11477000 Eel River at Scotia, California

(Gaging station in the Eel River basin, USGS California Water Science Center)

Review of peak discharge for the flood of December 23, 1964

Location: Lat 40°29'30", long 124°05'55", in SW 1/4 sec.5, T.1 N., R.1 E., Humboldt County, Hydrologic Unit 18010105, near center of span in left pier of A.S. Murphy Memorial Bridge on State Highway 283, 0.5 mi north of Scotia, and 6 mi upstream from Van Duzen River.

Published peak discharge: The published peak discharge determined by rating-curve extension was 752,000 ft^3/s at a stage of 72.0 ft and should be rated poor.

Drainage area: 3,113 mi^2.

Data for storm causing flood: The 1964–65 flooding was documented by Waananen and others (1971). According to Waananen and others (1971, p. A1)

> "The flooding was caused by three principal storms during the period December 19 to January 31. The December 19-23 storm was the greatest in overall intensity and areal extent. Crests occurred on many major streams December 23, 1964, 9 years to the day after the great flood of December 23, 1955… All the storms, and particularly the warm torrential rain December 21-23, reflected the combined effect of moist unstable air masses, strong west-southwest winds, and mountain ranges oriented nearly at right angles to the flow of air."

A rating curve, historical photographs taken after the flood of December 23, 1964, and photographs taken during the 2003 review and described herein are provided in figures A191–A196.

Method of peak discharge determination: The peak discharge is based on a rating-curve extension. According to the current (2007) station description in NWIS,

> "Maximum Discharge, 752,000 ft^3/s, Dec. 23, 1964, gage height of 72.0 ft. from floodmarks, from rating curve extended above 220,000 ft^3/s on basis of maximum flow at upstream stations."

Possible sources of error: During a review of rating curves for this gaging station by the USGS Ukiah Field Office, some measurements made in the 1940s were "left off" the rating developed in 1955 for the 1955 peak discharge. The 1955 peak discharge was 541,000 ft^3/s at a stage of 61.90 ft. The Field Office suggests that including the 1940 measurements would change the 1955 rating and the 1964 extension. The Field Office analysis indicated that a change for the 1964 peak discharge from 752,000 to about 590,000 ft^3/s might be in order.

The reasons for questioning the peak have been summarized by the USGS California Water Science Center as:

1. Measurements 171 and 172 made in February 1940 at 208,000 ft^3/s (stage 44.30 ft) and 304,000 ft^3/s (stage 52.19 ft), respectively, were not used in later ratings. These are the highest and third highest measurements made at the site.

2. The 1955 (and 1964) rating curve was drawn with a slight bend to the right to accommodate the estimated discharges. The California Water Science Center determined there was no overflow at the Scotia gaging station for either of these floods, so the only other factor that would cause the bend to the right would be scour, which would be possible considering the bed composition. However, this would have required about 10 ft of scour. Although the issue has never been debated, there is a possibility that the Van Duzen River, which enters the Eel River about 7–8 mi downstream, caused backwater at the Scotia gaging station.

Recommendations of what could have been done differently: The reasoning behind the decision to not use the 1940 measurements in the 1955 and subsequent ratings should have been documented.

Crews were brought in from outside to aid California personnel in documenting the flooding. There is also ample evidence of using a systems approach to define the various peak discharges; that is, the peak discharges (and the associated daily mean discharges) were compared to other peak discharges in the basin to assure internal consistency of the resulting numbers. The extraordinary flooding also was thoroughly documented in Waananen and others (1971).

Site visit and review: Kenneth Wahl, who was the USGS California District Surface Water Specialist at the time, visited this and other area gaging stations during May 25–27, 1976, specifically to look at the 1964–65 flood levels. A telephone conference between the current review team and representatives of the USGS California Water Science Center took place July 11, 2003, and during the week of July 13, 2003, John Costa (USGS Office of Surface Water) visited the gaging station and reach.

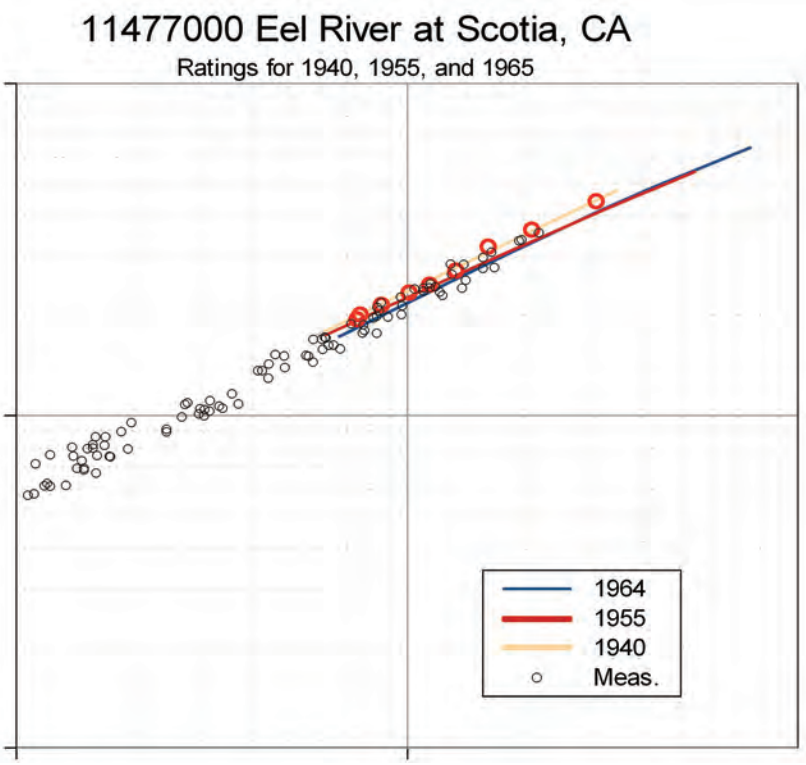

Figure A191. Rating curves for Eel River at Scotia, California in 1940, 1955, and 1964 with pre-1950 measurements indicated in red. Note that including the highest and third highest measurements from 1940 would pull the 1955 and 1964 ratings to the left.

A review of all high-water measurements shows that 1940 measurements 171 and 172 are indeed the highest and third highest measurements available. However, measurements made in 1953, 1956, and 1963 in the range of 193,000 to 217,000 ft^3/s show stages about 2 ft below those that would be expected from the 1940 measurements. Measurement 173 (161,000 ft^3/s) made in 1940 has a stage 1.25 ft higher than measurement 360 (164,000 ft^3/s) made in 1955. In fact, the 1940 measurements, for whatever reason, define the left-most measurements in the cloud of all high measurements. Stage versus width and stage versus velocity plots show that the 1940 measurements consistently define a slightly different relation than most of the other high measurements. However, nearly all the more recent high measurements were obtained with optical current meters, and these data were converted to mean velocity.

This suggests that the decision to not include those measurements in defining the 1955 rating was not an oversight but was based on comparisons of the data. Speculation by the review team is that the decision was made as part of the nationwide 1950 compilation review (U.S. Geological Survey Water-Supply Papers 1301-1319, published between 1954-61) in which all past ratings for an individual station were overlaid on a single plot.

Just downstream of the gaging station, the river did overflow the left bank, although that overflow was not extensive. A plot of measurement width versus stage shows a decided increase in width for stages above about 30 ft, and width for the highest measurements is about 800 ft. The elevation of the 1964 flood was about 107.5 ft above mean sea level (72.0 ft stage + 35.5 ft datum). Superimposing that elevation on the topographic map shows the flood width of about 1,800 ft at the bend downstream; the channel width at that point is about 1,000 ft. About 2 river miles downstream, the river exits the Scotia Bluffs; at this point, the right bank overflowed extensively (Waananen and others,1971, fig. 20, p. A66). The slope of the channel through this reach is about 5 ft in 10,000 ft (0.0005 ft/ft). With a depth of more than 60 ft and a slope of only about 2.6 ft/mi, overflow several miles away can have an effect on rating shape.

On July 10, 2003, Kenneth Wahl spoke to Rio Dell City Councilman Bud Leonard and Karen Hall, an employee of the Rio Dell City Hall. Both commented that the city lost property that was stored near the sewage treatment plant. Ms. Hall who lived just downstream and a little higher than the plant said her house was not affected. She did say, however, that houses downstream of the plant were flooded.

Recommendation: The original peak discharge of 752,000 ft^3/s should be accepted as published.

There is significant uncertainty in the 1964 peak discharge because (1) it is based on extending a rating curve that did not include the first and third largest measured floods in the gage history, and (2) most of the recent highest flows were measured with optical meters and converted to mean velocity. If this evaluation were done in 1955, the argument to base the rating extension for 1955 and 1965 on the highest measurement (made 1940) might be more compelling. However, in 2003, hydrologists have the benefit of all data collected since 1955. There are now 27 measurements of 100,000 ft^3/s or more. The 1940 measurements define the left envelope for a composite rating. Given all the data available, the band of reasonable extensions would range from about 600,000 to about 800,000 ft^3/s. The lower values would place more emphasis on the 1940s measurements; the higher values would place emphasis on the overflow.

Figure A192. View from right-bank flood plain to left bank following flood in 1964, Eel River at Scotia, California. Streamflow-gaging station located on this bridge.

Figure A193. View of downstream bridge from streamflow-gaging station, Eel River at Scotia, California, during flow of about 200,000 cubic feet per second on February 17, 2004.

Figure A194. View of downstream bridge from streamflow-gaging station during low-flow period, Eel River at Scotia, California, July 13, 2003.

Figure A195. View upstream from streamflow-gaging station during flow greater than 150,000 cubic feet per second, Eel River at Scotia, California, December 15, 2002.

Figure A196. View looking upstream from streamflow-gaging station during low-flow period, Eel River at Scotia, California, July 13, 2003.