

**EXPLANATION**

- Flood of September 6, 1960
- Pattered where approximated
- Boundary of 1960 flood
- Dashed where approximated
- Estimated water-surface contour for 1960 flood, contour interval 1 meter. Water-surface contour not determined below elevation of 3 meters
- Kilometers measured upstream from mouth along profile base line
- Location of bridge, as listed in table 1
- Floodmark elevation, in meters above mean sea level, and year of flood

Base from U.S. Geological Survey, Puerto Rico and Yabucoa, 1943-60

SCALE 1:20,000  
1 MILE  
2 KILOMETERS

CONTOUR INTERVAL 10 METERS  
DASHED LINES REPRESENT 5-METER CONTOURS  
DOTTED LINES REPRESENT 1-METER CONTOURS  
DOTTED LINES REPRESENT 1-METER CONTOURS  
DEPTH CURVES AND SOUNDINGS IN FEET—DATHIN IS MEAN, LOW WATER  
SOUNDING SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN, HIGH WATER  
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.2 METERS



**FLOODS IN THE YABUCOA AREA, PUERTO RICO**

The lower Río Guayanés basin is virtually unprotected from high-magnitude floods. Two such floods occurred during the period 1936-60. This hydrologic atlas provides factual and interpretive information to aid the planner, designer, or any other interested person to reach rational decisions related to land use in the flood plain of the lower Río Guayanés basin. Among the data presented are stream flood profiles and the area of inundation for the September 6, 1960, flood. Area of inundation and flood profiles are specifically for valley conditions that existed at the time of the flood. All elevations are referenced to mean sea level datum.

**The basin.**—The water in Río Guayanés is derived largely from the drainage of Sierra de Cayey, about 14 kilometers west of Yabucoa, and from Cuchillo de Panduras. The flow travels eastward into the study area or lower Río Guayanés basin, which is the complex composite flood plain of several streams. The basin is 22 kilometers in length, has a total drainage area of 49.3 square miles, and is shown on the location sketch, figure 1. Río Guayanés, the principal stream, empties into Pasaje de Vieques at Puerto Yabucoa. Other significant streams in the basin are Río del Ingenio and Caño de Santiago. Río Guayanés drains an area of 26.5 square miles upstream from the Highway PR-3 bridge, which is shown in figure 2. The area of inundation during the September 6, 1960, flood as delineated on the topographic map was about 12 square miles. The city of Yabucoa is situated on the south edge of the flood plain. A view of Yabucoa and Central Roig, looking north from Highway PR-3, is shown in figure 3.

The lower basin has a lattice-like appearance due to drains, levees, highways, and service roads. The levees afford flood protection from small to intermediate floodflows. Natural levees have formed along the rivers. These levees have been increased in height as the river channels have been enlarged and dredged. The profiles of the major levees of the basin and the pertinent features of the Río Limones channel are shown in figure 4. The levee elevations are referenced to the arbitrary base line shown on the topographic map. Details of the major river crossings within the study area are given in table 1.

**Flood history.**—Major floods are known to have occurred in 1931, 1936, 1945, 1952, 1956, 1960, and 1961. The largest floods of this group are those of May 20, 1936, and September 6, 1960. Only isolated and incomplete information is available for floods other than the 1960 flood. However, it is known that the 1936 flood reached a stage of 13.93 meters at the Highway PR-3 bridge over Río Guayanés. The 1960 flood reached a stage of 13.86 meters at this site. Stages of other floods are not defined.

Current-meter measurements of Río Guayanés made at Highway PR-3 define the stage-discharge relation from 30 to 1,200 cfs (cubic feet per second). The U.S. Soil Conservation Service has estimated the discharge of the 1960 flood at the valley cross section along Highway PR-3 to be 40,000 cfs. The total drainage area upstream from the highway is 36.6 square miles. The stage-discharge relation is shown in figure 5, from which the discharge of the 1936 flood is estimated to be 44,000 cfs in the range of moderate flow, the stage-discharge relation is controlled by the diversion dam at Central Roig, as shown in figure 4 and in table 1. The dam

flows out during high-magnitude floods and has no effect on them under existing valley conditions.

**Flood frequency.**—There are insufficient data to define the flood-frequency relation for sites in the Río Guayanés basin.

**Flood profiles.**—Flood elevations, referenced to the arbitrary base line shown on the topographic map, are shown in figure 6. The curves are a graphical portrayal of the average water-level profile. The profiles are well defined except for the interval between 2 and 5 kilometers above the mouth of Río Guayanés.

**Inundated area.**—The area of inundation that resulted from floodflow in the lower Río Guayanés basin is delineated on the topographic map. The delineation is a reasonably accurate portrayal with two exceptions: the area from Martorell east to Highway PR-905, which lies north of Highway PR-902, is undefined and is estimated; and the crests of the levees have not been removed from the blue-tinted inundated area. Several of the levees were breached by floodwaters, but locations of the breaks are not known. High-water elevations along the edge of the flood plain are uniform, however, indicating the levees did not effectively shield the flood plain from crossflow.

A flood on Río Limones on August 27, 1961, was very nearly equal in magnitude to that on September 6, 1960. The inundated area along Río Limones was virtually the same for both floods.

The delineated flood boundaries reflect the channel and flood plain conditions at the time of the 1960 flood. No attempt was made to ascertain the effect of changes in the channel or on the flood plain. The area inundated in future floods may be affected by changes in the channel, increased urbanization, and other cultural changes.

**Floodmark information.**—The inundated area was delineated on the basis of flood-stage information furnished by residents. Field surveys were conducted to determine the elevation of flood stages provided by personal interviews. Selected floodmark elevations are shown on the topographic map.

**Water-surface elevation.**—The estimated water-surface contours for the flood of September 6, 1960, are shown on the map.

**Depth of flooding.**—Depth of flooding can be estimated by subtracting the ground elevation from the water-surface elevation. Each is shown by contours on the map. Intermediate estimates of depth can be determined by interpolation.

**Cooperation and acknowledgment.**—This report was prepared as part of the floods investigation authorized by a cooperative agreement between the Department of Public Works, Commonwealth of Puerto Rico, and the U.S. Geological Survey. Many of the flood data were provided by the Department of Public Works. The U.S. Soil Conservation Service also furnished flood elevations, valley cross sections, and an estimate of the discharge of the 1960 flood.

**Additional information.**—Additional information relating to floods in the lower Guayanés basin can be obtained from the U.S. Geological Survey, San Juan, Puerto Rico, or from Sección de Control de Inundaciones, Negociado de Operaciones, Departamento de Obras Públicas, Santurce, Puerto Rico.

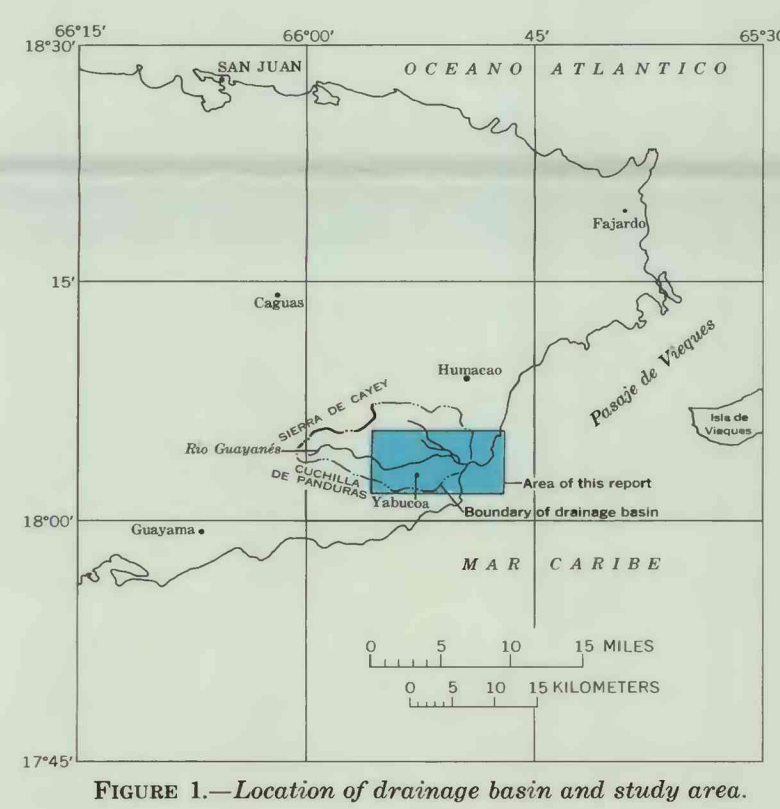


FIGURE 1.—Location of drainage basin and study area.



FIGURE 2.—Highway PR-3 bridge spanning Río Guayanés. The 1960 flood (shown by white line) reached a crest 0.5 meter below the roadway level.

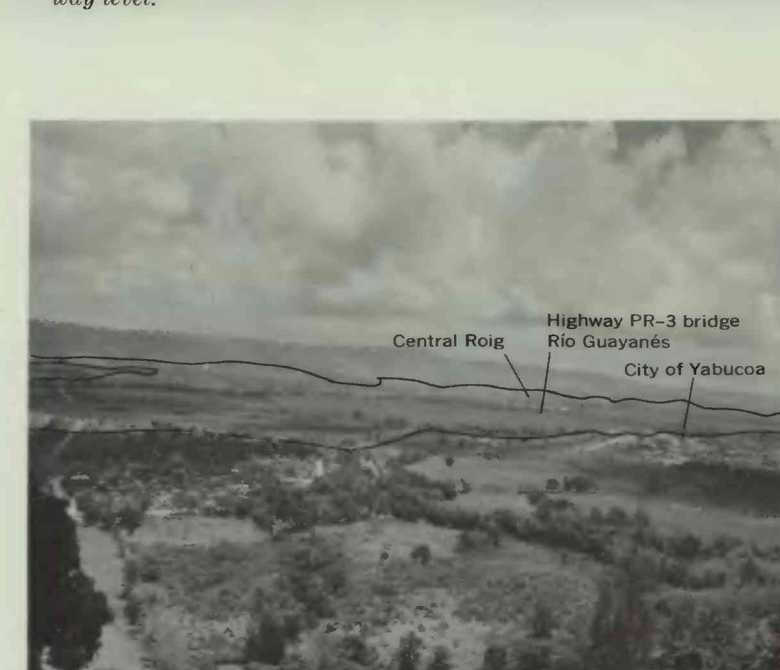


FIGURE 3.—City of Yabucoa and Central Roig. The 1960 flood inundated the entire flat area from the edge of Yabucoa to the edge of the distant hills and to the sea.

TABLE 1.—Bridges in the lower Río Guayanés basin.

Bridge	Stream	Location	Deck elevation (meters)	Low beam elevation (meters)	Area of bridge opening (square feet)
A	Río Agasate	Highway PR-3, km 94.0	14.7	13.5	230
B	Río del Ingenio Tributary	Highway PR-3, km 94.7	10.6	9.7	260
C	Río del Ingenio	Highway PR-3, km 94.9	10.7	10.1	170
D	Caño de Afadiero	Highway PR-3, km 95.6	8.6	8.2	220
E	Río Guayanés	Highway PR-3, km 98.4	14.1	12.8	810
F	Caño de Santiago	Highway PR-3, km 99.0	13.8	13.1	720
G	Quebrada Aguas Largas	Highway PR-182, km 0.8	14.2	13.5	90
H	Caño de Santiago	Highway PR-182, km 0.9	14.0	13.2	210
I	Río Guayanés	Highway PR-182, km 2.9	21.2	20.8	1,200
J	Río Limones	Highway PR-904, km 0.8	21.0	20.3	520
K	Río Guayanés	West side of Central Roig, just upstream of diversion dam	13.2	12.3	900
L	Río Guayanés	North side of Central Roig	12.2	11.5	940

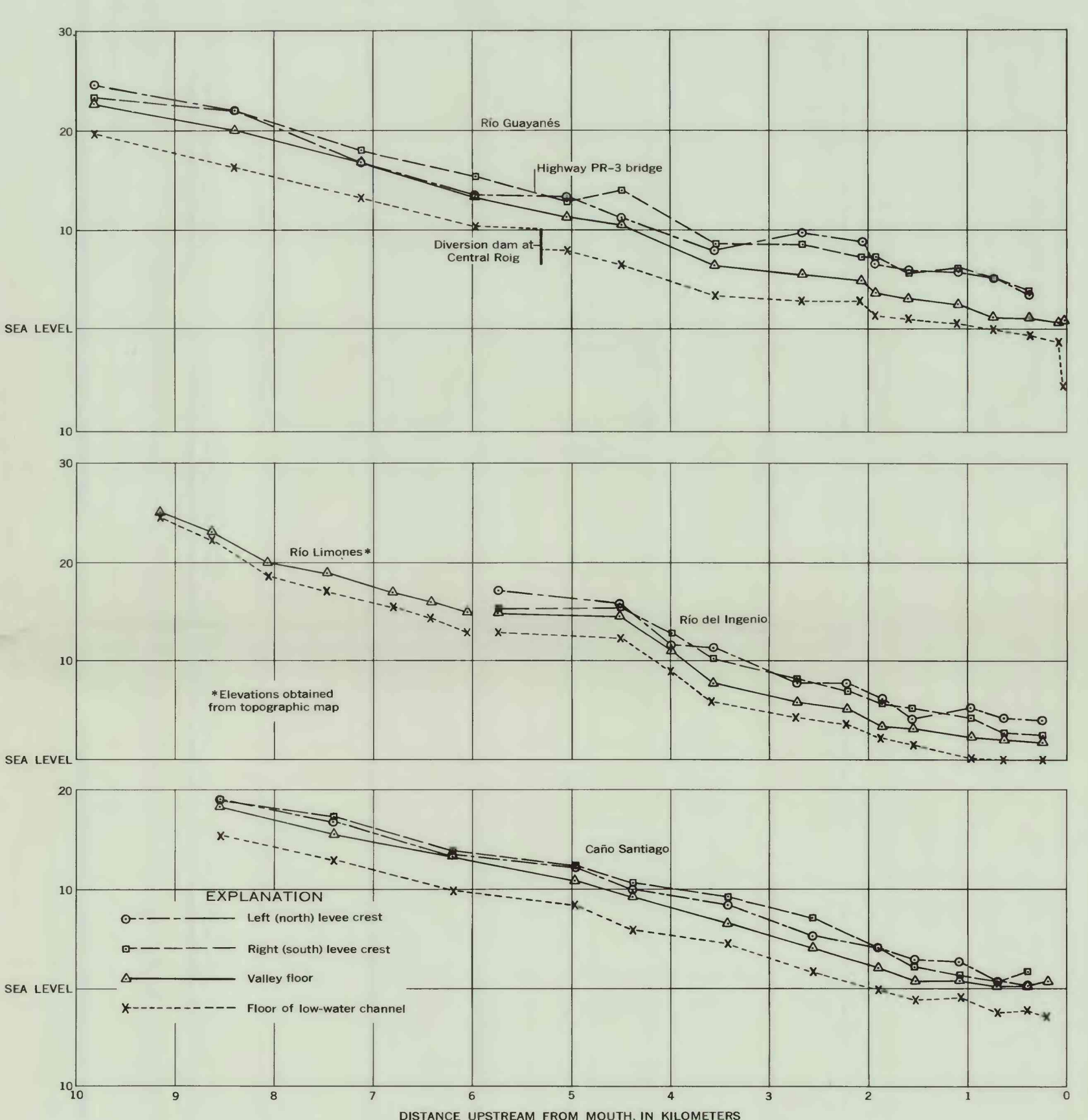


FIGURE 4.—Profiles of the levees and channels in lower Río Guayanés basin.

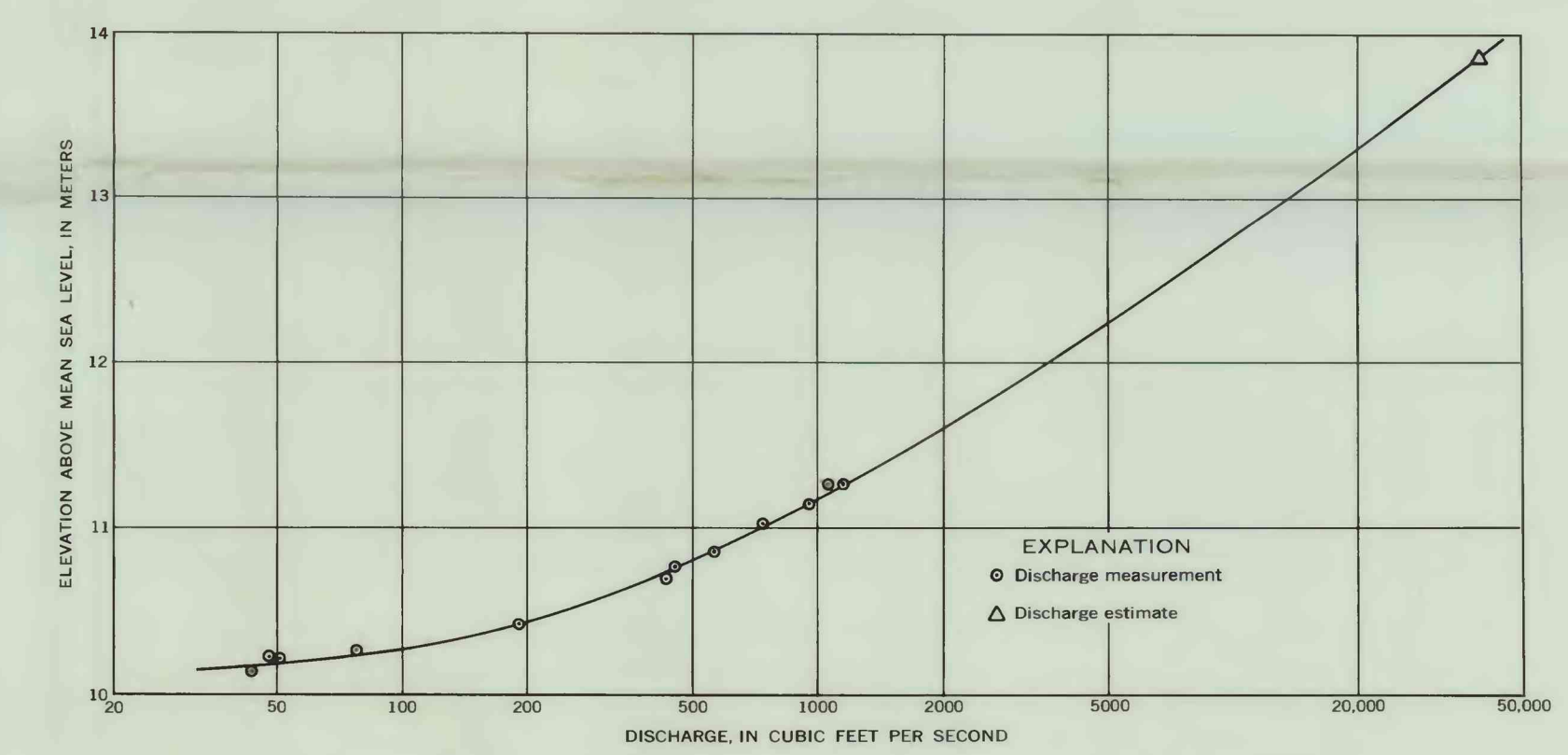


FIGURE 5.—Stage-discharge relation for Río Guayanés at Highway PR-3 bridge at Yabucoa.

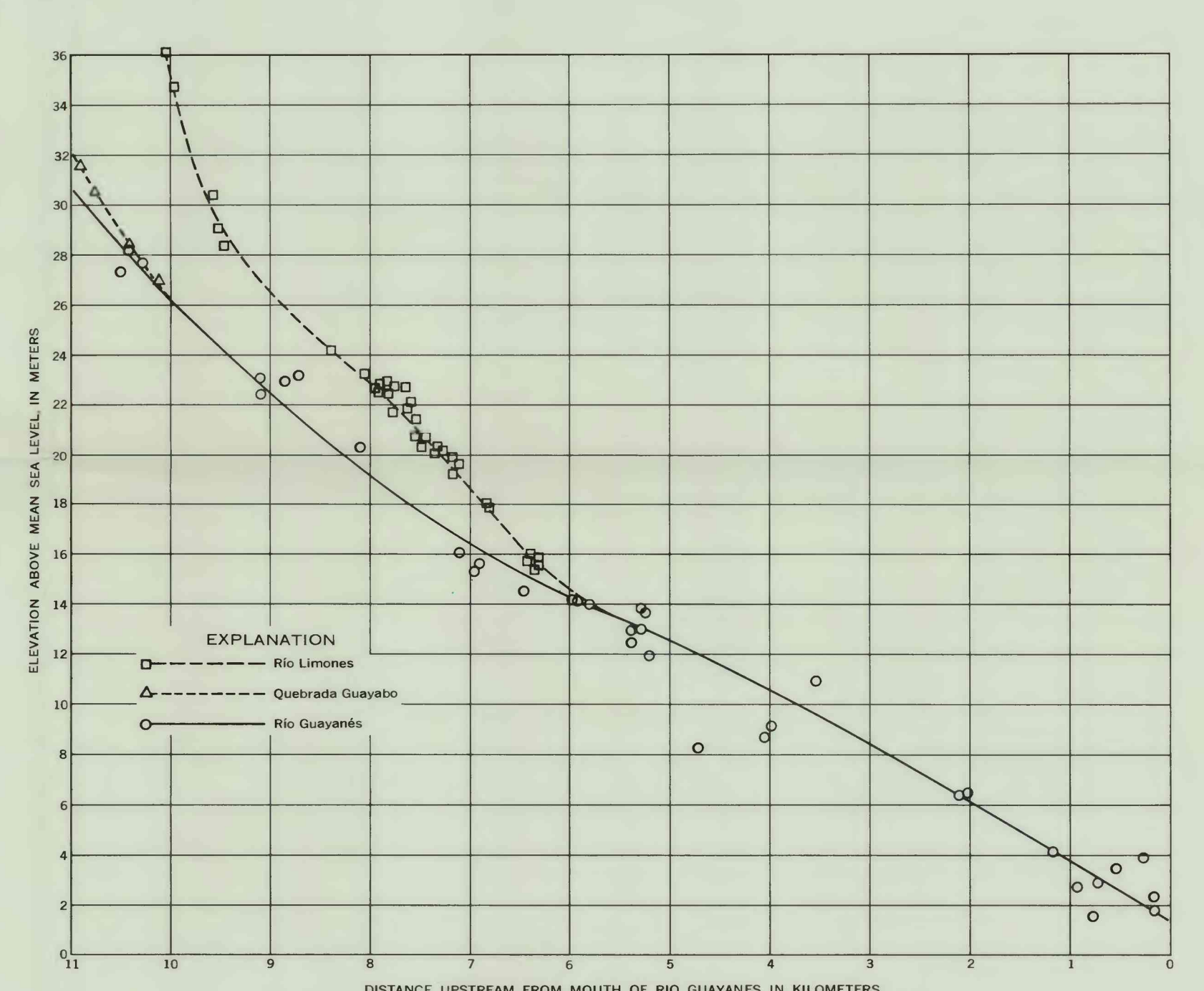


FIGURE 6.—Water-surface profiles, flood of September 6, 1960.

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