Nat Wilson

# GEOLOGY AND GROUND-WATER RESOURCES IN THE RALEIGH AREA NORTH CAROLINA

DIVISION OF GROUND WATER

**GROUND WATER BULLETIN NO. 15**

North Carolina
Department of Water Resources

RALEIGH
NOVEMBER
1968

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# DEPARTMENT OF WATER AND AIR RESOURCES

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The Honorable Dan K. Moore
Governor of North Carolina
Raleigh, North Carolina

Dear Governor Moore:

I am pleased to submit Ground Water Bulletin Number 15, "Ground Water Resources of the Raleigh Area, North Carolina" by V. Jeff May, Hydraulic Engineer and J. D. Thomas, Chemist, U. S. Geological Survey.

This report contains the results of a detailed study of ground water availability, quality and potential in the Raleigh Area. The study was made by the U. S. Geological Survey in cooperation with the North Carolina Department of Water and Air Resources. This report will be a valuable aid in the development and management of water resources in the Raleigh Area, and should contribute much to the future economy and welfare of the area.

Respectfully submitted,

George E. Pickett

# GEOLOGY AND GROUND-WATER RESOURCES IN THE RALEIGH AREA NORTH CAROLINA


By

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By

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GROUND WATER BULLETIN NUMBER 15


NORTH CAROLINA

DEPARTMENT OF WATER AND AIR RESOURCES

George E. Pickett, *Director*

Division of Ground Water

Harry M. Peek, *Chief*

PREPARED COOPERATIVELY BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR
AND THE NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

NOVEMBER 1968

## North Carolina
## Board of Water and Air Resources

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# GEOLOGY AND GROUND-WATER RESOURCES IN THE RALEIGH AREA, NORTH CAROLINA

By

V. Jeff May and J. D. Thomas

## ABSTRACT

The Raleigh area is in the northeastern part of central North Carolina and includes the following counties: Franklin, Granville, Vance, Warren, and Wake. The combined area of the five counties is 2,592 square miles, and the population in 1960 was 282,601.

The area lies entirely in the Piedmont physiographic province except for a small area in southern Wake County that is part of the Fall Zone. The land surface, which has a gentle southeast slope, has flat to rounded interstream areas separated by small streams that are controlled largely by structure and by larger streams which cut across structure.

The geology in the Piedmont province is complex. The Piedmont is underlain by gneiss, schist, granitic rocks, metamorphosed volcanic and sedimentary rocks, and Triassic sedimentary rocks of the Newark Group. In the Fall Zone metamorphic and igneous rocks of the Piedmont are unconformably overlain by unconsolidated sand and clay deposits of Cretaceous age.

Several towns and industries in the Raleigh area obtain their water supplies from wells. Ground water is the source for all private supplies.

The permeability of the rock units depends largely upon the occurrence of secondary interstices such as fractures and cleavage planes. Because the nature and abundance of these interstices vary in the different rock types, the yields of wells differ greatly from place to place.

The yield of wells in all of the metamorphic and igneous rocks, except greenstone, ranges from 12 to 22 gallons per minute. Adequate domestic supplies and small to moderate industrial and municipal supplies are obtained from these rocks.

The Triassic sedimentary rocks are poor aquifers. Most wells in these rocks yield less than 10 gallons per minute.

Topographic location has an important bearing on the yields of wells. The average yield of wells in draws is greater than twice the average yield of wells at other topographic locations.

The permeability of the rocks decreases with depth. Generally, little water is contained in the rocks below a depth of 200 to 250 feet.

Ground waters in the Raleigh area are mostly calcium and sodium bicarbonate type water. Some highly mineralized waters for this area are produced from the Triassic and metavolcanic rocks. The bromide concentration in ground water is probably from residual sea water. The well waters containing above-normal amounts of nitrate in the area have been polluted because of improper well casing.

# INTRODUCTION

## LOCATION AND SCOPE OF INVESTIGATION

The Raleigh area of north-central North Carolina (fig. 1) comprises Franklin, Granville, Vance, Wake, and Warren Counties. Adjacent counties are Halifax, Northampton, and Nash Counties on the east, Johnston and Harnett Counties on the south, and Person, Durham, and Chatham Counties on the west. The area is named for the City of Raleigh, the largest city in the area.

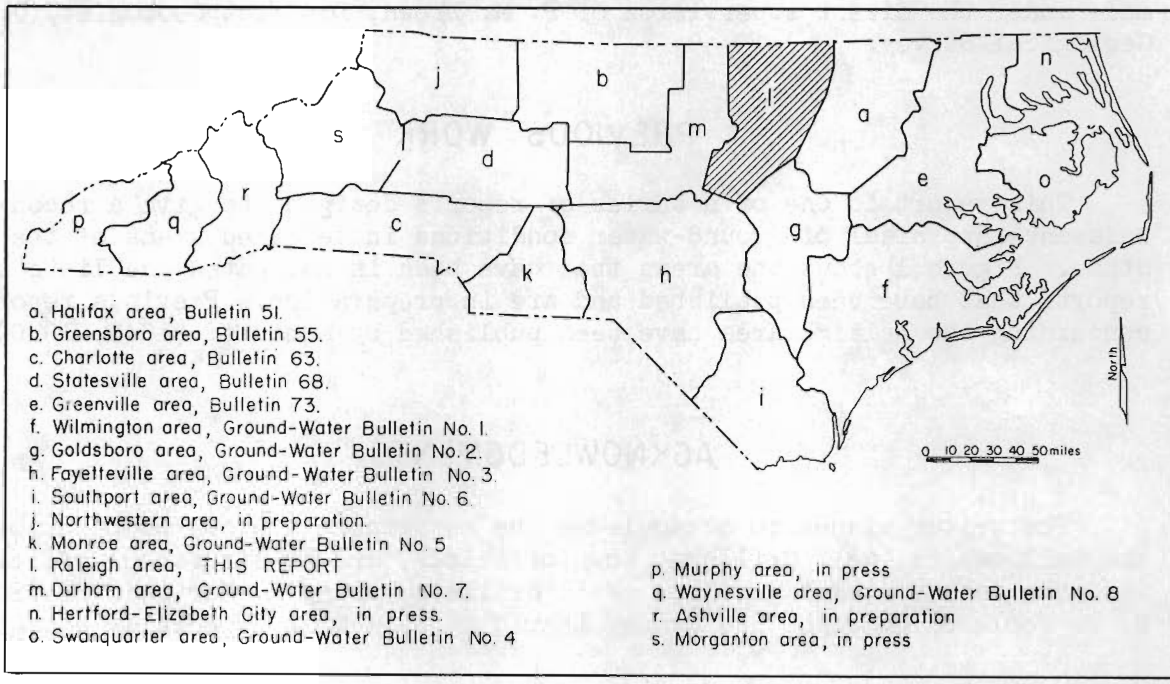



Figure 1.--Index map of North Carolina showing locations of reconnaissance ground-water investigations.

The purpose of the investigation was to compile, on a reconnaissance basis, pertinent data on ground-water resources within the five-county area. Phases of the investigation included collecting data on use, availability, chemical quality, and geologic controls of ground water.

The field work was done between July 1961 and January 1963. During this time, information was obtained on 883 wells and all the municipal ground-water supplies within the area. Some data on wells were obtained from well owners, well users, and well drillers. Other information was recorded from driller's files and from examination of wells and well locations. Town officials supplied the information on municipal water supplies.

The geologic map in this report is a reconnaissance map and defines only the major rock units that affect ground-water resources.

Water samples from typical wells in each aquifer were collected and analyzed by J. D. Thomas, Chemist, Quality of Water Branch, U. S. Geological Survey, Raleigh, N. C. Based on these analyses, interpretations were made of the general water type found in each aquifer.

## COOPERATION AND DIRECTION

This investigation was made by the Ground Water Branch, U. S. Geological Survey, under the general supervision of O. M. Hackett, Chief, Ground Water Branch, and Harry E. Brown, Director, N. C. Department of Water Resources. Field investigations and preparation of the report were made under the direct supervision of P. M. Brown, District Geologist, U. S. Geological Survey.

## PREVIOUS WORK

This report is one of a series of reports designed to give a reconnaissance appraisal of ground-water conditions in selected areas of the State. Figure 1 shows the areas that have been investigated and lists the reports that have been published and are in preparation. Previous reports concerning the Raleigh area have been published by Mundorff (1945, 1950).

## ACKNOWLEDGMENTS

The writer wishes to acknowledge the assistance and the cooperation of the well owners, well drillers, town officials, and public school officials who gave data concerning wells. Well drillers Manley S. Martin of Warrenton, N. W. Poole of Raleigh, and Sydney Ingold of Stem were especially cooperative.

# GEOGRAPHY

## PHYSIOGRAPHY

### PHYSICAL FEATURES

With the exception of a small area in southern Wake County belonging to the Coastal Plain province, the Raleigh area lies entirely within the Piedmont physiographic province. Fenneman (1928) classed the small area of Cretaceous sediments in Wake County within the Coastal Plain physiographic province. Features typical of physiography found both in the Piedmont and Coastal Plain provinces are represented in this area. Because of this overlapping of physiographic characteristics, this area can be more aptly described as part of a transition zone between the Piedmont and Coastal Plain provinces. This zone is often referred to as the Fall Zone or the Fall Line.

The Piedmont province in the Raleigh area, is characterized by rolling hills and v-shaped valleys. In the area underlain by metamorphic rocks, subdued ridges trend north to northeast with the regional structure. In the areas underlain by plutonic rocks, ridges are less frequent and the topography is characterized by knolls and rounded, irregular areas. In these terranes, metamorphic structures are less pronounced, and the relief has resulted from differential weathering where fracture systems are developed in the rocks. The more massive rocks have resisted weathering and form the rounded upland areas.

In the area underlain by Triassic sedimentary rocks, the topographic features have been controlled primarily by bedding and trend northeastward. The upland surface in southern Wake County, underlain by Coastal Plain sedimentary rocks, is flatter than adjoining areas underlain by metamorphic rocks. The relatively high permeability of the sedimentary deposits retards erosion and the generally flat upland surface area reflects the attitude of the underlying beds. Where streams have cut through the Coastal Plain sedimentary deposits they expose the underlying plutonic and metamorphic rocks in moderately steep-sided channels. A surficial blanket of weathered material, in places more than 100 feet deep, covers most of the Raleigh area.

### DRAINAGE

The four major drainage basins in the area trend east or southeast (fig. 2). From south to north these are formed by the Cape Fear River, Neuse River, Tar River, and Roanoke River.

The Cape Fear River skirts the southern tip of Wake County and follows a southeasterly course across the Coastal Plain of North Carolina. Metamorphic and plutonic rocks are exposed downstream in areas where the Cape Fear River has eroded its channel through the Coastal Plain sediments. Tributaries flowing south and southwest to the Cape Fear River drain the southwestern corner of Wake County. The Neuse and Tar Rivers rise in


Figure 2.--Map showing distribution of streams and drainage basins in the Raleigh area.

the Piedmont and flow through the Raleigh area. These two rivers and their tributaries drain more than 70 percent of the area. The tributaries flow in northeasterly and southeasterly directions in response to regional structural alignment. The Roanoke River and several of its tributaries drain the northern part of the area. The Roanoke River enters North Carolina in north-central Warren County and flows eastward into the Coastal Plain. Most of the tributaries to the Roanoke River in the Raleigh area flow northeastward.

All of the rivers and a few of the major tributaries follow subparallel southeasterly courses. They are locally deflected and controlled by regional structure. Flood plains are narrow and valley walls slope steeply down to the major streams. Cliffs have been formed in a few places where streams have cut across highly resistant rocks (fig. 3). The gradient of these major streams ranges from 1-1/2 to 2 feet per mile.

Figure 3.--Cliffs of garnetiferous biotite gneiss on the Neuse River in northwestern Wake County.

### ELEVATIONS

Land-surface elevations range from approximately 150 feet above mean sea level where the Neuse River leaves Wake County to more than 700 feet on Bowlings Mountain in west-central Granville County. The average elevation on the eastern edge of the area ranges from 250 to 300 feet. In a zone extending northwest through the central part of the area, elevations average between 400 and 450 feet. The highest elevations are in the northwestern part of the area.

Relief varies from 50 to 100 feet per mile throughout most of the area. Local areas of greater relief occur in Granville County where a few hills rise 200 to 300 feet above the surrounding land surface.

## AREA AND POPULATION

The five counties described in this report have an area of 2,592 square miles. Wake County is the largest with 864 square miles, 33.3 percent of the area.

According to the 1960 census, the population of the area was 282,601, or about 109 people per square mile. Urban population accounts for 45.8 percent of the total population. This percentage, or approximately 129,500 people, live in towns or cities of 2,500 or more. Raleigh is the largest city in the area and had, in 1960, a population of 93,931. Henderson, in Vance County, is the only other city that has a population more than 10,000.

## CLIMATE

### PRECIPITATION

Weather data are currently collected by the U. S. Weather Bureau at 11 stations within the Raleigh area. The normal monthly and annual precipitation and temperature for five of these stations is listed in table 1. Normal temperature and precipitation as listed are based on a 30-year period, 1931 through 1960. Comparison of records for these stations shows a nearly uniform annual precipitation over the entire area. The maximum difference in the normal annual precipitation is 3.3 inches and occurs between the N. C. State College station at Raleigh and the Raleigh-Durham Airport station, 10 miles west of Raleigh. June, July, and August are the wettest months with an average total precipitation of 14.8 inches. The driest months are October, November, and December which have an average total precipitation of 8.90 inches. The average annual snowfall is about 7 inches. Monthly distribution of precipitation at the Raleigh-Durham Airport Station and at the Henderson Station is shown graphically in figure 4.

Based on period of record from 1931 through 1961

| Station | Elevation | Jan. | | Feb. | | Mar. | | Apr. | | May | | June | | July | | Aug. | | Sept. | | Oct. | | Nov. | | Dec. | | Annual | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature | Precipitation | Temperature |
| Henderson 2 SW | 510 | 3.51 | 41.7 | 3.22 | 43.0 | 3.99 | 49.6 | 3.76 | 59.6 | 3.80 | 67.9 | 4.03 | 75.7 | 5.95 | 78.4 | 4.94 | 77.1 | 3.45 | 71.3 | 2.68 | 60.6 | 3.10 | 50.4 | 3.15 | 41.9 | 45.6 | 59.8 |
| Louisburg | 260 | 3.54 | 41.7 | 3.69 | 43.1 | 3.83 | 49.6 | 3.58 | 59.6 | 3.61 | 68.4 | 3.93 | 76.2 | 5.85 | 79.1 | 5.35 | 77.7 | 4.05 | 72.0 | 2.63 | 60.9 | 3.25 | 50.1 | 3.28 | 41.7 | 46.6 | 60.0 |
| Oxford | 500 | 3.45 | 41.9 | 3.31 | 43.1 | 3.70 | 49.3 | 3.77 | 59.4 | 3.93 | 67.8 | 4.45 | 75.4 | 5.44 | 78.1 | 4.77 | 76.8 | 3.56 | 71.3 | 2.74 | 60.6 | 3.07 | 50.5 | 3.17 | 42.1 | 45.4 | 59.7 |
| Raleigh-Durham Airport | 433 | 3.22 | 41.6 | 3.23 | 43.0 | 3.35 | 49.5 | 3.52 | 59.3 | 3.52 | 67.6 | 3.70 | 75.1 | 5.49 | 77.9 | 5.20 | 76.9 | 3.85 | 71.2 | 2.71 | 60.5 | 2.77 | 50.0 | 3.02 | 41.9 | 43.6 | 59.5 |
| Raleigh-State College | 400 | 3.33 | 43.3 | 3.49 | 44.3 | 3.72 | 50.7 | 3.78 | 60.6 | 3.80 | 69.2 | 3.94 | 76.9 | 5.90 | 79.4 | 5.35 | 78.0 | 4.57 | 72.5 | 2.77 | 62.3 | 3.01 | 51.8 | 3.20 | 43.6 | 46.9 | 61.1 |
| Average | | 3.41 | 42.0 | 3.39 | 43.3 | 3.72 | 49.7 | 3.68 | 59.7 | 3.73 | 68.2 | 4.01 | 75.9 | 5.72 | 78.6 | 5.12 | 77.3 | 3.90 | 71.7 | 2.70 | 60.9 | 3.04 | 50.6 | 3.16 | 42.3 | 45.6 | 60.0 |

Table 1.--Normal precipitation (inches) and temperature (°F) of five U. S. Weather Bureau stations in the Raleigh area

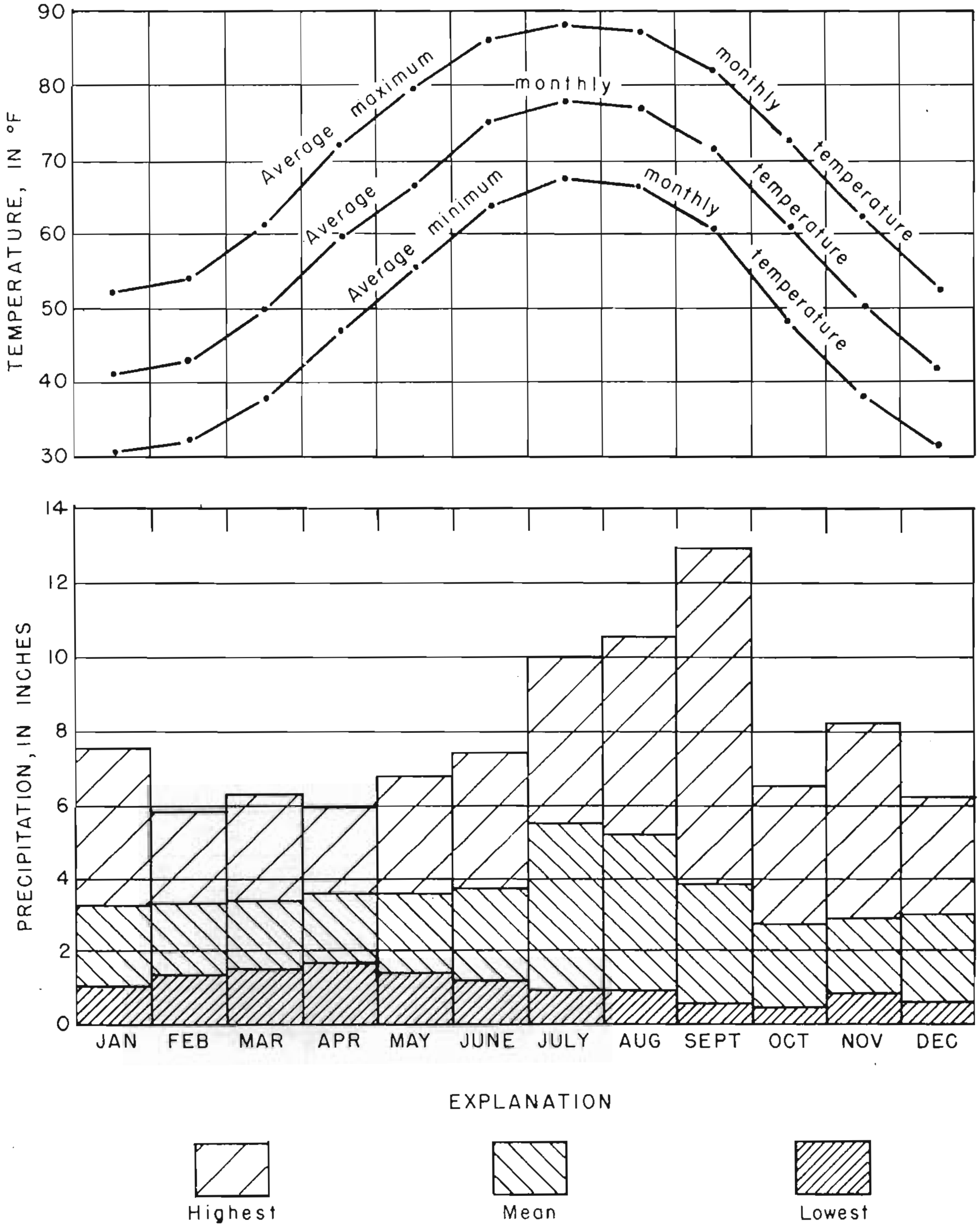



Figure 4.--Summary of climatic conditions at Raleigh-Durham Airport, Wake County (1931 to 1961)

## TEMPERATURE

The greatest difference in the normal annual temperature at any two stations in table 1 is 1.6°F, and occurs, as did the greatest precipitation difference, between the N. C. State College station and the Raleigh-Durham Airport station. The highest normal annual temperature occurs at the N. C. State College station, but an average of the temperatures at these two stations is 60.3°F, which is only 0.3°F greater than the average of the annual temperatures at all five stations. July is the hottest month and January is the coldest. The temperature range between these extremes is 36.6°F. The average monthly temperature and the average monthly extreme temperatures for the Raleigh-Durham Airport station are shown in figure 4.

# ECONOMIC DEVELOPMENT

Approximately 1,700 square miles, or about 66 percent, of the area of the five counties is in farms. According to the 1960 census, the value of all farm products sold was $57,966,000. Income from farm crops accounted for $48,431,000 of the total, and the remainder came from dairy, poultry, and livestock products. Tobacco is the largest crop; other important crops include cotton, corn, potatoes, hay, and vegetables. The 1960 census report shows 15.9 percent of the employed people in the area engaged in agriculture.

In 1960 manufacturing establishments in the five-county area employed 14,239 people in 327 industries. Wake County is the most industrialized county in the area; over one half of the industries are located in this county. The leading industries manufacture textiles, lumber and other wood products, and process tobacco. Raleigh is the largest and the most industrialized city in the area. In addition, many other types of industry are centered in and around Raleigh. Some of these are in the fields of electronics, machinery, iron and steel, and research. The Research Triangle area west of Raleigh is nationally known for its facilities for research work.

Crushed stone for use as road material, railroad ballast, and general construction purposes is the area's most important mineral resource. Major quarrying operations are located in gneiss or granite near Raleigh, Garner, and Rolesville in Wake County, and near Henderson in Vance County.

Tungsten deposits were discovered near Townsville in northwestern Vance County in 1942 by Joseph and Richard Hamme. From 1942 until the spring of 1963, these deposits were mined. At one time during this period this mine was the largest single producer of tungsten in the United States.

Other minerals that have been produced in the area include copper in northern Granville County and gold in Warren and Franklin Counties. Exploration programs have been conducted for chromite in northern Wake and southern Granville Counties, for pyrophyllite in western Granville County, and exploration for beryl has been proposed in southern Granville County.

The Triangle Brick Company in western Wake County produces brick and tile from weathered Triassic shale.

# GEOLOGY

## INTRODUCTION

The quantity and quality of ground water are directly related to the physical and chemical properties of the water-bearing material. Therefore, geologic mapping is essential to the interpretation of the hydrologic data obtained during the course of an investigation of water resources.

The reconnaissance geologic map shows broad rock units of similar age, lithology, and water-bearing properties. These units are generally composed of several related rock types. The contacts are in many places gradational and are based on the apparent change in the predominant rock type. A thick blanket of highly weathered residual material covers much of the area; consequently, some of the contacts between isolated outcrops are inferred from soil characteristics.

## REGIONAL STRUCTURE

A chain of felsic igneous intrusions is exposed along the eastern continental rim of the United States (Tectonic Map of the U. S., 1962). Part of this chain extends northeastward across eastern Wake County, central Franklin County, and crops out as two large plutons in Warren County. They are generally considered to be of late Paleozoic age and are sometimes referred to as Carboniferous granites. (See figure 5.)

The host rocks are predominantly gneisses and schists whose foliation and gneissic structure strike northeastward, approximately parallel to the elongation of the granitic intrusions. The intrusions and their host rocks are flanked on the east by a metasedimentary rock sequence and on the northwest by a low-rank metamorphic sequence of rocks of mixed volcanic and sedimentary origin. The latter sequence, commonly referred to as part of the Carolina Slate Belt, is exposed in western Wake County and underlies most of Granville and Vance Counties. Triassic sedimentary rocks are exposed in a trough that extends from the South Carolina line to a point in central Granville County. The Jonesboro fault forms the eastern contact of Triassic rocks with the metamorphosed volcanic and sedimentary rocks. The strike of the Triassic rocks is parallel to the fault plane, and the bedding dips toward it (southeast) at 10 to 15 degrees. Unconsolidated sand, clay, and gravel belonging to the Cretaceous Tuscaloosa Formation overlap the metamorphic rocks in the southern tip of Wake County.

The regional strike of bedding, cleavage, and foliation is predominantly to the north-northeast in the Raleigh area. Figure 6 shows open undulatory folds in mica schist trending north and northeastward. The dip of bedding and foliation in the metasedimentary and mica schist units is to the northwest, except near the granite contacts where dip reversals occur. The mica gneiss unit west of the granite contains interbedded mica schists, and the bedding planes between the schist and gneiss also dip to the northwest. However, in the small area of gneiss in northeastern Wake and southeastern Franklin Counties the foliation dips to the southeast. Cleavage in the

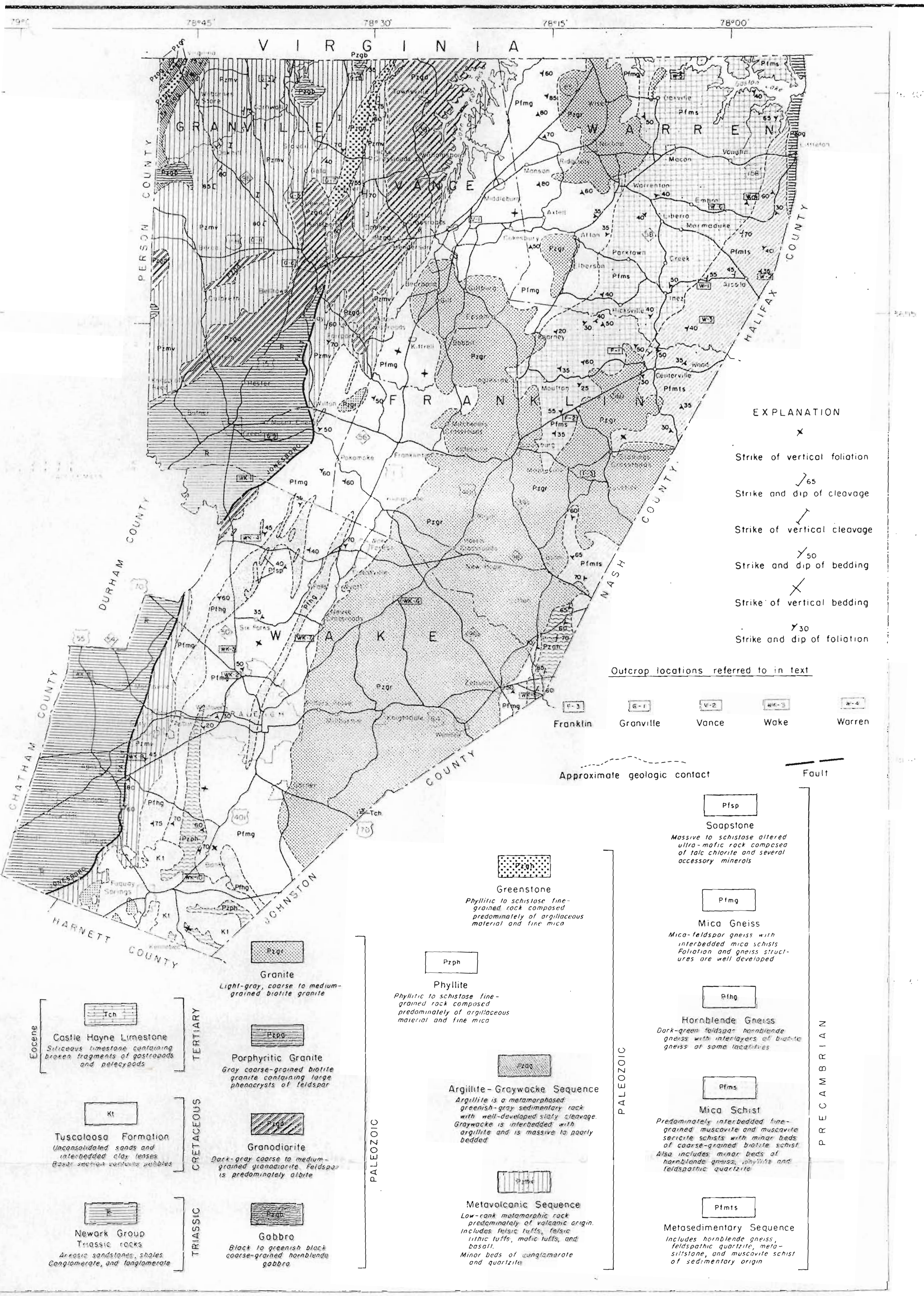


Figure 5.-Geologic map of the Raleigh area, North Carolina.

Figure 6.--Open, undulatory folds in mica schist, 8 miles northeast of Vaughan, Warren County.

metavolcanic sequence dips steeply to the northwest in western Wake County. The cleavage in Granville and Vance Counties dips predominantly to the northwest.

Laney (1917, p. 42-43) interpreted the structure of the metavolcanic rocks in northwestern Granville County as being the east limb of a tightly compressed synclinorium with isoclinal folds overturned to the northwest. The axis for this synclinorium, referred to as the Virgilina synclinorium, lies slightly west of Virgilina, Granville County, as indicated by strike and dip of beds in the argillite-graywacke unit (fig. 5). Parker (in press) has mapped and described another syncline 15 miles east of Virgilina which he calls the Spewmarrow syncline, and suggests that the two synclines are of the same magnitude separated by an anticline.

Interbedded gneiss and schist mapped by Mundorff (1948, p. 7-10) as dipping to the southeast in Rockingham and Caswell Counties are similar to rock types mapped as mica gneiss in the Raleigh area. Recent mapping in Person County by Bain (in press) shows these gneissic rocks to be bordered on the east by low-rank metamorphic rocks of volcanic or sedimentary origin. The same stratigraphic relationship exists in the Raleigh area, except that the mica gneiss and schist are bordered on the west by the sequence of low-rank volcanic and sedimentary rocks. The dip of the foliation and bedding in both areas is generally toward the volcanic-sedimentary sequence. From these relationships it appears that the gneisses and schists in the Raleigh area form the east limb of a synclinorium; rocks of volcanic and sedimentary origin occupy the trough. Laney (1917, p. 18) suggests an unconformity or fault contact between these units. In the Raleigh area this contact appears gradational. However, the actual contact relationship is obscured by changes in metamorphic rank and deep soil cover. The Raleigh area is a folded and uplifted area in which erosion apparently has removed volcanic-sedimentary rocks exposing the underlying schists and gneisses. The uplift and folding, in part, was caused by the intrusion of the granite. The volcanic-sedimentary sequence crops out east of the Raleigh area (N. C. State Geologic Map, 1958) and forms part of the basement underlying the Coastal Plain deposits.

# DISTRIBUTION AND CHARACTER OF THE MAP UNITS

## METASEDIMENTARY SEQUENCE

Parts of eastern Warren and Franklin Counties are underlain by a sequence of metamorphosed sedimentary rocks. The sequence is widest in southeastern Warren County, but pinches out between the mica schist unit and the porphyritic granite in the northeastern part of the county.

Included in the metasedimentary sequence are feldspathic quartzite, meta-siltstone, hornblende gneiss, and mica schist. All these units and their stratigraphic relationships can be seen between locations W-1 and W-2 (fig. 5).

The feldspathic quartzite, the uppermost unit of this sequence, conformably underlies the mica schist unit to the west. It is a finely banded light-gray rock composed of quartz, feldspar, mica, and minor accessory minerals. From 50 to 60 percent of the rock is fine-grained quartz which shows a halo of silica under the microscope. Angular to subrounded feldspar fragments compose 30 to 45 percent of the rock. Accessory minerals include biotite, muscovite, epidote, and hematite or ilmenite. The fine banding is caused by graded bedding or compositional difference in adjacent fine beds. The banded appearance is accentuated by secondary fine quartz veins along bedding planes. The average width of the bands is 1 to 2 mm and they are uniform in width for several feet in the same outcrop. The contact between the mica schist unit and the quartzite of the metasedimentary sequence is gradational. Mica schist is interbedded with quartzite near the top of the feldspathic quartzite.

The hornblende gneiss is a green to blackish-green rock composed of feldspar and hornblende in about equal proportions. The gneissic texture is formed by fine alternating bands of hornblende and feldspar. Alignment of the hornblende crystals in the dark bands is parallel to the strike and dip of the bedding. Feldspar rich bands have a considerably finer texture than the hornblende rich bands and the feldspar appears crushed or granular. The hornblende gneiss is conformable with recognizable beds within the metasedimentary sequence. The gneissic texture and cleavage are parallel to the bedding. Similar hornblende gneiss occurs in the mica schist unit west of the metasedimentary sequence, interbedded with feldspathic quartzite. The hornblende gneiss beds within the metasedimentary unit probably were originally impure carbonate beds. Kesler found similar hornblende gneiss of sedimentary origin in the vicinity of Kings Mountain, North Carolina (Kesler, 1944, p. 778-780).

Other units within the metasedimentary sequence include low-rank quartz muscovite schist and metamorphosed siltstone. The schist is composed of 60 to 70 percent mica, predominantly fine muscovite and sericite, 20 to 30 percent fine silt and argillaceous material, and minor amounts of other minerals (loc. W-3 in fig. 5). The foliation is parallel to the bedding.

The metasiltstone is composed primarily of fine quartz grains, medium quartz grains, and argillaceous material.

The beds in the metasedimentary sequence strike generally northeast and dip northwest. Presumably, they underlie rocks to the west which have the same general direction of strike and dip. Reversals of dip were noted near the eastern edge of the granite intrusion in Franklin County. One primary joint set in the quartzite strikes N.40°W. and is intersected at almost right angles by a second joint set. The quartzite breaks along these joint planes and along bedding into rectangular blocks (fig. 7).

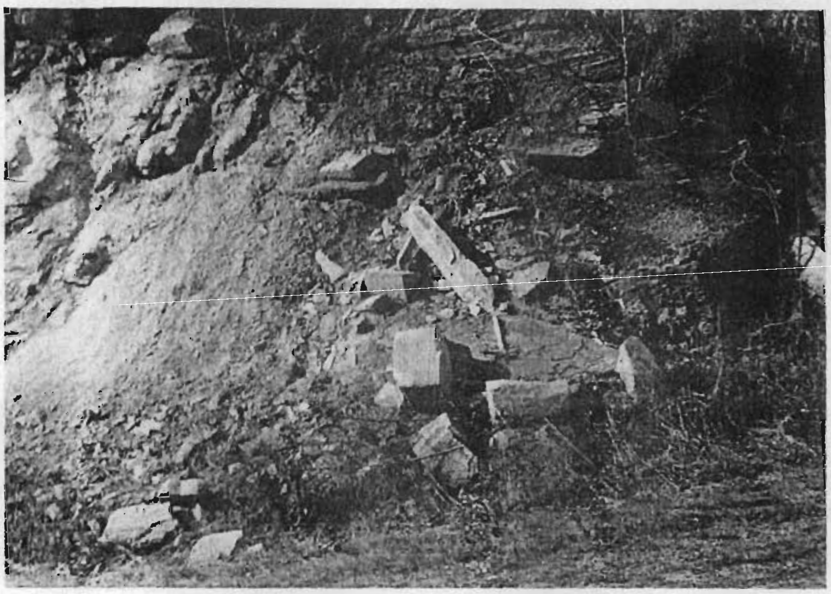


Figure 7.--Quartzite in the metasedimentary sequence, 3.5 miles southwest of Littleton, Warren County.

Soils formed from weathering of the units within the metasedimentary sequence vary in color and texture, depending upon the specific lithology underlying the soil. The feldspathic quartzite and metasiltstone weather to form a light-gray to light-brown sandy loam. In the partially weathered quartzite, the quartz content appears as grains in a matrix of kaolinized feldspar. A dark-red clay-soil forms from weathering of the hornblende gneiss. A brown, friable, silty clay-soil overlies the mica schist.

## MICA SCHIST

A northeast-trending belt consisting predominantly of well foliated schists with interbedded gneiss and phyllite underlies parts of Franklin and Warren Counties. In contact with the granite in north-central Franklin County, this belt extends east of the granite plutons in Warren County and is widest at the North Carolina-Virginia State line. It underlies about 15 percent of Franklin County and about 50 percent of Warren County.

Mica schist is the predominant rock type of this unit. Included with mica schist are muscovite schist, sericite-muscovite schist, and minor biotite schist. Commonly, two or more of these schists can be seen at one outcrop, and it is difficult to say which predominates throughout the unit. Therefore, a brief description is given of each type of schist at specific locations which are plotted on figure 5.

A silvery-gray to bluish-gray lustrous fine-grained muscovite schist crops out at location W-4. Individual muscovite flakes cannot be discerned with the unaided eye, but on cleavage surfaces, the foliation of these fine flakes gives the entire surface a silky luster. Pyrite and dark-red garnets are common accessory minerals.

The cleavage surfaces are wrinkled by many small parallel crenulations. Shearing along the axial planes of these crenulations has produced a secondary incipient cleavage. Gray to black zones in the schist contain well-disseminated graphite. Other accessory minerals include a fine dark-green mineral, probably chloritoid, well disseminated as inclusions in the muscovite, quartz as small granular veins between cleavage surfaces, and biotite. The bluish-gray color of the schist is probably due to the chloritoid and biotite which are so fine and well disseminated that individual flakes cannot be resolved megascopically. On weathered surfaces, the schist is bronze colored, caused by oxidation of the iron-bearing minerals. Similar schist has been described by Brown (1958, p. 32) in the vicinity of Lynchburg, Virginia, where it is part of the Evington Group.

A light-gray muscovite schist crops out at location W-5. It is composed predominantly of fine muscovite, sericite, chlorite, and minor amounts of quartz and biotite. Metacrysts of biotite and muscovite are set in a micaceous fine-grained matrix. Foliation is well to poorly developed. Where foliation is poorly developed, the rock appears more phyllitic than schistose and, perhaps, the phyllite (to be described later) interbedded with the schists is a metamorphic facies of the same rock. Well-developed foliation is wavy, but crenulations are not present. Weathered cleavage surfaces are pitted where the more easily weathered minerals have been chemically weathered and leached.

This muscovite schist is perhaps the most common schist in the mica schist unit. It crops out over most of the central and northwestern areas that are underlain by rocks of the mica schist unit. It is a relatively thin bed or sequence that is repeatedly brought to the surface by folding. Undulatory folds of this nature are exposed in a deep road cut in the northeastern corner of Warren County (fig. 6).

A coarse-grained biotite schist crops out at location F-1. It is a well-foliated rock composed almost entirely of coarse biotite flakes. Muscovite, chlorite, quartz, and garnet are minor constituents. The schist is contorted and tightly folded. Chevron folds are well-developed. Graphite-rich zones in the biotite schist are exposed 300 yards east of location F-1.

Minor rock types in the mica schist unit include feldspathic quartzite, hornblende gneiss, and phyllite. Coarse- to medium-grained hornblende gneiss interbedded with feldspathic quartzite and overlain by muscovite schist crops out at location F-2. The hornblende gneiss is a dark-green rock composed of hornblende and feldspar with a gneissic to schistose texture parallel to the hornblende gneiss and feldspathic quartzite bedding planes. The hornblende content increases toward the top of the section where it is an amphibolite gneiss without quartzite.

Light-tan feldspathic quartzite beds interbedded with hornblende-feldspar gneiss occur below the amphibolite gneiss. The quartzite is composed of quartz and feldspar, in about equal proportions, and minor amounts of muscovite and sericite. The quartzite is of sedimentary origin and the conformable nature of the hornblende-rich zones suggests that these are also metamorphosed sedimentary rocks. If this interpretation is valid, then the original sequence may have been arkosic sandstones interbedded with impure calcareous rocks, a section of calcareous rocks with no sandstone, and argillaceous deposits which have since been metamorphosed into schist.

Light greenish-gray phyllite crops out at location W-6. It is a fine-grained rock which shows the typical silky phyllitic luster on cleavage planes. The green color is presumably caused by microscopic chlorite minerals which upon weathering stain the rock a light brown to pinkish red. The phyllite appears to be a lower rank metamorphic facies of the sericite-muscovite schist.

Generally, the bedding in the mica schist unit strikes northeast and dips northwest. Cleavage is parallel to bedding. Folds are open and undulatory and trend in the same direction as the strike of the regional structure. Exceptions to the general northeast strike of foliation and bedding were noted at several places and plotted on figure 5, but these are only local deviations from the general northeast strike of bedding and regional structural features.

The schists and phyllite weather to form brown and red friable clay-soils, which are thicker on upland surfaces and gentle slopes. Muscovite and sericite are more resistant to weathering than most of the other minerals in the schists and are, consequently, prevalent as finely disseminated flakes in many of the soils. Soils overlying the hornblende gneiss are the typical dark-red plastic clay-soils.

## HORNBLENDE GNEISS

Hornblende gneiss crops out in three separate areas west of the large granite pluton in Wake County. The largest of these extends in a northeast direction from the Coastal Plain sediments in southwestern Wake County to the Granville-Wake County line. East of this unit, and trending approximately parallel to it, is another smaller hornblende gneiss body. The third body underlies a small area in southern Wake County.

All the hornblende gneiss bodies are composed essentially of hornblende, feldspar, and smaller amounts of quartz and biotite. They are medium to coarse grained and vary in color from green to dark-gray. Alternating thin bands of light and dark minerals give the rock a gneissic texture, but where the hornblende content is especially high, the gneissic texture is less apparent and the rock has a schistose foliation of well-developed and well-aligned hornblende crystals. In the two larger northeast-trending bodies biotite gneiss inter-beds grade into hornblende gneiss, which is the predominant rock type. The textural orientation of these biotite gneiss inter-beds is parallel to that of the hornblende gneiss; platy minerals in each are similarly aligned. The small hornblende gneiss body in southern Wake County is a coarse, massive rock with little gneissic texture and contains disseminated feldspar.

In the two larger hornblende gneiss bodies, the foliation generally strikes northeast and dips northwest conformable with the regional structure of the area. For this reason and because they apparently do not crosscut adjacent rocks, they are probably not metamorphosed mafic intrusives.

Rocks containing appreciable hornblende are easily weathered to form a dark-red clay-soil that is often more than 50 feet in depth in some areas. In the deeper stream cuts, pale-green saprolite overlies hard rock. Where this saprolite has been leached by water percolating downward from the surface, a buff-colored leached zone is formed around the rock fragments.

## MICA GNEISS

Foliated and gneissic rocks, mapped together as mica gneiss on figure 5, underlie parts of all five of the counties in the Raleigh area. Rocks of this unit underlie Coastal Plain sedimentary deposits in the extreme southern part of Wake County and crop out in a northeast-trending belt through the central part of the area to the North Carolina-Virginia State line. A small area east of Zebulon, Wake County, is also underlain by mica gneiss.

The predominant rock types included in the mica gneiss unit are biotite-feldspar gneiss, quartzitic gneiss, garnetiferous biotite gneiss, and inter-bedded mica schist and gneiss. Many of these are gradational and exhibit different local metamorphic features. However, they are all metamorphic rocks which show banding, foliation, or gneissic texture.

The biotite-feldspar gneiss is the predominant rock type in the mica gneiss unit in Granville, Vance, and Franklin Counties where the texture varies from medium-grained and equigranular to coarse-grained, and porphyritic with abundant augen. In Wake County it is in contact with, and outcrops extensively near the western edge of the granite. At the Nello Teer Quarry, about 6 miles north of Raleigh (loc. WR-1, fig. 5), it is composed predominantly of orthoclase feldspar, biotite, and quartz with minor amounts of muscovite and opaque minerals. Compositional and textural banding is prominent, the bands ranging in thickness from less than one inch to several feet. Feldspar is the chief constituent in the lighter colored bands and commonly occurs as euhedral to subhedral crystals that give these bands a coarse porphyritic texture. The medium-grained, equigranular, darker colored bands are composed primarily of biotite and quartz. Banding is not so prominent in the same rock type at the Greystone Quarry near Henderson, Vance County (loc. V-1, fig. 5). At this location the rock is a gray to pinkish-gray, medium-grained biotite-feldspar gneiss. Megascopically there is little difference in the overall composition of this rock and the rock at the Nello Teer Quarry near Raleigh.

Quartzitic gneiss is another important rock type included in the mica gneiss unit. It is a fine- to medium-grained, pale-gray to light-tan, granular rock that primarily consists of quartz, biotite, muscovite, and feldspar (loc. WK-2, fig. 5). Well-disseminated granular quartz is the most abundant mineral and composes 50 percent or more of the rock. Fine predominantly biotite mica forms thin continuous streaks throughout the rock. Muscovite and sericite content is less than biotite. A well-developed joint set intersecting the strike of gneissic texture orientation causes the rock to break into rectangular slabs from less than 1 foot up to as much as 6 feet in length. Graphite zones in the quartzitic gneiss can be traced along a northeastern strike for several miles. The graphite is associated with schistose beds within the gneiss and this association plus the continuity of these units and their conformable contact suggests a sedimentary origin for these beds. Perhaps they were deposited as fine-grained sediments, rich in organic matter, and were metamorphosed into the graphite-bearing schists.

Other rock types in the mica gneiss unit include garnetiferous biotite gneiss and interbedded schist and gneiss, schist predominating. The garnetiferous biotite gneiss is a well-foliated gneiss composed essentially of biotite, and quartz, but containing significant percentages of garnet, muscovite, and feldspar (loc. WK-3), fig. 5). Garnets compose 5 to 10 percent of the rock at some outcrops and give the rock a knotty appearance on cleavage planes. The fine-grained granular texture of the quartz and the predominance of biotite reflect a gradational lithologic change of the quartzite gneiss. In northwestern Wake County and in the southeastern corner of Granville County, garnetiferous biotite schist and quartz-biotite gneiss are interbedded (loc. WK-4, fig. 5). Also, conformable thin beds of hornblende gneiss occur with the interbedded mica schist and gneiss.

Isotope ratios of the potassium-argon ($K^{40}/Ar^{40}$) content of biotite mica from the Nello Teer Quarry near Raleigh, Wake County, and from the Graystone Quarry near Henderson, Vance County, have been recently analyzed to determine the age of the rocks at these particular locations. These analyses suggest that formation of the gneiss at the quarry near Raleigh occurred 238 million years ago, and formation of the gneiss at the quarry near Henderson occurred 259 million years ago, with a possible error of $\pm$10 million years (Kulp and Eckelmann, 1961, p. 408-409). The gneiss may have been formed during the middle to late Paleozoic, or at about the same time as the intrusion of the granite batholith east of the gneiss, but most likely the intrusion of the granite and the recrystallization of the biotite gneiss were contemporaneous processes.

Metamorphic structural features and bedding in the mica gneiss unit strike northeast. The unit has a variable northwest to southeast dip. Northwest dips, however, were more prevalent in the northern and southern areas underlain by rocks of the mica gneiss unit. In the small area underlain by mica gneiss east of the granite in Wake and Franklin Counties, the structural features dip southeast.

From these relationships, it appears that the rocks of the mica gneiss unit may be correlated with similar gneisses and schists mapped by Mundorff (1948, p. 7-10) west of the Raleigh area which underlie the belt of volcanic and sedimentary rocks commonly referred to as the Carolina Slate Belt.

The mica gneiss unit in most areas is deeply weathered forming brown to red clay-soils.

## SOAPSTONE

Irregular masses of soapstone crop out in northwestern Wake County and in the southeastern corner of Granville County. They are narrow bodies elongated to the northeast, and occur in rocks of the hornblende and mica gneiss units.

Typically, the soapstone is a massive to schistose pale-green to greenish-gray rock that is soft and gives a white, soapy-feeling powder when crushed. It is composed predominantly of talc and chlorite, but minor amounts of serpentine, olivine, anthophyllite, and tremolite were microscopically identified by D'Arcy, N. A., Jr. (The soapstone deposits of Wake County: N. C. State College, unpublished thesis). Randomly oriented emerald-green actinolite needles are prevalent, especially along cleavage planes in the more schistose soapstone. At one outcrop, a chlorite-rich silicified halo encloses massive soapstone. The alignment of the soapstone bodies suggests that most are thicker masses of a single continuous body.

Soapstone is commonly an alteration product of magnesia-rich rocks (Spock, 1953, p. 215). The soapstone bodies in the Raleigh area are elongated and conformable with regional structure in the host rocks. Most likely they were ultramafic intrusions along regional fracture zones or bedding planes in the country rock. Hydrothermal solutions associated with the granite batholith some 8 to 10 miles east of the soapstone may have played an important role in the alternation of the ultramafics.

The soapstone is more resistant to weathering than the surrounding country rock and crops out on ridges and slopes. Where weathered, it produces a stiff, brown clay-soil.

## METAVOLCANIC SEQUENCE

Slightly metamorphosed rocks of predominantly volcanic origin are exposed in a narrow band crossing most of Wake County, east of the Durham Triassic basin. Rocks of the same sequence underlie most of Granville County and a large part of western Vance County. The north end of the Durham Triassic basin separates the metavolcanic rocks in Wake County from those in Granville and Vance Counties.

The metavolcanic sequence includes an assemblage of phyllitic and sheared rocks that are primarily volcanic in origin, but also includes minor recognizable sedimentary rocks. Rocks of volcanic origin include intermediate to felsic lithic tuffs, fine-grained felsic tuff, mafic tuff, breccia, rhyolite, and basalt. A few beds of conglomerate and quartzite are interbedded with the rocks of the metavolcanic sequence.

The intermediate to felsic lithic tuffs are light cream to gray in color and in hand specimens are seen to be composed of light colored fragments of quartz and feldspar set in a fine-grained matrix (loc. G-3, fig. 5). Feldspar fragments are sheared and commonly displaced along shear planes. In the more phyllitic tuff, the fragments are recognizable only as discolored smears on cleavage surfaces. Fragments one-half inch long are common in some outcrops and compose as much as 10 to 15 percent of the rock (fig. 8). On freshly broken surfaces the rock has a characteristic silky luster caused by the high content of sericite. Parallel alignment of these sericite flakes gives the rock a good cleavage. Laney (1917) described this rock as a quartz porphyry and added: "If one regarded only the present texture of the rock, he would call it a sericite schist, which in fact the rock really is". Later in his description he stated: "It occurs in two phases, one of medium texture and decidedly porphyritic, with phenocrysts of both quartz and feldspar, and the other plainly tuffaceous or fragmental". Where the feldspar grains appear as phenocrysts, that is

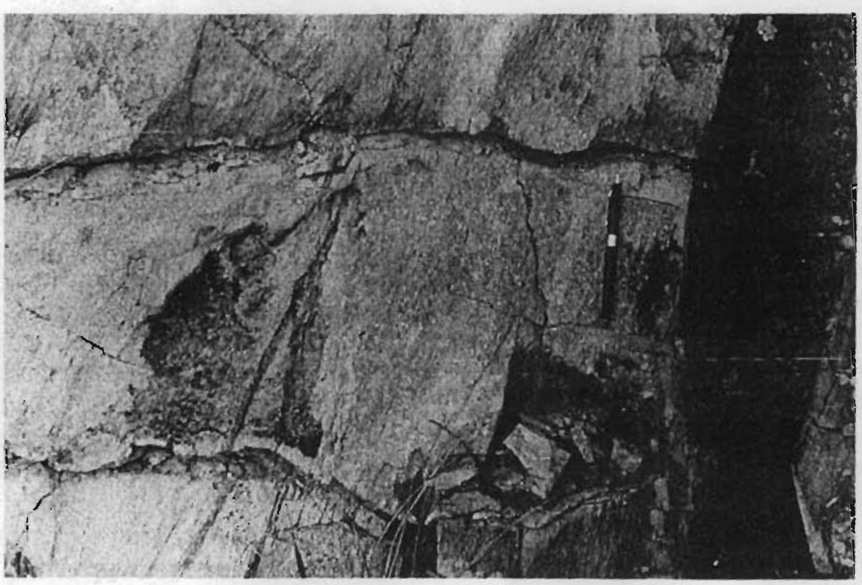


Figure 8.--Felsic tuff (lighter areas are feldspar fragments) 3 miles north of Cornwall, Granville County.

where they are bounded by crystal faces, the rock is similar to the crystal tuffs in Moore County as described by Conley (1962, p. 4). At some localities vague lamellar banding is discernible but because the rock is highly sericitic and stained by water percolating along cleavage surfaces, these bands cannot be definitely recognized as flow bands. At some locations these tuffs are intricately intruded by mafic dikes that are also sheared and phyllitic (fig. 9).

Figure 9.--Felsic tuff intruded by mafic dikes (dark bands).

White to light gray, fine-grained felsic tuff is a major rock type in the metavolcanic sequence. It is a massive to phyllitic rock that is composed almost entirely of fine-grained material (loc. G-4, fig. 5). Where it is highly sheared, sericite is abundant and the rock has a well-developed schistosity. The more massive types show little or no foliation or cleavage and break into angular fragments. Small quartz grains (beta quartz?) are prevalent in the more phyllitic felsic tuff at some outcrops. Laney (1917, p. 23) described this rock as a clastic acid rock, probably of volcanic origin, but he called it a schist.

Green- to greenish-gray mafic tuffs are interbedded with the felsic tuffaceous rocks in the metavolcanic sequence in Granville County (fig. 10). The mafic tuffs are generally sheared and phyllitic, commonly more phyllitic than the felsic tuffaceous rocks. Very little evidence remains regarding the original texture of the rock, however, vague outlines of fragments are discernible. The green color is due to recrystallization of chlorite and other dark minerals, and the good cleavage is a result of the parallel alignment of these minerals. A purplish-gray mafic tuff outcrops in the metavolcanic sequence near the contact of this sequence with the argillite-graywacke unit in northwestern Granville County. It is a massive, predominantly fine-grained rock, but olive-green lithic fragments are apparent on slightly weathered surfaces. Similar rocks in Moore County, mapped as andesitic tuffs, were described by Conley (1962, p. 5). The purplish color, from Conley's description of the rock, is due to primary hematite.

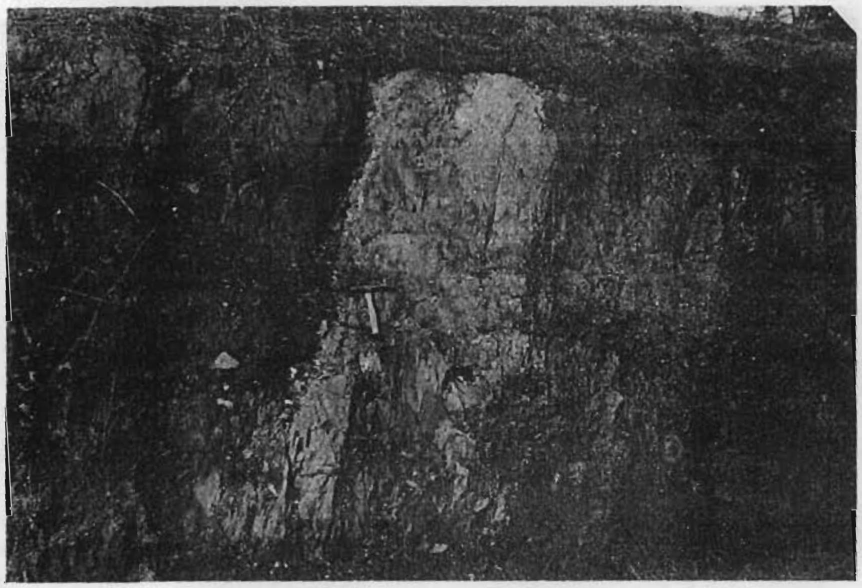


Figure 10.--Interbedded mafic and felsic tuff, 5 miles north of Stovall, Granville County.

Black- to dark-green basalitic rocks crop out 1 mile west of U. S. Highway 15 between Oxford and Stovall in Granville County (loc. G-5, fig. 5). This rock is typically aphanitic to fine-grained, and hard and lacks cleavage structure. At one outcrop, spheroidal inclusions of a lighter green material, one-half inch in diameter, were conspicuous on freshly broken surfaces. Pyrite is a common accessory mineral.

Sedimentary rocks within the metavolcanic sequence include conglomerate and at least one bed of quartzite. At location G-6, figure 5, the conglomerate is composed of small, well-rounded quartz pebbles, and subrounded to angular fragments in a finer tuffaceous matrix. The width of the outcrop area is 100 to 150 feet but the thickness of the rock could not be determined. This particular rock may have been formed from a mixture of pyroclastic and sedimentary material in a local, shallow depositional basin. A reddish-brown, medium- to fine-grained quartzite outcrops at location G-7, figure 5. It is a massive granular rock composed almost entirely of quartz exposed at the top of a monadnock hill that stands 100 to 200 feet above the surrounding upland surface, attesting to its resistance to erosion. Outcrops of this rock do not occur outside of this local area.

Laney (1917, p. 44) has described the volcanic-sedimentary rocks in northwestern Warren County as comprising the east limb of a synclinorium, the axis of which lies just west of Virgilina, Granville County. The southeast dip of cleavage was interpreted as resulting from tight folding and overturning of these folds to the northwest. This synclinorium as described by Laney is commonly referred to as the "Virgilina synclinorium" after the town of Virgilina in Granville County. In the easternmost area underlain by metavolcanic rocks in Granville and Vance Counties, the cleavage which generally is parallel to bedding consistently dips northwest. This direction of dip is less consistent farther west in Granville County, and at many places vertical and southeast dipping cleavage occur, however, the general northeast strike prevailed throughout the sequence. Parker (in press) has described a syncline of regional significance in Granville County and has drawn the axis of this syncline some 12 miles east of the synclinal axis described by Laney. He suggests that perhaps this is the true location of the axis of the Virgilina synclinorium but offers an alternate explanation of two synclines of regional significance (the syncline described by Laney and the syncline described by Parker) separated by an anticline. Bedding in the argillite-graywacke unit near Virgilina dips northwest and recent mapping by Bain (in press) in Person County west of the Virgilina area, shows these same rock types dipping southeast, with the change in dip occurring along a line approximating the synclinal axis described by Laney. From these relationships it appears that there are two synclines, as suggested by Parker, and future detailed mapping may delineate the anticline separating them.

Vertically dipping joints occur in the metavolcanic sequence, especially in the less foliated rocks. Strikes trending northeast and northwest are common for these joints; north-trending strikes are uncommon.

Soils formed from weathering of the rocks in the metavolcanic sequence vary in color and texture depending on the particular rock type underlying the soils. The felsic tuffaceous rocks weather to a light-colored ash-like soil that is generally shallow. The more mafic rocks weather to form dark-red clay-soils.

## PHYLLITE

Phyllite is exposed as a north-trending band from the southern tip of Wake County to the western city limits of Raleigh in the central part of the county. Phyllite in the southern part of this band is unconformably overlain by unconsolidated Coastal Plain sediments. Phyllite is exposed in the deeper draws where streams have cut through the overlying sediments. Another small area of phyllite crops out in northeastern Wake County and part of adjacent Franklin County.

The phyllite ranges in color from green to light tan, and partially weathered fragments are light shades of red and brown. The typical phyllite is a fine-grained rock with a distinctive phyllitic sheet (loc. WK-5, fig. 5). It is predominantly composed of fine micaceous minerals, chlorite and sericite, and much argillaceous material. Accessory minerals include metacrysts of pyrite, garnet, and fine, well-disseminated, greenish-black flakes of chloritoid (?). Where garnets are prevalent, the rock is more schistose and coarse grained. Color banding is apparent and is interpreted as bedding. Beds range in thickness from a few inches to several feet. Foliation is parallel to bedding, and a dense crenulation pattern on cleavage surfaces forms a prominent horizontal linear feature.

The relatively low metamorphic rank of the phyllite compared to rocks of the mica gneiss unit indicates that it is part of the Carolina Slate Belt of volcanic and sedimentary rocks in which it has been previously mapped (N. C. State Geologic Map, 1958).

Weathering of the phyllite produces a light-brown friable clay-soil that is commonly 50 to 75 feet in depth.

## ARGILLITE-GRAYWACKE

The argillite-graywacke unit in the Raleigh area is confined to the northwestern part of Granville County where it crops out as beds striking northeastward.

The argillite is a fine-grained gray to greenish-gray rock that breaks into platy fragments along a well developed, nearly vertical, slaty cleavage (loc. G-2, fig. 5). Bedding is discernible in the fragments and is generally at small angles to the cleavage planes. Laney (1917, p. 25) called this rock "Aaron slate" and found it to be composed of microscopic grains of quartz, chlorite, epidote, sericite, calcite, zoisite, black minerals, especially hematite, and much fine clay-like material.

Beds of massive, dark-green graywacke are interbedded with the argillite. The argillite is seen in hand specimen to be composed of a mixture of medium- to fine-grained quartz, feldspar, and micaceous minerals, and clay. Cleavage is poorly developed or non-existent. Several beds of conglomerate are associated with the graywacke near the base of the argillite-graywacke unit. These conglomerate beds are chiefly composed of well-rounded, small quartz pebbles and angular to subrounded fragments of volcanic tuff in a greenish-gray micaceous and sandy matrix. The pebbles average about one inch in diameter.

The argillite-graywacke unit directly overlies the metavolcanic sequence. The contact between these two units is not abrupt, but gradational over a distance of a few hundred feet.

Bedding and cleavage strike uniformly to the northeast. Cleavage planes are vertical to nearly vertical and are much better developed in the argillaceous beds than in the more massive graywacke beds. Bedding dips northwest. Poorly developed joint systems strike at small angles east and west of north and are better developed in the graywacke than in the argillite.

The argillite weathers to form bright red and brown clay-soils that are usually shallow, seldom exceeding a few feet in depth. Soils formed from weathered graywacke are much darker shades of red and where undisturbed show a characteristic mottled texture.

## GREENSTONE

Greenstone occurs within the argillite-graywacke unit in the northwestern corner of Granville County, and is interlayered with rocks of the metavolcanic sequence along the Granville-Vance County line.

The greenstone is typically a dark-green to greenish-gray metamorphosed mafic extrusive, which is fine-grained, and commonly has a good cleavage as a result of the parallel alignment of microscopic chlorite and other platy minerals (loc. G-1, fig. 5). Where foliation is well developed, it is a greenschist. Amygdules and small phenocrysts of feldspar are deformed and elongated in the direction of cleavage. Feldspar, quartz, and sparse calcite, occur as amygdaloidal minerals. Epidote and hornblende are common accessory minerals and appear to be alteration products of feldspar and pyroxene. The porphyritic texture of the rock can best be seen on slightly weathered surfaces where the feldspar crystals are discernible as lighter colored areas in a greenish-black matrix. On cleavage surfaces, sericite gives the rock a pearly luster.

The greenstone forms northeast-trending belts, and the cleavage also strikes northeast. Vertical to nearly vertical joints are transverse to the cleavage and are generally widely spaced and poorly developed.

The greenstone weathers to form shallow to moderately deep red clay-soils. Where hard rock is relatively close to the surface, the soils are greenish brown in color caused by the partial oxidation and decomposition of the green iron-bearing minerals in the rock.

## GABBRO

Gabbro crops out as four separate intrusions in Granville County. Two of these gabbro bodies are at the western edge of the county and extend into adjacent Person County. The other two bodies are in the northwestern part of Granville County, and one of these extends into Virginia. Outcrops are scarce and contacts were based primarily on the characteristic dark-red clay-soil formed from weathered gabbro, and on float material.

The typical gabbro is a coarse-to medium-grained rock composed almost entirely of hornblende and feldspar (loc. G-8, fig. 5). Feldspar and hornblende crystals are well developed and have no preferred orientation. The rock color ranges from black to greenish-black depending upon the feldspar hornblende ratio. Hornblende composes 50 percent or more of the rock; and in some outcrops of dense black gabbro, the hornblende content is much greater than 50 percent. Epidote is a common accessory mineral and occurs as an alteration product of the feldspar, and commonly as inclusions in the feldspar. Generally, the rock is uniform in texture and is little affected by metamorphism. Exfoliated boulders, as much as 5 feet in diameter, are abundant as float material at the gabbro intrusion which extends into Virginia.

The gabbro body about 3 miles north of Stovall is not as massive as some of the other bodies; it appears to be a complex of gabbroic dikes.

The gabbro weathers easily to form dark-red clay-soils in which small round manganese concretions are prevalent. Because the gabbro weathers more readily than adjacent host rocks, areas underlain by gabbro are topographically lower and flatter than surrounding areas. Soils overlying the gabbro are deep and outcrops of hard rock are sparse.

## GRANODIORITE

Lense-shaped bodies of granodiorite are exposed in Wake, Granville, and Vance Counties in a northeast-trending belt. Except for the small body in northwestern Wake County, this unit is completely enclosed by rocks of the metavolcanic sequence or bordered by Triassic sedimentary rocks. The largest body extends northeastward across Vance County into Virginia where it ends abruptly (Parker, in press).

The contacts between granodiorite and the phyllitic rocks of the metavolcanic sequence are gradational and as drawn, represent contact zones rather than well-defined lithologic changes. The granodiorite (loc. V-2, fig. 5) is a dark-gray, medium- to coarse-grained rock predominantly consisting of feldspar, quartz, and mica. Accessory minerals include sericite, muscovite, pyrite, magnetite or ilmenite, and epidote (Parker, in press). The feldspar content is variable in different outcrops but feldspar almost always constitutes 50 percent or more of the rock. The feldspar is mostly albite and albite twinning is discernible with a hand lense. Potash feldspar is present but seldom composes more than 5 percent of the rock. The rock has a pinkish tinge where microcline feldspar is present. The quartz content ranges from 25 to 35 percent and the quartz is blackish-gray to clear sometimes having a pale-blue tint. Disseminated biotite and hornblende, commonly partly altered to chlorite, make up about 5 to 7 percent of the rock. Fine-grained, silvery sericite is found replacing feldspar. Some of the feldspar has been altered to epidote and has a characteristic light-green color. The rare muscovite is probably a primary mineral.

Inclusions of phyllite are common in the granodiorite but are less frequent toward the center of the bodies. Many of the inclusions are disoriented but are not tightly folded nor do they possess minerals indicative of intense metamorphism. They are, however, more metamorphosed than similar rocks outside of the granodiorite bodies. The phyllites are sericite-chlorite phyllites ranging in color from greenish white to dark green, depending on the mafic mineral content. In the contact zones the strike of the foliation is northeast and commonly parallel to the granodiorite contact. However, near Dexter and Fairport in eastern Granville County, phyllite seems to grade along strike into granodiorite-rich zones. Metacrysts of feldspar and angular quartz, in places form a noticeable percentage of the phyllite and the resultant rock appears to be intermediate between typical phyllite and granodiorite.

Two medium- to coarse-grained, blackish-green gabbro bodies intrude the granodiorite. These narrow bodies are not shown on the geologic map; they are 1 to 2 miles long. One mile south of Providence in Granville County, massive, rounded boulders up to 6 feet in diameter are common where angular masses of gabbro have been subjected to spheroidal weathering.

Plagioclase feldspar and hornblende are the essential minerals of the gabbro. Especially noticeable are long hornblende needles matted in fractured zones where the walls of the fractures are lined with feldspar crystals. Occasionally, small needles appear in more massive areas away from the joints or fracture planes.

The origin of the granodiorite is not clear, but absence of high-temperature minerals in the host rock and in phyllite inclusions and the apparent lack of complex folding and shearing in either the host rock or inclusions precludes forceful injection of a molten mass. The lateral gradation from phyllite to porphyritic phyllite, to massive crystalline granodiorite plus the absence of evidence of forceful injection indicates a passive mode of implacement.

The granodiorite weathers to form a tan- to light-brown granular soil that in places is more than 50 feet thick. The thicker soils are on the upland interstream areas where erosion is slower than on the valley slopes.

## PORPHYRITIC GRANITE

Porphyritic granite underlies a small area in northeastern Warren County. The size of this pluton is unknown because it extends outside of the area of investigation and is not shown on other geologic maps. In Warren County it underlies a north-trending strip about 15 miles long averaging about 1 mile wide. Littleton is near the center of this strip.

The porphyritic granite is composed of feldspar, quartz, biotite, and minor accessory minerals (loc. W-7, fig. 5). Euhedral orthoclase feldspar crystals compose approximately 60 to 70 percent of the rock and they are aligned in a northerly direction, forming a weak gneissic texture. Some of these phenocrysts are 2 inches long and up to 1/2-inch thick (fig. 11).

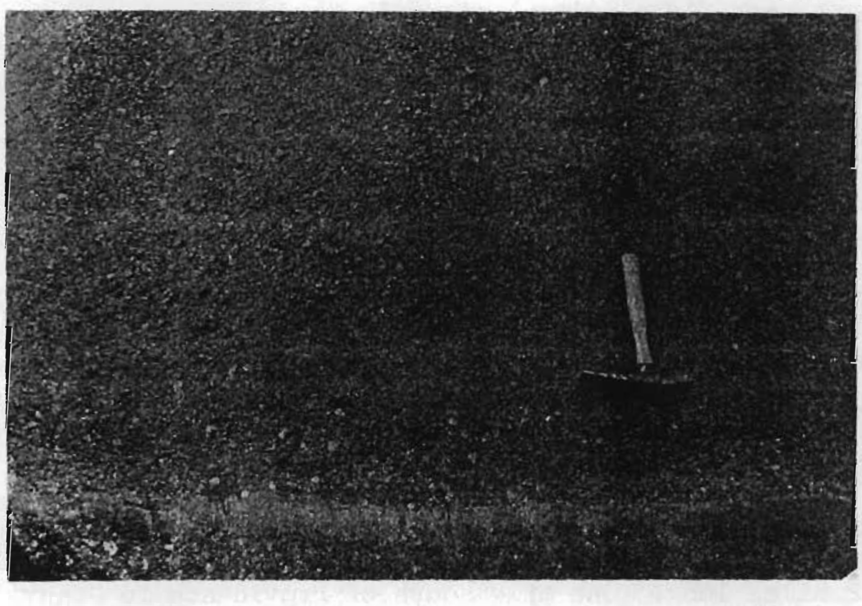


Figure 11.--Porphyritic granite containing large phenocrysts of orthoclase feldspar.

Parting along feldspar twinning planes is apparent. Microcline feldspar is predominant in some outcrops. Biotite mica composes 10 to 15 percent of the rock; biotite and quartz are the chief minerals in the fine-grained matrix. Accessory minerals include muscovite, pyrite, and magnetite(?). Mundorff (1946, p. 6) mapped and described similar granitic bodies east of Warren County in Halifax County.

Structural features are poorly developed in the porphyritic granite. Sheeting and jointing fractures are widely spaced. Boulders weathered from angular masses broken along fracture planes are commonly 10 to 12 feet in diameter. The gneissic texture produced by alignment of feldspar crystals was likely the result of preferential alignment of the crystals during intrusion. Later crystallization of biotite mica and quartz filled the inter-crystal areas to form the fine-grained matrix. Cataclastic texture is lacking indicating little or no dynamic metamorphism.

Light-brown to red topsoil is formed from weathering of the porphyritic granite. Sandy-loam topsoil grades into clayey subsoils which in turn grade into a zone of friable, partially decomposed granite immediately overlying hard granite.

## GRANITE

An irregularly shaped granite pluton underlies most of eastern Wake County and central Franklin County. North of this pluton two smaller granite bodies are exposed in Warren County. These and the large pluton are aligned in a northeasterly direction. The granite batholith is probably continuous at depth but has not been exposed by erosion across Warren County. This granite belt is more than 65 miles long in the Raleigh area; its largest body is more than 15 miles wide in Wake County.

The granite is a medium- to coarse-grained biotite granite that ranges in color from light to pinkish gray. The essential minerals are black to greenish-black biotite mica, feldspar, and quartz. Orthoclase is the predominant feldspar, but plagioclase feldspar is almost always present and in some outcrops composes a significant percentage of the rock. Biotite is well disseminated as small tabular books with no preferred orientation. The amount of biotite ranges from about 10 percent to less than 1 percent. Pink microcline feldspar is abundant at some localities. The quartz content ranges from about 30 percent in the medium-grained granite to as much as 50 percent in coarse-grained binary granite (consisting of quartz and feldspar only) in the vicinity of Louisburg, Franklin County, and Oxford, Granville County. Hard granite occurs in almost any road cut or stream channel in granite terranes. Two of the many quarry openings in the granite are at locations WK-6 and F-3, figure 5.

The granite is predominantly medium grained and massive throughout the interior of the plutons. Projecting from the massive granite are many large and small coarse-grained granite dikes and pegmatites which have intruded the host rock, forming pronounced migmatized zones in the host rock. The number of intrusions and metamorphism decreases outwardly. The pegmatites and granite dikes are much coarser than the host granite and are composed essentially of feldspar and quartz with minor amounts of mica (mostly muscovite) and hornblende. Graphic-granite dikes are common east of the large pluton in Warren County. The mica gneiss between the granite plutons in Warren County contains as much as 50 percent granitic intrusives.

The two prominent structural features in the granite are jointing and sheeting (fig. 12). Commonly there are at least two primary joint sets that intersect at nearly right angles. At the granite quarry about 1 mile southeast of Rolesville these joints strike N.25°E. and 0°E. and dip steeply to the northwest and north. Intersection of sheet-fracture planes with joint planes causes the granite to break into angular boulders and facilitates quarrying.

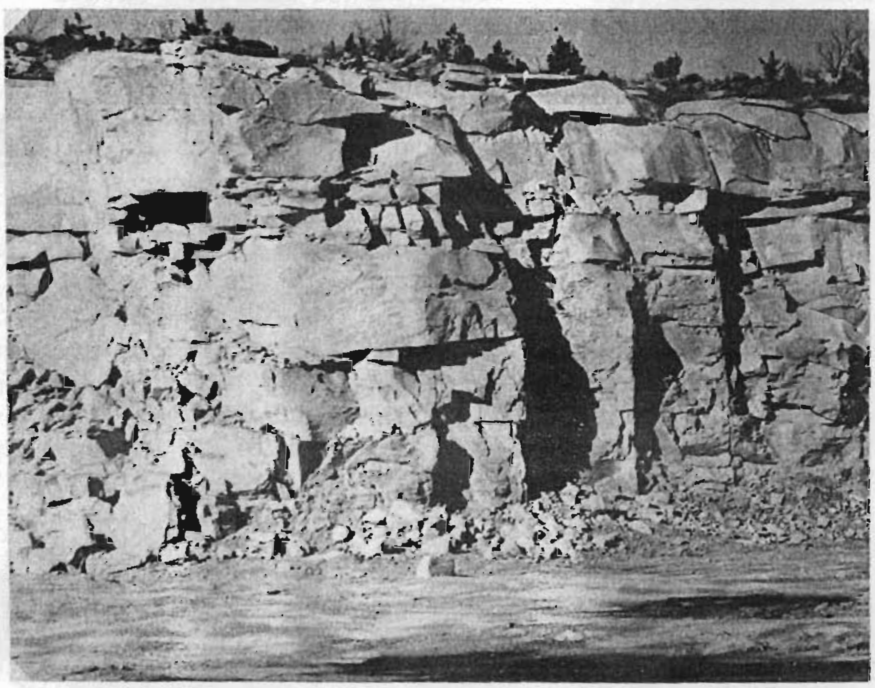


Figure 12.--Sheeting and jointing in granite at a quarry near Rolesville, Wake County.

Granite topsoil is light red to pinkish red and granular. The texture of the granite is preserved in undisturbed soils where the quartz is enclosed in a mass of weathered feldspar and mica. Residual quartz has accumulated on the surface by erosion of the clays formed from the more easily weathered components forming light-colored sandy loams. The thickest soils are found capping the upland surfaces but are seldom more than 30 feet thick. A much thinner soil veneer is found on the slopes of draws and valleys where unweathered granite usually crops out. Exfoliated boulders of granite are common. Floodplains are narrow and thin and unweathered granite is commonly exposed in stream channels.

The age of the granite plutons is unknown. However, similar felsic intrusions along the eastern continental rim of the United States are late Paleozoic in age (Tectonic Map of the United States, 1962).

## TRIASSIC ROCKS

Triassic sedimentary rocks underlie large areas in western Wake and southern Granville Counties. The rocks comprise part of the Triassic Durham basin which is one of the three subdivisions of the Triassic Deep River basin as divided by Prouty (1931). Triassic rocks in the Raleigh area include buff arkosic sandstones, red to maroon argillaceous sandstones, purple to maroon shales, and coarse fanglomerate. The source areas for these sedimentary rocks were the pre-Triassic metamorphic and granitic rocks west of the basin for the interbedded sediments, and the pre-Triassic rocks east of the basin for the fanglomerate. The Jonesboro fault forms the eastern contact of Triassic rocks with pre-Triassic rocks. In Granville County the western contact is an erosional surface.

Interbedded sandstone and shale can be seen at location WK-8 (figs. 5 and 13). Here the sandstone is essentially composed of quartz, feldspar, and iron oxide. The thick interbedded shales have weathered to a dark-red clay leaving the thinner sandstone beds as nearly horizontal ledges. The sandstone beds range in thickness from less than 1 foot to about 3 feet and can be traced for several miles along N. C. State Highway 55 north of Apex.

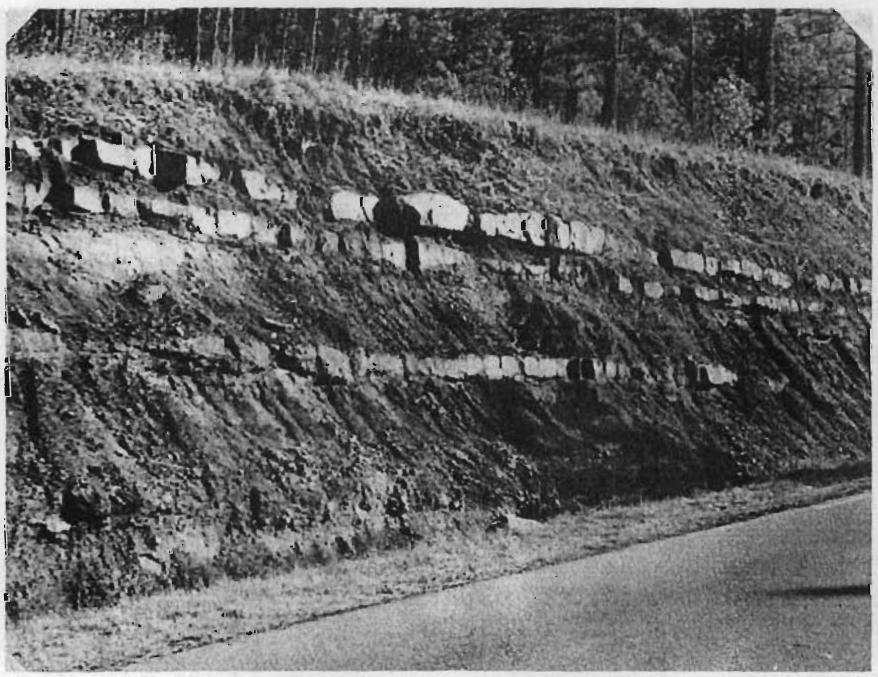


Figure 13.--Interbedded Triassic sandstone and shale, 8 miles north of Apex, Wake County.

Buff arkosic sandstone (loc. G-9, fig. 5) is the predominant Triassic rock type in Granville County. Angular fragments of feldspar and subrounded to angular quartz grains are the chief constituents of this rock. Mica composes about 5 percent of the rock. The angularity of the quartz and feldspar indicates a relatively close source area, perhaps the granodiorite which borders the Triassic on the northwest side of the basin. The composition of the arkosic sandstone also indicates that granodiorite was the chief source rock.

Basal beds of arkosic sandstone interbedded with maroon to purple shales unconformably overlie pre-Triassic rocks along the western edge of the Triassic basin in Granville County. Angular fragments of shale are in the lower part of the sandstone beds where the sandstones overlie the shale. At places the sandstones contain conglomeratic lenses of small, well-rounded pebbles.

Fanglomerate crops out along the eastern edge of the Durham basin forming a belt that is as much as 1 mile wide in places (loc. WK-9, fig. 5). It is composed of angular rock fragments and rounded to subrounded boulders, cobbles, and pebbles in a heterogeneous mixture. Boulders 1 foot in diameter are common. The interstices between the larger fragments and boulders are filled with sand, silt, and small pebbles.

Dense black diabase dikes intrude the Triassic sedimentary rocks. They strike at small angles east and west of north and range in thickness from a few inches to several tens of feet.

At some localities in Wake County, Triassic rocks are unconformably overlain by unconsolidated sands and clays which at one location are cross-bedded. These sands and clays are thin and may represent outliers of Coastal Plain sediments of Cretaceous age.

The Triassic sediments were deposited in a subsiding basin, probably during a period of moist to humid climatic conditions (Reinemund, 1955, p. 53).

The Triassic beds dip towards the Jonesboro fault at an average of 12 degrees, and strike approximately parallel to the fault plane. Vertical displacement of the fault is at least the maximum thickness of the strata. This was determined by Reinemund (1955, p. 27) to be about 10,000 feet. The thickness of Triassic rocks that has been removed by erosion is unknown, but the maximum vertical displacement was no doubt much greater than the maximum thickness of the strata now present. The fault plane dips west and northwest at about 65 degrees.

Soils formed from weathering of the shales are blackish-red to purple clay-soils. The arkosic sandstones weather to light-brown, sandy loam-soils that resemble soils formed from felsic intrusions. Fanglomerate weathers to dark-red soils which can be recognized by the abundant residual cobbles.

## TUSCALOOSA FORMATION

Smith and Johnson (1887, p. 95-116) proposed the name Tuscaloosa for sediments of Cretaceous age exposed at Tuscaloosa, Alabama. Cooke (1936, p. 19) first applied the name Tuscaloosa to Cretaceous equivalents in North Carolina.

Sediments of the Tuscaloosa Formation unconformably overlie pre-Cretaceous rocks in southern Wake County. The maximum thickness of these sediments is about 80 feet near the Harnett County line. Streams have cut through these sediments, exposing older rocks at many places along their channels forming a transition or Fall Zone between typical Piedmont and Coastal Plain topography.

No fossils were found in the Tuscaloosa Formation of the Raleigh area. Correlation is based on lithology similarity of the unconsolidated sediments with known Tuscaloosa sediments outside of the present area of investigation. (Brown, 1959; Conley, 1962; Pusey, 1960, and Mundorff, 1946.)

The Tuscaloosa Formation in Wake County is predominantly gray to white sand, with interbedded lenticular lenses of clay. Quartz is the chief constituent of the sands, but feldspar and mica at some localities compose up to 10 percent of the sand. At location WK-10, figure 5, the basal part of the Tuscaloosa Formation is a pebbly bed containing well rounded quartz pebbles ranging from less than 1 inch to as much as 3 inches in diameter. Quartz grains and concretions of iron oxide are common at the top of clay lenses. The iron oxide concretions are formed by precipitation of iron from ground water percolating downward through permeable sands overlying the impermeable clay zones. At the surface, the sand and clay are mixed in all proportions to form a light-colored sandy loam.

## CASTLE HAYNE LIMESTONE

An outlier of Castle Hayne limestone rests unconformably on Carboniferous(?) granite 1 mile north of U. S. Highway 70, on the Wake-Johnston County line. In Johnston County, several slabs of dense siliceous sandstone containing numerous fragments of gastropods and pelecypods are exposed at the surface (Pusey, 1960, p. 15). No exposures of this material were noted by the author to occur in Wake County; however, outcrops containing numerous shell fragments mixed with sand have been located by Dr. John M. Parker of the N. C. State College Geology Department (oral communication, 1962). According to Richards (1950, p. 14) deposits at this outlier lack typical Castle Hayne faunal species, but probably can be correlated with the Claiborne (middle Eocene) deposits of the Gulf Coast on the basis of several middle-Eocene fauna that are present.

# GROUND-WATER HYDROLOGY

## HYDROLOGIC CYCLE AND SOURCE OF GROUND WATER

The earth has a fixed quantity of water that is kept in continuous circulation between the atmosphere and the earth by energy supplied from the sun. This constant circulation of water in its various forms is called the hydrologic cycle. Hydrology is the science which is concerned with the complex and interrelated phases of the hydrologic cycle. Water in the saturated zone of the earth's crust is called ground water.

Precipitation in the form of rain or snow is the source of ground water. The average annual precipitation in the Raleigh area is about 45 inches, but only part of this reaches the zone of saturation. The proportion of precipitation that becomes ground water is controlled by such factors as the relative ability of the rocks and soil above the zone of saturation to transmit water, the precipitation intensity, the density of vegetation, the climate, and the topography.

The permeability or relative ability of soils to transmit water varies from place to place and thus variously affects the proportion of rainfall that is absorbed and transmitted as ground-water recharge, as well as the rate of recharge. Loose surficial soils may be compacted by the pounding of heavy rains which decreases their capacity to store and transmit water. Other factors which affect these characteristics of soils include parent rock, land usage, and type and density of the vegetative cover.

Rainfall intensity and duration have a considerable effect on the amount of water that is absorbed by the soil and transmitted downward to the water table. A large part of the heavy summer rains of short duration is immediately lost as surface runoff because of the inability of the soils to absorb and transmit water rapidly. The same amount of water falling as a gentle, steady rain would result in a much larger amount of water reaching the water table.

During the summer months, the amount of precipitation available as ground-water recharge is decreased considerably by losses due to evaporation and to transpiration by growing vegetation. The evaporative capacity of the air which is dependent upon temperature, humidity, and air movement, is greater during the summer months than during the remainder of the year. Transpiration losses through vegetation are also greatest during the summer. Water lost through evaporation and transpiration depletes soil moisture which must be replenished before recharge to the zone of saturation is possible. The net result is a decrease in ground-water levels during the summer and early fall despite heavier rains.

The viscosity of water varies inversely with temperature so that during warmer weather water percolates downward to the water table slightly faster than during cold weather.

In general, ground water is steadily moving under the influence of gravity from recharge to discharge areas. The rate at which it moves ranges from a few feet a day to a few feet a year (Meinzer, 1942, p. 449), varying directly with the hydraulic gradient and with the size and arrangement of the interstices.

Ground water may be discharged naturally by several methods. In humid areas, such as the Raleigh area, where the water table slopes toward the streams and rarely falls below the level of them, there is a continuous seepage which maintains the flow of the streams in dry periods and adds to the flow during wet periods. Where the water table is close to the surface, there is heavy discharge by evaporation and transpiration during the spring and summer months. Springs and seeps are also areas of natural ground-water discharge.

## THE OCCURRENCE AND MOVEMENT OF GROUND WATER

The amount of water that can be stored in the rocks and soil is controlled by the size, shape, and number of pore spaces they contain. The rocks of the earth's crust, including soils and other weathered materials, contain pore space or interstices that are filled with water in the zone of saturation. These interstices range in size from the microscopic pores in clays to cavernous openings in some limestones and dolomites. Unconsolidated sediments, such as gravel, sand and clay, contain primary pores between the individual grains. When these sediments are consolidated, such as the Triassic sedimentary rocks, the total volume of pore space is reduced by compaction and cementation of the sediments. In crystalline rocks such as granite, schist, and gneiss, the volume of primary pore space between individual components is very small. Most of the water in these rocks is contained in secondary interstices which were formed after the rock was lithified. The most important secondary interstices in the Raleigh area include joints, planes of cleavage and schistosity, and solution channels.

In the igneous and metamorphic rocks that underlie most of the Raleigh area, many of the interstices are formed or enlarged by normal weathering processes at or near the earth's surface. With depth, the size and abundance of interstices decreases, consequently most ground water is in the upper 100- to 200-foot-zone of the earth's crust. Several types of interstices are shown in figure 14. The path of water along interstices in some rock types is shown in figure 15.

Porosity is the ratio of the volume of the interstices to the total volume of the rock expressed as a percentage. The porosity of different rocks is variable. Clays commonly have a porosity of 50 percent or more. In some crystalline rocks such as granite, the porosity may be less than 1 percent.

Specific yield is the ratio of the volume of water a saturated rock will yield by gravity to the total volume of rock and is usually stated as a percentage.

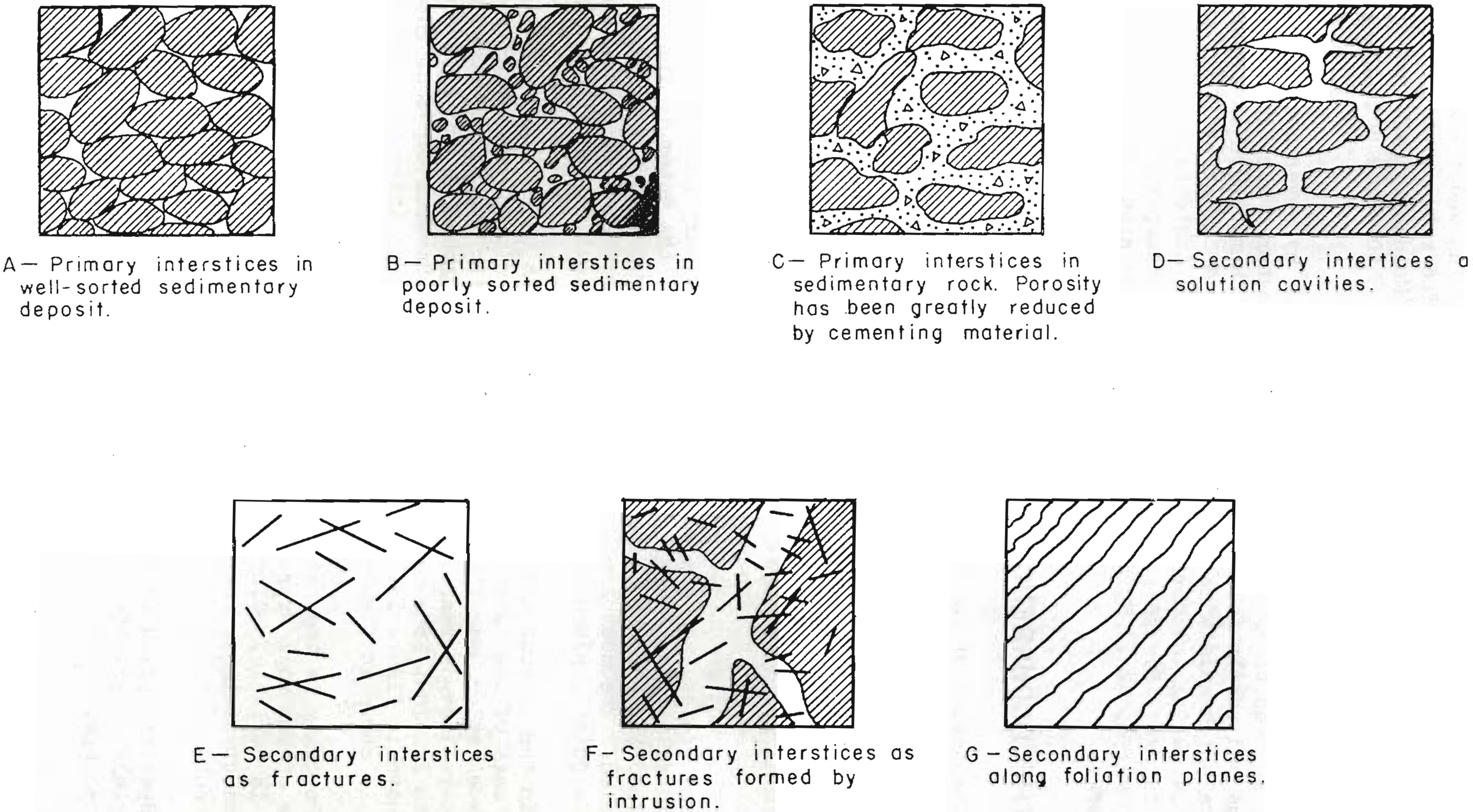



Figure 14.--Diagram illustrating several types of interstices.

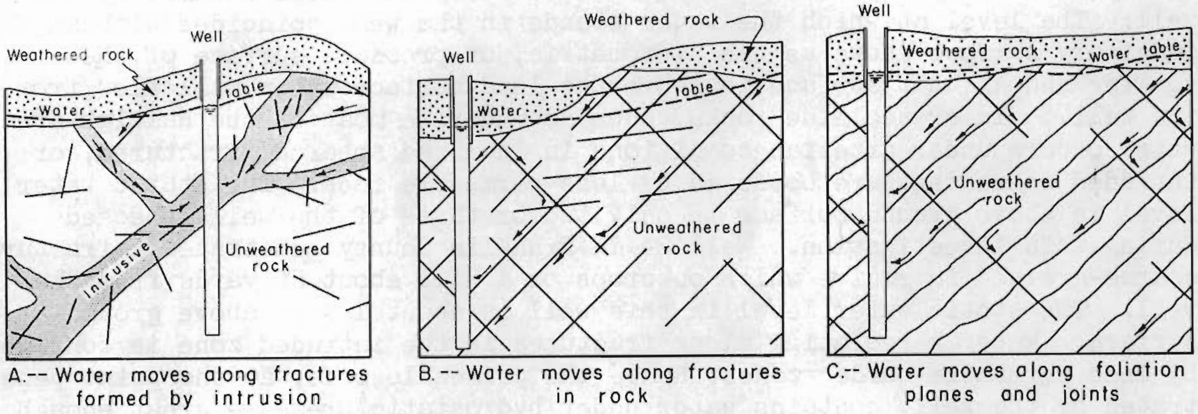



Figure 15.--Diagrams illustrating movement of water along secondary interstices.

A rock unit or formation that can yield usable quantities of water to wells is called an aquifer. The relative ability of an aquifer to transmit water is called its permeability. Porosity and permeability are not necessarily related. The porosity of a rock depends only upon the volume of the interstices in relation to the total volume of the rock, whereas the permeability depends upon the size and shape of the interstices, the degree to which these are connected, and the size and shape of the interconnections. Clay with a porosity of 50 percent may yield little or no water because the pores are so small that the water is held in place by molecular attraction. On the other hand, clean well-sorted sands or gravels may have less porosity but yield larger quantities of water because the pores are larger and interconnected. The permeability of sands or gravels is greatly decreased when clay or silt is mixed with them, or when they are consolidated by compaction and addition of a cementing material.

The top surface of this zone of saturation is known as the water table. The water table is not a stationary, flat surface, as the name implies, but is a fluctuating, irregular surface that locally parallels the topography. The general relation of the water table to the topography is shown in figure 16.

Rocks or unconsolidated material that contain unconfined water in the zone of saturation are water-table aquifers. An artesian aquifer contains water in the zone of saturation that is confined under pressure, the pressure being greater than atmospheric pressure. Brown (1959, p. 16, 17) explains ground-water occurring under artesian conditions as follows: "Water entering an artesian aquifer where it crops out or is overlain by permeable material percolates downdip by gravity, eventually passing a line beyond which the aquifer is filled to capacity and is both overlain and underlain by relatively impermeable beds. Because the weight of the water updip in an artesian aquifer exerts pressure on the water downdip in the same aquifer, the hydrostatic pressure increases progressively in a downdip direction. Thus the water level in a well that taps an artesian aquifer stands above the top of the aquifer and the weight of the column of water in the well counterbalances the hydrostatic pressure in the aquifer at the point where entered by the well. The level at which the water stands in the well coincides with an imaginary surface known as the piezometric, or pressure surface of the aquifer and if that surface is above the land surface water will flow from the well." In crystalline rocks, such as underlie most of the Raleigh area, water occurs under artesian conditions in inclined sheared, fractured, or intruded zones that are bordered by less permeable rock. The static water level is above ground surface in only two or three of the wells checked during this investigation. Well 24 in Franklin County penetrated a fractured, coarse-grained intrusive which outcrops on a hill about 50 yards from the well. The static water level in this well is about 1 foot above ground surface. Water percolating along fractures in the intruded zone is confined by less permeable border zones, hence the permeable zone, at the point penetrated by the well, contains water under hydrostatic pressure great enough to force the water in the well above ground surface.

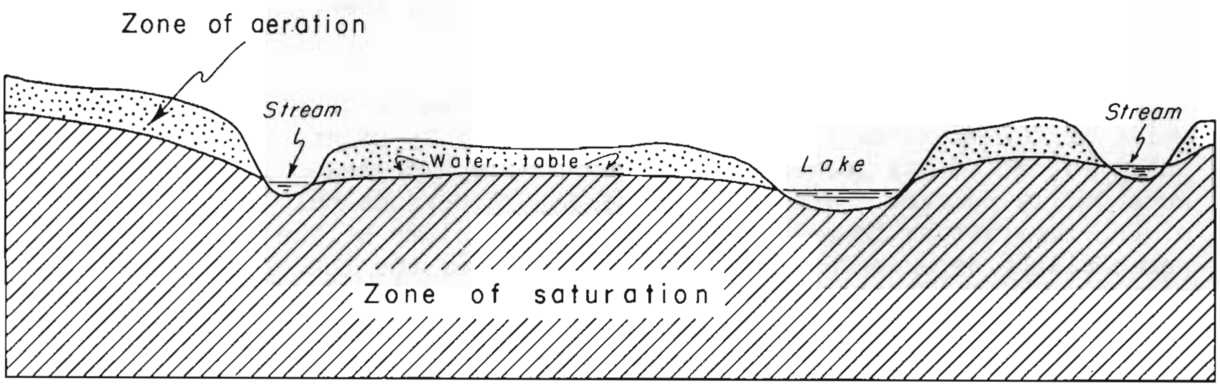



Figure 16.--Diagrammatic section illustrating relation of water table to topography.

Over a period of years recharge and discharge to the ground-water table balances, so no permanent rise or decline occurs. Seven hydrographs were selected for presentation in this report and are shown in figure 17. These particular wells were selected because they show water-table fluctuations at different locations throughout the area, they are located in different rock units, and because the water level in these wells is particularly sensitive to precipitation changes.

Certain general trends are reflected in the hydrographs that are common throughout the area of investigation. The most obvious is a general decline of the water levels through the summer, with the lowest point occurring in the late summer or early autumn. Recharge is relatively fast during the colder months when precipitation occurs generally as gentle, steady rains. Small fluctuations are caused by especially heavy rains or by above normal precipitation over a period of a month.

The movement of water through crystalline rocks in this area is generally slower than through unconsolidated sediments. A considerable time lag in water-table response to precipitation increases is reflected in the hydrograph

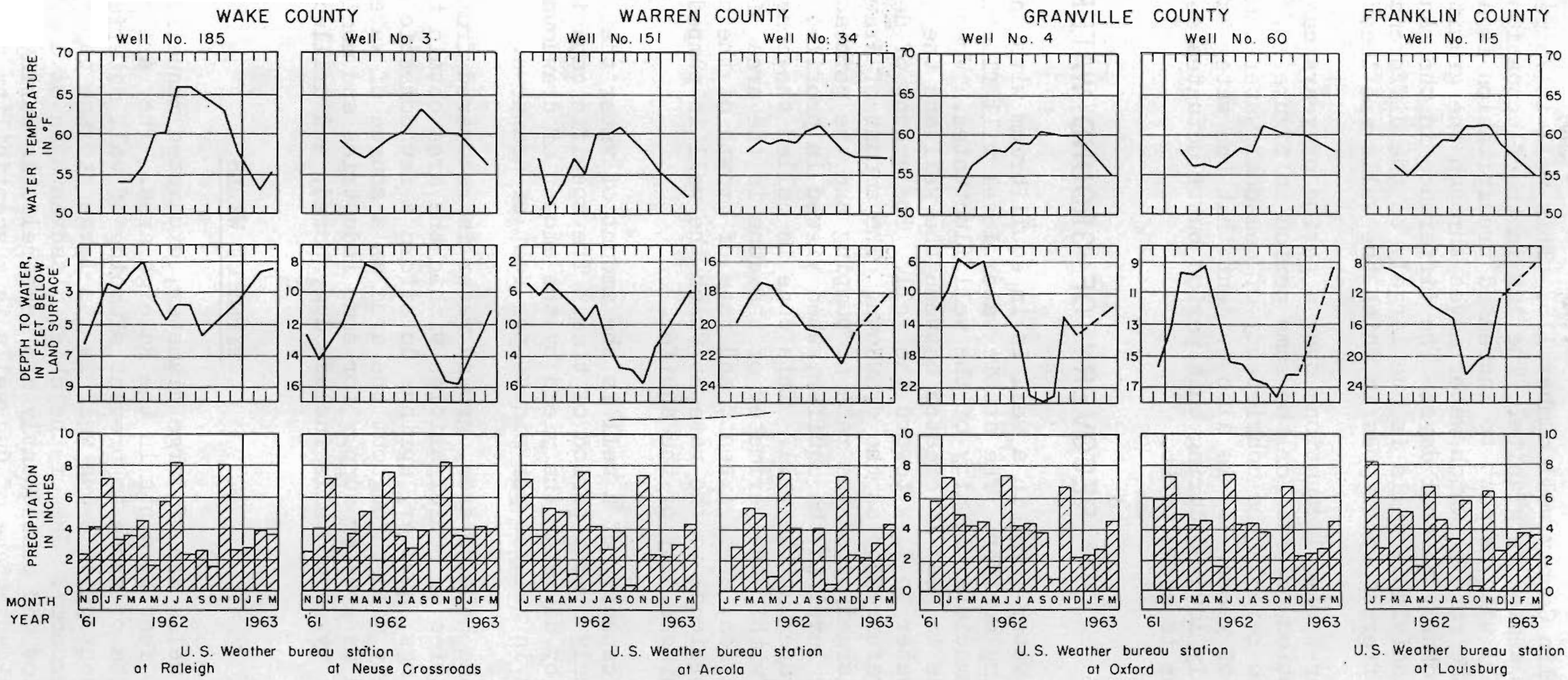



Figure 17.--Hydrographs of selected observation wells showing temperatures and relation to precipitation.

for Franklin County well number 115. This well is 75 feet deep and the steel casing is seated in granite. The lag in the fluctuations of the water level in the well with respect to increased precipitation is a relative measurement of the rate at which water moves through the granite. In this case the lag is probably several days. The difference in the range of fluctuation between individual wells is due largely to the differences in specific yield of the different rock types in which the wells are located.

Water-table fluctuations over a period of years can be compared with precipitation records for the same period in figure 18. A study of this hydrograph reveals the consistency of seasonal water-table fluctuations over a period of years. It is also evident that the water table has not been permanently lowered during this period but fluctuates as water leaves the aquifer or is added to it.

## RECOVERY OF GROUND WATER

The water level in a well is in equilibrium with the water level in the surrounding aquifer. The static water level will fluctuate as the water table in the immediate vicinity of the well fluctuates. When pumping commences, a difference in head is created between the well and the surrounding aquifer causing water to flow toward the well. The amount of decline at any given time is referred to as the drawdown. The amount of drawdown in any one well depends largely upon the rate of pumping and the permeability of the aquifer. The water level in the aquifer, when viewed in profile, is an inverted cone with the apex at the well. This cone is called the cone of depression and the area within the perimeter of the cone is the area of influence. The configuration, areal extent, and rate of growth of the cone of depression are proportional to the rate at which the well is pumped and to the coefficient of transmissibility of the aquifer.

The capacity of a well is the amount of water that a well will yield continuously over a period of time. The specific capacity of a well is computed by dividing the yield by the amount of drawdown and is usually expressed in gallons per minute per foot of drawdown.

In the Raleigh area, ground water is recovered from wells or springs. No industries or municipalities within the area obtain their water supply from springs, however, springs do afford a few domestic supplies. Wells are extensively used throughout the area as a source of water for homes, and are also used as a water supply for some industries and municipalities. The different types of wells include dug, bored, and drilled wells.

### TYPES OF WELLS

Dug wells are of large diameter, excavated manually, and usually do not exceed 50 feet in depth in the Raleigh area. They are commonly curbed with terra cotta or stone to prevent slumping of wall material into the well. The chief advantage of a dug well is its large storage capacity per foot of depth and its economy. One of the chief disadvantages of dug wells is that they are shallow and consequently are less reliable during periods of draught. Another disadvantage of dug wells is susceptibility to pollution by contaminated surface water.

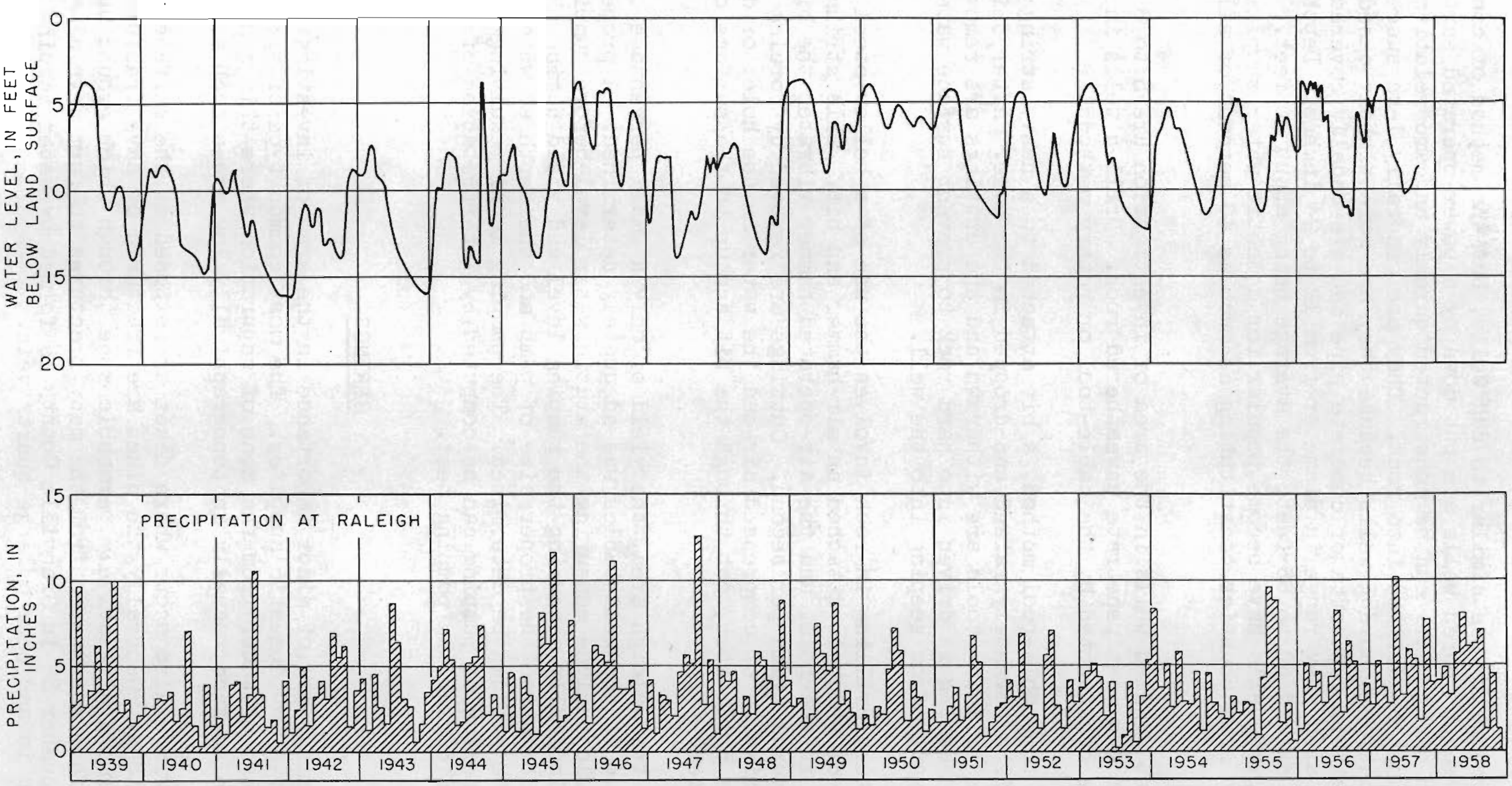



Figure 18.--Graphs showing relation of water-level fluctuations in a dug well to precipitation, for the period 1939-58.

Bored wells are similar to dug wells, but the method of construction is different. Bored wells are put down by a power-operated earth auger. Although bored wells can be constructed quickly and are relatively inexpensive, they cannot be drilled into rock. They are generally less susceptible to contamination than dug wells because they are more tightly cased from top to bottom with terra cotta or concrete pipe and are usually covered. In the Raleigh area they range in diameter from 12 to 24 inches. Depths do not usually exceed 60 to 65 feet, the average being about 40 feet. In recent years bored wells have become popular for domestic water supplies in the area, in some counties constituting as much as 40 percent of all domestic wells.

Most drilled wells in the area of investigation are 5 to 8 inches in diameter and most penetrate unweathered rock. Drilled wells in the Raleigh area are constructed by the cable-tool or rotary methods.

In the cable-tool method, a bit attached to a heavy string of drilling tools, is alternately raised and dropped in the hole. After drilling a few feet the drilling tools are withdrawn and the cuttings are removed with a bailer. Casing is driven into hard rock to prevent surface water or shallow ground water from seeping into the well.

Rotary drilling in rock involves the use of a hollow steel drill stem to one end of which is attached an air-hammer and bit. This string of tools is rotated in the hole, and the air-operated hammer vibrates the bit against the rock several times per second. Cuttings are removed by forcing compressed air, a mixture of compressed air and the water in the hole, or drilling mud down the drill stem, out through the bit and up to the surface outside the drill stem.

In the Raleigh area, the yield of only a small percentage of those wells presented in the well tables was adequately determined. A properly conducted test would include measuring the static water level before pumping begins, and periodically measuring the pumping level and yield during the test. With this information the proper size of pump and the depth at which the intake should be set can be determined. The pumping level resulting from a much longer period of pumping can be computed by interpretation of the data obtained during the pumping test.

## SPRINGS

Springs are of minor importance in the area of investigation, being used only for a few domestic supplies. The most common type of spring is formed by leakage of water from the zone of saturation where this zone is in contact with the surface, usually in topographically low areas such as draws.

Springs also occur where dikes are exposed at the surface in draws or depressions. Generally the dikes are fractured or have fractured the host rock forming a relatively permeable zone through which ground water flows to the surface and issues from the many fractures to form several springs. Spring number S2 in Granville County is formed by water issuing from fracture openings in and near a large quartz vein.

In the Raleigh area, most springs yield less than 10 gallons per minute with considerable fluctuations between wet and dry periods. Spring number S1 in Vance County is an exceptionally large spring, yielding 38 gallons per minute with very little seasonal fluctuations. The spring is fed by water issuing from fractures in granite. It provides the water supply for a nearby prison camp.

## PHYSICAL FACTORS AFFECTING RECOVERY

In the Raleigh area ground water from all rock types is generally of acceptable quality for domestic use provided it is free of surface pollution. Some of the physical factors which affect the quantity of available water in the Raleigh area are described below.

### Rock Texture

Rock texture refers to the size, shape, and arrangement of the component particles of a rock. Coarse-textured rocks generally are more permeable than fine-textured rocks and, consequently, may be better aquifers.

### Fracture Planes in Rock

The interstices in many of the rocks in the Raleigh area are secondary fractures. Wells drilled at places where fractures or fracture systems such as joints or zones of shearing are better developed will yield more water than wells drilled into more massive rocks.

### Cleavage and Schistosity

Cleavage planes and planes of schistosity are important avenues of ground-water movement and storage in the Raleigh area. They usually dip at some angle to the horizontal which allows water to percolate by gravity down dip along these schistose and cleavage planes. Yields are greater where schistose and cleavage planes are plentiful, especially where differential rock movement along these planes has caused some degree of separation.

### Quartz Veins and Diabase Dikes

Quartz is a hard, brittle mineral that fractures easily from stress caused by slight crustal movements. Quartz veins in the Raleigh area are generally more fractured than the enclosing rock, and hence, are better aquifers. Generally the veins are vertical or dip at nearly vertical angles. A well that is to penetrate an inclined vein should be located away from the outcrop area in the direction in which the vein dips. The presence of a quartz vein can be detected even in deeply weathered areas by the train of loose quartz fragments on the soil.

Dikes are tabular rock bodies of intrusive igneous rock. They are not usually good aquifers, but often the host rock adjacent to them may have been made more permeable by fractures resulting from the force of intrusion and heat. Many wells near Triassic diabase dikes in the Triassic sedimentary rocks are above average producers. These dikes sometimes form underground dams which obstruct the natural movement of ground water, causing the water table to be closer to the surface on one side of the dike.

## Topography

Topography is one of the most useful criteria in determining the relative water-bearing characteristics of the underlying rocks.

In general wells drilled on hills or other upland areas are less apt to yield the desired quantity of water than wells drilled in draws or other depressions. The reasons for this are stated by LeGrand and Mundorff (1952, p. 18-19) as follows:

> "(1) Hills and upland areas readily shed much water from precipitation as surface runoff. As a result, there is less seepage into the ground to become ground water. On the other hand, the lowlands obtain influent seepage directly from precipitation and also from upland surface runoff.
>
> "(2) The direction of movement of the ground water is toward the valleys where part of it discharges into streams. In addition, influent seepage may occur from upland rock slopes beneath the residual material. The more impervious the bedrock, the more readily is water deflected down the slope along this contact.
>
> "(3) Wells located in lowlands may salvage some of the water that would be lost naturally by discharge from the underground reservoir. There the depressed water level resulting from pumping, if near a discharge area, prevents further discharge out of the area.
>
> "(4) Wells on hills penetrate the water table at a greater depth than those in lowlands. When a well on a hill is pumped, the water table is lowered as a cone of depression, the center of the cone being at the well. As pumping continues the cone may grow larger and deeper but its span is limited because of the topography and because of the relatively low permeability of rocks at progressively greater depth below the surface. The yield of wells under these conditions is not great. On the other hand, wells in lowlands, even though penetrating the same rocks as those on uplands, intersect the water table near the ground surface. Thus, the water table can be lowered a greater distance by pumping than in a well of the same depth on a hill. The fact that the static and pumping water levels lie nearer the ground surface than in wells on hills results in the pumping level lying in a more permeable zone; hence the intake area is broader and the yield of the well is larger.

"(5) In many places hills exist because the rocks there have a greater resistance to erosion than in the valleys, this resistance being due in many places to poor jointing. Joints and fractures facilitate entrance of ground water, which promotes chemical decay and permits mechanical erosion. Thus depressions such as draws or valleys suggest that the rock underlying the depressions has more openings through which ground water can move than the rock underlying the hills."

Thickness of Weathered Material

Chemical weathering of rock is facilitated by the infiltration and movement of water. Therefore, a thick mantle of saprolite may be an indication that the underlying rock has joints, fractures, or pores which contain ground water. Saprolite is usually porous, although not necessarily very permeable, so that a thick mantle of saprolite has a large storage and recharge potential.

# THE PRINCIPAL ROCK UNITS AND THIER WATER-BEARING PROPERTIES

## INTRODUCTION

The areas underlain by each rock type or map unit are shown on the geologic map (fig. 5). Data on 883 wells are presented in tables 15, 19, 23, 27, and 30 in the county sections of this report.

## YIELD OF WELLS ACCORDING TO ROCK TYPE

Data from 773 drilled wells for which information was available concerning depth, yield, use, and topographic location were used to prepare the following tables (tables 2-10). These tables compare yields for each of nine rock units according to range in depth and topographic location. The variation in yield for each of these nine units is further illustrated in figures 20 and 21. Figure 19 compares the average yields per foot of well for all wells in each of the nine map units.

The geology and water-bearing properties of 14 of the map units are summarized in table 11. Information was not available for the Castle Hayne Limestone or the soapstone unit.

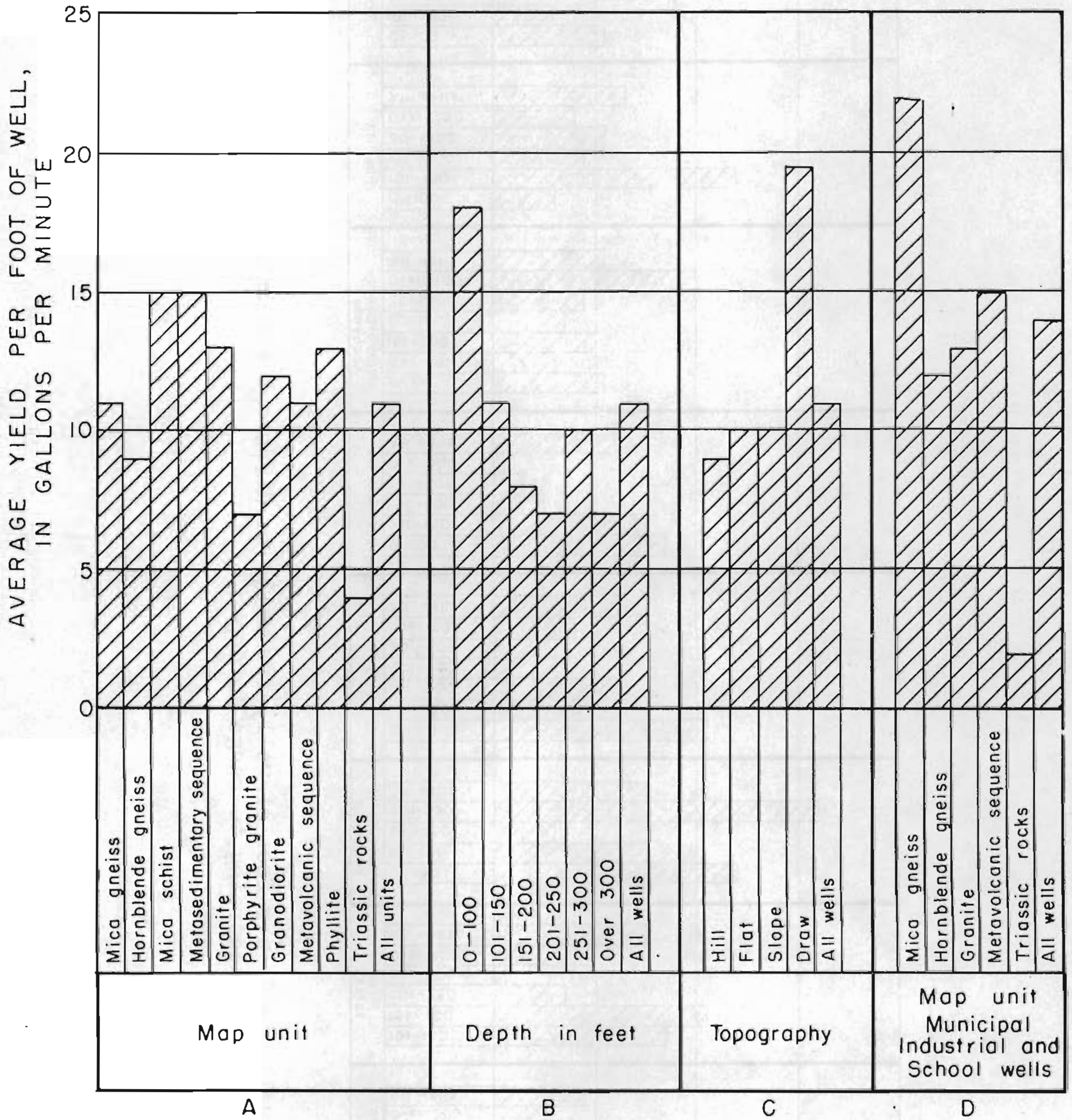



Figure 19.--Average yield per foot of well of the map units.

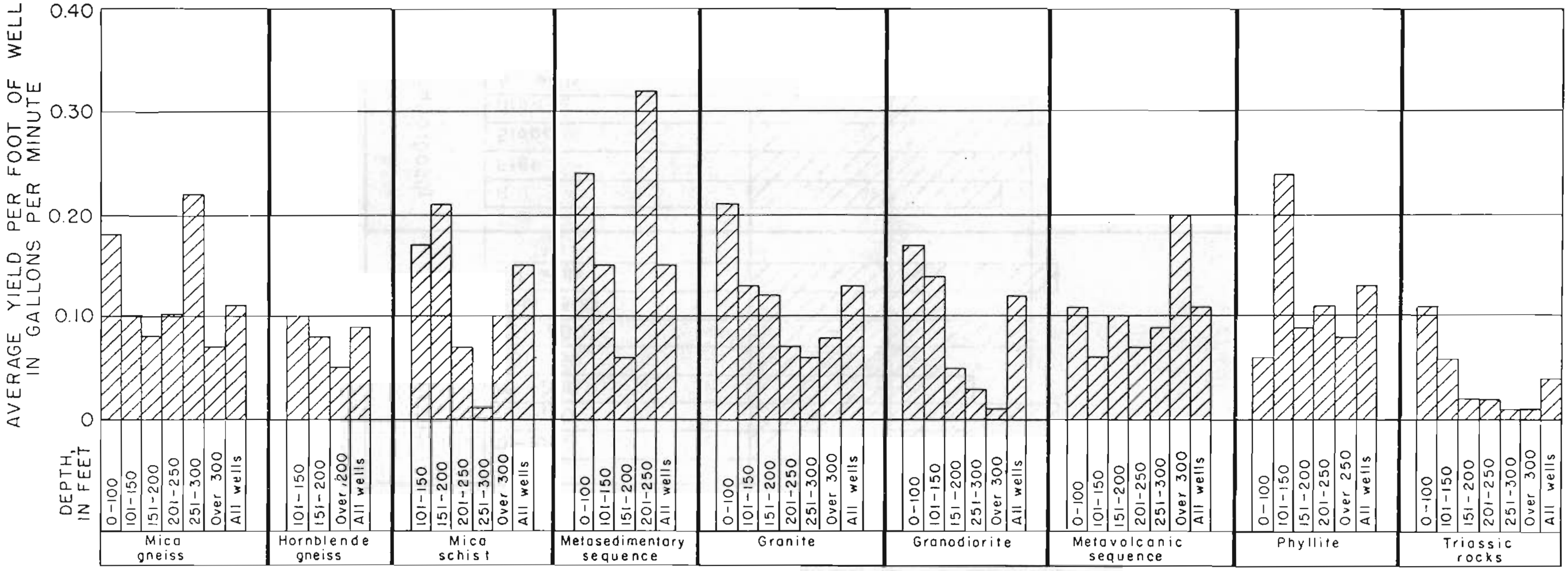



Figure 20.--Summary of well yield, per foot of well, for wells in different map units according to range in depth.

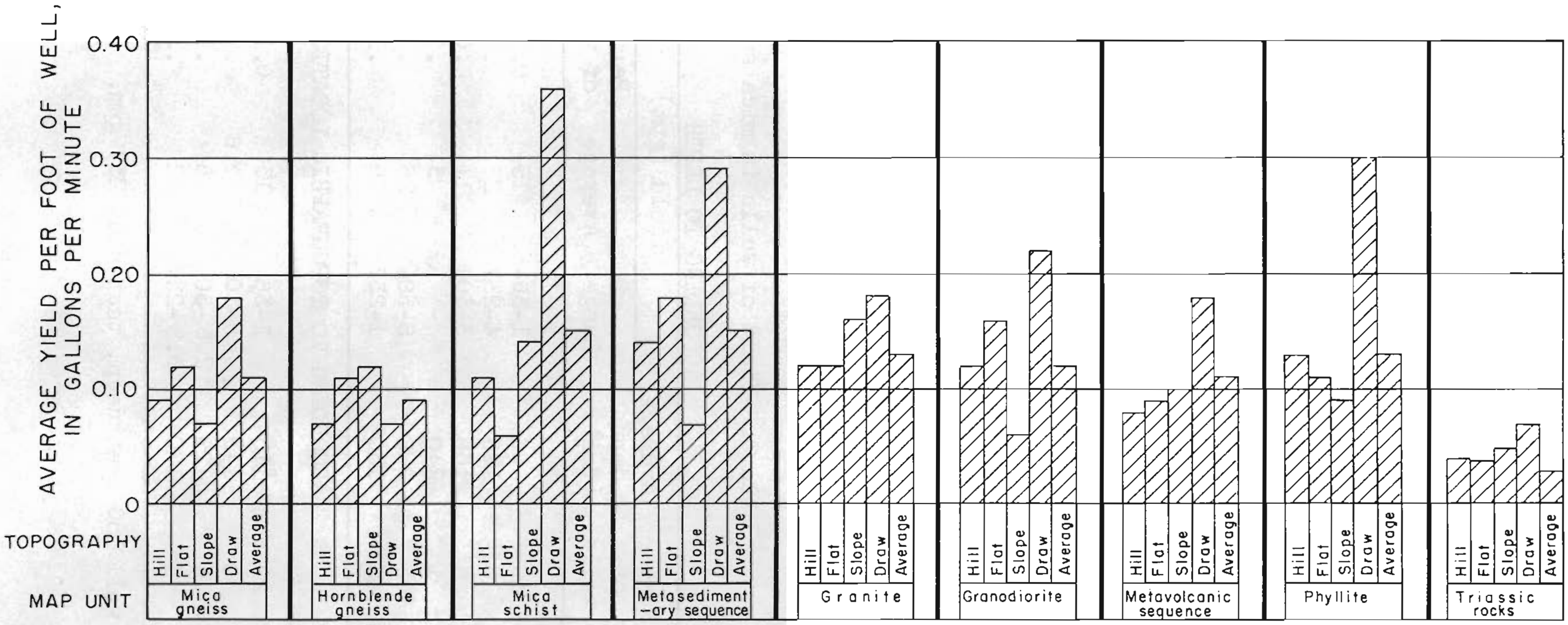



Figure 21.--Summary of well yield, per foot of well, for wells in different map units according to topographic location.

Table 2.--Yield of wells in the metasedimentary sequence

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | ACCORDING TO DEPTH | | | |
| 0-100 | 6 | 68 | 5.5-45 | 16 | 0.24 | 0 |
| 101-150 | 7 | 136 | 5-46 | 21 | .15 | 0 |
| 151-200 | 4 | 173 | 3-20 | 10 | .06 | 0 |
| 201-250 | 1 | 202 | - | 64 | .32 | - |
| All wells | 18 | 125 | 3-64 | 19 | .15 | 0 |
| | | | ACCORDING TO TOPOGRAPHIC LOCATION | | | |
| Hill | 7 | 118 | 4-45 | 16 | 0.14 | 0 |
| Flat | 4 | 117 | 5.5-46 | 21 | .18 | 0 |
| Slope | 4 | 148 | 3-20 | 11 | .07 | 0 |
| Draw | 3 | 120 | 10-64 | 35 | .29 | 0 |

Table 3.--Yield of wells in mica schist

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | ACCORDING TO DEPTH | | | |
| 0-100 | 19 | 86 | 1-36 | 15 | 0.17 | 5.3 |
| 101-150* | 18 | 126 | 4-237 | 27 | .21 | 0 |
| 151-200 | 8 | 168 | 3-30 | 11 | .07 | 0 |
| 201-250 | 1 | 240 | - | 3 | .01 | - |
| 251-300 | 3 | 288 | 5-50 | 28 | .10 | 0 |
| All wells | 49 | 130 | 1-237 | 19 | .15 | 2.0 |
| | | | ACCORDING TO TOPOGRAPHIC LOCATION | | | |
| Hill | 22 | 115 | 1-36 | 13 | 0.11 | 4.5 |
| Flat | 8 | 148 | 5-30 | 9.6 | .06 | 0 |
| Slope | 14 | 129 | 2.5-50 | 18 | .14 | 0 |
| Draw | 5* | 170 | 3.5-237 | 62 | .36 | 0 |

*Includes 1 well 150 feet deep, tested at 237 gpm.

Table 4.--Yield of wells in hornblende gneiss

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO DEPTH | | | | | | |
| 0-100 | 1 | 90 | - | 45 | 0.50 | - |
| 101-150 | 5 | 125 | 1.5-25 | 12 | .10 | 0 |
| 151-200 | 4 | 173 | 1-25 | 13 | .08 | 25 |
| Greater than 300 | 2 | 492 | 1.5-50 | 26 | .05 | - |
| All wells | 12 | 199 | 1-50 | 17 | .09 | 8.3 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 4 | 213 | 1.5-45 | 14 | 0.07 | 0 |
| Flat | 4 | 131 | 1.5-25 | 14 | .11 | 0 |
| Slope | 2 | 160 | - | 20 | .12 | - |
| Draw | 2 | 348 | 1-50 | 26 | .07 | - |

Table 5.--Yield of wells in mica gneiss

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO DEPTH | | | | | | |
| 0-100 | 62 | 78 | 2-45 | 14 | 0.18 | 0 |
| 101-150 | 59 | 123 | .5-45 | 12 | .10 | 8.2 |
| 151-200 | 33 | 169 | .5-75 | 13 | .08 | 12 |
| 201-250 | 14 | 228 | 2-100 | 23 | .10 | 0 |
| 251-300* | 7 | 273 | 0-295 | 60 | .22 | 14 |
| Greater than 300 | 13 | 401 | .5-160 | 27 | .07 | 15 |
| All wells | 188 | 148 | 0-295 | 16 | .11 | 5.8 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 62 | 157 | 0.5-75 | 14 | 0.09 | 6.5 |
| Flat | 53* | 141 | .5-295 | 17 | .12 | 7.6 |
| Slope | 55 | 221 | 0-160 | 15 | .07 | 5.5 |
| Draw | 18 | 171 | 3-100 | 30 | .18 | 0 |

*Includes one well 275 feet deep, tested at 295 gpm.

Table 6.--Yield of wells in the metavolcanic sequence

ACCORDING TO DEPTH

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) | | | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | Range | Average | Per foot of well | |
| 0-100 | 76 | 69 | 0.5-50 | 8 | 0.11 | 4.0 |
| 101-150 | 20 | 123 | 2-18 | 8 | .06 | 0 |
| 151-200 | 13 | 177 | 2-55 | 18 | .10 | 0 |
| 201-250 | 3 | 219 | 4-30 | 16 | .07 | 0 |
| 251-300 | 4 | 293 | 20-38 | 31 | .11 | 0 |
| Greater than 300 | 2 | 532 | 60-150 | 105 | .20 | - |
| All wells | 118 | 109 | .5-150 | 12 | .11 | .8 |

ACCORDING TO TOPOGRAPHIC LOCATION

| | | | | | | |
|---|---|---|---|---|---|---|
| Hill | 34 | 91 | 0.5-17 | 7 | 0.08 | 2.9 |
| Flat | 30 | 102 | 2-20 | 9 | .09 | 0 |
| Slope | 38 | 94 | 1.5-30 | 9 | .10 | 0 |
| Draw | 16 | 201 | 5-150 | 36 | .18 | 0 |

Table 7.--Yield of wells in phyllite

ACCORDING TO DEPTH

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) | | | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | Range | Average | Per foot of well | |
| 0-100 | 1 | 87 | - | 5 | 0.06 | - |
| 101-150 | 7 | 129 | 10-60 | 31 | .24 | 0 |
| 151-200 | 5 | 163 | 4-25 | 14 | .09 | 0 |
| 201-250 | 1 | 237 | - | 25 | .11 | 0 |
| Greater than 300 | 2 | 331 | 10-25 | 18 | .05 | - |
| All wells | 16 | 169 | 4-60 | 22 | .13 | 0 |

ACCORDING TO TOPOGRAPHIC LOCATION

| | | | | | | |
|---|---|---|---|---|---|---|
| Hill | 4 | 200 | 10-60 | 27 | 0.13 | 0 |
| Flat | 7 | 156 | 4-50 | 17 | .11 | 0 |
| Slope | 3 | 139 | 10-15 | 13 | .09 | 0 |
| Draw | 2 | 140 | 25-60 | 42 | .30 | - |

Table 8.--Yield of wells in granodiorite

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO DEPTH | | | | | | |
| 0-100 | 41 | 72 | 1-60 | 12 | 0.17 | 2.4 |
| 101-150 | 10 | 118 | 2-75 | 16 | .14 | 0 |
| 151-200 | 5 | 168 | .5-20 | 9 | .05 | 20 |
| 251-300 | 1 | 257 | - | 8 | .03 | - |
| Greater than 300 | 2 | 409 | 3-4 | 4 | .01 | - |
| All wells | 59 | 102 | .5-75 | 12 | .12 | 3.4 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 25 | 98 | 1-75 | 12 | 0.12 | 4.0 |
| Flat | 16 | 80 | 2-60 | 13 | .16 | 0 |
| Slope | 12 | 146 | .5-20 | 8 | .06 | 8.3 |
| Draw | 6 | 97 | 6.60 | 21 | .22 | 0 |

Table 9.--Yield of wells in granite

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO DEPTH | | | | | | |
| 0-100 | 109 | 70 | 0.5-60 | 15 | 0.21 | 1.4 |
| 101-150 | 49 | 122 | 1-80 | 16 | .13 | 2.0 |
| 151-200 | 26 | 178 | 0-90 | 21 | .12 | 3.9 |
| 201-250 | 17 | 227 | 0-60 | 15 | .07 | 18 |
| 251-300 | 7 | 292 | 0-50 | 19 | .06 | 14 |
| Greater than 300 | 9 | 403 | 2-90 | 33 | .08 | 0 |
| All wells | 217 | 128 | 0-90 | 17 | .13 | 3.7 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 63 | 121 | 0-60 | 15 | 0.12 | 6.4 |
| Flat | 76 | 145 | 0-82 | 17 | .12 | 3.9 |
| Slope | 53 | 96 | 2-90 | 15 | .16 | 0 |
| Draw | 25 | 133 | .5-69 | 24 | .18 | 4.0 |

Table 10.--Yield of wells in Triassic rocks

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) | | | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | Range | Average | Per foot of well | |
| **ACCORDING TO DEPTH** | | | | | | |
| 0-100 | 25 | 81 | 0-25 | 9 | 0.11 | 12 |
| 101-150 | 25 | 124 | 0-25 | 7 | .06 | 12 |
| 151-200 | 16 | 178 | .5-15 | 4 | .02 | 25 |
| 201-250 | 10 | 221 | 0-12 | 4 | .02 | 30 |
| 251-300 | 5 | 280 | .5-5 | 3 | .01 | 20 |
| Greater than 300 | 3 | 419 | .5-7 | 4 | .01 | 33 |
| All wells | 84 | 153 | 0-25 | 6 | .04 | 18 |
| **ACCORDING TO TOPOGRAPHIC LOCATION** | | | | | | |
| Hill | 23 | 149 | 0-12 | 6 | 0.04 | 30 |
| Flat | 42 | 154 | 0-25 | 6 | .04 | 12 |
| Slope | 14 | 158 | .5-25 | 8 | .05 | 14 |
| Draw | 5 | 123 | 0-24 | 8 | .07 | 20 |

Table 11.--Summary of the principal map units and their water-bearing properties

| Unit | Description | Water-bearing properties |
| --- | --- | --- |
| Cretaceous (Tuscaloosa Formation) | Gray to white sands, in places arkosic, with interbedded clay lenses. Pebbly beds at base at some localities. Maximum thickness in Wake County about 80 feet. | Water stored in primary interstices between sand particles. Yields adequate amounts for domestic use to dug and bored wells. Water commonly contains objectionable amounts of iron. |
| Triassic Rocks (Newark Group) | Includes buff colored arkosic sandstones, and red to maroon argillaceous sandstones and shales. Coarse fanglomerate near the Jonesboro fault forms the eastern boundary of the basin. | Rocks made impermeable by compaction and cementation. Water is stored in and moves along joint and fracture planes. Difficult to obtain adequate amounts of water for domestic use at many places. Most favorable locations for wells are in proximity to diabase dikes. Average yield of 84 drilled wells is 6 gpm. Fifteen of the 84 wells yield 1 gpm or less. Water at many places is moderately hard to hard. |
| Granite | Light to pinkish gray medium- to coarse-grained biotite granite. Associated with the granite are many coarse-grained dikes which have intruded the host rocks. | Water is stored in and moves along steeply dipping joints and nearly horizontal sheeting fractures. Adequate domestic supplies can be obtained from drilled wells at most places. Favorable locations may yield small industrial and municipal supplies. Average yield of 217 wells is 17 gpm. Water is soft and low in iron; quality suitable for domestic and most industrial purposes. |
| Porphyritic Granite | Coarse-grained porphyritic biotite granite showing a weak gneissic structure of rudely aligned orthoclase feldspar crystals and biotite. Feldspar crystals up to 2 inches in length are set in finer-grained groundmass of quartz and biotite. | Water circulates through widely-spaced joints and sheeting fractures. Has about the same water-bearing properties as the finer grained biotite granite described above. Average yield of five drilled wells is 16 gpm. Water is soft and low in iron. |

Table 11.--Summary of the principal map units and their water-bearing properties--continued

| Unit | Description | Water-bearing properties |
|---|---|---|
| Granodiorite | Typically a medium-grained albite granodiorite which is composed of feldspar, quartz, mica, and minor accessory minerals including sericite, pyrite, and epidote. Interlayered with phyllite rocks of metavolcanic unit in contact zones. | Water moves along joint and fracture planes. Adequate amounts of water for domestic use can be obtained at most places. Most favorable locations for drilled wells are in draws or other depressed areas. Average yield of 59 drilled wells is 12 gpm. Water soft to hard, and low in iron. |
| Gabbro | Chiefly coarse to medium grained black to greenish gray hornblende gabbro. Most bodies appear massive. The gabbro body 3 miles north of Stovall may be complex of gabbro dikes rather than one massive body. | Water moves along widely spaced joints and fractures. The average yield of two drilled wells (11 gpm) indicates that adequate domestic supplies of water can be obtained from the gabbro. Most favorable well sites are probably near the periphery of the bodies. The one water sample analyzed was soft and low in iron. |
| Greenstone | Metamorphosed mafic extrusive, fine-grained. Commonly has good cleavage from parallel alignment of chlorite and platy minerals. Amygdules and feldspar phenocrysts mashed and drawn out in the plane of cleavage. | Water moves along cleavage planes and joints. At most places adequate domestic supplies can be obtained from drilled wells. Average yield of 3 drilled wells is 4 gpm. Analysis of one water sample shows water to be very hard with a high iron content. |
| Phyllite | Fine-grained rock composed essentially of fine micaceous minerals, chlorite and sericite, and argillaceous material with minor amounts of pyrite, garnet, and chloritoid(?). Well developed schistose to phyllitic cleavage. Relic bedding apparent at places. | Water moves along foliation and joint planes. Adequate quantities of water available for domestic use at almost any location. Larger yields for industrial or municipal use may be obtained at favorable locations such as draws. The average yield of 16 drilled wells is 22 gpm. Water generally soft to moderately hard. |

Table 11.--Summary of the principal map units and their water-bearing properties--continued

| Unit | Description | Water-bearing properties |
|---|---|---|
| Argillite-Graywacke | Argillite is a fine-grained greenish gray bedded rock with a well-developed steeply dipping slaty cleavage. Massive graywacke is interbedded with argillite, especially near the base of the unit. Bedding strikes northeast and dips northwest. | Water moves along cleavage planes. Yields adequate amounts of water for domestic use. Moderate amounts of water can be obtained for industrial and municipal use at favorable locations. Average yield of two drilled wells is 21 gpm. No qualitative information available. |
| Metavolcanic Sequence | Includes an assemblage of phyllitic and sheared tuffaceous rocks of volcanic origin and minor beds of conglomerate and quartzite. Tuffs are mainly intermediate to felsic rocks which contain fragments and crystals at some localities. | Water moves along cleavage planes, joints, fractures, and quartz veins. Adequate amounts of water for domestic use available almost anywhere. Most favorable locations are in draws or quartz veins where small industrial and municipal supplies can generally be obtained. Average yield of 118 drilled wells is 12 gpm. Water hard to very hard at several localities, soft to moderately hard at other localities. Iron content generally low. |
| Mica Gneiss | Biotite-feldspar gneiss, quartzitic gneiss, garnetiferous biotite gneiss, and interbedded gneiss and schist. Most appear to be sedimentary in origin. Metamorphic structures and bedding strike mostly northeast with variable dips, most of which are northwest. | Water is stored in and moves along joints, fractures, and foliation planes. Wells at selected sites should yield adequate domestic supplies. Small yields for industries or municipalities may be obtained from large quartz veins or from rocks that are highly fractured. The average yield of 188 drilled wells is 16 gpm. Many wells yield 1 gallon a minute or less. Water generally soft, but may contain objectionable amounts of iron locally. |
| Hornblende Gneiss | Hornblende-feldspar gneiss with minor amounts of quartz and mica. Metamorphic structures conformable with structures in adjacent rock units. At places interbedded(?) with biotite gneiss. Schistose at places. | Water moves along joints, and foliation planes. Yields adequate amounts for domestic use nearly everywhere. The average yield of 12 drilled wells is 17 gpm. Water soft but contains objectionable amounts of iron at some places. |

Table 11.--Summary of the principal map units and their water-bearing properties--continued

| Unit | Description | Water-bearing properties |
|---|---|---|
| Mica Schist | Includes muscovite schist, sericite-muscovite schist, and biotite schist all of which have well-developed foliation. Also includes one relatively narrow northeast-trending zone of hornblende gneiss and feldspathic quartzite. Rocks mostly sedimentary in origin. | Water moves along foliation planes and fractures. Rocks of this unit are relatively good aquifers. Adequate amounts of water for domestic use can be obtained from drilled wells almost anywhere. Small municipal and industrial supplies available at favorable locations. Topographic location has an important bearing on yield of wells--hills should be avoided in favor of draws where possible. The average yield of 49 drilled wells is 19 gpm. Water is generally soft, but moderately hard at a few localities. Iron content is low to moderate. |
| Metasedimentary Sequence | Sequence of metamorphosed sediments. Feldspathic quartzite, metasiltstone, hornblende gneiss, and mica schist are principal rock types. Metamorphic structures parallel bedding which strikes northeast and dips generally northwest. | Water moves along foliation planes, joints, and other fractures. Adequate domestic supplies can be obtained from drilled wells at practically any location. Yields moderate industrial and municipal supplies to wells in favorable topographic locations. Wells in draws have higher yields than wells at other topographic locations. The average yield of 18 drilled wells is 19 gpm. Water is soft to moderately hard, with low to moderate iron content. |

## YIELD OF WELLS ACCORDING TO TOPOGRAPHY

The relative yields of wells according to topographic location are shown in table 12, and compared graphically as yield per foot of well in figure 19.

Minor topographic features are more important than major topographic features in determining the relative water-bearing characteristics of a restricted area underlain by crystalline rocks. Therefore, topography as used here includes only the surface features in the general vicinity of the well. Hills includes ridges, knolls or other upland surfaces that have sloping sides. Flat areas are those not inclined or inclined very little and not locally bounded by upland or depressed areas of any significance. Slopes are those surfaces on the sides of hills, ridges, knolls, or other upland areas which terminate in flat or depressed areas. Draws are relatively narrow, small depressions that may or may not contain a stream or spring. From these definitions a draw may be located on a slope or in a wide valley and a slope may be the side of a knoll in the same type of valley.

Wells on hills have a slightly lower average yield and yield per foot of well than do wells on slopes and flats (table 12).

Table 12.--Average yield of wells according to topographic location

| Topo-graphic location | Number of wells | Average depth (feet) | Yield (gpm) | | | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | Range | Average | Per foot of well | |
| Hill | 248 | 128 | 0-75 | 12 | 0.09 | 7.3 |
| Flat | 243 | 137 | 0-295 | 14 | .10 | 4.9 |
| Slope | 198 | 125 | .5-160 | 13 | .10 | 3.0 |
| Draw | 84 | 160 | 0-237 | 30 | .19 | 3.6 |
| All wells | 773 | 131 | 0-295 | 15 | .11 | 5.2 |

# YIELD OF WELLS ACCORDING TO DEPTH

The average yield of wells according to their range in depth are given in table 13. Figure 19 shows graphically the yield in gallons per foot of well in relation to the depth.

Table 13.--Average yield of wells according to depth

| Range in depth (feet) | Number of wells | Average depth (feet) | Yield (gpm) | | | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| | | | Range | Average | Per foot of well | |
| 0-100 | 350 | 74 | 0-60 | 13 | 0.18 | 2.9 |
| 101-150 | 204 | 123 | 0-237 | 14 | .11 | 4.5 |
| 151-200 | 110 | 172 | 0-90 | 14 | .08 | 10 |
| 201-250 | 47 | 224 | 0-100 | 16 | .07 | 13 |
| 251-300 | 27 | 284 | 0-295 | 29 | .10 | 11 |
| Greater than 300 | 35 | 412 | .5-160 | 29 | .07 | 5.7 |
| All wells | 773 | 131 | 0-295 | 15 | .11 | 5.2 |

There is a general decrease in the yield per foot of well from 0.18 gpm for wells 100 feet or less in depth to 0.07 gpm for wells 201 to 250 feet in depth. The increase in gallons per foot of well in the 251-300 interval is caused by one exceptionally good well which was tested at 295 gpm. If this well is excluded, the average yield per foot of well for wells 251 to 300 feet in depth would be 0.07 gpm instead of 0.10 gpm. It is interesting to note that the least percentage of wells yielding 1 gpm or less is for wells in the 0 to 100 foot range in depth. The average yield for wells in this depth range is 13 gpm which is more than adequate for domestic supplies, and most of the 350 wells 0 to 100 feet deep are domestic wells. The greatest percentage of wells yielding 1 gpm or less are between 201 to 250 feet in depth.

The reason for the general decrease in yield per foot of well with increased depth is the abundance of fractures and other interstices through which ground water moves decrease with depth. This is due partly to the weight of the overlying rocks which causes the fractures to become narrower (Mundorff, 1948, p. 32).

In very few instances is there justifiable evidence to warrant drilling to great depths in the rocks of the Raleigh area for substantial quantities of water. However, if the greatest amount of water is obtained above 200 to 250 feet, then the yield may be increased slightly with increased depth. If no water or very little water is encountered down to 250 feet, this is evidence that the rocks through which the well has penetrated contain few interstices through which ground water can move, and that the rocks below 250 feet contain even fewer such interstices.

# COUNTY DESCRIPTIONS

## INTRODUCTION

A description of the geography, geology, and ground-water resources is presented for each county with tables of well data and water analyses, and a map showing the location of wells for which data are given. The geology is shown on the geologic map, figure 5.

For drilled wells listed in the tables the depth of casing indicates roughly the depth to hard rock. The water levels listed are static levels reported by well drillers and owners, or measured by the author. Generally, the yields are estimates by the driller based on bailing tests. Because many of the tests were of short duration, the yields as recorded do not always represent the maximum capacity of the wells. Pumping tests of longer duration are so indicated in the tables.

Information concerning geography is from preliminary reports of the 1960 U. S. Census, and from personal observation. Town officials furnished the information on municipal water supply systems.

## FRANKLIN COUNTY

(Area: 494 square miles; population in 1960: 28,755)

### GEOGRAPHY

Franklin County is the third-largest county in the Raleigh area but is fourth in population. It is bounded on the east by Nash County, on the north by Warren and Vance Counties, on the west by Granville County, and on the south by Wake County. Louisburg, the county seat, is the largest town in the county. Other population centers include Youngsville, Franklinton, and Bunn.

The county is predominantly agricultural; its economy depends largely upon the sale of farm and dairy products. The major crops are tobacco, corn, and cotton. Textile manufacturing, lumbering, and tobacco processing are the leading industries.

Franklin County is in the Piedmont physiographic province. The topography is characterized by broad, rolling hills that have been formed by dissection of an uplifted peneplain. The relief is moderate, generally not exceeding 100 feet per mile near the larger streams. Altitudes range from near 500 feet above mean sea level in the western part of the county to slightly less than 200 feet in the eastern part.

More than 90 percent of the county is drained by the Tar River and its tributaries. A small area in southern Franklin County is drained by tributaries of the Neuse River. The Tar River and its major tributaries flow in a southeastern direction reflecting the general southeastern slope of the land surface. The large streams are only locally deflected and controlled by structure, but many small streams are controlled throughout their courses by the structure of the underlying rocks. Gradients of the smaller streams are moderate to high, whereas the major streams generally have low gradients.

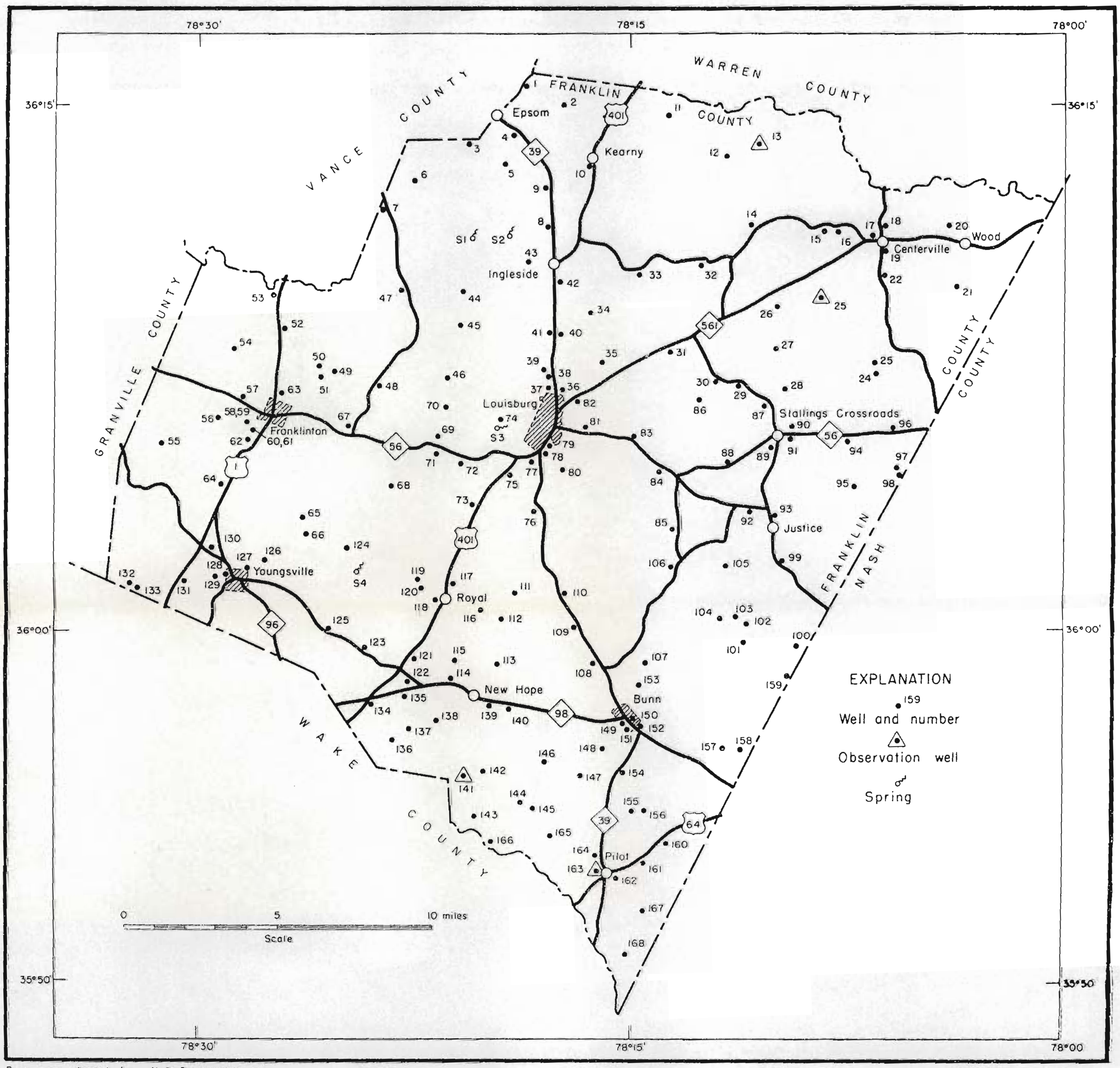
## GEOLOGY

Rocks of the metasedimentary sequence are exposed in the eastern part of Franklin County. Included in this sequence in the county are hornblende gneiss, feldspathic quartzite, and quartz-muscovite schist. All of the rock types are interbedded and conformable. Bedding and foliation strike north to northeast and undulatory folds dip both northwest and southeast. Folds of this nature in the schist can be seen on N. C. Highway 561 in the vicinity of Wood. Near the large granite pluton the predominant dip is eastward. The rocks are deeply weathered at most places; outcrops occur only in the deeper road cuts and in some stream channels.

Rocks of the mica schist unit crop out in a belt which extends from central Franklin County northeastward into Warren County. Included in this unit are muscovite schist, biotite schist, and a relatively thin zone of feldspathic quartzite and hornblende gneiss. Granite has intruded the rocks of this unit near the schist-granite contact. Many coarse-grained pegmatite dikes extend through the granite into the schist especially in the southern tip of the mica schist unit. The hornblende gneiss and feldspathic quartzite are interbedded and are conformable with overlying muscovite schist. Bedding and foliation strike northeast and dip northwest. The general northeast strike of structural features and bedding is consistent throughout most of the mica schist unit.

Mica gneiss is exposed at several places in the county. It is predominantly a biotite-feldspar gneiss containing varying amounts of quartz, muscovite, and accessory minerals. In the western part of the county, schist is interbedded with gneiss. Structural features in each rock type are essentially parallel and strike in a north to northeast direction. Textural and compositional banding in the gneiss is prominent near the granite. Banding appears in weathered outcrops as alternating lighter and darker colored clay zones. Many pegmatite dikes occur in the mica gneiss, especially in the contact zone between mica gneiss and granite. The rocks of the mica gneiss unit are probably sedimentary in origin. Dynamic and thermal metamorphism caused by the force of the granite intrusion and the emanations from the granite magma have migmatized and altered the rocks near the granite.

Phyllite is exposed in the southeastern corner of Franklin County. It is a light-tan to gray foliated rock composed of fine micaceous minerals and argillaceous material. Foliation strikes northeast and dips southeast parallel to a uniform color banding that is interpreted as bedding. Medium- to coarse-grained biotite granite underlies about two-thirds of Franklin County. It ranges in texture and composition from medium-grained biotite granite to coarse-grained binary granite. The coarse-grained binary granite at many localities appears to be a complex of large dikes and their host rock rather than a massive pluton. The chief minerals of both types of granite are orthoclase feldspar and quartz. Biotite mica, and plagioclase feldspar are present in varying proportions throughout the granite. Jointing is the most prominent structural feature; at most places at least two primary sets of joints intersect at near right angles.




Base map adapted from N.C. State Highway Commission County road map 1961.

Figure 22.--Map of Franklin County showing locations of wells and springs.

## GROUND WATER

Most of the domestic supplies, and one of the three municipal water supplies are obtained from wells. Springs are a source of water for a few homes.

Dug and bored wells are used extensively for domestic water supplies throughout the county. At most places the rocks are sufficiently weathered to permit construction of these types of wells to depths of up to 60 feet. Adequate amounts of water for domestic use can generally be obtained from dug or bored wells.

Data on 168 wells in Franklin County are presented below in table 15. Four springs are tabulated in table 16. Sufficient data were collected on 143 drilled wells to compare yields, depths, and other pertinent information in table 14 below.

Table 14.--Summary of data on wells in Franklin County

| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO ROCK TYPE | | | | | | |
| Metasedimentary Sequence | 12 | 117 | 3-64 | 21 | 0.18 | 0 |
| Mica Schist | 4 | 137 | 1-25 | 10 | .07 | 25 |
| Mica Gneiss | 25 | 182 | 0-100 | 14 | .08 | 12 |
| Phyllite | 5 | 139 | 10-60 | 41 | .29 | 0 |
| Granite | 97 | 126 | 0-60 | 14 | .11 | 5.2 |
| All wells | 143 | 135 | 0-100 | 16 | .12 | 6.3 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 61 | 144 | 0-60 | 14 | 0.10 | 9.8 |
| Flat | 22 | 132 | 2-50 | 15 | .11 | 0 |
| Slope | 34 | 128 | 0-36 | 10 | .08 | 5.9 |
| Draw | 26 | 129 | .5-100 | 24 | .19 | 3.8 |

According to table 14, the phyllite, rocks of the metasedimentary sequence, and granite are in that order the best aquifers. Considering all rock types, the average yield of 16 gpm is nearly the same as the average yield of 15 gpm for all wells in the Raleigh area and the average yield per foot of well for wells in Franklin County is only slightly larger than the same average for all wells in the five-county area.

Table 15.--Records of wells in Franklin County

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1¼ miles NE of Epsom------ | Roy E. Moss---- | Bored-- | 32 | 24 | 32 | Granite-- | -11 | 10-15 | | Flat-- | Adequately supplies 2 families |
| 2 | 2¼ miles NE of Epsom------ | J. C. Woodard | Drilled | 127 | 6 | 88 | --do----- | ------ | 10 | | Slope- | Analysis in table |
| 3 | 1½ miles SW of Epsom------ | Melvin Ayscue- | --do--- | 206 | 6 | 50 | --do----- | -28 | 1-3 | | Flat-- | Yield adequate for 1 family------- |
| 4 | 3/4 miles SE of Epsom--- | C. G. Eaves-- | Bored | 30 | 24 | 30 | --do----- | -15 | 10 | | --do-- | Adequately supplies 2 families |
| 5 | 1 3/4 miles S of Epsom--- | S. F. Ayscue | Drilled | 24 | 10-6 | 16 | --do----- | -10 | 9 | | --do-- | Ten inch casing to 8 feet, 6 inch casing to 16 feet------------ |
| 6 | 3½ miles SW of Epsom------ | P. C. Fuller- | --do--- | 330 | 6 | 12 | --do----- | -50 | 1-3 | | Hill-- | Reported inadequate yield----- |
| 7 | 4 3/4 miles SW of Epsom--- | Charles Brown-- | --do--- | 202 | 6 | 17 | --do----- | -17 | 1 | | --do-- | Yield of 1 gpm obtained at 30 feet------------- |
| 8 | 1¼ miles N of Ingleside-- | J. E. Hunt--- | --do--- | 163 | 6 | 40 | --do----- | ------- | 15-18 | | Slope-- | Adequately supplies 3 families |
| 9 | 2½ miles N of Ingleside-- | Perry Foster- | --do--- | 99 | 6 | 15 | --do----- | ------- | 10 | | Hill-- | |
| 10 | Kearney ----- | Mrs. W. H. Wilder- | Bored-- | 35 | 24 | 35 | --do----- | -20 | ------- | | Flat-- | |
| 11 | 3 miles NE of Kearney ---- | Mrs. Verlie Hicks-- | --do-- | 40 | 24 | 40 | Mica schist- | -29.56 | 8-10 | | Hill-- | Water level measured 3/16/62, temp. 60° F.---- |
| 12 | 4½ miles E of Kearney---- | E. E. Bobbitt--- | --do--- | 33 | 20 | 33 | --do----- | -22.4 | 1-3 | | Hill-- | Water level measured 4/4/62, temp. 59° F. Hard water reported.--------- |
| 13 | 5½ miles E of Kearney --- | W. H. Williams | --do--- | 60½ | 24 | 60½ | --do---- | -17.73 | ------- | | --do-- | Water level measured 4/4/62, temp. 59°F observation well |
| 14 | 4¼ miles W of Centerville | J. A. Bowers | Bored-- | 25 | 24 | 25 | Mica schist | -4.40 | 7-10 | | Slope-- | Water level measured 4/4/62, temp. 54° F |
| 15 | 1 3/4 miles W of Centerville------ | J. P. Dement | Drilled | 89 | 6 | 32 | Granite-- | ------ | 25+ | | Flat--- | Adequately supplie 3 families------ |
| 16 | 1½ miles W of Centerville | Franklin County Board of Education--- | --do--- | 219 | 6 | 95 | --do----- | ------ | 30 | | Draw--- | Perry School well, Centerville---- |
| 17 | Centerville-- | R. A. Leonard | --do--- | 96 | 6 | 93 | Metasediments-- | -15 | 45 | | Hill--- | Pumping level -60 feet at 45 gpm-- |
| 18 | Centerville-- | John Pleasants | --do--- | 145 | 6 | 115 | --do----- | -18 | 15+ | | --do--- | Analysis in table |
| 19 | Centerville-- | L. S. Ward | --do--- | 202 | 6 | 111 | --do----- | -12 | 64 | | Draw--- | Pumping level -80 feet at 64 gpm-- |
| 20 | ½ mile NW of Wood------- | Ollie Gupton | --do--- | 148 | 6 | 90 | --do----- | -30 | 30 | | Flat--- | Analysis in table |
| 21 | 1¼ miles S of Wood------- | B. T. Tucker- | Bored-- | 48 | 24 | 48 | --do----- | -33 | ------ | | Hill--- | Analysis in table |
| 22 | ½ mile S of Centerville | Willard Leonard | Drilled | 149 | 6 | 137 | --do----- | -35 | 10 | | --do--- | |
| 23 | 4 miles NE of Stallings Crossroads- | J. W. Thorne- | --do--- | 169 | 6 | -------- | --do----- | -7 | 3½ | | Slope-- | Hit hard rock within 10 feet of ground surface |
| 24 | 3 3/4 miles NE of Stallings Crossroads- | H. L. Thorne | --do--- | 40 | 6 | 7 | --do----- | flows- | 10 | | Draw-- | When not pumped well flows 1 to 2 gpm. Static level 1 ft above land surfacc. |
| 25 | 2 3/4 miles SW of Centerville------ | R. E. Stallings | --do--- | 152 | 6 | 8 | Granite-- | -10.38 | 0 | | Hill--- | Water level measured 3/22/62, temp. 56°F. Observation well-- |
| 26 | 4 miles SW of Centerville | George Rayner, Jr.----- | Drilled | 43 | 6 | 7 | Granite-- | -15 | 4 | | Slope-- | |
| 27 | 2-3/4 miles N of Stallings Crossroads- | Gradis Parrish | --do--- | 82 | 6 | 37½ | --do----- | -25 | 15 | | Hill--- | |
| 28 | 1½ miles N of Stallings Crossroads- | Robert Perry-- | --do--- | 186 | 6 | 17 | --do----- | -25 | 5 | | Flat--- | Adequately suplios 3 families------- |

Table 15.--Records of wells in Franklin County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 2 miles NW of Stallings Crossroads-- | Mrs. E. H. Gupton | --do--- | 215 | 6 | 7 | --do----- | -30 | 6 | | Hill--- | |
| 30 | 2 3/4 miles NW of Stallings Crossroads- | Mrs. S. N. Rowe--- | --do--- | 110 | 6 | 22 | --do----- | ------ | 3 | | Flat--- | |
| 31 | 5 miles NE of Louisburg-- | W. W. Wheeler | --do--- | 240 | 6 | ------- | Mica schist | ------ | 3 | | Slope-- | Analysis in table |
| 32 | 4 3/4 miles E of Ingleside | Jones Chapel Church- | --do-- | 89 | 6 | 70 | --do----- | ------ | 1 | | Hill--- | |
| 33 | 2 3/4 miles E of Ingleside | John R. Foster- | Bored-- | 51 | 20 | 51 | --do----- | -9.4 | 4-7 | | --do--- | Water level measured 4/4/62, temp. 59°F. Supplies 2 families------- |
| 34 | 2 miles SE of Ingleside-- | H. W. Hudson | Drilled | 196½ | 6 | 22 | Granite-- | -15 | 10-14 | | Slope-- | Moderately hard water reported |
| 35 | 2 3/4 miles NE of Louisburg-- | Lena Fogg | --do--- | 87 | 6 | 55 | --do----- | -30 | 6 | | Hill--- | |
| 36 | ½ mile N of Louisburg-- | L. R. Shuping | --do--- | 99 | 6 | 45 | --do----- | ------ | 35+ | | --do--- | Moderately hard water reported-- |
| 37 | ½ mile N of Louisburg-- | Ed Bartholomew | --do--- | 114 | 8 | 39 | --do----- | -20 | 30 | | --do-- | Drawdown of 70 ft at 30 gpm.----- |
| 38 | 3/4 mile N of Louisburg--- | Home Oil Company | Drilled | 219 | 6 | 83 | Granite-- | -20 | 2 | | Hill--- | |
| 39 | 1 mile N of Louisburg--- | T. H. Wynn--- | --do--- | 128 | 6 | 28 | --do----- | -30 | 30 | | --do--- | |
| 40 | 3 miles N of Louisburg--- | C. E. Atkins- | --do--- | 61½ | 6 | 47 | --do----- | -40 | 36+ | | Slope--- | |
| 41 | 3 miles N of Louisburg--- | C. E. Atkins- | --do--- | 62 | 6 | 13 | --do----- | ----- | 12 | | --do--- | Adequately supplies 3 families------ |
| 42 | 1 mile S of Ingleside-- | Elton Cooke-- | --do--- | 117 | 6 | ------- | Mica schist | -35 | 10 | | Draw--- | Slightly hard water reported-- |
| 43 | 1 miles W of Ingleside-- | S. J. Beasley | --do--- | 111 | 6 | 35 | Granite-- | -30 | 10+ | | Hill--- | |
| 44 | 3 miles SW of Ingleside-- | W. W. Wimm | Dug---- | 50 | 30 | 50 | --do----- | -42 | 15+ | | --do--- | Well dug in 1947 and has never gone dry-------- |
| 45 | 3½ miles SW of Ingleside-- | W. H. Cannady | Bored-- | 52 | 24 | 14 | --do---- | -39.0 | ------- | | --do--- | Bored 14 ft., dynamited 38 ft. Water level measured 4/5/62, temp. 59°F------ |
| 46 | 3½ miles NW of Louisburg-- | Norris Collins | Drilled | 75 | 6 | 68 | --do---- | -15 | 20 | | Draw--- | |
| 47 | 5 3/4 miles NE of Franklinton | Franklin County Board of Education--- | --do---- | 102 | 6 | 65 | Mica gneiss- | ----- | 20 | | Hill--- | Well at old site of Concord colored school-- |
| 48 | 4 miles NE of Franklinton | Bill Wilder- | --do--- | 50 | 6 | 32 | Granite-- | -20 | 6 | | Slope-- | |
| 49 | 2 3/4 miles NE Franklinton | Manassas Chapel | --do--- | 80 | 6 | 56 | Mica gneiss | ------ | 2 | | --do--- | |
| 50 | 2 miles NE of Franklinton | Miss Annie Conyers | --do--- | 110 | 6 | 35 | --do----- | -28 | 2 | | Hill--- | |
| 51 | 1 3/4 miles NE of Franklinton-------- | Jack Stroud | --do--- | 175 | 6 | 78 | --do----- | -16 | 5 | | Slope-- | |
| 52 | 3 miles N of Franklinton | Crescent Motel-- | Drilled | 85 | 6 | 35 | Mica gneiss- | ----- | 45 | | Hill--- | Adequately supplies 10-unit motel. Analysis in table------- |
| 53 | 4 miles N of Franklinton | W. L. McGhee | --do--- | 225 | 6 | 42 | --do----- | -30 | 7 | | --do--- | Moderately hard water reported-- |
| 54 | 2½ miles NW of Franklinton | Howard Pearce- | --do--- | 72 | 6 | 60 | --do----- | ------ | 2-4 | | Slope-- | |
| 55 | 3½ miles SW of Franklinton | Miss E. M. Holmes- | --do--- | 170 | 6 | 70 | --do----- | ------ | ½ | | --do--- | |
| 56 | 1 3/4 miles W of Franklinton-------- | Perry Wilder- | --do--- | 418 | 6 | 20 | --do----- | -25 | 20 | | Draw--- | Another well here is 444 feet deep and dry-------- |
| 57 | 1 mile NW of Franklinton | O. C. Carter- | --do--- | 150 | 6 | 72½ | --do----- | ----- | 10 | | Slope | |
| 58 | ½ mile W of Franklinton | C. H. Pergerson | --do--- | 77 | 8 | 41 | --do----- | -50 | 8 | | --do--- | Corrosive water reported. Adequately supplies 1 home and store |

Table 15.--Records of wells in Franklin County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | ½ mile W of Franklinton | C. H. Perperson- | --do--- | 384 | 6 | 25 | --do----- | -30.59 | ½- | | Hill--- | Inadequate yield, not used. Water level measured 4/9/62. Observation well |
| 60 | ½ mile SW of Franklinton | Preddy Hair Styling Salon-- | --do--- | 200 | 6 | 28 | --do----- | -11.7 | 5+ | | Slope-- | Water level measured 3/9/62, temp. 58° F.--- |
| 61 | ½ mile SW of Franklinton | Preddy Hair Styling Salon-- | --do--- | 275 | 6 | 38 | --do----- | ------ | 0 | | --do--- | Well about 30 ft. from well number 60 ----------- |
| 62 | 3/4 miles SW of Franklinton-------- | Franklin Oil Company | --do--- | 50 | 6 | 17 | --do----- | -10 | 18 | | --do--- | |
| 63 | 3/4 miles NE of Franklinton-------- | Ira Day-- | --do--- | 100½ | 6 | 55 | --do----- | -23.2 | 2-4 | | Hill--- | Water level measured 4/5/62, temp. 61° F.---- |
| 64 | 2 3/4 miles SW of Franklinton | Hubert H. Senter | Bored-- | 35 | 24 | 35 | Mica gneiss- | -18 | 14 | | Hill--- | |
| 65 | 3 miles NE of Youngsville | W. E. Thomas | Drilled | 216 | 6 | 105 | --do----- | -30 | 25-30 | | --do--- | |
| 66 | 2½ miles NE of Youngsville | C. L. Wrenn-- | Bored-- | 47 | 24 | 47 | --do----- | -36 | 10+ | | --do--- | Hit soft rock---- |
| 67 | 2½ miles E of Franklinton | Franklin Veneer Company | Drilled | 125 | 4 | ------- | --do----- | -35 | 2-4 | | --do--- | Inadequate yield, hard water reported-------------- |
| 68 | 6 miles SW of Louisburg-- | W. L. Lumpkin | --do--- | 64 | 6 | 22 | Granite-- | ------- | 14 | | Draw--- | |
| 69 | 3 3/4 miles W of Louisburg | E. L. Bowers | --do--- | 70 | 6 | -------- | --do----- | ------ | 6-10 | | Slope-- | Reported cased more than 40 ft. |
| 70 | 3½ miles W of Louisburg-- | Ed Bartholomew | --do--- | 259 | 6 | 33 | --do----- | -33.7 | 0 | | Hill--- | Water level measured 4/4/62 |
| 71 | 3 3/4 miles SW of Louisburg-- | Mrs. Viola Jones---- | --do--- | 54 | 6 | 31 | --do----- | -30 | 15 | | --do--- | |
| 72 | 3¾ miles SW of Louisburg--- | Billy Edwards | --do--- | 443 | 6 | 30 | --do----- | -14 | 15 | | Slope-- | Drawdown of 220 ft. at 15 gpm. All water obtained below 235 ft.-------- |
| 73 | 3½ miles SW of Louisburg-- | Bobby Davis-- | --do--- | 90 | 6 | 6 | --do----- | -2 | 3 | | --do--- | |
| 74 | 1 3/4 miles W of Louisburg | Raymond Wilson | --do--- | 220 | 6 | 11½ | --do----- | ------ | 12- | | Hill--- | Moderately hard, corrosive water reported------- |
| 75 | 2 miles SW of Louisburg-- | Miss Jessie Harris- | --do--- | 98 | 6 | 68 | --do----- | ------ | 20 | | Slope-- | |
| 76 | 2 3/4 miles S Louisburg-- | Kenan Hall--- | --do--- | 55 | 6 | 50 | --do----- | -15 | 12 | | Draw--- | |
| 77 | 1½ miles S of Louisburg-- | Johnston Cotton Company | --do--- | 170 | 6 | ------- | --do----- | ----- | 10 | | Slope-- | |
| 78 | Louisburg---- | Green Hill Country Club---- | Drilled | 164 | 6 | 66½ | Granite-- | ------ | 7 | | Draw--- | |
| 79 | Louisburg---- | Green Hill Country Club---- | --do--- | 75 | 12-8 | 16 | --do----- | ------ | 30 | | --do--- | Bored 14 feet.---- |
| 80 | ½ mile S of Louisburg-- | Floyd Height-- | --do--- | 140 | 6 | 40 | --do----- | ------ | 4 | | Hill--- | Bored 24 feet to soft rock------ |
| 81 | ½ mile E of Louisburg-- | Pruitt Lumber Company- | --do--- | 80 | 6 | ------- | --do----- | -9.08 | 10 | | Draw-- | Water level measured 4/4/62. Observation well |
| 82 | 1¼ miles NE of Louisburg-- | B. T. Rowe | --do--- | 98 | 6 | 69 | --do----- | -10 | 20 | | Flat--- | Second well here 120 ft. deep, cased 64 ft.; not used sand and silt in water----------- |
| 83 | 2½ miles E of Louisburg-- | Mrs. C. W. Southall | --do--- | 105 | 6 | 44 | Mica schist | -35 | 25 | | Slope-- | |
| 84 | 3 3/4 miles NW of Justice---- | Maple Springs Baptist Church-- | --do--- | 67 | 6 | 20 | Granite-- | -15 | 18 | | Draw--- | |
| 85 | 3¼ miles W of Justice---- | C. P. Harris-- | --do--- | 85 | 4 | 65 | --do----- | -15 | 15+ | | Slope-- | |
| 86 | 2 3/4 miles NW of Stallings Crossroads- | Mrs. [illegible] P. Neal--- | --do--- | 111 | 6 | 101 | --do----- | ------ | 15-20 | | Hill--- | Water contains iron---------- |

Table 15.--Records of wells in Franklin County--Continued

| Well No. | Location | Owner | Type of Well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87 | 1 mile N of Stallings Crossroads | St. Delight Baptist Church-- | --do---- | 40 | 6 | 30 | --do----- | ----- | 8 | | Flat--- | |
| 88 | 2 miles SW of Stallings Crossroads- | James H. Wheless | --do--- | 92 | 6 | 83 | --do---- | ----- | 5-7 | | Hill--- | Moderately hard water reported-- |
| 89 | ½ mile S of Stallings Crossroads- | Stallings' Milling Company | --do--- | 45 | 6 | 20 | --do---- | -16 | 20 | | --do--- | Slightly hard water reported-- |
| 90 | ½ mile NE of Stallings Crossroads | Stallings' Milling Company | Drilled | 120 | 6 | 60 | Meta-sediments | -20 | 30+ | | Draw--- | Adequately supplies 5 families and milling plant. Water slightly hard--------- |
| 91 | ½ mile E of Stallings Crossroads | Charlie Stallings | --do--- | 50 | 5 | 1 | --do----- | -18 | 10+ | | Hill--- | Hard water reported------------- |
| 92 | 1 mile NW of Justice---- | Tar River Baptist Association---- | --do--- | 106 | 6 | 65 | Granite-- | -15 | 15 | | Slope-- | |
| 93 | Justice------ | J. C. Bowder-- | --do--- | 44 | 6 | 24 | --do----- | -15 | 40 | | Hill--- | Slightly hard, corrosive water reported------- |
| 94 | 2¼ miles E of Stallings Crossroads | T. O. Nelms | --do--- | 198 | 6 | 148 | --do----- | -12 | 25-30 | | --do--- | Slightly hard water reported-- |
| 95 | 3 miles SE of Stallings Crossroads | D. B. Gardner----- | --do---- | 168 | 6 | 122 | --do----- | -12 | 24 | | Slope-- | |
| 96 | 3 3/4 miles E of Stallings Crossroads | P. R. Inscoe----- | --do--- | 115 | 6 | 105 | --do----- | -16 | 6 | | Flat--- | Analysis in table |
| 97 | 4 miles SE of Stallings Crossroads | I. T. Inscoe-- | --do--- | 120 | 4 | 100 | --do----- | -16 | 2 | | Slope-- | Yield adequate---- |
| 98 | 4 miles SE of Stallings Crossroads | I. T. Inscoe-- | --do--- | 63 | 6 | 60 | --do----- | -16 | 6 | | --do--- | |
| 99 | 1½ miles S of Justice---- | C. B. Harris-- | Bored-- | 27 | 20 | 27 | --do----- | -15 | 10 | | Flat--- | Hit rock at 27 feet----------- |
| 100 | 4 miles S of Justice---- | G. R. Sykes--- | --do--- | 28 | 24 | 28 | --do----- | -20 | 5-7 | | Slope-- | Slightly hard water reported-- |
| 101 | 4 miles S of Justice--- | E. R. Moore-- | Drilled | 150 | 6 | ------- | Metasediments-- | -50 | 8-10 | | Hill--- | Water is turbid and contains iron--------- |
| 102 | 3½ miles S of Justice--- | Eugene Fisher | Bored- | 58 | 24 | 58 | Granite-- | -25 | 25+ | | Slope-- | |
| 103 | 3¼ miles S of Justice--- | C. M. Moore-- | Drilled | 196 | 6 | ------- | --do----- | -47 | 5-7 | | Hill--- | Supplies 3 families |
| 104 | 3½ miles S of Justice--- | J. S. Collie- | --do--- | 148 | 6 | ------- | --do----- | -30 | 7-10 | | --do--- | |
| 105 | 2 miles SW of Justice--- | Rosa Webb | Bored-- | 25 | 24 | 25 | --do----- | -12 | 10 | | Slope-- | |
| 106 | 3½ miles SW of Justice | W. P. Murray--- | --do--- | 30 | 24 | 30 | --do----- | -15 | 5-7 | | Hill--- | Hit rock at 30 ft. |
| 107 | 2 miles N of Bunn------ | B. R. Alford- | Drilled | 85 | 8 | 20 | --do----- | -10 | 10 | | Slope-- | Adequately supplies 4 families------ |
| 108 | 2 miles NW of Bunn------ | John Winstead-- | --do--- | 73 | 6 | 10 | --do----- | -20 | 20 | | Flat-- | Water contains iron--------- |
| 109 | 3½ miles NW of Bunn---- | N. M. Edwards | Bored-- | 19 | 24 | 19 | --do----- | -6 | 7-10 | | Draw--- | |
| 110 | 4½ miles NW of Bunn---- | W. G. Wrenn-- | --do--- | 32 | 24 | 32 | --do----- | -16 | 4-6 | | Slope-- | |
| 111 | 3½ miles N of New Hope--- | C. H. Newton | Drilled | 55 | 6 | 32 | --do----- | -40 | 24 | | Hill--- | |
| 112 | 2 3/4 miles N of New Hope------- | Claude Moody-- | Bored-- | 41 | 24 | 41 | --do----- | -26 | 1-3 | | --do--- | Adequate yield-- |
| 113 | 1¾ miles NE of New Hope | J. P. Medlin---- | Drilled | 42½ | 6 | ------- | --do---- | -12.6 | 8-10 | | Draw-- | Water level measured 2/28/62-------- |
| 114 | ½ mile NW of New Hope--- | G. M. Driver- | --do-- | 206 | 6 | 20 | --do----- | -20 | 0 | | Hill-- | |
| 115 | 1¼ miles NW of New Hope | Mrs. Lonnie Robbins | --do-- | 75 | 6 | 5 | --do----- | -8.85 | ½- | | Draw--- | Water level measured 2/28/62, temp. 56° F. Observation well----------- |

Table 15.--Records of wells in Franklin County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 116 | 1¾ miles SE of Royal-- | Moses Loyd--- | Bored- | 25 | 24 | 25 | Granite | -10 | 8-10 | | Slope- | Did not hit rock |
| 117 | ¼ mile N of Royal----- | C. A. Arnold- | Drilled | 305 | 6 | -------- | --do---- | ------ | 3 | | --do-- | All water obtained at 125 feet |
| 118 | Royal------- | A. C. Joyner- | --do--- | 155 | 6 | 5 | --do----- | -40 | 2 | | Hill-- | |
| 119 | 1 mile NW of Royal----- | L. H. Wilson- | --do--- | 59 | 6 | ------- | --do----- | -15 | 40 | | Draw-- | Analysis in table |
| 120 | 3/4 miles NW of Royal-- | W. C. Tippett | --do--- | 500 | 6 | 30 | --do----- | -25 | 40+ | | Hill-- | Most of water obtained below 475 feet. Too hard for domestic use--- |
| 121 | 2 miles SW of Royal----- | Brooks Young-- | --do--- | 85 | 6 | 65 | --do---- | -17 | 35 | | --do-- | |
| 122 | 2 3/4 miles SW of Royal | Harris Chapel Church- | --do--- | 57 | 8-6 | 40 | --do---- | -20 | 20+ | | Draw-- | Diameter 8 inches to 40 feet, 6 inches below 40 feet-------- |
| 123 | 3 miles SW of Royal----- | M. T. Carter- | --do--- | 100 | 6 | -------- | --do---- | ------ | 15+ | | Hill-- | |
| 124 | 3½ miles NW of Royal-- | H. L. Preddy | --do--- | 150 | 6 | 86 | --do---- | -28 | 3-5 | | Hill-- | |
| 125 | 4 miles SW of Royal------ | George W. Murphy | Bored-- | 35 | 24 | 35 | --do---- | -20 | 10 | | Slope- | Water contains small amount of iron----------- |
| 126 | 1 mile NE of Youngsville | Ernest Grissom | --do--- | 35 | 24 | 35 | Mica gneiss | -27 | 5 | | Hill-- | |
| 127 | Youngsville- | Town of Youngsville-- | Drilled | 499 | 8 | 36 | --do---- | ------ | 3 | | --do-- | Not used, yield inadequate. |
| 128 | ½ mile W of Youngsville | Town of Youngsville-- | --do--- | 250 | 8 | 51 | --do---- | -22 | 100 | | Draw-- | Drawdown 170 feet after 10 hours pumping at 100 gpm |
| 129 | ½ mile W of Youngsville | Town of Youngsville--- | --do---- | 245 | 8 | ------ | --do---- | -20 | 50 | | --do-- | Pumped 24 hours at 50 to 75 gpm |
| 130 | 1¼ miles NW of Youngsville | F. C. Winston | Drilled | 123 | 6 | 60 | Mica gneiss | ------ | 8-10 | | Hill-- | Adequately supplies 2 families. Analysis in table----------- |
| 131 | 1½ miles W of Youngsville | E. J. Hayes-- | --do--- | 102½ | 6 | ------- | --do---- | -39.71 | 2- | | --do-- | Bored 50 feet. Water level measured 3/13/63, temp. 60°F. Observation well------ |
| 132 | 3½ miles W of Youngsville | James Lye | --do--- | 110 | 6 | 90 | --do---- | ------ | 18 | | --do-- | |
| 133 | 3¼ miles W of Youngsville | Howard Fay---- | --do--- | 210 | 6 | 90 | --do---- | -36 | 1-3 | | Hill-- | Analysis in table |
| 134 | 3¾ miles SW of New Hope | Zeb Whitaker---- | --do--- | 55½ | 6 | 22 | Granite- | -17 | 60 | | --do-- | Water corrosive-- |
| 135 | 2¼ miles W of New Hope-- | Leonard Frazier | --do--- | 81 | 6 | 70 | --do---- | -8 | 7 | | Draw-- | |
| 136 | 3 miles SW of New Hope-- | T. G. Lloyd-- | --do--- | 54 | 6 | 20 | --do---- | -26 | 15+ | | Hill-- | |
| 137 | 2½ miles SW of New Hope | Bill Perry-- | --do---- | 130 | 6 | -------- | --do---- | ------ | 15+ | | --do-- | |
| 138 | 1½ miles SW of New Hope | W. L. Rogers | --do--- | 125 | 6 | 80 | --do---- | -35 | 1½ | | --do-- | |
| 139 | ½ mile SE of New Hope-- | Jack Strickland--- | --do-- | 103 | 6 | 15 | --do---- | -15 | 10-15 | | --do-- | Hard water reported------- |
| 140 | 1¾ miles SE of New Hope | C. B. Richardson---- | --do--- | 60 | 6 | 20 | --do---- | -30 | 15 | | --do-- | |
| 141 | 2¼ miles S of New Hope-- | K. B. Dunn--- | --do--- | 150 | 6 | 10 | --do----- | -13.4 | 2- | | --do-- | Water level measured 2/27/62, temp. 60°F.--- |
| 142 | 2½ miles S of New Hope-- | T. C. Arnold | --do--- | 101 | 6 | ------- | --do---- | ------ | 3-5 | | Slope | Moderately hard water reported |
| 143 | 4 miles S of New Hope--- | J. S. Gray, Jr. | Drilled | 68 | 6 | 18 | Granite-- | -17 | 15 | | Draw-- | |
| 144 | 3 3/4 miles NW of Pilot--- | A. E. Pearce-- | --do-- | 101 | 6 | 58 | --do----- | -25 | 4-6 | | Flat-- | |
| 145 | 3¼ miles NW of Pilot------ | Franklin County Board of Education--- | --do--- | 300 | 6 | 61 | --do----- | ----- | 5 | | --do-- | Well now used by church-------- |

Table 15.--Records of wells in Franklin County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 3 miles SW of Bunn------- | Ben L. Perry-- | --do--- | 91 | 6 | 10 | --do----- | -20 | 5 | | Draw-- | |
| 147 | 2½ miles SW of Bunn------- | Carter Holmes- | --do--- | 105 | 6 | 5 | --do----- | -10 | 3-5 | | Slope- | Adequately supplies 2 families----- |
| 148 | 1¾ miles SW of Bunn------- | Franklin County Board of Education--- | --do--- | 199 | 6 | 111 | --do----- | ----- | 15 | | --do-- | Gethsemane School well-- |
| 149 | Bunn--------- | Carl Mullen- | --do--- | 186 | 6 | 59 | --do----- | -20 | 5 | | Flat-- | |
| 150 | Bunn--------- | John Wiggs | --do--- | 81½ | 6 | 39 | --do----- | ------ | 4 | | Hill-- | |
| 151 | Bunn -------- | Franklin County Board of Education--- | --do--- | 329 | 8 | 87 | --do----- | -15 | 15 | | Draw-- | Bunn School well. Another well here is 265 ft. deep, yield 6 gpm--------- |
| 152 | Bunn---------- | E. Williams-- | --do--- | 107 | 6 | 74 | --do----- | -20 | 30 | | Flat-- | |
| 153 | 1 mile N of Bunn-------- | Mrs. W. W. Winstead | --do--- | 100 | 6 | 53 | --do----- | ----- | 40 | | --do--- | Water turbid. Analysis in table-------- |
| 154 | 1 3/4 miles S of Bunn---- | C. T. Cheaves Estate- | --do--- | 100 | 6 | 65 | --do----- | -25 | 5 | | Hill-- | |
| 155 | 2¼ miles N of Pilot------ | S. C. Mullen- | --do--- | 92 | 6 | 20 | --do----- | -30 | 5-7 | | Flat--- | |
| 156 | 2½ miles N of Pilot----- | M. B. Reddingfield | Drilled | 120 | 6 | 90 | Granite-- | -20 | 10 | | Flat-- | Adequately supplies 3 families------ |
| 157 | 3 miles E of Bunn------ | Paul Sledge- | Bored-- | 50 | 20 | 50 | Metasediments- | ----- | 4-6 | | Hill-- | |
| 158 | 3 3/4 miles E of Bunn--- | J. J. Davis-- | Drilled | 67 | 8 | 30 | --do---- | -35 | 8-10 | | Slope-- | Analysis in table |
| 159 | 5¼ miles NE of Bunn---- | Howard Wilson- | --do--- | 72 | 6 | 50 | --do---- | -32 | 18 | | Hill--- | Corrosive water reported------ |
| 160 | 2¼ miles NE of Pilot-- | J. O. Williams | --do--- | 144 | 6 | 80 | Phyllite- | -20 | 60 | | --do--- | Analysis in table |
| 161 | 1¼ miles NE of Pilot-- | E. R. Privette | --do--- | 160 | 8 | ------- | --do---- | ----- | 25 | | Draw-- | Reported to have flowed when drilled------- |
| 162 | ¼ mile E of Pilot----- | H. E. Stallings | --do--- | 120 | 6 | ------- | --do---- | ------ | 60+ | | --do-- | Adequately supplies 6 to 8 families------ |
| 163 | Pilot------- | Calvin Spann-- | --do--- | 194 | 6 | ------- | Granite- | -6.17 | 10 | | --do--- | Water level measured 2/23/62, temp. 57°F. Observation well---------- |
| 164 | ½ mile N of Pilot----- | Calvin Spann-- | --do--- | 76 | 6 | 63 | --do---- | -15 | 15 | | --do-- | |
| 165 | 2¼ miles NW of Pilot | Jessie Privette | --do--- | 46 | 6 | 44 | --do---- | -26 | 20 | | Flat-- | |
| 166 | 4 miles w of Pilot----- | H. K. Baker-- | --do--- | 45 | 6 | 5 | --do---- | -20 | 11 | | Hill-- | Water contains small amount of iron----------- |
| 167 | 1 3/4 miles SE of Pilot | P. C. Massey- | --do--- | 129 | 6 | 90 | Phyllite | -15 | 10 | | Flat-- | |
| 168 | 2 3/4 miles SE of Pilot | Eddie Jones-- | --do--- | 144 | 6 | 122 | --do---- | -30 | 50 | | --do-- | |

Table 16.--Records of springs in Franklin County

| Spring Number | Location | Owner | Yield (gpm) | Chief Aquifer | Topography | Remarks |
|---|---|---|---|---|---|---|
| $S_1$ | 2-3/4 miles NW of Ingleside------ | Wesley Pendergrass------- | 2-4 | Granite | Head of draw | Spring fed by water percolating through saprolite overlying solid granite rock. Spring never known to go dry. Temp. 51°F----------- |
| $S_2$ | 1-3/4 miles NW of Ingleside------ | R. N. Ayscue | 8-10 | --do--- | Draw-------- | Water issues from near horizontal fracture in granite. Temp. 60°F---------------- |
| $S_3$ | 1-3/4 miles W of Louisburg------ | Raymond Wilson | 3 | --do--- | Head of draw | Water issues from joints in granite------------------- |
| $S_4$ | 3 miles W of Royal---------- | M. S. Perry | 3-5 | --do--- | Draw-------- | Spring fed from fractures in granite. Has been used for 50 years------------------ |

At most places adequate domestic supplies of water can be obtained from drilled wells in any of the rock units in Franklin County. Small industrial or municipal supplies may be obtained from wells located where ground water conditions are favorable. Visible features indicative of favorable ground water conditions include highly fractured zones in the rock, pegmatite dikes, quartz veins, and topographically low areas. The yield of wells located in draws in the county is almost twice the yield of wells at any other topographic location.

Complete analyses of 13 water samples from wells in Franklin County are given in table 17. At least one analysis was made of water in each of the rock units.

Ground water in Franklin County is principally of the calcium and sodium-bicarbonate type. The iron ranges from 0.03 ppm to 0.97 ppm. The water is soft to moderately hard. Ground water in Franklin County is suitable for most municipal, domestic, and industrial uses.

The hardest water came from well 31 in mica schist; it has a hardness of 125 ppm. The overall chemical quality indicates that the water entering the well had filtered through a carbonate-rich rock such as marble or dolomite. Rocks of this nature do not outcrop in the area. However, all of the rocks are deeply weathered and carbonate rocks are especially susceptible to chemical weathering. For all of the samples, the hardness ranged from 8 to 125 ppm, with only two samples having a hardness exceeding 70 ppm, one from the metasedimentary sequence and one from mica schist. The largest concentrations of iron, 0.97 and 0.89 ppm, were in water from mica gneiss, and from the metasedimentary sequence, respectively. These unusually large concentrations may be caused by slow filtration of water through rocks containing a large percentage of iron-bearing minerals, such as biotite mica and hornblende. Only these two samples had an iron content greater than 0.3 ppm.

## MUNICIPAL SUPPLIES

Only one of the three municipal water systems in Franklin County obtains its water from wells.

The town of Youngsville (population about 600) in the southwestern part of the county obtains its water supply from two drilled wells, numbers 128 and 129 in well table 15. The oldest well, number 129, was drilled in 1940 to a depth of 245 feet, and yields about 50 gpm with continuous pumping. Well number 128 was drilled in 1955 as a supplementary supply. It is 250 feet deep and yields 100 gpm with a drawdown of about 170 feet. The two wells are pumped alternatingly and supply water to an elevated tank which has a storage capacity of 90,000 gallons. The municipal system has about 200 tap-ons and the average daily consumption is 35,000 gallons. The water is of good chemical quality and is treated only to prevent corrosion of the pipes in the distribution system.

Table 17.--Chemical analyses of ground water from Franklin County. (Numbers at heads of columns correspond to well numbers in table 15.)

(Parts per million)

| | 2 | 18 | 20 | 21 | 31 | 52 | 96 |
|---|---|---|---|---|---|---|---|
| Date of Collection | 7/24/62 | 7/26/62 | 7/26/62 | 7/26/62 | 3/14/63 | 8/14/62 | 7/26/62 |
| Silica ($SiO_2$) | 30 | 33 | 33 | 8.4 | 26 | 47 | 42 |
| Aluminum (Al) | .1 | .1 | .0 | .1 | .1 | .0 | .1 |
| Iron (Fe) | .09 | .89 | .19 | .03 | .12 | .24 | .03 |
| Manganese (Mn) | .02 | .04 | .02 | .02 | .00 | .00 | .00 |
| Calcium (Ca) | 5.2 | 19 | 7.2 | 14 | 28 | 14 | 4.6 |
| Magnesium (Mg) | 3.4 | 8.5 | 3.1 | 1.3 | 13 | 3.5 | .4 |
| Sodium (Na) | 4.3 | 9.0 | 5.7 | 10 | 38 | 9.1 | 6.9 |
| Potassium (K) | 1.5 | 2.8 | 2.0 | 1.8 | 1.0 | .3 | 1.4 |
| Lithium (Li) | .0 | .1 | .1 | .0 | .2 | .1 | .0 |
| Bicarbonate ($HCO_3$) | 41 | 117 | 48 | 45 | 216 | 62 | 32 |
| Sulfate ($SO_4$) | 2.2 | 5.0 | 3.8 | 3.6 | 5.6 | 4.0 | .4 |
| Chloride (Cl) | 2.7 | 2.5 | 3.2 | 14 | 14 | 6.0 | 4.1 |
| Fluoride (F) | .2 | .2 | .1 | .1 | 2.0 | .3 | .0 |
| Nitrate ($NO_3$) | 4.6 | 1.3 | 1.2 | 11 | .0 | 6.2 | .9 |
| Phosphate ($PO_4$) | .0 | .0 | .1 | .0 | .0 | .1 | .1 |
| Dissolved Solids | 74 | 140 | 84 | 86 | 234 | 122 | 77 |
| Hardness as $CaCO_3$ | 28 | 82 | 30 | 40 | 125 | 49 | 14 |
| Noncarbonate | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| Specific Conductance | 78 | 183 | 85 | 140 | 370 | 140 | 64 |
| pH | 6.8 | 7.4 | 6.8 | 6.9 | 7.8 | 6.8 | 6.4 |
| Color | 3 | 7 | 2 | 3 | 5 | 2 | 2 |
| Map Unit | Granite | Meta-sediment | Meta-sediment | Meta-sediment | Mica schist | Mica gneiss | Granite |

| | 119 | 130 | 133 | 153 | 158 | 160 |
|---|---|---|---|---|---|---|
| Date of Collection | 7/26/62 | 3/4/63 | 8/14/62 | 7/25/62 | 8/14/62 | 7/25/62 |
| Silica ($SiO_2$) | 36 | 33 | 23 | 37 | 23 | 33 |
| Aluminum (Al) | .3 | .1 | .0 | .1 | .0 | .1 |
| Iron (Fe) | .07 | .03 | .97 | -- | .09 | .10 |
| Manganese (Mn) | .02 | .00 | .00 | .04 | .00 | .02 |
| Calcium (Ca) | 2.7 | 4.4 | 19 | 3.3 | 7.2 | 1.9 |
| Magnesium (Mg) | 1.5 | 1.0 | 3.8 | .4 | 2.5 | .5 |
| Sodium (Na) | 4.0 | 5.3 | 5.8 | 8.6 | 16 | 3.7 |
| Potassium (K) | 1.4 | 1.0 | 1.0 | 1.4 | 1.4 | 1.6 |
| Lithium (Li) | .0 | .0 | .0 | .0 | .0 | .0 |
| Bicarbonate ($HCO_3$) | 25 | 31 | 90 | 32 | 16 | 19 |
| Sulfate ($SO_4$) | 1.4 | 1.0 | 2.4 | 2.2 | 5.2 | 2.2 |
| Chloride (Cl) | 3.5 | 2.7 | 2.7 | 2.6 | 18 | 1.0 |
| Fluoride (F) | .1 | .1 | .1 | .0 | .0 | .0 |
| Nitrate ($NO_3$) | 1.7 | .0 | .1 | 1.2 | 20 | 1.4 |
| Phosphate ($PO_4$) | .0 | .2 | .0 | .0 | .0 | .0 |
| Dissolved Solids | 65 | 64 | 102 | 73 | 101 | 54 |
| Hardness as $CaCO_3$ | 14 | 16 | 62 | 10 | 28 | 8 |
| Noncarbonate | 0 | 0 | 0 | 0 | 15 | 0 |
| Specific Conductance | 55 | 54 | 140 | 66 | 158 | 40 |
| pH | 6.6 | 6.7 | 7.4 | 6.3 | 6.5 | 6.2 |
| Color | 0 | 5 | 2 | 3 | 2 | 3 |
| Map Unit | Granite | Mica gneiss | Mica gneiss | Granite | Meta-sediment | Phyllite |

# GRANVILLE COUNTY

(Area: 542 square miles; population in 1960: 33,110)

## GEOGRAPHY

Granville County, the most northwestern county in the Raleigh area, has the second largest area and population. It is bordered to the east by Vance and Franklin Counties, to the south by Wake and Durham Counties, to the west by Person and Durham Counties, and to the north by Virginia. Oxford, population 6,978, is the county seat and largest town in the county. Other population centers include Creedmoor, Virgilina, Stovall, and Butner.

The chief source of income in the county is from the sale of agricultural and dairy products. Tobacco is the chief crop, but cotton, corn, vegetables, and hay are also important sources of income. Industries include textile manufacturing plants, tobacco processing centers, and warehouses, and a tobacco research laboratory near Oxford. There are also several small locally owned sawmill and lumbering operations scattered over the county.

Granville County lies within the Piedmont physiographic province. The surface has been dissected by swift-flowing small streams producing many north and northeast trending ridges. One of the most prominent of these ridges is located 2 miles east of Culbreth in the southwestern section of the county. Bowlings Mountain, elevation 740 feet, is part of this ridge and is the highest point in the county. Several other monadnocks are between 600 and 700 feet in elevation, and rise 150 to 200 feet above the general surrounding surface. At most places, however, the relief is moderate and ranges from 100 to 125 feet.

The southern part of the county is drained by south-flowing tributaries of the Neuse River. The central part is drained southeastward by the Tar River and its tributaries. The northern part of the county is drained northward by tributaries of the Roanoke River. Most of the tributary streams rise within the county, and their courses are largely controlled by the differential resistance of rocks to erosion. The Tar River rises to the west of Granville County and flows southeastward across the general structural trend.

## GEOLOGY

Rocks of the mica gneiss unit crop out in southeastern Granville County. They are predominantly interbedded mica schists and gneisses. The schists are chiefly of the coarse-grained biotite-quartz variety containing large red garnets that are especially prevalent along the axes of small folds. The most abundant gneiss is a medium-grained quartz-feldspar-biotite gneiss that also contains garnets which are disseminated through the rock. It differs from the schist in that it contains feldspar and has a greater quartz content. The rocks are interbedded and appear to be of sedimentary origin. Bedding and foliation strike northeast and dip northwest.

Two soapstone bodies crop out in southeastern Granville County. They are enclosed by rocks of the mica gneiss unit, and are elongated in a northeast direction approximately parallel to the strike of structural features and bedding in the enclosing rocks. The soapstone is a massive to foliated pale-green rock composed essentially of chlorite and talc. Accessory minerals include actinolite, tremolite, and serpentine. The soapstone probably was formed by the hydrothermal alteration of ultramafic intrusives.

Rocks of the metavolcanic sequence underlie most of Granville County. Included in this sequence is an assemblage of rocks, that are at most places sheared and phyllitic, that are primarily of volcanic origin, but also included are minor beds of sedimentary origin. The rocks of volcanic origin include felsic to intermediate tuffs, mafic tuffs, breccia, a few rhyolite flows, and basalt. A few beds of conglomerate, and at least one bed of quartzite are interbedded with the rocks of volcanic origin. The tuffs predominate. The felsic to intermediate tuffs range in composition from fine-grained rocks composed of volcanic ash to lithic tuffs that contain fragments of feldspar and quartz set in a fine-grained matrix. Where the feldspar grains are euhedral to subhedral, the rock is similar to felsic crystal tuffs in Moore County, as described by Conley (1962, p. 4). Mafic tuffs are interbedded with the felsic tuffs at several places. The tuffaceous rocks have a well developed cleavage at most places that strikes north to northeast. Massive basalt and rhyolite are also minor rock types in the sequence.

Rocks of the argillite-graywacke unit underlie a small area in the extreme northwestern corner of Granville County. The argillite is a fine-grained, gray to greenish-gray rock that breaks into platy fragments along a nearly vertical cleavage. Massive green graywacke is interbedded with the argillite and at several places the contact between graywacke and argillite appears to be gradational. Beds of conglomerate are associated with the graywacke near the base of the sequence. Bedding in the sequence strikes northeastward and dips steeply to the northwest.

Greenstone crops out as narrow northeast-trending belts in the northwestern part of the county. A much larger belt of greenstone is exposed in northeastern Granville County. Typically the rock is green to greenish gray, fine textured, and contains small phenocrysts of feldspar, and amygdules filled with quartz, feldspar, and sparse calcite at most localities. Commonly the rock has a cleavage structure and where cleavage is especially well developed the rock is a green schist. Chlorite is the predominant mineral. Accessory minerals include hornblende, feldspar, and epidote. The greenstone is probably a metamorphosed mafic extrusion.

Granodiorite bodies are exposed across the central part of Granville County, and are enclosed by rocks of the metavolcanic unit or bordered by the younger indurated sediments of Triassic age. The granodiorite is a gray to pinkish-gray crystalline rock composed of feldspar (mostly albite), quartz, biotite mica, and accessory amounts of muscovite, orthoclase feldspar, sericite, and opaque minerals. Inclusions of rocks of the metavolcanic unit are common in the granodiorite, but the inclusions do not contain metamorphic minerals indicative of intense dynamic and thermal metamorphism. Around the edges of the bodies, rocks of the metavolcanic unit and granodiorite are interlayered. Contacts as shown on the geologic map represent contact zones wherein there is an apparent change in the predominant rock type.

The granodiorite in Granville County, as well as in Vance County, appears to have been emplaced by some process other than forceful intrusion of magma.

Hornblende gabbro underlies four small areas in the county. It is chiefly a medium- to coarse-grained, black- to greenish-black rock composed essentially of hornblende and plagioclase feldspar. Epidote is a common accessory mineral formed as an alteration product of feldspar. The gabbro weathers readily to a dark-red clay-soil, and exposures are usually exfoliated boulders that accumulate at the surface.

A small body of granite is exposed in the southeastern part of Granville County. It is a medium-grained biotite granite, essentially the same in texture and composition as the much larger granite pluton in Franklin and Wake Counties. A light-colored granular saprolite mantles granite at most localities.

The Triassic Durham basin extends into southern Granville County, and ends about 2 miles southeast of Oxford. Along the northwestern edge of the basin, interbedded arkosic sandstone and shale lie unconformable upon rocks of the metavolcanic unit. The beds dip at about 10 to 15 degrees towards the Jonesboro fault which forms the eastern boundary of the basin. The sandstone is a buff-colored rock that weathers to a light-colored sandy loam. Conglomerate lenses occur within the sandstone at several localities. The shales are purple to maroon and weather faster than the sandstones. A coarse fanglomerate of rounded to subrounded boulders, cobbles, pebbles, and angular rock fragments is exposed along the western edge of the Jonesboro fault. Many black diabase dikes intrude the Triassic rocks.

## GROUND WATER

All domestic water supplies are obtained from wells or springs. Springs are common, but only a few have been developed for domestic supplies. No industries or municipalities in the county use ground water.

Although dug and bored wells are a common source of water in the rural areas, fewer wells of these types are found in Granville County than in any of the other counties in the area of investigation. The rocks of the metavolcanic and Triassic units are not generally weathered deeply. Consequently, the weathered material overlying these rocks is not deep enough to insure an adequate supply of water through the drier seasons. Most of the rocks in the county weather to produce a relatively impermeable clay soil. Dug and bored wells in the county range in depth from 15 to 35 feet and average less than 5 gpm.

Records of 154 wells are presented below in table 19. Comparative yields and depths are shown below for 149 of the wells in table 18.

The average yield of 10 gpm for the 149 wells is 50 percent less than the average yield of all wells in the Raleigh area. Wells in the rocks of the argillite-graywacke unit have the largest average yield. Although data on only two wells in this unit were used in compilation of the comparative table, the average yield of 21 gpm does not appear to be greater than what can be expected, because water moves readily along the well-developed cleavage

Table 18.--Summary of data on wells in Granville County

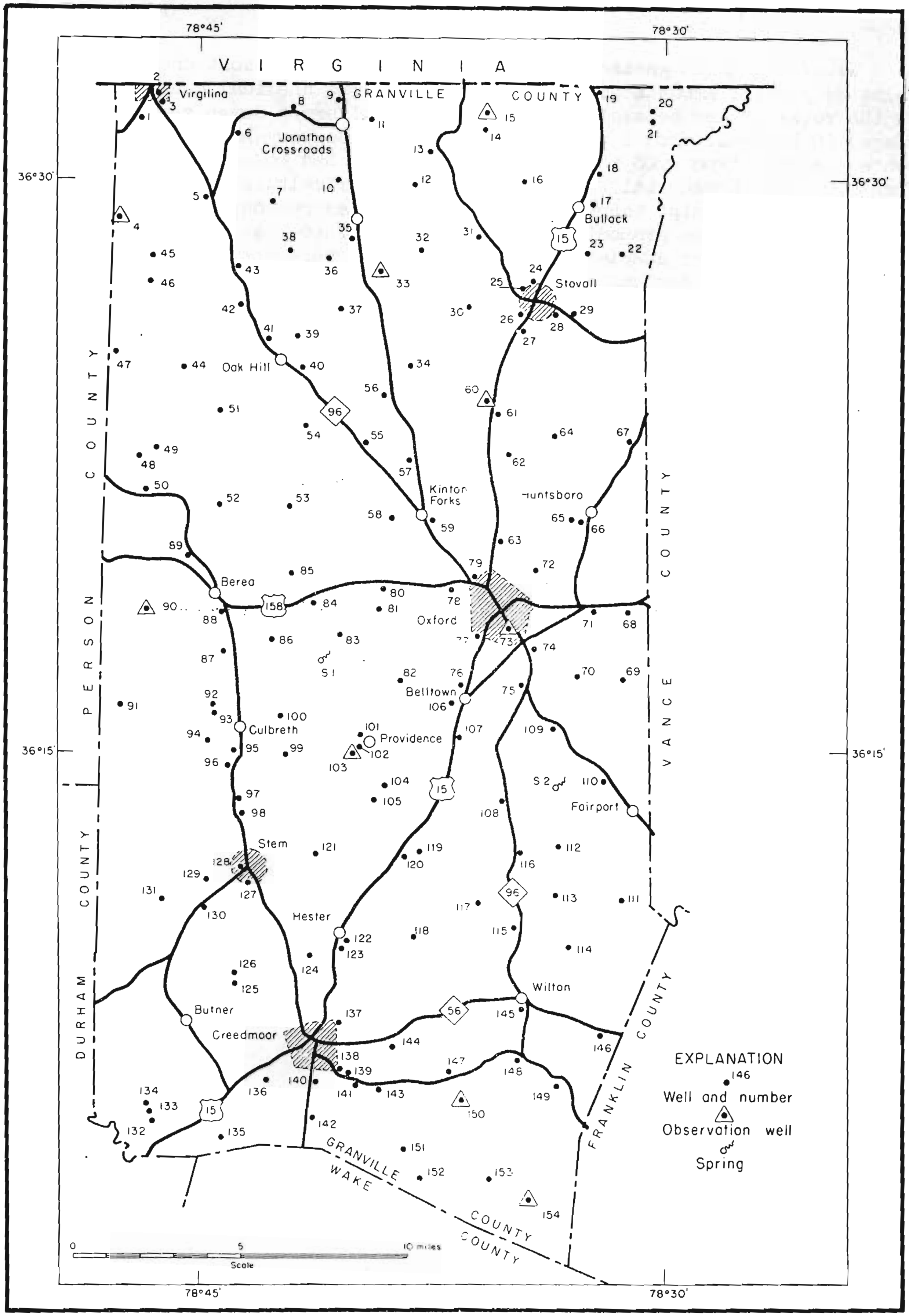
| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO ROCK TYPE | | | | | | |
| Mica Gneiss | 6 | 136 | 0.5-30 | 11 | 0.08 | 17 |
| Greenstone | 3 | 89 | .5-12 | 4 | .04 | - |
| Argillite-Graywacke | 2 | 85 | 12-30 | 21 | .25 | - |
| Meta-volcanic Sequence | 83 | 82 | .5-30 | 8 | .10 | 1.2 |
| Granodiorite | 26 | 75 | 2-60 | 14 | .19 | 0 |
| Gabbro | 2 | 70 | 10-12 | 11 | .16 | - |
| Triassic rocks | 27 | 141 | 0-25 | 9 | .06 | 22 |
| All wells | 149 | 94 | 0-60 | 10 | .11 | 6.0 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 46 | 98 | 0.5-25 | 8 | 0.08 | 6.1 |
| Flat | 41 | 82 | 2-20 | 10 | .12 | 0 |
| Slope | 50 | 101 | .5-30 | 9 | .09 | 4.0 |
| Draw | 12 | 87 | 0-60 | 16 | .18 | 1.1 |

structure in the rocks. In contrast, water moves slowly through the Triassic rocks because the only secondary openings are poorly developed widely spaced joints and fracture zones near diabase dikes. Primary openings in the sedimentary beds have been made smaller by compaction and cementation. The average yield per foot of well for wells in Triassic rocks in Granville County is 0.06 gpm. According to table 18, only greenstone yields less water. Considering the extent to which structural features are developed in greenstone, the average yield per foot of well of 0.04 gpm for three wells appears to be considerably less than what might be shown if more data were available.

Adequate domestic supplies of water can be obtained from drilled wells in most of the rock types. Wells should be located where ground-water conditions appear to be most favorable, especially in areas underlain by Triassic rocks. Wells located in draws generally yield more water than wells at other topographic locations. Other features indicative of favorable ground-water conditions include quartz veins in the metavolcanic unit, and diabase dikes in Triassic rocks.

Analyses of 14 water samples from selected wells in the county are given in table 12. Fifty percent of the ground water analyzed from Granville County was a calcium-bicarbonate type. Seventy-nine percent contained less than 0.3 ppm iron. Thirty-six percent of the samples were hard to very hard. Ground water in the county is suitable for most domestic, municipal, and industrial uses.

Water from mica gneiss is of good quality, usually soft and containing relatively small amounts of dissolved solids. The chemical quality of water in the rocks of the metavolcanic unit is not uniform. Seven samples analyzed ranged in hardness from 9 to 254 ppm (from soft to very hard water). Iron content ranged from 0.03 to 3.2 ppm; two samples had concentrations greater than 3.0 ppm. Commercial fertilizers used on agricultural land are probably the source of the high nitrate and chloride concentrations in some of the samples. Water from granodiorite is generally of good quality for domestic use. Only two water samples from Triassic rocks were analyzed. Both samples were of very good chemical quality.




Base map adapted from N.C. State Highway Commission County road map 1961

Figure 23.--Map of Granville County showing locations of wells and springs.

# Table 19.--Records of wells in Granville County

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 mile SW of Virgilina------- | W. V. Ellison---- | Drilled | 100 | 6 | 20 | Greenstone | -40 | ½ | | Hill-- | Hard water reported----- |
| 2 | Virgilina--------- | T. B. Nelson----- | --do--- | 118 | 6 | ------- | --do------ | -23 | 7½ | | Slope | Analysis in table-------- |
| 3 | 1/4 mile SE of Virgilina------- | Dallas Puryear--- | --do--- | 103 | 6 | 20 | Argillite and graywacke-- | -14 | 30 | | Draw- | Dug 20 feet---- |
| 4 | 3 miles W of Wilbourns Store----------- | T. F. Clark------ | --do--- | 70 | 6 | ------- | Greenstone--- | -11.80 | 1 | | Slope | Water level measured 12/27/61. Observation well--------- |
| 5 | 1/4 mile NW of Wilbourns Store----------- | Lonnie Humphreys- | --do--- | 46 | 6 | 6 | Metavolcanic sequence--- | -10 | 20 | | --do-- | Slightly hard water reported----- |
| 6 | 2-1/4 miles NE of Wilbourns Store----------- | W. C. Blackwell-- | --do--- | 74 | 6 | ------- | --do--------- | -15 | 5-10 | | Flat-- | Hard water reported------- |
| 7 | 1 3/4 miles E of Wilbourns Store----------- | W. S. Overton---- | --do--- | 52 | 6 | ------- | --do--------- | -32 | 3½ | | Hill-- | Adequate yield. Analysis in table-------- |
| 8 | 1 1/2 miles NW of Jonathan Crossroads------ | John M. Crute---- | --do--- | 63 | 6 | 14 | --do--------- | -25 | 7½ | | Flat-- | Slightly hard water reported----- |
| 9 | 3/4 miles N of Jonathan Crossroads------ | Frank Elliott---- | --do--- | 62 | 6 | 10 | --do--------- | ------ | 12 | | Slope- | |
| 10 | 1-1/2 miles SW of Jonathan Crossroads------ | John A. Clack---- | --do--- | 52 | 6 | 30 | --do--------- | ------ | 3-5 | | --do-- | |
| 11 | 3/4 miles E of Jonathan Crossroads------ | Charles A. Timberlake----------- | --do--- | 90 | 6 | 60 | --do--------- | -25 | 15+ | | Hill-- | |
| 12 | 2 miles NE of Cornwall-------- | Woody Boyd------- | Drilled | 75 | 6 | 15 | --do--------- | ------ | 5 | | --do-- | Moderately hard water reported----- |
| 13 | 3¼ miles NE of Cornwall-------- | J. A. Timberlake | Drilled | 93 | 6 | 30 | Metavolcanic sequence | ------ | 15+ | | Flat-- | Analysis in table----- |
| 14 | 3 3/4 miles NW of Bullock-------- | Claude Callahan | --do--- | 100 | 6 | 10 | --do--------- | -40 | 5 | | Hill-- | Adequate supplies for 2 families.--- |
| 15 | 4 miles NW of Bullock-------- | Claude Callahan | --do--- | 85 | 4 | 13 | --do--------- | -40.30 | ½ | - | --do-- | Water level measured 12/22/61. Observation well-------- |
| 16 | 2 miles NW of Bullock-------- | W. H. Vaughn---- | --do--- | 60 | 6 | 39 | Gabbro------ | -30 | 12+ | | Flat | Analysis |
| 17 | ¼ mile E of Bullock-------- | Charles Chappell | --do--- | 55 | 5 5/8 | 28 | Metavolcanic sequence | -21 | 4 | | Slope | Soft water reported---- |
| 18 | 1 mile N of Bullock-------- | Royster Hobgood-- | --do--- | 53 | 6 | 50 | --do-------- | -10 | 12 | | Flat | Analysis in table------- |
| 19 | 3½ miles N of Bullock-------- | J. D. Yancey----- | --do--- | 122 | 4 | 8 | --do-------- | ------ | 18 | | --do-- | Hard water reported, level below 40 ft. |
| 20 | 3½ miles NE of Bullock-------- | John Yancey------ | --do--- | 75 | 6 | 25 | --do-------- | -24 | 10 | | --do-- | |
| 21 | 3½ miles NE of Bullock-------- | T. F. Tungston-- | --do--- | 71 | 6 | 40 | --do-------- | -20 | 8 | | Slope | Furnishes store and 1 family-- |
| 22 | 2 miles SE of Bullock-------- | J. G. Morton---- | --do--- | 98 | 6 | ----- | Greenstone-- | -30 | 10-15 | | Flat-- | Well cased 40 to 50 feet--- |
| 23 | 1½ miles S of Bullock------- | Herbert P. Morton | --do--- | 180 | 6½ | ----- | Metavolcanic sequence | -45 | 15-20 | | Slope | Reported cased to 100+ feet-- |
| 24 | Stovall--------- | Granville County Board of Education---------- | --do--- | 69 | 6 | 53 | --do-------- | ------ | 15 | | --do-- | Has elevated storage tank-- |
| 25 | Stovall---------- | Mrs. Fannie S. Gill---------- | --do--- | 55 | 5 5/8 | 54 | --do-------- | -19 | 20 | | Flat-- | Soft water reported------- |
| 26 | Stovall---------- | Granville County Board of Education---------- | --do--- | 224 | 6 | 59½ | --do-------- | -22 | 30 | | Slope | Tested for 12 hours at 30 gpm, pumping level 90 ft.-- |
| 27 | 1 mile S of Stovall-------- | Granville County Board of Education---------- | Drilled | 179 | 6 | 90 | Metavolcanic sequence | -8 | 25 | | Slope- | Pumping level -30 feet----- |
| 28 | 1 1/4 miles SE of Stovall-------- | G. E. Williams--- | --do--- | 35 | 5 5/8 | 20 | --do-------- | -8 | 4 | | --do-- | |
| 29 | 1 1/4 miles E of Stovall-------- | Tommy Gill------- | --do--- | 80 | 5 5/8 | 34 | --do-------- | -26 | 3 | | Flat-- | Adequate supply- |
| 30 | 2 miles W of Stovall-------- | John Morton------ | --do--- | 85 | 6 | 65 | --do-------- | -17 | 5 | | --do-- | |
| 31 | 2 1/2 miles NW of Stovall-------- | Francis Smith---- | --do--- | 56 | 8 | 25 | --do-------- | ------ | 3 | | Slope- | Hard water reported----- |
| 32 | 1 3/4 miles SE of Cornwall------- | O. T. Parham----- | --do--- | 93 | 6 | 30 | --do-------- | -30 | 15 | | Hill-- | Dug 24 feet. Hard water reported----- |

Table 19.--Records of wells in Granville County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 1 1/2 miles SE of Stovall-------- | L. H. Jones------ | --do--- | 56 | 6 | 40 | --do-------- | -29.40 | 17 | | --do-- | Water level measured 12/28/61. Observation well--------- |
| 34 | 4 miles SW of Stovall-------- | A. L. Elliott---- | --do--- | 35 | 6 | 20 | --do-------- | -20 | 8-10 | | Slope- | Water reported moderately hard--------- |
| 35 | 1/2 mile SW of Cornwall------- | Samuel Watkins--- | --do--- | 112 | 6 | 60 | --do-------- | -60 | 15+ | | --do-- | Water level unchanged after 12 hours of bailing by driller------ |
| 36 | 1 1/4 miles SW of Cornwall | H. L. Blackwell-- | --do--- | 56 | 6 | ------ | --do-------- | ------ | 3 | | Hill-- | Dug 43 feet. Drilled remainder uncased------ |
| 37 | 2 1/2 miles S of Cornwall------- | Mountain Creek Baptist Church- | --do--- | 52 | 6 | 28 | --do-------- | -22 | 5 | | --do-- | Slightly hard water reported |
| 38 | 2 miles SW of Cornwall------- | J. S. Hart------- | --do--- | 78 | 6 | 22 | --do-------- | -30 | 3 | | --do-- | Slightly hard water reported |
| 39 | 1¼ miles SE of Oak Hill----------- | W. Y. Martin----- | Drilled | 90 | 6 | 50 | Metavolcanic sequence | ------ | 5 | | Slope | Water level reported below 50 feet----- |
| 40 | 2 miles SE of Oak Hill----------- | C. L. Blackwell-- | --do--- | 74 | 6 | ------ | --do--------- | -26 | 2½ | | --do-- | Dug 29 feet. Water supply adequate---- |
| 41 | ¼ mile SE of Oak Hill----------- | J. T. Gregory---- | --do--- | 70 | 6 | 30 | --do--------- | -20 | 9 | | --do-- | Slightly hard water reported. Adequate supply for home and service station |
| 42 | ½ mile NE of Oak Hill----------- | W. W. Daniel---- | --do--- | 75 | 6 | 29 | --do-------- | -23 | 6 | | --do-- | Analysis in table------- |
| 43 | 1 3/4 miles NE of Oak Hill------- | Granville County Board of Education---------- | --do--- | 169 | 6 | 32 | --do-------- | ------ | 15 | | Draw- | |
| 44 | 2½ miles SW of Oak Hill----------- | Mrs. J. D. Kern-- | --do--- | 50 | 6 | 65 | Gabbro------ | -50 | 10+ | | Hill- | Dug 55 feet--- |
| 45 | 2½ miles SW of Wilbourns Store | R. L. Royster---- | --do--- | 56 | 6 | 26 | Metavolcanic sequence | -14 | 1½ | | Slope | Analysis in table------- |
| 46 | 3 miles SW of Wilbourns Store | R. M. Smart------ | --do--- | 54 | 5 5/8 | 22 | --do-------- | -27.0 | 1½ | | --do- | Water level measured 12/29/61. Slightly hard water reported---------- |
| 47 | 4½ miles W of Oak Hill----------- | C. G. Adcock---- | --do--- | 67 | 6 | 29 | Argillite and graywacke | -35 | 10-15 | | --do-- | |
| 48 | 4 3/4 miles NW of Berea---------- | Charlie Huff---- | --do-- | 65 | 6 | 30 | Metavolcanic sequence | -45 | 8 | | Hill | Water reported moderately hard-------- |
| 49 | 4 3/4 miles NW of Berea---------- | J. C. Daniel---- | --do--- | 72 | 6 | 60 | --do-------- | -46 | 6-8 | | --do-- | Water reported slightly hard |
| 50 | 3 3/4 miles NW of Berea---------- | B. D. Huff, Jr.-- | Bored-- | 42 | 24 | 42 | --do-------- | -38 | ½- | | Slope | Hit soft rock at 19 feet. Well deepened by dynamiting |
| 51 | 2 3/4 miles SW of Oak Hill------- | A. N. Daniel----- | Drilled | 46 | 6 | 20 | Metavolcanic sequence | -20 | 5 | | Hill-- | Water reported corrosive--- |
| 52 | 2½ miles N of Berea | W. A. Slaughter- | --do--- | 85 | 6 | 50 | --do------- | -35 | 3 | | Slope- | Hard water reported------ |
| 53 | 3½ miles NE of Berea----------- | B. S. Currin----- | --do--- | 67 | 6 | 28 | --do------- | -9 | 3 | | Flat | |
| 54 | 1½ miles NW of Kinton Forks------ | M. C. Dixon------ | --do--- | 64 | 6 | 64 | --do------- | -34 | 5-8 | | --do-- | Well ended in saprolite--- |
| 55 | 2 3/4 miles NW of Kinton Forks--- | H. M. Puckett---- | --do--- | 85 | 6 | 60 | --do------- | ------ | 15-20 | | --do-- | Analysis in table------- |
| 56 | 3 3/4 miles N of Kinton Forks--- | Thurl Hockaday--- | --do--- | 72 | 6 | 16 | --do------- | -10 | 1½ | | Hill-- | Very hard water reported, sometimes muddy-------- |
| 57 | 1 3/4 miles NE of Kinton Forks--- | L. Douglas Jones | --do--- | 89 | 6 | 40 | --do------- | -7 | 1½ | | --do-- | |
| 58 | 3/4 miles W of Kinton Forks--- | William H. Day--- | --do-- | 40 | 6 | 30 | --do------- | -20 | 6-8 | | Slope | |
| 59 | ½ mile SE of Kinton Forks---------- | Huntsville Baptist Church-- | --do-- | 75 | 5 5/8 | 49 | --do------- | -19 | 7 | | --do-- | |
| 60 | 3 miles S of Stovall-------- | A. L. Weary----- | --do--- | 30 | 6 | ------ | --do------- | -15.70 | 1-3 | | --do-- | Water level measured 12/20/61. Observation well-------- |

Table 19.--Records of wells in Granville County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 3½ miles S of Stovall-------- | Tom Webb-------- | --do-- | 43 | 6 | 33 | --do-------- | ----- | 3-5 | | Flat- | Adequate supply |
| 62 | 3 miles NW of Huntsboro------ | Bobby Grissom--- | Bored | 31 | [illegible] | 31 | Granodiorite | -15 | 3-5 | | --do- | Adequate supply |
| 63 | 2 miles N of Oxford---------- | Henry Currin | Drilled | 28 | 6 | 20 | --do-------- | -14 | 5 | | ------ | Slightly hard water reported---------- |
| 64 | 2½ miles NW of Huntsboro------- | Roy Cottrell--- | --do-- | 103 | 6 | 100 | --do-------- | -60 | 10 | | Flat- | |
| 65 | 3/4 miles NW of Huntsboro------- | Wills Hancock--- | --do-- | 54 | 5 5/8 | 22 | --do------ | -21 | 5 | | Slope | |
| 66 | ½ mile SW of Huntsboro------ | Roy Crews------ | --do-- | 98 | 6 | ------ | --do------ | -15 | 13 | | Hill | Furnishes 3 families----- |
| 67 | 2½ miles NE of Huntsboro------- | N. Y. Barker----- | Drilled | 100 | 6 | ------ | Metavolcanic sequence | -11 | 5 | | Flat-- | Moderately hard water reported----------- |
| 68 | 3 miles SE of Huntsboro------- | Joe Hamey------- | --do--- | 92 | 6 | 75 | Granodiorite | -20 | 10+ | | Slope | |
| 69 | 4¼ miles SE of Oxford---------- | N. G. Blackwell-- | --do--- | 52 | 6 | 12 | --do------- | -20 | 6 | | Draw | Adequate supply for 2 families |
| 70 | 3 miles SE of Oxford---------- | Frank Hancock | --do--- | 60 | 5 5/8 | 48 | --do------- | -14 | 5 | | Flat-- | |
| 71 | 2 3/4 miles E of Oxford--------- | E. D. Longmire--- | --do--- | 83 | 6 | 53 | --do------- | ------ | 10-12 | | Slope | Adequately supplies 2 families and restaurant-- |
| 72 | 1 3/4 miles NE of Oxford--------- | Edward Taylor---- | --do--- | 72 | 6 | 68 | --do------- | -20 | 15-18 | | Flat- | Analysis in table------- |
| 73 | Oxford---------- | A. N. Critchard-- | --do--- | 487 | 6½ | ----- | --do------- | -4.60 | ----- | | Draw | Formerly Oxford municipal well. Water level measured 1/5/62. Observation well-------- |
| 74 | 1½ miles SE of Oxford--------- | A. R. Taylor---- | --do--- | 50 | 6½ | 20 | --do-------- | -16 | 8 | | Hill | Used only for chicken farm |
| 75 | 2½ miles S of Oxford--------- | J. W. Brummitt-- | --do--- | 43 | 6 | 20 | --do-------- | -21 | 5 | | --do-- | |
| 76 | 2 3/4 miles S of Oxford-------- | John H. Crumpler | --do--- | 54 | 6 | 20 | --do-------- | -15 | 5+ | | Flat | Analysis in table------- |
| 77 | ½ mile SW of Oxford--------- | Oxford Furniture Company------- | --do--- | 101 | 6 | 87 | --do-------- | -17 | 5 | | --do-- | Furnishes store and 1 home-- |
| 78 | 1½ mile NW of Oxford--------- | Hubert Hunt----- | --do--- | 60 | 6¼ | 20 | Metavolcanic sequence | -19 | 5 | | --do-- | |
| 79 | 1 mile NW of Oxford--------- | Charles T. Parham | --do--- | 49 | 5 5/8 | 26 | --do-------- | -22 | 2 | | --do- | |
| 80 | 3½ miles W of Oxford-------- | Ben Hester------ | --do--- | 88 | 6 | 10 | --do-------- | -23 | 5 | | --do-- | Moderately hard water reported----------- |
| 81 | 3½ miles W of Oxford--------- | L. W. Kern------ | Drilled | 80 | 6 | 31 | Granodiorite | -25 | 4 | | Flat-- | |
| 82 | 2 miles NW of Belltown------- | Marshall Woodlief | --do--- | 119 | 6 | 26 | Metavolcanic sequence | ------ | 4 | | Hill-- | Water level reported below 30 feet---------- |
| 83 | 4 miles SE of Berea---------- | C. T. Daniel---- | --do--- | 52 | 6 | 30 | Granodiorite | -5 | 15+ | | Flat-- | Bailer test of 15 gpm did not lower water level-- |
| 84 | 3 miles E of Berea---------- | Raymond Adcock-- | --do--- | 140 | 5 | 12 | Metavolcanic sequence | -20 | 5-7 | | ---do- | |
| 85 | 2½ miles E of Berea---------- | Roy T. Daniels-- | --do--- | 127 | 6 | 10 | --do-------- | ----- | 6 | | Hill-- | Water level reported -15 to -20 feet----- |
| 86 | 2 miles S of Berea---------- | G. M. Hendrick-- | --do--- | 84 | 6 | 34 | --do-------- | -60 | 10 | | Slope- | |
| 87 | 1 3/4 miles S of Berea--------- | M. W. Averette-- | --do--- | 82 | 6 | 60 | --do-------- | -25 | 12-15 | | Hill-- | Contains iron |
| 88 | ½ mile S of Berea--------- | M. L. Ellington- | --do--- | 70 | 5 5/8 | 45 | --do-------- | -14 | 8 | | Flat-- | |
| 89 | 1¼ miles NW of Berea--------- | Fred Oakley----- | --do--- | 72 | 6 | 30 | --do-------- | -30 | 5 | | --do-- | |
| 90 | 2 miles SW of Berea--------- | Ira Morris------ | --do--- | 140 | 6 | 28 | --do-------- | -8.76 | 6 | | Slope | Water level measured 1/3/62. Observation well--- |
| 91 | 3½ miles W of Culbreth------- | Elvin Mangum---- | --do--- | 127 | 6 | 30 | --do-------- | -20 | 6-8 | | --do-- | Adequately supplies 2 homes and chicken farm. Water moderately hard. |
| 92 | 1 mile NW of Culbreth------- | F. B. White, Jr. | --do--- | 55 | 6 | ----- | --do------- | ----- | 15 | | Draw-- | Well not used. Corrosive, hard water reported----- |

Table 19.--Records of wells in Granville County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 93 | 3/4 miles NW of Culbreth------- | F. E. White, Jr. | Drilled | 76 | 6 | 17 | Metavolcanic sequence | -10 | 2½ | | Slope-- | Analysis in table------ |
| 94 | 1 mile SW of Culbreth------- | E. C. Hilton---- | --do--- | 50 | 5 5/8 | 25 | --do-------- | -16 | 5 | | Draw-- | |
| 95 | 1 mile S of Culbreth------- | Manley Bullock-- | --do--- | 70 | 5 5/8 | 66 | --do-------- | -15 | 12 | | Slope-- | |
| 96 | 1½ miles S of Culbreth------- | Leo Jackson----- | --do--- | 100 | 6 | 90 | --do-------- | -25 | 12-14 | | --do--- | Adequately supplies 2 homes and chicken farm- |
| 97 | 2 miles N of Stem | Ollie Bullock--- | --do--- | 86 | 6 | 66 | --do-------- | -23 | 6 | | --do--- | |
| 98 | 1½ miles N of Stem | Ollie Bullock--- | --do--- | 73 | 6 | ----- | --do-------- | ------ | 8 | | Flat--- | Four families use from well |
| 99 | 1 3/4 miles SE of Culbreth------- | James Satterwhite | --do--- | 101 | 6 | ----- | --do-------- | -12 | 5 | | Hill--- | Reported cased 25 to 30 ft. |
| 100 | 1½ miles E of Culbreth------- | P. L. Satterwhite | --do--- | 87 | 6 | ------ | --do-------- | -35 | 3-5 | | --do-- | Four families use from well |
| 101 | 3 miles SW of Belltown------- | H. G. Averett---- | --do--- | 65 | 6 | 50 | --do-------- | ------ | 15+ | | Flat-- | Yield too large to test by bailing----- |
| 102 | 3 1/4 miles SW of Belltown------- | James Satterwhite | --do--- | 88 | 6 | 18 | --do-------- | -10 | 2-4 | | Slope | Slightly hard water reported---------- |
| 103 | 3½ miles SW of Belltown------- | James Satterwhite | --do--- | 101 | 5 | 10 | --do-------- | -16.98 | 1½ | | --do-- | Hard water reported. Water level measured 12/14/61. Observation well-------- |
| 104 | 3½ miles SW of Belltown------- | J. B. Oberton--- | --do--- | 48 | 6 | ------ | Granodiorite | ------ | 10 | | Hill-- | |
| 105 | 4½ miles NE of Stem----------- | J. K. Nelms----- | --do--- | 93 | 6 | 65 | --do-------- | -19 | 25+ | | --do-- | Slightly hard water reported. Well used for dairy farm.-- |
| 106 | ½ mile NW of Belltown------- | John N. Watkin-- | Drilled | 100 | 6 | ------- | Granodiorite | -18 | 60 | | Draw | Water level unaffected by normal domestic use. |
| 107 | 3/4 miles S of Belltown------- | S. D. Watkins Esso Station-- | --do--- | 85 | 6 | 56 | --do-------- | -18 | 15 | | Flat | |
| 108 | 3 miles SE of Belltown------- | Wallace Brummitt | --do--- | 165 | 6 | 41 | Triassic sandstone and shale- | -15 | 10 | | Hill-- | Dug 13 feet. Water level drops to -75 feet during late summer months------ |
| 109 | 2 3/4 miles E of Belltown------- | B. H. Harris---- | --do--- | 72 | 5 | 72 | Granodiorite | -15 | 15 | | Flat-- | |
| 110 | 1¼ miles NW of Fairport------- | W. I. Woodlief-- | --do--- | 122 | 6 | ----- | --do-------- | -37 | 15+ | | --do-- | Bailer test of 15 gpm did not lower water level. Contains iron-------- |
| 111 | 2 3/4 miles S of Fairport------ | W. H. Harris---- | --do--- | 74 | 6 | 38 | Mica neiss | ------ | 30 | | Slope | Analysis in table------- |
| 112 | 1½ miles SW of Fairport------ | E. Watkin------- | --do--- | 60 | 6 | 20 | Metavolcanic sequence | -45 | 2 | | Hill-- | Two families use from well |
| 113 | 3½ miles SW of Fairport------ | Clyde Wheeler--- | --do--- | 55 | 6 | 35 | --do-------- | -33 | 9½ | | Draw | |
| 114 | 2¼ miles NE of Wilton-------- | Herb Blackley--- | --do--- | 78 | ------ | ------ | Mica gneiss | ------ | 12½ | | Flat-- | |
| 115 | 2¼ miles N of Wilton-------- | R. A. Dixon----- | --do--- | 109 | 6 | 50 | Metavolcanic | -5 | 5-8 | | Hill-- | Dug 45 feet--- |
| 116 | 3 3/4 miles W of Fairport------ | Ruth Eakes------ | --do--- | 112 | 5 5/8 | 98 | --do-------- | -27 | 10 | | Slope | Hard water reported------ |
| 117 | 3¼ miles NW of Wilton-------- | W. B. Bragg----- | --do--- | 155 | 6 | 24 | Triassic sandstone and shale | -30 | [illegible] | | Hill-- | Well not used inadequate yield------- |
| 118 | 2½ miles E of Hester--------- | Hubert Gooch---- | Drilled | 152 | 6 | 15 | Triassic sandstone and shale | -52 | 2 | | Slope-- | Analysis in table------ |
| 119 | 3½ miles NE of Hester--------- | Mrs. E. C. Daniel | --do--- | 73 | 6 | 22 | --do-------- | -13 | 25+ | | --do--- | Moderately hard water reported----------- |
| 120 | 3 miles NE of Hester--------- | L. F. Cotten---- | --do--- | 63 | 6 | ----- | --do-------- | flows | 10+ | | --do-- | Maximum overflow 3 to 4 gpm during wet seasons. Contains Fe and is corrosive------ |
| 121 | 2 miles E of Stem | Joe L. Haskins-- | --do--- | 44 | 6 | 27 | Granodiorite | -13 | 10 | | Hill-- | Bored 27 feet. All water obtained at 30 feet.---- |

Table 19.--Records of wells in Granville County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122 | ¼ mile SE of Hester---------- | D. R. Crews----- | --do--- | 100 | 6 | 20 | Triassic sandstone and shale | ----- | 0 | | Draw-- | |
| 123 | ½ mile S of Hester---------- | D. R. Crews----- | --do--- | 164 | 6 | 23 | --do-------- | -50 | ½- | | Slope | Hard water reported---- |
| 124 | 1 mile SW of Hester---------- | H. V. Overton--- | --do--- | 88 | 6 | 24 | --do-------- | ----- | 10-12 | | --do-- | Corrosive and and contains iron-------- |
| 125 | 2 miles NE of Butner--------- | J. T. Aikens---- | --do--- | 94 | 6 | 22 | --do-------- | -20 | 15 | | Hill-- | Adequately supplies 2 families. Analysis in table-------- |
| 126 | 2¼ miles NE of Butner-------- | J. T. Goss------ | --do--- | 55 | 6 | 11 | --do-------- | -10 | 5 | | Flat-- | Supplies 3 families.--- |
| 127 | Stem------------ | C. S. Parrish--- | --do--- | 64 | 6¼ | 25 | Granodiorite | -15 | 18-20 | | --do-- | Supplies 3 families.--- |
| 128 | Stem------------ | Louis Gooch----- | --do--- | 100 | 6¼ | 27 | --do--------- | -15 | 2 | | --do-- | Slightly hard water reported------ |
| 129 | 1¼ miles SW of Stem------------ | W. J. Collier--- | Drilled | 73 | 5 5/8 | 48 | Granodiorite | -17 | 7 | | Hill--- | Adequately supplies 2 families---- |
| 130 | 2 miles SW of Stem | Durwood Harp----- | --do--- | 70 | 6 | 18 | --do--------- | ------ | 6 | | --do--- | |
| 131 | 2 3/4 miles SW of Stem------------ | Tom Goss--------- | --do--- | 48 | 6 | 9 | Metavolcanic sequence | ------ | 5-8 | | --do--- | |
| 132 | 3¼ miles S of Butner--------- | E. R. Coley------ | --do--- | 236 | 6 | ------ | Triassic sandstone and shale | ------ | ½ | | --do--- | Well not used, inadequate yield------ |
| 133 | 3¼ miles S of Butner--------- | E. R. Coley------ | --do--- | 136 | 6 | 20 | --do--------- | -3.8 | ½-1 | | Slope-- | Water level measured 12/12/61---- |
| 134 | 2 3/4 miles S of Butner--------- | S. L. Coley------ | --do--- | 212 | 6 | 110 | --do--------- | ------- | 12 | | Hill-- | Well located near mafic dike. Water level reported below 70 feet-------- |
| 135 | 4 miles SW of Creedmoor------ | R. U. Currin----- | --do--- | 50 | 6 | 22 | --do--------- | -10 | 15 | | --do-- | Dug approximately 20 feet-------- |
| 136 | 2 miles SW of Creedmoor------ | Mrs. Vernon Lanier-------- | --do--- | 130 | 6 | 60 | --do--------- | -16 | 20-25 | | --do-- | |
| 137 | 1 mile NE of Creedmoor------ | J. E. Moss------ | --do--- | 185 | 6 | 50 | --do--------- | ------ | 4 | | Flat-- | Moderately hard water reported.--------- |
| 138 | 3/4 miles SE of Creedmoor----- | Granville County Board of Education---------- | --do--- | 456 | 6 | 42 | --do--------- | -5 | 7 | | Slope | Well not used, water silty. School now on city water system------ |
| 139 | 3/4 miles SE of Creedmoor----- | Granville County Board of Education---------- | --do--- | 182 | 6 | 12 | --do--------- | -20 | 15 | | --do-- | Well not used, water silty. School now on city water system------ |
| 140 | 1 mile S of Creedmoor------ | O. H. Aiken------ | Drilled | 110 | 6 | 30 | Triassic sandstone and shale | -12 | 11 | | Hill-- | |
| 141 | 1½ miles SE of Creedmoor------ | Clarence E. Hicks | --do--- | 204 | 6 | 10 | --do--------- | -30 | 5 | | --do-- | Dug 20 feet. Adequately supplies 2 families---- |
| 142 | 2 miles S of Creedmoor------ | Fellowship Church | --do--- | 127 | 6 | ----- | --do--------- | ------ | 10 | | Flat-- | Most of water obtained at 28 feet.----- |
| 143 | 2 miles SE of Creedmoor------ | Roy A. Keith---- | --do--- | 69 | 6 | 20 | --do--------- | -24 | 24 | | Draw | Bored 20 feet |
| 144 | 2½ miles E of Creedmoor------ | E. L. Averett---- | --do--- | 85 | 6 | 20 | --do--------- | -25 | 3-5 | | Draw | Slightly hard water reported----------- |
| 145 | ¼ mile S of Wilton | Allen Thomerson-- | --do--- | 125 | 6 | ------ | Metavolcanic sequence | ------ | 12-15 | | --do-- | Adequately supplies home and store. moderately hard water reported------ |
| 146 | 2 3/4 miles SE of Wilton-------- | Graham Ball----- | --do--- | 152 | 6 | 42 | Mica gneiss | -40 | 5½ | | Slope | |
| 147 | 3 miles SW of Wilton-------- | T. W. Allen, Jr. | --do--- | 80 | 6 | 22 | Triassic sandstone and shale | -4 | 15-18 | | --do-- | Water obtained at 60 feet.--- |
| 148 | 2 miles S of Wilton--------- | H. D. Whitfield | --do--- | 97 | 6 | 60 | --do-------- | -20 | 10 | | Hill-- | Water corrosive |
| 149 | 2 3/4 miles SE of Wilton-------- | O. V. Bragg----- | --do--- | 119 | 8 | 90 | Mica gneiss | -30 | 10 | | --do-- | |
| 150 | 3½ miles SW of Wilton--------- | P. H. Cash------ | --do--- | 200 | 6 | 22 | Triassic sandstone and shale | -72.2 | 1- | | --do-- | Inadequate yield. Well not used. Water level measured 11/28/61----- |

Table 19.--Records of wells in Granville County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topo-graphy | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 151 | 4 miles SE of Creedmoor------ | Jack Turner----- | Drilled | 150 | 6 | 20 | Triassic sandstone and shale | -12 | 8-10 | | Draw-- | |
| 152 | 5 miles SE of Creedmoor------ | Hudie Smith----- | --do--- | 120 | 6 | ----- | Mica gneiss | ------ | ---- | | Slope-- | Hit hard rock at approximately 15 feet.------- |
| 153 | 5½ miles S of Wilton--------- | Coy C. Dillard-- | --do--- | 220 | 8 | 90 | --do-------- | -35 | 8 | | --do-- | All water obtained above 170 feet. Supplies 6 families.---- |
| 154 | 6 miles S of Wilton--------- | W. D. Bailey---- | --do--- | 175 | 6 | 50 | --do-------- | -49.95 | ½- | | Hill-- | Water level measured 11/29/61. Observation well--------- |

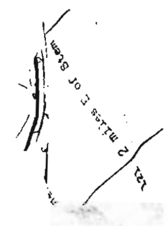


Table 20.--Records of springs in Granville County

| Spring Number | Location | Owner | Yield (gpm) | Chief Aquifer | Topography | Remarks |
|---|---|---|---|---|---|---|
| $S_1$ | 3-3/4 miles SE of Berea------- | Mrs. Otho A. Daniel------ | 2-4 | Meta-vol-canic se-quence | Head of draw | Water issues from fracture in rock. Has been de-pendable for 40 years, but becomes turbid after heavy rains------------- |
| $S_2$ | 2-1/2 miles NW of Fairport--- | C. B. Morgan-- | 5-7 | --do---- | Draw------- | Water issues from 4 or 5 openings formed by quartz intrusion--------------- |

Table 21.--Chemical analyses of ground water from Granville County. (Numbers at heads of columns correspond to well numbers in table 19.)

(Parts per million)

| | 2 | 7 | 13 | 16 | 18 | 42 | 45 |
|---|---|---|---|---|---|---|---|
| Date of Collection | 3/4/63 | 3/4/63 | 3/4/63 | 2/21/62 | 2/21/62 | 2/21/62 | 2/6/63 |
| Silica ($SiO_2$) | 24 | 34 | 23 | 16 | 29 | -- | 21 |
| Aluminum (Al) | .2 | .1 | .2 | .0 | .1 | .1 | .3 |
| Iron (Fe) | 2.3 | .03 | .04 | .04 | 3.2 | .03 | .20 |
| Manganese (Mn) | .03 | .00 | .00 | .00 | .04 | .00 | .02 |
| Calcium (Ca) | 51 | [illegible] | 5.0 | 8.8 | 76 | 36 | 33 |
| Magnesium (Mg) | 63 | 19 | 2.8 | 3.8 | 14 | 7.1 | 35 |
| Sodium (Na) | 36 | 25 | 4.1 | 9.0 | 18 | 5.4 | 56 |
| Potassium (K) | .1 | 2.0 | .1 | .8 | 1.8 | 1.5 | 2.1 |
| Lithium (Li) | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| Bicarbonate ($HCO_3$) | 360 | 61 | 30 | 63 | 157 | 140 | 144 |
| Sulfate ($SO_4$) | 4.4 | 15 | 3.4 | .6 | 121 | 9.4 | 17 |
| Chloride (Cl) | 116 | 44 | 2.8 | .4 | 21 | 3.6 | 134 |
| Fluoride (F) | .1 | .2 | .1 | .0 | .0 | .0 | .3 |
| Nitrate ($NO_3$) | .0 | 74 | .0 | 1.0 | 1.1 | 6.3 | 37 |
| Phosphate ($PO_4$) | .0 | .2 | .0 | .4 | .0 | .1 | .0 |
| Dissolved Solids | 472 | 267 | 57 | 72 | 358 | -- | 407 |
| Hardness as $CaCO_3$ | 388 | 135 | 25 | 38 | 254 | 120 | 225 |
| Noncarbonate | 94 | 85 | 0 | 0 | 125 | 5 | 107 |
| Specific Conductance | 853 | 408 | 62 | 118 | 568 | 258 | 740 |
| pH | 7.1 | 6.8 | 6.5 | 6.4 | 6.9 | 7.2 | 6.8 |
| Color | 3 | 3 | 5 | 3 | 3 | 2 | 20 |
| Map Unit | Green-stone | Meta-volcanic | Meta-volcanic | Gabbro | Meta-volcanic | Meta-volcanic | Meta-volcanic |

| | 55 | 72 | 76 | 93 | 111 | 118 | 125 |
|---|---|---|---|---|---|---|---|
| Date of Collection | 3/4/63 | 2/6/63 | 2/21/62 | 2/21/62 | 2/21/62 | 2/21/62 | 3/4/63 |
| Silica ($SiO_2$) | 9.6 | 34 | 35 | 26 | 21 | 28 | 43 |
| Aluminum (Al) | .1 | .1 | .2 | .0 | .0 | .0 | .1 |
| Iron (Fe) | 3.1 | .06 | .19 | .11 | .05 | .00 | .15 |
| Manganese (Mn) | .02 | .00 | .04 | .02 | .00 | .00 | .05 |
| Calcium (Ca) | 2.8 | 2.7 | 79 | 30 | 11 | 9.8 | 24 |
| Magnesium (Mg) | .5 | 1.5 | 39 | 8.3 | 7.2 | 3.0 | 8.6 |
| Sodium (Na) | 2.9 | 5.7 | 27 | 36 | 12 | 59 | 26 |
| Potassium (K) | .1 | .2 | .9 | .4 | 1.6 | 1.2 | .5 |
| Lithium (Li) | .0 | .0 | .1 | .1 | .0 | .1 | .0 |
| Bicarbonate ($HCO_3$) | 13 | 24 | 338 | 34 | 26 | 160 | 130 |
| Sulfate ($SO_4$) | 2.2 | 2.6 | 26 | 13 | 3.2 | 5.4 | 4.0 |
| Chloride (Cl) | .3 | 3.0 | 73 | 69 | 24 | 16 | 24 |
| Fluoride (F) | .0 | .0 | .2 | .0 | .0 | .1 | .2 |
| Nitrate ($NO_3$) | .4 | 2.5 | 1.1 | 24 | 35 | 6.0 | 6.0 |
| Phosphate ($PO_4$) | .0 | .0 | .2 | .1 | .1 | .5 | .0 |
| Dissolved Solids | 25 | 64 | 449 | 244 | 128 | 206 | 200 |
| Hardness as $CaCO_3$ | 9 | 14 | 357 | 108 | 56 | 37 | 95 |
| Noncarbonate | 0 | 0 | 80 | 80 | 35 | 0 | 0 |
| Specific Conductance | 32 | 52 | 798 | 450 | 192 | 330 | 292 |
| pH | 6.1 | 6.6 | 6.6 | 6.1 | 6.3 | 7.4 | 7.0 |
| Color | 5 | 3 | 5 | 3 | 3 | 3 | 5 |
| Map Unit | Meta-volcanic | Granodio-rite | Granodio-rite | Meta-volcanic | Mica Gneiss | Triassic | Triassic |

# VANCE COUNTY

(Area: 249 square miles; population in 1960: 32,002)

## GEOGRAPHY

Vance County lies in the north-central part of the Raleigh area; it is the smallest of the five counties. It is bounded on the east by Warren County, on the south by Franklin County, on the west by Granville County, and on the north by Virginia. Henderson, population 12,740, is the county seat and largest town in the county. Other population centers include Middlesburg, Townsville, and Kittrell.

The county is largely agricultural, tobacco being the chief crop. Cotton, corn, and dairy products are also important sources of income. Several industrial establishments are centered in and around Henderson. Chief among these are textile manufacturing, tobacco processing, and lumbering. Graystone quarry, located 1 mile north of Henderson, is one of the largest quarries in the State, and it produces large quantities of crushed stone.

Vance County is in the Piedmont physiographic province, and the topography is typical of that province. The uplifted surface has been dissected by small streams forming draws and small valleys that have floors generally less than 75 feet below the upland surfaces. Elevations range from slightly more than 300 feet above mean sea level, to almost 600 feet. The lowest elevations are in the northeastern corner of the county, and the highest are in the west central part near Dabney.

Vance County is drained by small streams which are tributary to either the Roanoke or Tar Rivers. Those tributary to the Roanoke River flow northward into the John H. Kerr Reservoir. The streams in the southern part of Vance County flow south or southeast to the Tar River which forms the southern boundary of the county. The drainage divide between the two major drainage basins extends in an east-west direction across the central part of the county. Stream gradients are moderate and flood plains are narrow.

## GEOLOGY

Mica gneiss crops out as a northeast-trending zone across the eastern half of the county. Predominantly the rock is a medium- to coarse-grained biotite-feldspar gneiss containing at most places metacrysts of feldspar that give it a porphyritic texture. The feldspar is mostly orthoclase which commonly comprises as much as 50 percent of the rock. Other minerals include quartz, plagioclase feldspar, muscovite, and minor amounts of opaque minerals. The contact between the granite and gneiss appears to be gradational, which at most places was mapped by characteristic soil types between isolated outcrops. The granite may have intruded the rocks that are now gneissic and partly assimilated and hydrothermally altered them. The gneiss near the granite may properly be called granite gneiss. Gneissic texture and foliation trend northeast.

Phyllitic rocks included in the metavolcanic unit are exposed in western Vance County. They are primarily fine-grained greenish-gray rocks composed of micaceous minerals, chiefly sericite and chlorite. Cleavage, which is well developed, strikes northeast and dips steeply to the northwest.

These rocks were mapped as metavolcanic (metamorphosed fine-grained tuffs) because there seemed to be no definite contact between them and recognized metavolcanic rocks in Granville County to the west.

Greenstone underlies a small area in northwestern Vance County. It is a fine-grained dark-green rock composed mostly of chlorite, but containing small amounts of epidote, hornblende, feldspar, quartz, and sericite. Cleavage is moderately to well-developed and strikes northeast. At places amygdules containing feldspar and quartz are elongated in the direction of cleavage. Apparently the rock is a metamorphosed mafic extrusive.

A granodiorite body, elongate in a northeast direction, is exposed across western Vance County. The granodiorite is medium- to coarse-grained, and is composed predominantly of feldspar, quartz, and mica. Accessory minerals include sericite, muscovite, pyrite, magnetite or ilmenite, and epidote (Parker, in press). The feldspar is chiefly albite, but orthoclase feldspar is commonly present as a minor constituent. Total feldspar content is generally 50 percent or greater. Quartz composed 25 to 35 percent of the rock as clear, gray, and rarely as pale blue grains.

Phyllitic rocks of the metavolcanic sequence and granodiorite are interlayered near the edge of the granodiorite body. Inclusions of phyllite occur in the granodiorite, but are less numerous near the center of the body. Neither the inclusions or the phyllite in the interlayered zone show evidence of intense dynamic or thermal metamorphism. At places phyllite appears to grade laterally into granodiorite.

Granite underlies a small area in the southeastern part of the county. It is part of a large pluton which crops out more extensively in Franklin and Wake Counties. The granite is a light-gray biotite granite, equigranular and medium to coarse grained. Pegmatite dikes, composed almost entirely of microcline feldspar and quartz, are associated with the granite.

## GROUND WATER

Henderson has the only municipal water supply in the county and it obtains its water from ponds. Most of the domestic supplies are obtained from wells. Springs are a source of water for a few homes, and one large spring (tested at 38 gpm) supplies water for a prison camp located 4 miles southeast of Henderson.

Most domestic water supplies are obtained from dug or bored wells. They generally range in depth from 20 to 50 feet and most yield less than 10 gpm. However, a yield of 1 gpm may be adequate for domestic uses because of the large storage capacity of the wells. Rocks of the mica gneiss unit and metavolcanic sequence are at most places sufficiently weathered to permit construction of dug and bored wells to a few feet below the water table.

Because the granite and granodiorite are not as deeply weathered, it is more difficult to construct satisfactory wells of this nature in areas underlain by these rocks.

Records of 122 wells in Vance County are included in the table of well data (table 23). Records of three springs are given in table 24. Sufficient data were collected on 89 drilled wells to compile the comparative table given below (table 22).

Table 22.--Summary of data on wells in Vance County

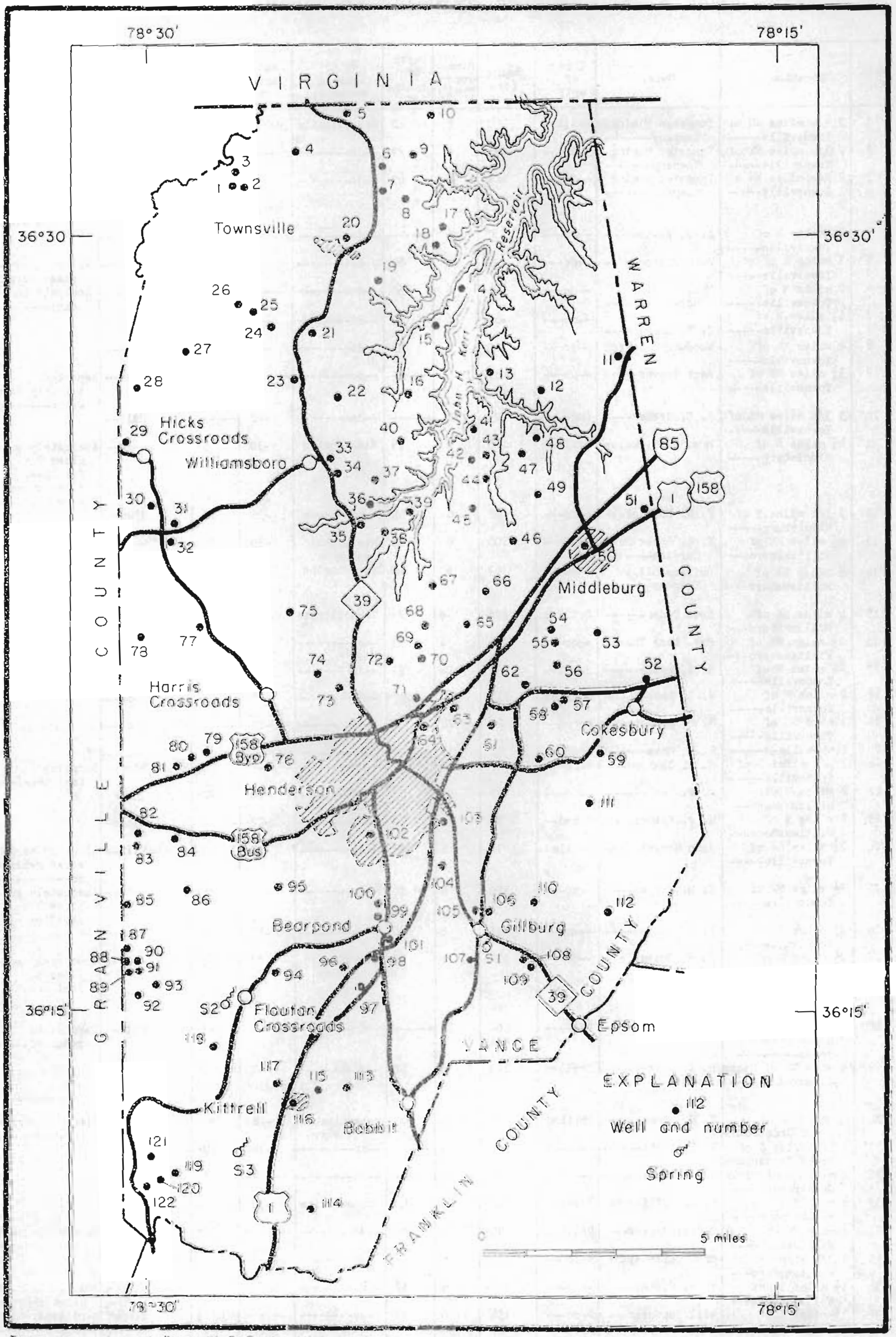
| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| ACCORDING TO ROCK TYPE | | | | | | |
| Mica Gneiss | 32 | 167 | 1-40 | 10 | 0.06 | 3.1 |
| Meta-volcanic Sequence | 12 | 105 | 3-36 | 12 | .11 | 0 |
| Granodiorite | 33 | 123 | .5-75 | 11 | .09 | 6.1 |
| Granite | 12 | 140 | 1-90 | 23 | .16 | 8.3 |
| All wells | 89 | 139 | .5-90 | 12 | .13 | 4.5 |
| ACCORDING TO TOPOGRAPHIC LOCATION | | | | | | |
| Hill | 42 | 136 | 1-75 | 12 | 0.09 | 4.8 |
| Flat | 13 | 126 | 1-82 | 8 | .06 | 7.7 |
| Slope | 26 | 158 | .5-90 | 14 | .09 | 3.9 |
| Draw | 8 | 112 | 12-36 | 18 | .16 | 0 |

Drilled wells in granite have the highest average yield (23 gpm), and the highest average yield per foot of well (0.16 gpm per foot of well). However, there are more wells in granite that yield 1 gpm or less than in any other rock type. About one out of 10 wells in granite falls into this category.

Adequate domestic supplies of water can be obtained from drilled wells at most places. Topographic features are important indicators of favorable ground-water locations and can be used in selecting well sites. As is shown by table 22, wells located in draws have the highest average yield and average yield per foot of well. Other visible features indicative of favorable ground-water conditions include quartz veins, coarse-grained granite or pegmatite dikes, and deeply weathered areas.

Complete analyses of seven water samples from wells in Vance County are given in table 25. Ground water in Vance County is principally of the calcium and sodium-bicarbonate type. Fifty-seven percent of the waters sampled were soft. Ground water in Vance County is suitable for most domestic, municipal and industrial uses.

Analysis of one sample from granite and one from mica gneiss indicate that these rocks yield a water that is soft and has a low iron content. Water from granodiorite is generally of good quality although at places it may be moderately hard to hard. The hardness of water from granodiorite ranged from 14 to 138 ppm and the iron content did not exceed 0.24 ppm. Two samples of water from rocks of the metavolcanic sequence were analyzed, and both were very hard. One sample had 9.0 ppm iron, but the water is corrosive and a large percentage of the iron probably comes from corrosion of the pipes in the distribution system.




Base map adapted from N.C. State Highway Commission County road map 1961

Figure 24.--Map of Vance County showing locations of wells and springs.

Table 23.--Records of wells in Vance County

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 3/4 miles NW of Townsville----- | Tungsten Mining Company------- | Drilled | 90 | 8 | 62 | Granodiorite | ------ | 13 | | Draw-- | |
| 2 | 2 3/4 miles NW of Townsville----- | Tungsten Mining Company------- | --do--- | 31 | 6 | 21 | --do-------- | ------ | ------ | | Hill-- | |
| 3 | 2 3/4 miles NW of Townsville----- | Tungsten Mining Company------- | --do--- | 142 | 6 | 40 | --do-------- | -17 | ------ | | --do-- | Combined yield of wells 2 and 3 is about 12 gpm------ |
| 4 | 2½ miles N of Townsville----- | A. B. Keeton---- | --do--- | 60 | 6 | ------- | --do-------- | -30 | 9 | | ---do-- | |
| 5 | 3 miles N of Townsville----- | John Wilson----- | --do--- | 99 | 6 | 80 | --do-------- | -30 | 5 | | ---do-- | Water is sometimes turbid. |
| 6 | 2 miles N of Townsville----- | Mrs. E. C. Norwood------- | --do--- | 61 | 6 | 50 | --do-------- | ------ | ----- | | ------- | Analysis in table------- |
| 7 | 1½ miles N of Townsville----- | J. H. Brewer---- | --do--- | 85 | 6 | 40 | --do-------- | -45 | 8 | | Hill--- | |
| 8 | 2 miles NE of Townsville----- | Woodworth Church | --do--- | 60 | 6 | 43 | --do-------- | -20 | 9 | | Flat-- | |
| 9 | 3¾ miles NE of Townsville----- | Jack Brewer----- | --do--- | 85 | 6 | ----- | --do-------- | ------ | 7½ | | --do-- | Reported slightly hard water------- |
| 10 | 3 3/4 miles NE of Townsville----- | O. E. Brewer---- | Dug---- | 25 | 36 | ------ | --do-------- | -20 | ----- | | Hill-- | |
| 11 | 4¼ miles N of Middleburg----- | Mrs. H. B. White | Drilled | 168 | 6 | 15 | Mica gneiss | -30 | 5+ | | --do-- | Adequately supplies 2 families. Water moderately hard---- |
| 12 | 3 3/4 miles N of Middleburg----- | F. D. Bullock--- | --do--- | 82 | 6 | 44 | --do------- | -35 | 10 | | Slope | |
| 13 | 4½ miles NE of Williamsboro--- | N. C. State Park Service------- | --do--- | 100 | 6 | 52 | Metavolcanic sequence | -30 | 5½ | | --do- | |
| 14 | 5 miles NE of Williamsboro--- | Huffman Oil Company------- | --do--- | 67 | 6 | 40 | Granodiorite | -12 | 8 | | Flat-- | Water turbid--- |
| 15 | 4 miles NE of Williamsboro--- | Leon Tuder------ | Drilled | 126 | 6 | 99 | Granodiorite | -25 | 7½ | | Hill-- | |
| 16 | 2½ miles NE of Williamsboro--- | Mrs. Lena Thomas | --do--- | 166 | 6 | 53 | --do-------- | -40 | 7 | | Slope-- | Hard water reported----- |
| 17 | 2¼ miles E of Townsville----- | R. A. Reese----- | Bored-- | 51 | 24 | 51 | --do-------- | -35 | 10- | | Hill--- | |
| 18 | 2 miles E of Townsville----- | W. T. Reese----- | Drilled | 115 | 6 | 90 | --do-------- | -28 | 3 | | --do--- | |
| 19 | 1 mile SE of Townsville----- | S. H. Johnston-- | Bored-- | 40 | 24 | 40 | --do-------- | -25 | ----- | | --do--- | Analysis in table |
| 20 | Townsville------- | E. E. Moss------ | Drilled | 61 | 6 | ------ | --do-------- | ------- | 9 | | --do--- | |
| 21 | 1 3/4 miles S of Townsville----- | C. U. Samford--- | --do--- | 67 | 6 | 40 | --do-------- | ------- | 5 | | Slope | Supplies 5 families----- |
| 22 | 2 miles N of Williamsboro--- | W. W. Neel------ | --do--- | 97 | 6 | 63 | --do-------- | -20 | 20+ | | Draw | |
| 23 | 2 miles N of Williamsboro--- | R. A. Fisher, Jr. | Bored-- | 36 | 24 | 36 | --do-------- | -22 | ----- | | Slope- | |
| 24 | 2¼ miles SW of Townsville----- | John Norwood---- | Drilled | 75 | 6 | 29 | --do-------- | -30 | 12 | | Hill-- | Slightly hard water reported----------- |
| 25 | 2½ miles SW of Townsville----- | F. W. Morgan---- | --do--- | 150 | 6 | 16 | --do-------- | -28 | 75 | | --do-- | Adequately supplies 4 families.---- |
| 26 | 2½ miles SW of Townsville----- | F. W. Morgan---- | --do--- | 75 | 6 | 20 | --do-------- | -45 | 9 | | Draw- | |
| 27 | 2½ miles N of Hicks Crossroads---------- | J. F. Twisdale-- | --do--- | 116 | 6 | 86 | Metavolcanic sequence | -28 | 15-18 | | ------- | Adequately supplies 5 families. |
| 28 | 1½ miles N of Hicks Crossroads--------- | L. B. Elliott--- | Dug---- | 62 | 36 | ------ | --do------- | ------ | 1-3 | | Hill- | Hard water reported----- |
| 29 | ½ mile NW of Hicks Crossroads----- | R. T. Satterwhite--------- | Drilled | 123 | 6 | 40 | --do------- | -8 | 9 | | --do-- | Slightly hard water reported---- |
| 30 | 1¼ miles S of Hicks Crossroads | S. W. Green------ | Drilled | 78 | 6 | 60 | Metavolcanic sequence | -18 | 36 | | Draw | Water contains iron-------- |
| 31 | 1 3/4 miles S of Hicks Crossroads | V. E. Knott------ | --do--- | 75 | 6 | ----- | --do--------- | -35 | 10+ | | Hill | |
| 32 | 2 miles S of Hicks Crossroads----- | Z. W. Clark------ | --do--- | 53 | 6 | ----- | --do--------- | ------ | 3 | | --do-- | |
| 33 | ½ mile E of Williamsboro--- | T. L. Williamson | Bored-- | 48 | 24 | 48 | Granodiorite | -30 | ------ | | --do-- | |
| 34 | ½ mile SE of Williamsboro--- | Carrie Morrow--- | Drilled | 95½ | 6 | 83 | --do-------- | ------- | 10+ | | --do-- | Moderately hard water reported |
| 35 | 1 3/4 miles SE of Williamsboro--- | Mrs. Ollie Ascue | --do--- | 430 | 6 | ----- | --do-------- | ------ | 3 | | Slope | |
| 36 | 1½ miles SE of Williamsboro--- | T. M. Hunter---- | --do--- | 105½ | 6 | 52½ | --do-------- | ------ | 2 | | Hill-- | Moderately hard water reported |
| 37 | 1½ miles E of Williamsboro--- | Will Jefferson-- | --do--- | 154 | 6 | 27 | --do-------- | ------ | ½ | | Slope | Hard water reported------- |
| 38 | 2¼ miles SE of Williamsboro--- | Thomas Royster-- | --do--- | 257 | 6 | 28 | --do-------- | ------ | 8½ | | --do-- | |

Table 23.--Records of wells in Vance County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | 2½ miles SE of Williamsboro--- | N. C. State Park Service------- | --do--- | 55 | 8 | 47 | --do-------- | -25 | 15 | | --do-- | Drawdown 2½ feet after 12 hours of pumping at 15 gpm |
| 40 | 2 miles E of Williamsboro--- | T. Hunter------- | --do--- | 166 | 6 | 53 | --do-------- | -40 | 7 | | Hill-- | Hard water reported------- |
| 41 | 3½ miles NW of Middleburg----- | N. C. State Park Service------- | --do--- | 62 | 6 | 30 | Metavolcanic sequence | -18 | 7 | | --do-- | Drawdown 24 feet after 12 hours of pumping at 7 gpm-------- |
| 42 | 3¼ miles NW of Middleburg----- | Henry White----- | --do--- | 160 | 6 | 35 | --do------ | -35 | 5 | | --do-- | |
| 43 | 3 miles NW of Middleburg----- | F. M. White----- | --do--- | 165 | 6 | 62 | Mica gneiss | -35 | 2½ | | --do-- | |
| 44 | 2 3/4 miles NW of Middleburg----- | Tom White------- | --do--- | 62 | 6 | ------ | --do------- | -25 | 5 | | --do-- | |
| 45 | 3 miles W of Middleburg----- | J. H. Huffman---- | Drilled | 78 | 6 | 40 | Mica gneiss-- | ------ | 4 | | Hill-- | |
| 46 | 1 3/4 miles W of Middleburg----- | F. H. Spain------ | --do--- | 458 | 6 | 16 | --do-------- | -26 | 10 | | --do-- | Adequately supplies 3 families---- |
| 47 | 2½ miles NW of Middleburg----- | Middleburg Girl Scout Camp----- | --do--- | 95 | 6 | 16 | --do-------- | -8 | 12 | | Draw-- | Hard water reported------- |
| 48 | 2 3/4 miles N of Middleburg----- | D. L. Meekins---- | --do--- | 69 | 6 | 41 | --do-------- | ------ | 30+ | | Hill-- | Adequately supplies trailer park of 60 trailers. Hard water reported----- |
| 49 | 1 3/4 miles N of Middleburg----- | H. J. Richardson | --do--- | 313 | 6 | 40 | --do------- | -40 | 1 | | --do-- | |
| 50 | Middleburg------- | J. T. Satterwhite | --do--- | 230 | 6 | 58 | --do-------- | -25 | 3 | | Flat-- | |
| 51 | 1¼ miles NE of Middleburg----- | P. G. Currin----- | --do--- | 77 | 6 | 67 | --do-------- | -32 | 9 | | Hill-- | |
| 52 | 3/4 miles NE of Cokesbury------ | T. P. Rose, Jr.-- | --do--- | 120 | 6 | 30 | --do-------- | -31 | 15 | | --do-- | |
| 53 | 1 3/4 miles N of Cokesbury------ | J. T. Satterwhite | --do--- | 488 | 6 | 18 | --do-------- | -8 | 2½ | | Slope | Hard water reported------ |
| 54 | 2½ miles NW of Cokesbury------ | W. H. Currin----- | Bored-- | 39 | 30 | 39 | --do-------- | -15 | 5+ | | Hill-- | |
| 55 | 2¼ miles NW of Cokesbury------ | Russell Dillard-- | Drilled | 161 | 6 | 19 | --do-------- | -15 | 9 | | Flat-- | Slightly hard water reported |
| 56 | 2 miles NW of Cokesbury------ | F. H. Ellington-- | --do--- | 90 | 6 | 45 | --do-------- | ------ | 10 | | Hill-- | Adequately supplies 2 families----- |
| 57 | 1½ miles W of Cokesbury------ | L. C. Purdue----- | --do--- | 408 | 6 | 40 | --do-------- | -39.20 | 40+ | | --do-- | Water too hard for domestic use. Water level measured 11/9/61. Observation well |
| 58 | 1½ miles W of Cokesbury------ | L. C. Purdue---- | --do--- | 65 | 6 | 40 | --do------- | -10 | 8 | | Slope | Adequately supplies 3 families |
| 59 | 1 3/4 miles SW of Cokesbury------ | R. C. Daniels---- | Drilled | 108 | 6 | 80 | Mica gneiss-- | -25 | 6 | | Slope-- | |
| 60 | 2½ miles SW of Cokesbury------ | Raymond Abbott--- | --do--- | 72 | 6 | 44½ | --do-------- | ------ | 30 | | --do-- | Slightly hard water reported---- |
| 61 | 2½ miles NE of Henderson------ | Carey's Chapel Baptist Church | --do--- | 117 | 6 | 58 | --do------- | -41 | 20 | | --do-- | |
| 62 | 3½ miles NE of Henderson------ | J. P. Rogers---- | --do--- | 164 | 6 | 48 | --do-------- | -34 | 20+ | | Hill-- | |
| 63 | Henderson-------- | W. B. Daniel, Jr. | --do--- | 127 | 6 | ------ | --do-------- | ------ | 5 | | Flat-- | Slightly hard water reported---- |
| 64 | Henderson-------- | Greystone Concrete Products Company | --do-- | 172 | 6 | 41 | --do-------- | -8 | 22 | | --do-- | Hard water reported---- |
| 65 | 3 3/4 miles NE of Henderson------ | Fletcher Satterwhite--------- | --do--- | 144 | 6 | 45 | --do-------- | ------ | 3½ | | --do-- | Hard water reported----- |
| 66 | 2½ miles SW of Middleburg----- | Flat Rock Church | --do--- | 102 | 6 | 63 | --do-------- | -20 | 6 | | Slope-- | Bored 22 feet. Moderately hard water reported.--- |
| 67 | 4 miles N of Henderson------ | Frank Powell---- | --do--- | 391 | 6 | 50 | --do-------- | -52 | 2½ | | Hill-- | Corrosive water reported----- |
| 68 | 3 miles N of Henderson------ | J. C. Gardner--- | --do--- | 165 | 6 | 40 | --do-------- | ----- | 5 | | --do-- | Slightly hard water reported |
| 69 | 2 3/4 miles N of Henderson------ | M. J. Jackson--- | Dug---- | 33 | 24 | 33 | --do-------- | -25 | ----- | | --do-- | Adequately supplies 3 families. Hard water reported----- |
| 70 | 2½ miles N of Henderson------ | James Reavis---- | Drilled | 146 | 6 | 22 | --do------- | -40 | 1½ | | --do-- | Slightly hard water reported |
| 71 | Henderson-------- | Edward Harris--- | --do--- | 97 | 6 | 70 | --do------- | -27 | 6 | | --do-- | Slightly hard water reported |
| 72 | 2¼ miles N of Henderson------ | R. M. Hawkins--- | Dug--- | 55 | 36 | 55 | Metavolcanic sequence | -33 | 10+ | | --do-- | |

Table 23.--Records of wells in Vance County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73 | 2 miles NW of Henderson------ | W. E. Hedrick---- | Drilled | 176 | 6 | 21 | Metavolcanic sequence | -23 | 20+ | | Draw-- | Hard water reported---- |
| 74 | 2 3/4 miles NW of Henderson------ | Tommy Richardson | --do--- | 388 | 6 | 20 | Granodiorite | ------ | 4 | | Hill--- | |
| 75 | 1 3/4 miles N of Harris Cross-roads---------- | W. B. Granger--- | --do--- | 184 | 6 | 23 | --do-------- | -29 | 9 | | Slope-- | Analysis in table------- |
| 76 | 1 3/4 miles S of Harris Cross-roads---------- | F. L. Waddile--- | --do--- | 169 | 6 | 30 | --do-------- | -24 | 15-20 | | Draw--- | Adequate supply for home and dairy.------ |
| 77 | 2 miles NW of Harris Cross-roads---------- | E. W. Green----- | --do--- | 64 | 6 | 40 | --do-------- | -5 | 10 | | Hill--- | Dug 24 feet. Adequately supplies 2 families---- |
| 78 | 3 miles NW of Harris Cross-roads---------- | L. L. Parker---- | --do--- | 119½ | 6 | 75 | Metavolcanic sequence | -20 | 8 | | --do--- | |
| 79 | 2 miles SW of Harris Cross-roads---------- | Clarence Greenway | --do--- | 123 | 6 | 60 | Granodiorite | -30 | 7 | | --do--- | Slightly hard water reported---- |
| 80 | 2¼ miles SW of Harris Cross-roads---------- | Charlie Greenway | --do--- | 113 | 6 | 31 | --do-------- | ----- | 4 | | Slope- | Slightly hard water reported---- |
| 81 | 2½ miles SW of Harris Cross-roads---------- | Lewis Greenway-- | Bored-- | 30 | 24 | 30 | --do-------- | -20 | 7 | | --do-- | |
| 82 | 4¾ miles SW of Harris Cross-roads---------- | Mrs. Walter T. Barnes------- | Drilled | 90 | 6 | ----- | --do-------- | ------ | 20+ | | --do-- | Hard water reported---- |
| 83 | 4½ miles SW of Harris Cross-roads--------- | J. A. Wright---- | Dug---- | 50 | 40 | ------ | --do-------- | ------ | 25 | | Hill-- | Moderately hard water reported---------- |
| 84 | 4 miles SW of Harris Cross-roads--------- | R. F. Wade------ | Bored-- | 40 | 30 | 40 | --do-------- | ------ | ------ | | Slope | Adequately supplies 2 families----- |
| 85 | 3¼ miles NW of Flovtan Cross-roads---------- | H. L. Wright----- | Dug---- | 45 | 36 | ------ | Granodiorite | ------ | ------ | | Hill--- | Hard water reported--- |
| 86 | 2 3/4 miles NW of Flovtan Cross-roads---------- | P. O. Wade------- | --do--- | 47 | 40 | ------ | --do-------- | ------ | ------ | | --do--- | Hard water reported--- |
| 87 | 3 miles NW of Flovtan Cross-roads---------- | W. E. Stovall---- | Bored--- | 35 | 26 | 35 | --do-------- | ------ | ------ | | Slope-- | |
| 88 | 2 3/4 miles NW of Flovtan Cross-roads--------- | F. T. Wrenn------ | Drilled | 31 | 6 | 30 | --do-------- | ------ | 10+ | | Hill-- | Adequately supplies 2 families--- |
| 89 | 2¾ miles NW of Flovtan Cross-roads---------- | Douglas Bredlove | Dug---- | 40 | 30 | ------ | --do-------- | ------ | ------ | | Flat--- | Moderately hard water reported--- |
| 90 | 2½ miles NW of Flovtan Cross-roads---------- | J. T. Wrenn, Estate-------- | --do--- | 25 | 36 | ------ | --do-------- | -30 | 10 | | Slope | |
| 91 | 2¼ miles NW of Flovtan Cross-roads---------- | J. C. Capps----- | --do--- | 36 | ----- | ------- | --do-------- | -18 | 10 | | Hill-- | Water hard, uses softener |
| 92 | 2½ miles W of Flovtan Cross roads---------- | Mrs. John Mitchell | Drilled | 120 | 6 | 95 | --do-------- | ------ | 30 | | --do-- | Hard water reported---- |
| 93 | 2 miles W of Flovtan Cross-roads--------- | L. C. Bredlove-- | --do--- | 52 | 6 | 21 | --do-------- | ------ | 1- | | --do-- | Yield inadequate------- |
| 94 | 1 mile NE of Flovtan Cross-roads--------- | Edwin Bowen----- | Bored-- | 37 | 30 | 37 | Mica gneiss | -12 | ----- | | --do-- | |
| 95 | 2½ miles N of Flovtan Cross-roads--------- | W. W. McCracken | Drilled | 141 | 6 | 22 | Metavolcanic sequence | -70 | 12 | | --do-- | Adequately supplies 4 homes. Analysis in table------ |
| 96 | 1½ miles SW of Bearpond------- | Mrs. Nora E. Pegg | Drilled | 139 | 6 | ------ | Granite------ | ------ | 18-20 | | Flat--- | Adequately supplies 2 families--- |
| 97 | 1½ miles S of Bearpond------- | T. A. Stove, Jr. | --do--- | 82 | 6 | 10 | --do--------- | ------ | 3 | | Slope-- | Bored 8 feet. Slightly hard water reported---------- |
| 98 | ½ mile S of Bearpond------- | Mrs. T. P. Stewart-------- | --do--- | 202 | 6 | 20 | --do--------- | ------ | ------ | | Flat--- | Hard water reported---- |
| 99 | ½ mile N of Bearpond------- | Vance Trucking Company-------- | --do--- | 140 | 6 | 10 | --do--------- | -5.10 | 1 | | --do--- | Water level measured 11/9/61. Observation well-------- |
| 100 | ½ mile N of Bearpond------- | Vance Trucking Company-------- | --do--- | 75 | 6 | 15 | --do-------- | ------ | 6 | | --do--- | Hard water reported---- |
| 101 | Bearpond--------- | Mrs. W. I. Harris | --do--- | 81 | 8 | 23½ | --do-------- | -9 | 8 | | --do--- | |

Table 23.--Records of wells in Vance County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102 | Henderson-------- | Pepsi Cola Bottling Company----------- | --do--- | 400 | 8 | 15 | --do-------- | ------ | 90 | | Slope | Water treated |
| 103 | Henderson-------- | B. H. Hicks------ | --do--- | 162 | 6 | 66½ | Mica gneiss | -30 | 5 | | Flat-- | |
| 104 | 2 miles NE of Bearpond------- | J. F. Lassiter--- | Bored-- | 42 | 24 | 42 | Granite----- | -23 | ----- | | Hill-- | Hit hard rock at 42 feet. Adequately supplies 3 families--- |
| 105 | ½ mile N of Gillburg------- | Mrs. P. S. Ellio | Drilled | 105 | 6 | 71½ | --do-------- | -30 | 20 | | Slope | Slightly hard water reported---------- |
| 106 | ½ mile NE of Gillburg------- | D. G. Faulkner-- | --do--- | 73 | 6 | 44 | --do-------- | -18 | 15+ | | --do-- | Drawdown less than 1 foot after 18 hours pumping at 15 gpm-- |
| 107 | 3/4 miles S of Gillburg------- | W. S. Smith----- | Drilled | 119 | 6 | 50 | Granite----- | -27 | 4 | | Slope | |
| 108 | 1¼ miles SE of Gillburg------- | S. G. Satterwhite | Drilled | 175 | 6 | 40 | Granite----- | -19 | 90 | | Slope-- | Drawdown 10 feet after pumping 8 hours at 90 gpm. Analysis---- |
| 109 | 1½ miles SE of Gillburg------- | B. M. Nowman----- | --do--- | 214 | 8 | 57 | --do-------- | ------ | 16 | | --do--- | Adequately supplies 2 families--- |
| 110 | 1½ Miles NE of Gillburg------- | Allison A. Faulkner------- | --do--- | 79 | 6 | 58 | --do-------- | -22 | 10+ | | --do--- | |
| 111 | 2¼ miles SW of Cokesbury------ | S. T. Franklin--- | Bored | 38 | 24 | 38 | Mica gneiss-- | -18 | 7 | | --do--- | Analysis in table------ |
| 112 | 3 miles E of Gillburg------- | T. H. Weldon, Sr. | Drilled | 66 | 6 | 43½ | --do-------- | ------ | 20 | | Hill-- | Slightly hard water reported---- |
| 113 | 1½ miles W of Bobbitt-------- | J. K. Spenser, Jr. | --do--- | 53 | 6 | 10 | --do-------- | ------- | 7 | | Slope- | Water contains iron-------- |
| 114 | 2½ miles S of Kittrell------- | Barker Wynn------ | Bored-- | 45 | 24 | 45 | --do-------- | -11 | 5+ | | Flat-- | |
| 115 | ½ mile NE of Kittrell------- | Thomas Rodgers--- | Drilled | 64 | 6 | ------- | --do-------- | ------- | 5 | | --do-- | Bored 24 feet to rock----- |
| 116 | Kittrell--------- | A. L. Overton---- | --do--- | 63 | 6 | 15 | --do-------- | -15 | 9 | | Slope | |
| 117 | ¼ mile NW of Kittrell------- | Kittrell College | --do--- | 181 | 8 | ------- | --do-------- | -14 | ----- | | --do-- | Moderately hard water reported---------- |
| 118 | 1¾ miles S of Flovtan Cross roads---------- | Mrs. A. L. Vandyke------- | --do--- | 94 | 8 | ------ | --do-------- | ------ | ------ | | Hill-- | Adequately supplies 2 families---- |
| 119 | 3 miles SW of Kittrell------- | C. T. Brummitt-- | --do--- | 216 | 6 | -20 | --do-------- | -18.70 | 2- | | Slope | Water level measured 11/9/61. Observation well-------- |
| 120 | 3 miles SW of Kittrell------- | C. T. Brummitt--- | Dug---- | 25 | 40 | ------ | Mica gneiss-- | -16.0 | ------ | | Slope-- | Water level measured 9/28/61---- |
| 121 | 3½ miles SW of Kittrell------- | W. H. Milton----- | Drilled | 63 | 6 | 32 | Metavolcanic sequence | ------ | 16 | | Hill-- | |
| 122 | 3 3/4 miles SW of Kittrell------- | Victor Roberts--- | --do--- | 325 | 6 | 20 | --do-------- | -30 | ½- | | --do-- | Analysis------ |

Table 24.--Records of springs in Vance County

| Spring Number | Location | Owner | Yield (gpm) | Chief Aquifer | Topography | Remarks |
|---|---|---|---|---|---|---|
| $S_1$ | 1/2 mile S of Gillburg------- | N. C. State Prison Department----- | 38 | Granite | Draw-------- | Spring fed from fractures in granite. Yield has been measured at 38 gpm and is the only water supply for prison camp----- |
| $S_2$ | 1/2 mile SW of Flovtan Crossroads---------- | B. B. Ayscue--- | ----- | Mica gneiss | --do-------- | Water issues from fracture opening in biotite gneiss. Temp. 59°F---------------- |
| $S_3$ | 1-1/2 miles SW of Kittrell-------- | William Moss--- | 1-3 | --do-- | --do-------- | Seep area developed by excavating to rock and installing terra cotta pipe reservoir. Water obtained from biotite gneiss saprolite overlying hard rock--------------------- |

Table 25.--Chemical analyses of ground water from Vance County. (Numbers at heads of columns correspond to well numbers in table 23.)

(Parts per million)

| | 6 | 19 | 75 | 95 | 108 | 111 | 122 |
|---|---|---|---|---|---|---|---|
| Date of Collection | 2/6/63 | 2/13/62 | 2/13/62 | 2/13/62 | 2/13/62 | 2/13/62 | 2/13/62 |
| Silica ($SiO_2$) | 38 | 31 | 40 | 32 | 20 | 23 | 24 |
| Aluminum (Al) | .0 | .1 | .0 | .0 | .0 | .0 | .0 |
| Iron (Fe) | .03 | .17 | .08 | .05 | .24 | .09 | 9.0 |
| Manganese (Mn) | .00 | .00 | .00 | .04 | .00 | .00 | .03 |
| Calcium (Ca) | 3.8 | 14 | 34 | 51 | 5.4 | 3.2 | 63 |
| Magnesium (Mg) | 1.1 | .7 | 13 | 8.1 | .9 | 1.1 | 32 |
| Sodium (Na) | 6.7 | 4.4 | 48 | 10 | 9.2 | 7.6 | 10 |
| Potassium (K) | .3 | .6 | 4.0 | 5.2 | 1.6 | 1.5 | 1.9 |
| Lithium (Li) | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| Bicarbonate ($HCO_3$) | 26 | 37 | 126 | 203 | 10 | 18 | 313 |
| Sulfate ($SO_4$) | 2.2 | 4.6 | 22 | 6.4 | 1.8 | 5.0 | 33 |
| Chloride (Cl) | 4.0 | 2.0 | 66 | 6.6 | 5.6 | 4.6 | 7.4 |
| Fluoride (F) | .1 | .1 | .2 | .1 | .1 | .0 | .2 |
| Nitrate ($NO_3$) | 1.8 | 4.0 | 18 | 2.6 | 24 | 5.5 | .3 |
| Phosphate ($PO_4$) | .2 | .7 | .8 | .3 | .2 | .1 | .2 |
| Dissolved Solids | 71 | 80 | 308 | 222 | 74 | 61 | 326 |
| Hardness as $CaCO_3$ | 14 | 38 | 138 | 162 | 17 | 12 | 288 |
| Noncarbonate | 0 | 7 | 35 | 0 | 9 | 0 | 31 |
| Specific Conductance | 58 | 110 | 537 | 357 | 96 | 69 | 548 |
| pH | 6.5 | 7.3 | 6.6 | 7.2 | 6.1 | 6.2 | 6.7 |
| Color | 5 | 15 | 5 | 3 | 3 | 3 | 7 |
| Map Unit | Granodio-rite | Granodio-rite | Granodio-rite | Meta-volcanic | Granite | Mica gneiss | Meta-volcanic |

# WAKE COUNTY

(Area: 864 square miles; population in 1960: 169,082)

## GEOGRAPHY

Wake County, in the southern part of the Raleigh area, is the largest and most densely populated county in the area. It is bounded by Johnston, Harnett, Chatham, Durham, Granville, and Franklin Counties. Raleigh, population 93,117 is the capital of North Carolina, and largest city in the area of investigation. Other population centers in the county include Cary, Apex, Garner, Wendell, Zebulon, Fuquay Springs, Rolesville, Wake Forest, and Holly Springs.

The county is the most industrialized county in the area, and most industries are located in or near Raleigh. Major industries are in the fields of electronics, research, textiles, lumber and wood products, iron and steel, and food and drink processing. Raleigh is the center of State government and several colleges are located in the city. Income from the sale of farm and dairy products is important to the economy of the rural areas of the county; tobacco is the chief crop.

Wake County lies mostly within the Piedmont physiographic province, an uplifted and partially dissected peneplain. The topography is gently rolling and interstream areas are usually broad and flat. The most rugged topography is near the larger streams where relief is generally between 50 and 100 feet per mile. No hills stand out prominently above the general upland surface. The Fall Zone, a boundary between the Piedmont and Coastal Plain provinces, passes through the southern part of Wake County.

The Neuse River and its tributaries drain about 80 percent of the county. The remaining 20 percent in the southwestern part of the county is drained by tributaries of the Cape Fear River. The Neuse River and many of its larger tributaries are antecedent streams which flow in a southeastern direction. The directions of the smaller stream courses are controlled primarily by regional structure and relative resistance to erosion of the underlying rocks.

## GEOLOGY

Rocks of the mica gneiss unit are exposed both east and west of the large granite pluton. The largest area underlain by these rocks is a north trending zone through the central part of the county west of the granite. The rocks consist principally of biotite-feldspar gneiss, quartzitic gneiss, garnetiferous biotite gneiss, and interbedded gneiss and schists. Near the main mass of granite, the biotite-feldspar gneiss is prominently banded. Light colored bands are composed mostly of orthoclase feldspar and quartz; darker bands are composed of biotite, quartz, and minor amounts of feldspar. The banded appearance is accentuated by textural differences; the biotite-rich zones are consistently finer grained than are the feldspar-rich zones. Quartzitic gneiss is exposed west of the banded gneiss as a northeast-trending zone that underlies most of the western part of the city of Raleigh.

The gneiss is composed of disseminated granular quartz and biotite mica. Schists are interbedded with the quartzitic gneiss and some of the schist beds are graphitic. Garnetiferous biotite gneiss interbedded with biotite schist and gneiss crop out extensively in northwestern Wake County.

Foliation and bedding strike northeastward and at most places, dip to the northwest.

Two northeast-trending zones of hornblende gneiss are interlayered with rocks of the mica gneiss unit. A third unit underlies a small area in southern Wake County. The gneiss is composed of hornblende and feldspar, but also contains accessory amounts of quartz and mica. The two larger units appear to be conformable with rocks of the mica gneiss unit, and perhaps are metamorphosed mafic extrusives or sediments. The small hornblende gneiss unit is a coarse massive rock in which gneissic texture is poorly developed. It is not conformable with enclosing rocks and is most likely a metamorphosed mafic intrusion.

Several elongated soapstone bodies crop out in northwestern Wake County. Typically the soapstone is a massive to schistose pale-green rock composed of talc, chlorite, and several iron and magnesium bearing accessory minerals. Many of the bodies are aligned so that apparently they are thicker masses of one continuous body. The suite of minerals in the soapstone is common to ultramafic rocks that have been hydrothermally altered.

A relatively narrow northeast-trending belt of metavolcanic rocks is exposed in the western part of the county. These rocks have been metamorphosed into low-rank phyllites, but fragments are discernible within some of the rocks and on their weathered surfaces. The rock is a white to cream metatuff in which quartz grains (beta quartz ?) are prevalent. Interlayered with this rock type are thin zones of green schistose rock which contain no visible primary features. All of the rocks have well developed cleavage which strikes northeast and dips steeply northwest.

Green to light-tan phyllite crops out as a narrow tongue extending northward from beneath Coastal Plain sediments in southern Wake County to near the center of the county. Phyllite also underlies a small area in northeastern Wake County. The rock is composed predominantly of fine sericite, chlorite, and argillaceous material. Foliation is parallel to uniform color banding which appears to be relict bedding. Foliation and bedding strike northeast. The thick mantle of soil which overlies the phyllite at most localities obscures the contact relationship between it and adjacent rocks. The phyllite may be part of the Carolina Slate Belt of volcanic and sedimentary rocks with which it has been previously mapped (N. C. State Geologic Map, 1958).

Medium-grained biotite granite, probably of Paleozoic age, underlies most of the eastern one-half of the county. It is part of a large granite pluton that underlies most of Franklin County, and parts of adjacent counties which are not included in the area of investigation. A smaller granite body is exposed underlying Cretaceous sediments in southern Wake County. Typically, the granite is light to pinkish gray, and is composed chiefly of orthoclase feldspar, biotite, and quartz. Plagioclase feldspar is a common accessory mineral. In Wake County the granite has intruded rocks of the mica gneiss unit and many coarse-grained dikes associated with the granite extend into these rocks. Sheeting, joint fractures, and exfoliated granite boulders are common. A veneer of light-colored granular saprolite covers much of the area underlain by the granite.

A small body of crystalline rock which is composed predominantly of plagioclase feldspar, chloritized biotite, and quartz crops out in northwestern Wake County. In composition, the rock is more closely related to the granodiorite which is exposed north and northeast of the body than to the granite to the west.

Interbedded sandstone and shale of the Newark Group of Triassic sedimentary rocks underlie large areas in western Wake County. The beds occur within the Triassic Durham Basin and dip gently eastward toward the Jonesboro fault which forms the eastern boundary. A coarse fanglomerate composed of boulders, cobbles, pebbles, and angular rock fragments forms a belt along the eastern edge of the fault. Vertical displacement of the fault is at least the maximum thickness of the strata in the basin which was determined by Reinemund (1955, p. 27) to be approximately 10,000 feet. Many diabase dikes, probably of Late Triassic age, have intruded the rocks. Near Bonsal in southwestern Wake County, a thin mantle of unconsolidated sands and clays of Cretaceous(?) age unconformably overlie Triassic rocks.

Coastal Plain strata unconformably overlie metamorphic and intruded rocks in southern Wake County. No fossils were found to occur in these unconsolidated sediments; they have been designated as part of the Tuscaloosa Formation of Cretaceous age on the basis of lithology and stratigraphic position with respect to sediments of known Cretaceous age outside of the Raleigh area. The formation in Wake County is composed predominantly of gray to white sand, and interbedded lenticular lenses of clay. Quartz and concretions of iron oxide are common at the top of clay lenses.

A mixture of shell fragments and sand occurs over a small area one mile north of highway U. S. 70 at the Wake-Johnston County line (oral communication, Dr. J. M. Parker, III, of the N. C. State College Geology Department). According to Richards (1950, p. 14), this outlying deposit is part of the Castle Hayne limestone of Eocene age.

## GROUND WATER

Raleigh, Apex, and Wake Forest obtain their municipal water supplies from surface sources. Outside of these towns, all domestic and industrial water supplies are obtained from ground-water sources. Seven towns and several residential developments use wells as a chief source of water supplies.

Dug and bored wells are common sources of domestic supplies in the rural areas. Yields of 10 to 15 gpm can be obtained from the saprolite overlying granite or from the unconsolidated Coastal Plain sediments. The soil overlying Triassic rocks generally will yield 3 to 5 gpm to dug or bored wells.

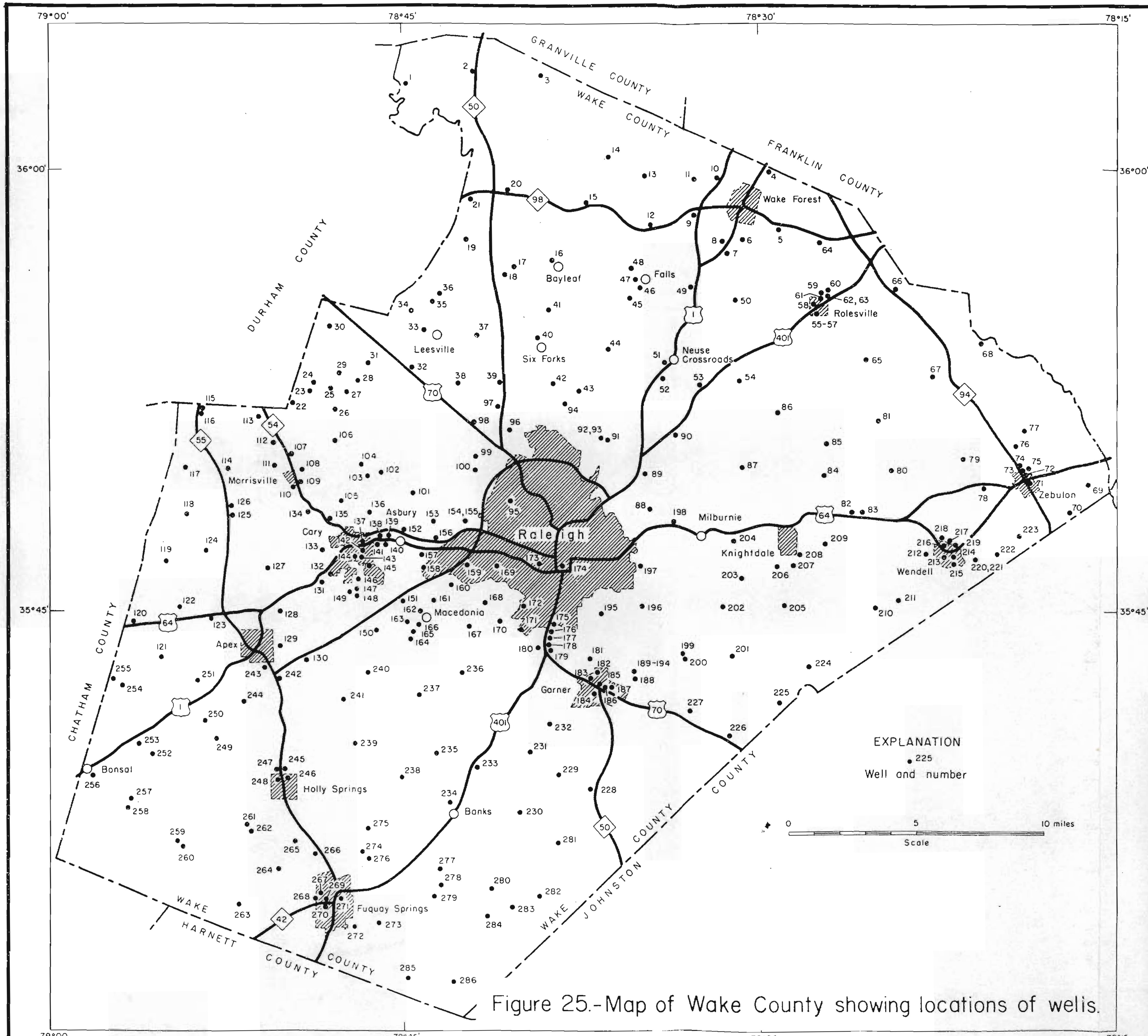



Figure 25.-Map of Wake County showing locations of wells.

Data on 286 wells in Wake County are given in table 27. Average yields, depths, and other pertinent information for 260 drilled wells are compared below in table 26.

Table 26.--Summary of data on wells in Wake County

ACCORDING TO ROCK TYPE

| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Average | Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| Hornblende Gneiss | 12 | 199 | 1-50 | 17 | 0.09 | 8.3 |
| Mica Gneiss | 80* | 147 | .5-295 | 19 | .13 | 6.2 |
| Phyllite | 11 | 183 | 4-25 | 14 | .08 | 0 |
| Meta-volcanic Sequence | 23 | 212 | 2.5-150 | 27 | .13 | 0 |
| Granite | 77 | 137 | 0-82 | 20 | .15 | 2.6 |
| Triassic rocks | 57 | 158 | 0-20 | 5 | .03 | 16 |
| All wells | 260 | 157 | 0-295 | 17 | .11 | 6.5 |

ACCORDING TO TOPOGRAPHIC LOCATION

| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Average | Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| Hill | 55 | 134 | 0-75 | 15 | 0.11 | 9.1 |
| Flat | 129* | 161 | 0-295 | 15 | .09 | 7.7 |
| Slope | 49 | 133 | .5-50 | 13 | .10 | 2.0 |
| Draw | 27 | 223 | 1-150 | 36 | .16 | 3.7 |

*Includes one well 275 feet deep, tested at 295 gpm.

According to table 26, the rocks of the metavolcanic unit, granite, and rocks included in the mica gneiss unit, in that order, are the best aquifers. The average yield and yield per foot of well for wells in these rock types in Wake County are considerably higher than the same averages for all wells in these rock types in the area of investigation. This is because most industries and municipalities which use ground water are located in Wake County and most obtain their water from these rocks. Triassic rocks are the poorest aquifers, having an average yield of 5 gpm and an average yield per foot of well of 0.03 gpm. The relatively less permeable nature of the Triassic rocks is shown by the large percentage (16 percent) of wells that yield 1 gpm or less. Wells which yield 10 to 20 gpm are common in all of the rocks in the county except the Triassic rocks. The reported yield of several wells was greater than 50 gpm. However, in most instances the yield was determined by bailer tests of short duration and, consequently, may be somewhat inaccurate. In general, wells penetrating granite or metamorphic rocks will at most places yield adequate amounts of water for domestic use. Where larger yields are desired, wells should be located where ground-water conditions are most favorable. Visible features which indicate favorable ground-water conditions include fracture zones, quartz veins, deeply weathered areas, intruded dikes, and topographically low areas such as draws or depressions. The best yielding wells in Triassic rocks are located near diabase dikes.

Table 27.--Records of wells in Wake County

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 3/4 miles NW of Bayleaf-------- | I. C. Wilkins---- | Drilled | 260 | 6 | 92 | Triassic sandstone and shale-- | ------ | 5 | | Hill-- | Water level reported to be below 190 feet. Well not used---- |
| 2 | 8¼ miles NW of Bayleaf-------- | O. Jones--------- | --do--- | 86 | 6 | 18 | --do--------- | -22 | 5 | | Flat-- | Supplies 3 families, and service station----- |
| 3 | 7½ miles N of Bayleaf-------- | O. Jones--------- | --do--- | 206 | 6 | 10 | --do--------- | -12.7 | ½ | | Hill-- | Water level measured 11/14/61. Observation well-------- |
| 4 | 1 3/4 miles N of Wake Forest---- | Owen Watford----- | Bored-- | 29 | 24 | 29 | Mica gneiss- | -22 | 10-15 | | Slope | |
| 5 | 1½ miles SE of Wake Forest---- | W. B. Joyner----- | Drilled | 160 | 5 5/8 | 20 | Granite----- | -50 | 3 | | --do- | Slightly hard water reported contains iron. |
| 6 | 1¼ miles S of Wake Forest---- | J. R. Jones------ | --do--- | 62½ | 6 | 20 | Mica gneiss | -30 | 20 | | --do-- | Adequately supplies 3 families----- |
| 7 | 1 3/4 miles S of Wake Forest---- | C. J. Lowery---- | --do--- | 63 | 6 | 18 | --do-------- | -35 | 18 | | Flat-- | |
| 8 | 1½ miles S of Wake Forest---- | C. J. Lowery---- | --do--- | 48 | 6 | 35 | --do------- | -23 | 25 | | Slope- | |
| 9 | 2 miles SW of Wake Forest---- | E. B. Jones----- | --do--- | 230 | 6 | 145 | --do------- | -35 | 10+ | | Flat-- | Supplies 8 families----- |
| 10 | 1½ miles NW of Wake Forest---- | B. Elmo Scoggin | --do--- | 227 | 6 | 87 | --do------- | -25 | 10 | | Slope | |
| 11 | 2 miles NW of Wake Forest---- | S. O. Rich------ | --do-- | 145 | 6 | 110 | Hornblende gneiss---- | -30 | 20 | | --do-- | Analysis------- |
| 12 | 3½ miles SW of Wake Forest---- | Elton Lowery---- | --do-- | 117 | 6 | 50 | Mica gneiss | -50 | 3 | | --do-- | |
| 13 | 4 miles W of Wake Forest--------- | Earl Brevoort---- | Drilled | 175 | 6 | ------ | Mica gneiss-- | -30 | 5 | | Hill-- | Reported cased more than 100 feet---- |
| 14 | 5½ miles NW of Wake Forest---- | J. P. Bailey----- | --do--- | 490 | 6 | 145 | Hornblende gneiss----- | -40 | 1½ | | --do-- | Yield inadequate, not used-------- |
| 15 | 2½ miles N of Bayleaf-------- | Owen Ray--------- | --do--- | 101 | 6 | 35 | Mica gneiss-- | ------ | 4 | | --do-- | |
| 16 | ½ mile N of Bayleaf-------- | Mrs. Wayne Norwood | --do--- | 160 | 8 | ------ | --do--------- | ------ | ½ | | Flat-- | Yield of well has decreased gradually---- |
| 17 | 1 3/4 miles W of Bayleaf-------- | J. R. Kipper----- | --do--- | 120 | 6 | 30 | Hornblende gneiss---- | -30 | 1½ | | ------- | |
| 18 | 2 miles W of Bayleaf-------- | W. T. Kipper----- | --do--- | 110 | 6 | 45 | --do-------- | -30 | 4 | | Hill-- | Analysis------ |
| 19 | 3½ miles W of Bayleaf-------- | Mrs. Charles A. Smith---------- | --do--- | 148 | 6 | 80 | Mica gneiss- | -110 | 4½ | | Flat-- | Corrosive, hard water reported----------- |
| 20 | 3½ miles NW of Bayleaf-------- | B. C. Monk------- | --do--- | 156 | 6 | 50 | --do-------- | -50 | 35 | | Slope | |
| 21 | 4 miles NW of Bayleaf-------- | Wake Minister Church--------- | --do--- | 230 | 6 | 30 | --do-------- | ------ | 4 | | --do-- | |
| 22 | 3 miles N of Morrisville---- | T. G. Johnson---- | --do--- | 91 | 6 | 10 | Triassic sandstone and shale | -17 | 7+ | | Flat | Obtained water at 71 feet. Analysis---- |
| 23 | 3½ miles N of Morrisville---- | Junius Sanders--- | --do--- | 200 | 6 | ------ | --do-------- | -150 | 1 | | --do-- | Reported cased more than 150 feet. Slightly hard water reported----------- |
| 24 | 4 miles N of Morrisville---- | J. R. Gibson----- | --do--- | 95 | 5 | ------ | --do-------- | -46 | 1 | | Hill | |
| 25 | 4 miles N of Morrisville---- | G. C. King------- | --do--- | 250 | 6 | ------ | --do-------- | -80 | 12 | | Slope | |
| 26 | 3½ miles NW of Morrisville---- | Raleigh-Durham Airport------- | --do--- | 241 | 6 | 100 | --do-------- | ------ | 2 | | Flat | |
| 27 | 3 miles NW of Morrisville---- | Raleigh-Durham Airport------- | Drilled | 285 | 6 | ------ | Triassic sandstone and shale | ------ | 2 | | Flat-- | |
| 28 | 3½ miles NW of Morrisville---- | Raleigh-Durham Airport------- | --do--- | 178 | 6 | 30 | --do-------- | ------ | 4 | | --do-- | |
| 29 | 3½ miles N of Morrisville---- | Raleigh-Durham Airport------- | --do--- | 258 | 6 | ------ | --do-------- | ------ | 3 | | --do-- | |
| 30 | 6¼ miles N of Morrisville---- | C. L. Smith----- | --do--- | 105 | 6 | ------ | --do-------- | -25 | 15+ | | Slope | Hard water reported--- |
| 31 | 5½ miles NW of Morrisville---- | Donnell W. Sorrell------- | --do--- | 210 | 8 | 12 | --do-------- | -70 | 5 | | Draw | Slightly hard water reported---- |
| 32 | 1½ miles SW of Leesville------ | E. M. Hester---- | --do--- | 120 | 6 | ------ | Mica gneiss | ------ | 25-30 | | --do-- | To fill large swimming pool does not affect well------- |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | ½ mile NW of Leesville------ | R. H. Ward------ | --do--- | 112 | 6 | 100 | --do-------- | -10 | 12+ | | Flat | Irony water reported---- |
| 34 | 1½ miles NW of Leesville------ | J. M. Seago----- | --do--- | 170 | 6 | 150 | Metavolcanic sequence | -30 | 2 | | --do- | |
| 35 | 1¼ miles N of Leesville------ | Billy Norwood--- | --do--- | 125 | 6 | 100 | Mica gneiss | ----- | 15 | | Hill | |
| 36 | 1 3/4 miles N of Leesville------ | R. L. Norwood--- | --do--- | 115 | 6 | ------ | --do-------- | -10 | 5 | | Flat | |
| 37 | 1½ miles E of Leesville------ | A. H. Calhoun--- | Bored-- | 30 | 18 | 30 | Hornblende gneiss---- | -20 | 10+ | | --do- | Adequately supplies 2 families--- |
| 38 | 2 miles SE of Leesville------ | Charlie W. Wray | Drilled | 270 | 6 | ------ | Mica gneiss | -10 | 10-15 | | --do-- | Supplies 5 families--- |
| 39 | 2¼ miles SW of Six Forks------ | Fred Haig------- | --do--- | 96 | 6 | 25 | --do-------- | -8 | 17 | | Hill-- | Corrosive water reported, Has neutralizer-- |
| 40 | ¾ mile NW of Six Forks------ | N. C. State Forestry Division------ | --do--- | 170 | 6 | 98 | --do-------- | -35 | 5 | | Flat-- | Bayleaf fire tower well. Analysis---- |
| 41 | 1½ miles N of Six Forks------ | C. N. Lawrence-- | Drilled | 132 | 6 | 35 | Mica gneiss-- | ------ | 6 | | Flat--- | |
| 42 | 1½ miles SE of Six Forks------ | G. H. Purser---- | --do--- | 45 | 6 | ------ | --do--------- | -18 | 10 | | Draw--- | |
| 43 | 2¼ miles SE of Six Forks------ | W. L. Lumpkin--- | --do--- | 96 | 6 | 85 | --do--------- | ------ | 5 | | Flat--- | Irony, corrosive water reported---- |
| 44 | 2 3/4 miles E of Six Forks------ | Lonnie Dean----- | --do--- | 140 | 5 | 80 | --do-------- | -20 | 15+ | | --do--- | |
| 45 | 1 mile S of Falls | H. O. Young----- | --do--- | 93 | 6 | 67 | --do-------- | -20 | 5 | | --do--- | |
| 46 | Falls------------ | Erwin Cotton Mill Company-------- | --do--- | 100 | 6 | 80 | --do-------- | -50 | 5 | | Hill--- | Water supply for employees of Erwin Cotton Mill. |
| 47 | Falls------------ | Erwin Cotton Mill Company-------- | --do--- | 130 | 6 | ----- | --do-------- | -35 | 6-8 | | Slope-- | Water supply for employees of Erwin Cotton Mill. |
| 48 | ½ mile NW of Falls | W. H. Blackman--- | --do--- | 125 | 6 | 9 | --do-------- | -15 | ½- | | --do--- | |
| 49 | 3¼ miles S of Wake Forest--------- | K. G. Marshall--- | --do--- | 113 | 6 | 10 | --do-------- | -55 | 12 | | Hill-- | Analysis------ |
| 50 | 3½ miles S of Wake Forest---- | J. M. Pearce----- | --do--- | 100 | 6 | 15 | Granite----- | -25 | 5 | | Flat-- | |
| 51 | Neuse Crossroads- | W. H. Allen------ | --do--- | 76 | 6 | 45 | --do-------- | -20 | 15 | | Slope | |
| 52 | 3/4 miles S of Neuse Crossroads---------- | W. H. Allen------ | --do--- | 74 | 6 | 45 | Mica gneiss | -20 | 30+ | | Hill-- | Adequately supplies 13 families---- |
| 53 | 1½ miles SE of Neuse Crossroads---------- | L. T. Averette-- | --do--- | 105 | 6 | 15 | Granite---- | -30 | 30 | | Flat-- | |
| 54 | 2 3/4 miles E of Neuse Crossroads---------- | Mrs. H. B. Jones | --do--- | 28 | 6 | 3 | --do------- | -20 | 8-10 | | Slope | Hard, corrosive water reported---- |
| 55 | Rolesville------- | Wake County Board of Education-- | --do--- | 210 | 6 | 5 | --do------- | ------ | 0 | | Flat-- | Rolesville School well |
| 56 | Rolesville------- | Wake County Board of Education-- | --do--- | 130 | 6 | 7 | --do-------- | ------- | 10 | | Draw-- | Rolesville School well-- |
| 57 | Rolesville------- | Wake County Board of Education--- | Drilled | 97 | 6 | 12 | Granite---- | -8 | 5 | | Flat-- | Rolesville School Well |
| 58 | Rolesville------- | Lonnie Weathers-- | --do--- | 155 | 6 | 80 | --do------- | -12 | 5 | | --do-- | |
| 59 | Rolesville------- | Town of Rolesville---------- | --do--- | 150 | 6 | 35 | --do------- | -3 | 10 | | Slope | Public water supply. Pumped 24 hours at 10 gpm-------- |
| 60 | Rolesville------- | Town of Rolesville--------- | --do--- | 105 | 6 | 30 | --do------- | -20 | 60 | | Draw | Drawdown 1 feet after 24 hours pumping at 60 gpm.----- |
| 61 | Rolesville------- | Wake Monument Company------- | --do--- | 80 | 6 | 15 | --do------- | -9.70 | 3 | | Flat | Water level measured 11/14/61. Observation well-------- |
| 62 | Rolesville------- | Wake Monument Company------- | --do--- | 140 | 6 | 20 | --do------ | -10 | 50 | | Hill | |
| 63 | Rolesville------- | Wake Monument Company------- | --do--- | 90 | 6 | 20 | --do------ | -10 | 25 | | --do-- | Pumped 24 hours at 25 gpm--- |
| 64 | 2½ miles N of Rolesville----- | R. A. Averette, Jr.---------- | Bored-- | 27 | 20 | 27 | --do------ | -16 | 5-10 | | Flat | Slightly hard water reported--- |
| 65 | 2 3/4 miles SE of Rolesville----- | L. Buffalo------ | Drilled | 35 | 6 | 5 | --do------ | -15 | 15+ | | Hill | Analysis----- |
| 66 | 2¼ miles NE of Rolesville----- | C. J. Perry----- | --do--- | 31 | 6 | 2 | --do------ | -12 | 20 | | --do- | Corrosive water reported---------- |
| 67 | 5¼ miles SE of Rolesville----- | W. A. Perry----- | --do--- | 47 | 6 | 14 | --do------ | -15 | 8 | | --do-- | Corrosive, hard water reported---------- |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | 5½ miles NW of Zebulon------- | W. H. Hopkins--- | --do--- | 100 | 6 | 70 | --do------ | -20 | 5 | | Flat | Well not used-- |
| 69 | 2½ miles E of Zebulon-------- | John Ihrie------- | Drilled | 105 | 6 | 100 | Phyllite--- | -13 | 15+ | | Hill-- | |
| 70 | 2 miles SE of Zebulon-------- | H. M. Perry------ | --do--- | 151 | 6 | 60 | Mica gneiss | -15 | 10 | | --do-- | |
| 71 | Zebulon--------- | Town of Zebulon-- | --do--- | 312 | 8 | 100 | Granite--- | -30 | 30 | | Draw-- | Public water supply. |
| 72 | Zebulon--------- | Town of Zebulon-- | --do--- | 165 | 8 | 45 | --do------ | -25 | 35 | | --do-- | |
| 73 | Zebulon--------- | Town of Zebulon-- | --do--- | 300 | 8 | 40 | --do------ | -20 | 50 | | --do-- | Drawdown 65 feet at 50 gpm--------- |
| 74 | Zebulon--------- | Town of Zebulon-- | --do--- | 150 | 8 | 30 | --do------ | -30 | 20 | | Slope | Drawdown 60 feet at 20 gpm--------- |
| 75 | Zebulon--------- | Wake County Board of Education-- | --do--- | 286 | 6 | 14 | --do------ | ------ | 10 | | --do-- | Shephard School well-- |
| 76 | 1½ miles N of Zebulon-------- | Harold Massey--- | --do--- | 54 | 6 | 30 | --do------ | -12 | 10 | | --do-- | |
| 77 | 2 miles N of Zebulon-------- | J. D. Tippitt | --do--- | 62 | 6 | 62 | --do------ | -15 | 3 | | Hill | Yield adequate |
| 78 | 1 3/4 miles W of Zebulon-------- | Raymond Massey-- | --do--- | 29 | 6 | 16 | --do------ | -5 | 10 | | Slope | |
| 79 | 2½ miles NW of Zebulon-------- | Robert E. Perry- | --do--- | 92 | 5 3/4 | 15 | --do------ | -20 | 10 | | Hill-- | |
| 80 | 4 miles NW of Wendell-------- | J. O. Allen----- | --do--- | 80 | 6 | ------ | --do------ | -10 | 20 | | Flat-- | Adequately supplies 3 families-- |
| 81 | 6 miles NW of Wendell-------- | Wake County Board of Education-- | --do--- | 75 | 6 | 44 | --do------ | -10 | 15 | | --do-- | Riley Hill School well-- |
| 82 | 2½ miles NE of Knightdale----- | Mrs. J. T. Knott | --do--- | 45 | 6 | 10 | --do------ | -20 | 21 | | Hill-- | Corrosive water reported---------- |
| 83 | 2½ miles NE of Knightdale----- | Mrs. J. T. Knott | Dug---- | 30 | 40 | ------ | --do------ | -23.90 | ------ | | --do-- | Water level measured 11/14/61. Observation well-------- |
| 84 | 2½ miles N of Knightdale----- | William Cozart--- | Drilled | 39 | 6 | 29 | Granite----- | -20 | 6 | | Flat-- | |
| 85 | 4 miles N of Knightdale----- | J. P. Robertson-- | --do---- | 95 | 6 | 60 | --do-------- | ------ | 20 | | --do-- | |
| 86 | 5 miles N of Knightdale----- | John H. Cooke---- | Bored-- | 32 | 20 | 22 | --do-------- | -1[illegible] | 10 | | Hill-- | |
| 87 | 3½ miles NW of Knightdale----- | A. C. Martin----- | Drilled | 68½ | 6 | 60 | --do-------- | -10 | 50 | | --do-- | |
| 88 | 2¼ miles NW of Milburnie------ | D. E. Caudle----- | --do---- | 73 | 6 | 15 | --do-------- | ------ | 10-15 | | Slope | |
| 89 | 3¾ miles NW of Milburnie------ | M. E. Jones------ | --do---- | 110 | 6 | ------ | --do-------- | ------ | 12-15 | | --do-- | |
| 90 | 4¼ miles N of Milburnie------ | C. C. Belote----- | --do---- | 80 | 6 | 20 | --do-------- | ------ | 7-10 | | --do-- | |
| 91 | 4¼ miles SW of Neuse Crossroads | E. C. Doddingfield | --do---- | 152 | 6 | 90 | Mica gneiss | ------ | ½ | | Flat-- | Not used, yield inadequate.--- |
| 92 | 4¼ miles SW of Neuse Crossroads | Wake County Board of Education-- | --do---- | 180 | 6 | 62 | --do-------- | -20 | 40 | | Draw-- | Millbrook School well---------- |
| 93 | 4¼ miles SW of Neuse Crossroads | Wake County Board of Education--- | --do---- | 243 | 8 | 79 | --do-------- | -25 | 21 | | --do-- | Millbrook School well---------- |
| 94 | 2½ miles SE of Six Forks------ | Mr. W.H.Anthony | --do---- | 147 | 6¼ | 80 | --do-------- | ------ | 10 | | Flat-- | |
| 95 | Raleigh---------- | J. M. Parker----- | --do---- | 142 | 4 | 135 | --do-------- | ------ | 12 | | Slope | |
| 96 | 3½ miles SW of Six Forks------ | K. K. Wood------- | --do---- | 140 | 6 | 130 | --do-------- | -40 | 5 | | Flat | |
| 97 | 3 miles SW of Six Forks------ | Wake County Board of Education--- | --do---- | 161 | 6 | 59 | --do-------- | ------ | 10 | | Hill | Jeffreys Grove school well--- |
| 98 | 4 miles SW of Six Forks------ | Wiley Robertson, Jr.------------ | --do---- | 141 | 6 | 70 | --do-------- | -61 | ½ | | --do-- | Well not used yield inadequate--------- |
| 99 | 1½ miles NE of Asbury--------- | J. L. Crosimore | --do---- | 105 | 6 | 25 | --do-------- | ------ | 5 | | Slope | Corrosive water reported------- |
| 100 | 4¼ miles NE of Asbury--------- | M. L. Tyson----- | --do---- | 90 | 6 | ------ | --do-------- | ------ | 5 | | Flat-- | Hard water reported------- |
| 101 | 2¼ miles N of Asbury-------- | Ernie Stone------ | Drilled | 73 | 6 | 60 | Hornblende gneiss---- | ------- | 5 | | Flat-- | |
| 102 | 3 miles N of Cary | A. E. King------- | --do---- | 100 | 6 | ------ | Mica gneiss | -50 | 15 | | --do-- | |
| 103 | 2¼ miles N of Cary----------- | C. G. Baggett---- | --do---- | 98 | 6 | ------ | Metavolcanic sequence-- | -37 | 15 | | --do-- | |
| 104 | 3 miles N of Cary | L. E. Sorrell---- | --do---- | 81 | 6 | ------ | --do-------- | -40 | 15 | | Hill-- | Well located in quartz vein--- |
| 105 | 2 miles NW of Cary---------- | E. Daniel Rambeau----------- | --do---- | 300 | 6 | ------ | Triassic sandstone and shale-- | ------ | 4 | | Slope | Inadequate supply for 3 families. Analysis------ |
| 106 | 2¼ miles NE of Morrisville---- | Joe Hopkins------ | --do---- | 105 | 6 | 85 | --do-------- | -65 | 6-10 | | Flat-- | Moderately hard water reported |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 107 | 1¼ mile N of Morrisville | Taylor's Gulf Station | --do-- | 93 | 6 | ------ | --do-- | -24 | 1 | | --do-- | |
| 108 | ¼ mile N of Morrisville | Walter H. Bishop | --do-- | 75 | 6 | ------ | --do-- | -25 | 5 | | Hill-- | |
| 109 | Morrisville | Bill Fears | --do-- | 80 | 6 | 10 | --do-- | -10 | 20 | | Flat-- | |
| 110 | Morrisville | D. H. Ferrell | --do-- | 72 | 6 | ------ | --do-- | -10 | 20 | | --do-- | Moderately hard water reported. |
| 111 | 3/4 miles NW of Morrisville | John Medlin | --do-- | 64 | 6 | ------ | --do-- | -20 | 4 | | Slope | Too hard for domestic use |
| 112 | 1 3/4 miles NW of Morrisville | Unit Structures, Inc. | --do-- | 200 | 6 | ------ | --do-- | ------ | 5½ | | Flat-- | |
| 113 | 2 3/4 miles NW of Morrisville | Marjorie L. Dawkins | --do-- | 101 | 6 | ------ | --do-- | -17 | 3½ | | --do-- | Hard water reported |
| 114 | 2½ miles W of Morrisville | H. M. Pittard | --do-- | 100 | 6 | 40 | --do-- | -40 | 5 | | --do-- | Dug 18 feet |
| 115 | 4½ miles NW of Morrisville | Triangle Brick Company | --do-- | 232 | 8 | 25 | --do-- | -24 | 10 | | --do-- | Well tested at 10 gpm for 6 hours. Hard water reported |
| 116 | 4½ miles NW of Morrisville | Triangle Brick Company | Drilled | 497 | 8 | 20 | Triassic sandstone and shale | -9.10 | 3-5 | | Flat-- | All water obtained at 50 feet. Water level measured 11/14/61. Observation well |
| 117 | 4¼ miles W of Morrisville | W. D. Page | --do-- | 93 | 6 | 14 | --do-- | -16 | 1-3 | | Hill-- | |
| 118 | 4½ miles SW of Morrisville | W. A. Yates | --do-- | 120 | 6 | 20 | --do-- | -21 | 5 | | Flat-- | |
| 119 | 6 miles SW of Morrisville | Glenwood Johnson | --do-- | 108 | 6 | 15 | --do-- | -35 | 2-4 | | Slope | |
| 120 | 5 miles W of Apex | J. B. Hill | --do-- | 107 | 6 | ------ | --do-- | ------ | 5 | | Flat-- | |
| 121 | 3 3/4 miles W of Apex | Earl Scott | --do-- | 196 | 6 | 37 | --do-- | -18 | 2½ | | --do-- | |
| 122 | 3½ miles NW of Apex | Ruth Wimberly | --do-- | 105 | 6 | ------ | --do-- | ------ | 1 | | --do-- | Inadequate yield |
| 123 | 2 miles NW of Apex | Fred C. Rose | --do-- | 129 | 6 | 30 | --do-- | -18 | 1½ | | Hill-- | |
| 124 | 4½ miles NW of Apex | C. G. Branton | --do-- | 90 | 6 | 20 | --do-- | -30 | 5 | | Flat-- | Analysis |
| 125 | 5¼ miles N of Apex | Raymond Johnson | --do-- | 200 | 6 | 30 | --do-- | -20 | 2 | | --do-- | Water obtained at 40 feet |
| 126 | 5¼ miles N of Apex | Raymond Johnson | --do-- | 125 | 6 | 20 | --do-- | -25 | 3 | | --do-- | All water obtained at 90 feet |
| 127 | 3¾ miles N of Apex | K. P. Upchurch | --do-- | 210 | 6 | 20 | --do-- | ------ | 5 | | --do-- | Hard, irony water reported |
| 128 | 2 miles NE of Apex | J. H. Mills | --do-- | 162 | 6 | 10 | --do-- | -57 | 5 | | --do-- | pH 7.8, 360 ppm chloride, total hardness 342 ppm |
| 129 | 1 mile E of Apex | Ben Francis | Drilled | 157 | 6 | 58 | Triassic sandstone and shale | -120 | 5 | | Flat-- | Adequately supplies 3 families |
| 130 | 2 miles E of Apex | George Mangum | --do-- | 150 | 6 | 60 | Metavolcanic sequence | -20 | 2½ | | Hill-- | Analysis |
| 131 | 2 miles SW of Cary | James Atkinson | --do-- | 105 | 6 | 80 | --do-- | -20 | 8 | | Slope | Well tested at 8 gpm for 24 hours |
| 132 | Cary | Town of Cary | --do-- | 300 | 6 | 84 | --do-- | -15 | 38 | | Draw-- | Public water supply |
| 133 | 1½ miles W of Cary | E. W. Sauls | --do-- | 203 | 6 | 135 | --do-- | -15 | 3½ | | Slope | Water obtained at 170 feet. Hard water reported |
| 134 | 2½ miles NW of Cary | Robert S. Curtis | --do-- | 150 | 6 | ------ | Triassic sandstone and shale | -50 | 5-7 | | Flat-- | Adequately supplies 2 families |
| 135 | 1½ miles NW of Cary | Graham Covald | --do-- | 205 | 6 | 15 | --do-- | ------ | 0 | | Hill-- | Yield when drilled 3 gpm, dry now. 2 other wells have 150 to 200 feet deep, also dry |
| 136 | 1¼ miles N of Cary | Mrs. W. E. Marley | --do-- | 150 | 6 | ------ | Metavolcanic sequence | -30 | 3½ | | Flat-- | Corrosive water reported, has neutralizer |
| 137 | Cary | Town of Cary | --do-- | 562 | 10 | ------ | --do-- | -10 | 150 | | Draw-- | Drawdown less than 210 feet when pumped at 150 gpm for 48 hours |
| 138 | ½ mile E of Cary | Ready Mix Concrete Company | --do-- | 270 | 6 | ------ | --do-- | ------ | 30 | | Flat-- | Industrial water supply |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 139 | 1 mile E of Cary | Town of Cary | Drilled | 200 | 6½ | 65 | Hornblende gneiss | 4.50 | 1- | | Draw | Well not used. Yield inadequate. Water level measured 6/11/62, temp. 60°F. |
| 140 | 1 mile E of Cary | Cooper Furniture Company | --do-- | 90 | 6 | ------ | --do-- | ------ | 40-50 | | Hill | |
| 141 | ½ mile E of Cary | C. W. Holleman | --do-- | 165 | 6 | ------ | Metavolcanic sequence | -17 | 15 | | Slope | Adequately supplies 4 families |
| 142 | Cary | Town of Cary | --do-- | 300 | 8-6 | 40 | --do-- | -11 | 20 | | Draw | Well 8 inches to 180 feet, 6 inches below 180 feet |
| 143 | Cary | Town of Cary | --do-- | 300 | 10 | 74 | --do-- | -10 | 38 | | --do-- | |
| 144 | Cary | Wake County Board of Education | --do-- | 178 | 6 | 154 | --do-- | -20 | 19 | | Flat | Cary Junior High School well |
| 145 | Cary | Town of Cary | --do-- | 503 | 8 | ------ | --do-- | -20 | 60 | | Draw | Drawdown less than 210 feet when pumped at 60 gpm for 48 hours. |
| 146 | 1½ miles S of Cary | R. J. Pleasants | --do-- | 185 | 6 | ------ | --do-- | -14 | 14 | | Hill | |
| 147 | 1 3/4 miles S of Cary | W. B. Jones | --do-- | 180 | 6 | 90 | --do-- | -2 | 50-60 | | Draw | Adequately supplies 8 families |
| 148 | 2 miles S of Cary | W. P. Jones | --do-- | 185 | 6 | 130 | --do-- | -3 | 30 | | --do-- | Filter used to remove iron |
| 149 | 2 miles S of Cary | C. A. Keisler | --do-- | 230 | 6 | 60 | --do-- | ------ | 15 | | Flat | |
| 150 | 3 3/4 miles S of Cary | Bruce G. Taylor | --do-- | 164 | 6 | ------ | Hornblende gneiss | ------ | 5 | | Hill | |
| 151 | 2 3/4 miles SE of Cary | Harry Wiggs, Jr. | --do-- | 118 | 6 | ------ | Mica gneiss | ------ | 10 | | Slope | Moderate iron reported |
| 152 | ½ mile N of Asbury | R. S. Keith | Drilled | 126 | 6 | ------ | Mica gneiss | -8 | 35 | | Slope | |
| 153 | 1½ miles NE of Asbury | O. A. Williams | --do-- | 74 | 6 | 40 | --do-- | -44 | 12 | | Hill | |
| 154 | 2 3/4 miles NE of Asbury | N. C. State Highway Department | --do-- | 250 | 4 | ------ | --do-- | ------ | 14 | | --do-- | Abandoned well at Camp Polk Prison |
| 155 | 2 3/4 miles NE of Asbury | N. C. State Highway Department | --do-- | 150 | 3 | ------ | --do-- | ------ | 12 | | --do-- | Abandoned well at Camp Polk Prison |
| 156 | 1½ miles E of Asbury | Wake County Board of Education | --do-- | 237 | 6 | ------ | Phyllite | -20 | 25 | | --do-- | Mt. Vernon School well |
| 157 | 1 mile SE of Asbury | J. M. Cocke | --do-- | 155 | 6 | ------ | Mica gneiss | ------ | 13 | | Flat | Adequately supplies 6 families. Reported cased over 100 feet. |
| 158 | Raleigh | J. F. McConnell | --do-- | 153 | 6 | 130 | Phyllite | -8 | 4 | | --do-- | |
| 159 | Raleigh | Lamar Roberts | --do-- | 168 | 6 | 125 | Mica gneiss | -70 | 10 | | Slope | |
| 160 | 1 3/4 miles NE of Macedonia | Collin McNair | --do-- | 178 | 6 | 50 | --do-- | ------ | 5 | | --do-- | Water obtained at 172 feet |
| 161 | 3/4 miles NE of Macedonia | C. T. Smith | --do-- | 145 | 6 | ------ | Phyllite | -30 | 10 | | --do-- | |
| 162 | ¼ mile N of Macedonia | Walter Pinkerton | --do-- | 165 | 6 | 115 | --do-- | ------ | 5 | | Flat | |
| 163 | 3/4 miles W of Macedonia | Russell Jones | --do-- | 103 | 6 | 80 | Mica gneiss | -12 | 25 | | Hill | Adequately supplies 2 families. Analysis |
| 164 | 1 mile SW of Macedonia | Ben Johnson | --do-- | 115 | 6 | 80 | Phyllite | -5 | 15 | | Slope | Irony water reported |
| 165 | 3/4 miles SW of Macedonia | Henry B. Jones | --do-- | 157 | 6 | 106 | --do-- | -20 | 15 | | --do-- | Moderate iron content reported |
| 166 | ¼ mile SW of Macedonia | Wake County Board of Education | Drilled | 350 | 6 | 100 | Phyllite | -12 | 25 | | Flat | Swift Creek School well |
| 167 | 2 miles E of Macedonia | Dorothea Dix Hospital Farm | --do-- | 340 | 6 | 120 | Mica gneiss | -125 | 7 | | --do-- | Water turbid, high iron content reported |
| 168 | 2½ miles NE of Macedonia | Dorothea Dix Hospital Farm | --do-- | 230 | 6 | 180 | --do-- | ----- | 30 | | Slope | Drawdown 12 feet when pumped at 30 gpm for 24 hours |
| 169 | Raleigh | N. C. State Poultry Farm | --do-- | 140 | 6 | ------ | --do-- | -40 | 40-50 | | Flat | |
| 170 | 3 miles E of Macedonia | John Bennett | --do-- | 88 | 6 | 56 | --do-- | -30 | 7+ | | --do-- | Adequately supplies 3 homes |
| 171 | Raleigh | R. H. Ferneyhough | --do-- | 110 | 4 | 50 | --do-- | ------ | 1- | | --do-- | Water turbid |
| 172 | Raleigh | L. D. Safaright | --do-- | 73 | 6 | 10 | --do-- | ------ | 3½ | | Slope | |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 139 | 1 mile E of Cary | Town of Cary----- | Drilled | 200 | 6½ | 65 | Hornblende gneiss---- | 4.50 | 1- | | Draw-- | Well not used. Yield inadequate. Water level measured 6/11/62, temp. 60°F.---------- |
| 140 | 1 mile E of Cary | Cooper Furniture Company-------- | --do---- | 90 | 6 | ------ | --do-------- | ------ | 40-50 | | Hill-- | |
| 141 | ½ mile E of Cary | C. M. Holleman--- | --do---- | 165 | 6 | ------ | Metavolcanic sequence--- | -17 | 15 | | Slope- | Adequately supplies 4 families------ |
| 142 | Cary------------ | Town of Cary----- | --do---- | 300 | 8-6 | 40 | --do-------- | -11 | 20 | | Draw-- | Well 8 inches to 180 feet, 6 inches below 180 feet------ |
| 143 | Cary------------ | Town of Cary----- | --do---- | 300 | 10 | 74 | --do-------- | -10 | 36 | | --do-- | |
| 144 | Cary------------ | Wake County Board of Education--- | --do---- | 178 | 6 | 154 | --do-------- | -20 | 19 | | Flat-- | Cary Junior High School well--- |
| 145 | Cary------------ | Town of Cary----- | --do---- | 503 | 8 | ------ | --do-------- | -20 | 60 | | Draw-- | Drawdown less than 210 feet when pumped at 60 gpm for 48 hours. |
| 146 | 1½ miles S of Cary---------- | R. J. Pleasants-- | --do---- | 185 | 6 | ------ | --do-------- | -14 | 14 | | Hill-- | |
| 147 | 1 3/4 miles S of Cary---------- | W. B. Jones------ | --do---- | 180 | 6 | 90 | --do-------- | -2 | 50-60 | | Draw-- | Adequately supplies 8 families------ |
| 148 | 2 miles S of Cary | W. B. Jones------ | --do---- | 185 | 6 | 130 | --do-------- | -3 | 30 | | --do-- | Filter used to remove iron--- |
| 149 | 2 miles S of Cary | C. A. Keisler---- | --do---- | 230 | 6 | 60 | --do-------- | ------ | 15 | | Flat-- | |
| 150 | 3 3/4 miles S of Cary---------- | Bruce G. Taylor-- | --do---- | 164 | 6 | ------ | Hornblende gneiss---- | ------ | 5 | | Hill-- | |
| 151 | 2 3/4 miles SE of Cary---------- | Harry Wiggs, Jr. | --do---- | 118 | 6 | ------ | Mica gneiss-- | ------ | 10 | | Slope | Moderate iron reported------ |
| 152 | ½ mile N of Asbury-------- | R. S. Keith------ | Drilled | 126 | 6 | ------- | Mica gneiss- | -8 | 35 | | Slope | |
| 153 | 1½ miles NE of Asbury-------- | O. A. Williams--- | --do---- | 74 | 6 | 40 | --do-------- | -44 | 12 | | Hill-- | |
| 154 | 2 3/4 miles NE of Asbury-------- | N. C. State Highway Department | --do---- | 280 | 4 | ------ | --do-------- | ------ | 14 | | --do-- | Abandoned well at Camp Polk Prison------- |
| 155 | 2 3/4 miles NE of Asbury--------- | N. C. State Highway Department | --do---- | 180 | 3 | ------ | --do-------- | ------ | 12 | | --do-- | Abandoned well at Camp Polk Prison------- |
| 156 | 1½ miles E of Asbury--------- | Wake County Board of Education--- | --do---- | 237 | 6 | ------ | Phyllite---- | -20 | 25 | | --do-- | Mt. Vernon School well--- |
| 157 | 1 mile SE of Asbury--------- | J. H. Cooke------ | --do---- | 185 | 6 | ------ | Mica gneiss-- | ------ | 13 | | Flat-- | Adequately supplies 6 families. Reported cased over 100 feet. |
| 158 | Raleigh-------- -- | J. F. McConnell-- | --do---- | 153 | 6 | 130 | Phyllite---- | -8 | 4 | | --do-- | |
| 159 | Raleigh---------- | Lamar Roberts---- | --do---- | 168 | 6 | 125 | Mica gneiss-- | -70 | 10 | | Slope | |
| 160 | 1 3/4 miles NE of Macedonia------ | Collin McNair---- | --do---- | 178 | 6 | 50 | --do-------- | ------ | 5 | | --do-- | Water obtained at 172 feet--- |
| 161 | 3/4 miles NE of Macedonia------ | C. T. Smith------ | --do---- | 145 | 6 | ------ | Phyllite---- | -30 | 10 | | --do-- | |
| 162 | ¼ mile N of Macedonia------ | Walter Pinkerton | --do---- | 165 | 6 | 115 | --do-------- | ------ | 5 | | Flat-- | |
| 163 | 3/4 miles W of Macedonia------ | Russell Jones---- | --do---- | 103 | 6 | 80 | Mica gneiss-- | -12 | 25 | | Hill-- | Adequately supplies 2 families. Analysis------ |
| 164 | 1 mile SW of Macedonia------ | Ben Johnson------ | --do---- | 115 | 6 | 50 | Phyllite---- | -5 | 15 | | Slope | Irony water reported-------- |
| 165 | 3/4 miles SW of Macedonia------ | Henry B. Jones--- | --do---- | 157 | 6 | 106 | --do-------- | -20 | 15 | | --do-- | Moderate iron content reported------ |
| 166 | ¼ mile SW of Macedonia------ | Wake County Board of Education--- | Drilled | 350 | 6 | 100 | Phyllite---- | -12 | 25 | | Flat-- | Swift Creek School well-- |
| 167 | 2 miles E of Macedonia------ | Dorothea Dix Hospital Farm-- | --do---- | 340 | 6 | 120 | Mica gneiss-- | -125 | 7 | | --do-- | Water turbid, high iron content reported-------- |
| 168 | 2½ miles NE of Macedonia------ | Dorothea Dix Hospital Farm-- | --do---- | 280 | 6 | 150 | --do-------- | ----- | 30 | | Slope | Drawdown 12 feet when pumped at 30 gpm for 24 hours--------- |
| 169 | Raleigh---------- | N. C. State Poultry Farm------- | --do---- | 140 | 6 | ------ | --do-------- | -40 | 40-50 | | Flat-- | |
| 170 | 3 miles E of Macedonia------ | John Bennett----- | --do---- | 88 | 6 | 56 | --do-------- | -30 | 7+ | | --do-- | Adequately supplies 3 homes--------- |
| 171 | Raleigh---------- | R. H. Ferneyhough | --do---- | 110 | 4 | 50 | --do-------- | ------ | 1- | | --do-- | Water turbid---- |
| 172 | Raleigh---------- | L. D. Safaright-- | --do---- | 73 | 6 | 40 | --do-------- | ------ | 3½ | | Slope | |

Table 27.--Records of wells in Wake County--Continued

| Well No | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173 | Raleigh---------- | N. C. State Prison Department----- | --do---- | 495 | 4 | 58 | Hornblende gneiss---- | -14 | 50 | | Draw-- | Well at Central Prison, Raleigh. Water obtained from saprolite at 50 feet |
| 174 | Raleigh---------- | Sir Walter Hotel | --do---- | 243 | 8 | ------ | Mica gneiss-- | ------ | 75 | | Hill-- | Used in air conditioning system------- |
| 175 | 3 miles NW of Garner | Montlawn Memorial Park----------- | --do---- | 258 | 6 | 36 | --do--------- | -30 | 40 | | Slope | |
| 176 | 2 3/4 miles NW of Garner--------- | Mrs. C. Arvin---- | --do---- | 80 | 6 | 30 | --do--------- | -40 | 12-15 | | --do-- | Supplies 8 families and service station------- |
| 177 | 2 3/4 miles NW of Garner--------- | James E. Talton-- | --do---- | 82 | 6 | ------ | --do--------- | -40 | 16 | | Flat-- | Dug 40 feet----- |
| 178 | 2½ miles NW of Garner-------- | K. P. Wyatt------ | --do---- | 84 | 6 | 30 | --do--------- | ------ | 30+ | | --do-- | Adequately supplies 14 families------ |
| 179 | 2½ miles NW of Garner--------- | Amos Shirley----- | Drilled | 79 | 6 | 30 | Mica gneiss | ------ | 10 | | Flat-- | |
| 180 | 2 3/4 miles NW of Garner--------- | Scotty Uzle------ | --do---- | 100 | 6 | ------ | --do-------- | -30 | 5 | | --do-- | |
| 181 | ½ mile NW of Garner--------- | Town of Garner--- | --do---- | 295 | 8 | 20 | --do-------- | -10 | 295+ | | --do-- | Drawdown 10 feet when pumped at 295 gpm for 20 hours--------- |
| 182 | Garner---------- | Town of Garner--- | --do---- | 125 | 6 | 53 | --do-------- | ------ | 30 | | ------ | Powell Drive well---------- |
| 183 | Garner---------- | Town of Garner--- | --do---- | 251 | 6 | 73 | --do-------- | -10 | 32 | | Flat-- | School Acre s well---------- |
| 184 | Garner---------- | Town of Garner--- | --do---- | 491 | 8-6 | 121 | --do-------- | ------ | 60 | | --do-- | Well 8 inches to 416 feet, 6 inches below 416 feet.----- |
| 185 | Garner---------- | Town of Garner--- | --do---- | 145 | 8 | 45 | --do-------- | -6.20 | 20- | | Draw-- | Water level measured 11/16/61. Observation well---------- |
| 186 | Garner---------- | Town of Garner--- | --do---- | 192 | 8 | 166 | --do-------- | ------ | 75 | | Hill-- | Firehouse well-- |
| 187 | Garner---------- | Town of Garner--- | --do---- | 125 | 6 | 43 | Granite----- | ------ | 20 | | Flat-- | Rand well. |
| 188 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Company | --do---- | 250 | 6¼ | 57 | --do-------- | ------ | 50 | | --do-- | Tested for 24 hours at 50 gpm. Corrosive water reported------ |
| 189 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Company | --do---- | 150 | 6¼ | 23 | Granite----- | ------ | 10 | | --do-- | |
| 190 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Company | --do---- | 250 | 6½ | 34 | --do-------- | ------ | 3 | | --do-- | |
| 191 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Co. | Drilled | 230 | 6¼ | 22 | Granite----- | ------ | 60 | | Flat-- | |
| 192 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Co. | --do---- | 250 | 6¼ | 44 | --do-------- | ------ | 30 | | --do-- | |
| 193 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Co. | --do---- | 250 | 6¼ | 11 | --do-------- | ------ | 3 | | --do-- | |
| 194 | 1½ miles NE of Garner--------- | Jesse Jones Sausage Co. | --do---- | 200 | 6 | 16 | --do-------- | ------ | 20 | | --do-- | |
| 195 | 3 miles N of Garner--------- | D. E. Sanderford | --do---- | 99 | 6 | 40 | Mica gneiss-- | -60 | 25 | | Slope | |
| 196 | 3½ miles N of Garner--------- | W. H. Edwards---- | --do---- | 44 | 6 | ------ | Granite----- | ------ | 20 | | Flat-- | |
| 197 | 2 3/4 miles SW of Milburnie------ | Allan B. Denton-- | --do---- | 104 | 6 | 10 | --do--------- | -45 | 6 | | Hill-- | Hard water reported------- |
| 198 | 1 mile W of Milburnie------ | H. F. Partin----- | --do---- | 104 | 6 | 40 | --do--------- | -25 | 12-14 | | Flat-- | Corrosive, hard water reported |
| 199 | 3½ miles NE of Garner--------- | E. B. Gower------ | --do---- | 40 | 6 | 20 | --do--------- | -12 | 7 | | Slope | |
| 200 | 3½ miles NE of Garner--------- | E. B. Gower------ | --do---- | 140 | 6 | 22 | --do--------- | -12 | 1 | | Flat-- | Yield inadequate, well not used. |
| 201 | 6 miles S of Knightdale----- | Raymond Beasley-- | --do---- | 54 | 6 | 5 | --do--------- | ------ | 7 | | --do-- | |
| 202 | 4 miles S of Knightdale----- | Nathan Watson, Jr. | --do---- | 88 | 6 | 36 | --do--------- | -20 | 10 | | Slope | Adequately supplies 2 families------ |
| 203 | 2½ miles S of Knightdale----- | Jim Myrick------- | --do---- | 100 | 6 | 87 | --do--------- | -25 | 10 | | Hill-- | |
| 204 | 2½ miles W of Knightdale----- | E. P. Allen------ | --do---- | 100 | 6 | 75 | --do--------- | -20 | 20+ | | --do-- | Hard water reported------ |
| 205 | 2 3/4 miles S of Knightdale----- | Charles H. Smith | --do---- | 50 | 6 | ------ | --do--------- | ------ | 12 | | Flat-- | |
| 206 | 1 mile S of Knightdale----- | H. H. Hudson----- | --do---- | 98 | 8 | 15 | --do--------- | -17 | 20+ | | Hill-- | Slightly corrosive water reported------ |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 207 | ½ mile S of Knightdale----- | Town of Knightdale---------- | Drilled | 165 | 8 | ------- | Granite----- | ------ | 22 | | Flat-- | Tested for 48 hours at 22 gpm---------- |
| 208 | Knightdale------- | Town of Knightdale---------- | --do--- | 195 | 8 | ------- | --do-------- | ------- | 82 | | --do-- | Tested for 48 hours at 82 gpm. |
| 209 | 1 3/4 miles E of Knightdale----- | H. M. Croom----- | --do--- | 79 | 6 | 65 | --do-------- | -60 | 15 | | Hill-- | |
| 210 | 3 3/4 miles SW of Wendell-------- | F. M. Williams-- | --do--- | 42 | 6 | ------- | --do-------- | -26 | 12 | | Flat-- | Corrosive water reported----- |
| 211 | 2½ miles SW of Wendell-------- | Ray Nowell------- | --do--- | 72 | 6 | 14 | --do-------- | -6 | 13 | | Slope | |
| 212 | Wendell---------- | Town of Wendell-- | --do--- | 602 | 6 | 104 | --do-------- | ------- | 30 | | Flat-- | Water level in all Wendell municipal wells reported at -30 feet or less. |
| 213 | Wendell--------- | Town of Wendell-- | --do---- | 301 | 10 | 96 | --do-------- | ----- | 40 | | --do-- | Drawdown 64 feet when pumped at 40 gpm-------- |
| 214 | Wendell--------- | Town of Wendell-- | --do---- | 300 | 6 | 90 | --do-------- | ------ | 8-10 | | ----- | |
| 215 | Wendell--------- | Town of Wendell-- | --do---- | 100 | 8 | 46 | --do-------- | ------ | 20 | | --do-- | Drawdown 45 feet when pumped at 20 gpm-------- |
| 216 | Wendell---------- | Town of Wendell-- | --do---- | 200 | 8 | 90 | --do-------- | ------ | 50 | | --do-- | Drawdown 60 feet when pumped at 50 gpm-------- |
| 217 | Wendell--------- | Town of Wendell-- | --do---- | 125 | 8 | 78 | --do-------- | ----- | 80 | | --do-- | Drawdown 60 feet when pumped at 80 gpm-------- |
| 218 | Wendell---------- | Town of Wendell-- | --do---- | 300 | 8 | 90 | --do-------- | ------ | 30 | | --do-- | |
| 219 | Wendell---------- | Town of Wendell-- | --do---- | 300 | 8 | 94 | --do-------- | ------ | 30 | | --do-- | |
| 220 | 1 mile E of Wendell-------- | Wake County Board of Education-- | --do---- | 159 | 8 | 67 | --do-------- | -19 | 30 | | Draw | Carver School well---------- |
| 221 | 1 mile E of Wendell-------- | Wake County Board of Education | --do---- | 75 | 6 | 56 | --do-------- | ------ | 40 | | --do-- | Carver School well---------- |
| 222 | 2 miles E of Wendell------- | Willard Raper--- | Drilled | 127 | 6 | 117 | Granite----- | -20 | 20+ | | Hill-- | |
| 223 | 2½ miles NE of Wendell------- | Charlie Murray-- | --do---- | 79 | 6 | 68 | --do-------- | -20 | 6 | | Slope | Slightly corrosive water reported------ |
| 224 | 5 miles S of Knightdale---- | James R. Hinton-- | --do---- | 88 | 6 | 50 | --do-------- | -48 | 5 | | Hill-- | |
| 225 | 6½ miles S of Knightdale---- | Mrs. D. M. Adams | --do---- | 145 | 6 | ------ | --do-------- | ------ | 7 | | Flat-- | Adequately supplies 2 families------ |
| 226 | 5½ miles E of Garner-------- | L. B. Collins--- | --do---- | 219 | 6 | 51 | --do-------- | -15 | 12 | | --do-- | |
| 227 | 3 3/4 miles E of Garner-------- | Leland Poole----- | --do---- | 215 | 6 | 30 | --do-------- | -20 | 15 | | --do-- | |
| 228 | 4 miles S of Garner-------- | C. L. Britt------ | --do---- | 103 | 6 | 69 | Mica gneiss | -35 | 36+ | | Draw-- | |
| 229 | 3 3/4 miles S of Garner--------- | W. G. Woolard---- | --do---- | 91 | 6 | 67 | --do-------- | -30 | 2-4 | | Slope | Yield inadequate |
| 230 | 2½ miles E of Banks---------- | Charles Walton--- | --do---- | 75 | 6 | ------ | --do-------- | ------ | 6 | | Flat-- | Hard, irony water reported |
| 231 | 3 3/4 miles SW of Garner--------- | Fieldstream Farms---------- | --do---- | 160 | 6 | 105 | --do-------- | -25 | 20 | | Draw | Adequately supplies 3 families------ |
| 232 | 2¼ miles SW of Garner--------- | R. T. Dismukes--- | --do---- | 58 | 6 | ------ | --do-------- | ------ | 10 | | Hill-- | |
| 233 | 2 miles N of Banks--------- | B. O. Fuquay----- | --do---- | 85 | 6 | 80 | --do-------- | ------ | 10-15 | | Flat-- | Analysis-------- |
| 234 | ½ mile N of Banks | R. T. Stephens--- | --do---- | 122 | 6 | 75 | --do-------- | -14 | 12+ | | --do-- | Adequately supplies 4 families------ |
| 235 | 2½ miles N of Banks---------- | J. Lee Atkins---- | --do---- | 87 | 6 | 75 | Phyllite---- | -20 | 5½ | | --do-- | Corrosive water reported----- |
| 236 | 6 miles W of Garner--------- | J. A. Williams--- | --do---- | 115 | 6 | 90 | Mica gneiss-- | -10 | 10+ | | Draw-- | |
| 237 | 4 3/4 miles N of Banks--------- | Graham Newton---- | Drilled | 312 | 6 | ------ | Phyllite---- | ------ | 10 | | Hill-- | Supplies 2 families. Analysis------ |
| 238 | 2½ miles NW of Banks--------- | S. D. Bennett---- | --do--- | 183 | 6 | ------ | --do-------- | -30 | 20 | | Flat-- | Analysis-------- |
| 239 | 3½ miles NE of Holly Springs-- | C. B. Sorrells--- | --do---- | 107 | 6 | 60 | Hornblende gneiss---- | -18 | 7 | | --do-- | Analysis-------- |
| 240 | 6 miles N of Holly Springs-- | Paul C. Becher--- | --do---- | 176 | 6 | ------- | --do-------- | -40 | 20 | | Slope | |
| 241 | 4 miles N of Holly Springs-- | W. R. Franks----- | --do---- | 152 | 6 | 110 | --do-------- | ------ | 25+ | | Flat-- | Water reported to contain iron---------- |
| 242 | 1½ miles SE of Apex------------ | Phillips Gas Distributing Center---------- | --do---- | 300 | 6 | 3 | Triassic sandstone and shale | ------ | ½ | | Hill-- | Yield inadequate, well not used. |
| 243 | Apex------------ | Mrs. Allen Sutton | --do---- | 60 | 6 | ------ | Triassic---- | ------ | 1-3 | | --do-- | Yield inadequate Analysis------ |

Table 27.--Records of wells in Wake County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 244 | 2 miles S of Apex | Joe L. Wilkerson | --do---- | 135 | 6 | 16 | --do-------- | -5 | 3 | | Flat-- | Obtained water at 95 feet---- |
| 245 | Holly Springs---- | W. F. Jones------ | --do---- | 163 | 6 | 96 | --do-------- | -15 | 7 | | --do-- | Water reported to contain iron---------- |
| 246 | Holly Springs---- | E. G. Brewer----- | --do---- | 123 | 6 | 96 | Metavolcanic sequence--- | -22 | 6 | | --do-- | Adequately supplies 2 families------ |
| 247 | Holly Springs---- | Wake County Board of Education--- | --do---- | 113 | 6 | 80 | Triassic sandstone and shale | -15 | 12 | | Hill-- | Holly Springs colored school well---------- |
| 248 | Holly Springs---- | W. E. Jones------ | --do---- | 116 | 6 | 96 | --do-------- | -25 | 8 | | Flat-- | Water reported to contain iron---------- |
| 249 | 3¼ miles NW of Holly Springs-- | C. H. Burt------- | --do---- | 125 | 6 | 90 | --do-------- | -40 | 3 | | Hill-- | Water sometimes turbid-------- |
| 250 | 3¼ miles SW of Apex----------- | W. M. McLaurin--- | Bored--- | 27 | 20 | 27 | --do-------- | -8 | 6 | | Flat-- | |
| 251 | 2½ miles SW of Apex---------- | G. H. Holland---- | Drilled | 126 | 6 | ------ | Triassic sandstone and shale | -12 | 3½ | | Hill-- | |
| 252 | 3/4 miles SE of New Hill------ | Odell Eanns------ | --do---- | 97 | 5 | 40 | --do------- | -40 | 5 | | Flat-- | Hard water reported-------- |
| 253 | New Hill-------- | J. H. Bright----- | --do---- | 130 | 6 | 60 | --do------- | -65 | 8 | | --do-- | Analysis in table -------- |
| 254 | 2 miles NW of New Hill---------- | E. E. Olive------ | --do---- | 105 | 6 | 60 | Triassic sandstone and shale | -80 | 10 | | --do-- | |
| 255 | 2½ miles NW of New Hill------ | E. E. Olive------ | --do---- | 125 | 6 | 55 | --do------- | -30 | 25 | | --do-- | Analysis-------- |
| 256 | Bonsal---------- | J. H. Bowen------ | --do---- | 95 | 6 | 15 | --do------- | ------ | 6 | | --do-- | |
| 257 | 2 miles SE of Bonsal-------- | W. C. Poe-------- | --do---- | 150 | 6 | 18 | --do------- | -10 | 4 | | --do-- | Obtained water at 140 feet. Analysis------ |
| 258 | 2¼ miles SE of Bonsal-------- | S. B. Poe-------- | --do---- | 200 | 6 | 30 | --do-------- | -30 | 3½ | | --do-- | Obtained water at 35 feet.--- |
| 259 | 4 3/4 miles SW of Holly Springs | C. P. Ragan------ | --do---- | 303 | 6 | 45 | --do-------- | -18 | ½ | | --do-- | Yield inadequate. Obtained water at 125 feet. Hard water reported-------- |
| 260 | 4½ miles SW of Holly Springs | C. P. Ragan------ | --do---- | 140 | 6 | 45 | --do-------- | ------ | 0 | | --do-- | |
| 261 | 2 miles SW of Holly Springs | B. W. Holland---- | --do---- | 65 | 6 | 32 | Metavolcanic sequence-- | -20 | 50+ | | Draw-- | Drawdown 1 foot when pumped at 50 gpm-------- |
| 262 | 2 miles SW of Holly Springs | B. W. Holland---- | --do---- | 175 | 6 | 40 | --do-------- | -45 | 2-4 | | Flat-- | Yield inadequate. Obtained water at 45 feet.--- |
| 263 | 3½ miles E of Fuquay Springs | M. R. Burt------- | --do---- | 89 | 6 | 67 | Granite----- | ------ | 5 | | --do-- | Water silty.--- |
| 264 | 2½ miles NW of Fuquay Springs | J. C. Adcock----- | Drilled | 113 | 6 | 40 | Crystalline rock------ | -11 | 20+ | | Flat-- | Well abandoned. Objectionable iron content reported----- |
| 265 | 2 miles S of Holly Springs-- | Rebecca S. Mullen | --do---- | 197 | 6 | 8 | Metavolcanic sequence--- | -30 | 20 | | Slope- | |
| 266 | 2 miles N of Fuquay Springs | Douglas Curl----- | Bored--- | 33 | 20 | 33 | Cretaceous sand and clay------- | -15 | 2-4 | | Flat-- | |
| 267 | Fuquay Springs--- | Town of Fuquay Springs-------- | Drilled | 400 | 8 | 20 | Crystalline rock------- | -22 | 135+ | | Slope | Drawdown 25 feet when pumped at 135 gpm for 8 hours--------- |
| 268 | Fuquay Springs--- | Town of Fuquay Springs-------- | --do---- | 480 | 10 | 20 | --do--------- | -20 | 450 | | --do-- | Tested at 450 gpm for one hour. |
| 269 | Fuquay Springs--- | Town of Fuquay Springs-------- | --do---- | 300 | 7 | 15 | --do--------- | -15 | 90 | | --do-- | |
| 270 | Fuquay Springs--- | Town of Fuquay Springs-------- | --do---- | 325 | 8 | 25 | --do--------- | -22 | 110 | | --do-- | |
| 271 | Fuquay Springs--- | Town of Fuquay Springs-------- | --do---- | 350 | 8 | 15 | --do--------- | -18 | 90 | | --do-- | Drawdown 20 feet when pumped at 90 gpm-------- |
| 272 | 3/4 miles SE of Fuquay Springs | J. C. Holland---- | --do---- | 82 | 6 | 55 | Mica gneiss | -25 | 20 | | Flat-- | High iron content reported |
| 273 | 2 miles E of Fuquay Springs | Walker Tingen---- | Bored--- | 30 | 24 | 30 | Cretaceous sand and clay------ | -11 | 10 | | --do-- | |
| 274 | 2 miles N of Fuquay Springs | Stag Ballentine-- | Drilled- | 105 | 8 | ------ | Crystalline rock------ | ------ | 9 | | --do-- | High iron content reported |
| 275 | 2 3/4 miles N of Fuquay Springs | Carl Hackney | Bored--- | 39 | 24 | 39 | Cretaceous sand and clay------ | -12 | 2-4 | | ------ | |
| 276 | 2 miles NE of Fuquay Springs | Stag Ballentine-- | Drilled- | 376 | 8 | ------ | Mica gneiss | ------ | 34 | | Draw-- | High iron content reported |

Table 28.--Chemical analyses of ground water from Wake County. (Numbers at heads of columns correspond to well numbers in table 27.)

(parts per million)

| | 11 | 18 | 22 | 40 | 49 | 65 | 105[1] | 124 | 130 | 163 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date of Collection | 11/27/61 | 3/4/63 | 11/27/61 | 3/4/63 | 2/25/63 | 2/25/63 | 11/27/61 | 2/25/63 | 2/6/63 | 9/11/62 |
| Silica ($SiO_2$) | 29 | 26 | 44 | 41 | 30 | 16 | 24 | 37 | 23 | 31 |
| Aluminum (Al) | .1 | .1 | .2 | .1 | .1 | .1 | .2 | .1 | .1 | .0 |
| Iron (Fe) | .01 | .16 | .01 | .04 | .47 | .04 | .01 | .05 | .07 | -- |
| Manganese (Mn) | .00 | .00 | .00 | .00 | .00 | .00 | .05 | .01 | .04 | -- |
| Calcium (Ca) | 5.4 | 6.4 | 44 | 3.2 | 8.4 | 2.3 | 106 | 19 | 7.2 | 2.2 |
| Magnesium (Mg) | 2.4 | 2.9 | 25 | 2.1 | 2.3 | 1.4 | 25 | 4.5 | 2.9 | 1.3 |
| Sodium (Na) | 3.6 | 5.8 | 52 | 9.8 | 14 | 5.1 | 310 | 45 | 5.4 | 5.9 |
| Potassium (K) | .1 | 1.5 | 1.9 | .5 | 1.6 | .7 | 4.6 | 1.5 | .1 | 1.0 |
| Lithium (Li) | .0 | .0 | .6 | .0 | .0 | .0 | 1.4 | .0 | .0 | .0 |
| Bicarbonate ($HCO_3$) | 40 | 41 | 306 | 45 | 36 | 13 | 232 | 38 | 31 | 26 |
| Sulfate ($SO_4$) | .8 | 2.4 | 8.0 | 1.2 | 6.0 | 1.6 | 25 | 6.0 | 8.8 | 2.0 |
| Chloride (Cl) | .4 | 2.5 | 43 | 3.0 | 11 | 5.0 | 572 | 85 | 2.8 | 1.5 |
| Fluoride (F) | .1 | .1 | .2 | .1 | .1 | .0 | .2 | .1 | .2 | .0 |
| Nitrate ($NO_3$) | .1 | .0 | .7 | .0 | 17 | 4.5 | .1 | 12 | .2 | 1.6 |
| Phosphate ($PO_4$) | .0 | .1 | .0 | .4 | .0 | .0 | .0 | .0 | .0 | .1 |
| Dissolved Solids | 62 | 68 | 371 | 83 | 108 | 43 | 1180 | 229 | 66 | 60 |
| Hardness as $CaCO_3$ | 24 | 28 | 212 | 17 | 31 | 12 | 370 | 67 | 30 | 10 |
| Noncarbonate | 0 | 0 | 0 | 0 | 2 | 2 | 180 | 36 | 5 | 0 |
| Specific Conductance | 68 | 73 | 597 | 75 | 133 | 49 | 2200 | 375 | 79 | 50 |
| pH | 6.6 | 6.9 | 7.4 | 6.9 | 6.5 | 5.8 | 7.4 | 6.4 | 6.6 | 6.4 |
| Color | 3 | 5 | 2 | 3 | 5 | 5 | 3 | 3 | 5 | 3 |
| Map Unit | Hornblende gneiss | Hornblende gneiss | Triassic | Mica gneiss | Mica gneiss | Triassic | Triassic | Triassic | Meta-volcanic | Mica gneiss |

| | 233 | 237 | 238 | 239 | 245 | 253 | 255 | 257 | 265 |
|---|---|---|---|---|---|---|---|---|---|
| Date of Collection | 8/15/62 | 11/28/61 | 8/15/62 | 8/15/62 | 2/6/63 | 11/27/61 | 2/25/63 | 2/6/63 | 11/28/61 |
| Silica ($SiO_2$) | 33 | 24 | 12 | 33 | 38 | 34 | 40 | 30 | 31 |
| Aluminum (Al) | .0 | .1 | .2 | .0 | .1 | .1 | .1 | .1 | .2 |
| Iron (Fe) | .01 | .01 | .45 | .89 | .04 | .01 | .19 | .06 | 9.2 |
| Manganese (Mn) | .00 | .00 | .00 | .03 | .00 | .01 | .00 | .05 | .00 |
| Calcium (Ca) | 3.4 | 30 | 2.7 | 5.9 | 6.6 | 19 | 14 | 17 | 9.6 |
| Magnesium (Mg) | 4.0 | 8.8 | 4.0 | 5.3 | 4.0 | 9.5 | 5.0 | 5.3 | 6.0 |
| Sodium (Na) | 5.7 | 9.1 | .7 | 5.6 | 6.0 | 17 | 16 | 70 | 11 |
| Potassium (K) | .2 | 4.2 | .1 | .9 | 1.1 | .7 | .7 | 1.1 | 1.3 |
| Lithium (Li) | .0 | .2 | .0 | .0 | .0 | .2 | .0 | .0 | .2 |
| Bicarbonate ($HCO_3$) | 35 | 156 | 30 | 55 | 56 | 142 | 84 | 217 | 84 |
| Sulfate ($SO_4$) | 9.4 | 4.0 | 2.8 | 4.2 | 1.0 | 2.2 | 1.6 | 2.0 | 3.0 |
| Chloride (Cl) | 1.5 | 2.0 | .5 | 2.0 | 1.7 | 3.0 | 11 | 27 | .6 |
| Fluoride (F) | .1 | .1 | .0 | .1 | .0 | .1 | .2 | .2 | .2 |
| Nitrate ($NO_3$) | .3 | .2 | .4 | .2 | .0 | .1 | 6.6 | .0 | .1 |
| Phosphate ($PO_4$) | .4 | .0 | .0 | .0 | .3 | .1 | .0 | .7 | .0 |
| Dissolved Solids | 75 | 160 | 38 | 84 | 89 | 156 | 137 | 260 | 104 |
| Hardness as $CaCO_3$ | 25 | 110 | 24 | 37 | 34 | 86 | 56 | 64 | 50 |
| Noncarbonate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Specific Conductance | 80 | 240 | 62 | 98 | 92 | 228 | 180 | 400 | 140 |
| pH | 7.0 | 7.3 | 6.8 | 7.0 | 6.8 | 7.2 | 6.8 | 7.4 | 6.7 |
| Color | 2 | 3 | 3 | 2 | 5 | 3 | 3 | 5 | 3 |
| Map Unit | Mica gneiss | Phyllite | Phyllite | Hornblende gneiss | Triassic | Triassic | Triassic | Triassic | Crystal-line rock |

[1] Bromide (Br) 3.2 ppm.

Analyses of 19 water samples from wells in Wake County are given in table 28. The majority of the ground water samples are calcium, magnesium, and sodium-bicarbonate types. Ground water in Wake County is suitable for most uses.

Water from granite and the metamorphic rocks is of good chemical quality. At most places the water is soft and contains relatively low concentrations of iron and other dissolved solids. The chemical quality of water from Triassic rocks is not uniform. Hardness ranged from 34 to 370 ppm, and concentrations of dissolved solids ranged from 89 to 1,180 ppm. One analysis showed an anomalous chloride concentration of 572 ppm. (Chloride concentrations as low as 300 ppm may impart a salty taste to the water.) Although this analysis does not show a similarity to sea water, it does indicate that connate water may still be present in the Triassic rocks and that circulation of fresh water through these rocks is restricted. Water from the Cretaceous sands and clays in southern Wake County is reported to have objectionable concentrations of iron.

## MUNICIPAL SUPPLIES

Seven municipalities in Wake County obtain their water supplies either entirely or partially from ground-water sources.

Cary, population 3,392, obtains its water supply from several drilled wells all of which penetrate metavolcanic rocks or hornblende gneiss. At present 14 wells are pumped and supply an average daily consumption of 300,000 gallons. The yields of the wells range from about 10 to 50 gallons a minute; most yield less than 25 gpm. Treatment includes addition of Calgon for corrosion control and chlorination. An elevated tank with a storage capacity of 100,000 gallons is connected to the system for storage and to equalize pressure.

Fuquay Springs, population about 3,390, has five drilled wells connected to its municipal system which supply an average daily consumption of 240,000 gallons. All of the wells penetrate unconsolidated Coastal Plain sediments and obtain water from the crystalline rocks underneath. Storage facilities include two elevated tanks with a combined capacity of 300,000 gallons, and one 56,000 gallon underground reservoir. Treatment includes the addition of lime and alum, chlorination, and aeration.

Garner, population 3,491, obtains its water supply from nine wells which may be pumped alternately and individually as needed to supply an average daily consumption of 200,000 gallons. The best well has been tested for 20 hours at 295 gpm. Drawdown was 10 feet. One elevated tank, capacity 125,000 gallons, is connected to the system for storage and equalization of pressure. The water is of excellent chemical quality and is not treated.

Knightdale, population about 630, has two wells which have a combined yield of approximately 100 gpm. Average daily consumption is 50,000 gallons. The water is obtained from granite and is slightly corrosive. The water is treated by chlorination.

Rolesville, population about 360, installed its municipal system in the fall of 1962. Water is obtained from two wells which yield 10 and 60 gpm to supply an average daily consumption of about 25,000 gallons. A 75,000 gallon elevated tank is used for storage purposes and to insure adequate pressure. The water is of excellent chemical quality, and treated by chlorination.

Wendell, population 1,644, obtains its water supply from seven wells which supply an average daily consumption of 100,000 gallons. Storage facilities include an elevated tank, capacity 100,000 gallons, and a ground-level reservoir which has a capacity of 500,000 gallons. The water is obtained from granite and requires no treatment.

Zebulon, population 1,522, obtains about 25 percent of its water supply from four drilled wells. The remaining 75 percent is pumped directly from Little River into the treatment plant. The ground water is obtained from granite, is of excellent chemical quality, and requires no treatment. Average daily consumption is 200,000 gallons. An elevated tank and an underground reservoir have a combined storage capacity of 160,000 gallons.

## WARREN COUNTY

(Area: 443 square miles; population in 1960: 19,652)

### GEOGRAPHY

Warren County is the fourth largest county in the Raleigh area, but it has the smallest population. It is bounded on the north by Virginia, on the east by Halifax and Northampton Counties, on the south by Franklin County, and on the west by Vance County. Warrenton, population 1,124, is the county seat and largest town. Other towns and community centers include Norlina, Macon, Vaughan, and Littleton.

The county, predominantly rural, depends largely upon the sale of farm products for its income. Tobacco, cotton, cucumbers, and corn are the chief crops. Small textile manufacturing plants are centered in and around Warrenton. Several lumber mills are scattered over the county. Development of fishing and recreational facilities around Gaston Lake may be important to the economy of the county in the future.

Warren County is in the eastern part of the Piedmont physiographic province. The land surface is gently rolling and relief is generally less than 100 feet per mile. Topography is rugged near the Roanoke River and Fishing Creek, the two largest streams in the county. The highest elevations are near Afton in the southwestern part of the county where the altitude is slightly less than 500 feet above mean sea level, and the lowest elevations of about 200 feet are on the Roanoke River where it flows out of the county.

The northern part of the county is drained by streams which flow north into John H. Kerr Reservoir or Gaston Lake on the Roanoke River. Streams draining the southern two-thirds of the county flow southeastward to the Tar River.

## GEOLOGY

Rocks of the metasedimentary sequence are exposed in the eastern and southeastern sections of the county. Included in this sequence of rocks are feldspathic quartzite, hornblende gneiss, metasiltstone, and quartz-muscovite schist. All of the rocks are interbedded and appear to be conformable. They are metamorphosed sandstone, siltstone, shale, and impure carbonate beds. Foliation in the schist and gneiss is parallel to bedding which strikes northeast and dips northwest. Quartzite at the top unit of the sequence is the most resistant to weathering and generally is useful as a marker bed. Fine banding in the quartzite is caused by graded bedding and by secondary fine quartz veins between beds. Schist is interbedded with the quartzite near the top of the sequence.

A northeast-trending belt composed primarily of well-foliated rocks extends through the central part of the county. These rocks were mapped collectively as mica schist. Included in this unit are muscovite schist, sericite-muscovite schist, biotite schist, and a minor zone of hornblende gneiss and feldspathic quartzite. Phyllite is exposed two miles east of Embro and it appears to be a lower rank metamorphic facies of the sericite-muscovite schist. Foliation strikes generally northeast and dips steeply to the northwest. Where contacts between rock types are discernible the foliation is parallel to the contact planes. The rocks are deeply weathered to micaceous saprolite, and brown clay-soils.

Rocks of the mica gneiss unit crop out in western Warren County. The predominant rock type is a biotite-feldspar gneiss which ranges from a fine-grained equigranular gneiss to a coarse-grained porphyritic and augen gneiss. Quartz is present in varying proportions, and at places is second only to feldspar in the percentage of the rock it comprises. The rock at most places is distinctly banded caused by alternating biotite rich-zones and quartz-feldspar-rich zones. Near the Vance County line west of Axtell, porphyroblasts of orthoclase feldspar compose as much as 30 percent of the rock and are elongated parallel to the gneissic texture. The gneiss between the two large granite plutons has been intruded by pegmatites which commonly comprise more than one-third of the rock. Mica schist is interlayered with the gneiss at several localities. A relatively thin hornblende-feldspar gneiss zone occurs in the biotite gneiss one mile south of Manson. The metamorphic structural features in all of the rock types trend consistently northeast. Foliation in the schist strike northeast and dips mostly at large angles to the northwest.

Medium- to coarse-grained biotite granite crops out as two irregular plutons and one dike-like body in the county. The two plutons are aligned with the much larger granite pluton to the south, and all are probably surface exposures of one large granite batholith that has not been exposed by erosion entirely across Warren County. Typically the granite is a gray rock composed of orthoclase feldspar, biotite mica, and quartz. Microcline and plagioclase feldspar are common accessory minerals. Many coarse-grained pegmatities and graphic-granite dikes associated with the pluton north of Warrenton have intruded the host rocks. The elongated granite body north of Oakville is an especially large granite dike of this nature.

Much coarser porphyritic granite crops out in the northeastern part of the county. It is a biotite granite composed of large euhedral crystals of orthoclase feldspar set in a finer matrix of quartz and biotite. The phenocrysts of feldspar are up to two inches in length and are aligned in a northerly direction forming a weak gneissic texture. Biotite mica composes 10 to 15 percent of the rock, and commonly forms halos around large feldspar crystals. Jointing is poorly developed in the granite. Massive boulders weathered from irregular masses are as large as 12 feet in diameter.

## GROUND WATER

Most of the domestic supplies, a few industrial supplies, and two of the three municipal supplies in Warren County are obtained from ground-water sources. Springs are fairly common, but few are used as domestic supplies and none as industrial or municipal supplies. Some of the larger springs were formerly used as medicinal waters and resort hotels were constructed near them.

Dug wells are the source of most domestic water supplies in the county. Since the rocks are deeply weathered at most places, dug wells can generally be constructed deep enough to insure adequate yields even during the drier seasons. During past extended droughts, a few dug wells on the upland areas did not yield adequate amounts of water. In most instances adequate yields were obtained by drilling small-diameter wells at the bottoms of the dug wells. Bored wells are also common in the county and comparable in yield and depth to the dug wells. Most of the dug and bored wells range in depth from 35 to 65 feet and have yields of 5 to 10 gpm.

Records of 153 wells are included in table 30. Data on 132 drilled wells were used in compiling table 29.

The average yield of 18 gpm for drilled wells in Warren County is 20 percent higher than the average yield of all drilled wells in the Raleigh area. This is attributed to the fact that the rocks in Warren County are, in general, weathered more deeply than rocks in most other areas. Water moves readily along the foliation planes in the rocks of the mica schist unit facilitating chemical weathering to considerable depths. The weathered material acts as a reservoir for ground water, recharging the underlying rocks when water is removed by pumping a well.

Adequate domestic supplies can be obtained from drilled wells almost anywhere in the county. Wells located in draws yield on an average much more water than wells at other topographic locations. This fact should be carefully considered in selecting well sites, especially when large yields are desired.

Analyses of 16 water samples from wells in Warren County are given in table 31. Ground water in Warren County is principally of the calcium and sodium-bicarbonate types. Seventy-five percent of the ground water sampled contained less than 0.3 ppm iron. Eighty-eight percent of the ground water sampled was soft. Water from the metasedimentary sequence of rocks is of excellent quality for most uses. All of the samples analyzed from the metasedimentary sequence of rocks is of excellent quality for most uses.

Table 29.--Summary of data on wells in Warren County

ACCORDING TO ROCK TYPE

| Map Unit | Number of wells | Average depth (feet) | Yield (gpm) Range | Yield (gpm) Average | Yield (gpm) Per foot of well | Percent of wells yielding 1 gpm or less |
|---|---|---|---|---|---|---|
| Meta-sedimentary sequence | 6 | 141 | 5-46 | 15 | 0.11 | 0 |
| Mica schist | 45* | 129 | 2-237 | 20 | .15 | 0 |
| Mica gneiss | 45 | 122 | 1-160 | 18 | .15 | 2.2 |
| Porphyritic granite | 5 | 214 | 5-30 | 16 | .07 | 0 |
| Granite | 31 | 109 | 2-69 | 17 | .16 | 0 |
| All wells | 132 | 126 | 1-237 | 18 | .14 | .8 |
| **ACCORDING TO TOPOGRAPHIC LOCATION** | | | | | | |
| Hill | 44 | 119 | 2-36 | 14 | 0.12 | 0 |
| Flat | 38 | 124 | 1-46 | 14 | .11 | 2.6 |
| Slope | 39 | 119 | 2-160 | 18 | .15 | 0 |
| Draw | 11* | 186 | 3-237 | 48 | .29 | 0 |

*Includes one well 150 feet deep, tested at 237 gpm.

None of the samples analyzed from the metasedimentary sequence had a hardness exceeding 50 ppm. Locally the ground water from this sequence is corrosive and the water may contain above normal concentrations of iron. Water from rocks of the mica schist unit is generally soft but at places contains objectionable amounts of iron. Water from well number 49 is hard and contains anomalous amounts of sulfate and calcium, 135 and 60 ppm, respectively. Pyrite, an insoluble sulfide, is a common accessory mineral in the rocks of the mica schist unit. The sulfate probably comes from the oxidation of pyrite through normal weathering processes to soluble sulfates which are taken into solution as the water percolates through the weathered rock material. Water of good quality is obtained from granite and rocks of the mica gneiss unit. Only one analysis from mica gneiss showed an iron content exceeding 0.3 ppm. The iron content ranged from 0.01 to 2.0 ppm for all samples analyzed. Hardness ranged from 24 to 78 ppm.

## MUNICIPAL SUPPLIES

Two municipal supplies in the county are obtained from wells.

Littleton, population 1,011, obtains its water supply from five drilled wells, four of which are in Halifax County. The well in Warren County (well 41 in table 30) is 312 feet deep and yields 30 gallons per minute. The water is of good chemical quality and is not treated. There are 400 tap-ons in the distribution system. Each of the five wells can be pumped individually as needed. Average daily consumption is 40,000 gallons.

Norlina, population 927, obtains its water supply from three wells which supply an average daily consumption of 50,000 gallons. The water is obtained from granite, and is excellent in chemical quality.

The water supply for Warrenton is obtained from Fishing Creek, but two wells which are connected directly to the distribution system can be used when needed. Yield of each well is about 40 gallons per minute.

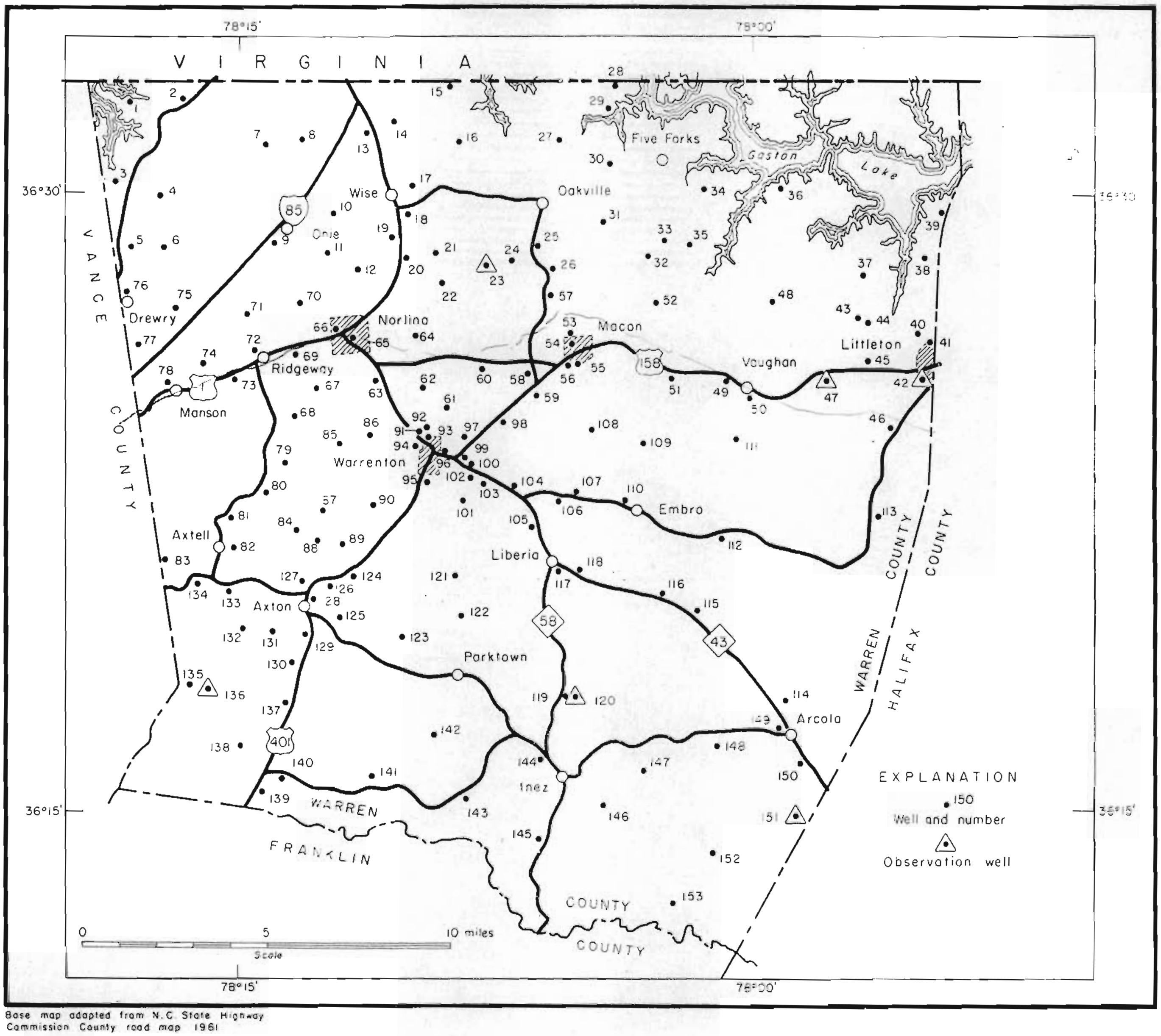



Figure 26.--Map of Warren County showing locations of wells.

# Table 30.--Records of wells in Warren County

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 miles N of Drewry--------- | C. H. Matherson-- | Drilled | 90 | 6 | 57 | Mica gneiss | ------ | 14 | | Hill-- | All water obtained below 75 feet------- |
| 2 | 4 3/4 miles NW of Oine----------- | Paul Lancaster--- | --do--- | 180 | 6 | 90 | --do-------- | -100 | 12 | | --do--- | Adequately supplies 2 families. Analysis------ |
| 3 | 3 miles N of Drewry--------- | James Boyd------- | --do--- | 46 | 6 | 46 | --do-------- | -35 | 5 | | Slope-- | Did not hit hard rock---------- |
| 4 | 2 3/4 miles NE of Drewry--------- | William Ellington | --do--- | 333 | 6 | ------ | --do-------- | ------- | 6 | | --do--- | |
| 5 | 1¼ miles N of Drewry--------- | J. C. Watkins---- | --do--- | 75 | 8 | 20 | --do-------- | ------- | 20+ | | Draw--- | |
| 6 | 1½ miles NE of Drewry--------- | Luther Kimbell--- | --do--- | 122 | 6 | 102½ | --do-------- | -15 | 18 | | Slope-- | |
| 7 | 2 3/4 miles N of Oine----------- | Percy Vaughan---- | --do--- | 91 | 6 | 46 | Granite----- | ----- | 6 | | Hill--- | |
| 8 | 2 3/4 miles NE of Oine----------- | W. F. Rooker----- | --do--- | 67½ | 6 | ------ | --do-------- | -27 | 12½ | | --do--- | Adequately supplies 2 families------ |
| 9 | Oine------------- | Clifton Rooker--- | --do--- | 80 | 6 | 38 | --do-------- | -25 | 7 | | ------- | |
| 10 | 1½ miles NE of Oine----------- | Al Gooch--------- | --do--- | 70 | 6 | 15 | --do-------- | ------- | 20+ | | Slope-- | Contains iron--- |
| 11 | 1¼ miles E of Oine----------- | George Robinson-- | --do--- | 200 | 6 | 66½ | --do-------- | ------- | 15 | | Hill--- | |
| 12 | 1 3/4 miles N of Norlina-------- | J. C. Fleming---- | --do--- | 108 | 6 | 10 | --do-------- | -20 | 10 | | Slope-- | |
| 13 | 2¼ miles NW of Wise----------- | Ed Rooker-------- | --do--- | 107 | 6 | 86 | --do-------- | -20 | 5 | | Flat-- | |
| 14 | 2½ miles N of Wise---------- | Rosa Felts------- | --do--- | 72 | 6 | 51 | Granite----- | -30 | 10 | | Slope-- | |
| 15 | 3½ miles NE of Wise---------- | R. L. Tolbert---- | --do--- | 113 | 6 | 94 | Mica gneiss | -30 | 25 | | Flat-- | Analysis-------- |
| 16 | 2½ miles NE of Wise---------- | George Nichols--- | --do--- | 105 | 6 | 36½ | --do-------- | -35.0 | 1 | | --do-- | Water level measured 1/24/61-- |
| 17 | 3/4 miles NE of Wise---------- | Locus Grove Church--------- | Drilled | 40 | 6 | 33 | Granite----- | -18 | 5 | | Flat--- | |
| 18 | Wise----------- | Joe Riggan------- | --do--- | 119 | 6 | 57 | --do-------- | -35.0 | 12 | | --do--- | Water level measured 3/20/58. Adequately supplies 1 home and store. |
| 19 | 3/4 miles SW of Wise----------- | Felix Williams--- | --do--- | 76 | 6 | 68 | --do-------- | -16.2 | 5 | | --do--- | Water level measured 3/20/62, temp. 59°---------- |
| 20 | 1¼ miles S of Wise----------- | Mrs. C. P. Holmes | --do--- | 125 | 6 | 52 | --do--------- | -28 | 30 | | --do--- | Adequately supplies 3 families------ |
| 21 | 1½ miles SE of Wise----------- | J. H. Williams--- | --do--- | 38 | 6 | 15 | --do--------- | -13 | 15+ | | Slope-- | |
| 22 | 1¼ miles SE of Wise---------- | Harry Stegall---- | --do--- | 110 | 6 | 20 | --do--------- | -20 | 2 | | --do--- | Water supply adequately supplies 1 family-------- |
| 23 | 2 3/4 miles SE of Wise---------- | J. B. Stegall---- | --do--- | 108 | 6 | ------ | --do-------- | -27.19 | 9-12 | | --do--- | Water level measured 2/5/62. Observation well---------- |
| 24 | 3 miles SE of Wise----------- | J. A. Ross------- | --do--- | 153 | 6 | 114½ | Mica schist-- | ------ | 29 | | Hill--- | |
| 25 | 3 miles N of Macon---------- | H. E. Perkinson-- | --do--- | 123 | 6 | 35 | --do--------- | -35 | 20+ | | --do--- | |
| 26 | 2½ miles N of Macon---------- | Wilson Copley---- | --do--- | 160 | 6 | 81 | --do--------- | -25.0 | 6 | | Flat-- | Water level measured.---- |
| 27 | 3 miles NW of Five Forks----- | R. A. Stamper, Jr. | --do--- | 57 | 6 | 22 | --do--------- | ------ | 36 | | Hill--- | |
| 28 | 2½ miles NW of Five Forks----- | Oliver Davis----- | Drilled | 112 | 6 | 62½ | Mica schist-- | -49 | 10+ | | Hill--- | Contains iron--- |
| 29 | 2 miles NW of Five Forks----- | S. W. Goode------ | --do--- | 86 | 6 | 65 | --do--------- | -40 | 8-10 | | --do--- | Well cased in soft rock, water gets muddy--------- |
| 30 | 1½ miles W of Five Forks----- | Webster Goode---- | --do--- | 93 | 6 | 67 | --do--------- | -40 | 8 | | --do--- | |
| 31 | 2¼ miles SW of Five Forks----- | Roger Fitts------ | --do--- | 78 | 6 | 71 | --do-------- | -15 | 15 | | --do--- | |
| 32 | 2½ miles S of Five Forks----- | Pine Grove Church | --do--- | 86 | 6 | 53½ | --do--------- | ------ | 5 | | Slope-- | |
| 33 | 2¼ miles S of Five Forks----- | Mrs. John Nicholson----------- | Bored--- | 42 | 20 | 42 | --do--------- | -40 | 3-5 | | Flat--- | Did not hit rock. Water contains iron---------- |
| 34 | 1¼ miles SE of Five Forks----- | Johnny J. Shearill | --do--- | 45 | 24 | 45 | --do--------- | -19.79 | 15 | | Draw--- | Water level measured 2/14/62. Observation well--------- |

Table 30.--Records of wells in Warren County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 2¼ miles SE of Five Forks----- | Siamon Gardner--- | Drilled | 123 | 6 | 119 | --do--------- | -30 | 14 | | Hill-- | |
| 36 | 3¼ miles SE of Five Forks----- | Eddie Williams--- | --do---- | 74 | 6 | 50 | --do--------- | -40 | 30 | | Slope-- | Analysis-------- |
| 37 | 3 miles NE of Littleton------ | R. L. Salmon----- | Bored--- | 57 | 24 | 57 | --do--------- | -39 | 5 | | Hill--- | Adequately supplies 1 family and store-------- |
| 38 | 3 miles N of Littleton------ | G. D. Ellis------ | Drilled- | 87 | 6 | ------ | Porphyritic granite---- | -20 | 10 | | Slope-- | |
| 39 | 4½ miles N of Littleton----- | Alvis B. Fleming | --do---- | 110 | 6 | 70 | --do--------- | ------ | 20+ | | Hill--- | Analysis------- |
| 40 | 1 mile N of Littleton------ | Hunter Fowler---- | --do---- | 60 | 6 | ------ | --do--------- | -20 | 10-15 | | --do-- | Water contains iron---------- |
| 41 | ½ mile N of Littleton------ | Town of Littleton | Drilled | 312 | 6 | ------ | Porphyritic granite---- | ----- | 30 | | Draw-- | Pump breaks suction at 38 gpm. Analysis |
| 42 | Littleton-------- | Pepsi Cola Bottling Company---- | --do---- | 500 | 8 | ------ | --do--------- | -12.58 | 5 | | Flat-- | Water level measured 2/13/62. Observation well---------- |
| 43 | 2½ miles NW of Littleton------ | Sam Moore-------- | --do---- | 134 | 6 | 79 | Mica schist-- | -30 | 20 | | Hill-- | All water obtained below 90 feet---------- |
| 44 | 2 miles NW of Littleton------ | Mrs. Robert King | --do---- | 100 | 6 | 80 | --do--------- | -30 | 15 | | --do-- | |
| 45 | 1 3/4 miles W of Littleton------ | Mrs. David Dobbitt-------- | --do---- | 82 | 6 | 47 | Metasedimentary sequence | -25 | 5½ | | Flat-- | Water reported moderately hard---------- |
| 46 | 2 miles SW of Littleton------ | Walter Pike------ | --do---- | 120 | 6 | 25 | --do--------- | ------ | 46 | | --do-- | All water obtained above 60 feet. Analysis------ |
| 47 | 2 3/4 miles W of Littleton------ | W. R. Rogers----- | --do---- | 94 | 8 | 46 | Mica schist-- | -19.0 | 25 | | Hill-- | Well not used, water muddy. water level measured 2/12/62------- |
| 48 | 2½ miles NE of Vaughan-------- | J. H. Spreggins--- | --do---- | 93 | 5 | ------ | --do--------- | -45 | 10+ | | Flat-- | Well drilled in 1950 and water level has not fluctuated appreciably----- |
| 49 | ½ mile W of Vaughan-------- | Johnny Shearin--- | --do---- | 179 | 6 | 87 | --do--------- | -20 | 5 | | Hill-- | Analysis-------- |
| 50 | ¼ mile S of Vaughan-------- | Warren County Board of Education----------- | --do---- | 288 | 6 | 65 | --do--------- | -10 | 30 | | Draw-- | |
| 51 | 2 miles W of Vaughan-------- | Vincent Williams | Bored-- | 42 | 24 | 42 | Mica schist | -20 | 12+ | | Flat-- | |
| 52 | 2½ miles NE of Macon---------- | Plummer Rodwell-- | Drilled | 104 | 6 | 67 | --do-------- | -30 | 25 | | Slope | Water gets muddy--------- |
| 53 | Macon------------ | William Wilson--- | --do---- | 183 | 6 | 111 | --do-------- | -35 | 5 | | Hill-- | |
| 54 | Macon------------ | Robert H. Shaw--- | --do---- | 170 | 6 | 109 | --do-------- | -10 | 2½ | | Slope | |
| 55 | Macon------------ | G. H. Gillilard-- | --do---- | 95 | 6 | 56 | --do-------- | ------ | 15 | | --do-- | Hard water reported Contains iron---- |
| 56 | Macon------------ | Mrs. Frank Owenby | --do---- | 83 | 6 | 59 | --do-------- | -30 | 35+ | | --do-- | |
| 57 | 1½ miles NW of Macon---------- | Mrs. Carrie Brame | --do---- | 90 | 6 | ------ | --do-------- | -30 | 6 | | Hill-- | Well not used--- |
| 58 | 1½ miles SW of Macon---------- | Mrs. Ray Puryear | --do---- | 138½ | 6 | 87 | --do-------- | ----- | 6 | | Flat-- | Analysis-------- |
| 59 | 2 miles SW of Macon---------- | Walter E. Loyd, Jr.------------ | --do---- | 120 | 6 | 84 | --do-------- | ------ | 5 | | --do-- | |
| 60 | 2 3/4 miles W of Macon---------- | Tom Frazier------ | --do---- | 55 | 6 | 42 | Granite----- | -15 | 20 | | --do-- | |
| 61 | 1½ mile N of Warrenton------ | C. C. Inscoe----- | --do---- | 175 | 6 | 66 | --do-------- | -15 | 30+ | | --do-- | Water contains much iron----- |
| 62 | 1 3/4 miles N of Warrenton------ | Billy Connell---- | --do---- | 103 | 6 | 63 | --do-------- | ------ | 30 | | --do-- | Yield 30 gpm with a 20-foot drawdown------ |
| 63 | 1½ miles SE of Norlina-------- | E. M. Robinson--- | --do---- | 59 | 6 | 50½ | --do-------- | -13 | 22+ | | --do-- | |
| 64 | 2 miles E of Norlina-------- | County School Garage--------- | --do---- | 84½ | 6 | 54½ | --do-------- | ----- | 10-15 | | --do-- | |
| 65 | Norlina---------- | Town of Norlina-- | --do---- | 83 | 6 | ------ | --do-------- | -20 | 45 | | --do-- | Drawdown 20 feet after 28 hours pumping at 45 gpm----------- |
| 66 | Norlina---------- | Town of Norlina-- | --do---- | 400 | 8-6 | 95 | --do-------- | -22 | 69 | | Draw-- | Well 8 inches to 150 feet, 6 inches below 150 feet. Drawdown 118ft after 24 hours at 69 gpm. |

Table 30.--Records of wells in Warren County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | 1 3/4 miles SW of Norlina-------- | O. A. Brauer---- | Drilled | 138 | 6 | 43 | Granite----- | -30 | 7 | | Slope-- | |
| 68 | 2 3/4 miles SW of Norlina-------- | William Franklin | --do---- | 77 | 6 | 36 | --do-------- | -15 | 12 | | --do--- | |
| 69 | 1 mile E of Ridgeway------- | Mrs. Elizabeth Anderson------ | --do---- | 135 | 6 | 72 | Mica gneiss | -30 | 3 | | Draw--- | Supplies 3 families------ |
| 70 | 1¼ miles NW of Norlina-------- | Hal Paschall---- | --do---- | 69½ | 6 | ------ | --do-------- | -18 | 35 | | Flat--- | Water reported moderately hard. |
| 71 | 1¼ miles N of Ridgeway------- | St. Paul's Lutheran Church | --do---- | 174 | 6 | 62 | --do-------- | -30 | 10 | | Hill--- | |
| 72 | Ridgeway--------- | W. H. Dacke------ | --do---- | 127 | 6 | 63½ | --do-------- | -25 | 15 | | Slope-- | Adequately supplies 2 families.----- |
| 73 | 1 mile SW of Ridgeway------ | Bowers and Burrows Oil Company------- | --do---- | 67 | 6 | 56 | --do-------- | -18 | 15+ | | Flat--- | Adequately supplies 1 family and service station---------- |
| 74 | 1½ miles W of Ridgeway------ | Leonard M. Bender | --do---- | 76 | 6 | 43 | --do-------- | -30 | 10 | | Hill--- | Adequately supplies 2 families. Analysis------ |
| 75 | 1½ miles SE of Drewry-------- | Adam Seaman------ | --do---- | 105 | 6 | ------ | --do-------- | ----- | 15 | | Slope-- | Hit hard rock at about 30 feet. |
| 76 | Drewry---------- | Ed White--------- | --do---- | 168 | 6 | 34 | --do-------- | -35 | 15+ | | Hill--- | Adequately supplies 2 families and store--------- |
| 77 | 1½ miles S of Drewry-------- | Ellis Fleming---- | --do---- | 121 | 6 | 91 | --do-------- | -30 | 30+ | | --do-- | |
| 78 | 2 3/4 miles SW of Ridgeway------ | Nat Miller------- | --do---- | 92 | 6 | 53 | --do-------- | -30 | 2 | | Slope-- | |
| 79 | 3 miles NE of Axtell--------- | Roosevelt Rose--- | --do---- | 147 | 6 | 42 | --do-------- | -40.37 | 20 | | --do--- | Water level measured 2/1/62. Observation well. |
| 80 | 2 miles NE of Axtell-------- | James Wilson---- | Drilled | 129 | 6 | 107 | Mica gneiss | -35 | 6 | | Hill-- | |
| 81 | 3/4 miles N of Axtell-------- | J. M. Stevenson- | --do--- | 143 | 6 | ------ | --do-------- | ------ | 7 | | Flat-- | |
| 82 | ¼ mile E of Axtell-------- | J. B. Russell--- | --do---- | 66 | 6 | 15 | --do-------- | ------ | 5½ | | Slope | Adequately supplies 1 family and store--------- |
| 83 | 1½ miles W of Axtell-------- | L. R. Stephenson | --do--- | 91 | 6 | 31 | --do-------- | -17 | 15+ | | --do-- | |
| 84 | 2¼ miles E of Axtell-------- | Robert Williams- | --do--- | 63 | 6 | 43 | --do-------- | -20 | 15 | | Hill-- | |
| 85 | 2½ miles W of Warrenton----- | Wilbert Daniel--- | --do--- | 146 | 6 | 39 | --do-------- | -40 | 2 | | Slope | Supplies 2 families------ |
| 86 | 1 3/4 miles W of Warrenton----- | Kelly Somerville | --do---- | 42 | 6 | 28 | Granite----- | -15 | 20 | | --do-- | |
| 87 | 3½ miles SW of Warrenton----- | Gus Alston------ | --do---- | 165 | 6 | 108½ | Mica gneiss | ----- | 5 | | Flat-- | Analysis-------- |
| 88 | 1 3/4 miles N of Afton--------- | Bobbie H. Wilson | --do---- | 99 | 6 | 42 | --do-------- | -20 | 10 | | Slope | Hard water reported------ |
| 89 | 2 miles NE of Afton--------- | Fernie L. Miller | --do---- | 102 | 6 | 36 | --do-------- | ------ | 6 | | Hill- | |
| 90 | 2 miles SW of Warrenton----- | Ben Williams---- | Bored--- | 55 | 24 | 55 | --do-------- | -45 | 1 | | --do-- | Did not hit hard rock. Moderately hard water reported |
| 91 | Warrenton------- | Peck Manufacturing Company--- | Drilled | 164 | 6 | 90 | --do-------- | ------ | 34 | | Draw-- | Tested at 34 gpm for 8 hours. Contains iron. Furnishes water for 30 families |
| 92 | Warrenton------- | Peck Manufacturing Company--- | --do--- | 212 | 6 | ------ | --do-------- | -31.4 | ------ | | Hill | Water level measured 2/2/62-------- |
| 93 | Warrenton------- | Warrenton Box and Lumber Company------- | Drilled-- | 56 | 6 | 15 | Mica gneiss | ------ | 7-10 | | Slope-- | |
| 94 | Warrenton------- | Fairview Cemetery------ | --do----- | 122 | 6 | 52 | --do-------- | -20 | 40 | | Draw--- | Water obtained below 106 feet |
| 95 | ¼ mile S of Warrenton----- | Manley Martin--- | --do----- | 312 | 8 | 54 | --do-------- | ------ | 160 | | Slope-- | Tested for 24 hours at 160 gpm. Used for emergency water supply by Warrenton-- |
| 96 | ½ miles E of Warrenton----- | Hal Connell----- | --do----- | 99 | 6 | 58 | --do-------- | -5 | 35+ | | Draw--- | Contains iron--- |
| 97 | 1 mile E of Warrenton----- | Phil Towns------ | --do----- | 109 | 6 | 49½ | Mica schist | ----- | 6 | | Hill--- | |
| 98 | 2 miles NE of Warrenton----- | D. E. Clark----- | --do----- | 73 | 4 | ------ | --do-------- | -20 | 3 | | Slope-- | |
| 99 | 3/4 miles E of Warrenton----- | James Jones----- | --do---- | 140 | 6 | 90 | --do-------- | -40 | 30 | | --do-- | |

Table 30.--Records of wells in Warren County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Drawdown (ft) | Topography | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 1 mile E of Warrenton | L. T. Thompson | --do-- | 143 | 6 | 40 | --do-- | ------ | 3½ | | Draw-- | |
| 101 | 1½ miles SE of Warrenton | Mrs. Grey Edgerton | --do-- | 78 | 6 | 45 | --do-- | ------ | 7 | | Slope-- | |
| 102 | 1¼ miles SE of Warrenton | E. C. Coker | --do-- | 152 | 6 | 48 | --do-- | -40 | 30 | | Draw-- | Drawdown of 40 feet after 2 hours pumping at 30 gpm |
| 103 | 4½ miles SE of Warrenton | Frank Twitty | --do-- | 282 | 6 | 46 | --do-- | -30 | 50+ | | Slope-- | Water is hard and contains iron |
| 104 | 2¾ miles SE of Warrenton | Warrenton Country Club | --do-- | 150 | 8 | 69 | --do-- | flows | 237 | | Draw-- | Drawdown 135 feet after 24 hours pumping at 237 gpm. flows 3 to 5 gpm. |
| 105 | 1½ miles NW of Liberia | A. D. Hardee | Drilled | 81 | 6 | 72 | Mica schist | -35 | 10 | | Hill-- | |
| 106 | 1 3/4 miles N of Liberia | Nick Hunt | --do-- | 148 | 6 | 118 | --do-- | -30 | 7 | | --do-- | |
| 107 | 2 miles N of Liberia | P. T. Cheek | --do-- | 185 | 6 | 78 | --do-- | -20 | 5 | | Slope | |
| 108 | 2½ miles NW of Embro | R. A. Tharington | Bored | 45 | 24 | 45 | --do-- | -40 | 1- | | --do-- | Hit rock at 45 feet. Moderately hard water reported |
| 109 | 1 3/4 miles NW of Embro | J. W. Carroll | Drilled | 102 | 6 | 102 | --do-- | -40 | 5 | | Flat-- | Did not hit hard rock |
| 110 | ½ mile NW of Embro | L. L. Brown | Bored | 39 | 24 | 39 | --do-- | -19 | 7-10 | | Hill-- | |
| 111 | 1½ miles S of Vaughan | M. D. Nelson | Drilled | 255 | 6 | 102 | --do-- | -20 | 4 | | ------- | |
| 112 | 2½ miles E of Embro | Joe Neal | --do-- | 100 | 6 | 62 | --do-- | -22 | 20 | | Slope-- | |
| 113 | 4½ miles SW of Littleton | Cicero Alston | --do-- | 155 | 6 | 45 | Metasedimentary sequence | -13 | 12-14 | | --do-- | Analysis |
| 114 | 1 mile N of Arcola | Joseph Williams | --do-- | 167 | 6 | 103 | --do-- | ------- | 4 | | Hill-- | |
| 115 | 3 miles SE of Embro | Roy Pittman | --do-- | 150 | 6 | 40 | Mica schist | -30 | 10 | | Flat-- | Slightly hard water reported |
| 116 | 2½ miles SE of Embro | A. J. King | --do-- | 296 | 6 | 20 | --do-- | -30 | 5 | | --do-- | Hard water reported |
| 117 | Liberia | H. B. Harvey | --do-- | 122 | 6 | 50 | --do-- | -40 | 30 | | --do-- | |
| 118 | 3/4 miles SE of Liberia | Welton Richardson | Bored | 100 | 24 | 100 | --do-- | -90 | 6-8 | | --do-- | Did not hit hard rock |
| 119 | 2 miles N of Inez | Alton Pridgen | Drilled | 165 | 6 | 98 | --do-- | -35 | 5 | | Hill-- | Moderately hard water reported |
| 120 | 2 miles N of Inez | Alton Pridgen | Bored | 39 | 30 | 39 | --do-- | -29.11 | 1-3 | | --do-- | Water level measured 1/17/62. Observation well |
| 121 | 2 3/4 miles W of Liberia | John Edmonds | Drilled | 57 | 6 | 10 | Mica schist | -40 | 1-3 | | Hill-- | |
| 122 | 3 miles SW of Liberia | Willie B. Williams | --do-- | 100 | 6 | 55 | --do-- | -45.15 | 25+ | | --do-- | Water level measured 1/29/62. Observation well |
| 123 | 2 3/4 miles SE of Afton | E. C. Kearney | --do-- | 85 | 6 | 55 | --do-- | -25 | 25 | | | Analysis |
| 124 | 1½ miles NE of Afton | Charles T. Pinnell | Drilled | 95 | 6 | ------- | Mica gneiss | ----- | 35 | | Slope-- | |
| 125 | 1 mile SE of Afton | Edward Munn | --do-- | 83 | 6 | 60 | --do-- | -27 | 7½ | | Flat-- | |
| 126 | 3/4 miles NE of Afton | Hunter Pinnell | --do-- | 201 | 6 | 105 | --do-- | -27 | 6 | | Hill-- | |
| 127 | 3/4 miles N of Afton | Mel Hicks | --do-- | 100 | 6 | 60 | --do-- | -30 | 2-4 | | Flat-- | |
| 128 | Afton | M. E. Wilson | --do-- | 46 | 5 | 8 | --do-- | -25 | 15 | | --do-- | |
| 129 | 3/4 miles S of Afton | Harry Limer | --do-- | 164 | 6 | 38 | Granite | -30 | 10 | | --do-- | Dug 34 feet |
| 130 | 1½ miles SW of Afton | Barker Williams | --do-- | 115 | 6 | 83½ | --do-- | -20 | 30 | | Hill-- | Analysis |
| 131 | 1¼ miles SW of Afton | Rosa Champion | --do-- | 75 | 6 | 12 | --do-- | -30 | 20 | | --do-- | |
| 132 | 1 3/4 miles SW of Afton | Joe King Williams, Jr. | --do-- | 194 | 6 | 15 | --do-- | -60 | 5-7 | | --do-- | |
| 133 | 1¼ miles S of Axtell | K. S. Summerville | --do-- | 125 | 6 | 60 | Mica gneiss | -25 | 13 | | Slope-- | |
| 134 | 1 mile S of Axtell | William Bender | Bored | 40 | 24 | 40 | --do-- | -18 | 22 | | Draw-- | Did not hit rock water corrosive |
| 135 | 3 3/4 miles SW of Afton | Oscar Ayscue | Drilled | 104 | 6 | 49 | --do-- | -40 | 4-6 | | Flat-- | Slightly hard water reported |
| 136 | 3½ miles SW of Afton | L. A. Ayscue | Dug | 58 | 24 | 55 | --do-- | -35.65 | ------ | | Hill-- | Water level measured 1/25/62. Observation well. |

Table 30.--Records of wells in Warren County--Continued

| Well No. | Location | Owner | Type of well | Depth (ft) | Diameter (in) | Depth of casing (ft) | Water-bearing material | Water level (ft) | Yield (gpm) | Draw-down (ft) | Topo-graphy | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 137 | 2½ miles S of Afton---------- | George Aycock--- | Drilled | 61 | 6 | 43 | Granite----- | -35 | 12 | | Slope-- | Moderately hard water reported |
| 138 | 4¾ miles S of Afton---------- | G. C. Brown------ | --do---- | 144 | 6 | 109 | --do-------- | -30 | 10+ | | Flat--- | |
| 139 | 6 miles SW of Parktown------- | R. V. Fleming---- | --do---- | 65 | 6 | 65 | Mica gneiss | -30 | 36+ | | Hill--- | |
| 140 | 5½ miles SW of Parktown------- | G. E. Cheek------ | --do---- | 181 | 6 | 90 | --do-------- | -30 | 8 | | Flat--- | Analysis-------- |
| 141 | 3½ miles SW of Parktown------- | Maggie Brown----- | Bored--- | 45 | 24 | 45 | Mica schist | -35 | 5-8 | | --do--- | |
| 142 | 1 3/4 miles S of Parktown------- | Beamon Hunt------ | Drilled | 137 | 6 | 50 | --do-------- | -50 | 15 | | Hill--- | |
| 143 | 2 3/4 miles SW of Inez----------- | S. M. Gardner---- | Bored--- | 42 | 30 | 42 | --do-------- | -28 | 22 | | Draw--- | |
| 144 | 3/4 miles NW of Inez----------- | Harry Williams--- | --do---- | 58 | 24 | 58 | --do-------- | -34 | 5-7 | | Hill--- | Hard water reported------ |
| 145 | 1 3/4 miles S of Inez----------- | James C. Harris-- | Dug----- | 22 | 30 | 22 | --do-------- | -20 | 7-10 | | --do--- | Well drilled 10 feet in soft rock---------- |
| 146 | 1½ miles SE of Inez---------- | Frederick Williams------- | --do----- | 38 | 30 | 38 | --do--------- | -28 | 4-6 | | Flat-- | Adequately supplies 2 families------ |
| 147 | 2¼ miles E of Inez | Albert M. Alston | Bored--- | 32 | 24 | 32 | Metasediment-ary sequence | -25 | 5-7 | | Hill--- | Slightly hard water reported |
| 148 | 2 miles W of Arcola--------- | Mrs. J. R. King-- | --do---- | 52 | 30 | 52 | --do--------- | -20 | 4-6 | | Flat-- | Water contains iron and is turbid-------- |
| 149 | Arcola----------- | Wildon T. Davis | Drilled | 120 | 6 | 93 | --do--------- | -31 | 5 | | --do--- | Analysis-------- |
| 150 | 1 mile SE of Arcola--------- | Arcola Lumber Company-------- | --do---- | 200½ | 6 | 160 | --do--------- | -14 | 20+ | | Slope-- | |
| 151 | 2½ miles S of Arcola--------- | Phil Richardson | Dug----- | 32 | 40 | ------- | --do--------- | -4.82 | 4-6 | | --do--- | Water level measured 1/16/62. Observation well---------- |
| 152 | 3 3/4 miles SW of Arcola--------- | T. A. Richardson | Dug----- | 22 | 24 | 22 | Metasediment-ary sequence | -18 | 1-3 | | Flat--- | |
| 153 | 5 3/4 miles SW of Arcola--------- | Thomas Williams | Drilled | 150 | 6 | 100 | --do--------- | -50 | 8-10 | | Hill--- | Analysis-------- |

Table 31.--Chemical analyses of ground water from Warren County. (Numbers at heads of columns correspond to well numbers in table 30.)

| | 2 | 15 | 36 | 39 | 41 | 46 | 49 | 58 |
|---|---|---|---|---|---|---|---|---|
| Date of Collection | 8/14/62 | 8/14/62 | 7/26/62 | 7/26/62 | 7/26/62 | 7/26/62 | 7/26/62 | 7/24/62 |
| Silica ($SiO_2$) | 33 | 27 | 36 | 28 | 28 | 31 | 23 | 26 |
| Aluminum (Al) | .0 | .0 | .0 | .0 | .0 | .2 | .0 | .1 |
| Iron (Fe) | .23 | .08 | .10 | .07 | .15 | .19 | .03 | 2.7 |
| Manganese (Mn) | .02 | .00 | .02 | .00 | .04 | .03 | .02 | .04 |
| Calcium (Ca) | 18 | 4.6 | 6.7 | 16 | 13 | 6.3 | 60 | 5.9 |
| Magnesium (Mg) | 8.3 | 3.1 | 2.4 | 3.7 | 1.8 | 2.8 | 4.1 | 3.1 |
| Sodium (Na) | 24 | 3.0 | 7.5 | 20 | 5.7 | 4.9 | 23 | 4.3 |
| Potassium (K) | 3.9 | .3 | 1.2 | 3.4 | 1.6 | 1.1 | 1.3 | 1.9 |
| Lithium (Li) | .1 | .1 | .0 | .2 | .0 | .0 | .2 | .0 |
| Bicarbonate ($HCO_3$) | 37 | 36 | 33 | 21 | 57 | 35 | 89 | 44 |
| Sulfate ($SO_4$) | 6.2 | 2.4 | 2.2 | 6.8 | 1.6 | 2.8 | 135 | 5.8 |
| Chloride (Cl) | 62 | 1.8 | 6.0 | 29 | 3.0 | 3.2 | 4.2 | 3.0 |
| Fluoride (F) | .0 | .0 | .1 | .2 | .3 | .3 | .5 | .1 |
| Nitrate ($NO_3$) | 10 | .3 | 11 | 50 | 1.4 | 6.9 | 1.3 | 1.3 |
| Phosphate ($PO_4$) | .0 | .0 | .0 | .1 | .0 | .1 | .0 | .0 |
| Dissolved Solids | 184 | 61 | 89 | 167 | 84 | 77 | 296 | 74 |
| Hardness as $CaCO_3$ | 78 | 24 | 54 | 56 | 40 | 28 | 168 | 28 |
| Noncarbonate | 48 | 0 | 0 | 38 | 0 | 0 | 94 | 0 |
| Specific Conductance | 302 | 68 | 109 | 238 | 108 | 83 | 418 | 76 |
| pH | 7.5 | 6.6 | 6.3 | 5.9 | 6.9 | 6.9 | 7.7 | 6.5 |
| Color | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 |
| Map Unit | Mica gneiss | Mica gneiss | Mica schist | Prophyritic granite | Prophyritic granite | Metasediment | Mica schist | Mica schist |

| | 74 | 87 | 113 | 123 | 130 | 140 | 149 | 153 |
|---|---|---|---|---|---|---|---|---|
| Date of Collection | 7/24/62 | 7/24/62 | 7/26/62 | 7/24/62 | 8/14/62 | 7/25/62 | 7/26/62 | 7/26/62 |
| Silica ($SiO_2$) | 35 | 33 | 25 | 32 | 34 | 33 | 42 | 16 |
| Aluminum (Al) | .2 | .1 | .0 | .1 | .1 | .1 | .1 | .1 |
| Iron (Fe) | 2.0 | .02 | .27 | .91 | .21 | .01 | .25 | 1.3 |
| Manganese (Mn) | .01 | .00 | .04 | .02 | .01 | .00 | .03 | .04 |
| Calcium (Ca) | 6.9 | 9.6 | 3.1 | 7.9 | 6.1 | 8.7 | 9.0 | 2.7 |
| Magnesium (Mg) | 3.3 | 5.1 | .2 | 4.8 | 2.7 | 6.3 | 4.2 | 1.1 |
| Sodium (Na) | 6.0 | 7.0 | 5.2 | 4.8 | 7.9 | 7.0 | 11 | 3.5 |
| Potassium (K) | 4.0 | 3.3 | 1.7 | 2.5 | .3 | 3.8 | 1.9 | 1.7 |
| Lithium (Li) | .1 | .1 | .0 | .0 | .0 | .0 | .1 | .0 |
| Bicarbonate ($HCO_3$) | 50 | 72 | 23 | 59 | 44 | 77 | 70 | 19 |
| Sulfate ($SO_4$) | 8.4 | 2.0 | 2.4 | 3.8 | 1.0 | 2.2 | 5.4 | 3.0 |
| Chloride (Cl) | 1.8 | 2.5 | 1.6 | 2.4 | 4.5 | 2.3 | 2.8 | 4.5 |
| Fluoride (F) | .1 | .1 | .0 | .0 | .0 | .1 | .2 | .0 |
| Nitrate ($NO_3$) | .2 | 2.2 | 1.4 | 1.3 | 1.9 | 1.4 | 1.1 | .0 |
| Phosphate ($PO_4$) | .0 | .0 | .0 | .0 | .0 | .1 | .0 | .0 |
| Dissolved Solids | 91 | 100 | 52 | 89 | 81 | 103 | 112 | 42 |
| Hardness as $CaCO_3$ | 32 | 46 | 9 | 40 | 26 | 48 | 40 | 12 |
| Noncarbonate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Specific Conductance | 106 | 127 | 56 | 107 | 100 | 128 | 120 | 51 |
| pH | 6.8 | 7.1 | 6.2 | 6.6 | 6.7 | 7.2 | 7.0 | 6.1 |
| Color | 5 | 3 | 3 | 4 | 2 | 3 | 4 | 3 |
| Map Unit | Mica gneiss | Mica gneiss | Metasediment | Mica schist | Granite | Mica gneiss | Metasediment | Metasediment |

# CHEMICAL QUALITY OF WATER

By

J. D. Thomas

## GENERAL QUALITY OF WATER

This section of the report evaluates the chemical quality of the ground water in the Raleigh area. Information concerning the chemical quality of water is important to the future development of the area, especially for industries that require ground water of a specific chemical quality.

The chemical quality of ground water depends upon the kinds and amounts of dissolved mineral constituents in the water. The amount and kind of mineral constituents in ground water at any one place and time depends on such factors as the temperature of the water, the hydrostatic and atmospheric pressures present in the system, the mineral composition of the host rocks and soil, the duration of contact or residence time between the water and the minerals of the rocks and soil, and the kind and quality of dissolved gases. Rainwater contains dissolved gases, principally carbon dioxide and oxygen derived from the atmosphere, the soil, and organic substances. Dissolved carbon dioxide forms a weak acid in water capable of reacting with and dissolving some minerals found in the rocks and soil.

Most of the ground waters analyzed were calcium, sodium, and magnesium-bicarbonate types, suitable for most uses. Objectionable amounts of iron, chloride, and hardness make some ground waters unfit for specific uses.

## DISSOLVED MINERAL CONSTITUENTS

The salts of the common metals, which include potassium, sodium, calcium, iron, and magnesium, make up most of the dissolved mineral constituents in ground water. These are in solution as cations or anions; cations are positively charged and anions are negatively charged. Chemical analyses of ground water determine the amount of cations and anions in solution.

The chemical analyses of ground water in this report are expressed in parts per million (ppm). A part per million is a unit of weight of one constituent in one-million unit weights of water.

Analyses of water from 69 selected wells were used to determine the chemical quality of ground water from the individual rock types of the Raleigh area.

The following is a discussion of the dissolved mineral constituents as they are usually reported in water analyses. The range and median of concentrations of chemical constituents in ground water in the Raleigh area are presented in table 32.

Table 32.--Range in concentration and median of concentrations of chemical constituents in ground water in the Raleigh area

| | (parts per million) | | |
|---|---|---|---|
| | Minimum | Maximum | Median |
| Silica ($SiO_2$) | 8.4 | 47 | 32 |
| Iron (Fe) | .00 | 9.2 | .10 |
| Calcium (Ca) | 2.7 | 106 | 8.8 |
| Magnesium (Mg) | .2 | 63 | 3.7 |
| Sodium (Na) | 2.5 | 310 | 5.7 |
| Potassium (K) | .1 | 5.2 | 1.4 |
| Bicarbonate ($HCO_3$) | 10 | 360 | 44 |
| Sulfate ($SO_4$) | .4 | 135 | 3.6 |
| Chloride (Cl) | .3 | 572 | 3.6 |
| Fluoride (F) | .0 | 2.0 | .1 |
| Nitrate ($NO_3$) | .0 | 74 | 3.6 |
| Hardness | 8 | 388 | 37 |
| Dissolved Solids | 25 | 1180 | 90 |
| Hydrogen-ion Concentration (pH) | 5.8 | 7.8 | 6.8 |
| Specific Conductance in Micromhos | 32 | 2200 | 118 |

## SILICA ($SiO_2$)

Silica in ground water is derived from the weathering of silicate minerals which include the feldspars, micas, amphiboles, and pyroxenes. Except in boiler feed and stream turbine water, the concentrations of silica in ground water in the Raleigh area are not objectionable for most industrial processes.

## ALUMINUM (Al)

Aluminum is a very common element in the earth's crust. However, high concentrations of aluminum are not common in ground water, because it is generally left behind in the clay minerals during the weathering process.

## IRON (Fe)

Iron is abundant in many rocks, especially those containing high percentages of ferromagnesian minerals, such as hornblende gneiss, and mafic volcanic rock. Iron is fairly soluble in ground water, especially in acidic ground water. Ferrous iron dissolved in ground water is oxidized to insoluble ferric hydroxide on exposure to air and is responsible for the red or brown stains on porcelain sinks and laundry. Additional iron may be added to water by the corrosive action of acidic ground water in contact with iron pipes and tanks of water systems.

Water containing less than 0.3 ppm iron is suitable for most domestic purposes. Seventy-nine percent of the ground-water samples analyzed for iron contained less than 0.3 ppm.

## MANGANESE (Mn)

The chemical behavior of manganese in water resembles that of iron. However, manganese is much less abundant in rocks and manganese concentrations in ground water are generally lower than iron concentrations. The U. S. Public Health Service recommends that manganese not exceed 0.05 ppm in drinking and culinary water. In the Raleigh area no water analyzed exceeded 0.05 ppm.

## CALCIUM AND MAGNESIUM (Ca and Mg)

Calcium and magnesium are common constituents of rocks in the Raleigh area. Minerals which contain calcium include calcite, plagioclase feldspar, the pyroxenes, and the amphiboles. Magnesium is usually present in the pyroxenes, biotite, olivine, and the amphiboles.

Calcium and magnesium account for most of the hardness of ground water. They combine with bicarbonate to form scale in boilers and other containers in which water is heated or evaporated. The U. S. Public Health Service recommends that drinking water contain less than 50 ppm magnesium. The highest concentration of magnesium in ground water from the Raleigh area was 63 ppm.

## SODIUM AND POTASSIUM (Na and K)

The presence of sodium and potassium in ground water usually can be attributed to the chemical breakdown of the plagioclase and orthoclase feldspars. Potassium is slightly less abundant in rocks than sodium.

However, potassium is generally much less concentrated in ground water due to the tendency of potassium to remain behind as a constituent of the clay minerals during the weathering process.

## LITHIUM (Li)

Lithium-bearing minerals are comparatively rare. The scarcity of lithium in rocks of the Raleigh area accounts for low concentrations in the ground water.

## BICARBONATE AND CARBONATE ($HCO_3$ and $CO_3$)

Bicarbonate is the principal anion in ground water in the Raleigh area. The principal cations are calcium, sodium, and magnesium. Unless calcium and magnesium are present in high concentrations, bicarbonate has little effect on the domestic utilization of water. Bicarbonate in ground water of the Raleigh area ranges from 10 to 360 ppm. No carbonate was reported in ground water analyzed from the Raleigh area.

## SULFATE ($SO_4$)

Sulfate may be derived from the decomposition of organic matter and the oxidation of iron-sulfide minerals such as marcasite and pyrite ($FeS_2$).

The concentrations of sulfate in ground water in the Raleigh area are low and are not particularly objectionable. The U. S. Public Health Service recommends that sulfate not exceed 250 ppm in drinking and culinary water.

## CHLORIDE (Cl)

Only small amounts of chloride are dissolved during the weathering of crystalline and sedimentary rocks.

The U. S. Public Health Service recommends that chloride concentrations in drinking and culinary water should not exceed 250 ppm. One sample of ground water analyzed from the Raleigh area contained chloride in excess of 250 ppm.

Abnormally high chloride concentrations in ground water in the Raleigh area may result from retention of fossil sea water in sedimentary rocks, or from domestic or industrial pollution. The association of bromide with chloride in well 105 (Wake County) and the low nitrate concentration suggests the presence of residual sea water.

## BROMIDE (Br)

Except for certain sedimentary deposits, rocks contain only small amounts of bromide. Bromide in ground water is considered a minor or trace element.

The chemical behavior of the bromide ion in water resembles that of chloride and both are concentrated in sea water and brines. The presence of bromide with high chloride concentrations may indicate a water that is in part fossil or residual sea water.

## FLUORIDE (F)

Fluoride in ground water is dissolved from fluoride-bearing minerals such as mica, apatite, and hornblende. According to medical evidence 1.0 to 1.5 ppm of fluoride ion will aid in the prevention of tooth decay. Excess amounts of fluoride are undesirable because it may cause mottling of teeth. One sample of ground water analyzed from the Raleigh area exceeded 1.5 ppm.

## NITRATE ($NO_3$)

Nitrate in ground water is considered to be the final oxidation product of nitrogenous organic materials. Water intended for human use should not exceed 45 ppm nitrate according to the U. S. Public Health Service. The median concentrations of nitrate in ground water analyzed from the Raleigh area is 3.6 ppm. Concentrations greater than 3.6 ppm may indicate pollution by sewage, fertilizers, or human wastes. Dug wells and improperly cased drilled wells are especially subject to contamination by surface water.

## PHOSPHATE ($PO_4$)

Phosphate in ground water may result from the solution of the mineral apatite or phosphate fertilizers. Phosphate concentrations in ground water sampled in the Raleigh area were below 0.8 ppm.

## HARDNESS

Hardness of water is related to the amount of calcium and magnesium in a particular water, and is expressed as equivalent parts per million of calcium carbonate ($CaCO_3$). Hardness of water is usually recognized by the increased amount of soap necessary to form and maintain a lather. The U. S. Geological Survey uses a classification of water hardness with respect to calcium carbonate as follows:

| Hardness as $CaCO_3$ (ppm) | Classification |
|---|---|
| 0 - 60 | Soft |
| 61 - 120 | Moderately hard |
| 121 - 180 | Hard |
| 181 + | Very hard |

Seventeen percent of the ground-water samples analyzed in the Raleigh area are classed as hard to very hard.

## TOTAL AND COMPUTED DISSOLVED SOLIDS

Total dissolved solids are the residue after a given volume of water has been evaporated and dried at a specific temperature (180°C. by the U. S. Geological Survey). Computed dissolved solids are equal to about one-half the bicarbonate plus the other chemical constituents in ppm. Computed dissolved solids are used in this report, unless stated otherwise.

The U. S. Public Health Service recommends that public water supplies should not contain more than 500 ppm dissolved solids. In the Raleigh area one sample of ground water was analyzed which contained more than 500 ppm dissolved solids.

## HYDROGEN-ION CONCENTRATION (pH)

The hydrogen-ion concentration, expressed in pH units, is a measure of the degree of acidity or basicity of the water. The pH of a solution is the negative logarithm of the concentration of the hydrogen ion in moles per liter. Water having a pH of 7.0 is neutral, lower than 7.0 is acidic, and higher than 7.0 is basic. The pH values are important indicators of the corrosive potential of ground water. Acid waters generally are more corrosive than alkaline waters. The pH of ground water in the Raleigh area ranges from 5.8 to 7.8.

## SPECIFIC CONDUCTANCE

Specific conductance is a measure of the property of a water to conduct an electric current. The conductance is primarily dependent upon the amount of dissolved constituents and their degree of ionization. Therefore, specific conductance values are used to estimate the total amount of solids in solution and are expressed in reciprocal ohms x $10^6$ (micromhos) at a standard temperature of 25°C.

# RELATIONSHIP OF CHEMICAL QUALITY OF GROUND WATER TO GEOLOGY

The chemical composition of a particular ground water should in some degree reflect the mineral composition of the rock with which it has been in contact. Weathering of igneous, metamorphic, and most sedimentary rocks releases principally silica, calcium, magnesium, sodium, potassium, and bicarbonate to ground water. Granite is composed largely of sodium and potassium feldspars and quartz; water from granite should be a sodium-bicarbonate type. Gabbro is composed largely of calcium feldspars and ferromagnesian minerals; water from gabbro should be a calcium or magnesium-bicarbonate type. However, this simple relationship becomes complicated if there is mixing of waters from adjacent rock types of different compositions or if the host rock is intermediate in composition.

Ground water quality shows no clear-cut relationship to geology in the Raleigh area. There are several possible reasons for the lack of relationship. The mineral composition of the rock types varies considerably within the map units, especially in the metavolcanic sequence and the granite and granodiorite units. Most ground water in the area is confined to the weathered portion of the rocks so that lateral movement and mixing of ground waters between rock types undoubtedly takes place. The effect of other factors such as selective absorption of ions and base excnange in the rocks of the area is not known.

More detailed mapping and water sampling is necessary to fully define relationships existing between ground-water quality and geology in the Raleigh area. The following discussion points out some possible relationships.

## METAVOLCANIC SEQUENCE

Analyses of water from selected wells in the metavolcanic sequence are in tables 21 and 25.

Most of the ground-water samples from the metavolcanic sequence are a calcium-bicarbonate type water. The variation of minerals in this unit are shown in the ranges of dissolved constituents. Acidic and basic rocks are contained in this unit which are also a factor in the variations. The hardness of the water ranged from soft to very hard. Iron ranged from 0.03 to 9.0 ppm. Pyrite is a common accessory mineral in the unit and is probably the source of iron. The sum of mineral constituents ranged from 25 to 407 ppm. The high iron concentrations in this unit may be objectionable for some uses.

## TRIASSIC ROCKS

Analyses of water from selected wells in the Triassic rocks are listed in tables 21 and 28.

In ground water of the Triassic rocks the principal cations are calcium and sodium. The principal anion is bicarbonate. Two samples were sodium-chloride type water. Bromide was found in one sample. Specific conductance ranged from 49 to 2,200 micromhos. Hardness ranged from 12 ppm to 370 ppm. Chloride ranged from 1.7 ppm to 572 ppm.

## MICA SCHIST

Analyses of water from selected wells in this unit are listed in tables 17 and 31.

Most of the ground waters from this unit are the calcium-bicarbonate type. Hardness ranged from soft to hard. Ground water from this unit has a fluoride range of 0.0 to 2.0 ppm. Muscovite schist is probably the source of fluoride.

## GRANITE AND GRANODIORITE

Analyses of water from selected wells in this unit are listed in tables 17, 21, 25, 28, and 31. The granite and granodiorite units include plutonic igneous rocks which range in composition from typical granite through granodiorite.

The water from granite and granodiorite is principally sodium-bicarbonate type. Eighty-six percent of the waters sampled were soft.

## METASEDIMENTARY SEQUENCE

Analyses of water from selected wells in this unit are listed in tables 17 and 31.

The water from the metasedimentary sequence is principally calcium and sodium-bicarbonate type. Most of the water sampled was soft. The iron ranged from 0.03 to 1.3 ppm. Biotite mica and hornblende are probably the sources of iron.

## HORNBLENDE GNEISS

Analyses of water from selected wells in this unit are listed in table 28.

Of the three samples from this unit two were calcium-bicarbonate types, and one was a magnesium-bicarbonate type. The low hardness of water from this unit can possibly be attributed to the feldspar content of the source rock.

## PHYLLITE

Analyses of water from selected wells in the phyllite unit are listed in tables 17 and 28.

The water from the phyllite unit showed no specific characteristics or type of water. The specific conductance ranged from 40 to 240 micromhos.

## MICA GNEISS

Analyses of water from selected wells in the mica gneiss unit are listed in tables 17, 28, and 31.

Water from the mica gneiss is generally a calcium-bicarbonate type. Most of the water analyzed from this unit is soft. The biotite-feldspar gneiss is probably the most extensive rock type in the mica gneiss unit and probably the source of the soft, calcium-bicarbonate water.

## SUMMARY AND CONCLUSIONS

The chemical character of the ground water in the Raleigh area shows little relation to the rock units. Ground water from the Triassic rocks usually contains more dissolved solids than water from the other units. Sodium-chloride water was present in a few wells in the metavolcanic, and Triassic rock units. Bromide occurs in association with excessive chloride in one well in Triassic rocks. Objectionable amounts of iron are reported in some water from the metavolcanic unit. Ground water in the area is of the sodium, calcium, and magnesium-bicarbonate type, and is suitable for most domestic, municipal, and industrial uses.

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