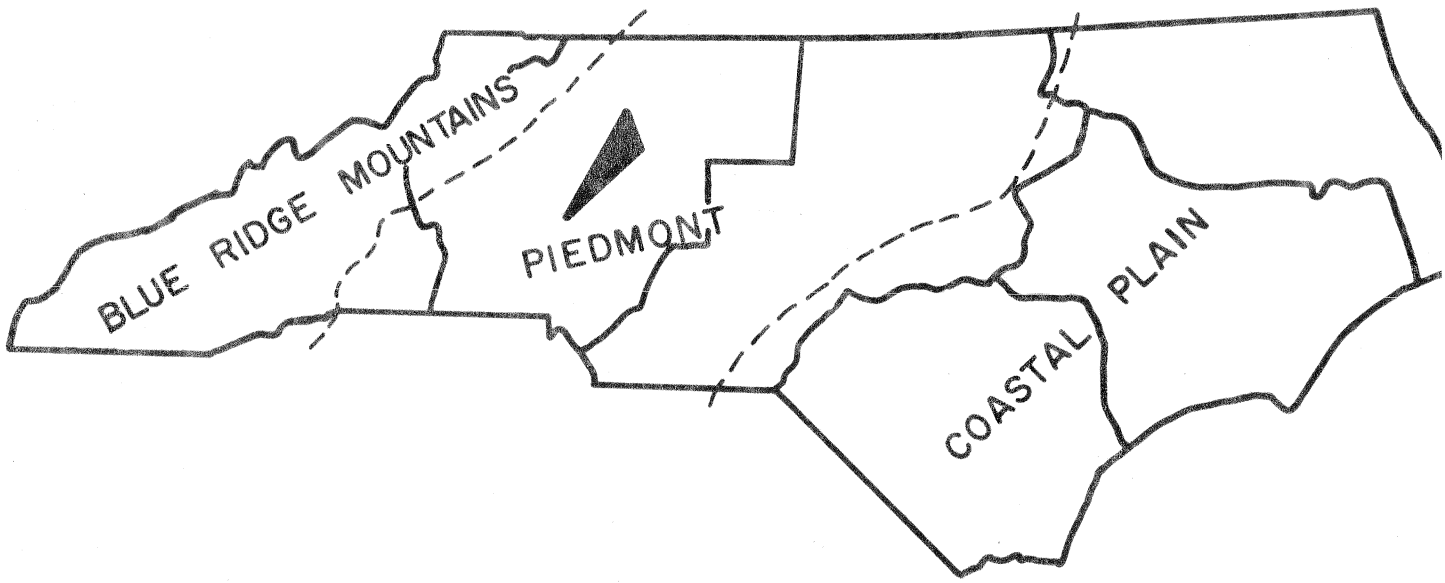
CHEMICAL AND PHYSICAL CHARACTER OF GROUND WATER IN THE SOUTH SCHOOL AREA IREDELL COUNTY, NORTH CAROLINA

GROUND-WATER CIRCULAR NO. 5



DIVISION OF GROUND WATER
NORTH CAROLINA
DEPARTMENT OF WATER RESOURCES
1965

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by

Richard R. Peace, Jr.

Ground-Water Circular No. 5

NORTH CAROLINA
DEPARTMENT OF WATER RESOURCES
Walter E. Fuller, Director

DIVISION OF GROUND WATER
Harry M. Peek, Chief

Raleigh
1965

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CHEMICAL AND PHYSICAL CHARACTER OF GROUND WATER IN THE SOUTH SCHOOL AREA, IREDELL COUNTY, NORTH CAROLINA

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INTRODUCTION

On March 1, 1965, Mr. Bob Shuford, Iredell County Manager, requested data on the quality of ground water in the area of the proposed South School. The location of the proposed school is on the south side of county road number 1005, locally called the Old Mountain Road, about three-quarters of a mile east of U. S. 21 (fig. 1).

This report is the result of the study in that area. Its purpose was to take water samples from representative wells in the area, to analyze the water as to the mineral content, to make a reconnaissance of the geology and to suggest, with some degree of accuracy, the quality of ground water that might be available on the proposed school property. To fulfill these purposes, fifteen selected wells were inventoried in the area and two chemical analyses made previously were studied. Two local drillers were consulted concerning wells and ground water conditions in the area. Time did not permit all wells in the area to be sampled. However, it is believed that the samples collected and analyzed are representative of the area. The inventoried wells were numbered according to the statewide well-numbering system that is based on 1- and 5-minute quadrangles.

This study and report was done under the direction of Harry Peek, Chief, Division of Ground Water.

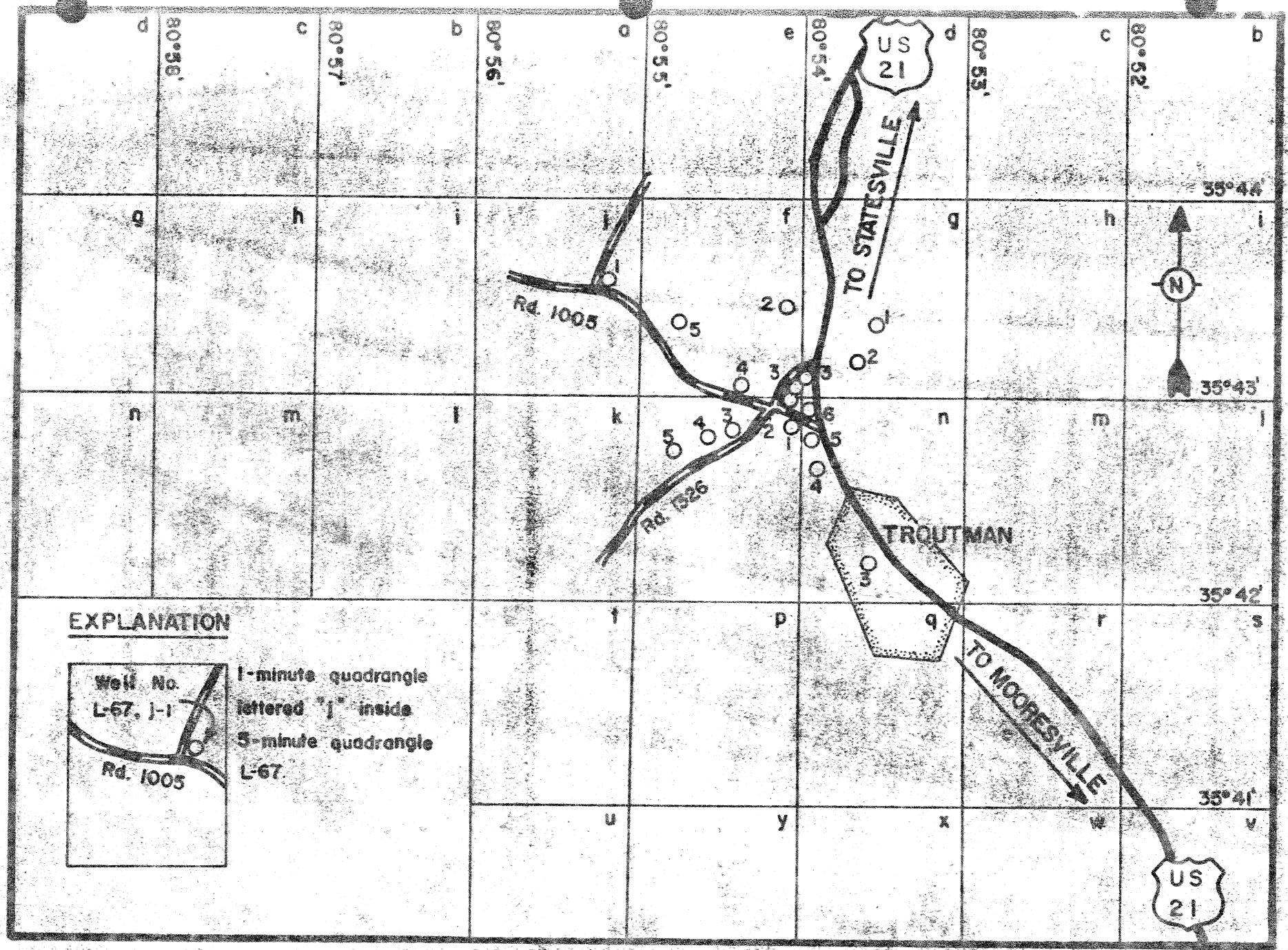

Figure 1 - MAP OF AREA STUDIED, SHOWING LOCATIONS OF SAMPLED WELLS

Acknowledgement is given to Carl Chambers Drilling Company of Statesville and to the Albert Rogers Drilling Company of Troutman for information concerning the area. Acknowledgement is also given to Mr. Earl Beaudry, Superintendent of the Statesville Water Filtration and Sewer Disposal Department for use of some laboratory equipment and to the people of the area under study who gave information concerning their water supplies.

GEOLOGY AND GROUND WATER

The area is predominately underlain by a gray mica ~~schist~~ gneiss of pre-Cambrian (?) age. Hornblende gneiss was observed in the western part of the area and hornblende saprolite was observed in some road cuts. Most of the soil is red to dark-red indicating the probable presence of some hornblende in all of the gneiss.

Ground water in the area occurs primarily in fractured zones of rock. A reconnaissance of the geology indicates that with careful well-site location, ground water in relatively large quantities--up to 50 gpm (gallons per minute) or more--can be obtained. No one reported quantity of water trouble in the area.

QUALITY OF WATER

Rainwater and snowfall contain only small amounts of dissolved matter but after falling on the ground, they begin to dissolve minerals from the soils and rocks which they pass over or through. The principal factors that determine the quality of ground water are the amount and

type of organic material in the soil zone, the mineral composition of the rock, the time the water is in contact with the soil and rock, the solvent ability of the water and the temperature of the water.

The most common mineral constituents in ground water are the cations--calcium, magnesium, sodium, potassium, and iron; and the anions--bicarbonate, carbonate, sulfate, chloride, fluoride, and nitrate. Silica, also, is present in most natural waters. Standards for drinking water established by the U. S. Public Health Service (1962) to control the quality of water supplied by common carriers generally are quoted as desirable for drinking water. According to these standards, supplies should not contain more than 0.3 ppm (parts per million) of iron, 250 ppm of sulfate, 250 ppm of chloride, 0.8 to 1.7 ppm of fluoride (depending on the annual average of maximum daily air temperatures), 45 ppm of nitrate, and 500 ppm of total dissolved solids.

Iron (Fe) is present in varying amounts in practically all rocks and soils. Water having a low pH may dissolve iron in objectionable quantities from piping. Iron in concentrations of more than 0.3 ppm may precipitate on exposure to air, forming an insoluble hydrated oxide that results in reddish-brown stains on fixtures and clothing. Water containing excessive iron is unsuitable for laundering and for manufacture of food, paper, ice, and some other products.

Calcium (Ca) and magnesium (Mg) are the chief constituents that impart the property of hardness to water. The other alkaline earths, strontium and barium are usually present only in small quantities. Hardness of water usually results from the solution of alkaline-earth minerals from

the soils and rocks. Water having a hardness of less than about 100 ppm is not considered objectionable for domestic purposes. A hardness of 200 to 500 ppm is decidedly noticeable and becomes increasingly troublesome.

Carbonate (CO_3) and bicarbonate (HCO_3) in ground water are caused by the solution of carbonate rocks. Both contribute to alkalinity but carbonate generally is present in small amounts or may be absent.

Sulfate (SO_4) is present in most rocks and soils and is a common constituent in ground water. When present in sufficient quantity, sulfate combines with calcium and magnesium to form a hard boiler scale.

Chloride (Cl) is normally present in most natural water. In small to moderate amounts it has little effect on the suitability of the water. Where present in sufficient concentration it imparts a salty taste to the water. Excessive chloride may cause the water to be corrosive. Chloride where present in large amounts may indicate pollution.

Fluoride (F) occurs in most natural waters in small amounts. Rainwater and Thatcher (1960, p. 163) stated, "Available evidence indicates that water containing less than 1.0 - 0.9 ppm of fluoride seldom causes mottling of children's teeth, and the literature describing the beneficial effect of 0.88 - 1.5 ppm in drinking water as an aid in the reduction of tooth decay in children is abundant."

Nitrate (NO_3) in ground water is generally considered the final oxidation product of nitrogenous organic material. High nitrate content along with abnormally high chloride indicates possible pollution.

Hydrogen-ion concentration (pH) is a measure of the relative acidity or alkalinity of water. A pH of 7.0 indicates that the water is neutral (hydrogen and hydroxyl ions in balance). A pH progressively less than 7.0 denotes increasing acidity, whereas a pH greater than 7.0 denotes increasing alkalinity. The pH of a water indicates its chemical activity toward metal surfaces. As the pH increases, the corrosive activity of the water normally decreasss; however, excessively alkaline waters are corrosive to some metals, particularly zinc.

Specific conductance (Micromhos at 25° C) is a measure of the ability of water to conduct electricity. It varies with the concentration and degree of ionization of the different minerals in solution and with the temperature. The greater the content of ionizable salts in a water, the greater the specific conductance. The conductance, however, does not indicate relative quantities of specific salts in the solution.

The temperature of ground water in a given locality is generally uniform, varying not more than a few degrees during the year.

The results of the fifteen tests and two tests previously made are given in Table 1. The locations of the wells are shown in figure 1. Using the United States Public Health Services' standards, all of the constituents were within these standards except the iron content. The iron content ranged from 0 to more than 5 ppm and was above 0.3 ppm in six of the seventeen analyses. In the sample from well L66-o4 the iron content was below 0.3 ppm in cold water (0.28 ppm) but when heated changed to 0.40 ppm. As indicated by these analyses the quantities of iron in the ground water of the area can be removed with a water-conditioning unit.

The chemical analyses, shown in Table 1, were made by means of the Hach direct reading photo-light meter, a Hach total hardness and calcium content kit, the pH by Beckman Zeromatic pH meter, the specific conductance by an Industrial Instrument Solu-Bridge conductivity meter, and the alkalinities by methyl purple and sulfuric acid method. The meters were checked with reagent blanks before each analysis and the reagent blanks were checked against like reagent blanks. Extreme care was taken in the iron content testing.

CONCLUSIONS

With careful selection of well sites, moderate quantities of ground water are available in the South School area. The water is generally of good quality, being soft and low in dissolved minerals. An exception is the relatively high iron content of water from some wells. However, the iron can be satisfactorily removed by a water-conditioning unit.

Table 1. -- Partial chemical analyses of water from selected wells in the South School area, Iredell County, North Carolina.

(Results are in parts per million except as indicated)

Well Number: L-66, f-2
Owner: Barium Springs Home for Children
Depth: 350 feet
Diameter: 6 inches
Yield: 50 gpm when drilled (1942); 22 gpm when abandoned.
Date of Collection: 3-3-65
Appearance when Collected: Muddy (Red)
Use: Not in use; formerly supplied part of need for orphanage.

Note: Because of sediments in sample, water was filtered before analyses.

Iron (Fe) At water temp. approx. 21° C	2.0	
Iron (Fe) At water temp. approx. 80° C	2.4	
Calcium (Ca)	12	
Carbonate (CO_3)	0	
Bicarbonate (HCO_3)	10	
Sulfate (SO_4)	4	
Chloride (Cl)	6	
Total Hardness (as $CaCO_3$)	16	
Specific conductance in micromhos at 25° C	140	
pH	6.8	
Temperature (°F)	51	(directly from pump)
Color (Apparent)	90	units
Turbidity	25	Jackson units

Well Number: L-66, f-3
Owner: G. L. Parker
Depth: 87 feet
Diameter: 2 inches
Cased to: 35 feet
Yield: 7½ gpm
Date of Collection: 3-3-65
Appearance when collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx. 21° C	1.65	
Iron (Fe) At water temp. approx. 80° C	1.79	
Calcium (Ca)	45	
Carbonate (CO_3)	0	
Bicarbonate (HCO_3)	50	
Sulfate (SO_4)	9	
Chloride (Cl)	2	
Silica (SiO_2)	47	
Total Hardness (as $CaCO_3$)	80	
Specific conductance in micromhos at 25° C	110	
pH	7.4	
Temperature (F°)	55.4	(from tank)
Color (Apparent)	70	units
Turbidity	17	Jackson units

Table 1. -- Continued

Well Number: L-66, f-4
Owner: R. D. Brotherton, Jr.
Depth: 82 feet
Diameter: 2 inches
Cased to: 71 feet

Yield: 6 gpm
Date of Collection: 3-5-65
Appearance when Collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx.	21° C	.90	
Iron (Fe) At water temp. approx.	80° C	.90	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		22	
Sulfate (SO_4)		3	
Chloride (Cl)		10	
Silica (SiO_2)		23	
Total Hardness (as $CaCO_3$)		25	
Specific conductance in micromhos at 25° C		55	
pH		6.5	
Temperature (°F)		54.4	(from tank
Color (Apparent)		20	units
Turbidity		10	Jackson units

Well Number: L-66, f-5
Owner: Victor Troutman
Depth: 112
Diameter: 2 inches
Cased to: 90 feet

Yield: 7 gpm
Date of Collection: 3-5-65
Appearance when collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx.	21° C	.18	
Iron (Fe) At water temp. approx.	80° C	.22	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		16	
Sulfate (SO_4)		1	
Chloride (Cl)		12	
Silica (SiO_2)		28	
Total Hardness (as $CaCO_3$)		10	
Specific conductance in micromhos at 25° C	less than	50	
pH		6.5	
Temperature (°F)		59.9	(directly from pump)
Color (Apparent)		8	units
Turbidity		3	Jackson units

Table 1. -- Continued

*Well Number: L-66, g-1
Owner: Barium Springs Home for Children
Depth: 60 feet
Diameter: 6 inches

Yield: 24 gpm
Date of Collection: 7-28-48
Use: Not in use March, 1965. Formerly supplied part of need for orphanage.

Iron (Fe)	.10
Calcium (Ca)	1.9
Magnesium (Mg)	1.1
Sodium and potassium (Na, K)	4.3
Carbonate (CO_3)	0
Bicarbonate (HCO_3)	12
Sulfate (SO_4)	2.3
Chloride (Cl)	2.2
Fluoride (F)	.1
Nitrate (NO_3)	3.6
Silica (SiO_2)	12
Total Hardness (as $CaCO_3$)	9
Dissolved solids	33
pH	5.76

*Analyses from "Geology and Ground Water in the Statesville area, N. C.", p. 45.

Well Number: L-66, g-2
Owner: Blanton and Moore, Inc.
Depth: 173 feet
Diameter: 2 inches
Cased to: 63 feet

Yield: 5 gpm
Date of Collection: 3-5-65
Appearance when Collected: Clear
Use: Drinking and bath for furniture factory.

Iron (Fe) At water temp. approx. 21° C		0	
Iron (Fe) At water temp. approx. 80° C		.15	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		18	
Sulfate (SO_4)		2	
Chloride (Cl)		10	
Silica (SiO_2)		30	
Total Hardness (as $CaCO_3$)		20	
Specific conductance in micromhos at 25° C	less than	50	
pH		6.6	
Color (Apparent)		0	units
Turbidity		0	Jackson units

Table 1. -- Continued

Well Number: L-66, g-3	Yield: 40 gpm
Owner: L. Jarvis	Date of Collection: 3-3-65
Depth: 58 feet	Appearance when Collected: Clear
Diameter: 2 inches	Use: Domestic

Iron (Fe) At water temp. approx. 21° C	.05	
Iron (Fe) At water temp. approx. 80° C	.18	
Calcium (Ca)	14	
Carbonate (CO_3)	0	
Bicarbonate (HCO_3)	10	
Sulfate (SO_4)	1	
Chloride (Cl)	4	
Silica (SiO_2)	11	
Total Hardness (as $CaCO_3$)	16	
Specific conductance in micromhos at 25° C	28	
pH	6.3	
Temperature (°F)	62.6	(from tank)
Color (Apparent)	10	units
Turbidity	0	Jackson units

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*Well Number: L-66, n-3	Cased to: 111 feet
Owner: Town of Troutman	Yield: 60 gpm
Depth: 560 feet	Date of Collection: 9-24-48
Diameter: 8 inches	Use: Part of public supply for Troutman, N. C.

Iron (Fe)	.13
Sodium and potassium (Na, K)	4.7
Magnesium (Mg)	4.0
Calcium (Ca)	11
Carbonate (CO_3)	0
Bicarbonate (HCO_3)	55
Sulfate (SO_4)	1.5
Chloride (Cl)	3.0
Silica (SiO_2)	24
Fluoride (F)	.0
Nitrate (NO_3)	4.0
Total Hardness (as $CaCO_3$)	44
Dissolved solids	84
pH	6.5

*Analyses from "Geology and Ground Water in the Statesville area, N.C.", p.45.

Table 1. -- Continued

Well Number: L-66, n-4		Yield: 12 gpm	
Owner: J. R. Shafer, Jr.		Date of Collection: 3-3-65	
Depth: 65 feet		Appearance when Collected: Clear	
Diameter: 2 inches		Use: Domestic and boat shop	
Cased to: 18 feet			
Iron (Fe)			
At water temp. approx. 21° C	.17		
Iron (Fe)			
At water temp. approx. 80° C	.2		
Calcium (Ca)	15		
Carbonate (CO_3)	0		
Bicarbonate (HCO_3)	30		
Sulfate (SO_4)	2		
Chloride (Cl)	4		
Silica (SiO_2)	30		
Total Hardness (as $CaCO_3$)	30		
Specific conductance			
in micromhos at 25° C	62		
pH	7.0		
Temperature (°F)	58.1	(from tank)	
Color (Apparent)	10	units	
Turbidity	6	Jackson units	

Well Number: L-66, n-5		Yield: 7 gpm	
Owner: Public Oil Co. (Mr. Raymer)		Date of Collection: 3-3-65	
Depth: 212 feet		Appearance when Collected: Clear	
Diameter: 2 inches		Use: Service station and oil company's office	
Iron (Fe)			
At water temp. approx. 21° C	.21		
Iron (Fe)			
At water temp. approx. 80° C	.23		
Calcium (Ca)	18		
Carbonate (CO_3)	0		
Bicarbonate (HCO_3)	34		
Sulfate (SO_4)	4		
Chloride (Cl)	6		
Silica (SiO_2)	28		
Total Hardness (as $CaCO_3$)	32		
Specific conductance			
in micromhos at 25° C	68		
pH	7.0		
Temperature (°F)	59	(from tank)	
Color (Apparent)	10	units	
Turbidity	0	Jackson units	

Table 1. -- Continued

Well Number: L-66, n-4
Owner: J. R. Shafer, Jr.
Depth: 65 feet
Diameter: 2 inches
Cased to: 18 feet

Yield: 12 gpm
Date of Collection: 3-3-65
Appearance when Collected: Clear
Use: Domestic and boat shop

Iron (Fe) At water temp. approx. 21° C	.17	
Iron (Fe) At water temp. approx. 80° C	.2	
Calcium (Ca)	15	
Carbonate (CO_3)	0	
Bicarbonate (HCO_3)	30	
Sulfate (SO_4)	2	
Chloride (Cl)	4	
Silica (SiO_2)	30	
Total Hardness (as $CaCO_3$)	30	
Specific conductance in micromhos at 25° C	62	
pH	7.0	
Temperature (°F)	58.1	(from tank)
Color (Apparent)	10	units
Turbidity	6	Jackson units

Well Number: L-66, n-5
Owner: Public Oil Co. (Mr. Raymer)
Depth: 212 feet
Diameter: 2 inches

Yield: 7 gpm
Date of Collection: 3-3-65
Appearance when Collected: Clear
Use: Service station and oil company's office

Iron (Fe) At water temp. approx. 21° C	.21	
Iron (Fe) At water temp. approx. 80° C	.23	
Calcium (Ca)	18	
Carbonate (CO_3)	0	
Bicarbonate (HCO_3)	34	
Sulfate (SO_4)	4	
Chloride (Cl)	6	
Silica (SiO_2)	28	
Total Hardness (as $CaCO_3$)	32	
Specific conductance in micromhos at 25° C	68	
pH	7.0	
Temperature (°F)	59	(from tank)
Color (Apparent)	10	units
Turbidity	0	Jackson units

Table 1. -- Continued

Well Number: L-66, o-2
Owner: D. W. Lawrence
Diameter: 3 inches

Date of Collection: 3-3-65
Appearance when Collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx. 21° C		.41	
Iron (Fe) At water temp. approx. 80° C		.42	
Calcium (Ca)		12	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		20	
Sulfate (SO_4)		3	
Chloride (Cl)		2	
Silica (SiO_2)		25	
Total Hardness (as $CaCO_3$)		32	
Specific conductance in micromhos at 25° C		52	
pH		6.7	
Temperature (°F)		59	(from tank)
Color (Apparent)		15	units
Turbidity		5	Jackson units

Well Number: L-66, o-3
Owner: D. L. Annas
Depth: 50 feet
Diameter: 2 inches
Cased to: 42 feet

Yield: 7 gpm
Date of Collection: 3-5-65
Appearance when Collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx. 21° C		.12	
Iron (Fe) At water temp. approx. 80° C		.21	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		4	
Sulfate (SO_4)		0	
Chloride (Cl)		12	
Silica (SiO_2)		14	
Total Hardness (as $CaCO_3$)		10	
Specific conductance in micromhos at 25° C	less than	50	
pH		6.0	
Color (Apparent)		9	units
Turbidity		2	Jackson units

Table 1. -- Continued

Well Number: L-66, o-4
Owner: H. Benfield
Depth: 97 feet
Diameter: 2 inches
Cased to: 84 feet

Yield: 5 gpm
Date of Collection: 3-5-65
Appearance when Collected: Clear
Use: Domestic

Iron (Fe) At water temp. approx. 21° C		.28	
Iron (Fe) At water temp. approx. 80° C		.40	
Calcium (Ca)		.28	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		20	
Sulfate (SO_4)		2	
Chloride (Cl)		9	
Silica (SiO_2)		25	
Total Hardness (as $CaCO_3$)		10	
Specific conductance in micromhos at 25° C	less than	50	
pH		6.3	
Temperature at time of Collection (°F)		54.6	(from tank)
Color (Apparent)		5	units
Turbidity		2	Jackson units

Well Number: L-66, o-5
Owner: M. L. Thomas
Depth: 130 feet
Diameter: 2 inches
Cased to: 50 feet

Yield: 3 gpm
Date of Collection: 3-5-65
Appearance when Collected: Dingy (Yellow tint)
Use: Domestic

Iron (Fe) At water temp. approx. 21° C	greater than	5	
Iron (Fe) At water temp. approx. 80° C	greater than	5	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3)		28	
Sulfate (SO_4)		10	
Chloride (Cl)		10	
Silica (SiO_2)		24	
Total Hardness (as ($CaCO_3$)		30	
Specific conductance in micromhos at 25° C		75	
PH		6.6	
Temperature (°F)		61.7	(directly from pump)
Color (Apparent)		340	units
Turbidity		90	Jackson units

Table 1. -- Continued

Well Number: L-67, j-1
Owner: T. Williams
Depth: 150 feet
Diameter: 6 inches
Cased to: 40 feet

Yield: 30 gpm
Date of Collection: 3-5-65
Appearance when Collected: Clear
Use: Service Station

Iron (Fe) At water temp. approx. 21° C		.69	
Iron (Fe) At water temp. approx. 80° C		1.65	
Calcium (Ca)	less than	17	
Carbonate (CO_3)		0	
Bicarbonate (HCO_3		14	
Sulfate (SO_4)		7	
Chloride (Cl)		8	
Silica (SiO_2)		28	
Total Hardness (as $CaCO_3$)		20	
Specific conductance in micromhos at 25° C		56	
pH		6.6	
Color (Apparent)		115	units
Turbidity		33	Jackson units

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