El Rancho Arroyo near Pojoaque, New Mexico

(Miscellaneous ungaged site in the Rio Grande basin, USGS New Mexico Water Science Center)

Review of peak discharge for the flood of August 22, 1952

Location: The flood was located about 3 mi west of Pojoaque, N.M. at 35.8902N and 106.0829W.

Published peak discharge: The peak discharge is 44,600 ft^3/s, August 22, 1952. This peak discharge was not published by the USGS at the time. After review at USGS Headquarters, the consensus was that the discharge was too uncertain to publish. However, Tate Dalrymple included the peak discharge in Chow's Handbook of Applied Hydrology (Chow, 1964, p. 25–12). The peak resurfaced during the nationwide flood-frequency project (Patterson, 1965).

From September 17, 1963, memorandum from Wilber Heckler, New Mexico District Engineer, to the Chief, Basic Records Section, Washington, D.C.:

> "The results of this measurement have never been published. Computations were reviewed by Dalrymple, Benson, and Hulsing, and apparently there was sufficient doubt about the result to decide against publishing it. The measurement was reviewed by Patterson September 17, 1963, and discussed with engineers in the Santa Fe office. Doubt still exists on portions of the measurement such as its warped section, high-water line on one side considerably higher on one side than the other, up to 2 ½ feet of scour in part of the channel, all vegetation in channel did not wash out despite the high velocities."

> "One conclusion is to recommend that the results of this measurement should not be published. We agree it was an unusual flood and suggest consideration be given to making mention of it in the list of miscellaneous measurements, but not to publish a discharge figure."

The discharge (44,000 ft^3/s from a drainage area of 6.7 mi^2) was included in Crippen and Bue (1977); they evidently took the value from Chow (1964). The discharge (45,000 ft^3/s from a drainage area of 6.9 mi^2) also appears in Glancy and Harmsen (1975, table 3) but is mislabeled as Trujillo Arroyo near Hillsboro, N. Mex. This is documented in a memorandum from A.G. Scott to P.A. Glancy dated October 24, 1975, and the November 5, 1975, response from J.P. Monis.

The discharge also was the topic of an exchange of memoranda from W.W. Reedy, Bureau of Reclamation, to William Hale, USGS (May 10, 1977), and a response from R.P. Thomas for Mr. Hale (May 16, 1977). The gist of these exchanges was that USGS had never published the discharge of 44,600 ft^3/s because of concern about the unusual hydraulic conditions and continued to believe the peak discharge value was too large.

Drainage area: 6.7 mi^2. The map scale for the original determination is unknown, but A.G. Scott (USGS) in a February 17, 1972, memorandum to M.S. Petersen (USGS) noted that he had

> "… checked the drainage area on 7 ½ min quads and arrived at 6.82 sq. mi."

Scott Waltemeyer (USGS New Mexico Water Science Center) used the 30-m (NED) and GIS to compute a drainage area of 6.773 mi^2 as part of this 2003 review.

Data for storm causing flood: The following is extracted from the September 22, 1952, summary prepared by Hugh Hudson (USGS):

> "State road 4, connecting Los Alamos with Santa Fe, was impassable for several hours on the evening of Aug. 22 as a result of extremely heavy rain in the headwaters of El Rancho and adjacent arroyos. El Rancho Arroyo crosses state road 4 as three arroyos which merge about 1,000 feet below the highway and about 300 feet above this slope-area reach. The Soil Conservation Service made a limited bucket survey after the storm and found that the rainfall in not more than an hour was 5 inches at El Rancho. Indications are that El Rancho was not in the center of the storm. The headwater drainage is uninhabited, so no rainfall data are obtainable where the maximum rainfall apparently occurred."

The following undated handwritten note was added by Hugh Hudson:

> "According to local residents, this flood is comparable only to the flood of 1829, and may have exceeded the 1829 flood."

Photographs taken during the 2003 review and described herein are provided in figures A150–A155.

Method of peak discharge determination: The peak discharge is based on a three-section slope-area measurement. The measurement had a number of nonstandard conditions as noted in section "Possible sources of error." In response to preliminary reviews, the third section was analyzed, and the cross sections were probed. The reach was slightly contracting with high velocities; the resulting Froude numbers were high—1.63, 1.61, and 1.83.

This survey was conducted by Hugh Hudson, and the results were reviewed by W.P. Somers, Tate Dalrymple, H. Hulsing, and M.A. Benson (USGS). It is difficult to conceive of a more qualified set of flood specialists. The review by the latter three persons included a field inspection on March 30, 1953. Their summary review comments (April 15, 1953) conclude with,

> "It is felt that unless additional field data show otherwise that this figure is the best obtainable, and it is recommended that it be checked and used."

The May 16, 1977, memorandum from R.P. Thomas to the Bureau of Reclamation ends with,

> "Also, a 1963 flood-routing analysis, using records at a regular station on the Rio Grande about 3 miles downstream, indicated 44,600 ft^3/sec to be too high."

That analysis apparently is described in a September 30, 1963, memorandum from W.L. Heckler (USGS) to the Basic Records Section in Washington, D.C. Flow at the gaging station on the Rio Grande at Otowi increased from 2,000 to 7,000 ft^3/s and receded in 2.5 hours. That represented a storm runoff of about 1,000 acre-ft at Otowi. The memorandum notes that a flood duration of 0.5 hour at El Rancho Arroyo with a peak discharge of 44,600 ft^3/s would produce 900 acre-ft from that arroyo alone (assuming a triangular hydrograph), and other tributaries were known to have carried some flow. The 2003 review notes that this is a mass balance rather than a routing analysis; such an analysis would have to consider the effects of bank storage when a very sharp peak discharge occurs in a wide, normally dry channel. A true routing would reduce the 900 acre-ft contribution from El Rancho by the time it reaches Otowi. This would allow a contribution from other tributaries.

Possible sources of error: The possible sources of error are well documented in the earlier reviews. They include:

- A transverse change in elevation from right to left of 6.3 ft at section A, 4.2 ft at section B, and 2.8 ft at section C. Top widths are slightly greater than 300 ft at all three sections. Longitudinal fall is 5.35 ft in 275 ft (slope = 0.019 ft/ft).
- Several irregularities were noted in the water-surface profile on the right bank.
- Computations were based on the then recommended practice of probing cross sections to determine scour depths. Those probed depths were included in the cross-sectional properties. The probed depths increase the cross-sectional areas by about 15–20 percent.
- High velocities (about 25 ft/s) lead to velocity heads of about 10 ft and Froude numbers of about 1.5–1.6, which are high but not unprecedented.

As part of the 2003 review, the original computations were coded for the current slope-area computation (SAC) program. When the water surface is treated like it was in the 1952 computation, SAC produces a result of 44,500 ft^3/s, agreeing with the original computation. Rerunning the SAC excluding the probed depths gives a discharge of 34,800 ft^3/s. Froude numbers excluding the probed depths were still high (1.78, 1.46, and 1.53), and the reach expands from section A to section B. However, the difference between 0- and 100-percent energy recovery for the three-section result is only 4 percent (for example, the expansion losses are accounted for properly and do not reduce the reliability of the measurement).

In the 1950s, the probing of depths was recommended. Currently (2007), that practice is not recommended unless there is strong evidence to support the idea that the channel filled after the peak discharge. The opposite is true in this case. The notes and reviews acknowledge that vegetation was protruding from the bed—a strong indicator that the amount of new deposition was small. However, with the sand beds that are common in New Mexico, one can almost always get penetration with a probe, which increases the cross-sectional area. Given the high velocities, this added area increases the discharge by significant amounts.

Recommendations of what could have been done differently: Everything was done according to proper hydraulic methods of the time, including some of the most extensive reviews imaginable. However, given the evidence of rooted vegetation protruding from the bed, probing the bed was definitely a questionable practice. In addition, the nearly direct link between the superelevation, the channel alignment, and the high velocities should have been recognized.

Site visit and review: The site was visited on August 5, 2003, by John Costa (USGS Office of Surface Water), Scott Waltemeyer (USGS New Mexico Water Science Center), Mark Smith (USGS Central Region), and Kenneth Wahl (USGS retired).

The site looks remarkably similar to the photographs taken in 1952, including a sand/gravel bed with small tufts of vegetation protruding. In viewing the reach as a whole, the channel alignment is slightly curving to the left throughout, and the right bank is largely a bluff. This alignment, coupled with high velocities (in the range of 20 ft/s), could explain the superelevation on the right bank; a velocity of 20 ft/s produces a potential static head of 6.2 ft.

Recommendations: The original peak discharge of 44,600 ft^3/s should not be used and should be retained in the peak-flow data base. The rating should be no better than "poor."

The original peak discharge is overestimated because of the inclusion of probed depths in the flow cross section. The computation can be easily corrected by recomputing the measurement using the original parameters and using the actual surveyed cross sections. This will result in a revised discharge of 34,800 ft^3/s and a unit runoff of 5,200 $(ft^3/s)/mi^2$.

Questions undoubtedly will remain, and the result can be considered no better than poor for all the reasons used originally to withhold publication.

Figure A150. View looking downstream of cross section 1, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

Figure A151. View looking upstream toward cross section 1, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

Figure A152. Right bank in slope-area reach with flood-scoured sandstone, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

Figure A153. View downstream toward right bank, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

Figure A154. View to right bank at new cross-section 3, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

Figure A155. View toward left bank at new cross section 3, El Rancho Arroyo near Pojoaque, New Mexico, August 5, 2003.

This page intentionally left blank.