Floods of June 1965 in South Platte River Basin, Colorado

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1850–B

Prepared in cooperation with the States of Colorado and Nebraska and with agencies of the Federal Government

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By H. F. MATTHAI

FLOODS OF 1965 IN THE UNITED STATES

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CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

FLOODS OF JUNE 1965 IN SOUTH PLATTE RIVER BASIN, COLORADO

By H. F. MATTHAI

ABSTRACT

Heavy, intense rains in three areas on three different days caused outstanding floods on many streams in the South Platte River basin from Plum Creek, just south of Denver, downstream to the Colorado-Nebraska State line. The flood-producing storms followed a relatively wet period, and rainfall of as much as 14 inches in a few hours was reported. The storms occurred over the Greeley-Sterling area on June 14–15, over the Plum Creek and Cherry Creek basins on June 16, and over the headwaters of Kiowa and Bijou Creeks on June 17 after heavy rains on June 15. The flood crest did not pass Julesburg, in the northeast corner of Colorado, until June 20.

Previous record high discharges on many tributaries with drainage areas on the plains were exceeded, sometimes severalfold. The six principal tributaries carrying snowmelt runoff were contributing, but not significant, factors in the floods. The attenuation of the peak flow by channel storage as the flood passed through Denver was considerable; yet the peak discharge of 40,300 cfs (cubic feet per second) of the South Platte River at Denver was 1.8 times the previously recorded high of 22,000 cfs in a period of record starting in 1889. The 1965 peak would have been still higher except that all flow from Cherry Creek was stored in Cherry Creek Reservoir.

Six persons were drowned, and two other deaths were attributed to the storms. The total damage amounted to $508.2 million, and about 75 percent of this occurred in the Denver metropolitan area.

Descriptions of the storms and floods, detailed streamflow records, and information on damages, flood profiles, inundated areas, and flood frequency are included in this report. Several comparisons of the magnitude of the flood are made, and all indicate that an outstanding hydrologic event occurred.

INTRODUCTION

UNFORGETTABLE EXPERIENCES

The morning of June 16 was most pleasant, but conditions changed rapidly shortly after noon. A tornado touched ground 15 miles south-southeast of Denver about 1 p.m. Within the next hour, another unroofed 30 homes in the little town of Palmer Lake, 40 miles south of

Denver. About 2 p.m., a dense mass of clouds descended and concealed the top of Dawson Butte, 7 miles southwest of Castle Rock; and the little light remaining faded until it was dark black and frightening, according to some people. A nearby rancher's wife described the intense quiet as awesome, but the calm did not last very long.

The deluge began, not only near Dawson Butte, but also at Raspberry Mountain, 6 miles to the south, near Larkspur. The rain came down harder than any rain the local residents had ever seen, and the temperature dropped rapidly until it was cold. The quiet was shattered by the terrible roar of wind, rain, and rushing water. Then the thudding of huge boulders, the snapping and tearing of trees, and the grinding of cobbles and gravel increased the tumult. The small natural channels on the steep slopes could not carry the runoff; so water took shortcuts, following the line of least resistance. Creeks overflowed, roads became rivers, and fields became lakes—all in a matter of minutes.

The flow from glutted ravines and from fields and hillsides soon reached East and West Plum Creeks. The combined flows in these creeks have been described as awesome, fantastic, and unbelievable; yet none of these superlatives seem adequate to describe what actually occurred. Large waves, high velocities, crosscurrents, and eddies swept away trees, houses, bridges, automobiles, heavy construction equipment, and livestock. All sorts of debris and large volumes of sand and gravel were torn from the banks and beds of the streams and were dumped, caught, plastered, or buried along the channel and flood plains downstream. A local resident stated, "The banks of the creek disappeared as if the land was made of sugar."

The flood reached the South Platte River and the urban areas of Littleton, Englewood, and Denver about 8 p.m. Here the rampaging waters picked up house trailers, large butane storage tanks, lumber, and other flotsam and smashed them against bridges and structures near the river. Many of the partly plugged bridges could not withstand the added pressure and washed out. Other bridges held, but they forced water over approach fills, causing extensive erosion. The flood plains carried and stored much of the flood water, which inundated many homes, businesses, industries, railroad yards, highways, and streets.

The flood peak passed through Denver during the night, and the immediate crisis was over by morning; but those in the inundated areas were faced with a Herculean task. The light of day revealed the nature of the destruction—mud in every nook and cranny, soggy merchandise, warped bowling alleys, drowned animals, the loss of irreplaceable personal possessions, to name a few types. The colossal cleanup job, which would take months, began.

Residents of the South Platte River basin will not forget the flood of June 1965. Some stories may be exaggerated in traditional Western

style; but when most of 14 inches of rain falls in about 3 hours, it is raining harder than most people have ever seen or will ever see. When one experiences a storm like this and sees the consequences, exaggeration is difficult—and pointless. The scars on the landscape, remains of damaged homes, piles of assorted debris, and deposits of sand and gravel along the streams are not fictitious; they are mute evidence that a disaster did occur. The actions of some people during the flood were heroic, or funny, or foolhardy; but practically everyone in the flood area worked hard and long to save property and to help others.

Man is proud of his efforts to control floods, but they have been rather puny. He is learning, the hard way perhaps, what the tremendous forces of floodwater can do.

The foregoing experiences and impressions are mainly those of people in the flood area between Larkspur and Denver, but similar events were experienced a few days earlier in the Greeley-Sterling area and during the next 6 days along Bijou and Kiowa Creeks and along the South Platte River all the way to Nebraska.

DESCRIPTION OF THE FLOOD AREAS

The floods of June 1965 in the South Platte River basin occurred principally in four areas: the area north of Greeley and north and west of Sterling; the Plum Creek and Cherry Creek basins; the Kiowa Creek and Bijou Creek basins; and along the South Platte River from Plum Creek to North Platte, Nebr. (fig. 1). The storms on June 14–15 occurred in the Greeley-Sterling area and in the Bijou Creek basin southwest of Deer Trail. Lone Tree, Coal, Crow, and Pawnee Creeks, their tributaries, and Bijou Creek were in flood June 14–16.

The main flood on June 16 originated in the Plum Creek basin, south of Denver. The South Platte River and all tributaries flowing out of the high mountains were not in flood but were carrying snowmelt water at about average or below average flows for June. The Cherry Creek basin had high floods, but all inflow was stored in Cherry Creek Reservoir, just upstream from Denver. Sand Creek and Toll Gate Creek were also above flood stage on June 16.

Kiowa and Bijou Creeks were at moderate to high flood stages on June 15 and at extremely high stages in the headwaters late on June 17. Channel storage and other losses reduced the Kiowa Creek flood downstream from Bennett to such an extent that very little flow reached the South Platte River. The reverse occurred along the entire length of Bijou Creek because the flood peaks on East, Middle, and West Bijou Creeks combined to cause an outstanding flood. This flood reached the mouth of Bijou Creek at midmorning on June 18.

The fourth area flooded was along the 300-mile reach of the South Platte River from the mouth of Plum Creek, about 15 miles upstream

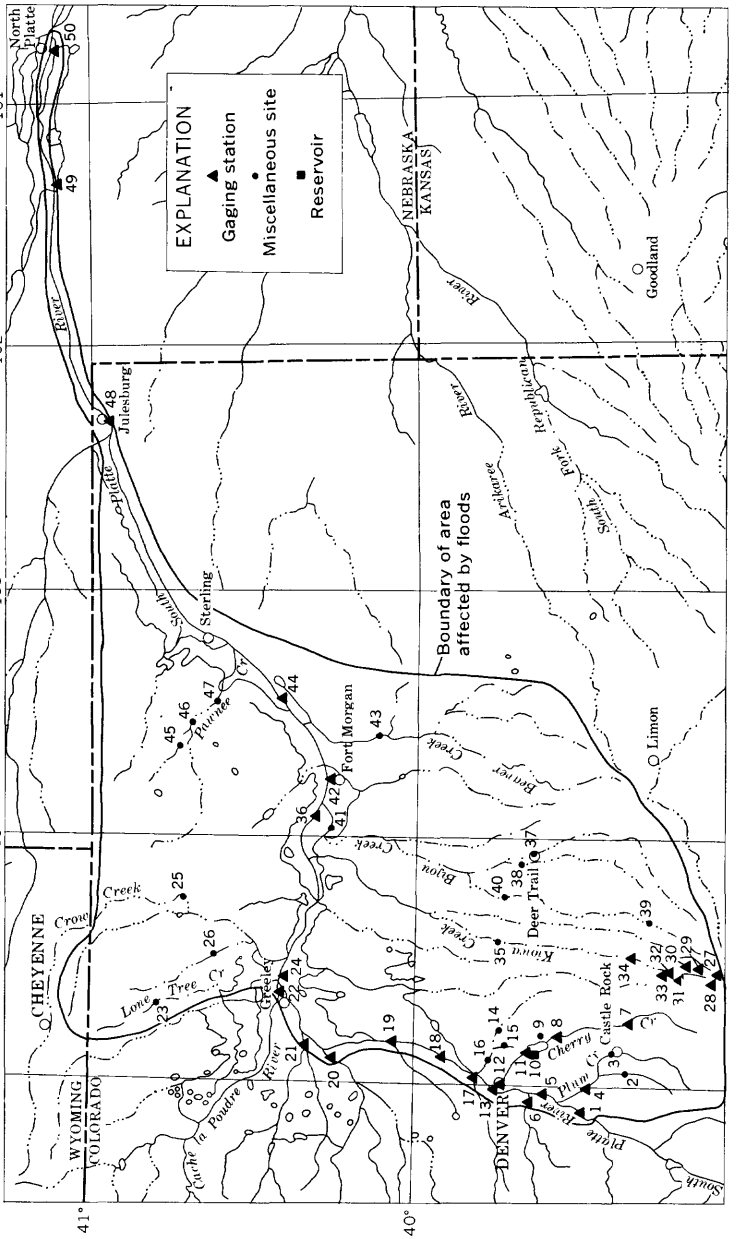

FIGURE 1.—Location of flood area and flood-data sites.

from Denver, to its mouth at North Platte, Nebr. The flood runoff from Pawnee Creek caused some flooding near Sterling on June 15–16. The most damaging flooding was in the Denver metropolitan area the night of June 16. This flood was generally within banks downstream from the vicinity of Greeley. The Bijou Creek flood of June 18 entered the South Platte River and caused most of the damage at Fort Morgan and downstream. The crest from Plum Creek passed the mouth of Bijou Creek about 35 hours later.

ACKNOWLEDGMENTS

The data in this report were collected as part of the cooperative programs established between the U.S. Geological Survey and other Federal, State, county, and municipal agencies. The data were collected and compiled under the supervision of J. W. Odell, Colorado district engineer of the Surface Water Branch, Water Resources Division. The field surveys and some computations were coordinated by H. F. Matthai, regional hydraulic specialist. Office computations were directed by C. T. Jenkins and R. J. Snipes. Experienced men from two other districts assisted with field surveys.

The U.S. Weather Bureau, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation furnished meteorological information precipitation, flood damage, and flood inundation data, and isohyetal maps. Their cooperation is gratefully acknowledged.

RELATIVE MAGNITUDE OF THE FLOODS

Both lay people and hydrologists have used one or more yardsticks or criteria to evaluate the relative magnitude of a flood. These range from the informal, but nevertheless valid, designation of "gully-washer" to "the maximum probable flood." Three criteria are used in this report: comparisons with maximum floods known and comparisons by frequency relations and channel conditions.

COMPARISON WITH MAXIMUM FLOODS KNOWN

Hoyt and Langbein (1955) plotted maximum discharges known in the United States in 1890 and in 1950 against drainage area. They pointed out that in the 60 years between 1890 and 1950, "the upper limit of our knowledge on floods has been pushed up about tenfold for very small drainage basins, and about threefold for large streams." Though they called their curve an enveloping curve, it is only nominally so, as they chose to draw it below six discharges shown on their graph.

The writer has found records of five more floods that plot above Hoyt and Langbein's curve. Three of them have occurred since 1950. An average curve (curve *A*, fig. 2) through the 11 high points is higher

333-527 O—69——2

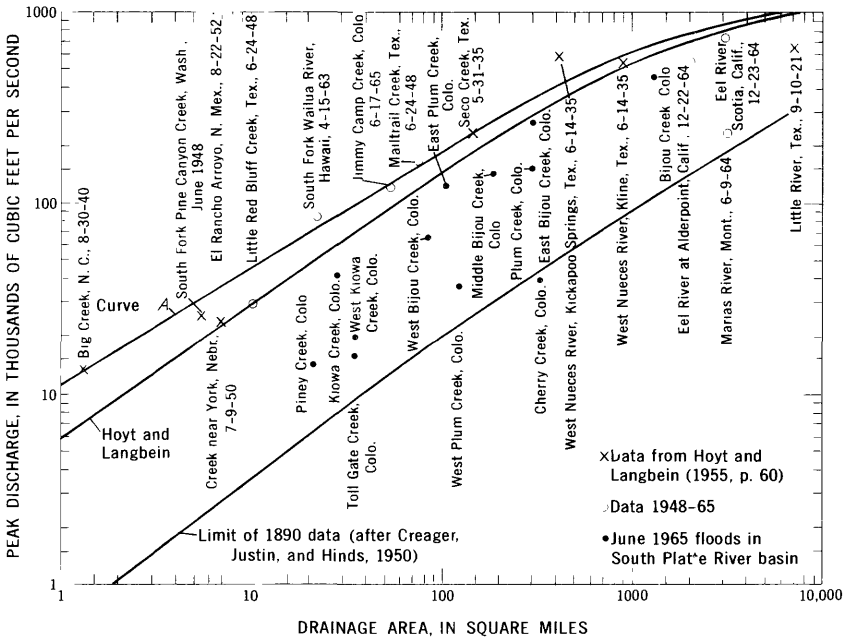

FIGURE 2.—Maximum discharges in relation to drainage area.

than their curve by 90 percent at 1 square mile and by 11 percent at 1,000 square miles.

The lower end of Hoyt and Langbein's curve is a straight line and can be expressed by

$$Q = CA^n$$

where

Q = peak discharge, in cubic feet per second,
C = constant,
A = drainage area, in square miles, and
n = slope of the line.

The empirical equation for their curve is $Q = 5{,}900\ A^{0.68}$. The equation for the writer's curve A (fig. 2) is $Q = 11{,}000\ A^{0.61}$ for the straight-line part below 200 square miles. Concerning the change between the 1890 and 1950 curves, Hoyt and Langbein stated, "This is no evidence that flood conditions are changing. The upward shift of the curves * * * is due entirely to an increased number of gaging stations and increased period of record." They attributed the curvature of the upper parts of both curves to the fact that the number of floods measured on the smaller streams greatly exceeds the number measured on the larger streams. Similar reasoning can explain the differences in

position and slope of curve *A* from Hoyt and Langbein's curve. The larger number of gaging stations, the additional 15 years of record, and the more extensive coverage of flood events, particularly on small drainage basins since 1950, have greatly increased the number of records of outstanding floods. All five of the additional records are for streams with drainage areas of less than 80 square miles. Recent floods on the larger streams have not exceeded Hoyt and Langbein's curve; consequently, the curves converge, and the slope of curve *A* is flatter than that of theirs.

Data for several peak discharges during the June 1965 floods and a few selected outstanding floods in other areas are tabulated in table 1. The tabulation includes the ratios of these discharges to the discharges from curve *A* for the same drainage area.

According to Hoyt and Langbein, "flood-discharge potentialities" in the South Platte River basin are less than half those shown by their curve in figure 2. Their conclusion is based on admittedly risky generalizations, but it can be used as a basis for comparison. The ratios of the June 1965 floods on several streams, particularly those on Bijou, Kiowa, and Plum Creeks, to curve *A* ranged from 0.40 to 0.76. Curve *A* is at least 11 percent higher below 1,000 square miles than Hoyt and Langbein's curve; thus the June 1965 floods, at seven or more locations, substantially exceeded the estimated "flood-discharge potentialities" of streams in the flood area.

TABLE 1.—*Comparison of recent outstanding floods with maximum floods known*

Stream	Drainage area (sq mi)	Date	Peak discharge (cfs)	Ratio to maximum flood curve *A*
Kiowa Creek at Elbert, Colo.	28.6	June 17, 1965	41,500	0.49
Jimmy Camp Creek near Fountain, Colo.	54.3	do	124,000	.98
West Bijou Creek near Kiowa, Colo.	85.7	do	67,200	.40
East Plum Creek near Castle Rock, Colo.	108	June 16, 1965	126,000	.65
Middle Bijou Creek near Deer Trail, Colo.	190	June 17, 1965	145,000	.69
East Bijou Creek at Deer Trail, Colo.	302	do	274,000	.76
Plum Creek near Louviers, Colo.	302	June 16, 1965	154,000	.43
Bijou Creek near Wiggins, Colo.	1,314	June 18, 1965	466,000	.67
Eel River at Alder Point, Calif.	2,079	Dec. 22, 1964	561,000	.71
Eel River at Scotia, Calif.	3,113	Dec. 23, 1964	752,000	.85
Marias River near Shelby, Mont.	3,242	June 9, 1964	241,000	.27

COMPARISON BY FREQUENCY RELATIONS

The relative magnitude of floods may be compared by the use of frequency relations; however, this comparison is limited in most areas areas to floods having a recurrence interval of 50 years or less. Detailed data concerning flood frequencies are in another section of this report.

Streamflow records on many streams in the flood area either do not antedate 1940 or have been obtained for only a few years. Firm frequency relations for unusual floods cannot be developed from short-term records. For example, the flood of June 1965 on Plum Creek was 20 times the previous maximum discharge in 23 years of record. Its true recurrence interval is certainly much greater than 24 years, but how much greater is not known. The trend of a curve through the station data indicates that the flood of June 16, 1965, on Plum Creek had a recurrence interval well in excess of 100 years.

Even at stations with comparatively long records, the 1965 floods greatly exceeded the previous maximums at some locations.

The 1965 peak discharge of the South Platte River at Denver was 183 percent of the previous maximum during 67 years of record. Historical information indicates that the 1965 peak discharge at Denver was the greatest since at least 1844, a period of 121 years. Even using the 122-year plotting position, the 1965 peak discharge plots well above the trend of the frequency curve through the station data.

The floods on Plum Creek, the South Platte River at Denver, and at some locations on Cherry, Kiowa, and Bijou Creeks had recurrence intervals in excess of 100 years, but the floods did not have such high recurrence intervals on all streams or at all points on the streams listed above.

Floods with recurrence intervals in excess of 100 years are certainly rare events, and at many locations the floods of June 1965 were in this category. Unfortunately, with our present knowledge, we cannot determine the true frequency of such floods, but there is the remote chance that floods of greater magnitudes might happen within a few years.

COMPARISON BY CHANNEL CONDITIONS

The extensive and large-scale changes caused by the floods of June 1965 in many stream channels and to the watersheds are additional evidence that the floods were outstanding events.

On June 14, the flood on Lone Tree Creek north of Nunn scoured a large hole in coarse gravel and cobbles under the bridge on U.S. Highway 85. Deposition of some of the material downstream from the bridge caused a change in the channel location and cutting of the right bank.

The heavy runoff flowing down steep gradients in the Castle Rock area of East and West Plum Creeks scoured the soil down to bedrock in places along the small tributary channels. Where channels were inadequate, the water flowed overland, cut new channels, and deposited sand, gravel, enormous boulders, and other debris on fields and pastures (figs. 3 and 4).

FIGURE 3.—Erosion scars and deposition south of Castle Rock, Colo., June 17, 1965. Denver Post photograph by Lowell Georgia.

FIGURE 4.—Results of overland flow along East Plum Creek south of Castle Rock, Colo. Photograph by Colorado Army National Guard on June 18, 1965.

In figure 4, the solid lines are tributaries of East Plum Creek as they are depicted in aerial photographs taken in October 1964. The dashed lines are the limits of the meanders of the low-water channel and of trees and brush of moderate density. The light areas in the photograph are deposits of sediment. Note the two major changes in the main channel position and that most of the trees and brush have been washed out.

A short reach of East Plum Creek at Castle Rock had been relocated twice during recent highway construction. During the flood the flow sought the original course of the stream and severely cut both the new and old banks. Several eastern tributaries of West Plum Creek built

up large alluvial fans at their mouths. Many old cottonwood trees along Plum Creek were uprooted, splintered, and peeled.

Through Denver and its suburbs, the amount of overbank flow along the South Platte River was aggravated by plugged bridges; and the depth was increased by encroachments on the flood plain. Even without these complications, the inundation would have been the greatest since at least 1844.

Along Bijou Creek and its tributaries, some mature alfalfa crops were almost completely buried by sediment, many trees were uprooted, and channels were widened by bank cutting. At one location on West Bijou Creek north of Byers, preflood vegetation was found under 12 feet of newly deposited sediment (McKee and others, 1967, p. 838).

The main line of the Chicago, Burlington & Quincy Railroad, built in 1882, crosses Bijou Creek near Wiggins. Bijou Creek floods have caused minor damage to the railroad at times and major damage in 1935, but nothing resembling the damage caused by the floods of June 1965.

The foregoing examples are only a few of the major changes made in channels in the flood area. Most of the changes were greater than any experienced at least since the area was settled, and they occurred in a sort time interval—only a few hours at the most. Such changes are irrefutable evidence that a flood of great magnitude occurred.

CAUSES

The floods in the South Platte River basin were not caused by one event, as often happens, but by several storm cells in three main areas on three different days.

The area north of the South Platte River between Greeley and Sterling received heavy, intense rains during the night of June 14–15. Torrential rains fell during the afternoon of June 16 near Castle Rock and Larkspur, 30 miles south of Denver. Severe thunderstorms occurred on June 15 in the Bijou Creek basin southwest of Deer Trail and again on the afternnon and evening of June 17 along the headwaters of Bijou and Kiowa Creeks.

ANTECEDENT CONDITIONS

Rains had been fairly general and frequent over the South Platte River basin since May 21. Daily rainfalls of over 1 inch were recorded at several sites between May 21 and June 3. Storm activity increased on June 4 and 5 with many reports of 2 to 3 inches of precipitation during these 2 days. Light rain occurred at many places most of the days from June 6 to June 13.

PLUM CREEK AND CHERRY CREEK BASINS

Little or no rain fell in the Plum Creek basin on June 14 or 15, but 4.76 inches had fallen at Castle Rock between May 21 and June 13. In the same period, 6.07 inches was recorded at Cherry Creek Dam and about 4 inches was recorded near Parker and near Greenland. This antecedent moisture wet the soil and caused a somewhat larger and more rapid runoff from the later heavy, intense rain. However, the magnitude and intensity of the rains on June 16 would have caused devastating floods without any priming of the soil.

KIOWA CREEK AND BIJOU CREEK BASINS

Light rains fell over most of the Kiowa Creek and Bijou Creek basins on June 14 and 15. Byers and Deer Trail received 2.74 and 2.64 inches, respectively, on June 15; about 1.45 inches fell in 1 hour at each location. Bucket survey reports show 4 to 6 inches on June 15 at seven locations in East, Middle, and West Bijou Creek basins. Most of these amounts fell in 30 minutes to an hour between 1800 and 1930 hours. This rain caused flooding primarily in the Bijou Creek basin.

Very little rain fell in the Kiowa-Bijou area during the concentrated storm of June 16 over the Plum and Cherry Creek basins.

PRECIPITATION

IN PERSPECTIVE

The U.S. Weather Bureau (1961) has developed some relations between rainfall, intensity, and frequency. These relations are only general and do not reflect the orographic effect of relatively isolated topographic features. The orographic effects of Dawson Butte and several other isolated features, especially those between Castle Rock and Palmer Lake, were quite pronounced during the storm of June 16. Thus, a direct comparison between the general relations and some of the observations of point rainfall could be misleading. However, if the possible anomalies are considered, the comparison should provide some perspective for an evaluation of the rainfall that did occur.

From the general relations, the 100-year 6-hour rainfall in the vicinity of Castle Rock is 3.2 inches, and the probable maximum 6-hour precipitation, for a 10-square-mile area, is about 22 inches. The maximum observed 6-hour rainfall in Denver was 2.91 inches in 1921.

Rainfall over 10-square-mile areas near Palmer Lake, Larkspur, and Castle Rock and on the divide between the Arkansas and South Platte Rivers southeast of Elbert, averaged about 10 inches in 3 or 4 hours This amount would be equivalent to at least 12 inches and

possibly as much as 15 inches in 6 hours as compared to the probable maximum of 22 inches. Thus, the very heavy and intense rainfalls were extremely rare events, but they might be exceeded sometime.

RAINFALL ON JUNE 14–15

Heavy, intense rains fell during the night of June 14–15 in the Lone Tree Creek, Crow Creek, and Pawnee Creek basins just south of the Colorado-Wyoming State line. At four locations north of Nunn within an area of 50 square miles, rainfall ranged from 5.5 to 7.0 inches, and 14 inches fell at a fifth location near the center of the area. The recording gage at Nunn registered 1.06 inches between 11 and 12 p.m. on June 14. Amounts of 5.5 to 7.0 inches are, respectively, about twice the 3-hour and 6-hour 100-year rainfalls, and the 14-inch rainfall is about four times the 24-hour 100-year rainfall.

The larger amounts in the Pawnee Creek basin west and north of Sterling ranged from 2.0 to 4.5 inches; however, oral reports of 1.05 inches in 20 minutes and 1.4 inches in 30 minutes indicate the high intensity of the rain. These intensities are near those for the 30-minute 25-year rainfall.

RAINFALL ON JUNE 16

Rainfall in the amounts and intensities that occurred south of Denver in the Plum Creek basin on June 16 usually requires some persistence of several conditions. There must be (1) large amounts of low-level moisture and a strong influx of this moisture to supply the rain-producing mechanism continuously, (2) unstable atmospheric conditions, particularly at upper levels, and (3) one or more mechanisms to lift the air. All of these conditions were present on June 16 (U.S. Weather Bureau, written commun., 1966).

The air movement near the surface was one of the contributing factors. There were moderate winds from the southeast June 14–18 bringing moist air from the Gulf of Mexico, and surface dewpoints were in the low 60's and upper 50's (° F), which are unusually high for eastern Colorado. The influx of moisture was rapid, and the moist air was in a rather deep layer. The low-level southeasterly flow was particularly strong on June 16; wind speeds of over 40 knots near 2,000 feet above the ground were reported at Amarillo, Tex., and Dodge City, Kans. The surface wind at Amarillo began gusting during the afternoon of June 16. The low-level flow had the characteristics of the low-level jet in this region, but the relatively high winds at the ground produced the unusual condition of a low-level jet in depth.

A trough over the Western United States was retarded and intensified at the 500 mb (millibar) level at approximately 18,000 feet, or 5,500 meters. By June 16, a quasi-stationary cold low had been created

333-527 O—69——3

at 500 mb over southern Nevada. The Plum Creek basin was to the east and slightly north of this low, the relative position most conducive to severe weather disturbances. This situation brought in cold air aloft which reduced the atmospheric stability to moderately low levels.

The air circulation about the low produced some lifting. This was not a prime factor in causing rain, but it was significant.

The general upslope from east to west of the High Plains caused a major uplift because the low-level winds had an easterly, or upslope component. The orographic effect of small-scale features such as Raspberry Mountain and Dawson Butte caused shower activity over these peaks early in the storm.

Showers and thunderstorms started to develop over the area east of the central Colorado mountains during the morning of June 16. By early afternoon the storms were located along a north-south line roughly from Denver to Pueblo. The northern part of this line of storms almost coincided with the major axes of the Plum Creek and Cherry Creek basins, a condition that caused record-breaking floods. The upper level steering winds had only a slight westerly component; therefore the thunderstorms were not carried away from the mountains, as generally happens, but remained over the high-rainfall areas for more than an hour. Then the thunderstorms moved slowly northward along this north-south line. This direction was almost directly down East and West Plum Creeks and Cherry Creek; thus the heavy rainfall tended to follow and augment the peak flows.

More than 14 inches of rain fell near Palmer Lake and near Larkspur (pl. 1) in about 4 hours, and over 12 inches fell near Castle Rock in about the same time. Most of this rain fell between 1400 and 1700 hours June 16. By 1800 hours the westerly component of the upper level steering winds increased and moved the storm line eastward.

RAINFALL ON JUNE 17

On the afternoon of June 17, thunderstorms developed south and east of Denver. The upper level steering winds were from the south-southwest to southwest, and the westerly component was greater than on the preceding day; therefore the rains were farther east. The orographic effect of Palmer Ridge, the divide between the Arkansas River and South Platte River basins, reinforced the uplift from the general east-west upslope traversed by the prevailing southeast winds. The cold low over Nevada had moved very little during the previous 24 hours; therefore, unstable atmospheric conditions were still present. The change in direction of the upper level steering winds between June 16 and 17 was partly offset by the difference in orientation between Plum Creek and Bijou and Kiowa Creeks so that the direction the storms

traveled was at a slight angle to the creeks and generally downstream.

Rainfall amounts ranged up to 12 inches in about 3 hours along the Palmer Ridge southeast of Elbert (pl. 2). Higher intensities for lesser amounts were recorded or observed nearby. The gage 3 miles northwest of Eastonville caught 2.16 inches of rain between 1800 and 1900 hours, 5.25 inches fell in 45 minutes 6 miles south of Agate during the evening, 2.75 inches fell in about 15 minutes about 22 miles east of Elbert, and most of 5.5 inches fell between 1800 and 1900 hours 12 miles northeast of Kiowa. All these rainfalls equal or greatly exceed the 100-year intensities for the time intervals given.

These amounts followed by only 48 hours rainfall of 4 to 6 inches in much of the Kiowa-Bijou area. The total precipitation and the high intensities over small areas produced extremely high rates of runoff.

DESCRIPTION OF THE FLOODS

The floods of June 1965 in the South Platte River basin occurred in four areas after one or more storms on four consecutive days, June 14–17. Records of six streams whose drainage basins are principally in the mountains, from the South Platte River at Waterton, which is upstream from Plum Creek, to the Cache la Poudre River near Greeley, show that snowmelt runoff from the Rocky Mountains was a contributing, but not significant, factor in the flood along the main stem of the South Platte River. Also, the irregular distribution of the heavy, intense rainfall, (pls. 1 and 2) was such that some tributaries contributed little or no runoff to the flood.

THE GREELEY-STERLING AREA

Heavy, intense rains along a belt about 30 miles wide and 100 miles long just south of the Colorado-Wyoming State line and from north of Greeley to north of Sterling caused floods on most left-bank tributaries of the South Platte River in the high plains.

Peak discharges were determined at one discontinued gaging station and at five miscellaneous sites in this area. The gaging station on Lone Tree Creek near Nunn was operated during the 1951–57 water years, and the maximum discharge during this period was 775 cfs in 1955, whereas the June 14, 1965, peak was 5,810 cfs.

A gaging station was operated on Crow Creek near Barnesville from July 1961 to September 1957. There was no flow at this site during this period because all flow is normally diverted or stored upstream for irrigation, municipal supply, and stock water. However, in June 1965, part of the flood flow even bypassed the gage site, and the overland flow inundated farm lands to the east. The peak near Barnesville occurred between 0900 and 1000 hours on June 15. A local resident,

who had lived in the area for 35 years, stated that the flood in 1965 was the highest he had seen, including the 1935 flood. At a site about 20 miles upstream from Barnesville, Crow Creek crested at 0700 hours on June 15, and the estimated peak discharge was 4,000 cfs. Coal Creek enters Crow Creek in the 20-mile reach above Barnesville and contributed a peak flow of 5,340 cfs, measured west of Briggsdale.

No previous flood records exist for the Pawnee Creek basin west of Sterling; therefore comparisons with previous floods cannot be made. The crest of 6,280 cfs on North Pawnee Creek near New Raymer occurred at 2400 hours on June 14. Runoff from the intervening area on North Pawnee Creek and that from South Pawnee Creek increased the discharge to 26,700 cfs at 0300 hours June 15 on Pawnee Creek near Stoneham. Locally, there was some backwater from jams of floating hailstones. Pawnee Creek peaked at 35,200 cfs at the bridge on State Highway 14, 13 miles west of Sterling.

At Julesburg, 63 miles downstream from Pawnee Creek, floodwaters from Pawnee Creek increased the flow of the South Platte River from 200 to 3,180 cfs, the highest since June 10, 1961. A description of higher floods in June 1965 on the South Platte River starts on page B22.

PLUM CREEK AND CHERRY CREEK BASINS

High intensity, heavy rains occurred near three centers in the Plum Creek basin on the afternoon of June 16. Over 12 inches fell near Castle Rock and over 14 inches fell near Palmer Lake and near Larkspur in about 4 hours. These rains caused the disastrous flood (fig. 5) that scarred the landscape (fig. 3) and caused the great amount of damage in the Denver metropolitan area.

East and West Plum Creeks crested at 126,000 and 36,800 cfs, respectively, during the afternoon of June 16. The unit runoff above the site on East Plum Creek just downstream from Castle Rock was 1,170 cfs per square mile for a drainage area of 108 square miles. Western tributaries of West Plum Creek and all tributaries of Plum Creek downstream from Sedalia were out of the high rainfall areas and contributed little or no runoff during the flood.

The Plum Creek gaging station near Louviers was destroyed, but observations indicated that the flow increased a thousandfold, from about 150 cfs to 154,000 cfs, in less than 3 hours. The recession was also rapid; a measurement of 988 cfs was made by wading at 1200 hours on June 17, only 18 hours from the peak. Streamflow records have been collected on Plum Creek either near Sedalia or near Louviers since 1942, and the maximum discharge prior to June 16, 1965, was 7,700

FIGURE 5.—View downstream on East Plum Creek south of Sedalia, Colo., late afternoon of June 16. Denver Post photograph by Lowell Georgia.

cfs in August 1945. The peak discharge on June 16, 1965, was 20 times the previous maximum discharge in 23 years.

The slope of Plum Creek near Louviers is 33 feet per mile. The combination of this steep slope, the sand and gravel streambed, and relatively open and straight reaches of channel was conducive to high velocities and standing waves. The computed mean velocities in seven

cross sections surveyed after the flood were near 15 fps (feet per second), which implies maximum velocities of about 20 to 22 fps.

The amount of scour and fill, the size of the cottonwood trees that were uprooted or bent over, and the matted condition of the debris on trees are physical indications that confirm the computed velocities.

The 39,900 cfs peak on Cherry Creek near Melvin occurred at 1830 hours on June 16 and was 2.3 times the previous maximum discharge in a record extending back to 1939. It even exceeded the peak discharge of 34,000 cfs, at a site 6 miles downstream, caused by the failure of Castlewood Dam in 1933. The June 1965 flood was the result of 3 to 6 inches of rain in a few hours over most of the drainage below Franktown. The peak flow at the gaging station above Franktown was only 1,000 cfs and occurred 1¼ hours after the peak passed Melvin, about 18 miles downstream.

Inflow to Cherry Creek Reservoir from Piney Creek reached a rate of 14,100 cfs at 1500 hours on June 16. The entire flow into Cherry Creek Reservoir was stored. Based on a change in storage of 810 acre-feet in the 10 minutes between 1920 and 1930 hours on June 16, the peak inflow rate was 59,000 cfs. The increase in contents during the 24 hours ending at 1700 hours on June 17 was 14,770 acre-feet.

The ungaged area between Melvin and Cherry Creek Dam is 27 square miles. If the combined flow of Cherry Creek and Piney Creek was 45,000 cfs at about 1900 hours on June 16, the ungaged area would have to contribute 14,000 cfs to obtain the computed peak inflow rate of 59,000 cfs. A flow of 14,000 cfs from 27 square miles is compatible with the location of the ungaged area with respect to the rainfall.

SOUTH PLATTE RIVER—PLUM CREEK TO BIJOU CREEK

The contribution to the flood area of the South Platte River basin above Plum Creek was relatively small. The flow at the Waterton gaging station was only 1,100 cfs at the time the flood crest from Plum Creek entered the South Platte River (fig. 6).

The flood crest on Plum Creek traveled the 15 miles from Louviers to Littleton on the South Platte River in 2½ hours, and channel storage and other losses reduced the discharge from 154,000 cfs to 110,000 cfs. (A flow of 110,000 cfs for 24 hours would supply the entire Denver Water Department demand for 580 days, or 19 months, at the average use of 122.45 mgd (million gallons per day).) The flood crest took 4¾ hours after passing Littleton to reach the gaging station at Denver, 11 miles downstream, where the attenuated peak discharge was 40,300 cfs.

The peak flow on Sand Creek was 18,900 cfs and reached the South Platte River about 4 hours before the main crest. Peak discharges in

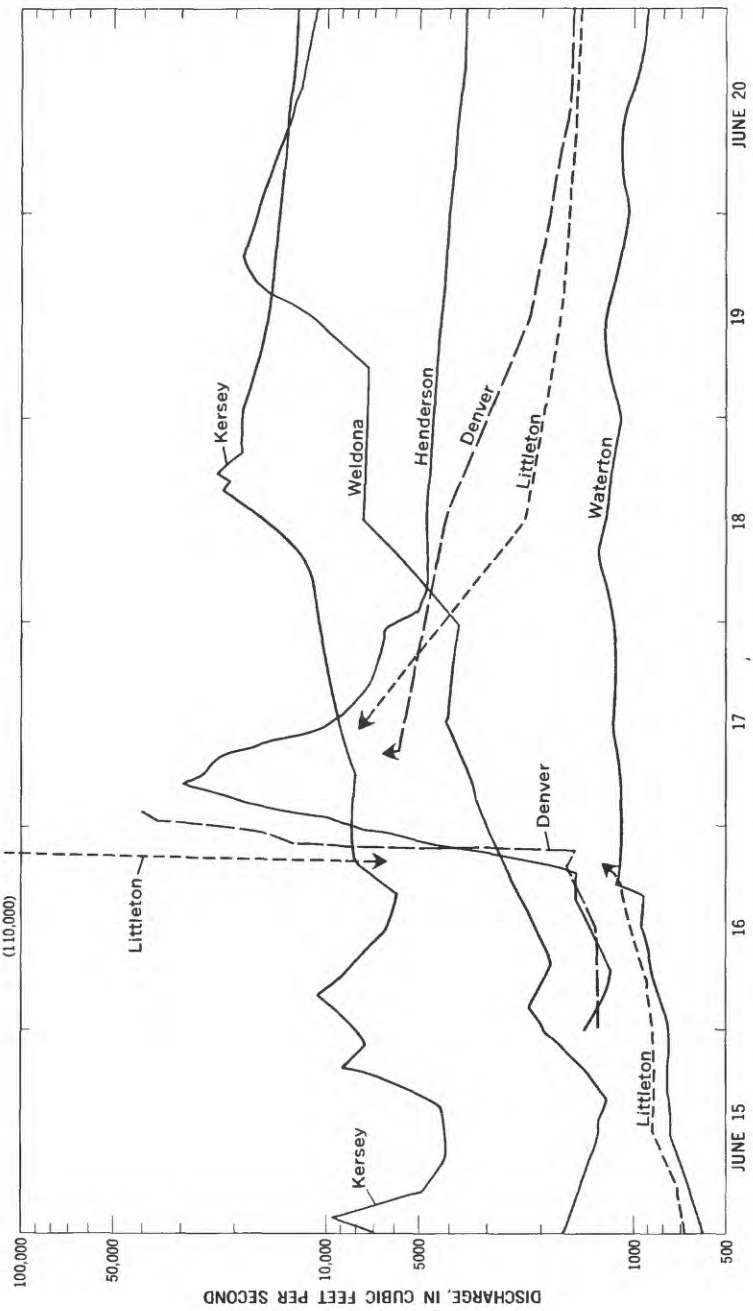

FIGURE 6.—Discharge hydrographs at selected gaging stations at South Platte River, Waterton to Bijou Creek.

1965 exceeded those of 1957 on Toll Gate Creek and Sand Creek near Aurora by 54 and 75 percent, respectively, but the discharge of Sand Creek at Denver in 1965 was only 74 percent of that in 1957. This anomaly is due to differences in the distribution and timing of the rainfall in 1957 compared with 1965.

The inflow from Sand and Clear Creeks kept the flow up to 36,800 cfs at Fort Lupton, 28 miles downstream from Denver. This discharge was much more than the main channel could carry at this location, and it was 4.1 times the previous maximum in 38 years of record.

Peak attenuation from channel storage was greater than the inflow from St. Vrain Creek and the Big Thompson and Cache la Poudre Rivers; therefore the peak discharge on the South Platte River near Kersey was down to 23,500 cfs. The crest reached Weldona 70 hours after it passed Littleton, and the discharge was only 18,800 cfs. Channel storage was not as significant in the 42-mile Kersey-Weldona reach because most of the flow remained within the main channel, and only some bottom lands were inundated. The contribution of Kiowa Creek to the South Platte River was very small notwithstanding the occurrence of major floods in the headwaters of Kiowa Creek.

KIOWA CREEK AND BIJOU CREEK BASINS

The floods on upper Kiowa and Bijou Creeks occurred on June 17, 24–30 hours after the floods on Plum and Cherry Creeks. Upstream from Elbert on Kiowa Creek and its tributaries, the crests occurred between 1900 and 2030 hours June 17. East and West Bijou Creeks peaked at 2400 hours June 17 near Deer Trail and Byers.

Sufficient records were obtained at three of five Soil Conservation Service flood-retention reservoirs near Elbert to allow computation of the maximum 5-minute inflow. Subwatershed R–3 has a drainage area of 2.82 square miles, and the maximum 5-minute inflow was 6,880 cfs, or 2,440 cfs per square mile. This inflow rate was reduced to a peak outflow of 2,010 cfs. The maximum 5-minute inflow from subwatershed Q–51 was 1,350 cfs, or 2,290 cfs per square mile, from 0.59 square mile. This inflow rate was reduced only 6 percent to a peak outflow of 1,270 cfs. The drainage area of subwatershed B–9 is 0.64 square mile, and the maximum 5-minute inflow was 597 cfs, or 933 cfs per square mile. The outflow reached a maximum of 33 cfs.

At K–79 Reservoir, the peak outflow in 1965 was 2,370 cfs, 60 percent more than the previous maximum outflow. Presumably, the maximum 5-minute inflow in 1965 also exceeded the 5,250 cfs inflow of 1957 or was at least 1,700 cfs per square mile from 3.20 square miles.

Subwatershed J–33 has an area of 1.12 square miles, and the previous maximum 5-minute inflow since 1956 was only 93 cfs. The maximum outflow in 1965 was 2,600 cfs; therefore the maximum 5-minute inflow probably exceeded 2,500 cfs per square mile.

Kiowa Creek at Elbert, 0.5 mile upstream from West Kiowa Creek had a peak discharge of 41,500 cfs at 1930 hours June 17, an hour before West Kiowa Creek crested at 20,000 cfs (fig. 7). The flood reached Bennett, about 40 miles down stream from Elbert, at 0130 hours June 18, and the peak discharge was 24,900 cfs. Between Bennett and the mouth of Kiowa Creek a distance of about 50 miles, the flood dissipated to such an extent that the flow near the mouth was not enough

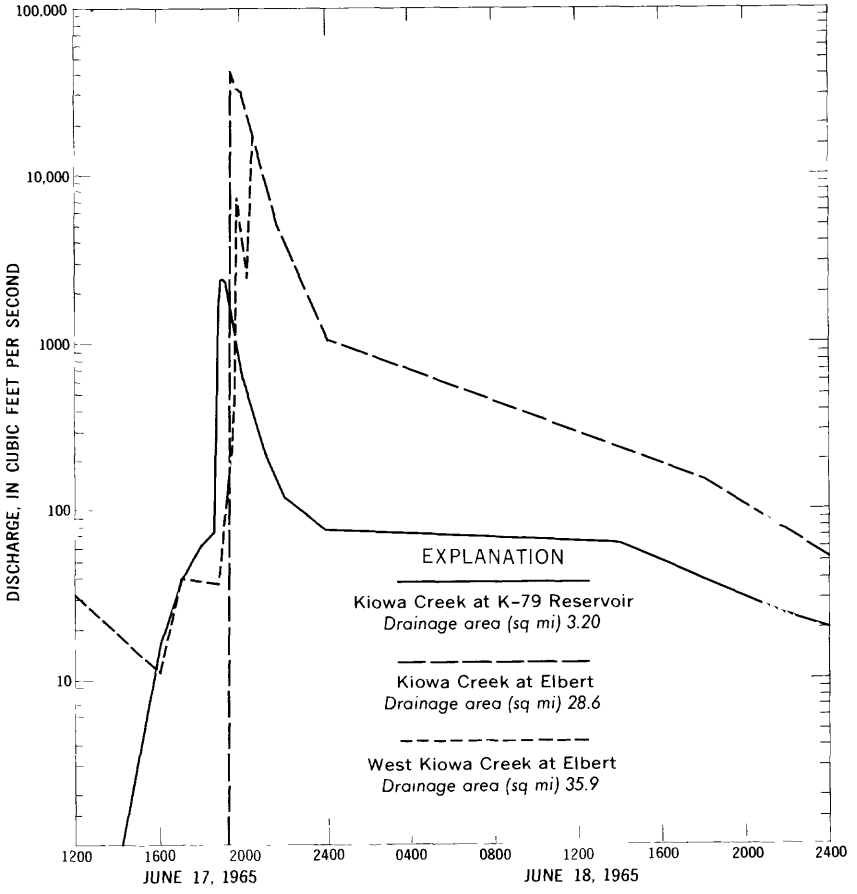

FIGURE 7.—Discharge hydrographs at selected gaging stations in Kiowa Creek basin.

to wash the grass out of the small low-water channel. This peak reduction is diametrically opposed to what occurred on Bijou Creek, where the combined flow of approximately 490,000 cfs in the three main forks produced a peak discharge of 466,000 cfs near Wiggins on the morning of June 18.

One of the reasons the flood of June 17–18 was high throughout the length of Bijou Creek is that an outstanding flood occurred on Bijou Creek about 48 hours earlier. An extension of a stage-discharge relation used in 1956 and defined to 35,000 cfs indicates a peak discharge between 120,000 and 150,000 cfs on the morning of June 16 near Wiggins. This estimate is partially substantiated by estimates of peak discharges made the morning of June 16 where U.S. Highway 40 crosses West Bijou Creek (70,000 cfs), Rattlesnake Creek (10,000 cfs), Middle Bijou Creek (29,000 cfs), and East Bijou Creek (32,000 cfs).

Most of the town of Deer Trail was flooded when East Bijou Creek reached a peak discharge of 274,000 cfs at 2400 hours June 17. This discharge is 11 times the previous maximum discharge known, which occurred in 1935. The 145,000 cfs peak on Middle Bijou Creek near Deer Trail was essentially the same as that of the flood of 1935, and the peak discharge of 75,500 cfs on West Bijou Creek at Byers was only 46 percent of the 1935 peak. (See table 2.) Peak discharges on Bijou Creek near Wiggins were 282,900 cfs in 1935 and 466,000 cfs in 1965. The latter discharge was augmented slightly by water released from storage after failure of the railroad fill, about 6 miles upstream.

The floods of June 17–18, 1965, on East Bijou and Bijou Creeks were the greatest since at least the mid-1800's, when the area was settled. The floods of June 15–16, 1965, may be the third highest in over 100 years at many locations in the Bijou Creek basin and possibly the second highest on East Bijou Creek at Deer Trail.

SOUTH PLATTE RIVER—BIJOU CREEK TO MOUTH

The Bijou Creek flood of June 17–18 reached the South Platte River about 35 hours before the flood moving down the South Platte River from Denver reached the mouth of Bijou Creek, and it caused the highest stages and greatest discharges downstream from Bijou Creek. Residents of Fort Morgan described three crests, which were caused by the Bijou Creek floods of June 15–16 and 17–18 and the main-stem South Platte River flood.

On June 18, Beaver Creek peaked at 24,300 cfs 13 miles upstream from its mouth, about 3 hours after the South Platte River crest passed the mouth of Beaver Creek near Brush.

The record at Balzac shows the three crests—on June 16, 18, and 20 (fig. 8). The peak discharge on June 18 was 123,000 cfs and was four times the maximum daily discharge of 31,200 cfs which occurred on June 11, 1921.

The record at Julesburg is incomplete; therefore the entire pattern of the floodflow is not known, but the peak discharge was 37,600 cfs. Only one crest was recorded at both Paxton and North Platte, Nebr., where the peak discharges were 33,800 and 22,200 cfs, respectively.

EFFECTS OF STORAGE

All reservoirs on the South Platte River are upstream from the flood area and had little effect on floodflows in the Denver area.

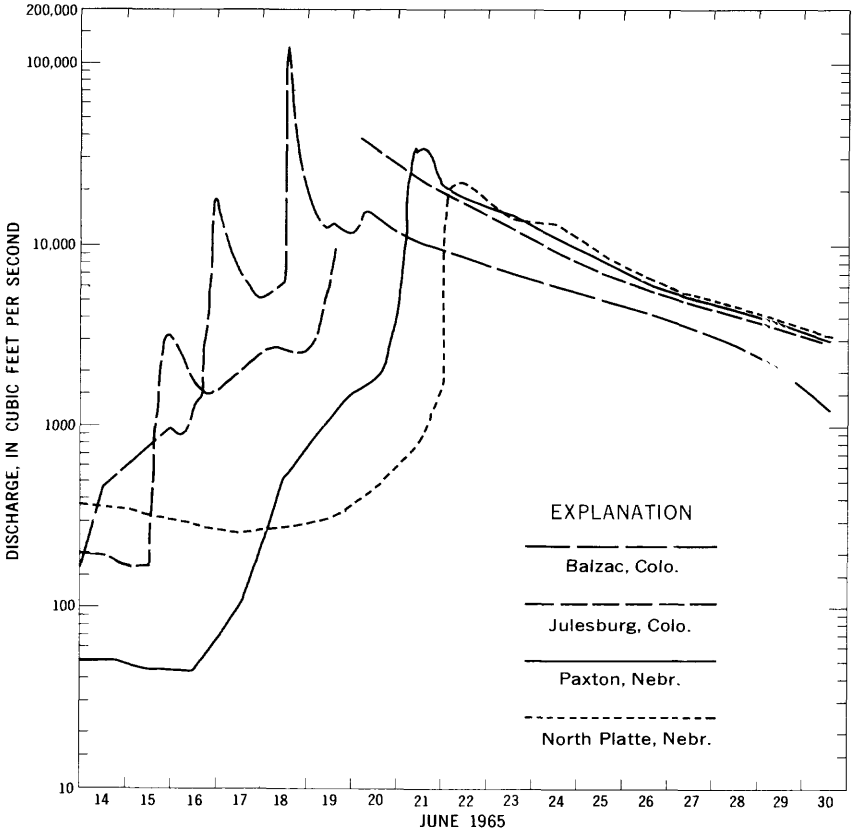

FIGURE 8.—Discharge hydrographs at selected gaging stations on South Platte River, Bijou Creek to mouth.

The entire flood runoff of Cherry Creek was stored in Cherry Creek Reservoir, just upstream from Denver. The peak inflow to the reservoir was about 59,000 cfs, and the outflow was zero. If the flood on Cherry Creek had not been controlled, the area along Cherry Creek in Denver would have been damaged entensively. The uncontrolled flood would have reached the South Platte River before the Plum Creek flood reached the mouth of Cherry Creek, but the contribution of Cherry Creek to the flood progressing down the South Platte River would have been significant.

Storage of floodwaters on the flood plains of Plum Creek and the South Platte River was an important factor in the reduction of possible flood damage as the flood moved downstream. Debris-choked bridges caused some local increases in stage and damage, but, along with other storage areas on the flood plains, caused a reduction of the peak discharge. The flood crested on Plum Creek near Louviers at 154,000 cfs, on the South Platte River at Littleton at 110,000 cfs, at 19th Street in Denver at 40,300 cfs, and at Henderson at 29,600 cfs. Between these locations, tributaries were adding small to moderate flows at the time of the main crest.

COMPARISONS WITH PREVIOUS FLOODS

Follansbee and Sawyer (1948) complied many details regarding floods in the South Platte River basin. Other reports prepared for notable floods that occurred in the same area are those by Murphy and others (1905), Follansbee and Hodges (1925), and the U.S. Geological Survey (1957, 1963).

SOUTH PLATTE RIVER

No estimates of the peak discharges for the floods of 1844, 1864, 1867, and 1876 are on record. General statements like "bottom lands near Denver were covered with water from bluff to bluff" were used in 1844 and 1864. The sources of the flood in May 1864 were Cherry and Plum Creeks, but the flood in June 1864 came from heavy rain on snow in the upper South Platte River basin. General estimates of the flood in May 1867 were that there was more water at a lower height in a wider channel than in 1864. By 1876, flood-plain encroachment had developed to such an extent that the following description appeared in the Rocky Mountain News of May 23, 1876: "[The South Platte] was higher to be sure—several feet higher perhaps in 1864—but it was not able to work such destruction at that time as now. There wasn't so much town here in 1864, as now, nor as many bridges."

The flood of May 31, 1894, originated in the upper South Platte River basin and has been estimated as 14,000 cfs at Denver. Mountain

tributaries from Clear Creek to St. Vrain Creek were also high, and bottom lands from Brighton to Brush were inundated.

Widespread rains June 2–7, 1921, caused flooding from the South Platte River canyon above Denver to the Colorado-Nebraska State line. At Fort Morgan, this flood was about the same height as that in 1894.

Plum Creek, Cherry Creek, and Big and Little Dry Creek basins received heavy rains on Sept. 9–10, 1933, and the resulting crest on the South Platte River at Denver, 22,000 cfs, was the highest up to that time. This flood attenuated to only 5,600 cfs at Henderson. The 22,000 cfs discharge was the maximum on record until it was exceeded by the 40,300 cfs peak in June 1965. Stated another way, the 1933 flood was the maximum in 71 years of record and probably the maximum in the 121 years since 1844, yet it was exceeded in 1965 by a flood flow 83 percent higher. Similar increases, some even larger, in known maximums have occurred at several places in the United States in recent years.

CHERRY CREEK

In 1858, Indians told of great floods on Cherry Creek in times past, but their stories were not taken for fact. The first flood of record occurred on May 19–20, 1864, and a personal account of the flood includes, "we could see the inky waves, 15 to 20 feet high, carrying trees, houses, cattle, and sheep—and for all we know, human beings—to certain destruction" (Colorado Mag., May 1927, in Follansbee and Sawyer, 1948, p. 60). Major floods occurred on May 22, 1876, and May 22, 1878, and a greater one occurred on July 26, 1885. The flood of July 14, 1912, came from heavy rains on about 100–200 square miles near Parker. The peak discharge determined by a slope-area measurement above Parker was 14,500 cfs.

An estimate of 17,000 cfs was made after the flood of July 28, 1922, at a site about 3 miles north of or downstream from Parker. The failure of Castlewood Dam on Aug. 3, 1933, caused the largest flood on Cherry Creek prior to 1965. Inflow to Castlewood Dam peaked near 35,000 cfs, and the stored water released when the dam failed caused a peak discharge estimated at 126,000 cfs just below the dam. This peak flow diminished to 15,000 cfs at Denver.

Since 1933, a detention reservoir, and since 1950, Cherry Creek Reservoir have contained the large floods on Cherry Creek. The peak inflow to Cherry Creek Reservoir in June 1965 was about 59,000 cfs.

KIOWA AND BIJOU CREEKS

Cloudburst rains in the Kiowa Creek and Bijou Creek basins on May 30 and 31, 1935, caused extremely high water on these streams

and on the South Platte River near Fort Morgan. The "Twenty-eighth Biennial Report of the Colorado State Engineer" contains some "tentative conclusions" and qualifies the published discharge figures with the comment:

"While some of the results, particularly those of the Pijou Creek discharge, appear to be incredible and entirely beyond anything which has ever occurred in Colorado or adjacent areas, they are submitted for whatever value they may have."

Table 2 includes the "tentative conclusions" for the 1935 flood and comparable discharges determined in 1965.

Discharges during the flood of May 1935 on Kiowa Creek were 43,500 cfs about 1 mile downstream from Elbert and 110,000 cfs about 12 miles downstream from Kiowa. In contrast, discharges in 1965 were 41,500 cfs plus an unknown, but substantial, flow from West Kiowa Creek at Elbert and 19,700 cfs at Kiowa. The heaviest rains in 1935 were near Elbert and Kiowa, whereas in 1965 they were along the headwater divide. Another notable flood occurred on Kiowa Creek on May 21, 1878, but no discharge figures are available. A Union Pacific locomotive plunged into the sands of Kiowa Creek during this flood and was never found.

TABLE 2.—*Comparison of peak discharges on Kiowa and Bijou Creeks for floods of 1935 and 1965*

Stream and location	Drainage area (sq mi)	Peak discharge (c.f.s.)	
		1935	1965
Kiowa Creek at Elbert	28.6	----------	41,500
West Kiowa Creek at Elbert	35.9	----------	20,000
Kiowa Creek at Elbert	65	43,500	----------
Kiowa Creek at Kiowa	111	----------	19,700
Kiowa Creek north of Kiowa	190	110,000	----------
Kiowa Creek at Bennett	236	75,300	24,900
East Bijou Creek at Deer Trail	302	25,000	274,000
Middle Bijou Creek below Wilson Creek	151	71,270	----------
Middle Bijou Creek near (Peoria) Deer Trail	190	143,640	145,000
West Bijou Creek near Kiowa	85.7	----------	67,200
West Bijou Creek at Johnsons Bridge	118	34,250	----------
West Bijou Creek south of Strasburg	187	44,400	----------
West Bijou Creek at Byers	277	164,670	75,500
Bijou Creek near Wiggins	1,314	282,900	466,000

NOTE.—Drainage areas for sites used only in 1935 not coordinated with drainage areas of 1965 sites.

FLOOD DAMAGE

Six persons were drowned, and at least two other deaths were attributed to the storms and activities related to the floods. Damage estimates, made shortly after the flood by a special Congressional com-

mittee, total $500 million in the South Platte River basin; about $300 million was in the Denver area.

The damage in the area north of Greeley and west of Sterling occurred June 14–16. Roads were flooded, bridges and bridge approaches were washed out, as much as 3 feet of water inundated parts of the towns of Galeton, Atwood, Sterling, and Greeley, and livestock, automobiles, and farm machinery were lost. Some flooding was caused after local drainage facilities became plugged by hail.

Lone Tree Creek overtopped a 20-foot-high earth-fill dam and washed out a 100-foot gap in the dam. The release of the stored water added to the flood problems downstream.

Near Atwood, floodwaters from Pawnee Creek undercut the Denver-Chicago main line of the Union Pacific Railroad.

The damage in rural areas in the Plum Creek basin was extensive. The heavy runoff deposited all kinds of debris—from sand to huge boulders and trees—on fields and pastures. Road embankments were severely eroded, and bridges on county, State, and interstate roads were destroyed. (See fig. 9.) Large cut banks, particularly along East

FIGURE 9.—Bridge on approach road from Castle Rock to Interstate Highway 25 destroyed by East Plum Creek. Denver Post photograph by William Peters.

Plum Creek, were left after land had been washed away. Much of the town of Castle Rock was inundated, and telephone service to about 100 phones in the town was disrupted. Seven homes, a church, the grange hall, and the lower part of the main street in Sedalia vanished during the flood.

The Denver and Rio Grande Western Railroad between Denver and Palmer Lake was built in 1871–72 and had never been damaged as extensively as it was in 1965. Five bridges, many culverts, and about 4 miles of track were damaged. Repairs to Rio Grande facilities cost $468,000. The Atchison, Topeka, & Santa Fe Railroad also follows the South Platte River and Plum Creek, and repairs, primarily to one bridge, cost about $500,000. The railroads worked together and were able to open the Santa Fe track to two-way traffic in 10 days. The Rio Grande track went into service about 6 weeks after the flood.

The floodwaters from Plum Creek soon exceeded the capacity of the main channel of the South Platte River, and residential, commercial, and industrial structures were flooded. Buoyant items such as butane gas storage tanks, house trailers, lumber, and truck vans floated downstream, plugged bridge openings, (fig. 10) and battered structures.

Bridge engineers report that scouring at bridge piers or abutments was not a factor in any bridge failures. The primary causes were the added thrust from the debris piled against the upstream side of the bridge and the increased water pressure against the bridge. The impact of large floating objects was part of the problem at some bridges. Cross sections at bridges before and after the flood showed a net scour of as much as 4 feet in the bed of the channel under bridges supported by closely spaced pile bents and (or) solid piers. At sites where bridges are supported by two or three columns, little or no net scour occurred.

Repairs and replacement of bridges and highways in the State Highway system alone cost $9 million. The city and county of Denver spent an additional $914,000 on repair of their streets and bridges.

About 8,000 telephones were put out of service by the flood in the metropolitan Denver area. Of these, 5,000 in Littleton, Englewood, and south Denver were still out 2 days after the flood.

The conditions in and near Denver on the morning after the flood can be described in many ways, but the most succinct and appropriate description is that the South Platte River valley was a mess. The city of Denver spent just over $1 million cleaning up mud and debris in addition to that spent by other municipalities, businesses, and individuals.

Flood damage figures have been compiled by the Soil Conservation Service for their Kiowa Creek Watershed Protection Project which

FIGURE 10.—South Platte River near West Bowles Ave., Littleton, Colo., on morning of June 17, 1965. Denver Post photograph by Edward Maker.

is the 118-square-mile basin above the town of Kiowa, Colo. The floods of June 1965 were several times the size of the design floods for the project structures. About 2,700 acres were flooded, and the total flood-water damage to crops, pasture, fences, livestock, and roads and bridges and to other flood-plain uses was about $135,700. Sediment deposition on about 315 acres of crop and pastureland caused damage of $16,600. Streambank erosion occurred along a total lineal distance of 9.5 miles of the main channels of East and West Kiowa Creeks and Kiowa Creek. Also, about 30 acres of crop and pastureland was a total loss from heavy erosion or streambank cutting. Erosion damage amounted to $14,700, and the total damage in the watershed was $167,000. Total damage for the period 1955–64 was only $6,600.

Damage caused by the flood of June 15 in the Bijou Creek basin could not be determined because a more devastating flood occurred only 48 hours later. Some livestock were lost during the June 15 flood, and on lower Bijou Creek in the early morning of June 16 a rancher had to be rescued from his fencepost perch where fast-rising water had trapped him.

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The flood peak on East Bijou Creek hit the town of Deer Trail about midnight on June 17. One observer describing the flood said, "It flushed the town." However, it left mud and debris in its wake.

The three forks of Bijou Creek washed out or damaged bridges on the main line of the Union Pacific Railroad and highway I 70–U.S. 40. Bijou Creek washed out the Chicago, Burlington & Quincy Railroad main line and highway I 80 S–U.S. 6 west of Fort Morgan. Alfalfa and other crops were partly buried by sediment deposits, and channel banks were cut badly at many localities. Four of the six drownings occurred in the Bijou Creek flood.

After the Bijou Creek flood reached the South Platte River, it damaged a bridge under construction at Fort Morgan, and inundated farm land, Interstate Highway 80 S, the Union Pacific Railroad tracks, and the eastern section of Sterling. The normally innocuous South Platte River was a mile or more wide and choked with debris. The flood crest traveled 4 to 5 miles per hour between Fort Morgan and Balzac.

Estimates of flood damage by types and location have been compiled by the U.S. Army Corps of Engineers. Their damage figures are summarized in table 3.

In addition, the Corps of Engineers has estimated miscellaneous secondary economic losses as follows:

Tourist income	$38,600,000
Interest on reconstruction loans	18,540,000
Tax revenues	36,486,000
Total	93,626,000

The total flood damage in the South Platte River basin was $508.2 million.

The floods in all four areas originated in or near the headwaters of the larger streams; therefore, the early warning of the approaching floods gave most people enough time to evacuate homes, remove livestock or equipment to higher ground, and otherwise prepare for high water. The losses were reduced through the cooperative efforts of many people and agencies and could have been reduced further except that in every major flood there are those who will not heed flood warnings until it is too late. Not only do they endanger their own lives and property, but they endanger the lives of others who try to rescue them.

FLOOD-CREST PROFILES AND INUNDATED AREAS

Graphs of flood-crest elevations versus river miles illustrate the relation between these two factors under the conditions that existed at maximum stages. The locations of these high-water marks, photo-

TABLE 3.—*Summary of flood damage, in thousands of dollars, in South Platte River basin, June 1955*

[Adapted from U.S. Army Corps of Engineers data]

Stream basin	Urban property					
	Residential	Commercial	Utilities	Publically owned	Miscellaneous	Subtotal
Plum Creek	450	810	98	21	169	1,548
South Platte River:						
Denver metropolitan	9,945	163,988	4,674	3,128	3,196	184,931
Brighton to Bijou Creek	8	5	4	4	4	25
Bijou Creek to Colorado-Nebraska State line	409	427	398	834	703	2,771
State line to North Platte, Nebr					5	5
Cherry Creek						
Sand Creek		163	43	21	89	316
Toll Gate Creek	19		40	90	20	169
Kiowa Creek						0
Bijou Creek	178	569	44	8	19	818
Badger Creek						0
Beaver Creek	122	19	66	19	23	249
Pawnee Creek	75				2	77
Miscellaneous areas	74	120	28	7	15	244
Total	11,280	166,101	5,395	4,132	4,245	191,153

Stream basin	Rural property				
	Farms and croplands	Livestock	Irrigation structures	Miscellaneous	Subtotal
Plum Creek	4,123	20	34	57	4,234
South Platte River:					
Denver metropolitan	1,590	67	39	492	2,188
Brighton to Bijou Creek	3,742	8	458	621	4,829
Bijou Creek to Colorado-Nebraska State line	5,924	3,287	8,560	1,629	19,400
State line to North Platte, Nebr	1,838	0	2,918	195	4,951
Cherry Creek	438	3	4	350	795
Sand Creek	13	3	61	17	94
Toll Gate Creek	20	5	1	25	51
Kiowa Creek	673	99	207	1,651	2,630
Bijou Creek	1,563	19	772	1,073	3,427
Badger Creek	224	32	95	402	753
Beaver Creek	358	20	137	361	876
Pawnee Creek	265	1	269	314	849
Miscellaneous areas	3,771	125	2,186	1,032	7,114
Total	24,542	3,689	15,741	8,219	52,191

Stream basin	Transportation				Total loss
	Streets, roads, and bridges	Railroads and trucking	Traffic delays and detours	Subtotal	
Plum Creek	3,281	1,018	2,353	6,652	12,434
South Platte River:					
Denver metropolitan	16,170	117,998	1,100	135,268	322,387
Brighton to Bijou Creek	826	413	639	1,878	6,732
Bijou Creek to Colorado-Nebraska State line	2,837	688	328	3,853	26,024
State line to North Platte, Nebr	281	0	151	432	5,388
Cherry Creek	463	0	48	511	1,306
Sand Creek	1,456	628	23	2,107	2,517
Toll Gate Creek	88	367	13	468	688
Kiowa Creek	1,967	619	276	2,862	5,492
Bijou Creek	5,496	2,614	688	8,798	13,043
Badger Creek	1,369	69	123	1,561	2,314
Beaver Creek	419	69	117	605	1,730
Pawnee Creek	1,407	276	105	1,788	2,714
Miscellaneous areas	3,092	675	632	4,399	11,757
Total	39,152	125,434	6,596	171,182	414,526

graphs, and map contours are used to establish the boundaries of the area inundated by the floods. Flood-crest profiles and the corresponding maps of inundated areas for several reaches of the South Platte River between the mouth of Plum Creek and Adams City, two reaches of Sand Creek from Aurora to the mouth, and the lower 4 miles of Toll Gate Creek are presented on plates 3 and 4.

The profiles and maps are adapted from data collected and furnished by the U.S. Army Corps of Engineers. Details concerning the profiles and maps are on file in the Corps' district office, Omaha, Nebr.

FLOOD FREQUENCIES

At many locations in the flood area, the floods of June 1965 exceeded the discharge of the 50-year flood by several orders of magnitude and probably exceeded the discharge of the 100-year flood at several locations. The true frequencies of floods of these magnitudes cannot be determined from the present records, which are relatively short.

The flood-frequency report (Matthai, 1968) for the flood area in the South Platte River basin has relations for one region, three hydrologic areas, and the main stem of the South Platte River. Coal, Lone Tree, and Crow Creeks are in one hydrologic area, and the peak discharges in June 1965 on these streams were, respectively, 5.0, 2.4, and 0.8 times the discharges for the 50-year floods. Only a small part of the drainage basin of Crow Creek contributed runoff to this flood; hence, the lower ratio.

Plum Creek is in another hydrologic area, and the peak discharges in 1965 on East Plum, West Plum, and Plum Creeks were, respectively, 44, 11, and 21 times the discharges for the 50-year floods.

Cherry, Sand, Kiowa, Bijou, and Beaver Creeks are in the third hydrologic area. The relations of the 1965 peak discharges in this area to size of drainage area and selected recurrence intervals are illustrated in figure 11.

The points plotted for Kiowa Creek subwatersheds Q–51 and R–33 are estimates of the maximum 5-minute inflow to the reservoirs. The highest ratios to the discharge of the 50-year flood are 11 for East Bijou Creek at Deer Trail and 9.0 for Bijou Creek near Wiggins.

The 1965 flood peaks along the South Platte River are plotted in figure 12 against miles above the mouth, and curves for the 25-year and 50–year floods are shown. The recurrence intervals of the peak discharges, mostly caused by the Plum Creek flood, are much greater than those for the 50-year floods between Littleton and Fort Lupton. Flood flows at Kersey and Weldona were less than the 25-year flood, but the tremendous discharge from Bijou Creek boosted the peak discharge in the South Platte River at Balzac to 4.1 times that of the

50-year flood. Channel storage and other losses reduced the flood peak until it was less than the 25-year flood at North Platte, Nebr.

DETERMINATION OF FLOOD DISCHARGES

The discharge at a stream-gaging station is computed from a stage-discharge relation. The stage is obtained from a water-stage recorder designed to provide a continuous record of stage. If the water-stage recorder malfunctions or is damaged by the flood, high-water marks and direct readings on a nonrecording gage are used. The discharge is generally measured by current meter, but indirect methods are used sometimes. The discharge measurements, at known stages, are used to compute the stage-discharge relation from which discharge may be calculated for any given stage.

Short extensions of the stage-discharge relation above the highest current-meter measurement can be made by using the results of slope-conveyance studies, by using other measurable hydraulic factors, or by logarithmic plotting. Long extensions of relations were defined by

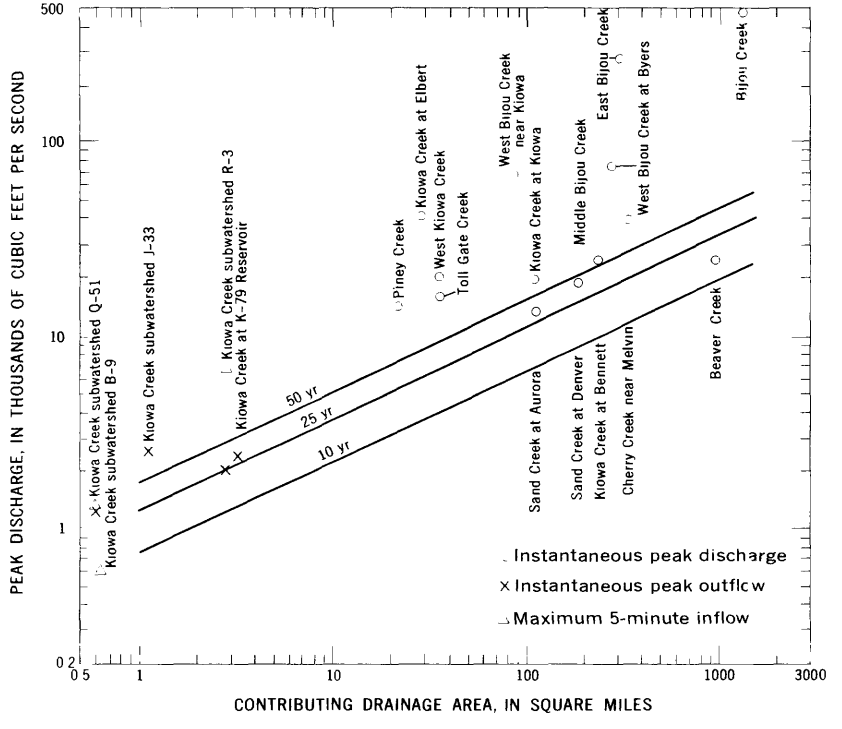

FIGURE 11.—Relation of peak discharge to size of drainage basin for Cherry, Sand, Kiowa, Bijou, and Beaver Creeks.

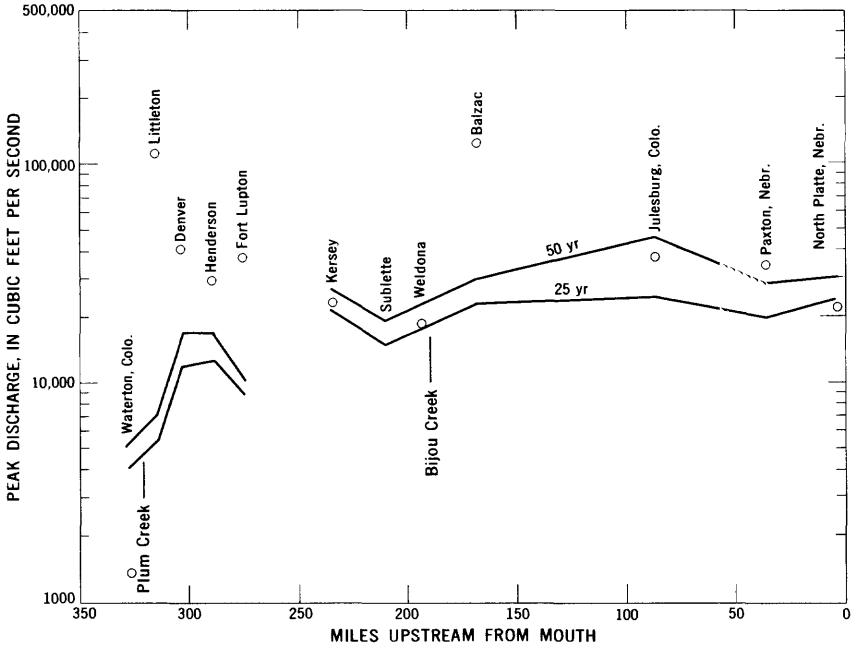

FIGURE 12.—Relation of peak discharge and selected flood frequencies to miles above mouth, South Platte River.

indirect measurements of the peak flow by the slope-area method, computations of flow through contractions such as bridges and culverts and over dams and road embankments, or a combination of these methods. At miscellaneous sites where high runoff occurred, the peak discharges were determined by indirect measurements. A total of 28 indirect measurements were made; 12 at active or discontinued gaging stations and 16 at miscellaneous sites.

STREAMFLOW DATA

EXPLANATION OF DATA

Detailed flood information, in addition to that in the regular annual reports of the Geological Survey, is compiled here for use in future hydraulic and hydrologic studies. Records of stage and discharge at 24 gaging stations, elevations and contents of one reservoir, and peak discharges at 25 miscellaneous sites are given.

The sites are numbered consecutively in downstream order, and these numbers identify the locations in figure 1. The permanent station numbers for the gaging stations correspond to the numbers in the annual reports.

SUMMARY OF FLOOD STAGES AND DISCHARGES

Maximum stages and discharges at gaging stations and miscellaneous sites within the flood area are summarized in table 4. The numbers in the first column correspond to those in figure 1 to facilitate identification of the sites for which flood data are tabulated.

The first column under "maximum flood previously known" shows the period of known floods before June 1965. This period is often longer than the period of continuous records of discharge because records of historical floods have been obtained.

The last column contains two sets of numbers. If the number is not footnoted, it is the recurrence interval of the June 1965 peak discharge, in years; if the recurrence interval of the June 1965 flood is more than 50 years, the number is footnoted, and is the ratio of the peak discharge in June 1965 to the discharge of the 50-year flood.

DATA FOR INDIVIDUAL SITES

The data tabulated for each site where floodflows were determined may include a station description, a short table of daily mean discharges for the days comprising the flood period, and a list of stages and discharges at indicated times during the rise to, and the recession from, the flood peak. Only the station description is presented for miscellaneous sites.

The station description contains information concerning the location, datum, type of gage, and drainage area. The method used to determine the stage during the flood period, the definition of the stage-discharge relation, and the conditions that might have affected that relation are explained. The maximum stage and (or) discharge at each site are given for the flood period in June 1965, for the indicated period of discharge record, and for floods prior to the period of record. Remarks on regulation and diversions and other pertinent information are included where applicable.

Tables of stages and discharges at indicated times are included so that these data and the daily mean discharges before and after the detailed period can be used to define both stage and discharge hydrographs.

TABLE 4.—*Summary of flood stages and discharges*

No.	Permanent station number	Stream and place of determination	Contributing drainage area (sq mi)	Maximum flood previously known					Maximum June 14–22, 1965				
				Prior to June 1965		Gage height (ft)	Discharge		Day	Time (hr)	Gage height (ft)	Discharge	
				Period	Year		Cubic feet per second	Recurrence interval (yr)				Cubic feet per second	Recurrence interval (yr)
		Platte River basin											
1	6-7080	South Platte River at Waterton, Colo	2,621	1926–65	1942	5.68	5,700	50	18	0830	2.90	1,320	3
2		West Plum Creek near Sedalia, Colo	125						16	1500		36,800	[1]11
3		East Plum Creek near Castle Rock, Colo	108						16	1600		126,000	[1]44
4	7095	Plum Creek near Louviers, Colo	302	1942–65	1945	[2]6.52	7,700	[1]1.1	16	1830	21	154,000	[1]21
5	7100	South Platte River at Littleton, Colo	3,069	1941–65	1942	[2]8.55	9,720	[1]1.3	16	2100	15.45	110,000	[1]15
6	7115	Bear Creek at mouth, at Sheridan, Colo	260	1914, 1927–65	1933 1938	[2]7.21	3,000	12	15	1700	4.70	284	1
7	7120	Cherry Creek near Franktown, Colo	169	1939–65	1945	[3]4.91	[3]9,170	11	16	1945	6.40	1,000	1
8	7125	Cherry Creek near Melvin, Colo	336	1933, 1939–65	1933	[2]9.72	[4]34,000	[1]1.3	16	1830	13	39,900	[1]1.5
9		Piney Creek near Melvin, Colo	21.9						16	1500		14,100	[1]1.9
10	7129.9	Cherry Creek Reservoir near Denver, Colo	385	1950–65	1960	5,551.86	[5]16,810		20	2400	5,560.34	[5]26,020	
11	7130	Cherry Creek below Cherry Creek Reservoir, Colo.	385	1933, 1950–65	1933		[6]34,000	[1]1.2				0	
12	7135	Cherry Creek at Denver, Colo	409	1885, 1933, 1942–65	1885		[7]20,000	22	17			25	
13	7140	South Platte River at Denver, Colo	3,804	1889–90, 1895–1965	1933	10.98	22,000	[1]1.3	17	0130 0145	[8]11.91 15.00	40,300	[1]2.4
14		Sand Creek at Sable Ave., Aurora, Colo	113	1957, 1965	1957		7,660	12	16	2000		13,400	35
15		Toll Gate Creek at E. 6th Ave., Aurora, Colo	35.8	1957, 1963, 1965	1957		10,400	[1]1.2	16	1600		16,000	[1]1.8
16		Sand Creek below Toll Gate Creek, at Denver, Colo.	187	1957, 1963, 1965	1957		25,500	[1]1.2	16	2200		18,900	41
17	7200	Clear Creek at mouth, hear Derby, Colo	575	1914, 1927–65	1938	[2]4.04	3,650	([9])	17	0730	4.97	2,740	([9])
18	7205	South Platte River at Henderson, Colo	4,713	1926–65	1957	11.35	14,800	40	17	0500	12.93	29,600	[1]1.7
19	7210	South Platte River at Ft. Lupton, Colo	5,010	1906, 1929–65	1942 1957	7.57	9,000	25	17	1130	9.40	36,800	[1]3.5
20	7310	St. Vrain Creek at mouth, near Platteville, Colo	976	1904–6, 1915, 1927–65	1938	[2]8.93	11,300	10	18	2100	5.77	3,070	2
21	7440	Big Thompson River at mouth, near La Salle, Colo.	828	1914–15, 1927–65	1951	[2]7.80	6,100	5	18	0900	6.77	1,960	2

22	7525	Cache la Poudre River near Greeley, Colo	1,877	1903–4, 1914–19, 1924–65	1917		[10] 4,220	(9)	19	1730	8.42	3,480	(9)	
23	7535	Lone Tree Creek near Nunn, Colo	199	1951–57	1955	4.65	775	12	14	2200		5,810	[1] 2.4	
24	7540	South Platte River near Kersey, Colo	9,598	1901–65	1921		[10] 31,000	[1] 1.1	18	1700	10.75	23,500	30	
25		Crow Creek near Keota, Colo	527						15	0700		4,000	29	
26		Coal Creek near Briggsdale, Colo	67.8						15			5,340	[1] 5.0	
27	7576	Kiowa Creek at K–79 Reservoir, near Eastonville, Colo.	3.20	1955–65	1957		[11] 5,250	[1] 1.8	17	1900	23.63	[12] 2,370	30	
28	7577	Kiowa Creek Subwatershed No. J–33 near Eastonville, Colo.	1.12	1956–65	1957		[11]93	3	17		19.68	[12] 2,600	[1] 4.0	
29	7577.5	Kiowa Creek Subwatershed No. R–3 near Elbert, Colo.	2.82	1956–65	1963		[11] 1,090	9	17	1915	23.33	[11] 6,880	[1] 2.5	
30	7578	Kiowa Creek Subwatershed No. Q–51 near Elbert, Colo.	.59	1957–65	1963		[11] 114	(9)	17	1915	28.70	[11] 1,350	(9)	
31	7579	Kiowa Creek Subwatershed No. B–9 near Elbert, Colo.	.64					(9)	17	2000	13.41	[11] 597	(9)	
32	7580	Kiowa Creek at Elbert, Colo	28.6	1935–65	1935		[13] 43,500	[1] 5.3	17	1930	12.57	41,500	[1] 5.1	
33	7581	West Kiowa Creek at Elbert, Colo	35.9	1962–65	1963	2.22	92	1	17	2030	7.40	20,000	[1] 2.2	
34	7582	Kiowa Creek at Kiowa, Colo	111	1935–65	1935		[14]		17	2330	18.5	19,700	[1] 1.3	
35	7583	Kiowa Creek at Bennett, Colo	236	1935, 1960–64	1935		[13] 75,300	[1] 3.3	18	0130	7.66	24,900	[1] 1.1	
36	7585	South Platte River near Weldona, Colo	13,245	1952–65	1957	9.92	14,200	15	19	1900	10.33	18,800	30	
37		East Bijou Creek at Deer Trail, Colo	302	1935, 1965	1935		25,000	48	17	2400		274,000	[1] 11	
38		Middle Bijou Creek near Deer Trail, Colo	190	1935, 1965	1935		143,640	[1] 7.0	17			145,000	[1] 7.1	
39		West Bijou Creek near Kiowa, Colo	85.7						17	1900		67,200	[1] 4.8	
40		West Bijou Creek at Byers, Colo	277	1935, 1965	1935		164,670	[1] 6.7	17	2400		75,500	[1] 3.1	
41	7590	Bijou Creek near Wiggins, Colo	1,314	1935–65	1935		282,900	[1] 5.5	18	0730	21.2	466,000	[1] 9.0	
42	7595	South Platte River at Fort Morgan, Colo	14,810	1935–65	1935		[13] 84,300	[1] 3.1	18	1000	18.2			
43		Beaver Creek near Brush, Colo	946						18	1400		24,300	15	
44	7600	South Platte River at Balzac, Colo	16,852	1916–65	1921		[15] 31,200	[1] 1.1	18	1320	13.32	123,000	[1] 4.2	
45		North Pawnee Creek near New Raymer, Colo	82.3						14	2400		6,280	(9)	
46		Pawnee Creek near Stoneham, Colo	387						15	0300		26,700	(9)	
47		Pawnee Creek near Sterling, Colo	629						15	0700		35,200	(9)	
48	7640	South Platte River at Julesburg, Colo	23,138	1902–65	1935		31,300	35	20	0530	10.44	37,600	40	
49	7650	South Platte River at Paxton, Nebr	23,700	1939–65	1942	9.34	16,900	18	21	0900	10.69	33,800	[1] 1.2	
50	7655	South Platte River at North Platte, Nebr	24,300	1897, 1914–15, 1917–65	1935	14.02	37,100	[1] 1.2	22	0900	10.43	22,200	20	

[1] Ratio to discharge of 50-year flood.
[2] Site and datum then in use.
[3] Highest flood known occurred Aug. 3, 1933, when Castlewood Dam failed.
[4] At site 6 miles downstream, caused by Castlewood Dam failure.
[5] Contents in acre- eet.
[6] Maximum flood known, caused by Castlewood Dam failure.
[7] Flood of May 19, 20, 1864, reached a somewhat higher stage.
[8] Backwater from South Platte River.
[9] Not defined.
[10] Daily discharge.
[11] Maximum 5-minute inflow.
[12] Instantaneous outflow.
[13] Maximum flood known.
[14] Maximum flood known; discharge at Elbert about 9½ miles upstream, 48,500 cfs, and at site about 12 miles downstream, 110,000 cfs.
[15] Daily discharge. Maximum discharge, not determined, occurred May 31, 1935 (gage height, 11.43 ft, site and datum then in use).

STATION DATA

PLATTE RIVER BASIN

(1) 6-7080. SOUTH PLATTE RIVER AT WATERTON, COLO.

Location.—Lat 39°29'18", long 105°05'32", in NE¼ sec. 34, T. 6 S., R. 69 W., on left bank 168 ft downstream from bridge on State Highway 221, half a mile east of Waterton, 5 miles west of Louviers, and 6 miles upstream from Plum Creek.

Drainage area.—2,621 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 5,484.43 ft above mean sea level, adjustment of 1912.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 1,200 cfs.

Maxima.—June 15–20, 1965: Discharge, 1,320 cfs 0830 hours June 18 (gage height, 2.90 ft).

1926 to May 1965: 5,700 cfs Apr. 23, 1942 (gage height, 5.68 ft).

Remarks.—Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day		*Discharge*
June	15	736
	16	943
	17	1,140
	18	1,200
	19	1,170
	20	1,070

(2) WEST PLUM CREEK NEAR SEDALIA, COLO.

[Miscellaneous site]

Location.—Lat 39°22'30", long 104°57'35", in NW¼ sec. 12, T. 8 S., R. 68 W., 4.2 miles upstream from confluence with East Plum Creek and 4.4 miles south of Sedalia.

Drainage area.—125 sq mi.

Maximum.—June 15–20, 1965: Discharge, 36,800 cfs 1500 hours June 16, by slope-area measurement of peak flow.

(3) EAST PLUM CREEK NEAR CASTLE ROCK, COLO.

[Miscellaneous site]

Location.—Lat 39°24'17", long 104°52'25", in sec. 34, T. 7 S., R. 67 W., 2.2 miles north of Castle Rock and 5.8 miles upstream from confluence with West Plum Creek.

Drainage area.—108 sq mi.

Maximum.—June 15–20, 1965: Discharge, 126,000 cfs 1600 hours June 16, by slope-area measurement of peak flow.

(4) 6-7095. PLUM CREEK NEAR LOUVIERS, COLO.

Location.—Lat 39°29'04", long 105°00'07", in SE¼ sec. 33, T. 6 S., R. 68 W., on right bank at downstream side of bridge on county road from U.S. Highway 85 to Louviers, three-quarters of a mile northeast of Louviers, 1.2 miles downstream from Indian Creek, and 7.5 miles upstream from mouth.

Drainage area.—302 sq mi.

Gage-height record.—Only floodmarks. Gage destroyed by flood. Altitude of gage is 5,585 ft (from topographic map).

Discharge record.—Discharge estimated on basis of slope-area measurement at 154,000 cfs, two current-meter measurements, one field estimate, and records for South Platte River at Littleton.

Maxima.—June 15–20, 1965: Discharge, 154,000 cfs 1830 hours June 16 (gage height, about 22.4 ft. from floodmarks).

1942 to May 1965: Discharge 7,700 cfs August 8, 1945 (gage height, 6.52 ft, site and datum then in use).

Mean discharge, in cubic feet per second, 1965

Day	*Discharge*
June 15	145
16	11,600
17	1,940
18	460
19	320
20	266

(5) 6-7100. SOUTH PLATTE RIVER AT LITTLETON, COLO.

Location.—Lat 39°37'10", long 105°01'10", in NE¼ sec. 17, T. 5 S., R. 68 W., on left bank 200 feet downstream from Crestline Avenue Bridge at Littleton and 3.1 miles upstream from Bear Creek.

Drainage area.—3,069 sq mi.

Gage-height record.—Water-stage recorder graph except 1800 hours June 16 to 2400 hours June 19. Once-daily staff-gage readings used June 18, 19. Peak stage determined from floodmark. Datum of gage is 5,304.36 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 5,000 cfs. Peak discharge estimated from indirect measurements of peak flow at point 1.6 miles downstream and on Plum Creek at point 12.7 miles upstream. Discharge June 16, 17 estimated on basis of peak discharge and typical recession.

Maxima.—June 15–20, 1965: Discharge, about 110,000 cfs 2100 hours June 16 (gage height, 15.45 ft, from floodmark).

1941 to May 1965: Discharge, 9,720 cfs Apr. 23, 1942 (gage height, 8.55 ft, from floodmark, site and datum then in use), from rating curve extended above 4,800 cfs.

Mean discharge, in cubic feet per second, 1965

Day	*Discharge*
June 15	803
16	10,200
17	7,770
18	2,280
19	1,740
20	1,550

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 14			*June 15*—Con.*			*June 16**		
2400	4.74	686	1200	5.02	873	0600	5.08	915
*June 15**			1800	5.00	859	1200	5.25	1,030
0600	4.80	722	2400	5.02	873	1800	5.38	1,130

*Daily means computed from data in addition to figures shown.

(6) 6-7115. BEAR CREEK AT MOUTH, AT SHERIDAN, COLO.

Location.—Lat 39°39'08", long 105°01'57", in NW¼NW¼ sec. 5, T. 5 S., R. 68 W. on left bank just downstream from bridge on road to Fort Logan Mental Health Center, at Highway Department maintenance building northwest city limits of Sheridan, 1.3 miles upstream from mouth and 2.1 miles west of city hall in Englewood.

Drainage area.—260 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 5,295 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 370 cfs and by float-area measurement at 2,900 cfs.

Maxima.—June 15–20, 1965: Discharge, 284 cfs 1700 hours June 15 (gage height, 4.70 ft).

1914, 1927 to May 1965: Discharge, 3,000 cfs July 7, 1933 (gage height, 6.95 ft, site and datum then in use), from rating curve extended above 1,100 cfs on basis of slope-area measurement of peak flow.

Remarks.—Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day	*Discharge*
June 15	270
16	263
17	256
18	256
19	226
20	194

(7) 6-7120. CHERRY CREEK NEAR FRANKTOWN, COLO.

Location.—Lat 39°21'30", long 104°45'50", in NE¼ sec. 15, T. 8 S., R. 66 W., on right bank 1.2 miles upstream from Russelville Gulch and 2.2 miles south of Franktown.

Drainage area.—169 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 6,150 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 200 cfs and by slope-area measurement at 1,730 cfs for peak flow on Aug. 21, 1965.

Maxima.—June 15–20, 1965: Discharge, 1,000 cfs 1945 hours June 16 (gage height, 6.40 ft).

1939 to May 1965: Discharge, 9,170 cfs Aug. 5, 1945 (gage height, 4.91 ft, site and datum then in use), by float measurement.

Highest flood known occurred Aug. 3, 1933, when Castlewood Dam failed.

Mean discharge, in cubic feet per second, 1965

Day	*Discharge*
June 15	6.0
16	105
17	175
18	63
19	26
20	13

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 14			*June 16*—Con.			*June 17**—Con.		
2400	2.40	5.2	1830	4.15	187	0700	4.44	254
*June 15**			1900	3.70	103	0800	4.25	209
1500	2.32	4.6	1915	3.45	66	1400	4.13	183
1900	2.40	5.2	1930	5.60	636	1800	3.92	143
2000	2.63	8.0	1945	6.40	1,000	2400	3.72	107
2100	2.64	8.1	2000	6.00	810	*June 18**		
2200	3.27	41	2030	5.40	556	0600	3.56	91
2400	3.01	19	2100	4.55	282	0800	3.39	66
June 16			2200	4.38	240	1600	3.23	43
0700	2.77	11	2400	4.33	228	2400	3.18	37
1300	2.90	14	*June 17**			*June 19**		
1630	2.89	14	0100	4.20	198	1200	3.07	28
1700	3.25	38	0400	4.13	183	2400	2.88	17
1730	4.97	402	0600	4.27	214	*June 20**		
1800	4.54	279	0630	4.66	312	1200	2.76	14
						2400	2.64	10

*Daily means computed from data in addition to figures shown.

(8) 6-7125. CHERRY CREEK NEAR MELVIN, COLO.

Location.—Lat 39°35'42", long 104°48'44", in SE¼SE¼ sec. 19, T. 5 S., R. 66 W., near right bank on downstream side of Arapahoe Road bridge, 0.9 mile upstream from Piney (South Cherry) Creek, 2.3 miles southeast of former site of Melvin, 5.5 miles upstream from Cherry Creek Dam, and 6.0 miles northwest of Parker.

Drainage area.—336 sq mi.

Gage-height record.—Only floodmarks; gage damaged by flood. Datum of gage is 5,625.81 ft above mean sea level, datum of 1929.

Discharge record.—Discharge estimated on basis of indirect measurement of peak flow, one current-meter measurement, and change in contents in Cherry Creek Reservoir.

Maxima.—June 15–20, 1965: Discharge, 39,900 cfs 1830 hours June 16 (gage height about 13 ft, from floodmarks).

1939 to May 1965: Discharge, 17,600 cfs July 18, 1946 (gage height, 7.45 ft, site and datum then in use), from rating curve extended above 11,000 cfs.

Flood of August 3, 1933, reached a stage of 9.72 ft, former site and datum, from floodmarks (discharge, 34,000 cfs, by slope-area measurement of peak flow at Kenwood damsite 6 miles downstream), caused by failure of Castlewood Dam.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	0
16	4,000
17	850
18	350
19	120
20	70

(9) PINEY CREEK NEAR MELVIN, COLO.

[Miscellaneous site]

Location.—Lat 39°36'35", long 104°48'35", in NW¼NW¼ sec. 20, T. 5 S., R. 66 W., at bridge on State Highway 83 0.7 mile upstream from mouth and 1.3 miles southeast of Melvin.

Drainage area.—21.9 sq mi.

Maximum.—June 15–20, 1965: Discharge, 14,100 cfs 1500 hours June 16, by indirect measurement of peak flow.

(10) 6–7129.9 CHERRY CREEK RESERVOIR NEAR DENVER, COLO.

Location.—Lat 39°39'03", long 104°51'13", in NE¼ sec. 2, T. 5 S., R. 67 W., at dam on Cherry Creek, 3.6 miles downstream from Piney Creek and 9.2 miles southeast of State Capitol Building in Denver.

Drainage area.—385 sq mi.

Gage-height record.—Water-stage recorder graph 2400 hours June 15 to 1700 hours June 16 and 0730 hours June 18 to June 21. Graph based on 10 gage readings 1700 hours June 16 to 0730 hours June 18. Datum of gage is mean sea level (levels by Corps of Engineers).

Maxima.—June 15–20, 1965: Contents, 26,020 acre-feet 2400 hours June 20 (elevation, 5,560.34 ft).

1950 to May 1965: Contents, 18,200 acre-feet Mar. 28, 1960 (elevation, 5,553.25 ft).

Remarks.—Reservoir stored all inflow during flood period.

Cooperation.—Gage-height record furnished by Corps of Engineers.

Elevation and contents at indicated time, 1965

Hour	Elevation (feet)	Contents (acre-feet)	Hour	Elevation (feet)	Contents (acre-feet)	Hour	Elevation (feet)	Contents (acre-feet)
June 15			*June 17*			*June 18*–Con.		
2400	5,544.17	10,470	0130	5,558.05	23,320	1200	5,560.07	25,690
June 16			0330	5,559.12	24,550	2400	5,560.20	25,850
1700	5,544.17	10,470	0600	5,559.38	24,870	*June 19*		
1900	5,549.94	15,090	1030	5,559.55	25,070	1200	5,560 27	25,930
1920	5,550.82	15,880	1700	5,559.69	25,240	2400	5,560.31	25,980
1930	5,551.72	16,690	2400	5,559.86	25,440	*June 20*		
2115	5,555.81	20,860	*June 18*			1200	5,560.33	26,010
2200	5,556.62	21,750	0730	5,560.00	25,610	2400	5,560.34	26,020
2400	5,557.45	22,660						

(11) 6–7130. CHERRY CREEK BELOW CHERRY CREEK RESERVOIR, COLO.

Location.—Lat 39°39'10", long 104°51'40", in SW¼SW¼ sec. 35 T. 4 S., R. 67 W., on right bank 2,000 ft downstream from Cherry Creek Dam, 2 miles southeast of Sullivan, 9 miles southeast of Civic Center in Denver, and 11 miles upstream from mouth.

Drainage area.—385 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 5,490.51 ft above mean sea level, datum of 1929 (Corps of Engineers bench mark).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 1,300 cfs.

Maxima.—June 1965: No flow.

1933 to May 1965: Discharge, 34,000 cfs Aug. 3, 1933, by slope-area measurement near present site (Castlewood Dam failure).

Remarks.—No flow during flood period. Flood flow regulated by Cherry Creek Reservoir. (See station 6–7129.9.)

(12) 6-7135. CHERRY CREEK AT DENVER, COLO.

Location.—Lat 39°44'58", long 105°00'08", in NE¼ sec. 33, T. 3 S., R. 68 W., on right bank on downstream side of Wazee Street Bridge in Denver, 0.5 mile upstream from mouth.

Drainage area.—409 sq mi.

Gage-height record.—Digital water-stage recorder record. Datum of gage is 5,175.48 ft above mean sea level, datum of 1929, supplementary adjustment of 1960.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 1,400 cfs and computation of flow over dam at 2,050 cfs. Discharge 0015 hours to 0415 hours June 17 estimated on basis of weather records and adjacent record.

Maxima.—June 15–20, 1965: Gage height, 11.91 ft 0130 hours June 17 (backwater from South Platte River).

1942 to May 1965: Discharge observed, 3,120 cfs Aug. 5, 1945 (gage-height, 5.25 ft, site and datum then in use).

Flood of July 26, 1885, reached a discharge of 20,000 cfs, by float measurement. Flood of May 19, 20, 1864, reached a somewhat higher stage. Flood of Aug. 3, 1933, reached a discharge of about 15,000 cfs as determined by rise of South Platte River at Denver.

Remarks.—Flood flow regulated by Cherry Creek Reservoir. (See station 6-7129.9.)

Mean discharge, in cubic feet per second, 1965

Day		Discharge
June	15	9.4
	16	18
	17	25
	18	17
	19	15
	20	14

(13) 6-7140. SOUTH PLATTE RIVER AT DENVER, COLO.

Location.—Lat 39°45'35", long 105°00'10", in NW¼ sec. 28, T. 3 S., R. 68 W., on right bank 20 ft upstream from 19th Street Bridge in Denver and 0.4 mile downstream from Cherry Creek.

Drainage area.—3,804 sq mi.

Gage-height record.—Water-stage recorder graph except 0030 hours June 17 to June 19. Peak stage determined from high-water mark near gage well. Datum of gage is 5,161.30 ft above mean sea level, datum of 1929, supplementary adjustment of 1960.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 2,700 cfs and by indirect measurement at 40,300 cfs. Discharge 0030 hours June 17 to June 19 estimated on basis of peak discharge, one discharge measurement, typical recession, and records for nearby stations.

Maxima.—June 15–20, 1965: Discharge, 40,300 cfs about 0145 hours June 17 (gage height, 15.00 ft, from floodmarks).

1889–90, 1895 to May 1965: Discharge, 22,000 cfs Sept. 10, 1933 (gage height, 10.98 ft), from rating curve extended above 8,800 cfs on basis of float-area measurement at gage height 9.44 ft.

Remarks.—Flood came principally from Plum Creek.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	1,250
16	2,840
17	12,000
18	4,200
19	2,200
20	1,650

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 15			*June 16*—Con.*			*June 17**		
2400	1.72	1,320	2120	1.90	1,590	0015	11.60	28,100
			2130	5.00	7,700	0030	13.50	34,800
*June 16**			2200	6.98	12,900	0145	15.00	40,300
0600	1.72	1,320	2300	7.81	15,500	0900	3.94	5,880
1200	1.73	1,340	2400	9.60	21,200			
1900	1.93	1,640						

*Daily mean computed from data in addition to figures shown.

(14) SAND CREEK AT SABLE AVENUE, AURORA, COLO.

[Miscellaneous site]

Location.—Lat 39°45′24″, long 104°49′04″, in SE¼ sec. 30, T. 3 S., R. 66 W., at bridge on Sable Avenue at northeast city limits of Aurora and 1.0 mile upstream from Toll Gate Creek.

Drainage area.—113 sq mi.

Maxima.—June 15–20, 1965: Discharge, 13,400 cfs 2000 hours June 16, by slope-area measurement of peak flow.

1957: Discharge, 7,600 cfs May 9, 1957, by indirect measurement of peak flow at site 0.9 mile downstream.

(15) TOLL GATE CREEK AT E. 6TH AVE., AT AURORA, COLO.

[Miscellaneous site]

Location.—Lat 30°43′32″, long 104°49′04″, on line between secs. 6 and 7, T. 4 S., R. 66 W., at East 6th Avenue at south city limits of Aurora, 3.5 miles upstream from mouth.

Drainage area.—35.8 sq mi.

Maxima.—June 15–20, 1965: Discharge, 16,000 cfs 1600 hours June 16, by indirect measurement of peak flow.

1957, 1963: Discharge, 10,400 cfs May 9, 1957, by indirect measurement of peak flow.

(16) SAND CREEK BELOW TOLL GATE CREEK, AT DENVER, COLO.

[Miscellaneous site]

Location.—Lat 39°46′05″, long 104°53′00″, in NW¼ sec. 27, T. 3 S., R. 67 W., at northeast city limits of Denver 1,000 ft upstream from Union Pacific Railroad bridge, 1.8 miles downstream from Toll Gate Creek, and 4 miles upstream from mouth.

Drainage area.—187 sq mi.

Maxima.—June 15–20, 1965: Discharge, 18,900 cfs 2200 hours June 16, by computation of peak flow through culvert.

1957, 1963: Discharge, 25,500 cfs May 9, 1957, by slope-area measurement of peak flow.

(17) 6-7200. CLEAR CREEK AT MOUTH, NEAR DERBY, COLO.

Location.—Lat 39°49'42", long 104°57'30", in SW¼SW¼ sec. 36., T. 2 S., R. 68 W., on right bank 160 ft downstream from York Street bridge, 0.6 mile upstream from mouth, and 2.5 miles west of Derby.

Drainage area.—575 sq mi.

Gage height record.—Water-stage recorder graph. Altitude of gage is 5,110 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 2,100 cfs.

Maxima.—June 15–20, 1965: Discharge, 2,740 cfs 0730 hours June 17 (gage height, 4.97 ft).

1914, 1927 to May 1965: Discharge, 3,650 cfs Sept. 3, 1938 (gage height, 4.04 ft, site and datum then in use), from rating curve extended above 1,300 cfs.

Remarks.—Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	2,230
16	2,390
17	2,620
18	2,360
19	2,450
20	2,480

(18) 6-7205. SOUTH PLATTE RIVER AT HENDERSON, COLO.

Location.—Lat 39°55'12", long 104°52'18", in NW¼SE¼ sec. 34, T. 1 S., R. 67 W., on left bank 1,200 ft upstream from bridge on State Highway 22 and 0.3 mile west of Henderson.

Drainage area.—4,713 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 5,005.12 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 9,000 cfs.

Maxima.—June 15–20, 1965: Discharge, 29,600 cfs 0500 hours June 17 (gage height, 12.93 ft).

1926 to May 1965: Discharge, 14,800 cfs May 9, 1957, (gage height, 11.35 ft), from rating curve extended above 9,500 cfs.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	1,200
16	1,930
17	13,000
18	4,760
19	4,300
20	3,770

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 15			*June 17**			*June 17**—Con.		
2400	3.82	1,450	0100	8.70	9,850	1300	8.42	8,960
*June 16**			0200	10.05	15,000	1700	7.79	7,180
0400	3.58	1,250	0300	10.90	19,100	2000	7.64	6,810
0700	3.50	1,190	0400	11.77	23,400	2300	7.53	6,550
1500	3.93	1,530	0500	12.93	29,600	2400	7.14	5,740
1800	3.96	1,560	0600	12.14	25,300	*June 18**		
1900	4.13	1,700	0700	11.98	24,500	0100	6.78	5,090
2100	5.45	3,140	0800	11.63	22,800	0400	6.60	4,790
2200	6.47	4,680	0900	10.70	18,100	1200	6.57	4,740
2300	7.25	5,950	1000	10.10	15,200	2400	6.48	4,600
2400	8.20	8,300	1100	9.00	10,900			

*Daily means computed from data in addition to figures shown.

(19) 6-7210. SOUTH PLATTE RIVER AT FORT LUPTON, COLO.

[Regular station, unpublished]

Location.—Lat 40°04'50", long 104°49'18", in NW¼ sec. 6, T. 1 N., R. 66 W., on left bank 50 ft downstream from bridge on State Highway 52 at Fort Lupton and 1 mile downstream from Big Dry Creek.

Drainage area.—5,010 sq mi.

Gage-height record.—Floodmarks only. Datum of gage is 4,888.66 ft above mean sea level, datum of 1929.

Maxima.—June 15–20, 1965: Discharge, 36,900 cfs 1130 hours June 17 (gage height, 8.49 ft), by indirect measurement of peak flow.

1906, 1929 to May 1965: Discharge, 9,000 cfs Apr. 26, 1942 (gage height, 7.24 ft, present datum, at site 650 ft upstream), from rating curve extended above 6,700 cfs.

(20) 6-7310. ST. VRAIN CREEK AT MOUTH, NEAR PLATTEVILLE, COLO.

Location—Lat 40°15'29", long 104°52'45", in SE¼NW¼ sec. 3, T. 3 N., R. 67 W., on right bank 140 ft downstream from bridge on county road, 1.3 miles upstream from mouth, and 4 miles northwest of Platteville.

Drainage area.—976 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 4,740 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 3,300 cfs.

Maxima.—June 10–21, 1965: Discharge, 3,070 cfs 2100 hours June 18 (gage height, 5.77 ft).

1904–6, 1915, 1927 to May 1965: Discharge, 11,300 cfs Sept. 3, 1938 (gage height, 8.93 ft, at site 140 ft upstream at different datum), from rating curve extended above 4,700 cfs.

Remarks.—Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 10	229
11	742
12	1,680
13	1,500
14	1,530
15	1,320
16	1,470
17	1,860
18	2,910
19	2,760
20	2,530
21	2,300

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 14			*June 16**—Con.			*June 18**—Con.		
2400	4.35	1,490	2400	4.62	1,770	1200	5.62	2,890
June 15			*June 17*			1800	5.76	3,060
0600	4.22	1,360	0600	4.59	1,740	2100	5.77	3,070
1200	4.16	1,300	1200	4.62	1,770	2400	5.75	3,050
2400	4.08	1,230	2200	4.88	2,060	*June 19*		
*June 16**			2400	5.24	2,450	0600	5.62	2,830
0600	4.07	1,220	*June 18**			1200	5.47	2,650
1200	4.31	1,450	0200	5.48	2,730	1800	5.51	2,700
1800	4.50	1,640	0600	5.53	2,790	2400	5.50	2,690

*Daily means computed from data in addition to figures shown.

(21) 6-7440. BIG THOMPSON RIVER AT MOUTH, NEAR LaSALLE, COLO.

Location.—Lat 40°21'00", long 104°47'04", in SW¼SE¼ sec. 33, T. 5 N., R. 66 W., on left bank just southeast of gage on Evans town ditch, 0.7 miles upstream from highway bridge, 1.6 miles upstream from mouth, and 4 miles west of LaSalle.

Drainage area.—828 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 4,680 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 1,500 cfs.

Maxima.—June 16–21, 1965: Discharge, 1,960 cfs 0900 hours June 18 (gage height, 6.77 ft).

1914–15, 1927 to May 1965: Discharge, 6,100 cfs. Aug. 4, 1951 (gage height, 7.80 ft, at site 0.7 mile downstream at different datum), from rating curve extended above 4,500 cfs, gage height, 8.72 ft May 9, 1957, present datum.

Remarks.—Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	182
17	842
18	1,480
19	680
20	286
21	114

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 15			*June 17*—Con.*			*June 18*—Con.*		
2400	1.77	145	1000	4.70	956	2000	5.65	1,400
*June 16**			1200	4.74	974	2400	5.07	1,120
1200	1.58	119	1400	4.70	956	*June 19**		
1500	1.61	123	1800	4.96	1,070	0800	4.05	624
1700	2.60	273	2000	5.06	1,120	1200	3.98	592
2000	2.91	328	2400	4.75	978	1900	4.10	644
2200	2.69	288	*June 18**			2400	3.88	552
2400	2.25	217	0200	5.00	1,090	*June 20**		
*June 17**			0600	6.40	1,770	0600	3.20	342
0030	2.20	209	0900	6.77	1,960	1300	2.60	226
0200	3.00	346	1200	6.24	1,690	1700	2.89	278
0600	4.05	672	1500	5.75	1,440	2400	2.35	181

*Daily means computed from data in addition to figures shown.

(22) 6–7525. CACHE LA POUDRE RIVER NEAR GREELEY, COLO.

Location.—Lat 40°25′04″, long 104°38′22″, in NW¼ sec. 11, T. 5 N., R. 65 W., on right bank 25 ft downstream from highway bridge, 3 miles east of courthouse in Greeley, and 3 miles upstream from mouth.

Drainage area.—1,877 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 4,610 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 2,800 cfs.

Maxima.—June 15–22, 1965: Discharge, 3,480 cfs 1730 hours June 19 (gage height, 8.42 ft).

1903–04, 1914–19, 1924 to May 1965: Daily discharge, 4,220 cfs June 24, 26, 1917.

Remarks.—Flow increased by release from Seaman Reservoir on North Fork Cache la Poudre River. Records do not represent storm runoff but inflow to flood area.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	731
16	1,480
17	2,350
18	2,900
19	3,400
20	3,160
21	2,760
22	2,690

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 14			*June 16**—Con.			*June 18**—Con.		
2400	5.48	697	1500	6.46	1,300	1200	8.04	2,980
*June 15**			1800	6.88	1,640	1800	8.23	3,220
0600	5.31	649	2100	7.12	1,870	2400	8.12	3,080
1200	5.34	681	2400	7.17	1,940	*June 19**		
1800	5.79	885	*June 17**			0600	8.40	3,450
2200	6.12	1,070	0600	7.43	2,230	1200	8.40	3,450
2400	6.50	1,310	1200	7.63	2,480	1730	8.42	3,480
*June 16**			1800	7.67	2,520	2400	8.31	3,330
0300	6.91	1,660	2400	7.64	2,490	*June 20**		
0800	6.56	1,370	*June 18**			1200	8.26	3,260
1200	6.40	1,260	0600	7.80	2,690	2400	7.87	2,780

*Daily means computed from data in addition to figures shown.

(23) 6-7535. LONE TREE CREEK NEAR NUNN, COLO.

[Gaging station, discontinued 1957]

Location.—Lat 40°46'00", long 104°47'25", in NE¼ sec. 8, T. 9 N., R. 66 W., 200 ft upstream from bridge on U.S. Highway 85 and 4.5 miles north of Nunn.

Drainage area.—199 sq mi.

Gage-height record.—Floodmarks only. Altitude of gage is 5,320 ft (from topographic map).

Maxima.—June 14–19, 1965: Discharge, 5,810 cfs 2200 hours June 14 (gage height, not determined), by indirect measurement of peak flow.

1951–57: Discharge, 775 cfs Aug. 7, 1955 (gage height, 4.65 ft), from rating curve extended above 110 cfs on basis of slope-area measurement of peak flow.

(24) 6-7540. SOUTH PLATTE RIVER NEAR KERSEY, COLO.

Location.—Lat 40°24'44", long 104°33'46", in NW¼SW¼ sec. 9, T. 5 N., R. 64 W., on downstream side of bridge on State Highway 37, 1.9 miles north of railroad in Kersey, and 2.5 miles downstream from Cache la Poudre River.

Drainage area.—9,598 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 4,575.77 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 17,000 cfs and extended by logarithmic plotting.

Maxima.—June 14–23, 1965: Discharge, 23,500 cfs 1700 hours June 18 (gage height, 10.75 ft).

1901 to May 1965: Daily discharge, 31,000 cfs June 7, 1921, from rating curve extended above 17,000 cfs by logarithmic plotting.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 14	4,000
15	6,030
16	7,700
17	8,480
18	15,900
19	16,200
20	13,500
21	11,600
22	10,600
23	9,800

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 13			*June 15*—Con.*			*June 17—Con.*		
2400	6.41	4,760	1930	7.55	8,800	2400	8.17	10,700
*June 14**			2200	7.20	7,500	*June 18**		
1200	5.91	3,830	2400	7.35	8,020	0600	8.37	11,500
1800	5.71	3,420	*June 16**			0900	8.75	12,800
2300	5.95	3,920	0400	8.05	10,800	1200	9.65	16,300
2400	6.97	6,710	0600	7.60	9,000	1530	10.57	21,600
*June 15**			1200	6.86	6,380	1630	10.35	21,000
0130	7.64	9,160	1600	6.72	5,960	1730	10.75	23,500
0300	7.24	7,640	2000	7.40	8,200	1900	10.15	20,400
0500	6.32	4,790	2400	7.44	8,360	2000	9.93	19,400
0900	6.05	4,120	*June 17**			2400	9.86	19,400
1200	6.05	4,120	0600	7.42	8,280	*June 19**		
1500	6.12	4,280	1200	7.68	9,320	1100	9.25	16,000
1800	6.85	6,350	1800	7.95	10,000	2400	8.94	14,500

*Daily means computed from data in addition to figures shown.

(25) CROW CREEK NEAR KEOTA, COLO.

[Miscellaneous site]

Location.—Lat 40°43′, long 104°14′, in sec. 29, T. 9 N., R. 61 W., just downstream from mouth of Jackson Draw and 9 miles west of Keota.

Drainage area.—633 sq mi, of which 106 sq mi probably is noncontributing.

Maximum.—June 14–19, 1965: Discharge, 4,000 cfs, estimated, 0700 hours June 15.

(26) COAL CREEK NEAR BRIGGSDALE, COLO.

[Miscellaneous site]

Location.—Lat 40°38′, long 104°30′, in SW¼ sec. 24, T. 8 N., R. 64 W., at bridge on State Highway 14, 8.8 miles west of Briggsdale.

Drainage area.—73.1 sq mi, of which 5.3 sq mi probably is noncontributing.

Maximum.—June 14–19, 1965: Discharge, 5,340 cfs June 15, by contracted-opening measurement of peak flow.

(27) 6-7576. KIOWA CREEK AT K-79 RESERVOIR, NEAR EASTONVILLE, COLO.

Location.— Lat 39°04′00″, long 104°34′55″, in SE¼NW¼ sec. 29, T. 11 S., R. 64 W., in reservoir area, 140 ft upstream and 250 ft from left end of earth-fill dam on Kiowa Creek and 1.2 miles west of Eastonville.

Drainage area.—3.20 sq mi.

Gage-height record.—Water-stage recorder graph except 1815 hours June 17 to 1400 hours June 18, for which graph was drawn on basis of peak stage and typical recession. Datum of gage is 7,287.14 ft above mean sea level (Soil Conservation Service bench mark).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 68 cfs and by slope-area measurements in spillway and theoretical flow in outlet tube at 1,480 and 2,370 cfs.

Maxima.—June 16–21, 1965: Outflow discharge, 2,370 cfs 1900 hours June 17 (gage height, 23.63 ft, from floodmarks). Inflow discharge, not determined, probably occurred between 1800 and 1900 hours June 17.

1955 to May 1965: Outflow discharge, 1,480 cfs July 30, 1957 (gage height, 22.79 ft), from rating curve extended above 68 cfs on basis of slope-area measurement of peak flow in spillway and theoretical flow in outlet tube. Inflow discharge, 5,250 cfs (average for 5-minute interval) July 30, 1957, computed from outflow and change in reservoir contents; no rainfall on reservoir surface during time of peak inflow.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	0.2
17	122
18	59
19	7.5
20	.9
21	.6

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 16			*June 17*—Con.*			*June 18**		
2400	5.02	0.2	1845	21.10	307	0600	17.55	70
*June 17**			1850	22.60	1,290	1400	14.29	64
0600	5.01	.1	1855	23.60	2,330	2200	10.20	24
1400	5.21	.7	1900	23.63	2,370	2400	9.52	20
1500	5.90	3.2	1915	23.58	2,310	*June 19**		
1600	8.57	15	1930	22.73	1,420	0600	7.86	12
1700	11.15	36	2000	21.72	620	1200	6.57	5.9
1800	13.54	62	2100	20.88	234	1700	5.73	2.5
1830	17.30	70	2200	20.40	117	2400	5.38	1.3
1840	19.80	75	2400	19.76	75			

*Daily means computed from data in addition to figures shown.

(28) 6-7577. KIOWA CREEK SUBWATERSHED NO. J-33 NEAR EASTONVILLE, COLO.

[Gaging station, unpublished record]

Location.—Lat 39°06'20", long 104°33'30", in NW¼SE¼ sec. 9, T. 11 S., R. 64 W., in reservoir site, near center and 100 ft upstream from earthfill dam on unnamed tributary to Kiowa Creek, 0.8 mile upstream from mouth and 3 miles north of Eastonville.

Drainage area.—1.12 sq mi.

Gage-height record.—Floodmarks only. Datum of gage is 7,136.44 ft above mean sea level (Soil Conservation Service bench mark).

Maxima.—June 16–21, 1965: Outflow discharge, 2,600 cfs June 17 (gage height, 19.68 ft, from floodmarks), by slope-area measurement in spillway and theoretical flow in outlet tube. Inflow discharge, not determined, occurred on June 17.

(29) 6-7577.5 KIOWA CREEK SUBWATERSHED NO. R-3 NEAR ELBERT, COLO.

[Gaging station, unpublished record]

Location.—Lat 39°09'20", long 104°31'15", in NW¼NE¼ sec. 26, T. 10 S., R. 64 W., in reservoir site, near center and 120 ft upstream from earthfill dam on unnamed tributary to Kiowa Creek, 300 ft downstream from unnamed tributary, 0.9 mile upstream from mouth, and 4.6 miles south of Elbert.

Drainage area.—2.82 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 6,935 ft (from topographic map).

Maxima.—June 16–21, 1965: Outflow discharge 2,010 cfs 1915 hours June 17 (gage height, 23.33 ft) by slope-area measurement in spillway and theoretical flow in outlet tube. Inflow discharge, 6,880 cfs (average for 5-minute interval) June 17, computed from outflow and change in reservoir contents.

(30) 6-7578. KIOWA CREEK SUBWATERSHED NO. Q-51 NEAR ELBERT, COLO.

[Gaging station, unpublished record]

Location.—Lat 39°10'05", long 104°31'15", in SW¼NE¼ sec. 23, T. 10 S., R. 64 W., at edge of pool, 150 ft upstream from left end of earthfill dam on unnamed tributary to Kiowa Creek, 750 ft upstream from unnamed tributary, 0.9 mile upstream from mouth, and 3.8 miles south of Elbert.

Drainage area.—0.59 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 6,970 ft (from topographic map).

Maxima.—June 16–21, 1965: Outflow discharge 1,270 cfs 1915 hours June 17 (gage height, 28.70 ft), by slope-area measurement in spillway and theoretical flow in outflow tube. Inflow discharge, 1,350 cfs (average for 5-minute interval) June 17, computed from outflow and change in reservoir contents.

(31) 6-7579. KIOWA CREEK SUBWATERSHED NO. B-9 NEAR ELBERT, COLO.

[Gaging station, unpublished record]

Location.—Lat 39°11'00", long 104°32'35", in SE¼NW¼ sec. 15, T. 10 S., R. 64 W., in reservoir site, near right quarter point and 180 ft upstream from earthfill dam on unnamed tributary to Kiowa Creek, 0.3 mile upstream from unnamed tributary, half a mile upstream from mouth, and 2.6 miles south of Elbert.

Drainage area.—0.64 sq mi.

Gage-height record.—Water-stage recorder graph. Altitude of gage is 6,890 ft (from topographic map).

Maxima.—June 16–21, 1965: Outflow discharge 33 cfs 2000 hours June 17 (gage height, 13.41 ft) by theoretical flow in outflow tube. Inflow discharge, 597 cfs (average for 5-minute interval) June 17, computed from outflow and change in reservoir contents.

(32) 6-7580. KIOWA CREEK AT ELBERT, COLO.

Location.—Lat 39°12'35", long 104°32'00", in SE¼NE¼ sec. 3, T. 10 S., R. 64 W., on right bank a quarter of a mile southeast of Elbert and half a mile upstream from West Kiowa Creek.

Drainge area.—28.6 sq mi.

Gage-height record.—Water-stage recorder graph except June 19, 20. Altitude of gage is 6,740 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 120 cfs and by slope-area measurement at 41,500 cfs. Discharge June 19, 20 estimated on basis of typical recession.

Maxima.—June 16–21, 1965: Discharge, 41,500 cfs 1930 hours June 17 (gage height, 12.57 ft).

1935 to May 1965: Maximum flood known occurred May 30–31, 1935; discharge at site about 1 mile downstream, 43,500 cfs, by slope-area measurement of peak flow. Most of the water is believed to have passed this station. For discussion of this flood, see Follansbee and Sawyer (1948).

Remarks.—Flood flow decreased by series of about 24 retarding dams on Kiowa Creek and tributaries above station.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	0
17	2,280
18	380
19	20
20	10
21	8

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 16			*June 17*—Con.			*June 18**		
2400		0	1945	12.10	33,000	0600	5.25	555
June 17			2000	11.90	31,000	1200	4.83	286
1915		0	2030	10.40	17,300	1800	4.54	150
1930	12.57	41,500	2130	8.15	5,750	2400	4.30	52
			2400	5.78	1,050			

*Daily means computed from data in addition to figures shown.

(33) 6-7581. WEST KIOWA CREEK AT ELBERT, COLO.

Location.—Lat 39°12'38", long 104°32'16", in SE¼NE¼ sec. 3, T. 10 S., R. 64 W., on right bank 260 ft downstream from bridge on State Highway 217 a quarter of a mile south of Elbert and half a mile upstream from mouth.

Drainage area.—35.9 sq mi.

Gage-height record.—Water-stage recorder graph except 2030 hours June 17 to June 20. Altitude of gage is 6,740 ft (from topographic map).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 80 cfs and by slope-area measurement at 20,000 cfs. Discharge 2030 hours June 17 to June 20 estimated on basis of one discharge measurement, weather records, typical recession, and records for Kiowa Creek at Elbert.

Maxima.—June 16–21, 1965: Discharge, 20,000 cfs 2030 hours June 17 (gage height, 7.40 ft).

1962 to May 1965: Discharge, 92 cfs Aug. 31, 1963 (gage height, 2.22 ft).

Remarks.—Flood flow decreased by a series of about 12 retarding dams on West Kiowa Creek and tributaries above station.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	0.2
17	710
18	150
19	50
20	20
21	10

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 15			*June 17*—Con.*			*June 17*—Con.*		
2400	1.22	0.2	1115	1.88	39	1930	3.05	242
June 16			1600	1.62	11	1945	6.16	7,120
2400	1.22	.2	1700	1.89	40	2000	5.67	4,480
*June 17**			1845	1.86	37	2015	5.09	2,570
1030	1.35	1.1	1900	2.00	53	2030	7.40	20,000

*Daily means computed from data in addition to figures shown.

(34) 6-7582. KIOWA CREEK AT KIOWA, COLO.

Location.—Lat 39°20′, long 104°29′, in SW¼ sec. 20, T. 8 S., R. 62 W., on left bank 0.7 mile upstream from bridge on State Highway 86 and 0.7 mile south of Kiowa.

Drainage area.—111 sq mi.

Gage-height record.—Water-stage recorder graph except 1200 hours June 16 to June 20. Altitude of gage is 6,350 ft (estimated from nearby bench mark).

Discharge record.—Stage-discharge relation defined by current-meter measurements below 250 cfs and by indirect measurements at 2,900 and 19,700 cfs. Discharge June 16–20 estimated on basis of contracted-opening measurement at 19,700 cfs at point 0.7 mile downstream, two current-meter measurements, and records for station at Elbert and West Kiowa Creek at Elbert.

Maxima.—June 16–21, 1965: Discharge, 19,700 cfs about 2330 hours June 17 (gage height, 18.5 ft, from floodmark).

1955 to May 1965: Discharge, 5,980 cfs July 20, 1957 (gage height, 6.62 ft, from floodmark), from rating curve extended above 2,200 cfs by logarithmic plotting.

Maximum flood known occurred May 30–31, 1935; discharge at Elbert 9.5 miles upstream, 43,500 cfs, and at site about 12 miles downstream, 110,000 cfs, by slope-area measurement of peak flow.

Remarks.—Flood flow regulated to some extent by a series of about 64 retarding dams on Kiowa Creek and on tributaries above station.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	3.5
17	770
18	2,130
19	110
20	45
21	20

(35) 6-7583. KIOWA CREEK AT BENNETT, COLO.

[Gaging station, discontinued 1964]

Location.—Lat 39°44′54″, long 104°24′46″, in NW¼ sec. 35, T. 3 S., R. 63 W., a quarter of a mile downstream from U.S. Highway 36, 40, and 287 and 1 mile southeast of Bennett.

Drainage area.—236 sq mi.

Gage-height record.—Floodmarks only. Altitude of gage is 5,430 ft (from topographic map).

Maxima.—June 16–21, 1965: Discharge, 24,900 cfs 0130 hours June 18 (gage height, 7.66 ft, from floodmark), by contracted-opening measurement of peak flow.

1960 to May 1965: Discharge, 3,420 cfs Sept. 22, 1963 (gage height, 3.70 ft, from floodmark), from rating curve extended above 810 cfs on basis of slope-area measurement of peak flow.

Flood of May 30–31, 1935 (discharge, 75,300 cfs) is maximum known.

(36) 6-7585. SOUTH PLATTE RIVER NEAR WELDONA, COLO.

Location.—Lat 40°19'20", long 103°55'15", in SW¼SW¼ sec. 7, T. 4 N., R. 58 W., on left bank 400 ft downstream from bridge on State Highway 144, 2.8 miles southeast of Weldona, and 4.2 miles upstream from Bijou Creek.

Drainage area.—13,245 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 4,307.80 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 6,300 cfs.

Maxima.—June 15–24, 1965: Discharge, 18,800 cfs 1900 hours June 19 (gage height, 10.33 ft).

1952 to May 1965: Discharge, 14,200 cfs May 11, 1957 (gage height, 9.92 ft).

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 15	1,470
16	2,320
17	4,460
18	5,820
19	12,500
20	13,500
21	9,540
22	7,440
23	6,240
24	5,370

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 14			*June 17**			*June 19**—Con.		
2400	5.14	1,680	1200	6.77	4,050	1900	10 33	18,800
*June 15**			2400	7.68	3,780	2100	10 17	18,000
1200	4.72	1,300	*June 18**			2400	10 04	17,300
1600	4.65	1,240	1200	7.98	7,680	*June 20**		
2000	4.97	1,510	1800	7.94	7,640	0600	9.62	15,200
2400	5.39	1,990	2400	7.86	7,500	1200	9.22	13,200
*June 16**			*June 19**			1800	8 92	11,800
0230	5.54	2,180	0600	7.86	7,500	2400	8 69	10,800
0800	5.30	1,870	1200	8.84	11,500	*June 21**		
1400	5.62	2,230	1500	9.82	16,200	1200	8 38	9,500
2400	6.20	3,050	1700	10.18	18,000	2400	8 10	8,380

*Daily means computed from data in addition to figures shown.

(37) EAST BIJOU CREEK AT DEER TRAIL, COLO.

[Miscellaneous site]

Location.—Lat 39°37', long 104°03', in sec. 13, T. 5 S., R. 60 W., at Deer Trail.

Drainage area.—302 sq mi.

Maxima.—June 16–21, 1965: Discharge, 274,000 cfs 2400 hours June 17, by slope-area measurement of peak flow.

1935: Discharge, 25,000 cfs May 30, by slope-area measurement of peak flow (computed by State Engineer of Colorado). For discussion of this flood, see Follansbee and Sawyer (1948).

(38) MIDDLE BIJOU CREEK NEAR DEER TRAIL, COLO.

[Miscellaneous site]

Location.—Lat 39°40′18″, long 104°05′52″, in sec. 28, T. 4 S., R. 60 W., just downstream from U.S. Highways 40 and 287, 5 miles northwest of Deer Trail, and 7 miles southeast of Byers.

Drainage area.—190 sq mi.

Maxima.—June 16–21, 1965: Discharge, 145,000 cfs June 17, by slope-area measurement of peak flow.

1935: Discharge, 143,640 cfs May 30, by slope-area measurement of peak flow (computed by State Engineer of Colorado). For discussion of this flood, see Follansbee and Sawyer (1948).

(39) WEST BIJOU CREEK NEAR KIOWA, COLO.

[Miscellaneous site]

Location.—Lat 39°16′, long 104°20′, in sec. 16, T. 9 S., R. 62 W., half a mile downstream from unnamed tributary, 2 miles upstream from State Highway 86, and 9 miles southeast of Kiowa.

Drainage area.—85.7 sq mi.

Maximum.—June 16–21, 1965: Discharge, 67,200 cfs 1900 hours June 17, by slope-area measurement of peak flow.

(40) WEST BIJOU CREEK AT BYERS, COLO.

[Miscellaneous site]

Location.—Lat 39°42′23″, long 104°14′07″, in sec. 8, T. 4 S., R. 61 W., at bridge on U.S. Highways 36, 40 and 287 half a mile north of Byers.

Drainage area.—85.7 sq mi.

Maxima.—June 16–21, 1965: Discharge, 75,500 cfs 2400 hours June 17, by indirect measurement of peak flow.

Flood of May 30, 1935 (discharge, 164,670 cfs) is maximum known.

(41) 6–7590. BIJOU CREEK NEAR WIGGINS, COLO.

[Gaging station, discontinued 1956]

Location.—Lat 40°14′53″, long 104°02′08″, in SW¼SW¼ sec. 6, T. 3 N., R 59 W., at bridge on U.S. Highways 6 and 34, 2 miles northeast of Wiggins and 5.7 miles downstream from Antelope Creek.

Drainage area.—1,314 sq mi.

Gage-height record.—Floodmarks only. Altitude of gage is 4,490 ft (from topographic map).

Maxima.—June 15–21, 1965: Discharge, 466,000 cfs 0730 hours June 18 (gage height, 21.2 ft), by slope-area measurement at site 5.6 miles downstream. Another major flood occurred June 15 (gage height, 15.9 ft, from floodmarks), discharge not determined.

1935 to May 1965: Discharge 282,900 cfs May 31, 1935. For discussion of this flood, see Follansbee and Sawyer (1948).

(42) 6-7595. SOUTH PLATTE RIVER AT FORT MORGAN, COLO.

[Gaging station, discontinued in 1958]

Location.—Lat 40°16'08", long 103°48'02", in sec. 31, T. 4 N., R. 57 W., at bridge on State Highway 52, half a mile north of Fort Morgan and 3.5 miles downstream from Bijou Creek.

Drainage area.—14,810 sq mi.

Gage-height record.—Floodmarks only. Datum of gage is 4,254.39 ft above mean sea level (levels by State Engineer of Colorado).

Maxima.—June 14–21, 1965: Gage height, 18.2 ft 1000 hours June 18 (discharge, not determined).

1935 to May 1965: Discharge, 84,300 cfs May 31, 1935, by slope-area measurement of peak flow 1 mile upstream; flood came principally from Bijou Creek.

(43) BEAVER CREEK NEAR BRUSH, COLO.

[Miscellaneous site]

Location.—Lat 40°08', long 103°35', in sec. 13, T. 2 N., R. 56 W., at bridge on State Highway 71, 7 miles south of Brush and 13 miles upstream from mouth.

Drainage area.—946 sq mi.

Maximum.—June 16–21, 1965: Discharge, 24,300 cfs 1400 hours June 18, by indirect measurement of peak flow.

(44) 6-7600. SOUTH PLATTE RIVER AT BALZAC, COLO.

Location.—Lat 40°24'24", long 103°27'58", in NE¼NE¼ sec. 13, T. 5 N., R. 55 W., on right bank just upstream from highway bridge at Balzac siding, 2.8 miles northeast of Union and 7.0 miles downstream from Beaver Creek.

Drainage area.—16,852 sq mi.

Gage-height record.—Water-stage recorder graph. Datum of gage is 4,091.06 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 6,400 cfs extended above on basis of indirect measurements and by an indirect measurement at 123,000 cfs. Discharges June 14 to 1800 hours June 16 and June 25 computed by combining flows in channels no. 1 and 2.

Maxima.—June 14–25, 1965: Discharge, 123,000 cfs 1320 hours June 18 (gage height, 13.32 ft).

1916 to May 1965: Discharge not determined, occurred May 31, 1935 (gage height, 11.43 ft); maximum daily discharge determined, 31,200 cfs June 11, 1921.

Remarks.—Flood came principally from Bijou Creek.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 14	464
15	766
16	4,330
17	8,320
18	27,700
19	13,400
20	13,300
21	10,400
22	8,680
23	6,920
24	6,020
25	5,110

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 15			*June 17**—Con.			*June 18*—Con.		
2400	4.83	960	0600	9.33	10,200	2100	10.63	25,900
*June 16**			1200	8.75	7,380	2400	10.07	20,600
0500	4.70	865	1800	8.32	5,800	*June 19**		
0800	4.80	924	2100	8.08	5,200	0300	9.59	16,700
1200	5.01	1,270	2400	8.03	5,080	0700	9.15	13,600
1600	5.18	1,460	*June 18*			1030	8.98	12,500
1700	6.74	2,530	0600	8.25	5,620	1330	9.07	13,000
1800	7.11	2,940	1200	8.48	6,240	1800	8.92	12,100
2000	7.59	4,180	1230	11.60	32,000	2400	8.85	11,700
2100	8.82	7,690	1300	13.25	117,000	*June 20**		
2200	10.33	17,700	1320	13.32	123,000	0300	8.98	12,500
2300	10.40	18,300	1400	13.03	107,000	0600	9.33	14,800
2400	10.28	17,200	1500	12.60	83,000	0800	9.39	15,200
*June 17**			1700	11.82	47,800	1200	9.26	14,300
0300	9.76	12,900	1900	11.17	32,000	2400	8.89	11,900

*Daily means computed from data in addition to figures shown.
NOTE.—All gage heights are from gage on channel 1.

(45) NORTH PAWNEE CREEK NEAR NEW RAYMER, COLO.

[Miscellaneous site]

Location.—Lat 40°45′, long 103°48′, in sec. 18, T. 9 N., R. 57 W., just upstream from Igo Creek, 7 miles upstream from confluence with South Pawnee Creek and 11.5 miles north of New Raymer.

Drainage area.—82.3 sq mi.

Maximum.—June 14–21, 1965: Discharge, 6,280 cfs 2400 hours June 14, by slope-area measurement of peak flow.

(46) PAWNEE CREEK NEAR STONEHAM, COLO.

[Miscellaneous site]

Location.—Lat 40°42′, long 103°39′, in sec. 5, T. 8 N., R. 56 W., 2 miles downstream from confluence of North Pawnee and South Pawnee Creeks and 6 miles north of Stoneham.

Drainage area.—387 sq mi.

Maximum.—June 14–21, 1965: Discharge, 26,700 cfs 0300 hours June 15, by slope-area measurement of peak flow.

(47) PAWNEE CREEK NEAR STERLING, COLO.

[Miscellaneous site]

Location.—Lat 40°37′, long 103°27′, in NE¼ sec. 31, T. 8 N., R. 54 W., at bridge on State Highway 14, 3 miles downstream from Raymer Creek and 13 miles west of Sterling.

Drainage area.—629 sq mi.

Maximum.—June 14–21, 1965: Discharge, 35,000 cfs 0700 hours June 15, by contracted-opening measurement of peak flow.

(48) 6-7640. SOUTH PLATTE RIVER AT JULESBURG, COLO.

Location.—Lat 40°58′46″, long 102°15′15″, in NE¼ sec. 33, T. 12 N., R. 44 W., on left bank 215 ft downstream from bridge on U.S. Highway 385, 0.9 mile southeast of Julesburg, 3 miles upstream from Colorado-Nebraska State line, and 8 miles downstream from Lodgepole Creek.

Drainage area.—23,138 sq mi.

Gage-height record.—Water-stage recorder graph June 13 to 0720 hours June 19. Peak stage determined from high-water mark in gage well. Gage heights 1500 hours June 19 and 0700 hours June 20 from gage readings during discharge measurements. Datum of gage is 3,446.76 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 37,000 cfs. Discharge June 19–30 estimated on basis of two discharge measurements and records for station at Paxton, Nebr. Discharges for 1500 hours June 19 and 0700 hours June 20 from discharge measurements.

Maxima.—June 14–25, 1965: Discharge, 37,600 cfs 0530 hours June 20 (gage height, 10.44 ft, from floodmark in gage well).

1902 to May 1965: Discharge, 31,300 cfs June 2, 1935, from rating curve extended above 16,000 cfs.

Remarks.—Records prior to June 19 are sum of flows in main channel plus those in secondary channel.

Mean discharge, in cubic feet per second, 1956

Day		Discharge
June	14	197
	15	1,080
	16	1,890
	17	1,910
	18	2,040
	19	3,700
	20	30,000
	21	23,000
	22	17,000
	23	12,500
	24	9,200
	25	7,000

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)
June 14		
2400		168
*June 15**		
1030		164
1100		167
1200		195
1300		297
1400		436
1500		976
1600		1,310
1800		2,240
2000		2,810
2100		3,090
2300		3,180
2400		3,140
*June 16**		
0300		2,690
0600		2,300
1200		1,740
1800		1,490
2400		1,580
*June 17**		
0600		1,740
1200		1,960
1800		2,300
2400		2,590
*June 18**		
0600		2,720
1200		2,620
*June 18**—Con.		
1800		2,500
2400		2,580
*June 19**		
0200	4.56	2,830
0400	4.70	3,080
0600	5.00	3,620
0720	5.12	3,970
1500	6.69	9,800
2400		
June 20		
0530	10.44	37,600
0700	10.32	36,100
2400		

*Daily means computed from data in addition to figures shown.

(49) 6–7650. SOUTH PLATTE RIVER AT PAXTON, NEBR.

Location.—Lat 41°07′, long 101°21′, in sec. 8, T. 13 N., R. 35 W., near left bank on downstream side of pier of highway bridge, half a mile south of Paxton.

Drainage area.—23,700 sq mi, approximately.

Gage-height record.—Water-stage recorder graph. Datum of gage is 3,047.34 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements below 30,000 cfs.

Maxima.—June 16–27, 1965: Discharge, 33,800 cfs 0900 hours June 21 (gage height, 10.69 ft).

1939 to May 1965: Discharge, 16,900 cfs May 7, 1942 (gage height, 9.34 ft); gage height, 9.5 ft Apr. 30, 1942.

Mean discharge, in cubic feet per second, 1965

Day	Discharge
June 16	44
17	98
18	527
19	1,060
20	2,100
21	24,900
22	17,700
23	14,700
24	11,000
25	8,400
26	6,220
27	5,220

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 20			*June 20*—Con.			*June 21*—Con.		
0000	4.72	1,540	1700	5.25	2,180	0800	10.47	29,520
0100	4.73	1,550	1800	5.40	2,290	0900	10.69	33,800
0200	4.74	1,560	1900	5.57	2,490	1000	10.58	31,600
0300	4.75	1,560	2000	5.78	2,750	1100	10.67	33,400
0400	4.77	1,590	2100	6.00	3,050	1200	10.65	33,000
0500	4.78	1,600	2200	6.25	3,400	1300	10.66	33,200
0600	4.80	1,630	2300	6.54	3,860	1400	10.66	33,200
0700	4.85	1,680	2400	6.80	4,420	1500	10.65	33,000
0800	4.87	1,710	*June 21*			1600	10.62	32,400
0900	4.87	1,710	0000	6.80	4,420	1700	10.62	32,400
1000	4.88	1,720	0100	6.97	5,000	1800	10.55	31,000
1100	4.89	1,720	0200	7.24	5,900	1900	10.44	29,040
1200	4.92	1,760	0300	7.55	7,070	2000	10.32	27,200
1300	4.95	1,790	0400	8.75	12,000	2100	10.20	25,400
1400	5.00	1,850	0500	9.75	19,900	2200	10.07	23,610
1500	5.07	1,980	0600	10.07	23,600	2300	9.97	22,340
1600	5.15	2,020	0700	10.23	25,850	2400	9.85	20,950

*Daily means computed from data in addition to figures shown.

(50) 6-7655. SOUTH PLATTE RIVER AT NORTH PLATTE, NEBR.

Location.—Lat 41°07′, long 100°46′ in sec. 9, T. 13 N., R. 30 W., near left bank on downstream side of bridge on U.S. Highway 83, three-quarters of a mile south of North Platte and 4 miles upstream from confluence with North Platte River.

Drainage area.—24,300 sq mi, approximately.

Gage-height record.—Water-stage recorder graph. Datum of gage is 2,787.73 ft above mean sea level, datum of 1929.

Discharge record.—Stage-discharge relation defined by current-meter measurements.

Maxima.—June 18–29, 1965: Discharge, 22,200 cfs 0900 hours June 22 (gage height, 10.43 ft).

1897, 1914–15, 1917 to May 1965: Discharge observed, 37,100 cfs June 3, 1935 (gage height, 14.02 ft).

Mean discharge, in cubic feet per second, 1965

Day	*Discharge*
June 18	274
19	307
20	440
21	793
22	19,700
23	14,000
24	13,100
25	9,090
26	6,830
27	5,320
28	4,490
29	3,920

Gage height and discharge at indicated time, 1965

Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)	Hour	Gage height (feet)	Discharge (cfs)
June 22			*June 22*—Con.			*June* 22—Con.		
0000	4.70	1,640	0900	10.43	22,200	1800	9.9[illegible]	19,900
0100	7.96	10,100	1000	10.40	22,000	1900	9.7[illegible]	19,200
0200	9.83	19,300	1100	10.36	21,800	2000	9.6[illegible]	18,900
0300	10.08	20,400	1200	10.28	21,500	2100	9.6[illegible]	17,000
0400	10.16	20,800	1300	10.26	21,400	2200	9.48	18,800
0500	10.20	21,000	1400	10.26	21,400	2300	9.43	17,800
0600	10.28	21,400	1500	10.18	21,100	2400	9.2[illegible]	17,100
0700	10.33	21,900	1600	10.03	20,400			
0800	10.40	22,000	1700	9.96	20,100			

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INDEX

[Italic page numbers indicate major references]

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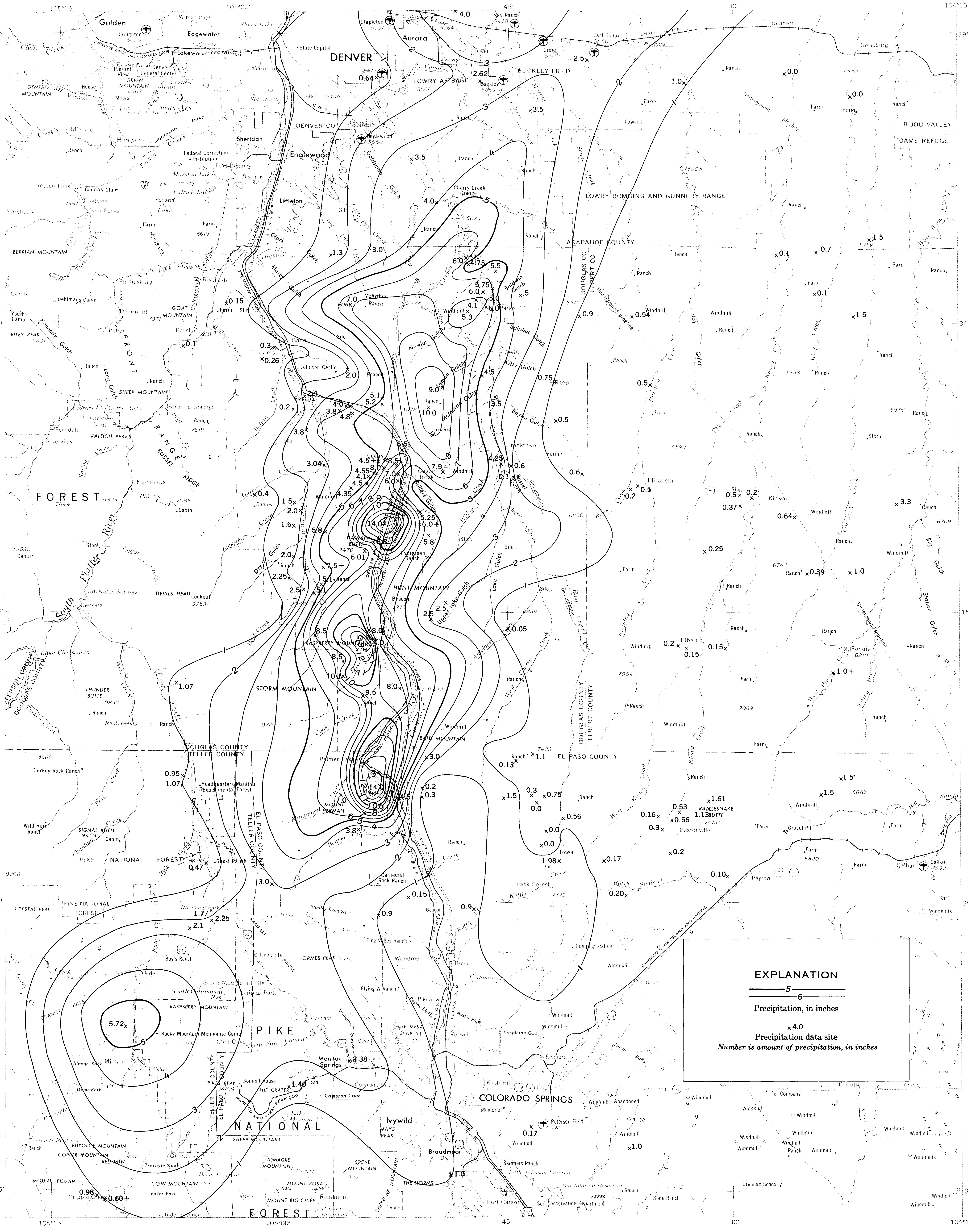


Base from U.S. Geological Survey Denver, 1953
and Pueblo, 1954
Point elevations are in feet above mean sea level

Isohyets furnished by U.S. Bureau of Reclamation

ISOHYETAL MAP FOR STORMS OF JUNE 16, 1965, SOUTH PLATTE RIVER BASIN, COLORADO

SCALE 1:250 000

5 0 5 10 15 MILES

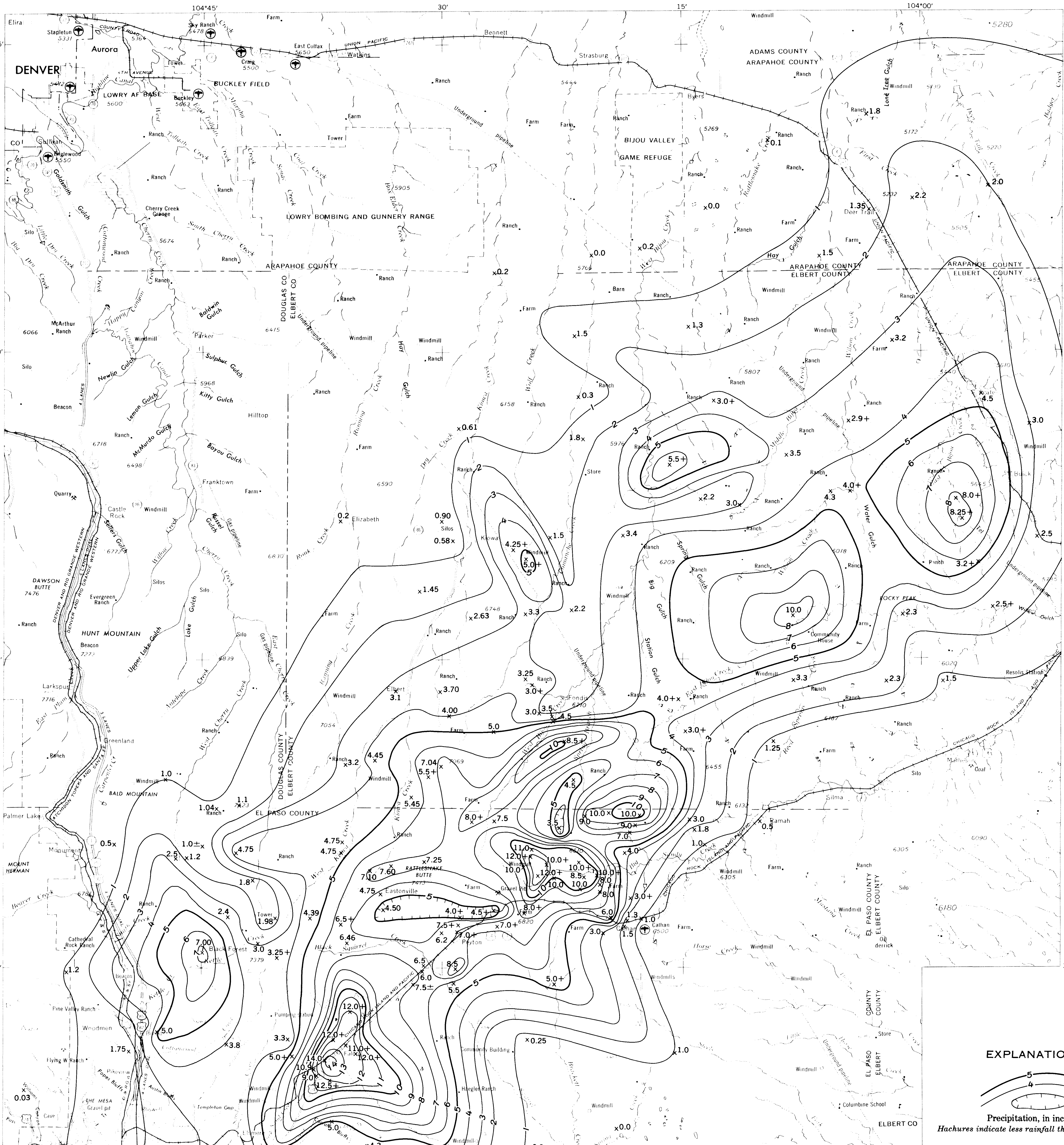
5 0 5 10 15 KILOMETERS

DATUM IS MEAN SEA LEVEL

TRUE NORTH
MAGNETIC NORTH
13½°
APPROXIMATE MEAN
DECLINATION, 1969

333-527 O - 69 (In pocket) No. 1

PREPARED IN COOPERATION WITH THE
STATES OF COLORADO AND NEBRASKA
AND WITH FEDERAL AGENCIES



Base from U.S. Geological Survey Denver, 1953;
Limon and Pueblo, 1954
Point elevations are in feet above mean sea level

Isohyets furnished by U.S. Bureau of Reclamation

ISOHYETAL MAP FOR STORMS OF JUNE 17, 1965, SOUTH PLATTE RIVER BASIN, COLORADO

SCALE 1:250 000

5 0 5 10 15 MILES

5 0 5 10 15 KILOMETERS

DATUM IS MEAN SEA LEVEL

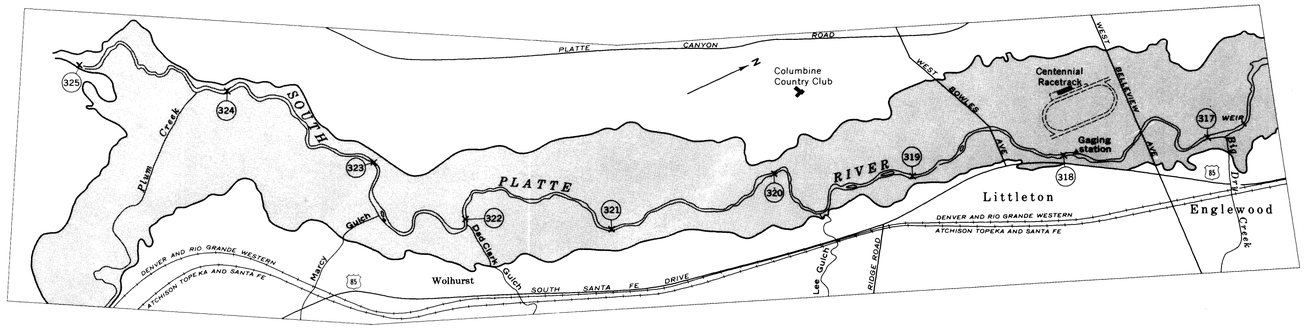
APPROXIMATE MEAN DECLINATION, 1969

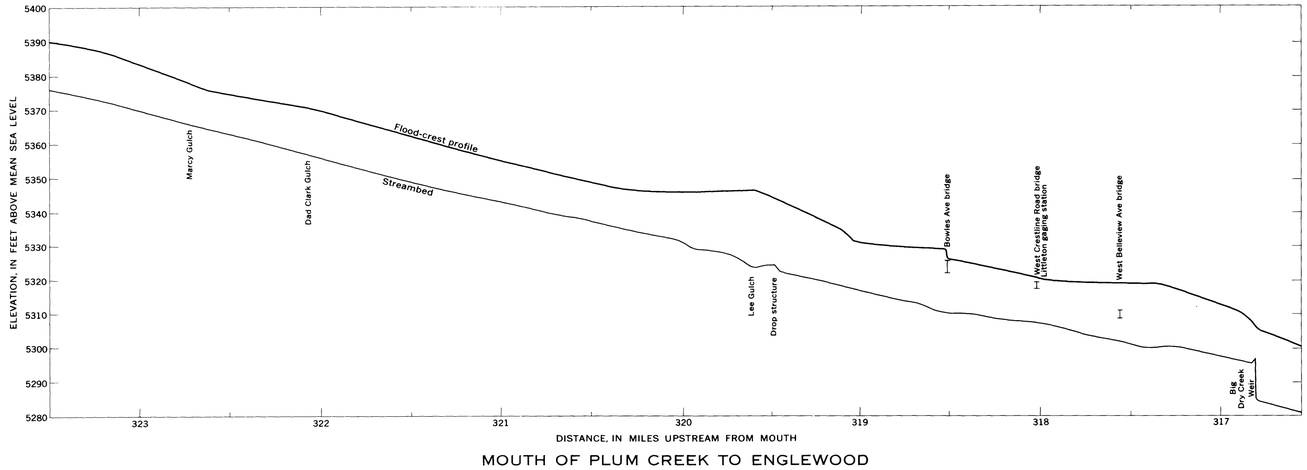
333-527 O - 69 (In pocket) No. 2

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

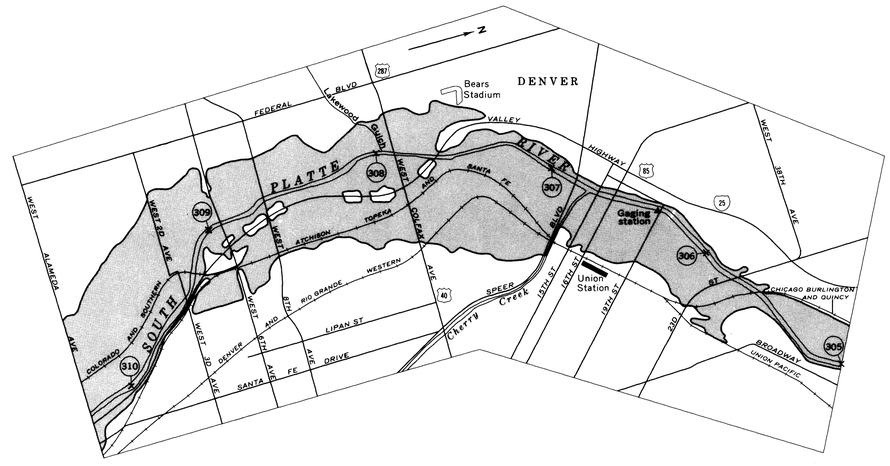
PREPARED IN COOPERATION WITH THE
STATES OF COLORADO AND NEBRASKA
AND WITH FEDERAL AGENCIES

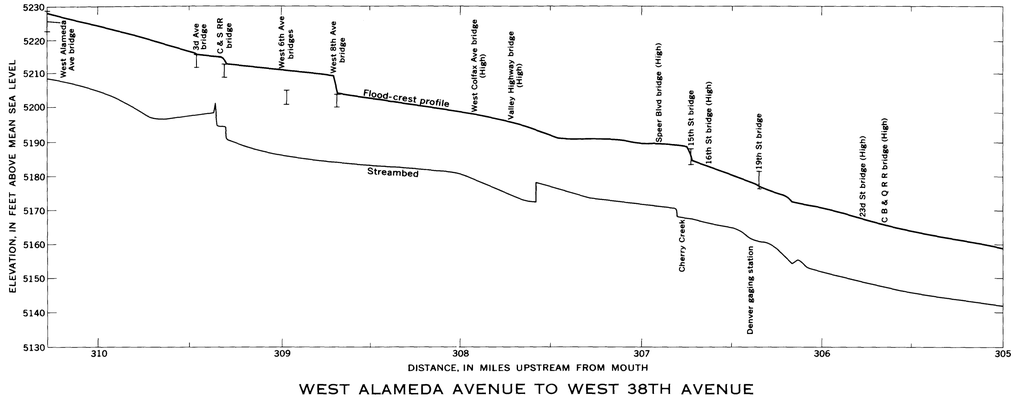
WATER-SUPPLY PAPER 1850-B
PLATE 3



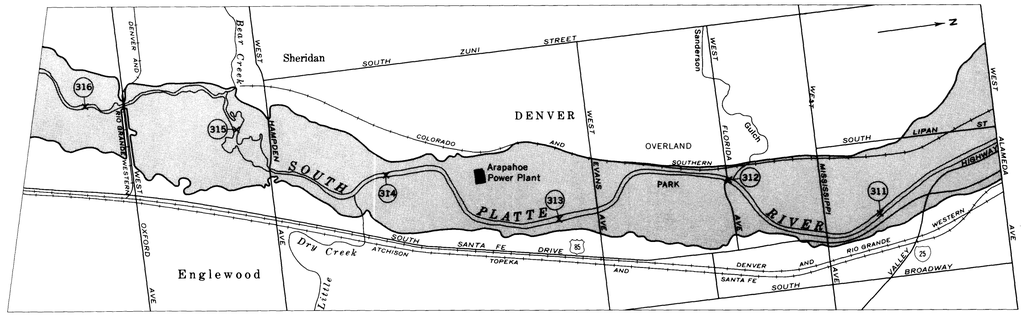


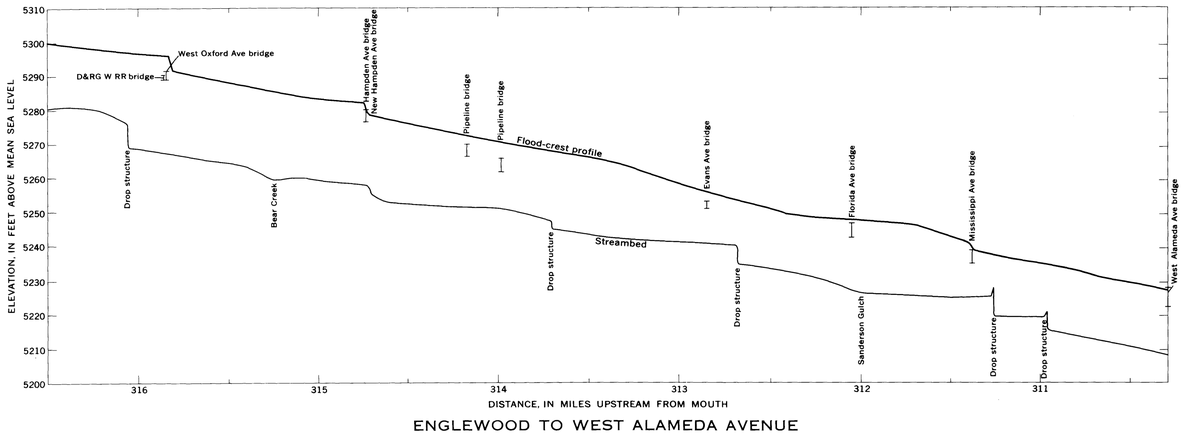
MOUTH OF PLUM CREEK TO ENGLEWOOD





WEST ALAMEDA AVENUE TO WEST 38TH AVENUE





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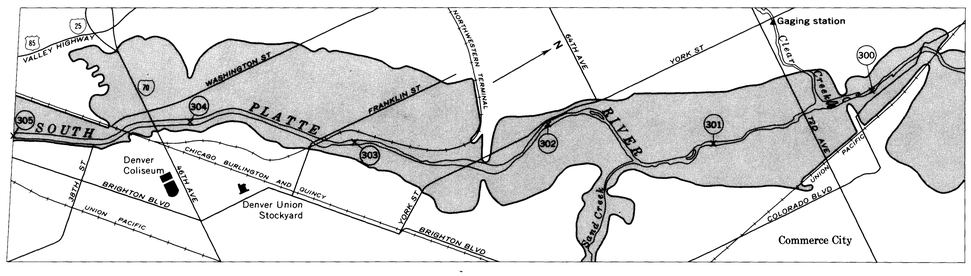
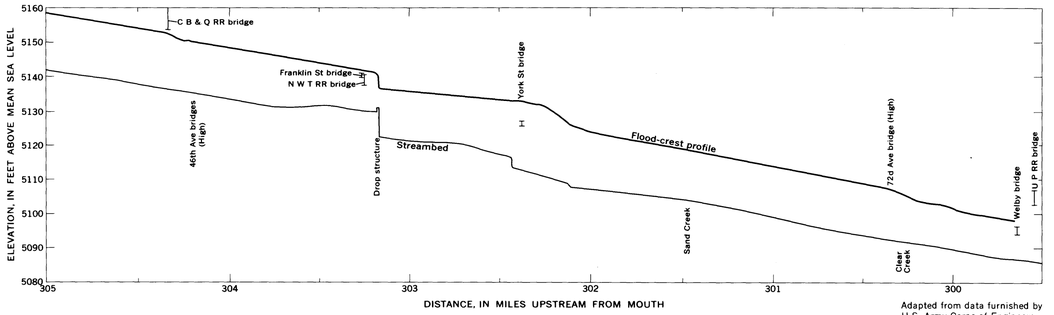




Adapted from data furnished by
U.S. Army Corps of Engineers

WEST 38TH AVENUE TO ADAMS CITY

AREAS INUNDATED AND PROFILES OF FLOOD-CREST ELEVATIONS SOUTH PLATTE RIVER, AT AND NEAR DENVER, COLORADO

0 ½ 1 2 MILES
0 .5 1 2 KILOMETERS

EXPLANATION

Area flooded

Boundary of June 16, 1965, flood

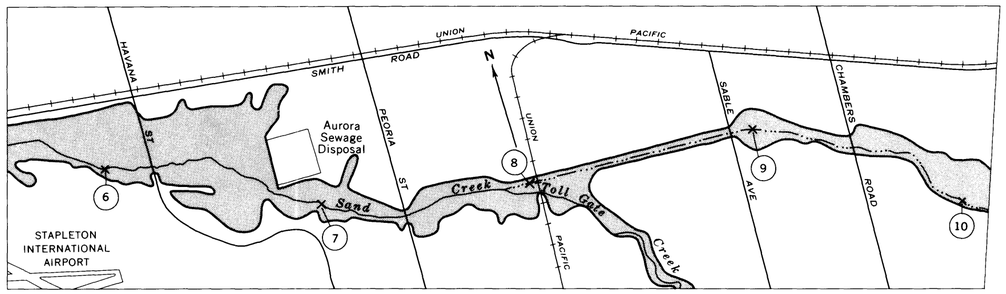
310 River mile measured upstream from mouth

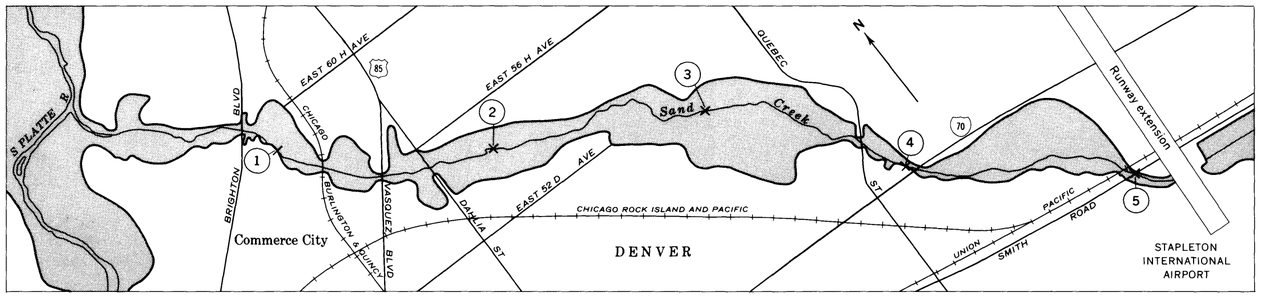
333-527 O - 69 (In pocket) No. 3

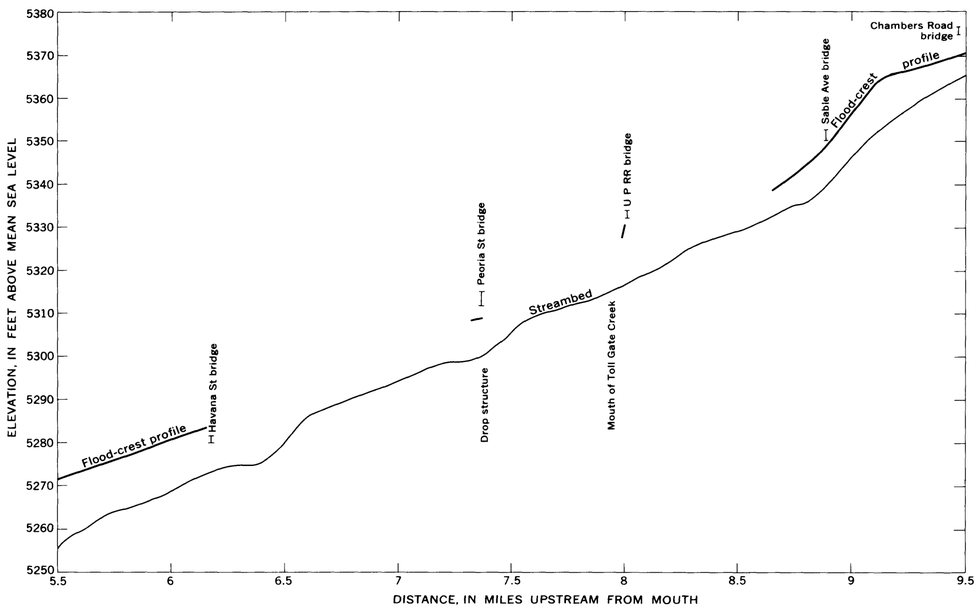
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
STATES OF COLORADO AND NEBRASKA
AND WITH FEDERAL AGENCIES

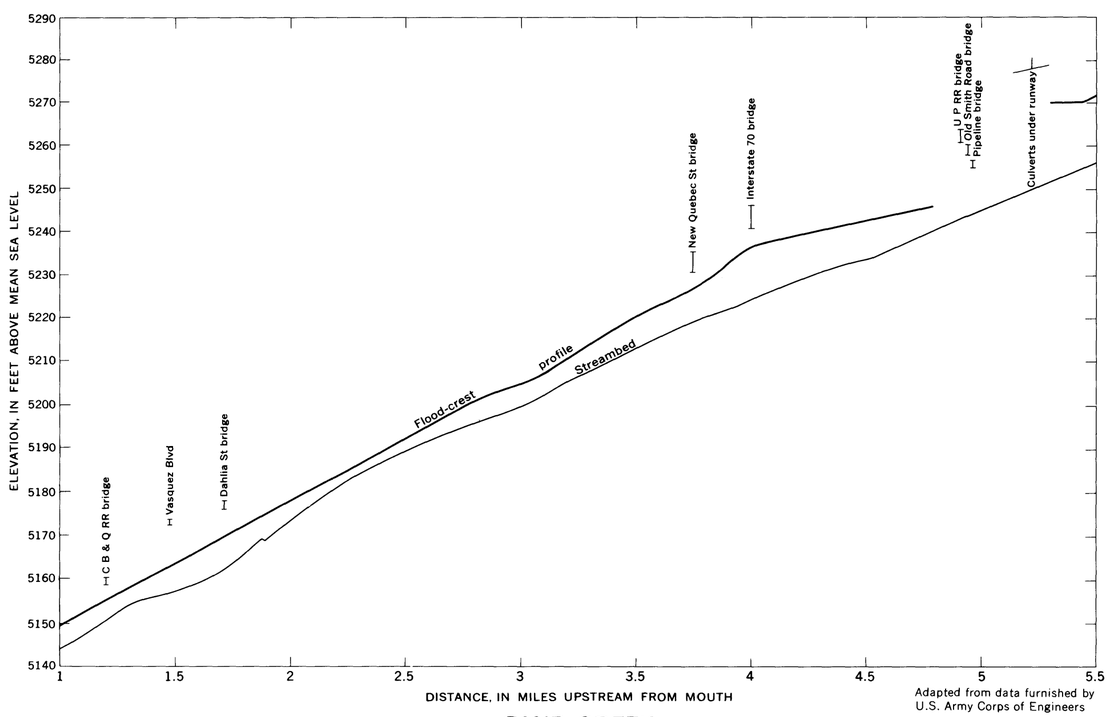
WATER-SUPPLY PAPER 1850-B
PLATE 4





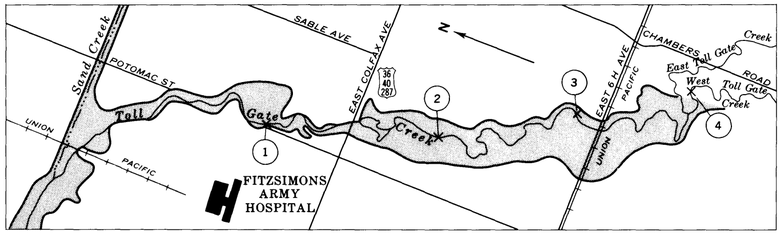


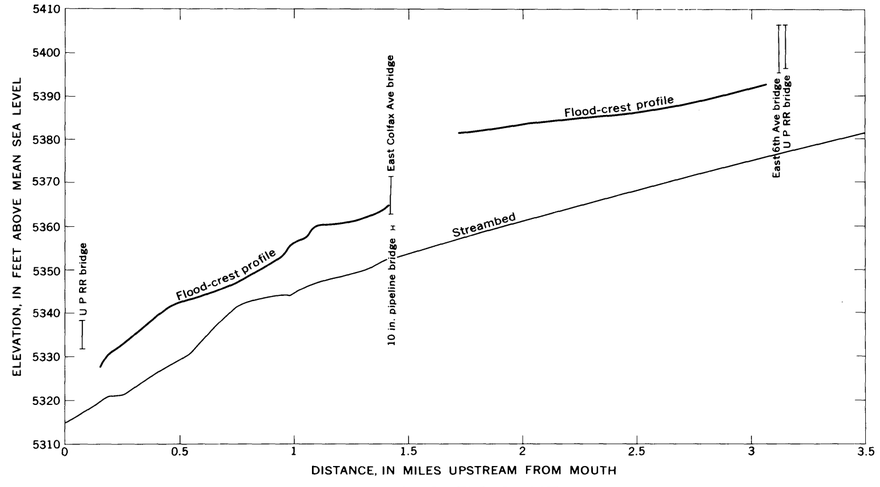
SAND CREEK
Mile 10 to mile 5.5



SAND CREEK
Mile 5.5 to mouth

Adapted from data furnished by
U.S. Army Corps of Engineers





TOLL GATE CREEK
East 6th Avenue to mouth

EXPLANATION

Area flooded

Boundary of June 16, 1965, flood

×—(6) River mile measured upstream from mouth

AREAS INUNDATED AND PROFILES OF FLOOD-CREST ELEVATIONS SAND CREEK AND TOLL GATE CREEK, NEAR DENVER, COLORADO

0 ½ 1 2 MILES
0 .5 1 2 KILOMETERS

333-527 O - 69 (In pocket) No. 4