References

Ralph R. Woolley "Cloudburst Floods in Utah, 1850-1938" U.S. Geological Survey W.S.P. 994, 1947

p. 80 "Mechanics of Mudflows" —

"the initial flushing of the slopes carries loose materials of all kinds into the stream channel. This piles up as it is pushed forward by the water and acts as a dam in retarding the flow, thus permitting further accretion of freer water from upstream. In a short time an immense crest has accumulated and plunges down the canyon with terrific force. The wave travels with a definite rolling motion; the material in contact with the stream bed moves with relatively little horizontal velocity, and the material occupying a higher position in the mass shoots to the front of the wave and down. Free water accumulating upstream in a sort of traveling reservoir, because of its swifter velocity, continually passes over the surface of the debris mass and falls over the fore part of the wave, to be immediately overridden and mixed into the under part of the flow. Huge clumps of earth from the banks collapse into the flow, and undercutting induces slides that often extend far up the steep hill slopes. At constrictions in the channel the mass is retarded until sufficient head has been built up to force the flow through at a greater velocity or until the opening is enlarged. Often gigantic boulders will become wedged in narrow places, forming dams behind which great quantities of debris are deposited. A sudden widening of the channel, as at a fork, also causes the stream to drop part of its debris load. (Parrish Creek).

At times two or more successive waves may debouch — these waves apparently indicate a lack of coincidence — of flows from the tributaries. (Lost Creek)

A mudflow moves under two distinct influences — the fluidity of its mass and the impetus of the free water. In flows in which there is a large excess of water much of the solid material is carried as bed load, and the heap of debris that gathers at the fore part of the wave is carried forward at greater velocity because of the force of the water and the lower viscosity of the mixture.

When the flood spills from the canyon mouth — free water, which has not become incorporated into the debris mass, runs rapidly ahead, draining over the surface of the mudflow. (Layton)

p.82 "In the viscosity of the mudflow, which enables it to maintain appreciable depth even on unconfined surfaces, lies the explanation of its great destructive and transportive power. When it encounters an obstacle, such as a house or barn, it does not divert easily, as water does, but piles up against the structure until it attains sufficient head to divert all the newly arriving material. Often before this head is attained the pressure of the mass will cave in the walls or thrust the structure from its foundations. Huge boulders weighing more than 100 tons have been moved incredible distances by these flows.

The so-called "floating" action is therefore in reality a rolling and sliding action whereby the weight of the boulder seen at the surface is transmitted to the stream bed through a layer of well-lubricated silt, sand, gravel, and smaller boulders which may be likened to a mass of ball bearings. The buoyancy of the mudflow, however, is of material importance, for tests indicate that its specific gravity is slightly under 2, so that a boulder weighing 260 tons with a specific gravity of 2.6, would have a weight of 160 tons in water and only 80 tons in a mudflow. Thus it is not uncommon to find huge boulders weighing 85 tons or more deposited hundreds of feet from the mouths of canyons on flood fans with gradients of no more than 5°.

Wooley "Cloudburst Floods in Utah 1850-1938"
WSP 994, 1947

p. 49 California: (from Eaton)
Sat debris = 70%, Addit. water = 30%
∴ wet = 1 3/7 × dry volume

Dry porosity = 30-40%
30 × .70 + 30 = 51% water
40 × .70 + 30 = 58% " .

Therefore estimate water discharge as average 52% of debris flow in cu. ft. / duration (sec).

p. 50

Steed -	2.42 sq mi.	1120 cfs. aver.	460 csm	Aug 13, 1923
Davis -	1.48 "	810 "	550	"
Farmington -	7.0 [1]	2450 max	350	"
Parrish -	2.03	1040 aver.	515	July 10, 1930
Price R. -	530 [2]	10,000 max	18.8	Sept 1927
Snowville -	1.17	660 aver.	565	July 13, 1938

1] estimated volume of water to fluidify debris deposit. Any excess water would increase figs.
2] C.S. Jarvis "Lava Dams"
3] estimated 9-10,000 cfs.

p. 52 Summer flood = 400-600 csm or 10 times spring RO.
Spring channel capacity needed = 40-60 csm. small tribs. 2-10 mi².

p. 54 Max intensity = .90 "/5 min S.L. Cty Aug 13, 1923
= .42 " Davis Co. July 10, 1930.

p. 54 (Dry Creek) Aug 6, 1901 - Millburn (from Deseret News Aug 7, 1901)
"It was an amazing sight - - - an avalanche of water fraught with trees and boulders hurling itself down the mtns. - - Before reaching the village, the water spread out over the plateau, but even then it was about 3 ft. deep in some parts of town"

Aug 1889 - Mayfield (from Deseret News, Aug 23, 1889)
"Wood Canyon, 1½ mi. long. From this canyon poured forth a stream of water 60 rods or more in width and fully 5 ft. deep in the center. This torrent came down at a terrific rate".

p. 61 1878 floods from two streams in Davis Co. 1901, 1923, 1930.

p.75 "Mudflows" is a well mixed mass of water and alluvium, which, because of its high viscosity and low fluidity as compared to water moves at a much slower rate, usually piling up and overtopping the stream channel and spreading over the fan like a huge sheet of wet mortar or concrete. Its inertia is tremendous. Buildings in its path are pushed from their foundations and walls crushed in. Willard 1923; a large dairy barn carried ½ mi. by mudflow, 155 acres covered with alluvium. Survey Mar. 1939 showed 200,000 [124 ac-ft] cu. yds. of gravel & sand ave 13,300 [8.3 ac-ft]/year from spring freshets in debris basin built 1924. 1936 flood 65,000 [40 ac-ft] yds³ of alluvium over 30 acres.

1930 }
1934 } 3 floods
1936 }
124/3 = 41 ac-ft

Steed 1923 100,000 [62 ac-ft] yds³ of alluvium, 1901 small, covered 70 acres.

Davis ~~1923~~ Flows since 1923 have covered 86 acres.

Parrish 1923 covered 80 acres, strip 100 to 600 ft wide X 3000 ft.

¾ ton boulder 3400 ft. on slope 2° 3.5%
40 ton " same distance 3-4° 5.7 (½ between hwy & apex)
85 " 1000 ft " 5-6° 8.7-10.5% ~~3%~~

Snowslide 1938 50,000 [31 ac-ft] yds alluvium. dammed river 14 ft.
450 ft. of Hwy under 13 ft.
40 Ton boulder at apex ave. slope 11° (19%) (length 1300' fall 250')

Lost Canyon 1938 36,000 [22 ac-ft] yds³ ave slope 11°-18° (32%)