THE DESCHUTES RIVER HYDROGRAPH FORECAST[1/]

By

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In 1962 the irrigation districts located near Bend, Oregon, and the watermaster for the area contacted the Soil Conservation Service about forecasting the natural Deschutes River stages at Bend, Oregon, during the irrigation season. They needed to know what the flow of the river would be, over and above that which was released from the reservoirs located higher up on the watershed. Their management practices were dependent on how much natural flow there would be, when it would peak, and when it would drop to certain levels.

The problems in constructing the forecast were varied and intriguing. The Deschutes River Basin is located in central and northcentral Oregon on the east flank of the Cascade Mountains (Plate I). The flow of the river is primarily dependent on the flow of springs and the mountain snowpack. The river is regulated by three primary reservoirs, and there are losses in the river of 15-20 percent from the outlets down to the diversions near Bend. During the summer most of the water, except a small amount for fish, is used for irrigating land along the Middle Deschutes from Bend to Madras.

Table I indicates the six irrigation districts involved, their potential reservoir storage, amount and priority of the natural river flow, and the irrigable acres for each district. Plate II is a more detailed map showing the districts and the snow courses, springs, streams, and irrigation reservoirs located on the upper section of the watershed. With the procedures developed by Frost[3/], Barton[4/], and Pearson and Peck[5/] in mind, a scheme was developed to forecast the various critical levels of the natural flow of the Deschutes River at Bend and the dates that these levels would occur during the irrigation season.

TABLE I

District	Potential Storage	Diversion Water Right: Date	Diversion Water Right: Acre Feet	Irrigable Acres
RIVER RIGHT			16,344	
Swalley	None	1899	38,451	4,607
Central Oregon	29,000 a.f. Crane Prairie	1900 1907	402,376	45,016
Lone Pine	10,500 a.f. Crane Prairie	1900	14,274	2,369
Arnold	10,500 a.f. Crane Prairie	1905	47,746	4,292
Tumalo	86,900 a.f. Crescent Lake	1905	4,246	7,282
North Unit	200,000 a.f. Wickiup	Balance of Natural Flow		50,000

The total volume of water at Bend is equal to the flow of the Little Deschutes at La Pine, the inflow to Crane Prairie Reservoir and the flow of five large springs (Sheep

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Springs, Browns Creek, Davis Creek, Fall River and Spring River) located at various points along the river. A correlation was obtained between water content of the snowpack and rainfall versus April-July volumes (1,000's acre-feet) of the Little Deschutes, Plate III. The volume was graphically correlated to peak flow, Plate IV. The peak of this stream was then correlated to various low flow levels and their associated dates during the April-October period. (See Plate V.) Correlations for the Crane Prairie inflow was done in the same manner.

The original analysis of the data from the springs indicated that the flows were very stable. Accordingly, the March 15 flow in c.f.s. was used as the forecasted flow amount for each of the ensuing months through October. In 1966 changes were noted in two of the springs showing an increase in one and a decrease in the other during the summer months. The forecast procedure for these springs was revised to take this into consideration.

The forecasted "hydrographs" of the Little Deschutes, Crane Prairie Inflow, and the flow of the springs are plotted on graph paper along with the water rights of the various districts. These hydrographs are algebraically added to obtain the final hydrograph at Bend, Plate VI. Where the forecasted hydrograph falls below a specific water right the date the delivery of the right will stop is indicated.

This procedure has been used each year since 1963. Typical observed versus forecasted hydrographs for 1967 and 1968 are shown on Plate VI and VII.

The forecast information is presented by the Soil Conservation Service at water forecast meetings held annually in the Bend area. The watermaster and the irrigation district manager use this information in managing the river and their irrigation water.

A new procedure for the volume forecast has been developed using the multiple regression method suggested by Schermerhorn and Barton[6/]. In this method the fall, winter, and spring precipitation variables were held constant while testing different snow variables. After determining the best snow variable, it was held constant with the fall and winter precipitation indexes while the spring index was tested. This provided a sound basis for testing significance because all runoff elements were included in each variable analysis. The new forecast for the Little Deschutes volume is illustrated by Plate VIII. Instead of using the volume to forecast the peak and the peak to forecast the low flow dates, equations are being developed using the "locking in" method to forecast these runoff variables directly from snow water content and precipitation (Plate IX).

Maximum water content and snowmelt rates as provided by snow pillows will undoubtedly improve the accuracy of forecasting the day of the peak flow and the recession curve. This type of data will be incorporated into the procedure when enough becomes available and when the water user decides he wants a frequently up-dated forecast as the irrigation season progresses.

Conclusion

This procedure has been used successfully to find critical levels and the dates of these levels on the Deschutes River, and it has been demonstrated that these are forecasted with reasonable accuracy.

Bibliography

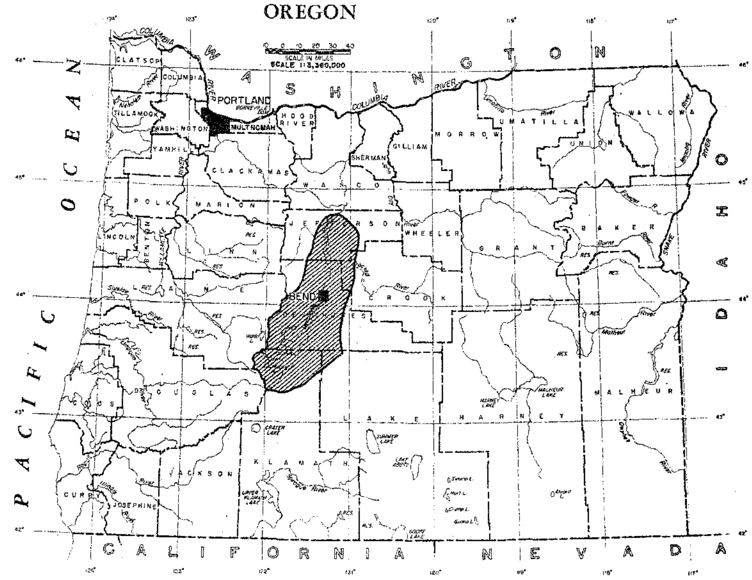
3/ Frost, W. T. - Low Flow Forecasts on The Rogue River. Proceedings Western Snow Conference, 1961, 72-81.

4/ Barton, M. - Forecasting The Date Of Low Flow (200 cfs) on East Carson River, Nevada. Proceedings Western Snow Conference, 1961, 83-88.

5/ Pearson, G. and Peck, E. - Critical Flow Forecasting For Irrigation Requirements In The Sevier River Basin, Utah. Proceedings Western Snow Conference, 1961, 92-100.

6/ Schermerhorn, V. and Barton, M. - A Method For Integrating Snow Survey and Precipitation Data, Proceedings Western Snow Conference, 1968, 27-32.

PLATE I
OREGON



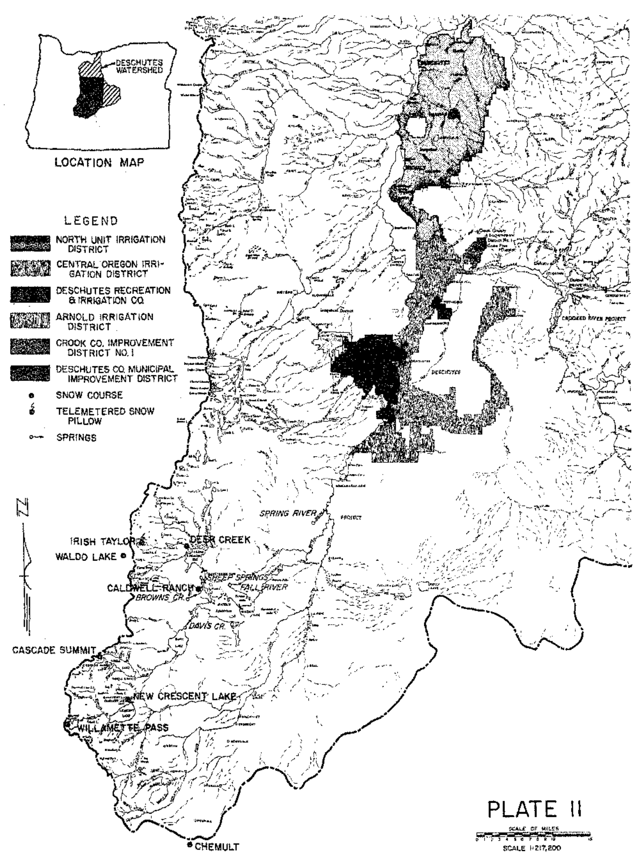


PLATE II

SCALE OF MILES
SCALE 1:217,800

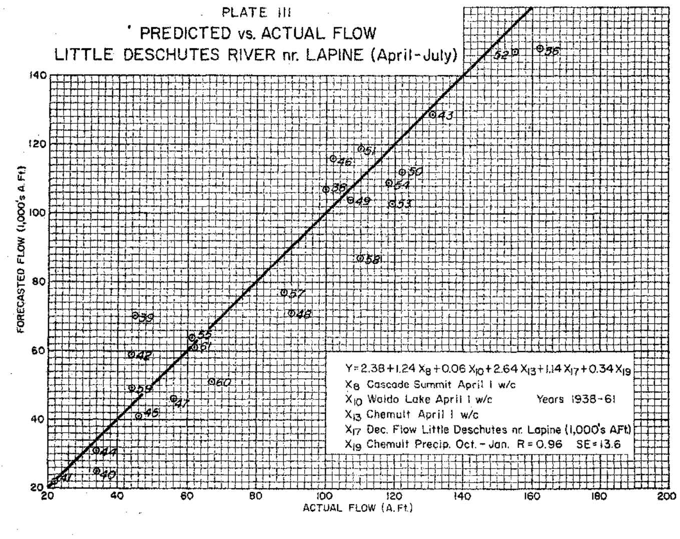


PLATE III
PREDICTED vs. ACTUAL FLOW
LITTLE DESCHUTES RIVER nr. LAPINE (April-July)
FORECASTED FLOW (1,000's A.Ft.)
ACTUAL FLOW (A.Ft.)
Y=2.38+1.24 X8+0.06 X10+2.64 X13+1.14 X17+0.34 X19
X8 Cascade Summit April 1 w/c
X10 Waldo Lake April 1 w/c
Years 1938-61
X13 Chemult April 1 w/c
X17 Dec. Flow Little Deschutes nr. Lapine (1,000's AFt)
X19 Chemult Precip. Oct.-Jan. R=0.96 SE=13.6

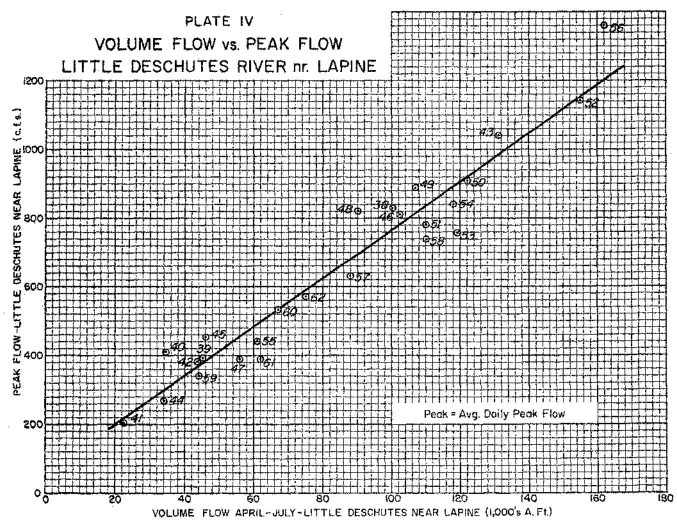


PLATE IV
VOLUME FLOW vs. PEAK FLOW
LITTLE DESCHUTES RIVER nr. LAPINE
PEAK FLOW-LITTLE DESCHUTES NEAR LAPINE (c.f.s.)
VOLUME FLOW APRIL-JULY-LITTLE DESCHUTES NEAR LAPINE (1,000's A.Ft.)
Peak = Avg. Daily Peak Flow

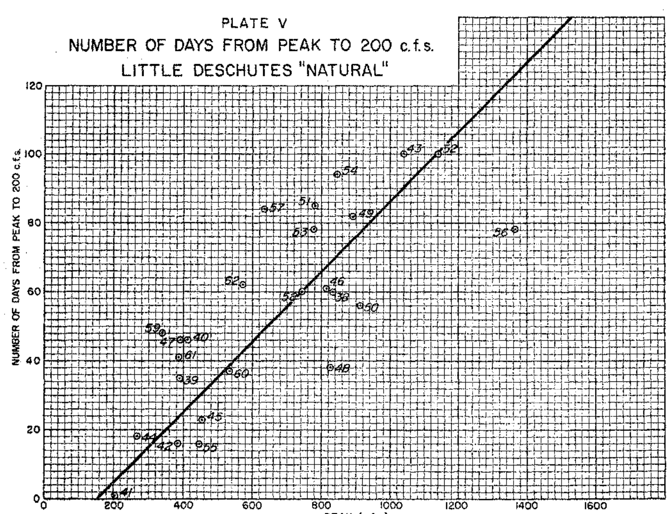


PLATE V
NUMBER OF DAYS FROM PEAK TO 200 c.f.s.
LITTLE DESCHUTES "NATURAL"
NUMBER OF DAYS FROM PEAK TO 200 c.f.s.
PEAK (c.f.s.)

PLATE VI

WATER PRIORITIES DESCHUTES RIVER AT BEND-1967

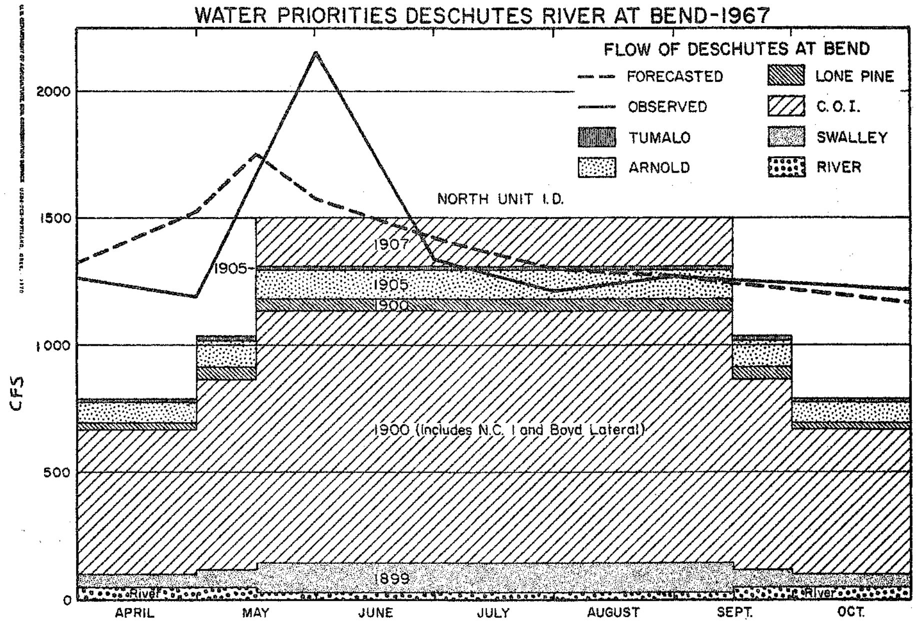


PLATE VII

WATER PRIORITIES DESCHUTES RIVER AT BEND-1968

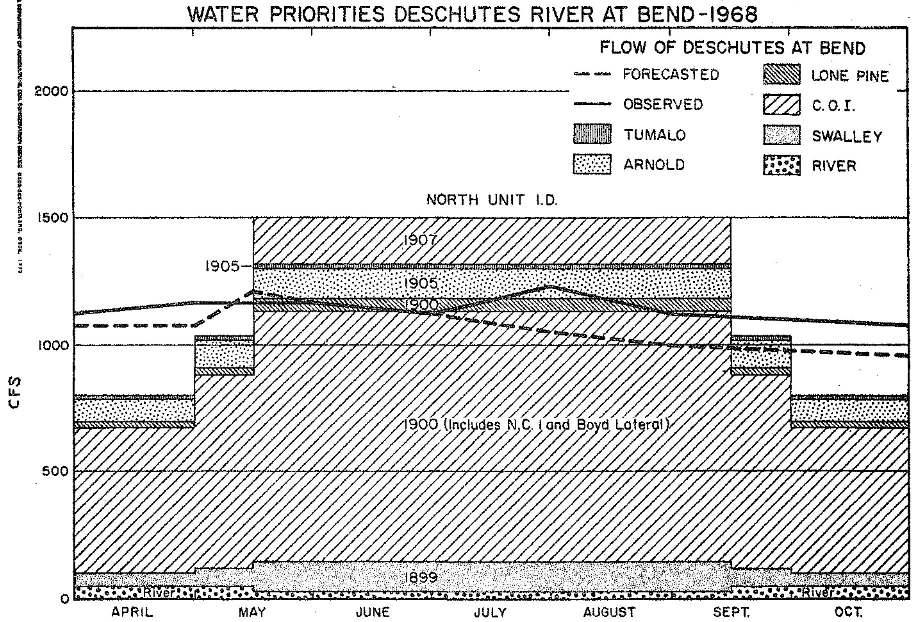


PLATE VIII

PREDICTED vs. ACTUAL FLOW

LITTLE DESCHUTES nr. LAPINE (April-July)

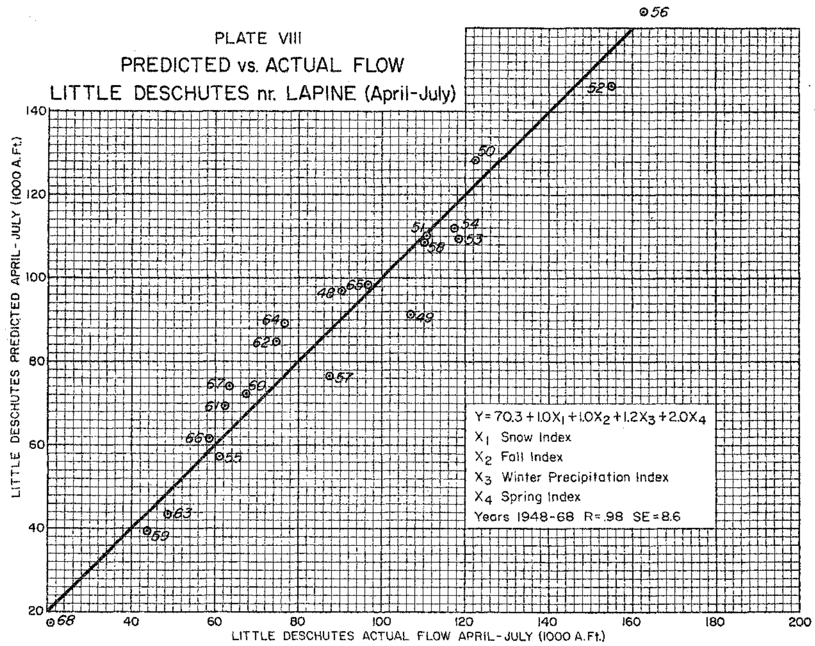


PLATE IX

PREDICTED vs. ACTUAL PEAK FLOW

LITTLE DESCHUTES nr. LAPINE