11067000 Day Creek near Etiwanda, California

(Discontinued gaging station in the Santa Ana River basin, USGS California Water Science Center)

Review of peak discharge for the flood of January 25, 1969

Location: Lat 34°11’06”, long 117°32’20”, in NW 1/4 NW 1/4 SW 1/4 sec.8 T.1 N., R.6 W., San Bernardino County, Hydrologic Unit 18070203, on left bank, 0.5 mi downstream from confluence of two main forks, and 4 mi north of Etiwanda.

Published peak discharge: There is no acceptable published peak discharge for this flood. The stage is published as 9.90 ft, the highest stage measured at the gaging station between 1928 and 1972 when the gaging station was discontinued.

Drainage area: 4.56 mi^2.

Data for storm causing flood: The area of the San Gabriel Mountains in southern California was subjected to intense local storms for more than a week between January 18–26, 1969. A stagnant low-pressure system over the Pacific Ocean sent streaming waves of moisture-laden air into southern California as a succession of storm fronts. Storm total precipitation at Etiwanda was 15.45 in., of which 8.07 in. fell January 24–25, 1969, just prior to the debris flow (Singer and Price, 1971). More than 42 in. of rain fell at high elevations in the San Gabriel Mountains at Lytle Creek Ranger Station, 7.5 mi north-northeast of Etiwanda (Scott, 1971; Singer and Price, 1971). Brush fires the previous year caused extraordinary runoff and numerous debris flows in burned basins. Scott (1971) reports numerous debris flows from small drainage basins in the Glendora area. Day Creek is only 18 mi east of Glendora and in the same geologic setting. Historical photographs taken after the flood of January 25, 1969, and photographs taken during the 2003 review and described herein are provided in figures A183–A190.

Method of peak discharge determination: A four-section slope-area indirect discharge measurement was made on February 8–9, 1969. The reach was selected downstream of the streamflow-gaging station at the head of an alluvial fan extending downstream of the canyon mouth of Day Creek. There were large variations in subreach discharge results (19,300–47,600 ft^3/s) and a significant expansion. Conveyance ratios were exceeded in all reaches. The four-section slope-area result was 29,740 ft^3/s. During review, these comments were made:

> “I don’t believe we should use the results of the four section slope area reach. I don’t believe that the changes in areas of the sections are indicated as changes in slope. If the slope does not decrease with area increase, either a very large increase in “n” takes place or the discharge is increasing between sections. Since we feel quite sure that the above isn’t taking place, there must be either an error in profile or section area. I feel quite strongly about the definition of the cross sections. It may be that high water marks defined both banks at the level indicated but I very much doubt if it did this at the same time. I believe that the flow meandered back and forth as debris blocked the flow. Probably no section completely describes the true flow area but since No. 1 is the smallest, it comes closest. Since slope doesn’t change through the reach (an indication that area has little effect on the flow), I would suggest we use the minimum section and compute Q = KS1/2 and rate the result poor.” (signed L.A. Martens, 3-3-69).

Using the section with the smallest cross-sectional area and nearest the head of the alluvial fan, the slope-conveyance indirect-discharge measurement was calculated to be 9,500 ft^3/s and called an estimate.

Possible sources of error: The most significant error in this indirect discharge measurement was the misinterpretation of this event as a water flood. At and downstream of the streamflow-gaging station, botanical, sedimentological, and geomorphological evidence is unequivocal that at the streamflow-gaging station, the peak flow in January 1969 was a debris flow. Debris flows occurred all around this area from the 1969 storm and were well documented (Scott, 1971). Downstream of the streamflow-gaging station, the middle and downstream parts of the coalescing alluvial fans of Day and Deer Creeks experienced significant flooding (Singer and Price, 1971).

This streamflow-gaging station was operated from 1928 to 1972. The site is extraordinarily difficult to measure high flows because of the volume of sediment moved, an unstable channel, multiple flow paths, steep channel (slope of 0.088), and debris flows that have occurred. The five largest peaks in the period of record were based on indirect methods and determined as:

1. 1938 (five values determined; 4,200–44,000 ft^3/s), final value is based on estimated rainfall-runoff.
2. 1943 (two values determined; 720–1,500 ft^3/s), final value is based on arbitrary estimate.
3. 1950 (six values determined; 580–852 ft^3/s), final value is based on slope-area analysis.

4. 1966 (three values determined; 800–1,740 ft^3/s), final value is based on gage height and field estimate.

5. 1969 (two values determined; 9,450–29,740 ft^3/s), final value is based on slope-conveyance (determined herein to be unreliable).

USGS should not have tried to measure peak discharges at this site. None of the five largest flows in 45 years is based on direct measurements or rating curves. Photographs from the 1938 flow present strong evidence that the peak was a debris flow, not a water flood. None of the five largest peak discharges for this site should be considered reliable, and evidence indicates one and perhaps two were debris flows, not water floods.

Recommendations of what could have been done differently: If this event had been correctly identified as a debris flow, an indirect discharge measurement would not have been attempted. In describing the debris flows from this storm near the Glendora, Calif. area, Scott (1971, p. C247) reported:

> "Inspection of the channels indicates that normal indirect measurement of peak discharge would give extreme values and that sometimes the resultant values probably would exceed enveloping curves developed for maximum floods in small drainage basins in southern California."

Field work should have focused on the factors that are most significant to debris flows, such as failure volume, source materials, and valley geomorphology, and not peak discharge. A very slow-moving debris flow can have a high stage at a gage site but produce a small peak discharge. Field evidence documented below indicates that at the streamflow-gaging station, the debris flow was not moving rapidly.

Site visit and review: To document the interpretation that the January 1969 flow at Day Creek near Etiwanda was a debris flow, several debris-flow experts made a field reconnaissance of the original field site on September 25, 2002. The results of the field trip are reported in a memorandum to K. Michael Nolan, USGS Western Region Surface-Water Specialist, dated September 30, 2002, authored by Thomas C. Pierson and Jon J. Major, research scientists with USGS. Most of their memorandum is quoted here:

> "SUBJECT: Field visit to Day Creek (CA) Indirect Measurement Site, 9/25/02
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> At your request, we accompanied a field party to visit the site where an indirect measurement of the January 25, 1969, "flood" was made near the USGS stream gage at Day Creek nr Etiwanda (11067000) in the San Gabriel Mountains, just north of Ontario, California. The field party consisted of USGS staff (yourself, Robert Meyer, Dale Cox, Jim Bowers, Bill Kirby, Bob Jarrett, and the two of us) and private consultants (Martin Becker, Doug Hamilton, and Phil Schaller). The purpose of the site visit was to determine, by examination of remaining deposits and other field evidence, whether the "flood" of January 25, 1969, had been a debris flow or a water flow that had transported a large volume of coarse sediment. We understood that no flood or debris-flow events larger than the 1969 event had occurred in this drainage since that time. We also understood that the indirect measurement that was made shortly after the 1969 event by CA district staff had resulted in an unusually high and controversial peak discharge value, which had been entered into the USGS peak-flow database.
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> We examined the sedimentologic and morphologic characteristics of the deposits along part of the original indirect measurement reach—from the site of the now discontinued gaging station to just upstream of the apex of the fan. This reach, several hundred feet long, is bounded approximately by cross sections 1 and 3 of the original survey. We compared the present-day deposit morphology to that of deposits left by the event in question in the photographs dated February 7, 1969, in order to verify as best we could that we were examining deposits from the 1969 event. We conclude that the 1969 event was definitely a debris flow and not a water flood, at least in the reach we examined. The evidence we found leading us to this conclusion includes:
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> 1. The remnants of the highest recent deposits in the valley cross section (matching the positions of the 1969 deposits shown in the 1969 photographs) show that the original depositional surface was broadly convex, with lobate lateral and frontal margins.
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> 2. The lobes of debris were about 1-2 m high and had coarse clasts (boulders) concentrated on the outer margins of the lobes; the bouldery rims held back finer grained debris.
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> 3. Except at the margins where boulders were concentrated, the deposit exhibited a clast-supported, extremely poorly sorted texture with no visible stratification. All voids between clasts were completely and tightly packed with matrix material.

4. The matrix material was dominantly coarse sand to fine gravel in size but with a few percent of fines (apparently mostly silt); in some places the matrix material was loose and in other places it was slightly cohesive.

5. Coarse clasts on the surface and exposed in cut banks within the main body of the deposit appeared to have random orientations (i.e. no imbrication), although some fabric had developed along the bouldery flow margins.

6. The upstream ends of the stone-masonry side walls of the weir structure that had been constructed at the gage site were not chipped or battered (even the mortar between the blocks).

7. Trees (live oaks) buried in about 1 m of coarse debris from the 1969 event showed no abraisional damage on the upstream sides of their trunks; they were alive and appeared to be quite healthy.

8. The 1969 photos reveal that the bouldery deposits left by the flow filled the weir box to within about 1 m of the bottom of a steel foot bridge mounted on the stone walls above the weir. The upstream sides of the bridge beams showed no evidence of impact by debris. There were no dents and the paint had not been chipped or abraided. This indicates that the bridge had not been touched by the flow.

The physical evidence and characteristics listed in points 1–5 are typical of debris flows and are not found where water floods have transported the debris. Water floods may deposit convex bars but do not leave behind broadly convex deposits, which debris flows typically do. Water floods do not leave lobate deposits, but such lobes are in fact a diagnostic feature of debris-flow deposits. Although floods transporting coarse debris may not leave well-stratified deposits, they usually do leave localized pockets of well-sorted sand and gravel, which we did not see. Except at deposit surfaces where fluvial reworking had probably taken place, the deposits we examined were everywhere extremely poorly sorted. Coarse flood debris typically has numerous small voids between coarse clasts; the coarse clasts in the deposits we examined were all tightly packed with matrix material. Finally, cobbles and small boulders in flood deposits typically show some degree of imbrication (i.e. a type of sediment fabric where a—b axis planes of relative flattened clasts dip upstream); the clasts in the main body of the deposit we examined seemed to be randomly oriented, although fabrics had developed somewhat along the bouldery margins of the deposit (characteristic of debris-flow margins).

The observations described in points 6–8 demonstrate, furthermore, that the event could not have been a water flood. A flood of water generating sufficient shear force to transport the many boulders observed having mean diameters between 0.5 and about 1.0 m would have to have been deep enough to heavily damage or wash away the foot bridge on the weir. In addition, flow velocities would have been high enough to propel cobbles and small boulders into the upstream ends of the weir walls to cause damage there and on the upstream sides of tree trunks in the flow. Because the weir walls and the bridge were completely undamaged and trees were gently surrounded by debris, we infer that the debris-flow surges that spread through this valley reach were moving slowly, probably no more than 1–2 m/s. The slow velocity was probably due to frictional resistance provided by the bouldery surge fronts.

The photos taken on February 7, 1969, show that the fresh January deposit had been eroded very little. The water in the creek was flowing in a narrow channel on the left side of the valley that appears to have been less than 1 m deep. Between that time and today, the deposit experienced more severe erosion by water flow (with relatively little deposition). It is likely that this erosion occurred in late February 1969, when a storm having a rainfall magnitude nearly equal to the storm that triggered the January debris flow occurred but failed to trigger a significant debris flow (according to Robert Meyer).

It is likely that the 1969 debris flow transformed to a more dilute type of flood flow (probably hyperconcentrated flow) at some point farther downstream on the fan. However, disturbance of deposits by the more recent construction of the debris basin at the fan apex and the lack of ground-based photo documentation that would enable identification of 1969 deposits has precluded determination of where the transformation might have taken place. In any case, the published peak-flow value of 9,500 cfs for the January 25, 1969, debris flow is definitely not valid."

Consultants invited to attend this field trip have produced memoranda of their own that argue that the February 1969 event at the streamflow-gaging station was not a debris flow, but a water flood. Most of their memoranda pertain to arguments of the differences to public safety between water floods and debris flows, and other examples of floods and debris flows in other locations, or in areas downstream of the streamflow-gaging station. One memorandum reports results of a sensitivity analysis on the cross-sectional data from the indirect discharge measurement but assumes velocities for the flow that were at odds with field evidence at the streamflow-gaging station (Douglas Hamilton, External Memorandum, November 1, 2002). Another memorandum correctly concludes that both debris flow and water floods are active in Day Creek Canyon during large runoff (Phillip Shaller, Summary of Observations, Field Trip of September 25, 2002). The preponderance of evidence points to the January 25, 1969, event as a debris flow, an event incompatible with the streamflow record at the streamflow-gaging station.

Recommendations: The January 1969 peak discharge is indeterminate, and no meaningful value can be entered into the Peak-Flow File for this event. The stage for this event, 9.90 ft, remains with no discharge associated with it. Individuals interested in the flow history at this site need to exercise due diligence in interpretation of the 1969 debris flow. The record stage but no discharge are clear indications of an unusual event with extensive photographic and written documentation in USGS files.

Figure A183. Unknown location in Day Creek, California, following debris flow showing abrasion on trees, but no major damage in spite of very coarse materials being moved.

Figure A184. View looking upstream toward slope-area reach, Day Creek near Etiwanda, California, February 1969.

Figure A185. View looking downstream at left bank at cross section 2, Day Creek near Etiwanda, California, February 1969.

Figure A186. View looking downstream from cross section 3 toward cross section 4, Day Creek near Etiwanda, California, February 1969.

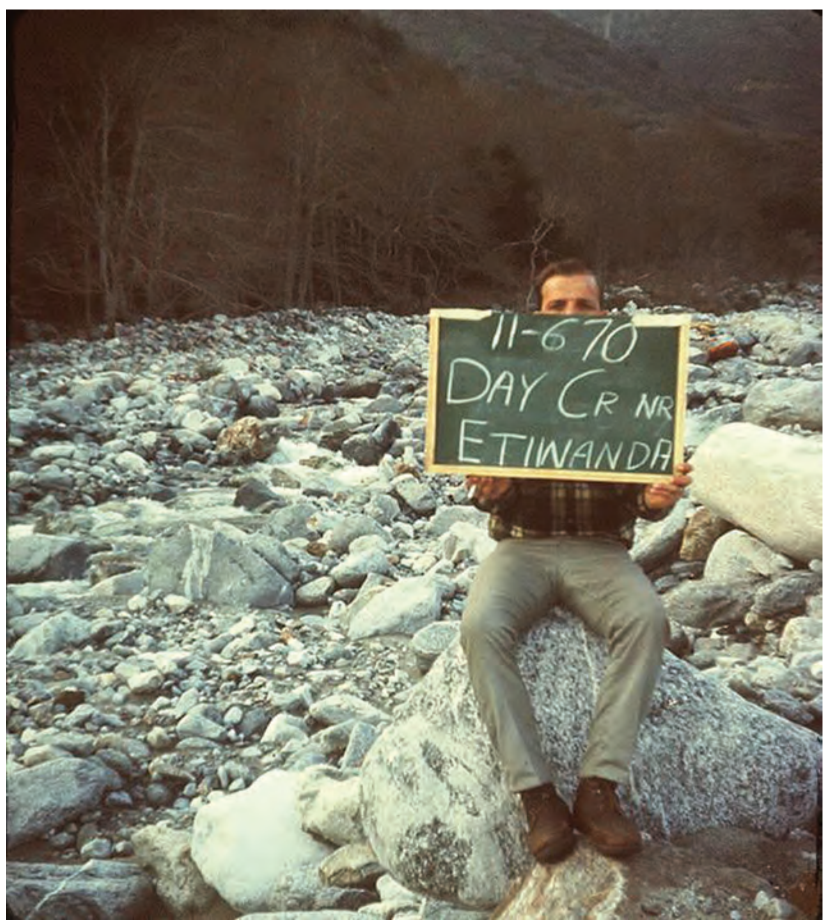

Figure A187. View of slope-area reach, Day Creek near Etiwanda, California, November 1970.

Figure A188. View of debris-flow lobe in slope-area reach, Day Creek near Etiwanda, California, November 1970.

Figure A189. Debris-flow deposit arrested by tree near slope-area reach, Day Creek near Etiwanda, California, September 2002.

Figure A190. Boulder front of debris-flow lobe, Day Creek near Etiwanda, California, September 2002. Flow is from left to right.