GEOLOGIC FRAMEWORK, HYDROGEOLOGY, AND GROUND-WATER QUALITY OF THE POTOMAC GROUP AQUIFER SYSTEM, NORTHWESTERN CHARLES COUNTY, MARYLAND

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 91-4059

Prepared in cooperation with the

TOWN OF INDIAN HEAD, MARYLAND and the
UNITED STATES NAVY, NAVAL ORDNANCE STATION

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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	milliimeter
inch per year (in/yr)	25.4	millimeter per year
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second
foot per mile (ft/mi)	0.1894	meter per kilometer
mile (mi)	1.609	kilometer
gallon per minute (gal/min)	0.06308	liter per second
gallon per minute per foot [(gal/min)/ft])	0.2070	liter per second per minute
gallon per day per foot [(gal/d)/ft]	12.42	liter per day per meter
million gallons per day (Mgal/d)	0.04381	cubic meters per second
million gallons per year (Mgal/yr)	0.00379	cubic hectometer per year

Some data on sediment cores in meters (m) can be converted to feet by multiplying by 3.281.

Water temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the following equation:

$$°F = 1.8 (°C) + 32$$

Sea level: In this report, "*sea level*" refers to the National Geodetic Vertical Datum of 1929 (NGVD 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 and specific conductance are given in metric units. Chemical concentration is expressed in milligrams per liter (mg/L), or micrograms per liter (µg/L). Specific conductance is expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm).

GEOLOGIC FRAMEWORK, HYDROGEOLOGY, AND GROUND-WATER QUALITY OF THE POTOMAC GROUP AQUIFER SYSTEM, NORTHWESTERN CHARLES COUNTY, MARYLAND

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ABSTRACT

This report presents the results of a study conducted from 1988 to 1990 by the U.S. Geological Survey, in cooperation with the Town of Indian Head and the U.S. Navy, Naval Ordnance Station (NOS), to assess the hydrologic and hydrochemical conditions in the Potomac Group aquifer system in northwestern Charles County, Maryland.

Large-scale ground-water withdrawals began in the Indian Head area around 1900. Withdrawals are from multiscreen production wells tapping unconsolidated, fluvial, sand deposits of the Patapsco and Patuxent Formations, which collectively comprise the Lower Cretaceous Potomac Group aquifer system. Continual pumping during this century in the Indian Head area, combined with recent pumping in the area to the northeast, has resulted in a regional decline in the potentiometric surface of the confined Potomac Group aquifer system. In the vicinity of Indian Head, the pumping has changed the hydraulic gradient and reversed the direction of ground-water flow in the subcrop area of the confined aquifers under the adjacent Potomac River.

Total pumpage in the Indian Head area during the 1980's ranged from about 1.5 to 2.0 million gallons per day. During 1988-90, static water-level altitudes in observation wells ranged from about 55 to 100 feet below sea level. The prepumping heads in wells screened in the confined aquifers at Indian Head were above sea level; thus, it is likely that ground water in the aquifer subcrop area previously discharged to the Potomac River. River water in this area can range from fresh to brackish. Dissolved-solids concentration varies considerably in response to substantial changes in upstream flow conditions. In 1980, the average chloride concentration in interstitial water from twelve 1-meter-long cores of river-bottom sediment collected near Indian Head was about 500 milligrams per liter.

A downward head gradient has probably existed since about the 1920's and has resulted in river-water intrusion, or recharge to the subcrop area of the confined aquifers. The magnitude and extent of river-water intrusion into the aquifer system is controlled, in part, by the hydraulic gradient, the depth and location of the present day Potomac River channel, and relative differences in the permeability of river-bottom sediments. Significant changes in the permeability of the river bottom could result from scour associated with floods or from the

dredging of shipping channels in shoal areas. The hydraulic connection between the modern Potomac River and Potomac River paleochannel deposits, which are relatively permeable sediments deposited in valleys formed during periods of lowered sea level, tends locally to intensify river-water recharge. The magnitude and extent of river-water intrusion in the Indian Head area is greatest where the paleochannel deposits intersect the Potomac River shoreline.

Because of pumping-induced water-level declines and the proximity of the area to the tidal Potomac River, previous investigators acknowledged that intrusion of brackish river water could impair the chemical quality of the adjacent ground water. Comparison of historical ground-water-quality data with data collected in 1988 indicates that the chemical character of ground water in a zone adjacent to the Potomac River shoreline has gradually changed from a native sodium bicarbonate type with dissolved-solids concentration less than 250 milligrams per liter to a sodium chloride type with dissolved-solids concentrations greater than 500 milligrams per liter. In the zone of the aquifer most affected by river-water intrusion, concentrations of river-water indicator constituents such as chloride, dissolved solids, sodium, and total organic carbon are elevated above background concentrations. The maximum chloride concentration observed in ground water in 1988 was 210 milligrams per liter. Chloride and dissolved-solids concentrations have increased gradually in a zone of the aquifer adjacent to the river, and it has taken about 40-50 years for the comparatively higher chloride river water to reach its present extent and spatial distribution.

INTRODUCTION

Because of pumping-induced water-level declines, and proximity to the tidal Potomac River, river-water intrusion into confined-aquifer sediments hydraulically connected to the Potomac River has long been recognized as a possible threat to the ground-water quality of the Indian Head area, northwestern Charles County, Md. (Fiedler and Jacob, 1939; and Slaughter and Otton, 1968, p. 20). Fluvial sand deposits of the Lower Cretaceous Patuxent and Patapsco Formations (Potomac Group) have been tapped by all production wells in the Indian Head area.

In the early 1980's, increasing dissolved-solids and chloride concentrations were noted in water from several of the production wells in the Indian Head area (Maryland Water Resources Administration, 1984). In 1987, the U.S. Geological Survey (USGS), in cooperation with the Town of Indian Head and the U.S. Navy, Naval Ordnance Station (NOS), began an investigation to define the hydrogeology and assess changes in the chemical quality of ground water in the Potomac Group aquifer system in northwestern Charles County.

The study area covers about 165 mi^2 in Southern Maryland and Northern Virginia and is approximately centered on the Indian Head peninsula, which is about 20 mi south of Washington, D.C. (fig. 1) and is bounded by the eastern shore of the Potomac River and the western shore of Mattawoman Creek (fig. 2). Both the town of Indian Head and NOS are on the peninsula (fig. 2). The community of Potomac Heights is about 2.0 mi east of NOS. The NOS was originally known as the Naval Powder Factory, was later known as the Naval Propellant Plant, and is presently (1990) referred to as "NOS." Southern Maryland is in the Atlantic Coastal Plain Physiographic Province. The climate is humid, and temperate and mean annual precipitation at the La Plata climatological station (fig. 1) for 1951-80 was 42.6 in/yr (National Oceanic and Atmospheric Administration, 1988).

The Indian Head area has been the location of large ground-water withdrawals from the confined aquifers of the Potomac Group since about 1900

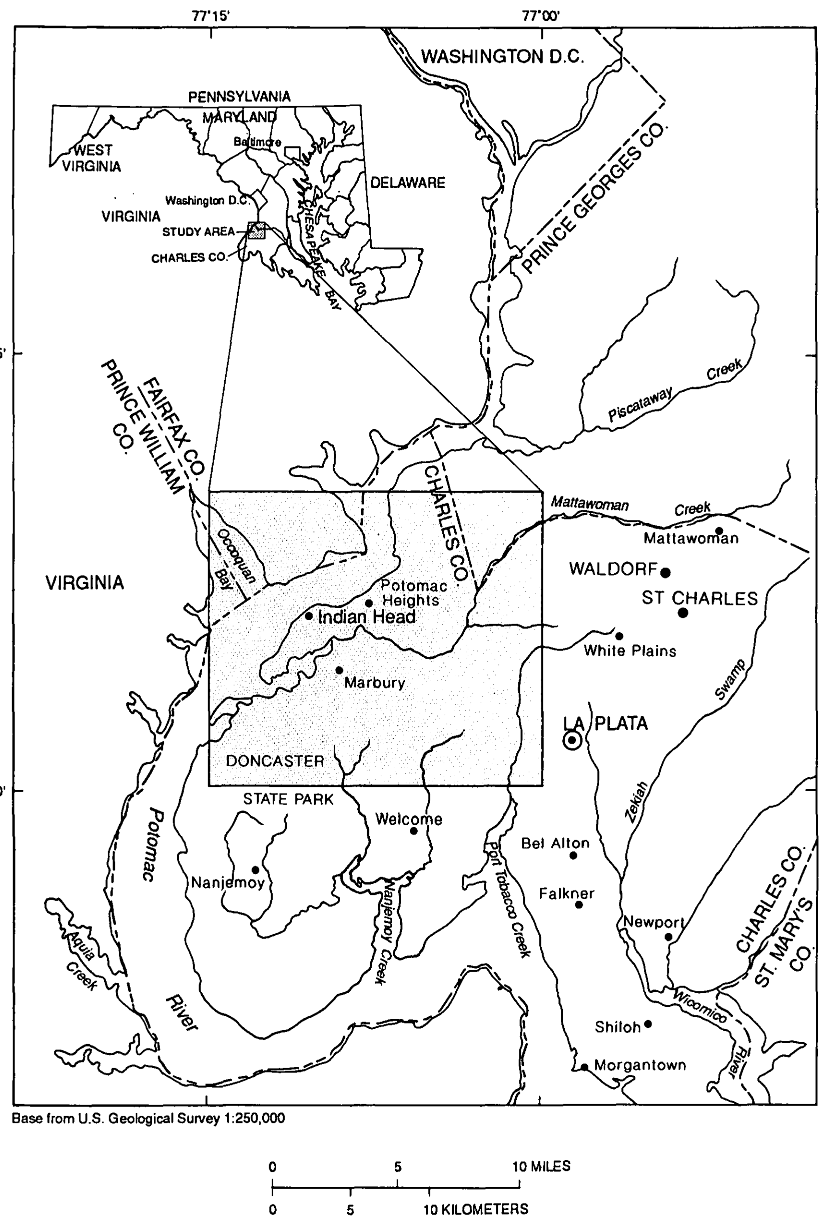


Figure 1. Location of the study area.

(Fiedler and Jacob, 1939, p. 12). Ground-water pumpage at NOS generally ranged from about 0.5 to 1.0 Mgal/d in the decades prior to World War II (1920-40). Although the magnitude of pumpage by NOS during World War II is uncertain, it could have ranged from 2.0 to as much as 3.0 Mgal/d. Pumpage at NOS averaged about 2.0 Mgal/d during the Vietnam War (1965-75).

During the 1980's, pumpage in the Indian Head area (NOS and neighboring towns) ranged from about 1.5 to 1.9 Mgal/d. Pumpage during the 1980's along the Route 210 corridor, immediately northeast of the Indian Head area (fig. 2), probably ranged from about 0.3 to 0.5 Mgal/d (Wheeler and Wilde, 1989, p. 59). The continual large scale withdrawals in the Indian Head area, combined with smaller withdrawals since about 1960, along the Route 210 corridor, has substantially reduced the head in the confined aquifers. In 1933, the static water level in observation wells at NOS ranged from 35 to about 100 ft below sea level (Fiedler and others, 1937). In 1988-90, static water levels in observation wells in the same area ranged from 55 to about 100 ft below sea level.

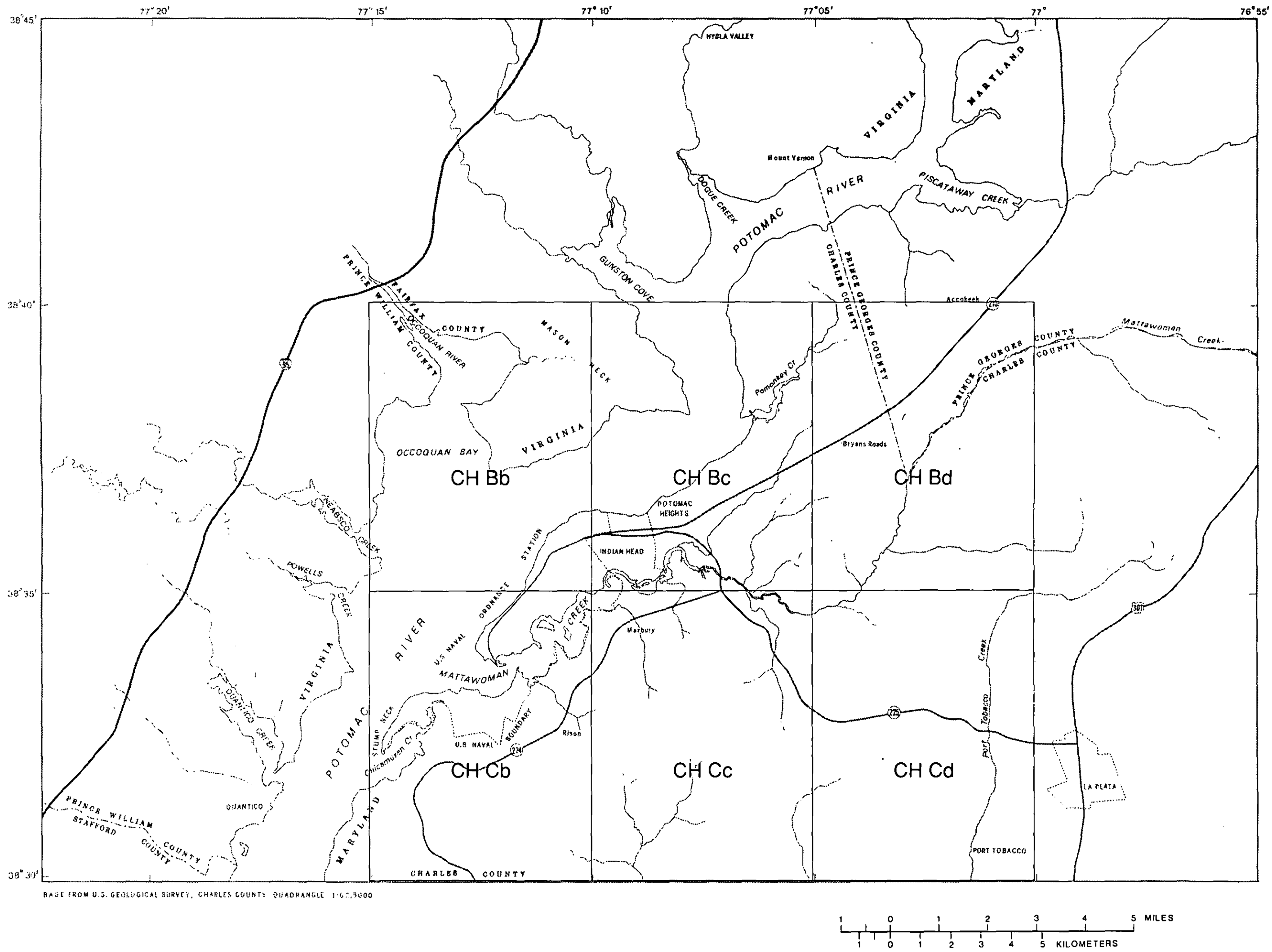


Figure 2. Location of 5-minute county quadrangles.

Purpose and Scope

This report describes the geologic framework, hydrogeology, and ground-water quality of the Potomac Group aquifer system in the Indian Head area of northwestern Charles County, Md. In addition, this report presents historical and recent hydrogeologic data, and describes changes in the water quality of the Potomac Group aquifer system at Indian Head. For the purposes of this report, the Potomac Group aquifer system in the Indian Head area is defined as a multiaquifer unit, which consists of separate confined aquifers in the Lower Cretaceous Patapsco and Patuxent Formations.

Water levels were measured in 13 observation wells during 1988-90 to assess changes in the potentiometric surface in the area. One hundred and three water samples were collected from 26 production and observation wells in the Indian Head area and analyzed to characterize inorganic ground-water quality during 1988-89. A reconnaissance marine-seismic-reflection survey was conducted in 1988 on the Potomac River and Mattawoman Creek to help evaluate the geometry of the deposits beneath these estuaries. Preliminary data from a 700-ft-long continuous core that was drilled at NOS in 1989-90 are presented.

Information on regional geology and stratigraphy, well depths and locations, and ground-water pumpage, levels, and quality was gathered from a variety of published and unpublished sources. Sources of unpublished data included well-drillers' logs and records, and files of the USGS, Maryland Geological Survey, Maryland Water Resources Administration, NOS, and the Town of Indian Head. These data were compiled and evaluated to construct regional hydrogeologic sections, potentiometric-surface maps, preliminary structure-contour maps of the Potomac Group deposits, water-level hydrographs, and plots of ground-water pumpage and water quality in the Potomac Group aquifer system.

Previous Investigations

One of the first descriptions of the ground-water resources of the unconsolidated sediments in the Maryland part of the Atlantic Coastal Plain was by Darton (1896), who used the previously proposed term "Potomac Formation" to refer to the nonmarine, basal Cretaceous deposits cropping out near the inner edge of the Atlantic Coastal Plain sequence. Clark and Bibbins (1897) renamed these deposits the Potomac Group in Maryland, which they subdivided into the Patuxent, Arundel, Patapsco, and Raritan Formations. On the basis of an analysis of pollen assemblages, the Raritan Formation was determined to be Upper Cretaceous and is no longer considered to be part of the Lower Cretaceous Potomac Group in Maryland (Brenner, 1963, p. 3).

The USGS conducted a series of hydrogeologic investigations in the Indian Head area during the 1930's. The data and interpretations were published in two USGS Open-File Reports: Fiedler, Cady, and Meinzer (1937) and Fiedler and Jacob (1939). These investigations included inventories of wells and pumpage during the early 1900's, and measurements of water-level fluctuations and well interference, water quality, and aquifer characteristics based on tests from wells at NOS.

Slaughter and Laughlin (1966) published records of wells and springs, chemical analyses, and selected well logs in Charles County. Slaughter and Otton (1968) documented ground-water conditions in Charles County and described the hydrogeology of the Indian Head area in detail. Hansen (1968) used borehole-geophysical and lithologic data to construct a series of geologic sections that provide regional correlation of the Cretaceous and Tertiary Coastal Plain deposits in southern Maryland. Glaser (1969) provided a detailed description of the sedimentary history and lithology of the Cretaceous deposits of the Maryland Coastal Plain.

Contractors for the U.S. Navy conducted two hydrologic investigations at NOS. These include a test-drilling program conducted during 1970-71 (data on file at NOS) and an inventory of potable-water supplies in the early 1980's (Shoemake and others, 1982).

From 1977 to 1981, the USGS conducted an interdisciplinary investigation of the Potomac River estuary (Callender and others, 1984), which involved studies of the processes and dynamics controlling water quality and flow in the river. Samples of the water column, river-bed sediment, flora, and fauna were collected to characterize the water quality, flow, and aquatic biology. Shallow cores and marine-surface-geophysical data also were collected for palynological and chronostratigraphic studies to interpret the hydrogeologic framework and sedimentation patterns of the Potomac River estuary. A flow through water-quality monitor was operated on the Potomac River, at the NOS, by the USGS from October 1977 to September 1981. Data collection at this site included hourly measurements of pH, water temperature, dissolved-oxygen concentration, and specific conductance. A tide gage was maintained by the USGS at this site from 1977 to 1990.

A report by the Maryland Water Resources Administration (1984) presents a comprehensive water-resources development and management plan for Charles County. This report includes a chapter titled "Saline Water Intrusion at the Town of Indian Head." The report describes the available data and implications of brackish-water intrusion from the tidal Potomac River into the aquifers of the Potomac Group. Water-level, water-quality, and ground-water-pumpage data were analyzed. The water-quality data showed a trend toward increased concentrations of total dissolved solids and chloride in the water from several supply wells in the area.

A 4-year study of the ground-water resources in the Waldorf area of north-central Charles County was completed in 1989 (Fleck and Wilson, 1990). Water-level, lithostratigraphic, and aquifer-hydraulic data were used to establish the hydrogeologic framework and to construct and calibrate a ground-water-flow model. This model was used to simulate the changes in water levels resulting from potential changes in pumpage in the Waldorf area (fig. 1).

Data-Collection Network

Field data collected during 1988-90 for this project included continuous (hourly) and periodic water-level measurements in the wells shown in figure 3. Four or five water-quality samples were collected from each of the production wells. These ground-water samples were analyzed to determine concentrations of major inorganic constituents, selected inorganic trace elements, total organic carbon, and tritium. Two water samples also were

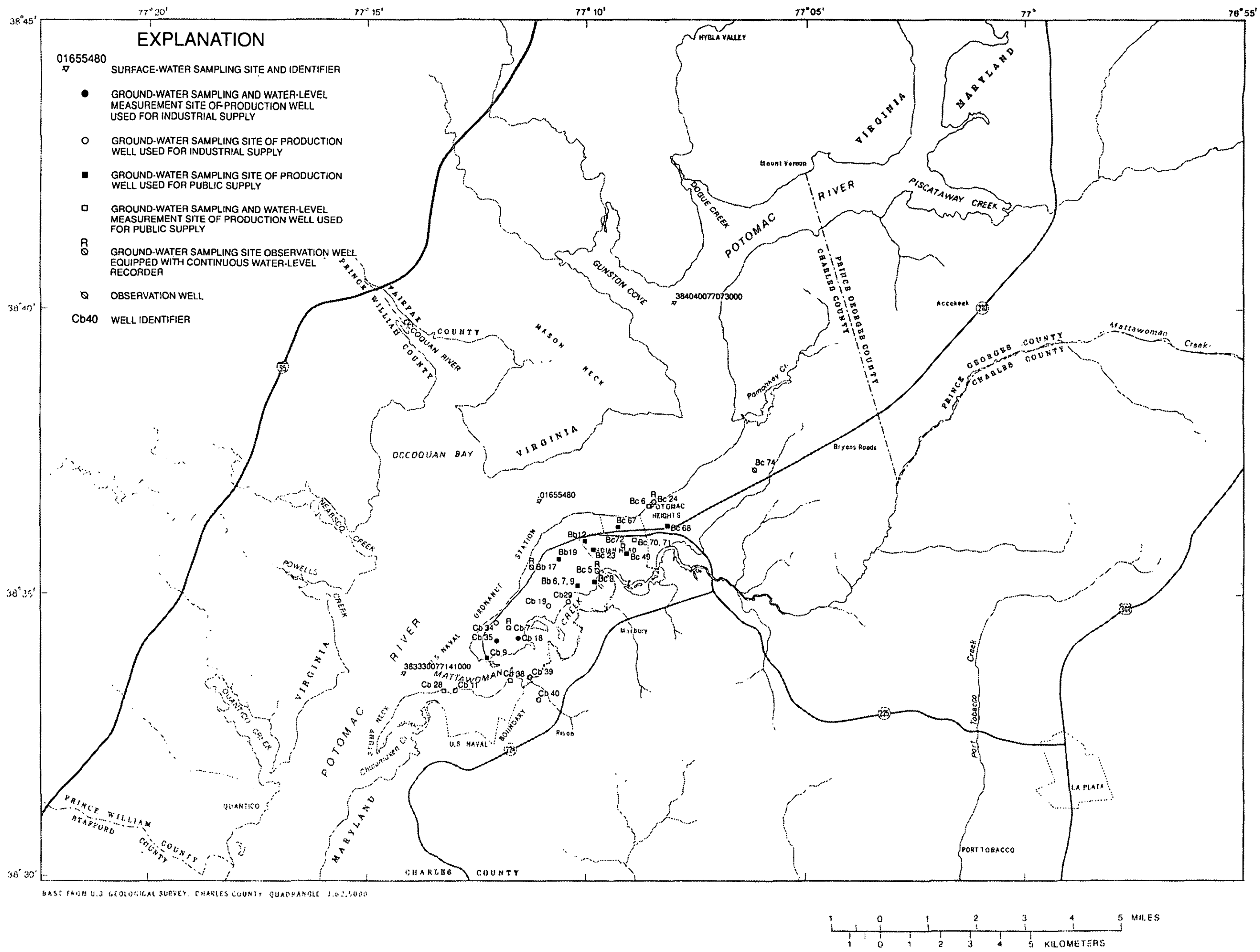


Figure 3. Location of water-quality-sampling and water-level-measurement sites.

collected at each of three locations in the Potomac River estuary (fig. 3) to characterize the quality of the river water adjacent to Indian Head.

Well-Identification System

Since about 1950, water wells in Maryland have been assigned a State permit number when a drilling permit is issued. In this report, wells and borings in Maryland are identified and located using an identification system adopted from the Maryland Geological Survey. The locations of wells in Maryland that were inventoried for this study are shown on plate 1. All wells in a quadrangle have not been inventoried and new wells are not included in the identification system until they are inventoried. In this report, the wells and test borings in Virginia have been assigned arbitrary identifiers on maps and tables.

This system used in Maryland consists of two pairs of letters followed by a number (for example, CH Bc 72). The first pair of letters is the county prefix (CH for Charles County), which, for expediency, is omitted in most tables in this report. The second two letters designate one of the 5-minute quadrangles of latitude and longitude into which the county has been subdivided (fig. 2). Each quadrangle within a county is designated from north to south by the first letter and from west to east by the second letter. The wells that have been inventoried in each quadrangle are sequentially numbered as they are inventoried; thus, CH Bc 72 is the 72d well inventoried in the Bc 5-minute quadrangle in Charles County.

Acknowledgments

The author wishes to thank the Public Works and Utilities Division personnel of the Town of Indian Head and the Naval Ordnance Station for providing access to the historical information in their files and for assisting in the collection of water-quality samples from their production wells. Gratitude is also expressed to the many well drillers who provided well-construction and borehole-geophysical data from their files. The author thanks John M. Wilson of the Maryland Geological Survey, for contributing suggestions in a review of an earlier draft of this manuscript.

GEOLOGIC FRAMEWORK

The Indian Head peninsula lies about 8 to 10 mi downdip of the Fall Line (fig. 4), which approximately marks the western extent of the Atlantic Coastal Plain deposits. West of the Fall Line, the crystalline rocks of the Piedmont are exposed. The Atlantic Coastal Plain deposits form a wedge of continental and marine sediments that thickens from a few feet at the Fall Line to more than 7,000 ft at the Maryland coastline of the Atlantic Ocean (Hansen and Edwards, 1986, p. 11).

Stratigraphy

The generalized stratigraphic and hydrogeologic framework of the Indian Head area is shown in figure 5. The total thickness of the Coastal Plain deposits at Indian Head ranges from about 650 to 750 ft. These deposits rest unconformably on an eroded, subsiding crystalline basement-rock surface (Obermeier, 1984). Table 1 shows the stratigraphic relations and generalized hydrologic character of the geologic deposits in the Indian Head area. Most of the Coastal Plain deposits in this area consist primarily of interbedded layers of unconsolidated clastic sediments (Potomac Group), which were deposited during the Early Cretaceous Epoch. The depositional environment in the Maryland Coastal Plain during Early Cretaceous time was primarily fluvial, in riverine or deltaic settings (Glaser, 1969, p. 71). In the Indian Head area, the Potomac Group consists of alternating and interbedded layers of clay, silt, sand, and gravel, which thicken and dip gently to the southeast.

The Tertiary deposits in the Indian Head area consist of unconsolidated marine sediments that rest unconformably on the eroded surface of the Potomac Group deposits (Hansen, 1978, p. 17). The Tertiary deposits are relatively thin (20-40 ft) and pinch out or are absent on the Indian Head peninsula. Tertiary deposits are absent in the lowlands at Indian Head, where the Potomac Group deposits also were deeply eroded, and the Potomac Group is unconformably overlain by a complex of late Miocene to Pleistocene fluvial and estuarine sediments (paleochannel deposits) that subsequently filled the eroded channels and valleys (fig. 5).

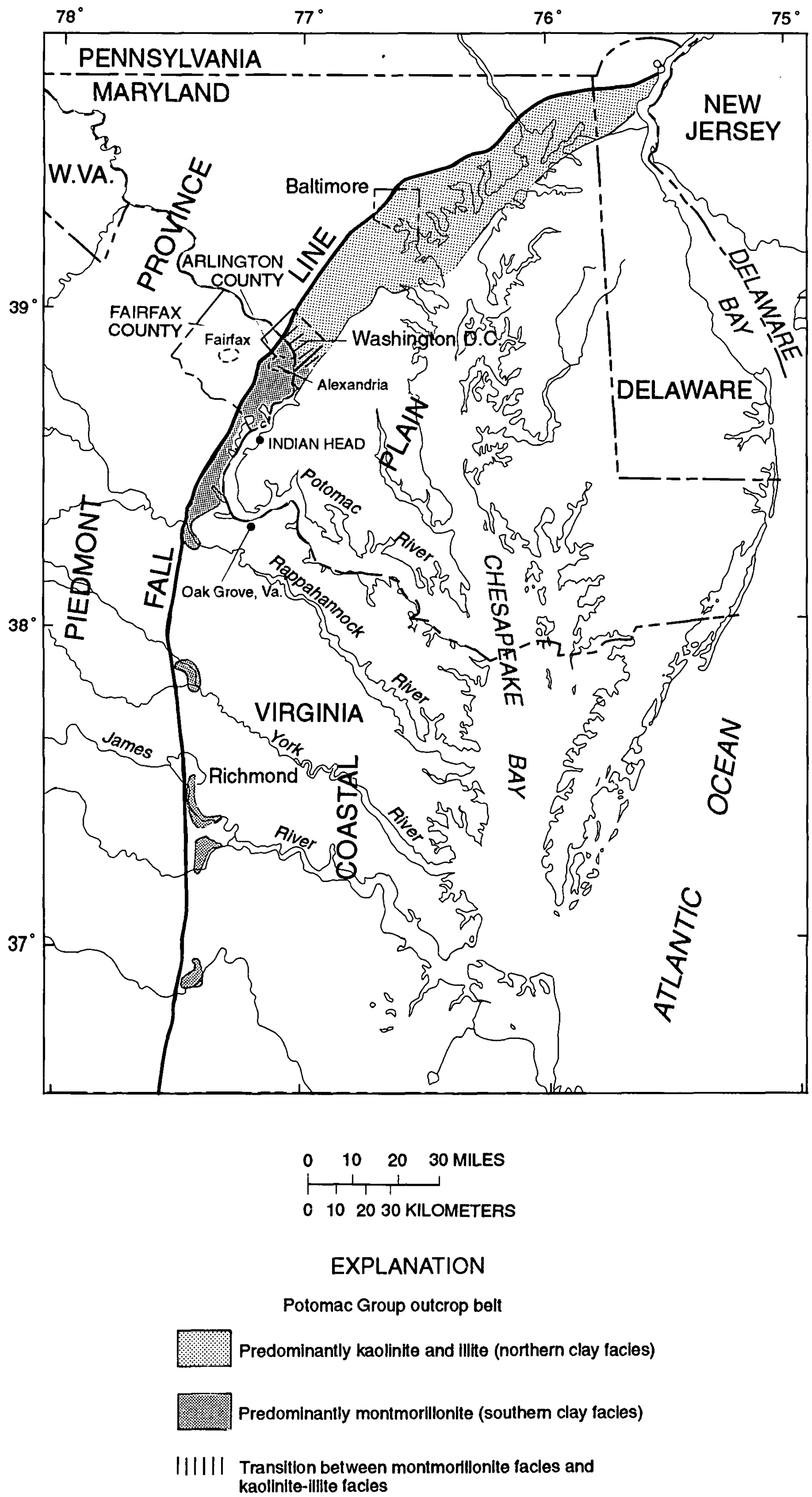


Figure 4. Potomac Group outcrop belt and physiographic provinces in the Middle Atlantic States (From Force and Moncure, 1978).

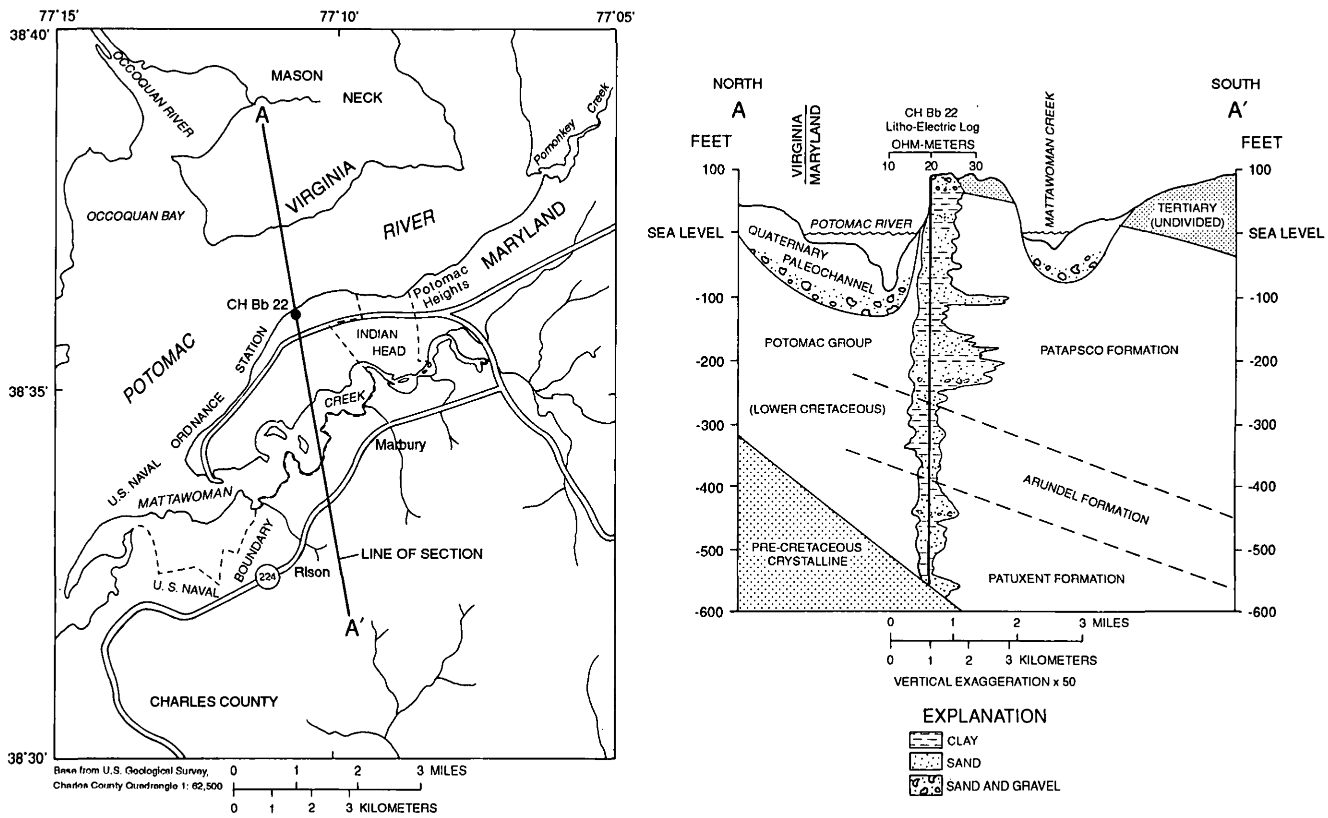


Figure 5. Generalized stratigraphic and hydrogeologic framework in the Indian Head area.

The location of the hydrogeologic sections and the identifiers and locations of wells and auger holes used for geologic control are shown on plate 2. Table 3 (at end of report) lists additional information on wells in Charles County that were used to construct the sections, and table 4 (at end of report) lists additional information on wells and auger holes in Virginia that were used for control.

The hydrogeologic sections (pls. 3 and 4) show the general configuration and stratigraphic relations of the geologic deposits in the vicinity of the Potomac River and Indian Head. The wedge of Coastal Plain sediments thickens southeastward from the outcrop at the Fall Line (fig. 4). The individual Potomac Group formations increase in thickness to the southeast; however, much of the increase is from clay units, which thicken downdip.

Pre-Cretaceous Basement Complex

The Potomac Group deposits in the Indian Head area lie unconformably over pre-Cretaceous gneiss, schist, and gabbroic rocks, which in this report are collectively referred to as the "basement complex." To the west, in the Piedmont of Virginia, this rock complex crops out at the land surface. To the east, in Charles and St. Marys Counties, Md., several test holes have been drilled into Triassic (?) or Jurassic (?) rocks beneath the Potomac Group deposits. Presence of these rocks indicates that in some areas, buried Mesozoic rift basins underlie the Cretaceous deposits of the Maryland Coastal Plain (Hansen and Edwards, 1986, p. 12).

The approximate altitude and configuration of the top of the pre-Cretaceous basement complex in the Indian Head area is shown in figure 6. On a regional scale, the basement-rock surface dips to the east-southeast at about 80 to 100 ft/mi. The contours were developed using a compilation of data and interpretations on basement depth and structure in the Virginia Coastal Plain, as adapted from Seiders and Mixon (1981) and Mixon and others (1972). Lithologic data from deep holes in northwestern Charles County, Md., were adapted

Table 1. - Stratigraphic relations and hydrologic character of geologic deposits in the Indian Head area of Charles County, Maryland.

System	Series	Group	Formation	Range of Thickness (feet)	Hydrologic Character	Map Symbol on fig. 7
Quaternary and Tertiary	Holocene to Miocene		Alluvium and terrace deposits	30-100	Water table to semi-confined aquifer	Q
			Unconformity			
Tertiary	Paleocene	Pamunkey	Aquia	20-40	Confining Unit	Ta
			Unconformity			
Cretaceous	Lower Cretaceous	Potomac	Patapsco — Upper	250-300	Confining unit Aquifer Confining unit	Kp
			Patapsco — Middle		Aquifer	
			Patapsco — Lower part		Confining unit Aquifer	
			Unconformity			
			Arundel	50-75	Confining unit	
			Patuxent	250-300	Aquifer Confining unit Aquifer	
			Unconformity			
Pre-Cretaceous Rock			Basement complex	Unknown	Confining unit	

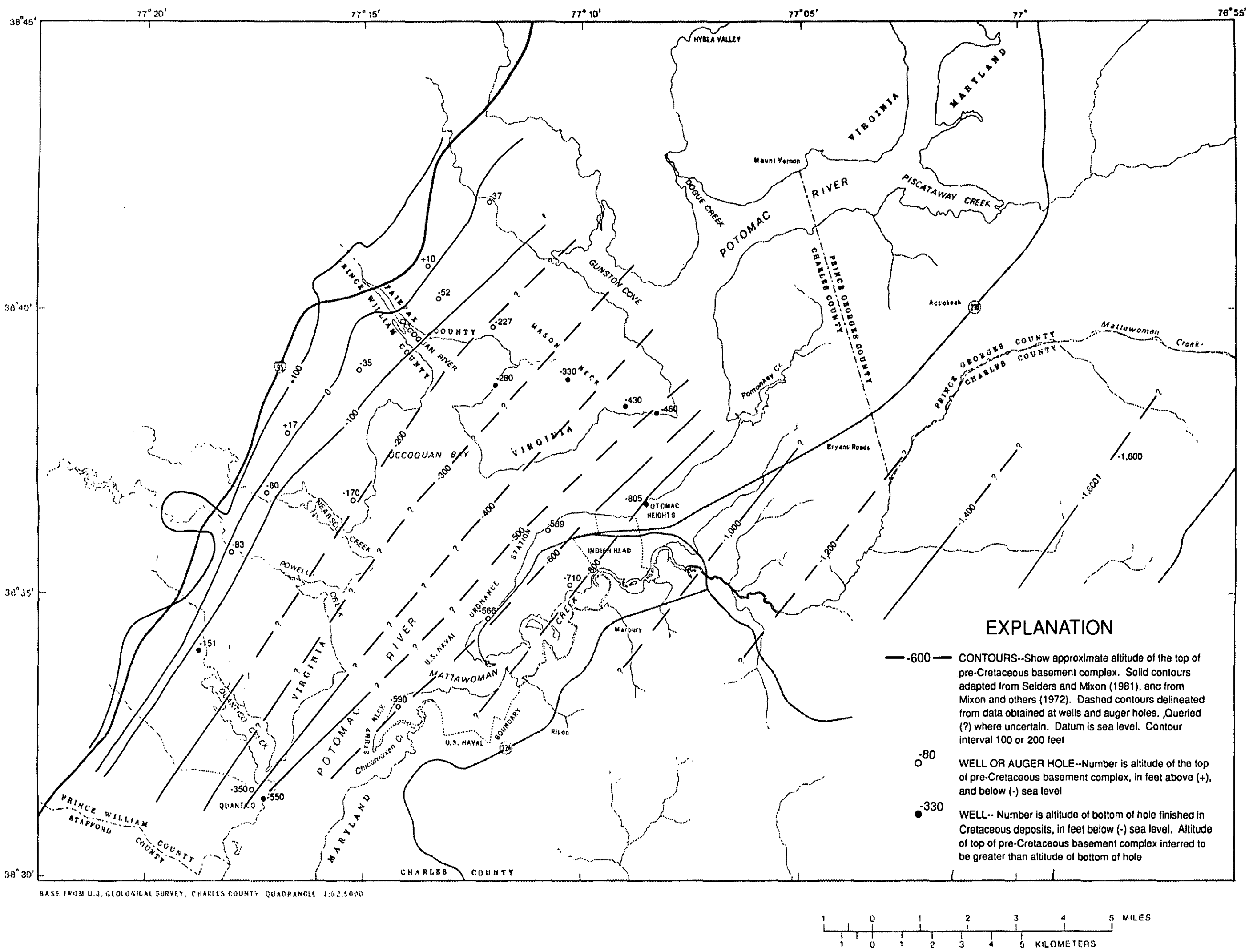


Figure 6. The approximate altitude and configuration of the top of the pre-Cretaceous basement complex.

from Wilson and Fleck (1990) and compiled from the files of the USGS, Towson, Md., office.

The surface of the basement complex underlying this region was extensively eroded before deposition of the Lower Cretaceous deposits. Mixon and others (1972) mapped the geology of the Piedmont and Coastal Plain in the Quantico quadrangle and noted a step-like steepening of the basement-rock surface near the Fall Line (pls. 3 and 4). This offset is generally aligned with the axis of the Stafford fault system. This fault consists of a series of en echelon, northeast-trending, high-angle reverse faults that parallel the Fall Line in Stafford and Prince William Counties, Va. (Seiders and Mixon, 1981). These observations indicate that tectonism could have affected the regional paleodrainage systems that distributed the Cretaceous sediments on the surface of the basement complex in this area. A northeast-striking, up-to-the-East reverse fault, which is part of the Brandywine fault system, trends through the Waldorf area of northwestern Charles County. The basement complex and the Lower Cretaceous units (Patuxent, Arundel, and Patapsco Formations) are offset across the fault, which has about 250 ft of throw in the Waldorf area (Wilson and Fleck, 1990, p. 12 and 13).

Cretaceous Potomac Group Deposits

The Potomac Group is the oldest sedimentary deposit cropping out in the inner belt of the Atlantic Coastal Plain. Potomac Group deposits rest unconformably on the eastern, seaward-sloping margin of the ancestral Piedmont and Appalachian Mountain ranges. The Potomac Group is the product of fluviodeltaic sedimentation during the Early to Late Cretaceous Epochs (Glaser, 1969, p. 74).

In outcrop in the Maryland type area, the Potomac Group is divided into three formations (Brenner, 1963, p. 1): the basal Patuxent Formation, which is conformably overlain by the Arundel Formation, which is unconformably overlain by the Patapsco Formation (table 1). In the Potomac River lowlands of the Virginia Coastal Plain, deposits of the upper part of the Potomac Group have traditionally been divided into a clay facies and a sand facies because the Arundel Formation lacks sufficient surface exposure and is difficult to map and correlate. At Oak Grove, Va. about 30 mi south of Indian Head (fig.4), Reinhardt and others (1980) divided the Cretaceous deposits into a lower (zone I) and an upper (zone II) Potomac Formation on the basis of the stratigraphic palynological studies by Brenner (1963) in the Coastal Plain of Maryland. Brenner's zone I included the Patuxent and Arundel Formations, and his zone II, which was divided into three subzones, comprised the Patapsco Formation.

Overall, on the basis of continuous cores retrieved from well CH Bb 22 at Indian Head (fig. 5), the coarsest deposits of the Potomac Group, representing the depositional environment of highest energy, are in the basal Patuxent Formation. During Early Cretaceous time, terrigenous sediments were shed from an uplifted Piedmont-Blue Ridge Province and distributed seaward by rivers (Glaser, 1969, p. 60). Sea-level rises shifted the location of the nearshore and deltaic deposition landward, whereas periods of falling sea levels shifted the location of fluvial and deltaic deposition seaward. Migration and lateral shifting of paleodrainage systems resulted in facies changes within contemporaneous depositional units. Thus, major changes in the lithology of the Potomac Group deposits at Indian Head reflect major changes in depositional environments and sediment loads.

Slaughter and Otton (1968), in an earlier report about the hydrogeology of Charles County, Md., used the name "Patapsco-Raritan" to designate the lithologic interval in the Potomac Group above the Arundel Formation. In this report, the same lithologic interval in the Indian Head area is called the "Patapsco Formation." Although determination of the presence or absence of Upper Cretaceous deposits in this area was beyond the scope of this study, all available geologic maps indicate that Upper Cretaceous deposits are absent along the Potomac River in northwestern Charles County and adjacent areas in Virginia.

The generalized geology of the surficial deposits in the Indian Head area is shown in figure 7 as adapted and generalized from Seiders and Mixon (1981), Mixon and others (1972), Froelich and others (1978), Glaser (1978), and McCartan (1989). In Fairfax and Prince William Counties, Va., the Potomac Group crops out in a 4- to 6-mile-wide belt between the Potomac River and the Fall Line. In northwestern Charles County, the few surface exposures of the Potomac Group are primarily in the bluffs overlying the Maryland shore of the Potomac River (fig 7).

Patuxent and Arundel Formations

The basal part of the Potomac Group in Maryland has been divided into the Patuxent and Arundel Formations. According to Glaser (1969), in the type area, the Patuxent Formation is composed primarily of medium-grained to coarse-grained sand or pebbly sand and gravel interbedded with relatively thin, pale-gray clays. The Arundel Formation is predominantly a tough, dark-gray to maroon, massive clay containing abundant lignite and sideritic concretions. In the Indian Head area, the clays of the Arundel Formation are useful as a lithologic marker that separates the Patuxent from the Patapsco Formations. The clay is very dense and generally requires more time to penetrate with a hydraulic rotary drill rig than do overlying and underlying strata.

Although the sediment source for the Patuxent and Arundel Formations was continental in origin, the Patuxent sediments were generally deposited in high-energy fluvial and deltaic environments. According to Glaser (1969, p. 71), in the type area, the general lack of silt and clay throughout the lower part of the Patuxent Formation attests to the predominance of bedload deposition. In the Indian Head area, thick fine-grained layers generally

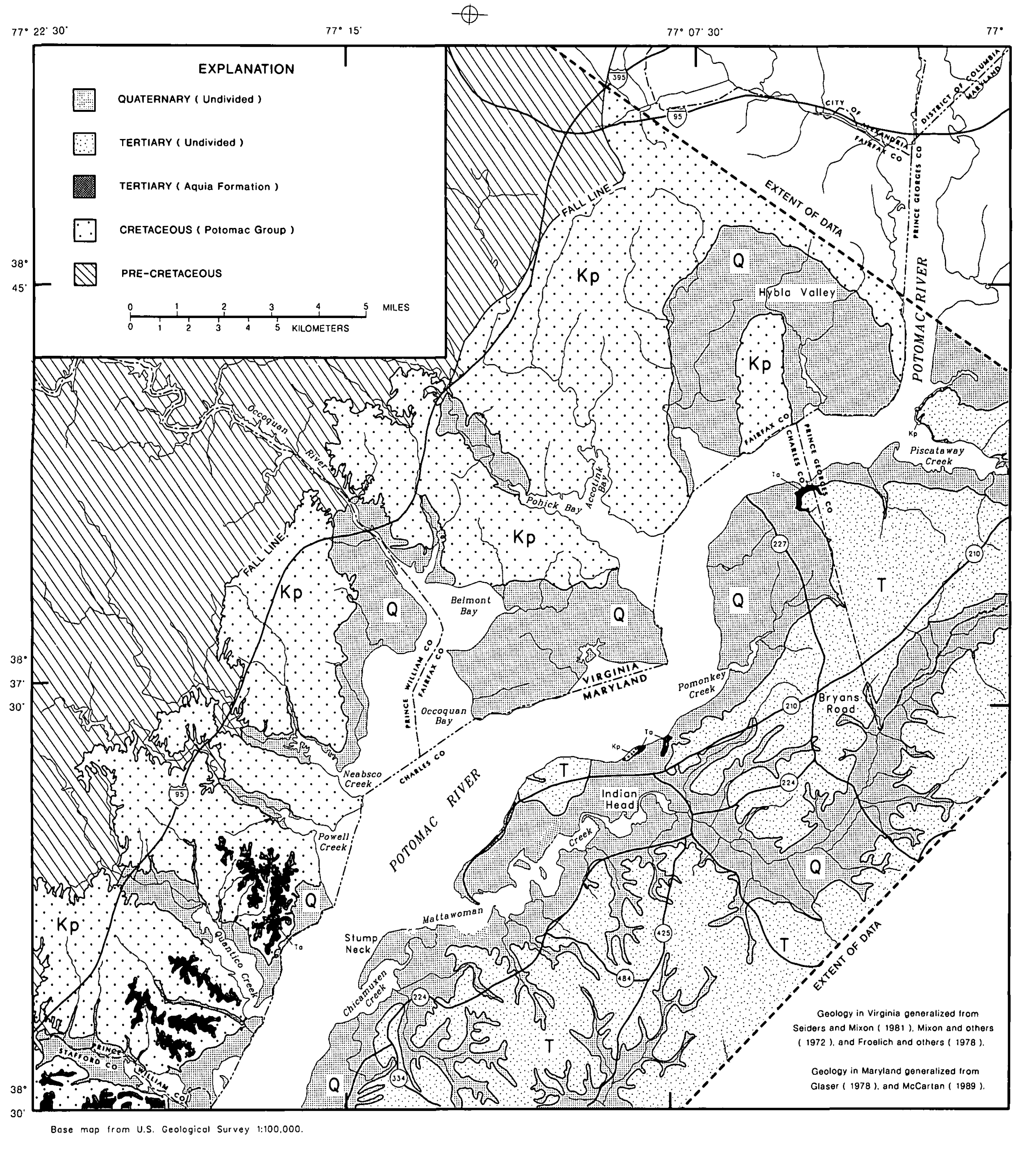


Figure 7. Surficial geology in the Indian Head area.

separate the major sand layers in the Patuxent Formation (pls. 3 and 4).

The Arundel Formation was probably deposited in a quiet, shallow, freshwater environment (Glaser, 1969, p. 72). Deposits of the Arundel Formation record a period of low-energy fluvial deposition. Glaser (1969, p. 72) stated that "The association of massive lignitic clays, logs and rooted stumps, terrestrial reptile bones, and the complete absence of marine fossils, points to deposition in shallow, probably discontinuous, backswamp basins maintained by ponded drainage and slow sediment influx."

The approximate altitude and configuration of the top of the Patuxent-Arundel Formations (undivided) in the Indian Head area is shown in figure 8. The regional dip of the Patuxent-Arundel Formations is to the east-southeast and ranges from about 80 to 100 ft/mi.

Patapsco Formation

The Patapsco Formation rests unconformably on the undivided Patuxent-Arundel Formations (Brenner, 1963, p. 38). In the Indian Head area, the Patapsco Formation consists of layers of fine to medium-grained sand and silt, separated by thick clay layers (pls. 3 and 4). The lithologic character

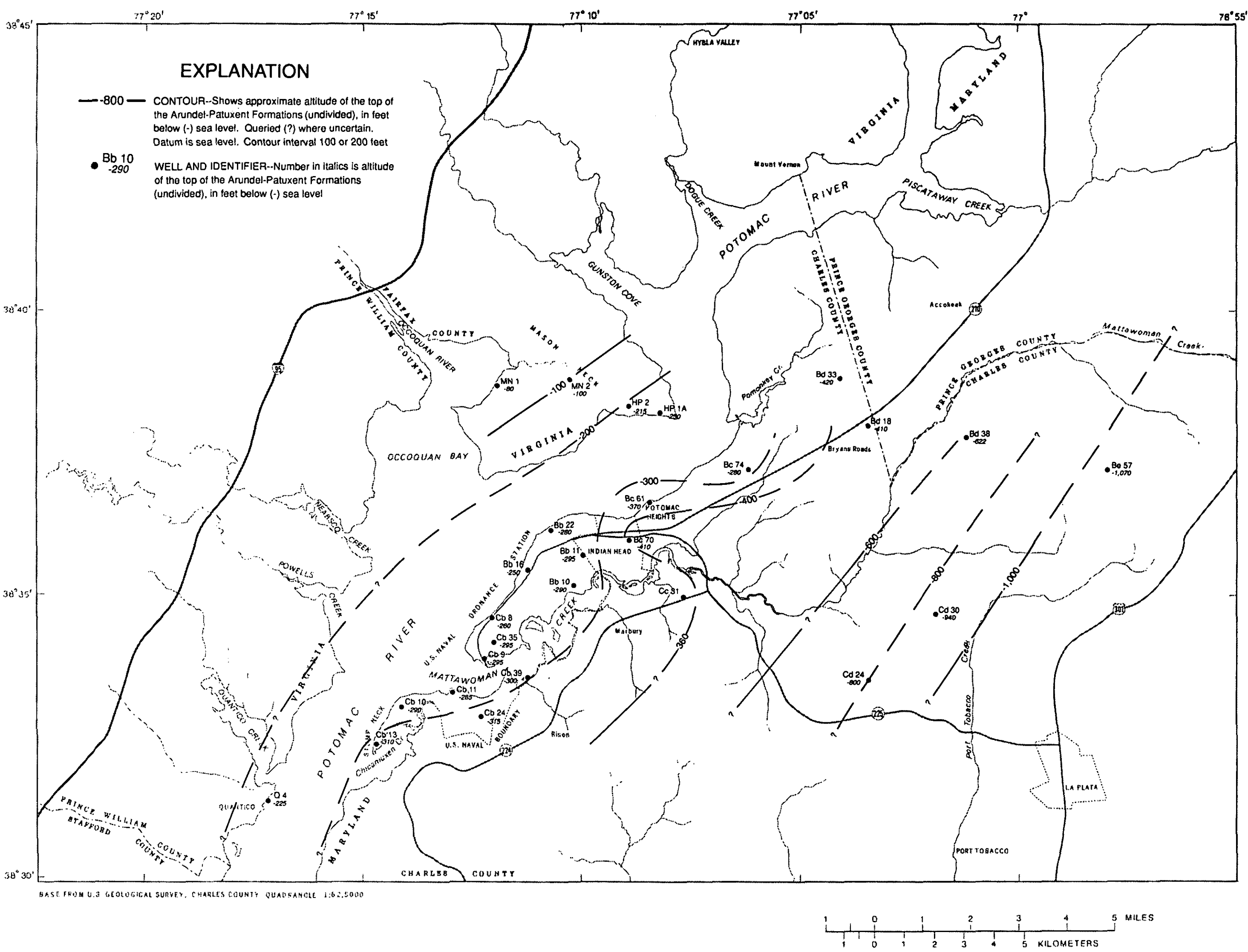


Figure 8. Top of the Arundel-Patuxent Formations (undivided).

of the sediments in the type area indicates deposition on a low deltaic plain by sluggish, low-gradient, perhaps meandering rivers (Glaser, 1969, p. 73). On the basis of continuous core samples from well CH Bb 22 (fig. 5) at Indian Head, the Patapsco Formation sand layers are generally finer-grained than the Patuxent Formation sand units. In addition, beds of lignitic plant remains are common in some of the Patapsco Formation deposits at Indian Head, and some of the upper sand layers are well cemented.

The deposits of the Patapsco Formation at Indian Head commonly grade upward from coarse-grained to fine-grained clasts. The basal part of these sequences typically consist of coarse-grained sand and interbedded gravel-pebble zones that represent the depositional environment of highest energy in the sequence. The coarse deposits grade upward to medium- or fine-grained sand and are overlain by finer sand and silt. These grade upward to silty, hard gray clay containing lignite and carbonaceous plant remains. Several repetitions of this coarse-to-fine upward-grading sedimentary sequences were observed in the continuous core from well CH Bb 22. The borehole-geophysical logs from well CH Bb 22 are shown in figure 9, and a condensed lithologic description of the core is given in table 5 (at the end of report). The coarse-to-fine sequences are also reflected in several of the electric borehole-geophysical logs shown in figure 9 and plates 3 and 4.

The approximate altitude and configuration of the top of the Patapsco Formation in the study area is shown in figure 10. This surface has been eroded, and in the lowland areas along the Potomac River near Indian Head, it is unconformably overlain by late Miocene to Quaternary fluvial and estuarine deposits. On the isolated upland of the Indian Head peninsula and throughout the inter-stream uplands to the east, the Patapsco Formation is unconformably overlain by the Tertiary Aquia Formation (David Powars, U.S. Geological Survey, written commun., 1989).

Tertiary and Quaternary Deposits

The principal focus of this report is the hydrogeologic conditions in the Potomac Group aquifer system. A brief discussion of the overlying Tertiary and Quaternary deposits is relevant because these deposits have modified the hydrogeologic framework and thus can influence recharge and ground-water flow in the underlying confined aquifers of the Potomac Group.

The Tertiary deposits are marine sedimentary units that unconformably overlie the eroded surface of the Potomac Group in the Indian Head area (table 1). Most of the upper Tertiary units have been eroded away except on the isolated upland at Indian Head, where the Tertiary Aquia Formation forms a veneer (20-30 ft thick) that overlies the eroded surface of the Patapsco Formation. On a regional scale, the Tertiary units generally thicken and dip to the east (pls. 3 and 4). The western extent of the upper Tertiary units, which are stratigraphically above the Aquia Formation, is several miles east of the Indian Head area (fig. 7). Hansen (1978, p. 10) attributes the regional pinch-out of Upper Cretaceous and Paleocene deposits in this area of the Coastal Plain to tectonic activity and antecedent basement-rock structure.

Deposits of the Aquia Formation are present in the study area on the top of the bluffs along the Maryland shore of the Potomac River and on several isolated hilltops in northeastern Prince William County, Va. (fig. 7). The Aquia Formation ranges from olive-black to olive-gray micaceous, glauconitic, fine- to coarse-grained quartz sand with a few beds of olive-gray silty clay and very fine silty sand (McCartan, 1989). These sediments are marine in origin and were deposited in middle- to shallow-shelf environments.

In the Indian Head area and throughout north-western Charles County, the Tertiary Formations of the interstream uplands are unconformably over-lain by a fluvial-sedimentary unit, which is com-posed of gravel, sand, and loam. Following Clark's usage, Hack (1955, p. 10) called these deposits the Brandywine Formation and estimated that they ranged in age from Miocene to Pliocene. On a regional scale, Bennett and Meyer (1952, p. 68) referred to these surficial sediments as the "upland deposits" of southern Maryland. Otton (1955, p. 103) points out that, when saturated to a sufficient thickness, these deposits are capable of yielding large quantities of water to hand-dug wells and that they constituted an important source of

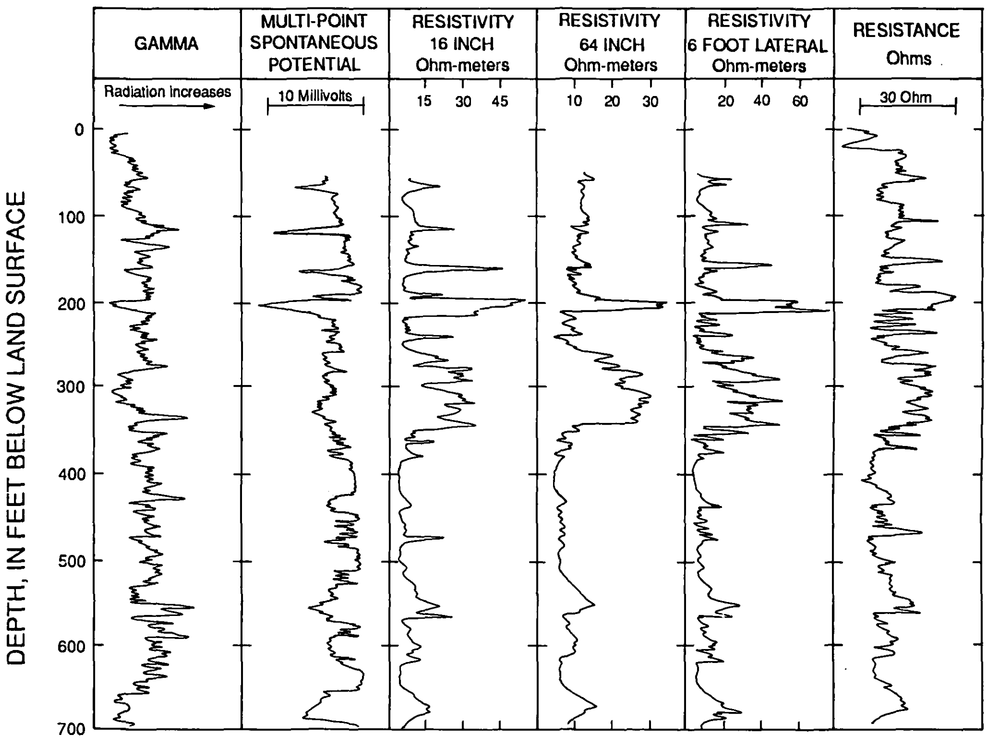


Figure 9. Borehole-geophysical logs of well CH Bb 22.

ground-water supply in rural southern Maryland. Mixon and Seiders (1981) mapped the location of these "upland deposits" in the Quantico and Occoquan quadrangles and proposed an age ranging from late Tertiary to early Quaternary. McCartan (1989) subdivided the Tertiary "upland deposits" in Charles County into the Upland Gravel 4, Upland Gravel 3, and the Park Hall Formation, which range in age from early to late Pliocene.

For this report, the surface outcrop area of the Tertiary and Quaternary units (fig. 7) was modified and generalized from the original maps. Except for the Paleocene Aquia Formation designated "Ta" on figure 7, all of the later Tertiary units have been grouped together and mapped as a single unit designated "T" on figure 7. Where distinguishable, the individual Tertiary units at sites used for geologic control are shown on plates 2 and 3. The single Quaternary unit designated "Q" on figure 7 represents individual Quaternary units grouped as a single map unit. McCartan (1989) subdivided the Quaternary sediments in Charles County into five map units that range in age from Lower Pleistocene to Holocene. Seiders and Mixon (1981) mapped Holocene terrace deposits (Qal), Wisconsinan and pre-Sangamon Pleistocene terraces (Qp1 and Qp2), and Miocene to Pleistocene terraces (QTs) in the lowlands along the Virginia side of the Potomac River. Detailed geologic mapping of these geologic units is available in the publications cited in figure 7.

Erosional History of Potomac Group Deposits

Chesapeake Bay is an estuary formed by the post-Wisconsin (Holocene) rise in sea level, which drowned the lower valley of the ancestral Susquehanna River system and its tributaries (Hack, 1957, p. 817). During the multiple glaciations of the Pleistocene, the rivers in the Chesapeake Bay region incised either new or deeper channels into unconsolidated Cretaceous and Tertiary deposits as they established new base levels with the lowered sea level. Colman and others (1990) document the presence of three

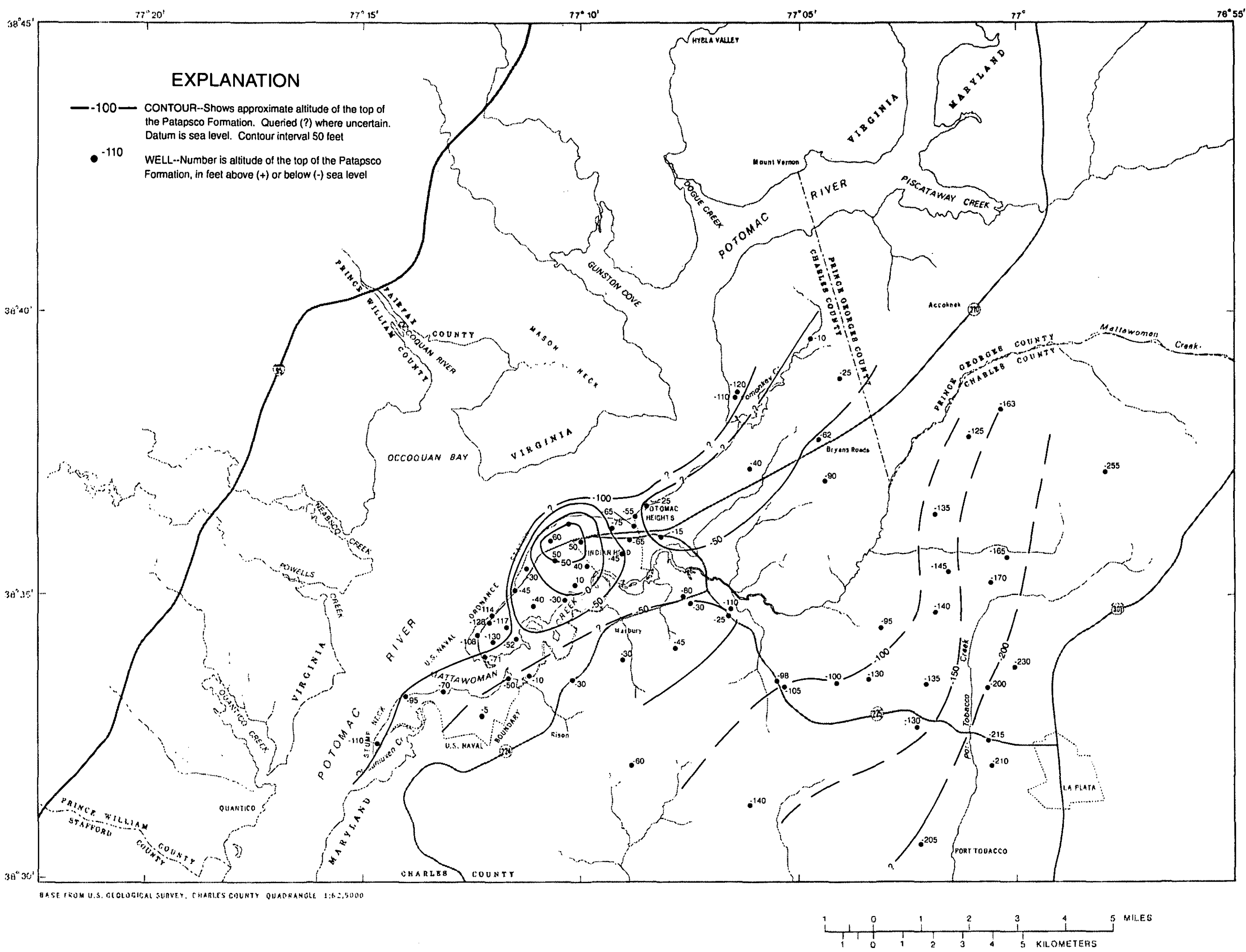


Figure 10. The approximate altitude and configuration of the top of the Patapsco Formation in the study area.

ancestral Susquehanna River channels in the deposits under the Chesapeake Bay and the Delmarva Peninsula.

Undifferentiated Quaternary deposits (fig. 7) are present in the major stream valleys and along the Potomac River lowlands. These fluvial and estuarine sediments were deposited in channels and valleys cut by the ancestral Potomac River system during the Quaternary. Several cycles of regression and transgression of the Quaternary seas occurred during the geomorphologic evolution of the Chesapeake Bay region (Kerhin and others, 1988). Because of the presence of several Pleistocene terrace deposits of differing age in Virginia (Seiders and Mixon, 1981) and in Charles County, Md. (McCartan, 1989), similar cycles of downcutting and subsequent channel filling probably occurred repeatedly along the Potomac River near the Fall Line in Maryland and Virginia.

Well logs show that in the vicinity of Indian Head, the Patapsco Formation was eroded by the ancestral Potomac River (fig. 10); however, the precise depth of erosion into the Potomac Group deposits under the modern Potomac River estuary is unknown. On the basis of an analysis of the lithology of foundation borings at the Woodrow Wilson Bridge on the Potomac River (about 20 mi upstream) near Alexandria, Va., Hack (1957) postulated a Wisconsinan age for the latest valley of the ancestral Potomac River. This valley cut downward into Tertiary and Cretaceous deposits to a depth of about 90 to 100 ft below sea level.

Knebel and others (1981) used marine surface-geophysical methods and borehole-lithologic data to establish the sedimentary depositional framework of the Potomac River estuary downstream from the Route 301 bridge at Morgantown in southern Charles County, Md. (fig. 1). They determined that the Wisconsinan valley of the Potomac River in that area has a sinuous trend, a flat bottom, relief of about 50 to 110 ft, and axial depths of about 125 to 175 ft below sea level. Chappelle and Drummond (1983, fig. 16, p. 37) showed the generalized location and approximate depth of the Wisconsinan channels of several rivers tributary to the Chesapeake Bay.

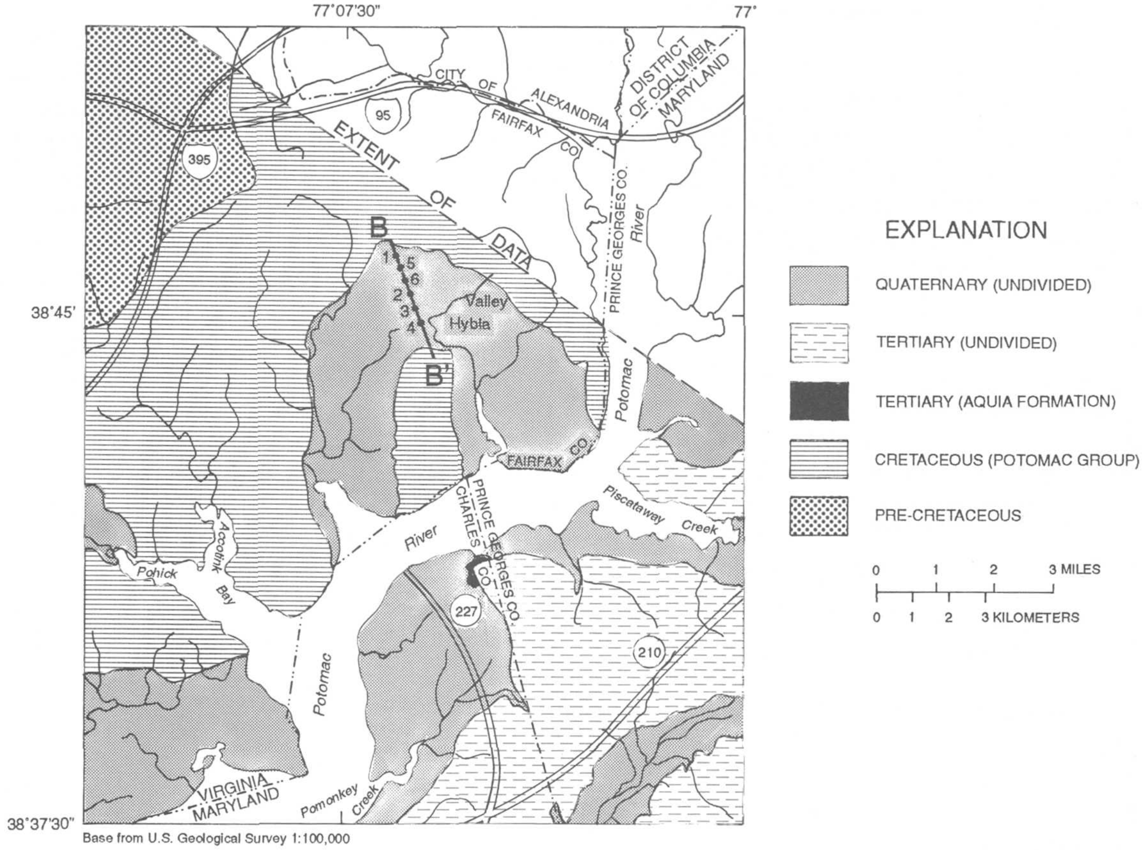
In 1978, the USGS cored several holes in Hybla Valley and on Mason Neck in eastern Fairfax County, Va., to determine the lithology and cross-sectional geometry of channel deposits of the ancestral Potomac River. The generalized land-surface altitude, depth, lithology, and geometry of deposits that fill a channel eroded into Cretaceous deposits in Hybla Valley, Va. is depicted in figure 11. This area is adjacent to the Potomac River, about 6 mi north of the Indian Head area. These paleochannel deposits range from fluvial to estuarine in origin and were deposited by an aggrading river system during a period of rising sea level (Froelich and others, 1978, p. 3).

The coring revealed an asymmetric valley floor and relatively thick, fluvial sand and gravel deposits at the base of the channel fill. The basal part of the paleochannel unconformably overlies deposits of the Potomac Group (undifferentiated). The coarse basal deposits are overlain by sequences of sand, silt, clay, and organic-rich sediments that grade upward from coarse to fine-grained. These sedimentary sequences represent the transition from point-bar to levee to overbank deposits (Froelich and others, 1978, p. 3). The basal paleochannel deposits consist of coarse-grained sand and gravel that is more permeable than the Cretaceous deposits that have been replaced; thus, throughout the Potomac River lowlands, similar paleochannel deposits could be hydraulically connected to the Potomac River.

Froelich and others (1978) concluded that the base of the paleochannel in central Hybla Valley ranges from at least 18 to more than 85 ft below modern sea level. They delineated areas along the Virginia Shore that were underlain by paleochannel deposits contiguous with the Potomac River as potentially favorable locations for wells designed to induce river-water recharge. They also inferred that other similar deposits of the ancestral Potomac River (designated "Q" in figure 7) are present on the Maryland shore of the Potomac, but noted that most of these deposits underlie the modern Potomac River (fig. 5) or its tributaries (Froelich and others, 1978, p. 1).

The topography and bathymetry of the Indian Head 7 1/2 minute quadrangle and the approximate extent of Potomac River paleochannel deposits in this area are shown in figure 12. The approximate margin of these deposits is outlined on either side by a slightly eroded, upland scarp that is approximately marked by the 50-ft topographic contour. The surficial deposits in this area are shown in figure 7 as undifferentiated Quaternary sediments, which includes all paleochannel and terrace deposits along the Potomac River lowlands. McCartan (1989) differentiates these deposits into five units that range in age from Lower Pleistocene to Holocene.

The upper surface of the paleochannel deposit that trends north-south through the town of Indian Head, forms a trough or wide, flat lowland that ranges from a maximum altitude of 30 to 40 ft above sea level, to a minimum of about 10 to 15 ft below sea level, where eroded by Mattawoman Creek (fig. 12). The altitude of the upper surface of the paleochannel deposit in Hybla Valley ranges from 30 to 40 ft above sea level (fig. 11). These two paleochannels could be contemporaneous with the Pleistocene terrace unit (Qp2) mapped by Mixon and Seiders (1981) in theVirginia Coastal Plain. The lower surface of this deposit is an erosional unconformity on the Patapsco Formation that is at least 75 ft below sea level at Indian Head (fig. 10 and pl. 4). On the southwest end of the peninsula, the base of an associated paleochannel deposit is about 125 ft below sea level (fig. 10).



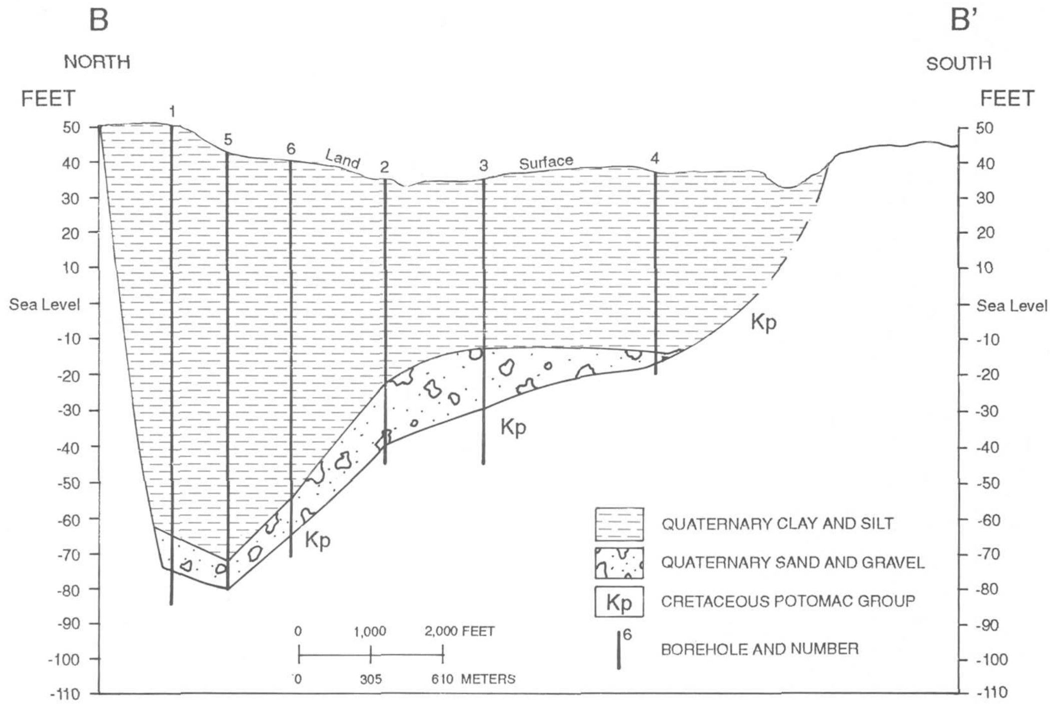


Figure 11. Generalized geologic map and section of Hybla Valley, Va.

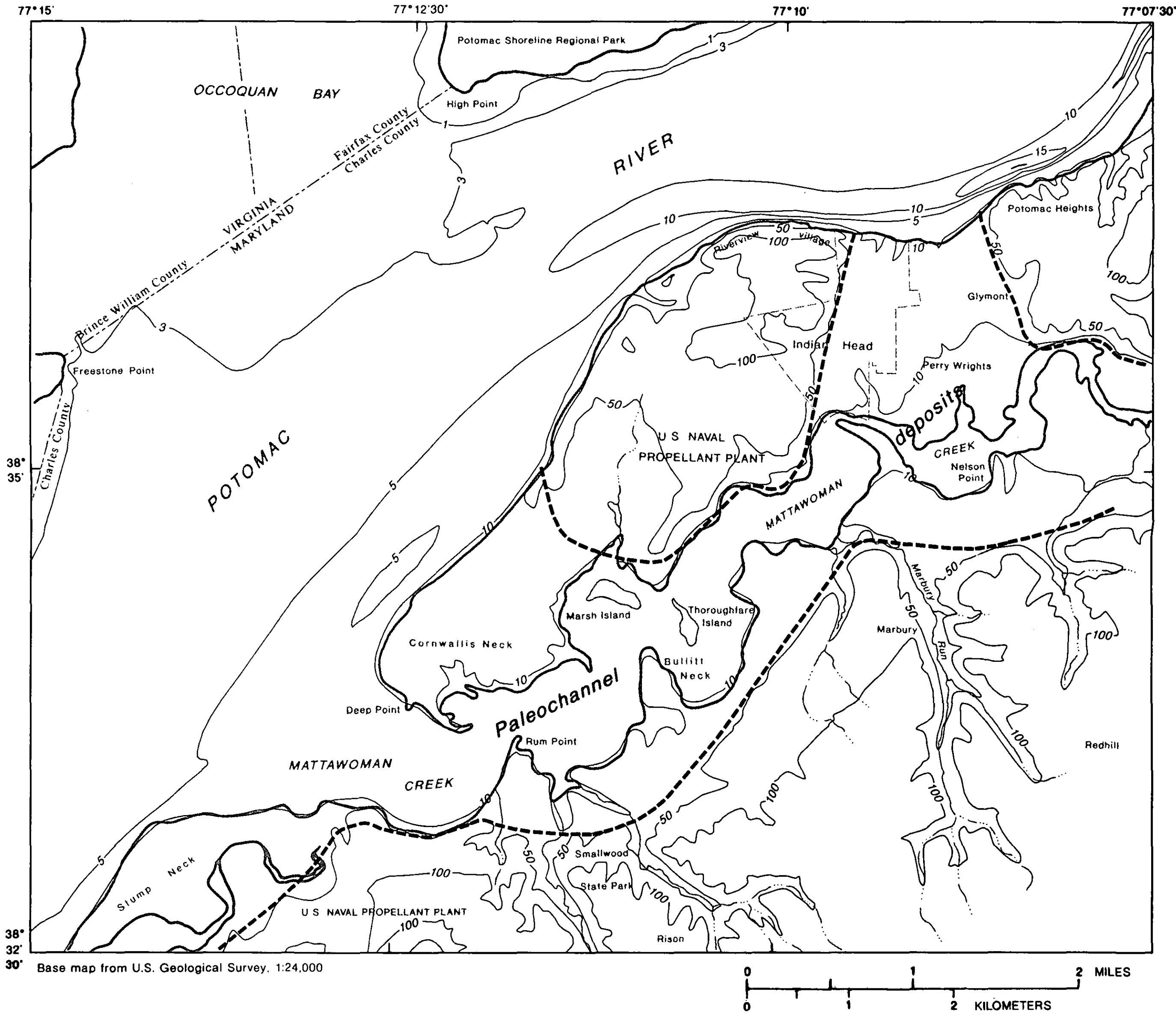


Figure 12. Approximate margins of Potomac River paleochannel deposits in the Indian Head area. (Topographic contours variable in feet; Bathymetric contours 5 meter interval.)

Bathymetric data for the modern Potomac River (fig. 12) indicate that geomorphologically, the river has a sinuous, deep channel with a wide, shallow shelf opposite bends in the river. The thalweg (path of the channel) of the modern Potomac River north of Indian Head probably represents a vestige of the drowned, late Wisconsinan Potomac River channel. Near Potomac Heights and Riverview Village (fig. 12), the thalweg is adjacent to the Maryland shore and ranges in depth from 65 to about 100 ft.

The approximate altitude and configuration of the top of the Patapsco Formation in the Indian Head area, was determined using well logs (fig. 10). At least two different Quaternary channels have been eroded to different depths in the Patapsco Formation at Indian Head. Furthermore, the Wisconsinan Potomac River could have incised a channel as deep as 125 or more feet below sea level (fig. 5). In Occoquan Bay (fig. 12), this deep channel is buried by Holocene deposits, which form a shoal at this location in the Potomac River estuary. These Holocene deposits could be 100 or more feet thick. Thus, repeated downcutting by the ancestral Potomac River has probably removed or eroded upper geologic units in the Potomac Group.

Since the Holocene transgression, which submerged and buried the Wisconsinan channel with fluvial and estuarine sediments, the Potomac River estuary in the Indian Head area has become the site of deposition for an organic-rich gray to black clay or silty clay that blankets most of the earlier deposits (Callendar and others, 1984). River-bottom sediment deposited since the European settlement of the Potomac River basin reflects major increases in soil erosion and sedimentation rates. Much of the river bottom in the Indian Head area is covered by modern estuarine mud and clay layers that can range from about 3 m to more than 8 m in thickness (Jerry Glenn, U.S. Geological Survey, written commun., 1990).

In 1988, a reconnaissance, marine-seismic-reflection survey was conducted in the Potomac River and its tributaries near Indian Head. The intent of this reconnaissance survey was to try to delineate the geometry of the channel fill and other deposits beneath the river. However, the gas-laden, organic-rich layer of estuarine mud and clay that blankets much of the river bottom limited penetration of the source signal. Although the geometry and extent of paleochannels was not determined, the survey qualitatively confirmed the nearly ubiquitous presence of the estuarine mud and silt in this part of the river. This survey also located, and confirmed the depths of, several deep scour holes in the thalweg adjacent to Potomac Heights. In this area, the maximum depth of the thalweg ranges from 90 to 110 ft.

HYDROGEOLOGY

The geologic deposits that underlie an area collectively form the physical framework of the ground-water-flow system. Lithology, extent, and continuity of the deposits affect the characteristics of the ground-water-flow system. The Patapsco and Patuxent Formations in the Indian Head area each contain several confined aquifers consisting of saturated, poorly consolidated layers of sand and gravel deposits that can range from a few feet to about 20 ft in thickness (pls. 3 and 4). Compared to the interbedded confining units (clays), the sand and gravel deposits have relatively high hydraulic conductivities.

Ground-water flow in a confined aquifer is controlled chiefly by the quantity and location of recharge and discharge, by the hydraulic gradient, and the hydraulic conductivity of the aquifer. The rate of natural ground-water flow in the Patapsco and Patuxent aquifers is generally low and ranges from a few feet to several tens of feet per year (Otton, 1955, p. 109).

Aquifers

In this report, the aquifers and confining units in the Patapsco and Patuxent Formations are collectively referred to as the "Potomac Group aquifer system " (table 1). The Potomac Group deposits crop out along an extensive belt in the Virginia Coastal Plain, but their surface exposure in Maryland is very limited (fig. 7). In Virginia, precipitation on the outcrop area recharges the Potomac Group aquifer system, and water-table conditions prevail in the western updip margin. Along the Virginia shore of the Potomac River, the deeper sand layers of the Potomac Group are overlain by confining units.

Slaughter and Otton (1968) conducted aquifer tests in the Indian Head area using selected production wells screened in the Potomac Group aquifers. Transmissivities ranged from about 3,000 to 6,000 (gal/d)/ft or 400-800 ft^2/d and storage coefficients ranged from 0.0002 to about 0.004 (Slaughter and Otton, 1968, p. 49).

The Patapsco Formation in the Indian Head area contains three relatively continuous sand layers. These layers consist of medium- to fine-grained sand, separated by clay beds or lenses that locally function as confining units. The sand layers appear as deflections to the right in the electric logs shown on plates 3 and 4, and figure 9, whereas the clay appears as deflections to the left on the electric logs and as deflections to the right on the gamma logs. In this report, the term "Patapsco aquifer" refers to these prominent sand layers in a lithologic interval of the Patapsco Formation previously subdivided into the upper, middle, and lower Patapsco-Raritan Formation (Slaughter and Otton, 1968, p. 22).

In the Maryland part of the study area, the Patapsco Formation crops out along the shore and bluffs of the Potomac River, but is confined by overlying Tertiary sediments immediately to the east (fig. 7). Ground water in the outcrop area is under water-table or semiconfined conditions and is probably hydraulically connected to the shallow flow system in the overlying surficial gravel deposits. Ground water in the middle and lower parts of the Patapsco aquifer is confined in this area, and although less influenced by the shallow flow system, in this area these aquifers probably are hydraulically connected to the Potomac River indirectly through the Quaternary deposits beneath the Potomac River estuary (fig. 5).

The Arundel Formation consists almost entirely of hard clay and silt and is frequently referred to as the "Arundel Clay." It functions hydrologically as a confining unit, and, where present, it separates the Patuxent aquifers from the overlying Patapsco aquifers.

In this report, the term "Patuxent aquifer" refers to the two major sand layers of the Patuxent Formation, which show as major deflections to the right on the electric logs shown on figure 9 and plates 3 and 4. On a regional scale, the Patuxent Formation is a multiaquifer unit consisting of several sand layers of differing thickness and lateral extent. Ground water in the Patuxent aquifer is effectively confined by the Arundel Formation and other interbedded clay units in the Patuxent Formation.

Effects of Pumping

The confined aquifers in the Potomac Group have provided most of the ground water withdrawn in the Indian Head area during this century (Slaughter and Otton, 1968, p. 47). Long-term pumping in the Indian Head area has caused substantial reductions in the hydraulic head in the Patapsco and Patuxent aquifers. Early wells drilled into the Potomac Group aquifers flowed naturally when first drilled. These wells eventually ceased to flow when the ground-water levels declined because of pumping. In 1895, the water level in a well screened in the Patuxent aquifer at NOS was 13 ft above sea level (Darton, 1896). In 1989, water levels in wells in the same area are as much as 70 to 90 ft below sea level.

Most of the production wells in the Indian Head area are screened in two or more sand layers. Several production wells drilled after World War II were gravel walled, which also established a hydraulic connection to otherwise separate confined aquifers. At present, water levels are approximately equal in the confined aquifers in the Indian Head area because of the long-term pumping and use of multiscreen wells. The water levels indicate considerable hydraulic connection between the aquifers. They also indicate that the aquifers in this area have responded as a system to the pumping stress, and, possibly, that the ground-water-flow system is in approximate steady state (that is, in a slowly evolving equilibrium) with the pumping stresses.

Long-term pumping from multiscreen wells has possibly induced vertical leakage through confining units as well as increased lateral flow through the aquifers. Even unpumped multiscreen wells can provide a pathway for flow between two or more separate confined aquifers and can contribute to equalization of heads between aquifers. Slaughter and Otton (1968, p. 52) suggested that the sand units deeper than about 200 ft below sea level were in hydraulic continuity in the Indian Head area because of the use of multiscreen wells.

History of Pumping

Darton (1896, p. 134) described a well drilled at NOS in 1895 that was screened in the Patuxent aquifer, yielded 11 gal/min, and had an initial static water level of about 10 ft above sea level. The first large-capacity production well in the area was drilled at NOS in 1899. This well was screened in the lower part of the Patapsco and the upper part of the Patuxent aquifers. The well yielded 104 gal/min and had an initial static water level of 13 ft above sea level (Slaughter and Otton, 1968, p. 45).

By 1938, 14 production wells had been drilled at NOS, and pumpage had increased from about 0.28 Mgal/d in 1899 to about 1.0 Mgal/d in 1938 (Fiedler and Jacob, 1939). Slaughter and Otton (1968, p. 47) estimated that 60 percent of the total pumpage from 1899 to 1954 at NOS was withdrawn from the Patapsco aquifer, the remainder being withdrawn from the Patuxent aquifer.

Fiedler and Jacob (1939) published data on ground-water levels and aquifer and well characteristics based on extensive pumping tests of production wells at NOS during 1938. At that time, most of the wells at NOS were about 1,000 ft southeast of the powerplant, in what was known as "well group no. 1" (see location shown for wells CH Bb 1-10, 14, and 15 on pl. 1). In 1933, static ground-water levels at NOS ranged from 35 to 102 ft below sea level, and pumping water levels ranged from 64 to 160 ft below sea level (Fiedler and Jacob, 1939, p. 13). Well yields at NOS in 1933 ranged from 86 to 304 gal/min, and specific capacities ranged from 2.1 to 10.2 (gal/min)/ft (Fiedler and Jacob, 1939, p. 13).

During the 1950's and 1960's, several production wells were drilled at NOS and, to the east, in the Indian Head-Glymont area. The new wells at NOS were drilled some distance away from the former locus of pumping at well group no. 1. The production wells drilled in the towns of Indian Head and Potomac Heights, are several thousand feet east of the former NOS pumping center. Thus, although the pumping stress in the Indian Head area has gradually increased with time, the pumping is now more decentralized than before the 1950's.

Locations and amounts of pumpage for the production wells active in the Indian Head area during 1988 are shown in figure 13. Annual average daily withdrawal of ground water at NOS and reported pumpage from NOS and the towns of Indian Head and Potomac Heights from 1980 through 1988 are shown in figure 14. Substantial increases in pumpage at NOS have generally corresponded to periods of increased ordnance production during major military conflicts (fig. 14). Pumpage at NOS during the 1980's was considerably less than in the previous several decades. During the 1980's, pumpage at NOS remained relatively stable and averaged about 1.4 Mgal/d. The combined pumpage of the towns of Indian Head and Potomac Heights also remained relatively stable during the 1980's and averaged about 0.5 Mgal/d.

Trends in ground-water use in Charles County and the percentage of each type of use for the years 1950, 1960, 1970, and 1980 are shown in figure 15. Total ground-water withdrawals in Charles County have more than quadrupled from 1950 to 1980. During this period, however, total pumpage in the Indian Head area remained relatively stable. Although pumpage at NOS accounted for about 43 percent of the total pumpage in the county in 1950, it accounted for about 11 percent of the total in 1980 (fig. 15).

Ground-water withdrawals have increased substantially in the central and north-central parts of Charles County because of population growth and the associated increased demand for water. Regional changes in the amount and extent of ground-water withdrawals in Charles County during 1950-80 are shown in figure 16. Pumpage along the Route 210 corridor northeast of the Indian Head area is now substantial, whereas little or no ground water was withdrawn in these areas in the 1950's. Currently, ground-water withdrawals in the Waldorf area are the largest in Charles County (fig. 16). Although some ground water withdrawn in the northwestern and north-central part of the county in 1980 was from the Patuxent aquifer, most withdrawals were from the Patapsco and overlying Magothy aquifers (Wheeler and Wilde, 1989, p. 55).

Ground-Water Levels and Flow

Water levels in the Potomac Group aquifer system began to decline with the operation of the first production wells. Most of the water that was initially withdrawn was probably derived from reductions in the volume of water stored in the aquifer. Storage in an aquifer is depleted while the cone of depression around the pumping wells expands; once the cone stabilizes, ground-water withdrawals are balanced either by a reduction in the natural discharge or by an increase in the rate of recharge or a combination of both (Heath, 1983, p. 32).

By 1933, continued pumping at NOS had created a cone of depression in the potentiometric surface of the Potomac Group aquifer system. The center of the cone was near well group no. 1, and

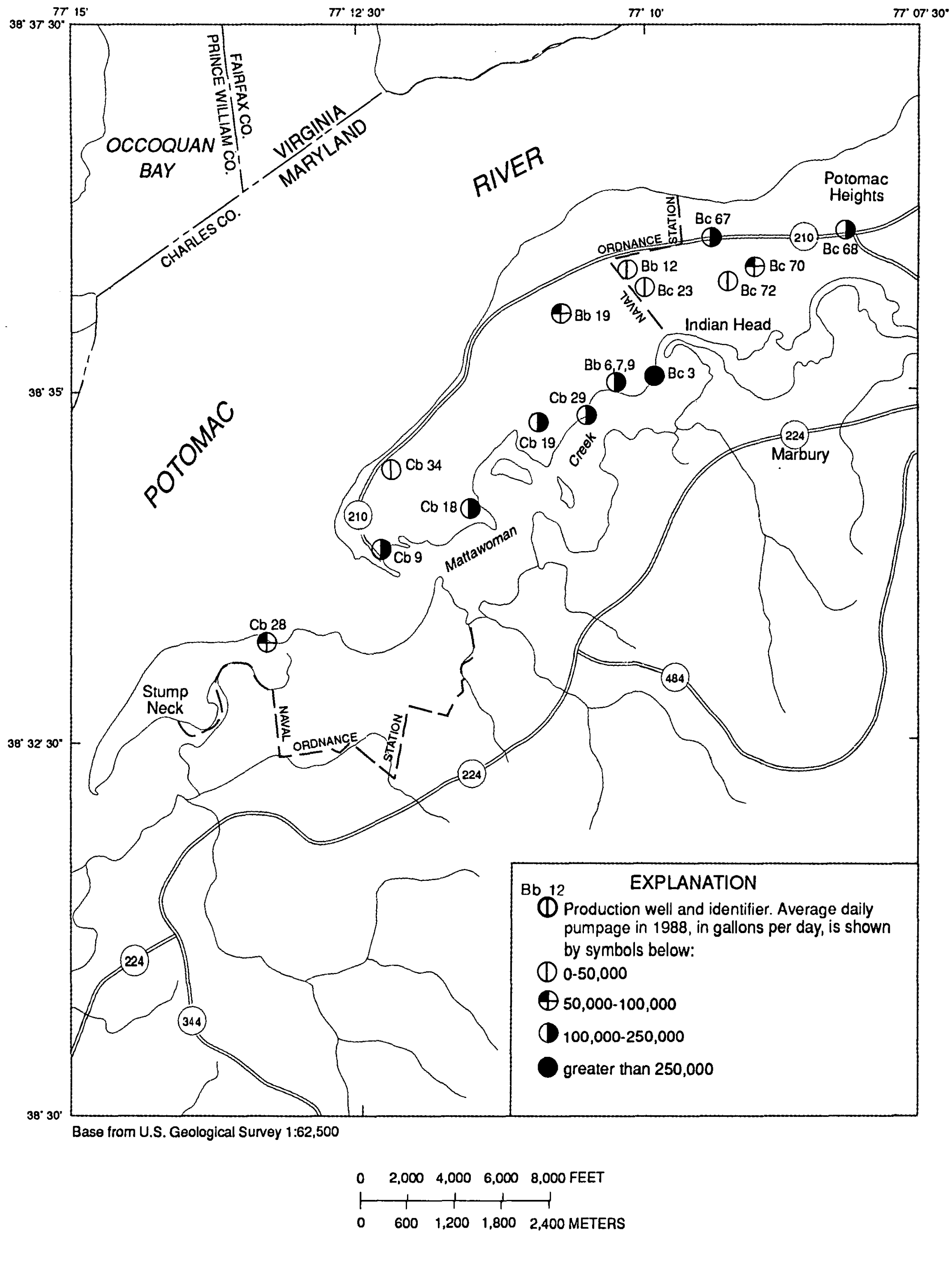


Figure 13. Location of production wells in the Indian Head area and average daily pumpage during 1988.

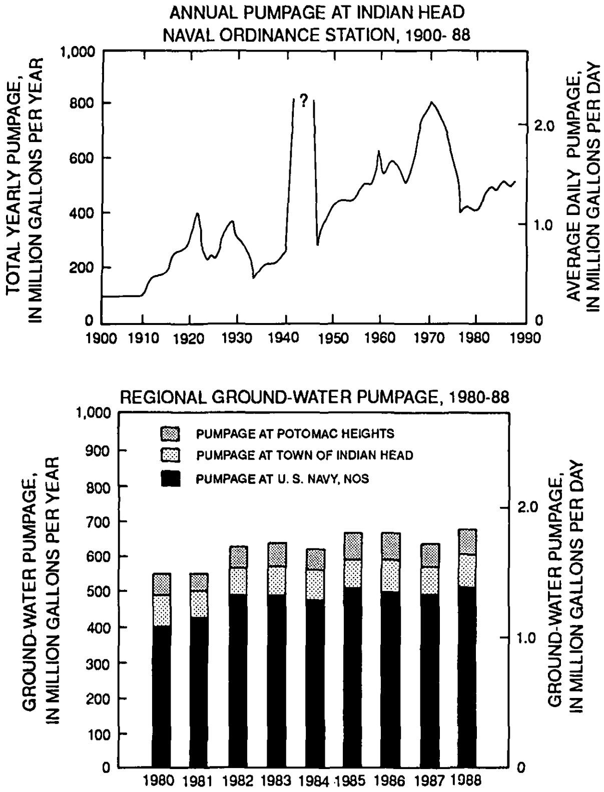


Figure 14. Ground-water pumpage from the Potomac Group aquifer system, at (A) Naval Ordnance Station, 1900-1988 and pumpage in the (B) Indian Head area, 1980-88.

static water-level altitudes at NOS ranged from 35 to 102 ft below sea level (Fiedler and Jacob, 1939, p. 13). This cone of depression represented a considerable change from the prepumping hydraulic gradients and indicated changes in velocity and direction of ground-water flow. Water-level data collected from observation wells in the Indian Head area during 1981-89 are summarized in tables 6 and 7 (at end of report).

Hydrographs based on water-level measurements in observation wells in the Indian Head area are shown in figure 17. Long-term water-level records for wells CH Bc 71, CH Bc 17, and CH Cb 7 show that, although water levels in these wells have fluctuated as much as 45 ft during the period of record (1952-89), the potentiometric surface in this area generally has been at least 60 ft below sea level during the period.

The water level in well CH Bb 17 is affected substantially by tidal fluctuations in the nearby Potomac River (fig. 18). This well is about 600 ft from the river and is screened in the Patapsco aquifer from 188 to 242 ft below sea level. The tidal fluctuations, along with the elevated

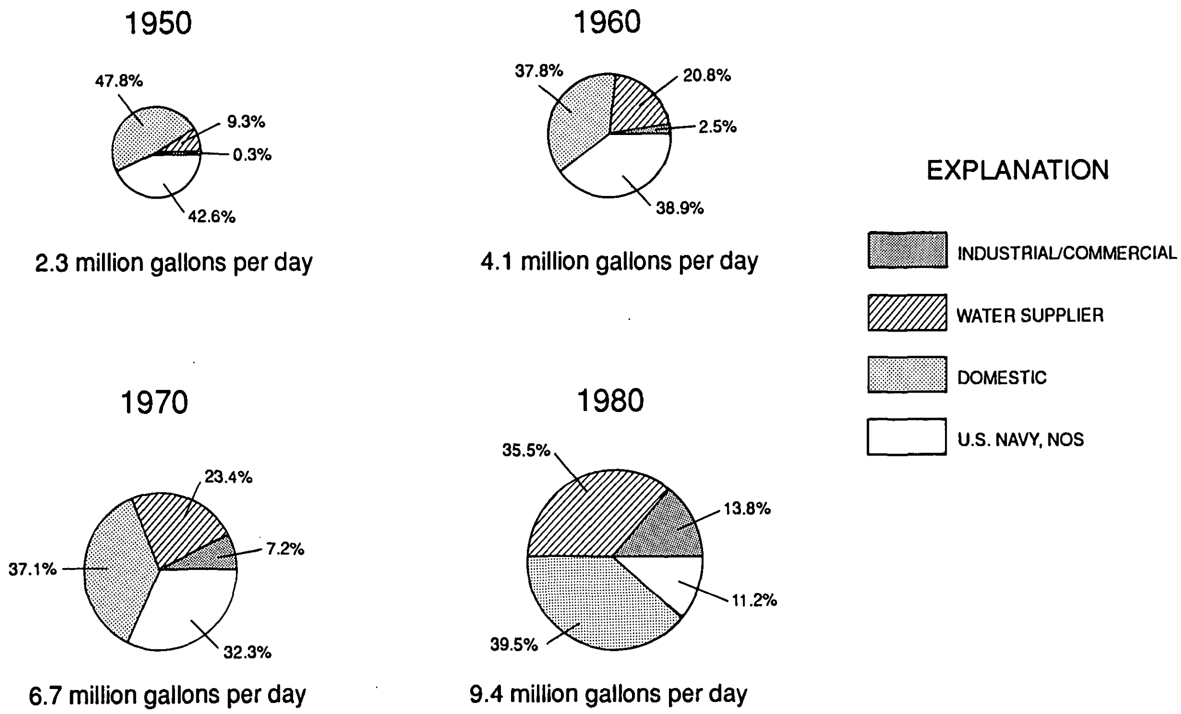


Figure 15. Ground-water use in Charles County, Md., and percentage of each type of use, 1950, 1960, 1970, and 1980. (From Wheeler and Wilde, 1989, p. 57).

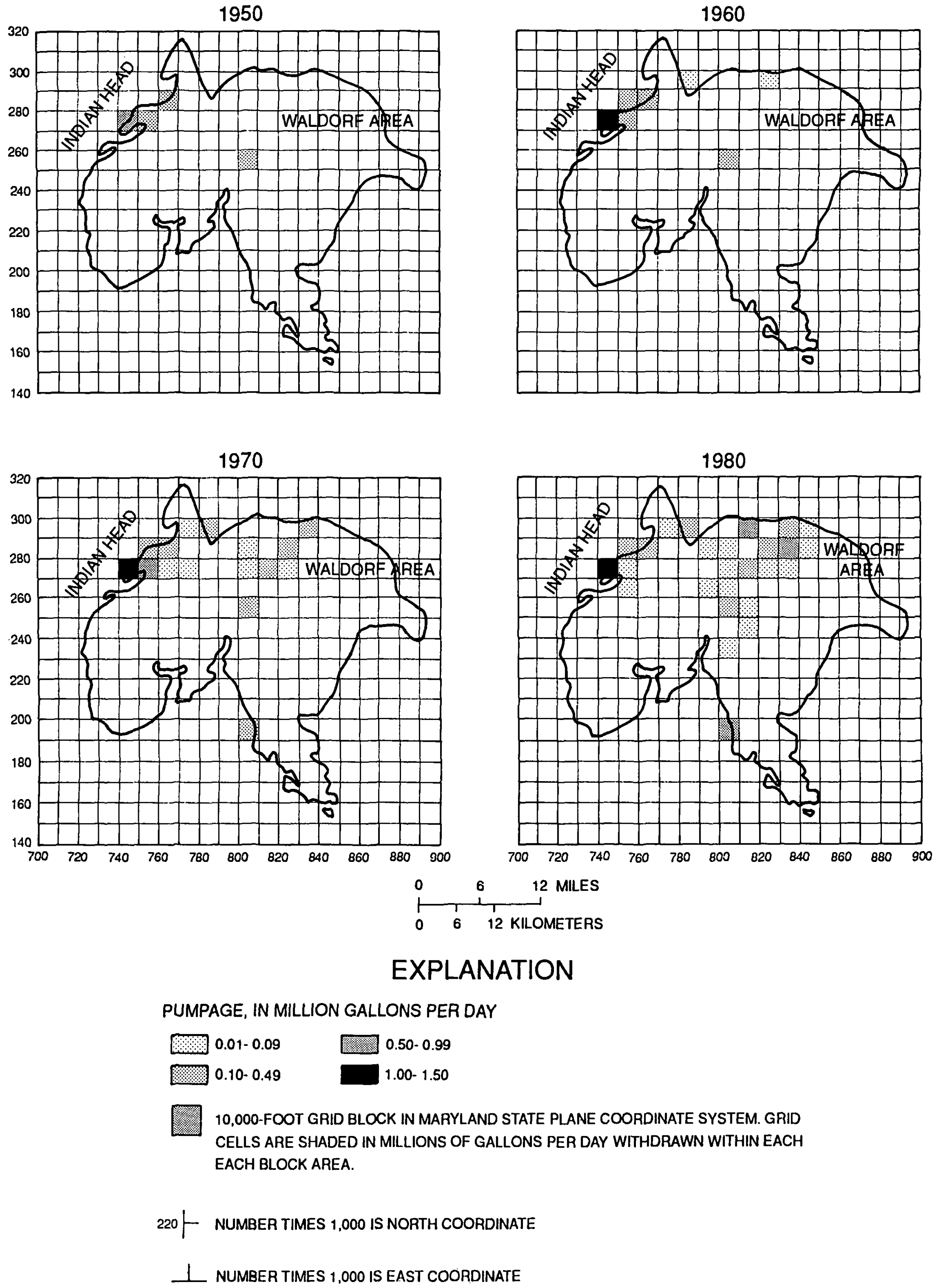


Figure 16. Regional pumping centers and ground-water withdrawals in Charles County, Md., 1950, 1960, 1970, and 1980. (From Wheeler and Wilde, 1989, p. 59).

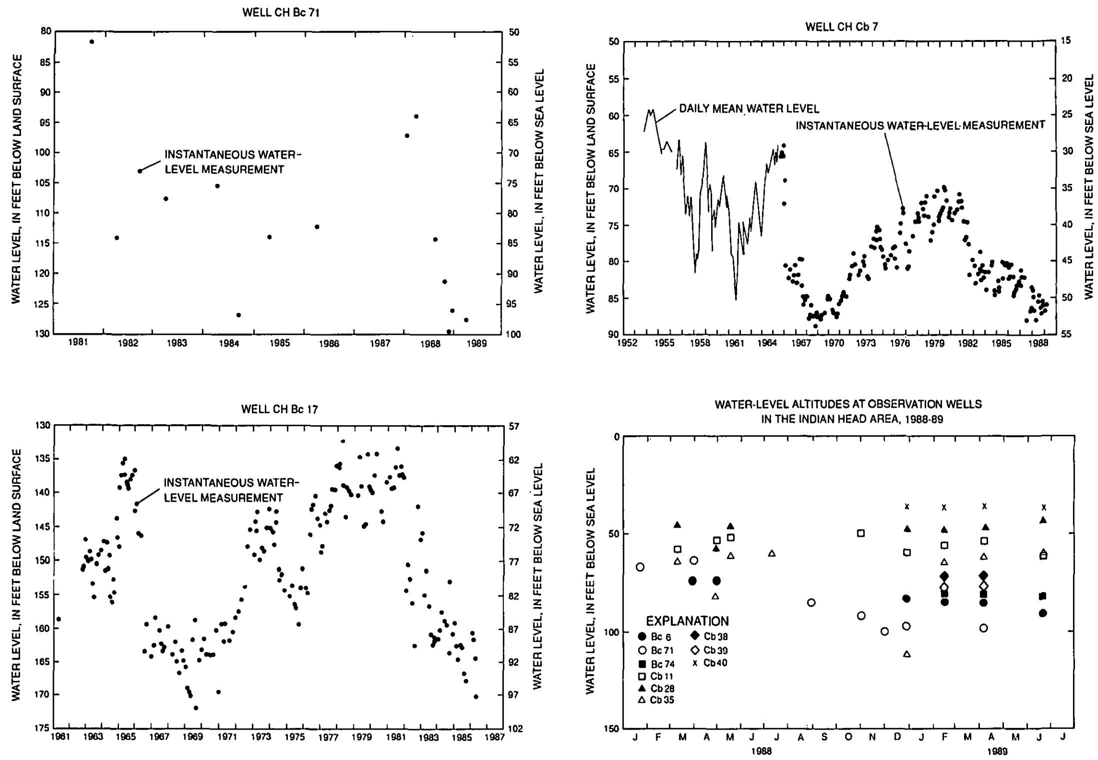


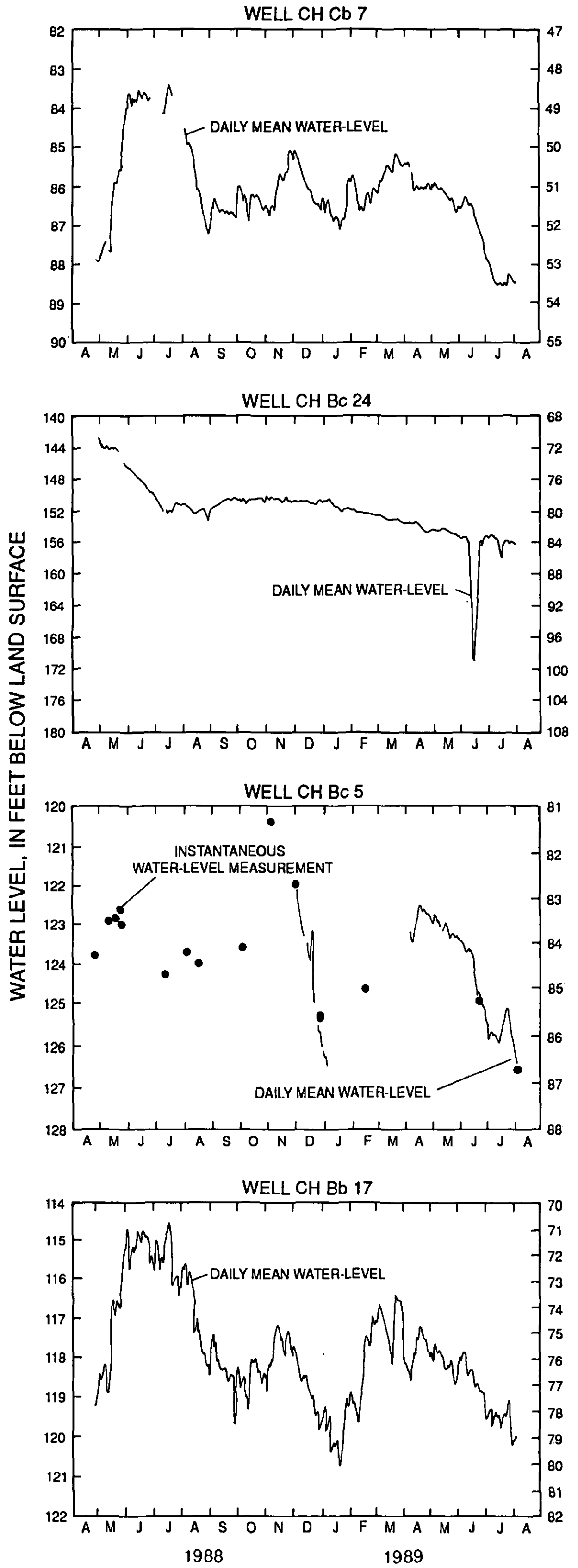
Figure 17. Water-level altitudes in observation wells in the Indian Head area measured periodically, 1952-89.

concentration of river-water indicator constituents (see section on Ground-Water Quality), indicate that this part of the Patapsco aquifer is indirectly hydraulically connected to the Potomac River through the overlying channel fill and river-bottom deposits.

The greatest pumping stresses in the Indian Head area from 1900 to 1989 occurred during World War II (1940-45) and the period 1965-75 (fig. 14). Water levels declined substantially in observation wells CH Bc 17 and CH Cb 7 in response to the pumping stresses that peaked around 1970 (fig. 17). During 1975-80, pumpage from NOS was less than that of the previous 10 years, and the water levels in wells CH Bc 17 and CH Cb 7 partially recovered as a result of the reduced withdrawals (figs. 14 and 17).

Pumpage from NOS during the 1980's increased only slightly from that during 1975-80 (fig. 14). Pumpage at the towns of Indian Head and Potomac Heights totaled about 0.5 Mgal/d during the 1980's. Continued population growth in the Indian Head and Potomac Heights areas will probably lead to gradual increases in ground-water withdrawals in the immediate area northeast of NOS. Ground-water withdrawals for small-community and domestic supplies along the Route 210 corridor have gradually increased in the past several decades 1970's-80's (fig. 16).

During the years prior to the 1980's, water levels in observation wells at Indian Head



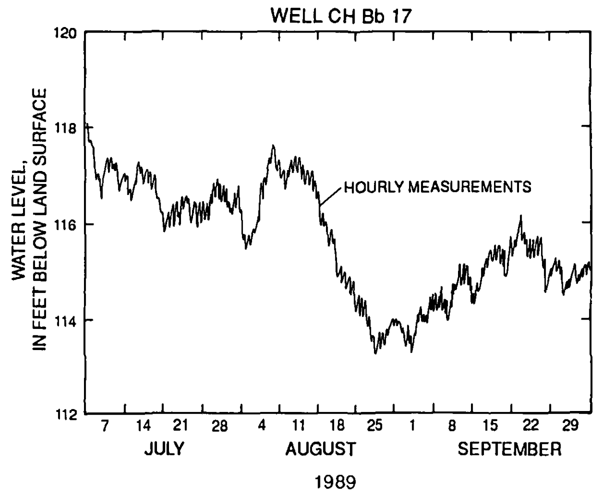


Figure 18. Water-level altitudes in observation wells in the Indian Head area continuously recorded, 1988-89.

fluctuated primarily in response to the magnitude and timing of withdrawals at NOS. Yet, despite reduced or stable rates of ground-water withdrawals at NOS during the 1980's, water levels in some observation wells at Indian Head were as low in 1989 as they were during the peak-pumping stress around 1970 (for example, well CH Cb 7, fig. 17). This suggests that reductions in the head of the aquifer system to the northeast are now affecting water levels in the Indian Head area. The rate of ground-water inflow from the northeast toward the Indian Head area could be declining gradually as head gradients have decreased across this area.

Fleck and Wilson (1989) documented declining heads in the Patapsco aquifer between the Indian Head and Waldorf areas. Their data and numerical simulations show a gradual coalescing of two distinct cones of depression in the Patapsco aquifer that are centered on, and result from pumping stresses in, the Indian Head and Waldorf areas.

The approximate altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area in the early 1960's is shown in figure 19. This map is based on water-level measurements made in the Indian Head area during 1961-62 (Slaughter and Otton, 1968, p. 51) and shows a regional, elongated cone of depression in the potentiometric surface. The cone was roughly centered on well group no. 1 at NOS, and

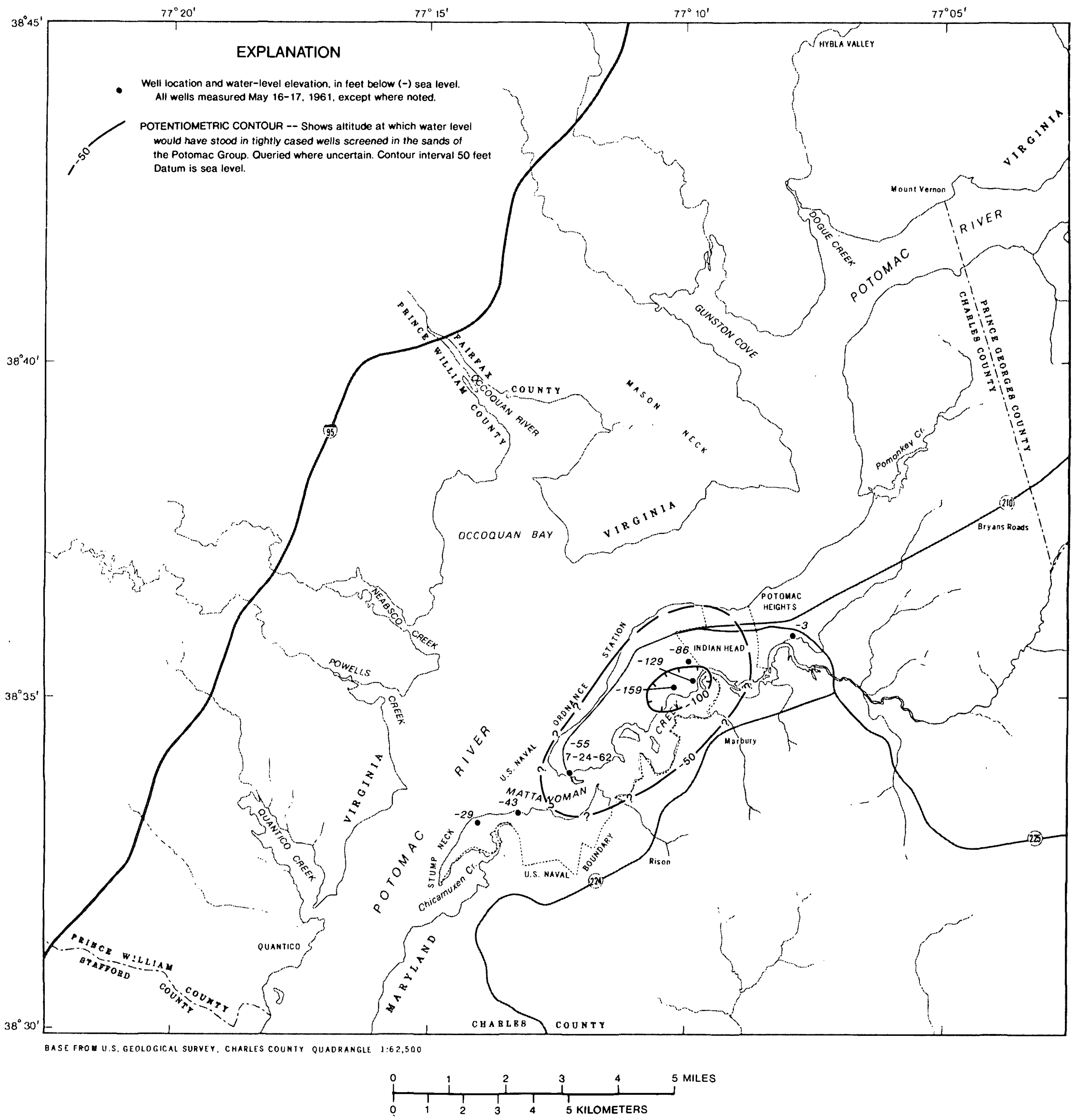


Figure 19. The altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area, 1961-62. (From Slaughter and Otton, 1968, p. 51).

pumping water levels as deep as 159 ft below sea level were measured at the center of the cone.

Figure 20 is a similar map of the potentiometric surface compiled from synoptic water-level measurements made in some of the same wells in the Potomac Group aquifer system during 1989. Although not all of the observation wells measured in 1961-62 were measured during 1989, data were included for several wells drilled after 1962. Comparison of figures 19 and 20 clearly shows the persistence of a regional cone of depression in the potentiometric surface of the Potomac Group aquifer system. The cone is centered on the Indian Head peninsula, extends several miles in all

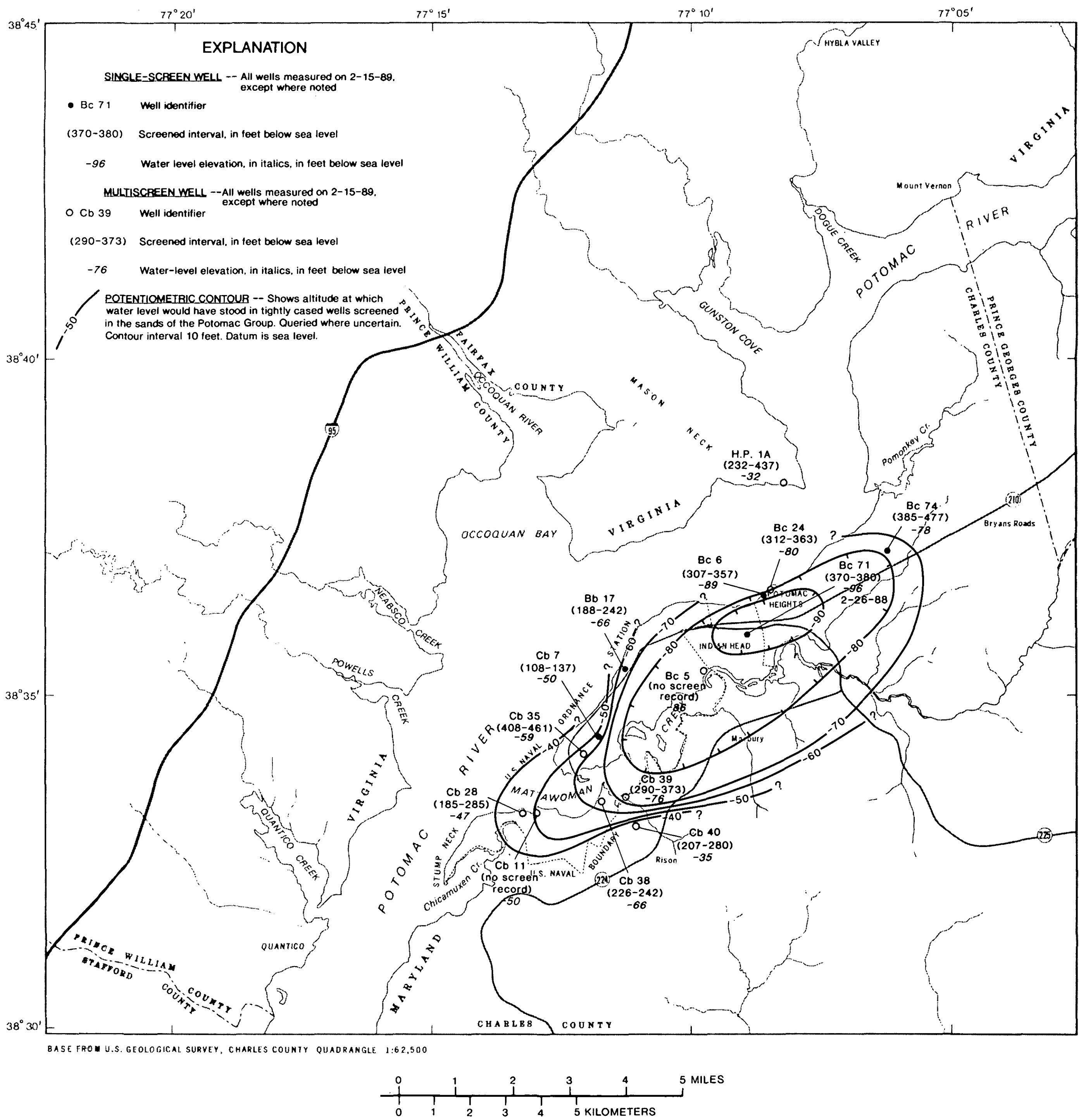


Figure 20. The altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area, 1989.

directions, and probably extends several hundred feet under the Potomac River. The cone of depression is broader and extends farther to the northeast because the hydraulic head in the aquifer system northeast of NOS is lower now than in the 1960's (figs. 19 and 20). Pumping levels greater than 200 ft below sea level were measured again in several production wells in the area during 1990. Ground-water levels in the Stump Neck area and the southwestern end of the Indian Head peninsula (figs. 19 and 20) are still very near the levels measured in the 1960's. This suggests that a re-charge boundary (the Potomac River) has been intercepted to the southwest and that ground-water recharge from the southwest could be in equilibrium with pumping stresses in this area.

In 1960, pumpage from wells at NOS accounted for about 40 percent of the total withdrawals in Charles County (fig. 15) and NOS was the location of the largest pumping stress in the county (fig. 16). By 1980, however, pumpage at NOS was only about 11 percent of the total ground-water withdrawals in the county. Some of the increased pumpage was along the Route 210 corridor to the northeast of NOS (fig. 16), but most of the new withdrawals were in the Waldorf area, about 12 to 15 mi east of the Indian Head area (fig. 1). Thus, the map of the potentiometric surface in the Indian Head area in 1961-62 (fig. 19) shows conditions before the development of pumping stresses in the northwestern and central parts of the county.

In summary, under natural, prepumping conditions, ground-water flow was generally downdip in the aquifers and head gradients were probably favorable for upward leakage from the aquifers to the Potomac River. However, pumpage from the Potomac Group aquifers has altered the natural ground-water-head gradients and reversed the ground-water-flow direction in the aquifer subcrop beneath the river. It appears that, since the development of area ground-water supplies, water from the Potomac River has provided recharge to the Potomac Group aquifer system in the Indian Head area.

GROUND-WATER QUALITY

In the previous section on ground-water flow, the concept of the Potomac Group aquifer system was used to describe, and draw generalizations about, the flow of ground water in the Indian Head area. In areas affected by the pumping stresses of multiscreen wells, the hydraulic-head distribution is similar in Patapsco and Patuxent aquifers. Originally, the natural chemical quality of water in the two aquifers probably differed slightly because of differences in flow paths, aquifer composition and residence times. However, because most production wells in this area have multiple-screen intervals that admit water from different aquifers tapped by the well bore, data are generally unavailable to compare or contrast the variations in natural chemical quality of water between the Patapsco and Patuxent aquifers. Thus, the following sections of the report will focus on the areal extent of water-quality changes in the aquifer system as a whole, as evaluated by analysis of composite samples of water from multiple-screen wells.

Prepumping Water Quality

The natural chemical quality of water in a ground-water system is determined by the types and concentrations of solutes that it contains. In general, the types and concentrations of solutes in ground water reflect the chemical quality of the recharge water, the types and solubilities of minerals in the geologic medium, and the amount of time the water has been in the system.

Water-quality data for the Potomac Group aquifer system prior to development in the Indian Head area are lacking. However, chemical analyses of the water collected from several wells by the USGS in 1937 indicate that the water in the Potomac Group aquifer system was a very soft, sodium bicarbonate type with dissolved-solids concentrations of less than 250 mg/L (Fiedler and others, 1937). Wells CH Bb 1, 5, 6, 8, and 9 were sampled, and the samples were analyzed for bicarbonate concentration. Only the sample from well CH Bb 1 was analyzed to determine the concentrations of the major dissolved ions. Bicarbonate concentrations in the five samples ranged from 139 to 156 mg/L, and the mean concentration was 146 mg/L. The narrow range in bicarbonate concentration suggests that the samples were similar in major-anion chemistry (Fiedler and others, 1937).

In the water from well CH Bb 1, the total hardness (as $CaCO_3$) was 4.5 mg/L; thus, the water would be classified as soft (Heath, 1983, p. 65). Because of the relatively low dissolved-solids concentration (less than 250 mg/L), the water also was relatively unmineralized. The chemical character of the water indicates that sodium and bicarbonate are the major dissolved ions in solution. Concentrations of major inorganic constituents (in mg/L) in the water sample are:

Chemical concentration of major dissolved ions in water from well CH Bb 1, June 12, 1937, in milligrams per liter

Silica (SiO_2)	39	Carbonate (CO_3)	0.1
Iron (Fe)	0.04	Bicarbonate (HCO_3)	156
Calcium (Ca)	.8	Sulfate (SO_4)	9.9
Magnesium (Mg)	.6	Chloride (Cl)	8.0
Sodium (Na)	66	Fluoride (F)	1.2
Potassium (K)	1.7	Nitrate (NO_3)	.18
Total dissolved solids	210	Total hardness ($CaCO_3$)	4.5

Previously published data on the quality of ground water in the Potomac Group aquifer system in the Indian Head area were compiled for this report and are presented in table 8 (at end of report). The data shown in table 8 also include previously unpublished chemical analyses of ground water from the files of the town of Indian Head and NOS. Selected chloride-concentration data from some wells listed in table 8 are presented later in figures 22 and 25.

On the basis of previously collected ground-water-quality data, most water withdrawn from the Potomac Group aquifer system in the Indian Head area has been a relatively soft, unmineralized water that is potable without chemical treatment. Municipal water supplies have customarily been chlorinated, however, to safeguard against possible pathogens. In general, the background or native quality of ground water in the Potomac Group aquifer system in northwestern Charles County is characterized by low (less than 250 mg/L) dissolved-solids concentrations and chloride concentrations less than about 20 mg/L.

Historical well records and water-quality data compiled for this study document several test wells in the Patapsco aquifer that yielded water with objectionably high dissolved-iron concentrations. Several test wells were drilled and abandoned at NOS in the 1970's because of undesirable concentrations of dissolved solids, iron, and chloride.

Changes in Water Quality Since Development

Ground-water quality in the Indian Head area has gradually changed in a zone of the aquifer that is adjacent and parallel to the Potomac River. The chemical quality of water in this zone has changed from the native sodium bicarbonate-type water with a low dissolved-solids concentration (less than 250 mg/L) to a sodium chloride-type water with a comparatively higher dissolved-solids concentration (greater than 500 mg/L). The observed changes are restricted to the western and northwestern, or riverward side, of the Indian Head peninsula. These changes indicate the intrusion of river water, which can have much higher chloride, sodium, dissolved-solids, and organic-carbon concentrations than the native ground water.

Unlike the main body of Chesapeake Bay, which is almost always either brackish or saline, the water in the Indian Head area of the Potomac River varies from fresh to brackish depending primarily on the magnitude of freshwater inflow, which controls the dissolved-solids concentration. Water containing dissolved-solids concentrations less than about 1,000 mg/L is generally considered to be fresh. Concentrations between 1,000 and 10,000 mg/L are considered brackish, whereas water containing more than 10,000 mg/L of dissolved solids is considered saline (Heath, 1983, p. 65).

Typical concentration ranges for selected indicator chemical constituents in the Potomac River and the ground-water system are shown in table 2. The ground-water-quality data were collected as part of this study and the river-water-quality data for the Potomac River were previously collected by USGS personnel. In general, ground water in a zone of the aquifer near the river, has concentrations of river-water indicator constituents that are intermediate between concentrations in the native ground water and those in the Potomac River.

Because of the variable river-water quality and the interaction between the surface-water and ground-water systems, knowledge of the bathymetry, geomorphology, and water-quality characteristics of river-bottom sediments and the Potomac River is necessary in understanding the controls on the location and extent of river-water intrusion. Water in the Potomac River at Indian Head can range from fresh during periods of high streamflow to brackish during extended low-flow periods when saltwater moves upriver from Chesapeake Bay.

Table 2. *Typical concentration range of selected chemical constituents in the ground-water system and the Potomac River*

[mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; >, greater than]

	Chloride, dissolved (mg/L)	Total dissolved solids (mg/L)	Total organic carbon (mg/L)	Sodium, dissolved (mg/L)	Alkalinity, dissolved (mg/L)	Barium, dissolved (µg/L)	Strontium, dissolved (µg/L)
Native ground water	<20	<250	<0.5	50 - 80	100 - 150	< 10	< 10
Ground water near river	100 - 200	>500	1.0 - 5.0	80 - 250	150 - 350	50 - <100	50 - <100
Potomac River water	20 - 1,000	150 - 3,000	2.0 - 8.0	20 - 1,000	>40	100 - 300	100 - 300

Specific conductance is often used as an indicator of the dissolved-solids concentration because the electrical conductivity of water increases with increasing dissolved solute concentrations. The highest specific conductances occur primarily during extended periods of low streamflow in the Potomac River (fig. 21). Daily mean streamflow in the Potomac River at Washington, D.C., and daily mean specific conductance of water in the Potomac River at Indian Head during 1978-81 are shown in figure 21.

Thus, the chloride concentration in the Potomac River estuary near Indian Head can also vary because of extreme meteorologic and climatic events. The chloride concentration in the river decreased from 1,200 mg/L on October 9 to 13 mg/L on October 20, 1954, because of a large inflow of freshwater associated with runoff from a hurricane (Durfor, 1961). During the drought years of 1930-31, the chloride concentration was 3,220 mg/L on November 12, 1930 (Fiedler and Jacob, 1939, p. 50).

Laboratory analytical results for six river-water samples collected in the Potomac River near Indian Head during 1988 are listed in table 9 (at end of report). The locations of the river sampling sites are shown in figure 3. These river-water samples represent the spatial variation in the concentration of the major dissolved inorganic constituents.

From 1977 to 1982, the USGS conducted an interdisciplinary study of the Potomac River estuary. Samples of the river-bottom sediments and the water column were collected for analysis and determination of a number of chemical, physical, biological, and chronological properties and characteristics. A series of twelve 1-meter-long and three 12-meter-long cores of the river-bottom sediments were collected in the estuary near Indian Head. Pore fluids were extracted and analyzed for concentrations of chloride and other selected chemical constituents. Chloride concentrations in pore water averaged about 500 mg/L in the twelve 1-meter-long cores (Goodwin and others, 1984, p. 110), and probably represents the average concentration of chloride in the river water recharging the aquifer system.

Slaughter and Otton (1968, p. 20) stated that because of the pumping-induced hydraulic gradients in the Indian Head area, the ground-water system in the area was at risk from brackish-water intrusion into aquifers extending under the river. They reported that a well located at NOS 75 ft from the river had a chloride concentration of 160 mg/L and was abandoned in 1963. By the early 1970's, water from several wells near the river had elevated chloride and dissolved-solids concentrations.

Chloride concentrations during 1970-75 in water from selected wells in the Indian Head area

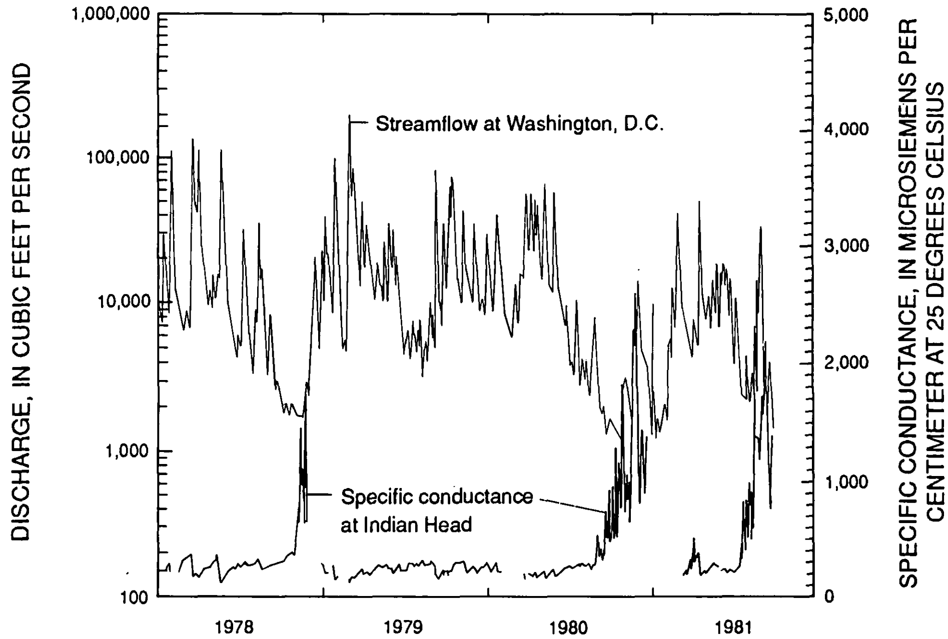


Figure 21. Daily mean streamflow of the Potomac River at Washington, D.C., and daily mean specific conductance of the Potomac River at Indian Head, Md., 1978-81.

are shown in figure 22. The lines on the map connect points of approximately equal chloride concentration. The interpretations are imprecise because of the paucity of data and the extended period over which the concentrations were measured. For the purposes of this map, it is assumed that concentrations of chloride in the ground-water system changed slowly during 1970 to 1975. The lines of equal chloride concentration in figure 22 represent the maximum values measured during the period (table 8).

River water probably began to recharge the aquifer system only after large-scale ground-water withdrawals had reversed the flow direction in the aquifer subcrop. A zone of elevated chloride concentration in ground water adjacent to the river indicates that river water gradually mixed with, or displaced, the native ground water in this part of the aquifer system before the early 1970's. The maximum observed chloride concentration in ground water during 1970-75 was 176 mg/L in a well on the south-western end of the Indian Head peninsula (fig. 22).

The analytical results for ground-water samples collected in 1988 from 26 wells in the Indian Head area are compiled in table 10 (at end of report). The locations of sampling sites are shown in figure 23. Four of the twenty-six wells are water-level observation wells and were sampled only once. The remainder are multiscreen production wells, which were all sampled at least four times. Water samples from all 26 wells were

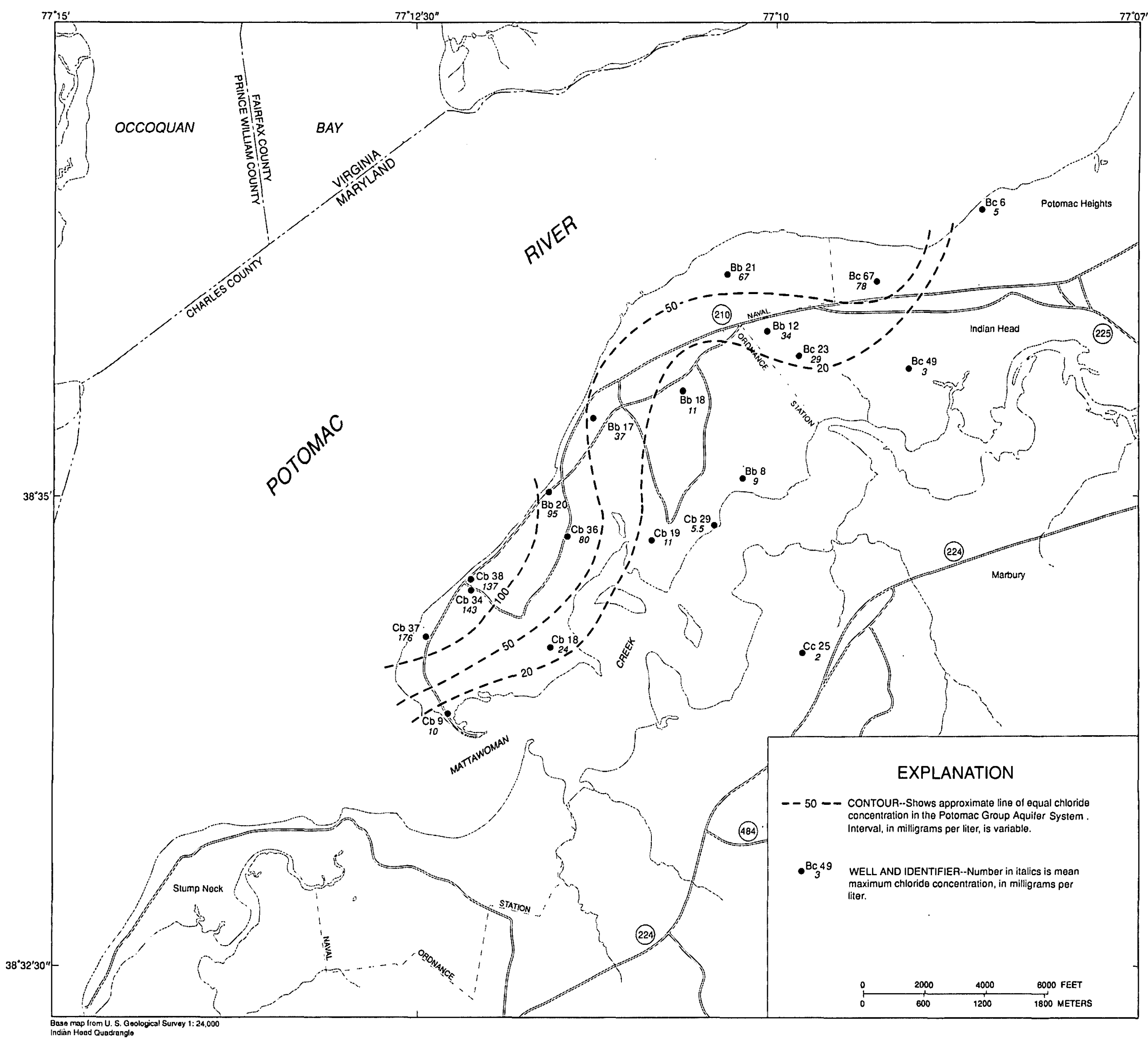
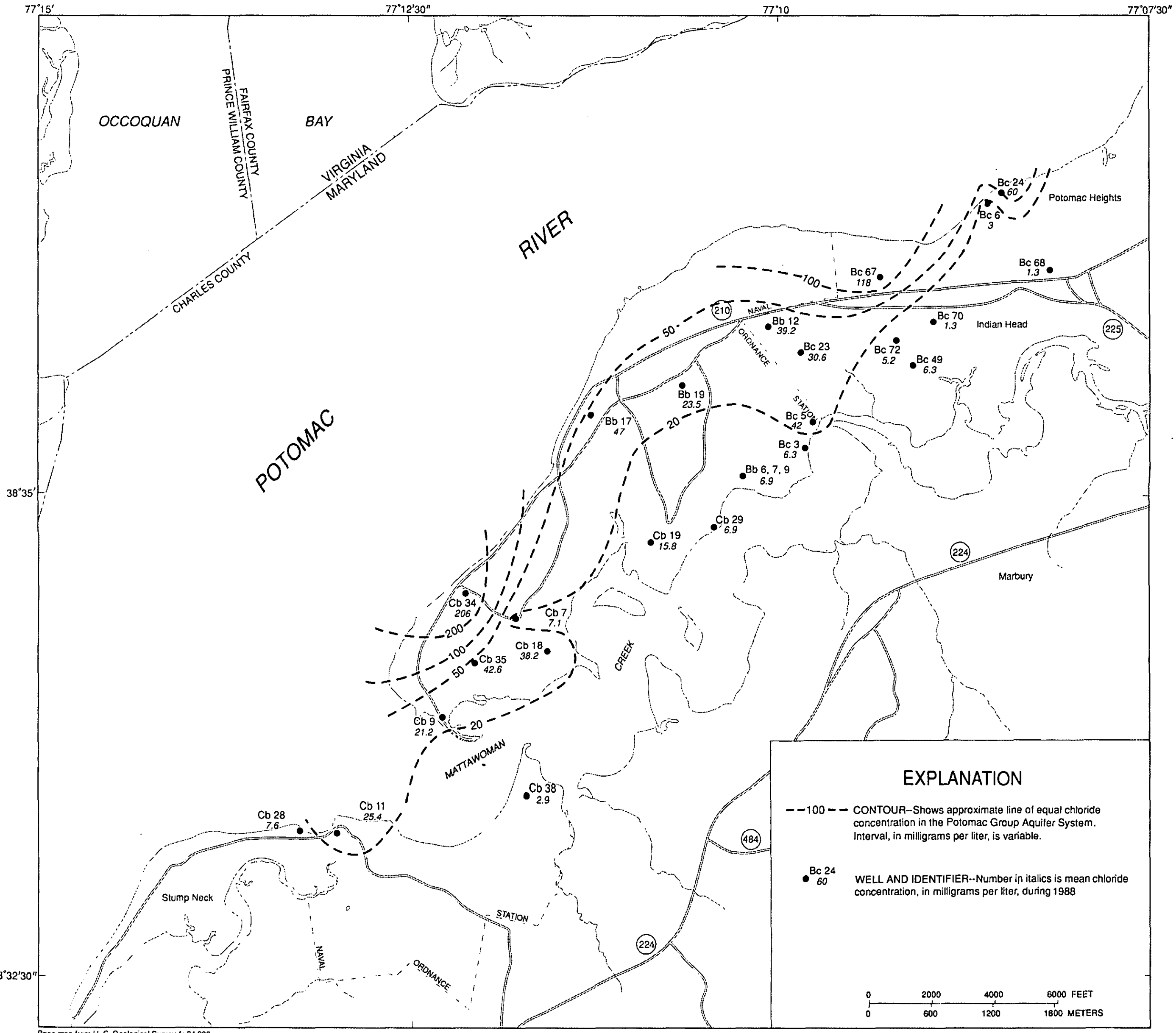


Figure 22. Maximum concentrations of dissolved chloride in water from wells sampled during 1970-75.



Base map from U. S. Geological Survey 1: 24,000
Indian Head Quadrangle

Figure 23. Mean concentrations of dissolved chloride in water from wells sampled during 1988.

analyzed to determine the concentrations of major dissolved inorganic constituents, selected trace elements, and total organic carbon. In addition, samples from 11 selected wells were also analyzed for tritium. Tritium is a radioisotope of hydrogen and has been used for estimating the approximate age of water in ground-water systems.

The statistical distribution and range of concentrations for selected chemical constituents and properties of ground water in the Indian Head area during 1988 are shown in figure 24. The median dissolved-solids concentration was 215 mg/L and the median alkalinity was about 160 mg/L (fig. 24). These concentrations are similar to those measured in well CH Bb 1 in 1937, which indicates that the water in many of the wells still has chemical-constituent concentrations that resemble background conditions.

Relating the median value to the upper and lower quartiles of the concentration distribution for a constituent indicates the skewness of the statistical population. The shape of the box plot depicts the range of concentration values in the various parts of the sample population. The extreme values represent constituent concentrations that are considerably greater, or less, than the rest of the sample population (fig. 24).

In general, most water in the Potomac Group aquifer system is not highly mineralized and is predominantly a sodium bicarbonate type. However, the data indicate elevated river-water indicator constituent concentrations in the water in some wells, particularly sodium, chloride, and dissolved-solids concentrations, which skew these constituent distributions upwards in the plots. Water from production wells CH Cb 34 and CH Bc 67 consistently contains the maximum concentration of the chemical constituents shown in figure 24.

Selected data on chloride concentrations in water from selected wells in the Indian Head area from 1938 to 1988 are summarized in figure 25. Concentrations began to increase in some wells in the mid-1970's, even though no increases were apparent in other wells in the same general area. Two groups are evident on this figure, one with background chloride concentrations clustered in the 1 to 20 mg/L range and one with chloride concentrations substantially elevated above background. The maximum chloride concentration in ground water observed during 1988 was 210 mg/L at well CH Cb 34, which is screened in the Patapsco aquifer from 180 to 202 ft below sea level (table 3). The secondary maximum contaminant level for chloride in drinking water is 250 mg/L; above this concentration, some aesthetic impairment of water quality may be perceived (U.S. Environmental Protection Agency, 1988).

Mean chloride concentrations in water from wells sampled during 1988 are shown in figure 23. Comparison of the lines of equal chloride concentration in figures 22 and 23 generally shows the same zone of elevated concentrations. On both maps, the wells with the highest chloride concentrations are in the same area, along the Potomac River shoreline on the western side of the Indian Head peninsula. Most of these wells are screened in the middle and lower sands of the Patapsco aquifer. The well-screen depths generally range from about 200 to 300 ft below sea level, except for well CH Bc 67, which is screened in the Patuxent aquifer from 458 to 492 ft below sea level (table 3). In most instances where data are available for the same well, the mean chloride concentration in 1988 is greater than the maximum concentration measured in the 1970's (figs. 22 and 23).

Mean concentrations of total dissolved solids in water from wells in the Potomac Group aquifers during 1988 in the Indian Head area are shown in figure 26. The contours represent lines of approximately equal dissolved-solids concentration. The zone of elevated dissolved-solids concentration corresponds generally to the zone of elevated chloride concentration in the aquifer (fig. 23). Because most of the wells are screened at multiple intervals (table 3), it is difficult to determine the precise vertical distribution of water having the elevated concentrations of chloride and dissolved solids. The close proximity of the wells with the highest chloride and dissolved-solids concentrations to the Potomac River indicates that the river is the recharge source for this zone of the aquifer system (figs. 23 and 26). The secondary maximum contaminant level for dissolved

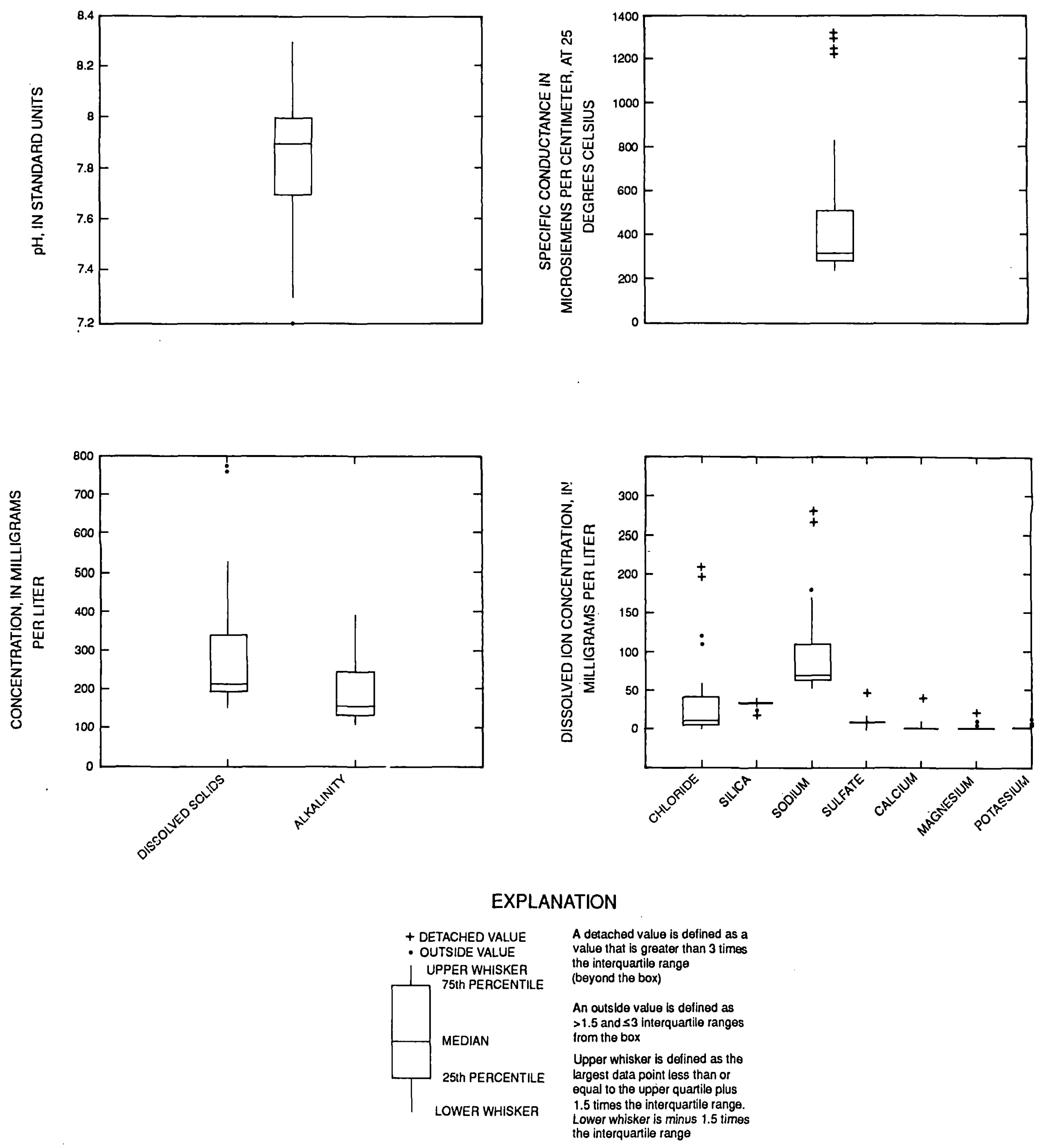


Figure 24. Statistical distributions of concentrations of selected chemical constituents and physical properties of water from 26 wells in the Indian Head area, 1988.

solids in drinking water is 500 mg/L; above this concentration, some aesthetic impairment of water quality can be perceived (U.S. Environmental Protection Agency, 1988).

Boxplots of the concentration of total organic carbon (TOC) in ground water collected during 1988 and TOC in surface water collected by the USGS from the Potomac River at Indian Head during 1975-88 are shown in figure 27. The median TOC concentration in the ground water is less than about 0.5 mg/L, whereas the median concentration in river water is close to 6 mg/L.

Ground water typically has lower organic-carbon concentrations than surface water because (1) the longer residence times of water in the aquifer system allow organic carbon to be adsorbed onto aquifer matrix materials or oxidized to carbon dioxide and water, and (2) the aquifer matrix generally contains only trace amounts of water-soluble organic carbon (Thurman, 1986, p. 15). The source of much of the organic carbon in rivers and streams is the organic carbon derived from plants and soil matter (Thurman, 1986, p. 85). Consequently, the median TOC concentration in the Potomac River near Indian Head is about 10 times greater than the median TOC concentration in water in the Potomac Group aquifer system (fig. 27).

Mean TOC concentrations during 1988 in water from wells in the Potomac Group aquifer in the Indian Head area are shown in figure 28. The lines of equal concentrations delineate locations of approximately equal TOC concentration. The general location and spatial distribution of elevated TOC concentrations in the aquifer correlates well with the spatial distribution and extent of elevated chloride (fig. 23) and dissolved solids (fig. 26) concentrations in the aquifer. In the confined aquifers at Indian Head, TOC concentrations greater than about 1 mg/L indicate the presence of river water (fig. 27).

Chlorination of water with a significant dissolved-organic carbon concentration produces chloroform and other trihalomethanes (THM) and, in the presence of bromide at concentrations greater than about 0.2 mg/L, brominated species of THM become an important fraction of the total THM production (Thurman, 1986, p. 227). The bromide concentration during 1989 in water from area wells ranged from less than 0.010 to 0.49 mg/L (table 8). The water-treatment industry has developed treatment technologies, such as the addition of ammonia, for water supplies containing significant amounts of dissolved organic carbon. Use of ammonia and chlorine during production of finished water supplies reduces the level of THM production due to the formation of chloroamines, which react more slowly than free chlorine with the organic carbon (Thurman, 1986, p. 228).

Tritium is a radioisotope of hydrogen. It decays purely by beta-particle emission and has a half-life of 12.3 years; it is produced naturally, in very small quantities, by cosmic-ray spallation and by interaction of fast neutrons and nitrogen in the upper atmosphere (Thatcher and others, 1977). Tritium is also a product of thermonuclear-weapons testing that occurred primarily during the late 1950's and early 1960's. By 1954, the concentration of the thermonuclear tritium in the atmosphere was significantly greater than the natural concentration (Thatcher and others, 1977, p. 7).

Ground water entering an aquifer after 1952 can be chronologically dated by correlation of tritium concentrations in the ground water with peak concentrations of fallout (Thatcher and others, 1977, p. 7). The dating of ground water originating as recharge before 1952 is based on computations of the radioactive decay of the natural, original tritium concentration in water. Tritium concentration of the Potomac River at the USGS gage at Point of Rocks, Md., 1961-84, is shown in figure 29. Tritium concentrations in the Potomac River during this period peaked around 1963 and have steadily declined since then. To determine the relative age of ground water with elevated chloride concentrations, water samples were collected from 11 wells in the Indian Head area on August 29, 1988, and analyzed for tritium concentrations: wells CH Bb 9, Bb 12, Bb 19, Bc 6, Bc 23, Bc 67, Cb 9, Cb 11, Cb 28, Cb 34, and Cb 35. These wells were selected for sampling because chloride and dissolved-solids concentrations in water from these wells were higher than background concentrations (table 8) or because the wells were near the Potomac River. The well locations are shown in

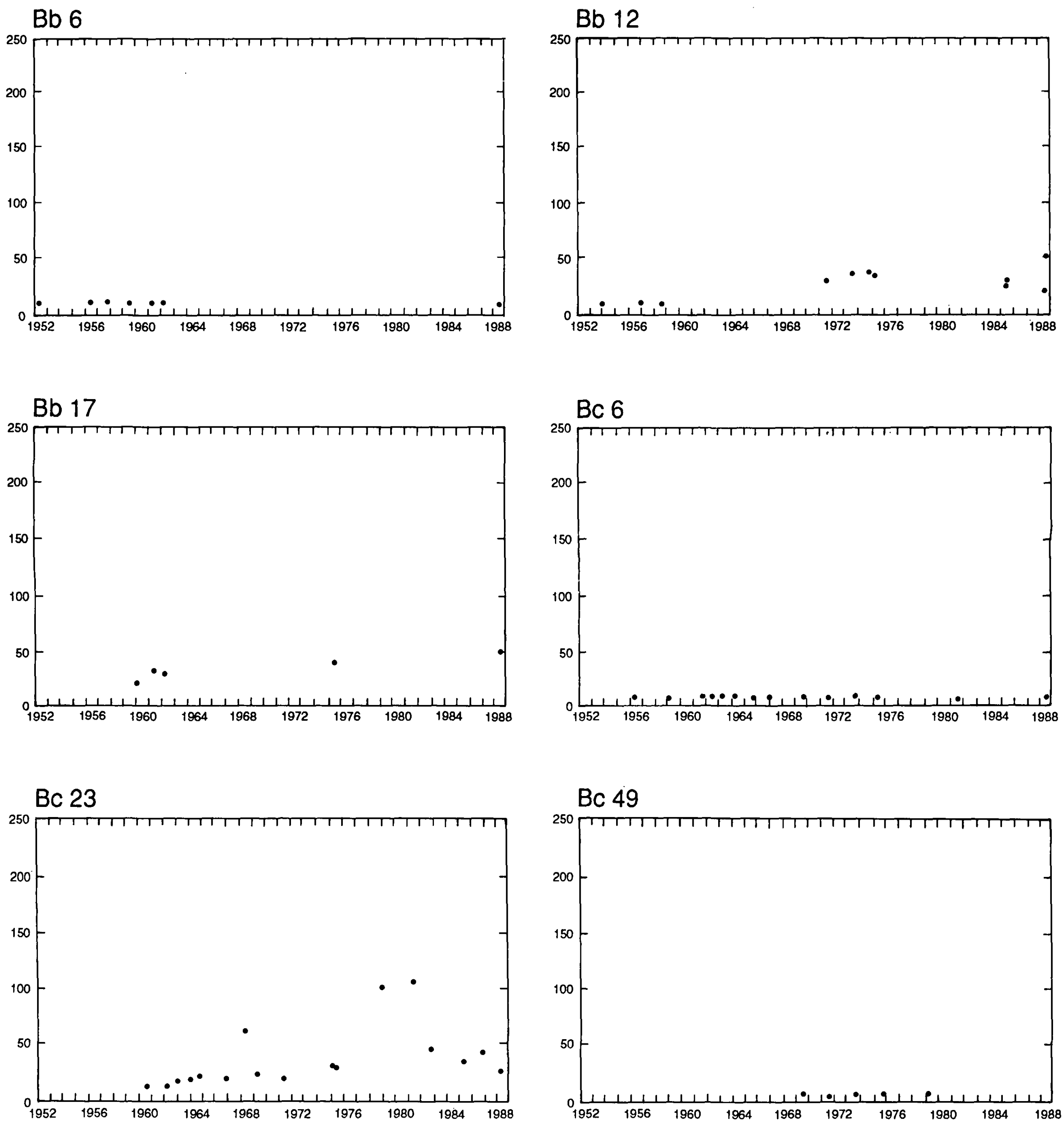


Figure 25. Chloride concentrations in water from selected wells in the Indian Head area, 1938-88.

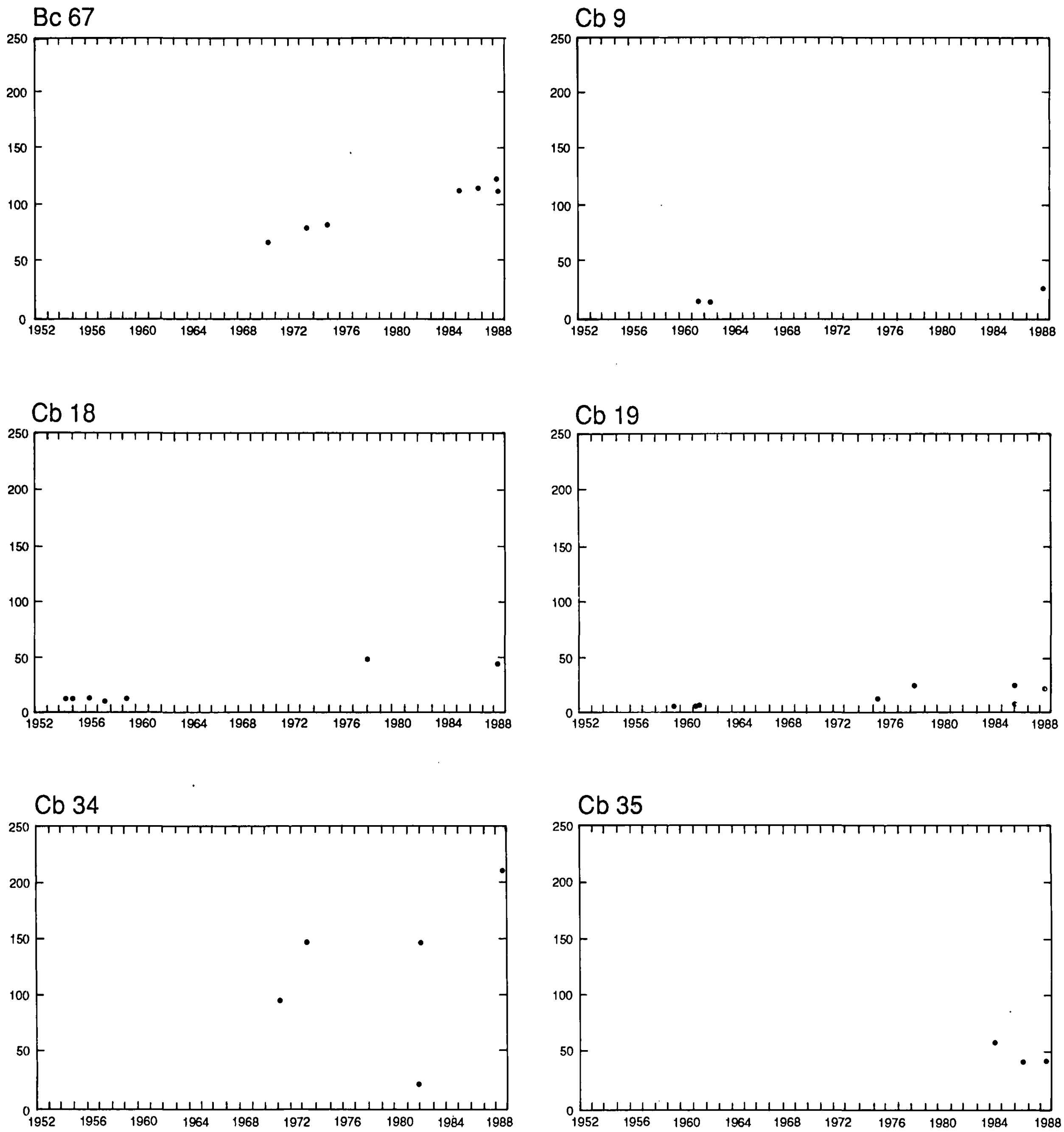
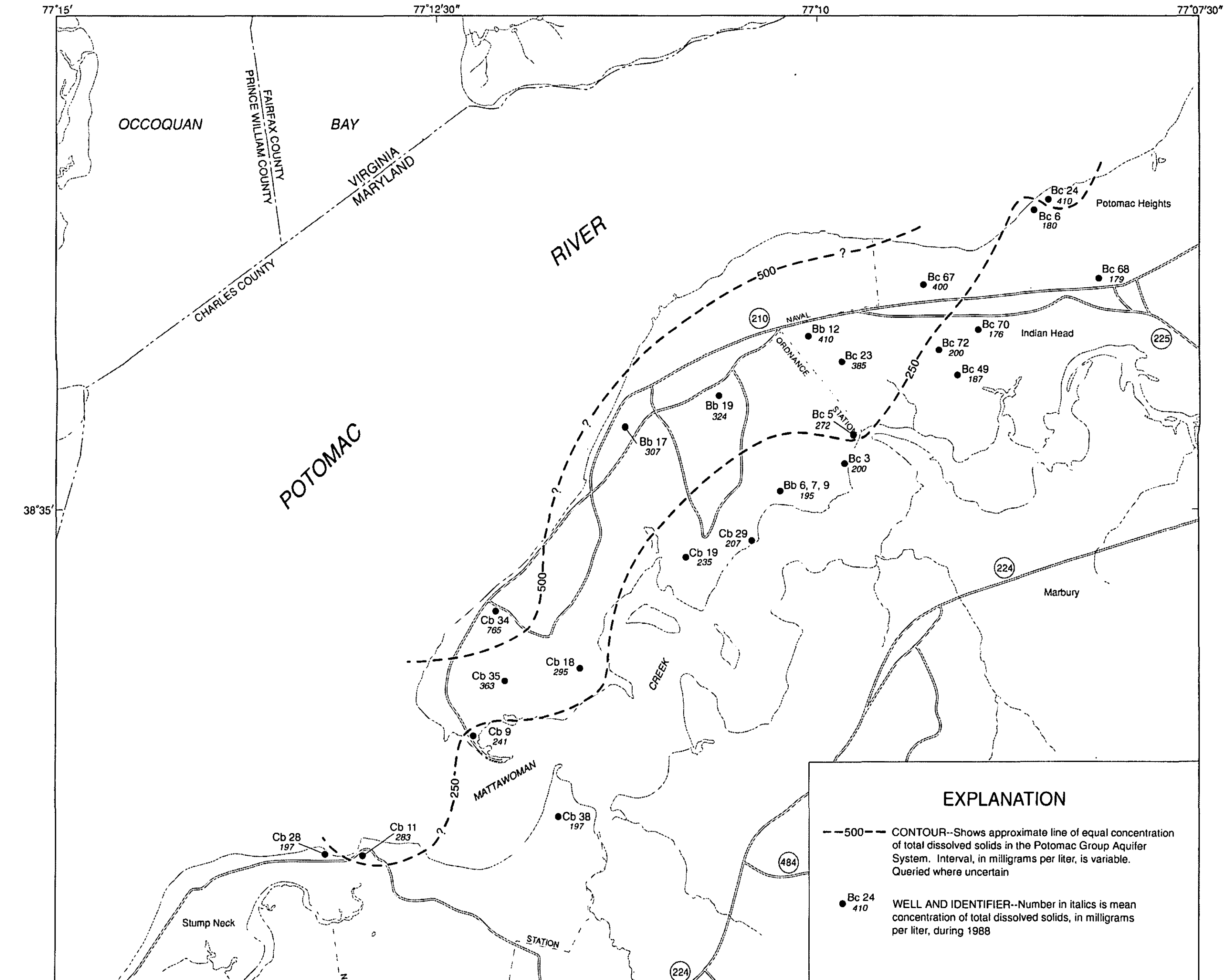


Figure 25. Chloride concentrations in water from selected wells in the Indian Head area, 1938-88--Continued.



Base map from U. S. Geological Survey 1: 24,000
Indian Head Quadrangle

Figure 26. Mean concentration of total dissolved solids in water from wells sampled during 1988.

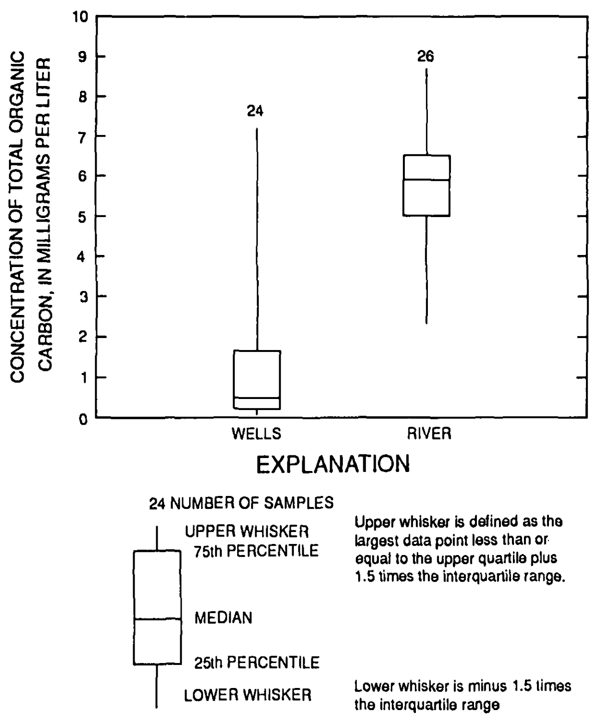


Figure 27. Statistical distribution of concentrations of total organic carbon in water from wells in the Indian Head area during 1988 and in water from the Potomac River at Indian Head during 1975-88.

figures 23, 26, and 28. The tritium concentration in the water from all wells was below the detection limit. This indicates that the high-chloride water withdrawn from these wells in 1988 probably entered the aquifer system before 1952.

On the basis of the low tritium concentrations, the high-chloride ground-water/river-water mixture withdrawn from these wells in 1988 probably entered the aquifer after the regional pumping stresses altered hydraulic gradients (which started the intrusion process), prior to the mid-1950's. Large-scale pumping in this area began about 1920 (fig. 14), and the first evidence of changing ground-water quality was apparent by about 1970 (fig. 22). Therefore, it has taken at least 40 years, and perhaps more than 50 years, for the river water to travel from the point of recharge to the point of discharge at the well. This suggests that even a complete cessation of ground-water withdrawals from the Potomac Group aquifers in the Indian Head area would not have an immediate effect on the spatial distribution and extent of the river-water zone in the ground-water system.

Effects of Erosion of Confining Units

On the basis of borehole data from the Fort McHenry tunnel construction in Baltimore, Md., Chapelle (1985, p. 21) reported that the Pleistocene Patapsco River had eroded and truncated the Arundel Formation in the harbor area. The sediments that were subsequently deposited in the eroded channel were gravel-, sand-, and silt-sized material. Chapelle (1985, p. 67) concluded that the Pleistocene erosional channel provided a conduit for water to leak out of, or into, the underlying Patuxent aquifer because the paleochannel deposit is much more permeable than the Arundel Formation deposits that had been removed. As a consequence of intensive pumping of the Patuxent aquifer near the permeable paleochannel, brackish water intruded the aquifer near the Baltimore industrial area, and, by 1945, a zone of brackish water about 4 mi wide extended into the aquifer near the harbor (Bennett and Meyer, 1952).

In a similar hydrogeologic setting, Phillips (1987) reported that the extent of brackish-water intrusion into the Potomac aquifers in northern Delaware was controlled, in part, by the presence of Pleistocene erosional channels that had truncated aquifer system confining units near centers of large pumping stress. On the basis of core samples from borings in the Delaware River, Phillips (1987) was able to delineate zones where the confining unit in the upper part of the Potomac aquifers had been eroded and replaced by more permeable paleochannel deposits.

Near the Fall Line of Maryland and Virginia, substantial episodes of major erosion and downcutting into the Potomac Group deposits occurred in the vicinity of the Potomac River lowlands. The top of the Patapsco Formation is an erosional surface with local relief greater than 150 ft in the Indian Head area (fig. 10). Hack (1957) and Froelich and others (1978) have shown that, in this area, the ancestral Potomac River incised channels and valleys into the underlying Tertiary and Cretaceous

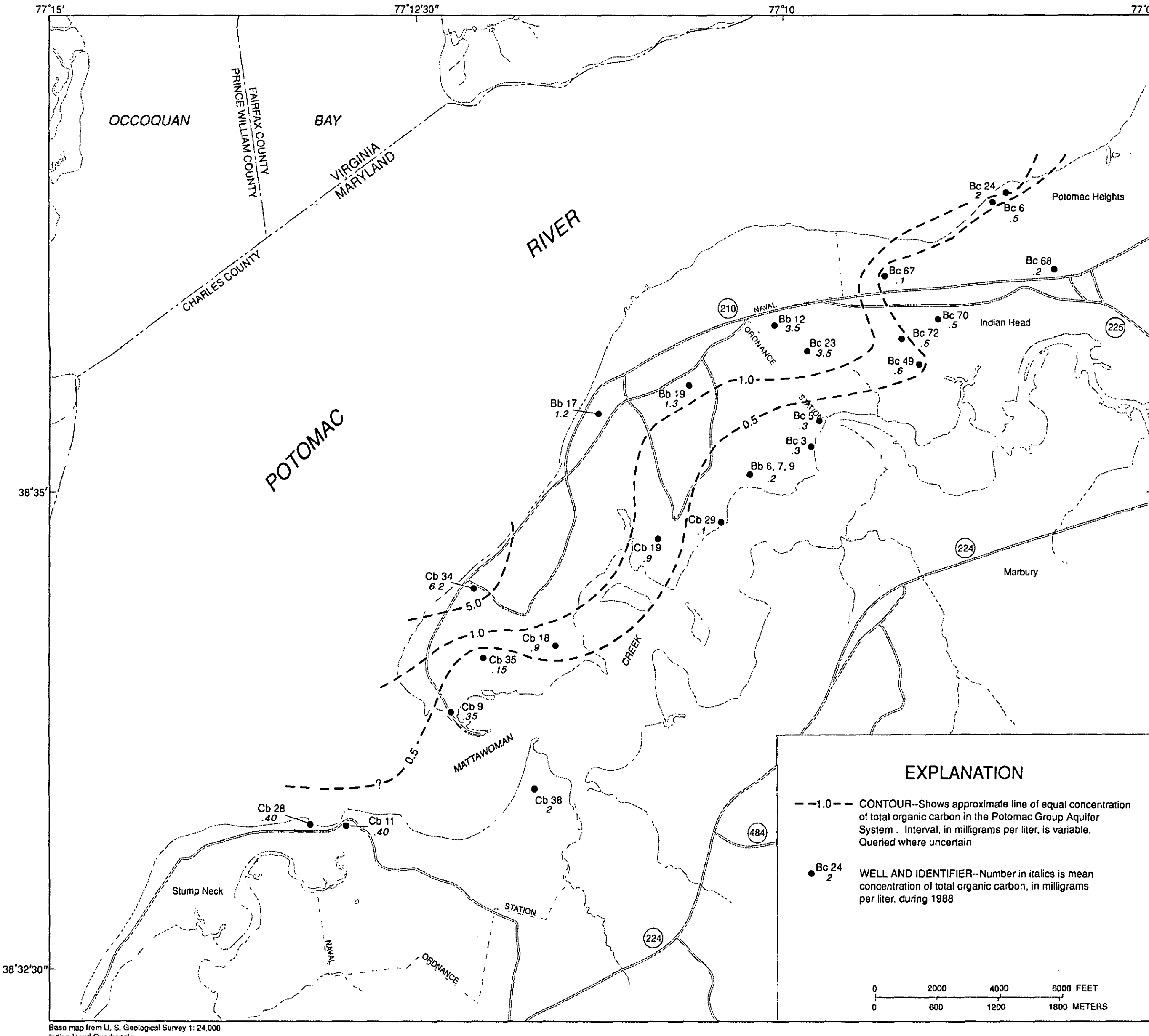


Figure 28. Mean concentration of total organic carbon in water from wells sampled during 1988.

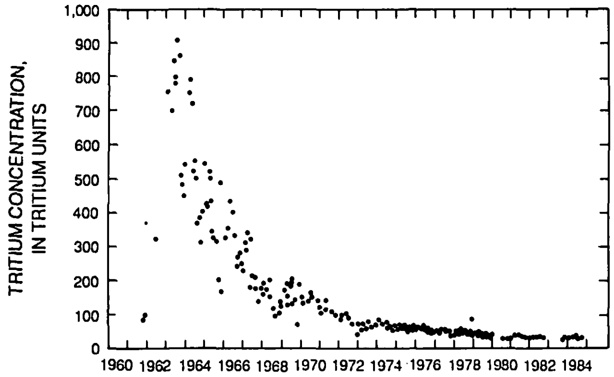


Figure 29. Tritium concentration in water from the Potomac River at Point of Rocks, Md., 1961-84.

sediments that range from 90 to 100 ft below sea level. Knebel and others (1981) have shown that, after the Wisconsinan Potomac River channel was drowned by the rising Holocene sea, it was subsequently filled by sandy and silty fluvial and shallow estuarine sediments.

The contours representing the altitude of the top of the Patapsco Formation (fig. 10) can also be interpreted to represent lines of equal altitude on the base of the paleochannel deposit delineated in the Indian Head area by figure 12. These contours indicate the presence of two erosional channels, cut to different depths, in the Patapsco Formation at Indian Head. This observation supports Hack's (1957, p. 826) earlier conclusion that at least two periods of low sea level were involved in the cutting and filling of drowned tributary valleys of Chesapeake Bay.

The sedimentary framework beneath the Potomac River near Indian Head is not well known. However, a generalized picture of the framework can be constructed using information on paleochannel and modern estuary deposits elsewhere as reported by Froelich and others (1978), Chapelle (1985), and Phillips (1987). During 1978-79, the USGS collected three 12-m-long cores of the river-bottom sediment in the Indian Head area of the Potomac River. The coarse-grained Holocene deposits under the Potomac River near Indian Head are blanketed by a layer of estuarine mud and clay that could function as a confining unit for the underlying deposits. The thickness of the estuarine mud and clay in the cores ranged from 1 m to more than 8 m (Jerry Glenn, U.S. Geological Survey, written commun., 1990).

Dredging operations were conducted in the Potomac River during the mid-1960's at Mattawoman shoal, about 3/4 mi southwest of NOS. The reported depth of dredging was about 21 ft below sea level (fig. 12). Dredging of the river bottom at this shoal could have exposed more permeable deposits at depth under the riverbed; thus, dredging of the Mattawoman shoal could have improved the hydraulic connection between the river and the underlying deposits, possibly increasing the rate of river-water recharge to the confined aquifers in this area.

In 1988, a smaller dredging operation was conducted adjacent to Sweden Point Marina, near the mouth of Mattawoman Creek (fig. 12). This activity could have changed the permeability of the creek bottom. The head difference between the surface-water and ground-water systems is 40 to 50 ft (fig. 20) indicating the potential for downward flow from the creek to the underlying aquifers.

Slaughter and Otton (1968, p. 20) concluded that brackish-water intrusion into the ground-water system had not occurred because the layer of estuarine mud and clay blanketing the river bottom probably had sealed the aquifers from direct contamination by downward movement of river water. However, elevated chloride concentrations were measured in water from several test wells drilled adjacent to the river on the Indian Head peninsula in the mid-1970's (fig. 22).

Most wells that have water with elevated chloride concentrations (fig. 23) are screened in the lower and middle parts of the Patapsco aquifer from about 200 to 300 ft below sea level (table 10). Thus, the elevated chloride concentration in water from well CH Bc 67 (120 mg/L) is anomalous because this well is screened in the deeper Patuxent aquifer, from 458 to 492 ft below sea level (table 3). The elevated concentration of chloride and other river-water indicator constituents in water from well CH Bc 67 indicates that river water is recharging the

Patuxent aquifer in this location, although recharge from a deep source of brackish ground water is not precluded. Similarly, in nearby Mason Neck, Va., a production well (HP 2, see table 4) adjacent to the Potomac River and screened from 400 to 430 ft below sea level yielded water with a chloride concentration of 163 mg/L in 1989 (Craig Cameron, Laboratory Director, Fairfax County Water Authority, written commun. 1990). High-chloride water in the Patuxent aquifer on either side of the river suggests that, in some locations, the Patuxent aquifer is also recharged by downward leakage of river water through overlying deposits.

Well CH Bc 67 is about 1,250 ft south of the Potomac River shoreline (pl. 1) in an area underlain by a paleochannel deposit that fills a valley eroded at least 75 ft below sea level into the Patapsco Formation (figs. 7 and 10). This deposit could be lithologically and hydrologically similar to the paleochannel deposit about 6 mi to the north in Hybla Valley, Va. (Froelich and others, 1978). Well HP 2 is about 1,000 ft north of the river in an area underlain by paleochannel deposits, the base of which ranges from 30 to 80 ft below sea level (Froelich and others, 1978, p. 32-37).

Another possible contributing factor for the elevated chloride concentration in water from well CH Bc 67 is that the axial channel (thalweg) of the modern Potomac River is at least 65 ft to as much as 100 ft deep, and in this area is close to the Maryland shore (fig. 12). This modern deep channel segment is a relatively unburied vestige of the late Wisconsinan Potomac River channel, which was incised during the low stand of sea level associated with the last glacial period.

In the area of Occoquan Bay, to the west of Indian Head (fig. 12), this Wisconsinan channel was subsequently buried by late Pleistocene and Holocene fluvial and estuarine sediments. The 12-meter-long cores collected by the USGS in this area of the estuary provide some rough quantitative knowledge of the type and extent of Holocene and modern estuarine deposits.

In a similar geomorphic region in Delaware, Phillips (1987, p. 26) reported that the vertical hydraulic conductivity of sand and gravel (basal paleochannel deposits) ranged from about 3.8×10^{-4} to 3.3×10^{-2} ft/s. The overlying Holocene deposits in the Delaware River are primarily silt, silty sand, and some gravel and peat. These materials form confining units with vertical hydraulic conductivities that range from 2.9×10^{-10} to 3.3×10^{-5} ft/s (Phillips, 1987, p. 26).

In addition to dredging, large-magnitude floods in the Potomac River can occasionally scour the river bottom in the deep channel near Potomac Heights or in the shoal area of Occoquan Bay (pl. 1). Most surficial river-bottom deposits are estuarine, and consist of organic-rich mud and clay, which could function as a confining unit between the river and the underlying deposits (Slaughter and Otton, 1968, p. 20). Periodic removal or nondeposition of these estuarine river-bottom deposits probably exposes the more permeable paleochannel deposit near the bottom and wall of the modern Potomac River channel (fig. 12). Consequently, the rate of river-water recharge in this part of the estuary could increase if scouring exposes more of the paleochannel deposit below the estuarine mud and clay.

Comparison of the contour values and the zone of ground water with the maximum chemical concentration shown in figures 23, 26, and 28 with the location of the paleochannel deposits shown in figure 12 indicates that the most extensive areas of river-water intrusion at Indian Head are where the paleochannel deposits are contiguous with and adjacent to the Potomac River. The paleochannel deposits are considerably more permeable than the eroded confining units, and the hydraulic connection between the paleochannel deposits and the river would allow substantial river-water inflow in this area. Froelich and others (1978) suggested that pumping of wells drilled into paleochannel deposits contiguous with the Potomac River would probably induce river-water recharge to the aquifer.

SUMMARY AND CONCLUSIONS

This report presents information and data on the hydrogeology of the Coastal Plain deposits in the Indian Head area of northwestern Charles County, Maryland. These data were used to refine the geologic framework of the Potomac Group aquifer system and to estimate the extent of chemical-quality changes in the confined ground-water system in this area. The data are presented in maps and figures that describe the regional hydraulic gradients, chemical quality, and hydrogeologic and stratigraphic framework of the Potomac Group aquifer system. Compilations of data include well characteristics, water-level measurements, and water-quality data for wells in northwestern Charles County, Md., and adjacent areas in Fairfax and Prince William Counties, Va.

Ground-water withdrawals from the Potomac Group aquifer system began in the Indian Head area around 1900. Continual ground-water withdrawals in the Indian Head area during this century, combined with more recent withdrawals immediately to the northeast, have substantially lowered the potentiometric surface of the Potomac Group aquifer system in northwestern Charles County. In 1989, the static water level in the confined aquifers at Indian Head ranged from about 55 to 100 ft below sea level. The cone of depression in the potentiometric surface is roughly centered on the Indian Head peninsula, extends several miles in a northeast-southwest direction, and probably extends a distance of several hundred feet under the Potomac River.

The prepumping water levels in the confined aquifers were above sea level; thus, it is unlikely that the Potomac River was originally a source of recharge to the confined aquifer system. However, continued ground-water withdrawals have altered the natural head gradients and reversed the ground-water-flow direction in the aquifer subcrop area beneath the river. It appears that, during much of this century, water from the Potomac River has provided recharge to the Potomac Group aquifer system in the Indian Head area.

Estimates of the age of the high-chloride ground water, on the basis of low tritium concentrations, indicate that the water withdrawn from wells in 1988 probably recharged the confined aquifer system before 1952. Qualitatively, over the past half century, the river water has gradually mixed with and displaced much of the native ground water in a zone of the aquifer adjacent to the Potomac River shoreline. On a regional scale, a dynamic equilibrium probably exists between the present pumpage which changes slowly from year to year, and the extent and spatial distribution of the river-water zone in 1988. Substantial changes in pumpage magnitude or location can be expected to slowly modify the extent and location of the river-water zone until a new equilibrium is reached.

The specific location of river-water recharge to the confined aquifers is controlled, in part, by the hydraulic gradients, the depth and location of the present-day Potomac River channel, and the type of surficial river-bottom sediment near Indian Head. Another important factor that appears to intensify river-water recharge is the presence of paleo-channel deposits, which fill valleys previously eroded into the underlying Potomac Group aquifer system. There is considerable indirect evidence for preservation of two or more systems of buried channel deposits under and adjacent to the Potomac River estuary or its tributaries in the Indian Head area. The magnitude of river-water recharge to the aquifer system could also be increased in some areas as a result of recent scouring (that is, removal) of low permeability surficial river-bottom deposits by floods or by dredging in the shipping channels.

The background chloride concentration in water in the Potomac Group aquifer system in northwestern Charles County ranges from about 1 to 20 mg/L. In 1988, water in several wells near the Potomac River on the Indian Head peninsula had chloride and dissolved-solids concentrations elevated above background concentrations. The maximum chloride concentration measured in the Potomac Group aquifer system during 1988 was 210 mg/L in water from well CH Cb 34. The chloride concentration in water from the same well in 1971 was 95 mg/L. Most of the wells, having water with higher-than- background chloride concentrations were found in the Patapsco aquifer and are screened from about 200 to 300 ft below sea level. However, water from well CH Bc 67, which is screened in the Patuxent aquifer from 458 to 492 ft below sea level, and from well HP 2 also screened in the Patuxent from 400 to 430 ft below sea level, has higher-than-background chloride and dissolved-solids concentrations. The presence of higher-than-background chloride concentrations in water in the Patuxent aquifer on opposite sides of the river is indirect, but tangible, evidence to suggest that in this area, the Arundel Formation may have been truncated, or at least deeply incised, under this part of the Potomac River.

In the Indian Head area, the chemical quality of water in the Potomac River ranges from fresh to brackish and large changes in dissolved-solids concentration occur in response to substantial changes in the magnitude of fresh-water inflow. Consequently, the quality of the river water which recharges the aquifers can be fresh or brackish. The rate at which river water recharges the aquifers is probably relatively constant in any location, whereas the chemical quality of the recharge can be variable, depending on the conditions that control salinity in the Potomac River estuary. Recharge from a variable-salinity source could allow slugs of differing-quality river water to enter the aquifers. In the areas most affected by river-water intrusion, the dissolved-solids and chloride concentrations have gradually approached the USEPA's secondary maximum contaminant level.

Collectively, figures 23, 26, and 28 document the extent and location of the river water zone in the Potomac Group aquifer system in 1988. These figures also show that the ground-water-quality characteristics in the vicinity of well group no. 1 have not changed significantly compared to the ground-water-quality changes in water from wells affected by the river-water plume. The water-level cone of depression is centered in approximately the same general area of the aquifer where water-quality changes have not occurred (fig. 20), suggesting that native ground-water inflow from the east continues to provide much of the water withdrawn from this group of wells (fig. 13) and other wells located along the eastern, Mattawoman Creek side of the peninsula. Alternatively, pumpage by active-production wells located near the river intercepts and discharges some of the higher-chloride river water, somewhat inhibiting inland movement of the river-water and native ground-water interface.

On a regional scale, the center of the cone of depression is a mixing zone for the river water and the native ground water, which moves radially inward from the surrounding area. The gradual decline of water levels in the Potomac Group aquifers between the Indian Head and Waldorf areas may slightly reduce the rate of native-ground-water inflow to the Indian Head area from the east. Reduced freshwater inflow from the east may lead to relative increases in the amount of river water drawn to some of the production wells along the shore in the Indian Head area, possibly causing an increase in the concentrations of river-water indicator-constituents in water from wells near the shore in the Indian Head area. Ironically, reduced or discontinued pumpage by some of the wells most affected by the river-water intrusion could actually increase the landward extent of the river-water zone, as the river-water continues to migrate toward the center of the cone of depression.

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DATA TABLES

Compiled by Daniel D. Edwards

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*

[USGS, U.S. Geological Survey; ft asl, feet above sea level; ft, feet; in., inches; ft bls, feet below land surface; gal/min, gallons per minute; hrs, hours; (gal/min)/ft, gallons per minute per foot; <, before; -, no information available]

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-	CH-										
Bb 1	-	U.S. Navy	1899	Cable	29	388	8	0-206	8	206-218	Patapsco
							8	218-331	8	331-345	
							8	345-372	8	372-388	
Bb 2	-	U.S. Navy	1902	Cable	27	409	8	0-207	8	207-226	Patapsco
							8	226-293	8	293-333	
							8	333-369	8	369-390	
Bb 3	-	U.S. Navy	1910	Cable	33	432	8	-	-	-	-
Bb 4	-	U.S. Navy	1910	Cable	34	394	8	0-265	8	265-276	Patapsco
							8	276-312	8	312-323	
							8	323-365	8	365-381	
							8	381-385	8	385-394	
Bb 5	-	U.S. Navy	1910	Cable	43	395	8	0-271	8	271-281	Patapsco
							8	281-320	8	320-332	
							8	332-381	8	381-391	
Bb 6	-	U.S. Navy	1915	Cable	38	398	8	0-251	8	251-261	Patapsco
							8	261-301	8	301-311	
							8	311-376	8	376-397	
Bb 7	-	U.S. Navy	1915	Cable	39	419	8	0-255	8	255-265	Patapsco
							8	265-308	8	308-317	
							8	317-377	8	377-399	
Bb 8	-	U.S. Navy	1915	Cable	36	397	8	0-223	8	223-231	Patapsco
							8	231-262	8	262-273	
							8	273-310	8	310-321	
							8	321-372	8	372-394	
Bb 9	-	U.S. Navy	1915	Cable	32	399	8	0-185	8	185-195	Patapsco
							8	195-235	8	235-245	
							8	245-285	8	285-294	
							8	294-355	8	355-376	

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1933	102	173	150	-	2.1	D	A, C	A	U.S. Navy; well group no. 1; well no. 1	CH-Bb 1
1945	-	220	-	-	-					
1910	-	-	145	-	-	D	A, C	A	U.S. Navy; well group no. 1; well no. 2	Bb 2
1933	97	129	134	-	4.2					
1944	-	-	70	-	-					
1956	-	-	60	-	-					
1910	-	-	35	-	-	-	-	A	U.S. Navy; well group no. 1; well no. 3; former observation well	Bb 3
1952	184.12	-	-	-	-					
1910	-	-	140	-	-	D	B, C	A	U.S. Navy; well group no. 1; well no. 4	Bb 4
1933	118	167	143	-	2.9					
1944	-	-	80	-	-					
1956	-	-	60	-	-					
1910	-	-	140	-	-	D	A, C	A	U.S. Navy; well group no. 1; well no. 5	Bb 5
1933	116	155	124	-	3.2					
1953	-	-	125	-	-					
1954	-	-	127	-	-					
1956	-	-	115	-	-					
1961	-	-	85	-	-					
1981	138.25	-	-	-	-					
1933	130	199	248	-	3.6	D	B, C	P	U.S. Navy; well group no. 1; well no. 6	Bb 6
1945	-	220	-	-	-	E				
1953	-	-	100	-	-					
1956	-	-	90	-	-					
1959	146	212	-	-	-					
1960	-	-	100	-	-					
1981	-	-	50	-	-					
1933	134	196	154	-	2.5	D	A, C	P	U.S. Navy; well group no. 1; well no. 7	Bb 7
1945	-	-	120	-	-	E				
1953	-	-	120	-	-					
1956	-	-	120	-	-					
1960	-	-	117	-	-					
1961	-	-	95	-	-					
1980	-	-	90	-	-					
1933	127	173	212	-	4.6	D	B, C	A	U.S. Navy; well group no. 1; well no. 8	Bb 8
1945	-	-	155	-	-	E				
1953	-	-	80	-	-					
1956	-	-	100	-	-					
1960	178	226	-	-	-					
1981	120	-	-	-	-					
1933	134	150	126	-	7.9	D	A, C	P	U.S. Navy; well group no. 1; well no. 9	Bb 9
1945	-	-	110	-	-	E				
1953	-	-	95	-	-					
1956	-	-	110	-	-					
1960	150	246	110	-	-					

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH- Bb 10	CH- -	U.S. Navy	1920	Cable	26	1,200	-	-	-	-	-
Bb 11	11906	U.S. Navy	1952	Cable	82	542	8 8	1-263 279-347	8 8	263-279 347-378	Patapsco
Bb 12	13284	Town of Indian Head	1953	Rotary	95	515	10 10 10	2-238 245-248 260-288	10 10	238-245 248-260 288-298	Patapsco
Bb 13	14260	U.S. Navy	1953	Rotary	19	456	-	-	-	-	-
Bb 14	11907	U.S. Navy	1952	Cable	29	452	8 8 8	0-209 234-336 350-437	8 8 8	209-234 336-350 437-452	Patapsco
Bb 15	21710	U.S. Navy	1955	Rotary	29	600	-	-	-	-	-
Bb 16	22351	U.S. Navy	1956	Rotary	52	600	-	-	-	-	-
Bb 17	-	U.S. Navy	1957	Rotary	52	330	16 10	0-230 230-240	10	240-294	Patapsco
Bb 18	710023	U.S. Navy	1970	Rotary	88	405	6	0-320	6	320-360	Patapsco
Bb 19	720122	U.S. Navy	1972	Rotary	90	405	20 12	0-250 250-270	12	270-380	Patapsco
Bb 20	710057	U.S. Navy	1971	Rotary	50	408	6	0-199	6	199-224	Patapsco
Bb 21	710021	U.S. Navy	1970	Rotary	115	405	6	0-200	6	200-230	Patapsco
Bb 22	880847	U.S. Navy	1989	Rotary	98	700	2	0-200 205-220	2	200-205	Patapsco
Bc 1	-	U.S. Navy	1918	Cable	14	396	-	-	-	-	-
Bc 2	-	U.S. Navy	1918	Cable	17	409	8	-	-	-	-

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
-	-	-	-	-	-	D	-	A	U.S. Navy; well group no. 1; well no. 15A; test hole drilled to basement	CH- Bb 10
1952	156.96	-	25	-	-	D	-	A	U.S. Navy; well no. 20	Bb 11
1953	149	203.5	220	8	4.0	D	E	P	Owner's well no. 1	Bb 12
-	-	-	-	-	-	D	E	A	U.S. Navy; well no. 6; test hole	Bb 13
1952	159	340	128	24	.7	D	A, C	A	U.S. Navy; well group no. 1; well no. 1A	Bb 14
1955	195	-	25	4	-	D	C	A	U.S. Navy; well no. 13; test hole D	Bb 15
1956	100	-	300	4	-	D	A,C	A	U.S. Navy; well no. 23A; test hole E	Bb 16
1957 1960 1963	105 - 200	- - -	500 450 -	24 - -	- - -	C, D G	B, D E	O	U.S. Navy; well no. 23B; observation well, May 1988 to present	Bb 17
1970	128	227	226	24	2.3	D, E	E	A	Matz-Childs & Assoc.; test well no. 2; aquifer-test results available	Bb 18
1972	150	248	500	24	5.1	D, E	E	P	U.S. Navy; well no. 2A	Bb 19
1971	83	182	250	24	2.5	D	-	A	Matz-Childs & Assoc.; test well no. 3A	Bb 20
1970	150	199	100	24	2.0	D, E	E	A	Matz-Childs & Assoc.; test well no. 4; aquifer-test results available	Bb 21
1990	130	-	-	-	-	C, D, E, G, O	-	O	Continuous core drilled by USGS	Bb 22
1933 1952 1961 1981	- 152 133 81	- - - -	86 - - -	- - - -	6.6 - - -	-	-	A	U.S. Navy; well group no. 2; well no. 10	Bc 1
1933 1938 1942 1953 1956	- - 124 - -	- - - - -	100 132 - 100 100	- - - - -	- 10.2 - - -	- -	B, D E	A	U.S. Navy; well group no. 2; well no. 11; water-level records for the period 1961-75; well sealed Nov. 20, 1975	Bc 2

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bc 3	-	U.S. Navy	1918	Cable	19	390	8	-	-	-	-
Bc 4	-	U.S. Navy	1918	Cable	33	393	8	-	-	-	-
Bc 5	-	U.S. Navy	1918	Cable	39	430	8	-	-	-	-
Bc 6	-	Potomac Heights Mutual Home Owners Association	1941	Rotary	65	417	18 8	0-350 350-362	8	362-412	Patapsco
Bc 7	-	R.L. Teates	1939	Cable	-	290	3	-	-	-	-
Bc 8	-	E.G. Dodd	1917	Cable	38	90	3	-	-	-	-
Bc 9	-	Harry N. Rees	<1938	Cable	125	-	-	-	-	-	-
Bc 10	-	Louise Brown	1919	Dug	125	39	36	-	-	-	-
Bc 11	-	-	-	Dug	20	13	-	-	-	-	-
Bc 1	4720	Ford's Wonder Bar	1949	Rotary	156	234	6	0-228	-	-	-
Bc 13	8452	Aubry W. Posey	1951	Cable	130	260	6	0-260	-	-	-
Bc 14	8742	John W. Jenkins	1952	Cable	170	500	6	0-500	-	-	-
Bc 15	11904	U.S. Navy	1952	Cable	77	258	8 8	0-242 250-258	8	242-250	Patapsco
Bc 16	11905	U.S. Navy	1952	Cable	80	450	8	-	8	345-361	Patapsco
Bc 17	11905	U.S. Navy	1952	Cable	73	450	8 8	0-345 361-450	8	345-361	Patapsco
Bc 18	-	Edward Taylor	1940	-	145	267	6	-	-	-	-

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
										CH-
1938	-	-	242	-	4.7	-	A, D	P	U.S. Navy; well group no. 2; well no. 12	Bc 3
1953	-	-	133	-	-			E		
1956	-	-	120	-	-					
1960	-	251	115	-	-					
1968	-	-	87	-	-					
1938	-	-	304	-	4.9	-	-	A	U.S. Navy; well group no. 2; well no. 13	Bc 4
1952	67.2	-	-	-	-					
1953	-	-	100	-	-	C, G	A, D	O	U.S. Navy; well group no. 2; well no. 14; observation well, May 1988 to present	Bc 5
1956	-	-	120	-	-		E			
1960	-	234	130	-	-					
1941	-	-	385	-	6.0	D	B, D	P	Owner's well no. 1	Bc 6
1945	174.5	238.5	-	-	-		E			
1960	104	250	365	-	2.5					
-	-	-	-	-	-	-	-	-	Well supplied 19 homes in 1946; location unknown	Bc 7
-	-	-	-	-	-	-	-	A	Well supplied 12 homes in 1946	Bc 8
-	-	-	-	-	-	-	-	A		Bc 9
1946	30	-	-	-	-	-	-	A	Observation well from Nov. 1946 through Dec. 1952	Bc 10
1947	10.5	-	-	-	-	-	-	A		Bc 11
1949	125	160	12	3	.3	D	A	-		Bc 12
1951	120	140	10	3	5.0	D	-	-		BC 13
1952	120.5	-	-	-	-					
1952	190	250	12	-	.2	D	-	-		Bc 14
1952	120.12	-	-	-	-	D	D	A	U.S Navy; well no. 22; abandoned test well	Bc 15
1961	128.05	-	-	-	-					
-	-	-	-	-	-	-	-	A	U.S. Navy; well no. 23; replaced by well no. 21; well sealed	Bc 16
1961	158.54	-	-	-	-	D, G	-	A	U.S. Navy; well no. 21; replaced CH Bc 16; water-level data from 1960 through 1985	Bc 17
1981	138.01	-	-	-	-					
-	125	200	18	18	.2	-	-	D		Bc 18

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bc 19	-	Cliff Pierce	1952	Dug	12	16	36	-	-	-	-
Bc 20	6962	K. Raby	1952	Jetted	125	284	3	0-265	-	-	-
Bc 21	21711	U.S. Navy	1956	Rotary	58	600	-	-	-	-	-
Bc 22	41840	H. Milman	1961	Rotary	145	281	4 2	0-252 252-271	2	271-281	Patapsco
Bc 23	30288	Town of Indian Head	1958	Rotary	65	352	16 10 8 8 8	0- 60 0-228 250-262 270-280 292-305	8 8 8 8	229-250 262-270 280-292 305-311	Patapsco
Bc 24	20874	Potomac Heights Mutual Home Owners Association	1955	Rotary	72 10	446	10 10	0-384 399-415	10 10	384-399 415-435	Patapsco
Bc 25	22540	B. Hancock	1956	Cable	22	255	6	0-251	-	-	-
Bc 26	30031	M. Kirkland	1958	Cable	80	223	6	0-222	-	-	-
Bc 27	15410	F. Moody	1954	Cable	72	388	4	0-388	-	-	-
Bc 28	10744	M. Wheeler	1952	Cable	152	342	5	0-333	5	333-342	Patapsco
Bc 29	13628	J. Warder	1953	Rotary	172	442	4 2 2 2	0-210 215-383 388-423 428-441	2 2 2	210-215 383-388 423-428	Patapsco
Bc 30	8566	R. Lewis	1951	Cable	23	237	6	0-232	-	-	-
Bc 31	12872	J. Ely	1953	Cable	33	293	6	0-283	-	283-293	Patapsco
Bc 32	25315	J. Ely	1956	Rotary	33	321	4 2	0-278 288-307	4 2	278-288 307-312	Patapsco
Bc 33	35668	D. Gelzer	1959	Rotary	80	421	4 2	0-195 195-411	2	411-421	Patapsco
Bc 34	-	D. Gelzer	1954	Dug	75	26	20	0- 26	-	-	-
Bc 3	24943	D. Gelzer	-	Dug	78	25	48	-	-	-	-
Bc 36	24943	A. Teske	1956	Rotary	121	275	4 2	0-250 250-270	2	270-275	Patapsco
Bc 37	12170	M. Johnson	1953	Cable	122	260	6	0-256	6	256-260	Patapsco

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1952	8.72	-	-	-	-	-	-	D		CH-Bc 19
1952	118	125	5	6	0.7	D	-	D		Bc 20
1956	150	-	25	4	-	D	-	A	U.S. Navy; test hole C	Bc 21
1961	145	220	20	4	.3	D	D	D		Bc 22
1958	141	206	240	24	3.7	D	E	P	Owner's well no. 2; aquifer-test results available	Bc 23
1955	122	135	250	4	19.2	D, G	E	O	Owner's well no. 2; observation well May 1988 to present	Bc 24
1956	55	150	10	7	.1	D	-	-		Bc 25
1958	83	120	15	4	.4	D	-	-		Bc 26
1954	70	80	6	15	.6	D	-	-		Bc 27
1952	132	135	16	12	5.3	D	-	-		Bc 28
1953	97	160	4.5	6	.1	D	-	-		Bc 29
1951	48	100	20	8	.4	D	-	-		Bc 30
1953	110	140	30	10	1.0	D	-	A		Bc 31
1956	90	225	30	4	.2	D	-	A		Bc 32
1959 1960	110 105.39	170 -	12 -	4 -	.2 -	D	-	-		Bc 33
1960	18.51	-	-	-	-	-	-	A		Bc 34
1960	20.66	-	-	-	-	-	-	A		Bc 35
1956	125	205	13	4	.2	D	-	-		Bc 36
1953	105	160	13	4	.2	D	-	D		Bc 37

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bc 38	33724	J. Scomoni	1959	Rotary	122	486	4	0-274	2	275-280	Patapsco
							2	269-275	2	476-481	
							2	280-476			
							2	481-486			
Bc 39	33286	R. Jenkins	1959	Rotary	120	491	4	0-230	2	486-491	Patuxent
							2	224-486			
Bc 40	37153	M. Bowie	1959	Rotary	125	480	4	0-252	2	470-480	Patuxent
							2	240-470			
Bc 41	31974	Bessenyey	1958	Cable	50	281	6	0-263	6	263-281	Patapsco
Bc 42	13831	Bragunier	1954	Rotary	160	547	4	0-210	2	212-212	Patapsco
							2	210-212	2	391-396	
							2	217-391	2	514-519	
							2	396-514	2	535-540	
							2	519-535			
Bc 43	-	-	-	Dug	172	35	20	0- 35	-	-	-
Bc 44	15286	Green Meadows Water Co.	1954	Rotary	172	612	4	2-410	2	580-595	Patuxent
							2	410-580			
							2	595-612			
Bc 45	17128	Green Meadows Water Co.	1954	Rotary	175	590	4	0-320	2	580-590	Patuxent
							2	320-580			
Bc 46	19008	J. Jenkins	1955	Rotary	182	639	4	0-332	2	-	-
							2	325-639			
Bc 47	-	C. Branson	-	Dug	38	10	24	0- 10	-	-	-
Bc 48	-	J. Morton	1942	-	22	19	-	0- 19	-	-	-
Bc 49	28980	Town of Indian Head	1958	Cable	33	404	8	0-340	8	340-350	Patapsco
							8	350-355	8	355-365	
							8	365-384	8	384-404	
Bc 50	41917	Gilbert Hyatt, Jr.	1961	Jetted	35	184	2	0-147	1	169-184	Patapsco
									1	147-169	
Bc 51	44247	St. Mary's Star of the Sea	1961	Rotary	172	637	4	0-344	3	618-637	Patuxent
							2	344-618			
Bc 52	43258	D. Ford	1961	Cable	157	431	6	0-421	6	421-431	Patapsco
Bc 53	44383	Dr. Frank Susan	1961	Rotary	78	331	4	2-296	2	317-321	Patapsco
							2	296-317			
Bc 54	44629	E. Jenkins	1961	Rotary	184	635	6	0-256	4	620-635	Patuxent
							4	239-620			
Bc 55	45048	F. Zihlman	1962	Rotary	145	535	4	0-325	3	523-534	Patapsco
							2	295-523			

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1959	120	220	20	4	0.2	D	-	D		CH-Bc 38
1959	127	210	12	4	.1	D	-	D		Bc 39
1959	130	160	18	4	.6	D	-	D		Bc 40
1958	60	170	70	8	.6	D	-	D		Bc 41
1954	93	140	5	4	.1	D	-	-		Bc 42
1960	23	-	-	-	-	-	-	-		Bc 43
1954	160	180	10	4	.5	D	-	-		Bc 44
1954	156	182	10	4	.6	D	-	-		Bc 45
1955	170	245	30	4	.4	D	-	-		Bc 46
1960	6	-	-	-	-	-	-	-		Bc 47
1960	10	-	-	-	-	-	-	-		Bc 48
1958	52	160	190	48	1.8	D	E	P	Owner's well no. 6; Woodland Village well no. 2	Bc 49
1961	50	68	7	10	.4	D	-	-		Bc 50
1961	190	230	30	4	.8	D	-	-		Bc 51
1961	170	250	20	3	.3	D	-	-		Bc 52
1961	84	106	15	4	.7	D	-	-		Bc 53
1961	90	400	35	4	.1	D	-	-		Bc 54
1962	155	250	20	6	.2	D	-	P		Bc 55

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH- Bc 56	CH- 44738	B. Wright	1961	Rotary	160	388	4 2	0-253 253-378	2	378-388	Patapsco
Bc 57	48471	M. Sansbury	1962	Rotary	12	199	2	2-194	2	194-199	Patapsco
Bc 58	48472	D. Cane	1962	Rotary	13	205	2	0-200	2	200-205	Patapsco
Bc 59	48473	R. Thompson	1962	Rotary	12	188	2	2-183	2	183-188	Patapsco
Bc 60	36323	G. Thompson	1959	Rotary	90	438	4 2	0-196 186-428	2	428-438	Patapsco
Bc 61	56515	Potomac Heights Mutual Home Owners Association	1964	Rotary	70	875	4 2	0-246 246-439	2	439-444	Patapsco
Bc 62	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	50	540	6 6 6	0-414 424-444 464-494	6 6 6	414-424 444-464 494-514	Patapsco
Bc 63	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	48	470	6	0-144	6	144-174	Patapsco
Bc 64	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	48	540	6 6 6	0-414 424-444 464-494	6 6 6	414-424 444-464 494-514	Patuxent
Bc 65	660043	Jenkins Lane Water Company	1966	Rotary	176	622	6 4	0-434 420-589	4	589-619	Patuxent
Bc 66	720028	Pomonkey Water Company	1971	Rotary	155	648	6 4	0-430 420-618	4	618-639	Patuxent
Bc 67	720053	Town of Indian Head	1971	Rotary	30	522	10 5 5	0-410 410-488 498-511	5 5	488-498 511-522	Patuxent
Bc 68	670051	Potomac Heights Mutual Home Owners Association	1967	Rotary	75	540	20 8 8 8	0-381 359-414 424-444 464-494	8 8 8	414-424 444-464 494-514	Patuxent
Bc 69	732078	Town of Indian Head	1978	Rotary	68	619	-	-	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1961	168	228	15	4	0.3	D	-	D		CH-Bc 56
1962	18.6	60	20	4	.5	D	-	D		Bc 57
1962	23	70	17	5	.5	D	-	D		Bc 58
1962	10	65	20	6	.4	D	-	-		Bc 59
1959	100	-	18	4	-	D	-	-		Bc 60
1964	122	-	6	48	-	D, E G	-	A	Test well; sealed	Bc 61
1966	125	250	200	8	1.6	D	E	-		Bc 62
1966	88	160	55	16	.8	D	-	A	Test well; sealed	Bc 63
1966	125	250	200	8	1.6	D	-	A	Test well for CH Bc 68; sealed	Bc 64
1966	192	220	24	8	.9	D	-	-		Bc 65
1971	190	206	43	12	2.7	D	-	-		Bc 66
1971	102	181	300	24	3.8	D	E	P	Owner's well no. 3; aquifer-test results available	Bc 67
1967	148	288	517	24	3.7	D	E	P	Owner's well no. 3	Bc 68
1978	-	-	-	-	-	E, G	-	A	Test hole	Bc 69

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CH- Bc 70	CH- 732329	Town of Indian Head	1979	Rotary	35	483	8 8	0-372 392-412	8 8	372-392 412-442	Patapsco
Bc 71	732415	Town of Indian Head	1979	Rotary	30	440	2	0-400	2	400-410	Patapsco
Bc 72	810922	Town of Indian Head	1984	Rotary	34	500	12 6 6 6 6	0-220 220-224 254-284 304-334 347-360	6 6 6	224-254 284-304 334-347	Patapsco
Bc73	710022	U.S. Navy	1970	Rotary	55	408	-	-	-	-	-
Bc 74	812919	Montrose Height Subd.	1988	Rotary	165	748	4 2 2 2 2	0-435 435-550 566-574 589-637 642-748	2 2 2	550-566 574-589 637-642	Patuxent
Bd 1	-	Pomonkey Elementary School	1945	Cable	180	292	8 6	-	-	-	-
Bd 2	-	J. W. Key	1898	Dug	180	25	36	0- 25	-	-	-
Bd 3	-	W. H. Thompson	-	Dug	187	24	36	-	-	-	-
Bd 4	-	Pearl Mason	-	Dug	180	20	32	-	-	-	-
Bd 5	-	J. W. Clark	1920	Dug	180	18	32	-	-	-	-
Bd 6	-	-	-	Dug	170	9	43	-	-	-	-
Bd 7	-	N. Robie	<1940	Dug	180	30	42	-	-	-	-
Bd 8	-	N. Robie	1929	Dug	183	26	36	-	-	-	-
Bd 9	-	Mitchel	<1935	Dug	200	20	36	-	-	-	-
Bd 10	-	-	-	Dug	200	19	-	-	-	-	-
Bd 11	6963	Pomonkey Elementary School	1950	Cable	180	269	6	0-259	6	259-269	Magothy
Bd 12	-	John H. Mulholland Corp.	-	-	140	-	-	-	-	-	-
Bd 13	7257	P. Pfisterer	1951	-	140	200	6	0-179	-	-	-

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
										CH-
1979	80	306	96	24	0.4	D, E G	E	P	Owner's well no. 4	Bc 70
1979	82	250	17	5	.1	D, E	-	-	Observation well Sept. 1981 to present	Bc 71
1984	96	156	160	24	2.7	D, E	E	P	Owner's well no. 5; Woodland Village no. 2	Bc 72
-	-	-	-	-	-	D, E	-	A	Matz, Childs & Assoc.; Test well no. 3; sealed	Bc 73
1988	-	256	53	24	2.1	D,G	-	T		Bc 74
-	-	-	-	-	-	-	-	P		Bd 1
1946	20	-	-	-	-	-	-	-		Bd 2
1946 1960	18 15	-	-	-	-	-	-	D		Bd 3
1946 1960	15 15	-	-	-	-	-	-	D		Bd 4
1946	13.4	-	-	-	-	-	-	-	Observation well Nov. 1946 through Oct. 1947	Bd 5
1947	3.2	-	-	-	-	-	-	-	Site of old Benfield Schoold	Bd 6
-	-	-	-	-	-	-	-	-		Bd 7
1947	18	-	-	-	-	-	-	-		Bd 8
1945	18	-	-	-	-	-	-	-		Bd 9
1947	13.6	-	-	-	-	-	-	-		Bd 10
1950	150	210	25	8	.4	D	-	P		Bd 11
1950	-	-	17	-	-	-	-	-	Spring	Bd 12
1951	47	198	3	-	.1	D	-	D		Bd 13

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bd 14	Oil & Gas 8	J. H. Willett	1954	Cable	192	1,177	8	-	-	-	Patuxent
Bd 15	14997	U.S. Army Corps of Engineers	1954	Cable	205	334	6	0-324	6	324-334	Aquia
Bd 16	16856	Indian Head Manor	1954	Rotary	180	506	4 2 2 2	0-338 329-412 422-454 459-506	2 2	412-422 454-459	Patapsco
Bd 17	16857	Indian Head Manor	1954	Rotary	170	460	4 2 2	0-297 288-411 416-455	2 2	411-416 455-460	Patapsco
Bd 18	22911	Indian Head Manor	1956	Rotary	178	673	6 4	0-404 390-662	4	662-673	Patuxent
Bd 19	17938	E. Dutton	1955	Rotary	165	640	4 2	0-300 293-629	2	629-640	Patapsco
Bd 20	32983	A. Branning	1958	Rotary	12	224	2	0-219	2	219-224	Patapsco
Bd 21	-	-	-	Dug	178	13	20	-	-	-	-
Bd 22	21161	S. Hampton Village	1956	Rotary	175	651	6 4	0-352 344-627	4	627-644	Patuxent
Bd 23	26304	Pomonkey High School	1957	Cable	173	270	8	0-252	8	252-270	Patapsco
Bd 24	14669	A. Lund	1954	Rotary	178	301	4 2 2 2	0-238 238-243 248-258 268-299	2 2	243-248 258-268	Patapsco
Bd 25	30448	A. Lund	1958	Rotary	178	301	4 2 2 2	0-229 229-240 245-257 267-301	2 2	240-245 257-267	Patapsco
Bd 26	-	-	-	Dug	175	24	36	-	-	-	-
Bd 27	-	E. Jones	1950	Dug	195	17	20	-	-	-	-
Bd 28	43458	USGS	1961	Augered	185	58	4	-	-	-	-
Bd 29	42481	N. Indian Head Estates	1961	Rotary	170	626	6 4 4	0-445 445-570 620-626	4	570-620	Patuxent
Bd 30	44610	R. Speake	1961	Rotary	175	672	4 2	2-293 293-656	2	656-671	Patuxent

	Water level		Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1962	190.8	-	-	-	-	D	-	T	Oil and gas test hole	CH-Bd 14
1954	170	300	25	24	0.2	D	B, C D	P		Bd 15
1954	160	205	25	4	.6	D	-	P		Bd 16
1954	160	220	27	4	.5	D	-	P		Bd 17
1956	168	276	63	4	.6	D	-	P		Bd 18
1955	169	293	7	-	.1	D	-	D		Bd 19
1958	13	60	15	4	.3	D	-	D		Bd 20
1960	10	-	-	-	-	-	-	-		Bd 21
1956	179	255	60	4	.8	D	-	P		Bd 22
1957	125	190	45	12	.7	D	-	P		Bd 23
1954	107	131	10	6	.4	D	-	P		Bd 24
1958	146	186	20	4	.5	D	-	P		Bd 25
1960	19	-	-	-	-	-	-	-		Bd 26
1960	12	-	-	-	-	-	-	D		Bd 27
1961	14	-	-	-	-	D	-	T		Bd 28
1961	180	220	126	4	3.2	D	-	P		Bd 29
1961	185	245	30	4	.5	D	-	P		Bd 30

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-	CH-										
Bd 31	45830	L. Ullman	1962	Rotary	177	879	4 2	0-304 304-863	2	863-879	Patapsco
Bd 32	670085	J.C.P. High School	1967	Rotary	175	660	6	0-648	6	648-660	Patapsco
Bd 33	660079	Potomac Utilities	1966	Rotary	180	654	18 10	0-460 415-536	10 10 10	536-556 561-586 556-561	Patapsco
Bd 34	720151	E. Dutton	1972	Rotary	170	920	6 4	0-375 362-839	5 2 4 2	839-859 875-905 859-869 864-875	Patapsco
Bd 35	720050	Potomac Utilities	1973	Rotary	175	666	20 10	0-550 495-595	10	595-645	Patuxent
Bd 36	731127	R. Stockman	1976	Rotary	180	363	4	0-353	4	353-363	Patapsco
Bd 37	731819	Green Park LTD	1978	Rotary	195	591	4 2 2 2 2 2 2	0-362 354-488 493-501 506-514 519-555 560-564 569-591	2 2 2 2 2	488-493 501-506 514-519 555-560 564-569	Patapsco
Bd 38	732270	Berry Rd. Joint Venture	1980	Rotary	200	875	6 4	0-680 610-696	4	696-721	Patapsco
Bd 39	732377	Cherry Walk Joint Venture	1979	Rotary	200	900	6 4 4 4 4 4	0-560 550-738 756-769 774-825 846-866 886-900	4 4 4 4	738-756 769-774 825-846 866-886	Patapsco
Bd 40	732417	Berry Rd. Joint Venture	1979	Rotary	185	904	4 2 2 2	0-492 438-736 741-825 846-904	3 3	736-741 825-846	Patapsco
Bd 41	710093	Avon Crest Corp.	1972	Rotary	200	521	6	0-408	-	408-521	Patapsco
Bd 42	732377	Cherry Walk Joint Venture	1979	Rotary	200	900	4 2 2 2 2 2	0-470 462-738 754-769 774-825 846-867 878-900	3 3 3 3	738-754 769-774 825-846 867-878	Patapsco
Bd 43	732377	Cherry Walk Joint Venture	1979	Rotary	200	907	4 2 2 2	0-491 479-741 757-832 848-907	3 3	741-757 832-848	Patapsco

	Water level		Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1962	195	260	8	5	.1	D	-	D		CH-Bd 31
1967	190	410	30	3	.1	D	-	P		Bd 32
1966	194	250	400	8	7.0	D, E	-	P	Owner's well no. 1	Bd 33
1972	188	360	12	48	.1	D, G	-	P		Bd 34
1973	205	259	300	8	5.5	D	-	P		Bd 35
1976	198	216	30	8	1.7	D	-	D		Bd 36
1978	188.50	197.88	11	6	1.2	D	-	-	aquifer-test results available	Bd 37
1980	205	-	-	-	-	D, E G	-	T	aquifer-test results available	Bd 38
1979	219	260	88	12	2.1	D, G	-	P	CH Bd 39, 42, 43 were drilled on same permit	Bd 39
1979	212	249	26	12	.7	D, G	-	P		Bd 40
1972	154	351	46	8	.2	D	-	P		Bd 41
1979	216	249	30	6	.9	D	-	O	Former test hole; well no. 4	Bd 42
1979	216	225	17	6	1.9	D	-	-		Bd 43

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-	CH										
Bd 44	732500	Berry Rd. Joint Venture	1980	Rotary	180	840	12 6 4	0-40 40-500 500-799	4	799-822	Patapsco
Bd 45	732743	S. Kwindmceki	1980	Rotary	205	476	4	0-444	4	444-462	Patapsco
Bd 46	811714	Charles Co. Department of Public Works	1986	Rotary	180	859	6 4 4 4	0-695 695-700 730-805 820-830	4 4	700-730 805-820	Patapsco
Bd 47	880124	Cherry Walk Joint Venture	1988	Rotary	200	900	-	-	6	-	-
Cb 1	-	-	<1947	Dug	100	41	-	-	-	-	-
Cb 2	-	L.G. Kragh	<1947	Dug	143	48	-	-	-	-	-
Cb 3	-	-	<1947	Dug	140	46	-	-	-	-	-
Cb 4	-	Thomas H. Speake	<1947	Dug	107	38	-	-	-	-	-
Cb 5	-	W.W. Linton	<1947	Dug	140	33	-	-	-	-	-
Cb 6	7846	Dept. of Forests & Parks	1951	Rotary	22	208	4	0-195	2	195-200	Patapsco
Cb 7	11908	U.S. Navy	1952	Cable	36	400	8 8	0-154 167-400	6	154-167	Patapsco
Cb 8	11932	U.S. Navy	1953	Rotary	38	615	20 12 12 12 10 10	0- 82 0- 85 93-124 133-153 153-221 229-234	12 12 10 10	85 - 93 124-133 221-229 234-242	Patapsco
Cb 9	11931	U.S. Navy	1953	Rotary	24	623	16 10 8 8 8	0-150 0-191 206-230 234-241 245-268	8 8 8 8	191-206 230-234 241-245 268-280	Patapsco
Cb 10	-	U.S. Navy	1945	Cable	20	610	-	-	-	-	-
Cb 11	-	U.S. Navy	1945	Cable	5	454	-	-	-	-	-

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1980	208	402	91	24	0.5	D	-	T	Owner's well no. 2	CH-Bd 44
1980	188	275	10	8	.1	D, G	-	D		Bd 45
1986	233	288	90	-	1.7	-	E	P	Owner's well no. 3	Bd 46
-	-	-	-	-	-	E, G O	-	P		Bd 47
1947	39.2	-	-	-	-	-	-	A	Abandoned domestic well; filled in	Cb 1
1947 1960	38.2 39.5	- -	- -	- -	- -	-	-	D		Cb 2
1947	44.3	-	-	-	-	-	-	D		Cb 3
1947 1960	37.2 34.4	- -	- -	- -	- -	-	-	D		Cb 4
1947 1960	31.6 29.9	- -	- -	- -	- -	-	-	D		Cb 5
1951	35	41	35	4	5.8	D	-	D		Cb 6
1952	67	140	151	24	2.1	D, G	-	O	U.S. Navy; well no. 19; observation well 1952 to present	Cb 7
1953	52	131	559	24	7.1	D, E	B, D	A	U.S. Navy; well no. 16; drilled to basement complex	Cb 8
1953 1960 1978 1980 1981	52 81.6 - - -	192 156 - - -	310 206 185 185 150	24 - - - -	2.2 - - - -	D	B, D	P	U.S. Navy; well no. 15; drilled to basement complex	Cb 9
1953	-	-	52	-	-	D	D	A	U.S. Navy; well no. 13SN; drilled to basement complex	Cb 10
1945	30	157	80	-	.6	D	D	A	U.S. Navy; well no. 43SN; standby well	Cb 11

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							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cb 12	-	U.S. Navy	1945	Cable	35	441	-	-	-	-	-
Cb 13	-	U.S. Navy	1944	Cable	15	443	-	-	-	-	-
Cb 14	-	U.S. Navy	-	-	25	200	-	-	-	-	-
Cb 15	14261	U.S. Navy	1953	Rotary	30	452	2	-	8	261-295	Patapsco
Cb 16	13185	U.S. Navy	1961	Rotary	31	605	3	-	8 8	208-220 274-302	Patapsco
Cb 17	14007	U.S. Navy	1953	Rotary	31	454	-	-	-	-	Patapsco
Cb 18	15753	U.S. Navy	1954	Rotary	30	452	16 10	0-185 185-261	8	261-285	Patapsco
Cb 19	13185	U.S. Navy	1954	Rotary	32	605	16 10	0-120 0-208	8 8 8	208-220 274-302 220-274	Patapsco
Cb 20	-	Alexandria Methodist Church	-	Dug	128	19	36	-	-	-	-
Cb 21	-	P. Williams	1958	Dug	40	24	24	-	-	-	-
Cb 22	36684	F. Simmons	1960	Cable	48	167	5	0-162	5	162-167	Patapsco
Cb 23	38172	E. Gallahue	1960	Cable	72	260	6	0-253	6	253-260	Patapsco
Cb 24	30696	U.S. Navy	1958	Rotary	135	580	6	0-496	-	-	-
Cb 25	-	U.S. Navy	1958	Rotary	30	603	4	0-570	4	570-585	Patuxent
Cb 26	-	U.S. Navy	1958	Rotary	5	600	4 4 4 4	0-185 190-203 208-225 230-275	4 4 4 4	185-190 203-208 225-230 275-285	Patapsco
Cb 27	40772	U.S. Navy	1960	Rotary	5	331	-	-	-	-	Patapsco
Cb 28	41102	U.S. Navy	1961	Rotary	5	331	24 10 10 10	0-152 0-190 200-230 240-280	10 10 10	190-200 230-240 280-290	Patapsco
Cb 29	-	U.S. Navy	1956	Rotary	12	350	16 10 10	0-220 0-228 239-269	10 10	228-239 269-286	Patapsco

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
										CH-
1945	71.4	-	40	12	-	D	D, E	A	U.S. Navy; well no. 66SN	Cb 12
1956	85	-	15	36	-					
-	-	-	52	-	-	D	-	A	U.S. Navy; well no. 51SN	Cb 13
1953	33.6	-	-	-	-	-	-	A	U.S. Navy; well no. 11SN	Cb 14
1954	77	-	-	-	-	D	-	A	U.S. Navy; well no. 5; test hole for CH Cb 18	Cb 15
1954	33.4	-	-	-	-	D	D	A	U.S. Navy; well no. 3; test hole for CH Cb 19	Cb 16
-	-	-	-	-	-	D	-	A	U.S Navy; well no. 4; former test hole	Cb 17
1954	77	210	350	12	2.6	D	D, E	I	U.S Navy; well no. 17	Cb 18
1956	-	-	300	-	-					
1960	125	221	232	-	-					
1977	120	218	160	-	-					
1980	-	-	-	-	-					
1954	95	187	363	24	3.9	D	B, D	I	U.S. Navy; well no. 18	Cb 19
1960	100	175	300	2	4.0		E			
1970	125	180	170	-	3.1					
1980	-	-	115	-	-					
1960	11.6	-	-	-	-	-	-	P		Cb 20
1960	29.8	-	-	-	-	-	-	D		Cb 21
1960	48	120	15	6	.2	D	-	P		Cb 22
1960	67	95	7	3	.2	D	-	D		Cb 23
1958	188	202	8	78	.6	D	-	P		Cb 24
1958	110	195	18	24	.2	D	-	A	Sydnor; test well 2	Cb 25
1958	48	60	23	-	1.9	D	D	A	U.S Navy; well no. 1SN	Cb 26
-	-	-	-	-	-	D, E	-	A	U.S. Navy; test hole	Cb 27
1961	65	200	275	40	2.0	D	D, E	P	U.S. Navy; well no. 2012SN	Cb 28
1956	100	-	-	-	-	D	D, E	I	U.S. Navy; well no. 24A or "A" well	Cb 29
1957	-	-	350	17	-					
1979	-	-	160	-	-					
1980	-	-	108	-	-					
1981	-	-	100	-	-					

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							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cb 30	-	U.S. Navy	1961	-	35	167	-	-	-	-	-
Cb 31	22350	U.S. Navy	1956	Rotary	12	600	-	-	-	-	-
Cb 32	-	-	-	-	-	-	-	-	-	-	-
Cb 33	-	-	-	-	-	-	-	-	-	-	-
Cb 34	720121	U.S. Navy	1972	Rotary	30	233	20 12	0-200 0-217	12	217-232	Patapsco
Cb 35	810572	U.S. Navy	1984	Rotary	25	503	6 4 4	0-433 461-467 486-488	4 4	433-461 467-486	Patuxent
Cb 36	710024	U.S. Navy	1970	Rotary	65	425	6 6	0-190 212-220	6 6	190-212 220-240	Patapsco
Cb 37	710058	U.S. Navy	1971	Rotary	35	403	6	0-276	6	276-296	Patapsco
Cb 38	-	U.S. Navy	1978	Rotary	4	250	4 2	0-210 210-231	2	231-246	Patapsco
Cb 39	732804	General Smallwood St. Park	1980	Rotary	10	426	6 4 4	0-300 290-300 310-373	4 4	300-310 373-383	Patapsco
Cb 40	730357	General Smallwood St. Park	1974	Rotary	80	301	6 4	0-227 227-287	4	287-301	Patapsco
Cc 1	-	M.. Scott	-	Dug	174	19	-	-	-	-	-
Cc 2	-	Cockerham	-	Dug	120	18	-	-	-	-	-
Cc 3	-	Hudson Garage	-	Dug	60	22	-	-	-	-	-
Cc 4	6766	S. Cockerham	1950	Cable	122	201	6	0-177	-	-	-
Cc 5	6948	M. Scott	1950	Cable	170	274	5	0-215	-	-	-
Cc 6	-	L. Bowie	1940	Dug	125	18	-	-	-	-	-
Cc 7	-	Buckley	1930	Dug	150	31	36	0-31	-	-	-
Cc 8	-	O. Schuegard	-	Dug	130	13	40	-	-	-	-
Cc 9	-	Carter	<1930	Dug	140	19	-	-	-	-	-
Cc 10	-	Bicknell	1933	Cable	120	135	6	-	-	-	-
Cc 11	-	-	-	-	60	-	-	-	-	-	-

Water level			Yield test							USGS
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	local well no.
										CH-
1961	61	-	-	-	-	-	-	A		Cb 30
1956	95	-	-	-	-	D	-	A	U.S. Navy; test hole for Cb 29	Cb 31
-	-	-	-	-	-	-	-	-	Changed to Bb 18	Cb 32
-	-	-	-	-	-	-	-	-	Changed to Bb 19	Cb 33
1972	83	200	250	24	2.1	D	E	I	U.S. Navy; well no. 3A	Cb 34
1984	84	255	226	24	1.3	D, E G	E	I	U.S. Navy; well no. 16A	Cb 35
1970	90	135	210	24	4.7	D	E	A	Matz-Childs & Assoc.; test well no. 1	Cb 36
1971	97	205	187	8	1.7	D	-	A	Matz-Childs & Assoc.; test well no. 4A	Cb 37
1978	18	100	20	5	.2	D	E	P	U.S. Navy; well on Rum Point	Cb 38
1980	79	166	32	24	.4	D	-	P	Water-level observation during winter months	Cb 39
1974	107	129	17	10	.8	D	-	P	Water-level observation during winter months	Cb 40
1947	9.3	-	-	-	-	-	-	-		Cc 1
1947	15.1	-	-	-	-	-	-	-		Cc 2
1947	17.0	-	-	-	-	-	-	-		Cc 3
1950	63	160	16	4	.2	D	-	D		Cc 4
1950	68	-	8	4	-	D	A, D	D		Cc 5
1952	6.3	-	-	-	-	-	-	-		Cc 6
1952	13.9	-	-	-	-	-	-	-		Cc 7
1952	9.1	-	-	-	-	-	-	-		Cc 8
1952	14.2 -	-	-	-	-	-	-			Cc 9
1952	41.3	-	-	-	-	-	-	-		Cc 10
1960	-	-	3	-	-	-	-	-		Cc 11

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cc 12	8531	O. Millard	1955	Cable	40	104	6	0- 99	6	99-104	Patapsco
Cc 13	32144	N. DeSantis	1959	Cable	65	239	6	0-234	6	234-239	Patapsco
Cc 14	16355	M. Blanton	1954	Cable	52	231	6	0-225	6	225-230	Patapsco
Cc 15	27722	C. Twiford	1957	Cable	122	334	5	0-330	5	330-334	Patapsco
Cc 16	20415	J. Mathews	1955	Rotary	128	401	4 2 2	0-294 294-322 332-396	2 2	322-332 396-401	Patapsco
Cc 17	13463	R. Mitchell	1953	Cable	142	330	6	0-325	6	325-330	Patapsco
Cc 18	14668	J. Weston	1954	Rotary	140	371	4 2 2	0-332 337-342 347-360	2 2 2	332-337 342-347 360-370	Patapsco
Cc 19	39279	R. Smith	1960	Jetted	100	216	2 1	0-155 149-205	1	205-216	Patapsco
Cc 20	41715	R. Smith	1961	Cable	130	348	6	0-343	4	343-348	Patapsco
Cc 21	42338	Myrtle Grove Game Refuge	1961	Rotary	103	680	4 2	0-257 257-670	2	670-680	Pataspsco
Cc 22	43460	USGS	1961	Augered	150	43	4	-	-	-	-
Cc 23	690053	Gale Bailey Elementary School	1969	Rotary	145	929	6 4 4	0-279 279-873 893-929	4	873-893	Patuxent
Cc 24	690091	Gale Bailey Elementary School	1969	Rotary	145	312	6 4	0-294 294-299	6	299-310	Patapsco
Cc 25	680044	Du-Mar Estates Water Co.	1968		75	406	6 4	0-292 285-391	4	391-406	Patapsco
Cc 26	710060	Garden Estates	1971	-	135	320	4	0-300	2	300-320	Patapsco
Cc 27	710061	Garden Estates	1971	-	130	320	4	0-300	2	300-320	Patapsco
Cc 28	56912	R. Smith	1964	Rotary	130	353	4	0-343	4	343-353	Patapsco
Cc 29	730963	Charles Co. Sanitary District	1975	Rotary	40	545	6 4	0-170 165-180	5	180-198	Patapsco
Cc 30	690058	Lackey High School	1969	Rotary	95	494	8 8 8	0-273 278-314 329-334	8 8	273-278 314-329	Patapsco

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1955	12	85	18	4	0.2	D	-	P		CH-Cc 12
1959	38	200	12	8	.1	D	-	D		Cc 13
1954	15	-	10	-	-	D	-	D		Cc 14
1957	60	200	9	8	.1	D	-	D		Cc 15
1955	149	210	11	4	.2	D	-	D		Cc 16
1953	90	195	6	4	.1	D	-	D		Cc 17
1954	97	230	7	4	.1	D	-	D		Cc 18
1960 1961	55 62.3	75 -	4 -	4 -	.2 -	D	-	D		Cc 19
1961	134	158	22	12	.9	D	-	P		Cc 20
1961	109	159	15	4	.3	D	-	D		Cc 21
1961	17.6	-	-	-	-	D	-	A	Test hole	Cc 22
1969	174	268	6	1	.1	D	-	P	Owner's well no. 1	Cc 23
1969	135	159	14	12	.6	D	-	P	Owner's well no. 2	Cc 24
1968	120	143	20	8	.9	D	E	P		Cc 25
1971	95	145	23	3	.5	D	-	P	Owner's well no. 1	Cc 26
1971	95	145	25	4	.5	D	-	P	Owner's well no. 2	Cc 27
1964	96	104	25	8	3.1	D	-	P		Cc 28
1976	37	148	8	24	.1	D, E	-	-		Cc 29
1969	129	220	76	8	0.8	D	-	P		Cc 30

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cc 31	731416	Dravo Corp	1977	Rotary	35	563	6	0-200	4	438-453	Patapsco
							4	200-438	4	480-505	
							4	453-480	4	544-554	
							4	505-544			
Cc 32	730898	Red Hill Estates	1976	Rotary	135	375	4	0-300	3	343-353	Patapsco
							2	291-343			
							2	353-375			
Cc 33	730448	Charles Co. Commissioners	1974	Rotary	122	589	4	0-299	2	570-585	Patapsco
							2	294-570			
							2	585-589			
Cd 1	-	Community of Port Tobacco	-	-	22	139	2	-	-	-	-
Cd 2	-	J. Brown	1930	Dug	196	21	36	-	-	-	-
Cd 3	-	I. Proctor	1947	Dug	180	8	-	-	-	-	-
Cd 4	-	G. Dixon	1940	Dug	190	-	36	-	-	-	-
Cd 5	-	M. Grevemberg	-	-	30	-	-	-	-	-	-
Cd 6	-	Warren	-	Dug	172	29	-	-	-	-	-
Cd 7	2998	Hawthorne Country Club	1948	Cable	160	565	6	0-555	6	555-565	Patapsco
Cd 8	9820	R.D. Evans	1952	Cable	160	411	-	-	-	-	-
Cd 9	9771	Port Tobacco School	1952	Cable	149	423	6	0-416	6	416-423	Patapsco
Cd 10	-	J. Johnson	<1952	Dug	570	20	36	-	-	-	-
Cd 11	-	L. Davis	1952	Dug	170	16	36	-	-	-	-
Cd 12	10168	J. Mitchell	1952	Jetted	64	420	2	0-170	1	240-260	Patapsco
							1	170-240	1	400-420	
							1	260-400			
Cd 13	14155	E. Burroughs	1954	Rotary	182	516	4	0-305	2	490-505	Patapsco
							2	300-490			
							2	505-516			
Cd 14	27696	H.E. Ryerson	1957	Rotary	152	485	4	0-300	2	475-485	Patapsco
							2	292-475			

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1977	75	185	125	24	1.1	D, E	E	P		CH-Cc 31
1976	142	182	10	8	.2	D	-	P		Cc 32
1974	134	142	10	20	1.2	D	-	P		Cc 33
1947 1951	- -	- -	1.6 2.6	- -	- -	-	-	P		Cd 1
1947	16.7	-	-	-	-	-	-	-		Cd 2
1947	5.8	-	-	-	-	-	-	-		Cd 3
-	-	-	-	-	-	-	-	D		Cd 4
1947	-	-	0.5	-	-	-	-	-		Cd 5
1947	28.1	-	-	-	-	-	-	-		Cd 6
1948	165	265	35	12	.4	D	D	D		Cd 7
1952	110	140	7	2	.2	D	-	D		Cd 8
1952	130	334	40	18	.2	D	D	P		Cd 9
-	-	-	-	-	-	-	A, D	D		Cd 10
1952	9.4	-	-	-	-	-	-	D		Cd 11
1952	22	42	10	6	.4	D	-	D		Cd 12
1954	160	200	5	4	.1	D	-	D		Cd 13
1957	147	205	30	4	.5	D	-	D		Cd 14

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH- Cd 15	CH- 17354	B. Demott	1955	Rotary	155	578	4 2 2 2 2 2 2	0- 302 302- 384 389- 404 409- 466 481- 531 536- 545 555- 578	2 2 2 2 2	384- 389 404- 409 466- 481 531- 536 545- 555	Patapsco
Cd 16	-	B. Demott	1955	Rotary	160	480	-	-	-	-	-
Cd 17	32030	I. Jones	1958	Rotary	155	388	4 2	0- 300 310- 378	2 2	300- 310 378- 388	Patapsco
Cd 18	32029	G. Hyatt	1958	Rotary	150	410	4	0- 400	2	400- 410	Patapsco
Cd 19	18234	G. Mc Phee	1955	Rotary	165	564	4 2 2	0- 301 290- 543 563- 564	2	543- 563	Patapsco
Cd 20	40327	J. Scott	1960	Rotary	110	472	4 2 2	0- 289 289- 460 470- 472	2	460- 470	Patapsco
Cd 21	39974	R. Barbour	1960	Jetted	22	252	2 1	0- 63 63- 232	1	232- 252	Magothy
Cd 22	41077	J. Dyson	1960	Jetted	185	460	2 1	0- 231 231- 442	1	442- 462	Magothy
Cd 23	46388	R.V. Rollins	1962	Jetted	150	250	2 1	0- 230 224- 239	1	239- 250	Aquia
Cd 24	33114	U.S. Army	1955	Rotary	160	1,003	6 4 4 4	0- 813 700- 885 900- 960 970-1,003	5 5	885- 900 960- 970	Patapsco
Cd 25	43455	USGS	1961	Augered	55	23	2	0- 5	2	5- 10	-
Cd 26	43724	Mt. Carmel Church	1961	Cable	166	407	6	0- 397	6	397- 407	Magothy
Cd 27	-	L. Johnson	1961	Augered	142	54	36	-	-	-	-
Cd 28	47072	Port Tobacco Riviera	1962	-	14	162	-	-	2	152- 162	Aquia
Cd 29	46384	R.V. Rollins	1962	Jetted	141	225	2	0- 210	1	215- 225	Aquia
Cd 30	680042	Utilico Corp.	1968	Cable	193	1,346	6 4 4 4 4 4	0- 408 368- 936 946-1,085 1,100-1,108 1,118-1,310 1,330-1,346	4 4 4 4	936- 946 1,085-1,100 1,108-1,118 1,310-1,330	Patapsco

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1955	155	195	11	4	0.3	D	-	D		CH-Cd 15
-	-	-	-	-	-	-	-	-		Cd 16
1958	90	158	15	16	.2	D	-	D		Cd 17
1958	105	144	10	4	.3	D	-	D		Cd 18
1955	158	215	11	4	.2	D	-	D		Cd 19
1960	165	195	10	4	.3	D	-	D		Cd 20
1960	-	12	10	3	.8	D	-	D	Well was flowing in 1960	Cd 21
1960	110	150	6	10	.2	D	-	D		Cd 22
1962	147	154	6	3	.9	D	-	D		Cd 23
1955	178	345	65	48	.5	D	D	P		Cd 24
1961	4.5	-	-	-	-	D	_	O	Observation well	Cd 25
1961	105	200	20	8	.2	D	D	P		Cd 26
1961	26.3	-	-	-	-	-	-	D		Cd 27
1962	-	10	10	2	-	-	-	-	Well was flowing in 1962	Cd 28
1962	-	-	5	3	-	D	-	D		Cd 29
1968	175	282	68	12	.6	D, E	-	P		Cd 30

EXPLANATION OF CODES

Well-log codes:
C, caliper
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O, other

Chemical analyses reference codes:
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B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-	CH-										
Cd 31	660072	Keech-Neave Development Co., Inc.	1966	Rotary	130	650	6	0-406	6	406-436	Patapsco
							6	436-472	6	472-482	
							6	482-504	6	504-509	
							6	509-523	6	523-528	
							6	528-557	6	557-562	
							6	562-570			
Cd 32	650090	Charles Co. Junior College	1965	Rotary	155	657	4	0-345	4	345-355	-
							4	355-376	4	376-381	
							4	381-390	4	390-400	
							4	400-427	4	427-437	
							4	437-450	4	450-455	
							4	455-471			
							4	481-502			
Cd 33	690105	Charles Co. Vocational Tech. Center	1969	Rotary	190	917	4	0-355	2	390-395	-
							2	343-390	2	415-420	
							2	395-415	2	449-454	
							2	420-449	2	472-482	
							2	454-472	2	501-511	
							2	482-501			
							2	511-597			
Cd 34	730498	McDonough High School	1974	Rotary	200	532	6	0-400	4	400-415	Patapsco
							4	415-464	4	464-474	
							4	474-486	4	486-506	
							4	506-521	4	521-526	
							4	526-532			
Cd 35	730601	R. Fiest	1974	Rotary	175	1,206	-	-	-	-	-
Cd 36	680004	Charles Co. Community College	1967	Cable	180	643	6	0-631	6	631-643	Patapsco
Cd 37	700077	Charles Co. Vocational Tech. Center	1970	Rotary	180	546	6	0-389	6	389-394	Patapsco
							6	394-415	6	415-418	
							6	418-448	6	448-455	
							6	455-472	6	472-478	
							6	478-501	6	501-509	
Cd 38	731346	Fennel Heating and Plumbing Co.	1977	Rotary	180	578	4	0-546	3	546-566	Patapsco
							3	566-569	3	569-575	
Cd 39	730159	W. Shelton	1973	Rotary	180	670	4	0-285	2	343-363	Patapsco
							2	285-343			
							2	363-670			
Cd 40	-	USGS	1984	Rotary	90	255	-	-	-	-	-

Water level			Yield test							
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1966	90	165	105	24	1.4	D, E	-	D		CH- Cd 31
1965	117	195	25	9	.3	D, E	-	P		Cd 32
1969	149	303	5	36	0	D	-	T		Cd 33
1974	185	275	50	24	.6	D	E	P		Cd 34
-	-	-	-	-	-	D	-	A		Cd 35
1967	190	300	34	12	.3	D	-	P		Cd 36
1970	139	187	45	20	.9	D	-	P		Cd 37
1977	210	235	30	12	2.0	D, E G	-	D		Cd 38
1973	168	190	8	5	.4	D	-	P		Cd 39
-	-	-	-	-	-	D, E G	-	-		Cd 40

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 4. *Summary of information for selected wells and auger holes in Prince William and Fairfax Counties, Virginia*

[USGS, U.S. Geological Survey; ft asl, feet above sea level; ft, feet; in., inches; ft bls, feet below land surface; gal/min, gallons per minute; hrs, hours; (gal/min)/ft, gallons per minute per foot; -, no data available]

Map designation	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (ft)	Casing		Screen		Primary geologic unit
						Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
HP 1	Hallowing Point Development	1949	Cable	35	312	8	0-305	8	305-312	Potomac Group
HP 1A	Hallowing Point Development	1987	Rotary	35	496	6 4	0-267 282-329	4 4	267-282 329-334	Potomac Group
HP 2	Hallowing Point Development	1963	Cable	35	466	8	0-434	8	434-464	Potomac Group
MN 1	Mason Neck State Park	1981	Rotary	21	308	6 6 6	0-170 180-195 200-270	6 6 6	170-180 195-200 270-280	Potomac Group
MN 2	Mason Neck State Park	1981	Rotary	30	359	6 6 6	0-127 132-248 258-288	6 6 6	127-132 248-258 288-293	Potomac Group
BP 1	Fairfax County Water Authority	1961	Cable	60	296	-	-	-	-	Potomac Group
[1]AH 1	USGS	-	Augered	47	30	-	-	-	-	Chopawamsic Formation
[1]AH 2	USGS	-	Augered	30	65	-	-	-	-	Chopawamsic Formation
[1]AH 3	USGS	-	Augered	7	65	-	-	-	-	Chopawamsic Formation
[1]AH 4	USGS	-	Augered	30	20	-	-	-	-	Chopawamsic Formation
[1]AH 5	USGS	-	Augered	27	62	-	-	-	-	Chopawamsic Formation
[2]AH 6	USGS	-	Augered	17	97	-	-	-	-	Chopawamsic Formation
[2]AH 7	USGS	-	Augered	5	151	-	-	-	-	Potomac Group
[2]AH 8	USGS	-	Augered	-	-	-	-	-	-	Chopawamsic Formation
[2]MW 1	USGS	-	Augered	-	-	-	-	-	-	Chopawamsic Formation
[3]Q 1	U.S. Marine Corps at Quantico	before 1930	Cable	8	358	-	-	-	-	Potomac Group
[3]Q 2	U.S. Marine Corps at Quantico	before 1930	Cable	28	360	-	-	-	-	Potomac Group
[3]Q 3	U.S. Marine Corps at Quantico	before 1930	Cable	8	355	-	-	-	-	Potomac Group
[3]Q 4	U.S. Marine Corps at Quantico	before 1930	Cable	8	551	-	-	-	-	Potomac Group
[3]Q 5	U.S. Marine Corps at Quantico	before 1930	Cable	45	391	-	-	-	-	Potomac Group
[3]Q 6	U.S. Marine Corps at Quantico	before 1930	Cable	27	350	-	-	-	-	Potomac Group

Water level			Yield test						
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal/min)/ft]	Available well logs	Well status or use	Remarks	Map designation
1949	60	150	60	10	0.67	D	A	Owner's well no. 1	HP 1
1987	67.5	138	150	24	2.1	D, G	P	Owner's well no. 1A; replaced HP 1	HP 1A
1963	89	-	60	-	-	D	P	Owner's well no. 2	HP 2
1981	33	-	125	-	-	D, G	P	Owner's well no. 1; gravel pack 55-308 ft bls	MN 1
1981	65	-	100	-	-	D, G	P	Owner's well no. 2; gravel pack 52-359 ft bls	MN 2
-	-	-	-	-	-	D	T	Owner's test well no.1	BP 1
-	-	-	-	-	-	D	T	Basement at 17 ft asl	[1] AH 1
-	-	-	-	-	-	D	T	Basement at 35 ft asl	[1] AH 2
-	-	-	-	-	-	D	T	Basement at 52 ft bsl	[1] AH 3
-	-	-	-	-	-	D	T	Basement at 10 ft asl	[1] AH 4
-	-	-	-	-	-	D	T	Basement at 35 ft bsl	[1] AH 5
-	-	-	-	-	-	D	T	Basement at 80 ft bsl	[2] AH 6
-	-	-	-	-	-	D	T	Well did not hit basement	[2] AH 7
-	-	-	-	-	-	D	T	Basement at 83 ft bsl	[2] AH 8
-	-	-	-	-	-	D	T	Basement at 170 ft bsl	[2] MW 1
-	-	-	-	-	-	D	-	Owner's well no. 1; basement at 350 ft bsl	[3] Q 1
-	-	-	-	-	-	D	-	Owner's well no. 2	[3] Q 2
-	-	-	-	-	-	D	-	Owner's well no. 3	[3] Q 3
-	-	-	-	-	-	D	-	Owner's well no. 4; basement at 543 ft bsl	[3] Q4
-	-	-	-	-	-	D	T	Owner's test well no. 1	[3] Q 5
-	-	-	-	-	-	D	T	Owner's test well no. 2	[3] Q 6

EXPLANATION OF CODES

Footnotes
[1] Data compiled from Seiders and Mixon, 1981.
[2] Data compiled from Mixon and others, 1972.
[3] Data compiled from Cady, 1938.

Well log code
D, descriptive
G, geophysical

Well status or use codes
A, abandoned
P, public supply
T, test hole

Table 5. *Lithologic description of continuous core from well CH Bb 22*

[Land surface elevation is 98 feet above sea level]

Depth below land surface, in feet	Description of material	Geologic unit
0 - 29	Clay, red, sandy; hard, gravel and cobble at base	*Park Hall Formation, Tertiary, Upper Pliocene*
29 - 49	Clay, gray, silty; hard, marbled with (red) oxidized stain	*Patapsco Formation, Lower Cretaceous*
49 - 64	Silt, gray, clayey; hard, cobble bed at base	
64 - 72	Sand, blue-gray, silty; cemented	
72 - 90	Clay, red and blue; hard	
90 - 104	Sand, gray and brown, very fine	
104 - 109	Silt, gray and brown, sandy; cemented, oxidized stain	
109 - 119	Sand, blue-gray, silty; very soft, carbonaceous, visible plant remains	
119 - 156	Sand, blue-gray, silty; cemented, marbled with (red) oxidized stain	
156 - 165	Sand, blue-gray, coarse; very soft	
165 - 188	Clay and silt, blue-gray; firm, carbonaceous	
188 - 195	Sand, gray, fine to coarse; soft, carbonaceous, visible plant remains	
195 - 200	Clay, gray and black; carbonaceous, pyrite crystals	
200 - 217	Sand, white, coarse with pebbles; very soft	
217 - 225	Silt, blue and green, sandy; firm	
225 - 245	Sand, blue-gray, silty; cemented	
245 - 260	Sand, green, silty; bedding planes evident, cemented	
260 - 285	Sand, blue-gray, silty; soft	
285 - 310	Sand, blue gray, coarse; very soft	
310 - 326	Sand, blue-gray, coarse with gravel; soft, visible plant remains	
326 - 335	Sand, blue-gray, coarse with pebbles; soft, intact clay balls	
335 - 355	Sand, gray-white, coarse; very soft	
355 - 371	Clay, gray-black, sandy; hard	
371 - 385	Silt, blue-gray, sandy; carbonaceous	
385 - 415	Clay, red and blue, silty; very hard, fractured	*Arundel Formation, Lower Cretaceous*
415 - 438	Sand, green, silty; hard	
438 - 450	Clay, blue and brown, silty; marbled	
450 - 460	Sand, green and brown, silty	*Patuxent Formation, Lower Cretaceous*
460 - 477	Sand, blue-gray, coarse; soft	
477 - 505	Clay, red and blue; hard, fractured	
505 - 520	Sand, blue and brown, silty; hard	
520 - 555	Sand, blue-gray, coarse; soft, intact clay balls	
555 - 565	Clay, gray and black, silty; carbonaceous, visible plant remains, rounded pebbles and gravel	
565 - 570	Clay, blue-green, silty; hard	
570 - 600	Sand, green, silty; very soft	
600 - 615	Sand, white, silty; carbonaceous	
615 - 630	Clay, blue-gray, silty; very hard, fractured	
630 - 643	Clay, red and blue, silty; marbled, very hard, fractured	
643 - 663	Sand, blue-gray, coarse; soft, mica flakes evident, pebbles with angular edges	
663 - 670	Sand, white-gray, coarse; soft, rounded gravel and pebble beds	
670 - 687	Sand, blue-green, fine; soft, rounded gravel and pebbles, mica flakes intact clay balls	
687 - 700	Schist, black and green, micaceous; weathered	*Crystalline "Basement" pre-Cretaceous*

Table 6. *Periodic water-level measurements at observation wells in the Indian Head area, 1981-89*

[Water levels, in feet below land-surface datum]

USGS local well number: **CH Bc 6**
Land-surface datum: 65 feet above sea level
Well depth: 412 feet
Well-screen interval(s): 362 to 412 feet
Highest water level: 138.05 feet below land surface, Mar. 31, 1988
Lowest water level: 148.92 feet below land surface, Apr. 7, 1989

Date	Water level	Date	Water level	Date	Water level
Mar. 31, 1988	138.05	Dec. 29, 1988	146.83	Apr. 7, 1989	148.92
Apr. 30, 1988	138.27	Feb. 15, 1989	147.86		

USGS local well number: **CH Bc 71**
Land-surface datum: 30 feet above sea level
Well depth: 410 feet
Well-screen interval(s): 400 to 410 feet
Highest water level: 81.58 feet below land surface, Sept. 23, 1981
Lowest water level: 129.31 feet below land surface, Dec. 1, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Sept. 23, 1981	81.58	Apr. 13, 1984	105.36	Jan. 22, 1988	97.04	Dec. 1, 1988	129.31
Apr. 13, 1982	113.90	Sept. 18, 1984	126.74	Mar. 31, 1988	93.74	Dec. 28, 1988	125.93
Sept. 23, 1982	102.90	Apr. 25, 1985	113.85	Aug. 30, 1988	114.16	Apr. 7, 1989	127.44
Apr. 5, 1983	107.52	Apr. 3, 1986	112.01	Nov. 2, 1988	121.14		

USGS local well number: **CH Bc 74**
Land-surface datum: 165 feet above sea level
Well depth: 748 feet
Well-screen interval(s): 550 to 566, 574 to 589, 637 to 642 feet
Highest water level: 228.77 feet below land surface, Feb. 16, 1989
Lowest water level: 229.42 feet below land surface, Apr. 7, 1989

Date	Water level	Date	Water level
Feb. 16, 1989	228.77	Apr. 7, 1989	229.42

USGS local well number: **CH Cb 11**
Land-surface datum: 5 feet above sea level
Well depth: 454 feet
Well-screen interval(s): unknown
Highest water level: 53.90 feet below land surface, Nov. 1, 1988
Lowest water level: 63.90 feet below land surface, Dec. 29, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 10, 1988	63.11	May 18, 1988	56.18	Dec. 29, 1988	63.90	Apr. 7, 1989	57.99
Apr. 30, 1988	58.08	Nov. 1, 1988	53.90	Feb. 15, 1989	60.15		

USGS local well number: **CH Cb 28**
Land-surface datum: 5 feet above sea level
Well depth: 290 feet
Well-screen interval(s): 190 to 200, 230 to 240, 280 to 290 feet
Highest water level: 50.38 feet below land surface, Mar. 10, 1988
Lowest water level: 62.35 feet below land surface, Apr. 30, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 10, 1988	50.38	Apr. 30, 1988	62.35	Dec. 29, 1988	51.25	Apr. 7, 1989	51.05
Apr. 30, 1988	62.35	May 18, 1988	50.58	Feb. 15, 1989	52.42		

Table 6. *Periodic water-level measurements at observation wells in the Indian Head area, 1981-89*--Continued

USGS local well number: **CH Cb 35**
Land-surface datum: 25 feet above sea level
Well depth: 488 feet
Well-screen interval(s): 433 to 461, 467 to 486 feet
Highest water level: 84.89 feet below land surface
Lowest water level: 135.72 feet below land surface

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 9, 1988	89.55	Apr. 29, 1988	86.19	July 11, 1988	84.89	Feb. 15, 1989	88.91
Mar. 10, 1988	89.21	May 18, 1988	86.40				
Dec. 29, 1988	135.72	Apr. 7, 1989	86.10				

USGS local well number: **CH Cb 38**
Land-surface datum: 5 feet above sea level
Well depth: 246 feet
Well-screen interval(s): 231 to 246 feet
Highest water level: 75.48 feet below land surface, Apr. 7, 1989
Lowest water level: 76.27 feet below land surface, Feb. 15, 1989

Date	Water level	Date	Water level
Feb. 15, 1989	76.27	Apr. 7, 1989	75.48

USGS local well number: **CH Cb 39**
Land-surface datum: 10 feet above sea level
Well depth: 383 feet
Well-screen interval(s): 300 to 310, 373 to 383 feet
Highest water level: 58.19 feet below land surface, Dec. 29, 1988
Lowest water level: 86.08 feet below land surface, Feb. 15, 1989

Date	Water level	Date	Water level	Date	Water level
Dec. 29, 1988	58.19	Feb. 15, 1989	86.08	Apr 7, 1989	85.28

USGS local well number: **CH Cb 40**
Land-surface datum: 80 feet above sea level
Well depth: 301 feet
Well-screen interval(s): 287 to 301 feet
Highest water level: 114.85 below land surface, Apr. 7, 1989
Lowest water level: 115.35 below land surface, Feb. 15, 1989

Date	Water level	Date	Water level	Date	Water level
Dec. 29, 1988	115.07	Feb. 15, 1989	115.35	Apr. 7, 1989	114.85

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*

[Water-level depth, in feet below land surface; climatic year April 1988 through March 1989; ---, data not available]

CH Bb 17 Station number 383524077111802
Latitude 383524, longitude 0771118, U.S. Navy well "B"
Well depth 294 feet, land-surface datum 52 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	119.28	115.35	115.60	115.79	118.51	119.31	---	117.74	119.43	118.80	---
2	---	119.14	115.43	115.83	115.74	118.15	118.73	---	117.56	119.31	---	---
3	---	119.01	114.78	115.44	115.74	118.04	118.33	118.94	117.50	119.17	---	---
4	---	118.72	114.69	115.03	115.59	117.75	118.18	118.95	118.00	119.82	---	---
5	---	118.45	115.15	115.13	115.80	117.47	---	118.39	118.01	119.85	---	---
6	---	118.57	115.70	115.48	116.00	117.45	118.41	118.15	117.95	119.37	---	---
7	---	118.45	115.72	115.54	116.11	117.49	118.74	118.19	117.91	119.45	---	---
8	---	118.56	115.45	115.79	115.74	117.66	118.97	118.01	118.14	119.31	---	---
9	---	118.17	115.16	115.65	115.76	117.88	118.48	118.20	118.14	119.51	---	---
10	---	118.14	115.36	115.45	115.82	118.08	118.29	117.85	118.40	119.84	---	---
11	---	118.22	115.38	115.44	116.11	118.25	118.71	118.06	118.57	120.05	---	---
12	---	118.80	115.20	115.54	116.14	118.17	119.11	118.32	118.71	120.00	---	---
13	---	118.79	114.93	115.68	116.22	118.00	119.46	117.58	118.42	120.07	---	---
14	---	118.92	114.70	115.40	116.39	118.29	119.29	117.39	118.46	120.36	---	---
15	---	118.43	114.81	115.12	116.65	118.32	119.00	117.49	118.33	120.10	118.23a	---
16	---	117.69	114.98	114.90	117.35	118.33	119.01	117.25	118.90	120.11	---	---
17	---	117.38	114.90	114.61	117.41	118.23	118.48	117.12	118.73	120.09	---	---
18	---	116.92	115.11	114.70	117.17	118.35	118.04	117.67	118.86	120.14	---	---
19	---	116.59	114.83	114.77	117.01	118.42	118.07	117.54	118.66	120.12	---	---
20	---	116.45	114.74	115.34	117.14	118.27	118.12	117.25	118.85	120.04	---	---
21	---	117.12	114.80	115.93	117.47	118.40	117.96	117.60	119.15	120.76	---	---
22	---	117.14	114.82	116.21	117.79	118.69	118.09	117.93	119.48	120.52	---	---
23	---	116.58	114.71	116.22	117.75	118.40	118.24	117.88	119.27	120.42	---	---
24	---	116.75a	115.03	116.12	117.77	118.51	118.14	117.85	119.06	120.24	---	---
25	---	116.72	114.99	115.92	118.05	118.35	118.25	117.77	119.14	120.10	---	---
26	---	116.88	114.97	115.93	118.07	118.53	118.28	117.40	119.50	119.96	---	---
27	---	116.13	115.66	116.28	118.22	119.04	118.41	117.30	119.58	119.63	---	---
28	---	115.85	115.64	116.40	118.22	119.56	118.33	117.19	119.28	119.61	---	---
29	118.63a	115.73	115.39	116.21	118.00	119.66	118.62	117.79	119.82	119.12	---	---
30	119.21	115.51	115.56	116.49	118.23	119.45	118.63	117.84	119.67	119.22	---	---
31	---	115.24	---	116.16	118.54	---	118.58	---	119.40	119.24	---	---

CH Bc 5 Station number 383524077094401
Latitude 383524, longitude 0770944, U.S. Navy well no. 14,
Well depth 430 feet, land-surface datum 39.2 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	---	---	---	---	---	---	---	---	126.12	---	---
2	---	---	---	---	---	---	---	---	122.13a	126.18	---	---
3	---	---	---	---	---	---	---	120.41a	122.19	126.25	---	---
4	---	---	---	---	123.72a	---	---	---	122.39	126.41	---	---
5	---	---	---	---	---	---	123.62a	---	122.52	---	---	---
6	---	---	---	---	---	---	---	---	122.58	---	---	---
7	---	---	---	---	---	---	---	---	122.60	---	---	---
8	---	---	---	---	---	---	---	---	122.75	---	---	---
9	---	---	---	---	---	---	---	---	122.81	---	---	---
10	---	---	---	---	---	---	---	---	122.90	---	---	---
11	---	122.90a	---	124.27a	---	---	---	---	123.06	---	---	---
12	---	123.23	---	---	---	---	---	---	123.27	---	---	---
13	---	123.34	---	---	---	---	---	---	---	---	---	---
14	---	123.43	---	---	---	---	---	---	---	---	---	---
15	---	123.39	---	---	---	---	---	---	123.48	---	---	---

a, instantaneous water-level measurement

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*--Continued

CH Bc 5 Station number 383524077094401--Continued
Latitude 383524, longitude 0770944, U.S. Navy well no. 14,
Well depth 430 feet, land-surface datum 39.2 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
16	---	---	---	---	---	---	---	---	123.82	---	---	---
17	---	---	---	---	124.01a	---	---	---	123.88	---	---	---
18	---	---	---	---	---	---	---	---	124.01	---	---	---
19	---	122.84a	---	---	---	---	---	---	---	---	---	---
20	---	---	---	---	---	---	---	---	124.44	---	---	---
21	---	---	---	---	---	---	---	---	124.64	---	---	---
22	---	---	---	---	---	---	---	---	124.93	---	---	---
23	---	---	---	---	---	---	---	---	125.01	---	---	---
24	---	122.60a	---	---	---	---	---	---	---	---	---	---
25	---	123.03a	---	---	---	---	---	---	---	---	---	---
26	---	---	---	---	---	---	---	---	125.46	---	---	---
27	---	---	---	---	---	---	---	---	125.62	---	---	---
28	123.77a	---	---	---	---	---	---	---	125.23a	---	---	---
29	123.94a	---	---	---	---	---	---	---	125.86	---	124.64a	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

CH Bc 24 Station number 383633077083001
Latitude 383633 longitude 0770830 Potomac Heights well no. 2
Well depth 435 feet, land-surface datum 72 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	142.71	146.47	150.06	151.03	152.91	150.25	150.04	150.87	150.71	151.79	---
2	---	143.12	146.59	150.24	151.05	152.52	150.21	---	150.95	150.58	---	---
3	---	143.39	146.34	150.42	151.10	152.14	150.37	150.89	150.75	150.49	---	---
4	---	143.61	146.51	150.62	151.18	151.64	150.58	150.64	150.98	151.00	---	---
5	---	143.91	146.80	150.97	---	151.51	150.65	150.03	150.88	150.90	---	---
6	---	143.80	147.05	151.30	151.44	151.64	150.97	149.84	150.77	150.62	---	---
7	---	143.84	147.11	151.54	151.55	151.51	151.02	150.12	150.67	150.70	---	---
8	---	143.57	147.05	151.77	151.56	151.34	150.96	150.24	150.83	150.56	---	---
9	---	143.64	147.08	151.99	151.63	151.29	150.47	150.34	150.78	150.76	---	---
10	---	143.61	147.29	152.07	151.66	151.18	150.31	150.10	150.73	151.01	---	---
11	---	143.80	147.38	---	151.93	151.15	150.62	150.17	150.78	151.12	---	---
12	---	143.83	147.47	152.17	152.05	151.03	150.86	150.36	150.94	151.01	---	---
13	---	143.80	147.59	152.17	152.06	150.82	151.05	150.10	150.72	151.06	---	---
14	---	143.81	147.79	151.98	152.15	150.94	150.81	150.20	150.71	151.28	---	---
15	---	143.85	148.01	152.00	152.36	150.89	150.60	150.25	150.71	151.11	152.02a	---
16	---	143.89	148.19	152.13	152.59	150.85	150.66	150.25	151.03	151.23	---	---
17	---	143.91	148.34	152.21	152.39	150.67	150.48	150.12	150.83	151.38	---	---
18	---	143.84	148.59	152.41	152.23	150.61	150.41	150.46	150.93	151.54	---	---
19	---	143.97	148.69	152.35	152.12	150.62	150.54	150.42	150.84	151.56	---	---
20	---	144.23	148.79	152.29	151.97	150.56	150.55	150.18	150.98	151.61	---	---
21	---	144.13	149.10	152.04	151.94	150.64	150.28	150.62	151.09	152.24	---	---
22	---	144.13	149.33	151.88	151.99	150.81	150.22	150.92	151.20	152.01	---	---
23	---	144.11	149.50	151.59	151.79	150.55	150.26	150.79	150.93	152.00	---	---
24	---	144.22	149.67	151.32	151.60	150.62	150.17	150.70	150.72	151.91	---	---
25	---	144.40	149.41	151.24	151.70	150.45	150.35	150.69	150.81	151.86	---	---
26	---	---	149.39	151.09	151.67	150.43	150.36	150.65	151.04	151.76	---	---
27	---	146.29	149.69	151.00	151.78	150.42	150.39	150.53	151.03	151.77	---	---
28	---	146.14	149.57	150.95	151.83	150.38	150.24	150.57	150.72	152.00	---	---
29	---	146.13	149.62	150.95	151.74	150.40	150.35	150.99	151.11	151.93	---	---
30	142.58a	146.21	149.85	150.94	153.67	150.23	150.28	150.82	150.92	151.99	---	---
31	---	146.37	---	150.94	153.61	---	150.22	---	150.69	151.99	---	---

a, instantaneous water-level measurement

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*--Continued

CH Cb 7 Station number 383422077114601
Latitude 383422, longitude 0771146, U.S. Navy well no. 19
Well depth 400 feet, land-surface datum 36 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	87.91	83.99	---	---	87.29	86.81	86.49	85.37	86.52	85.76	---
2	---	87.91	84.01	---	---	87.15	86.54	86.46	85.16	86.43	---	---
3	---	87.88	83.72	---	---	86.96	86.19	86.71	85.04	86.29	---	---
4	---	87.72	83.53	---	84.36a	86.78	85.97	86.82	85.38	86.53	---	---
5	---	87.68	83.67	83.89	84.54	86.57	85.92	86.64	85.41	86.72	---	---
6	---	87.57	83.92	---	84.74	86.43	86.07	86.52	85.41	86.43	---	---
7	---	87.61	83.96	---	84.96	86.32	86.28	86.61	85.50	86.43	---	---
8	---	87.51	83.89	---	84.86	86.36	86.46	86.56	85.65	86.34	---	---
9	---	87.43	83.73	---	84.86	86.42	86.31	86.68	85.62	86.40	---	---
10	---	87.36	83.81	---	84.95	86.51	86.14	86.66	85.65	86.60	---	---
11	---	---	83.92	84.05	85.19	86.64	86.31	86.60	85.86	86.75	---	---
12	---	87.61	83.87	84.09	85.31	86.68	86.64	86.75	85.84	86.75	---	---
13	---	87.63	83.72	84.19	85.34	86.55	86.93	86.40	85.80	86.77	---	---
14	---	87.72	83.55	84.11	85.45	86.66	86.99	86.13	85.76	86.96	---	--
15	---	87.57	83.53	83.91	85.63	86.72	86.89	86.11	85.93	86.84	86.48a	---
16	---	87.11	83.68	83.73	85.90	86.73	86.92	85.93	86.02	86.83	---	---
17	---	86.82	83.67	83.49	86.03	86.67	86.69	85.67	86.07	86.84	---	---
18	---	86.50	83.81	83.41	86.03	86.69	86.34	85.90	86.05	86.84	---	---
19	---	86.19	83.73	83.44	86.02	86.71	86.24	85.89	86.07	86.85	---	---
20	---	85.86	83.60	83.52	86.07	86.66	86.27	85.61	86.21	86.79	---	---
21	---	85.86	83.63	83.73	86.23	86.64	86.14	85.69	86.43	87.16	---	---
22	---	85.93	83.62	---	86.46	86.78	86.12	85.87	86.44	87.19	---	---
23	---	85.66	83.58	---	86.54	86.71	86.25	85.86	86.28	87.12	---	---
24	---	85.56	83.74	---	86.53	86.71	86.23	85.82	86.26	87.05	---	---
25	---	85.51	83.83	---	86.68	86.66	86.31	85.78	86.45	86.97	---	---
26	---	85.54	83.84	---	86.77	86.65	86.37	85.51	86.56	86.88	---	---
27	---	85.16	---	---	86.89	86.67	86.47	85.33	---	86.67	---	---
28	---	84.87	---	---	86.99	86.70	86.43	85.11	---	86.47	---	---
29	87.79a	84.60	---	---	86.99	86.79	86.59	85.35	86.63	86.02	---	---
30	87.90	84.41	---	---	87.10	86.80	86.65	85.38	86.68	85.94	---	---
31	---	84.19	---	---	87.24	---	86.67	---	86.54	86.00	---	---

a, instantaneous water-level measurement

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*

[Chemical concentration, in milligrams per liter (mg/L) unless otherwise noted; all analyses by USGS laboratory unless indicated by *; µS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; --, no data available]

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bb 1	07/19/38	7.6	65	210	--	--	42	1.0	0.6	2.1	150	12	1.0	--
	05/26/52	6.2	60	195	261	7.7	34	1.1	.2	2.1	150	10	.7	--
	07/13/56	11	69	229	299	8.0	30	.7	.1	2.9	160	9.6	.8	4.3
Bb 2	05/28/52	20	78	222	342	8.3	19	.3	.2	2.5	170	10	.6	--
	10/11/73*	19	--	--	300	8.0	34.5	.1	2.4	--	--	8	--	--
Bb 4	05/28/52	10	68	215	291	8.2	25	.4	.1	2.7	150	16	.8	.8
Bb 5	05/28/52	6.1	65	198	274	8.0	27	.6	.1	2.6	152	14	.8	--
	07/13/56	6.1	67	202	270	8.0	34	.3	<.1	2.4	150	11	.9	5
	10/14/57	9.0	66	219	304	7.9	32	.9	.5	3.2	157	8.6	.8	3.7
	06/17/59	9.8	66	208	279	7.9	39	.9	.2	2.5	149	12	1.2	4.0
	04/27/61	8.5	62	199	280	7.6	34	.3	.2	2.5	142	10	1.0	4.6
Bb 6	07/15/38	2.0	--	--	--	--	--	--	--	--	--	--	--	-
	05/28/52	7.1	64	196	282	8.0	25	.5	--	2.4	151	12	.7	.5
	07/13/56	7.0	65	207	280	8.0	32	.9	.1	2.4	155	11	1.0	3.3
	10/14/57	9.0	70	216	309	8.0	34	.7	.3	3.2	166	10	.9	2.2
	06/17/59	7.2	65	205	286	7.8	38	.7	.2	2.4	151	12	1.1	4.0
	04/27/61	8.0	62	195	285	7.5	33	.5	.2	2.5	145	11	1.0	4.4
	03/15/62	7.5	--	199	--	--	--	--	--	--	--	--	--	--
Bb 7	07/15/38	9.0	--	--	--	--	--	--	--	--	--	--	--	--
	05/28/52	10	71	220	310	7.9	25	.3	.1	2.5	163	12	1.2	.4
	07/13/56	11	71	229	308	7.9	34	.3	.2	2.4	164	11	1.1	6.7
	10/14/57	9.0	73	220	316	7.9	35	.4	.5	3.2	171	10	.9	3.8
	06/17/59	10	72	226	312	7.8	39	.9	.4	2.6	163	12	1.3	4.2
	04/27/61	9.5	67	211	303	7.5	35	.4	.2	2.5	153	11	1.1	5.9
	03/15/62	10	--	219	--	--	--	--	--	--	--	--	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bb 8	07/19/38	4.3	60	192	--	--	36	1.1	0.6	2.0	144	13	1.0	--
	01/25/51	7.0	56	196	284	7.7	34	1.4	.3	4.7	145	14	1.1	--
	05/15/52	6.6	64	198	276	7.9	34	.3	.2	2.6	150	14	.7	--
	07/13/56	6.2	65	210	281	8.0	35	.4	.1	2.4	155	11	.9	5.8
	10/14/57	8.5	69	227	314	7.9	36	.4	.5	3.2	168	10	.9	3.6
	06/17/59	6.2	69	216	289	7.8	45	.4	.2	2.8	160	13	1.0	4.4
	04/27/61	7.0	62	199	279	7.4	35	.4	<.5	2.5	140	12	.9	5.1
	05/27/75*	9.3	67	--	--	--	--	.1	--	--	--	--	--	--
Bb 9	05/28/52	2.7	61	198	255	7.9	37	1.5	.2	2.7	153	16	.8	--
	07/13/56	3.0	63	198	262	7.9	35	.5	.1	2.7	146	11	.8	4.7
	10/14/57	3.0	58	202	275	7.8	37	.9	.6	3.2	154	11	.8	3.4
	04/27/61	2.5	58	186	259	7.4	36	.7	.1	2.8	138	12	.9	4.8
	03/15/62*	3.0	--	191	--	--	--	--	--	--	--	--	--	--
	05/27/75*	3.0	59	168	--	--	--	.1	--	--	--	--	--	--
	12/17/85*	6.0	59	--	--	7.7	--	--	--	--	--	--	.7	--
Bb 12	12/15/53*	6.2	--	232	--	--	--	--	--	--	--	--	--	--
	11/15/56*	7.0	--	184	--	--	--	--	--	--	--	--	--	--
	07/15/58*	6.5	--	274	--	--	--	--	--	--	--	--	--	--
	06/18/71*	28	110	386	--	--	--	--	--	--	--	--	--	--
	06/22/73*	34	113	398	--	--	--	--	--	--	--	--	--	--
	09/24/74*	36	120	474	--	--	--	--	--	--	--	--	--	--
	03/05/75*	32	140	416	--	7.9	35	4.8	3.5	--	278	4.2	.4	--
	08/25/82*	--	--	412	--	--	--	--	--	--	--	--	--	--
	05/09/85*	22	102	328	--	--	--	--	--	5.6	--	2.4	.4	--
	06/05/85*	28	99	366	--	--	--	--	--	6.8	--	1.1	3.7	--
Bb 13	07/13/56*	7.0	65	207	280	8.0	32	.9	.1	2.4	155	11	1.0	3.3

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bb 14	10/14/57	11	66	218	314	7.8	34	0.4	0.5	3.2	157	9.4	0.8	3.2
	06/15/59	14	73	217	315	7.8	37	.9	.3	2.8	159	11	1.0	3.5
	04/27/61	19	72	221	333	7.7	30	.5	.1	2.7	152	11	1.0	3.8
Bb 15	12/29/55	--	--	--	315	--	--	--	--	--	--	--	--	--
	01/05/56	15	60	238	352	8.2	37	6.8	4.4	5.2	194	1.6	.3	1.6
Bb 16	03/01/56	13	--	--	325	8.3	--	--	--	--	164	--	--	4.8
Bb 17	12/12/59	18	93	271	377	7.6	39	1.7	.5	3.7	210	7.2	.6	2.6
	04/27/61	28	100	295	459	7.4	36	1.3	.5	4.4	240	2.0	.6	2.2
	03/00/62*	26	--	277	--	--	--	--	--	--	--	--	--	--
	05/27/75*	37	103	286	--	--	--	.1	--	--	--	--	--	--
Bb 18	11/02/70*	11	--	227	--	--	34	--	.45	--	--	3	.5	--
Bb 19	10/11/73	--	--	--	300	--	34.5	.1	2.40	--	--	8	--	--
Bb 20	01/18/71*	95	--	399	--	--	40	--	8	--	--	.5	--	--
Bb 21	12/17/70*	67	--	389	--	--	45	--	3.7	--	--	5	--	--
Bc 2	05/15/52	2.6	58	187	253	7.9	34	.3	.20	2.6	140	14	.6	--
	07/13/56	2.2	59	190	255	8.0	34	--	--	--	--	--	--	--
	10/14/57	2.5	59	193	255	7.8	37	.4	.10	3.2	140	10	.8	3.2
Bc 3	07/27/38	11	72	211	--	--	26	1.5	.40	2.2	170	11	1.1	--
	05/28/52	14	76	220	323	7.9	29	.5	.10	2.9	170	14	.7	--
	07/13/56	7.3	66	210	280	8.0	31	.3	.20	2.3	160	9.4	.9	4.5
	10/14/57	5.0	64	198	276	7.8	35	.7	.50	2.4	150	9.6	.8	3.0
	6/17/59	3.6	61	194	267	7.8	37	.7	.60	2.5	150	12	1.0	2.9
	4/27/61	4.0	60	194	268	7.4	35	.5	.05	2.8	150	10	.8	4.2
	7/15/62*	4.5	--	202	--	--	--	--	--	--	--	--	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 5	05/26/52	19	77	227	337	7.8	27	0.5	0.10	2.8	170	11	0.8	--
	07/13/56	23	84	242	362	8.0	26	.4	.10	2.8	170	9.0	.9	3.6
	10/14/57	23	78	240	373	7.7	28	.4	.40	1.8	170	9.4	.0	3.5
	06/17/59	25	83	238	371	7.9	36	.8	.40	3.0	170	10	1.1	2.8
	04/27/61	25	80	235	373	7.5	28	.7	.40	3.3	170	11	.9	3.2
	03/15/62*	26	--	241	--	--	--	--	--	--	--	--	--	--
Bc 6	03/15/56	3.6	--	188	258	--	--	--	--	--	--	--	--	--
	11/15/58	3.3	--	206	--	--	--	--	--	--	--	--	--	--
	03/09/61	2.5	56	185	258	7.7	45	.8	.05	2.1	130	14	1.0	6.6
	04/15/61*	4.5	--	170	--	--	--	--	--	--	--	--	--	--
	08/15/61*	5.0	--	230	--	--	--	--	--	--	--	--	--	--
	05/15/62*	4.5	--	206	--	--	--	--	--	--	--	--	--	--
	03/15/63*	6.0	--	170	--	--	--	--	--	--	--	--	--	--
	03/15/64*	5.3	--	194	--	--	--	--	--	--	--	--	--	--
	09/15/65*	3.5	--	194	--	--	--	--	--	--	--	--	--	--
	12/15/66*	4.0	--	186	--	--	--	--	--	--	--	--	--	--
	06/15/69*	4.5	--	210	--	--	--	--	--	--	--	--	--	--
	06/15/70*	1.2	--	196	--	--	--	--	--	--	--	--	--	--
	06/15/71*	4.0	--	194	--	--	--	--	--	--	--	--	--	--
	06/15/73*	5.1	--	200	--	--	--	--	--	--	--	--	--	--
	03/15/75*	4.7	--	188	--	--	--	--	--	--	--	--	--	--
	06/15/81*	2.0	--	220	--	--	--	--	--	--	--	--	--	--
Bc 12	03/28/50	1.2	70	224	357	7.8	16	5.9	2.4	8.6	210	13	.5	--
Bc 15	04/14/55	6.0	68	215	299	7.8	36	.6	1.0	3.6	160	7.3	1.1	5.8
Bc 22	01/31/56	10	--	--	348	8.2	--	--	--	--	190	--	--	3.8
	02/07/56	2.8	--	--	260	8.2	--	--	--	--	150	--	--	3.8

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 23	10/15/60*	11	--	248	--	--	--	--	--	--	--	--	--	--
	08/15/61*	--	--	270	--	--	--	--	--	--	--	--	--	--
	05/15/62*	12	--	264	--	--	--	--	--	--	--	--	--	--
	03/15/63*	16	--	282	--	--	--	--	--	--	--	--	--	--
	04/15/64*	18	--	294	--	--	--	--	--	--	--	--	--	--
	12/15/64*	20	--	318	--	--	--	--	--	--	--	--	--	--
	12/15/66*	17	--	320	--	--	--	--	--	--	--	--	--	--
	06/15/68*	62	--	292	--	--	--	--	--	--	--	--	--	--
	06/15/69*	22	--	344	--	--	--	--	--	--	--	--	--	--
	06/15/71*	28	--	386	--	--	--	--	--	--	--	--	--	--
	06/18/71*	17	95	280	--	--	--	--	--	--	--	--	--	--
	07/28/71*	--	--	320	--	--	--	--	--	--	--	--	--	--
	01/14/74	--	130	374	--	--	--	--	--	--	--	--	--	--
	03/27/75	29	120	348	--	7.0	33	2.2	1.9	--	23	5.0	0.4	--
	06/15/75*	28	--	322	--	--	--	--	--	--	--	--	--	--
	12/07/82*	44	120	426	--	--	--	--	--	--	--	--	--	--
	06/05/85*	32	103	374	--	--	--	--	--	6.3	--	<1	.3	--
	12/22/86*	41.9	--	--	--	--	--	--	--	--	--	--	--	--
Bc 24	09/14/55*	--	--	--	--	7.6	--	--	--	--	--	--	--	--
	11/27/62*	--	--	201	--	--	--	--	--	--	--	--	.7	--
Bc 49	06/15/69*	4.5	--	216	--	--	--	--	--	--	--	--	--	--
	06/15/70*	1.2	--	206	--	--	--	--	--	--	--	--	--	--
	06/15/71*	2.0	--	200	--	--	--	--	--	--	--	--	--	--
	07/15/73*	3.2	--	210	--	--	--	--	--	--	--	--	--	--
	08/15/75*	3.4	--	182	--	--	--	--	--	--	--	--	--	--
	02/15/79*	4.0	--	188	--	--	--	--	--	--	--	--	--	--
Bc 63	11/20/62	--	--	201	--	7.7	30.4	--	--	--	--	--	.7	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 67	07/14/70*	66	--	380	--	7.4	--	0.1	--	--	--	10.7	1.3	--
	06/22/73*	78	97	346	--	--	--	--	--	--	--	--	--	--
	03/06/75	81	126	366	--	7.5	35	<1	<1	--	157	7.7	1.6	--
	08/25/82*	--	--	387	--	--	--	--	--	--	--	--	--	--
	08/25/82*	--	--	380	--	--	--	--	--	--	--	--	--	--
	06/05/85*	110	121	394	--	--	--	--	--	--	--	--	--	--
	11/26/86*	112	--	--	--	--	--	--	--	--	--	--	--	--
Bc 70	03/08/82	2	72	--	--	--	--	--	--	--	--	--	--	--
	05/09/85	3	49	174	--	7.7	--	--	--	1.8	--	10	.90	--
	06/05/85	2	62	192	--	7.4	--	--	--	2.5	--	10	.90	--
	11/26/86	3.7	--	--	--	--	--	--	--	--	--	--	--	--
Bd 15	05/12/60	6.5	--	170	273	8.0	11	16	4.4	--	140	17	.20	--
Bd 46	06/26/86*	2.9	95	297	410	7.4	33	.6	.30	3.7	250	13	1.4	--
Cb 7	02/29/52*	2.8	61	204	277	7.8	34	3.3	.10	2.6	156	15	1.0	.2
Cb 8	08/26/53	101	47	339	536	6.9	32	23	19	2.7	140	.8	<.05	.2
	01/15/71*	61	29	244	385	6.9	34	30	7.8	--	--	1.8	<.05	--
	05/15/75*	137	--	410	--	6.9	35	62	56	--	--	--	--	--
Cb 9	07/13/56	6.5	68	213	291	7.8	33	.9	.50	3.2	160	11	1.2	4.7
	10/14/57	6.0	64	209	293	7.6	35	.4	.50	1.8	160	10	.50	13.0
	06/17/59*	8.4	72	224	318	7.6	36	1.0	.60	3.3	170	13	1.5	5.5
	04/27/61*	10	70	219	322	7.3	35	.8	.60	3.5	160	12	1.3	6.1
	03/15/62*	11	--	234	--	--	--	--	--	--	--	--	--	--
	05/27/75*	--	--	238	--	--	--	.1	--	--	--	--	--	--
Cb 10	10/18/55	28	100	308	464	7.5	33	1.4	1.0	1.1	228	6.6	.70	4.8

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cb 11	07/13/56	51	140	407	638	8.0	36	1.4	0.5	5.7	312	7.0	1.3	1.7
	10/14/57	49	150	420	650	7.6	38	.7	.5	8.8	316	7.0	1.1	3.7
Cb 12	11/01/55	49	150	406	646	7.7	34	.8	.1	5.7	316	7.4	1.0	2.3
	07/16/56	53	150	411	650	7.9	35	1.4	.2	5.6	309	7.0	1.3	1.6
	10/14/57	--	146	417	650	7.7	37	.9	.5	8.8	316	7.0	1.2	3.8
Cb 16	04/27/61	11	76	232	340	7.6	35	.3	.1	3.5	174	12	1.3	6.2
Cb 18	09/11/54	8.0	78	230	315	7.4	27	.6	.2	2.6	176	6.9	1.5	9.1
	04/14/55	8.2	75	230	323	7.8	34	.4	.8	3.6	177	6.1	1.0	5.3
	07/13/56	9.8	75	230	326	8.0	33	.5	.3	3.2	176	11	1.2	4.4
	10/14/57	8.5	71	229	301	7.7	35	.4	.2	2.4	174	11	.5	13.0
	06/15/59	9.8	78	235	336	7.9	40	.9	.2	3.3	179	13	1.7	4.5
	04/27/61*	11	76	232	340	--	35	.1	3.5	--	174	12	1.3	6.2
	03/15/62*	12	--	238	--	--	--	--	--	--	--	--	--	--
	05/27/75*	24.5	88	260	--	--	--	--	--	--	--	--	--	--
	03/23/78*	45.3	91	--	--	--	15	.8	3.4	--	--	1.0	--	--
Cb 19	07/13/56	7.5	68	210	296	7.7	34	.9	.3	3.1	160	9.4	.9	2.7
	10/14/57	8.0	70	217	309	7.7	35	.4	.2	2.4	170	9.8	.2	--
	06/15/59*	1.9	60	192	261	7.7	37	1.4	.4	2.8	150	11	1.0	3.8
	04/27/61*	2.5	58	188	262	7.3	36	1.0	.2	2.9	140	12	.9	5.3
	03/15/62*	5.5	--	202	--	--	--	--	--	--	--	--	--	--
	05/27/75*	11.0	72	226	--	--	--	--	--	--	--	--	--	--
	03/15/78*	21.4	--	--	--	--	--	--	--	--	--	--	--	--
	12/16/85*	21.0	74	--	--	8.0	--	--	--	--	--	--	.8	--
Cb 26	11/12/58	13	73	220	334	7.5	35	1.4	.8	4.3	171	11	1.1	6.0

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cb 28	01/12/61	9.0	69	211	310	7.3	33	0.7	0.50	13	160	1.1	<0.05	6.70
	03/15/62	8.0	--	209	--	--	--	--	--	--	--	--	--	--
	12/17/85*	10	62	381	--	7.4	--	--	--	--	--	--	1.02	<.2
	06/09/87*	--	57	--	--	--	--	--	--	--	--	--	--	--
Cb 29	10/14/57	2.0	59	198	270	7.8	36	.1	2.8	10	151	.70	.09	2.60
	04/27/61	7.5	66	207	298	7.5	36	.5	2.9	12	154	.90	.09	4.90
	03/15/62*	7.5	--	216	--	--	--	--	--	--	--	--	--	--
	05/15/75*	5.5	--	188	--	--	--	--	--	--	--	--	--	--
	05/27/75*	5.5	158	188	--	--	--	--	--	--	--	--	--	--
	03/15/78*	7.0	--	--	--	--	--	--	--	--	--	--	--	--
Cb 34	01/15/71	95	--	399	--	7.3	40	8	--	.5	--	--	.5	--
	01/15/73	143	--	--	950	7.1	30	44	--	--	--	--	--	--
	11/15/81	140	--	--	950	6.7	33	12	--	10	110	--	--	--
Cb 35	06/19/84*	58	10.4	335	--	--	34	<.01	8.5	10	--	.6	.26	--
	07/03/86*	42	29.6	415	37	7.4	30	8	--	12	312	.90	.7	1.50
Cb 36	10/30/70*	233	--	--	--	--	33	.4	--	7	--	.6	.4	--
Cb 37	03/02/71*	176	--	508	--	--	36	.1	--	13	--	2.0	--	--
Cc 5	04/02/52	.5	88	265	411	7.9	36	3.5	7.6	7.5	270	.90	.80	.30
Cc 25	05/15/69*	3.5	--	330	--	--	--	--	--	--	--	--	--	--
	07/15/71*	2.1	--	290	--	--	--	--	--	--	--	--	--	--
	07/15/72*	2.1	--	304	--	--	--	--	--	--	--	--	--	--
	06/15/73*	2.6	--	268	--	--	--	--	--	--	--	--	--	--
	05/15/75*	3.0	--	250	--	--	--	--	--	--	--	--	--	--
	02/15/79*	2.0	--	254	--	--	--	--	--	--	--	--	--	--
	05/15/81*	2.0	--	242	--	--	--	--	--	--	--	--	--	--
Cc 31	05/02/77*	1.0	70	280	--	--	48	.09	--	13.2	173	.98	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cd 7	04/03/52	7.0	--	306	465	7.9	24	0.2	4.9	4.0	300	1.3	0.80	1.00
Cd 9	03/09/61	.5	--	275	423	7.9	36	.1	5.7	5.2	270	.90	<.50	1.70
Cd 10	04/17/52	3.8	4.4	110	173	6.8	15	1.3	5.7	5.8	96	<.05	.62	<.05
Cd 24	05/12/60	7.5	--	200	279	6.8	40	1.2	5.7	13	150	1.2	.31	<.05
Cd 26	12/15/61	20	57	262	424	7.6	13	5.6	6.8	20	220	.50	.31	.11
Cd 34	09/25/74*	4.0	94	305	--	--	30	5.44	--	--	--	.70	.66	--

Table 9. *Summary of selected chemical-quality analyses of water samples collected from the Potomac River near Indian Head area, northwestern Charles County, Maryland, 1988*

[μS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; μg/L, micrograms per liter; <, less than; --, no data avalilable]

Local identifier	Station no.	Date	Specific conductance, (μS/cm)	pH (standard units)	Water temperature, (C)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)
Potomac River at Indian Head	01655480	08-30-88	403	8.0	15.5	23	11	35	51	56	0.081
		11-01-88	--	--	--	34	19	92	85	170	.38
Potomac River at Buoy 45/46	383330077141000	08-30-88	944	7.5	14.5	20	21	120	69	210	.61
		11-01-88	--	--	--	40	56	390	150	710	2.2
Potomac River at Buoy 64/66	384040077073000	08-30-88	396	8.0	15.0	29	10	31	53	43	.044

Local identifier	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents dissolved (mg/L)	Iron (mg/L as Fe)	Manganese (mg/L as Mn)
Potomac River at Indian Head	0.31	216	203	<3	3
	2.5	480	442	7	4
Potomac River at Buoy 45/46	.88	530	461	14	69
	2.4	1,450	1,380	<3	11
Potomac River at Buoy 64/66	.61	222	201	12	4

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*

[USGS, U.S. Geological Survey; TIH, Town of Indian Head; PH, Potomac Heights; SN, Stump Neck; min, minutes; gal/min, gallons per minute; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L milligrams per liter; µg/L, micrograms per liter; <, less than; >, greater than; -, no data available]

USGS identifier	Local identifier	Station no.	Date	Primary geologic units	Water level, depth below and surface (feet)	Depth of well (feet)	Depth, to top of sample interval (feet)	Depth, to bottom of sample interval (feet)
CH Bb 6	USN 6	383505077101006	05-17-88	Patapsco	--	398	251	397
			08-29-88		--	398	251	397
			11-01-88		--	398	251	397
			12-01-88		--	398	251	397
CH Bb 7	USN 7	383505077101007	05-17-88	Patapsco	--	399	255	399
			08-29-88		--	399	255	399
			11-01-88		--	399	255	399
			12-01-88		--	399	255	399
CH Bb 9	USN 9	383505077101009	05-17-88	Patapsco	--	390	185	376
			08-29-88		--	390	185	376
			11-01-88		--	390	185	376
			12-01-88		--	390	185	376
CH Bb 12	TIH 1	383552077100401	05-19-88	Patapsco	--	515	238	298
			05-26-88		--	515	238	298
			08-30-88		--	515	238	298
			11-02-88		--	515	238	298
			12-02-88		--	515	238	298
CH Bb 17	USN B	383524077111802	05-24-88	Patapsco	116.75	294	240	294
CH Bb 19	USN 2	383533077104002	05-18-88	Patapsco	--	380	270	380
			08-29-88		--	380	270	380
			11-01-88		--	380	270	380
			12-01-88		--	380	270	380
CH Bc 3	USN 12	383507077094903	05-17-88	Patuxent	--	390	--	--
			08-29-88		--	390	--	--
			11-01-88		--	390	--	--
			12-01-88		--	390	--	--
CH Bc 5	USN 14	383524077094401	05-25-88	Cretaceous	123.03	430	--	--
CH Bc 6	PH 1	383631077083501	05-19-88	Patuxent	--	412	362	412
			05-26-88		--	412	362	412
			08-30-88		--	412	362	412
			11-02-88		--	412	362	412
CH Bc 23	TIH 2	383545077095501	05-19-88	Patapsco	--	352	229	311
			05-26-88		--	352	229	311
			08-30-88		--	352	229	311
			11-02-88		--	352	229	311
			12-02-88		--	352	229	311
CH Bc 24	PH 2	383633077083001	05-26-88	Patuxent	147.66	435	383	435
CH Bc 49	TIH 6	383540077090701	05-19-88	Patuxent	--	404	340	404
			08-30-88		--	404	340	404
			11-02-88		--	404	340	404
			12-01-88		--	404	340	404
CH Bc 67	TIH 3	383606077092101	05-19-88	Patuxent	--	522	488	522
			05-26-88		--	522	488	522
			08-30-88		--	522	488	522
			11-02-88		--	522	488	522
			12-02-88		--	522	488	522
CH Bc 68	PH 3	383610077081001	05-19-88	Patuxent	--	514	414	514
			08-30-88		--	514	414	514
			11-02-88		--	514	414	514
			12-01-88		--	514	414	514

Elevation of land-surface data above sea level (feet)	Pump or flow period prior to sampling (min)	Estimated flow rate instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Water temperature (°C)	Color (platinum-cobalt units)	Calcium, dissolved (mg/L as Ca)	USGS identifier
38.7	1,000	150	286	7.9	17.0	3	0.27	CH Bb 6
	1,000	150	386	7.6	20.0	--	.30	
	1,000	150	280	8.0	16.0	--	.32	
	1,000	150	255	7.9	15.5	--	.33	
38.9	50	150	315	7.9	18.0	1	.31	CH Bb 7
	60	150	310	7.9	19.0	--	.28	
	60	150	300	8.0	16.0	--	.25	
	1,000	150	302	7.9	16.0	--	.26	
32.1	1,000	150	262	7.8	17.0	1	.36	CH Bb 9
	1,000	150	265	7.4	19.0	--	.35	
	1,000	150	274	--	15.5	--	.40	
	1,000	150	256	7.8	17.0	--	.41	
95	20	200	750	7.2	18.5	14	5.8	CH Bb 12
	360	200	337	7.2	12.0	--	--	
	70	200	651	7.3	17.0	--	4.5	
	15	200	835	7.3	15.0	--	8.2	
	20	200	622	7.2	16.0	--	4.6	
52	240	7.2	497	7.7	19.0	3	4.4	CH Bb 17
90	15	150	473	7.6	17.5	2	.75	CH Bb 19
	30	150	493	7.8	17.0	--	.81	
	15	150	497	7.7	15.5	--	.89	
	15	150	501	7.6	16.5	--	.94	
18.7	1,000	150	281	8.0	18.0	2	.19	CH Bc 3
	1,000	150	280	7.7	18.0	--	.19	
	1,000	150	281	8.0	15.5	--	.29	
	1,000	150	279	8.0	15.5	--	.22	
39.2	240	8.0	420	8.0	16.0	2	.65	CH Bc 5
70	30	150	252	8.0	17.0	<1	.05	CH Bc 6
	30	150	246	8.1	17.5	--	--	
	120	150	251	8.0	17.5	--	.07	
	60	150	256	8.1	15.5	--	.14	
65	240	150	720	7.5	18.5	13	4.1	CH Bc 23
	360	150	467	7.3	18.0	--	--	
	120	150	485	7.5	16.5	--	1.9	
	240	150	511	7.6	14.5	--	2.1	
	120	150	719	7.5	15.0	--	5.2	
72	240	8.0	659	7.2	17.5	2	34	CH Bc 24
33	45	150	294	7.6	17.0	1	.58	CH Bc 49
	45	150	272	7.9	16.5	--	.35	
	60	150	261	8.0	15.0	--	.33	
	20	150	243	8.0	15.5	--	.30	
30	20	200	675	7.7	18.5	<1	.29	CH Bc 67
	360	200	647	7.7	10.0	--	--	
	120	200	678	7.9	18.5	--	.32	
	30	200	660	7.9	16.5	--	.32	
	120	200	653	8.0	17.0	--	.36	
75	20	150	244	7.8	16.5	<1	.12	CH Bc 68
	30	150	245	8.0	18.0	--	.11	
	30	150	249	8.0	15.0	--	.12	
	60	150	244	7.9	16.5	--	.12	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*--Continued

USGS identifier	Local identifier	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)
CH Bb 6	USN 6	0.25	67	2.3	130	9.0	7.5	0.90	0.040
		.29	67	--	--	8.9	7.9	--	.036
		.25	64	--	--	8.5	7.3	--	.040
		.25	66	--	--	8.4	7.0	--	.035
CH Bb 7	USN 7	.27	70	2.3	138	10	11	1.0	.040
		.32	71	--	--	11	10	--	.047
		.21	66	--	--	10	9.7	--	.050
		.24	71	--	--	9.8	9.3	--	.045
CH Bb 9	USN 9	.34	62	1.8	121	11	2.9	.80	<.010
		.33	61	--	--	11	3.2	--	.019
		.34	63	--	--	12	4.1	--	.018
		.24	64	--	--	12	3.3	--	.021
CH Bb 12	TIH 1	3.9	170	7.7	341	4.8	49	.30	.49
		--	--	--	163	--	12	--	.078
		3.1	140	--	--	3.3	39	--	.25
		5.8	180	--	--	5.5	59	--	.39
		2.9	140	--	--	4.0	37	--	.17
CH Bb 17	USN B	.86	110	3.6	227	2.1	47	.80	.22
CH Bb 19	USN 2	.73	110	3.6	219	3.6	21	.60	.18
		.84	110	--	--	2.5	23	--	.18
		.83	120	--	--	2.3	24	--	.18
		.81	120	--	--	1.9	26	--	.041
CH Bc 3	USN 12	.14	67	2.0	130	8.3	6.2	.80	.035
		.29	65	--	--	8.1	6.6	--	.030
		.32	68	--	--	7.7	6.5	--	.033
		.19	68	--	--	8.2	6.2	--	.035
CH Bc 5	USN 14	.51	100	3.5	202	9.1	42	.80	.15
CH Bc 6	PH 1	.03	57	1.0	114	14	2.9	.90	.011
		--	--	--	110	--	3.1	--	.013
		.06	58	--	--	14	3.0	--	.014
		.06	57	--	--	14	3.2	--	.021
CH Bc 23	TIH 2	3.1	140	7.2	394	3.9	41	.40	.20
		--	--	--	291	--	24	--	.14
		1.5	110	--	--	3.0	21	--	.13
		1.7	110	--	--	2.9	24	--	.16
		3.9	170	--	--	4.9	43	--	.16
CH Bc 24	PH 2	14	80	9.9	220	42	60	.50	.19
CH Bc 49	TIH 6	.27	68	2.8	215	10	8.8	.70	.034
		.22	63	--	--	12	6.0	--	.010
		.15	61	--	--	12	4.1	--	.027
		.14	59	--	--	12	--	--	.017
CH Bc 67	TIH 3	.24	150	4.0	152	7.3	120	1.5	.38
		--	--	--	155	--	110	--	.38
		.30	140	--	--	7.0	120	--	.37
		.28	140	--	--	7.2	120	--	.37
		.37	140	--	--	7.1	120	--	.38
CH Bc 68	PH 3	.12	58	1.2	149	18	1.6	.70	.012
		.18	57	--	--	12	1.3	--	.010
		.16	56	--	--	12	1.2	--	.011
		.22	58	--	--	12	1.2	--	<.010

Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 (total as N)	Phosphorus, total, (mg/L as P)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Carbon, organic total (mg/L as C)	USGS identifier
33	196	198	<0.100	1.70	45	14	0.3	CH Bb 6
32	199	194	--	--	52	11	--	
32	191	189	--	--	48	11	--	
34	188	193	--	--	47	12	--	
33	202	211	<.100	.02	78	7	.1	CH Bb 7
33	216	207	--	--	56	7	--	
32	201	197	--	--	34	9	--	
34	200	204	--	--	23	9	--	
34	187	186	<.100	1.60	34	10	.2	CH Bb 9
34	185	182	--	--	35	8	--	
34	202	190	--	--	65	12	--	
34	189	191	--	--	57	12	--	
35	477	483	<.100	.63	1,000	89	3.5	CH Bb 12
--	239	--	--	--	--	--	--	
34	414	397	--	--	660	68	3.5	
33	529	516	--	--	1,200	120	--	
35	394	388	--	--	670	75	--	
30	307	336	<.100	1.70	410	7	1.2	CH Bb 17
35	319	307	<.100	.77	170	27	1.3	CH Bb 19
33	320	307	--	--	250	31	--	
34	337	323	--	--	260	28	--	
35	320	325	--	--	240	18	--	
33	193	196	<.100	1.40	59	6	.3	CH Bc 3
33	200	192	--	--	69	8	--	
33	210	194	--	--	70	9	--	
35	199	196	--	--	39	9	--	
25	272	303	<.100	.77	260	18	.3	CH Bc 5
37	186	181	<.100	.09	69	1	.5	CH Bc 6
--	181	--	--	--	--	--	--	
35	186	177	--	--	30	<1	--	
36	169	178	--	--	53	3	--	
34	462	471	<.100	.53	760	88	3.5	CH Bc 23
--	330	--	--	--	--	--	--	
34	316	307	--	--	290	43	--	
34	341	317	--	--	310	43	--	
33	478	468	--	--	980	110	--	
33	410	407	<.100	.15	1,400	43	2.0	CH Bc 24
33	206	253	<.100	1.10	130	8	.6	CH Bc 49
33	185	188	--	--	120	7	--	
32	187	180	--	--	110	7	--	
32	171	--	--	--	130	9	--	
35	402	410	<.100	.95	110	14	<.1	CH Bc 67
--	392	--	--	--	--	--	--	
34	396	394	--	--	85	9	--	
34	403	395	--	--	130	9	--	
35	407	396	--	--	130	10	--	
36	182	205	<.100	.06	57	2	.2	CH Bc 68
35	177	174	--	--	62	3	--	
35	189	173	--	--	52	5	--	
36	170	176	--	--	55	5	--	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988--Continued*

USGS identifier	Local identifier	Station no.	Date	Primary geologic units	Water level, depth below and surface (feet)	Depth of well (feet)	Depth, to top of sample interval (feet)	Depth, to bottom of sample interval (feet)
CH Bc 70	TIH 4	383554077085702	05-19-88	Patapsco	--	442	372	442
			08-29-88		--	442	372	442
			11-02-88		--	442	372	442
			12-01-88		--	442	372	442
CH Bc 72	TIH 5	383548077091101	05-19-88	Patapsco	--	360	224	347
			08-30-88		--	360	224	347
			11-02-88		--	360	224	347
			12-01-88		--	360	224	347
CH Cb 7	USN 19	383422077114601	05-11-88	Patapsco	87.68	400	154	167
CH Cb 9	USN 15	383354077121501	05-17-88	Patapsco	--	280	191	280
			08-29-88		--	280	191	280
			11-01-88		--	280	191	280
			11-28-88		--	280	191	280
CH Cb 11	USN 43SN	383313077125401	05-18-88	Patuxent	53.09	454	--	--
			05-26-88		--	454	--	--
			08-29-88		--	454	--	--
			11-01-88		--	454	--	--
			12-01-88		--	454	--	--
CH Cb 18	USN 17	383412077112802	05-17-88	Patapsco	--	295	261	295
			08-29-88		--	295	261	295
			11-01-88		--	295	261	295
			11-28-88		--	295	261	295
CH Cb 19	USN 18	383448077105202	05-18-88	Patapsco	--	302	208	302
			08-29-88		--	302	208	302
			11-01-88		--	302	208	302
			12-01-88		--	302	208	302
CH Cb 28	USN 2012	383315077131401	05-18-88	Patapsco	50.58	290	190	290
			05-26-88		--	290	190	290
			08-29-88		--	290	190	290
			11-01-88		--	290	190	290
			12-02-88		--	290	190	290
CH Cb 29	USN A	383451077102601	05-17-88	Patapsco	--	286	228	286
			08-29-88		--	286	228	286
			11-01-88		--	286	228	286
			12-01-88		--	286	228	286
CH Cb 34	USN 3A	383427077121001	05-17-88	Patapsco	--	232	217	232
			05-25-88		--	232	217	232
			08-29-88		--	232	217	232
			11-01-88		--	232	217	232
			12-02-88		--	232	217	232
CH Cb 35	USN 16A	383407077120501	05-18-88	Patuxent	86.40	486	433	486
			05-25-88		--	486	433	486
			08-30-88		--	486	433	486
			12-01-88		--	486	433	486
			12-02-88		--	488	433	486
CH Cb 38	USN RUM PT	393328077114201	05-18-88	Patapsco	--	235	220	235
			08-30-88		--	235	220	235
			11-01-88		--	235	220	235
			12-01-88		--	235	220	235

Elevation of land-surface data above sea level (feet)	Pump or flow period prior to sampling (min)	Estimated flow rate instantaneous (gal/min)	Specific conductance (μS/cm)	pH (standard units)	Water temperature (°C)	Color (platinum-cobalt units)	Calcium, dissolved (mg/L as Ca)	USGS identifier
35	20	200	242	7.7	18.5	2	0.09	CH Bc 70
	30	200	242	8.0	17.5	--	.09	
	240	200	245	8.2	15.5	--	.11	
	15	200	241	8.0	16.0	--	.09	
34	15	200	264	7.8	17.0	<1	.33	CH Bc 72
	120	200	275	7.9	16.5	--	.27	
	15	200	286	8.0	14.5	--	.27	
	15	200	286	7.8	15.5	--	.30	
36	105	6.00	290	6.8	14.0	--	2.8	CH Cb 7
24	>1,000	150	370	7.8	16.5	2	.83	CH Cb 9
	>1,000	150	312	7.9	18.0	--	.73	
	>1,000	150	365	8.2	15.0	--	.75	
	>1,000	150	385	7.8	16.5	--	1.7	
5	20	100	590	7.5	17.0	2	1.5	CH Cb 11
	30	100	594	7.9	14.0	--	--	
	60	100	314	7.6	20.0	--	2.0	
	30	100	324	7.6	16.5	--	1.5	
	20	100	325	7.7	16.0	--	1.6	
30.5	>1,000	150	481	7.6	16.5	2	.42	CH Cb 18
	>1,000	150	421	7.8	18.0	--	.41	
	>1,000	150	481	--	15.0	--	6.7	
	>1,000	150	488	7.9	17.5	--	.46	
32	20	150	374	8.0	18.5	1	.52	CH Cb 19
	120	150	376	8.0	18.0	--	.50	
	120	150	370	8.1	15.5	--	.50	
	15	150	288	8.1	15.0	--	.70	
5	20	150	297	7.5	16.5	3	1.7	CH Cb 28
	20	150	277	7.4	17.0	--	--	
	60	150	292	7.4	19.0	--	1.6	
	40	150	291	7.8	14.0	--	1.6	
	60	150	290	7.7	15.5	--	1.7	
12.4	150	150	302	8.0	17.0	2	.25	CH Cb 29
	120	150	301	8.1	18.0	--	.23	
	120	150	330	8.2	15.5	--	.30	
	>1,000	150	287	7.9	15.5	--	.24	
30	>1,000	120	1,310	7.0	14.5	45	8.1	CH Cb 34
	20	120	1,230	7.1	16.0	--	--	
	60	120	1,300	7.2	17.0	--	8.1	
	60	120	1,290	7.7	15.5	--	7.7	
	15	120	1,220	7.6	16.0	--	7.9	
25	20	200	575	7.8	19.0	2	.39	CH Cb 35
	30	200	551	7.8	17.0	--	--	
	20	200	578	8.0	18.5	--	.41	
	60	200	509	7.7	16.5	--	.41	
	>1,000	200	522	7.9	17.0	--	.56	
5	20	15	290	7.7	17.0	3	1.1	CH Cb 38
	20	15	--	--	--	--	1.1	
	20	15	288	7.9	14.5	--	1.0	
	15	15	277	7.9	15.5	--	1.1	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*--Continued

USGS identifier	Local identifier	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)
CH Bc 70	TIH 4	0.14	60	1.8	158	13	1.3	0.90	<0.010
		.11	57	--	--	13	1.3	--	<.010
		.05	55	--	--	13	1.3	--	.019
		<.01	57	--	--	15	1.3	--	<.010
CH Bc 72	TIH 5	.19	64	2.3	121	10	3.7	.80	.026
		.33	62	--	--	10	4.7	--	.030
		.24	65	--	--	10	5.4	--	.037
		.30	72	--	--	8.9	7.0	--	.041
CH Cb 7	USN 19	1.7	63	2.7	136	9.9	7.1	.90	--
CH Cb 9	USN 15	.74	76	2.8	146	11	22	1.1	.075
		.72	82	--	--	11	21	--	.079
		.73	82	--	--	17	21	--	.071
		1.2	83	--	--	11	21	--	.078
CH Cb 11	USN 43SN	.74	140	4.6	270	8.3	45	1.2	.16
		--	--	--	246	--	48	--	.17
		.70	68	--	--	11	10	--	.024
		.57	68	--	--	11	12	--	.032
		.63	75	--	--	10	12	--	.035
CH Cb 18	USN 17	.51	110	2.8	181	7.6	40	1.1	.17
		.44	92	--	--	11	31	--	.11
		.51	110	--	--	7.2	41	--	.17
		.51	110	--	--	7.1	41	--	.18
CH Cb 19	USN 18	.48	86	2.7	155	8.1	18	.80	.093
		.36	85	--	--	7.9	18	--	.091
		.47	80	--	--	7.7	19	--	.092
		.48	69	--	--	9.0	8.3	--	.029
CH Cb 28	USN 2012SN	1.3	66	3.9	134	12	7.2	1.1	.038
		--	--	--	118	--	6.6	--	.034
		1.2	63	--	--	12	6.6	--	.024
		1.3	64	--	--	11	6.8	--	.037
		1.1	68	--	--	11	11	--	.018
CH Cb 29	USN A	.21	70	2.0	139	10	7.0	.80	.044
		.28	70	--	--	10	7.1	--	.024
		.29	70	--	--	9.8	6.9	--	.041
		.22	73	--	--	10	6.9	--	.038
CH Cb 34	USN 3A	8.7	270	7.5	364	12	210	.50	1.1
		--	--	--	370	--	210	--	1.3
		8.4	250	--	--	14	200	--	1.2
		8.3	260	--	--	3.1	200	--	1.1
		8.1	260	--	--	4.6	210	--	.88
CH Cb 35	USN 16A	.39	130	3.4	305	7.7	44	1.2	.16
		--	--	--	265	--	43	--	.16
		.36	130	--	--	7.8	43	--	.15
		.48	130	--	--	7.8	41	--	.15
		.55	140	--	--	7.7	42	--	.15
CH Cb 38	USN RUM PT	1.0	62	3.0	135	15	3.1	1.0	.010
		1.0	65	--	--	13	2.9	--	.015
		.95	63	--	--	15	2.9	--	.015
		.98	65	--	--	12	2.9	--	.015

Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 (total as N)	Phosphorus, total, (mg/L as P)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Carbon, organic total (mg/L as C)	USGS identifier
35	181	207	<0.100	1.60	80	6	0.1	CH Bc 70
35	183	173	--	--	89	5	--	
35	187	171	--	--	92	5	--	
37	155	--	--	--	67	5	--	
36	197	190	<.100	1.40	97	11	.5	CH Bc 72
34	197	188	--	--	120	7	--	
34	206	193	--	--	120	8	--	
35	200	206	--	--	160	9	--	
33	--	203	<.100	1.70	370	55	--	CH Cb 7
33	242	235	<.100	1.90	110	19	.6	CH Cb 9
32	247	232	--	--	91	19	.1	
31	238	240	--	--	96	20	--	
32	239	238	--	--	110	22	--	
34	374	398	<.100	.92	480	21	<.1	CH Cb 11
--	389	--	--	--	--	--	--	
34	214	206	--	--	110	14	.7	
33	224	210	--	--	97	11	--	
33	217	216	--	--	240	14	--	
33	304	304	<.100	1.60	170	19	.8	CH Cb 18
33	272	262	--	--	210	20	1.0	
32	311	306	--	--	190	20	--	
33	293	301	--	--	220	19	--	
35	242	245	<.100	1.40	100	16	.7	CH Cb 19
34	246	240	--	--	110	14	1.1	
34	250	236	--	--	110	15	--	
34	205	200	--	--	74	15	--	
32	201	206	<.100	2	640	30	.2	CH Cb 28
--	195	--	--	--	--	--	--	
32	193	194	--	--	620	29	.6	
31	194	193	--	--	590	36	--	
31	206	201	--	--	140	18	--	
34	207	208	<.100	1.60	110	10	.1	CH Cb 29
33	196	203	--	--	100	12	--	
32	217	202	--	--	99	9	--	
31	210	273	--	--	260	33	--	
39	768	778	<.100	0.30	2,400	370	5.2	CH Cb 34
--	775	--	--	--	--	--	--	
38	759	740	--	--	3,100	350	7.2	
37	754	737	--	--	410	310	--	
38	772	750	--	--	810	340	--	
34	366	404	<.100	0.75	110	120	<.1	CH Cb 35
--	363	--	--	--	--	--	--	
33	366	351	--	--	120	14	.2	
34	350	349	--	--	68	12	--	
35	371	361	--	--	81	20	--	
33	201	201	<.100	1.90	460	22	.2	CH Cb 38
33	196	197	--	--	420	23	--	
33	197	197	--	--	360	23	--	
33	194	196	--	--	490	22	--	