SUPPLEMENTARY REPORT ON SURFACE-WATER AND GROUND-WATER SURVEYS, NUECES RIVER BASIN, TEXAS

WATER RESOURCES DIVISION
Austin, Texas
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A report on the ground-water and surface-water surveys of the Nueces River Basin was included in a report by the Bureau of Reclamation, entitled "Comprehensive plan for water-resources development of the Nueces River Basin, project planning report number 5-14.04-3, February 1946".

SURFACE WATER

The Nueces River and its tributaries above the Balcones fault zone, which crosses the basin just north of Uvalde, lie within the Edwards Plateau region where vegetation is sparse and the steep rocky slopes are conducive to abnormally high rates of flood runoff during period of excessive rainfall. A number of the peak-discharge rates recorded on streams in the Edwards Plateau region far exceed those recorded in other areas of equal size in the United States. The low flow of these streams is maintained by springs. As the streams cross the Balcones fault zone all or a large part of the low flow and some of the flood flow is lost from the stream channels by seepage into the underlying formations. Downstream from the fault zone the streams pass into rolling country having comparatively flat slopes, thicker soils, and a heavier vegetative cover. Large stream-flow losses occur in the wide overflow areas of the middle reaches of the basin when up-river flood runoff passes through this region after a prolonged drought.

In the lower reaches of the basin the flat Coastal Plain is traversed and runoff rates are much less than those in the upper part of the basin. The drainage area of the Nueces River basin is 17,000 square miles. The average rainfall ranges from 20 inches in the headwaters to 30 inches near the mouth.

Runoff characteristics vary widely from the Edwards Plateau region to the Coastal Plain. As an example, the following records are cited: The longest record of stream flow in the basin is on the Nueces River at Three Rivers, where the drainage area is 15,600 square miles. During the period extending from 1915 to 1949 the mean discharge was 832 second-feet; the minimum yearly mean discharge was 74.9 second-feet for the water year 1917; and the maximum yearly mean discharge was 3,519 second-feet for the water year 1935. The highest peak discharge was 85,000 second-feet on September 18, 1919. Zero flow has occurred at various times. At the gaging station on the Frio River at Concan located just upstream from the fault zone, with a drainage area of 485 square miles, the mean discharge from 1924 to 1949 was 104 second-feet. The minimum yearly mean discharge was 32.1 second-feet for the water year 1948; the maximum yearly mean discharge was 341 second-feet for the water year 1932. The highest peak discharge was 162,000 second-feet on July 1, 1932, and the lowest flow was 7.5 second-feet on September 8, 1948.

Basic runoff data are needed to show the surface-water yields and variations in runoff in all sections of the basin. Runoff data are also needed to show stream-flow losses by seepage into the underlying formations of the Balcones fault zone. Special stream-flow investigations to determine the distribution of seepage losses are also needed to supplement ground-water investigations.

The current program of surface-water investigations is conducted by the U. S. Geological Survey in cooperation with the Texas State Board of Water Engineers and the Corps of Engineers, U. S. Army. A plan for expansion of the stream-gaging program in an attempt to meet the diverse and growing Federal, State, and local needs is set forth below.

Surface water in the Nueces River Basin is used largely for irrigation, municipal, and industrial supplies. An increasingly urgent and important need of water is for industrial and domestic uses in the rapidly growing city of Corpus Christi. In the investigation of the quantity and availability of surface water, an expansion of the present program in Texas is planned to include additional gaging stations on the more important tributaries and gaging stations on tributaries above and below the Balcones fault zone in order to determine stream-flow losses. Special seepage investigations to determine the distribution of stream-flow losses in the Balcones fault zone are also contemplated.

At the end of July 1950, the Geological Survey, in cooperation with other Federal, State, and municipal agencies, was operating 14 discharge stations and two stage-only stations in the basin. For a better coverage of streams within the basin, it is recommended that 16 additional stations as listed below be established and that the equipment at some of the existing stations be improved.

The following list and table show the proposed new stations and estimated cost of the recommended 3-year program:

Proposed new stations

1. Nueces River near Indio
2. Elm Creek near Crystal City
3. Picosa Creek near Crystal City
4. Chaparrosa Creek near Crystal City
5. Dry Frio River near Concan
6. Frio River below Dry Frio River
7. Sabinal River at Sabinal
8. Seco River above fault zone
9. Seco River below fault zone
10. Hondo River near Tarpley
11. Hondo River near Hondo
12. Verde Creek above fault zone
13. Leona River near Divot
14. San Miguel Creek near Tilden
15. Atascosa River near Pleasanton
16. Ramireno Creek near George West

Estimated cost for present and additional surface-water investigational work in the Nueces River Basin for a 3-year period

	1st year	2nd year	3rd year	Totals
For installation of 16 new gaging stations at an average cost of $2,500 per station	$20,000	$20,000	0	$40,000
Special seepage investigations and miscellaneous measurements	1,500	1,500	1,500	4,500
Repairs and new equipment at existing stations	2,000	2,000	0	4,000
For operation of 16 new stations at $700 annually per station	2,800	8,400	11,200	22,400
For operation of existing stations - 14 discharge stations at $700 and 8 stage-only stations at $200 annually per station	10,200	10,200	10,200	30,600
Totals - - -	$36,500	$42,100	$22,900	$101,500

NOTE: The above cost estimate does not provide for the installation of new stream-flow and lake-level stations that should be established in connection with the construction of new reservoirs and main diversion canals. If the Oakville dam is constructed as proposed, the reservoir will inundate at least three and perhaps four existing gaging stations for which substitute stations would be required. When preparing plans and cost estimates for the construction of reservoirs and river diversions, provisions should be made for the installation of suitable lake-level and stream-flow stations necessary to the successful operation of such projects. The Geological Survey will assist in these details and will operate the stations if funds are provided for such work.

GROUND WATER

Studies of the geology and hydrology along the Balcones fault zone from Austin southward to San Antonio and thence westward to Kinney County are being made by the U. S. Geological Survey in cooperation with the Texas State Board of Water Engineers. However, in order to analyze thoroughly the effects of constructing dams and impounding irrigation supplies on the Nueces and its tributaries above the fault zone in Uvalde and Medina Counties, additional detailed studies of the relation between surface water and ground water are essential.

The report of the Bureau dated June 29, 1950, is concerned primarily with a water supply for the Corpus Christi Bay area; therefore, the present discussion is confined to that part of the Nueces Basin downstream from the Balcones fault zone.

The following statement is from a manuscript report entitled "Ground water in the Corpus Christi area," by Walter N. White, July 1940:

> "Down to 2,000 feet, or thereabout, Corpus Christi and vicinity is underlain by water-bearing sands of three formations, which are, in the order of increasing depth beneath the surface, the Beaumont clay, the Lissie formation, and the Goliad sand. In parts of the Texas Coastal Plain the sands of these formations yield large quantities of excellent water to wells. In the Corpus Christi region, however, for various reasons, the water in them in general is highly mineralized, the chloride content in particular being beyond the standards considered permissible in a high grade water supply. * * * In a narrow strip paralleling Laguna Madre from the vicinity of Seadrift in Calhoun County, southeast through Aransas, San Patricio, and a part of Nueces County, a limited amount of water of good quality occurs in shallow beach deposits that for the most part are less than 100 feet in depth.
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> "Inventories of the water supplies in most of the counties in this part of the Coastal Plain have been made, and reports published by the Texas Board of Water Engineers in cooperation with the U. S. Geological Survey, the Texas Bureau of Economic Industrial Chemistry, and the Works Projects Administration. * * *

"The data available in this office lead to the conclusion that conditions are not favorable for obtaining a supply of ground water for the flying field (near Corpus Christi) that will conform with standards set up by the U. S. Public Health Service, within a distance of 40 miles of the field. Ground water of acceptable quality apparently can be obtained in Refugio County, at distances of 50 to 60 miles; in Bee County, within 50 miles; in Goliad County at slightly more than 50 miles; and in Jim Wells County, or northern part of Brooks County, at about 60 miles."

The principal formations within the Nueces Basin downstream from the Balcones fault zone that will yield relatively large quantities of water suitable for municipal and industrial uses are the Indio formation and the Carrizo sand. These rocks, which crop out in western Dimmit and Zavala Counties and in northern Zavala, Frio, and Atascosa Counties, dip southeastward. The rate of dip ranges from a few feet to probably more than 150 feet per mile, but the average dip in the eastern part of the basin is about 100 feet per mile.

At the outcrop the Indio formation is composed predominantly of thin-bedded and laminated sand and arenaceous shale; but it includes layers of clay, lenses and persistent layers of sandstone, a few beds of lignite, and numerous concretions. Near the outcrop the Indio is not an important aquifer; the sands are neither as thick nor as permeable as the overlying Carrizo sand.

The Carrizo sand consists of beds of massive, commonly cross-bedded, loosely cemented, remarkably clean sand. The thickness ranges from less than 100 feet to more than 400 feet; in Dimmit and Zavala Counties the average thickness is about 200 feet but in Frio and Atascosa Counties the average thickness is about 300 feet.

The current withdrawal of water from the Carrizo sand in Dimmit, Zavala, Frio, and Atascosa Counties amounts to about 75,000 acre-feet a year, most of which is used for irrigation. Withdrawals of about 35,000 acre-feet in Dimmit

and Zavala Counties in 1947-48 exceeded the transmission capacity of the sand. Withdrawals in Frio and Atascosa Counties do not exceed the transmission capacity of the sand, but it is believed that withdrawals within or adjacent to the irrigation areas to supplement the water requirement of the Bay area would be unwise.

Sands of the Indio formation and the Carrizo sand thicken considerably in southern Frio and Atascosa Counties, northern LaSalle County, and northwestern McMullen County. Electrical logs indicate more than 500 feet of freshwater sands. Potable water occurs in the sands at depths of 3,000 to 4,000 feet. The water is under sufficient artesian head to rise above the land surface, and some wells have natural flows of 1,000 to 1,500 gallons a minute.

In order to estimate the quantity of water that can be withdrawn from the Indio formation and Carrizo sand within the Nueces Basin, computations have been made on the basis of the following assumptions: Twenty wells spaced 1 mile apart in northern McMullen County and southern Atascosa County in a line 35 miles south of and parallel to the outcrop of the Carrizo sand; each well pumped at a rate of 2,000 gallons a minute; a thickness of the sands in the reservoir of 500 feet; an average coefficient of permeability of 200 for each foot of thickness; a coefficient of storage of 0.0003; and a specific capacity of each well of 20 gallons a minute per foot of drawdown. Withdrawal of 2,000 gallons a minute from 20 wells is equivalent to 57,600,000 gallons a day or approximately 60,000 acre-feet a year.

On the basis of the above assumptions and also assuming adequate recharge to replenish the withdrawals from the outcrop, the computed pumping levels after 20 years of continuous operation would range from about 365 feet below the present static level in the center wells to about 310 feet in the wells at the end of the line.

According to information in the Bureau's report, plans call for development of the maximum attainable water supply of 400,000 acre-feet annually from the Nueces River for use in the Bay area. It is concluded that such a quantity of water cannot be developed from ground water in the Nueces Basin. Only meager quantities of ground water suitable for most municipal and industrial uses can be developed within 50 miles of Corpus Christi. However, a supply of 50,000,000 gallons a day, or about 56,000 acre-feet a year, can be developed in the east-central part of the basin at a distance of about 100 miles from Corpus Christi.