COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

GROUND-WATER RESOURCES OF ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA

Allen Sinnott and
G. Chase Tibbitts, Jr.

MINERAL RESOURCES REPORT 9

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
1968

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

GROUND-WATER RESOURCES OF ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA

Allen Sinnott and
G. Chase Tibbitts, Jr.

MINERAL RESOURCES REPORT 9

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
1968

Commonwealth of Virginia
Department of Purchases and Supply
Richmond
1968

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

Richmond, Virginia

MARVIN M. SUTHERLAND, *Director*
CHARLES A. CHRISTOPHERSEN, *Deputy Director*
A. S. RACHAL, JR., *Executive Assistant*

BOARD

CARLISLE H. HUMELSINE, Williamsburg, *Chairman*
ANDREW A. FARLEY, Danville, *Vice-Chairman*
JOE P. GILLS, Roanoke
ALLAN M. HEYWARD, Newport News
FRANK E. DICKERSON, Virginia Beach
CLAUDE A. JESSUP, JR., Charlottesville
W. MARTIN JOHNSON, Lynchburg
WILLIAM H. KING, Burkeville
GARLAND E. MOSS, Chase City
ERNEST L. SMITH, Grundy
JOHN S. THORNTON, Culpeper
ARCHIE L. WENRICH, Hopewell

PUBLISHER'S NOTE

Investigations of the ground-water resources of the Coastal Plain were begun in 1937 as a cooperative project between the U. S. Geological Survey and the Virginia Geological Survey. This project was carried on intermittently, and the manuscript for the Eastern Shore counties was submitted to the Virginia Division of Mineral Resources on April 29, 1968.

In an effort to expedite publication the length of the manuscript was reduced; the original copy is on open file in the library of the Virginia Division of Mineral Resources. The printed report contains sections of the manuscript as edited by the U. S. Geological Survey staff. The report does indicate the possible yields from shallow aquifers and this information is of value. To determine the complete ground-water potential for the Eastern Shore would require drilling of deep wells and evaluation of production data. The Eastern Shore counties are a portion of the Delmarva Peninsula which is undergoing a ground-water evaluation study by the U. S. Geological Survey.

CONTENTS

	Page
Abstract	1
Introduction and acknowledgments	2
Purpose of the investigation	5
Methods of fieldwork	5
Previous investigations	6
Well construction	8
Shallow wells	8
Deep wells	9
Jetting method	10
Cable-tool method	11
Hydraulic-rotary method	12
Accomack County	13
Location and development	13
Drainage and topography	14
Geology	15
Basement complex	15
Cretaceous and Paleocene deposits	15
Eocene deposits	15
Miocene deposits	16
Pleistocene deposits	19
Ground-water resources	19
Water from Cretaceous and Paleocene deposits	19
Water from Eocene deposits	21
Water from Miocene deposits	21
Water from Pleistocene deposits	22
Quality of water	24
Water from Cretaceous and Eocene deposits	24
Water from Miocene deposits	25
Water from Pleistocene deposits	27
Summary of ground-water resources	28
Well records and chemical analyses	29
Northampton County	68
Location and development	68
Drainage and topography	68
Geology	70
Basement complex	70
Cretaceous and Paleocene deposits	70
Eocene deposits	71
Miocene deposits	71
Pleistocene deposits	73

PAGE

Ground-water resources 74
Water from pre-Miocene deposits..... 74
Water from Miocene deposits..... 74
Water from Pleistocene deposits..... 76
Quality of water..... 77
Water from Cretaceous, Paleocene, and Eocene deposits..... 77
Water from Miocene deposits..... 78
Water from Pleistocene deposits..... 80
Summary of ground-water resources..... 81
Well records and chemical analyses 81
References 109
Index 111

ILLUSTRATIONS

PLATE — PAGE

1. Geologic sections across the Eastern Shore peninsula.. In pocket
2. Diagrammatic columnar section, and table describing the principal geologic formations of the Eastern Shore peninsula of Virginia..... In pocket
3. Map of Accomack County showing location of wells listed in Table 1..... In pocket
4. Map of Northampton County showing locations of wells listed in Table 6..... In pocket

FIGURE

1. Map of the Virginia Coastal Plain, showing the Eastern Shore peninsula and the location of the geologic sections on Plate 1.. 3
2. Diagrammatic correlation of U. S. Geological Survey test holes along the Eastern Shore peninsula, Virginia..... 17
3. Sand and gravel pit, in deposits of the Columbia Group of Pleistocene age 20
4. Coarse gravel and boulders up to 6 inches long in gravel pit... 20
5. Sand dunes on Savage Neck..... 69
6. Low wave-cut cliff truncating Princess Anne terrace on beach south of Occahannock Creek 70
7. Columbia Group of Pleistocene age, showing details of sedimentation in a section in cliff..... 73

TABLES

PAGE

1. Records of wells in Accomack County, Virginia..... 30
2. Logs of wells in Accomack County, Virginia..... 46
3. Logs of selected deep wells in Maryland near the Maryland-Virginia boundary 49
4. Chemical analyses of ground waters from wells in Accomack County, Virginia 53
5. Chemical analyses of waters from deep wells in Somerset County, Maryland 67
6. Records of wells in Northampton County, Virginia..... 82
7. Logs of wells in Northampton County, Virginia..... 94
8. Chemical analyses of ground waters from wells in Northampton County, Virginia..... 97

ERRATA

1) Cobbs, wherever it appears, should read Cobb (as Cobb Island; Cobb Bay)
2) p. 23, line 11 and 12, delete and indeed on the entire peninsula
3) p. 76, line 28: in the entire peninsula should read in that County

GROUND-WATER RESOURCES OF ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA[1]

By

ALLEN SINNOTT and G. CHASE TIBBITTS, JR.[2]

ABSTRACT

The area considered in this report consists of two counties, Accomack on the north and Northampton to the south, that are in the northeastern part of the Virginia Coastal Plain province. It is at the lower end of the peninsula that extends southward from Maryland, the Delmarva Peninsula, that forms the Eastern Shore. The Atlantic Ocean borders the peninsula on the east and Chesapeake Bay on the west.

Fieldwork for this investigation was carried out chiefly during the summers of 1948, 1952, and 1953.

The area is largely rural in character with no large cities. Among the largest towns are Kiptopeke, Cape Charles, Exmore, Onancock, Accomac, and Chincoteague. The terminal of the old ferry to Norfolk was located at Cape Charles. The Chesapeake Bay Bridge-Tunnel reaches the Eastern Shore just south of Kiptopeke. The town of Tangier is an island community in Chesapeake Bay. The principal industries on the Eastern Shore peninsula are truck farming, lumbering, fishing, and the canning of vegetable and fish products. There is an Air Force base near Cape Charles, and the National Aeronautics and Space Administration has facilities near Chincoteague (Wallops Island).

The region has a mild climate with a mean annual temperature of 58° and a mean annual precipitation of 43 inches. The entire peninsula has low relief and is veneered by Pleistocene deposits, largely sands and clays. The sandy aquifers supply water for most domestic supplies. The Pleistocene deposits are immediately underlain by deposits of Miocene age which furnish water supplies for the largest municipal and industrial installations. The still deeper Eocene, Paleocene, and Cretaceous rocks have been penetrated by very few wells. On the Eastern Shore of Virginia, the deepest wells in use are those on Tangier Island. These wells end in Eocene sands and supply a number of domestic users with moderately mineralized water. No wells reach

---

[1] Manuscript released for publication by permission of the Director, U. S. Geological Survey.

[2] U. S. Geological Survey.

basement rocks which presumably lie about 3,000 feet below the surface.

Water in the shallow Pleistocene deposits is derived from local precipitation. A substantial part of the water in the underlying clayey and marly Miocene aquifers has also originated as local precipitation. The chemical characteristics of water in very deep Miocene aquifers suggests that they are in hydrologic continuity with the artesian water-bearing formations west of Chesapeake Bay.

Domestic water supplies are obtained largely from shallow wells ending in Pleistocene deposits. There are a few batteries of shallow wells that supply larger quantities of water, as at Chincoteague, where 140,000 gallons per day is pumped.

The larger ground-water supplies are ordinarily obtained from wells reaching Miocene aquifers. One such deep well at Exmore yielded 746 gallons per minute with 37 feet of drawdown at the time of its completion. A well at Cape Charles is pumped regularly at a rate of 645 gpm.

Water from both Pleistocene and Miocene deposits is generally of good quality. Moderate hardness is common and a few waters are high in iron. Fluoride is almost invariably very low or absent. Very deep wells in the Miocene yield a high bicarbonate water with a fairly high chloride content. A few shallow wells yield slightly brackish water, due to contamination by salt spray or by intrusion of ocean or bay waters.

There are as yet no areas where withdrawal is excessive and there appears to be ample additional water available for immediately foreseeable needs. An increase in use of ground water for irrigation may eventually create problem areas. Somewhat highly mineralized water from Eocene and older beds will necessarily be limited to special uses.

INTRODUCTION AND ACKNOWLEDGMENTS

This report presents the results of a study of the ground-water resources of the Eastern Shore peninsula in Virginia, which was made by the U. S. Geological Survey in cooperation with the Virginia Department of Conservation and Economic Development, Division of Mineral Resources. The area comprises Accomack and Northampton Counties, and is the Virginia part of the so-called Delmarva Peninsula: the latter extends south from Pennsylvania, and includes parts of the States of Delaware, Maryland, and Virginia, marking the eastern shore

of Chesapeake Bay. The investigation was started under the general direction of the late A. Nelson Sayre, former Chief of the Branch of Ground Water of the U. S. Geological Survey, and the late William M. McGill, former State Geologist. It was discontinued in 1957 but the work was resumed in 1966 under the general direction of George E. Ferguson, Regional Hydrologist, and J. Wyatt Gambrell, District Chief, Water Resources Division, U. S. Geological Survey; and Marvin M. Sutherland, Director, Virginia Department of Conservation and

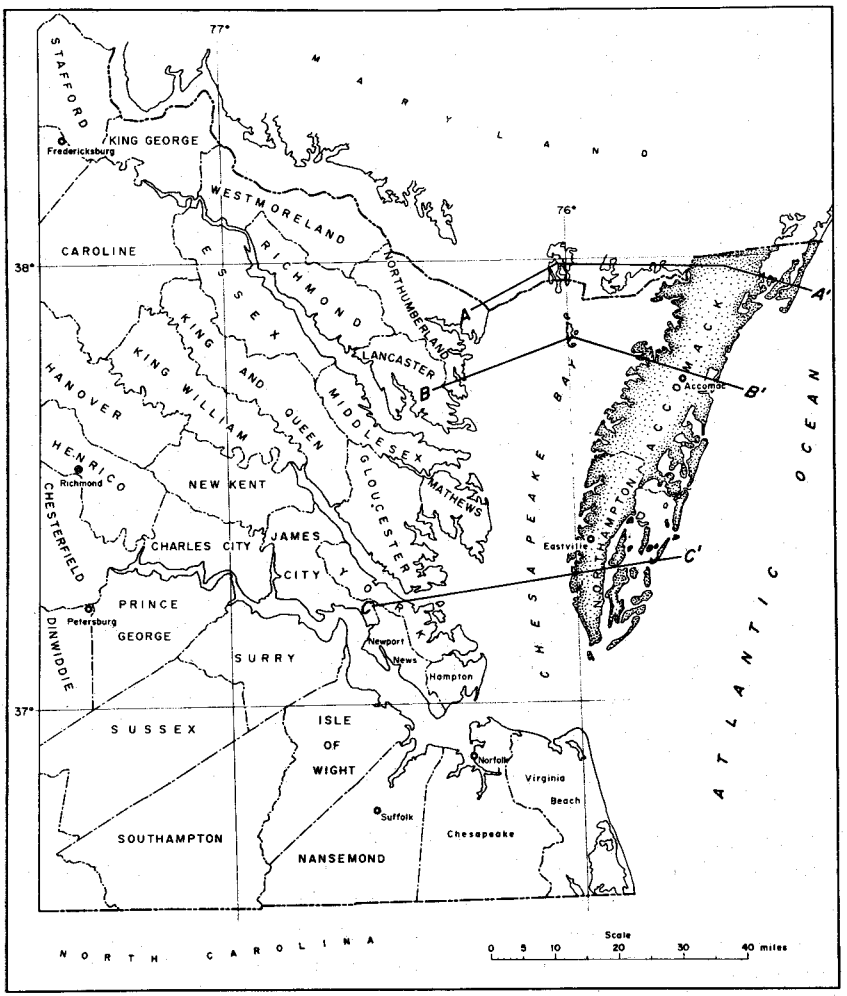


Figure 1. Map of the Virginia Coastal Plain, showing the Eastern Shore peninsula and the location of the geologic sections on Plate 1.

Economic Development, and James L. Calver, State Geologist and Commissioner of the Virginia Division of Mineral Resources.

The area covered by this report is shown in Figure 1. Some information was collected in the field on several occasions from 1942 to 1946 by D. J. Cederstrom of the U. S. Geological Survey, during work incidental to other cooperative ground-water studies in the Virginia Coastal Plain. Most of the well records shown in Tables 1 and 6 were obtained by the junior author. Some were collected during the summer of 1948 for an earlier draft of this report prepared in 1951 by the senior author. Additional funds were made available in 1952, and many more wells were canvassed for information that summer, followed a year later by a test-drilling program.

Records of more than 300 wells have been obtained, and comprehensive, partial and preliminary chemical analyses of the water from more than 150 of these wells have been made in the Quality of Water Laboratories of the Geological Survey. Driller's logs of wells were obtained whenever possible, and several sets of samples of drill cuttings were collected for study.

The writers acknowledge the assistance of the following well drillers and drilling contractors: John Scott & Son, of Melfa; William J. Porter, of Saxis; Shannahan Artesian Well Co., Inc., St. Michaels, Md.; Paul Schweitzer, of Norfolk, formerly President of the Layne-Atlantic Company; J. G. Perry, Virginia Machinery and Well Co., Richmond; Garland S. Sydnor, Garland S. Sydnor, Jr., and Guy E. Webb, of Sydnor Hydrodynamics, Inc., Richmond; James P. Prine, formerly of Norfolk, Va.; and Edgar C. Cusick, of Church Creek, Maryland. Information relating to irrigation in the area was supplied by T. W. Edminster, then of Blacksburg, James H. Lillard, of Blacksburg, both with the U. S. Soil Conservation Service; George Davis, of the Department of Geography, University of Virginia, H. A. Stewart, of the Virginia Truck Experiment Station in Norfolk, and Alfred C. Walker, formerly Ground Water Geologist with the Virginia Geological Survey. The late Henry Jander supplied information on the old flowing well and other wells on Tangier Island, and collected samples from wells on Smith Island, Md. Otis D. Marshall and his successor, Leroy Jester, Jr., water superintendents of the town of Chincoteague, furnished data on the water system of that town. William J. Gillespie, Civil Engineer at what was then the Naval Aviation Ordnance Test Station, Chincoteague, supplied data on the wells at the station, and W. G. Lewers has made periodic water-level measurements at the

Federal observation well at the station since March 1948. (That facility, since mid-1959, has been operated as Wallops Station, Main Base, of the National Aeronautics and Space Administration.) Mr. Lewers also assisted the writers in providing arrangements for a pumping test in the spring of 1954.

The late Julia A. Gardner, of the Branch of Paleontology and Stratigraphy of the Federal Survey, identified megafossils in cuttings from several wells, and Ruth Todd, I. G. Sohn, and F. Stearns MacNeil identified Foraminifera, Ostracoda, and megafossils from drill cuttings obtained during the 1953 test-drilling program. Mrs. Frances H. Dowell provided technical assistance with a model which was used in developing the geologic correlations. Many residents in the area freely furnished information on their wells during the course of the field work.

For assistance in various ways during the initial stage of the work, acknowledgment is here also made to John R. Drummond, of Nandua, Ralph E. Long, of Capeville, Ralph Onley, of Modest Town, and Harold Wescoat, of Eastville—all members of the Eastern Shore Board of Soil Conservation District Supervisors; John Rogers and Roy Nottingham, County Agricultural Agents for Accomack and Northampton Counties, respectively; and to John N. Selby, of Accomac, field representative of the U. S. Soil Conservation Service.

PURPOSE OF THE INVESTIGATION

This investigation was undertaken to describe the occurrence of ground water on the Eastern Shore peninsula, and its relation to the sub-surface geology, so that this essential natural resource may be utilized in the best manner by municipalities, industries, and by domestic and irrigation users. From the data here presented, it is hoped that these users may be able to anticipate to a reasonable degree the availability and the character of the ground water to be expected at various places on the peninsula.

METHODS OF FIELDWORK

During the field phases of this investigation, factual data were obtained on an adequate number of representative wells in the two counties. The wells were chosen partly on the basis of geographical distribution and partly for the purpose of obtaining typical wells which tap aquifers from various stratigraphic horizons at different depths. The majority of the larger wells were visited in the field; selected

wells were also visited among the many shallow dug and driven wells that supply individual users throughout the two counties.

Many well owners furnished certain information. A few were able to furnish driller's logs, or could describe in a general way the formations penetrated during the course of construction of their wells. For the larger industrial or municipal wells, where relatively complete data had been compiled, all available recorded information was obtained. These records have been tabulated and are published in this report. (See Tables 1 and 6.)

The samples of water from a representative number of wells on the peninsula were collected for chemical analysis. Minimum determinations on all samples included the determination of chloride and fluoride content and the soap hardness. Samples from selected wells were also taken for "partial" analysis, which included, in addition to the constituents mentioned, determinations of bicarbonate, sulfate, nitrate, and iron. Some of the most heavily pumped wells were sampled for comprehensive analysis. Nearly all of these analyses are listed in this report (Tables 4, 5, and 8).

Because of the large topographic contour interval on most maps available when field work was in progress and the low relief in the area, generally about 50 feet, an airplane altimeter was used during part of the work to estimate the altitude of the land surface at some of the wells. It is believed that the altitudes so determined are probably more reliable than would have been determined by simple inspection of topographic maps.

PREVIOUS INVESTIGATIONS

The Eastern Shore peninsula has low relief, and good exposures of deposits older than Holocene age are entirely restricted to the Pleistocene terrace cover (Clark and Miller, 1912, p. 189). The only extended published discussion of ground-water conditions in the Eastern Shore counties is that by Sanford (1913) which is found in Virginia Geological Survey Bulletin 5. In spite of the limited information at his disposal Sanford wrote creditable sections on the ground-water conditions in Accomack and Northampton Counties in that early bulletin.

Some information developed during the present study was published several years ago. Summaries of the geology and ground-water conditions on the peninsula, descriptions of wells, and stratigraphic corre-

lations on selected wells were released in three circulars prepared by the present writers (Sinnott and Tibbitts, 1954, 1955, and 1957).

In the Coastal Plain west of Chesapeake Bay detailed studies had been made on the subsurface geology by Cederstrom (1945a, 1945b, 1946a, and 1946b), and Richards (1948). Geophysical investigations had been made by Ewing and others (1937). The ground-water work referred to was carried out in counties west of Chesapeake Bay. During the course of that work formation samples were obtained during the drilling of deep wells for relatively large municipal and industrial ground-water supplies. These samples have afforded an excellent opportunity for paleontologic correlations, especially by means of microfossils.

Because very few wells deeper than about 300 feet have been constructed in the Eastern Shore counties, the characteristics of the Eocene and Cretaceous sediments must be largely inferred from their shallower occurrence on the mainland counties west of Chesapeake Bay. Practically all of the so-called deep wells on the Eastern Shore tap strata of Miocene age; consequently, most of this report is concerned with the occurrence of ground water in the Miocene aquifers and in the more readily accessible Pleistocene deposits.

In the mainland counties, where many well logs and drill cuttings have been obtained, stratigraphic correlations can generally be carried out in some detail. On the Eastern Shore, however, such interpretation has been limited because of the scarcity of subsurface data. The exploratory test holes drilled in the Miocene formations during this investigation in 1953 have yielded substantial additional information, particularly in the relatively unknown depth range from 300 to 450 feet below the surface. The correlations for the deeper Eastern Shore wells, shown on the geologic sections of Plate 1, have been based in large part on the test-hole information, including paleontologic studies, from the Crisfield, Md., well and in part on extrapolation of data on wells in the mainland Tidewater counties near the western shore of Chesapeake Bay.

The microfauna contained in the subsurface samples obtained during the drilling of the four exploratory test holes have been studied by U. S. Geological Survey specialists. Significant data also have been obtained from the published work of other investigators based on subsurface data on wells in Maryland near the Virginia Eastern Shore.

Ruth Todd (1955) of the U. S. Geological Survey, determined the

Foraminifera from the exploratory holes, and discussed the probable correlations and the environments of deposition; I. G. Sohn (1954), also of the Survey, studied the ostracodes. The late Julia A. Gardner (1948) of the Survey studied shells from drill cuttings from a well at Cheriton in Northampton County, and made tentative age assignments to the subsurface material.

Doris S. Malkin (Mrs. Doris Malkin Curtis) made a preliminary correlation of samples from a deep well drilled on Smith Island, Maryland, about 10 miles north of Tangier Island in Chesapeake Bay. Her correlation (Malkin, 1947) is included in this report (Table 3) by permission of Shell Oil Company. A paper by McLean (1950) contains stratigraphic correlations of samples from a deep well at Crisfield, near the Virginia-Maryland boundary.

Wentworth (1930) discussed the geomorphic history of the Eastern Shore. A brief article on the Pleistocene terraces on the peninsula has been published by the writers (Sinnott and Tibbitts, 1961).

Following a study of the megafossils of drill cuttings from the exploratory test holes and certain other wells by F. Stearns MacNeil of the U. S. Geological Survey (written communication, 1955), a circular on stratigraphic correlations on the the Eastern Shore peninsula was published by the writers (Sinnott and Tibbitts, 1957).

WELL CONSTRUCTION

Ground water is discharged artificially by means of wells constructed so as to penetrate one or more water-bearing formations. The water is either pumped, or, in certain favorable areas, flows naturally at the surface. The various methods commonly used in well construction on the Eastern Shore peninsula are discussed briefly in this section.

SHALLOW WELLS

Most of the shallow wells described in this report obtain water from deposits of the Columbia Group of Pleistocene age. Dug wells, to 35 feet in depth and from 2 to 6 feet in diameter, are common throughout both counties. Owing to the unconsolidated character of the Pleistocene deposits, dug wells are usually lined from top to bottom with some form of curbing such as wood, brick, tile, or cement pipe.

Dug wells are manually excavated, preferably several feet below the water table, and the curbing added as the digging progresses. The cuttings are removed by means of a bucket, and any water that col-

lects is pumped off. Puddled clay is sometimes poured into the space between the outside of the curbing and the wall of the hole in an effort to seal off contamination from the surface.

In recent years the majority of shallow wells have been constructed by driving small diameter pipe equipped with drive-point strainers into the water-table aquifers. Driven wells are generally deeper than dug wells, having a practical depth limit of about 60 feet.

Some form of maul or simple triphammer is used to drive the pipe to the desired depth. The maximum diameter of pipe that can be used in this type of construction is 2-inch, and that only if the formations penetrated are soft and the well does not exceed about 30 feet in depth. Smaller pipe, from ¾ to 1½ inches in diameter, can be set at greater depths.

The chief disadvantage of shallow wells is the likelihood of contamination from surface sources. Contamination is much more likely in dug wells because of the difficulty of effectively sealing the joints in the curbing. Driven wells are usually tightly sealed, but may be contaminated by infiltration through the shallow formations.

The Eastern Shore is an area of little relief and generally unsuited to impoundment of surface water for irrigation. In some places, however, large pits have been dug at topographically low points, not only to collect surface runoff but also to intersect the water table. Thus, these irrigation ponds are, in effect, large dug wells. Although they are readily subject to organic pollution, they are nevertheless well suited as sources for irrigation supplies.

Water is drawn from dug wells by means of either bucket lifts or hand-operated suction lift pumps. Likewise, most driven wells are equipped also with hand pumps; where larger yields are desired they may be equipped with shallow-well jet pumps. Where local hydrogeologic conditions are favorable, batteries of driven wells (9a and 47a, Accomack County) are pumped as a unit to provide municipal and irrigation supplies.

DEEP WELLS

Wells more than 60 feet in depth on the Eastern Shore are termed deep wells. These wells obtain water from Miocene and lower Pleistocene deposits; a few reach deposits of Eocene age.

Yields of about 30 gpm (gallons per minute) are readily obtained by jetted wells, 2 and 3 inches in diameter; larger yields may be

achieved by constructing large-diameter wells by either the cable-tool or rotary drilling methods.

On the Eastern Shore, the Miocene aquifers commonly contain confined water under artesian pressure which in some low-lying areas is sufficient to cause wells tapping them to flow above the land surface. On higher ground, the static levels of wells in these aquifers range between 5 and 20 feet below land surface and pumps are required. Shallow-well pumps can be used for small-diameter domestic wells where the static level is within 20 to 30 feet of the land surface. Larger diameter wells, with larger yields, however, require deep-well pumps because the drawdown caused by pumping usually lowers the water level below the limit of suction lift of shallow-well pumps—roughly about 30 feet.

Deep wells are not as subject to contamination from surface sources as shallow wells because of the greater depths to the aquifers and the consequent filtering action of the intervening beds. Moreover, the formation usually slumps tightly against the pipe after the well is constructed, greatly reducing the hazard of direct contamination along the outside of the casing.

Jetting Method

Most of the deep domestic wells on the Eastern Shore are constructed by the jetting method. In this method, hole is made by pumping water through a continuous line of hollow rods or "drill pipe" to which a bit is attached. The water is forced through constricted openings in the bit against the bottom and sides of the hole. The line of rods is activated up and down by means of a walking beam or eccentric arm and, at the same time, is given a slight rotary motion by manually twisting the string of drill pipe. The resulting hole is created largely by the force of the water and to a lesser degree, by the cutting action of the bit.

In drilling water passes down the hole through the string of pipes and returns to the surface in the annular space outside the rods and then flows into a system of pits in which the cuttings settle. The water is then picked up by the pump and recirculated. As the hole deepens, the operation is stopped temporarily and more pipe is added to the line of rods.

The casing is either advanced immediately behind the rods as the well is deepened or is "washed in" after an exploratory hole has been

completed. The strainer or screen attached to the end of the casing may be washed in at the same time. The screen also may be installed after the pipe is in place. A lead seal extending above the top of the screen is swaged against the inside of the casing in order to prevent sand from entering between the screen and the casing and plugging the well.

Jetted wells are developed by surging and pumping with air. Generally the surging or pumping action is gentle at first until all the mud and most of the fine sand have been removed from the aquifer around the screen, after which agitation is increased until all of the fines have been removed.

Although most jetted wells on the Eastern Shore are between 2 and 4 inches in diameter and from 100 to 300 feet in depth, it is possible to construct 6-inch wells to depths of 200 feet by this method and also to drill 2-inch wells to nearly 1,000 feet. Jetted wells are cheaply and quickly drilled and require only relatively simple equipment. For example, Mr. C. R. Bull drilled a 154-foot well (169, Northampton County) on his farm with a home-made rig. Moreover, a number of shallow wells in both counties have been "washed in" by pumping water through a small-diameter pipe and simply allowing the pipe to sink by its own weight as the material is loosened and washed out. The pipe used in this method of jetting is left in the hole and, therefore, serves as both drilling rod and casing.

Cable-Tool Method

Some of the older large-diameter municipal and industrial wells on the Eastern Shore probably were constructed by the cable-tool method. In areas of unconsolidated sediments this method is slower than the jet or rotary methods of drilling, hence, most of the recent large-diameter wells on the peninsula have been constructed with rotary rigs.

In drilling by the cable-tool method, a heavy bit hung on a flexible steel cable is repeatedly raised and dropped. The cable passes over a pulley near the top of a tall mast and from there back down to a walking beam activated by the engine. Owing to the elasticity of the cable, the resulting blows have a whip-like snap that largely accounts for the breaking up of the formation.

Water is added to the hole and forms a thin clayey mud in combination with the cuttings. The mud and cuttings are removed at intervals with a bailer. In loose material, the casing closely follows or is

driven slightly ahead of the hole, but in tight clay the hole may be left uncased for several tens of feet.

In water-bearing formations enough open hole can sometimes be made below the end of the casing in which to set the screen. However, in sandy formations where the hole caves, the casing is driven through the water-bearing stratum and the screen is set in place; the casing is then jacked back to expose the screen.

Cable-tool wells are developed by intermittently surging and pumping until the water pumped becomes clear. This process of development removes the fine material and leaves a natural residual envelope of coarse sand and gravel around the screen. This effectively increases the permeability of the formation around the screen permitting a greater inflow of water. In coarse gravel formations a cable-tool well may be completed without a screen, or with slotted pipe instead of a screen; however, this type of construction does not permit maximum development of the formation and, particularly in open-end development, the well eventually may become partly clogged.

Hydraulic-Rotary Method

Most of the municipal and industrial wells on the Eastern Shore have been drilled by the hydraulic-rotary method, as were the four U. S. Geological Survey test holes. Rotary drilling is particularly adapted to rapid construction of larger-diameter wells in areas of unconsolidated sediments. In such a hole electric logs can be made after the hole is completed in order to assist in determining the most favorable places at which to set the well screens. The casing with one or more screens can then be made up and installed in the well in one operation.

In the rotary method, hole is made by a bit attached to a continuous string of rapidly rotating hollow drill rods. A suitable drilling mud, commonly consisting of bentonite clay mixed with water, is pumped from a mixing pit down through the hollow rods, and out through openings in the bit where the resulting washing action contributes to the cutting of the formations being drilled. The mud, with the suspended cuttings, then passes up the annular space between the rods and the wall of the hole, and flows into another pit where the cuttings settle out. From this pit, the mud returns to the mixing pit through a shallow connecting ditch and is recirculated by the pump.

The uppermost drill rod is a keyed steel bar known as a "kelly" which passes through the rotary table. The rotary table is powered

by the motor and spins the kelly and attached drill rods, imparting the rotary motion for which the method is named. Additional rods are added below the kelly as the hole deepens. A constant downward pressure can be maintained on the line of rods by means of a hydraulic pulldown system. This pressure may be increased or decreased as required by the characteristics of the formation being penetrated.

The circulating drilling mud plasters the walls of the hole and prevents caving, usually allowing the entire hole to be drilled without casing. When the desired depth is reached, the drill rods are extracted and the casing, with appropriately spaced screens, is lowered into the hole. The annular space around each screen is sometimes filled with small gravel, forming a highly permeable artificial envelope around the screen and effectively increasing the yield of the well.

Rotary wells require more developing than wells constructed by other methods because initially the mud used in drilling penetrates the aquifer and largely seals off the water. This drilling mud in the aquifer around the screen must be removed in order to allow water to enter the well. Removal is accomplished by "backwashing," during which water is alternately forced into the well, and out through the screen into the aquifer, returning through the screen when the pressure is released. This surging action tends to clear the mud from water-bearing formation. The well is then pumped intermittently ("rawhided") in order to develop the aquifer. In recent years, detergents have been added during backwashing to break down the drilling mud that has penetrated the aquifer.

Most rotary wells on the Eastern Shore are equipped with electrically powered turbine pumps and are built to obtain the maximum yield possible from the formations penetrated. The majority tap several aquifers of Miocene age. An exception is the 63-foot irrigation well (115, Accomack County) on the Van Kesteren farm that yields 450 gpm from the Pleistocene Columbia Group.

ACCOMACK COUNTY

LOCATION AND DEVELOPMENT

Accomack County lies in the northern part of the Eastern Shore peninsula of Virginia. It is bounded on the north by the State of Maryland, on the south by Northampton County, and on the east and west by the Atlantic Ocean and Chesapeake Bay, respectively. Its total land area is 470 square miles and the population in 1960, according

to the U. S. Census was 30,635—a decrease of 3,197 since 1950. This county received the name originally given to the entire Eastern Shore by the Indians, meaning "the other side land."

The soil of the county is very productive, and it is one of the most important counties for the production of Irish potatoes and sweet potatoes. Lumbering is an important industry. Truck farms are also prominent, canning factories are important, and the poultry industry is increasing.

Freight service is furnished by the Penn Central (formerly Pennsylvania) Railroad directly through the county from Maryland. The railway line is roughly paralleled by U. S. Highway 13. In addition to U. S. Highway 13 there are several other important State highways, particularly 178, 316, and 175, the latter connecting the mainland with Chincoteague Island off the northeastern shore.

Among the larger towns are Accomac, the county seat, Onancock, Parksley, Wachapreague, Onley, Belle Haven, and Chincoteague.

Tangier, on a small island of the same name 10 miles offshore in the middle of Chesapeake Bay, is an isolated community gaining its livelihood chiefly from fish and shell fish products. Chincoteague is noted for oysters, and also for its ponies, which are brought over from Assateague Island on the annual "pony penning day" in July.

DRAINAGE AND TOPOGRAPHY

Like Northampton County, Accomack County has no major streams. Surface drainage is accomplished by many minor creeks flowing bayward or seaward from the almost imperceptible divide that passes longitudinally through the middle of the county. At the mouths of these creeks, particularly along the ocean side of the county, longshore currents have developed bay-mouth bars and lagoons. The aspect of the shoreline on both sides is one of submergence, as is also true of the Chesapeake Bay region as a whole.

Important creeks and tidal inlets on the Bay side are Deep Creek, northwest of the town of Accomac; Chesconnessex and Onancock Creeks, west and northwest of Onancock; and Pungoteague, Nandua, and Craddock Creeks, in the southwest part of the county. Occahannock Creek is at the extreme southwest, and forms part of the boundary between Accomack and Northampton Counties.

On the ocean side, barrier beaches and bay-mouth bars have been developed opposite all the creeks. Chincoteague Bay is the longest of

these, extending northeastward into Maryland, and is bounded on the east by Assateague and Chincoteague Islands. Among the lagoons lying southward from Chincoteague Bay are Bogues, Metomkin, and Burtons Bays. Bradfords, Swash, Revel Island, and Upshurs Bays are four lagoons clustered behind Parramore Island in the southwest part of the county.

Among the barriers enclosing the lagoons only Chincoteague Island is extensively inhabited. However, on Wallops Island, there is the Launch Area facility of the National Aeronautics and Space Administration, and there is a small settlement on Upshurs Neck at the southeastern part of the county.

The total relief in Accomack County is about 60 feet, the highest altitudes being in the vicinity of Melfa in the southern third of the county.

Although the entire surface of the county is nearly level, minor topographic features, including Pleistocene terrace scarps and Carolina bays, may be discerned from careful observation.

GEOLOGY

Basement Complex

The so-called basement complex of igneous and metamorphic rocks probably lies on the order of 4,500 to 7,500 feet below the surface in Accomack County. (Spangler and Peterson, 1950, Fig. 12.) The nearest well in Virginia that reached these rocks is the oil and gas test well drilled in 1929 at Mathews on the western shore. (See Plate 1, section C-C′.)

Cretaceous and Paleocene Deposits

As shown in the log (Table 3), McLean (1950) described the Paleocene–Late Cretaceous section at the municipal well at nearby Crisfield, Md., as being largely clayey. The higher (Paleocene) beds are glauconitic and the deeper (Late Cretaceous) beds include varicolored clay. At Smith Island, Maryland, 10 miles north of Tangier Island in Chesapeake Bay, the lowermost 40 feet of unfossiliferous medium-grained white quartz sand is probably of Paleocene age. (See Table 3.)

Eocene Deposits

With the exception of the early well on Tangier Island (183, Plate 3 and Table 1) rocks of Eocene age have not been penetrated by wells

in Accomack County, so far as known. However, the character of the lithology is described for the two Maryland wells just discussed, and is probably similar in a general way to the Eocene section beneath at least the northern part of Accomack County.

McLean (1950, p. 136) places the Eocene between 760 and about 860 feet below the surface at Crisfield, Md., the rocks consisting chiefly of glauconitic coarse to medium sands. The entire Eocene section in this well is assigned to late Eocene age, and therefore would be correlative with the Chickahominy Formation. In her descriptions of samples from the well up-dip on Smith Island, Malkin places the Eocene between 590 and 800 feet, and notes that the rocks are sand, shells, and glauconitic marl (Table 3).

Miocene Deposits

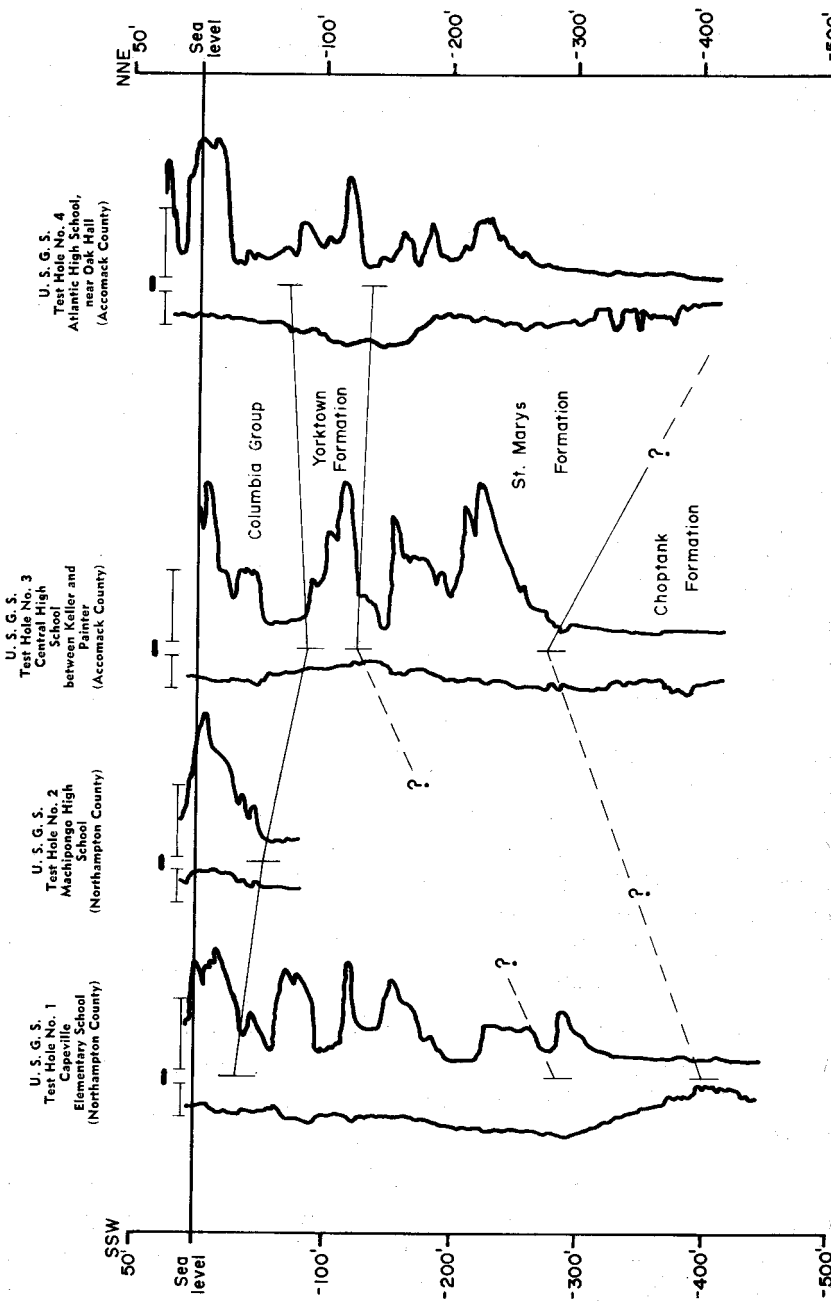
Rocks of Miocene age in Accomack County do not crop out at the surface, being everywhere overlain by deposits of the Columbia Group of Pleistocene age. The several formations, designated as the Chesapeake Group, extend from a little more than 100 to as much as 700 feet below the surface. Consequently, most of the so-called "deep" wells in the county tap water from aquifers of Miocene age.

The character of the Miocene rocks is not uniform from place to place, and closely spaced wells are likely to show considerable variation in the depth to water-yielding sandy beds.

The Chesapeake Group consists of four formations which are, from oldest to youngest, Calvert, Choptank, St. Marys, and Yorktown. No wells in Accomack County are known to have reached deposits of the Calvert Formation.

The Choptank Formation begins at about 310 feet below the surface in the U.S.G.S. test hole no. 3 (Fig. 2), extending through the entire depth of the hole to 450 feet. (Tables 1 and 2 and Fig. 3). The deposits consist of silty sand and sandy clay with many shell fragments. There are no good water-bearing zones in this part of the Choptank at this locality.

Figure 2. Diagrammatic correlation of U. S. Geological Survey test holes along the Eastern Shore peninsula, Virginia, showing electric logs. Scale for left curve (spontaneous potential) of each log indicates 50 millivolts; scale for right curve (resistivity), 100 ohms m^2/m. Stratigraphic correlations by F. Stearns MacNeil based on megafossils.


NNE
50'
Sea level
-100'
-200'
-300'
-400'
-500'
U. S. G. S.
Test Hole No. 4
Atlantic High School,
near Oak Hall
(Accomack County)
U. S. G. S.
Test Hole No. 3
Central High
School
between Keller and
Painter
(Accomack County)
U. S. G. S.
Test Hole No. 2
Machipongo High
School
(Northampton County)
U. S. G. S.
Test Hole No. 1
Capeville
Elementary School
(Northampton County)
Columbia Group
Yorktown Formation
St. Marys Formation
Choptank Formation
?
SSW
50'
Sea level
-100'
-200'
-300'
-400'
-500'

The St. Marys Formation extends from about 175 feet below the surface in Accomack County, and reaches 310 feet at U.S.G.S. test hole no. 3 near Keller, but apparently thickens northeastward to at least 451 feet below the surface at test hole no. 4 near Oak Hall (Figure 2). Thus, as would be expected, more wells reach the St. Marys in the northern part of the county.

Typically the lithology of the St. Marys Formation is interbedded blue sandy clay and silty sand and abundant shell fragments.

The Yorktown Formation everywhere underlies the Pleistocene Columbia Group, and is thus more readily reached by wells deeper than about 100 feet in the county. Its thickness, according to MacNeil's study of the megafossils from the U.S.G.S. test holes (Figure 2), ranges from about 30 to 60 feet in Accomack County, although it is said to thicken to about 250 feet in southern Northampton County. The character of the material is generally sand and blue, black, or brown clay, and shells.

A relatively deep well drilled at Onancock (108a) in 1890 penetrated gravel, sand, and shells from 150 to 175 feet, fine sand from 180 to 308 feet, "hard rock"—probably limestone—at 308 to 310 feet, and clay and sandy clay to 480 feet. Water was found at 90, 140 and 486 feet (Sanford, 1913, p. 125). Although this well has been abandoned, it is, to the writers' knowledge, the deepest for which there is any lithologic data on record in this county; the lowest part of the section probably approaches to within 100 to 200 feet of the Miocene-Eocene contact. Although the well thus evidently penetrated more than 150 feet of the Choptank Formation, water was finally developed from the Yorktown Formation at 140 feet below the surface. Sanford also reports that another well was attempted at Onancock in 1895 and was drilled to a depth of about 600 feet, but was unsatisfactory. There is no record of the material penetrated.

The character of the Yorktown Formation at the south end of Wallops Island, according to the log of well 61, consists of clay and sand from 99 to 133 feet, sand and shells to 145 feet, and 2 feet of gravel to about 147 feet.

Two well logs in the Harborton area in the southwestern part of the county (132, 133, Table 2 and Plate 3) show a water-bearing sand in the Pleistocene at a depth of less than 15 feet, some water-bearing sand near 50 feet, probably also in the Pleistocene, and fairly good sand below about 125 feet in the Yorktown Formation. By contrast,

the log of a well reaching the St. Marys at Pungoteague (151, Table 2), about 2½ miles to the south, indicates that almost the entire section is more or less water-bearing with only 3 feet of blue mud from 110 to 113 feet. These two sections demonstrate the variable character of the subsurface lithology of the Miocene and Pleistocene.

Pleistocene Deposits

The deposits at or near the surface in Accomack County constitute the Columbia Group of formations of Pleistocene age. As explained earlier, the several formations are not differentiated in this report.

The Pleistocene rocks in the Virginia Coastal Plain are generally yellowish or brownish in contrast to the usual white or gray color of the underlying Yorktown Formation of the Miocene Chesapeake Group. Locally, the Yorktown also may be yellowish, and because fossils are rare it is difficult to determine the position of the base of the Pleistocene. The total thickness of the Columbia Group probably ranges from about 30 to about 125 feet in Accomack County, depending on the topographic situation and on the pre-Pleistocene erosion surface on the top of the Yorktown on which the Columbia Group was laid down. The lithology of the Pleistocene deposits consists of yellow sands, sandy clays, and some gravel beds; the latter are not commonly of great lateral extent (Figures 3, 4). Cross-stratification is widespread.

A brief petrographic study of samples across the biostratigraphic contact between the Miocene and Pleistocene section in U.S.G.S. test holes 3 and 4 showed that heavy minerals also may be useful in determining the contact (Sinnott, 1955). Pyrite, garnet, and altered grains are more abundant in the Miocene, whereas zircon and kyanite are more abundant in the Pleistocene.

GROUND-WATER RESOURCES

Water from Cretaceous and Paleocene Deposits

The potential of this horizon as a water-bearing zone under favorable conditions is indicated by the performance of a well drilled by the Layne-Atlantic Company for the town of Crisfield, Md., about 16 miles west of New Church, Va. Although this well taps minor aquifers in the Miocene Calvert Formation and in beds of Late Eocene (Jackson) age, the chief water-bearing zone reported was within Upper Cretaceous deposits. When completed, it was a flowing well, with a water level 4 feet above the surface. It was test pumped at 330 gpm with a drawdown of 104 feet. Water is obtained principally

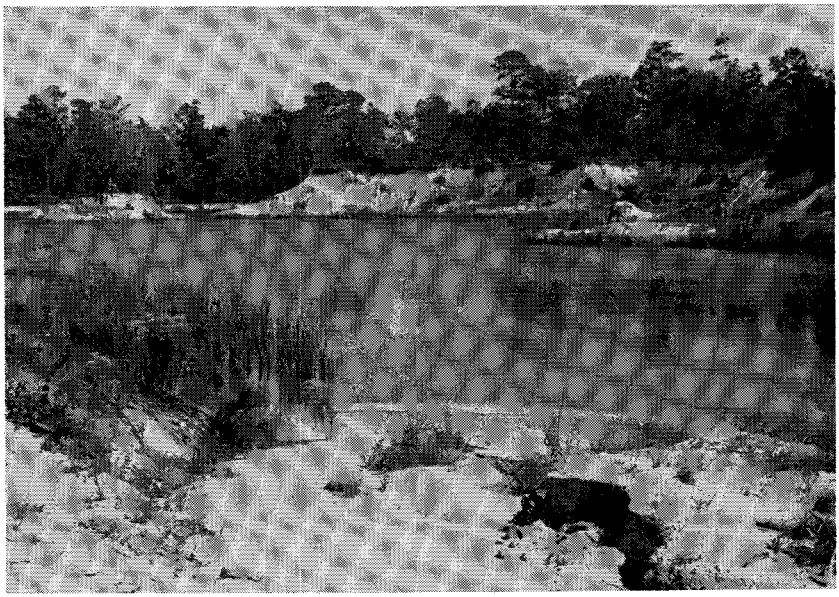


Figure 3. Sand and gravel pit, in deposits of the Columbia Group of Pleistocene age, east of Mappsville, Accomack County. Lake level indicates position of water table.

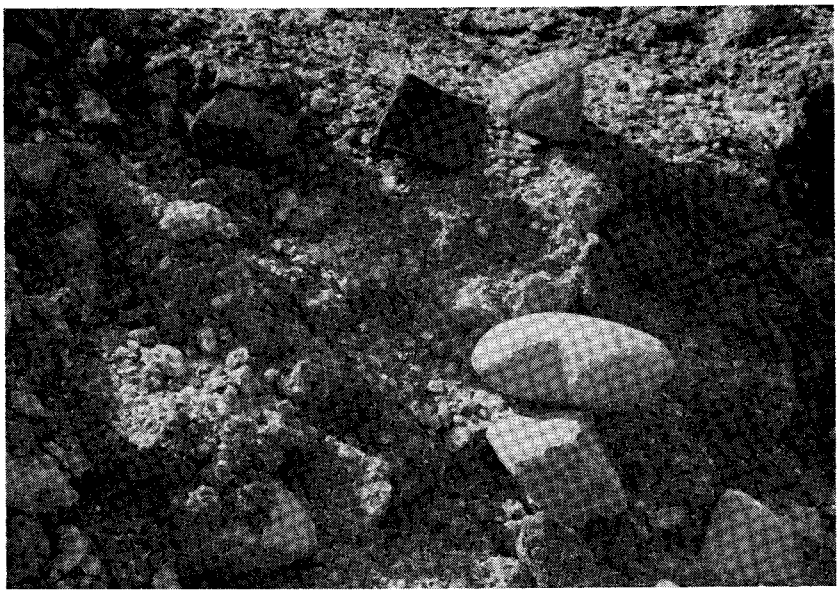


Figure 4. Coarse gravel and boulders up to 6 inches long in gravel pit 1½ miles west of Hallwood, Accomack County.

Figure 3. Sand and gravel pit, in deposits of the Columbia Group of Pleistocene age, east of Mappsville, Accomack County. Lake level indicates position of water table.

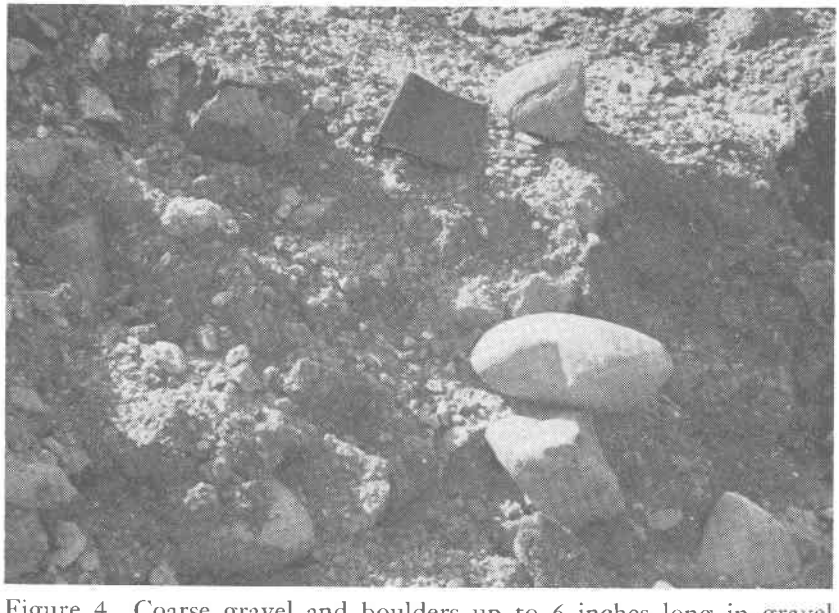


Figure 4. Coarse gravel and boulders up to 6 inches long in gravel pit 1½ miles west of Hallwood, Accomack County.

from coarse to medium clear quartz sand at 1,125 to 1,142 feet. According to a mechanical analysis of this sand (commun., Layne-Atlantic Co.), the median diameter is 0.34 millimeter, and the coefficient of sorting is 1.35, indicating that the material is moderately well sorted.

Several wells put down to depths of 840 feet or more on Smith Island, Maryland, in Chesapeake Bay about 10 miles north of Tangier Island, were all flowing wells with reported yields of up to 10 gallons per minute at the time of construction in the 1940's. These wells probably develop water from a quartz sand in the (upper) part of the Mattaponi Formation which is considered to be of Paleocene age.

Water from Eocene Deposits

So far as known, the only wells in Accomack County that reach deposits of Eocene age are those on Tangier Island. The old fish factory well (183, Table 1) was still flowing in 1948. However, there are several other wells of comparable depth that supply water to small groups of individuals.

Water from Miocene Deposits

Most of the larger ground-water supplies in Accomack County are obtained from the two younger formations of the Chesapeake Group. In general, properly developed wells 6 inches or more in diameter may be expected to have dependable yields of at least 100 gpm, whereas smaller diameter wells yield between 10 and 20 gpm. Discussion of the several formations of the Chesapeake Group follows.

Calvert and Choptank Formations The oldest formation of the Chesapeake Group is the Calvert; there are no wells of record that were completed in this formation in Accomack County.

However, two wells of small yield—about 5 gpm—tap water from the overlying Choptank Formation (108a and 160). Of the two U.S.G.S. test holes in the county, the one near Keller (no. 3, Table 2) penetrated nearly 150 feet of the Choptank, but no good water-bearing zones were found.

From this meager amount of information, it appears that the Choptank Formation holds little promise as a potential future source of ground water in the county.

St. Marys Formation The St. Marys is believed to be tapped by more than 50 wells in Accomack County. Although not as widely

utilized as a source of ground water as the overlying Yorktown Formation, it nevertheless supplies several important installations.

Most of the wells are 2 inches in diameter; these have yields averaging between 15 and 20 gpm. Among those of larger diameter, yields range from 115 gpm for two 4-inch diameter wells (51b and 108c), 140 gpm for a 6-inch diameter well (47a), to yields of 194 gpm and 254 gpm for 8-inch diameter wells (57b and 6a, respectively).

Yorktown Formation More than 60 wells for which data are available tap the Yorktown Formation for ground water in Accomack County. Of these, more than 80 percent are 2 inches in diameter; their average yield is about 16 gpm. Some of them, however, yield as much as 30 gpm (33, 83, and 91). Three wells are of larger diameter: well 61, at the Wallops Island Launch Area, National Aeronautics and Space Administration; well 87a, town of Parksley; and well 109b, town of Onancock. These yield, respectively, 30, 50 and 100 gpm.

Many of the wells tapping Miocene beds are flowing wells. Such wells are necessarily at relatively low altitudes—generally less than 10 feet above sea level. The largest flow reported was at well 160, which was finished in the Choptank Formation, owned by the Town of Wachapreague. This well is 385 feet deep, and is reported to flow at about 6 gpm at high tide and 3 gpm at low tide. The increase in flow is an effect known as "tidal loading," and is noted also in many other flowing wells throughout Tidewater Virginia.

Other flowing wells tapping Miocene rocks are well 56 (Table 1) west of Mearsville, which is 190 feet deep and flows 2 gpm (gallons per minute) from an aquifer in the St. Marys Formation, and well 81 at Hopkins, 100 feet deep, flowing 1½ gpm from the Yorktown. A small flow from the St. Marys is reported for well 88, northwest of Greenbush, but this well is equipped with an electric pump for normal operation. Another flowing well (128a), east of Onley, drilled barely into the uppermost part of the Yorktown, is at a very low altitude—approximately at sea level—and is submerged at high tide. It flows at about 1 gpm, but required installation of a pump for regular use. Well 166 at Craddockville in the Yorktown Formation was estimated to flow about 10 gpm in 1948, supplying a farm and a small pond. The flowing wells mentioned here and entered in Table 1 may be considered representative of many similar wells in the county.

Water from Pleistocene Deposits

Columbia Group Among the wells canvassed for information in

the county, nearly 60 obtained water from the Pleistocene Columbia Group. Most of these are 1¼ to 2 inches in diameter, and their average yield is about 17 gpm per well. Most are jetted or driven wells, constructed to provide water for small farms and rural homes.

Besides the smaller diameter wells, there are several installations utilizing wells of larger diameter, as much as 8 inches, tapping these deposits, that yield substantially more water. Among these are well 86, operated by the town of Parksley, which yields 150 gpm, and well 115, 2 miles east-southeast of Onancock, which is 63 feet deep and yields 450 gpm with 56 feet of drawdown. This well has the largest sustained yield of any well in the county, and indeed on the entire peninsula, for which data are available. The well is used for irrigation, the water being distributed directly on the crops by a sprinkler system.

Although some of the wells in the Pleistocene deposits have poor yields, for example, well 124 near Onancock, which is said to require redriving frequently, the most common difficulty concerns the chemical and possibly also the bacterialogical quality of the water, discussed in a later section.

At one locality, southwest of Craddockville, the owner reported that a 128-foot well struck "quicksand" and filled, necessitating abandonment in favor of a shallow driven well (171), 28 feet deep, which has proved satisfactory.

In favorable localities, several shallow wells may be utilized together for larger supplies. In such arrangements, they can be pumped separately or they can be pumped together as a single composite well. The latter method is employed at the municipal water system plant (9a, Table 1) for the town of Chincoteague. At this plant, 28 wells, some driven and some jetted, are pumped as a unit, and yield 140,000 gpd (gallons of water per day). The wells are on the peninsula proper, about 3½ miles west of the town, and the water is piped across the straits, which connect Chincoteague Bay with the Atlantic Ocean, to the island community. These wells are 50 to 65 feet deep, and obtain water chiefly from Pleistocene sand, gravel, and shells near the bottom of the section penetrated. One of the wells yields water from similar water-bearing material of Miocene age at a depth of 230 feet; the water level in that well is reported to be about 7 feet above sea level.

Formerly, residents in the town of Chincoteague obtained water individually from privately-owned shallow wells or rain cisterns. In

1948, Mr. Otis D. Marshall, then Water Superintendent, estimated that less than half a dozen shallow wells—12 to 15 feet deep—were still in use on the island. Water from the island wells was commonly brackish, and as the population of the town increased it became necessary to establish a municipal supply system. As of 1967, Mr. Leroy Jester, Jr., present Water Superintendent, reported that to his knowledge virtually no wells for individual use were in service on the island.

On Tangier Island there is no municipal supply as yet, although one had been under consideration a few years ago. More recently, several deep wells were drilled, privately financed, each supplying a small sub-community. These wells were drilled more than 900 feet deep and probably reach the equivalent of the Mattaponi Formation of Late Cretaceous and Paleocene age. The old fish factory well in the Eocene deposits (183, Table 1), 860 feet deep and flowing as of 1948, is located at some distance from the main part of the town and is not used.

Prior to the construction of the deep wells, all residents of the island obtained water from shallow wells about 10 to 15 feet deep in the Pleistocene deposits, and from rain cisterns. A few of the shallow wells were more satisfactory than some others, and were used by several families more or less as common property.

QUALITY OF WATER

Water from Cretaceous and Eocene Deposits

On the basis of available information, there are no wells in Accomack County that reach deposits of Cretaceous age.

An analysis of water obtained from Eocene deposits at the old fish factory well (183, Table 4) on Tangier Island shows that the water is a soft sodium bicarbonate type having a dissolved solids content of 857 ppm. The chloride content is moderately high, 115 ppm and the fluoride content, 3.2 ppm, is more than twice the generally permissible maximum of 1.5 ppm (U. S. Public Health Service, 1962).

According to the map given in Bulletin 68 of the Virginia Geological Survey (Cederstrom, 1946b, Fig. 1) the boundary of the zone of high-chloride artesian ground water should pass close to Tangier Island and just north of Accomack County. The chloride determination (183, Table 4) of 115 ppm in the water from the Tangier well indicates that Tangier Island and northern Accomack County lie

just within the high-chloride zone. As pointed out above, the deep well water at Tangier Island is not of optimum quality but does have a wide range of usefulness.

It is likely that ground water from Eocene and older aquifers in central and southern Accomack County contain much more than 115 ppm of chloride, as a consequence of which it would probably be unfit for most ordinary uses.

Water from deep wells tapping Paleocene rocks in Smith Island (Table 5), like that from Tangier Island, is a soft sodium bicarbonate type with high fluoride content. The chloride content, however, is only about 10 ppm (parts per million).

The soft sodium bicarbonate type water from the deep wells on Tangier and Smith Islands are similar to deep waters found elsewhere in the eastern part of the Coastal Plain.

Water from Miocene Deposits

In the northern and middle parts of Accomack County, water from the Miocene aquifers is generally of the hard calcium bicarbonate type. They are similar to waters from the somewhat shallow, characteristically limy Miocene formations elsewhere in Virginia (Cederstrom, 1946b, p. 43).

Calvert and Choptank Formations As discussed earlier, no wells recorded here reach the Calvert Formation in the county, and only two wells obtain water from the Choptank. Of these, the 385-foot Wachapreague well was sampled in 1948. The analysis (160, Table 4) shows that the water is a soft sodium bicarbonate type but which contains 93 ppm of chloride. This water is similar to that from the Eocene and Cretaceous aquifers elsewhere in the mainland part of the Coastal Plain. The character of the Wachapreague water suggests that deeper Miocene beds, like the Eocene and older aquifers, are recharged from the area west of Chesapeake Bay in contrast to shallower beds that are probably recharged only by local precipitation.

The other Choptank well, 108a in Onancock, was drilled in 1894 and soon abandoned. Water was found at 486 feet, but was not developed, possibly because of its undesirable chemical quality.

St. Marys and Yorktown Formations Inasmuch as the chemical character of ground water from the two younger formations of the Miocene Chesapeake Group are similar, it is convenient to discuss them together.

In the northern third of Accomack County, water from the St. Marys and Yorktown Formations is generally of the hard calcium bicarbonate type (4a, 6a, and 22, Table 4). Hardness of the water from these wells ranges from 81 to 168 ppm; chloride ranges from 11 parts in wells 4a and 22, to 93 ppm, in well 6a at New Church. The fluoride content commonly is very low—less than 0.5 ppm.

Water from the 75-foot well (1, Table 4) at Franklin City is fairly high in chloride, 158 ppm. The hardness is also fairly high, 168 ppm. Although this well probably reaches the upper part of the Yorktown Formation, there evidently is hydraulic continuity with adjacent Chincoteague Bay, perhaps indirectly through Pleistocene sands. Contamination from salt water spray during storms may be possible. (See Hem, 1959, p. 107-110.) Chloride and hardness are both high also—64 and 180 ppm, respectively—in water from well 61 developed in the Yorktown Formation at the Launch Area on Wallops Island, National Aeronautics and Space Administration. An even more highly mineralized water is that from the unused well (13) on Chincoteague Island. It is 102 feet deep and contains 693 ppm of chloride and 388 ppm of hardness. The aquifer tapped by this well probably is in the uppermost part of the Yorktown, but, again, hydraulic continuity with the overlying Pleistocene deposits and, in turn, with the brackish water of Assateague Bay seems indicated.

In the middle third of the county, from Bloxom to Onley, including Onancock and Accomac, the county seat, ground water from the Miocene aquifers also is hard and high in bicarbonate. A complete analysis of water from one of the municipal wells of Onancock (108c, Table 4) indicates that the water is moderately mineralized. It contains 203 ppm of dissolved solids and is moderately high in bicarbonate, 168 ppm. The chloride content is 15 ppm and most of the other constituents are low.

Other analyses available from this part of the county show that the water from the Miocene beds here ranges in hardness from 57 ppm, in well 76 that is 2 miles west-southwest of Bloxom, to 123 ppm in well 88, 3 miles northwest of Greenbush. Chloride is low, less than 25 ppm except in wells 88 and 93 near Chesconnessex, which had 48 and 92 ppm, respectively. The sulfate and fluoride concentrations are very low, the former averaging about 2 ppm, and the latter about 0.1 ppm.

In the southern third of the county, a comprehensive analysis of water from a deep well at Pungoteague (151) is available (Sanford,

1913, p. 344-345). The well is 210 feet deep and ends in the St. Marys Formation. The water is moderately mineralized. It is only moderately hard (108 ppm) but is high in bicarbonate (218 ppm) and moderate to low in most of the other constituents. Also at Pungoteague, but tapping the shallower Yorktown Formation, is a well (153) yielding water of low mineralization. This well is 128 feet deep and yields water having only 18 ppm of bicarbonate and 36 ppm of hardness.

Among other deep wells in the southern part of the county, wells 166 at Craddockville and 177 at Belle Haven, yield waters with chloride concentrations of 15 and 1 ppm, respectively, and hardness of 42 and 102 ppm. Both wells are believed to tap the Yorktown Formation.

Even though the general character of ground water in the St. Marys and Yorktown is similar, such a wide range of variation of particular constituents among individual wells probably is evidence of local hydraulic discontinuity between the two formations.

In summary, wells in Accomack County that tap aquifers of Miocene age yield water high in bicarbonate, averaging about 160 ppm in that constituent. The chloride content is generally about 25 ppm, although in a few well waters it may exceed 100 ppm. Sulfate and fluoride are low—the latter averaging less than 0.3 ppm. Hardness ranges between about 70 and 125 ppm in samples from the Miocene throughout the county, with certain local exceptions.

Water from Pleistocene Deposits

Shallow wells in the northern part of Accomack County tap water in sands of the Pleistocene Columbia Group. A partial analysis of water from one of these, well 2 (Table 4) at Greenbackville, is low in all the constituents tested except iron, which is very high, 4.9 ppm. The group of wells pumped as a unit for the municipal supply for Chincoteague (9a) produces water of moderate mineralization—172 ppm of dissolved solids. The nitrate content is high, 18 ppm, suggesting organic pollution. Water from a 28-foot well at Hallwood (51c) is highly mineralized, having a specific conductance of 1,020 micromhos. Total dissolved solids content should be, therefore, about 700 ppm. However, the water is not hard (51 ppm) and the chloride content is only 16 ppm. Fluoride is apparently absent. Other constituents were not determined, although iron probably is rather high, as the owner reported an iron taste, and yellow stains are deposited on laundry. At Mappsville, an analysis of the water from a 21-foot well (60)

shows 57 ppm of hardness and only 6 parts of chloride. Fluoride was not detected and the low specific conductance of 166 micromhos indicates that the concentrations of other constituents not determined are low.

In central Accomack County, two wells, each about 20 feet deep, one west of Bloxom (64) and the other east (66) of that town, yield a somewhat hard water of moderate mineralization. Water from a 40-foot driven well at Hopeton (78), between Bloxom and Parksley, is similar. Well 99 north of Onancock, yields water that is reported to have an iron taste. In addition, the water contains 48 ppm of chloride. Fluoride is absent. A partial analysis from the 68-foot well at the County School at Accomac (102) shows that water is relatively soft containing 57 ppm of hardness. It is low in other constituents determined except iron. Iron is excessively high, 7.5 ppm.

In the southern part of the county, water from wells tapping Pleistocene beds have a chloride content that ranges from 18 to 130 ppm. Hardness ranges from 45 to 108 ppm in the samples at hand. Fluoride was not detected. (See analyses, Table 4, wells 124, 171, 163, and 182). Water from the well at Upshurs Neck (182) was reported "hard, with iron and saline taste." The chloride content is 130 ppm. Water from well 124, nearly 3 miles southwest of Onancock has a higher concentration of dissolved solids but the water is soft and the chloride content is only 18 ppm.

In summary, ground water from the Columbia Group in Accomack County is commonly low in dissolved solids. Iron may be present in excessive amounts but fluoride is characteristically low or absent and chloride is low to moderate. The ground water is generally not as hard as that from the underlying Miocene aquifers. Locally, however, nitrate may be excessive in water from open dug wells indicating pollution from surface drainage.

SUMMARY OF GROUND-WATER RESOURCES

Ground water of ample quantity is available from properly constructed wells of shallow to moderate depth in Accomack County for domestic, stock, and agricultural needs as well as for moderate-sized municipalities and industrial plants. The individual aquifers are commonly lenticular in character and discontinuous laterally so that, at least for the larger developments, inexpensive test wells should first be jetted down in order to determine the most favorable locations

for permanent wells. The chemical quality of the water is generally satisfactory.

Below about 300 feet lowermost Miocene and older formations will yield water that is mineralized to a greater or lesser degree.

WELL RECORDS AND CHEMICAL ANALYSES

Records of wells in Accomack County and chemical analyses of water samples are given in Tables 1, 2, and 4 on the following pages. In addition, logs of selected deep wells on the Eastern Shore of Maryland near the Virginia State line are given in Table 3, and analyses of certain wells on Smith Island, Md., are given in Table 5.

The locations of the wells listed in Tables 1, 2 and 4 are shown on Plate 3.

TABLE 1.—Records of Wells in Accomack County, Virginia

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
1	E of Greenbackville, at Franklin City	W. F. Pulley	.....	.....	3	Dv	75
2	Greenbackville	John H. Selby	.....	1938	6 (?)	Dv	45
3a	Greenbackville	Rhodes	Wm. J. Porter	1954	4	J	217
3b	2.5 mi. NNW of Horntown	Frank Taylor	John Scott	1944?	30	J	189
3c	1.5 mi. NE of Horntown, at Sinnickson	Nelson Collins	John Scott	1945	4	J	62
4a	New Church	John F. Nelson, Jr.	Custis (?)	1915	23	J	180
4b	Horntown	A. R. Kelley	.....	1953	30	Dv	30
5	2.8 mi. W of New Church	H. Pardee	F. Kellam	1951	19	J	127
6a	New Church	H. E. Kelley Co.	Layne-Atlantic Co.	.....	25	D	259
6b	New Church	H. E. Kelley Co.	.....	.....	25	D	250
7	1 mi. N of Oak Hall	Charles Brittingham	Wm. J. Porter	1953	25	J	265
8a	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	1947	30	D	65
8b	Wallops Station (Main Base), 6 mi. W. of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	35	D	62
8c	Wallops Station (Main Base), 6 mi. W. of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	37	D	60
8d	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	1947	30	D	60
8e	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	21	D	60
8f	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	33	D	55
8g	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	31	D	64
8h	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	33	D	54
8i	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	.....	22	D	65
8j	Wallops Station (Main Base), 6 mi. W of Chincoteague	Natl. Aero. and Space Administration	Layne-Atlantic Co.	1953	30	D	228
9a	4 mi. W of Chincoteague	Town of Chincoteague	Town	.....	7	Dv, J	50 65

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
1¼	Miocene (?)	Yorktown (?) Fm	0	20	D	See analysis, Table 4. Flows occasionally. Temp., 60° F.	1
1¼	Pleistocene	Columbia Group	(—)	4	D	See analysis, Table 4.	2
2	Miocene	St. Marys Fm	−21½	30	D,S		3a
2	Miocene	Yorktown Fm	−15	.....	D,S	See analysis, Table 4. Temp., 73° F.	3b
2	Pleistocene	Columbia Group	nearly flows	.....	I	See analysis, Table 4. Temp., 61° F. Supplies oyster packing plant.	3c
2	Miocene	Yorktown Fm	(—)	.....	D	See analysis, Table 4.	4a
1¼	Pleistocene	Columbia Group	.....	.....	D	Water rusts well points	4b
2	Miocene	Yorktown Fm	−12	15	D	See analysis, Table 4. Water from coarse sand.	5
10–8	Miocene	St. Marys Fm	(—)	254	I	See analysis, Table 4. Temp., 59° F. Drilled to 317 ft. Another similar well at this location.	6a
3	Miocene	St. Marys Fm	(—)	.....	I	Used to supply reduced needs of plant during winter.	6b
2	Miocene	St. Marys (?) Fm	−13	25	D	Pumped sand when first developed.	7
8	Pleistocene (?)	Columbia (?) Group	.....	70	.....	Station well A-40. Drawdown 13 ft. when pumping 70 gpm. Well drilled to 101 ft.	8a
8	Pleistocene	Columbia Group	(—)	60	Obs	See analysis, Table 4. Station well B-8. Federal observation well.	8b
8	Pleistocene	Columbia Group	(—)	65	D	See analysis, Table 4. Station well B-43.	8c
8	Pleistocene	Columbia Group	(—)	70	D	Well drilled to 104 ft. Drawdown 9 ft. at 70 gpm. Station well B-49.	8d
8	Pleistocene	Columbia Group	(—)	65	D	See analysis, Table 4. Station well D-36.	8e
8	Pleistocene	Columbia Group	(—)	50	D	Station well D-37a.	8f
8	Pleistocene	Columbia Group	(—)	60	D	Station well D-38.	8g
8	Pleistocene	Columbia Group	(—)	54	D	See analysis, Table 4. Drawdown 16 ft. at 100 gpm. Well drilled to 72 ft. Station well D-39.	8h
8	Pleistocene	Columbia Group	(—)	85	D	See analysis, Table 4. Drawdown 17 ft. at 100 gpm. Well drilled to 77 ft. Station well D-40.	8i
.....	Miocene	St. Marys (?) Fm	−15	137	D	Drawdown 65 ft. Drilled to 346 ft.	8j
.....	Pleistocene	Columbia Group	−7	.....	PS	See analysis, Table 4. 28 wells pumped as a unit. Combined yield 175,000 gpd in winter, 225,000 gpd in summer.	9a

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
9b	4 mi. W of Chincoteague	Town of Chincoteague	John Scott	1944	7	J	230
10	4 mi. W of Chincoteague	Town of Chincoteague	Wm. J. Porter	1955	7	J	55
11	2 mi. W of Horntown	Sidney H. Webb	Linton	1953	25	J	93
12	1.9 mi. SW of Horntown	L. L. Detwiler	Russell	1954	20	Dv	22
13	Chincoteague	Wilde Maddox	Wm. J. Porter		1	J	102
14	Chincoteague	John M. Hurdles, Sr.	Wm. J. Porter	1952	3	J	120
15	2 mi. W of Oak Hall, near Withams	B. Rantz	Wm. J. Porter	1952	15	J	140
16	2.5 mi. W of Oak Hall, near Withams	R. Burton	Wm. J. Porter		15	J	140
17	Oak Hall	Kellam Distributing Co.	John Scott	1949	25	J	230
18	2 mi. E of Oak Hall, near Wattsville	B. Rantz	Wm. J. Porter	1953	20	J	173
19	0.1 mi. W of Jenkins Bridge	Dr. Fletcher	Wm. J. Porter	1952	10	J	133
20	1 mi. NW of Jenkins Bridge	Taylor Grayson		1948	7	J	185
21	1 mi. NW of Jenkins Bridge	Taylor Grayson			7	J	123
22	Jenkins Bridge	W. K. Colonna	Wm. J. Porter	1947	15	J	123
23	2 mi. E of Jenkins Bridge, near Makemie Park	Hilton Gladden	John Scott	1951	25	J	180
24	0.3 mi. S of Oak Hall	Page Fisher	John Scott	1949	30	J	250
25	1 mi. S of Oak Hall	Andrew Hall	John Scott	1948	30	J	170
26	Atlantic	Richard Thornton	John Scott	1950	27	J	65
27	Saxis	Luther Matthews	Wm. J. Porter		5	J	170
28	Saxis	School	Wm. J. Porter	1948	7	J	112
29	Assateague Beach Coast Guard Station	U. S. Coast Guard	R. C. Scott	1955	2	J(?)	264
30	Saxis	Vernon Drewer	Wm. J. Porter		5	J	190
31	SW tip of Saxis Island	P. Martin	Wm. J. Porter		3	J	125
32	3.5 mi. NW of Hallwood	J. Myer Taylor		1936	7	J	90
33	2 mi. N of Hallwood, near Makemie Park	James Byrd	Wm. J. Porter		5	J	162
34	2 mi. N of Hallwood, near Makemie Park	Neal Parker	Wm. J. Porter	1952	5	J	140
35	1 mi. NE of Temperanceville	Norman Parks	John Scott	1949	25	J	174
36	1 mi. SE of Atlantic	E. Taylor	Wm. J. Porter	1946	15	J	133
37	1.3 mi. SE of Atlantic	Willard Taylor	Wm. J. Porter	1946	15	J	99
38	0.3 mi. N of Temperanceville	Reed Onley	Wm. J. Porter		30	J	180
39	Temperanceville	Roy Mears	John Scott	1948	27	J	174

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone		Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
	Geologic Age	Stratigraphic Unit or Named Aquifer					
3½	Miocene	Yorktown Fm	land surface	.....	PS	Pumped with shallow wells (9) as part of battery.	9b
2	Pleistocene	Columbia Group	(—)	.....	PS	13 wells pumped as unit.	10
2	Pleistocene (?)	.....	.....	.....	D,S	Drilled to 115 ft.	11
1	Pleistocene	Columbia Group	.....	.....	D,S	Necessary to redrive often.	12
2	Miocene	Yorktown Fm	flows	.....	D	See analysis, Table 4. Equipped with 60-mesh screen.	13
2	Miocene	Yorktown Fm	.....	.....	.....	Well abandoned. Another dry hole within 50 ft. at this location.	14
2	Miocene	Yorktown Fm	−13	20	D	Equipped with 60-mesh screen.	15
2	Miocene	Yorktown Fm	−13	20	D	Water cloudy when well first used.	16
2	Miocene	St. Marys Fm	.....	13+	D	See analysis, Table 4.	17
2	Miocene	Yorktown Fm	−27	6+	D	Furnishes two apartments.	18
2	Miocene	Yorktown Fm	−3	11	D	Equipped with 60-mesh screen.	19
2	Miocene	St. Marys (?) Fm	.....	.....	.....	Well abandoned; water very saline.	20
2	Miocene	Yorktown Fm	−2	.....	D,S	Near well No. 20, but in different aquifer.	21
2	Miocene	Yorktown Fm	−2	.....	D	See analysis, Table 4. Screen set at 115-123 ft.	22
2	Miocene	St. Marys Fm	−4	15	D	4 ft. drawdown in 2 hrs. pumping. Water from coarse sand.	23
2	Miocene	St. Marys Fm	−30	16+	PS	See analysis, Table 4. Water from fine sand.	24
2	Miocene	St. Marys (?) Fm	.....	5	D	See analysis, Table 4.	25
2	Pleistocene	Columbia Group	−12	16+	D,S	Another similar well at this location.	26
2	Miocene	Yorktown Fm	−10	6	D	This is believed to be the only well at this depth in area.	27
2	Pleistocene (?)	Columbia (?) Group	(—)	.....	PS	See analysis, Table 4. Drilled to 115 ft.	28
3	Miocene	St. Marys Fm	(—)	20	D		29
2	Miocene	St. Marys Fm	−3	41+	I	Small drawdown. Another similar well in this location.	30
2	Miocene	Yorktown Fm	flows	.....	D	Reported soft.	31
1½	Pleistocene (?)	Columbia (?) Group	(—)	.....	D,S	See analysis, Table 4. Temp., 66° F. Water from blue sand near bottom of well.	32
2	Miocene	Yorktown (?) Fm	−10	30	D,S	Water from coarse sand.	33
2	Miocene	Yorktown (?) Fm	flows	2	D	Another similar well at this location.	34
2	Miocene	Yorktown (?) Fm	−28	15	D	See analysis, Table 4. 2 ft. drawdown in 2 hrs. pumping Water from gravel.	35
2	Miocene	Yorktown Fm	−19	20-30	D	Water from sand and shells.	36
2	Miocene	Yorktown Fm	flows +5	10	D,S	Water from gravel.	37
2	Miocene	Yorktown Fm	(—)	25	D	Typical of 12 wells drilled by Porter in area.	38
2	Miocene	Yorktown Fm	−30	.....	D	Reported soft. 8 ft. drawdown in 4-5 hrs. Pumping.	39

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
40	Temperanceville	Wm. Matthews	Wm. J. Porter	1948	40	J	176
41	Temperanceville	Pat Long	John Scott	1950	27	J	200
42	1.3 mi. SE of Temperanceville	L. Chesser	L. Chesser	.....	20	Dv	28
43	3 mi. ESE of Temperanceville, near Assawoman	Lecato Conquest	.....	.....	5	J	82
44	3 mi. ESE of Temperanceville, near Assawoman	Lecato Conquest	.....	.....	5	J	180
45	Between Hallwood and Rt. 13	Frederick Hall	John Scott	1949	30	J	265
46	Hallwood	K. Gladden	John Scott	1948	25	J	248
47a	Hallwood	J. W. Taylor Packing Co.	M. A. Pentz	1948	25	J	160
47b	Hallwood	J. W. Taylor Packing Co.	Sydnor Pump & Well Co., Inc.	1954	25	D	246
48	0.8 mi. W of Hallwood	Anna Roberts	John Scott	1948	25	J	232
49	Hallwood	Dewey Marshall	John Scott	1950	25	J	240
50	Hallwood	Henry Davis	John Scott	1951	30	J	237
51a	Hallwood	Jas. A. Hall	I. B. Clark	1903	17	J(?)	186
51b	Hallwood	J. W. Taylor Co.	.....	.....	12	D	250
51c	Hallwood	Brook Mears	Brook Mears	1945	12	Dv	28
52	Hallwood	Melvin Toppin	John Scott	1948	25	J	231
53	0.8 mi. S of Hallwood	Nock	John Scott	1950	25	J	240
54	Fishing Point, Assateague Island	Seaside Fish Co.	.....	1935	−1	.....	412?
55	2.5 mi. ESE of Hallwood	John B. Gordy	.....	.....	40	J	130
56	2.5 mi. WSW of Hallwood, near Mearsville	May Adkins	.....	1936	9	J	190
57	2 mi. SW of Hallwood, at Mears	Geo. E. Taylor	John Scott & Son	1936	9	J	256
58	1.5 mi. SSE of Hallwood	Samuel B. Groton	.....	1946	25	J	199
59	Mappsville	Bloxom Auto Co.	John Scott	1951	25	J	255
60	1.3 mi. ENE of Mappsville	Flemings Bros.	W. Ewell	1948	25	Dv	21
61	Wallops Island Launch Area	Natl. Aero. and Space Administration	Virginia Machinery and Well Co.	1946	9	D	147
62	Mappsville	Linwood D. Lewis	John Scott	1950	25	J	225

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Miocene	Yorktown Fm	(—)	.....	D	See analysis, Table 4. Screen set at 164-176 ft.	40
2	Miocene	St. Marys Fm	−30	18+	D	See analysis, Table 4. 3-4 ft. drawdown in 3 hrs. pumping. Water from coarse sand.	41
1	Pleistocene	Columbia Group	.....	.....	D,S	Water from fine sand. 32-ft. dug well at this location.	42
2	Miocene	Yorktown (?) Fm	flows	.....	D,S	Necessary to redrill often. Water from fine sand.	43
2	Miocene	St. Marys (?) Fm	flows	.....	D,S	Necessary to redrill often. Water from coarse sand and shell.	44
2	Miocene	St. Marys Fm	−30	14+	D	See analysis, Table 4. 3-4 ft. of drawdown in 4 hrs. pumping.	45
2	Miocene	St. Marys Fm	−1.5	25	D	Reported soft. Penetrated shale (?) at 248 ft.	46
6	Miocene	St. Marys Fm	.....	140	I	See analysis, Table 4. Three 160-ft. wells pumped as unit.	47a
14-8	Miocene	St. Marys Fm	.....	194	I	See analysis, Table 4. 8-in. 40-slot screen from 226 to 246 ft. Drilled to 290 ft. Another 239-ft. well used as standby.	47b
2	Miocene	St. Marys Fm	−1.5	25	D	See analysis, Table 4. Equipped with 60-mesh screen.	48
2	Miocene	St. Marys Fm	−1.5	16+	D	See analysis, Table 4. 4 ft. of drawdown in 3-4 hrs. pumping.	49
2	Miocene	St. Marys Fm	−1.5	16+	D	See analysis, Table 4. 8 ft. of drawdown with two 4 gpm pumps after 2 hrs. pumping.	50
1½	Miocene	St. Marys Fm	(—)	.....	.....	From Bulletin 5, p. 129; 298-299.	51a
4	Miocene	St. Marys Fm	(—)	115	.....	Pumps continuously. Several 27-foot driven wells at this locality.	51b
2	Pleistocene	Columbia Group	−24	5½	.....	Shells and gravel near bottom. Iron stains on laundry. Temp. 65° F.	51c
2	Miocene	St. Marys Fm	−1.5	25	I	See analysis, Table 4. Two similar wells at this location. Pumping reduces static head to −22½ ft. Water from very fine sand. Equipped with 60-mesh screen.	52
2	Miocene	St. Marys Fm	−1.5	16±	D	Reported soft.	53
6	Miocene	Yorktown Fm	flows	.....	.....	Abandoned. Below tide level.	54
.....	Miocene	Yorktown Fm	(—)	.....	D,S	See analysis, Table 4.	55
1½	Miocene	St. Marys Fm	+1.5 flows	2	D	See analysis, Table 4. Temp., 60° F.	56
2-1½	Miocene	St. Marys Fm	−1.5	.....	D	See analysis, Table 4. Temp., 61° F.	57
2	Miocene	Yorktown (?) Fm	(—)	.....	D	See analysis, Table 4. Temp., 61° F.	58
2	Miocene	St. Marys Fm	−30	16+	D	See analysis, Table 4. 4-5 ft. of drawdown in 3 hrs. pumping.	59
2	Pleistocene	Columbia Group	−2	.....	D,S	See analysis, Table 4. Temp., 61° F. W. Ewell, tenant.	60
6-4½	Miocene	Yorktown Fm	−4	30	D	See analysis, Table 4. Pumps 30 gpm with 60-ft. drawdown.	61
2	Miocene	St. Marys Fm	−32	16+	D	See analysis, Table 4. Water from coarse sand.	62

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
63	Mappsville	Metcalf	John Scott	1952	25	J	255
64	1.5 mi. NW of Bloxom	L. M. Jenkins	L. M. Jenkins	1945	16	Dv	23
65	1.5 mi. NNE of Nelsonia	H. W. Gillespie	John Scott & Son	1945	40?	J	220
66	1.5 mi. E of Bloxom	John Custis	Frank Millburn		19	D	18
67	0.5 mi. E of Bloxom	Preston Langford	John Scott	1951	25	J	265
68	Nelsonia	Jack West	John Scott	1950	23	J	240
69	Nelsonia	L. N. Bloxom	John Scott	1948	25	J	230
70	Nelsonia	Alva Bloxom	John Scott	1952	25	J	255
71	1 mi. W of Modest Town	Short Mason	John Scott	1948	18	J	228
72	0.5 mi. S of Nelsonia	C. Mears	John Scott	1951	25	J	230
73	0.8 mi. W of Modest Town	Abe Ewell	John Scott	1951	25	J	230
74							
75	1 mi. SW of Nelsonia	G. R. Taylor	G. R. Taylor	1947	12	Dv	34
76	2.5 mi. SW of Bloxom	Forrest Annis	Wm. Taylor	1935	6	D	138
77	1 mi. W of Modest Town	B. Pickens	John Scott	1950	25	J	228
78	Between Bloxom and Parksley, at Hopeton	Milton R. Poulson		1944	21	Dv	40
79	2.5 mi. SE of Bloxom, at Gargatha	Wm. S. Mears	Wm. S. Mears	1936	20	Dv	18
80	2 mi. W of Parksley	H. R. Costin	John Scott	1952	25	J	220
81	Hopkins	J. L. Copper		1914	7	J	100
82	1 mi. W of Hopkins, between Doe and Hunting Creeks	B. Watkinson	Wm. J. Porter		3	J	123
83	Tobacco Island	Linwood Duncan	Wm. J Porter		3	J	123
84	2 mi. E of Parksley	C. B. Ross	John Scott	1950	28	J	228
85	2 mi. E of Parksley	Dicks	Wm. J. Porter		25	J	165
86	2 mi. E of Parksley	Town of Parksley	Sydnor Pump & Well Co., Inc.	1947	30(?)	D	65
87a	2 mi. E of Parksley	Town of Parksley	Sydnor Pump & Well Co., Inc.		30(?)	D	165
87b	2 mi. E of Parksley	Town of Parksley	Sydnor Pump & Well Co., Inc.	1951	30(?)	D	77
88	1 mi. SSW of Hopkins	H. J. Richardson	John Scott & Son	1943	3	J	220
89	1.3 mi. NW of Greenbush	Walter Grosvenor	John Scott	1951	25	J	50
90	0.5 mi. NE of Chesconessex	Bailey East		1905	5	J	116
91	0.3 mi. NE of Chesconessex	Black	Wm. J. Porter	1951	7	J	730

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (—) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table 4.	63
1½	Pleistocene	Columbia Group	(—)	1.5	D	See analysis, Table 4. Temp., 63° F.	64
2	Miocene	St. Marys Fm	−14	.....	D	See analysis, Table 4. Shallow well nearby abandoned because water "very irony."	65
24	Pleistocene	Columbia Group	−6	.....	D,S	See analysis, Table 4. Temp., 68° F. Bucket lift.	66
2	Miocene	St. Marys Fm	−24	16+	D	See analysis, Table 4. 4 ft. drawdown in 2 hrs. pumping.	67
2	Miocene	St. Marys Fm	−31	13+	D	See analysis, Table 4. Water from medium sand.	68
2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table 4. 6 ft. of drawdown in 8 hrs. pumping. Water from compact sand and shell.	69
2	Miocene	St. Marys Fm	−30	16+	D	Reported soft.	70
2	Miocene	St. Marys Fm	−30	16+	D	See analysis, Table 4. 9 ft. drawdown in 4 hrs. pumping. Water from compact sand and shell.	71
2	Miocene	St. Marys Fm	−29	.....	D	See analysis, Table 4.	72
2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table 4.	73
.....	.....	.....	.....	.....	.....	.....	74
1¼	Pleistocene	Columbia Group	.....	50	D,S	Temp., 64° F. Water from sand and gravel from 30-34 ft.	75
1½	Miocene	Yorktown Fm	−1.5	.....	D	See analysis, Table 4. Temp., 61° F. Struck water in sand and gravel below blue sand.	76
2	Miocene	Yorktown (?) Fm	−30	16+	D	6 ft. of drawdown in 3 hrs. pumping.	77
1¼	Pleistocene	Columbia Group	.....	50	D	See analysis, Table 4. Temp., 65° F.	78
1¼	Pleistocene	Columbia Group	−2	.....	D	Temp., 66° F.	79
2	Miocene	St. Marys Fm	−16	15	D	5 ft. of drawdown in 2 hrs. pumping. Water from fine sand.	80
1½	Miocene	Yorktown Fm	flows +1.25	1.5	D	See analysis, Table 4. Temp., 63° F.	81
2	Miocene	Yorktown Fm	flows	2	D	Salt water at 70 ft.	82
2	Miocene	Yorktown (?) Fm	−2	30	D	Soda taste (?).	83
2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table 4.	84
2	Miocene	Yorktown (?) Fm	−17	20	D	Water from blue sand.	85
8	Pleistocene	Columbia Group	.....	150	PS	Town well No. 2.	86
8	Miocene	Yorktown (?) Fm	(—)	50	PS	Town well No. 1. Drilled to 200 ft.	87a
.....	.....	.....	.....	100	PS	Town well No. 3. Drilled to 90 ft.	87b
2	Miocene	St. Marys Fm	+1	5	D,S	See analysis, Table 4. Temp., 64° F. Flowing well, but pumped for use.	88
2	Pleistocene	Columbia Group	−10	13+	D	See analysis, Table 4. 12 ft. after 3 hrs. pumping.	89
1½	Miocene	Yorktown Fm	(—)	.....	D,S	From Bulletin 5, p. 124.	90
2	Miocene	Yorktown Fm	−8	30	D	Water from sand and shells.	91

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
92	Chesconessex	W. Edwards	John Scott	1949	4	J	150
93	0.1 mi. SW of Chesconessex	Mrs. D. W. Marsh	W. Watson	1948	6	J	160
94	2.3 mi. WNW of Greenbush	Milton Russell	John Scott	1948	25	J	123
95	Greenbush	Methodist Church		1930	40	J	140
96	Greenbush	J. E. Justice and H. C. Watson	John Scott	1951	20	J	265
97	Greenbush	W. Taylor and D. D. Mears	John Scott	1948	23	J	267
98	Greenbush	Vernon Belote	John Scott	1951	25	J	265
99	2.5 mi. W of Greenbush	Bernard C. Evans	Bernard C. Evans	1944	16	Dv	28
100	1.5 mi. WSW of Greenbush	H. A. West	John Scott	1952	25	J	220
101	0.3 mi. S of Greenbush	Earnest A. Coard	John Scott	1947	30	J	272
102	Accomac	School		1932	30	J	68
103	3 mi. W of Onancock	Forrest Chandler	John Scott	1952	6	J	60
104	Accomac	Accomack Co. Jail	John Scott	1951	30	J	73
105	Accomac	H. C. Watson	John Scott	1952	30	J	75
106	Accomac	Dr. J. L. DeCormis	John Scott	1950	30	J	160
107	Accomac	Dr. J. L. Tears	John Scott	1950	30	J	161
108a	Onancock	Town of Onancock	J. H. K. Shannahan	1894	15		486
108b	Onancock	Town of Onancock	Custis		20	J	175
108c	Onancock	Town of Onancock	M. A. Pentz	1927	20	D	210
109a	Onancock	Town of Onancock	Berry	1929	20	B	40
109b	Onancock	Town of Onancock	Sydnor Pump & Well Co., Inc.	1952	20	D	150
110	1.5 mi. N of Cashville	Wm. Hundley	John Scott	1951	5	J	105
111	1 mi. W of Onancock, at Finneys Wharf	Charles Johnson	John Scott	1951	10	J	127
112	0.5 mi. W of Onancock, near Finneys Wharf	Mrs. Beeching	John Scott	1951	5	J	99
113	0.8 mi. N of Cashville	Robert Daley	John Scott	1951	11	J	105
114	0.5 mi. NNE of Cashville	Clyde Parker	John Scott	1948	10	J	105
115	1.5 mi. E of Onancock	J. Van Kesteren	M. A. Pentz	1947	20	J	63
116	Onley	Parker Norfolk	John Scott	1950	25	J	50
117	Onley	Carroll Revell	John Scott	1950	25	J	287
118	0.5 mi. S of Onancock	Mrs. Doris C. Evans	John Scott	1949	23	J	53
119	0.1 mi. W of Onley	H. C. Watson	John Scott	1949	25	J	187
120	Onley	R. C. Evans	John Scott	1948	25	J	187

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Miocene	Yorktown Fm	−6	15	D	See analysis, Table 4. 4 ft. of drawdown in 4 hrs. pumping. Water from fine sand.	92
1½	Miocene	Yorktown Fm	−6	.....	D	See analysis, Table 4.	93
2	Miocene	Yorktown Fm	−12	13+	S	Supplies mink farm. Reported soft.	94
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 4. Temp., 65° F. Supplies three families.	95
2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table 4. 5 homes and 2 stores use well.	96
2	Miocene	St. Marys Fm	−30	16+	D	See analysis, Table 4. 6 ft. drawdown in 3½ hrs. pumping.	97
2	Miocene	St. Marys Fm	−32	15	D	See analysis, Table 4. 5 to 6 ft. drawdown 4 hrs. pumping.	98
1¼	Pleistocene	Columbia Group	−25	.....	D	See analysis, Table 4. Temp., 68° F.	99
2	Miocene	St. Marys Fm	−23	15	D	6 to 8 ft. drawdown in 3 hrs. pumping.	100
.....	Miocene	St. Marys Fm	−23	40	D	See analysis, Table 4.	101
2	Pleistocene	Columbia Group	−6	15	PS	See analysis, Table 4. Temp., 64° F.	102
2	Pleistocene	Columbia Group	−3	20	D	3 ft. of drawdown in 3 hrs. pumping.	103
2	Pleistocene	Columbia Group	−12	17+	PS	See analysis, Table 4. Similar wells at this location. Water from sand and gravel.	104
2	Pleistocene	Columbia Group	.....	.....	D	.....	105
2	Miocene	Yorktown Fm	−28	15	D	See analysis, Table 4. Supplies physician's office and house. Water from fine sand.	106
2	Miocene	Yorktown Fm	−28	15	D	See analysis, Table 4. Supplies physician's office and home. Water from fine sand.	107
.....	Miocene	Choptank Fm	.....	5	Ab	From Bulletin 5, p. 126; 300-301.	108a
.....	Miocene	St. Marys Fm	−12	26	PS	Two other similar wells here. All flow into underground tank.	108b
4	Miocene	St. Marys Fm	−12	115	PS	See analysis, Table 4. Temp., 61° F. Two other similar wells here.	108c
38	Pleistocene	Columbia Group	−12	80	PS	Two similar wells here. All three pumped as unit.	109a
9	Miocene	Yorktown (?) Fm	(—)	100	PS	.....	109b
2	Miocene	Yorktown Fm	−4	15	D	4 ft. drawdown in 2 hrs. pumping.	110
2	Miocene	Yorktown Fm	−6	16+	D	Pumping reduced static level 3 ft.	111
2	Miocene	Yorktown (?) Fm	−4	16+	D	4 ft. of drawdown in 2 hrs. pumping.	112
2	Miocene	Yorktown (?) Fm	−10	25	D	Water from coarse sand.	113
2	Miocene	Yorktown (?) Fm	−4	25	D	.....	114
8	Pleistocene	Columbia Group	−3	450	I	Drawdown, 56 ft. Specific capacity 20 gpm/ft. of drawdown.	115
2	Pleistocene	Columbia Group	−12	20	D	Water from gravel.	116
2	Miocene	St. Marys Fm	−23	15	D	Reported soft. Water from coarse sand.	117
2	Pleistocene	Columbia Group	−12	16+	D	Iron reported in water. 4 ft. of drawdown in 2 hrs. pumping.	118
2	Miocene	Yorktown Fm	−23	16+	D	4 ft. of drawdown in 3 hrs. pumping. Water from coarse sand.	119
2	Miocene	Yorktown Fm	−28	.....	D	Little drawdown. Water from coarse sand. Equipped with 60-mesh screen.	120

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
121	1 mi. S of Onancock	L. F. Chandler	Wm. J. Porter	1949	23	J	90
122	1 mi. SSW of Onancock	Guy Buckle	John Scott	1952	15	J	49
123	1 mi. SSW of Onancock	Guy Buckle, Jr.	John Scott	1952	15	J	155
124	1.5 mi. SSW of Onancock	C. C. Belote & Sons	White	1947	30	Dv	22
125	0 3 mi. S of Cashville	Cashville Baptist Church	John Scott	1952	16	J	118
126	1 mi. SSW of Cashville	L. C. Scott	John Scott & Son	1936	6	J	128
127	0 8 mi. S of Cashville	Thomas White	John Scott	1951	8	J	105
128a	2 mi. SSE of Accomac	C. R. Bull		1935	0	J	90
128b	Mouth of Metomkin Inlet	U. S. Coast Guard	Tidewater Well and Pump Co.	1956	4		320
129	1 mile E of Onley	Parker Norfolk	John Scott	1951	25	J	62
130	Onley	Mrs. D. Watson	John Scott	1952	25	J	187
131	0.8 mi. WNW of Harborton	E. Hartley	John Scott	1948	5	J	100
132	Harborton	J. W. Adams	J. W. Adams	1905	8		140
133	1.5 mi. E. of Harborton	H. Battail	I. B. Clark	1906	10		150
134	0.5 mi. WNW of Melfa	Catherine Warren	John Scott	1952	25	J	93
135	1 mi. E. of Locustville	Wilbur Millner, Jr.	John Scott	1951	8	J	160
136	0.3 mi. S of Harborton	Mr. Evans	John Scott	1948	6	J	168
137	0.3 mi. S of Harborton	John Brittingham	John Scott	1949	6	J	168
138	2.5 mi. W of Melfa	R. M. Wyman	Harold Graham	1949	14	Dv	18-22
139	Melfa	Wade Moore	John Scott	1948	25	J	194
140	Melfa	Mrs. Frank Bull	John Scott	1948	25	J	194
141	Melfa	Mrs. Anna Grinalds	John Scott	1948	25	J	93
142	Melfa	H. D. Phillips	John Scott	1949	25	J	93
143	East Point	R. Hobbs		1951	7	J	180
144	2 mi. SSW of Harborton	Harold Harrison	Harold Harrison	1941	5	Dv	11
145	1.5 mi SSW of Locustville	M. Lohr	John Scott	1948	16	J	220
146	Pungoteague	Rubin Bishop	John Scott	1951	16	J	140
147	Pungoteague	Geo. Drummond	John Scott	1951	16	J	140
148	Pungoteague	School	Wm. J. Porter		20	J	140

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone		Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
	Geologic Age	Stratigraphic Unit or Named Aquifer					
2	Pleistocene	Columbia Group	−5	20	D	.....	121
2	Pleistocene	Columbia Group	−6	20	D	3 ft. of drawdown in 1½ hrs. pumping.	122
2	Miocene	Yorktown Fm	.....	19	D	Reported soft.	123
1½	Pleistocene	Columbia Group	(—)	.....	D	See analysis, Table 4. Temp., 68° F. Poor yield; necessary to redrive frequently.	124
2	Pleistocene	Columbia Group	−4	20+	D	Water from coarse sand.	125
2	Miocene	Yorktown Fm	−1	.....	D,S	See analysis, Table 4. Temp., 63° F. Used for poultry farm.	126
2	Miocene	Yorktown Fm	−4	15	D	Reported soft. Water from gravel.	127
1½	Miocene	Yorktown (?) Fm	+2	1	D	See analysis, Table 4. Temp., 63° F. Well is submerged at high tide.	128a
.....	Miocene	St. Marys Fm	.....	.....	Ab	.....	128b
2	Pleistocene	Columbia Group	−13	16+	D	Water from gravel.	129
2	Miocene	Yorktown Fm	−23	13+	D	4 ft. of drawdown in 1 hr. pumping.	130
2	Miocene	Yorktown Fm	−4	16+	D	Reported soft.	131
1½	Miocene	Yorktown Fm	(—)	.....	D	From Bulletin 5, p. 127; 298-299.	132
1½	Miocene	Yorktown Fm	(—)	.....	D	From Bulletin 5, p. 127; 298-299.	133
2	Pleistocene	Columbia Group	−12	15	D	3 ft. of drawdown in 1 hr. pumping. Water from quartz sand.	134
2	Miocene	Yorktown Fm	flows	flows 5 pumps 16+	D	Water from fine sand.	135
2	Miocene	Yorktown Fm	0	.....	D	Little drawdown. Water from coarse gray sand. Equipped with 60-mesh screen.	136
2	Miocene	Yorktown Fm	flows	.....	D	Little drawdown. Water from coarse gray sand. Equipped with 60-mesh screen.	137
1½	Pleistocene	Columbia Group	−6	.....	Irr	Six wells pumped as unit for nursery; yield, 110 gpm.	138
2	Miocene	Yorktown Fm	−12	15+	D	3 to 4 ft. of drawdown in 2 hrs. pumping. Well taps two aquifers; 1st 160 ft.; 2d 184-194 ft.	139
2	Miocene	Yorktown Fm	−12	15+	D	3 to 4 ft. of drawdown in 2 hrs. pumping. Well taps two aquifers; 1st 160 ft.; 2d 184-194 ft.	140
2	Pleistocene	Columbia Group	−9	.....	D	4 ft. drawdown in 1 hr. pumping. Water from coarse sand.	141
2	Pleistocene	Columbia Group	−13	15	D	3 to 4 ft. of drawdown in 3 hrs. pumping. Water from coarse sand. Another similar well at this location.	142
1½	Miocene	Yorktown Fm	.....	10	D	Water from sand and shells.	143
1½	Pleistocene	Columbia Group	(—)	.....	D,S	Temp., 65° F. Typical of shallow wells in this locality.	144
2	Miocene	St. Marys (?) Fm	−12	16+	D	Water from "salt and pepper" sand.	145
2	Miocene	Yorktown Fm	−20	16+	D	Water from coarse sand and shell.	146
2	Miocene	Yorktown Fm	−20	15+	D	13 ft. of drawdown after pumping. Water from coarse sand.	147
2	Miocene	Yorktown Fm	−18	20	PS	Water from sand.	148

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
149	Pungoteague	Upshur Daugherty	John Scott	.....	16	J	110
150	Pungoteague	Mrs. Will Kellam	John Scott	1951	16	J	110
151	Pungoteague	S. W. Ames	I. B. Clark	1903	18	.....	210
152	Pungoteague	O. Hoffman	John Scott	1951	16	J	222
153	Pungoteague	School	Mr. Lord	1948	12	J	128
154	1.8 mi. W of Pungoteague, on Nandua Creek	J. R. Drummond, Jr.	Fred Kellam	1952	4	J	108
155	Keller	Charles Ballard	John Scott	1951	25	J	85
156	Keller	John Campbell	John Scott	1948	25	J	265
157	Keller	Eastern Shore Fire Insurance Co.	John Scott	1949	20	J	265
158	Wachapreague	Milton Dougherty	John Scott	1949	6	J	120
159	Wachapreague	School	Wm. J. Porter	1944	7	J	113(?)
160	Wachapreague	Town of Wachapreague	.....	1900	5	D	385
161	Wachapreague	Wachapreague Volunteer Fire Dept.	John Scott	1950	7	J	83
162	Wachapreague	P. K. Duer	John Scott	1952	7	J	94
163	2 mi. SE of Keller	Mrs. Priscilla A. Mears	Smith	1947	30	Dv	39
164	1 mi. N of Craddockville	Levin Johnson	John Scott	1950	11	J	63
165	1.3 mi. NW of Craddockville	Milton Beasley	John Scott	1951	5	J	127
166	0.5 mi. N of Craddockville	L. T. Johnson	.....	.....	7	D	170
167	Painter	School	.....	.....	17	J	98
168	1.5 mi. W of Painter	S. Mason	John Scott	1952	23	J	173
169	1.5 mi. WSW of Craddockville	F. Kellam	John Scott	1953	7	J	150
170	2.8 mi. WSW of Craddockville	Royall	John Scott	1948	7	J	123
171	3.3 mi. WSW of Craddockville	Dr. W. B. Lingo	J. F. Lingo	1947	5	Dv	28
172	2 mi. SW of Craddockville	Mr. McKay	John Scott	1951	5	J	115
173	1 mi. S of Craddockville	Will Kellam	John Scott	1948	12	J	190
174	2 mi. S. of Craddockville	E. S. Sturgis	John Scott	1949	5	J	134
175	Belle Haven	G. J. Barfield	John Scott	1950	23	J	160
176	Belle Haven	Charles Byrd	John Scott	1945	19	J	202
177	Belle Haven	George C. Duer	.....	1933	30	J	198
178	Belle Haven	Burleigh Mears	John Scott	1950	20	J	202

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Pleistocene (?)	Columbia Group	−23	15	D	8 ft. of drawdown after pumping. Water from coarse sand.	149
2	Pleistocene (?)	Columbia Group	−6	15	D	Water from medium-fine sand.	150
1½	Miocene	St. Marys Fm	−10	.....	D,S	See analysis, Table 4. From Bulletin 5, p. 128; 300-301.	151
2	Miocene	St. Marys Fm	−20	16+	D	12 ft. of drawdown in 3 hrs. pumping. Water from coarse sand and shells.	152
2	Miocene	Yorktown (?) Fm	(—)	.....	PS	See analysis, Table 4. Temp., 68° F.	153
2	Pleistocene	Columbia Group	flows	.....	D,S	See analysis, Table 4.	154
2	Pleistocene	Columbia Group	−13	11+	D	12 ft. of drawdown in 5 hrs. pumping. Water from coarse sand.	155
2	Miocene	St. Marys Fm	−28	15	D	Water from fine white sand.	156
2	Miocene	St. Marys Fm	−30	15	D	Water from fine sand.	157
2	Miocene	Yorktown Fm	−8	14+	D	Supplies two houses.	158
2	Pleistocene	Columbia Group	−8	30	PS	.....	159
4–2	Miocene	Choptank Fm	(+)	3–6	PS	See analysis, Table 4. Temp., 61° F. Flows 3 gpm at low tide, 6 gpm at high tide. Used by fishing boats.	160
2	Pleistocene	Columbia Group	−4	.....	PS	Fire station and store use well.	161
2	Pleistocene	Columbia Group	−4	13+	D	Water from fine sand.	162
1½	Pleistocene	Columbia Group	−34	.....	D	See analysis, Table 4. Temp., 67°F. Supplies general store.	163
3	Pleistocene	Columbia Group	flows	32	Irr	Supplies irrigation pond. Not screened. Water from sand and gravel.	164
3	Miocene	Yorktown Fm	flows	3–4	D	3-in. casing to 63 ft.; no screen. Water from fine sand.	165
1½	Miocene	Yorktown Fm	flows	10	D,S	See analysis, Table 4. Temp., 61° F. Supplies farm and small lake.	166
1½	Pleistocene	Columbia Group	(—)	5	PS	See analysis, Table 4.	167
2	Miocene	Yorktown (?) Fm	−23	20	D	6 ft. of drawdown in 3 hrs. pumping. Water from gravel.	168
2	Miocene	Yorktown Fm	−13	13+	D	Reported soft. Water from fine sand.	169
2	Miocene	Yorktown Fm	−4	16+	D	Water from coarse sand. Equipped with 60-mesh screen.	170
1½	Pleistocene	Columbia Group	−8	.....	D	See analysis, Table 4. Temp., 63° F. Well at this location sunk to 128 ft. in 1947, struck "quicksand," and filled.	171
2	Miocene	Yorktown Fm	−13	15	D	Water slightly saline.	172
2	Miocene	Yorktown Fm	−30	.....	D	9 ft. of drawdown in 8 hrs. pumping. Water from fine sand and shells.	173
2	Miocene	Yorktown Fm	−4–5	20	D	Reported soft. Water from coarse sand.	174
2	Miocene	Yorktown Fm	−24	15	D	5 ft. of drawdown in 4 hrs. pumping. Water from coarse sand.	175
2	Miocene	Yorktown (?) Fm	−34	16+	D	Supplies 3 houses and business.	176
1¼	Miocene	Yorktown (?) Fm	.....	.....	D	See analysis, Table 4. Water from sand and shells near bottom.	177
2	Miocene	Yorktown (?) Fm	−30	15	D	Water from gravel and shell.	178

TABLE 1.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply
S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
179	0.1 mi. E of Belle Haven	Kellam Distributing Co.	John Scott	1951	25	J	200
180	1.8 mi. ENE of Belle Haven	Levin Johnson	John Scott	1949	23	J	202
181	0.5 mi. SW of Quinby	W. Mapp	Wm. J. Porter	1952	5	J	210
182	4.5 mi. S of Quinby on Upshurs Neck	John T. Pritchard	John T. Pritchard	1945	4	Dv	13
183	Tangier Island			1925?	2?		860
USGS Test Hole 3	2 mi. S of Keller, at Central High School	United States Geological Survey	Sydnor Pump & Well Co., Inc.	1953	30	D	420
USGS Test Hole 4	0.5 mi. S of Oak Hall, at Atlantic High School	United States Geological Survey	Sydnor Pump & Well Co., Inc.	1953	35	D	372

Measurement: gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

Diameter of well (inche)s	Principal Water-Bearing Zone		Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
	Geologic Age	Stratigraphic Unit or Named Aquifer					
2	Miocene	Yorktown (?) Fm	−30	15	D	5 ft. of drawdown in 4 hrs. pumping. Water from coarse sand.	179
2	Miocene	Yorktown (?) Fm	−30	16+	D	Two houses use well. 8 ft. of drawdown in 5 hrs. pumping.	180
2	Miocene	Yorktown (?) Fm	flows	flows 1½	D,S	.....	181
1¼	Pleistocene	Columbia Group	−3	5	D,S	See analysis, Table 4. Temp., 69° F.	182
.....	Late Eocene (?)	Chickahominy (?) Fm	flows	.....	Ab	See analysis, Table 4. Flowing in 1948. Former fish factory well.	183
3	Miocene	Choptank Fm	−26	.....	Test hole	See log, Table 2. Drilled to 450 feet. Screened interval, 415-420 feet, produced ⅛ gpm. Several good water-bearing zones at shallower depths were not tested.	USGS Test Hole 3
3	Miocene	St. Marys Fm	−18	.....	Test hole	See log. Table 2. Drilled to 451 feet. Screened interval, 367-372 feet, produced ⅛ gpm. Several good water-bearing zones at shallower depths were not tested.	USGS Test Hole 4

TABLE 2.—Logs of wells in Accomack County, Virginia

U. S. Geological Survey test hole 3, Central High School, 1 mile north-northeast of Painter

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude 30 feet

	Thickness (feet)	Depth (feet)
Clay, gray, sandy; possibly fill from school excavation	7	7
Columbia Group (Pleistocene):		
Soil, black, organic; possibly topsoil under fill	2	9
Sand, iron-stained, quartz, fine to medium; black sand; organic material; scattered small gravels from 25 feet; streaks of dark-gray clay from 30 feet; shell fragments from 46 feet; water-bearing zone	51	60
Clay, gray-green, soft; abundant shell fragments; sandy	18	78
Clay, dark-gray, very hard	⅔	78⅔
Sand, white to gray, quartz, medium; scattered shell fragments; black sand; water-bearing zone	11⅓	90
Clay, dark-gray, heavy, sandy, silty; abundant shell fragments from 105 feet	27	117
Clay, dark-gray, heavy; interbedded with coarse quartz sand	5	122
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, dark-gray, soft; abundant small gravels; black sand; gravel in lenses; possible water-bearing zone	3	125
Sand, gray, quartz, fine; abundant shell fragments; silt	5	130
Clay, dark-gray, soft; abundant shell fragments	5	135
Shells, white, fragments; silt; clay, water-bearing zone	15	150
Sand, gray-green, quartz, very fine; abundant silt; shell fragments; gray clay	10	160
St. Marys Formation:		
Sand, gray-green, quartz, very fine; abundant silt; shell fragment; gray clay; streak of mud at 164 feet; organic specks from 160 feet	22	182
Clay, dark-gray, hard	1	183
Sand, blue-gray, quartz, very fine; abundant clay; shell fragments	7	190
Shells, white, broken; 15 percent dark-gray clay; possible water-bearing zone	21	211

TABLE 2 (Continued)

U. S. Geological Survey test hole 3—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)—Continued		
St. Marys Formation—Continued		
Sand, gray, quartz, very fine; abundant silt; clay; abundant black sand	14	225
Shells, white, broken; trace clay and silt; organic specks; possible water-bearing zone	21	246
Sand, gray-green, quartz, very fine; abundant shell fragments; abundant silt and clay; marl streaks at 246, 250, 260, 263, 266, and 270 feet	65	311
Choptank Formation:		
Chert, black, very hard	1	312
Sand, gray, quartz; very abundant; silt; shell fragments; clay; 18 inches hard marl at 328 feet; 4-inch streak shells at 349⅔ feet	38	350
Clay, dark-gray, sticky; shell fragments	10	360
Sand, gray, quartz, very fine, silty, clay; scattered shell fragments	16	376
Clay, dark-gray, sticky; abundant silt; abundant sand; scattered shell fragments from 395 feet	74	450

U. S. Geological Survey test hole 4, Atlantic High School, near Oak Hall
(Drilled by Sydnor Hydrodynamics, Inc.)
(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude 35 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, light-yellow, fine sandy	7	7
Sand, iron-stained and white; quartz, fine to coarse; streaks of small gravels from 7 to 35 feet; black sand; scattered streaks of gray silt; layer of heavy blue clay 27 to 28 feet; specks of brown clay from 35 feet; water-bearing zone	46	53
Clay, gray-green, soft; abundant fine sand; abundant silt; black sand; scattered shell fragments from 60 feet	20	73
Clay, gray-green, soft; interbedded coarse iron-stained sand; scattered shell fragments	3	76
Clay, dark gray-green, solid; very fine quartz sand; shell fragments; solid streaks of shells 104 feet	29	105

TABLE 2 (Continued)

U. S. Geological Survey test hole 4—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, dark gray-green, solid; very fine quartz sand; shell fragments; silty from 110 feet; medium gravels from 115 feet; streak of large gravels at 129 to 130 feet, and 145 to 147 feet	45½	150½
Sand, white, medium; abundant shell fragments; clay; water-bearing zone	6½	157
Clay, gray-green, soft; abundant sand; 3-inch marl streak at 167 feet; scattered shell fragments from 175 feet; streaks of fine quartz sand from 150 to 175 feet	18	175
St. Marys Formation:		
Clay, gray-green, soft; abundant sand; streaks of fine quartz sand from 175 to 195 feet; black organic specks; abundant black sand from 200 feet	30	205
Shells, white, broken; abundant clay and silt to 215 feet; abundant black sand; black organic specks; 6-inch streak of marl at 227½ feet; possible water-bearing zone	35	240
Sand, gray-green, quartz, very fine; abundant silt and sand; shell fragments	58	298
Clay, gray-green, heavy; abundant sand; shell fragments; interbedded sand and clay 300 to 302 feet; streak of mud at 326 feet; streak of marl at 356 feet; black sand	67	365
Sand, gray, quartz, very fine; clay; abundant shell fragments; black sand; possible water-bearing zone	29⅔	394⅔
Chert, black, very hard	⅓	395
Sand, gray, quartz, very fine; clay; shell fragments; streak of marl at 402 feet; sand coarser from 410 feet; appearance of gas bubbles at 350 feet	56	451

Well 101, Greenbush; Earnest A. Coard
(John Scott, driller; sample descriptions by A. Sinnott)
Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Not sampled	50	50
Sand, yellow, quartz	20	70

TABLE 2 (Continued)

Well 101—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene):		
Yorktown Formation:		
Silt, clayey; small shell fragments	30	100
Sand, fine, silty; shells, broken	47	147
Sand, fine, well-sorted, chiefly quartz; scattered shell fragments	64	210
St. Marys Formation:		
Clay, gravelly; shell fragments	20	230
Undescribed	30	260
Sand; gravel, clean; shell fragments	12	272

TABLE 3.—Logs of selected deep wells in Maryland near the Maryland-Virginia boundary.

Bradshaw well, Smith Island; Somerset County, Md.
(Lithology and Foraminifera by Doris S. Malkin, January 23, 1947; published by permission of Shell Oil Company)

	Thickness (feet)	Depth (feet)
Recent and Pleistocene Series, undifferentiated:		
Fine, medium, and coarse grained gray and buff quartz sand with shell fragments and rare *Elphidium* spp.	40	40
Chesapeake Group (?) (Miocene):		
Cohansey (?) Sand (Yorktown (?) equivalent):		
Very fine-grained brownish-gray sand; no fauna	20	60
Chesapeake Group (Miocene):		
St. Marys Formation:		
Gray glauconitic silty clay with shell fragments and rare Foraminifera (*Elphidium* spp.)	110(?)	170(?)
Choptank(?) Formation:		
Gray glauconitic silty clay, argillaceous silt, and silty sand, with abundant shell fragments. Foraminifera rare in upper part, increasing below 240 ft., including *Nonionella auris, Cibicides americanus, C. concentricus, Nonion*		

TABLE 3 (Continued)

Bradshaw well—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)—Continued		
Choptank(?) Formation—Continued		
pizzarense; abundant *Nonion incisum* and spp. at 240 ft.; *Textularia* cf. *agglutinans, Eponides* cf. *frigida* var. *calida;* 270-300 ft. *Discorbis floridana, D. candeiana, D. valvulata,* etc., with *Textularia* spp. and *Bulimina gracilis*	130(?)	300
Calvert Formation:		
Glauconitic silty sand (Plum Point Member) to 470 ft.; diatomaceous silt (Fairhaven Member) 470-540 ft.; glauconitic silt with lignite, with rare fauna 540-590 ft. Foraminiferal fauna abundant, including *Discorbis* spp., *Valvulineria floridana, Nonion* spp., *Eponides* cf. *mansfieldi, Textularia mayeri, T.* spp., *Spiroplectammina* sp., *Cibicides concentricus;* abundant specimens of *Textularia* spp. 370-400 ft.; abundant *Siphogenerina lamellata-transversa* 400-540 ft. Diatoms abundant 470-540 ft.; associated with abundant fauna including *Siphogenerina* and *Uvigerina* spp., etc.	290	590
[Note: The subdivisions of the Miocene indicated above are provisional, subject to revision after study of surface samples and range charting. The validity of micropaleontologic criteria for these subdivisions has not yet been established.]		
Upper Eocene Series, undifferentiated:		
Medium-grained gray sand with shell fragments and rare foraminifera: *Discorbis assulata*	20	610
Middle Eocene Series:		
Nanjemoy Formation:[1]		
Gray marly glauconitic sand and sandy marl. Marked increase in fauna; assemblage includes *Cristellaria* spp., *Marginulina winniana, Alabamina obtusa, Ceratobulimina* cf. *eximia, Siphonina* cf. *claibornensis, Discorbis forishi* (?) *Cibicides mauricensis, C.* cf. *westi, C.* spp., *Nonion planatum, Cyroidina* cf. *octocamerata, Bulimina pupoides, Globorotalia inconspicua,* etc.	50	660

[1] Compare with log of Crisfield well.

TABLE 3 (Continued)

Bradshaw well—Continued

	Thickness (feet)	Depth (feet)
Paleocene Series, undifferentiated:		
Aquia Formation:[2]		
Glauconite and highly glauconitic marl, with fauna fairly abundant in most samples, including: *Cibicides blanpiedi, C., hypoconoides, C. burlingtonensis, Parrella* sp., *Lenticulina degolyeri, Eponides* cf. *lotus, Gaudryina* sp., *Nodosaria affinis;* below 710 ft. *Vaginulinopsis brantlyi, Cibicides neelyi, Globorotalia wilcoxensis,* etc., plus above. 740-800 ft. Paleocene? Fauna includes, in addition to above, very large *Cristellaria* sp., *Hemicristellaria* cf. *rancocasensis, Anomalina* spp. *Robulus midwayensis,* etc.	140	800
Upper Cretaceous (?) Series:[3]		
Medium-grained white frosted subangular quartz sand; no fauna observed	40	840

Crisfield, Somerset County; Town of Crisfield

Log by Layne-Atlantic Co., modified after published correlation and lithologic notes by McLean (1950, pages 133-136.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene), 0-174 feet		
Beach sand and gravel	60	60
Soft clay	20	80
Medium hard clay	15	95
Soft clay	79	174
Chesapeake Group (Miocene), 174-760 feet		
Yorktown and St. Marys Formations:		
Shells	16	190
Brown and gray clay	58	248
Sandy clay and silt	72	320
Choptank Formation:		
Sandy clay, shells, and hard sand	72	392

[2] The typical Aquia of Aquia Creek is considered to be absent in this area.
[3] The sand here may be in the Paleocene part of the Mattaponi Formation.

TABLE 3 (Continued)

Crisfield—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)—Continued		
Calvert Formation:		
Clay	246	638
Hard clay	79	717
Coarse sand	4	721
Hard clay and sand	39	760
Upper Eocene, 760-860 feet		
Chickahominy(?) Formation:		
Glauconitic coarse to medium sand	42	802
Calcareous clay	58	860
Paleocene, 860-1,067 feet		
Calcareous sandy glauconitic clay; glauconitic sand at base	207	1,067
Upper Cretaceous, 1,067-1,302 feet		
Monmouth(?) Formation:		
Clay	58	1,125
Fine white sand	17	1,142
Clay	55	1,197
Fine mucky sand	15	1,212
Hard blue and red clay	90	1,302

Remarks: McLean's (1950) correlation given here is followed in the cross sections on Plate 1, with the exception of the base of the Pleistocene, which has been tentatively taken by the writers at 60 feet (about 50 feet below sea level).

TABLE 4.—Chemical Analyses of Ground Waters from Wells in Accomack County, Virginia (Parts per Million, Except Micromhos and pH) [Analyses by U. S. Geological Survey]

WELL NUMBER	1	2	3b	3c	4a	5
LOCATION	Franklin City E of Greenbackville	Greenbackville	NNW of Horntown	E of Horntown	New Church	W of New Church
DEPTH (FEET)	75	45	189	62	180	127
GEOLOGIC AGE	Miocene (?)	Pleistocene	Miocene	Pleistocene	Miocene	Miocene
FORMATION OR GROUP	Yorktown Formation	Columbia Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation
DATE	Aug. 17, 1948	Aug. 17, 1948	Sept. 29, 1955	Sept. 29, 1955	Aug. 19, 1948	Apr. 16, 1953
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	4.1	4.9	.00	.39	.21	.....
Calcium (Ca)	.....	.....	4.4	7.0	.....	9.9
Magnesium (Mg)	.....	.....	2.2	1.0	.....	6.6
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	0	0	.....	11
Bicarbonate (HCO_3)	232	34	342	447	186	289
Sulfate (SO_4)	1	6	.....	.....	1	.....
Chloride (Cl)	158	10	7.2	11	11	55
Fluoride (F)	.0	.0	.....	.....	.0	.1
Nitrate (NO_3)	.....	.2	.....	.....	.3	.4
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	168	36	20	22	120	52
pH	.....	.....	8.2	8.2	.....	8.5
Specific conductance (micromhos at 25°C)	876	105	521	671	322	629

TABLE 4.—Continued

WELL NUMBER	6a	6a	8b	8c	8e	8h
LOCATION	New Church	New Church	W of Chincoteague	W of Chincoteague	W of Chincoteague	W of Chincoteague
DEPTH (FEET)	259	259	62	60	60	54
GEOLOGIC AGE	Miocene	Miocene	Pleistocene	Pleistocene	Pleistocene	Pleistocene
FORMATION OR GROUP	St. Marys Formation	St. Marys Formation	Columbia Group	Columbia Group	Columbia Group	Columbia Group
DATE	Aug. 19, 1948	May 30, 1955	Sept. 18, 1947	Sept. 18, 1947	Sept. 18, 1947	Sept. 18, 1947
Silica (SiO_2)	.....	28	.....	.....	.....	.....
Iron (Fe)	.18	.64	4.0	0.15	0.1	4.0
Calcium (Ca)	.....	28	.....	.....	.....	.....
Magnesium (Mg)	.....	13	.....	.....	.....	.....
Sodium (Na)	.....	64	.....	.....	.....	.....
Potassium (K)	.....	14	.....	.....	.....	.....
Carbonate (CO_3)	.....	0	.....	.....	.....	.....
Bicarbonate (HCO_3)	221	229	37	39	28	37
Sulfate (SO_4)	7	6.7	.....	.....	.....	.....
Chloride (Cl)	93	66	17	17	12	19
Fluoride (F)	.1	.2	.....	.....	.....	.....
Nitrate (NO_3)	.6	.9	.....	.....	.....	.....
Dissolved solids	.....	345	.....	.....	.....	.....
Hardness as $CaCO_3$	123	124	39	31	19	24
pH	.....	8.0	6.1	6.2	6.4	6.0
Specific conductance (micromhos at 25°C)	650	567	.....	.....	.....	.....

TABLE 4.—Continued

WELL NUMBER	8i	9a	13	17	22	24
LOCATION	W of Chincoteague	W of Chincoteague	Chincoteague	Oak Hall	Jenkins Bridge	S of Oak Hall
DEPTH (FEET)	65	50-65	102	230	123	250
GEOLOGIC AGE	Pleistocene	Pleistocene	Miocene (?)	Miocene	Miocene	Miocene
FORMATION OR GROUP	Columbia Group	Columbia Group	Yorktown Formation	St. Marys Formation	Yorktown Formation	St. Marys Formation
DATE	Aug. 17, 1948	Aug. 18, 1948	May 15, 1954	Apr. 16, 1953	Aug. 19, 1948	Apr. 16, 1953
Silica (SiO_2)	11	17	.....	.....	.....	.....
Iron (Fe)	.06	.27	.....	.....	.18	.....
Calcium (Ca)	2.1	16	.....	12	.....	6.4
Magnesium (Mg)	2.2	9.4	.....	12	.....	3.4
Sodium (Na)	8.0	20	.....	.....	.....	.....
Potassium (K)			.....	.....	.....	.....
Carbonate (CO_3)	0	0	0	6	.....	18
Bicarbonate (HCO_3)	12	40	650	220	176	247
Sulfate (SO_4)	4.5	38	.....	.....	1	.....
Chloride (Cl)	10	25	693	178	11	14
Fluoride (F)	.0	0.0	.....	.2	.2	.2
Nitrate (NO_3)	3.8	18	.....	3.2	.6	2.2
Dissolved solids	52	172	.....	.....	.....	.....
Hardness as $CaCO_3$	14	79	388	77	81	30
pH	6.9	6.3	7.7	8.5	.....	8.7
Specific conductance (micromhos at 25°C)	74 calc.	246 calc.	3,140	942	314	455

TABLE 4.—Continued

WELL NUMBER	25	28	32	35	40	41
LOCATION	S of Oak Hall	Saxis	NW of Hallwood	NE of Temperanceville	Temperanceville	Temperanceville
DEPTH (FEET)	170	112	90	174	176	200
GEOLOGIC AGE	Miocene	Pleistocene (?)	Pleistocene (?)	Miocene	Miocene	Miocene
FORMATION OR GROUP	St. Marys (?) Formation	Columbia Group	Columbia Group	Yorktown (?) Formation	Yorktown Formation	St. Marys Formation
DATE	Apr. 16, 1953	Aug. 18, 1948	Sept. 2, 1948	Apr. 15, 1953	Aug. 19, 1948	Apr. 15, 1953
Silica (SiO_2)	.....	42	.....	.....	.....	.....
Iron (Fe)	.....	.97	.....	.....	.....	.....
Calcium (Ca)	30	56	.....	29	.....	22
Magnesium (Mg)	3.5	3.2	.....	3.2	.....	4.8
Sodium (Na)	.....	12	.....	.....	.....	.....
Potassium (K)	.....		.....	.....	.....	.....
Carbonate (CO_3)	0	0	.....	0	.....	0
Bicarbonate (HCO_3)	114	188	.....	107	.....	90
Sulfate (SO_4)	.....	4.0	.....	.....	.....	.....
Chloride (Cl)	9.4	14	24	8.8	10	9.2
Fluoride (F)	.2	.3	.2	.1	.0	.2
Nitrate (NO_3)	.2	1.5	.....	.5	.....	.7
Dissolved solids	.....	233	.....	.....	.....	.....
Hardness as $CaCO_3$	88	153	135	86	102	76
pH	8.3	7.7	.....	8.1	.....	7.6
Specific conductance (micromhos at 25°C)	207	333 calc.	866	201	209	182

TABLE 4.—Continued

WELL NUMBER	45	47a	47b	48	49	50
LOCATION	Hallwood	Hallwood	Hallwood	W of Hallwood	Hallwood	Hallwood
DEPTH (FEET)	265	160	246	232	240	237
GEOLOGIC AGE	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation
DATE	Apr. 15, 1953	Apr. 6, 1955	Apr. 6, 1955	Apr. 14, 1953	Apr. 15, 1953	Apr. 14, 1953
Silica (SiO_2)	.....	31	16	.....	.....	.....
Iron (Fe)	.....	.44	.06	.....	.....	.....
Calcium (Ca)	23	25	23	23	23	23
Magnesium (Mg)	10	5.5	9.5	12	11	13
Sodium (Na)	.....	8.0	18	.....	.....	.....
Potassium (K)	.....	2.1	7.0	.....	.....	.....
Carbonate (CO_3)	0	0	0	0	0	0
Bicarbonate (HCO_3)	144	112	142	148	157	156
Sulfate (SO_4)	.....	.5	1.0	.....	.....	.....
Chloride (Cl)	8.0	7.8	17	15	20	15
Fluoride (F)	.0	.1	.1	.1	.1	.1
Nitrate (NO_3)	1.4	.2	.7	3.0	1.1	2.8
Dissolved solids	.....	129	154	.....	.....	.....
Hardness as $CaCO_3$	100	85	96	107	101	110
pH	8.1	8.1	8.3	8.1	8.1	8.1
Specific conductance (micromhos at 25°C)	250	199	275	272	307	279

TABLE 4.—Continued

WELL NUMBER	52	55	56	57	58	59
LOCATION	W of Hallwood	ESE of Hallwood	WSW of Hallwood	Mears	SSE of Hallwood	Mappsville
DEPTH (FEET)	231	130	190	256	199	255
GEOLOGIC AGE	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	St. Marys Formation	Yorktown Formation	St. Marys Formation	St. Marys Formation	Yorktown (?) Formation	St. Marys Formation
DATE	Apr. 14, 1953	Aug. 18, 1948	Sept. 3, 1948		Sept. 2, 1948	Apr. 14, 1953
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.12	.....	.72	.....
Calcium (Ca)	23	.....	.....	.....	.....	28
Magnesium (Mg)	11	.....	.....	.....	.....	5.2
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	0	.....	.....	.....	.....	0
Bicarbonate (HCO_3)	146	.....	166	.....	125	118
Sulfate (SO_4)	.....	.....	6	.....	1	.....
Chloride (Cl)	13	9	101	10	10	13
Fluoride (F)	.1	.2	.2	.1	.1	.1
Nitrate (NO_3)	1.2	.....	4	.....	.1	2.0
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	104	117	78	57	81	91
pH	8.0	.....	.....	.....	.....	8.1
Specific conductance (micromhos at 25°C)	269	218	645	267	224	214

TABLE 4.—Continued

WELL NUMBER	60	61	62	63	64	65
LOCATION	Mappsville	Wallops Island	Mappsville	Mappsville	NW of Bloxom	NNE of Nelsonia
DEPTH (FEET)	21	147	225	255	23	220
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Pleistocene	Miocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	St. Marys Formation	St. Marys Formation	Columbia Group	St. Marys Formation
DATE	Sept. 2, 1948	1946?	Apr. 14, 1953	Apr. 14, 1953	Sept. 3, 1948	Aug. 18, 1948
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	3.1	.....	.....	.....	.....
Calcium (Ca)	.....	.....	37	27	.....	.....
Magnesium (Mg)	.....	.....	8.9	6.2	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	0	0	.....	.....
Bicarbonate (HCO_3)	.....	180	162	122	.....	112
Sulfate (SO_4)	.....	2	.....	.....	.....	2.0
Chloride (Cl)	6	64	13	13	10	8.0
Fluoride (F)	.0	.....	.1	.1	.1	.0
Nitrate (NO_3)	.....	1.5	1.9	2.1	.....	.3
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	57	180	130	94	90	78
pH	.....	.....	8.1	8.4	.....	.....
Specific conductance (micromhos at 25°C)	166	.....	283	220	271	209

TABLE 4.—Continued

WELL NUMBER	66	67	68	69	71	72
LOCATION	E of Bloxom	E of Bloxom	Nelsonia	Nelsonia	W of Modest Town	Nelsonia
DEPTH (FEET)	18½	265	240	230	228	230
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	Columbia Group	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation
DATE	Sept. 3, 1948	Apr. 18, 1953	Apr. 17, 1953	Apr. 17, 1953	Sept. 16, 1953	Apr. 17, 1953
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.....	.....	.....
Calcium (Ca)	.....	22	27	23	23	20
Magnesium (Mg)	.....	9.1	9.3	5.8	10	5.5
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	0	12	0	9	0
Bicarbonate (HCO_3)	.....	121	119	97	133	87
Sulfate (SO_4)	.....	.....	.....	.....	.....	.....
Chloride (Cl)	26	9.5	11	9.8	10	9.0
Fluoride (F)	.0	.0	.1	.0	.2	.1
Nitrate (NO_3)	.....	.5	.5	.7	1.3	.6
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	102	94	107	80	80	72
pH	.....	8.1	8.8	8.2	8.7	8.0
Specific conductance (micromhos at 25°C)	297	222	245	188	259	172

TABLE 4.—Continued

WELL NUMBER	73	76	78	81	84	88
LOCATION	W of Modest Town	WSW of Bloxom	SSW of Bloxom	Hopkins	E of Parksley	SSW of Hopkins
DEPTH (FEET)	230	138	40	100	228	220
GEOLOGIC AGE	Miocene	Miocene	Pleistocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	St. Marys Formation	Yorktown Formation	Columbia Group	Yorktown Formation	St. Marys Formation	St. Marys Formation
DATE	Apr. 17, 1953	Sept. 3, 1948	Sept. 3, 1948	Sept. 3, 1948	Apr. 18, 1953	Sept. 4, 1948
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.09	.....	.12	.....	.....
Calcium (Ca)	24	.....	.....	.....	27	.....
Magnesium (Mg)	4.8	.....	.....	.....	12	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	7	.....	.....	.....	0	.....
Bicarbonate (HCO_3)	90	180	.....	156	152	.....
Sulfate (SO_4)	.....	1	.....	1	.....	.....
Chloride (Cl)	9.6	17	26	10	7.6	48
Fluoride (F)	.1	.3	.0	.1	.1	.0
Nitrate (NO_3)	.5	.1	.....	.3	1.1	.....
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	81	57	99	102	116	123
pH	8.7	.....	.....	.....	8.3	.....
Specific conductance (micromhos at 25°C)	195	294	328	271	254	462

TABLE 4.—Continued

WELL NUMBER	89	92	93	95	96	97
LOCATION	NW of Greenbush	Chesconessex	SW of Chesconessex	Greenbush	Greenbush	Greenbush
DEPTH (FEET)	50	150	160	140	265	267
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	St. Marys Formation	St. Marys Formation
DATE	Apr. 18, 1953	Apr. 18, 1953	Sept. 4, 1948	Sept. 4, 1948	Apr. 18, 1953	Apr. 18, 1953
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.13	.....	.....
Calcium (Ca)	15	32	.....	.....	22	21
Magnesium (Mg)	3.9	10	.....	.....	15	12
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	0	0	.....	.....	0	0
Bicarbonate (HCO_3)	28	234	.....	113	181	132
Sulfate (SO_4)	.....	.....	.....	1	.....	.....
Chloride (Cl)	15	17	92	10	23	9.9
Fluoride (F)	.0	.1	.1	.1	.2	.1
Nitrate (NO_3)	2.7	2.9	.....	.1	4.6	1.7
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	53	123	72	75	116	100
pH	7.0	8.2	.....	.....	8.1	8.0
Specific conductance (micromhos at 25°C)	156	402	997	210	350	236

TABLE 4.—Continued

WELL NUMBER	98	99	101	102	104	106
LOCATION	Greenbush	W of Greenbush	S of Greenbush	Accomac	Accomac	Accomac
DEPTH (FEET)	265	28	272	68	73	160
GEOLOGIC AGE	Miocene	Pleistocene	Miocene	Pleistocene	Pleistocene	Miocene
FORMATION OR GROUP	St. Marys Formation	Columbia Group	St. Marys Formation	Columbia Group	Columbia Group	Yorktown Formation
DATE	Apr. 18, 1953	Sept. 5, 1948	Sept. 4, 1948	Sept. 4, 1948	May 29, 1953	May 29, 1953
Silica (SiO_2)	.....	.....	.....	.....	15	.....
Iron (Fe)	.....	.....	.08	7.5	.04	.....
Calcium (Ca)	22	.....	.....	.....	17	21
Magnesium (Mg)	14	.....	.....	.....	2.8	8.8
Sodium (Na)	.....	.....	.....	.....	8.2	.....
Potassium (K)	.....	.....	.....	.....	.8	.....
Carbonate (CO_3)	0	.....	.....	.....	0	0
Bicarbonate (HCO_3)	181	.....	191	55	27	130
Sulfate (SO_4)	.....	.....	1	6	22	.....
Chloride (Cl)	31	48	14	15	17	10
Fluoride (F)	.1	0	.3	.1	.1	.0
Nitrate (NO_3)	2.9	.....	.1	.1	1.2	.4
Dissolved solids	.....	.....	.....	.....	107	.....
Hardness as $CaCO_3$	114	132	111	57	54	88
pH	8.2	.....	.....	.....	7.2	7.8
Specific conductance (micromhos at 25°C)	374	619	341	165	163	235

TABLE 4.—Continued

WELL NUMBER	107	108c	124	126	128a	151
LOCATION	Accomac	Onancock	SSW of Onancock	SSW of Cashville	SSE of Accomac	Pungoteague
DEPTH (FEET)	161	210	22	128	90	210
GEOLOGIC AGE	Miocene	Miocene	Pleistocene	Miocene	Miocene (?)	Miocene
FORMATION OR GROUP	Yorktown Formation	St. Marys Formation	Columbia Group	Yorktown Formation	Yorktown Formation	St. Marys Formation
DATE	May 29, 1953	Sept. 4, 1948	Sept. 5, 1948	Sept. 5, 1948		1906
Silica (SiO_2)	.....	24	.....	.....	.....	45
Iron (Fe)	.....	.07	.....	.12	.....	.1
Calcium (Ca)	21	24	.....	.....	.....	25
Magnesium (Mg)	8.6	8.5	.....	.....	.....	11
Sodium (Na)	.....	34	.....	.....	.....	32
Potassium (K)	.....		.....	.....	.....	14
Carbonate (CO_3)	0	0	.....	.....	.....	0
Bicarbonate (HCO_3)	128	168	.....	237	.....	218
Sulfate (SO_4)	.....	6.5	.....	1	.....	1.6
Chloride (Cl)	9.8	15	18	25	8	12
Fluoride (F)	.0	.1	.0	.3	.1	.....
Nitrate (NO_3)	.4	2.9	.....	.1	.....	3.6
Dissolved solids	.....	203	.....	.....	.....	250
Hardness as $CaCO_3$	88	95	45	102	81	.....
pH	8.0	7.9	.....	.....	.....	.....
Specific conductance (micromhos at 25°C)	231	290 calc.	1,420	444	271	358 calc.

TABLE 4.—Continued

WELL NUMBER	153	154	160	163	166	167
LOCATION	Pungoteague	Nandua	Wachapreague	SE of Keller	Craddockville	Painter
DEPTH (FEET)	128	108	385	39	170	98
GEOLOGIC AGE	Miocene (?)	Pleistocene	Miocene	Pleistocene	Miocene	Pleistocene
FORMATION OR GROUP	Yorktown Formation	Columbia Group	Choptank Formation	Columbia Group	Yorktown Formation	Columbia Group
DATE	Sept. 5, 1948	Apr. 18, 1953	Sept. 7, 1948	Sept. 3, 1948	Sept. 5, 1948	Sept. 13, 1948
Silica (SiO_2)	.....	.....	14	.....	.....	.....
Iron (Fe)	.62	.....	.14	.....	5.0	13
Calcium (Ca)	.....	21	5.5	.....	.....	.....
Magnesium (Mg)	.....	7.5	3.8	.....	.....	.....
Sodium (Na)	.....	.....	180	.....	.....	.....
Potassium (K)	.....	.....		.....	.....	.....
Carbonate (CO_3)	.....	0	0	.....	.....	.....
Bicarbonate (HCO_3)	18	116	346	.....	28	166
Sulfate (SO_4)	7	.....	4.0	.....	23	1
Chloride (Cl)	7	10	93	24	15	10
Fluoride (F)	.2	.1	.7	.0	.2	.3
Nitrate (NO_3)	.9	.6	.8	.....	.1	5.9
Dissolved solids	.....	.....	482	.....	.....	.....
Hardness as $CaCO_3$	36	83	29	75	42	111
pH	.....	7.7	8.1	.....	.....	.....
Specific conductance (micromhos at 25°C)	88.1	216	688 calc.	263	134	293

TABLE 4.—Continued

WELL NUMBER	171	177	182	183
LOCATION	WSW of Craddockville	Belle Haven	Upshurs Neck	Tangier Island
DEPTH (FEET)	28	198	13	860
GEOLOGIC AGE	Pleistocene	Miocene	Pleistocene	Late Eocene (?)
FORMATION OR GROUP	Columbia Group	Yorktown (?) Formation	Columbia Group	Chickahominy (?) Formation
DATE	Sept. 5, 1948		Sept. 3, 1948	1948
Silica (SiO_2)	.....	.....	.....	12
Iron (Fe)	.....	.....	.....	.....
Calcium (Ca)	.....	.....	.....	.....
Magnesium (Mg)	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	339
Potassium (K)	.....	.....	.....	
Carbonate (CO_3)	.....	.....	.....	28
Bicarbonate (HCO_3)	.....	.....	.....	579
Sulfate (SO_4)	.....	.....	.....	58
Chloride (Cl)	20	1	130	115
Fluoride (F)	.0	.....	.0	3.2
Nitrate (NO_3)	.....	.....	.....	.4
Dissolved solids	.....	.....	.....	857
Hardness as $CaCO_3$	54	102	108	15
pH	.....	.....	.....	8.4
Specific conductance (micromhos at 25°C)	206	740	871	.....

TABLE 5.—Chemical Analyses of Waters from Deep Wells in Somerset County, Maryland. (Parts per Million, Except pH.) (Data from Rasmussen and Slaughter, 1955, Tables 35, 38, and 41)

LOCATION	Smith Island	Smith Island	Smith Island	Smith Island
OWNER	Lora C. Whitelock	Clayton Middleton	Harvey Bradshaw	Charlton Evans
DEPTH (FEET)	841	850	820	852
GEOLOGIC AGE	Late Cretaceous	Late Cretaceous	Late Cretaceous	Late Cretaceous
FORMATION OR GROUP	Magothy (?) Formation	Magothy (?) Formation	Magothy (?) Formation	Magothy (?) Formation
DATE	Apr. 26, 1948	Apr. 26, 1948	Apr. 26, 1948	Apr. 26, 1948
Silica (SiO_2)	11	11	.....	.....
Iron (Fe)	.02	.02	.....	.....
Calcium	2.0	1.8	.....	.....
Magnesium (Mg)	.8	.7	.....	.....
Sodium (Na), Potassium (K)	241	217	.....	.....
Bicarbonate (HCO_3)	506	457	598	518
Carbonate (CO_3)	37	31	.....	.....
Sulfate (SO_4)	32	30	14	35
Chloride (Cl)	10	10	10	8.0
Fluoride (F)	3.0	2.8	1.4	4.4
Nitrate (NO_3)	1.5	.1	1.5	.2
Dissolved solids	588	522	.....	.....
Hardness as $CaCO_3$	8	7	10	9
pH	8.4	8.5	.....	.....

NORTHAMPTON COUNTY

LOCATION AND DEVELOPMENT

Northampton County occupies the southern part of the Eastern Shore peninsula in eastern Virginia. It is bounded by Accomack County on the north and by the Atlantic Ocean and Chesapeake Bay on the east and west, respectively. Its total land area is 226 square miles, and its population, according to the 1960 census, was 16,966—a decrease of 334 since 1950.

Its soil is very favorable for truck farming; Irish potatoes and sweet potatoes are large industries. General farm crops, strawberries, cabbage, lima beans, and snap beans are extensively raised. These agricultural products, together with much of the output of the important seafood industries, are prepared for the market by local canneries at Cheriton, Machipongo, and Exmore. Willis Wharf is a fishing and oystering center. The county seat is Eastville, in the central part; the largest community is Cape Charles.

Ferry service across Chesapeake Bay to Little Creek, near Norfolk, and Old Point Comfort, formerly left the Eastern Shore at Cape Charles. In about 1952, the ferry terminal on the peninsula was moved to Kiptopeke at the southern extremity, where it remained until the completion of the Chesapeake Bay Bridge-Tunnel in 1964. The bridge-tunnel connects U.S. Highway 13 on the Eastern Shore with the southerly continuation of that highway at Cape Henry across the mouth of Chesapeake Bay. State Highway 183 and 186 also serve the county. Motorbus transportation is available along Highway 13. Railway freight service is provided by the Penn Central (formerly Pennsylvania) Railroad through the county as far south as Kiptopeke, with a spur line into Cape Charles.

DRAINAGE AND TOPOGRAPHY

Northampton County, like Accomack, has no major streams. It is drained by numerous small creeks which flow westward or eastward from a divide which passes along the length of the peninsula. Along the eastern shore of Chesapeake Bay are several tidal inlets which mark the submerged mouths of the larger creeks draining the western part of the county: among the larger of these are Occahannock Creek at the north boundary, Nassawadox Creek, Mattawoman Creek, and Cherrystone Inlet near Cape Charles. Along the eastern side of the county are many marshy islands which extend 9 miles east of the main

shoreline. Both the eastern and western sides of the county are typically drowned shorelines. A few minor spits have been developed, which partly enclose the several "bays"—Hog Island Bay at the north, Cobbs Bay, South Bay, and Magothy Bay at the south. Sand dunes occur at Savage Neck south of Wilkins Beach, 3½ miles west-southwest of Eastville (Figure 5). Low wave-cut cliffs are exposed in many places along the west side of the peninsula (Figure 6).

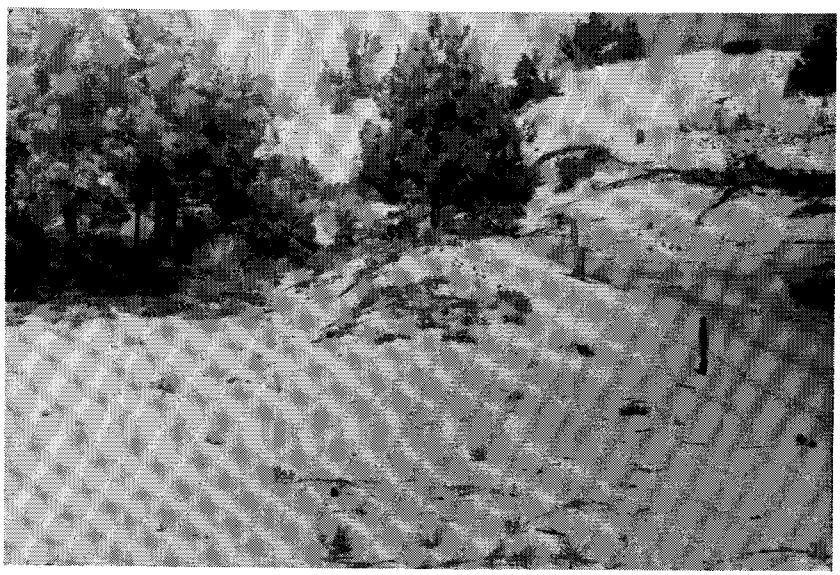


Figure 5. Sand dunes on Savage Neck, 3½ miles west-southwest of Eastville, south of Wilkins Beach, Northampton County. Position of water table, after recent rainfall, is marked by small pool at right.

The altitudes in Northampton County range from sea level on the bay and ocean sides of the peninsula to nearly 50 feet on the subdued ridge along the middle axis of the county; a maximum altitude of about 70 feet is reached on the truncated cliffs between Cheapside and Kiptopeke Beach at the south end of the peninsula. Carolina bays, generally only visible from the air or on aerial photographs, may be noted in several places on the newer topographic maps of 10-foot contour interval, especially between Eastville and Cheriton, where their sand rims reach the 40-foot contour line. Minor scarps, believed to mark the position of shorelines developed during higher stands of sea level during the several stages of continental glaciation in Pleistocene time, may be noted particularly in the southern part of the county (Sinnott and Tibbitts, 1961).

shoreline. Both the eastern and western sides of the county are typically drowned shorelines. A few minor spits have been developed, which partly enclose the several "bays"—Hog Island Bay at the north, Cobbs Bay, South Bay, and Magothy Bay at the south. Sand dunes occur at Savage Neck south of Wilkins Beach, 3½ miles west-southwest of Eastville (Figure 5). Low wave-cut cliffs are exposed in many places along the west side of the peninsula (Figure 6).

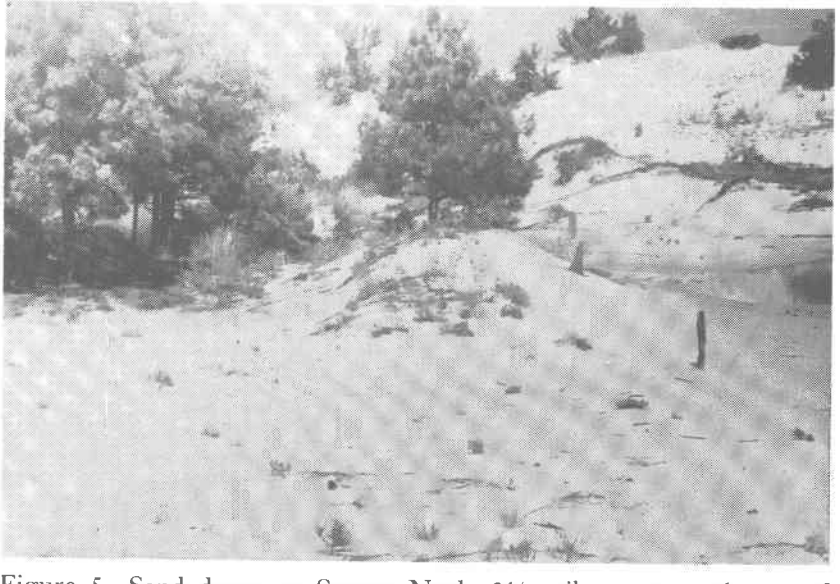


Figure 5. Sand dunes on Savage Neck, 3½ miles west-southwest of Eastville, south of Wilkins Beach, Northampton County. Position of water table, after recent rainfall, is marked by small pool at right.

The altitudes in Northampton County range from sea level on the bay and ocean sides of the peninsula to nearly 50 feet on the subdued ridge along the middle axis of the county; a maximum altitude of about 70 feet is reached on the truncated cliffs between Cheapside and Kiptopeke Beach at the south end of the peninsula. Carolina bays, generally only visible from the air or on aerial photographs, may be noted in several places on the newer topographic maps of 10-foot contour interval, especially between Eastville and Cheriton, where their sand rims reach the 40-foot contour line. Minor scarps, believed to mark the position of shorelines developed during higher stands of sea level during the several stages of continental glaciation in Pleistocene time, may be noted particularly in the southern part of the county (Sinnott and Tibbitts, 1961).

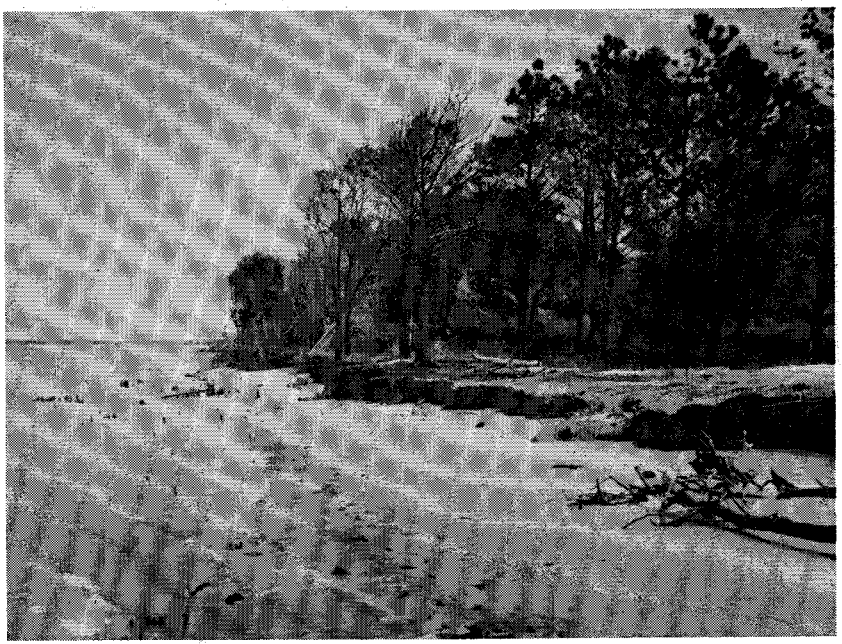


Figure 6. Low wave-cut cliff truncating Princess Anne terrace on beach south of Occahannock Creek, about 6 miles west of Exmore, Northampton County. (After Sinnott and Tibbitts, 1961.)

GEOLOGY

Northampton County is underlain at depth by a basement complex of igneous and metamorphic rocks, believed to be chiefly of Precambrian age. These rocks are overlain by successively younger unconsolidated beds of sand, gravel, clay, and shell marl, which are of Cretaceous, Paleocene, Eocene, Miocene, and Pleistocene age. (See columnar section, Plate 2.)

Basement Complex

No wells, so far as known, have ever reached the basement complex in this county. The bedrock surface beneath the unconsolidated sediments in Northampton County probably lies at depths of from 2,800 to 4,200 feet below sea level (Spangler and Peterson, 1950, Fig. 12).

Cretaceous and Paleocene Deposits

As shown in the geologic section (Plate 1, section *C-C'*), the old well (90) at Cape Charles is believed to have penetrated the Potomac Group

Figure 6. Low wave-cut cliff truncating Princess Anne terrace on beach south of Occahannock Creek, about 6 miles west of Exmore, Northampton County. (After Sinnott and Tibbitts, 1961.)

GEOLOGY

Northampton County is underlain at depth by a basement complex of igneous and metamorphic rocks, believed to be chiefly of Precambrian age. These rocks are overlain by successively younger unconsolidated beds of sand, gravel, clay, and shell marl, which are of Cretaceous, Paleocene, Eocene, Miocene, and Pleistocene age. (See columnar section, Plate 2.)

Basement Complex

No wells, so far as known, have ever reached the basement complex in this county. The bedrock surface beneath the unconsolidated sediments in Northampton County probably lies at depths of from 2,800 to 4,200 feet below sea level (Spangler and Peterson, 1950, Fig. 12).

Cretaceous and Paleocene Deposits

As shown in the geologic section (Plate 1, section *C-C'*), the old well (90) at Cape Charles is believed to have penetrated the Potomac Group

of beds of Early(?) Cretaceous age. The line of separation of the Potomac Group of formations from the overlying Mattaponi Formation of Paleocene to Late Cretaceous age cannot be made on the basis of data at hand.

The mottled clay reported between 1331 and 1585 feet is characteristic of the Mattaponi Formation west of Chesapeake Bay. However, it is not possible to subdivide the Mattaponi Formation in the Cape Charles well into its component units. "Green clay with black specks" noted at 890 to 950 feet might, insofar as lithology is concerned, be assigned anywhere in the Eocene or in the upper Cretaceous part of the Mattaponi Formation. In view of the great uncertainties concerning the deep formations here, the Cape Charles log is subdivided as far as possible on the basis of McLean's correlation of strata present in the Crisfield well, making reasonable allowances for the fact that Cape Charles is a little up dip from Crisfield. However, even with this assistance, the contact between the Mattaponi Formation and the Potomac Group remains conjectural. Further, it should also be borne in mind that the assumption that Upper Cretaceous beds extend as far down as about 1,600 feet is based on extremely meager data.

Presumably the Cobbs Island well (180) reached beds near the top of the Mattaponi Formation. The log gives no lithologic detail.

Eocene Deposits

The two deep wells just mentioned, at Cape Charles and Cobbs Island, are thought to have penetrated 100 to 150 feet of beds of late Eocene age. Upper Eocene beds assigned to the Chickahominy(?) Formation are reported by McLean in the Crisfield well and there is a reasonable probability that upper Eocene beds are present in southern Northumberland County.

Miocene Deposits

Rocks of the Chesapeake Group, of Miocene age, do not crop out at the surface anywhere in the county, being overlain by the younger Pleistocene sediments. The top of the Yorktown Formation, which is the youngest of the group, lies at depths of about 25 to 100 feet below the surface in the county.

Except in a few places where adequate drill cuttings are available, it is difficult or impossible to differentiate among the several forma-

tions of the Chesapeake Group; most of what has been done thus far has been based on a study of the fossils contained in the deposits.

Although no wells tap the Calvert or Choptank Formations in Northampton County, the two deepest test holes of record, wells 90 and 180 at Cape Charles and Cobbs Island, respectively, penetrate these formations. Material tentatively ascribed to these formations, according to the well logs, are green and gray clay, mud, fine sand and some shells. They show little promise as possible aquifers, as indeed was borne out by the tests made at the time of drilling.

In U.S.G.S. test hole 1 at Capeville (Figure 2, Table 7), material correlated with the Choptank Formation by means of megafossils by MacNeil (personal communication, 1955) consists of soft sandy gray-green clay with scattered shell fragments, black chert, coarse(?) sand 22 feet thick, and dark gray silty clay. The sand yielded virtually no water. The shallow test hole at Machipongo yielded a moderate supply of 16 gpm from an aquifer in the Yorktown Formation (Figure 2).

St. Marys and Yorktown Formations According to the drillers' logs which are available from wells drilled in Northampton County, that part of the Chesapeake Group penetrated by the wells—chiefly the Yorktown Formation but including also the upper part of the St. Marys—consists generally of sand, sandy clay, and shell marl with minor lenses of gravel. There are usually several water-bearing beds separated by clayey layers.

For example, at Cheriton (well 76), the Yorktown Formation consists of shells and clay with some gravel; there are water-bearing beds from 122 to 125 feet, and from 158 to 164 feet, each consisting of shells and gravel.

In a 270-foot well at Exmore (2), the uppermost part of the Miocene section, in the Yorktown Formation, is largely clay. From 165 to 184 feet is a coarse sand, with 4 feet of "hard shell rock" at the base, underlain by 26 feet of clay. A bed of gravel, sand and shells occurs from 210 to 238 feet, also in the Yorktown Formation. The underlying 32-foot section, consisting of shells and clay, down to the total depth of the well at 270 feet, is correlated with the St. Marys Formation. Another well at Exmore (9) penetrated shells and clay of the Yorktown from 209 to 215 feet, and sand, shells, and clay of the St. Marys from 277 to 288.

Pleistocene Deposits

The Columbia Group of formations of Pleistocene age occurs as a veneer, about 25 to 100 feet thick, upon the underlying Miocene deposits in Northampton County. The unconsolidated Pleistocene rocks are chiefly yellow sand, sandy clay, and minor lenses of gravel. Cross-bedding is common in the sandy formations (Figure 7). In many

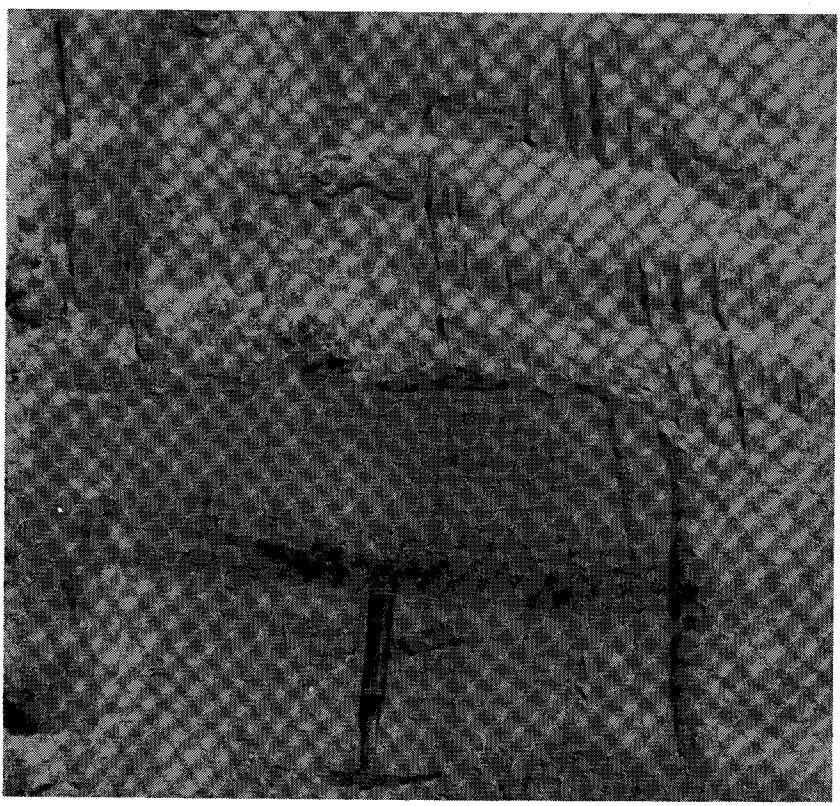


Figure 7. Columbia Group of Pleistocene age, showing details of sedimentation in a section in cliff, ½ mile southeast of old ferry terminal, Kiptopeke Beach, Northampton County. Lens of fine gravel 4 inches thick (at handle of pick), overlain by 10 inches of well-sorted sand, in turn overlain by cross-bedded sand.

wells it is difficult to distinguish beds of the Columbia Group from the underlying Yorktown Formation except where fossil shells are present and where there is a color change from yellowish in the Pleistocene to gray in the Yorktown. Because individual Pleistocene beds

Pleistocene Deposits

The Columbia Group of formations of Pleistocene age occurs as a veneer, about 25 to 100 feet thick, upon the underlying Miocene deposits in Northampton County. The unconsolidated Pleistocene rocks are chiefly yellow sand, sandy clay, and minor lenses of gravel. Cross-bedding is common in the sandy formations (Figure 7). In many

Figure 7. Columbia Group of Pleistocene age, showing details of sedimentation in a section in cliff, ½ mile southeast of old ferry terminal, Kiptopeke Beach, Northampton County. Lens of fine gravel 4 inches thick (at handle of pick), overlain by 10 inches of well-sorted sand, in turn overlain by cross-bedded sand.

wells it is difficult to distinguish beds of the Columbia Group from the underlying Yorktown Formation except where fossil shells are present and where there is a color change from yellowish in the Pleistocene to gray in the Yorktown. Because individual Pleistocene beds

commonly interfinger and are of limited areal extent, it is not usually possible to trace them laterally for more than a few hundred feet.

GROUND-WATER RESOURCES

Water from Pre-Miocene Deposits

The two deep wells in the county have failed to note the presence of good water-bearing sands at depth. According to Sanford (1913, p. 246), at Cape Charles (90) the driller "found no strongly water-bearing sand between 40 and 1,520 feet." The well was never put into use. The Cobbs Island well (180) was abandoned because when tested it produced only brackish water.

It is entirely likely that even if water in large quantity could be produced from the pre-Miocene formations, that water would be brackish and of very limited usefulness.

Water from Miocene Deposits

Calvert and Choptank Formations The two oldest formations of the Chesapeake Group are the Calvert and Choptank Formations. So far as the writers are aware, no wells in Northampton County are known to tap these deposits.

St. Marys Formation The canvass of representative wells in the county lists seven wells that tap water-bearing materials in the St. Marys Formation. These range in yield from 15 gpm (43, at Bayford, 2 inches in diameter) to 275 gpm (9, at Exmore, 8 inches in diameter). Substantial yields were also obtained from two of the other 6-inch wells; 44 b, a public supply well at Nassawadox, yields 150 gpm, and a school well at Machipongo (54) is pumped at a rate of 60 gpm. This may be substantially lower than its potential capacity.

Comparatively small yields—up to about 30 gpm—are obtained from wells 2 inches in diameter (43, 68) and 3 inches in diameter (44a). In general, supplies of about 25 gpm can be expected from 2-inch diameter wells from the St. Marys Formation in Northampton County, whereas some assurance of maximum yields of over 100 gpm would be afforded by properly developed wells 6 inches or more in diameter.

Yorktown Formation More than 90 of the wells canvassed in Northampton County draw water from aquifers in the Yorktown Formation. Most of these wells are 2 inches in diameter, and their yield averages from 15 to 25 gpm. Three wells 3 inches in diameter (3, 4,

and 89) have yields that range up to 100 gpm, and 4-inch wells (13, 14, 64) yield up to 200 gpm.

Well 93, a 4-inch well 175 feet deep drilled in 1927 for the town of Cape Charles, was reported to produce water "with some salt," and was abandoned, although it had a substantial yield of 110 gpm.

Two 8-inch wells (2, 10) produce 310 and 200 gpm, respectively.

One of the town wells at Eastville (63) formerly pumped 75 gpm from fine sand and shells in the Yorktown Formation. However, although it was reported to have a maximum yield of 200 gpm, it was abandoned some years ago because sand was being drawn into the screen, perhaps because it was pumped at a higher capacity than the capacity at which it was developed initially. It seems likely that the well might have been salvaged by installing a finer screen, followed by careful redevelopment or perhaps by simple redevelopment.

Well 31 at Willis Wharf, 142 feet deep, was reported to be flowing at a rate of 28 gpm in 1948. The effect of loading by tidewater was apparent in that the flow was less at low tide. In 1946, well 83 b at Oyster flowed at a rate of about half a gallon per minute.

In a 271-foot well (76) at Cheriton, the driller noted water-bearing beds of sand, shells, and gravel from 110 to 125 feet, shells and coarse gravel from 158 to 164 feet, and shells and silty clay from 177 to 190 feet below the surface. The yields from each of these zones was not recorded, but the middle zone was reported to be especially favorable.

The 8-inch town well at Exmore (2) had the highest tested yield of record in the county and in the entire Virginia Eastern Shore. At the time it was drilled in 1950 it yielded 746 gpm with a drawdown of 37 feet at that time. The well draws water from coarse sand and very hard "shell rock," in the Yorktown Formation, from 165 to 184 feet below the surface. Its present pump has a capacity of 310 gpm.

A much higher yield from the Yorktown Formation—645 gpm—is delivered by well 92, one of the town wells of Cape Charles; this well has the highest operational yield (as distinct from tested yield) recorded during this study for any well in either county.

In summary, the Miocene deposits, especially where they contain shells, yield water copiously to wells in many areas. The wells are commonly less than 200 feet deep but a few are deeper. As in Accomack County, however, the lenticular character of the formations makes it impracticable to predict whether or not a new well at a

particular site will provide an adequate supply of water. It seems advisable, therefore, before planning large developments, to jet down a few small-diameter test holes prior to drilling permanent production wells, in order to select those sites promising the greatest yield. Samples of ground water for chemical analysis also should be collected to insure against tapping high-chloride water which is present in some places in the Miocene.

Most waters (except those few that are brackish) are of excellent quality for irrigation as well as for most other domestic and commercial uses.

Water from Pleistocene Deposits

Many rural homes and farms obtain their water supply from shallow dug or driven wells which tap water from the sands and gravels that make up the Columbia Group of Pleistocene age. The wells are commonly 2 inches or less in diameter and most of them yield less than 5 gallons per minute.

In the group of 70 wells tapping the Pleistocene in the county that were visited during the field canvass, four are pumped at 25 gpm or more (wells 33, 36, 128, and 177). Two are irrigation wells, one (177) is at the Cape Charles Air Force Base, and another (36) is a school well. The latter has the highest reported yield, 37 gpm, from the Columbia Group in Northampton County.

Considering the availability of larger quantities of water from these beds, there is little doubt that large-diameter wells equipped with pumps of greater capacity might yield 50 to 100 gpm, or more, where the water-bearing material is coarse and there is a minimum of interference from nearby wells. It will be recalled, in the description of ground-water conditions in Accomack County, that the highest recorded tested yield for any well in the entire peninsula is from a well in the Pleistocene deposits. (See well 115, Accomack County, Table 1.)

Locally, as in low places near the shore on the ocean or bay side of the peninsula, prolonged heavy pumping may induce encroachment of the sea water into the shallow ground-water reservoirs. This would occur when the water table was lowered below sea level and the hydraulic gradient (slope of the water table) reversed. With the water table sloping towards, rather than away from, the land the flow of water would be landward. So far as known, the shallow Pleistocene

beds are in hydraulic continuity with the ocean and bay waters offshore.

In order to prevent, so far as possible, the encroachment of saline water into the shallow ground-water reservoirs, perhaps the most dependable arrangement for relatively large withdrawals of water from the Pleistocene aquifers is a battery of small-diameter shallow wells so disposed as to intercept the maximum natural ground water flow from the land to the sea, i.e., roughly parallel to the shoreline. Such wells could be driven, jetted, or drilled, and should be spaced as widely apart as possible consistent with the requirements for unit operation. It is believed that under favorable conditions on the order of a million gallons of water per day might be obtained by such a system. Such an arrangement of wells is in operation in northeastern Accomack County for the town of Chincoteague, and is discussed in the chapter for that county.

QUALITY OF WATER

Water from Cretaceous, Paleocene and Eocene Deposits

As stated previously, no wells produce water from deposits of Cretaceous age in Northampton County. The only wells that obtain water from the Eocene deposits are those on Tangier Island in Accomack County. The chemical quality of the ground water from the Cretaceous and Eocene deposits would be similar to that obtained at Tangier Island (183, Table 4) except the total dissolved solids would be greater nearly everywhere. Water from that well is a soft sodium bicarbonate type somewhat high in chloride. The well at Cobbs Island (180) yielded brackish water from Paleocene deposits.

The high-chloride ground water in the deeper aquifers in the eastern part of the Coastal Plain has been attributed by Sanford (1913, p. 114) to the presence of residual ocean water, which saturated the sediments during several post-Cretaceous marine advances, and which has since been only incompletely flushed out by the eastward migration of fresh artesian ground water from the recharge areas along the Fall Zone.

The high sodium chloride (and sodium bicarbonate) content that would be expected from the deep aquifers would therefore largely restrict their use to cooling and to certain other specialized applications. Use of the water for domestic purposes would be precluded as well as use for irrigation.

Deep somewhat saline ground water would be more economical to desalinize than sea water. However, careful development of both shallow and moderately deep ground waters is at present a more practicable approach to increasing the total available supply on the Eastern Shore than desalinization. Further, there is ample opportunity for increasing ground water retention and availability by artificial recharge in this low-lying province in which a sandy cover is everywhere present. Such practices are already being carried out on a small scale by farmers who have established "irrigation ponds."

Water from Miocene Deposits

St. Marys Formation Chemical analyses are available of waters from three of the seven wells recorded that tap the St. Marys Formation in Northampton County.

Well 9 at Exmore is 295 feet deep and yields water that is very high in chloride, 690 ppm. (More than half the sodium is present as sodium chloride, the remainder as sodium bicarbonate. Less than half of the bicarbonate is present as calcium and magnesium bicarbonate.) The origin of the water is obscure. In chemical characteristics it is similar to water in the Eocene and Cretaceous beds elsewhere in the Coastal Plain (Cederstrom, 1946b). Thus it may have migrated eastward beneath the bay through Miocene beds or initially through older beds after which it "leaked" upward into Miocene beds. Possible movement downward from surficial beds seems somewhat less likely.

Well 29, 240 feet deep, at Willis Wharf, half a mile southeast of Exmore, yields hard water with a chloride concentration of 101 ppm.

A 200-foot well (43) at Bayford is reported to yield "salty water" from fine dark gray sand in the St. Marys.

A comprehensive analysis was made of water from a well at the Northampton-Accomack Memorial Hospital at Nassawadox. (See analysis, well 44b, Table 8). The well is screened in both the Yorktown and St. Marys Formations; the generally excellent character of the water suggests that it is derived principally from the Yorktown. It is a moderately hard calcium bicarbonate water containing only 176 ppm of dissolved solids.

Yorktown Formation Water from wells 160 to 200 feet deep, tapping the Yorktown Formation in the vicinity of Exmore (12, 13, 14, Table 8) in the northern part of Northampton County, are moderately hard bicarbonate waters. Bicarbonate is 120 and 194 ppm in wells 13

and 14. Chloride is low, less than 20 ppm; nitrate, sulfate and fluoride are all low. Well 39 near Nassawadox, also in the northern part of the county, was jetted to 90 feet and yields water with a chloride content of only 10 ppm and a hardness of 72 ppm. Although not determined, iron apparently is a problem, as staining of clothing is reported. Fluoride was not present in the sample taken.

About 3 miles southwest of Bridgetown, well 51, 98 feet deep yields water with 205 ppm of chloride. Its location near Hungars Creek suggests that there may be local hydraulic continuity between the aquifer and the brackish water of Chesapeake Bay, and that this may contribute to the high chloride content. The moderately high nitrate (4.1 ppm) in the water from this well might be from organic pollution, although it is a driven well and presumably relatively safe from such pollution from surface sources. This well is pumped at a rate of only 5 gallons per minute.

At Eastville, near the middle of the county, an unused 146-foot well (63) in the Yorktown yields water having a low chloride concentration of 17 ppm, and a dissolved solids content of 145 ppm.

Two cannery wells (75 and 76) that obtain water from the Yorktown at Cheriton, near the town of Cape Charles, are 170 and 250 feet deep, respectively. Water samples from both were low in chloride (22 and 4 ppm, respectively). The nitrate content in water from well 75 is 5.3 ppm, pointing to the possibility of organic pollution. About 2 miles east of Cheriton, at Oyster, an old flowing well (83b), reported to be about 150 feet deep, yields a moderately hard calcium bicarbonate water which is only moderately mineralized. Dissolved solids are 177 ppm and the chloride concentration is 18 ppm.

Near the south end of the county, a 65-foot well (176) at Cape Charles Air Force Base, near Kiptopeke, yielded water with 24 ppm chloride. Other constituents are low. Water of similar quality is obtained from well 151, 91 feet deep, near Townsend, 3 miles north of Kiptopeke.

In summary, ground water from aquifers of Miocene age tapped by most wells in Northampton County are commonly high in bicarbonate, averaging about 165 ppm. Chloride is generally low, less than 25 parts in water from most wells, among wells tapping the St. Marys Formation. Most samples from Miocene wells are only moderately mineralized.

Water from at least one very deep well in the Miocene in Northampton County is rather highly mineralized.

Water from Pleistocene Deposits

In Northampton County, 35 shallow dug or driven wells tapping aquifers in the Pleistocene Columbia Group were sampled for chemical analysis. (See Table 8.) These wells range in depth from 12 to 82 feet and average about 30 feet in depth.

In the northern part of the county, wells 1, 21, 40, 42, and 48 yield water ranging in chloride from 21 to 79 ppm with hardness ranging from 42 to 165 ppm. Fluoride was not detected. Water from well 21 at Wardtown was found to have an unusually high nitrate content, 25 ppm, indicating that the well is probably polluted. All waters except that from well 16 were reported high in iron by the users. The moderately high chloride in these well waters and in well waters elsewhere in the county noted below is believed to be derived largely from contamination of the shallow ground-water body by infiltration of salt spray from the ocean during storms. (See discussion by Hem, 1959, p. 107-110.)

Well 46 near Nassawadox was jetted to 82 feet, and yields a hard calcium bicarbonate water with a chloride concentration of 24 ppm and a hardness of 140 ppm (Table 8).

At the north of Eastville, seven wells tapping the Columbia Group (50a, 52, 55, 57, 58, 60 and 66) were found to yield water having a chloride content ranging from 11 to 63 ppm. Fluoride in these waters averages less than 0.1 ppm. In two of these wells (55 and 60), determinations for nitrate and sulfate were made and found to be low. Hardness ranges from 24 ppm at well 60, in Kendall Grove, to 138 ppm at well 58 near Eastville, although the hardness for the other shallow well samples near Eastville (66) was only 60 ppm.

Iron is very high in some waters from Pleistocene aquifers. Water from wells 21 and 55 contain, respectively, 5.5 and 5.7 ppm.

High nitrate, 36 ppm, strongly indicating organic pollution, was found in the sample from a 22-foot driven well (70) 3 miles northeast of Cheriton. (See Table 8). Another driven well (82) yielding water with high nitrate, 37 ppm, is at Oyster; sulfate also is relatively high, with 46 ppm. Wells 97 and 111, near Seaview, yield water similar in quality, with moderately low hardness, and a chloride content of about 10 ppm. For one of these wells (111) sulfate and nitrate were determined and found to be 48 and 6 parts respectively. The high nitrate strongly suggests organic pollution. Bicarbonate in the sample from well 111 was very low, only 17 ppm. A 25-foot well near

Townsend (136) yields water with 96 ppm of hardness and 37 ppm of chloride. Fluoride was not detected.

The two irrigation ponds sampled were found to contain water of moderately low mineralization.

In summary, about one-third of the shallow wells in Northampton County, tapping deposits of the Pleistocene Columbia Group, are likely to yield water with more than 30 ppm of chloride which probably originates from infiltration of salt spray from the ocean blown inland during storms. In general, the chloride concentration cannot be predicted with any certainty before a well is constructed. Some waters are high in iron.

Locally, nitrate may be a problem, and unusually high concentrations were found in water from several wells tapping the Columbia Group.

SUMMARY OF GROUND-WATER RESOURCES

Ample supplies of ground water are available for the present and immediate future in Northampton County from properly constructed wells. A few wells ending in Miocene formations yield over 250 gpm and one well in the Pleistocene yields 200 gpm. For all ordinary uses the chemical quality of the water is generally excellent but hardness, iron and chloride are objectionably high in a few well waters. Water from wells deeper than about 300 feet may be excessively high in chloride. Drilling of test wells should be considered before large permanent wells are constructed.

WELL RECORDS AND CHEMICAL ANALYSES

Records of wells in Northampton County, available logs of wells, and chemical analyses of water samples are given in Tables 6, 7, and 8 on the pages that follow. For locations of wells listed in Tables 6 through 8 see the map of Northampton County, Plate 4.

TABLE 6.—Records of Wells in Northampton County, Virginia

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
1	0.3 mi. W of Concord Wharf	Joseph H. Mears	Herbert Senn	1940	7	Dv	17
2	0.1 mi. N of Exmore	Town of Exmore	Layne-Atlantic Co.	1950	38	D	270
3	Exmore	Roland Holeman	John Scott	1948	25	J	169
4	Exmore	Herbert Senn	John Scott	1948	25	J	164
5	Exmore	L. Robins	John Scott	1949	25	J	168
6	Exmore	V. Bayly	John Scott	1948	25	J	168
7	Exmore	John H. Dulany and Son, Inc.	Sydnor Pump & Well Co., Inc.	1947	25	D	230
8	Exmore	John H. Dulany and Son, Inc.	Shannahan Artesian Well Co., Inc.	1950	25	D	70
9	Exmore	John H. Dulany and Son, Inc.	Sydnor Pump & Well Co., Inc.	1942	25	D	295
10	Exmore	John H. Dulany and Son, Inc.	Shannahan Artesian Well Co., Inc.	.....	25	D	194
11	0.8 mi. W of Exmore	J. E. Turner Estate	Turner	1953	25	Dv	12–18
12	Exmore	Eastern Storage Corp.	.....	1900	25	J	200
13	Exmore	Coca Cola Bot. Co.	M. A. Pentz	1938	35	D	168
14	Exmore	Dr. Pepper Bot. Co.	M. A. Pentz	.....	35	D	175
17	Exmore	T. O. Twyford	John Scott	1948	25	J	168
18	Exmore	H. Flax & E. C. Long	John Scott	1948	25	J	169
19	Exmore	Mrs. Elvy Outten	W. Watson and John Scott	1948	25	J	164
20	Exmore	Harry Tatium	John Scott	1949	25	J	168
21	3 mi. W of Exmore, at Wardtown	Harry H. Sturgis	William Starchie	1948	23	Dv	22
22	1 mi. S of Exmore at Hadlock	P. C. Kellam	John Scott	1950	30	J	168
23	Willis Wharf	Ollie Robins	John Scott	1950	10	J	95
24	Willis Wharf	J. S. Robins	John Scott	1949	8	J	99
25	Willis Wharf	F. Calf	John Scott	1948	12	J	123
26	Willis Wharf	P. C. Killmon	John Scott	1949	9	J	87
28	Willis Wharf	Ballard Bros.	John Scott	1950	6	J	160
29	Willis Wharf	Ballard Bros.	Custis	1930	6	J	240
30	Willis Wharf	J. E. Crowder	John Scott	1950	10	J	95
31	Willis Wharf	Terry	.....	1946	2	.....	142
32	0.3 mi. S of Willis Wharf	Bruce Mears	Wm. J. Porter	1950	7	J	210
33	1.5 mi. S of Exmore	Tankard Nurseries	John Scott	1950	25	J	49

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
1½	Pleistocene	Columbia Group	(—)	.....	D	See analysis, Table 8. Temp., 66° F.	1
8	Miocene	Yorktown Fm	−34	310	PS	Screen, 160-190 ft. 13 ft. drawdown after pumping 310 gpm. Tested at 746 gpm with 37 ft. of drawdown.	2
3	Miocene	Yorktown Fm	−32	30	D	Pulled pump line in 1952 to remove stuck jet. Water from gravel.	3
3	Miocene	Yorktown Fm	−32	50	D	Reported soft. Two houses and one store use well. Water from coarse gravel.	4
2	Miocene	Yorktown Fm	−34	16+	D	4 ft. of drawdown after 4 hrs. pumping 16 gpm. Water from gravel.	5
2	Miocene	Yorktown Fm	−34	16½	D	Two houses use well. Water from gravel and shells.	6
6–4½	Miocene	Yorktown (?) Fm	.....	150	I	.....	7
16-10	Pleistocene (?)	Columbia (?) Gr.	.....	200	I	45 ft. of drawdown in 24 hrs. pumping 200 gpm. Gravel packed.	8
8	Miocene	St. Marys Fm	.....	275	Ab	See analysis, Table 8. Collected in 1945(?); well later abandoned (1952) because of increasing saline contamination.	9
16–8	Miocene	Yorktown Fm	−30	200	I	19 ft. of drawdown after 24 hrs. pumping at 200 gpm. Drilled to 230 ft.	10
1¼	Pleistocene	Columbia Group	(—)	.....	D	Water contains iron.	11
6	Miocene	Yorktown (?) Fm	(—)	100	I	See analysis, Table 8.	12
4	Miocene	Yorktown Fm	−22	45	I	See analysis, Table 8. Another similar well at this location.	13
4	Miocene	Yorktown Fm	−27	35	I	See analysis, Table 8. Casing set on "rock."	14
2	Miocene	Yorktown Fm	−34	15	D	Supplies 5 houses. Water from gravel.	17
2	Miocene	Yorktown Fm	−34	16+	D	Supplies 2 houses and motel. Water from gravel.	18
2	Miocene	Yorktown Fm	−34	16+	D	Supplies 2 houses. 4 ft. of drawdown after pumping 16 gpm.	19
2	Miocene	Yorktown Fm	−34	16+	D	Aquifer consists of 9 ft. of gravel.	20
1¼	Pleistocene	Columbia Group	−17	4	D	See analysis, Table 8. Temp., 64° F.	21
2	Miocene	Yorktown Fm	−34	11+	D, I	Reported soft.	22
2	Pleistocene (?)	Columbia (?) Gr.	−8	18½	D	Supplies two houses.	23
2	Pleistocene (?)	Columbia (?) Gr.	−26	14	D	Shallow well at this location failed. Water from sand.	24
2	Miocene	Yorktown Fm	−4	25	D	1 ft. of drawdown after 1 hr. pumping 25 gpm.	25
2	Pleistocene	Columbia Group	−5	15	D	Another similar well at this location 83 ft. deep. Very little drawdown. Water from coarse sand.	26
2	Miocene	Yorktown Fm	−23	13+	I	.....	28
2	Miocene	St. Marys Fm	.....	.....	I	See analysis, Table 8.	29
2	Pleistocene (?)	Columbia (?) Gr.	−6	25	D	Water from coarse sand and shells.	30
2½	Miocene	Yorktown Fm	flows	flows 28	I	Reported soft. Yields less at low tide.	31
2	Miocene	Yorktown Fm	−23	13+	D	.....	32
3	Pleistocene	Columbia Group	−12	25	I	Two other similar wells at this location, at depths of 51 ft. Water from gravel.	33

TABLE 6.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
34	0.5 mi. SW of Jamesville	W. L. Chandler	Fred Kellam	1953	20	J	82
36	2 mi. S of Exmore	School	John Scott	1951	25	J	78
37	1.5 mi. NE of Silver Beach		Wm. J. Porter	1951	20	J	85
38	1.5 mi. NE of Silver Beach	Siebam	Wm. J. Porter		20	J	60
39	2 mi. NW of Nassawadox	John S. Turner	John Scott	1947	30	J	90
40	2.5 mi. S of Exmore	James G. Scanlan		1941	12		21
41a	Silver Beach	B. M. Mears	John Scott	1949	8	J	185
41b	0.5 mi. S of Silver Beach	C. J. Prettyman	C. J. Prettyman	1954	8	Dv	40
42	0.3 mi. NE of Bayford	Alex G. Mitchell		1934	11	Dv	18
43	Bayford	Curtis Jones	John Scott	1949	7	J	200
44a	Nassawadox		John Scott	1951	30	J	265
44b	Nassawadox		Layne-Atlantic Co.	1952	30	D	304
45	Franktown	Dr. Wm. J. Sturgis	John Scott	1949	30	J	80
46	Nassawadox	Northampton Lbr.Co.		1946	30	J	82
47	1 mi. S of Franktown	T. K. Burton	John Scott	1949	9	J	100
48	1.5 mi. SW of Franktown	Elton E. Gunter	Herbert Senn	1939	20	Dv	12
49	2 mi. SSW of Nassawadox, near Kellam Field	C. Ward	John Scott	1949	30	J	128
50a	Bridgetown	Richard S. Floyd	Tiachara	1938	3	Dv	30
50b	Birdsnest	Kellam	Wm. J. Porter	1950	25	J	172
51	3 mi. SW of Bridgetown at Vaucluse.	V. E. Minich	Long	1937	8		98
52	1.5 mi. SE of Birdsnest	Elgenfritz Nursery Corp.			21	Dv	14
53	Machipongo	Sydnor Test Hole	Sydnor Pump & Well Co., Inc.	1953	25	D	210
54	Machipongo	School	Sydnor Pump & Well Co., Inc.	1953	25	D	365
55	Machipongo	School			25	J	23
56	Machipongo	W. R. Shannonhouse.	John Scott	1950	25	J	49
57	2.5 mi. W of Machipongo	Mrs. G. E. Coulbourn.	E. P. Dryden	1947	28	Dv	20
58	2 mi. NW of Eastville	Wm. T. Savage	George Bradford	1945	20	Dv	22
59	1.8 mi. NW of Eastville	J. E. Johnston	White Brothers		20	J	95
60	2.5 mi. ENE of Eastville, at Kendall Grove	Mrs. Serna Harmon		1944	19	Dv	30
61	0.8 mi. NE of Wilkins Beach	M. Acuff	Wm. J. Porter		2	J	134
62	0.8 mi. W. of Eastville	Ben Mears	John Scott	1952	10	J	153
63	Eastville	Town of Eastville	M. A. Pentz	1940	30	D	165
64	Eastville	Town of Eastville	M. A. Pentz	1952	30	D	138
65	Eastville	Town of Eastville	M. A. Pentz		30	D	111
66	0.5 mi. E. of Wilkins Beach	William Lawson		1947	30	Dv	14
67	Eastville	Ben Mears	John Scott	1951	30	J	189

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Miocene	Yorktown Fm	(—)	.....	D, S	Reported soft.	34
3	Pleistocene	Columbia Group	−12	37	PS	Reported soft.	36
2	Miocene	Yorktown Fm	−12	15	D	.....	37
2	Pleistocene (?)	Columbia (?) Gr.	−10	20	I	Five similar wells at this location.	38
1½	Miocene	Yorktown Fm	(—)	4	D, S	See analysis, Table 8. Temp., 67° F. Stains clothes.	39
1¼	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	40
2	Miocene	Yorktown Fm	−30	16+	D	Supplies 7 cabins. Water from medium sand.	41a
1½	Pleistocene	Columbia Group	(—)	.....	D	Reported soft.	41b
1¼	Pleistocene	Columbia Group	−15	3	D	See analysis, Table 8. Temp., 65° F.	42
2	Miocene	St. Marys Fm	−2	15	D	Reported saline. Pumps sand when heavily pumped. Water from fine dark gray sand.	43
3	Miocene	St. Marys Fm	−28	33+	.....	Test hole, not in use.	44a
18-6	Miocene	St. Marys Fm	−21	150	PS	See analysis, Table 8. Six screens between 160 ft. and 300 ft. Drilled to 321 ft.	44b
2	Pleistocene (?)	Columbia (?) Gr.	−8	16+	D	4 ft. of drawdown after 3 hrs. pumping 6 gpm	45
4	Pleistocene	Columbia Group	.....	.....	I	See analysis, Table 8. Water from sand and shells.	46
2	Miocene	Yorktown Fm	.....	15	D	Water from coarse sand.	47
1½	Pleistocene	Columbia Group	−7	4	D, S	See analysis, Table 8. Temp., 68° F.	48
2	Miocene	Yorktown Fm	−23	15	D	Seven ft. of drawdown after 5 hrs. pumping 15 gpm. Water from coarse sand.	49
1½	Pleistocene	Columbia Group	(—)	.....	D	See analysis, Table 8. Temp., 65° F.	50a
2	Miocene	Yorktown Fm	−22	9	D	Supplies 2 houses.	50b
1¼	Miocene	Yorktown Fm	(—)	5	D, S Irr	See analysis, Table 8. Temp., 61° F.	51
1½	Pleistocene	Columbia Group	.....	.....	D, I Irr	See analysis, Table 8.	52
.....	Miocene	Yorktown Fm	.....	.....	.....	Test hole for well 54.	53
6	Miocene	St. Marys Fm	−26	60	PS	Screen set at 210-220, 250-266, and 291-301 ft. Pump rod set at 195 ft.	54
1½	Pleistocene	Columbia Group	(—)	15	PS	See analysis, Table 8. Temp., 71° F.	55
2	Pleistocene	Columbia Group	−15	20	I	Two other similar wells at this location at depths of 46 and 48 ft.	56
1¼	Pleistocene	Columbia Group	(—)	2	D	See analysis, Table 8. Temp., 67° F.	57
1½	Pleistocene	Columbia Group	−14	.....	D, S	See analysis, Table 8. Temp., 69° F.	58
2	Miocene	Yorktown Fm	(—)	.....	D, S	See analysis, Table 8.	59
1½	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	60
1½	Miocene	Yorktown Fm	flows	2½	I	See analysis, Table 8. Temp., 58° F. Slight organic odor.	61
2	Miocene	Yorktown Fm	−13	15	D, S	Water from coarse sand.	62
6	Miocene	Yorktown Fm	−46	75	PS	See analysis, Table 8. Well is not in use; screen filling with sand.	63
4	Miocene	Yorktown Fm	−21	200	PS	Specific capacity, 2.5 gpm/ft. of drawdown.	64
6	Miocene	Yorktown Fm	−19	.....	PS	Specific capacity, 1.9 gpm/ft. of drawdown	65
1½	Pleistocene	Columbia Group	−4	.....	D	See analysis, Table 8. Temp., 75° F. Stains cooking utensils.	66
2	Miocene	Yorktown Fm	−23	14	D	Water from fine reddish sand.	67

TABLE 6.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
68	0.5 mi. S. of Eastville	Hoovermale	Wm. J. Porter		30	J	302
69	1.3 mi. S of Eastville	M. Moore			30	Dv	21
70	1.8 mi. NE of Cobbs	Mrs. H. C. Wise, Sr.		1948	20	Dv	22
71	0.1 mi. N of Cheriton	Geo. T. Turner III	John Scott	1949	25	J	296
72	Cheriton	C. L. Grayson Jones	John Scott	1948	30	J	80
73	Cheriton	F. Rolley	John Scott	1952	30	J	300
74	Cheriton	L. Keller		1948	19	Dv	13
75	Cheriton	G. L. Webster Can. Co.			20	D	170
76	Cheriton	G. L. Webster Can. Co.	Virginia Machinery & Well Co., Inc.	1946	20	D	271
77	Cheriton	Huff Brothers	Huff Brothers		20	Dv	63
78	Cheriton	Paul Watson	Wm. J. Porter	1949	20	J	302
79	Cheriton	Jones			20	J	299
80	Cheriton	C. Charnock		1951	20	J	299
81	Oyster	Roberts (?)			0	J(?)	182
82	0.3 mi. W of Oyster	William T. Taylor		1945	17	Dv	26
83a	Oyster	Granville McCready	Wm. J. Porter	1949	5	J	185
83b	Oyster				5		150(?)
84	Oyster	H. A. Smith	Tom Parks and Wm. J. Porter	1940	5	J	185
85	Oyster	B. L. Bell	Wm. J. Porter		5	J	165
86	Oyster	N. R. Steelman	John Scott	1946	5	J	185
87	N Bank, end of King Creek	Elmore Ballard	John Scott		7	J	185
88	0.5 mi. NE of Cape Charles	George Tinkham	John Scott		10	J	300
89	Cape Charles	Formerly N. Y., Philadelphia & Norfolk RR Co.	T. M. Ward	1900	8		90
90	Cape Charles	Formerly N. Y., Philadelphia & Norfolk RR Co.		1910	20	D	1,810
91	Cape Charles	Town of Cape Charles	Layne-Atlantic Co.	1927	25	D	195
92	Cape Charles	Town of Cape Charles	Layne-Atlantic Co.	1938	25	D	210
93	Cape Charles	Town of Cape Charles	Layne-Atlantic Co.	1927	25		175
94	Cape Charles	Town of Cape Charles		1927	25	J	80
95	0.5 mi. N of Seaview	B. B. Downing	John Scott	1949		J	105
96	0.3 mi. NE of Seaview	Otho Moore	John Scott	1949		J	105
97	0.3 mi. NE of Seaview	Mrs. J. W. Outten		1945	15	Dv	15
98	1.5 mi. W of Seaview, at Fairview	H. L. Gladden	H. L. Hart		19	Dv	25
99	1.5 mi. SE of Cape Charles on E bank of Old Plantation Creek	B. A. Travis	B. A. Travis	1951	5	Dv	34

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
2	Miocene	St. Marys Fm	−29	25	D	Drilled to 307 ft.	68
1¼	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	69
1¼	Pleistocene	Columbia Group	−18	.....	D	See analysis, Table 8.	70
2	Miocene	Yorktown Fm	−13	15	D	Supplies 3 houses. Water from fine light gray sand.	71
2	Miocene	Yorktown Fm	−8	16+	I	2 other similar wells at this location; total pumpage 16+ gpm.	72
2	Miocene	Yorktown Fm	−13	20	D	Water from fine sand and shells.	73
1¼	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	74
18-8	Miocene	Yorktown Fm	.....	.....	I	See analysis, Table 8.	75
.....	Miocene	Yorktown Fm	(—)	.....	I	.....	76
2	Pleistocene	Columbia Group	(—)	.....	D, S	From Bulletin 5, p. 245.	77
2	Miocene	Yorktown Fm	(—)	33	D	Reported soft.	78
2	Miocene	Yorktown Fm	(—)	21	D	Water from sand and shells.	79
2	Miocene	Yorktown Fm	−14	.....	D	Water from fine sand.	80
2	Miocene	Yorktown Fm	flows	4	Ab	See analysis, Table 8. Yields less at low tide. Well covered by high tide.	81
1½	Pleistocene	Columbia Group	−22	.....	D, S	See analysis, Table 8.	82
	Miocene	Yorktown Fm	flows	.....	I	See analysis, Table 8. Another similar well at this location, 183 ft. deep.	83a
1	Miocene	Yorktown Fm	flows	½	.....	See analysis, Table 8.	83b
2	Miocene	Yorktown Fm	flows	.....	I	See analysis, Table 8. Two other similar wells at this location, both 185 ft. Water from sand and shells.	84
2	Miocene	Yorktown Fm	(—)	.....	D	Reported hard.	85
2	Miocene	Yorktown Fm	flows	flows 7	I	See analysis, Table 8. Two other similar wells at this location, both 185 ft. One drilled by Porter. Water from sand and shells.	86
2	Miocene	Yorktown Fm	−18	15	D	Water from coarse sand.	87
2	Miocene	Yorktown Fm	−6	16+	D, I	Necessary to redrill to 300 ft., originally 80 ft. Water from shells.	88
3	Miocene	Yorktown Fm	−6	100	Ab	From Bulletin 5, Va. Geol. Survey, page 246.	89
.....	Cretaceous (?)	Potomac (?) Group	.....	.....	Ab	Test hole; never used.	90
.....	Miocene	Yorktown Fm	−20	300	PS	Well relined March 1940	91
M	Miocene	Yorktown Fm	−13	645	PS	Drawdown 65 ft. while pumping 645 gpm.	92
4	Miocene	Yorktown Fm	−20	147	Ab	Contains some salt. No odor. 110 ft. drawdown while pumping 147 gpm.	93
2	Miocene	Yorktown Fm	.....	.....	PS	12 80-ft. wells in use, 1952.	94
2	Miocene	Yorktown Fm	−12	20	D	Water from shell bed.	95
2	Miocene	Yorktown Fm	−13	18+	D	.....	96
1¼	Pleistocene	Columbia Group	−11	.....	D	See analysis, Table 8. Temp., 69° F.	97
1½	Pleistocene	Columbia Group	−21	.....	D, S	See analysis, Table 8. Temp., 65° F.	98
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft. Water from fine white sand.	99

TABLE 6.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
100	2 mi. SW of Seaview	W. J. Goffigon	W. J. Goffigon	1951	20	Dv	16
101	0.5 mi. S of Seaview	Ralph Long	John Scott	1949	20	J	99
102	0.5 mi. S of Seaview	Ralph Long	John Scott	1949	20	J	160
103	0 5 mi. S of Seaview	Ralph Long	John Scott	1948	20	J	105
104	0.5 mi. SSE of Seaview	Scott	Wm. J. Porter	1953	20	J	115
105	2.3 mi. NNW of Capeville	Frank D. Scott	Ashby	.....	20	Dv	27
106	2 mi. NNW of Capeville	Kemper Goffigon	.....	1952	20	J	140
107	1 8 mi. NNW of Capeville	Richard Brown	Z. Rea	1949	20	Dv	40
108	2 mi. NNW of Cheapside, near mouth of Old Plantation Creek	G. F. Parsons	Wm. J. Porter	1954	11	J	125
109	2 mi. NNW of Cheapside, near mouth of Old Plantation Creek	G. F. Parsons	Wm. J. Porter	1951	4	J	101
110	2 mi. NNW of Cheapside, near mouth of Old Plantation Creek	G. F. Parsons	Wm. J. Porter	1952	4	J	119
111	1 8 mi. NNE of Capeville	Mrs. L. D. Bull	John Wilson	1936	6	Dv	17
114	1.5 mi. NW of Capeville	G. E. Scott	.....	1946	20	Dv	27
115	1.3 mi. N of Cheapside	Roland Belote	Roland Belote	.....	20	Dv	20
116	1 mi. NNW of Capeville	A. H. Hunt	A. H. Hunt	1947	20	Dv	30
117	1 mi. N of Cheapside	Roland Belote	Roland Belote	1947	20	Dv	20
118	1.5 mi. NW of Capeville	Harvey Belote	Wm. J. Porter	1949	20	J	120
119	1 mi. NW of Capeville	Capeville Lumber Co.	Fred Kellam	1951	20	J	144
120	0 8 mi. N of Cheapside	Hume Dixon	.....	.....	20	Dv	30
123	0 8 mi. NW of Capeville	V. M. Martin	Lewis	1951	20	J	88
124	0.8 mi. WNW of Capeville	Mrs. Mary A. Rolley	John Scott	1952	20	J	134
125	0 8 mi. NNE of Cheapside	Wm. Parsons	Wm. J. Porter	1950	20	J	104
126	0.8 mi. NW of Capeville	Frank Parsons	John Scott	1951	20	J	100
127	0 3 mi. N of Capeville	H. Richardson	Wm. J. Porter	1952	20	J	101
128	0.1 mi. NW of Capeville	C. E. Culver & Sons	.....	.....	20	J	53
130	0.3 mi. SE of Capeville	Hume Dixon	Dixon	1950	20	Dv	30
131	0 8 mi. N of Townsend	M. G. Scott	Winder	1951	20	Dv	20
132	0.8 mi. N of Townsend	M. G. Scott	.....	1920	20	Dv	102
135	0.8 mi. SSW of Cheapside	L. T. Nottingham	Tom Parks	.....	20	J	75
136	1 mi. W of Townsend	Henry D. Warren	C. Charnark	1938	20	Dv	25
137	0.3 mi. W of Townsend	Mrs. D. K. Long	John Scott	1952	20	J	117
138	0.3 mi. W of Townsend	C. D. Whitehead	.....	.....	20	Dv	21
139	0.3 mi. W of Townsend	Mary D. Wilkins	John Scott	1952	20	J	112

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
1	Pleistocene	Columbia Group	.....	.....	D	Four similar wells on farm; two pumped as unit to supply house.	100
2	Miocene	Yorktown Fm	−13	15	D	3 ft. of drawdown after pumping 2 hours at 15 gpm.	101
2	Miocene	Yorktown Fm	−12	12+	Irr	Supplies pond.	102
2	Miocene	Yorktown Fm	.....	15	Irr	Supplies pond.	103
2	Miocene	Yorktown Fm	−12	40	D	Water from shells and sand.	104
1½	Pleistocene	Columbia Group	.....	.....	D	Necessary to redrive often.	105
2	Miocene	Yorktown Fm	−34(?)	6+	D,S	See analysis, Table 8. Water from sand.	106
1½	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	107
2	Miocene	Yorktown Fm	−½	6+	D	Same aquifer as 109-110. Chert (?) bed at 60 ft. Drilled to 135 ft.	108
2	Miocene	Yorktown Fm	flows	20	Irr	See analysis, Table 8. Supplies small irrigation pond. No screen; open end. Water from shell bed.	109
2	Miocene	Yorktown Fm	flows	.....	Irr	See analysis, Table 8. Supplies small irrigation pond. No screen; open end. Water from shell bed.	110
1½	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8. Temp., 67° F.	111
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft.	114
1½	Pleistocene	Columbia Group	−12	5	D	See analysis, Table 8.	115
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft.	116
1½	Pleistocene	Columbia Group	.....	.....	D	Reported hard.	117
2	Miocene	Yorktown Fm	.....	7	D	See analysis, Table 8. Shallow well at this location goes dry in summer. Water from sand.	118
2	Miocene	Yorktown Fm	−16	.....	D,I	See analysis, Table 8. Water from sand and shells.	119
1½	Pleistocene	Columbia Group	.....	.....	D,S	Reported soft.	120
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8.	123
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8. Water from shell bed.	124
1½	Miocene	Yorktown Fm	−18	.....	D	See analysis, Table 8. Water from black sand and fine shells.	125
2	Miocene	Yorktown Fm	−14	15	D	Water from shell bed.	126
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8.	127
2	Pleistocene	Columbia Group	−10	25	I	.....	128
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft. Necessary to redrive often.	130
1½	Pleistocene	Columbia Group	.....	.....	D	Reported hard.	131
1½	Miocene	Yorktown Fm	flowed	.....	Ab	Reported flowing in 1920. Well destroyed in 1930. Unusually deep for driven well.	132
2	Miocene	Yorktown (?) Fm	−31(?)	.....	D,S	See analysis, Table 8.	135
1¼	Pleistocene	Columbia Group	−22	.....	D,S	See analysis, Table 8.	136
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8. Replaces unsatisfactory shallow well. Water from sand and shells.	137
1½	Pleistocene	Columbia Group	−10	.....	D	Went dry in 1950. Reported hard. Water from sand.	138
2	Miocene	Yorktown Fm	−30	.....	D	See analysis, Table 8. Shallow well at this location abandoned because of abundant iron in water. Water from sand and shells.	139

TABLE 6.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
140	Townsend	Mrs. Parsons	Elliott		20	Dv	24
146	0.3 mi. S of Townsend	Mrs. Kenneth Pusey			20	Dv	46
150	0.5 mi. S of Townsend	Wm. Heath	John Scott	1950	20	J	90
151	1 mi. SE of Townsend	L. D. Bull	Wm. J. Porter	1948	6	J	91
153	0.5 mi. S of Townsend	C. Ward		1949	20	J	103
154	0.5 mi. SW of Townsend	U. S. Coast Guard	John Scott	1951	20	J	87
159	0.3 mi. ENE of Kiptopeke Beach	H. Kellam	Wm. J. Porter	1947	20	J	40
160	0.5 mi. ENE of Kiptopeke Beach	L. Mears	J. Mears	1952	20	Dv	22
161	0.5 mi. ENE of Kiptopeke Beach	Mrs. Whitehead		1948	20	Dv	12
163	0.3 mi. E of Kiptopeke Beach	Walter Parsons	Wm. J. Porter	1951	20	J	60
164	Kiptopeke Beach	Virginia Ferry Corp.	Layne-Atlantic Co.	1950	20	D	179
165	0.5 mi. SE of Kiptopeke Beach	J. B. Latimer		1949	25	J	93
166	0.8 mi. SE of Kiptopeke Beach	Mrs. J. H. Latimer		1951	25	J	55
167	1.5 mi. N of Kiptopeke	H. D. Spady	John Scott	1949	25	J	230
168	1.5 mi. N of Kiptopeke	Mrs. S. R. Bull			25	Dv	44
169	2 mi. NE of Kiptopeke	Charles R. Bull	Charles R. Bull	1946	20	J	154
170	0.8 mi. N of Kiptopeke	Lucy and Sally Dixon	John Scott	1949	20	J	227
171	0.5 mi. NNE of Kiptopeke	Hume Dixon		1944	20	J	48
172	0.8 mi. NE of Kiptopeke	W. W. and H. Dixon		1940	10	J	42
173	0.3 mi. E. of Kiptopeke	Lucy Dixon	John Scott	1949	20	J	73
174	0.3 mi. E of Kiptopeke	Lucy Dixon	S. U. Grinalds	1951	20	Dv	28
175	Cape Charles Air Force Base	U. S. Air Force	Layne-Atlantic Co.	1954	10	D	85
176	Cape Charles Air Force Base	U. S. Air Force	Layne-Atlantic Co.	1954	10	D	65
177	Cape Charles Air Force Base	U. S. Air Force	Layne-Atlantic Co.	1954	10	D	58
178	Cape Charles Air Force Base	U. S. Air Force		1944	10	D	74

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone: Geologic Age	Principal Water-Bearing Zone: Stratigraphic Unit or Named Aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
1¼	Pleistocene	Columbia Group	.....	.....	D	Bitter taste reported.	140
1¼	Pleistocene	Columbia Group	.....	.....	D	See analysis, Table 8.	146
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8. Water from shell bed.	150
2	Miocene	Yorktown Fm	almost flows	12	D, I	See analysis, Table 8. Another well at this location 96 ft. deep. Water from sand and shells 85-91 ft.	151
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8. Water from shell bed.	153
2	Miocene	Yorktown Fm	−10	.....	.....	See analysis, Table 8. Used for fire control.	154
1½	Pleistocene	Columbia Group	−37 (?)	.....	Irr	See analysis, Table 8. 3 other similar wells at this location supplying small irrigation pond. Water from white sand.	159
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft.	160
1½	Pleistocene	Columbia Group	.....	.....	D	Reported soft.	161
1½	Pleistocene	Columbia Group	.....	.....	D, S	See analysis, Table 8. Another well 40 ft. deep at this location.	163
18-6	Miocene	Yorktown Fm	−23	50	I, PS	Specific capacity, 2.9 gpm/ft. drawdown.	164
2	Miocene	Yorktown Fm	.....	.....	D, S	See analysis, Table 8. Water from gravel. Shallow well at this location contaminated with oil from fuel tank.	165
1½	Pleistocene	Columbia Group	.....	.....	D, S	See analysis, Table 8. Several old wells at this location at depths from 38 to 40 ft.	166
2	Miocene	Yorktown Fm	−23	10	D, S	See analysis, Table 8. Limited yield. Considerable difficulty encountered in drilling well.	167
2	Pleistocene	Columbia Group	.....	.....	D, S	Reported hard.	168
4	Miocene	Yorktown Fm	−7	25	D, S	See analysis, Table 8. 1½ ft. of drawdown after 8 hrs. pumping 25 gpm.	169
2	Miocene	Yorktown Fm	.....	.....	D	See analysis, Table 8. Shallow well water at this location was unsatisfactory because of abundant iron.	170
2	Pleistocene	Columbia Group	−20	.....	D, S	See analysis, Table 8. Well deepened in 1951 because it went dry.	171
2	Pleistocene	Columbia Group	−12	.....	D, S	See analysis, Table 8. Washed up shells from surface to 42 ft.	172
2	Miocene	Yorktown (?) Fm	.....	.....	D, S	See analysis, Table 8. Test hole drilled to 299 ft. No aquifer encountered after gravel and shells at 73 ft., however.	173
1¼?	Pleistocene	Columbia Group	−16	.....	D	The shallow aquifer in this location is fine white sand which fills the well screens in about one year.	174
.....	Miocene	Yorktown Fm	−7	27	D	14 ft. of drawdown while pumping 27 gpm. Station well 1.	175
.....	Miocene	Yorktown Fm	−8	40	D	See analysis, Table 8. 15-ft. drawdown while pumping 40 gpm. Station well 2.	176
.....	Pleistocene	Columbia Group	−8	35	D	24-ft. drawdown while pumping 35 gpm. Station well 3.	177
2	Miocene	Yorktown Fm	.....	.....	Ab	See analysis, Table 8. (This well no longer used.)	178

TABLE 6.—Continued

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

No.	LOCATION	Owner or Tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)
179	Cape Charles Air Force Base (GATR) site, 1.2 mi. ESE of Kiptopeke Beach, near Cedar Grove)	U. S. Air Force.....	.....	1960	9	D	60
180	Cobb Island.....	U. S. Coast-Guard...	.....	.....	9	D	1,001
USGS Test Hole 1	0.3 mi. S of Capeville at Capeville Elementary School	United States Geological Survey	Sydnor Pump & Well Co., Inc.	1953	20	D	165
USGS Test Hole 2	Machipongo High School.....	United States Geological Survey	Sydnor Pump & Well Co., Inc.	1953	25	D	65

Measurement: gpm, gallons per minute
Temp., temperature
Fm, formation

Diameter of well (inches)	Principal Water-Bearing Zone		Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	REMARKS	No.
	Geologic Age	Stratigraphic Unit or Named Aquifer					
4	.....	.....	−9	.....	D	Station well 4.	179
18-6	Eocene	Pamunkey (?) Group	flows	.....	Ab	Flows slightly during high tide. Well abandoned; water brackish.	180
3	.....	.....	−23	.....	Test hole	See log, Table 7. Drilled to 470 feet. Screened interval, 460-465 feet, produced ¼ gpm. Several good water-bearing zones of shallower depths were not tested	USGS Test Hole 1
3	.....	.....	−11	16	Test hole	See log, Table 7; analysis, Table 8 Drilled to 100 feet. Screened interval, 60-65 feet, produced 16 gpm.	USGS Test Hole 2

TABLE 7.—Logs of wells in Northampton County, Virginia

U. S. Geological Survey test hole 1, Capeville Elementary School, at Capeville
(Drilled by Sydnor Hydrodynamics, Inc.)
(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)
Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, reddish; traces of fine sand; silt; abundant clay	7	7
Sand, iron-stained, brown to white, coarse to medium, quartz; black sand from 35 to 53 feet; 18-inch to ¼-inch iron-stained quartz gravels throughout; water-bearing zone	46	53
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, medium-gray, sticky, silty; scattered shell fragments; rough limestone chips	9	62
Clay and shells, gray and white, silty; abundant mica; quartz pebbles from 70 to 90 feet; shark teeth	28	90
Shells, white, fragments; traces of clay and silt; hard chert chips from 110 to 130 feet; varicolored quartz pebbles from 115 to 125 feet; clear quartz pebbles from 125 to 130 feet; greenstone pebbles up to ⅛-inch in diameter, from 125 to 130 feet; water-bearing zone	40	130
Clay, gray-green, soft; very abundant shell fragments, interbedded (shells possibly 50%); sandy, hard clay bed from 137 to 138 feet; silty; iron stained quartz pebbles at 145 feet	30	160
Silt, gray-green, clayey; scattered shell fragments	10	170
Shells, white, broken; trace of clay and silt; quartz sand at 180 feet; water-bearing zone	35	205
Clay, gray-green, soft; very abundant shell fragments	10	215
Sand, gray, quartz, very silty; scattered shell fragments; scattered quartz pebbles; black sand; clay	25	240
Clay, dark-gray, heavy glauconitic; scattered quartz pebbles	7	247
Sand, black, fine; abundant shell fragments; clay; scattered quartz pebbles; possible water-bearing zone	45	292
Clay, gray-green, heavy; scattered shells; black sand; sand lens from 306-308 feet; 6-inch marl streak at 310 feet	18	310

TABLE 7 (Continued)

U. S. Geological Survey test hole 1—Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)—Continued		
St. Marys Formation:		
Sand, gray, quartz, fine; abundant clay; abundant shell fragments; marl streaks at 311 and 314 feet	15	325
Sand, dirty white, quartz, very fine, glauconitic; trace of clay; abundant shell fragments; possible water-bearing zone	25	350
Clay, gray-green, soft, very sandy; scattered shell fragments; wood chips; streak of marl at 376 feet; beds of very hard marl from 405-508 feet	75	425
Choptank Formation:		
Clay, gray-green, soft, very sandy; scattered shell fragments; wood chips; very hard marl from 435-439 feet	15	440
Chert, black, very hard	2	442
Sand, iron-stained, quartz, coarse; trace of clay; scattered shell frayments; possible water-bearing zone	22	464
Clay, dark-gray, heavy, silty; scattered shell fragments	6	470

Well (U.S.G.S. test hole 2); Machipongo; Machipongo High School
(Drilled by Sydnor Hydrodynamics, Inc.)
(Sample descriptions by G. Chase Tibbitts, Jr.; correlations by F. Stearns MacNeil)
Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, reddish; fine sand; clay; silt	6	6
Sand, white and iron-stained; quartz; fine to medium coarse; 1/16-inch diameter iron-stained gravels from 20 to 67 feet; accessory black chert fragments from 10 feet; appearance of glauconitic sand at 55 feet; very abundant gray silt from 60 to 67 feet; water-bearing zone	61	67
Clay, dark-gray, hard	½	67½
Sand, gray, fine, glauconitic; abundant silt	10½	78
Marl, green, hard	⅓	78⅓
Sand, light-gray, fine, glauconitic; abundant silt	4⅔	83
Clay, dark-gray, soft, sandy; silt; scattered small gravels; shell fragments from 90 feet; harder drilling from 90 feet	17	100

TABLE 7 (Continued)

Well 53, Machipongo; Machipongo High School (Sydnor test hole, 100 feet from U.S.G.S. test hole 2)

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions by G. Chase Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, reddish, fine, sandy	7	7
Sand, iron-stained, quartz, fine to coarse; streak of brown clay at 25 feet; streak of dark-gray clay at 56 feet, water-bearing zone	62	69
Clay, dark-gray; interbedded with coarse quartz sand streaks; black organic specks	11	80
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, dark-gray, solid; scattered shell fragments from 90 feet	50	130
Clay, gray, solid; interbedded coarse sand and shells	10	140
Shells, white, broken; traces of clay and fine sand; water-bearing zone	27	167
Clay, dark-gray, solid, silty, sandy; shell fragments	13	180
Yorktown(?) Formation:		
Clay, dark-gray, solid, silty, sandy; shell fragments; trace of hard chert gravels at 190 feet	20	200
Sand, gray, very fine, clayey; streaks of shell fragments	10	210

TABLE 8.—Chemical Analyses of Ground Waters from Wells in Northampton County, Virginia. (Parts per Million, Except Specific Conductance and pH.) [Analyses by U. S. Geological Survey]

WELL NUMBER	1	9	12	13	14	21
LOCATION	W of Concord Wharf	Exmore	Exmore	Exmore	Exmore	Wardtown
DEPTH (FEET)	17	295	200	168	175	22
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Miocene	Pleistocene
FORMATION OR GROUP	Columbia Group	St. Marys Formation	Yorktown (?) Formation	Yorktown Formation	Yorktown Formation	Columbia Group
DATE	Sept. 11, 1948		Sept. 1948			
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.36	.....	5.5
Calcium (Ca)	.....	81	.....	.....	.....	.....
Magnesium (Mg)	.....	112	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	.....	.....	.....	.....
Bicarbonate (HCO_3)	.....	268	.....	120	194	106
Sulfate (SO_4)	.....	16	.....	1	1	23
Chloride (Cl)	35	690	19	10	16	30
Fluoride (F)	.0	.....	.0	.....	.18	.0
Nitrate (NO_3)	.....	.....	.....	.6	1.7	25
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	165	193	141	81	135	42
pH	.....	.....	.....	.....	.....	.....
Specific conductance (micromhos at 25°C)	500	.....	355	.....	.....	355

TABLE 8.—Continued

WELL NUMBER	29	39	40	42	44b	46
LOCATION	Willis Wharf	NW of Nassawadox	S of Exmore	0.3 mi NE of Bayford NE of Nassawadox	Nassawadox	Nassawadox
DEPTH (FEET)	240	90	21	18	304	82
GEOLOGIC AGE	Miocene	Miocene	Pleistocene	Pleistocene	Miocene	Pleistocene
FORMATION OR GROUP	St. Marys Formation	Yorktown Formation	Columbia Geoup	Columbia Group	Yorktown and St. Marys Formations	Columbia Group
DATE	Sept. 13, 1948	Sept. 11, 1948	Sept. 13, 1948	Sept. 11, 1948	Apr. 15, 1955	Sept. 14, 1948
Silica (SiO_2)	.....	.....	.....	.....	17	19
Iron (Fe)	.....	.....	.....	.....	.0	1.1
Calcium (Ca)	.....	.....	.....	.....	28	53
Magnesium (Mg)	.....	.....	.....	.....	9.2	2.0
Sodium (Na)	.....	.....	.....	.....	16	13
Potassium (K)	.....	.....	.....	.....	2.5	
Carbonate (CO_3)	.....	.....	.....	.....	0	.....
Bicarbonate (HCO_3)	.....	.....	.....	.....	131	142
Sulfate (SO_4)	.....	.....	.....	.....	3.5	17
Chloride (Cl)	101	10	68	21	29	24
Fluoride (F)	.0	.0	.0	.0	.1	.0
Nitrate (NO_3)	.....	.....	.....	.....	2.0	.4
Dissolved solids	.....	.....	.....	.....	176	208
Hardness as $CaCO_3$	108	72	48	75	108	140
pH	.....	.....	.....	.....	8.0	7.9
Specific conductance (micromhos at 25°C)	666	187	668	287	316	297 (calc.)

TABLE 8.—Continued

WELL NUMBER	48	50a	51	52	55	57
LOCATION	SWof Franktown	Bridgetown	SW of Bridgetown	SE of Birdsnest	Machipongo	W of Machipongo
DEPTH (FEET)	12	30	98	14	23	20
GEOLOGIC AGE	Pleistocene	Pleistocene	Miocene	Pleistocene	Pleistocene	Pleistocene
FORMATION OR GROUP	Columbia Group	Columbia Group	Yorktown Formation	Columbia Group	Columbia Group	Columbia Group
DATE	Sept. 12, 1948	Sept. 11, 1948	Sept. 12, 1948	Sept. 14, 1948	Sept. 12, 1948	Sept. 12, 1948
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	1.8	.....	5.7	.....
Calcium (Ca)	.....	.....	.....	.....	.....	.....
Magnesium (Mg)	.....	.....	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	.....	.....	.....	.....
Bicarbonate (HCO_3)	.....	.....	194	.....	14	.....
Sulfate (SO_4)	.....	.....	6	.....	4	.....
Chloride (Cl)	79	11	205	17	63	28
Fluoride (F)	.0	.1	.5	.0	.1	.0
Nitrate (NO_3)	.....	.....	4.1	.....	.1	.....
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	108	69	69	81	30	.....
pH	.....	.....	.....	.....	.....	.....
Specific conductance (micromhos at 25°C)	465	129	1,020	236	141	390

TABLE 8.—Continued

WELL NUMBER	58	59	60	61	63	66
LOCATION	NW of Eastville	NW of Eastville	ENE of Eastville	NE of Wilkins Beach	Eastville	E of Wilkins Beach
DEPTH (FEET)	22	95	30	134	165	14
GEOLOGIC AGE	Pleistocene	Miocene	Pleistocene	Miocene	Miocene	Pleistocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group
DATE	Sept. 12, 1948	May 26, 1952	Sept. 14, 1948	May 26, 1954	Sept. 2, 1948	Sept. 12, 1948
Silica (SiO_2)	.....	.....	.....	46	39	.....
Iron (Fe)	.....	.....	.75	.23	.04	.....
Calcium (Ca)	.....	.....	.....	31	26	.....
Magnesium (Mg)	.....	.....	.....	3.4	3.7	.....
Sodium (Na)	.....	.....	.....	19	11	.....
Potassium (K)	.....	.....	.....	2.7		.....
Carbonate (CO_3)	.....	0	.....	.....	0	.....
Bicarbonate (HCO_3)	.....	54	38	131	96	.....
Sulfate (SO_4)	.....	.....	18	4.1	1.2	.....
Chloride (Cl)	21	8.8	15	20	17	49
Fluoride (F)	.0	.....	.0	.0	.1	.1
Nitrate (NO_3)	.....	.....	.1	1.0	.2	.....
Dissolved solids	.....	.....	.....	187	145	.....
Hardness as $CaCO_3$	138	44	24	91	80	60
pH	.....	7.5	.....	7.8	8.0	.....
Specific conductance (micromhos at 25°C)	431	138	122	266	207 (calc.)	.....

TABLE 8.—Continued

WELL NUMBER	69	70	74	75	76	81
LOCATION	S of Eastville	NE of Cobbs	Cheriton	Cheriton	Cheriton	Oyster
DEPTH (FEET)	21	22	13	170	271	182
GEOLOGIC AGE	Pleistocene	Pleistocene	Pleistocene	Miocene	Miocene	Miocene
FORMATION OR GROUP	Columbia Group	Columbia Group	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation
DATE	Sept. 1948	Sept. 14, 1948	Sept. 1948	Mar. 1946	July 1, 1946	Mar. 5, 1946
Silica (SiO_2)	.....	.....	.....	26	.....	32
Iron (Fe)	.....	.09	.....	.14	.11	.04
Calcium (Ca)	.....	.....	.....	33	.....	29
Magnesium (Mg)	.....	.....	.....	5.6	.....	10
Sodium (Na)	.....	.....	.....	12	.....	16
Potassium (K)	.....	.....	.....		.....	
Carbonate (CO_3)	.....	.....	.....	0	9	0
Bicarbonate (HCO_3)	.....	20	00	81	381	144
Sulfate (SO_4)	.....	13	.....	29	1.0	.8
Chloride (Cl)	15	16	24	22	4.0	18
Fluoride (F)	.0	.0	.0	.1	.....	.2
Nitrate (NO_3)	.....	36	.....	5.3	.1	.6
Dissolved solids	.....	.....	.....	182	.....	177
Hardness as $CaCO_3$	51	54	108	105	24	113
pH	.....	.....	.....	7.5	8.9	7.3
Specific conductance (micromhos at 25°C)	147	227	381	260 (calc.)	.....	253 (calc.)

TABLE 8.—Continued

WELL NUMBER	82	83a	84	86	97	98
LOCATION	W of Oyster	Oyster	Oyster	Oyster	NW of Seaview	W of Seaview
DEPTH (FEET)	26	185	185	185	15	25
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Pleistocene	Pleistocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group
DATE	Sept. 14, 1948	Dec. 16, 1952	Dec. 16, 1952	Dec. 16, 1952	Sept. 13, 1948	Sept. 13, 1948
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	0.26	.....	.....	.....	.....	.....
Calcium (Ca)	.....	.....	.....	.....	.....	.....
Magnesium (Mg)	.....	.....	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	.....	.....	.....	.....
Bicarbonate (HCO_3)	28	157	150	157	.....	.....
Sulfate (SO_4)	46	1	1	1	.....	.....
Chloride (Cl)	10	20	24	20	9	12
Fluoride (F)	.1	.3	0.4	.3	.0	.0
Nitrate (NO_3)	37	.....	.....	.....	.....	.....
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	72	126	120	126	60	72
pH	.....	.....	7.7	7.8	.....	.....
Specific conductance (micromhos at 25°C)	230	302	311	302	154	211

TABLE 8.—Continued

WELL NUMBER	106	107	108	109	111	115	118
LOCATION	NNW of Capeville	NNW of Capeville	NNW of Cheapside	NNW of Cheapside	NNE of Capeville	N of Cheapside	NW of Capeville
DEPTH (FEET)	140	40	125	101	17	20	120
GEOLOGIC AGE	Miocene	Pleistocene	Miocene	Miocene	Pleistocene	Pleistocene	Miocene
FORMATION OR GROUP	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group	Yorktown Formation
DATE	Oct. 22, 1952	Oct. 22, 1952	Sept. 5, 1952	Sept. 5, 1952	Sept. 13, 1948	Oct. 18, 1952	Oct. 18, 1952
Silica (SiO_2)	.....	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	0	.79	.....	.....
Calcium (Ca)	.....	.....	.....	.....	.....	2	.....
Magnesium (Mg)	.....	.....	.....	.....	.....	12	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	0	.....	.....	.....	.....
Bicarbonate (HCO_3)	83	13	107	104	17	29	72
Sulfate (SO_4)	24	110	12	20	48	140	52
Chloride (Cl)	8.2	58	13	13	10	30	17
Fluoride (F)	.1	.2	.2	.2	.1	.1	.3
Nitrate (NO_3)	.....	.....	.....	.....	6	.....	.....
Dissolved solids	.....	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	78	184	99	98	57	79	93
pH	7.5	6.5	7.6	7.7	.....	6.3	7.8
Specific conductance (micromhos at 25°C)	191	417	223	221	197	248	225

TABLE 8.—Continued

WELL NUMBER	119	123	124	125	127	135
LOCATION	NW of Capeville	NW of Capeville	WNW of Capeville	NNE of Cheapside	N of Capeville	SSW of Cheapside
DEPTH (FEET)	144	88	134	104	101	75
GEOLOGIC AGE	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene (?)
FORMATION OR GROUP	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation
DATE	Oct. 19, 1952	Oct. 19, 1952	Sept. 10, 1952	Sept. 10, 1952	Sept. 10, 1952	Sept. 11, 1952
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.....	.....	.....
Calcium (Ca)	42	.....	.....	.....	.....	.....
Magnesium (Mg)	9.2	.....	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	.....	.....	.....	.....
Bicarbonate HCO_3)	118	61	84	90	121	92
Sulfate (SO_4)	48	23	52	50	20	23
Chloride (Cl)	32	7.2	9.2	12	10	12
Fluoride (F)	0.2	0.1	0.2	.3	.2	.2
Nitrate (NO_3)	.....	.....	.....	.....	.....	.....
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	143	88	91	93	98	86
pH	7.6	7.6	7.7	7.7	7.9	7.8
Specific conductance (micromhos at 25°C)	360	245	210	214	231	209

TABLE 8.—Continued

WELL NUMBER	136	137	139	146	150	151
LOCATION	W of Townsend	W of Townsend	E of Townsend	S of Townsend	S of Townsend	SE of Townsend
DEPTH (FEET)	25	117	112	46	90	91
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Pleistocene	Miocene	Miocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation
DATE	Sept. 13, 1948	Sept. 6, 1952	Sept. 6, 1952	Sept. 4, 1952	Aug. 16, 1952	Sept. 13, 1948
Silica (SiO_2)	.....	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.....	.....	.....
Calcium (Ca)	.....	.....	.....	25	.....	.....
Magnesium (Mg)	.....	.....	.....	7.6	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	.....	.....	.....	.....
Bicarbonate (HCO_3)	.....	92	78	29	112	84
Sulfate (SO_4)	.....	13	65	23	13	22
Chloride (Cl)	37	29	20	44	19	13
Fluoride (F)	.0	0.2	.2	.2	.2	.2
Nitrate (NO_3)	.....	.....	.....	.....	.....	.....
Dissolved solids	.....	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	96	107	112	94	124	93
pH	.....	7.9	7.6	6.8	7.6	7.7
Specific conductance (micromhos at 25°C)	390	261	256	344	288	205

TABLE 8.—Continued

WELL NUMBER	153	154	159	163	165
LOCATION	S of Townsend	SW of Townsend	ENE of Kiptopeke Beach	E of Kiptopeke Beach	SE of Kiptopeke Beach
DEPTH (FEET)	103	87	40	60	93
GEOLOGIC AGE	Miocene	Miocene	Pleistocene	Pleistocene	Miocene
FORMATION OR GROUP	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group	Yorktown Formation
DATE	Sept. 4, 1952	Sept. 4, 1952	Sept. 11, 1952	Aug. 14, 1952	Aug. 14, 1952
Silica (SiO_2)	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.....	.....
Calcium (Ca)	.....	.....	.....	.....	.....
Magnesium (Mg)	.....	.....	.....	.....	.....
Sodium (Na)	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	.....	0	.....	.....
Bicarbonate (HCO_3)	99	81	26	106	99
Sulfate (SO_4)	7	24	46	110	23
Chloride (Cl)	16	22	24	29	26
Fluoride (F)	.2	.2	.2	.3	.2
Nitrate (NO_3)	.....	.....	.....	.....	.....
Dissolved solids	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	89	102	47	162	128
pH	7.8	7.5	6.8	7.5	7.4
Specific conductance (micromhos at 25°C)	211	242	188	426	335

TABLE 8.—Continued

WELL NUMBER	166	167	169	170	171
LOCATION	SE of Kiptopeke Beach	N of Kiptopeke	NE of Kiptopeke	N of Kiptopeke	NNE of Kiptopeke
DEPTH (FEET)	55	230	154	227	48
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Pleistocene
FORMATION OR GROUP	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Columbia Group
DATE	Aug. 12, 1952	Aug. 14, 1952	Aug. 12, 1952	Aug. 12, 1952	Aug. 12, 1952
Silica (SiO_2)	.....	.....	.....	.....	.....
Iron (Fe)	.....	.....	.....	.....	.....
Calcium (Ca)	47	.....	.....	.....	28
Magnesium (Mg)	15	.....	.....	.....	5.4
Sodium (Na)	.....	.....	.....	.....	.....
Potassium (K)	.....	.....	.....	.....	.....
Carbonate (CO_3)	.....	0	.....	.....	.....
Bicarbonate (HCO_3)	79	121	121	113	89
Sulfate (SO_4)	110	5	5	5	8
Chloride (Cl)	40	15	15	13	51
Fluoride (F)	.3	.4	.4	.4	.2
Nitrate (NO_3)	.....	.....	.....	.....	.....
Dissolved solids	.....	.....	.....	.....	.....
Hardness as $CaCO_3$	179	98	98	87	92
pH	7.2	7.7	7.8	7.6	7.3
Specific conductance (micromhos at 25°C)	456	243	253	243	324

TABLE 8.—Continued

WELL NUMBER	172	173	176	178	USGS Test Hole No. 2
LOCATION	NE of Kiptopeke	E of Kiptopeke	Cape Charles Air Force Station	Cape Charles Air Force Station	Machipongo
DEPTH (FEET)	42	73	65	74	65
GEOLOGIC AGE	Pleistocene	Miocene	Miocene	Miocene	Pleistocene
FORMATION OR GROUP	Columbia Group	Yorktown (?) Formation	Yorktown Formation	Yorktown Formation	Columbia Group
DATE	Aug. 12, 1952	Aug. 12, 1952	May 6, 1942	Sept. 27, 1955	May 25, 1954
Silica (SiO_2)	.....	.....	.....	18	19
Iron (Fe)	.....	.....	.5	.0	.06
Calcium (Ca)	38	.....	.....	41	9.9
Magnesium (Mg)	10	.....	.....	7.0	5.1
Sodium (Na)	.....	.....	.....	28	18
Potassium (K)	.....	.....	.....	2.1	1.6
Carbonate (CO_3)	.....	.....	.....	0	.....
Bicarbonate (HCO_3)	26	72	98	120	6
Sulfate (SO_4)	130	21	3	24	41
Chloride (Cl)	32	12	24	54	27
Fluoride (F)	.3	.3	.....	.0	.0
Nitrate (NO_3)	.....	.....	.4	.2	.1
Dissolved solids	.....	.....	.....	230	131
Hardness as CaCO	136	74	84	131	46
pH	6.6	7.5	.....	7.9	5.7
Specific conductance (micromhos at 25°C)	370	190	.....	402	201

REFERENCES

Cederstrom, D. J., 1945a, Geology and ground-water resources of the Coastal Plain in southeastern Virginia: Virginia Geol. Survey Bull. 63, 384 p.

_____ 1945b, Selected well logs in the Virginia Coastal Plain north of James River: Virginia Geol. Survey Circ. 3, 82 p.

_____1946a, Genesis of ground waters in the Coastal Plain of Virginia: Econ. Geology, v. 41, no. 3, p. 218-245.

_____ 1946b, Chemical character of ground water in the Coastal Plain of Virginia: Virginia Geol. Survey Bull. 68, 62 p.

Clark, W. B., and Miller, B. L., 1912, The physiography and geology of the Coastal Plain province of Virginia: Virginia Geol. Survey Bull. 4, 274 p.

Ewing, W. M., Crary, A. P., Rutherford, H. M., and Miller, B. L. 1937, Geophysical investigations in the emerged and submerged Atlantic Coastal Plain: Geol. Soc. America Bull., v. 48, no. 6, p. 753-812.

Gardner, Julia A., 1948, Megafossils from a well at Cheriton, Northampton County, Va.: U. S. Geol. Survey manuscript report.

Hem, J. D., 1959, Study and interpretation of the chemical characteristics of natural water: U. S. Geol. Survey Water-Supply Paper 1473, 269 p.

Malkin, Doris S., 1947, Sample descriptions and correlation of material from the Bradshaw well, Smith Island, Somerset County, Md.: Memorandum report, Shell Oil Co., Inc., 2 p. Unpublished.

McLean, J. D., Jr., 1950, Stratigraphic study of well at Crisfield, Somerset County, Maryland: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 1, p. 133-138.

Rasmussen, W. C., and Slaughter, T. H., 1955, Ground-water resources of Somerset, Wicomico, and Worcester Counties, Maryland: Maryland Dept. Geology, Mines, and Water Resources Bull. 16, 170 p.

Richards, H. G., 1948, Studies on the subsurface geology and paleontology of the Atlantic Coastal Plain: Acad. Nat. Sci. Philadelphia Proc., v. 100, p. 39-76.

Sanford, Samuel, 1913, The underground-water resources of the Coastal Plain province of Virginia: Virginia Geol. Survey Bull. 5, 361 p.

Sinnott, Allen, 1955, Heavy-mineral correlation in Coastal Plain sediments (abs.): Virginia Jour. Sci., v. 6, no. 4, p. 288.

Sinnott, Allen, and Tibbitts, G. C., Jr., 1954, Summary of geology and ground-water resources of the Eastern Shore peninsula, Virginia: Virginia Div. Geology, Min. Resources Circ. 2, 18 p.

———— 1955, Records of selected wells on the Eastern Shore peninsula, Virginia: Virginia Div. Geology, Min. Resources Circ. 3, 39 p.

———— 1957, Subsurface correlations based on selected well logs from the Eastern Shore peninsula, Virginia: Virginia Div. Min. Resources, Min. Resources Circ. 6, 11 p.

———— 1961, Pleistocene terraces on the Eastern Shore peninsula, Virginia: U. S. Geol. Survey Prof. Paper 424-D, art. 381, p. D248-D250.

Sohn, I. G., 1954, Ostracodes from rotary drill cuttings from test holes on the Eastern Shore peninsula, Virginia: U. S. Geol. Survey manuscript report, open file.

Spangler, W. B., and Peterson, J. J., 1950, Geology of Atlantic Coastal Plain in New Jersey, Delaware, Maryland, and Virginia: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 1, p. 1-99.

Todd, Ruth, 1954, Smaller Foraminifera from rotary drill cuttings from test holes on the Eastern Shore peninsula, Virginia: U. S. Geol. Survey manuscript report.

U. S. Public Health Service, 1962, Drinking water standards: Public Health Service Pub. No. 956, 61 p.

Virginia Division of Planning, 1965a, Economic Data Summary, Accomack County: Richmond, Va., 20 p.

Virginia Division of Planning, 1965b, Economic Data Summary, Northampton County: Richmond, Va., 18 p.

Wentworth, C. K., 1930, Sand and gravel resources of the Coastal Plain of Virginia: Virginia Geol. Survey Bull. 32, 146 p.

INDEX

PAGE

Accomac 26, 28
Accomack County 13, 14
Aquia Formation 51

Basement complex 15, 70
Bayford 78
Belle Haven 27
Bloxem 28

Calvert Formation 21, 25, 50, 52, 72, 74
Cape Charles 71, 72, 74, 75, 79
Capeville 72, 94
Carolina bays 15, 69
Cheriton 8, 72, 75, 79
Chesapeake Group 16, 49, 71
Chickahominy Formation 16, 52, 71
Chincoteague 23, 27, 77
Choptank Formation 16, 18, 21, 25, 47, 49, 50, 51, 72, 74, 95
Cobbs Island 72, 74
Columbia Group 19, 21, 22, 23, 27, 28, 46, 47, 48, 51, 73, 76, 80
81, 94, 95, 96
Craddockville 27
Cretaceous deposits 15, 19, 70, 77
Crisfield, Md. 8, 15, 16, 19, 51
Cross-bedding 73

Delmarva Peninsula 2

Eastern Shore peninsula 2, 3, 6
Eastville 75, 79, 80
Eocene deposits 15, 16, 21, 24, 71, 77
Exmore 72, 75, 78

Flowing wells 22
Foraminifera 8
Franklin City 26

Greenbackville 27
Greenbush 48

Hallwood 27
Harborton 18

PAGE

Heavy minerals 19
High-chloride ground water 77
Hopeton 28
Hungars Creek 79

Machipongo 72, 95
Mappsville 27
Mathews 15
Mattaponi Formation 21, 24, 71
Megafossils 72
Microfauna 7
Miocene deposits 16, 21, 71, 74, 78

Nanjemoy Formation 50
Nassawadox 78, 79, 80
New Church 26
Northampton County 68

Oak Hall 47
Onancock 18, 22, 23, 25, 26
Ostracodes 8
Oyster 79, 80

Painter 46
Paleocene deposits 15, 19, 52, 70, 77
Parksley 23
Pleistocene deposits 18, 19, 22, 27, 73, 76, 80
Potomac Group 71
Princess Anne terrace 70
Pungoteague 19, 26, 27

St. Marys Formation 18, 19, 21, 22, 25, 46, 47, 48, 49, 51, 72, 74, 78, 95
Sand dunes 69
Scarps 69
Seaview 80
Smith Island, Md. 8, 15, 16, 21, 49

Tangier Island 15, 21, 24
Tidal loading 22
Townsend 81

PAGE

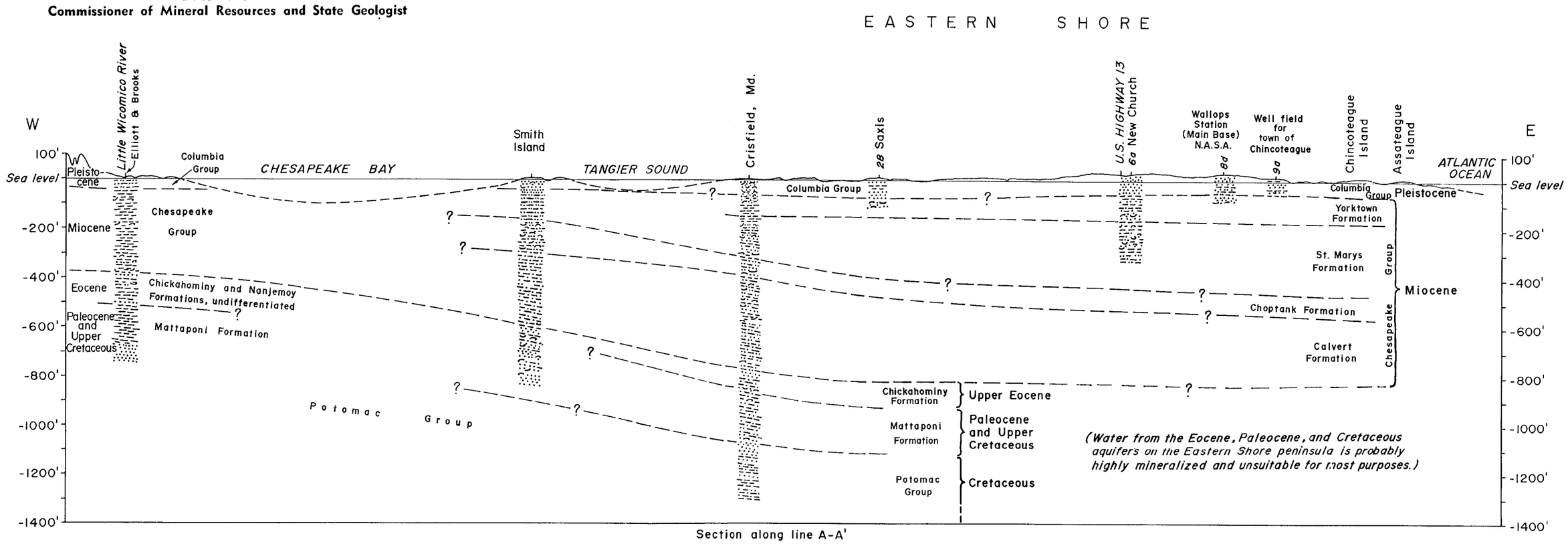
Wachapreague 22
Wallops Island 18, 22, 26
Well construction 8-13

cable-tool 11, 12
driven 9
dug 8
jetted 10, 11
rotary 12, 13

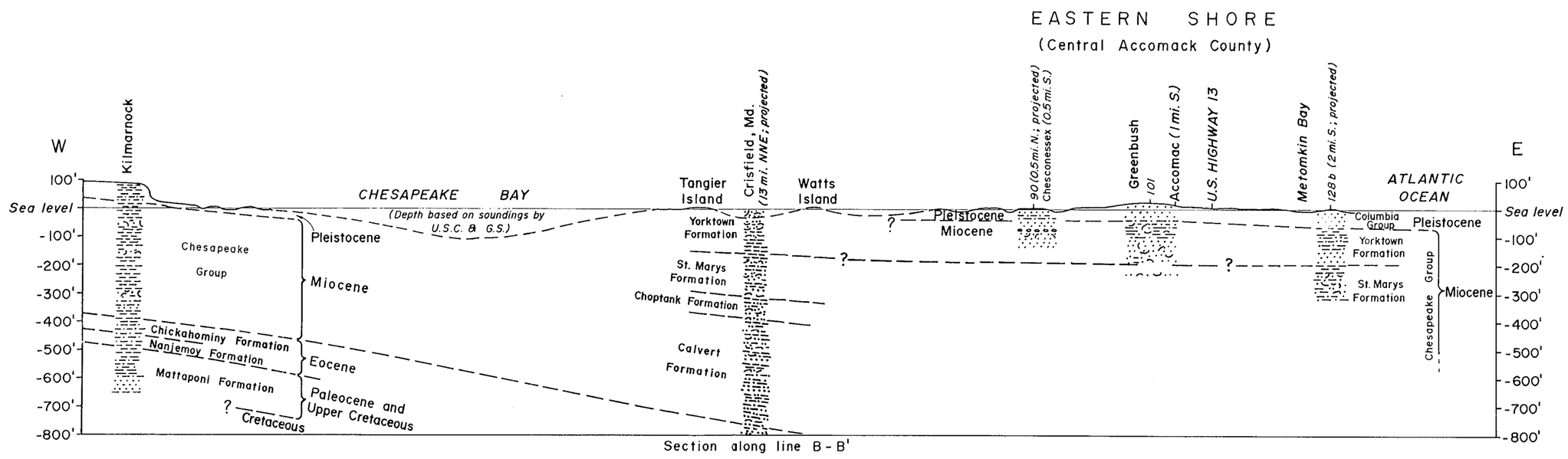
Willis Wharf 75, 78

Yorktown Formation 18, 19, 22, 25, 46, 48, 49, 51, 71, 72, 74, 78, 94, 96

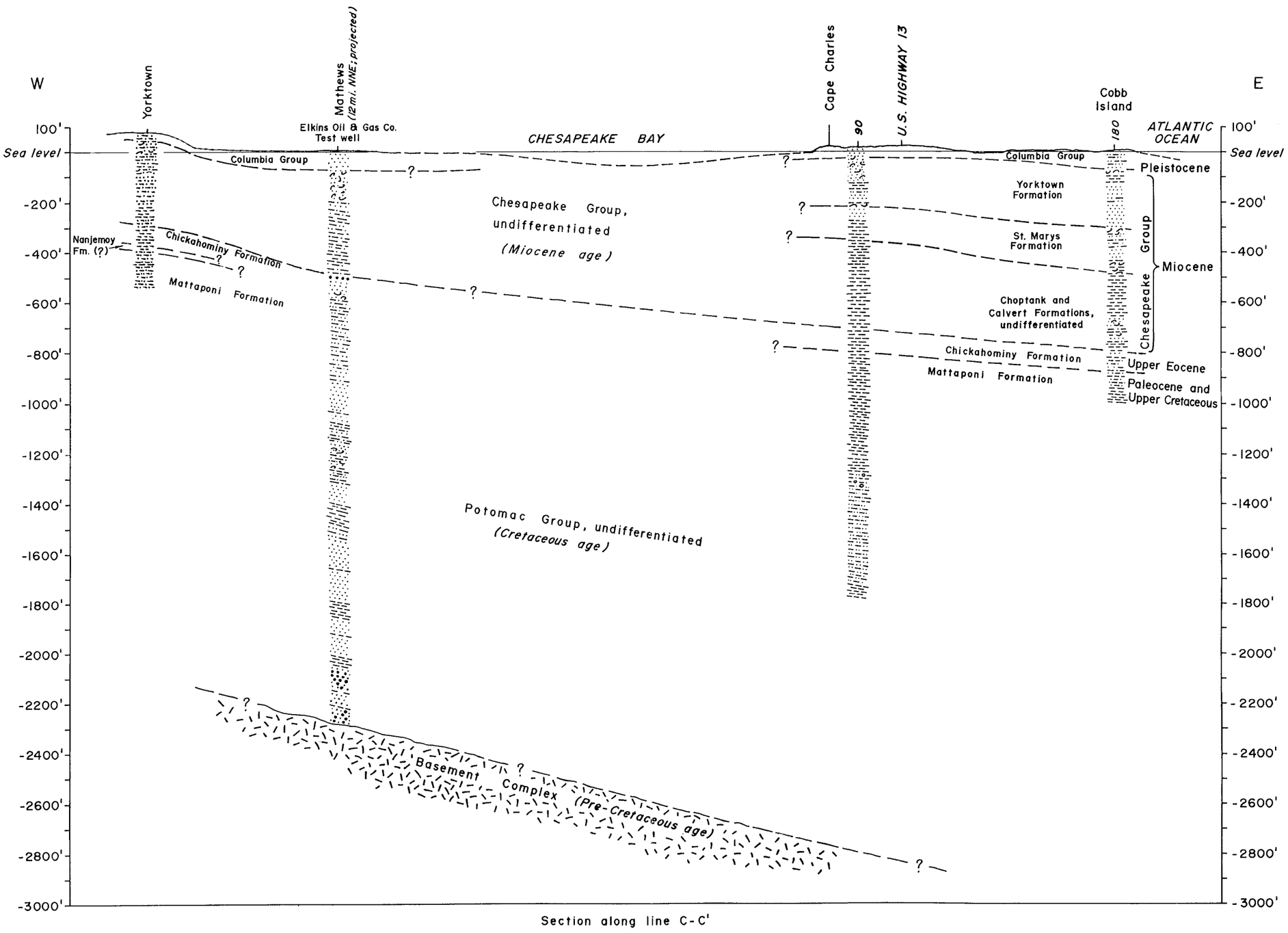
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist



Section along line A-A'



Section along line B-B'



Section along line C-C'

EXPLANATION

Clay
Sand
Silty Clay
Gravel
Sandy Clay
Fossil shells

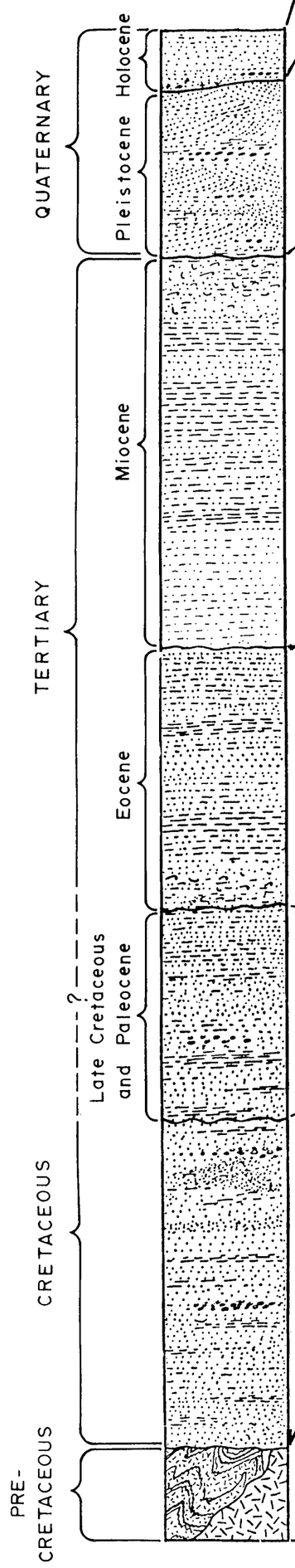
Scale ratio, vertical to horizontal, 53:1

0 1 2 3 4 5 MILES

GEOLOGIC SECTIONS ACROSS THE EASTERN SHORE PENINSULA

(For locations, see Figure 1 in text)

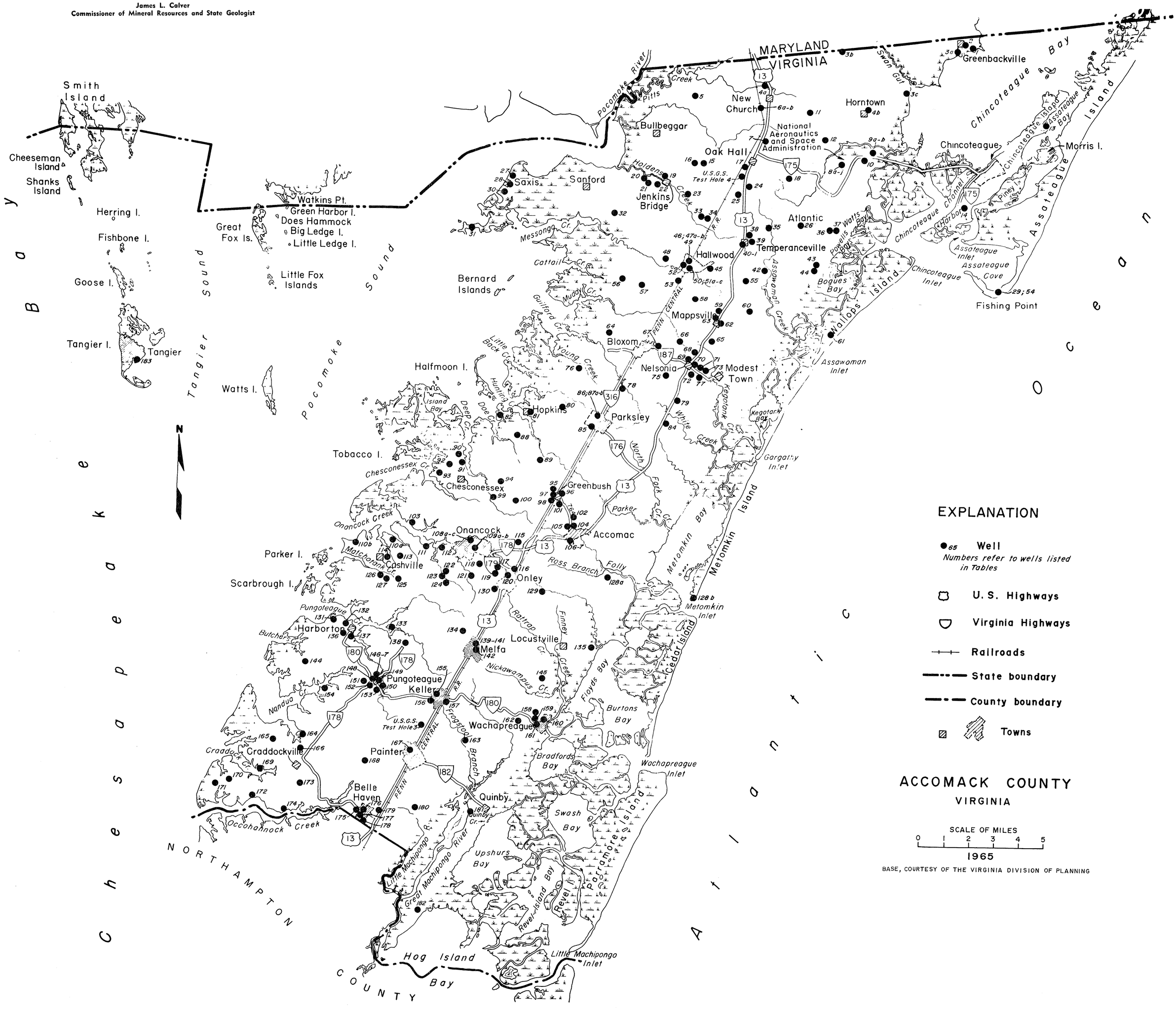
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist



Formations and lithology	Origin	Distribution	Water-bearing character
Unnamed silts, sands and gravels.	Wind deposits; beach, littoral, and shallow marine deposits; minor stream deposits.	Dunes; beaches, bars, and spits; deposits in creek beds.	In limited areas, and in favorable topographic situations, beach and bar deposits may yield small quantities of ground water of fair quality.
The Columbia Group consists largely of unconsolidated yellowish cross-bedded clayey sands and gravels. In places, may reach about 100 feet in thickness. The formations have not been differentiated in this report.	Marine and estuarine shallow water deposits.	Underlies entire area; exposed at the surface everywhere except where covered by dunes, beach deposits, or other deposits of Recent age.	Supplies small quantities of ground water to many shallow dug and driven wells throughout area. Quality good, but locally high in iron. At least one municipality (Chincoteague) obtains practically its entire water supply from these deposits.
The Chesapeake Group consists of sands, clays, and marls. Shells are abundant in the Yorktown Formation, the youngest of the Group; the St. Marys Formation is largely gray and dark blue clay; the Choptank Formation is green and dark gray sandy clay, with quartz sand and chert; basal Calvert Formation is chiefly light-colored and characteristically contains much diatomaceous earth. The Chesapeake Group is probably on the order of 500-800 feet thick in the area.	Formed by marine deposition. Seas submerged entire area of the present Coastal Plain, and in places may have extended a few miles west of the present Fall Zone.	The Group underlies entire Eastern Shore peninsula. Not exposed at the surface.	Tapped for ground water by nearly all of the deep wells in the area. Generally not tapped below about 300 feet, however, owing to high chloride content of deeper beds. Most of the wells probably tap the Yorktown and St. Marys Formations.
The Eocene formations consist of sands and clays of the Chickahominy Formation of Late Eocene age, possibly underlain by as much as 20 feet of beds of the Nanjemoy Formation of middle and early Eocene age.	Deposited in marine waters.	These formations underlie the entire Eastern Shore peninsula. Not exposed at the surface. Known only from logs of wells at Crisfield, Md., Cape Charles, and on Cobb Island.	Although important sources of water on the Virginia mainland, these formations have been reached by very few wells on the Eastern Shore peninsula. Water from deep wells on Tangier Island is somewhat mineralized.
The Mattaponi Formation, of Paleocene and Late Cretaceous age, is represented by clays and minor fine sands. At Cape Charles, this formation may be as much as 500 feet thick.	Deposited under shallow-water marine and estuarine conditions.		Water from the well on Cobb Island is reported brackish.
The Potomac Group consists of sands, clays, and minor gravel lenses. Not differentiated into formations in this report. May exceed 1,500 feet in thickness.	Deposited by streams, chiefly as deltaic deposits; contains plant fossils.	Underlies entire area. Not exposed at the surface.	Tapped by wells in Crisfield, Md., near the Maryland-Virginia State line. Also, reached, but not tapped for water, in an early test hole at Cape Charles. Ground water is likely to be high in fluoride and chloride.
Crystalline basement rocks, including metamorphic rocks and igneous bodies, in places cut by later igneous intrusives. Probably lies at depths ranging from 7,000 feet or more near the Maryland-Virginia State line to about 3,000 feet at the south end of the peninsula.	Meta-sediments, including schists and gneisses; igneous intrusives.	Underlie entire area. Not exposed at the surface.	Not practicable as sources of ground water.

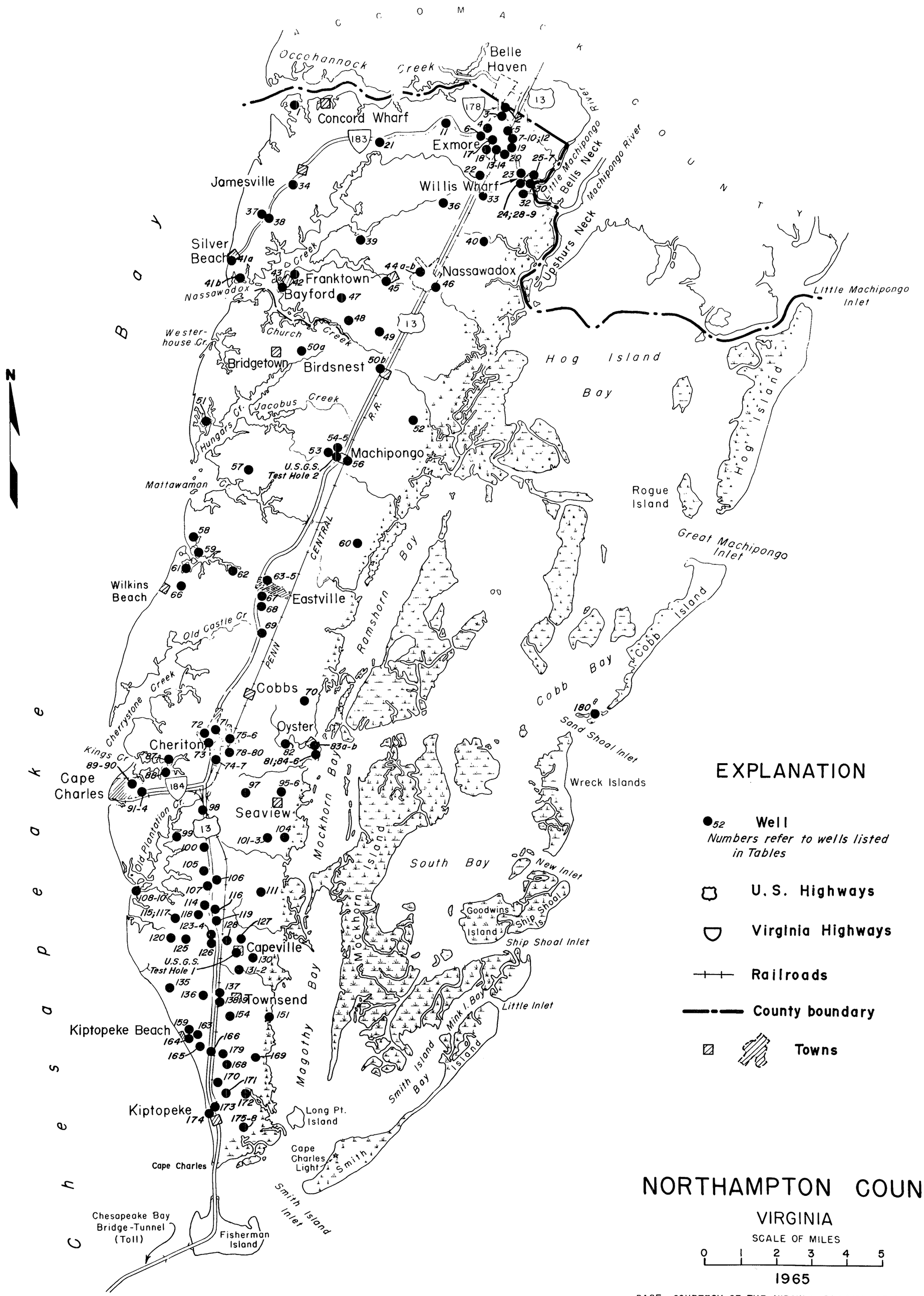
DIAGRAMMATIC COLUMNAR SECTION, AND TABLE DESCRIBING THE PRINCIPAL GEOLOGIC FORMATIONS OF THE EASTERN SHORE PENINSULA OF VIRGINIA

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist



COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist



NORTHAMPTON COUNTY

VIRGINIA

SCALE OF MILES

0 1 2 3 4 5

1965

BASE, COURTESY OF THE VIRGINIA DIVISION OF PLANNING