SUMMARY OF GEOLOGY AND GROUND-WATER CONDITIONS IN THE FREDERICKSBURG DISTRICT, EASTERN SPOTSYLVANIA COUNTY, VIRGINIA

A Preliminary Report

SEYMOUR SUBITZKY

MINERAL RESOURCES CIRCULAR NO. 4

VIRGINIA DIVISION OF GEOLOGY

Commonwealth of Virginia

Department of Conservation and Development

DIVISION OF GEOLOGY

William M. McGill, State Geologist

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By

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Prepared in cooperation with the Geological Survey of the United States Department of the Interior

Charlottesville, Virginia

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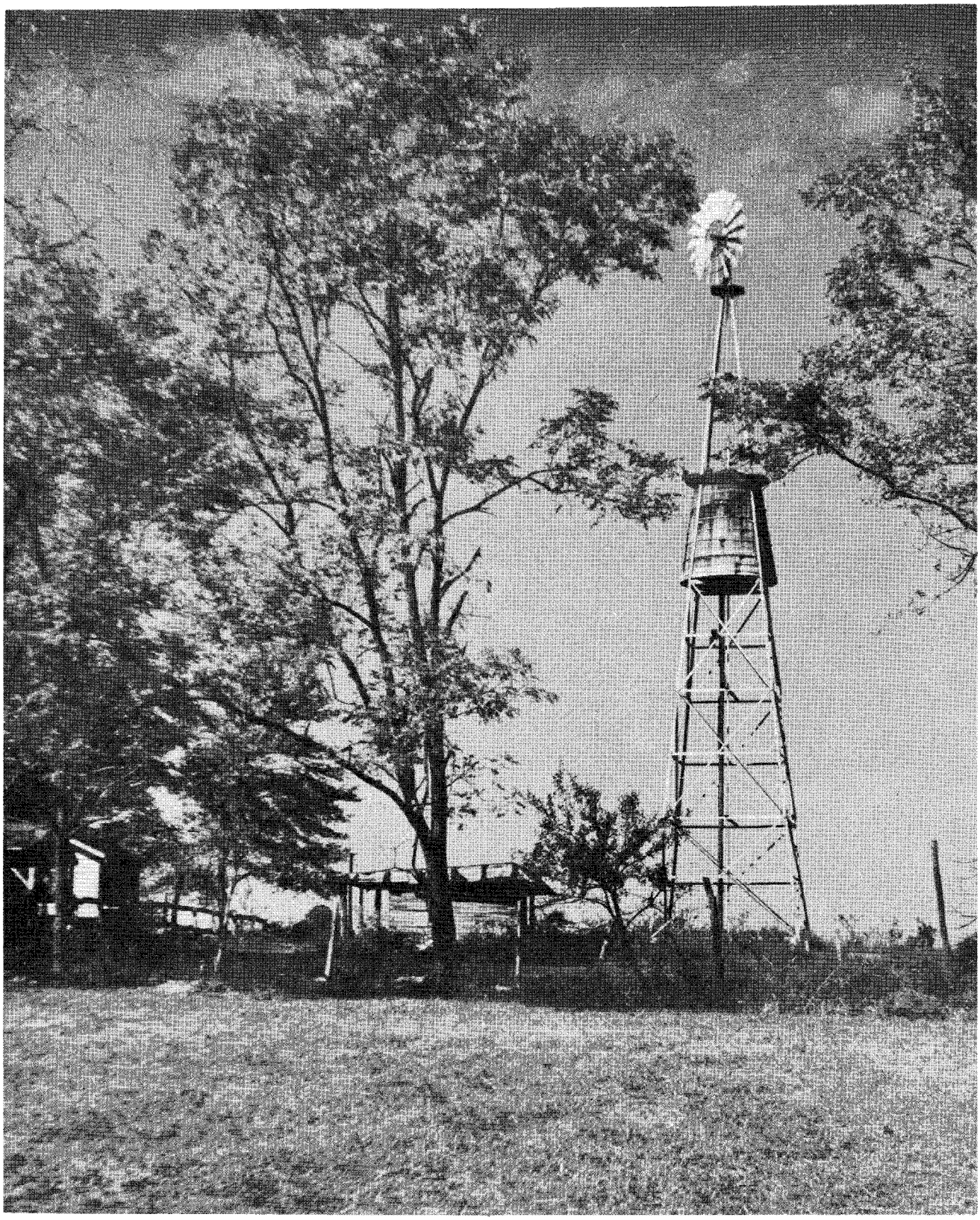
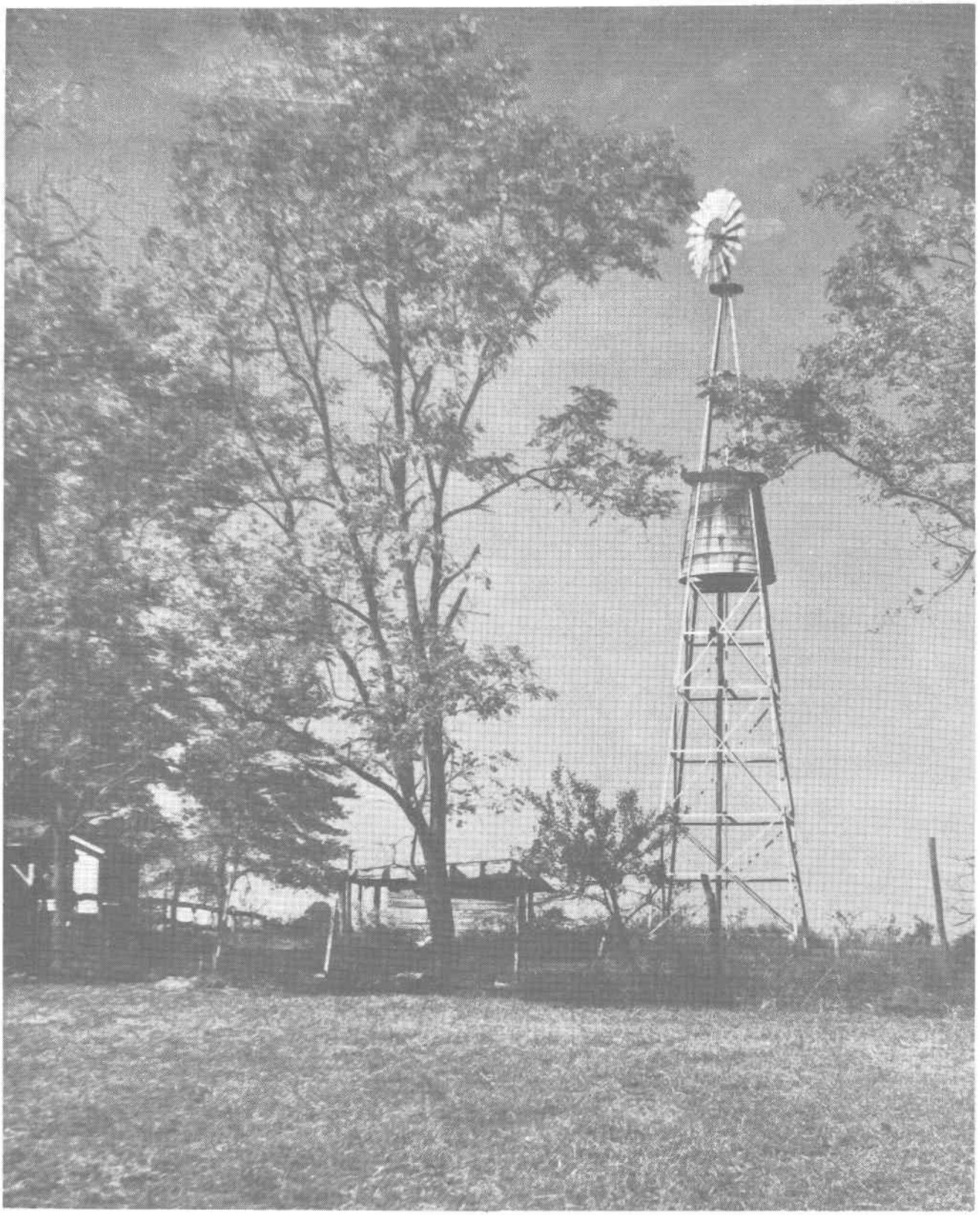


Windmill and elevated water tank. Windmills are still retained on some farms in eastern Spotsylvania County to provide power for shallow-well force pumps.



Windmill and elevated water tank. Windmills are still retained on some farms in eastern Spotsylvania County to provide power for shallow-well force pumps.

SUMMARY OF GEOLOGY AND GROUND-WATER CONDITIONS IN THE FREDERICKSBURG DISTRICT, EASTERN SPOTSYLVANIA COUNTY, VIRGINIA

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INTRODUCTION

The United States Geological Survey, in cooperation with the Virginia Division of Geology, has carried on ground-water investigations in the Coastal Plain province of Virginia continuously since 1937. These studies were begun under the general supervision of Arthur Bevan, former State Geologist, and the late O. E. Meinzer, former Chief, Ground Water Branch, U. S. Geological Survey, and have continued under the direction of William M. McGill, present State Geologist, and A. N. Sayre, present Chief, Ground Water Branch. The ground-water studies in the Fredericksburg district, Spotsylvania County were begun in July 1953 under the supervision of Allen Sinnott, District Geologist, Ground Water Branch, U. S. Geological Survey.

This preliminary report is being made available to meet the demands for the present expansion and development of the Fredericksburg district in eastern Spotsylvania County, Va. (Fig. 1). It contains brief discussions of the source and occurrence of ground water, geology and water-bearing properties of the rocks, and chemical quality of the ground water. Included are factual data consisting of 112 well records, 24 well logs, and 15 chemical analyses. The records of wells, given in Table 1, were compiled from observations in the field, and from information furnished by well owners, well drillers, and county officials.

The well logs, containing generalized descriptions of materials penetrated in the drilling of wells (Table 2) were obtained largely from local well drillers, although for some of the wells the information was obtained directly from well owners. Drill cuttings from three deep test holes drilled under the auspices of the Spotsylvania County Board of Supervisors were furnished the Geological Survey and have been studied in the laboratory. Logs of two test holes drilled by J. T. Ellington also have been made available. Fossils from two of the test holes and from other sources in the area are being studied by the Geological Survey. This information will aid in determining the proper stratigraphic position of the subsurface rocks, and will be discussed in a more comprehensive report to be prepared at a later date.

A generalized geologic columnar section (Fig. 2) shows diagramatically the types of rock found at depth and their geologic age shown in Figure 3.

Most of the wells in the area (Fig. 4) penetrate coarse sandy gravels of Pleistocene age that supply sufficient water for domestic needs. A few deeper wells obtain water from the deeper water-bearing sands and sandstone of Cretaceous age. Northwest of Four Mile Fork and in the Five Mile Fork area, ground water is yielded by a few wells from the weathered zone of igneous and metamorphic rocks of pre-Cretaceous age.

Water samples were collected from many wells in the area and were tested in the field to determine the gross variations in chemical constituents from one geologic formation to another. One well in the weathered zone of igneous and metamorphic rocks and selected representative wells tapping both shallow and deep water-bearing sands were resampled for comprehensive analyses which are given in Table 3.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the helpful cooperation received from the many domestic and subdivision well owners in furnishing basic well data and in allowing free access to wells for measurements and sampling. Thanks are due the Sydnor Pump & Well Co., Inc., of Richmond, Va., who made available many of the well logs and basic well data of the area. Thanks are also due the following drillers for furnishing well logs: Leazer Pump & Well Co. and J. T. Ellington, Fredericksburg, Va.; Virginia Machinery & Well Co., Richmond, Va.; Mitchell's Well & Pump Co., Petersburg, Va.; and Layne-Atlantic Co., Glen Burnie, Md.

LOCATION OF AREA

The area covered by this preliminary report, shown in Figure 1, represents approximately 31 square miles in eastern Spotsylvania County, Va.

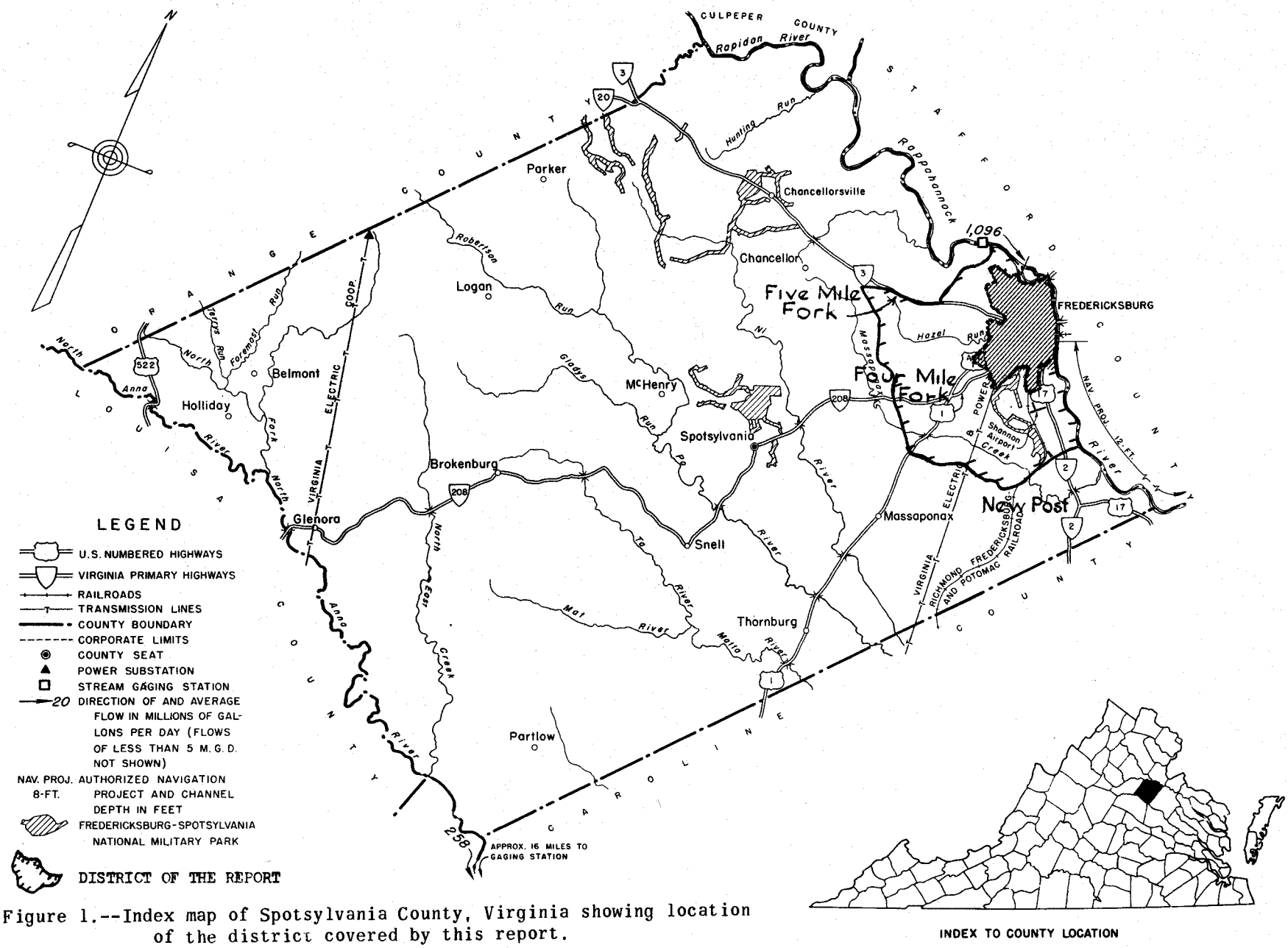
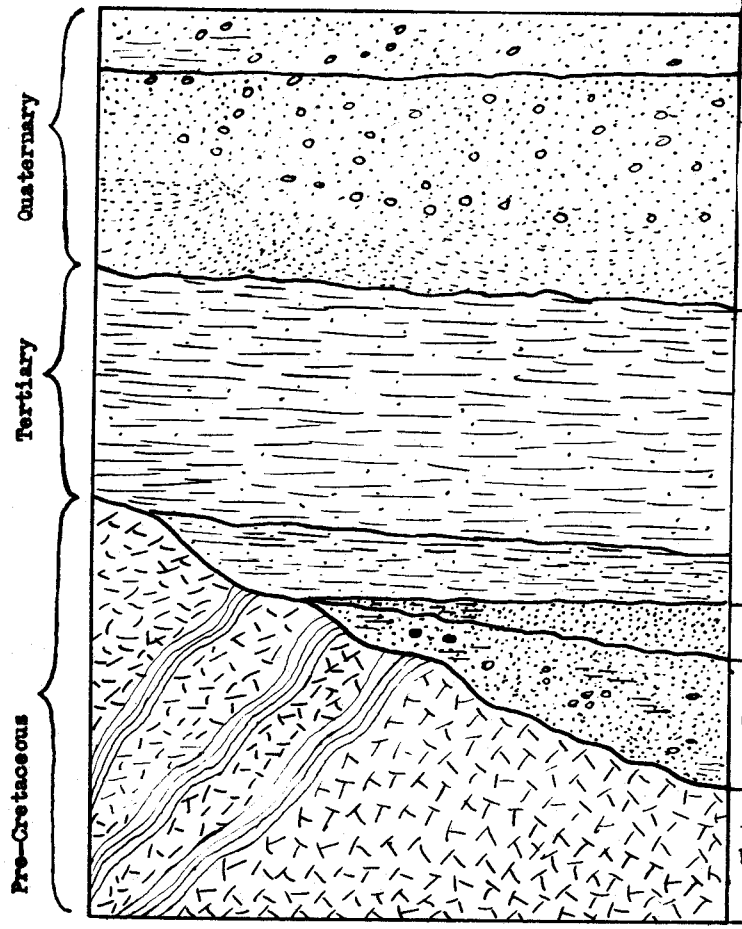


Figure 1.--Index map of Spotsylvania County, Virginia showing location of the district covered by this report.

(Base map courtesy of Division of Planning and Economic Development, Virginia Dept. of Conservation and Development.)



Geologic age	Water-bearing properties
Recent	Not considered water bearing in the district.
Pleistocene	Moderate quantities of ground water—up to 10 gpm from many dug wells.
Miocene	Not considered water bearing. Acts as "cap rock" for underlying aquifers.
	Not considered water bearing.
Eocene	So far as known, not considered water bearing in the district.
Cretaceous	Tapped by wells yielding about 15 gpm. Water contains objectionable amounts of iron and small quantities of hydrogen sulfide.
Pre-Cretaceous basement complex	Small amounts of water are derived from shallow wells tapping the westhered portion. A few deep wells have been reported to yield salt water.

Figure 2.--Generalized columnar section giving age and water-bearing properties of rock units in the Frecericksburg district, Virginia.

MAJOR DIVISIONS OF GEOLOGIC TIME IN USE BY THE U. S. GEOLOGICAL SURVEY				
Era	Period or System	Epoch or Series	Approx. no. of million years ago[1]	Approx. length in millions of years[1]
Cenozoic	Quaternary	Recent Pleistocene	0-1	1
	Tertiary	Pliocene	1-12	11
		Miocene	12-28	16
		Oligocene	28-40	12
		Eocene Paleocene	40-60	20
Mesozoic	Cretaceous	Upper (Late) Lower (Early)	60-130	70
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	130-155	25
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	155-185	30
Paleozoic	Permian	Provincial series recognized in west Texas	185-210	25
	Carboniferous systems: Pennsylvanian	No formal subdivisions	210-235[2]	25
	Carboniferous systems: Mississippian	No formal subdivisions	235-265[2]	30
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	265-320	55
	Silurian	Upper (Late) Middle (Middle) Lower (Early)	320-360	40
	Ordovician	Upper (Late) Middle (Middle) Lower (Early)	360-440	80
	Cambrian	Upper (Late) Middle (Middle) Lower (Early)	440-520	80
Proterozoic	Precambrian[3]	Upper Precambrian rocks. (Keweenawan and other provincial series.)	520-2100+	1600+
		Middle Precambrian rocks (Huronian and other provincial series.)		
		Lower Precambrian rocks. (Provincial series.)		

[1] Report of the National Research Council, Committee on the Measurement of Geologic Time, 1949-50.

[2] Estimate of J. P. Marble, Chairman of Committee on Measurement of Geologic Time, March 17, 1954.

[3] Precambrian is official U. S. Geological Survey spelling as of 4/26/55.

For the age of the crust of the earth, the data are at present uncertain, but the order of magnitude is about 3,250 million years. The margin of error in the estimate of the age for the Quaternary is ±50,000 years; Tertiary ±1 to 2 million years; Mesozoic ±5 million years; Paleozoic ±10 million years; Proterozoic ±10 to 300 million years.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series. There is no formal subdivision of time of the Proterozoic; subdivisions of the Precambrian have only local significance.

GEOLOGIC NAMES COMMITTEE, 1954

Figure 3.--Major divisions of geologic time in use by the U. S. Geological Survey.

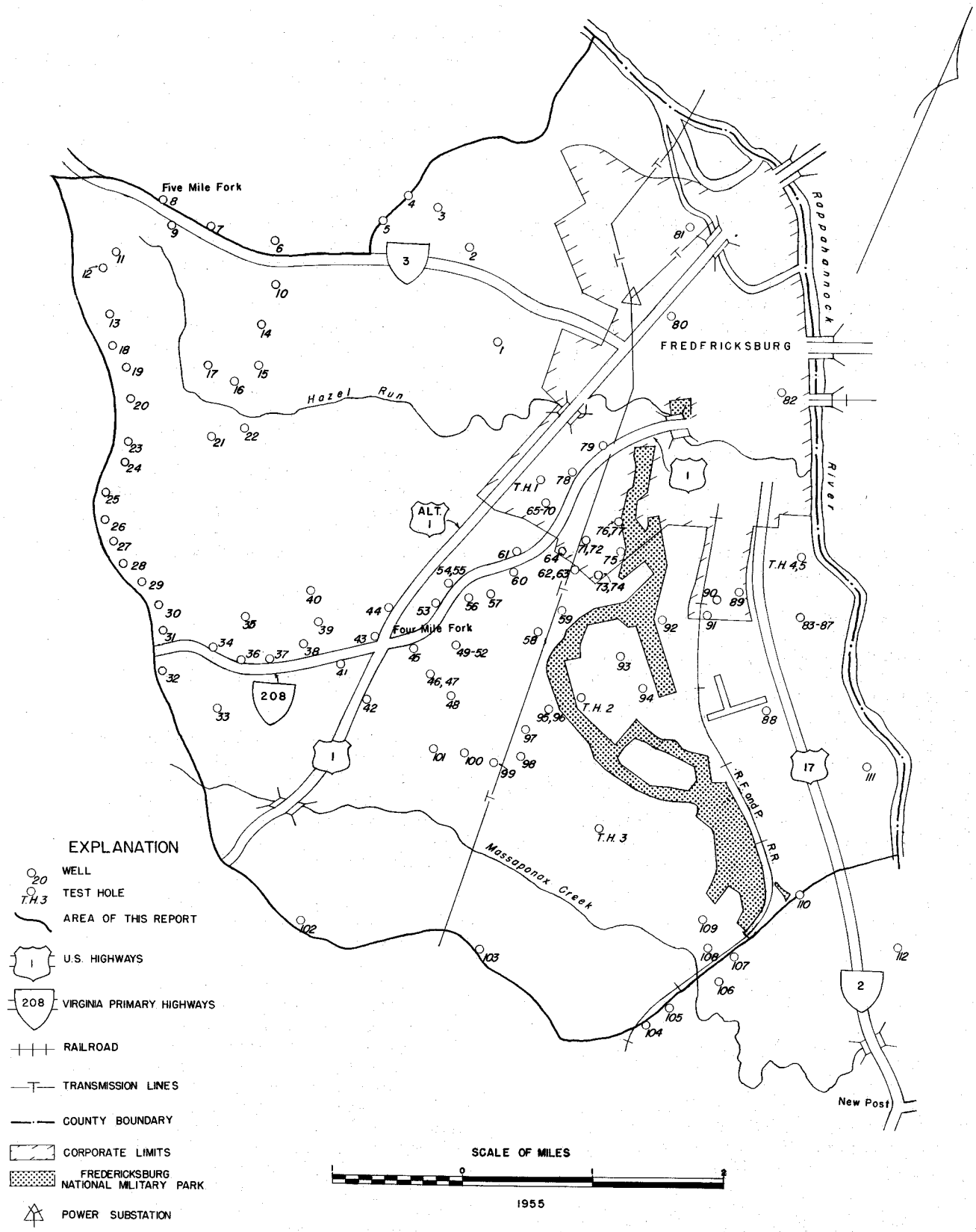


Figure 4.-- Map showing location of wells and test holes in eastern Spotsylvania County, Virginia

GROUND WATER

Source

Ground water is stored in the pore spaces and open joints, called voids or interstices, in the rocks of the earth's crust. It has been defined by Meinzer (1923) as that part of the subsurface water which is in the zone of saturation and which supplies wells or springs. Although this water occupies underground reservoirs, its source lies in the atmosphere. Essentially all ground water in the area results from infiltration of precipitation or streamflow.

Occurrence

In the area covered by this report the top of the zone of saturation, known as the water table, ranges in depth from a few feet to about 50 feet below the land surface.

Below the shallowest water body, which occupies terrace deposits of Quaternary age, are a number of relatively impermeable clay beds. Beneath these beds are extensive deposits of water-bearing materials; the water in these materials is confined by the clay beds under artesian pressure. Wells tapping this deeper zone are called artesian wells. The water in an artesian well may or may not flow at the land surface, depending on the amount of pressure developed. The level defined by the height to which artesian water will rise in artesian wells under its full pressure head is called the piezometric surface.

MATERIALS PENETRATED

Drillers' Logs

Logs of 19 wells and 5 test holes (Table 2) have been furnished for use in this report by well owners and drillers who have operated in the area.

From the writer's study of the drillers' logs, it appears that a few of their terms should be defined. "Marl" is a fine-grained calcareous sediment resembling clay, but the term is used by drillers to denote all clayey material. The term "rock or shale" is used by some drillers to indicate hard-packed sand, sandstone, other cemented granular sedimentary rocks, or hard clay. "Mud" described in the logs generally means fine-grained sandy clay or silt that is broken down easily by drilling fluids.

Sand is a loose, unconsolidated granular sediment consisting mostly of rounded or irregularly shaped quartz grains. Sand ranges in size from very fine to coarse, and grades into fine gravel. Gravel consists of the same type of material as sand, except that minerals and rocks other than quartz are more abundant, and its component grains range in size from 2 millimeters (about one-twelfth inch) to several inches.

Silt is a fine-grained material intermediate between sand and clay. Its individual particles are visible only under magnification. Clay is the finest grained sediment consisting of individual particles. Its smaller particles cannot be examined individually even under a high-powered microscope.

SUMMARY OF GEOLOGY AND WATER-BEARING PROPERTIES

The rocks that underlie this area range in age from pre-Cretaceous to Recent. A basement complex of crystalline igneous and metamorphic rocks of pre-Cretaceous age is overlain by sand, sandstone, silt, clay, and gravel of Cretaceous, Eocene, Miocene, Pleistocene, and Recent age.

The crystalline rocks yield very little water to wells, and then only where the rocks are fractured.

Unconsolidated sedimentary deposits, whose water-bearing properties depend upon the size, shape, and arrangement, of the component grains and consequently on the volume of open space between the grains, are capable of storing large volumes of water, and some are capable of yielding water freely to wells. Clay and silt, because of their extremely fine grain size, act as confining layers or "cap rock" for the deeper water-bearing sands and as a "footing" for shallow wells deriving water from overlying sands and gravels.

Pre-Cretaceous Rocks

Basement Complex

Lithology and distribution

The crystalline rocks forming the basement complex in the area consist of granite and granite gneiss of questionable age. Since these rocks are overlain by younger sedimentary rocks of Cretaceous age, they are here termed pre-Cretaceous in age.

Granite and granite gneiss crop out along the Rappahannock River at Fredericksburg (Pl. 2A), and just west of U. S. Highway 1 (Alt.) on Hazel Run. The buried surface of the basement rocks is very irregular in the immediate vicinity of Fredericksburg, but in general it slopes gently to the southeast to a depth of about 150 feet below sea level along the eastern edge of the area.

Water-bearing properties

Rocks of the basement complex yield very little water in comparison with other water-bearing rocks in the area. Several shallow wells penetrating the upper, weathered, portion of these rocks yield sufficient water for domestic use. Well Nos. 72 and 112, drilled to depths of 655 and 620 feet below the land surface, respectively, have been reported to yield salt water containing more than 400 ppm (parts per million) of chloride.

Cretaceous System

The Cretaceous of the Coastal Plain province of Virginia consists of the Potomac group and formations of Upper Cretaceous age. The Potomac group, assigned to the Cretaceous in this area consists of the basal Patuxent formation and overlying Patapsco formation. Formations of Upper Cretaceous age are absent in this area.

Lithology and distribution

Only the Patuxent formation, consisting of sand, sandstone, clay, and minor gravels, is identifiable in the vicinity of Fredericksburg. Although the Patapsco formation has been shown in published maps as extending as far south as Fredericksburg, Cederstrom (1945) has pointed out that its presence has not been definitely proved south of Fort Belvoir, Va.

The Patuxent formation crops out along Hazel Run east of U. S. Highway 1 (Alt.) in the vicinity of the National Memorial Cemetery; several places southwest of Hazel Run along U. S. Highway 1 (Alt.) to Four Mile Fork and extending along U. S. Highway 1 to the southern boundary of the area.

Water-bearing properties

The outcrop area of the Patuxent formation in the vicinity of Fredericksburg serves as a recharge area for its ground-water reservoir. The recharge water supplying this extensive water-bearing formation is obtained primarily from precipitation and stream infiltration as is true in all such areas in Virginia where water-bearing units of the Coastal Plain are exposed at the surface.

Several wells in the area penetrate water-bearing Cretaceous sands at elevations ranging from 30 feet above sea level along the western boundary of the area to approximately 200 feet below sea level at the eastern edge. The yield of these wells ranges from 2 to 40 gpm (gallons per minute) and averages about 15 gpm. The yield is dependent upon the nature of the water-bearing material and the number of water-bearing zones encountered.

Tertiary System

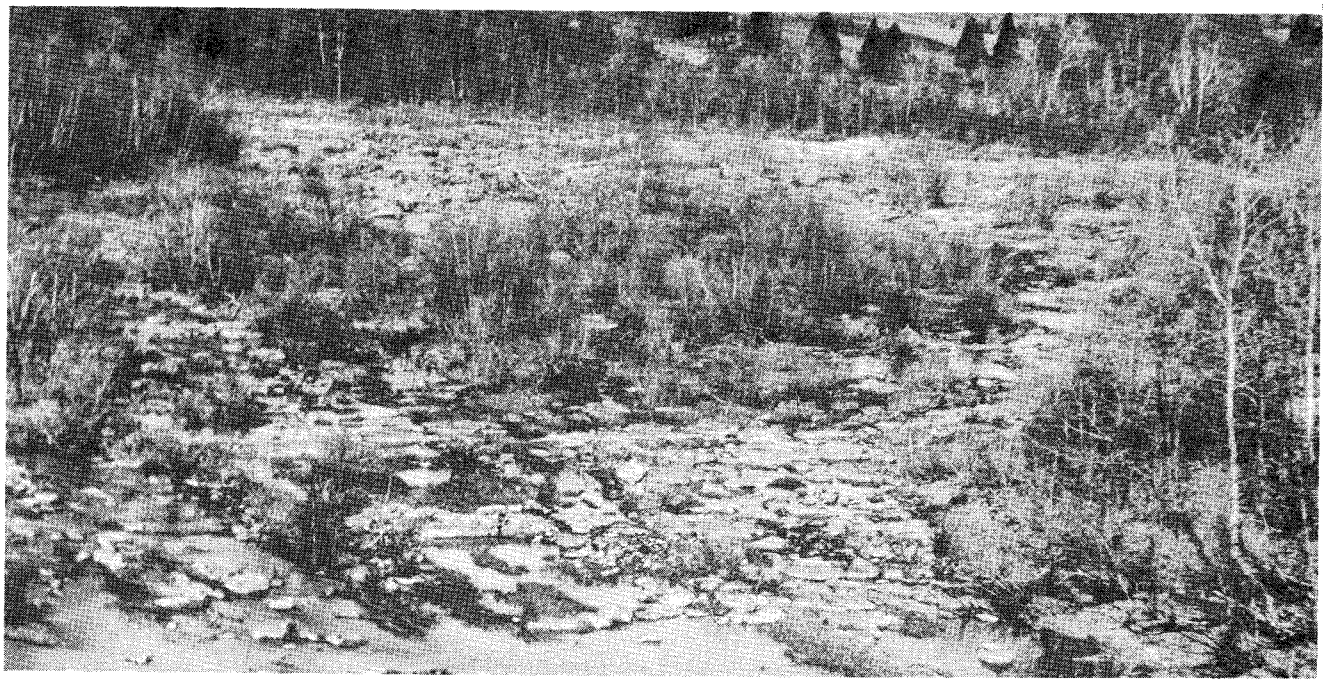
Paleocene Series

Data on eastern Spotsylvania County are not sufficient to show whether beds of Paleocene age are present. Cederstrom (1954) has described beds of this age, the Mattaponi formation, in the subsurface section at nearby Colonial Beach and Dahlgren.

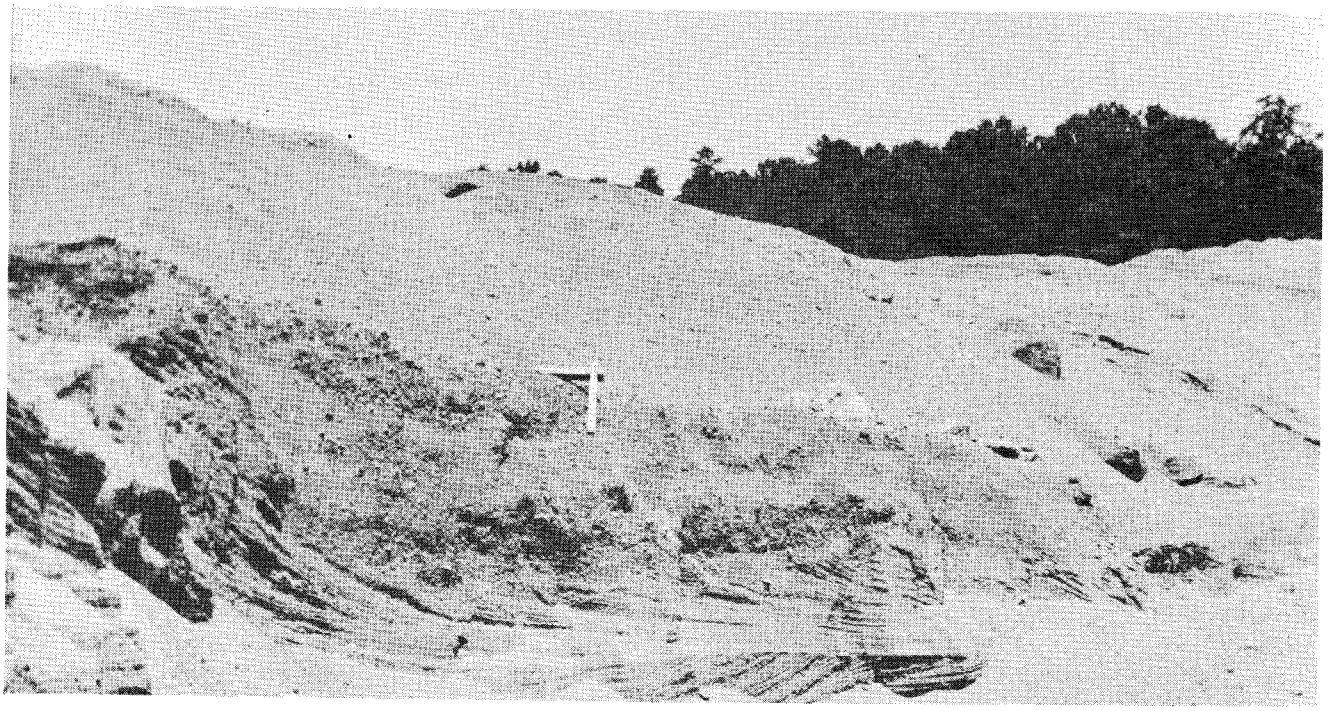
Eocene Series

The Pamunkey group, of Eocene age, consists in other areas of the Aquia formation

Plate 2

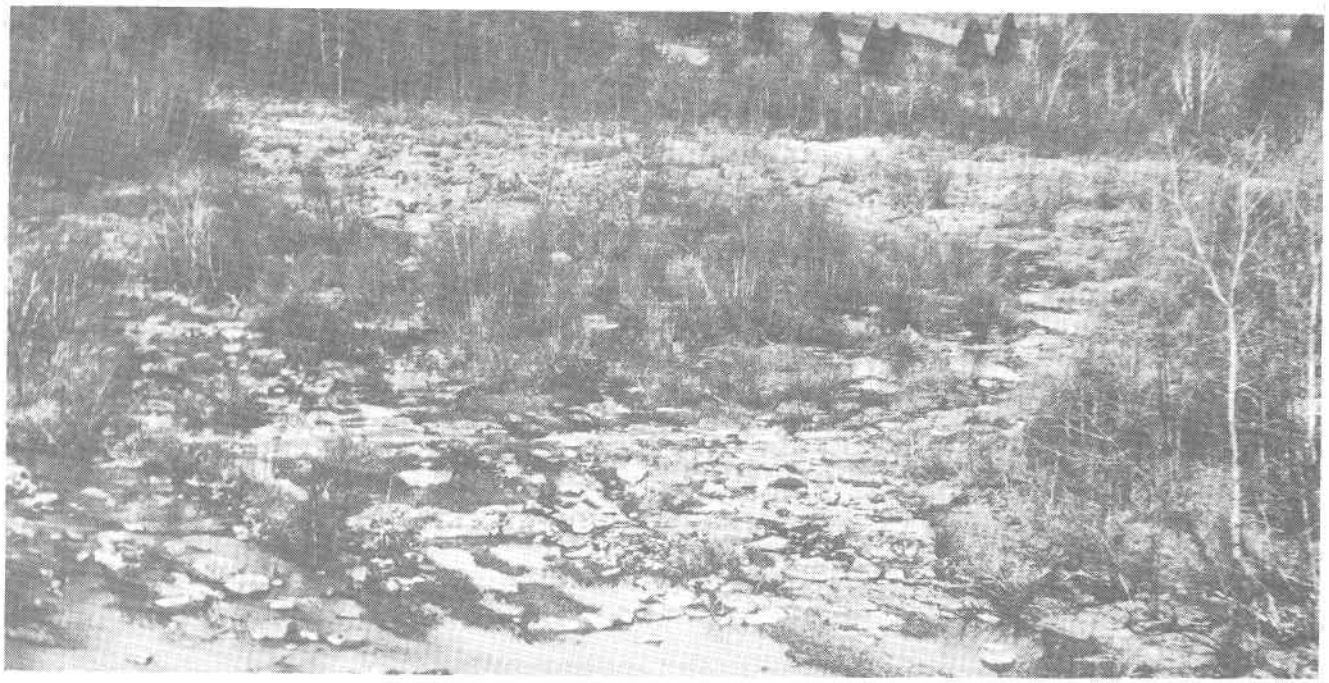


A, Granite and granite gneiss of the basement complex exposed in the Rappahannock River at Fredericksburg. These rocks mark the western boundary of Coastal Plain sediments and provide a source of replenishment to the ground-water reservoirs of the sedimentary rocks of the area covered by this report.



B, Cross-bedded sand characteristic of the lower terrace deposits of Pleistocene age. These materials were derived from the Piedmont crystalline rocks and deposited in tidal estuaries.

Plate 2



A, Granite and granite gneiss of the basement complex exposed in the Rappahannock River at Fredericksburg. These rocks mark the western boundary of Coastal Plain sediments and provide a source of replenishment to the ground-water reservoirs of the sedimentary rocks of the area covered by this report.

B, Cross-bedded sand characteristic of the lower terrace deposits of Pleistocene age. These materials were derived from the Piedmont crystalline rocks and deposited in tidal estuaries.

and the overlying Nanjemoy formation. Only the Aquia formation is present in this area.

Lithology and distribution

The Aquia formation consists of bright-colored sandy micaceous clays in the vicinity of Fredericksburg and dark-green sand and clay where observed along the banks of the Rappahannock River opposite the mouth of Massaponax Creek.

West of U. S. Highway 1 (Alt.) on the "heights" overlooking Fredericksburg, the Aquia formation overlies pre-Cretaceous granite and granite gneiss. To the east the Aquia formation disappears for a short distance, reappearing along the north bank of the Rappahannock River opposite the mouth of Massaponax Creek.

Water-bearing properties

So far as known, no wells in the area tap the Aquia formation.

Miocene Series

The Chesapeake group in other areas of the Coastal Plain is composed of four formations: The basal Calvert formation, overlain successively by the Choptank, St. Marys, and Yorktown formations. Only the Calvert is present in this area.

Lithology and distribution

The Calvert formation consists of green clay, very fine white quartz sand, and contains numerous diatom microfossils.

The Calvert formation lies near the surface in the vicinity of Fredericksburg. In most of the area the Calvert formation is overlain by terrace sands and gravels of Pleistocene age, but locally where material of Pleistocene age has been removed by erosion it is covered by deposits of Recent age.

Water-bearing properties

In this area the Calvert formation is not considered to be water bearing, but serves as a "cap rock" confining water under artesian pressure in the deeper water-bearing sands. Several shallow dug wells in the area have been carried down to this formation, but they derive little or no water from it.

Miocene Series(?) (Undifferentiated)

Overlying the Calvert formation or, locally, sands of Cretaceous age, vari-colored clays appear at the base of the Pleistocene terrace deposits. The clays appear in road cuts along U. S. Highway 1 (Alt.) between Fredericksburg and Four Mile Fork. They may be of Miocene age. They are not water bearing.

Quaternary System

Pleistocene Series

Lithology and distribution

Terrace deposits of the Columbia group of Pleistocene age, which in this area are not subdivided consist of sand and gravel with varying amounts of clay and loam. The higher (older) terrace deposits consist of varying amounts of coarse gravel with somewhat rounded pebbles mixed with clay, silt, and sand. Lower (younger) deposits consist largely of cross-bedded sand and some gravel (Pl. 2B).

The Pleistocene deposits form the greater part of the surface material in the area, except where they are overlain locally by deposits of Recent age.

The higher terraces are along U. S. Highway 1 (Alt.) at altitudes ranging from approximately 200 to 300 feet above sea level, and the lower terraces are observed just west of U. S. Highway 17 southeast of Fredericksburg at altitudes ranging from approximately 60 to 100 feet above sea level.

Water-bearing properties

Many of the shallow wells in the area derive water from the terrace deposits. These wells yield moderate quantities of water--up to 10 gpm. Shallow wells tapping the higher (older) terrace deposits yield water high in iron; however, those tapping the lower terrace deposits yield soft water of good quality.

Recent Series

Lithology and distribution

Deposits of Recent age in eastern Spotsylvania County are thin and consist of alluvial silt, sand, and gravel occurring along creek and river beds.

Water-bearing properties

Evaluation of available data indicates that no wells are deriving water from deposits of Recent age in the area.

QUALITY OF WATER

Source and Significance of Mineral Constituents in Natural Waters

Essentially all the ground water in the vicinity of Fredericksburg is derived from precipitation, entering the ground directly through the soil, or indirectly from streams. The water that falls as rain or snow contains only small amounts of dissolved mineral matter, but upon reaching the earth's surface it begins to dissolve minerals from the soil and rocks. The amount and nature of the mineral constituents in ground water differ greatly from one area to another, depending upon the chemical properties of the rocks, the temperature of the water, and the length of time the water remains in contact with the rocks and soils. The mineral constituents or other characteristics of natural waters considered here include those that have a practical effect on the value of the waters for ordinary use.

The following discussion of the chemical constituents of ground water has been adapted in part from publications of the U. S. Geological Survey.

Parts per million (ppm) is a measure of the amount of a dissolved constituent in a million parts of water by weight. The chemical constituents given in Table 3 are stated in ppm, except for the determination of specific conductance which is measured in units of micromhos (at 25°C).

Dissolved solids.--The quantity reported as dissolved solids (the residue on evaporation) consists mainly of the dissolved mineral matter in the water. It may contain also some organic matter and water of crystallization. Water containing less than 500 ppm of dissolved solids is usually satisfactory for domestic and most industrial uses. Water having more than 1,000 ppm of dissolved solids generally is not satisfactory because it may contain enough of certain chemical constituents to produce a noticeable taste or render the water undesirable in other respects. Dissolved solids contained in water samples collected in this area range from 22 to 331 ppm. All the samples contained less than 500 ppm and are suitable for most uses.

Specific conductance.--The specific conductance of a water is a measure of its ability to conduct a current of electricity. It varies with the concentration and degree of ionization of the different minerals in solution. Values for specific conductance of waters analyzed in the area are less than 600 micromhos (at 25°C). The specific conductance in micromhos generally is roughly 1½ times the dissolved-solids content in parts per million.

Hardness as $CaCO_3$.--The hardness of water is commonly indicated by the amount of soap required to make a permanent lather. Hardness is generally expressed as the amount of calcium carbonate equivalent to the calcium and magnesium in the water. Calcium and magnesium are the principal constituents that cause hardness. Water having a hardness of less than 60 ppm is generally considered soft. A moderate hardness of 61 to 120 ppm does not seriously interfere with the use of water for most purposes but increases the soap consumption. Water having a hardness between 121 and 200 ppm is considered hard, and is sometimes softened for household use. A hardness of more than 200 ppm is considered excessive, necessitating treatment of the water for many uses. The hardness reported for water in the area ranges from 10 to 169 ppm. In general, most ground water in the area is considered soft.

Hydrogen sulfide (H_2S).--Hydrogen sulfide is the well-known "rotten egg" gas. It is generally believed to originate from decomposition of organic matter and the reduction of sulfate. In this area small quantities of hydrogen sulfide are present in some waters derived from sands of Cretaceous age. Aside from imparting an odor and taste to the water, it is entirely harmless in the small quantities present.

Silica (SiO_2).--Silica is dissolved from practically all rocks. A few natural waters contain less than 3 ppm of silica and

some contain more than 50 ppm. Silica affects the usefulness of water because it contributes to the formation of boiler scale. Silica in waters of the area ranges from 10 to 47 ppm.

Iron (Fe).--Iron is a common constituent of ground water. Quantities in excess of 0.3 ppm may precipitate as ferric hydroxide. Excessive iron in water causes staining of fixtures and clothing, and renders the water unsuitable without treatment for laundering, manufacturing of food, paper, ice, and other products. Many wells in the area yield water containing more than 0.3 ppm of iron.

Calcium and magnesium (Ca and Mg).--Calcium and magnesium are dissolved from many rocks but particularly from limestone, dolomite, and gypsum. Most waters from granite contain less than 10 ppm of calcium; many waters from limestone contain 30 to 70 ppm. Water from dolomite (magnesian limestone) may contain 20 to 50 ppm of magnesium. In soft water the concentration of magnesium may amount to only 1 or 2 ppm. In this area, calcium and magnesium combined range from 3.4 to 52 ppm.

Sodium and potassium (Na and K).--Sodium and potassium are derived from practically all rocks and soils, but they contribute only a small part of the dissolved mineral material in most waters of the area. Ground water derived from deep aquifers is likely to contain more sodium than that from shallow aquifers. Moderate quantities of these constituents have little effect on the usability of water, but more than 50 to 100 ppm of sodium when present as the bicarbonate may cause foaming in boilers. Irrigation water that contains high percentages of sodium salts may cause deflocculation of poorly drained soils, which adversely affects plant growth. Many wells in the area yield water containing from 20 to 40 ppm of sodium and potassium combined.

Carbonate and bicarbonate (CO_3 and HCO_3).--Carbonate and bicarbonate in natural water result largely through the action of carbon dioxide which enables the water to dissolve carbonates of calcium and magnesium. Carbonate is not present in appreciable quantities in ground water in the area. The bicarbonate in water that comes from relatively insoluble rocks like granite may amount to less than 10 ppm; water from limestone may contain 200 to 400 ppm, and some highly mineralized waters of the sodium bicarbonate type may contain 1,000 ppm or more of bicarbonate. Ground water containing large quantities of bicarbonates is unsatisfactory for use in boilers or condensing systems because they may contribute to foaming or to the formation of boiler scale. The bicarbonate content in ground water in this area generally ranges from 6 to 130 ppm and has little effect on the usefulness of the water.

Sulfate (SO_4).--Sulfate is dissolved in large quantities from gypsum and from deposits of sodium sulfate. Some sulfate is derived from the oxidation of sulfides of iron. Sulfate in water that contains calcium and magnesium contributes to the formation of hard scale in steam boilers. In this area sulfate content generally ranges from 1 to 30 ppm.

Chloride (Cl).--In the Fredericksburg district, chloride in ground water generally originated from residual sea water left after marine sediments were deposited. The chloride content of water from wells in the area ranges from less than 10 ppm to 114 ppm. A few wells drilled into bedrock have been reported to be high in dissolved solids and yield water containing from 550 to 5,500 ppm of chloride. Waters containing more than 250 ppm of chloride is not desirable for most domestic and industrial uses.

Fluoride (F).--Fluoride is dissolved from fluoride-bearing minerals in rocks. Dean (1936) and other investigators report that water that contains more than 1 to 1.5 ppm of fluoride is associated with the dental defect known as mottled enamel. Fluoride in concentrations up to about 1 ppm has been shown to retard tooth decay (Dean and others, 1942) if such water is used during the period of calcification of the teeth. The ground waters analyzed in the area contain up to 0.2 ppm of fluoride, not enough to be of significance in either the mottling of enamel or the prevention of decay.

Nitrate (NO_3).--Nitrate in water is considered a final oxidation product of nitrogenous organic material. In places it may be derived from artificial fertilizers. Nitrate is present in small quantities in most ground waters. Some ground water contains high concentrations of nitrate which may indicate the presence of sewage, surface wash, or other sources of pollution. If present in quantities greater than about 45 ppm in water used in infant-feeding formulas, nitrate may cause infant cyanosis ("blue baby") (Faucett and Miller, 1946; Waring, 1949; Maxcy, 1950).

Sanitary Considerations

The analyses of water given in Table 3 show only the amounts of dissolved mineral constituents present in the samples at time of collection and do not indicate their sanitary quality. Water from a well may contain mineral matter that imparts an objectionable taste or odor and yet may be free from harmful bacteria. On the other hand, water from a well may be clear and tasteless and yet may contain harmful bacteria. Abnormal quantities of such mineral constituents as nitrate and chloride may indicate organic pollution.

PRELIMINARY CONCLUSIONS

The area covered by this report was the first unit studied during the ground-water investigation in Spotsylvania County. From the available data, certain preliminary generalizations can be made at this time.

Shallow wells, less than 50 feet deep, yield up to 10 gpm of water that is low in dissolved mineral constituents, but locally contains objectionable amounts of iron. Wells of this type are of large diameter (generally 36 inches), are usually dug or bored, and supply sufficient water for most domestic and farm needs. A few dug wells, such as Nos. 97 and 98 in Table 1, are approximately 90 feet deep in places where the topography and geology make it necessary to carry wells to greater depths to penetrate the normal "shallow" water-bearing unit.

Wells penetrating the deeper water-bearing units range in depth from 100 to 400 feet below the land surface. The yields of these wells range from 2 to 40 gpm and average approximately 15 gpm. Water from these deeper wells contains less than 500 ppm of dissolved solids, permitting use of the water for most domestic purposes, but most of these well waters have a slight hydrogen sulfide odor and contain undesirable quantities of iron.

A few wells in the area have been drilled deeper than 400 feet into the basement complex of crystalline rocks. These wells have been reported to yield salty water.

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Table 1.—Records of wells in eastern Spotsylvania County, Virginia

gpm, gallons per minute; ppm, parts per million
Temp., temperature (degrees Fahrenheit)

Type of well: B, bored; D, drilled; Dg, dug
Use of Water: Ab, abandoned; D, domestic; I, industrial; PS, public supply; S, stock

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
1	2.8 mi. E.-SE. of Five Mile Fork	N. B. Rowe	Virginia Machinery and Well Co.	1922	235	D	150	6	-64	7	D	See log, Table 2; analysis, Table 3. Hydrogen sulfide odor.	1
2	2.4 mi. E. of Five Mile Fork	H. F. Marcus			245	Dg	30	36	-15	5	D	Reported soft.	2
3	2.1 mi. E.-NE. of Five Mile Fork	I. L. Dumire	C. Ward	1948	250	Dg	22	36	-12		D	Temp., 59°F.	3
4	1.9 mi. E.-NE. of Five Mile Fork	C. E. Gatewood	do.	1952	255	Dg	18	36	-12	5	D	Temp., 60°F.	4
5	1.7 mi. E. of Five Mile Fork	H. I. Curtis	Seay	1951	250	Dg	27	36	-21	5	D	do.	5
6	1.0 mi. E.-SE. of Five Mile Fork	H. Bernstein	Syunor Pump & Well Co., Inc.	1946	340	D	182	6	-30		D	See log, Table 2; water level reported in 1946.	6
7	.4 mi. E.-SE. of Five Mile Fork	E. O. Paytes			325	Dg	25	36	-19	5	D, S	Temp., 60° F.	7
8	Five Mile Fork	S. L. Powell	E. Powell	1917	342	Dg	28	24	(-)		D, S	Temp., 59° F.	8
9	.2 mi. S.-SE. of Five Mile Fork	H. Bishop	T. Powell		342	Dg	24	30	-16		D, S	Temp., 58° F.	9
10	1.1 mi. E.-SE. of Five Mile Fork	L. A. Vaughan	Fry	1950	310	Dg	22	36	-19	5	D	Temp., 60° F.	10
11	.5 mi. S.-SW. of Five Mile Fork	J. M. McCarty		1939	340	Dg	29	36	-20	5	D, S		11
12	.7 mi. S.-SW. of Five Mile Fork	H. E. Sorels			335	Dg	33	30	-23		Ab	See analysis, Table 3. Hydrogen sulfide odor. Temp., 60° F. Water derived from weathered granite.	12
13	1.0 mi. S. of Five Mile Fork	J. H. Fitzpatrick	Banks	1951	322	Dg	25	30	-14		D, S	Temp., 58° F.	13
14	1.8 mi. SE. of Five Mile Fork	T. Ross			305	Dg	27	36	-20	5	D	Temp., 59° F.	14
15	1.5 mi. SE. of Five Mile Fork	D. Fairchilds		1952	302	Dg	25	48	-20		D	Temp., 60° F.	15
16	1.6 mi. S.-SE. of Five Mile Fork	L. J. White		1941	270	Dg	30	40	-23	9	D	Temp., 59° F.	16
17	1.4 mi. S.-SE. of Five Mile Fork	G. Howard		1953	262	Dg	16	36	(-)		D	Well went dry Sept. 1953.	17
18	1.2 mi. S. of Five Mile Fork	F. A. Payne			322	Dg	23	40	-15		D	Temp., 58° F. Well lined with brick.	18

Table 1.—Records of wells in eastern Spotsylvania County, Virginia—Continued

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
19	1.3 mi. S. of Five Mile Fork	D. Payne	Seay	1952	320	Dg	29	30	-22		D	Temp., 61° F. at kitchen tap. Water derived from weathered granite.	19
20	1.6 mi. S. of Five Mile Fork	L. Hinkle			302	Dg	45	36	-26		D	Temp., 56° F. Water derived from weathered bedrock. Turbid appearance.	20
21	1.9 mi. S.-SE. of Five Mile Fork	R. Johnson			282	Dg	19	36	-14		Ab	Temp., 60° F. Water reported poor in quality.	21
22	2.0 mi. S.-SE. of Five Mile Fork	R. P. Lewis			260	Dg	21	35	-12		D	Temp., 58° F. Well lined with brick.	22
23	1.8 mi. S. of Five Mile Fork	A. A. Thacker		1910?	270	Dg	35	48	-21		D	do. Water level reported July 1953.	23
24	2.0 mi. S. of Five Mile Fork	W. Robinson	W. Robinson	1952	280	D	23	4	-10		D	Temp., 62° F. Water level reported July 1953.	24
25	2.2 mi. S. of Five Mile Fork	F. Lettner		1953	270	Dg	23	36	-16	5	D	Temp., 60° F.	25
26	2.5 mi. S. of Five Mile Fork	G. Obier	G. Obier	1951	270	Dg	35	40	-19		D	Turbid appearance.	26
27	2.7 mi. S. of Five Mile Fork	W. R. Minter	W. R. Minter	1951	270	Dg	31	36	-25		D	Temp., 60° F.	27
28	2.9 mi. S. of Five Mile Fork	L. J. Williams	M. P. Martin	1953	270	B	36	36	-17		D	Temp., 58° F.	28
29	3.0 mi. S. of Five Mile Fork	J. H. Croushore	C. Ward	1951	270	Dg	28	36	-17	5	D	Temp., 60° F.	29
30	3.1 mi. S. of Five Mile Fork	R. Harlow		1951	270	Dg	32	36	-14		D	do. Water not used for drinking since 1951.	30
31	3.3 mi. S. of Five Mile Fork	J. W. Seay		1951	270	Dg	23	36	-14	5	D	Temp., 58° F.	31
32	1.7 mi. W.-SW. of Four Mile Fork	Wm. A. Wilkason		1919	270	Dg	28	36	-20		D	Temp., 55° F.	32
33	1.4 mi. SW. of Four Mile Fork	S. B. Coleman			245	Dg	35	36	-16	5	D	Temp., 58° F. Reported slight iron taste.	33
34	1.3 mi. W.-SW. of Four Mile Fork	J. Feducia		1953	262	Dg	22	30	-7	5	D	Temp., 58° F.	34
35	1.1 mi. W. of Four Mile Fork	H. Hailey	H. Hailey	1953	248	Dg	31	36	-7		D	Temp., 57° F.	35
36	1.1 mi. W.-SW. of Four Mile Fork	C. F. Milstead		1936	260	Dg	23	36	-6	5	D	Temp., 59° F.	36

Table 1.—Records of wells in eastern Spotsylvania County, Virginia—Continued

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
37	.8 mi. W.-SW. of Four Mile Fork.	J. A. Dillard			255	Dg	23	24	-14	5	D	Temp., 58° F.	37
38	.6 mi. W.-SW. of Four Mile Fork	F. D. Motley		1953	250	Dg	28	36	-10	5	D	do.	38
39	.5 mi. W.-of Four Mile Fork	C. Catlett		1950	260	Dg	26	36	-11	5	D	Temp., 59° F.	39
40	.7 mi. W.-NW. of Four Mile Fork	S. E. McWhirt		1950	260	Dg	24	36	-13	5	D	Temp., 62° F. at outside tap.	40
41	.4 mi. SW. of Four Mile Fork	B. Dillard		1951	260	Dg	20	36	-13	5	D	Temp., 58° F.	41
42	.4 mi. S. of Four Mile Fork	A. K. Stephens	M. P. Martin	1953	242	B	48	30	-12	5	D	See analysis, Table 3. Organic odor. Reported soft. Contains iron.	42
43	Four Mile Fork	B. Kay			250	Dg	20	36	-11		D	Temp., 58° F. Supplies three houses.	43
44	.3 mi. N. of Four Mile Fork	J. U. Weaver		193[illegible]	250	Dg	21	36	-11	5	D	Temp., 56° F. Dry summer of 1953.	44
45	.2 mi. E. of Four Mile Fork	J. J. Dickerson		195[illegible]	255	Dg	21	30	-9	5	D	Temp., 56° F.	45
46	.4 mi. E.-SE. of Four Mile Fork	D. W. Herron		1952	250	Dg	22	36	-12	5	D	Temp., 60° F. Slight yellow color after heavy rains.	46
47	.4 mi. E.-SE. of Four Mile Fork	L. A. Bennett	M. P. Martin	1953	253	B	23	36	-13	5	D	Temp., 60° F.	47
48	.7 mi. E.-SE. of Four Mile Fork	T. Talley	do.	1953	245	B	25	36	-15	5	D		48
49	Bellevue Court Subdivision, .5 mi. E.-NE. of Four Mile Fork	Sydnor Pump & Well Co., Inc.	Sydnor Pump & Well Co., Inc.	1952	245	D	275	6	(-)	10	PS	See analysis, Table 3.	49
50	do.	do.	do.	1954	245	D	279	6	(-)		Ab	See log, Table 2.	50
51	do.	do.	do.	1951	240	D	211	8	-154	2	PS	do.	51
52	do.	do.	do.	1946	240	D	512	8-6	-140		Ab	do.	52
53	.5 mi. NE. of Four Mile Fork	B. T. Pitts	H. Leazer	1951	250	D	175	6	-75	8	PS	See analysis, Table 3.	53
54	Cottage Green Subdivision, .7 mi. N.-NE. of Four Mile Fork	G. T. Waite	Mitchell's Well and Pump Co.	1949	244	D	275	8	(-)	25	PS	See log, Table 2; analysis, Table 3. 25 gpm after 8 hours pumping.	54
55	do.	do.	Leazer Pump & Well Co.	1953	244	D	275	8-6	(-)	15	PS	See log, Table 2; analysis, Table 3. 15 gpm after 8 hours pumping.	55
56	.7 mi. NE. of Four Mile Fork	R. Curtis		1935	240	Dg	30	48	-18		Ab		56

Table 1.—Records of wells in eastern Spotsylvania County, Virginia—Continued

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
57	Spotswood Village, .9 mi. NE. of Four Mile Fork	Dozer and Hart	Craver and Jenkins	1950	220	D	259	6	-166	40	PS	See analysis, Table 3. Temp., 59° F. Water level obtained by air-line gage.	57
58	1.2 mi. E.-NE. of Four Mile Fork	W. A. Webster	Leazer Pump & Well Co.	195[illegible]	135	D	139	6	-74	5	D	See log, Table 2; analysis, Table 3.	58
59	1.6 mi. E.-NE. of Four Mile Fork	R. Tasker	C. Ward	195[illegible]	136	Dg	45	36	-38	5	D	Temp., 58° F.	59
60	1.2 mi. NE. of Four Mile Fork	J. McWhirt, Jr.	Seay	194[illegible]	240	Dg	16	36	-10	5	D	Temp., 60° F.	60
61	1.3 mi. NE. of Four Mile Fork	E. E. Ervin		1950	245	Dg	24	36	-17	5	D	Temp., 58° F.	61
62	Jackson Park Subdivision, 1.6 mi. E.-NE of Four Mile Fork	H. H. Simpson			220	D	286	5	(-)	13	PS, Ab		62
63	do.	do.	Mitchell's Well and Pump Co.		220	D	286	5	(-)	15	PS	See analysis, Table 3. Temp., 59° F. 15 gpm after 24 hours pumping. Well supplies 45 homes.	63
64	1.6 mi. NE. of Four Mile Fork	D. Smith	Gentry	1953	220	B	23	36	-11	5	D	Temp., 59° F.	64
65	Courtland Hts. Subdivision, 1.7 mi. N.-NE. of Four Mile Fork.	Sydnor Pump & Well Co., Inc.			240	Dg	25	36	-22		Ab		65
66	do.	do.	Sydnor Pump & Well Co., Inc.	1949	240	D	266	8	-192	10	Ab	See log, Table 2. 10 gpm after 4 hours pumping.	66
67	do.	do.	do.	1951	240	D	47	8	-19	15	Ab	See log, Table 2. 15 gpm after 2 hours pumping.	67
68	do.	do.	do.		240	D		8	(-)		Ab	Capped.	68
69	do.	do.			240	Dg	34	36	-21		Ab		69
70	do.	do.	Sydnor Pump & Well Co., Inc.		240	D	30	6	-20		Ab		70
71	Dillard Subdivision, 1.8 mi. NE. of Four Mile Fork	do.	do.	1952	220	D	99	8-6	-60	10-7	Ab	See log, Table 2. Temp., 59° F. 10 gpm after 14 hours pumping, 7 gpm after 3 hours.	71
72	do.	do.	do.	1949	200	D	655	8-6	-146	14	Ab	See log, Table 2. 14 gpm after 4 hours pumping. Water reported to contain 9,844 ppm salt. Deepened to 655 feet in 1949.	72
73	do.	do.	do.	1952	200	D	107	8	-69	30	PS	See analysis, Table 3.	73

Table 1.—Records of wells in eastern Spotsylvania County, Virginia—Continued

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
74	Dillard Subdivision, 1.8 mi. NE. of Four Mile Fork	Sydnor Pump & Well Co., Inc.	Sydnor Pump & Well Co., Inc.	1948	200	D	600	8-6	-190	5	Ab	See log, Table 2. Deepened to 600 feet in 1948. 5 gpm after 5 hours pumping.	74
75	2.0 mi. NE. of Four Mile Fork	G. Lowe	Leazer Pump & Well Co.	1951	100	D	175	6	(-)		D	Reported to contain iron.	75
76	2.1 mi. NE. of Four Mile Fork	U. S. Dept. of Interior, National Park Service			120	Dg	22	36	-13	5	D	See analysis, Table 3. Temp., 56° F. Iron removal filter.	76
77	do	do.	Sydnor Pump & Well Co., Inc.	1939	120	D	165	6	-106	15	Ab	See log, Table 2. Reported to contain iron.	77
78	2.0 mi. N.-NE. of Four Mile Fork	H-C Super Market	Leazer Pump & Well Co.	1953	235	D	267	8	(-)	10	D	See analysis, Table 3. 10 gpm after 8 hours pumping.	78
79	2.2 mi. N.-NE. of Four Mile Fork	P. C. Goodloe			200	Dg	57	48-36	-50	5	Ab	Temp., 58° F. Dry summer of 1952 and 1953. Water level reported May 1954.	79
80	Fredericksburg	State Normal School	Sydnor Pump & Well Co., Inc.	1910	130	D	536	10-8	-120	9	Ab	See log, Table 2. 9 gpm after 4 hours pumping.	80
81	do.	E. D. Cole	Alexander	1902	50	D	120	2	-20		Ab	See analysis, Table 3. From Va. Geol. Survey Bulletin 5, p. 274, 352-353.	81
82	Fredericksburg Victoria Theater	B. T. Pitts	Mitchell's Well and Pump Co.	1937	48	D	153	6	-30		D	See log, Table 2. Temp., 58° F. Used for air conditioning.	82
83	Sylvania Hts. Subdivision, .8 mi. SE. of Fredericksburg	A. W. Embry	W. Taylor	1937	65	Dg, D	45	36-8	-15	10	PS	36-inch diameter to 26 feet, 8-inch to 45 feet.	83
84	do.	do.		1937	65	D	46	6	(-)		Ab		84
85	do.	do.		1937	65	D	50	8	-15	10	PS	Temp., 59° F.	85
86	do.	do.	H. Leazer	1937	65	D	50	8	-14		PS		86
87	do.	do.	Sydnor Pump & Well Co., Inc.	1950	65	D	225	10-6	-31	10	PS	See log, Table 2. Bowls of pump set 80 feet below land surface.	87
88	.7 mi. S.-SE. of Fredericksburg	Shannon Airport		1950?	60	Dg	23	36	-17	5	D	Temp., 60° F.	88
89	Fredericksburg	A. R. Sullivan			55	Dg	19	36	-14		D	Temp., 58 ° F. Supplies several houses. Fredericksburg city limits extended Jan. 1, 1955.	89
90	do.	Tidewater Mill Co.		1950	70	Dg	13	36	-10		I	Temp., 58° F. Fredericksburg city limits extended Jan. 1, 1955.	90
91	do.	do.	J. T. Ellington	1954	75	B	23	36	-12	60	I	See analysis, Table 3. Temp., 58°F. Reported small(?) drawdown in 8 hours pumping 60 gpm.	91

Table 1.—Records of wells in eastern Spotsylvania County, Virginia—Continued

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well	Diameter of well (inches)	Approximate water level above (+) or below (-) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
92	.2 mi. W.-SW. of Fredericksburg	D. Litten	Seay		80	Dg	15	36	-10	5	D	Temp., 59° F.	92
93	.6 mi. SW. of Fredericksburg	B. Brooks			80	Dg	16	36	-11	5	D	Temp., 58° F.	93
94	.7 mi. S.-SW. of Fredericksburg	W. M. Cutshall		1954	80	Dg	20	36	-13		D	do.	94
95	1.4 mi. E. of Four Mile Fork	J. Tavenner		1953	119	Dg	14	36	-6	5	D	Temp., 59° F. Water reported soft.	95
96	do.	J. Beverly		1951	121	Dg	15	36	-9			Temp., 56° F. Turbid appearance.	96
97	1.3 mi. E. of Four Mile Fork	R. D. Hull	Seay	1952	230	Dg	93	36	-86	5	D	See log, Table 2. Temp., 60° F.	97
98	1.4 mi. E. of Four Mile Fork	R. Pearson	do.	1954	228	Dg	94	36	-81	5	D	See log, Table 2. Temp., 59° F.	98
99	1.3 mi. E.-SE. of Four Mile Fork	R. H. McCarthy	R. H. McCarthy		240	Dg	23	40	-19	5	D, S	Temp., 58° F.	99
100	1.1 mi. E.-SE. of Four Mile Fork	R. D. Holloway	R. D. Holloway	1933	241	Dg	29	36	-19	5	D	Temp., 59° F.	100
101	.9 mi. SE. of Four Mile Fork	H. M. Parker		1933	241	Dg	18	36	-12	4	D	do.	101
102	1.2 mi. S.-SE. of Four Mile Fork	J. L. Taylor	J. L. Taylor	1946	240	Dg	30	48-30	-22	5	D	Temp., 58° F.	102
103	1.4 mi. SE. of Four Mile Fork	G. T. Jones			222	Dg	22	49	-16		S	do. Not used for drinking	103
104	2.0 mi. W. of New Post	F. Lucas			88	Dg	23	40-36	-18		D, S	Temp., 59° F. Last 3 feet of well cased. Slight hydrogen sulfide odor.	104
105	1.9 mi. W. of New Post	G. E. Mills		1940?	80	Dg	15	30	-11	5	D	Temp., 58° F.	105
106	1.7 mi. W.-NW. of New Post	J. P. Terry			88	Dg	30	36	-24	5	D, S	Temp., 60° F.	106
107	1.6 mi. W.-NW. of New Post	E. Smith	Seay	1941	88	Dg	30	36	-22	5	D	Temp., 58° F.	107
108	1.9 mi. W.-NW. of New Post	B. F. Skinner		1946	118	Dg	36	36-30	-27		D	do. Last 6 feet of well cased.	108
109	2.1 mi. W.-NW. of New Post	H. L. Atkinson	C. Ward	195?	140	Dg	47	36	-35		D	Temp., 57° F.	109
110	1.7 mi. NW. of New Post	O. R. Eastriot			78	Dg	12	30	-6	5	D	Temp., 60° F.	110
111	2.6 mi. N.-NW. of New Post	Fredericksburg Country Club	H. Leazer	1946	60	D	110	8	(-)	10	D	Reported to contain iron.	111
112	Greenfield Village Subdivision 1.2 mi. N.-NW. of New Post	Sydnor Pump & Well Co., Inc.			70	D	620	6	(-)	40	Ab	Water is reported to contain 800-900 ppm of salt. Two other wells nearby provide water; wells are not as deep.	112

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia

Well No. 1. 2.8 mi. E.-SE. of Five Mile Fork; N. B. Rowe

(Log by Virginia Machinery & Well Co.)

Altitude 235 feet

	Thickness (feet)	Depth (feet)
Clay, red	40	40
"Marl," gray*	37	77
Sand	3	80
"Marl," gray*	70	150

* Driller's term "marl," believed to refer to clay.

Well No. 6. 1.0 mi. S.-SE. of Five Mile Fork; H. Bernstein

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 340 feet

Topsoil, gray	2	2
Bedrock and clay	6	8
Clay, red	59	67
Clay, yellow, and mica	15	82
Sand and clay, mixed	10	92
Sand, gray; clay, hard	17	109
Granite, gray, weathered	30	139
Granite, gray	43	182

Well No. 50. Bellevue Court Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 245 feet

Clay	5	5
Sand, clay, and gravel	7	12
Sand and gravel	33	45
Clay, blue	5	50
Clay, blue, and gravel	35	85
Mixed boulders and clay	65	150
Clay, white	15	165
Sand and gravel; sand and clay streaks	25	190
Clay, brown	10	200
Clay, brown, hard	40	240
Sand	10	250
Clay, brown	25	275
Clay, tough	2	277
Granite rock	2	279

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 51, Bellevue Court Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 240 feet

	Thickness (feet)	Depth (feet)
Sand and clay	6	6
Clay, red; sand	34	40
Clay, gray; sand	20	60
Clay, blue	64	124
Clay, red	11	135
Clay, gray	10	145
Clay and sand mixed; non-water-bearing	28	173
Sand, medium-coarse; gravel; little water	5	178
Sand; gravel mixed with clay	21	199
Clay, brown, hard	12	211

Well No. 52. Bellevue Court Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 240 feet

Clay, yellow	20	20
Clay, yellow; sand	8	28
Sand and gravel; mixed yellow clay	10	38
Gravel	9	47
Clay, yellow; gravel	3	50
Mud, black	75	125
Clay, gray	25	150
Sand and clay	50	200
Clay, red	3	203
Clay, brown	79	282
Granite, gray	26	308
Sandstone	12	320
Granite, gray	192	512

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 54. Cottage Green Subdivision; G. T. Waite

(Log by Mitchell's Well & Pump Co.)

Altitude 244 feet

	Thickness (feet)	Depth (feet)
Sand and clay	20	20
Sand and gravel	10	30
Clay, light-blue	10	40
Clay, black	71	111
Clay, blue	88	199
Sand, gray, hard	46	245
Sand, white, hard	5	250
Sand, gray, hard	15	265
Sand, white, hard	10	275

Well No. 55. Cottage Green Subdivision; G. T. Waite

(Log by Leazer Pump & Well Co.)

Altitude 244 feet

Soil	4	4
Clay, sandy, yellow	21	25
Sand; water-bearing	10	35
Clay, blue	35	70
Sandy clay, blue	60	130
Clay, green-blue	30	160
Clay, red	15	175
Clay, sandy, gray	25	200
Sand, fine	30	230
Clay, sand (shale?)	5	235
Sand, coarse	10	245
Clay, blue	30	275

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 58. 1.2 mi. E.-NE. of Four Mile Fork; W. A. Webster

(Drilled by Leazer Pump & Well Co.)

(Log by S. Subitzky)

Altitude 135 feet

	Thickness (feet)	Depth (feet)
Soil	3	3
Gravel; some sand; water-bearing	18	21
Silt, light-brown	25	46
Clay, blue; sand and gravel; water-bearing	14	60
Clay, blue, green	4	64
Clay, red	3	67
Clay, red, blue; some gravel	8	75
Clay, red, blue, green	2	77
Clay, red	2	79
Clay, gray	5	84
Clay; sand, brown (bailer test 2½ gpm)	6	90
Clay, brown, blue; sand and gravel	10	100
Sand, white; clay, yellow, green	39	139

Well No. 66. Courtland Heights Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 240 feet

Sand, yellow, hard	10	10
Clay, red	5	15
Sand, yellow; gravel	7	22
Sand, yellow; clay	13	35
Clay, blue	43	78
Clay, gray; thin streaks of gray fine sand	7	85
Sand, gray; clay	25	110
Clay, dark-gray	19	129
Sand, fine, gray	2	131
Clay, brown	4	135
Clay, red	30	165
Sand, gray, green; clay	15	180
Sand, gray	1	181
Sand, white and gray	2	183
Sand, gray; clay	17	200
Sand, gray; streaks of clay	5	205
Sand, gray; clay	4	209
Sand, coarse, gray; clay	9	218
Sand, gray; clay	10	228
Clay, green; sand	1	229
Clay; sand streaks	6	235
Clay, green; sand	15	250
Clay and sand	3	253
Clay, gray; sand	1	254
Sand, gray, coarse; gravels and clay streaks	11	265
Sand, coarse, gray	1	266

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 67. Courtland Heights Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 240 feet

	Thickness (feet)	Depth (feet)
Clay, red	17	17
Sand and clay	13	30
Sand and gravel	12	42
Clay, yellow	5	47

Well No. 71. Dillard Subdivision; Sydnor Pump & Well Co., Inc.

(log by Sydnor Pump & Well Co., Inc.)

Altitude 220 feet

Gravel	18	18
Gravel, soft	2	20
Clay, yellow	2	22
Clay, blue	41	63
Clay, blue; gravel	16	79
Clay and gray sand	6	85
Sand, hard; gravel	5	90
Clay, wet; sand	9	99

Well No. 72. Dillard Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 200 feet

Clay, red; rock	10	10
Clay, red	30	40
Clay, gray	10	50
Clay, yellow	10	60
Marl, dark	22	82
Sand, coarse	10	92
Undescribed	16	108
Sand	2	110
Clay, red	10	120
Clay, green	20	140
Clay, red	36	176
Clay, green	4	180
Sand	12	192
Clay, green	10	202
Sand, coarse	10	212
Clay	5	217
Clay and gravel	3	220
Clay, tough	30	250

Log continued on next page

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 72. Dillard Subdivision; Sydnor Pump & Well Co., Inc.--Continued

	Thickness (feet)	Depth (feet)
Clay, sandy, tough	50	300
Clay, gray, tough	5	305
Slate, sandy, gray	10	315
Slate, gray	10	325
Slate, sandy	12	337
Granite, gray	10	347
Granite, light; hardpan	15	362
Granite, light	13	375
Granite, gray and black	18	393
Granite, gray	17	410
Granite, light	5	415
Granite, gray and black	45	460
Granite, gray	30	490
Granite, gray and black	18	508
Granite, gray	7	515
Granite, very light	8	523
Granite, green	7	530
Granite, gray	100	630
Granite, gray and black	10	640
Granite, gray	15	655

Well No. 74. Dillard Subdivision; Sydnor Pump & Well Co., Inc.

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 200 feet

Gravel	20	20
Clay, gray	58	78
Sand, fine; gravels	2	80
Sand, fine	8	88
Marl, dark	16	104
Sand; clay, red	6	110
Clay, red	30	140
Clay, green	25	165
Sand and clay	20	185
Clay, green	8	193
Sand	22	215
Marl, blue	1	216
Mud; sand and clay	16	232
Hard material	18	250
Hardpan	15	265
Clay, hard	24	289
Granite, gray	311	600

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 77. 2.1 mi. NE. of Four Mile Fork; National Park Service

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 140 feet

	Thickness (feet)	Depth (feet)
Clay, yellow; sand	35	35
Mud, blue; sand	28	63
Clay, yellow and red	22	85
Clay, hard, brown and blue; dry	35	120
Mud, blue; sand; some water	30	150
Sand, white	13	163
Sand, white; caving hard	2	165

Well No. 80. Fredericksburg; State Normal School

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 120 feet

Clay, red	3	3
Clay, white	2	5
Gravel, white	3	8
Marl, blue; or clay	75	83
Granite, soft, blue	18	101
Granite, gray	123	224
Marl, blue, sticky (?)	½	224½
Granite, hard, gray	98½	323
Sand, loose; like decomposed sandstone	1	324
Granite, hard and soft, gray	96	420
Mud, blue; crevice	1	421
Granite, hard, light-gray	2	423
Mud, blue, sticky and sand. (Blue running sand mixed with marl on the order of quicksand. Tested well and relined with 8-inch pipe,)	4	427
Rock, soft, blue	2	429
Sand and blue mud	5	434
Rock, soft, blue	4	438
Mud, blue	7	445
Rock, soft, blue	2	447
Mud, blue	11	458
Rock, soft, blue	9	467
Mud, blue	3	470
Rock, soft, blue	2	472
Mud, blue	1	473
Rock, soft, blue	2	475
Mud, blue	1	476
Sandstone, hard, brown	39	515
Sandstone, hard, brown; crevice	8	523

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well ;No. 82, Fredericksburg Victoria Theater; B. T. Pitts

(Log by Mitchell's Well & Pump Co.)

Altitude 48 feet

	Thickness (feet)	Depth (feet)
Gravel and sand	30	30
Mud, red	10	40
Clay, blue; gravel	54	94
Sand	11	105
Mud, blue	9	114
Rock, soft	34	148
Rock, hard	5	153

Well No. 87, Sylvania Heights Subdivision; A. W. Embry

(Log by Sydnor Pump & Well Co., Inc.)

Altitude 64 feet

Clay, red	4	4
Sand, gravel, and clay, red	30	34
Clay, light-red; sand, gravel, coarse	9	43
Clay, hard red, sticky	18	61
Sand, blue and gray; clay, muddy and sticky	8	69
Sand; clay, gray, muddy and sticky	6	75
Sandy gravel, medium-coarse; clay	17	92
Clay, blue gray, mixed	79	171
Sand, medium-coarse; clay, gray	54	225

Well No. 97. 1.3 mi. E. of Four Mile Fork; R. D. Hull

(Generalized log described by Mrs. R. D. Hull)

Altitude 230 feet

Sandy gravel	20	20
Clay, red and yellow	20	40
Marl (clay), blue	40	80
Sand; sand and gravel	13	93

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Test hole No. 4. .7 mi. SE. of Fredericksburg; American Viscose Corp.

(Log by J. T. Ellington)

Altitude 65 feet

	Thickness (feet)	Depth (feet)
Sand and gravel	27	27
Rock (flint)	4	31
Sand and gravel	9	40
Clay, red	15	55
Clay, blue	75	130
Sandstone	140	270

Test hole No. 5. .7 mi. SE. of Fredericksburg; American Viscose Corp.

(Log by J. T. Ellington)

Altitude 65 feet

Sand and gravel; 12-inch boulders	15	15
Gravel, coarse	3	18
Sand and gravel	15	33
Rock; flint	4	37
Sand and gravel	5	42
Clay, red	9	51

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Well No. 98. 1.4 mi. E. of Four Mile Fork; R. Pearson

(Log by S. Subitzky and R. Pearson)*

Altitude 228 feet

	Thickness (feet)	Depth (feet)
Clay, sand, yellow	20	20
Clay, sandy, dark-green	10	30
Clay, green, white when dry	60	90
Sand, yellow	2	92

* This log was compiled from material lying around the well and pointed out to the author by Mr. Pearson.

Test hole No. 1. 1.7 mi. N.-NE. of Four Mile Fork

(Log by Layne-Atlantic Company)

Altitude 240 feet

Clay and topsoil	10	10
Clay, soft; sand, coarse	12	22
Gravel, small	10	32
Gravel and clay, red	2	34
Clay, blue, and gravel, large	29	63
Clay, soft, blue	40	103
Clay, blue and red, hard	58	161
Sand, fine	6	167
Clay, blue and gray	10	177
Sand, coarse	10	187
Sand, fine; clay, blue (quartz chips from 229-249)	62	249
Clay, blue; rock, weathered-granite	14	263

Table 2.--Logs of wells in eastern Spotsylvania County, Virginia--Continued

Test hole No. 2. 1.5 mi. E.-NE. of Four Mile Fork

(Log by Layne-Atlantic Company)

Altitude 110 feet

	Thickness (feet)	Depth (feet)
Clay, topsoil	8	8
Clay, some gravel	15	23
Clay, gravel, and sand	5	28
Sand, coarse; gravel, large	18	46
Clay, red, hard	8	54
Clay, white	6	60
Clay, brown	6	66
Clay, white; some sand	39	105
Clay, white and blue; gravel (small)	20	125
Clay, white and blue, hard and soft streaks	21	146
Clay, red and white	22	168
Clay, and sand, coarse	5	173
Clay, red; gravel (some)	14	187
Clay, sandy, blue	25	212
Sand, fine, dirty	6	218
Sand and clay, fine; rock, weathered	9	227
Rock, weathered; granite mica, black, feldspar	4	231
Rock, weathered; granite	1	232

Test hole No. 3. 2.2 mi. E.-SE. of Four Mile Fork

(Log by Layne-Atlantic Company)

Altitude 220 feet

Clay, sandy, red; sand and gravel, coarse	14	14
Sand, coarse; gravel, small	9	23
Clay, blue	21	44
Clay, blue, hard (silty); softer from 65-85 ft	41	85
Clay, sandy; blue (more sand from 106-126 ft.)	62	147
Clay, gray; sand, coarse	16	163
Clay, red, hard	25	188
Clay, hard red, yellow, blue	20	208
Clay, sandy, gray and yellow	21	229
Clay, sandy, gray	20	249
Clay, sandy, gray and red	6	255
Sand, medium-fine	5	260
Sand, medium coarse, interbedded with clay	17	277
Clay, red, hard, trace gray	13	290
Clay, sandy, gray	8	298
Sand, hard, coarse and fine; some clay	9	317
Sandy clay, hard, gray	10	327
Sand, coarse to fine; some very hard; gravel	5	332
Clay, gray, very hard, traces of red	19	351
Sand, hard, coarse	4	355
Sand, medium coarse; micaceous	4	359
Sand, medium coarse; bedrock, weathered	5	364

Table 3.--Chemical analyses of ground waters from eastern Spotsylvania County, Virginia
(Parts per million except specific conductance)

Well Number	1	12	42	49	53
Location	E.-SE. of Five Mile Fork	S.-SW. of Five Mile Fork	S. of Four Mile Fork	E.-NE. of Four Mile Fork	NE. of Four Mile Fork
Depth (feet)	150	33	48	275	175
Date	June 23, 1955	August 12, 1953	April 1, 1955	March 17, 1954	June 23, 1954
Silica (SiO_2)	47	10	--	30	39
Iron (Fe)	a 3.0	b 5.6	0.3	a .48	a 3.9
Calcium (Ca)	7.4	4.5	--	9.5	13
Magnesium (Mg)	4.0	4.0	--	6.9	5.6
Sodium (Na)	4.7	42	--	23	12
Potassium (K)	3.1	--	--	4.5	4.5
Carbonate (CO_3)	0	0	--	0	0
Bicarbonate (HCO_3)	36	63	--	96	85
Sulfate (SO_4)	5.2	30	--	8.8	12
Chloride (Cl)	9.2	43	--	16	2.8
Fluoride (F)	.1	--	--	.2	.0
Nitrate (NO_3)	.1	2.2	--	.1	.6
Dissolved solids	104	c 169	c 75	140	120
Hardness as $CaCO_3$	35	28	--	52	56
Specific conductance (micromhos at 25°C)	106	273	119	208	149

a Fe in solution at time of collection.
b Fe in solution and suspension at time of collection.
c Calculated.

Table 3.--Chemical analyses of ground waters from eastern Spotsylvania County, Virginia--Continued
(Parts per million except specific conductance)

Well number	54	55	57	58	63
Location	N.-NE. of Four Mile Fork	N.-NE. of Four Mile Fork	NE. of Four Mile Fork	E.-NE. of Four Mile Fork	E.-NE. of Four Mile Fork
Depth (feet)	275	275	259	139	286
Date	March 17, 1954	July 20, 1955	July 20, 1955	October 13, 1953	March 17, 1954
Silica (SiO_2)	34	--	--	33	28
Iron (Fe)	a 2.3	--	a 5.0	a 12	a 1.4
Calcium (Ca)	31	--	--	12	14
Magnesium (Mg)	21	--	--	7.5	8.2
Sodium (Na)	36	--	--	5.6	15
Potassium (K)	6.9	--	--	4.0	3.9
Carbonate (CO_3)	0	0	0	0	0
Bicarbonate (HCO_3)	84	84	82	75	102
Sulfate (SO_4)	14	--	--	10	10
Chloride (Cl)	112	114	3.0	2.2	7.6
Fluoride (F)	.2	.2	.2	.2	.2
Nitrate (NO_3)	.1	.2	.3	.0	.1
Dissolved solids	292	b 331	b 92	107	135
Hardness as $CaCO_3$	164	169	52	60	69
Specific conductance (micromhos at 25°C)	520	534	148	150	195

a Fe in solution at time of collection.
b Calculated.

Table 3.--Chemical analyses of ground waters from eastern Spotsylvania County, Virginia--Continued
(Parts per million except specific conductance)

Well number	70	76	78	81	91
Location	NE. of Four Mile Fork	NE. of Four Mile Fork	N.-NE. of Four Mile Fork	Fredericksburg	Fredericksburg
Depth (feet)	107	22	265	120	23
Date	March 17, 1954	June 21, 1954	June 21, 1954	1902(?)	July 21, 1955
Silica (SiO_2)	40	13	38	12	--
Iron (Fe)	a .34	a .03	a .51	--	a 0.06
Calcium (Ca)	1.8	2.5	22	.5	--
Magnesium (Mg)	3.0	.9	8.2	2.9	--
Sodium (Na)	2.4	1.3	37	3.3	--
Potassium (K)	2.2	.7	4.2	--	--
Carbonate (CO_3)	0	0	0	10	0
Bicarbonate (HCO_3)	6	11	103	--	16
Sulfate (SO_4)	17	.8	12	3.5	--
Chloride (Cl)	1.8	2.4	58	--	3.4
Fluoride (F)	.1	.0	.2	--	.1
Nitrate (NO_3)	.0	.2	.3	--	4.4
Dissolved solids	84	22	232	43	b 38
Hardness as $CaCO_3$	17	10	88	--	18
Specific conductance (micromhos at 25°C)	57	25.3	378	--	61.4

a Fe in solution at time of collection.
b Calculated.