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Site Name (Subject):	SUPERIOR PRODUCTS COMPANY
Site ID (Document ID):	NCD024600579
Document Name (DocType):	Preliminary Assessment/Site Inspection (PA/SI)
Report Segment:	
Description:	Site Inspection Prioritization
Date of Document:	9/29/1994
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NCD 024 600 579 GUILFORD
SUPERIOR PRODUCTS COMPANY
SITE INSPECTION PRIORITIZATION
GREENSBORO NC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

September 29, 1994

RECEIVED
OCT 03 1994
SUPERFUND SECTION

4WD-WPB

Ms. Pat DeRosa, Head
CERCLA Branch
North Carolina Department of Environment,
Health and Natural Resources
Division of Solid Waste Management
P.O. Box 27687
Raleigh, North Carolina 27611-7687

Dear Ms. DeRosa:

The following reports have recently been reviewed and accepted by EPA - Region IV Site Assessment Section:

<u>Site Inspections</u>

Forbes Road Well Site	NFRAP
Spann Property	NFRAP

<u>Site Inspection Prioritizations (SIPs)</u>

Anilox Roll	NFRAP
Asheboro Municipal Landfill	NFRAP
Ashland Petroleum Company	NFRAP
BP Oil	NFRAP
Carochem	NFRAP
Cone Mills Corporation Plant	NFRAP
Croft Metals	NFRAP
Dayco Corporation	NFRAP
Eaton Corporation	NFRAP
Fasco Industries, Inc.	NFRAP
Gaston Co., Dyeing Machine Company	NFRAP
Gaston Co., Dyeing Machine Company (Stanley)	NFRAP
Greensboro City Landfill	NFRAP
Harrisburg Park Landfill	NFRAP
Henson Landfill	NFRAP
Highway 801 Barber	NFRAP
Holding Pond for Scrubber Waste	NFRAP
Honeywell Micro Switch Division	NFRAP
Kelly-Springfield Tire Company	Further Action
Lee County Landfill	NFRAP
Marantz Piano Company	NFRAP
Old Western NC Fairgrounds	NFRAP

Olin Corp. Ecusta Paper & Film Group	NFRAP
Pantasote, Inc.	NFRAP
REA Magnet Wire Company	Further Action
Rowe Corporation Property	NFRAP
S&S Metals Recycling Site	NFRAP
Scovill Inc.	NFRAP
Stewart-Warner Site	NFRAP
Superior Products Company	NFRAP
Texaco, Inc.	NFRAP
Torpedo Wire and Strip	NFRAP
Union County Landfill	Further Action
Uniroyal, Inc.	NFRAP

EXPANDED SITE INSPECTION

Davis Park Road TCE Site	Further Action

Enclosed please find the Remedial Site Assessment Decision Forms for each report generated by the North Carolina Superfund program and a copy of the actual report generated by the EPA Contractor.

If you have any questions concerning these site decisions, please call me at (404) 347-5059, Extension 6150.

Sincerely,

Cynthia K. Gurley

Cynthia K. Gurley
North Carolina, PO

Enclosures

BLACK & VEATCH Waste Science, Inc.

The Curtis Center, Suite 705, 601 Walnut Street, Philadelphia, Pennsylvania 19106-3307, (215) 928-0700, Fax: (215) 928-1780

RECEIVED
OCT - 7 1994
SUPERFUND SECTION

U.S. Environmental Protection Agency
Superior Products Company Site
Work Assignment 12

BVWS Project 52012.231
BVWS File D
July 26, 1994

Mr. Narindar Kumar
Chief, Site Assessment Section
U.S. Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta, Georgia 30365

REC'D
SEP 23 1994

DATE REPORT ACCEPTED 9-15-94
DISPOSITION NFRAP
SAM SIGNATURE Cynthia Gunley

Subject: Site Inspection Prioritization
Superior Products Company Site
Greensboro, Guilford County, NC
EPA ID. NCD024600579

Dear Mr. Kumar:

BLACK & VEATCH Waste Science, Inc. (Black & Veatch) has been tasked by the U.S. Environmental Protection Agency (EPA), to conduct a Site Inspection Prioritization at the Superior Products Company site located on Highway 70 East, Greensboro, North Carolina (Ref. 1, p. 3). According to the scope of work for Superior Products, a preliminary Hazard Ranking System (HRS) score was prepared to determine the need for future activities at the site.

The Superior Products Company site is located in a rural area, approximately 2.5 miles east of the city of Greensboro, North Carolina. The site is located on the north side of Highway 70, and is approximately 12 acres in size (Refs. 2, pp. 6; 3). Superior Products Company has been owned and operated by Seaboard Industries, Inc. since 1968. The site was owned and operated by South Oil from the late 1950's until it was sold to Seaboard Industries. From the late 1950's until 1975, the site was used as a re-refining facility for used oil. Since 1976, the site has been used to blend and package oil into a variety of products, such as transmission fluid, motor oil, and diesel lubricants (Ref. 2, p. 9).

The site consists of a receiving office, warehouse, a worker shed and more than 20 storage and refining vessels (Ref. 2, p. 12). Other site features include a pond located northwest of the receiving building and a surface impoundment, on the eastern portion of the site, that was ordered to be filled in by a consent order issued by the North Carolina Environmental Management Commission in May 1975 (Ref. 2, pp. 6, 9, 10, 12, 13). The consent order also

stipulated the removal of oil soaked soil from the processing area (Ref. 2, p. 10). Excavation and backfilling in the processing area were completed in early 1976 (Ref. 2, p. 10). Between 1976 and 1988, there have been at least three spills: approximately 400 gallons of water and Nº 5 fuel oil were discharged into the South Buffalo Creek; approximately 50 gallons of oil leaked onto the ground in 1985 when a vessel was ruptured by vandals; and a spill in 1980, but no specific details were available in the review of the file material (Ref. 2, p. 10). File data does not indicate whether any remedial actions were implemented in response to these spills (Ref. 2, p. 10).

There is a pond, approximately 50 feet long by 30 feet wide, located in front of the receiving building situated between the main railroad track and a rail spur (Ref. 2, p. 13). Based on this information, material is assumed to be transported to and from the site by railcar using this spur. Due to the topography of the area runoff is collected in this pond (Ref. 3). For the purposes of this report, the pond area will be considered a source area of approximately 1,178 square feet of contaminated soil (Ref. 2, p. 13).

The former surface impoundment was unlined, and had a capacity of approximately 700,000 gallons (Ref. 2, pp. 9, 12). Runoff from the processing area was collected in this impoundment (Ref. 2, p. 9). File data indicates that wastes were deposited in the surface impoundment (Refs. 1, p. 4; 2, pp. 12, 13). The surface impoundment was filled in 1976, but was located on the eastern portion of the site, between the processing area and the South Buffalo Creek (Refs. 2, pp. 9, 13; 3). Based on the topography of the site, and the proximity of the creek, it is believed that the surface impoundment discharged into the South Buffalo Creek (Refs. 2, p. 12; 3).

The process area, approximately 250 feet long by 250 feet wide, is located on the northeastern portion of the site (Ref. 2, p. 13). For purposes of this report, this area will be considered a source area of approximately 62,500 square feet of contaminated soil, due to the large number of tanks and likelihood of spills onto the soil.

In October 1987, an EPA Field Investigation Team (FIT) contractor conducted a Site Screening Investigation (SSI) and collected eleven environmental samples (two grab surface soil, two composite surface soil, three sediment, two surface water, and two groundwater) to characterize the three source areas onsite (Ref. 2, pp. 20-22). The samples were analyzed for organic contaminants and inorganic contaminants, under EPA Contract Laboratory Program (CLP) protocols (Ref. 2, pp. 24).

One sediment sample was collected from the pond located in front of the receiving building during the SSI (Ref. 2, pp. 20-22). Analytical results were compared to the site background soil sample because the pond is located in a low lying area, with no flow. This comparison indicated the presence of aluminum, arsenic, barium, chromium, cobalt, copper, magnesium, manganese, nickel, zinc, and xylene (Ref. 2, pp. 51-56, 77-83).

One surface soil sample and one surface soil composite sample were collected in the former surface impoundment area during the SSI (Ref. 2, pp. 20-22). Analytical results were compared to the site background soil sample. This comparison indicated the presence of arsenic, barium, beryllium, cadmium, copper, lead, magnesium, nickel, zinc, 1,2-dichlorobenzene, naphthalene, 2-methylnaphthalene, phenanthrene, phenol, styrene, trichloroethylene, and xylene (Ref. 2, pp. 51-63, 84-90).

One surface soil composite sample was collected from the process area (Ref. 2, pp. 20-22). The analytical results were compared to the site background soil sample. This comparison indicated the presence of arsenic, barium, copper, lead, magnesium, nickel, zinc, and xylene (Ref. 2, pp. 51-56, 70-76).

No documentation exists to indicate a release of contaminants to groundwater. One onsite groundwater sample and one offsite residential well sample were collected during the SSI (Ref. 2, pp. 20-22). There was no background sample collected, so the inorganic analytical results could not be compared to determine if contamination had occurred. The organic analytical results did not indicate the presence of contaminants above the Sample Quantitation Limit (SQL) in either sample (Ref. 2, pp. 105-108, 111-114). The samples were analyzed for organic contaminants and inorganic contaminants, under EPA Contract Laboratory Program (CLP) protocols (Ref. 2, pp. 24).

The site is located within the Piedmont Physiographic Province and is underlain by a sheared granite complex (Ref. 4, pp. 2, 3). The sheared granite complex has an estimated hydraulic conductivity of 10^{-4} cm/sec (Ref. 5). Soils in the site vicinity are comprised of weathered granite bedrock and have an estimated hydraulic conductivity of 10^{-7} cm/sec (Ref. 5).

Surface water is the primary source of potable water within 4 miles of the site; however, some of the residents within 4 miles of the site use private groundwater wells to obtain drinking water (Ref. 6). Drinking water wells within 4 miles of the site draw groundwater from fractures in the sheared granite complex. These wells have an average depth of 150 feet below land surface (bls) (Ref. 4, pp. 5, 9, 13). According to well records in the site vicinity, water levels in the wells are between 8 and 20 feet bls (Ref. 4, pp. 18, 24). The nearest known potable well is located approximately 500 feet southeast of the former surface impoundment source area (Ref. 3). There are approximately 3,919 people using private groundwater wells for drinking water supplies within 4 miles of the site (0-0.25 mile, 149; 0.25-0.50 mile, 78; 0.50-1 mile, 322; 1-2 miles, 1,052; 2-3 miles, 1,142; 3-4 miles, 1,176) (Refs. 3; 7; 8; 10). Wellhead protection areas have not yet been delineated within the state of North Carolina (Ref. 9).

One sediment sample and one surface water sample were collected in the South Buffalo Creek, downstream of the probable point of entry (PPE) into the creek (Ref. 2, pp. 20-22). The surface water sample analytical results were compared to the upstream background surface water sample. This comparison indicated the presence of copper and cyanide in the

surface water (Ref. 2, pp. 91-102). However, the cyanide cannot be attributed to the site (Ref. 2, pp. 9, 10, 12). The downstream sediment sample was compared to the upstream background sediment sample. This comparison did not indicate any contaminants above the background concentrations (Ref. 2, pp. 45-50, 64-69).

Overland flow from the site is primarily directed approximately 350 feet to the northeast toward South Buffalo Creek, the PPE. The pathway continues north northeast along South Buffalo Creek for approximately 4.2 miles where it joins Buffalo Creek. The pathway then follows Buffalo Creek northeast for approximately 9.3 miles (13.5 miles downstream of the PPE), where it joins Reedy Fork. The 15-mile downstream pathway ends in Reedy Fork, approximately 1.5 miles downstream of the confluence of Buffalo Creek and Reedy Fork (Ref. 11).

The average annual flow of the waterbodies along the surface water pathway was calculated by comparing the drainage area (131 mi^2) and the average annual flow (102 cubic feet per second (cfs)) of the Reedy Fork near Gibsonville, NC, which is located on the 15-mile surface water pathway, to the drainage area of the waterbodies along the pathway and calculating an estimated average annual flow (Ref. 12). South Buffalo Creek has a drainage area of 43.5 mi^2 and an estimated average annual flow of 33.8 cfs (Ref. 12). Buffalo Creek has a drainage area of 97.4 mi^2 and an estimated average annual flow of 75.8 cfs (Ref. 12).

There are no known drinking water intakes along the surface water pathway (Refs. 3; 11). Fishing for human consumption and recreational use is unlikely in South Buffalo Creek, Buffalo Creek, and Reedy Creek due to access and size constraints of these creeks (Refs. 3; 11; 13). There is no known wetland frontage on any portion of the 15-mile downstream pathway (Ref. 11). There are no known threatened or endangered species along the surface water pathway (Ref. 14).

Analytical results of the soil samples indicated the presence of various inorganics, volatiles, and semivolatiles attributable to the site (Ref. 2, pp. 51-63, 70-90). The site is an active facility with 7 employees onsite (Ref. 15). The site is accessible from all sides except the portion of the northwestern border paralleled by tracks of the Southern Railroad (Ref. 2, pp. 12-13). A fence separates the site from the railroad and a forested ridge to the northwest (Ref. 2, pp. 12-13).

There are no known residences, schools, day care facilities, terrestrial sensitive environments, commercial agriculture operations, or commercial silviculture operations within 200 feet of the source areas (Refs. 3; 14). There are approximately 788 people living within a 1-mile radius of the Superior Products Company site (0-0.25 mile, 149; 0.25-0.50 mile, 95; 0.50-1 mile, 544) (Ref. 7).

No documentation exists to indicate a release to air has occurred (Ref. 2, pp. 19-22). There are approximately 7,780 people living within a 4-mile radius of the site (0-0.25 mile, 149;

0.25-0.50 mile, 95; 0.50-1 mile, 544; 1-2 miles, 1,857; 2-3 miles, 1,759; 3-4 miles, 3,376) (Ref. 7). There are no known sensitive environments within 4 miles of the site, except for approximately 169 acres of wetlands located 2-4 miles southwest of the site (2-3 miles, 5 acres and 3-4 miles, 164 acres)(Refs. 3; 14). The nearest known school is located approximately 1.75 miles northeast of the site (Ref. 3). There are no known recreational areas within 0.5 mile of the site (Ref. 3).

The existing information, data and additional information collected were sufficient to evaluate the Superior Products Company site. The hazardous waste quantity (HWQ) of 100 was calculated using a 1,178 ft^2 area of contaminated soil (pond in front of the Receiving building), a 700,000 gallon surface impoundment (former surface impoundment area), and 62,500 square feet of contaminated soil (process area) (Refs. 2, pp. 12-13; 3). The HRS scoring is based on an observed release of contaminants to surface water and soil, and a potential release of contaminants to groundwater and air. Based on the finding of this report, further investigations are not recommended for the Superior Products Company site.

Pathway	Site Score
Groundwater	20.03
Surface Water	0
Soil Exposure	1.07
Air	1.00
Overall Score	**10.04**

Very truly yours,

BLACK & VEATCH Waste Science, Inc.

Robert A. Martel

Robert A. Martel
Site Manager

Enclosure

References

1. U.S. Environmental Protection Agency, *Potential Hazardous Waste Site Inspection Report for the Superior Products Company site*, October 28, 1987.

2. NUS Corporation, *Site Screening Investigation Report - Superior Products Company*, August 30, 1988; Text, and Appendix A only.

3. Black & Veatch Waste Science, Inc. (Black & Veatch), *Four-Mile Vicinity Map for the Superior Products Company Site*, based on U.S. Department of the Interior, Geological Survey Topographic Maps, 7.5 minute series, Quadrangles for Lake Brandt, NC, 1951, Photorevised, 1968; Brown's Summit, NC, 1951, Photorevised, 1968; Ossipee, NC, 1970; Greensboro, NC, 1951, Photorevised 1968; McLeansville, NC, 1952, Photorevised 1968; Gibsonville, NC, 1970.

4. North Carolina Department of Conservation and Development, Division of Mineral Resources, *Geology and Ground Water in the Greensboro Area, North Carolina*, by M.J. Mundorff, Bulletin No. 55, 1948.

5. R. Allan Freeze and John A. Cherry, Groundwater. Englewood Cliffs, NJ: Prentice-Hall, Inc. 1979, p. 29.

6. Corry T. Platt, Black & Veatch, in telephone memorandum with Mrs. Clark, Greensboro City Water Department, June 8, 1994. Subject: Public Water Supply in Greensboro, NC.

7. Robert A. Martel, Black & Veatch in memorandum to Superior Products Company File, July 5, 1994. Subject: Results of Calculation of Air and Groundwater Populations.

8. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census, *1990 Census of Population and Housing, Summary Population and Housing Characteristics, North Carolina*, Document No. 1991 CPH-1-35.

9. Corry T. Platt, Black & Veatch, in telephone memorandum with Randy Prillaman, NCDEM, Groundwater Section, March 23, 1994. Subject: Wellhead Protection Areas.

10. Bureau of the Census, Graphical Exposure Modeling System, Guilford County, North Carolina, Data Down Load by Robert Martel, Black & Veatch, July 4, 1994.

11. Black & Veatch, *Fifteen-Mile Surface Water Pathway Map for Superior Products Company Site, Greensboro, NC*, based on U.S. Department of the Interior, Geological Survey Topographic Maps, 7.5 minute series, Quadrangles for McLeansville, NC, 1952, Photorevised 1968; Brown's Summit, NC, 1951, Photorevised, 1968.

12. Robert A. Martel, Black & Veatch, Calculation of Flow Rates in Surface Water Pathway, July 5, 1994, with attached U.S. Department of the Interior, Geological Survey, *Water Resources Data, North Carolina, Water Year 1992*, U.S. Geological Survey Water-Data Report NC-92-2, pp. XIII, 142.

13. Black & Veatch Field Notebook for Greensboro City Landfill, Greensboro, Guilford County, North Carolina, Project No. 52012.216, Site Reconnaissance, May 17 and 18, 1994; p. 5 only.

14. Unites States Fish and Wildlife Service. 1983. Endangered and Threatened Species. Region 4 - Atlanta.

15. Robert A. Martel, Black & Veatch, in telephone memorandum with Sharon, Receptionist, Superior Products Company, July 6, 1994. Subject: Number of Employees.

REFERENCE NO. 1

United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington, DC 20460

EPA Form 2070-13
July, 1981

EPA

Potential Hazardous Waste Site

Site Inspection Report

1

REFERENCE NO. 2

NUS CORPORATION

A Halliburton Company

FIELD INVESTIGATION TEAM ACTIVITIES AT UNCONTROLLED HAZARDOUS SUBSTANCES FACILITIES — ZONE I

NUS CORPORATION
SUPERFUND DIVISION

1

R-586-8-8-18

FINAL
SITE SCREENING INVESTIGATION REPORT
SUPERIOR PRODUCTS COMPANY
GREENSBORO, NORTH CAROLINA
NCD024600579

Prepared Under
TDD No. F4-8708-17
CONTRACT NO. 68-01-7346

Revision 0

FOR THE

WASTE MANAGEMENT DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

AUGUST 30, 1988

NUS CORPORATION
SUPERFUND DIVISION

Prepared By	Reviewed By	Approved By
Kent Hankinson Project Manager	Greg Schank Assistant Regional Project Manager	Murray Warner, P.E. Regional Project Manager

2

REFERENCE NO. 3

REFERENCE NO. 4

NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
R. BRUCE ETHERIDGE, *Director*

DIVISION OF MINERAL RESOURCES
JASPER L. STUCKEY, *State Geologist*

BULLETIN NUMBER 55

Geology and Ground Water
IN THE
Greensboro Area, North Carolina

By
M. J. MUNDORFF

PREPARED IN COOPERATION WITH THE GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR

RALEIGH
1948

has the least. The greatest annual precipitation averaged over the entire area was 55.52 inches in 1929. The least annual precipitation averaged for the entire area was 29.75 inches in 1941.

The average annual snowfall is nearly 10 inches.

Temperature.—Records of the temperature are obtained by the U. S. Weather Bureau at Greensboro, Greensboro Airport, High Point, Reidsville, and Winston-Salem. In addition, records of temperature are available for Oak Ridge from 1890 to 1902 and for Saxon, Stokes County, from 1891 to 1914.

The mean annual temperature during the period of record at the five stations now being maintained is 58.8° F. The coldest month is January, with a mean temperature of 40.6° F.; and the warmest month is July with a mean temperature of 77.8° F. High Point is the warmest station, with a mean annual temperature of 60.2° F., and Winston-Salem and Greensboro Airport are the coldest stations with a mean annual temperature of 57.9° F.

The average date of the last killing frost in the spring is about April 12, and the average date of the first killing frost in the autumn is about October 25, leaving an average growing season of about 196 days.

DRAINAGE

The entire area is drained by three major drainage systems, the Yadkin, the Dan, and the Cape Fear. Most of the drainage of Forsyth County and the southwestern corner of Stokes County is into Yadkin River, which forms the western boundary of Forsyth County. The remainder of Stokes County and most of Rockingham and Caswell Counties is drained by Dan River. Most of Guilford County, all of Alamance County, the southern part of Rockingham County, and the southwestern corner of Caswell County are drained by Haw River. The southwestern corner of Guilford County is drained by Deep River, which combines with Haw River to form the Cape Fear. All these streams empty into the Atlantic Ocean to the southeast and south, but the courses of the individual streams within the area are diverse. The drainage pattern is largely controlled by the geology of the area.

PHYSIOGRAPHY

The Greensboro area lies entirely within the upland section of the Piedmont physiographic province which is an uplifted, submaturely to maturely dissected peneplane on more or less resistant rocks.[1] In the Greensboro area the upland surface, which generally slopes to the east and southeast, is interrupted by a number of monadnock hills, some of which rise nearly 1,500 feet above the surrounding peneplane remnants.

Igneous, metamorphic, and sedimentary rocks occur in the Greensboro area. The metamorphic rocks include gneisses, schists, slates, and quartzite; the igneous rocks include granites and diorites; the sedimentary rocks include conglomerate, sandstone, and shale of Triassic age.

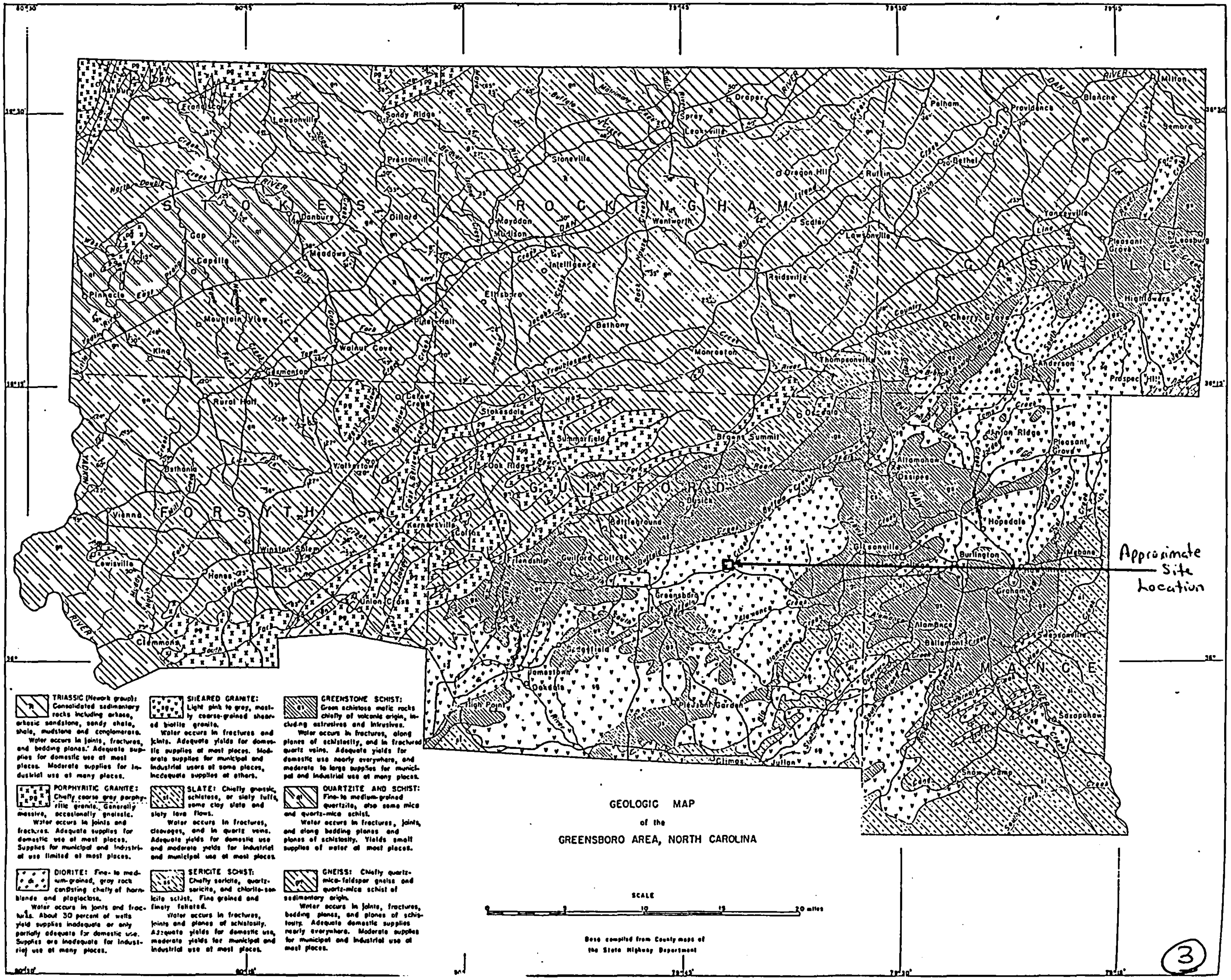
The quartzites, and many of the gneisses and schists, have been derived from sediments. The bedding in these rocks, as well as the schistosity, strikes generally northeast-southwest. The igneous rocks intruded into them are generally elongated in the same direction and, where metamorphosed, the structural elements also strike northeast-southwest. The cleavage and bedding in the slates and the bedding in the Triassic sedimentary rocks strike in the same direction. As these rocks differ considerably in resistance to erosion, structural control of the topography is considerable.

At some time during the interval between the last part of the Triassic period and the first part of the Cretaceous period, the area was eroded to a low-lying plain of little relief, save for a few monadnock hills. Widely spaced trunk streams, meandering across the area, moved sluggishly in wide floodplains. There is little doubt that this peneplane sloped to the east and southeast and that the streams discharged into the Atlantic Ocean. Subsequently, the peneplane was uplifted and probably tilted slightly so that the southeastward slope was increased. The present altitude of the upland surface in the western and northwestern part of the Greensboro area is about 1,200 feet, whereas the altitude along the southeastern edge is about 500 feet. After the area was uplifted the streams began to cut down rapidly, forming narrow, steep-walled valleys. The main streams probably followed more or less the channels of the former streams, in many places, however, cutting off the old meanders and in general straightening and shortening the courses. Between these main streams some of the smaller streams followed parallel courses.

[1] Fenneman, Nevin M., Physiographic divisions of the United States: Assoc. Am. Geographers Annals, vol. 18, no. 4, p. 290, 1928.

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY
COOP[redacted]N WI[redacted]
NORTH CAROLINA DEPARTMENT OF CONSERVATION AND DEVELOPMENT

STATE BULLETIN 55, PLATE 1



Rising above the general upland surface formed by the peneplane remnants are a number of monadnocks. A small monadnock range in central and western Stokes County is the highest of these. This range includes Sauratown Mountain, Moores Knob, Hanging Rock, Cooks Wall, and several lower peaks. This group is capped by beds of highly resistant quartzite. Pilot Mountain, to the southwest in Surry County, belongs to this group. The altitude of Moores Knob is 2,572 feet and that of Pilot Mountain is 2,415 feet. A number of other peaks rise well above 2,000 feet, 1,000 feet or more above the general upland surface.

Although the entire area is included in the Piedmont upland section, the Triassic rocks have been eroded more easily than the other rocks so that a partial lowland has developed on them. Along the southeastern edge of the Triassic belt this lowland is separated from the upland by a very prominent scarp, the surface of the Triassic being 200 to 300 feet lower than the surface of the crystalline rocks to the southeast. Northwestward the Triassic gradually rises 300 to 400 feet and the surface on the Triassic merges into the surface on the crystalline gneisses and schists without any pronounced break in the topography.

The relation of the physiography and topography to the geology of the Triassic basin is shown in the generalized cross-section of figure 2.

GEOLOGY

INTRODUCTION

Most of the time in the field was spent in obtaining hydrologic data, but some attention was also given to the geology. Before completion of the field work it became apparent that existing geologic maps were entirely inadequate for use in arriving at any conclusions regarding the quantity and quality of water available from the different rock units. Therefore, 5 additional weeks were spent in making a reconnaissance of the geology of the area; and the reconnaissance data, together with the notes made during the collection of the data on the wells, were used in making a geologic map of the area. Considering the large size of the area and the short time spent in mapping, it is readily apparent that the geology was necessarily greatly generalized and that the map can be considered only a reconnaissance map. The rock units chosen are rather broad and often include several kinds of rock. For example, the Triassic includes sandstone, arkose, conglomerate, shale, and mudstone. The Triassic could easily have been divided into three or four formations if time had permitted and the mapping had been done on large-scale base maps. Similarly, the gneiss and schist unit includes several types of gneisses and schists which probably could be separated into individual formations. The units chosen for the mapping were the broadest possible that would include rocks of similar ages, petrology, and water-bearing properties.

Because of the complexity of the geology, the time available did not permit the complete separation of even these broad units, so that some areas shown as one rock unit on the map may actually include some small areas of rocks belonging to another unit. Furthermore, the small scale of the map does not permit the showing of very small areas.

AREAL DISTRIBUTION AND CHARACTER OF THE ROCKS

Gneiss.—This unit includes several types of interbedded gneisses and schists, most of which appear to be of sedimentary origin. Most of these rocks are identical with rocks in other sections of the State which were mapped by Arthur Keith as Carolina gneiss[1], although small areas of hornblende schist and gneiss are included with this unit in the Greensboro area that are similar to Keith's Roan gneiss. The unit forms a broad belt trending northeast-southwest. It underlies nearly one-half of the Greensboro area, occupying most of Forsyth, Rockingham, and Caswell Counties and occurring in large areas in Stokes and Guilford Counties.

The most abundant rock is quartz-mica-feldspar gneiss with the proportion of quartz differing greatly from place to place. The feldspar usually is predominantly plagioclase although nearly always some potash feldspar is also present. At a few places the potash feldspar, either orthoclase or microcline, or both, predominates. At some places the proportion of quartz increases greatly so that the rock is actually a quartzite gneiss. The rock has a medium to coarse texture and is usually light gray in color. However, at many places a larger proportion of biotite gives the rock a darker color. In some areas the gneiss is very fine-textured and finely

[1] Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Cranberry folio, (no. 90), 1903; also Asheville folio (no. 116), 1904; Mount Mitchell folio (no. 124), 1905; Nantahala folio (no. 143), 1906; Pisgah folio (no. 147), 1907; and Gaffney-Kings Mountain folio (no. 222), 1931.

SUMMARY OF ROCK UNITS AND THEIR WATER-BEARING PROPERTIES

The following table lists the rock units shown on the map, plate 1, and gives a brief geologic and hydrologic description of them.

ROCK UNITS IN THE GREENSBORO AREA

Unit	*Description*	*Water-bearing Properties*
Triassic (Newark group)	Consolidated sedimentary rocks consisting of arkose, arkosic sandstone, sandy shale, shale, mudstone, and conglomerate. Mostly red, brown, and yellow in color. Lenticular in many places.	Water occurs in fractures, joints, and along bedding planes. Entirely adequate supplies for domestic use nearly everywhere. Moderate to moderately large supplies for municipal and industrial use at many places, but yields decrease with continuous pumping. Average yield of 50 wells is 17 gallons a minute. Water at many places is moderately hard to hard.
Porphyritic granite	Commonly gray, very coarse porphyritic granite, generally massive, but gneissic at places owing to only partial assimilation of intruded gneisses and schists. At a few places medium-textured, equigranular.	Water occurs in joints and fractures. Adequate supplies for domestic use obtained at most places. Limited quantities for industrial and municipal supplies at most places, larger supplies at a few places. Average yield of 47 wells is 8 gallons a minute.
Diorite	Usually fine- to medium-grained, gray to dark greenish gray; consists chiefly of plagioclase and hornblende. Massive at many places but schistose or gneissic at a few places.	Water occurs in joints and fractures. About 30 percent of wells yield supplies inadequate or only partially adequate for domestic use. Supplies are inadequate for municipal and industrial use at many places. Average yield of 26 wells is 6 gallons a minute. Water generally moderately hard to hard, low in iron.
Sheared granite	Light pink to gray, mostly coarse-grained biotite granite. Greatly sheared, at places schistose or gneissic. Cut by innumerable green mafic schistose or slaty dikes which resemble the greenstone schist.	Water occurs in fractures and joints. Adequate yields for domestic supplies at most places. Moderate to moderately large supplies for municipal and industrial users at some places, but inadequate supplies at a number of places. Average yield of 116 wells is 14 gallons a minute. Water moderately hard at many places, soft at other places; usually low in iron content.
Slate	Chiefly gneissic, schistose, or slaty tuffs consisting of mineral grains and fragments in a fine-grained matrix of volcanic ash and some land waste. Usually tough, hard, light-colored. Include some clay slates.	Water occurs in joints, fractures, slaty cleavages, and in quartz veins. Adequate yields for domestic use nearly everywhere. Moderate yields for municipal and industrial use at most places. Average yield of 40 wells is 16 gallons a minute. Water generally soft to moderately hard but at a few places is hard or very hard.
Sericite schist	Chiefly sericite, quartz-sericite, and chlorite-sericite schist. Usually fine-grained and finely foliated. Schistosity strikes northeast, dip is vertical. Very deeply weathered.	Water occurs in joints, fractures, and planes of schistosity. Yields are adequate for domestic supplies at most places and moderate supplies can be obtained for municipal and industrial use at most places. Average yield of 14 wells is 10.5 gallons a minute. Water usually soft, in some places contains objectionable amounts of iron.
Greenstone schist	Green, slightly to highly schistose mafic rocks chiefly of volcanic origin. Consist of lava flows, tuffs, breccias, and some intrusives. Usually greatly sheared and fractured. Quartz veins at many places.	Water occurs in joints, fractures, along planes of schistosity, and in fractured quartz veins. Yields adequate domestic supplies nearly everywhere and moderate to moderately large supplies for municipalities and industries. Average yield of 135 wells is 28 gallons a minute, the highest of all units. Water generally moderately soft and in some places contains objectionable iron.
Quartzite and schist	Fine- to medium-grained quartzite, gneissic appearance at places because of muscovite contained; also mica schist, quartz-mica schist, quartz-chlorite-mica schist, moderately coarse and greatly crenulated.	Water occurs in fractures, joints, along bedding planes, and planes of schistosity. Yields small supplies of water at most places. Average yield of 27 wells is 5 gallons a minute. Water usually soft and low in iron.
Gneiss	Quartz-mica-feldspar gneiss, quartz-mica schist, hornblende plagioclase gneiss, hornblende schist, and marble. Mostly of sedimentary origin. Bedding usually distinct, striking northeast. Dip generally moderate.	Water occurs in joints, fractures, bedding planes, and planes of schistosity. Yields adequate domestic supplies practically everywhere. Moderate to moderately large supplies for municipal and industrial use at most places. Average yield of 350 wells in area is 11.5 gallons a minute. Water ranges from soft to extremely hard. Iron content usually low.

5

This phase resembles chert. All these rocks are tough and hard when unweathered but in some places upon weathering they disintegrate into their component minerals. Thus a weathered tuff containing quartz grains and pebbles resembles a friable silty sandstone.

Most of the tuff has a slaty or schistose cleavage; in many exposures the cleavage is prominent, but at some places it may be obscure or entirely absent. At many exposures of the coarser phases the tuff has a gneissic appearance caused by crude banding of the coarse feldspar or quartz grains and fragments. Clay slate, a very fine-grained buff-colored rock with smooth cleavage planes, occurs in Guilford County south of Big Alamance Creek and at a few other places.

The cleavage planes of the slates usually are vertical and strike northeast. At only a few places can the bedding be observed. These rocks were formed mostly by the commingling of volcanic ash and other ejecta with some land waste. Some of the beds are believed to have been deposited in water but many may have been deposited directly on the land. The clay slates probably were formed by the deposition of clay and silt in bodies of water.

The age of the slates has usually been considered to be pre-Cambrian. There is little or no direct evidence either supporting or disproving this correlation. Probably the arguments most commonly advanced for a pre-Cambrian age are the degree of metamorphism and the absence of any fossils. The argument based on degree of metamorphism appears to be very weak because at many places in the United States rocks much younger than pre-Cambrian have undergone as much or more metamorphism than these slates. Detailed studies of the slates have been made in only a few places. The most important of these, made by Laney[1], Pogue[2], and Stuckey[3], all state that no evidence was found regarding the age but place the slates in the pre-Cambrian because that has been the accepted age.

Sheared granite.—This unit is very distinctive and can generally be readily distinguished in the field. It is a sheared, in many places schistose or gneissic, biotite granite cut by innumerable greenish-colored mafic dikes which have been metamorphosed to a slate or schist. The dikes have a close resemblance to the greenstone schists, and in general appear in much greater numbers near the southeastern margin of the granite belt, near the contacts with the greenstone schists.

The granite crops out in an irregular and interrupted belt across southeastern Guilford County, most of Alamance County, and the southeastern corner of Caswell County. In this belt it is very closely associated with the greenstone schist and, in southeastern Alamance County, with the tuffaceous slates.

The granite is most commonly a light-pink coarse-grained rock consisting chiefly of orthoclase, plagioclase, biotite, and quartz. At a few places the granite is light gray and medium-grained, the feldspar being chiefly plagioclase. Nearly everywhere the granite has been greatly sheared, with the development of a schistose or gneissic structure. The biotite occurs in large smears which wrap around the surfaces of the feldspar and quartz crystals.

Microscopic examination of a thin-section cut from a specimen obtained 5 miles east of High Point indicated that the granite has undergone a considerable amount of metamorphism. Orthoclase occurred in a few large-zoned crystals, with some microcline which showed strain shadow. The feldspar is chiefly albite which showed both albite and pericline twinning. The crystals are large and many of them are curved as much as 5°. Some form an S-curve. Quartz occurs only in very small grains, as though granulated or mylotinized, and occurs in stringers threading between the feldspar crystals. Nearly all the quartz grains show prominent strain shadows. There is considerable green, very pleochroic hornblende which occurs in large curved crystals. There are also a few scattered augite crystals. Biotite is quite plentiful and threads in between the other minerals, curving around their margins. The small amount of chlorite is similar to the biotite in its occurrence.

Probably more than 90 percent of the dikes, which cut the granite in such great numbers, are of one general type. They are generally several inches to several feet wide, a few being up to about 25 feet in width. Some of them can be traced for hundreds of feet. The dikes occur nearly everywhere in the granite in great numbers. Rarely does an outcrop of 200 or 300 feet of granite fail to expose at least one dike, and at many places 10 or 12 dikes cut the granite in an outcrop of that size. The dikes appear to be more num-

[1] Laney, F. B., The Gold Hill mining district of North Carolina: North Carolina Geol. and Econ. Survey Bull. 21, p. 74, 1910.
[2] Pogue, J. E., Jr., Cid mining district of Davidson County: North Carolina Geol. and Economic Survey Bull. 22, p. 95, 1910.
[3] Stuckey, J. L., The pyrophyllite deposits of North Carolina: North Carolina Dept. Cons. and Devel. Bull. 37, p. 25, 1928.

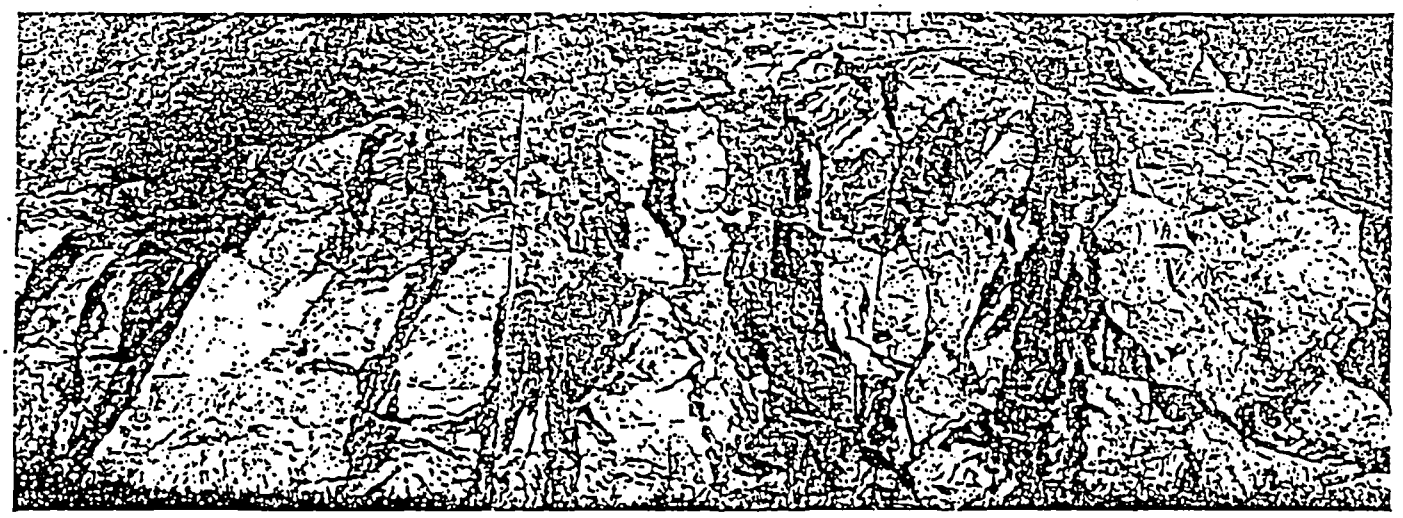


Plate 7—Sheared granite with inclusions of gneiss, both cut by mafic dikes. Metamorphism has produced a gneissic structure in the granite and has altered the dikes to schist.

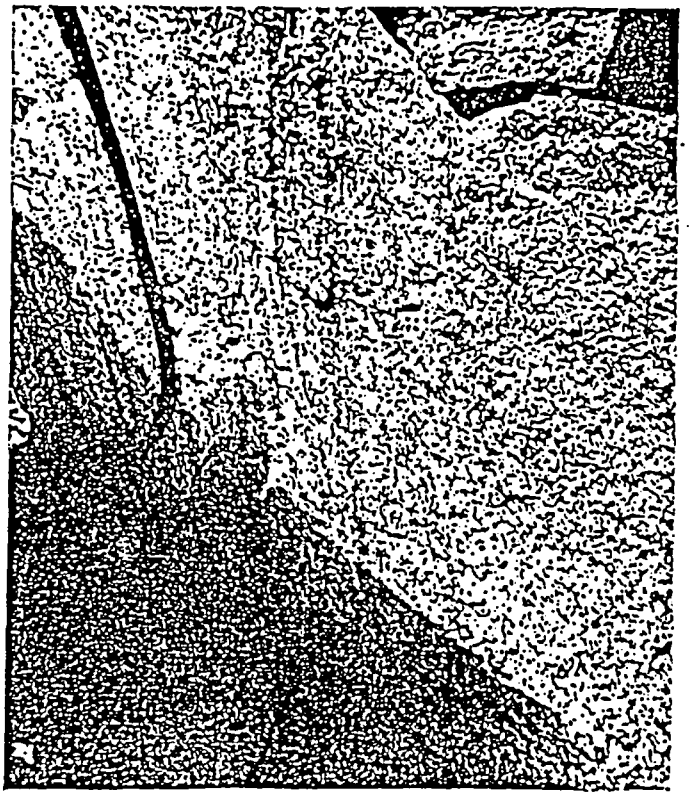


Plate 8—Close-up of sheared granite.

erous and more closely spaced along the margins of the granite, where it is in contact with the greenstone schist. In fact, in some exposures near the margin of the granite the dikes occupy more area than the granite into which they are intruded.

The typical dike is a very fine-grained greenish-colored schist. Brownish-colored dikes are noted at a few places and, except for the color, they are similar to the green dikes. Microscopic study shows that the rock consists chiefly of chlorite, biotite, plagioclase, and augite. Present in minor amounts are muscovite, apatite, and garnet. The chlorite occurs as a matrix of felted shards from which the biotite and augite developed. Both the biotite and augite occur in idimorphic crystals ranging in size from the smallest that can

be discerned with the microscope to crystals several hundred times that size. The plagioclase contains many inclusions of muscovite and chlorite and some biotite.

A few felsic dikes cut the granite at places. These are fine-grained, light-colored, and appear to consist chiefly of feldspar and quartz.

Diorite.—Diorite crops out in a number of places in Alamance, Caswell, and Guilford Counties. The four areas of diorite shown on the map include one just north of High Point, one about 8 miles northeast of Julian, a small area at Swepsonville, and a much larger area in south-central Caswell County. Besides the areas shown on the map, many other outcrops of diorite were mapped with other rocks, mostly because their small size did not permit their separation on the map scale used. Many outcrops of diorite were included in the areas mapped as greenstone schist, and conversely, some greenstone schist may be included with the diorite, particularly in the area near High Point and the one in Caswell County. The greenstone schist and diorite appear to be closely associated areally, and because the soils are so similar it is difficult to distinguish them where outcrops of fresh rock are few. Some outcrops of diorite which are not shown on the map are as follows: between Graham and Haw River; between Graham and Swepsonville; 6 miles west of Climax and at several other places between Climax and High Point; 5 miles south of Greensboro; 6 miles north of High Point; and near Buffalo Creek, about 8 miles northeast of Greensboro.

There is considerable variation in the diorite not only from place to place but apparently within the same mass. It is usually fine- to medium-grained but at some places is quite coarse. The color ranges from medium gray to dark greenish gray. Plagioclase and hornblende are the chief minerals, with a little quartz in some places. The hornblende is a greenish-colored variety and at some places the plagioclase is partially altered to epidote, thus giving the rock a greenish cast. Plagioclase commonly makes up about 65 percent of the rock but it ranges from about 50 to 75 percent.

At many places the diorite is massive and has no apparent schistosity, but at other outcrops it is quite schistose. It was not determined whether the diorite is all of one age or whether two or more periods of intrusion are represented. The range in degree of metamorphism of the diorite is no greater than the range in any of the other rock units mapped. It is quite possible that all the rock units, as mapped, include rocks of greatly different ages. However, it seems very likely that degree of metamorphism is not a good criterion of age in this area. Not only will different kinds of rocks react very differently to metamorphic forces; but the environment, particularly the depth at which metamorphism occurs and the distance from the metamorphic focal point, has a large effect on the degree of metamorphism.

Some of the diorite is definitely older than the older granite, which at a few places was observed to be intrusive into the diorite. At other places field relations suggest that the diorite was intrusive into the granite. If so there must be two ages of diorite intrusion.

Porphyritic granite.—This unit includes those granites thought to be younger than the sheared biotite granite described previously. At most outcrops the granite is porphyritic, but in a few places it is not. Most of it, whether porphyritic or not, appears to belong to the same period of intrusion. The largest area is in southeastern Forsyth and northwestern Guilford Counties where it crops out in irregularly shaped masses and elongate bodies paralleling the regional strike. It is intimately intruded into the gneisses and schists, which makes mapping difficult. In this area almost every outcrop of the granite is porphyritic. The other general area in which the granite occurs is in northern Stokes County, where many of the outcrops are of non-porphyritic granite.

The granite in southeastern Forsyth County and northwestern Guilford County is usually medium to very coarse grained, medium gray, and contains large phenocrysts of feldspar. Orthoclase crystals 8 inches long were observed in an outcrop 4 miles southwest of Belew Creek. The groundmass consists of feldspar, quartz, and biotite. At one exposure, 1¼ miles west of Union Cross on U. S. Highway 311, the granite is a medium-grained, equigranular light-gray rock consisting mostly of feldspar with some quartz and a little biotite, and containing numerous tiny clear rose-colored garnets. At many places, particularly southeast of Winston-Salem, dikes and fingers of granite can be seen cutting the biotite gneisses and schist. The granites have intruded these rocks much more complexly than could be shown on the map. At places the metamorphic rock appears to have been almost entirely digested by the granitic magma so that only small pods, lenses, and stringers of partially digested gneiss remain; and in many of these outcrops the granite has assumed in part the gneissosity of the metamorphic rocks. At other places the gneiss and schist appears

4. Erosion to a peneplane so that all that remained of the Triassic basin was the southeastern part, and in this part, too, erosion had removed much material, beveling all the strata.
5. Planation of the Triassic by the Dan River and its tributaries, forming the sloping surface that terminates so abruptly against the gneisses to the southeast.

The age of these rocks has been definitely established as Triassic on the basis of fossil plants and animals found in them.

GROUND WATER[1]

SOURCE

The source of the ground water in the Greensboro area for all practical purposes is from precipitation as rain or snow. Little or no water is derived from the interior of the earth in the area.

The average yearly precipitation in the area is nearly 45 inches. In eastern United States stream flow carries off about one-third of the precipitation as direct run-off. Meinzer[2] estimates that about one-third of the precipitation reaches the water table. The remaining third is lost by evaporation and transpiration before reaching the water table.

In the Greensboro area, where the surficial materials in many places are impermeable clays, the recharge may be somewhat less than average. Thus recharge to the ground water in this area is probably somewhat less than 15 inches per year. Although seasonal fluctuations of the water table are considerable and there may be a considerable change in water level between dry and wet years, over a period of many years the net change in water level is zero, assuming no long term climatic change, so that the average annual recharge to the ground water is equaled by the average annual discharge. Ground water is discharged through springs, seeps, and wells, and by evaporation and transpiration. Most of the water discharged by the springs and seeps enters the streams and maintains their flow during periods of no rainfall.

OCCURRENCE

Large quantities of water are contained below the surface in the openings or interstices in the rocks. These interstices range in size from the minute pores in clays to large tunnels and caverns in lavas and limestones. The interstices in unconsolidated sedimentary rocks such as gravel, sand, and clay are the pores or openings between the sand or clay particles. Crystalline rocks such as granite, gneiss, and schist have little pore space between the component grains. The interstices in these rocks are the joints, fractures, cleavage planes, planes of schistosity, bedding planes, and solution channels. Consolidated sedimentary rocks, such as the Triassic sandstones and shales, have had their primary porosity reduced by compaction and by the deposition of minerals between the grains. However, in these rocks jointing and fracturing has produced secondary interstices in which water may accumulate. Several types of interstices are shown in figure 3.

The porosity of a rock is the percentage of the total volume that is occupied by the interstices. The porosity of rock materials covers a very wide range. The porosity of some clays is more than 50 percent, whereas the porosity of some crystalline rocks may be less than 1 percent. The porosity of clean sands and gravels usually is between 20 and 40 percent. When sands and clays are cemented and compacted to form sandstones and shales, the porosity is greatly decreased.

Because of the secondary interstices in the igneous and metamorphic rocks, such as joints, fractures, and cleavage planes, are formed or enlarged by weathering processes near the earth's surface, they decrease in number and size with depth. Solution and removal of minerals in the soil may result in a porosity of 50 percent or more, but the porosity decreases downward in the subsoil and in the partially decomposed and disintegrated bedrock. The solid bedrock may have a very low porosity.

A saturated rock or soil may have a large porosity and yet yield little water even though allowed to drain for a long time. A clay, for example, with a porosity of 50 percent might not yield any water by gravity because of the smallness of the pores, the water being retained because of molecular attraction. Some water also may be retained in a rock because the interstices are isolated or poorly interconnected. Even

[1] For a detailed discussion of the principles governing the occurrence and movement of ground water, see U. S. Geol. Survey Water-Supply Papers 489 and 494.
[2] Meinzer, O. E., Hydrology, p. 401, McGraw Hill, 1942.

in clean, coarse, well-sorted sand an appreciable part of the water will be retained as a thin film on the surface of the grains, and thicker films will be retained at the intersection of the surfaces of the grains. The ratio of the volume of water a saturated rock will yield by gravity, to the total volume of rock, is known as the specific yield and is stated as a percentage.

Probably the most important characteristic of an aquifer is its permeability, that is, its relative ability to transmit water. This characteristic may have little relation to the porosity; a clay, for example, with a porosity of 50 percent may transmit water very slowly, or not at all, whereas a sand or gravel with a porosity half as great may transmit large quantities of water in a short time. Clays are impermeable because the pores are so small that the water is held by molecular attraction. In silt and extremely fine sand the pores are larger and the molecular attraction is less but may still be so great that water is transmitted very

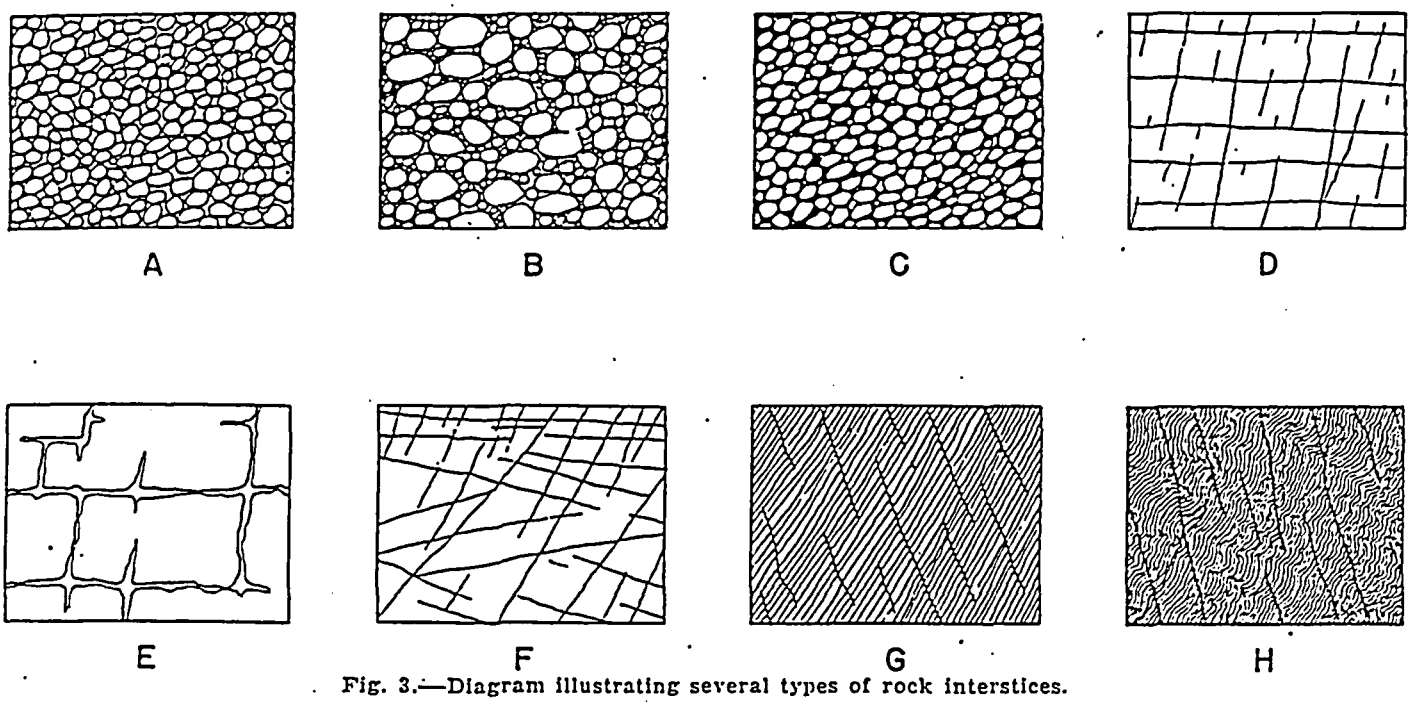


Fig. 3.—Diagram illustrating several types of rock interstices.

slowly. A small amount of clay or fine sand will greatly decrease the permeability of a medium or coarse sand. The concepts of porosity, specific yield, and permeability apply particularly to more or less homogeneous materials such as soil, clay, sand, gravel, semiconsolidated sandstones, and some limestones. It is more difficult to apply these concepts to rocks in which the interstices consist entirely of fractures, joints, cleavage planes, and similar openings because the rocks are non-homogeneous.

The movement of ground water is usually due entirely to the force of gravity, and ordinarily the velocity of flow varies directly with the hydraulic gradient; that is, the flow is laminar (non-turbulent). Under natural conditions the points of discharge are at a lower elevation than the points or areas of recharge.

In a humid region, such as the Greensboro area, recharge to the ground water is in the interstream areas. The ground water discharges into the perennial streams and lakes, and the lowest points on the water table are at these places. Rain water percolates more or less vertically downward to the water table and then moves laterally toward the point of discharge in some stream valley, lake, or swamp. The streams contribute to ground-water recharge only in periods of flood, when they recharge the alluvium and bedrock along their channels. This water generally drains quickly back into the streams when the floods pass.

During the winter and spring, when the water table is high, the head is greater, therefore the velocity is higher and the volume of discharge is greater than in the autumn when the water table is low.

THE WATER TABLE

Rain falling on an area percolates downward through the soil until it reaches the zone of saturation, beneath which all of the pores and interstices are completely filled with water. The surface of this zone

of saturation is known as the water table. The water table is not a stationary surface but is continually fluctuating, rising during and immediately following periods of rainfall and declining during periods of fair weather. In humid regions such as the Greensboro area, the water table is an undulating surface, usually reflecting, in a subdued way, the irregularities of the topography. The relief—that is, the difference in elevation between high and low points—of the water table generally is much less than the relief of the topography.

The depth to the water table depends principally upon the climate, the topography, and the character of the rocks. As the climate is nearly uniform throughout the Greensboro area, and most of the rocks are consolidated, brittle rocks with similar types of interstices, differences in depth to the water table depends largely upon the topography. In stream valleys the water table may be at or very near the surface. On wide flat uplands the water table generally ranges from a few feet to a few tens of feet below the surface. On hills and in sharply dissected areas near the larger streams the water table may be more than 100 feet below the surface. The greatest depth to water measured in the Greensboro area was 161 feet in well 50 in Stokes County. This well was on a high hill rising above the valley of Dan River. The relation of the water table to the topography in homogeneous materials is illustrated in figure 4.

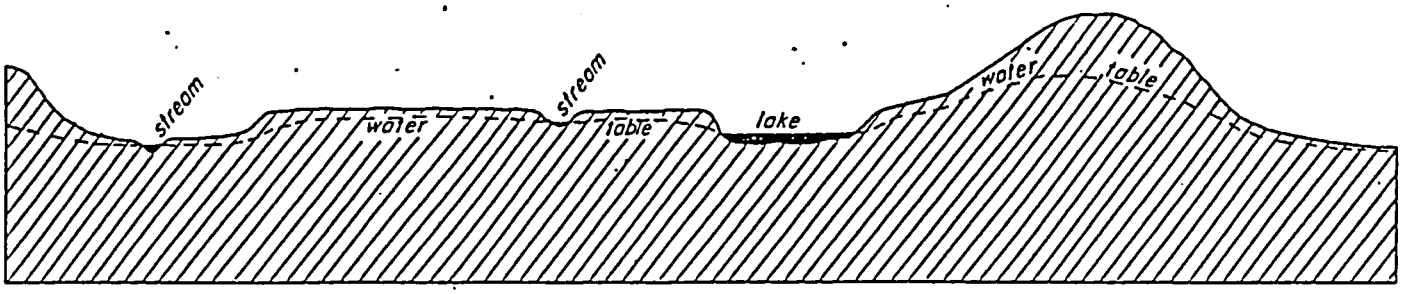


Fig. 4.—Diagrammatic section illustrating the relation of the water table to the topography.

FLUCTUATIONS OF THE WATER TABLE

Because the source of ground water is precipitation, the water table fluctuates with the rainfall. However, a number of factors complicate the correlation of ground-water level and rainfall. The intensity and duration of the rainfall has a considerable bearing upon the proportion of water that runs off directly, evaporates, and reaches the water table. A heavy rainfall of short duration may result in a high percentage of surface runoff because of the inability of the soil to transmit the water to the water table rapidly. The same amount of rain, falling over a longer period, may result in a much larger proportion of water reaching the water table. However, during the longer period of rainfall there might be an increase in the total amount of water evaporated, thus reducing to that extent the amount of water that will reach the water table.

Temperature also has a considerable effect. The viscosity of water varies inversely with temperature, so that cold water percolates through the earth more slowly than warm water. This means that water recharged during cold weather moves downward to the water table more slowly than water recharged when the weather is warm. When the ground is frozen, no water can percolate downward to the water table.

The evaporation capacity of the air, which is dependent upon temperature, humidity, and the rate of air movement, determines the rate of evaporation and thus has considerable bearing on the proportion of rainfall that may reach the water table. Transpiration losses through vegetation may have an even greater effect.

During the summer evaporation and transpiration losses are high and much of the rainfall occurs in short, heavy showers that result in high surface run-off. It is principally because of these three reasons that the ground-water level recedes during the summer and autumn although these months have the heaviest rainfall.

During the winter the vegetation is dormant so that little water is lost by transpiration, the evaporative capacity of the air is low and little water is lost by evaporation, and rain is apt to fall slowly and steadily. Therefore, the ground-water supplies are replenished during these months although the rainfall is less during these months than in the summer and autumn. However, the first winter rains often do not have as

THE ROCK UNITS AND THEIR WATER-BEARING PROPERTIES

INTRODUCTION

The areas in which the different units crop out are shown on plate 1. As was explained in the description of the geology of the area, this is only a reconnaissance map and in some places is not completely accurate in detail. Many small areas of one type of rock occurring within larger areas of another type are not shown.

Data on 1,254 wells are tabulated and given with the county descriptions in this report. In order to compare the water-yielding properties of wells in the different rock units, tables were prepared showing the average depth, average yield, and other pertinent data for all drilled wells 3 inches or more in diameter, in each rock unit, for which there were sufficient data. The topographic location was noted for most wells, and other tables give the same data tabulated according to topographic location. These tables are given with the description of each rock unit.

Relative water-bearing properties of the rock units.—A table showing the relative merits of wells in different rock units is given below. Figure 7-A shows graphically the yield per foot of well for wells in the different rock units.

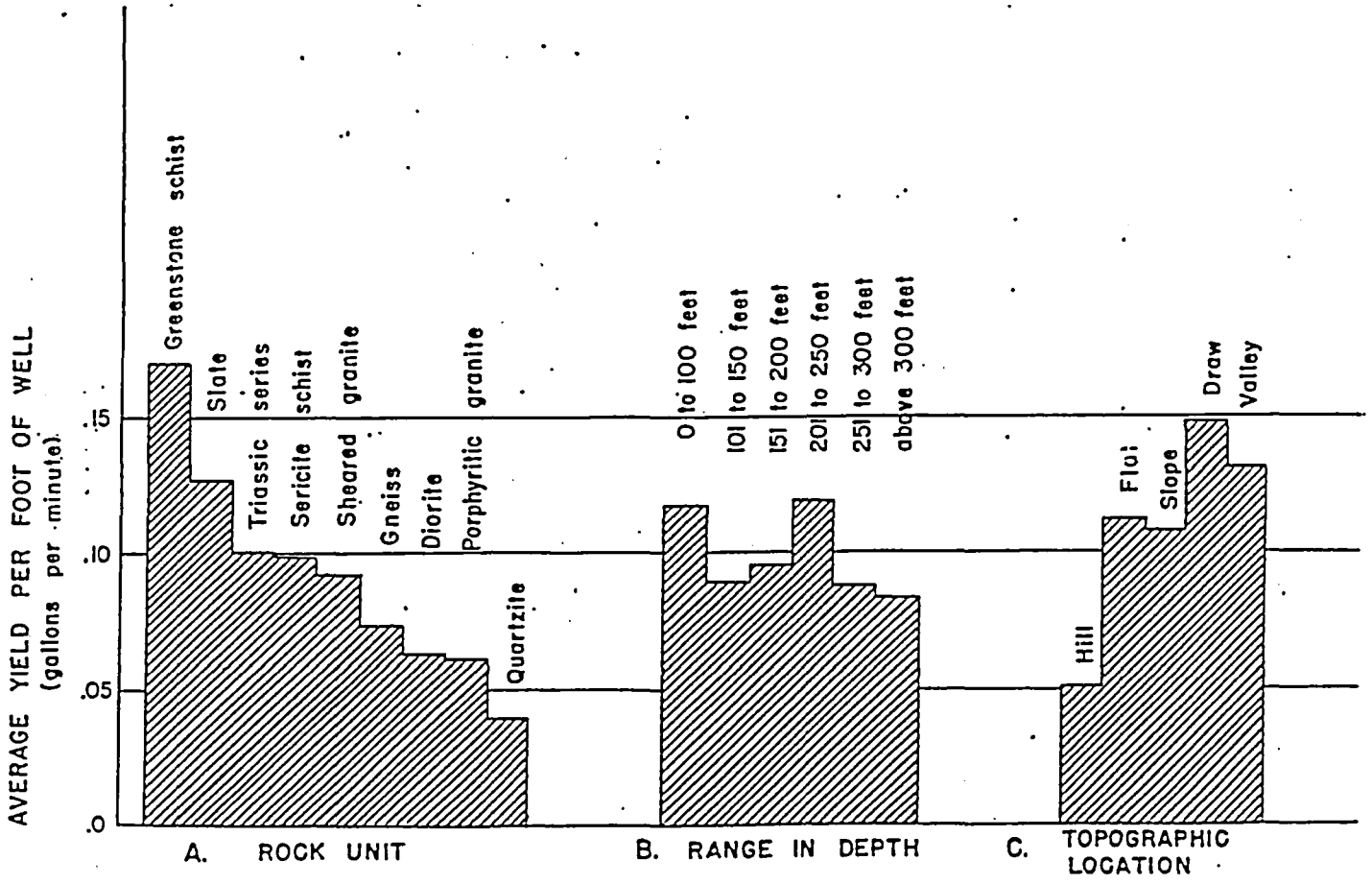


Fig. 7—A. Average yield, per foot of well, of wells in the different rock units.
B. Average yield, per foot of well, according to range in depth.
C. Average yield, per foot of well, according to topographic location.

The 812 wells have an average depth of 151 feet, an average yield of 14½ gallons a minute, and an average yield per foot of well of 0.097 gallons a minute. The lowest yield was zero and the highest yield was 212 gallons a minute. The number of wells yielding less than 1 gallon a minute is 103, about 11½ percent of the total.

TABLE 1—AVERAGE YIELD OF WELLS ACCORDING TO ROCK TYPE
(Drilled wells 3 inches or more in diameter)

Rock Unit	Number of Wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 1 gallon a minute
			Range	Average	Per foot of Well	
Gneiss	350	154	0—125	11½	.074	15
Quartzite	27	126	0—20	5½	.042	15
Greenstone schist	136	166	¼—200	28	.170	8
Sericite schist	14	106	½—25	10½	.099	14
Slate	40	125	1—75	16	.126	2½
Sheared granite	116	150	0—212	14	.093	14
Diorite	26	97	0—25	6	.063	31
Porphyritic granite	47	141	0—30	8	.061	11
Triassic	50	171	·1—150	17	.100	2
Diabase dikes (Triassic)	3	136	----------	0	----------	----------
Greenstone and granite	3	185	----------	26	----------	----------
All Wells	812	151	0—212	14½	.097	11½

Greenstone schist has by far the highest average yield and average yield per foot of well, nearly 65 percent greater than the average yield of wells in Triassic rocks, which have the next highest average yield. Wells in the slates and sheared granites have only slightly lower average yields than wells in the Triassic. However, wells in the slates have a much higher average yield per foot of well than those in either the Triassic rocks or the sheared granite. Wells in the gneiss, with an average yield of 11½ gallons a minute, are fifth in yield but are sixth in average yield per foot of well. Average yields of wells in the other rock units range downward to 5 gallons a minute and to 0.042 gallons a minute per foot of well in the quartzite unit.

Certain factors make this table of comparative average yields somewhat misleading. Cities, towns, and industries are not distributed evenly throughout the Greensboro area but are concentrated in a few places. Thus, municipalities and industries, which seek and obtain much larger yields than are obtained from domestic wells, are concentrated on certain of the rock units, whereas few municipal and industrial wells are located in some of the other rock units. Nearly all the industrial developments and municipalities in Alamance and Guilford Counties are underlain by greenstone or sheared granite. In Forsyth County nearly all municipal and industrial supplies are obtained from gneiss. Most of the industries in Stokes County and the only municipality using well water are located in the Triassic. Most of the industries and municipalities using ground water in Rockingham County are also located in the Triassic. There are few industrial and municipal wells in Caswell County and all of these are in gneiss.

The effect that this concentration of large ground-water users in certain of the rock units has on the average yield of wells of the different units is considerable. The greenstone schist, with the highest average yield, has the highest proportion of industrial and municipal wells; 41 percent of the wells used in compiling the above table were of this type. The Triassic rocks, which have the second highest average yield, are a close second with 38 percent of municipal and industrial wells. The slate, granite, and gneiss which average third, fourth, and fifth in average yield are also third, fourth, and fifth with 20, 15½, and 12½ percent, respectively, of industrial and municipal wells. (The porphyritic granite and biotite granite were combined to obtain the figure for granite.) The diorite, which is sixth in percent of municipal and industrial wells, is seventh in average yield. The chlorite-sericite schist and the quartzite and schist have no municipal or industrial wells and are sixth and eighth (last), respectively, in average yields.

The following table summarizes the data for industrial and municipal wells drilled in six of the rock units and probably gives a more accurate estimate of the relative amounts of water that can be obtained from wells drilled in these rocks.

TABLE 2—AVERAGE YIELD OF MUNICIPAL AND INDUSTRIAL WELLS[1] ACCORDING TO ROCK TYPE
(Wells 5 inches or more in diameter)

Type of Rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 10 gallons a minute
			Range	Average	Per foot of well	
Granite	26	361	2—212	33½	.093	34
Gneiss	44	286	1—125	34½	.121	0
Greenstone	56	282	3—200	55½	.197	3½
Slate	8	315	5—32	22	.071	12½
Triassic	10	291	8—150	35	.120	21
Diorite	3	181	10—25	17	.092	0
All wells	156	297	1—212	41	.138	13

[1] Includes colleges, airports, county homes, hospitals, prison camps, broadcasting stations, etc., but does not include county schools.

In table 2, as in table 1, wells in the greenstone schist are shown to have a considerably higher average yield than wells in any other rock unit. The average yield is 60 percent greater than the average yield of wells in the Triassic, which have the second highest average yield. This compares closely with the 65 percent advantage for 3-inch and larger wells in greenstone schist shown in table 1, and it is evident that the large proportion of industrial and municipal wells was not responsible for the higher average yield for wells in this particular rock unit. It seems certain that in the Greensboro area the greenstone schist will yield, on the average, more water than any other rock.

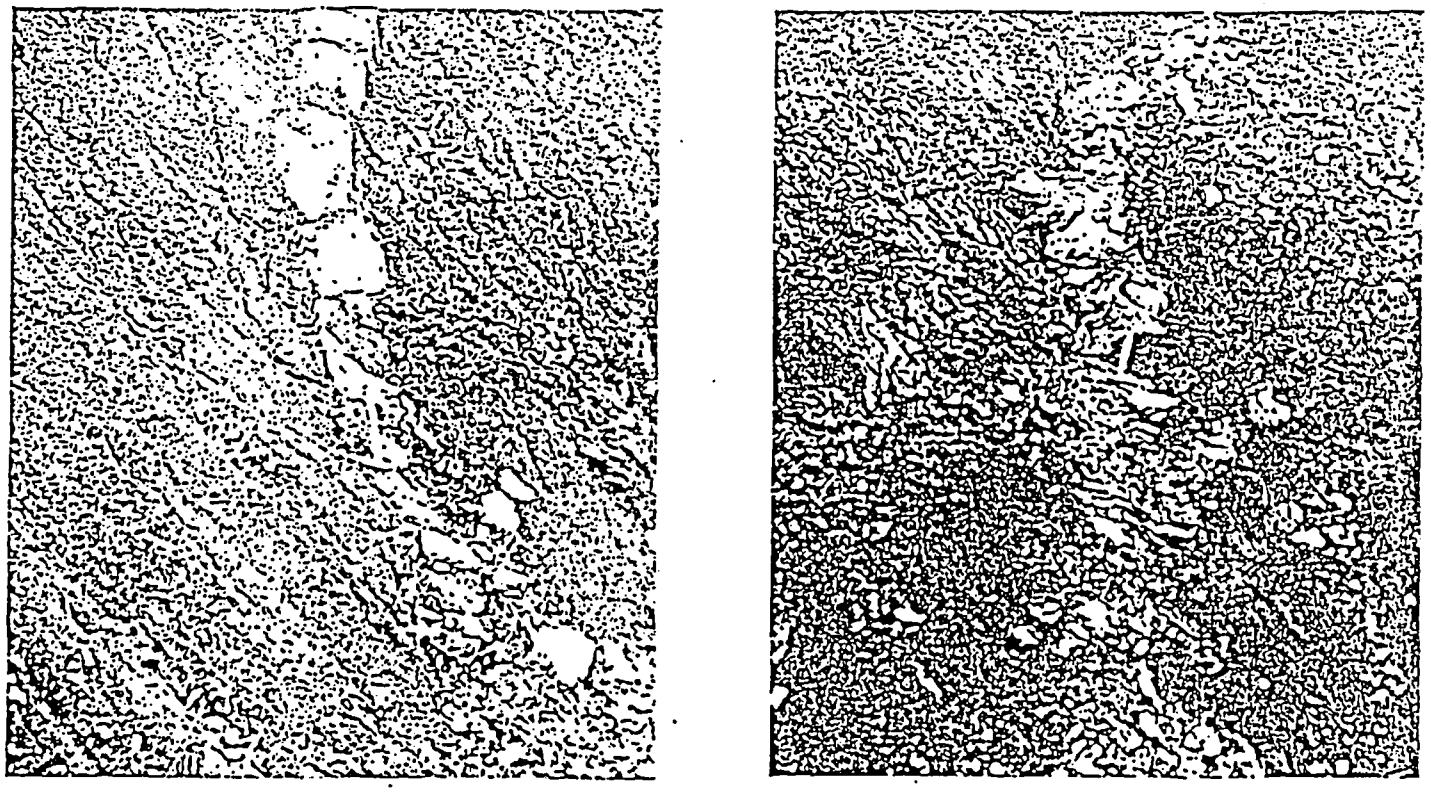
In table 2, as in table 1, wells in the Triassic are second in average yield, but the yield of wells in granite and in gneiss are so close as to be almost equal to the Triassic, and in yield per foot of well the gneiss actually is second to the greenstone schist. The most significant changes in ratings between the two tables is the advance of the gneiss from sixth to second place in yield per foot of well, and the drop of the slates from a strong second to a poor fifth in both average yield and average yield per foot of well. Of considerable significance is the column showing percent of the wells that yield less than 10 gallons a minute. Only 3½ percent of the wells in the greenstone schist yield less than 10 gallons a minute, whereas 34 percent of the wells in granite yield less than 10 gallons a minute. This indicates that the range in yield of wells in greenstone schist is not nearly so great as in granite. The tendency in granite would seem to be for some wells to yield very little, whereas others would have large yields. In the greenstone schist, the wells would have more nearly uniform yields. Wells in gneiss, slate, and in the Triassic have ranges between these two extremes. There are too few industrial and municipal wells in the diorite to form any conclusion about them.

Effect of topographic location.—The topographic location was noted for 802 of the 812 wells of table 1. The number of wells, average depth, range in yield, average yield, and percent of wells yielding less than 1 gallon a minute for wells in five different topographic locations are given in table 3a and the average yield per foot of well for wells in the different topographic locations is shown graphically in figure 7-C.

TABLE 3a—AVERAGE YIELD OF WELLS ACCORDING TO TOPOGRAPHIC LOCATION
(Drilled wells 3 inches or more in diameter)

Topographic Location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 1 gallon a minute
			Range	Average	Per foot of well	
Hill	282	147	0—125	7½	.052	28
Flat	152	154	0—200	17	.113	3
Slope	228	127	0—120	14	.108	6
Draw	66	180	½—212	27	.146	3
Valley	74	212	0—150	28	.132	1
All wells	802	151	0—212	14½	.097	12½

14



A B

Plate 12—Slate containing quartz veins, through the fractures of which ground water circulates.

solid rock, went dry during the drought of 1941-1942, and many of these were deepened by drilling a well 6 inches in diameter in the bottom.

Analyses were made of four samples of water from wells in slate and include wells 18, 38, 194, and 212 in Alamance County. Of the four samples, three were soft (less than 60 parts per million), and the fourth was very hard (480 parts per million). The well yielding the very hard water is only 58 feet deep, and, in addition to being hard, the water also has a chloride content of 165 parts per million. This water is not characteristic of the slate. About half the users reporting on hardness reported slightly hard to hard water, the other half reporting soft to moderately soft water. Most of the waters reported soft were from wells drilled in fine-grained sericite schist, whereas the hard waters were from wells drilled in slaty tuffs and breccias.

Iron was determined on only two of the four samples and was only 0.01 part per million in each. Of the users reporting, about one-third reported little to much iron and two-thirds reported no iron.

SHEARED GRANITE

The sheared biotite granite crops out in central and northeastern Guilford County; south-central, central, and northwestern Alamance County; and southeastern Caswell County. It is a very distinctive unit and at most places is easily distinguished from other granites. It has been greatly sheared and at many places has a schistose or gneissic structure. It is cut by innumerable greenish-colored basic schistose dikes which greatly resemble the greenstone schist. In places the dikes occupy nearly as great a total area as the granite which they intrude, and they generally are more numerous near the southeastern margin of the granite belt.

The granite is chiefly a light-pink to gray coarse-grained rock consisting of orthoclase, plagioclase, biotite, and quartz, and minor accessories. The biotite occurs in large tabular crystals which have been smeared and wrapped around the surfaces of the feldspar crystals.

The granite is about an average aquifer, drilled wells yielding at most places satisfactory amounts for domestic users and, at favorable locations, generally yielding 25 to 50 gallons a minute for industries and municipalities. Several exceptionally good wells yield from 100 to 212 gallons a minute.

According to table 1, the sheared granite is a close fourth in average yield and in average yield per foot of well. The average yield of wells in granite in the Greensboro area is 14 gallons a minute.

In the Halifax area the average yield of wells in granite was only 10.6 gallons a minute[1]. However, the average depth in that area was only 128 feet, so that the average yield per foot of well was 0.084, only about 10 percent less than that of the sheared granites of the Greensboro area.

In table 2 the average yield of industrial and municipal wells in granite, including wells in both the sheared granite and the porphyritic granite, is nearly 2½ times as much as the average yield of all wells in granite, but the average depth is also 2½ times as great so that the yield per foot of well is the same.

If it were not for the generally larger diameter of the industrial and municipal wells, they probably would have a lower yield per foot of well. In table 2 the granite ranks fourth of the six units, both in average yield and average yield per foot of well. The average depth of these wells is considerably greater than in any other unit, owing in part to several exceptionally deep wells which were continued to excessive depths after failure to obtain water at moderate depths.

In table 9 the average depth, average yield, and other data for wells in the sheared granite are tabulated according to range in depth and according to topographic location.

TABLE 9—AVERAGE YIELD OF WELLS IN SHEARED BIOTITE GRANITE
(Drilled wells 3 inches or more in diameter)

ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells Yielding less than 1 gallon a minute
			Range	Average	Per foot of well	
0—100	67	71	¼—38	9	0.128	15
101—150	25	128	0—40	10	.076	16
151—200	10	178	0—26	14	.078	10
201—250	1	240	------	30	.125	0
251—300	2	268	4—100	52	.195	0
Above 300	12	535	2—212	43	.073	8
All wells	116	150	0—212	14	.093	(1)

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic Location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 1 gallon a minute
			Range	Average	Per foot of well	
Hill	37	134	0—30	6	0.045	38
Flat	28	156	0—60	15½	.097	7
Slope	34	127	¼—70	13	.104	3
Draw	10	251	3—212	39	.156	0
Valley	8	167	3—30	18	.108	0

The average yield per foot of well in the 0-100 foot range is greater than in any other range except the 251-300 foot range and is 37 percent greater than the average for all ranges. The average yield per foot of depth for wells in the different depth ranges is shown graphically in figure 8. The wells in the 0-100 foot range have an average depth of about 71 feet, but because the water table is generally 20 to 25 feet below the surface, the average thickness of water-bearing rock penetrated by this group of wells is less

[1] Mundorff, M. J., Ground water in the Halifax area, North Carolina: North Carolina Dept. Cons. and Devel. Bull. 51, p. 22, 1946.

than 50 feet. Assuming an average depth below the water table of 50 feet, the wells in this group have a average yield per foot of 0.183 gallon a minute, which is nearly twice the average for all wells in granite.

In the report on the ground-water resources of the Halifax area[1] it was concluded that much of th water from wells in granite of that area was obtained from the fractured and jointed rock just below th weathered mantle. This conclusion also appears to be valid for wells in the sheared granite of the Greens boro area.

Topography appears to be as important a factor in the yield of wells in granite as it is in other rocks Wells located on hills in the granite have an average yield of only 43 percent as much as the average for a the wells and the average yield per foot of well is only about 47 percent of the average for all the wells Wells drilled in draws have by far the highest average yield and yield per foot of well. It seems probabl

Plate 13—Granite quarry in east edge of Winston-Salem. Dark areas are from ground-water seeps from joints. Most of the seeps are from the horizontal joints.

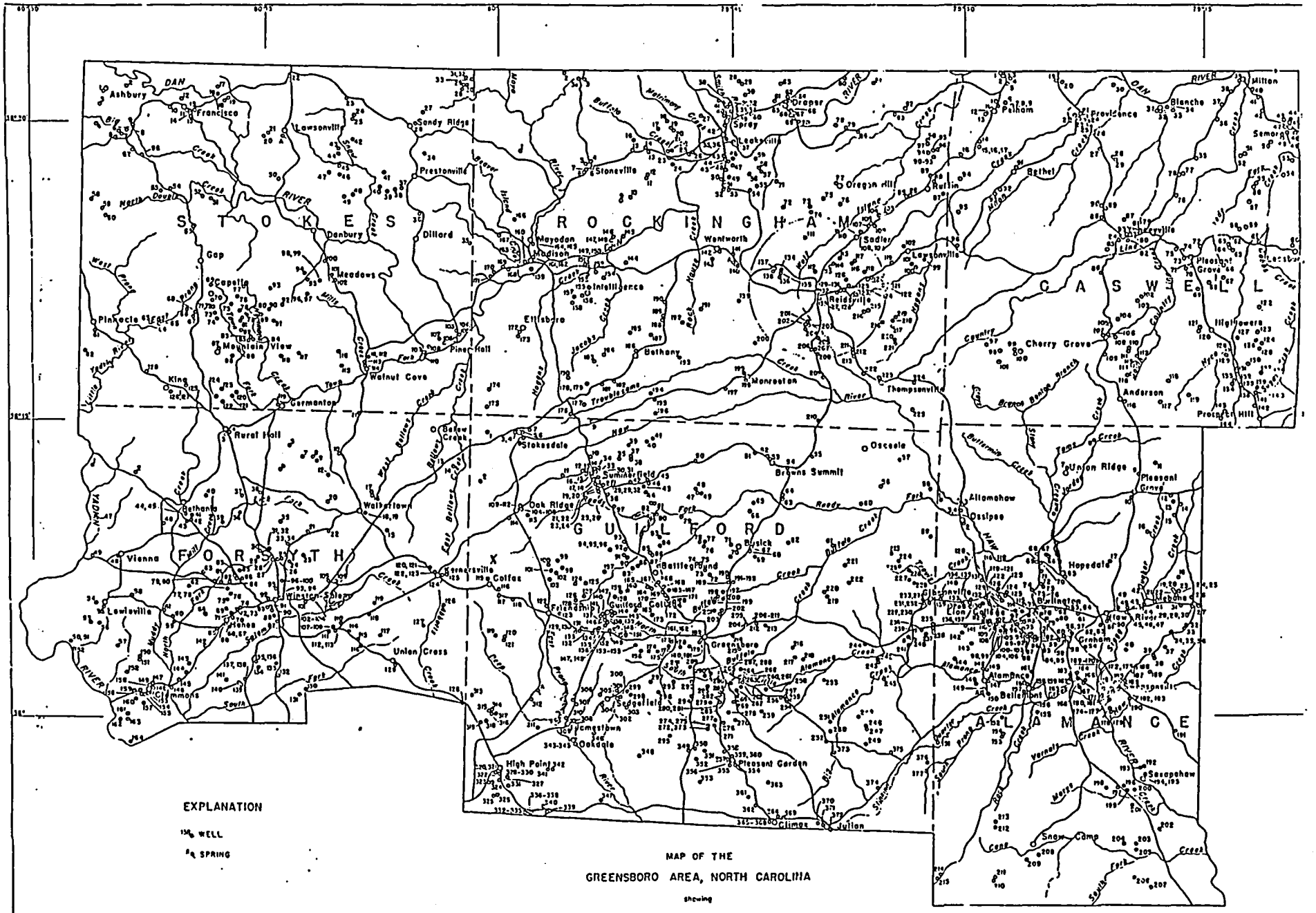
that topographic location is even more important in this rock unit than in the others. The relation betwee topographic location and average yield per foot of well is shown graphically in figure 9.

Many dug wells are used for domestic supplies in this unit; however, the yield generally is not large Probably a larger proportion of dug wells fail during droughts in this unit than in any other rock. A grea many dug wells failed during the drought of 1941 and 1942. Many of these were originally dug to soli rock so could not be deepened by digging and were deepened by drilling a 6-inch hole in the bottom of th well. Adequate yields were obtained in most such wells by drilling 10 to 50 feet. At some places the soli granite is so close to the surface that the water table is close to or below the top of the rock, and dug well are generally unsatisfactory. At these places drilled wells are most commonly used, but springs are utilize also.

Analyses were made of samples of water from eight wells drilled in the sheared granite. These ar wells 65 and 113 in Alamance County; wells 117 and 137 in Caswell County; and wells 201, 206, 343, an

[1] Op. cit., p. 21.

IN COOPERATION WITH
NORTH CAROLINA DEPARTMENT OF CONSERVATION AND DEVELOPMENT



MAP OF THE
GREENSBORO AREA, NORTH CAROLINA
showing
LOCATION OF WELLS AND SPRINGS LISTED IN THE REPORT

ANALYSES OF GROUND WATER FROM FORSYTH COUNTY, NORTH CAROLINA

(Analysts: E. W. Lohr and M. S. Berry, U. S. Geological Survey. Numbers at heads of columns correspond to numbers in table of well data)

(parts per million)

	2	3	93	124	164
Silicia (SiO_2)	31	28	22	31	20
Iron (Fe)	.02	.02	.03	.03	.03
Calcium (Ca)	5.7	22	64	23	6.7
Magnesium (Mg)	3.1	8.0	24	7.4	3.0
Sodium and Potassium (Na+K)	14	7.2	67	7.0	1.3
Carbonate (CO_3)	0	0	0	0	0
Bicarbonate (HCO_3)	63	112	46	92	30
Sulfate (SO_4)	3.2	9.1	10	17	3.7
Chloride (Cl)	1.2	1.5	225	5	1.2
Fluoride (F)	----------	----------	.0	.5	----------
Nitrate (NO_3)	.0	.0	47	2.0	2.2
Dissolved solids	80	130	603	143	71
Total hardness as $CaCO_3$	27	88	258	88	29
Date of collection	May 21, 1943	May 20, 1943	Oct. 16, 1942	Oct. 13, 1942	May 10, 1943
Depth (feet)	130	350	714	308	110
Chief aquifer	Gneiss	Gneiss	Gneiss	Granite	Granite

GUILFORD COUNTY

(Area, 651 square miles; population, 153,916)

Geography, physiography, and drainage.—Guilford County, in the south-central part of the Greensboro area, is the largest of the six counties and has the largest population. It has four incorporated cities and towns and about 14 unincorporated towns and villages. Greensboro, located in the center of the county, is the largest city and county seat. High Point, the only other city, is in the extreme southwestern corner of the county. Greensboro is an important center of textile manufacturing and High Point also has a number of textile factories, although it is better known as a center of furniture manufacturing. There are a few factories in the smaller towns and villages, but the remainder of the county is dominantly agricultural. Guilford County has a good system of paved roads and railroads, most of which radiate from Greensboro.

Guilford County is in the Piedmont physiographic province. Its surface is formed by the uplifted and partially dissected peneplane of that province. The land surface near the larger streams is gently rolling, with a relief of 100 to 150 feet. The interstream areas are broad and generally quite flat. No large trunk streams flow through or near Guilford County and therefore there are no deep valleys. Because the base-level is higher, dissection has generally been less extensive than in other counties of the Greensboro area. Guilford County is underlain by rocks of several different types. Because some of these differ considerably in resistance to erosion, both the topography and the drainage pattern are greatly influenced by the geology. However, topographic maps have not been made of any part of the county, and the geology is complex and at many places obscure, so that the exact relation of the topography and drainage to the geology cannot always be ascertained. The outstanding feature is the northeastward trend of the ridges and streams. Apparently some of the streams flow along or near the contact between different kinds of rocks, whereas others flow in weaker rocks, the more resistant rocks forming interstream divides. The major exception to the northeastward trend of the streams is Deep River, which flows southeastward chiefly across diorite and granite, which are uniformly resistant.

Practically all of Guilford County is drained by the two main branches of the Cape Fear River system, Haw River and Deep River. About 75 percent of the county is drained by Haw River and its tributaries, the most important of which are Reedy Fork, Buffalo Creek, and Alamance Creek. Practically all of the remaining 25 percent is drained by Deep River, only a few square miles of the southwest corner of the county draining southward into Yadkin River.

Geology.—The geology of Guilford County apparently is more complex than that of any other county of the Greensboro area. Seven of the nine geologic units crop out in Guilford County and the areal distribution of most of them is quite irregular.

The gneiss unit crops out in several irregular belts extending northeastward across the northwestern corner of the county. These belts are separated by areas of porphyritic granite, which was intruded into the gneiss. The principal rocks of the gneiss unit are banded quartz-mica-feldspar gneiss and quartz-mica schist. They are chiefly of sedimentary origin, and although the rocks have been greatly changed by metamorphism at many places the bedding planes can still be distinguished. The granite has intimately intruded the gneiss so that the boundaries between the two units necessarily are greatly generalized.

The greenstone schist crops out in large, irregularly shaped areas in the southeastern two-thirds of the county. These areas are separated by areas of sheared granite. The greenstone schist consists of a green fine- to medium-grained basic schistose rocks, chiefly of volcanic origin. At most places the rock is highly schistose but at a few places it is coarser and fairly massive.

The sericite schist crops out in a belt extending northeastward across the county from a point near Guilford College. It is closely associated with the greenstone schist and may be a metamorphosed tuff or possibly a metamorphosed clay. The rock is greatly weathered, and usually the only recognizable minerals are quartz, sericite and iron oxide, the latter apparently an oxidation product of chlorite and hornblende.

The slate unit is limited to a narrow, highly irregular belt extending across the southeastern corner of the county and to a small patch in the south edge of High Point. The rocks are mostly tuffaceous slates but include some clay slates.

The sheared granite is exposed over about 50 percent of the southeastern half of the county, where it forms a fairly continuous area interrupted by large patches of greenstone and slate. The granite is generally a moderately coarse pink schistose and gneissic rock consisting chiefly of quartz, biotite, and feldspar. The granite has been considerably metamorphosed and intensely sheared. The outstanding feature of the granite is the schistose and slaty dikes, which are green in color and greatly resemble the greenstone schists.

Diorite crops out at a number of places but was mapped separately at only two places. The outcrops otherwise are too small or not well enough exposed to map separately. Places where diorite crops out but is not shown on the map include the vicinity of Sedgefield, Pleasant Garden, along State highway 62 between Climax and High Point, and an area about 6 miles north of High Point. The diorite is a medium- to coarse-grained, dark-gray to greenish-gray rock consisting chiefly of plagioclase and hornblende. It generally is massive but at a few places is somewhat schistose.

The porphyritic granite outcrops in irregular, elongated patches across the northwestern corner of the county, where it is closely associated with the gneiss. In places the gneiss has been completely assimilated by the granite but in other places the gneiss has only been impregnated by emenations from the granitic magma. Because the granite has so intimately intruded the gneiss and because every gradation between true granite and true gneiss can be found, the map is necessarily greatly generalized.

The porphyritic granite is generally coarse-grained and medium gray, with large phenocrysts of feldspar. The ground mass consists of quartz, biotite, and feldspar. At most places the granite is entirely massive, but at some places the granite has some of the schistosity of the gneiss.

Ground water.—Nearly all domestic water supplies, many industrial supplies, and one of the three municipal water supplies are obtained from wells.

Dug wells are extensively used for domestic supplies in rural districts. Generally they are from about 15 to 50 feet deep and 2½ to 4 feet in diameter. Wells can generally be dug deep enough in gneiss and schist that they will not go dry even during a drought. However, at some places in granite, diorite, greenstone schist, and slate, the rock is so close to the surface that dug wells frequently go dry.

Bored wells are used considerably in suburban areas and are cheaply and easily constructed. They are bored by power-driven earth augers and cannot go below the completely weathered zone. For this reason, they are not always successful in rocks such as granite and diorite, where the water table at times declines below the weathered zone. Most bored wells are cased, and where they are properly constructed and of sufficient depth that they will not go dry, they are a satisfactory source of supply. Dug and bored wells

obtain their water from the weathered rock material at and just below the water table. For this reason, extra precautions must be observed to prevent contamination.

There are a large number of drilled wells in Guilford County. Records of more than 350 drilled wells are given in the tables of well data. Many of these were core-drilled with chilled shot and are 2 or 3 inches in diameter. There are many other core-drilled wells in Guilford County which do not appear in the table. Core-drilled wells have the advantages of all drilled wells and are cheaper than the larger percussion-drilled wells. However, although they are satisfactory for domestic wells, their small size makes them unsatisfactory for most industrial plants. About 7 or 8 gallons a minute is the maximum rate at which water can be removed from a 2-inch well by a deep-well pump. The average yield of 157 wells 2 inches in diameter in Guilford County is 6 gallons a minute and the average yield of 20 wells 3 inches in diameter is 10½ gallons a minute. These quantities are near the maximum amount that can be pumped from wells of that diameter and suggest that many of the wells would yield more than can be withdrawn from the well.

Most industrial, and public-supply wells are drilled with a percussion drill and are from 4 to 8 inches in diameter. The 6-inch well is by far the commonest. The larger-diameter wells encounter more fractures and cracks than small-diameter wells. Also, because a larger pump can be used, more water can be pumped from a large-diameter well than from a small-diameter well.

Drilled wells, both core-drilled and churn-drilled, have certain advantages over dug or bored wells. Because they are generally tightly cased and the water is obtained from crevices in the rock, they are much less liable to contamination. The depth of water in the well is generally large in comparison with the fluctuation of the water level, so that the yield decreases only slightly during a drought.

A summary of data on drilled wells 3 inches or more in diameter is given below:

TABLE 16—SUMMARY OF DATA ON WELLS IN GUILFORD COUNTY
(Drilled wells 3 inches or more in diameter)

ACCORDING TO ROCK TYPE

Type of Rock	Number of Wells	Average Depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 1 gallon a minute
			Range	Average	Per foot of Well	
Gneiss	20	123	1—50	15.6	0.126	5.0
Greenstone schist	67	163	1—200	36.5	.223	3.0
Sericite schist	8	116	5—20	11.1	.105	0
Slate	4	273	5—15	10.5	.039	0
Sheared granite	54	175	0—70	14.4	.093	13.0
Porphyritic granite	26	137	½—30	10.9	.079	3.8
All wells	179	158	0—200	22.0	.139	6.1

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic Location	Number of Wells	Average Depth (feet)	Yield (gallons a minute)			Percent of wells yielding less than 1 gallon a minute
			Range	Average	Per foot of Well	
Hill	41	203	0—100	15.5	0.076	24.4
Flat	44	170	0—200	22.2	.131	2.3
Slope	55	130	2—120	21.8	.168	0
Draw	16	125	2½—75	22.8	.182	0
Valley	22	158	10—100	34.4	.218	0

According to this table, wells in greenstone schist have by far the greatest average yield and average yield per foot of well. Wells in the gneiss unit rank second both in average yield and average yield per foot of well. Wells in sheared granite rank third in average yield but are fourth in average yield per foot of well, being exceeded in that respect by wells in sericite schist. Wells in the porphyritic granite rank fifth in both respects and wells in slate are sixth and lowest. However, data on only four wells in slate are included, one of which was very deep and had a low yield. If this one well were omitted, the record for the slate would be more than twice as good. It is obvious that not much importance can be given the position of the slates in table 16. The relative rank of wells in slate is given more accurately in table 1.

Although the greenstone schist is generally an excellent aquifer, at some places it is not. In the vicinity of Whitset and southwestward it apparently yields rather meagerly. Wells in the greenstone schist between Greensboro and Browns Summit and in the vicinity of Sedgefield have not been uniformly successful. Fortunately, at most places where water is needed for industrial purposes, excellent wells have usually been obtained.

More wells are drilled in granite (including together the sheared granite and porphyritic granite) than in any other rock. Results have generally been quite uncertain. No particular area can be designated as unusually poor, except possibly the vicinity of the County Home just east of Greensboro, and no areas can be designated as exceptionally good. At a number of places where a well several hundred feet deep was drilled and only a few gallons a minute was obtained, a second well drilled a few hundred feet away obtained several times as much water. It is apparent that the success or failure of a well depends on encountering fractures and joints in the rock. The second part of table 16, showing the average yields of wells in different topographic location, is significant in that connection. Wells drilled on hills have by far the lowest average yield and average yield per foot of well. Wells in valleys have much the highest average yield and average yield per foot of well. Wells in draws are second, on slopes third, and in flat areas fourth. Wells on hills have an average yield 30 percent less and an average yield per foot of well 42 percent less than wells drilled on flat areas. A hill is a poor location for a well because it is quite commonly underlain by rock which is more resistant to erosion. In many places the rock in hills is resistant to erosion because it has few fractures, joints, and similar openings facilitating the movement of ground water, which promote weathering and thus make the rock easily susceptible to erosion. Naturally if the avenues of movement of ground water are limited, the amount of water yielded by a well drilled there will be small.

In some of the other counties it was observed that wells drilled in draws had a greater average yield and average yield per foot of well than wells drilled in valleys. This was attributed to the relative large width of the valley in comparison with the width of the fracture or joint zone which originally determined the location of the valley. Draws, on the other hand, may be either wider or narrower than the zone of weakness which localized them. That wells in the valleys of Guilford County have a higher average yield and average yield per foot of well than wells in draws may be partly attributed to the small size of the Guilford County valleys.

Analyses of eight samples of water from wells in Guilford County are given in the table of analyses. Seven of the samples are from wells in granite and one is from a well in greenstone schist.

The seven samples from the granite ranged from soft to very hard and from 0.0 to 0.04 part per million in iron content. There is evidence of considerable contamination in some of the samples and in these there is little correlation between depth and hardness. However, in the samples from wells 22, 43, and 111, which appear to be free from contamination, increasing hardness correlates with increasing well depth.

The water from the well in greenstone, well 328, which has a relatively large amount of chloride, sulfate, and nitrate and therefore appears to be somewhat contaminated, is moderately hard.

Temperatures range from 59 to 63° F. and average 61° F.

Municipal supplies.—Gibsonville, population 1,753, has had a public supply since 1822, obtaining its water from two deep wells, one in Guilford County and the other in Alamance County. Well 234, Guilford County, is 201 feet deep and yields 100 gallons a minute. Well 139, Alamance County, is 335½ feet deep and was tested at 112 gallons a minute but is now being pumped at about 45 gallons per minute. Well 233, Guilford County, is only a short distance from well 234. The pumping of the one causes a large drawdown in the other, so well 233 was abandoned. Logs of wells 233 and 234 are given following the table of well data.

The turbine pump on well 234 discharges into a 154,000-gallon concrete reservoir. Centrifugal pumps force the water into the mains. A 75,000-gallon elevated tank gives additional storage. Well 139 in Alamance County pumps directly into the mains. The water from neither well is treated. Consumption of water averages about 55,000 gallons a day.

Greensboro, population 59,319, obtains its water from an impounded lake on Reedy Fork and Horsepen Creek, about 7 miles north of the city. The lake covers an area of 450 acres and has a capacity of 1,000,000,000 gallons. An auxiliary reservoir a mile south of the lake and 120 feet higher gives additional raw-water storage of 20,000,000 gallons. The water is pumped to the treatment plant in the city through a 24-inch line by three steam-driven centrifugal pumps and one water wheel. Water treatment consists of coagulation with alum, filtration, chlorination, and final adjustment of pH with lime. There are two concrete clear-water reservoirs with capacities of 3,000,000 and 18,000,000 gallons, respectively, and two elevated tanks with capacities of 250,000 and 500,000 gallons, respectively. The capacity of the treatment plant is 12,000,000 gallons a day. The maximum consumption is about 7,000,000 gallons a day and the average is about 5,500,000 gallons a day. About 25 percent of the water is used by industries.

In addition to the municipal water plant in Greensboro is the Buffalo Water Works, owned by the Proximity Manufacturing Company. Water is obtained from Buffalo and Richland Creeks. The total capacity of the storage lakes on these creeks is about 1,000,000,000 gallons. The water is treated by coagulation with alum and lime, filtration, final adjustment of pH with lime, and chlorination. The filter plant has a capacity of about 4,500,000 gallons a day but filter plants at some of the mills increase the capacity to about 8,500,000 gallons a day. The total consumption is about 8,000,000 gallons a day, most of which is used by the mills. Nearly 7,000 people in the mill villages are also supplied with water.

High Point, population 38,495, obtains its supply from an impounded lake on Deep River 5 miles northeast of the city. The dam is 45 feet high and the lake has an area of 350 acres. The water flows by gravity 4,000 feet through a 30-inch pipe to the raw-water pumping station. Four electrically driven centrifugal pumps with a total capacity of 8,000,000 gallons a day and one gasoline-driven pump with a capacity of 3,500,000 gallons a day pump the water to the treatment plant through parallel 24-inch and 12-inch lines. Treatment consists of coagulation with alum, the addition of ammonia and chlorine, filtration, secondary chlorination, and final adjustment of pH with lime. The clear-water reservoir has a capacity of 3,200,000 gallons and a 1,000,000-gallon elevated tank furnishes additional storage. The pumps on the distribution system exactly duplicate the raw-water pumping system. The capacity of the source is reported to be 15,000,000 gallons a day and the capacity of the treatment plant is 6,000,000 gallons a day. The maximum consumption is about 4,000,000 gallons a day and the average is about 3,500,000 gallons a day.

RECORDS OF WELLS IN GUILFORD COUNTY

Well Number	Location	Owner	Driller[1]	Type of Well[2]	Depth of Well (feet)	Depth of Casing (feet)	Diameter of Well (inches)	Depth to Water (feet)[3]	Yield Gallons a Minute	Chief Aquifer	Topographic Location	Remarks
1	1½ miles W of Stokesdale	W. R. Hutchins	Well Drillers Inc.	Dr	222		6	60R	1±	Gneiss	Hill	Soft water.
2	3½ miles SW of Stokesdale	C. S. Linville	do	Dr	100+		6		5	Granite	Slope	Hard water.
3	Stokesdale	Geo B. Jones	Z. V. Jones	Cr-Dr	99	50	2		4	Gneiss	Flat	Soft water, no iron.
4	Do	Jim Knight	do	Cr-Dr	112		3		5	do	do	Used by 3 families. Water slightly hard.
5	Do	Dr. V. E. Edwards	do	Cr-Dr	95		2		6	do	do	
6	Do	Carl Lemon	Well Drillers Inc.	Dr	188	57	6	20R	15	do	Valley	Soft water. Drawdown reported 65 feet.
7	Do	Paul Knight	Z. V. Jones	Cr-Dr	110		2		4	do	Flat	Soft water.
8	Do	Stokesdale School		Dr	140		6		15	do	do	
9	3 miles N of Summerfield	Mrs. Blanche Robinson	J. Stafford	Cr-Dr	125		2		5	do	do	No water in a 300-foot well at same location
10	2 miles N of Summerfield	C. C. Winfree	Frank Gardner	Cr-Dr	117		3		3-4	Granite	do	Water slightly hard.
11	2 miles NW of Summerfield	Miss Elizabeth Ogburn	F. L. Smith	Dr	131½	120	6		15-20	do	do	

[1] Vir Mach. Co.=Virginia Machinery & Well Co.; Dan. Well Co.=Danville Well Drilling Co.; Sydnor Well Co.=Sydnor Pump & Well Co.
[2] Dr=Drilled, Br=Bored, Cr-Dr=Core Drilled, B-Dr=Bored and Drilled, D-Dr= Dug and Drilled.
[3] Depth to water from land surface; R=Reported, M=Measured.

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RECORDS OF WELLS IN GUILFORD COUNTY—*Continued*

Well Number	Location	Owner	Driller[1]	Type of Well[2]	Depth of Well (feet)	Depth of Casing (feet)	Diameter of Well (inches)	Depth to Water (feet)[3]	Yield Gallons a Minute	Chief Aquifer	Topographic Location	Remarks
187	3 miles NW of Greensboro.	E. G. Rawlins	?	Cr-Dr	95		2		5-6	Schist	Slope	
188	2 miles NW of Greensboro	R. G. Hardin	F. L. Smith	Dr	290±?		6		14	do	Flat	Soft water, no iron.
189	3½ miles NE of Greensboro	Rankin School	?	Dr	120		6		15	Greenstone		
190	4 miles NE of Greensboro.	Mrs. C. A. McNealy.	W. B. Mayhew	Cr-Dr	132		2	23R	5	do	Flat	Hard water.
191	Do	H. B. Powell	do	Cr-Dr	80		2	25R	7½	Granite?	Slope	Water is not hard.
192	Do	G. D. Wyrick	Carl Greggerson	Cr-Dr	215		2		3½	Greenstone	Flat	Moderately soft water.
193	Do	O. H. Graham	do	Cr-Dr	170		2		6½	do	do	Do
194	Do	R. E. Fitchett	W. B. Mayhew	Cr-Dr	80		2		7¾	do	Slope	Soft water.
195	Do	Joe Walters	do	Cr-Dr	120		2		7	do	do	
196	Do	do	do	Cr-Dr	70		2		6	do		
197	Greensboro	Proximity Mfg. Co., White Oak Mill		Dr	322		8?		55	do	Valley	
198	Do	Proximity Mfg. Co., (Revolution Mill).	Sydnor Well Co.	Dr	437		8		100	do	do	Not in use at present.
199	Do	do	do	Dr	402	60±	8		100	do	do	
200	Do	Proximity Mfg. Co., Print Works	do	Dr	100		8		100	do	do	
201	Do	Proximity Mfg. Co., Hubbard St.	Sydnor Well Co.	Dr	282		8	17R	180	do	Slope	Log in table Analysis in table. Temperature 61° F.
202	Do	Proximity Mfg. Co., at Standpipe	do	Dr	487		8		70	Granite?	do	Not in use.
203	Do	Proximity Mfg. Co., Revolution Mill	do	Dr	858		8		5	Granite	Flat	Do
204	East edge of Greensboro	Mrs. George Smith	J. Stafford	Cr-Dr	126		2		8	do		Soft water, no iron.
205	Do	Bessemer School	J. R. Cummings	Dr	110		6		10-12	do		
206	3 miles E of Greensboro	County Home	W. B. Mayhew	Cr-Dr	78	60	3		6	do		Analysis in table.
207	Do	do	do	Cr-Dr	78	60	3		6	do		
208	Do	do	Heater Well Co.	Dr	250	35	8		4	do		
209	Do	do	do	Dr	100		8		6	do	Slope	
210	Do	County Dairy	J. R. Cummings	Dr	700		6		2	do	do	
211	Do	do	do	Dr	700		6	165R	7	do	Hill	Hard water.
212	Do	Prison Camp	W. B. Mayhew	Cr-Dr	120		2	30R	7	do	Slope	Soft water, no iron.
213	3½ miles E of Greensboro	Tabor Hudson	Heater well Co.	Dr	72		6	20R	5	do	Flat	Soft water.
214	Greensboro	D. D. Stout, Home Ice Plant	do	Dr	200	74	6	10R	24	do	do	Soft water; pH 6.5; Chloride 6 parts per million. Log in table.
215	2 miles SE of Greensboro	J. V. Hunt, Woodland Dairy Farm	Danville Well Co.	Dr	256		6	20R	30	Greenstone	Valley	Drawdown 100 feet.
216	5½ miles E of Greensboro.	P. C. Clapp	Well Drillers Inc.	Dr	123½		6	21R	20±	Granite	Flat	Soft water.
217	6 miles E of Greensboro	Miss Hazel Teague	do	Dr	104		6		10-15	do	do	Soft water, no iron.
218	Do	A. W. Higgins	do	Dr	160		6		26	do	do	Soft water.
219	6 miles W of Gibsonville	McLeansville School.	J. R. Cummings	Dr	120		6		12	do		Water contains some iron.
220	Do	A. B. Holt	?	Br	27	27	24	16M		do	Flat	
221	5 miles NW of Gibsonville.	Robah C. LaMarr	Heater Well Co.	Dr	49	42	6	20R	1	do	Hill	
222	5 miles W of Gibsonville	L. L. Bolick	do	Dr	42		6	8R	20	do	Draw	Soft water, no iron.
223	3 miles NW of Gibsonville.	P. E. Lowe	W. P. Phillippi	Cr-Dr	50½	45	2	25R	9½	Greenstone	Slope	Water from quartz vein at 45 to 50 feet.
224	2½ miles NW of Gibsonville	L. G. Loy	do	Cr-Dr	53	30	2		5	do	do	Hardness 35 to 40 parts per million.
225	2 miles NW of Gibsonville.	Friedens Lutheran Church	do	Cr-Dr	148		2		4	do	Flat	
226	1½ miles NW of Gibsonville	Mrs. Eric Summers	W. P. Phillippi	Cr-Dr	48		2			Greenstone	Slope	Water moderately hard, some iron.
227	1¼ miles NW of Gibsonville	W. J. Sockwell	F. L. Smith	Dr	67		6	25R	9	do		Water slightly hard, some iron.
228	1 mile NW of Gibsonville.	R. C. Apple	W. P. Phillippi	Dr	137	18	2		5	do	Hill	
229	Gibsonville	Minneola Mfg. Co.	Sydnor Well Co.	Dr	557	207	8	70R	65	do	Draw	Pumping level reported to be 90 feet below surface.
230	Do	do	do	Dr	436	80	10	50R	50	do	Flat	Water reported to be coming from above 200 feet. Temperature 63° F.

[1], [2], [3] Footnotes given at beginning of table.

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LOG OF WELL 133, 2 MILES SE OF FRIENDSHIP
(Driller's log)

	Thickness (feet)	Depth (feet)
Greenstone schist (?):		
Clay, red	65	65
Sand	5	70
Shale	6	76
Granite, gray	28	104
Granite, bluish	52	156
Granite, very fine-grained, blue	48	204

LOG OF WELL 164, 1 MILE SW OF BATTLEGROUND
(Driller's log, with comments by the writer)

	Thickness (feet)	Depth (feet)
Greenstone schist (?):		
Shale, yellow	51	51
Flint, blue (silicified schist?)	9	62
Flint, dark gray (silicified schist?)	8	70
Granite, gray	8	78
Varied blue stone and quartz	12	90
Rock, green, blue, yellow	5	95

LOG OF WELL 183, 3 MILES NW OF GREENSBORO
(Driller's log)

	Thickness (feet)	Depth (feet)
Sericite schist (?):		
(Old well)	28	28
Clay	30	58
Mud	15	73
Shale, blue	28	101

LOG OF WELL 201 AT GREENSBORO
(Driller's log)

	Thickness (feet)	Depth (feet)
Greenstone schist:		
Soil	3	3
Sandstone, becoming harder	17	20
Blue granite	30	50
Hard gray granite	78	128
Black granite (crevice struck at 144 feet and had to fill in 2 or 3 times to turn tools)	18	146
Dark blue granite, hard	128	274
Blue granite	7	281
Gray granite	1	282

Completion test: Static level 17 feet. Pump setting 218 feet. Pumped 2¼ hours at 225 gallons a minute, 19 hours at 180 gallons a minute. (Well originally 274 feet deep. Deepened to 282 feet in 1944. Samples examined from the last 8 feet of drilling were greenstone schist.)

LOG OF WELL 214, AT EAST EDGE OF GREENSBORO
(Driller's log, with comments by the writer)

	Thickness (feet)	Depth (feet)
Granite:		
Granite, weathered	42	42
Granite, weathered, yellow	29	71
Granite, gray	19	90
Granite, light gray	12	102
Rock, hard, blue (salty dike?)	51	153
Granite, gray	29	182
Granite, light gray	18	200

LOG OF WELL 233, GIBSONVILLE
(Driller's log)

	Thickness (feet)	Depth (feet)
Greenstone schist:		
Clay, red and gray	133	133
Rock, soft, rotten	18	151
Rock, white flint	9	160
Rock, white flint, and blue-green rock	20	180
Rock, soft blue, caving	21	201

LOG OF WELL 299, 1¼ MILES NE OF SEAGRFIELD
(Driller's log)

	Thickness (feet)	Depth (feet)
Greenstone schist:		
Clay, red	22	22
Clay, yellow and sand	23	45
Sand, yellow and blue	7	52
Sand, white	16	68
Sand, white and white flint rock	5	73
Shale, blue	14	87

LOG OF WELL 362, 1¾ MILES NW OF CLIMAX
(Driller's log)

	Thickness (feet)	Depth (feet)
Granite:		
Clay	22	22
Quicksand	5	27
Sandrock	12	39
Granite, gray, hard	111	150

ROCKINGHAM COUNTY

(Area, 572 square miles; population, 57,898)

Geography, physiography, and drainage.—Rockingham County, in the north-central part of the Greensboro area, is the second largest county in the area. There are five incorporated cities and towns in the county and four unincorporated towns and villages. Reidsville is the largest incorporated city, but the combined population of Leaksville-Spray is considerably more, although most of the area is not incorporated. Reidsville has an important cigarette manufacturing industry and Leaksville-Spray has a number of large textile mills. Textile mills and furniture factories are located in the other, smaller towns. Agriculture is the chief occupation outside these towns. Rockingham County has an excellent system of improved highways and is served by three railroad systems.

Rockingham County is in the Piedmont physiographic province, which is characterized by a dissected upland plateau-like surface formed by uplift and partial dissection of a peneplane. Large areas between the larger streams are relatively flat, but near these streams the upland has been dissected and the topography has reached approximate maturity, most of the surface consisting of slopes with little flat upland or lowland. The surface is particularly rugged in a strip several miles wide along the southeast side of the Dan River basin. In this area even the smaller streams tributary to the Dan have cut down several hundred feet below the upland surface. The basin of Dan River, formed in Triassic rocks, possibly should be considered as a separate division of the Piedmont province, because it is much lower and has had a different physi-

REFERENCE NO. 5

R. Allan Freeze

Department of Geological Sciences
University of British Columbia
Vancouver, British Columbia

John A. Cherry

Department of Earth Sciences
University of Waterloo
Waterloo, Ontario

GROUNDWATER

Prentice-Hall, Inc.
Englewood Cliffs, New Jersey 07632

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

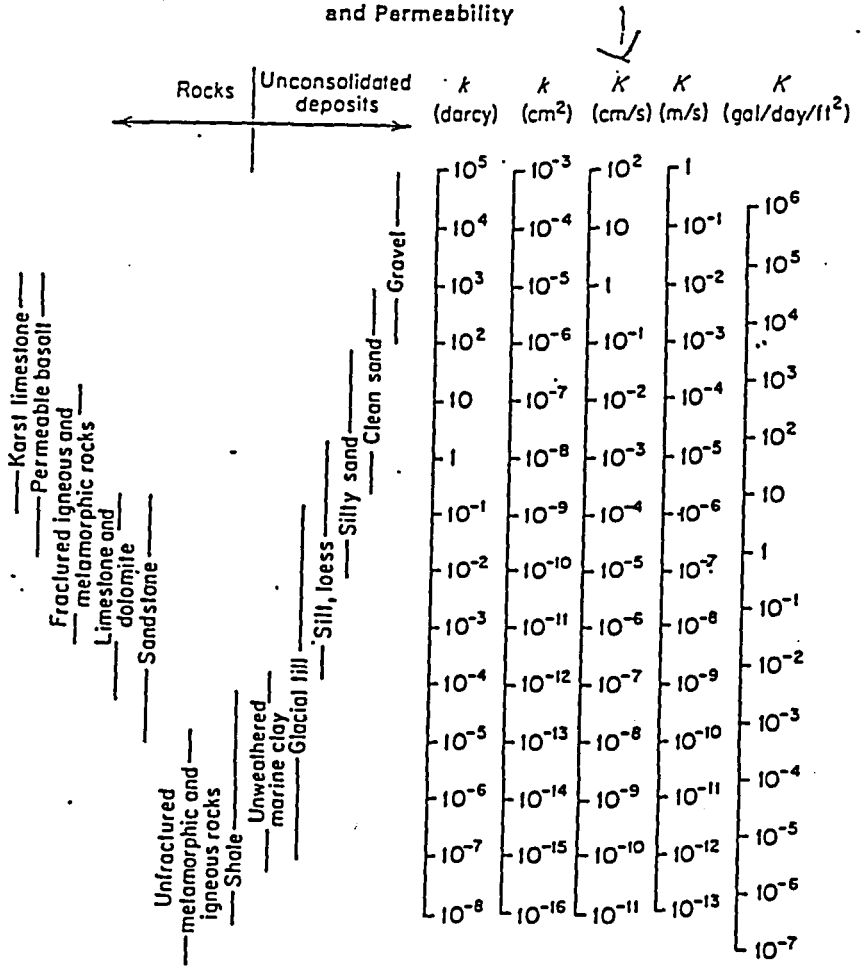
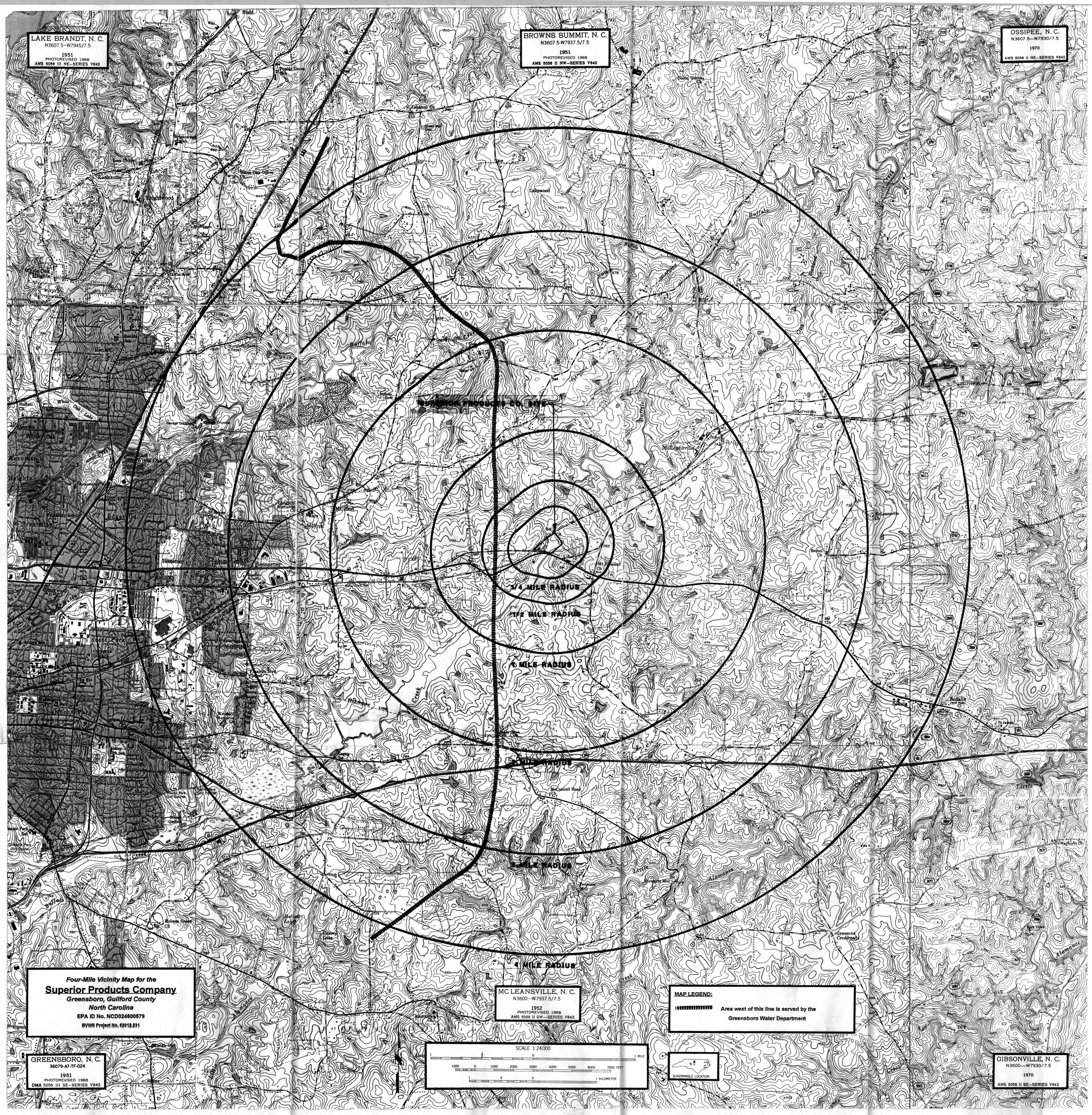


Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	5.74×10^{5}
gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.74×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.


LAKE BRANDT, N. C.
N3607.5—W7945/7.5
1951
PHOTOREVISED 1968
AMS 5056 III NE—SERIES V842
BROWNS SUMMIT, N. C.
N3607.5-W7937.5/7.5
1951
PHOTOREVISED 1968
AMS 5056 II NW—SERIES V842
OSSIPEE, N. C.
N3607.5—W7930/7.5
1970
AMS 5056 II NE—SERIES V842
1/4 MILE RADIUS
1/2 MILE RADIUS
1 MILE RADIUS
2 MILE RADIUS
3 MILE RADIUS
4 MILE RADIUS
Four-Mile Vicinity Map for the
Superior Products Company
Greensboro, Guilford County
North Carolina
EPA ID No. NCD024600579
BVWS Project No. 82012.331
GREENSBORO, N. C.
36079-A7-TF-024
1951
PHOTOREVISED 1968
DMA 5056 III SE—SERIES V842
MC LEANSVILLE, N. C.
N3600—W7937.5/7.5
1952
PHOTOREVISED 1968
AMS 5056 II SW—SERIES V842
MAP LEGEND:
Area west of this line is served by the
Greensboro Water Department
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
QUADRANGLE LOCATION
GIBSONVILLE, N. C.
N3600—W7930/7.5
1970
AMS 5056 II SE—SERIES V842

REFERENCE NO. 6

BLACK & VEATCH Waste Science, Inc.
Philadelphia Office

TELEPHONE MEMORANDUM

U.S. EPA - Region IV
Greensboro City Landfill
Public Water Supply in Greensboro, NC

B&V Project 52012.218
B&V File C
June 8, 1994
1430h

To: Mrs. Clark
Company: Greensboro City Water Department
Phone No.: (910) 373-2055

Recorded by: Corry T. Platt

I called the Greensboro City Water Department (GWD) to inquire about the sources of public water and the service area within the Greensboro City Landfill area. Mrs. Clark said the City of Greensboro obtains its potable water from three lakes in the Greensboro area. The lakes are Lake Townsend, Lake Higgins, and Lake Brant. In addition to serving approximately 79,000 metered connections, the GWD sells water to Guilford County.

In the Greensboro City Landfill site area the GWD provides drinking water to residents within the city limits. Within 4 miles of the Greensboro City Landfill site the GWD provides drinking water to resident of and west of Rt. 29, along Huffine Mill Road to the State Prison, and south from the State Prison towards South Buffalo Creek.

Residents not served by the GWD within 4 miles of the Greensboro City Landfill obtain their drinking water from private groundwater wells.

Note: Following Mrs. Clark's description of the service area, the extent of the GWD service area was approximately located on the Greensboro City Landfill 4 mile vicinity map.

REFERENCE NO. 7

BLACK & VEATCH Waste Science, Inc.

MEMORANDUM

U.S. EPA-Region IV
Superior Products Co.
Results of Calculation of Air and Groundwater Populations

BVWS Project 52012.231
BVWS File N
July 5, 1994

To: Superior Products Co. File

From: Robert Martel

I calculated the population residing within 4 miles using a house count method and GEMS database results, and the population served by private wells within 4 miles of the Superior Products Company site using a house count method. The population residing within four miles was determined by counting the houses in the 0-¼, ¼-½, ½-1, and 1-2 mile rings depicted on the 4 mile map and then multiplying the number of houses per ring by the Guilford County population per household value of 2.44 persons. The population residing within 2-4 miles of the site was calculated using the GEMS database results. The results of the population within 4 miles of the site are depicted in Table 1.

The population served by groundwater within 4 miles was determined by counting the number of houses in each ring depicted on the 4 mile map not served by the Greensboro City Water Department public water system and then multiplying the number of houses per ring by the Guilford County population per household value of 2.44 persons. The results are depicted in Table 2.

TABLE 1
Population within 4 miles of the
Superior Products Company Site

Distance Ring (miles)	Population
0 - ¼	149[1]
¼ - ½	95[1]
½ - 1	544[1]
1 - 2	1,857[1]
2 - 3	1,759[2]
3 - 4	3,376[2]
Total	**7,780**

Note:
[1] References 3, 8
[2] Reference 10

TABLE 2
Population Served by Private Wells within 4 miles
of the Superior Products Company Site

Distance Ring (miles)	Houses Counted	County Population per Household[1]	Population
0 - ¼	61	2.44	149
¼ - ½	32	2.44	78
½ - 1	132	2.44	322
1 - 2	431	2.44	1,052
2 - 3	468	2.44	1,142
3 - 4	482	2.44	1,176
Total	1,606		3,919

Note:
[1] Reference 8

REFERENCE NO. 8

U.S. Department of Commerce
Economics and Statistics Administration
BUREAU OF THE CENSUS

1990 CPH-1-35

CENSUS '90

1990 Census of Population and Housing

Summary Population and Housing Characteristics

North Carolina

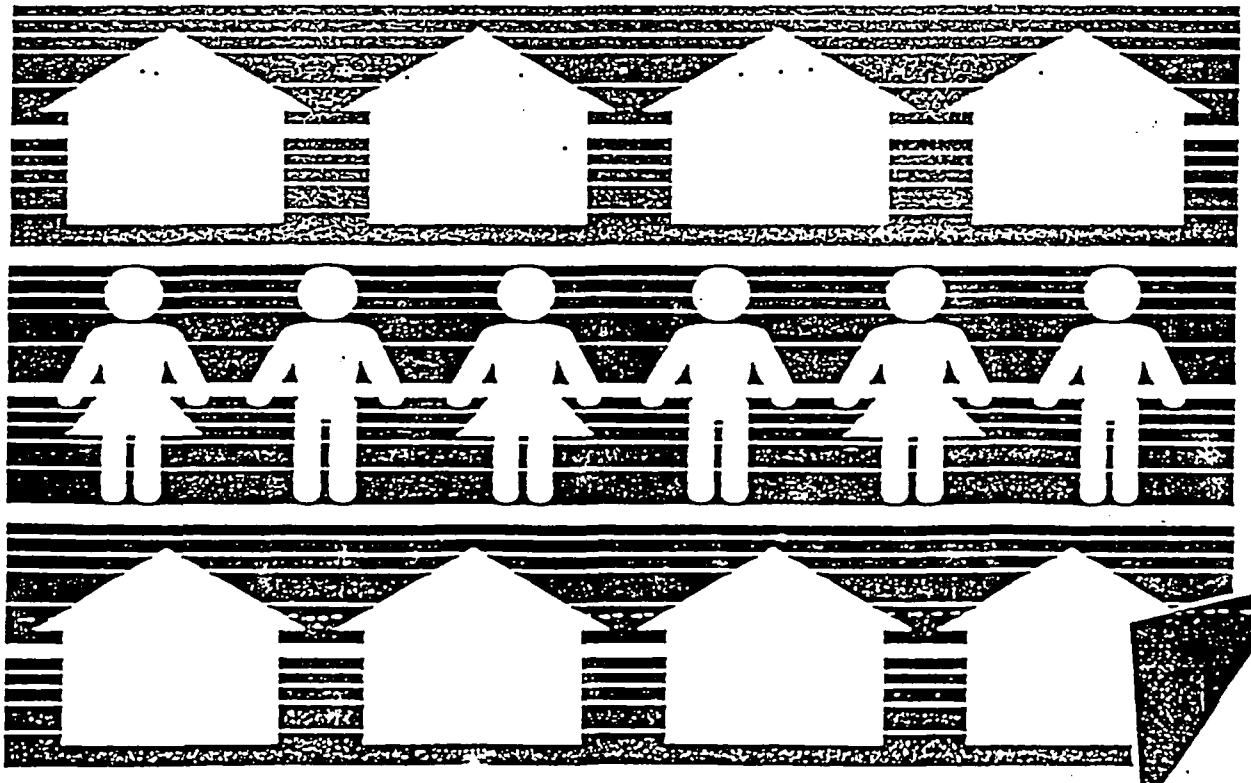


Table 6. Household, Family, and Group Quarters Characteristics: 1990

[For definitions of terms and meanings of symbols, see text]

State County and [In Selected States] County Subdivision	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Nonfamily households: Householder living alone: Total	Nonfamily households: Householder living alone: 65 years and over: Total	Nonfamily households: Householder living alone: 65 years and over: Female	Persons per— Household	Persons per— Family	Persons in group quarters: Total	Persons in group quarters: Institutionalized persons	Persons in group quarters: Other persons in group quarters
The State	6 404 167	2 517 026	1 812 053	1 424 206	309 876	704 973	596 959	226 384	182 329	2.54	3.03	224 470	83 400	141 070
COUNTY														
Alamance County	105 327	42 652	30 745	24 295	5 130	11 907	10 467	4 598	3 748	2.47	2.94	2 886	1 173	1 713
Alexander County	27 245	10 331	8 049	6 715	952	2 282	2 022	839	651	2.64	3.02	299	299	–
Alleghany County	9 381	3 894	2 829	2 421	303	1 065	990	539	433	2.41	2.88	209	193	16
Anson County	23 117	8 531	6 359	4 552	1 475	2 172	2 042	1 075	860	2.71	3.23	357	344	13
Ashe County	21 965	8 848	6 748	5 643	816	2 100	1 935	1 014	809	2.48	2.89	244	220	24
Avery County	13 918	5 520	4 162	3 500	480	1 358	1 229	549	420	2.52	2.95	949	320	629
Beaufort County	41 704	16 157	11 840	9 140	2 186	4 317	3 915	1 974	1 605	2.58	3.07	579	441	138
Bertie County	20 321	7 412	5 501	3 831	1 419	1 911	1 797	957	755	2.74	3.28	67	67	–
Bladen County	28 150	10 760	8 017	5 854	1 762	2 743	2 579	1 243	1 000	2.62	3.11	513	509	4
Brunswick County	50 497	20 069	15 291	12 636	2 031	4 778	4 227	1 640	1 194	2.52	2.91	488	307	181
Buncombe County	169 713	70 802	49 335	39 637	7 684	21 467	18 868	8 174	6 642	2.40	2.90	5 108	2 966	2 142
Burke County	73 281	29 184	21 711	17 462	3 148	7 473	6 589	2 706	2 228	2.51	2.93	2 463	2 410	53
Cabarrus County	97 255	37 515	28 367	23 279	3 972	9 148	8 038	3 599	2 971	2.59	3.02	1 680	1 223	457
Caldwell County	69 917	27 172	20 656	16 653	2 944	6 516	5 660	2 287	1 846	2.57	2.97	792	735	57
Camden County	5 875	2 180	1 692	1 385	225	488	437	234	169	2.69	3.11	29	–	29
Carteret County	51 554	21 238	15 276	12 681	2 021	5 962	5 081	1 901	1 431	2.43	2.88	1 002	750	252
Caswell County	20 053	7 468	5 781	4 454	1 024	1 687	1 593	727	573	2.69	3.13	640	624	16
Catawba County	116 387	45 700	33 773	27 418	4 841	11 927	10 270	3 844	3 115	2.55	2.99	2 025	1 134	891
Chatham County	38 315	15 293	11 227	9 115	1 605	4 066	3 445	1 412	1 141	2.51	2.95	444	377	67
Cherokee County	19 899	7 966	6 069	5 065	765	1 897	1 764	975	759	2.50	2.91	271	196	75
Chowan County	13 233	5 113	3 775	2 842	767	1 338	1 238	641	499	2.59	3.07	273	273	–
Clay County	7 150	2 928	2 177	1 894	203	751	699	418	314	2.44	2.90	5	4	1
Cleveland County	83 012	32 037	24 282	19 011	4 168	7 755	7 011	3 202	2 624	2.59	3.02	1 702	915	787
Columbus County	48 953	18 459	13 754	10 381	2 757	4 705	4 351	2 152	1 695	2.65	3.15	634	624	10
Craven County	78 014	29 542	22 481	18 189	3 511	7 061	6 121	2 436	1 930	2.64	3.07	3 599	811	2 788
Cumberland County	253 362	91 500	69 966	54 433	12 883	21 534	17 718	4 724	3 752	2.77	3.19	21 204	1 499	19 705
Currituck County	13 486	5 038	3 854	3 272	407	1 184	984	419	312	2.68	3.08	250	217	33
Dare County	22 542	9 349	6 425	5 498	682	2 924	2 264	714	522	2.41	2.88	204	140	64
Davidson County	125 358	48 944	37 176	30 410	5 120	11 768	10 262	4 189	3 319	2.56	2.96	1 319	1 277	42
Davie County	27 541	10 785	8 270	6 999	953	2 515	2 246	1 025	817	2.55	2.95	318	288	30
Duplin County	39 368	14 925	11 036	8 376	2 099	3 889	3 553	1 779	1 439	2.64	3.12	627	560	67
Durham County	173 310	72 297	45 985	33 614	10 321	26 312	20 860	5 553	4 471	2.40	2.99	8 525	2 175	6 350
Edgecombe County	55 856	20 319	15 085	10 000	4 293	5 234	4 703	2 124	1 717	2.75	3.25	702	657	45
Forsyth County	257 466	107 419	72 621	55 715	14 052	34 798	29 870	9 779	7 975	2.40	2.94	8 412	3 493	4 919
Franklin County	35 237	13 503	10 047	7 640	1 865	3 456	3 120	1 384	1 126	2.61	3.07	1 177	568	609
[illegible] County	172 791	65 347	49 754	38 905	8 439	15 593	13 580	5 720	4 720	2.64	3.07	2 302	1 458	844
[illegible] County	9 202	3 352	2 593	2 040	404	759	705	394	288	2.75	3.19	103	102	1
[illegible] County	7 176	2 772	2 166	1 839	246	606	562	294	225	2.59	2.98	20	18	2
Gaston County	35 191	13 134	9 883	7 501	1 857	3 251	2 889	1 236	978	2.68	3.13	3 154	3 079	75
Greene County	14 665	5 395	4 066	3 003	875	1 329	1 189	574	481	2.72	3.18	719	704	15
Guilford County	335 348	137 706	97 891	71 195	17 570	44 815	36 578	12 180	9 951	2.44	2.97	12 072	3 084	8 988
Halifax County	54 122	20 335	14 874	10 092	4 018	5 461	5 005	2 398	1 897	2.66	3.18	1 394	1 356	38
Harnett County	65 340	25 150	18 529	14 489	3 154	6 621	5 773	2 438	1 962	2.60	3.06	2 482	1 240	1 242
Haywood County	46 152	19 211	14 120	11 831	1 774	5 091	4 601	2 337	1 886	2.40	2.83	790	751	39
Henderson County	68 206	28 709	21 169	18 113	2 344	7 540	6 838	3 531	2 859	2.38	2.80	1 079	967	112
Hertford County	21 612	8 150	5 921	4 164	1 473	2 229	2 063	977	766	2.65	3.19	911	279	632
Hoke County	21 612	7 405	5 794	3 847	1 605	1 611	1 419	523	420	2.92	3.34	1 244	1 244	–
Hyde County	5 383	2 094	1 533	1 151	321	561	516	269	191	2.57	3.07	28	19	9
Iredell County	92 082	35 573	26 869	21 726	4 023	8 704	7 646	3 271	2 682	2.59	3.02	849	814	35
Jackson County	23 834	9 683	6 970	5 749	981	2 713	2 242	966	745	2.46	2.91	3 012	280	2 732
Johnston County	80 341	31 566	23 217	18 566	3 634	8 349	7 441	3 380	2 750	2.55	3.01	965	893	72
Jones County	9 412	3 492	2 639	2 034	482	853	774	406	311	2.70	3.17	2	2	–
Lee County	40 651	15 689	11 739	9 087	2 135	3 950	3 482	1 369	1 107	2.59	3.03	723	672	51
Lenoir County	55 652	21 938	15 611	11 131	3 798	6 327	5 706	2 580	2 073	2.54	3.06	1 622	1 559	63
Lincoln County	49 802	18 764	14 661	12 207	1 827	4 103	3 580	1 467	1 173	2.65	3.03	517	517	–
McDowell County	35 064	13 680	10 366	8 576	1 363	3 314	2 996	1 399	1 135	2.56	2.99	617	416	201
Macon County	22 992	9 834	7 235	6 236	773	2 599	2 388	1 307	1 021	2.34	2.76	507	233	274
Madison County	16 104	6 488	4 806	4 058	516	1 682	1 510	789	581	2.48	2.92	849	104	745
Martin County	24 813	9 317	6 900	5 087	1 518	2 417	2 213	1 100	906	2.66	3.17	265	257	8
Mecklenburg County	499 886	200 219	134 361	103 211	25 013	65 858	52 037	12 990	10 610	2.50	3.05	11 547	3 578	7 969
Mitchell County	14 288	5 779	4 420	3 777	479	1 359	1 265	669	539	2.47	2.88	145	130	15
Montgomery County	22 279	8 290	6 274	4 823	1 119	2 016	1 838	876	690	2.69	3.14	1 067	997	70
Moore County	58 010	23 827	17 483	14 312	2 473	6 344	5 662	2 744	2 201	2.43	2.87	1 003	970	33
Nash County	75 450	29 041	21 224	16 322	3 968	7 817	6 926	2 880	2 316	2.60	3.09	1 227	807	420
New Hanover County	116 999	48 139	32 400	24 723	6 383	15 739	12 434	4 372	3 512	2.43	2.95	3 285	1 321	1 964
Northampton County	20 055	7 591	5 644	3 958	1 436	1 947	1 816	968	704	2.64	3.13	743	742	1
Onslow County	115 274	40 658	32 971	28 037	3 843	7 687	6 271	1 752	1 384	2.84	3.16	34 564	954	33 610
Orange County	84 627	36 104	21 123	16 854	3 380	14 981	10 110	2 257	1 839	2.34	2.93	9 224	770	8 454
Pamlico County	11 247	4 523	3 382	2 717	547	1 141	1 055	528	410	2.49	2.93	125	112	13
Pasquotank County	29 884	11 384	8 326	6 356	1 681	3 058	2 725	1 342	1 065	2.63	3.13	1 414	383	1 031
Pender County	28 497	11 112	8 420	6 707	1 371	2 692	2 388	1 055	796	2.56	2.99	358	348	10
Perquimans County	10 303	3 988	3 038	2 444	468	950	862	443	342	2.58	3.02	144	144	–
Person County	29 830	11 423	8 570	6 607	1 547	2 853	2 608	1 209	994	2.61	3.07	350	304	46
Pitt County	102 400	40 491	26 434	19 369	5 857	14 057	10 412	3 104	2 511	2.53	3.10	5 524	946	4 578
Polk County	14 187	6 110	4 346	3 693	511	1 764	1 599	952	768	2.32	2.79	229	227	2
Randolph County	105 440	41 096	31 363	26 135	3 957	9 733	8 590	3 435	2 789	2.57	2.97	1 106	1 050	56
Richmond County	43 534	16 793	12 270	9 126	2 551	4 523	4 174	2 011	1 650	2.59	3.11	984	875	109
Robeson County	103 186	36 154	27 429	18 451	7 353	8 725	7 891	3 355	2 651	2.85	3.34	1 993	1 280	713
Rockingham County	85 242	33 446	24 671	19 351	4 193	8 775	7 959	3 569	2 982	2.55	3.02	822	781	41
Rowan County	107 079	42 512	31 055	25 100	4 618	11 457	10 236	4 748	3 815	2.52	2.99	3 526	2 408	1 118
Rutherford County	56 197	22 198	16 480	13 191	2 551	5 718	5 255	2 556	2 050	2.53	2.99	721	721	–
Sampson County	46 754	17 526	13 191	10 058	2 525	4 335	3 975	2 032	1 610	2.67	3.14	543	490	53
Scotland County	32 679	11 837	8 971	6 225	2 338	2 866	2 618	1 173	935	2.76	3.25	1 075	401	674
Stanly County	50 734	19 747	14 967	12 451	1 975	4 780	4 396	2 164	1 725	2.57	3.01	1 031	470	561
Stokes County	36 862	14 123	11 022	9 341	1 273	3 101	2 825	1 246	1 016	2.61	3.00	361	361	–
Surry County	60 950	24 252	18 252	15 253	2 341	6 000	5 474	2 732	2 256	2.51	2.94	754	650	104
Swain County	10 653	4 173	3 063	2 382	550	1 090	985	467	369	2.55	3.01	615	215	400
Transylvania County	24 283	9 924	7 496	6 442	797	2 428	2 224	1 131	912	2.45	2.86	1 237	178	1 059
Tyrrell County	3 852	1 471	1 075	810	213	393	359	208	148	2.62	3.13	4	4	–
Union County	82 633	29 307	23 530	19 607	3 063	5 777	5 018	2 148	1 755	2.87	3.18	1 578	455	1 123

REFERENCE NO. 9

BLACK & VEATCH Waste Science, Inc.
Philadelphia Office

TELEPHONE MEMORANDUM

U.S. EPA - Region IV
North Carolina General
Wellhead Protection Areas

B&V Project multiple
B&V File C
March 23, 1994
1330h

To: Randy Prillaman
Company: NC DEM, Groundwater Section
Phone No.: (919) 733-7015

Recorded by: Corry T. Platt

I called Mr. Randy Prillaman to determine if Wellhead Protection Areas have been delineated within the State of North Carolina. Mr. Prillaman said that Wellhead Protection Areas have not yet been delineated within North Carolina.

Mr. Prillaman said there is a pilot study occuring in Gaston County regarding Wellhead Protection Areas (WHPA) and currently the state is awaiting notice from the U.S. EPA if their grant for the delineation of WHPAs will be funded. If funding is granted, then work on the the delineations will begin. He is unsure when the delineations would be complete if funding was to be recieved this year. He recommended following up on this phone call later in the year (October or November) to find out if any guidance has been written.

Corry T. Platt

REFERENCE NO. 10

USEPA Graphical Exposure Modeling System (GEMS) Data Down Load by R. Martel
07/04/94

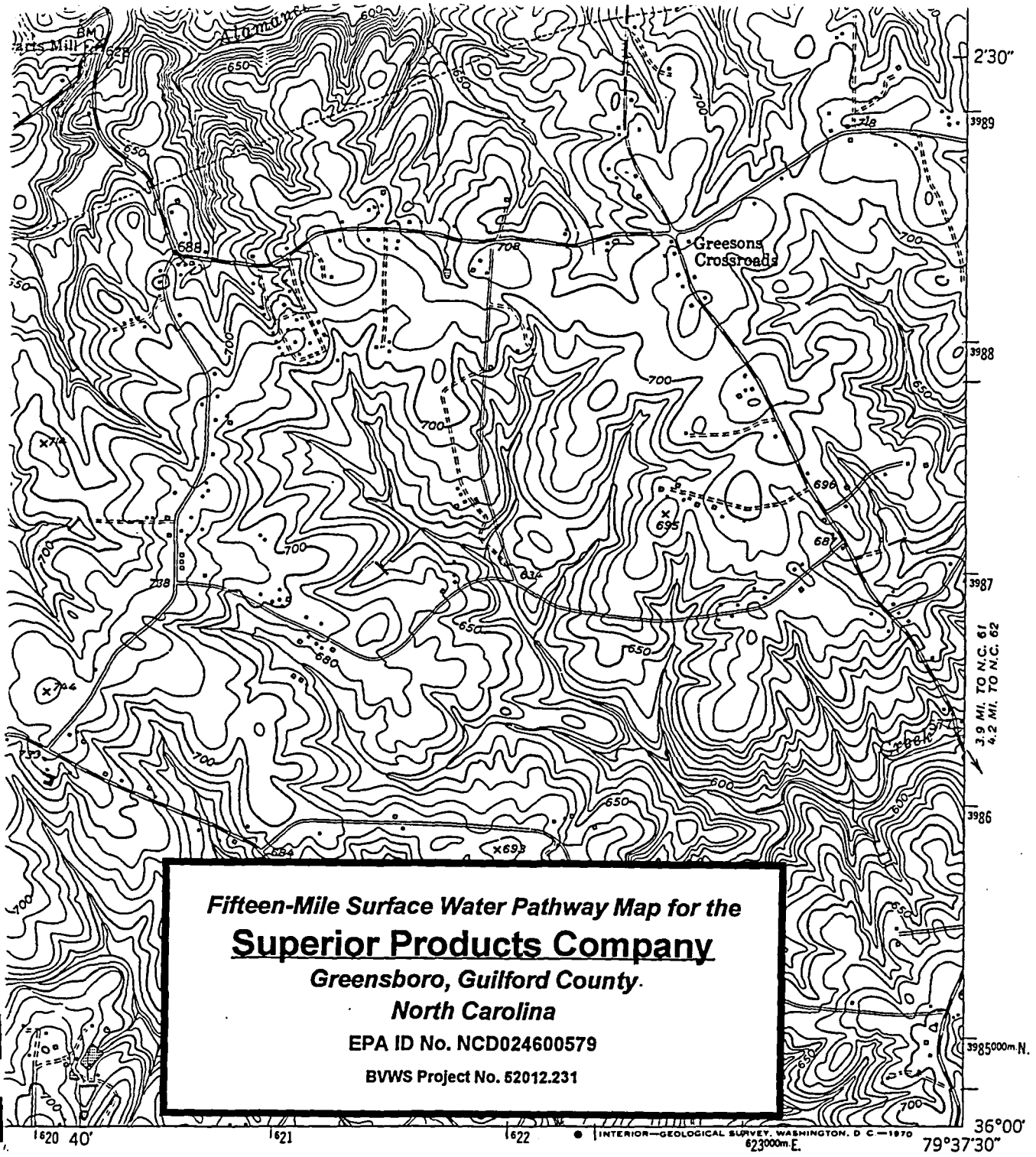
CENSUS DATA

Superior Products Co.
LATITUDE 36: 5:21 LONGITUDE 79:40:22 1990 HOUSING

KM	0.00-.400	.400-.800	.800-1.60	1.60-3.20	3.20-4.80	4.80-6.40	SECTOR TOTALS
S 1	0	0	0	185	1061	0	1246
S 2	0	0	0	0	694	242	936
S 3	0	0	0	0	4	229	233
S 4	0	0	0	0	0	176	176
S 5	0	0	326	0	0	548	874
S 6	0	0	0	0	0	816	816
S 7	0	0	0	835	0	1365	2200
S 8	0	0	0	0	0	0	0
RING TOTALS	0	0	326	1020	1759	3376	6481

Press RETURN key to continue ...
ANSILG ONRINH0:09600 7E1 [Home]=Menu FDX 8 LF X

REFERENCE NO. 11



1 MILE

ROAD CLASSIFICATION

Heavy-duty — Light-duty

Medium-duty — Unimproved dirt

Interstate Route — U.S. Route — State Route

QUADRANGLE LOCATION

MC LEANSVILLE, N. C.

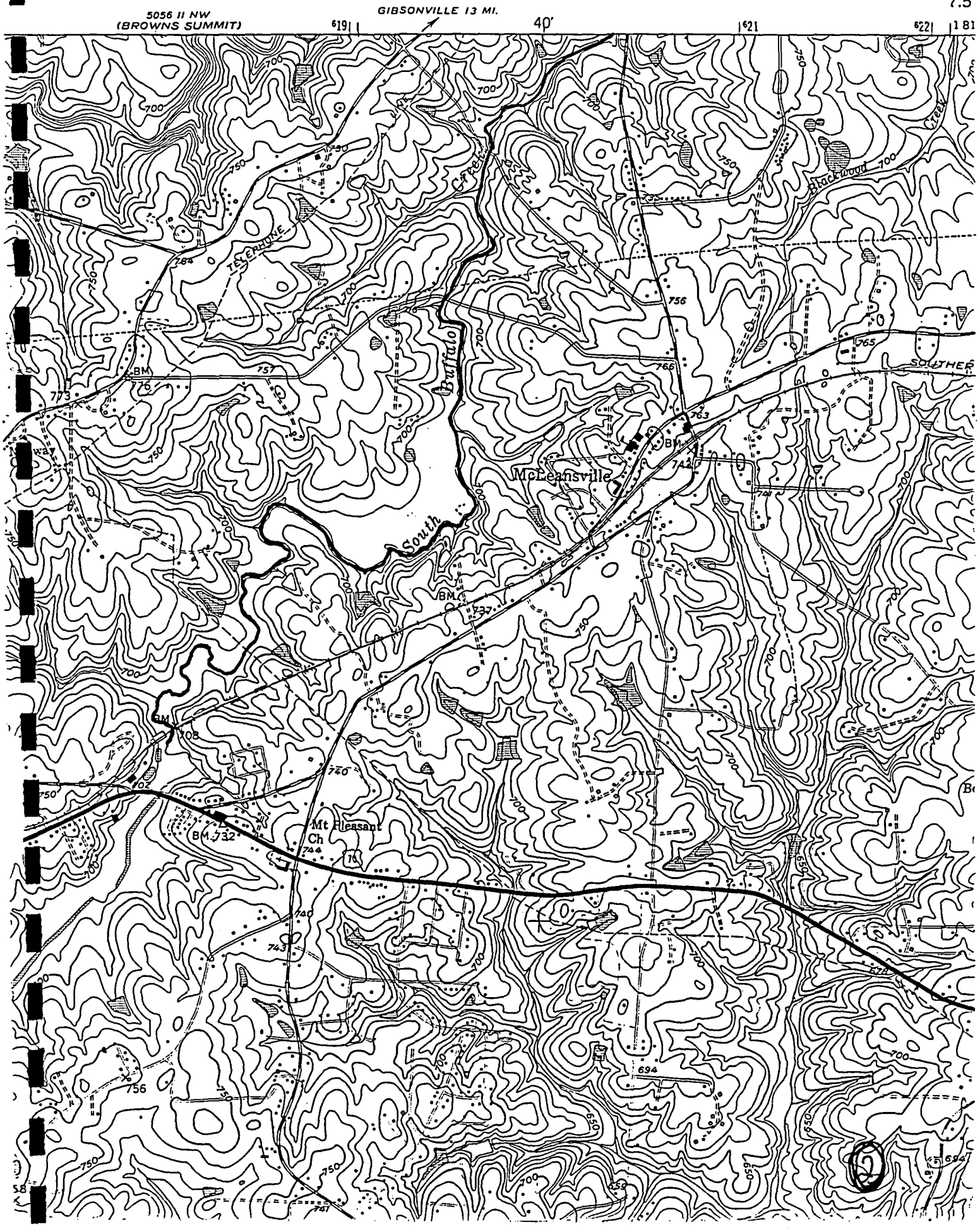
N3600—W7937.5/7.5

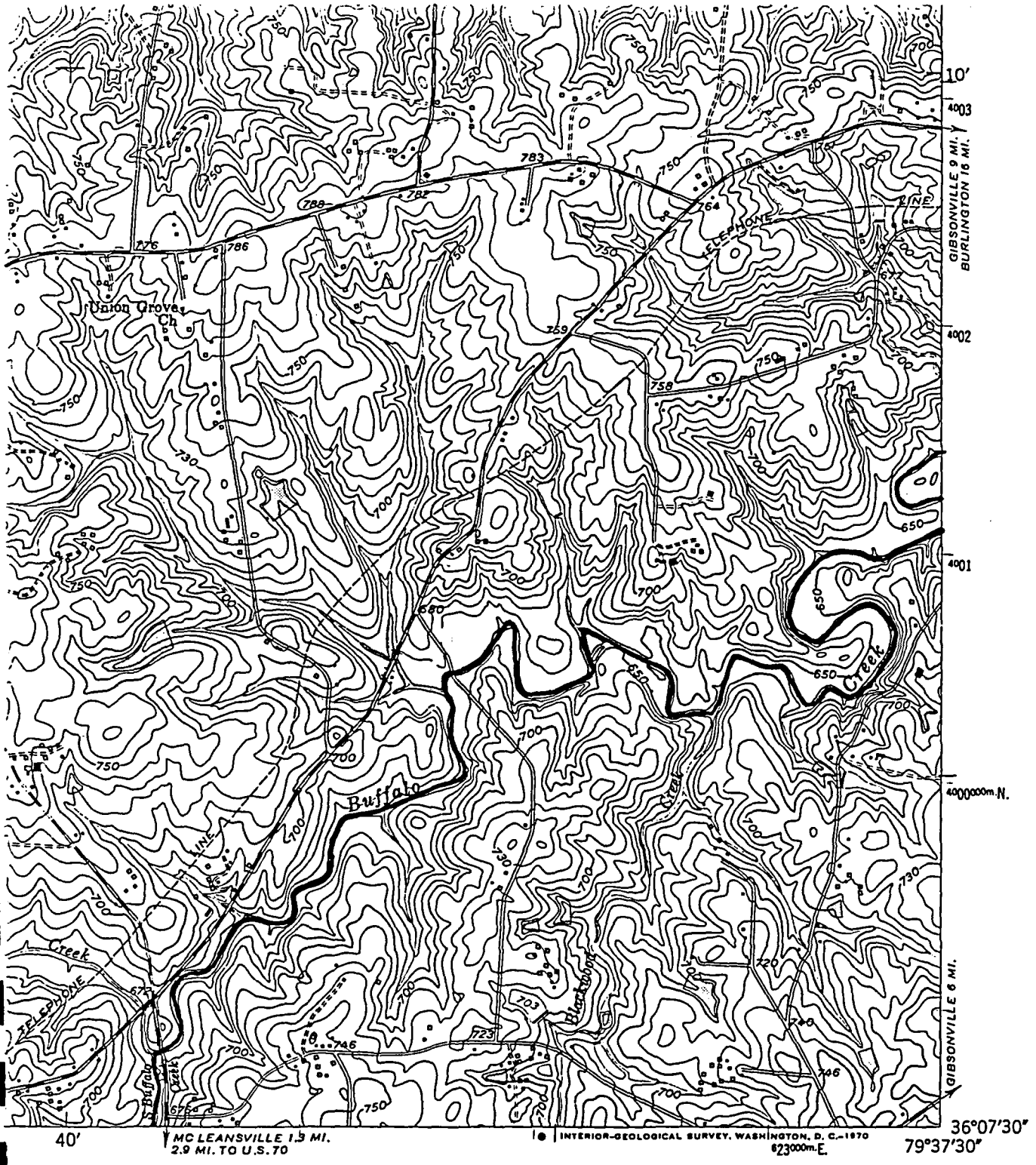
1952

PHOTOREVISED 1968

AMS 5056 II SW—SERIES V842

1


5056 II NW
(BROWNS SUMMIT)
GIBSONVILLE 13 MI.
40'
7.5
TELEPHONE
Buffalo
Creek
South
Blackwood
Creek
McLeansville
Mt Pleasant
Ch
BM 732
BM 708
BM 737
BM 742
BM 763
BM 773
SOUTHER



MILE

ROAD CLASSIFICATION

Heavy-duty ——— Light-duty ———

Medium-duty ——— Unimproved dirt - - - - -

U. S. Route State Route

QUADRANGLE LOCATION

BROWNS SUMMIT, N. C.

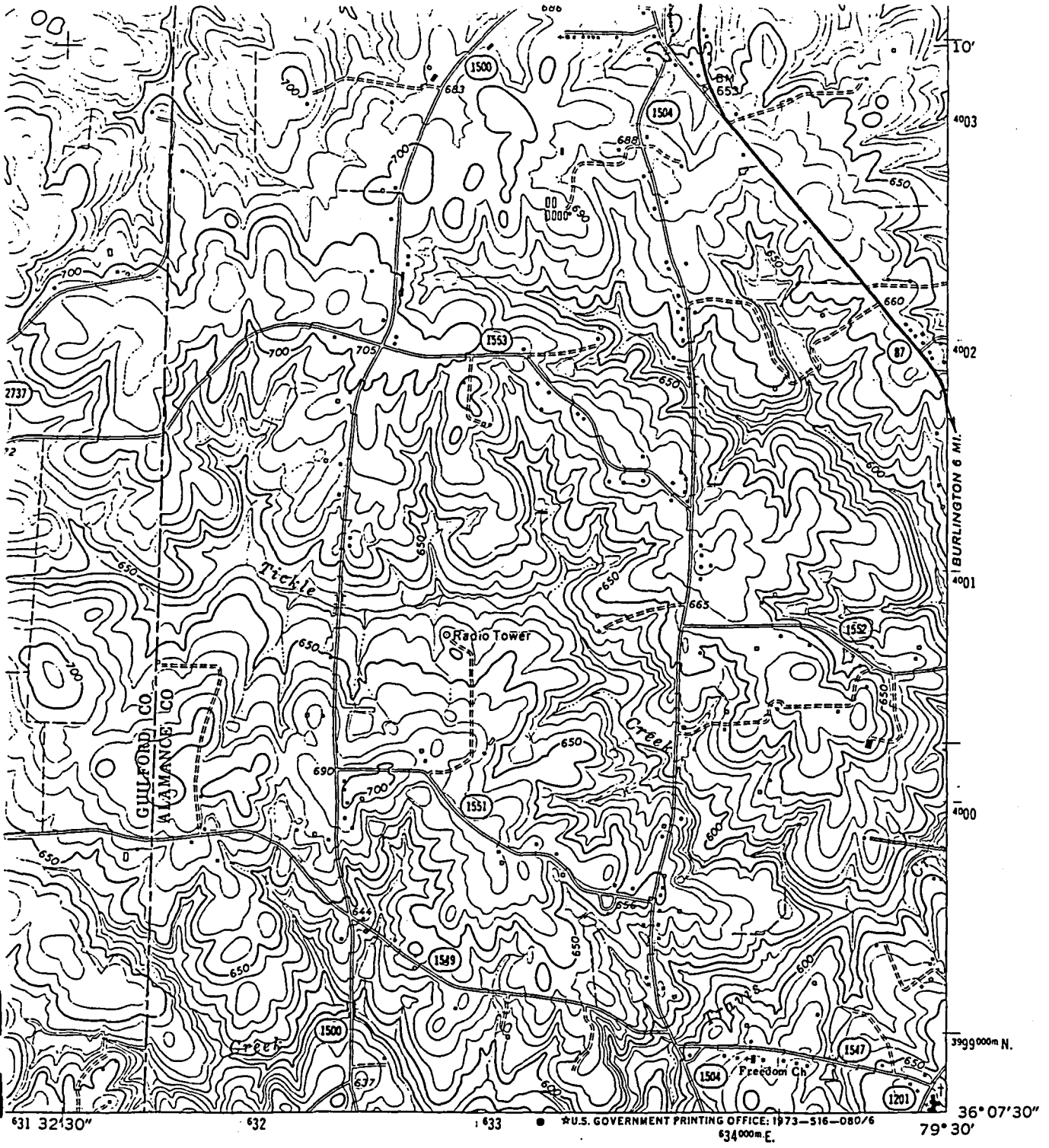
N3607.5-W7937.5/7.5

1951

PHOTOREVISED 1968

AMS 5056 II NW—SERIES V842

3



★U.S. GOVERNMENT PRINTING OFFICE: 1973—516—080/6

MILE

(BURLINGTON)
5156 III SW

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

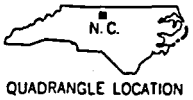
Secondary highway, hard surface

Unimproved road

Interstate Route

U. S. Route

State Route



QUADRANGLE LOCATION

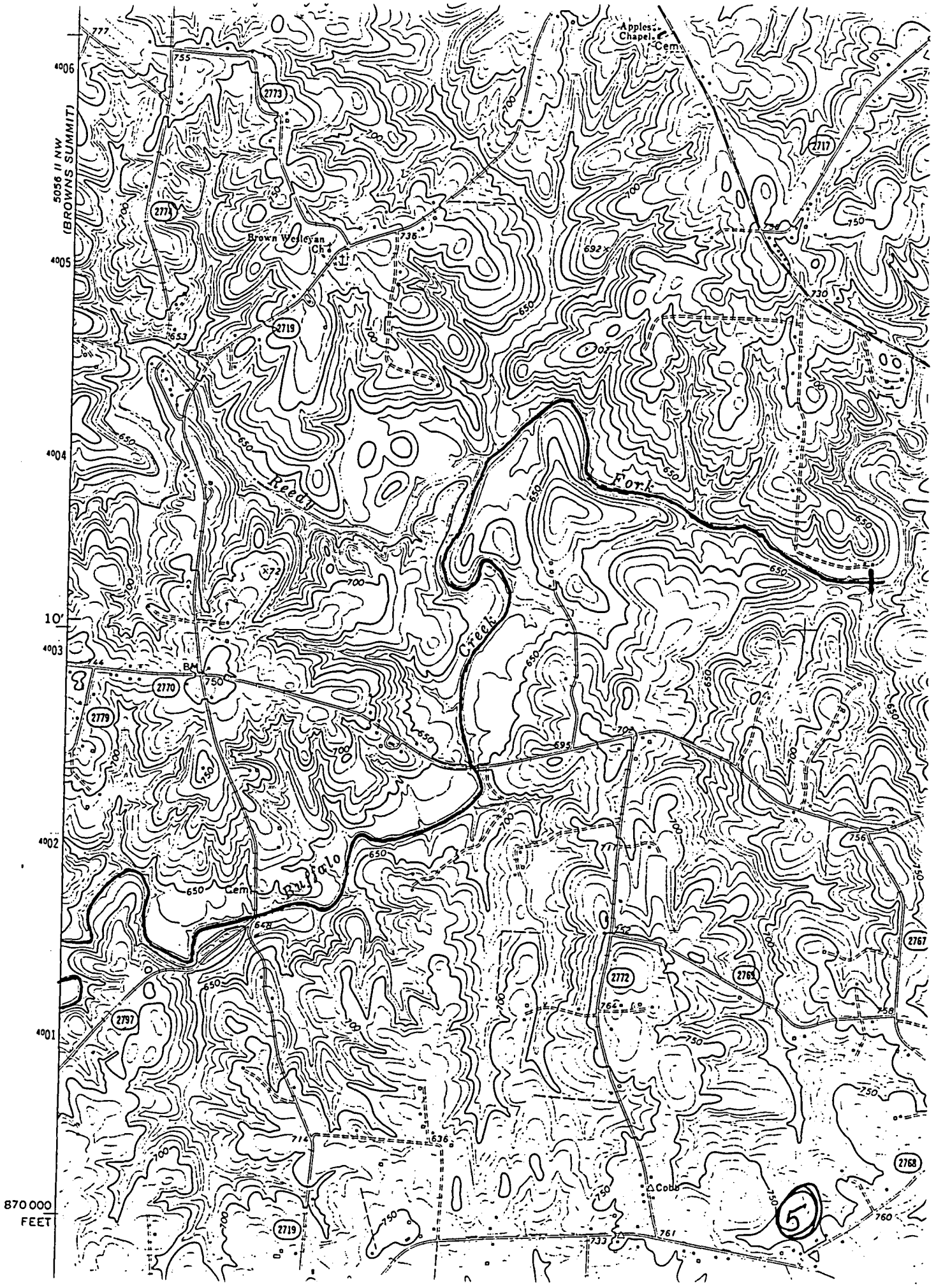
OSSIPEE, N. C.

N3607.5—W7930/7.5

1970

AMS 5056 II NE—SERIES V842

4


5056 II NW
(BROWNS SUMMIT)
Apples Chapel
Cem
Brown Wesleyan Ch
Reedy
Fork
Creek
Buffalo
Cem
BM
Cobb
870 000
FEET
10'
4006
4005
4004
4003
4002
4001
2773
2774
2717
2719
2770
2779
2797
2772
2768
2767
5

REFERENCE NO. 12

BLACK & VEATCH ENGINEERS-ARCHITECTS

Owner USEPA
Plant Superior Products Co. Unit
Project No. 52012-231 File No.
Title Calculation of Flow Rates in the Surface Water Pathway

Computed By R. Martel
Date 07/05 1994
Checked By
Date 19
Page 1 of 1

Drainage Area of Reedy Fork near Gibsonville, NC = 131 mi²
Average Annual Flow rate of Reedy Fork, near Gibsonville, NC = 102 cfs

Drainage Area of Buffalo Creek = 97.4 mi²

Calculate Average Annual Flow rate:

$$\frac{102 \text{ cfs}}{131 \text{ mi}^2} = \frac{X}{97.4 \text{ mi}^2} \qquad X = 75.8 \text{ cfs}$$

Drainage Area of South Buffalo Creek = 43.5 mi²

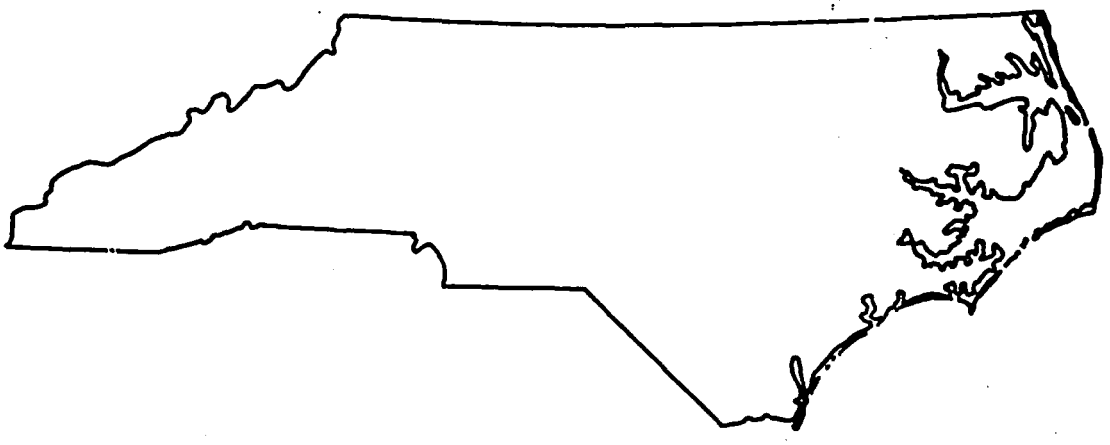
$$\frac{102 \text{ cfs}}{131 \text{ mi}^2} = \frac{y}{43.5 \text{ mi}^2} \qquad y = 33.8 \text{ cfs}$$

DO NOT WRITE IN THIS SPACE

PGN-175A

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

Water Resources Data
North Carolina
Water Year 1992



U.S. GEOLOGICAL SURVEY WATER-DATA REPORT NC-92-1
Prepared in cooperation with the North Carolina Department of Environment, Health, and Natural Resources, and with other State, municipal, and Federal agencies

Station number	Station name	Drainage area (mi²)	Period of record
	Cape Fear River Basin		
0209330990	Brooks Lake tributary near Browns Summit (d)	0.06	1985-90
0209331325	Candy Creek at SR 2700 near Monticello (d)	1.10	1985-90
02093500	Haw River near Benaja (d)	168	1928-71
02094000	Horsepen Creek at Battle Ground (d)	15.9	1925-31
			1934-59
02095000	S Buffalo Creek near Greensboro (d)	33.6	1928-58
0209509100	S Buffalo Creek at SR 2821 at McLeansville (d)	43.5	1986-88
02095500	North Buffalo Creek near Greensboro (d)	37.1	1929-90
0209555450	Buffalo Creek at SR 2719 near Osceola (d)	97.4	1986-87
0209560800	Reedy Fork Creek at NC 61 near Osceola (d)	243	1986-88
02096000	Stony Creek near Burlington (d)	44.2	1952-59
02096700	Big Alamance Creek near Elon College (d)	116	1957-80
02096842	Cane Creek 0.1 m upst SR 1126 near Buckhorn (d)	.64	1979-81
02096850	Cane Creek near Teer (d)	33.7	1959-73
02097000	Haw River near Pittsboro (d)	1,310	1928-73
02097243	Third Fork Creek at Durham (d)	16.7	1968-73
02097500	Morgan Creek near Chapel Hill (d)	30.1	1923-32
0209782150	New Hope River Trib at SR 1716 nr Farrington (d)	2.05	1986-88
02098000	New Hope River near Pittsboro (d)	285	1949-73
02098500	West Fork Deep River near High Point (d)	32.1	1923-26
			1928-58
02100000	Muddy Creek near Archdale (d)	16.7	1934-41
02101000	Bear Creek at Robbins (d)	134	1939-71
0210108450	Suck Creek Trib near Zion Grove (d)	.67	1986-88
02101800	Tick Creek near Mount Vernon Springs (d)	15.5	1958-81
02103000	Little River at Manchester (d)	348	1938-50
02103500	Little River at Linden (d)	460	1928-71
02104000	Cape Fear River at Fayetteville	4,395	1889-1903
			1928-40
02104387	Buckhead Creek near Owens (d)	2.62	1976-80
02104500	Rockfish Creek near Hope Mills (d)	284	1929-31
			1939-54
02105524	Ellis Creek Trib at SR 1325 near White Oak (d)	1.81	1979-81
02105900	Hood Creek near Leland (d)	21.6	1956-73
02106000	Little Coharie Creek near Roseboro (d)	92.8	1950-92
02106681	Black River near Dunn (d)	48.3	1976-77
02107000	South River near Parkersburg (d)	379	1951-86
02107500	Colly Creek near Kelly (d)	103	1950-71
02107600	Northeast Cape Fear River near Seven Springs (d)	47.5	1958-75
0210782005	Nahunga Creek at SR 1301 near Warsaw (d)	8.28	1983-90
0210789100	Grove Creek at Kenansvile (d)	22.6	1983-90
0210797940	Limestone Creek at NC 24 near Hadley (d)	1.61	1986-88
02108500	Rockfish Creek near Wallace (d)	69.3	1955-81
	Pee Dee River Basin		
02112500	Fisher River near Dobson (d)	109	1920-32
02113500	Yadkin River at Siloam (d)	1,226	1976-87
02115500	Forbush Creek near Yadkinville (d)	21.7	1940-71
02115750	Muddy Creek near Lewisville (d)	82.8	1964-70
02115800	Silas Creek near Clemmons (d)	11.8	1964-70
02115841	Tar Br Trib at First St at Winston-Salem (d)	.05	1979-82
02115850	Salem Creek at Winston-Salem (d)	51.3	1964-70
02115854	Salem Creek Trib at Hawthorne Rd, Winston-Salem (d)	.50	1979-82
02115856	Salem Creek near Atwood (d)	65.6	1971-82
02115860	Muddy Creek near Muddy Creek (d)	178	1964-79
			1988-91
02115900	South Fork Muddy Creek near Clemmons (d)	42.2	1964-79
			1988-91
02117030	Humpy Creek near Fork (d)	1.05	1968-83
02117500	Rocky Creek at Turnersburg (d)	102	1940-71
02119000	South Yadkin River at Cooleemee (d)	569	1928-65
02119400	Third Creek near Stony Point (d)	4.84	1956-69
02120500	Third Creek at Cleveland (d)	87.4	1940-71
02121000	Yadkin River near Salisbury (d)	3,470	1895-1927
02121180	North Potts Creek at Linwood (d)	9.62	1980-90
02121493	Leonard Creek near Bethesda (d)	5.16	1978-81
02122500	Yadkin River at High Rock (d)	4,000	1919-27
02123000	Uwharrie River near Trinity (d)	11.3	1934-41
02123500	Uwharrie River near Eldorado (d)	347	1938-71
02124471	Dutch Buffalo Creek at NC 49 nr Mt Pleasant (d)	45.1	1985-87
02125500	Richardson Creek near Marshville (d)	170	1940-44
02125557	Gourdvine Creek at SR 1715 near Olive Branch (d)	8.75	1978-82
02125696	Lane Creek at SR 2115 near Trinity (d)	3.98	1969-79
02125699	Wicker Branch at SR 1940 near Trinity (d)	5.83	1978-82
02125816	Lane's Creek near Marshville (d)	87.8	1985-87
02126500	Little Brown Creek near Polkton (d)	13.5	1935-41
02127000	Brown Creek near Polkton (d)	110	1937-71
02127500	Pee Dee River near Ansonville (d)	6,330	1938-42
02129500	N Fork Jones Creek near Wadesboro (d)	9.43	1935-41

CAPE FEAR RIVER BASIN

02094500 REEDY FORK NEAR GIBSONVILLE, NC

LOCATION.--Lat 36°10'31", long 79°37'01", Guilford County, Hydrologic Unit 03030002, on right bank 0.2 mi downstream of Huffines Mill on Secondary Road 2719, 1.2 mi upstream from Buffalo Creek, and 6 mi northwest of Gibsonville.

DRAINAGE AREA.--131 mi^2.

PERIOD OF RECORD.--September 1928 to current year.

REVISED RECORDS.--WSP 1303: 1929-40 (monthly and yearly runoff). WSP 1383: 1929-30, 1933(M), 1934, 1937(M), 1939-42(M), 1948. WDR NC-81-1: Drainage area.

GAGE.--Water-stage recorder and rock-masonry control. Datum of gage is 626.88 ft above National Geodetic Vertical Datum of 1929.

REMARKS.--No estimated daily discharges. Records good. Flow regulated since 1923 by Lake Brandt (station 02094117), 14 mi upstream; since 1957 by Lake Higgins (station 02093981) on Brush Creek, a tributary to Lake Brandt; since 1943 by Richland Lake 12 mi upstream from station; and since 1968 by Lake Townsend (station 02094305), 9 mi upstream from station. City of Greensboro diverted an average of 23.8 ft^3/s from Lake Brandt and an average of 25.5 ft^3/s from Lake Townsend for municipal water supply. Maximum discharge prior to regulation by Lake Townsend: 11,600 ft^3/s, Sept. 25, 1947; gage height: 20.77 ft; minimum discharge not determined. Maximum discharge for regulated period: 5,660 ft^3/s, from high-water mark in well. Minimum discharge for regulated period also occurred July 30, Aug. 6, 7, 1977.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood in July 1916 reached a stage of 17.90 ft, from information by local resident; discharge, 8,640 ft^3/s.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1991 TO SEPTEMBER 1992
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10	28	15	23	17	33	29	132	20	12	41	15
2	13	29	21	21	16	25	26	28	17	100	14	15
3	29	27	22	120	16	23	25	22	17	26	11	15
4	30	27	36	792	15	20	24	19	147	140	10	16
5	25	28	22	1010	18	19	24	172	79	30	12	16
6	229	29	18	889	15	21	22	37	24	46	8.5	35
7	46	34	18	819	14	394	21	112	17	340	9.0	23
8	33	33	18	711	15	86	21	320	38	70	11	18
9	29	33	17	394	16	34	20	74	529	16	13	16
10	28	80	28	55	16	47	19	27	200	11	9.0	14
11	30	47	33	22	15	97	19	21	44	9.5	9.0	14
12	26	36	26	18	15	40	25	20	307	9.0	11	14
13	25	32	22	17	15	29	42	22	53	8.0	390	13
14	26	22	23	111	15	24	25	18	24	8.0	890	13
15	27	19	22	23	38	22	346	16	23	7.5	690	13
16	28	17	20	20	75	22	51	15	107	7.0	120	13
17	32	15	19	17	32	20	30	14	97	6.6	200	12
18	28	14	19	17	263	86	21	16	30	6.6	81	12
19	26	14	20	16	43	94	17	17	23	6.6	28	14
20	25	14	19	16	27	36	15	16	19	6.2	23	15
21	26	14	20	17	24	25	1830	15	17	5.8	22	14
22	26	15	18	15	28	24	4500	14	17	68	21	16
23	26	21	18	70	25	22	1980	13	14	120	20	23
24	28	16	20	176	27	21	893	12	14	320	20	21
25	26	14	21	31	81	20	100	12	24	95	19	14
26	25	13	20	25	631	73	39	13	18	23	18	15
27	28	12	20	20	487	119	405	14	17	99	25	15
28	25	13	23	19	444	35	167	17	15	250	175	15
29	25	12	134	19	171	26	75	135	14	46	26	15
30	26	13	43	20	---	24	29	80	13	19	17	14
31	29	---	28	18	---	26	---	36	---	17	16	---
TOTAL	1037	721	803	5541	2614	1587	10840	1479	1978	1928.8	2959.5	478
MEAN	33.5	24.0	25.9	179	90.1	51.2	361	47.7	65.9	62.2	95.5	15.9
MAX	229	80	134	1010	631	394	4500	320	529	340	890	35
MIN	10	12	15	15	14	19	15	12	13	5.8	8.5	12

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1929 - 1992, BY WATER YEAR (WY)

MEAN	73.1	62.7	98.3	163	172	168	145	88.1	68.8	67.9	59.1	62.4
MAX	661	233	275	644	468	479	613	365	477	596	315	534
(WY)	1960	1950	1933	1978	1960	1952	1987	1978	1982	1984	1940	1947
MIN	2.85	6.70	5.97	11.1	19.9	16.4	11.2	7.43	6.08	2.83	2.82	2.27
(WY)	1969	1970	1969	1981	1977	1976	1976	1986	1986	1986	1977	1968

SUMMARY STATISTICS	FOR 1991 CALENDAR YEAR		FOR 1992 WATER YEAR		WATER YEARS 1929 - 1992	
ANNUAL TOTAL	48598.7		31966.3			
ANNUAL MEAN	133		87.3		102	
HIGHEST ANNUAL MEAN					188	1984
LOWEST ANNUAL MEAN					20.1	1967
HIGHEST DAILY MEAN	3430	Mar 30	4500	Apr 22	7240	Sep 25 1947
LOWEST DAILY MEAN	8.3	Sep 16	5.8	Jul 21	.40	Oct 14 1954
ANNUAL SEVEN-DAY MINIMUM	8.6	Sep 12	6.6	Jul 15	1.2	Oct 8 1954
INSTANTANEOUS PEAK FLOW			5010	Apr 22	5660*	Jun 21 1972
INSTANTANEOUS PEAK STAGE			14.19	Apr 22	14.92*	Jun 21 1972
INSTANTANEOUS LOW FLOW			5.8	Jul 21	1.4*	Jul 29 1977
ANNUAL RUNOFF (CFSM)	1.02		.67		.78	
ANNUAL RUNOFF (INCHES)	13.80		9.08		10.58	
10 PERCENT EXCEEDS	388		136		236	
50 PERCENT EXCEEDS	28		22		37	
90 PERCENT EXCEEDS	14		13		7.7	

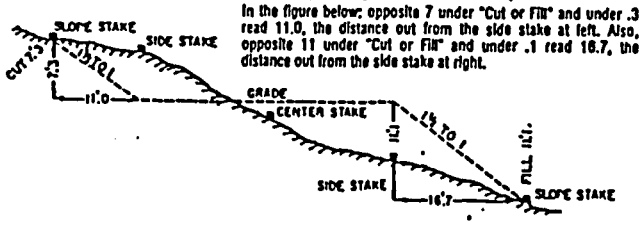
* See REMARKS.

REFERENCE NO. 13

DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

Roadway of any Width. Side Slopes 1½ to 1.

In the figure below: opposite 7 under "Cut or Fill" and under .3 read 11.0, the distance out from the side stake at left. Also, opposite 11 under "Cut or Fill" and under .1 read 16.7, the distance out from the side stake at right.



Cut & Fill	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Cut & Fill
	Distance out from Side or Shoulder Stake										
0	0.0	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	0
1	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.9	1
2	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.2	4.4	2
3	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	3
4	6.0	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	4
5	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.6	8.7	8.9	5
6	9.0	9.2	9.3	9.5	9.6	9.8	9.9	10.1	10.2	10.4	6
7	10.5	10.7	10.8	11.0	11.1	11.3	11.4	11.6	11.7	11.9	7
8	12.0	12.2	12.3	12.5	12.6	12.8	12.9	13.1	13.2	13.4	8
9	13.5	13.7	13.8	14.0	14.1	14.3	14.4	14.6	14.7	14.9	9
10	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1	16.2	16.4	10
11	16.5	16.7	16.8	17.0	17.1	17.3	17.4	17.6	17.7	17.9	11
12	18.0	18.2	18.3	18.5	18.6	18.8	18.9	19.1	19.2	19.4	12
13	19.5	19.7	19.8	20.0	20.1	20.3	20.4	20.6	20.7	20.9	13
14	21.0	21.2	21.3	21.5	21.6	21.8	21.9	22.1	22.2	22.4	14
15	22.5	22.7	22.8	23.0	23.1	23.3	23.4	23.6	23.7	23.9	15
16	24.0	24.2	24.3	24.5	24.6	24.8	24.9	25.1	25.2	25.4	16
17	25.5	25.7	25.8	26.0	26.1	26.3	26.4	26.6	26.7	26.9	17
18	27.0	27.2	27.3	27.5	27.6	27.8	27.9	28.1	28.2	28.4	18
19	28.5	28.7	28.8	29.0	29.1	29.3	29.4	29.6	29.7	29.9	19
20	30.0	30.2	30.3	30.5	30.6	30.8	30.9	31.1	31.2	31.4	20
21	31.5	31.7	31.8	32.0	32.1	32.3	32.4	32.6	32.7	32.9	21
22	33.0	33.2	33.3	33.5	33.6	33.8	33.9	34.1	34.2	34.4	22
23	34.5	34.7	34.8	35.0	35.1	35.3	35.4	35.6	35.7	35.9	23
24	36.0	36.2	36.3	36.5	36.6	36.8	36.9	37.1	37.2	37.4	24
25	37.5	37.7	37.8	38.0	38.1	38.3	38.4	38.6	38.7	38.9	25
26	39.0	39.2	39.3	39.5	39.6	39.8	39.9	40.1	40.2	40.4	26
27	40.5	40.7	40.8	41.0	41.1	41.3	41.4	41.6	41.7	41.9	27
28	42.0	42.2	42.3	42.5	42.6	42.8	42.9	43.1	43.2	43.4	28
29	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	44.9	29
30	45.0	45.2	45.3	45.5	45.6	45.8	45.9	46.1	46.2	46.4	30
31	46.5	46.7	46.8	47.0	47.1	47.3	47.4	47.6	47.7	47.9	31
32	48.0	48.2	48.3	48.5	48.6	48.8	48.9	49.1	49.2	49.4	32
33	49.5	49.7	49.8	50.0	50.1	50.3	50.4	50.6	50.7	50.9	33
34	51.0	51.2	51.3	51.5	51.6	51.8	51.9	52.1	52.2	52.4	34
35	52.5	52.7	52.8	53.0	53.1	53.3	53.4	53.6	53.7	53.9	35
36	54.0	54.2	54.3	54.5	54.6	54.8	54.9	55.1	55.2	55.4	36
37	55.5	55.7	55.8	56.0	56.1	56.3	56.4	56.6	56.7	56.9	37
38	57.0	57.2	57.3	57.5	57.6	57.8	57.9	58.1	58.2	58.4	38
39	58.5	58.7	58.8	59.0	59.1	59.3	59.4	59.6	59.7	59.9	39
40	60.0	60.2	60.3	60.5	60.6	60.8	60.9	61.1	61.2	61.4	40

Field Logbook for Recons of:

1) Northeast Chemical Co. #52012.249

2) Gulf Oil Corp. #52012.218

3) Greensboro City Landfill #52012.216

4) Highway 801 Barber #52012.223

5) Rowe Corp. #52012.227

~~6) Old Western NC Fairgrounds #52012.~~ opp

6) Henson Landfill #52012.221

7) Old Western NC Fairgrounds #52012.224

The paper in this book is made of 50% high grade rag stock with a WATER RESISTING surface sizing.

1

Greensboro City Landfill #52012.216

2030 Drive to crossing of Huffin Mills Rd and North Buffalo Creek (guging station is depicted on Topo map and is present in the creek). This is a good size stream (about 15-20 feet wide) and is probably part of the surface water pathway. No signs of fishing (fishing line or rods) were observed in or around the stream.

2045 Leave Site Area.

Date: 18 May 1994
Time: 0900
Weather: Temp 65°
Cloud Cover 100%
Wind none precip none

0900- Return to site. Proceed to security/weigh station. Ask to see facility manager. They send me to the 1st building.

Corey T. Platt 5/18/94

Greensboro City Landfill #52012.216

0905 Met with Frank Coggins who is the facility manager. Asked about what section of the landfill would have been active in 1959-1970. He showed me a map (aerial photo) of the site and which section of the landfill was on the Superfund list. They do Groundwater monitoring at the site with 5 wells located along the perimeter of the landfill used during 1959-1970. This area was closed in 1978 and they continue to maintain the cover (2 feet of soil) and repair leachate outbreaks from this area. Leachate has entered the stream Buffalo Creek, which is the northern boundary of the pre-1978 landfill. Another area (currently outside of the fenced area along White St. was used pre-1978 as a burn pit. Both of these areas were marked on the topo map. The City of Greensboro has purchased

Corey T. Platt 5/18/94

REFERENCE NO. 14

ENDANGERED AND THREATENED SPECIES

U.S. FISH AND WILDLIFE SERVICE

REGION 4 - ATLANTA

PREFACE

The materials in this notebook are provided as an aid to anyone having a continuing need for current information on Federally listed endangered and threatened species found within Region 4 of the U.S. Fish and Wildlife Service. This area includes the Carolinas, Georgia, Florida, Alabama, Tennessee, Kentucky, Mississippi, Arkansas, Louisiana, Puerto Rico, and the Virgin Islands.

Recipients of the notebook are placed on a permanent mailing list and will automatically receive updated information whenever listing or other changes occur. Questions or comments pertaining to the notebook should be directed to the Endangered Species Office, U.S. Fish and Wildlife Service, Richard B. Russell Federal Building, 75 Spring St., S.W., Atlanta, Georgia 30303; telephone 404/221-3583 or FTS 242-3583. Other questions pertaining to endangered species matters should be addressed to one of the Service field stations listed at the end of this Preface.

The notebook is divided into two primary sections. Materials in the first section provide quick reference as to what species are listed, proposed, or under review, the states where they occur, the location of critical habitat areas, and other related information. The second part of the notebook contains species accounts which briefly discuss such things as the status, range, life history, and management needs of listed species. Please note that the range maps for these species generally reflect current distribution, but in many cases they reflect distribution rather broadly and should only be interpreted in relation to other information included in the species account.

The Endangered Species Act - General

Passage of the Endangered Species Act of 1973 gave the United States one of the most far-reaching laws ever enacted by any country to prevent the extinction of imperiled animals and plants. Under the law, the Secretary of the Interior (acting through the U.S. Fish and Wildlife Service) has broad powers to protect and conserve all forms of wildlife and plants he finds in serious jeopardy. The Secretary of Commerce, acting through the National Marine Fisheries Service, has similar authority for protecting and conserving most marine life.

Congress addressed the question of why we should save endangered species in the preamble to the Endangered Species Act, holding that endangered and threatened species of fish, wildlife and plants "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." In making this statement, Congress was summarizing a number of convincing arguments advanced by thoughtful scientists, conservationists, and others who are greatly concerned by the disappearance of wildlife.

Protecting endangered species and restoring them to the point where their existence is no longer jeopardized is the primary objective of the U.S. Fish and Wildlife Service's Endangered Species Program.

The Listing Process

The Fish and Wildlife Service follows a formal "rulemaking" procedure in determining which species should be placed on the U.S. List of Endangered and Threatened Wildlife and Plants. The Act defines an "endangered" species as one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is defined as one that is likely to become endangered within the foreseeable future.

A "rulemaking" is the process used by Federal agencies (and many states) to propose and later adopt regulations which have the effect of law, and apply to all U.S. residents. The proposed rule is published in the Federal Register, a daily Government publication, to provide for public notification and a period for comments. The proposal is then reevaluated, and if adopted it is published again as a final rule. Endangered or threatened species are placed on the list, reclassified, or deleted through this process.

Protection Under the Act

Section 9 of the Act prohibits the illegal possession, import, export, or interstate or foreign sale of listed species (including their parts and products). It is also illegal to kill, harrass, harm, or remove listed species of animals from the wild. Taking of plants is prohibited only on Federal lands. Under Section 7 of the Act, Federal agencies are required to insure that actions they authorize (by permit), fund, or carry out do not jeopardize the existence of listed species or adversely affect critical habitat.

Penalties for violations can range from a warning and seizure of illegally held wildlife specimens and products to a maximum of $20,000 and/or a year in jail for criminal offenses.

Critical Habitat

The Endangered Species Act, as amended, calls for the conservation of what is termed "critical habitat"--the areas of land, water, and air space an endangered or threatened species needs for survival. These areas include such things as food and water, breeding sites, cover or shelter, and sufficient habitat to provide for normal population growth and behavior. Critical habitat is usually included with the proposal to list a species. However, if it is determined separately at a later date, the rulemanking procedure is the same as for classifying a species as endangered or threatened.

One of the primary threats to most species is the destruction or modification of essential habitat areas by uncontrolled land and water development. Accordingly, the law requires all Federal agencies to insure that actions they authorize (by permit), fund, or carry out do not jeopardize the existence of listed species or adversely affect critical habitat.

It should be emphasized, however, that not all Federal actions will necessarily be detrimental to critical habitat. There may be many kinds of actions which can be carried out within a critical habitat area without reducing the species' numbers or distribution, or otherwise posing jeopardy to it.

In summary, the designation of critical habitat does not create a nature preserve or refuge. It does not affect private, local, or state projects unless Federal funds or permits are involved. It does provide a means by which listed species can be protected from adverse impacts resulting from Federal action.

Consultation

Section 7 of the Act requires all Federal agencies to review their actions, and if they determine that their actions may affect a listed species or its habitat, they must enter into consultation with the Fish and Wildlife Service. During the course of such consultation the involved agency and the Fish and Wildlife Service will try to determine a course of action which will allow for completion of the agency's project and at the same time not jeopardize the species. Most consultations accomplish this goal.

In the case of a conflict, the Act provides a means whereby under certain conditions the affected Federal agency may be exempted from the requirements of Section 7. Exemption applications must be submitted to the Secretary of the Interior for consideration. If the Secretary decides the application meets exemption criteria, it is then passed on to a seven-member cabinet-level Endangered Species Committee for a final decision.

Conservation and Recovery

A main aim of the Service's Endangered Species Program is to restore populations of listed species to a point where they are no longer in danger of extinction and are again self-sustaining members of their ecosystem. Recovery plans for a number of these species are already being carried out. The plans may recommend the acquisition of land, new research, captive breeding, or may call for special wildlife and habitat management techniques.

In addition to overseeing the development and implementation of recovery plans, the Fish and Wildlife Service utilizes the authorities and funding provided under the Act to provide for technical assistance, management, law enforcement, land acquisition, research, status surveys, and financial assistance to state agencies which have entered into a cooperative agreement with the Service.

Permits

The Service's Wildlife Permit Office can issue permits for certain activities involving endangered or threatened species. Permits for

endangered species are issued only for scientific or breeding purposes. In addition to these purposes, permits for threatened species may be issued for educational activities, zoo exhibitions, and other special purposes.

U.S. Fish and Wildlife Service Endangered Species Field Offices - Region 4

U.S. Fish and Wildlife Service (serves KY, NC, SC, TN)
100 Otis Street, Room 224
Asheville, NC 28801
Phone: 704/259-0321
FTS 672-0321

U.S. Fish and Wildlife Service (serves AL, AR, LA, MS)
Jackson Mall Office Center
300 Woodrow Wilson Avenue, Suite 316
Jackson, MS 39213
Phone: 601/960-4900
FTS 490-4900

U.S. Fish and Wildlife Service (serves GA and FL)
2747 Art Museum Drive
Jacksonville, Florida 32207
Phone: 904/791-2580
FTS 946-2580

U.S. Fish and Wildlife Service (serves PR and VI)
Post Office Box 491
Boqueron, PR 00622
Phone: 809/851-7297

CRITICAL HABITAT INDEX

Alabama	- *Etheostoma boschungi*, "slackwater darter"
	Peromyscus polionotus ammobates, "Alabama beach mouse"
	Peromyscus polionotus trissyllepsis, "Perdido Key beach mouse"
	Speoplatyrhinus poulsoni, "Alabama cavefish"
Arkansas	- *Percina pantherina*, "leopard darter"
Florida	- *Ammospiza maritima mirabilis*, "Cape Sable sparrow"
	Ammospiza maritima nigrescens, "dusky seaside sparrow"
	Crocodylus acutus, "American crocodile"
	Peromyscus polionotus allophrys, "Choctawhatchee beach mouse"
	Peromyscus polionotus trissyllepsis, "Perdido Key beach mouse"
	Rostrhamus sociabilis plumbeus, "Everglade kite"
	Trichechus manatus, "Florida manatee"
Georgia	- *Percina antesella*, "amber darter"
	Percina jenkinsi, "Conasauga logperch"
Kentucky	- *Myotis sodalis*, "Indiana bat"
	Palaemonias ganteri, "Kentucky cave shrimp"
Louisiana	- No designations
Mississippi	- *Grus canadensis pulla*, "Mississippi sandhill crane"
North Carolina	- *Hudsonia montana*, "mountain golden heather"
	Hybopsis monacha, "spotfin chub"
	Menidia extensa, "Waccamaw silverside"
	Notropis mekistocholas, "Cape Fear shiner"

Puerto Rico - Agelaius xanthomus, "yellow-shouldered blackbird"

Anolis roosevelti, "giant anole"

Cyclura stejnegeri, "Mona ground iguana"

Eleutherodactylus jasperi, "golden coqui"

Epicrates monensis monensis, "Mona boa"

Eretmochelys imbricata, "hawksbill sea turtle"

Sphaerodactylus micropithecus, "Monito gecko"

South Carolina - No designations

Tennessee - Etheostoma boschungi, "slackwater darter"

Hybopsis cahni, "slender chub"

Hybopsis monacha, "spotfin chub"

Myotis sodalis, "Indiana bat"

Noturus baileyi, "smoky madtom"

Noturus flavipinnis, "yellowfin madtom"

Percina antesella, "amber darter"

Percina jenkinsi, "Conasauga logperch"

Virgin Islands - Ameiva polops, "St. Croix ground lizard"

Dermochelys coriacea, "leatherback sea turtle"

12/16/87

Endangered and Threatened Species in Region 4*

(E=Endangered; T=Threatened)

Mammals:	Distribution:
Bat, gray (E)	AL,AR,FL,GA,KY,NC,TN
Bat, Indiana (E)	AL,AR,FL,GA,KY,NC,TN
Bat, Ozark big-eared (E)	AR
Bat, Virginia big-eared (E)	KY,NC
Cougar, Eastern (E)	KY,NC,SC,TN
Deer, Key (E)	FL
Manatee, West Indian (E)	AL,FL,GA,NC,PR,SC
Mouse, Alabama beach (E)	AL
Mouse, Choctawhatchee beach (E)	FL
Mouse, Key Largo cotton (E)	FL
Mouse, Perdido Key beach (E)	AL, FL
Panther, Florida (E)	AL,AR,FL,GA,LA,MS,SC,TN
Shrew, Dismal Swamp southeastern (T)	NC
Squirrel, Carolina northern flying (E)	NC,TN
Whale, finback (E)	Oceanic
Whale, humpback (E)	Oceanic
Whale, right (E)	Oceanic
Whale, sei (E)	Oceanic
Whale, sperm (E)	Oceanic
Wolf, red (E)	LA
Woodrat, Key Largo (E)	FL
Birds:	
Blackbird, yellow-shouldered (E)	PR
Caracara, Audubon's Crested (T)	FL
Crane, Mississippi Sandhill (E)	MS
Curlew, Eskimo (E)	LA (historic, near extinction)
Eagle, bald Southeastern (E)	AL,AR,FL,GA,KY,LA,MS,NC,SC,TN
Falcon, American peregrine Eastern (E)	AL,GA,KY,NC,SC,TN
Falcon, Arctic peregrine (T)	AL,AR,FL,GA,KY,LA,MS,NC,PR, SC,TN
Jay, Florida scrub (T)	FL
Kite, Everglade (E)	FL
Parrot, Puerto Rican (E)	PR
Pelican, brown (E)	LA,MS,PR,VI

*Includes the Carolinas, Georgia, Florida, Alabama, Tennessee, Kentucky, Mississippi, Arkansas, Louisiana, Puerto Rico, and the Virgin Islands.

Birds (cont'd):	Distribution
Pigeon, Puerto Rican plain (E)	PR
Plover, piping (T)	AL,FL,GA,LA,MS,NC,PR,SC
Sparrow, Cape Sable (E)	FL
Sparrow, dusky seaside (E)	FL (near extinction)
Sparrow, Florida grasshopper (E)	FL
Stork, wood (E)	FL,GA,SC
Tern, least; interior population (E)	AR,KY,LA,MS,TN
Tern, roseate (T)	FL,PR,VI
Warbler (wood), Bachman's (E)	AL,AR,FL,GA,KY,LA,MS,NC,SC,TN (historic, possibly extinct)
Warbler (wood), Kirtland's (E)	FL,GA,KY,NC,SC,TN
Whip-poor-will, Puerto Rican (E)	PR
Woodpecker, ivory-billed (E)	AL,AR,FL,GA,KY,LA,MS,NC,SC,TN (historic, probably extinct)
Woodpecker, red-cockaded (E)	AL,AR,FL,GA,KY,LA,MS,NC,SC,TN

Reptiles and Amphibians:	
Alligator, American (T,S/A) *	AL,AR,FL,GA,LA,MS,NC,SC
Anole, giant (E)	PR
Boa, Mona (T)	PR
Boa, Puerto Rican (E)	PR
Boa, Virgin Islands tree (E)	VI
Coqui, golden (T)	PR
Crocodile, American (E)	FL
Florida bonamia (T)	FL
Heller's blazing star (T)	NC
Higuero de Sierra (E)	PR
Gecko, Monito (E)	PR
Iguana, Mona ground (T)	PR
Lizard, St. Croix ground (E)	VI
Salamander, Red Hills (T)	AL
Shiner, Cape Fear (E)	NC
Skink, blue-tailed mole (T)	FL
Skink, sand (T)	FL
Snake, Atlantic salt marsh (T)	FL
Snake, eastern indigo (T)	AL,FL,GA,MS,SC
Toad, Puerto Rican crested (T)	PR
Tortoise, gopher (T)	AL,LA,MS

* Alligators are biologically neither endangered nor threatened and may be hunted as permitted under State law. For law enforcement purposes they are classified as "Threatened due to Similarity of Appearance."

Reptiles and Amphibians (cont'd):	Distribution
Turtle, Alabama red-bellied (E)	AL
Turtle, flattened musk (T)	AL
Turtle, green (T) (E in Florida)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, hawksbill (E)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, Kemp's (Atlantic) ridley (E)	AL,FL,GA,LA,MS,NC,SC
Turtle, leatherback (E)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, loggerhead (T)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, ringed sawback (T)	LA,MS
Fishes:	
Cavefish, Alabama (T)	AL
Cavefish, Ozark (T)	AR
Chub, slender (T)	TN
Chub, spotfin (T)	NC,TN
Dace, blackside (T)	KY,TN
Darter, amber (E)	TN,GA
Darter, Bayou (T)	MS
Darter, leopard (T)	AR
Darter, Okaloosa (E)	FL
Darter, slackwater (T)	AL,TN
Darter, snail (T)	GA,TN,AL
Darter, watercress (E)	AL
Logperch, Conasauga (E)	TN,GA
Madtom, smoky (E)	TN
Madtom, yellowfin (T)	TN
Shiner, Cape Fear (E)	NC
Silverside, Waccamaw (T)	NC
Sturgeon, shortnose (E)	FL,GA,NC,SC
Mollusks:	
Mussel, Alabama lamp pearly (E)	AL,TN
Mussel, Appalachian monkeyface (E)	TN
Mussel, birdwing pearly (E)	TN
Mussel, Cumberland bean pearly (E)	KY,TN
Mussel, Cumberland monkeyface pearly (E)	TN
Mussel, Curtus' (E)	MS
Mussel, dromedary pearly (E)	TN
Mussel, fat pocketbook pearly (E)	AR
Mussel, fine-rayed pigtoe pearly (E)	AL,TN
Mussel, green-blossom pearly (E)	TN
Mussel, Judge Tait's (E)	AL,MS
Mussel, Marshall's (E)	AL

Mollusks (Cont'd.):	Distribution
Mussel, orange-footed pearly (E)	AL,TN,KY
Mussel, pale lilliput pearly (E)	AL
Mussel, penitent (E)	AL,MS
Mussel, pink mucket pearly (E)	AL,KY,TN,AR
Mussel, rough pigtoe pearly (E)	KY,TN,AL
Mussel, shiny pigtoe pearly (E)	AL,TN
Mussel, stirrup shell (E)	AL
Mussel, tan riffle shell (E)	KY,TN (historic occurrence)
Mussel, Tar River spiny (E)	NC
Mussel, tuberculed-blossom pearly (E)	KY,TN (historic, possibly extinct)
Mussel, turgid-blossom pearly (E)	TN,AL,AR (historic, possibly extinct)
Mussel, white warty-back pearly (E)	TN
Mussel, yellow-blossom pearly (E)	AL,KY,TN (historic, possibly extinct)
Snail, noonday (T)	NC
Snail, painted snake coiled forest (T)	TN
Snail, Stock Island tree (T)	FL
Arthropods	
Butterfly, Schaus swallowtail (E)	FL
Crayfish (cave species; no common name) (E)	AR
Crayfish, Nashville (E)	TN
Shrimp, Kentucky cave (E)	KY
Plants:	
Alabama leather flower (E)	AL
Beautiful goetzea (E)	PR
Beautiful pawpaw (E)	FL
Blue Ridge goldenrod (T)	NC,TN
Bunched arrowhead (E)	NC,SC
Canby's dropwort (E)	NC,SC,GA
Carter's mustard (E)	FL
Chapman's rhododendron (E)	FL
Cook's holly (E)	PR
Crenulate lead-plant (E)	FL
Deltoid spurge (E)	FL
Elfin tree fern (E)	PR
Florida bonamia (T)	FL
Florida golden aster (E)	FL
Florida torreya (E)	FL,GA

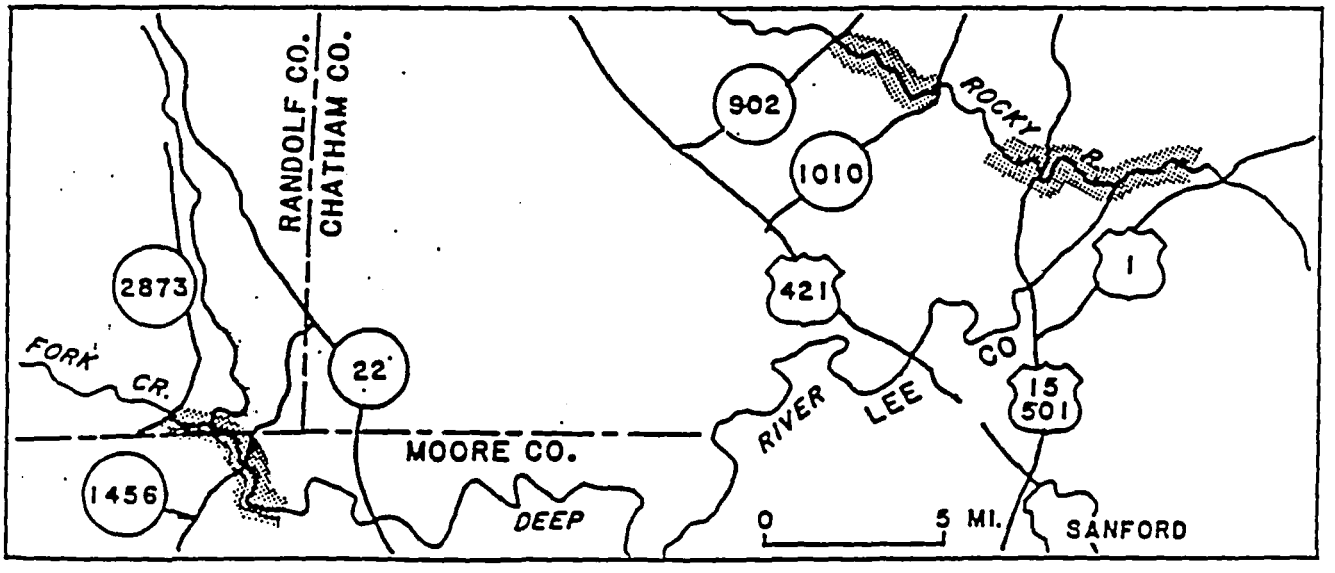
Plants (cont'd):	Distribution
Four-petal pawpaw (E)	FL
Fragrant prickly-apple (E)	FL
Garber's spurge (T)	FL
Geocarpon minimum (T)	AR
Green pitcher plant (E)	AL,GA,NC
Hairy rattleweed (E)	GA
Harper's beauty (E)	FL
Heller's blazing star (T)	NC
Highlands scrub hypericum (E)	FL
Higuero de Sierra (E)	PR
Key tree-cactus (E)	FL
Lakela's mint (E)	FL
Large-flowered skullcap (E)	GA,TN
Longspurred mint (E)	FL
Miccosukee gooseberry (T)	FL,SC
Mountain golden heather (T)	NC
Palo de Ramon (E)	PR
Papery whitlow-wort (T)	FL
Persistent trillium (E)	GA,SC
Pondberry (E)	AR,GA,MS,NC,SC
Prickly-ash (E)	PR, VI
Pygmy fringe tree (E)	FL
Rough-leaved loosestrife (E)	NC
Rugel's pawpaw (E)	FL
Ruth's golden aster (E)	TN
Scrub lupine (E)	FL
Scrub mint (E)	FL
Scrub plum (E)	FL
Short's goldenrod (E)	KY
Small whorled pogonia (E)	GA,NC,SC,TN
Small's milkpea (E)	FL
Snakeroot (E)	FL
Tennessee coneflower (E)	TN
Tiny polygala (E)	FL
Vahl's boxwood (E)	PR
Wheeler's peperomia (E)	PR
Wide-leaf warea (E)	FL
Wireweed (E)	FL

NORTH CAROLINA - Critical Habitat

Notropis mekistocholas, "Cape Fear shiner"

(1) Chatham County. Approximately 4.1 miles of the Rocky River from North Carolina State Highway 902 Bridge downstream to Chatham County Road 1010 Bridge;
(2) Chatham and Lee Counties. Approximately 0.5 river mile of Bear Creek, from Chatham County Road 2156 Bridge downstream to the Rocky River, then downstream in the Rocky River (approximately 4.2 river miles) to the Deep River, then downstream in the Deep River (approximately 2.6 river miles) to a point 0.3 river mile below the Moncure, North Carolina, U.S. Geological Survey Gaging Station; and
(3) Randolph and Moore Counties. Approximately 1.5 miles of Fork Creek, from a point 0.1 river mile upstream of Randolph County Road 2873 Bridge downstream to the Deep River then downstream approximately 4.1 river miles of the Deep River in Randolph and Moore Counties, North Carolina, to a point 2.5 river miles below Moore County Road 1456 Bridge.

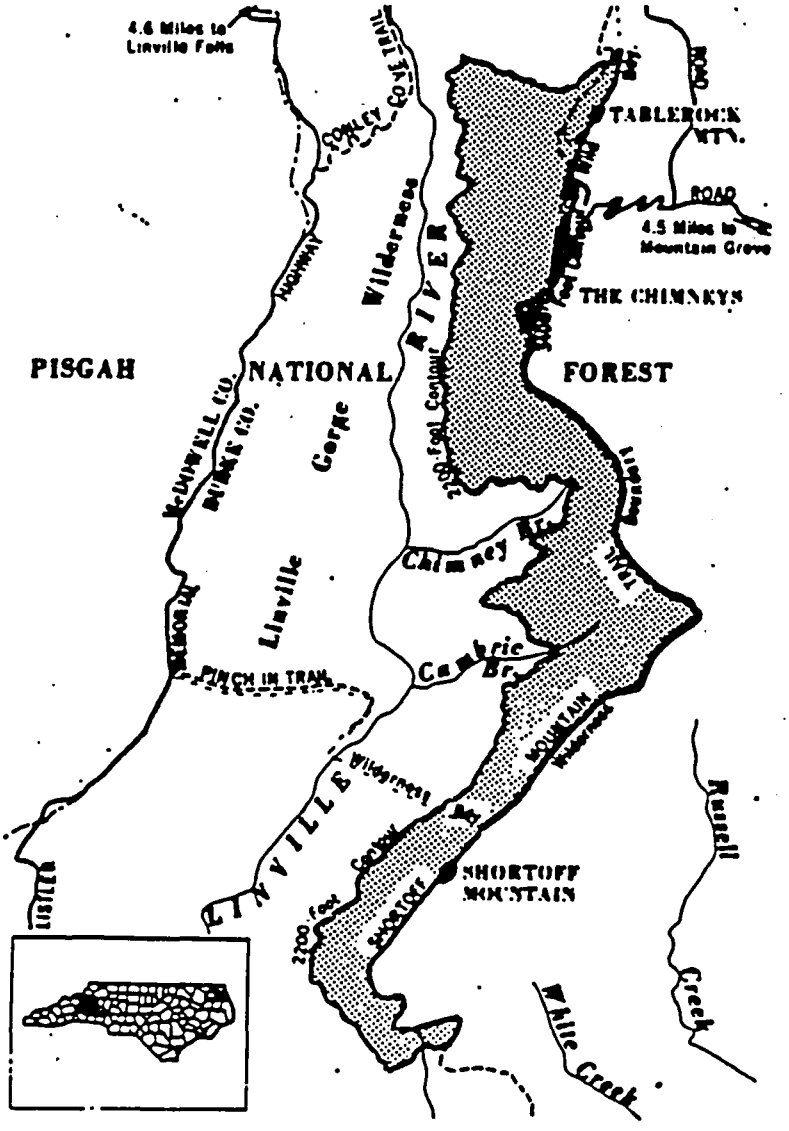
Constituent elements include clean streams with gravel, cobble, and boulder substrates with pools, riffles, shallow runs and slackwater areas with large rock outcrops and side channels and pools with water of good quality with relatively low silt loads.



NORTH CAROLINA - Critical Habitat

Hudsonia montana, "mountain golden heather"

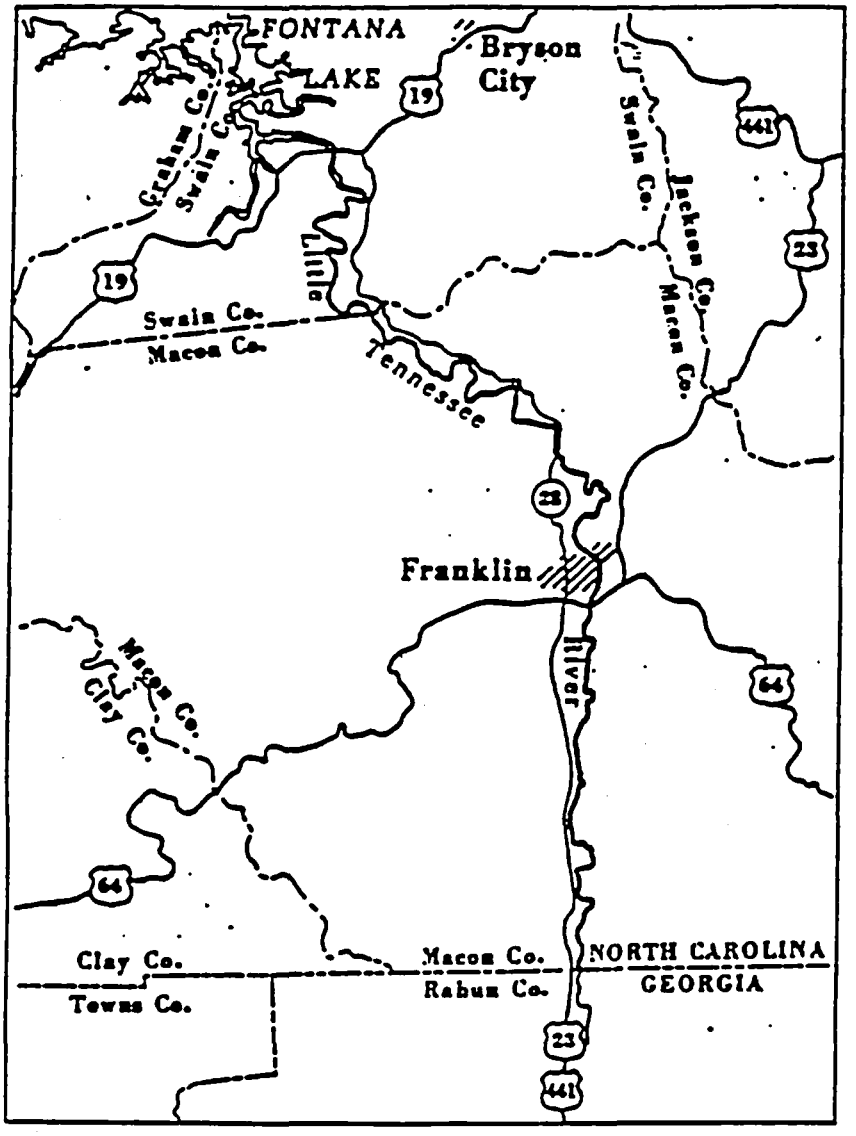
Burke County. The area bounded by the following: on the west by the 2200' contour; on the east by the Linville Gorge Wilderness Boundary north from the intersection of the 2200' contour and the Shortoff Mountain Trail to where it intersects the 3400' contour at "The Chimneys"--then follow the 3400' contour north until it reintersects the Wilderness Boundary--then follow the Wilderness Boundary again northward until it intersects the 3200' contour extending west from its intersection with the Wilderness Boundary until it begins to turn south--at this point the Boundary extends due east until it intersects the 2200' contour.



NORTH CAROLINA - Critical Habitat

Hybopsis monacha, "spotfin chub"

Macon and Swain Counties. Little Tennessee River, main channel from the backwaters of Fontana Lake upstream to the North Carolina-Georgia state line.

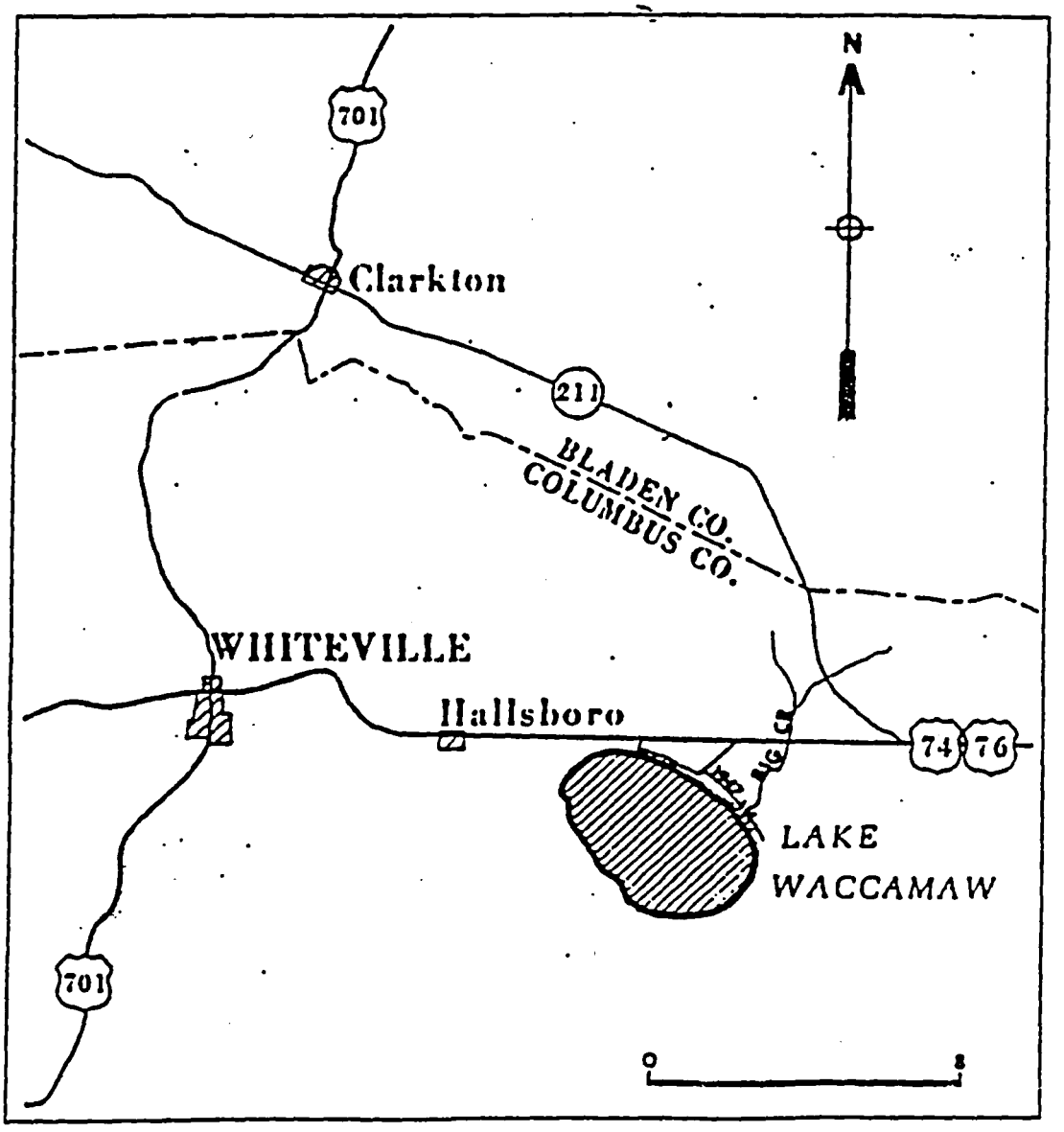


NORTH CAROLINA - Critical Habitat

Menidia extensa, "Waccamaw silverside"

Columbus County. Lake Waccamaw in its entirety to mean high water level, and Big Creek from its mouth at Lake Waccamaw upstream approximately 0.6 kilometer (0.4 mile) to where the creek is crossed by County Road 1947.

Constituent elements include high quality clear open water, with a neutral pH and clean sand substrate.



REFERENCE NO. 15

BLACK & VEATCH Waste Science Inc.
Philadelphia Office

TELEPHONE MEMORANDUM

U.S. Environmental Protection Agency
Superior Products Co. SIP

BVWS Project 52012.231
BVWS File
07/06/94
10:00am

To:	Sharon (Receptionist)
Company:	Superior Products Co.
Phone No.:	1-910-375-5811
Recorded by:	Robert Martel RM

I inquired as to how many people are employed at their manufacturing facility in Greensboro, NC. She said that approximately 7 people were employed there.