

# The Great New Year's Flood of 1997 in Northern California

by

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The New Year's flood of 1997 was probably the largest in the 90-year Northern California record which begins in 1906. It was notable in the intensity, volume of flood water, and the areal extent from the Oregon border down to the southern end of the Sierra. Many new flood records were set.

This was a classic orographic event with warm moist winds from the southwest blowing over the Sierra Nevada and dumping amazing amounts of rain at the middle and high elevations, especially over a 3 day period centered on New Year's Day. The sheer volume of runoff exceeded the flood control capacity of Don Pedro Dam on the Tuolumne River and Millerton Reservoir on the upper San Joaquin River with large spills of excess water. Most of the other large dams in northern California were full or nearly full at the end of the storms.

Amounts of rain at lower elevations were not unusual. For example, downtown Sacramento in the middle of the Central Valley had 3.7 inches during the week from December 26 through January 2. But Blue Canyon, at the one-mile elevation between Sacramento and Reno, had over 30 inches, an orographic ratio of over 8, far more than the usual 3 to 4 for most storms. Many Valley folks could not understand that there was a problem because they were not seeing a lot of rain. Meanwhile, the entire northern Sierra was observing 20 inches, some 40 percent of average annual precipitation.

Floods were produced on the Coast Range as well, but not to record levels. The Russian, Napa, and Pajaro Rivers did not rise as high as the severe floods of 1995. Further north, the Eel, Klamath and Smith Rivers rose higher than 1995, but did not set records.

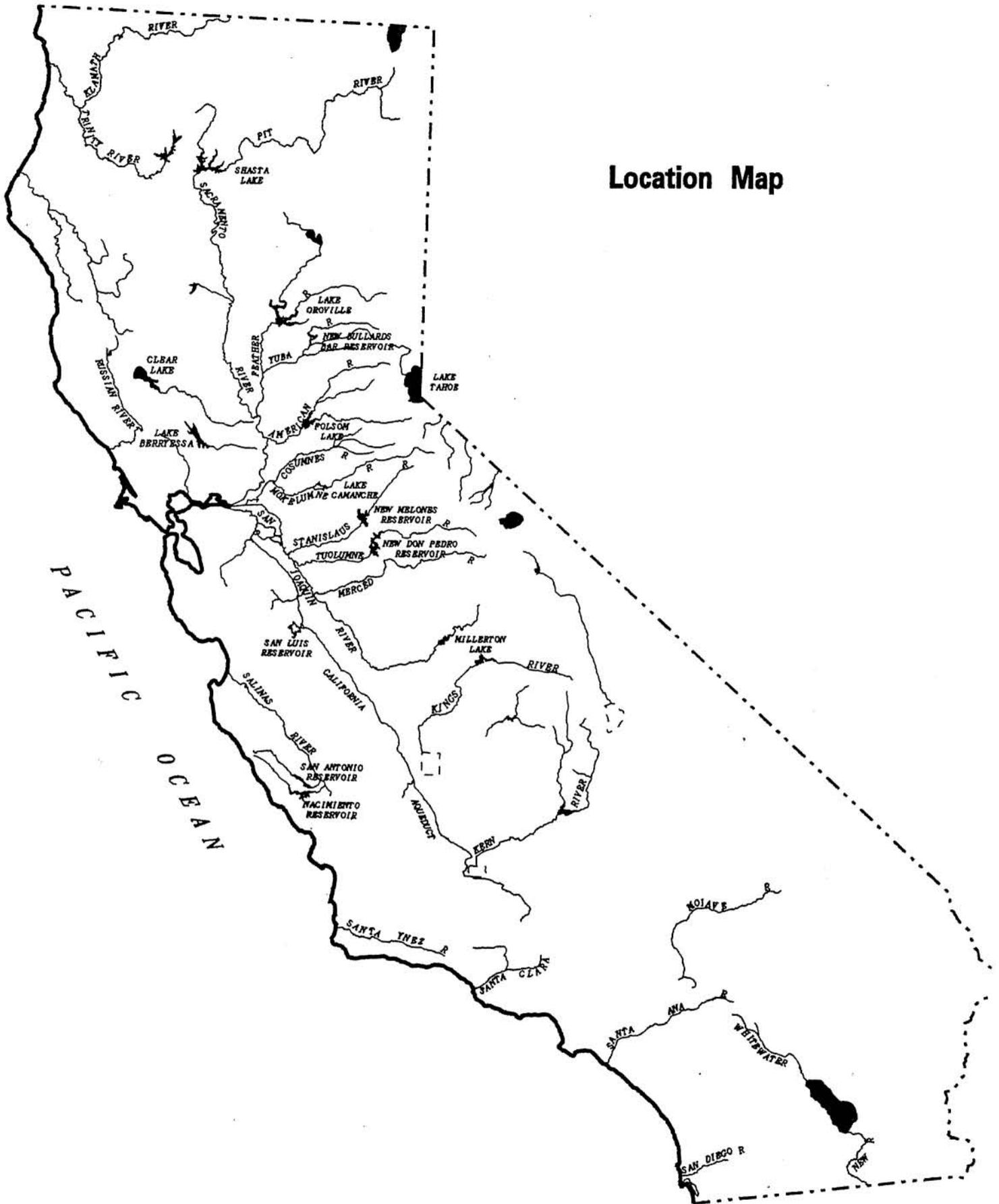
Antecedent conditions were conducive to high runoff. Heavy storms during the first half of December had saturated the ground.

The big storm was preceded by a very cold snowstorm which produced heavy snows to low elevations a few days before Christmas. The lower elevation snow melted during the New Year's storm (for example, at the mile high Blue Canyon station where

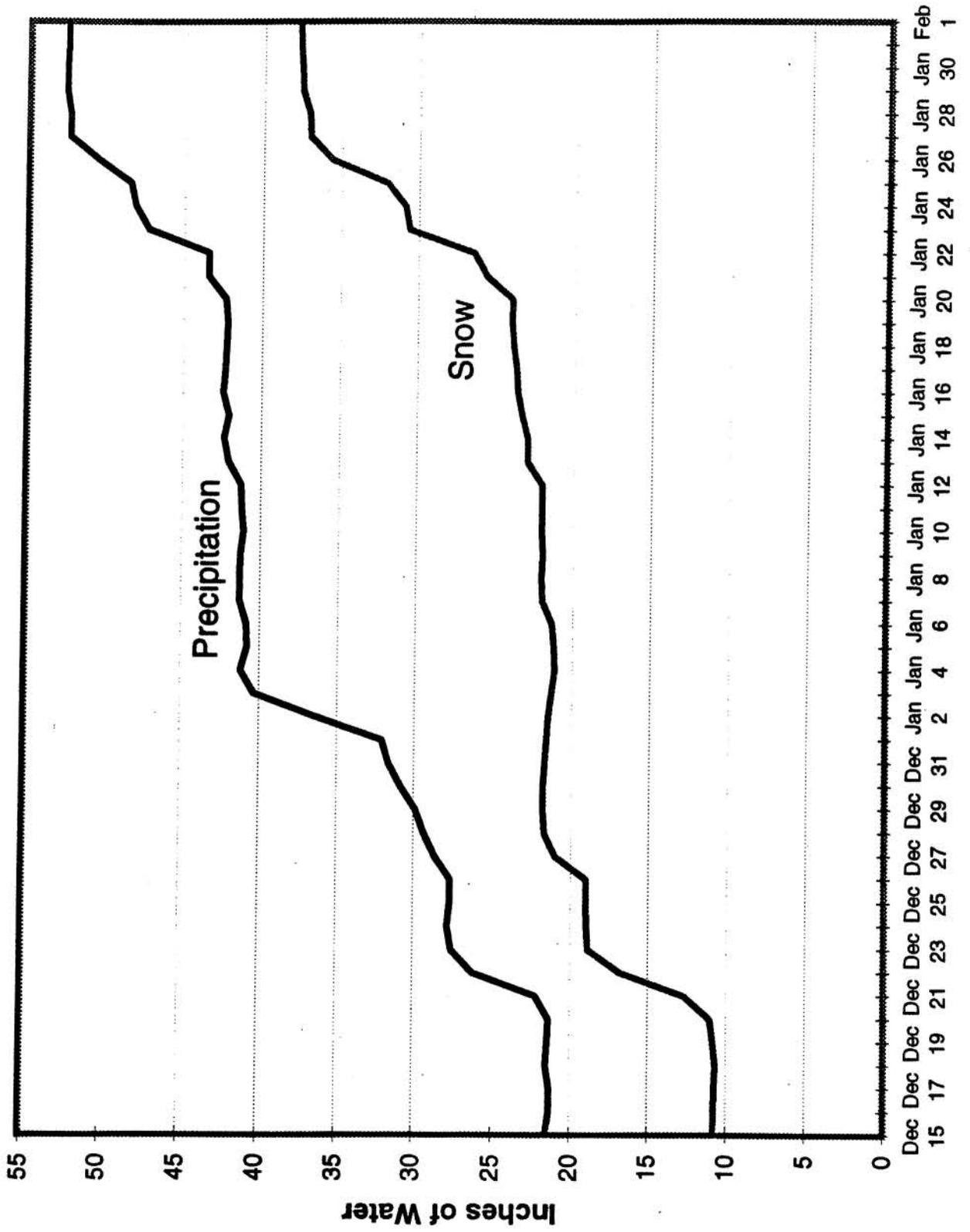
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# Location Map



# Alpha American River Basin



over 30 inches of rain melted the 5 inches of water content in the snowpack there) but the middle and high elevation snowpack remained with the rain percolating through the pack. Not much loss was observed on the snow sensors over 6,000 feet in elevation in the northern Sierra, in spite of rain levels up to 9,000 feet at times. The second figure shows accumulated precipitation on snow water content at the Alpha snow sensor at 7600 feet near Echo Summit of Highway 50.

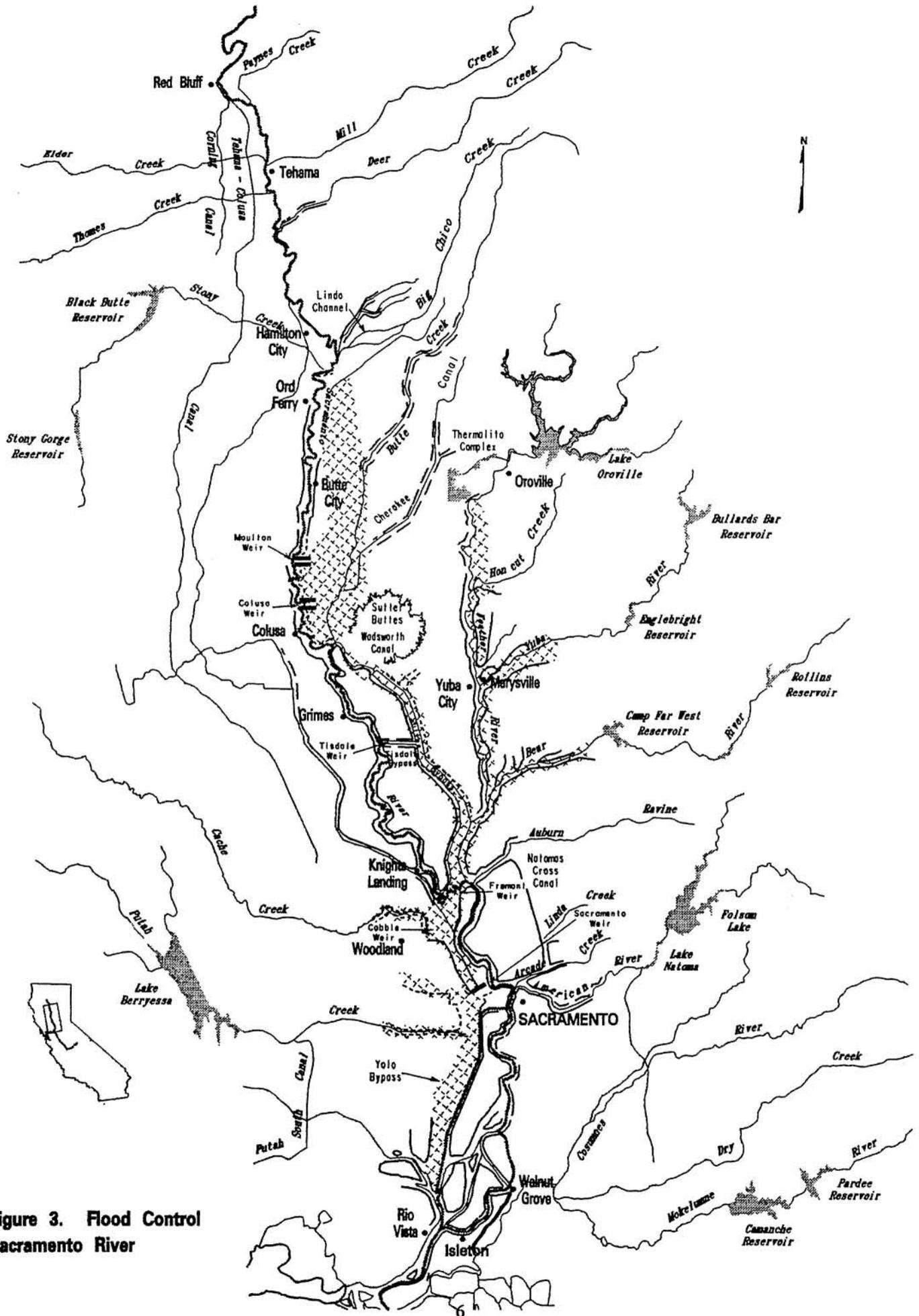
This contrasts with the popular impression that the melting snow caused the floods. Snowmelt, mostly from lower elevations added to the runoff, perhaps 15 percent. But the bulk of runoff was simply too much rain.

The total amount of precipitation at Blue Canyon for the two month December through January period was a record 75 inches, about 43 inches during December and 32 inches in January. The annual total at this station averages about 63 inches. The December amount was second wettest, after that of 1955, also a flood year.

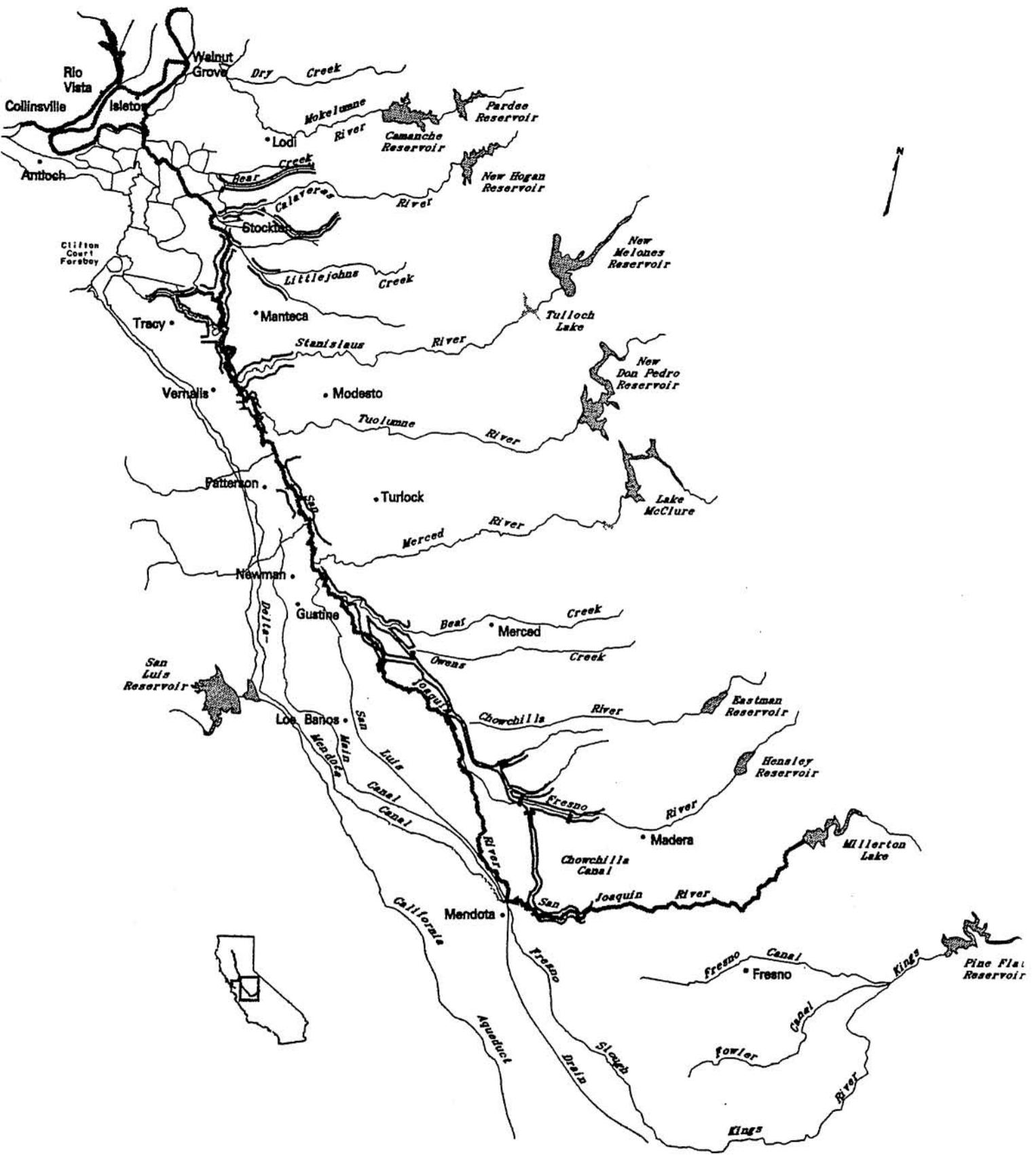
The overall Sacramento River region flood control system performed well, greatly reducing the peak flows on the Sacramento River system. Even so, total flow at the latitude of Sacramento in the river and in Yolo bypass was estimated at 600,000 cfs which is nearly half that of the combined Missouri and Mississippi River flow of 1.3 million cfs at St. Louis in the great flood of 1993. There were two serious levee breaks in the Sacramento Valley, one on the Feather River south of Marysville, the other on Sutter Bypass west of Yuba City. (See map of Flood Control Project). Major flooding occurred along the uncontrolled Cosumnes River southeast of Sacramento and on the Tuolumne River near Modesto and the San Joaquin River near Fresno. The volume of flood waters overwhelmed dikes along the lower San Joaquin River from near the mouth of the Tuolumne River to the Delta near Manteca with massive flooding.

Rainfall was relatively light after January 3, allowing the flood control system to drain and restoring reservoir flood control space. After the 20th of January, another siege of heavy rain occurred. This was not as heavy as the year-end storms (about 2/3 as much and perhaps half as much at Shasta Dam) and, although warmer than normal, had snow levels about 2000 feet lower which helped hold more water on the mountains as snow. But even so, runoffs were large with higher peaks on a few streams.

Sacramento River region reservoir flood control storage had been pretty well restored before the second storm and it was handled quite easily, even restraining normal flood releases to avoid overtopping the partly completed levee break repairs on Sutter Bypass and along the Feather River south of Marysville. This time low elevation stations also caught heavy rain with some local creek flooding.



**Figure 3. Flood Control Sacramento River**



**Figure 4. Flood Control  
San Joaquin River and Tributaries**

In the San Joaquin River region there had not been enough time to restore full flood control space. The channel capacity of the rivers is much more constricted than in the Sacramento Valley, limiting downstream releases. Amounts were quite heavy with over 11 inches estimated in the Stanislaus and San Joaquin (above Friant) basins during a 7-day period. At one point, on January 24, in view of the weather forecasts, it appeared that a number of the foothill reservoirs would fill and spill and OES and others were alerted. Happily, the next two days of rain were less than forecast and releases were controlled to channel capacity downstream. The subsequent peak at Newman gage on the San Joaquin River was 61.1 feet, exceeding the old record by 0.2 foot. Peak flow there was probably around 30,000 cfs. The sustained high flow continued to put strain on the levees but no other significant breaks occurred. Daily conference calls were held during the flood period with all operators in the region, hosted by our Division of Flood Management.

### Oroville

Oroville Reservoir is a 3.5 MAF SWP reservoir on the Feather River of Northern California. It has 750 TAF of flood space, designed to control the standard project flood, a roughly 1/200 event. The SPF has a peak flow of 440,000 cfs and a 72 hour volume of 1.52 MAF. This flood would be controlled to a release of 170,000 cfs -- within channel design capacity downstream.

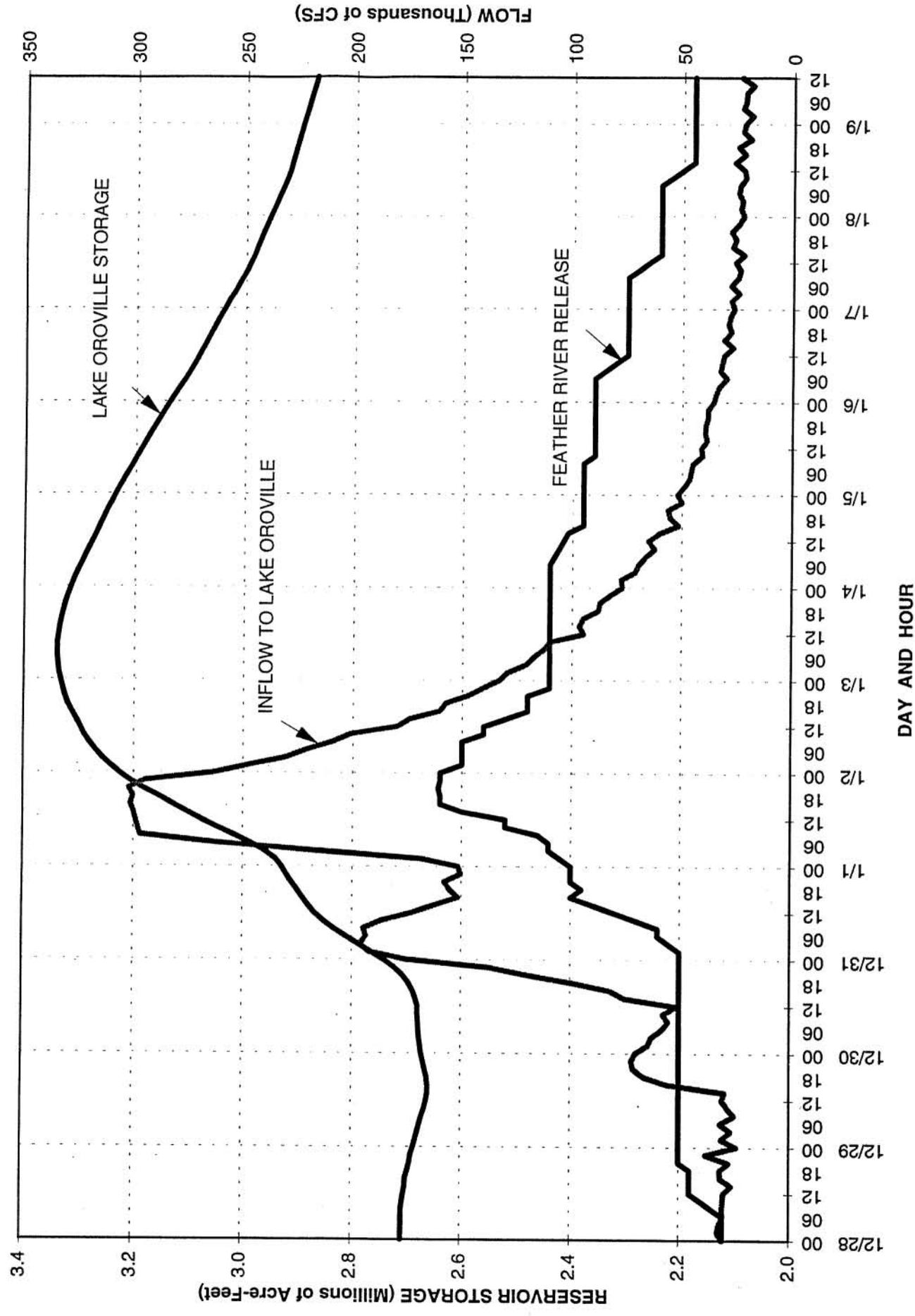
Initial estimates of the peak inflow at Oroville were just over 300,000 cfs, reduced perhaps 30,000 cfs from unimpaired runoff by upstream storage. The estimated 3 day unimpaired volume seems to have been about 1.4 MAF, about 92 percent of SPF. The peak is strange; looking almost truncated for about 12 hours (see chart).

In volume, this flood exceeded the previous record of the 1986 flood by quite a margin, perhaps 25 percent. At one point on January 1, we thought the inflow would be so much that the Lake would fill and spill - perhaps 250,000 cfs worth. People were evacuated from the City of Oroville downstream. Happily the rain eased a little sooner than expected and the dam contained the runoff.

### Comparison with Other Floods

I'd like to spend a little time comparing this flood to other floods this century, using 3 Sacramento basin rivers. First, let's look at the one day estimated peak annual flows of the American River near Sacramento. Flood control on this stream has been the subject of controversy after the 1986 flood. Auburn dam has been proposed to provide badly needed flood protection for the downstream urban area, but the proposal has been bogged down in environmental and cost controversy.

# LAKE OROVILLE OPERATIONS, December and January



The existing major flood control dam, Folsom dam, was designed just prior to 1950 and built in 1955, presumably to contain the standard project flood, with the record on hand. But look what has happened since. (See chart). It seems there is a trend for bigger and bigger floods. Now, the original design probably doesn't provide over a 1 in 70 year protection. Because of high levees the consequences of a failure would be disastrous.

Where there are large flood control reservoirs, a better measure of comparison is the 3-day volume - which more nearly corresponds to the need for flood space. The 3-day chart on the American River shows 1997 as essentially the same as 1986. Comparatively on the American River, the 1997 flood was a somewhat smaller flood than in river basins north and south of the American.

The Feather River Chart shows the comparison for Oroville Dam. As noted before, this one was perhaps 25 percent bigger than 1986, which itself was the biggest to that time, although not too much more than a 1907 flood. Also, you can see that the increasing trend with time is not as obvious as on the American River, unless one looks at the last 1997 event.

The 3rd chart is for the upper Sacramento River at Shasta Dam. Again, 1997 really stands out.

The Tuolumne River is a stream which has 100 years of measured record, one of the longest in California. The 1997 flood event on the fourth 3-day bar chart was by far the biggest in the record. The only other near comparison was the December 1955 flood.

The last chart shows 3-day flood flows on the 3 Sacramento basin rivers in one chart expressed as a ratio of the median flood. The historical medians are 44,300 cfs for the Sacramento River at Shasta Dam, 35,300 cfs for the Feather River at Oroville, and 22,400 cfs for the American River at Folsom. I've shown the 11 largest floods this century. Notice that the range (the ratio) becomes larger as one goes south to the American River. Also, the apparent increasing size trend is more dominant in the American River. Why? I'm not sure. Is it possible there's some influence from upwind urban areas?

### Flood Frequencies

The recent flood again set a lot of new records on major Sierra rivers. When these are plugged into a frequency determination, the amounts at a given frequency or the risk at given design levels will go up. We'll introduce a new round of charts and probably a bunch of determinations that the existing 100-year levels are not that anymore, but less, and a new round of project work will be needed to provide revised

100-year flood protection, some in areas which have just done a lot of work. This is one of the problems with working on statistics based on relatively short record. Maybe for major projects we should go back to the old standard project flood idea or justify to some level of historical storm. People are being misled by all these numbers and risks, not realizing how tentative they are and the rather large uncertainty involved.

### Conclusion

I'm sure there's a lot of other questions. But the great flood of 1997 is going to keep a lot of us busy for a while, evaluating its impact on how we provide flood protection for people and property and what the appropriate level of risk is. Looking back, it seems that we have often thought too small. Are we overreacting to an unusual event, or are things changing to the point when the past is not a reliable guide to the future?

The final report of the Governor's Flood Emergency Action Team (FEAT), published in May, has over 50 long term action recommendations which are now the basis for the State's flood policy. Hopefully, as these are implemented, they will help protect California from future flood disasters.