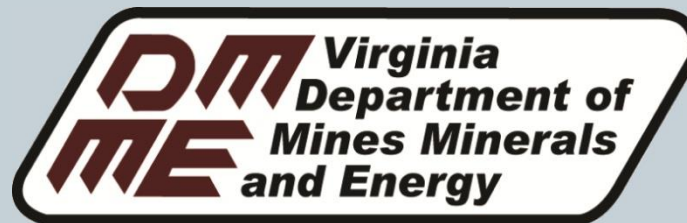


Potential Natural Gas Drilling in the Taylorsville Basin: Geology, Regulations, and Resource Protection



DAVID SPEARS
STATE GEOLOGIST

VIRGINIA DEPARTMENT OF MINES, MINERALS AND ENERGY



Mission of the Department of Mines, Minerals and Energy



We enhance the development and conservation of energy and mineral resources in a safe and environmentally sound manner to support a more productive economy.

DMME STRATEGIC PLAN



- **Goal 1:**
 - Provide for safe and environmentally sound mineral and fossil fuel extraction.
- **Goal 2:**
 - Encourage economic development through our customers' wise management of Virginia's resources.
- **Goal 3:**
 - Enable DMME personnel to perform at their full potential.

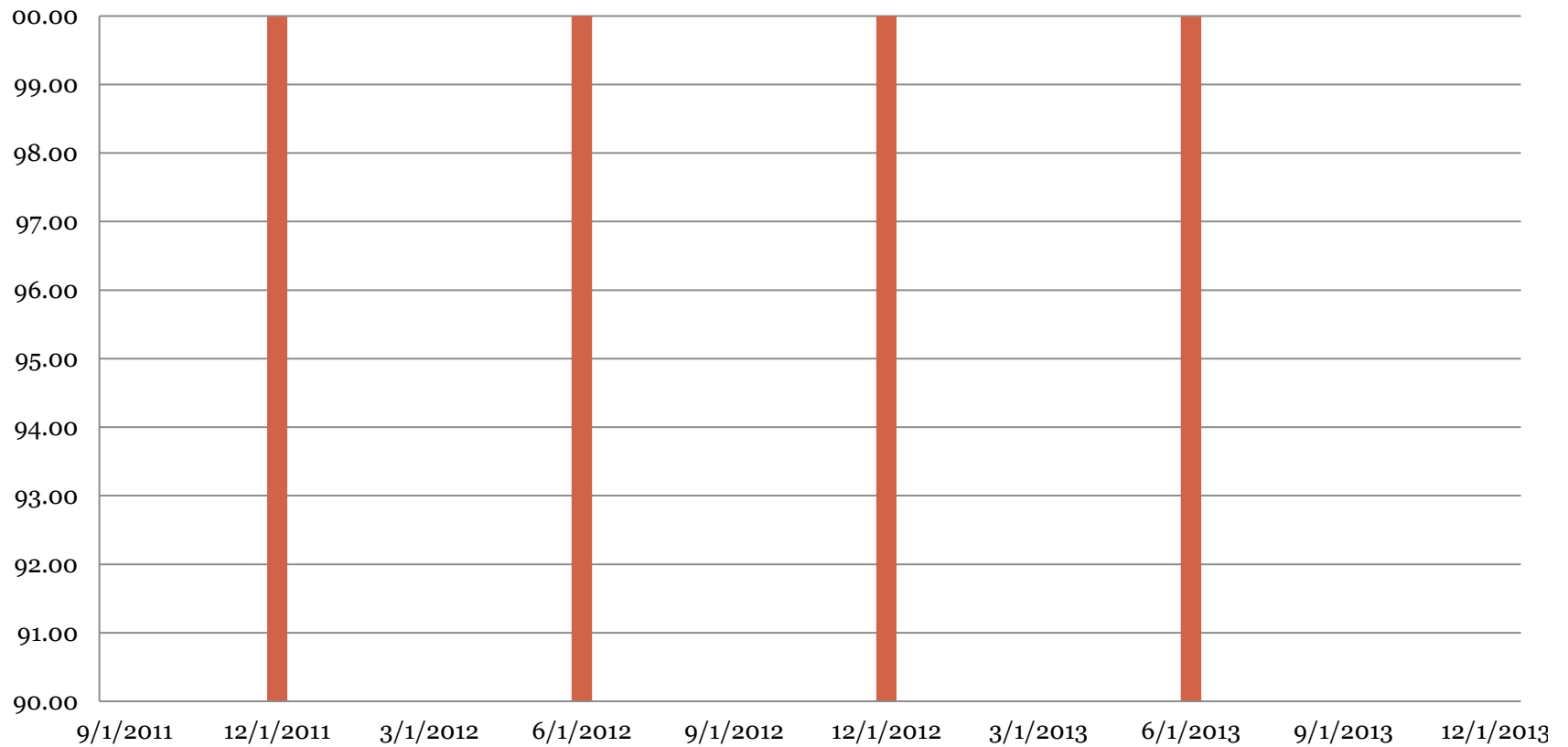
DMME's Organization



- Division of Mines – coal mine worker safety
- Division of Mined Land Reclamation – coal mining environmental protection
- Division of Mineral Mining – hard minerals worker safety and environmental protection
- Division of Gas and Oil – gas and oil worker safety and environmental protection
- Division of Energy – energy procurement, management, and efficiency
- Division of Geology and Mineral Resources – mineral and energy resource studies and mapping

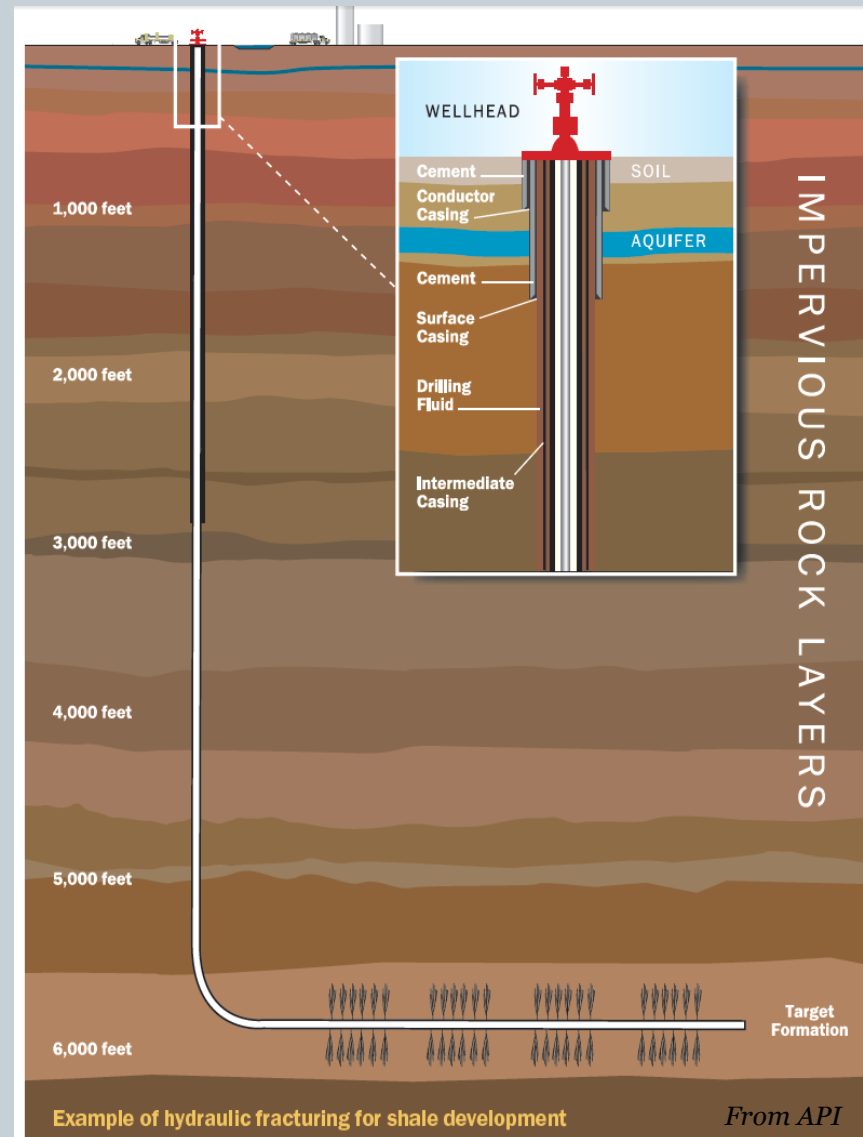
DMME PERFORMANCE MEASURES

Percentage of sites with no adverse off-site environmental damage or public safety hazards



What is Hydraulic Fracturing?

- The process in which fluid pressure is applied to exposed reservoir rock until fracturing occurs.
- The fluid sometimes carries a proppant (usually sand) into the fracture. The fracture closes on the sand, which generally has a higher porosity than the reservoir rock.
- Hydrocarbons (oil and natural gas) flow more freely to the wellbore (increases conductivity).



HYDRAULIC FRACTURING IN VIRGINIA



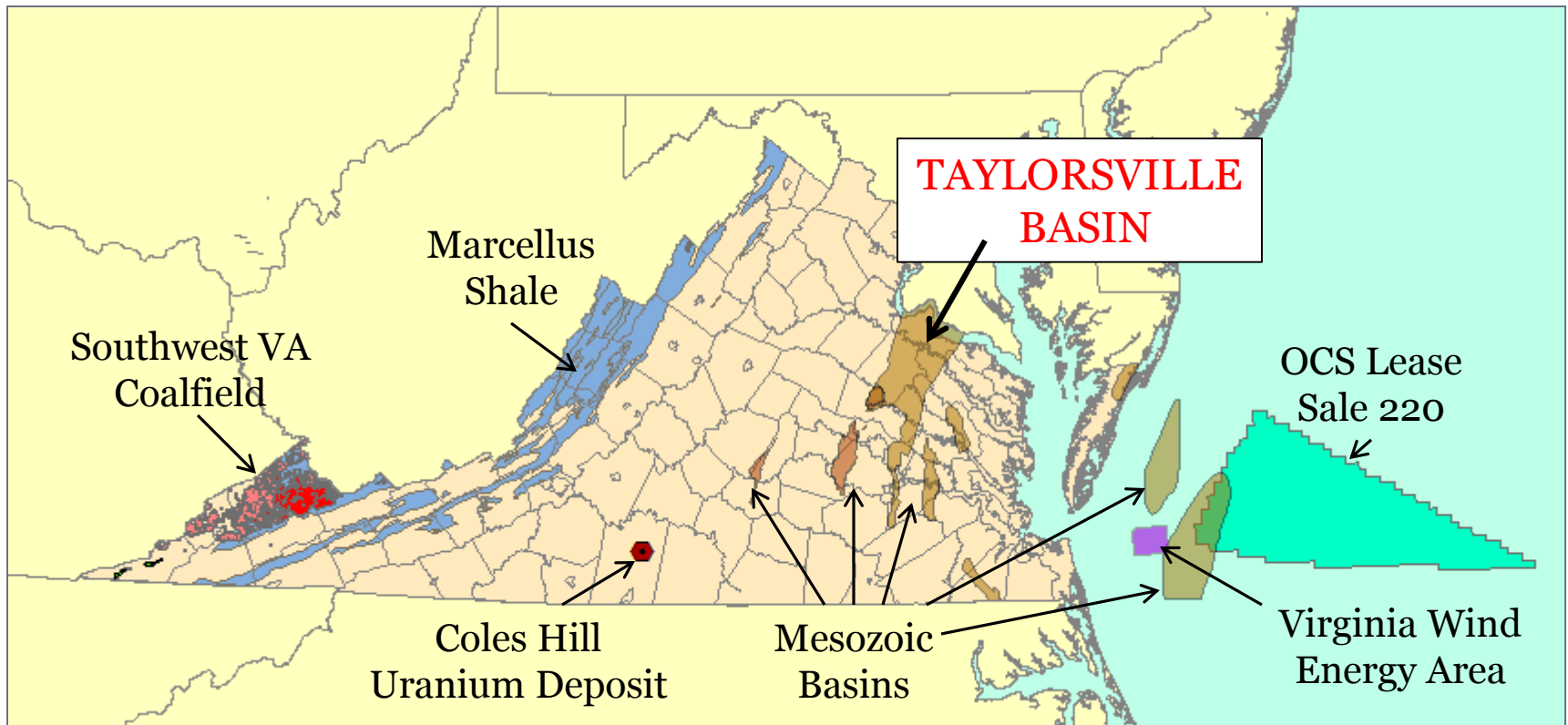
- Technique has been utilized in the Commonwealth since the 1960s.
- Over 8,000 wells have been hydraulically fractured in Southwest Virginia.
- There have been no documented instances of surface or groundwater degradation from hydraulic fracturing in Virginia.

HYDRAULIC FRACTURING IN VIRGINIA

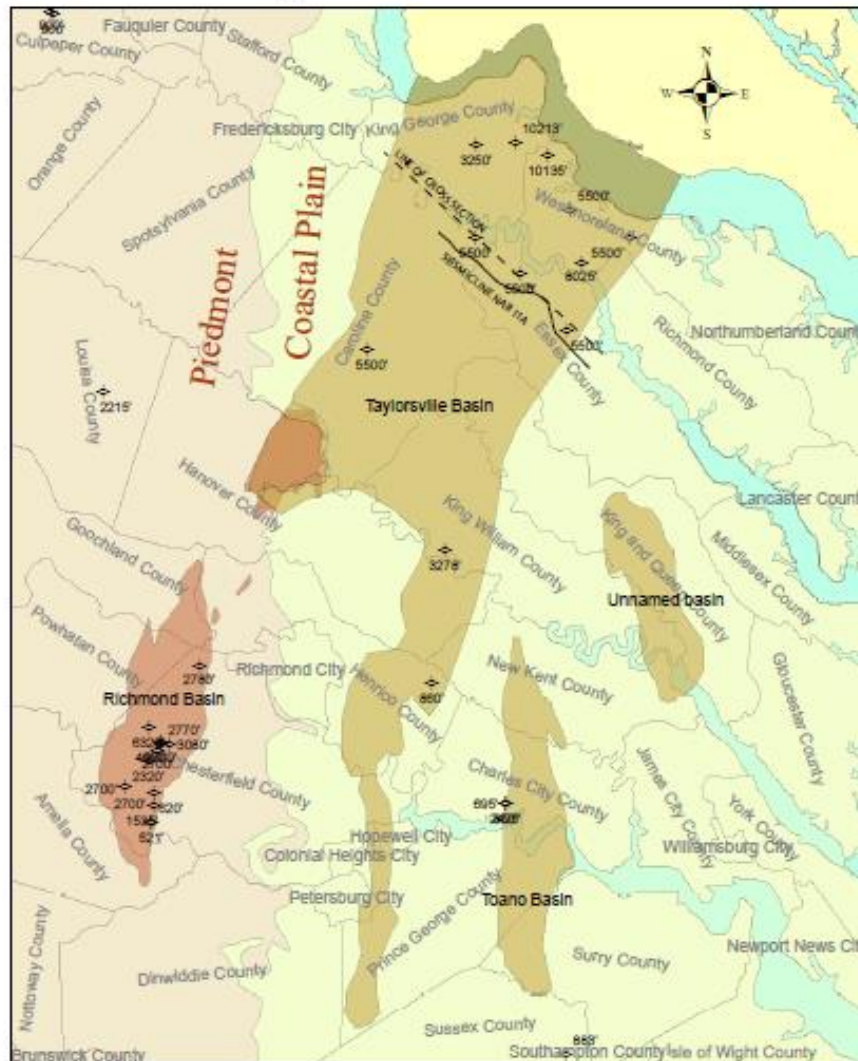


- Hydraulically fractured wells in Virginia typically require 0-300,000 gallons of water.
- Increasingly, operators are utilizing nitrogen-based foam to fracture wells.
- By contrast, fractured wells in the Marcellus shale typically use 4-5 million gallons of water.

Some Potential Future Energy Resources



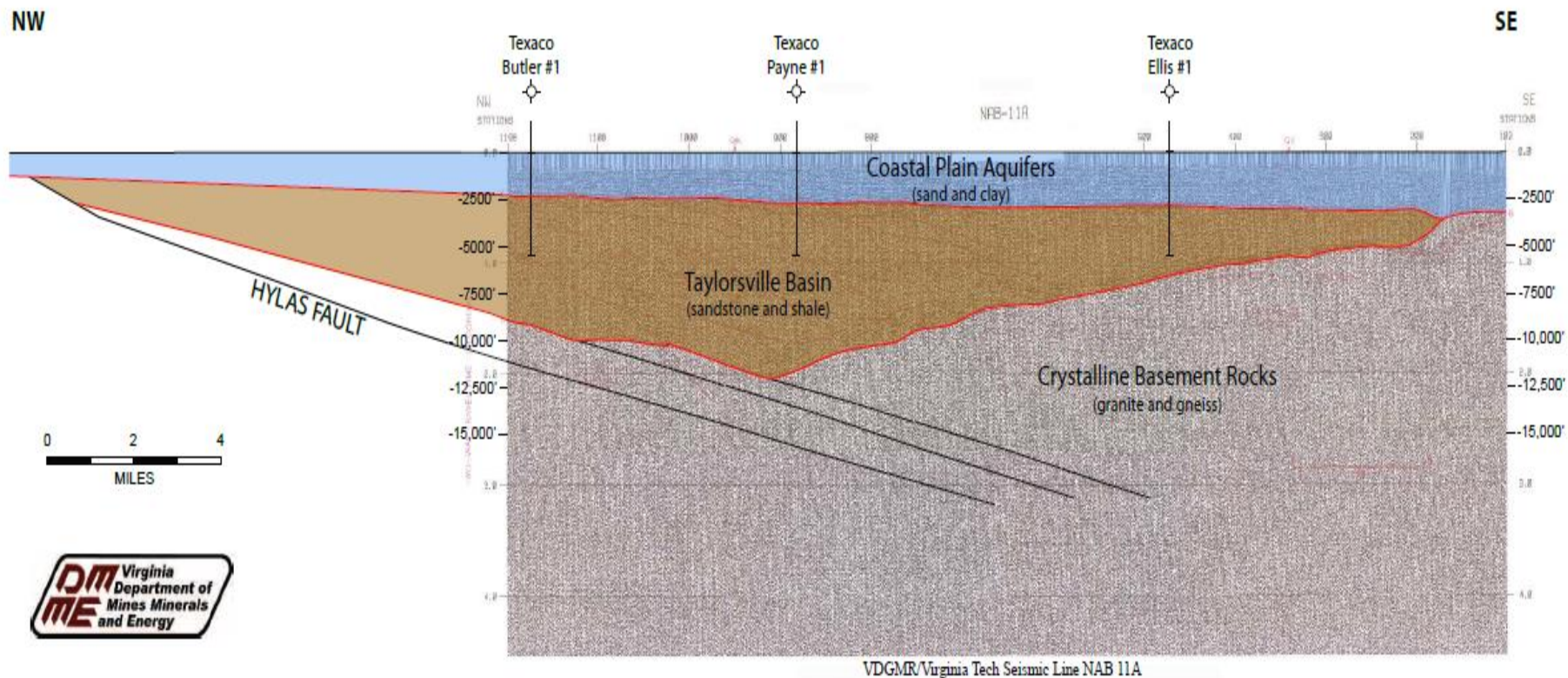
Virginia Portion of the Taylorsville Mesozoic Basin



◆ Plugged Oil and Gas Wells
 ■ Buried Mesozoic Basins
 ■ Exposed Mesozoic Basins

0 5 10 20
Miles

Generalized Geologic Cross-section and Partial Seismic Profile across the Taylorsville Mesozoic Basin King George, Caroline, and Essex Counties, Virginia



Assessment of Undiscovered Oil and Gas Resources of the East Coast Mesozoic Basins of the Piedmont, Blue Ridge Thrust Belt, Atlantic Coastal Plain, and New England Provinces, 2011

Introduction

During the early opening of the Atlantic Ocean in the Mesozoic Era, numerous extensional basins formed along the eastern margin of the North American continent from Florida northward to New England and parts of adjacent Canada. The basins extend generally from the offshore Atlantic continental margin westward beneath the Atlantic Coastal Plain to the Appalachian Mountains. Using a geology-based assessment method, the U.S. Geological Survey (USGS) estimated a mean undiscovered natural gas resource of 3,860 billion cubic feet and a mean undiscovered natural gas liquids resource of 135 million barrels in continuous accumulations within five of the East Coast Mesozoic basins (fig. 1; table 1): the Deep River, Dan River-Danville, and Richmond basins, which are within the Piedmont Province of North Carolina and Virginia; the Taylorsville basin, which is almost entirely within the Atlantic Coastal Plain Province of Virginia and Maryland; and the southern part of the Newark basin (herein referred to as the South Newark basin), which is within the Blue Ridge Thrust Belt Province of New Jersey (fig. 1). The provinces, which contain these extensional basins, extend across parts of Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, and Massachusetts (fig. 1).

The basins formed along the continental margin in response to the regional uplift, extension (rifting), and crustal thinning that occurred during the early opening of the Atlantic Ocean in middle Carnian (Late Triassic) time, approximately 227 million years ago. The basins were filled with a variety of sediments as they formed, including boulder beds, coarse-grained fluvial to deltaic sandstones, red siltstones, mudstones, gray and

black shales, and coal. These deposits represent the diverse fluvial to deltaic and lacustrine environments that existed within the basins. The rifting ended early in the Jurassic with the onset of regional volcanism and intrusion of diabase dikes and sills.

Source Rocks

The source rocks for oil and gas within the Mesozoic basins include the gray and black shales and the coal beds. The shales accumulated in nearshore deltas, in interdistributary bays, and in the deeper portions of the lakes that



Figure 1. Map of the Eastern United States showing the locations of the five quantitatively assessed East Coast Mesozoic basins, the nine basins that were not quantitatively assessed, and the U.S. Geological Survey province boundaries. Each basin includes one continuous gas assessment unit (tables 1, 2).

The Taylorsville Basin was part of a recent study by the U.S. Geological Survey on the undiscovered oil and gas resources in east coast Mesozoic Basins.

Total Petroleum System (TPS) and Assessment Unit (AU)	Field type	Total undiscovered resources											
		Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
		F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Taylorville Basin Composite TPS													
Taylorville Basin Continuous Gas AU	Gas					516	985	1,880	1,064	16	34	71	37
Richmond Basin Composite TPS													
Richmond Basin Continuous Gas AU	Gas					99	194	382	211	4	10	20	11
Newark Basin Composite TPS													
South Newark Basin Continuous Gas AU	Gas					363	785	1,698	876	1	4	10	4
Deep River Basin Composite TPS													
Deep River Basin Continuous Gas AU	Gas					779	1,527	2,990	1,660	35	75	158	83
Dan River-Danville Basin Composite TPS													
Dan River-Danville Basin Continuous Gas AU	Gas					17	42	106	49	0	0	1	0
Total continuous resources						1,774	3,533	7,056	3,860	56	123	260	135

USGS assigned **1.06 trillion cubic feet** of gas to the Taylorville Basin.

That's about 2½ times Virginia's total annual consumption of natural gas.

For comparison, the USGS assigned **410 Tcf** to the Marcellus Shale in Pennsylvania, New York, and West Virginia.

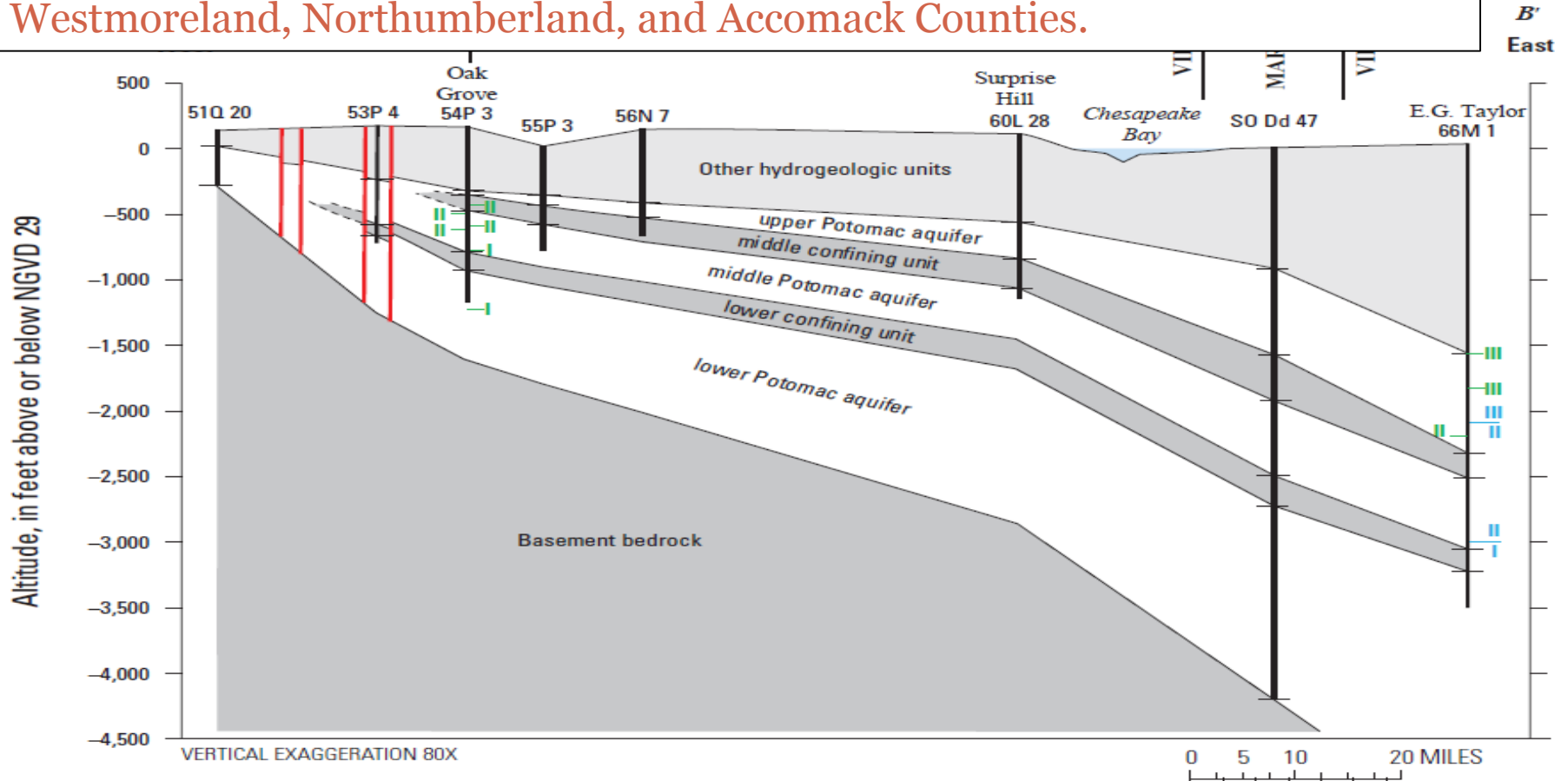
Prepared in cooperation with the Virginia Department of Environmental Quality

**Sediment Distribution and
Hydrologic Conditions of
the Potomac Aquifer in
Virginia and Parts of
Maryland and
North Carolina**

Scientific Investigations Report 2013-5116

USGS and VA DEQ recently completed a study of the Potomac Aquifer, the deepest aquifer in the Northern Neck and Middle Peninsula.

USGS/DEQ aquifer cross-section from Fredericksburg through King George, Westmoreland, Northumberland, and Accomack Counties.

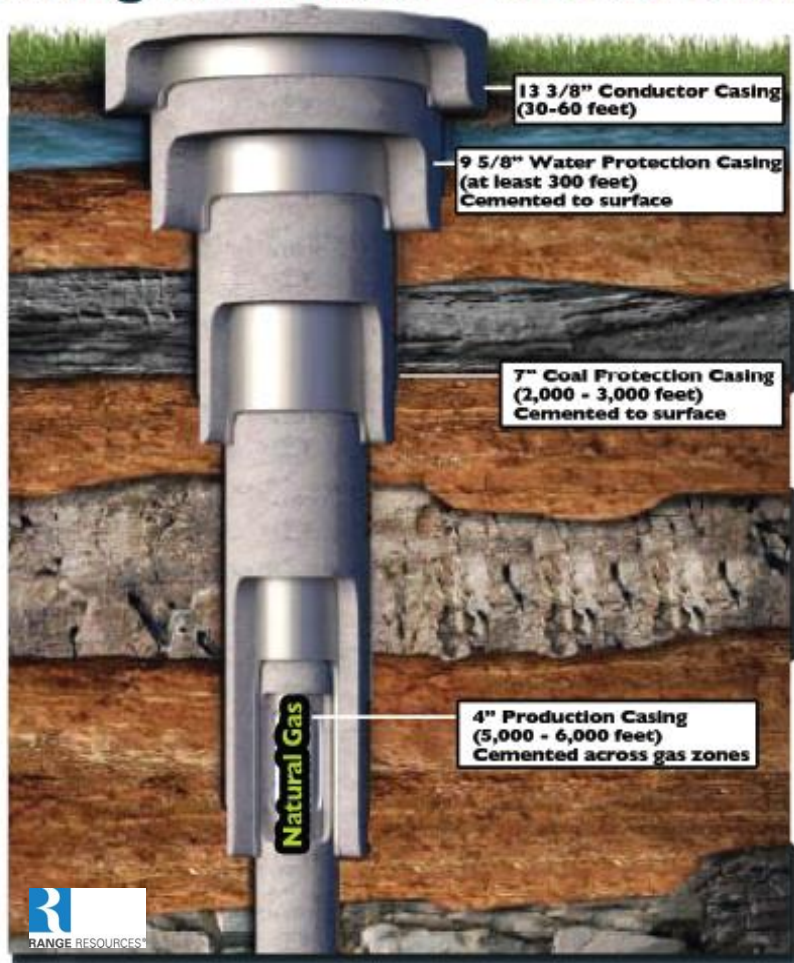


The Potomac Aquifer is the source for large groundwater withdrawals such as paper mills that withdraw 20 – 30 million gallons per day.

Hydraulically fractured wells in Virginia typically use 0 – 300,000 gallons of water.

Typical Casing Design

Casing Schematic - Not to Scale



Rock Formations containing natural gas are several thousand feet deep. Multiple casings are cemented to surface to protect water resources.



PROGRAM REQUIREMENTS



- **All oil and gas operators must comply with:**
 - The Virginia Gas and Oil Act of 1990
 - Virginia Gas and Oil Regulation
 - Virginia Gas and Oil Board Regulations
 - State Water Control Law
 - Virginia Pollution Discharge Elimination System Regulations
 - Additional requirements for the Tidewater Region

PERMIT REQUIREMENTS



- Applicants are required to notify parties who may be directly affected by the proposed operation, including surface and mineral owners.
- These parties have the right to object to permits on specific grounds that are outlined in the law

PERMIT REQUIREMENTS



- Applicants also must inform localities and publish notices in at least one newspaper of general circulation which is published in the locality where the well is proposed.
- Applications must contain operations plans that detail necessary construction, erosion and sediment control, drilling and stimulation plans, etc.

PROGRAM REQUIREMENTS



- The Gas and Oil Act allows operators access to private water wells within 750 feet of a gas well operation for sampling purposes.
- The law requires operators to replace water supplies if water wells are contaminated or their supply is interrupted by a gas well operation within 750 feet.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- Found in 62.1-195.1 of the Code of Virginia
 - Prohibits drilling in the Chesapeake Bay or its tributaries.
 - This prohibition also extends to the greater distance of:
 - ✦ Bay Resource Protection Areas
 - ✦ 500 feet from the shoreline of the waters of the Bay.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- Before drilling can occur, an environmental impact assessment must be submitted to DMME and reviewed by DEQ.
- EIA must be submitted to all appropriate state agencies for their review.
- DMME must consider DEQ's findings before a permit can be issued.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- For directional drilling, the operator must obtain the permission of all affected surface owners.
- Casing is set and pressure grouted from the surface to a point at least 2500 feet below the surface or 300 feet below the deepest known ground water, whichever is deeper.
- Multiple blowout preventers must be employed.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- An oil discharge contingency plan must be submitted to and approved by the State Water Control Board.
- Operator must also demonstrate financial responsibility to implement plan.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- Before an oil well can be placed into production:
 - DMME must find that production is likely and imminent.
 - DMME must then notify the Secretaries of Commerce and Trade and Natural Resources.
 - The Secretaries shall produce a report to the Governor and General Assembly.

ADDITIONAL REQUIREMENTS FOR DRILLING IN TIDEWATER REGION



- Before an oil well can be placed into production:
 - The Governor may recommend legislative and regulatory changes.
 - The General Assembly may accept those legislative changes or implement its own.
 - DMME cannot issue a permit for an oil production well until all of the above steps are completed.

REGULATORY FRAMEWORK



- 4 VAC 25-150
 - Sets out requirements for:
 - ✦ Permit applications
 - ✦ Hearing process for objections
 - ✦ Technical requirements
 - ✦ Reporting requirements
 - ✦ Enforcement procedures

REGULATORY UPDATE



- Last fall, DMME initiated a regulatory action to review its requirements for drilling.
 - Chemical disclosure requirements
 - Review of current industry best practices
 - Review to determine if additional requirements are necessary for different regions of the Commonwealth

REGULATORY UPDATE



- DMME will utilize a Regulatory Advisory Panel to assist in reviewing regulations.
- These meetings will be open to the public.
- At least one public hearing will be held after proposed regulations are published in the Virginia Register of Regulations.

Thank you



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