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AVAILABILITY OF GROUND WATER IN MONTGOMERY COUNTY, MARYLAND

By

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ABSTRACT

Montgomery County, Md., is underlain by consolidated rocks that, on the basis of well yields, have been subdivided into six hydrogeologic units. The distribution of the hydrogeologic units are shown on a map (scale 1:62,500). Most wells drilled in the county yield between 6 and 25 gal/min (0.4 to 1.6 L/s); however, about one-third of the wells drilled in the most productive hydrogeologic unit yielded more than 25 gal/min (1.6 L/s). Water from all units is suitable for domestic, public supply, and most industrial uses, but may require treatment for the removal of iron and hardness.

INTRODUCTION

Montgomery County lies north and west of the District of Columbia and, within about 12 miles (19 kilometers) of the District, is largely urban or suburban. In the past 15 or 20 years, even several of the more distant towns have grown in response to the move of governmental and commercial offices into the suburbs. Most of the water consumed in this area is supplied from surface-water sources by the Washington Suburban Sanitary Commission. However, in the more rural northern and western sections of the county, or wherever the Commission's water mains have not been laid, the only source of supply is water pumped from wells. Some users other than private homes, such as schools, country clubs, smaller commercial establishments, and the town of Poolesville, draw on ground-water supplies. Thus, although most of the inhabitants of Montgomery County are supplied from surface-water sources, ground water is an important resource.

OCCURRENCE OF GROUND WATER

The source of ground water in Montgomery County is chiefly local precipitation that has worked its way down by gravity through the soil and into the underlying saturated material. Within the saturated zone, that is, the zone beneath the water table, water moves laterally to points of discharge in stream valleys and appears as seeps or springs. Pumping of wells located near streams may reverse the normal slope of the water table and induce water from the streams to enter the water-bearing formations (aquifers).

Ground water that is unconfined and is in contact with the atmosphere occurs under water-table conditions. Under such conditions, the water level in a water-table well fluctuates in response to precipitation, to demands of vegetation, and to pumping. The water in most wells in Montgomery County occurs under water-table conditions, whether the well be tens or hundreds of feet deep and regardless of the method of boring or drilling the hole. Many people believe that all water-table wells are shallow, dug wells whose contained water is merely surface drainage, but this is not true.

Almost all of Montgomery County lies in the Piedmont province, where the rocks are hard and consolidated. The three most areally extensive types are schist; gneiss and granitic rocks; and phyllite. Smaller areas of diabase and various mafic and ultramafic rocks occur in nearly every part of the county. The western part of the county is underlain by sedimentary rocks consisting of siltstone, shale, and sandstone, with a lesser amount of conglomerate. Distribution of the various rock types is shown on the bedrock map of Montgomery County (Froelich, 1975a). Immediately above the rock and below the soil is a zone of fairly soft weathered material known as saprolite. The thickness of the overburden (soil and saprolite) in the county is shown by Froelich (1975b). Along the extreme eastern boundary of the county adjoining Prince Georges County, a veneer of Coastal Plain sediment overlies the hard crystalline rock of the Piedmont. Deposits of unconsolidated alluvium lie in most of the larger stream valleys, particularly along the Potomac River. These latter two lithologic units are not shown on the map because of their limited thickness and areal extent.

The behavior of ground water in a particular area is controlled largely by lithology, the character and thickness of the overburden, the degree to which the underlying rocks are fractured and jointed, and the topography. Ground water enters a well at the base of the weathered zone and (or) through the cracks and fractures in the hard rock. Studies of crystalline rocks in Montgomery County and in other areas having similar lithology indicate that where the weathered zone is clayey, ground-water movement is retarded, and well yields are generally low. Yields are also low where the underlying hard rock has not been sufficiently broken up by earth movements to develop "storage space" for water or paths for water movement. As the number and size of fractures tend to die out with increasing depth, there is usually little to be gained in continuing to drill in search of additional water below 200 to 300 feet (60 to 90 meters). A comparison of well yields and topographic position shows that the most productive wells are in valleys and draws, whereas the least productive are on hilltops.

AVAILABILITY OF GROUND WATER

In order to determine the water-bearing characteristics of the rocks underlying Montgomery County, records of 474 wells were sorted according to the lithology (rock type) shown by Froelich (1975a) on the bedrock map of the county. Within each lithology, the wells were subdivided into three yield classes: small, 0 - 5 gallons per minute (gal/min) (0 - 0.3 liter per second [L/s]); medium, 6 - 25 gal/min (0.4 - 1.6 L/s); and large, over 25 gal/min (1.6 L/s). On the basis of this sorting, six hydrogeologic units were identified. These units are shown on the accompanying map together with the statistical data for the yields of the wells in each unit. The units are numbered according to their water-yielding abilities--unit 1 is the best aquifer, and unit 5 is the poorest. The data available for unit 6 were considered insufficient to make a valid statistical analysis. The quartzite (unit 6) and phyllite (unit 5) are interbedded in some areas and thus have a close field relationship; however, as the rock types have very different physical characteristics and may have quite different hydrologic properties, it was not considered desirable to combine the two sets of statistics. As no wells are known to end in what Froelich called "quartz bodies," this rock type was omitted from consideration.

It will be observed that the highest percentage of wells in each of the hydrogeologic units, except unit 5, falls in the medium-yield range. To some extent, this is not surprising, as by far the largest majority of wells were drilled for domestic and farm purposes. The highest percentage of large yields (32 percent) and the smallest percentage of small yields (13 percent) are found in wells ending in unit 1 (gneiss and granitic rock). Only in this unit are large yields as much as one-third (32 percent) of the total number of wells. At the opposite end of the scale, and in agreement with data obtained in other studies, wells ending in unit 5 (phyllite) have the highest percentage of small yields (51 percent) and the lowest percentage of large yields (5 percent). Large yields are the smallest fraction of the total wells in all units, with the exception of unit 1.

Note that these statistics should be used with care lest the data be misinterpreted. For example, the statistics indicate that nearly one-fourth (23 percent) of the wells ending in unit 2 yield more than 25 gal/min (1.6 L/s), and, arithmetically, this is true. What the statisics do not show, however, is the history of some of these more productive wells. Most of the now-abandoned public-supply wells drilled for the towns of Rockville and Gaithersburg ended in unit 1. Because relatively large quantities of water were needed, the wells were originally tested at higher rates than they would have been had they been drilled for domestic purposes. The yields gradually declined, use of those wells was discontinued, and replacement wells were drilled at other sites, until a total of several dozen wells had been drilled.

This sequence of events demonstrates that a high initial yield from a crystalline-rock well does not necessarily mean and, in fact, probably does not mean that that yield can be sustained indefinitely.

Records of 564 wells were also sorted according to geohydrologic units and four depth ranges: 0 - 50 feet (0 - 15 meters); 51 - 150 feet (16 - 46 meters); 151 - 250 feet (46 - 76 meters); and over 250 feet (76 meters). No significant differences were noted between geohydrologic units. Most wells (64 percent) are 51 - 150 feet (16 - 46 meters) deep; the remaining wells are split rather evenly into the other three depth ranges.

There is a tendency for higher yields and deeper wells to be concentrated around towns and institutions where users require above-average quantities of water. It is interesting to note that unit 1, which has the highest percentage of wells in the large-yield range, also has the highest percentage of wells over 250 feet deep (19 percent). However, aside from this observation, it is difficult to note any particular relationship between rock type and well depth.

Wells in all yield and depth ranges may be found in all parts of the county. This may be due in part to the fact that none of the geohydrologic units are uniform throughout. It is also probable that, in many places, conditions at each individual well site are more important in determining the yield of a well than the lithology alone, although other variables may in themselves be related to the lithology.

Where drilling sites can be chosen to take advantage of one or more of the features controlling ground-water availability, such as lithology, topography, fracture patterns, and nearby streams, yields of over 100 gal/min (6.3 L/s) can be obtained for at least a time. This was demonstrated some years ago at a test site near Laytonsville, in Montgomery County, where one well ending in unit 2 was pumped at an average of 150 gal/min (9.5 L/s) during a 22-hour test (Nutter and Otton, 1969, p. 33). More recently, a well ending in unit 5 near Clarksburg was reported to produce an average of 100 gal/min (6.3 L/s) during a 72-hour test. The high yield of this well, which ends in what is generally considered one of the poorer aquifers, is probably the result of being located at or near the intersection of fracture traces. More detailed information on the factors affecting the yields of wells may be found in the publications listed under "Selected References" at the end of this text.

WATER QUALITY

Ground water in Montgomery County generally contains less than 250 mg/L (milligrams per liter) of dissolved mineral matter, reported as dissolved solids. The water is suitable for domestic, public supply, and most industrial uses, but may require treatment for the removal of iron and hardness.

Iron in concentrations greater than 0.3 mg/L causes staining of fabrics and plumbing fixtures. Such concentrations of dissolved iron are likely to occur throughout all six hydrogeologic units. The range in iron content of 41 samples of ground water was 0.02 to 13.0 mg/L. The average content was 1.6 mg/L, and the median value was 0.28 mg/L.

Hardness is caused by calcium and magnesium and is recognized by its soap-consuming tendency and the formation of scale. Durfor and Becker (1964, p. 27) have defined water with up to 60 mg/L hardness as "soft," 61 - 120 mg/L as "moderately hard," 121 - 180 mg/L as "hard," and more than 180 mg/L as "very hard." Water from unit 3 is almost always hard and, in places, may be very hard. Hard water also occurs in unit 2, particularly within about 5 miles (8 kilometers) of the Potomac River.

SUMMARY AND CONCLUSIONS

In most areas of Montgomery County, adequate ground-water supplies for domestic and farm use may be obtained; however, in some places, it may be necessary to drill more than one well on a single property for even these modest demands. Wells that can be pumped for several tens of gallons per minute over long periods of time should be considered to be the more productive wells of the county. Larger yields can no doubt be obtained if the sites are selected judiciously.

Although certain rock types are more or less productive than others, there is such a wide variety of both yields and depths within each unit in Montgomery County, that, at present, it is impossible to delineate areas in the county that consistently provide either above-average or below-average yields. Thus, some test drilling will be required to locate productive well sites in the county.

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1/ The name of this agency was changed to the Maryland Geological Survey in June 1964.