FLOOD PLAIN INFORMATION
COLORADO RIVER-ONION CREEK TO MONTOPOLIS BRIDGE AUSTIN, TEXAS

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PHOTOGRAPH OF SOUTH CONGRESS AVENUE BRIDGE DURING FLOOD OF JUNE 1935. VIEW IS TO THE SOUTH. (PHOTO COURTESY AUSTIN-TRAVIS COUNTY COLLECTION, AUSTIN PUBLIC LIBRARY)

PREPARED FOR
THE CITY OF AUSTIN, TEXAS
BY
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT
SEPTEMBER 1976

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Flood plains along the Colorado River are primarily rural, being sparsely populated, and have extensive areas of open space that may come under pressure for future development. Although floods have occurred in the past, studies indicate even larger floods are possible, causing extensive property damage and even loss of life.

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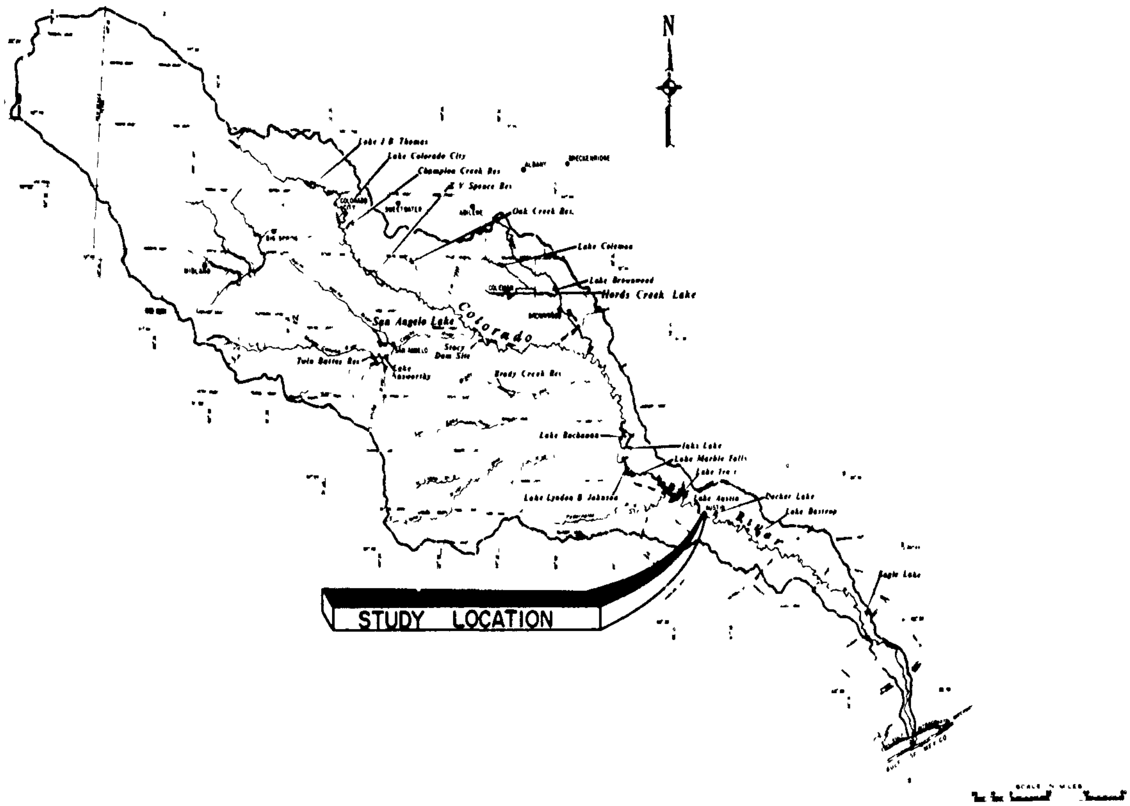
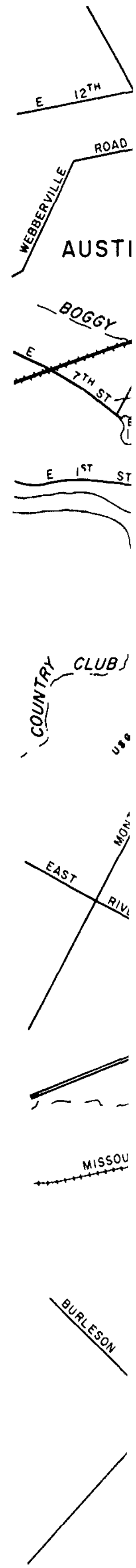




CORPS OF ENGINEERS, U.S. ARMY

FORT WORTH, TEXAS, DISTRICT

WATERSHED & VICINITY MAPS

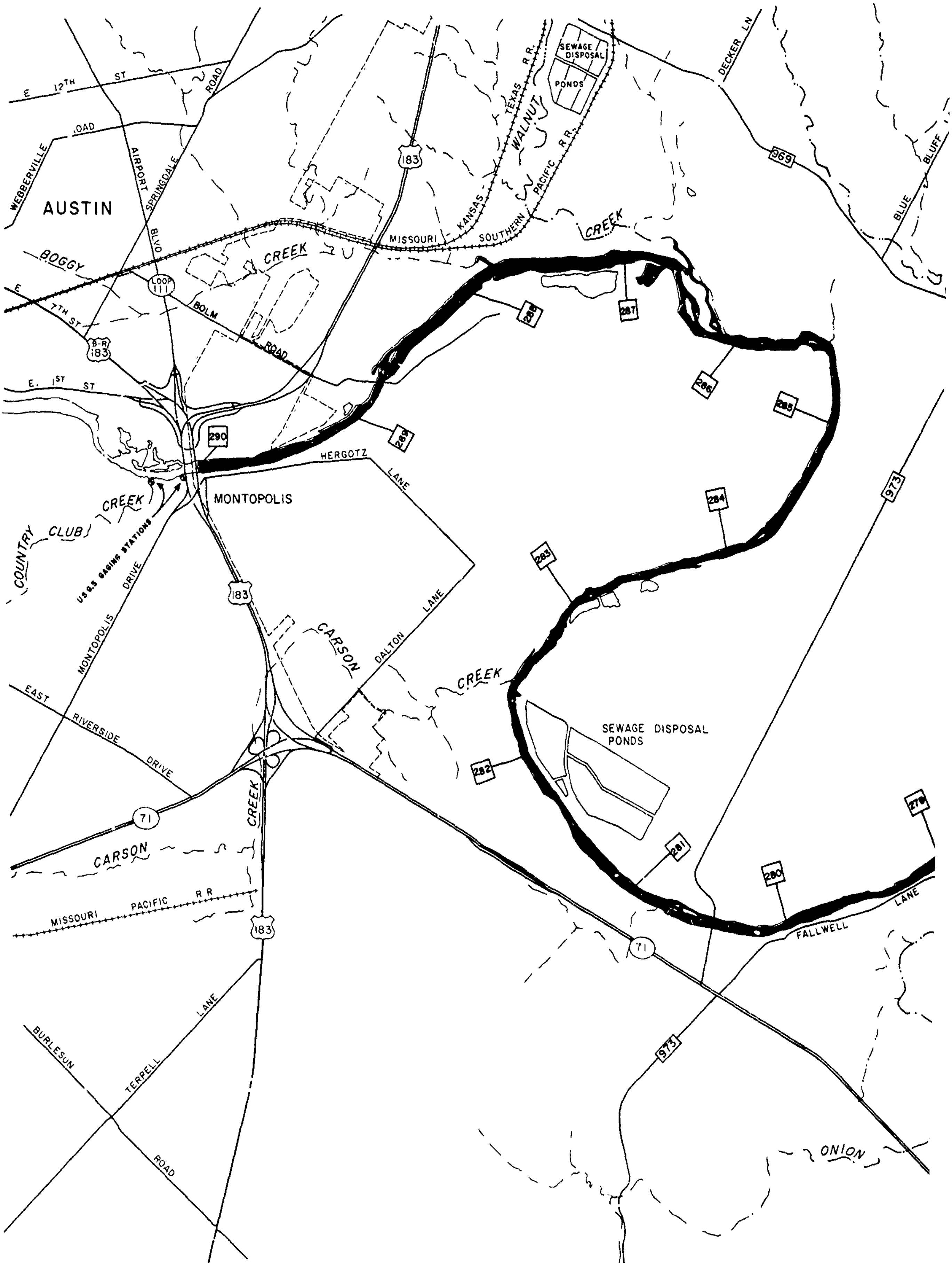
COLORADO RIVER
ONION CREEK TO
MONTOPOLIS BRIDGE

LEGEND

290 — RIVER MILES ABOVE MOUTH

REACHES COVERED BY THIS REPORT

WATERSHED BOUNDARY



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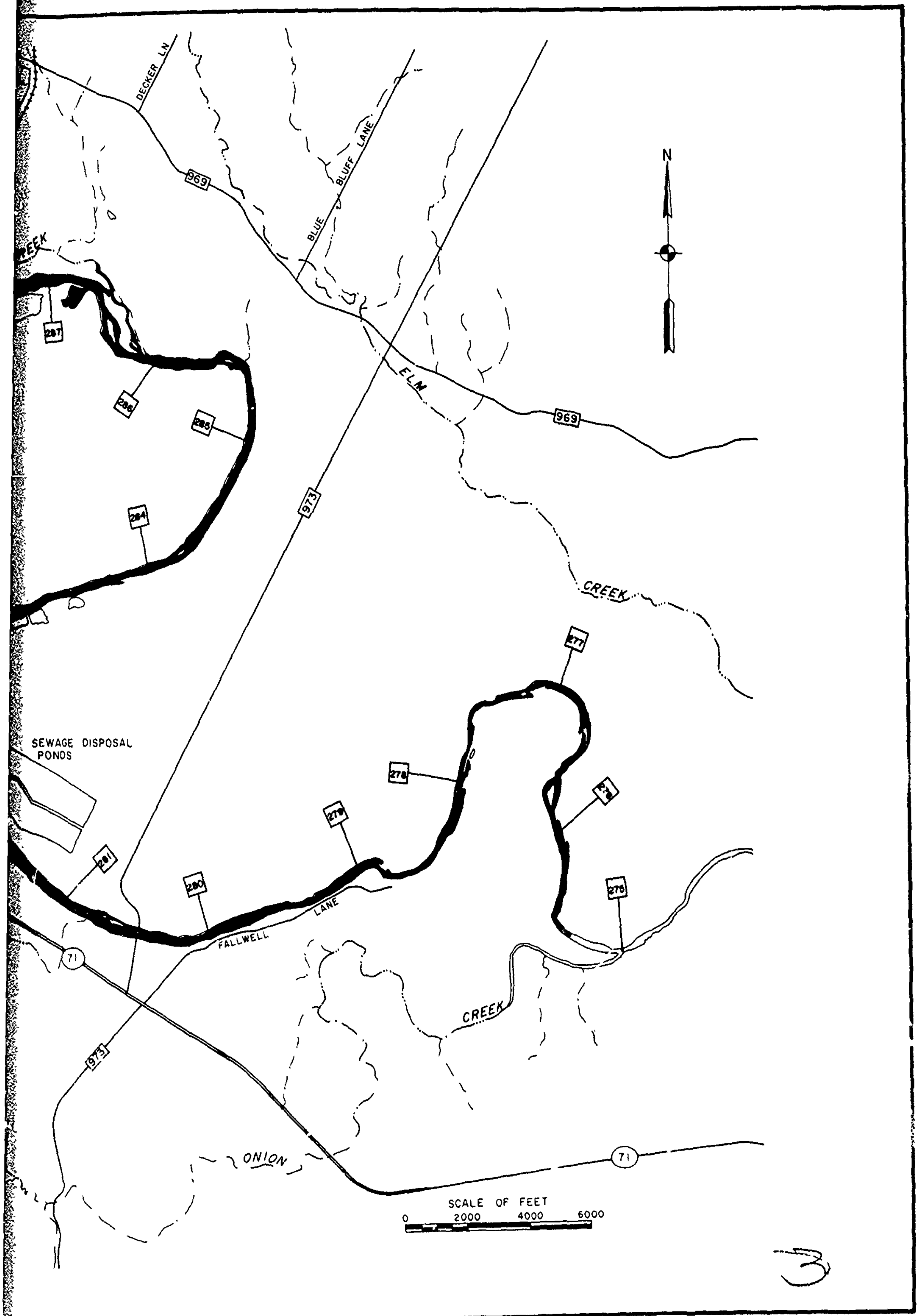
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PREFACE

The flood plains along the Colorado River covered by this report are primarily rural, being sparsely populated, and have extensive areas of open space that may come under pressure for future development. Although floods have occurred in the past, studies indicate that even larger floods are possible. The Colorado River has experienced flood damage in the past, but larger floods, coupled with unrestricted development in and along the flood plain, could cause extensive property damage and even loss of life.

The purpose of this report is to furnish information on the flood hazard areas in the Colorado River watershed in the vicinity of Austin, Travis County, Texas. As shown on Plate 1, the study area considered encompasses about 14.7 miles of channel, extending from the confluence with Onion Creek to Montopolis bridge (US Highway 183). The report's contents are designed to provide local, State, and Federal government agencies, commercial interests, and concerned citizens in this area of the Colorado River watershed with definitive data that will aid in planning the best use of flood prone lands or contribute to the solution of local flood problems. Aside from serving as a tool for improving general land use management, the report can be helpful in locating and designing bridges and establishing criteria for flood plain zoning ordinances, local building codes, and subdivision regulations. The decision making process must consider the existing environmental attributes of the flood plain areas and evaluate their probable role in the planned future growth of the involved communities. The report includes information not only on past floods but also on the nature and extent of probable future floods which can be reasonably expected in this reach of the watershed. Its concluding section provides guidance on various flood plain management measures which could be adopted in a realistic program to reduce present and future flood losses. The report does not contain specific plans or recommendations for the solution of flood problems, as these are properly the responsibility of local government.

The report was prepared at the request of the City of Austin, Texas, through the Texas Water Development Board, under the continuing authority granted by Section 206 of the 1960 Flood Control Act, as amended.

The assistance and cooperation of the US National Oceanic and Atmospheric Administration (NOAA); National Weather Service; the US Geological Survey; Texas Water Development Board; State Department of Highways and Public Transportation; the Lower Colorado River Authority; the Engineering Department, City of Austin; newspapers; and numerous private citizens in supplying useful data are appreciated and gratefully acknowledged.

An informative brochure entitled, "Floods on Colorado River - Onion Creek to Montopolis Bridge, Austin, Texas," has been prepared to accompany this report. Copies of the brochure, and this report, can be obtained from the Director of Engineering, City of Austin, Texas, and from the Texas Water Development Board. The Fort Worth District of the Corps of Engineers will, upon request, provide interpretation and limited technical assistance in use of the information contained herein.

BACKGROUND INFORMATION

Settlement

In 1839, Mirabeau B. Lamar, President of the Republic of Texas, appointed a commission to locate a site for the permanent capital. The community of Waterloo was selected and renamed in honor of Stephen F. Austin, the Father of Texas. The United States census that year listed Austin population at 629 persons; 3,138 were in Travis County.

By 1880, the population of Austin had grown to 11,013 people. The University of Texas opened in 1883.

In 1940, the Census Bureau counted 87,930 people in the city and 111,053 people in Travis County. During the early 1940's, Camp Swift and Bergstrom Air Force Base were established near the city. Enrollment at the University of Texas reached more than 19,000 soon after World War II. In 1948, Austin was the site of state headquarters for 72 associations; in 1968, 224 international, national, regional, district, and state associations were headquartered in the city.

Since 1960, more than 50,000 houses and apartment units have been built, and the city has gained 100,000 people. Building permits have exceeded $200 million for each of the past three years. The city has extended and improved water, sewer, electric, drainage, street, park, and other facilities to keep pace with current growth and provide for the future.

The economy of Austin has expanded substantially during the last several years, with nonagricultural wage and salary employment growth averaging 7.5 percent (6,975 new jobs) annually between 1965 and 1969. The greatest employment increase occurred between 1968 and 1969 when wage and salary employment grew by 7,995 jobs, including gains of 1,270 in manufacturing and 6,725 in nonmanufacturing. This employment increase was the largest on record for all the years for which estimates have been made. The highest increases in nonmanufacturing industries were 3,340 jobs in Federal, State, and local governments; 1,105 jobs in contract construction; 1,100 jobs in trade; and 695 jobs in services. The total Travis County labor force was estimated at 161,800 in 1973.

The continued increase in enrollment at the University of Texas, the largest university in the South, is responsible for growth in several sectors of the economy, trade, services, construction, and State government. Enrollment at the university was over 40,000 for the fall semester 1973-74. Military strength and civilian employment at Bergstrom Air Force Base were 5,120 and 570, respectively, in January 1974, and both have remained relatively stable during the past few years; many businesses have hired college students on a part time basis to fill job vacancies.

The most notable change since 1965 has been the average 17 percent annual growth in manufacturing employment between 1965 and 1969; the increase was less than 10 percent during the entire first half of the 1960 decade. This unprecedented growth in the manufacturing sector is largely a result of Texas Instruments; IBM; TRACOR, Incorporated; and the John Roberts Company (school ring manufacturer) building plants in the area, and the expansion of several existing manufacturing firms.

Austin is a leading educational center, the State capital, and a city of commercial importance. It is now the home of more than a quarter million people and is expected to grow by more than 100,000 people during the next 10 years.

The Stream and its Valley

The Colorado River Basin, as shown on Plate 1, extends from near the Texas-New Mexico state line to the Central Texas Gulf Coast. Rising from intermittent draws in northeastern Dawson County, the Colorado River flows generally southeast for approximately 580 miles. The watershed includes all or portions of 62 counties in the state and has a total drainage area of 41,763 square miles. About 1,900 square miles of this drainage area is in New Mexico.

As the Colorado River Basin crosses the state, it extends across three basic physiographic provinces - the Great Plains, the North Central Plains, and the Gulf Coastal Plains. In the Southern High Plains of the Great Plains, the area rises gently from 2,700 feet on the east to more than 4,000 feet along the New Mexico border. East of this escarpment, the surface topography of the basin is characterized by the low rolling hills of the

North Central Plains. The basin topography below the North Central Plains consists of the rugged features of the Edwards Plateau, featuring steep hills and numerous streams, and the Gulf Coastal Plain, which is moderately hilly in the northwest portion below Austin and generally flat and featureless near the coast.

The name Colorado, meaning red, is a misnomer, as the waters of the stream are generally clear and nave been historically. Most historians agree that the name Colorado was first applied to the Brazos River by Alonso de Leon in 1690 and the names of the streams were inadvertently interchanged during the period of Spanish exploration.

The drainage area of the Colorado River at the US Geological Survey gage upstream from the Montopolis bridge in Austin is 38,400 square miles. For the 14.7 miles of river covered in this report, the average streambed slope of the Colorado River is 1.79 feet per mile.

Pertinent drainage areas for the Colorado River at significant points, as well as for the study area, are given in Table 1.

TABLE 1

DRAINAGE AREAS IN THE COLORADO RIVER WATERSHED

Location	Mile Above Mouth	Drainage Area Sq Mi
COLORADO RIVER		
Mouth	0.0	41,763
LaGrange	174.0	40,430
Smithville	212.0	39,880
Austin (1,000 feet above Montopolis bridge)	290.3	38,400
Mansfield Dam	318.0	38,130

Developments in the Flood Plain

The Colorado River Basin is generally sparsely developed, with cities and towns scattered throughout the watershed. Total basin population was 835,000 in 1970, which was about 7.5 percent of the State's total. The bulk of this population is located in the cities of Austin, San Angelo, Midland, Odessa, Big Spring, and Brownwood.

The flood plains of the study reach are lightly populated, with the main land use being agricultural and mining of sand and gravel. Light development has occurred in the upper limit of the study area around the Montopolis bridge, but little, if any, of this development has encroached onto the flood plain of the Colorado River. Numerous sand and gravel pits are scattered throughout the study reach, and the city of Austin maintains two sewage disposal sites in the flood plain, one located from river mile 281.06 to river mile 282.34, and the other from river mile 289.00 to river mile 289.54.

The rapid population growth and economic development of the Austin area will undoubtedly lead to increased pressures for intensified flood plain land use. Proper land use planning can guide future developers and government officials and help insure intelligent, compatible use of the flood plains of the Colorado River.

For this report, a "reasonable" amount of future development was assumed for determining as up-to-date profiles and flood plains as possible. While it is realized that the study reach is located in an area of potential growth, no attempts have been made to predict what developments will occur in the flood plains or in the watershed in the distant future. Dynamic growth demands dynamic, flexible planning. The useful life of this report depends entirely on how long the "current" flood situation depicted herein adequately defines the existing flood situation for the purpose of land use planning. As conditions in the watershed change, the involved city and other governmental bodies should seek updated flood plain information studies that can be based, as was this report, on then existing conditions plus sound, well defined plans for the future.

Transportation facilities in the study area include US Highway 183, State Highway 71, FM 973, the Missouri-Kansas-Texas railroad, the Southern Pacific railroad, and numerous city, county, and private roads.

SOURCES OF DATA AND RECORDS

A knowledge of extreme floods on the Colorado River at Austin extends back more than 100 years. Information in "Annals of Travis County and All of the City of Austin," an unpublished manuscript in the University of Texas library, by Frank Brown, indicates that the flood of July 7, 1869 produced a stage that, at the time, was the maximum stage at Austin since at least 1833. A continuous record of stages and discharges began in February 1898.

The US Geological Survey and the US Weather Bureau have established and maintained gages at several different locations in Austin since 1898. From June 20, 1939 to October 16, 1963, the US Geological Survey maintained a recording gage at the upstream side of the US Highway 183 bridge (Montopolis bridge). From October 17, 1963 to the present, a continuous water stage recorder (bubble gage) has been operated by the US Geological Survey at a site 1,000 feet upstream from Montopolis bridge.

A considerable amount of flood history on the Colorado River is available from the various US Geological Survey and US Weather Bureau gage records mentioned above. In addition, historical information was also obtained from the many water supply papers of the US Geological Survey on particular floods that have occurred, from newspaper records, the State Department of Highways and Public Transportation, and the City of Austin. The flood profiles and flooded area maps in this report were developed from these sources.

All elevations appearing in this report are based on US Coast and Geodetic Survey 1929 mean sea level (msl) datum. The base maps prepared for the report are enlarged USGS quadrangle sheets (7½ minute series) entitled "Austin East, Texas," and "Montopolis, Texas," dated 1966 with photo revision in 1973; and "Manor, Texas," and "Webberville, Texas," dated 1968 with photo revision in 1973.

To assist report users in locating actual flood boundaries or for determining the elevations of existing or proposed structures in relation to flood elevations, a tabulation of elevation reference marks is shown on Plate 14. These bench marks, also shown on the Flooded Area Maps (Plates 4 through 13), include US Coast and Geodetic Survey and Corps of Engineers reference marks.

A total of 17 field surveyed cross sections were used in the study and were taken during March, April, and May 1976. The locations of these field cross sections are shown on the Flooded Area and High Water Profile plates.

Structural data on bridges and culverts were obtained from bridge plans and field surveys. Elevation datum on bridge plans was confirmed by field survey. The source of the bridge plans was the State Department of Highways and Public Transportation.

FLOOD SITUATION

Flood Season and Flood Characteristics

Most of the flood producing storms that occur over the Colorado River Basin result from frontal type storms, remnants of tropical hurricanes, and thunderstorms. Most of the floods that have occurred in the general geographical region have resulted from heavy rains during the spring or fall. Although thunderstorms occur more frequently during the spring and fall months in this area of central Texas, they may occur at any time. The city of Austin is located in a hydrologic province which results in some of the highest rainfall rates experienced in the United States. Such storms occurred in 1915 and 1921, and in a lesser magnitude in more recent years. The US Geological Survey has recorded peak floodflows from small streams in the vicinity of Austin which are some of the highest per square mile that have occurred in the United States. Storms causing these peak floodflows will occur again. In all probability, urban development in the Austin area will increase rates of floodflows, as well as total volumes of runoff for local streams and the Colorado River.

Factors Affecting Flooding and Its Impact

Obstructions to floodflows. Natural obstructions to floodflows include trees, brush, and other vegetation growing along the streambanks in floodway areas. Manmade encroachments on or over the streams such as dams, bridges, and culverts can also create more extensive flooding than would otherwise occur. Representative obstructions to floodflows are shown in Figure 1.

During floods, trees, brush, and other vegetation growing in floodways impede floodflows, thus creating backwater and increased flood heights. Trees and other debris may be washed away and carried downstream to collect on bridges and other obstructions to flow. As floodflow increases, masses of debris break loose and a wall of water and debris surges downstream until another obstruction is encountered. Debris may collect against a bridge until the load exceeds its structural capacity and the bridge is destroyed. The limited capacity of obstructive bridges or culverts, debris plugs at the culvert mouth, or a combination of these

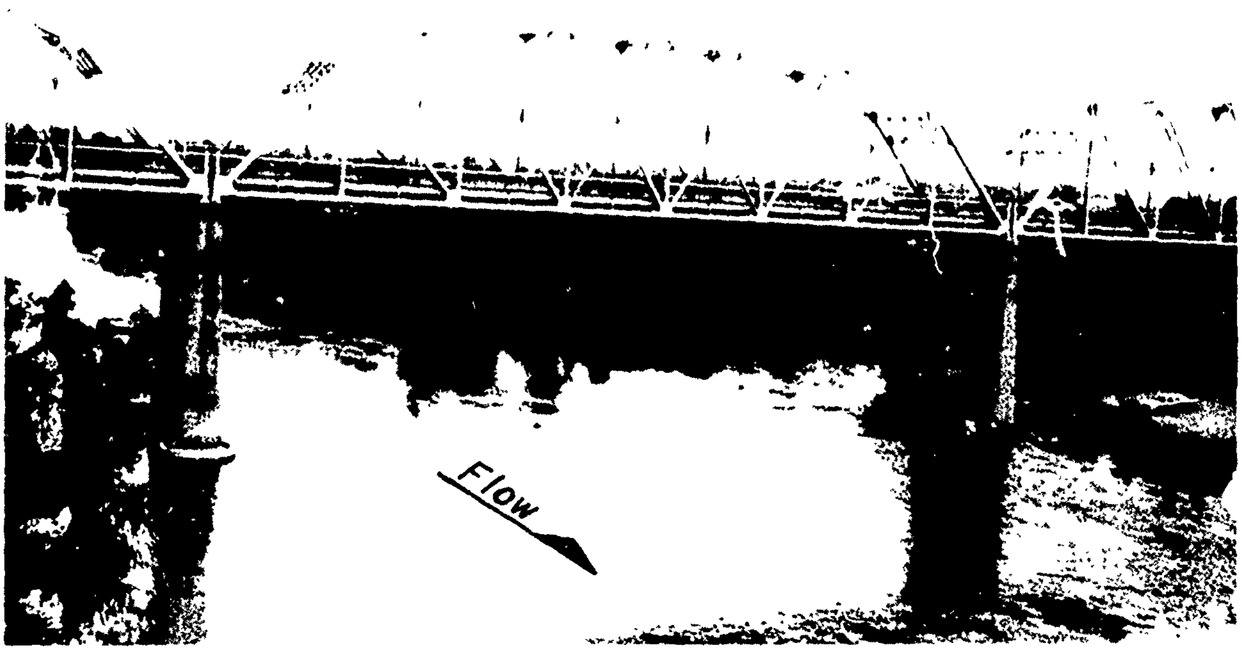


FIGURE 1.--TYPICAL BRIDGES

Upper photograph shows the downstream side of the Bolm Road bridge at river mile 288.74. Lower photograph shows the downstream side of the southbound lane of the U.S. Highway 183 bridge at river mile 290.08.

factors retard floodflows and result in flooding upstream, erosion around the culvert entrance and bridge approach embankments, and possible damage to the overlying roadbed.

In general, obstructions restrict floodflows and result in overbank flows and unpredictable areas of flooding, destruction of or damage to bridges and culverts, and an increased velocity of flow immediately downstream. It is impossible to predict the degree or location of the accumulation of debris; therefore, for the purposes of this report, it was necessary to assume that there would be no accumulation of debris to clog any of the bridge or culvert openings in the development of the flood profiles.

There are four bridges distributed throughout the study area. Pertinent structural information on all bridges can be found in Table 2 on page 10.

Flood damage reduction measures. Flood control structures which have an effect on Colorado River flooding in Austin consist primarily of upstream reservoirs. San Angelo Lake on the North Concho River and Hords Creek Lake on Hords Creek are existing Corps of Engineers projects. Twin Buttes Reservoir on the South and Middle Concho Rivers was constructed by the Bureau of Reclamation. The Bureau also constructed Lake Travis (Mansfield Dam) on the Colorado River above Austin, which is operated for power by the Lower Colorado River Authority. Congress has given the Corps of Engineers responsibility for flood control for the above mentioned Bureau of Reclamation built lakes. Brady Creek Reservoir on Brady Creek was built by the Soil Conservation Service. As a part of a program of runoff retardation and soil erosion prevention, the Soil Conservation Service has constructed more than 200 detention structures in the Colorado River Basin. There are 13 non-Federal reservoirs existing or under construction in the Colorado River Basin with an individual capacity greater than 5,000 acre-feet. None of these non-Federal lakes have flood control storage allocated in their operation. Lake Travis (Mansfield Dam) is the only reservoir in the "Highland Lakes" chain above

TABLE 2

BRIDGE AND CULVERT DESCRIPTIONS

COLORADO RIVER

Identification	Mile Above Mouth	Type of Structure	Width of Bridge Opening feet	Number of Spans	Culvert Size
FM 973	280.46	Concrete and steel	449	15	-
Bolm Road	288.74	Concrete and steel	108	5	-
US Highway 183 (north bound)	290.01	Concrete	1,109	13	-
US Highway 183 (south bound)	290.08	Concrete and steel	1,220	9	-

Austin which has allocated storage for flood control. It is operated in coordination with five other projects on the Colorado River for generating hydroelectric power and for water supply. The other projects include Lake Buchanan, Inks Lake, Lake Lyndon B. Johnson, Marble Falls Lake, and Lake Austin.

The city of Austin utilizes a comprehensive plan for regulating development in the flood plains within its jurisdiction. The plan is threefold in nature, consisting of the creek ordinance, subdivision ordinance, and building code, working together to bring the management program into full compliance with the requirements of the Federal Insurance Administration (HUD) for the federal insurance program. The creek ordinance was passed in 1974 and in addition to its impact on the efficiency of the hydraulic systems, introduced new and important environmental regulations affecting the creeks and waterways. Extracts of this creek ordinance are given in Exhibit 1, pages 12-13.

Flood warning and forecasting. The National Oceanic and Atmospheric Administration, National Weather Service Office, in Austin, Texas, issues flash flood warnings for Travis County where the study area is located. Flash flood watches for this area are issued by the Weather Service Forecast Office in San Antonio. The National Weather Service Meteorological Observatory in Hondo, Texas, provides radar coverage for evaluation of rainfall over Travis County and provides for detection of storms which may produce excessive rainfall and flash flooding. Accurate flash flood forecasting also requires adequate and timely rainfall and river stage data. It is even more essential that such basic data, particularly rainfall reports, be available for areas subject to flash flooding. A community flash flood reporting network of stream and rainfall stations and a flash flood procedure developed and operated in conjunction with the National Weather Service is a positive approach to the flash flood problem. Emergencies and natural disaster plans should be made and kept current by every community faced with potentially hazardous situations that occasionally result in excessive precipitation and the resultant flooding.

<u>EXHIBIT 1</u>

<u>HIGHLIGHTS OF THE CREEK ORDINANCE</u>

<u>CITY OF AUSTIN, TEXAS</u>

I. Development Permit Required

No development, except development which has an inconsequential effect on the environment and on drainage and which has been exempted by the director of engineering, shall be undertaken on any land, tract, parcel, or lot which is adjacent to or crossed by a waterway until a permit for said development has been obtained from the director of the city's engineering department.

II. Definitions: Development - Waterway

A. <u>Development</u>: The following shall constitute development:

1. The commencement of excavation or the deposit of fill.
2. The clearing or removal of natural ground cover and/or trees in connection with site preparation.
3. The alteration or improvement of a bed, bank, or flood plain of a waterway.

B. <u>Waterway</u>: A stream, creek, branch, drainway, or watercourse.

III. Development Plans

A. The director of engineering shall review all applications for development permits and shall upon accepting an application notify the owner of all property located within 300 feet of the applicant's property. He may ask for written comments from the parks and recreation board and/or the citizens board of natural resources and environmental quality.

B. The director of environmental resources management shall review and comment to the director of engineering on all applications for development permits.

C. No plans and specifications shall be accepted, reviewed, or approved by the director of engineering unless accompanied by a certificate bearing the seal of a Texas professional engineer certifying to the adequacy of the design, hydraulically and structurally, of any proposed alterations or improvements to a

EXHIBIT 1 (continued)

bed or bank of a waterway, except that minor improvements as determined by the director of engineering do not require the service of a Texas professional engineer.

IV. Development Permit Approval Standards

A development permit shall be issued if upon review of the application it is found:

1. That the development plans provide a sufficient waterway for the design flood due allowance having been made for the fact that the quantity of water coming down any waterway may be increased as storm sewers and drains are built in the future; and,
2. That any proposed walls, arches, or whatsoever other form of proposed improvements are of sufficient strength to resist any pressure of earth or building from the outside and pressure or abrasion of water and debris from the inside; and,
3. That all proposed grades are such that water will not gather in pools which may become stagnant or foul; and,
4. That the proposed development will not result in additional identifiable adverse flooding of other property; and
5. That both temporary and permanent erosion control measures are adequate to minimize siltation of the waterway; and
6. That the proposed development preserves the natural and traditional character of the land and waterway to the greatest extent feasible.

V. Appeal of Development Permit by Aggrieved Persons

The owner of any property located within 300 feet of the property covered by a development permit and/or the owner of any upstream or downstream property adjacent to the waterway which is likely to be adversely affected by the proposed development, may appeal such permit to the planning commission and subsequently to the city council.

Reference: Ordinance No. 740307-I Austin City Code

A flood warning service for the Colorado River from Onion Creek to Montopolis bridge has been established by the National Weather Service Forecast Office in San Antonio. The stage forecasts at Montopolis bridge will be provided by the River Forecast Center in Fort Worth, Texas. The National Weather Service also provides an information dissemination facility fo~ the distribution of severe weather and flash flood warnings along with general weather forecasts, namely, the NOAA Weather Wire, a teletype circuit linking the National Weather Service Office with outlets to news media: newspapers, radio, television, and any other private or governmental agencies in the area where a primary wire service has been established. Others interested can, at their expense, arrange for a teletype drop on this circuit which provides invaluable weather information for areas faced with potentially hazardous situations arising from occasional hydrometeorological excesses of nature.

Further information regarding this service can be obtained from any Weather Service Office.

Flood fighting and emergency evacuation plans. There are no formal, active flood fighting or emergency evacuation plans for the city of Austin or Travis County at this time. However, the fire department, police department, and other involved city agencies will meet in the near future to draw up and implement such a plan. Questions involving such future plans should be directed to the fire department, city of Austin, Texas.

Material storage on the flood plain. Floatable material, such as lumber crates and empty storage tanks, may be carried away by floodwaters, causing serious damage to downstream structures and could clog bridge openings, creating more hazardous flooding problems. Since the study area is relatively undeveloped, there are no large quantities of floatable materials stored along the flood plains of the Colorado Rive

PAST FLOODS

Summary of Historical Floods

From the sources mentioned previously, it is known that large floods occurred on the Colorado River in 1843, 1852, July 1869, 1870, June 1899, April 1900, April 1908, December 1913, April and September 1915, September 1921, May 1922, May 1929, June 1935, September 1936, July 1938, June 1940, April 1941, September 1952, June 1957, October 1959, 1960, 1961, May 1965, and May 1970. Between 1898 and September 9, 1940, when storage began in Lake Travis, the flood of June 15, 1935 was the largest recorded, and the flood of July 15, 1938 was the second largest. No outstanding floods have been experienced on the Colorado River at Austin since the construction of Lake Travis; however, floods originating above Lake Travis would have produced extremely large floods in 1952 and 1957 had the reservoirs between San Saba and Austin not been in existence at the time of the floods.

Table 3 lists the 10 largest annual floods that have occurred or would have occurred (without the upstream reservoirs) on the Colorado River at Austin. If the flood peaks of 1935 and 1938 and the routed peak discharges of the 1952 and the 1957 floods are considered, it is significant to note that of the five largest floods that occurred, or would have occurred, during the 143-year period 1833-1974, four of them transpired within a 23-year period, 1935-1957.

Flood Descriptions

Following are descriptions of some of the known large floods that have occurred on the Colorado River in the Austin vicinity. These are based on newspaper accounts, records of the US Geological Survey and the US Weather Bureau, and other historical records.

July 7, 1869

Probably the greatest flood on the Colorado River at Austin since at least 1833. The following excerpt from an unpublished manuscript in the University of Texas library entitled "Annals of Travis County and all of the City of Austin" by Frank Brown describes this great flood.

TABLE 3

HIGHEST TEN ANNUAL FLOODS IN ORDER OF DISCHARGE MAGNITUDE

COLORADO RIVER AT AUSTIN, TEXAS

Order No.	Date of Crest	Gage Height Stage		Gage Height Elevation	Observed Peak Discharge cfs	Routed Peak Discharge cfs
1	July 7, 1869	51.0	(1)	453.27	-	-
2	June 15, 1935	50.0	(1)	452.27	481,000	60,000 (3)
3	September 17, 1952	9.59	(1)	411.86	3,720	480,000 (2)
4	June 4, 1957	22.60	(1)	424.87	40,800	426,000 (2)
5	July 25, 1938	45.2	(1)	447.47	276,000	157,000 (3)
6	October 8, 1959	22.4	(1)	424.67	37,800	250,000 (2)
7	September 28, 1936	31.4	(4)	453.26	234,000	150,000 (3)
8	May 16, 1965	14.15	(1)	416.42	16,100	183,000 (2)
9	December 4, 1913	27.0	(4)	448.86	164,000	-
10	May 15, 1970	13.82	(1)	416.09	15,300	160,000 (2)

(1) Stage at present US Geological Survey gage located 1,000 feet upstream from US Highway 183 (Montopolis bridge). Datum of gage is 402.27 feet msl.

(2) Estimated discharges that would have occurred if the upstream Colorado River Basin reservoirs had not been constructed.

(3) Estimated discharges that would have occurred if the upstream Colorado River Basin reservoirs had been in operation at the time the flood occurred. Assumed that Lake Travis was operated according to Code of Federal Regulation, Title 33, paragraph 208.19, as revised January 1971.

(4) Stage at old Congress Avenue gage. Datum of gage was 421.86 feet msl.

"The highest and probably the most disastrous flood that ever came down the Colorado within a hundred years occurred early in July (1869). Certainly none such ever occurred within the memory of oldest inhabitants of the white race. The floods of 1833, 1836, 1843, 1852, and 1870 did not approach it in volume, by eight or ten feet. Early in the first week of July rains commenced falling and so continued at short intervals for several days. The stream commenced gradually rising, but no apprehension was felt of the heavy overflow. On the 6th, a tremendous flood suddenly came down in solid walls, overflowing all the lowlands and spreading over the valleys to the hills. The river rose to the top of the bluffs. The people thought the highest was reached, but the water continued to rise rapidly, and much alarm was felt. The river reached its highest mark on the evening of July 7, at about 9 o'clock. The rise was estimated at forty-six feet. The mass of waters rushed down from the narrow and confined channel between the mountains above, to the wider one below, with such fearful velocity that the middle of the stream was higher than the sides, and the aspect it presented was appalling. During the night a slight fall occurred, and by morning the river had gone down several feet. From that time it gradually fell, and in about three days could be safely ferried.

"Such a flood may not occur again for a century to come, maybe never, for it will require a combination of circumstances as unlikely to occur as any that can be imagined."

<u>April 7, 1900</u>

Dallas Morning News

April 8, 1900

"Austin, Texas, April 7.- The great dam across the Colorado River, which was constructed seven years ago at a cost of an even $1,000,000, was swept away this morning by an unprecedented flood in that river. The break occurred at 11:15 o'clock, causing an instant rise of fully 50 feet in the river below the dam. This torrent of water swept down upon the broad valley below in all of its force, leaving death and destruction in its wake. The powerhouse, municipal water, electric light and power plant, all situated immediately below the dam, were flooded instantly and eight persons, men and boys, were caught in the powerroom and all except one were drowned like rats in a trap. . ."

April and September 1915

The April 22, 1915 flood was most disastrous on Waller and Shoal Creeks, tributaries of the Colorado River, where 32 lives were lost. However, the Colorado River did wash out four crest gates from the almost completed Lake Austin Dam. They were immediately replaced, but shortlived as the September 17, 1915 flood carried away 24 crest gates and did considerable other damage to the structure.

June 15, 1935

This was the second largest flood since at least 1833 on the Colorado River.

U.S.G.S. Water Supply Paper 796-G
Major Texas Floods of 1935

"There was no flood of consequence on the Colorado River above the mouth of the Llano River when the Llano River flood of June 1935 reached the Colorado. The Pedernales River added its flow to the Colorado about halfway between the mouth of the Llano and Austin. The peaks from the two tributaries nearly joined in the Colorado. There was not much rain near or below Austin, and little flow was added below the mouth of the Pedernales. . . .The peak stage at Austin in June 1935 is about 1 foot lower than the peak stage in July 1869, which was the highest stage known."

Austin American-Statesman
June 16, 1935

"Thirty persons were marooned at Hornsby Bend, between 40 and 50 others were rescued and safely housed in the Montopolis bridge sector, and the Congress Avenue bridge across the Colorado River here had withstood the ravages of one of the most disastrous floods in Austin's history Saturday night. . .

"The Montopolis bridge was torn away and washed downstream at 11 a.m. by the rough waters in that section.

"The water spread out nearly a mile wide near Austin to a width of three miles or more at Webberville."

* * * * *

Scenes of damages inflicted by historic floods in Austin are shown in Figures 2 and 3 on pages 20 and 21.

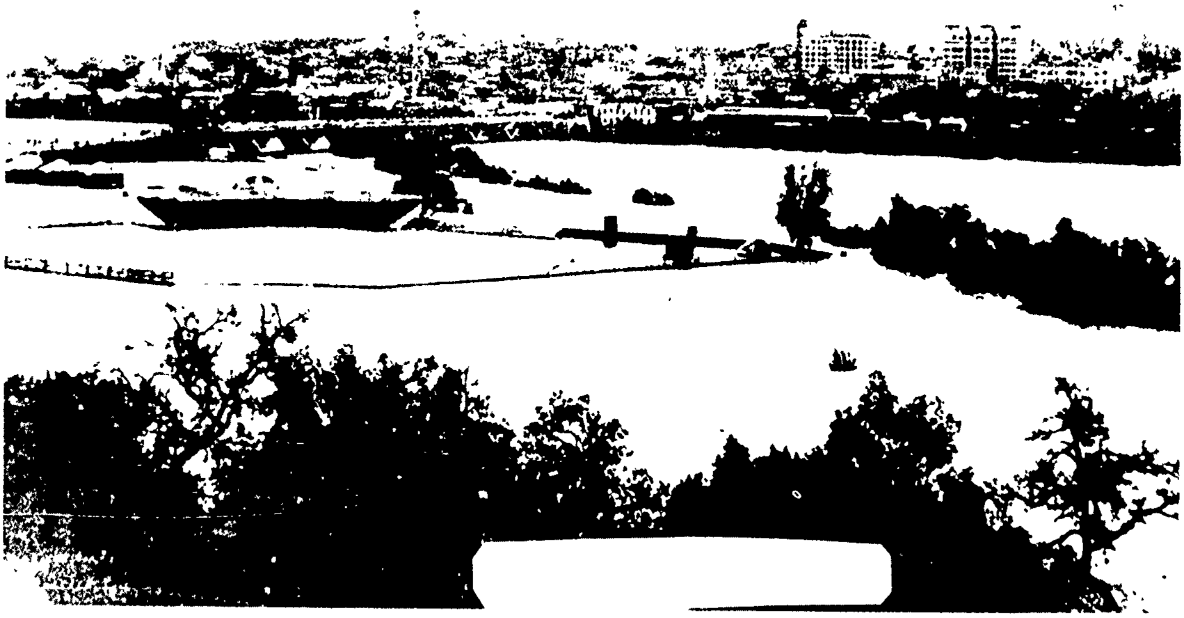


FIGURE 2.--HISTORICAL FLOOD SCENES ON COLORADO RIVER

Upper photograph is view of Congress Avenue Bridge from south bank during December 1913 flood. Lower photograph is scene during September 1936 flood looking north from south bank. (Photos courtesy of Austin-Travis County Collection, Austin, Texas, Public Library.)

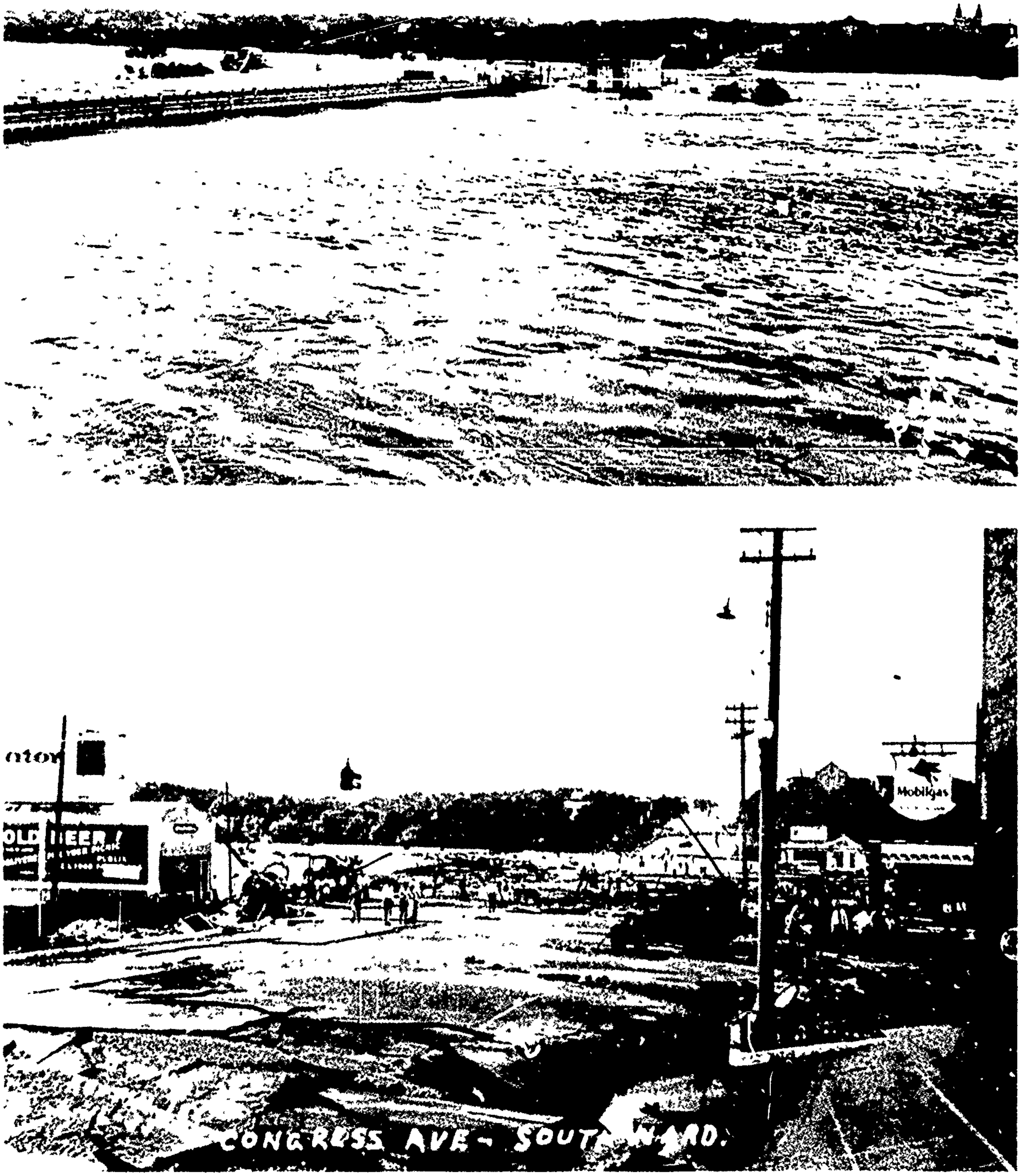


FIGURE 3.--HISTORICAL FLOOD SCENES ON COLORADO RIVER

These photographs depict the magnitude and severity of the June 1935 flood, second largest at Austin since at least 1833. (Photos courtesy of Austin-Travis County Collection, Austin, Texas, Public Library.)

FUTURE FLOODS

Large floods have been experienced in the past on the Colorado River and on streams in the general geographical region of its watershed. Intense storms similar to those causing these floods could again occur over all, or portions, of the Colorado River watershed, resulting in floods of equal or greater magnitude than those experienced in the past. It is therefore desirable in determining possible future floods on the Colorado River to consider storms and floods that have occurred on watersheds whose topography, watershed cover, and physical characteristics are similar to those of the Colorado River. Table 4 lists some of the maximum known floods on streams in the vicinity of Austin, Texas. Discussion of the future floods in this report is limited to those that have been designated as the 10-year, 50-year, 100-year, and 500-year frequency floods.

Flood Magnitudes and Their Frequencies

Frequency curves of peak flows for the Colorado River were constructed on the basis of available information and floodflows up to the magnitude of the 500-year flood were computed from these curves. The frequency curves thus derived, which are available on request, reflect the judgment of engineers who have studied the area and are familiar with the region. Floods larger than the 500-year flood are possible, but the combinations of factors necessary to produce such large flows would be extremely rare. The peak discharges in the Colorado River watershed covered by this report for the 10-, 50-, 100-, and 500-year frequency floods are given below.

Frequency	Peak Discharge (cfs)
10-year	50,000
50-year	102,000
100-year	170,000
500-year	335,000

The 100-year frequency flood is defined as a flood having an average frequency of occurrence in the order of once in 100 years, at a designated location, although the flood may occur or be exceeded in any year and possibly in successive years. The 100-year frequency of occurrence

TABLE 4

MAXIMUM KNOWN FLOOD DISCHARGES ON

STREAMS IN THE VICINITY OF AUSTIN, TEXAS

Stream	Location	Drainage Area Sq Mi	Date	Peak Discharges: Gage Height feet	Peak Discharges: Discharge cfs	Peak Discharges: Per Sq Mi cfs
Walnut Creek	Webberville Road Austin, Texas	51.3	May 15, 1970	23.69	6,020	117
Barton Creek	Near Austin, Texas	114.0	May 28, 1929	-	39,400	346
Waller Creek	38th Street, Austin, Texas	2.3	October 29, 1960	7.77	1,970	853
Waller Creek	23rd Street, Austin, Texas	4.1	October 29, 1960	7.96	3,710	898
West Branch, Waller Creek	Between 26th and 26½ Streets, Austin, Texas	1.3	June 12, 1951	-	890	685
Wilbarger Creek	Near Pflugerville, Texas	4.6	September 1921	8.0	2,300	499
Onion Creek	Del Valle, Texas	337.0	May 28, 1929	24.75	76,000	226
Onion Creek	Del Valle, Texas	337.0	September 1921	33.6 (1)	-	-
Onion Creek	Near Dripping Springs Hays County, Texas	54.8	May 28, 1929	-	21,900	400
Onion Creek	Buda, Hays County, Texas	151.0	May 28, 1929	-	53,200	352
Rabbs Creek	1.5 miles south of Ward Fayette County, Texas	92.8	June 30, 1940	-	55,000	593
Buckners Creek	2 miles SW of La Grange Fayette County, Texas	184.0	June 30, 1940	-	106,000	576
San Marcos River	Ottine, Texas	1,249.0	May 29, 1929	43.3	202,000	162
Blanco River	Wimberley, Texas	364.0	May 28, 1929	31.0	113,000	310
Pedernales River	Johnson City, Texas	947.0	September 11, 1952	42.5	441,000	466

(1) Historical data.

can be expressed in terms of percentage to avoid the possible inference of regularity of occurrence. Thus, a flood with a 100-year recurrence interval would have a 1 percent chance of being equalled or exceeded in any year. Perhaps more significantly, it has about a 25 percent chance of occurrence during a 30-year mortgage period.

In the GLOSSARY OF TERMS, page 37, are additional definitions of flood frequency, including definitions of the 10-, 50-, and 500-year floods.

Hazards of Large Floods

The hazards to life and extent of damage caused by any flood depend on the topography of the area flooded, depth and duration of flooding, velocity of flow, rate of rise, and developments on the flood plains.

Velocities greater than three feet per second combined with depths of three feet or more are generally considered hazardous to life, as well as property. Water flowing in excess of four feet per second is capable of transporting large rocks and causing severe erosion of stream-banks and fill around bridge abutments. When velocities drop below two feet per second, debris and silt deposits can build up, extending the flood damages and creating adverse health conditions.

Flooding is a natural phenomena. Only when development is allowed in a flood plain that is inconsistent with the flood hazard does flooding become a "flood problem." Property damages caused from flooding can rise to overwhelming proportions. Besides the obvious threat to buildings and contents, a private citizen can suffer additional indirect costs. The entire community suffers when streets, bridges, sewers, and other public utilities are destroyed or otherwise made inoperative. Adding to the physical hazards, a flood can unleash illness and deadly epidemic diseases. Sanitary sewers become pressure lines, blowing manhole covers to spew raw sewage into the surface floodwaters; sewage treatment plants and feeder lines can be washed out, adding to the pollution and hazard of epidemic. Newspapers sometimes report a "lighter side of the news" in picturing children at play in the mud and standing water left by a receding flood. Unfortunately, however, the contamination threat to domestic water supplies cannot be illustrated with similar ease.

Flooded areas and flood damages. The study areas subject to flooding by the 100-year and 500-year floods are shown on Plates 4 through 13. The 100-year flood would inundate an area of about 4,675 acres along the Colorado River in the reach studied. Depths of flow for any given location can be estimated from the high water profiles shown on Plates 15 and 16. Typical cross sections of the river and flood plains at selected locations are shown on Plate 17. Stream characteristics, topographic maps, aerial mosaics, and valley cross section surveys were used to compute and define the flood situation. Delineations of floodwaters from the streams studied which would "back up" tributaries were not shown for fear of giving the impression of defining the maximum flood plain limits along these streams.

Obstructions. Brush and debris washing downstream during floods often collect against bridges or within any restricted flow area, reducing the waterway openings and otherwise impeding floodflow. Obstructive new development and future land filling in or near the rivers' floodways could be a major factor in multiplying the adverse effects described, especially for floods of the magnitude of the 100-year frequency or larger.

Flood crests for the 100-year and 500-year floods and pertinent elevations at bridge crossings within the study area are listed in Table 5. For study purposes herein, it has been assumed that no clogging would occur and all bridge structures would stand intact. Significant changes in this premise, imposed by differing conditions of a future flood, could alter the estimated flood crests and flood limits shown in the table and related plates.

Velocities of flow. Water velocities during floods depend largely on the size and shape of the cross sections, conditions of the stream, and the bed slope, all of which vary on different streams and at different locations on the same stream. Velocities for the 100-year frequency flood on the Colorado River range from 4.8 feet/second to 10.7 feet/second in the channel and from 0.8 feet/second to 2.9 feet/second on the overbanks. Higher velocities could occur at or immediately below bridges or other

TABLE 5

BRIDGES - PERTINENT ELEVATIONS

COLORADO RIVER

Identification	Mile Above Mouth	Streambed feet	Low Steel feet	Bridge Floor feet	100-Year Flood Crest feet	500-Year Flood Crest feet
FM 973	280.46	385.5	413.9	415.2	424.0	431.6
Bolm Road	288.74	385.0	418.1	421.7	438.0	447.0
US Highway 183 (north bound)	290.01	394.5	449.1	453.1	442.4	451.4
US Highway 183 (south bound)	290.08	398.0	456.2	459.6	442.4	451.4

obstructions. Velocities for the 500-year flood would be slightly higher than those experienced during a 100-year flood.

Rates of rise and duration of flooding. Example flood characteristics of the 100-year and 500-year floods are shown in Table 6. These data reflect maximum conditions at river mile 286.04, which is just downstream from the confluence of Walnut Creek. Plate 2 shows the 100-year stage hydrograph at the same location.

Photographs, future flood heights. Water surface elevations for the 500-year flood exceed those of the 100-year flood on the average by about 8.0 feet on the study reach. Figure 4 shows the height that would be reached by the 100-year frequency flood on the FM 973 bridge at river mile 280.46.

TABLE 6

FLOOD CHARACTERISTICS - AVERAGED MAXIMUM CONDITIONS

Characteristic	Location: River mile 286.04, Magnitude of Occurrence: 100-year Flood	500-year Flood
Peak discharge (cfs)	170,000	335,000
Height of rise above bank full stage (feet)	40.9	49.4
Rate of rise (feet per hour)	2.1	2.2
Duration of flooding above bank ful' stage (hours)	63	96

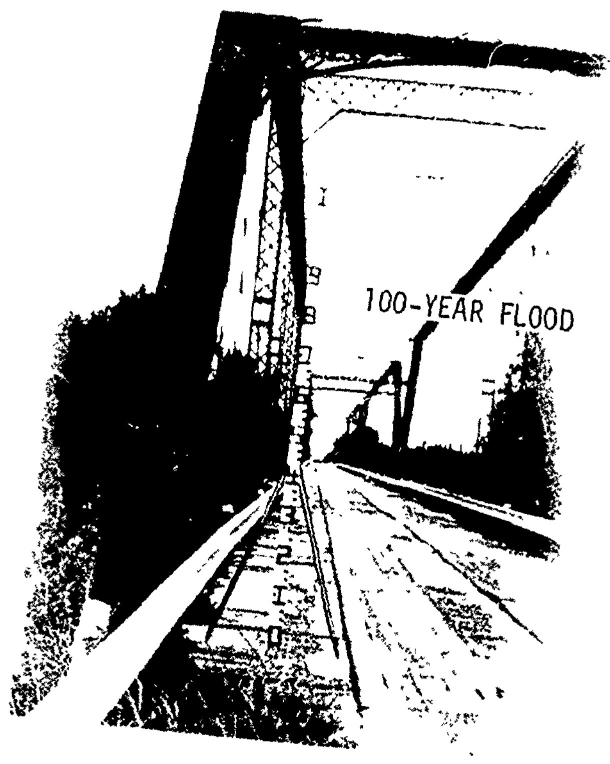


FIGURE 4.--FLOOD HEIGHTS

This figure shows the potential 100-year frequency flood height at the F.M. 973 bridge over the Colorado River at river mile 280.46.

GUIDELINES FOR FLOOD PLAIN MANAGEMENT

Man has been building on and occupying the flood plains of rivers and streams since the arrival of pioneer settlers. The streams first provided transportation and water supply and later their gentle valley grades encouraged the construction of highways and railroads. Today, uncontrolled growth of cities often results in unwise encroachment on the flood plains of local streams.

Through bitter experience, man has learned that floods periodically inundate portions of the flood plain, damaging property and often causing loss of life. This experience has led to a relatively new approach for reducing flood damages. Called "flood plain management", this approach consists of applying controls over the use of land lying adjacent to streams. Planned development and management of flood hazard areas can be accomplished by a variety of means.

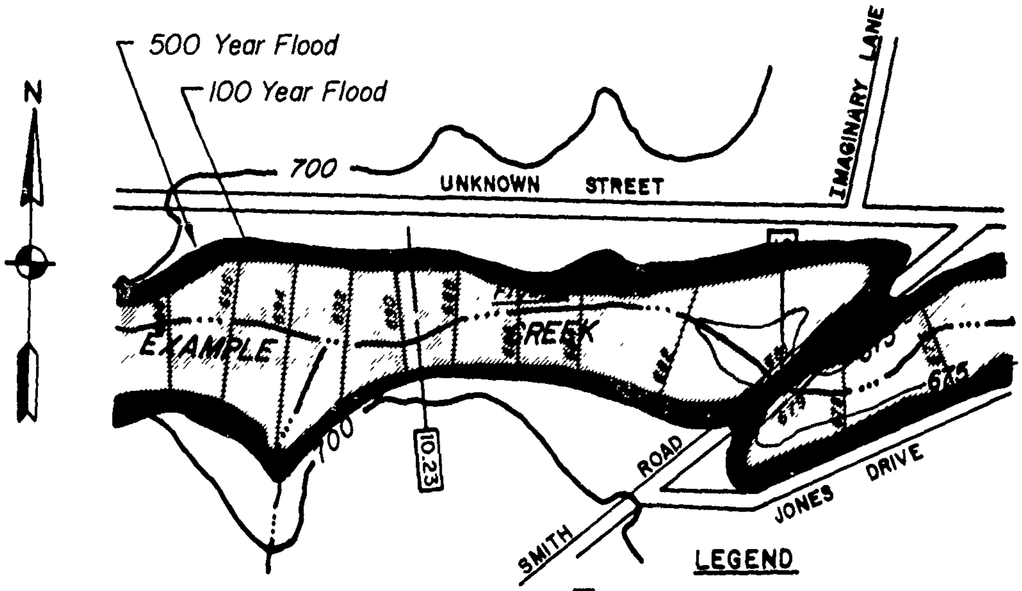
Interpretation of Data

Flooded area maps, profiles, and selected cross sections are provided in this report to define the limits of flooding that would occur during a 100-year flood and a 500-year flood. In addition, profiles for 10-year and 50-year floods are also shown.

The areas that would be inundated by the 100- and 500-year floods are shown on Plates 4 through 13. The computed water surface elevations for these floods are shown on Plates 15 and 16. Locations of cross sections are shown on Plates 4 through 13, 15, and 16. Typical cross sections are shown on Plate 17. The actual limits of these overflow areas on the ground will vary from those shown because the scales of the available maps do not permit precise plotting of the flooded area boundaries. Important land use decisions in specific areas should be verified by field surveys. Changes in the land use, drainage patterns, and structural occupancy of the flood plain may result in higher flood elevations than those shown.

Hypothetical examples of the maps, profiles, and cross sections which follow depict the areal limits and elevations of the respective floods at an imaginary location and are shown on Figure 5, page 31.

HYPOTHETICAL FLOOD PLAIN INFORMATION



FLOODED AREA

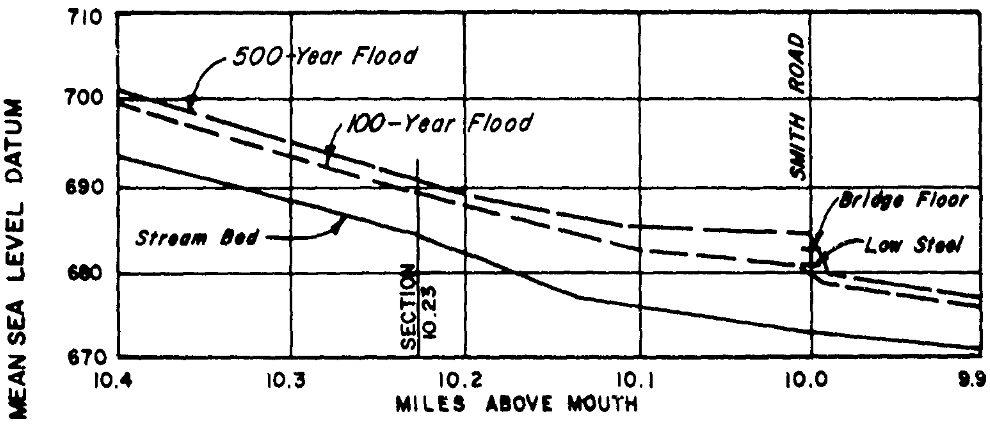
SCALE 1" = 500'

LEGEND

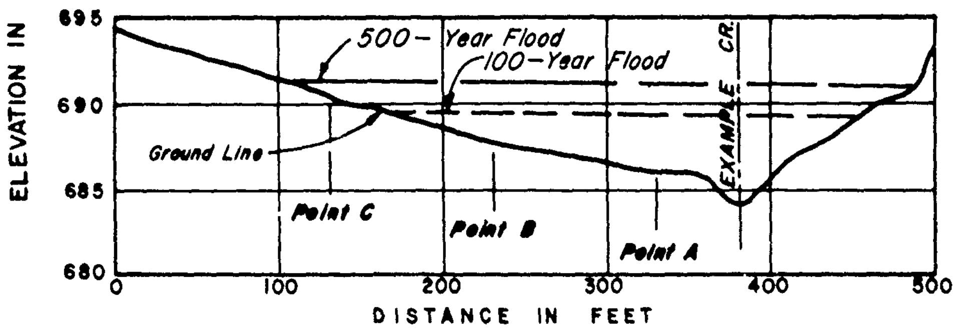
10 — Miles Above Mouth

10.23 — Cross Section

690 — 100 Year Flood Elev.



FLOOD PROFILE



CROSS SECTION 10.23

VIEW LOOKING DOWNSTREAM

FIGURE 5

The lateral limits of flooding from the 100-year flood are shown by the blue shaded area, while the solid blue area indicates the additional area that would be inundated by the 500-year flood. The solid blue line and numeral in the shaded area represent the elevation of the 100-year flood at that particular location. The flood profile shows the relative depth of floodwaters along the centerline of the stream. The cross section example indicates the depth and lateral extent of flooding that would occur at the specified cross section; other information on floodflow depths at the location of the cross section is tabulated below. Similar data can be developed for any flood plain location in the study reaches considered in this report.

Location	Distance from stream centerline feet	Depth of floodwater 100-year flood feet	Depth of floodwater 500-year flood feet
Point A	50	3.4	5.1
Point B	150	1.7	3.5
Point C	250	-	1.0

By using information as illustrated above, together with other data such as frequency of occurrence, velocity of flow, and duration of flooding, government entities and individuals can make knowledgeable decisions relative to the use, development, and management of areas subject to inundation.

Flood Plain Management Tools

The main purpose of this report is to provide guidance for intelligent land use in the Colorado River watershed. This includes recognition of the existing flood hazards associated with streams in the area. Citizens of this and other watersheds have learned from bitter experience that the development of flood hazard areas should take place only with full knowledge of the risk and social cost involved. The following remarks concerning possible uses for the data presented herein are not intended to be all inclusive. They are meant to provide a cursory guide for utilizing the information on the flooding conditions in the Colorado River watershed to the best advantage. The methods available for reducing flood losses can be subdivided into two general classifications, regulatory and non-regulatory.

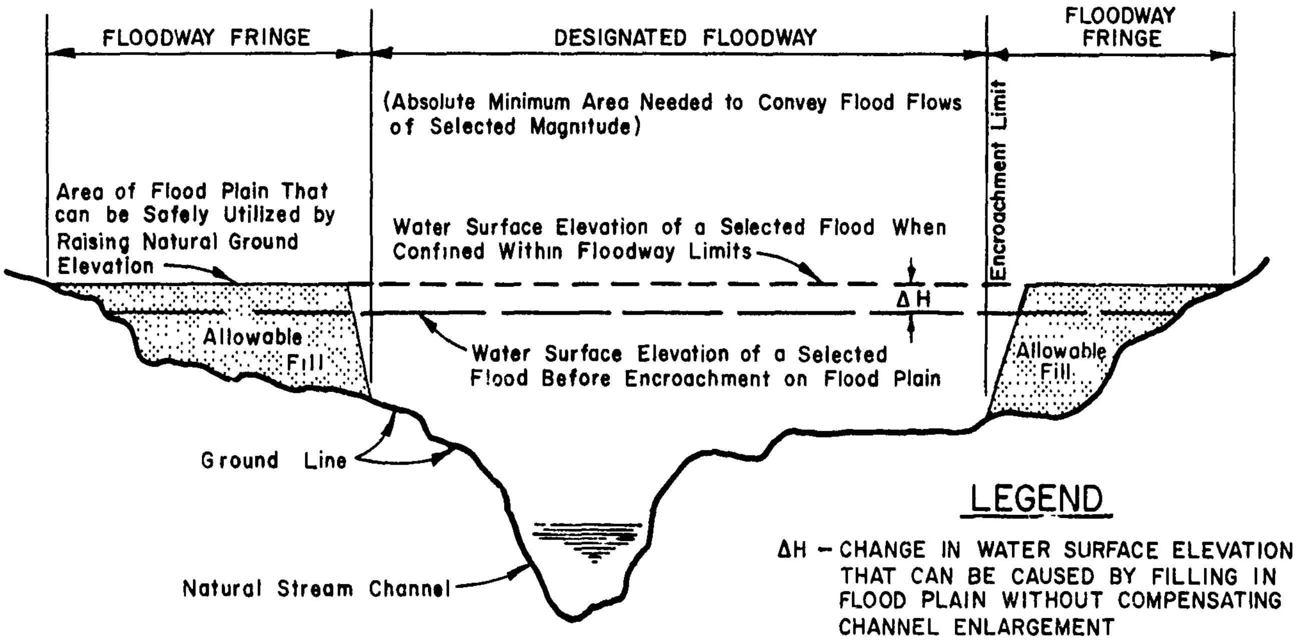
Regulatory measures. Regulation of flood plain land use can substantially contribute to the reduction of future flood damages and risk, while contributing to other important objectives such as regional development and improvement or preservation of environmental attributes. (Of course, use here of the word regulation is not meant to imply nonuse of flood plain lands or any type of inequitable treatment of present or future land owners.)

Federal agencies do not have the authority to regulate flood plain development. This authority was assigned to the states (and their political subdivisions) in the tenth amendment to the U. S. Constitution and has never been delegated to the Federal Government. Consequently, it is local governmental bodies utilizing available state legislation that have to assume the day to day responsibility for guiding development in flood prone areas. Refer to Article 8280, Vernon's Annotated Texas Civil Statutes, Flood Control and Insurance Act of 1969, for one example of state enabling legislation.

The principal regulatory devices used at local governmental levels include zoning ordinances, subdivision regulations, and building and health codes. The following is a discussion of these four types of regulations.

a. Flood plain zoning ordinances are usually "superimposed" on existing zoning ordinances. They may be used to implement broader land use plans and to reduce future flood losses by stipulating the type of building development permitted in flood prone areas. They can also be used to limit flood plain development by establishing flood plain encroachment limits. These regulations should exclude obstructions from floodway areas which adversely affect flood heights and allocate the flood plain to uses consistent with the degree of the flood threat. Floodways can be established along modified (enlarged, straightened) or natural stream channels. See the GLOSSARY OF TERMS for a definition of the terms floodway and encroachment limits. The floodway and encroachment limit concepts are also illustrated on Figure 6, page 34.

b. Subdivision control ordinances may also be effective tools for flood plain building control. Subdivision control relates to



FLOODWAY FRINGE

Suggested Uses

Uses permitted in the floodway area. Residential, Commercial, Industrial, Public & other development with floodwater entry points at or above design elevation for encroachment.

Uses Not Appropriate

Hospitals & Nursing Homes
Boarding Schools & Orphanages
Sanitariums
Detention Facilities
Refuge Center
Permanent Storage of Materials or Equipment (Emergency Equipment)

FLOODWAY AREA

Suggested Uses

Farms, Truck Gardens & Nurseries
Livestock & Other Agricultural Uses.
Non-obstructive Structures
Parking Lots, Playgrounds & Parks
Golf Course & Open Recreation
Preserves & Reservations.

Uses Not Appropriate

Land Fills & Obstructive Structures
Floatable Storage
Disposal of Garbage
Rubbish, Trash or Offal
All uses precluded from floodway fringe area.

FIGURE 6 – FLOOD PLAIN CROSS SECTION SHOWING FLOODWAY & ENCROACHMENT LIMIT CONCEPTS

the way in which land is divided and made ready for building development. For example, a city may control the subdivision of land within its jurisdiction by requiring that a large percentage of the minimum lot area of a subdivision be a designated height above an adopted floodwater elevation as a requisite for plat approval. Unlike zoning ordinances which extend only to a city's limits, cities have some control over subdivision development in areas within their extraterritorial jurisdiction. (Refer to Article 970a, Vernon's Annotated Texas Civil Statutes.) In Texas, this extraterritorial jurisdiction varies from one-half mile (population of less than 5,000) beyond the city limits to five miles (population over 100,000) beyond the city limits.

c. Building codes set forth standards of construction for the purpose of protecting health, safety and general welfare of the public. Building codes may be written to set minimum standards for water (flood) proofing of structures, for establishing minimum first floor elevations consistent with potential flood occurrences, and requirements for material strength and proper anchorage.

d. Health codes can serve as a control over the use of flood plains for waste disposal and the construction of water and sewage treatment facilities that may create health problems during floods.

Nonregulatory measures. Other methods that can be used to reduce flood damage losses include:

a. Structural measures can be used to reduce flood heights (channel modifications, dams) or provide a barrier between floodwaters and development (levees, dikes).

b. Fee purchase of lands for open space uses.- Many grant and loan programs are available to local governments through the Department of Housing and Urban Development and other federal agencies for preserving flood plain lands as green belts, development of these areas for parks, nature trails, etc.

c. Acquisition of flooding easements.- Purchase of less than fee interest in flood prone land is another approach to controlling development.

d. Flood proofing by elevating structures, water proofing, or filling of low areas for building sites.- Some buildings can be raised in place up to a reasonable limit to reduce flood damages. Other structures can be made to withstand flood velocities and depths through the use of bulkheads, watertight openings, flotation anchors, plumbing cutoff valves, and structural reinforcements. Structures can be built in flood plain fringe areas at elevations above a selected flood magnitude. However, this should be done only in connection with an established floodway width or encroachment limits to eliminate obstructions that would raise upstream flood stages.

e. Flood insurance can now be made available through the Department of Housing and Urban Development to cities that adopt appropriate flood plain regulations. Flood insurance does not reduce flooding or flood caused damages, but reduces the risk of large economic losses by individual flood victims.

f. Development policies in regard to extending public services.- "Flood conscious" governmental policies that limit or discourage the extension of public roads, utilities, and other services into flood prone areas can play an important role in encouraging prudent flood plain use. Private developments usually depend on the extension of public services. By avoiding the extension of such services into flood hazard areas, local government and private utility companies can encourage the occupancy of safer and, in the long run, cheaper flood free areas.

Very little building is carried on without outside financing. Therefore, lending institutions, both federal and private, are in a position to exercise control over flood plain development by denying mortgage guarantees or funds to subdivision or individual builders for projects that will eventually become "flood problems."

GLOSSARY OF TERMS

DISCHARGE. As applied to a stream, the rate of flow, or volume of water flowing in a given stream at a given place and within a given period of time, usually quoted in cubic feet per second (cfs) or gallons per minute (gpm).

DRAINAGE AREA. The area tributary to a lake, stream, sewer, or drain. Also called catchment area, watershed, and river basin.

ENCROACHMENT LIMITS. A limit of obstruction to flood flows. Encroachment limits are normally established on the ground through the use of markers. These encroachment "lines" are roughly parallel to a stream but do not have to be equidistant from the centerline of a stream channel on each bank. Encroachment lines are established by assuming that the area landward (outside) of the lines will be ultimately developed in such a way that it will not be available to convey flood flows.

FLOOD. An overflow of land not normally covered by water and that is used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally, a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow and other problems.

FLOOD FREQUENCY. A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative streamflow or rainfall and runoff records. A 10-year frequency flood would have an average frequency of occurrence in the order of once in 10 years (a 10 percent chance of being equalled or exceeded in any given year). A 50-year frequency flood would have an average frequency of occurrence in the order of once in 50 years (a 2 percent chance of being equalled or exceeded in any given year. A 100-year frequency flood would have an average frequency of occurrence in the order of once in 100 years (a 1 percent chance of being equalled or exceeded in any given year). A 500-year frequency flood would have an average frequency of occurrence in the order of once in 500 years (a 0.2 percent chance of being equalled or exceeded in any given year).

FLOOD PEAK. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN. The relatively flat area or low lands adjoining the channel of a river, stream or watercourse or ocean, lake or other body of standing water, which has been or may be covered by flood water.

FLOOD PROFILE. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

FLOODWAY. The minimum area of a flood plain required to convey a flood peak of a selected magnitude. This usually consists of the most hazardous area of the flood plain where water velocities are appreciable. Areas on the landward side of a floodway normally convey little or no flood flow although they are inundated by water during floods.

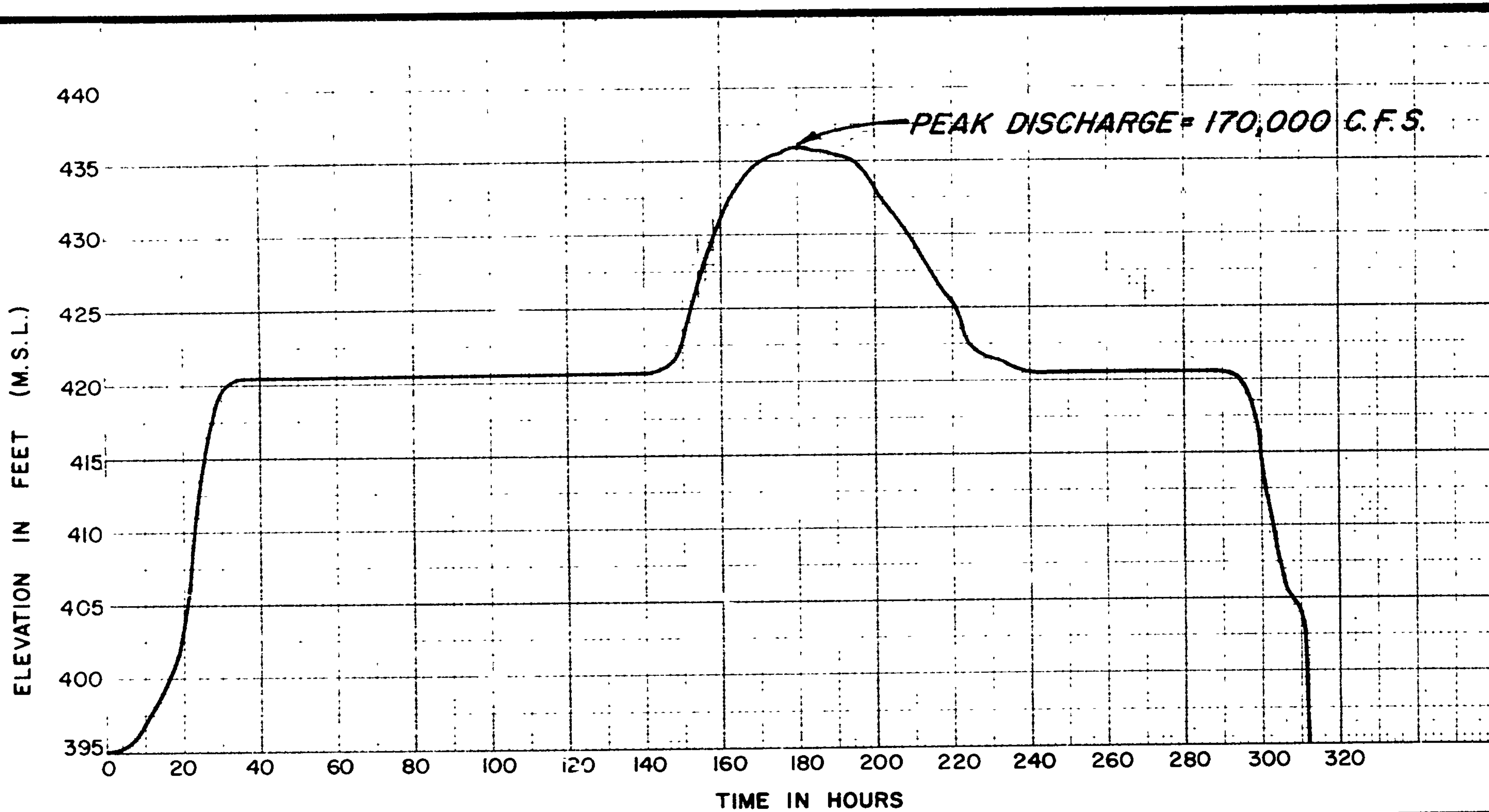
LOW STEEL. The lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows.

MEAN SEA LEVEL. A determination of mean sea level that has been adopted as a standard datum for heights. Elevation in feet and decimals thereof is a measurement vertically above the datum as used in surveys and engineering reports.

ONE HUNDRED YEAR FLOOD. A flood having an average frequency of occurrence in the order of once in 100 years, at a designated location, although the flood may occur in any year and possibly in successive years. It would have a 1 percent chance of occurrence in any year. In the past, this flood has been referred to as the Intermediate Regional Flood.

STAGE HYDROGRAPH. A graph showing flow (discharge) values against time at a given point, usually measured in cubic feet per second (cfs). The area under the curve indicates total volume of flow.

WATERSHED. (1) The area contained within a divide above a specified point on a stream; (2) the divide between drainage basins.

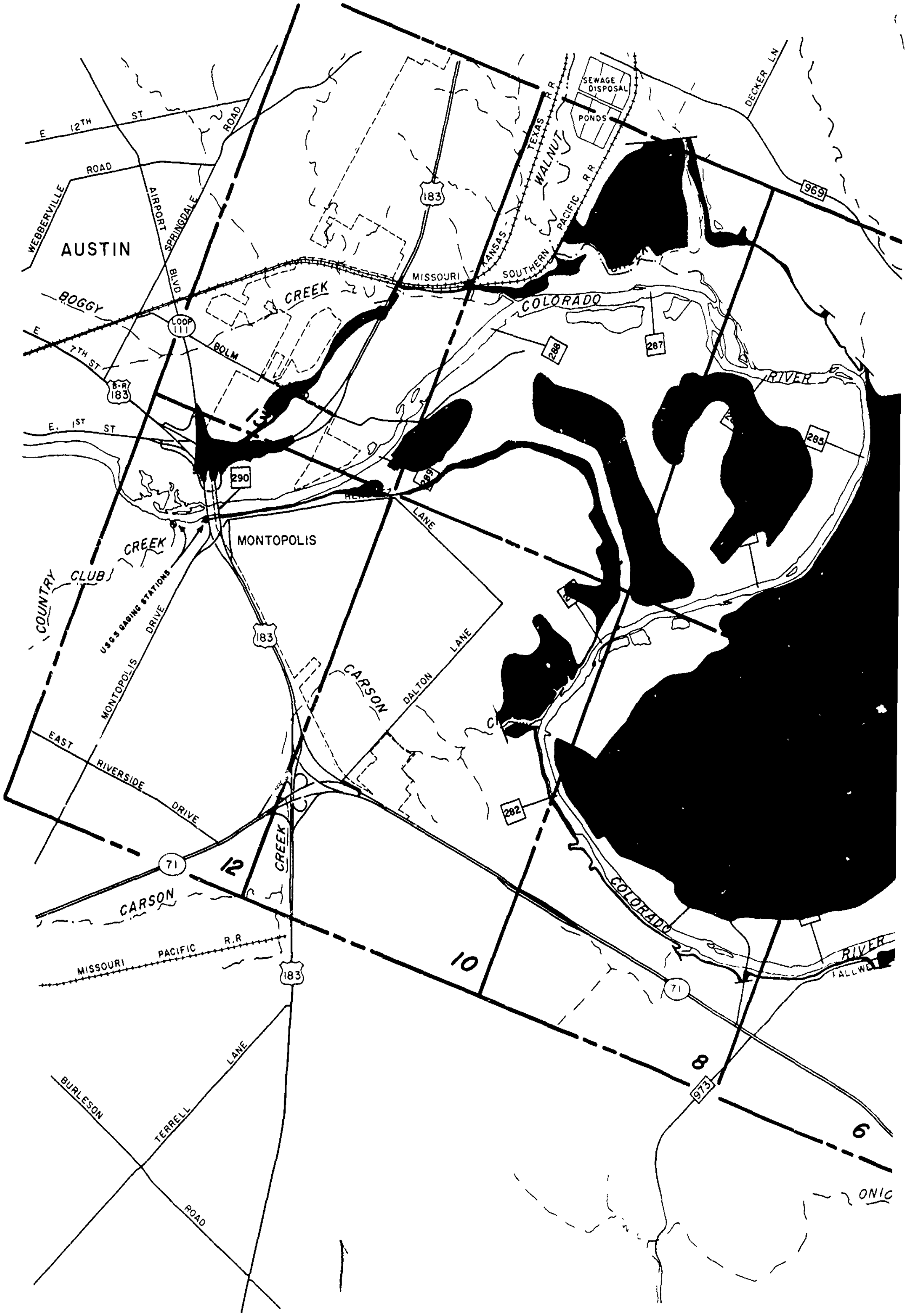


CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

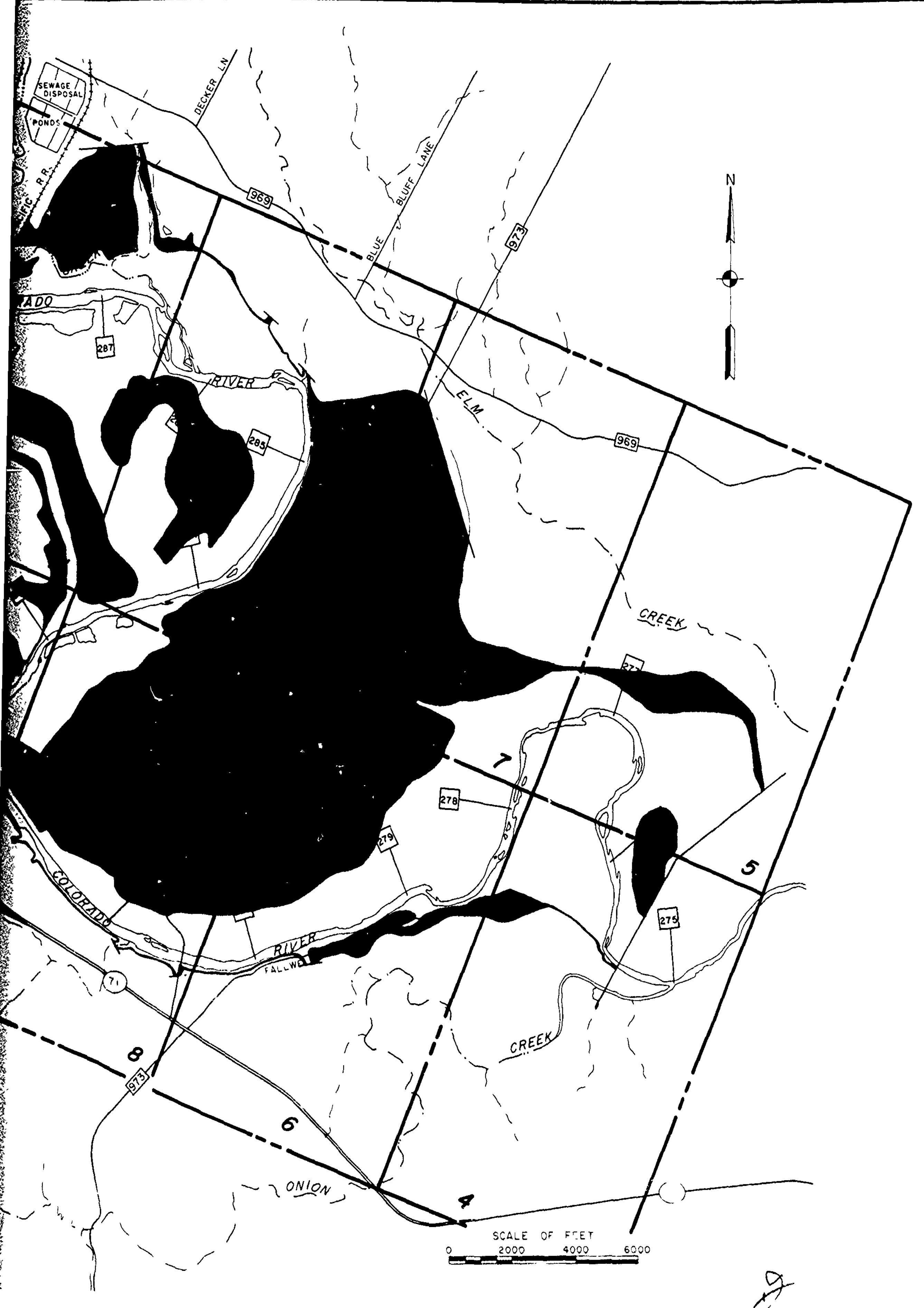
100-YEAR FREQUENCY
STAGE HYDROGRAPH

COLORADO RIVER BETWEEN
MOUTH OF WALNUT CREEK
AND PUMPING STATION

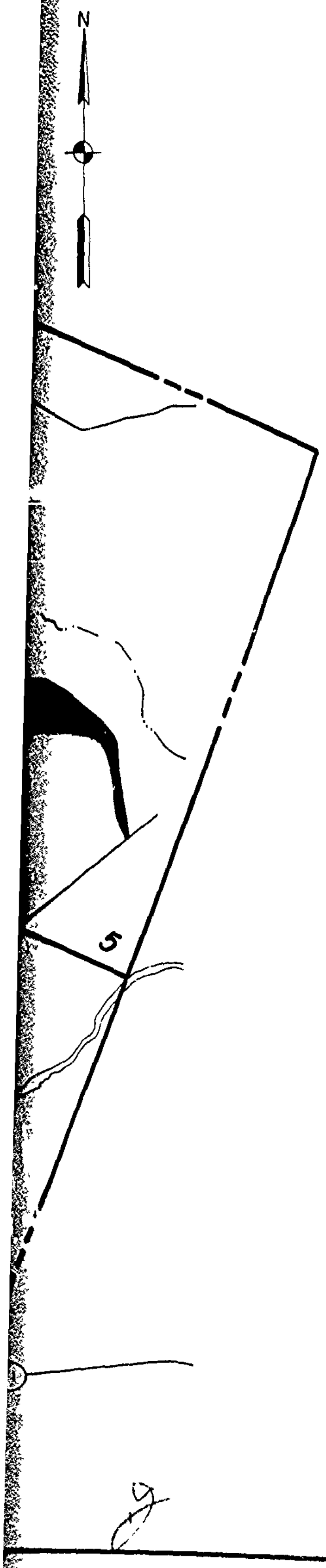
(RIVER MILE 286.04)



SEWAGE DISPOSAL
PONDS
DECKER LN
969
E 12TH ST
ROAD
WEBBERVILLE ROAD
AIRPORT BLVD
SPRINGDALE ROAD
AUSTIN
183
TEXAS
KANSAS
MISSOURI
WALNUT
SOUTHERN PACIFIC R.R.
BOGGY CREEK
LOOP 111
COLORADO
288
287
E 7TH ST
BOLM
B-R 183
RIVER
E. 1ST ST
13
290
289
285
MONTOPOLIS
CREEK
COUNTRY CLUB
U S G S GAGING STATIONS
LANE
DRIVE
MONTOPOLIS
CARSON
DALTON LANE
EAST RIVERSIDE DRIVE
282
71
12
CREEK
CARSON
COLORADO
RIVER
MISSOURI PACIFIC R.R
10
183
71
8
973
6
BURLESON ROAD
TERRELL LANE



SEWAGE DISPOSAL PONDS
R.R.
DECKER LN
BLUE BLUFF LANE
969
973
ADO
287
RIVER
285
ELM
CREEK
278
279
275
7
5
COLORADO
RIVER
71
8
973
6
ONION
4
CREEK
N
SCALE OF FEET
0 2000 4000 6000



LEGEND

OVERFLOW LIMITS

100 YEAR FLOOD

500 YEAR FLOOD

10 PLATE NUMBER

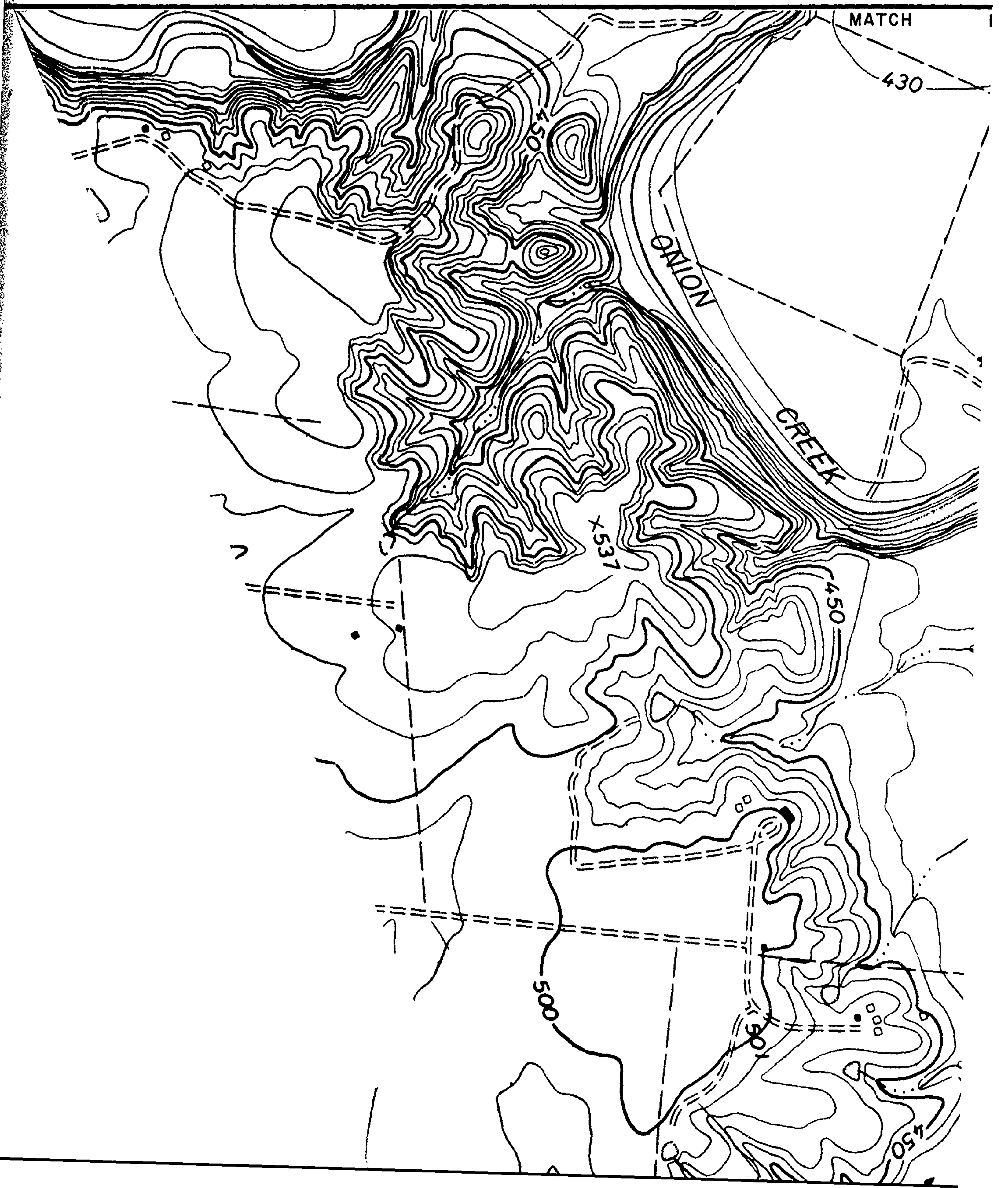
290 RIVER MILES ABOVE MOUTH

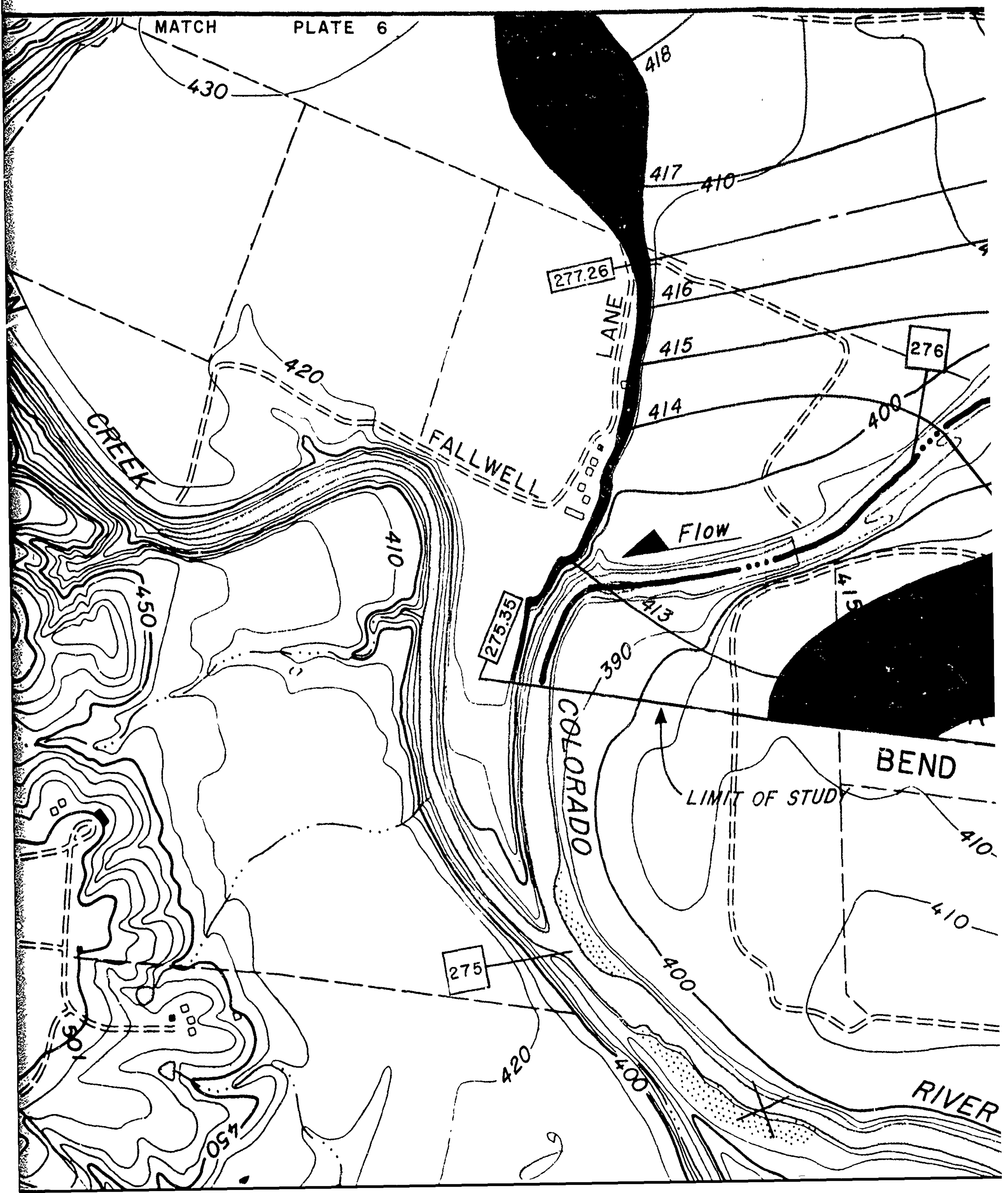
CORPS OF ENGINEERS, U.S. ARMY

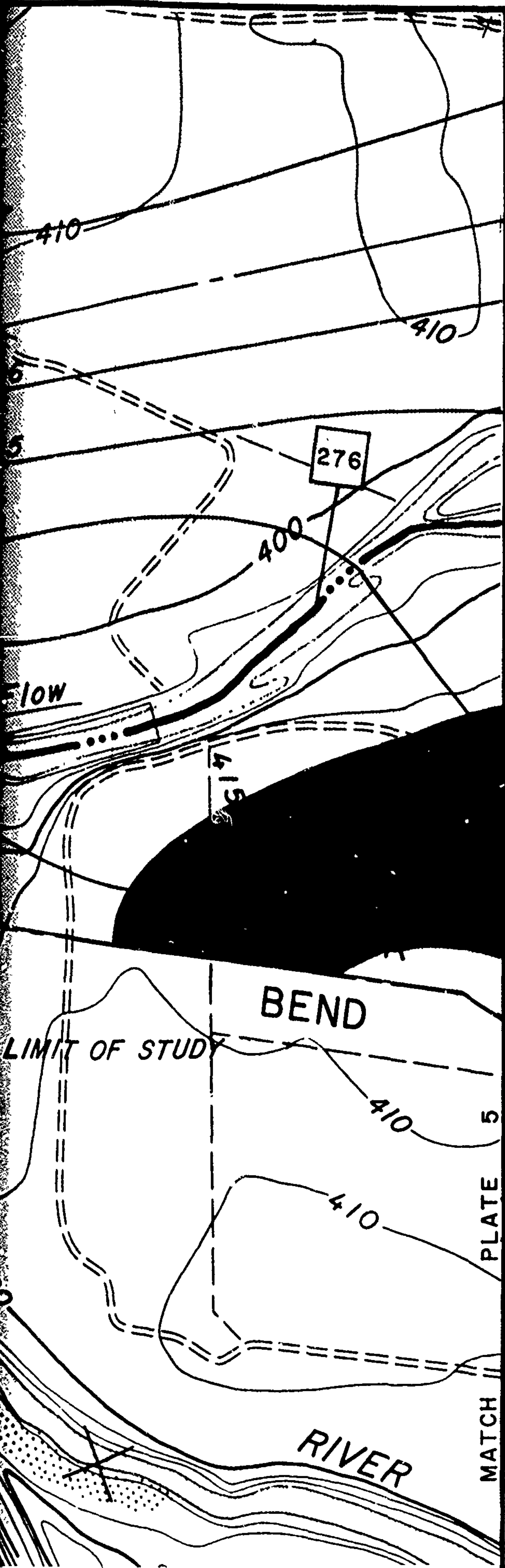
FORT WORTH, TEXAS, DISTRICT

INDEX MAP

COLORADO RIVER
ONION CREEK TO
MONTOPOLIS BRIDGE


MATCH
430
450
ONION
CREEK
x537
450
500
450


MATCH PLATE 6
430
418
417
410
277.26
416
LANE
415
276
420
414
400
CREEK
FALLWELL
Flow
410
450
275.35
413
390
COLORADO
BEND
LIMIT OF STUDY
410
410
275
400
420
400
450
RIVER



LEGEND

OVERFLOW LIMITS

STREAM BED

100 YEAR FLOOD

500 YEAR FLOOD

413

100 YEAR FLOOD ELEVATION

275 RIVER MILES

275.35 CROSS SECTIONS

420 GROUND ELEVATION IN FEET, USC & GS 1929 M S L DATUM

NOTES

1. LIMITS OF OVERFLOW INDICATED WILL VARY SOME FROM ACTUAL LOCATIONS ON GROUND AS EXPLAINED IN THE REPORT
2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

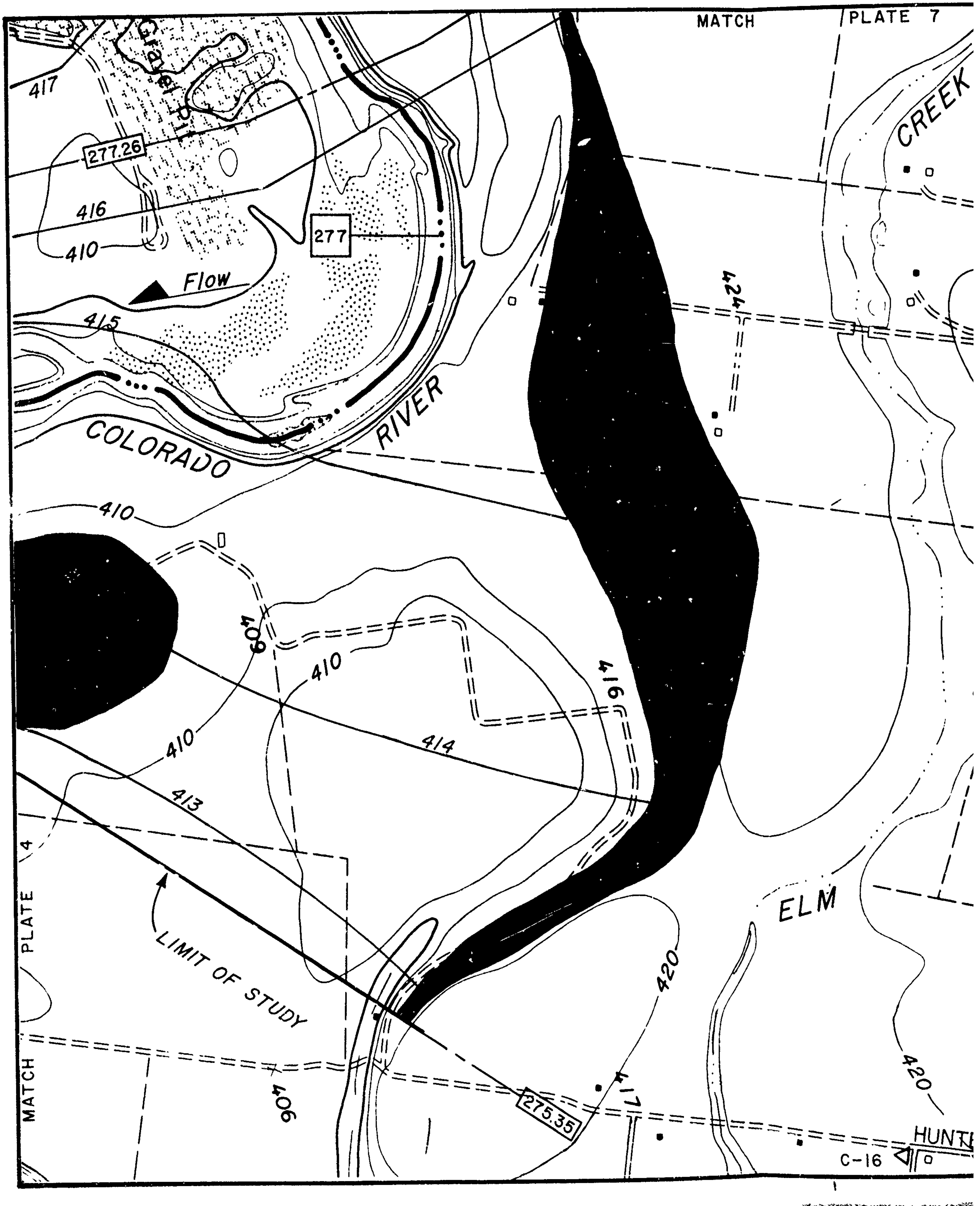
N

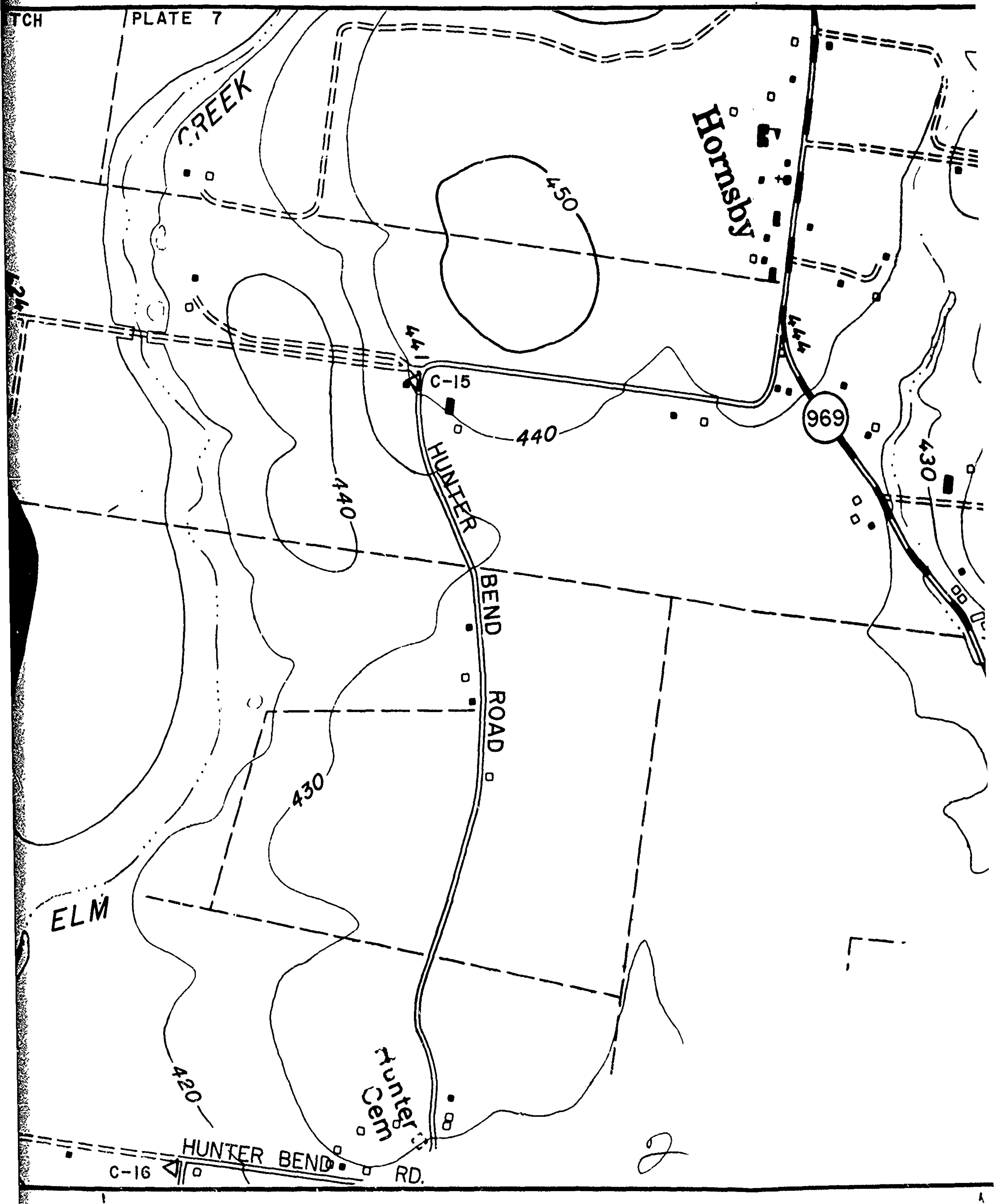
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

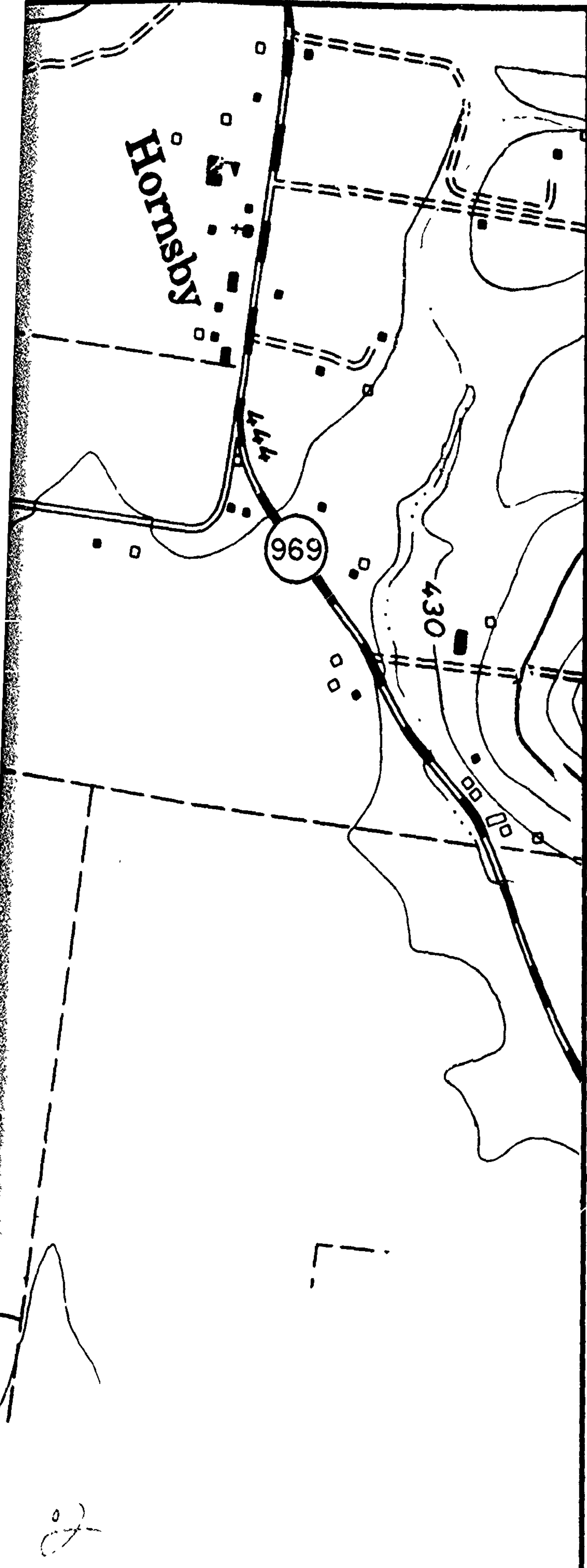
FLOODED AREAS

COLORADO RIVER

SCALE OF FEET
0 800 1600


MATCH
PLATE 7
Gravel Pit
417
277.26
416
410
277
Flow
415
COLORADO
RIVER
CREEK
424
410
409
410
410
414
413
419
ELM
420
LIMIT OF STUDY
MATCH PLATE 4
406
275.35
417
420
HUNT
C-16


TCH
PLATE 7
CREEK
Hornsby
450
441
444
C-15
969
440
HUNTER
BEND
ROAD
430
ELM
420
Hunter's
Cem
HUNTER BEND
RD.
C-16
2



LEGEND

OVERFLOW LIMITS

413 STREAM BED

100 YEAR FLOOD

500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

277 RIVER MILES

277.26 CROSS SECTIONS

420 GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

△ ELEVATION REFERENCE MARK

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N

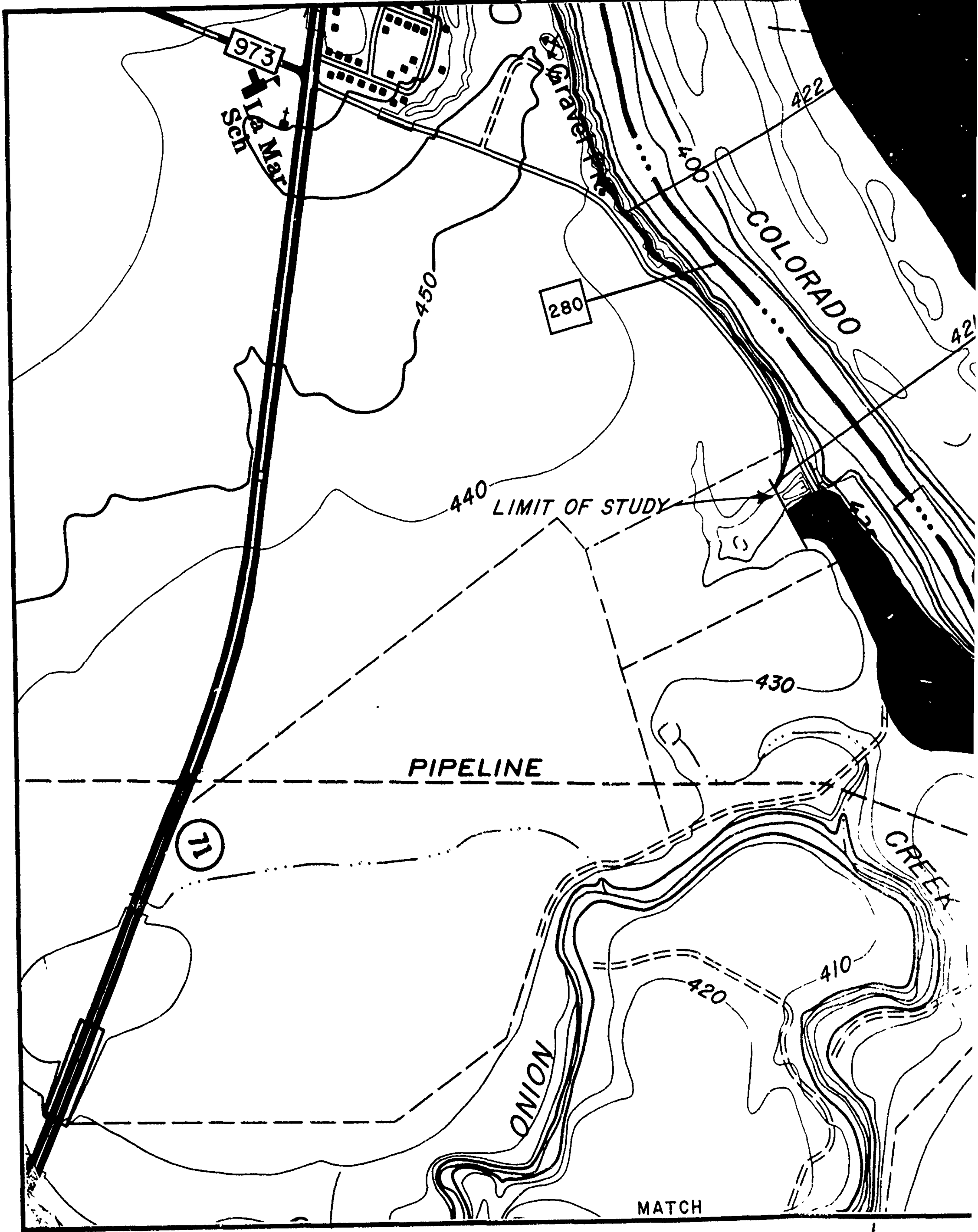
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

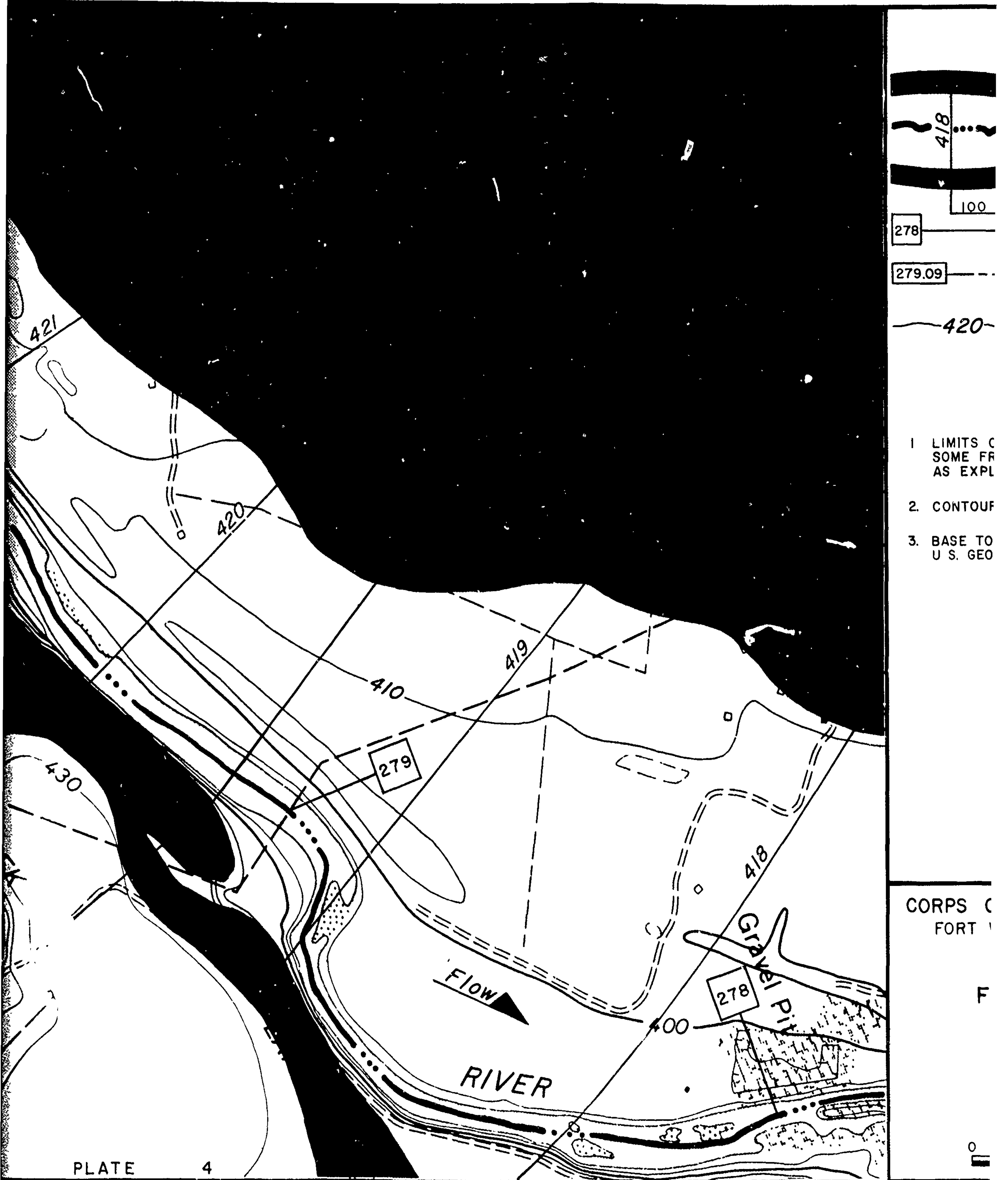
COLORADO RIVER

SCALE OF FEET
0 800 1600

3



973
La Mar
Sch
Gravel Pits
422
400
COLORADO
280
450
440
LIMIT OF STUDY
430
PIPELINE
71
CREEK
410
420
ONION
MATCH



421
420
419
410
430
279
418
400
278
Flow
RIVER
Gravel Pit
418
100
278
279.09
420
1 LIMITS C
SOME FR
AS EXPL
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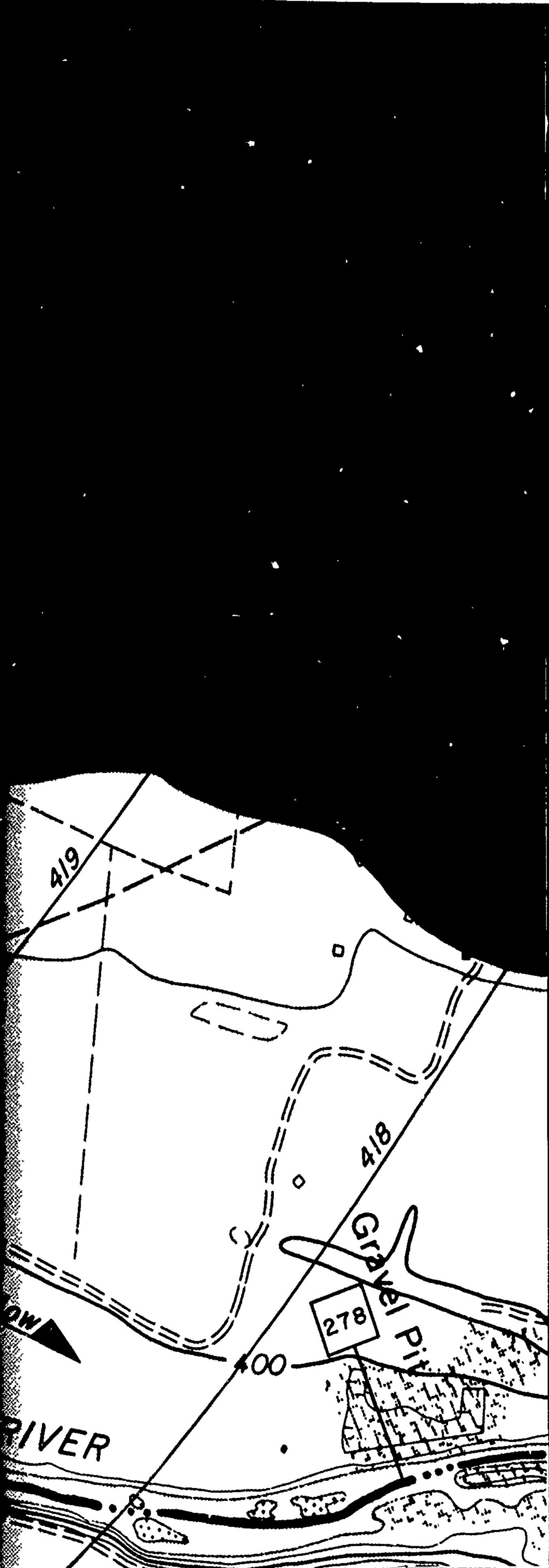
3. BASE TO
U S. GEO
CORPS C
FORT
F
0

PLATE 4



LEGEND

OVERFLOW LIMITS

418

STREAM BED

100 YEAR FLOOD

500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

278 — RIVER MILES

279.09 — CROSS SECTIONS

420 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

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2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

N

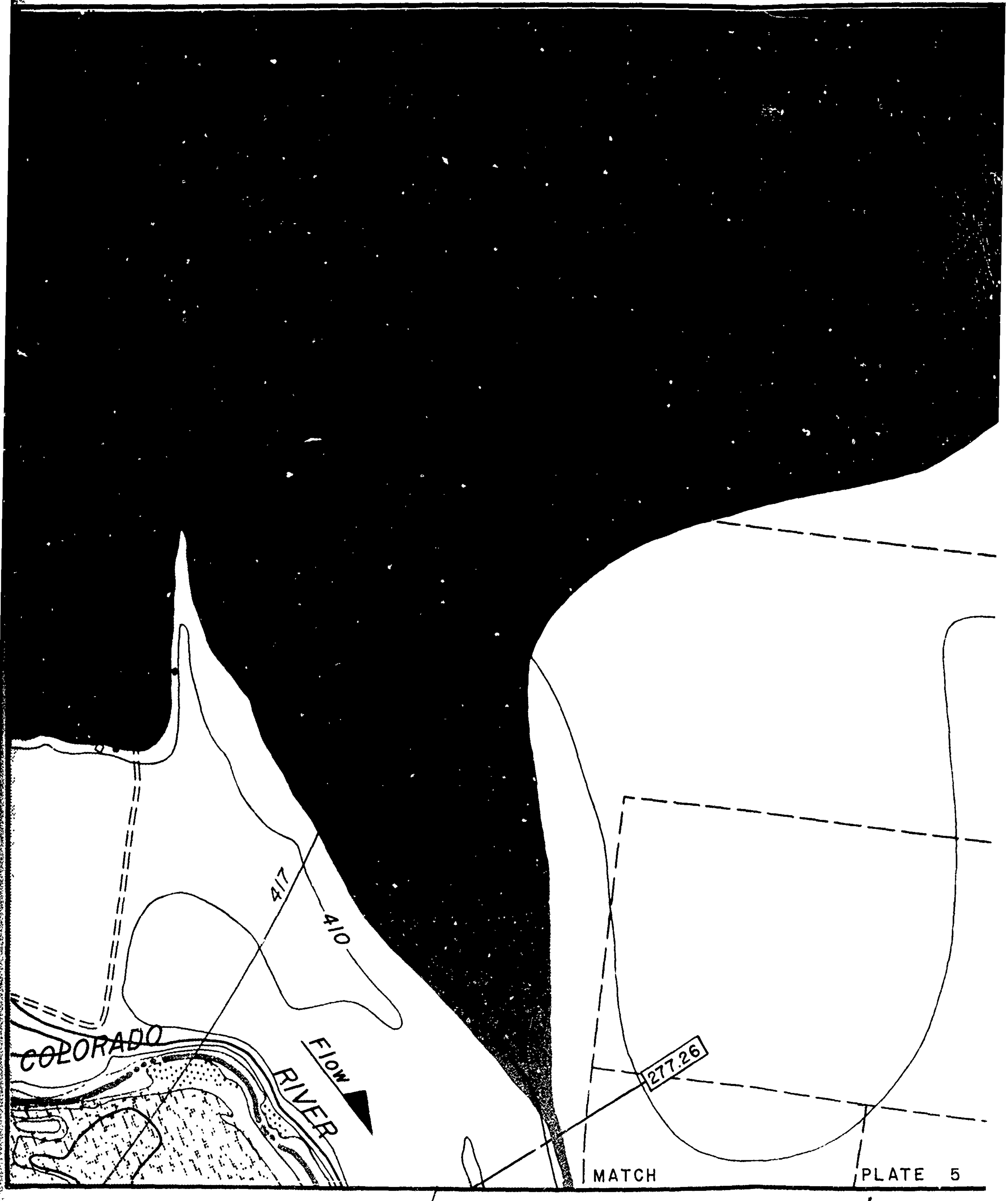
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

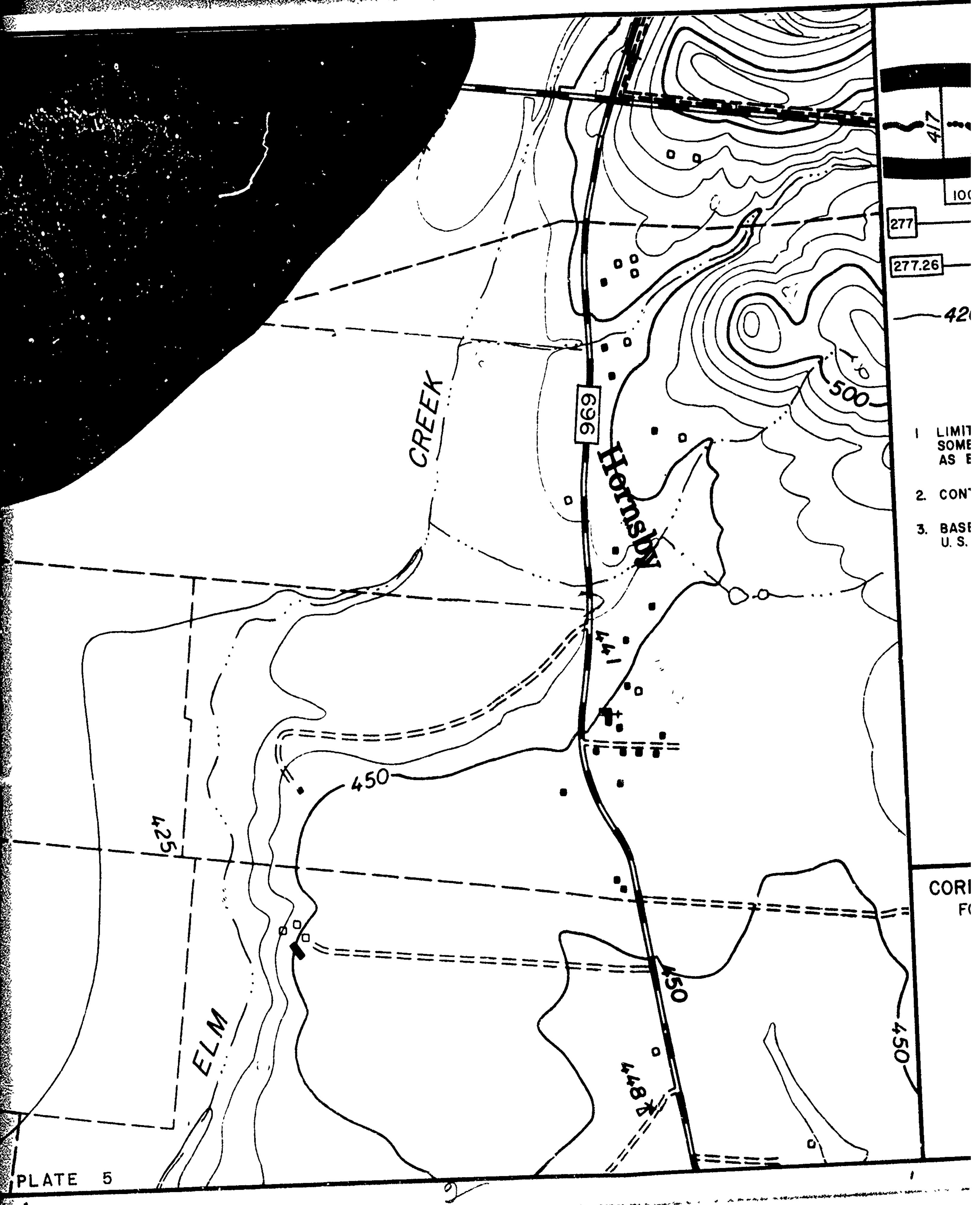
FLOODED AREAS

COLORADO RIVER

SCALE OF FEET

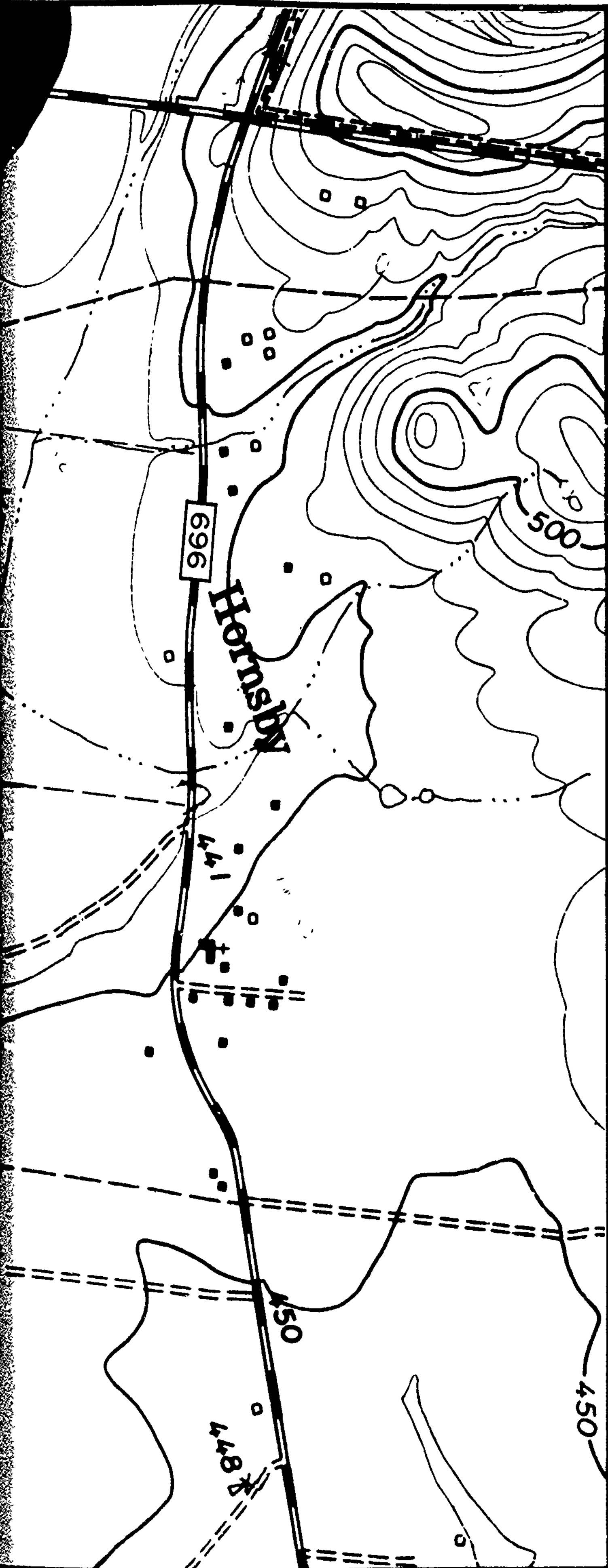
0 800 1600


417
410
COLORADO
RIVER
Flow
277.26
MATCH
PLATE 5



417
100
277
277.26
420
500
CREEK
969
Hornsby
441
450
425
ELM
448
1 LIMIT
SOME
AS E
2. CONT
3. BASE
U. S.
CORI
FO

PLATE 5



LEGEND

OVERFLOW LIMITS

417 STREAM BED — 100 YEAR FLOOD — 500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

277 RIVER MILES

277.26 CROSS SECTIONS

420 GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

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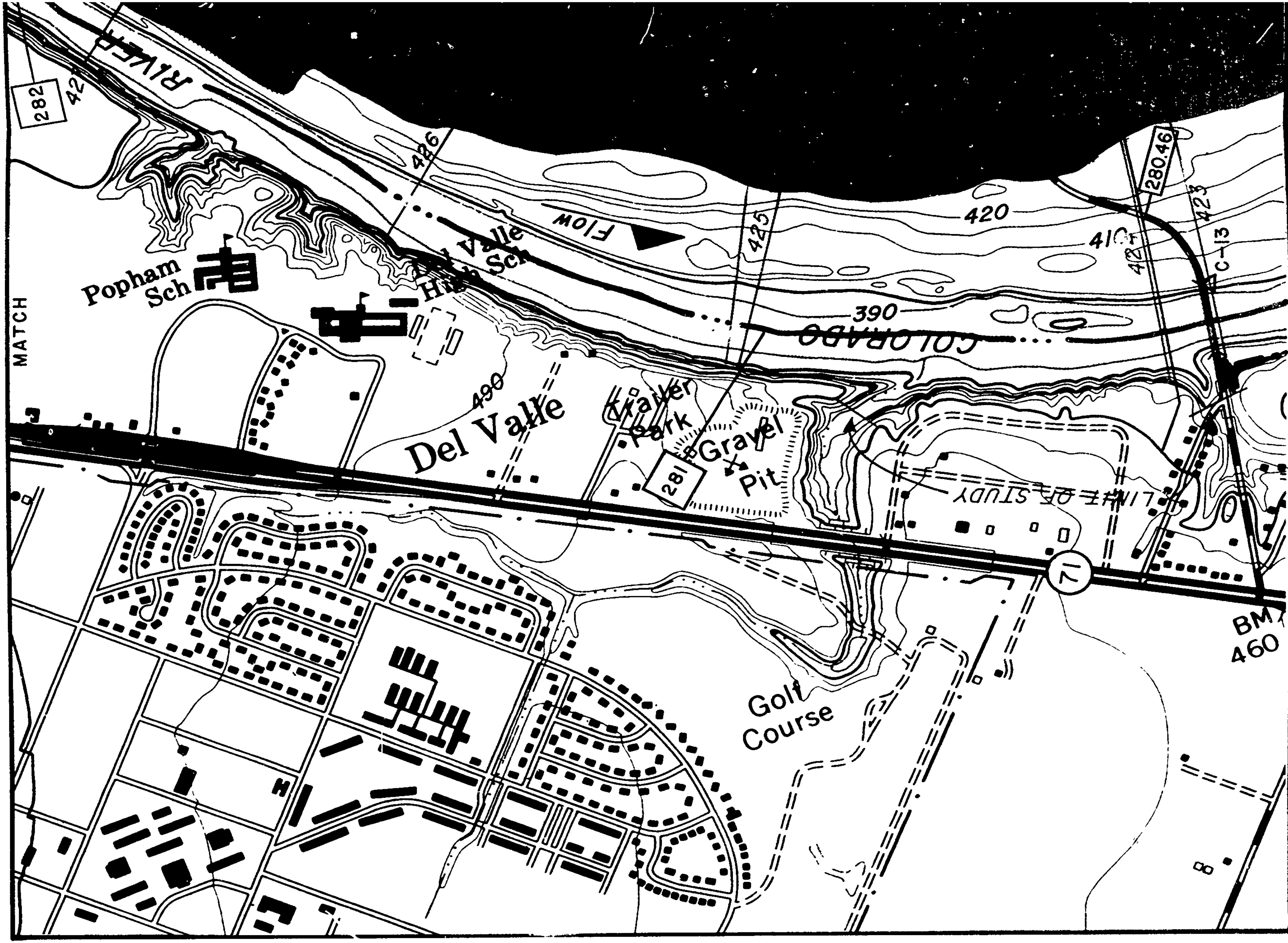
N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

COLORADO RIVER

SCALE OF FEET
0 800 1600



MATCH
282
RIVER
Popham Sch
Del Valle High Sch
Flow
426
425
420
390
COLORADO
Del Valle
490
Park
281
Gravel Pit
LIMIT OF STUDY
280.46
423
C-13
71
Golf Course
BM 460

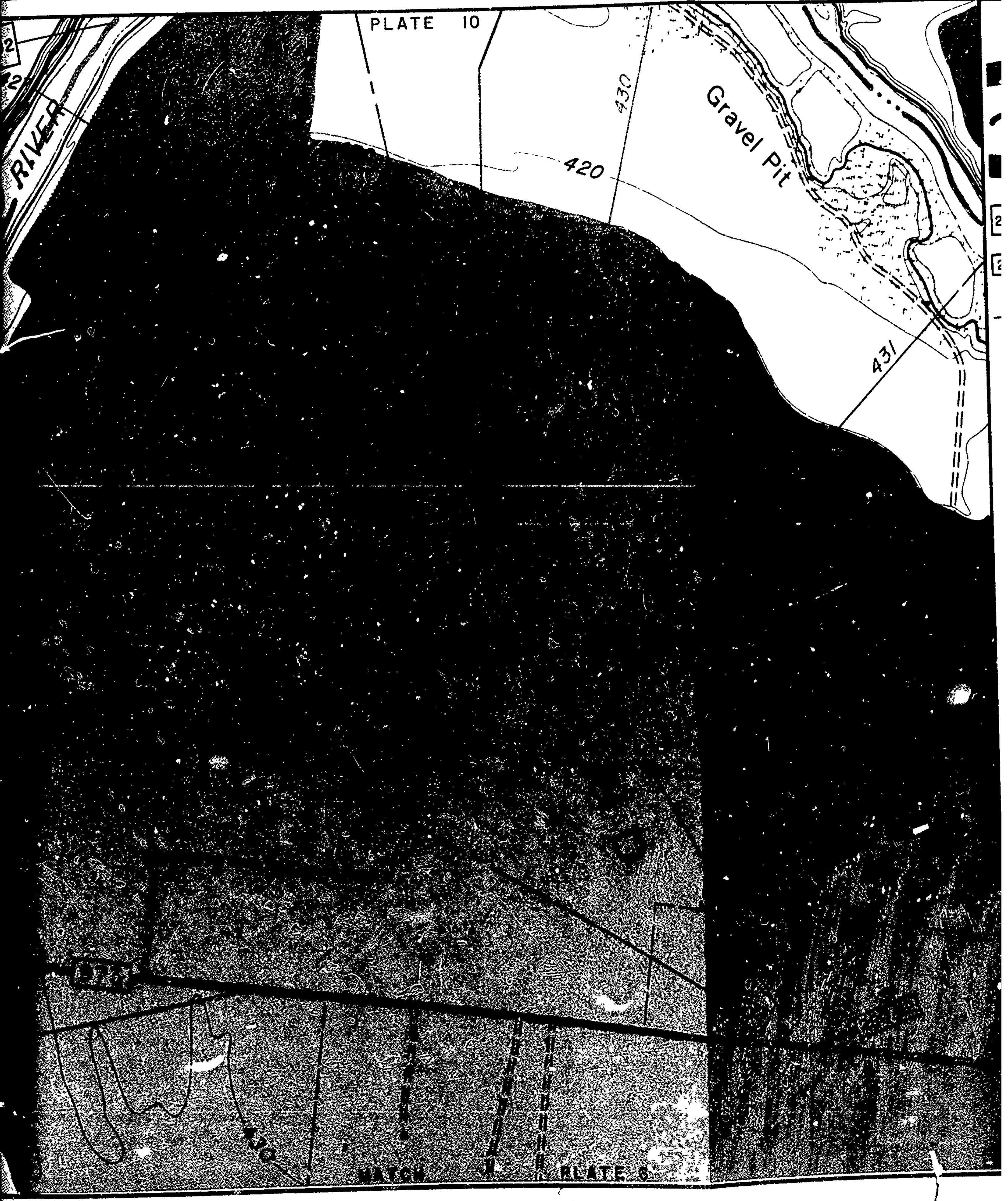
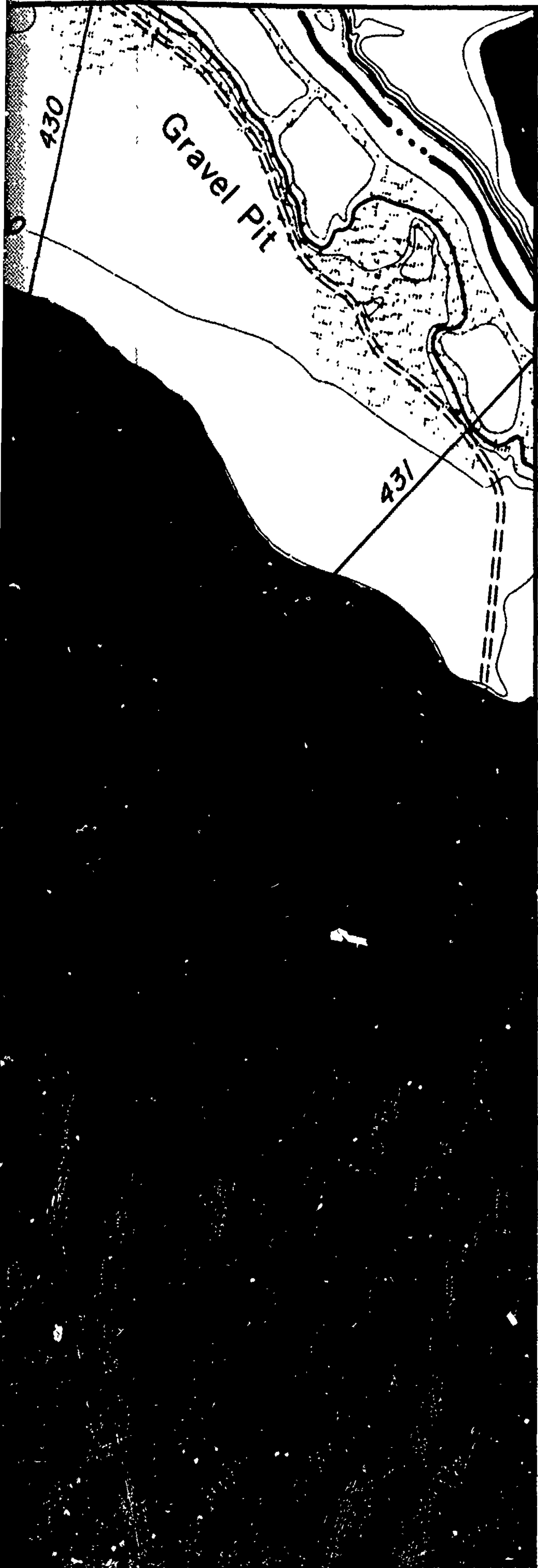


PLATE 10
RIVER
430
420
Gravel Pit
431
MATCH
PLATE 6



LEGEND

OVERFLOW LIMITS

430 STREAM BED

100 YEAR FLOOD

500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

281 — RIVER MILES

281.04 — CROSS SECTIONS

420 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S L' DATUM

△ ELEVATION REFERENCE MARK

NOTES:

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2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

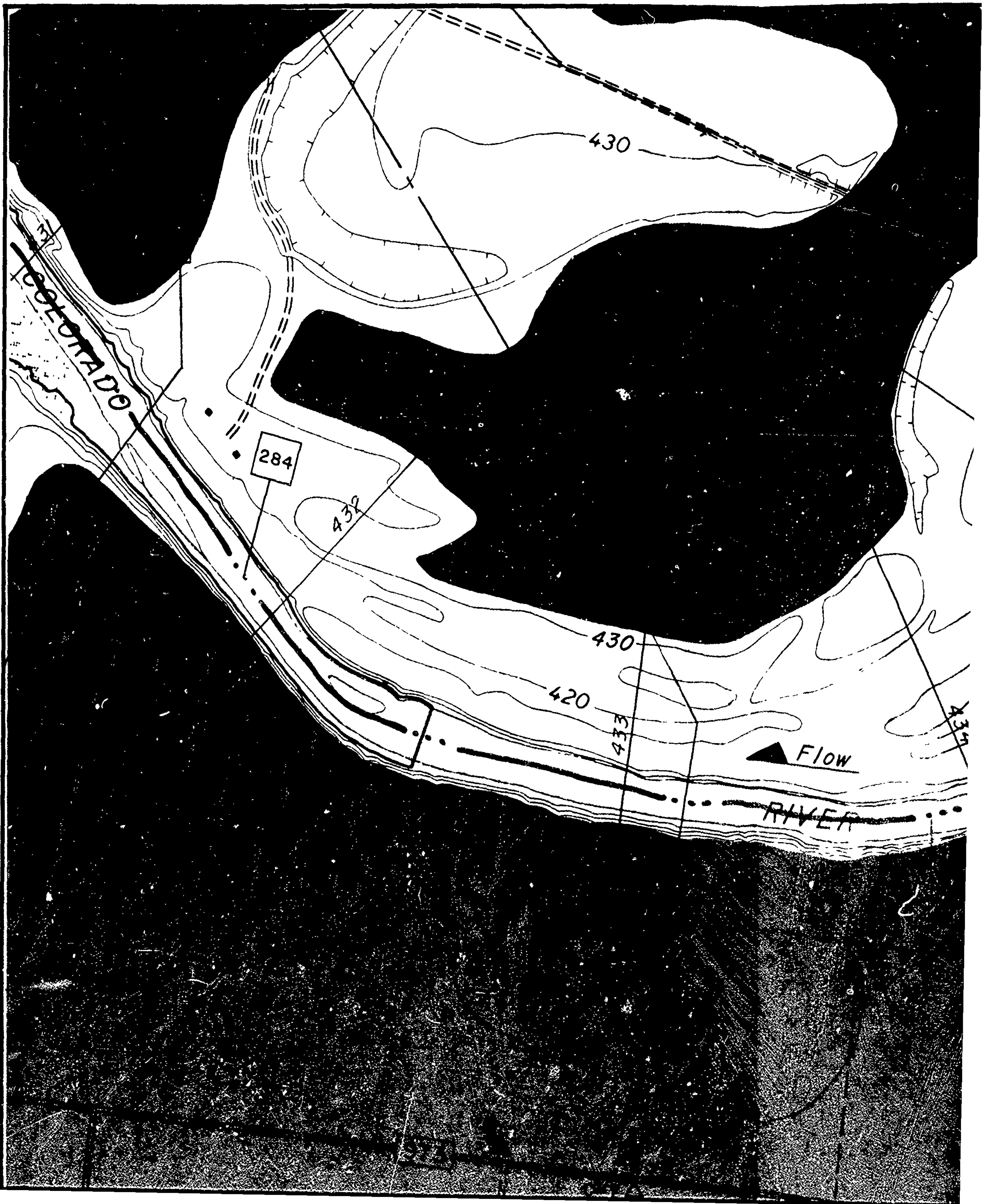
FLOODED AREAS

COLORADO RIVER

SCALE OF FEET

0 800 1600

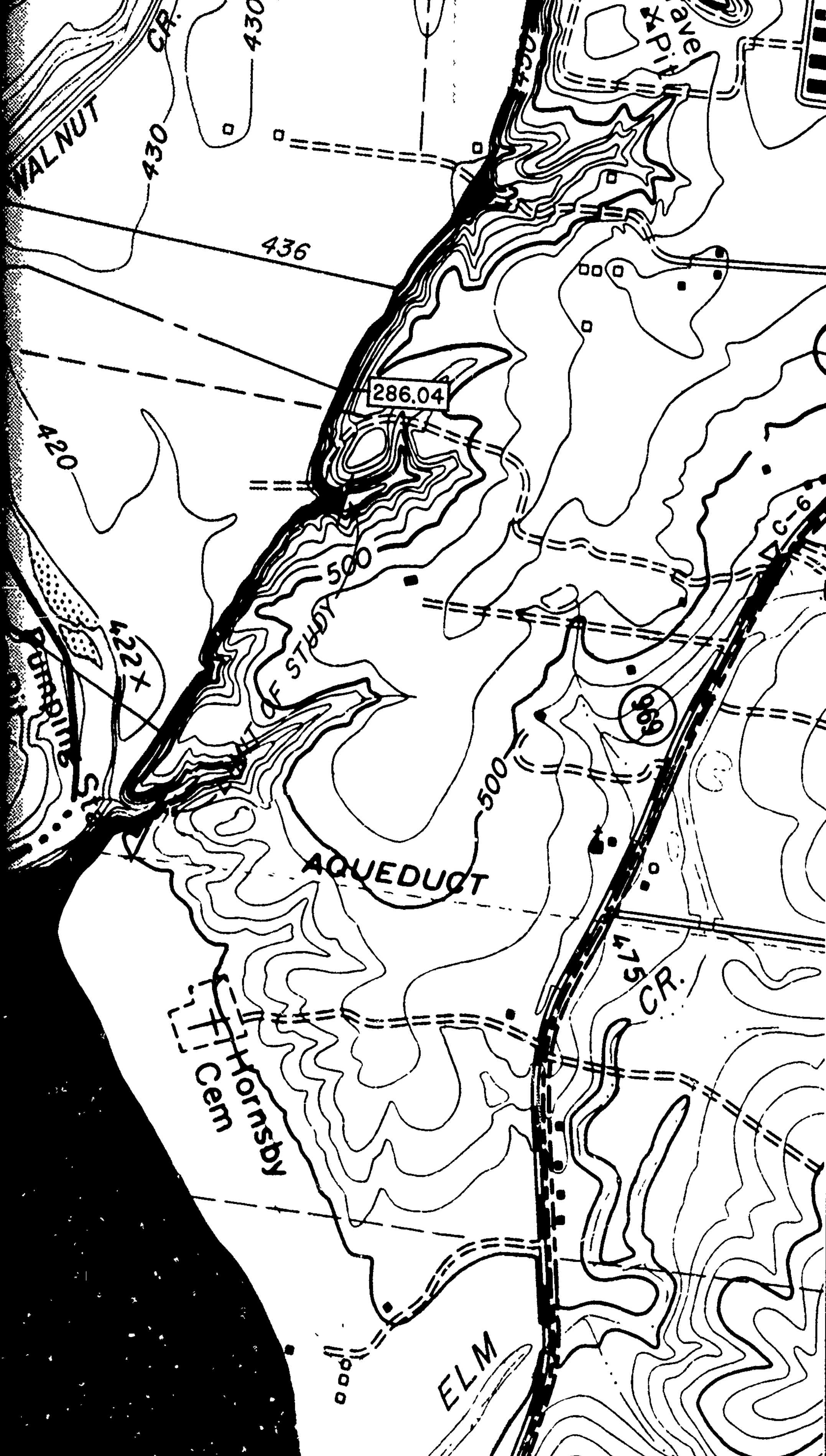
PLATE 8



430
COLORADO
284
432
430
420
433
434
Flow
RIVER


PLATE II
430
430
WALNUT CR.
436
286.04
420
435
500
500
Gravel Pit
Pumping Sta
422
AQUEDUCT
434
Flow
RIVER
Hornsby Cem
ELM
475
969

PLATE II



LEGEND

OVERFLOW LIMITS

436 STREAM BED — 100 YEAR FLOOD

100 YEAR FLOOD ELEVATION

284 — RIVER MILES

286.04 — CROSS SECTIONS

430 — GROUND ELEVATION FEET, USC & GS 19 M.S.L. DATUM

△ ELEVATION REFERE MARK

NOTES:

1. LIMITS OF OVERFLOW INDICATED WILL SOME FROM ACTUAL LOCATIONS ON GR AS EXPLAINED IN THE REPORT
2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED U. S. GEOLOGICAL SURVEY

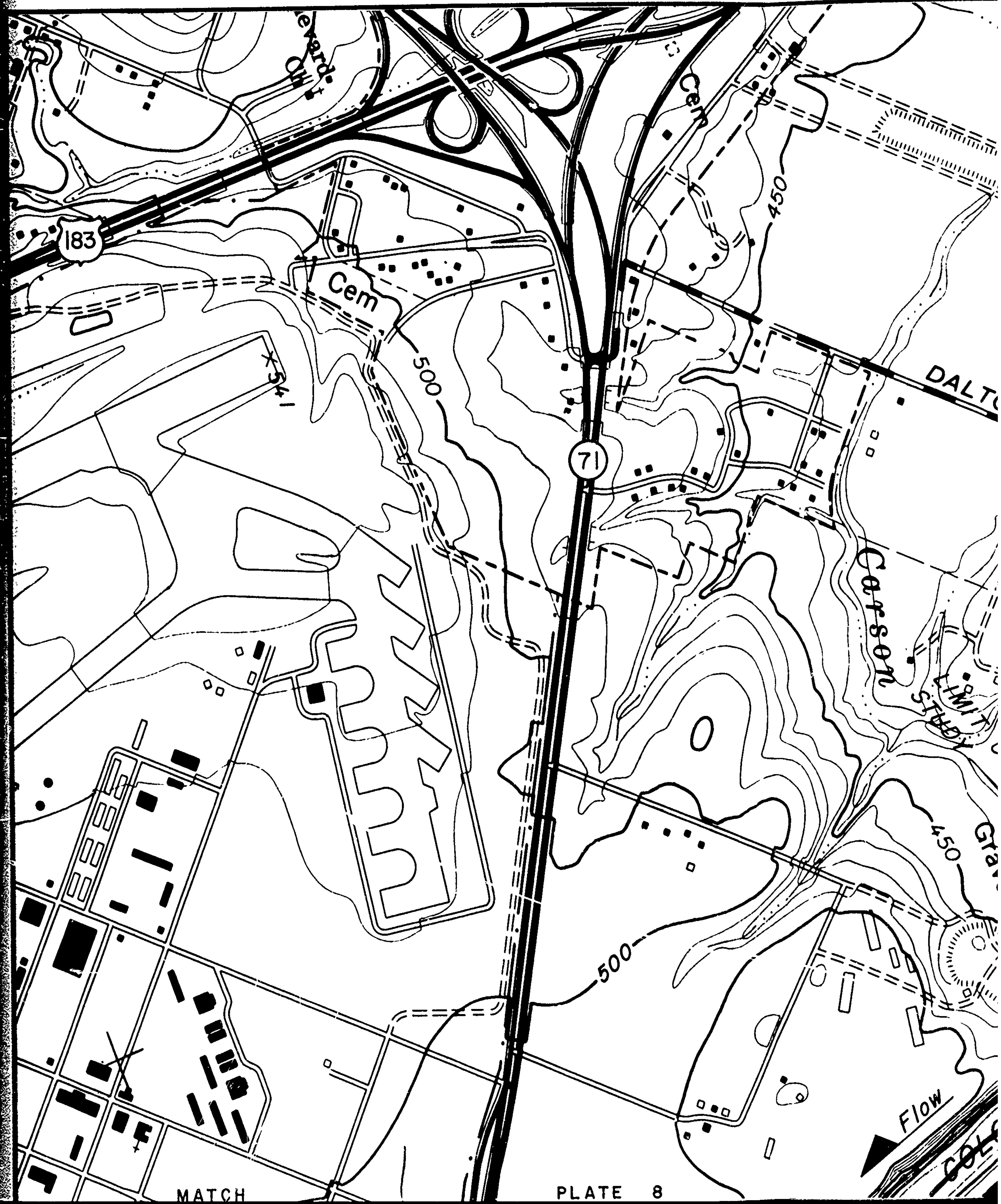
CORPS OF ENGINEERS, U.S A
FORT WORTH, TEXAS, DISTRIC

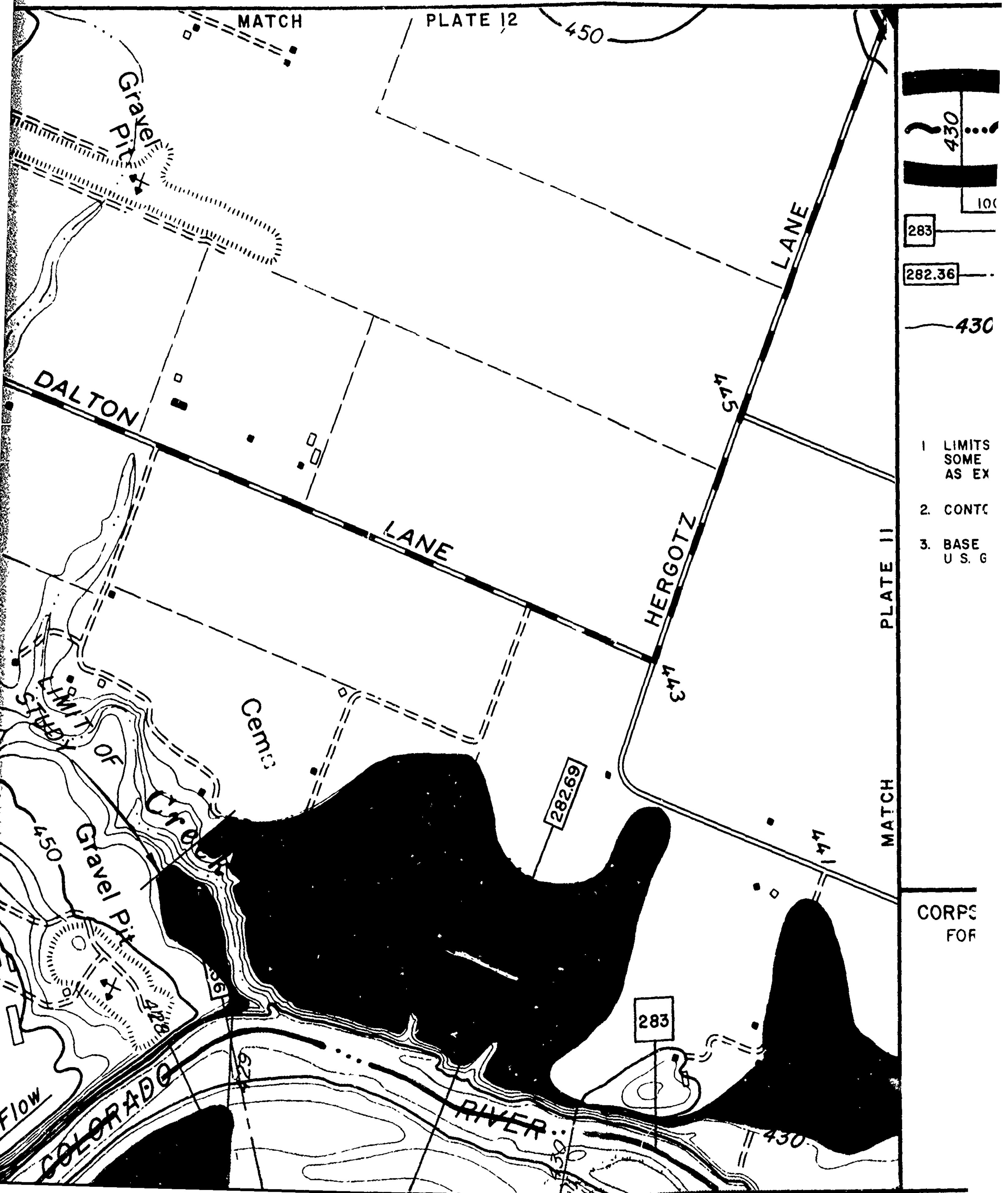
FLOODED AREAS

COLORADO RIVER

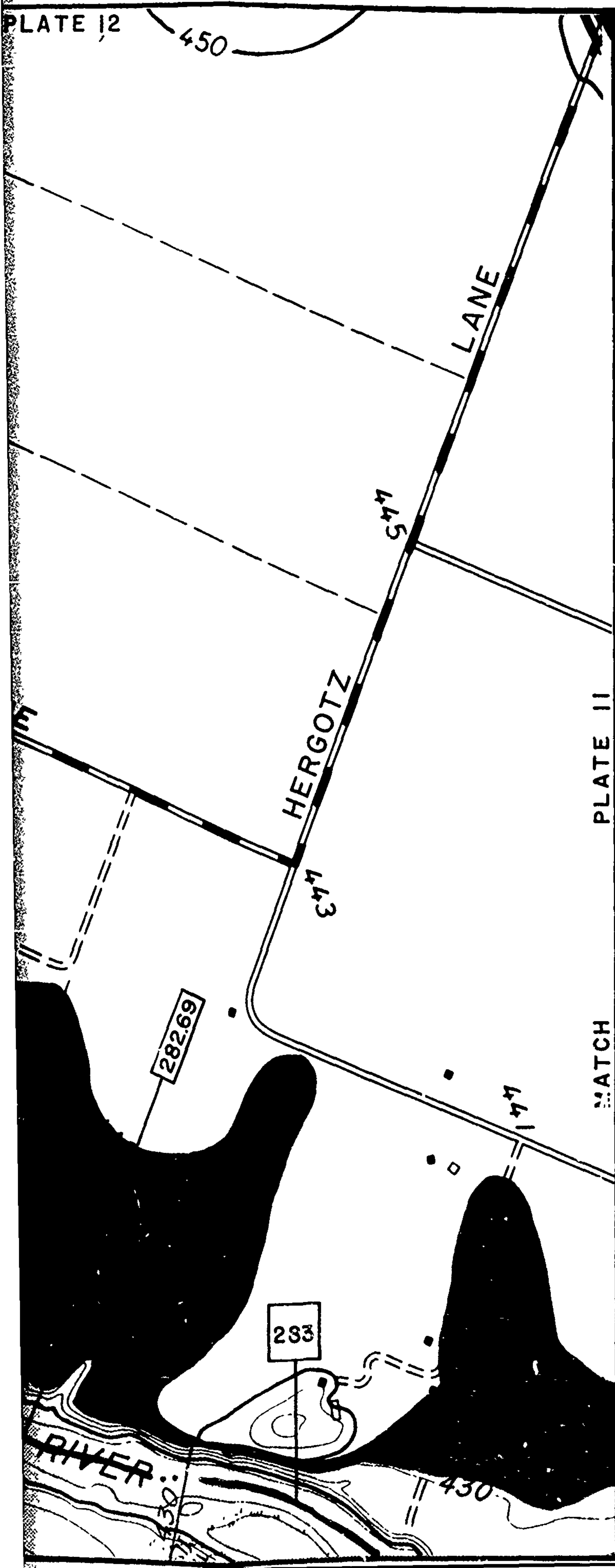
SCALE OF FEET
0 800 1600

PL


Cem
Cem
183
500
541
450
71
Carson
450
500
Flow
MATCH
PLATE 8



MATCH
PLATE 12
450
Gravel Pit
DALTON LANE
HERGOTZ LANE
PLATE 11 MATCH
Cem
LIMIT OF STUDY
Creek
Gravel Pit
450
428
282.69
283
430
Flow
COLORADO RIVER
283
282.36
430
1 LIMITS
SOME
AS EX
2. CONTC
3. BASE
U S. G
CORPS
FOR



LEGEND

OVERFLOW LIMITS

STREAM BED — 100 YEAR FLOOD — 500 YEAR FLOOD

430 — 100 YEAR FLOOD ELEVATION

283 — RIVER MILES

282.36 — CROSS SECTIONS

430 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S L' DATUM

NOTES:

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2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

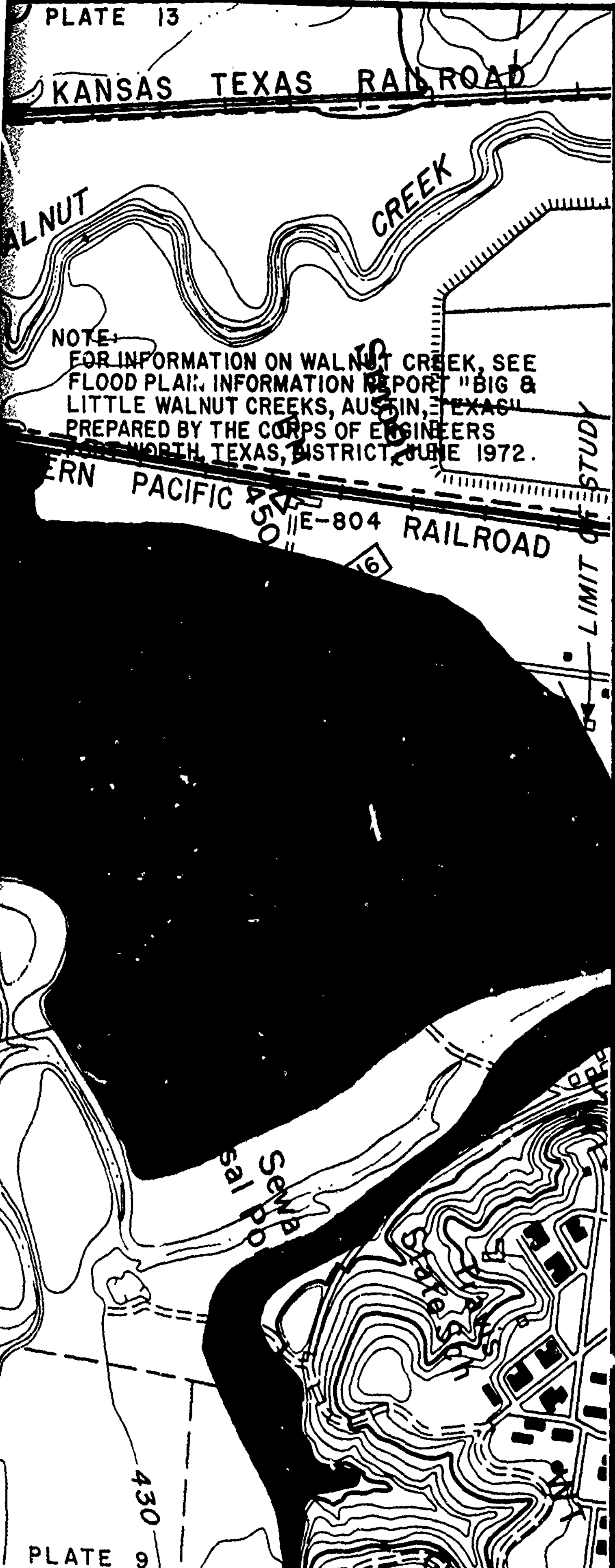
FLOODED AREAS

COLORADO RIVER

SCALE OF FEET
0 800 1600

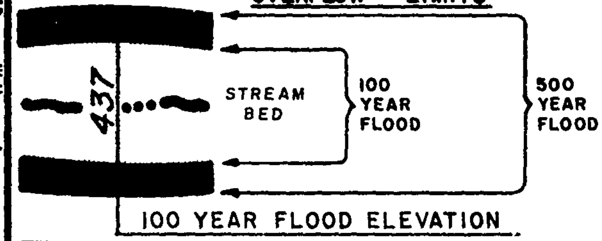
MATCH PLATE 10


MATCH
PLATE 13
MISSOURI
KANSAS TEXAS RA
BM
LIMIT OF STUDY
WALNUT
NOTE:
FOR INFORMATION ON WALNU
FLOOD PLAIN INFORMATION R
LITTLE WALNUT CREEKS, AUS
PREPARED BY THE CORPS OF E
FORT WORTH, TEXAS, DISTRICT
ERN PACIFIC
E-804
450
288
ROAD
GRAVEL PIT
COLORADO
RIVER
Flow
437
430
Sewa
sal Po
PLATE 9
2



LEGEND

OVERFLOW LIMITS



287 — RIVER MILES

287.76 — CROSS SECTIONS

440 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

△ ELEVATION REFERENCE MARK

NOTES:

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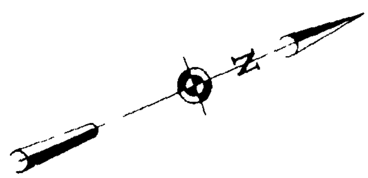
2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

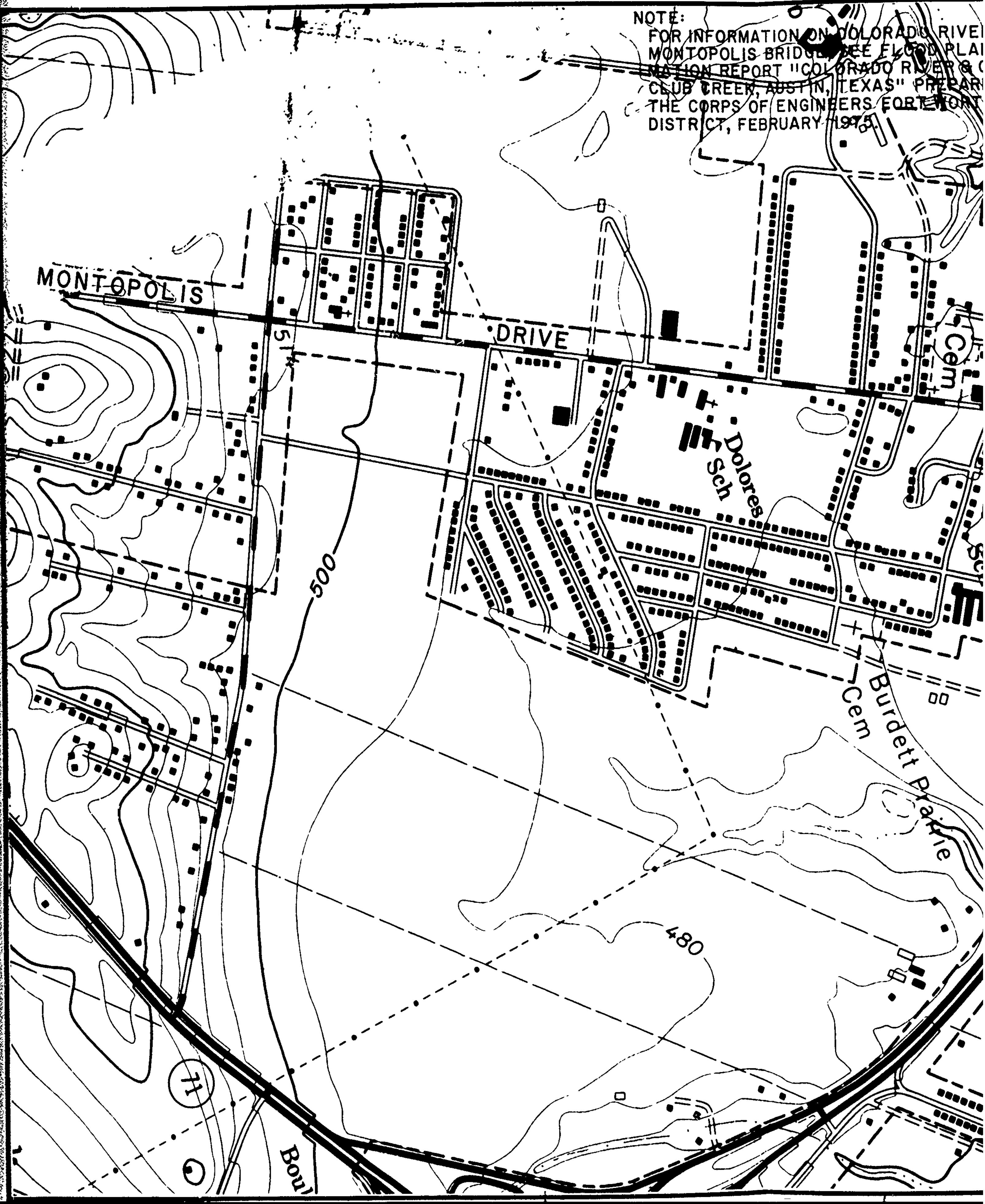


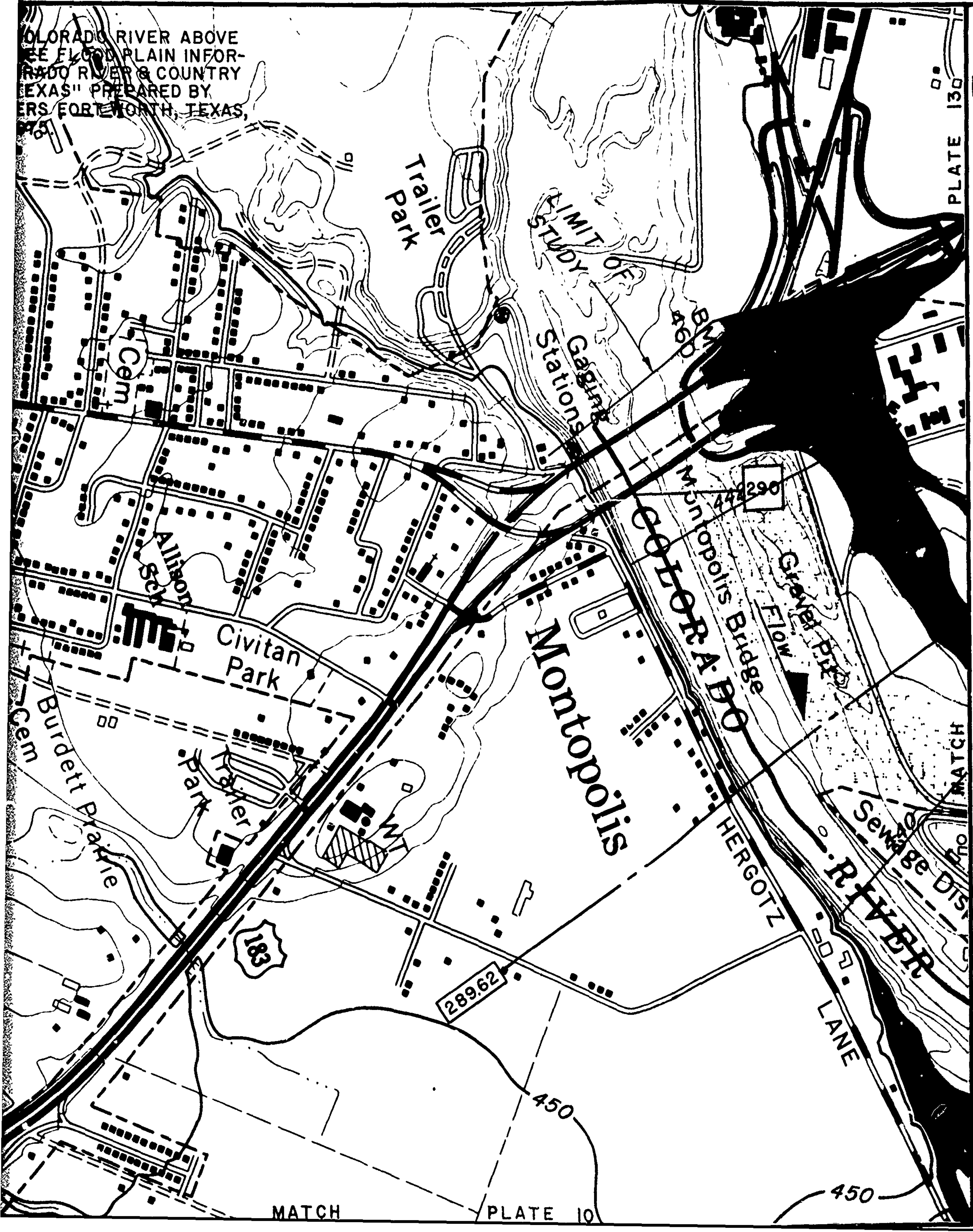
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

COLORADO RIVER

SCALE OF FEET
0 800 1600


NOTE:
FOR INFORMATION ON COLORADO
MONTOPOLIS BRIDGE
CLUB CREEK, AUSTIN, TEXAS"
THE CORPS OF ENGINEERS
DISTRICT, FEBRUARY 1975.
MONTOPOLIS
DRIVE
Dolores
Sch
Cem
Cem
Burdett Prairie
500
480
71



440

290

289.62

43

1 LIM
SOM
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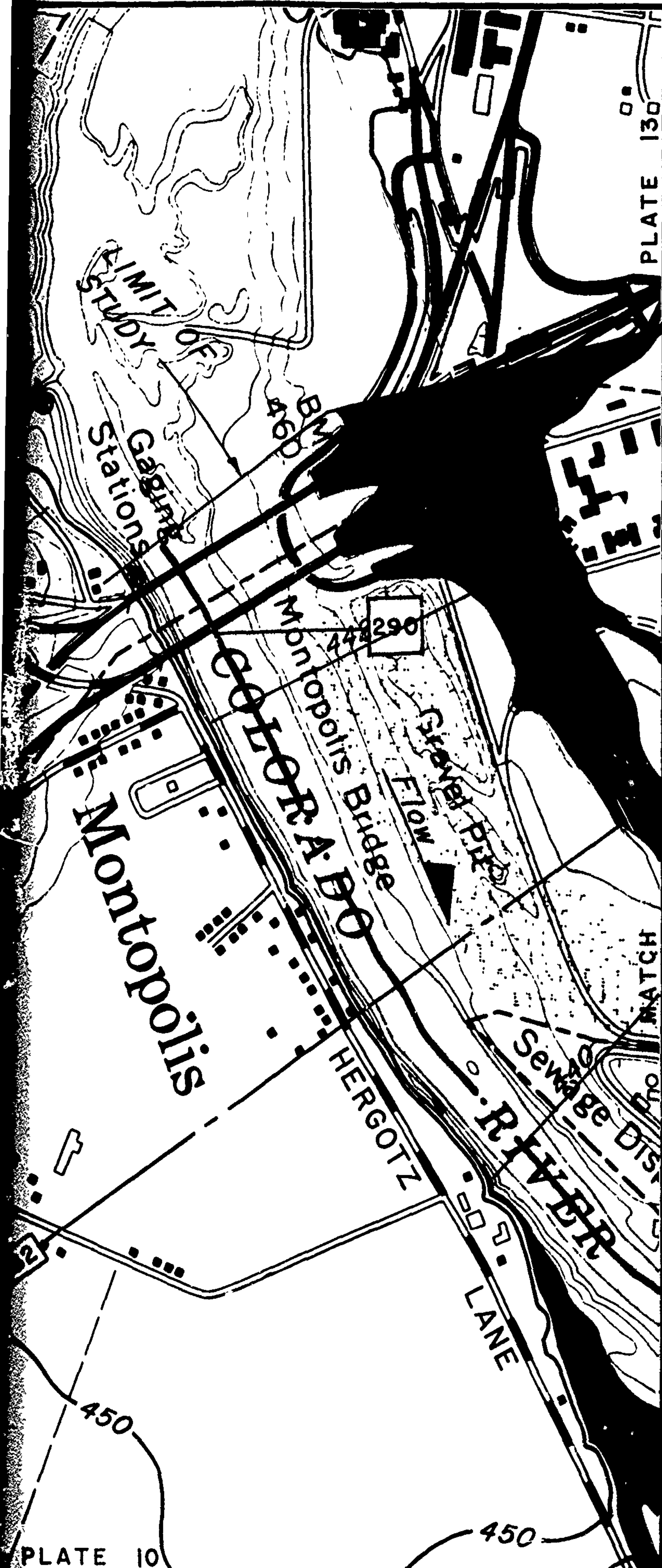
3. BAS
U. S

CORF
FC



LEGEND

OVERFLOW LIMITS

440 STREAM BED — 100 YEAR FLOOD — 500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

290 — RIVER MILES

289.62 — CROSS SECTIONS

450 — GROUND ELEVATION IN FEET, USC & GS 1929 M S L DATUM

NOTES

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2. CONTOUR INTERVAL 10 FEET
3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S GEOLOGICAL SURVEY

N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

COLORADO RIVER

SCALE OF FEET
0 800 1600

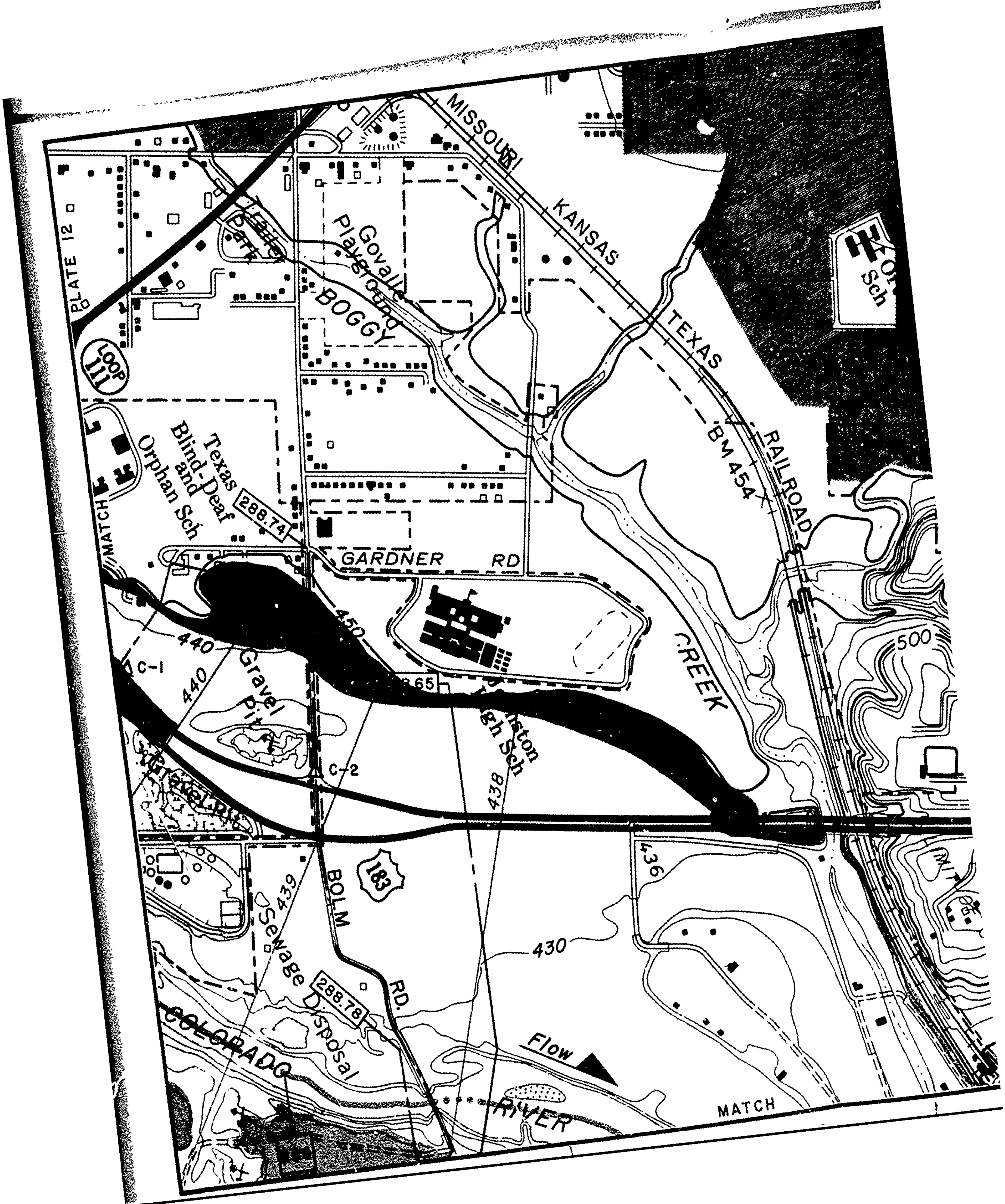

PLATE 12
LOOP 111
MISSOURI
KANSAS
TEXAS
RAILROAD
Govalle Playground
Park
BOGGY
CREEK
Texas Blind-Deaf and Orphan Sch
288.74
GARDNER RD
BM 454
450
440
440
C-1
Gravel Pit
Gravel Pit
C-2
438
500
436
183
BOLM RD.
439
Sewage Disposal
288.78
430
Flow
COLORADO
RIVER
MATCH
MATCH
Sch

PLATE 11

LEGEND

OVERFLOW LIMITS

438

STREAM BED

100 YEAR FLOOD

500 YEAR FLOOD

100 YEAR FLOOD ELEVATION

289 — RIVER MILES

289.62 — CROSS SECTIONS

440 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

△ ELEVATION REFERENCE MARK

NOTES:

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3. BASE TOPOGRAPHIC MAPS PUBLISHED BY U. S. GEOLOGICAL SURVEY

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CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

COLORADO RIVER

SCALE OF FEET

DESIGNATION	DESCRIPTION
C-1	Chiseled square on concrete base for south... at 1 bound traffic lane of Ed Bluestein Boulevard. M of Bolm Road and Ed Bluestein Boulevard.
C-2	Chiseled square on concrete located 2.0 feet eas island in center of Bolm Road. Mark is located of Bolm Road and southwest bound traffic lane of
E-804	Standard brass USC&GS cap set in a concrete post Said marker is 1.8 mile east along T&NO Railroad southwest from mile post 109, 25 feet southwest warehouse.
C-6	60-penny nail in a guy pole located on southwest Road and Imperial Drive. Said nail is facing in
C-7	60-penny nail in a power pole located in east R southwest along FM 973 from intersection with W metal gate in opposite R.O.W. fence.
C-8	60-penny nail in a power pole in east R.O.W. of FM 973 from intersection with Platt Lane.
C-13	Chiseled square on end and center of the walk a Colorado River.
C-15	60-penny nail in a power pole on south side of mile southwest along Hunter Bend Road from inte
C-16	60-penny nail in a power pole on the southeast Road and a gravel county road to the east. Sai Hunter Bend Road from Hunter Cemetery.

*1929 Mean Sea Level Datum

DESCRIPTION	ELEVATION*
base for south[illegible] leg of a large road sign across west uestein Boulevard. Mark is 0.4 mile west from intersection in Boulevard.	437.71
located 2.0 feet east of extreme west tip of a traffic ad. Mark is located about 280 feet west from intersection bound traffic lane of Ed Bluestein Boulevard.	440.32
t in a concrete post which projects 0.4 foot above ground. along T&NO Railroad from the station in Austin, 130 feet , 25 feet southwest of southwest side of a sheet metal	449.54
located on southwest corner of intersection of Webberville id nail is facing intersection.	482.83
e located in east R.O.W. line of FM 973 and being 1.25 mile intersection with Webberville Road. There is a large silver, . fence.	440.22
e in east R.O.W. of FM 973 being 0.4 mile southwest along h Platt Lane.	436.86
enter of the walk at northeast corner of FM 973 bridge over	415.95
e on south side of sharp bend in Hunter Bend Road and 0.6 Bend Road from intersection with FM 969.	440.06
e on the southeast corner of the intersection of Hunter Bend d to the east. Said intersection is 0.35 mile southerly along Cemetery.	417.73

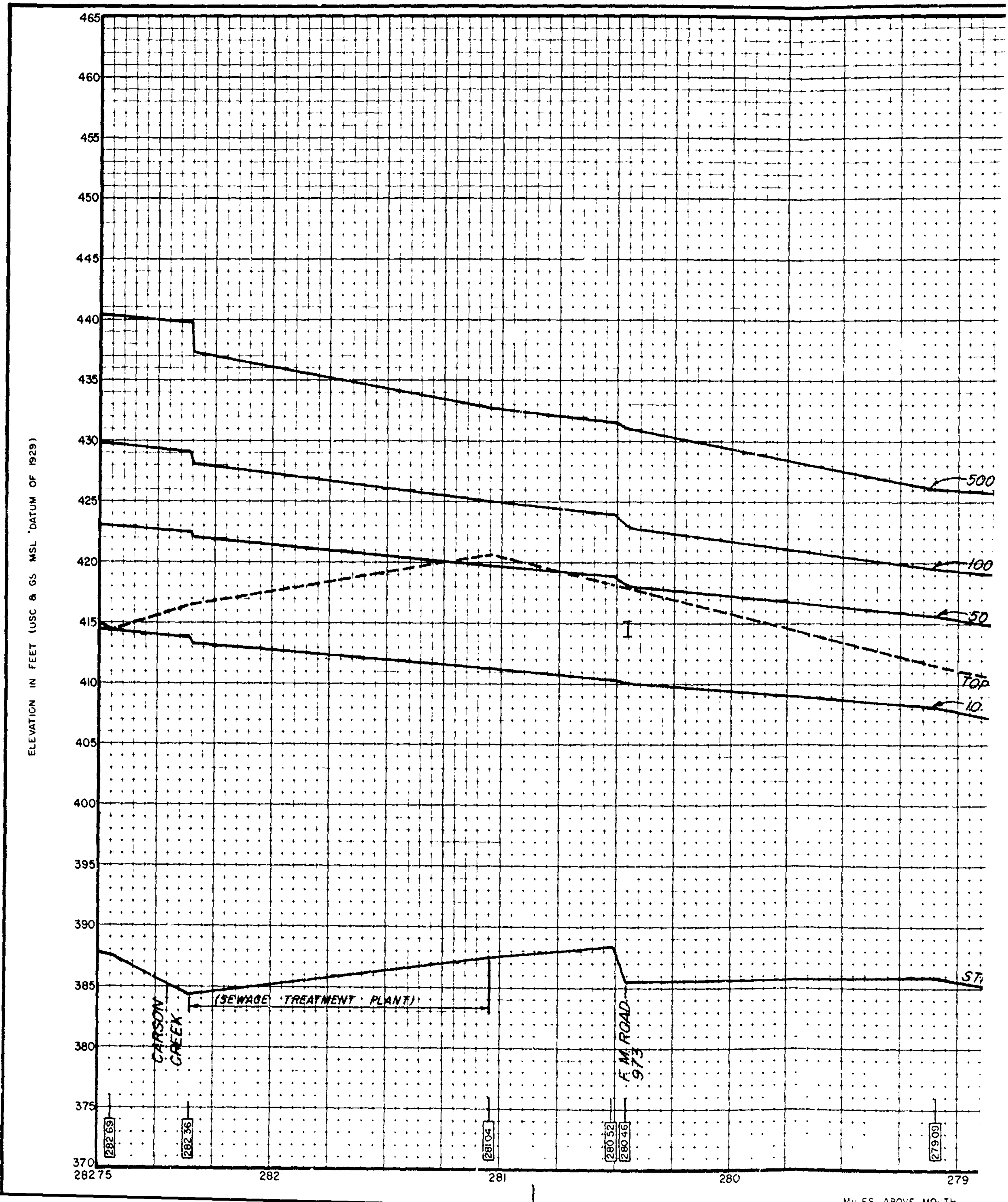
	ELEVATION*
ss west tersection	437.71
raffic ersection	440.32
ve ground. 130 feet metal	449.54
ebberville	482.83
1.25 mile large silver,	440.22
st along	436.86
ridge over	415.95
and 0.6	440.06
Hunter Bend utherly along	417.73

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

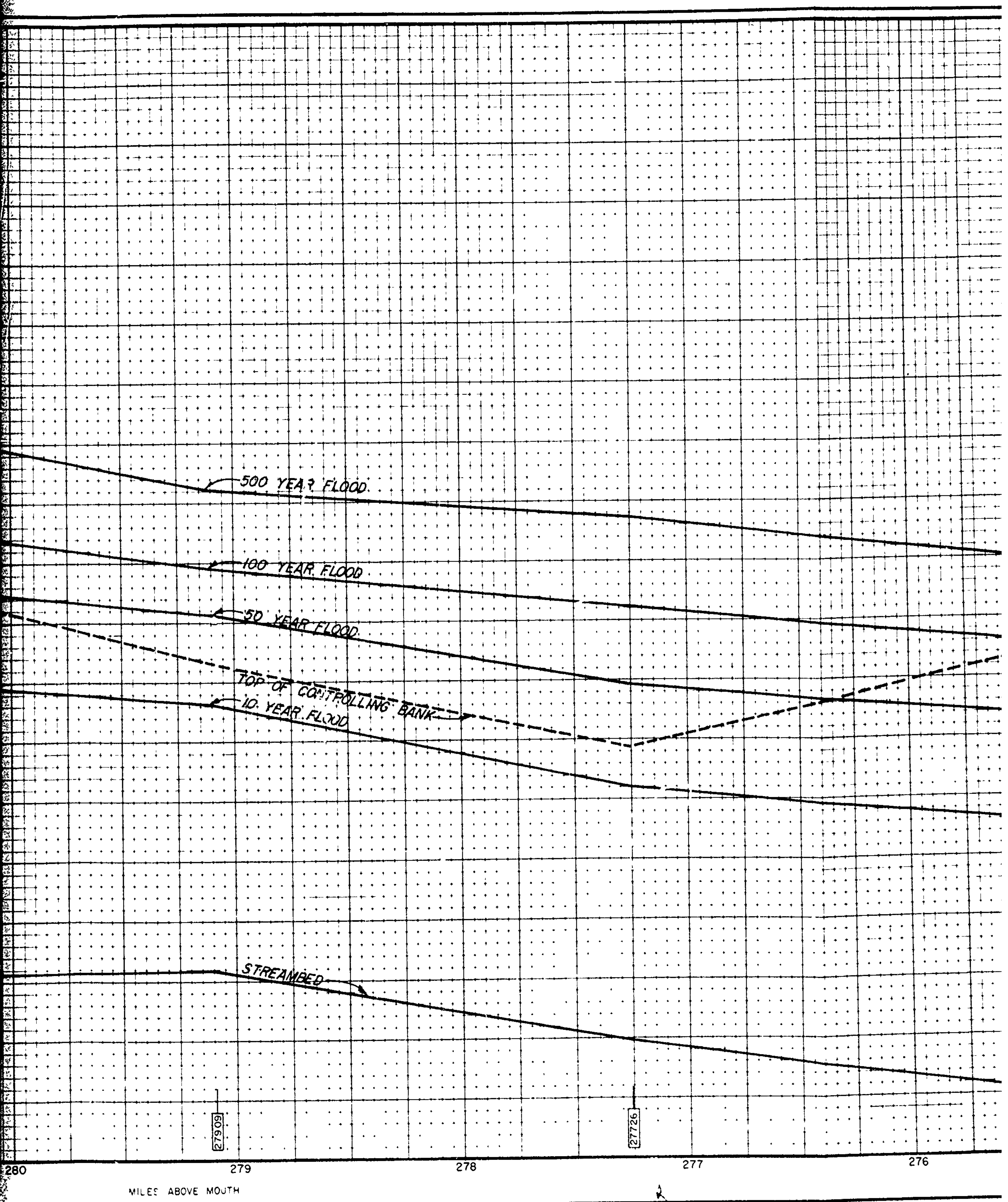
ELEVATION REFERENCE MARKS

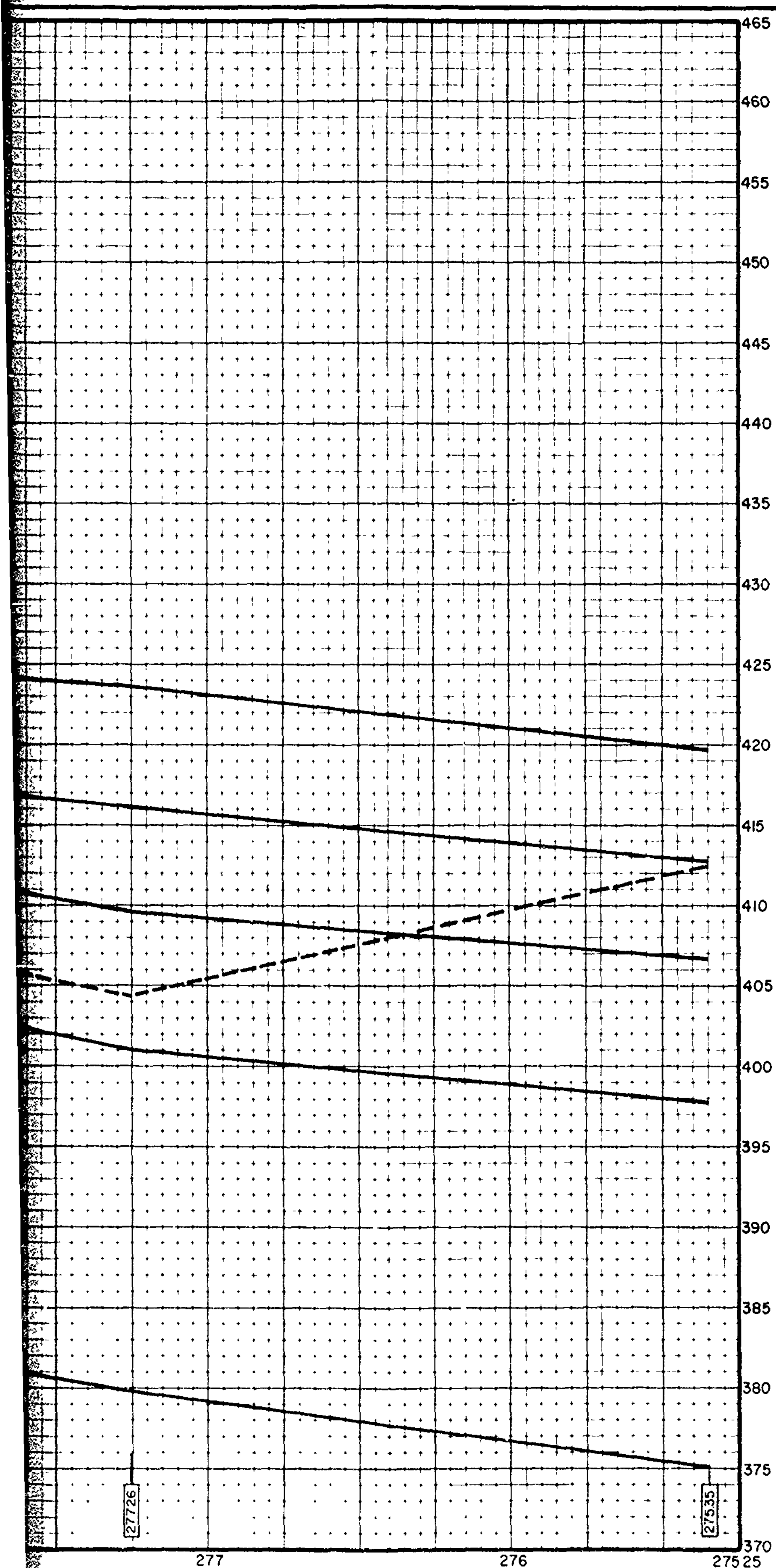
COLORADO RIVER

ONION CREEK TO
MONTOPOLIS BRIDGE



ELEVATION IN FEET (USC & GS MSL DATUM OF 1929)
465
460
455
450
445
440
435
430
425
420
415
410
405
400
395
390
385
380
375
370
500
100
50
TOP
10
ST
CARSON CREEK
(SEWAGE TREATMENT PLANT)
F. M. ROAD 973
282.69
282.36
281.04
280.52
280.46
279.09
282.75
282
281
280
279
MILES ABOVE MOUTH


500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
TOP OF CONTROLLING BANK
10 YEAR FLOOD
STREAMBED
27909
27726
280
279
278
277
276
MILES ABOVE MOUTH



LEGEND

279.09 CROSS SECTION

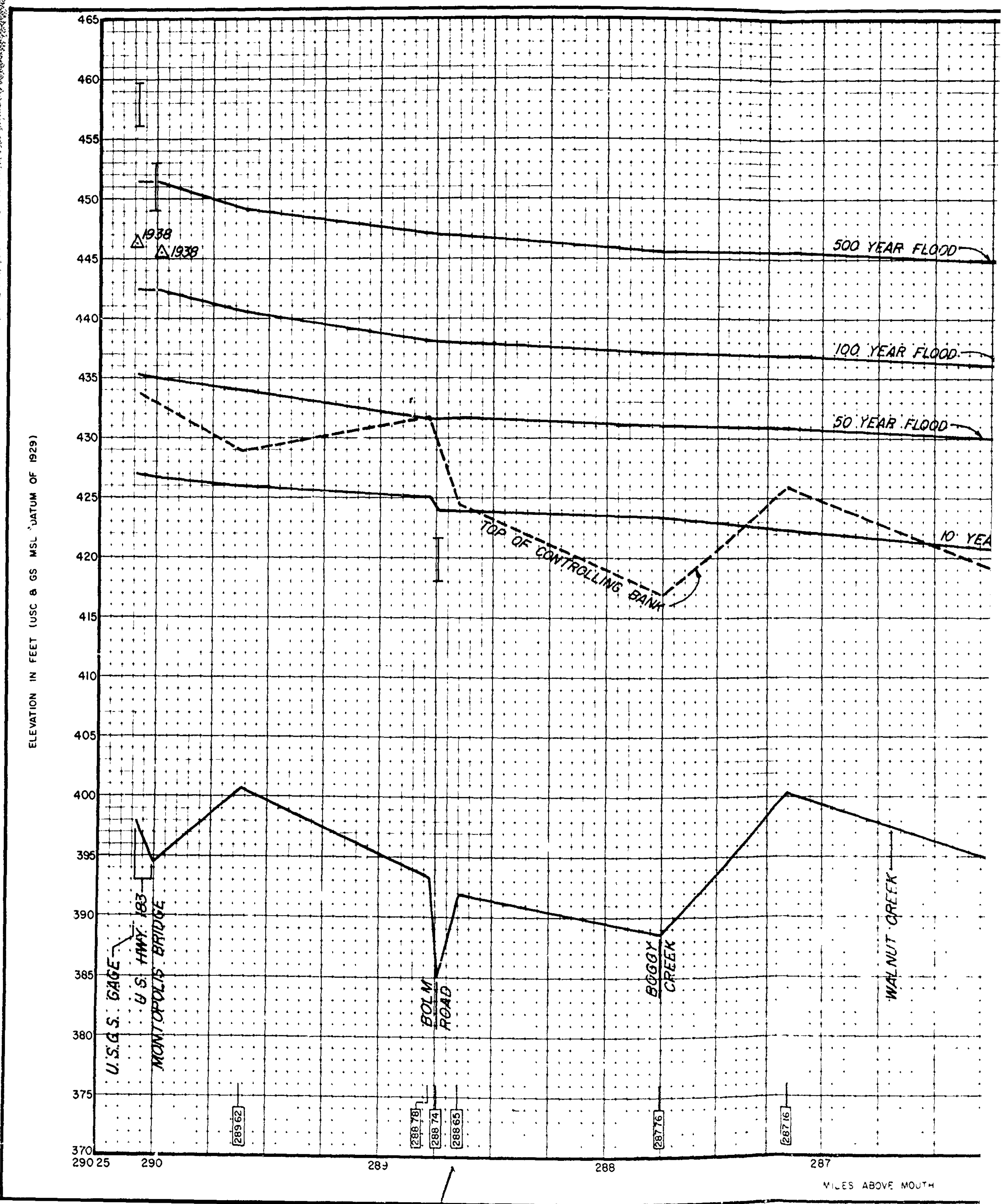
FLOOR

LOW STEEL

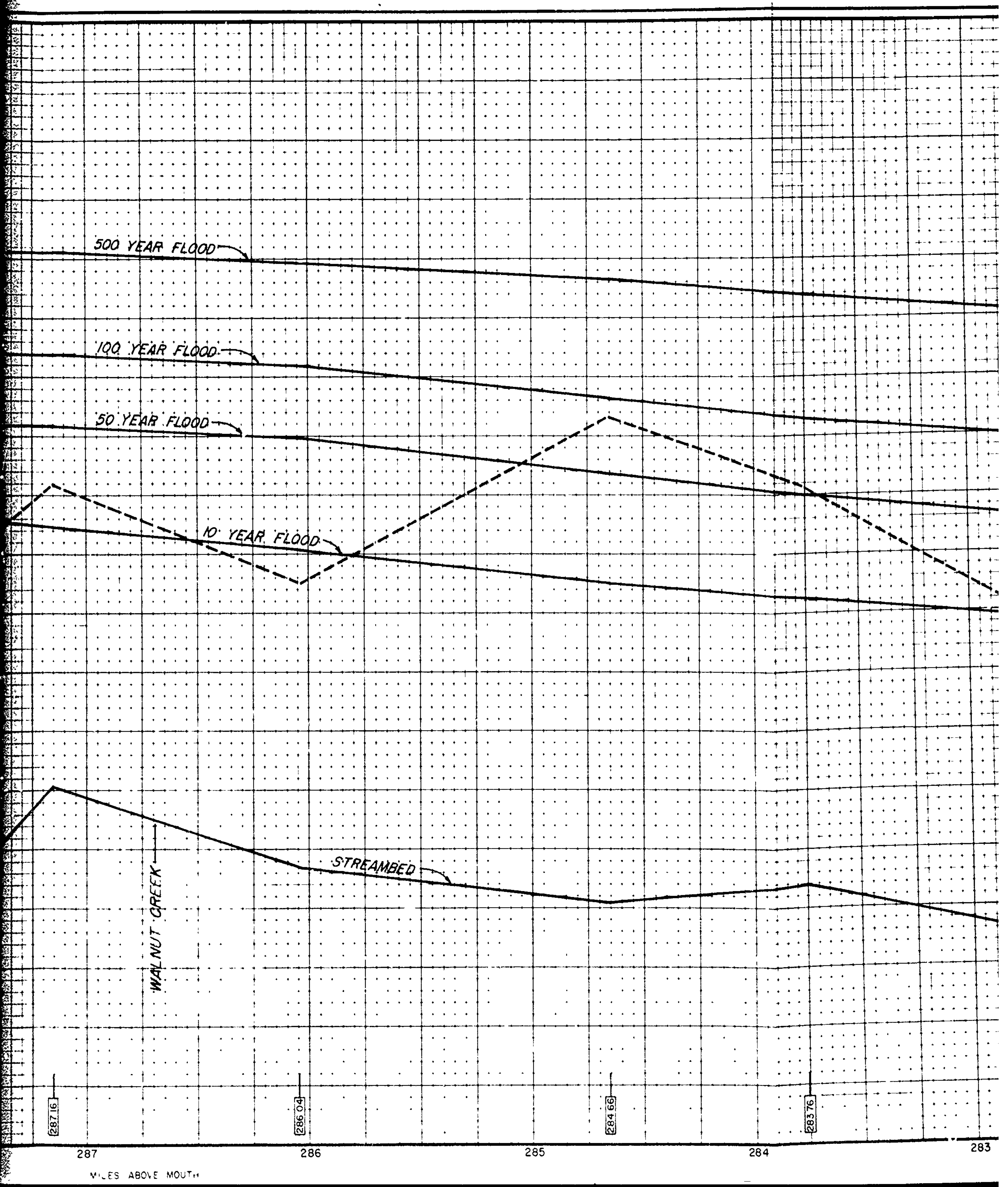
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

HIGH WATER PROFILES

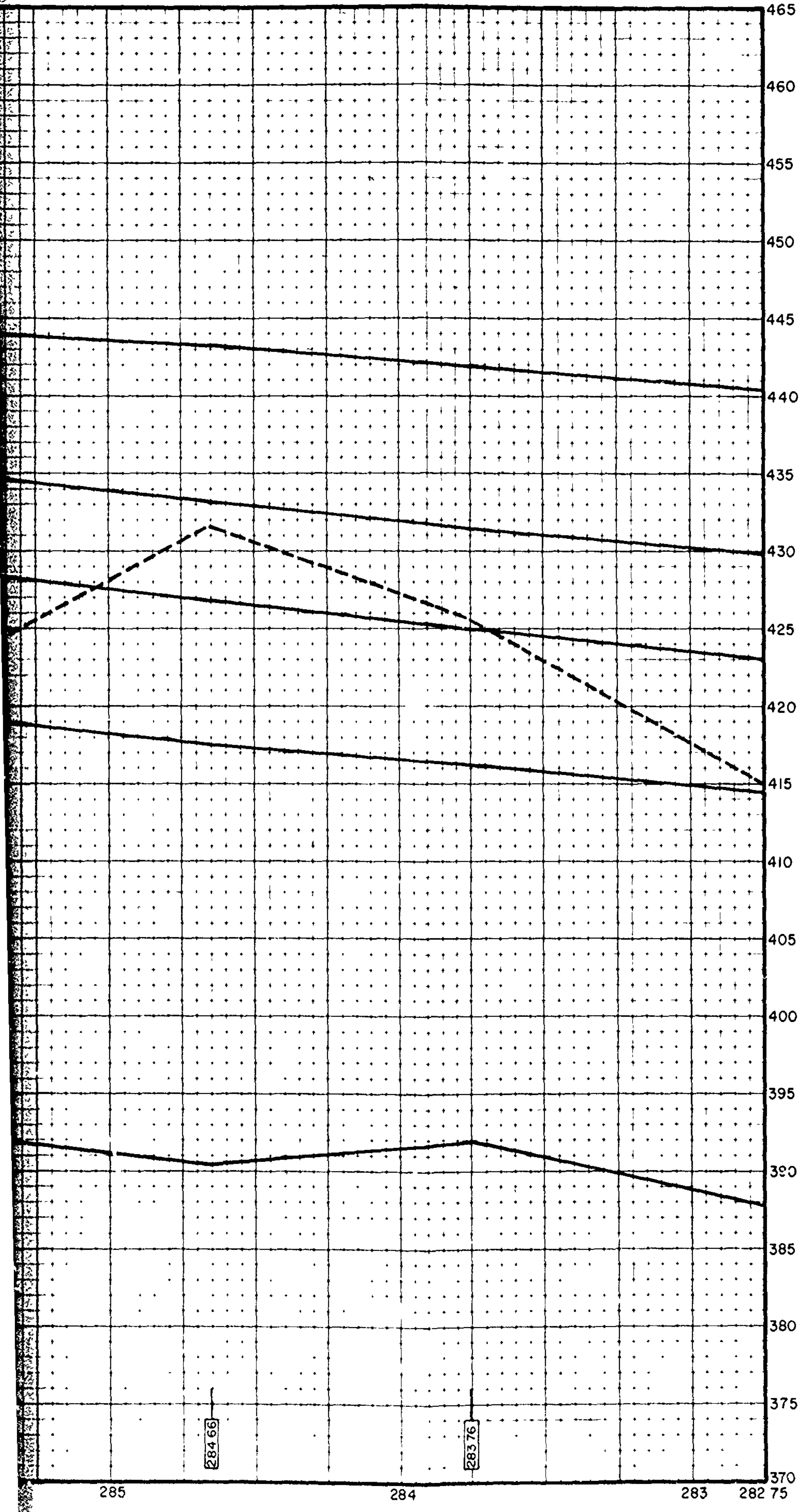
COLORADO RIVER



ELEVATION IN FEET (USC & GS MSL DATUM OF 1929)
465
460
455
450
445
440
435
430
425
420
415
410
405
400
395
390
385
380
375
370
1938
1938
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEA
TOP OF CONTROLLING BANK
U.S.G.S. GAGE
U.S. HWY. 183
MONTOPOLIS BRIDGE
BOLM ROAD
BOGGY CREEK
WALNUT CREEK
28962
28878
28874
28865
28776
28716
290 25
290
289
288
287
MILES ABOVE MOUTH



500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAMBED
WALNUT CREEK
287.16
286.04
284.66
283.76
287
286
285
284
283
MILES ABOVE MOUTH



LEGEND

283.76 — CROSS SECTION

FLOOR

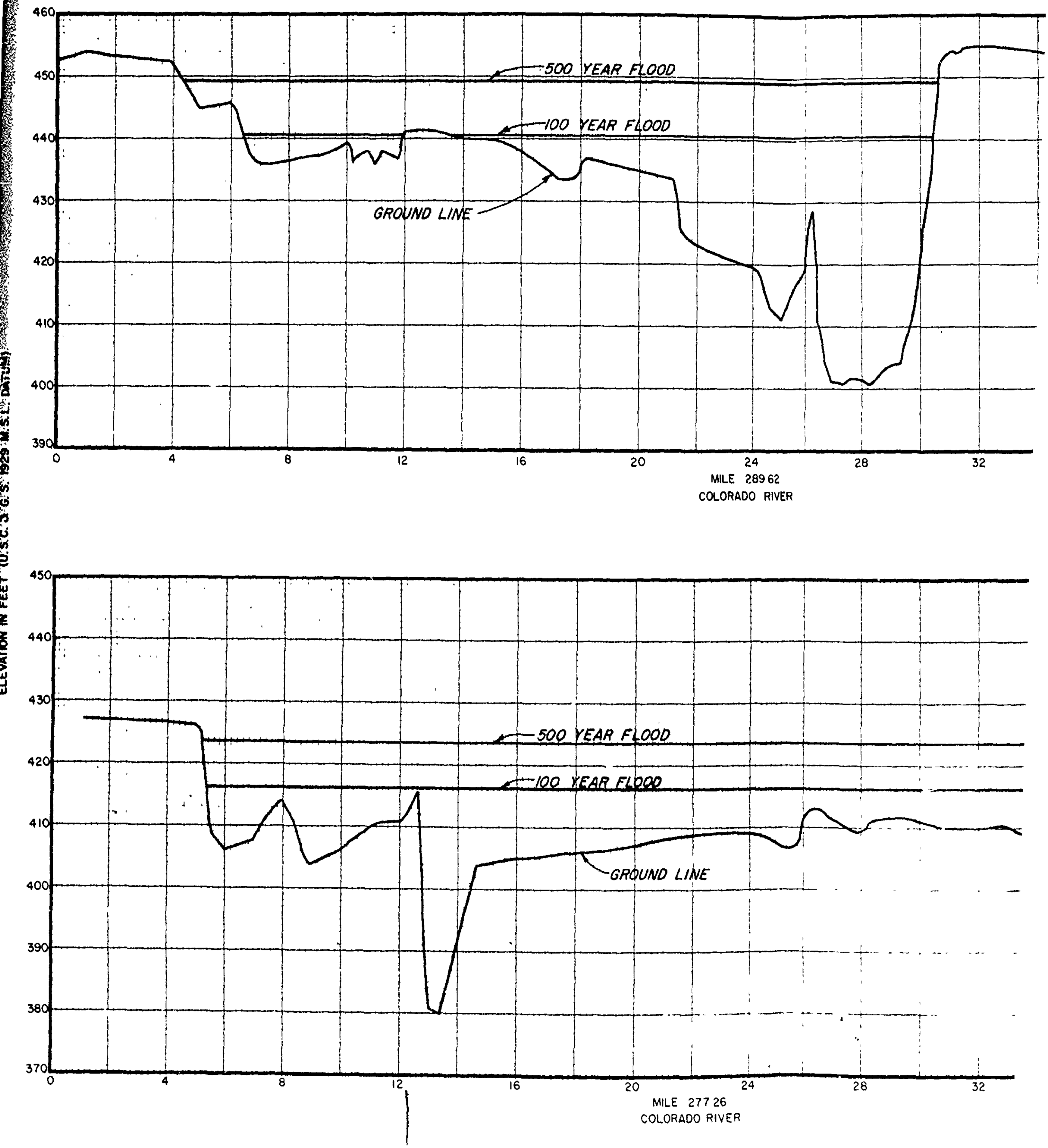
LOW STEEL

CORPS OF ENGINEERS, U. S. ARMY

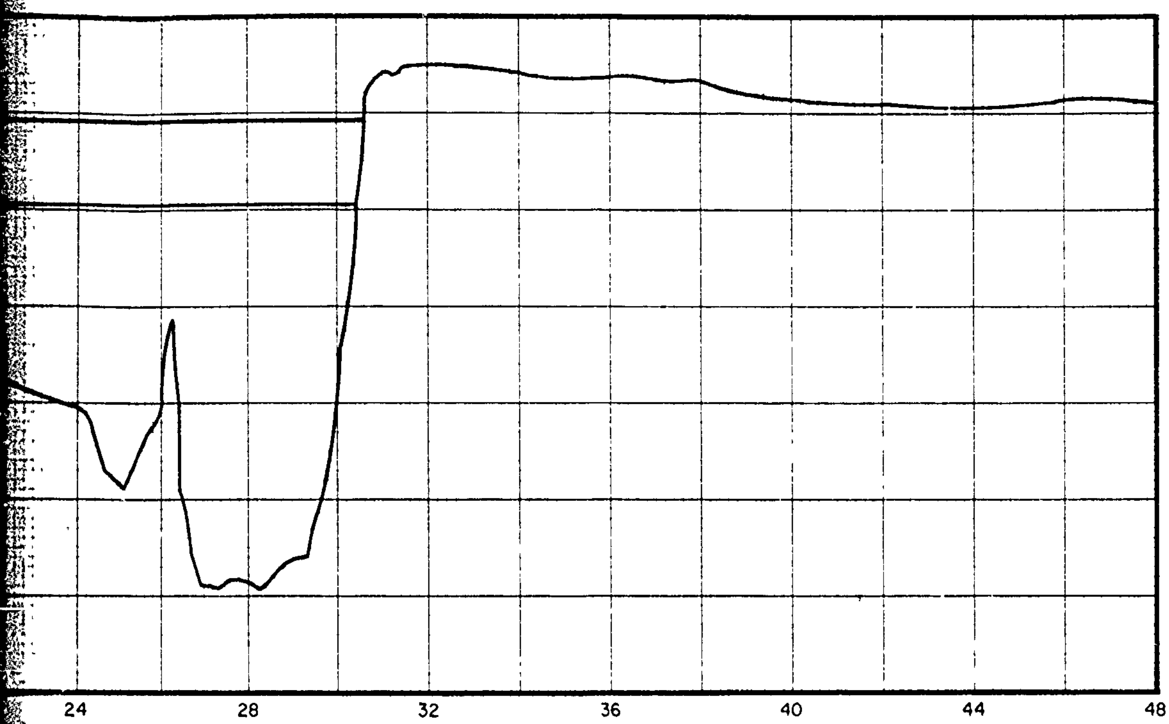
FORT WORTH, TEXAS, DISTRICT

HIGH WATER PROFILES

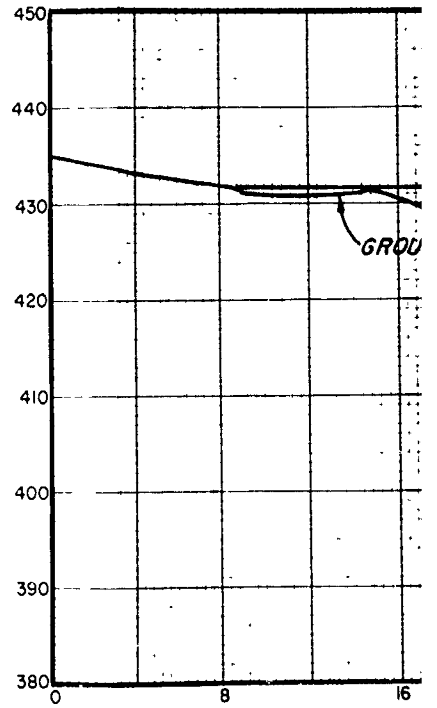
COLORADO RIVER

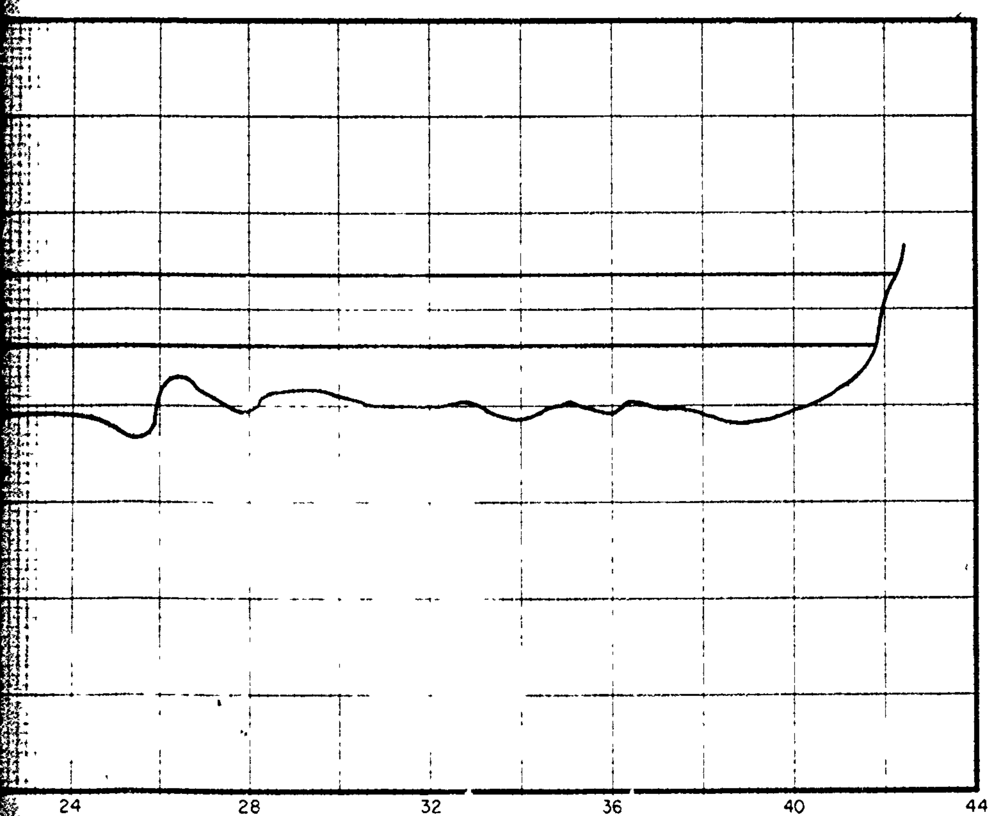


ELEVATION IN FEET (U.S.C. & G.S. 1929 M.S.L. DATUM)
500 YEAR FLOOD
100 YEAR FLOOD
GROUND LINE
460
450
440
430
420
410
400
390
0
4
8
12
16
20
24
28
32
MILE 289.62
COLORADO RIVER
500 YEAR FLOOD
100 YEAR FLOOD
GROUND LINE
450
440
430
420
410
400
390
380
370
0
4
8
12
16
20
24
28
32
MILE 277.26
COLORADO RIVER



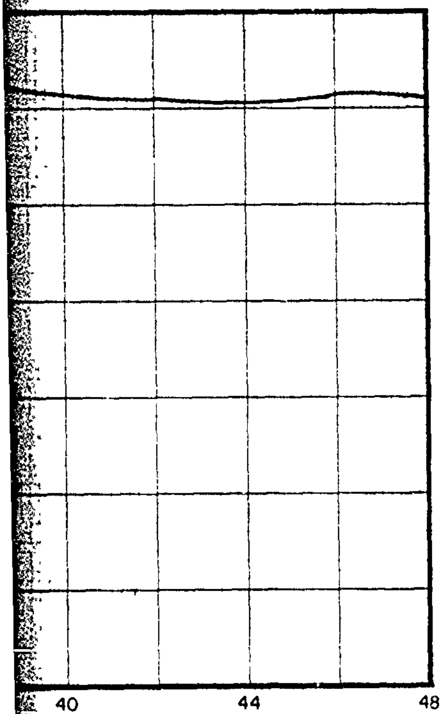
MLE 289 62
LORADO RIVER

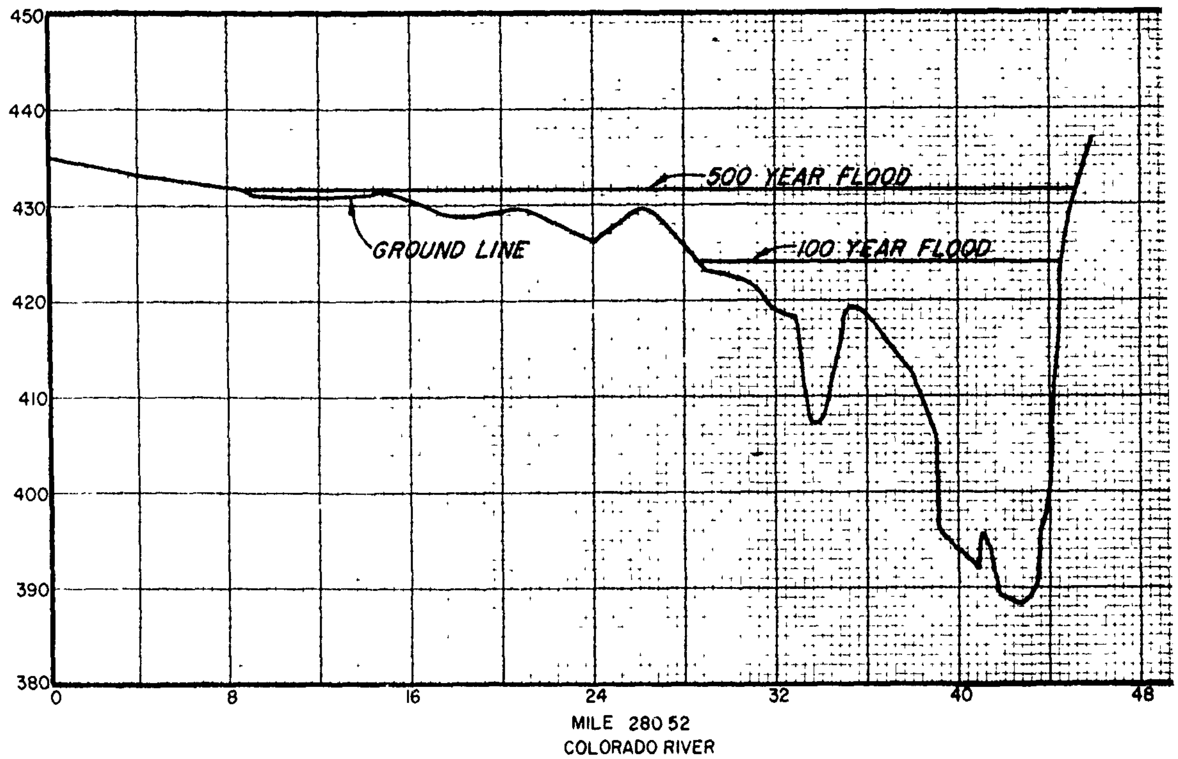


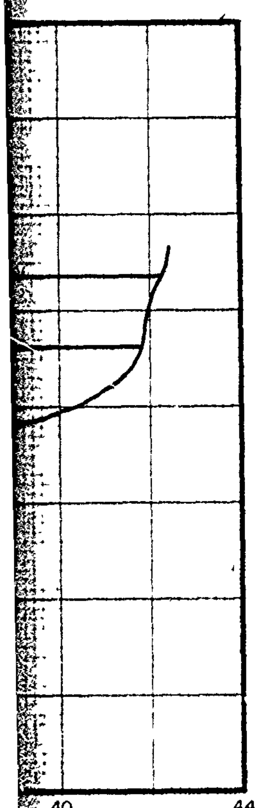


7.26
RIVER

NOTE Sections taken looking downstream
14 sections not shown







NOTE Sections taken looking downstream
14 sections not shown

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

CROSS SECTIONS

COLORADO RIVER
ONION CREEK TO
MONTOPOLIS BRIDGE