(ENGLISH TEXT)

INTERNATIONAL BOUNDARY AND WATER COMMISSION
United States and Mexico

El Paso, Texas
June 13, 1967

JOINT REPORT OF THE PRINCIPAL ENGINEERS ON THE INTERNATIONAL WORKS NEEDED IN THE UNITED STATES AND MEXICO FOR TIJUANA RIVER FLOOD CONTROL IN BOTH COUNTRIES

The Honorable Commissioners,
International Boundary and Water Commission,
United States and Mexico,
El Paso, Texas, and Ciudad Juárez, Chihuahua.

Sirs:

In pursuance of your instructions, we respectfully submit for your consideration this report on the flood problem along the Tijuana River in the United States and in Mexico, and the general plan which we recommend for its solution.

The 1944 Water Treaty provides, with respect to the Tijuana River, that the Commission shall study, investigate, and submit to the two Governments for their approval: Plans for storage and flood control to promote and develop domestic, irrigation, and other feasible uses of the waters of this system; an estimate of the cost of the proposed works and the manner in which the construction of such works or the cost thereof should be divided between the two Governments; and recommendations regarding the parts of the works to be operated and maintained by the Commission and by each Section.

Minute No. 182 of the Commission dated September 23, 1946, subsequently approved by the two Governments instructed the Consulting Engineers of the two Sections jointly to continue or to undertake studies and investigations concerning the Tijuana River to include additional storage reservoirs for flood control and for the conservation of water in years of abundance for use during years of scarcity, and the construction of levees on both sides of the stream for the protection of existing developments along the Tijuana River proper from Rodríguez Dam to the Pacific Ocean.

Need for Flood Protection

In 1946, when Minute No. 182 was approved, the City of Tijuana, Baja California, had a population of 12,000 and San Ysidro, California, nearly 1,400, and there were about 500 inhabitants along the Tijuana River in the United States, and it was recognized that there was a need to undertake joint flood protection studies.

At present, the City of Tijuana, Baja California, has nearly 275,000 population. The riparian area in the United States was annexed in 1956 to the City of San Diego with a population of 700,000. To provide areas for further urban development, the floodplain of the Tijuana River in the two countries is urgently needed. Protection of the floodplain against overflow is necessary before developments can proceed.

Recently, in November 1965 and December 1966, relatively small floods caused the loss of two lives and appreciable property damage. We believe that an international flood protection project for the Tijuana River is urgent, so as to safeguard human lives, to prevent damage to the properties of each country, and to provide for much needed expansion of urban development.

The Tijuana River

The Tijuana River and tributary drainage basin is almost triangular in shape and varies in width from 2 miles (3.2 kilometers) near the Pacific Ocean to nearly 65 miles (105 kilometers) measured along the eastern divide situated at about 60 miles (97 kilometers) east of the coast. The total area of the basin is approximately 1,700 square miles (4,426 square kilometers), of which approximately 1,200 square miles (3,126 square kilometers), 70 percent, lie in Mexico and approximately 500 square miles (1,300 square kilometers), 30 percent, in the United States. The two principal tributaries, Cottonwood Creek (Rio del Alamar), which rises in the United States, and the Rio Las Palmas, which rises in Mexico, join about 5 miles (8 kilometers) south of the international boundary

and about 11 miles (17.7 kilometers) upstream from the Pacific Ocean to form the Tijuana River.

The floodplain of the Tijuana River in Mexico from the railroad bridge to the international boundary is approximately 2.7 miles (4.3 kilometers) in length with an average width of 0.6 miles (1 kilometer), and in this distance embraces about 1,080 acres (430 hectares) in the heart of the City of Tijuana, Baja California. In the United States, the floodplain is nearly 6 miles (9.7 kilometers) in length from the boundary to the Pacific Ocean, averages about 1.3 miles (2.1 kilometers) in width, and embraces almost 5,200 acres (2,100 hectares) which now form a part of the cities of San Diego and Imperial Beach, California. Ordinary floods spread over a large part of the floodplain, and unusual floods would cover the entire plain. There are tributary arroyos in each country that discharge across the international boundary into the other country.

Three dams have been constructed in the Tijuana River basin, but the total capacity of each is designed and operated only for conservation, and no part of their capacity is allocated to flood control. They are described as follows:

Dam	Location	Yr. Completed	Capacity: Cubic Meters Thousands	Capacity: Acre-Ft.	Total Drainage Basin: Sq.Km.	Total Drainage Basin: Sq. Mi.
Rodríguez	Río Las Palmas Mexico	1936	138,000	111,900	2,533	976
Morena	Cottonwood Creek U.S.	1910	62,000	50,200	296	114
Barrett	Cottonwood Creek U.S.	1921	55,000	44,800	640	247

Two other damsites have been studied: Marron site on Cottonwood Creek (Rio del Alamar), located immediately downstream from the international boundary, with a drainage basin of 488 square miles (1,265 square kilometers), and Cancio site on the Río Las Palmas, upstream from Rodríguez Dam, with a drainage basin of 575 square miles (1,490 square kilometers). During the last 20 years the flows of the Las Palmas River and Río del Alamar have been insignificant.

as a consequence of which the study of such works as storage reservoirs has been deferred.

Design Flood

Although the existing dams in the Tijuana River basin are conservation reservoirs and have no capacity allotted for flood control, we believe that for the ordinary floods they could generally control 85 percent of the area of their drainage basins; in these conditions, the uncontrolled area would be 659 square miles (1,732 square kilometers) and with the enveloping curve of maximum floods observed in Southern California there would result a maximum flood peak of 111,000 cubic feet (3,150 cubic meters) per second.

The same observed data with respect to maximum floods in Southern California show that, if the Marron and Cancio Dams should be constructed, these together with the existing dams would not materially reduce the maximum peak flood which may be expected.

Since, under the above assumptions regarding control by existing dams, the maximum floods either with or without Marrón and Cancio Dams are practically the same, the construction of these works as flood regulating structures cannot be justified.

We have assumed that the existing storage dams partly control floods, but in the event of a storm of the dimensions of maximum floods that have occurred in Southern California, the reservoirs could be completely filled at the beginning of the flood and, in this circumstance, the flood would have a maximum flow of 135,000 cubic feet (3,820 cubic meters) per second.

We suggest that the plan most adequate for flood protection on the Tijuana River in both countries would be the construction of a flood channel to safely convey the maximum flood that can reasonably be expected through the cities of Tijuana, San Diego, and Imperial Beach.

Proposed Solution

We propose that the Tijuana River be channelized in a concrete-lined canal to begin at the railroad bridge, extending to the northwest through the City of Tijuana, Baja California, to the international boundary and having a length of 2.7 miles (4.3 kilometers); the alignment thence to veer westward following for a distance of 6 miles (9.7 kilometers) a course near the boundary, in United States territory, to discharge into the Pacific Ocean, reference attached plan.

The invert of the channel should have a constant grade throughout its entire length, except at the ends of the channel where variation in gradient would be necessary to adjust to the engineering needs of the project.

The channel cross section would have a bottom width of approximately 230 feet (70 meters) and 1.5:1 slopes. For engineering reasons, the bottom width could increase to 310 feet (95 meters) at the mouth. The cross section should provide capacity for 111,000 cubic feet (3,150 cubic meters) per second computed with a coefficient of roughness of n = 0.015 and a freeboard of 3.78 feet (1.15 meters), or the cross section could provide for a capacity of 135,000 cubic feet (3,820 cubic meters) per second calculated with a coefficient of roughness of n = 0.014 and a freeboard of 2.5 feet (0.76 meters); we believe that the waves of water that might be produced as a consequence of the current and of the bridge piling and alignment of the channel could be accommodated within the freeboards above indicated, and in case later studies show that the proposed freeboards are insufficient, they could be increased as may be found necessary.

The cross section of the channel should be provided with a pilot channel with sufficient capacity for ordinary flows and with a system of underdrainage for the control of uplift.

The channel should be provided with adequate intake structures at its entrance, and those which may be required for the tributary arroyos and other drainage; it should be provided with a transition structure at the lower end

to protect the channel from erosion due to discharges to the ocean. A maintenance road should be provided along each levee.

Division of Work and Costs

The benefits to each country of the proposed project would directly result from the portion of the works constructed in that country, and it would appear that a fair division of the works would be for each country to pay the costs of the design, construction, operation and maintenance of the part of the project located in its territory.

On the basis of field data and preliminary studies, estimates of costs for each Section of the Commission were prepared.

Estimated construction costs include engineering, design, rights-of-way, and relocations:

	Mexican Currency	United States Currency
Works in Mexico	$130,000,000	$10,400,000
Works in United States	192,500,000	15,400,000
Total Cost - International Project	$322,500,000	$25,800,000
Estimated annual cost of operation and maintenance of the works:		
In Mexico	$138,750	$11,100
In United States	212,500	17,000

Recommendations

We recommend:

1. That the plan to construct the channelization of the Tijuana River from the railroad bridge to the Pacific Ocean, which is described in this report, be adopted by the Commission as an international flood control project on the Tijuana River.
2. That each country at its own expense, and as soon as practicable, execute the design of the part of the project located in its own territory, with coordination and supervision by the Commission.

3. That each country at its expense, and as soon as practicable, simultaneously execute construction of the part of the project which is located in its own territory, with coordination and supervision by the Commission.

4. That each country at its expense perform the operation and maintenance of the part of the project which is located in its own territory, under the Commission's supervision.

Respectfully,

(signed) W. E. Walker
W. E. Walker
Principal Engineer
United States Section

(signed) N. Sánchez
Norberto Sánchez G.
Principal Engineer
Mexican Section