Groundwater Characterization and Monitoring Program

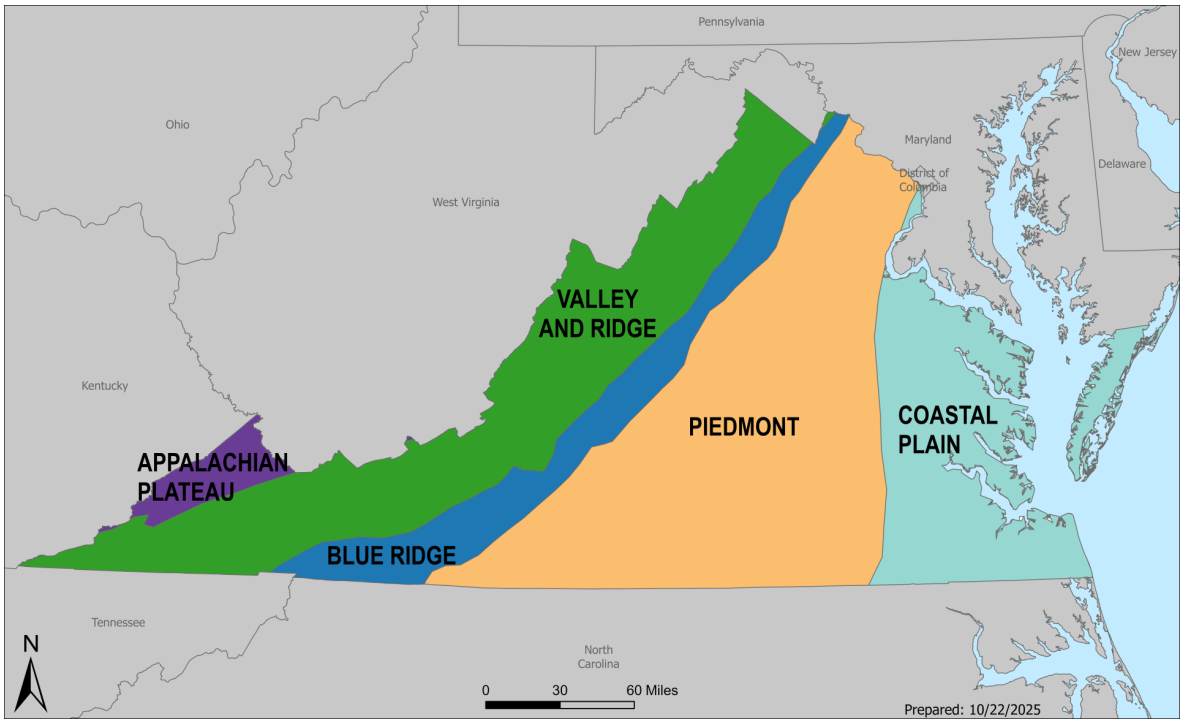
DEQ's Groundwater Characterization and Monitoring Program (GCMP) collects, analyzes, and interprets hydrogeologic data to understand groundwater availability, quantity, and quality. The results inform groundwater-resource management and water supply planning across the Commonwealth. Program staff also serve as DEQ's hydrogeology experts and provide technical assistance to other DEQ programs, other agencies and government partners, and the public.

Most GCMP staff are assigned to Virginia's Coastal Plain province, where the regulatory Groundwater Management Areas are located. The Coastal Plain aquifer system generally consists of a layered sequence of aquifers and confining units, composed of mostly unconsolidated sediments that contain groundwater in the pore spaces between grains. The system also features the buried Chesapeake Bay impact crater. Comprehensive descriptions appear in the "Selected Publications" listed below.

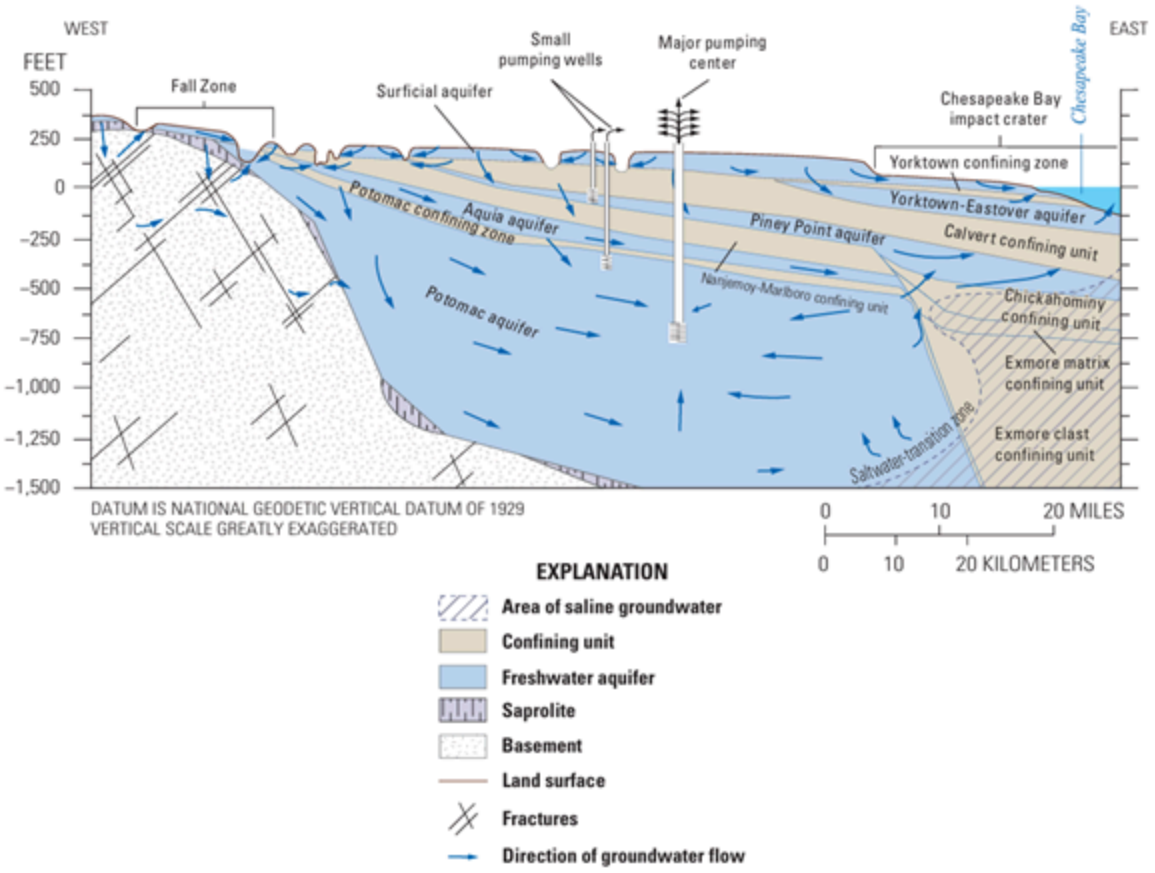
GCMP staff also cover Virginia's western provinces: Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau. In these provinces, groundwater occurs mainly in the fractures and joints of the hard rock. Groundwater occurrence, movement, and quality vary significantly with the local geology.

DEQ relies on well construction data submitted by well drillers in the form of the Uniform Water Well Completion Report (Form GW-2). For the fillable PDF form itself, and for details about submitting either the PDF form by email or the web form through the myDEQ portal, see the **Water Well Registration** page.

For information on private wells, see the **VDH Private Well Program** page. The Private Well Regulations linked on that page include requirements for the permanent abandonment of private wells, including monitoring, observation, and remediation wells. For information about waterworks wells, including their abandonment, see the **VDH Office of Drinking Water** page.



Map of the Virginia Physiographic Provinces (2025).



Generalized hydrogeologic section showing principal aquifers, confining beds, and conceptual patterns of groundwater flow in the Virginia Coastal Plain west of Chesapeake Bay. Reproduced from Kearns and Pope, 2025.

Groundwater Characterization -

DEQ geologists collect and analyze data from cores, well cuttings, and borehole geophysical logs to identify and describe the geologic and hydrogeologic formations present at specific depths in the subsurface. The results guide the construction of permitted wells in the regulatory Groundwater Management Areas to ensure that each well withdraws from the appropriate aquifer. Data collected from the drilling of state observation wells establishes hydrogeological control points across the Commonwealth. The data also support the development of hydrogeologic frameworks and groundwater flow models for use in specific permitting decisions and longer-term resource management.

Top left: Example of geologic cuttings from well drilling laid out in 10 ft sections.

Bottom left: Shark teeth caught by DEQ geologists from geologic cuttings.

Bottom middle: Shells, clay, and sand caught by DEQ geologists.

Right: DEQ staff collecting and describing cuttings from a drill rig.

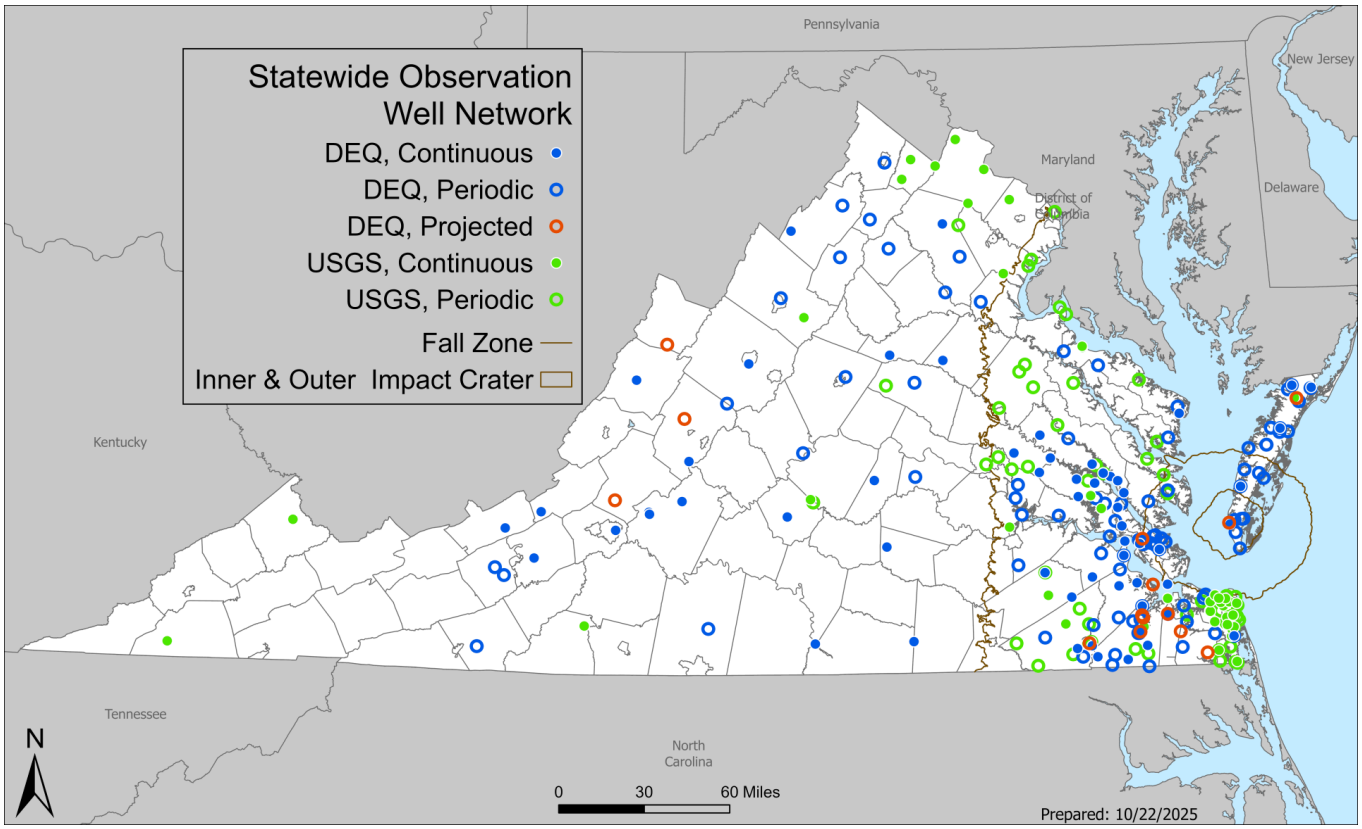
DEQ's geophysical logging truck on a site.

Groundwater Monitoring -

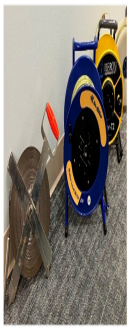
To monitor groundwater levels and quality, DEQ relies on the statewide groundwater observation well network. This network is a long-term, cooperative project of DEQ and the U.S. Geological Survey's (USGS) Virginia and West Virginia Water Science Center. It consists of over 440 individual wells. Over 300 wells are operated by DEQ, with the remainder operated by USGS. Of the total, 385 wells are located within the Groundwater Management Areas (GWMAs) of the Virginia Coastal Plain. Within the GWMAs, 164 wells are equipped to monitor water levels continuously, in near-real time. Some wells are grouped as multi-well research stations to monitor multiple aquifers, or multiple intervals within one aquifer. Some wells are dedicated to subnetworks for specific purposes, such as long-term climate (precipitation) response research, drought monitoring, or chloride (saltwater) monitoring. DEQ and USGS are currently expanding the statewide network, both in the Virginia Coastal Plain and in regions west of I-95.

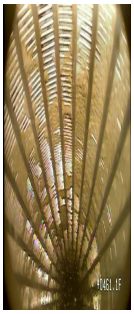
Each well in the statewide network is a scientific instrument carefully designed, constructed, and maintained to provide representative data from a known aquifer at a specific location and depth below land surface (and corresponding elevation above sea level). Standard procedures govern the operation

and maintenance of wells and the collection, analysis, and approval of data for publication. The resulting high-quality data sets flow into public-facing federal databases, where they support **drought monitoring**, **water supply planning**, **groundwater withdrawal permitting**, and the overall management of groundwater resources. They also provide the foundation for groundwater research in Virginia.



Map of the Virginia State Observation Well Network (2025).





Left: Example of a DEQ real-time water-level monitoring station.

Top right: Steel tape and water level meters used to gage water wells.

Bottom right: Water well screened interval as seen from a downhole camera.

DEQ employee operating a downhole camera for a well integrity survey.

Ambient Groundwater Quality -

Within the GCMP, the Ambient Groundwater Quality Monitoring Program collects groundwater samples from the statewide groundwater observation well network to characterize natural background groundwater quality, as influenced by pumping effects. For example, local and regional groundwater extraction may contribute to the potential movement of saline groundwater into freshwater aquifers. The relatively local effects of anthropogenic (human-caused) contamination are generally beyond the scope of this program but are addressed by other DEQ programs.

DEQ's groundwater sampling pump truck.

Typically, samples are collected from designated trend-monitoring wells, newly installed state observation wells, and additional wells selected to address program objectives and priorities. Projected groundwater sampling locations appear in DEQ's **Annual Water Quality Monitoring Plan**. The samples are analyzed by Virginia's Division of Consolidated Laboratory Services. The analytical results support program and agency objectives, such as groundwater withdrawal permitting and the monitoring of potential saltwater migration. DEQ also continues to expand its network of chloride-monitoring wells, generally following a strategy developed in cooperation with USGS.

Left: Submersible pump inside of pump truck.

Right: DEQ staff during groundwater sampling event.

Additional Resources -

Environmental Data Mapper

Virginia Environmental Data Hub

USGS | National Water Dashboard

Water Resources of the United States—National Water Information System (NWIS) Mapper

Selected Publications -

USGS Publications Coauthored by DEQ Staff:

Hydrogeologic Framework of the Virginia Eastern Shore (U.S. Geological Survey Scientific Investigations Report 2019-5093)

Hydrogeology and Simulation of Groundwater Flow in Fractured-Rock Aquifers of the Piedmont and Blue Ridge Physiographic Provinces, Bedford County, Virginia (U.S. Geological Survey Scientific Investigations Report 2015-5113)

The effects of the Chesapeake Bay impact crater on the geological framework and correlation of hydrogeologic units of the lower York-James Peninsula, Virginia (U.S. Geological Survey Professional Paper 1612)

Virginia Coastal Plain Hydrogeologic Framework, (U.S. Geological Survey Professional Paper 1731, 2006)

Additional USGS Reports:

A conceptual framework and monitoring strategy for movement of saltwater in the coastal plain aquifer system of Virginia (U.S. Geological Survey Scientific Investigations Report 2015-5117)

Groundwater-quality data and regional trends in the Virginia Coastal Plain, 1906-2007 (U.S. Geological Survey Professional Paper 1772)

Hydrogeologic framework and hydrologic conditions of the Piney Point aquifer in Virginia (U.S. Geological Survey Scientific Investigations Report 2017-5041)

Revisions to the Virginia Coastal Plain hydrogeologic framework Southwest of the James River (U.S. Geological Survey Scientific Investigations 2022-5049)

Sediment distribution and hydrologic conditions of the Potomac aquifer in Virginia and parts of Maryland and North Carolina (U.S. Geological Survey Scientific Investigations Report 2013-5116)

Simulation of groundwater flow in the Coastal Plain aquifer system of Virginia (U.S. Geological Survey Scientific Investigations Report 2009-5039)

Simulation of groundwater-level and salinity changes in the Eastern Shore, Virginia (U.S. Geological Survey Scientific Investigations Report 2009-5066)