Hydrogeologic Framework of the Shallow Aquifer System of York County, Virginia

By Allen R. Brockman and Donna L. Richardson

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For additional information write to:
District Chief
U.S. Geological Survey
3600 West Broad Street
Room 606
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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
foot per mile (ft/mi)	0.1894	meter per kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
gallon per minute (gal/min)	0.06308	liter per second

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in report: Chemical concentration in water is expressed in milligrams per liter (mg/L).

HYDROGEOLOGIC FRAMEWORK OF THE SHALLOW AQUIFER SYSTEM OF YORK COUNTY, VIRGINIA

By Allen R. Brockman and Donna L. Richardson

ABSTRACT

This report describes the hydrogeologic framework of the York County, Virginia, shallow aquifer system. The York County shallow aquifer system is in the upper 200 feet of Miocene to Holocene sediments and consists of three aquifers: the Columbia (upper), the Cornwallis Cave (middle), and the Yorktown-Eastover (lower). The Columbia and Yorktown-Eastover aquifers are redefined from earlier investigations. The Cornwallis Cave aquifer is defined as the aquifer in sandy or shelly sediments of the Moore House Member of the Yorktown Formation (Pliocene) and the confined aquifer in sandy sediments (of late Pliocene to Holocene age) above the Yorktown Formation. Only the Yorktown-Eastover aquifer currently is used for domestic water supply; well yield generally does not exceed 10 gallons per minute.

The Columbia aquifer is unconfined, but the Cornwallis Cave and Yorktown-Eastover aquifers generally are confined by three confining units that underlie the county. The Cornwallis Cave confining unit separates the upper and middle aquifers, and the Yorktown confining unit separates the middle and lower aquifers of the system. Where one or both of the upper confining units are missing, aquifers combine and are designated as the undivided York County shallow aquifer system. The Eastover-Calvert confining unit underlies the Yorktown-Eastover aquifer. The Yorktown confining unit is redefined from earlier investigations. The Cornwallis Cave confining unit is defined as silt or clay sediments of the Moore House Member and younger Pliocene to Holocene sediments above the Cornwallis Cave aquifer. The Eastover-Calvert confining unit is defined as the lower Miocene to upper Miocene silt and clay sediments of the Calvert, St. Marys, and Eastover Formations.

INTRODUCTION

Population growth and increased water use have led to questions about the quantity and quality of the shallow (less than 150 ft deep) ground-water resources in York County, Va. Most of the county is supplied by surface-water sources developed by the City of Newport News. However, many residents in the eastern part of the county rely on shallow wells for their water needs. The shallow aquifer system is the only source of fresh ground water, because chloride concentrations in water from aquifers underlying the shallow aquifer system in this area of the county exceed the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level[1] of 250 mg/L (Cederstrom, 1957; Larson, 1981; and U.S. Environmental Protection Agency, 1988). In 1989, the U.S. Geological Survey (USGS), in cooperation with the York County Department of Environmental Services, began a study to characterize and delineate the shallow aquifer system of York County.

[1]Secondary Maximum Contaminant Levels: Contaminants that affect the aesthetic quality of drinking water.

Purpose and Scope

This report describes the aquifers and confining units that compose the shallow aquifer system throughout York County, Va., including the altitude of the top, thickness, and areal extent of these units. Sources of data include geophysical and driller's logs from eight pilot holes drilled for this study by the Virginia Water Control Board. Additional sources of data are other geophysical and drillers' logs from State and private wells, test wells, and miscellaneous geotechnical borings. The hydrogeologic framework is interpreted through use of aquifer and confining unit maps and hydrogeologic sections.

Previous Investigations

Geologic reports about the Virginia Coastal Plain and the Coastal Plain physiographic provinces of adjacent States were reviewed. Brown and others (1972) constructed 36 subsurface-stratigraphic sections and provided a detailed structural analysis of the Atlantic Coastal Plain physiographic province from North Carolina to New York. Teifke (1973) described the paleontology and subsurface stratigraphy of Virginia Coastal Plain geologic formations that range in age from Cretaceous to Miocene. Onuschak (1973) reconstructed depositional environments for the Pleistocene and Holocene sediments of the Virginia Coastal Plain. Ward and Blackwelder (1980) named the Eastover Formation and divided the Yorktown Formation into four members in a study area that included the Coastal Plain physiographic province of Virginia and adjacent areas in Maryland and North Carolina. Mixon and others (1989) compiled a geologic map (scale 1:250,000) and geologic sections of the Virginia Coastal Plain.

Other geologic researchers focused on the geology of the York-James peninsula and adjacent areas. Roberts (1932) described the paleontology and surficial geology of the lower peninsula (James City County to the City of Hampton). Bick and Coch (1969) mapped the surficial geology of the Williamsburg, Hog Island, and Bacons Castle quadrangles, and Johnson (1972) mapped the Yorktown, Poquoson West, and Poquoson East quadrangles (scale 1:24,000 for both study areas). Johnson, Berquist, and Ramsey (1980) described the surficial Miocene to Pleistocene stratigraphy of the lower peninsula (New Kent and Charles City Counties to the City of Hampton) in a geologic-field-trip guidebook. In another guidebook, Johnson, Ward, and Peebles (1987) described the surficial Miocene to Holocene stratigraphy of the lower peninsula (James City County to the City of Hampton) and adjacent parts of the southern Hampton Roads area.

Hydrogeologic reports about the Virginia Coastal Plain physiographic province also were reviewed. Sanford (1913) described the "underground waters" of the Virginia Coastal Plain, providing information about hydrogeologic units and water quality. Cederstrom (1945) briefly described hydrogeologic units and recorded drillers' log descriptions from 81 wells in the area of the Virginia Coastal Plain north of the James River. DeBuchananne (1968) compiled ground-water data from the Virginia Eastern Shore and the Coastal Plain area of the James, York, and Rappahannock River basins to construct hydrogeologic, ground-water use, and ground-water quality maps of the area (scale 1:500,000). Meng and Harsh (1988) defined the hydrogeologic framework of the Virginia Coastal Plain as part of the Virginia Regional Aquifer-System Analysis (RASA) study.

Three previous hydrogeologic studies describe the aquifers specific to the York-James peninsula. Cederstrom (1957) reported on the first comprehensive hydrogeologic study of the peninsula (from the Fall Line to the Chesapeake Bay and from the Mattaponi and York Rivers to the James River) and provided well-construction records, drillers' logs, and ground-water quality data. The Virginia State Water Control Board (1973) described the hydrogeology and water quality of the "upper and principal artesian systems" in the same area of the peninsula investigated by Cederstrom. The hydrogeologic framework described in the present study is a refinement of the York County portion of the hydrogeologic framework originally described in Meng and Harsh (1988) and modified in Laczniak and Meng (1988).

Approach

The investigation involved four stages of activity: (1) researching, collecting, and compiling existing well and borehole data, (2) collecting additional data, (3) constructing hydrogeologic sections, and (4) drafting altitude and thickness maps for each unit. The investigation was designed to refine the interpretations and hydrogeologic data set established during earlier USGS investigations in the study area.

A review of existing well and borehole data in the study area vicinity was conducted to assess additional data needs. Both geophysical and drillers' logs were available for 12 wells recorded in USGS files. An additional 27 drillers' logs were collected from USGS files and reports, Virginia Electric Power Company borehole records, and Hampton Roads Sanitation District borehole records. This information provided 39 control points.

Additional well data were needed throughout the York County area, but the data-collection effort was restricted to east-central, northeastern, and southeastern York County. Data collection was restricted to these areas to focus on the part of the county where future water supplies potentially could be concentrated. Borehole cuttings, drillers' logs, single-point resistivity logs, and natural-gamma logs were collected from eight hydraulic-rotary pilot holes drilled by the Virginia Water Control Board for the data-collection effort. Counting the existing 39 control points identified from USGS files and other records, these eight pilot holes brought the total to 47 control points for the hydrogeologic framework.

Four hydrogeologic sections were constructed from electric-geophysical, drillers', and borehole logs compiled for this study. Electric-geophysical-log data were supplemented with drillers'-log data in areas where the geophysical data were sparsely distributed or were of poor quality. A detailed discussion of the principles of geophysical-log interpretation and correlation in the Virginia Coastal Plain physiographic province is presented in Meng and Harsh (1988).

Altitude and thickness maps of the top and thickness of each hydrogeologic unit were constructed from the four hydrogeologic sections. In addition, information from other wells and test holes and from geologic outcrop, topographic, and bathymetric data (scale 1:24,000) were used to construct the maps.

Acknowledgments

The authors would like to thank Martin Fisher and Connie Bennett of the York County Department of Environmental Services for their cooperation and support in this study. Special thanks are extended to the Virginia Water Control Board and especially to Scott Bruce, of their staff, who coordinated the drilling of the eight pilot holes. The authors express their appreciation to Dr. Jerre H. Johnson of William and Mary College for providing stratigraphic information and analysis. The Virginia Department of Transportation, Virginia Electric Power Company, and Hampton Roads Sewage District provided borehole logs that were invaluable to framework interpretation.

DESCRIPTION OF STUDY AREA

A description of the location, physiographic setting, and geology of York County is included for orientation purposes. The geologic description is limited to the sediments containing the York County shallow aquifer system.

Location and Physiographic Setting

York County is in the east-central part of the Coastal Plain physiographic province of Virginia (fig. 1) and encompasses a land area of about 108 mi. The county is oriented in a northwest-southeast direction and extends approximately 25 mi; however, it is only 3 to 8 mi wide. In 1990, the county's population was approximately 40,000 (Martin Fisher, York County Department of Environmental Services, written commun., 1992).

The boundaries of York County are a combination of political and natural borders. The York River and Gloucester County bound York County to the north. James City County forms the remainder of the northern border and part of the western border. Also on the western border are the Cities of Williamsburg and Newport News. South of York County is the City of Hampton. The eastern part of the county is bordered by the City of Poquoson, the Poquoson River, and the Chesapeake Bay.

The county is subdivided into five geographical areas for orientation purposes in this report (fig. 2). These subdivided areas are western, west-central, east-central, northeastern, and southeastern York County.

About 40 percent of the land in York County is Federally owned (fig. 1). The Yorktown Battlefield unit of the Colonial National Historical Park is in east-central York County. The U.S. Naval Supply Center and the U.S. Coast Guard Reserve Training Center also are in east-central York County. The U.S. Naval Weapons Station is in west-central York County. The Cheatham Annex of the U.S. Naval Supply Center and Camp Peary Naval Reservation are in western York County.

Future domestic ground-water supplies potentially could be developed in northeastern and southeastern York County, where less land is government-owned. The Chisman Creek superfund site and a large privately owned facility, the Yorktown Refinery, are located in this area.

Geology

The stratigraphy and inferred depositional environments of the sediments containing the shallow aquifer system of York County and the underlying clays were described by previous investigators. The findings of these previous geologic investigations are summarized in this report.

Stratigraphy

The stratigraphy of the shallow aquifer system of York County consists of nine formally named geologic formations, which range in age from early Miocene to late Pleistocene, and undifferentiated deposits of Holocene age (fig. 3). The lower Miocene to middle Miocene Calvert Formation and overlying middle Miocene St. Marys Formation contain fine-grained sediments in the York County area and are separated by an unconformity (Ward, 1984 and Meng and Harsh, 1988). Outside of York County, in other areas of the Virginia Coastal Plain physiographic province, the Choptank Formation separates the two formations. The Calvert and St. Marys Formations are in the Chesapeake Group. Sediments of the Calvert Formation are interbedded shelly and sandy clay, silty clay, and diatomaceous clay. Sediment of the St. Marys Formation is silty and sandy clay with shells.

The upper Miocene Eastover Formation unconformably overlies the St. Marys Formation in York County and is divided into two members containing sediments of different grain size (Ward and Blackwelder, 1980). The Eastover Formation is in the Chesapeake Group. The lower member of the Eastover Formation is the Claremont Manor Member and the upper member is the Cobham Bay Member. Sediments of the Claremont Manor Member are fine-grained silty or clayey sand fining upward to clay or silt. Sediment of the Cobham Bay Member is fine-grained shelly sand.

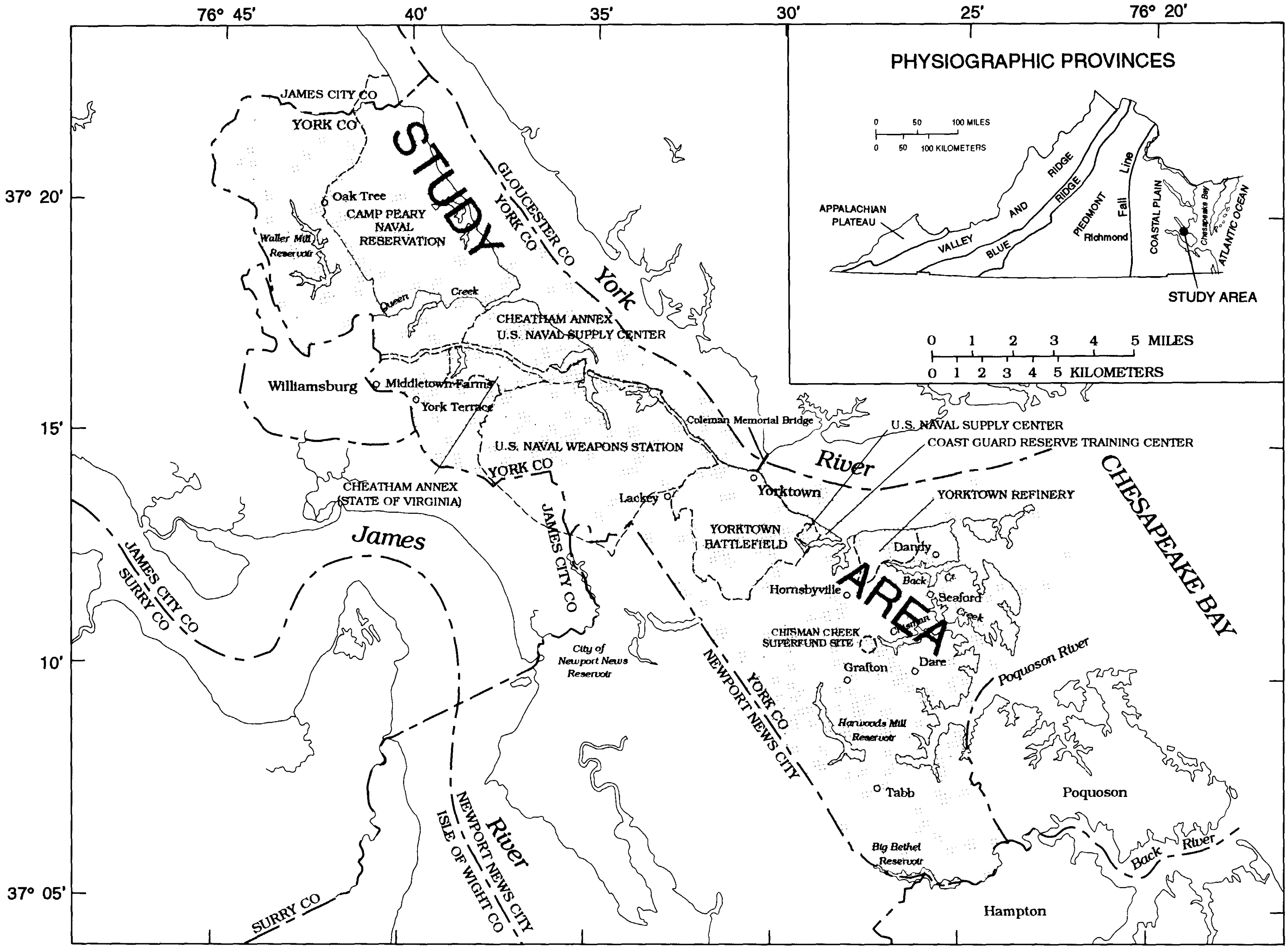


Figure 1.--Location of York County and physiographic provinces of Virginia.

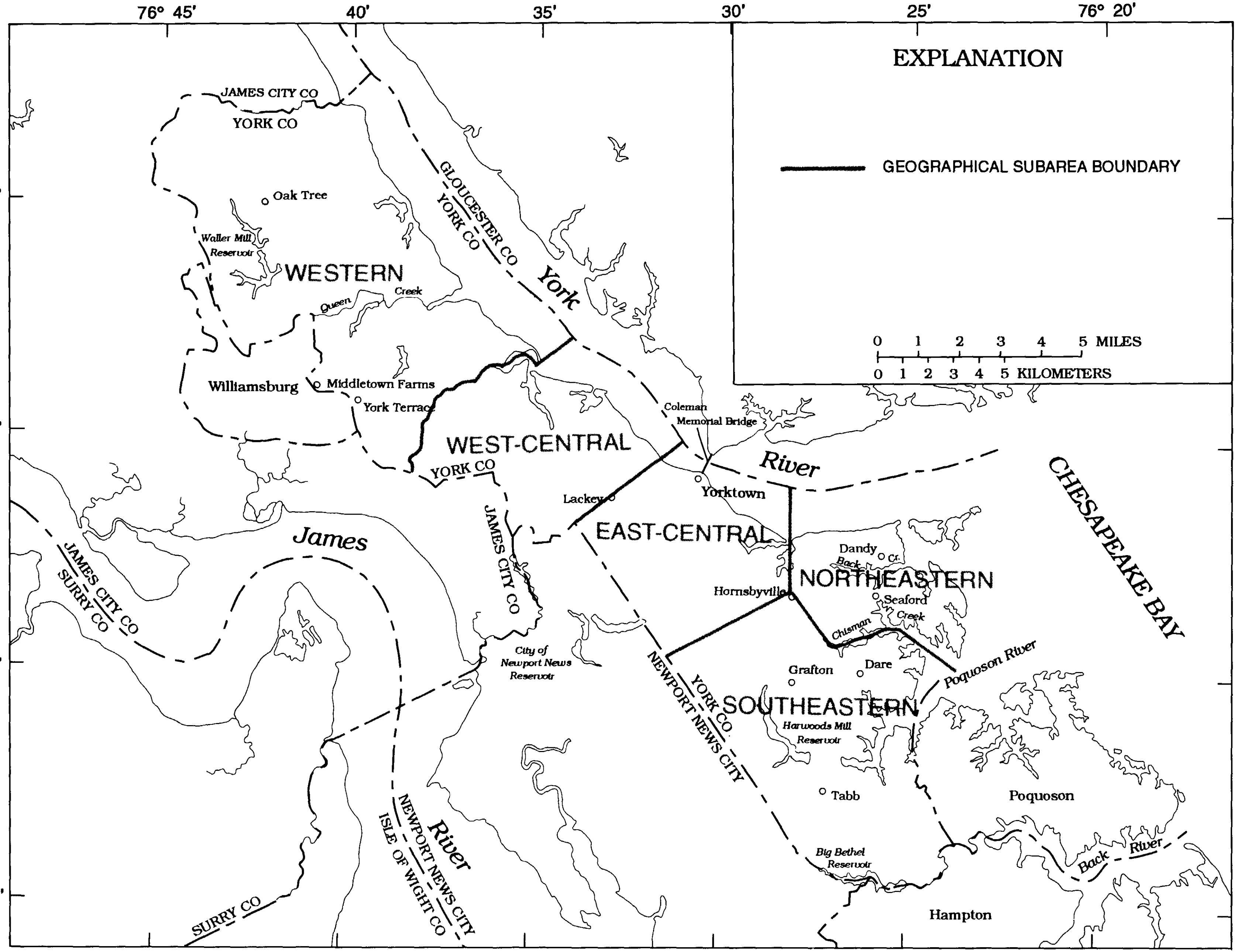


Figure 2.--Geographical subareas of York County.

System	Series	Geologic Unit		
Quaternary	Holocene	Alluvial and Marsh deposits		
	Pleistocene	Tabb Formation		
		Shirley Formation		
		Chuckatuck Formation		
Tertiary	Pliocene	Windsor Formation		
		Bacons Castle Formation		
		Chesapeake Group	Yorktown Formation	Moore House Member
				Morgarts Beach Member
				Rushmere Member
				Sunken Meadow Member
	Miocene		Eastover Formation	Cobham Bay Member
				Claremont Manor Member
			St. Marys Formation	
			Calvert Formation	

Figure 3.--Geology of the York County shallow aquifer system.

The lower Pliocene Yorktown Formation unconformably overlies the Eastover Formation in York County and is divided into four members with different sedimentary characteristics (Ward and Blackwelder, 1980). The Yorktown Formation is in the Chesapeake Group. The four members of the formation and their sediment types are: (1) the Sunken Meadow Member--medium-grained to coarse-grained shelly sand; (2) the Rushmere Member--fine-grained to coarse-grained sand or sandy shells; (3) the Morgarts Beach Member--clay, silt, and fine-grained sand; and (4) the Moore House Member--fine-grained sand, shell hash, or bioclastic sand. At the top of the Yorktown is a weathered zone and an unconformity surface.

Pliocene, Pleistocene, and Holocene age deposits unconformably overly the Yorktown Formation in terraces throughout much of York County (Mixon and others, 1989). These are: (1) the upper Pliocene Bacons Castle Formation--clayey silt and silty fine-grained sand; (2) the upper Pliocene or lower Pleistocene Windsor Formation--sand, gravel, silt, and clay; (3) the middle (?) Pleistocene Chuckatuck Formation--sand, silt, and clay and minor amounts of peat; (4) the middle Pleistocene Shirley Formation--sand, gravel, silt, and peat; (5) the upper Pleistocene Tabb Formation--sand, silt, clay, and peat; and (6) Holocene alluvium and soft marsh mud from undifferentiated formations.

Depositional History

Previous geological researchers have reconstructed depositional environments from analyses of fossils and sedimentary structures in the formations containing the shallow aquifer system and the underlying clays. Sediments of Miocene age were deposited in a marine environment that was distinctly different from that of modern Chesapeake Bay and tributary estuaries that border York County today. Pliocene, Pleistocene, and Holocene sediments were deposited in similar depositional environments to those environments currently found in and near the York County study area.

Miocene to lower Pliocene sediments were deposited in a marine embayment during a series of marine transgressions (Ward, 1984; Ward and Blackwelder, 1980). Silty clay in the Calvert and St. Marys Formations was deposited in a shallow bay during four or more marine transgressions in the early Miocene to middle Miocene (Ward, 1984). Fine-grained sand, silt, and clay of the Claremont Manor Member of the Eastover Formation were deposited in an open-marine embayment (Ward and Blackwelder, 1980). Fine-grained shelly sand of the Cobham Bay Member of the Eastover Formation was deposited in an open-marine, shallow subtropical bay. Fine-grained to coarse-grained shelly sand in the Sunken Meadow and Rushmere Members of the Yorktown Formation was deposited on an open-marine shallow shelf. The fine-grained Morgarts Beach Member sediments of the Yorktown Formation were deposited in a wide lagoon behind barrier bars located east of the York County study area. The fine-grained sand and shells of the Moore House Member of the Yorktown Formation are a marine-regressive sequence, deposited in a progressively shallowing sea.

Upper Pliocene to Holocene sediments were deposited in an environment that evolved from an open-marine setting into the estuarine and bay setting of the modern Chesapeake Bay (Johnson, Ward, and Peebles, 1987). Silt and fine-grained sand of the Bacons Castle Formation were deposited during a marine transgression. Windsor Formation sediments were deposited under marine or lagoonal conditions. Sand, silt, and clay of the Chuckatuck Formation were deposited in a bay environment. Shirley Formation sediments were deposited in rivers and estuaries. Tabb Formation sediments were deposited in estuaries, on barrier islands, on beach ridges, in rivers, on flood plains, and on point bars. Sediments of Holocene age were and are deposited in the Chesapeake Bay, in estuaries, in marshes, on beach ridges, in rivers, on flood plains, and on point bars.

HYDROGEOLOGIC FRAMEWORK

The basis for developing the hydrogeologic framework of York County shallow aquifer system and a description of the aquifer system and component hydrogeologic units are presented in this section. The hydrogeologic framework for the shallow aquifer system was interpreted through the use of geophysical logs, drillers' logs, geologic and bathymetric maps, dip projection, and map interpolation. Seven hydrogeologic units, including the basal confining unit, were identified in the shallow aquifer system of York County.

Geophysical-log data from wells in and adjacent to York County were used as the principal basis for the hydrogeologic framework interpretation presented in this report (well locations in fig. 4). Electric logs were used instead of natural-gamma logs because the gamma-log pattern of glauconitic sand, common in many of the sedimentary deposits in the study area, is similar to that of clay. The potential for misinterpreting glauconitic sand as confining-unit sediment is minimized by the use of electric-geophysical logs.

Where geophysical-log data from wells in and adjacent to York County were unavailable, drillers' logs were used for supplementary correlation data (fig. 4). Drillers' logs are less precise than geophysical logs in recording stratigraphic contacts but are the only well-log data available in some locations in the study area. Hydrogeologic units were correlated in four hydrogeologic sections transecting the county (figs. 5-8).

The four hydrogeologic sections, other geophysical and drillers'-log data, geologic and bathymetric maps, dip projection, and map interpolation were used to construct altitude and thickness contour maps of each unit in the study area. A tabulation of the well and borehole data used to construct the contour maps is given in table 1, at the end of this report. Geologic maps (scale 1:24,000) of areas in York County (Bick and Coch, 1969; Johnson, 1972) show outcrop areas of the geologic formations and were a source for indicating hydrogeologic-unit boundaries. The bathymetry of the York River and other Chesapeake Bay estuaries on topographic maps (scale 1:24,000) in the study area was used to verify the extent of hydrogeologic units under major water bodies. The structural dip of the hydrogeologic units, calculated from contacts in logged wells, was projected into areas without data to generate contoured altitude and thickness maps of each hydrogeologic unit. After preliminary maps of each unit were drafted, thickness and altitude contours were adjusted through an interpolation of the contoured data from the maps of overlying and underlying hydrogeologic units.

The hydrogeologic framework of the York County shallow aquifer system includes seven units: (1) the undivided York County shallow aquifer system, (2) the Columbia aquifer, (3) the Cornwallis Cave confining unit, (4) the Cornwallis Cave aquifer, (5) the Yorktown confining unit, (6) the Yorktown-Eastover aquifer, and (7) the Eastover-Calvert confining unit. These units are defined and described in this report (fig. 9).

York County Shallow Aquifer System (Undivided)

The undivided York County shallow aquifer system is herein defined as the aquifer system in sandy and shelly sediments of Miocene to Holocene age where confining units, common in other areas of the county, are missing (fig. 9). The aquifer system is generally confined, but is unconfined locally. The system is not fully divided into the constituent aquifers and confining units in areas of York County where one or more of the confining units are missing and two or more of the aquifers combine into a single hydrologic unit. Electric-geophysical-log patterns of sediments in the undivided shallow aquifer system reflect the sedimentary deposits included in the aquifer system at any specific well location. Examples of electric-geophysical-log patterns are illustrated on logs of wells 58F64, 59F2, and 59F97 in figures 5 and 8 and 58F64 in figure 7.

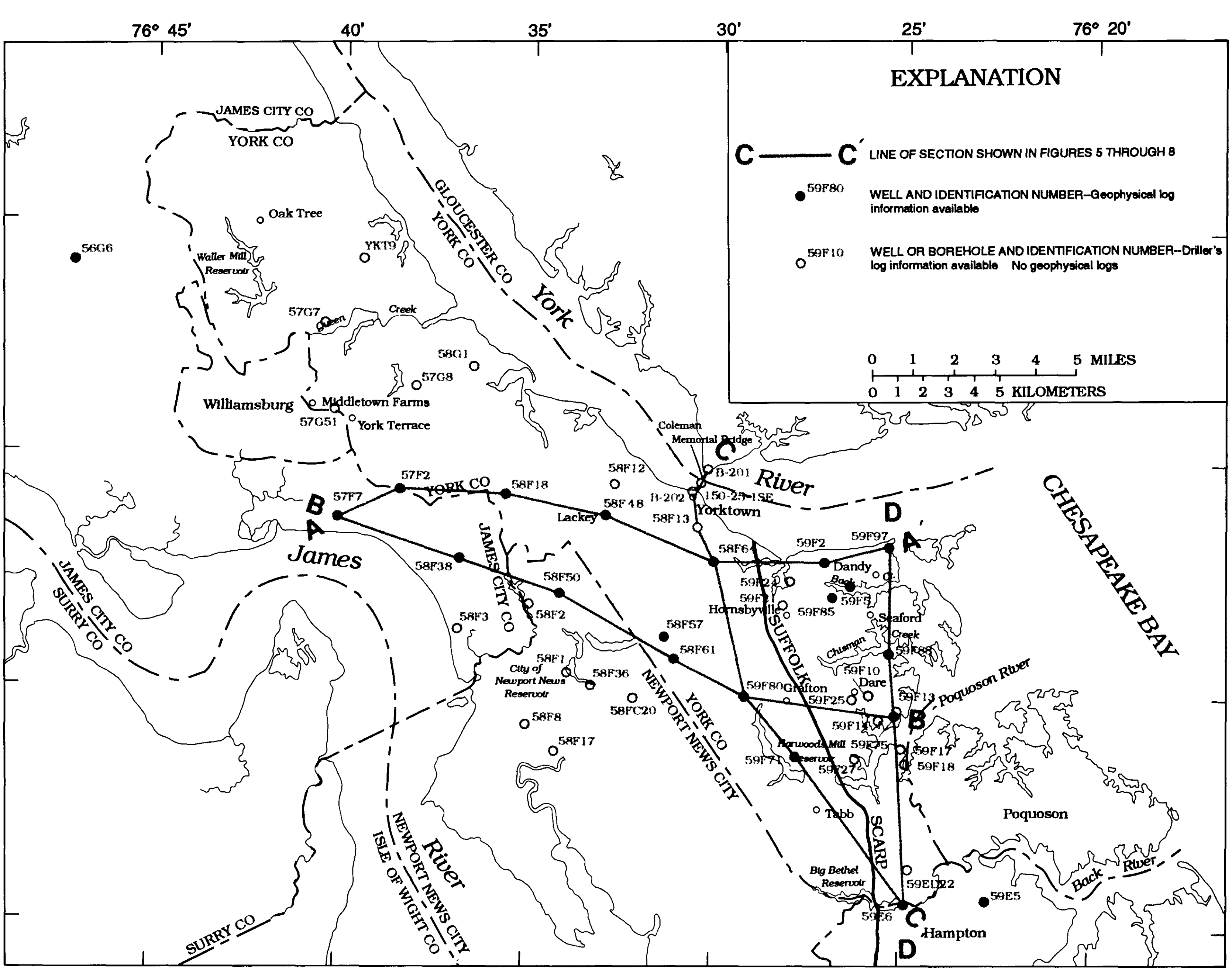


Figure 4.--Location of wells, borings, and hydrogeologic sections in York County.

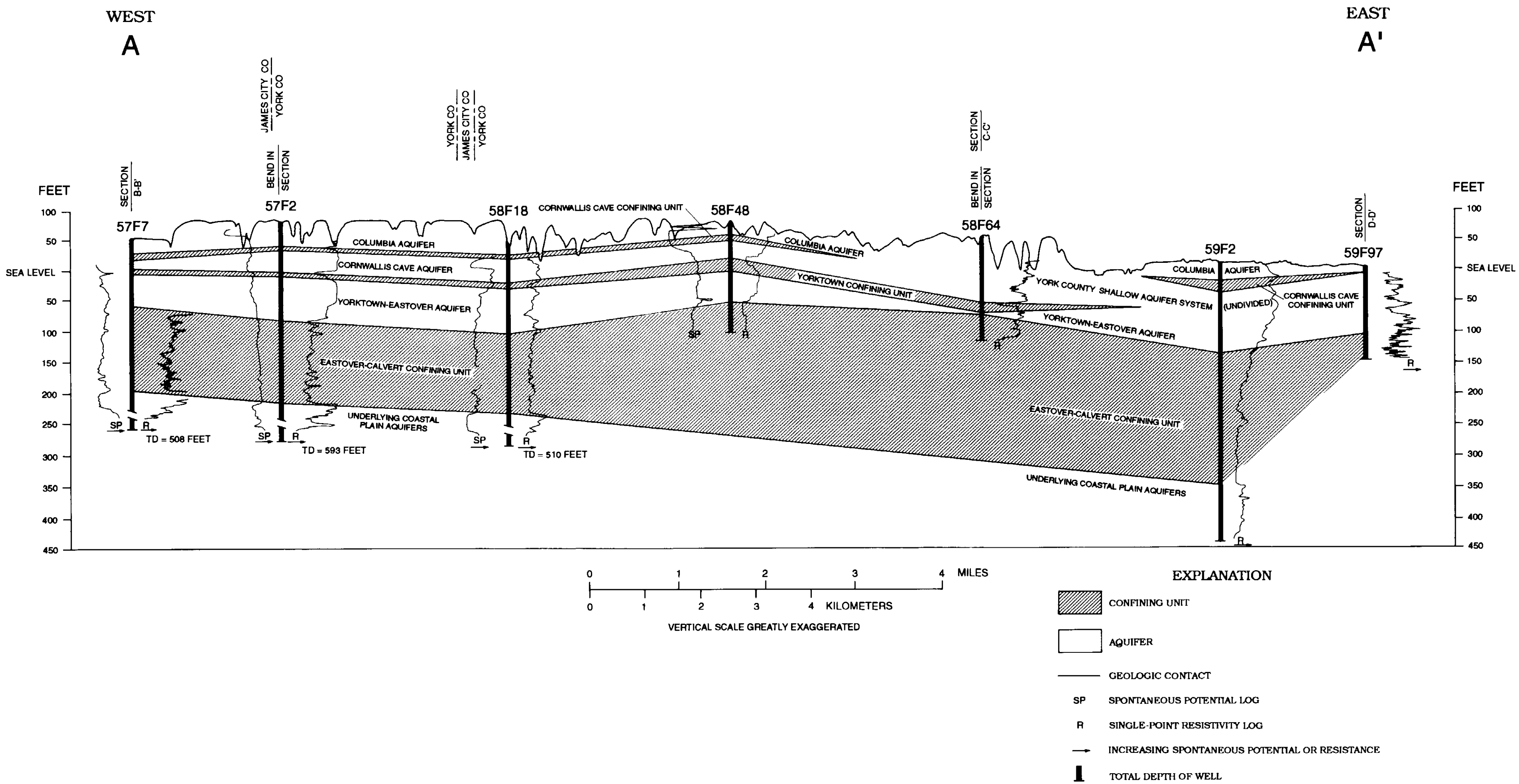


Figure 5.--Hydrogeologic section A-A' in York County and adjacent area.

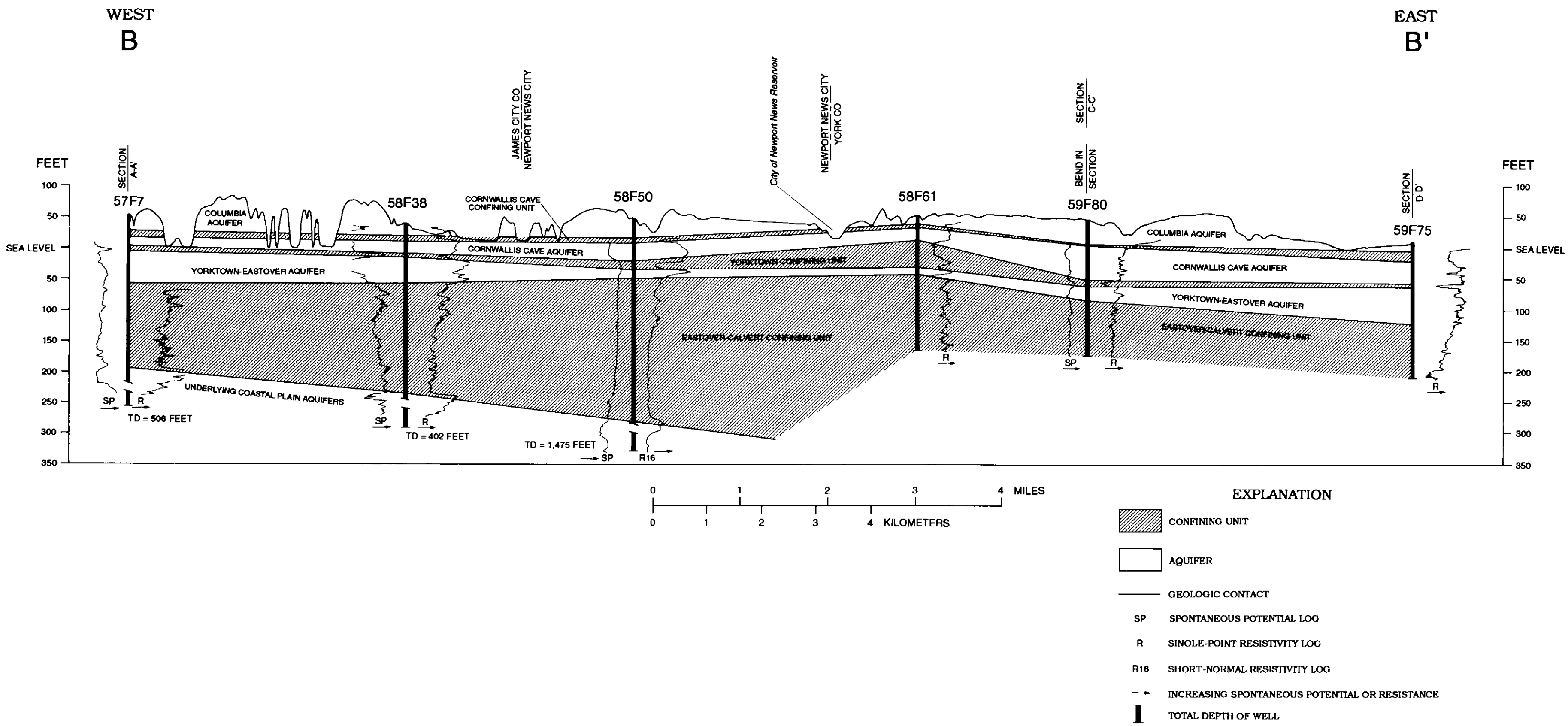


Figure 6.--Hydrogeologic section B-B′ in York County and adjacent area.

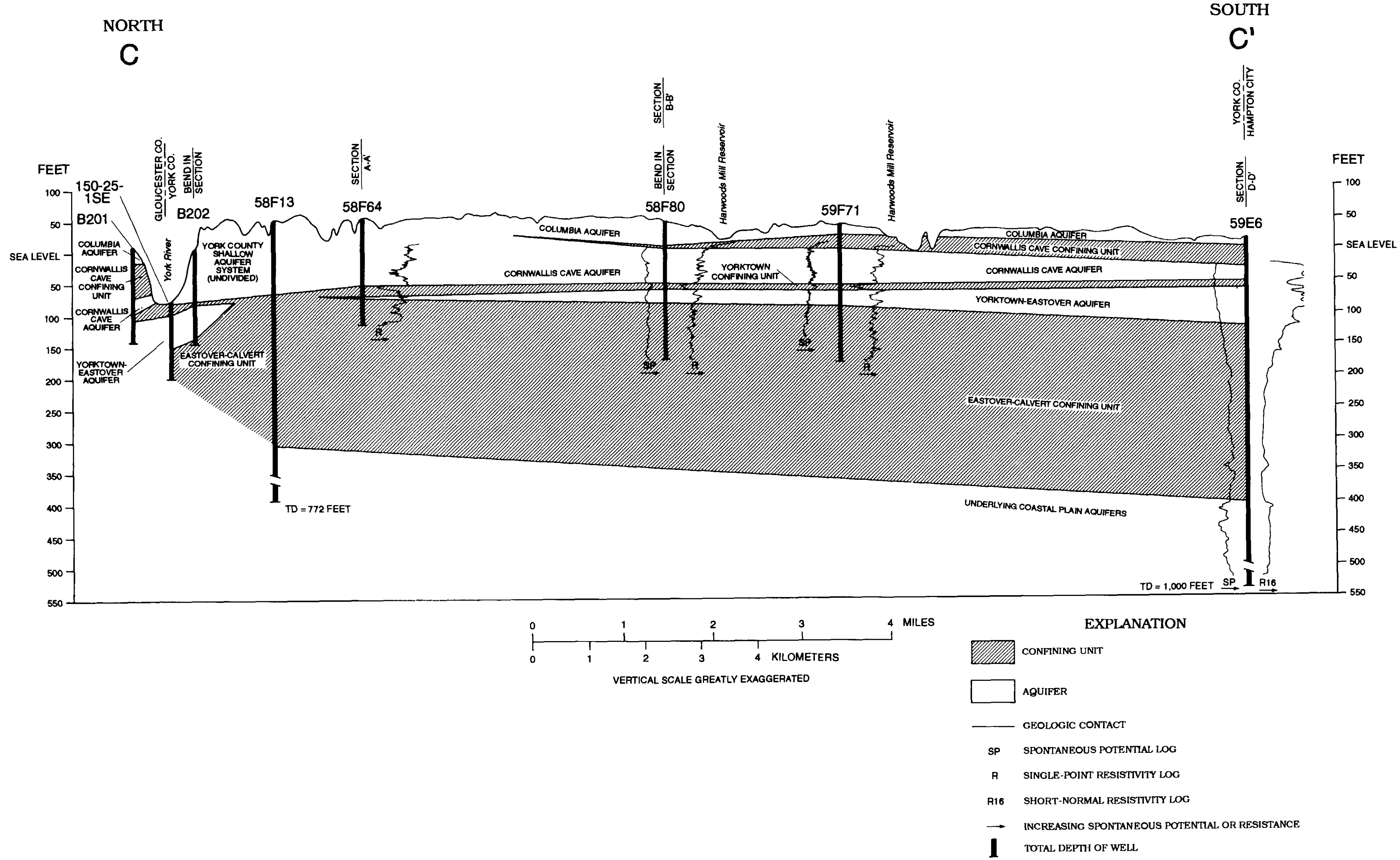


Figure 7.--Hydrogeologic section C-C' in York County and adjacent area.

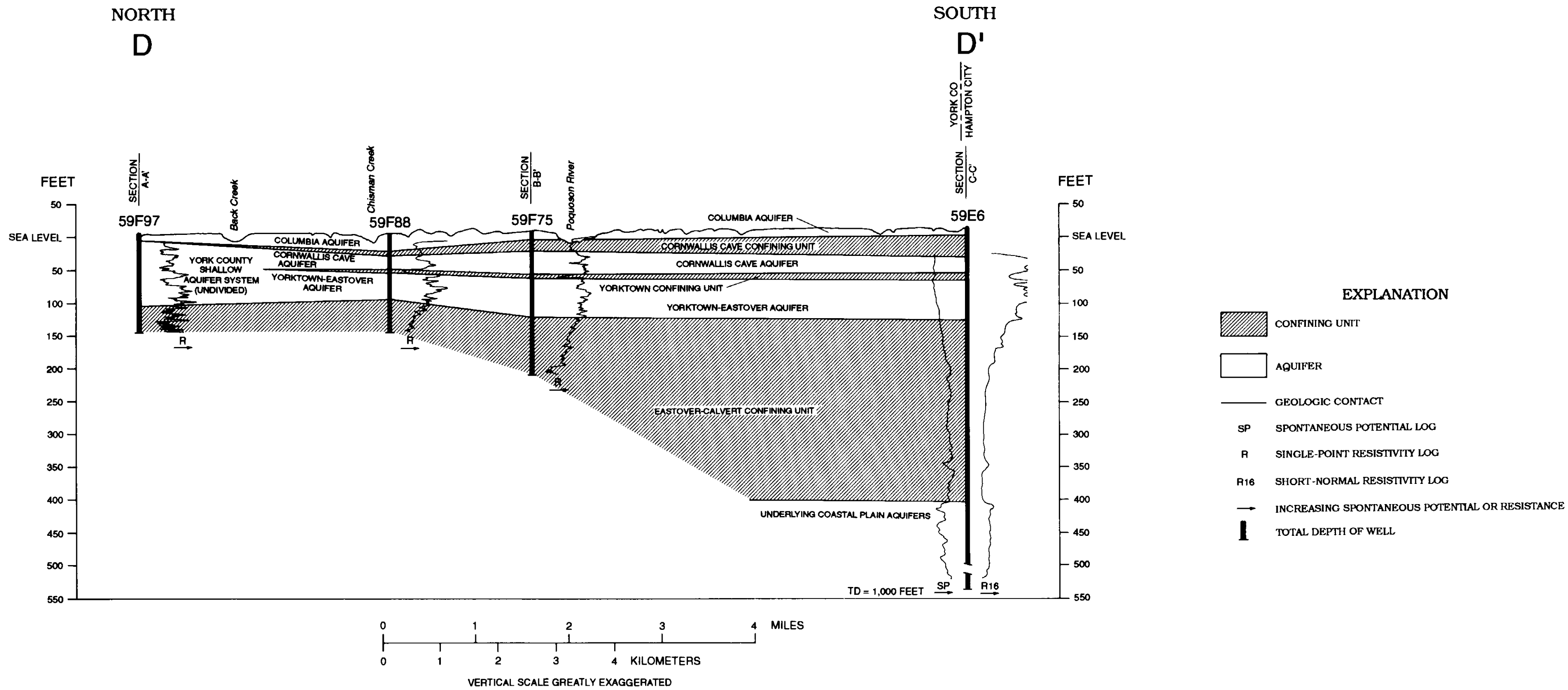


Figure 8.--Hydrogeologic section D-D′ in York County and adjacent area.

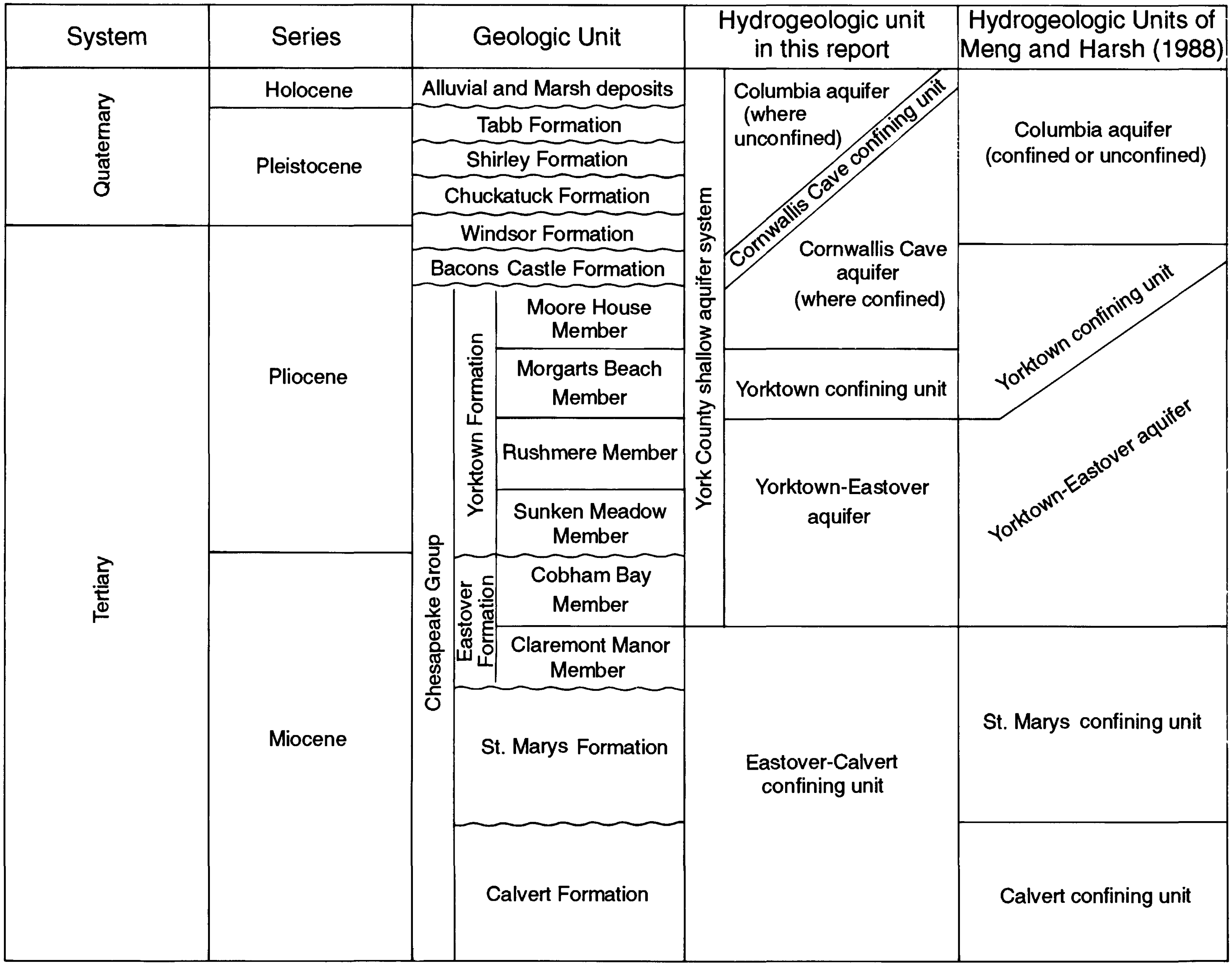


Figure 9.--Relation between geology and Hydrogeology of York County.

General physical characteristics of the undivided York County aquifer system include sediment composition, altitude and thickness range, and areal distribution. Sediments of the undivided aquifer system in different areas of York County are recorded in drillers' logs as shells and (or) fine-grained sand, with minor amounts of clay or silt. Altitude and thickness maps of the undivided aquifer system are not presented, because the saturated thickness is variable and complex. Instead, the boundary of the undivided aquifer system is shown on the thickness and altitude maps of each of the constituent aquifers, and the general area of the county underlain by the undivided York County shallow aquifer system is indicated in figure 10.

A brief description of hydrologic characteristics of the undivided York County aquifer system is included here as part of the framework description of the aquifer system. No domestic or public wells open to the entire thickness of the undivided York County aquifer system were identified in this study; thus, representative yield data are unavailable. Vertical ground-water flow through the shallow aquifer system is less restricted in areas of the county where the system is undivided, because one or more of the intervening confining units are missing in these areas. Recharge and contaminants could potentially reach the lower part of the system more readily than in other areas of the county where confining units, restrictive to vertical flow, are present.

Columbia Aquifer

Meng and Harsh (1988, p. C51-C52) defined the Columbia aquifer as "the predominantly sandy surficial deposits of Pliocene to Holocene age" above the "clayey deposits of the upper Yorktown Formation and Bacons Castle Formation." The aquifer was defined generally as unconfined, but locally confined or semiconfined (Meng and Harsh, 1988, p. C52).

In this report the Columbia aquifer in York County is redefined as the unconfined aquifer in sandy sediments of the upper Pliocene Bacons Castle Formation; in sandy sediments of the Pleistocene Windsor, Chuckatuck, Shirley, and Tabb Formations; and in unnamed sandy sediments of Holocene age (fig. 9). Confined aquifers in these Pliocene, Pleistocene, and Holocene sediments are not part of the Columbia aquifer as defined in this report; but are classified instead as a lower hydrogeologic unit in the shallow aquifer system. In addition, unconfined aquifers contained in sediments of the Yorktown Formation and older formations in the county are not part of the Columbia aquifer.

General physical characteristics of the Columbia aquifer in York County include sediment composition, altitude and thickness range, and areal distribution. Sediments of the Columbia aquifer in different areas of York County are recorded in drillers' logs as fine-grained to coarse-grained sand, clay, silt, and shells. The top of the Columbia aquifer is the water table. The altitude of the water table fluctuates seasonally and generally is subparallel to the land surface; thus, altitude and thickness maps of the aquifer were not prepared. The aquifer generally is 5 ft or more in thickness. Most of the county is underlain by the aquifer, but the unit is missing in stream valleys of western and west-central York County where the topographic relief exceeds 25 ft.

A brief description of hydrologic characteristics of the Columbia aquifer in York County is included here as part of the framework description of the unit. Only three domestic wells open to the aquifer were identified in this study. No yield data are available for these three wells. Other domestic wells in the county, not identified in this study, could be open to the Columbia aquifer (Martin Fisher, York County Department of Environmental Services, oral commun., 1992). Recharge to the Columbia aquifer is derived from precipitation at the land surface that infiltrates downward through the aquifer sediments and flows downward or laterally toward discharge sites, including rivers, streams, marshes, and estuaries. Water flowing downward from the Columbia aquifer is a source of recharge to underlying aquifers (Laczniak and Meng, 1988).

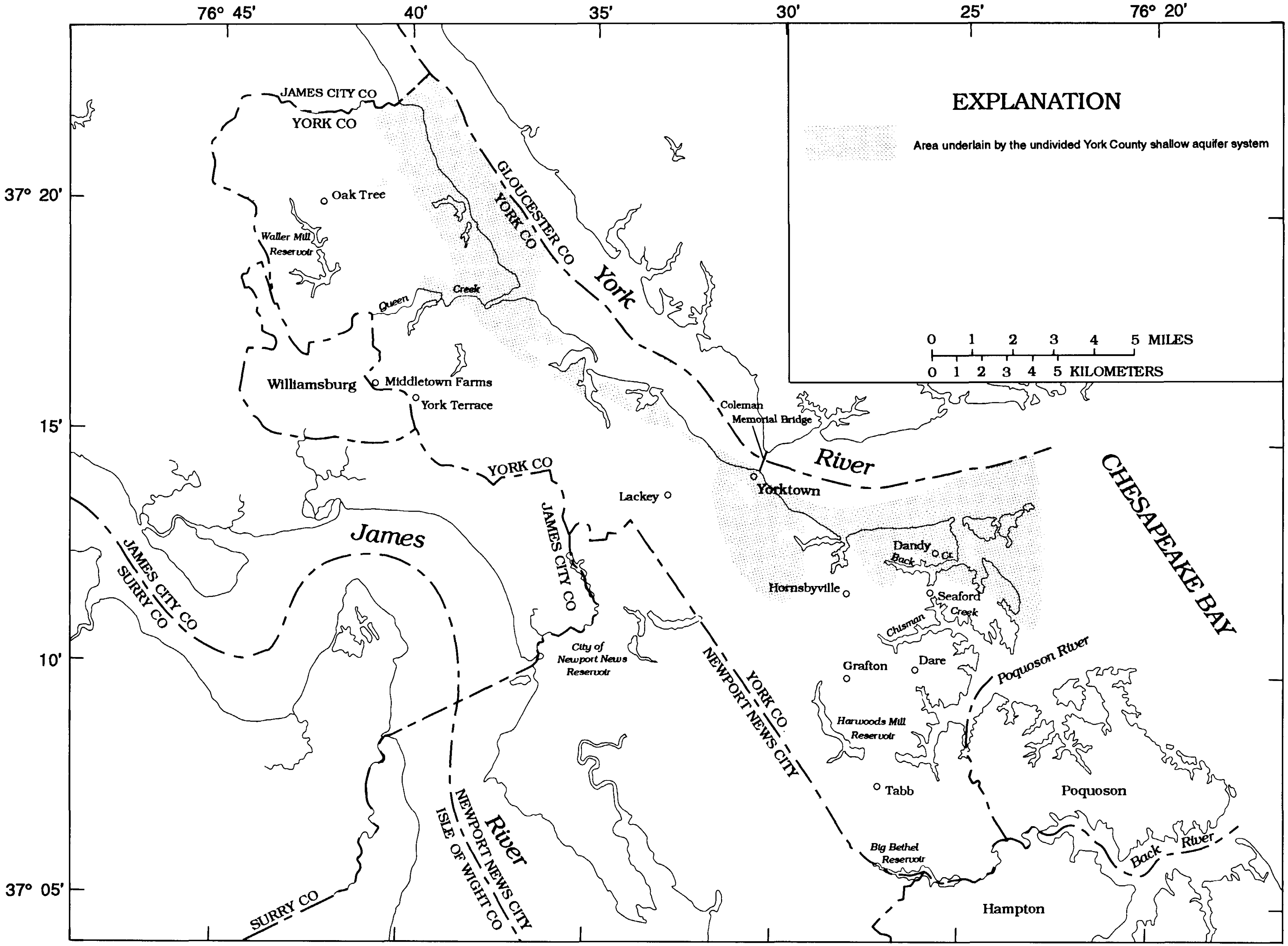


Figure 10.--Generalized area underlain by the undivided York County shallow aquifer system.

Cornwallis Cave Confining Unit

The Cornwallis Cave confining unit is herein defined as the silt or clay sediments overlying the uppermost confined aquifer in York County. The Cornwallis Cave confining unit contains sediments of the lower Pliocene Moore House Member of the Yorktown Formation; the upper Pliocene Bacons Castle Formation; the Pleistocene Windsor, Chuckatuck, Shirley, and Tabb Formations; and (or) unnamed sediments of Holocene age (fig. 9). Typical electric-geophysical-log patterns of sediments in the Cornwallis Cave confining unit are illustrated on logs of wells 58F38 in figure 6 and 59F88 in figure 8.

The Cornwallis Cave confining unit is approximately equivalent to the Yorktown confining unit of Meng and Harsh (1988, p.C51). In the report, Meng and Harsh (1988) defined the Yorktown confining unit as "clayey deposits of the upper parts of the Yorktown Formation and the Bacons Castle Formation." The Yorktown confining unit was identified on electric-geophysical logs as a "broad U-shaped profile," indicating the uppermost clay unit (Meng and Harsh, 1988, p.C52).

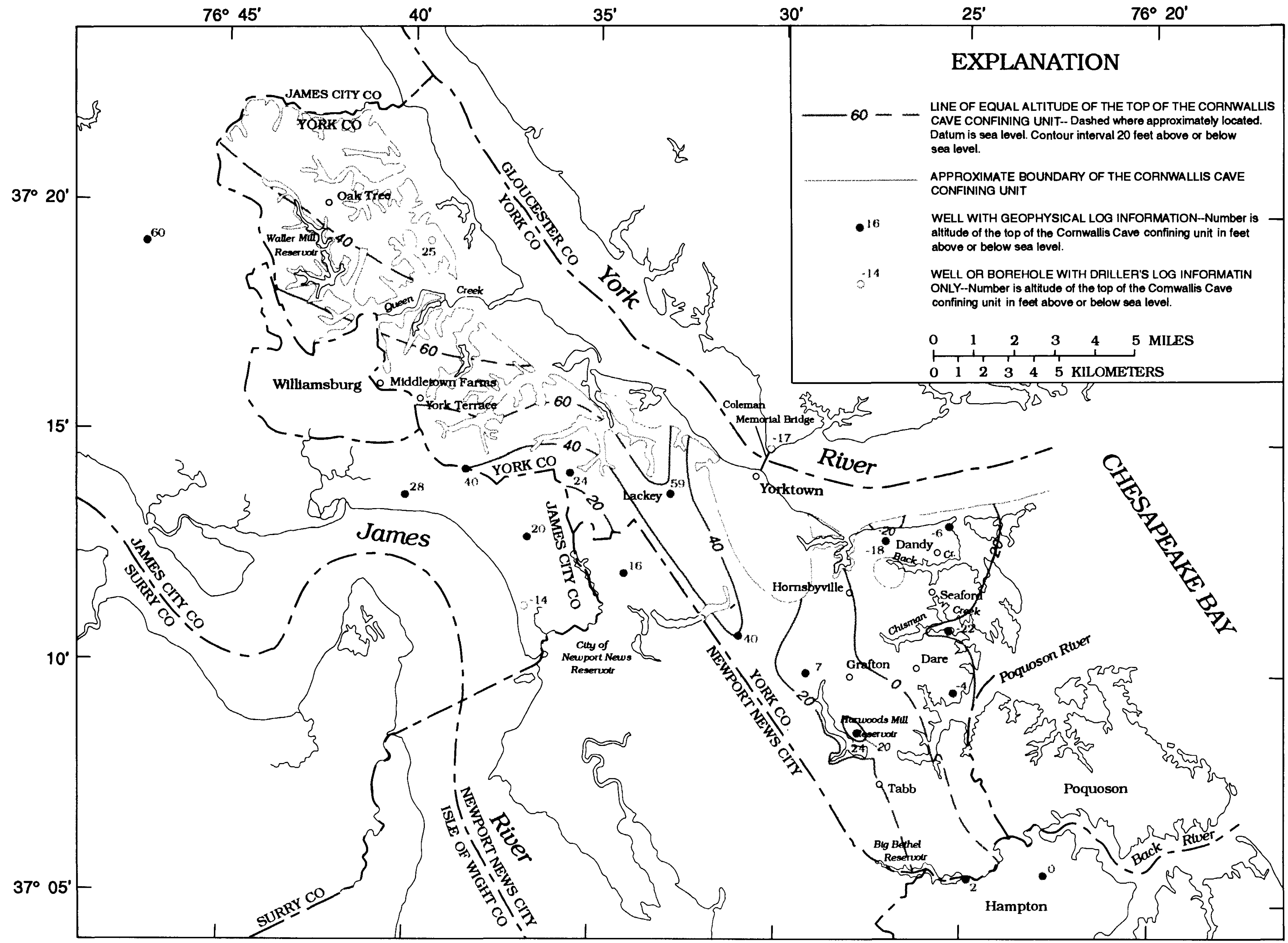
The Cornwallis Cave confining unit is named in this report to reflect local hydrogeologic differences from the Yorktown confining unit described in the Virginia Coastal Plain investigation by Meng and Harsh (1988). Well logs from Coastal Plain wells in Virginia generally record a single confining unit in the Pliocene-Holocene sediments; however, two confining units are recorded from this stratigraphic interval in York County. The upper confining unit is named the "Cornwallis Cave" confining unit for the Cornwallis Cave, a historic and geographic feature near Yorktown, to indicate the limited range of the unit. A geographic name also was chosen because a single rock-stratigraphic name does not apply to the multiple rock units in the confining-unit interval.

General hydrogeologic characteristics of the Cornwallis Cave confining unit in York County include sediment composition, altitude and thickness range, areal distribution, and hydrology. Sediments of the confining unit in different areas of York County are recorded in drillers' logs as clay, silt, or fine-grained sand; with or without shells. The top of the confining unit is highest in altitude at Lackey, at 59 ft above sea level, and lowest near Dare, at 22 ft below sea level (fig. 11). The altitude of the confining unit potentially exceeds 60 ft in parts of western and west-central York County. The maximum thickness of the confining unit is 22 ft at Harwoods Mill Reservoir and the minimum thickness is 0 ft along the outcrop and subcrop areas of the confining unit near the York River (fig. 12). The thickness of the confining unit potentially exceeds 30 ft in southeastern York County near Hampton. Most of the county is underlain by the confining unit, but the unit is missing under the York River, along a band near the river, and in stream valleys of western and west-central York County. The Cornwallis Cave confining unit impedes vertical ground-water flow between the Columbia aquifer and underlying aquifers in York County.

Cornwallis Cave Aquifer

The Cornwallis Cave aquifer is herein defined as the aquifer in sandy and shelly sediments of the Moore House Member of the Yorktown Formation and the confined aquifer in sandy sediments overlying the Yorktown Formation in York County (fig. 9). The Cornwallis Cave aquifer generally is overlain by the Cornwallis Cave confining unit and is confined throughout the county. The aquifer is unconfined locally in sediments of the Moore House Member, where the overlying confining unit is missing. In addition to sediments of the Moore House Member of the Yorktown Formation, the Cornwallis Cave aquifer contains sediments of the upper Pliocene Bacons Castle Formation; the Pleistocene Windsor, Chuckatuck, Shirley, and Tabb Formations; and (or) unnamed sediments of Holocene age (fig. 9). Typical electric-geophysical-log patterns of sediments in the Cornwallis Cave aquifer are illustrated on logs of wells 58F18 in figure 5, 58F50 in figure 6, and 59F71 in figure 7.

The Cornwallis Cave aquifer is approximately equivalent to the upper part of the Yorktown-Eastover aquifer of Meng and Harsh (1988). The Yorktown-Eastover aquifer defined by Meng and Harsh (1988, p. C50) includes sandy deposits in the upper part of the Eastover Formation, the Yorktown Formation, and the Bacons Castle Formation.



Additional data from geologic and bathymetric maps were used for contour construction

Figure 11.--Altitude of top of Cornwalllis Cave confining unit.

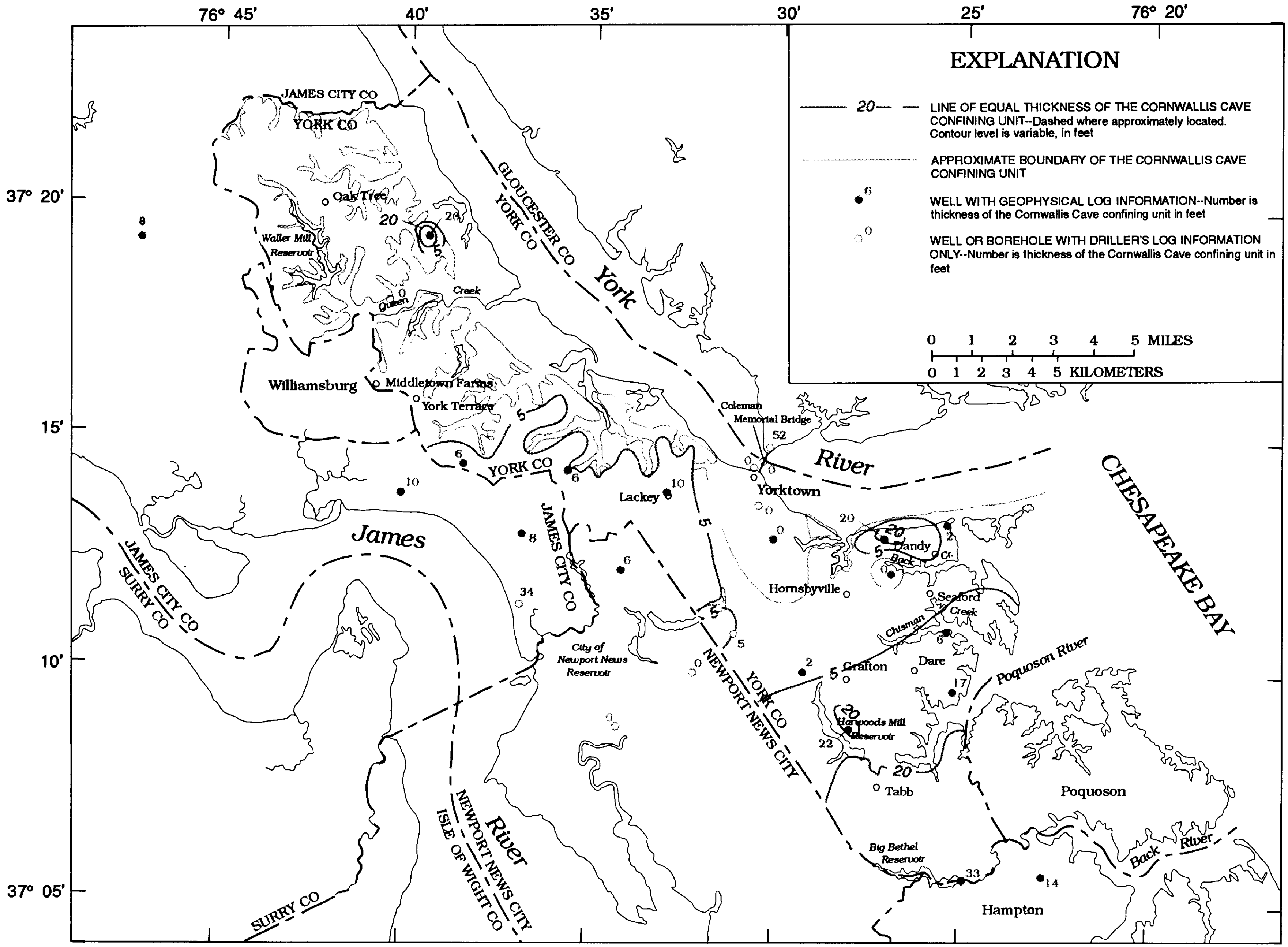


Figure 12.--Thickness of Cornwallis Cave confining unit.

The Cornwallis Cave aquifer is named in this report to reflect local hydrogeologic differences from the Yorktown-Eastover aquifer described by Meng and Harsh (1988) in their study area. Throughout most of the Virginia Coastal Plain physiographic province, the sediments of the Eastover and Yorktown Formations contain only one aquifer, the Yorktown-Eastover aquifer (Meng and Harsh, 1988). In York County, however, sediments of the Eastover and Yorktown Formations contain two aquifers; the upper aquifer is described in this section of the report. The upper aquifer is named the "Cornwallis Cave" aquifer for the Cornwallis Cave in Yorktown. The geographic name was chosen to reflect the limited extent of the aquifer and to identify a hydrogeologic unit containing the sediments of multiple stratigraphic formations.

General physical characteristics of the Cornwallis Cave aquifer in York County include sediment composition, altitude and thickness range, and areal distribution. Sediments of the aquifer in different areas of York County are recorded in drillers' logs as shells, fine-grained sand, and clay or silt. The top of the aquifer is highest in altitude in western York County (near Williamsburg), at 53 ft above sea level, and lowest near Dare, at 28 ft below sea level (fig. 13). The altitude of the unit is potentially less than 30 ft below sea level in parts of southeastern York County near Hampton. The maximum thickness of the aquifer is 56 ft near Grafton and the minimum thickness is 0 ft in the vicinity of the York River and in two minor areas northeast of Williamsburg and east of the City of Newport News Reservoir (fig. 14). The thickness of the aquifer potentially exceeds 60 ft in an area of the county northwest of Grafton. The altitude and thickness of the unconfined parts of the Cornwallis Cave aquifer change with the fluctuation of the water table, which defines the top of the aquifer in these areas. Altitude and thickness contours are not interpreted in these unconfined areas as a result. Aquifer altitude and thickness contours are not extended into areas of the county along the York River and in northeastern York County, where the shallow aquifer system is not divided into individual units. Most of the county is underlain by the aquifer, but the unit is missing under part of the York River and in minor areas previously noted.

A brief description of hydrologic characteristics of the Cornwallis Cave aquifer in York County is included here to complement the framework description. Though generally confined throughout the county, the aquifer is unconfined under part of the York River (adjacent to western York County) and in most stream valleys elsewhere in the county (fig. 13). No domestic or public wells open to the Cornwallis Cave aquifer were identified in this study; thus, yield data are unavailable. Other domestic wells in the county, not identified in this study, could be open to the Cornwallis Cave aquifer (Martin Fisher, York County Department of Environmental Services, oral commun., 1992). Ground water from the Columbia aquifer recharges the Cornwallis Cave aquifer and flows downward or laterally through the Cornwallis Cave aquifer toward discharge sites, including rivers, estuaries, and the Chesapeake Bay. Limited yields along the aquifer limit at the York River (fig. 14) and elsewhere northeast of Williamsburg and east of the City of Newport News Reservoir could result in additional drawdown in wells drilled in the vicinity.

Sinkholes and solution cavities are common in part of east-central and southeastern York County on the western side of the Suffolk Scarp. This karst area is underlain by shell beds in the Moore House Member. Solution cavities typically form within 50 ft of land surface in these shell deposits along the top of the Cornwallis Cave aquifer. The cavity ceilings are commonly cemented with iron oxide, and the underlying shell beds are dissolved. Although the sediments of the aquifer are similar on opposite sides of the scarp, the karst terrane is on the high side of the scarp, generally in areas of high topographic relief (at or greater than 25 ft).

Yorktown Confining Unit

Meng and Harsh (1988, p. C51) defined the Yorktown confining unit as "the predominantly clayey deposits of the upper parts of the Yorktown Formation and the Bacons Castle Formation." The electric-resistivity-log pattern of the Yorktown confining unit is described as "a broad U-shaped profile indicating the uppermost competent clay in the stratigraphic section" (Meng and Harsh, 1988, p. C52).

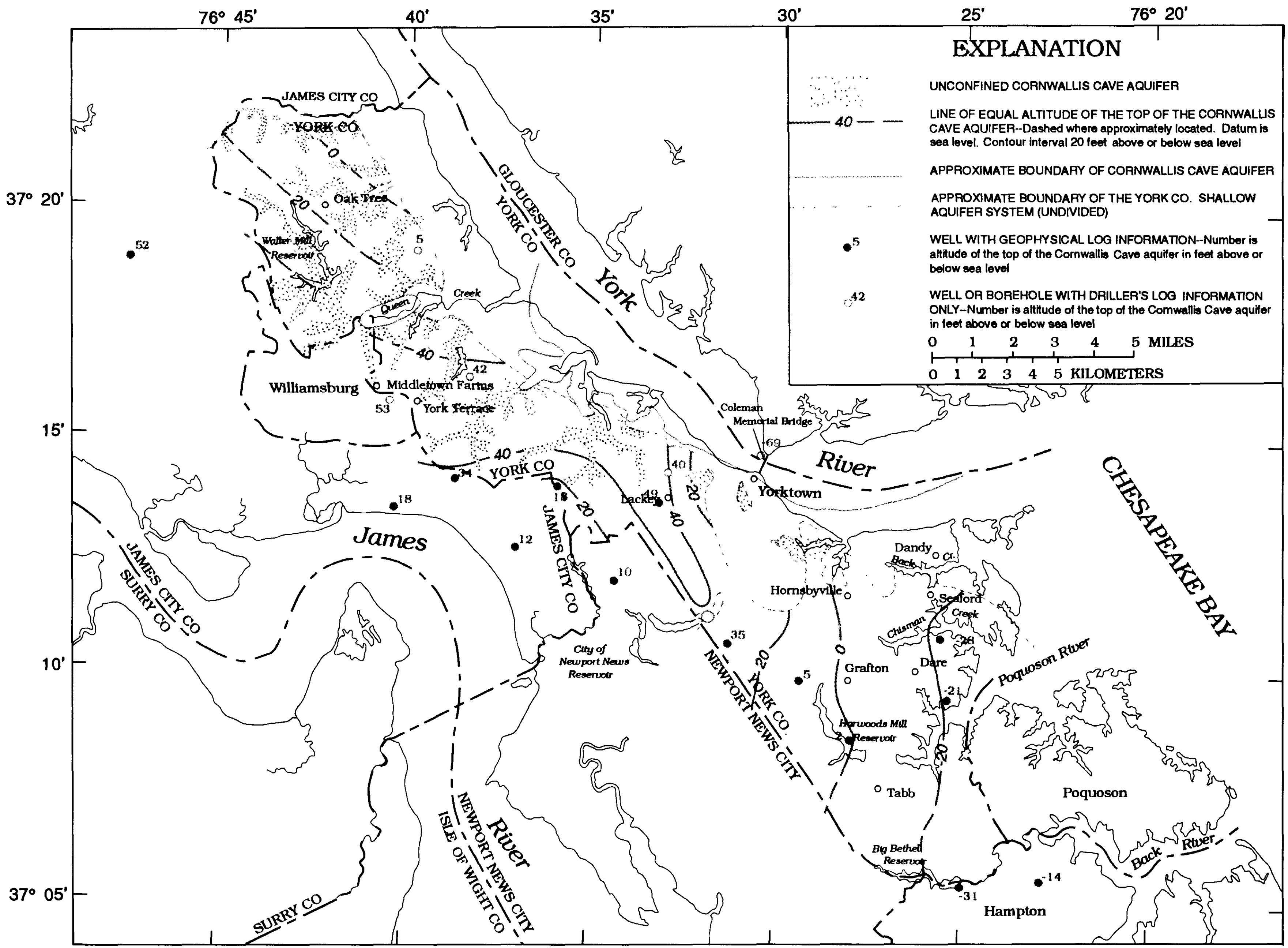


Figure 13.--Altitude of top of Cornwallis Cave aquifer.

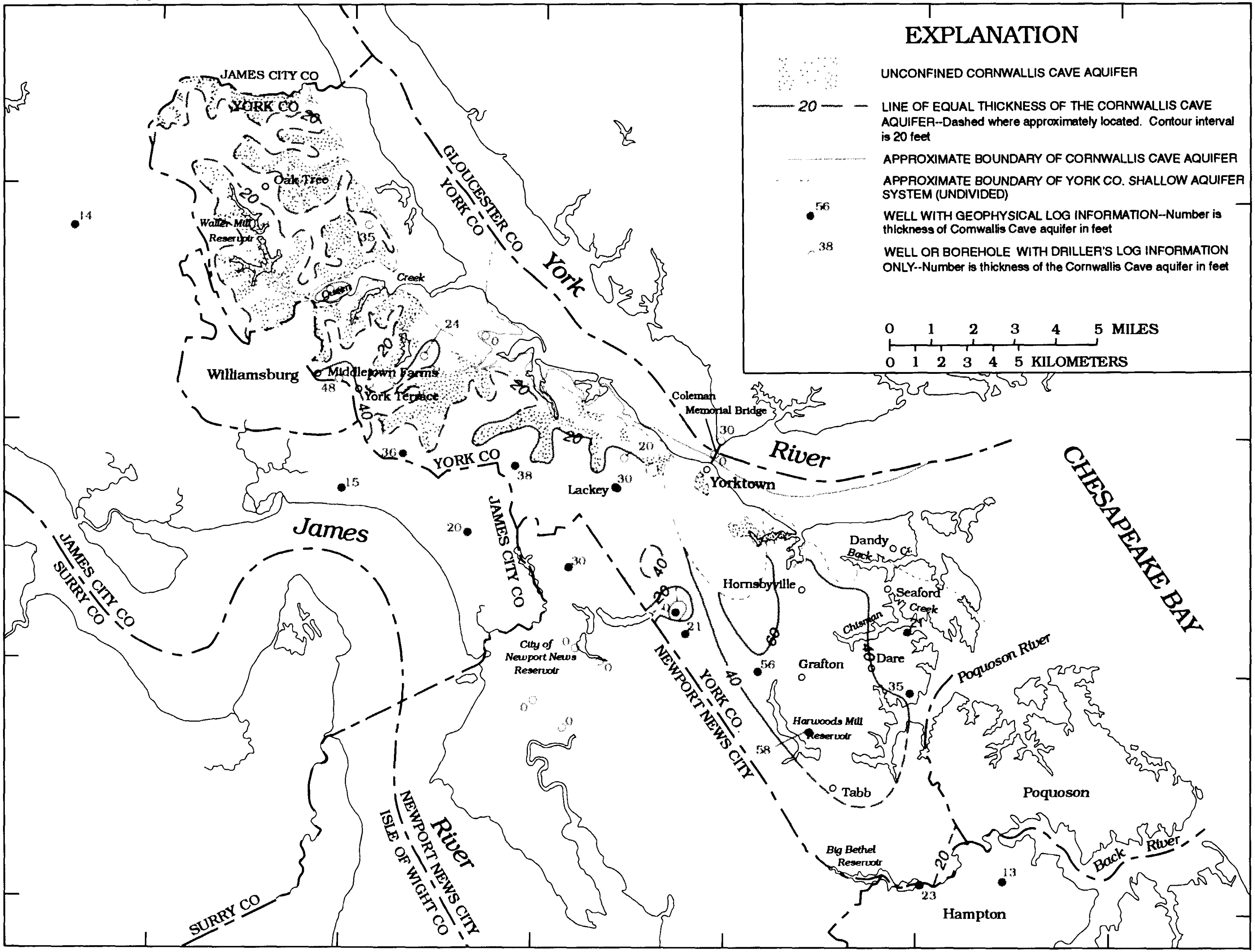


Figure 14.--Thickness of Cornwallis Cave aquifer.

The Yorktown confining unit is redefined as the silt or clay of the Morgarts Beach Member of the lower Pliocene Yorktown Formation in this report to accurately reflect the hydrogeology of York County (fig. 9). The electric-resistivity-log patterns of two confining units in the Yorktown Formation stratigraphic interval are broad U-shaped profiles in the study area (well logs 58F18 in fig. 5 and 58F38 and 58F50 in fig. 6). In their definition of the Yorktown confining unit, Meng and Harsh (1988) approximately described the stratigraphic position of the upper confining unit recorded on well logs in York County. The upper unit is defined as the Cornwallis Cave confining unit in this report. The lower confining unit is the Morgarts Beach Member.

General hydrogeologic characteristics of the Yorktown confining unit in York County include sediment composition, altitude and thickness range, areal distribution, and hydrology. Sediments of the confining unit in different areas of York County are recorded in drillers' logs as clay, silt, or fine-grained sand; with or without shells. The top of the confining unit is highest in altitude near Lackey, at 20 ft above sea level, and lowest under the York River near Yorktown, at 80 ft below sea level (fig. 15). The altitude of the unit is potentially less than 100 ft below sea level under the York River east of Yorktown. The maximum thickness of the confining unit is 44 ft near the City of Newport News Reservoir and the minimum thickness is 0 ft under part of the York River and in part of northeastern York County (fig. 16). Most of the county is underlain by the confining unit, but the unit is missing in the areas of 0 thickness noted above. The Yorktown confining unit impedes vertical ground-water flow between overlying and underlying aquifers in York County.

Yorktown-Eastover Aquifer

Meng and Harsh (1988, p. C50) defined the Yorktown-Eastover aquifer as the sandy facies of the Eastover (upper part), Yorktown, and Bacons Castle Formations. The aquifer was defined as confined by the Yorktown confining unit in the eastern and central parts of the Virginia Coastal Plain physiographic province, but unconfined in the area farther west, adjacent to the Fall Line.

In this report, the Yorktown-Eastover aquifer is redefined to reflect well-construction and water-use patterns in York County. The Yorktown-Eastover aquifer is defined in this report as the aquifer in sandy and shelly sediments of the upper Miocene Cobham Bay Member of the Eastover Formation and the lower Pliocene Sunken Meadow and Rushmere Members of the Yorktown Formation (fig. 9). The Yorktown-Eastover aquifer generally is overlain by the Yorktown confining unit and confined throughout the county, but the aquifer is unconfined locally where the overlying confining unit is missing. The Yorktown-Eastover aquifer is the bottom aquifer in the shallow aquifer system.

As specifically defined in this report, the Yorktown-Eastover aquifer contains only the sandy sediments in the lower part of the Yorktown Formation. The Yorktown-Eastover aquifer, as defined by Meng and Harsh (1988), includes sandy sediments from higher in the Yorktown Formation and from the Bacons Castle Formation (both in the Cornwallis Cave aquifer interval). The Yorktown-Eastover aquifer, as here defined, is the water source for most of the domestic-well users in the county.

General physical characteristics of the Yorktown-Eastover aquifer in York County include sediment composition, altitude and thickness range, and areal distribution. Sediments of the aquifer in different areas of York County are recorded in drillers' logs as fine-grained to medium-grained sand with small amounts of clay or sand and minor areas with shells. The top of the aquifer is highest in altitude at Lackey, at 2 ft below sea level, and lowest under the York River near Yorktown, at 98 ft below sea level (fig. 17). The altitude of the unit is potentially less than 100 ft below sea level under the York River east of Yorktown. The maximum thickness of the aquifer is 72 ft west of Lackey and the minimum thickness is 0 ft in a minor area south of Yorktown (fig. 18). The thickness of the aquifer potentially exceeds 120 ft north of Lackey. Altitude and thickness contours are not interpreted in unconfined areas of the aquifer, because the water table (and aquifer top) fluctuates in these areas. As with the Cornwallis Cave aquifer, aquifer altitude and thickness contours are not extended into areas of the county along the York River and in northeastern York County, where the shallow aquifer system is not divided into individual units. Most of the county is underlain by the aquifer, but the unit is missing in a minor area south of Yorktown.

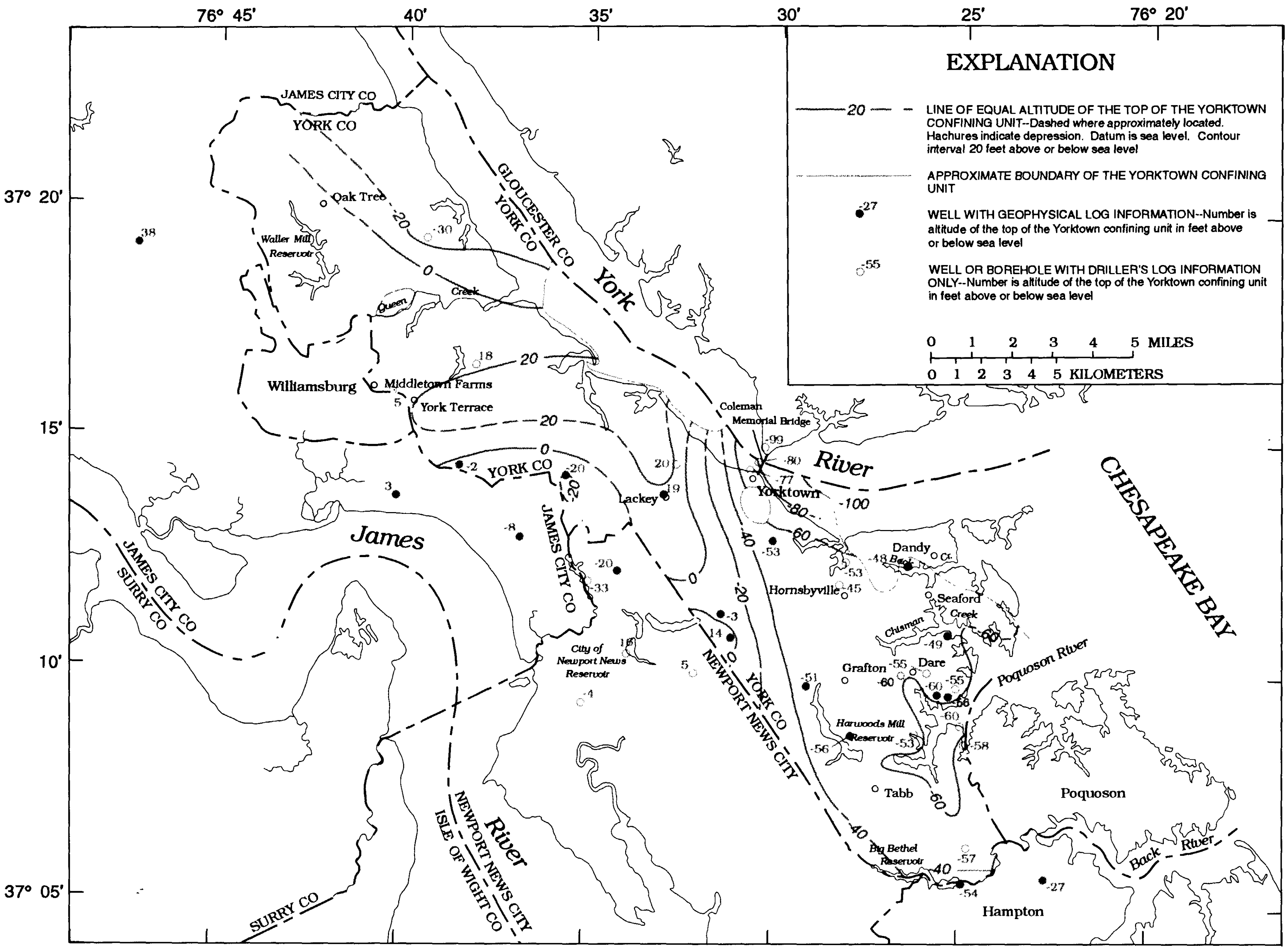


Figure 15.--Altitude of top of Yorktown confining unit.

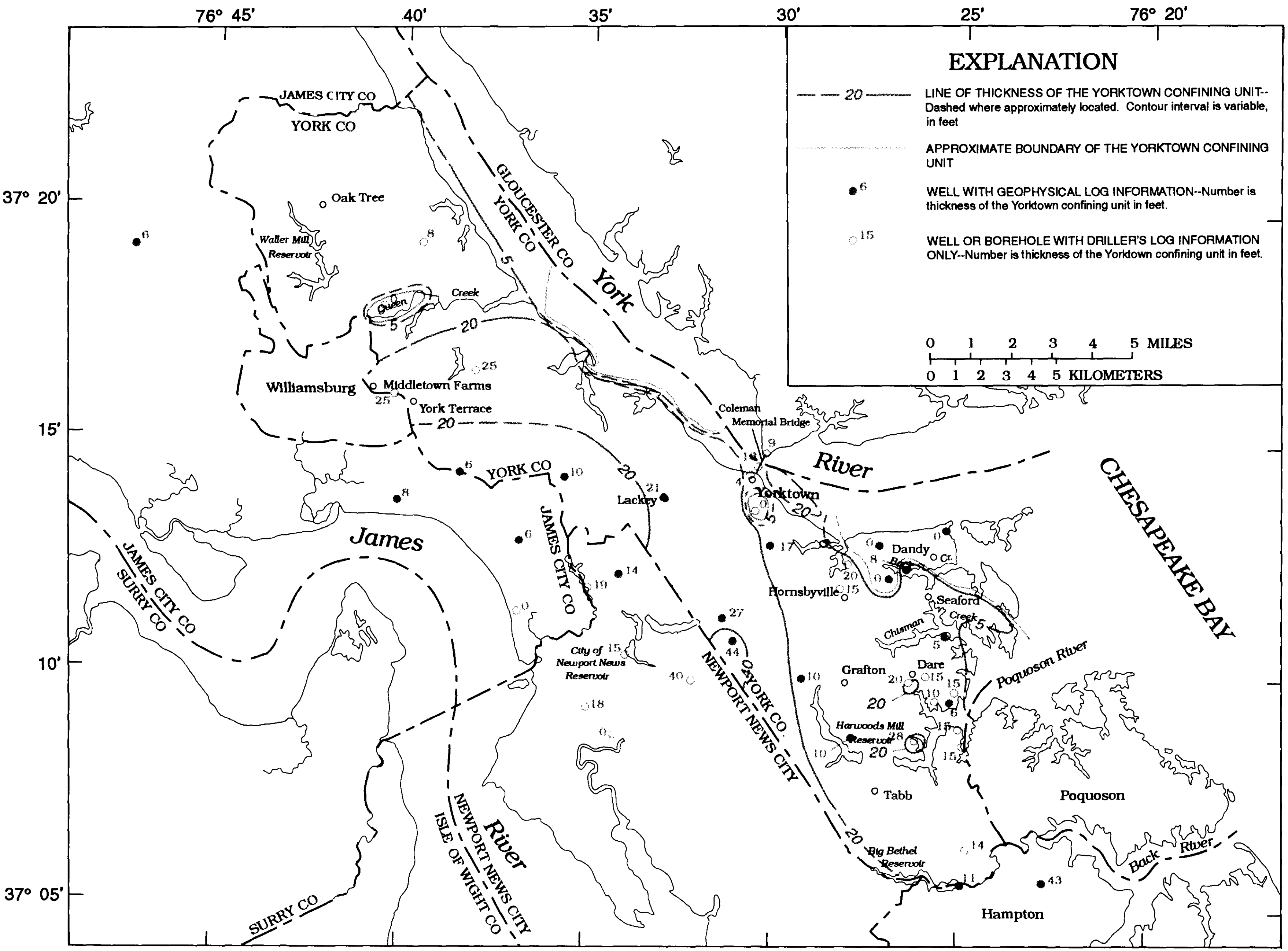


Figure 16.--Thickness of Yorktown confining unit.

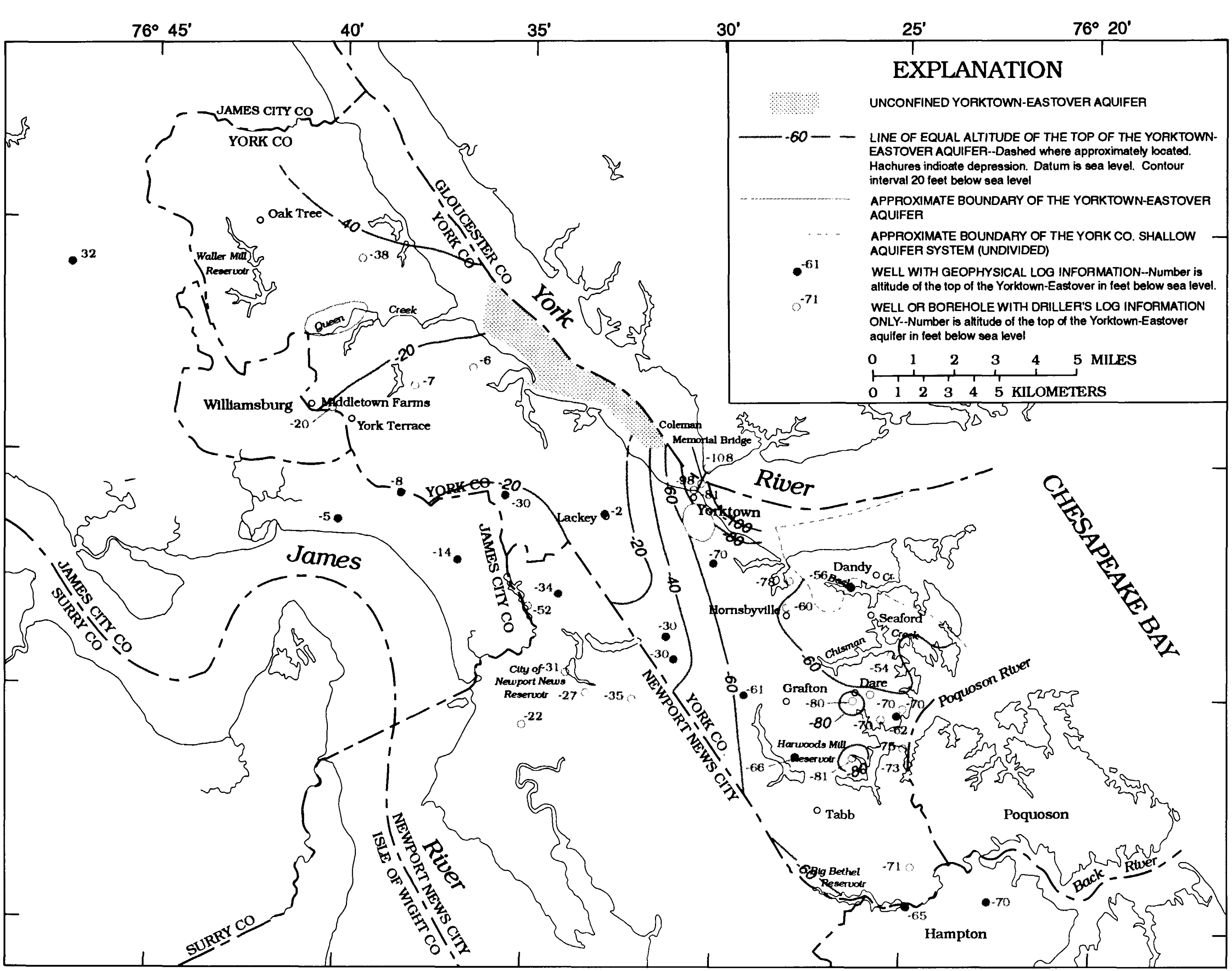


Figure 17.--Altitude of top of Yorktown-Eastover aquifer.

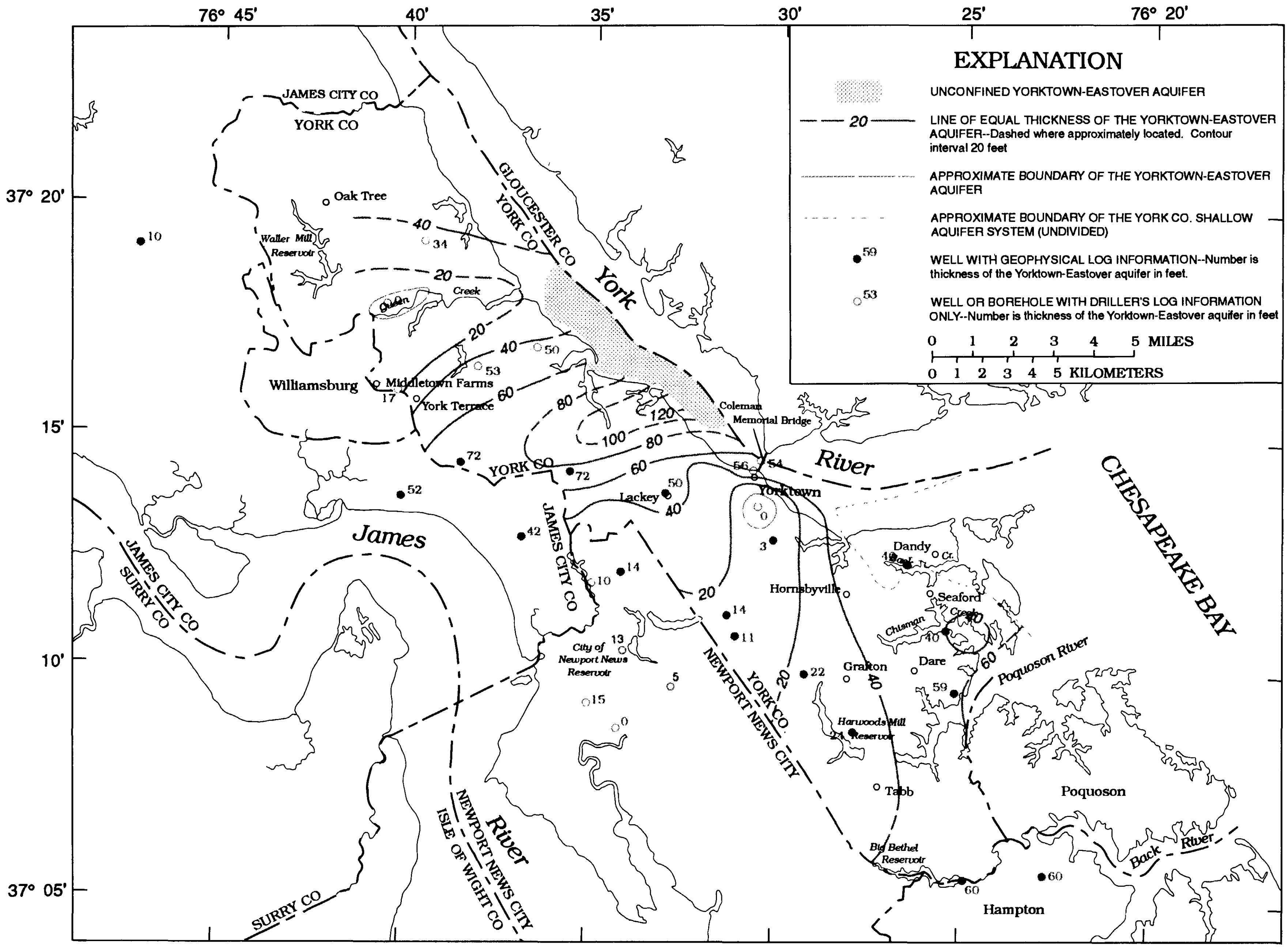


Figure 18.--Thickness of Yorktown-Eastover aquifer.

A brief description of hydrologic characteristics of the Yorktown-Eastover aquifer in York County is included here as part of the framework description of the unit. Though generally confined throughout the county, the aquifer is unconfined under part of the York River, northwest of Yorktown (fig. 17). No public water systems with wells open to the Yorktown-Eastover aquifer were identified in this study; however, yield data are available from domestic wells throughout the county. Domestic well yields from the Yorktown-Eastover aquifer range from less than 5 to 9 gal/min. Ground water recharges the Yorktown-Eastover aquifer from the overlying aquifers. Ground water discharging from the Yorktown-Eastover aquifer flows laterally northward and eastward from upgradient areas in the center of the York-James peninsula toward the York River and the Chesapeake Bay. A small amount of water moves downward through the Eastover-Calvert confining unit to recharge underlying aquifers (adapted from Laczniak and Meng, 1988). Boundary effects along the aquifer limit boundary south of Yorktown could result in increased drawdown near pumping wells in this area, as compared to similar wells in the aquifer with similar pumping rates elsewhere in the county (fig. 18).

Eastover-Calvert Confining Unit

The Eastover-Calvert confining unit is herein defined as the silt and clay sediments of the Calvert Formation, the St. Marys Formation, and the Claremont Manor Member of the Eastover Formation in York County (fig. 9). The confining unit underlies the Yorktown-Eastover aquifer and is the base of the shallow aquifer system of York County. South of Yorktown, the Yorktown-Eastover aquifer is missing and the Eastover-Calvert confining unit includes silt and clay strata of the Morgarts Beach Member of the Yorktown Formation in addition to the other stratigraphic units typically included in the confining unit (figs. 19 and 20). Typical electric-geophysical-log patterns of sediments in the Eastover-Calvert confining unit are illustrated on logs of wells 57F2 and 59F2 in figure 5, 59F80 in figure 6, and 59E6 in figure 7.

The Eastover-Calvert confining unit is equivalent to the St. Marys and Calvert confining units of Meng and Harsh (1988). In their report, Meng and Harsh (1988, p. C50) define the St. Marys confining unit as the clayey facies of the St. Marys Formation and the lower clayey facies of the Eastover Formation. The Calvert confining unit is defined as the clayey deposits of the Calvert Formation (Meng and Harsh, 1988, p. C48).

The Eastover-Calvert confining unit is named in this report to reflect local hydrogeologic differences from the St. Marys and Calvert confining units described by Meng and Harsh (1988) in their study area. The Miocene sediments of the Virginia Coastal Plain physiographic province are divided into two confining units by Meng and Harsh (1988), because the St. Marys aquifer separates the two units in Accomack County, on the Eastern Shore of Virginia. The St. Marys aquifer is missing from the Miocene sedimentary sequence in York County; therefore, the two confining units form a thick composite confining unit in the study area. The composite confining unit is named the "Eastover-Calvert" confining unit to reflect the youngest and oldest constituent stratigraphic formations.

General hydrogeologic characteristics of the Eastover-Calvert confining unit in York County include sediment composition, altitude and thickness range, areal distribution, and hydrology. Sediments of the confining unit in different areas of York County are recorded in drillers' logs as clay and silt with minor sand lenses. The top of the confining unit is highest in altitude northeast of Williamsburg, at 25 ft below sea level, and lowest under the York River near Yorktown, at 152 ft below sea level (fig. 19). The altitude of the unit is potentially less than 140 ft below sea level under the York River north of Lackey. The maximum thickness of the confining unit is 360 ft in western York County (east of Williamsburg) and the minimum thickness is 125 ft, also in western York County, southeast of Oaktree (fig. 20). All of the county is underlain by the confining unit. The Eastover-Calvert confining unit impedes vertical ground-water flow between the shallow aquifer system and underlying aquifers in York County.

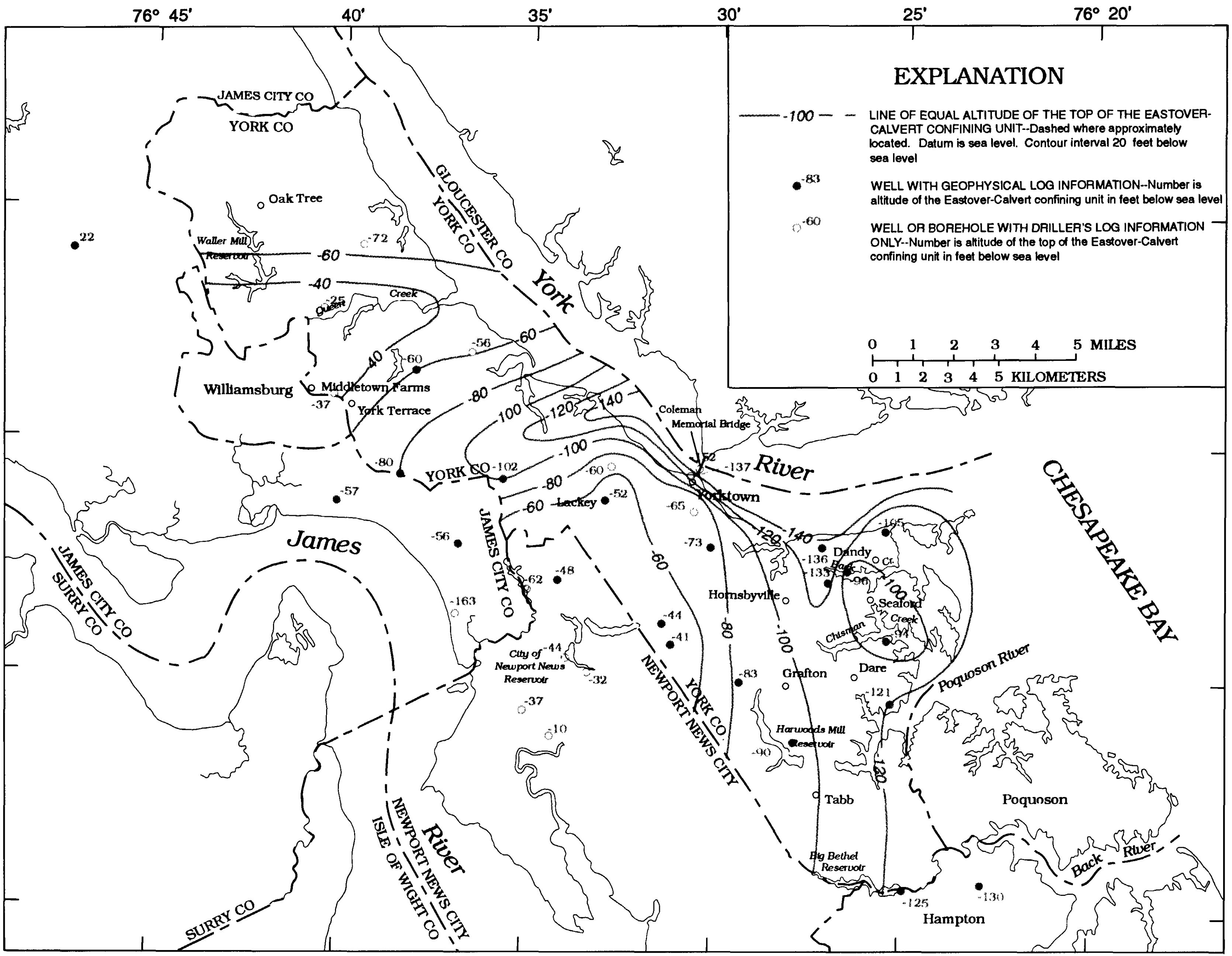


Figure 19.--Altitude of top of Eastover-Calvert confining unit.

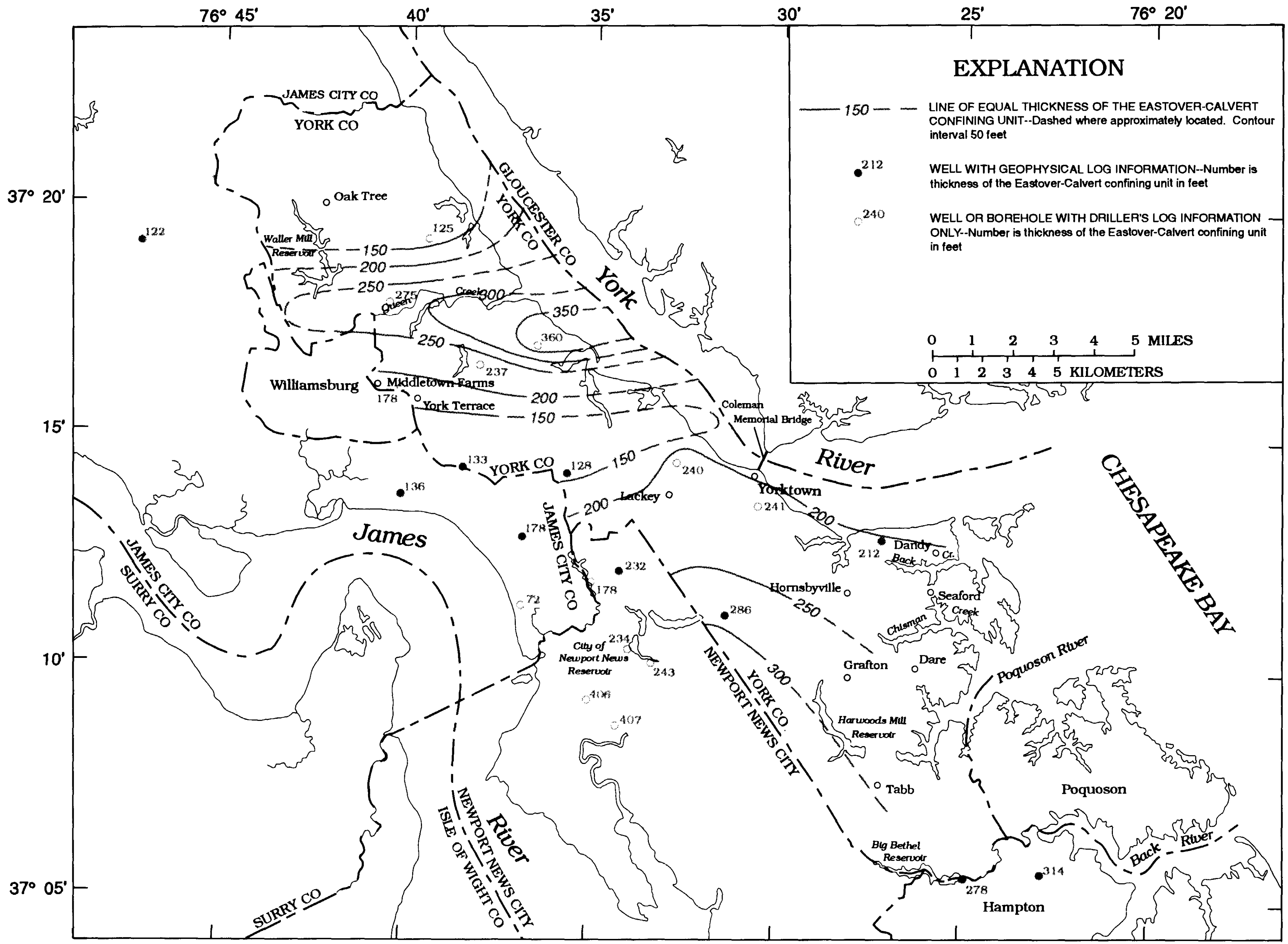


Figure 20.--Thickness of Eastover-Calvert confining unit.

SUMMARY AND CONCLUSIONS

Seven hydrogeologic units comprise the York County shallow aquifer system: (1) the undivided York County shallow aquifer system, (2) the Columbia aquifer, (3) the Cornwallis Cave confining unit, (4) the Cornwallis Cave aquifer, (5) the Yorktown confining unit, (6) the Yorktown-Eastover aquifer, and (7) the Eastover-Calvert confining unit. These seven units are in Miocene to Holocene sediments in York County, and the top of the deepest unit is within 200 ft of land surface.

The altitude and thickness of the uppermost hydrogeologic unit of the York County shallow aquifer system is complex, and, in most areas of the county, the saturated thickness of the unit is seasonally variable and, therefore, not shown on the maps in this report. The extent of the undivided York County shallow aquifer system can be delineated in areas near the York River, where one or both of the upper confining units are missing and two or more aquifers constitute a single unit. The Columbia aquifer is unconfined and missing in some stream valleys in western and west-central York County but underlies the remainder of the county.

The altitude and thickness of the other five units of the York County shallow aquifer system are shown on maps in this report. The top of the Cornwallis Cave confining unit is between 59 ft above and 22 ft below sea level in the county and ranges in thickness from 0 (where the unit is missing near the York River) to 22 ft. The top of the Cornwallis Cave aquifer is 53 ft above to 28 ft below sea level and ranges in thickness from 0 (where the unit is missing near the York River and in a few other areas near Williamsburg and the City of Newport News Reservoir) to 56 ft. The top of the Yorktown confining unit is 20 ft above to 80 ft below sea level and ranges in thickness from 0 (where the unit is missing under parts of the York River and northeastern York County) to 44 ft. The top of the Yorktown-Eastover aquifer is 2 to 98 ft below sea level and ranges in thickness from 0 (where the unit is missing in a minor area south of the town of Yorktown) to 72 ft. Both the Cornwallis Cave and Yorktown-Eastover aquifers generally are confined throughout the county. The top of the Eastover-Calvert confining unit is 25 to 152 ft below sea level and ranges in thickness from 125 to 360 ft in York County.

Three hydrogeologic units of the York County shallow aquifer system described in earlier investigations were redefined in this study, and four hydrogeologic-unit definitions are introduced in this report. The Columbia aquifer, Yorktown confining unit, and Yorktown-Eastover aquifer are redefined from earlier investigations. The undivided York County shallow aquifer system is defined in this report as the part of the aquifer system where one or both of the upper confining units are missing and two or more of the aquifers combine into a single unit in sediments of the Eastover, Yorktown, and Bacons Castle, of Miocene and Pliocene age; Windsor of Pliocene and Pleistocene age; Chuckatuck, Shirley, and Tabb Formations of Pleistocene age; and unnamed sediments of Holocene age. The Cornwallis Cave confining unit is defined as silt or clay sediments of the lower Pliocene Moore House Member and younger Pliocene to Holocene sediments above the Cornwallis Cave aquifer. The Cornwallis Cave aquifer is defined as the aquifer in sandy or shelly sediments of the Moore House Member of the Yorktown Formation (Pliocene) and the confined aquifer in sandy sediments (of late Pliocene to Holocene age) above the Yorktown Formation. The Eastover-Calvert confining unit is defined as the lower Miocene to upper Miocene silt and clay sediments of the Calvert, St. Marys, and Eastover Formations.

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