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NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
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A POSSIBLE NEW SOURCE OF GROUND-WATER SUPPLY IN THE ELIZABETH CITY AREA, NORTH CAROLINA

BY

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PREPARED IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

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By: M. J. Mundorff*

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Introduction

The Elizabeth City area is in Pasquotank County in the northeast corner of the North Carolina Coastal Plain. According to the 1940 Census Report, the population of Elizabeth City was 11,564 and that of the county was 20,568.

This report is presented to show the possibility of obtaining a ground-water supply of considerably better quality and much greater quantity than the present supply. The data and information upon which this report is based was obtained at intervals during the past 6 years as a part of the program of ground-water investigations in North Carolina being carried on in cooperation between the U. S. Department of the Interior, Geological Survey, and the North Carolina Department of Conservation and Development; and also during investigations of ground-water supplies for the Lighter-Than-Air Base, the Consolidated Assembly Base (Lend-Lease Base), the Patrol Plane Base, all near Elizabeth City, and the Sea Plane Base at Harvey Point. Also, a few days were spent in the summer of 1947 filling in gaps in the knowledge of the area.

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History of water supply for Elizabeth City

From some time prior to 1910 until 1934, the water supply for Elizabeth City was obtained from Knobbs Creek, a tributary to the Pasquotank River. Pasquotank River is brackish much of the time and the water in Knobbs Creek becomes brackish periodically, especially during periods of drought. Although tide dams and other structures were constructed on Knobbs Creek, the water became quite brackish on numerous occasions from 1930 to 1933. The situation became so critical that the city called on the North Carolina Department of Conservation and Development for assistance. The Department of Conservation and Development requested the U. S. Geological Survey to cooperate with them in making an investigation of the ground-water resources of the Elizabeth City area. S. W. Lohman was assigned to the project and spent 2 months in the winter of 1932-1933 in the area. The results of his investigation[1/] showed that water from the deeper beds was too salty for use; that water from the intermediate beds was available in large quantities and, although somewhat brackish, might be used; and that water from the shallower beds, although hard, corrosive, and containing considerable iron, was low in chloride and, by using a large number of wells spaced over a wide area, was present in sufficient quantity to supply the city. As a result of his investigation, a shallow well field, covering 60 acres and containing about 60 wells, was developed about 3 miles west of the city. Because of increased consumption by the city and decreasing yield of the individual wells, it has been necessary to expand the well field and drill additional wells from time to time. By 1947 about 225 wells, covering an area of 300 acres, were being pumped.

Present water supply

At the present time the city is pumping 225 shallow wells. The wells are 30 feet deep, and have a 1¼-inch screen 3 feet long at the bottom of a 2-inch drop pipe. The hole is jetted 10 inches in diameter and gravel is placed around the screen and pipe to within 10 or 15 feet of the surface. These 225 wells are furnishing about 750,000 gallons of water per day, which is at the rate of about 2 gallons a minute per well. Elizabeth City uses about 1,000,000 gallons of water daily and the 250,000 gallons of water not furnished by the shallow wells is supplied by three wells of intermediate depth at the water treatment plant. These wells are about 80 feet to 90 feet in depth, are 6 and 8 inches in diameter, and yield from 200 to 400 gallons a minute each. They are pumped just enough to supply the deficiency from the shallow well fields.

Ground water has now been used as a source of supply at Elizabeth City for 13 years. The water has always been potable and available in sufficient quantity to furnish the city and is therefore a much better supply than the water from Knobbs Creek, which frequently became too salty for use. However, for both quantitative and qualitative reasons the present supply is becoming less and less satisfactory and the city is at present examining the possibility of obtaining a better supply.

1/ Lohman, S. W., Geology and ground-water resources of the Elizabeth City Area, North Carolina: U. S. Geol. Survey Water Supply Paper 773-A, pp. 1-57, 1936.

The raw water from the shallow well field has a hardness of about 200 to 300 parts per million, an iron content which generally is about 6 to 8 parts per million and a chloride content of 15 or 20 parts per million. Worse, however, than the hardness and high iron content of the water is its corrosiveness, which is probably due largely to the high carbon-dioxide content. As the water is pumped by vacuum pumps at two central pumping stations, the carbon dioxide is released in the wells and pipes, and corrosion of the metal is rapid. Expansion of the well field has been to the west, into Dismal Swamp; and the corrosiveness of the ground water apparently increases in that direction. The combination of increasing consumption of water in Elizabeth City, decreasing yield of the individual wells, and increasing corrosiveness of the water has resulted in a greatly accelerated maintenance program to replace corroded wells and pipes. The water from the aquifers at a depth of 80 to 90 feet at the water treatment plant is available in large quantities, two or three wells pumped continuously would supply the city. However, the water from these wells is of rather unsatisfactory quality. It has a hardness of about 350 to 400 parts per million and a chloride content of 250 to 300 parts per million.

Geology of the Elizabeth City area

Elizabeth City is on the outer part of the Coastal Plain on the lowest of the Pleistocene terraces. The ground surface is very flat and ranges in altitude from a few feet to about 15 feet above sea level. Beginning a few miles west of Elizabeth City, the Great Dismal Swamp extends for many miles to the north and west.

The uppermost formation is the Pamlico formation of Pleistocene age, whose surface forms the terrace occupying the entire area included in this report. This formation ranges from about 30 to 50 feet or more in thickness and consists of fine- to medium-grained gray sand and bluish-colored clay.

Underlying the Pamlico formation are strata of Pliocene age consisting chiefly of fine sands, silt, and clay, all with some shells and occasional layers of coarser sand. Because of inconclusive paleontological evidence the thickness of the Pliocene strata is not known exactly, but it is, apparently, about 40 to 50 feet.

Beneath the Pliocene deposits are strata of Miocene age. These deposits consist of blue clay, sand, and some shell rock. Both the blue clay and the sand commonly contain considerable quantities of shells. The thickness of the Miocene is probably about 400 to 500 feet.

Below the Miocene are strata of Eocene and Cretaceous age. The thickness and depth to which these deposits extend are not known. A cross-section of wells along a line from a test well 4½ miles west of Elizabeth City through a well at the filtration plant to the Lighter-Than-Air Base near Weeksville is shown in figure 1. The location of the section is shown in figure 2, the map accompanying this report. It appears from this section that the dip of the strata is generally about 5 feet per mile.

Ground water in the Elizabeth City area

Three horizons have been considered as a possible source of ground-water supply in the Elizabeth City area; the shallow horizon from 0 to about 30 feet, the intermediate horizon from 45 or 50 to about 125 feet and the deep horizon, which includes all water-bearing strata found below about 125 feet.

Shallow-water horizon.--The strata from the surface to about 30 feet consist chiefly of very fine sands with some layers of silt or clay and rarely thin layers of coarser sand. At many places these strata contain shells.

Because of the fineness of the sand the yield of an individual well is very small. Even by placing an envelope of gravel around the well, the city has been able to obtain only a few gallons a minute from each well.

At most places the water is moderately hard to very hard. The hardness of the water from Elizabeth City's shallow well field ranges from about 200 to 300 parts per million. The water is high in iron, generally containing from 5 to 10 parts per million, and is very corrosive. It is the combination of low individual yield per well and the corrosiveness of the water which cause the trouble in the present shallow well field. Lohman[1] made a thorough study of the shallow water-bearing beds in the vicinity of Elizabeth City in 1933-1934 and it is probable that the location of the present shallow well field is as satisfactory as any other location would be.

Deep-water horizon.--During the course of Lohman's investigation a deep test well was drilled at the filtration plant in Elizabeth City. No water-bearing beds were found between 95 feet and 482 feet and the water at 482 feet contained 3,280 parts per million of chloride, which is far too much for domestic use. A well drilled in the western part of the county (near Parkville, which is in Perquimans County) in 1903 is reported[2] to have yielded salty water below 300 feet. A 600-foot well at Hertford, in Perquimans County, yields water with a chloride content of more than 3,000 parts per million. At a depth of 270 feet in a well at Harvey Point, also in Perquimans County, the water had a chloride content of 1,400 parts per million. In view of high chloride content of the strata below about 300 feet, water from those depths cannot be considered as a source of supply for Elizabeth City. It is possible that potable water may be found between the base of the intermediate zone (about 125 feet) and 300 feet but from the evidence available at the present time this appears unlikely. No water-bearing strata were found between 95 and 482 feet in the well drilled at the filtration plant. A well drilled to a depth of 1,208 feet in 1915-1916 near the tide dam on Knobbs Creek encountered no water-bearing strata between about 90 or 100 feet to 493 feet and the water at 493 feet was very salty. A well drilled to 270 feet at Harvey Point encountered no water-bearing strata

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1/ Op. cit.

2/ Clark, W. B., Miller, B. L., Stephenson, L. W., Johnson, B. L., and Parker, H. N., The Coastal Plain of North Carolina: North Carolina Geol. and Econ. Survey, vol. 3, p. 455, 1912.

below 76 feet and the water from the sandy clay at 270 feet had a chloride content of 1,400 parts per million. A number of wells drilled at and near Edenton have failed to find any water-bearing strata between 100 and 212 feet.

Intermediate water-bearing horizon.--Strata between depths of about 45 feet and 125 feet are included in the intermediate horizon. No one stratum is continuous over the area, but there are several strata that are quite extensive. They are generally a foot or two to 15 or 20 feet thick. The upper water-bearing strata generally are sands or gravels with little or no shell, and the lower strata contain much shell. The water-bearing strata are separated generally by layers of silt or clay.

At the time Lohman made his investigation of the area, serious consideration was given to these strata as a possible source of ground-water supply for the city. Quantitatively it is by far the best horizon. A large supply of water was shown to be available from the strata between 75 and 93 feet in well 114 at the filtration plant. Lohman stated that "two or more properly constructed wells in this sand should yield the amount of water required for the public supply of Elizabeth City." However, because of the objectionably high chloride content of the water, ranging from about 100 to more than 300 parts per million in various parts of the city, it was not very desirable as a source of supply. Another objectionable feature was the excessive hardness of the water, which ranged from about 200 to more than 400 parts per million.

After development of the first shallow well field several wells were drilled into the intermediate horizon at the filtration plant to serve as an auxiliary supply and to use in emergencies. These wells range in depth from 80 to 100 feet and yield 200 to 400 gallons a minute each. The water has a chloride content of 250 to 300 parts per million, and a hardness of 350 to 400 parts per million, and is therefore unsatisfactory as the principal source of supply.

Since the inauguration of the cooperative ground-water investigation in 1941 a great deal of valuable information and data have been obtained. Information obtained along the coast of North Carolina, particularly at Camp Lejeune and in the vicinity of Pamlico River and Albemarle Sound, indicated that high chloride is found at shallower depths immediately adjacent to the drowned estuaries or bays of the North Carolina coast. Furthermore, it appeared that high chlorides were found at shallower depths near the heads of these bays than farther down the bays (down the dip of the strata).

In 1942 construction was begun on the Lend-Lease Base and the Patrol Plane Base, both adjacent to the Coast Guard Station about 3½ miles southeast of Elizabeth City. At that time the Coast Guard Station was using water from the shallow horizon, obtaining its supply from two gravel-walled wells. These wells were yielding only about 20 to 25 gallons a minute each, and the water was high in iron and very corrosive.

Conclusions of the U. S. Geological Survey based on the knowledge of the areal relationship of the fresh and salt water as mentioned above indicated that there was a very good possibility of obtaining water of moderately low chloride content from strata of the intermediate horizon at the Patrol Plane Base and the Lend-Lease Base. It was recommended to the Navy that an attempt

be made to obtain water from drilled wells 75 or 80 feet deep. It was also recommended that the wells be drilled as far from the Pasquotank River as possible. Three wells were drilled at the Lend-Lease Base and two at the Patrol Plane Base. The first well at the Lend-Lease Base was located closer to the river than the other wells. Not a great deal of water was obtained and the water had a chloride content of 345 parts per million at 50 feet, 148 parts per million at 75 feet, and 173 parts per million at 116 feet. The next two wells, 98 and 99 feet deep (to bottom of screen) were drilled farther from the river and yielded 220 gallons a minute and 264 gallons a minute, respectively. As was predicted, the water had a fairly low chloride content (49 and 62 parts per million, respectively) but was quite hard.

Two wells were also drilled at the Patrol Plane Base, about 1 mile northwest of the Lend-Lease Base. These wells, 75 and 74 feet deep, yielded respectively 188 and 165 gallons a minute when tested with an air compressor. The water had a chloride content of 27 and 15 parts per million, respectively, which was even less than anticipated. What was more surprising, however, was the fact that the water had a hardness of only 62 and 49 parts per million, respectively. These wells were the only ones known at that time to be yielding soft water from the intermediate horizon in the vicinity of Elizabeth City. Logs of the Lend-Lease wells and the Patrol Plane wells are given below:

Well 187, Lend-Lease well 2

Total depth, 109 feet; diameter, 8 inches; screen, 76-98 feet; yield, 220 gallons a minute; static level, 6 feet below surface.

Log

	Depth (feet)
Stiff gray clay	0 - 8
Soft blue silty sand	8 - 20
Blue silty sand	20 - 40
Fine blue silty sand and clay	40 - 45
Fine gray sand, water	45 - 54
Fine gray sand and clay	54 - 62
Blue clay	62 - 71
Fine gray sand	71 - 77
Medium coarse gray sand	77 - 80
Gray sand and shell	80 - 86
Medium fine sand and shell	86 - 98
Fine gray sand	98 -105

Well 188, Lend-Lease well 5

Total depth, 106.5 feet; diameter, 8 inches; screen, 88-99 feet; yield, 264 gallons a minute; static level, 5 feet below surface.

Log

	Depth (feet)
Yellow clay	0 - 7
Fine blue sand and clay	7 - 48
Fine gray sand	48 - 57
Coarse gray sand	57 - 61
Stiff blue clay	61 - 68
Medium fine gray sand	68 - 81
Fine black sand	81 - 88
Medium gray sand and shell	88 - 99
Fine gray sand	99 -110

Well 189, Patrol Plane well 3 (south)

Total depth, 85 feet; diameter, 8 inches; screen, 65-75 feet; yield, 188 gallons a minute; static level, 2.5 feet below surface.

Log	Depth (feet)
Gray clay	0 - 9
Fine yellow sand	9 - 40
Medium fine gray sand	40 - 57
Fine sand and clay	57 - 65
Coarse gray sand	65 - 68
Coarse sand and gravel	68 - 75
Blue clay and shells	75 - 80

Well 190, Patrol Plane well 4 (north)

Total depth, 84.25 feet; diameter, 8 inches; screen, 54-74 feet; yield, 165 gallons a minute; static level, 6 feet below surface.

Log	Depth (feet)
Blue clay	0 - 7
Fine blue sand and clay	7 - 27
Fine brown sand	27 - 48
Fine gray sand and clay	48 - 59
Coarse gray sand	59 - 64
Medium gray sand and clay	64 - 78
Blue clay	78 - 85

The logs of well 189 at the Patrol Plane Base and well 187 at the Lend-Lease Base are shown graphically in figure 1.

The Lend-Lease wells are screened in strata about 25 feet deeper than the Patrol Plane wells, and this may, in part, account for the much greater hardness of the water. However, possibly more important, no shells were reported in the sands yielding the water in the Patrol Plane wells, whereas both Lend-Lease wells yield water from sand containing shells. Both of the Lend-Lease wells encountered coarse sands apparently free of shell, but 17 feet of the 20 feet of screen in well 187 was opposite shell-bearing sands and all of the screen of well 188 was set in shell-bearing sands. It is quite possible that if the water in these wells were obtained only from sands free of shell, the water would be soft.

About the same time that the wells at the Patrol Plane Base and Lend-Lease Base were drilled, several wells were drilled at the Harvey Point Seaplane Base. The logs of these wells and those of the Patrol Plane wells are quite similar and analyses of the water are remarkably similar. It is quite possible that the wells at both bases obtain water from the same strata. Analyses of the water are given in the table at the end of this report.

The hardness of water from many jetted wells is included in the table of well data and it seems remarkable that all these analyses indicate hard waters, whereas drilled wells at both the Patrol Plane Base and Harvey Point yield soft water. It is quite possible that the procedure followed in completing a jetted well prevents, in some cases, utilization of water-bearing strata which would yield soft water. The 1¼-inch pipe, usually with a 5-foot strainer, is jetted down into a water-bearing horizon; the smaller jetting pipe is then removed and a wooden plug is driven down to the bottom of the strainer. Many times good sands are passed because the sand runs up inside the strainer and pipe before the plug can be sent to the bottom. Therefore, it is nearly always necessary to jet into a stratum containing shells, which prevent the sand from running up the casing. It is probable that softer water was passed in many jetted wells because of this reason.

From time to time during the winter of 1946-1947 additional hydrologic data were obtained in Pasquotank County and adjacent counties. Pertinent data on all important wells are given in the table at the end of this report and the location of the wells is shown on the map. The map also shows the area within which nearly all wells drilled into the intermediate horizon yield water with a chloride content of 100 parts per million or more. This area is termed the high-chloride zone. The high-chloride zone occupies a tongue-shaped area several miles across, entirely surrounding Elizabeth City. It is apparent that water with a low chloride content, in sufficient quantity to supply the city, cannot be obtained within the city, but it can be obtained from the intermediate horizon within about 3 miles of the city in almost any direction. However, even in the low-chloride zone, some of the deeper wells yield water with a chloride content of more than 100 parts per million.

The only place that soft water is known to occur in the intermediate horizon near Elizabeth City is at the Patrol Plane Base and in well 213, southwest of the Patrol Plane Base. Well 213 is on a direct line between the Patrol Plane Base and Harvey Point and, as this line is about parallel to the strike of the formations in the area, it may be that there is a soft-water zone along this line. Although a search was made for other wells along this line, not enough information was obtained to prove definitely the existence of such a soft-water zone. However, it is suggestive that wells 201 and 204, which are near the line, have a much lower hardness and chloride content than the other wells in the area.

Possibility of changes in the quality of water.--The possibility of change in the quality of the water in the intermediate horizon if it were used as the source of supply is an important consideration.

The only adverse changes that need be considered are the possibility of an increase in the hardness of the water or in the chloride content.

The hardness of the water in the intermediate horizon at the treatment plant has not increased. The water from well 114 had a hardness of 330 to 358 parts per million at the time of Lohman's investigation in 1932. The hardness of the present wells at the treatment plant, which are about the same depth as well 114, ranges from about 300 to 400. The hardness of the water from all four wells used at the Lend-Lease Base and the Patrol Plane Base actually decreased slightly from 1943 to 1947.

There are several possible ways that an increase in chloride content can occur in a water from a well. One way is by contamination from a saltier water from below. Because of the continuous impermeable layers of silt and clay underlying the water-bearing strata in the intermediate horizon, this probably does not occur in the Elizabeth City area. A second way is by a change in the relative proportions of water supplied from two or more strata in a well when one stratum yields water with a different chloride content than the others. A third way in which the chloride content can increase is by lateral encroachment of saltier water. In the Elizabeth City area the strata apparently are overlain by silts and clays which would prevent entrance of salty water from the Pasquotank River or other surface source; but as has been shown, the strata adjacent to the bays already contain saltier water than the same strata farther from the bays, so that the chloride content could increase by lateral movement of such water.

When well 114 was drilled in 1932, a sample of the water in the 75 to 93 foot stratum was obtained before continuing the drilling to 482 feet.

The water at 482 feet had a chloride content of about 3,250 parts per million, and the casing was pulled, the bottom part of the hole was plugged, and further tests were made on the 75 to 93 foot sand. Whereas the water from that sand had a chloride content of 180 parts per million before deepening, the chloride content of the water, after deepening and subsequent abandoning the bottom part of the hole, ranged from 298 to 308 parts per million. It was thought that some of the high-chloride water at 482 feet, which was under greater head than that in the 75 to 93 foot stratum, might have leaked upwards into the 75 to 93 foot sands. However, the present wells in these sands, after 15 years have elapsed and many million gallons of water have been removed from the stratum, still yield water with a chloride content averaging about 300 parts per million. It is probable that several strata are actually represented in the interval 75 to 93 feet and that the water obtained in the first test was coming from a slightly higher horizon than the water in subsequent tests. It should be noted that the chloride content of the ground water in the Elizabeth City area increases considerably with relatively small increases in depth of well.

The chloride content of the water from the Lend-Lease wells has increased somewhat since they were drilled. The chloride content of wells 187 and 188 was 49 and 65 parts per million, respectively, when the wells were drilled in 1942 and 1943. The respective chloride contents were 72 and 83 parts per million in April 1947. This increase in chloride content may be due to lateral encroachment from the saltier water in the strata adjacent to Pasquotank River or may be caused by an increase in the proportion of water furnished by the deeper strata in the wells.

The chloride contents of wells 189 and 190 at the Patrol Plane Base were 27 and 15 parts per million, respectively, when the wells were drilled in 1942. The chloride content of well 189 had decreased to 19 parts per million by April 1947, and the chloride content of well 190 had decreased to 11 parts per million in August 1944, the last date for which an analysis is available.

The chloride content of well 5 at Harvey Point was 18 parts per million when it was drilled in February 1943, was 16 parts per million in July 1945, the last date for which an analysis is available, and ranged from 19 to 11 parts per million between those dates. The chloride content of well 6 at Harvey Point was 12 parts per million in both the first and last analyses made, in February 1943 and July 1945, and ranged from 10 to 16 parts per million.

Summary and conclusions

The present water supply for Elizabeth City is not entirely satisfactory for both quantitative and qualitative reasons. The yield of individual wells in the shallow well field is very low (2 - 3 gallons a minute), necessitating a large number of wells; and the corrosiveness of the water results in a large and expensive maintenance program. The water is hard (200 - 300 parts per million) and has a high iron content (generally 6 - 8 parts per million).

The supplementary supply from the intermediate horizon at the treatment plant is available in large quantity but is excessively hard (350 to 400 parts per million) and high in chloride (250 to 300 parts per million).

A better supply both quantitatively and qualitatively can be obtained from the intermediate horizon outside the city limits but within about 3 miles of the treatment plant, in almost any direction, except possibly to the northwest, but the preferable directions are west, south, or southeast. Water from this horizon probably can be obtained within the present shallow well field. Four or five screened wells, not more than about 85 feet deep, would furnish the entire supply for the city. The water at most places would have a hardness of 250 to 300 parts per million, a chloride content of 40 to 80 parts per million, and an iron content between 1 and 7 parts per million. As the chloride content of the successively deeper aquifers is progressively higher, it would be essential to obtain the water from as near the top of the intermediate horizon as possible.

A still more satisfactory supply quite possibly could be obtained from the upper, non-shell-bearing sands and gravels of the intermediate horizon, particularly near the Patrol Plane Base. It is quite possible that the soft-water sands present at the Patrol Plane Base extend to the southwest. Four or five wells drilled into strata similar to those penetrated by the wells at that base would furnish the entire supply for the city. The water has a hardness of only about 40 to 60 parts per million, a chloride content of 10 to 20 parts per million, and an iron content of 1 to 2 parts per million. Over a period of about 2 years both the hardness and the chloride content of both wells at the Patrol Plane Base declined appreciably.

It is probable that sands yielding soft water have been passed up by the jetted wells in some areas because of the difficulty in completing a jetted well in running sand. Soft-water sands comparable to those at the Patrol Plane Base might be found in other areas by proper test drilling.

The wells at the Patrol Plane Base are not being pumped at the present time, although the equipment is still intact. Additional testing of the soft-water horizon could be made by pumping one or both of these wells for an indefinite period, possibly a year or more. The water could be delivered to the city through the 6-inch line which runs from the city to the base. Well 3 could be pumped; and well 4, which is between well 3 and the sound, could be used as an observation well to record changes in water level in the aquifer and any indication of encroachment of salty water from the direction of the sound. The zeolite softening unit at the Base, which is not being used, possibly could be used to remove the iron, and thus a supplementary supply of water of superior quality would be delivered to the city at the same time the aquifer was being tested.

Analyses of water in the Elizabeth City area
(parts per million)

Well No.			Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$
Pasquotank County:												
153	72	Oct. 1 1941	1.3	47	6.1	18	164	6	29	---	0.64	142
187	109	Nov. 27 1942	6.0	---	---	---	320	2	49	0.1	---	237
187	do	Mar. 4 1943	6.6	---	---	---	312	3	62	.1	---	231
188	99	Jan. 12 1943	.59	---	---	---	296	1	62	.1	.2	198
189	75	Dec. 12 1942	1.3	---	---	---	75	5	27	.1	---	62
190	85	Nov. 19 1943	1.2	13	4.0	15	67	5.7	15	.1	.1	49
Perquimans County:												
5	81	Nov. 19 1943	.38	20	3.2	13	72	4.2	18	.1	1.8	63
6	85	July 3 1945	---	---	---	---	113	3	12	---	3.6	82

Records of wells in the Elizabeth City Area

Well No.	Location	Owner	Driller	Type of well	Depth (feet)	Diameter (inches)	Yield (gallons a minute)	Total hardness	Chloride (Cl)	Remarks
				Camden County						
3	Camden	Texaco Station	White	Jetted	75-80	1¼	---	175	125	
4	do	County Courthouse	do	do	85-90	1¼?	6	---	90	
5	do, 2½ miles east of	Frank White	do	do	95	1¼	4	207	50	
6	do, 1 mile east of	R. L. Whaley	-----	Driven	30	1¼	---	178	43	
7	do, 2 miles east of	Dennis Whaley	-----	Jetted	112	1¼	---	216	69	
				Pasquotank County						
13	Elizabeth City 4 miles northwest of	Bruce Davis	-----	Jetted	104	1¼	---	---	119	Water in 64-71 foot sand reported to have flowed.
54	do, 3½ miles northwest of	Cecil Pritchard	-----	do	106	1¼	---	---	138	Water at 60-65 feet also.
55	do, 3 miles northwest of	Hershey Sawyer	-----	do	110	1¼	---	---	84	HCO_3 = 552 parts per million.
114	do, Filter Plant	City	Car. Dril. & Equip. Co.	Drilled	93	6	198	358	308	Test well drilled to 482 feet.
119	do	Crystal Ice & Coal Company	-----	Jetted	81	2	75-80	177	181	Two wells, same depth and yield.
126	do	Virginia Dare Hotel	-----	do	88	2	---	315	190	
129	do, 1½ miles southeast of	State Normal	-----	Drilled	90	8	60	140	136	Two wells, same depth, diameter, and yield.
151	Weeksville, 2½ miles northeast of	L.T.A. Naval Station	Car. Dril. & Equip. Co.	do	52.25	12-8	16	---	165	Test well 1; gravel-walled.

Records of wells in the Elizabeth City Area (continued)

Well No.	Location	Owner	Driller	Type of well	Depth (feet)	Diameter (inches)	Yield (gallons a minute)	Total hardness	Chloride (Cl^-)	Remarks
			Pasquotank County (continued)							
152	Weeksville, 2½ miles northeast of	L.T.A.Naval Station	Car. Dril. & Equip. Co.	Drilled	30	12-8	8.5	17	14	Test well 2; gravel-walled.
153	do	do	do	do	73.25	12-8	50	142	29	Test well 3; gravel-walled.
157	Elizabeth City, 3½ miles southeast of	U.S.Coast Guard	Layne Atlantic Co.	do	34	17½-2	28	---	---	
158	do	do	do	do	34	17½-2	28	---	---	
159	Weeksville	Weeksville Ginning Co.	-----	Jetted	50	1¼	10	267	177	
160	do	do (W.A.Turner)	----	do	55	1¼	---	---	---	Flows
161	do, 4 miles south of	M.S.Cartwright (W. G. James)	Frank White	do	50	1¼	5-10	170	40	
162	do, 3 miles south of	M.S.Cartwright	do	do	45	1¼	---	150	30	Flowed when completed.
163	Weeksville	W.D. Lister (James Trueblood)	do	do	45	1¼	10-15	150	30	
178	do, 2½ miles northeast of	L.T.A. Naval Station	Layne Atlantic Co.	do	169	2	---	---	---	Test well.
179	Elizabeth City	City	Sydnor Pump & Well Co.	Drilled	1207.75	10-6	---	---	---	
186	do, 4 miles southeast of	U.S.Coast Guard Lend-Lease Well 1	do	do	134.3	8	47	240	360	Abandoned.
187	do	do, Well 2	do	do	109	8	220	237	49	
188	do	do, Well 5	do	do	106.5	8	264	198	62	

Records of wells in the Elizabeth City Area (continued)

Well No.	Location	Owner	Driller	Type of well	Depth (feet)	Diameter (inches)	Yield (gallons a minute)	Total hardness	Chloride (Cl)	Remarks
			Pasquotank County (continued)							
189	Elizabeth City, 3 miles southeast of	Patrol Plane, Well 3	Sydnor Pump & Well Co.	Drilled	85	8	165	62	27	
190	do	do, Well 4	do	do	84.25	8	188	49	15	
191	do, 3 miles west of	City (A.H. Jones)	Frank White	Jetted	68	1¼	—	279	39	Large supply of water.
192	do, 4 miles southwest of	Foreman Dairies	-----	do	70	1¼	—	285	59	
193	do, 1½ miles southwest of	C. H. Neese	-----	do	73	1¼	—	300	245	
194	do, 3 miles northwest of	Clarence Scott Well at barn	-----	do	122	1¼	—	369	238	
195	do, 3 miles northwest of	do, Well at house	-----	do	77	1¼	—	366	94	
196	do, 2 miles northwest of	Charles Pritchard	-----	do	—	1¼	—	279	95	
197	do, at filter plant	City, well 1	Sydnor Pump & Well Co.	Drilled	80-90	8	—	393	290	
198	do	do, well 2	do	do	80-90	6	—	—	—	
199	do	do, well 3	do	do	80-90	8	—	357	235	
200	do	do, well 4 (observation well)	do	do	80-90	8	—	—	—	
201	do, 2½ miles southeast of	G.H.Hatfield	-----	Jetted	72	1¼	—	94	58	Large supply
202	do, 2½ miles south of	Mrs. Mattie Harrell	Frank White	do	82	1¼	—	207	101	
203	do, 2½ miles south of	T.L.Overman	-----	Driven	19	1¼	15+	50	19	

Records of wells in the Elizabeth City Area (continued)

Well No.	Location	Owner	Driller	Type of well	Depth (feet)	Diameter (inches)	Yield (gallons a minute)	Total hardness	Chloride (Cl)	Remarks
			Pasquotank County (continued)							
204	Elizabeth City, 5½ miles south of	M. B. Sample (Henry Brick-house)	-----	Jetted	85?	1¼	---	147	19	
205	do, 6 miles southwest of	C. C. Pritchard	Frank White	do	85	1¼	---	200	44	
206	do	L. M. Twiford (Mr. Ives)	-----	do	60	1¼	---	207	62	
207	do, 2½ miles southeast of	A. B. Etheridge	-----	do	85	1¼	---	180	111	
208	do, 2 miles southeast of	M. B. Brothers	Frank White	do	80	1¼	---	194	129	
209	do, 1 mile south of	Herman White	-----	do	80	1¼	---	206	75	
210	do, 2 miles south of	David Fearing	-----	do	85	1¼	---	204	115	
211	do, 1½ miles northwest of	Brites Dairy	Dillard Smithson	do	60	1¼	---	234	90	
213	do, 4½ miles south of	C.O. Robbinson	-----	Driven ?	45	1¼	---	56	8	
214	Weeksville, 3 miles southwest of	J. N. Keaton	-----	Jetted	100	1¼	---	267	760	
			Perquimans County							
1	Harvey Point	U. S. Navy	Sydnor Pump & Well Co.	Drilled	77.25	8	12	---	---	Casing pulled, well abandoned.
2	do	do	do	do	81	8	70	219	10	Used as observation well after others completed.
3	do	do	do	do	271	8	---	---	---	Well abandoned.

Records of wells in the Elizabeth City Area (continued)

Well No.	Location	Owner	Driller	Type of well	Depth (feet)	Diameter (inches)	Yield (gallons a minute)	Total hardness	Chloride (Cl)	Remarks
			Perquimans County (continued)							
4	Harvey Point	U. S. Navy	Sydnor Pump & Well Co.	Drilled	86	8	188	90	13	Well capped; held in reserve. Screens: 35-44 feet, 50-56 feet, 63-76.5 feet.
5	do	do	do	do	81	8	165	63	18	Main supply well. Screen: 36-71 feet.
6	do	do	do	do	85	8	---	82	12	Auxiliary supply well. Screens: 38-45.5 feet, 50.5-77 feet.
13	Newhope Proper	A. C. Caddy	Spruil	Jetted	90	1¼	---	250	26	
14	Newhope	L. R. Webb	Frank White	do	100	1¼	---	---	152	
47	do	Mrs. M.E.Sumner	-----	do	50	1¼	---	162	26	
50	do, 3 miles east of	N. C. Spivey Well in lot	-----	do	45	1¼	---	135	24	

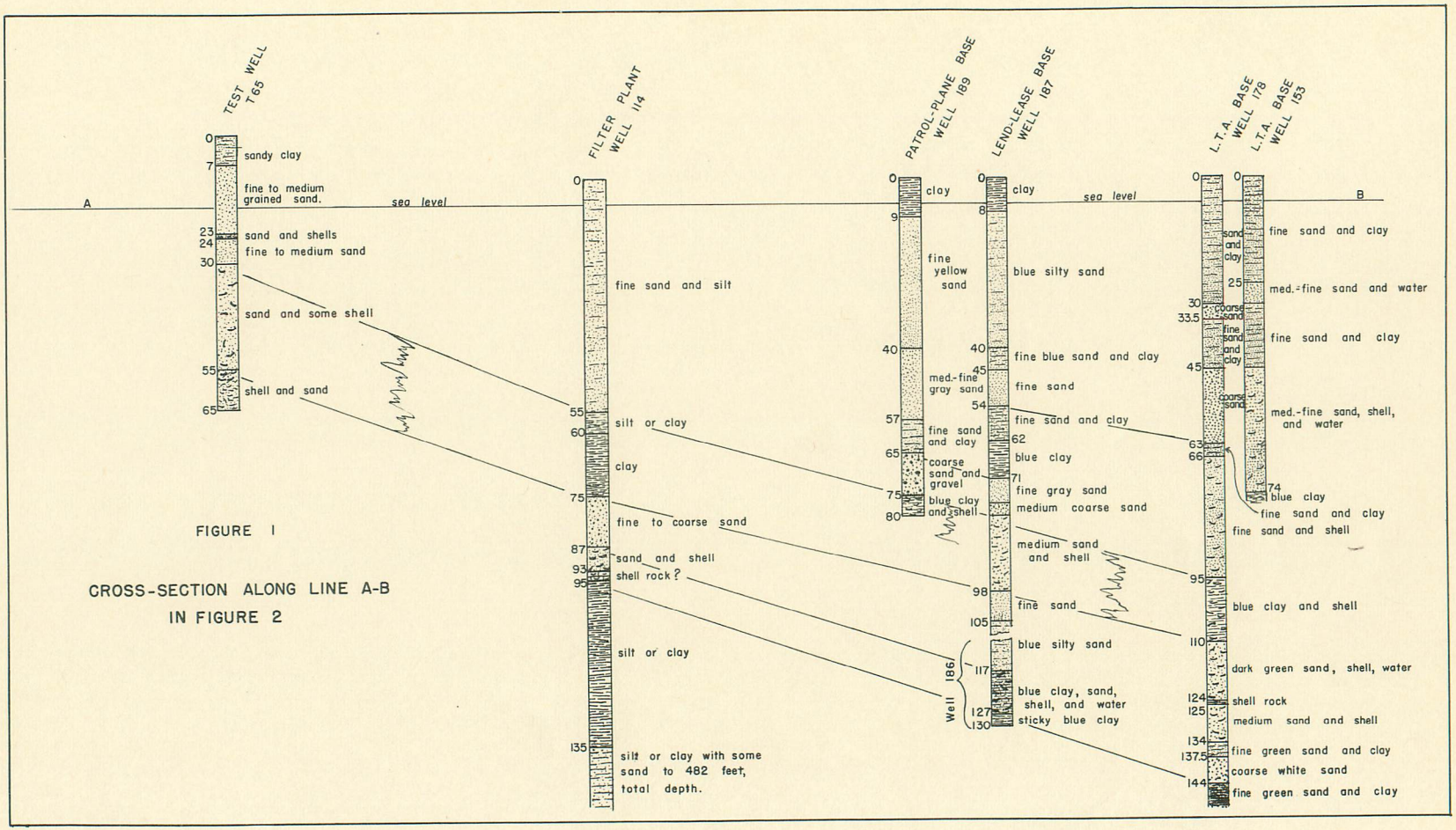

FIGURE 1

CROSS-SECTION ALONG LINE A-B IN FIGURE 2

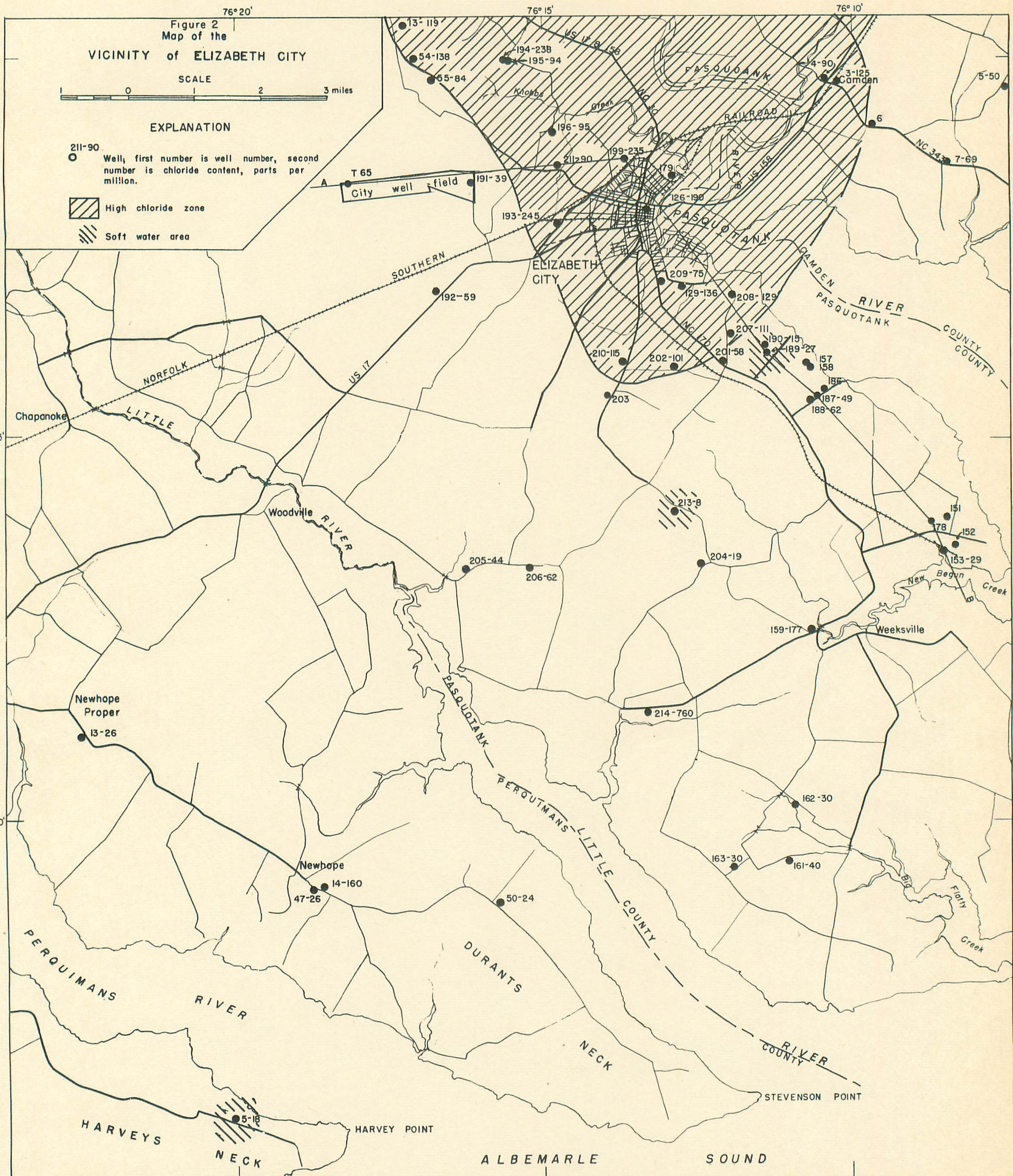
Figure 2
Map of the
VICINITY of ELIZABETH CITY
SCALE
1 0 1 2 3 miles
EXPLANATION
211-90
Well; first number is well number, second number is chloride content, parts per million.
High chloride zone
Soft water area
76° 20'
76° 15'
76° 10'
36° 20'
36° 15'
36° 10'
City well field
T 65
191-39
13-119
54-138
55-84
194-238
195-94
196-95
211-290
199-235
193-245
179
126-190
4-90
3-125
Camden
5-50
6
7-69
ELIZABETH CITY
PASQUOTANK
PASQUOTANK RIVER
CAMDEN COUNTY
PASQUOTANK COUNTY
209-75
129-136
208-129
207-111
190-15
189-27
157
158
210-115
202-101
201-58
186
187-49
188-62
203
192-59
SOUTHERN
NORFOLK
US 17
US 158
NC 170
NC 343
RAILROAD
Chapanoke
LITTLE RIVER
Woodville
213-8
205-44
206-62
204-19
151
178
152
153-29
New Begun Creek
159-177
Weeksville
214-760
Newhope Proper
13-26
162-30
163-30
161-40
Big Flatty Creek
Newhope
14-160
47-26
50-24
PASQUOTANK COUNTY
PERQUIMANS COUNTY
LITTLE RIVER
DURANTS NECK
PERQUIMANS RIVER
HARVEYS NECK
5-18
HARVEY POINT
STEVENSON POINT
ALBEMARLE SOUND