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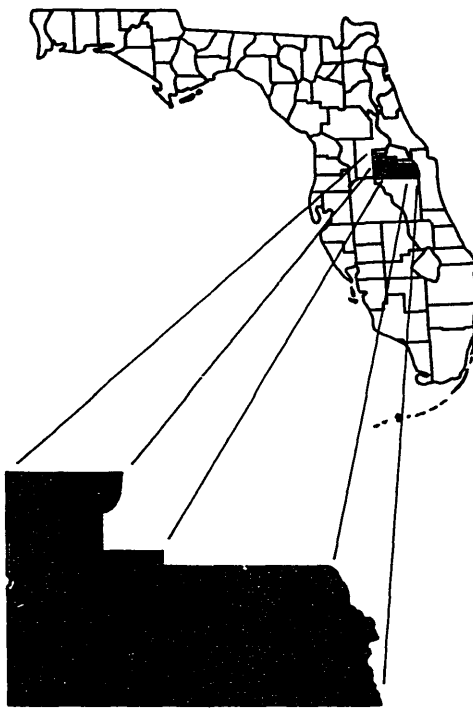

ORANGE COUNTY FLORIDA

TALLAHASSEE
1968

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
DIVISION OF GEOLOGY
FLORIDA BOARD OF CONSERVATION
and the
BOARD OF COUNTY COMMISSIONERS OF ORANGE COU

WATER IN ORANGE COUNTY, FLORIDA

By

B.F. Joyner, W.F. Lichtler, and Warren Anderson

What is the source of Orange County's water? Where is it stored? How much is available? How good is it? How is it used? What are present and future water problems? What can be done to protect sources of good water? These are some of the questions often asked about water. Some of these questions are easy to answer; others are difficult.

WHAT IS THE SOURCE OF ORANGE COUNTY'S WATER?

The source of all fresh water in Orange County is rain--either on the county or on adjacent higher land areas. The average annual rainfall in Orange County is 52 inches, an average of 2,500 mgd (million gallons per day). Normally more than half this rainfall occurs during the 4-month rainy season from June through September.

WATER CYCLE

Water in nature constantly moves in what is known as the hydrologic cycle. It falls from the atmosphere as precipitation, evaporates from the land, vegetation, and surface-water bodies, moves over and through the ground to the lakes, rivers, and ocean and again evaporates.

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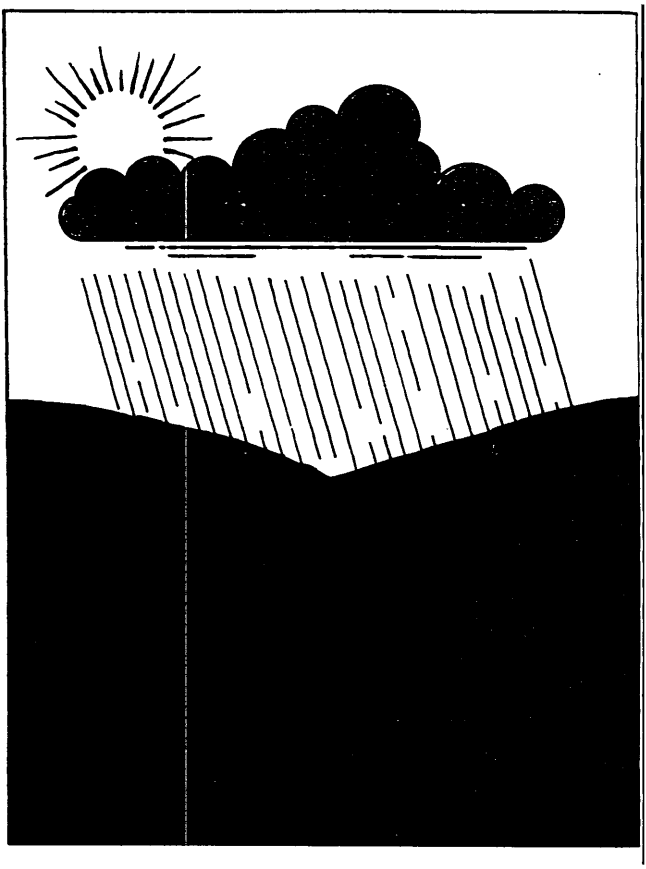


Figure 1. Rain--Source of Orange County's water.

Of the 52 inches of rain that fall on Orange County in an average year, about 35 inches, or 1,750 mgd, returns to the atmosphere by evaporation from lakes, streams, and the land, and by transpiration from vegetation--an orange tree of average size transpires about 35 gallons of water per day. About 17 inches of rain, or 750 mgd, are left to recharge the ground-water reservoirs and help maintain flow in streams in the county.

In addition to the rainfall on Orange County, an average of about 180 mgd flows into the county from Lake and Osceola counties, both in

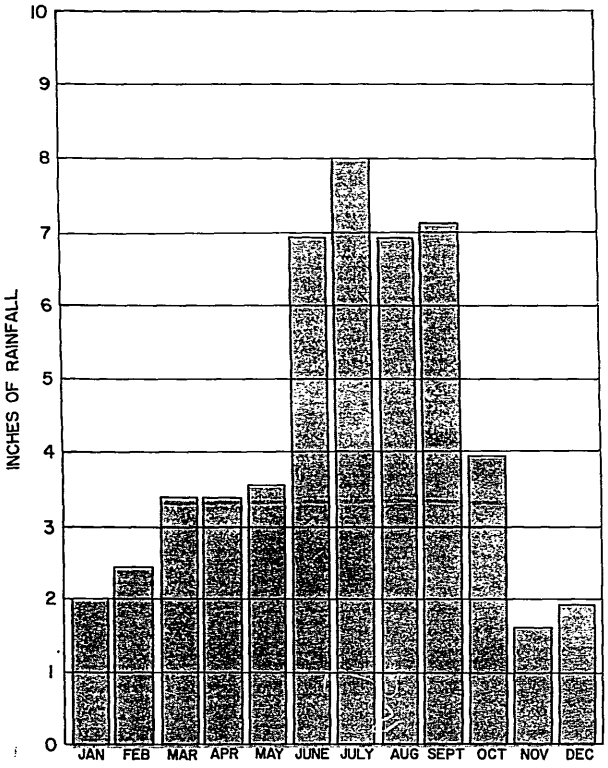


Figure 2. Average monthly rainfall at Orlando.

streams and through the ground. About 30 mgd is consumed by various water users within Orange County, leaving about 900 mgd that flows from Orange County into Seminole, Brevard, and Lake counties in streams and through the ground.

WHERE IS ORANGE COUNTY'S WATER STORED?

Orange County has enormous quantities of water stored on the surface and in the ground. The total amount varies somewhat from the rainy season to the dry season and from years of above-average rainfall and years of below-average rainfall. However, the amount of variation is small because most of the water is stored underground.

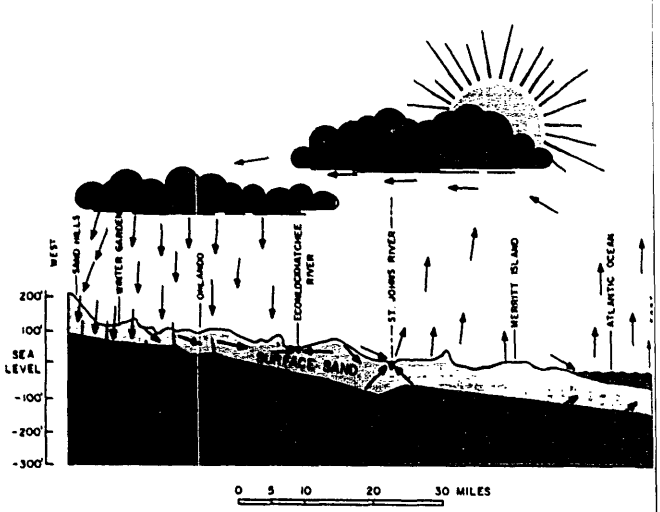


Figure 3. Cross section of Orange and Brevard counties illustrating hydrologic cycle.

Stream channels in Orange County are not deeply incised and the amount of water stored in channels is insignificant in most streams. Seepage of ground water to the stream channels temporarily sustains streamflow during dry weather, but all streams go dry or recede to very low flow during extended droughts except for the St. Johns River and the spring-fed Wekiva River.

The amount of water stored in lakes varies considerably because lakes are subject to high evaporation losses (about 4 feet per year), seepage losses, and low rates of recharge during dry weather. Levels of some lakes fluctuate as little as 2 feet; others more than 20 feet. Water stored in the upper foot of the 55,000 acres of lake surface in Orange County is 18 billion gallons, enough to provide nearly 50 million gallons of water per day for a year.

The water stored in the lakes and streams in Orange County is generally soft, and low in mineral content, but it often is highly colored because of dissolved organic matter.

The quantity of water stored in the ground in Orange County is estimated at many trillion gallons. Porous rocks which are capable of

yielding water to wells and springs are called aquifers. The uppermost ground-water reservoir in Orange County is the nonartesian or water-table aquifer which is composed primarily of quartz sand. This aquifer extends from the water table to a depth of about 30 to 40 feet below the land surface. The water-table aquifer will yield small to moderate quantities of water (5 to 20 gallons per minute) to small diameter sand-point wells. Larger yields can be obtained from larger diameter (over 2-inch) wells with screens. In most parts of the county, the water table is near the land surface and suction-type pumps are adequate to lift the water to the surface. However, in some areas of western Orange County the water table is more than 10 to 15 feet below the surface and submersible or deep-well jet pumps must be used.

Water from the water-table aquifer is generally very soft, low in mineral content, and slightly corrosive. In some areas the water is high in iron and/or color and may cause staining of fixtures and surfaces wetted by sprinklers. Shallow wells may be subject to contamination from septic-tank effluent or other pollutants unless the wells are located a sufficient distance from possible sources of contamination. In areas where the aquifer is composed of clean, coarse sand, and where wells are safe from pollution, the water-table aquifer is a good source of water for domestic use.

The Hawthorn Formation lies between the water-table aquifer and the underlying Floridan aquifer. Most of the Hawthorn Formation is relatively impermeable clayey sand and confines water in the underlying artesian Floridan aquifer. However, in some areas, particularly east and south of Orlando, porous layers of shell, sand, or gravel within the Hawthorn Formation will yield moderate to large supplies of water. The water levels in wells that penetrate these zones are usually intermediate between the water table and the water level of the Floridan aquifer. Water in the Hawthorn Formation is usually hard, low in color and iron, and pro-

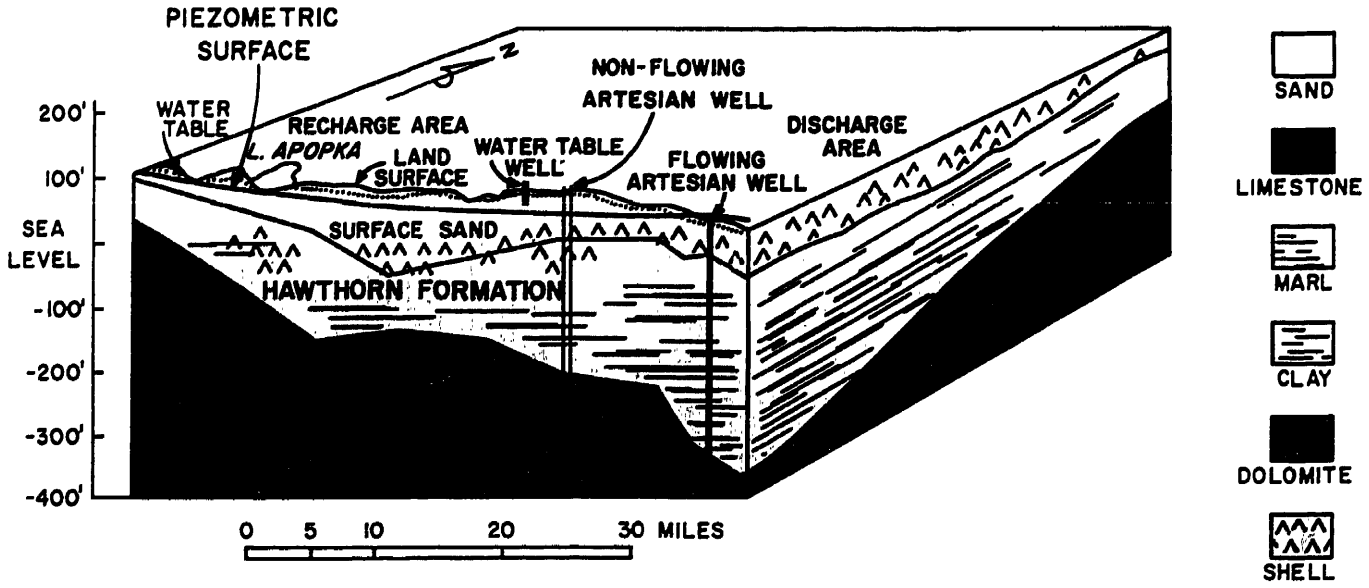


Figure 4. Block diagram of Orange County.

tected from pollution by surrounding, relatively impermeable beds.

The principal water-storage reservoir in Orange County is the Floridan aquifer which underlies all of Florida and parts of Georgia, South Carolina, and Alabama. In Orange County this ground-water reservoir is more than 1,300 feet thick and is composed, generally, of limestone and dolomitic limestone. The depth to the top of the aquifer ranges from about 50 feet below the land surface in parts of western Orange County to about 350 feet in the southeastern part of the county. Solution channels and pore spaces in the limestone range in diameter from a fraction of an inch to more than 200 feet. Yields of 4,000 gpm (gallons per minute) or more can usually be obtained from large diameter (20 inches or more) wells drilled into the Floridan aquifer.

The water in the Floridan aquifer is artesian, which means it will rise above the top of the aquifer in a penetrating well. The imaginary surface that coincides with the water level in a well in an artesian aquifer is called the piezometric surface. The piezometric surface ranges from more than 100 feet below the land surface (non-flowing areas) in high areas in the western part of Orange County, to more than 15

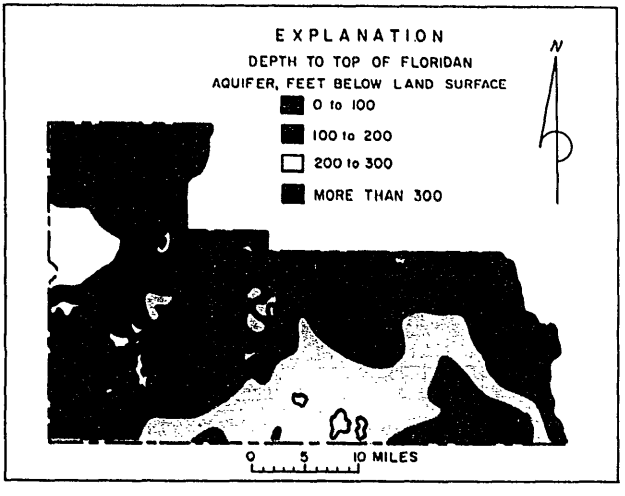


Figure 5. Depth to top of Floridan aquifer.

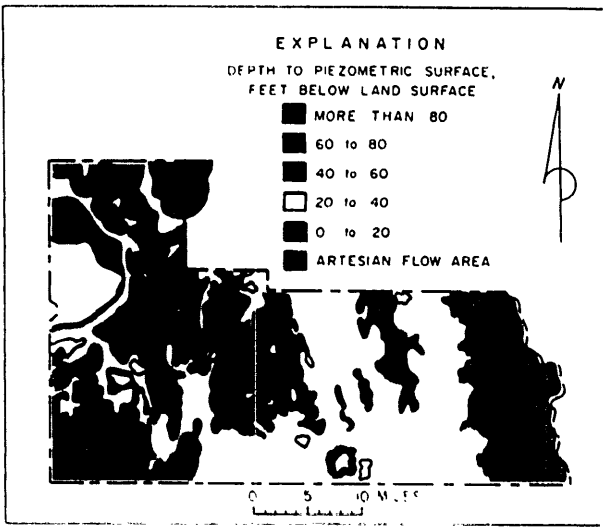


Figure 6. Piezometric surface of the Floridan aquif

feet above the land surface (flowing areas), the St. Johns River valley in the extreme e tern part of the county.

The piezometric surface is highest in southwestern part of the county and slc downward to the northeast and east. Grc water moves down gradient in a direction ge rally at right angles to the piezometric cont

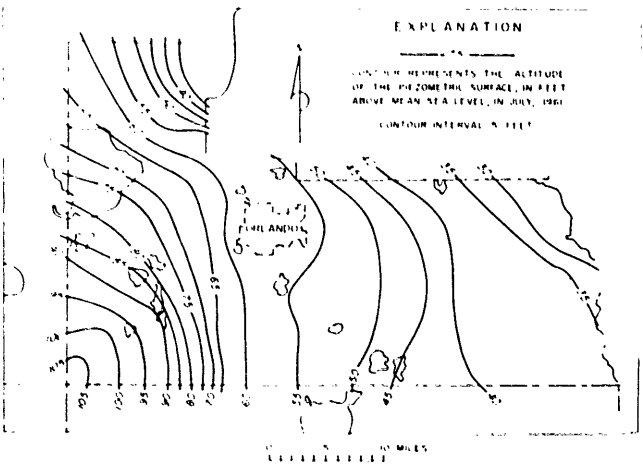
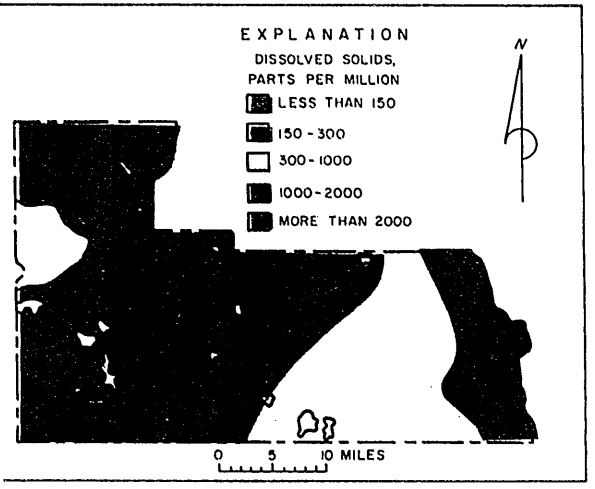


Figure 7. Altitude of piezometric surface at averag conditions.

The mineral content of the water in the ridan aquifer is lowest in the western part the county and increases toward the east. t of the increase is due to solution of the estone as the water moves slowly eastward ard the sea, however, most of the increase bably is caused by residual saline water that ered the aquifer when the sea last covered nge County.



ıre 8. Dissolved solids in water from the Floridan aquifer.

Except for the salt water in the eastern of the county and highly colored water in s of the water-table aquifer, ground water is able for domestic, irrigational, and most ıstrial purposes. The principal dissolved stituents in water in Orange County are: ca, calcium, magnesium, sodium, chloride, fate, and bicarbonate.

HOW IS WATER USED?

Use of water in Orange County is increasing at a rapid rate. In 1965 the total use was about 100 mgd exclusive of water used for electric power generation. About 30 mgd of the water used was consumed--evaporated or incorporated in a product. All water for municipal, industrial, and domestic supplies and about half the water

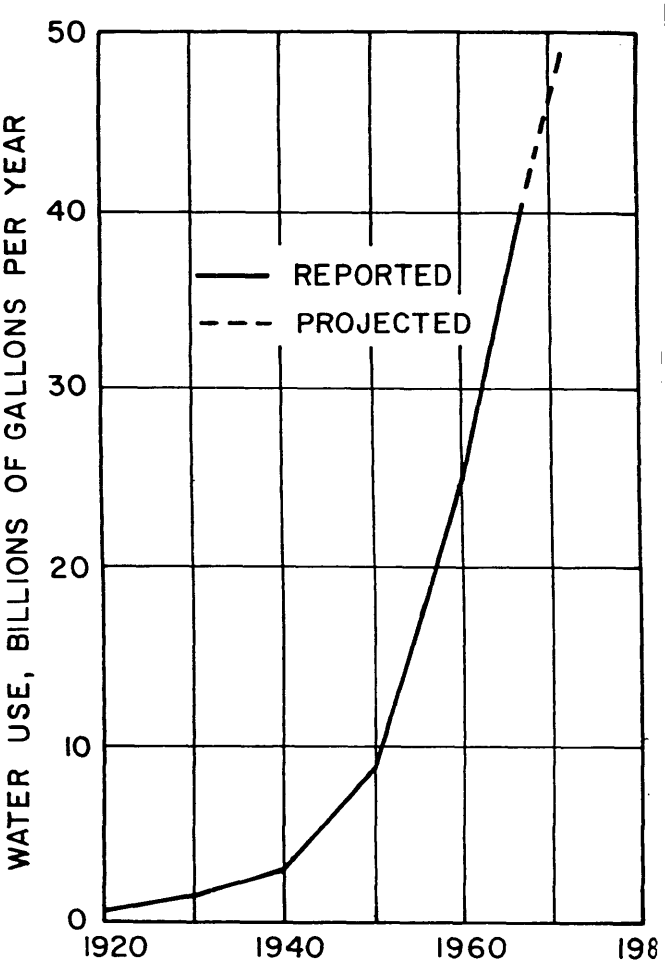


Figure 9. Water use in Orange County.

used for irrigation in Orange County came from ground-water sources--primarily the Floridan aquifer. Total ground-water pumpage was approximately 80 mgd. This amount included 11 mgd that the City of Cocoa and vicinity including Cape Kennedy, NASA, and Patrick Air Force Base drew from ground-water reservoirs in eastern Orange County. The water in the Floridan aquifer underlying Brevard County is generally too highly mineralized for most uses.

Lakes and ponds in Orange County provide water for irrigation, but the largest uses of surface water are for recreation and cooling for

Photo – U. S. Soil Conservation Service

Figure 10. Citrus grove irrigation in Orange County.

electric power generation. The 1,100 lakes and ponds in the county constitute a valuable resource. Many are used for boating, swimming. fishing, skiing, and other recreational activities. They also moderate the surrounding air temperature and attract a great number of tourists to Orange County. Lakes have played a large part in establishing Orlando's reputation as one of the 10 most beautiful cities in the countrv.

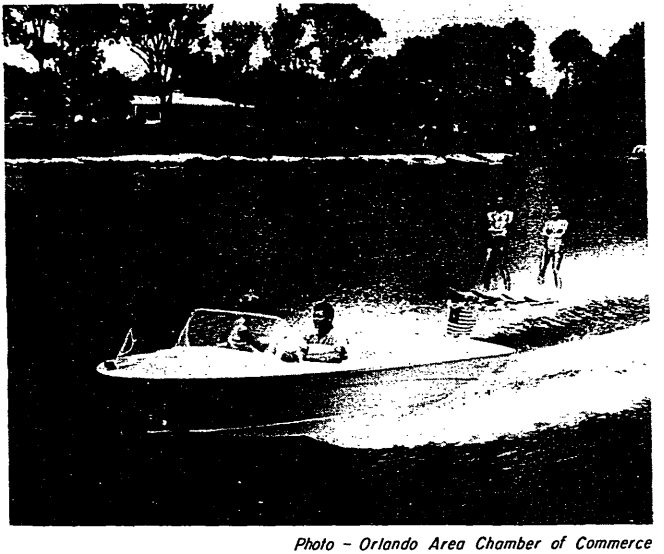


Photo – Orlando Area Chamber of Commerce

Figure 11. Water for recreation.

Streams in Orange County are used for fishing, boating, and swimming; however, most of the streams go dry during droughts.

WHAT ARE THE WATER PROBLEMS?

In 1960 many homes were flooded by high lake levels. In 1962 the docks of some lake-front homes were left high and dry by low lake levels. These extremes illustrate one of the major surface-water problems in Orange County--too much water during wet periods and not enough during dry periods.

Photo – U. S. Soil Conservation Service

Figure 12. Flooding in 1960.

More than 300 drainage wells have been drilled in Orange County since 1906 to drain excess surface water and to dispose of waste. Prior to 1950, raw sewage and citrus pulp were put into the Floridan aquifer. Such practices have been outlawed, but the quality of the water entering drainage wells is not easily controlled or regulated. Some parts of the Floridan aquifer are still subject to pollution. Some streams and lakes receive treatment plant effluent and other contaminants. The continued increase in need

or water calls for increased attention to area-vide water planning and conservation.

WHAT ABOUT THE FUTURE?

At present (1968) there is more than enough vater entering the ground-water reservoirs in)range County to meet all demands and to still naintain flow in the springs and flow of ground vater into Seminole, Brevard, and Lake coun-;ies. If recharge to the Floridan aquifer is sig-ıificantly reduced by urbanization and by diver-sion of water to the sea, and if water use in the ·egion continues to increase, increasing atten-tion will need to be given to conservation and water developmental measures to satisfy the demand for fresh water.

A tremendous amount of water is stored underground, but long-term withdrawal of more water than enters the aquifer promotes problems. Excessive withdrawal lowers water levels and invites intrusion of salt water from the ocean or from greater depths in the aquifer. Pollution of the water also impairs its usefulness. Lowering of artesian levels tends to promote formation of sink holes.

WHAT CAN BE DONE?

Accurate information, sound planning, and farsighted land-use management are the keys to most of the water-management problems of Orange County.

Much of the flood damage to homes and other property can be avoided by recognizing that lake levels naturally rise and fall in response to variations in rainfall. If the flood plains of lakes are kept in their natural state or are developed in such a manner that the developments will not be greatly harmed by high water, damage can be minimized and water can be saved from wet periods for use during droughts. To do this, it is necessary to know the expected high-water stage of the lakes and to develop only land safe from flooding. Removal of deve-

lopment in most settled areas is probably not practical, but in some cases the best interests of the county may be served by removing homes that are subject to flooding.

Surplus surface water can be a blessing in disguise if managed properly. Research can probably devise an economically feasible plan whereby surplus surface waters can be collected, treated if necessary, and then stored underground for later use. Drainage wells, which now are a hazard because of pollution, could thus be converted into recharge wells, which would preserve and enhance the water resources of the region.

The pollution problem increases as population density increases. However, modern methods of sewage can usually purify water to the stage where it safely can be put underground or into streams and lakes. In the long run, treatment of waste water before it enters streams and lakes may be less expensive than trying to solve the problems created by pollution of surface-water bodies.

The need for water in the distant future cannot be definitely foreseen. However, the population will undoubtedly continue to increase and it is safe to assume water needs will also continue to increase until much of the available water is used. Annual rainfall in Orange County varies considerably--extremes are 40 inches in 1943 to 69 inches in 1960--whereas evapotranspiration losses remain relatively constant. One year of above average rainfall provides many times the volume of recharge to the water reservoirs than does a year of below average rainfall. As below average years of rainfall occur more than twice as frequently as above average years (48 below and 27 above in the past 75 years of record), the importance of the years of floods is evident.

The rolling highlands of western Orange County absorb almost all the rainfall that does not evaporate. Preservation of this region in its natural state or improving its recharge capacity is important. This can be done by guiding

uture urban and industrial expansion to the ›astern areas of the county and preserving the vestern highlands for agricultural use. This ›ermits recharge and at the same time yields ı high rate of return through agri-business.

Surface drainage is sluggish in the eastern ›art of the county because of the flat terrain, ınd downward movement of water is slow be-:ause of the relatively impermeable sub-strata. Vater control must be provided before this area :an be developed. If excess surface water is :ollected, treated, and allowed to recharge :he Floridan aquifer through wells, water sup-›lies will increase, the danger of salt-water ıntrusion will decrease, and development of the ırea will be aided. Collection, treatment, and storage of all excess surface water in the county nay not now be feasible, but such a goal is worthwhile.

WHAT ABOUT EMERGENCY WATER SUPPLIES?

Citizens of Orange County need not be overly concerned with contamination of the ground-water supply by radioactive fallout except those whose wells are subject to contamination by drainage wells. The water stored underground is protected from immediate contamination, whereas the water above ground in streams and lakes would be immediately exposed to radioactive fallout. The artesian aquifer is at least 50 feet below land surface and would probably not be contaminated. Water taken directly from an uncontaminated artesian well would be safe to drink during or after radioactive fallout.

HOW WAS THE WATER RESOURCE MEASURED?

The measurement of Orange County's water resources involves many complex operations. The services of experienced geologists, engi-

neers, and chemists were necessary to measure and study the many variables in water quantity, quality, and movement.

In order to obtain information on Orange County's underground water, many existing wells were studied and tested and where necessary test wells were drilled. Drill cuttings were examined and water samples were analyzed for their chemical content. Water levels were measured to determine seasonal and long-term changes and pumping tests were conducted to obtain a knowledge of the ability of the aquifers to transmit and store water. The amount of water stored in the aquifers was estimated using geologic and well and pumping-test information.

The quantity and quality of surface water changes more rapidly and frequently than the quantity and quality of ground water. Continuous records or many measurements of the physical and chemical characteristics of streams and lakes are necessary in order to obtain extremes, frequencies, and averages.

The stage (water level) of some streams in the county was measured continuously; and, for some streams and lakes, periodic stage measurements were made. Several stream discharge measurements were made at each gaging site and a stage-discharge relation was defined. By using a continuous record of stage and the stage-discharge relation, a continuous discharge was computed.

Many water samples from streams and lakes were analyzed for dissolved chemical constituents in order to define the ranges, trends, and averages in water quality.

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WHERE CAN MORE INFORMATION BE OBTAINED?

Additional information on the water resources of Orange County is contained in the following reports of the Florida Geological Survey prepared by the U.S. Geological Survey in cooperation with Orange County and the Division of Geology, Florida Board of Conservation:

Ground Water conditions in Orlando and vicinity, Florida: Fla. Geological Survey Report of Inv. No. 5, by A.G. Unklesbay.

Interim Report on the Water Resources of Orange County, Florida: Fla. Geological Survey Inf. Circ. No. 41, by W.F. Lichtler, Warren Anderson, and B.F. Joyner, 1964.

Water Resources of Orange County, Florida: Fla. Geological Survey Report of Inv. No. 50, by W.F. Lichtler, Warren Anderson, and B.F. Joyner, 1968.

Control of Lake Levels in Orange County, Florida: Fla. Geological Survey Inf. Circ. No. 47, by Warren Anderson, W.F. Lichtler, and B.F. Joyner, 1965.

Availability of Ground Water in Orange County, Florida: Fla. Geological Survey Map Series No. 21, by W.F. Lichtler and B.F. Joyner, 1966.

Availability and quality of surface water in Orange County, Florida: Fla. Geological Survey Map Series No. 24, by Warren Anderson and Boyd F. Joyner, 1966.

Water Resources records of Orange County, Florida: Fla. Geological Survey Inf. Circ. No. -- by W.F. Lichtler, Warren Anderson, and B.F. Joyner, in preparation.

Surface and quality of water records of Florida: prepared annually by the U.S. Geological Survey.

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