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GROUND-WATER FEATURES IN ESCAMBIA AND SANTA ROSA COUNTIES, FLORIDA

by
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Escambia and Santa Rosa counties cover 759 and 1,151 square miles, respectively, in western Florida. The land elevations range from sea level to 290 feet above sea level. Temperatures in Pensacola are mild with an average annual air temperature of 68°F. Extreme temperatures range from 7° to 103°F, but usually the temperature range is from 25° to 95°F. About 275 frost-free days occur yearly.

The ready availability of large quantities of water of good quality plus the favorable climate and other factors have resulted in a rapid increase in population in the area as shown by the U.S. Bureau of Census figures: Escambia County increased from 74,667 in 1940 to 173,829 in 1960; Santa Rosa County increased from 16,085 in 1940 to 29,547 in 1960. Several large industries are in the southern half of Escambia County and the southwestern part of Santa Rosa County. Chemicals, synthetic fibers, and paper are the major products. Military operations, tourists, agriculture, fishing, and shipping also contribute to the economy of the area.

GROUND WATER

Most of the area has sufficient ground water for industrial, municipal, and irrigation requirements. Water for industrial use is taken from wells that range in diameter from 4 to 30 inches and are generally 30 to 500 feet deep into the sand-and-gravel aquifer. The wells are equipped with 10 to 120 feet of screen and yield 50 to 2,000 gpm (gallons per minute). However, these large-capacity wells must be properly located, spaced a sufficient distance apart, and pumped a reasonable amount to prevent unnecessary lowering of the water level which may result in salt-water encroachment in some areas.

Sufficient ground water for domestic needs can be found almost everywhere in the area. The water level is usually near the surface of lands of low elevation and much deeper beneath the highest lands. Domestic wells usually are less than 150 feet deep and most of them are less than 100 feet deep. They range from 1¼ to 4 inches in diameter. The wells are drilled into the sand-and-gravel aquifer until permeable sands or gravels are located and the well screen is set there. The wells usually have 5 to 20 feet of screen and supply from 5 to 50 gpm.

The temperature of the water in the sand-and-gravel aquifer ranges from 66° to 74°F and in general reflects the average annual air temperature. The temperature of water from the upper limestone of the Floridan aquifer ranges from 84° to 92°F. Water from the lower limestone of the Floridan aquifer is as high as 95°F. The temperature of ground water in this area increases about 1°F for each 50 to 85 feet of well depth.

Water will flow from wells drilled to the limestone aquifer when the artesian pressure head is higher than the land surface. The areas of artesian flow are usually low lands along streams, such as those which are found at the towns of Molino and Pine Barren. Wells on the high lands such as at Cantonment do not flow. Water in the sand-and-gravel aquifer is under water-table conditions and the water surface in wells tapping this aquifer is always below ground level. Both aquifers are recharged by rain water which seeps into the sand-and-gravel aquifer. As recharge is not continuous, the water levels in the aquifers fluctuate with the seasons and wet and dry cycles. This natural fluctuation of water level plus that imposed by pumping must be reckoned with in the proper design of a well and pumping system.

SUMMARY

The potential of the sand-and-gravel aquifer is not fully utilized in Escambia and Santa Rosa counties. Large quantities of ground water can be developed throughout much of the area. Additional ground water can be withdrawn safely from other parts of the area if the wells are located properly with regard to hydrologic factors.

The Floridan aquifer can furnish moderate to large quantities of water in certain areas, especially the northern half of the two counties. The water storing and water transmitting properties, the chemical quality of the water, and the artesian pressure head all need to be determined by test drilling and other tests before the aquifer can be fully appraised.

USE OF MAPS AND CHARTS

The illustrations indicate the type of water and its probable availability at a given location. Because some of the illustrations are based on sea level, a knowledge of the elevation of the land surface above sea level is helpful. An example of use of the information is given by the following hypothetical example.

Suppose a ground-water supply is desired in the area mid-way between Pensacola and Cantonment at the junction of U.S. Highways 29 and 90A. Topographic maps show that the land surface is 100 feet above sea level at this site. Figure 8 indicates that the sand-and-gravel aquifer is between 500 and 1,000 feet thick; figure 7 shows the base of the aquifer is 600 feet below sea level or about 700 feet below ground level, and the top of the shell beds (fig. 9) are 300 feet below sea level or 400 feet below ground level. The water level ranges from 50 to 75 feet above sea level (25 to 50 feet below the ground surface), and it rises and falls with wet or dry years (fig. 10). The mineral content of the water above the shell bed would be about 20 ppm (parts per million) (fig. 12). There are no large industrial or municipal water plants in the area (fig. 8) and the sand-and-gravel aquifer is capable of yielding over 1,000 gpm to wells (fig. 15).

Figures 3 and 4 indicate that the Pensacola Clay is about 500 feet thick at this location. The upper limestone is about 300 feet thick and the top of the Floridan aquifer is about 1,200 feet below the land surface. The artesian pressure head is about 70 feet above sea level or about 30 feet below the ground surface. The chloride content of the water from the upper limestone is about 1,000 ppm (fig. 13) and the fluoride content is from 3 to 4 ppm (fig. 14). The clay bed between the upper and lower limestones is about 175 feet thick (figs. 3 and 4). The top of the lower limestone is 1,500 feet below sea level (fig. 6) or 1,600 feet below the land surface. The lower limestone is 550 feet thick (from figs. 3 and 4).

In summary, at this location a good supply of good quality water, adequate in quantities for irrigation, industrial or municipal supply can be obtained in the sand-and-gravel aquifer from a well less than 700 feet in depth. As the non-pumping water level is expected to be as much as 75 feet below ground and allowance must be made for drawdown, a turbine pump would be required.

Additional information relative to the geology and water resources of the area is contained in the following publications.

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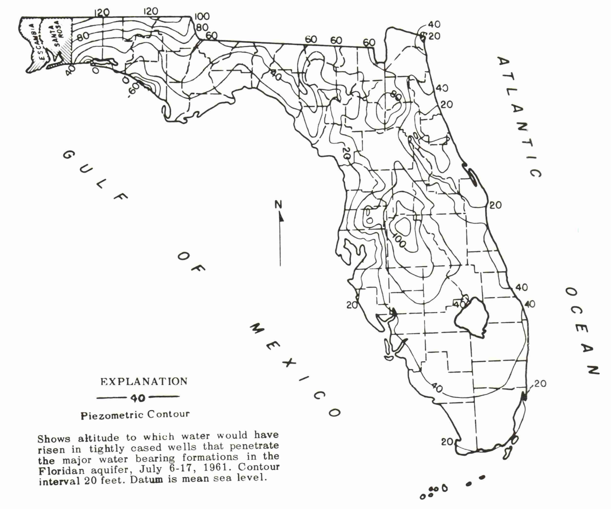

Figure 1. Location of Escambia and Santa Rosa Counties, and the piezometric surface of the Floridan aquifer, 1961.

The lines on the piezometric surface represent the height, in feet above sea level, to which water will rise in wells tightly cased into the limestones of the Floridan aquifer. The piezometric surface in Escambia and Santa Rosa Counties slopes generally from north to south, the direction of water movement in the aquifer. The piezometric surface indicates the water discharges into the Gulf of Mexico. In northwestern Florida the aquifer receives most of its water from southern Alabama where the limestones come to the surface.

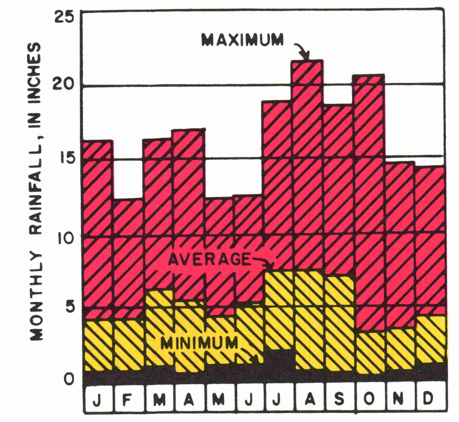

Figure 2. Average, highest, and lowest monthly rainfalls at Pensacola.

Pensacola's rainfall averaged 63.4 inches per year from 1931 to 1960. This yearly total of more than 5 feet supplies the area's fresh water and amounts to an average of 5½ billion gallons of water falling on Escambia and Santa Rosa Counties daily. The greatest rainfall was 90.4 inches in 1953 and the least was 28.7 inches the next year (1954). August is the wettest month with an average of 7.7 inches. October is the driest month with an average of 2.9 inches but the rain during that month has varied from nearly zero to 20.5 inches.

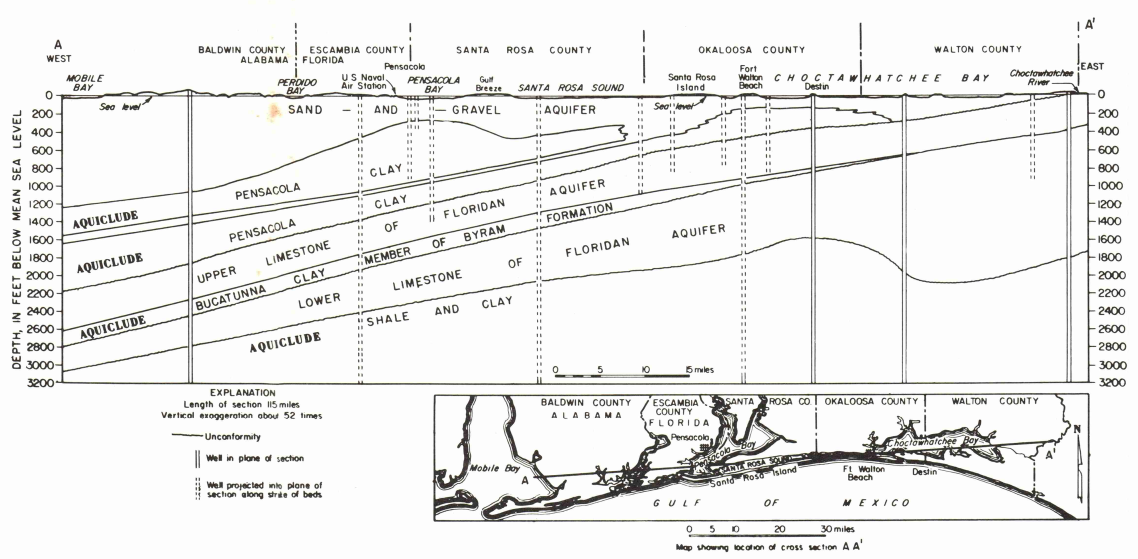

Figure 3. Geology along the gulf coast of northwestern Florida showing aquifers and aquicludes.

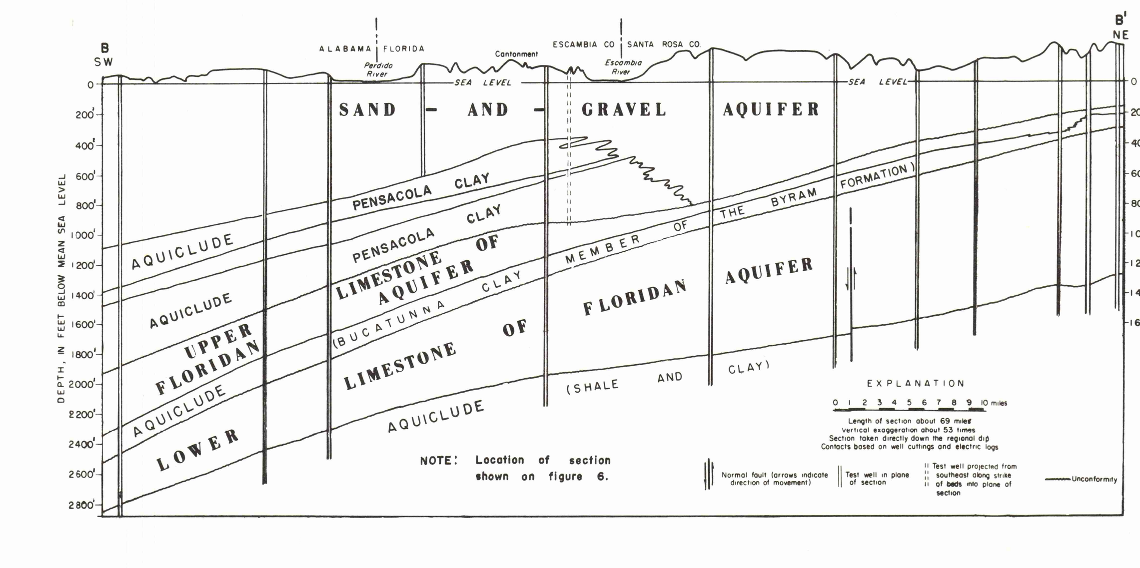

Figure 4. Geology across Escambia and Santa Rosa Counties showing aquifers and aquicludes.

Ground water in Escambia and Santa Rosa Counties occurs in beds of sand, gravel, and limestone. The area fortunately has thick beds of permeable sand and gravel near the surface that contain large quantities of excellent water. The Pensacola Clay and other clay beds do not supply water to wells but restrict the movement of water between aquifers and are called aquicludes.

Most of the wells in Escambia and Santa Rosa Counties draw water from the sand-and-gravel aquifer. This aquifer extends from the surface to depths ranging from 200 feet to 1,000 feet and thickens to the west. Although composed predominantly of quartz sand, the aquifer contains numerous beds of clay and quartz gravel. However, permeable sand-and-gravel beds capable of furnishing sufficient water to wells are usually found within 100 or 200 feet of the surface.

The sand-and-gravel aquifer is underlain by the Pensacola Clay in the southern half of the area and the upper limestone of the Floridan aquifer in the northern part. The upper limestone ranges in thickness from 30 feet in the north to more than 400 feet along the Gulf Coast. The limestone slopes to the southwest at about 30 to 40 feet per mile. The upper limestone is composed of brown to gray hard dolomitic limestone and dolomite. The lower part of the bed is cream-colored to light gray, soft to hard, sandy limestone with shell fragments. The hard layers of limestone slow the drilling time considerably.

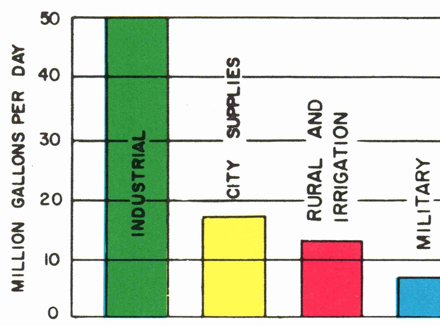

Figure 5. Average daily use of ground water in 1962 in Escambia and Santa Rosa Counties.

Every day an average of 87 million gallons of water is pumped from the sand-and-gravel aquifer in Escambia and Santa Rosa Counties. Most of this water is developed near Pensacola-more than 80 percent within 15 miles of the city. Industries are the largest users of ground water with 50 mgd (million gallons per day) or about 60 percent of the total. Total use averages 150 gallons per person per day. Not all the water used is consumed, a portion of it returns to the ground or is discharged to streams.

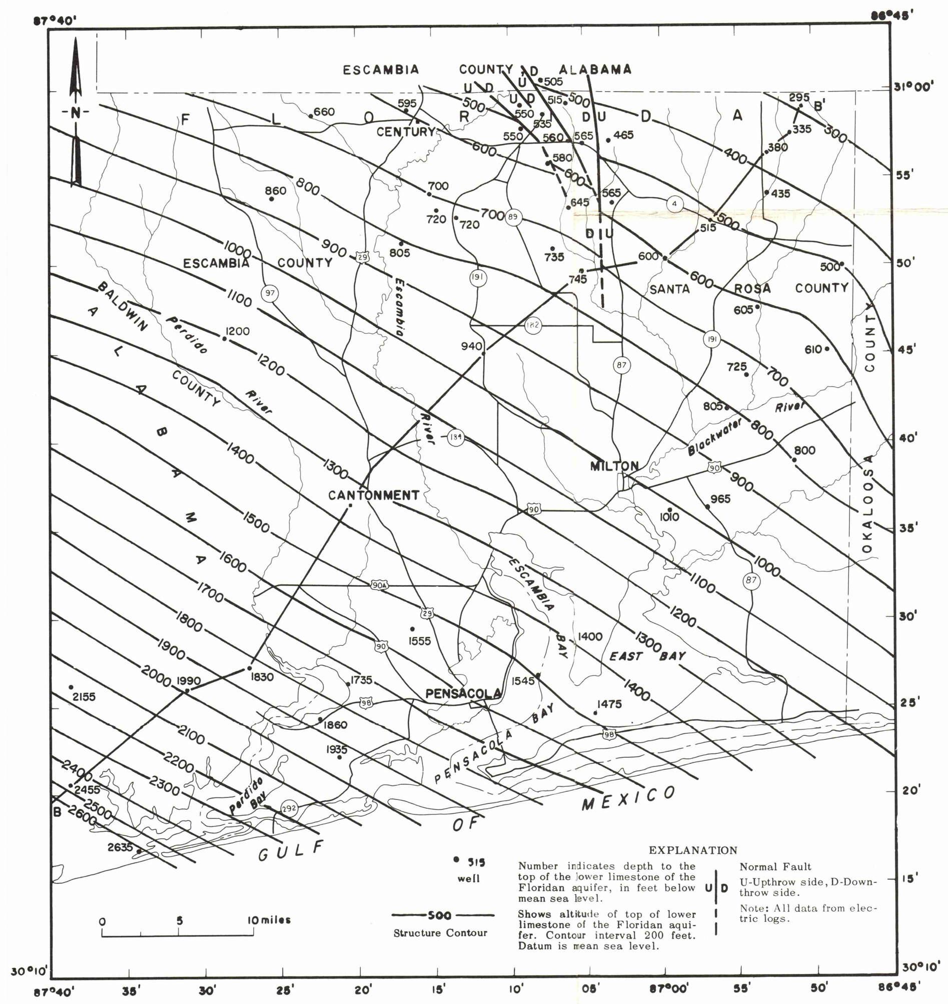

Figure 6. Top of the lower limestone of the Floridan aquifer.

The contours show that this limestone becomes deeper toward the southwest at about 35 feet per mile. This limestone aquifer thins toward the Gulf of Mexico and ranges in thickness from 360 to 1,200 feet. A clay bed from 45 to 200 or more feet thick separates the upper and lower limestones of the Floridan aquifer and greatly restricts the movement of water between the two limestone aquifers. Water in the lower limestone is fresh in the northern half of the area and very salty in the southern half. No fresh water occurs below the lower limestone in the area. A well tapping the full thickness of the lower limestone near the center of the area flowed at 125 gpm with an artesian pressure head of 40 feet above land surface and was pumped at more than 600 gpm.

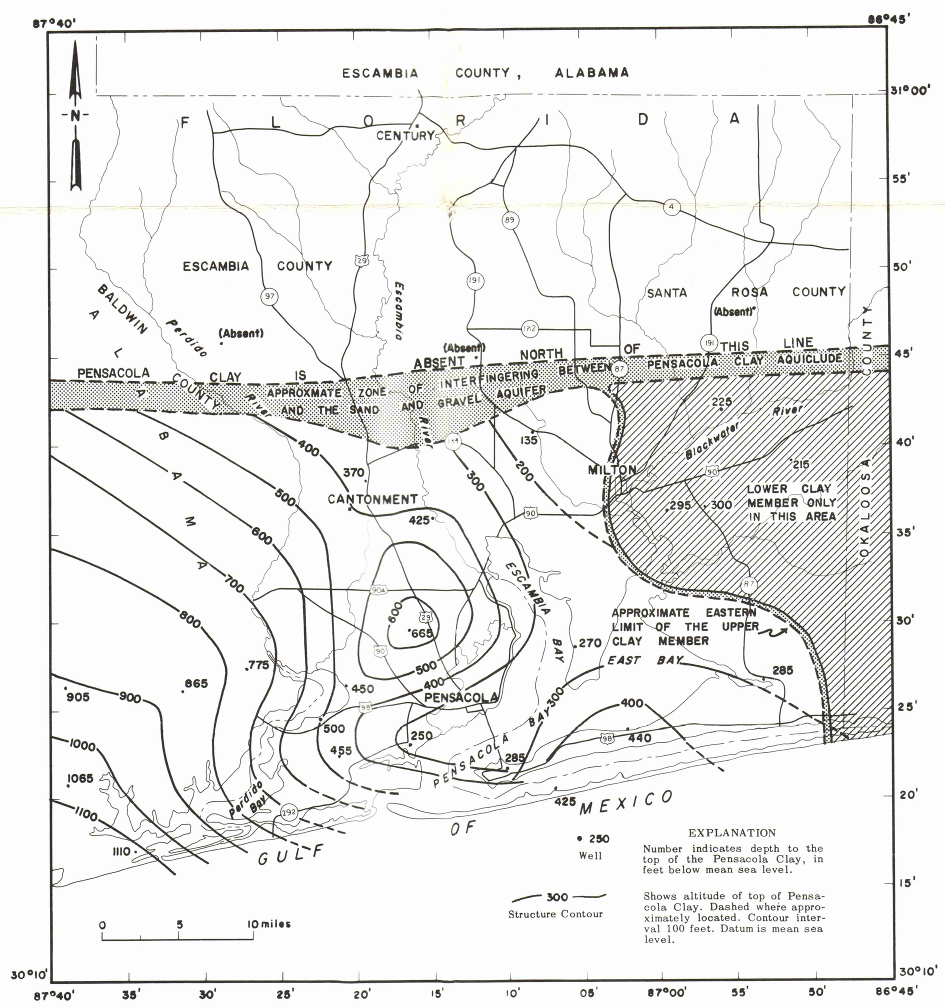

Figure 7. Top of the Pensacola Clay.

The contours represent the top of the Pensacola Clay in feet below sea level. The two beds of clay which compose this aquiclude lie immediately below the sand-and-gravel aquifer in the southern half of the two counties. The clay is nearly water tight and the beds range from 150 to nearly 1,000 feet thick. The clay beds are separated by a 20 to 160 feet thick bed of sand. The upper bed of clay is absent over much of Santa Rosa County. The top of the Pensacola Clay coincides with the base of the sand-and-gravel aquifer.

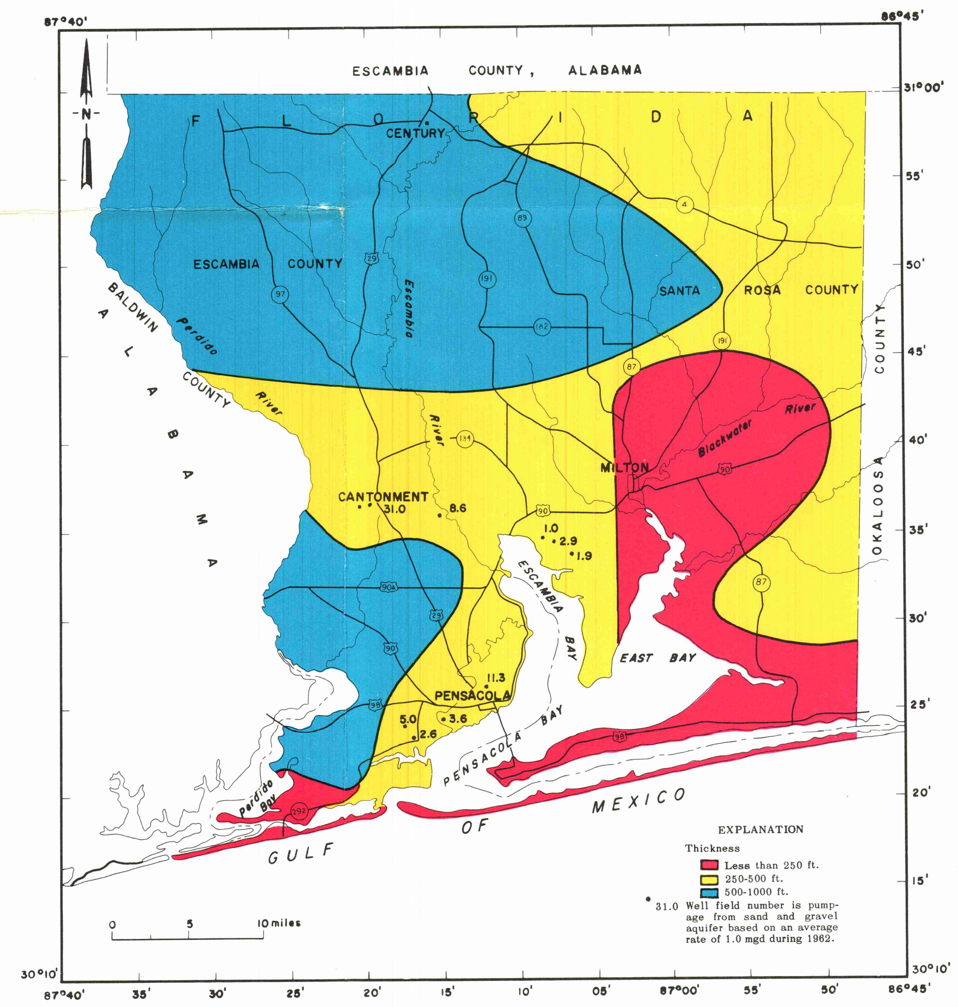

Figure 8. Thickness of the sand-and-gravel aquifer and average pumping rates of the larger well fields.

The colors show the general thickness of the sand-and-gravel aquifer in feet below the land surface. This aquifer is 1,000 feet thick in the north and much thinner along the Gulf of Mexico. Almost all the ground water used in the two counties comes from permeable parts of this aquifer. The aquifer, however, contains discontinuous beds of clay and sandy clay which do not furnish water to wells.

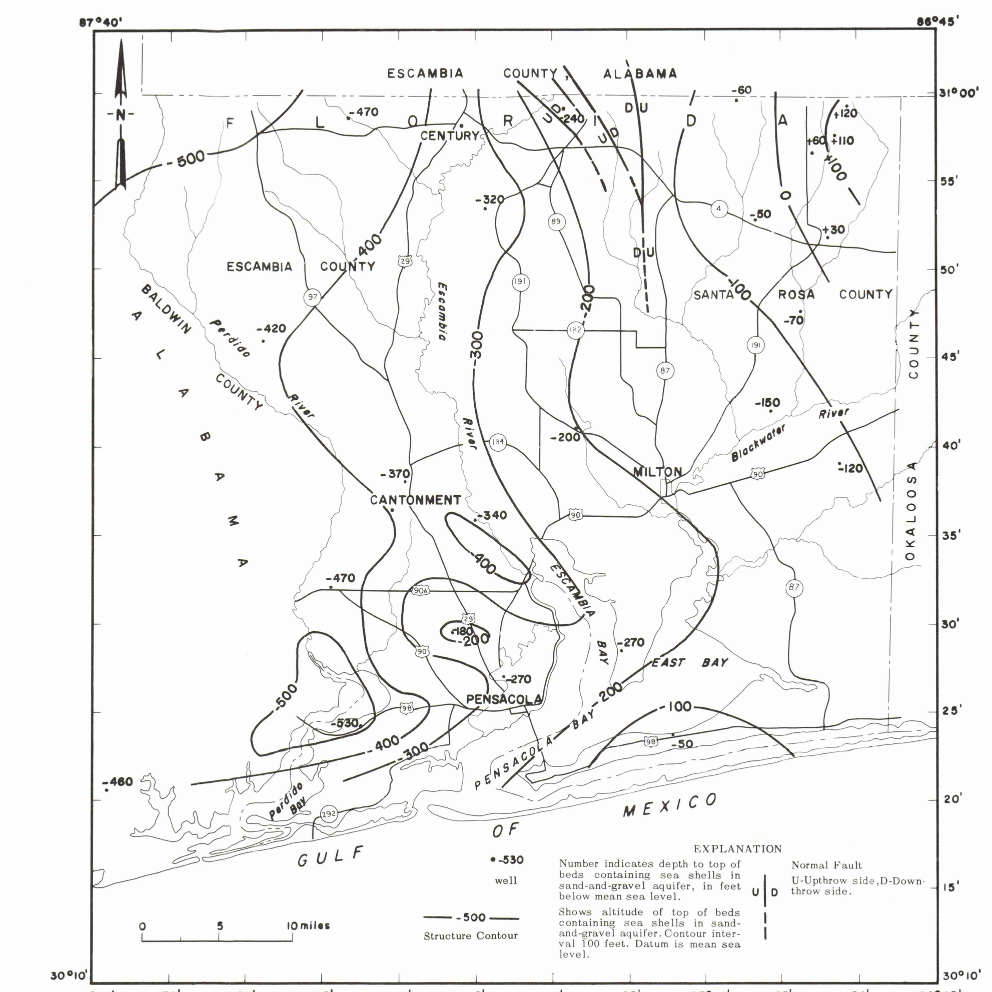

Figure 9. Top of the beds in the sand-and-gravel aquifer that contain sea shells.

The contour lines represent the top of the beds in the sand-and-gravel aquifer that contain fossil sea shells. Above this surface, the beds lack shells and below it, the beds may be composed of 50 percent shells. Wells yield soft and slightly mineralized water from above this surface. The hardness of the water is usually less than 25 ppm. Deeper wells that penetrate the shell beds produce harder water because the water dissolves some of the minerals from the shells. The hardness of water from the deeper wells is as much as 150 ppm. Near the Gulf of Mexico, the shell beds occur near the surface.

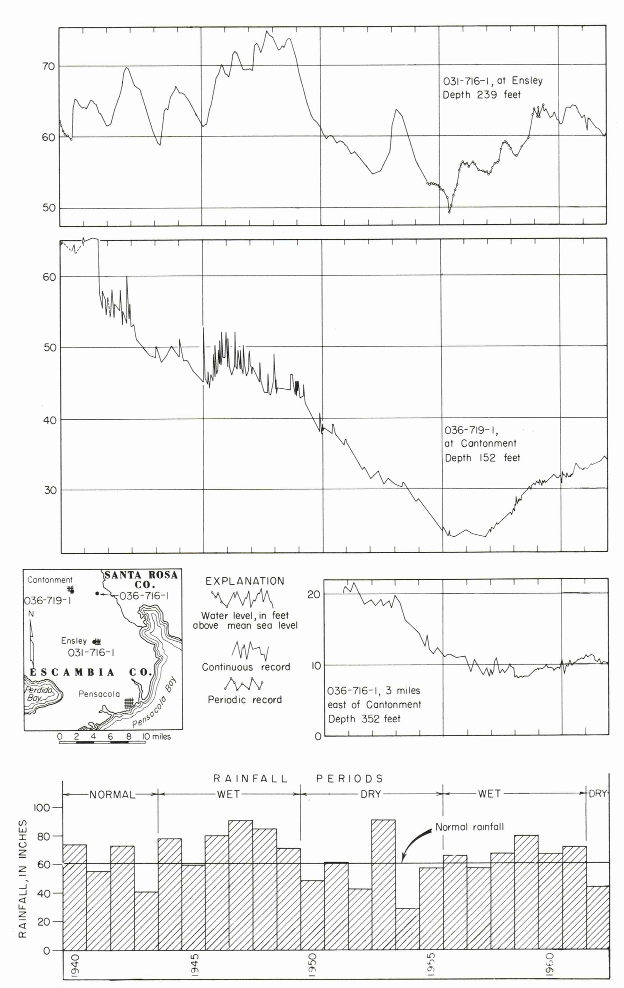

Figure 10. Fluctuation of the water level in three wells in the sand-and-gravel aquifer and graph of the yearly rainfall at Pensacola.

The graphs show the changes in storage of water in the sand-and-gravel aquifer. Rain adds to the amount of water underground and dry weather reduces the amount. The top graph shows changes in the water level which reflect wet and dry periods. The water level, which has fluctuated 26 feet since 1940, helps explain why some wells that barely penetrate the aquifer go dry or produce less water during droughts. The well screens should be set deep enough so they are below the water table during dry years. The water level in some wells in the lower lying areas where pumping is light has changed less than 5 feet during the same period. The two middle graphs are of wells near industrial plants and show lowering of the water table caused by heavy pumping. When such a lowering of the water level occurs in wells near surface bodies of salt water, the salt water may contaminate the aquifer.

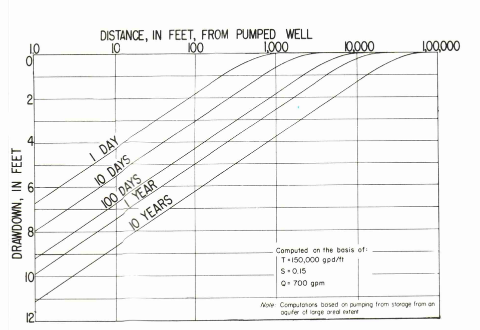

Figure 11. Graph showing approximate drawdowns caused by pumping a well in the sand-and-gravel aquifer.

When a well is pumped, the water level in the well and in the surrounding area declines. The approximate amount of this decline or drawdown can be determined from the graph. This figure shows theoretical drawdowns in the vicinity of a well pumped at the rate of 700 gpm (about 1 mgd) from an aquifer having a transmissibility of 150,000 gpd (gallons per day)/per foot and a storage coefficient of 0.15. As the drawdowns outside the pumped well vary directly with discharge, drawdowns for greater or lesser rates of discharge may be computed from these curves. For example under the assumed conditions, the drawdown 100 feet from a well discharging at 700 gpm would be 4.3 feet after 100 days of pumping. If the well had discharged 2,100 gpm for the same length of time, the drawdown at the same distance would have been three times as much, or 12.9 feet. The values from the graph may be used to help determine well spacing, drawdown at salty bays or rivers, depth of pump column, or type of pump.

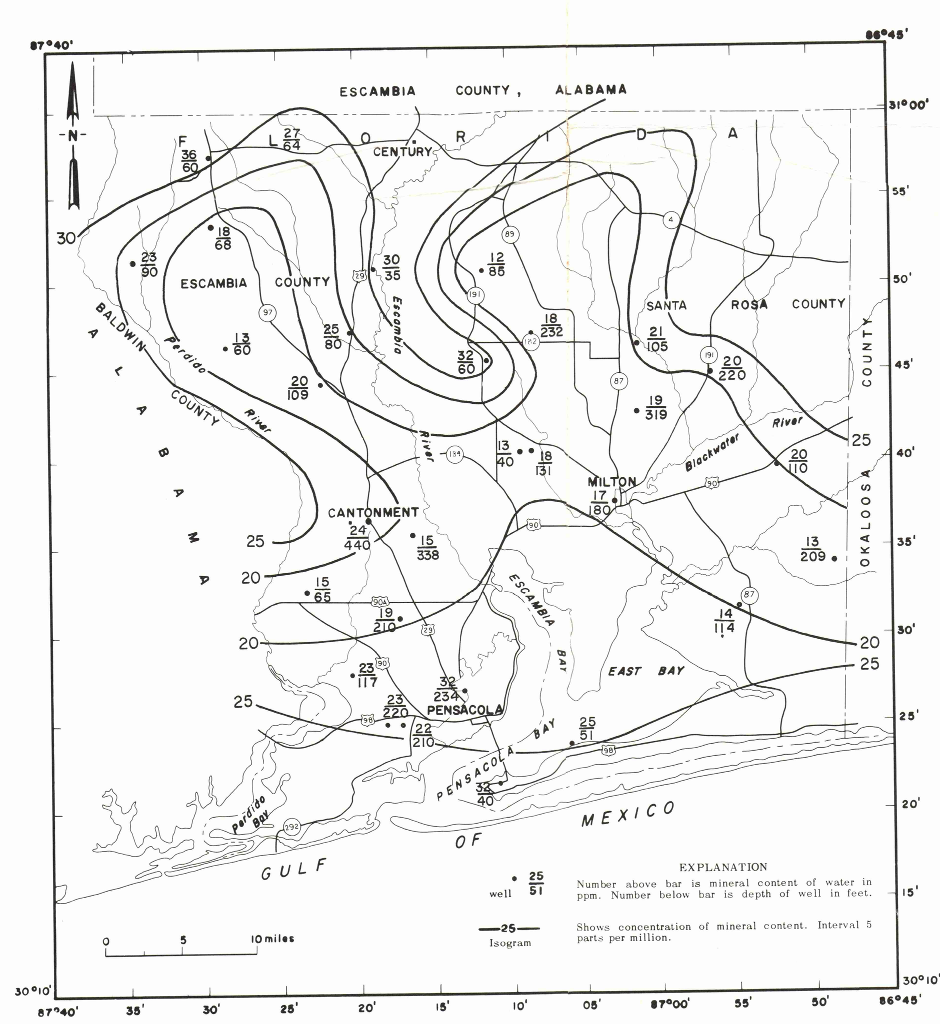

Figure 12. Mineral content of water from the upper part of the sand-and-gravel aquifer.

Contours show equal amounts of mineral matter dissolved in water from the upper part of the sand-and-gravel aquifer, the part above the sea shell beds. The water containing the least minerals comes from the central part of the area where recharge is large. Most of the water in the aquifer is exceptionally soft and slightly mineralized. Most of the water meets or exceeds the requirements for municipal or industrial uses. However, treatment is required to reduce its corrosiveness and neutralize its acidity. The dissolved minerals in the water are generally less than 40 ppm.

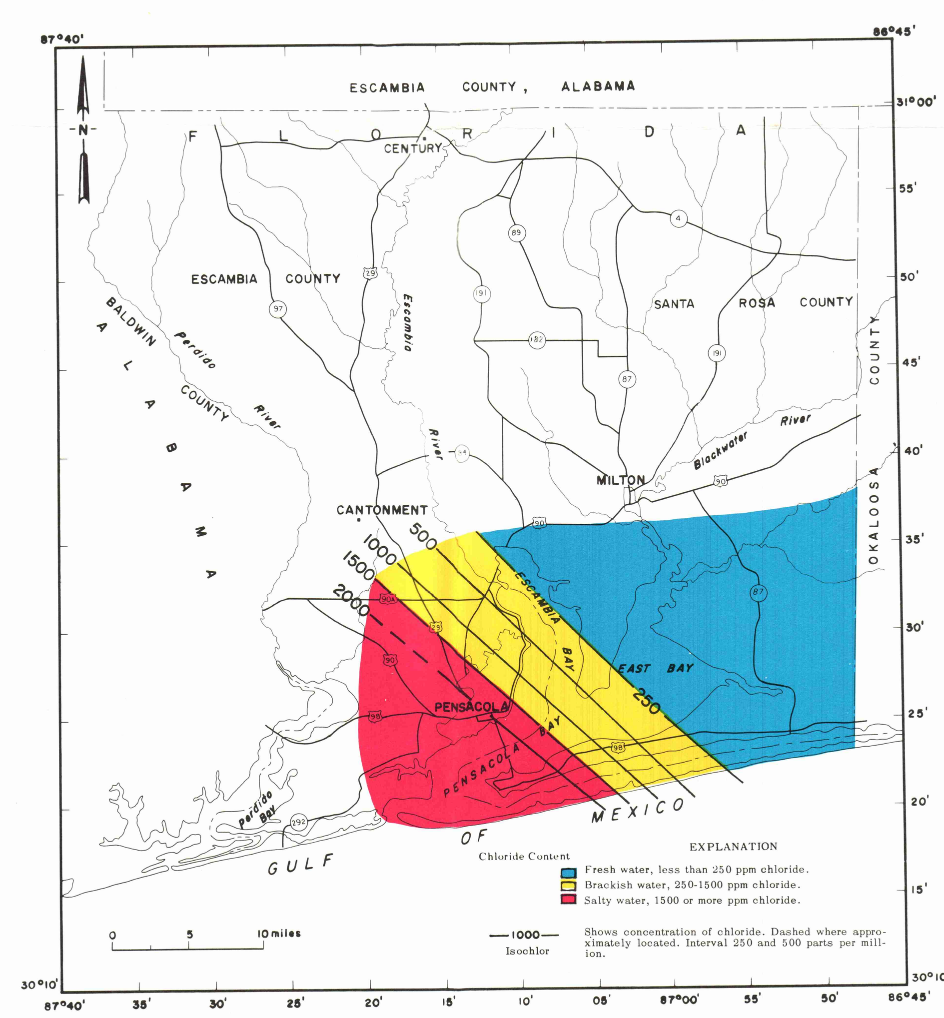

Figure 13. Chloride content of water from the upper limestone of the Floridan aquifer.

Water from the upper limestone, in the blue colored area, is suitable for most uses. In the yellow colored area, water from the upper limestone is suitable for some uses but generally not for drinking. Water in the red colored area is too salty for almost all uses. Water in the upper limestone is potable in most of Santa Rosa County and the northern part of Escambia County. The chloride content of this potable water is generally less than 50 ppm and as low as 7 ppm. Water from the upper limestone in the Pensacola-Fort Walton Beach area is softer than water from any other limestone bed in Florida.

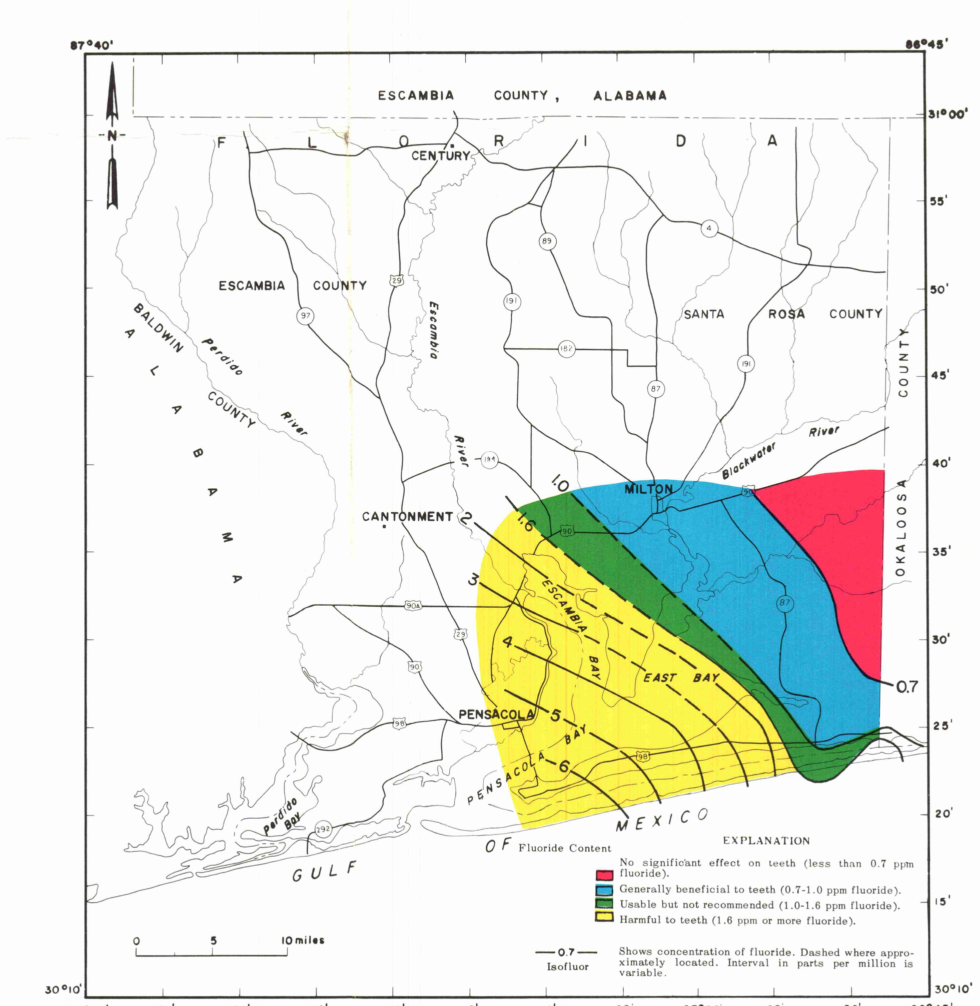

Figure 14. Fluoride content of water from the upper limestone of the Floridan aquifer.

Water from the upper limestone, in the red colored area, contains so little fluoride that it would not have a significant effect on teeth. Water in the upper limestone, in the blue colored area, has enough fluoride to be generally beneficial to the development of decay resistant teeth in children. Water in the green area would be beneficial by reducing tooth decay but may cause mottled enamel (dental fluorosis) in some cases. Water in the yellow area contains fluoride in concentration above that generally recommended for drinking water.

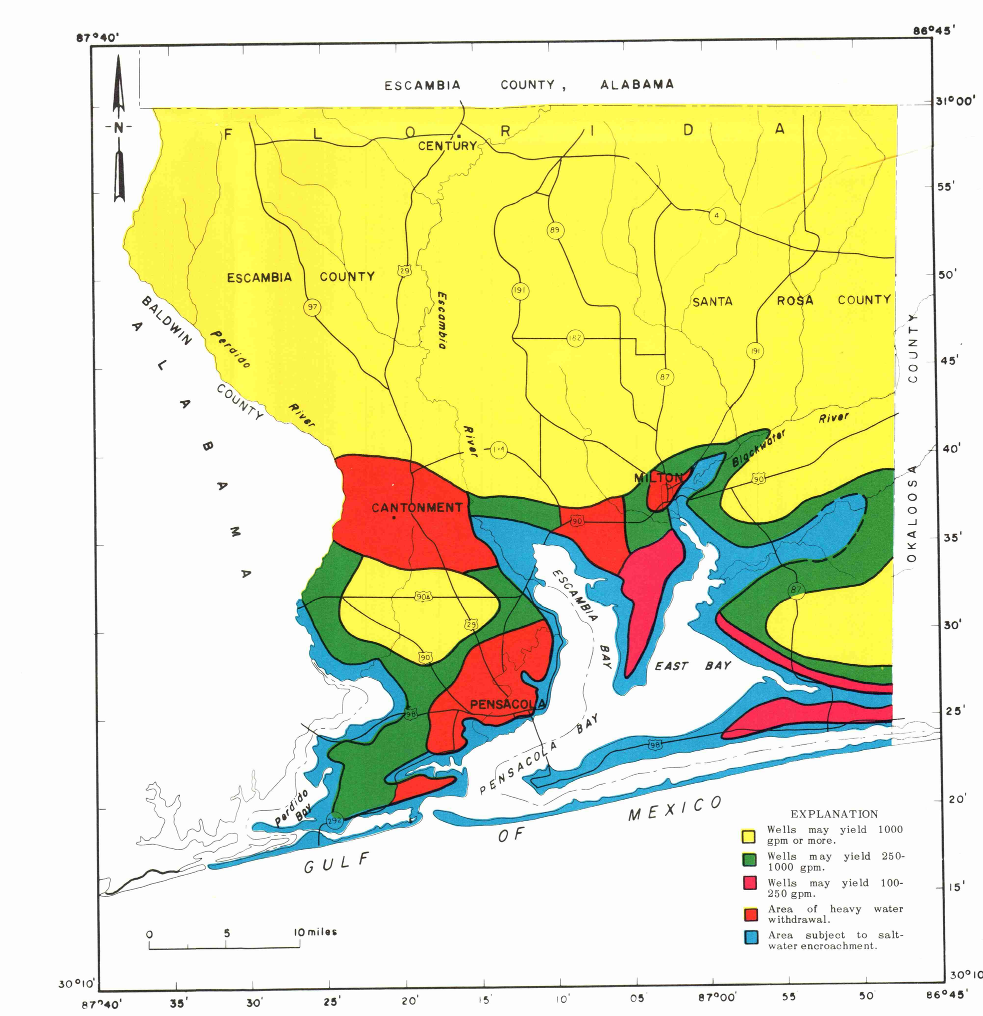

Figure 15. General areas of water availability in the sand-and-gravel aquifer in Escambia and Santa Rosa Counties.

Most large-capacity wells in the yellow area would be successful because the sand-and-gravel aquifer is permeable and thick. The possibility of salt-water encroachment restricts the amount of water that can be withdrawn from the green area. However, yields of 250 to 1,000 gpm can be safely pumped in the green area. The red color indicates areas where yields of 100 to 250 gpm can be safely pumped without danger of salt-water encroachment. The blue color indicates where pumping of large wells could cause salt water from nearby bays, rivers, or the Gulf of Mexico to move into the aquifer. The orange color indicates where large quantities of ground water are presently being pumped.