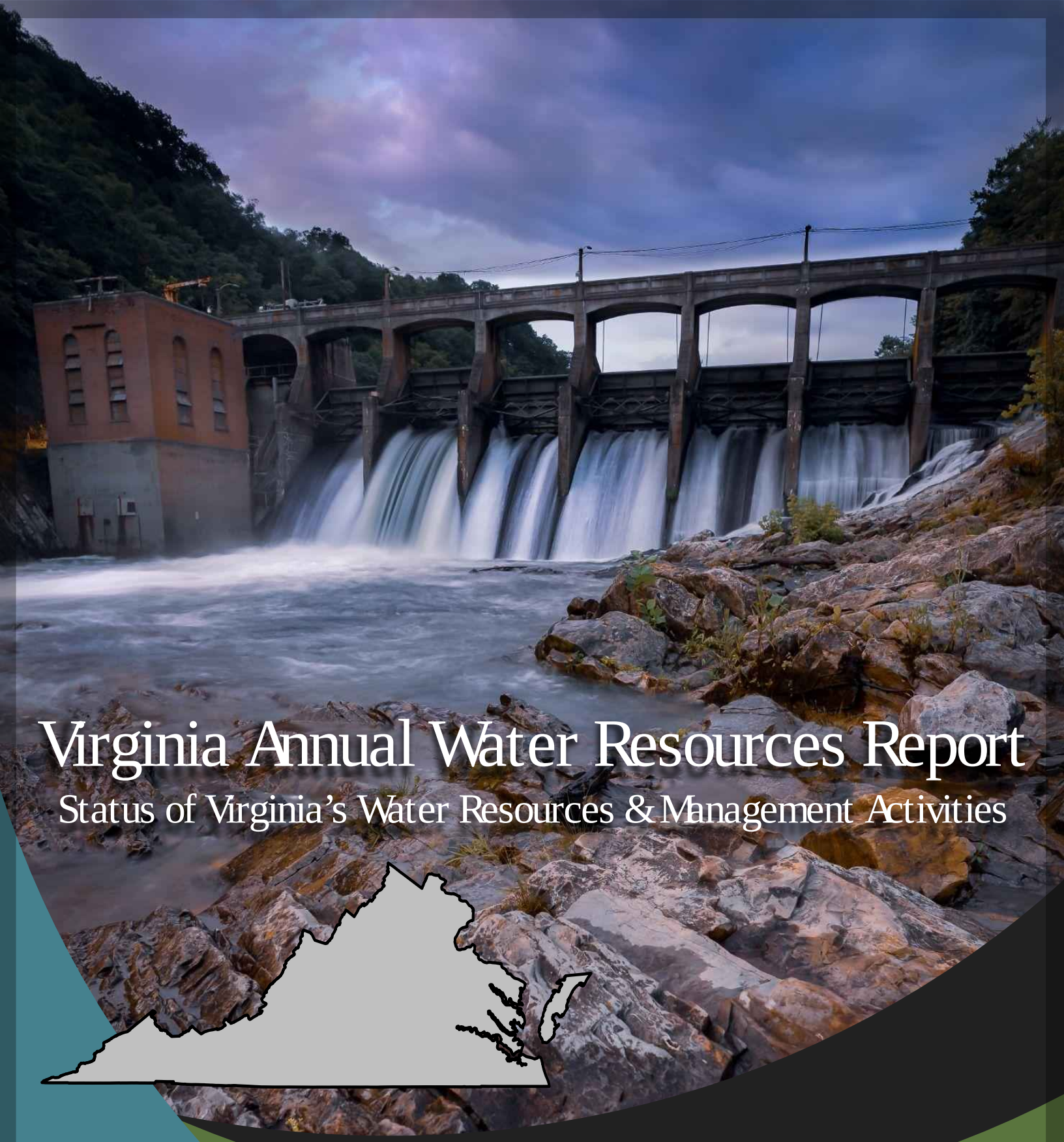

Virginia Annual Water Resources Report

Status of Virginia's Water Resources & Management Activities

Virginia Department of Environmental Quality

Commonwealth of Virginia

December 2023

DEQ
Virginia Department of Environmental Quality

Annual Water Resources Report cover photo by Trevor Lawson, 2021.

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Acronyms

BGD: Billion Gallons per Day
BGY: Billion Gallons per Year
BSE: Virginia Tech Biological Systems Engineering
CIA: Cumulative Impact Analysis
CSO: Consent Special Order
DEQ: Virginia Department of Environmental Quality
EPA: Environmental Protection Agency
FERC: Federal Energy Regulatory Commission
GPD: Gallons per Day
GW: Groundwater
GCMP: Groundwater Characterization and Monitoring Program
GWMA: Groundwater Management Area
HRSD: Hampton Roads Sanitation District
ICPRB: Interstate Commission on the Potomac River Basin
IFIM: Instream Flow Incremental Method
JPA: Joint Permit Application
MGD: Million Gallons per Day
NPDES: National Pollutant Discharge Elimination System
NWIS: USGS National Water Information System
ORM: Office of Regulatory Management
OWS: Office of Water Supply
PDC: Planning District Commission
PEEP: Permitting Evaluation and Enhancement Platform
PWS: Public Water Supply
RAP: Regulatory Advisory Panel
SW: Surface Water
SWCB or Board: State Water Control Board
SWIFT: Sustainable Water Initiative for Tomorrow
SWIP: Surface Water Investigations Program
USACE: United States Army Corps of Engineers
USDA: United States Department of Agriculture
USGS: United States Geological Survey
VDH: Virginia Department of Health
VGIN: Virginia Geographic Information Network
VMRC: Virginia Marine Resources Commission
VWP: Virginia Water Protection (Permit Program)
WSP: Water Supply Plan
WSPA: Water Supply Planning & Analysis
WTP: Water Treatment Plant
WUDR: USGS Water Use Data and Research Program
WWTP: Waste Water Treatment Plant

Executive Summary

The Virginia Annual Water Resources Report (Annual Report) is submitted in October of each year to the Governor and the Virginia General Assembly in accordance with § 62.1-44.40 of the Code of Virginia. The Annual Report focuses on water quantity and supply, summarizing reported water withdrawals for the 2022 calendar year, identifying water withdrawal trends, and providing an update on the Commonwealth's water resources management activities. Where applicable, the Annual Report also serves as a status report on activities associated with the State Water Resources Plan between five year updates. The 2020 State Water Resources Plan was released in January 2022 after completing an extensive public comment and stakeholder outreach process.

Water quality issues are addressed in the most recent biennial Water Quality Assessment Integrated Report, published by the Virginia Department of Environmental Quality (DEQ).

Chapter 1 provides an overview of water resource management activities and outcomes during 2022. This chapter discusses several DEQ programs including water withdrawal permitting and compliance, water supply planning and analysis, groundwater characterization and monitoring, surface water investigations, and drought assessment and response.

Chapter 2 provides a brief overview on how withdrawals are reported to DEQ, summarizes 2022 reported water withdrawals at the statewide level for all water use types, and compares 2022 reported withdrawals to average use over the past five years.

Chapter 3 provides an overview of water withdrawal reporting for the year 2022, as well as comparisons to reporting in recent years, for each of the following water withdrawal use categories: public water supply, commercial, manufacturing, power generation, mining, agriculture, and irrigation.

Chapter 4 identifies new, continuing, and future priorities, challenges, or other topics of specific interest for DEQ. These include updates on new legislative or regulatory actions, programmatic goals and achievements, and other items.

In addition to the main chapters, the report includes several appendices that provide: the top 20 largest reported withdrawals in 2022 (Appendix 1), reported use by locality (Appendix 2), an overview of Virginia's water resources and climatic conditions (Appendix 3), and some additional information on water transfers (Appendix 4).

Water Withdrawal Permitting;

Since January 2022, DEQ issued 91 groundwater and 19 surface water withdrawal permits.

DEQ manages groundwater withdrawal permits within the Eastern Virginia Groundwater Management Area and Eastern Shore Groundwater Management Area as well as surface water withdrawal permits statewide. A significant focus of this administration and the DEQ Director is improving permit processing timelines. DEQ's agency-wide Permitting Enhancement and Evaluation Platform (PEEP) is underway and is intended to improve efficiency and transparency throughout permitting processes and will be particularly beneficial in identifying critical path improvement for complex individual permit issuance processes. In preparation to integrate effectively into the PEEP process, DEQ's water quantity management programs are addressing a number of issues, including: incorporating program data and data management into the DEQ enterprise system, working to bring on new hires to fill vacancies, and accelerating new hire training.

DEQ continues to process a backlog of water withdrawal permit applications with 69 groundwater withdrawal and 22 surface water withdrawal applications in progress. Since January 1, 2022, DEQ has issued 91 groundwater withdrawal permits and 19 surface water withdrawal permits. Review of water withdrawal applications requires extensive inter-agency coordination and a technical evaluation by highly qualified personnel, all of which contribute to longer permit processing timelines than is typical in other DEQ permit programs. Vacancy rates within the permit program remain a consistent challenge. In the past year, all of the program's senior permit writers retired or took promotional opportunities. DEQ continues to work to fill these vacancies through continuous recruitment strategies.

Summary of 2022 Water Withdrawal Reporting and Trends:

Surface Water: Reported withdrawals increased by 2.9% compared to five-year average.

Groundwater: Reported withdrawals decreased by 1.8% compared to five-year average. Public water supply surpassed manufacturing withdrawals.

In calendar year 2022, 1,173 facilities reported water withdrawals to DEQ. Total reported withdrawals in 2022 were approximately 5.70 billion gallons per day (BGD), including the cooling water withdrawals at nuclear and fossil fuel power generation facilities, which make up 77% of this total. The 2022 total reported withdrawal is 0.8% less than the five-year average of 5.74 BGD due to a reduction in reported power generation withdrawals.

Excluding power generation, 2022 reported withdrawals totaled 1.27 BGD, a 2.4% increase compared to the five-year average. The increase over the last five years is primarily driven by increased withdrawals from public water supply facilities. Reported use for many categories dropped in 2020 due to economic and social impacts associated with the COVID-19 pandemic. While lessening impacts from COVID-19 contributed to the increase in 2022 compared to previous years, 2022 reported water use also exceeded the volumes reported prior to the pandemic.

In 2022, public water supply withdrawals increased by 5.0% to 823 million gallons per day (MGD), which is the highest reported volume since 2007 (838 MGD). Despite successes in reducing per capita water use, reported public water supply withdrawals have steadily increased over the last ten years as Virginia's population continues to grow in the urban and suburban areas served by public water supplies. Other drivers of increased reported withdrawals in 2022 were increases in irrigation, which were 4.5% higher than the five-year average. Both 2021 and 2022 featured periods of drought conditions which contributed to the increase in irrigation compared to the average.

Surface Water: Total reported surface water withdrawals excluding power generation increased by 2.9% compared to the five-year average and surface water withdrawals accounted for approximately 91% of total

reported withdrawals in 2022. Public water supply remains the largest non-power use type for surface water withdrawals with 751 million gallons per day (MGD) reported in 2022. Surface water withdrawals for public water supply increased by 5.1% compared to the five-year average. Approximately 78.5% (888.7 MGD) of 2022 reported surface water withdrawals were associated with unpermitted surface water intakes. Unpermitted surface water use is primarily from facilities that are exempt from permitting requirements.

Groundwater: In 2022, reported groundwater withdrawals were 1.8% lower than the five-year average. Groundwater withdrawals accounted for approximately 9% of total withdrawals in 2022 with 138 MGD reported. Manufacturing and industrial use has historically accounted for the largest total withdrawals for reported groundwater withdrawals. In 2022, public water supply withdrawals surpassed manufacturing for one of the first times with 58.9 MGD reported and 3.5% greater than the five-year average. Manufacturing withdrawals were comparable and decreased slightly with 57.4 MGD reported, a 2% decrease compared to the five-year average. Reported groundwater withdrawals for non-irrigation agricultural use were 15.4% higher than the five-year average. This is largely a representation of newly permitted poultry farms on the Eastern Shore reporting for the first few years. Forty-nine percent of reported groundwater withdrawals by volume were associated with unpermitted groundwater wells. Reported unpermitted groundwater use is primarily from public water supply or manufacturing facilities located outside of current groundwater management areas (GWMA).

Water Resources Priorities and Challenges:

- Water withdrawal permits are currently being incorporated into PEEP.
- DEQ completed a project to expand climate change simulation models.
- First full scale groundwater injection facility nearing completion of permitting process.

The following section summarizes several of the water resource management priorities, challenges, or other topics of specific interest that are discussed in more detail in Chapter 4. These include updates on new legislative or regulatory actions, programmatic goals and achievements, and other items.

The Permitting Enhancement and Evaluation Platform (PEEP): Will provide online public facing resources to communicate and track the critical steps to obtain permitting approvals from DEQ. Water withdrawal permitting is currently being incorporated in future PEEP updates.

Potomac River Basin Environmental Flows: In 2021, the commissioners of the Interstate Commission on the Potomac River Basin (ICPRB) passed a Resolution on Enhancing Water Supply Resilience for the Washington Metropolitan Area.

A two day workshop was convened by ICPRB in May of 2022 focusing on new approaches to determine environmental flows, and determining what data, analysis tools, and assessments are needed to make a scientifically defensible calculation. DEQ participated in the workshop which also included representatives from Maryland, West Virginia, and Pennsylvania, as well as from federal agencies such as the Army Corps of Engineers, Environmental Protection Agency (EPA), and the United States Geological Survey (USGS), among other groups. ICPRB produced a Workshop Report summarizing the results of that workshop. DEQ will continue to support this important effort to evaluate environmental flows that support all human and environmental beneficial uses of the Potomac River.

Climate Change Modeling and Drought Forecasting: To address uncertainty related to the potential for climate change to impact streamflow, DEQ developed a series of climate change scenarios that simulate how streamflow may respond to various meteorological conditions that are within a reasonable boundary based on predictions of the best available global climate models. These scenarios represent the initial effort by DEQ to address climate uncertainty related to surface water resources within the Chesapeake Bay drainage area. In 2021-2022, DEQ completed a project to expand climate change input meteorology data sets to

include rivers outside of the Chesapeake Bay watershed. In addition, this project also expanded the climate change simulation period from 10 years (1990-2000) to 1984-present. These model improvements also allow DEQ to simulate future drought conditions using the baseflow recharge expected from current conditions as a starting point, potentially allowing better predictions of the severity of a summer or fall drought when winter and spring conditions suggest the potential for one to occur.

Addressing Unreported Water Use: DEQ staff conduct compliance activities annually to identify users who meet the threshold for annual withdrawal reporting as well as to contact users who have previously reported but have failed to do so consistently. In addition, DEQ works to address known gaps in withdrawal reporting data through projects like a USGS Water Use Data and Research grant funded project to develop estimates of unreported agricultural water use in Virginia and was completed in Fall 2022.

Eastern Virginia Groundwater Management Area: One of the long-term water resource management challenges in Virginia is the historic over-allocation of groundwater from the Coastal Plain aquifer system in the Eastern Virginia Groundwater Management Area (GWMA), particularly from the Potomac Aquifer. The Hampton Roads Sanitation District's (HRSD) Sustainable Water Initiative for Tomorrow Project (SWIFT) proposes to inject treated water into the Potomac aquifer by constructing injection wells at sites across the Hampton Roads area. The first full-scale injection facility is nearing completion of the EPA Underground Injection Control Permit process for the HRSD James River Plant. Once completed, this project may be capable of injecting up to 16 MGD to augment the Potomac Aquifer.

1 2022 Water Resources Management Updates

Citizens of the Commonwealth of Virginia enjoy access to over 100,000 miles of non-tidal streams and rivers, 248 publicly-owned lakes, 236,000 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. However, an increasing population and a growing economy can present challenges for managing water resources despite the relative bounty Virginia enjoys. Virginia benefits from a robust economy and an increasing population drawn by the many opportunities available. The state's water resources are shared across a variety of beneficial uses, including in-stream uses such as recreation, navigation, habitat for wildlife, and the aesthetic value of rivers and streams, as well as off-stream uses such as supplying drinking water, agricultural, commercial, or industrial facilities. Increasing demands coupled with limited resource availability and competition for water highlight the importance of active management of Virginia's water resources. This means placing a greater emphasis on collaboration with state and local governments, planning partners, and permittees to find cost-effective solutions that conserve the Commonwealth's water resources and ensure their ability to support all beneficial uses into the future, particularly during periods of drought.

DEQ's mission is "to protect and enhance Virginia's environment, and promote the health and well-being of the citizens of the Commonwealth." State law determines how this mission is to be fulfilled with respect to water resources. More information on the statutes and regulations related to water resources management can be found on the DEQ website. The following sections briefly discuss the various DEQ programs involved in water resources planning and management (Water Supply Planning and Analysis, Water Withdrawal Permitting and Compliance, Groundwater Characterization and Monitoring, Drought Assessment and Response, and Surface Water Investigations) as well as updates on the work done by each program in 2022.

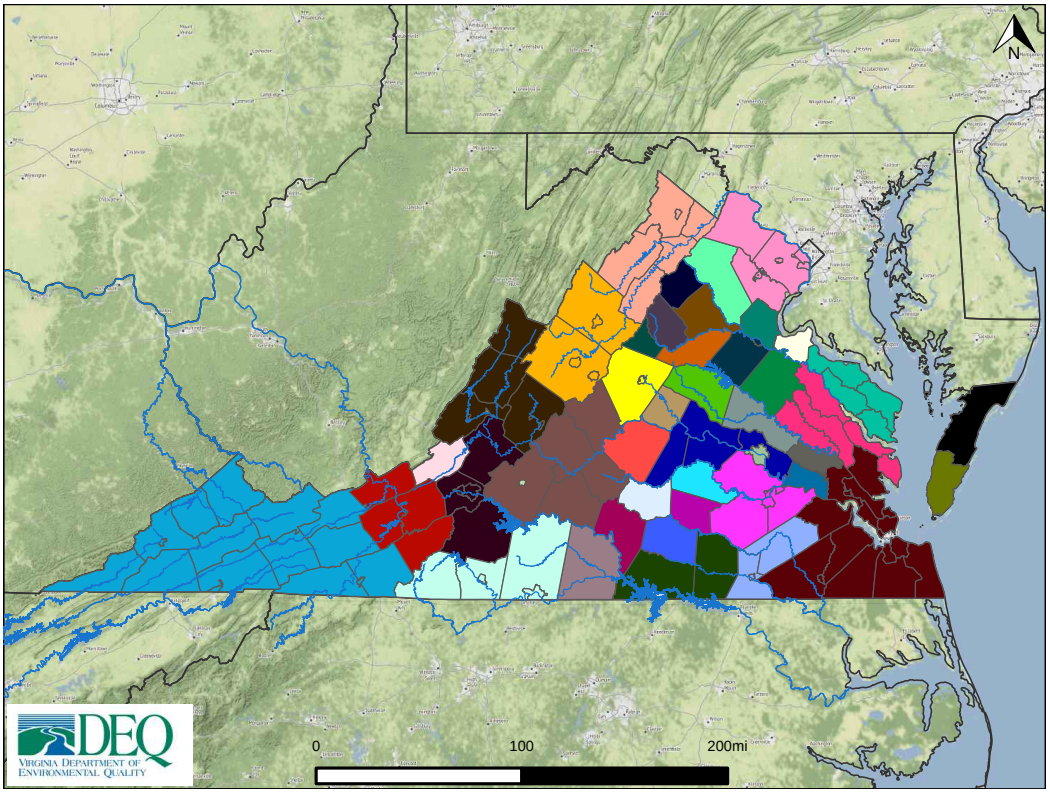
1.1 Water Supply Planning and Analysis

In response to the 2001-2002 drought, during which some water utilities and localities were unable to meet the demands as streamflows decreased to record levels, the Virginia General Assembly enacted a statute (Chapter 3.2 of the Code of Virginia) that required the development of a comprehensive water supply planning program requiring periodic development of local, regional, and state water supply plans that include information on environmental resources, existing and anticipated water sources, existing and projected water use and demand, the potential for water supply deficits, and proposals for new sources of water to address deficits if necessary. The Local and Regional Water Supply Planning Regulation (9VAC25-780) was adopted in 2005 in accordance with section 62.1-44.38:1.A of the Code of Virginia. Localities and regional partnerships were required to submit their initial water supply plans to DEQ no later than November 2011.

Following submission, staff reviewed a total of 48 water supply plans, of which 10 were local plans and 38 were regional plans. DEQ submitted final compliance determinations to all planning partners in late 2013. In 2018, all 323 localities in Virginia reviewed their water supply plans and addressed compliance conditions, in accordance with the required five-year review and submissions deadline.

Legislation enacted following the 2020 General Assembly Session (2020 Va. Acts Ch. 1105) required the State Water Control Board (SWCB) to adopt regulations designating regional planning areas based primarily on river basins, to encourage the development of cross-jurisdictional water supply projects, and to estimate the risk that each locality and region in the Commonwealth will experience water supply shortfalls. This law also directs localities to participate in cross-jurisdictional, coordinated water resource planning, and to develop a single water supply plan for each regional planning area. A Regulatory Advisory Panel (RAP) made up of a variety of stakeholders advised DEQ in the development of proposed amendments for SWCB consideration through the collaborative approach of regulatory negotiation and consensus during a series of meetings in 2021 and 2022. In the Spring of 2023, the draft regulation was approved, and a public comment period initiated in May 2023. The public comment period ended on July 21, 2023 and DEQ will review and incorporate comments, as necessary, in the drafting of a final regulation in the Fall of 2023.

Figure 1: Current Water Supply Planning Programs according to 2011 Water Supply Plans



- Accomack County + Towns Regional WSP
- Albemarle County, City of Charlottesville, Town of Scottsville Regional Water Supply Plan
- Amelia County Water Supply Plan (LOCAL PLAN)
- Appomattox River Water Authority (ARWA) + Hopewell Regional WSP
- Buckingham County & Town of Dillwyn Regional Plan
- Caroline County & the Town of Bowling Green Regional WSP
- Charles City County (LOCAL PLAN)
- Charlotte County Regional WSP
- Craig County−Town of New Castle Regional WSP
- Culpeper County + Town Regional WSP
- Cumberland, Goochland, Henrico, and Powhatan Counties Water Supply Plans
- Fauquier County Regional Water Supply Plan
- Fluvanna County + Town of Columbia Regional WSP
- Greene County + Stanardsville Regional WSP
- Greensville, Sussex, Emporia Regional Water Supply Plan
- Halifax County and Towns
- Hampton Roads Planning District Commission (HRPDC) Regional WSP
- Hanover County & Town of Ashland Regional
- King George County WSP (LOCAL PLAN)
- Lake Country Regional WSP
- Louisa County and Towns
- Lunenburg County + Towns Regional WSP
- Madison County + Town Regional WSP
- Middle Peninsula Regional Water Supply Plan
- New Kent County WSP (LOCAL)
- New River Valley WSP
- Northampton County + Towns Regional WSP
- Northern Neck Regional WSP
- Northern Shenandoah Regional WSP
- Northern Virginia Regional Water Supply Plan
- Nottoway County and Towns
- Orange County Regional Water Supply Plan
- Prince Edward County and Town of Farmville Water Supply Plan
- Rappahannock County + Town of Washington WSP
- Region 2000 Regional Water Supply Plan
- Richmond, City of (LOCAL PLAN)
- Roanoke Valley Alleghany Regional Commission Regional WSP
- Southwest VA Regional Water Supply Plan
- Spotsylvania County and City of Fredericksburg Regional Water Supply Plan
- Stafford County Water Supply Plan (LOCAL PLAN)
- Upper James River Basin WSP
- Upper Shenandoah Regional WSP
- West Piedmont Planning District Commission Regional Water Supply Plan

Once adopted, the amended Local and Regional Water Supply Planning Regulation will substantially impact the process and requirements for the next plan submission cycle. DEQ will provide additional information on how this action may impact requirements for water supply plans as the regulatory process progresses. More information on the program and the ongoing regulatory process can be found on the DEQ website.

1.1.1 Virginia State Water Resources Plan

The water supply plans and other water use reporting and source data collected by DEQ form the basis of the Virginia State Water Resources Plan (State Plan). The first iteration of the State Plan was published in October 2015. It includes the results of a cumulative impact analysis (CIA) conducted using data from local and regional water supply plans and water withdrawal data submitted by individual users under the Water Withdrawal Reporting Regulation.[1] In general, the goal and intent of the State Plan is to use the locally sourced data to conduct analysis that localities can use to inform future planning efforts and permit applications for future water withdrawal projects.

Using updated information submitted in the 2018 water supply plan five year review cycle, DEQ developed the 2020 State Plan. The 2020 State Plan includes updated demand and source information, improved discharge data, and enhanced CIA modeling, including new metrics and scenarios, including the first ever climate change CIA scenarios. Analysis was also conducted at a more localized scale with detailed summaries for each of the 20 minor basins on existing sources, demand projections, water use trends, and modeling results.[2]

1.1.2 VAHydro

Data used in the State Plan such as locality provided demand and source data, annual withdrawal reporting, and withdrawal permit reporting is collected via VAHydro, a web-based, interactive platform that provides the basis for more efficient data collection and analysis. VAHydro is designed to link modules pertaining to water withdrawal permitting, water supply planning, water withdrawal reporting, groundwater well registration, and drought monitoring/modeling of both surface water and groundwater (Figure 2). The goal for VAHydro is to give DEQ staff, as well as localities, water users, and regional stakeholders, the ability to use up-to-date water use data to inform decision making in everyday local and regional water management efforts. Beginning in 2022, DEQ began a long-term project to migrate VAHydro data and functionality into the DEQ enterprise system. This project is expected to continue at least through 2023 during which time VAHydro will continue to operate.

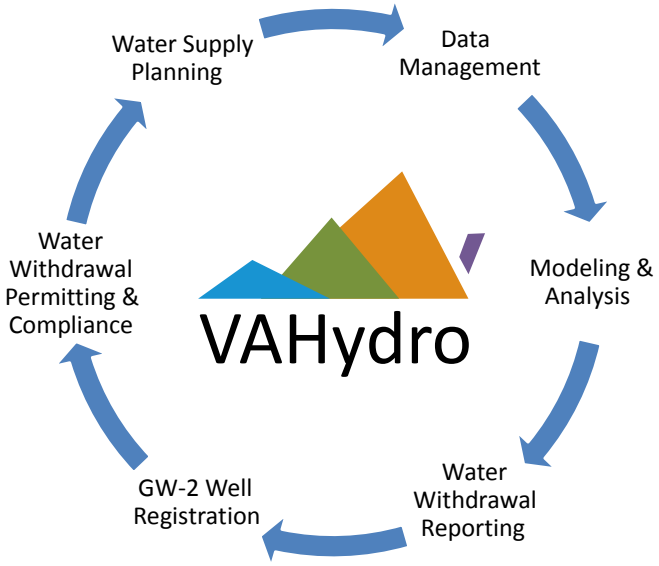
1.1.3 Modeling and Analysis

DEQ staff in the Water Supply Planning and Analysis program perform a number of highly technical functions to serve other DEQ programs. Foremost of all is maintaining and utilizing an operational surface water model to conduct CIA for individual surface water withdrawal permit projects as well as basin-wide analyses and water supply planning simulations such as those presented in the State Plan. DEQ modelers routinely update the VAHydro surface water model both internally and in collaboration with partners ranging from the United States Geological Survey (USGS), Virginia Tech Department of Biological Systems Engineering (BSE), and the Chesapeake Bay Program. Through a variety of grant and program funded projects, partner organizations publish the results of work that serves to advance the state of the science, informing water resources management in professional peer-reviewed journal papers to ensure methodological documentation and scientific integrity.

[1] 9VAC25-200.

[2] The nine major river basins within Virginia are further divided into 20 minor basins to provide a higher resolution, more localized scope for analysis. Minor basins are generally delineated around significant tributaries to the major river (for instance, Shenandoah Minor Basin is a tributary to the Potomac-Shenandoah Major Basin), or by physical characteristics of the area geography. For instance, the James River Basin is subdivided by the Upper James, Middle James, and Lower James minor basins, which are located in the Ridge and Valley, Piedmont, and Coastal Plain geographical regions of Virginia respectively.

Figure 2: Modules within VAHydro



The Virginia Tech BSE Department completed a one-year project (July 2021 – June 2022) providing analytical support to DEQ to enable rapid development of meteorological inputs to the VAHydro model. This collaboration resulted in the ability to run model simulations using continuous, updated meteorological data (data through the current day including temperature, precipitation, and evapotranspiration), an expanded spatial range of model meteorology in southern Virginia, and the ability to perform advanced drought forecasting simulations. In addition to these program benefits and the development of reliable technical documentation, these efforts lay the groundwork for expanding the model simulations presented in the State Plan for evaluating the effects of Climate Change in the Southern Rivers portion of Virginia.

DEQ is finalizing the next generation operational model platform in Hydrologic Simulation Program-Python (HSP2). The transition from Hydrologic Simulation Program–FORTAN (HSPF) to HSP2 provides increased model speed and the ability to efficiently handle sub-daily timesteps, improved turnaround time for permit model technical evaluations, improved debugging and quality assurance abilities, and facilitates dynamic updates and future model maintenance through an active, supportive community of Python users. The Virginia Tech BSE Department completed a one-year project (July 2022 – June 2023) providing analytical support to DEQ for the translation of the VAHydro model into the new HSP2 framework. Program benefits resulting from this collaboration include robust data format handling and integration with existing model elements (e.g. withdrawals, point sources, land use, runoff), technical documentation of methodology, workflows for data post-processing, visualization and quality assurance, performance optimization, and model validation and testing for computational accuracy compared to current methods. DEQ plans to complete HSP2 model implementation by the end of 2023.

In June 2022 a technical paper was published in the Journal of the American Water Resources Association Estimating Facility-Level Monthly Water Consumption of Commercial, Industrial, Municipal, and Thermoelectric Users in Virginia summarizing the results of a two-year project completed in 2020 funded by a USGS Water Use Data and Research Program (WUDR) grant. The project was a collaboration between the Virginia Tech BSE Department and DEQ to improve estimates of consumptive use in Virginia, as well as to develop a suite of tools to transfer data on water withdrawals, discharges, and consumptive use between the National Pollutant Discharge Elimination System (NPDES), VAHydro, and USGS National Water Information System (NWIS) databases. This research was integrated into the surface water model and was

instrumental in the cumulative impact modeling associated with the 2020 State Plan to better account for consumptive use. Evaluating consumptive use is critical for creating an accurate surface water budget and determining water availability in different locations across the Commonwealth.

In the fall of 2022, DEQ completed a two-year project developing better estimates of agricultural water use (funded by a USGS WUDR grant). This project was completed in cooperation with the Virginia Tech BSE Department. Primary objectives for this project included the development of a set of coefficients to estimate unreported agricultural water withdrawals at the county level based on irrigation data from United States Department of Agriculture (USDA) and literature crop water requirements, the generation of monthly total irrigation withdrawal time-series for major agricultural counties in Virginia, as well as an estimation of a range of total irrigation withdrawals under different meteorological scenarios (e.g., average year conditions, moderate drought conditions, and extreme drought conditions). One of the major challenges localities had when preparing water supply plans was collecting information on water use from agricultural water users, and the majority of the plans have limited estimates for agricultural water use. Agricultural water use is also under reported, although DEQ continues to work to engage with agricultural communities to improve awareness of reporting requirements annually. This project helps address these gaps by improving estimates of water used for irrigation at the county level using USDA Agricultural Census data and DEQ water withdrawal reporting data. DEQ collaborated on a technical paper summarizing project findings, which is currently under peer review.

1.2 Water Withdrawal Reporting

The Water Withdrawal Reporting Regulation requires the annual reporting of monthly water withdrawals (surface water and groundwater) of volumes greater than an average of 10,000 gallons per day (GPD) during any month, or one million gallons per month for crop irrigation. The regulation allows the submission of metered and estimated water withdrawal information. DEQ offers electronic reporting that allows reporters to enter withdrawal data on a monthly basis; mail in reporting is also accepted. DEQ maintains withdrawal data as far back as 1982 and categorizes water withdrawals by water use types: agriculture, commercial, irrigation, manufacturing and industrial, mining, fossil fuel power, hydropower, nuclear power, and public water supply. The database also categorizes withdrawals by water source (groundwater, surface water, or transfer) and source sub-type (reservoir, spring, stream, or well). Analyses of the reported 2022 data are provided in Chapters 2 and 3, and in Appendices 1 and 2.

Annual water withdrawal reporting is one of the most important data sources for DEQ. Reporting of water withdrawals allows for informed modeling and planning decisions related to the Commonwealth's future water demands and availability. Reported water withdrawals are linked into the surface water model, which enables staff to prepare up-to-date and accurate water budgets and conduct CIA in support of permit decisions and water supply planning efforts. Withdrawal data is also used by other programs within DEQ, other agencies, and the public. The effectiveness of the Commonwealth's water resource management depends on the comprehensiveness and accuracy of this self-reported withdrawal information.

Each year DEQ works to increase the number and quality of withdrawal reports. This includes reaching out to facilities to ensure continued reporting, especially as points of contact change or leave the company.

1.3 Water Withdrawal Permitting and Compliance

This program administers the permitting and related compliance and reporting activities required by statutes aimed at the management and protection of groundwater and surface water resources. Under the Ground Water Management Act of 1992[3], Virginia manages groundwater through a permit program regulating the withdrawal of groundwater in certain areas designated as Groundwater Management Areas (GWMAs). Currently, there are two GWMAs in the state. The Eastern Virginia GWMA comprises areas east of Interstate 95 and west of the Chesapeake Bay and Atlantic Ocean coast. The Eastern Shore GWMA includes

[3] § 62.1-254 et seq. of the Code of Virginia.

Accomack and Northampton counties. Any person or entity located within a declared GWMA must obtain a groundwater withdrawal permit to withdraw 300,000 gallons or more of groundwater in any one month. Projects involving surface water withdrawals from state waters and related permanent structures are permitted under the Virginia Water Protection (VWP) Permit Program Regulation as provided by Article 2.2 of the State Water Control Law[4]. DEQ issues VWP individual permits for such withdrawals through use of the Joint Permit Application (JPA) process.

A significant focus of this administration and the DEQ Director is improving permit processing timelines. DEQ's agency-wide Permitting Enhancement and Evaluation Platform (PEEP) is underway and is intended to improve efficiency and transparency throughout permitting processes and will be particularly beneficial in identifying critical path improvements for complex individual permit issuance processes. In preparation to integrate effectively into the PEEP process, DEQ's water quantity management programs are addressing a number of issues including: incorporating program data and data management into the DEQ enterprise system, working to bring on new hires to fill vacancies, and accelerating new hire training.

DEQ continues to process a backlog of groundwater withdrawal and surface water withdrawal permit applications with 69 groundwater and 22 surface water applications in progress. Since January 1, 2022, DEQ has issued 91 groundwater withdrawal permits and 19 surface water withdrawal permits. Review of water withdrawal applications requires extensive inter-agency coordination and a technical evaluation process, both of which contribute to longer permit processing timelines than is typical in other DEQ permit programs. Vacancy rates within the permit program remain a consistent challenge. DEQ continues to work to fill these vacancies through continuous recruitment strategies.

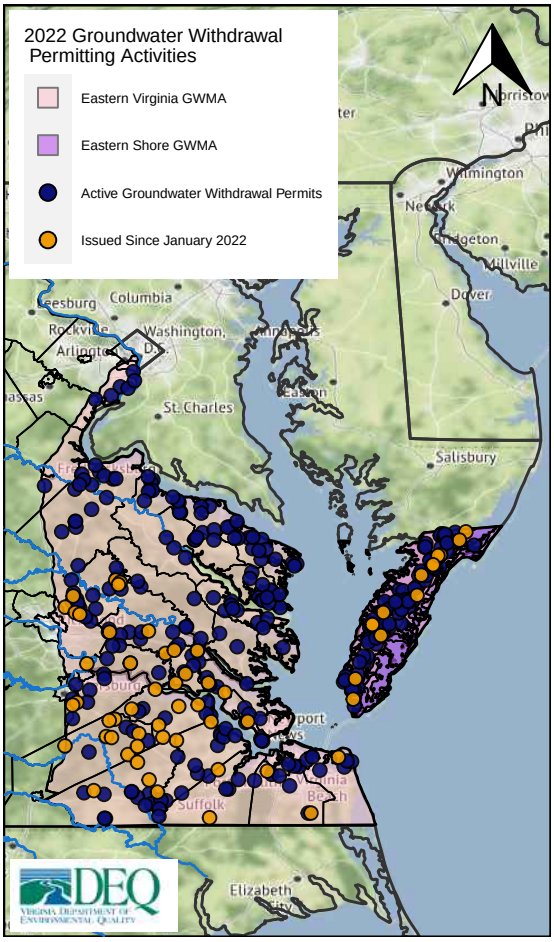
1.4 Groundwater Withdrawal Permitting

Groundwater withdrawal permit applications for new or expanded withdrawals in a GWMA are evaluated to determine impacts of the proposed permit on the groundwater resource. The evaluation determines the area of impact, the potential for a proposed withdrawal to cause salt water intrusion, and assesses the impact of the combined drawdown from all existing lawful withdrawals. Existing lawful withdrawals include those permits issued under historic use conditions and current new or expanded use permits, as well as users that withdraw less than 300,000 gallons per month.

As of September 1, 2023, DEQ administers a total of 373 groundwater withdrawal permits. Currently permits are authorized to withdraw a combined total of approximately 44.0 BGY, which equates to an annual average withdrawal rate of 121 MGD. Figure 3 provides a spatial overview of groundwater withdrawal permitting activities in Virginia. A complete list of all active groundwater permits is available upon request.

[4] §§ 62.1-44.15:20 through 62.1-44.15:23.1 of the Code of Virginia.

Figure 3: 2022 Groundwater Withdrawal Permitting Activities



1.5 Surface Water Withdrawal Permitting

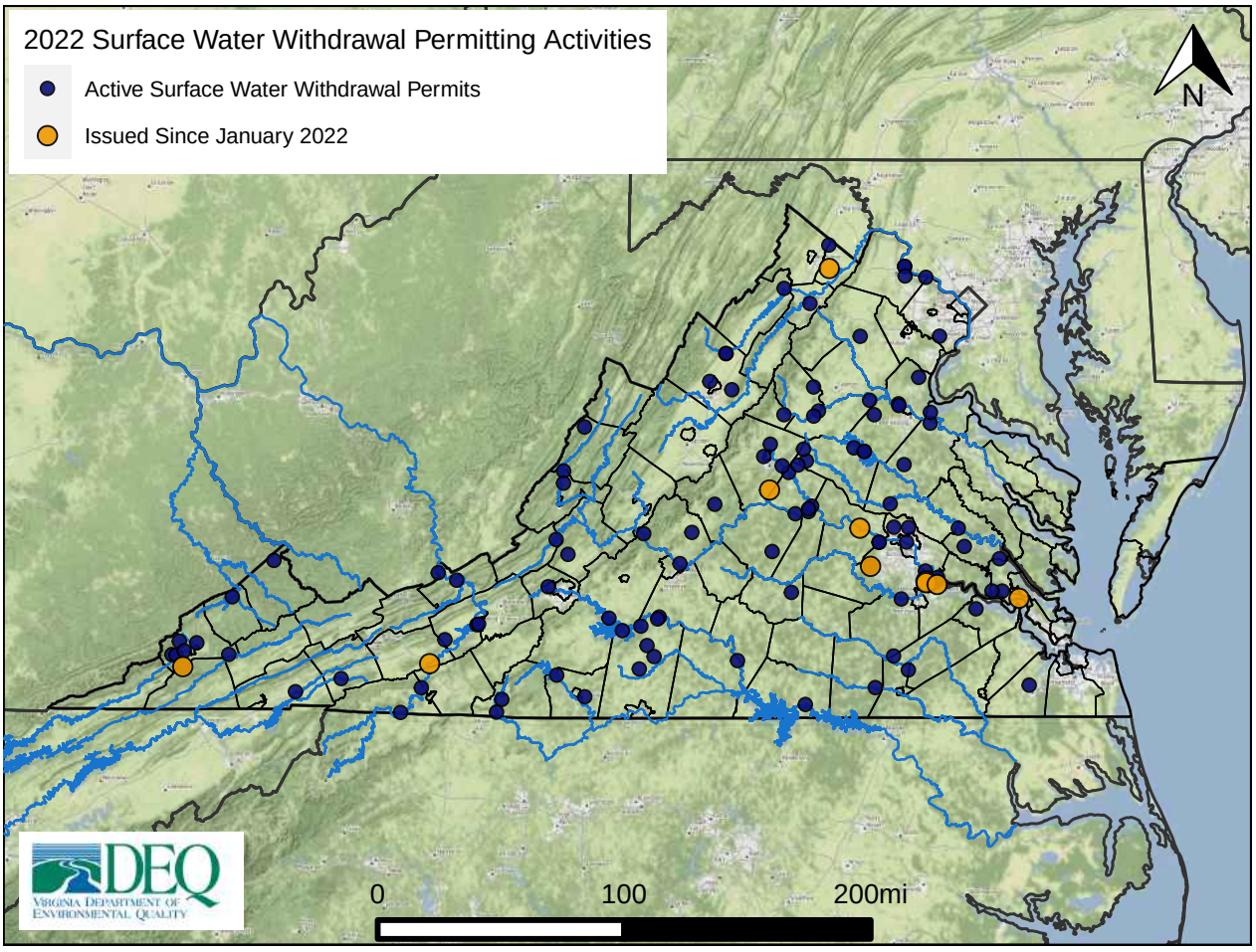
Application for a surface water withdrawal permit is made through the submittal of a JPA to DEQ, the Virginia Marine Resources Commission (VMRC), and the U.S. Army Corps of Engineers (USACE). DEQ's evaluation of surface water withdrawal permit applications includes an in-depth analysis of the applicant's water demand and a CIA of the project to determine potential impacts on existing in-stream and off-stream beneficial uses. To conduct these analyses, DEQ uses an operational hydrologic model to determine the cumulative impacts to aquatic life, water quality, recreation, and down stream water availability for existing intakes.

Each new or re-issuance permit application is modeled to evaluate any potential impact to beneficial uses downstream of the withdrawal site. Staff uses the output of this analysis to inform the permit determination and to develop appropriate limits on withdrawal volumes and minimum in-stream flow conditions if a permit is issued. Figure 4 illustrates Virginia Water Protection (VWP) surface water withdrawal permitting activities, including permits issued since January 2022. Currently, DEQ administers 146 VWP permits for surface water withdrawals. Since January 1, 2022 DEQ has issued 19 surface water withdrawal permits, and there are 22 still in the permitting process.

An ongoing effort for the Water Withdrawal Permitting program is processing VWP permit applications for a large number of hydroelectric power facilities that are or will be applying for Federal Energy Regulatory

Commission (FERC) relicensure as their 30 year licenses expire. Any applicant for a federal license or permit to conduct an activity that may result in a discharge to navigable waters must apply for a Section 401 Certification. A Section 401 Certification is a statement from the state that there is reasonable assurance that the facility will comply with the Clean Water Act and any state established water quality standards. The DEQ VWP Permit Program serves as the Commonwealth's Section 401 Certification for FERC licenses as established by the VWP Regulation.[5] Ten of the twenty two regulated hydroelectric facilities in Virginia are currently undergoing or will be initiating the re-licensing process with FERC and DEQ within the next five years, resulting in an increase in VWP permit applications overall. The VWP permitting process for these facilities will incorporate current scientific framework and regulatory requirements, which are more robust than those in place during the original Section 401 Certification issuance processes. Previous certifications generally required only a minimum release from the facility downstream. Once issued, current VWP permits provide enhanced data collection, instream flow management during droughts or low flow events, and better protections for instream beneficial uses, especially in regions where multiple hydroelectric facilities are located on the same river.

Figure 4: 2022 Surface Water Withdrawal Permitting Activities



[5] 9VAC25-210-340.

1.6 Groundwater Characterization and Monitoring

In 2022 the Groundwater Characterization and Monitoring Program (GCMP) completed a reorganization that began in late 2021. The Program was restructured to accommodate a Groundwater Characterization Team, consisting of two geologists focusing on groundwater conditions in the hard-rock provinces of Virginia and three geologists working primarily in the Coastal Plain's two Groundwater Management Areas (Eastern Virginia and Eastern Shore). A separate Groundwater Monitoring Team of six groundwater geologists was established to focus on the operation and maintenance of the State Observation Well network, the collection and management of groundwater-level data, and the collection of ambient groundwater quality data. A new Program Manager position was created to manage both teams.

Significant funding was provided to the GCMP for a multi-project effort to occur through Fiscal Year 2024. The first phase of project execution will be to construct an extensometer in the vicinity of the West Point Paper Mill. Extensometers monitor changes in aquifer thickness that can occur in response to changing pressures within the aquifer system. Changes in aquifer pressure are typically associated with groundwater withdrawals, groundwater injection (which will be occurring at several locations within the Hampton Roads Sanitation District), natural recharge, and surface loading from tidal influences. In 2022, DEQ geologists assisted in selecting the extensometer site at the Hampton Roads Sanitation District's West Point Operation Center. Installation began in April of 2023, and will complete the Eastern Virginia network of four extensometers to measure changes in aquifer levels and surrounding land subsidence.

The second phase of project execution will be to install up to approximately 20 climate response network (CRN) wells in the hard-rock provinces of Virginia. These wells are intended to measure hydrostatic pressures within the shallow portions of fractured-rock aquifer systems for the purpose of evaluating the relation between long-term climatic trends and groundwater levels. The final stage of project execution will be the construction of up to approximately 19 chloride monitoring wells in the Coastal Plain. In 2022, DEQ geologists focused primarily on identifying potential drill sites and securing the necessary access. Installation of the CRN wells is expected to begin in 2023.

The GCMP provided technical support to groundwater withdrawal permittees and new applicants in multiple localities, including Fairfax, Caroline, and Sussex Counties, and on the Eastern Shore. DEQ geologists collected hydrogeological data and provided on-site support and quality control for permittees' contractors. Through detailed evaluation of borehole geophysical logs and drill cuttings, DEQ geologists determined the aquifer depths and characteristics at each well location. These determinations helped to ensure that production wells were constructed in accordance with groundwater withdrawal permit conditions, with their screens and pumps correctly placed within the permitted aquifers. The GCMP provided similar technical support to the Hampton Roads Sanitation District's Sustainable Water Initiative for Tomorrow (SWIFT) team during drilling and construction of managed aquifer recharge (MAR) injection wells and monitoring wells at the James River Treatment Plant in Newport News.

Staff also conducted groundwater resource investigations in the Piedmont, Blue Ridge, and Valley and Ridge physiographic provinces to better understand the complexities associated with the flow and storage of groundwater in fractured-rock aquifers. During the 2022 calendar year, borehole geophysical investigations took place in Loudoun, Louisa, Cumberland, Fauquier, and Augusta Counties. Typically, data from borehole logging is used to describe local hydrogeologic conditions in the vicinity of the wellbore. Borehole log data from multiple wells can also be used to describe aquifer systems at a more regional scale. In 2022, staff continued an effort to archive historic borehole geophysical log data collected by DEQ. Logs will be stored in the USGS borehole geophysical log database, available for public access at the following link https://webapps.usgs.gov/geologlocator/#!/

With the new staff available in 2022, the GCMP resumed quarterly groundwater-level monitoring across the network of State Observation Wells, ending a period of reduced frequency that had been imposed by resource limitations and the pandemic emergency. DEQ geologists also continued to evaluate the integrity of existing groundwater monitoring wells to ensure that measured groundwater levels remained representative of hydraulic conditions in the aquifer. This is a critical need, as more than half of the 294 State Observation

Wells in the network exceed 30 years of age and need repair, maintenance, or abandonment and replacement. Over time, monitoring wells can lose connection to the aquifer through sediment infill, mineral encrustation, or growth of bacterial mats. Staff developed a priority list of wells to help guide the evaluation and maintenance efforts, as resources allow. In 2023, three compromised wells were slated for permanent abandonment as a result of this evaluation.

The GCMP's Ambient Groundwater Quality Monitoring Program continued to focus on the collection of groundwater samples from locations designated as "trend wells." These wells were selected for regular sampling to monitor for saltwater "upconing," the transient upwelling of saline groundwater that can occur in response to the local removal of fresh groundwater by supply wells, and for the more regional phenomenon of lateral saltwater intrusion in the Coastal Plain aquifer system. Additional "spot well" sampling is anticipated in 2023.

DEQ staff provided technical support to groundwater withdrawal permittees and new applicants in multiple localities, including Fairfax and Essex Counties, where DEQ geologists collected hydrogeological data and provided on-site support and quality control for permittees' contractors. Through detailed evaluation of borehole geophysical logs and drill cuttings, DEQ geologists determined the aquifer depths and characteristics at the well locations. These determinations help to ensure that production wells are constructed in accordance with groundwater withdrawal permit conditions, with their screens and pumps correctly placed within the permitted aquifer.

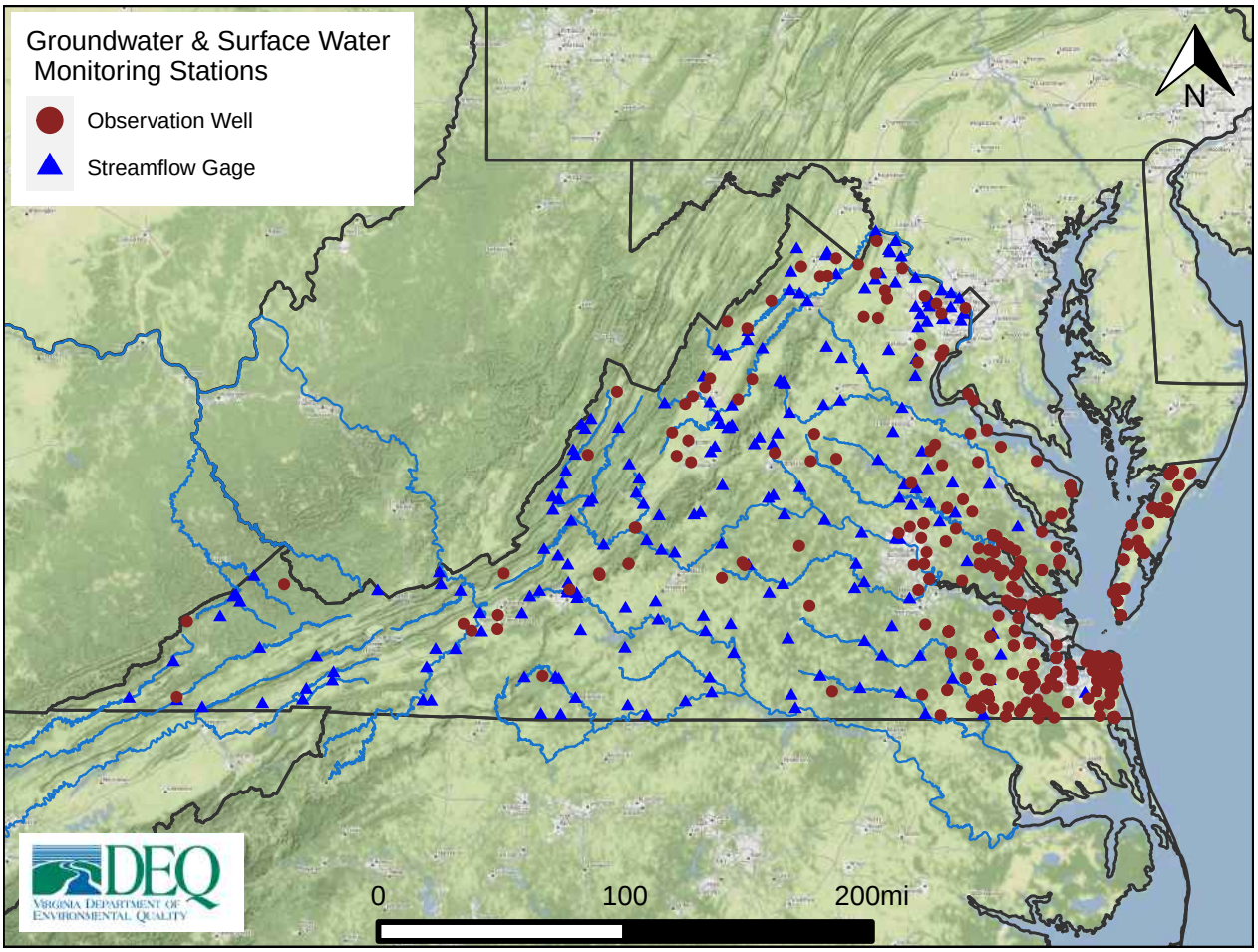
1.7 Surface Water Investigations

DEQ's Surface Water Investigations Program (SWIP) and the USGS National Streamflow Information Program are the primary entities responsible for collecting surface hydrologic data in Virginia. Their collaboration provides a comprehensive picture of real-time and historical hydrologic conditions in the Commonwealth. The SWIP mission is the systematic collection of reliable hydrologic data concerning the quantity of surface water in the Commonwealth, using the same standards and procedures as the USGS. Virginia is currently the only state partnering with the USGS on the collection of real-time streamflow data where state-collected data are incorporated directly into the USGS database. Data accuracy, attained through use of state-of-the-art equipment and personnel training in USGS methods, is the key to maintaining this unique partnership.

SWIP field personnel collected and processed data from the network of 69 surface water discharge monitoring stations on a six to eight week schedule, or more frequently in times of drought or flood. Monitoring often occurs in extreme conditions such as low and high water, and involves the servicing of sensitive equipment, maintaining permanent gauging stations, and measuring streamflow ("discharge"). The data obtained from each surface water discharge monitoring station is continually measured and uploaded into the USGS National Water Information System (NWIS) database where it is accessible by citizens, localities, and state and federal agencies for water supply planning, emergency management response planning, water withdrawal permitting, and natural resource management purposes. Development of and access to this data is essential for the successful planning and management of the Commonwealth's water resources. In October of 2022, SWIP added eight additional surface water monitoring stations to its network.

Figure 5 provides a spatial overview of active surface water and groundwater monitoring stations in Virginia.

Figure 5: Groundwater and Surface Water Monitoring Stations



1.8 Drought Assessment and Response

Since the adoption of the Virginia Drought Assessment and Response Plan in 2003, drought watch declarations have been issued for various regions nearly every year with drought warning declarations occurring less frequently. A Drought Emergency declaration has not been issued since the 2002 drought.

Moderate drought conditions existed across much of central, southeast, and the Eastern Shore throughout most of 2022. Drought watches were issued in December of 2021 for the Chowan, Eastern Shore, Southeast Virginia, Roanoke, and York-James evaluation regions. As conditions improved throughout the winter recharge period, the drought watches were lifted for the Chowan, Southeast Virginia, and York-James evaluation regions in February 2022. Watch conditions persisted within the Eastern Shore and Roanoke regions until being lifted in April 2022.

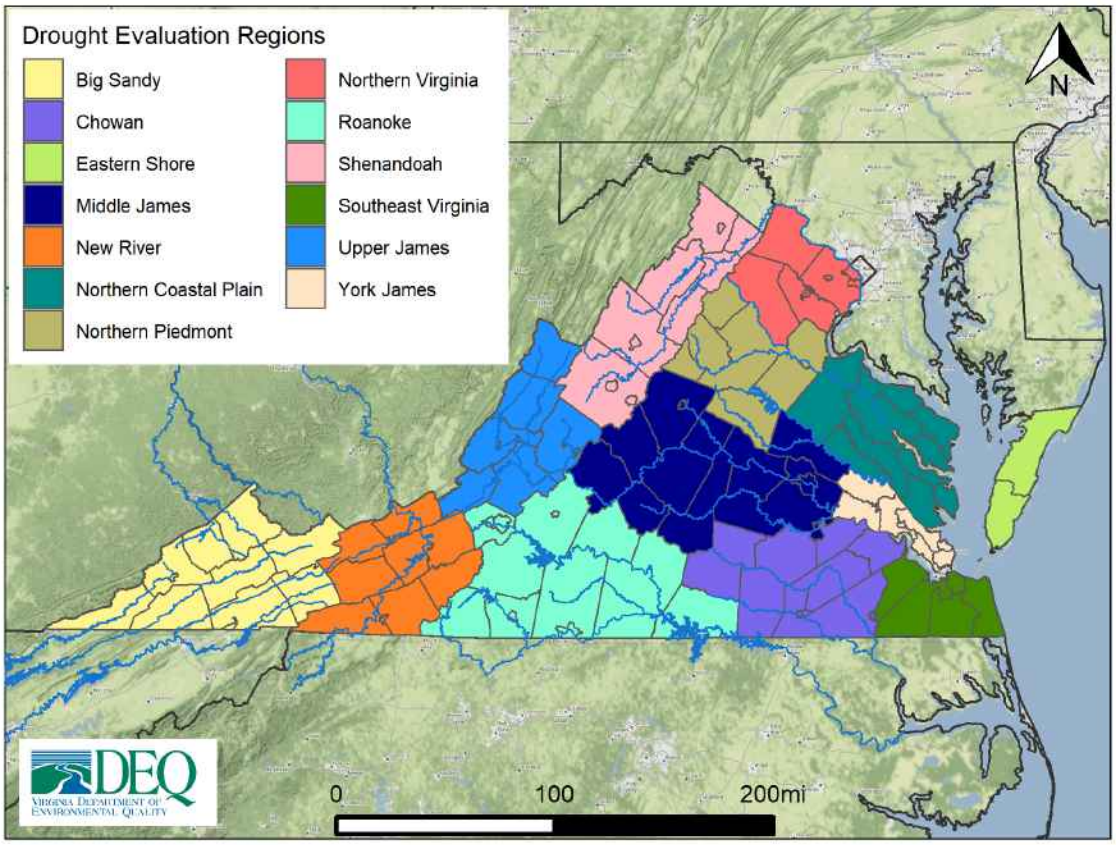
Dry conditions returned in late spring and early summer, with moderate to severe drought conditions leading to drought watches being issued for the Chowan, Southeast, and York-James evaluation regions in June 2022. Watch conditions persisted until being lifted in the Chowan, Southeast, and York-James evaluation regions in late August. Throughout September, precipitation deficits and observed agriculture impacts led to a watch declaration being issued for the Chowan, Eastern Shore, Southeast, and York-James drought evaluation regions. In October, Hurricane Ian provided significant precipitation across the majority of the Commonwealth, with upwards of 400% of normal historic rainfall occurring in some regions. The resulting

recovery of streamflows and groundwater monitoring wells provided normal conditions for the remaining of 2022.

Dry conditions returned in early spring and summer of 2023, with moderate to severe drought conditions observed across the southern and southeastern portions of the Commonwealth. As a result, in April 2023 DEQ issued a drought watch advisory for the Chowan, Eastern Shore, Northern Coastal Plain, Southeast Virginia, and York-James drought evaluation regions. This advisory remained in place for the Chowan, Northern Coastal Plain, Southeast, and York-James regions until mid-May 2023. Dry conditions persisted throughout early summer with continued declines in streamflow, precipitation, and groundwater levels which resulted in a drought watch advisory being issued for the Shenandoah, Northern Coastal Plain, Northern Piedmont, and Northern Virginia drought evaluation regions in June 2023. Significant precipitation events throughout late June provided beneficial relief to drought indicators.

As of September 1, 2023 onset of drought conditions returned, with significant dryness occuring within the Shenandoah drought evaluation region. On August 30, 2023 DEQ announced a drought warning declaration for the Shenandoah region with near record low surface water and groundwater indicators observed. Widespread impacts to agricultural producers was also reported in the region. Additional drought watch advisories were issued for the Eastern Shore, Northern Virginia, and York-James evaluation regions. DEQ provides a drought indicator map that is updated daily and can be viewed online at Current Drought Conditions in Virginia.

Figure 6: Drought Evaluation Regions



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2 Summary of 2022 Water Withdrawal Reporting

Chapter 2 provides a brief overview on how withdrawals are reported to DEQ, summarizes 2022 reported water withdrawals at the statewide level for all water use types, and compares 2022 reported withdrawals to the average use over the past 5 years. Also covered are withdrawals categorized by source type (groundwater and surface water), as well as how withdrawals vary across the state.

2.1 Background on Water Withdrawal Reporting in Virginia

Most facilities report withdrawals to DEQ through the Annual Water Withdrawal Reporting program, and withdrawals can be reported online or by mail. Facilities that report water withdrawals in compliance with surface water and groundwater withdrawal permits are also included in this report.

A total of 1,173 facilities reported water withdrawals to DEQ for the calendar year 2022, which is similar to the number of facilities reporting in recent years. Some annual variation in the number of facilities reporting is expected as facilities cease or start operation. Facilities that fail to report to the Annual Water Withdrawal Reporting program also contribute to this variation. DEQ staff prioritize compliance contacts to such facilities on an annual basis using criteria such as the relative size of withdrawal to the source and the potential for in-stream or off-stream beneficial uses of the source or sources to be impacted by withdrawals in the area. Compliance for facilities with withdrawal permits is managed by the Withdrawal Permitting and Compliance program; permitted facilities that fail to report are addressed through compliance and enforcement processes in accordance with current guidance.

Water withdrawals reported to DEQ are categorized as coming from either a surface water source such as a stream (including rivers), reservoir, or spring, or a groundwater source such as a well or dug pond that intersects the groundwater table. Water withdrawn in the Commonwealth may be used by the withdrawing entity or locality, or it may be "transferred" to another entity or locality. While some water transfers are reported to DEQ, they are not included in the withdrawal data presented in this chapter since the water is accounted for when it is initially withdrawn from the source. More information on water transfers reported to DEQ can be found in Appendix 4.

Water withdrawals are further categorized into use types according to how the water is used. Use type categories include: Agriculture, Commercial, Fossil Power, Irrigation, Manufacturing, Mining, Nuclear Power, and Public Water Supply. Specifics of what each of the use type categories includes can be found in Chapter 3, Sections 3.3 - 3.9.

DEQ staff continuously strive to improve the accuracy of reported withdrawal amounts and classification of data through a proactive data quality assurance/quality control process. Improvements in previously published data sets occur due to identification and correction of errors. As such, minor changes may be noted when comparing current data to prior publications of this report.

2.2 Consumptive Use

Although some portion of a withdrawal is generally returned to the source, facilities are required to report "gross" withdrawals to DEQ. In other words, the withdrawal totals in this report do not account for water returned back to a source through discharges or other means. The proportion of a withdrawal that is not returned to a source, for example water that infiltrates into the ground via irrigation or discharge into septic systems, or is lost to treatment processes or leaks, is considered "consumptive use".

DEQ accounts for the consumptive use of a facility when evaluating a permit application. However, because consumptive use can vary significantly across use-types and even across facilities within the same use type, it is not practical to account for consumptive use in this report. Figure 7 provides ranges of consumptive use across use-types, and shows how these varying consumptive use rates would affect how a surface water withdrawal impacts flow in a stream.[6] Agriculture and irrigation have very high consumptive use as the water applied to those uses does not generally return to a stream in a manner that can be readily measured. Consumptive use for public water supply varies seasonally with higher consumptive use during the summer when irrigation increases and minimal consumptive use during the winter. Consumptive use for industrial facilities varies based on the specific water use, but most industrial facilities have low consumptive use. Power generation facilities that use water for once-through cooling systems return almost all water to the source.

Consumptive use also varies by source; while groundwater withdrawals from confined aquifers may be returned to surface water streams via discharges, they are not returned to the source aquifer so they are considered entirely consumptive in terms of their impact on the aquifer.

For more information on this subject, see the recent publication produced by DEQ and Virginia Tech which provides a review of consumptive use values across use types and discusses methodologies for estimating consumptive use.[7]

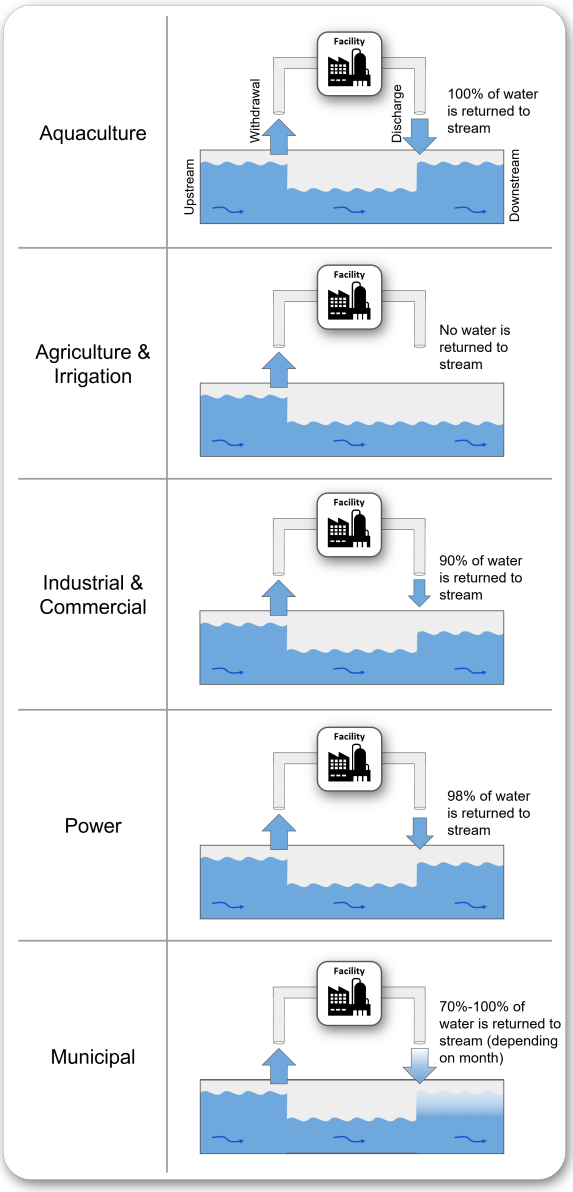


Figure 7: Impact of Consumptive Use Across Use-Types on a Source Stream

[6] 2020 Virginia State Water Resources Plan (Section 4.2.6.1 Estimating Consumptive Use Factors).

[7] McCarthy, M., Brogan, C., Shortridge, J., Burgholzer, R., Kleiner, J., and Scott, D., 2022, *Estimating Facility-Level Monthly Water Consumption of Commercial, Industrial, Municipal, and Thermoelectric Users in Virginia*: Journal of the American Water Resources Association, https://doi.org/10.1111/1752-1688.13037.

2.3 2022 Reported Withdrawals

A summary of water withdrawals reported to DEQ from 2018-2022 is represented in Table 1. Total reported withdrawals in 2022 were approximately 5.70 billion gallons per day (BGD), including the cooling water withdrawals at nuclear and fossil fuel power generation facilities, which make up 78% of this total. The total reported withdrawal is a 0.8% decrease from the five-year average of 5.75 BGD. The decrease is due to a reduction in reported power generation withdrawals. Because withdrawals associated with power generation are around 3.5 times greater than all other reported withdrawals, and are also largely non-consumptive, this report generally discusses withdrawals with power generation excluded. This lessens the likelihood that trends in reported use for other use categories are being obscured.

Excluding power generation, reported 2022 withdrawals totaled 1.27 BGD, which represents a 2.4% increase compared to the five-year average (2018-2022). The 2022 total excluding power generation is the second highest within the last five years, only slightly behind 2021. The increase in reported use over the last five years is largely driven by increased withdrawals from public water supply facilities. Despite successes in reducing per capita water use, reported public water supply withdrawals have steadily increased over the last fifteen years as Virginia's population continues to grow in the urban and suburban areas served by water utilities. Reported use for many categories dropped in 2020 due to economic and social impacts from the COVID-19 pandemic. While some lessened impacts of COVID-19 continued through 2022, reported water use exceeded the volumes reported prior to the pandemic. A detailed discussion of reported withdrawals for each of the use types in Table 1 is provided in Chapter 3.

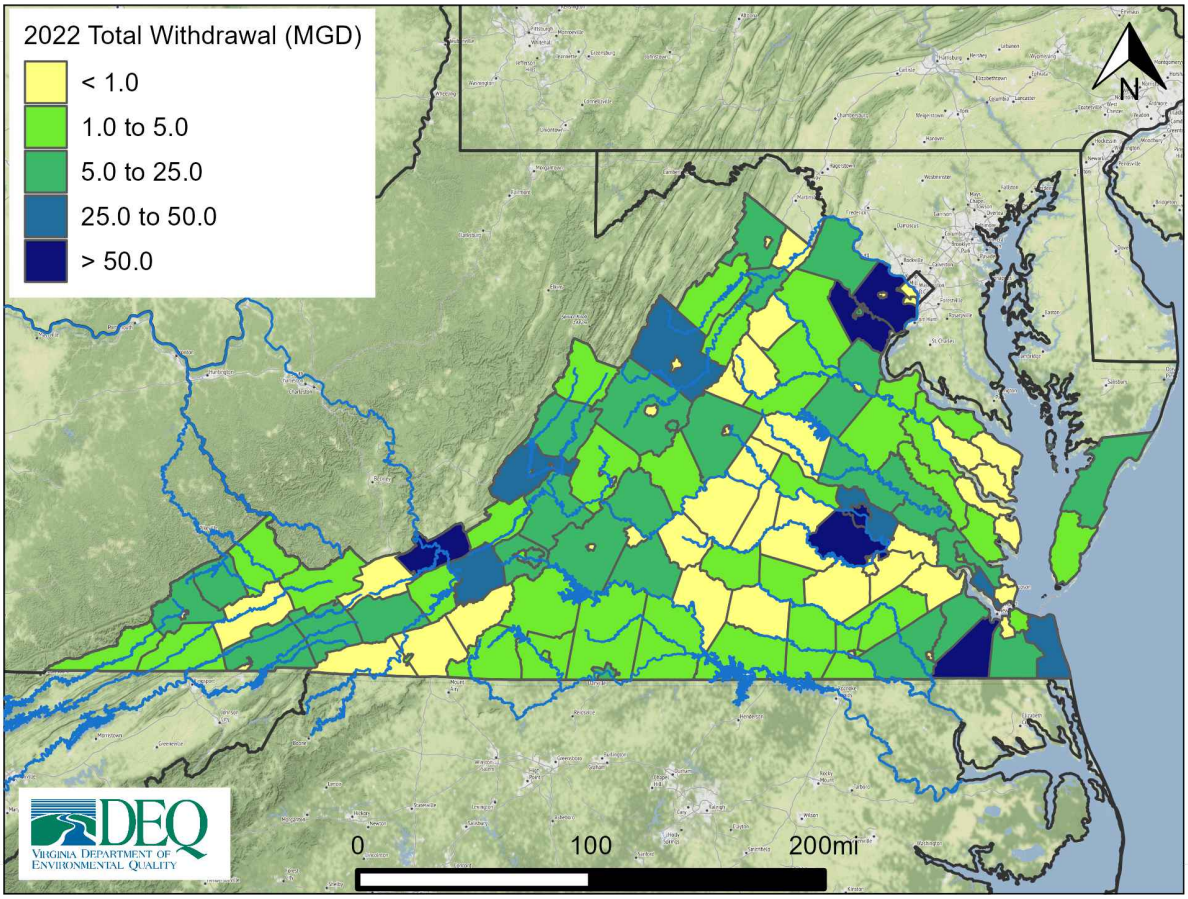
Table 1: Summary of Virginia Water Withdrawals by Use Category and Source Type 2018 - 2022 (MGD)

Category	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater							
Agriculture	0.88	1.22	1.33	1.30	1.42	1.230	15.4
Commercial	3.90	4.52	3.64	4.11	4.02	4.040	-0.5
Irrigation	1.80	2.01	1.93	1.89	1.75	1.880	-6.9
Manufacturing	60.57	57.76	58.00	59.67	57.47	58.690	-2.1
Mining	18.04	17.57	19.69	20.72	14.81	18.170	-18.5
Public Water Supply	55.27	55.13	55.82	59.75	58.98	56.990	3.5
Fossil Power	0.12	0.07	0.07	0.06	0.07	0.080	-12.5
Nuclear Power	0.38	0.37	0.36	0.37	0.29	0.350	-17.1
Surface Water							
Agriculture	32.70	30.98	29.73	28.58	26.92	29.780	-9.6
Commercial	7.98	9.94	6.38	8.84	7.69	8.170	-5.9
Irrigation	12.89	20.12	15.78	21.16	18.76	17.740	5.7
Manufacturing	304.17	293.49	301.92	309.55	303.16	302.460	0.2
Mining	16.84	13.74	15.62	12.91	10.32	13.890	-25.7
Public Water Supply	727.72	727.44	671.65	744.07	764.02	726.980	5.1
Fossil Power	1012.39	752.18	635.84	732.32	751.66	776.880	-3.2
Nuclear Power	3705.29	3739.35	3863.89	3656.36	3678.73	3728.720	-1.3
Total (GW + SW)							
Agriculture	33.58	32.20	31.06	29.88	28.34	31.010	-8.6
Commercial	11.88	14.47	10.02	12.95	11.71	12.210	-4.1
Irrigation	14.69	22.13	17.71	23.05	20.51	19.620	4.5
Manufacturing	364.74	351.25	359.92	369.22	360.63	361.150	-0.1
Mining	34.88	31.31	35.31	33.63	25.13	32.050	-21.6
Public Water Supply	782.99	782.56	727.47	803.82	823.00	783.970	5.0
Fossil Power	1012.51	752.25	635.91	732.38	751.73	776.960	-3.2
Nuclear Power	3705.67	3739.72	3864.25	3656.73	3679.02	3729.080	-1.3
Total - without power							
Total Groundwater	140.47	138.21	140.42	147.45	138.45	141.000	-1.8
Total Surface Water	1102.30	1095.71	1041.08	1125.11	1130.87	1099.010	2.9
Total (GW + SW)	**1242.77**	**1233.91**	**1181.49**	**1272.56**	**1269.33**	**1240.010**	**2.4**
Total - power only							
Total Groundwater	0.50	0.44	0.43	0.43	0.36	0.430	-16.3
Total Surface Water	4717.68	4491.53	4499.73	4388.68	4430.39	4505.600	-1.7
Total (GW + SW)	**4718.18**	**4491.97**	**4500.16**	**4389.11**	**4430.75**	**4506.034**	**-1.7**
Total All Categories							
Total (GW + SW)	**5960.95**	**5725.88**	**5681.65**	**5661.67**	**5700.08**	**5746.044**	**-0.8**

2.4 2022 Reported Water Withdrawals by Locality

Demand for water varies considerably across Virginia. Figure 8 shows the total 2022 reported withdrawals excluding power generation within each locality. The largest withdrawals were reported across major population centers, including Northern Virginia, the greater Richmond area, and the Tidewater area. Localities with significant industrial and mining facilities such as Giles County can influence overall demands.

Figure 8: 2022 Total Reported Water Withdrawals By Locality Excluding Power Generation



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Excluding power generation, the City of Hopewell has the highest total 2022 reported water use resulting from industrial facilities that withdraw from the tidal James River. The City of Suffolk, which contains two public water supply reservoirs operated by the City of Norfolk, as well as the counties of Chesterfield, Fairfax, and Giles make up the remainder of the top 5 localities. The City of Suffolk and Fairfax County withdrawals are primarily for providing public water supply to the large urban/suburban regions. Giles County use is largely due to withdrawals associated with manufacturing and mining, while Chesterfield has significant public water supply and manufacturing users.

2022 reported withdrawals for each locality can be found in Table 21 located in Appendix 2.

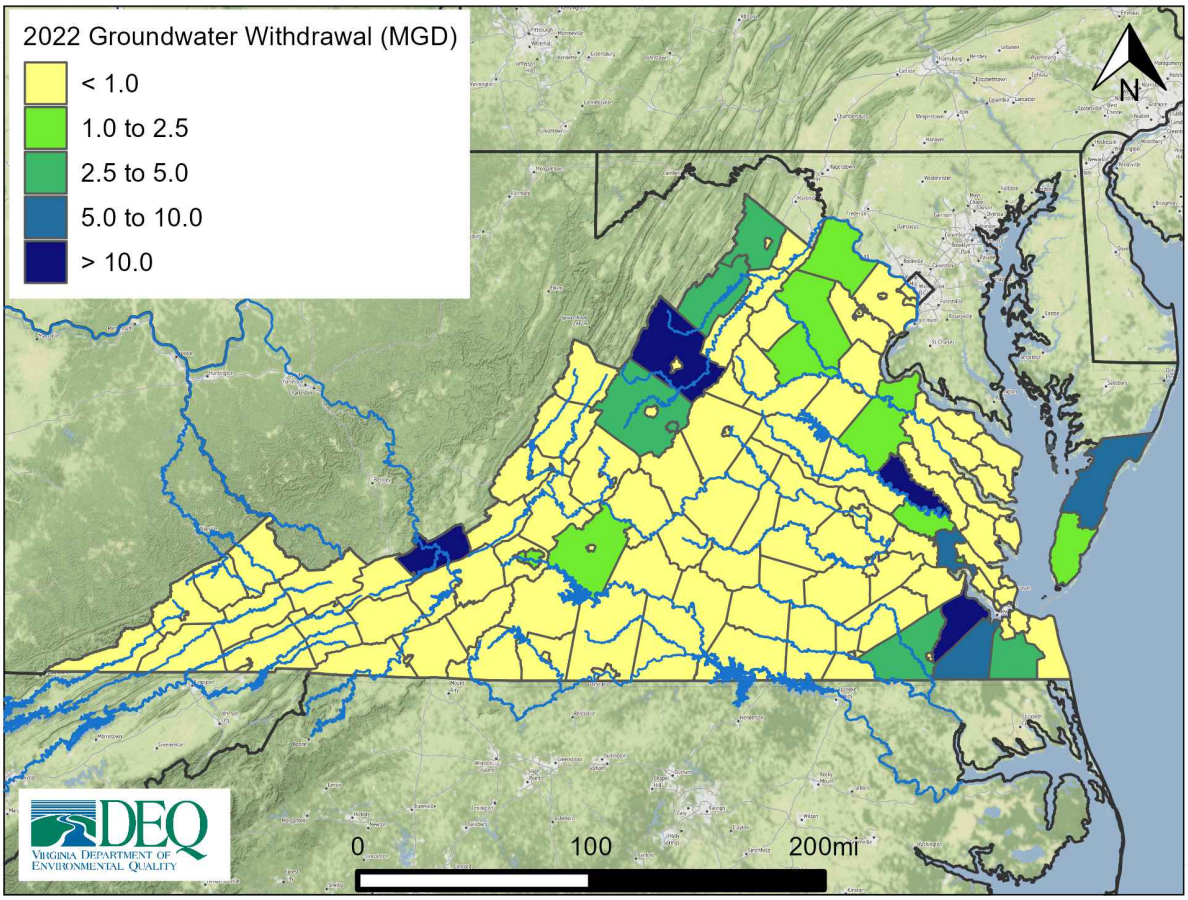
2.5 2022 Reported Water Withdrawals by Source Type

When comparing reported withdrawals based on the type of source (surface water or groundwater), there are several historic trends that continued in 2022. Surface water sources (streams, reservoirs, and springs) continued to supply the vast majority of water needs in Virginia, including for nuclear power facilities, large industrial facilities, and large public water suppliers that serve the major population centers of Virginia. In 2022, surface water sources comprised 89% of total reported withdrawals when excluding power generation, which is consistent with the average proportion over the last five years. Groundwater use is most prevalent in the Coastal Plain areas east of Interstate 95 and on the Eastern Shore where confined aquifers provide reliable and high quality water to areas with limited access to fresh surface water. Groundwater also supplies most rural public water supplies and small self-supplied facilities across use-types for which the relative affordability and accessibility of groundwater is crucial. The following section covers 2022 reported withdrawals categorized by groundwater and surface water in more detail.

Groundwater: As indicated in Table 1, 2022 reported withdrawals from groundwater sources excluding power generation totaled 138 MGD, which is a decrease of 1.8% when compared to the five-year average. The agriculture and public water supply categories reported increases in withdrawals compared to the five-year averages for 2022. Cumulative reported declines in all other water use categories resulted in the overall reduction in groundwater demands. Public water supply facilities reported 59 MGD in withdrawals from groundwater sources, a 3.5% increase from the 5 year average. Overall, groundwater use for public water supply has shown an increasing trend over the last five years. This trend is likely to continue to the extent that groundwater remains the most practical source for portions of the Commonwealth that are experiencing population growth, such as the Tidewater region, and along the I-95 corridor. Mining use reported the greatest reduction, declining 18.5% compared to the five-year average, due to closure of a large mine in southwest Virginia.

Cumulative reported groundwater withdrawals within each locality are shown in Figure 9. For most localities in Virginia, reported groundwater use remains below 1 MGD. The largest reported groundwater withdrawals in 2022 continued to be from industrial facilities located in Isle of Wight, King William, and Giles counties. Significant groundwater withdrawals are also evident in the Tidewater region where many public water suppliers, including the cities of Suffolk, Norfolk, as well as James City County, use groundwater as their primary source or as a supplement to surface water. Groundwater use in areas such as the Eastern Shore and the Shenandoah Valley is relatively higher than other parts of the state due to several factors, including the limited availability of surface water, a higher relative concentration of reporting agricultural facilities, and the presence of one or more industrial facilities that rely on groundwater as their primary source.

Figure 9: 2022 Groundwater Withdrawals by Locality



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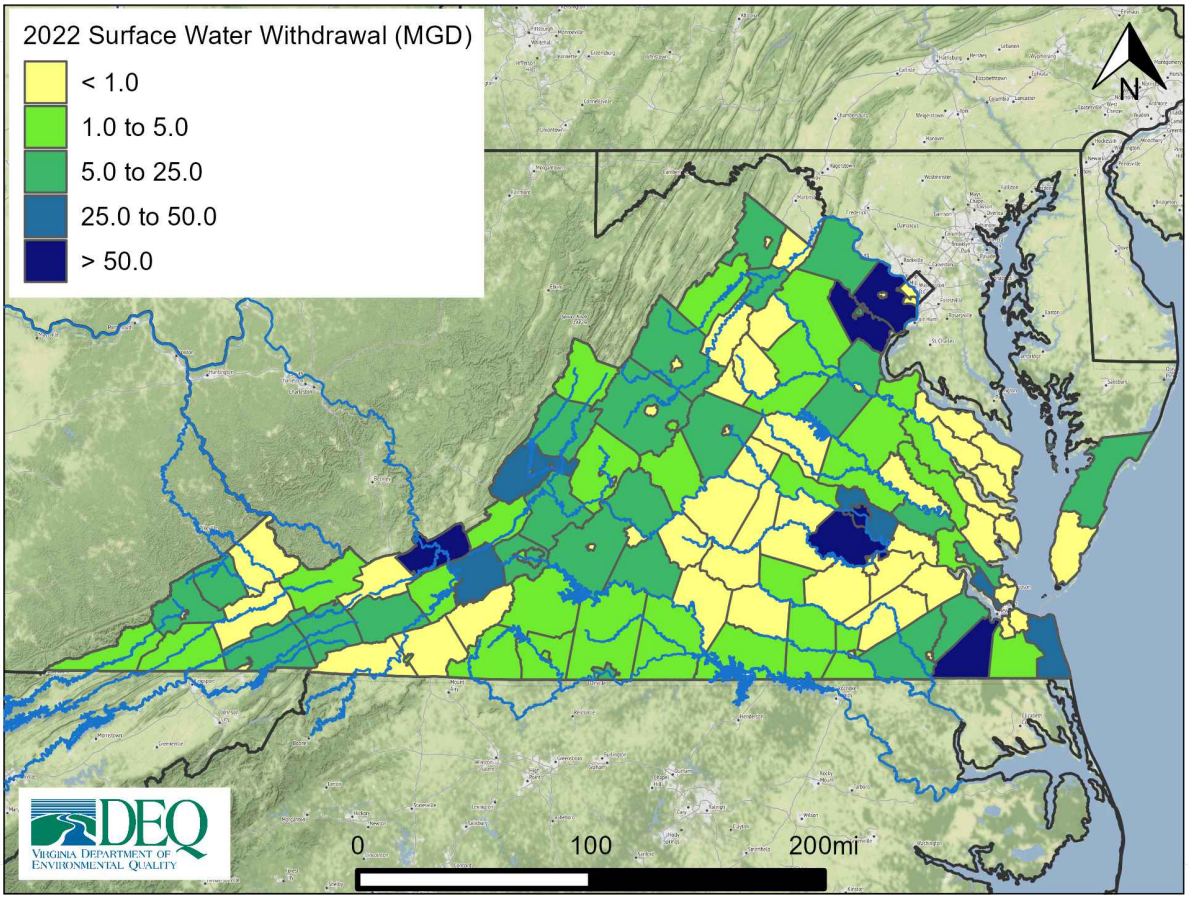
Surface Water: Total reported surface water withdrawals in 2022 decreased by 0.8% compared to the five-year average, which is a result of a 3.2% reduction in withdrawals for fossil power as well as a 1.3% reduction in withdrawals for nuclear power. However, when excluding power generation, reported surface water withdrawals for 2022 totaled 1131 MGD, an increase of 2.9% compared to the five-year average. This increase is the result of increased withdrawals for public water supply facilities. Public water supplies continue to increase, with a 2.7% increase from 2021. Public water supply withdrawals for surface water continue to increase consistently due to population growth in the metropolitan areas primarily served by surface water. Reported surface water withdrawals for agriculture and mining decreased by approximately 10% and 26% respectively compared to the average.

Cumulative reported surface water withdrawals within each locality are shown in Figure 10. Surface water withdrawals were distributed widely across the state and were greatest around cities and counties with dense population centers and significant manufacturing water uses. The largest reported surface water withdrawals occurred within the City of Hopewell, Chesterfield County, and Fairfax County, driven by public water supply facilities in Fairfax County and Chesterfield County, as well as manufacturing facilities in the City of Hopewell and Chesterfield County. In addition, agriculture and irrigation use of surface water is spread throughout Virginia, although focused in more rural counties.

Figure 10: 2022 Surface Water Withdrawals by Locality



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2.6 2022 Permitted and Unpermitted (Excluded) Withdrawals

Unpermitted withdrawals make up a large portion of the total reported withdrawals within Virginia. Table 2 compares reported withdrawals from users that hold a VWP surface water withdrawal or groundwater withdrawal permit, and reported withdrawals from unpermitted facilities.[8] Unpermitted surface water withdrawals include withdrawals that are excluded from VWP permitting requirements pursuant to §62.1-44.15:22 of the Code of Virginia or 9VAC25-210-310, based on exclusions related to the size, age, and purpose of the withdrawal. Unpermitted groundwater withdrawals are those not required to obtain a groundwater withdrawal permit under the Ground Water Management Act of 1992. These include withdrawals located outside of a groundwater management area, those that withdraw less than 300,000 gallons in any month, and those that are otherwise excluded pursuant to 9VAC25-610-50.

In 2022, unpermitted withdrawals represented approximately 75% of the total reported withdrawals in Virginia when excluding power generation. The majority of unpermitted withdrawals come from surface water sources, with 79% of reported surface water withdrawals associated with unpermitted facilities. About half of reported groundwater withdrawals (51%) are from users operating under a Groundwater Withdrawal Permit. Of the top 20 largest reported withdrawals in 2022, 14 are from facilities that are unpermitted (see Table 20).

Table 2: 2022 Permitted and Unpermitted (Excluded) By Use Type Withdrawals (MGD)

	Annual Withdrawal Amount		**% of Total**	
Use Type	**Unpermitted**	**Permitted**	**Unpermitted**	**Permitted**
Groundwater				
Agriculture	0.22	1.20	0.16	0.87
Commercial	1.70	2.32	1.23	1.68
Irrigation	0.49	1.26	0.35	0.91
Manufacturing	20.23	37.24	14.61	26.90
Mining	14.81	0.00	10.70	0.00
Public Water Supply	30.43	28.55	21.98	20.62
Total Groundwater	**67.88**	**70.57**	**49.03**	**50.98**
Surface Water				
Agriculture	26.32	0.61	2.33	0.05
Commercial	6.32	1.37	0.56	0.12
Irrigation	18.48	0.27	1.63	0.02
Manufacturing	293.19	9.97	25.93	0.88
Mining	10.28	0.04	0.91	0.00
Public Water Supply	534.12	229.90	47.23	20.33
Total Surface Water	**888.71**	**242.16**	**78.59**	**21.40**

The largest unpermitted groundwater withdrawals are for manufacturing/industrial facilities, mining facilities, and public water supply facilities located outside of the groundwater management areas. Withdrawals for public water supply were the largest contributor to total groundwater withdrawals. In 2022, 22.0% of the total reported groundwater withdrawals were associated with unpermitted public water supply facilities located outside groundwater management areas. Note that groundwater withdrawals for domestic and private well use are not included in the reported use totals, as such use falls below the reporting threshold and is not required to be reported to DEQ.

As with groundwater, unpermitted surface water withdrawals in 2022 were dominated by withdrawals associated with public water supply and manufacturing facilities. Withdrawals from unpermitted public water

[8] Currently unpermitted facilities that have applied for withdrawal permits, and whose applications are currently under review, are counted as permitted withdrawals for the purpose of this table.

supply facilities made up 70% of the total reported public water supply surface water withdrawal volume in 2022, while unpermitted manufacturing facilities made up 97% of the total reported manufacturing surface water volume. Unpermitted withdrawals, whether groundwater or surface water, continue to present a significant challenge for management of the resource. More information on measures DEQ is taking to better evaluate the impacts from unpermitted users is provided in Chapter 4 of this report.

Unreported unpermitted withdrawals are not represented in Table 2, however unreported withdrawals are of interest to DEQ. These withdrawals consist primarily of those that do not exceed the reporting thresholds for their use type as stated in 9VAC25-200-30. Trends in increased private groundwater well completion reports received by DEQ and VDH point to an increase in private groundwater well construction. Since 2016, over 13,000 wells have been registered with DEQ through electronic submission; 1,790 wells were registered electronically with DEQ in 2022 alone. Note that wells may also be registered via submission of a hard copy uniform water well completion form (GW-2) and this total does not include those.

Though water withdrawal data is not collected with groundwater well completion reports, the increase in private well construction can be viewed as a metric for evaluating increasing unreported and unpermitted groundwater withdrawals. Unreported and unpermitted withdrawals also include users who may be withdrawing above the thresholds requiring reporting but are not in compliance with the regulation. Identification of such users is an ongoing effort for DEQ. More details on how DEQ continues to address this challenge can be found in Chapter 4.

3 Water Withdrawals By Use Category

Chapter 3 provides an overview of water withdrawal reporting for the year 2022, as well as comparisons to recent years reporting, for each water withdrawal use type. Water withdrawals reported annually to DEQ are grouped into the following categories:

- 3.3 Public Water Supply - includes water withdrawn and treated to produce water to supply municipal and non-municipal water systems that primarily provide residential use. Such systems may also supply commercial and industrial facilities located within their service area. Public water supply does not include private and domestic well withdrawals under 300,000 gallons per month, which are not required to be reported.
- 3.4 Agriculture - includes water withdrawn for raising livestock, fish farming/hatcheries, and general farm use, but does not include water used for crop irrigation.
- 3.5 Irrigation - includes water withdrawn to promote crop growth, including but not limited to tobacco, corn, soybeans, turf grass, and nursery products.
- 3.6 Commercial - includes water withdrawn for use by golf courses, local and federal installations, hotels, resorts, and correctional centers, among others.
- 3.7 Mining - includes water withdrawn for pit dewatering, excavation, processing, and removal of bulk products such as coal, rock, sand, and gravel.
- 3.8 Manufacturing - includes water withdrawn for use by industrial facilities that generally produce goods such as paper mills, food processors, pharmaceutical companies, furniture manufacturing, and concrete plants, among others.
- 3.9 Power Generation - includes water withdrawn for fossil fuel power and nuclear power. Withdrawals or diversions of water for hydroelectric power (hydropower) generation are nearly all non-consumptive and are exempt from the annual water withdrawal reporting requirements.

3.1 Water Use by Use Category At A Glance

Figure 11 compares the average total water withdrawals from 2018-2022 to 2022 totals for each use-type category, excluding Power Generation (Nuclear Power and Fossil Fuel Power). Figures 12 and 13 split this comparison by source type as well. In summary, total withdrawals from public water supplies increased, while mining and agriculture decreased compared to the 5-year average. Commercial, irrigation, and manufacturing stayed mostly consistent. Due to this, the proportion of public water supply increased slightly, matched by a decrease in each other category except irrigation. The public water supply and manufacturing use-types continue to be the largest withdrawals in the state.

Figure 11: Groundwater + Surface Water Withdrawals, 2018-2022 Average and 2022 Total

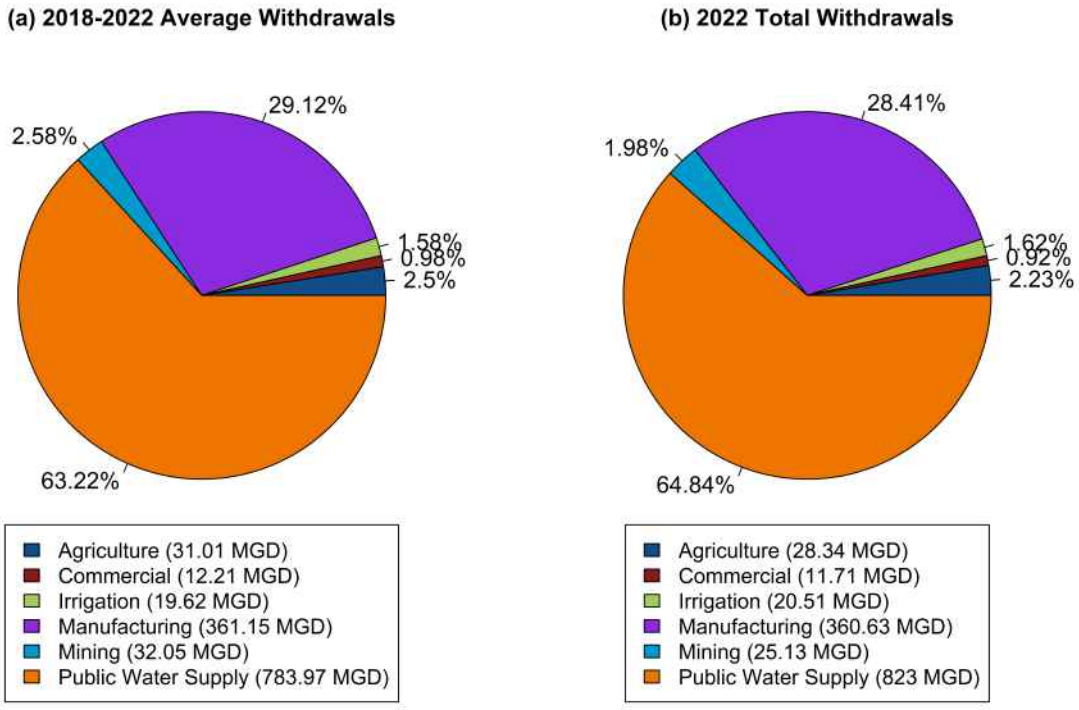


Figure 12: Groundwater Withdrawals, 2018-2022 Average and 2022 Total

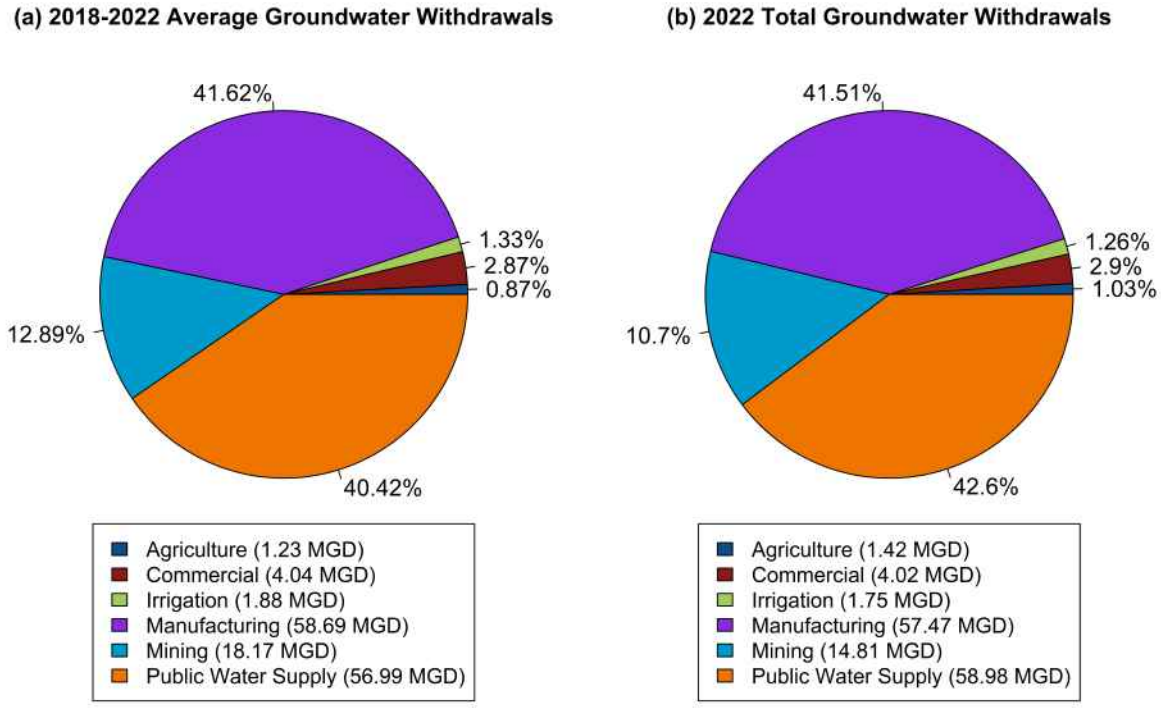
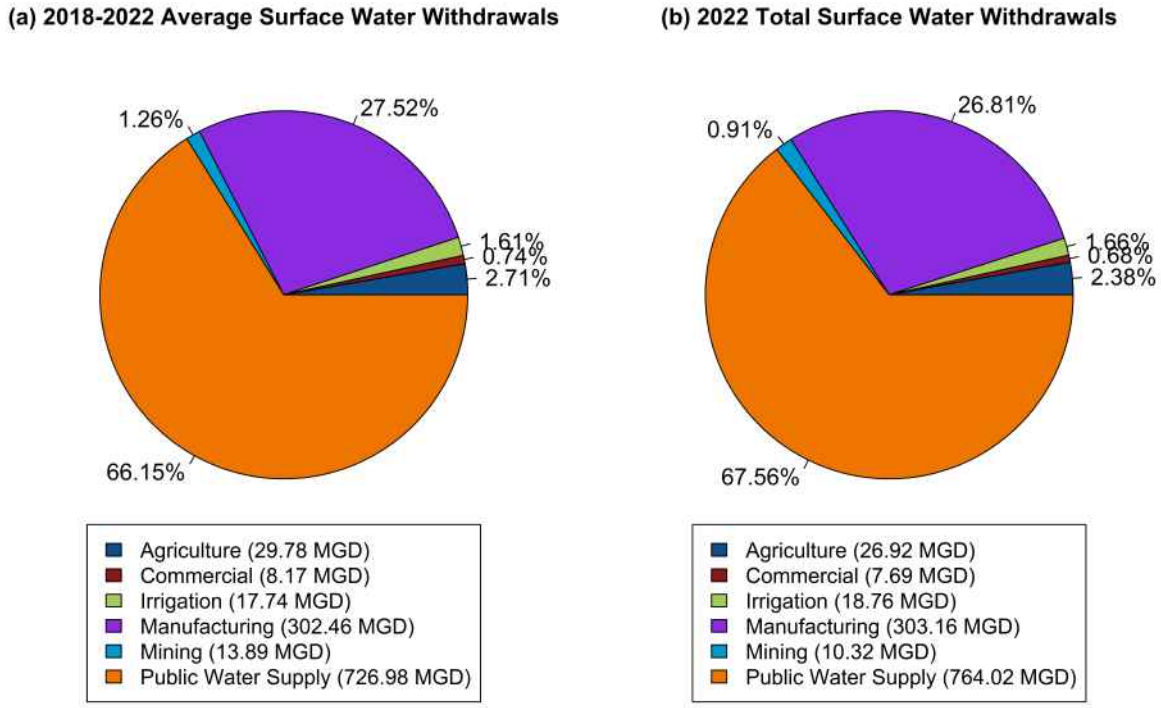


Figure 13: Surface Water Withdrawals, 2018-2022 Average and 2022 Total



3.2 Water Use Category Specific Section Overview

Each of the following sections includes the following for the relevant use-type category:

- A map depicting withdrawal point locations for each category, scaled by the magnitude of the 2022 reported annual withdrawal rate of individual measuring points (wells and surface water intakes)
- A table that lists reported withdrawals for the five-year period between 2018 and 2022 in terms of an annual average rate by source type (groundwater or surface water)
- A bar graph illustrating the reported quantity withdrawn for each source type (groundwater or surface water) between 2018 and 2022, as well as the withdrawal amounts relative to the five-year average
- A table listing facilities reporting the largest withdrawals for 2022, facility location, reported 2022 annual withdrawal rate, and the average annual withdrawal rate for the five-year period from 2018 to 2022

3.3 Public Water Supply

Water withdrawals for public water supply are primarily delivered to domestic users by both municipal and non-municipal community water systems; however, significant volumes are also delivered to commercial and industrial customers by water suppliers. Deliveries to specific users are generally not reported to DEQ; therefore, the reported withdrawals for public water supply do not differentiate between the categories of end users.

While most reporting public water systems are small systems that use groundwater (over 80%), the majority of the population in Virginia is served by large surface water systems with extensive service areas. The largest public water supply withdrawals are located within or near population centers such as the Washington D.C., Richmond, Hampton Roads, and Roanoke metropolitan areas. The largest public water supply purchases are located in the same areas, where water purveyors with large reservoirs or river withdrawals are able to supply both the population within their localities as well as, in some cases, neighboring localities. Smaller public water supply systems are spread throughout the state serving small towns or communities. Figure 14 shows spatial locations and size of water use of public water supply systems across the Commonwealth.

Figure 14: All 2022 Public Water Supply Water Withdrawals by Withdrawal Point Location

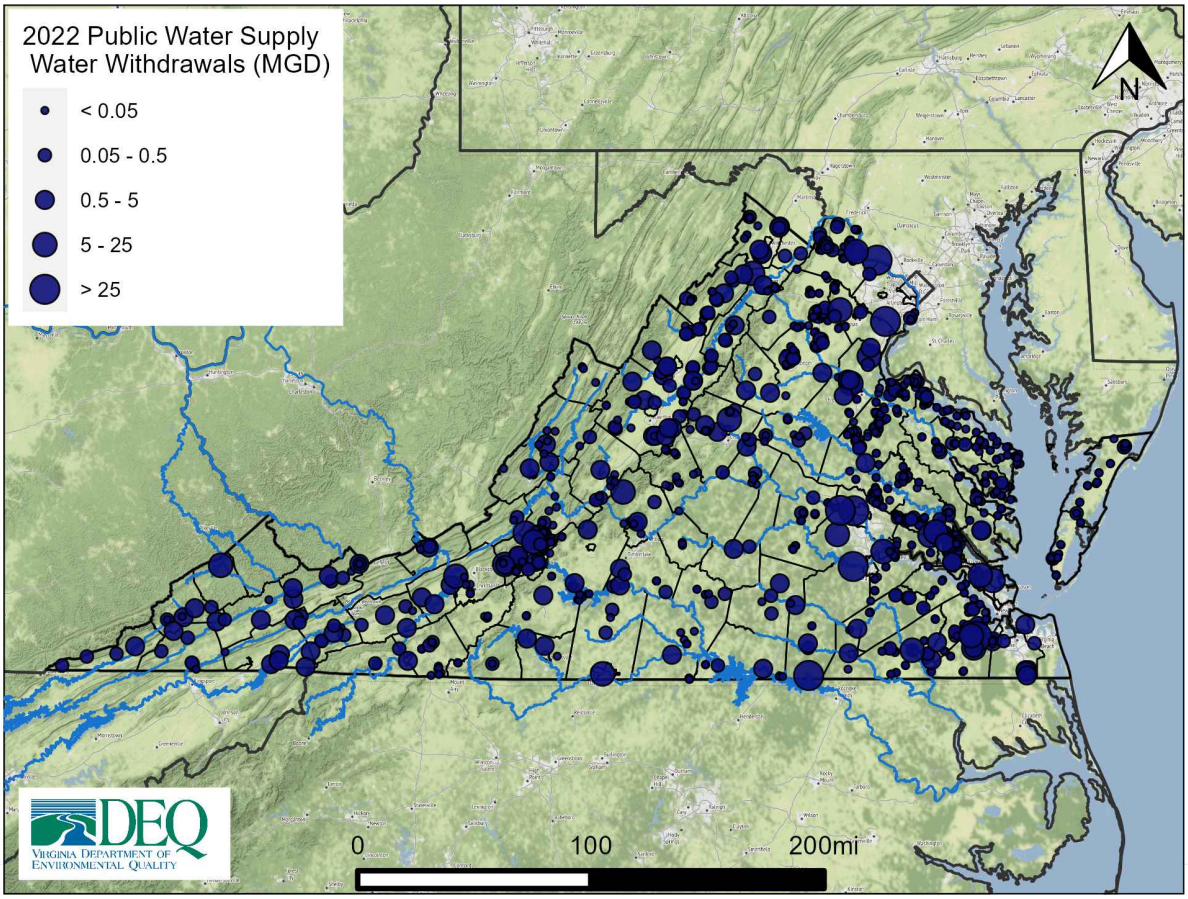


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Table 3: 2018 - 2022 Public Water Supply Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater	55.27	55.13	55.82	59.75	58.98	56.99	3.5
Surface Water	727.72	727.44	671.65	744.07	764.02	726.98	5.1
Total (GW + SW)	**782.99**	**782.56**	**727.47**	**803.82**	**823.00**	**783.97**	**5.0**

Water withdrawals for public water supply make up 64.8% of all non-power generation withdrawals in Virginia, so changes in this category can impact overall reported water use significantly. Reported 2022 water withdrawals for public water supply increased by 5.0% when compared to the average of the previous five years (see Table 3). A 5.1% increase in reported surface water withdrawals for public water supply water is the major driver of overall increases in this category, as surface water supplied 93% of the total reported withdrawals for 2022 public water supply. Reported groundwater withdrawals for public water supply increased by 3.5% compared to the five-year average.

There is an increasing trend in public water supply withdrawals reported over the last ten years (see Figure 15). Despite successes in reducing per capita water use, reported public water supply withdrawals have steadily increased over the last ten years as Virginia's population continues to grow in the urban and suburban areas served by public water supplies. The decrease in 2020 public water supply use is an outlier largely attributed to temporary closures and other mitigation strategies due to the COVID-19 pandemic.

Tables 4 and 5 list the five public water supply facilities that reported the largest groundwater and surface water withdrawals in 2022 respectively. Table 6 displays information supplied by VDH regarding the number of public water supply systems by type and the total population served by all such systems.

Figure 15: 2013-2022 Public Water Supply Water Withdrawal Trend

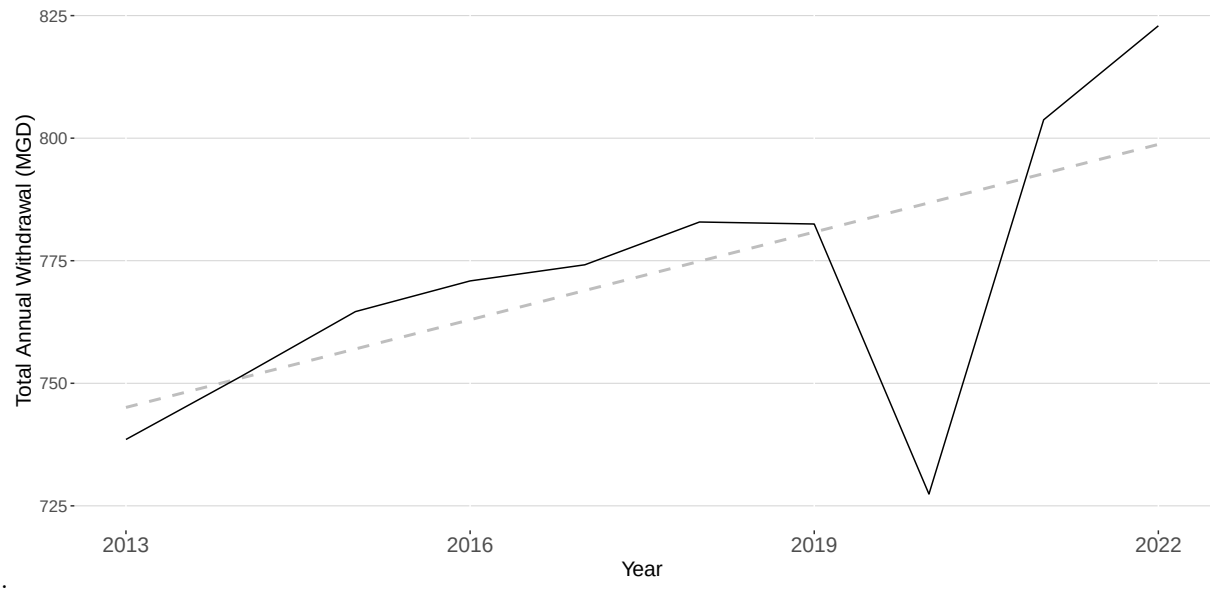

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Figure 16: 2018-2022 Public Water Supply Water Withdrawals by Source Type

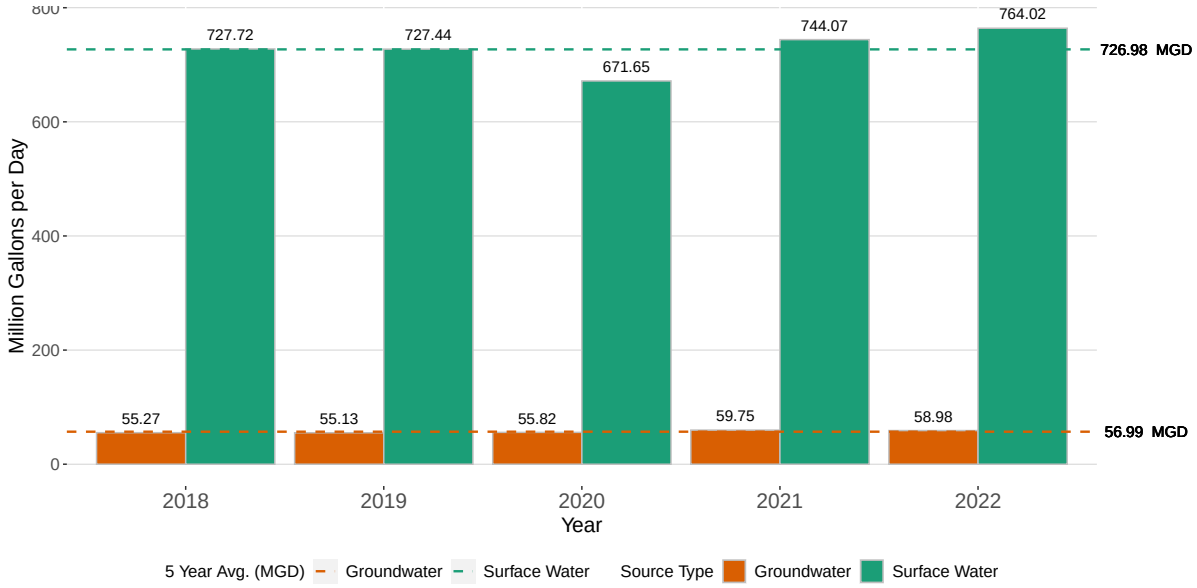

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Table 4: Highest Reported Public Water Supply Groundwater Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
James City Service Authority Central System	James City County	GW	5.2	5.3
Western Tidewater Water Authority	City of Suffolk	GW	3.6	4.0
Northwest River/Western Branch Systems	City of Chesapeake	GW	3.3	3.8
Three Springs Service Area	Rockingham County	GW	2.8	3.0
Frederick County Sanitation Authority	Frederick County	GW	2.0	2.5

Table 5: Highest Reported Public Water Supply Surface Water Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Fairfax Water: Corbalis WTP	Fairfax County	SW	86.2	82.1
City of Richmond WTP	City of Richmond	SW	66.6	68.2
Fairfax Water: Griffith WTP	Prince William County	SW	64.6	67.5
City of Norfolk: Western Branch Reservoir	City of Suffolk	SW	66.0	51.7
Virginia Beach Service Area	City of Virginia Beach	SW	30.2	43.6

Table 6: Number of Public Water Supply Systems and Population Served in 2022

Category	Community Water Systems	Nontransient Noncommunity Water Systems	Transient Noncommunity Water Systems	Total
Number of Systems	1,076	505	1,248	2,827
Population Served	7,300,801	286,743	194,298	7,781,842

3.4 Agriculture (Non-Irrigation)

Withdrawals for agriculture include non-irrigation withdrawals from livestock, poultry, and fish farms. Information concerning agricultural irrigation withdrawals is provided in the "Irrigation (Agricultural) Water Withdrawals" section 3.5 below. In total, withdrawals for non-irrigation agriculture make up 2.2% of all reported 2022 non-power generation withdrawals in Virginia. Figure 17 shows the spatial distribution of reported 2022 groundwater and surface water withdrawals for agricultural purposes statewide, with the highest number of withdrawals located on the Eastern Shore, within the Shenandoah Valley, and within the Virginia Coastal Plain. Table 7 provides the reported agriculture non-irrigation withdrawals in total as well as by source for the last five years. Overall, reported use in this category dropped by 8.6% compared to the five-year average, driven by reductions in surface water withdrawals. The majority of water withdrawn for agricultural use is obtained from surface water (see Figure 18), primarily via springs located in western Virginia that support fish farms and hatcheries, including those operated by the Department of Wildlife Resources. Reported 2022 surface water withdrawals for agriculture uses decreased by 9.6% compared to the five-year average. This continues the downward trend of surface water agricultural use.

Figure 17: All 2022 Agriculture (Non-Irrigation) Water Withdrawals by Withdrawal Point Location

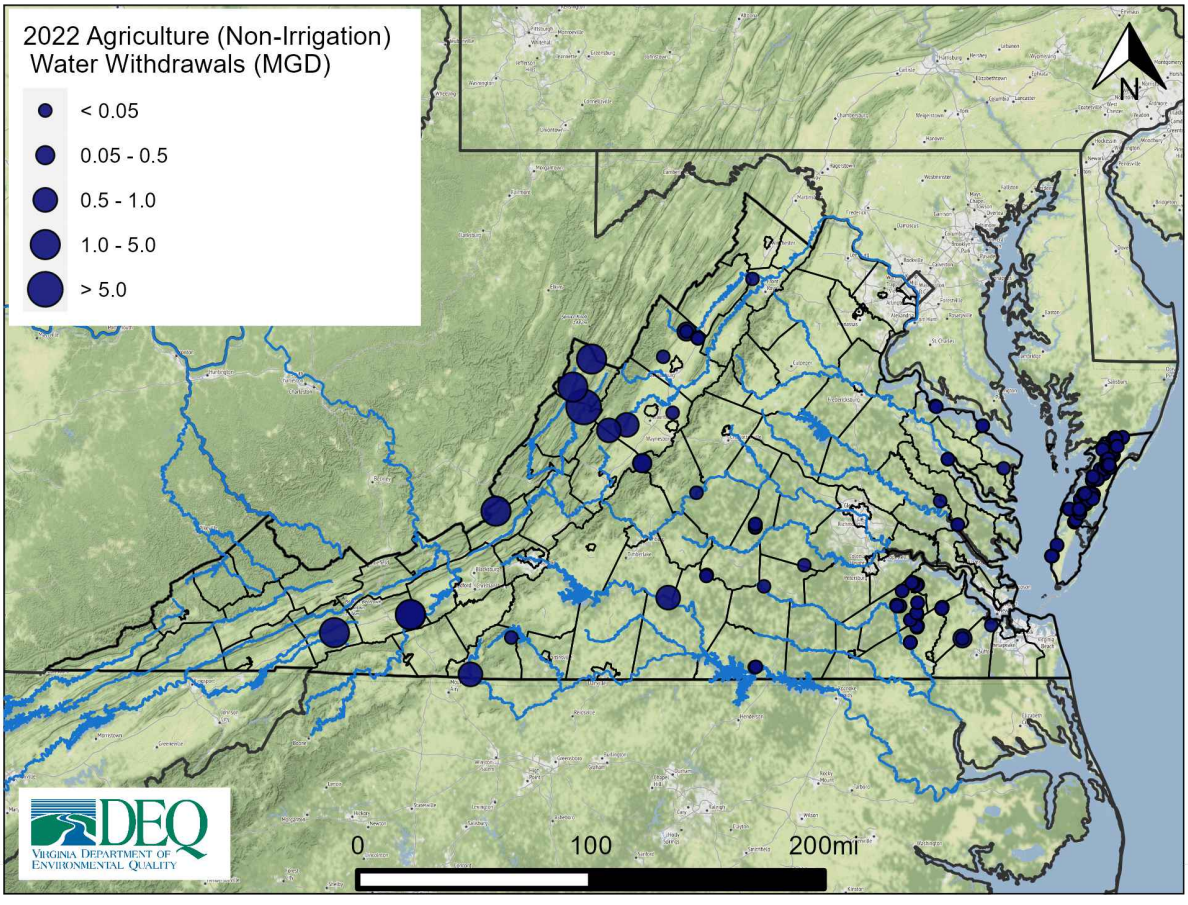

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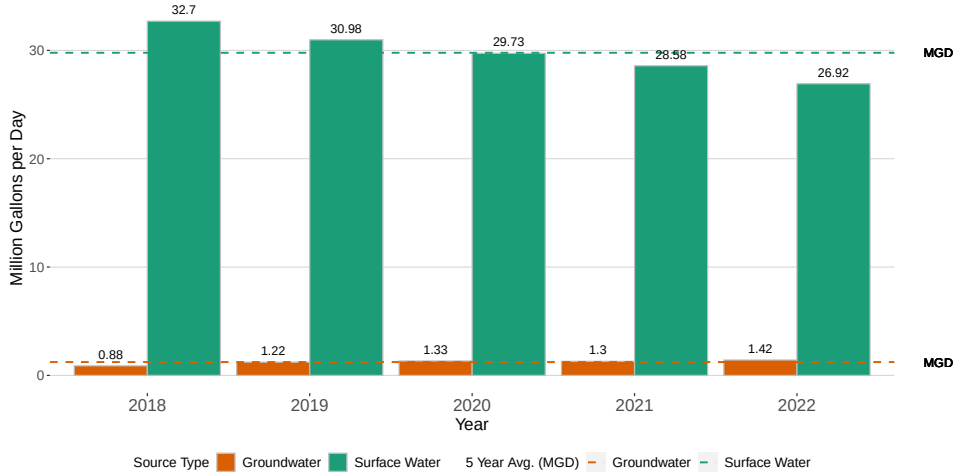
Figure 18: 2018-2022 Agriculture Water Withdrawals by Source Type



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Although surface water is the primary source by volume, the majority of farms reporting agriculture withdrawals make use of groundwater sources as well. Groundwater is generally used as a supplement for surface water during droughts or during high-flows where turbidity or water quality issues can limit use of surface water. Reported groundwater withdrawals increased by 15.4% when compared to the five-year average, an increase of approximately 190,000 gallons per day. The major driver for this increase was a series of hog farms in Sussex and Surry county.

Table 8 lists the five facilities reporting the largest withdrawals for non-irrigation agriculture use in 2022, all of which are fish hatcheries. Note that most fish hatcheries typically have little to no consumptive use.

Table 7: 2018 - 2022 Agriculture Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater	0.88	1.22	1.33	1.30	1.42	1.23	15.4
Surface Water	32.70	30.98	29.73	28.58	26.92	29.78	-9.6
Total (GW + SW)	**33.58**	**32.20**	**31.06**	**29.88**	**28.34**	**31.01**	**-8.6**

Table 8: Highest Reported Agriculture Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Coursey Spring Fisheries	Bath County	SW	11.8	9.5
Wytheville Fish Hatchery	Wythe County	SW/GW	3.2	3.2
Marion Fish Cultural Station	Smyth County	SW	3.1	3.0
Paint Bank Fish Cultural Sta.	Craig County	SW	3.3	2.9
Laurel Hill Trout Farm-South Monterey	Highland County	SW	3.1	2.9

3.5 Irrigation (Agricultural)

Agricultural irrigation withdrawals are associated with farms irrigating crops such as corn, soybeans, sod, as well as nursery products. Water withdrawals from agricultural irrigation made up 1.6% of all non-power generation withdrawals in Virginia for 2022, totaling 20.51 MGD in reported withdrawals. Figure 19 illustrates the distribution of reported 2022 groundwater and surface water withdrawals for irrigation purposes statewide. As with previous years, most large-scale irrigation facilities are located in the Coastal Plain, the Eastern Shore, and Shenandoah Valley. Reported water withdrawals for irrigation in 2022 were 4.5% more than the five-year average (Table 9). The increased withdrawals may be the result of a drier growing season in 2022 compared to average, leading to additional irrigation needs. Surface water continues to be the major water source type for irrigation, representing approximately 91.5% of 2022 total irrigation withdrawals (Figure 20).

The five facilities reporting the highest withdrawals for irrigation in 2022 are listed in Table 10.

Figure 19: All 2022 Irrigation (Agricultural) Water Withdrawals by Withdrawal Point Location

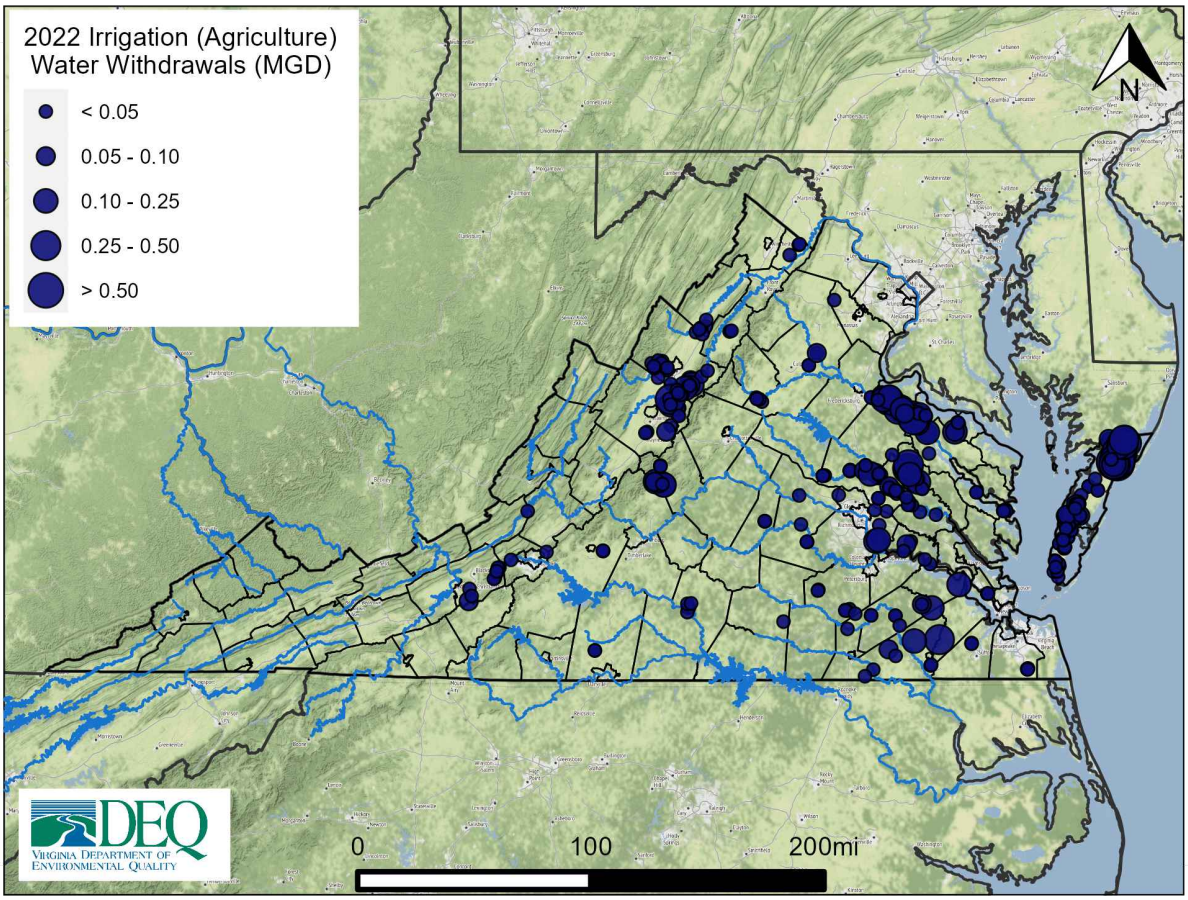

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Table 9: 2018 - 2022 Irrigation Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater	1.80	2.01	1.93	1.89	1.75	1.88	-6.9
Surface Water	12.89	20.12	15.78	21.16	18.76	17.74	5.7
Total (GW + SW)	**14.69**	**22.13**	**17.71**	**23.05**	**20.51**	**19.62**	**4.5**

Figure 20: 2018-2022 Irrigation Water Withdrawals by Source Type

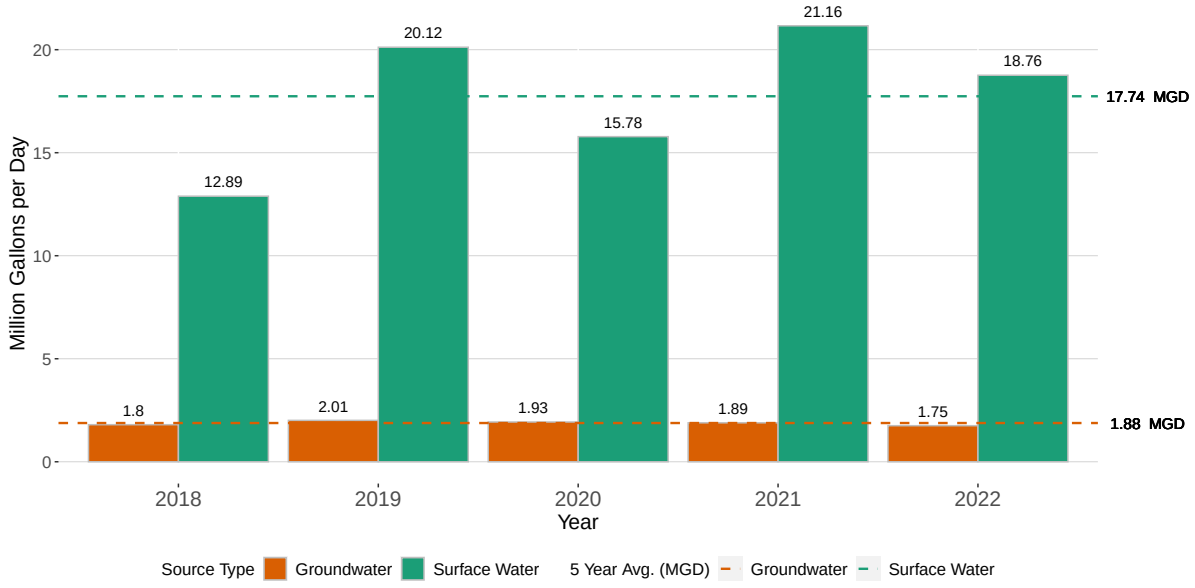

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Table 10: Highest Reported Irrigation Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Arbuckle Farms	Accomack County	SW	3.0	3.7
Dublin Farms Inc.	Accomack County	SW	2.0	2.6
Glenwood	King and Queen County	SW	1.2	1.3
Saunders Brothers, Inc.	Nelson County	SW/GW	1.0	0.9
Woodlawn \ Walsingham Farms	King George County	SW	0.6	0.8

3.6 Commercial

Commercial operations include golf courses, universities, hotels, resorts, and other similar entities. Water withdrawals from commercial activities make up 0.92% of all reported non-power generation withdrawals in Virginia. Figure 21 illustrates the distribution of reported 2022 groundwater and surface water withdrawals for commercial purposes, which are located predominantly near population centers. Reported commercial water withdrawals decreased by 4.1% compared to the five-year average (Table 11), and continued to rely primarily on surface water sources (Figure 22). Withdrawals had fallen by almost 25% from 2019 to 2020 (compared to average), likely as a result of the COVID-19 pandemic. Commercial withdrawals have since increased, but reported commercial withdrawals are still well below the pre-pandemic volume of 14.5 MGD in 2019. The five facilities reporting the largest 2022 water withdrawals for commercial operations are listed in Table 12. 2022 withdrawal volumes for the top five users are consistent with the five-year average.

Figure 21: All 2022 Commercial Water Withdrawals by Withdrawal Point Location

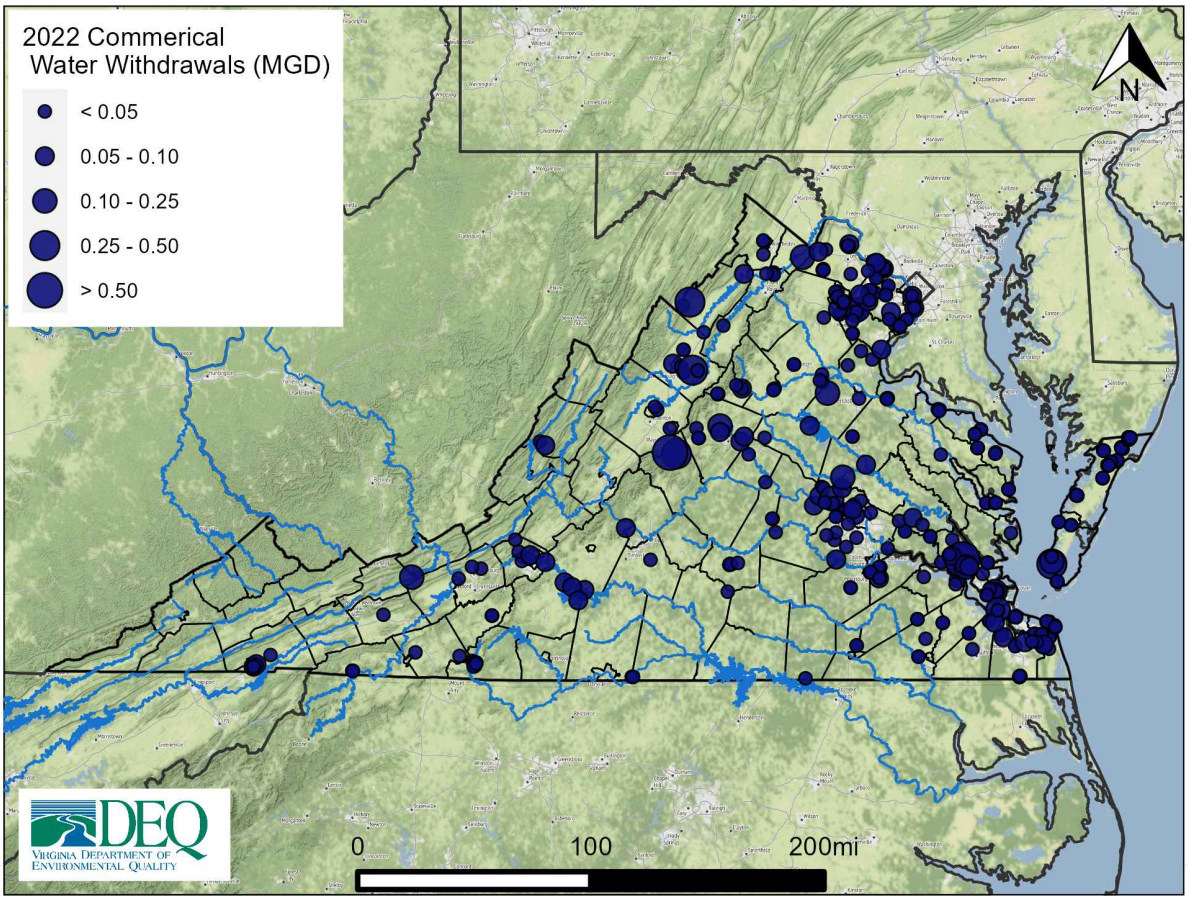

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Table 11: 2018 - 2022 Commercial Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	multi_yr_avg	% Change 2022 to Avg.
Groundwater	3.90	4.52	3.64	4.11	4.02	4.04	-0.5
Surface Water	7.98	9.94	6.38	8.84	7.69	8.17	-5.9
Total (GW + SW)	**11.88**	**14.47**	**10.02**	**12.95**	**11.71**	**12.21**	**-4.1**

Figure 22: 2018-2022 Commercial Water Withdrawals by Source Type

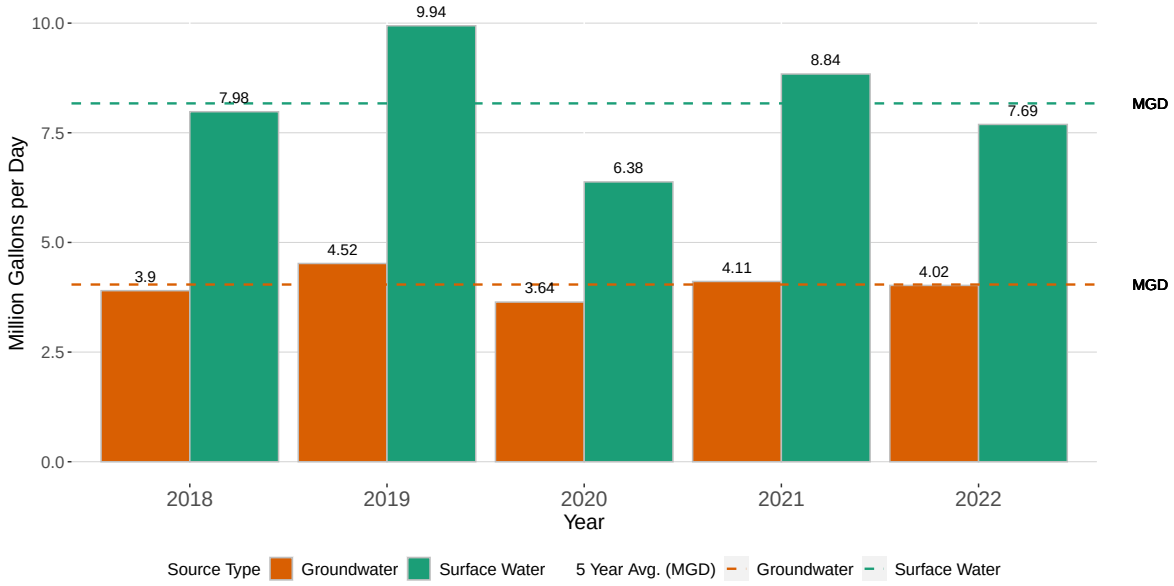

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Table 12: Highest Reported Commercial Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Colonial Williamsburg	City of Williamsburg	GW	1.0	1.1
Lake Monacan-Stoney Creek (Wintergreen)	Nelson County	SW	0.9	1.0
Bay Creek Resort & Club	Northampton County	SW	0.5	0.4
Kingsmill Resort	James City County	SW/GW	0.1	0.3
Massanutten Resort Surface Water Withdrawal Project	Rockingham County	SW	0.3	0.3

3.7 Mining

The mining use category includes withdrawals for operations such as sand and gravel, rock, and coal mining. Reported water withdrawals from mining operations were approximately 2.0% of all non-power generation withdrawals in Virginia. Figure 23 illustrates the distribution of reported 2022 groundwater and surface water withdrawals for mining purposes statewide. The majority of stone and sand mining facilities are located along the Interstate 95 corridor. Additional stone and coal mining withdrawals are located in southwestern Virginia. Total reported water withdrawals for mining purposes in 2022 decreased by 21.6% as compared to the five-year average (Table 13). While several mines across Virginia reported a decrease in water use compared to 2021, the significant change this year can be attributed mostly to a large mining facility in Giles County becoming inactive. This decrease was seen from both groundwater and surface water usage. In 2022, the majority of reported withdrawals for mining continued to be from groundwater sources (Figure 24). This is largely due to the dewatering of the water table that must be completed for many types of mining to prevent flooding, which is done through wells constructed in the water table. Such withdrawals are reported under groundwater withdrawals. The five facilities reporting the largest 2022 mining withdrawals are listed in Table 14.

Figure 23: All 2022 Mining Water Withdrawals by Withdrawal Point Location

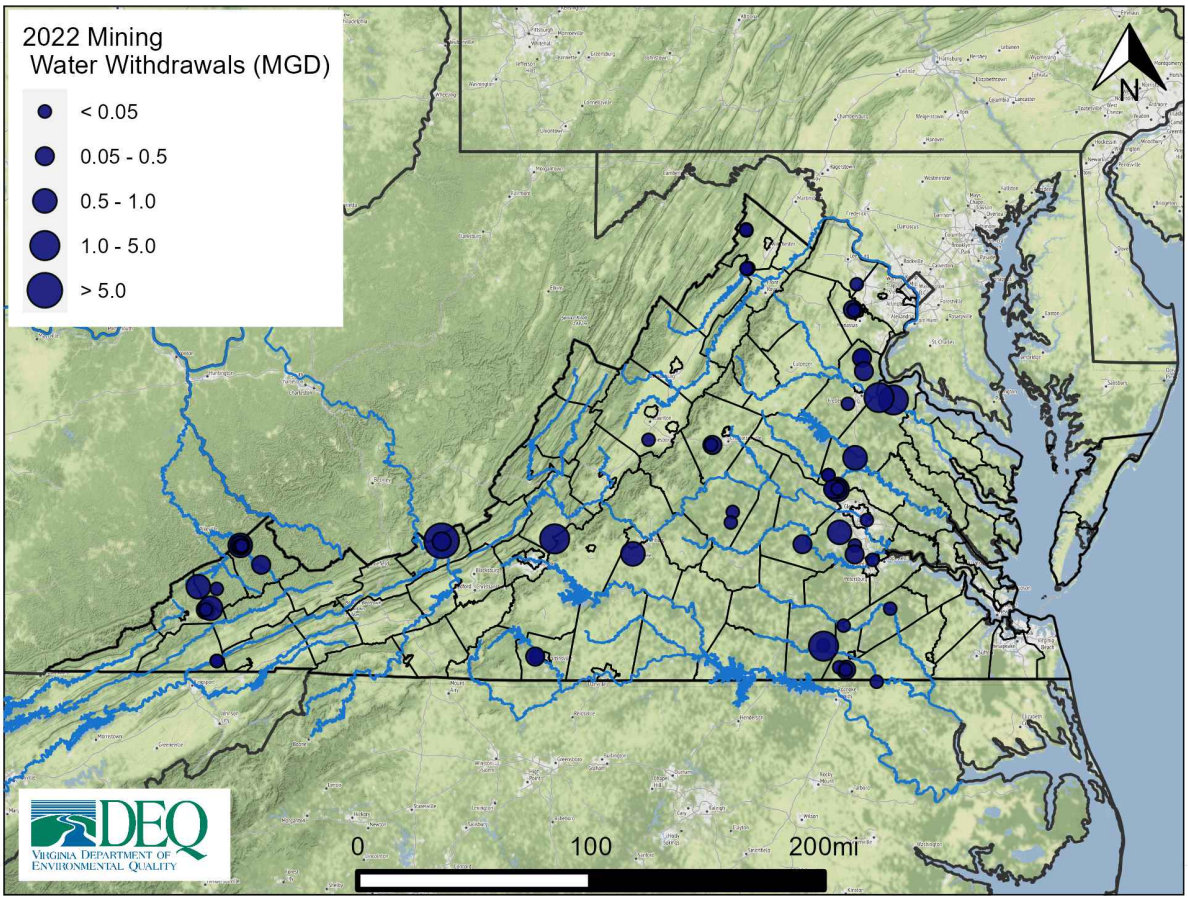

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Table 13: 2018 - 2022 Mining Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater	18.04	17.57	19.69	20.72	14.81	18.17	-18.5
Surface Water	16.84	13.74	15.62	12.91	10.32	13.89	-25.7
Total (GW + SW)	**34.88**	**31.31**	**35.31**	**33.63**	**25.13**	**32.05**	**-21.6**

Figure 24: 2018-2022 Mining Water Withdrawals by Source Type

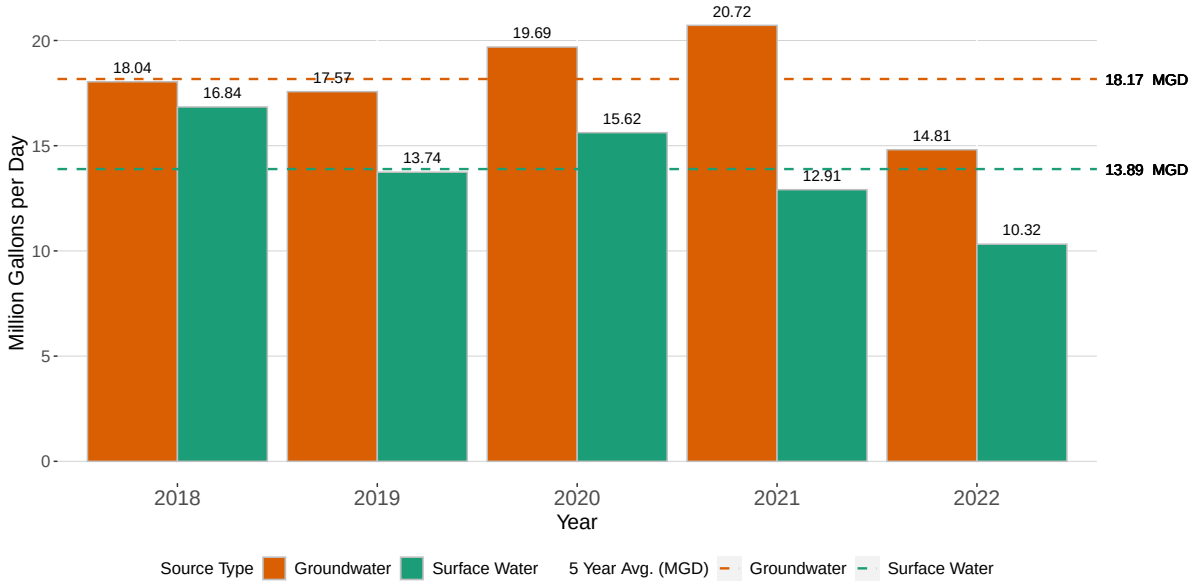

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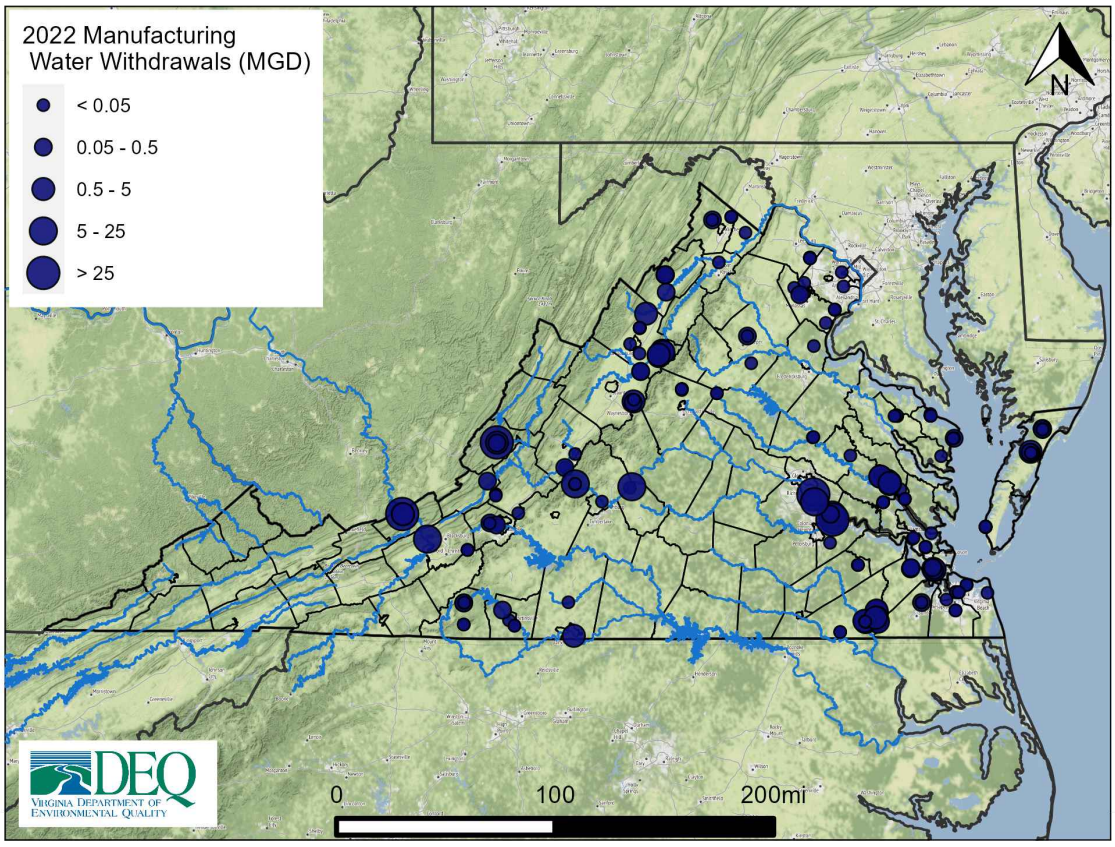
Table 14: Highest Reported Mining Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Lhoist North America Kimballton Plant 1	Giles County	GW	12.1	13.1
Boxley Materials Company Blue Ridge Plant	Bedford County	GW	1.8	1.3
Hayfield Sand And Gravel	Caroline County	SW	0.5	1.1
Rappahannock Farms Sand & Gravel	King George County	SW	1.3	1.1
Vulcan Construction Materials Lawrenceville Quarry	Brunswick County	SW/GW	1.4	1.0

3.8 Manufacturing

The manufacturing use category includes industrial operations such as chemical and plastics manufacturing, paper mills, food processors, and other manufacturing related withdrawals. Water withdrawals from manufacturing users accounted for 28.4% of all reported non-power generation withdrawals in Virginia in 2022. Manufacturing water withdrawals are spread throughout much of Virginia (Figure 25) with facilities found in both rural and urban areas. The major determining factor for siting manufacturing facilities is access to sufficient quantity and quality of water, whether it be groundwater or surface water. Clusters of large-scale manufacturing withdrawals occur in the Middle James River Basin around the City of Richmond, as well as in the New and the Upper James river basins. Facilities located in the Coastal Plain generally rely on groundwater with wells constructed in the productive Potomac Aquifer or along productive fractures in the Western region of the State. All of the locations with large surface water withdrawals are situated on or near major rivers to facilitate water supply.

Figure 25: All 2022 Manufacturing Water Withdrawals by Withdrawal Point Location



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Reported 2022 manufacturing withdrawals decreased by 0.1% compared to the five-year average, although there was a slightly larger drop (2.3%) compared to last year's withdrawals, as shown in Table 15. Surface water is the predominate water source type for manufacturing, accounting for approximately 84% of reported withdrawals in 2022 (See Figure 26).

Table 16 lists the five facilities reporting the largest groundwater withdrawals associated with this category in 2022, and Table 17 lists the five facilities reporting the largest surface water withdrawals associated with this category in 2022.

Table 15: 2018 - 2022 Manufacturing and Industrial Water Withdrawals by Source Type (MGD)

Source Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater	60.57	57.76	58.00	59.67	57.47	58.69	-2.1
Surface Water	304.17	293.49	301.92	309.55	303.16	302.46	0.2
Total (GW + SW)	**364.74**	**351.25**	**359.92**	**369.22**	**360.63**	**361.15**	**-0.1**

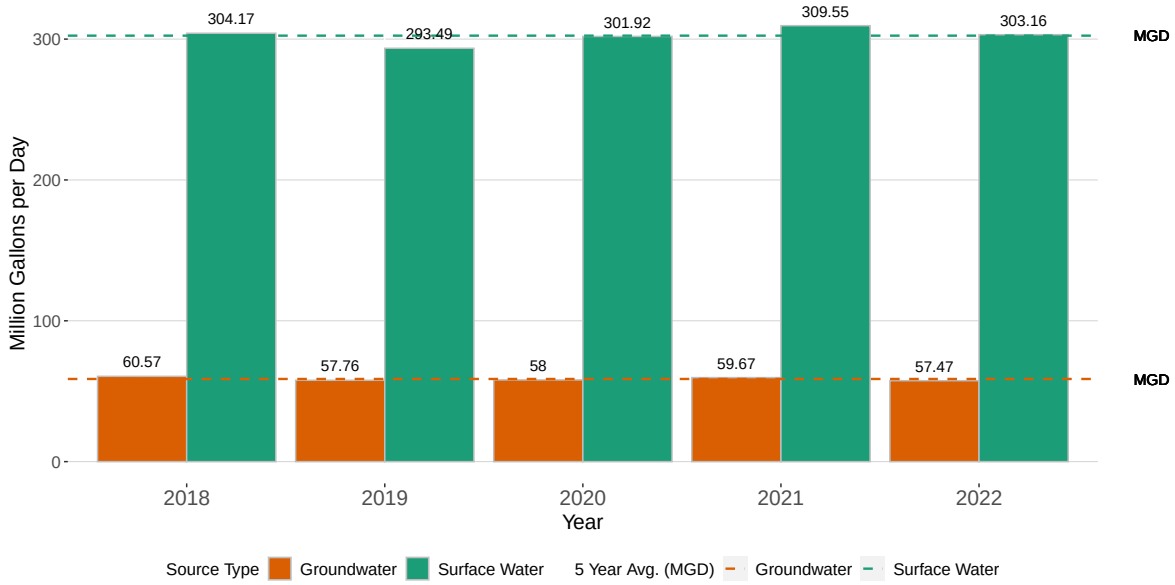
Table 16: Highest Reported Manufacturing and Industrial Groundwater Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
WestRock CP, LLC: West Point Mill Water System	King William County	GW	16.4	16.2
International Paper: Franklin Virginia Mill	Isle of Wight County	GW	14.0	14.0
Merck & Co: Elkton Plant	Rockingham County	GW	5.9	5.8
Celanese Acetate LLC: Celco Plant	Giles County	GW	5.5	4.9
The LYCRA Company: Waynesboro Plant	City of Waynesboro	GW	3.9	3.6

Table 17: Highest Reported Manufacturing and Industrial Surface Water Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
AdvanSix Resins & Chemicals: Hopewell Plant	City of Hopewell	SW	101.8	99.9
Celanese Acetate LLC: Celco Plant	Giles County	SW	53.7	53.2
WestRock Virginia Corporation: Covington Plant	Alleghany County	SW	37.7	38.9
Dupont E I De Nemours & Co: Spruance Plant	Chesterfield County	SW	24.1	27.9
U.S. Radford Ammunitions WTP 1	Montgomery County	SW	19.4	20.7

Figure 26: 2018-2022 Manufacturing Water Withdrawals by Source Type



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3.9 Power Generation

The power generation use category includes water withdrawn for fossil fuel power and nuclear power. Withdrawals or diversions of water for hydroelectric power (hydropower) generation are nearly all non-consumptive and are exempt from the annual water withdrawal reporting requirements. As a result, a detailed description for hydropower is not included; however, a brief discussion of consumptive use of water is provided in Chapter 2.2.

The largest power generation facilities are located in central and eastern Virginia (see Figure 27), including two nuclear-power generating plants located in Louisa and Surry counties, which alone account for approximately 64.5% of all reported withdrawals in 2022, although most of the water withdrawn for these facilities is returned to the source after use for cooling. Total power generation withdrawals in 2022 decreased by 1.7% as compared to the five-year average (Table 18). This was driven by a decrease in both fossil fuel and nuclear power. Total power withdrawals increased slightly from 4,389 MGD last year to 4,431 MGD in 2022, but 2022 withdrawals are still below the 5 year average. Groundwater withdrawals reported by power generation facilities in 2022 remain insignificant compared to surface water withdrawals, which is consistent with historical trends (Figure 28). The five power generation facilities with the highest reported withdrawals are listed in Table 19. Four of the five facilities saw a decrease in water usage as compared to the five-year average.

Figure 27: All 2022 Power Generation Water Withdrawals by Withdrawal Point Location

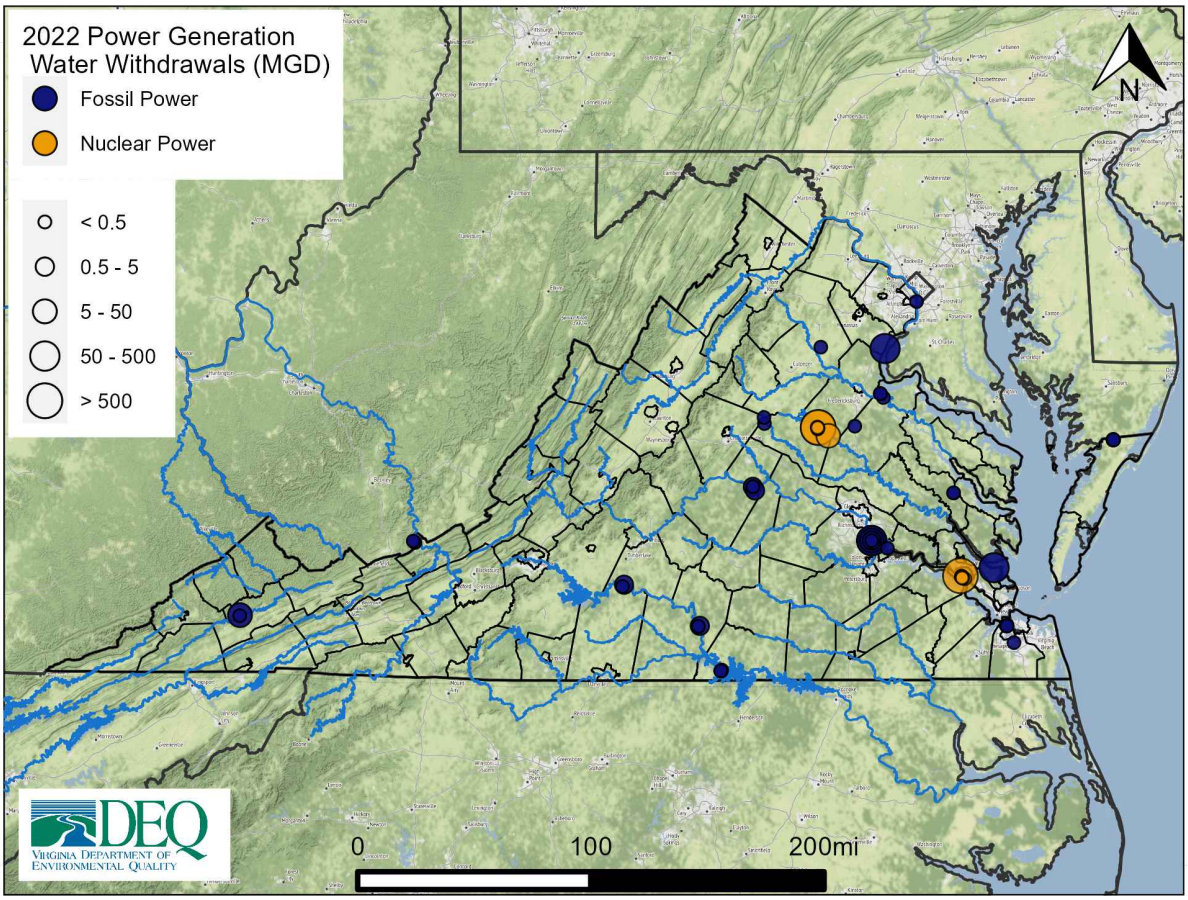

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Table 18: 2018 - 2022 Power Generation Water Withdrawals by Source Type (MGD)

Power Type	2018	2019	2020	2021	2022	5 Year Avg.	% Change 2022 to Avg.
Groundwater							
Fossil	0.12	0.07	0.07	0.06	0.07	0.080	-12.5
Nuclear	0.38	0.37	0.36	0.37	0.29	0.350	-17.1
Total Groundwater	0.50	0.44	0.43	0.43	0.36	0.430	-16.3
Surface Water							
Fossil	1012.39	752.18	635.84	732.32	751.66	776.880	-3.2
Nuclear	3705.29	3739.35	3863.89	3656.36	3678.73	3728.720	-1.3
Total Surface Water	4717.68	4491.53	4499.73	4388.68	4430.39	4505.600	-1.7
Total (GW + SW)	**4718.18**	**4491.97**	**4500.16**	**4389.11**	**4430.75**	**4506.034**	**-1.7**

Figure 28: 2018-2022 Power Generation Water Withdrawals by Source Type

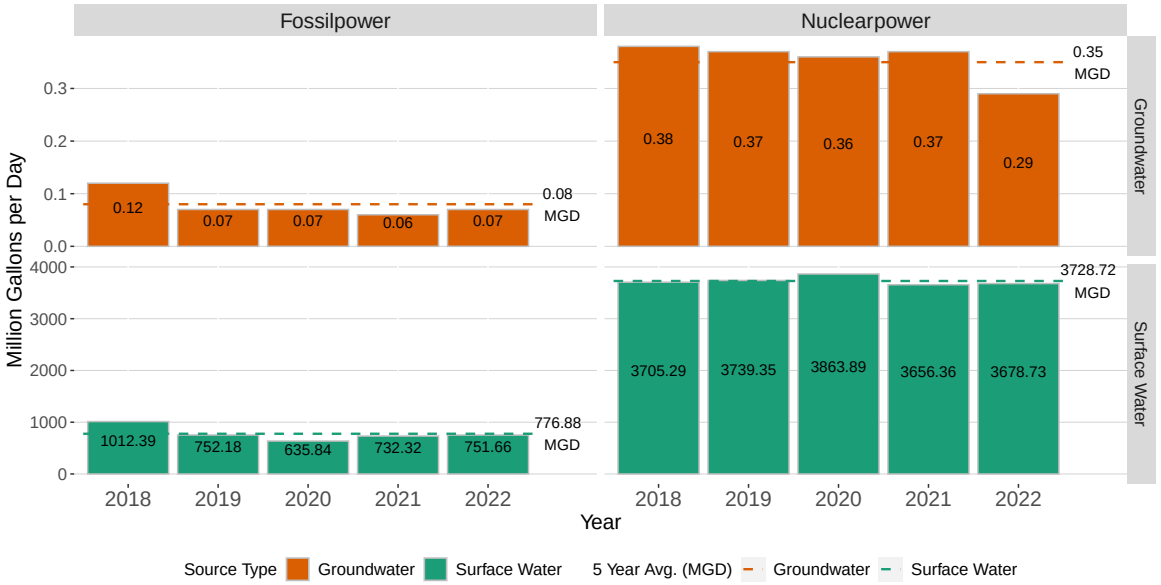

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Table 19: Highest Reported Power Generation Withdrawals in 2022 (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal
Surry Power Station	Surry County	SW/GW	1871.1	1860.4
North Anna Nuclear Power Plant	Louisa County	SW/GW	1858.0	1818.6
Chesterfield Power Station	Chesterfield County	SW	499.9	549.2
Yorktown Fossil Power Plant	York County	SW	208.0	130.3
Possum Point Power Station	Prince William County	SW	58.1	58.0

4 Water Resource Priorities and Challenges

The following section identifies new, continuing, and future priorities, challenges, or other topics of specific interest in terms of water resources management at DEQ. These include updates on new legislative or regulatory actions, programmatic goals and achievements, and other items.

4.1 Permitting Enhancement and Evaluation Platform (PEEP)

DEQ has initiated a new program called the Permitting Enhancement and Evaluation Platform (PEEP) that leverages technological improvements to foster transparency, collaboration, and efficiency in DEQ permit processes. The program will include public-facing online resources that convey and track the critical steps to obtain approvals from DEQ, including to the maximum extent practicable the steps needed from the applicant and other agencies. PEEP will be a Critical Path Management (CPM) tool that will assist permit writers, project managers, applicants and their agents, as well as the public, to understand the permit processes and steps needed to ensure timely decisions. This will increase transparency for external users and offer new ways for permit writers and managers to organize and monitor progress on applications. As of July 1, 2023 Virginia Water Protection (VWP) surface water withdrawal permits may be viewed in PEEP. Groundwater permitting activities are expected to be included in PEEP by early 2024.

4.2 Addressing Unreported Water Use

Another ongoing priority is evaluating and addressing unreported use below the regulatory threshold requiring withdrawal reporting (domestic or private well use for instance), and use above the regulatory threshold that is nonetheless not currently being reported. DEQ staff conduct compliance activities annually to identify users who meet the threshold for annual withdrawal reporting as well as to contact users who have previously reported but have failed to do so consistently. The extent of these contacts is highly dependent on available staff resources each year and must be balanced against other program responsibilities. In addition, DEQ works to address known gaps in this data through projects like the 2020-2021 USGS Water-Use Data and Research Grant project to develop estimates of unreported agricultural water use in Virginia (discussed in more detail in Chapter 1), which was completed in the fall of 2022.

In fiscal year 2022, DEQ contracted with the USGS to improve estimates of domestic use that falls below the reporting threshold. Previously, estimates of domestic use were at the county and annual resolutions. Using land use / land cover data sets, DEQ and VDH well construction database information, and census population data, the spatial resolution of domestic use was improved within the county level. The finer spatial resolution and updated aquifer depths improved the estimated distribution of aquifer use. Additionally, using monthly level DEQ annual water withdrawal reporting data, seasonal patterns of use were incorporated into the estimates.

In fiscal year 2022, DEQ contracted with the USGS to establish a new baseline estimate and a method to annually update these estimates of domestic and private groundwater use. This information is used to inform the total pumping used for groundwater modeling scenarios that determine the water available to each permittee. It is increasingly important to keep this information updated from year to year to ensure that decisions are made based on the most up to date information. DEQ registers new private well information in groundwater management areas via water well completion forms that will be used by USGS and DEQ, in conjunction with other data, to refine domestic use estimates. The most recent estimate of domestic groundwater withdrawals from aquifer systems in the Coastal Plain was more than 40 MGD, or over half the volume (66 MGD) of the reported groundwater withdrawals associated with permitted facilities referenced in the 2019-2020 Virginia Coastal Plain Model Report.[9] As Virginia's population continues to grow, it will be important to update these estimates to better inform water availability in the Coastal Plain aquifers.

[9] Virginia Coastal Plain Model (VAHydroGW-VCPM) 2019-2020 Annual Simulation of Potentiometric Groundwater Surface Elevations of Reported and Total Permitted Use.

4.3 Eastern Virginia Groundwater Management Area

Hampton Roads Sanitation District's (HRSD) Sustainable Water Initiative for Tomorrow Project (SWIFT) pilot program offers reason for cautious optimism. A pilot injection well at HRSD's SWIFT Research Center is providing field data on how injections impact pressure in the Potomac and overlying aquifers.[10] The center currently collects data from observation wells and from an extensometer operated by USGS which measures changes in land elevation in response to the injection. These data are critical to evaluating model results and calibrating the model with respect to the simulation of the proposed injections. In 2022, DEQ geologists assisted in selection of an additional extensometer site at the HRSD West Point Operation Center. Installation began in April 2023, and will complete the Eastern Virginia network of four extensometers. The first full-scale injection facility is nearing completion of the EPA Underground Injection Control Permit process for the HRSD James River Plant. Once completed this project may be capable of injecting up to 16 MGD to augment the Potomac Aquifer. If the final permit is issued, it will remain in effect for 10 years. The project is projecting construction of of all facilities over a ten year period, with full scale operations by 2030.

Recent legislation has paved the way for the first general permits from the surficial (water table) aquifer for groundwater withdrawals in the Eastern Virginia and Eastern Shore GWMAs for irrigation and agricultural use respectively. These general permits will offer a streamlined permit process and are intended to increase withdrawals from the surficial (water table) aquifer, which recharges more readily, and thereby reduce withdrawals from confined aquifers. Withdrawals from confined aquifers such as the Potomac Aquifer cannot be permitted under these general permits given the technical criteria that must be evaluated for withdrawals from a confined aquifer.

4.4 Eastern Shore Groundwater Management Area

In 2019, an update to the Hydrogeologic Framework of the Virginia Eastern Shore, a joint effort between USGS and DEQ was published.[11] This study was a substantial update to the prior hydrogeologic framework, which was published in 1994, and included significant improvements in the understanding of the saltwater-fresh water interface, and the location and effect of paleochannels on aquifer flow patterns and well yields. This work was made possible by data collected through the groundwater withdrawal permit program and the work of DEQ geologists. A new Eastern Shore groundwater model is nearing completion. The new model will include the updated hydrogeologic information and the results of a detailed review of water use, including better characterization of surficial aquifer use. The new model incorporates the new framework and water use data including domestic use estimates.

4.5 Evaluating Impacts to Aquatic Life from Surface Water Withdrawals

In managing water resources to protect all beneficial uses, the expectation is that DEQ use the most current science and best available evaluation methods when reviewing project impacts. Two DEQ-led publications[12] [13] in the Journal of American Water Resources Association present a new method of evaluating impacts on species richness as a result of changes in flow: the elfgen R package. This work was selected as the best technology paper by the Journal's editors in 2021. The technique will allow for project-scale evaluation of potential aquatic impacts to be completed at less cost to applicants than traditional field methods such as Instream Flow Incremental Methodology while resulting in similar data value.

[10] https://www.hrsd.com/swift/about

[11] McFarland, E.R., and Beach, T.A., 2019, Hydrogeologic framework of the Virginia Eastern Shore: U.S. Geological Survey Scientific Investigations Report 2019–5093, 26 p., 13 pl., https://doi.org/10.3133/sir20195093.

[12] Kleiner et al. - DOI: https://doi.org/10.1111/1752-1688.12876.

[13] Rapp et al. - DOI: https://doi.org/10.1111/1752-1688.12876.

4.6 Recent and Ongoing Legislative and Regulatory Actions

Over the past year, DEQ coordinated several regulatory actions related to water resources management in response to legislation passed by the General Assembly. A summary of each action and the current status is provided below:

- Legislation enacted following the 2019 General Assembly Session (2019 Va. Acts Ch. 755) directed the State Water Control Board (SWCB) to adopt regulations providing incentives, such as an expedited general permit process, for the withdrawal of groundwater from the surficial aquifer, rather than the confined aquifer, in the Eastern Shore GWMA. In 2019, DEQ published a Notice of Intended Regulatory Action to establish the framework for the issuance of a general permit for withdrawals from the surficial aquifer in the Eastern Shore GWMA as a way to incentivize surficial aquifer withdrawals. The final regulation was approved by the SWCB on December 14, 2021 and became effective December 21, 2022 (9VAC 25-910).

- Legislation enacted following the 2020 General Assembly Session (2020 Va. Acts Ch. 1105) requires the SWCB to adopt regulations designating regional planning areas based primarily on river basins, to encourage the development of cross-jurisdictional water supply projects, and to estimate the risk that each locality and region in the Commonwealth will experience water supply shortfalls. This law also directs localities to participate in cross-jurisdictional, coordinated water resource planning, and to develop a single water supply plan for each regional planning area. A Regulatory Advisory Panel (RAP) was formed and met six times during 2021-2022. Additional amendments were made following the 2022 General Assembly Session (2022 Va. Acts Ch.331) that provide a mechanism for a locality to request, subject to approval by the Department, a change of its designated regional planning area to an adjoining planning area. Proposed regulatory amendments were developed and presented to the SWCB on June 22, 2022. Amendments were approved by the SWCB and a public comment period concluded on July 21, 2023. Final amendments are expected to be developed and submitted to the SWCB in the Fall of 2023.

- Legislation enacted following the 2020 General Assembly Session (2020 Va. Acts Ch. 670) prohibits construction of wells for non-agricultural irrigation in aquifers other than the surficial (water table) aquifer, unless DEQ determines this aquifer is inadequate to meet the proposed beneficial use, once the SWCB adopts a general permit for regulation of withdrawals from the surficial aquifer. A Technical Advisory Committee was formed and met through June, 2021. The proposed regulation was approved by the SWCB on December 14, 2021, and a public comment period concluded on May 15, 2022. The SWCB approved the final regulation on June 22, 2022, and it became effective on November 9, 2022 (9VAC 25-920).

- Legislation enacted following the 2021 General Assembly Special Session I (2021 Special Session I Va. Acts Ch. 100) will improve the efficiency and effectiveness of water use by requiring all applications for VWP permits for surface water withdrawals and Ground Water Withdrawal permits to include: 1) a water auditing plan, and 2) a leak detection and repair plan that satisfy the requirements in regulations to be adopted by the SWCB. These plans would also, once approved, be incorporated by reference as conditions in the permit. A RAP was formed and it met four times. The proposed amendments are currently in executive review.

- Legislation enacted following the 2022 General Assembly Session (Chapter 356 of the 2022 Acts of Assembly) limits the authority of the SWCB to the issuance of regulations, and transfers the SWCB's existing authority to issue permits and orders to DEQ. DEQ addressed this statutory change in a substantial regulatory package provided to the SWCB on August 25, 2022.

Appendix 1: Top 20 Reported Water Withdrawals in 2022 (Excluding Power Generation)

SW: Surface Water, GW: Groundwater, *Permitted Withdrawal, **Unpermitted Withdrawal

Table 20: Top 20 Reported Water Withdrawals in 2022 Excluding Power Generation (MGD)

Facility	Locality	Type	5 Year Avg.	2022 Withdrawal	Category
AdvanSix Resins & Chemicals: Hopewell Plant**	City of Hopewell	SW	101.8	99.9	Manufacturing
Fairfax Water: Corbalis WTP**	Fairfax County	SW	86.2	82.1	Municipal
City of Richmond WTP**	City of Richmond	SW	66.6	68.2	Municipal
Fairfax Water: Griffith WTP**	Prince William County	SW	64.6	67.5	Municipal
Celanese Acetate: Celco Plant**	Giles County	SW/GW	59.2	58.1	Manufacturing
City of Norfolk: Western Branch Reservoir**	City of Suffolk	SW	66.0	51.7	Municipal
City of Virginia Beach Service Area**	City of Virginia Beach	SW	30.2	43.6	Municipal
WestRock Virginia Corporation: Covington Plant**	Alleghany County	SW/GW	38.2	39.6	Manufacturing
Appomattox River Water Authority: Chesdin Reservoir WTP*	Chesterfield County	SW	36.0	37.7	Municipal
Dupont E I De Nemours & Co: Spruance Plant**	Chesterfield County	SW/GW	24.3	28.1	Manufacturing
Henrico County WTP & Service Area*	Henrico County	SW	25.2	26.3	Municipal
City Of Newport News: Waterworks Lee Hall*	City of Newport News	SW/GW	21.9	23.1	Municipal
Virginia American Water: Hopewell District**	City of Hopewell	SW	22.5	22.6	Municipal
U.S. Radford Ammunitions WTP 1**	Montgomery County	SW	19.4	20.7	Manufacturing
City of Newport News: Harwood's Mill WTP**	York County	SW	18.6	19.1	Municipal
WestRock CP LLC: West Point Mill Water System*	King William County	SW/GW	16.4	16.2	Manufacturing
International Paper Company: Franklin Virginia Mill*	Isle of Wight County	SW/GW	16.3	16.1	Manufacturing
City of Portsmouth: Lake Kilby WTP*	City of Suffolk	SW/GW	16.8	15.8	Municipal
City of Newport News: Diascund Reservoir**	New Kent County	SW	10.9	15.8	Municipal
City of Norfolk: Lake Prince Pumping Station**	City of Suffolk	SW	7.4	14.4	Municipal

Appendix 2: Water Withdrawals Within Localities in 2022 (MGD) (Excluding Power Generation)

Table 21, shown below, lists the reported water withdrawals, both permitted and unpermitted, that occurred in 2022 within individual localities.

Table 21: Water Withdrawals Within Localities in 2022 (MGD)

Locality	GW Withdrawal	SW Withdrawal	GW + SW Total	Percent of Total Withdrawal
Accomack County	5.30	6.71	12.01	0.95
Albemarle County	0.21	10.76	10.97	0.86
Alleghany County	0.70	40.25	40.95	3.23
Amelia County	0.11	0.08	0.19	0.02
Amherst County	0.00	18.93	18.93	1.49
Appomattox County	0.00	0.00	0.00	0.00
Arlington County	0.01	0.08	0.09	0.01
Augusta County	3.37	7.27	10.65	0.84
Bath County	0.18	10.53	10.71	0.84
Bedford County	1.46	17.01	18.47	1.45
Bland County	0.07	0.12	0.19	0.02
Botetourt County	0.73	8.13	8.86	0.70
Brunswick County	0.01	2.13	2.14	0.17
Buchanan County	0.26	0.75	1.01	0.08
Buckingham County	0.00	0.39	0.39	0.03
Campbell County	0.06	6.26	6.31	0.50
Caroline County	1.36	2.44	3.81	0.30
Carroll County	0.23	0.30	0.52	0.04
Charles City County	0.08	0.56	0.64	0.05
Charlotte County	0.14	0.13	0.27	0.02
Chesterfield County	0.39	92.40	92.78	7.31
City of Alexandria	0.00	0.00	0.00	0.00
City of Bedford	0.00	0.00	0.00	0.00
City of Bristol	0.00	0.00	0.00	0.00
City of Buena Vista	0.05	0.03	0.08	0.01
City of Charlottesville	0.00	0.00	0.00	0.00
City of Chesapeake	4.21	3.43	7.64	0.60
City of Clifton Forge	0.00	0.00	0.00	0.00
City of Colonial Heights	0.00	0.00	0.00	0.00
City of Covington	0.00	3.49	3.49	0.27
City of Danville	0.00	5.45	5.45	0.43
City of Emporia	0.00	0.87	0.87	0.07
City of Fairfax	0.01	0.02	0.03	0.00
City of Falls Church	0.00	0.00	0.00	0.00
City of Franklin	0.88	0.00	0.88	0.07
City of Fredericksburg	0.00	0.01	0.01	0.00
City of Galax	0.00	1.57	1.57	0.12
City of Hampton	0.19	0.00	0.19	0.02
City of Harrisonburg	0.00	0.06	0.06	0.00
City of Hopewell	0.00	132.41	132.41	10.43
City of Lexington	0.00	0.00	0.00	0.00

City of Lynchburg	0.00	0.00	0.00	0.00
City of Manassas	0.31	12.91	13.22	1.04
City of Manassas Park	0.00	0.00	0.00	0.00
City of Martinsville	0.00	1.83	1.83	0.14
City of Newport News	0.20	31.05	31.25	2.46
City of Norfolk	0.05	0.97	1.02	0.08
City of Norton	0.00	0.64	0.64	0.05
City of Petersburg	0.01	0.01	0.02	0.00
City of Poquoson	0.00	0.00	0.00	0.00
City of Portsmouth	0.11	0.00	0.11	0.01
City of Radford	0.00	2.59	2.59	0.20
City of Richmond	0.05	68.28	68.33	5.38
City of Roanoke	1.34	13.44	14.78	1.16
City of Salem	1.31	2.73	4.04	0.32
City of South Boston	0.00	0.00	0.00	0.00
City of Staunton	0.00	0.00	0.00	0.00
City of Suffolk	7.95	79.64	87.59	6.90
City of Virginia Beach	0.15	43.73	43.88	3.46
City of Waynesboro	4.81	1.64	6.45	0.51
City of Williamsburg	1.14	0.00	1.14	0.09
City of Winchester	0.01	0.00	0.01	0.00
Clarke County	0.07	0.68	0.75	0.06
Craig County	0.08	3.02	3.10	0.24
Culpeper County	1.29	1.28	2.57	0.20
Cumberland County	0.02	0.01	0.03	0.00
Dickenson County	0.00	5.70	5.70	0.45
Dinwiddie County	0.04	0.28	0.32	0.03
Essex County	0.38	1.27	1.65	0.13
Fairfax County	0.29	82.67	82.96	6.54
Fauquier County	1.76	1.17	2.93	0.23
Floyd County	0.12	0.11	0.23	0.02
Fluvanna County	0.13	0.72	0.85	0.07
Franklin County	0.14	1.00	1.15	0.09
Frederick County	2.88	6.35	9.22	0.73
Giles County	19.07	53.21	72.28	5.69
Gloucester County	0.56	0.87	1.43	0.11
Goochland County	0.08	1.79	1.87	0.15
Grayson County	0.13	0.05	0.18	0.01
Greene County	0.03	0.72	0.74	0.06
Greensville County	0.03	1.53	1.56	0.12
Halifax County	0.11	1.76	1.87	0.15
Hanover County	0.45	4.89	5.34	0.42
Henrico County	0.01	26.73	26.75	2.11
Henry County	0.00	3.30	3.30	0.26
Highland County	0.06	4.78	4.83	0.38
Isle of Wight County	15.79	5.23	21.02	1.66
James City County	5.47	4.69	10.15	0.80
King George County	1.38	1.93	3.31	0.26
King William County	16.91	0.26	17.16	1.35
King and Queen County	0.01	1.40	1.42	0.11

Lancaster County	0.44	0.00	0.44	0.03
Lee County	0.00	2.21	2.21	0.17
Loudoun County	1.43	16.33	17.77	1.40
Louisa County	0.32	0.39	0.70	0.06
Lunenburg County	0.00	0.51	0.51	0.04
Madison County	0.04	0.11	0.15	0.01
Mathews County	0.01	0.00	0.01	0.00
Mecklenburg County	0.12	1.88	2.00	0.16
Middlesex County	0.29	0.08	0.38	0.03
Montgomery County	0.12	28.23	28.35	2.23
Nelson County	0.15	2.53	2.68	0.21
New Kent County	1.05	22.86	23.92	1.88
Northampton County	1.21	0.82	2.03	0.16
Northumberland County	0.34	0.02	0.35	0.03
Nottoway County	0.01	1.13	1.13	0.09
Orange County	0.07	2.07	2.14	0.17
Page County	0.98	0.79	1.77	0.14
Patrick County	0.12	1.05	1.17	0.09
Pittsylvania County	0.00	1.75	1.75	0.14
Powhatan County	0.11	0.12	0.23	0.02
Prince Edward County	0.06	0.99	1.05	0.08
Prince George County	0.25	0.19	0.44	0.03
Prince William County	0.43	69.16	69.59	5.48
Pulaski County	0.00	4.71	4.71	0.37
Rappahannock County	0.05	0.00	0.05	0.00
Richmond County	0.31	0.00	0.31	0.02
Roanoke County	0.23	11.42	11.65	0.92
Rockbridge County	0.28	1.44	1.72	0.14
Rockingham County	14.91	11.05	25.96	2.04
Russell County	0.09	0.63	0.72	0.06
Scott County	0.08	1.23	1.31	0.10
Shenandoah County	3.02	1.94	4.96	0.39
Smyth County	0.78	5.60	6.38	0.50
Southampton County	3.29	7.12	10.41	0.82
Spotsylvania County	0.18	12.13	12.32	0.97
Stafford County	0.01	14.83	14.83	1.17
Surry County	0.24	0.26	0.50	0.04
Sussex County	0.98	0.08	1.06	0.08
Tazewell County	0.10	4.60	4.70	0.37
Warren County	0.13	7.51	7.64	0.60
Washington County	0.08	8.80	8.88	0.70
Westmoreland County	0.94	0.57	1.51	0.12
Wise County	0.01	6.73	6.74	0.53
Wythe County	0.06	8.45	8.51	0.67
York County	0.36	19.15	19.51	1.54
Total	**138.45**	**1130.87**	**1269.33**	**100.00**

Appendix 3: Water Resources Information and Climactic Conditions

State Population
(2020 census) – 8,644,727
(2022 Weldon Cooper Center Estimate[14]) – 8,696,955

State Surface Area – 42,775 square miles (39,490 sq. miles total land area, 3,285 sq. miles inland waters)

Major River Basins (with Current Estimates of Annual Mean River Flow):
- Tennessee-Big Sandy (4,132 sq. miles, 3,225 MGD)
- Albemarle Sound-Chowan River (4,252 sq. miles, 1,748 MGD)
- James (10,236 square miles, 5,501 MGD)
- New (3,068 square miles, 3,304 MGD)
- Rappahannock (2,714 square miles, 1,100 MGD)
- Roanoke (6,274 square miles, 5,120 MGD)
- Shenandoah (3,041 sq. miles, 1,797 MGD)
- Chesapeake Bay-Small Coastal (3,157 sq. miles, 97 MGD)
- York (2,669 square miles, 1,060 MGD)

Total Non-tidal River/Stream Miles - 100,927 (This estimate represents mileage determined by the USGS National Hydrography Dataset)

Publicly-Owned Lakes and Reservoirs
There are 248 publicly-owned lakes in the Commonwealth:

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

Additionally, hundreds of small privately-owned lakes and ponds are distributed throughout the state.

Freshwater Wetlands - 808,000 acres

Tidal and Coastal Wetlands - 236,900 acres

Estuary (excluding small coastal areas) - 2,308 sq. miles

Atlantic Ocean Coastline - 120 Miles

Statewide Average Annual Rainfall – 44.3 inches

Average Freshwater Discharge of All Rivers - Approximately 22,850 MGD

Average Freshwater Discharge into the Chesapeake Bay – Approximately 9,500 MGD

Climatic Conditions: As of September 1, 2023, precipitation for the water year beginning October 1, 2022 was near-normal to above-normal throughout the New River Valley, Roanoke Valley, and Central Virginia area surrounding Lynchburg. Precipitation over the water year is below normal for the Shenandoah Valley, Northern Virginia, and far Southwest Virginia regions. Streamflows for much of Virginia have remained within normal ranges throughout the water year. Below normal flows were observed primarily throughout the spring and summer months and were focused within the Shenandoah Valley and Northern Virginia regions. Exceptionally low streamflows occurred within the Shenandoah drought evaluation region in late summer with a drought warning declared August 30, 2023, with below 5th percentile of historic streamflows observed. Groundwater levels in the Climate Response Network observation wells were below normal levels throughout spring and summer for the Shenandoah, Northern Virginia, and Eastern Shore. Much below and near record low groundwater levels were observed in late summer for many wells within the Shenandoah and Northern Virginia regions. On August 30, 2023, a drought warning declaration was announced for the Shenandoah drought evaluation region, with near record low surface water and groundwater indicators observed. The DEQ drought website includes the most up to date information related to drought and current conditions.

[14]University of Virginia Weldon Cooper Center, Demographic Research Group. (2022). Virginia Population Estimates. Retrieved from https://demographics.coopercenter.org/virginia-population-estimates.

Appendix 4: Water Transfers

Water transfers means water that has been withdrawn from surface or groundwater and transported via water pipelines, or other means of conveyance, to a different facility or service area. Water transfers generally represent water that is purchased, sold, or distributed to other water users or customers from a main supplier, although large water utilities may transfer water between sources and service areas they own. Transferred water data is reported to DEQ as a release (the point the water is sent from) or a delivery (the point where water is received). In some cases a transfer is reported from both sides of the transaction, but in others only one side reports the transfer.

In 2022, 163 water transfers were reported to VAHydro with approximately 468 MGD transferred on average each day. Transfers primarily occurred within regional water distribution systems that sold or purchased water from a larger primary source such as a reservoir. In general, withdrawals from a water source (groundwater or surface water) account for the largest portion of a locality's water use. Transferred water provides an additional supply connection that can be a primary water source or supplementary during drought or other conditions.

The largest water transfers occurred within Richmond, Hampton Roads, and Northern Virginia. The City of Richmond provides water supply to numerous customers, including Chesterfield, Hanover, and Henrico Counties. The Hampton Roads region includes many of the reported water transfers with the Cities of Norfolk and Virginia Beach the primary provider and recipient. The City of Virginia Beach is primarily supplied by transferred water that originates from Lake Gaston, located in south central Virginia. The raw water is initially transferred to the City of Norfolk for processing, and finished water is transferred to the City of Virginia Beach. This system represents the greatest travel distance of any transfer in Virginia. Additionally, Northern Virginia localities are largely interconnected and supplied by water authorities in the region including Fairfax Water and Loudoun Water.

Currently, not all water transfers are consistently reported to VAHydro, in part because many systems lack the technology or resources to track and report water transfers. For example, there are localities that have reported water releases, but there are no corresponding records indicating the water has been received and used by another locality or entity. Some entities reportedly sell water but do not track where the water is sent. Improvements in the quality of reporting and methods DEQ uses to track the transfer of water, both within systems and between entities, are necessary to better understand the impact transfers have in Virginia.