virginia Marine Resources Commission (VMRC) and U.S. Army Corps of Engineers (USACE); both agencies have jurisdiction over activities in streams, lakes and/or wetlands. The USACE typically regulates, under Section 404 of the Clean Water Act, impacts to wetlands, lakes and streams caused by construction of dams and intakes structures and other associated infrastructure. VMRC typically asserts jurisdiction on structures proposed to be sited on state-owned bottomlands that have a drainage area of greater than five square miles.

The evaluation of surface water withdrawal applications includes an in-depth analysis of the applicant's water demand as well as an evaluation of the cumulative effects (Cumulative Impact Analysis, or CIA) of the project to determine the potential impact on existing beneficial uses. Beneficial uses are defined by Section 62.1-44.3 of the Code of Virginia as both instream and offstream uses. Examples of instream beneficial uses are the protection of fish and wildlife resources and habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. Offstream beneficial use examples are domestic (including public water supply), agricultural uses, electric power generation, commercial, and industrial uses. DEQ staff has developed and maintained an operational model covering all streams and large impoundments in the Commonwealth for the purpose of performing the CIA. Each new or renewing VWP permit 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 Staff use the output of these models to arrive at a set of operational rules that minimize impacts on all beneficial uses.

Coverage of a surface water withdrawal activity under a VWP permit includes the quantity of water that is authorized to be withdrawn and requirements for the volume of flow that must be maintained downstream of the withdrawal, either through releases from reservoir storage or flow past the intake in a stream channel. Permit conditions include measures to conserve water during droughts and reporting requirements to demonstrate compliance. The VWP permit also covers any other impacts to surface waters proposed by the project as well as compensation requirements to mitigate those impacts.

Surface Water Withdrawal Permitting Efforts

As of the date of this report, there are 89 active VWP permits. Because existing facilities were originally excluded from the VWP permitting requirements, water use by facilities with VWP permits makes up a relatively small percentage of the total reported 2013 surface water withdrawals (excluding power generation uses). Of the 404 non-power generation facilities that reported surface water withdrawals during 2013 totaling approximately 1067 million gallons per day (mgd) (see Section IV), 44 facilities with active VWP permits reported 192 mgd (18%). The remaining 45 permits that are among

the 89 listed as active either did not withdraw during 2013, did not report withdrawals, or their corresponding facilities have not yet been constructed.

Three existing permits have active applications in process for modification or reissuance. There are also seven new applications for surface water withdrawals in-process state-wide (Figure 12). During 2013, surface water withdrawal permitting efforts included the following actions:

Because existing facilities were originally excluded from the VWP permitting requirements, water use by facilities with VWP permits makes up a relatively small percentage (18%) of the total reported 2013 surface water withdrawals (excluding power generation uses)

- DEQ issued VWP permits to the following facilities:
    - Engel Family Farms, withdrawal from the James River, Henrico County
    - Hammock Dairy Farm, withdrawal from Pie Creek, Pittsylvania County
    - Viniterra Golf Course, withdrawal from Crumps Mill Pond on Southern Branch, New Kent County
    - Greene County White Run Pumped Storage Reservoir, withdrawal from Rapidan River in Green County

- DEQ issued modified or reissued VWP permits to the following facilities:
    - Appomattox Regional Water Authority, withdrawal from Lake Chesdin on the Appomattox River
    - Henrico County, Cobbs Creek Reservoir and withdrawal from the James River in Cumberland County
    - Stafford County, Rocky Pen Run Reservoir and withdrawal from the Rappahannock River, Stafford County
    - Bedford Regional Water Authority, withdrawal from Smith Mountain Lake in Bedford County

- DEQ received a Joint Permit Application for surface water withdrawals from the following facilities:
    - Greensville County Raw Water Reservoir and Intake, for a new withdrawal from the Nottoway River in Greensville County
    - Aqua Virginia Inc. Lake Caroline Public Water System Intake, for resumption of withdrawal from Lake Caroline in Caroline County
    - Jewell Smokeless Coal Corporation, for a new withdrawal from Dismal Creek in Buchanan County

- DEQ received requests to modify or reissue existing VWP permits issued to the following facilities:

- Stafford County, Rocky Pen Run Reservoir and withdrawal from the Rappahannock River, Stafford County
- Henrico County, Cobbs Creek Reservoir and withdrawal from the James River in Cumberland County
- Nelson County Service Authority, withdrawal from Black Creek Reservoir in Nelson County

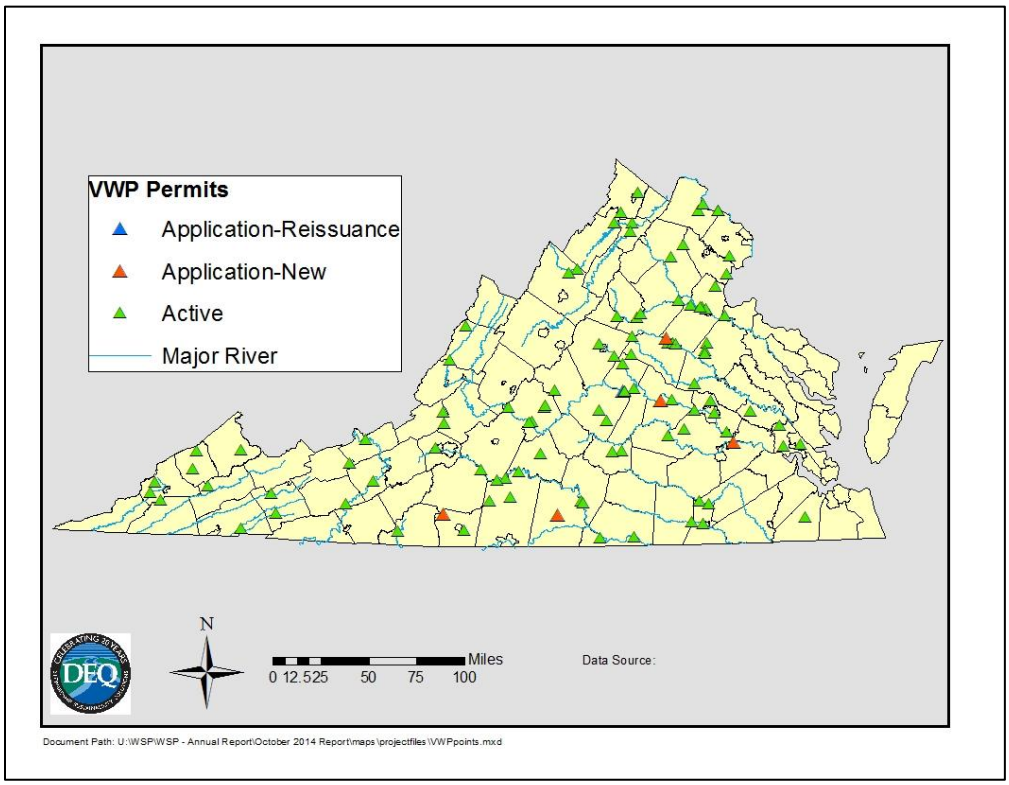


Figure 12: Locations of Virginia Water Protection (VWP) active permits and applications.

Drought Assessment and Response

OWS coordinates drought monitoring activities in Virginia through the statewide Drought Monitoring Task Force (DMTF). The 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 meets to assess conditions and make recommendations regarding drought status. The DMTF also periodically releases Drought Status Reports summarizing drought conditions in the Commonwealth (see Appendix 2). DEQ also maintains a Drought webpage that displays the current status of a series of drought indicators across thirteen drought evaluation regions. The status of three of the four indicator types (precipitation deficit, stream flows and groundwater levels) is updated daily. The fourth

indicator, reservoir storage, is updated monthly, or more frequently depending upon drought conditions. Drought monitoring, assessment and response protocols follow the procedures described by the Virginia Drought Assessment and Response Plan (Virginia Drought Response Technical Advisory Committee, 2003).

IV. SUMMARY OF WATER WITHDRAWALS IN 2013

The Virginia Water Withdrawal Reporting Regulation (9 VAC 25-200-10 *et seq*.) requires that individuals or facilities that withdraw water at volumes greater than 10,000 gallons per day (gpd) (one million gallons per month for crop irrigators) must measure and report annually to DEQ the monthly volume of water withdrawn. As described in the Water Withdrawal Reporting portion of Section III, the purpose of annual withdrawal reporting is to enable appropriate planning for the Commonwealth's future water needs through the collection of water use information.

For 2013, withdrawals were reported by 955 user facilities for 2257 withdrawal measuring points. The reported 2013 withdrawals exceeded 7 billion gallons per day for all use types, including water used for cooling at nuclear and fossil fuel power generation facilities. Excluding power generation, the reported 2013 withdrawals totaled approximately 1.2 billion gallons per day. These withdrawal volumes equal the volume of water withdrawn. They do not identify how much water was returned to the source water body and therefore do not identify the net withdrawal volumes.

The reported 2013 withdrawals totaled approximately 7 billion gallons per day.

Water diverted for hydropower use is essentially non-consumptive use. These flows are also exempted from the reporting requirement and are generally not reported to the VWUDS database. 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 does not include water withdrawn for power generation. Details regarding 2013 fossil fuel and nuclear power generation water withdrawals (excluding hydropower) are included in Section VI of this report. Appendix 3 lists the top 20 individual non-power generating water withdrawals ranked by the amount of their 2013 reported withdrawals.

Water withdrawn in the Commonwealth may be used by a withdrawing entity or locality, or it may be transferred to another entity/locality. The water use data presented in this report were compiled from database records that record water withdrawn by a locality or entity (withdrawals), water transferred to another locality (releases), and water purchased from another locality (deliveries). Ideally, the total amount of water reported as released from the transferring facility should equal the total reported as deliveries by the receiving facility. In reality however, the amounts of reported deliveries are generally significantly less than the amount reported as released. This discrepancy is most likely due to incomplete reporting of deliveries from facilities that purchase water. In order to avoid double counting, this report will generally refer to "water use" as synonymous with "water withdrawn", and any reporting or illustration of water transfers will be clearly marked as "water transferred" or "water purchased".

A summary of how water transfers are stored in the VWUDS database can be found in Appendix 4.

Water withdrawals are derived from both surface water and groundwater. Four sources of withdrawals are characterized in the VWUDS database: streams (rivers), reservoirs, wells and springs. Springs discharge groundwater to surface water bodies and provide baseflow to streams and rivers. Previous DEQ water resource status reports categorized springs as groundwater sources. For this report, however, springs were categorized as surface water sources because withdrawals from springs generally occur after the water has discharged from the groundwater flow system and become part of the headwaters or main body of a stream. Water withdrawn from springs would otherwise become part of the surface water flow system that the spring supplied before withdrawals began at that location. A small number of withdrawals from dug farm ponds and quarries that are unconnected to surface streams are categorized in the VWUDS database as derived from groundwater. In this report groundwater withdrawals consist only of withdrawals from wells or unconnected ponds or quarries (listed as reservoirs). Surface water withdrawals consist of water withdrawn from streams or rivers, springs and reservoirs or ponds that are connected to surface streams. Therefore, direct comparisons between figures or tables that illustrate or list withdrawals by source type with similar figures or tables in DEQ water resource status reports from previous years may be misleading.

2013 Water Withdrawals by Source and Location

Water withdrawals in Virginia during 2013 for non-power generation uses were predominantly from surface water sources, with streams, reservoirs and springs comprising 89% of the total of 1202 mgd (Figure 13). Approximately 7 mgd of the 385 mgd shown as derived from reservoirs were categorized as groundwater (unconnected to a surface stream). The total 2013 non-power generation withdrawal rate was about 1.5% less than the 2012 total of 1221 mgd. The proportions of the total withdrawal rate by source type were also nearly the same as the previous year.

Water withdrawals in Virginia during 2013 for non-power generation uses were predominantly from surface water sources, with streams, reservoirs and springs comprising 89% of the total of 1202 mgd.

Figures 14 through 16 depict the spatial distribution of 2013 water withdrawals in Virginia. As with previous years, the largest groundwater withdrawals occurred predominantly in the Coastal Plain, Eastern Shore and Shenandoah Valley regions. Surface water withdrawals were distributed widely across the state and were greatest around cities and counties that serve as population centers. Significant surface water volumes were also withdrawn in rural counties for irrigation and other uses. Figure 17 contains six pie charts that depict the magnitudes and proportions of

2013 withdrawals by major use category (excluding power generation). Because water withdrawals fluctuate from year to year due to weather variability and economic or other factors, the average water withdrawals over the 2009 – 2013 period are also depicted for each category for comparison. The average water withdrawals over the 2009 – 2013 period for each category shown by Figure 17 (as well as all similar figures and tables in Sections V and VI) were calculated using the same source categories (e.g., springs as surface water) as were the 2013 withdrawal totals. Therefore, direct comparisons can be made between 2013 withdrawal totals and the 2009-2013 averages.

Withdrawals for public water supply and for manufacturing were the largest for both 2013 and for the average of the five-year period. Pumping for agriculture, irrigation, mining and commercial uses made up lesser, but still significant, portions of the total withdrawal totals. 2013 withdrawal totals were approximately equal to or slightly less than the 2009 – 2013 average for all major uses except agriculture, which increased relative to previous years.

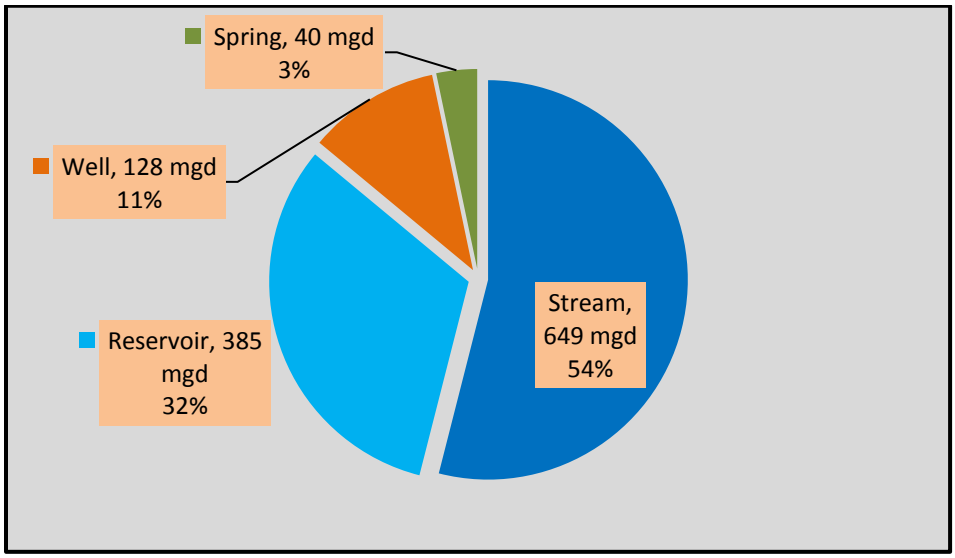


Figure 13: Total Water Withdrawals by Source in 2013 (excluding power generation).

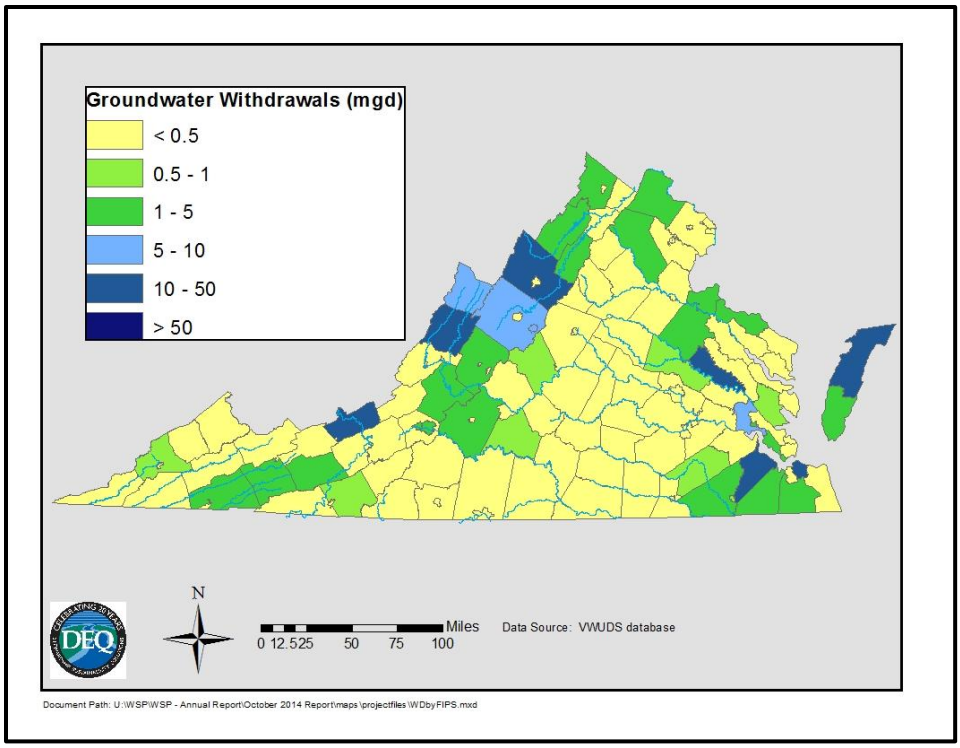


Figure 14: 2013 Total Groundwater Withdrawals by Locality (mgd).

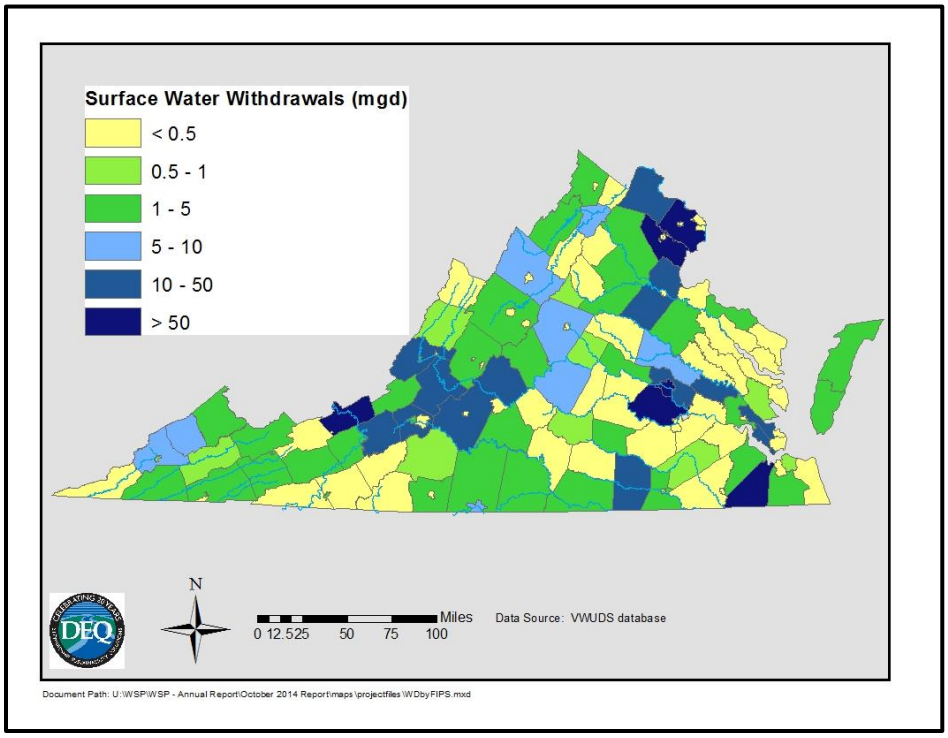


Figure 15: 2013 Total Surface Water Withdrawals by Locality (mgd).

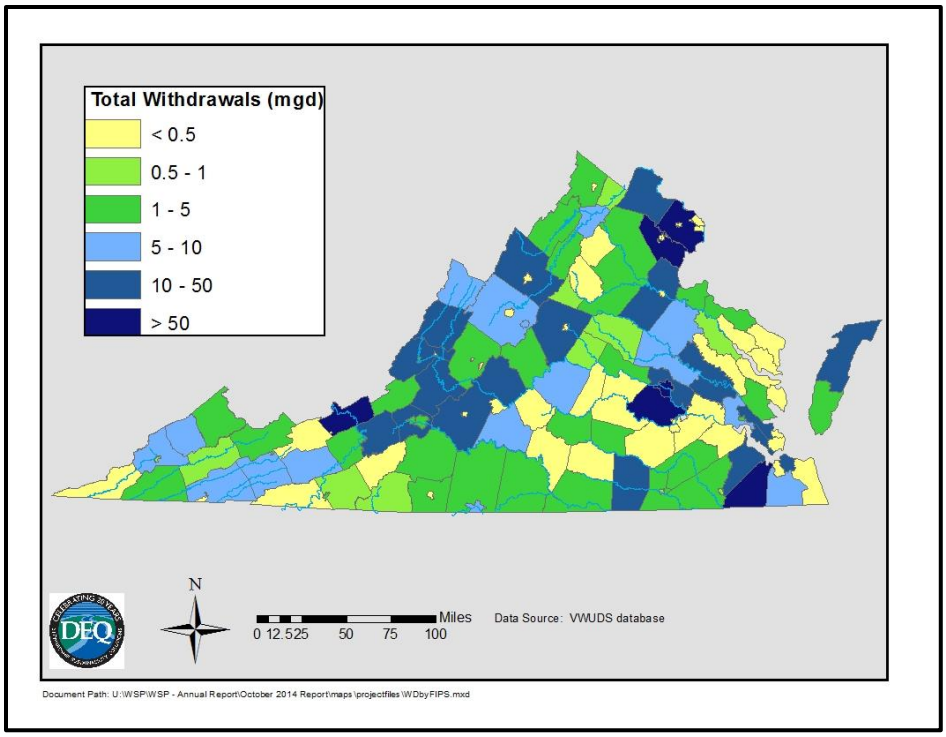


Figure 16: 2013 Total (Groundwater plus Surface Water) Withdrawals by Locality (mgd).

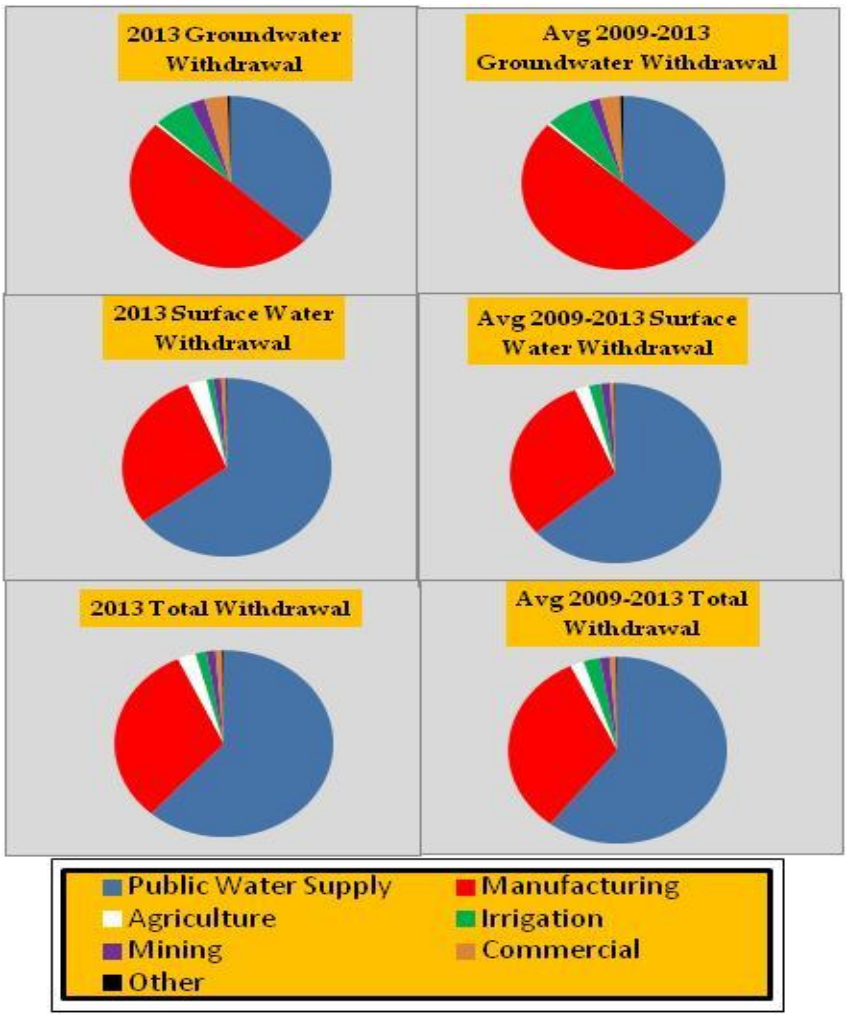


Figure 17: Water withdrawals in Virginia by category and source, including average withdrawals for 2009 – 2013, showing the preponderance of withdrawals for public supply and manufacturing (power generation withdrawals excluded).

The variable spatial distributions of groundwater and surface water withdrawals illustrated by Figures 14 to 16 suggest that withdrawals also vary considerably between Virginia's major surface water basins (Table 2). Surface water withdrawals are concentrated along the larger river basins such as the James, Potomac and New rivers. Total withdrawals during 2013 in the James River Basin amounted to 49% of all withdrawals in Virginia. The largest volumes of

(photo courtesy of James River Association)

Total withdrawals during 2013 in the James River Basin amounted to 49% of all non-power generation withdrawals in Virginia.

groundwater were produced from karstic limestone formations in the Shenandoah River valley and by coastal plain aquifers in the downstream portions of the Chowan, James and York river basins. Shallow aquifers on the Eastern Shore also produce significant quantities of groundwater.

Table 2: 2013 Withdrawals by Major Surface Water Basin (excluding power plant withdrawals).

Basin Name	Basin Area in Virginia (mi^2)	Groundwater (mgd)[1]	Surface Water (mgd)	Basin Total (mgd)	Percent of Statewide Total Withdrawal
Big Sandy	998	0.2	9.1	9.3	1%
Chowan/Albemarle Sound	4220	21.2	9.9	31.1	3%
Eastern Shore	787	11.7	2.3	14.0	1%
James	10265	23.6	567.3	590.9	49%
Lower Potomac	2316	5.3	190.7	196.0	16%
New	3068	13.9	96.3	110.3	9%
Rappahannock	2712	2.7	16.0	18.7	2%
Roanoke	6393	5.3	88.5	93.8	8%
Shenandoah	3365	27.1	30.6	57.8	5%
Small Coastal/Chesapeake Bay	814	1.0	1.2	2.3	0%
Tennessee	3134	1.2	23.2	24.5	2%
York	2674	22.5	31.6	54.1	5%
Totals:	40746	135.9	1066.9	1202.8	100%

[1]: includes withdrawals from dug ponds, reservoirs & quarries

V. RECENT TRENDS IN WATER WITHDRAWALS IN VIRGINIA

Table 3 contains a summary of water withdrawals in Virginia as reported in VWUDS for the 2009 through 2013 period (excluding withdrawals for power generation). The table compares the average annual 2013 withdrawals by source type and use category with the corresponding average rates for the five-year period prior to and including 2013.

Table 3: Summary of Virginia Water Withdrawals: 2009 - 2013.

	Category	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Average MGD	2013 Diff. from Average (MGD)	2013 % Diff. from Average
Ground – water[1]	Agriculture	0.8	0.9	0.5	0.6	0.6	0.7	-0.1	-11.6
	Commercial	3.9	4.7	4.6	4.8	5.0	4.6	0.4	9.7
	Irrigation	8.3	11.3	9.3	11.9	8.4	10.2	-1.8	-18.1
	Manufacturing	87.3	69.7	61.3	63.4	67.5	69.8	-2.4	-3.4
	Mining	2.4	1.9	2.9	2.3	3.4	2.6	-0.3	-10.6
	Other	0.6	0.7	0.7	0.7	0.7	0.7	0.0	-3.2
	Public Water Supply	54.7	50.2	54.5	52.7	50.0	52.4	-2.4	-4.6
	Total (GW)	**157.9**	**139.4**	**133.8**	**136.3**	**135.5**	**141.0**	**-5.4**	**-3.9**
Surface Water	Agriculture	16.7	22.6	29.1	29.9	31.9	24.6	7.3	29.9
	Commercial	6.8	9.0	8.0	6.8	7.1	7.5	-0.5	-6.4
	Irrigation	19.7	24.0	19.2	18.2	11.0	20.3	-9.3	-46.0
	Manufacturing	369.6	362.1	320.6	322.7	311.7	337.3	-25.6	-7.6
	Mining	17.7	19.7	16.0	12.0	12.7	15.6	-3.6	-23.1
	Other	1.1	2.5	2.3	2.2	2.2	1.3	0.9	68.6
	Public Water Supply	701.1	735.2	720.5	699.8	690.3	709.4	-19.1	-2.7
	Total (SW)	**1132.7**	**1175.0**	**1115.6**	**1091.6**	**1066.7**	**1116.0**	**-49.2**	**-4.4**
Total (GW + SW)	Agriculture	17.4	23.5	29.6	30.5	32.5	25.3	7.3	28.8
	Commercial	10.7	13.7	12.6	11.6	12.1	12.1	0.0	-0.3
	Irrigation	28.0	35.3	28.5	30.2	19.3	30.5	-11.2	-36.6
	Manufacturing	456.9	431.8	381.9	386.1	379.2	407.2	-28.0	-6.9
	Mining	20.1	21.6	18.8	14.3	16.1	18.2	-2.1	-11.5
	Other	1.7	3.2	3.1	2.8	2.9	2.0	0.9	43.9
	Public Water Supply	755.7	785.4	775.0	752.4	740.3	761.8	-21.5	-2.8
	Total	**1290.6**	**1314.4**	**1249.4**	**1227.9**	**1202.3**	**1256.9**	**-54.6**	**-4.3**

[1]: includes withdrawals from dug ponds, reservoirs & quarries

Groundwater withdrawals in 2013 were 5.4 mgd (approximately 4%) less than the average rate of 141 mgd for the five-year period. Surface water withdrawals continued to decrease slightly relative to the previous three years and were about 4% lower than the five-year average. Total withdrawals for 2013 were therefore also about 4% below the 2009-2013 average of 1116 mgd. This decrease in overall withdrawals is driven by small, but relatively steady declines in surface water withdrawals for public supply and manufacturing purposes. Manufacturing withdrawals declined by approximately 78 mgd since 2009, with a slight increase between 2011 and 2012. Public-supply withdrawals have declined each year since 2010 (a relatively dry year).

Reported 2013 groundwater and surface water pumpage for irrigation decreased significantly relative to 2012 and was approximately 37% less than the 5-year average of 30.5 mgd. Surface water withdrawals for agricultural purposes continued an increasing trend; total 2013 agricultural withdrawals were therefore nearly 29% greater than the 5-year average.

VI. CATEGORIES OF WATER WITHDRAWALS IN VIRGINIA

This section provides detailed information regarding water withdrawals for each of the major water use categories for 2013 and for the last five years (2009 – 2013). Withdrawals by source types are described for this time period and the spatial distributions of 2013 withdrawals for each category are illustrated. The facilities that reported the largest withdrawals also are listed.

Agricultural Water Withdrawals in Virginia

Agriculture includes operations such as commodity farms, fish farms, and hatcheries. Figure 18 shows the state-wide total of groundwater and surface water use for agriculture from 2009 to 2013. The majority of water withdrawn for agricultural uses flows from springs located in western Virginia (77% for 2013, see Table 4 and Figure 19). Note that, beginning with this year's annual water resources report, springs have been categorized as surface water sources. Because of this change, direct comparisons between Figure 18 and Table 4 and corresponding figures and tables from previous reports should not be attempted.

Agricultural withdrawals from springs have increased steadily over the past five years (Table 4). The increased spring withdrawals during 2013 were dominated by those from the Commonwealth's Coursey Spring Fish Hatchery, where 2013 withdrawals were nearly 5 mgd greater than the 2009-2013 average (Table 5).

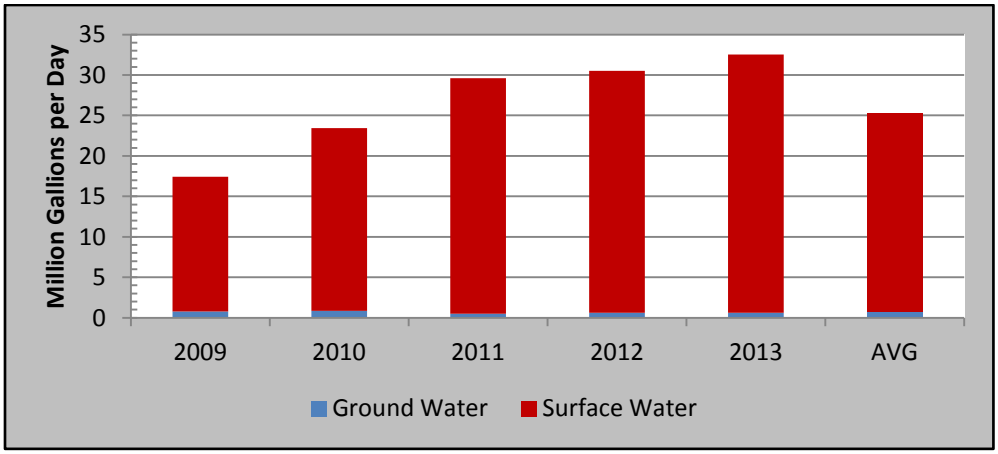


Figure 18: 2009-2013 Agricultural Water Withdrawals by Source Type.

Table 4: 2009-2013 Agricultural Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW (wells)	0.8	0.9	0.5	0.6	0.6	0.7	0.1	12
Total SW:	16.7	22.6	29.1	29.9	31.9	24.6	7.3	30
Reservoirs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Springs	10.2	17.3	22.0	22.9	25.1	18.1	7.0	39
Streams	6.4	5.3	7.1	7.0	6.8	6.5	0.3	5
Total GW + SW	17.4	23.5	29.6	30.5	32.5	25.3	7.3	29

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals

Table 5: Top Water Withdrawals for Agriculture in 2013.

Owner Name	Facility	City/County	Type	Source	Avg. MGD[1]	2013 MGD
Commonwealth of Virginia	Coursey Spring Fisheries	Bath	GW	Coursey Spring	7.71	12.59
Virginia Trout Company Inc	Terry Place Plant	Highland	GW	Blue Spring	4.48	4.66
Commonwealth of Virginia	Wytheville Fish Hatchery	Wythe	GW	Boiling and West Springs	3.34	3.36
Commonwealth of Virginia	Marion Fish Cultural Station	Smyth	SW	Staleys Creek	3.01	2.89
Commonwealth of Virginia	Paint Bank Fish Cultural Station	Craig	SW	Paint Bank Branch	2.58	2.82
Virginia Trout Company Inc	Monterey Plant	Highland	GW	Vandev ender Spring	2.41	2.22

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

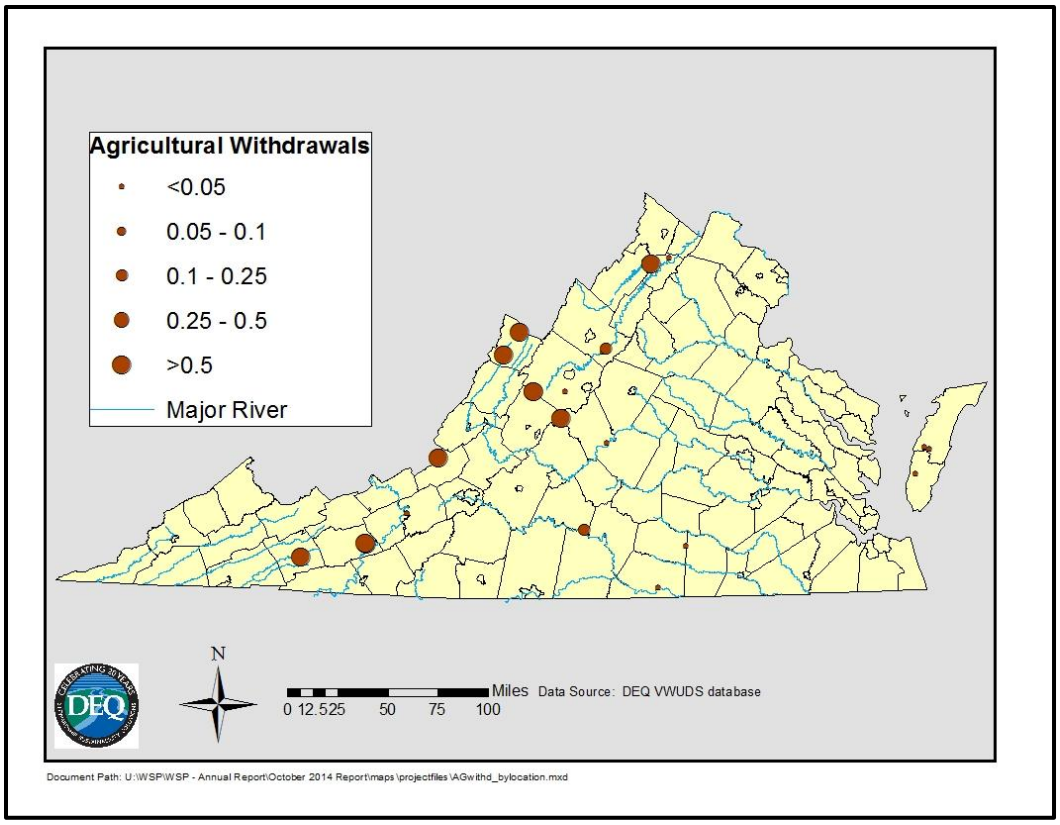


Figure 19: 2013 Agricultural Water Withdrawals by Withdrawal Point Location (mgd).

Irrigation Water Withdrawals in Virginia

Irrigation withdrawals are used to promote growth in crops such as tobacco, corn, soybeans, turf grass, and ornamental nursery products. Figure 20 shows the state-wide total of irrigation-related groundwater and surface water withdrawals for 2009-2013. Surface water continues to be the major source of water for irrigation in terms of the total amount used. The majority of the reported groundwater withdrawals for irrigation are from "dug" ponds or reservoirs that do not have a connection with a perennial stream

Reported water withdrawals for irrigation in 2013 were significantly lower than those reported for previous years due primarily to an approximately 50% decrease in 2013 reported stream withdrawals compared to 2012 and to the 2009-2013 average.

Center Pivot Irrigation

and are therefore categorized as groundwater sources (Table 6). There are no major transfers of water for irrigation, so the water withdrawals also represent water use. Reported water withdrawals for irrigation in 2013 were significantly lower than those reported for previous years due primarily to an approximately 50% decrease in 2013 reported stream withdrawals compared to 2012 and to the 2009-2013 average. This decrease is apparently due mainly to lower reported withdrawals by many users, rather than non-reporting by a small number of large users. The drop in reported withdrawals from streams was accompanied by significantly lower reported withdrawals from wells and reservoirs (both groundwater and surface water, Table 6). As with previous years, most large-scale irrigation facilities are located in the northern coastal plain (Northern Neck) counties and on the Eastern Shore (Table 7 and Figure 21).

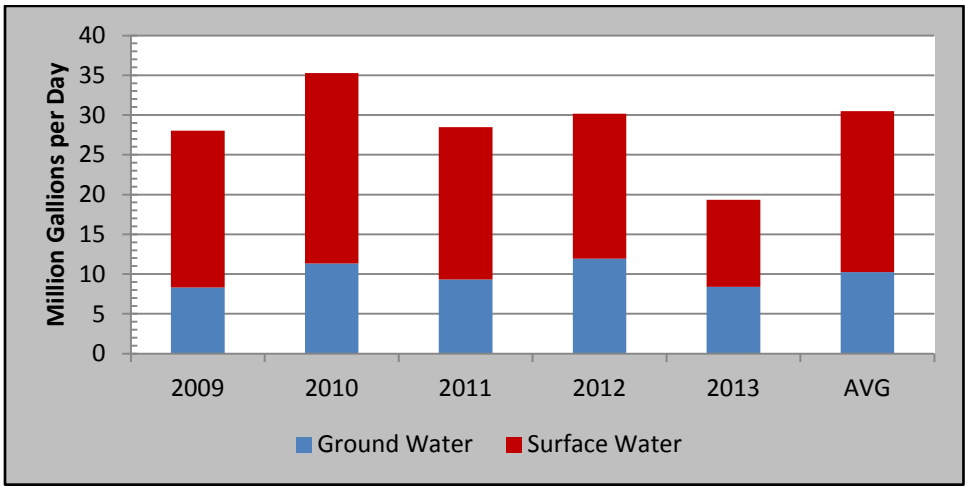


Figure 20: 2009-2013 Irrigation Water Withdrawals by Source Type.

Table 6: 2009-2013 Irrigation Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW	8.3	11.3	9.3	11.9	8.4	10.2	1.8	18
reservoirs[3]	5.9	8.5	6.7	9.1	6.6	7.5	0.9	12
wells	2.5	2.9	2.6	2.8	1.7	2.7	1.0	36
Total SW	19.7	24.0	19.2	18.2	11.0	20.3	9.3	46
reservoirs	7.5	8.1	8.2	7.0	5.2	7.7	2.4	32
springs	0.1	0.2	0.3	0.3	0.2	0.2	0.0	16
streams	12.1	15.8	10.8	11.0	5.6	12.4	6.8	55
Total GW + SW	28.0	35.3	28.5	30.2	19.3	30.5	11.2	37

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals
[3]: withdrawals from dug ponds or reservoirs that are not connected to perennial streams

Table 7: Top Water Withdrawals by Specific Source for Irrigation in 2013.

Owner Name	Facility	City/County	Type	Source	Avg. MGD[1]	2013 MGD
Robert C Darby and Sons	Arbuckle Farms	Accomack	GW	6 Dug Ponds	4.75	4.31
E Phillip and David L Hickman	Dublin Farms	Accomack	SW/GW	13 Farm Ponds, 1 Dug Pond	2.29	1.75
Eagle Tree Farms	Eagle Tree	Westmoreland	SW	Pee Dee Creek & Rappahannock River	0.33	0.92
John Yaros	Yaros Farms, Inc.	Northampton	SW	farm reservoirs	0.6	0.7
Larry and Neva Muse	Penn Farm	Westmoreland	SW/GW	Line Creek & dug farm pond	0.44	0.58

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

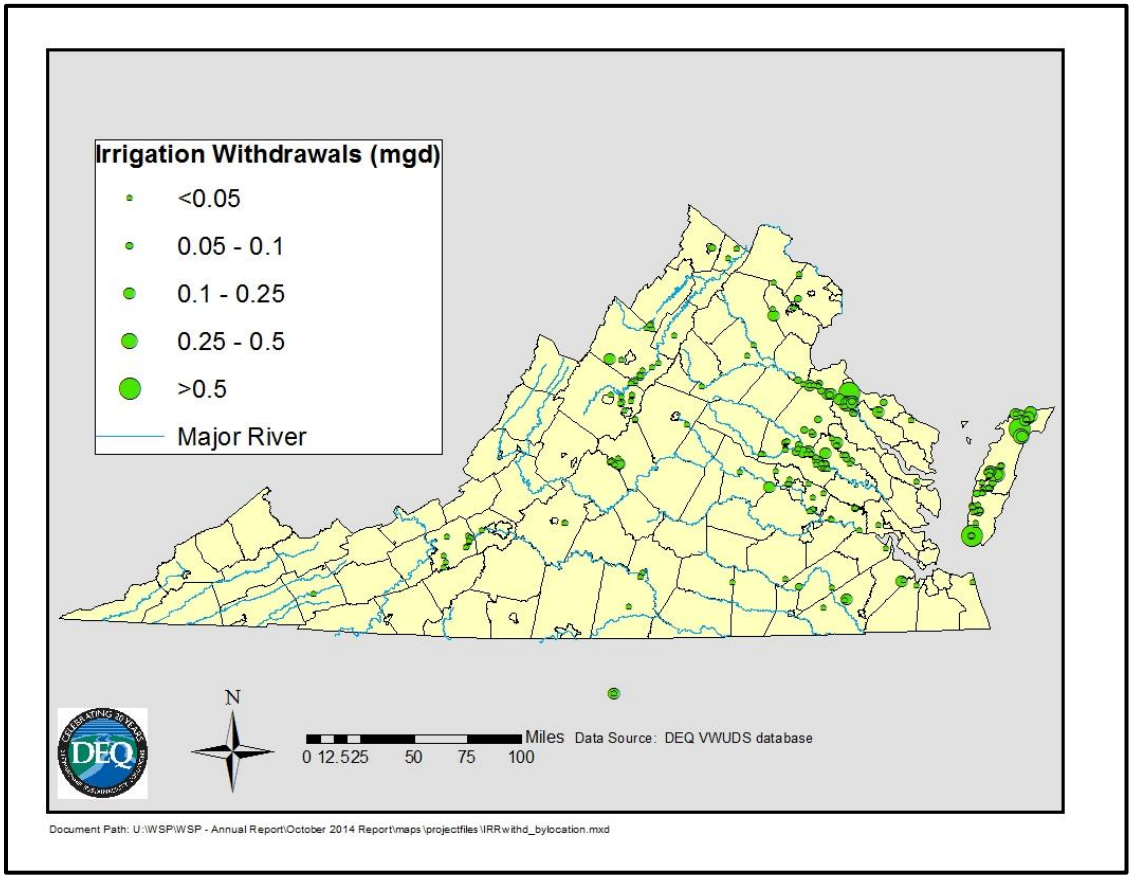


Figure 21: 2013 Irrigation Water Withdrawals by Withdrawal Point Location (mgd).

Commercial Water Withdrawals in Virginia

Commercial operations include golf courses, local and federal installations, hotels, resorts and correctional centers, among others. Figure 22 shows the state-wide total of groundwater and surface water withdrawals for commercial purposes from 2009-2013. Surface water withdrawal totals are typically greater than groundwater withdrawal totals for commercial operations. Total water withdrawals for commercial operations in 2013 were essentially equal to average withdrawals over the past five years (Table 8). The five facilities reporting the largest 2013 water withdrawals for commercial operations are listed in Table 9. In addition to water withdrawals, the total commercial water use in some counties also includes water transferred from elsewhere (Table 10, Figure 23). Commercial water withdrawals and transfers are spread throughout Virginia, predominantly near population centers.

Hotels and motels and sports and recreation clubs (*i.e.* private golf courses or country clubs) and public golf courses were the commercial subcategories with the largest 2013 withdrawals and together accounted for about 61% of the total commercial withdrawals (Table 11, Figure 24).

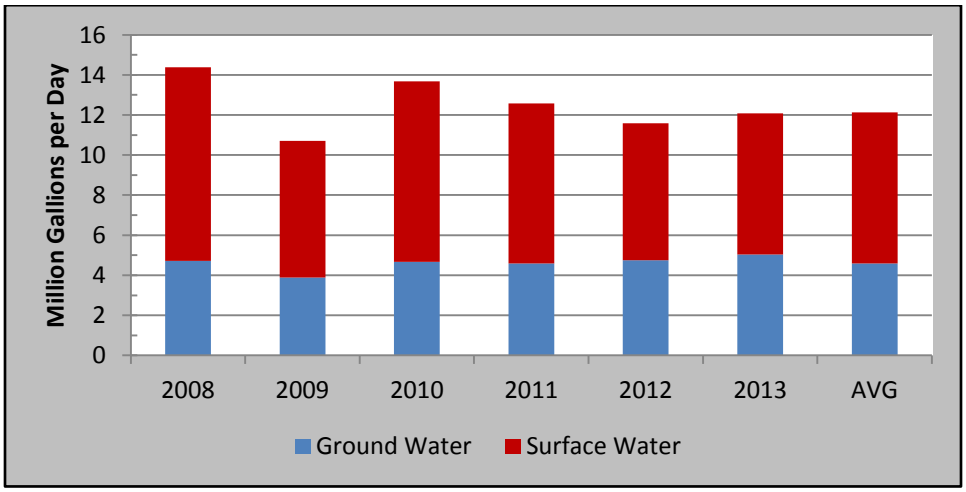


Figure 22: 2009-2013 Commercial Water Withdrawals by Source Type.

Table 8: 2009-2013 Commercial Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW (wells)	3.9	4.7	4.6	4.8	5.0	4.6	0.4	10
Total SW:	6.8	9.0	8.0	6.8	7.1	7.5	0.5	-6
Reservoirs	3.5	5.1	4.2	4.2	4.6	4.3	0.3	7
Springs	1.0	0.8	0.9	0.1	0.1	0.6	0.5	-84
Streams	2.4	3.1	2.9	2.6	2.4	2.7	0.3	-11
Total GW + SW	10.7	13.7	12.6	11.6	12.1	12.1	0.0	0

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals

Table 9: Top Water Withdrawals by Specific Source for Commercial Operations in 2013.

Owner Name	Facility	City/County	Type	Source	Avg. MGD[1]	2013 MGD
Colonial Williamsburg, Inc.	Colonial Williamsburg Hotel	Williamsburg	GW	6 wells	1.16	1.81
Central Virginia Water Storage Corp.	Storage Reservoir (CVWSC)	Buckingham	SW	CVWSC Storage Reservoir	0.77	1.34
Wintergreen Partners, Inc.	Lake Monocan	Nelson	SW	Lake Monocan	0.89	1.01
Commonwealth of Virginia	James River Correctional Center	Goochland	SW	James River, Beaverdam Creek	0.7	0.67
Bay Creek Resort & Club	Bay Creek Resort & Club	Northampton	SW	2 ponds	0.08	0.39

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

Table 10: Top Water Transfers for Commercial Operations in 2013.

Source	Purchaser	Purchaser Facility	Purchaser Location	Avg. MGD[1]	2013 MGD
Fairfax County WA, Potomac WTP	Metro Washington Airport Authority	Dulles International Airport	Fairfax County	0.8	0.81
Wintergreen Partners, Inc.-Lake Monocan	Nelson County Service Authority	Wintergreen Mt Service Area	Nelson County	0.28	0.26
Commonwealth of Virginia, James River Correctional Facility	County of Goochland	Goochland Courthouse Service Area	Goochland County	0.12	0.08

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

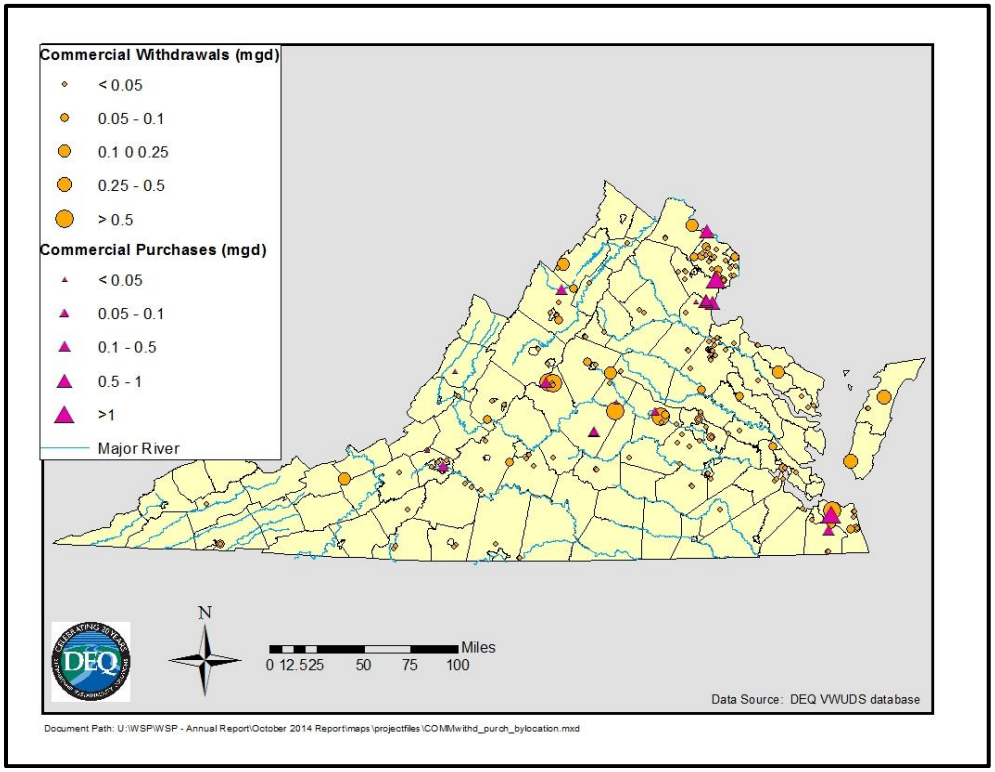


Figure 23: 2013 Commercial Water Withdrawal and Purchases (mgd).

Table 11: 2009-2013 Commercial Water Withdrawals by Subcategory.

General Subcategory	Specific Sub-Category	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD
Hotels and Other Lodging	Hotels and motels	1.6	1.5	1.3	0.6	3.1
Amusement and Recreation Services	Membership sports and recreation clubs	2.0	2.9	2.5	2.5	2.4
Amusement and Recreation Services	Public golf courses	2.0	3.1	2.4	2.2	1.8
Justice, Public Order, and Safety	Correctional institutions	1.2	1.3	0.9	1.3	1.5
Trucking and Warehousing	Special warehousing & storage	0.4	0.7	0.7	0.7	1.4
Administration of Economic Programs	Admin. of general economic programs	0.3	0.4	0.4	0.2	0.7
Executive, Legislative, and General	General government	0.1	0.1	0.1	0.1	0.3
Amusement and Recreation Services	Amusement and recreation	0.1	0.1	0.1	0.1	0.2

(This table includes only those sub-categories with >0.1 mgd of self-supplied withdrawals in 2013; therefore totals may not match those in Figure 24.)

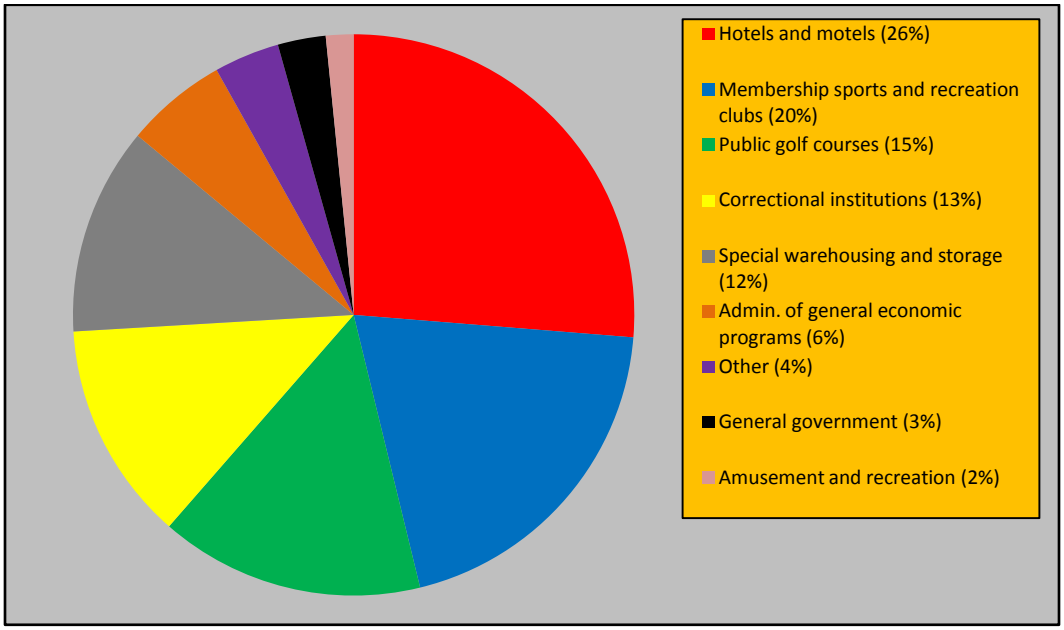


Figure 24: 2013 Commercial Withdrawals by Specific Sub-Category.

Mining Water Withdrawals in Virginia

Mining includes operations such as sand, rock, and coal mining. Total water withdrawals in 2013 for mining purposes increased relative to 2012 but were less than the 2009 – 2013 average (Figure 25 and Table 12). Surface water remained the major source of water for mining purposes, with about 57% of the total supplied by reservoirs. Because there are no major transfers of water for mining purposes, the water withdrawals also represent water use. The five facilities reporting the largest 2013 mining withdrawals are listed in Table 13. The majority of stone and sand mining facilities are located along the I-95 corridor; coal mining withdrawals are located in the southwestern Appalachian Basin (Figure 26). Crushed and broken granite activities accounted for approximately 41% of the total 2013 water withdrawals for mining. Coal mining and processing activities made up 27% of mining withdrawals and quarrying for limestone, sand and gravel accounted for most of the remainder (Table 14 and Figure 27). Withdrawals for construction sand and gravel, however, were similar to the low levels reported for 2012 (0.1 mgd), indicating a significant decline compared to earlier years.

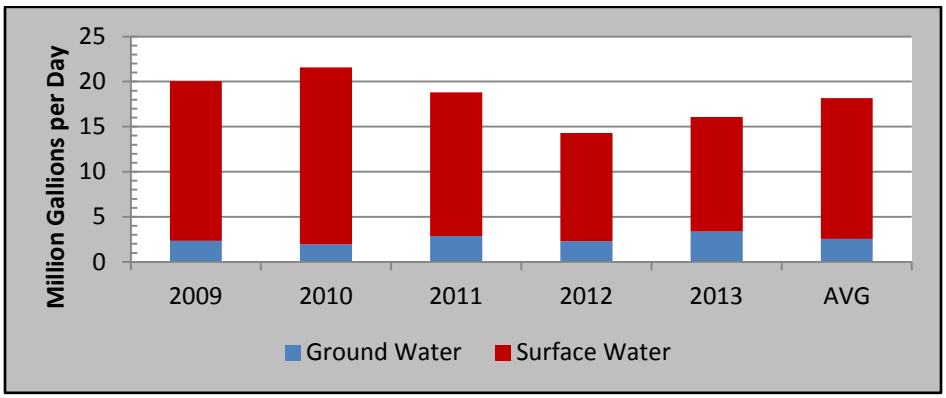


Figure 25: 2009-2013 Mining Water Withdrawals by Source Type.

Table 12: 2009-2013 Mining Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW:	2.4	1.9	2.9	2.3	3.4	2.6	0.8	32
Reservoirs[3]	0.04	0.04	0.04	0.04	0.04	0.04	0.0	0
Wells	2.3	1.9	2.8	2.3	3.3	2.5	0.8	32
Total SW:	17.7	19.7	16.0	12.0	12.7	15.6	2.9	-19
Reservoirs	9.5	11.8	8.2	6.0	7.3	8.6	1.3	-15
Streams	8.3	7.9	7.7	6.0	5.4	7.0	1.7	-24
Total GW + SW:	20.1	21.6	18.8	14.3	16.1	18.2	2.1	-12

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals
[3]: withdrawals from dug ponds or reservoirs that are not connected to perennial streams

Table 13: Top Withdrawals by Specific Source for Mining Operations in 2013.

Owner Name	Facility	City/County	Type	Source	Avg. MGD[1]	2013 MGD
Boxley Materials Company	Blue Ridge Plant	Bedford	SW	Quarry	1.25	1.79
Vulcan Construction Materials	Manassass Plant	Prince William	SW	Pump Silting Basin #1	1.64	1.79
Vulcan Construction Materials	Royal Stone Plant	Goochland	SW/GW	Little Tuckahoe Creek, Quarry Sump, & Well	1.14	1.24
Dickenson-Russell Coal Co LLC	McClure #1 Mine & Prep Plant	Dickenson	SW	Caney Creek	0.86	1.07
Paramont Coal Co VA LLC	Toms Creek Prep Plant	Wise	SW	Little Toms Creek & Upper Banner Mine Reservoir	1.02	1.04

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

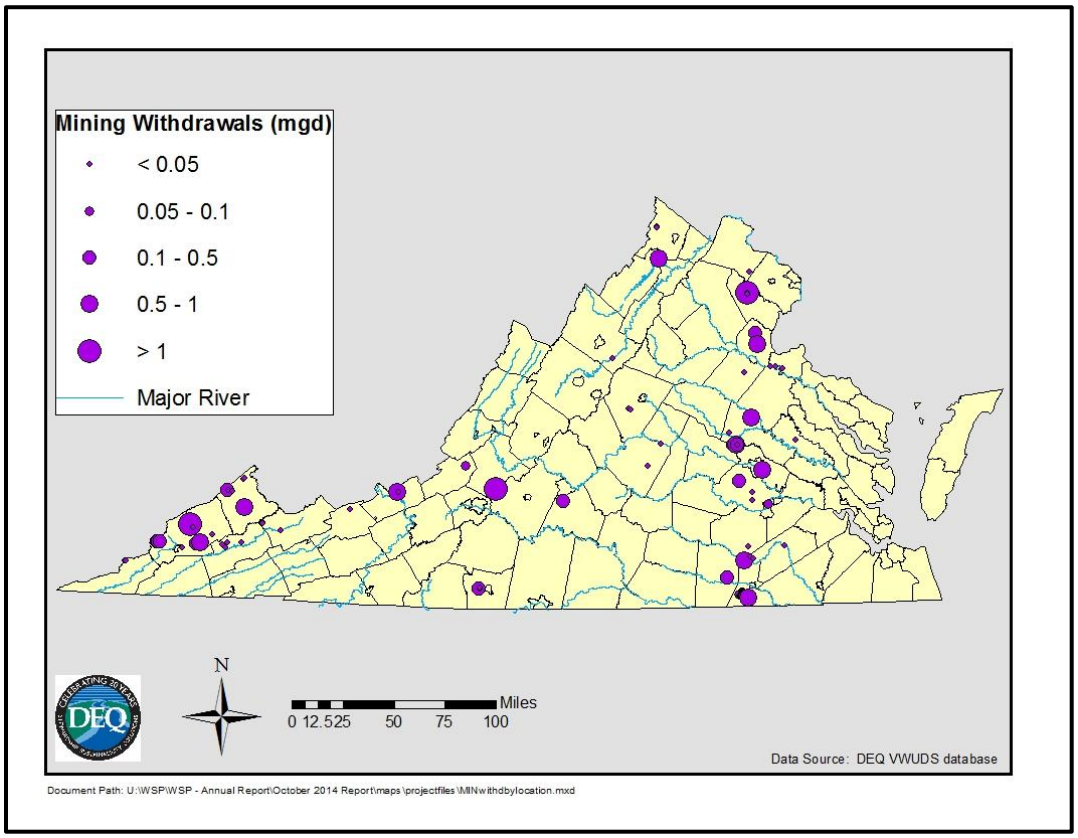


Figure 26: 2013 Mining Water Withdrawals by Withdrawal Point Location (mgd).

Table 14: 2009-2013 Mining Water Withdrawals by Sub-Category.

General Sub-Category	Specific Sub-Category	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD
Nonmetallic Minerals, Except Fuels	Crushed and broken granite	9.0	8.7	7.9	5.9	6.6	7.6
Nonmetallic Minerals, Except Fuels	Crushed and broken limestone	3.6	3.3	2.4	2.1	2.8	2.9
Coal Mining	Coal mining services	1.7	1.9	2.3	2.8	2.6	2.2
Coal Mining	Bituminous coal mining	1.0	1.1	1.1	1.1	1.0	1.1
Nonmetallic Minerals, Except Fuels	Crushed and broken stone	0.3	0.1	0.1	0.1	0.6	0.2
Nonmetallic Minerals, Except Fuels	Construction sand and gravel	3.5	2.7	2.6	0.2	0.1	1.8
Nonmetallic Minerals, Except Fuels	Industrial sand	0.02	0.03	0.02	0.03	0.06	0.03
Nonmetallic Minerals, Except Fuels	Clay and related minerals	0.04	0.06	0.06	0.06	0.03	0.05

(This table includes only those sub-categories with >0.1 mgd of self-supplied withdrawals in 2013; therefore totals may not match those in Figure 27.)

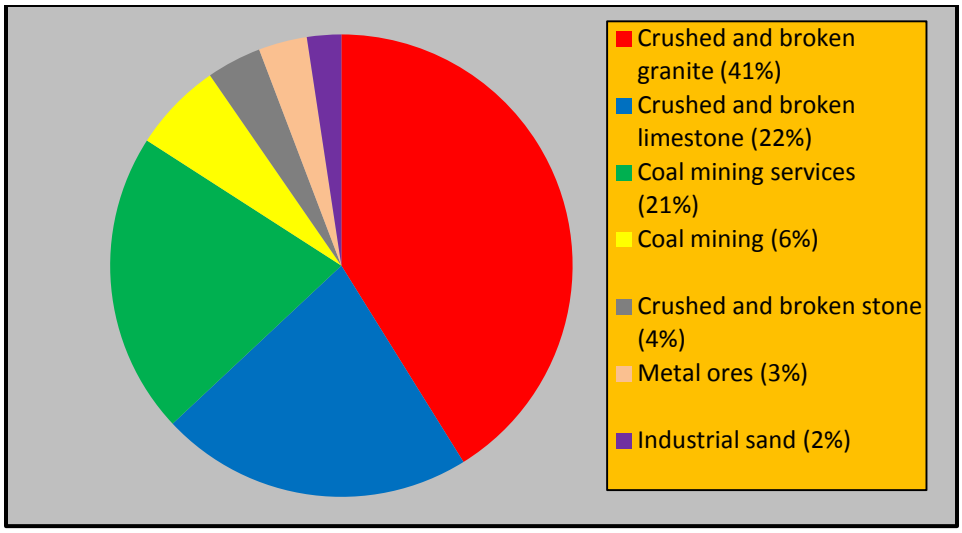


Figure 27: 2013 Mining Water Withdrawals by Sub-Category (mgd).

Manufacturing Water Withdrawals in Virginia

Manufacturing includes operations such as paper mills, food processors, drug companies, furniture, and concrete companies. Figure 28 illustrates the changes in state-wide totals of groundwater and surface water withdrawals for manufacturing from 2009-2013. Manufacturing withdrawals during 2013 declined slightly relative to the previous year and totaled about 28 mgd (7%) less than the 2009 – 2013 average (Table 15). Surface water is the predominant source of water for manufacturing, accounting for about 82% of the total withdrawals in 2013. There are no major transfers of water reported for manufacturing purposes, so the water withdrawals generally represent water use. Table 16 lists the seven largest facilities in terms of manufacturing water withdrawals in 2013. Four of these facilities manufacture chemicals and allied products while the remaining three manufacture paper and allied products. Withdrawals reported for these subcategories remained very similar to those reported for 2012. Water used for chemical and allied products totaled about 245mgd, which equals 65 percent of the 2013 total manufacturing withdrawals (Table 17 and Figure 29). Withdrawals for manufacturing paper and allied products totaled approximately 94 mgd (25%) of the 2013 manufacturing withdrawals. Water withdrawals by the chemical and paper industries together accounted for 339 mgd in 2013, or about 28% of all non-power generation withdrawals in Virginia.

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Water withdrawals for manufacturing purposes are spread throughout much of Virginia (Figure 30). Clusters of large-scale withdrawals occur in the Tidewater, Richmond and

Shenandoah Valley regions, as well as the New River and the Jackson/Upper James River basins. All of the manufacturing locations with large withdrawals are situated on or near major rivers to facilitate water supply.

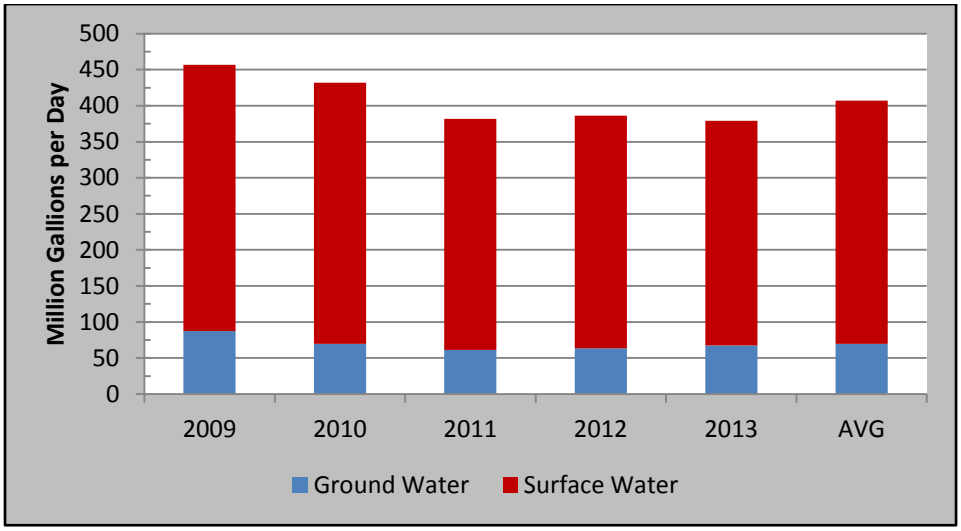

Figure 28: 2009-2013 Manufacturing Water Withdrawals by Source Type.

Table 15: 2009-2013 Manufacturing Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW (wells):	87.3	69.7	61.3	63.4	67.5	69.8	2.4	3
Total SW:	369.6	362.1	320.6	322.7	311.7	337.3	25.6	8
Reservoirs	2.6	2.9	3.0	3.1	3.0	2.9	0.1	3
Springs	0.0	0.2	0.2	0.6	0.4	0.3	0.1	36
Streams	367.1	359.0	317.4	319.1	308.4	334.2	25.8	8
Total GW + SW:	456.9	431.8	381.9	386.1	379.2	407.2	28.0	7

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals

Table 16: Top Water Withdrawals for Manufacturing Facilities in 2013.

Owner Name	Facility	City/County	Subcategory	Type	Source	Avg. MGD[1]	2013 MGD
Honeywell International, Inc	Hopewell Plant	City of Hopewell	Chemicals and Allied Products	SW	James River	107.45	108.26
Celanese Acetate, LLC	Celco Plant	Giles County	Chemicals and Allied Products	SW	New River	56.5	57.83
Meadwestvaco Corporation	Covington Plant	Alleghany County	Paper & Allied Products	SW	Jackson River	38.74	38.6
Dupont E I De Nemours & Co.	Spruance Plant	Chesterfield County	Chemicals and Allied Products	SW	James River	28.28	28.48
Rock-Tenn Corp.	West Point Plant	King William County	Paper & Allied Products	GW	Potomac Aquifer	19.06	19.61
United States Government.	Radford Ammunitions WTP	Montgomery County	Chemicals and Allied Products	SW	New River	22.58	18.66
Rock-Tenn Corp.	Hopewell Plant	City of Hopewell	Paper & Allied Products	SW	James River	16.45	15.80

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

Table 17: 2009-2013 Manufacturing Withdrawals by Sub-Category.

General Subcategory	Specific Sub-Category	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg MGD[1]
Chemicals and Allied Products	Chemical preparations	102.9	113.4	112.2	113.4	111.3	110.6
Paper and Allied Products	Paperboard Mills	86.3	87.1	86.2	83.8	82.4	85.2
Chemicals and Allied Products	Cellulosic manmade fibers	58.0	53.2	56.9	56.5	57.8	56.5
Chemicals and Allied Products	Organic fibers, noncellulosic	30.2	31.2	30.8	33.8	31.5	31.5
Chemicals and Allied Products	Industrial inorganic chemicals	24.3	27.9	33.5	28.2	24.4	27.7
Chemicals and Allied Products	Plastics materials and resins	13.0	11.4	10.9	12.7	13.0	16.3
Stone, Clay, and Glass Products	Lime	6.7	7.8	8.3	7.6	12.7	12.1
Chemicals and Allied Products	Medicinals and botanicals	8.6	8.5	7.9	7.8	7.4	7.6
Paper and Allied Products	Sanitary food containers	5.2	3.7	4.9	5.1	7.2	8.0
Transportation Equipment	Ship building and repairing	5.2	3.2	2.4	7.8	5.2	4.8
Paper and Allied Products	Paper mills	32.7	15.3	7.6	13.0	4.5	4.6
Food and Kindred Products	Poultry slaughtering and processing	1.9	1.8	2.8	1.9	2.7	2.2

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

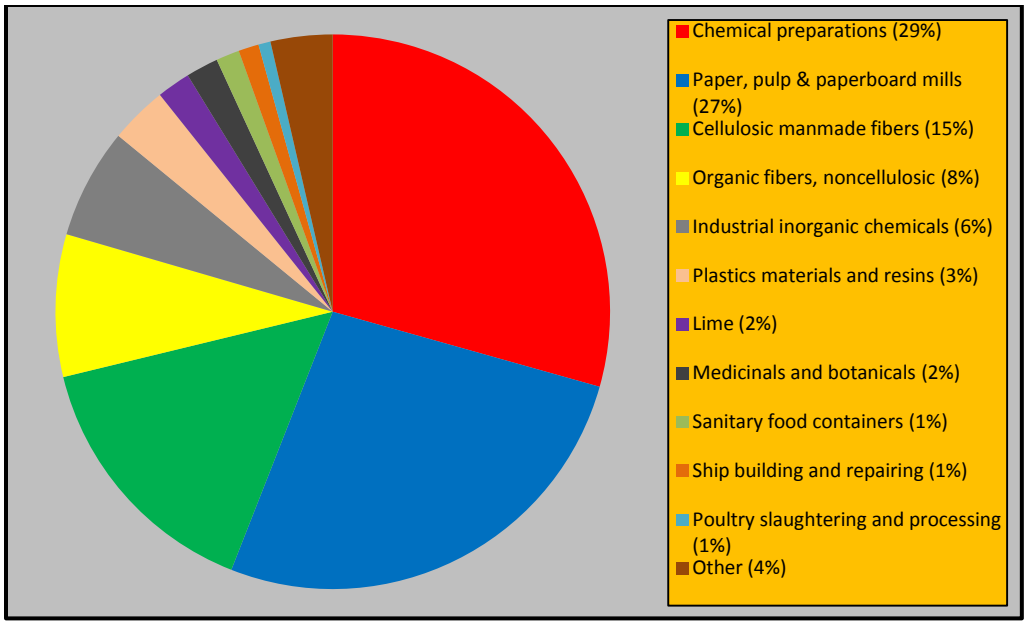

Figure 29: 2013 Manufacturing Water Withdrawals by Specific Sub-Category (mgd).

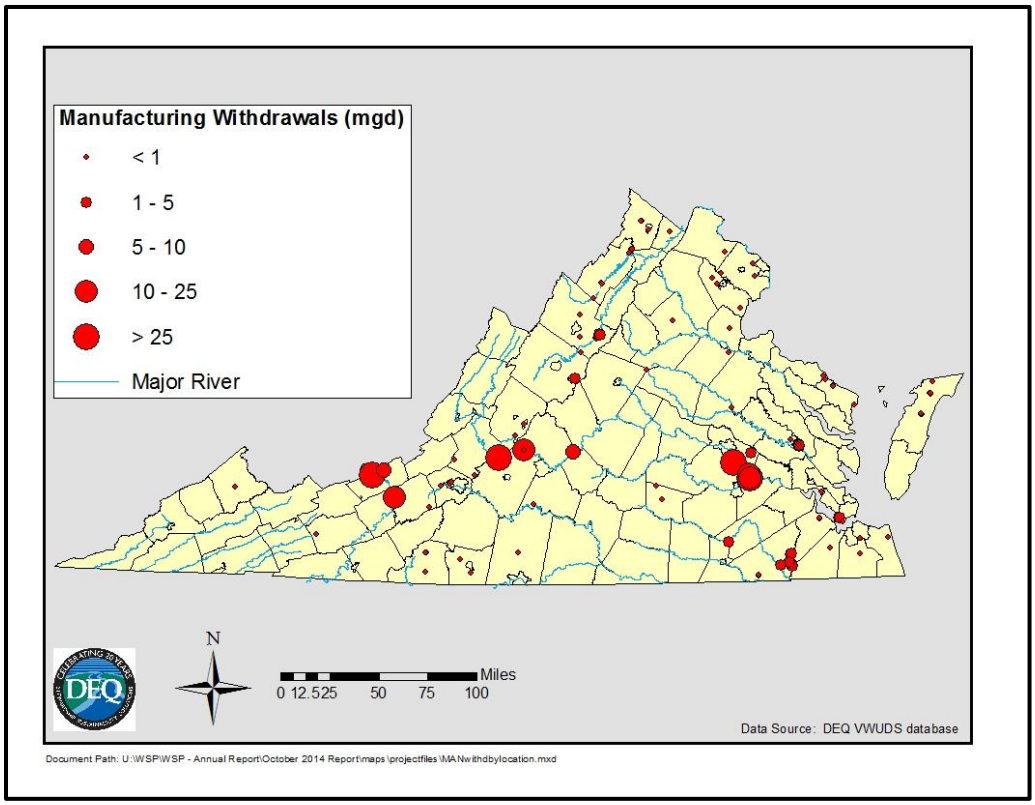

Figure 30: 2013 Manufacturing Water Withdrawals by Withdrawal Point Location (mgd).

Public Water Supply Water Withdrawals in Virginia

Public water supply includes municipal and private water purveyors. Water withdrawals for public supply are delivered mainly to domestic users, but significant volumes are also delivered to commercial and industrial customers. However, deliveries to specific users are generally not reported to DEQ. Therefore, the reported public-supply withdrawals do not differentiate among the categories of end users.

Figure 31 illustrates the state-wide totals of groundwater and surface water withdrawals for public water supply from 2009-2013. Total water withdrawals for public water supply during 2013 were about 3% less than the average for the 2009-2013 period (Table 18) and slightly less than 2012 withdrawals. As with manufacturing, surface water is the major source of water for public water supply in terms of the overall quantities used. Surface water reservoirs supplied about 48% of the total 2013 public-supply withdrawals in Virginia and about 30% of all non-power generation withdrawals. Table 19 lists the 9 facilities that withdrew water for public water supply at the greatest rates during 2013. Note that the facilities and withdrawal rates in this list are not identical to those listed in Appendix 3 because the latter reports the total system withdrawals. That is, some public water supply systems contain multiple facilities that, while not large enough individually to be reported by Table 19, are larger when considered cumulatively.

Surface water reservoirs supplied about 48% of the total 2013 public-supply withdrawals in Virginia and about 30% of all non-power generation withdrawals.

There are several major transfers of water that occur for public water supply. Therefore, the total water used for public water supply in each locality includes the water withdrawals in that locality, as well as water transferred into that locality from elsewhere, minus any water sold to other localities. Reporting of domestic water withdrawals by private households is not required; therefore, all of the water withdrawals for public water supply were reported from public or community water systems. The ten largest water transfers for public water supply are listed in Table 20. Table 21 displays information from the Environmental Protection Agency's most recent report tabulating the number of public water systems in Virginia as of Federal Fiscal Year 2011 (ending September 30, 2011) and the corresponding population served by these systems. While the greatest number of systems use groundwater (nearly 86%), the majority of the population is served by surface water systems.

The largest public supply water withdrawals are located within or near population centers such as the Washington DC metropolitan region, Richmond, Hampton Roads and Roanoke (Figure 32). The largest public water supply purchases (Figure 33) are located in the same areas, where suppliers with large reservoirs or river withdrawals sell

water to their neighbors. Smaller public supplies are scattered throughout the rest of the state.

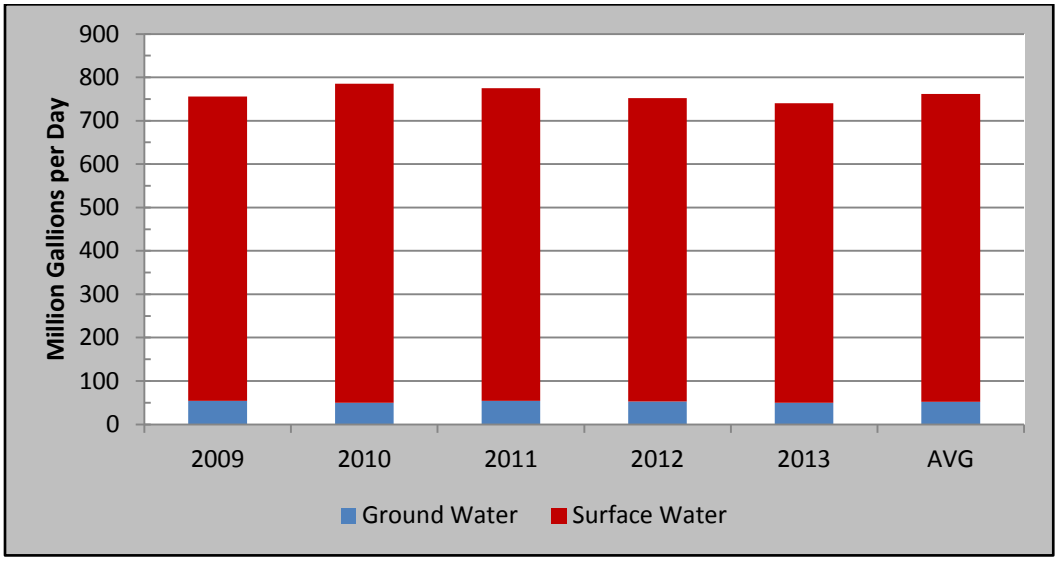

Figure 31: 2009-2013 Public Water Supply Water Withdrawals by Source Type.

Table 18: 2009-20123 Public Water Supply Water Withdrawals by Source Type.

Source Type:	2009 MGD	2010 MGD	2011 MGD	2012 MGD	2013 MGD	Avg. MGD	Abs. Difference[1] (MGD)	% Diff.[2]
Total GW:	54.7	50.2	54.5	52.7	50.0	52.4	2.4	-5
Reservoirs[3]	0.3	0.4	0.4	0.4	0.4	0.4	0.0	1
Wells	54.3	49.8	54.1	52.3	49.6	52.0	2.4	-5
Total SW:	701.1	735.2	720.5	699.8	690.3	709.4	19.1	-3
Reservoirs	338.9	366.5	363.6	364.0	356.6	357.9	1.3	0
Springs	13.3	17.4	16.3	14.5	13.7	15.0	1.3	-9
Streams	348.7	351.3	340.4	321.1	319.8	336.3	16.5	--5
Total GW + SW:	755.7	785.4	775.0	752.4	740.3	761.8	21.5	-3

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals
[3]: withdrawals from quarries or reservoirs that are not connected to perennial streams

Table 19: Top Water Withdrawals by Public Water Supply Facilities in 2013.

Owner Name	Facility	City/County	Type	Source	Avg. MGD[1]	2013 MGD
Fairfax County Water Authority	Potomac River WTP	Fairfax County	SW	Potomac River	89.5	84.4
City of Norfolk	Western Branch Reservoir	Suffolk	SW	Western Branch Reservoir	58.9	60.0
Fairfax County Water Authority	Occoquan Reservoir	Prince William County	SW	Occoquan Reservoir	60.6	59.6
City of Richmond	Richmond WTP	City of Richmond	SW	James River and Kanawha Canal	62.6	58.5
Appomattox River Water Authority	Lake Chesdin WTP	Chesterfield County	SW	Lake Chesdin	30.9	30.2
City of Virginia Beach	Virginia Beach Service Area	City of Virginia Beach	SW	Lake Gaston	26.5	28.7
City of Portsmouth	Lake Kilby WTP	Suffolk	SW/GW	Lakes Kilby, Meade & 6 wells	19.7	26.6
Henrico County	Henrico County WTP	Henrico County	SW	James River	25.2	23.7
City of Newport News	Lee Hall WTP & ROF	City of Newport News	SW	Lee Hall Reservoir	23.9	23.5

[1]Avg. MGD = Average water withdrawals from 2009-2013 (MGD)

Table 20: Top Water Transfers for Public Water Suppliers in 2013.

Source	Supplier	Purchaser Owner Name	Purchaser Facility	2013 MGD
City of Norfolk	Norfolk Service Area	City of Virginia Beach	Virginia Beach Service Area	32.0
US Government	Dalecarlia WTP	Arlington County	Arlington Service Area	22.2
Fairfax County Water Authority	Occoquan Reservoir	Prince William County Service Authority	OWDT Service Area	20.2
Appomattox River Water Authority	Lake Chesdin WTP	Chesterfield County	Chesterfield County Service Area	19.1
Fairfax County Water Authority	Potomac River WTP	Loudoun Water	Lower Broad Run Service Area	18.6
Fairfax County Water Authority	Occoquan Reservoir	Virginia American Water Company	Alexandria Service Area	14.9
Virginia American Water Company	Alexandria Service Area	City of Alexandria	Alexandria Service Area	14.9
US Government	Dalecarlia WTP	City of Falls Church	Falls Church Service Area	14.3
City of Richmond	City of Richmond Service Area	Henrico County	City-County Contract Service Area	11.6
City of Richmond	City of Richmond Service Area	Chesterfield County	Chesterfield County Service Area	8.0

Table 21: Number of Public Water Systems and Population Served by Public Water Systems in Virginia, Federal Fiscal Year ending September 30, 2011.

	Total	Groundwater	Surface Water
Number of Systems	2787	2395	392
Population Served	7,090,048	751,035	6,339,013

Source: http://water.epa.gov/scitech/datait/databases/drink/sdwisfed/upload/epa816r13003.pdf (page 14, accessed 9/3/14).

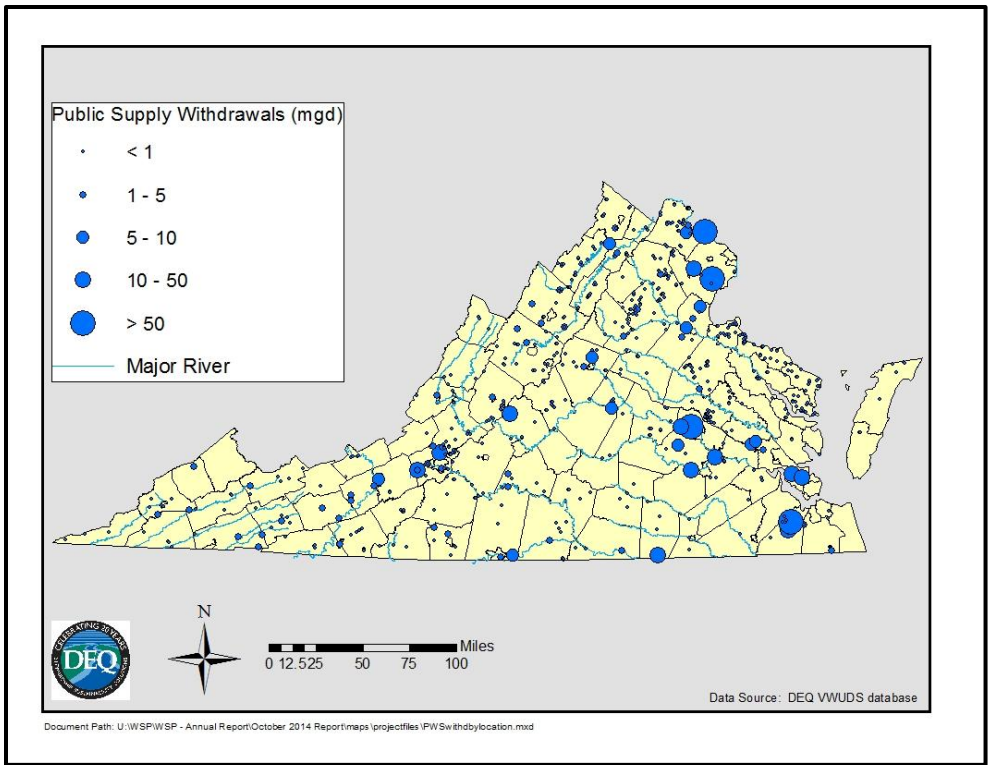

Figure 32: 2013 Public Supply Water Withdrawals by Location (mgd).

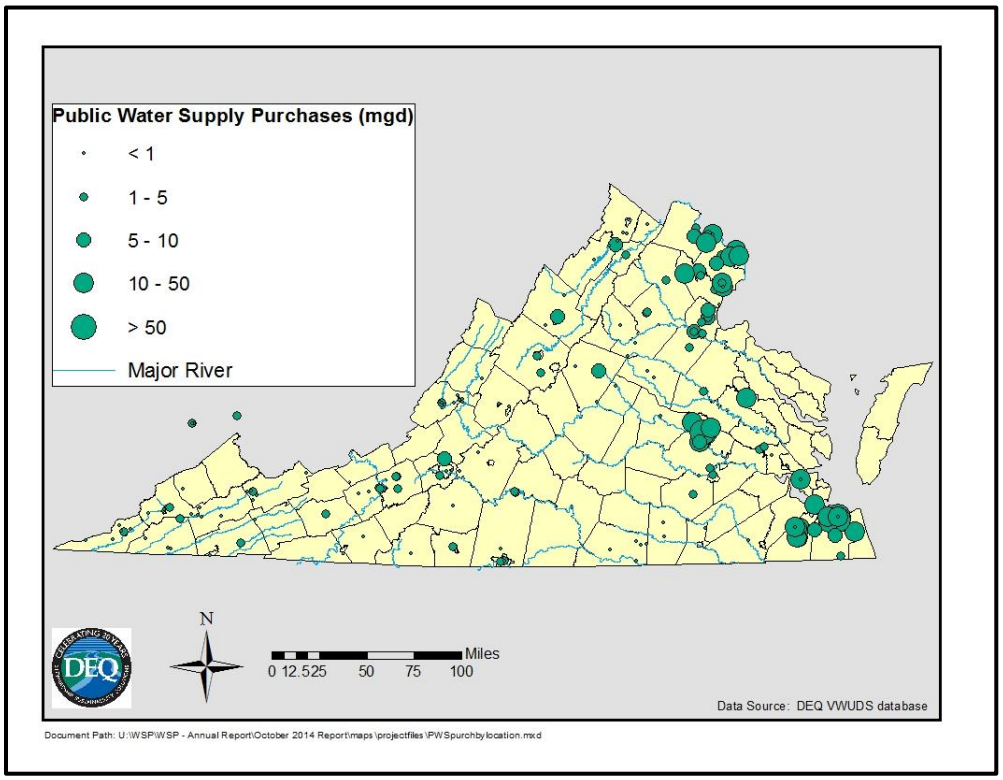

Figure 33: 2013 Public Supply Water Purchases by Location (mgd).

Power Generation Water Withdrawals in Virginia

Withdrawals for power generation are treated separately because most of the water diverted for these purposes is used non-consumptively. Withdrawals during 2013 by nuclear and fossil-fuel power generating plants are listed in this section. Water diverted for hydropower use is exempted from reporting and is nearly all non-consumptive use. Therefore, these flows are generally not reported to the VWUDS database. Groundwater withdrawals by power generators in 2013 were insignificant compared to surface water withdrawals. Total power generation withdrawals continued a slight declining trend over the past 5 years (Figure 34 and Table 22). 2013 total withdrawals were approximately 770 mgd (11.6%) less than the reported 2009 totals. The seven power generation facilities with the greatest 2013 withdrawals are listed in Table 23. Most of the large fossil-fuel facilities are located in central or eastern Virginia. Virginia has two nuclear-powered generating plants, located in Louisa and Surry counties (Figure 35).

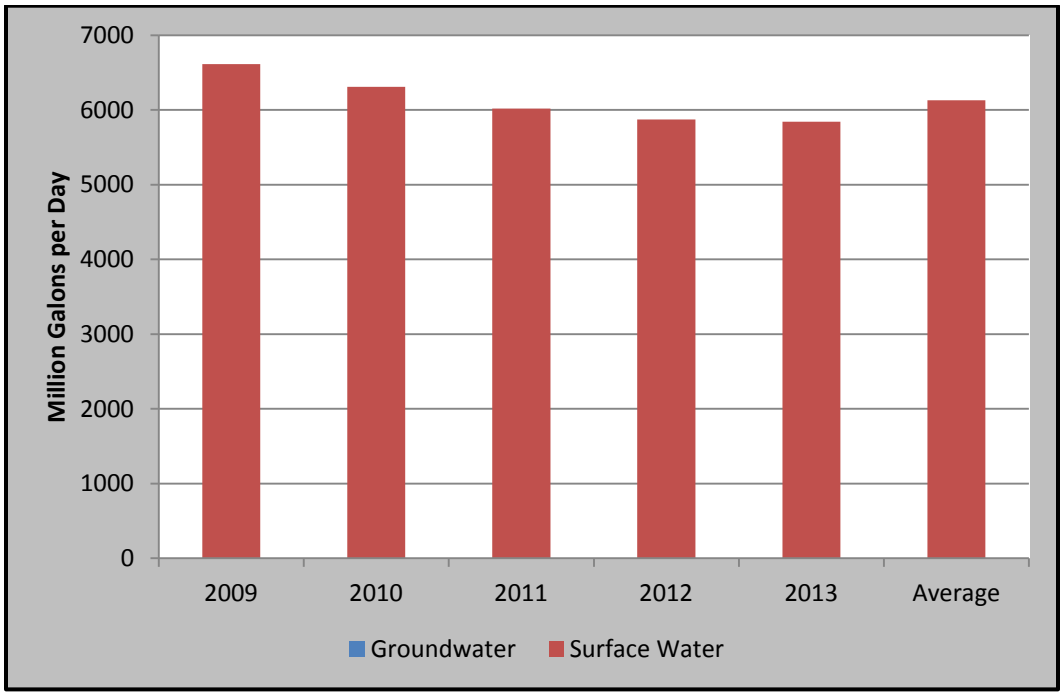

Figure 34: 2009-2013 Power Generation Withdrawals by Source Type.

Table 22: Power Generation Withdrawals by Source Type for 2009 – 2013 (excluding Hydropower).

Source type	2009 (MGD)	2010 (MGD)	2011 (MGD)	2012 (MGD)	2013 (MGD)	Avg. (MGD)	Abs. Difference[1]	% Diff.[2]
Total GW:	1	1.6	0.4	0.6	0.3	0.8	0.5	58.8
Wells-Fossil	0.6	1.2	0	0.2	0.02	0.4	0.4	94.3
Wells-Nuclear	0.4	0.4	0.3	0.3	0.3	0.3	0.0	11.7
Total SW:	6611	6309	6015	5871	5843	6130	287	5
Reservoirs-Fossil	1	1	1	1	1	1	0	19
Reservoirs-Nuclear	1886	1820	1732	1909	1695	1808	114	6
Streams-Fossil	2763	2580	2335	2024	2184	2377	193	8
Streams-Nuclear	1961	1907	1948	1938	1964	1943	20	1
TOTAL GW+SW (both Types):	6612	6311	6015	5871	5843	6130	287	5

[1]Abs Difference = difference between 2013 water withdrawals and average 2009-2013 water withdrawals (MGD)
[2]% Diff. = percent difference in 2013 water withdrawals from average 2009-2013 water withdrawals

Table 23: Top Water Withdrawals by Power Generation Facilities in 2013.

Owner Name	Facility	City/County	Type[1]	Major Source	Avg. MGD[2]	2013 MGD
Dominion Generation	Surry Nuclear Plant	Surry	N	James River	1943.6	1963.9
Dominion Generation	North Anna Nuclear Power Plant	Louisa	N	Lake Anna	1808.4	1694.8
Dominion Generation	Chesterfield Power Station	Chesterfield	F	James River	821.2	836.2
Dominion Generation	Yorktown Fossil Power Plant	York	F	York River	641	634.2
Dominion Generation	Chesapeake Energy Center	Chesapeake	F	South Branch, Elizabeth River	457.3	356.9
Dominion Generation	Possum Point Power Station	Prince William	F	Potomac River	147.1	145.4
Appalachian Power Company	Glen Lyn Power Plant	Giles	F	New River	102.9	120.8

[1]N = Nuclear; F = Fossil
[2]Avg. MGD = Average water withdrawals from 2008-2012 (MGD)

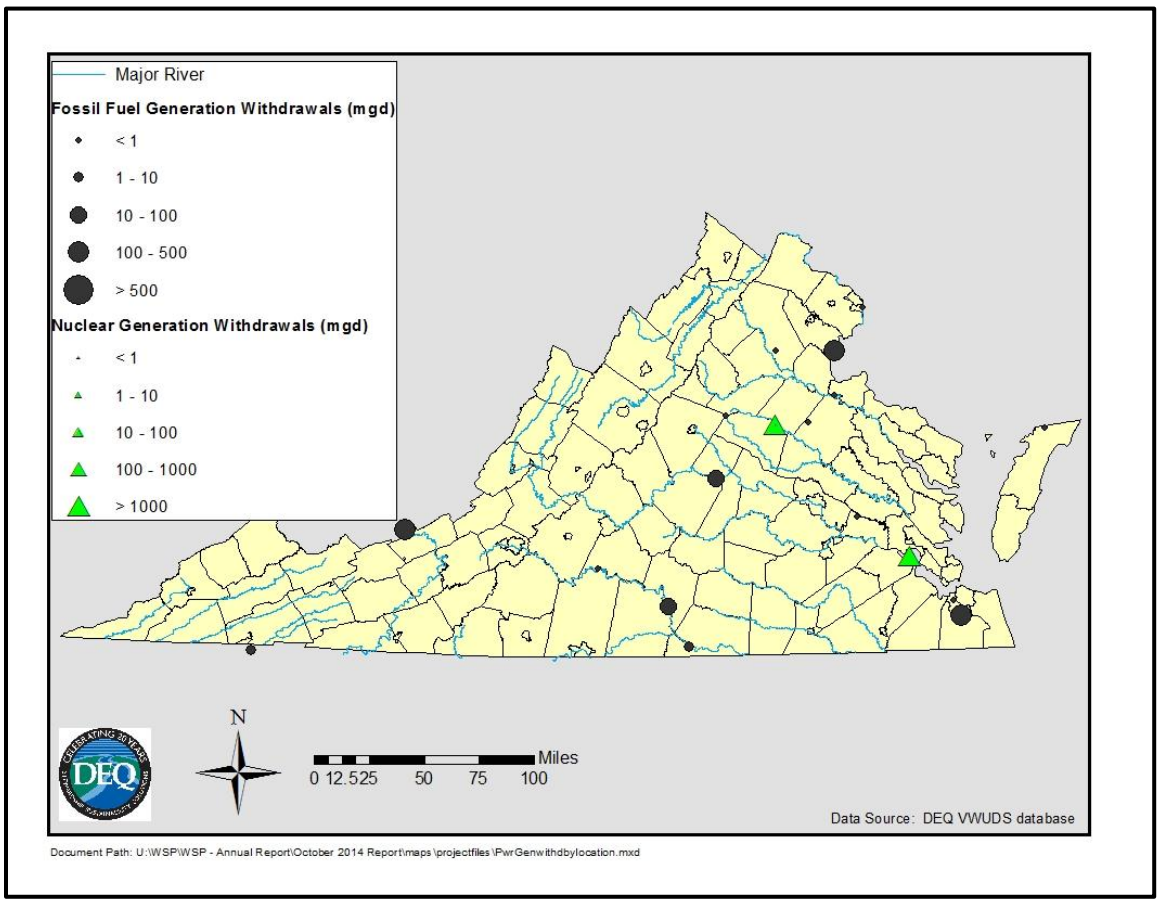

Figure 35: 2013 Power Generation Withdrawals by Withdrawal Point Location (mgd).

Consumptive Use of Water

A portion of all water withdrawn from groundwater or surface water sources is consumed and becomes unavailable for further use. Consumptive water use refers to that portion of a water withdrawal that is not returned to the source due to evapotranspiration, domestic use, incorporation into products or crops, or diversion from the source basin. The amount, or proportion of water consumed varies widely depending upon its type of use.

Most of the water withdrawn for irrigation of crops is consumed by evapotranspiration and incorporation into the irrigated crop. The percent of water consumed by agricultural, commercial, manufacturing and mining facilities varies greatly depending on the specific use, product or process at each facility. Estimates of domestic or public supply consumptive use can vary significantly depending upon whether wastewater is returned to the source stream or transported to another basin or stream within the same basin. Domestic consumptive use also varies greatly with weather patterns and time of

year. Previous estimates of domestic consumptive use made by the USGS for Virginia were approximately 10 percent of estimated annual withdrawal volumes for domestic use (Solley, 1998). More recent estimates of summertime public-supply related consumptive use in Ohio, Indiana and Wisconsin ranged from 16 to 20 percent of withdrawals, with an annual average range of 6 to 8 percent (Shaffer, 2009). Without specific information about the types and distribution of end users, however, estimates of consumptive use from public-supply withdrawals can be very uncertain. Given this uncertainty, changes in statutory or regulatory authority may be needed in the future to enable DEQ to better characterize consumptive losses.

At thermoelectric power plants, the type of cooling system used determines the relative amount of consumptive use. Once-through cooling systems return most of the diverted water to the original source, therefore causing a relatively insignificant amount of consumptive use. Closed-loop cooling systems recirculate diverted water through wet cooling towers and can lose a significant percentage of total water withdrawn to evaporation (Diehl, et al, 2013). In Virginia, 6 of the 7 largest thermoelectric power plants in terms of water withdrawals (Table 23) utilize once-through cooling. The Possum Point plant and other smaller plants across Virginia use wet cooling tower systems and may therefore have relatively greater consumptive losses.

VII. WATER RESOURCES - WHAT'S ON THE HORIZON

Although Virginia historically has enjoyed plentiful water resources relative to demand, the growth of the Commonwealth's economy and population continues to present a challenge for maintaining both the quality and quantity of these resources. This challenge is compounded by traditional behaviors and perceptions oriented toward the promotion of water resource consumption. Our water resources are used for a variety of important and sometimes competing in-stream and off-stream uses. Over the past decade, increased demand and competition for water coupled with reduced rainfall have established a greater sense of urgency in Virginia's approach to resource management. As Virginia nears the margins of the state's ability to satisfy water demand, resource management short term priorities must incorporate a focus on influencing consumer perceptions and behavior. This task requires promoting a long term shift in consumer behavior from consumption to conservation and re-use. Continued efforts to conserve Commonwealth water resources will ensure the sustainability of all beneficial water demands for the state's economy, welfare, and environment.

As Virginia nears the margins of the state's ability to satisfy water demand, resource management short term priorities must incorporate a focus on influencing consumer perceptions and behavior.

KEY WATER RESOURCE SIGNALS - The following are important water resource signals observed across the Commonwealth:

- Groundwater levels along the fall line have, in some locations, fallen below the elevation of the top of the confined aquifers. (The fall line is described as the boundary between the Piedmont and Coastal Plain physiographic provinces. It loosely mirrors Interstate 95 in the Commonwealth.) Groundwater levels in portions of southeastern Virginia continue to fall below critical surface elevations

as designated by the "80%" criterion in the groundwater withdrawal permitting regulation (9VAC25-610-110).

- In several locations, current local demands for groundwater to support desired growth in established Groundwater Management Areas can no longer be sustained by the coastal plain aquifer system at total permitted amounts. Model scenarios using the recently revised Virginia Hydro Groundwater Model indicate that withdrawals at or near total permitted rates would result in groundwater levels dropping below critical thresholds over wide areas. Field observations also indicate that in some areas measured water levels are even lower than those predicted by the improved model.
- DEQ estimates that approximately 82% of all existing surface water withdrawn in Virginia (approximately 875 mgd) are excluded by statute from Virginia Water Protection permit requirements. As part of the preparation of the State Water Resources Plan (SWRP) required by § 62.1-44.38, DEQ analyzed historic and projected surface water withdrawal information along with other pertinent data from local and regional water supply plans. This state-wide cumulative impact analysis of the future demands projected by the planning localities indicates that 97% of the 2040 surface water demand of nearly 1.5 billion gallons per day is projected to come from 25% of the stream reaches that were analyzed by model simulation.
- The SWRP analysis also indicated that 23% of the 2040 demand (445 mgd) is expected to come from groundwater resources. This demand is equivalent to approximately 300 mgd of new groundwater withdrawals across the Commonwealth, relative to average 2009-2013 withdrawal totals. Seventy-five percent of the 2040 groundwater demand (334 mgd) is projected to be needed outside current Groundwater Management Areas.
- The SWRP analyses indicate that, in certain watersheds, water may not be available for new and expanded uses during drought events. DEQ anticipates the need for increased storage and the expanded use of conjunctive systems and wastewater reuse projects to meet future water demands in some areas of the Commonwealth. Limitations in the accuracy of current un-metered water use reporting may require future programmatic changes to adequately account for water use and availability.

WATER RESOURCE MANAGEMENT OPPORTUNITIES - Based on the observed water resource management signals mentioned in the previous section, DEQ has undertaken the following initiatives for sustainable water resource management. Several of these initiatives involve opportunities for collaboration with local, state, federal, and non-profit organizations as well as trade industry groups to increase understanding of the Commonwealth's water resources so that water can be supplied sustainably for all beneficial uses:

- As part of the preparation of the SWRP, DEQ constructed a relational database to compile, organize and analyze the data submitted with the Local and Regional Water Supply Plans. This database, which includes information describing thousands of community water systems and self-supplied facilities, will be used to further refine the SWRP and to support future analyses that guide future water resource management decisions.
- During early 2014, a series of meetings and workshops were held in the expanded Eastern Virginia GWMA to explain the groundwater permitting regulation and to discuss the permitting process and related administrative and technical requirements with prospective permit applicants.
- Updated groundwater simulation models are in place now to provide assistance with permitting analyses in both the expanded Eastern Virginia GWMA and the Eastern Shore GWMA. These models are being used to evaluate the potential impacts of groundwater withdrawal projects and to assess resource sustainability. These evaluations can also assist with the determination of appropriate permit monitoring conditions.
- Significant data gaps continue to exist in the State Observation Well Network west of the fall line and in Virginia's Northern Neck. DEQ collaboratively works with local governments to identify existing wells that meet established criteria for inclusion in the network. Some of these wells that have been converted to observation wells allow for the collection of depth integrated hydraulic head values in complex fractured rock and karst groundwater systems of the Blue Ridge and Valley and Ridge physiographic provinces. By obtaining information about the vertical and temporal distribution of isolated hydraulic head values in representative crystalline rock and karst environments, a unique opportunity is created for studying the response of these stratified system components to groundwater inputs and outputs (*i.e.* precipitation, evapotranspiration, pumping, and stream base flow).
- In cooperation with biologists and hydrologists from Virginia Tech, OWS has recently completed a project to collect historical aquatic habitat relationships in the form of Weighted Usable Area (WUA) tables from all Instream Flow Incremental Methodology (IFIM) studies completed throughout the Commonwealth of Virginia. These studies provide quantitative information about historic or current habitat conditions for aquatic organisms. In all, eight IFIM studies carried out between 1981and 2012 in the Commonwealth of Virginia were reviewed for this project. The studies represent 400 river miles and span the Valley and Ridge, Piedmont and Coastal Plain physiographic regions. Habitat maps for thirty three different species of fish were evaluated, nine habitat guilds, and macroinvertebrates and mussels. The objective of this project was to establish a general repository for these time- and data-intensive studies in a form readily available for analysis. Creating this repository enhances DEQ's ability to quantify ecological needs in future water supply permitting and planning in Virginia, by enabling OWS staff to: 1) use flow:habitat and

flow:ecology data sets to better understand critical habitat and flow needs; 2) investigate the potential link between critical habitat needs and flow metrics; 3) permit estimation of habitat impacts due to expected flow alterations; and 4) explore the potential for estimating critical flows for habitat preservation in stream reaches without IFIM studies.

- DEQ and USGS are in the process of documenting and publishing a report describing a new statistical tool to predict summer low flows in major streams with long-term gauging stations. This tool will be used as a forecasting tool to recognize the onset of drought conditions before they occur so that effective cooperative efforts between water users and water managers can begin prior to the onset of a drought.
- DEQ and USGS are also collaborating on a project to identify and design an optimal network to monitor lateral and vertical saltwater intrusion within the coastal plain aquifer system.
- The Virginia Ambient Groundwater Monitoring Strategy document was developed in November 2013 (DEQ, 2013a). This document describes the current coverage of ambient (background) groundwater quality samples taken in Virginia and presents a strategy for collecting ambient groundwater quality data for the purpose of describing the current geochemical composition of groundwater throughout Virginia. The current plan for implementation of the Strategy is described in the FY 2014 Ambient Groundwater Quality Sampling Implementation Plan for Fiscal Year 2014 (DEQ, 2013b). Both documents can be downloaded from the GWCP Reports and Publications webpage.

WATER RESOURCE MANAGEMENT INVESTMENT CHALLENGES -

To effectively manage water resources for current and future generations, continued financial investment is necessary for responsible management, policy development and implementation, and improved local government and public participation:

- The number of long term monitoring data stations for surface water flow, groundwater levels, and water resource use has consistently declined over the last twenty years. Federal funding cuts have recently resulted in the elimination of several important stations in Virginia. Sustained funding to support surface water flow and groundwater level data collection and analysis is essential to accurately account for the Commonwealth's water resources. Such surface and groundwater data are an integral part of many DEQ programs including numerous permitting programs, establishment of total maximum daily loads (TMDLs), water supply planning, and overall resource characterization.
- Investment in regional water supply program implementation is necessary to build long-term local government stewardship of local and regional water resources. A secure source of funding for planning grants to local governments

is a fundamental element to the success of the State Water Resources Plan implementation and long-term plan maintenance.

- An estimated 20,000 wells are drilled in Virginia each year by approximately 400 water well drillers. Resources required to obtain well location (latitude/longitude to sub meter accuracy) and enter well construction information into a geo-referenced database have historically not been available. Members of the Virginia Water Well Association have expressed interest in implementing a grass roots program to obtain sub-meter coordinates at the time the well is drilled, as well as entering construction information into a data base that can be made available to resource managers. Funding is required to obtain commercially available hardware, software, and Global Positioning System units for distribution to water well contractors cooperating with the Commonwealth to obtain well locations and other information used by groundwater resource managers.
- Water well construction information is vital for understanding and describing local and regional groundwater systems. DEQ maintains a GIS database of historic well construction records. Each record describes in varying detail the location and physical properties of the well and the water-bearing properties of the geologic material in which the well is completed. These well records include information from the SWCB, DEQ, USGS, VDGMR, VDH, county governments, and well drillers. Currently, the well construction database houses well construction and location data for approximately 57,000 wells state wide. There are, however, a significant number of historic legacy well files that remain to be entered into the database. These records are located within the files of local health departments and more resources are needed to acquire and enter these data into the database.
- Estimates of public supply-related consumptive use can vary significantly depending upon whether wastewater is returned to the source stream or transported to another basin or stream within the same basin. Domestic consumptive use also varies greatly with the types of end users and with weather patterns and time of year. Recent estimates of summertime public-supply related consumptive use in Ohio, Indiana and Wisconsin ranged from 16 to 20 percent of withdrawals. Without specific information about the types and distribution of end users, however, estimates of consumptive use from public-supply withdrawals can be very uncertain. Given this uncertainty, changes in statutory or regulatory authority may be needed in the future to enable DEQ to better characterize consumptive losses.

VIII. REFERENCES CITED

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APPENDICES

Appendix 1: Virginia's Water Resources Data

State Population (2012 estimate from U.S. Census Bureau) – 8.186 million

State Surface Area – 40,746 square miles (excluding Chesapeake Bay)

Major River Basins (with Current Estimates of Annual Mean River Flow):

Big Sandy (998 square miles, 652 MGD)

Chowan River/Albemarle Sound (4,220 square miles, 1,724 MGD)

Eastern Shore (787 square miles, no large river)

James (10,265 square miles, 5,437 MGD)

New (3,068 square miles, 3,229 MGD)

Rappahannock (2,712 square miles, 1,085 MGD)

Roanoke (6,393 square miles, 4955 MGD)

Shenandoah/Lower Potomac (5681 square miles, 1842 MGD)

Small Coastal (814 square miles, 97 MGD)

Tennessee (3134 square miles, 2,334 MGD)

York (2,674 square miles, 1,053 MGD)

Perennial River Miles (freshwater) - 52,232 miles

Publicly Owned Lakes and Reservoirs

Larger than 5,000 acres	5	109,838 acres
Smaller than 5,000 acres	243	52,392 acres
Total	248	162,230 acres

Freshwater Wetlands - 808,000 acres

Tidal and Coastal Wetlands - 236,900 acres

Estuary - 2,308 Square Miles

Atlantic Ocean Coastline - 120 Miles

State-wide Average Annual Rainfall – 42.9 inches

Average Freshwater Discharge of All Rivers - Approximately 22.5 billion gallons per day

Average Freshwater Discharge into the Chesapeake Bay – Approximately 9.5 billion gallons per day

Appendix 2: Drought Monitoring Task Force Report

VIRGINIA DROUGHT MONITORING TASK FORCE
Drought Status Report
August, 2014

Normal to above normal precipitation amounts fell across most of Virginia during July and early August 2014. Stream flows and groundwater level hydrologic drought indicators across the Commonwealth are also currently in the normal to above normal range.

Estimates of precipitation as a percent of normal rainfall indicate that the dry conditions previously prevalent in southwestern Virginia ended over the last 30 days. Relatively small areas of less than normal rainfall over the past month exist in the Upper James River Basin, parts of the Chowan River basin and in the northern part of the Coastal Plain (Appendix A, page 13). Precipitation totals since the beginning of the current water year (October 1, 2013) are now at or above normal ranges across most of Virginia, except for parts of the Upper James River and Shenandoah River basins. Precipitation estimates based on radar in parts of northwestern Virginia along the Virginia-West Virginia border (pages 13 and 14) are generally considered to be underestimated due to that area's distance from radar stations.

The most recent U.S. Drought Monitor web pages indicate that abnormally dry conditions exist across approximately 12% of Virginia and no areas are mapped as Moderate Drought (D1). The areas previously mapped as abnormally dry in southwestern Virginia have receded and now cover two smaller areas of that region (Appendix B, page 15). The National Weather Service outlooks for the next 8-14 day, one month and three month periods, as well as the NOAA Seasonal Drought Outlook for the period through October 2014, do not indicate a high probability for an extension of dry conditions across Virginia.

Reports from the Climatology Office at the University of Virginia, the United States Geological Survey (USGS), the Virginia Department of Environmental Quality (VDEQ), the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Health, Office of Drinking Water follow below. The VDEQ report is a listing of recent conditions at the 4 major drought indicator reservoirs.

The next meeting of the Virginia Drought Monitoring Task Force is scheduled for Thursday, October 9, 2014 from 1:30 pm to 2:30 pm.

Report from the Climatology Office at the University of Virginia
August 14, 2014

Largely due to frontal activity, rainfall totals across most of the Commonwealth have been in the normal range or above for the first half of August, including the New River and Roanoke Drought Regions, with two to three times normal for the period. Only the Chowan region fell appreciably below normal (Appendix C, page 16).

For the most part, rainfall during July was the result of scattered thunderstorm activity, with large portions of the state receiving less than 75 percent of normal for the month. Many smaller areas received significantly less, leading to some (primarily short-term) moisture shortages. On average, however, only two regions (Upper James and Eastern Shore) have averaged less than 90% for the summer so far.

Rainfall totals since the beginning of the growing season have been in the 90-plus percent of normal range for all regions. Nonetheless, summer is typically the time for high moisture losses due to direct evaporation and uptake from plants.

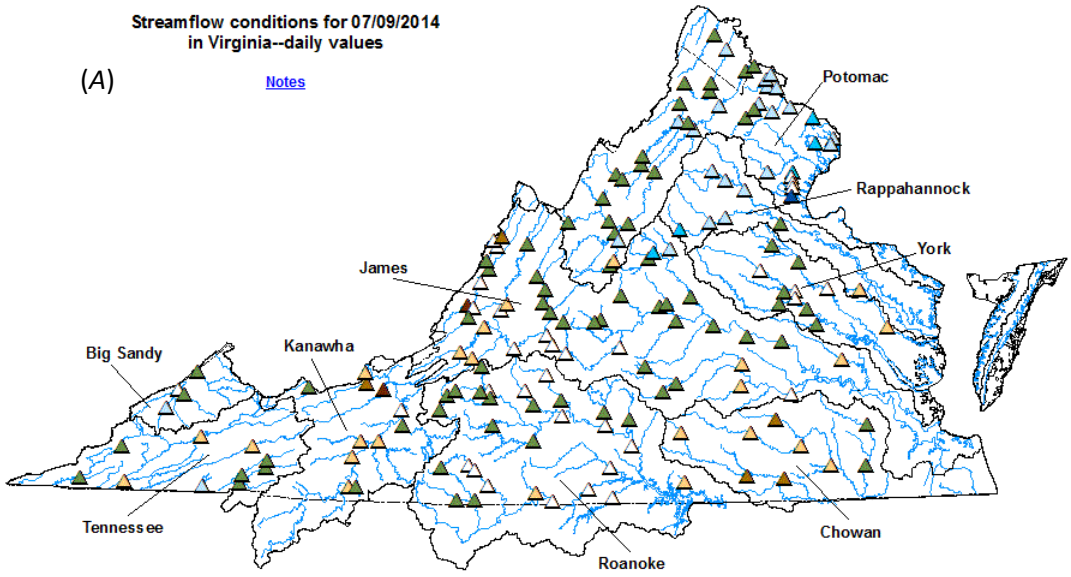
Thunderstorm activity will likely remain the primary source of moisture through the summer, and those locations missed by these systems may well see some shortages, particularly in the short-term, which can be problematic, particularly for agricultural interests.

Tropical cyclone activity has not been a significant factor as of yet, but as we get further into the hurricane season, the likelihood of receiving significant moisture across a large portion of the Commonwealth from tropical systems and their remnants is increasing. This could result in a rapid improvement for those drier areas of Virginia.

U.S. Geological Survey
August 14, 2014

Streamflow conditions continue to be in the normal to above normal percentiles across Virginia (fig. 1). A similar pattern is evident in streamflow drought conditions where short- and long-duration conditions are absent, except in the Upper James River Basin where precipitation has been just below normal in the Maury River Basin (fig 2).

Groundwater conditions are in the normal to above normal percentile classes across the Commonwealth (fig. 3). Water levels in a majority of the observation wells have reached the seasonal high and are following the normal summer/autumn recession (fig. 4). Normal to above normal percentile classes occur in all of the wells (table 1) in the Virginia Climate Response Network (http://groundwaterwatch.usgs.gov/NetMapT1L2.asp?ncd=crn&sc=51).



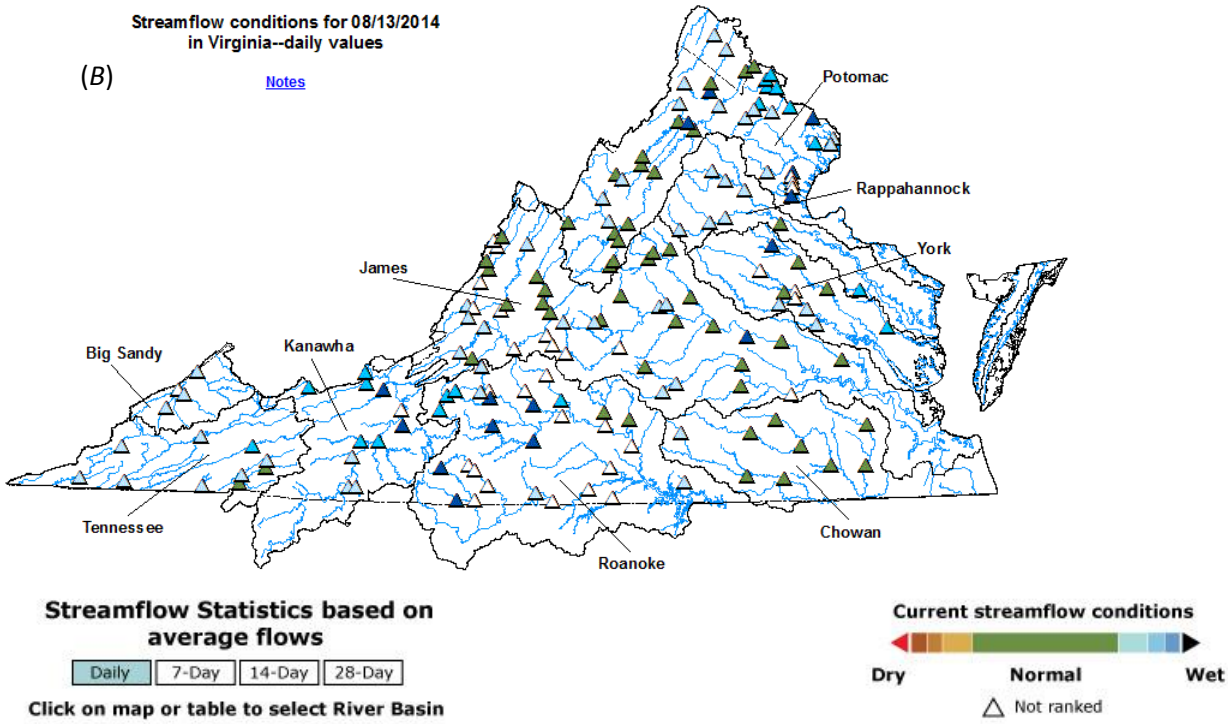


Figure 1. Streamflow conditions for (A) July 9, 2014 and (B) August 13, 2014 in Virginia.

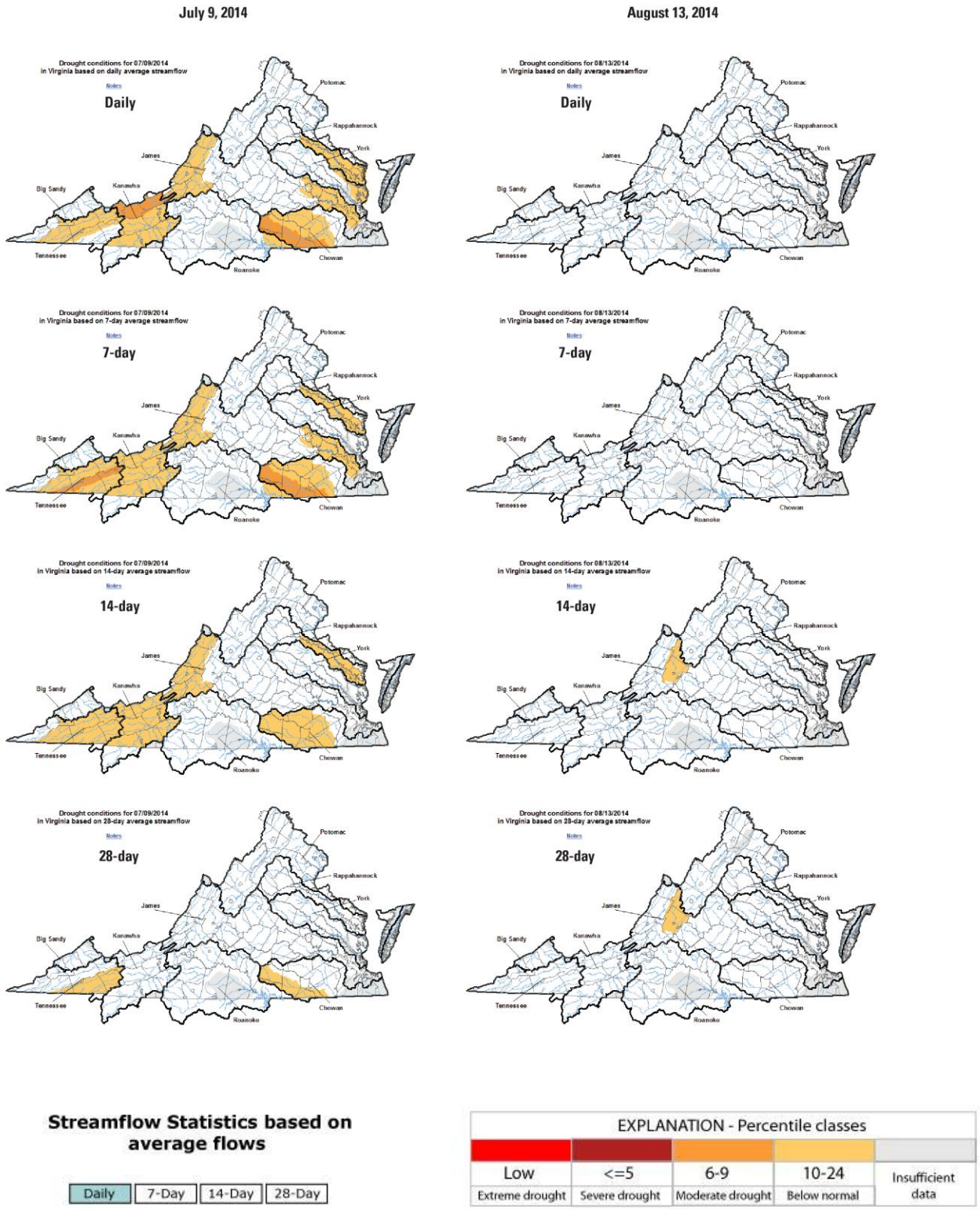


Figure 2. Comparison of drought conditions in Virginia based on daily, 7-, 14-, and 28-day average streamflows referenced to July 9, 2014 and August 13, 2014.

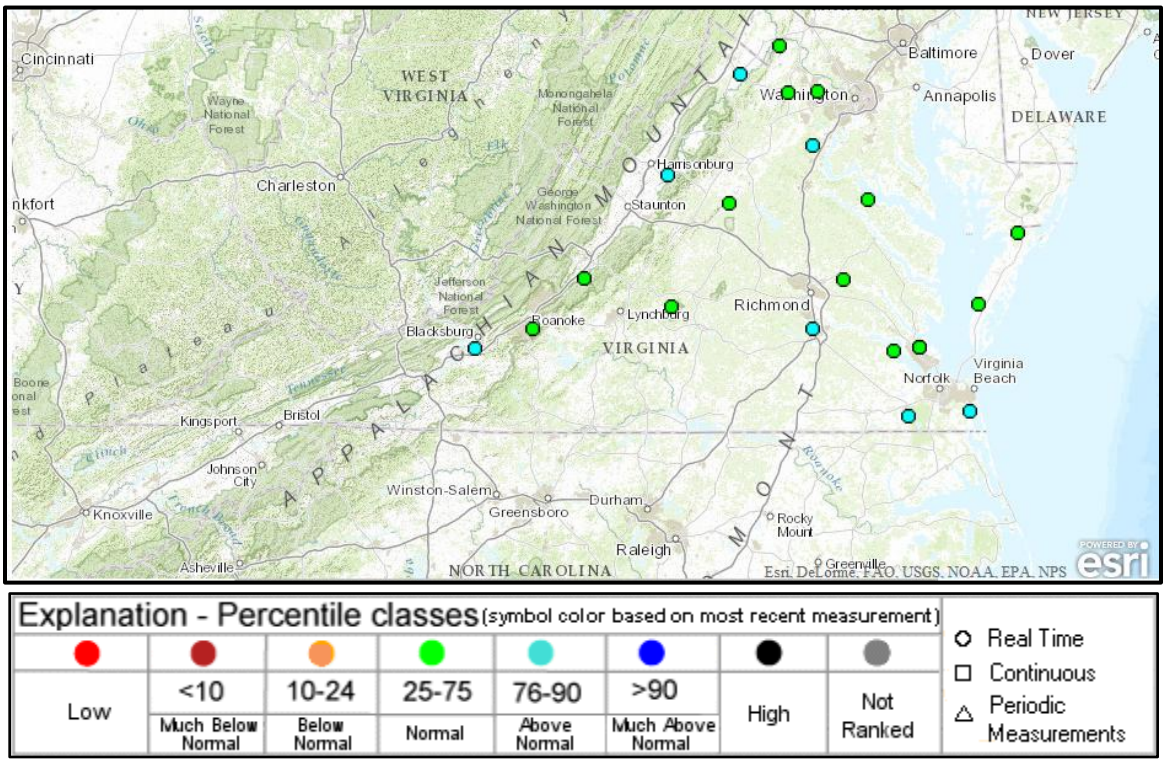


Figure 3. Groundwater-level conditions from the Virginia Climate Response Network for August 13, 2014 in Virginia. http://groundwaterwatch.usgs.gov/NetMapT1L2.asp?ncd=crn&sc=51

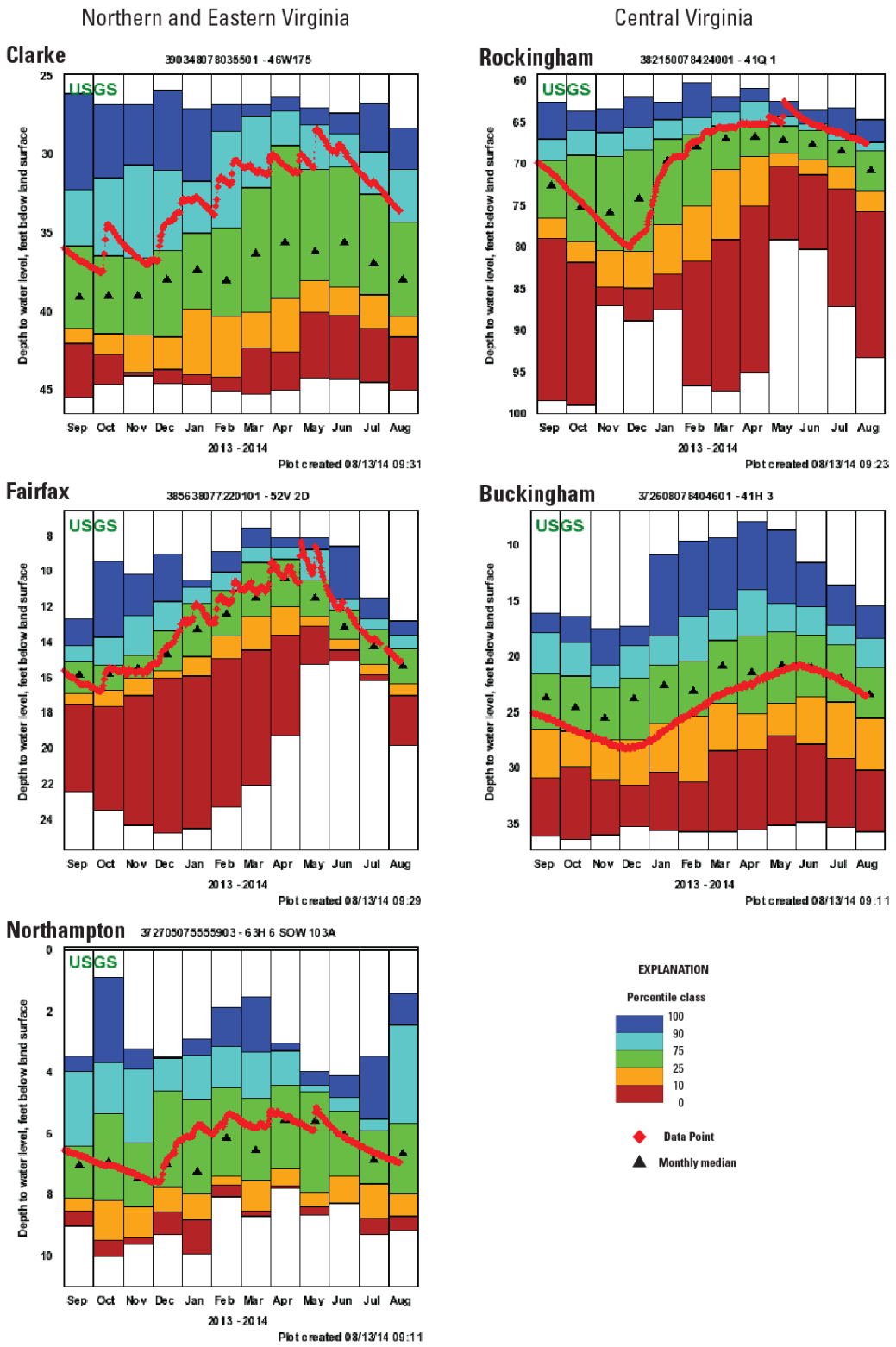


Figure 4. Hydrographs from selected wells showing groundwater levels in in Virginia from September 1, 2013 to present.

Table 1. Current percentile classes for groundwater levels in the Virginia Climate Response Network (VA-CRN), August 13, 2014.

[Groundwater levels are classified as normal between the 25th and 75th percentiles. Site names in red are shown on figure 4.]

Map index	Site ID	Site name	11-Dec-13	12-Mar-14	14-May-14	9-Jul-14	13-Aug-14
1	363928076332901	58B 13	75-90	75-90	>90	50-75	75-90
2	364126076003501	62B 1 SOW 098A	75-90	>90	75-90	50-75	75-90
3	370712076413203	57E 13 SOW 094C	75-90	75-90	75-90	50-75	25-50
4	370812080261901	27F 2 SOW 019	75-90	75-90	50-75	25-50	75-90
5	370841076275204	59F 74 SOW 184C	50-75	25-50	25-50	50-75	25-50
6	371644077244601	51G 1	50-75	50-75	50-75	50-75	75-90
7	371653079552101	31G 1 SOW 008	25-50	25-50	<10	10-25	50-75
8	372608078404601	41H 3	10-25	25-50	25-50	50-75	25-50
9	372705075555903	63H 6 SOW 103A	25-50	50-75	25-50	50-75	25-50
10	373737077083201	53K 19 SOW 080	50-75	50-75	75-90	50-75	50-75
11	373758079271601	35K 1 SOW 063	50-75	75-90	50-75	50-75	25-50
12	375723075344404	66M 19 SOW 110S	50-75	50-75	75-90	75-90	50-75
13	381002078094201	45P 1 SOW 030	50-75	50-75	75-90	75-90	50-75
14	381132076551001	55P 9	25-50	>90	75-90	50-75	25-50
15	382150078424001	41Q 1	25-50	50-75	75-90	>90	75-90
16	383423077245901	51S 7	25-50	50-75	>90	75-90	75-90
17	385607077381101	49V 1	75-90	50-75	50-75	50-75	50-75
18	385638077220101	52V 2D	50-75	50-75	75-90	50-75	50-75
19	390348078035501	46W175	75-90	75-90	75-90	75-90	75-90
20	391542077423801	49Y 1 SOW 022	50-75	50-75	50-75	50-75	50-75

Virginia Department of Environmental Quality
Conditions of Major Drought Indicator Reservoirs
August, 2014

Four large multi-purpose reservoirs are identified as drought indicators in the Virginia Drought Assessment and Response Plan: Smith Mountain Lake, Lake Moomaw, Lake Anna and Kerr Reservoir. Below is a summary of reported conditions at these reservoirs in mid-August, 2014:

- **Smith Mountain Lake** was at an adjusted elevation of 795.15 ft, 0.15 ft above full pool level. The adjusted elevation is the level the lake would be if the water currently held in the lower Leesville Lake for reuse were pumped back into Smith Mountain Lake. Levels at Smith Mountain Lake have continued at or near full pool level in response to inflows generally within the normal range within the upper Roanoke River Basin.
- **Lake Moomaw** on the Jackson River was at 1572.82 feet, which is 9.18 ft below the top of the conservation pool (1582.0 feet MSL) and 7.82 ft above the Drought Watch level. Inflows to Lake Moomaw have recently decreased in response to lower summer rainfall. However, inflows have remained within the normal range.
- **Lake Anna** was at elevation 249.9 ft (1.9 ft above drought watch). The Drought Watch stage for Lake Anna Lake is elevation 248 feet and below.
- **Kerr Reservoir** was at 300.89 feet, which is 1.39 ft above the guide curve level for this time period and therefore 4.39 ft above Drought Watch status. Inflows to Kerr Reservoir have been in the normal to slightly above normal ranges.

Current water levels at Drought Indicator Reservoirs:

Reservoir Name	Date / Time	Reported Elevation (ft msl)	Drought Watch Range (ft msl)	Drought Warning Range (ft msl)	Current Guide Curve Elevation) ft msl)	Drought Evaluation Region(s) represented
Smith Mt Lake	August 14th /11:30	**795.15**	793 – 791.5	791.5 – 790.0		Roanoke River
Lake Moomaw	August 14th / 11:30	**1572.82**	1565 – 1562.5	1562.5 – 1560.0		Upper & Middle James River
Lake Anna	August 13th /	**249.9**	248 - 246	246 – 244		Northern Piedmont
Kerr Reservoir	August 15th / 0800	**300.89**	3 – 6 ft below guide curve	> 6 ft below guide curve	299.50	Roanoke River, Southeast Virginia

STATUS OF AGRICULTURAL DROUGHT
Virginia Department of Agriculture and Consumer Services
August 2014

According to the U.S. Department of Agriculture Crop Weather Report released on August 11, 2014, 71 percent of topsoil moisture ranged from adequate to surplus and 69 percent of subsoil moisture ranged from adequate to surplus. The majority of the state's corn and soybean crops are in good to excellent condition. Parts of the state are still in need of rain.

Northern Virginia

Northeastern Virginia

Fruit and vegetable harvest is underway and most producers report that the quality is generally good, moisture conditions are adequate, and irrigation sources are in good shape. In some northern parts of the region, soil moisture was low during July 2014, which negatively impacted corn growth.

Northwestern Virginia

Conditions are dry and crops are beginning to show signs of stress; however, damage is minimal at this time. Some producers report that the dry conditions are negatively impacting fruit size. Farm ponds and streams are very low.

Southern Virginia

Southside

Below average rainfall has increased the horticulture industry's use of irrigation. Corn crops suffered irreparable damage from the dry conditions. Recent rain helped other crops that were showing signs of moisture stress. Tobacco producers anticipate above-average yields for the year.

Southwestern Virginia

The below average rainfall has significantly decreased hay yields and available grazing pastures and has increased the horticulture industry's use of irrigation. The rain received during August 8 - 10, 2014, helped the sweet corn and pumpkin crops, which are in their growth stage.

Southeastern Virginia

Both crops and soil moisture in Southeastern Virginia are in good shape.

Central Virginia

Some areas continue to experience dry conditions, while other areas report adequate soil moisture.

Eastern Virginia

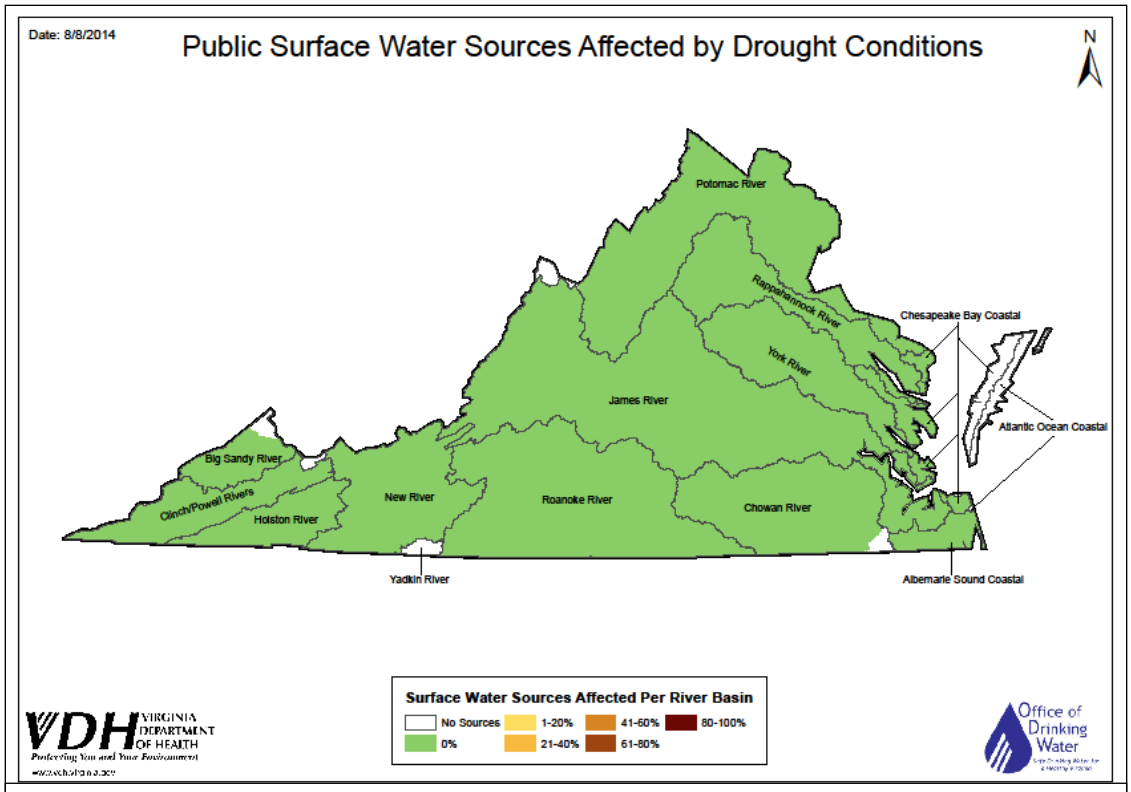
Crops look good across Eastern Virginia, which has adequate moisture at this point.

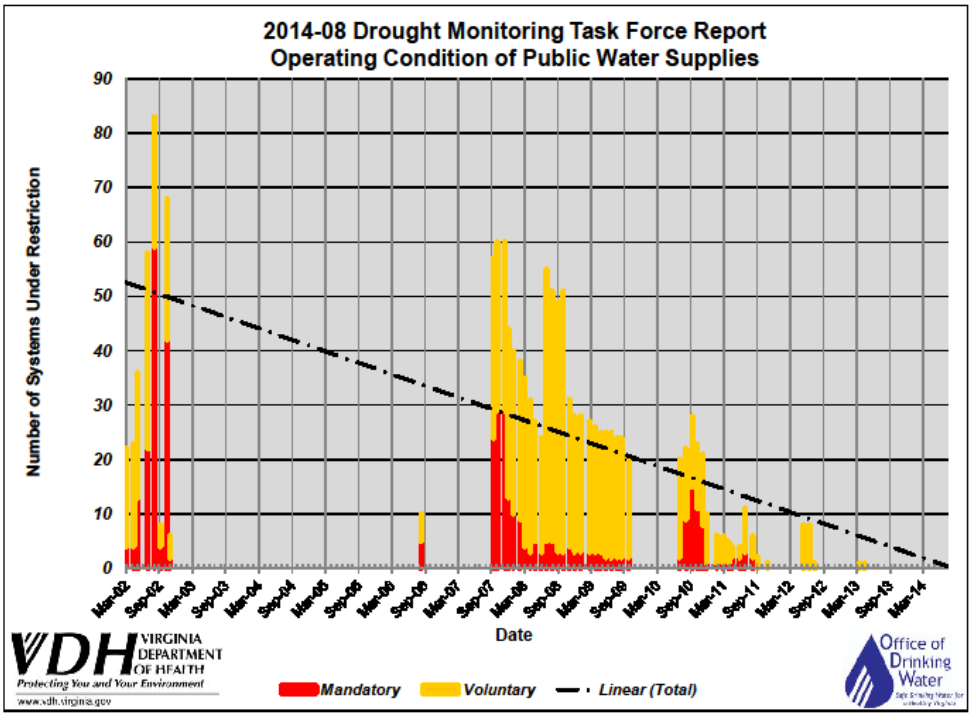
Virginia Department of Health, Office of Drinking Water
August 2014

ODW's DMTF Latest Report

As of August, 2014, there are no Public Drinking Water Systems operating under voluntary or mandatory water use restrictions in Virginia. However, the High Country Horse Camp (PWSID 1173265) closed because their well went dry. This was a shallow well with a depth of approximately 80 feet. It is unclear if the situation is a result of abnormally dry conditions in Smyth County.

ODW's Drought Monitoring map and trend are illustrated below. The first map reflects the percentage of public surface water sources operating under drought restrictions within the main river basins of Virginia. The trend chart below shows the amount of waterworks that have been affected by drought conditions since March, 2002.

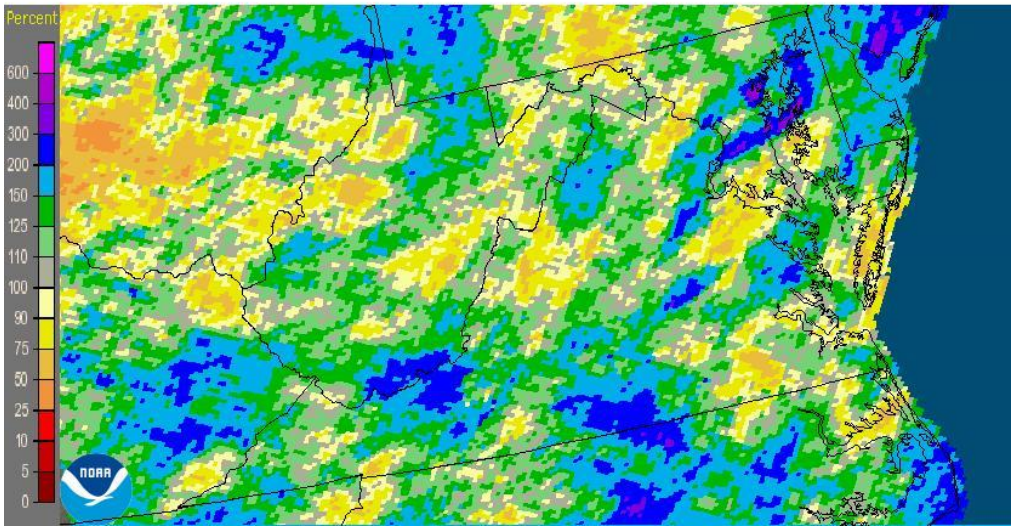

Date: 8/8/2014
Public Surface Water Sources Affected by Drought Conditions
N
Potomac River
Rappahannock River
York River
James River
Chesapeake Bay Coastal
Atlantic Ocean Coastal
Big Sandy River
Clinch/Powell Rivers
Holston River
New River
Roanoke River
Chowan River
Yadkin River
Albemarle Sound Coastal
Surface Water Sources Affected Per River Basin
No Sources
0%
1-20%
21-40%
41-60%
61-80%
80-100%
VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment
Office of Drinking Water


2014-08 Drought Monitoring Task Force Report
Operating Condition of Public Water Supplies
Number of Systems Under Restriction
0
10
20
30
40
50
60
70
80
90
Mar-02
Sep-02
Mar-03
Sep-03
Mar-04
Sep-04
Mar-05
Sep-05
Mar-06
Sep-06
Mar-07
Sep-07
Mar-08
Sep-08
Mar-09
Sep-09
Mar-10
Sep-10
Mar-11
Sep-11
Mar-12
Sep-12
Mar-13
Sep-13
Mar-14
Date
Mandatory
Voluntary
Linear (Total)
VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment
www.vdh.virginia.gov
Office of Drinking Water

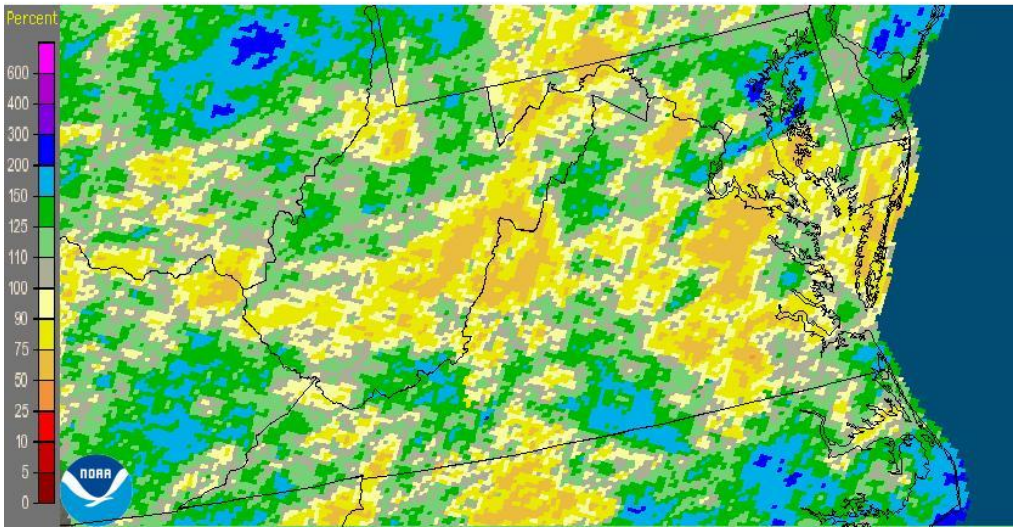
APPENDIX A

30 & 60-Day Percent of Normal Precipitation (accessed from http://water.weather.gov/precip/)

Virginia: Current 30-Day Percent of Normal Precipitation
Valid at 8/14/2014 1200 UTC- Created 8/14/14 16:21 UTC

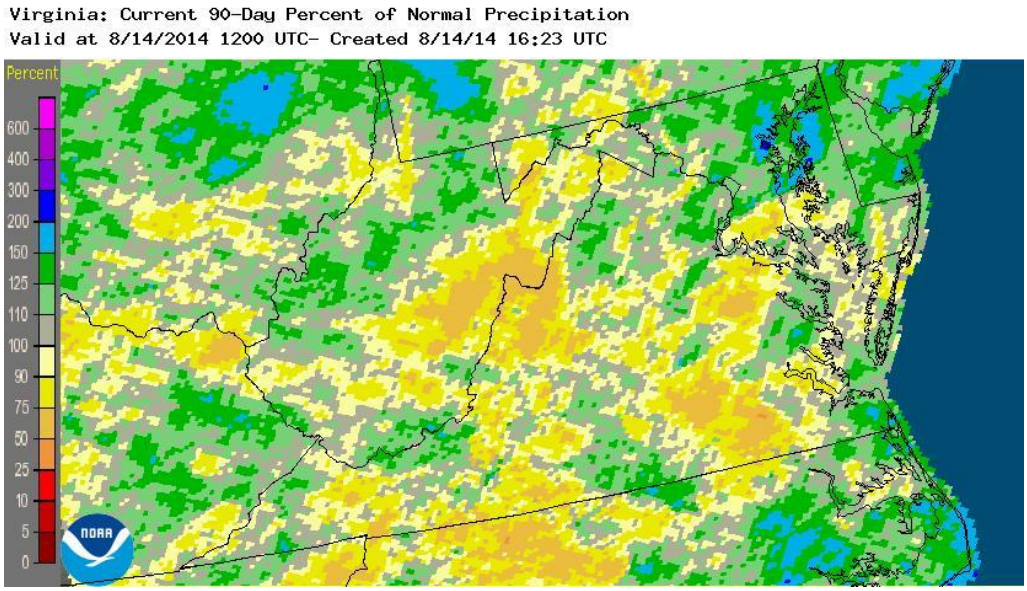


Virginia: Current 60-Day Percent of Normal Precipitation
Valid at 8/14/2014 1200 UTC- Created 8/14/14 16:22 UTC

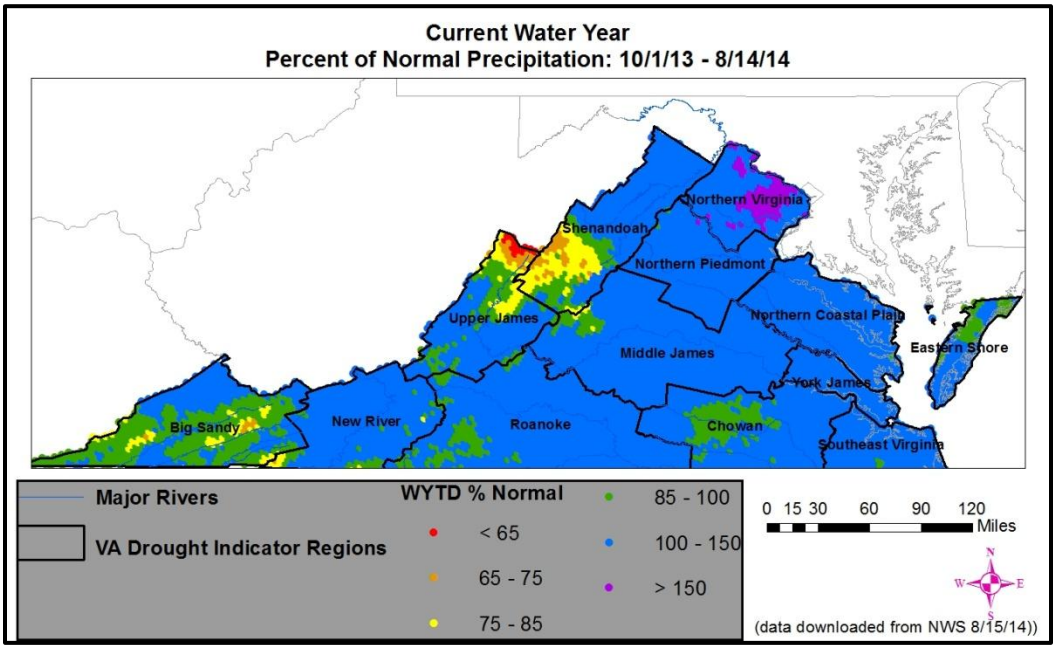


APPENDIX A (continued)

90-Day & (accessed from http://water.weather.gov/precip/)



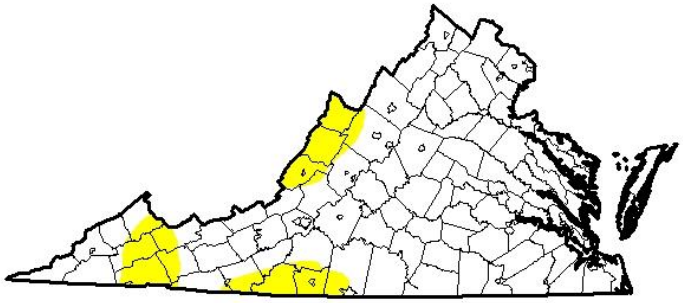
Current Water Year Percent of Normal Precipitation (data from NWS)



APPENDIX B

U.S. Drought Monitor

Virginia



August 12, 2014

(Released Thursday, Aug. 14, 2014)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	87.67	12.33	0.00	0.00	0.00	0.00
Last Week *8/5/2014*	76.74	23.26	0.00	0.00	0.00	0.00
3 Months Ago *5/13/2014*	88.99	11.01	0.00	0.00	0.00	0.00
Start of Calendar Year *12/31/2013*	99.81	0.19	0.00	0.00	0.00	0.00
Start of Water Year *10/1/2013*	69.70	30.30	0.00	0.00	0.00	0.00
One Year Ago *8/13/2013*	100.00	0.00	0.00	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Richard Tinker
CPC/NOAA/NWS/NCEP

http://droughtmonitor.unl.edu/

APPENDIX C

PRELIMINARY PRECIPITATION SUMMARY

Prepared: 8/14/14

	DROUGHT REGION	OBSERVED	Aug 1, 2014 - Aug 13, 2014 NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	2.23	1.73	0.50	129%
2	New River	4.44	1.49	2.95	297%
3	Roanoke	4.32	1.68	2.64	257%
4	Upper James	1.77	1.50	0.26	117%
5	Middle James	2.24	1.73	0.51	130%
6	Shenandoah	1.73	1.50	0.22	115%
7	Northern Virginia	2.51	1.74	0.77	144%
8	Northern Piedmont	1.88	1.73	0.15	109%
9	Chowan	1.40	1.95	-0.54	72%
10	Northern Coastal Plain	2.56	1.74	0.82	147%
11	York-James	2.14	2.20	-0.06	97%
12	Southeast Virginia	2.79	2.31	0.48	121%
13	Eastern Shore	1.94	1.75	0.19	111%
	Statewide	2.58	1.73	0.85	149%

	DROUGHT REGION	OBSERVED	Jul 1, 2014 - Aug 13, 2014 NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	7.07	6.21	0.86	114%

2	New River	7.17	5.28	1.89	136%
3	Roanoke	8.15	6.07	2.08	134%
4	Upper James	4.51	5.54	-1.03	81%
5	Middle James	5.25	6.14	-0.88	86%
6	Shenandoah	5.14	5.26	-0.13	98%
7	Northern Virginia	6.12	5.51	0.61	111%
8	Northern Piedmont	6.30	6.13	0.17	103%
9	Chowan	5.96	6.46	-0.50	92%
10	Northern Coastal Plain	7.32	6.19	1.13	118%
11	York-James	6.60	7.30	-0.70	90%
12	Southeast Virginia	10.44	7.38	3.05	141%
13	Eastern Shore	5.37	5.75	-0.38	93%
	Statewide	6.48	6.07	0.41	107%

	DROUGHT		Jun 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	10.98	10.35	0.63	106%
2	New River	9.27	9.13	0.14	101%
3	Roanoke	10.99	9.96	1.03	110%
4	Upper James	7.60	9.25	-1.66	82%
5	Middle James	9.04	9.65	-0.61	94%
6	Shenandoah	9.30	8.97	0.33	104%
7	Northern Virginia	9.75	9.37	0.38	104%
8	Northern Piedmont	10.56	10.14	0.42	104%
9	Chowan	10.41	10.11	0.31	103%

10	Northern Coastal Plain	10.89	9.75	1.13	112%
11	York-James	9.85	10.71	-0.86	92%
12	Southeast Virginia	13.90	10.99	2.91	126%
13	Eastern Shore	7.02	8.73	-1.71	80%
	Statewide	10.01	9.86	0.15	102%

	DROUGHT		May 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	14.53	15.17	-0.64	96%
2	New River	12.55	13.34	-0.79	94%
3	Roanoke	14.80	14.29	0.50	104%
4	Upper James	11.60	13.53	-1.93	86%
5	Middle James	14.22	13.89	0.33	102%
6	Shenandoah	14.07	12.81	1.25	110%
7	Northern Virginia	16.51	13.71	2.80	120%
8	Northern Piedmont	16.64	14.36	2.28	116%
9	Chowan	13.81	14.20	-0.39	97%
10	Northern Coastal Plain	13.57	13.91	-0.35	98%
11	York-James	12.78	14.98	-2.20	85%
12	Southeast Virginia	17.91	14.85	3.06	121%
13	Eastern Shore	12.23	12.25	-0.02	100%
	Statewide	14.26	14.12	0.14	101%

	DROUGHT		Apr 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	17.23	18.93	-1.70	91%
2	New River	16.32	16.89	-0.57	97%
3	Roanoke	19.79	18.09	1.70	109%
4	Upper James	15.47	16.93	-1.46	91%
5	Middle James	19.28	17.23	2.06	112%
6	Shenandoah	17.58	15.73	1.85	112%
7	Northern Virginia	21.75	17.01	4.74	128%
8	Northern Piedmont	22.12	17.65	4.48	125%
9	Chowan	18.99	17.63	1.36	108%
10	Northern Coastal Plain	19.67	17.00	2.66	116%
11	York-James	19.16	18.28	0.88	105%
12	Southeast Virginia	23.14	18.10	5.04	128%
13	Eastern Shore	16.36	15.17	1.19	108%
	Statewide	18.87	17.54	1.33	108%

	DROUGHT		Mar 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	20.42	23.18	-2.76	88%
2	New River	18.59	20.56	-1.97	90%
3	Roanoke	23.15	22.36	0.79	104%
4	Upper James	18.99	20.72	-1.73	92%
5	Middle James	22.58	21.29	1.30	106%
6	Shenandoah	20.40	18.93	1.47	108%

7	Northern Virginia	25.81	20.67	5.14	125%
8	Northern Piedmont	25.27	21.46	3.82	118%
9	Chowan	23.19	22.00	1.19	105%
10	Northern Coastal Plain	22.65	21.28	1.36	106%
11	York-James	22.52	22.97	-0.45	98%
12	Southeast Virginia	27.10	22.30	4.80	122%
13	Eastern Shore	19.76	19.48	0.28	101%
	Statewide	22.17	21.58	0.59	103%

	DROUGHT		Feb 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	23.93	26.76	-2.83	89%
2	New River	22.10	23.49	-1.39	94%
3	Roanoke	26.25	25.67	0.58	102%
4	Upper James	23.11	23.57	-0.47	98%
5	Middle James	26.08	24.41	1.67	107%
6	Shenandoah	24.03	21.34	2.69	113%
7	Northern Virginia	29.52	23.34	6.18	126%
8	Northern Piedmont	28.89	24.43	4.46	118%
9	Chowan	26.05	25.17	0.89	104%
10	Northern Coastal Plain	25.78	24.42	1.36	106%
11	York-James	24.71	26.50	-1.79	93%
12	Southeast Virginia	30.11	25.80	4.31	117%

13	Eastern Shore	22.43	22.67	-0.24	99%
	Statewide	25.55	24.71	0.84	103%

	DROUGHT		Jan 1, 2014	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	26.25	30.49	-4.24	86%
2	New River	23.72	26.70	-2.99	89%
3	Roanoke	29.47	29.59	-0.12	100%
4	Upper James	25.10	26.85	-1.75	93%
5	Middle James	29.16	28.07	1.09	104%
6	Shenandoah	25.92	24.19	1.72	107%
7	Northern Virginia	32.07	26.62	5.45	120%
8	Northern Piedmont	31.43	27.95	3.48	112%
9	Chowan	29.00	29.28	-0.28	99%
10	Northern Coastal Plain	28.63	28.17	0.45	102%
11	York-James	27.57	30.64	-3.07	90%
12	Southeast Virginia	33.49	29.96	3.53	112%
13	Eastern Shore	25.41	26.23	-0.82	97%
	Statewide	28.18	28.35	-0.17	99%

	DROUGHT		Dec 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	32.65	34.13	-1.48	96%
2	New River	28.90	29.41	-0.51	98%
3	Roanoke	35.08	32.84	2.24	107%

4	Upper James	31.39	29.80	1.59	105%
5	Middle James	35.00	31.24	3.77	112%
6	Shenandoah	31.17	26.78	4.39	116%
7	Northern Virginia	37.38	29.72	7.66	126%
8	Northern Piedmont	36.96	31.23	5.74	118%
9	Chowan	35.38	32.30	3.08	110%
10	Northern Coastal Plain	34.57	31.45	3.12	110%
11	York-James	32.97	34.03	-1.06	97%
12	Southeast Virginia	38.98	33.14	5.84	118%
13	Eastern Shore	31.34	29.47	1.87	106%
	Statewide	33.96	31.47	2.49	108%

	DROUGHT		Nov 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	36.02	37.41	-1.39	96%
2	New River	32.03	32.44	-0.42	99%
3	Roanoke	38.31	36.20	2.11	106%
4	Upper James	34.37	33.16	1.21	104%
5	Middle James	38.22	34.75	3.47	110%
6	Shenandoah	33.27	29.83	3.44	112%
7	Northern Virginia	40.12	33.13	7.00	121%
8	Northern Piedmont	39.69	35.03	4.66	113%
9	Chowan	38.36	35.41	2.96	108%

10	Northern Coastal Plain	37.62	34.59	3.02	109%
11	York-James	35.48	37.40	-1.92	95%
12	Southeast Virginia	42.03	36.21	5.82	116%
13	Eastern Shore	33.76	32.41	1.35	104%
	Statewide	36.95	34.70	2.25	106%

	DROUGHT		Oct 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	37.38	40.29	-2.91	93%
2	New River	34.73	35.61	-0.89	98%
3	Roanoke	40.60	39.91	0.69	102%
4	Upper James	36.45	36.41	0.03	100%
5	Middle James	41.47	38.59	2.88	107%
6	Shenandoah	38.03	33.02	5.01	115%
7	Northern Virginia	46.61	36.61	10.00	127%
8	Northern Piedmont	44.27	39.02	5.25	113%
9	Chowan	41.57	38.99	2.58	107%
10	Northern Coastal Plain	40.93	38.10	2.82	107%
11	York-James	39.87	40.93	-1.06	97%
12	Southeast Virginia	46.41	39.87	6.53	116%
13	Eastern Shore	37.75	35.62	2.13	106%
	Statewide	40.19	38.20	1.99	105%

	DROUGHT		Sep 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.

1	Big Sandy	41.04	43.75	-2.71	94%
2	New River	36.65	39.02	-2.38	94%
3	Roanoke	42.14	44.14	-2.00	95%
4	Upper James	37.84	39.91	-2.07	95%
5	Middle James	42.85	42.72	0.13	100%
6	Shenandoah	39.00	36.69	2.30	106%
7	Northern Virginia	47.92	40.68	7.24	118%
8	Northern Piedmont	45.69	43.30	2.40	106%
9	Chowan	42.72	43.42	-0.70	98%
10	Northern Coastal Plain	42.45	42.19	0.26	101%
11	York-James	40.74	45.83	-5.09	89%
12	Southeast Virginia	47.86	44.30	3.56	108%
13	Eastern Shore	39.32	39.23	0.09	100%
	Statewide	41.83	42.20	-0.37	99%

	DROUGHT		Aug 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	46.21	47.58	-1.37	97%
2	New River	39.80	42.33	-2.53	94%
3	Roanoke	46.03	47.86	-1.83	96%
4	Upper James	41.60	43.24	-1.64	96%
5	Middle James	48.41	46.54	1.87	104%
6	Shenandoah	43.25	40.02	3.22	108%

7	Northern Virginia	49.72	44.53	5.19	112%
8	Northern Piedmont	51.58	47.12	4.47	109%
9	Chowan	46.85	47.73	-0.88	98%
10	Northern Coastal Plain	47.20	46.05	1.15	102%
11	York-James	45.55	50.70	-5.15	90%
12	Southeast Virginia	52.35	49.42	2.92	106%
13	Eastern Shore	43.17	43.10	0.07	100%
	Statewide	46.23	46.03	0.20	100%

	DROUGHT		Jul 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	51.99	52.06	-0.07	100%
2	New River	51.25	46.12	5.12	111%
3	Roanoke	53.89	52.25	1.64	103%
4	Upper James	48.14	47.28	0.85	102%
5	Middle James	54.63	50.95	3.68	107%
6	Shenandoah	47.42	43.78	3.63	108%
7	Northern Virginia	54.63	48.30	6.33	113%
8	Northern Piedmont	55.88	51.52	4.36	108%
9	Chowan	53.76	52.24	1.53	103%
10	Northern Coastal Plain	51.47	50.50	0.96	102%
11	York-James	51.44	55.80	-4.36	92%
12	Southeast Virginia	58.11	54.49	3.61	107%
13	Eastern Shore	47.56	47.10	0.46	101%
	Statewide	52.58	50.37	2.21	104%

	DROUGHT		Jun 1, 2013	- Aug 13, 2014	
	REGION	OBSERVED	NORMAL	DEPARTURE	% OF NORM.
1	Big Sandy	58.20	56.20	2.00	104%
2	New River	58.36	49.97	8.38	117%
3	Roanoke	60.79	56.14	4.65	108%
4	Upper James	54.55	50.99	3.55	107%
5	Middle James	62.39	54.46	7.93	115%
6	Shenandoah	53.54	47.49	6.05	113%
7	Northern Virginia	61.17	52.16	9.01	117%
8	Northern Piedmont	62.82	55.53	7.29	113%
9	Chowan	62.06	55.89	6.17	111%
10	Northern Coastal Plain	58.92	54.06	4.86	109%
11	York-James	59.10	59.21	-0.11	100%
12	Southeast Virginia	63.28	58.10	5.17	109%
13	Eastern Shore	52.59	50.08	2.51	105%
	Statewide	59.54	54.16	5.38	110%

Appendix 3: Top 20 Water Withdrawal Systems in 2013 (Non-Power Generation)

Owner	System	Category*	Total (MGD)
HONEYWELL INTERNATIONAL INC	HOPEWELL PLANT	MAN	108.3
FAIRFAX COUNTY WATER AUTHORITY	POTOMAC RIVER WTP	PWS	84.4
NORFOLK, CITY OF	NORFOLK	PWS	60.7
FAIRFAX COUNTY WATER AUTHORITY	OCCOQUAN RESERVOIR	PWS	59.6
RICHMOND, CITY OF	RICHMOND (CITY) WTP	PWS	58.5
CELANESE ACETATE LLC	CELCO PLANT	MAN	57.8
NEWPORT NEWS, CITY OF	NEWPORT NEWS	PWS	57.3
MEADWESTVACO CORPORATION	COVINGTON PLANT	MAN	38.6
APPOMATTOX RIVER WATER AUTHORITY	LAKE CHESDIN WTP	PWS	30.2
CITY OF PORTSMOUTH	PORTSMOUTH	PWS	29.6
VIRGINIA BEACH, CITY OF	VIRGINIA BEACH SERVICE AREA	PWS	28.7
DUPONT E I DE NEMOURS & CO	SPRUANCE PLANT	MAN	28.5
HENRICO COUNTY	HENRICO COUNTY WTP	PWS	23.7
ROCK-TENN CP, LLC	WEST POINT PLANT	MAN	19.6
VIRGINIA AMERICAN WATER CO	HOPEWELL DISTRICT	PWS	19.3
UNITED STATES GOVERNMENT	RADFORD AMMUNITIONS WTP 1	MAN	18.7
WESTERN VIRGINIA WATER AUTHORITY	ROANOKE CITY	PWS	15.0
INTERNATIONAL PAPER CORP	FRANKLIN PLANT	MAN	14.9
GP BIG ISLAND, LLC	BIG ISLAND PLANT	MAN	14.1
CITY OF MANASSAS	MANASSAS	PWS	13.4
		TOTAL	780.9

***Category: MAN= Manufacturing, PWS= Public Water Supply**

Appendix 4: Water Transfers in the VWUDS Database

Water use is tracked in the VWUDS database by recording different actions: WL = withdrawal, RL = release, DL = delivery, SR = System Release, and SD = System Delivery. Withdrawals from a water source (groundwater or surface water), in general, account for the largest portion of a locality's actual water use. Some users, however, buy water from another entity and record the amounts in the database as deliveries (DL). Other users sell water to another entity and record the water sold as releases (RL). Some users record both deliveries and releases along with their withdrawals. For the purposes of this report, transfers are defined as releases (RL) and deliveries (DL) between different owners or water systems. System release (SR) records contain data regarding the amounts of water released from a water treatment facility to a service area within a particular water system. System delivery (SD) records contain data about water received within a particular service area from, for example, a water treatment facility. Some entities report withdrawals, releases (sales) to outside customers, deliveries (purchases) of water from another outside customer, as well as system releases and deliveries within their own water treatment and distribution system.

Currently, not all water transfers are consistently reported to the VWUDS database. For example, in several instances, there are localities who have reported water releases (RL), but there are no corresponding data indicating the water has been received and used by another locality (DL). Or, some entities reportedly sell water (RL), but have no reported means of receiving water (WL or DL or SR).