Department of Natural Resources
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

REPORT OF INVESTIGATIONS NO. 34

THE AVAILABILITY OF GROUND WATER IN WESTERN MONTGOMERY COUNTY, MARYLAND

by
Edmond G. Otton

Prepared in cooperation with the
United States Department of the Interior
Geological Survey
Maryland Geological Survey
Montgomery County, Maryland
and the
Town of Poolesville, Maryland

1981

CONVERSION OF MEASUREMENT UNITS

The following factors may be used to convert the Inch-pound units published in this report to International System (SI) metric units.

To convert from	Multiply by	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
	Flow	
gallon per minute (gal/min)	.06309	liter per second (L/s)
million gallons per day (Mgal/d)	.04381	cubic meters per second (m^3/s)
	Transmissivity	
foot squared per day (ft^2/d)	.093	meter squared per day (m^2/d)

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CONTENTS

	Page
Abstract	1
Introduction	3
Well-numbering system	3
Acknowledgments	4
General geology	4
Occurrence of ground water	5
Ground water in storage	6
Movement of ground water	8
Major aquifers	8
Phyllite and associated rocks	8
Depth and diameter of wells	9
Yields and specific capacities of wells	9
Hydraulic properties — hydraulic conductivity and transmissivity	9
Sedimentary rocks of Triassic age	10
Ground-water occurrence	11
Depth of water-yielding zones	13
Local geohydrology	14
Depth and diameter of wells	14
Yields and specific capacities of wells	14
Hydraulic properties — hydraulic conductivity and transmissivity	15
Minor aquifers	23
Terrace deposits of Tertiary (?) age	23
Sediments of Quaternary age	23
Ground-water use	23
National Institutes of Health Animal Center	23
Domestic and farm	24
Town of Poolesville	24
Ground-water conditions at Boyds	26
Ground-water conditions at Dickerson	26
Ground-water conditions at Poolesville	29
Change in yield of wells	30
Effect of pumping on ground-water levels	31
Course of future development	34
Chemical quality of water	36
Silica (SiO_2)	36
Iron (Fe) and manganese (Mn)	36
Sulfate (SO_4)	37
Chloride (Cl)	38
Fluoride (F)	38
Nitrate (NO_3 as N)	38
Dissolved solids	39
Copper (Cu) and Zinc (Zn)	39
Hardness and pH	39
Hazards of ground-water contamination	40
Summary	41
Selected references	42
Supplemental ground-water data	45

ILLUSTRATIONS

		Page
Figure 1.	Map showing location of study area	3
2.	Map showing general geology, linear geologic features, and location of high-yielding wells	pocket
3.	Mean monthly water level in observation well MO-DC 1 near Dawsonville, and mean monthly precipitation at Boyds	6
4.	Diagram of ground-water occurrence in crystalline rocks such as phyllite and schist	9
5.	Diagram of ground-water occurrence in jointed and creviced consolidated sedimentary rocks	13
6.	Graph showing number of wells in various depth intervals and number of water-yielding fractures in these intervals	13
7.	Three geohydrologic sections in the vicinity of Poolesville: Section A-A′ from Martinsburg to Sewage Pond Road; Section B-B′ from the N.I.H. Animal Center through Poolesville; Section C-C′ from Offut Road to Maryland Route 28	pocket
8.	Specific capacity of wells versus saturated thickness of aquifer penetrated	15
9.	Well pumpage at Poolesville 1974-1979 and pumping level in two supply wells	25
10.	Map of Boyds area showing topography and geology	27
11.	Map of Dickerson area showing topography and geology	28
12.	Time-drawdown graph of water levels during an aquifer test on well -CB 29 near Dickerson	30
13.	Graphs showing decrease in yield of Town of Poolesville's wells in 1978	31
14.	Potentiometric map of the Poolesville area, November 15-16, 1978	32
15.	Potentiometric map of the Poolesville area, January 15-16, 1979	33
16.	Geology of the Poolesville area showing linear features and approximate area of hydraulic influence of town wells	35
17.	Graph showing hardness of water from wells in Triassic sedimentary rocks and in pre-Triassic crystalline rocks	39
18.	Map showing distribution of hardness and pH of water in western Montgomery County	pocket
19.	Water levels in selected observation wells, 1977-79	53
20.	Map showing location of 5-minute quadrangles in western Montgomery County	64
21.-30.	5-minute quadrangle maps showing well locations	65 to 74

TABLES

		Page
Table 1.	Gravity yield (storage coefficients) of small drainage basins in Maryland and Pennsylvania	6
2.	Storage coefficients determined from aquifer tests on wells in crystalline rocks and in consolidated sediments	7
3.	Summary of aquifer tests in phyllite and associated rocks	10
4.	Values of transmissivity of phyllitic rocks as determined from specific-capacity tests on wells	10
5.	Laboratory values of porosity for consolidated sedimentary rocks of Triassic age	12
6.	Distribution of 80 wells according to their productivity (yield)	14
7.	Hydraulic conductivity (K) values for sedimentary rocks of Triassic age	17
8.	Transmissivity values of Triassic sedimentary rocks determined from aquifer tests and from specific-capacity values for wells	18
9.	Annual pumpage from wells at the N.I.H. Animal Center from 1971 through 1978	24
10.	Records of municipal wells at Poolesville	25
11.	Summary of water-quality data from aquifers in western Montgomery County	37
12.	Lithologic description of cuttings from selected wells	46
13.	Montgomery County well records	54

THE AVAILABILITY OF GROUND WATER IN WESTERN MONTGOMERY COUNTY, MARYLAND

By

Edmond G. Otton

ABSTRACT

Western Montgomery County is underlain by pre-Triassic crystalline phyllite and schist, by Triassic shale, siltstone, and sandstone, by terrace deposits of Tertiary (?) age, and by surficial alluvial deposits of Quaternary age. Water occurs chiefly in fractures and crevices in the rocks under water-table or modified artesian conditions. The source of all the ground water is local precipitation, amounting annually to about 42 inches.

Yields of wells range from a few to 400 gallons per minute. Specific capacity, a better index of the productivity of wells, ranges widely. The median specific capacity of 21 crystalline-rock wells is 0.18 gallon per minute per foot, and the median specific capacity of 80 wells in the consolidated sediments is 0.15, suggesting little significant difference between the two major rock types. Median transmissivity of the crystalline rocks is 35 square feet per day and the median transmissivity of the Triassic sedimentary rocks is 17 square feet per day. Storage coefficients range widely, but the mean value in the Triassic rocks at the Poolesville well field is about 0.01.

In 1978, well pumpage at the N.I.H. Animal Center averaged 28,000 gallons per day; pumpage from four wells at Poolesville during 1978 averaged 246,000 gallons per day. Ground-water use in the remainder of the area in 1978 is estimated to have been 250,000 gallons per day.

During dry periods of 60 days or more, the yield of the four public-supply wells at Poolesville declines substantially. In 1978, this decline amounted to about 36 percent, based on the comparative yield of the wells during two 60-day periods. Additional well supplies are needed by the town to prevent future water crises.

Chemical quality of the water is suitable for most uses. Water from the crystalline rocks is mildly acidic and soft. Water from the Triassic rocks is commonly mildly alkaline and has a greater hardness. Because of the relatively thin soil zone and the fractured nature of the underlying rocks, chances of polluting the aquifers are relatively great. Possible pollutants might be septic-tank effluent, road salt, chemical fertilizers, and insecticides and herbicides. Because of the relative ease of movement of water in fractured rocks, the effects of spills of hazardous or toxic wastes could be intensified.

INTRODUCTION

This report summarizes the preliminary conclusions of a 2-year study by the U.S. Geological Survey and the Maryland Geological Survey to determine the availability of ground water in a 93-mi^2 area in western Montgomery County, Maryland. This investigation was requested by officials of Montgomery County and the Town of Poolesville to determine the nature and adequacy of the ground-water resource.

The study area lies in the Piedmont region of central Maryland and the southeast corner of the area is about 15 mi northwest of Washington, D.C. (fig. 1). The southern and western boundaries are the Potomac River. The entire area is drained by tributaries of the Potomac River—chiefly Seneca Creek, Broad Run, and the Little Monocacy River.

Topographically, the area consists of a few square miles of flat uplands, a considerable area of rolling, dissected uplands, and 4 to 5 mi^2 of relatively flat, lowland terraces bordering the Potomac River on the south and west. Land elevations range from 200 ft above mean sea level (m.s.l.) near the mouth of Seneca Creek to 627 ft m.s.l. near Slidell, providing a total relief of more than 425 ft.

Well-Numbering System

The wells and springs described in this report are numbered according to a coordinate system in which Maryland counties are divided into 5-minute quadrangles of latitude and longitude. The first letter of the well number designates a 5-minute segment of latitude; the second letter designates a 5-minute segment of longitude. These letter designations are followed by a number assigned to wells chronologically. This letter-number sequence is the quadrangle designation, which is preceded by an abbreviation of the county name. Thus, well MO-ED 7 is the seventh well inventoried in quadrangle ED in Montgomery County. In reports describing wells in only one county, the county prefix letters are frequently omitted from the well number. However, the numbering system currently in use (1979) differs slightly from that used in earlier published reports, such as Meyer (1958). In the 1958 report, well MO-ED 7 was designated as Mont-Ed 7. The discontinuance of the use of lowercase letters in the well designation was necessitated by the change

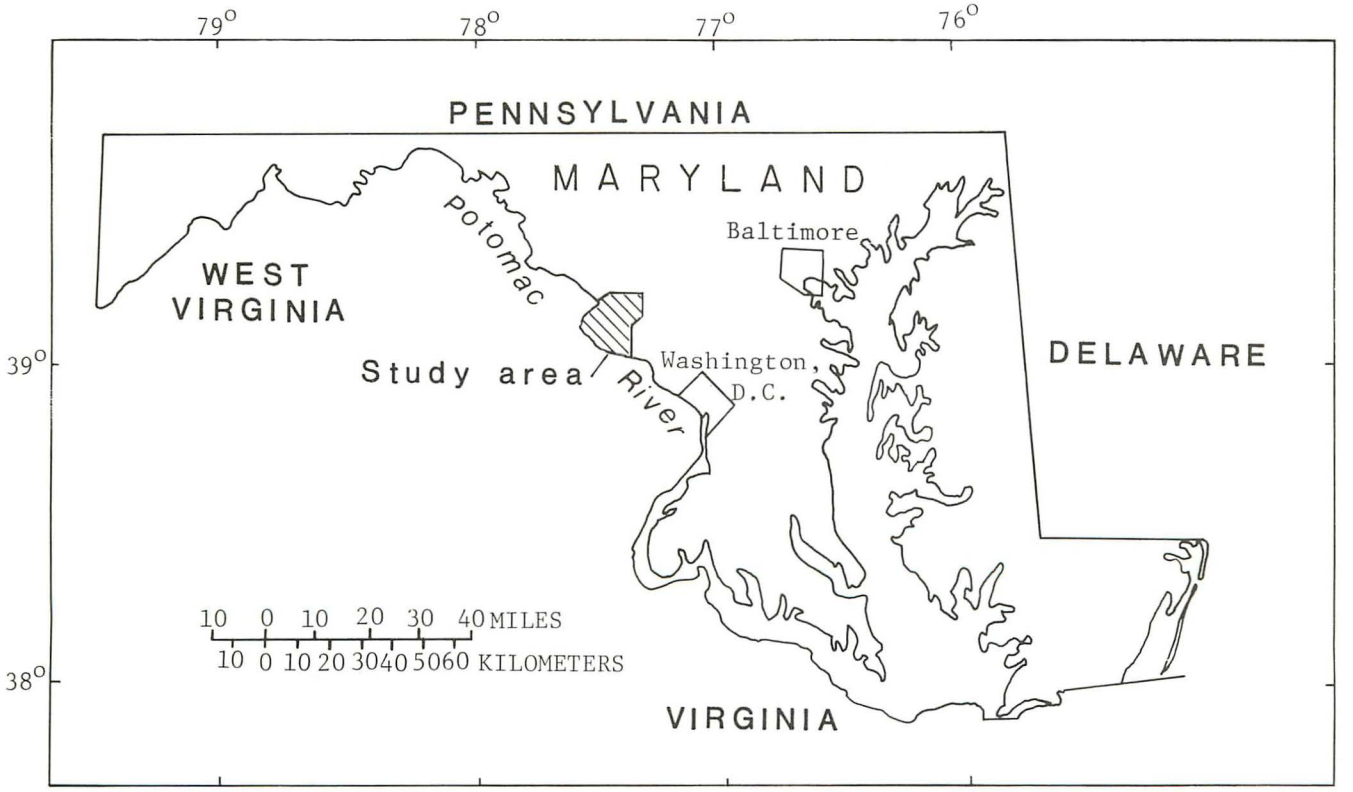


Figure 1. — Location of study area.

in 1970 to a computer storage and retrieval system for well information.

Water wells drilled in Maryland since 1945 also have a number assigned by the Maryland Water Resources Administration. Prior to 1965 the wells were numbered sequentially on a statewide basis. Beginning in 1965 the well number consisted of a two-letter county prefix (for example, MO for Montgomery County) followed by a two-digit number indicating the State fiscal year in which the permit was issued (for example, -72 for the 1972 fiscal year). A four-digit chronologic sequence number follows the fiscal year designation. Thus, well MO-72-0010 is the 10th well permit issued for Montgomery County during the 1972 fiscal year.

Since fiscal year 1973, however, the wells have again been numbered sequentially in Montgomery County regardless of the fiscal year they were drilled.

Acknowledgments

The author wishes to express his appreciation to the well drillers, municipal, county, and State officials, local residents and all others who supplied information on their wells, or permitted water-level measurements to be made. Particular thanks are given personnel of the Montgomery County Office of Environmental Planning, Commissioners of the Town of Poolesville, the Maryland National Capital Park and Planning Commission, the Washington Suburban Sanitary Commission, the National Institutes of Health (N.I.H.) Animal Center, and the Potomac Electric Power Company (PEPCO).

Acknowledgement is also given the engineering firms of Shaeffer and Roland, Inc., and to the firm of CH_2M-Hill and Associates for information on the engineering properties of earth materials in the study area.

GENERAL GEOLOGY

Figure 2 is a map showing the generalized geology of western Montgomery County. Two major rock types underlie the area. The oldest is phyllite and associated rocks, classified as unit A of Froelich (1975b). These ancient crystalline rocks, occupying about one-third of the report area, lie north and east of Poolesville. They consist of quartzitic, chloritic, sericitic, gray to green phyllite. Veins and bands of white to gray quartzite, as much as 30 ft thick, are common within the phyllite. All the rocks are intensely foliated and fractured. In the northwestern part of the area, east of Dickerson, bands of folded quartzite are so prominent that Froelich (1975b) has designated these rocks as unit C, but they are not differentiated on figure 2 of this report.

South and west of the outcrop area of phyllite, a structural trough occurs, which extends across the Potomac River to the foot of the Catoctin Mountains. This troughlike basin is filled with sedimentary rocks of Triassic age. The basin extends southward from Frederick, Md., to central Virginia. It is known as the Culpeper basin and is one of a series of similar basins along the east coast of the United States. The sedimentary rocks in the basin consist of arkosic red to brown interbedded siltstone, shale, and sandstone. Along the western border of the Triassic basin, in Loudoun County, Va., and in Frederick County, Md., a distinctive limestone conglomerate is present. Locally, this rock has been quarried as a building stone; it is sometimes known as "Potomac marble."

The Triassic sedimentary rocks have been intruded in several places by a series of diabase dikes and sills. Diabase is a hard, dense dark-gray to black crystalline rock derived from a molten source deep in the earth's crust. Diabase commonly occurs in the form of ridges, and one such ridge extends southward from the Frederick County line along the east boundary of the N.I.H. Animal Center nearly to the Potomac River.

The Triassic sedimentary rocks in Montgomery County are probably no more than 2,000 ft thick, which is much less than suggested by earlier writers (Stose and Stose, 1946, p. 86).

Terrace deposits of Tertiary (?) age cover about 6 mi^2 along the uplands east of the Potomac River. Few wells yield water from them and little is known about them, although they range from a few to 90 ft in thickness. They appear to be poorly sorted gravel in a silt and clay matrix.

Alluvial deposits of Quaternary age overlie the consolidated Triassic sedimentary rocks along extensive areas bordering the Potomac River. Few data are available concerning the character and thickness of these deposits. In road cuts, they appear to be mostly clay and silt. Dingman and Meyer (1954, p. 12) report their maximum thickness probably does not exceed 50 ft. It is possible that thin water-yielding sands and gravel may be present in the alluvium, but no data are available to confirm or deny this possibility.

OCCURRENCE OF GROUND WATER

Ground water is the water beneath the land surface in the zone of saturation. The zone of saturation extends downward to unknown depths where all (or most) voids in the rocks disappear. Ground water in the study area occurs in joints, faults, crevices, and in the consolidated sediments to a limited degree in the interstitial pores and voids.

Precipitation is the source of all ground water in the study area. Precipitation is part of the hydrologic cycle, which also includes evaporation and transpiration (evapotranspiration) and runoff. Runoff may be classified as overland runoff and ground-water runoff. Runoff, or streamflow, is a combination of overland runoff and ground-water runoff, or base flow as it is sometimes called. Base flow provides the water that maintains the flow of streams during dry periods, or during periods between storms. The elements of the hydrologic cycle may be quantitatively expressed by the hydrologic budget equation. In ordinary terms, assuming ground-water use (pumping) is negligible, this is expressed as follows:

$$P = R + ET \pm \Delta S$$

where

P = precipitation,

R = runoff,

ET = evapotranspiration, and

ΔS = change in ground-water storage.

Two of the four items in the above equation are relatively easy to measure; these are precipitation and runoff. Evapotranspiration, because it is difficult to measure, is commonly determined as the water unaccounted for after runoff from a basin is subtracted from precipitation in it. Over a long period of time, change of ground-water storage equals zero, but for short periods water may be added to or subtracted from the aquifers. An exception to this situation could occur where geohydrologic conditions provide a means for water to move out of a stream basin and discharge into another basin, or into an estuary, bay, or ocean. Heavy ground-water pumping and the export of water from the basin would also be an exception to the idealized concept of the hydrologic budget equation.

In a publication describing the water resources of Howard and Montgomery Counties, Dingman and Meyer (1954, p. 39) studied the hydrologic budget for the Rock Creek basin in Montgomery County. These authors determined that the hydrologic budget for the 62-mi^2 drainage area above the stream-gaging station, for the period 1933-49, was as follows:

$$P = R + ET \pm \Delta S$$

or, annually in inches of water:

$$43.5 = 12.6 + 30.9 + 0.$$

Based on an analysis of the stream hydrograph for the 17-year period, these authors determined that the ground-water runoff averaged 8.5 in. per year, or about 20 percent of the annual average precipitation of 43.5 in. The Rock Creek basin is underlain mainly by schist and gneiss and was semiurbanized during the time represented by the streamflow analysis.

Dingman and Ferguson (1956, p. 48), utilizing an analysis of the stream hydrograph of the Little Gunpowder Falls basin during the period 1927-49, determined that the ground-water runoff averaged 11.3 in. per year, or 27 percent of the precipitation. The 36-mi^2 area above the gaging station on Little Gunpowder Falls basin is underlain chiefly by schist, gneiss, and amphibolite. At the time of the study, the area was largely rural in character.

The mean of the two values of ground-water runoff given above is 9.9 in. per year, which is 23 percent of the average annual precipitation. For the area of this report, an average annual precipitation of 42 in. is assumed (Schwiesow and others, 1970, p. 24). As 23 percent of 42 in. equals 9.7 in., ground-water runoff is estimated to be about 10 in.

Ground-water runoff is equal to total ground-water discharge minus discharges to evapotranspiration (ET) and pumping. The amount of recharge not ultimately consumed by evapotranspiration is called effective recharge. Assuming that pumping is negligible, the effective recharge is equal to ground-water runoff, and in the study area the effective recharge is estimated to be 10 in. per year.

The behavior of the hydrologic cycle in aquifers during an annual cycle is shown in figure 3. The heavy line on the figure is a plot of the mean monthly water level in an observation well near Dawsonville during the period, 1949-60. This well,

6 in. in diameter, is 110 ft deep and was measured monthly during the 12-year period of record. The graph shows that November through February is the period of ground-water recharge characterized by rising water levels. The period, April through September, is characterized by falling ground-water levels. However, the maximum precipitation occurred during the months of June, July, and August, a period of declining ground-water levels. Of course, during these warm months, evapotranspiration is at a maximum and the effect of the relatively heavy precipitation is merely to put an upward bulge in the declining ground-water level. The low point in the ground-water curve occurs in October when evapotranspiration decreases significantly and precipitation is also low, averaging about 2.8 in. during the 12-year period of record. Because of the decreased evapotranspiration rate, the fall rains of November and December become very effective in recharging the ground-water reservoirs.

On the average, the ground-water level in well MO-DC 1 fluctuated throughout a range of nearly 12 ft. As the well was unaffected by pumpage, this provides a rough index of natural changes in ground-water storage, although, in any one annual cycle, an even greater range can occur.

Ground Water in Storage

Even in areas underlain by relatively dense and poorly porous crystalline rocks and consolidated sediments (the rocks underlying western Montgomery County), substantial amounts of water can be stored. The water is stored both in voids in the saprolite and in fractures, crevices, and bedding-plane joints in the hard rock. The storage potential of the rocks decreases with depth, and at depths of several thousand feet it must be very low, probably less than 1 percent.

The capacity of an aquifer to store water is measured by the *storage coefficient* (S), defined as the volume of water an aquifer releases from or takes into storage per unit of surface area per unit change in head (Lohman, 1972, p. 8). The storage coefficient for unconfined aquifers is approximately equal to gravity drainage, providing gravity drainage is complete. Commonly, storage coefficients may range between values of 0.30 ($3x10^{-1}$) to 0.00001 ($1x10^{-5}$). Three different situations may exist within the common range of coefficients; these are:

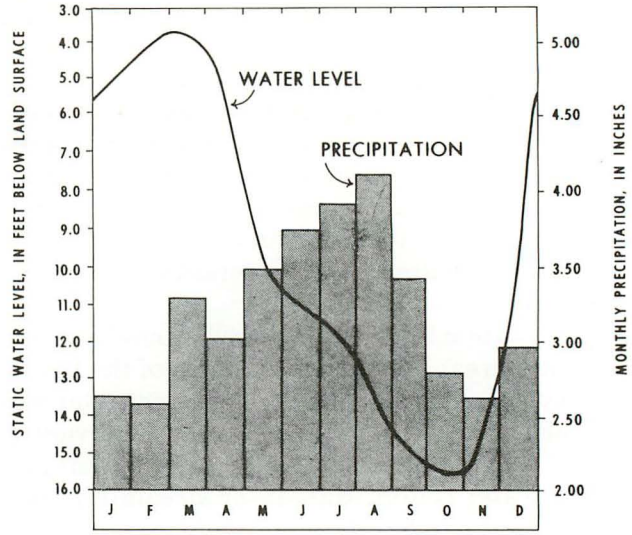


Figure 3. — Mean monthly water level in observation well MO-DC 1 near Dawsonville, and mean monthly precipitation at Boyds.

Storage coefficient (percent)	Situation
0.30 to 0.05	Water table
0.049 to 0.001	Intermediate (modified artesian)
0.0009 to 0.00001	Artesian

Storage coefficients for unconfined crystalline-rock aquifers may be determined by using streamflow and observation-well measurements in relatively homogeneous drainage basins. The results of these studies of basins in Maryland and Pennsylvania are in table 1.

Table 1. — Gravity yield (storage coefficients) of small drainage basins in Maryland and Pennsylvania.

Basin studied	Rock type	Storage coefficient (percent)	Reference
Muddy Creek, Pa.	quartz-mica schist	8	Lloyd, O.B., Jr., and Growitz, D.J. (1977)
Brandywine, Pa.	schist, gneiss, and granite	7	Olmsted and Hely (1962, p. A-16)
Piney Run, Carroll County, Md.	quartz-mica schist	8	Nutter and Otton (1969, p. 28)
Little Conestoga Creek basin, Pa.	carbonate rocks	4	Meisler and Becker (1971, p. 56)
Big Pipe Creek at Bruceville, Md.	phyllite and schist	1.2	Trainer and Watkins (1975, p. 25)
Seneca Creek at Dawsonville, Md.	shale, siltstone, and schist	0.7	Do.

The more than tenfold range in the storage coefficient shown above may be due, in part, to slight variations in the method of analysis used by the different authors. However, it may be due also to inherent differences in the characteristics of the rocks in the different basins. The relatively low values reported for Big Pipe Creek and Seneca Creek (1.2 and 0.7 percent, respectively) may be the result of the thin weathered zone commonly occurring in areas underlain by phyllite, shale, and siltstone. Thin saprolite provides only minimal storage of ground water.

Webster and others (1970, p. I-21) determined that the fracture porosity (storage coefficient) of a chlorite-hornblende schist near Aiken, S.C., was 0.08 percent. This value was determined by a method involving the determination of the travel time of a tracer substance, tritium, between an input and an output well. The test required extensive preparation and a long pumping period, but the method offers promise for use in other areas, possibly using inexpensive substances such as sodium chloride or sodium iodide for tracers. The formula given by these authors is:

$$\theta = \frac{3qo(tao)}{\pi L^2 m}$$

where:

θ = porosity, in percent,

qo = input-output rate of flow during test,

tao = Shortest transit time along path between the two wells,

L = distance between the two wells, and

m = thickness of the aquifer.

Storage coefficients determined from aquifer tests in crystalline rocks commonly fall in the intermediate or artesian situation. Storage coefficients from aquifer tests where artesian conditions prevail are orders of magnitude less than those values given in table 1. This is due in part to the short period of pumping from which the coefficient is determined, as most of the water initially is derived from the dewatering of large volumes of rock in the vicinity of the well. This water occurs under artesian conditions in the fractures. Gradually, the effect of the dewatering is transmitted to the shallower saturated materials, where water-table conditions largely prevail. Values of storage coefficients determined from aquifer tests in both crystalline rocks and in consolidated sediments are given in table 2.

Table 2. Storage coefficients determined from aquifer tests on wells in crystalline rocks and in consolidated sediments.

Well No.	Area Location	Rock type	Length of test (days)	Storage coefficient (S)
MO-CF 19 [1]	Laytonsville (Mont. Co.)	pelitic schist	4.7	0.017
MO-CF 21 [1]	Laytonsville (Mont. Co.)	pelitic schist	5.1	.003
MO-CF 24 [1]	Laytonsville (Mont. Co.)	boulder gneiss	2.9	.002
MO-DB 25 [2]	N.I.H. Animal Center	shale and sandstone	2.1	.004
MO-DB 26 [2]	N.I.H. Animal Center	shale and sandstone	5.0	.0006
MO-DB 54	Poolesville (Mont. Co.)	shale and sandstone	0.4	.00008
MO-DB 79	Poolesville (Mont. Co.)	shale and sandstone	6.9	.0002
CA-BB 6 [3]	Taneytown (Carroll Co.)	shale and sandstone	——	.0002
52V-2D [4]	Reston, Va.	shale and sandstone	1.0	.0009

[1] Data from Nutter and Otton (1969, p. 33).
[2] Data from consultant's report to National Institutes of Health.
[3] Data from Meyer (1958, p. 123).
[4] Data from Larson (1978, p. 20).

Movement of Ground Water

Water in an aquifer may occur under either unconfined (water-table) conditions or confined (artesian) conditions. In an unconfined aquifer the top of the saturated zone is free to fluctuate in response to recharge to or discharge from the aquifer. Under confined conditions the water in an aquifer is confined under hydrostatic pressure beneath a relatively impermeable bed or layer of rock. In cased wells tapping a confined aquifer, the water level rises above the confining layer to a level called the potentiometric surface. When the potentiometric surface of an aquifer penetrated by a well is above the land surface, the well flows. The potentiometric surface may also fluctuate in response to changes in rates of recharge and discharge, whether from natural or man-induced causes.

The capacity of a rock or soil to yield water to wells is determined by its permeability or hydraulic conductivity, a measure of the ease of movement of water through a rock or soil under a hydraulic gradient. The permeability is governed chiefly by the number, size, shape, and degree of interconnection of the primary and secondary openings. The U.S. Geological Survey has adopted the term "intrinsic permeability" to refer to the property of the medium alone to transmit a fluid and "hydraulic conductivity" to include the properties of natural ground water that affect its ease of movement (Lohman, 1972, p. 5).

The "transmissivity" (T) indicates the capacity of an aquifer to transmit water through the entire thickness of an aquifer. It is defined as the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient (Lohman, 1972, p. 6).

The transmissivity and storage coefficient are commonly determined by means of aquifer tests. These properties may also be determined by means of formulae using the base flow of streams and the altitudes of water levels in wells, or at the mouths of springs. These formulae will be used in a subsequent part of this report.

Natural rates of movement of ground water in a Piedmont schist range from very slow to moderately rapid. At hydraulic gradients on the order of 25 feet per 1,000 feet (0.025), ground-water movement ranges from less than 0.01 ft/d to 20+ ft/d, depending on the local hydraulic conductivity. Rates lesser or greater than these are of course common, and the flow rates will change in response to changes in the hydraulic gradient.

MAJOR AQUIFERS

Phyllite and Associated Rocks

Ancient crystalline rocks, chiefly phyllite and, locally, bands of quartzite with interlayered phyllite underlie the northeast one-third of the area. Mafic rocks (greenstone and green schist) are also present in a relatively small area southwest of Barnesville. Phyllite is a gray and green foliated rock composed mainly of very fine-grained mica and chlorite, which imparts a surface sheen to the rock. The phyllite is sericitic, chloritic, and quartzose.

The mafic rocks consist of darker meta-volcanic and meta-igneous rocks forming a complex also filled with both large and small quartz veins and pods.

All these rocks are foliated, fractured, and jointed, although the joint planes may be poorly defined in the phyllitic and schistose rocks. Faults are common in these rocks, but individual fault zones may be difficult to identify in the field. Phyllite and phyllitic schist weather to a saprolite consisting of a thin soil containing abundant angular, flattish rock fragments (channers). Residual quartz is common in the thin soils. The distribution of phyllite and related rocks is shown on figure 2.

Streams in the Piedmont, both large and small, commonly tend to be oriented along major linear zones of rock fracturing or breakage. Such zones may extend for a mile or two, or may extend for only a few hundred feet. Within these zones, rock weathers more readily and voids are larger and more common. The best wells commonly are situated along or near linear zones of rock weakness. The location and trend of these zones are difficult to identify, although, in some places, they are marked by straight stream reaches or by tonal differences in the surface soils.

Figure 2 shows the location of many "linear features" that may be fracture traces. These are shown to aid in the siting of wells where maximum yields are desired.

Because of the irregular distribution of the fractures and voids in the crystalline rocks, it is difficult to locate wells with assurance that the required yield can be obtained. In general, wells in valleys yield more water than wells on hilltops or on hillsides. Some rock types, such as marble, generally yield more water than phyllite or schist, but rock type may not be as important in determining the yield of a well as its topographic location, or whether or not it was drilled along a major linear feature. Figure 4 shows a typical crystalline-

rock well, and indicates the somewhat random nature of the fractures in the rocks. The figure also shows some fractures isolated from sources of surface recharge (see the basal fracture in the hypothetical well) and these could be rapidly dewatered during pumping. The water table (the top of the zone of saturation) is higher beneath hills than it is in valleys. Arrows in the figure indicate the direction of ground-water movement from the upland hilltop area to the adjacent stream valleys. The arrows are not intended to imply, however, that the flow is through the relatively impervious hard rock between the fractures.

Depth and Diameter of Wells

The depth of 35 wells in the crystalline rocks ranges from 40 to 300 ft and the median is 116 ft. The deepest well, MO-CC 35, is 0.8 mi northeast of Beallsville and was drilled for domestic use. It reportedly yielded 1 gal/min and had a specific capacity of less than 0.01 (gal/min)/ft.

Most domestic wells are 6 in. in diameter, although a few of the older wells in the area are 4 in. in diameter. Wells are generally cased at least to the base of the weathered zone. In recent years, Montgomery County has required that all drilled wells be cased to a minimum depth of 40 ft.

Yields and Specific Capacities of Wells

The reported yields of 26 wells in the crystalline rocks range from 0 to 100 gal/min. These wells are 6 in. in diameter and, with the exception of test well MO-CD 47, yielding 100 gal/min, are domestic wells. The median yield of the wells is 7.5 gal/min, and 7 wells (27 percent) yield less than 2 gal/min. Wells yielding less than 2 gal/min are not considered adequate for a domestic supply by the Maryland Water Resources Administration [1].

The most productive well (MO-CD 47) was drilled for test and exploratory purposes at a proposed sanitary landfill site near Clarksburg, 0.7 mi northeast of the area of this report. The well is in a small swale along a presumed fracture trace. It is 125 ft deep and was yield-tested for 72 hours in April 1975 at 100 gal/min.

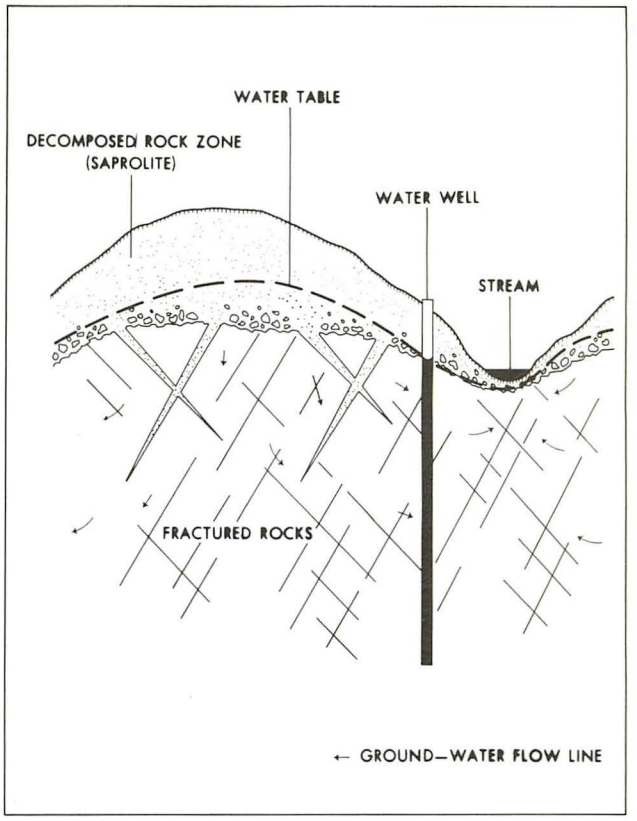


Figure 4. — Diagram of ground-water occurrence in crystalline rocks such as phyllite and schist.

The specific capacity [2] of 21 wells ranges from 0.0 to 2.4 (gal/min)/ft of drawdown. The median specific capacity is 0.18 (gal/min)/ft, indicating that these rocks are generally a poor aquifer. The maximum reported specific capacity was from well MO-CD 47, based on the 72-hour test.

Hydraulic Properties — Hydraulic Conductivity and Transmissivity

The crystalline phyllites and phyllitic schists are overlain by a relatively thin saprolite. Little information is available concerning the permeability of this material. According to Meyer (1958, p. 46), its thickness, based on the casing-length records of 54 wells in Carroll and Frederick Counties, ranges from a few to 57 ft and averages about 19 ft. Recent boring data from areas underlain by phyllite north of the area of this report suggest that the average thickness of the saprolite may be even less than indicated by Meyer. No determinations of the permeability of this material are available.

Values of transmissivity have been determined on the basis of three aquifer tests; these are from wells north and east of the study area. The results of these tests are summarized in table 3.

[1] The Maryland Water Resources Administration defines the minimum yield for a domestic water-supply system as one that will yield not less than 250 gallons of water for a 2-hour period. The well water-supply system shall be capable of producing this quantity at least three times (750 gallons total) during any one 24-hour period (Maryland Water Resources Administration, Title 08, Subtitle 05, Chapter 02 — Groundwater Regulations, p. 213).

[2] Specific capacity of a well is the yield per foot of drawdown of the water level in the well. No time period is, however, specified for the measurement of this parameter, which is commonly expressed in gallons per minute per foot of drawdown. For many domestic wells the period of measurement ranges from 2 to 6 hours. Generally, drawdown increases in a well with increased time of pumping. Determination of the specific capacity of a well is a more reliable measurement of well productivity than measurement of its yield, as specific capacity is less dependent on the test yield selected. At a constant yield rate, the drawdown of a well slowly increases with increasing time; hence, its specific capacity gradually decreases. This will occur until the expanding cone of influence of the well intercepts a source of recharge sufficient to equal the discharge from the well.

Table 3. — Summary of aquifer tests in phyllite and associated rocks.

Well No.	Location	Depth of pumped well (ft)	Length of test (hours)	Transmissivity in ft^2/d (T)	Average yield during test (gal/min)	Date of test
CL-EC 75	S. of Winfield, Carroll Co.	248	6	12	15	Nov. 1974
MO-CD 47	S. of Clarksburg, Montgomery Co.	125	72	[1] 71	100	Apr. 1975
FR-EH 10	NW. of Mt. Airy Frederick Co.	260	64	[2] 670	236	Jan. 1975

[1] Based on drawdown slope computed for period from 2,000 to 4,500 minutes in pumped well.
[2] Based on drawdown slope computed for period from 1 to 200 minutes in pumped well.

Approximate values for the transmissivity of an aquifer may also be determined on the basis of a formula given by Lohman (1972, p. 52). This formula, given below, makes use of the relationship between the specific capacity of a well and the hydraulic properties of the aquifer. The formula is based on the assumption that all wells are 100 percent efficient, which none are. For wells with screens, most of the loss of efficiency is caused by the screen and the fine materials trapped behind it. Little is known concerning the efficiency of open-hole rock wells.

$$\frac{Q}{s} \cong \frac{4\pi T}{2.30 \log\left(\frac{2.25Tt}{r_w^2 S}\right)}$$

where:

$\frac{Q}{s}$ = specific capacity of the well, in (gal/min)/ft of drawdown,

T = transmissivity, in ft^2/d,

S = storage coefficient, dimensionless,

t = time, in days, and

r_w = effective radius of the well, in feet (assumed to be 0.5 foot for rock wells).

Using the above relationship, William Fleck of the U.S. Geological Survey (oral commun., 1979) devised a computer program to generate the appropriate curve-matching response to a large number of variables in the above formula. This program was used to determine the approximate transmissivity of the aquifer from specific-capacity tests. Results are given in table 4.

Table 4. — Values of transmissivity of phyllitic rocks as determined from specific-capacity tests on wells.

Well No.	Well depth (feet)	Specific capacity (gal/min)/ft	Length of test (hours)	Transmissivity in ft^2/d (T)
MO-CC 2	125	1.2	4	165
MO-CC 3	112	2.0	3	260
MO-CC 34	125	0.2	2	27
MO-CC 37	98	0.3	2	35
MO-CD 31	185	0.1	-	13
MO-DC 64	150	0.1	5	13

The data in tables 3 and 4 indicate a range in transmissivity values of 12 to 670 ft^2/d, and a median value of 35 ft^2/d, based on 9 values. This supports the conclusion that the phyllitic rocks are a poor aquifer, and in some places, approach the limit of being considered an aquifer.

Sedimentary Rocks of Triassic Age

About two-thirds of western Montgomery County is underlain by shale, siltstone, and sandstone, comprising a group of sedimentary rocks of Triassic age (fig. 2). These rocks lie in a geological basin known as the Culpeper basin, where they have been extensively studied near Culpeper, Va. In Montgomery County, the basin extends west-

ward from the lower part of Seneca Creek to the Potomac River, and extends southward from the Frederick County line into the area of this report just east of Dickerson, to a point about 1/4 mi northeast of Poolesville.

The basin is also present on the west side of the Potomac River in Loudoun County, Va. Here it terminates in a major fault against the Catoctin Mountains. A 2- to 3-mile-wide extension of the basin trends northward into Frederick County near Frederick, Md. North of this city, another major structural feature affecting the Triassic rocks, the Gettysburg basin, extends across the Maryland line to Gettysburg, Pa., and beyond.

The rocks of the Culpeper basin are designated the Newark Group. In Maryland, the Newark Group is represented by the New Oxford Formation. In western Montgomery County, the Newark Group consists mainly of red and gray shale, siltstone, arkosic sandstone, and a basal conglomerate unit along the eastern border of the basin.

The maximum stratigraphic thickness of the Newark Group in the Culpeper basin has been reported to range from 2,100 ft a few miles southwest of Frederick, to 10,200 ft south of Dickerson, Md. (Lee, 1977, p. C2). A maximum stratigraphic thickness of 35,000 ft has been estimated in the vicinity of Antioch, Va., by Lee. Recent data from a test well in Montgomery County suggest that many of the published estimates of the thickness of the Newark Group in both Maryland and Virginia are too great. The geologist's log of test well MO-CB 26, located 3 mi southwest of Dickerson and drilled to a depth of 885 ft, shows that the bottom 77 ft of the well penetrated gray, argillaceous limestone, probably the Frederick Limestone of Cambrian age. The record of strata penetrated by this well is given by Nutter (1975, p. 32). It is possible, however, that many of the previous estimates of thickness refer to stratigraphic thickness (measured at right angles to dipping beds) and not to total thickness of sediments at a specific site.

The Triassic shales and siltstones are commonly bright red to maroon, blocky and platy, thin- to medium-bedded, and intensely jointed in places. The siltstones in many localities are deep red and may contain small-scale ripple marks and thin dark-colored laminations. The sandstones vary from pink to light red or reddish gray. Individual beds range in thickness from a few inches to 15 ft. Quartzite and phyllite pebbles are found at some places. At least two directions of jointing are common in the sandstones. The strata dip generally west to southwest and dip angles range from 2° to 25°, averaging 13° in 33 field measurements (Froelich, 1975b).

The Triassic sedimentary rocks have been intruded by diabase dikes and sills at several places in the Culpeper basin. An extensive, but narrow dike trends southward from Dickerson to a point about 1/2 mile east of the N.I.H. Animal Center where it continues to a point just north of the Potomac River. A diabase mass, at least 200 ft thick and covering about 2 mi^2, lies just south and west of Boyds (fig. 2). This laccolith extends westward to about 0.3 mi from Bucklodge Branch of Seneca Creek. The diabase is a dark, dense, massive to blocky, igneous rock only moderately jointed or fractured. Commonly, at the contact of the diabase rocks with the intruded sedimentary rocks, a baked zone has been produced in the rocks. Few wells, however, are known to definitely penetrate the baked zone. In general, the diabase is believed to be a poor aquifer. Very few wells penetrate it in the area of this report.

Ground-Water Occurrence

The occurrence of water in the red shales, siltstones, and sandstones is similar to its occurrence in the jointed and fractured crystalline rocks, except that the horizontal or subhorizontal component of ground-water movement along bedding planes may be somewhat greater than in the metamorphic crystalline rocks. Evidence for this assumption is inconclusive and is based on field examination of spring and seep zones, and on the well-interference data obtained from a 7-day pumping test on well MO-DB 47 at Poolesville.

In general, most of the water in the consolidated sediments is stored in the fractures and crevices which comprise systems having various degrees of connection. The mean porosity of 9 samples of sandstone and conglomeratic sandstone in table 5 is 6.1 percent, which places these measurements near the lower limit of a large number of porosity values of sandstones reported by Maxwell (1964, p. 706). In some places the porosity of sandstones in the zone of active ground-water circulation may be relatively high due to secondary solution of calcareous cementing material. The term "effective porosity" is sometimes used to denote porosities which effectively result in an increase in permeability. Some clays have high porosity, but extremely low permeability. Hence, they have "ineffective porosity."

The data in table 5 suggest that where the strata have low porosity values, ground water obtained from wells must be derived from fractures and crevices in the rocks.

A geophysical well log analysis by Nutter (1975, p. 9) of data from a test well at Dickerson showed a median effective porosity of 1 percent, and a range

Table 5. — Laboratory values of porosity for consolidated sedimentary rocks of Triassic age.

Location or Identification	Well depth (ft)	Type of sedimentary rock	Porosity (percent)	Specimen or Laboratory No.	Source of data
Mudd No. 3, Prince Georges County, Md.	1,503	sandstone (?)	9.4	8103	(1)
Do.	1,533	sandstone (?)	5.6	8113	(1)
Do.	1,554	do.	5.1	8118	(1)
Frederick County, Md. (outcrop)	-	sandstone, arkosic	7.6	72MD42	(2)
Thomasville, Pa. (well)	333	do.	0	72MD43	(2)
Thomasville, Pa. (well)	373	siltstone	0.2	72MD44	(2)
Orangeburg, N.Y. (outcrop)	-	sandstone (average of 3 cores)	11.1	-	(1)
Do.	-	conglomerate	7.9	-	(1)
Ramapo, N.Y. (outcrop)	-	conglomeratic sandstone	1.1	-	(1)
Newark-Gettysburg basin, Pa. (outcrop)	-	arkosic conglomerate	7.1	57PA7	(1)
Do.	-	siltstone, sandy	9.7	57PA9	(1)
Do.	-	arkose, fine grained	14.4	57PA5	(1)
Connecticut basin (outcrop)	-	arkose (average of 25 samples)	2.6	38-62	(1)

1/ From Bain (1973, table 3).
2/ From Nutter (1975, table 5).

of <1 to 6 percent in five strata at well depths ranging from 210 to 830 ft. The strata analyzed were mainly arkosic sandstones.

The mode of occurrence of water in the consolidated sedimentary rocks is shown graphically by figure 5. In the idealized figure, the small stream flows along a major joint or fracture zone in the rocks. This fracture zone is the loci of a number of smaller subsidiary fractures, where the intensity of fracturing has increased the permeability of the rocks below and adjacent to the stream. Of course, not all streams necessarily follow the pattern of joints and fractures in the rocks. The general direction of ground-water movement toward the stream is shown by flow-line arrows. The potentiometric surface marks the fluctuating upper limit of the zone of saturation. The hypothetical well shown in the diagram penetrates only two fractures, but because of the proximity of the well to the fractures beneath the stream, it

might be a moderately productive well. The source of water in the well is local precipitation, although the occurrence of water-yielding fractures at depths of a few hundred feet in the well might give the erroneous impression that the water comes from a distant source.

Depth of Water-Yielding Zones

The depth of occurrence of water-yielding fractures and crevices in the Triassic rocks is not known with any degree of certainty, but the width and frequency of openings in the rocks decreases with increasing depth. The openings are believed to be largely a result of tectonic and weathering processes acting on the rocks subsequent to deposition or solidification. Some of the openings may result from solution of calcium carbonate by ground water. The calcium carbonate appears to be a cementing material in some of the sandstones and siltstones.

Figure 6, based on drillers' well-completion reports, shows the number of wells in the various depth intervals down thru 500 ft, and the number of water-yielding fractures reported in these intervals. Based on records of 154 wells, the modal depth intervals are from 100 to 150 ft. That is, wells are most commonly completed in this depth range. However, the modal range of water-yielding zones is from 75 to 99 ft. That is, more wells penetrate water-yielding zones in this depth interval than in any other. Unfortunately, information concerning the depth of the water-yielding zones is available from only the more recent well-completion reports submitted to the Maryland Water Resources Administration. Although the chances of penetrating water-yielding zones decrease below depths of about 250 ft, a few of the deeper wells do encounter water at much greater depths and have higher yields. Six water-yielding fractures (or zones) were encountered in test well MO-EC 10 at depths ranging from 68 to 782 ft, with the major producing zones at 320-22 and 535-38 ft. This well is about 4 miles south of Poolesville along the flood plain of the Potomac River valley. Nutter (1975, p. 14) reports that water was encountered at a depth of 635 ft in a 1,004-ft test well drilled in 1972 at the Pepco generating plant near Dickerson. Water-yielding zones were also reported (Nutter, p. 14) at depths of 480 and 615 ft in a very deep gas test well drilled near Keymar in Carroll County, Md. (well CL-BB 38). Cook (1885, p. 115-117) reports that water-bearing zones were encountered at depths of 1,120 and 2,020 ft in a 2,100-ft deep well in Triassic strata near Patterson, N.J. However, the water at the greater depth was strongly saline and the well had to be plugged back to a depth of 900 ft. Usable water, however, had been encountered above this depth in the well.

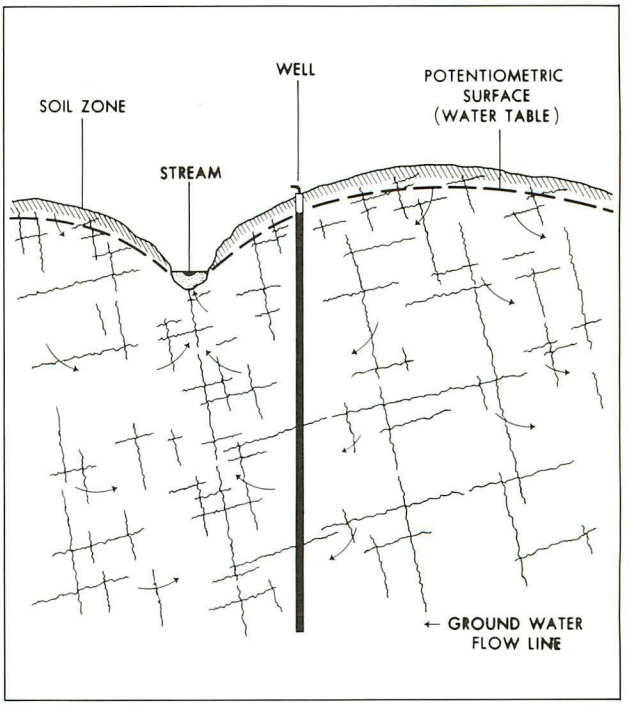


Figure 5. — Diagram of ground-water occurrence in jointed and creviced consolidated sedimentary rocks.

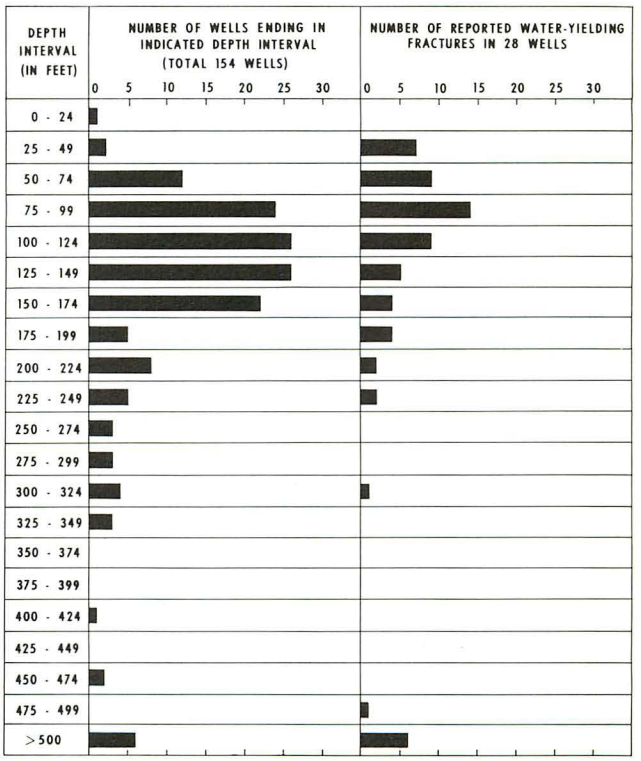


Figure 6. — Number of wells in various depth intervals and number of water-yielding fractures in these intervals.

Local Geohydrology

Three geohydrologic sections were compiled in the vicinity of Poolesville and across the central part of the study area. The purpose of the sections is to determine if any relationship may exist between the depth and position of the water-yielding zones in wells and the local topography and geology. To emphasize the topographic features, the vertical scale of the sections is about 24 times greater than the horizontal scale.

Figure 7 (section A-A′) shows a 5-mi profile from Martinsburg to Sewage Pond Road. Most wells on the profile encounter domestic ground-water supplies at depths of 100 ft or less. The gamma log of well -DC 18 at Poolesville shows the abundance of shale layers in the Triassic sedimentary rocks. It should be noted that no water-yielding zones are present in wells -DC 18 or -DC 19 below a depth of 225 ft.

Section B-B′ (fig. 7) is a 5-mi profile extending northeastward from the N.I.H. Animal Center to well -DC 67 beyond Poolesville. It shows the sloping boundary between the basin of Triassic rocks and the underlying phyllite. The log of well -DC 59 shows the nearly uniform intensity of relatively high gamma radiation in phyllite. This well penetrated only one water-yielding zone (near the contact of the Triassic rocks and the underlying phyllite) and yielded only about 4 gal/min. Perhaps the most significant geologic feature shown in the section is the diabase dike east of well -DB 27. This dike probably serves as a barrier to horizontal movement of ground water. Five water-yielding zones were encountered in test well -DB 68 at the Animal Center, and its yield is estimated to be 125 gal/min. This well is situated on the intersection of two fracture traces and is one of the most productive wells in the study area. It is being used (1979) as an observation well to record changes in ground-water levels.

Section C-C′ (fig. 7) is a 4-mi profile again showing the boundary between the Triassic rocks and the underlying phyllite. The log of well -DB 47 at the south end of Poolesville also shows the nature of the strata of Triassic age and the predominance of shale and siltstone layers. Also shown are five water-yielding zones in the well, the deepest zone occurring at a depth of approximately 270 ft. It is of interest that several domestic wells apparently obtain adequate supplies of water at depths of 125 ft of less.

Depth and Diameter of Wells

The depths of wells in the Triassic sedimentary rocks in western Montgomery County range from 11 to 1,004 ft, and the median well depth is 135 ft, based on 140 well records. Most of the wells in the area are 6 in. in diameter, but a few older drilled wells are only 4 in. in diameter. Some of the public supply and institutional wells are 8 and 10 in. in diameter.

Yields and Specific Capacities of Wells

The yields of 80 wells ending in Triassic rocks range from 1 to 400 gal/min and the median yield is 12 gal/min. Domestic, institutional, and public-supply wells are included in the range. The mean yield of 8 of the most productive wells (chiefly institutional and public-supply wells) is 135 gal/min. The most productive well in the area is -EC 10, 4 mi south of Poolesville. This 8-in.-diameter well was drilled in November 1979 as a test and observation well by the U.S. Geological Survey. It is 857 ft deep, penetrated mostly red shale, and was pump-tested for 12 hours. The reason for the exceptionally high yield of this well is not known, but it may be related to fractures associated with possible faulting along the valley of the Potomac River. This well and 12 others in the report area yielding 50 gal/min or more are shown in figure 2.

Table 6 shows the distribution of wells according to their productivity (yield). The distribution shown in the table may be slightly inaccurate as not all domestic wells are pumped to their maximum capacity, and the pumping periods during which the yields were measured range widely.

Table 6. — Distribution of 80 wells according to their productivity (yield).

Yield class (gal/min)	Number of wells	Percent of total
1 to 5	17	21
6 to 50	53	66
51 to 100	9	11
> 100	2	2

The specific capacities of 64 wells having pump tests of 2 hours or longer range from 0.01 to 8.9 (gal/min)/ft of drawdown, and the median specific capacity is 0.15 (gal/min)/ft. Included in this range are public-supply, commercial and domestic wells. Information relating to the above is tabulated below.

Specific capacity of Triassic wells

Range of values (gal/min)/ft	Number of values	Percent of total
0.01 to 0.09	20	31
.1 to .99	36	56
1.0 to 8.9	8	12

Thus, if 100 ft of drawdown were available, the median well would yield 15 gal/min. The maximum value of specific capacity, 8.9 (gal/min)/ft, was from well -EC 10, the 857-ft-deep test well previously discussed. The next highest value, 2.3 (gal/min)/ft, was from well -DB 26 at the National Institutes of Health Animal Center. This 6-in.-diameter well is 145 ft deep and is located along a small swale or ravine. It appears to lie on an east-west trending fracture zone.

Specific capacities also may be used to rank the productivity of aquifers. It is of interest to note that the median specific capacity of the Triassic sedimentary rocks, 0.15 (gal/min)/ft, is slightly less than the median value for the crystalline rocks, 0.18 (gal/min)/ft. This supports the conclusion that the Triassic rocks are also an aquifer of limited productivity, at least in many places.

As has been previously mentioned, the productivity of the Triassic rocks is influenced by the number, extent, and frequency of water-yielding fractures. These must, of course, occur below the water table to affect the yield of wells. If, in a group of wells of random depth and location, the distribution of the fractures was uniform throughout the depth of a well, then wells which penetrate a greater thickness of saturated aquifer should have higher yields and greater available drawdown. Thus, a plot of specific capacity values versus thickness of saturated aquifer should show (fig. 8) a trend of points from lower to higher specific capacity values and from lesser to greater thickness of saturated aquifer. However, figure 8 shows no such clearly defined trend (positive correlation), but instead shows a slight upward trend of points from left to right (negative correlation),suggesting that depth of penetration of the aquifer by the well is not the major controlling factor relative to its productivity. This probably indicates a nonrandom distribution of fractures involving both well depth and well location. The plotted data are also biased by the low number of very shallow wells, that is wells penetrating less than 50 ft of saturated thickness.

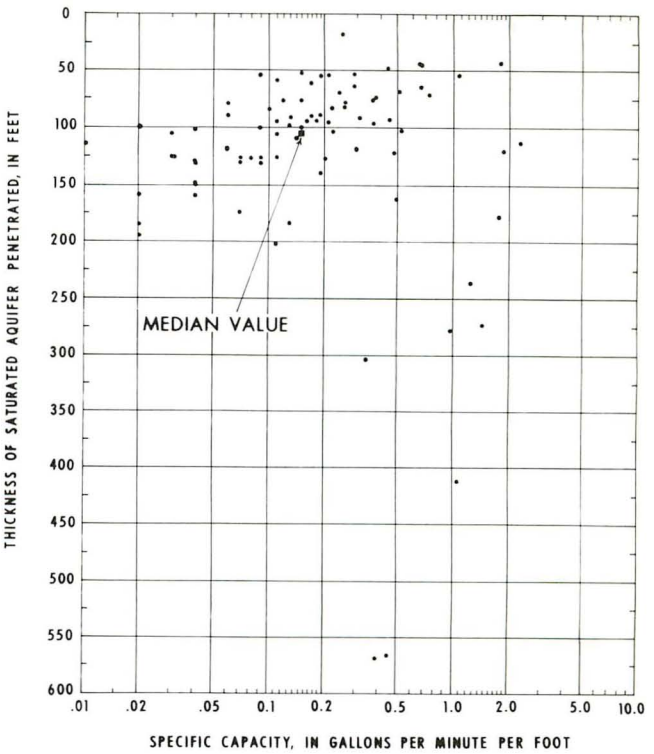


Figure 8. — Specific capacity of wells versus saturated thickness of aquifer penetrated.

Hydraulic Properties — Hydraulic Conductivity and Transmissivity

Hydraulic conductivity is a measure of the rate of movement of water through earth materials and is commonly measured in cubic feet per day per square foot of area across which the flow takes place under a unit hydraulic gradient. Hydraulic conductivity is designated as (K) in mathematical formulae, and is affected by temperature, which affects the viscosity of the water. The higher the temperature of the water, the lower will be the viscosity and the easier it will be for the water to pass through the pores of the aquifer. Because we are usually concerned with water of relatively uniform temperatures, temperature is seldom included in hydraulic computations. For laboratory tests, K is usually expressed at 20°C.

Transmissivity is the capacity of an aquifer to transmit water through its entire thickness and is designated as (T) in many formulae. Aquifer thickness is commonly designated as (m), and the relation between hydraulic conductivity and transmissivity is:

$$T = K \times m$$

Hydraulic conductivity of the Triassic sedimentary rocks, mainly sandstone and siltstone, was determined by Nutter (1975, p. 9) and by the CH_2M Hill consulting firm (1974, Section B.2). The results of these determinations are in table 7. The hydraulic conductivity of three core samples of residuum from an outcrop in Frederick County ranged from 0.046 to 0.36 ft/d. The hydraulic conductivity of 16 laboratory tests on rock specimens ranges from 0.00003 to 0.882 ft/d. The median value is 0.117 ft/d, which is in the range of conductivities given by Bouwer (1978, p. 38) for sandstones and for carbonate rocks with secondary porosity (effective porosity, presumably). The following range of the hydraulic conductivity of various rocks is indicated by the above and other authors as:

(Values in ft/d)

Sandstone	0.003 to 3.3
Carbonate rock with secondary porosity	0.033 to 3.3
Shale	0.00000033
Gneiss[1]	0.00006 to 0.0066
Basalt[1]	0.000005 to 0.13

[1]Values from Peters, 1968, Groundwater Course: California Dept. of Water Resources, Sacramento, Calif., p. 5-7.

Transmissivity values of an aquifer are commonly determined by conducting aquifer tests in which a well is pumped at a constant rate and the drawdown is measured in the pumped well and in one or more observation wells. These data are used to plot time versus drawdown graphs from which values of transmissivity (T) and storage coefficient (S) may be obtained. The equations used to compute values of T and S are based on certain assumptions concerning the geohydrologic system. Among these are the requirement that the aquifers are isotropic and homogeneous. However, deviations from the idealized assumptions result from the Triassic shales, siltstones and sandstones being anisotropic and nonhomogeneous. Water flows largely through the interconnecting interstices, chiefly fractures and joints, and in places along solutionally developed bedding planes (fig. 5).

Other methods for determining aquifer transmissivities include formulae for the approximate conversion of well specific capacities to transmissivities and formulae, such as the parabola formula, for determining transmissivities. The use of this formula requires estimates of annual ground-water recharge rates and data on the approximate mean water levels in selected wells.

Values of transmissivity and storage coefficients may be used to compute quantities of water flowing through an aquifer, or to compute declines in the potentiometric surface due to dumping or due to natural causes. Knowledge of these parameters are essential for use in problems of hydraulic well interference and to estimate the sustained availability of ground-water supplies.

Table 8 lists the values of transmissivity of Triassic sedimentary rocks as determined by means of aquifer tests and from the specific capacity of wells, as reported by the drillers. The method of estimating transmissivity from specific-capacity values is described in an earlier section of this report. Values of transmissivity in table 8 range from 5 to 1,540 ft^2/d and the median value is 17 ft^2/d, based on 80 values.

Table 7. — Hydraulic conductivity (K) values for sedimentary rocks of Triassic age.

Location	Sample or Identification No.	Depth (ft)	(K) (ft/d)	(K) (cm/s)	Type of sedimentary rock	Source of data	Remarks
U.S. 15 and Devilbiss Rd. (Frederick County, Md.)	72MD36	0-0.5	0.046	0.00002	residuum	Nutter (1975)	U.S.G.S. laboratory analysis.
Do.	72MD35	0.5-1.0	.36	.00013	do.	do.	Do.
Do.	72MD34	1.5-2.0	.13	.00004	do.	do.	Do.
U.S. 15 north of Md. Route 26 (Frederick County)	72MD42	4.0	.00028	.00000001	arkosic sandstone	do.	Do.
Thomasville, Pa.	72MD43	333	---	---	arkosic sandstone (chunk)	do.	Impermeable at 234 psi; U.S.G.S. laboratory.
Do.	72MD44	373	.00003	.00000001	siltstone (core)	do.	U.S.G.S. laboratory analysis.
Dickerson area (Montgomery County, Md.)	DB-1 (W-3-615)	13-61	.093	.000033	arkosic sandstone and siltstone	CM_2 Hill, Inc. (1974)	Packer test in borehole.
Do.	DB-2 (do.)	33.8-88	.184	.000065	medium- to coarse-grained sandstone	do.	Do.
Do.	DB-3 (do.)	21.7-80	.205	.000725	sandstone, siltstone and shale	do.	Do.
Do.	DB-4 (do.)	13.4-76	.141	.000049	arkosic sandstone and siltstone	do.	Do.
Do.	DB-5 (do.)	35-80	.652	.000232	do.	do.	Do.
Do.	DB-6 (do.)	15.5-16	.014	.000005	medium-grained, friable sandstone, gray	do.	Do.
Do.	DB-6 (do.)	65.6-79	.051	.000018	conglomeratic sandstone and siltstone	do.	Do.
Do.	DB-7 (do.)	55.6-80	.496	.000175	arkosic sandstone	do.	Do.
Do.	DB-8 (do.)	55.4-80	.882	.000311	siltstone and arkosic sandstone	do.	Do.
Do.	DB-9 (do.)	56.5-75.5	.527	.000186	medium- to coarse-grained sandstone	do.	Do.
Do.	DB-10 (do.)	24.0-50	.181	.000064	medium-grained sandstone and thin siltstone layers	do.	Do.
Do.	DB-11 (do.)	9-10	.011	.000004	medium-grained sandstone, gray	do.	Do.
Do.	DB-15 (do.)	11-11.5	.008	.000003	medium-grained sandstone, gray, slightly weathered	do.	Do.
Do.	DB-15	12-12.5	.003	.000001	do.	do.	Do.

Table 8. — Transmissivity values of Traissic sedimentary rocks determined from aquifer tests and from specific capacity values for wells.

Well No.	Owner or identifier	Well depth (ft)	Type of sedimentary rock	Yield (gal/min)	Specific capacity (gal/min)/ft	Transmissivity (T) (ft^2/d) 1/	Remarks 2/
MO-CB 1	R. Dayhoff	80	shale and sandstone	7	0.09	10	SCT; 1-hour test.
-CB 7	H. Glickman	74	do.	2.5	.25	30	SCT; 1-hour test.
-CB 15	Pepco Generating Plant	250	shale, siltstone, and sandstone	15	.10	10	SCT.
-CB 20	Neutron Products Co.	148	do.	12	.14	15	SCT; possibly some water from phyllite.
-CB 21	A. Heller	150	shale and siltstone	3	.04	< 5	SCT.
-CB 22	A. Heller	100	do.	25	.51	65	SCT.
-CB 23	Hubert Cythe	114	---	8	.15	15	SCT.
-CB 24	Wheaton Lumber Co.	125	shale and siltstone	15	.20	25	SCT.
-CB 26	U.S.G.S. test at Cherrington recreation area.	885	shale, siltstone, and sandstone	75	1.00	150	AT; First 24 hours used in computations.
-CB 29	Pepco Generating Plant	1,004	do.	100	1.40	80	AT; T based on first 11 hours drawdown.
-CB 30	Mr. Wong	115	shale and siltstone	115	.17	15	SCT; 1-hour test.
-CB 31	M. Carlisle	110	---	10	.26	30	SCT; 4-hour test.
-CB 32	J. Belcher	85	---	8	.21	25	SCT; 2-hour test.
-CC 27	S. Ayers	110	---	20	.74	95	SCT; 1-hour test.
-CC 28	J. Robinson	120	---	15	.18	20	SCT; 2-hour test.

_/ See footnotes at end of table.

Table 8. — Transmissivity values of Traissic sedimentary rocks determined from aquifer tests and from specific capacity values for wells.—continued.

Well No.	Owner or identifier	Well depth (ft)	Type of sedimentary rock	Yield (gal/min)	Specific capacity (gal/min)/ft	Transmi-sivity (T) (ft^2/d) 1/	Remarks 2/
MO-DA 3	H. Hopkins	85	---	45	1.07	140	SCT; 1-hour test.
-DA 4	M. Hopkins	85	---	5	.11	10	SCT; 2-hour test.
-DB 1	Selby Brothers	62	---	5	.09	10	SCT; 1-hour test.
-DB 2	H. Keifer	150	---	3	.03	< 5	SCT; 1-hour test.
-DB 4	J. Kimmerling	76	---	8	.19	20	SCT; 1-hour test.
-DB 6	Montgomery County Board of Education	175	---	12.5	.11	15	SCT; 24-hour test.
-DB 7	do.	150	---	3	.03	< 5	SCT; 12-hour test.
-DB 8	H. Siegel	165	---	10	.10	10	SCT; 5-hour test.
-DB 12	R. Allnutt	81	---	8	.29	30	SCT; 1-hour test.
-DB 15	St. Georges Church	94	---	10	.26	30	SCT; 1-hour test.
-DB 16	National Institutes of Health Animal Center	205	shale and silt-stone	20	1.70	300	AT; T based on 24-hour test.
-DB 17	J. Offutt	83	---	4.5	.15	15	SCT; 1-hour test.
-DB 18	Presbyterian Church	95	---	16	.38	50	SCT; estimated 2-hour test.
-DB 19	B. Siegel	141	---	17	.20	25	SCT; 3-hour test.
-DB 20	do.	245	---	15	.14	15	SCT; 4-hour test.
-DB 22	do.	80	---	7	.13	15	SCT; estimated 2-hour test.
-DB 26	National Institutes of Health Animal Center	145	shale and silt-stone	53	1.10	460	AT; T based on first 24-hours pumping.
-DB 29	D. Willard	103	---	15	.37	50	SCT; 4-hour test.

_/ See footnotes at end of table.

Table 8. — Transmissivity values of Traissic sedimentary rocks determined from aquifer tests and from specific capacity values for wells.—continued.

Well No.	Owner or identifier	Well depth (ft)	Type of sedimentary rock	Yield (gal/min)	Specific capacity (gal/min)/ft	Transmi-sivity (T) (ft^2/d) 1/	Remarks 2/
MO-DB 30	C. Jamison	143	---	10	0.13	15	SCT; 2-hour test.
-DB 31	R. Hayden	200	---	6	.04	< 5	SCT; 1/2-hour test.
-DB 32	De Sterkenberg	122	---	8	.13	15	SCT; 2-hour test.
-DB 33	do.	165	---	7	.08	10	SCT; 2-hour test.
-DB 34	Economy Oil Co.	185	---	5	.04	< 5	SCT; 2-hour test.
-DB 35	F. Miller	125	---	4	.06	5	SCT; 2-hour test.
-DB 36	Levitt and Sons, Inc.	280	---	150	.97	180	SCT; 24-hour test.
-DB 44	E. Netkovsky	120	Red sandstone and shale	20	.31	35	SCT; 1-hour test.
-DB 46	R. Hoewing	102	Red rock	10	.67	85	SCT; 1-hour test.
-DB 49	Town of Poolesville	600	Shale and thin sandstone layers	48	1.00	100	AT; Observation well 264 ft from pumped well. 3/
-DB 49	R. Queen	245	---	3	.02	< 5	SCT; 1-hour test.
-DB 50	E. Barge	100	shale and silt-stone	12	.24	30	SCT; 5-hour test.
-DB 52	A. Spates	150	red shale and sandstone	6	.07	10	SCT; 6-hour test.
-DB 53	W. McCrassin	230	siltstone and shale, red	3	.02	< 5	SCT; 2-hour test.
-DB 59	A. Graham	140	rock, red, and clay, brown	15	.15	15	SCT; 2-hour test.
-DB 60	H. Kleinsorg	170	---	4	.04	< 5	SCT; 4-hour test.
-DB 61	C. Williams	150	---	20	.48	70	SCT; 4-hour test.
-DB 68	U.S.G.S. test well	252	shale, siltstone, and broken sand-stone	56	1.30	160	AT; T value from 6-hour test.

_/ See footnotes at end of table.

Table 8. — Transmissivity values of Traissic sedimentary rocks determined from aquifer tests and from specific capacity values for wells.—continued.

Well No.	Owner or identifier	Well depth (ft)	Type of sedimentary rock	Yield (gal/min)	Specific capacity (gal/min)/ft	Transmissivity (T) (ft^2/d) 1/	Remarks 2/
MO-DC 2	C. Roberts	130	shale, red, and gray rock	7	0.17	15	SCT; 2-hour test.
-DC 7	E. Preston	135	shale, red, and sandstone, red	15	.45	50	SCT; 1-hour test.
-DC 14	E. Jones	74	rock, red, and shale	16	.44	50	SCT; 1-hour test.
-DC 15	B. Siegel	155	do.	10	.09	10	SCT; 3-hour test.
-DC 16	do.	155	rock, red; some shale	10	.11	10	SCT; 3-hour test.
-DC 19	Town of Poolesville	450	shale, sandstone and siltstone	95	1.10	150	AT; T value from first 12 hours of test.
-DC 20	A. Strang	165	---	7	.07	5	SCT; 2-hour test.
-DC 21	B. Wolfrey	120	---	4	.04	> 5	SCT; 2-hour test.
-DC 22	J. Trauth	145	rock, red, and sandstone, gray	18	.22	25	SCT; 2-hour test.
-DC 23	G. Darby	165	---	6	.06	5	SCT; 2-hour test.
-DC 25	G. Butler	143	---	12	.13	15	SCT; 2-hour test.
-DC 26	G. Morningstar	143	---	3	.03	> 5	SCT; 2-hour test.
-DC 29	Levitt and Sons, Inc.	315	Sandstone and shale	60	.34	55	SCT; 24-hour test.
-DC 31	Town of Poolesville (No. 3 well)	285	shale, siltstone and thin sandstone	100	1.45	230	AT; T value from first 6 hours of test.
-DC 33	J. Windolph	105	rock, red, and sandstone, gray	10	.22	25	SCT; 1-hour test.
-DC 34	F. Bernsdorff	145	do.	8	.09	10	SCT; 2-hour test.
-DC 35	F. Campbell	165	sandstone, gray and red; some shale	20	.19	20	SCT; 1-hour test.
-DC 37	E. Fistine	200	rock, red, and sandstone, gray	3	.02	> 5	SCT; 1-hour test.

_/ See footnotes at end of table.

Table 8. — Transmissivity values of Traissic sedimentary rocks determined from aquifer tests and from specific capacity values for wells.—continued.

Well No.	Owner or identifier	Well depth (ft)	Type of sedimentary rock	Yield (gal/min)	Specific capacity (gal/min)/ft	Transmissivity (T) (ft^2/d) 1/	Remarks 2/
MO-DC 38	J. Windolph	105	---	7	0.10	10	SCT; 1-hour test.
-DC 39	A. Uhl	160	sandstone, gray	12	.16	15	SCT; 1-hour test.
-DC 40	Mr. Rouch	130	sandstone and shale	40	.52	70	SCT; 3-hour test.
-DC 41	Charles Kohlhoss	125	sandstone and shale, red	30	.37	40	SCT; 1-hour test.
-DC 43	Robert McElfish	131	sandstone and siltstone	15	1.88	290	SCT; 2-hour test.
-DC 44	R. Simms	65	sandstone and shale	20	.69	95	SCT; 2-hour test.
-DC 46	L. Stevens	130	"rockstone" and shale	10	.09	10	SCT; 5-hour test.
-DC 47	H. Lackey	165	siltstone and shale	10	.09	10	SCT; 2-hour test.
-DC 50	Elijah Methodist Church	105	sandstone and shale, red	10	.29	35	SCT; 2-hour test.
-DC 55	Poolesville Methodist Church	92	sandstone, red and gray	12	.67	85	SCT; 1-hour test.
-EC 10	U.S.G.S. test 4 miles S. of Poolesville	857	shale and siltstone	400	8.9	1,540	AT; 12-hour test.

1/ Values rounded to nearest 5 units of measurement.

2/ SCT = specific capacity test; AT = aquifer test.

3/ Storage coefficient from aquifer test = 1.8×10^{-4}.

MINOR AQUIFERS

Terrace Deposits of Tertiary (?) Age

At three localities in the western part of the area, terrace deposits of presumed Tertiary age lie above the red shales, siltstones, and sandstones of Triassic age (fig. 2). These deposits cover 5 to 6 mi^2, and have been designated as Upland Gravel deposits by Froelich (1975a). They consist of gravel, sand, silt, and clay. Most of the gravel and sand is poorly sorted in a red-brown clay-silt matrix derived from the older Triassic sedimentary rocks. Based on drillers' logs of four wells, the maximum thickness of these deposits is about 90 ft.

Little is known of the hydrologic properties of these materials as most of the wells are completed in the underlying Triassic strata. A common drilling practice is to case off these deposits to avoid collapse of the well. Hydrologically, the terrace deposits function mainly to provide recharge to the underlying rocks. Static water levels in wells in these deposits are reported to be as deep as 60 ft west of Martinsburg (well -DB 82), but may be much less in wells in other localities. A few dug wells formerly obtained water from these deposits, but most of these have been abandoned in favor of drilled wells tapping underlying units.

Sediments of Quaternary Age

Quaternary alluvial deposits occur along the valley of the Potomac River and along some of the major tributary streams. These deposits consist mainly of transported silt, clay, gravel and sandy gravel. The maximum width of the area of their occurrence is in the vicinity of Sycamore Landing road south of Poolesville and both north and south of Whites Ferry at the westernmost edge of Montgomery County. The thickness of the deposits ranges from a featheredge to as much as 33 ft along the Potomac River (Froelich, 1975a).

Little is known of their hydrologic properties, but they are generally not used as an aquifer. The driller of well -CB 18, about 3 mi west of Seneca, reportedly penetrated "clay and sand" from a depth of 0 to 22 ft. However, the well was completed at a depth of 140 ft and produced water from the underlying Triassic strata. The driller of well -EC 2, located 0.5 mi north of the mouth of Seneca Creek, reported yellow clay from a depth of 0-10 ft and gravel from 10-17 ft. This description indicates the presence of alluvial deposits. However, the well yields water from an underlying sandstone at a depth of 75 ft. It is possible that localized sands or gravel deposits here and elsewhere would yield modest supplies of ground water.

No data are available concerning the hydrologic properties of the alluvial deposits along the Potomac River or along the major tributary streams.

GROUND-WATER USE

The three major ground-water uses in western Montgomery County are institutional, represented by the N.I.H. Animal Center; domestic and farm, represented by the several homes and farms; and public supply, represented by the town of Poolesville. The total quantity of ground water used in the area in 1978 is estimated to be 520,000 gal/d.

National Institutes of Health Animal Center

As of early 1979, four supply wells had been drilled at the N.I.H. Animal Center. These wells yield water from the Triassic rocks and their depths range from 145 to 205 ft. The initial yields of the wells were reported to range from 20 to 53 gal/min.

Records of well pumpage are available for the Animal Center from 1971 to the present time (early 1979) and these records continue to be maintained by the N.I.H. Table 9 shows the total pumpage by years and also the daily average pumpage. The maximum pumpage occurred in 1976 when nearly 15 Mgal was withdrawn; the daily average during 1976 was about 41,000 gal. Generally, peak ground-water withdrawals take place during the summer months; during the peak month of July 1976, about 1.88 Mgal were pumped at an average rate of 61,000 gal/d (about 42 gal/min).

Table 9. — Annual pumpage from wells at the N.I.H. Animal Center from 1971 through 1978.

Year	Annual total (Mgal)	Daily average (gal)	Number of wells used
1971	12.091	33,125	4
1972	13.523	37,050	4
1973	14.352	39,320	4
1974	14.087	38,490	4
1975	13.078	35,830	4
1976	14.983	41,050	[1]3
1977	12.765	34,975	3
1978	8.810	24,135	3

[1]Well 4 (-DB 27) not operated after 1975.

Domestic and Farm

Ground-water use for domestic and farm purposes is difficult to estimate, but a crude estimation can be made on the basis of population. Based on a recent population study of Montgomery County (Maryland-National Capital Park and Planning Commission, 1976), the January 1976 rural and urban population of the area of this report was estimated to be 6,590. Assuming that the population increased 10 percent between January 1976 and January 1979, the present (Jan. 1979) population would now be approximately 7,250. Because Poolesville is furnished water by a public supply system, it is necessary to subtract the Poolesville population of 3,400 from the 7,250 total, leaving a population of 3,850 for the remainder of the area.

Based on an average daily per capita water use of 65 gal, the use of ground water in the report area, exclusive of Poolesville and the N.I.H. Animal Center, is about 250,000 gal/d (3,850x65).

Four small, unincorporated communities in the area are included in the population estimate. Residents of these communities are supplied water by individual wells and springs. Although the boundaries of the communities are not defined, their population is estimated to be as follows (Montgomery County Council, 1976):

Community or locality	Estimated population		1979 ground-water use (gal/d)
	1976	1979[1]	
Boyds	67	190	12,350
Dickerson	154	230	14,950
Jerusalem	125	70	4,550
Jonesville	65	50	3,250

[1]Estimates by Montgomery County Office of Environmental Planning (oral commun., Feb. 1980).

The above estimates of rural and domestic ground-water use are only approximations. More reliable estimates will be possible when the 1980 census figures become available, but all estimates are subject to changing use and demand patterns. A significant use not included in the above estimates is the use of well water for supplemental crop irrigation during dry periods. The extent of this practice in the area is not known.

Town of Poolesville

Water for the Town of Poolesville is obtained from four wells ranging in depth from 285 to 600 ft, all ending in consolidated strata of Triassic age. Data concerning these wells are given in table 10.

Pumping from the Poolesville supply wells began in 1970, but complete daily records of metered well pumpage are not available for the first few years of operation. By 1976, three wells were in use and the average pumping rate was 207,475 gal/d.

In August 1977, a fourth well (-DB 47) was added to the system. The demand for water has increased each year since the well system was installed and the following tabulation shows the total annual pumpage, the daily average pumping rate, and the relative change from 1976 through 1978.

Year	Total pumpage (galx10^6)	Daily average (gal)	Percent change from 1976
1976	75.728	207,475	-
1977	78.225	214,315	+3.2
1978	89.969	246,495	+18.8

In addition to the annual variations in ground-water pumping shown above, seasonal variations in water use occur throughout the year. Use during the summer is greater than during the winter. The peak monthly pumping period occurred in June 1978 when a total of 8.770 Mgal were used, or at an average daily rate of 292,000 gal. Ground-water withdrawals were over 8 Mgal each month during May, June, and July 1978. Tabulated below are the quantities used during this peak period.

Month	Total pumpage (galx10^6)	Daily average (gal)	Rate in gal/min
May	8.130	262,260	182
June	8.770	292,340	203
July	8.596	277,315	193

Table 10. — Records of municipal wells at Poolesville.

Well No.	State Permit No.	Town No.	Altitude (ft)	Well depth (ft)	Casing diameter (in.)	Length of casing (ft)	Initial yield (gal/min)	Specific capacity (gal/min)/ft	Hours pumped on yield test
MO-DC 18	MO-70-0014	1	395	597	7	63	53	0.4	24
MO-DC 19	MO-70-0046	2	410	450	6	63	95	1.0	24
MO-DC 31	MO-73-0075	3	385	285	8	82	100	1.5	24
MO-DB 47	MO-73-1584	4	420	600	8	62	50	.4	24

Figure 9 shows monthly use of ground water from April 1974 through May 1979. The general trend toward increasing water use is shown as is the seasonal variations in the demand for water. The figure also shows the records of the water levels of two of the wells used in the system. Although the water levels in individual wells reflect mainly day-to-day changes in the pumping regime of the well, they also show general water-level trends in the aquifer, especially during periods of prolonged steady pumping. For example, well-DC 18 (Town No. 1) showed a general downward decline of the water level of about 85 ft during the period from May 1976 to the end of March 1977. However, an even greater fluctuation of the water level occurred in well-DB 47 (Town No. 4) from late October to the end of December 1978, when the water level rose about 178 ft. This rise in level resulted in part from substantial ground-water recharge in the middle of December of that year.

Additional discussion of pumping rates at Poolesville and their effect on ground-water levels in the aquifer is in a subsequent section of this report.

An analysis of the total pumpage from each well may provide information on the hydraulic character of the aquifer at the well site, unless a well is not used because of pump failure or for similar reasons. Tabulated below is the total gallons pumped from each Poolesville well during 1978.

Well No.	Total pumpage (galx10^6)	Percent of total
Town No. 1	14.268	15.9
Town No. 2	24.474	27.2
Town No. 3	27.617	30.5
Town No. 4	23.610	26.3
All wells	89.969	99.9

The above data show that 84 percent of the Poolesville water supply during 1978 was furnished by wells 2, 3, and 4 and only 16 percent by well 1.

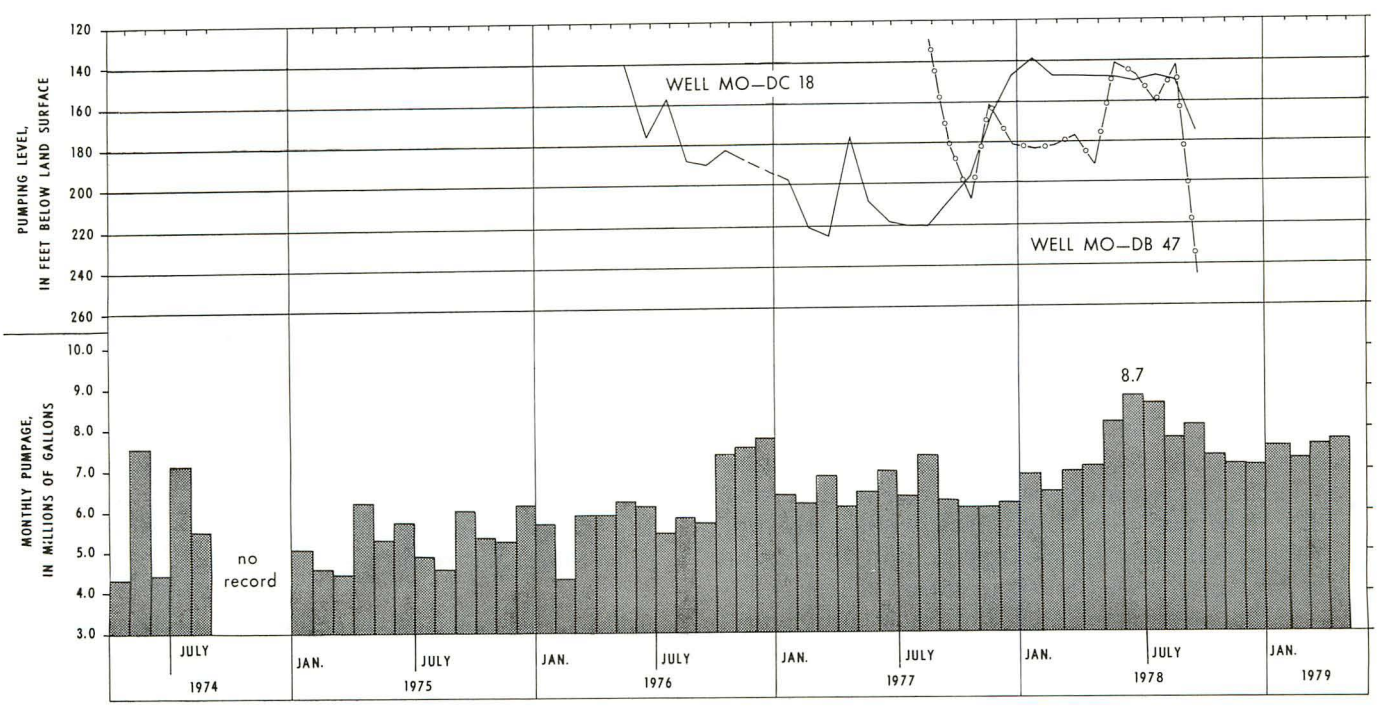


Figure 9. — Well pumpage at Poolesville 1974-1979 and pumping level in two supply wells.

GROUND-WATER CONDITIONS AT BOYDS

Boyds, a small unincorporated community, is in the northeastern corner of the report area at the intersection of Maryland Routes 117 and 121 (fig. 10). The community is underlain by a 2- to 3-mi^2 diabase sill in the southern part, and by slaty, quartzitic phyllite in the central and northern part.

Within a radius of 1.5 mi of the center of town, 11 inventoried wells have a range in depth of 40 to 230 ft, with a median depth of 125 ft. The yields of nine of these wells range from 0.5 to 25 gal/min, and their median yield is 7 gal/min. Specific capacities for seven wells range from 0.05 to 0.5 (gal/min)/ft and the median specific capacity is 0.17 (gal/min)/ft. All but 2 of the 11 wells for which records are available end in phyllite. Except for the well at the Taylor Elementary School, all are domestic wells.

The most productive well, -CD 52, is a 6-in.-diameter domestic well drilled in 1975 to a depth of 95 ft. The specific capacity of this well is reported to be 0.44 (gal/min)/ft. It appears to be located on a northeast-southwest trending fracture trace, which may account for its higher than median yield. However, as the well was only tested for 1 hour, its long-term yield may be less than the reported 25 gal/min.

Development of a public ground-water supply for a community such as Boyds (population 180) would depend on the likelihood that a well yielding at least 25 to 35 gal/min could be obtained. Two optimally spaced wells yielding a minimum of 25 gal/min would furnish the community with as much as 72,000 gal/d, or enough water to provide for 1,100 persons (based on a per capita demand of 65 gal/d). However, because of the low storage capacity of the crystalline rock aquifers, the yield of even the best wells may decline substantially during prolonged drought. If such a decline in yield should be as great as 50 percent, then additional reserve wells would be needed to furnish the required water during these periods. As would be expected during a drought, declining water levels, and depletion of water stored in the aquifers is also the period of greatest need for the water.

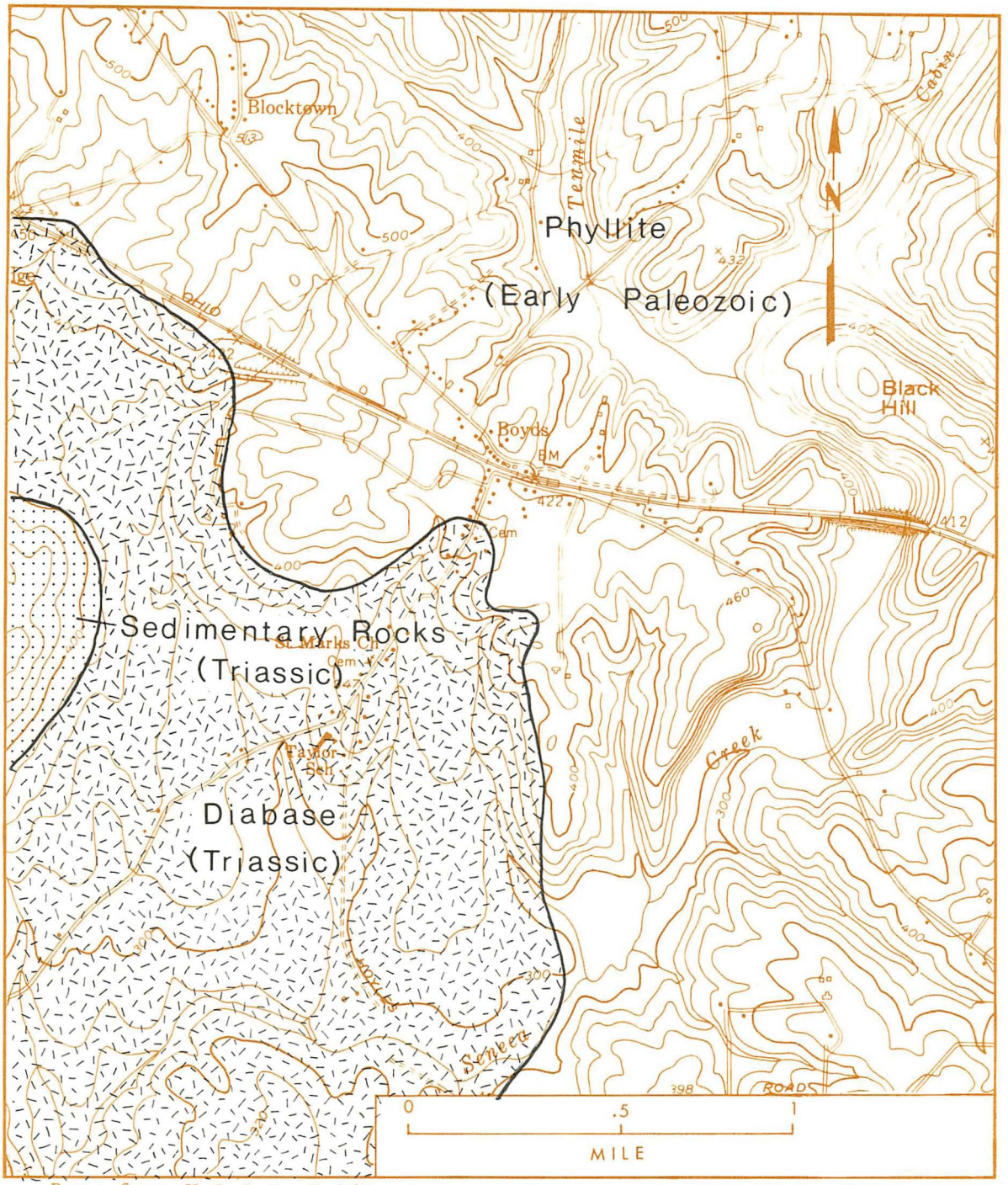
GROUND-WATER CONDITIONS AT DICKERSON

Dickerson is an unincorporated community in the northwest corner of the report area (fig. 11). The community lies just west of the eastern border of the Triassic sedimentary rocks, so that most of the town is underlain at the surface by these rocks. The thickness of the Triassic rocks at Dickerson is from 100 to 300 ft, with the greater thickness occurring at the west end of town.

The records of 11 wells within a radius of 1 mi from the center of town show their depths range from 71 to 148 ft, and the median depth is 100 ft. The yields of 8 wells range from 7 to 20 gal/min, and the median yield is 11 gal/min. Specific capacities of seven wells range from 0.10 to 2.85 (gal/min)/ft, and the median specific capacity is 0.21 (gal/min)/ft. Four of the eleven wells for which information is available are school and commercial wells. The remaining seven wells are domestic wells. It is possible that these wells were not tested at their maximum capacity, and, hence, the data are somewhat biased in favor of less-than-maximum possible yields. The most productive well, -CB 14, was drilled to a depth of 71 ft at the Dickerson Church. This well reportedly yielded 20 gal/min on a 1-hour test in 1953. It is apparently on or near an east-west trending fracture trace of relatively small extent.

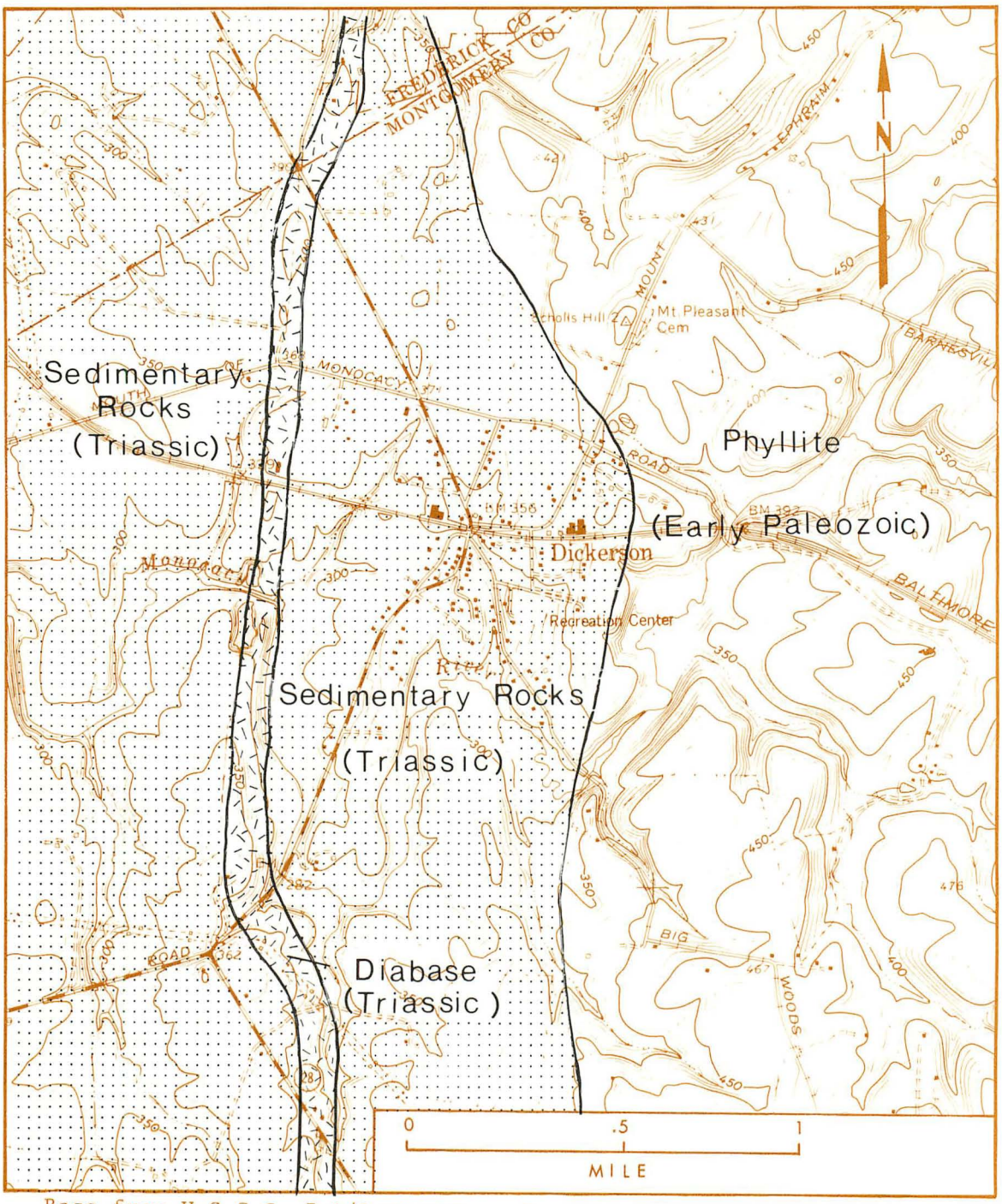
Were a public ground-water supply to be planned for a community similar to Dickerson and situated in an area of similar rocks, a well yielding at least 25-35 gal/min would be required. Two suitably spaced wells[1] yielding the minimum quantity on a sustained basis could furnish the community with as much as 72,000 gal/d, a rate adequate to supply Dickerson and to allow for additional growth. However, as stated previously, the yields of even the best wells may decline significantly during drought and, hence, the problem of an inadequate water supply could occur as the town's water requirements approached the combined capacity of the wells. Exploration for a central water supply for Dickerson would ideally be based on test wells at favorable sites, as along linear features, or at the intersection of two or more of these features (possible fracture traces).

[1]Although one well might be adequate for the water requirements of a small commnunity, two wells would assure an uninterupted supply should a pump failure occur, should some other emergency situation arise, or even for normal maintenance.



Base from U.S.G.S. 7 1/2 minute quadrangle; geology modified from A.J. Froelich, 1975, and K.Y. Lee, 1977

Figure 10. — Boyds area showing topography and geology.



Base from U.S.G.S. 7 1/2 minute quadrangle; geology modified from A.J. Froelich, 1975, and K.Y. Lee, 1977

Figure 11. — Dickerson area showing topography and geology.

That the yields of wells in the Triassic strata can decline substantially, even during brief pumping periods, is illustrated by the results of the drilling and pump testing of well -CB 29. This well, 1.5 mi southwest of Dickerson, was drilled to a depth of 1,004 ft as a potential drinking and boiler-water supply for the Potomac Electric Power Company (PEPCO) generating plant along the Potomac River. During November 1973, well -CB 29 was test pumped for 47-1/2 hours, and the results of the test were reported by the consultants (Dames and Moore, 1974). Figure 12, based on information from their report, shows graphically the drawdown slope of the pumping level in well -CB 29. The well was pumped for 77 gal/min during the first 60 minutes of the test, and, thereafter, the rate was increased to 100 gal/min. The line designated as slope A on the graph was used to compute the transmissivity of 80 ft^2/d.

The most significant fact revealed from this test is the existence of a major hydraulic boundary in the aquifer, which caused a marked decline in the pumping level at about 780 minutes after pumping started. Using a formula described by Strausberg (1969, p. 24), it is possible to estimate the radius of the boundary distance from the pumping well. The formula requires the use of a value for the coefficient of storage, and on the basis of estimated storage coefficients of 0.01 and 0.005, the distance to the hydraulic boundary is from 70 to 100 ft from the pumped well, depending on which value is used.

The formula given by Strausberg is:

$$r_b = \sqrt{\frac{7.79 \times 10^{-4}\ T\ t_b}{S}}$$

where:

r_b = minimum distance from the well to a possible boundary, in ft;
T = transmissivity, in ft^2/d;
t_b = time after pumping started when an image well becomes "effective" at the intersection of two drawdown limbs, in minutes; and
S = coefficient of storage.

The change in drawdown slope at 780 minutes shown on figure 12 could also be the result of dewatering of a fracture zone if two or more such zones are furnishing water to the well, and this explanation is suggested as an alternative to the boundary situation described in the analysis.

Based largely of the results of the test on well -CB 29, the design engineers of the PEPCO plant decided to abandon the proposed groundwater supply. At the present time (1979), no ground water is used by the plant, and even the drinking water is treated Potomac River water.

GROUND—WATER CONDITIONS AT POOLESVILLE

The Town of Poolesville occupies a relatively flat upland, interstream area at the intersection of Maryland Routes 109 and 107. It lies along the east edge of the Culpeper basin and is underlain by 600 or more feet of Triassic shale, siltstone, and thin sandstone. These sediments are underlain at depth by older phyllitic rock which is exposed at the surface 0.7 mi northeast of Poolesville, just east of Dry Seneca Creek. The local geology of the area is well illustrated by figure 7 (section C—C′), a north-south trending geohydrologic profile extending from Offutt Road to Maryland Route 28.

The underlying strata consist of interbedded red to purplish brown shale and siltstone, with subordinate beds of light gray to red-brown arkosic sandstone. The shales and siltstones are thin to medium-bedded, and commonly are intensely jointed, at least where observed at the surface. Some of the siltstones are also calcareous. The sandstones range in thickness from about 1 to 10 ft, and some layers are conglomeratic, containing quartz and yellowish-tan quartzite pebbles. The geophysical logs of the deeper wells at Poolesville indicate that roughly 80 percent of the strata down

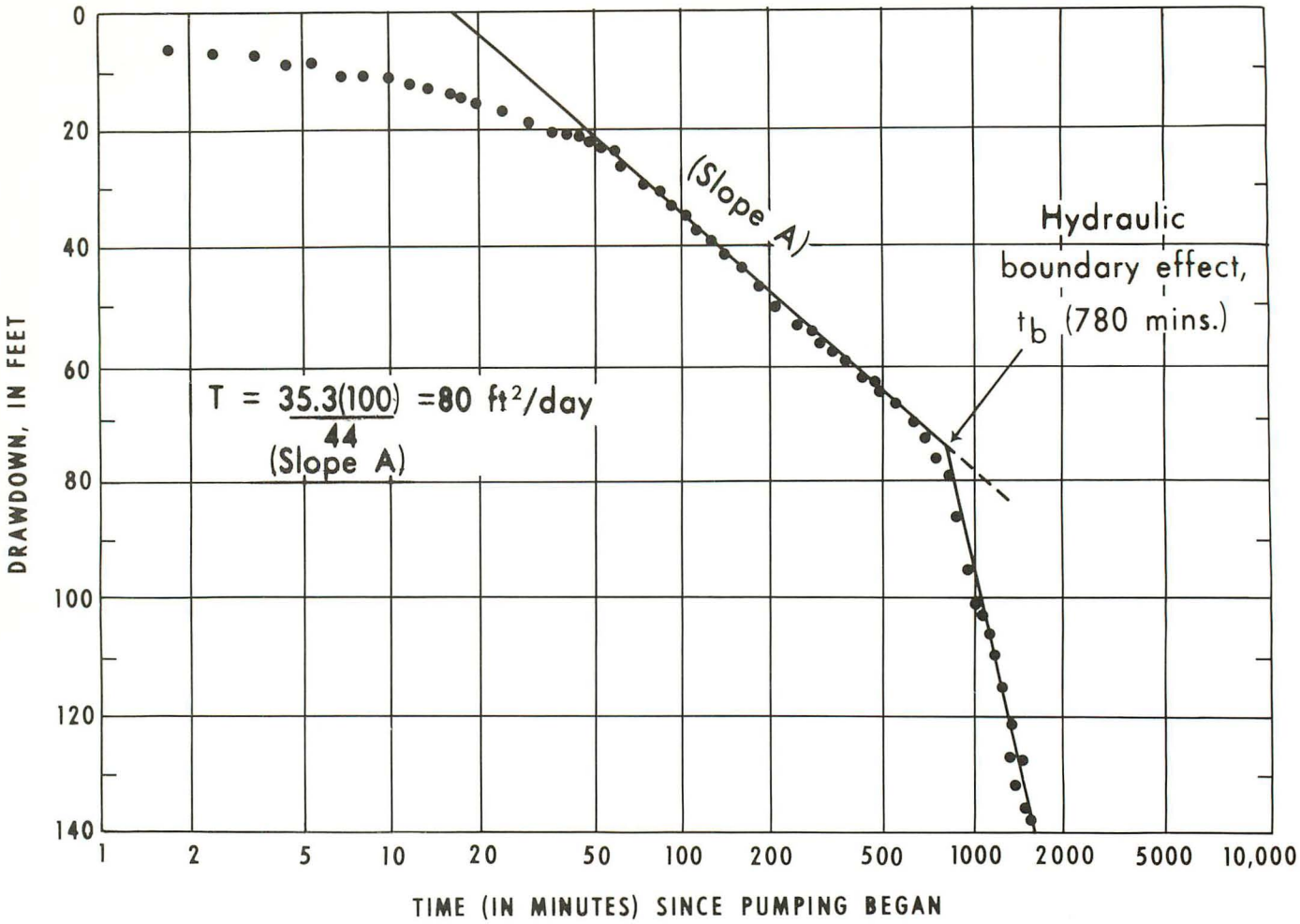


Figure 12. — Time-drawdown graph of water levels during an aquifer test on well MO-CB 29 near Dickerson.

to a depth of 600 ft consist chiefly of shale and siltstone. An unpublished geologic map of the Poolesville quadrangle by K.Y. Lee of the U.S. Geological Survey shows that the Triassic strata near Poolesville dip generally west and southwest from 12° to 24°. The mean dip angle of seven measurements is 16°(from the horizontal).

Prior to 1969, water supplies in Poolesville were obtained from individual wells and springs, but the exact number of these remaining in use is not known. Possibly 50 to 60 homes and stores had privately owned, individual water systems. The depths of these wells commonly were from 75 to 150 ft, and a few of the older wells were brick-lined dug wells. By 1963, several of the wells had become contaminated, chiefly by effluent from nearby domestic sewage-disposal systems, and the town was urged by health authorities to develop a central water and sewer system. In 1969, the first two town wells were completed, water mains were laid, and a water storage tank was built. In 1972, a third well was added to the system, and in 1977, a fourth well was completed. By May 1979, the town was being supplied by four municipal wells ranging in depth from 285 to 600 ft. Table 10 provides important information on the Town of Poolesville wells.

Changes in Yields of Wells

The yields of rock wells may be expected to change due to seasonal changes in the water levels in the aquifer and to the withdrawal of water from storage by the pumping wells. An analysis of the yields of the four Poolesville supply wells during different time periods indicates the extent of the problem caused by declines in the yield of wells during dry periods when little or no ground-water recharge takes place. The total combined initial design yield of the four wells was 298 gal/min (429,000 gal/d). This quantity would be more than adequate to supply the peak daily average demand of 203 gal/min (or 292,000 gal/d) measured during

June 1978. However, the initial design yield rate of 298 gal/min was based on each well being tested individually during periods when the aquifer had not yet been heavily stressed, and hydraulic interference was minimal. It is, therefore, doubtful if the four wells ever yielded water at this rate when pumped simultaneously. Based on reliable pumping records kept by the Poolesville water department, an analysis of pumping rates during two 2-month periods in 1978 shows the change in well production caused by changing conditions in the aquifer. The change in production is due mainly to decreased transmissivity caused by lowered water levels in the area of the well field. During the high recharge period of January-Febuary 1978, the four town wells yielded 267 gal/min (384,000 gal/d). Subsequently, during the dry, low-recharge period of October-November 1978, the four wells yielded only 172 gal/min (248,000 gal/d). This is a net decline in yield of 36 percent from the January-Febuary period, or a decline of 43 percent from the initial design yields. The results of the tests on each well are given in figure 13.

Effect of Pumping on Ground-Water Levels

To evaluate the changes in water levels in the Triassic-rock aquifer near Poolesville, a series of water-level measurements were made in 35 observation wells in and near the town. Four of the wells measured periodically are the town supply wells, and the remaining wells are mostly private domestic wells in which the owners permitted water-level measurements to be made. Some of these wells were abandoned when the owners were furnished with water from the municipal system. Some of the water-level measurements began in the fall of 1977, and others began in spring and summer of 1978. Measurements were continued into May 1979, and a few wells continue to be measured as part of the Statewide observation-well program in Maryland.

A series of monthly potentiometric maps were compiled from these data, beginning in July 1978. Two of these maps (figs. 14 and 15) are presented and discussed in this report. Figure 14 shows the elevation of the potentiometric (water table) surface as measured during a 2-day period near the end of a "dry" interval extending from mid-August until November 17, 1978. During the 94-day drought, only 4.2 in. of preciupitation fell and most of this was on August 30, September 12, and October 5. Because of the dry condition of the soil, very little, if any, of this precipitation recharged the aquifer. Thus, the measurement period of November 15-16 reflected a 3-month interval of little or no recharge to the aquifer.

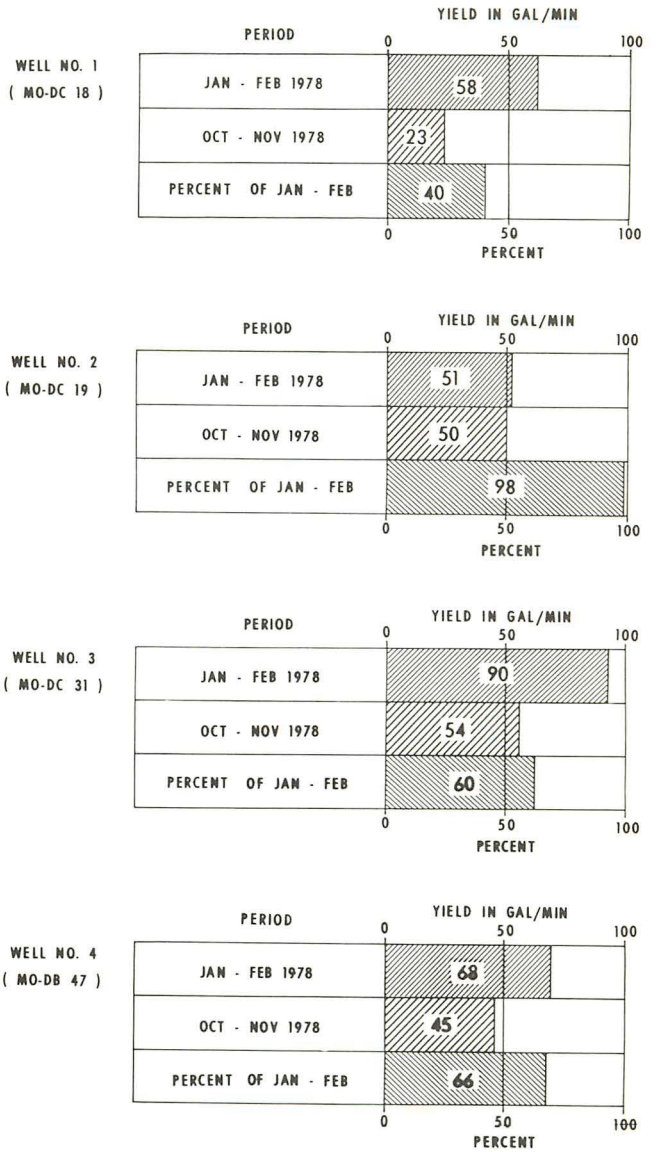


Figure 13. — Decrease in yield of Town of Poolesville's wells in 1978.

Figure 14 shows that the cone of depression resulting from the pumping of the Poolesville wells extends along the northeast-southwest direction for about 1.4 mi and along the northwest-southeast direction for about 1.0 mi. Because of the absence of observation wells at critical places near the edge of the cone of depression, it is difficult to determine the total area of hydraulic influence of the pumping wells and the shape and extent of their cone of influence, but it is crudely estimated to cover 1.2 mi^2, and to be roughly elliptical. Note that by mid-November, the cone of influence of wells -DC 18, -DC 19, and -DC 31 had merged to form a single, irregularly shaped cone with a sad-

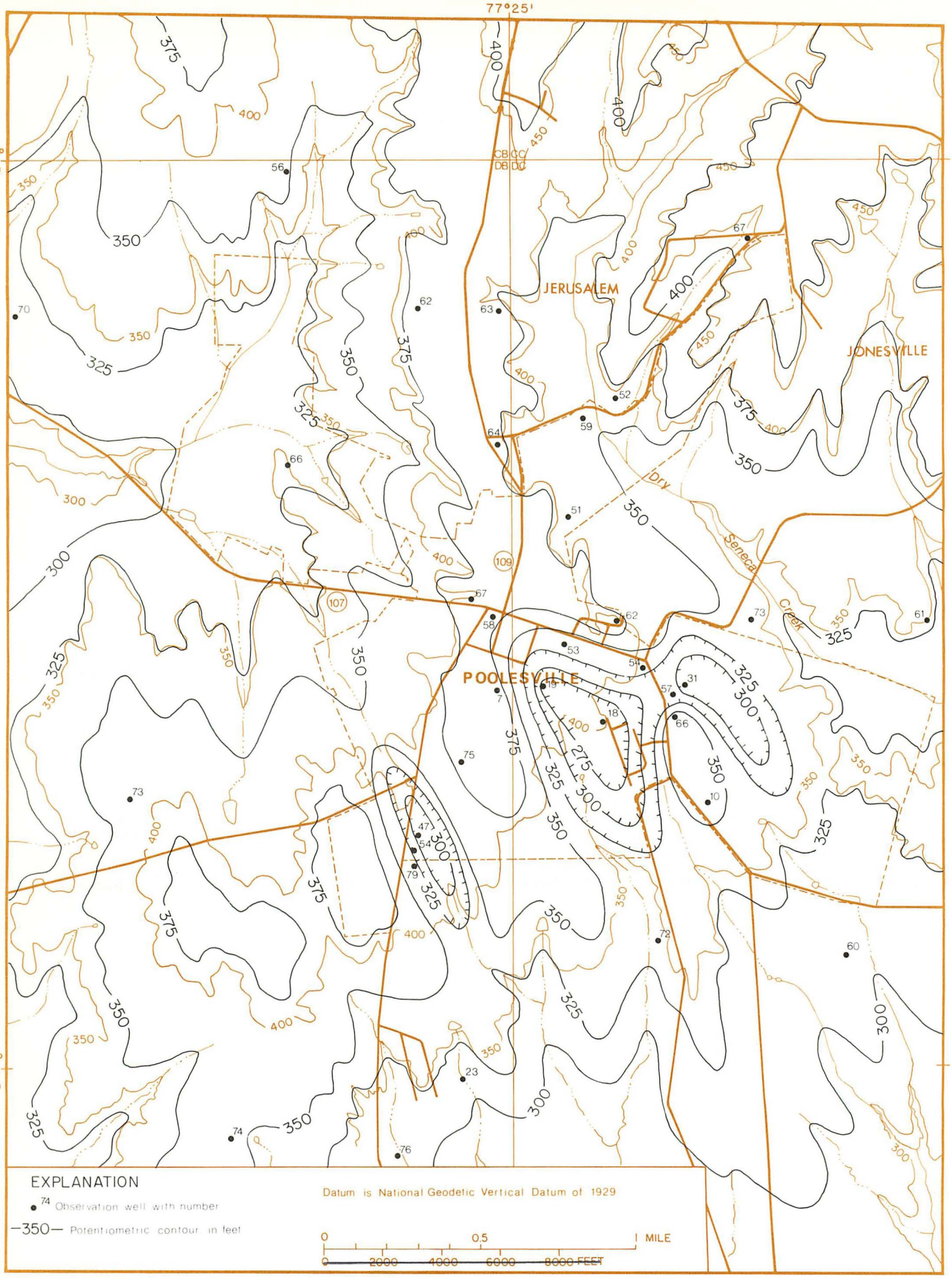


Figure 14. — Potentiometric map of the Poolesville area, November 15-16, 1978.

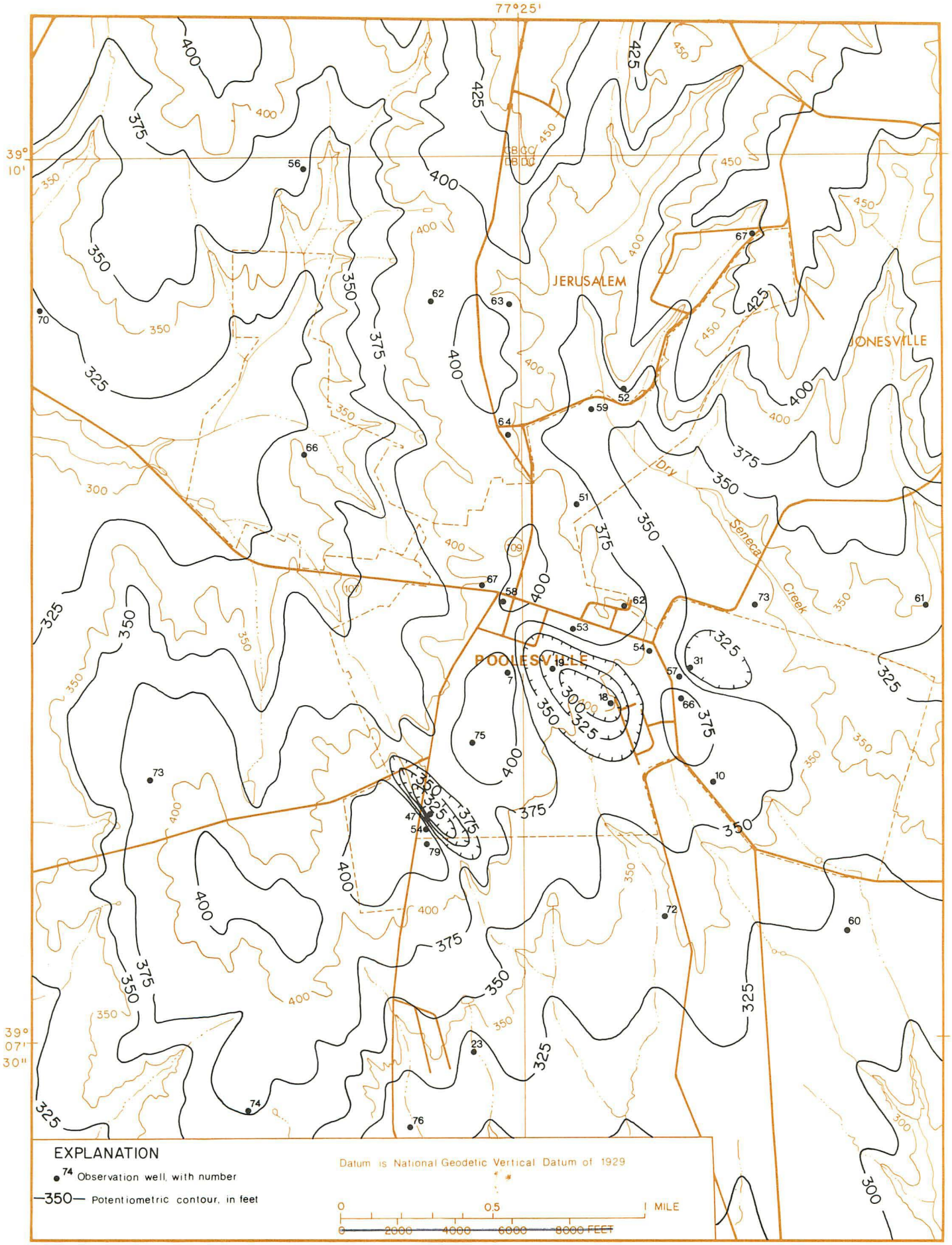


Figure 15. — Potentiometric map of the Poolesville area, January 15-16, 1979.

dle in the vicinity of well -DC 57. Maximum drawdown brought water levels to an altitude less than 200 ft in the vicinity of well -DC 18 (contours not shown on the map). Pumping from well -DC 47 caused a separate elongated troughlike cone, oriented NW-SE, estimated to be 0.7 mi long and perhaps 0.3 mi wide. Pumping from wells both southwest and northeast of observation well -DB 75 may have affected its water level, because by November 15, the level had dropped 6.6 ft from the previous measurement of October 12. However, it is not possible to determine how much of this decline is caused by the Poolesville pumping, or how much is the result of a natural water-level decline in the aquifer.

A series of rainstorms that began on November 17 continued into January. Because of the virtual cessation of evapotranspiration, the heavy and frequent precipitation, and the decreased use of water, a significant rise in water levels occurred in the aquifer, both in the vicinity of the Poolesville well field and distant from it. Figure 15, based on water-level measurements in mid-January 1979, shows the changed condition in the aquifer. By this time, ground-water levels in the entire area had risen noticeably, ranging from 0.8 to 15.2 ft and averaging about 6.5 ft in 10 observation wells unaffected by pumping. The maximum rise occurred in well -DC 51, 0.4 mi northeast of the center of Pooleville.

Examination of the cone of depression of Poolesville shows that the cone around well -DC 31 is much less prominent than it was on November 15-16. The cone surrounding wells -DC 18 and -DC 19 is smaller and the area enclosed by the +300-ft contour around well -DC 18 covers only about 25 percent of the area it did in mid-November 1978. The cone surrounding well -DB 47 appears to be 50 to 60 percent smaller and the water level in well -DB 7 had risen 24.8 ft, and in -DB 75 had risen 23.2 ft. By mid-January 1979, the +375-ft potentiometric contour had been replaced by the +400-ft contour in the vicinity of these wells, showing a rise of the water level of approximately 25 ft in this locality.

Figures 14 and 15 are also useful in showing the shape and extent of the surface drainage basins and the extent to which the potentiometric contours follow the pattern of the surface drainage. Since idealized ground-water flow occurs at right angles to the potentiometric contours, the maps would be useful in predicting directions of ground-water flow and in assessing likely flow paths, should any contaminant be introduced into the ground-water system.

Course of Future Development

The annual estimated rate of recharge to the aquifer at Poolesville, based on 10 in. per year, amounts to 552,000 gal/d over the estimated 1.2 mi^2 of area affected by the pumping wells. This rate of recharge is nearly double the average daily demand of 292,000 gal/d during the peak month of June 1978. However, as indicated previously, the problem is that during the recurrent dry periods, most, or all of the water is derived from aquifer storage and the recharge is not available when it is needed. The storage coefficient of the aquifer is estimated to be 1 percent in the uppermost 250 ft of the saturated zone and is probably less than this at greater depths.

Thus, during the dry periods when the well yields decline, the peak monthly demand of 292,000 gal/d[1] would exceed the "dry weather" yield of the four supply wells (248,000 gal/d) by about 15 percent. The yield of the wells during the peak month of June 1978 was adequate to supply the demand as water was still available in the aquifer from the winter and spring recharge. Had the peak demand of 292,000 gal/d occurred during the October-November period, the wells probably would have been unable to deliver at this rate, although some leeway in the water-supply system is provided for short time periods by the 500,000-gallon-water-storage tank located near well 1.

Wells 1, 2, 3, and 4 are inadequate to supply Poolesville during extensive drought, and one to two additional wells of at least 50 gal/min capacity each are required to supply the current (1979) demand during stress periods. To avoid excessive hydraulic interference between pumping wells (such interference is noticeable on figure 14 between wells -DC 18 and -DC 19), it will be necessary to locate additional wells beyond the area of influence of the current supply wells and preferably along suspected fracture traces. Figure 16 shows the location of several linear features in the vicinity of Poolesville that may be fracture traces. These features probably represent favorable sites for additional wells. Also shown on figure 16 is the approximate area of hydraulic influence during November 1978, resulting from the pumping of the four wells.

The new wells, ideally, would be located on the basis of exploratory test drilling, together with pumping tests of sufficient duration to demonstrate the yield capabilities of the wells and their hydraulic effect, if any, on other nearby wells. The installation of such wells would solve the short-

[1]The actual demand during a few peak days in the summer of 1978 was more than 350,000 gal/d.

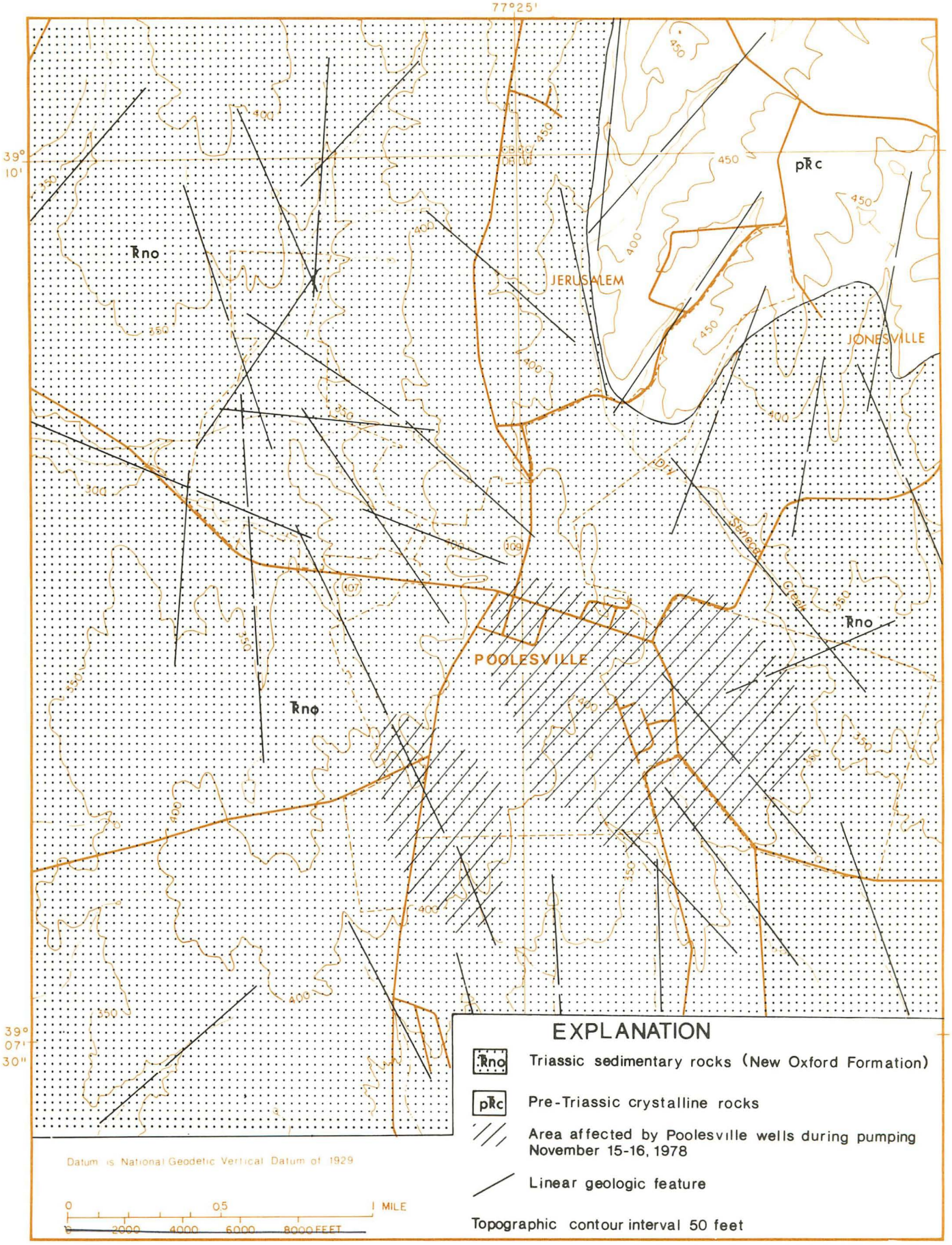


Figure 16. — Geology of the Poolesville area showing linear features and approximate area of hydraulic influence of town wells.

term water-supply problem of Poolesville.

In order to provide the additional supply of ground water needed to sustain Poolesville during future droughts, a substantial program of ground-water exploration is necessary. The objective of this program would be to locate an additional well field of several wells having a combined yield approximately equivalent to that of the current four supply wells. This doubling of the supply would require an investment in well drilling and testing, plus engineering and land acquisition costs. It might also involve the construction of a pipeline to bring the water to Poolesville.

Alternatives, other than a ground-water source, might include an extension of the Washington Suburban Sanitary Commission water mains westward from Gaithersburg, or constructing a reservoir on Seneca Creek or Broad Run. Another alternative might be constructing an intake and treatment plant on the Potomac River south or west of Poolesville.

CHEMICAL QUALITY OF THE WATER

The ground water in western Montgomery County is generally of a chemical quality suitable for most uses, except where wells may have become contaminated by septic tank effluent, road salt, or other harmful substances. The water from wells in the crystalline rocks is commonly slightly acidic (pH less than 7.0), and generally soft. The water from wells in the Triassic sediments is commonly slightly alkaline (pH greater than 7.0), and may be moderately hard to hard. During this and previous investigations, 49 laboratory chemical analyses of ground water were made, and 14 field analyses were made. Also, 19 field analyses of water from several small streams were made during periods of dry-weather flow. These were made to compare chemical quality of ground water with chemical quality of nearby surface water. Table 11 summarizes the important ground-water quality information for the area. The following sections briefly discuss the chemical constituents or properties of most concern to the water user.

Silica (SiO_2)

Silica is dissolved from quartz, feldspar and other siliceous minerals in the rocks, and is a common constituent in all ground waters. Silica has little effect on domestic use, but affects some industrial uses as it contributes to the formation of boiler scale and must be removed from feed water for high pressure boilers. The silica concentration in 27 analyses ranges from 5.3 to 26 mg/L. Water from the Triassic sediments generally has a higher concentration of silica than water from the crystalline rocks (table 11).

Iron (Fe) and Manganese (Mn)

Iron is dissolved in water in small concentrations in nearly all aquifers. Water can be rendered unsuitable for many uses where the iron concentration exceeds a few milligrams per liter. Concentrations of iron in excess of 300 µg/L (0.3 mg/L) cause stains on plumbing fixtures, cooking utensils, and fabrics, but the iron concentration of water can usually be reduced by relatively simple treatment. Iron concentration of 24 samples ranges from 20 to 13,000 µg/L (0.002 to 13 mg/L). The median iron concentration of water from the crystalline rocks (950 µg/L) is much higher than in water from the Triassic sedimentary rocks (90 µg/L); this difference may be due to the iron dissolved from well casings, pipes, etc., in the water systems of the wells sampled, particularly where the ground water is moderately acidic.

Manganese is also a common dissolved constituent in ground water and its occurrence is often coincident to that of iron. It is derived from the solution of manganese minerals in the rocks. Concentrations of manganese in excess of 200 µg/L can cause formation of a dark brown or black stain on porcelain fixtures or on fabrics. The U.S. Environmental Protection Agency (1977b, p. 17144) secondary maximum contaminant level[1] for man-

[1]The Environmental Protection Agency defines the "secondary maximum contaminant level" as the advisable maximum level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

Table 11. — Summary of water-quality data from aquifers in western Montgomery County. Concentrations in mg/L, except as indicated.

[Concentrations in mg/L, except as indicated.]

Constituent or property	Maximum	Minimum	Median	Number of samples	Maximum concentration recommended for drinking water 1/
Silica (as SiO_2)					
Triassic sedimentary rocks	26	9.1	21	19	N.R. 2/
pre-Triassic crystalline rocks	13	5.3	6.3	8	
Iron (ug/L as Fe)					
Triassic sedimentary rocks	4,900	20	90	17	1/ 300
pre-Triassic crystalline rocks	13,000	30	950	7	
Manganese (ug/L as Mn)					
Triassic sedimentary rocks	700	0	10	18	1/ 50
pre-Triassic crystalline rocks	280	5	60	7	
Sulfate (as SO_4)					
Triassic sedimentary rocks	370	0.2	8.5	19	1/ 250
pre-Triassic crystalline rocks	26	0.1	3.5	8	
Chloride (as Cl)					
Triassic sedimentary rocks	48	1.2	5.2	23	1/ 250
pre-Triassic crystalline rocks	77	2.0	3.5	19	
Fluoride (as F)					
Triassic sedimentary rocks	0.2	0.0	0.1	18	3/ 1.4-2.4
pre-Triassic crystalline rocks	2.5	0.0	0.1	8	
Nitrate (NO_3 as N)					
Triassic sedimentary rocks	8.8	0.2	1.8	16	1/ 10
pre-Triassic crystalline rocks	16	0.7	3.6	7	
Dissolved solids (Sum of constituents)					
Triassic sedimentary rocks	721	96	180	13	1/ 500
pre-Triassic crystalline rocks	232	46	68	8	
Hardness (Ca and Mg)					
Triassic sedimentary rocks	420	29	120	23	N.R.
pre-Triassic crystalline rocks	160	7	77	19	
pH					
Triassic sedimentary rocks	8.2	4.6	7.3	22	1/ 6.5-8.5
pre-Triassic crystalline rocks	7.6	4.2	5.5	19	

1/ U.S. Environmental Protection Agency, 1976, Quality criteria for water. (See also Federal Register, v. 42, no. 62, Mar. 31, 1977, for secondary maximum contaminant levels.)
2/ N.R. = none recommended.
3/ Recommended limits for fluoride vary according to the annual average maximum daily air temperature. These limits apply only to naturally occurring fluoride.

ganese in domestic water supplies is 50 µg/L. Concentrations of manganese in 25 analyses range from 0 to 700 µg/L (0.0 to 0.7 mg/L). Samples from the crystalline rocks have a higher median concentration of manganese (60 ug/L) than those from the Triassic sedimentary rocks (median value, 10 µg/L). This may be due to the acidic water dissolving greater quantities of manganese from rocks where manganese is a common mineral. The analyses indicate that manganese may cause minor quality problems in some well supplies.

Sulfate (SO_4)

Sulfate may be present in water from igneous rocks as a result of solution of the minerals of the feldspathoid group; many sedimentary rocks contain sulfide minerals which oxidize upon solution to form sulfates. While sulfate in water in moderate concentrations is not known to have a harmful effect on humans, the presence of the sulfate ion can have a laxative effect at concentrations above a few hundred mg/L. Sodium or magnesium sulfate in concentrations of 300 to 400 mg/L are said

to impart an undesirable taste to water and coffee. Because of uncertainty concerning the effect of sulfate concentrations in water in the range of 250 to 1,000 mg/L on human health, the U.S. Environmental Protection Agency (1977b, p. 17146) has established only a secondary maximum contaminant level of 250 mg/L for sulfate in their drinking water regulations.

The sulfate concentrations of 19 analyses range from 0.1 to 370 mg/L. The median value in water from wells in the Triassic sedimentary rocks is 8.5 mg/L and the median value from the phyllitic rocks is 3.5 mg/L.

Chloride (Cl)

Chloride is present in almost all natural water and is not considered harmful to humans. Chloride is an essential element for plants and animals and both may constitute a secondary source of chloride in ground water. Primary sources are rocks of sedimentary and igneous origin and oceanic water. Even precipitation commonly contains chloride in concentrations ranging from 1 to 8 mg/L (Hem, 1959, p. 110).

Chloride concentrations in water in excess of 250 mg/L may impart a slight salty taste to the water, which is objectionable to many people (U.S. Environmental Protection Agency, 1977b, p. 17144). Chloride concentrations in uncontaminated ground water in western Montgomery County usually are less than 10 mg/L. Concentrations significantly higher than 10 mg/L may indicate ground-water contamination.

Chloride concentrations in 42 analyses of ground water ranged from 1.2 to 77 mg/L (table 11). The maximum concentration of 77 mg/L was found in a 125-ft domestic well at Barnesville, well -CC 40. It is possible that this well was or is contaminated from some not yet identified source.

Fluoride (F)

Fluoride is a minor constituent of most ground water where it is commonly derived from solution of the minerals, fluorite or apatite. Minerals of the mica group may also contribute fluoride into solution in the ground water. Fluoride in excessive concentrations is undesirable in waters used for drinking. Somewhat inconclusive evidence suggests that continued ingestion of water containing more than 4 mg/L of fluoride may cause endemic fluorosis.

The fluoride concentration in 26 analyses in and near the study area ranges from 0.0 to 2.5 mg/L and the median value is about 0.1 mg/L, which is well below the U.S. Environmental Protection Agency recommended limiting range of 1.4 to 2.4 mg/L (table 11). The maximum value of 2.5 mg/L is from well -BE 34, a 90-ft drilled well near Damascus, just north of the area of this report. The well ends in phyllitic rocks. The analysis was made in 1952, and the high chloride (27 mg/L) and nitrate (16 mg/L as N) concentrations suggest this well may have been contaminated, at least at the time of sampling.

Nitrate (NO_3 as N)

Most of the nitrate ions in ground water appear to be derived from decomposition of organic matter in the soil, although small amounts may result from the decomposition of igneous rocks. The average nitrate concentration of rain water is reported to be 0.05 mg/L as N (Hem, 1959, p. 115). In western Montgomery County, the nitrate concentration of ground water normally should not exceed 3-5 mg/L as N. Nitrate concentration in excess of this amount probably is the result of pollution of the ground water by chemical fertilizers, septic tank effluent, or barnyard wastes.

Medical studies have indicated that nitrate nitrogen concentrations exceeding 10 mg/L in drinking water may contribute to, or be the main cause of a condition in infants known as methemoglobinemia (infant cyanosis or "blue babies"). Therefore, water containing nitrate nitrogen concentration in excess of 10 mg/L should not be used for drinking water, according to the U.S. Environmental Protection Agency (1977, p. 81).

Only 1 of 23 analyses for nitrate was in excess of the limiting value of 10 mg/L. This water sample, containing 16 mg/L of nitrate nitrogen, was from well -BE 34, the 90-ft deep well near Damascus, mentioned previously. As stated before, this well was probably contaminated at the time of sampling.

The range in nitrate nitrogen concentration in 23 analyses is from 0.2 to 16 mg/L. The median nitrate concentration of the water from the Triassic sedimentary rocks is 1.8 mg/L, and from the crystalline rocks is 3.6 mg/L. This slight difference is not considered to be significant.

Dissolved Solids

Dissolved solids, sum of the solid constituents, is a measure of the mineral matter in the water. No recommended limit for dissolved solids concentrations in water has been established by the U.S. Environmental Protection Agency (1976, p. 205) although the agency states that excess dissolved solids concentrations are objectionable in drinking water because of possible physiological effects, unpalatable mineral tastes, and higher costs because of corrosion effects or the necessity for additional water treatment.

Dissolved solids in 21 analyses range from 46 to 721 mg/L. Water from the crystalline rocks is generally low in dissolved solids.

Copper (Cu) and Zinc (Zn)

These elements are considered trace elements in most natural ground water. The presence of copper in the water may be caused by solution from copper pipes in the household distribution system. Zinc, present as the coating in galvanized steel pipes, may also be dissolved from distribution systems. Such solution may be expected to take place where the water has a pH of less than 7.0. The U.S. Environmental Protection Agency (1976, p. 54) has recommended that copper in domestic water supplies not exceed a concentration of 1,000 µg/L, and that the zinc concentration not exceed 5,000 µg/L (1976, p. 245). The results of six analyses of well water in the study area for copper and zinc are given in the following table.

Well No.	Aquifer	Date of Analysis	Well depth (ft)	pH	Cu (µg/L)	Zn (µg/L)
MO-BE 34	pTRC[1]	May 1952	90	6.2	<5	8,000
-CB 1	TRNO[2]	do.	80	6.0	<5	3,000
-CD 15	pTRC	do.	75	6.3	90	5,100
-CD 26	pTRC	Aug. 1955	112	6.3	0	30
-DA 1	TRNO	May 1952	40	7.4	<5	50
-DB 1	TRNO	do.	62	6.9	<5	5,500

[1] pTRC - pre-Triassic crystalline rocks.
[2] TRNO - Triassic sedimentary rocks, (New Oxford Formation).

In the six analyses above, copper concentrations ranged from 0 to 90 µg/L, all below the U.S. Environmental Protection Agency limiting level of 1,000 µg/L, and the zinc concentrations ranged from 30 to 8,000 µg/L. Three of the values for zinc are in excess of the limiting level of 5,000 µg/L. The maximum value of 8,000 µg/L was from well -BE 34 near Damascus.

Hardness and pH

Hardness is an important factor affecting the use of water; hard water consumes more soap than soft water and causes the formation of an objectionable curd. The curd is difficult to remove from fabrics and from containers where it may be deposited. Scale may also be deposited and cause a special problem in steam boilers. The main cause of hardness is the solution of compounds of calcium and magnesium, although iron, manganese, and aluminum may contribute to a limited degree to water hardness.

Figure 17 shows graphically the frequency distribution of well water hardness. The water from the Triassic sedimentary rocks has greater hardness than the water from the crystalline rocks. The data used to compile figure 17 are from hardness tests on 42 samples. The maximum hardness of 420 mg/L as $CaCO_3$ is from well -EC 10, located 4 mi south of Poolesville in the flood plain of the Potomac River. Well -EC 10 is a test and observation well drilled to a depth of 857 ft.

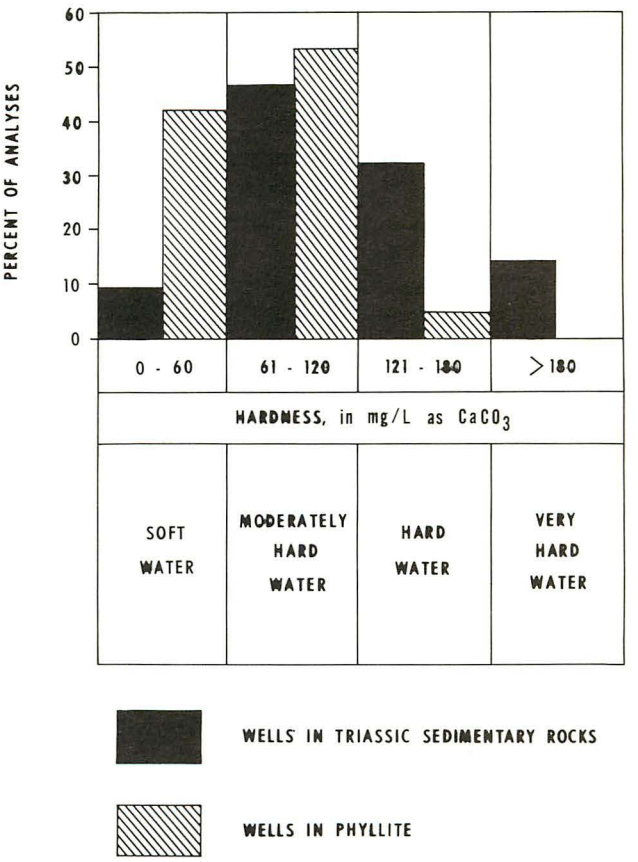


Figure 17. — Hardness of water from wells in Triassic sedimentary rocks and in pre-Triassic crystalline rocks.

The softest water analyzed (7 mg/L as $CaCO_3$) is from well -CC 31 located just north of Beallsville along Maryland Route 109. Well -CC 31 is 160 ft deep and penetrates phyllitic and quartzitic rocks.

The location of the wells tested for hardness is shown on figure 18, along with the underlying geology of the area. Figure 18 also shows the pH of the water at the time of collection.

Hydrogen-ion activity is expressed in terms of pH units. In simple terms, pH is a measure of the hydrogen-ion activity of the water[1]. A pH of 7.0 indicates neutral water; a pH of greater than 7.0 indicates alkaline water; and a pH of less than 7.0 indicates acidic water. Most ground waters in the United States have pH values ranging from 6.0 to 8.5 (Hem, 1970, p. 93).

The pH of ground water, based on 41 samples in western Montgomery County ranges from 4.2 to 8.2. Most of the water from the crystalline rocks has a pH below 7.0. The median value of 19 samples is 5.5 Most of the water from the Triassic sedimentary rocks is alkaline and the median pH of 21 samples is 7.3. The acidic well water (low pH) from the crystalline rock areas causes solution of metals from water pipes and storage tanks. In some instances, water of low pH contains lead dissolved from soldered pipe joints in household water systems, and the lead concentration of this water may exceed the U.S. Environmental Protection Agency (1976, p. 82) mandatory limiting concentration of 50 µg/L. In such situations the source of the lead may be incorrectly assumed to be from the aquifer. Nevertheless, some treatment or remedy is advised.

HAZARDS OF GROUND-WATER CONTAMINATION

In the Piedmont, ground water occurring under water-table or modified artesian conditions is readily subject to being contaminated—most commonly by septic-tank effluent, road salts, chemical fertilizers, and herbicides and insecticides. The existence of a thick layer of soil and saprolite may attenuate many types of contaminants, but in some localities, as in parts of the area of this report, the soils are only a few feet thick and the fractured, jointed bedrock lies relatively near the land surface. Water moving through the fractured, rock may thus be subject to little filtering and adsorption. Thus, both bacteriological and chemical contaminants may travel through the aquifers subject chiefly to dilution by uncontaminated water and to gradual dispersion in their passage thru the ground.

Ground water in the Poolesville area (and similar areas underlain by Triassic rocks) appears to be particularly susceptible to contamination because of the thin soil cover and the extensive fracturing of the underlying shale and sandstone. Should contamination occur at the land surface, for example by the spill of a toxic chemical, the chemical would move into the ground, and in a few hours or days would reach the saturated zone. From an estimate of the transmissivity of the aquifer near Poolesville, its porosity and the slope of water table, it is possible to predict roughly the rate of movement of a contaminant from its point of entrance into the aquifer to the nearest pumping well. An analysis of a hypothetical case follows, based on the potentiometric map of the Poolesville aquifer on November 15-16, 1978 (fig. 14). A chemical contaminant is spilled at the intersection of Routes 107 and 109, approximately 1,300 ft from the nearest town well, MO-DC 19. Figure 14 shows that on November 15-16, the hydraulic gradient between well -DC 19 and the above-mentioned street intersection was about 100 ft in 1,300 ft, or a gradient of 0.077. The transmissivity of the aquifer at well -DC 19 is 150 ft^2/d (table 8) and the hydraulic conductivity, based on a 250-ft estimated thickness of the uppermost creviced part of the aquifer, is 0.60 ft/d. Effective porosity of this zone is assumed to be approximately the same as the storage coefficient, which was estimated to be 0.01 percent. Based on the formula commonly used to predict rates of ground-water movement (Lohman and others, 1972, p. 14), the contaminating substance might arrive at well -DC 19 in about 283 days (9-1/2 months) after it entered the saturated zone in the aquifer. The average rate of flow toward the well would be about 4.6 ft/d. The formula used and the computations are:

$$v = \frac{K I}{\theta_e}$$

[1]Measurement of pH of a solution, however, does not indicate the quantity of acid or base that must be added to make the solution more acidic or more basic. This resistance to change is called "buffering capacity" and its determination, known as "acidity" or "alkalinity," is done by titrating with a strong base or acid.

where:

v = velocity of movement, in ft/d;

K = T/m, or 150/250 (hydraulic conductivity, in ft/d);

I = hydraulic gradient, in ft (100/1,300 in this problem);

θ_e = effective porosity, dimensionless (0.01 for the Poolesville area);

or

$$v = \frac{(0.60)\ (0.077)}{0.01} = 4.6 \text{ ft/d.}$$

However, if an average porosity of 0.05 is used, then the average ground-water velocity would amount to only 0.9 ft/d and the contaminant would take 1,444 days (about 4 years) to reach the well. The above discussion assumes that the contaminating substance would move through the aquifer at the same speed as would a particle of water. Using the first analysis (velocity of 4.6 ft/d), a contaminant spill at a distance of only 100 ft, instead of 1,300 ft, would arrive at the well in 22 days, based on the same average flow gradient. In this case, relatively little time would be available for any emergency or corrective action.

It is possible that the actual rates of movement of water through the aquifer (Triassic rocks) are much faster than indicated above, due to the fracturing and crevicing of the rocks. Current theory is not adequate to properly evaluate this condition. More realistic estimates of flow rates through the aquifer at a specific location can be made by conducting actual field tests using a harmless tracer substance introduced into the aquifer system and determining the time required for the substance to flow from the point of introduction to the pumping well or wells. Although such tests are seldom made, they might be worthwhile, especially in places like Poolesville.

SUMMARY

1. Ground water in western Montgomery County occurs under water-table and modified artesian (intermediate) conditions, chiefly in fractures and crevices in the underlying rocks. The source of all the ground water is local precipitation, averaging 42 in. annually. Water-yielding fractures in the Triassic rocks in Maryland are known to occur in wells to depths of 782 ft. Most wells penetrate at least one water-yielding fracture in the depth interval from 75 to 99 ft.
2. Study area is underlain by two major rock types, pre-Triassic crystalline rocks and Triassic sedimentary rocks—chiefly shale, siltstone, and sandstone. Neither major rock type is a good aquifer and yields of 100 gal/min or more from individual wells are exceptional. The median specific capacity of 21 crystalline-rock wells is only 0.18 (gal/min)/ft and the median specific capacity of 80 Triassic wells is 0.15 (gal/min)/ft, but the slight difference between the two rock types is probably not significant.
3. Transmissivity values of the crystalline rocks range from 12 to 670 ft^2/d and the median value of 9 determinations is 35 ft^2/d. Transmissivity values of the Triassic consolidated sedimentary rocks range from <5 to 1,540 ft^2/d and the median value of 80 determinations is 17 ft^2/d.
4. Pumpage from the N.I.H. Animal Center was 41,000 gal/d in 1976, and 28,000 gal/d in 1978, a 32-percent decrease. Pumpage from wells at Poolesville during 1976 was 207,000 gal/d and 246,000 gal/d in 1978, a 19-percent increase. Use of ground water in the remainder of the report area, largely rural in character, is estimated to be 250,000 gal/d, giving a total ground-water use of 520,000 gal/d in 1978.
5. Owing to the low storage capacity of the aquifers and to a drought, the yield of the Poolesville wells declined from 384,000 gal/d in January-February 1978 to 248,000 gal/d during October-November 1978, for a net decline of 36 percent in their capacity. This drop in yield of the wells occurred during the summer and fall when demand for water normally is highest. If future water deficiencies are to be avoided, additional high-yielding wells will be required, even if the town's population and water demands remain at 1978 levels. It is likely that during wet seasons, or periods of slack water demand, such wells may be unused. If the 1978 water demand does increase substantially, then possibly a new well field will be needed. This field would have to be located beyond the cone of depression of the present four wells, and the development of the field will require

test drilling and exploratory studies. It appears that favorable sites are along linear features. A promising area for testing and exploration lies 1 to 1.5 mi west and northwest of Poolesville.

6. Chemical quality of the ground water is generally suitable for most uses. Water from wells in the crystalline rock area is mildly acidic (pH below 7.0) and generally soft. Water from wells ending in the Triassic sedimentary rocks is mildly alkaline (pH above 7.0) and is harder. Iron and manganese content of water from a few wells are above the secondary maximum Environmental Protection Agency limits, but these constitutents can be removed by water treatment.
7. Because ground water occurs under water-table conditions and the soil zone is relatively thin in much of the area, the chances of contaminating the aquifers are moderately high. Possible contaminants are septic-tank effluent, truck spills of toxic chemicals, road salt, chemical fertilizers, and herbicides and insecticides.

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SUPPLEMENTAL GROUND-WATER DATA

Table 12. — Lithologic description of cuttings from selected wells.

Well No.: MO-DB 47
Owner: Town of Poolesville
Elevation: 420 feet
Driller: Sydnor Hydrodynamics, Inc.
Location: Poolesville
State Permit No.: MO-73-1584

Depth (ft)	Description	Color
0- 10	Sandstone, dirty, silty, some clayey shale, gritty, arkosic	Pale red (5 R 6/2)
10- 20	Same as above, a few coarse mica flakes	Pale red (5 R 6/2) to pale brown (5 YR 5/2)
20- 40	Shale, very silty, gritty, arkosic, sandy; a few small pieces of whitish-pink calcite	As above
40- 50	Same as above, with a few pieces calc-cemented sandstone, darker in color than above	As above
50- 60	Sand, muddy, gritty, with some fine quartz gravel, rounded to subrounded; fragments appear to be porous	As above, pale red
60- 70	Same as above, gritty	As above
70- 80	Sandstone, hard, fine to medium grained, calc-cemented with some fine mica	Darker than above (grayish red when wet)
80- 85	Sandstone, as above - grades into shale, fissle, hard	Grayish red (10 R 4/2)
85- 90	No sample	
90-100	Shale, fissle, hard; very little grit or sandstone	Grayish red to pale reddish brown (10 R 4/2 to 10 R 5/4)
100-105	Sandstone, fine (or siltstone), calc-cemented, with some fine mica, slightly mottled	Pale yellowish brown (10 YR 6/2)
105-110	Same as above, arkosic and lighter in color, micaceous, mottled	Pale red (10 R 6/2)
110-115	Same as above, but darker in color	(10 YR 6/2)
115-120	As above, with mica and pieces dark, red shale, darker in color	Brownish-gray (5 YR 4/1)
120-130	As above, with some mica	(5 YR 4/1)
130-135	Shale, fissle, gritty, hard; some pieces sandstone, calc-cemented as above	Grayish red (10 R 4/2)
135-140	Shale, hard, fissle; a few small pieces carbonaceous material	Moderate brown (5 YR 3/4)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DB 47--Continued

Depth (ft)	Description	Color
140-145	Sandstone, hard, arkosic, somewhat mottled with a dark mineral	Pale yellowish brown mottled with black (10 YR 6/2)
145-150	As above, with pieces of dark rock of uncertain identity; dark rock is non-calcareous	As above (10 YR 6/2)
150-160	As above, but grades into shale, hard, finely micaceous; few pieces of yellow-brown sandstone	Pale brown to moderate brown
160-170	Siltstone, shaly, hard, some fine mica; few pieces calc-cemented fine sandstone	Moderate brown (5 YR 3/4)
170-200	As above, with slightly increased amount fine sandstone, lighter in color	Moderate brown
200-210	As above, but about 30 percent of sample is mottled gray calc-cemented sandstone; a few pieces brown limestone	Moderate brown to mottled grayish white
210-220	Siltstone, shaly, and layers, brown mottled dolomitic (?) limestone, whitish and pale red	As above (10 R 6/2)
220-230	Siltstone, hard, shaly, with fine mica; less limestone fragments	Moderate brown (5 YR 3/4)
230-240	Grades into mottled, hard, calc-cemented fine sandstone	Moderate brown (5 YR 3/4) to pale red (10 R 6/2)
240-260	Siltstone, hard, shaly	Moderate brown (5 YR 3/4)
260-270	Sandstone, mottled, calc-cemented; some dark siltstone, shaly, finely micaceous	Pale red (10 R 6/2 to pale brown (5 YR 5/2)
270-280	Sandstone, fine, loose, with some cemented fragments, slightly calcareous, mottled	Pale red (10 R 6/2)
280-285	Sandstone, fine, loose, as above; contains small grains of pink mineral--probably feldspar	Pale red (10 R 6/2) to pale yellowish brown (10 YR 6/2)
285-290	Sandstone, loose as above; feldspar and mica common	As above
290-295	As above, but grading into siltstone, shaly, hard; few pieces dark greenish-gray mineral	Moderate brown (5 YR 3/4)
295-300	Sandstone, loose, similar to interval 260-290 feet, arkosic	Pale red (10 R 6/2)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DB 47--Continued

Depth (ft)	Description	Color
300-310	Sandstone, hard, feldspathic, arkosic, mottled	Light brownish gray (5 YR 6/1)
310-315	As above, but grades into a hard, impure, silty limestone; fine mica common	Brownish gray (5 YR 4/1) to dark yellowish brown (10 YR 4/2)
315-320	Siltstone, calcareous, hard, as above; some fragments brownish red shale	Brownish gray (5 YR 4/1)
320-325	Shale, silty; few small pieces calc-siltstone	Pale brown (5 YR 5/2)
325-330	Shale, silty, as above; some micaceous calc-cemented sandstone	As above (5 YR 5/2)
330-335	Shale, silty, as above; increase in mottled fine sandstone	As above (5 YR 5/2)
335-340	Shale, silty, as above, with some fine mottled sandstone	Brownish gray (5 YR 4/1)
340-350	Sandstone, mottled, hard, mottled, micaceous, arkosic; less calc-cement than in above layers	Pale brown (5 YR 5/2)
350-355	As above, with some loose sand	As above (5 YR 5/2)
355-370	Shale, silty, some fine mica; a few fragments white calcite, grades into calc-siltstone at base	Moderate brown (5 YR 3/4)
370-375	Limestone, silty, impure; a few large fragments white and pink calcite; some mica; fragments brown shale	Medium dark gray (03 N3) to grayish brown (5 YR 3/2)
375-395	Shale, brown, silty, with many fragments grayish-brown, impure, silty limestone; some pink and white calcite (very little limestone at base)	Moderate brown (5 YR 3/4)
395-400	Shale, very silty, hard; few fragments pink-white calcite	Moderate brown (5 YR 3/4)
400-420	Sandstone, fine, calcareous, silty, loose with some mottled gray fragments; some pink calcite	Pale brown (5 YR 5/2)
420-430	No sample	
430-440	As above (400-420)	Pale brown (5 YR 5/2)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DB 47--Continued

Depth (ft)	Description	Color
440-450	Shale, silty, hard, gritty; fragments gray calc-cemented fine sandstone; some fine mica	Pale brown (5 YR 5/2)
450-460	Siltstone, shaly, pale brown to mottled pale gray; a few pieces white and pink calcite	Pale brown (5 YR 5/2 to light brownish gray (5 YR 6/1)
460-480	Shale, hard, arkosic; fragments white calcite; fragments mottled, gray, calc-cemented siltstone	Moderate brown (5 YR 3/4) to mottled gray
480-500	Sandstone, hard to loose, silty, calc-cemented, mottled, some brown shale; some pink calcite or feldspar	Pale yellowish brown (10 YR 6/2) to moderate brown (5 YR 3/4)
500-520	Shale, hard, relatively uniform; a few small fragments white calcite	Moderate brown (5 YR 3/4)
520-555	Siltstone, hard, mottled, calc-cemented; fragments pink and yellow calcite; some fine mica	Medium gray (04 N4) to pale yellowish brown (10 YR 6/2)
555-565	Shale, hard, gritty; softer than above; few fine fragments medium gray siltstone; few large pieces pink-white calcite	Moderate brown (5 YR 3/4)
565-580	Siltstone, hard, mottled, gritty, finely micaceous; some fragments brown shale	Medium gray (04 N4) to brownish gray (5 YR 4/1)
580-590	Shale, hard, silty (similar to 555-565 feet)	Moderate brown (5 YR 3/4)
590-600	Sandstone or siltstone, hard mottled, gritty; some fragments brown shale; few small pieces pink calcite; some fine mica	Medium gray (04 N4) to moderate brown (5 YR 3/4)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DC 59
Owner: U.S. Geological Survey (Elgin farm)
Elevation: 370 feet
Driller: L. F. Easterday
Location: Poolesville, Md.
State Permit No.: MO-73-1896

Depth (ft)	Description	Color
0- 5	Soil, clayey, silty and gritty; a few pieces grit; some fine mica	Moderate yellowish brown (10 YR 5/4)
5- 10	Soil, clayey, some silt, lumpy; some fine mica	Pale brown (5 YR 5/2)
10- 16	Shale, clayey, disintegrated with small pieces red siltstone, gritty and lumpy; few pieces small gravel	Grayish red (10 R 4/2)
16- 20	Shale, gritty, broken; some pieces broken siltstone or fine sandstone (top of rock at 16 feet); hole dry at time of drilling	Pale red (5 R 6/2) to grayish red (10 R 4/2)
20- 25	Clayey, silt, gritty, muddy; some subangular pieces siltstone; very moist drilling at 23 feet	Grayish red (10 R 4/2)
25- 30	Clay, sandy, muddy, loose fragments of siltstone and shale, very gritty (water saturated)	Pale red (5 R 6/2)
30- 35	Shale and siltstone, broken, clayey; angular pieces siltstone up to 1 inch in diameter; few very small pieces of phyllite	Grayish red (5 R 4/2)
35- 40	Siltstone, grading to sandstone, hard, dense; few small pieces greenish rock or mineral	Mottled grayish brown (5 YR 3/2) to brownish gray (5 YR 4/1)
40- 45	Sand, clayey, silty; some angular fragments dark siltstone; may be disintegrated sandstone	Brownish gray (5 YR 4/1)
45- 50	Silt, clayey, gritty, with small pieces shale (silt fragments are lumpy) top of Reston member	Light brownish gray (5 YR L/1)
50- 55	Sandstone fragments in clay matrix; some angular fragments green sandstone; some small pieces pink quartz; few fragments black shale	Medium light gray (N6) to brownish gray (5 YR 4/1)
55- 60	Sandstone fragments as above; some pink and white quartz; some of the sandstone pieces are mottled green and pale brown	Medium gray (N5) to mottled dusky yellow green (5 GY 5/2)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DC 59--Continued

Depth (ft)	Description	Color
60- 65	Conglomerate; broken angular fragments of pink and white quartz; a few pieces gray-brown limestone; fragments greenish, mottled fine sandstone; few pieces green shale	Mottled gray, brown and green (diverse colors)
65- 70	No sample	
70- 75	Conglomerate; broken fragments of pink and white quartz; a few pieces greenish gray calcareous, siltstone; a few small fragments pink feldspar; pieces dark green shale, broken	Mottled gray, brown and green (diverse colors)
75- 80	Sandstone, broken, calc-cemented; a few pieces brown, fissle shale; some mottled light-colored fragments sandstone	Dark greenish gray (5 GY 6/1) and brownish gray (5 YR 4/1)
80- 85	Conglomerate, similar to 70-75 feet; some pieces clear quartz and red to whitish angular quartz, a few angular fragments tan dolomite; a few small fragments green shale	Color variable
85- 90	Conglomerate, as above	Color as above
90- 95	Conglomerate, as above with much more dark brown siltstone; a few pieces tan dolomite, as above	Color as above
95-100	Sandstone, silty, calc-cemented, gritty; some fine mica; some fragments mottled greenish siltstone	Pale brown (5 YR 5/2) to grayish brown (5 YR 3/2)
100-105	As above, but with color change, slightly micaceous, calc-cemented; some fragments shale, hard, brownish gray; few pieces pink calcite	Mottled medium gray (N5) and brownish gray (5 YR 4/1)
	Base of Triassic Rocks	
105-110	Phyllite, hard, with a sheen; some fragments up to 1 1/2 inch in size and platy; some fragments of calc-cemented sandstone from above; a few pieces brown calcite and/or dolomite	Grayish blue green (5 BG 5/2) to dusky blue green (5 BG 3/2)

Table 12. — Lithologic description of cuttings from selected wells—continued.

Well No.: MO-DC 59--Continued

Depth (ft)	Description	Color
110-120	Phyllite, as above, with a few pieces whitish calcite (fragments smaller than above)	Grayish blue green (5 BG 5/2)
120-230	Phyllite, as above, with a few fragments calcite; cuttings smaller than near top of this unit	As above
230-252	Phyllite, as above, with some small fragments white calcite	As above
252-262	Calcite layer, phyllitic; sample estimated 60-percent calcite, white; one small fragment red-brown shale (caving)	White ( ) to pale blue green (5 BG 5/2)

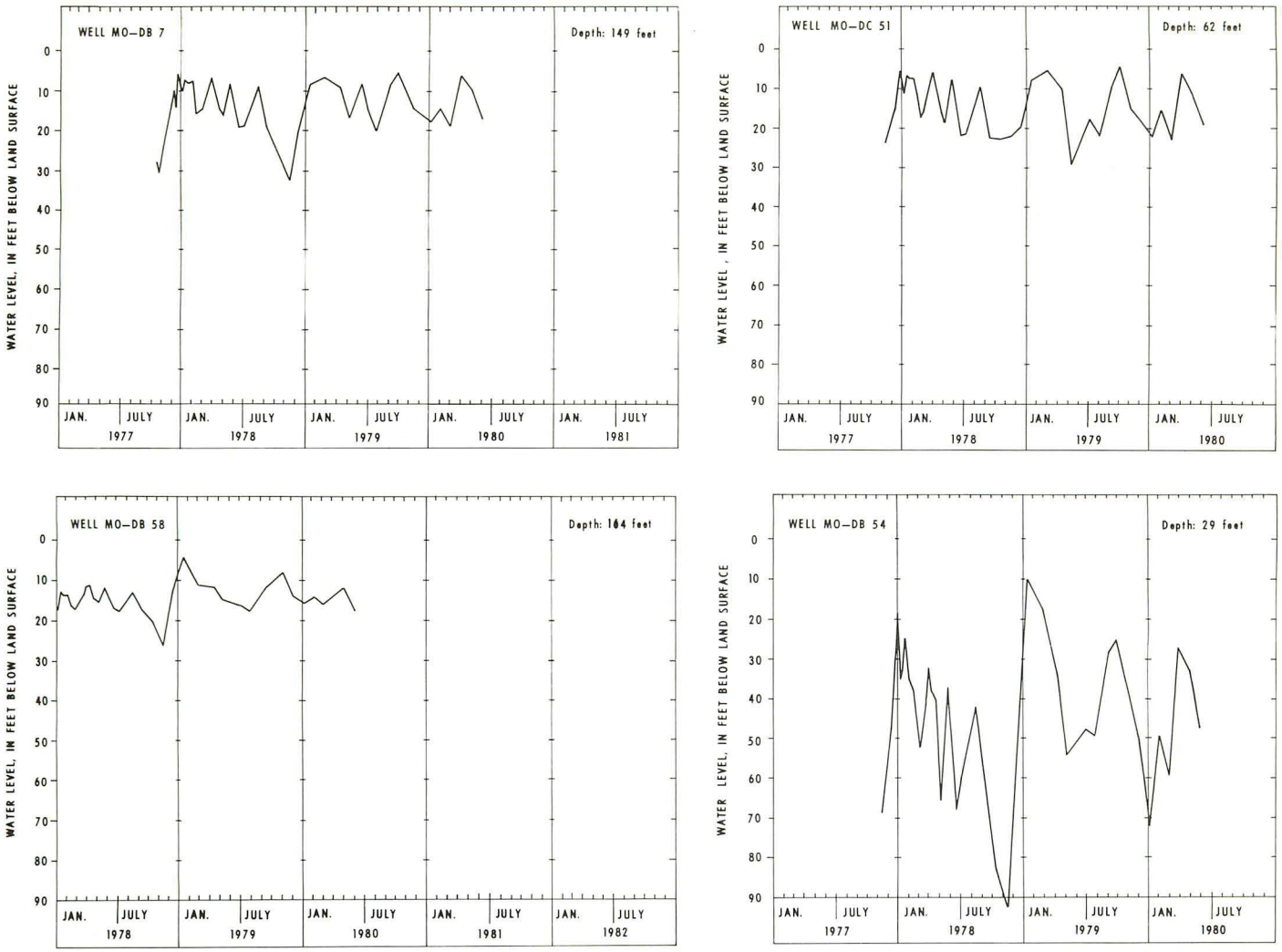


Figure 19. — Water levels in selected observation wells, 1977-79.

Table 13. — Montgomery County well records.

LOCAL NUMBER	PERMIT NUMBER	OWNER	CONTRACTOR	DATE COMPLETED	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	CASING DIAM-ETER (INCHES)	DEPTH CASED
MONTGOMERY COUNTY								
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
MO CB 1	MO-00-0265	DAYHOFF, R T	STOTTLEMYER	03/05/1946	365	80.00	5.62	15
MO CB 2	--	DAY, ROBERT J	--	1936	330	75.00	8	--
MO CB 3	--	WATKINS	--	1950	270	100.00	6	--
MO CB 4	--	DICKERSON SCHOOL	GREENE	1952	320	129.00	6	--
MO CB 5	--	DICKERSON SCHOOL	--	1922	330	75.00	6	--
MO CB 6	--	GLICKMAN, HARRY	--	1937	395	70.00	6	--
MO CB 7	MO-00-3723	GLICKMAN, HARRY	HILTON	03/25/1949	380	74.00	6	30
MO CB 8	--	MATHEWS, W K	HILTON	1938	405	50.00	6	--
MO CB 9	--	BLISS, F	--	?	420	95.00	6	--
MO CB 10	--	BLISS, F	--	?	335	65.00	6	--
MO CB 11	--	HILDEBRAND, J C	HILTON	11/25/1931	415	94.00	6	--
MO CB 14	MO-01-2458	DICKERSON, CHURCH	HILTON	06/03/1953	330	71.00	5.62	26
MO CB 15	MO-02-8678	POTOMAC POWER CO	HILTON	12/23/1957	340	250.00	6	28
MO CB 16	--	POTOMAC POWER CO	HILTON	12/23/1957	310	197.00	6	--
MO CB 17	--	POTOMAC PWR CO	HILTON	12/23/1957	350	250.00	6	--
MO CB 18	--	NATIONAL PARK SERV	HOFFMAN	04/01/1969	210	140.00	6.25	50
MO CB 19	--	NEUTRON PRODUCTS	HILTON	08/24/1971	375	100.00	6	--
MO CB 20	MO-69-0053	NEUTRON PRODUCTS	HILTON	10/28/1968	375	148.00	6.25	42
MO CB 21	MO-05-0547	HELLER, ANTHONY	HILTON	04/18/1963	420	150.00	6.25	28
MO CB 22	MO-66-0438	HELLER, ANTHONY	HILTON	05/09/1966	415	100.00	6.25	22
MO CB 23	MO-68-0206	LYTHE, HUBERT	HILTON	07/01/1968	375	114.00	6.25	24
MO CB 24	MO-69-0097	WHEATON LUMBER	GREEN	11/ /1968	350	125.00	6.25	24
MO CB 25	MO-72-0176	YATES, JOHN R	HILTON	04/07/1972	395	100.00	6	18
MO CB 26	MO-72-0191	GEOLOGICAL SURVEY U S	KEYSER	05/17/1972	220	885.00	6	40
MO CB 27	--	GEOLOGICAL SURVEY U S	KEYSER	05/19/1972	220	75.00	6	18
MO CB 28	--	WESTLAND, DAN	KEYSER	06/05/1972	380	310.00	6	37
MO CB 29	MO-73-0284	PEPCO	KEYSER	07/30/1973	315	1004.00	8	40
MO CB 30	MO-73-0173	WONG	HILTON	03/22/1973	380	115.00	6	40
MO CB 31	MO-73-1131	CARLISLE, MAURICE	HILTON	01/07/1977	360	110.00	6	45
MO CB 32	MO-73-0899	BELCHER	--	11/07/1975	310	85.00	--	--
MO CB 33	MO-73-0293	CLARK	--	08/21/1973	450	100.00	--	--
MO CB 34	MO-73-0488	THACHER	EASTERDAY	05/13/1974	425	240.00	6	42
MO CB 35	--	PEPCO POWR PLANT	--	?	330	66.00	--	--
MO CB 36	MO-73-0281	STULL, JAMES	GARVER	06/29/1973	339	100.00	6	60
MO CB 37	MO-73-2213	FERRIS, CHARLES	EASTERDAY	07/03/1978	320	140.00	6	87
MO CC 1	MO-00-3371	PETTICORD	STOTTLEMYER	11/12/1948	605	90.00	6	30
MO CC 2	MO-00-0835	FARR, W S	HILTON	06/06/1951	460	125.00	6	--
MO CC 3	MO-00-3256	FARR, W S	HILTON	10/18/1948	450	112.00	6	66
MO CC 4	MO-00-3240	FARR, W S	HILTON	10/03/1948	470	48.00	6	20
MO CC 5	MO-00-4585	BROWN, THOMAS W	STOTTLEMYER	09/10/1949	620	100.00	6	33
MO CC 6	MO-00-9514	SANGSTER, H L	HILTON	02/14/1952	520	165.00	6	32
MO CC 7	--	--	--	?	570	45.00	6	--
MO CC 8	--	HODGES, W W	--	?	610	50.00	48	--
MO CC 9	MO-00-1105	MCLANE, CLYDE	HILTON	06/02/1952	400	55.00	6	18
MO CC 10	MO-00-3675	KNILL, EDGAR	HILTON	02/28/1949	545	74.00	6	40
MO CC 11	--	FINK, MAYNARD	HILTON	11/04/1932	570	88.00	6	10
MO CC 12	--	SELLMAN, SCHOOL	--	?	555	63.00	6	--
MO CC 13	--	SELLMAN CHURCH	GREENE	03/01/1950	555	100.00	6	--
MO CC 14	--	HAYES	--	?	560	46.00	60	--
MO CC 15	--	HAYES	--	?	560	80.00	6	--
MO CC 16	--	HILTON, W	--	?	590	400.00	6	--
MO CC 17	--	HILTON, W B	--	?	580	86.00	6	--
MO CC 18	MO-00-3637	STEVENS	HILTON	02/24/1949	570	74.00	6	68
MO CC 19	--	WHITE, W M	HILTON	1943	465	80.00	6	--
MO CC 20	--	WHITE, W M	--	1940	480	60.00	6	--
MO CC 21	--	CHISHOLM	HILTON	01/10/1929	525	62.00	6	16
MO CC 22	--	GRIFFITH, WILLIAM B	HILTON	12/23/1951	500	86.00	6	46
MO CC 23	MO-00-0259	APPLETREE, BRENDON	STOTTLEMYER	03/12/1946	450	85.00	6	--
MO CC 24	MO-00-4447	MAXWELL, EDWARD	HILTON	09/06/1949	510	86.00	6	48
MO CC 25	MO-03-8281	DICKERSON ELEM SCHL	HILTON	04/30/1960	440	200.00	6	58
MO CC 26	MO-03-2638	SIMPSON HOME, MARY	GREEN	11/30/1958	430	92.00	5.62	70
MO CC 27	MO-03-1147	AYERS, STUART	HILTON	06/28/1958	440	110.00	6	48
MO CC 28	MO-07-0049	ROBINSON, JOHN	HILTON	10/26/1966	460	120.00	6.25	92
MO CC 29	--	WEBER, CHARLES M	HILTON	1955	350	100.00	6	--
MO CC 30	MO-73-0590	POOLE JR, WILSON C	HILTON	08/02/1974	540	124.00	6	46
MO CC 31	MO-73-0502	MD NAT CAP PARK	EASTERDAY	04/29/1974	530	160.00	6	21
MO CC 32	MO-73-1646	POOLE, WILSON	HILTON	07/20/1977	510	200.00	6	46
MO CC 33	MO-73-0692	BODMAN, GEORGE	EASTERDAY	12/31/1974	500	80.00	6	43
MO CC 34	MO-73-0910	STRAMBERG, JOHN	HILTON	11/14/1975	565	125.00	6	55
MO CC 35	MO-73-0560	LILLARD, JAMES	EASTERDAY	06/27/1974	550.00	300.00	6	38
MO CC 36	MO-73-0422	CONOY, SUE	HILTON	01/31/1974	475	145.00	6	45
MO CC 37	MO-67-0040	ARABIAN HORSE FND	HILTON	08/22/1966	560	98.00	6	58
MO CC 38	MO-73-0987	HERSBERGER, JOHN.	HILTON	04/12/1976	515	105.00	6	42
MO CC 39	MO-73-0579	PUMPHERY, ROBERT	HILTON	08/21/1974	490	105.00	6	43
MO CC 40	MO-73-0776	GAMBUL, JOHN	HILTON	05/21/1975	545	125.00	6	42
MO CC 41	MO-73-1198	MT ZION METH CH	HILTON	11/08/1976	530	210.00	6	46
MO CC 42	MO-73-0458	SHULTZ, HOWARD L	HILTON	03/04/1974	545	160.00	6	42
MO CC 43	MO-73-0470	SELLEY, ROLAND	HILTON	03/19/1974	580	205.00	6	43

Table 13. — Montgomery County well records—continued.

PRINCIPAL AQUIFER 1/	WATER LEVEL (FEET)	DRAW-DOWN (FEET)	DATE DISCHARGE MEASURED	DISCHARGE (GALLONS PER MINUTE)	PUMPING PERIOD (HOURS)	SPECIFIC CAPACITY (GPM/FT)	USE OF WATER 1/	TYPE OF LIFT 1/	LOCAL NUMBER
--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--
231NOXF	10.00	65	03/05/1946	7	1.0	0.1	H	P	MO CB 1
231NOXF	39.92	--	--	--	--	--	H	P	MO CB 2
231NOXF	--	--	--	--	--	--	H	J	MO CB 3
231NOXF	5.00	--	--	--	--	--	T	J	MO CB 4
231NOXF	--	--	--	--	--	--	U	J	MO CB 5
231NOXF	55.60	--	--	--	--	--	H	P	MO CB 6
231NOXF	57.00	10	11/12/1952	3	1.0	0.3	H	P	MO CB 7
231NOXF	9.64	--	--	--	--	--	S	J	MO CB 8
110TRRC	43.10	--	--	--	--	--	H	P	MO CB 9
231NOXF	15.10	--	--	--	--	--	H	C	MO CB 10
231NOXF	--	--	01/24/1934	30	--	--	H	P	MO CB 11
231NOXF	28.00	11	06/03/1953	20	1.0	1.8	T	J	MO CB 14
231NOXF	49.00	131	12/23/1957	15	--	0.1	U	U	MO CB 15
231NOXF	137.00	--	--	--	--	--	U	U	MO CB 16
231NOXF	40.00	--	--	--	--	--	U	U	MO CB 17
231NOXF	15.60	--	04/01/1969	20	--	--	R	U	MO CB 18
231NOXF	--	--	--	--	--	--	F	S	MO CB 19
231NOXF	39.00	83	10/28/1968	12	4.0	0.1	C	S	MO CB 20
231NOXF	19.00	67	04/18/1963	3	2.0	0.0	T	S	MO CB 21
231NOXF	31.00	49	05/09/1966	25	--	0.5	T	S	MO CB 22
231NOXF	38.00	55	07/01/1968	8	--	0.1	H	S	MO CB 23
231NOXF	30.00	70	11/ /1968	15	4.0	0.2	C	S	MO CB 24
231NOXF	21.00	50	04/07/1972	3	--	0.1	H	S	MO CB 25
231NOXF	1.60	--	05/17/1972	75	22.0	--	U	U	MO CB 26
231NOXF	1.70	--	05/23/1972	8	--	--	U	P	MO CB 27
231NOXF	26.00	--	06/06/1972	15	--	--	H	S	MO CB 28
231NOXF	47.80	150	09/06/1973	100	28.0	0.7	C	T	MO CB 29
231NOXF	54.00	47	03/22/1973	8	1.0	0.2	I	S	MO CB 30
300IJMV	28.00	38	01/07/1977	10	4.0	0.3	H	S	MO CB 31
231NOXF	31.00	38	11/07/1975	8	2.0	0.2	H	U	MO CB 32
231NOXF	30.00	56	08/21/1973	6	1.0	0.1	H	U	MO CB 33
231NOXF	50.00	--	--	--	--	--	H	U	MO CB 34
231NOXF	7.18	--	--	--	--	--	H	--	MO CB 35
231NOXF	45.00	--	06/29/1973	15	1.0	--	H	S	MO CB 36
231NOXF	35.00	105	07/03/1978	129	2.0	1.2	H	S	MO CB 37
300IJMV	30.00	20	11/12/1948	10	1.0	0.5	H	P	MO CC 1
300IJMV	26.00	37	06/06/1951	45	4.0	1.2	H	P	MO CC 2
300IJMV	35.00	15	10/18/1948	30	3.0	2.0	H	P	MO CC 3
300IJMV	25.00	10	10/03/1948	5	1.0	0.5	H	J	MO CC 4
300IJMV	22.00	73	09/10/1949	3	1.0	0.0	H	J	MO CC 5
300IJMV	18.00	--	02/14/1952	0.5	--	--	H	P	MO CC 6
300IJMV	20.00	--	--	--	--	--	S	J	MO CC 7
300IJMV	18.00	--	--	--	--	--	S	J	MO CC 8
300IJMV	20.00	15	06/02/1952	30	1.0	2.0	H	C	MO CC 9
300IJMV	30.00	10	02/28/1949	30	--	3.0	H	J	MO CC 10
300IJMV	40.00	--	1934	9	--	--	H	J	MO CC 11
300IJMV	28.71	--	--	--	--	--	U	U	MO CC 12
300IJMV	20.16	--	11/12/1952	7	--	--	T	P	MO CC 13
300IJMV	43.65	--	--	--	--	--	H	B	MO CC 14
300IJMV	--	--	--	--	--	--	H	P	MO CC 15
300IJMV	--	--	?	0.3	--	--	U	U	MO CC 16
300IJMV	--	--	?	4	--	--	H	U	MO CC 17
300IJMV	40.00	20	02/24/1949	10	--	0.5	H	P	MO CC 18
377HRPR	49.06	--	--	--	--	--	S	P	MO CC 19
377HRPR	--	--	--	--	--	--	U	U	MO CC 20
300IJMV	29.54	--	11/14/1952	14	--	--	I	P	MO CC 21
300IJMV	28.00	32	12/23/1952	20	2.0	0.6	H	P	MO CC 22
377HRPR	45.00	25	03/12/1946	20	--	0.8	H	P	MO CC 23
300IJMV	42.00	23	09/06/1949	12	1.0	0.5	H	U	MO CC 24
300IJMV	22.00	138	04/30/1960	5	5.0	0.0	T	S	MO CC 25
300IJMV	10.00	30	11/30/1958	10	--	0.3	T	U	MO CC 26
231NOXF	38.00	27	06/28/1958	20	1.0	0.7	U	U	MO CC 27
231NOXF	26.00	85	10/26/1966	15	2.0	0.2	H	S	MO CC 28
231NOXF	--	--	--	--	--	--	H	S	MO CC 29
300IJMV	--	70	08/02/1974	15	1.0	0.2	H	S	MO CC 30
300IJMV	40.00	120	04/29/1974	20	1.0	0.2	N	S	MO CC 31
300IJMV	38.00	--	--	--	--	--	H	S	MO CC 32
300IJMV	30.00	50	12/31/1974	40	1.0	0.8	H	S	MO CC 33
300IJMV	54.00	64	11/14/1975	15	2.0	0.2	H	S	MO CC 34
300IJMV	50.00	250	06/27/1974	1	1.0	0.0	H	U	MO CC 35
300IJMV	43.00	91	01/31/1974	25	1.0	0.3	H	U	MO CC 36
300IJMV	26.00	55	08/22/1966	15	2.0	0.3	T	U	MO CC 37
300IJMV	26.00	62	04/12/1976	5	3.0	0.1	H	U	MO CC 38
300IJMV	29.00	57	08/21/1974	10	1.0	0.2	S	U	MO CC 39
300IJMV	26.00	87	05/21/1975	5	2.0	0.1	H	U	MO CC 40
300IJMV	21.00	174	11/08/1976	2	3.0	0.0	H	S	MO CC 41
300IJMV	38.00	111	03/04/1974	2	1.5	0.0	H	S	MO CC 42
300IJMV	36.00	154	03/19/1974	0.5	1.0	0.0	H	S	MO CC 43

1/ SEE CODE EXPLANATION

Table 13. — Montgomery County well records—continued.

LOCAL NUMBER	PERMIT NUMBER	OWNER	CONTRACTOR	DATE COMPLETED	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	CASING DIAMETER (INCHES)	DEPTH CASED
MONTGOMERY COUNTY -- CONTINUED								
MO CC 44	MO-73-0219	BARTLETT, ATWOOD S	EASTERDAY	07/13/1973	525	300.00	6	42
MO CC 45	MO-71-0013	GARRETT, THOMAS A	HILTON	08/08/1970	495	125.00	6	89
MO CC 46	MO-69-0145	DORSETT, H J	HILTON	04/21/1969	560	125.00	6	37
MO CC 47	MO-69-0187	ST MARY'S CATH CHRCH	HILTON	05/27/1969	550	145.00	6	24
MO CC 48	MO-73-0744	JAMISON, CHARLES	KEYSER-GRVER	03/28/1975	565	402.00	6.25	65
MO CC 49	MO-73-0594	CONLEY, RONALD W	HILTON	08/20/1974	570	165.00	6	44
MO CC 50	MO-73-1637	YODER JR, THOMAS W	HILTON	10/20/1977	620	210.00	6	45
MO CC 51	MO-73-1192	MAXWELL, LOIS H	HILTON	09/08/1976	580	200.00	6	46
MO CC 52	MO-73-0940	MARTON, DONALD R	HILTON	12/04/1975	530	165.00	6	44
MO CC 53	MO-73-0966	MARTON, DONALD R	HILTON	04/07/1976	530	105.00	6	43
MO CC 54	MO-73-1759	SWEENEY, EDWARD D	HILTON	04/21/1978	490	110.00	6	43
MO CC 55	MO-73-1333	CLARK, TERRY M	GARVER	02/18/1977	470	443.00	6	61
MO CC 56	MO-73-1557	CHADWICK JR, GEORGE A	HILTON	06/17/1977	410	170.00	6	44
MO CC 57	MO-73-1184	HAYES, F S	HILTON	11/12/1976	440	150.00	6	46
MO CC 58	MO-73-0991	SNOUFFER, BENJAMIN G	EASTERDAY	04/14/1976	540	285.00	6	42
MO CC 59	MO-73-1317	SPEARY, WILLIAM	HILTON	02/03/1977	400	210.00	6	45
MO CC 60	MO-73-0983	SHOEMAKER, JAMES W	HILTON	04/12/1976	480	125.00	6	100
MO CC 61	MO-73-1193	BROWN, EDWIN R	HILTON	11/20/1976	456	130.00	6	43
MO CC 62	MO-73-0536	JOHNSON, EDWIN	HILTON	07/15/1974	620	118.00	6	22
MO CC 63	MO-73-0015	MENKE, GEORGE	HILTON	08/22/1972	580	125.00	6	20
MO CC 64	MO-73-0524	ANTHONY, GILBERT	EASTERDAY	05/15/1974	582	200.00	6	43
MO CC 65	--	--	--	?	450	--	--	--
MO CC 66	MO-73-0337	MOORE, EARL	HILTON	08/30/1973	535	105.00	6	42
MO CC 67	MO-73-1012	CLIFFORD, NEAL E	HILTON	05/14/1976	550	105.00	6	44
MO CC 68	MO-73-0656	KING JR, RICHARD	HILTON	11/09/1974	465	125.00	6	42
MO CD 1	MO-00-8428	CARLIN, MELVIN	HILTON	08/16/1951	570	151.00	6	30
MO CD 2	--	KNOTT, JOHN	EASTERDAY	08/08/1952	590	95.00	6	22
MO CD 3	--	WADE, KEVIN	GREEN	03/ /1952	490	95.00	--	--
MO CD 4	MO-00-8614	SHEPPARD, ERNEST	HILTON	09/11/1951	450	99.00	6	68
MO CD 5	MO-00-3223	HOUGH, HENRY	HILTON	10/06/1948	570	87.00	--	--
MO CD 6	MO-00-3222	HOWARD, RICHARD	HILTON	10/09/1948	590	55.00	6	25
MO CD 7	--	BERGFIELD, WILLIAM E	BROWN	08/ /1952	570	38.00	6	--
MO CD 8	--	WILEY, WILLARD	GREENE	1949	490	80.00	6	--
MO CD 9	--	SANDBOWER, LLOYD	--	1910	450	--	--	--
MO CD 10	--	TAYLOR SCH, HUGH	--	1951	330	40.00	6	--
MO CD 11	--	WIMS, WILSON	GREENE	1948	570	90.00	6	--
MO CD 12	MO-00-1625	CISSEL, RICHARD	EASTERDAY	07/29/1952	610	84.00	6	--
MO CD 13	MO-00-3262	HAMMOND, O W	GREENE	11/05/1948	550	135.00	6	15
MO CD 14	--	MICHAELS, LEO	--	1949	610	85.00	6	--
MO CD 15	--	BOARD OF EDUC MONT CO	--	1922	540	75.00	6	--
MO CD 16	--	WHITEMAN, RICHARD	BROWN	1924	670	112.00	6	--
MO CD 17	--	DAVIDSON, GARDINER	BROWN	1926	650	118.00	6	--
MO CD 18	--	BOARD EDC MNTCO	--	1918	640	80.00	6	--
MO CD 19	--	BRD EDUC MNT CO	GREEN	1946	650	--	6	--
MO CD 20	--	TRIGONING, J M	--	1945	630	90.00	8	85
MO CD 21	--	BRD ED MONT CO	--	1924	490	105.00	6	--
MO CD 22	--	GANLEY, NETTIE	HILTON	?	470	83.00	6	16
MO CD 24	MO-03-8795	CLARKSBURG CH	BROWN	06/10/1960	640	170.00	6.25	20
MO CD 25	MO-04-1033	MEADOWBROOK EST	CROMWELL	11/04/1960	550	100.00	5.62	21
MO CD 26	MO-02-1344	ATOM ENER COMM	GREEN	12/12/1955	460	112.50	8	8
MO CD 27	--	ATOM ENRG COMM	GREEN	02/20/1956	480	304.00	8	41
MO CD 28	MO-02-3795	GROVE LIME CO, M J	KEYSER	07/02/1956	420	230.00	5.62	33
MO CD 29	MO-02-6935	GULF OIL CO	KEYSER	05/29/1957	520	150.00	5.62	48
MO CD 30	MO-02-7328	A T & T	GREEN	07/05/1957	510	300.00	6	22
MO CD 31	MO-03-1439	MOORE, JOHN	HILTON	07/24/1958	350	185.00	--	--
MO CD 32	MO-73-0342	CRAWFORD	GARVER	08/27/1973	540	100.00	6	72
MO CD 33	MO-73-0906	BERNHARD, RICHARD L	MAYNE	10/10/1975	580	145.00	6	46
MO CD 34	MO-73-1575	LEEDY, THOMAS	HILTON	07/22/1977	580	170.00	6	45
MO CD 35	MO-73-1798	FITZWATER JR, HERMAN	HILTON	03/30/1978	500	150.00	6	45
MO CD 36	MO-73-1121	ROSWELL, DONALD	HILTON	08/23/1976	515	150.00	6	45
MO CD 37	MO-73-1113	KAMACHAITIS, WILLIAM	CLINE	07/23/1976	490	190.00	6	45
MO CD 38	MO-73-1817	PURDUM, J W	CLINE	12/20/1977	630	125.00	6	90
MO CD 39	MO-73-1112	MCGREW, RONALD E	HILTON	09/07/1976	540	185.00	6	85
MO CD 40	MO-73-1364	THOMPSON, JOSEPH F	HILTON	02/18/1977	530	158.00	6	45
MO CD 41	MO-73-1089	FULLERTON, LUCIA	HILTON	07/30/1976	525	105.00	6	45
MO CD 42	MO-73-0945	BIFTZEL, DEAN	HILTON	12/19/1975	525	185.00	6	42
MO CD 43	MO-73-1020	HAASER, ROY	EASTERDAY	04/28/1976	410	125.00	6	42
MO CD 44	MO-73-0802	EATON, FLOYD	EASTERDAY	06/16/1975	560	305.00	6	42
MO CD 45	--	MONTGOMERY CO	--	1975	560	125.00	6	15
MO CD 46	--	MONTGOMERY CO	--	1975	550	125.00	6	16
MO CD 47	--	MONTGOMERY CO	--	1975	562	125.00	6	42
MO CD 48	--	MONTGOMERY CO	--	1975	570	122.00	6	13
MO CD 49	--	MONTGOMERY CO	--	1975	605	75.00	--	--
MO CD 50	--	MONTGOMERY CO	--	1975	580	40.00	--	--
MO CD 51	MO-73-1912	ECKER, RALPH	HARLEY	03/01/1978	420	250.00	6	41
MO CD 52	MO-73-0483	CHADWICK, GEORGE	HILTON	05/21/1975	418	95.00	6	42
MO CD 53	MO-73-1881	CAVELL, JOHN	EASTERDAY	12/28/1977	570	160.00	6	63
MO CD 54	MO-73-2302	BINGHAM, DAVID	--	09/01/1978	480	110.00	6	42
MO CD 55	MO-73-0431	SMITH, HARPER	EASTERDAY	12/28/1973	385	140.00	6	68
MO DA 1	--	JORDON, RAYMOND	--	1948	205	40.00	6	--

Table 13. — Montgomery County well records—continued.

PRINCIPAL AQUIFER 1/	WATER LEVEL (FEET)	DRAW-DOWN (FEET)	DATE DISCHARGE MEASURED	DISCHARGE (GALLONS PER MINUTE)	PUMPING PERIOD (HOURS)	SPECIFIC CAPACITY (GPM/FT)	USE OF WATER 1/	TYPE OF LIFT 1/	LOCAL NUMBER
231NOXF	40.00	260	07/13/1973	1	1.0	0.0	H	S	MO CC 44
300IJMV	30.20	81	08/08/1970	10	1.5	0.1	H	S	MO CC 45
300IJMV	26.00	92	04/21/1959	3	2.0	0.0	H	S	MO CC 46
300IJMV	35.00	25	05/27/1969	6	1.5	0.2	T	S	MO CC 47
300IJMV	85.00	5	03/28/1975	0.5	2.0	0.1	H	S	MO CC 48
300IJMV	41.00	95	08/20/1974	6	2.0	0.1	H	S	MO CC 49
300IJMV	36.00	143	10/20/1977	2	5.0	0.0	H	S	MO CC 50
300IJMV	24.00	166	09/08/1976	2	3.0	0.0	H	S	MO CC 51
300IJMV	19.00	127	12/04/1975	1	3.0	0.0	U	S	MO CC 52
300IJMV	21.00	43	04/07/1975	4	4.0	0.1	H	S	MO CC 53
300IJMV	22.08	--	04/21/1978	20	5.0	--	H	S	MO CC 54
300IJMV	34.08	26	02/18/1977	2	2.0	0.1	H	S	MO CC 55
300IJMV	31.00	98	06/17/1977	3	5.0	0.0	H	S	MO CC 56
300IJMV	29.00	99	11/12/1975	12	3.0	0.1	H	S	MO CC 57
300IJMV	--	--	--	--	--	--	H	S	MO CC 58
300IJMV	60.00	115	02/03/1977	1	4.0	0.0	H	S	MO CC 59
300IJMV	37.26	62	04/12/1976	15	4.0	0.2	H	S	MO CC 60
300IJMV	28.00	83	11/20/1976	10	3.0	0.1	H	S	MO CC 61
300IJMV	31.00	79	07/15/1974	4	1.0	0.1	H	S	MO CC 62
300IJMV	36.00	61	08/22/1972	5	1.0	0.1	H	S	MO CC 63
300IJMV	50.00	150	05/15/1974	3	1.0	0.0	H	S	MO CC 64
300IJMV	26.70	--	--	--	--	--	I	J	MO CC 65
300IJMV	31.00	55	08/30/1973	6	1.0	0.1	H	S	MO CC 66
300IJMV	31.00	27	05/14/1976	15	4.0	0.6	H	S	MO CC 67
300IJMV	38.00	71	11/09/1974	12	2.0	0.2	H	S	MO CC 68
300IJMV	40.00	40	08/16/1951	2	--	0.1	H	U	MO CD 1
300IJMV	12.00	--	08/08/1952	2	--	--	H	P	MO CD 2
300IJMV	49.00	1	03/ /1952	30	--	30.0	H	J	MO CD 3
300UPPC	36.00	22	09/11/1951	15	--	0.7	H	J	MO CD 4
300UPPC	40.00	30	10/06/1948	6	--	0.2	U	U	MO CD 5
300UPPC	30.00	15	10/09/1946	5	--	0.3	H	J	MO CD 6
300IJMV	12.00	--	08/ /1952	30	--	--	H	J	MO CD 7
300IJMV	--	--	--	--	--	--	H	J	MO CD 8
300UPPC	--	--	--	--	--	--	H	P	MO CD 9
231DIBS	--	--	--	--	--	--	T	J	MO CD 10
300UPPC	--	--	--	--	--	--	H	J	MO CD 11
300UPPC	34.00	50	07/29/1952	5	--	0.1	H	U	MO CD 12
300IJMV	30.00	40	11/05/1948	10	--	0.3	H	U	MO CD 13
300IJMV	84.00	--	--	--	--	--	H	J	MO CD 14
300UPPC	--	--	--	--	--	--	U	P	MO CD 15
300IJMV	50.00	--	1924	2	--	--	S	A	MO CD 16
300IJMV	70.00	--	1926	4	--	--	H	U	MO CD 17
300IJMV	--	--	--	--	--	--	U	U	MO CD 18
300IJMV	--	--	--	--	--	--	T	J	MO CD 19
300WSCK	--	--	--	--	--	--	S	S	MO CD 20
300UPPC	--	--	--	--	--	--	U	J	MO CD 21
300UPPC	--	--	?	0.5	--	--	H	P	MO CD 22
300IJMV	42.00	--	06/10/1950	2	--	--	T	A	MO CD 24
300IJMV	25.00	25	11/04/1960	10	--	0.4	H	Z	MO CD 25
300IJMV	5.00	--	12/12/1955	4	2.0	--	U	U	MO CD 26
300IJMV	3.50	217	02/20/1956	10	2.0	0.0	U	U	MO CD 27
300UPPC	20.00	--	07/02/1956	20	5.0	--	C	U	MO CD 28
300IJMV	28.00	10	05/29/1957	15	2.0	1.5	T	U	MO CD 29
300IJMV	15.00	13	07/05/1957	5	8.0	0.4	C	U	MO CD 30
231DIBS	10.00	20	07/24/1958	2	--	0.1	H	U	MO CD 31
300IJMV	--	--	08/27/1973	20	--	--	H	S	MO CD 32
300IJMV	40.00	--	--	--	--	--	H	S	MO CD 33
300IJMV	36.00	76	07/22/1977	3	4.0	0.0	H	S	MO CD 34
300IJMV	61.70	59	03/30/1978	3	5.0	0.1	H	S	MO CD 35
300IJMV	39.00	88	08/23/1976	5	3.0	0.1	H	S	MO CD 36
300UPPC	54.00	116	07/23/1976	15	3.0	0.1	H	S	MO CD 37
300IJMV	47.00	78	12/20/1977	7	1.0	0.1	H	S	MO CD 38
300UPPC	66.00	103	09/07/1976	2	5.0	0.0	H	S	MO CD 39
300UPPC	38.00	83	02/18/1977	3	4.0	0.0	H	S	MO CD 40
300UPPC	55.50	53	07/30/1976	4	3.0	0.1	H	S	MO CD 41
300IJMV	21.00	149	12/19/1975	2	4.0	0.0	H	S	MO CD 42
300UPPC	12.00	113	04/28/1976	20	2.0	0.2	H	S	MO CD 43
300UPPC	45.00	260	06/16/1975	1	1.0	0.0	H	S	MO CD 44
300IJMV	2.00	--	1975	10	--	--	U	--	MO CD 45
300IJMV	3.00	--	1975	0.1	--	--	U	--	MO CD 46
300IJMV	4.00	--	1975	100	72.0	--	U	--	MO CD 47
300IJMV	9.00	--	1975	0.3	--	--	U	--	MO CD 48
300IJMV	--	--	--	--	--	--	U	--	MO CD 49
300IJMV	--	--	1975	0.5	--	--	U	--	MO CD 50
300IJMV	10.00	187	03/01/1978	2	3.0	0.0	H	S	MO CD 51
300UPPC	17.00	56	05/21/1975	25	1.0	0.4	U	S	MO CD 52
300IJMV	62.69	97	12/28/1977	2	2.0	0.0	H	S	MO CD 53
300UPPC	57.58	--	09/01/1976	7	--	--	H	S	MO CD 54
300UPPC	30.85	109	10/23/1978	15	2.0	0.1	H	S	MO CD 55
231NOXF	15.82	--	--	--	--	--	H	P	MO DA 1

1/ SEE CODE EXPLANATION

Table 13. — Montgomery County well records—continued.

LOCAL NUMBER	PERMIT NUMBER	OWNER	CONTRACTOR	DATE COMPLETED	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	CASING DIAMETER (INCHES)	DEPTH CASED
MONTGOMERY COUNTY -- CONTINUED								
MO DA 2	--	NATIONAL, PARK SERV	HOFFMAN	02/18/1969	200	135.00	6	36
MO DA 3	MO-73-0045	HOPKINS, HOLLIS	HILTON	08/24/1973	225	85.00	6	21
MO DA 4	MO-73-0831	HOPKINS, MASON	HILTON	08/22/1975	220	85.00	6	42
MO DB 1	--	SELBY, BROTHERS	STOTTLEMYER	03/05/1946	415	62.00	6	40
MO DB 2	MO-00-7344	KEIFER, HELEN	KEIFER	07/22/1951	305	150.00	6	44
MO DB 3	MO-00-7345	WELLS, C C	STOTTLEMYER	04/07/1951	430	110.00	6	97
MO DB 4	MO-00-1430	KIMMERLING, J W	HILTON	07/28/1952	385	76.00	6	24
MO DB 5	--	MONTGOMERY, CO BRD EDU	--	1932	410	175.00	6	--
MO DB 6	MO-00-1297	MONTGOMERY, CO BRD EDU	HAINES	10/ /1952	420	175.00	6	38
MO DB 7	MO-00-1298	MONTGOMERY, CO BRD EDU	HAINES	10/ /1952	415	150.00	8	20
MO DB 8	MO-00-4665	SEIGEL, HARRY	HILTON	09/23/1949	360	165.00	6	22
MO DB 9	--	PALMER, SADIE	PALMER	1934	310	11.50	48	--
MO DB 10	--	YEAGER	--	?	335	76.00	6	--
MO DB 11	--	SMITH, M	--	1935	285	--	6	--
MO DB 12	MO-00-3903	ALLNUTT, RICHARD W	HILTON	05/10/1949	365	81.00	6	32
MO DB 13	--	CORCORAN, THOMAS	GREENE	1947	325	231.00	6	100
MO DB 14	--	SYDNER, RAY E	--	?	305	68.00	6	--
MO DB 15	MO-01-7659	ST GEORGES, CHURCH	HILTON	02/23/1955	405	94.00	6	12
MO DB 16	MO-01-4313	NAT INST, HEALTH	HILTON	10/13/1960	280	205.00	6	40
MO DB 17	MO-04-1677	OFFUTT, JOHN R	HILTON	11/29/1959	365	83.00	8	35
MO DB 18	MO-02-4601	POOLESVILLE, PRESBY CHRC	--	09/26/1956	400	95.00	5.62	40
MO DB 19	MO-03-1959	SIEGEL, BERNARD N	GREENE	09/20/1958	400	141.00	6	10
MO DB 20	MO-03-1960	SIEGEL, BERNARD N	GREENE	09/14/1958	335	245.00	6	12
MO DB 21	MO-04-4078	SIEGEL, BERNARD N	KEYSER	08/ /1961	370	325.00	6.25	21
MO DB 22	MO-03-5551	SIEGEL, BERNARD N	GREENE	07/22/1959	220	80.00	5.62	26
MO DB 23	--	SIEGEL, BERNARD N	KEYSER	08/ /1961	330	325.00	6.25	13
MO DB 24	MO-03-9308	LEVITT, & SONS	KEYSER	06/24/1960	400	467.00	6	37
MO DB 25	MO-04-9668	NATL INST, HEALTH	HILTON	11/07/1962	280	200.00	6	48
MO DB 26	MO-04-9669	NTL INST, HEALTH	HILTON	11/14/1962	280	145.00	6	58
MO DB 27	MO-67-0069	NTL INST, HEALTH	HILTON	09/02/1966	290	190.00	6	40
MO DB 28	--	--	HOFFMAN	02/14/1969	200	125.00	6	30
MO DB 29	MO-65-0460	WILLARD, D J	--	04/28/1965	410	103.00	6.25	45
MO DB 30	MO-66-0325	JAMISON, CHARLES	--	02/17/1966	410	143.00	6.25	41
MO DB 31	MO-67-0112	HAYDEN, ROGER A	EASTERDAY	10/22/1966	305	200.00	6.25	18
MO DB 32	MO-67-0147	DE STERKENBERG	HILTON	12/09/1966	360	122.00	6.25	26
MO DB 33	MO-69-0113	DE STERKENBERG	HILTON	02/05/1969	385	165.00	6.25	38
MO DB 34	MO-67-0166	ECONOMY, OIL CO	--	01/04/1967	410	185.00	6.25	25
MO DB 35	MO-69-0154	MILLER &, FRANK	HILTON	04/28/1969	300	125.00	6.25	43
MO DB 36	MO-04-4079	LEVITT, & SONS	KEYSER	08/19/1961	260	280.00	8	23
MO DB 37	--	SIEGEL, FARM ESTAB	KEYSER	08/07/1961	315	340.00	8	26
MO DB 38	--	LEVITT, & SONS	KEYSER	08/22/1961	325	210.00	6	--
MO DB 39	--	WALTON LGE, IZAAK	BROWN	1950	300	140.00	6	--
MO DB 40	--	WALTON LGE, IZAAK	STOTTLEMYER	1960	280	170.00	6	--
MO DB 41	--	WALTON LGE, IZAAK	--	?	230	75.00	5	--
MO DB 42	--	WALTON LGE, IZAAK	--	1950	230	120.00	6	--
MO DB 43	MO-65-0389	THOMAS, MYRA	MAYNE	02/26/1965	410	82.00	5.62	52
MO DB 44	MO-02-0083	HNETKOVSKY, ED	HILTON	12/08/1971	310	120.00	6	20
MO DB 45	--	NORRIS, CHARLES	KEYSER	1956	360	75.00	6	--
MO DB 46	MO-02-0152	HOEWING, R L	BROWN	?	325	102.00	6	23
MO DB 47	MO-73-1584	POOLESVILLE, TOWN OF	SEAY JR	06/30/1977	420	600.00	8	62
MO DB 48	MO-73-0426	QUEEN, ROBERT	KEYSER	11/27/1973	330	325.00	6	42
MO DB 49	MO-73-0740	QUEEN, ROBERT	EASTERDAY	04/01/1975	310	245.00	6	41
MO DB 50	MO-73-1889	BARGE, EMORY D	HILTON	04/21/1978	350	100.00	6	42
MO DB 51	MO-73-0369	JARMAN, RALEIGH	KEYSER	09/28/1973	330	155.00	6	45
MO DB 52	MO-73-1463	SPATES, ALFRED W	HILTON	03/28/1977	320	150.00	6	45
MO DB 53	MO-73-1469	MCCRASSIN, WAYNE	EASTERDAY	03/24/1977	370	230.00	--	--
MO DB 54	MO-05-1319	MATTHEWS, CHARLES	HILTON	04/30/1963	420	105.00	6	29
MO DB 55	--	--	--	?	380	57.80	6	--
MO DB 56	--	MORGAN	--	?	375	--	--	--
MO DB 57	MO-73-0859	MOORE, GEORGE	HILTON	07/28/1975	405	150.00	6	--
MO DB 58	--	CNTRY PEDL, RESTAURANT	--	--	405	--	--	--
MO DB 59	MO-73-1497	GRAHAM, ALONGO	EASTERDAY	03/24/1977	405	140.00	6	84
MO DB 60	MO-73-1462	KLEINSORG, HORST	HILTON	06/10/1977	270	170.00	6	45
MO DB 61	MO-73-1544	WILLIAMS, CLIFTON	HILTON	09/30/1977	310	150.00	6	50
MO DB 62	--	MULDOON	--	?	430	45.50	--	--
MO DB 63	--	--	--	?	420	38.00	--	--
MO DB 64	--	MOORE, LESTER	--	?	405	40.00	--	--
MO DB 65	--	CALLAHAN, DANIEL J	--	?	320	36.70	--	--
MO DB 66	--	--	--	?	400	--	--	--
MO DB 67	--	NORMAN	--	?	400	--	--	--
MO DB 68	MO-73-1869	--	EASTERDAY	05/24/1978	260	252.00	6	40
MO DB 69	--	--	--	?	390	75.00	6	--
MO DB 70	--	CH OF GOD, POOLESVILL	--	?	335	--	--	--
MO DB 71	MO-73-1894	RINCKE, REGIN	CROMWELL	03/07/1978	350	125.00	6	42
MO DB 72	MO-73-0634	KLEINSORG, HORST	HILTON	10/09/1974	270	155.00	6	45
MO DB 73	--	SPATES, ALFRED	--	?	391	--	--	--
MO DB 74	--	JAMISON	--	?	380	58.50	6	--
MO DB 75	--	OXLEY, R C	--	?	420	90.00	--	--
MO DB 76	--	ITT CORP	--	?	325	95.35	6	--
MO DB 77	MO-73-1316	STONE, CHARLES F	GARVER	12/17/1976	405	205.00	6	83

Table 13. — Montgomery County well records—continued.

PRINCIPAL AQUIFER 1/	WATER LEVEL (FEET)	DRAW-DOWN (FEET)	DATE DISCHARGE MEASURED	DISCHARGE (GALLONS PER MINUTE)	PUMPING PERIOD (HOURS)	SPECIFIC CAPACITY (GPM/FT)	USE OF WATER 1/	TYPE OF LIFT 1/	LOCAL NUMBER
231NOXF	8.00	--	02/18/1969	40	--	--	R	P	MO DA 2
231NOXF	31.00	42	08/24/1973	45	1.0	1.1	H	S	MO DA 3
231NOXF	26.00	47	08/22/1975	5	2.0	0.1	H	S	MO DA 4
231NOXF	8.14	57	05/22/1952	5	1.0	0.1	H	U	MO DB 1
231NOXF	45.00	90	07/22/1951	3	1.0	0.0	H	J	MO DB 2
231NOXF	35.00	35	04/07/1951	20	1.0	0.6	H	--	MO DB 3
231NOXF	21.00	42	07/28/1952	8	1.0	0.2	H	P	MO DB 4
231NOXF	--	--	1932	6	--	--	T	J	MO DB 5
231NOXF	18.89	110	10/ /1952	13	24.0	0.1	T	S	MO DB 6
231NOXF	25.00	115	10/ /1952	3	12.0	0.0	T	--	MO DB 7
231NOXF	22.00	98	09/23/1949	10	5.0	0.1	H	P	MO DB 8
231NOXF	--	--	--	--	--	--	H	R	MO DB 9
231NOXF	17.29	--	--	--	--	--	S	P	MO DB 10
231NOXF	20.60	--	--	--	--	--	S	J	MO DB 11
231NOXF	28.00	28	05/10/1949	9	1.0	0.3	H	J	MO DB 12
231NOXF	20.00	--	1948	20	--	--	S	P	MO DB 13
231NOXF	27.56	--	--	--	--	--	H	R	MO DB 14
231NOXF	16.00	39	02/23/1955	10	1.0	0.3	T	U	MO DB 15
231NOXF	22.00	151	10/13/1960	20	4.0	0.1	T	S	MO DB 16
231NOXF	31.00	31	11/29/1959	5	1.0	0.1	H	P	MO DB 17
231NOXF	21.00	42	09/26/1956	16	--	0.4	T	U	MO DB 18
231NOXF	15.00	85	09/20/1958	17	3.0	0.2	H	S	MO DB 19
231NOXF	15.00	105	09/14/1958	15	4.0	0.1	H	P	MO DB 20
231NOXF	25.00	--	08/ /1961	20	3.0	--	H	--	MO DB 21
231NOXF	15.00	55	07/22/1959	7	--	0.1	H	U	MO DB 22
231NOXF	20.00	--	08/ /1961	40	12.0	--	Z	U	MO DB 23
231NOXF	13.30	--	09/02/1971	18	--	--	U	--	MO DB 24
231NOXF	24.00	14	11/07/1952	25	--	1.8	T	S	MO DB 25
231NOXF	32.00	23	11/14/1952	53	24.0	2.3	T	S	MO DB 26
231NOXF	29.00	41	09/02/1956	20	4.0	0.5	T	S	MO DB 27
231NOXF	9.00	--	02/14/1969	12	--	--	P	P	MO DB 28
231NOXF	28.00	39	04/28/1965	15	4.0	0.4	C	S	MO DB 29
231NOXF	46.00	75	02/17/1966	10	2.0	0.1	C	S	MO DB 30
231NOXF	40.00	160	10/22/1966	5	0.5	0.0	H	S	MO DB 31
231NOXF	31.00	62	12/09/1966	8	2.0	0.1	H	S	MO DB 32
231NOXF	39.00	83	02/05/1969	7	2.0	0.1	S	S	MO DB 33
231NOXF	36.00	135	01/04/1967	5	2.0	0.0	C	S	MO DB 34
231NOXF	35.00	67	04/28/1969	4	2.0	0.1	H	P	MO DB 35
231NOXF	2.40	154	09/03/1971	150	24.0	1.0	U	--	MO DB 36
231NOXF	0.45	--	09/17/1968	20	12.0	--	S	P	MO DB 37
231NOXF	--	--	08/22/1961	65	--	--	U	P	MO DB 38
231NOXF	--	--	1959	2	--	--	H	J	MO DB 39
231NOXF	62.67	--	10/19/1971	5	--	--	H	--	MO DB 40
231NOXF	--	--	--	--	--	--	Z	P	MO DB 41
231NOXF	--	--	1959	8	--	--	H	P	MO DB 42
231NOXF	5.00	--	02/26/1965	4	3.0	--	H	J	MO DB 43
231NOXF	29.00	64	12/08/1971	20	1.0	0.3	H	S	MO DB 44
231NOXF	--	--	--	--	--	--	H	S	MO DB 45
231NOXF	58.60	15	10/17/1972	10	1.0	0.7	H	S	MO DB 46
231NOXF	33.00	110	06/30/1977	50	24.0	0.5	P	S	MO DB 47
231NOXF	32.00	--	11/27/1973	6	1.0	--	H	S	MO DB 48
231NOXF	50.00	195	04/01/1975	3	1.0	0.0	H	S	MO DB 49
231NOXF	30.00	49	04/21/1978	12	5.0	0.2	H	U	MO DB 50
231NOXF	30.00	--	09/29/1973	5	1.0	--	H	S	MO DB 51
231NOXF	20.00	85	03/28/1977	6	6.0	0.1	S	P	MO DB 52
231NOXF	45.00	185	03/24/1977	3	2.0	0.0	H	S	MO DB 53
231NOXF	71.20	--	--	--	--	--	U	S	MO DB 54
231NOXF	3.17	--	--	--	--	--	--	--	MO DB 55
300IJMV	21.76	--	--	--	--	--	U	J	MO DB 56
231NOXF	--	--	--	--	--	--	H	S	MO DB 57
231NOXF	19.15	--	--	--	--	--	U	S	MO DB 58
231NOXF	40.00	100	03/24/1977	15	2.0	0.2	H	S	MO DB 59
231NOXF	41.00	89	06/10/1977	4	4.0	0.0	I	S	MO DB 60
231NOXF	29.00	42	09/30/1977	20	4.0	0.5	H	S	MO DB 61
231NOXF	37.55	--	--	--	--	--	U	U	MO DB 62
231NOXF	29.61	--	--	--	--	--	U	U	MO DB 63
231NOXF	7.55	--	--	--	--	--	U	U	MO DB 64
231NOXF	27.00	--	--	--	--	--	R	U	MO DB 65
231NOXF	29.40	--	--	--	--	--	H	U	MO DB 66
231NOXF	7.75	--	--	--	--	--	U	U	MO DB 67
231NOXF	13.20	--	05/24/1978	150	--	--	U	--	MO DB 68
231NOXF	8.92	--	--	--	--	--	U	U	MO DB 69
231NOXF	--	--	--	--	--	--	T	U	MO DB 70
231NOXF	35.00	85	03/07/1978	20	2.0	0.2	H	S	MO DB 71
231NOXF	58.00	78	10/09/1974	2	4.0	0.0	H	S	MO DB 72
231NOXF	23.55	--	--	--	--	--	S	U	MO DB 73
231NOXF	16.67	--	--	--	--	--	U	U	MO DB 74
231NOXF	28.92	--	--	--	--	--	H	J	MO DB 75
231NOXF	20.40	--	--	--	--	--	U	U	MO DB 76
231NOXF	30.00	10	12/17/1976	25	2.0	2.5	H	S	MO DB 77

1/ SEE CODE EXPLANATION

Table 13. — Montgomery County well records—continued.

LOCAL NUMBER	PERMIT NUMBER	OWNER	CONTRACTOR	DATE COMPLETED	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	CASING DIAMETER (INCHES)	DEPTH CASED
MONTGOMERY COUNTY -- CONTINUED								
MO DB 78	MO-73-0944	WALL, JEAN R	HILTON	01/30/1976	305	125.00	6	45
MO DB 79	--	GORE, J	--	1962	422	97.30	--	--
MO DB 80	MO-73-2145	BROWN, ELIZABETH	--	05/18/1978	380	120.00	6	42
MO DB 81	MO-73-2338	ROMANCHOCK, JIM	EASTERDAY	08/15/1978	335	200.00	6	44
MO DB 82	MO-73-2127	BROWN, MALCOLM	EASTERDAY	05/12/1978	450	200.00	6	149
MO DC 1	--	BYRD, J D	--	1925	340	110.00	6	--
MO DC 2	MO-00-4919	ROBERTS, C E	--	10/30/1949	330	--	6	50
MO DC 3	MO-00-1116	ROLFE, A G	HILTON	06/20/1952	475	70.00	6	22
MO DC 4	--	ROLFE, A G	--	1940	420	120.00	6	--
MO DC 5	--	CO HGHY, DEPARTMENT	--	1925	470	90.00	6	--
MO DC 6	--	METHODIST, CHURCH	WOOTEN	?	415	72.00	6	--
MO DC 7	MO-00-9163	PRESTON, E J	HILTON	12/17/1951	365	135.00	6	28
MO DC 8	--	ALLNUTT, C L	BROWN	1949	310	203.00	6	--
MO DC 9	--	GILLIAM, M M	HILTON	1930	370	136.00	6	--
MO DC 10	--	CAMPBELL, FRED M	--	?	371	30.00	48	--
MO DC 11	--	CLEMENTS, T H	BROWN	1940	325	97.00	6	--
MO DC 12	--	MATHEWS, CHARLES	--	1915	305	136.00	6	--
MO DC 13	--	ALLNUTT, LEWIS	HILTON	1948	270	137.00	6	--
MO DC 14	MO-66-0163	JONES, ELMER	HILTON	10/16/1965	405	74.00	6.25	22
MO DC 15	MO-03-5127	SIEGEL, BERNARD N	GREENE	06/24/1959	320	155.00	5.62	22
MO DC 16	MO-03-5552	SIEGEL, BERNARD N	GREENE	08/28/1959	325	155.00	5.62	15
MO DC 17	MO-03-5831	SIEGEL, BERNARD N	KEYSER	08/15/1959	325	317.00	6.25	23
MO DC 18	MO-70-0014	POOLESVILLE, TOWN OF	SYDNOR	08/26/1969	395	597.00	6.50	597
MO DC 19	MO-70-0046	POOLESVILLE	SYDNOR	09/17/1969	415	450.00	6.50	450
MO DC 20	MO-65-0553	STRANG, A C	--	06/18/1965	280	165.00	--	--
MO DC 21	MO-66-0179	WOLFREY, BERT R	HILTON	10/09/1965	320	120.00	6.25	22
MO DC 22	MO-65-0144	TRAUTH, JOHN A	HILTON	10/14/1965	330	145.00	6.25	22
MO DC 23	MO-67-0038	DARBY, GORDON T	HILTON	08/30/1966	370	165.00	6.25	24
MO DC 24	MO-67-0149	BACON, EDWARD W	EASTERDAY	01/26/1967	320	160.00	6.25	23
MO DC 25	MO-68-0016	BUTLER, GORMAN H	HILTON	07/24/1967	385	143.00	6.25	31
MO DC 26	MO-67-0304	MOURNINGSTAR, GERALD	HILTON	09/24/1967	310	143.00	6.25	20
MO DC 27	MO-68-0230	WEEDON, GEORGE	BROWN	05/23/1968	305	64.00	6	30
MO DC 28	MO-04-4441	LEVITT, & SONS	KEYSER	08/13/1959	305	400.00	6.25	20
MO DC 29	MO-03-9309	LEVITT, & SONS	KEYSER	07/07/1960	360	315.00	8	33
MO DC 30	--	POOLE, WILLIAM R	GREEN	1972	280	150.00	6	--
MO DC 31	MO-73-0075	POOLESVILLE, TOWN OF	SYDNOR	10/13/1972	378	285.00	8	82
MO DC 32	--	UHL, ALEXANDER	HILTON	1955	355	90.00	5	--
MO DC 33	MO-71-0156	WINDOLPH, JOHN L	HILTON	07/15/1971	310	105.00	6	20
MO DC 34	MO-71-0074	BERNSDORFF, F F	HILTON	10/27/1970	330	145.00	6	28
MO DC 35	MO-00-0103	CAMPBELL, FRED M	HILTON	01/03/1970	375	165.00	6	42
MO DC 36	MO-00-0072	WEITZER, DAVID	HILTON	11/06/1969	280	205.00	6	47
MO DC 37	MO-72-0036	FISTARE, ETHEL M	HILTON	09/13/1971	315	200.00	6	22
MO DC 38	MO-71-0165	WINDOLPH, JOHN F	HILTON	09/18/1970	320	105.00	6.25	22
MO DC 39	MO-73-0121	UHL, ALEXANDRIC	HILTON	02/07/1973	355	160.00	6	60
MO DC 40	MO-73-1124	ROUCH	HILTON	07/07/1976	390	130.00	6	43
MO DC 41	MO-73-0489	KOHLHOSS, CHARLES	HILTON	06/11/1974	320	125.00	6	42
MO DC 42	MO-73-0549	SMITH JR, CHARLES E	HILTON	07/24/1974	300	120.00	6	40
MO DC 43	MO-73-0728	MCELFISH, ROBERT L	KEYSERGARVER	03/25/1975	390	131.00	6.25	46
MO DC 44	MO-73-0597	SIMMS, ROLAND	HILTON	09/04/1974	405	65.00	6	24
MO DC 45	MO-73-1367	TALLEY, VIOLA	EASTERDAY	12/14/1976	440	160.00	6	63
MO DC 46	MO-73-1368	STEVENS, L M	HILTON	05/20/1977	370	130.00	6	44
MO DC 47	MO-73-0645	LACKEY, HARRY T	HILTON	11/15/1974	200	165.00	6	25
MO DC 48	MO-73-0950	DARBY, LAWRENCE A	HILTON	02/06/1976	290	105.00	6	30
MO DC 49	MO-73-0417	LYLES, WILLIAM T	KEYSER	11/19/1973	385	205.00	6	41
MO DC 50	MO-65-5253	ELIJAH, METH CHRCH	HILTON	12/02/1963	400	105.00	6.25	38
MO DC 51	--	ROUCH	--	?	395	62.30	72	--
MO DC 52	--	--	--	?	390	--	6	--
MO DC 53	--	--	--	?	410	106.40	6	--
MO DC 54	--	--	--	?	390	--	6	--
MO DC 55	MO-03-5558	PLSVL METH, CHRC	HILTON	08/10/1959	395	92.00	5.62	45
MO DC 56	MO-73-1139	COHER, EMORY	HUGHES	08/25/1976	300	125.00	6	42
MO DC 57	--	--	--	?	380	--	6	--
MO DC 58	--	POOLESVILLE, TOWN OF	SYDNOR	10/13/1972	380	285.00	8	82
MO DC 59	MO-73-1896	GEOL SURV, U S	EASTERDAY	04/28/1978	370	262.00	6	42
MO DC 60	--	BERNSDORFF	--	?	335	37.80	--	--
MO DC 61	--	UHL	--	?	340	25.95	--	--
MO DC 62	--	PETERS, FORREST	--	?	403	29.70	--	--
MO DC 63	MO-73-0711	IMES, JERRY	MAYNE	02/06/1975	450	100.00	6	42
MO DC 64	MO-73-1774	FROHLICH, ELMER	HILTON	03/11/1974	460	150.00	6	48
MO DC 65	MO-73-1915	BAUMAN, BETTY	HILTON	04/21/1978	339	130.00	6	48
MO DC 66	--	BANACH	--	?	390	22.90	60	--
MO DC 67	MO-66-0479	BAPTIST CH, JERUSALEM	HILTON	06/03/1966	450	81.00	6.25	52
MO DC 68	MO-73-1840	YOUNG, WILLIAM R	CROMWELL	03/23/1978	450	250.00	6	42
MO DC 69	MO-73-1770	GARRISON, ROBERT W	HILTON	03/11/1978	340	150.00	6	50
MO DC 70	MO-73-1749	MANN, JAMES H	HILTON	12/30/1977	240	110.00	6	46
MO DC 71	MO-73-1701	ANDERSON, CHESTER W	HILTON	02/27/1978	485	210.00	6	46
MO DC 72	MO-73-2284	U S GEOLOGICAL, SURVEY	GARVER	08/07/1978	330	275.00	6	41
MO DC 73	MO-73-1941	CONLON, THOMAS	HILTON	08/21/1978	370	130.00	6	43
MO DC 74	MO-73-1861	MENONITE CHURCH, DAWSONVLLE	HILTON	01/27/1978	319	130.00	6	40
MO DC 75	MO-73-1616	GILDAR, RICHARD A	EASTERDAY	10/24/1977	375	260.00	6	42

Table 13. — Montgomery County well records—continued.

PRINCIPAL AQUIFER 1/	WATER LEVEL (FEET)	DRAW-DOWN (FEET)	DATE DISCHARGE MEASURED	DISCHARGE (GALLONS PER MINUTE)	PUMPING PERIOD (HOURS)	SPECIFIC CAPACITY (GPM/FT)	USE OF WATER 1/	TYPE OF LIFT 1/	LOCAL NUMBER
231NOXF	31.00	78	01/30/1975	3	2.0	0.0	H	S	MO DR 78
231NOXF	91.65	--	--	--	--	--	H	S	MO DR 79
231NOXF	8.20	112	05/18/1978	25	3.0	0.2	H	S	MO DR 80
231NOXF	6.40	194	08/15/1978	4	3.0	0.0	H	S	MO DR 81
231NOXF	60.00	140	05/12/1978	20	4.0	0.1	H	S	MO DR 82
231NOXF	3.57	--	--	--	--	--	H	P	MO DC 1
231NOXF	40.00	0	10/30/1949	7	2.0	7.0	H	P	MO DC 2
300IJMV	15.26	6	11/04/1952	20	2.0	3.3	H	--	MO DC 3
300IJMV	--	--	--	--	--	--	S	P	MO DC 4
300IJMV	--	--	--	--	--	--	H	P	MO DC 5
231NOXF	--	--	?	3	--	--	T	U	MO DC 6
231NOXF	42.00	33	12/17/1951	15	1.0	0.5	H	--	MO DC 7
231NOXF	--	--	1949	6	--	--	S	P	MO DC 8
231NOXF	--	--	--	--	--	--	S	P	MO DC 9
231NOXF	15.00	--	--	--	--	--	S	P	MO DC 10
231NOXF	--	--	1949	5	--	--	S	P	MO DC 11
231NOXF	--	--	--	--	--	--	S	P	MO DC 12
231NOXF	--	--	1949	20	--	--	S	P	MO DC 13
231NOXF	22.00	36	10/16/1965	16	1.0	0.4	H	S	MO DC 14
231NOXF	30.00	110	06/24/1959	10	3.0	0.1	S	P	MO DC 15
231NOXF	30.00	90	08/28/1959	10	3.0	0.1	H	U	MO DC 16
231NOXF	25.00	15	08/15/1959	80	15.0	5.3	I	T	MO DC 17
231NOXF	29.00	137	08/26/1964	53	24.0	0.4	P	T	MO DC 18
231NOXF	36.00	87	09/19/1959	95	24.0	1.1	P	T	MO DC 19
231NOXF	39.00	97	06/18/1965	7	2.0	0.1	H	P	MO DC 20
231NOXF	19.00	92	10/09/1965	4	2.0	0.0	H	P	MO DC 21
231NOXF	41.00	82	10/14/1965	18	2.0	0.2	H	P	MO DC 22
231NOXF	47.00	102	08/30/1956	6	2.0	0.1	H	S	MO DC 23
231NOXF	10.00	150	01/26/1967	6	0.5	0.0	H	S	MO DC 24
231NOXF	26.00	95	07/24/1967	12	2.0	0.1	H	S	MO DC 25
231NOXF	18.00	98	09/24/1967	3	2.0	0.0	H	S	MO DC 26
231NOXF	40.00	10	05/23/1958	30	1.0	3.0	H	S	MO DC 27
231NOXF	--	--	08/13/1959	30	12.0	--	C	T	MO DC 28
231NOXF	11.78	176	09/03/1971	60	24.0	0.3	U	--	MO DC 29
231NOXF	--	--	--	--	--	--	H	S	MO DC 30
231NOXF	12.20	69	11/01/1972	100	24.0	1.5	P	S	MO DC 31
231NOXF	--	--	--	--	--	--	H	S	MO DC 32
231NOXF	21.00	46	07/15/1971	10	1.0	0.2	U	S	MO DC 33
231NOXF	41.00	81	10/27/1970	8	2.0	0.1	H	S	MO DC 34
231NOXF	26.00	105	01/03/1970	20	1.0	0.2	H	S	MO DC 35
231NOXF	31.00	154	11/06/1969	11	2.0	0.1	S	S	MO DC 36
231NOXF	41.00	139	09/13/1971	3	1.0	0.0	H	S	MO DC 37
231NOXF	20.00	69	09/18/1970	7	1.0	0.1	H	S	MO DC 38
231NOXF	66.00	75	02/07/1973	12	1.0	0.2	H	S	MO DC 39
231NOXF	28.00	77	07/07/1976	40	3.0	0.5	H	--	MO DC 40
231NOXF	30.00	81	06/11/1974	30	1.0	0.4	H	S	MO DC 41
231NOXF	31.00	81	07/24/1974	15	1.0	0.2	I	U	MO DC 42
231NOXF	12.00	8	03/25/1975	15	2.0	1.9	H	S	MO DC 43
231NOXF	21.00	29	09/04/1974	20	2.0	0.7	H	S	MO DC 44
231NOXF	58.57	101	11/14/1977	2	2.0	0.0	H	S	MO DC 45
231NOXF	16.00	86	05/20/1977	10	5.0	0.1	H	S	MO DC 46
231NOXF	35.53	103	10/05/1977	10	2.0	0.1	H	S	MO DC 47
231NOXF	29.00	57	02/06/1976	7	2.0	0.1	H	S	MO DC 48
231NOXF	12.00	--	11/19/1973	3	1.0	--	H	S	MO DC 49
231NOXF	41.00	35	12/02/1953	10	2.0	0.3	T	S	MO DC 50
231NOXF	25.59	--	--	--	--	--	U	--	MO DC 51
300IJMV	15.50	--	--	--	--	--	U	J	MO DC 52
231NOXF	49.33	--	--	--	--	--	U	--	MO DC 53
231NOXF	61.90	--	--	--	--	--	U	--	MO DC 54
231NOXF	28.00	18	08/10/1959	12	1.0	0.7	T	J	MO DC 55
231NOXF	12.00	109	08/25/1976	1	2.5	0.0	H	S	MO DC 56
231NOXF	28.10	--	--	--	--	--	U	--	MO DC 57
231NOXF	12.20	69	11/01/1972	100	24.0	1.5	P	U	MO DC 58
300IJMV	5.37	255	04/28/1978	4	3.0	0.0	U	--	MO DC 59
231NOXF	19.18	--	--	--	--	--	U	S	MO DC 60
231NOXF	11.70	--	--	--	--	--	U	U	MO DC 61
231NOXF	19.70	--	--	--	--	--	U	B	MO DC 62
300IJMV	50.00	--	02/06/1978	10	2.0	--	H	--	MO DC 63
300IJMV	50.59	33	03/11/1974	4	5.0	0.1	H	--	MO DC 64
231NOXF	29.00	64	04/21/1978	4	5.0	0.1	H	U	MO DC 65
231NOXF	15.45	--	--	--	--	--	U	U	MO DC 66
300IJMV	13.40	45	06/03/1978	15	2.0	0.3	T	--	MO DC 67
300IJMV	40.00	205	03/23/1978	3	3.0	0.0	H	S	MO DC 68
231NOXF	41.00	48	03/11/1978	7	5.0	0.1	H	S	MO DC 69
231NOXF	36.00	36	12/30/1977	8	5.0	0.2	H	S	MO DC 70
300IJMV	34.00	135	02/27/1978	2	5.0	0.0	H	S	MO DC 71
231NOXF	4.90	--	08/07/1978	12	4.0	--	U	--	MO DC 72
231NOXF	29.10	69	08/21/1978	3	5.0	0.0	H	S	MO DC 73
231NOXF	79.00	22	01/27/1978	3	4.0	0.1	N	S	MO DC 74
231NOXF	30.66	229	10/24/1978	4	2.0	0.0	H	S	MO DC 75

1/ SEE CODE EXPLANATION

Table 13. — Montgomery County well records—continued.

LOCAL NUMBER	PERMIT NUMBER	OWNER	CONTRACTOR	DATE COMPLETED	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	CASING DIAMETER (INCHES)	DEPTH CASED
MONTGOMERY COUNTY -- CONTINUED								
MO DC 76	MO-73-0034	BOWERS, JAMES	HILTON	09/01/1972	330	110.00	6	16
MO DC 77	MO-73-1902	JACKSON, HERMAN	HILTON	02/03/1978	342	130.00	6	73
MO DC 78	MO-73-2082	SCHULTZ, ROBERT	EASTERDAY	05/26/1978	465	180.00	--	--
MO DC 79	MO-73-2229	ALLNUTT, LEWIS	HILTON	07/14/1978	310	130.00	6	42
MO DC 80	MO-73-1149	ALLNUTT III, LEWIS	HILTON	10/08/1976	259	100.00	6	42
MO DC 81	MO-73-0490	EDMONDS, JAMES	--	05/13/1974	340	105.00	--	--
MO DC 82	MO-73-2330	HODGES, RICHARD	HILTON	10/07/1978	325	170.00	--	--
MO DC 83	MO-73-2420	WEITZER, DAVID	HILTON	11/03/1978	290	190.00	6	42
MO DC 84	MO-73-2494	HARPER, ROLAND C	HILTON	01/04/1979	440	130.00	6	42
MO DC 85	MO-73-1968	KLINE, ALLAN	EASTERDAY	10/21/1977	328	160.00	6	65
MO DD 23	MO-73-0874	SCHWARTZ, ROBERT	CLINE	02/13/1976	395	100.00	6	66
MO DD 24	MO-73-2485	JACKSON, JAMES	QUYNN	11/10/1978	295	150.00	6	62
MO EC 1	MO-00-3008	HUNTER, J F	--	03/20/1948	200	84.00	6	48
MO EC 2	MO-00-3830	COOLEY, WILLIAM	STOTTLEMYER	04/09/1952	200	75.00	6	21
MO EC 3	--	STOTTLEMYER	HILTON	03/31/1933	200	38.00	6	--
MO EC 4	MO-00-3006	MILLER, JOSEPH	STOTTLEMYER	03/14/1948	200	95.00	6	31
MO EC 5	MO-01-7664	PIERPONT, H Y	HILTON	04/23/1951	340	157.00	6	38
MO EC 6	MO-68-0033	NATIONAL, PARK SERV	HILTON	09/06/1967	175	124.00	6.25	40
MO EC 7	--	NATIONAL, PARK SERV	DELMARVA	09/28/1970	190	136.00	--	128
MO EC 8	--	NATIONAL, PARK SERV	HOFFMAN	02/05/1969	190	125.00	6	42
MO EC 9	MO-66-0345	KLINE, JOHN L	GREENE	05/12/1966	210	118.00	6	--
MO EC 10	MO-73-2833	GEOLOGICAL, SURVEY U.S.	KYKER	11/28/1979	200	857.50	8	26
MO EG 1	--	BROWN, WALTER A	--	1932	280	20.00	--	--

Table 13. — Montgomery County well records—continued.

PRINCIPAL AQUIFER 1/	WATER LEVEL (FEET)	DRAW-DOWN (FEET)	DATE DISCHARGE MEASURED	DISCHARGE (GALLONS PER MINUTE)	PUMPING PERIOD (HOURS)	SPECIFIC CAPACITY (GPM/FT)	USE OF WATER 1/	TYPE OF LIFT 1/	LOCAL NUMBER
231NOXF	19.00	77	09/01/1972	3	1.0	0.0	H	S	MO DC 76
231NOXF	29.00	69	02/03/1978	8	4.0	0.1	H	S	MO DC 77
231NOXF	20.00	160	05/31/1978	4	3.0	0.0	H	S	MO DC 78
231NOXF	29.00	69	07/14/1978	3	--	0.0	H	S	MO DC 79
231NOXF	41.92	46	10/08/1976	5	3.0	0.1	H	S	MO DC 80
231NOXF	47.00	44	05/13/1974	6	1.0	0.1	H	S	MO DC 81
231NOXF	32.00	73	10/07/1978	5	4.0	0.1	H	S	MO DC 82
231NOXF	47.00	101	11/03/1978	6	5.0	0.1	H	S	MO DC 83
300IJMV	36.00	55	01/04/1973	4	5.0	0.1	H	S	MO DC 84
231NOXF	45.00	115	10/21/1977	20	--	0.2	H	S	MO DC 85
300UPPC	29.00	71	--	20	1.0	0.3	H	S	MO DD 23
300UPPC	33.00	107	11/10/1978	7	2.0	0.1	H	S	MO DD 24
231NOXF	33.00	51	03/20/1948	6	1.0	0.1	H	J	MO EC 1
231NOXF	15.00	60	04/09/1952	2	--	0.0	H	J	MO EC 2
231NOXF	--	--	03/31/1933	4	--	--	H	J	MO EC 3
231NOXF	35.00	60	03/14/1948	3	2.0	0.0	H	P	MO EC 4
231NOXF	60.00	23	04/23/1951	12	2.0	0.5	H	J	MO EC 5
231NOXF	28.00	8	04/06/1957	30	6.0	3.8	Z	S	MO EC 6
231NOXF	6.00	55	09/28/1970	10	4.0	0.2	Z	S	MO EC 7
231NOXF	18.00	--	08/25/1971	40	--	--	R	P	MO EC 8
231NOXF	50.00	50	05/12/1966	10	3.0	0.2	H	U	MO EC 9
231NOXF	8.35	15	--	400	12.0	27.0	U	--	MO EC 10
--	--	--	--	--	--	--	U	--	MO EG 1

1/ SEE CODE EXPLANATION BELOW.

AQUIFER CODES

231NOXF - TRIASSIC NEW OXFORD FORMATION
231DIBS - UPPER TRIASSIC DIKES AND SILLS
300IJMV - PALEOZOIC IJAMSVILLE FORMATION
300WSCK - PALEOZOIC WISSAHICKON FORMATION
300UPPC - PALEOZOIC UPPER PELITIC SCHIST OF WISSAHICKON FORMATION
377HRPR - LOWER CAMBRIAN HARPERS FORMATION
110TRRC - QUATERNARY TERRACE DEPOSITS

USE OF WATER

R - RECREATION
S - STOCK
I - IRRIGATION
N - INDUSTRIAL
C - COMMERCIAL
H - DOMESTIC
U - UNUSED
F - FIRE

TYPE OF LIFT

J - JET
P - PISTON
S - SUBMERSIBLE
T - TURBINE
U - UNUSED

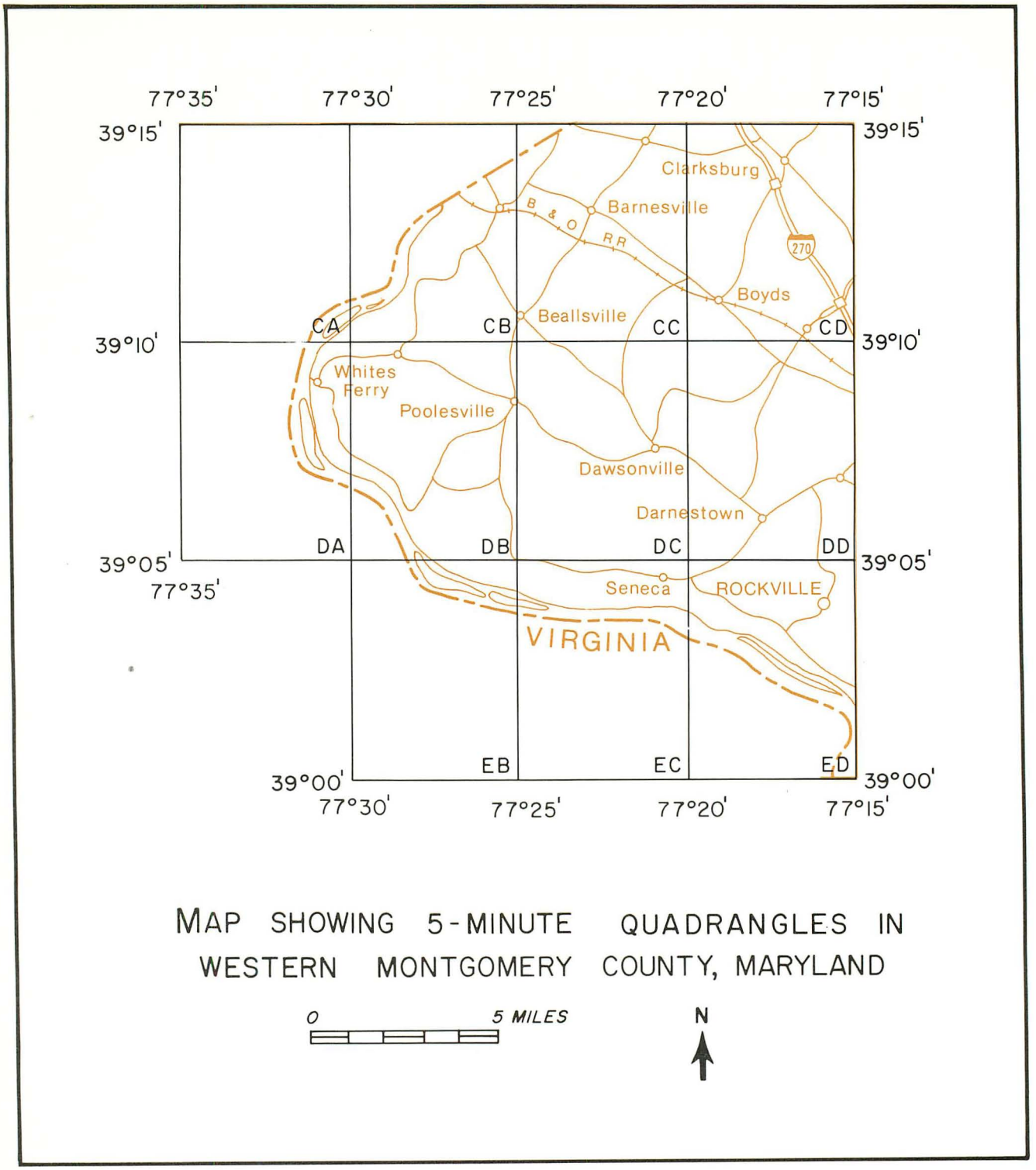
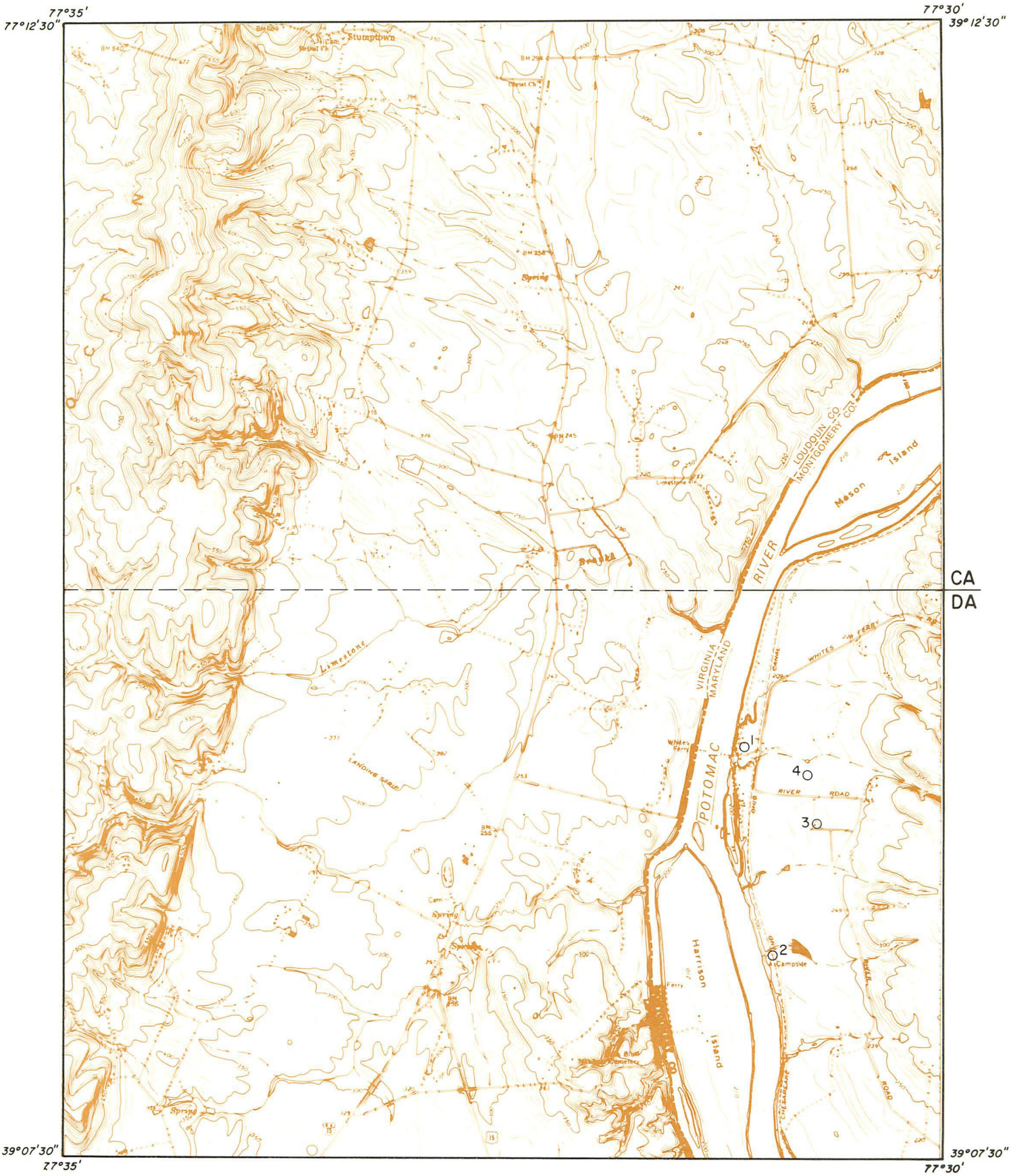


Figure 20. — Map showing location of 5-minute quadrangles in western Montgomery County.



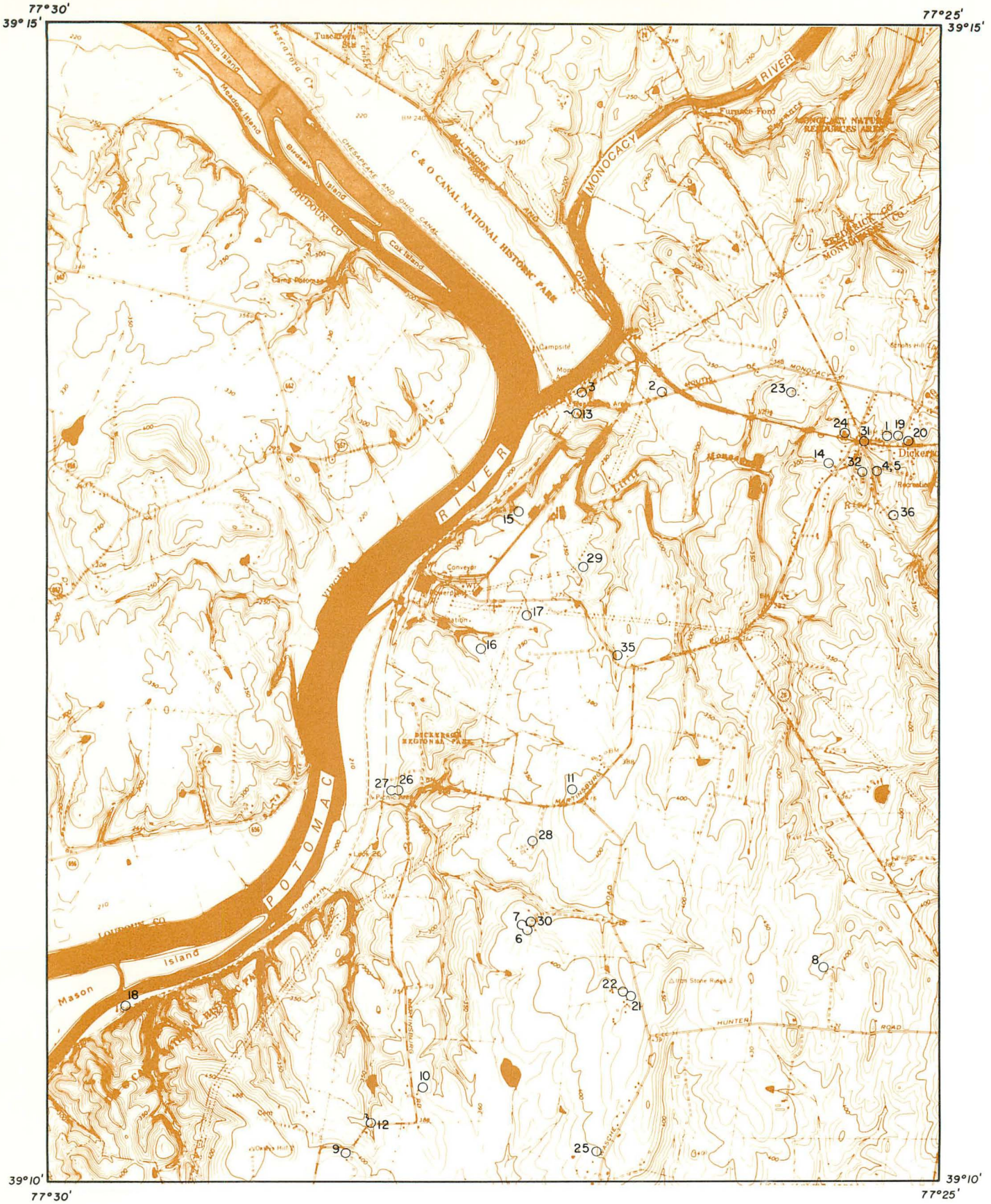
CA, DA

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N



CB

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

CC

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

CD

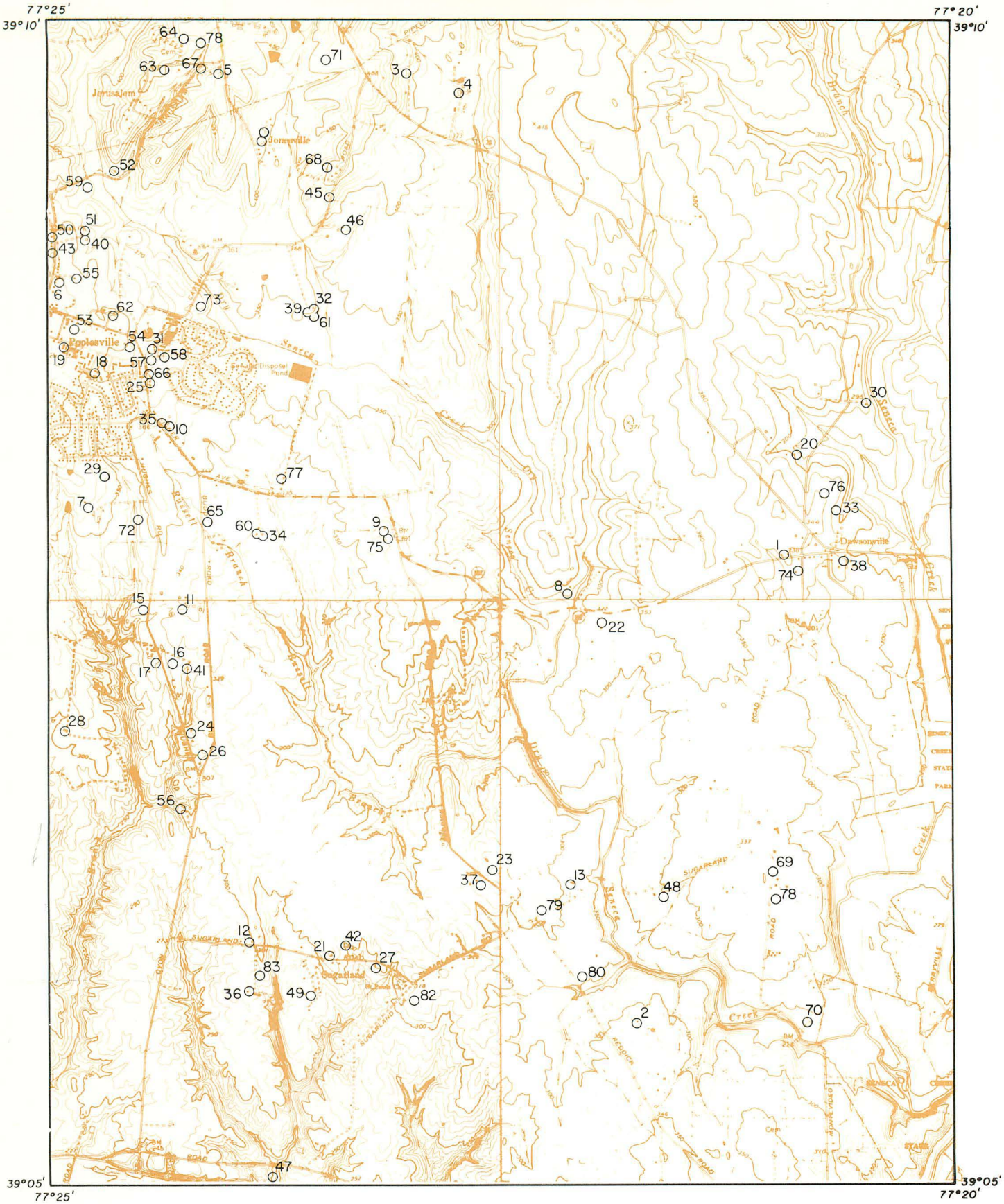
1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

77°30'
39°10'
77°25'
39°10'
39°05'
77°30'
39°05'
77°25'
Martinsburg
NATIONAL INSTITUTES OF HEALTH ANIMAL FARM
MONTGOMERY CO
DB
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
N


77°25'
39°10'
77°20'
39°10'
39°05'
77°25'
39°05'
77°20'
Jerusalem
Jonesville
Poplarville
Dawsonville
Sugarland
Seneca
Creek
Branch
Sugarland Road
Seneca Creek State Park
Disposal Pond
Cem
DC
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
N

DD

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

EB

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

EC

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

ED

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

MARYLAND GEOLOGICAL SURVEY
Merryman Hall
The Johns Hopkins University
Baltimore, Maryland 21218

Selected Reports of Investigations:

1. Chemical quality of water and trace elements in the Patuxent River Basin, by S.G. Heidel and W.W. Frenier, 1965., 40 p. $3.50*
3. Water resources of the Salisbury area, Maryland, by D.H. Boggess and S.G. Heidel, 1968, 69 p. 3.00
5. Chemical quality reconnaissance of water of Maryland streams, by J.D. Thomas, 1966, 61 p. 2.00
9. Chemical and physical character of municipal water supplies in Maryland, by J.D. Thomas and S.G. Heidel, 1969, 52 p. 1.00
10. Ground-water occurrence in the Maryland Piedmont, by L.J. Nutter and E.G. Otton, 1969, 56 p. 2.50
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16. Flow characteristics of Maryland streams, by P.N. Walker, 1971, 160 p. 2.50
17. Water resources of Dorchester and Talbot Counties, Maryland with special emphasis on the ground-water potential of the Cambridge and Easton areas, by F.K. Mack, W.E. Webb, and R.A. Gardner, 1971, 107 p. 5.25
18. Solid-waste disposal in the geohydrologic environment of Maryland, by E.G. Otton, 1972, 59 p. 3.00
19. Hydrogeology of the carbonate rocks, Frederick and Hagerstown Valleys, Maryland, by L.J. Nutter, 1973, 70 p. 3.50
20. Hydrogeology of the formation and neutralization of acid waters draining from underground mines of western Maryland, by E.F. Hollyday and S.W. McKenzie, 1973, 50 p2.25
22. An evaluation of the Magothy Aquifer in the Annapolis Area, Maryland, by F.K. Mack, 1974, 75 p. 3.00
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34. The availability of ground water in western Montgomery County, Maryland, by E.G. Otton, 1981, 76 p. 5.75

*microfiche

Maryland Residents Add 5% Sales Tax

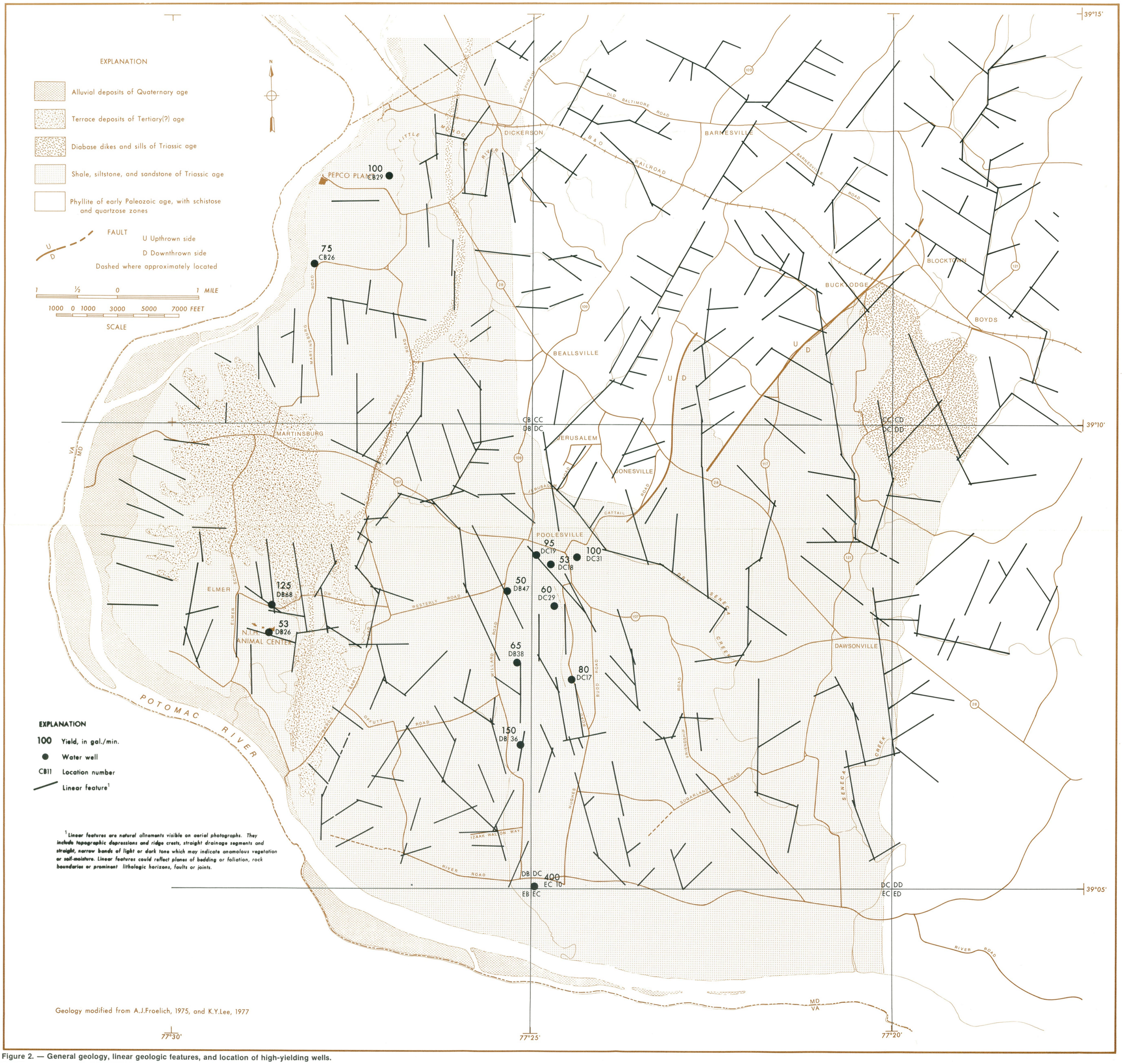

Figure 2. — General geology, linear geologic features, and location of high-yielding wells.

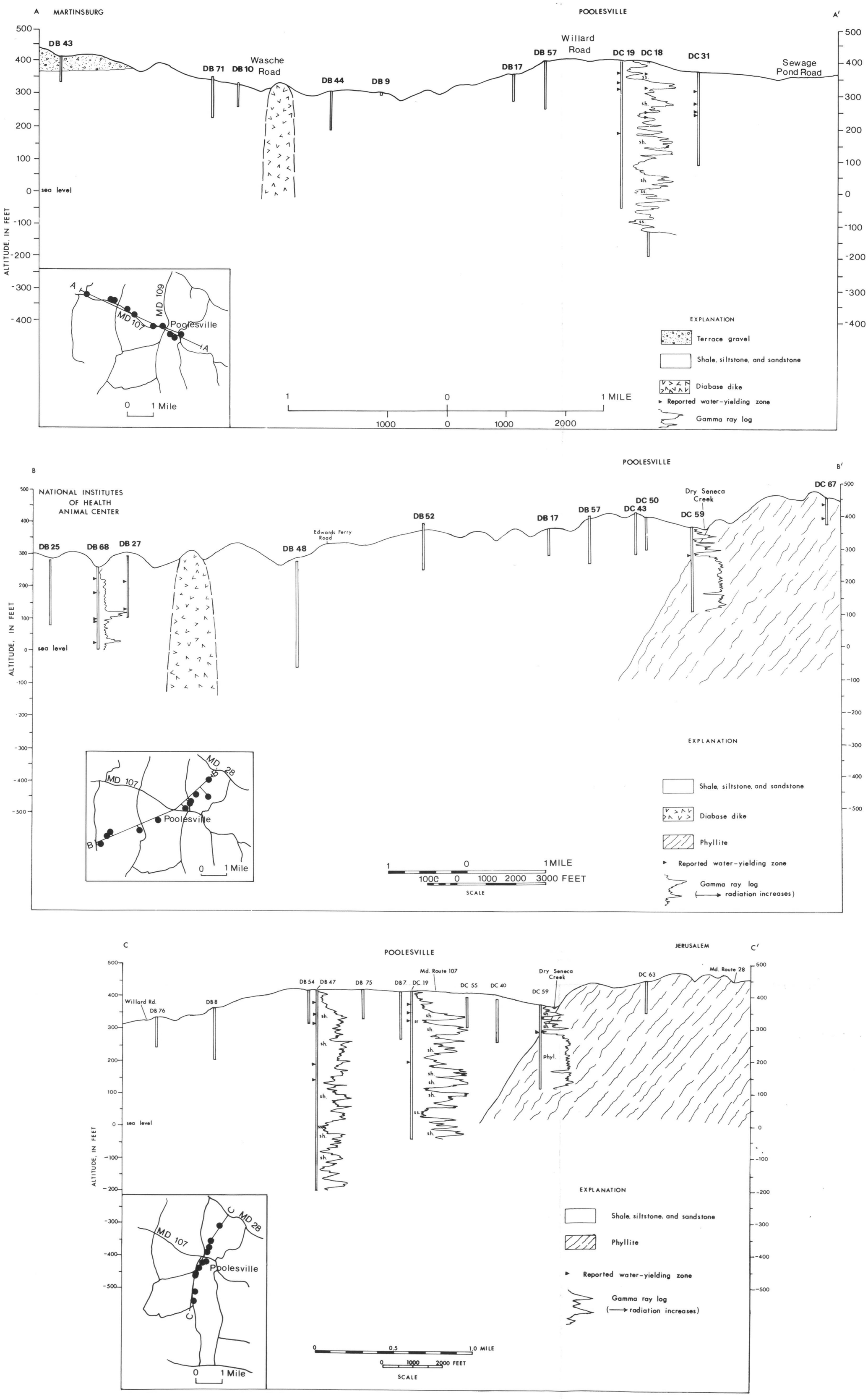

Figure 7. — Three geohydrologic sections in the vicinity of Poolesville: Section A-A′ from Martinsburg to Sewage Pond Road; Section B-B′ from the N.I.H. Animal Center through Poolesville; Section C-C′ from Offut Road to Maryland Route 28.

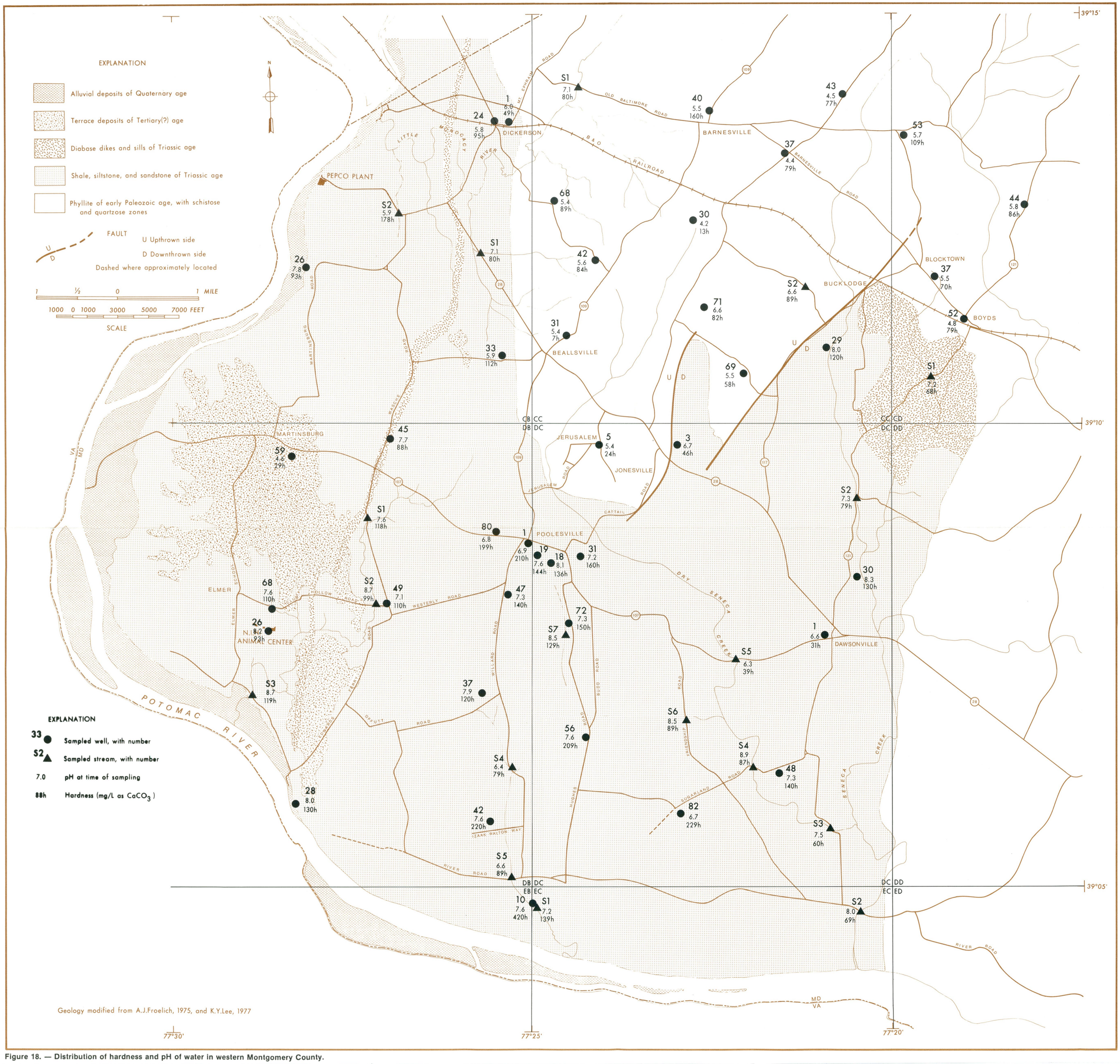

Figure 18. — Distribution of hardness and pH of water in western Montgomery County.