Prepared in cooperation with the
Power Plant Assessment Program of the Maryland Department of Natural Resources
and the
Maryland Geological Survey

Potentiometric Surface and Water-Level Difference Maps of Selected Confined Aquifers in Southern Maryland and Maryland's Eastern Shore, 1975–2011

Scientific Investigations Report 2012–5165

U.S. Department of the Interior
U.S. Geological Survey

Cover. Aerial view of study area in Southern Maryland and Maryland's Eastern Shore modified from the National Aeronautics and Space Administration (NASA) Terra satellite MODIS (Moderate Resolution Imaging Spectroradiometer) image of September 2011.

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U.S. Geological Survey, Reston, Virginia: 2012

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Suggested citation:
Curtin, S.E., Andreasen, D.C., and Staley, A.W., 2012, Potentiometric surface and water-level difference maps of selected confined aquifers of Southern Maryland and Maryland's Eastern Shore, 1975–2011: U.S. Geological Survey Scientific Investigations Report 2012–5165, 36 p.

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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
gallon (gal)	3.785	cubic decimeter (dm^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Potentiometric Surface and Water-Level Difference Maps of Selected Confined Aquifers in Southern Maryland and Maryland's Eastern Shore, 1975–2011

By Stephen E. Curtin[1], David C. Andreasen[2], and Andrew W. Staley[2]

Abstract

Groundwater is the principal source of freshwater supply in most of Southern Maryland and Maryland's Eastern Shore. It is also the source of freshwater supply used in the operation of the Calvert Cliffs, Chalk Point, and Morgantown power plants. Increased groundwater withdrawals over the last several decades have caused groundwater levels to decline. This report presents potentiometric surface maps of the Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers using water levels measured during September 2011. Water-level difference maps also are presented for the first four of these aquifers. The water-level differences in the Aquia aquifer are shown using groundwater-level data from 1982 and 2011, whereas the water-level differences in the Magothy aquifer are presented using data from 1975 and 2011. Water-level difference maps in both the upper Patapsco and lower Patapsco aquifers are presented using data from 1990 and 2011.

These maps show cones of depression ranging from 25 to 198 feet (ft) below sea level centered on areas of major withdrawals. Water levels have declined by as much as 112 ft in the Aquia aquifer since 1982, 85 ft in the Magothy aquifer since 1975, and 47 and 71 ft in the upper Patapsco and lower Patapsco aquifers, respectively, since 1990.

Introduction

The U.S. Geological Survey (USGS) and the Maryland Geological Survey (MGS) have maintained a groundwater-level monitoring network since the 1940s to observe changes in groundwater levels over time. Groundwater-level monitoring has been especially critical for Southern Maryland and Maryland's Eastern Shore where groundwater is the primary source of water supply. Many observation wells were added to the network in the early 1970s following the establishment of the Maryland Department of Natural Resources Power Plant Research Program (PPRP) in order to monitor groundwater levels at Maryland power plants. Water-level data collected from the monitoring network and water-withdrawal data from the confined aquifers that supply water for the operation of Maryland's power plants are used by the PPRP to evaluate potential impacts of Maryland's power plants on groundwater resources.

Purpose and Scope

The purpose of this report is to assess the regional effects of groundwater withdrawals on water levels in Southern Maryland and Maryland's Eastern Shore. This report presents potentiometric surface maps for the Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers for September 2011. The potentiometric surface maps in this report are meant to represent groundwater levels and withdrawal amounts, at an instant in time. The water-level measurements were actually made over a period of about 1 month and may reflect short-term variations in water levels throughout the study area that are related to short-term changes in withdrawal rates. This report also presents water-level difference maps for: (1) the Aquia aquifer (1982–2011); (2) the Magothy aquifer (1975–2011); and (3) the upper and lower Patapsco aquifers (1990–2011). The water-level difference maps represent the change in potentiometric surfaces over time.

[1] U.S. Geological Survey

[2] Maryland Geological Survey

Description of Study Area

The study area for this report includes Baltimore City, Anne Arundel, Baltimore, Harford, Prince George's, Calvert, Charles and St. Mary's Counties, which are located west of Chesapeake Bay, and parts of Cecil, Kent, Queen Anne's, Talbot, and Dorchester Counties on Maryland's Eastern Shore (fig. 1). Two wells used for these maps are located in Northern Virginia, just across the Potomac River from southern Charles County.

The Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers are part of the Alantic Coastal Plain sediments, which become deeper and thicker towards the southeast (fig. 2; table 1). The Paleocene Aquia Formation, which includes the Aquia aquifer, is composed of fine to coarse-grained, greenish-brown sand that contains layers of silty clay. Cemented layers of shell debris are found throughout. The formation's characteristic green color is caused by the presence of glauconite sand. The Aquia aquifer is the source of water for many self-supplied private residences and some public suppliers. The Late Cretaceous Magothy Formation, which includes the Magothy aquifer, consists of light gray to white sand and fine gravel interbedded with thin layers of clay. The aquifer's excellent water-bearing characteristics make it a valuable source of water for some users, including public suppliers in many areas of Southern Maryland and Maryland's Eastern Shore. The Early Cretaceous Patapsco Formation, which is part of the Potomac Group, includes the upper and lower Patapsco aquifers. It is a complexly layered unit with lenses of tan and gray sand and gravel, interbedded with variegated red, brown, and gray silt and clay. The upper and lower Patapsco aquifers are very productive and widely used, particularly by public suppliers and industries. The Early Cretaceous Patuxent Formation, which includes the Patuxent aquifer, is the basal unit of the Potomac Group and lithologically similar to the Patapsco Formation. The Patuxent aquifer is very productive and widely used by public suppliers and industries in southern Baltimore County, the northern part of Anne Arundel and Prince George's Counties, and northwestern Charles County, however it is not widely used in the rest of Southern Maryland and Maryland's Eastern Shore.

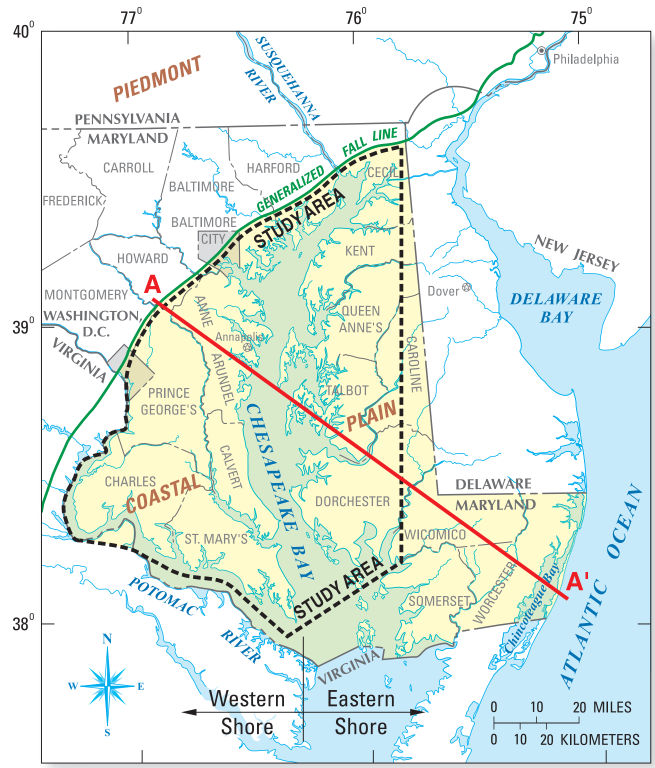


Figure 1. Location of study area in the Atlantic Coastal Plain of Maryland and part of northern Virginia. (Refer to figure 2 for line of section A-A′.)

History of Monitoring and Mapping Groundwater Levels

In the early 1940s, the USGS, in cooperation with MGS, began systematic monitoring of groundwater levels in the Aquia, Magothy, lower Patapsco, upper Patapsco, and Patuxent aquifers, in order to evaluate the effects of groundwater production. The monitoring effort was expanded in the early 1970s to evaluate groundwater withdrawals from the Chalk Point coal-fired power plant in southern Prince George's County. In subsequent years, monitoring was expanded to evaluate groundwater withdrawals from the Calvert Cliffs nuclear power plant in southern Calvert County and the Morgantown coal-fired power plant in southern Charles County, as well as groundwater withdrawals from an increased number of municipal, commercial, domestic, and irrigation wells. The Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources was established as a result of the Power Plant Siting and Research Act of 1971, which required the evaluation of the environmental impacts associated with power generation plants in Maryland. Potentiometric surface and water-level difference maps were prepared and published as part of a funding agreement between USGS, MGS, and the PPRP in order to supply groundwater data for inclusion in PPRP's periodic Cumulative Environmental Impact Reports. A complete list of these maps is presented in appendix 1. The first potentiometric surface map published as part of this effort was for the Magothy aquifer using groundwater levels from September 1975, followed by a map of the Aquia aquifer using groundwater levels from September 1982. These maps helped evaluate the effects of withdrawals at the Chalk Point power plant in southern Prince George's County and the Calvert Cliffs nuclear power plant in southern Calvert County, respectively. To evaluate the effects

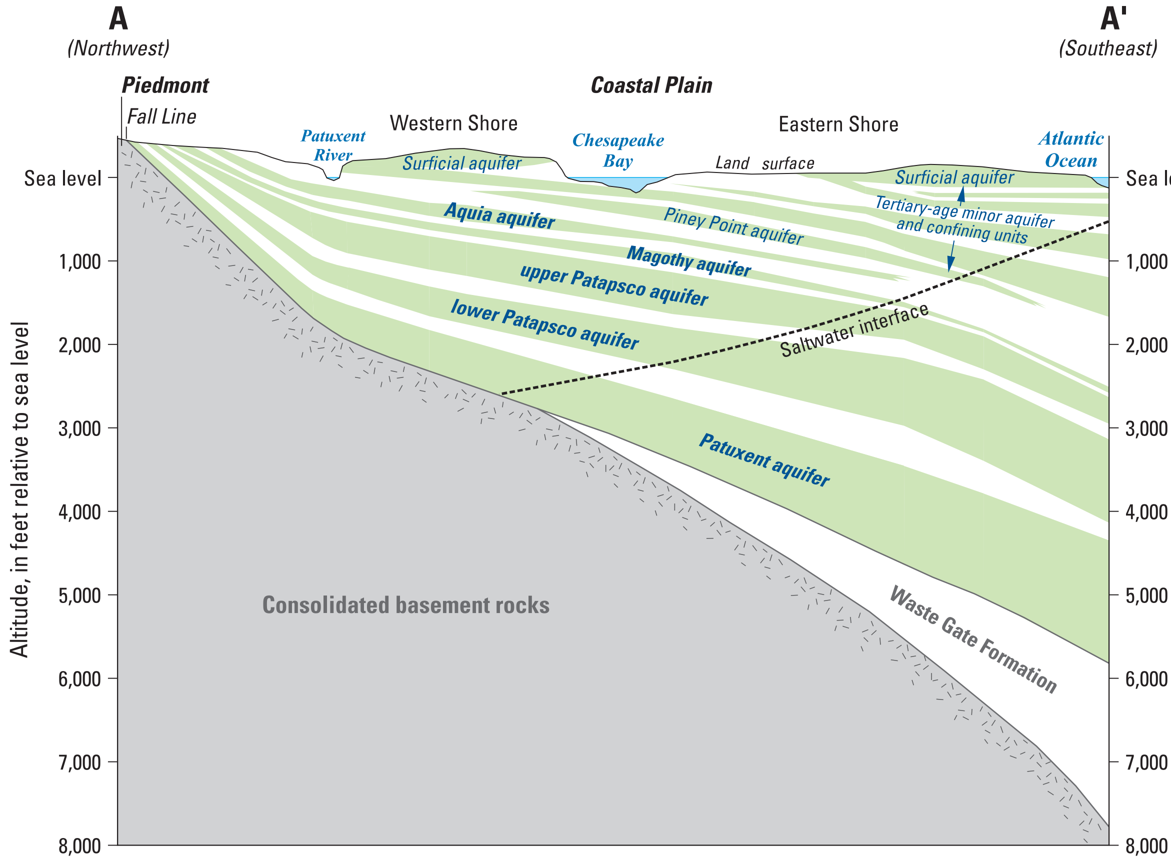


Figure 2. Schematic diagram of the Atlantic Coastal Plain aquifer system (line of section shown in figure 1; relative thicknesses of aquifers and confining units not to scale).

of withdrawals at the Morgantown power plant in southern Charles County, and withdrawals from additional wells at the Chalk Point power plant, the first potentiometric surface maps were developed for the upper and lower Patapsco aquifers using groundwater levels from September 1990. The first potentiometric surface map using groundwater levels from September 2007 was developed to evaluate the effects of groundwater withdrawals from the Patuxent aquifer at the Chalk Point power plant.

In addition to the maps published for the PPRP reports, Achmad and Hansen (2001) assembled a comprehensive set of potentiometric surface and water-level difference maps for the Piney Point, Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers using groundwater level data from 1970 through 1996. This report also includes a compilation of groundwater withdrawals and selected hydrographs. Soeder and others (2007) published a similar report for the same set of aquifers for the period 1980–2005, which included a model evaluation of the relation between withdrawals and water levels.

Method of Analysis

USGS and MGS personnel measured groundwater levels that were used to construct the potentiometric surface and water-level difference maps primarily during the month of September of selected years. The water-level data were reviewed and approved by the USGS and stored in the Groundwater Site Inventory (GWSI) database, which is part of the National Water Information System (NWIS) maintained by USGS. This database is available to the public on the NWIS Web site (*http://waterdata.usgs.gov/nwis/*). Selected water-level data were retrieved from GWSI and used in the preparation of the maps in this report (appendixes 2a–2e). Water-withdrawal data included on the maps were derived from the Site-Specific Water-Use Data System (SWUDS), also maintained by USGS. Water-use data on the maps are shown using a series of symbols representing the location and rates of groundwater withdrawals greater than 10,000 gallons per day (gal/d). The 2011 potentiometric surface maps show water-withdrawal data for 2010 (the most recent data available). The

Table 1. Generalized stratigraphy and hydrogeology of Southern Maryland and Maryland's Eastern Shore.

[Modified from Soeder and others, 2007]

System	Series	Group	Formation	Hydrogeology
Quaternary	Holocene		undifferentiated	*surficial aquifers*
	Pleistocene			
Tertiary	Pliocene			
	Miocene	Chesapeake	St. Mary's	confining units and minor aquifers
			Choptank	
			Calvert	
	Oligocene		unnamed	*Piney Point aquifer*
	Eocene	Pamunkey	Piney Point	
			Nanjemoy	confining unit
			Marlboro	
	Paleocene		Aquia	*Aquia aquifer*
			Brightseat/ Hornerstown	
Cretaceous	Upper Cretaceous		Severn or Monmouth	confining units and minor aquifers
			Matawan	
			Magothy	*Magothy aquifer*
	Lower Cretaceous	Potomac	Patapsco	confining unit
				upper Patapsco aquifer
				confining unit
				lower Patapsco aquifer
			Arundel Clay	confining unit
			Patuxent	*Patuxent aquifer*
			Waste Gate	*"Waste Gate" brine aquifer*
Jurassic, Triassic, Paleozoic to Precambrian				**consolidated basement rocks**

withdrawal data originated from the Maryland Department of the Environment (MDE) water-withdrawal database. Permitted water users who withdraw greater than 10,000 gal/d are required to submit monthly withdrawal amounts, which are subsequently entered into the MDE database. USGS periodically retrieves the data, checks for quality assurance, and enters them into SWUDS. All groundwater-withdrawal data included in this report were supplied by Wendy McPherson of USGS, by way of written communication, unless otherwise noted.

In preparing the potentiometric surface maps, the groundwater levels were adjusted to feet relative to sea level using the National Geodetic Vertical Datum of 1929 (NGVD 29) land-surface altitudes, which have different levels of accuracy depending on how they were originally determined. The data were plotted and manually contoured by visually interpolating between data points. The contours are dashed in areas where data are sparse. The maps also include the outcrop area of the aquifer, and the aquifer boundary if its location is within the area shown.

Potentiometric Surface and Water-Level Difference Maps

Maps are presented for the Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers for Southern Maryland and Maryland's Eastern Shore using water levels measured in September 2011. The location and quantity of major groundwater withdrawal sites in 2010 are included on the maps to help show the relation between pumping centers and aquifer drawdowns. Maps showing the decline in water levels from 1975, 1982, or 1990 to 2011 also are presented. The maps include the outcrop area of the aquifer, and the aquifer boundary if its location is within the area shown.

Aquia Aquifer

The potentiometric surface of the Aquia aquifer during September 2011 is shown in figure 3. The map is based on water-level measurements in 83 wells. The highest measured water level was 50 ft above sea level in the outcrop area of the aquifer in the central part of Anne Arundel County. Water levels in the subcrop area of Kent County were as high as 25 ft above sea level. South of those areas, water levels were lower and mostly below sea level. The hydraulic gradient[1] increased southeastward toward a cone of depression around well fields at Solomons Island in southern Calvert County and Lexington Park in southern St. Mary's County. This cone of depression is the result of withdrawals predominantly from municipal supply wells in this area. The Calvert Cliffs nuclear power plant is located along the northern edge of this cone of depression, where the water level was measured at 99 ft below sea level. The lowest measured water level of 157 ft below sea level occurred at the center of a cone of depression at Lexington Park.

The water-level differences in the Aquia aquifer in Southern Maryland and Maryland's Eastern Shore between September 1982 and September 2011 are shown in figure 4. The map, based on water- level differences obtained from 52 wells, shows that the potentiometric surface during the 29-year period ranged from an increase of 8 ft in the northernmost part of the study area and in the outcrop of the aquifer, to a decline of 112 ft at Lexington Park. Lexington Park is near the southeasternmost part of the study area and approaches the downdip boundary of the aquifer. At the Calvert Cliffs nuclear power plant, water levels declined by 70 ft. Groundwater withdrawals from the Aquia aquifer in the study area have increased from 5 million gallons per day (Mgal/d) in 1982 to over 15 Mgal/d in 2010.

Magothy Aquifer

The potentiometric surface of the Magothy aquifer in the Magothy Formation in Southern Maryland and Maryland's Eastern Shore during September 2011 is shown in figure 5. The map is based on water-level measurements in 66 wells. The highest measured water level was 88 ft above sea level in the outcrop area of the aquifer in the northern part of Anne Arundel County.

Water levels are lower towards the south. As a result of withdrawals predominantly from municipal supply wells, shallow, localized cones of depression formed around well fields in east-central Anne Arundel County. A relatively large cone of depression occurred in the Waldorf area, which resulted in measured groundwater levels as low as 79 ft below sea level in this area. Groundwater withdrawals from the Chalk Point power plant resulted in a water level of 54 ft below sea level in an observation well at this site.

The water-level differences in the Magothy aquifer in Southern Maryland and Maryland's Eastern Shore between September 1975 and September 2011 are shown in figure 6. The map, based on water-level differences obtained from 48 wells, shows that during the 36-year period, the potentiometric surface changed little near the outcrop area, which is in the northernmost part of the study area, but declined as much as 85 ft at Waldorf. Waldorf is located near the southern extent and downdip boundary of the aquifer. Water withdrawal from the Magothy aquifer in the study area increased from about 7 Mgal/d in 1975 (Wheeler and Wilde, 1989) to nearly 9 Mgal/d in 2010.

[1] Hyraulic gradient of an aquifer—the rate of change of pressure head per unit of distance of flow at a given point in a given direction.

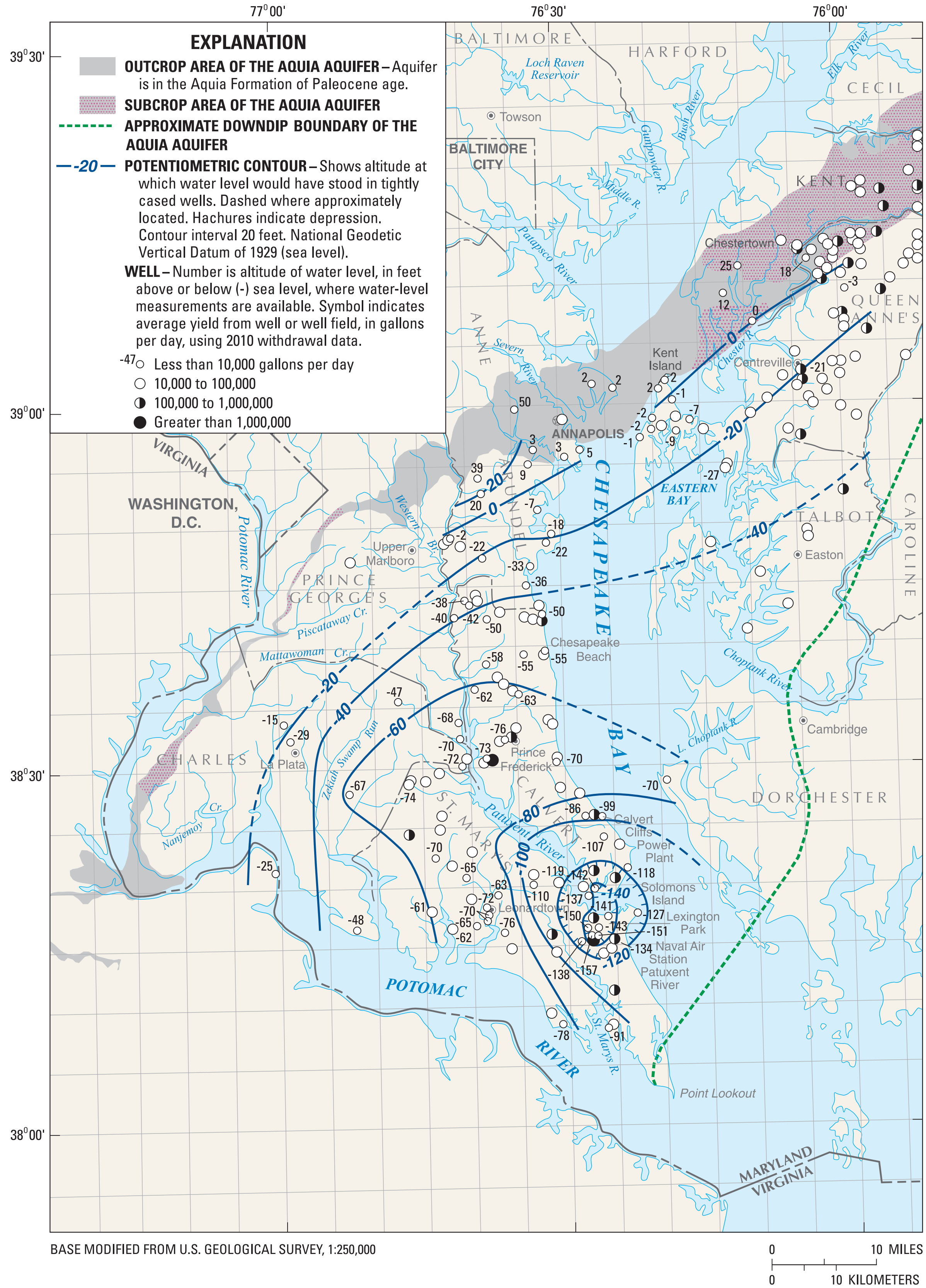


Figure 3. Potentiometric surface of the Aquia aquifer in Southern Maryland and Maryland's Eastern Shore, September 2011.

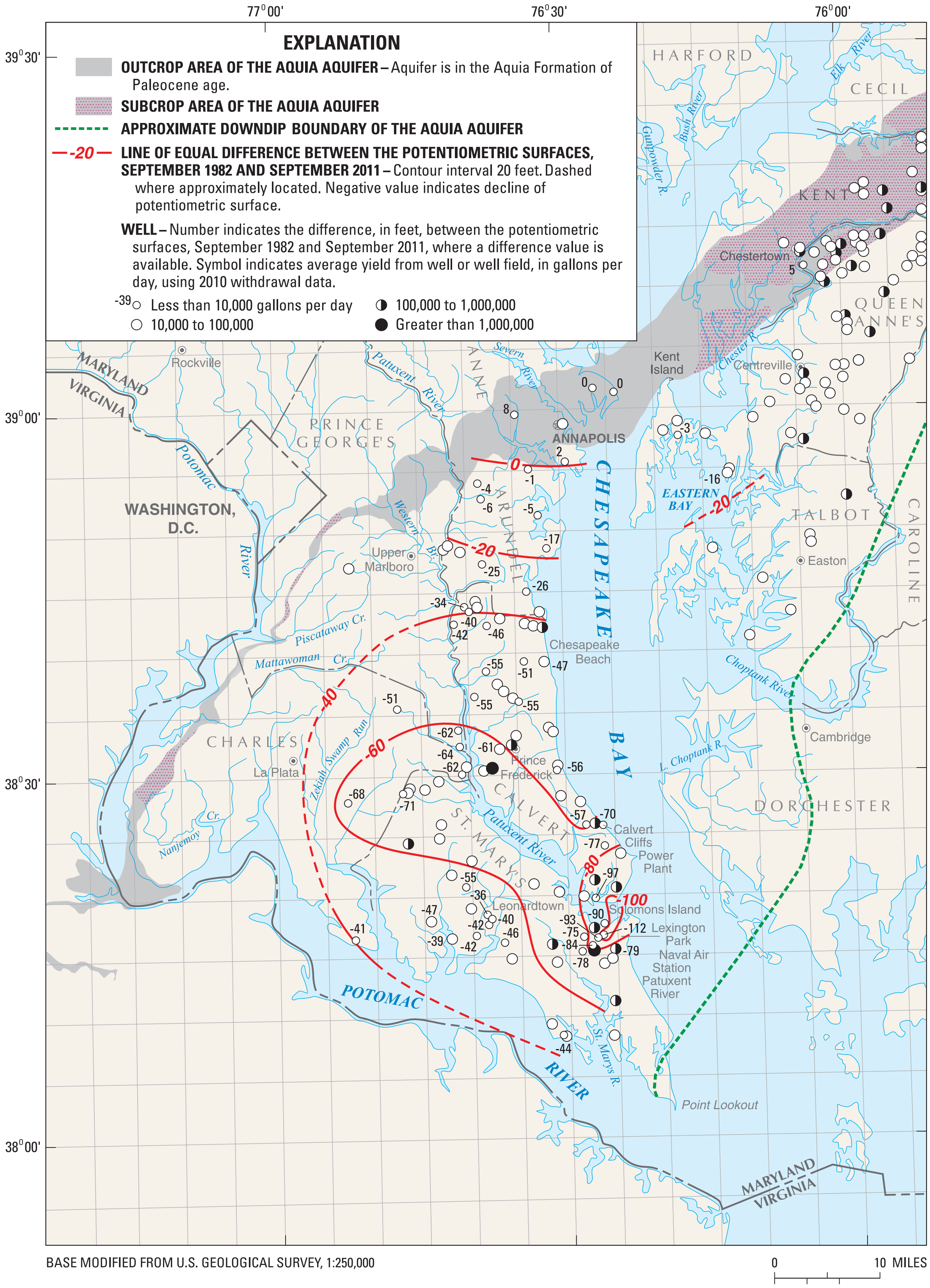


Figure 4. The difference between the potentiometric surfaces of the Aquia aquifer in Southern Maryland and Maryland's Eastern Shore, September 1982 and September 2011.

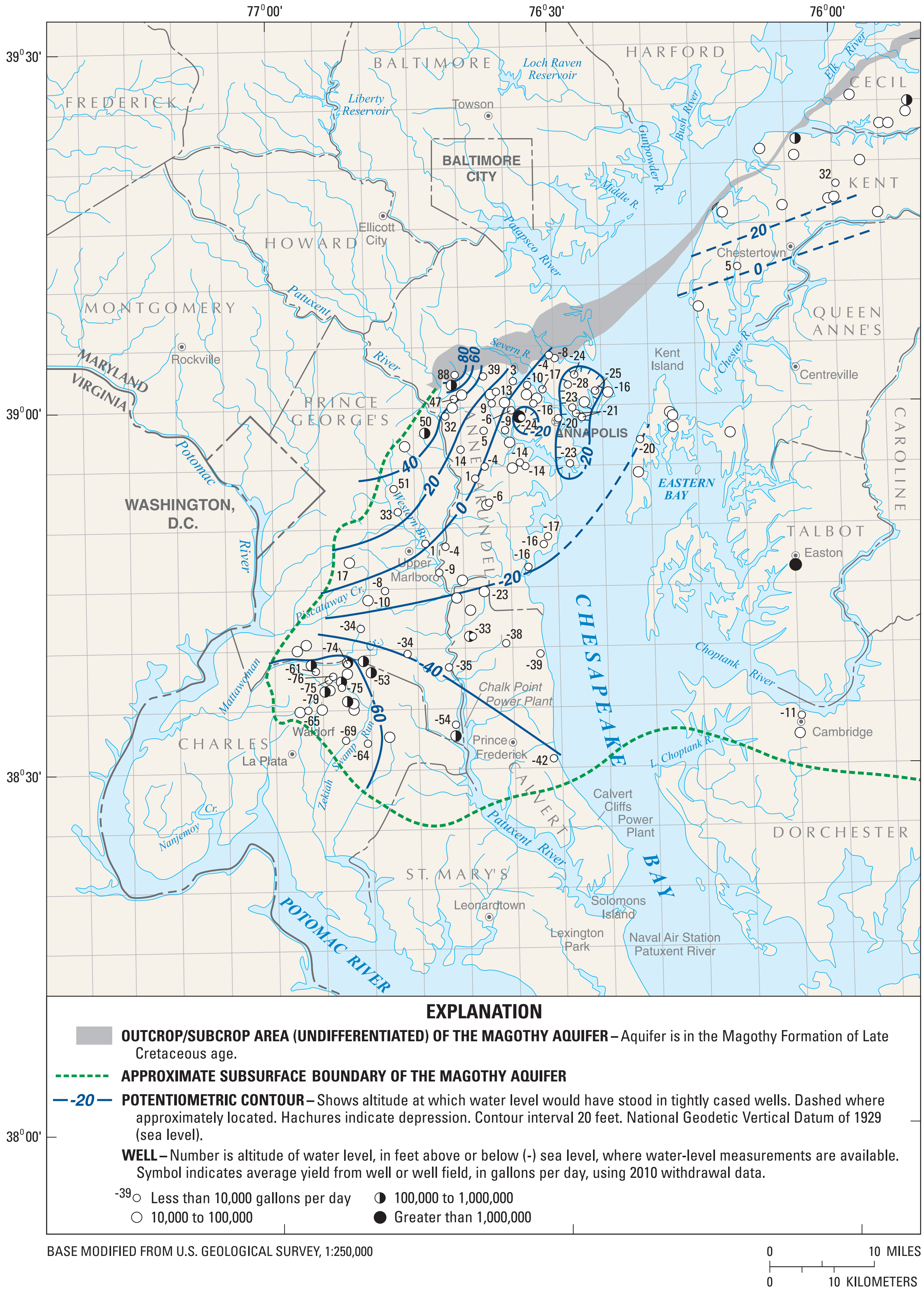


Figure 5. Potentiometric surface of the Magothy aquifer in Southern Maryland and Maryland's Eastern Shore, September 2011.

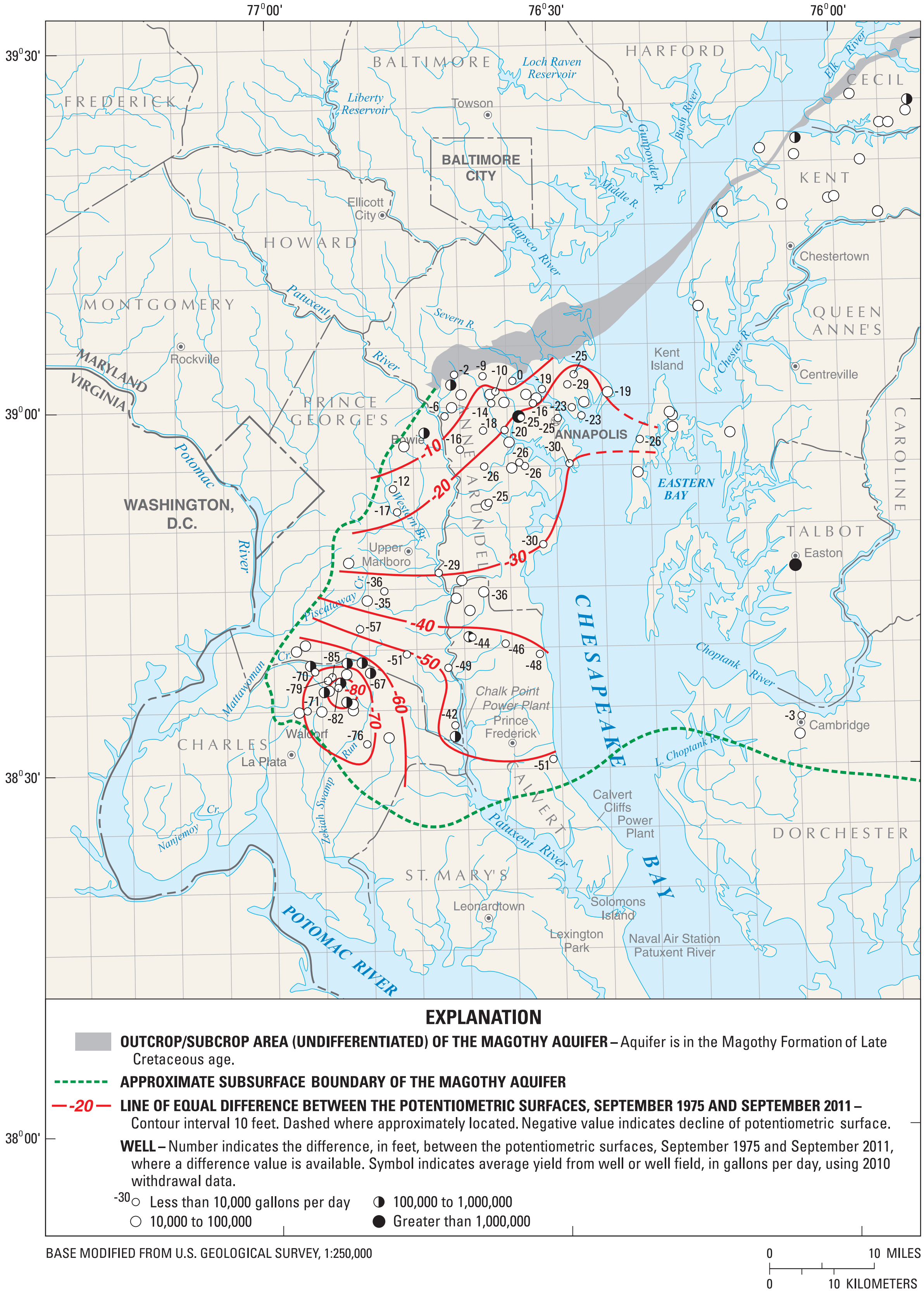


Figure 6. The difference between the potentiometric surfaces of the Magothy aquifer in Southern Maryland and Maryland's Eastern Shore, September 1975 and September 2011.

Upper Patapsco Aquifer

The potentiometric surface of the upper Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore during September 2011 is shown in figure 7. The map is based on water-level measurements in 61 wells. The highest measured water level was 120 ft above sea level near the outcrop area of the aquifer in northern Anne Arundel County. Water levels are lower to the south toward well fields in the Annapolis-Arnold area. The lowest water level in that area was 35 ft below sea level. Two relatively large cones of depression were located in the Waldorf-LaPlata area in southern Charles County and the Lexington Park-Leonardtown area in southern St. Mary's County. The lowest measured groundwater levels were 110 ft below sea level south of Waldorf, and 78 ft below sea level near Leonardtown. Smaller cones of depression formed around the Chalk Point power plant and Easton, where the water level was as low as 63 ft below sea level at the Chalk Point power plant and 56 ft below sea level at Easton.

The water-level differences in the upper Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore between September 1990 and September 2011 are shown in figure 8. The map, based on water-level differences obtained from 37 wells, shows that during the 21-year period, the potentiometric surface changed little at the edge of the outcrop area in northern Anne Arundel County. Water-level declines of 29 ft at Broad Creek, 13 ft near Arnold, 35 ft at Waldorf, 39 ft at the Chalk Point power plant, and 47 ft at Lexington Park were observed during this period.

Lower Patapsco Aquifer

The potentiometric surface of the lower Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore during September 2011 is shown in figure 9. The map is based on water-level measurements in 70 wells. The highest measured water level was 106 ft above sea level near the outcrop area of the aquifer in northern Prince George's County. Water levels were lower towards well fields at Severndale, Broad Creek, Arnold and Crofton Meadows. The measured groundwater levels were 107 ft below sea level at Severndale, 32 ft below sea level at Broad Creek, 64 ft below sea level at Arnold, and 39 ft below sea level at Crofton Meadows. There was also a relatively large cone of depression in Charles County that includes Waldorf, La Plata, Indian Head, and the Morgantown power plant. The groundwater levels measured were as low as 198 ft below sea level at Waldorf, 148 ft below sea level at La Plata, 113 ft below sea level at Indian Head, and 101 ft below sea level at the Morgantown power plant.

The water-level differences in the lower Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore between September 1990 and September 2011 are shown in figure 10. The map, based on water-level differences obtained from 45 wells, shows that the change of the potentiometric surface during the 21-year period ranged from increases of 27 ft at Indian Head and 9 ft near the outcrop area in Glen Burnie, to declines of 63 ft at Arnold, 64 ft at Severndale, 27 ft at Crofton Meadows, 56 ft at Waldorf, 71 ft near La Plata, 40 ft at the Morgantown power plant, 36 ft at the Chalk Point power plant, and 34 ft at Swan Point. There were no groundwater withdrawals from the lower Patapsco aquifer at the Chalk Point power plant, therefore the decline in water level may be due to upward leakage to the upper Patapsco aquifer. Combined withdrawals from the upper and lower Patapsco aquifers increased from 29 Mgal/d in 1990 to over 40 Mgal/d in 2010. Most of the total withdrawal was from the lower Patspsco aquifer.

Patuxent Aquifer

The potentiometric surface of the Patuxent aquifer in Southern Maryland and Maryland's Eastern Shore during September 2011 is shown in figure 11. The map is based on water-level measurements in 45 wells. The highest measured water level was 168 ft above sea level in the outcrop area of the aquifer in northern Prince George's County. Water levels were lower south and east towards well fields at Glen Burnie, Bryans Road, the Morgantown power plant, and the Chalk Point power plant. The measured groundwater levels were 76 ft below sea level at Glen Burnie, 71 ft below sea level near Bryans Road, 28 ft below sea level at the Morgantown power plant, and 135 ft below sea level at the Chalk Point power plant. The relatively low water level at the Chalk Point power plant was the result of the use of the Patuxent aquifer beginning in 2009. The monitoring well is located immediately adjacent to one of four production wells in this aquifer, and as a result, the water level is affected by pumping of these production wells. The Patuxent aquifer withdrawal rates in the study area have decreased overall from more than 21 Mgal/d in 1990 to 13 Mgal/d in 2010. This is partly due to reduced water use from the Patuxent aquifer at Fort Meade in northern Anne Arundel County following the Persian Gulf War, which ended in 1991, and decreased withdrawals from well fields at Crofton Meadows in Anne Arundel County and the City of Bowie in Prince George's County after 1992 (Soeder and others, 2007).

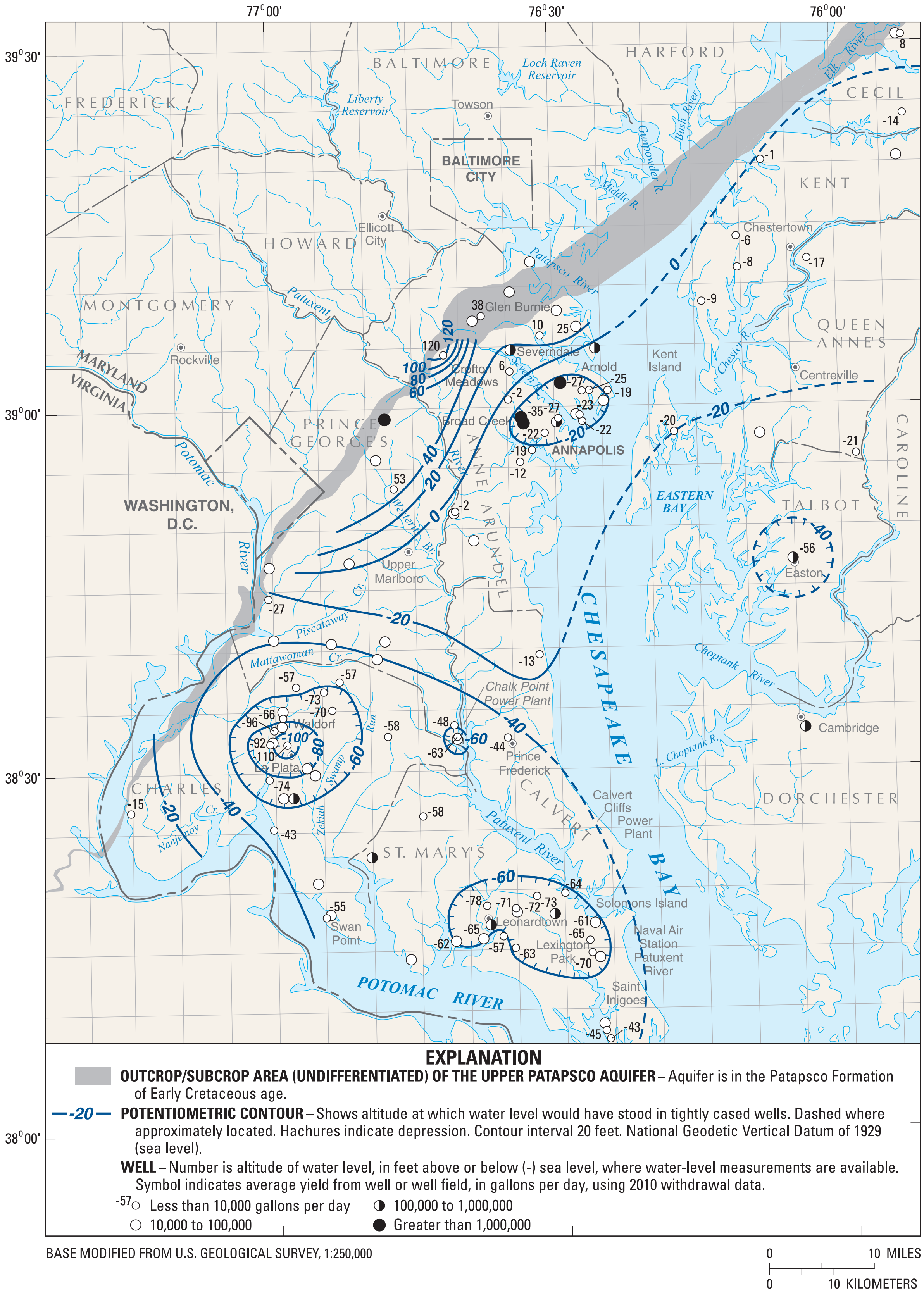
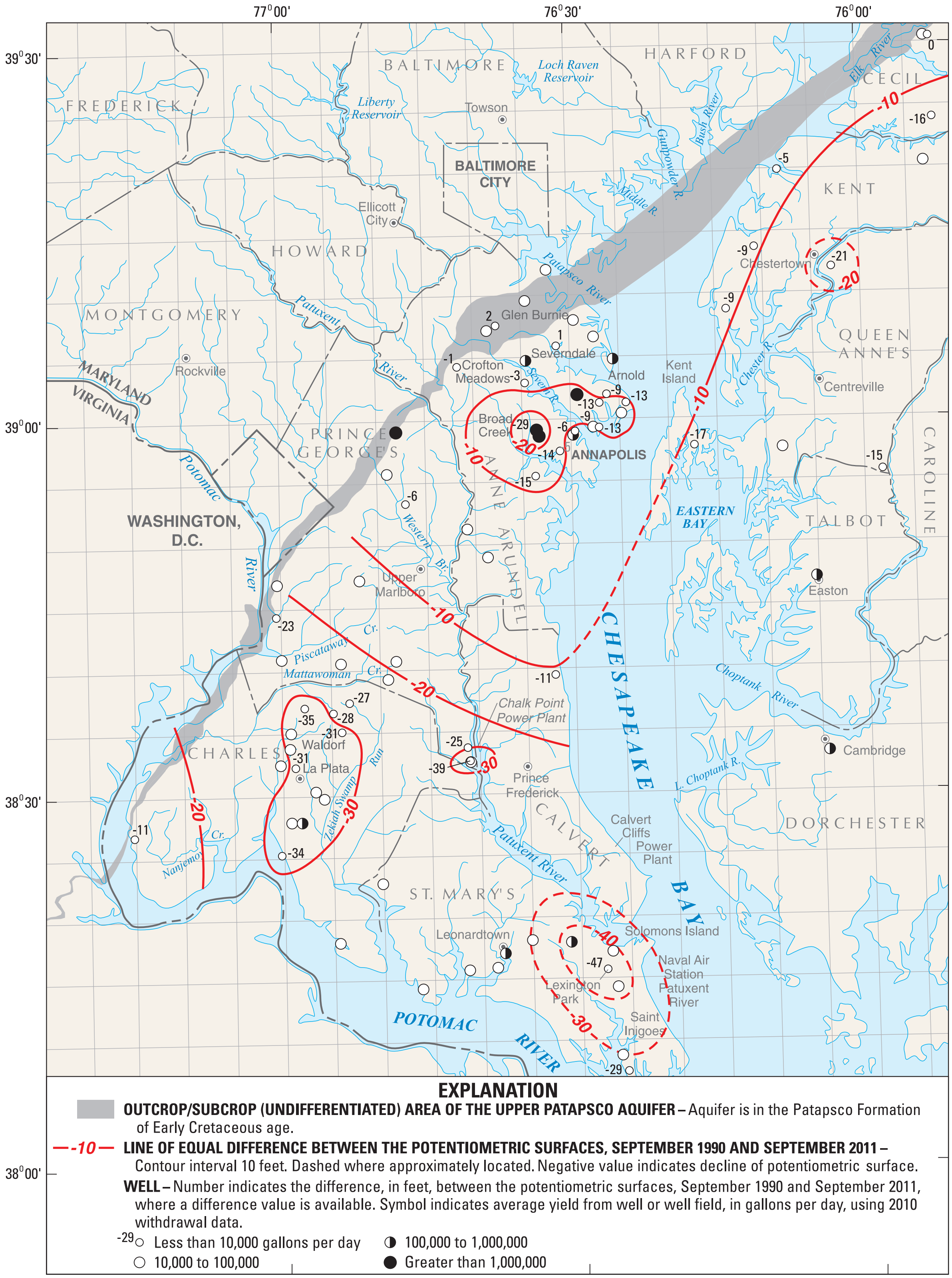


Figure 7. Potentiometric surface of the upper Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore, September 2011.



BASE MODIFIED FROM U.S. GEOLOGICAL SURVEY, 1:250,000

0 10 MILES

0 10 KILOMETERS

Figure 8. The difference between the potentiometric surfaces of the upper Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore, September 1990 and September 2011.

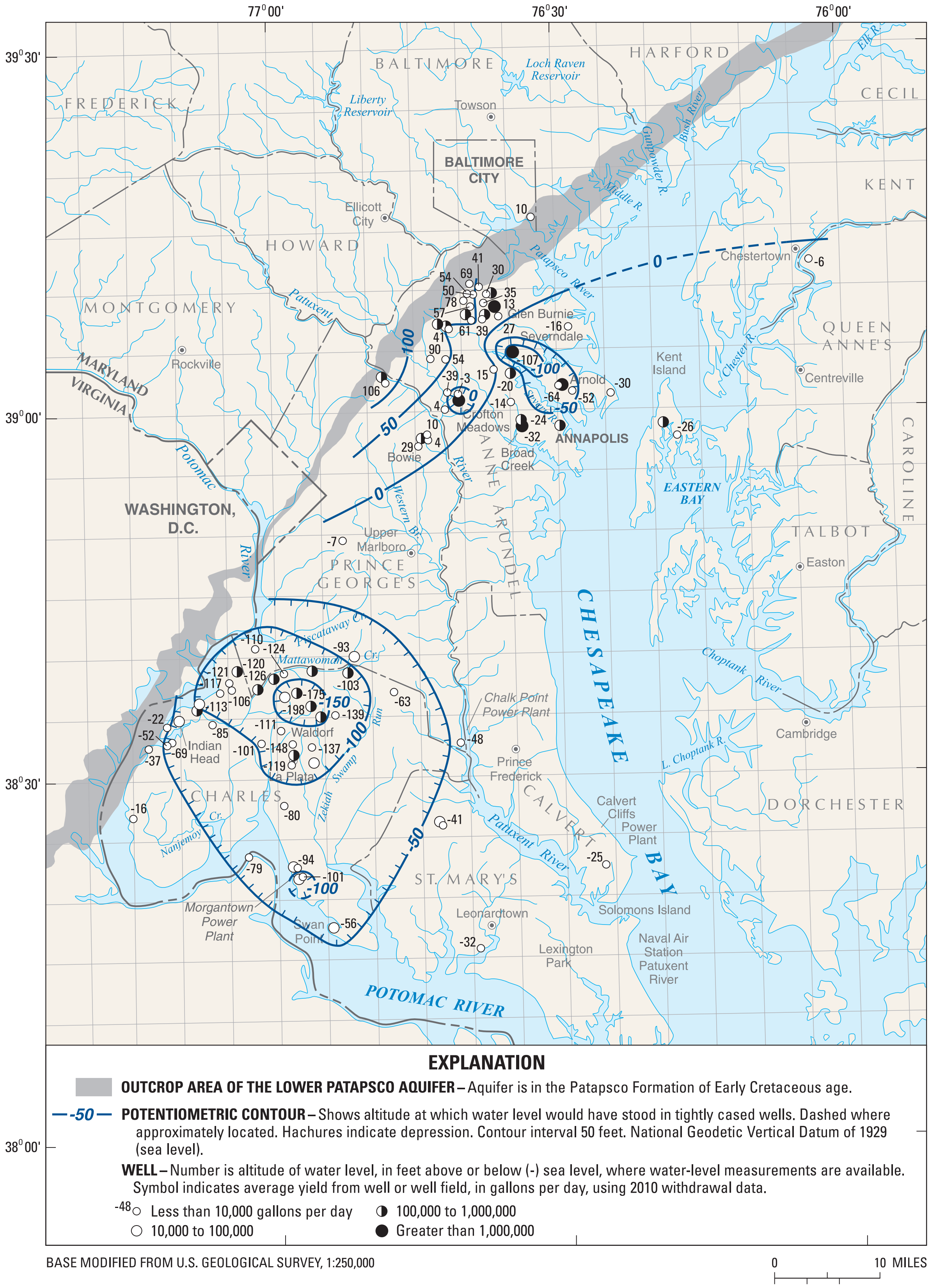


Figure 9. Potentiometric surface of the lower Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore, September 2011.

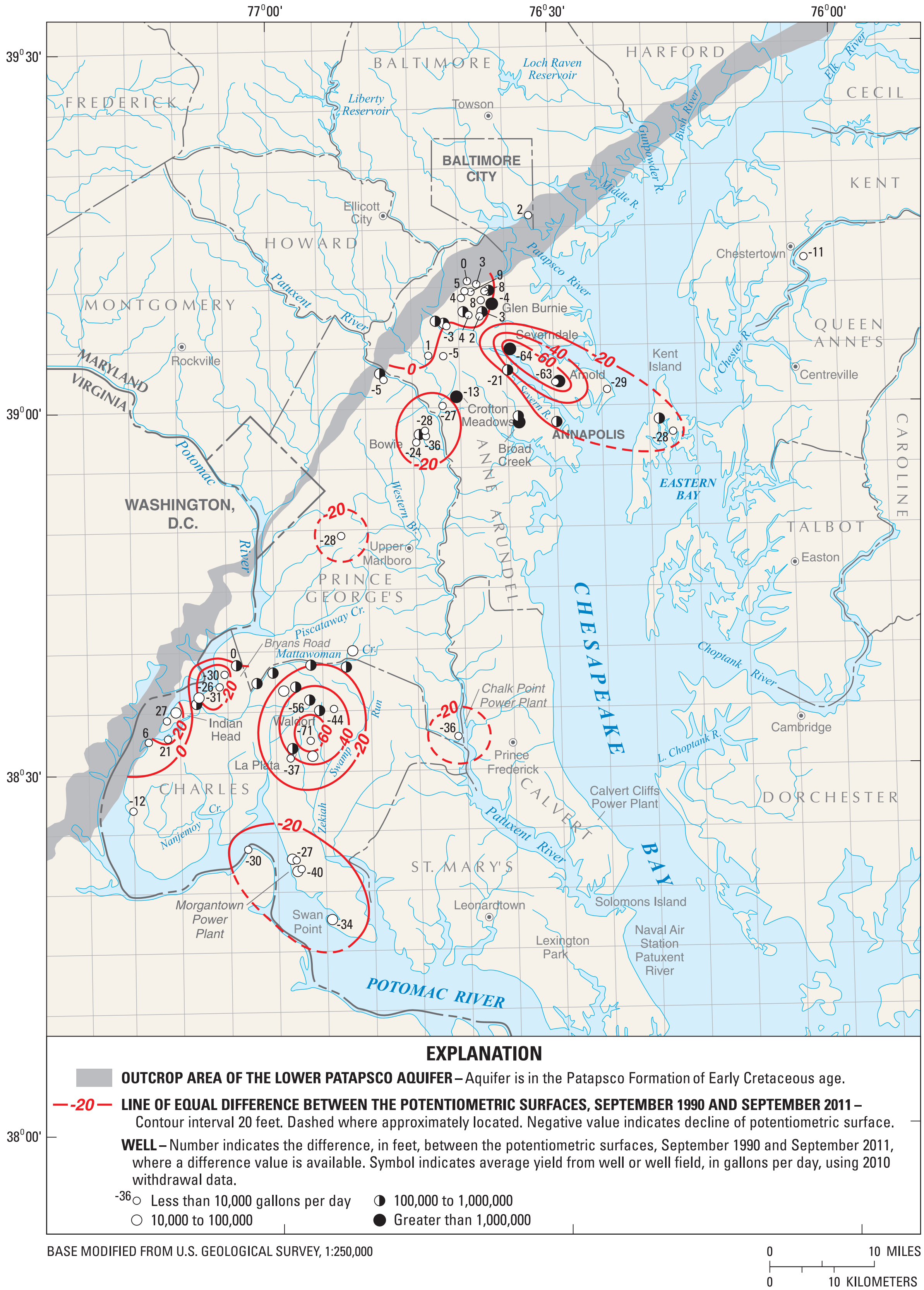


Figure 10. The difference between the potentiometric surfaces of the lower Patapsco aquifer in Southern Maryland and Maryland's Eastern Shore, September 1990 and September 2011.

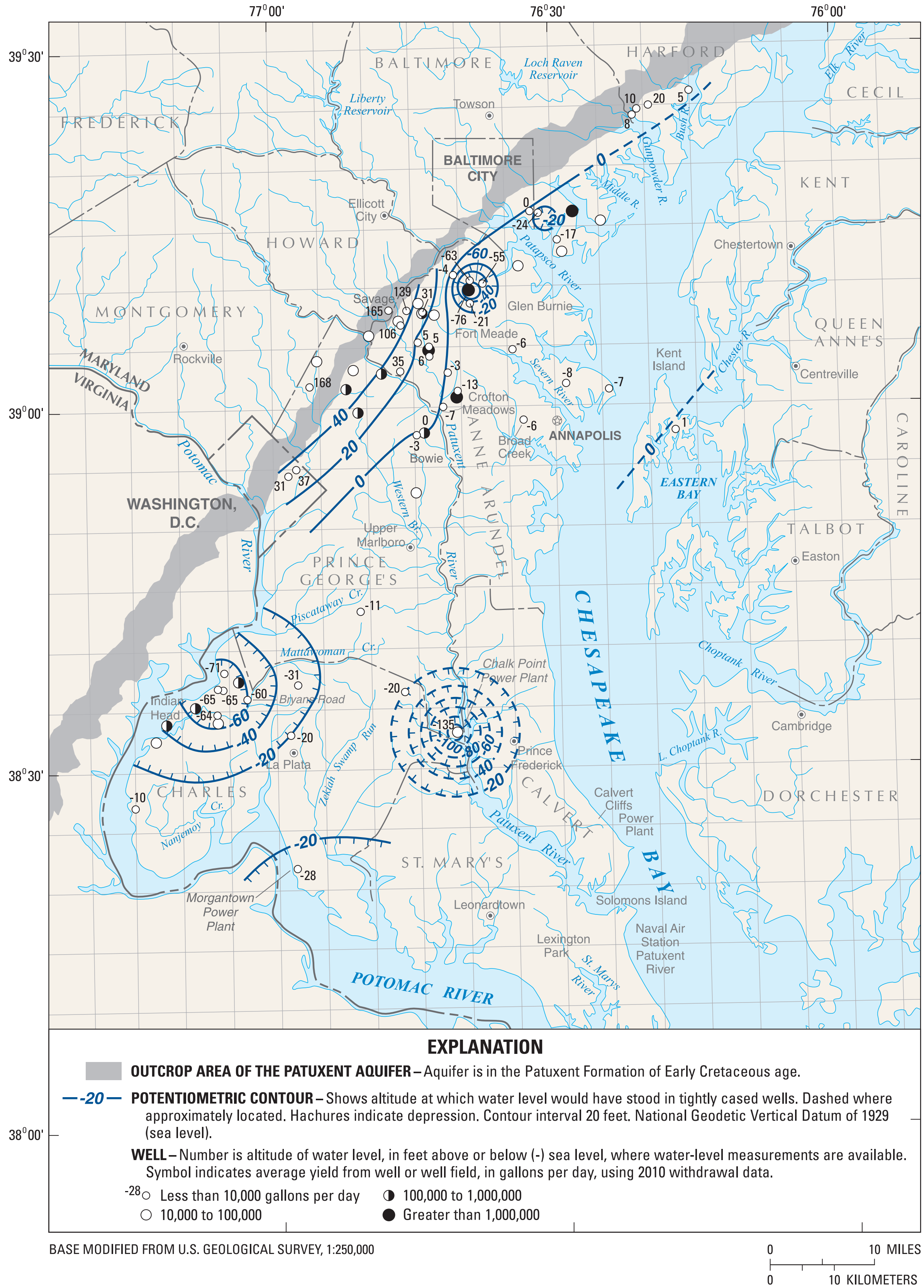


Figure 11. Potentiometric surface of the Patuxent aquifer in Southern Maryland and Maryland's Eastern Shore, September 2011.

Summary and Conclusions

Groundwater has been and is expected to continue to be a major source of freshwater supply for Southern Maryland and Maryland's Eastern Shore. The principal aquifers in the study area from which groundwater is withdrawn are the Aquia, Magothy, upper Patapsco, lower Patapsco, and Patuxent aquifers. Groundwater withdrawals from those aquifers have increased substantially over the last several decades as a direct result of population increases and increased use of water for irrigation. A groundwater-level monitoring network is maintained by the U.S. Geological Survey (USGS) and the Maryland Geological Survey (MGS) to observe changes in groundwater levels over time. In each aquifer, the water levels tend to be lower in wells farther away from the outcrop area where the aquifers receive recharge. Water levels in the Aquia aquifer ranged from 50 feet (ft) above sea level to 157 ft below sea level in 2011, and declined by as much as 112 ft between 1982 and 2011. Groundwater withdrawals from the Aquia aquifer have increased from about 5 million gallons per day (Mgal/d) in 1982 to over 15 Mgal/d in 2010. Water levels in the Magothy aquifer ranged from 88 ft above sea level to 79 ft below sea level in 2011, and declined by as much as 85 ft between 1975 and 2011. Water withdrawal from the Magothy aquifer increased from about 7 Mgal/d in 1975 to nearly 9 Mgal/d in 2010. Water levels in the upper Patapsco aquifer ranged from 120 ft above sea level to 110 ft below sea level in 2011, and declined by as much as 47 ft between 1990 and 2011. Water levels in the lower Patapsco aquifer ranged from 106 ft above sea level to 198 ft below sea level in 2011, and declined by as much as 71 ft between 1990 and 2011. Groundwater withdrawals from the Patapsco aquifers increased from 29 Mgal/d in 1990 to over 40 Mgal/d in 2010. Most of the total withdrawals were from the lower Patapsco aquifer. Water levels in the Patuxent aquifer ranged from 168 ft above sea level to 135 ft below sea level. Withdrawal rates from the Patuxent aquifer decreased from over 21 Mgal/d in 1990 to 13 Mgal/d in 2010. The groundwater-level and withdrawal data presented in this report can be used to assist in determining the sustainability of the confined aquifer system in Southern Maryland and Maryland's Eastern Shore.

Acknowledgments

The authors would like to express thanks to all of the USGS and MGS personnel that contributed water-level measurements that were used in the development of the maps. Timothy Auer of USGS produced the final maps and figures for this report. Valerie Gaine of USGS provided the editorial review and Andrew LaMotte of USGS provided Geographic Information System (GIS) support. Cheryl Dieter and Matthew Pajerowski, both of USGS, provided useful technical comments and advice throughout the report process, and Peter Lapa-Lilly of USGS diligently cross-referenced the data for the maps and tables.

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Wheeler, J.C., and Wilde, F.D., 1989, Ground-water use in the Coastal Plain of Maryland, 1900–1980: U.S. Geological Survey Open-File Report 87–540, 173 p.

Appendixes

Appendix 1: Chronology of reports on potentiometric surface and water-level difference mapping by aquifer for Southern Maryland and Maryland's Eastern Shore

AQUIA AQUIFER

POTENTIOMETRIC SURFACE MAPS

POTENTIOMETRIC SURFACE OF THE AQUIA AQUIFER IN SOUTHERN MARYLAND, SEPTEMBER 1982, by Mack, F.K., Wheeler, J.C., and Curtin, S.E.: U.S. Geological Survey Open-File Report 83–929, 1983, 1 p. (A revision of this map was done in 1992.)

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LOWER PATAPSCO AQUIFER

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PATUXENT AQUIFER

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Appendix 2a. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Aquia aquifer).

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1982–2011
AA Cf 122	390149076261702	39.03061111	-76.43738889	20	2.13	-0.38
AA Cg 25	390127076240301	39.02427797	-76.40051418	17.33	1.64	0.40
AA De 102	385512076331602	38.92002778	-76.55419444	49.57	9.26	-0.51
AA De 137	385930076342102	38.99177795	-76.57218569	133.6	49.66	8.06
AA De 195	385628076323603	38.94122379	-76.54301693	37	2.51	--
AA Df 98	385550076292101	38.93066879	-76.48884808	11.31	3.21	1.82
AA Df 103	385623076274401	38.93983528	-76.46190312	26.51	4.73	--
AA Ed 45	385406076383901	38.90205556	-76.64366667	110	39.40	-4.16
AA Ed 49	385249076382101	38.88808333	-76.63933333	60	20.41	-5.68
AA Ee 67	385124076322001	38.85661111	-76.53805556	11.2	-6.65	-4.57
AA Fc 35	384833076415602	38.80928124	-76.69857717	51.3	-1.55	--
AA Fd 46	384727076382501	38.79575000	-76.63686111	140.25	-21.47	-24.65
AA Fe 46	384840076312801	38.81147222	-76.52425000	8.48	-21.97	-16.93
AA Fe 48	384508076334101	38.75244444	-76.56119444	85	-35.55	-26.48
AA Fe 60	384917076305802	38.82150473	-76.51579051	8.5	-17.66	--
AA Fe 92	384644076331201	38.77900546	-76.55301359	9	-33.46	--
CA Ba 11	384357076401601	38.73261660	-76.67079721	115.31	-37.68	-34.25
CA Ba 13	384231076412501	38.70872819	-76.68996469	56	-40.15	-41.50
CA Bb 27	384333076394701	38.72595018	-76.66274113	137.87	-42.02	-39.81
CA Bb 33	384222076380101	38.70622871	-76.63329482	110.6	-49.80	-45.84
CA Bc 44	384243076320201	38.71206271	-76.53356707	7.57	-50.49	--
CA Cb 26	383837076381001	38.64373027	-76.63579433	115.29	-57.58	-55.38
CA Cb 32	383632076392701	38.60900883	-76.65718402	95.2	-62.26	-54.94
CA Cc 18	383940076314801	38.66141667	-76.52972222	111.31	-54.69	-47.41
CA Cc 57	383605076344601	38.60119444	-76.57969444	138.6	-62.93	-55.28

Appendix 2a. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Aquia aquifer). —Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1982–2011
CA Cc 58	383924076341201	38.65678589	-76.56967972	122.5	-54.90	-51.00
CA Db 40	383053076382101	38.51484463	-76.63884873	23.38	-73.06	--
CA Db 47	383239076354201	38.54428840	-76.59468004	140.4	-75.93	-60.56
CA Dc 29	383025076304701	38.50706708	-76.51273101	123.1	-70.23	-56.09
CA Ed 42	382528076280701	38.43123443	-76.46300729	121.72	-86.34	-57.49
CA Ed 52	382549076260101	38.43040093	-76.43328409	10	-99.10	-70.30
CA Fd 54	382407076260301	38.40206788	-76.43383978	129.4	-106.63	-76.78
CA Fe 30	382134076233301	38.35956803	-76.39217179	118.82	-118.28	--
CA Gd 6	381952076270901	38.33123539	-76.45217406	12.58	-142.41	-96.81
CA Gd 61	381956076275301	38.33222222	-76.46472222	18.1	-136.96	--
CH Bg 11	383536076473601	38.59345318	-76.79302354	196.78	-46.94	-51.18
CH Ce 41	382225076591002	38.54039844	-76.98580733	194.23	-28.75	--
CH Ce 62	383348076595401	38.56333333	-76.99833333	195	-15.03	--
CH Ch 15	383043076404501	38.51206691	-76.67885078	9.78	-72.05	-62.06
CH Df 17	382800076530301	38.46678988	-76.88385908	160.97	-67.37	-68.00
CH Ff 59	381639076523201	38.27762869	-76.87524772	8	-47.87	-41.10
DO Db 19	382847076190901	38.48019444	-76.31938889	1.5	-70.04	--
KE Cb 100	391124076101004	39.18986111	-76.16861111	65.69	25.45	--
KE Db 42	390909076122302	39.15294444	-76.20630556	25	11.98	--
KE Dc 91	390626076083302	39.10733302	-76.14217115	4.64	0.16	--
PG Hf 35	383228076410601	38.54123278	-76.68468474	11.22	-70.21	-63.97
PG Hf 42	383348076411303	38.56338889	-76.68530556	27.76	-67.67	-62.31
QA Be 17	391203076024303	39.20094315	-76.04494493	25	18.00	4.87
QA Cf 78	390845075582302	39.14583333	-75.97305556	61	-3.09	--
QA Db 32	390201076182703	39.03372248	-76.30717813	18	1.80	--
QA Db 35	390119076191001	39.02205595	-76.31912290	7.5	1.85	--
QA Db 37	390023076174302	39.00650065	-76.29495549	7.1	-0.79	--
QA De 27	390251076034401	39.04761175	-76.06188876	10.19	-21.29	--
QA Ea 78	385718076211502	38.95511290	-76.35384487	11.8	-1.10	--
QA Ea 80	385757076200102	38.96594599	-76.33328901	8.5	-2.18	--
QA Eb 113	385748076172001	38.96344615	-76.28856542	11.34	-8.61	-3.47
QA Eb 155	385843076155302	38.97872357	-76.26439846	3.9	-7.11	--
QA Eb 156	385852076195201	38.98122338	-76.33078935	12.01	-1.77	--
QA Fc 7	385429076120201	38.90816973	-76.20022712	10	-26.63	-15.54
SM Bb 15	382838076470101	38.47755556	-76.78322222	165.3	-73.85	-71.08
SM Cc 8	382235076435801	38.37722222	-76.73247222	128.85	-69.87	--
SM Cc 22	382055076404601	38.34873729	-76.67912944	133	-65.37	-54.67

Appendix 2a. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Aquia aquifer).—Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1982–2011
SM Ce 38	382222076304602	38.33972222	-76.61258333	15.92	-119.30	--
SM Ce 43	382012076332901	38.33679183	-76.55773433	88	-109.70	--
SM Dc 42	381648076421801	38.28012808	-76.70468677	13.5	-62.30	-38.84
SM Dc 59	381807076442801	38.30207246	-76.74079961	40.89	-60.91	-47.39
SM Dd 1	381745076381201	38.29513889	-76.63658333	93.28	-70.05	-41.61
SM Dd 39	381834076381301	38.30957098	-76.63662749	107.5	-71.99	-36.37
SM Dd 49	381616076364702	38.27025000	-76.61394444	118.94	-75.76	-45.55
SM Dd 50	381807076380001	38.30207108	-76.63301624	99.4	-69.98	-39.71
SM Dd 68	381654076394502	38.28179411	-76.66218455	125	-65.10	-42.40
SM Dd 69	381923076372501	38.32318167	-76.62329338	125	-62.51	--
SM Df 1	381552076265001	38.26484714	-76.44689638	93.35	-151.48	--
SM Df 10	381715076261601	38.28679129	-76.43800705	46	-141.13	-89.98
SM Df 62	381632076275301	38.27568050	-76.46439701	104	-150.20	-74.77
SM Df 71	381527076283101	38.25697222	-76.47527778	69.15	-138.33	-77.57
SM Df 80	381532076250101	38.25901362	-76.41661743	42	-134.45	--
SM Df 86	381548076272103	38.26345833	-76.45550783	112.09	-156.68	-83.70
SM Df 95	381617076263201	38.27151369	-76.44134058	80	-142.91	-111.91
SM Df 98	381634076270501	38.27630556	-76.45083333	80.46	--	-93.01
SM Dg 10	381555076244801	38.26540242	-76.41300616	22	--	-79.05
SM Dg 19	381747076223901	38.29600000	-76.37638889	10	-126.58	--
SM Fe 31	380834076303402	38.14291667	-76.50927778	9.08	-78.37	-44.26
SM Ff 64	380821076255501	38.13941667	-76.43144444	10	-91.22	--
VA 54Q 21	382129077005801	38.35805550	-77.01611110	20.46	-24.83	--

Appendix 2b. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Magothy aquifer).

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1975–2011
AA Cc 95	390247076403501	39.04649876	-76.67607829	131.09	87.78	-1.84
AA Cc 117	390103076402603	39.01761031	-76.67357794	134.14	47.20	--
AA Cd 12	390124076361202	39.02344392	-76.60302027	98.82	12.59	-9.99
AA Cd 48	390001076364301	39.00038866	-76.61163149	102.8	9.02	-13.84
AA Cd 78	390238076373301	39.04399906	-76.62552112	128.82	39.46	-8.81
AA Ce 103	390214076342201	39.03733276	-76.57246385	59.2	2.70	0.16
AA Ce 128	390404076300703	39.06788823	-76.50162836	7.13	-8.37	--
AA Ce 130	390148076325202	39.03011077	-76.54746303	2.68	-9.54	--
AA Ce 133	390410076302401	39.06955484	-76.50635074	15.14	-4.02	--
AA Ce 138	390049076322702	39.01372216	-76.54051831	69	-15.98	-16.49
AA Ce 151	390132076311401	39.02561111	-76.52061111	84	-17.07	-18.63
AA Cf 99	390150076283002	39.03066661	-76.47468304	93.7	-28.13	-28.59
AA Cf 104	390242076274501	39.04522222	-76.46233333	26.77	-24.33	-25.16
AA Cf 152	390121076253301	39.02258333	-76.42630556	22	-24.83	--
AA Cg 7	390123076241102	39.02316687	-76.40273647	17	-16.19	-18.75
AA Dc 15	385928076414601	38.99122176	-76.69580059	109.99	31.63	-6.15
AA Dc 20	385637076400802	38.94372222	-76.66819444	92.19	14.49	-15.50
AA Dd 37	385807076351901	38.96872286	-76.58829686	132.93	-8.99	-19.79
AA Dd 40	385511076373101	38.91986111	-76.62488889	135.79	-4.16	-25.55
AA Dd 42	385808076373502	38.96900041	-76.62607589	105.48	5.10	-18.29
AA De 1	385915076340401	38.98761141	-76.56718545	13.72	-24.06	-25.31
AA De 103	385512076331603	38.92002778	-76.55413889	49.67	-13.93	-25.55
AA De 124	385528076334601	38.92455556	-76.56219444	27.84	-13.70	-26.22
AA De 135	385932076344401	38.99233346	-76.57857479	48.8	-5.52	--
AA Df 20	385916076270702	38.98788963	-76.45162640	21.87	-21.29	-23.07
AA Df 79	385905076293601	38.98483408	-76.49301641	5.17	-20.46	-24.73
AA Df 82	385953076280201	38.99816712	-76.46690492	87.77	-23.12	-23.14
AA Df 84	385518076282701	38.92178016	-76.47384740	7.32	-22.64	-30.25
AA Df 87	385934076274301	38.99288949	-76.46162684	19.86	-21.27	--
AA Ed 39	385210076371002	38.86955831	-76.61912966	176.47	-5.98	-24.75
AA Ed 65	385406076383902	38.90219444	-76.64361111	110	0.87	--
AA Fc 34	384833076415601	38.80928124	-76.69857717	51	-3.64	--
AA Fe 47	384843076312601	38.81236111	-76.52386111	6.36	-15.98	-30.28

Appendix 2b. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Magothy aquifer).
—Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1975–2011
AA Fe 51	384917076305801	38.82150473	-76.51579051	8.5	-16.62	--
AA Fe 93	384644076331202	38.77900546	-76.55301359	11.38	-15.85	--
CA Bb 10	384028076354201	38.67456310	-76.59468126	186.9	-37.75	-45.55
CA Bb 23	384458076375501	38.74956097	-76.63162850	146.86	-22.51	-36.31
CA Bb 25	384109076391101	38.68595130	-76.65274014	119.78	-33.34	-44.43
CA Cc 56	383934076320001	38.65956383	-76.53301106	96.11	-39.08	-47.77
CA Dc 35	383050076305501	38.51401138	-76.51495340	91.6	-41.99	-51.29
CH Be 17	383502076565101	38.58400842	-76.94719515	204.23	-65.09	-71.09
CH Be 43	383819076555501	38.63872909	-76.93163942	216.79	-60.72	-70.25
CH Bf 98	383739076543001	38.62761839	-76.90830529	216.39	-75.10	-79.05
CH Bf 124	383750076540801	38.63067388	-76.90191623	207.78	-75.58	-85.14
CH Bf 133	383640076545901	38.61122996	-76.91608320	223.5	-79.39	-35.98
CH Bf 134	383728076531701	38.62456301	-76.88774907	202.09	-75.41	-81.84
CH Bf 135	383814076500301	38.63734061	-76.83385862	207.82	-52.68	-67.24
CH Bf 143	383918076522201	38.65511772	-76.87247107	206.59	-73.56	--
CH Cf 29	383219076503502	38.53873238	-76.84274687	178.02	-63.95	-75.52
CH Cf 39	383259076531001	38.54967778	-76.88629444	139.59	-68.80	--
DO Ce 15	383408076042402	38.56905556	-76.07288889	6	-10.77	-2.77
KE Be 43	391823075594701	39.30672222	-75.99505556	65	32.17	--
KE Cb 97	391124076101001	39.19000000	-76.16872222	65.84	4.68	--
PG Cf 33	385806076435303	38.96844427	-76.73107937	115.4	49.58	--
PG De 21	385130076465501	38.85883333	-76.78161111	95.76	33.14	-16.62
PG De 32	385323076471801	38.88983461	-76.78802541	131.85	50.63	-11.62
PG Ed 50	384715076522001	38.78777778	-76.87166667	240.88	16.56	--
PG Ef 34	384623076424001	38.77316667	-76.71113889	39.18	-8.94	-29.45
PG Ef 40	384847076440401	38.81316667	-76.73380556	79.85	1.18	--
PG Fd 32	384148076510901	38.69678323	-76.85219305	226	-33.50	-56.63
PG Fd 39	384410076502501	38.73544444	-76.83980556	233.42	-9.53	-35.40
PG Fe 30	384453076482101	38.74805556	-76.80569444	237.59	-8.13	-36.24
PG Ge 15	383940076461301	38.66122904	-76.76996804	210.51	-33.62	-51.16
PG Gf 35	383832076414701	38.64213889	-76.69686111	34.96	-34.92	-48.86
PG Hf 41	383348076411302	38.56338889	-76.68538889	28.3	-54.33	-42.33
QA Ea 27	385718076205501	38.95400183	-76.34801133	18.27	-19.63	-26.35

Appendix 2c. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (upper Patapsco aquifer).

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1990–2011
AA Bd 159	390737076374402	39.12708333	-76.62908333	75.48	38.24	1.69
AA Be 102	390559076312602	39.10005556	-76.52425000	36.36	10.31	0.69
AA Bf 100	390629076273601	39.10838889	-76.45955556	52	24.57	--
AA Cc 43	390422076414501	39.07288717	-76.69552364	180	119.67	-0.85
AA Ce 120	390303076344301	39.05094364	-76.57829744	161.8	6.34	-3.18
AA Ce 137	390043076345402	39.01205531	-76.58135287	57.5	-1.86	--
AA Cf 128	390149076261703	39.03038892	-76.43773751	14	-24.66	-9.46
AA Cf 134	390121076270501	39.02261122	-76.45107122	24	-26.68	-13.14
AA Cg 24	390123076241603	39.02316687	-76.40412540	12.68	-19.06	-12.70
AA De 95	385853076333001	38.98150050	-76.55801837	73.2	-34.55	-28.99
AA De 128	385530076334701	38.92488889	-76.56261111	28.31	-12.44	-14.76
AA De 199	385753076310801	38.96433333	-76.51944444	35	-22.36	-13.60
AA De 230	385627076322901	38.94080556	-76.54144444	33	-19.09	--
AA Df 19	385921076270701	38.98955626	-76.45079309	15.84	-21.56	-12.95
AA Df 89	385934076274302	38.99288949	-76.46162684	20.58	-22.57	-8.52
AA Df 99	385905076293604	38.98483408	-76.49301641	5.17	-27.27	-6.01
AA Ec 12	385125076404801	38.85694444	-76.67947222	55	-1.70	--
CA Cc 55	383934076320201	38.66000000	-76.53388889	105	-13.41	-10.74
CA Db 96	383244076354201	38.54567726	-76.59468006	152.42	-44.07	--
CE Ce 56	393026075523101	39.50761111	-75.87491667	38	8.42	-0.22
CE Ee 29	392403075521801	39.40147222	-75.87152778	75	-13.93	-16.08
CH Be 60	383706076575604	38.61845178	-76.96525147	212.8	-57.31	-35.18
CH Bf 151	383508076540703	38.58567521	-76.90163812	192.8	-69.56	-30.62
CH Bf 157	383637076545803	38.61122996	-76.9160832	225	-72.70	-28.00
CH Bf 158	383732076531902	38.62484077	-76.88830465	193	-57.10	-27.12
CH Cd 31	383222077004401	38.53956505	-77.01191924	130	-91.98	--
CH Cd 54	383346077000901	38.56277778	-77.00250000	180	-96.01	--
CH Ce 16	383217076590201	38.53764167	-76.98323056	187.45	-110.10	-31.16
CH Ce 50	383420076592501	38.57232222	-76.98957778	202.18	-65.72	-14.87
CH Cg 24	383254076481401	38.54877778	-76.80338889	171.88	-57.64	-54.43
CH Da 21	382659077152401	38.44984513	-77.25636926	90	-14.76	-11.07

Appendix 2c. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (upper Patapsco aquifer).—Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1990–2011
CH Dd 33	382607077002601	38.49116667	-76.92347222	99.8	-43.27	-33.81
CH Dd 38	382925077010101	38.49920278	-77.01667778	77.19	-73.81	--
CH Fe 5	381803076550801	38.30096131	-76.91858214	12	-55.24	--
KE Ac 20	392007076075501	39.33491667	-76.13150000	7	-0.94	-5.42
KE Cb 36	391400076101401	39.23316667	-76.17061111	40	-6.00	-8.57
KE Cb 103	391124076101005	39.18986111	-76.16836111	65.6	-8.30	--
KE Db 40	390837076140401	39.14377778	-76.23416667	15	-8.66	-9.45
PG De 33	385323076471802	38.88944444	-76.79786111	103.68	52.60	-6.20
PG Fb 36	384423077004501	38.73977778	-77.01216667	78	-26.75	-22.60
PG Hf 40	383348076411301	38.56350000	-76.68533333	27.98	-47.54	-24.86
PG Hf 44	383250076405304	38.54734373	-76.68107351	10.45	-62.80	-39.26
QA Be 16	391203076024302	39.20094315	-76.04494493	25	-17.20	-20.95
QA Eb 111	385751076171601	38.96427946	-76.28745430	14.03	-19.58	-17.04
QA Ef 29	385534075573601	38.92733560	-75.96077192	61.69	-20.55	-14.89
SM Bc 41	382621076445301	38.43911111	-76.74788889	160	-58.02	--
SM Dc 64	381559076400201	38.26651673	-76.66690712	33	-62.01	--
SM Dd 78	381827076350402	38.30762592	-76.58412478	130	-71.30	--
SM Dd 79	381834076381303	38.30861111	-76.63472222	113	-77.93	--
SM Dd 80	381616076384503	38.27123853	-76.64551709	27	-65.19	--
SM Dd 81	381509076351401	38.25611111	-76.58472222	114	-62.94	--
SM Dd 83	381621076364701	38.27250000	-76.61305556	120	-56.98	--
SM De 52	381753076310001	38.29818075	-76.51634354	110	-73.07	--
SM De 59	381914076331002	38.32000000	-76.55277778	151	-71.92	--
SM Df 84	381548076272102	38.26345833	-76.45550783	108.39	-64.54	-46.52
SM Df 88	381955076293901	38.33206901	-76.49384225	20	-63.81	--
SM Df 100	381721076264801	38.28916667	-76.44652778	21	-60.70	--
SM Ef 94	381440076271701	38.24444444	-76.45472222	80	-70.23	--
SM Ff 36	380724076251901	38.12261111	-76.42166667	7.51	-43.30	-29.28
SM Ff 65	380823076255501	38.13986111	-76.43208333	10	-45.20	--
TA Cd 57	384709076050301	38.78594908	-76.08383090	12	-56.17	--

Appendix 2d. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (lower Patapsco aquifer).

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1990–2011
3S5E-46	391556076315301	39.26566311	-76.53107459	10	10.44	1.61
AA Ad 102	391032076385904	39.17566368	-76.64941189	76.72	69.44	-0.34
AA Ad 109	391006076380101	39.16800000	-76.63405556	35.78	41.29	2.58
AA Bc 215	390700076412601	39.11677544	-76.69024614	124	41.18	-2.84
AA Bd 37	390848076363601	39.14677541	-76.60968798	38.2	12.58	-3.64
AA Bd 56	390950076384001	39.16399721	-76.64413382	61.6	54.11	4.65
AA Bd 101	390855076373402	39.14871975	-76.62579969	55	34.60	7.94
AA Bd 152	390821076365401	39.13963889	-76.61502778	53.29	26.92	2.84
AA Bd 155	390938076383701	39.16116667	-76.64313889	57.5	50.41	8.53
AA Bd 156	390922076371001	39.15583333	-76.61908333	68.99	29.88	7.66
AA Bd 157	390737076374401	39.12711111	-76.62913889	75.75	38.75	2.17
AA Bd 158	390744076390001	39.12919444	-76.64972222	108.25	60.56	4.43
AA Bd 160	390908076394402	39.15255556	-76.66183333	88	77.59	4.33
AA Bd 181	390839076385702	39.14416667	-76.64916667	180.78	57.03	--
AA Bf 99	390654076283601	39.11486111	-76.47697222	40	-16.00	--
AA Cc 40	390423076432001	39.07350000	-76.72211111	136.92	89.86	1.40
AA Cc 82	390422076414505	39.07288717	-76.69552364	178.71	54.44	-5.03
AA Cc 89	390010076415703	39.00277770	-76.69916660	52.77	4.11	-27.12
AA Cc 115	390103076402601	39.01761031	-76.67357794	134.38	-3.41	-12.96
AA Cc 137	390126076402901	39.02399910	-76.67441136	115.34	-39.45	--
AA Cd 128	390327076363701	39.05761005	-76.60996516	110	15.08	--
AA Ce 94	390450076343503	39.08066544	-76.57607530	90	-106.58	-64.43
AA Ce 124	390303076344303	39.05094364	-76.57829744	160	-20.00	-20.87
AA Ce 136	390043076345401	39.01305556	-76.58277778	60	-14.49	--
AA Cf 137	390205076292702	39.03444444	-76.49000000	124.3	-63.51	-62.64
AA Cf 167	390154076282802	39.03155556	-76.47461111	106	-52.45	--
AA Cg 23	390123076241602	39.02316687	-76.40412540	12.57	-30.45	-28.73
AA De 206	385833076332801	38.97594508	-76.55746267	81.74	-32.09	--
AA De 232	385915076335304	38.98750000	-76.56472222	119	-24.20	--
CA Fd 85	382236076255401	38.37679034	-76.43133979	106.81	-25.08	--
CH Bc 24	383633077083001	38.60916660	-77.14166660	72	-113.28	-25.90
CH Bc 76	383754077051201	38.63178443	-77.08636630	171	-120.90	-29.90
CH Bc 81	383709077061002	38.61928477	-77.10247779	156.46	-116.57	-30.50
CH Bd 33	383844077040701	38.64567294	-77.06831029	180	-119.58	-0.18
CH Bd 50	383734077044901	38.62622905	-77.07997718	180	-105.68	--

Appendix 2d. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (lower Patapsco aquifer).—Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011	Water-level difference 1990–2011
CH Bd 51	383715077014901	38.62095152	-77.02997567	185	-125.73	--
CH Be 58	383706076575602	38.61845178	-76.96525147	212.5	-175.01	--
CH Be 64	383553076562002	38.59817470	-76.93858384	209	-197.85	-55.78
CH Be 72	383903076594301	38.65095071	-76.99497476	110	-124.03	--
CH Bf 146	383508076540701	38.58567521	-76.90163812	192.8	-138.81	-44.28
CH Bf 150	383901076524301	38.65039561	-76.87830454	215	-102.60	--
CH Bg 17	383706076475401	38.61845242	-76.79802398	199.99	-62.81	--
CH Cb 7	383422077114601	38.57289712	-77.19581333	36	-21.92	26.75
CH Cb 28	383315077131401	38.55484207	-77.22025822	5	-36.84	6.26
CH Cb 38	383328077114201	38.55789757	-77.19470201	4	-52.16	21.09
CH Cb 42	383328077111702	38.55789758	-77.18775738	5	-68.69	--
CH Cc 31	383455077074401	38.58206362	-77.12858934	35	-84.93	--
CH Cd 42	383256077015301	38.54894167	-77.03612222	188.43	-100.92	--
CH Ce 35	383111076584801	38.52018889	-76.97973611	173.16	-118.74	-36.50
CH Ce 37	383236076563901	38.54345407	-76.94386147	184.95	-136.53	-70.68
CH Ce 53	383420076592504	38.57234193	-76.98997428	202.36	-110.74	--
CH Ce 56	383251076583901	38.54762048	-76.97719596	196.48	-147.52	--
CH Da 20	382654077152701	38.44845629	-77.25720260	90	-16.41	-11.52
CH De 52	382752076593601	38.46472222	-76.99527778	166	-80.16	--
CH Ee 70	382154076574801	38.36568153	-76.96386135	22.83	-101.36	-40.32
CH Ee 78	382240076582801	38.37790336	-76.97413948	75	-93.87	-27.04
CH Ff 60	381806076545401	38.30179462	-76.91469316	12	-56.01	-33.59
PG Be 14	390226076481001	39.04096944	-76.80231111	150.44	106.35	-5.48
PG Cf 76	385757076440402	38.96594431	-76.73413502	127.61	3.54	-36.35
PG Cf 77	385757076442002	38.96594428	-76.73857961	147	10.07	-27.99
PG Cf 80	385816076434502	38.96261107	-76.72913484	150	28.85	-23.75
PG Ed 34	384933076530001	38.82580556	-76.88447222	270	-7.48	-27.67
PG Fb 57	384056077015501	38.68233859	-77.03164270	170	-110.24	--
PG Gd 6	383958076520601	38.66622852	-76.86802658	217	-92.63	--
PG Hf 32	383250076405303	38.54953333	-76.68140556	10.45	-48.13	-35.99
QA Be 15	391203076024301	39.20094315	-76.04494493	25	-5.82	-11.17
QA Eb 112	385751076171602	38.96427946	-76.28745430	13.92	-26.44	-27.77
SM Bc 39	382605076430201	38.43475000	-76.71677778	162.41	-41.10	--
SM Dd 72	381626076393401	38.27400000	-76.65961111	110.92	-32.16	--
VA 54R-2	382341077032401	38.39472220	-77.05666660	70	-78.70	-29.90

Appendix 2e. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Patuxent aquifer).

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011
2S5E-1	391617076322001	39.27158333	-76.53847222	28.2	0.05
AA Ac 11	391101076404001	39.18383333	-76.67738889	136.9	-3.67
AA Ad 29	391015076373501	39.17108333	-76.62583333	37	-54.55
AA Ad 90	391032076385902	39.17566368	-76.64941189	77.85	-62.85
AA Bb 88	390756076464201	39.13222222	-76.77833333	174.85	138.89
AA Bb 90	390657076462601	39.11583333	-76.77388889	163.5	105.64
AA Bc 163	390524076442501	39.09010891	-76.73996976	135.11	4.57
AA Bc 240	390752076441001	39.13121945	-76.73580346	260	30.94
AA Bd 57	390952076384102	39.16455276	-76.64441161	70	-76.47
AA Bd 182	390839076385703	39.14433333	-76.64933333	180.78	-20.54
AA Cb 1	390303076463201	39.05011111	-76.77575000	129.1	34.95
AA Cc 102	390004076420001	39.00122153	-76.69968967	53.96	-6.99
AA Cc 113	390256076413101	39.04899865	-76.69163437	151.89	-2.59
AA Cc 119	390437076432302	39.07705364	-76.72274680	139	5.09
AA Cc 124	390419076432301	39.07205371	-76.72274674	130	6.33
AA Cc 135	390126076403001	39.02399910	-76.67468914	114.81	-13.35
AA Ce 117	390450076343402	39.08055556	-76.57583333	86	-5.52
AA Cf 166	390154076282801	39.03155556	-76.47461111	106	-8.15
AA Cg 22	390123076241601	39.02316687	-76.40412540	12.61	-7.44
AA De 203	385854076333202	38.98177826	-76.55857394	94.39	-6.46
BA Fe 19	391607076312901	39.26859444	-76.52430000	12.51	-23.97
BA Gf 11	391356076293501	39.23216667	-76.49255556	13.57	-16.70
CH Bc 75	383645077062401	38.61261830	-77.10636674	124.59	-65.24

Appendix 2e. Water-level data for Southern Maryland and Maryland's Eastern Shore wells used in this report (Patuxent aquifer).
—Continued

[All depth and altitude measurements are in feet. Land and water altitudes are measured from the National Geodetic Vertical Datum of 1929 (NGVD 29). Digital latitude and longitude measured relative to North American Datum 1983 (NAD 83); --, no data; USGS, U.S. Geological Survey]

Well number	USGS site identification number	Latitude NAD 83 (decimal degrees)	Longitude NAD 83 (decimal degrees)	Surface altitude (NGVD 29) (feet)	Water-level altitude 2011
CH Bc 77	383644077055501	38.61234054	-77.09831095	96.64	-65.47
CH Bc 78	383809077053401	38.63595096	-77.09247762	20.96	-71.37
CH Bd 52	383553077032401	38.59817437	-77.05636520	47.5	-60.15
CH Be 57	383706076575601	38.61845178	-76.96525147	212.26	-30.58
CH Bg 18	383621076462801	38.60586111	-76.77436111	190	-19.62
CH Cc 34	383441077063901	38.57817487	-77.11053325	41.82	-63.86
CH Ce 57	383250076584001	38.54734271	-76.97747375	193.47	-19.99
CH Da 18	382654077152501	38.44845629	-77.25664704	89.9	-10.15
CH Ee 96	382151076580901	38.36434167	-76.96745278	22.99	-28.10
HA De 181	392606076145801	39.43510856	-76.24912239	12.22	5.37
HA Ec 11	392435076203301	39.40983023	-76.34218097	11.7	10.37
HA Ec 46	392408076210101	39.40233020	-76.34995895	23.16	8.40
HA Ed 47	392455076192101	39.41538590	-76.32218033	90.5	20.48
HO Df 60	390830076473902	39.14166667	-76.79416667	211.41	165.46
PG Bc 16	390151076561501	39.03107500	-76.93720556	189.02	167.61
PG Cf 66	385745076445201	38.96261097	-76.74746879	150.07	-3.37
PG Cf 81	385745076445202	38.96261097	-76.74746879	117.35	0.09
PG Fd 62	384309076511401	38.71928256	-76.85358218	228.6	-10.81
PG Hf 43	383300076411601	38.55003333	-76.68738611	45.04	-134.76
QA Eb 110	385751076171603	38.96427946	-76.28745430	13.98	1.44
WE Ca 35	385429076583601	38.90811111	-76.97666667	150.82	31.29
WE Ca 36	385460076574801	38.91663889	-76.96319444	43.48	37.28

Prepared by USGS West Trenton Publishing Service Center.
Edited by Valerie M. Gaine.
Graphics and layout by Timothy W. Auer.

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Curtin, S.E., and others—**Potentiometric Surface and Water-Level Difference Maps of Selected Confined Aquifers in Southern Maryland and Maryland's Eastern Shore, 1975–2011**—Scientific Investigations Report 2012–5165

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