EXHIBIT D

PRADO DAM RECESSION LIMB INFLOW FORECAST MODEL

PRADO DAM

SANTA ANA RIVER

RIVERSIDE COUNTY, CALIFORNIA

Los Angeles District Office

U.S. Army Corps of Engineers

September 1991

PRADO DAM RECESSION LIMB INFLOW FORECAST MODEL

PRADO DAM WATER CONTROL MANUAL

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Exhibit D

I - PROCEDURE OUTLINE

PURPOSE: This procedure produces a recession limb hydrograph for a flood event. It can only be used after the peak inflow to Prado Reservoir has occurred.

1-01 Introduction. The recession forecast model is based on a historical analysis of 17 floods which was prepared by the Reservoir Regulation Section of the LAD in the early 1980's. The model employs a graphical procedure to forecast the recession curve from the peak to seven days into the future.

1-02 Procedure. The following outlines the eleven step procedure for preparing a forecast recession limb inflow hydrograph to Prado Dam.

a. Step 1. Plot the existing inflow hydrograph on 3-cycle semi-log paper with a range of 100,000 cfs on the log scale and 2 hours per division on the arithmetic scale.

b. Step 2. Determine the volume of inflow for the current water year, i.e., 1 October to the time of forecast. Option 6 of the LAD's RESCAL program can be used to determine this volume.

c. Step 3. Determine the first inflection point from Plate D-01. Note that the first inflection point must be less than the peak inflow. If this is not the case, one cannot use this forecast model. Retain this value for Step 5.

d. Step 4. Determine the time in hours between the peak and the first inflection point using the following equation:

$$T_1 = 20.41 \left(\log(Q_{peak}) - \log(Q_{1st\ IP})\right) \qquad \text{(Eq. D-1)}$$

where:

T_1 = the time in hours between the peak inflow and the first inflection point;
Q_{peak} = the peak inflow in cfs;
$Q_{1st\ IP}$ = the first inflection point flow in cfs. Obtained from Plate D-01. Note that Q_{peak} must be greater than $Q_{1st\ IP}$.

e. Step 5. Draw a straight line from the peak inflow to the 1st inflection point (determined in step 3) using the T_1 calculated from Eq. D-1.

f. Step 6. Determine the volume of inflow for the past 30 days. Again option 6 of the LAD's RESCAL program can be used to determine this volume.

g. Step 7. Determine the second inflection point from Plate D-02. Note that the second inflection point must be less than the first inflection point. If this is not the case, this method cannot be used. Retain this value for Step 9.

h. Step 8. Determine the time in hours between the first inflection point and the second inflection point using the following equation:

$$T_2 = 81.65 (\log(Q_{1st\ IP}) - \log(Q_{2nd\ IP})) \quad \text{(Eq. D-2)}$$

where:

T_2 = the time in hours between the first inflection point and the second inflection point;
$Q_{1st\ IP}$ = the first inflection point in cfs;
$Q_{2nd\ IP}$ = the second inflection point flow in cfs. Obtained from Plate D-02. Note that $Q_{1st\ IP}$ must be greater than $Q_{2nd\ IP}$.

i. Step 9. Draw a straight line from the first inflection point to the second inflection point (determined in step 7) using the T_2 calculated from Eq. D-2.

j. Step 10. Determine the time in hours between the second inflection point and the base flow using the following equation:

$$T_3 = 228.62 (\log(Q_{2nd\ IP}) - \log(Q_{BF})) \quad \text{(Eq. D-3)}$$

where:

T_3 = the time in hours between the second inflection point and the base flow;
$Q_{2nd\ IP}$ = the second inflection point in cfs;
Q_{BF} = the base flow in cfs.

Draw a straight line from the second inflection point to the base flow using the T_3 calculated from Eq. D-3.

k. Step 11. The resulting plot is the forecast inflow hydrograph.

II - EXAMPLE APPLICATION OF THE FORECAST MODEL

2-01 Storm of 17-18 February 1990. The following example uses the inflow hydrograph from the storm of 17-18 February 1990. The winter storm was winding down at the time the forecast was prepared. The peak of 4,400 cfs shown on Plate D-03 was a secondary peak. The primary peak of 8,000 cfs had occurred about 10 hours earlier. The time of forecast was 1000 on 18 February 1990.

a. Step 1. The dashed line on Plate D-03 shows the inflow hydrograph for the recession portion of the storm event. At the time of forecast only the portion of the hydrograph up to 1000 on 18 February 1990 was known.

b. Step 2. Using option 6 of the RESCAL program, the total inflow volume from 1 October 1989 to 1000 18 February 1990 was determined to be 168,800 ac-ft.

c. Step 3. From Plate D-01 the first inflection point inflow is found to be 1,300 cfs.

d. Step 4. Using Eq. D-1 the T_1 is calculated to be:

$T_1 = 20.41\ (\log(4{,}400) - \log(1{,}300))$

$T_1 = 10.8$ hours = 11 hours

e. Step 5. Therefore the first inflection point occurs at 1900 hours on 18 February 1990. A straight line is drawn from the peak at 0800 18FEB90 to the first inflection point at 1900 18FEB90.

f. Step 6. The inflow volume for the past 30 days is also found by using option 6 of the RESCAL program. The inflow volume was 23,329 ac-ft.

g. Step 7. From Plate D-02 the second inflection point is found to be 775 cfs.

h. Step 8. Using Eq. D-2 the T_2 is calculated to be:

$T_2 = 81.65\ (\log(1{,}300) - \log(775))$

$T_2 = 18.3$ hours = 18 hours

Therefore the second inflection point occurs at 1300 19 February. A straight line is drawn from the first inflection point at 1900 18FEB90 to the second inflection point at 1300 19FEB90.

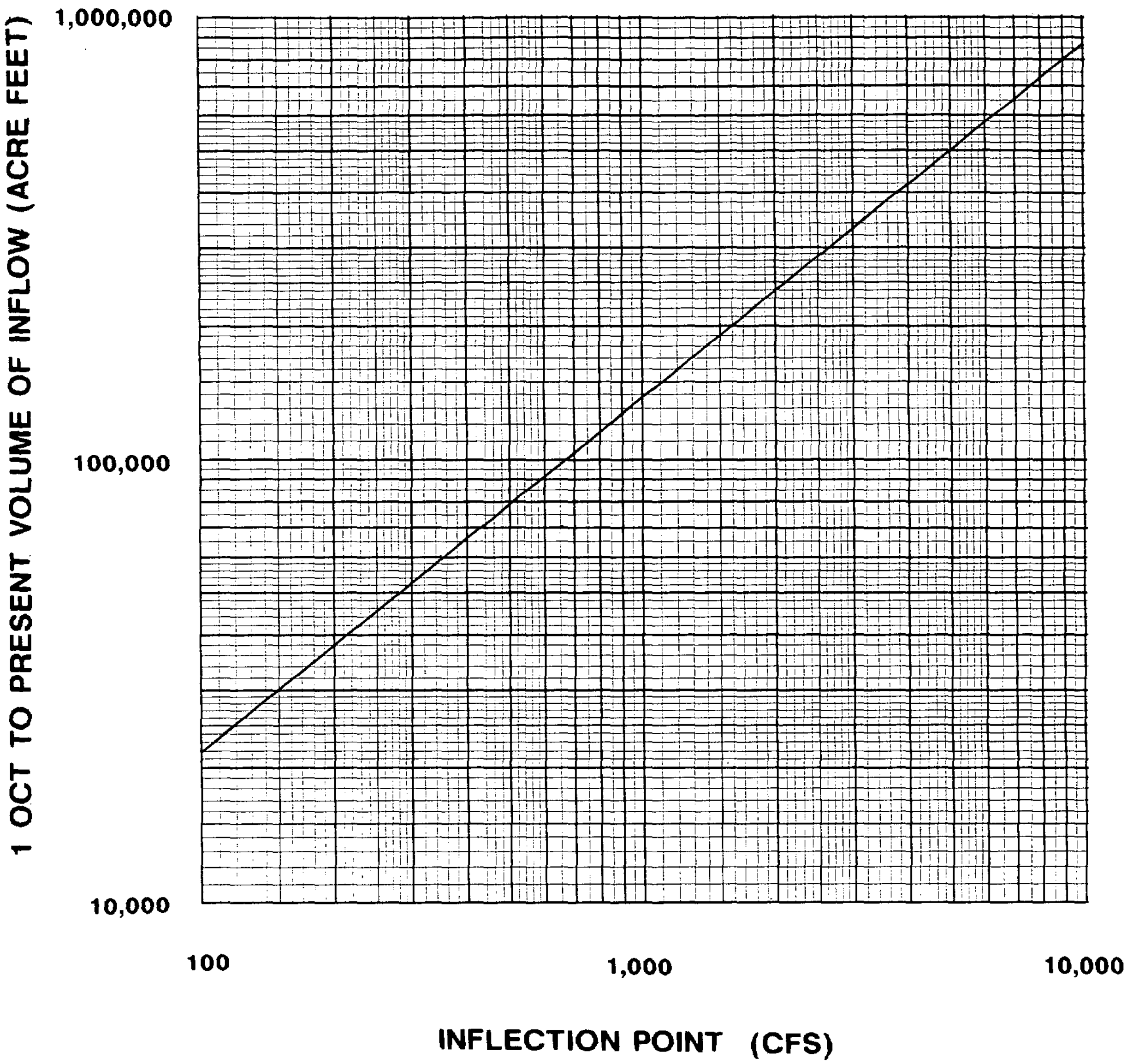
i. Step 9. The base flow for prior to the runoff event was approximately 200 cfs. Using Eq. D-3 the T_3 is calculated to be:

T_3=228.62 (log(775) - log(200))

T_3=134.5 hours = 135 hours

j. Step 10. Therefore the base flow is reached at 0400 25 February. A straight line is drawn from the second inflection point at 1300 19FEB90 to the base flow at 0400 25FEB90.

k. Step 11. The resultant plot (Plate D-03) is the forecast inflow hydrograph, which compares favorably with the actual inflow hydrograph.



PRADO DAM
SANTA ANA RIVER, CALIFORNIA
WATER CONTROL MANUAL

FIRST INFLECTION POINT

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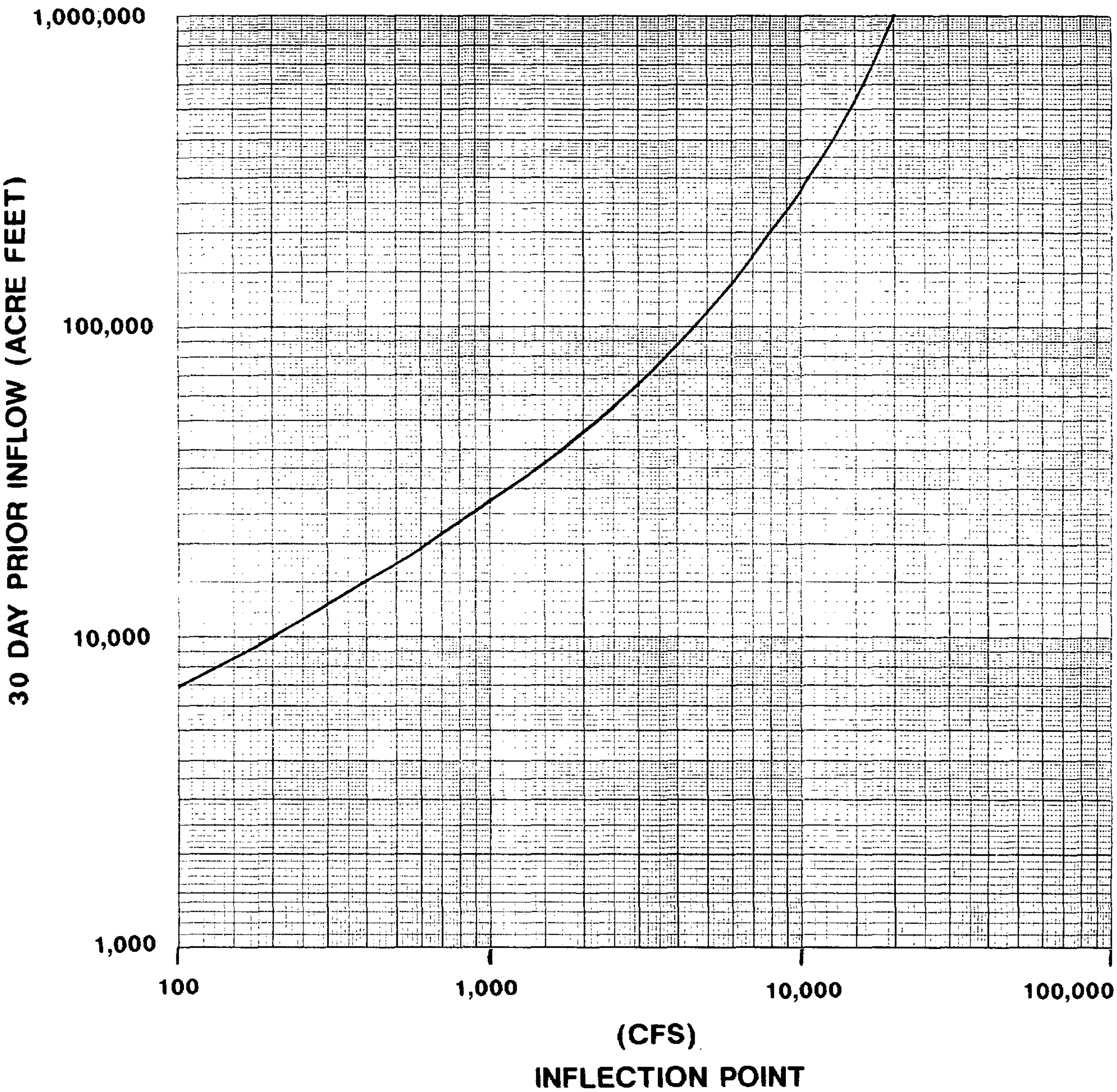

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SECOND INFLECTION POINT

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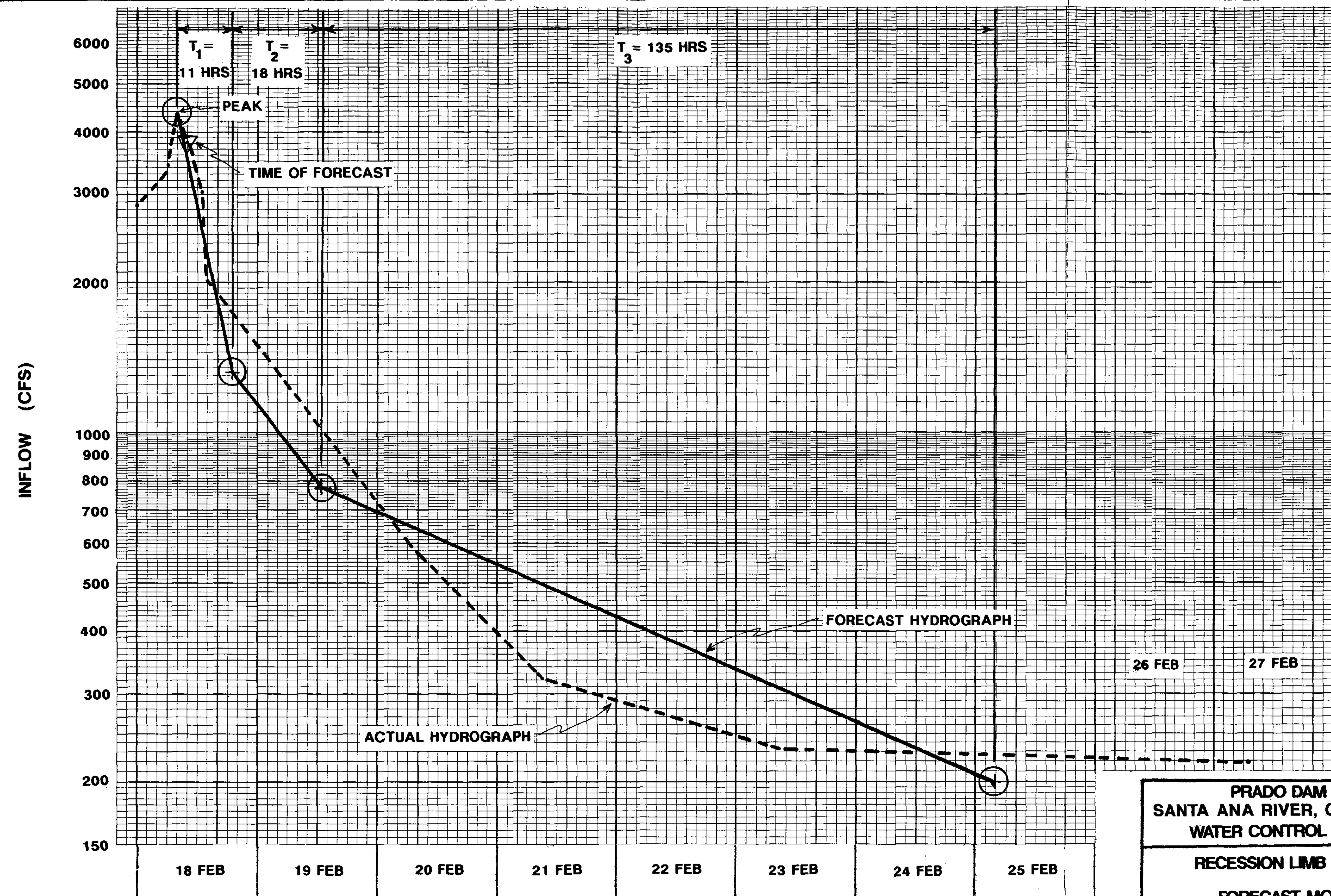

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RECESSION LIMB INFLOW FORECAST MODEL

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