DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
WYOMING HIGHWAY DEPARTMENT

HYDROLOGIC INVESTIGATIONS ATLAS
HA–699 (SHEET 1 OF 2)

Table 1.—*Maximum water-surface elevation and discharge data for the flood of August 1, 1985*

Site number and location	Drainage area[1] (square miles)	Average maximum water-surface elevation (feet above sea level)		Maximum discharge (cubic feet per second)	Unit discharge (cubic feet per second per square mile)	Approximate time of maximum discharge (Mountain Daylight Time)
		Upstream from (at) location	Downstream from location			
Crow Creek						
1–upstream from Interstate Highway 25	252.8	6,074.2	---	2,300	(2)	8:00– 8:30 p.m.
2–at 19th Street	257.1	6,054.7	6,053.2	2,980	(2)	8:45– 9:15 p.m.
3–at Warren Avenue	294.1	6,023.9	---	4,460	(2)	9:30–10:00 p.m.
4–at Morrie Avenue	295.6	6,011.9	6,008.9	6,260	(2)	10:15–10:45 p.m.
5–at Interstate Highway 80	296.4	5,980.9	---	7,470	(2)	10:30–11:00 p.m.
Unnamed tributary of Crow Creek						
6–at College Drive	4.35	---	---	3,540	814	9:00– 9:30 p.m.
Dry Creek						
7–at Buffalo Avenue	.95	---	---	3,820	4,020	7:30– 8:00 p.m.
8–at Interstate Highway 25	1.88	6,146.5	6,137.5	[3]4,960	2,640	8:00– 8:30 p.m.
9–at Yellowstone Road	2.64	6,126.6	6,117.6	[3]5,820	2,200	8:00– 8:30 p.m.
10–at Powderhouse Road and Dell Range Boulevard	3.76	6,086.8	6,075.6	[4]4,080	1,090	8:30– 9:30 p.m.
11–upstream from College Drive	6.67	5,996.1	---	5,880	882	9:00– 9:30 p.m.
12–at East Pershing Boulevard	9.27	5,955.6	5,953.7	[4]4,310	465	11:15–11:45 p.m.

[1]Part of which may be non-contributing.
[2]Not computed, most of drainage area did not contribute to storm runoff.
[3]Includes 4,240 cubic feet per second through culverts—assumed to be clear of debris.
[4]Includes 640 cubic feet per second through culverts—assumed to be clear of debris.
[5]Includes 470 cubic feet per second through culverts—assumed to be clear of debris.
[6]Includes 260 cubic feet per second flowing east along Dell Range Boulevard.
[7]Includes 180 cubic feet per second through culverts—assumed to be clear of debris.

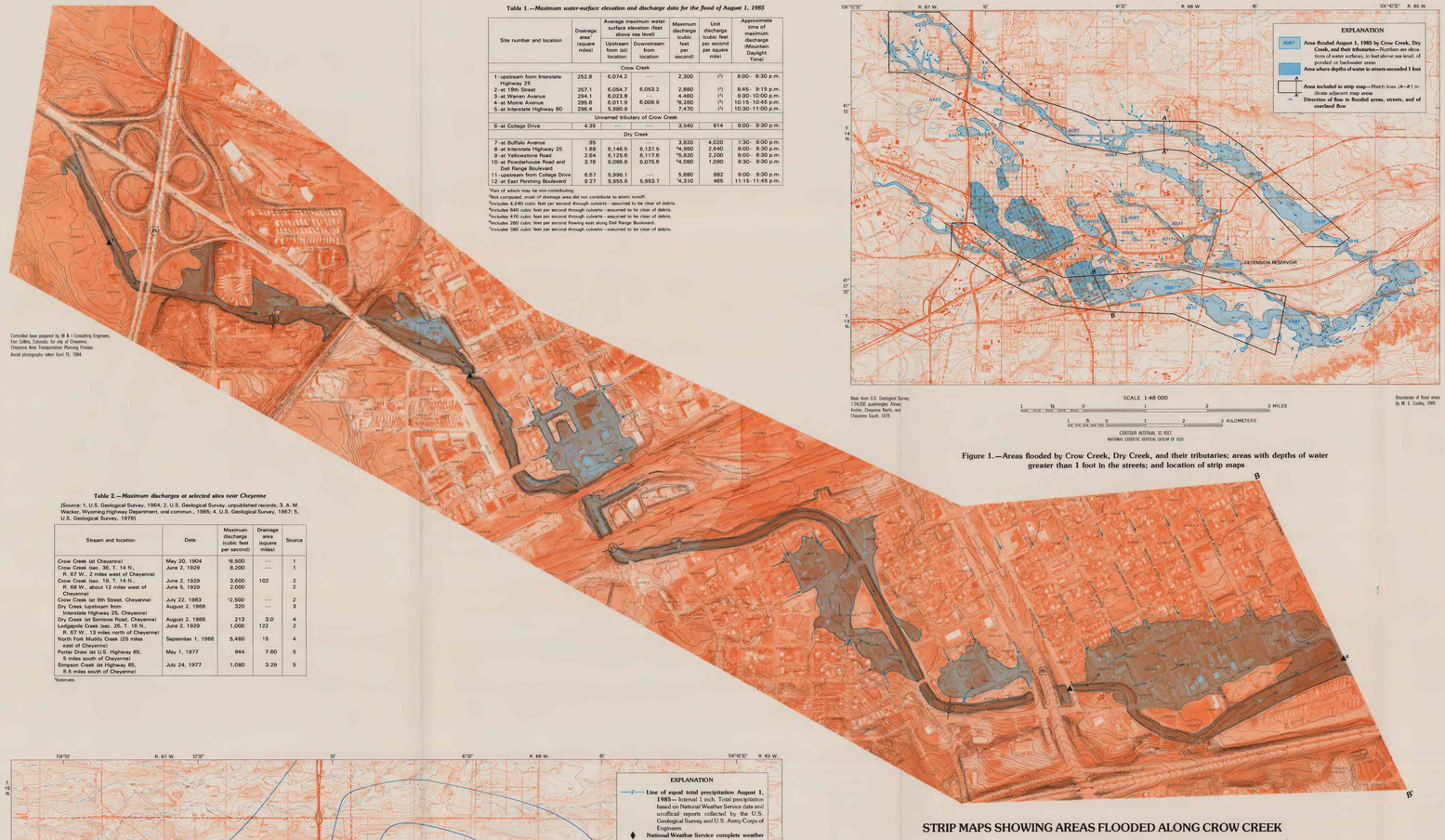

Figure 1.—Areas flooded by Crow Creek, Dry Creek, and their tributaries; areas with depths of water greater than 1 foot in the streets; and location of strip maps

Table 2.—*Maximum discharges at selected sites near Cheyenne*

[Source: 1, U.S. Geological Survey, unpublished records; 3, A. M. Wacker, Wyoming Highway Department, oral commun., 1985; 4, U.S. Geological Survey, 1967; 5, U.S. Geological Survey, 1978]

Stream and location	Date	Maximum discharge (cubic feet per second)	Drainage area (square miles)	Source
Crow Creek (at Cheyenne)	May 20, 1904	[1]6,500	---	1
Crow Creek (sec. 36, T. 14 N., R. 67 W., 2 miles west of Cheyenne)	June 2, 1929	6,300	---	1
Crow Creek (sec. 36, T. 14 N., R. 68 W., about 12 miles west of Cheyenne)	June 2, 1929	3,600	102	2
	June 5, 1929	2,000		2
Crow Creek (at 9th Street, Cheyenne)	July 22, 1983	[2]2,500	---	2
Dry Creek (upstream from Interstate Highway 25, Cheyenne)	August 2, 1985	320	1.88	3
Dry Creek (at Seminoe Road, Cheyenne)	August 2, 1966	213	3.0	4
Lodgepole Creek (sec. 26, T. 16 N., R. 67 W., 13 miles north of Cheyenne)	June 2, 1929	1,000	122	2
North Fork Muddy Creek (25 miles east of Cheyenne)	September 1, 1966	5,460	15	4
Porter Draw (at U.S. Highway 85, 5 miles south of Cheyenne)	May 1, 1977	944	7.60	5
Simpson Creek (at Highway 85, 8.5 miles south of Cheyenne)	July 24, 1977	1,080	3.29	5

[1]Estimate.

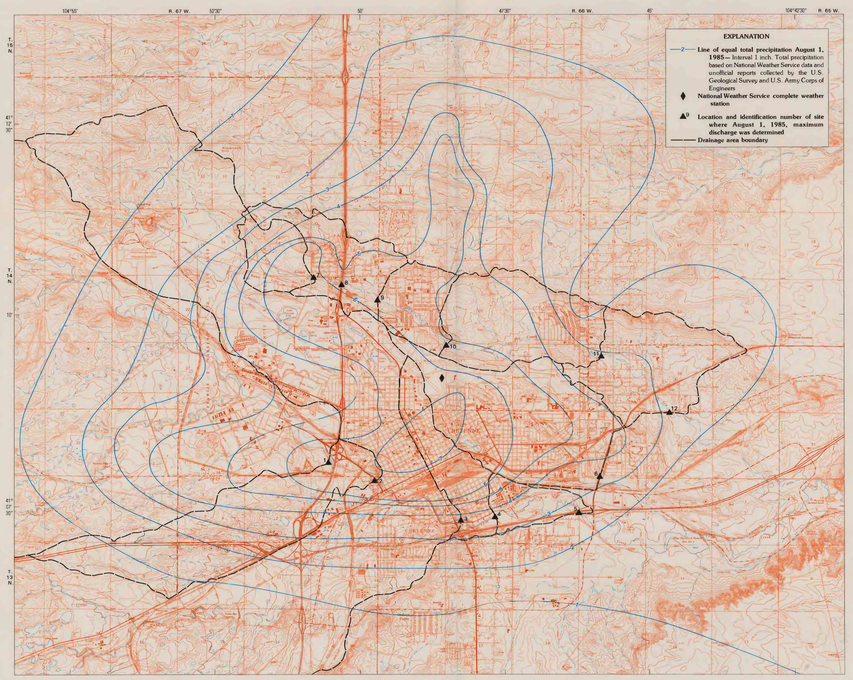

Figure 2.—Areal distribution of precipitation, location of sites where maximum discharge was determined, and drainage area boundaries

FLOOD OF AUGUST 1, 1985, IN CHEYENNE, WYOMING

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STRIP MAPS SHOWING AREAS FLOODED ALONG CROW CREEK

LOCATION OF STUDY AREA

Figure 3.—Profiles of water-surface elevations August 1, 1985, and of streambed elevations April 15, 1984, along Crow Creek

INTRODUCTION

The August 1, 1985, flood in Cheyenne was one of the most devastating historic floods in Wyoming. The flood was the result of unusually severe thunderstorms that were centered over Cheyenne and that covered an area of about 50 square miles. There were 12 storm-related deaths (Federal Emergency Management Agency, 1985), numerous injuries, and an estimated $61.1 million (J. D. Swanson, Federal Emergency Agency, written commun., 1985) in damage. The damage estimates, in millions, were categorized as follows: homes and personal property ($50.48); city, county, and State properties ($3.82); Federal properties ($3.10); businesses ($3.04); utilities ($0.62); and agricultural (less than $0.01). The maximum August 1, 1985, discharges measured by indirect methods in Crow Creek ranged from 2,300 to 8,260 cubic feet per second and in Dry Creek they ranged from 3,820 to 5,880 cubic feet per second. The flood in Crow Creek at sites in the southeast part of Cheyenne exceeded the previously defined 100-year flood, and the flood in Dry Creek was exceeded to a greater than the previously defined 100-year flood (Federal Insurance Administration, 1982).

This report documents the areal distribution of precipitation, flood magnitude and areal extent, and water-surface profiles of flooding in Crow Creek and Dry Creek; areas throughout the city that were inundated or had depths of water in the street greater than 1 foot also are defined. The hydrologic information provides a technical data base for land-use planning and hydraulic and hydrologic design.

The U.S. Geological Survey and the Wyoming Highway Department worked cooperatively in collecting the data and in providing funding for the report. Other agencies contributing data to the report include the city of Cheyenne, National Weather Service, U.S. Army Corps of Engineers working with the Federal Emergency Management Agency, and the U.S. Air Force, F. E. Warren Air Force Base. Contributions by area residents of information relating to the present and past floods and of flood photographs are gratefully acknowledged.

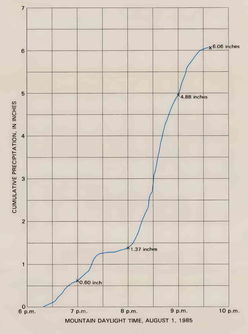
DESCRIPTION OF THE DRAINAGE AREA

Crow Creek, a tributary to the South Platte River, originates in the Laramie Mountains, 30 miles west of Cheyenne. However, the precipitation from the intense thunderstorms causing the flood did not extend more than about 3 miles west of Cheyenne. Thus, the drainage area contributing to the flood of August 1, 1985, was a small fraction (about 40 square miles) of the actual drainage area of Crow Creek (297 square miles) upstream from the eastern edge of the city. Crow Creek flows eastward through the urban area of south Cheyenne (fig. 1) and receives inflow from several unnamed tributaries in the area south of the airport, where some of the maximum precipitation depths were reported. There are no facilities for storage of floodwaters in Crow Creek along its course through Cheyenne, but several natural depressions, including permanent lakes, occur in the Cheyenne area and provide some storage for storm runoff. During the flood, temporary storage was provided by these natural depressions and also by railroad and road embankments. Downstream from site 5 (fig. 2) there are two on-stream reservoirs that provided some storage, helping to decrease the maximum discharge.

Dry Creek, a tributary of Crow Creek, has a drainage area of 11.9 square miles upstream from its mouth. The headwaters of Dry Creek are northwest of Cheyenne on the F. E. Warren Air Force Base (fig. 2). The headwaters area within the Air Force base is mostly a undeveloped and covered with native grasses. North Fork Dry Creek, a tributary drainage adjacent to and north of Dry Creek, has two small storage reservoirs near its headwaters; during the flood, one impounded about 11 acre-feet, and the other about 3 acre-feet. The maximum spill through the outlet pipe at the larger, upstream structure was estimated to be about 190 cubic feet per second (W. R. Bailey, Wyoming Highway Department, oral commun., 1985). The streams flow from the Air Force base into an urban area upstream from Interstate Highway 25 (fig. 2). The drainage area predominantly is urban along its southeasterly course through the city, and the stream channel largely is manmade. Carey Reservoir, between sites 10 and 11, provided temporary storage for about 157 acre-feet during the flood (D. S. Benner, Cheyenne City Engineer Department, oral commun., 1985). Railroad and road embankments, depressions, as well as fences that became plugged with debris, also provided temporary storage. This storage helped to attenuate the flood peak except when plugged fences failed, probably causing a sudden release of water.

PRECIPITATION

Several thunderstorms passing over the city combined to produce 6.06 inches of rain and hail between 6:20 and 9:45 p.m. (Mountain Daylight Time) at the National Weather Service recording station at the Cheyenne airport. The maximum 1 hour precipitation was 3.51 inches between 8 and 9 p.m. as shown below on the cumulative precipitation graph. One of the storm cells became stationary over the Dry Creek area in the northwest part of the city and by 7:45 p.m. had reached an altitude of more than 60,000 feet above sea level according to the National Weather Service (written commun., 1985). Another storm cell over central Cheyenne continued to increase in intensity until about 9:30 p.m., causing torrential rain, severe hail, and winds of as much as 70 miles per hour (National Weather Service, written commun., 1985).



According to the National Weather Service (written commun., 1985), the 6.06 inches of precipitation is a new record for 24 hours in Cheyenne and in Wyoming. Previous record 24-hour totals were 4.70 inches for Cheyenne (1896) and 5.50 inches for Wyoming (1927). Also, the 3.51 inches is a new record for 1 hour in both Cheyenne and Wyoming.

A survey of precipitation accumulation throughout the city and adjacent areas indicated that maximum total precipitation of more than 7 inches occurred near the center of Cheyenne (fig. 2) and that most of the city received more than 4 inches of precipitation. Hail occurred throughout the city, but was most intense within the southern one-half of the area bounded by the 6-inch line of equal precipitation. In some of the natural depressions, the hail accumulated in drifts several feet deep.

DESCRIPTION OF FLOODING

There were few areas of Cheyenne spared from flooding, either from Crow Creek, Dry Creek, their tributaries, or overland (sheet) flow. Flooding was magnified and complicated in some areas of the city because of the effect of urban development on drainage: plugging of storm drains, culverts, and fences; and railroad and road embankments creating temporary storage for the fast-rising waters. Photographs (shown on sheet 2) taken during and after the flood illustrate the extent of the catastrophy throughout the city.

DISCHARGE

Maximum discharges were measured at selected locations along Crow Creek (sites 1–5) and Dry Creek (sites 7–12) and are listed in table 1; location of sites are shown in figure 2 and on the strip maps. A maximum discharge also was computed for an urban drainage (site 6) that is tributary to Crow Creek. The drainage upstream from College Drive is a combination of several unnamed tributaries. The assumption was made that the peaks in the unnamed tributaries occurred simultaneously. All measurements were made by indirect methods after the flood by surveying high-water profiles, determining hydraulic properties at each site, and computing the discharge using appropriate hydraulic formulas. Unit discharges were computed for the area tributary to Crow Creek and for the Dry Creek discharge-measurement sites (table 1)

The maximum discharge in Crow Creek increased between sites 1 and 4; runoff from the intervening areas was significant, particularly between sites 3 and 4. The highway embankment at site 5 caused considerable upstream storage, causing a slight decrease in the magnitude of the maximum discharge.

Flow in the unnamed tributaries crossing College Drive (site 6) filled a detention reservoir (fig. 1) located about 2,000 feet southeast of site 6. The reservoir has a design capacity of 125 acre-feet at elevation 5,974 feet (A. M. Wacker, Wyoming Highway Department, oral commun., 1985); however, flow was further ponded by a railroad embankment just downstream from the reservoir. Outflow from this area was estimated to be 200 cubic feet per second through a 5-foot diameter culvert under the railroad embankment.

The maximum discharge in Dry Creek was increased by tributary inflow between sites 7 and 9 and between Carey Reservoir and site 11. However, the discharge was attenuated by storage provided by a small pond and road embankments between sites 9 and 10 and by road embankments between sites 11 and 12. The maximum discharge in the main channel at site 10 was 3,820 cubic feet per second and may have increased slightly between site 10 and Carey Reservoir. The discharge in the main channel of Dry Creek, immediately downstream from Carey Reservoir, was 3,680 cubic feet per second, indicating slight attenuation of the peak by the reservoir. Neither the maximum discharge of water that flowed down Dell Range Boulevard rather than the main channel nor overland flow could be determined; therefore, a total discharge figure is not available for Dry Creek downstream from Carey Reservoir. Downstream from site 12, the flow was obstructed by a railroad embankment where flow was constricted by a culvert with 43 square feet of cross-sectional area.

The maximum discharge in the upstream reaches was reported by local residents to have occurred between 8:00 and 8:30 p.m. in Crow Creek (site 1) and between 7:30 and 8:00 p.m. in Dry Creek (site 7). The maximum discharge reached site 5 in Crow Creek between 10:30 and 11:00 p.m., and in Dry Creek, the maximum discharge occurred at site 12 between 11:15 and 11:45 p.m. as observed by Geological Survey personnel. An observer in the area of Carey Reservoir reported precipitation ended about 7:30 p.m. and that an initial flood peak occurred about 7:40 p.m. After the initial flood peak, inflow to the reservoir began receding until precipitation started again about 7:50 p.m. The observer at Carey Reservoir estimated the maximum discharge occurred about 9:00 p.m. Times for the maximum flow at the discharge measurement sites, as estimated by area residents, are listed in table 1.

INUNDATED AREAS AND FLOOD PROFILES

Flooding was less extensive along Crow Creek than along Dry Creek. Upstream from 16th Street, flow in Crow Creek was confined to the main channel and some low areas; downstream from 16th Street, overflow increased progressively. Flow in Crow Creek between Warren Avenue and Interstate Highway 80 overtopped Morrie Avenue.

Overflow from Dry Creek inundated the flood plain and adjacent low-lying areas as far southeast as the Union Pacific Railroad downstream from site 12. All roads that cross Dry Creek in the urban area were overtopped.

The lateral extent of the flood in each creek is shown on the strip maps and in figure 1, which also shows other areas of the city where depths of water in the street exceeded 1 foot. Also shown in figure 1 are maximum water-surface elevations for ponded areas and backwater areas caused by roads and channel constrictors. All flood mapping was done on topographic maps (scale 1:2,400) having a 2-foot contour interval; the maps were provided by the city of Cheyenne. The overall accuracy of the elevation of the water surface is assumed to be about 1 foot because of errors inherent in topographic mapping, visual delineation of the flood boundary, and the irregularity of the water surface, which is characteristic of turbulent flow. The flood boundary in some areas could not be defined with sufficient accuracy because of a lack of flood marks. These indefinite boundaries are indicated by question marks in figure 1 and on the strip maps.

Profiles of the water surface and streambed along Crow Creek and Dry Creek are shown in figures 3 and 4. Abrupt changes in slope of the profile indicate the difference in water-surface elevations upstream and downstream from cross-stream structures, such as road crossings.

CHEYENNE FLOOD HISTORY

Large floods are not uncommon in the Crow Creek and Dry Creek drainages and in the Cheyenne area (table 2); however, because the area along Crow Creek (since 1867) was urbanized earlier than that of Dry Creek (since about 1950) and because of Crow Creek's greater drainage area, more historical flood information is available for Crow Creek. Prior to the August 1, 1985, flood, the largest known floods in Crow Creek occurred in 1904 and 1929, each having a maximum discharge (table 2) comparable to the 1985 flood. In addition, information provided by area residents indicates that significant floods also occurred in Crow Creek in 1883 and 1896.

Historic flood information is more indefinite for Dry Creek than for Crow Creek, and most information comes from long-time area residents. According to F. L. Vosler (oral commun., 1985), these large floods have occurred prior to 1985 in the downstream reaches of Dry Creek: He noted that since 1916, floods of a magnitude similar to the August 1, 1985, flood occurred in 1918, 1935, and 1955. The approximate magnitude of the 1955 flood also was verified by Dennis and Edward Steele (oral commun., 1985). Jack Ketchem (oral commun., 1985), and other residents. Dennis Steele (oral commun., 1985) said the water-surface elevation during the 1955 flood was 0.5 to 1.0 foot lower than that during the August 1, 1985, flood. Mr. Ketchem also recalled a bank-to-bank flood on Dry Creek in 1929. Other than the August 1, 1985, maximum discharge, the only other maximum discharge that has been determined for Dry Creek occurred August 2, 1966 (table 2), when the Wyoming Highway Department (oral commun., 1985) reported the maximum flow slightly inundated Bishop Boulevard and was 1 foot deep over Yellowstone Road.

The historical perspective of the August 1, 1985, flood along Dry Creek was further verified during onsite inspections made while collecting data for preparation of the inundation maps. Where effects of urbanization are minimal, the 1985 flood was found to have inundated parts of the bottomland lying beyond flood-plain alluvial deposits.

The following table lists a brief description of significant historic floods and possible flood-producing storms in the Cheyenne area; this information and maximum discharge data from table 2 provide a chronology of and discharge reference for significant floods in the Cheyenne area.

SUMMARY OF SIGNIFICANT FLOODS AND FLOOD-PRODUCING STORMS IN THE CHEYENNE AREA

[Source: 1, U.S. Army Corps of Engineers, 1968; 2, U.S. Army Corps of Engineers, 1970; 3, oral communication with area residents.]

Date	Source	Description
1883	3	Significant flood in Crow Creek.
July 15, 1896	1 (p. 14)	Precipitation was 4.70 inches in 3 hours and 4.86 inches in 24 hours.
	3	Significant flood in Crow Creek.
May 20, 1904	2 (p. 10)	Precipitation of 0.63 inch was recorded the night of May 19, and during the afternoon of May 20, 1.10 inches of rain and hail fell in 1 hour. Precipitation probably was more intense along the upstream part of the Crow Creek Valley. The maximum discharge was estimated to be 6,500 cubic feet per second.
1918	3	Large flood occurred in downstream reaches of Dry Creek, approximately the same magnitude as August 1, 1985, flood.
June 14, 1926	1 (p. 14)	Severe hailstorm lasting from 10:20 p.m. to 11:05 p.m. concentrated in a 1- by 6-mile area and produced 2.51 inches of precipitation.
April 23, 24, 1929	1 (p. 14)	Storm produced 3.20 inches of precipitation within 24 hours.
1929	3	Large flood in Dry Creek.
June 2, 5, 1929	2 (p. 11)	Flood in Crow Creek (8,200 cubic feet per second, June 2) was caused by precipitation near the headwaters where the ground already was saturated and tributaries were full from melting snow.
June 1935	3	Large flood in downstream reaches of Dry Creek, approximately the same magnitude of August 1, 1985, flood. Precipitation during the storm was greatest in the Round Top area in headwaters of Dry Creek. Flooding possibly occurred in Crow Creek.
August 26, 1940	1 (p. 15)	A severe storm producing 1 inch of precipitation in 10 minutes caused flooding along Dry Creek.
June 14, 15, 1955	1 (p. 15) and 2 (p. 12)	Intense rains occurred on the afternoon of June 14 and continued into the next day, producing 2.68 inches of precipitation.
	3	Large flood occurred in downstream reaches of Dry Creek at approximately the same magnitude as the August 1, 1985, flood.
1972	3	Flood occurred in downstream reaches of Dry Creek; water-surface elevations were slightly lower than those for the 1955 flood.

ADDITIONAL INFORMATION

The Crow Creek and Dry Creek drainages in Cheyenne have been analyzed in previous flood-related studies and reports. The U.S. Army Corps of Engineers prepared flood-inundation maps and described flood characteristics for Crow Creek (1970) and Dry Creek (1969). The Federal Insurance Administration (1977) prepared a report detailing probable flood-flow characteristics along both channels. The report later was updated (Federal Insurance Administration, 1982). Flood-prone area maps of the Cheyenne area were published by the Geological Survey (1973).

Additional information relating to the August 1, 1985, flood is available from the U.S. Geological Survey and other agencies. The work maps (scale 1:2,400) used to delineate inundated areas (fig. 1 and strip maps) may be inspected at the District Office, U.S. Geological Survey, Cheyenne, and are available from the Cheyenne City Engineer. Aerial photography taken August 2, 1985, is available for inspection at the Wyoming Highway Department, Cheyenne, in black and white (scale 1:4,800) and colored infrared (scale 1:2,400). Satellite imagery of the storm and detailed description of the storm development is on file with the National Weather Service, Cheyenne.

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U.S. Army Corps of Engineers, 1969, Flood plain information report, Dry Creek, Volume I, Cheyenne, Wyoming: Omaha, Nebraska, 23 p.

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U.S. Geological Survey, 1964, Compilation of records of surface waters of the United States, October 1950 to September 1960, part 6–B, Missouri River Basin below Sioux City, Iowa: U.S. Geological Survey Water-Supply Paper 1730, 514 p.

_____1967, Water resources data for Wyoming, part 1, surface water records, water year 1966: Cheyenne, Wyoming, 272 p.

_____1973, Flood-prone area maps, Cheyenne North and Cheyenne South quadrangles: Cheyenne, scale 1:24,000.

_____1978, Water resources data for Wyoming, water year 1977, volume 1. Missouri River Basin: U.S. Geological Survey Water-Data Report WY–77–1, 616 p.

CONVERSION FACTORS

The following factors may be used to convert inch-pound units used in this report to metric units:

Multiply	by	To obtain
inch	2.540	centimeter
foot	0.3048	meter
mile	1.609	kilometer
mile per hour	1.609	kilometer per hour
square foot	0.09290	square meter
square mile	2.590	square kilometer
acre-foot	1,233	cubic meter
cubic foot per second	0.02832	cubic meter per second
cubic foot per second per square mile	0.01093	cubic meter per second per square kilometer