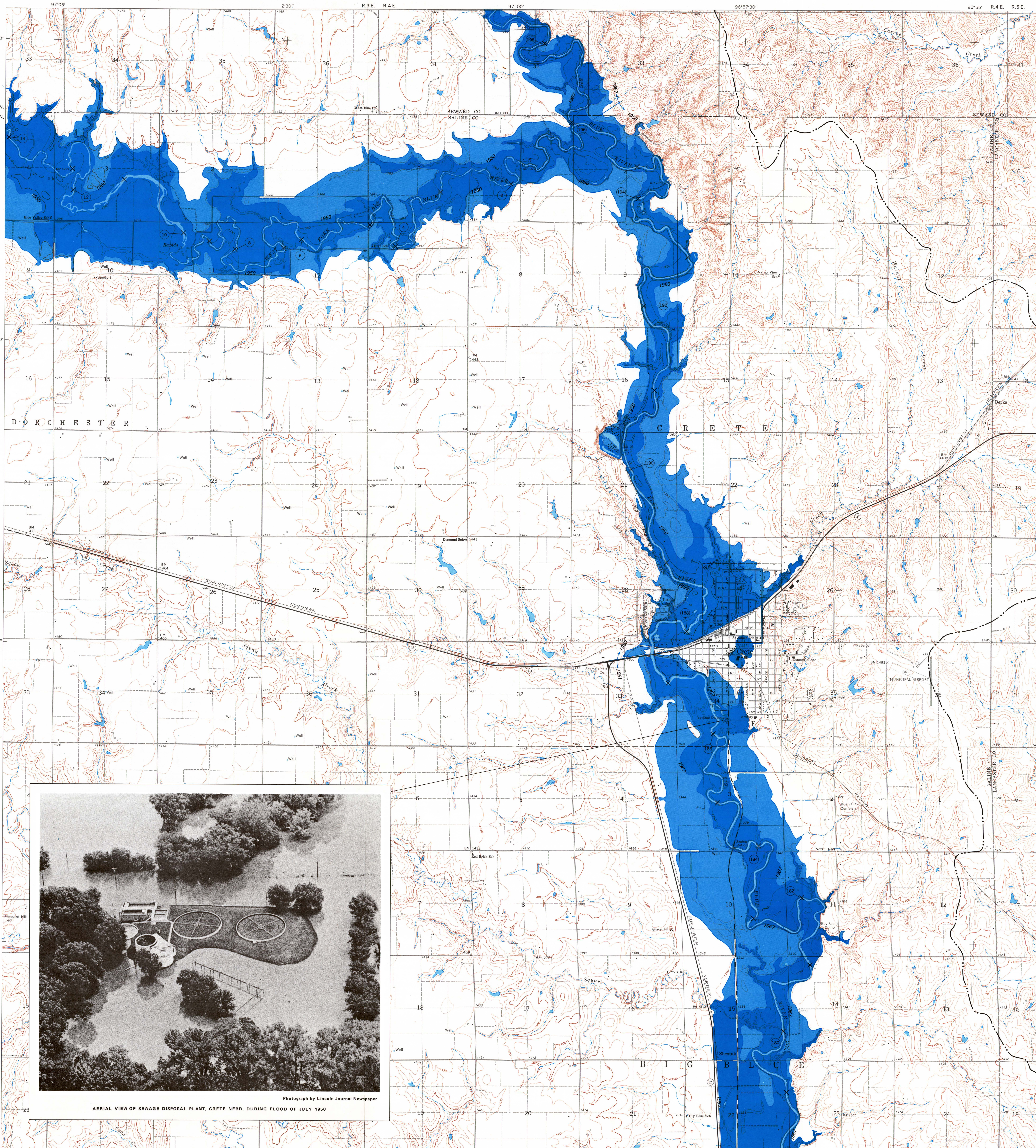

Photograph by Lincoln Journal Newspaper

AERIAL VIEW OF SEWAGE DISPOSAL PLANT, CRETE NEBR. DURING FLOOD OF JULY 1950

Base from U.S. Geological Survey Crete North, Crete South, Dorchester, and Pleasant Hill, 1964

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1974—W73080

EXPLANATION

- Area inundated by flood of record
- Area inundated by hypothetical 100-year flood
- Boundary of July 1950 flood
- Boundary of June 1967 flood
- Approximate boundary of 100-year flood
- Drainage divide
- River mile measured along river channel
- Areas inundated by different floods, upstream and downstream

FLOODS IN THE VICINITY OF CRETE, NEBRASKA

By
F. Butler Shaffer and Kenneth J. Braun

1974

BIG BLUE RIVER BASIN IN SOUTHEASTERN NEBRASKA SHOWING LOCATION OF REPORT AREA

FLOODS IN THE VICINITY OF CRETE, NEBRASKA

Crete, population of about 4,500, is the largest city in Saline County in southeastern Nebraska. Its business district and much of its residential area are in the valley of the south-flowing Big Blue River; the remainder of its residential area and Doane College, a Liberal Arts school with an enrollment of about 800 students, are on the east valley slope overlooking the main part of the city. Although the municipal boundary encloses a quarter-mile loop of the river channel, all of the developed part of the city is east of the river and, except for the residential area north of the Burlington Northern Railroad, is more than 10 feet above flood stage.

On the west side of the river, opposite the north part of Crete, is a privately developed park, which includes a pavilion, livestock display buildings, and several residences.

Within the area shown on the map, the Big Blue River valley is nearly straight and ranges in width from 1 to 1.5 miles. Its floor is about 100 feet below the general level of the upland plain to the west of the valley and about 150 feet below the hilltops of the rolling terrain to the east. The valley's side slopes have grades ranging from about 5 to 60 percent. Most of the valley floor is highly productive agricultural land. State Highway 33 and one of the main lines of the Burlington Northern Railroad cross the valley at Crete. State Highway 82 and a branch line of the railroad follow the valley south from Crete.

Nearly all the area drained by the Big Blue River lies to the west of the valley. Approximately 75 percent of the drainage area is cropland and the remainder is mostly in pasture and timber.

At low stages the Big Blue River is 60 to 100 feet wide and flows in a channel incised 15 to 30 feet below the adjacent bottomland. Owing to its sinuosity, the river channel is longer than the valley it traverses; the channel, as shown on the map, is 19.6 miles long whereas the valley length is only 11.3 miles. Within this reach, the low-flow gradient of the river is about 2 feet per mile, whereas the gradient of the valley floor averages 4.5 feet per mile.

About 5 miles upstream from Crete, the Big Blue River is joined by its West Fork. Both in extent of area drained and in average discharge, the two streams at their confluence are nearly the same. Their combined drainage areas plus the area drained by the Big Blue River between the confluence and Crete is about 2,700 square miles, of which 2,580 square miles contribute directly to surface runoff.

Generally runoff from only part of the contributing drainage area causes flooding at Crete because most flood-producing storms are areally smaller than the basin. Under certain circumstances, one small part of the drainage area—the 12 square miles drained by Walnut Creek—can be the sole cause of flooding. Walnut Creek flows through the northern part of Crete and joins the Big Blue River at the west city boundary.

The Big Blue River, joined by the Little Blue River about 21 miles south of the Nebraska-Kansas State line, flows into the Kansas River at Manhattan, Kansas, which is about 57 miles south of the State line.

Flood history.—According to information compiled in the middle 1940's by the Corps of Engineers, U.S. Army, the greatest flood on the Big Blue River at Crete occurred in 1844, long before the site was a town. Several local people stated they had been told that floodwaters in 1844 reached halfway up the slope to the present location of Doane College. A flood of such magnitude would inundate the main business district and most of the residential area to a depth of several feet.

At no time since Crete first became a site of permanent settlements (about 1870) has there been a flood that approached the reported magnitude of the 1844 flood. Accounts of 19 floods in the period 1872–1944 are contained in "Pioneer Days in Crete, Nebraska," by A. R. Gregory (1937) and in newspapers published when the floods occurred. Two dams—the Crete Mills Upper Dam in SW¼ sec. 27, T. 8 N., R. 4 E., and the Crete Mills Lower Dam in SW¼ sec. 34, T. 8 N., R. 4 E.—were washed out or damaged several times in that 72-year period. Severe damage to railroad property, to residences and streets in the lower parts of Crete, to county-road bridges, and to bottom-land crops occurred during the greater floods; and in both 1923 and 1930 Walnut Creek flooded in the north residential part of Crete.

Peak stages and discharges of floods in the Crete vicinity have been measured since March 1945, when a gage was installed on the Big Blue River at the old State Highway 82 bridge 1.5 miles south of Crete. As of 1969, annual peak stages have exceeded an elevation of 1,330 feet at the gaging station in 19 of the 25 years of record (fig. 1). Only slight flooding occurred at Crete in some of those years, but moderately severe to severe flooding occurred in the 8 years that the peak stage at the gaging station exceeded an elevation of 1,336 feet. The three greatest floods of record were 1,340.4 feet on July 10, 1950, discharge 27,600 cfs (cubic feet per second), 1,340.0 feet on June 3, 1951 (25,000 cfs), and 1341.5 feet on June 16, 1967 (24,300 cfs). Although the peak discharge during the 1967 flood was 3,300 cfs less than that of the 1950 flood, the peak stage of the 1967 flood at the gaging station was the highest of record, exceeding that of the 1950 flood by 1.06 feet. The higher stage with lesser discharge was attributed to higher roadway embankments, increase in river-bank vegetation, and abundance of logs and other jam-causing debris in the river channel, all of which contributed to a reduction of the channel's carrying capacity.

During the 1950 flood the peak discharge of the West Fork near Dorchester (19 miles upstream from the confluence of the West Fork with the Big Blue River) was 49,400 cfs, 79 percent greater than the peak discharge which passed Crete. The reduction in peak discharge between Dorchester and Crete was attributed to water going into channel and bank storage. If a similar storm were to center in the vicinity of the West Fork-Big Blue River confluence, a much higher stage and correspondingly greater extent of inundation would occur at Crete.

Of the 41 annual peak discharges for which the month of occurrence is known, 15 were in June and 26 were in May, June, and July. None occurred in November, December, or January, which generally are months of little precipitation. Rapid melting of a heavy snow cover or rain on frozen ground are the principal causes of floods in February and March whereas intense downpours on an already soaked terrain generally are the cause of floods in April and later months.

Extent of flooding.—The maximum known extent of flooding since the city of Crete was established is shown on the map. The boundaries of the inundated areas shown along the Big Blue River above the mouth of the West Fork are those for the 1967 flood, boundaries along both the West Fork and the Big Blue River from the mouth of the West Fork south to Crete are those for the 1950 flood, and boundaries along the Big Blue River south of Crete are those for both the 1950 and 1967 floods. The storms causing the two floods were not centered over the same part of the Big Blue River drainage basin; that for the 1950 flood centered over York, Nebr., which is about 37 miles west-northwest of Crete and in the drainage basin of the West Fork, and that for the 1967 flood centered over Seward, which is on the Big Blue River about 21 miles upstream from Crete. Below Crete the boundaries of the two floods are based on records of stage obtained at the gaging station and shown on the map as virtually the same although the 1967 peak stage was 1.06 feet higher than that of 1950 because of greater backwater effect from obstructions in the downstream channel. The estimated extent of the 100-year flood if it were to occur under channel conditions existing in 1969 is also shown on the map.

Areas inundated by floods of record include considerable agricultural land along the West Fork and the Big Blue River, residential and commercial properties in the lower lying parts of Crete, and the Crete sewage disposal plant. Part of the flooding at Crete in 1950 was due to flow from the Walnut Creek drainage area. This flow, added to floodwaters of the Big Blue River, aggravated the backwater problem caused by the railroad and highway embankments. Some of the backwater escaped southward through a culvert beneath the railroad at the Hawthorne Avenue crossing, continued south along Hawthorne to 13th Street, where it turned westward and inundated a several-block low area near the center of Crete. Gates have since been installed in the outlet works of a new storm-sewer system to prevent future flooding in this part of Crete.

The recurrence intervals of peak discharges (adjusted to present channel conditions) for the 1950, 1951, and 1967 floods at the Crete gaging station are about 15, 12, and 11 years, respectively. However, recurrence intervals for any given discharge are not necessarily the same at different sites along the stream because hydraulic conditions differ from one channel section to another.

A 100-year flood, which would have a peak stage of 32.5 (elevation 1,344.2) feet at the gaging station under present channel conditions would inundate a greater area than did the floods of 1950, 1951, and 1967. Although the floodwaters would extend farther into Crete, the central business district and much of the residential area south of the railroad still would be unaffected. However, more agricultural land would be flooded.

If the peak discharge of future floods were the same as those of 1950, 1951, and 1967, the extent of inundation would not necessarily be exactly like that shown on the map. Natural and manmade changes in the conveyance of the river channel and its adjacent flood plain are constantly occurring. For these reasons, plans for use of the flood plain and appraisals of the potential flood hazards in flood-prone areas should include an evaluation of all factors affecting the extent of inundation, as well as the flood boundaries shown on the maps.

Flood frequency.—Graphs indicating the probability that a flood of specified peak discharge or peak stage will occur at Crete in this or any future year are shown in figures 2 and 3. As applied to flood events, recurrence interval is the average interval of time within which a given flood will be exceeded once. Frequencies of floods can be stated in terms of their exceedence probabilities (virtually reciprocals of their recurrence intervals for floods with recurrence intervals greater than 10 years). For example, a flood with a 25-year recurrence interval would have a 4-percent chance of being exceeded in any one year. The stage-frequency curve (fig. 3) is based on channel conditions existing in 1969. Future channel conditions, affected by new highways, channel changes, and urbanization, may define somewhat different frequency relations. It is emphasized that recurrence intervals are average figures—the average number of years between floods that exceed a given magnitude. The fact that a major flood occurs in one year does not reduce the probability of that flood being exceeded in the next year or even in the following week.

Flood profiles.—The profile of the water surface of the highest flood of record and the profile of low flow of the West Fork and the Big Blue River are shown in figures 4 and 5. Baseline for the profiles is located along the thalweg—the center line of the low-water channel. River miles upstream from the mouth, used for the profiles in figures 3 and 4, are also marked along the river on the flood map. The low-flow profiles are noticeably affected by backwater from dams whereas the corresponding flood profiles are affected only slightly. Water that overflows the flood plain north of the city is ponded by the railroad embankment that extends diagonally across the northern part of Crete. This overflow must pass through the relatively small opening of the railroad bridge at river mile 187.4 to escape downvalley.

Flood profiles can be used for estimating the water depth at any place within the inundated area by subtracting the land-surface elevation from the elevations of the flood profile at the corresponding river-mile distance upstream from the river mouth. Approximate ground elevations can be estimated from information indicated by contours on the map although more accurate elevations can be obtained by leveling to nearby bench marks.

Acknowledgments.—Flood information was furnished by residents of the area and by officials of the City of Crete; National Weather Service of the National Oceanic and Atmospheric Administration; U.S. Corps of Engineers, Kansas City District; and Nebraska Air National Guard.

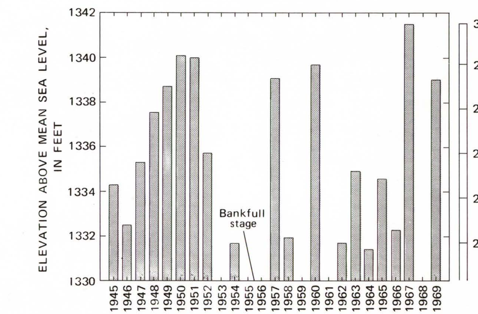

FIGURE 1. – *Annual peak stages above elevation 1,330 feet, Big Blue River near Crete, Nebr., 1945-69.*

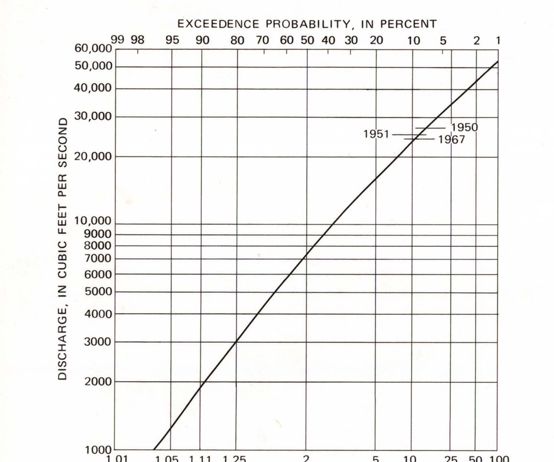

FIGURE 2. – *Frequency of flood discharges on the Big Blue River near Crete.*

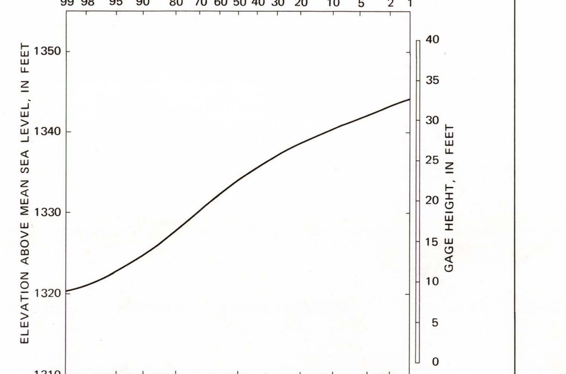

FIGURE 3. – *Frequency of peak stages on the Big Blue River near Crete, adjusted to present channel conditions.*

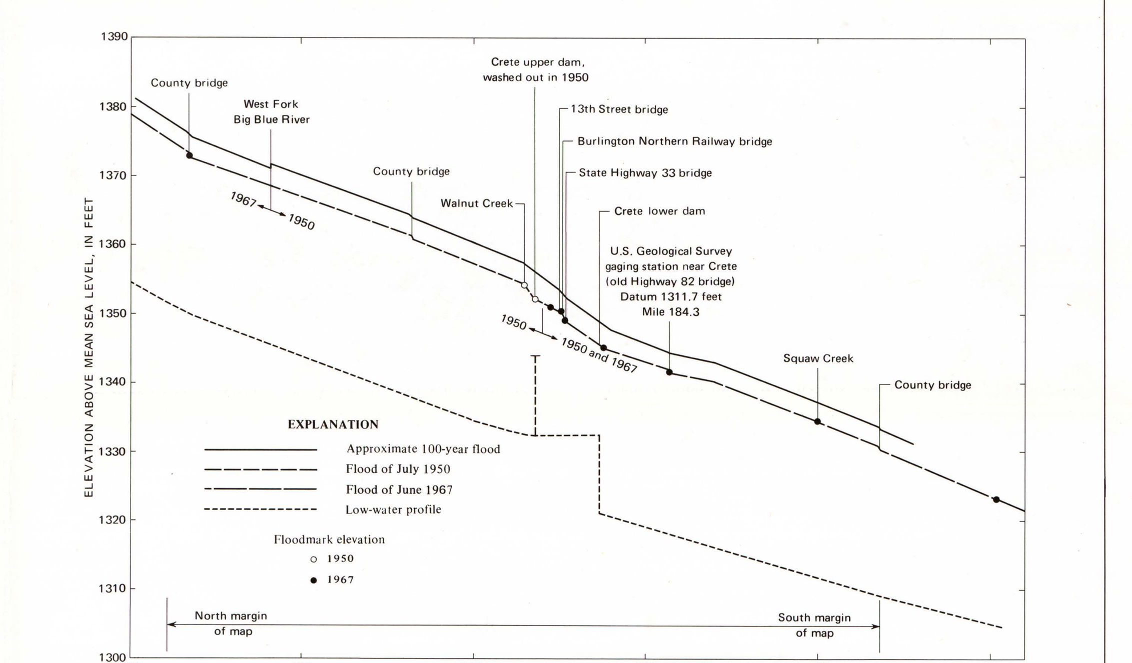

FIGURE 4. – *Profiles of floods and low-water flow of the Big Blue River.*

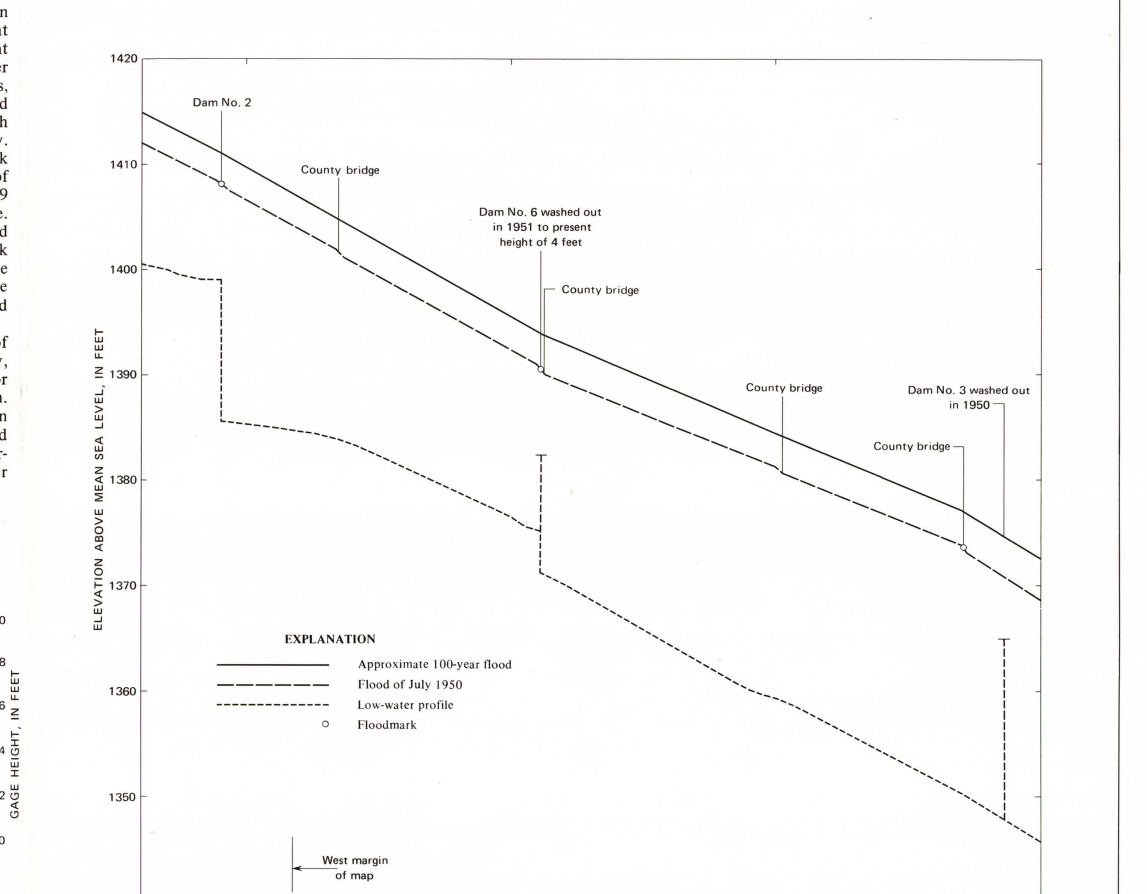

FIGURE 5. – *Profiles of floods and low-water flow of the West Fork Big Blue River.*