UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLOODS OF JUNE 4 AND 12, 1976,

AT CULBERTSON, MONTANA

Open-File Report 78-429

Prepared in cooperation with the
Federal Highway Administration and the
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FACTORS FOR CONVERTING U.S. CUSTOMARY UNITS TO METRIC UNITS

For those readers who may prefer to use metric units rather than U.S. customary units, the conversion factors for the terms used in this report are listed below:

Multiply U.S. customary unit	By	To obtain metric unit
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
foot (ft)	.3048	meter (m)
foot per second (ft/s)	.3048	meter per second (m/s)
inch (in)	25.40	millimeter (mm)
mile (mi)	1.609	kilometer (km)
square foot (ft^2)	.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)

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ABSTRACT

Runoff from rainfall caused flooding in the town of Culbertson, Montana, on June 4 and 12, 1976. Flood damage was mostly to business and residential structures within Culbertson. Two small drainages contributed the peak flows, which at one site exceeded 1,200 cubic feet per second per square mile of contributing area.

Flow from the Missouri River tributary No. 5 at Culbertson consisted of flow through a pipe-arch at the State Highway 16 crossing and flow that overtopped the right bank of the main channel. Maximum combined pipe-arch and bypass flow for the June 12 flood was 1,330 cubic feet per second.

Flow from Diamond Creek consisted of flow through a culvert at the U.S. Highway 2 crossing west of Culbertson and flow that overtopped a road. Maximum combined culvert and bypass flow for the June 4 flood was 1,320 cubic feet per second. Failure of a small dam increased the flow volume of the June 4 flood.

INTRODUCTION

Runoff from heavy rains on two small sparsely populated drainage basins caused flooding in Culbertson, Mont., on June 4 and 12, 1976. The contributing drainages were an unnamed coulee on the north side of town and Diamond Creek on the northwest side (pl. 1). Flood damage was mostly to business and residential structures within Culbertson. The value of flood damage was not estimated. No lives were lost in the flood.

The purpose of this report is to define the magnitudes of peak flows from the drainage basins that contributed to flooding in Culbertson on June 4 and 12, 1976. The contributions were determined by field investigation of high-water marks (debris lines), discussions with residents subsequent to the flooding, and calculations of flood magnitudes.

The U.S. Geological Survey operates a crest-stage gage on the unnamed coulee. The location of the gage is listed as "Missouri River tributary No. 5 at Culbertson" (station number 06185400) in streamflow publications. Therefore, the unnamed coulee will be identified in this report as Missouri River tributary No. 5. No previous streamflow data have been collected by the Geological Survey on Diamond Creek.

METEOROLOGIC CONDITIONS

The precipitation station at Culbertson recorded 1.73 inches of rainfall on June 4 and 4.33 inches on June 12 (National Weather Service, 1976). Antecedent rainfall at Culbertson was 0.09 inch on June 3; no rainfall was recorded on June 1-2 or June 9-11. Rainfall of 2 to 4 inches for each storm was unofficially reported by residents in the upper reaches of the contributing drainages; however, the amounts were not confirmed. Storm rainfall in this area often occurs in a cellular pattern, with one location receiving heavy amounts while a nearby location receives little or none.

HYDRAULIC CONDITIONS

Missouri River tributary No. 5

The Missouri River tributary No. 5 has a drainage area of 3.82 mi^2 upstream from the crest-stage gage, which is located at the State Highway 16 crossing (site A, pl. 1) near the rodeo ground. The drainage structure is a corrugated metal multiplate pipe-arch measuring 12.7 feet wide, 7.5 feet high, and 124 feet long. Each end is mitered for 11 feet, starting at a point 2 feet above the inverts and extending to the crown. The upstream end of the invert is 1.12 feet higher than the downstream end. After the flooding the pipe-arch was clean and no evidence of obstruction of flow by debris during the flooding was apparent.

The maximum flow of the Missouri River tributary No. 5 at the crest-stage gage for the period of record 1963-75 was 495 ft^3/s on July 24, 1963 (Johnson and others, 1976); all water flowed through the pipe-arch. The corresponding water surface was 6.66 feet higher than the upstream invert.

June 4 flood

Peak flow of the Missouri River tributary No. 5 through the pipe-arch at the crest-stage gage during the flood of June 4, 1976, was computed to be 740 ft^3/s; the highest water surface was 10.12 feet above the upstream invert. Flow through the pipe-arch was computed according to the method outlined by Bodhaine (1968) for type 2 flow.

Part of the floodwater of the Missouri River tributary No. 5 overflowed the right bank of the main channel on June 4. The overflow occurred 200 to 400 feet upstream from the pipe-arch and the floodwater did not return to the main channel. The bypass water crossed the access road to the rodeo grounds, flowed along the west side of Highway 16, and then crossed Highway 16 at a borrow pit about 0.3 mile south of the main channel crossing. The bypass flow for the June 4 flood was not determined.

June 12 flood

Peak flow of the Missouri River tributary No. 5 through the pipe-arch at the crest-stage gage during the flood of June 12, 1976, was computed to be 770 ft^3/s; the highest water surface was 10.52 feet above the upstream

invert. Flow was computed according to the method of Bodhaine (1968).

Like the June 4 flood, part of the floodwater on June 12 overflowed the right bank of the main channel and crossed Highway 16 about 0.3 mile south of the main channel crossing. The peak bypass flow for the June 12 flood was 556 ft^3/s. The flow along the highway embankment was determined by a four-section slope-area measurement as outlined by Dalrymple and Benson (1967).

The maximum combined pipe-arch and bypass flow for the June 12 flood was 1,230 ft^3/s. Local contribution to flow from the rodeo ground drainage area (pl. 1) was not estimated but probably occurred prior to the peak main-channel overflow.

Diamond Creek

Diamond Creek has a drainage area of 3.90 mi^2 upstream from the U.S. Highway 2 crossing (site D, pl. 1). The drainage structure is a 6-foot diameter corrugated metal culvert that is 150 feet long and is positioned at an oblique angle to the road. The upstream invert is 1.88 feet higher than the downstream invert. After the flooding the culvert was clear of debris and was not damaged by the high flood heads and extreme velocities.

June 4 flood

Observation of high-water marks at the culvert on Diamond Creek indicated that the highest level of the floodwater was 13.88 feet above the upstream crown (20.25 feet above the invert). There was free outflow and the maximum water surface at the outlet was 5.88 feet above the downstream invert. Maximum flow through the pipe was computed to be 447 ft^3/s, using a U.S. Geological Survey method outlined by Bodhaine (1968) for type 6 flow. The maximum flow is attributed to the June 4 flood.

The June 4 flood of Diamond Creek overtopped the road crown starting at a point about 130 feet east of the intersection of the centerline of U.S. Highway 2 and the culvert and continuing east to 3rd Avenue West. The flow across Highway 2 west of 3rd Avenue West was computed to be 391 ft^3/s, using U.S. Geological Survey methods (Hulsing, 1967). The cross section of flow extending from Highway 2 north on 3rd Avenue West had an area of 321 ft^2. The mean velocity was estimated to not exceed 1.5 ft/s, for an estimated flow of 480 ft^3/s flowing east. Thus, the maximum culvert bypass flow is estimated to have been about 870 ft^3/s. Much of the flow crossing Highway 2 west of 3rd Avenue West returned to the channel immediately below the highway and, therefore, did not contribute to flooding of the town. High-water marks showed that the flow crossing Highway 2 was perpendicular to the highway and that the flow across 3rd Avenue West was parallel to the highway.

The maximum combined culvert and bypass flow for the June 4 flood thus was 1,320 ft^3/s.

June 12 flood

The June 12 overflow of Diamond Creek at U.S. Highway 2 was of smaller magnitude than the overflow of June 4. Because of the profusion of higher debris left by the June 4 flood, the June 12 ponded elevation could not be defined by direct means. A highway maintenance man who was present during the June 12 flood stated that water flowed out of the ponded area eastward along the road. He also said that the road possibly would not have been overtopped near the east edge of the highway fill except for the strong winds that caused high waves. A resident at 222 6th Street said the flood of June 12 did not overtop the road at that location. A member of the Moore family (house closest to Diamond Creek above the highway on the west) stated that the June 4 flood was about 1 foot higher than the June 12 flood, but he could not locate definite high-water marks at the house. Inspection of the area north of town indicated that sheet floodwater flowed toward town from an area of 0.24 mi^2, which would have contributed directly to the June 12 flooding.

Dam failure

The Diamond Creek Dam was constructed in 1934 0.5 mile upstream from U.S. Highway 2. The dam failed during the flooding of Diamond Creek on June 4.

Two distinct lines of high-water marks, the higher of which was attributed to the June 4 flood, were found upstream from the Diamond Creek Reservoir. Measurements of peak discharges upstream from the reservoir were of poor reliability because a flattening of water-surface profile occurred for some distance upstream from the county road (site B, pl. 1) and limited the length of reach that was suitable for measuring purposes. This flattening of profile occurred at both flood magnitudes. Using the slope-area method (Dalrymple and Benson, 1967), the peak flow upstream from the reservoir was computed to be 4,080 ft^3/s for June 4 and 2,020 ft^3/s for June 12; the maximum outflow from the reservoir was computed to be 2,730 ft^3/s with fair reliability.

The dam reduced the peak flow downstream but contributed to flooding of the town because water stored in the reservoir prolonged the length of time that the flow at the highway exceeded the culvert capacity. The 2,020 ft^3/s peak that occurred on June 12 was nearly controlled by pondage upstream from the highway and culvert outflow. Because the 4,080 ft^3/s peak inflow on June 4 was reduced to 2,730 ft^3/s outflow, it is reasonable to assume that the dam remained partly intact until after the flood crest had passed.

RECURRENCE INTERVALS

Recurrence intervals of flood magnitudes can be defined as the interval, in years, during which a flood of a given magnitude will be equaled or exceeded once on the long-term average. Recurrence intervals of flood magnitudes for the Missouri River tributary No. 5 and Diamond Creek (table 1) were obtained from a frequency study by Johnson and Omang (1976). The recurrence intervals exceed the 100-year flood.

Table 1.--Flood data

Map letter (pl. 1)	Stream and site	Drainage area (mi^2)	Date 1976	Discharge (ft^3/s)	Unit discharge [$(ft^3/s)/mi^2$]	Recurrence interval (years)
A	Missouri River tributary No. 5 at Culbertson (crest-stage gage).	3.82	June 12	1,330	348	> 100
B	Diamond Creek above county road northwest of Culbertson.	3.32	June 4	4,080	1,229	> 100
C	Diamond Creek below reservoir near Culbertson.	--	June 4	[a]2,730	--	--
D	Diamond Creek at Highway 2 at Culbertson.	3.90	June 4	[b]1,320	338	--

[a]Affected by storage in Diamond Creek Reservoir.

[b]Partly estimated.

REFERENCES

Bodhaine, G. L., 1968, Measurement of peak discharges at culverts by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A3, 60 p.

Dalrymple, Tate, and Benson, M. A., 1967, Measurement of peak discharge by the slope-area method: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A2, 12 p.

Kilsing, Harry, 1967, Measurement of peak discharge at dams by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A5, 29 p.

Johnson, M. V., and Omang, R. J., 1976, A method for estimating magnitude and frequency of floods in Montana: U.S. Geol. Survey Open-File Rept. 75-650, 35 p.

Johnson, M. V., Omang, R. J., and Hull, J. A., 1976, Annual peak discharges from small drainage areas in Montana through September 1975: U.S. Geol. Survey open-file rept., 204 p.

National Weather Service, 1976, Climatological data, Montana: National Oceanic and Atmospheric Adm., v. 79, no. 6.