HYDROGEOLOGY OF AQUIFERS IN CRETACEOUS AND YOUNGER ROCKS IN THE VICINITY OF ONSLOW AND SOUTHERN JONES COUNTIES, NORTH CAROLINA

By William L. Lyke and M.D. Winner, Jr.

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CONVERSION FACTORS

The following factors may be used to convert the U.S. customary units published in this report to the International System of Units (SI).

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Volume	
gallon (gal)	3.785	liter (L)
	Gradient	
foot per mile	0.1894	meter per kilometer (m/km)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

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ABSTRACT

Unconsolidated sediments in Onslow and Jones Counties overlie crystalline basement rocks and range in thickness from about 700 feet to more than 1,800 feet, thickening toward the east. This material is composed of permeable sand and limestone interlayered with relatively impermeable clay and silt beds. The permeable sediments are divided into two groups: aquifers in Quaternary and Tertiary rocks and aquifers in Cretaceous rocks. Aquifers in Cretaceous rocks provide most of the ground water for public supplies and are the focus of this report.

The aquifers in Cretaceous rocks are the Peedee, Black Creek, upper Cape Fear, and lower Cape Fear aquifers, which are composed of beds or groups of beds of sand and gravel. Each aquifer is overlain by a bed or layer of clay and silt, which impedes the flow of water between aquifers. The thickness of Cretaceous hydrogeologic units ranges from about 700 feet to more than 1,300 feet.

Hydrogeologic units are correlated using 60 geophysical logs and accompanying drillers logs along with water-level and water-quality data. Three hydrogeologic sections demonstrate the continuity of the aquifers and confining units, show water levels and chloride concentrations in water from test intervals, and delineate where chloride concentration in water exceeds 250 milligrams per liter within each aquifer. Maps of each aquifer in Cretaceous rocks show altitude of its top, thickness, sand percentage, and the transition from freshwater to saltwater. Maps of the confining units show thickness and sand percentage of each. Data for all aquifers and confining units are tabulated.

INTRODUCTION

An increase in ground-water withdrawals in the central Coastal Plain of North Carolina is causing continuing water-level decline in aquifers in

Cretaceous rocks that underlie the area. A number of communities that rely on these aquifers have become concerned about this decline and its future effect on their ground-water supply. Some water suppliers have had to lower pumps in their wells or to locate new wells away from existing well fields. In 1983, the U.S. Geological Survey, in cooperation with the North Carolina Department of Environment, Health, and Natural Resources (formerly known as the North Carolina Department of Natural Resources and Community Development) and 11 other local agencies, began an investigation in the central Coastal Plain area (fig. 1) to better understand and define the ground-water flow system there. The study was to refine the hydrogeologic framework and assess the effects of pumpage on the ground-water system and to present alternatives in resource management and development through use of a ground-water flow model.

The original study area for the central Coastal Plain aquifer study was expanded southward in 1986 to include all of Onslow County, parts of Pender, Craven, Lenoir, and Carteret Counties, and additional areas in Duplin and Jones Counties (fig. 1). Water systems in these areas also utilize aquifers in Cretaceous sediments and are experiencing water-level declines as well.

Purpose and Scope

As part of the investigation of the expanded study area, this report presents the results of a detailed hydrogeologic examination of aquifers in Cretaceous rocks underlying Onslow County, southern Jones County, and parts of Carteret, Craven, Duplin, Lenoir, and Pender Counties (fig. 1). The emphasis of this report is on the sediments of Cretaceous age because these rocks contain the aquifers that provide most of the ground water used for public supply in the study area.

This report describes the lithology, altitude of the top, thickness, percentage of permeable material, confining units, water levels, and chloride concentration in water for each of the major aquifers in Cretaceous sediments in the area. Hydrogeologic sections, contour maps showing altitude of the top, thickness, and sand percentage of aquifers and thickness and sand percentage of confining units, and a data table are presented to facilitate understanding of the physical dimensions of the aquifer system. The data presented in this report constitute part of the

hydrogeologic data base for a model of the ground-water flow system of the area and provide a hydrogeologic framework for future studies.

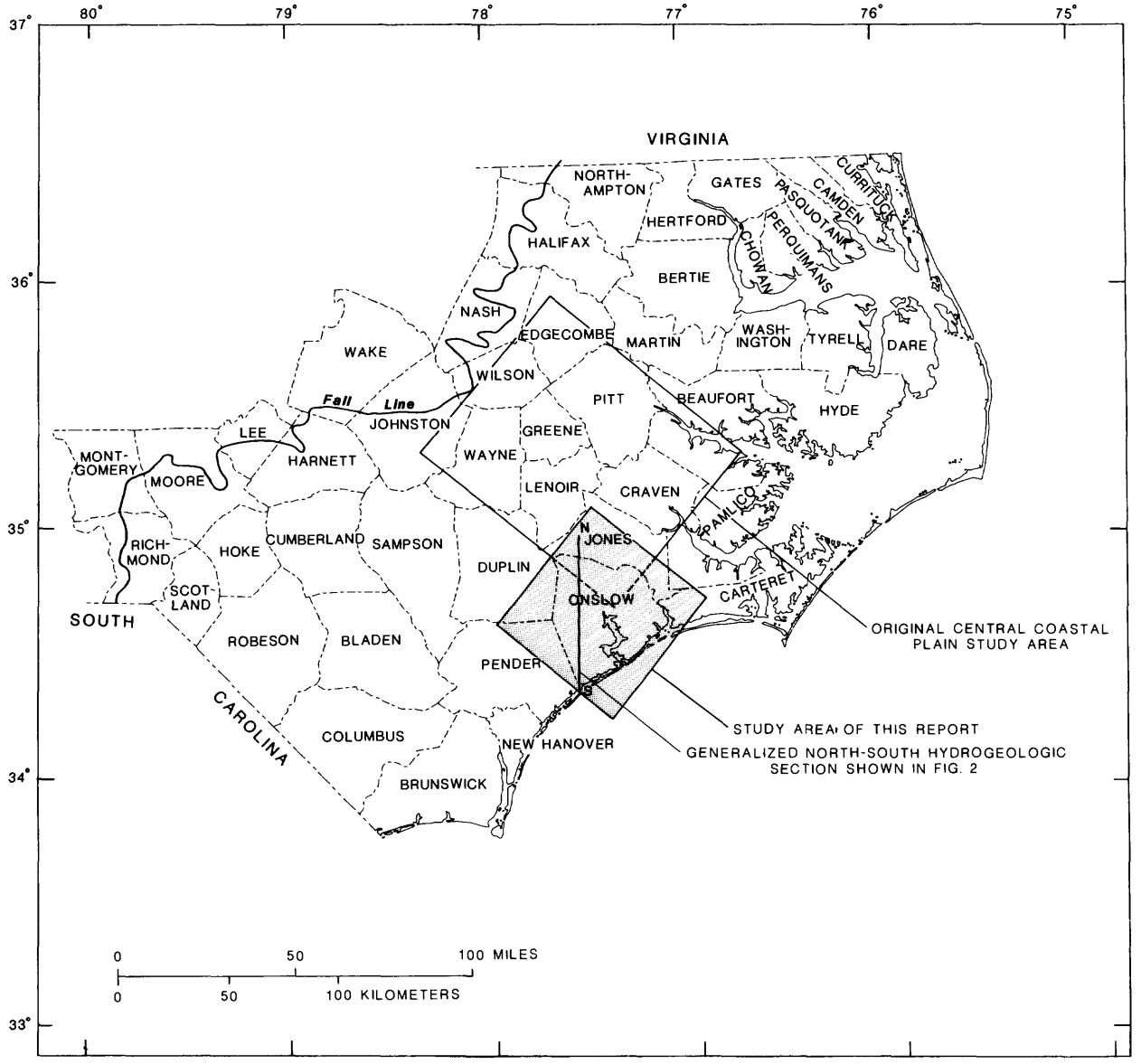


Figure 1.--Location of study area in the North Carolina Coastal Plain.

Acknowledgments

This report was prepared in cooperation with the North Carolina Department of Environment, Health, and Natural Resources (EHNR), Onslow County, Jones County, and the City of Jacksonville. The authors gratefully

acknowledge the assistance provided by the Groundwater Section, Division of Environmental Management, EHNR, which furnished data collected as part of their ongoing research-station program. Borehole geophysical logs and drillers logs have been documented, drill-stem tests have been run, and water samples have been collected and analyzed at research-station sites since about 1966. In the central Coastal Plain study area, EHNR has drilled 9 exploratory test holes and completed 31 observation wells. Two of these test holes were completed specifically for the investigation of the expanded study area. Some borehole geophysical logs were furnished by the Geological Survey Section, Division of Land Resources, EHNR.

Previous Studies

Previous studies in the area include multi-county reconnaissance studies and detailed investigations of smaller areas. A report by Brown and others (1972) described the stratigraphy and aquifer characteristics in the area as part of a multi-state investigation of Coastal Plain sediments.

Additional hydrogeologic studies covering multi-county areas include those by Billingsley and others (1957), LeGrand (1960), Narkunas (1980), and the North Carolina Department of Natural Resources and Community Development (1984). Investigations of smaller areas include a report on Old Settler's Beach, Onslow County, and Surf City, Pender County, by Shiver and Register (1978) and another report for the Georgetown community near Jacksonville by North Carolina Department of Natural Resources and Community Development (1979).

The hydrogeologic framework for the area of this investigation is based on the hydrogeologic framework developed for the entire Coastal Plain of North Carolina as part of the U.S. Geological Survey nationwide program for ground-water studies called Regional Aquifer Systems Analysis (RASA). The RASA program in North Carolina included a hydrogeologic framework that describes the geology, hydrology, and geochemistry of a multi-layered aquifer system of the Coastal Plain (Winner and Coble, 1987), and a digital flow model that simulates ground-water flow within the framework (G.L. Giese, U.S. Geological Survey, written commun., 1988). A refined and more detailed framework for the original central Coastal Plain study area was described by Winner and Lyke (1987).

Other reports resulting from the central Coastal Plain aquifer study include a structure map of the altitude of the top of crystalline basement rocks (Lyke and Winner, 1986) and a report of the historical ground-water pumpage (1900 to 1980) from the aquifers in Cretaceous rocks underlying the original central Coastal Plain study area and its relationship of pumpage to an overall water-level decline in these aquifers (Winner and Lyke, 1986). Also, nonpumping ground-water levels were measured in December 1986 for all aquifers in Cretaceous sediments for the entire central Coastal Plain aquifer study area. These data have been presented as four potentiometric surface map reports (Brockman and others, 1989; Lyke and others, 1989; Winner and others, 1989a and 1989b).

DELINEATION OF HYDROGEOLOGIC UNITS

Aquifer boundaries tend to parallel boundaries of geologic rock units in the study area. Geologic formations identified in the area are, in descending order, the Castle Hayne Limestone and Beaufort Formation of Tertiary age and the Peedee, Black Creek, and Cape Fear Formations of Cretaceous age. These formations generally thicken toward the southeast and are underlain by southeastern sloping crystalline bedrock composed of relatively impermeable igneous and metamorphic rocks (fig. 2). Although aquifer boundaries may coincide with or parallel those of geologic rock units in local areas, they do not coincide with geologic unit boundaries throughout the study area.

The aquifers and their confining units underlying the study area have been correlated with and named for units identified in the original central Coastal Plain study (Winner and Lyke, 1987) and North Carolina RASA study. This report extends these hydrogeologic correlations into the expanded study area. Geologic and hydrogeologic units in the North Carolina Coastal Plain are listed in table 1. A generalized section of aquifers and confining units in the study area (fig. 2) depicts the relation between aquifers in Quaternary and Tertiary rocks and those in the Cretaceous rocks in the study area. The altitude of the top of the crystalline basement rocks which underlie the entire aquifer system in the study area is shown in plate 1.

In this report, these aquifers are divided into two groups: (1) aquifers in Quaternary and Tertiary rocks and (2) aquifers in Cretaceous

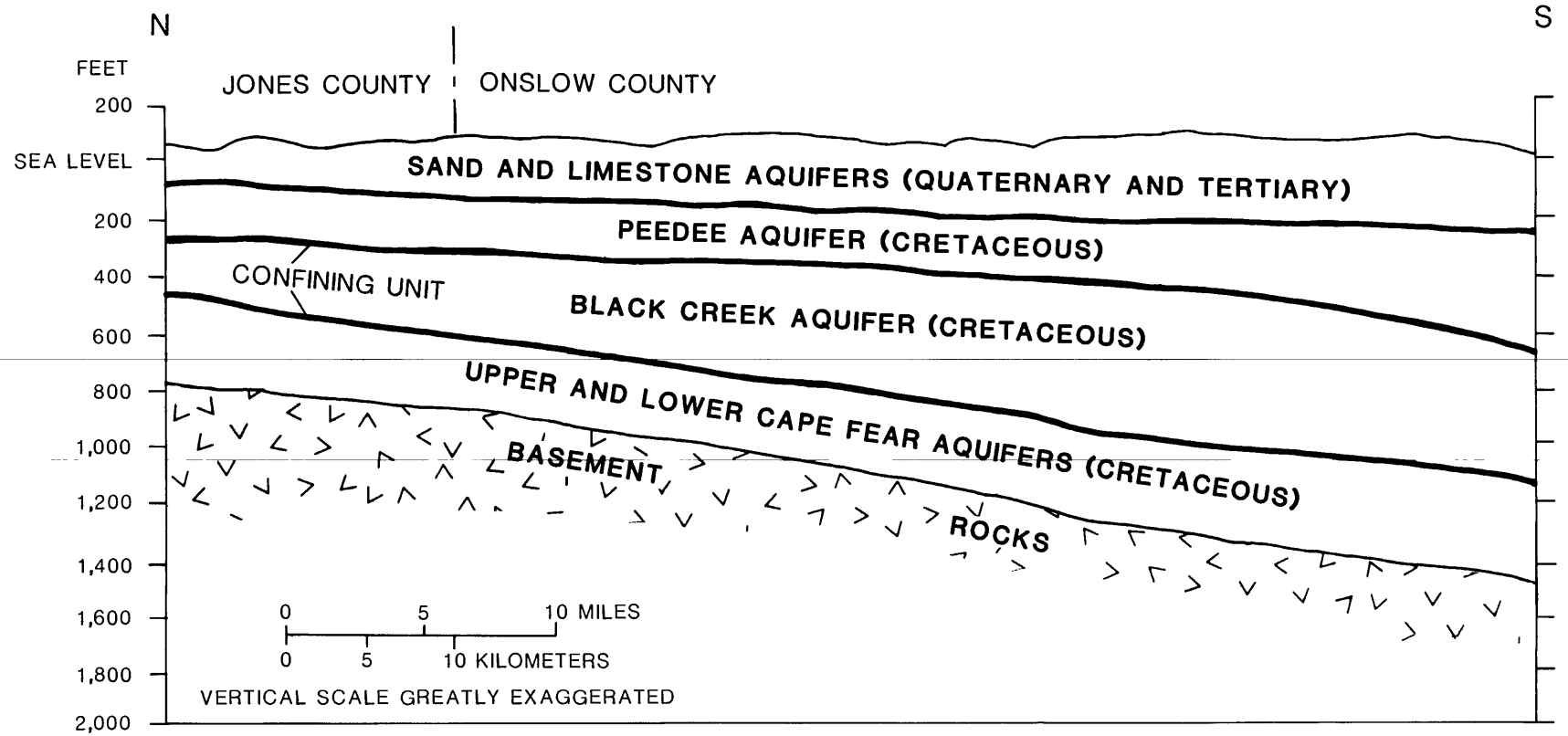


Figure 2.--Generalized north-south hydrogeologic section in the study area.

Table 1.--*North Carolina Coastal Plain geologic and hydrogeologic units*

System[1]	Geologic units	Hydrogeologic units
Quaternary	Quaternary deposits	Surficial aquifer
Tertiary	Yorktown Formation[2]	Yorktown confining unit[2] Yorktown aquifer[2]
	Eastover Formation[2]	Pungo River confining unit[2].
	Pungo River Formation[2]	Pungo River aquifer[2]
	Belgrade Formation	Castle Hayne confining unit
	River Bend Formation	Castle Hayne aquifer
	Castle Hayne Limestone	
	Beaufort Formation	Beaufort confining unit Beaufort aquifer
Cretaceous	Peedee Formation	Peedee confining unit Peedee aquifer
	Black Creek Formation	Black Creek confining unit
	Middendorf Formation[2]	Black Creek aquifer
	Cape Fear Formation	Upper Cape Fear confining unit Upper Cape Fear aquifer Lower Cape Fear confining unit Lower Cape Fear aquifer
	Unnamed units[2]	Lower Cretaceous confining unit[2] Lower Cretaceous aquifer[2]

[1]System identification of a given hydrogeologic unit is only approximate and reflects the age or ages of the principal geologic unit or units comprising that hydrogeologic unit.

[2]Unit not present in study area.

rocks. The aquifers in Cretaceous rocks supply most of the ground water used for public supply in the central Coastal Plain area (Winner and Lyke, 1986) and are emphasized in this report.

Mapping Criteria

For the purpose of developing a hydrogeologic framework to be used to define the movement of ground water, this report has adopted a concept of hydrogeologic units similar to the concept of "hydrostratigraphic unit" proposed by Maxey (1964, p. 126) to describe, "...bodies of rock with considerable lateral extent that compose a geologic framework for a reasonably distinct hydrologic system." The system of hydrogeologic units used within this report is similar to that identified in the RASA study and as used by Winner and Lyke (1987).

Criteria generally used to map geologic formations are the lithologic properties or the paleontologic content of the rocks. Hydraulic properties of rocks such as porosity, hydraulic conductivity, or storage coefficients are not used to define geologic units. Aquifer definition depends upon the mapping of hydraulically connected permeable units. In this report, individual aquifers and confining units were grouped into major hydrogeologic units based on: (1) significant differences in hydraulic head, (2) evidence of widespread lateral transmission of drawdown effects, thus indicating lateral hydraulic connection, and (3) similarities in water quality.

Correlation Methods

The primary method used to compile and compare data and to correlate the aquifers and confining units in the study area was to construct hydrogeologic sections based on geophysical logs, water-level measurements, and chemical data from available wells. Data from 17 geophysical logs were used to construct three hydrogeologic sections, and an additional 43 logs were used to fill data gaps between the sections. Locations of all wells are shown in plate 2, and a listing of altitudes, thicknesses, and percentages of permeable material for each aquifer and confining unit at each data site are given in table 3 at the back of this report. The percentage of permeable material for each aquifer in each well was

determined by estimating the amount of silt, sand, or limestone present in each aquifer based on the analysis of available well logs.

The geophysical logs at test holes at EHNR ground-water research stations were selected as the principal logs of each section because these test holes usually were drilled to basement, and, equally as important, the EHNR program also provided water-level and water-quality data throughout the geologic column at each research-station test hole. The hydrogeologic framework of the study area was developed through five sets of data: (1) bore-hole geophysical logs, (2) geologists' or drillers' logs, (3) water-level measurements observed in wells and uncorrected for chloride-ion concentration, (4) chemical analyses of water samples from wells, and (5) the hydrogeologic frameworks developed for the entire North Carolina Coastal Plain (Winner and Coble, 1987) and the original central Coastal Plain study area (Winner and Lyke, 1987).

The characteristics of stratigraphic units were refined for the study area from previous work (Winner and Coble, 1987) by means of correlation of lithologic units between wells mainly through the use of standard single-point electric logs (self-potential and resistance curves) and natural gamma-ray radiation logs. The method of correlation used was to superimpose logs from adjacent wells to determine the continuity of sediments from well to well by comparing the log traces. Interpretation of lithology from geophysical logs was aided by drillers' logs.

The distribution of water levels in each research-station test hole was compared with its geophysical log, and appropriate confining units were selected on the basis of head distribution. The log correlations and analysis of heads in wells along the sections led to the definition of aquifers and confining units shown in plate 3. Individual aquifers or confining units may not be part of the same lithostratigraphic or time-stratigraphic unit everywhere because (1) of lithofacies changes and erosional unconformities in the sedimentary rocks of the study area, and (2) the rate of water movement vertically through a given confining unit cannot be assumed to be the same everywhere.

Hydrogeologic sections were constructed by projecting aquifer determinations, well data, and map data to a straight line of section rather

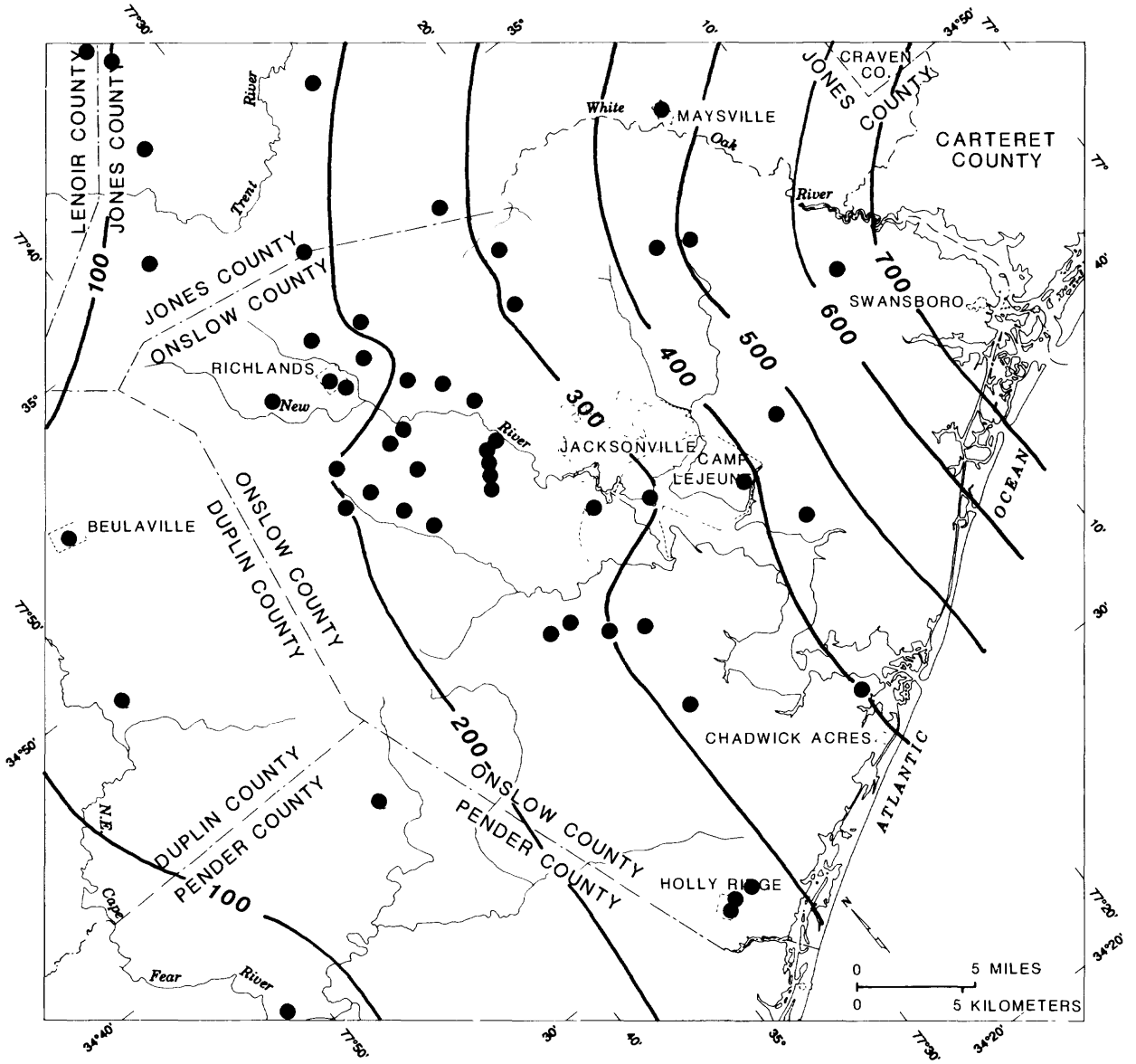
than using a well-to-well line of section (plate 1). For the straight line method, data at well locations were projected to a point on the cross section along a line perpendicular to the line of section (plate 1). Therefore, the point of juncture of two lines of section may not have identical data values on both sections. The only data points in common on two crossing sections are at wells located on both sections. Although both the straight line and well-to-well methods are accepted methods of cross-section construction, the straight line of section method was chosen for this report to be compatible with the method used in the report describing the hydrogeology of the original central Coastal Plain study area (Winner and Lyke, 1987). This method of cross-section construction has also been used in other reports of regional scope (Brown and others, 1972; Winner and Coble, 1987).

Chloride concentrations were used in conjunction with the analysis of logs and water-level data to help delineate the hydrogeologic units. The chloride ion was used because it is commonly used as an indicator of saltwater in Coastal Plain aquifers and because of the large amount of chloride data available. Chloride distribution in Coastal Plain aquifers is gradational in nature, and chloride concentrations in water generally increase with depth and in the downdip (or seaward) direction. The boundary between freshwater and water approaching seawater in composition is called the transition zone and can be many hundreds of feet thick in the vertical dimension and up to several miles wide horizontally (Meisler, 1986). Departures from uniform chloride concentration gradients may be directly related to ground-water flow laterally within the aquifer and vertically across confining units.

HYDROGEOLOGY OF AQUIFERS IN QUATERNARY AND TERTIARY ROCKS

Aquifers in Quaternary and Tertiary rocks occur throughout the study area, overlie aquifers in Cretaceous rocks (fig. 2), and are composed of sand, clayey sand, clay, and limestone beds. Each aquifer has distinctive hydrogeologic characteristics that extend over large areas of the North Carolina Coastal Plain (Winner and Coble, 1987). From top to bottom, the aquifers in Quaternary and Tertiary rocks in the study area are the surficial aquifer, the Castle Hayne aquifer, and the Beaufort aquifer. These aquifers are separated by confining units composed of clay and silt beds.

As a group, the aquifers in Quaternary and Tertiary rocks and confining units dip and thicken to the east and are more than 700 ft thick in the eastern part of Onslow County near Swansboro (fig. 3). The average thickness for the entire system in the study area is about 240 ft. The



EXPLANATION

—100— LINE OF EQUAL THICKNESS OF ROCKS OF QUATERNARY AND TERTIARY AGE-- Interval 100 feet

● WELL LOCATION

Figure 3.--Thickness of aquifers in Quaternary and Tertiary rocks in the study area.

percentage of permeable material composing each aquifer varies from 46 to over 90 percent, but as a whole the aquifers contain an average of 76 percent permeable material in the study area.

The surficial aquifer occurs everywhere in the study area and is composed of Quaternary deposits of sand, silt, and clay. These deposits are remnants of beach terraces, offshore bars, and lagoonal sediments laid down during higher sea levels of the past. To a minor degree the surficial aquifer also includes recent river-laid sediments along the flood plains of the White Oak and New Rivers and their larger tributaries.

In the study area, the surficial aquifer averages 23 ft in thickness but may be more than 80 ft thick in a few places. The amount of permeable material (sand) in the surficial aquifer averages about 76 percent and varies between 48 and 90 percent.

The Castle Hayne aquifer is the most productive single aquifer in the entire North Carolina Coastal Plain (Winner and Lyke, 1986) and is composed largely of limestone and sand of the Castle Hayne Limestone as well as similar younger beds. This hydrogeologic unit pinches out in the western part of the study area near Chinquapin and Beulaville, Duplin County, and west of Players, Pender County (fig. 4). The top of the Castle Hayne aquifer generally dips eastward at an average rate of 3 feet per mile (ft/mi) in the study area, ranging in altitude from about 56 ft above to 43 ft below sea level. The thickness of the unit in 46 wells in the study area averaged 147 ft, ranging from 23 to 393 ft thick. The percent limestone and sand in the aquifer averages 68 percent and ranges from 50 to 90 percent.

The Beaufort aquifer is the oldest of the aquifers in Tertiary rocks in the study area and consists primarily of fine to medium glauconitic sands, clayey sands, shell and limestone, and interbedded clays of the Beaufort Formation. The Beaufort aquifer underlies most of the study area but does not extend as far west as does the Castle Hayne aquifer (fig. 4). The top of the aquifer dips eastward at an average rate of 18 ft/mi from about 63 ft below to more than 485 ft below sea level. The thickness of the Beaufort aquifer in 43 wells in the study area averaged 58 ft and ranged from 20 to 148 ft. This aquifer averages about 84 percent sand and ranges from 46 to 88 percent sand.

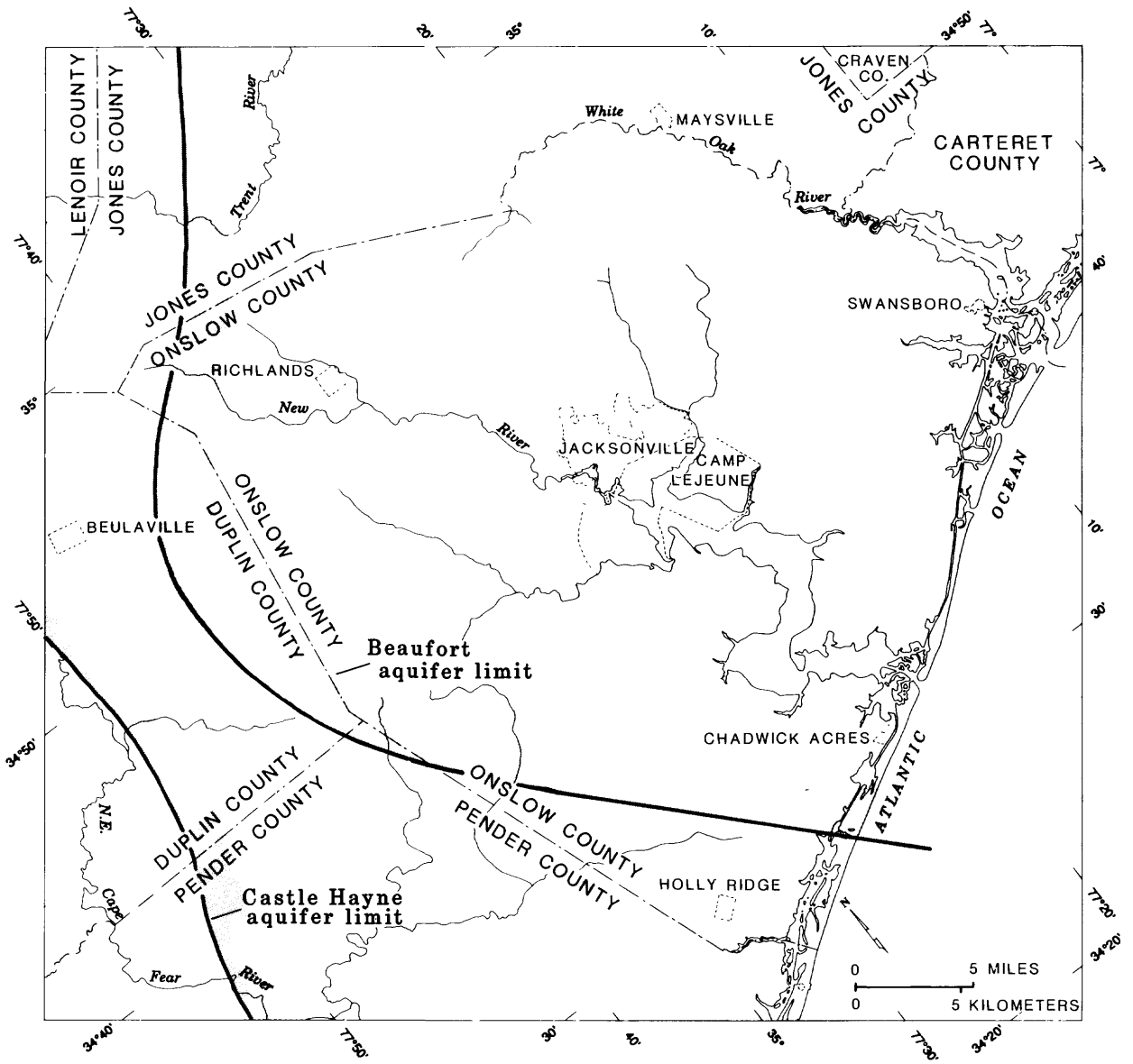


Figure 4.--Extent of the Castle Hayne and Beaufort aquifers.

HYDROGEOLOGY OF AQUIFERS AND CONFINING UNITS IN CRETACEOUS ROCKS

The aquifers in Cretaceous rocks underlie the Quaternary and Tertiary aquifers and overlie basement rocks (fig. 2) throughout the study area. These aquifers include the Peedee aquifer, the Black Creek aquifer, and the upper and lower Cape Fear aquifers. The Lower Cretaceous aquifer, which occurs in some areas of the Coastal Plain in North Carolina, does not occur in the study area.

The aquifers of the Cretaceous System are composed of sand, silty and clayey sand, clay, with minor beds of limestone, and are separated by

confining units of clay and silt. As a group, the aquifers in Cretaceous rocks present beneath the study area contain about 60 percent permeable material.

The aquifers in Cretaceous rocks dip and thicken eastward from less than 700 ft thick near Beulaville, Duplin County, to more than 1,400 ft thick near Swansboro, Onslow County (fig. 5). The thickness of the aquifers is about four times that of the aquifers in Quaternary and Tertiary rocks in the study area. The aquifers in Cretaceous rocks in the study area are described in detail in the following sections.

Geologic and hydrologic descriptions for each aquifer are supplemented with maps of the altitude of top, thickness, and distribution of permeable material. Confining units are also described, and maps showing the thickness and areal distribution of permeable material are presented for each. A summary of these data for the aquifers and confining units in Cretaceous rocks is presented in table 2. The average thickness and percent permeable material values identified in table 2 are arithmetic averages based on observed point data and were not adjusted areally. Most wells from which data were obtained are centrally located (plate 2) in the study area in the central or north-central part of Onslow County.

Chemical analysis of water samples were used to define the position of water containing more than 250 milligrams per liter (mg/L) chloride, the generally accepted upper limit for drinking water (U.S. Environmental Protection Agency, 1976). For the purposes of this report, water containing this chloride-ion concentration, or greater, is termed saltwater. On the hydrogeologic sections (plate 3), the updip limit of water containing 250 mg/L chloride is shown where present in each aquifer. All test data for chloride concentration and measured water levels at EHNR research-station test holes are presented on these sections.

The contact between freshwater and saltwater is also represented on the maps of aquifer tops. Here, two lines are shown. One represents the updip presence of saltwater at the bottom of the aquifer, the other its updip presence at the top of the aquifer, eastward of which the aquifer wholly contains water with chloride concentrations greater than 250 mg/L. The roughly parallel lines shown on maps represent the transition from fresh-

water to saltwater within each aquifer where freshwater is present in the upper part of the aquifer and saltwater in the lower part.

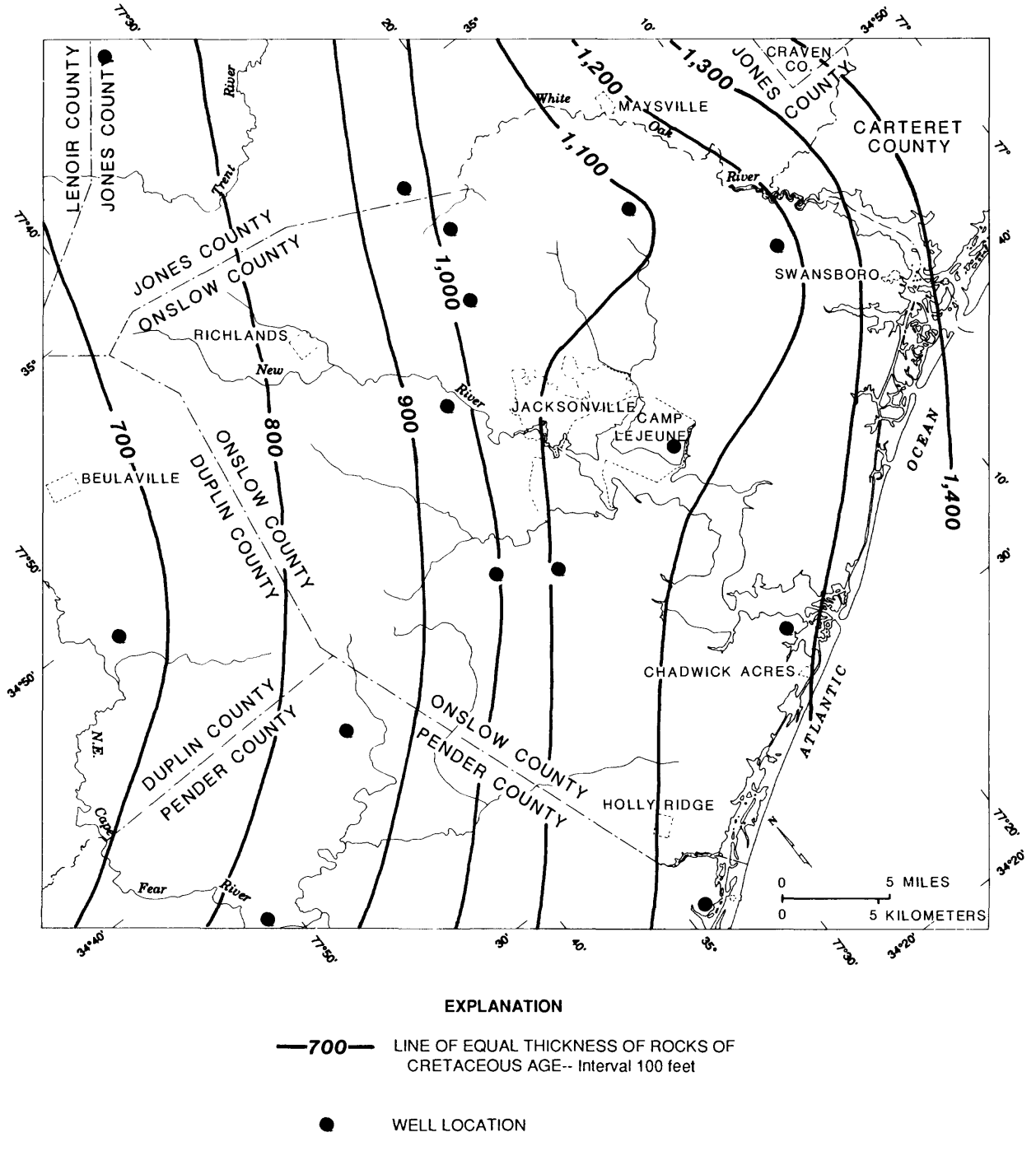


Figure 5.--Thickness of aquifers in Cretaceous rocks in the study area.

Table 2.--*Summary of properties of the aquifers and confining units in Cretaceous rocks*
[Altitude, in feet, refers to distance above or below sea level]

Aquifer or confining unit	Altitude of top (feet)		Thickness (feet)			Percent of permeable material		
	Highest observed	Lowest observed	Minimum observed	Maximum observed	Average	Minimum observed	Maximum observed	Average
Peedee confining unit	-31	-633	4	66	33	10	42	19
Peedee aquifer	-69	-673	88	287	147	51	79	64
Black Creek confining unit	-157	-758	23	137	67	9	44	25
Black Creek aquifer	-245	-838	163	535	359	36	62	51
Upper Cape Fear confining unit	-438	-1,221	38	112	59	10	41	20
Upper Cape Fear aquifer	-484	-1,263	35	198	105	36	77	62
Lower Cape Fear confining unit	-671	-1,411	20	74	43	8	47	22
Lower Cape Fear aquifer	-699	-1,445	43	330	171	50	70	60

Each aquifer, its overlying confining unit, and the occurrence of saltwater are described in the following sections. Although confining units overlie their respective aquifers, the aquifer has been described first because of its relative importance to water-supply managers. These aquifers are described in descending stratigraphic order.

Peedee Aquifer

The Peedee aquifer is the uppermost and youngest of the aquifers in Cretaceous rocks and is named for the Peedee Sand of Late Cretaceous age as described by Clark and others (1912) and the Peedee Formation (Stephenson and Rathbun, 1923), which is the principal geologic unit in the aquifer. The Peedee aquifer may locally include sand units older or younger than the Peedee Formation where these sand units are hydraulically connected to the aquifer. The Peedee aquifer is composed of fine- to medium-grained sands interbedded with gray to black marine clays and silts. The sand beds are commonly gray or greenish-gray and contain varying amounts of glauconite. Thin beds of partially consolidated calcareous sandstone and limestone are interlayered with sands in some places, and shells are common throughout the unit. The relation of the Peedee aquifer to the other aquifers in the study area is shown in the hydrogeologic sections (plate 3).

The Peedee aquifer underlies all of the study area (plate 4A). The top of the aquifer dips toward the east-southeast at an average rate of about 20 ft/mi from an altitude of more than 33 ft above to more than 673 ft below sea level (plate 4A). The Peedee aquifer averages 147 ft thick in the 46 wells for which data are available and generally thickens toward the south from 88 ft in eastern Lenoir County to 287 ft near Surf City in Pender County (wells 10 and 60, plate 4B). On the average, the Peedee aquifer contains 64 percent permeable material with values ranging from 51 to 79 percent (table 3). The percentage of permeable material exceeds 60 percent in a large area in the northern part of Onslow County (plate 4B).

The Peedee aquifer and its confining unit are overlain by the aquifers in Quaternary and Tertiary rocks and may be in direct contact in some places with these aquifers present in the study area. The Peedee aquifer is underlain everywhere in the study area by the Black Creek aquifer and its overlying confining unit.

The Peedee aquifer contains saltwater in downdip areas. The transition from freshwater to saltwater in the Peedee aquifer occurs in a sinuous band trending northeastward from the vicinity of Surf City, Pender County, to the Maysville area in Jones County (plate 4A). The band varies from 3 to 5 miles in width.

The highest measured chloride concentration in water from the Peedee aquifer was 3,359 mg/L in well 44 at Camp Lejeune (plate 3A) where the entire aquifer contains saltwater. At Deppe, Onslow County, on the western edge of saltwater in the aquifer, the Peedee contains freshwater at its top but likely contains water with chloride values equal to or greater than 250 mg/L at the bottom of the unit (wells 13 and 14, plate 3C). Water samples in aquifers above and below the Peedee at Deppe had chloride concentrations of 1,000 and 700 mg/L, respectively. This is probably a local situation in which a combination of aquifer transmissivity and confining-unit leakage has allowed the flushing of saltwater to proceed here farther eastward in the Peedee than in the other units. A similar situation was noted for an area north of Jones County in Craven County. However, in that area data showed that saltwater in the Peedee aquifer overlies freshwater in the Black Creek aquifer (Winner and Lyke, 1987).

Peedee Confining Unit

The Peedee confining unit overlies the Peedee aquifer and is composed of clay, silt, and sandy-clay beds. These strata are not correlated with a particular geologic unit, but they are composed of either the uppermost beds of the Peedee Formation, lowermost Quaternary or Tertiary sediments, or a combination of these. The Peedee confining unit regionally acts to impede ground-water flow into or out of the Peedee aquifer. The relation of the Peedee confining unit to other hydrogeologic units in the study area is shown in plate 3.

The thickness of the Peedee confining unit ranges from 4 to 66 ft, averaging about 33 ft in 55 wells in the area (table 2). The unit generally is less than 25 ft thick in the western part of the study area (plate 4C). It is also less than 25 ft thick in a few scattered areas in Onslow and Jones Counties. The unit is more than 50 ft thick in several small areas in the central and northern parts of the study area (plage 4C).

Although the Peedee confining unit is composed of clay and silt beds, some thin sand beds of local extent occur within the unit in most places. The Peedee confining unit averages about 19 percent permeable material, ranging from less than 10 to 42 percent (table 2). If the sand content of the confining unit is appreciable (20 to 30 percent or more), then its capacity to confine the Peedee aquifer is diminished and water can move through the confining unit more easily in these areas. The Peedee confining unit contains more than 20 percent permeable material throughout central Onslow County from Richlands to Sneads Ferry (plate 4C).

Black Creek Aquifer

The Black Creek aquifer is named for and consists largely of sediments of the Black Creek Formation as described by Clark and others (1912). However, the aquifer may also include sand beds older or younger than the Black Creek Formation in local areas. As defined by the North Carolina RASA study (Winner and Coble, 1987), the Black Creek aquifer also includes sediments of the Middendorf Formation in the southern Coastal Plain area, but this formation has not been identified in the study area.

The sediments of the Black Creek aquifer are a fluvio-marine series consisting of thinly-laminated gray clay interlayered with gray to tan sands, occurring in some outcrops as either sand-dominated or clay-dominated layers. Other outcrops show well-defined beds of clean sand and gray clay. A primary characteristic of Black Creek sediments, and one that is used to help identify it in the subsurface, is its high content of organic material, mostly lignitized wood. Shells and glauconite are also common. Hydrogeologic sections show the correlation of the Black Creek aquifer in the study area (plate 3).

The Black Creek aquifer underlies all of the study area. The top of the aquifer dips toward the east at an average rate of 20 ft/mi from an observed altitude of 245 ft below sea level at Chinquapin, Duplin County, to more than 1,000 ft below sea level in Carteret County (plate 5A). The Peedee aquifer overlies the Black Creek aquifer and its confining unit throughout the study area. The upper Cape Fear aquifer and its confining unit underlie the Black Creek aquifer.

The Black Creek aquifer averages 359 ft thick based on 21 observations ranging in thickness from 163 to 535 ft (table 2). It is the thickest aquifer in the study area. This aquifer thickens toward the south attaining a maximum thickness in southern Onslow County near the communities of Verona and Dixon (plate 5B). Also, the amount of permeable material comprising the aquifer exceeds 50 percent in this area as well as in several other smaller areas in the study area (plate 5B). The average percentage of permeable material in the Black Creek aquifer is 51 percent, ranging from 36 to 62 percent sand (table 2). This is the lowest average value for all of the aquifers in Cretaceous rocks in the study area.

The occurrence of saltwater in the Black Creek aquifer is interpreted from water-quality data and is shown on the hydrogeologic sections in plate 3, A and B. The transition from freshwater to saltwater in the Black Creek aquifer generally parallels that in the overlying Peedee aquifer, but it lies farther to the west. This transition zone is shown in plate 5A as a 6- to 9-mile wide band extending from west of Maysville, Jones County, to Players in Pender County. Chloride-concentration data in water from the Black Creek aquifer east of this area range from 266 mg/L (well 51, plate 3B) to 3,839 mg/L (well 44, plate 3, A and C).

Black Creek Confining Unit

The Black Creek aquifer is overlain and confined by a number of clay, silty-clay, and sandy-clay beds called the Black Creek confining unit. These are believed to belong mostly to the uppermost sediments of the Black Creek Formation. However, some clay beds in the overlying Peedee may be included as part of this confining unit. The continuity of the Black Creek confining unit is interpreted by means of geophysical log correlations and from head relations and water-quality data shown on hydrogeologic sections (plate 3).

In contrast to the relatively uniform thickness of the Peedee confining unit, the Black Creek confining unit exhibits more variability in thickness (plate 5C). It is thinnest (minimum 23 ft at well 19) in northern and central Onslow County, but in other areas, the unit is over 100 ft thick. The maximum observed thickness is 137 ft in well 7 near the Onslow-Jones County line in Jones County (table 2 and plate 5C). The average thickness of the unit is 67 ft, from 45 observations.

The Black Creek confining unit incorporates some sand beds, generally of limited areal extent, that contribute to a 25 percent average content of permeable material for the unit. Permeable material constitutes from 9 to 44 percent of the confining unit (table 2). The largest area where the sand content of the confining unit exceeds 25 percent (plate 5C) is in a broad band extending from Beulaville, Duplin County, to Silverdale, Onslow County.

Upper Cape Fear Aquifer

The upper Cape Fear aquifer consists of permeable zones in the upper part of the Cape Fear Formation. The Cape Fear Formation in the study area, as described from geophysical logs and drillers' logs, is composed largely of alternating beds of sand and clay that are commonly 3 to 5 ft thick but may range from less than a foot to over 40 ft in thickness. Downdip, these sediments are interbedded with a few deposits interpreted on geophysical logs to be thin limestone beds. The Cape Fear Formation has been separated into upper and lower aquifer units in the North Carolina Coastal Plain on the basis of head differences (Winner and Coble, 1987).

The upper Cape Fear aquifer occurs throughout the study area as shown by the correlations in plate 3. The top of the aquifer ranges from an observed 484 ft below sea level in Jones County (well 3, table 3) to more than 1,400 ft below sea level in Carteret County. The top of the aquifer dips steadily toward the east-southeast at an average slope of about 24 ft/mi (plate 6A).

The thickness of the upper Cape Fear aquifer ranges from 35 to 198 ft, based on 17 observations, and averages 105 ft (table 2). The aquifer is generally less than 100 ft thick in a northeast trending band through the center of the study area (plate 6B). The maximum observed thickness of the aquifer is 198 ft in well 3 in Jones County.

The sands that comprise the upper Cape Fear aquifer have a diverse grain size ranging from very fine to coarse sand with some gravel, but they are most commonly described as medium or fine-to-medium sands on lithologic logs. On the average, the amount of permeable material in the upper Cape Fear aquifer averages 62 percent, ranging from 36 to 77 percent sand (table 2). The aquifer contains more than 60 percent permeable material in central

parts of Onslow and Jones Counties (plate 6B). This area generally coincides with the area where the aquifer is less than 100 ft thick. Throughout the study area, the upper Cape Fear aquifer and its confining unit are overlain by the Black Creek aquifer; the upper Cape Fear aquifer is underlain by the lower Cape Fear confining unit.

Saltwater is present in the upper Cape Fear aquifer east of a line approximately between Comfort, Jones County, and Chinquapin, Duplin County, as shown in plate 6A. The transition from freshwater to saltwater in the aquifer occurs over an area about 6- to 8-miles wide that lies west of the transition zone in the overlying Black Creek aquifer (plate 5A). Chloride concentrations in samples collected from various saltwater-bearing intervals in the upper Cape Fear aquifer range from 420 mg/L (well 2, plate 3A) to 13,896 mg/L (well 44, plate 3, A and C).

Upper Cape Fear Confining Unit

The upper Cape Fear confining unit is composed largely of clay and silt beds that overlie the upper Cape Fear aquifer. These beds, which commonly separate aquifers having significant head or water-quality differences, were correlated throughout the study area by means of geophysical logs (plate 3). This confining unit, which contains thin sand lenses locally, is composed of beds belonging to either the Black Creek or Cape Fear Formations.

The overall thickness of the upper Cape Fear confining unit averages about 59 ft, based on geophysical and lithologic data from 19 wells in the area. The unit thickens to over 50 ft in a northeast trending band in the central part of the study area (plate 6C). This area generally coincides with the area where the upper Cape Fear aquifer is thinnest (less than 100 ft). The maximum observed thickness of the confining unit is 112 ft in well 58 near Maple Hill, Pender County. Minimum thickness is 38 ft in well 16 about 3 miles northeast of Half Moon, Onslow County.

On the average, about 20 percent of the upper Cape Fear confining unit consists of permeable material in the form of localized thin beds of fine sand (table 2). The percentage of permeable material ranges from 10 to 41 percent. Those parts of the study area where the sand content of the upper Cape Fear confining unit exceeds 20 percent are shown in plate 6C. In these areas, the unit is less effective as a confining unit than where it contains a greater percentage of clay.

Lower Cape Fear Aquifer

The lower Cape Fear aquifer is composed of older sand beds of the Cape Fear Formation and is present thought the study area. The lower Cape Fear aquifer and its confining unit are the lowermost hydrogeologic units of this study and are overlain by the upper Cape Fear aquifer and underlain by basement rocks. The aquifer includes all of the sediments from its confining unit to basement rocks. The altitude of the basement rocks for this study area is presented in plate 1. Correlations of this aquifer within the study area are shown in plate 3.

The altitude of the top of the lower Cape Fear aquifer and the thickness of the unit are shown in plate 7, A and B respectively. The top of the aquifer dips toward the east-southeast at an average rate of 24 ft/mi. The altitude of the top of the aquifer ranges from 699 to 1,445 ft below sea level.

The lower Cape Fear aquifer progressively thickens toward the east from 43 ft thick in well 2 near Chinquapin, Duplin County, to more than 400 ft west of Swansboro, Onslow County (plate 7B). The average thickness of the lower Cape Fear aquifer is 171 ft, based on 15 observations (table 2).

The permeable beds comprising the lower Cape Fear aquifer are similar to those of the upper Cape Fear; that is, they range from very fine to coarse sand and include a few thin limestone beds from place to place. Interspersed with the sand and limestone are beds of clay and silt, some of which may be tens of feet thick. The average content of permeable material for the lower Cape Fear aquifer is 60 percent (table 2). Percent permeable material ranges from 50 to 70 percent in 15 wells that fully penetrate the aquifer. The distribution of the data suggests that the sand content exceeds 60 percent primarily in the central and southwest portions of Onslow County (plate 7B).

The approximate areal extent of the transition from freshwater to saltwater in the lower Cape Fear aquifer is shown in plate 7A. It is the westernmost transitional area of the four aquifers in Cretaceous rocks and is based largely on the data presented by Winner and Lyke (1987) for the original study area. The line of equal chloride concentration of 250 mg/L

in water at the bottom of the lower Cape Fear aquifer lies to the northwest of the study area. The minimum observed chloride concentration value was 470 mg/L from well 3 in western Jones County, and the highest was 10,400 mg/L from well 32 at Jacksonville in Onslow County (plate 3, A and B). The only freshwater likely to occur in this aquifer will be in the transitional area, but this has yet to be verified.

Lower Cape Fear Confining Unit

The lower Cape Fear confining unit is composed of clay and silt beds of the Cape Fear Formation that contain local beds of thin, fine sand. As mentioned previously, this unit is defined as separating the upper and lower Cape Fear aquifers primarily on the basis of head differences and chloride concentration between the aquifers and is correlated throughout the study area from geophysical log data (plate 3). The lower Cape Fear confining unit has been further defined by significant differences in observed chloride concentrations in water between aquifers, such as in well 3 in Jones County (plate 3B) and in well 32 in Onslow County (plate 3, A and B).

The lower Cape Fear confining unit thickens toward the east-southeast from a minimum of 20 ft at well 58 near Maple Hill, Pender County, to a maximum of 74 ft in well 44 at Camp Lejeune, Onslow County (plate 7C). The average confining-unit thickness of 43 ft is based on 17 observations. Farther east, the unit is estimated to be more than 75 ft thick. Apart from the general eastward thickening trend, other features suggested by the few data available are a localized thinning of the confining unit in well 28 near Silverdale, Onslow County, and at well 58 near Maple Hill, Pender County.

Local sand beds included within the lower Cape Fear confining unit constitute between 8 and 47 percent of its total thickness (table 2); but on the average, the content of permeable material is about 22 percent. Data show the sand content of the confining unit to locally exceed 20 percent near Verona, Deppe, and Jacksonville in Onslow County and near Chinquapin in Duplin County.

SUMMARY

Onslow and southern Jones Counties are underlain by an eastward-dipping and easterly-thickening wedge of sedimentary rocks that range in age from Quaternary and Tertiary sand, limestone, silt, and clay deposits to Cretaceous deposits of similar composition. All these sediments overlie crystalline basement rocks and reach a maximum observed thickness of more than 1,800 ft in the study area.

The stratigraphic continuity of these sediments was delineated by use of 60 geophysical logs, 17 of which were used to construct three hydrogeologic sections across the study area. Sediments were then grouped into aquifers and confining units according to: (1) lithologic similarities, (2) water-level and water-quality differences in aquifers separated by confining units, and (3) widespread effects of pumping.

The aquifers in the study area are classified as belonging to either a group of aquifers in Quaternary and Tertiary sediments or to a group of aquifers in Cretaceous sediments. The aquifers in Quaternary and Tertiary sediments overlie the aquifers in Cretaceous sediments, constitute the smaller volume of sediments in the study area (nearly 250 ft average thickness), and include the uppermost surficial aquifer, the Castle Hayne aquifer, and the Beaufort aquifer. The most productive of these is the Castle Hayne aquifer, which is composed of limestone and sand.

The Cretaceous hydrogeologic units, which make up about four times the sediment volume of the Quaternary and Tertiary hydrogeologic units, are the focus of this investigation and include from the shallowest to the deepest, the Peedee aquifer, the Black Creek aquifer, and the upper and lower Cape Fear aquifers and the confining units separating them. Hydrogeologic characteristics for each of the units in Cretaceous rocks have been determined from observed well data and are summarized in tabular form.

The Peedee aquifer, the shallowest and therefore youngest of the aquifers in Cretaceous rocks, ranges in altitude from 33 feet above sea level to 673 feet below sea level in the study area. The average thickness and percent of permeable material for this aquifer is 147 feet and 64 percent, respectively. The top of the Black Creek aquifer ranges in

altitude from 245 to 838 ft below sea level. This aquifer is the thickest aquifer in the study area, averaging 359 ft thick, although it contains the lowest percentage of permeable material, averaging 51 percent. The upper and lower Cape Fear aquifers average 105 and 171 ft thick, respectively. The average percent of permeable material present in both the upper and lower Cape Fear aquifers are 62 and 60 percent, respectively. These values are similar to the average percentage of permeable material in the Peedee aquifer.

Confining units of silt and clay that overlie each aquifer in Cretaceous rocks are defined on the basis of their continuity throughout the study area and their apparent effect in separating aquifers with significantly different heads. These units average about 30 to 70 ft thick, but may be over 100 ft in some places. Locally, some confining units contain more than 40 percent sand, which tends to reduce their effectiveness in restricting vertical ground-water flow in those areas.

The occurrence of saltwater (with chloride concentrations greater than 250 mg/L) is delineated for each aquifer in Cretaceous rocks. The transition from freshwater to saltwater in each aquifer is shown on hydrogeologic sections and maps.

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Table 3.--*Aquifer and confining unit data*

[**Well No:** NRCD Well-numbering system. American Petroleum Institute (API) number given for oil-test well. **Map No:** Reference number for data in text, maps and cross sections. Sequentially listed in this table. **Log Depth:** Depth of well log in feet below land surface. **Latitude and Longitude:** given in degrees, minutes and seconds. **Altitude of Land Surface:** Given in feet above sea level. **Basement:** Where known, altitude of top is in feet below sea level. **AQ:** Aquifer-- **SUR**, surficial aquifer; **CLH**, Castle Hayne aquifer; **BFR**, Beaufort aquifer; **PD**, Peedee aquifer; **BC**, Black Creek aquifer; **UCF**, upper Cape Fear aquifer; **LCF**, lower Cape Fear aquifer. **CONF UNIT:** Confining unit separating aquifers. **ALT TOP:** Altitude of top of aquifer or confining unit in feet above or below sea level. **Thick:** Thickness of aquifer or confining unit in feet. **PCT PERM MATERIAL:** Percent of permeable material comprising aquifer or confining unit. Dashes indicate data were incomplete or were not estimated; blank spaces indicate aquifers or confining units are not present or were not reached by test hole]

D U P L I N C O U N T Y

Town of Beulaville — Well No: U29v-

Map No: **1** Log Depth 430 Latitude: 345525 Longitude: 774630 Altitude of Land Surface: 85 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	85	55	47			15	9	-213	-251				
THICK	30	8	23			6	222	38	--				
PCT PERM MATERIAL	66	<10	78			<10	55	36	--				

NRCD Chinquapin Research Station — Well No: W29d6

Map No: **2** Log Depth 822 Latitude: 344922 Longitude: 774847 Altitude of Land Surface: 45 Basement: -742

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	45					37	33	-199	-245	-539	-579	-671	-699
THICK	8					4	232	46	294	40	92	28	43
PCT PERM MATERIAL	90					<10	66	11	55	<10	43	47	70

Table 3.--*Aquifer and confining unit data*--Continued

JONES COUNTY

NRCD Beaver Creek Research Station — Well No: S26i2(x)
Map No: **3** Log Depth: 855 Latitude: 350820 Longitude: 773150 Altitude of Land Surface: 55 Basement: -785

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	55	--	--			-43	-91	-186	-275	-438	-484	-682	-705
THICK	--	--	--			48	95	89	163	46	198	23	80
PCT PERM MATERIAL	--	--	--			17	58	28	44	26	58	8	58

R.L. Fordham — Well No: S26x1
Map No: **4** Log Depth: 400 Latitude: 354513 Longitude: 773333 Altitude of Land Surface: 73 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	73	40	23			-37	-95	-195	-285				
THICK	33	17	60			58	100	90	--				
PCT PERM MATERIAL	61	24	72			21	74	23	--				

Jones County Water System — Well No: T25j2
Map No: **5** Log Depth: 475 Latitude: 350333 Longitude: 772543 Altitude of Land Surface: 47 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	47	27	15	-102	-108	-143	-167	-301	-405				
THICK	20	12	117	6	35	24	134	104	--				
PCT PERM MATERIAL	--	<10	81	<10	71	<10	57	19	--				

Table 3.--*Aquifer and confining unit data*--Continued

Weyerhaeuser Company — Well No: T27t1
Map No: **6** Log Depth: 500 Latitude: 350117 Longitude: 773538 Altitude of Land Surface: 56 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	56	--	--			-60	-91	-229	-312				
THICK	--	--	--			31	138	83	--				
PCT PERM	--	--	--			19	67	11	--				
MATERIAL													

Peter Henderson Oil Company — Well No: U24p- API No. 32-103-1(Dr. Hofmann No.1)
Map No: **7** Log Depth:1,232 Latitude: 345615 Longitude: 772430 Altitude of Land Surface: 50 Basement: -1,163

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	--	17	-155	-162	-194	-260	-383	-520	-788	-830	-930	-980
THICK	--	--	172	7	32	66	123	137	268	42	100	50	183
PCT PERM	--	--	82	<10	62	17	59	14	48	21	65	<10	57
MATERIAL													

NRCD Comfort Research Station — Well No: U26j2
Map No: **8** Log Depth: 877 Latitude: 345809 Longitude: 773014 Altitude of Land Surface: 71 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	71	61	48	-60	-92	-119	-153	-267	-390	-640	-711		
THICK	10	13	108	32	27	34	114	123	250	71	--		
PCT PERM	50	31	83	16	85	<10	57	24	49	18	--		
MATERIAL													

Table 3.--*Aquifer and confining unit data*--Continued

Town of Maysville — Well No: V22d1
Map No: **9** Log Depth: 504 Latitude: 345435 Longitude: 771330 Altitude of Land Surface: 35 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	35	17	-1	-330	-353	-385	-407						
THICK	18	18	329	23	32	22	--						
PCT PERM MATERIAL	72	17	>90	26	69	18	--						

L E N O I R C O U N T Y

John Casey — Well No: S26c1
Map No: **10** Log Depth: 368 Latitude: 350909 Longitude: 773242 Altitude of Land Surface: 79 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	79	36	26			-31	-69	-157	-249				
THICK	43	10	57			38	88	92	--				
PCT PERM MATERIAL	65	<10	>90			21	72	15	--				

O N S L O W C O U N T Y

Onslow County Water System Well No. 6 — Well No: U26u-
Map No: **11** Log Depth: 670 Latitude: 345505 Longitude: 773030 Altitude of Land Surface: 62 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	62	52	40	-104	-122	-158	-188	-306	-370				
THICK	10	12	144	18	36	30	118	64	--				
PCT PERM MATERIAL	--	<10	83	33	50	33	61	31	--				

Table 3.--*Aquifer and confining unit data*--Continued

Town of Richlands — Well No: U26w-
Map No: **12** Log Depth: 756 Latitude: 345525 Longitude: 773245 Altitude of Land Surface: 52 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	52	--	22	-52	-87	-139	-168	-298	-360	-665			
THICK	--	--	64	35	52	29	130	62	305	--			
PCT PERM MATERIAL	--	--	78	<10	88	10	52	21	47	--			

E.T. Burton — Well No: V23v- API No. 32-133-3(Hoffman Forest No. 1)
Map No: **13** Log Depth:1,570 Latitude: 345000 Longitude: 771640 Altitude of Land Surface: 40 Basement: -1,520

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	40	--	--	-302	-322	-465	-499	-670	-745	-1,070	-1,110	-1,225	-1,280
THICK	--	--	--	20	143	34	171	75	325	40	115	55	240
PCT PERM MATERIAL	--	--	--	<20	77	18	73	20	52	<10	59	30	57

NRCD Deppe Research Station — Well No: V23x2
Map No: **14** Log Depth:1,000 Latitude: 345016 Longitude: 771814 Altitude of Land Surface: 45 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	45	2	-20	-283	-306	-420	-458	-621	-714				
THICK	43	22	263	23	114	38	163	93	--				
PCT PERM MATERIAL	90	18	80	35	80	18	77	27	--				

Table 3.--*Aquifer and confining unit data*--Continued

B.P. Seay — Well No: V24g- — API No. 32-133-4 (Hoffman Forest No. 1)
Map No: **15** Log Depth: 1,433 Latitude: 345400 Longitude: 772345 Altitude of Land Surface: 52 Basement: -1,319

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	52	--	-61	-208	-223	-288	-326	-448	-582	-883	-928	-1,022	-1,068
THICK	--	--	147	15	65	38	122	134	301	45	94	46	251
PCT PERM MATERIAL	--	--	80	<10	63	<10	73	22	46	11	64	17	69

B.P. Seay — Well No: V24p- — API No. 32-133-5 (Hoffman Forest No. 2)
Map No: **16** Log Depth: 1,337 Latitude: 345155 Longitude: 772445 Altitude of Land Surface: 32 Basement: -1,303

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	32	--	--	-184	-200	-270	-333	-463	-595	-900	-938	-1,033	-1,068
THICK	--	--	--	16	70	63	130	132	305	38	95	35	235
PCT PERM MATERIAL	--	--	--	19	64	<10	62	30	56	<10	63	17	51

City of Jacksonville Well No. 15 — Well No: V25p3
Map No: **17** Log Depth: 630 Latitude: 345131 Longitude: 772916 Altitude of Land Surface: 50 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	40	14	-134	-158	-194	-235	-360	-432				
THICK	10	26	148	24	36	41	125	72	--				
PCT PERM MATERIAL	--	<10	68	29	56	34	64	30	--				

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 9 Well No: V25x-
Map No: **18** Log Depth: 660 Latitude: 345030 Longitude: 772830 Altitude of Land Surface: 32 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	32	5	0	-146	-167	-232	-264	-396	-451				
THICK	27	5	146	21	65	32	135	55	--				
PCT PERM MATERIAL	48	<10	62	24	46	31	64	33	--				

Town of Richlands Well No: V26g-
Map No: **19** Log Depth: 535 Latitude: 345359 Longitude: 773300 Altitude of Land Surface: 60 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	60	30	2	-40	-70	-143	-184	-321	-344				
THICK	30	28	42	30	73	41	137	23	--				
PCT PERM MATERIAL	66	60	67	--	60	15	63	30	--				

Town of Richlands Well No: V26h1
Map No: **20** Log Depth: 557 Latitude: 345340 Longitude: 773237 Altitude of Land Surface: 45 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	45	32	25	-69	-91	-133	-173	-321	-353				
THICK	13	7	94	22	42	40	148	32	--				
PCT PERM MATERIAL	--	<10	55	36	81	10	51	38	--				

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 5 Well No: V26i-
Map No: **21** Log Depth: 645 Latitude: 345345 Longitude: 773105 Altitude of Land Surface: 32 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	32	22	12	-90	-104	-142	-188	-322	-384				
THICK	10	10	102	14	38	46	134	62	--				
PCT PERM MATERIAL	70	40	83	43	66	30	52	32	--				

City of Jacksonville Well No. 16 Well No: V26k3
Map No: **22** Log Depth: 820 Latitude: 345228 Longitude: 773008 Altitude of Land Surface: 50 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	41	27	-105	-126	-162	-214	-337	-406	-768			
THICK	9	14	132	21	36	52	123	69	362	--			
PCT PERM MATERIAL	--	<10	61	19	67	31	65	35	44	--			

Onslow County Water System Well No. 10 Well No: V26s-
Map No: **23** Log Depth: 662 Latitude: 345105 Longitude: 773110 Altitude of Land Surface: 30 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	30	21	16	-114	-135	-198	-225	-360	-400				
THICK	9	5	130	21	63	27	135	40	--				
PCT PERM MATERIAL	>60	20	74	38	71	<10	74	40	--				

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 11 Well No: V26w-
Map No: **24** Log Depth: 660 Latitude: 345047 Longitude: 773207 Altitude of Land Surface: 52 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	52	--	21	-93	-110	-163	-189	-325	-361				
THICK	--	--	114	17	53	26	136	36	--				
PCT PERM MATERIAL	--	--	57	29	66	15	68	39	--				

Northwest Onslow Water Association Well No: V27a1
Map No: **25** Log Depth: 484 Latitude: 345436 Longitude: 773451 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	65	44	38	-43	-63	-99	-143	-297	-329				
THICK	21	6	81	20	36	44	154	32	--				
PCT PERM MATERIAL	76	<10	59	22	67	16	59	25	--				

Frosty Morn Packing Company Well No: V27t1
Map No: **26** Log Depth: 337 Latitude: 345146 Longitude: 773455 Altitude of Land Surface: 70 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	70	42	26	-46	-66	-140	-156						
THICK	28	16	72	20	76	16	--						
PCT PERM MATERIAL	86	<10	56	30	74	<10	--						

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 1 Well No: V27u-
Map No: **27** Log Depth: 647 Latitude: 345025 Longitude: 773550 Altitude of Land Surface: 82 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	82	66	56	-30	-46	-94	-118	-300	-332				
THICK	16	10	86	16	48	24	182	32	--				
PCT PERM	81	<10	56	<10	79	<10	64	44	--				
MATERIAL													

Colonial Oil and Gas Corporation Well No: W22v- API No. 32-133-22(Parker No. 1)
Map No: **28** Log Depth:2,009 Latitude: 344526 Longitude: 771136 Altitude of Land Surface: 37 Basement: -1,775

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	37	-24	-40	-433	-485	-633	-673	-758	-838	-1,221	-1,263	-1,411	-1,445
THICK	61	16	393	52	148	40	85	80	383	42	148	34	330
PCT PERM	--	--	--	19	47	<10	65	38	47	14	68	24	58
MATERIAL													

Bryan Marr Utility Company Well No: W24w1
Map No: **29** Log Depth: 241 Latitude: 344528 Longitude: 772254 Altitude of Land Surface: 45 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	45	37	28										
THICK	8	9	--										
PCT PERM	90	<10	--										
MATERIAL													

Table 3.--*Aquifer and confining unit data*--Continued

City of Jacksonville Hwy 258 Field, Well No. 3 Well No: W25f1
Map No: **30** Log Depth: 688 Latitude: 344804 Longitude: 772942 Altitude of Land Surface: 39 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	39	11	2	-125	-155	-193	-243	-373	-413				
THICK	28	9	127	30	38	50	130	40	--				
PCT PERM MATERIAL	71	22	52	13	58	28	65	20	--				

City of Jacksonville Hwy 258 Field, Well No. 4 Well No: W25f3
Map No: **31** Log Depth: 698 Latitude: 344815 Longitude: 772932 Altitude of Land Surface: 33 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	33	10	-3	-119	-140	-191	-247	-379	-419				
THICK	23	13	116	21	51	56	132	40	--				
PCT PERM MATERIAL	--	<10	52	38	67	36	64	20	--				

NRCD Jacksonville Research Station Well No: W25f5(x)
Map No: **32** Log Depth:1,226 Latitude: 344837 Longitude: 772916 Altitude of Land Surface: 26 Basement: -1,173

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	51	45	29	-115	-133	-173	-235	-369	-411	-805	-863	-969	-995
THICK	6	16	144	18	40	62	134	42	394	58	106	26	178
PCT PERM MATERIAL	--	--	--	22	80	23	63	19	36	24	64	31	67

Table 3.--*Aquifer and confining unit data*--Continued

City of Jacksonville Hwy 258 Field, Well No. 1 Well No: W25o1
Map No: **33** Log Depth: 740 Latitude: 344930 Longitude: 773145 Altitude of Land Surface: 50 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	24	12	-112	-134	-187	-228	-352	-401				
THICK	26	12	124	22	53	41	124	49	--				
PCT PERM MATERIAL	--	<10	56	<10	64	20	65	20	--				

City of Jacksonville Hwy 258 Field, Well No. 2 Well No: W25o2
Map No: **34** Log Depth: 737 Latitude: 344752 Longitude: 772949 Altitude of Land Surface: 45 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	45	21	9	-117	-139	-195	-245	-366	-415				
THICK	24	12	126	22	56	50	121	49	--				
PCT PERM MATERIAL	--	50	63	27	79	20	76	20	--				

Onslow County Water System Well No. 7 Well No: W26c-
Map No: **35** Log Depth: 668 Latitude: 344925 Longitude: 773230 Altitude of Land Surface: 75 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	75	49	39	-83	-109	-162	-203	-337	-393				
THICK	26	10	122	26	53	41	134	56	--				
PCT PERM MATERIAL	85	<10	59	15	75	<10	67	21	--				

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 2 Well No: W26e-
Map No: **36** Log Depth: 655 Latitude: 344955 Longitude: 773455 Altitude of Land Surface: 82 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	82	66	45	-42	-72	-136	-158	-310					
THICK	16	21	87	30	64	22	152	--					
PCT PERM MATERIAL	--	24	53	20	69	32	63	--					

Onslow County Water System Well No. 3 Well No: W26g-
Map No: **37** Log Depth: 650 Latitude: 344845 Longitude: 773350 Altitude of Land Surface: 82 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	82	56	48	-76	-94	-156	-186	-324	-380				
THICK	26	8	124	18	62	30	138	56	--				
PCT PERM MATERIAL	77	25	81	22	81	33	61	25	--				

Onslow County Water System Well No. 4 Well No: W26n-
Map No: **38** Log Depth: 660 Latitude: 344235 Longitude: 773330 Altitude of Land Surface: 60 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	60	30	18	-90	-112	-200	-224	-348	-388				
THICK	30	12	108	22	88	24	124	40	--				
PCT PERM MATERIAL	--	<10	81	18	57	42	71	25	--				

Table 3.--*Aquifer and confining unit data*--Continued

Onslow County Water System Well No. 8 Well No: W26r-
Map No: **39** Log Depth: 668 Latitude: 344645 Longitude: 773242 Altitude of Land Surface: 46 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	46	--	--	-100	-126	-206	-230	-356	-390				
THICK	--	--	--	26	80	24	126	34	--				
PCT PERM MATERIAL	--	--	--	38	83	42	79	41	--				

Pines Trailer Park Well No: X22x1
Map No: **40** Log Depth: 288 Latitude: 344054 Longitude: 771248 Altitude of Land Surface: 52 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	52	-31	-43										
THICK	83	12	--										
PCT PERM MATERIAL	88	33	--										

U.S. Marine Corps Test Well No. 1 Well No: X23n-
Map No: **41** Log Depth: 480 Latitude: 344249 Longitude: 771837 Altitude of Land Surface: 30 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	30	20	10	-310	-338	-420	-442						
THICK	10	10	320	28	82	22	--						
PCT PERM MATERIAL	>90	<10	59	43	66	18	--						

Table 3.--*Aquifer and confining unit data*--Continued

U.S. Marine Corps Test Well No. 8 Well No: X23y5
Map No: **42** Log Depth: 500 Latitude: 343930 Longitude: 771950 Altitude of Land Surface: 20 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	20	12	4	-300	-327	-400	-445						
THICK	8	8	304	27	73	45	--						
PCT PERM MATERIAL	90	<10	76	<10	62	24	--						

U.S. Marine Corps Test Well No. 12 Well No: X24f-
Map No: **43** Log Depth: 360 Latitude: 344303 Longitude: 772458 Altitude of Land Surface: 5 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	5	2	-3	-238	-251	-290	-315						
THICK	3	5	235	13	39	25	--						
PCT PERM MATERIAL	>90	<10	55	31	51	24	--						

NRCD Hadnot Point Research Station Well No: X24s2(x)
Map No: **44** Log Depth:1,520 Latitude: 344129 Longitude: 772104 Altitude of Land Surface: 20 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	20	-22	-30	-282	-304	-374	-395	-610	-665	-1,098	-1,144	-1,234	-1,308
THICK	42	8	248	22	70	22	215	55	433	46	90	74	--
PCT PERM MATERIAL	76	13	70	18	57	23	56	18	48	13	36	14	--

Table 3.--*Aquifer and confining unit data*--Continued

U.S. Marine Corps Test Well No. 15 Well No: X25c-
Map No: **45** Log Depth: 420 Latitude: 344425 Longitude: 772707 Altitude of Land Surface: 5 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	5	-5	-15	-185	-205	-253	-277						
THICK	10	10	170	20	48	24	--						
PCT PERM MATERIAL	>90	<10	53	<10	63	25	--						

N.C. Oil and Gas Corporation Well No: X26r- API No. 32-133-10(Sheppard No. 1)
Map No: **46** Log Depth:1,276 Latitude: 344150 Longitude: 773215 Altitude of Land Surface: 50 Basement: -1,223

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	--	--	-145	-163	-200	-215	-385	-445	-876	-930	-1,040	-1,070
THICK	--	--	--	18	37	15	170	60	431	54	110	30	153
PCT PERM MATERIAL	--	--	--	17	68	20	59	33	53	28	64	17	62

N.C. Oil and Gas Corporation Well No: X26s- API No. 32-133-8(James No. 1)
Map No: **47** Log Depth:1,254 Latitude: 344200 Longitude: 773200 Altitude of Land Surface: 47 Basement: -1,200

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	47	27	12	-153	-178	-201	-219	-368	-435	-871	-932	-1,053	-1,081
THICK	20	15	165	25	23	18	149	67	436	61	121	28	119
PCT PERM MATERIAL	85	40	79	16	65	22	51	20	56	41	62	21	63

Table 3.--*Aquifer and confining unit data*--Continued

N.C. Oil and Gas Corporation — Well No: X26u- — API No. 32-133-13(Baucom No. 1)
Map No: **48** Log Depth:1,414 Latitude: 344020 Longitude: 773020 Altitude of Land Surface: 57 Basement: -1,355

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	57	--	--	-150	-170	-243	-278	-380	-453	-955	-1,005	-1,093	-1,141
THICK	--	--	--	20	73	35	102	73	502	50	88	48	157
PCT PERM MATERIAL	--	--	--	50	82	29	54	34	62	24	62	31	60

Virginia Polytechnical Institute — Well No: Y23f- — Geothermal Test Hole No. 15
Map No: **49** Log Depth:1,678 Latitude: 343903 Longitude: 771916 Altitude of Land Surface: 31 Basement: -1,630

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	--	--	--	--	--	--	--	--	--	--	--	--	--
THICK	--	--	--	--	--	--	--	--	--	--	--	--	--
PCT PERM MATERIAL	--	--	--	--	--	--	--	--	--	--	--	--	--

N.C. Oil and Gas Corporation — Well No: Y25d- — API No. 32-133-9(International Paper Co. 1)
Map No: **50** Log Depth:1,248 Latitude: 343930 Longitude: 772850 Altitude of Land Surface: 57 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	57	--	--	-163	-191	-253	-288	-390	-440	-975	-1,023	-1,123	-1,178
THICK	--	--	--	28	62	35	102	50	535	48	100	55	--
PCT PERM MATERIAL	--	--	--	36	48	11	64	40	60	25	60	36	--

Table 3.--*Aquifer and confining unit data*--Continued

NRCD Folkstone Research Station — Well No: Y25q2(x)
Map No: **51** Log Depth:1,210 Latitude: 343642 Longitude: 772901 Altitude of Land Surface: 67 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	67	43	11	-190	-220	-240	-258	-400	-450	-975	-1,042		
THICK	24	32	201	30	20	18	142	50	525	67	--		
PCT PERM MATERIAL	75	<10	60	17	70	17	67	20	61	22	--		

U.S. Marine Corps Test Well No. 18 — Well No: Y25v-
Map No: **52** Log Depth: 300 Latitude: 343536 Longitude: 772706 Altitude of Land Surface: 50 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	50	6	-8	-202	-224								
THICK	44	14	194	22	--								
PCT PERM MATERIAL	68	29	57	27	--								

N.C. Oil and Gas Corporation — Well No: Z24h- API No. 32-133-11(Justice No. 1)
Map No: **53** Log Depth:1,681 Latitude: 343300 Longitude: 772230 Altitude of Land Surface: 30 Basement: -1,636

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	30	--	--	-280	-325	-370	-415	-670	-768	-1,140	-1,215	-1,325	-1,395
THICK	--	--	--	45	45	45	255	98	372	75	110	70	241
PCT PERM MATERIAL	--	--	--	18	67	22	55	20	51	33	77	36	62

Table 3.--*Aquifer and confining unit data*--Continued

Virginia Polytechnical Institute — Well No: Z25r- — Geothermal Test Hole No. 15A
Map No: **54** Log Depth:1,575 Latitude: 343130 Longitude: 772723 Altitude of Land Surface: 36 Basement: -1,525

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	--	--	--	--	--	--	--	--	--	--	--	--	--
THICK	--	--	--	--	--	--	--	--	--	--	--	--	--
PCT PERM MATERIAL	--	--	--	--	--	--	--	--	--	--	--	--	--

Holly Ridge Homes — Well No: AA26c-
Map No: **55** Log Depth: 460 Latitude: 342940 Longitude: 773230 Altitude of Land Surface: 60 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	60	32	16			-201	-215						
THICK	28	16	217			14	--						
PCT PERM MATERIAL	--	<10	55			<10	--						

Holly Ridge Homes — Well No: AA26d2
Map No: **56** Log Depth: 388 Latitude: 342936 Longitude: 773309 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	65	37	20			-199	-213						
THICK	28	17	219			14	--						
PCT PERM MATERIAL	64	12	50			14	--						

Table 3.--*Aquifer and confining unit data*--Continued

Town of Holly Ridge — Well No: AA26d3
Map No: **57** Log Depth: 416 Latitude: 342942 Longitude: 773302 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	65	21	1			-208	-221						
THICK	44	20	209			13	--						
PCT PERM	68	<10	59			15	--						
MATERIAL													

P E N D E R C O U N T Y

N.C. Oil and Gas Company — Well No: X28w- API No. 32-141-5(Cowan No. 1)
Map No: **58** Log Depth:1,000 Latitude: 344030 Longitude: 774230 Altitude of Land Surface: 33 Basement: -956

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	33	24	18			-27	-47	-285	-405	-679	-791	-872	-892
THICK	9	6	45			20	238	120	274	112	81	20	64
PCT PERM	90	<10	90			<10	75	12	48	19	56	<20	59
MATERIAL													

NRCD Burgaw Research Station — Well No: Y30s5
Map No: **59** Log Depth: 931 Latitude: 343616 Longitude: 775120 Altitude of Land Surface: 19 Basement: -912

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	19	8	2			-23	-47	-277	-345	-635	-726	-761	-803
THICK	11	6	25			24	230	68	290	91	35	42	109
PCT PERM	73	<10	64			<15	58	12	47	<10	74	<10	50
MATERIAL													

Table 3.--*Aquifer and confining unit data*--Continued

N.C. Oil and Gas Company Well No: AA26x- API No. 32-141-4(Batts No. 2)
Map No: **60** Log Depth:1,462 Latitude: 342600 Longitude: 773350 Altitude of Land Surface: 10 Basement: -1,445

	SUR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ
ALT TOP	10		--			-221	-246	-533	-607	-1,006	-1,092	-1,202	-1,267
THICK	--		>112			25	287	74	399	86	110	65	178
PCT PERM MATERIAL	--		--			<10	73	9	58	12	71	<10	60