OPERATIONAL FORECASTING OF THE DAY-TO-DAY RUNOFF IN THE FEATHER RIVER BASIN [1]

By

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During the construction of the 735-foot earthfill dam at Oroville on the Feather River and the subsequent operation of this multipurpose reservoir on completion of the dam, it is and will be necessary to forecast the day-to-day inflow during the snowmelt season. While forecasts of the April-July volume of runoff have been regularly made on this stream, no method of day-to-day forecasting of the mean flows has been devised. This study is an attempt to utilize the knowledge acquired in snow research in the last 10 years to develop a forecasting procedure. A weakness in the method is that the authors have not, as yet, worked on the problem of making temperature forecasts for periods of 5 to 30 days in advance.

Our first attempt to forecast snowmelt on a day-to-day basis was to select for a pilot study a small basin that would be representative of the Feather River Basin. The Butt Creek Basin, shown in Figure 1, lying west of Lake Almanor, was chosen for in the first phase of the study. This basin has a drainage area of 69 square miles with elevations ranging from 4,400 feet to 7,800 feet. An existing snow course, Humbug Summit, is located in the basin at the 5,000-foot level. Temperatures and snowfall data were available at the P.G.&E. Canyon Dam (Lake Almanor) station.

The retreat of the snow line during the months of April to July was determined from data obtained at snow courses and precipitation stations reporting daily "snow on ground" observations. For several snowmelt seasons, the snowmelt was determined from actual temperature data using a simple temperature versus melt relationship of the type developed by the Corps of Engineers' Snow Investigation Program. The formula relating this melt was

$$M = .04\ (T-37)$$

where M = the daily snowmelt in inches

T = the mean daily temperature at Canyon Dam (Elevation 4,550 feet)

The melt was computed for each 500-foot elevation band by elevation adjustment of the temperature with a lapse rate of 1.75°F per 500 feet. A one-day unit hydrograph [3] was developed and efforts were then made to reproduce the observed mean-daily stream flow hydrographs. Figure 2 shows the actual and reconstituted hydrograph for the snowmelt season for April through May 1952. Losses, due to evapotranspiration and infiltration, were determined to be on the order of 0.25 inch/day in the period April 1-20 and 0.50 inch/day after April 20. The daily losses were subtracted from the calculated daily melt values to yield the melt water available for runoff. Due to the limited number of seasons available for study with moderate or heavy snowpack and with adequate temperature data, and to the unsatisfactory reconstitution of two of the snowmelt seasons, attention was then diverted to a larger area of the Feather River Basin.

The Feather River Basin is located in the Northern Sierra Nevada and consists of 3,611 square miles above Oroville. Elevations range from 500 to 8,300 feet. Location of snow courses are shown in Figure 1. The average elevation of the snow line for the basin on April 1st is 5,500 feet, which accounts for approximately 40 percent of the area

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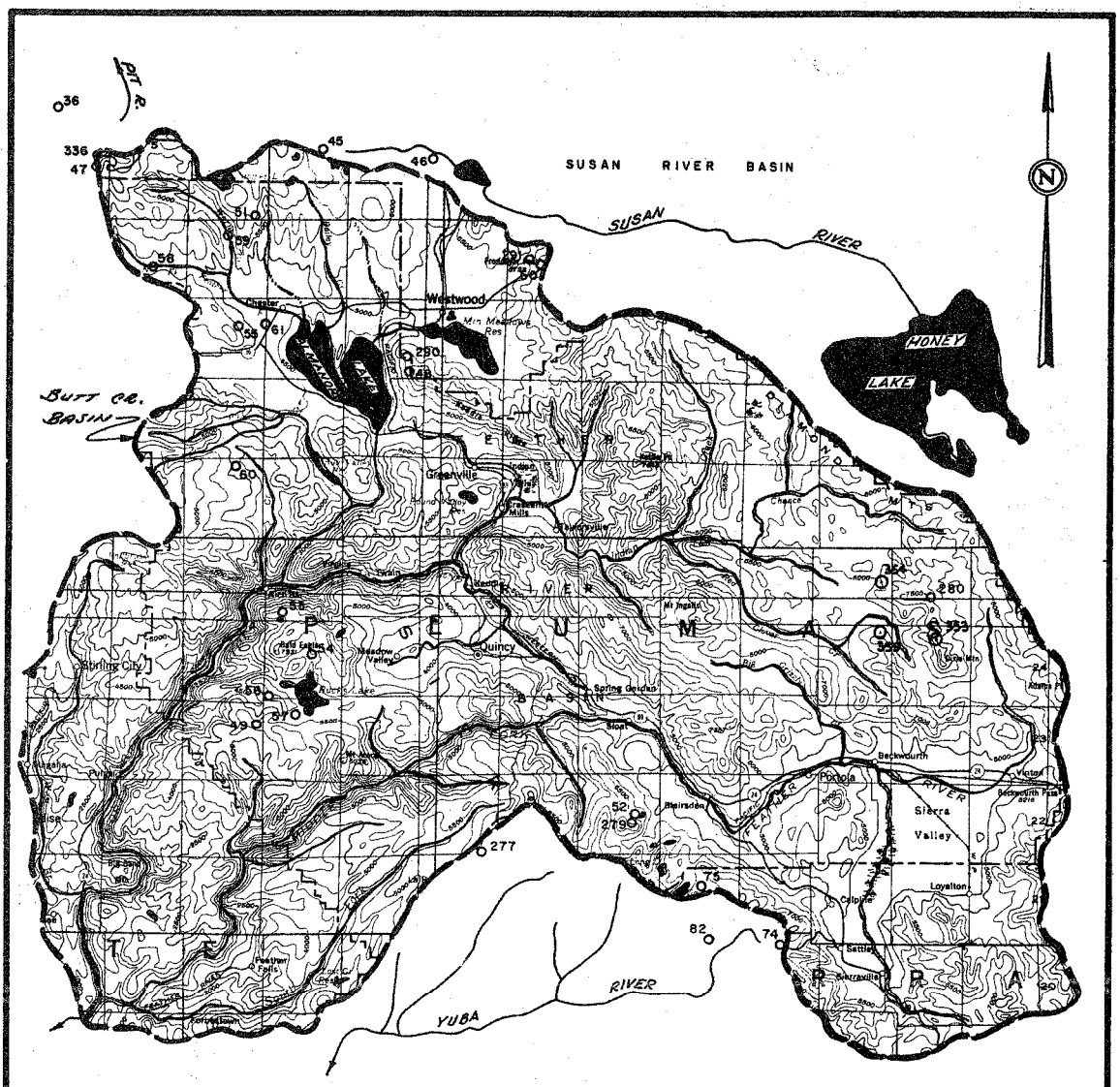
1/ Presented at the Western Snow Conference, Yosemite Park, California, April 16-20,1963.
2/ California State Department of Water Resources.
3/ Summary Report of the Snow Investigations, "Snow Hydrology," Corps of Engineers, June 1956.



BASIN	SNOW COURSE	CALIFORNIA NUMBERS	ELEVATION IN FEET
FEATHER RIVER	Lower Lassen Peak	47	8200
	Mount Dyer No. 1	48	7400
	Letterbox	49	5600
	Fredonyer Pass No. 1	50	5600
	Harkness Flat	51	6400
	Eureka Lake	52	6200
	Three Lakes	53	6100
	Mill Creek Flat	54	5800
	Mount Stover	55	5600
	Browns Camp	56	5400
	Haskins Flat	57	5200
	Feather River Meadows	58	5500
	Warner Creek	59	5000
	Humbug Summit	60	5000
	Chester Flat	61	4600
	Church Meadows	75	6700
	Eureka Bowl	279	6800
	Rowland Creek	280	6850
	Mount Dyer No. 2	290	6200
	Fredonyer Pass No. 2	291	5200
	Upper Lassen Peak	336	8400
ADJACENT BASINS			
PIT RIVER	Manzanita Lake	36	5900
SUSAN RIVER	Lake Nokopen	45	6450
	Norvell Flat	46	5700
YUBA RIVER	Yuba Pass	74	6700
	Sardine Flat	82	5700
	Gibsonville	277	5400

LEGEND

- ○ EXISTING SNOW COURSE
- ● ABANDONED SNOW COURSE
- RIVER BASIN

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF OPERATIONS
CALIFORNIA COOPERATIVE SNOW SURVEYS

SNOW COURSE LOCATIONS

FEATHER RIVER BASIN #520
INCLUDING SNOW COURSES LOCATED IN
SUSAN RIVER BASIN #620

1959

SCALE OF MILES
0 5 10 15

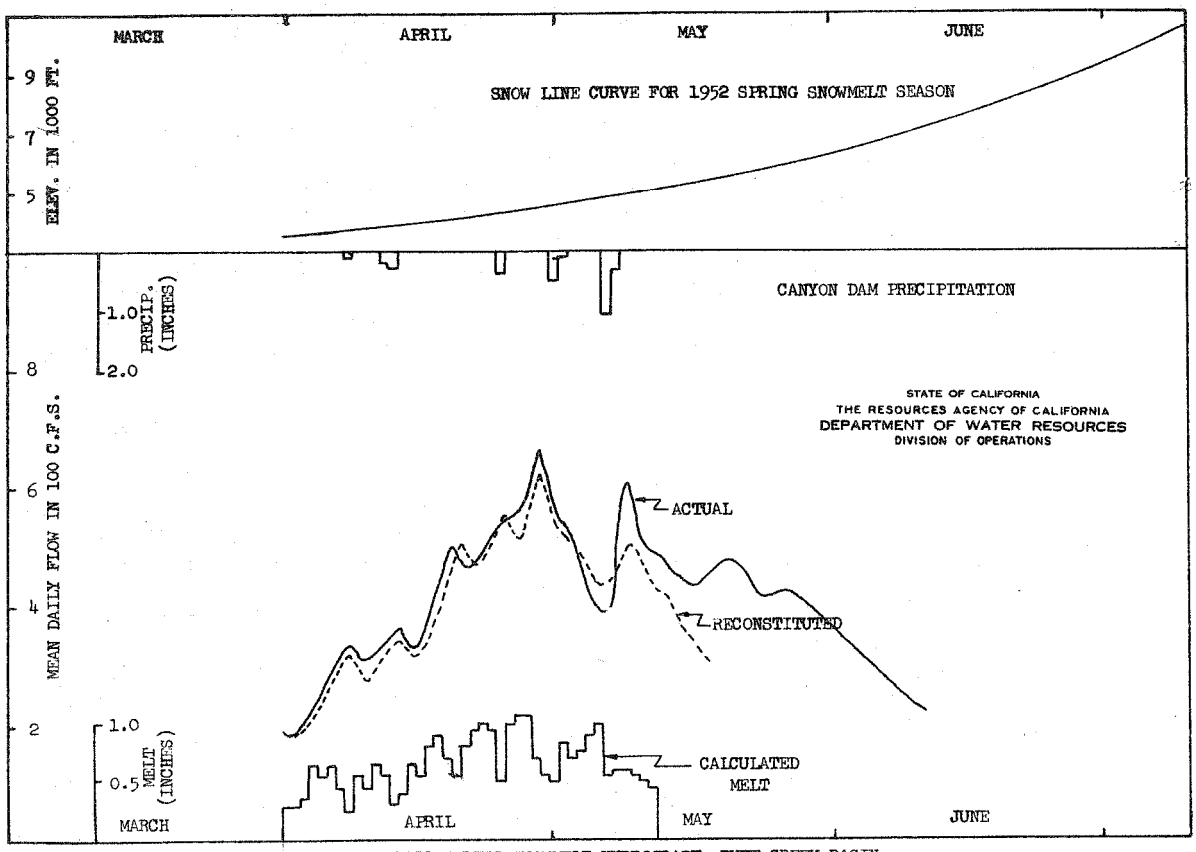


Figure 2 RECONSTITUTION OF THE 1952 SPRING SNOWMELT HYDROGRAPH--BUTT CREEK BASIN

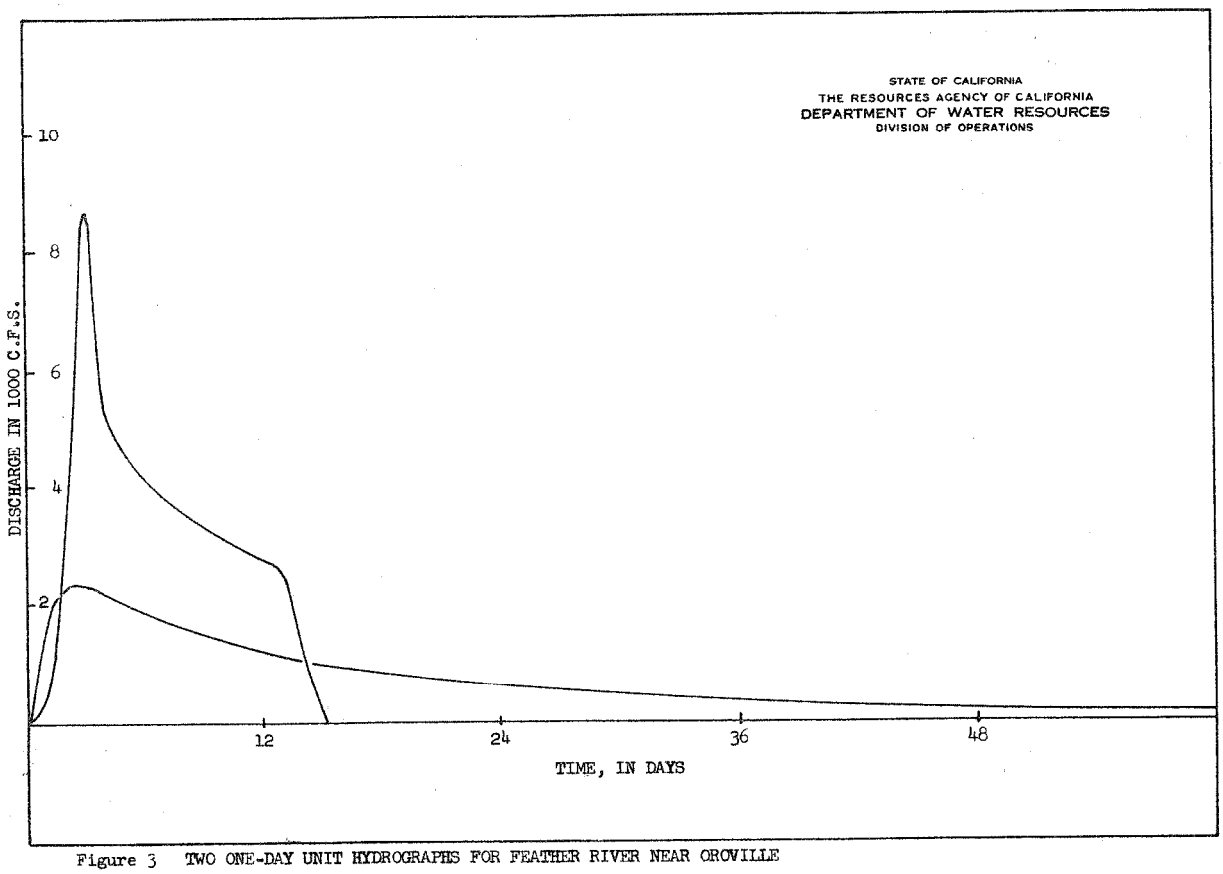


Figure 3 TWO ONE-DAY UNIT HYDROGRAPHS FOR FEATHER RIVER NEAR OROVILLE

of the total basin area, but in years of heavy snowpack the snow line may be as low as 3,500 feet (85 percent of the area).

For melt computations the temperature was determined by averaging data for seven index stations ranging in elevation from 2,710 to 5,850 feet. Elevation adjustment of the temperature again was made by the use of the lapse rate of 3.5°F per 1,000 feet. The same melt formula used in the Butt Creek Basin was utilized for the entire Feather River Basin, but the elevation breakdown was by 1,000-foot elevation bands.

A snowmelt unit hydrograph developed for the entire Feather River Basin is shown on Figure 3. This unit graph method follows the technique used by C. E. Hildebrand 4/ in the Corps of Engineers' Snow Investigation Program and involves the use of two unit hydrographs, one for the slow-moving ground water and the other for the faster surface runoff.

Losses due to evapotranspiration and infiltration were found to average 0.48 inch/day.

Reconstitution of the snowmelt hydrograph for the Feather River at Oroville was made for the snowmelt seasons of 1952 and 1958. The 1952 hydrograph is shown on Figure 4, and the 1958 hydrograph on Figure 5. The reconstitutions were considered to be satisfactory.

The success of this method is dependent on accurate temperature forecasts for periods of 5 to 30 days in advance. This meteorologic aspect of the problem has not yet been solved and we intend to pursue this phase of the study in the near future. Aerial reconnaissance of the basin periodically during the snowmelt season will provide useful data on the retreat of the snow line during the melt season.

Also, the authors would like, as further phases of this study, to apply this method to seasons of low or moderate snowpack. We anticipate that the unit hydrographs will have to be modified to account for the higher snow line in these years of lesser snowpack.

The method for years of low to moderate snowpack will also be useful for the operation of Oroville Reservoir.

4/ Technical Bulletin No. 14, Corps of Engineers, "A Unit-Hydrograph Method of Hydrograph Synthesis for Snow-Covered Areas," by C. E. Hildebrand, September 1952.

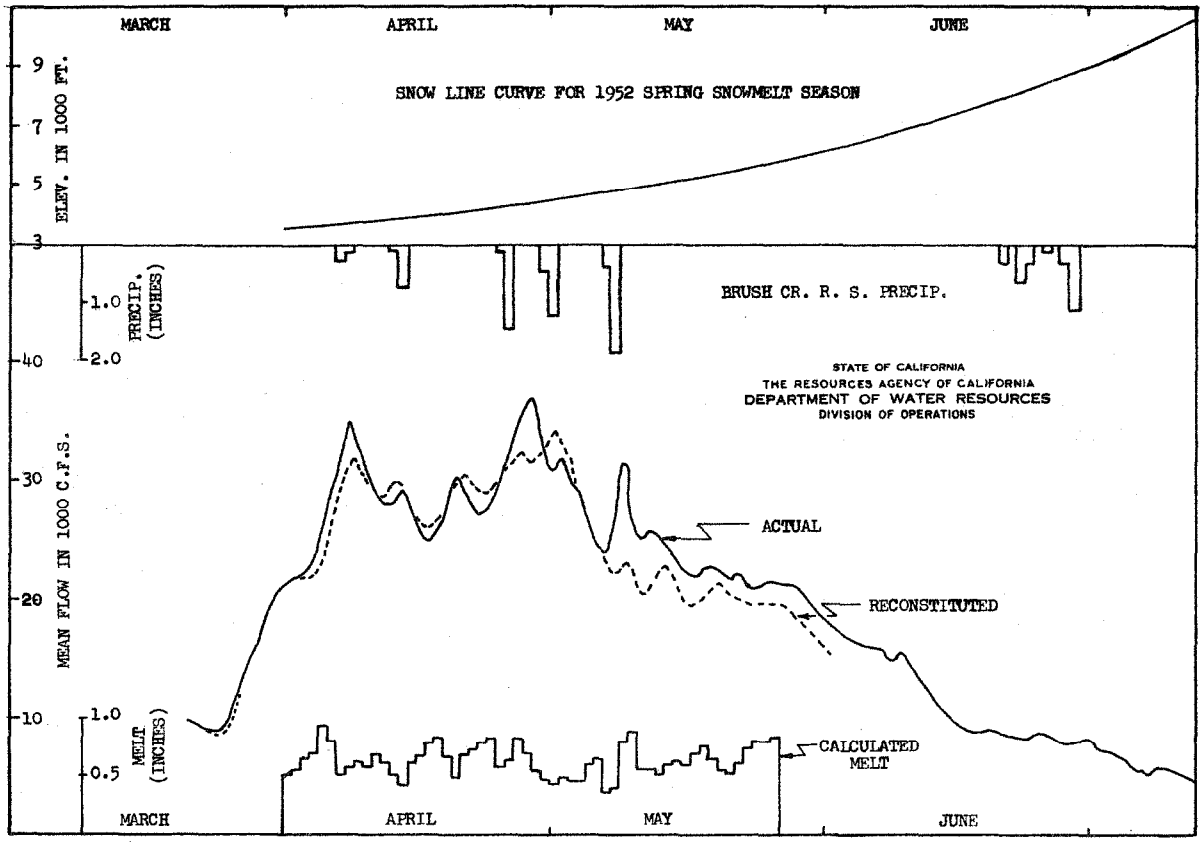


Figure 4 RECONSTITUTION OF THE 1952 SPRING SNOWMELT HYDROGRAPH--FEATHER RIVER NR. OROVILLE

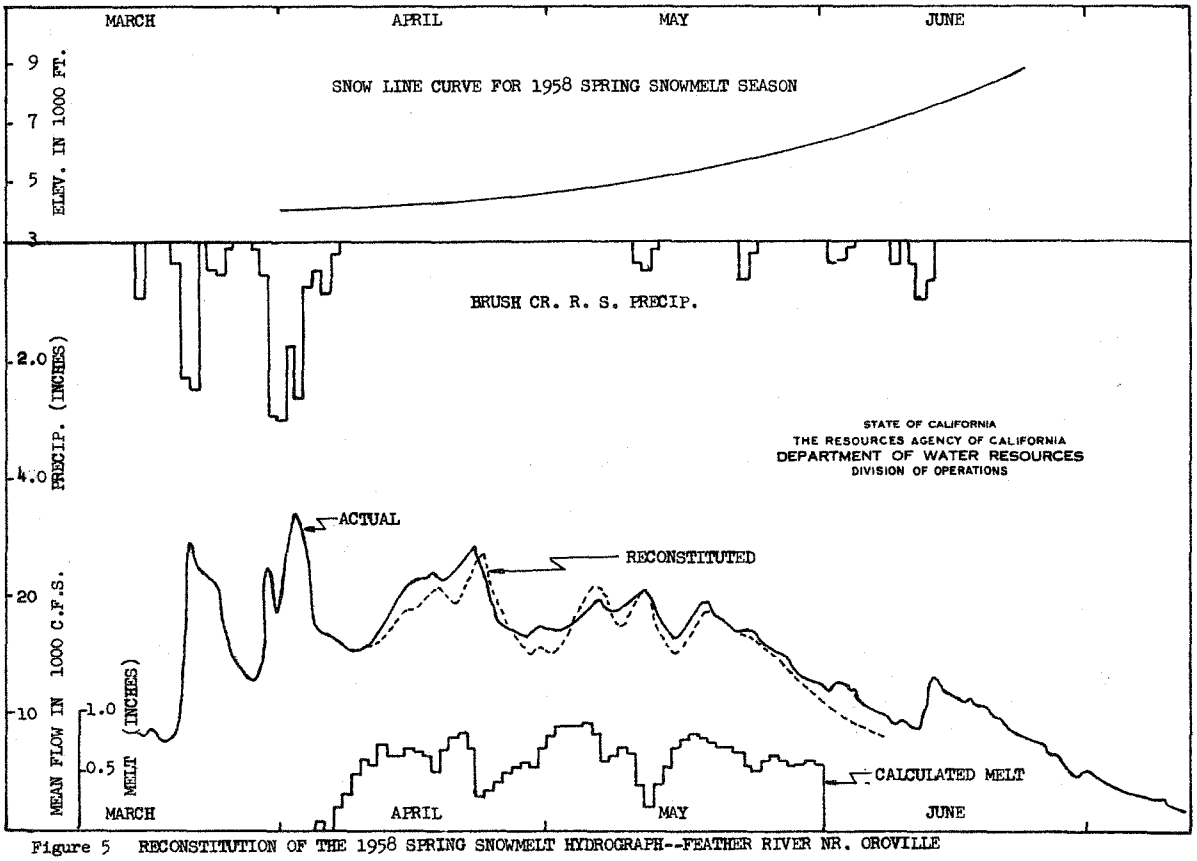


Figure 5 RECONSTITUTION OF THE 1958 SPRING SNOWMELT HYDROGRAPH--FEATHER RIVER NR. OROVILLE