APPENDIX B

HYDROLOGY

AND

HYDRAULICS

APPENDIX B

HYDROLOGY/HYDRAULICS

Hydrology

General: The primary components which influence hydrologic characteristics of the study area include the Big Cypress Bayou, Little Cypress Bayou, Black Cypress Bayou, Lake O' The Pines, and Caddo Lake.

The Cypress Bayou Basin is located in northeast Texas and northwest Louisiana. It is the watershed upstream of Caddo Dam. Big Cypress Creek rises in the northeastern corner of Wood County, Texas, and follows a meandering course in a generally northeasterly direction for a distance of about 80 miles before entering Caddo Lake.

Climatology. The climate of the Cypress Bayou Basin is subtropical with hot humid summers. Rainfall is plentiful and is evenly distributed throughout the year. The mean annual precipitation is 45 inches. In late spring, summer and early fall, precipitation is almost entirely of the local and thundershower type, whereas in late fall, winter and early spring, precipitation is usually more regional in nature. This results from the interaction of cold, polar air masses with warm, moist, tropical air from the Gulf of Mexico. However high intensity rains of short duration may occur at almost anytime of the year.

Snowfall in the basin averages just under 2 inches a year. The mean daily minimum and maximum temperatures are 35□F and 95□F.

Stream Gaging Stations. There are five stream gaging stations in the Cypress Creek watershed.

Development of Discharge - Frequency Relationship

Discharge- Frequency relationship presented in Table 1 is taken from a Basin Planning study done in 1983. In-house program SWFHYD was used to determine this relationship. Point rainfall for the 10-, 50-, 100-, 500-year and standard project storms were developed considering the following data: National Weather Service (NWS) Technical Paper 40, National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NWS Hydro-35, Five to 60-Minute Precipitation Frequency for the Eastern and Central United States," and Corps of Engineers Civil Engineer Bulletin No. 52-8, "Standard Project Flood (SPF) Determinations." The 500-year storm was based on extrapolation of data from the previously mentioned sources. Figure 15 of Technical paper 40, "Depth-Area Duration Curves," was used to adjust the synthetic rainfall with respect to the drainage area of each discharge point. Standard unit hydrograph techniques were used in applying the frequency storms to the subbasin.

Routing the flood hydrographs through each subbasin reach was accomplished using the modified Puls routing method. Elevation discharge-storage relationships for each reach were developed from a HEC-2 backwater model. The routing reaches correspond to the subbasin boundaries.

Flood hydrographs were developed for 1-, 2-, 5-, 10-, 25-, 50-, 100-, 500-year, and SPF events. Peak discharges for each frequency were computed at each point of interest.

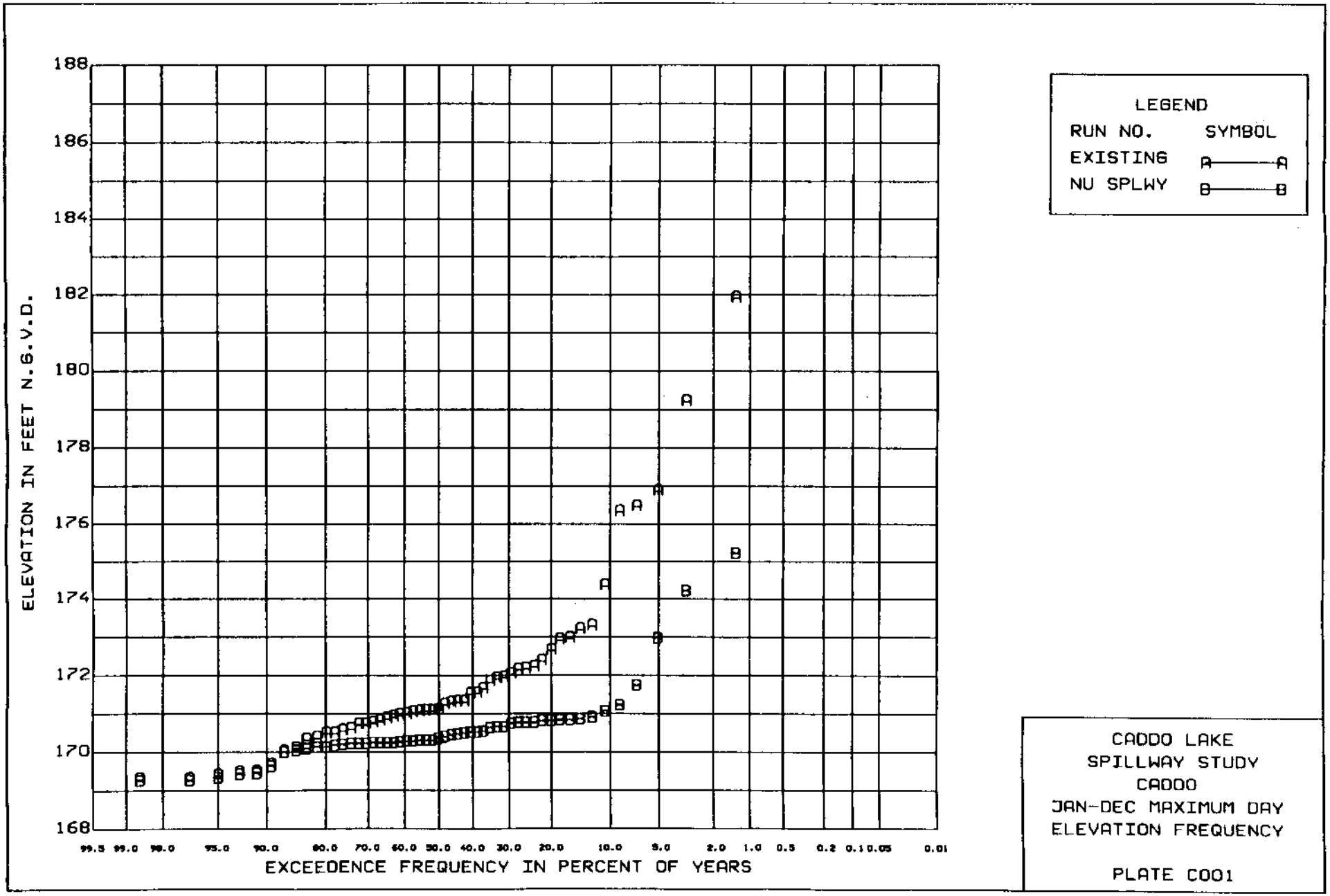
Elevation and Flow Duration

Mathematical model "SUPER" outputs were used to plot annual and monthly elevation duration and flow duration curves for Caddo Lake. Daily average flows in cfs and evaporation in inches for the period of record 1938 through 1990 were used. The model was developed by using elevation/area/capacity curves, outflow rating curves and storage parameters for Caddo Lake as part of the input with linkage to nineteen other reservoirs and 35 control points. Two computers runs were made, one for existing conditions, and another for proposed conditions. For proposed conditions, a rating curve for Labyrinth weir in combination with existing structure for Caddo Lake was used. Plates C001 through C030 present the elevation frequency, elevation duration, flow frequency, and flow duration curves respectively for the existing and proposed conditions at Caddo Lake. The modified release schedule at Lake O' The Pines will not have any significant impact on Caddo Lake. Elevation duration curves C002 through C015 indicate that Caddo Lake will have lower elevations compared to existing conditions due to the proposed modified spillways.

TABLE 1

Cypress Bayou, GI,Reconnaissance Study
Expected Probability Peak Discharges (CFS) for the given Frequency
Existing Conditions

Location	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year	SPF
Caddo Lake (	4,500	8,500	13,700	18,000	24,300	30,000	37,000	65,100	153,800
Karnack Gage, Big Cypress	4,500	9,000	17,700	25,500	38,300	50,900	67,500	129,900	148,600
Big Cypress, Below Little Cypress	4,500	9,000	18,000	26,200	40,000	54,000	72,000	141,300	156,600
Little Cypress, Above Big Cypress	3,000	6,300	10,500	14,000	20,300	27,500	38,500	102,800	114,000
Big Cypress, Below Black Cypress	3,000	4,500	7,000	9,500	14,200	18,900	24,700	47,500	65,500
Black Cypress, Above Big Cypress	2,000	4,000	6,100	8,400	12,400	16,500	21,100	38,500	50,900
Big Cypress, Above Black Cypress	3,000	3,000	4,300	5,600	7,600	9,500	11,400	31,000	42,000
Lake O' The Pines, Outflows	3,000	3,000	3,000	3,000	3,000	3,000	5,000	31,000	42,000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186
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178
176
174
172
170
168
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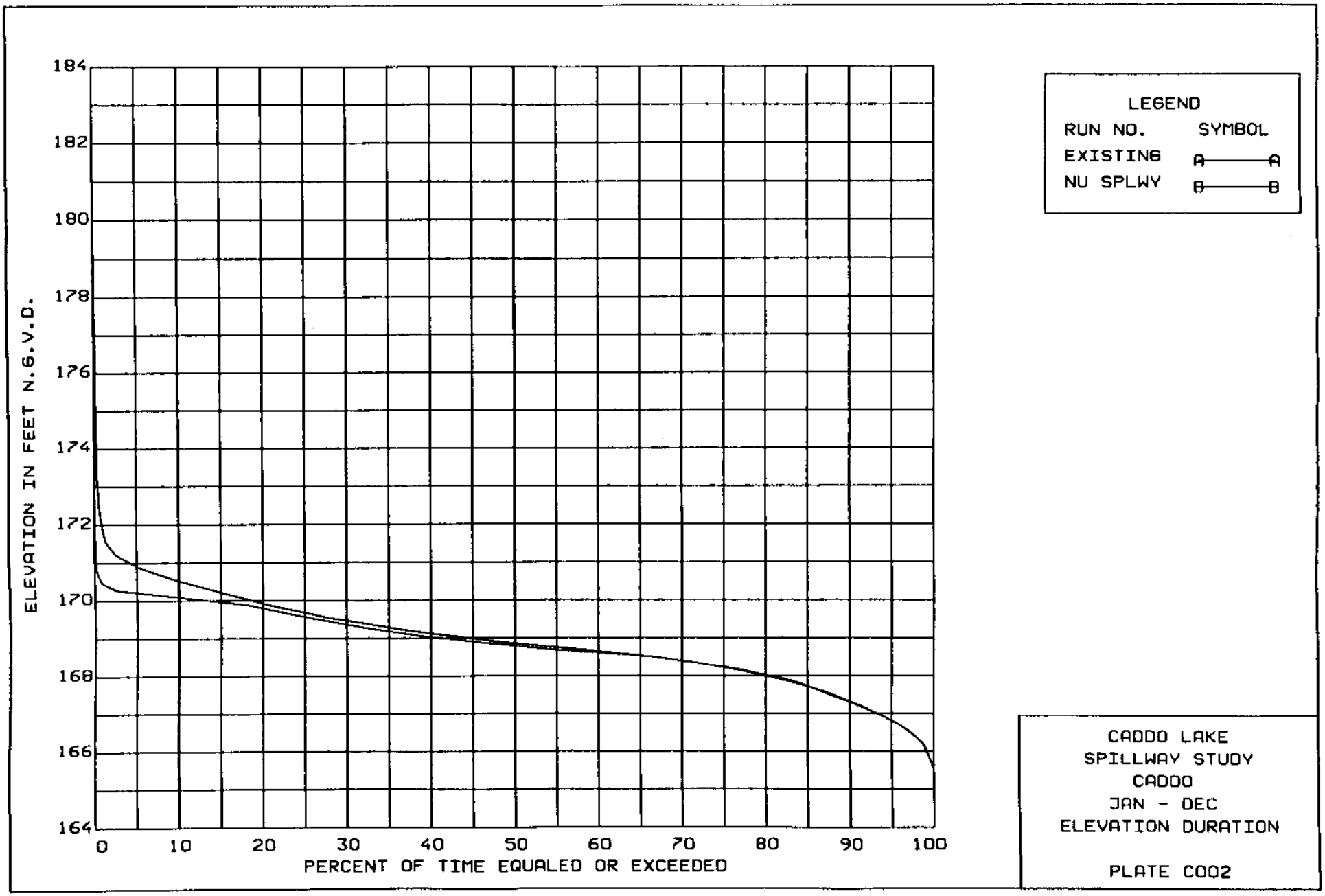
EXCEEDENCE FREQUENCY IN PERCENT OF YEARS
LEGEND
RUN NO. SYMBOL
EXISTING A—A
NU SPLWY B—B
CADDO LAKE
SPILLWAY STUDY
CADDO
JAN-DEC MAXIMUM DAY
ELEVATION FREQUENCY
PLATE C001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166
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ELEVATION IN FEET N.G.V.D.
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20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO. SYMBOL
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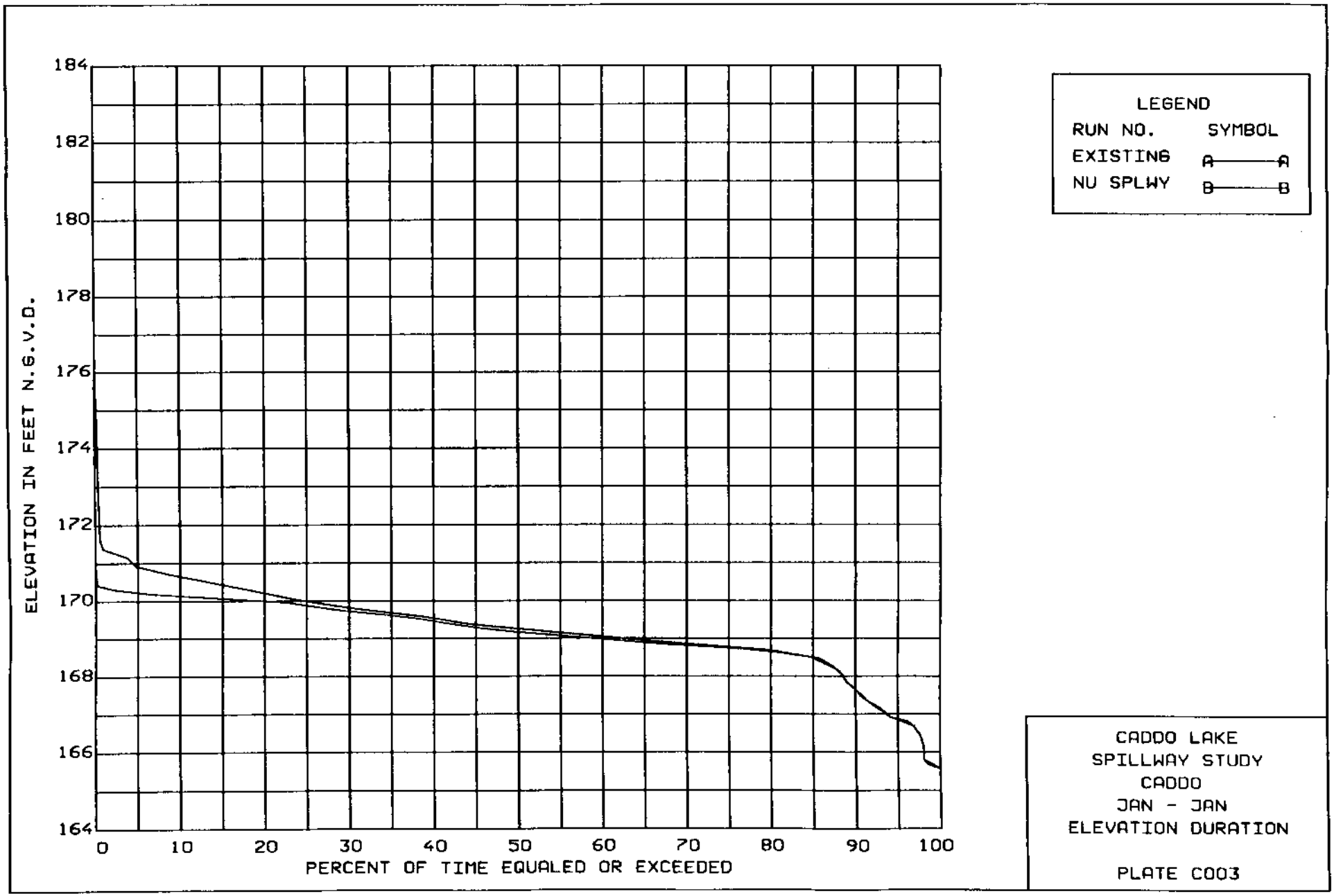
NU SPLWY B B
CADDO LAKE
SPILLWAY STUDY
CADDO
JAN - DEC
ELEVATION DURATION
PLATE C002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168
166
164
ELEVATION IN FEET N.G.V.D.
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80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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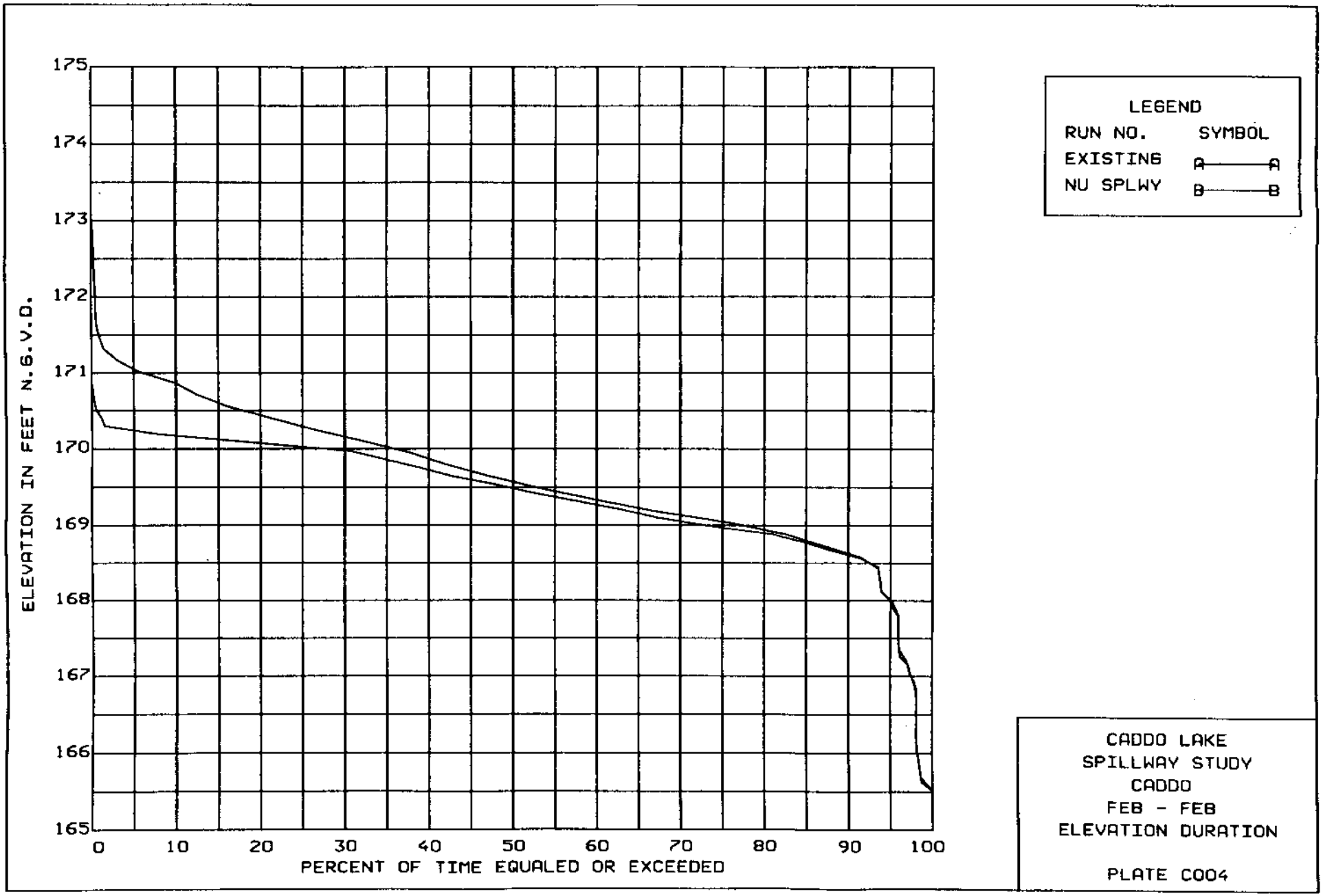
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
JAN - JAN
ELEVATION DURATION
PLATE C003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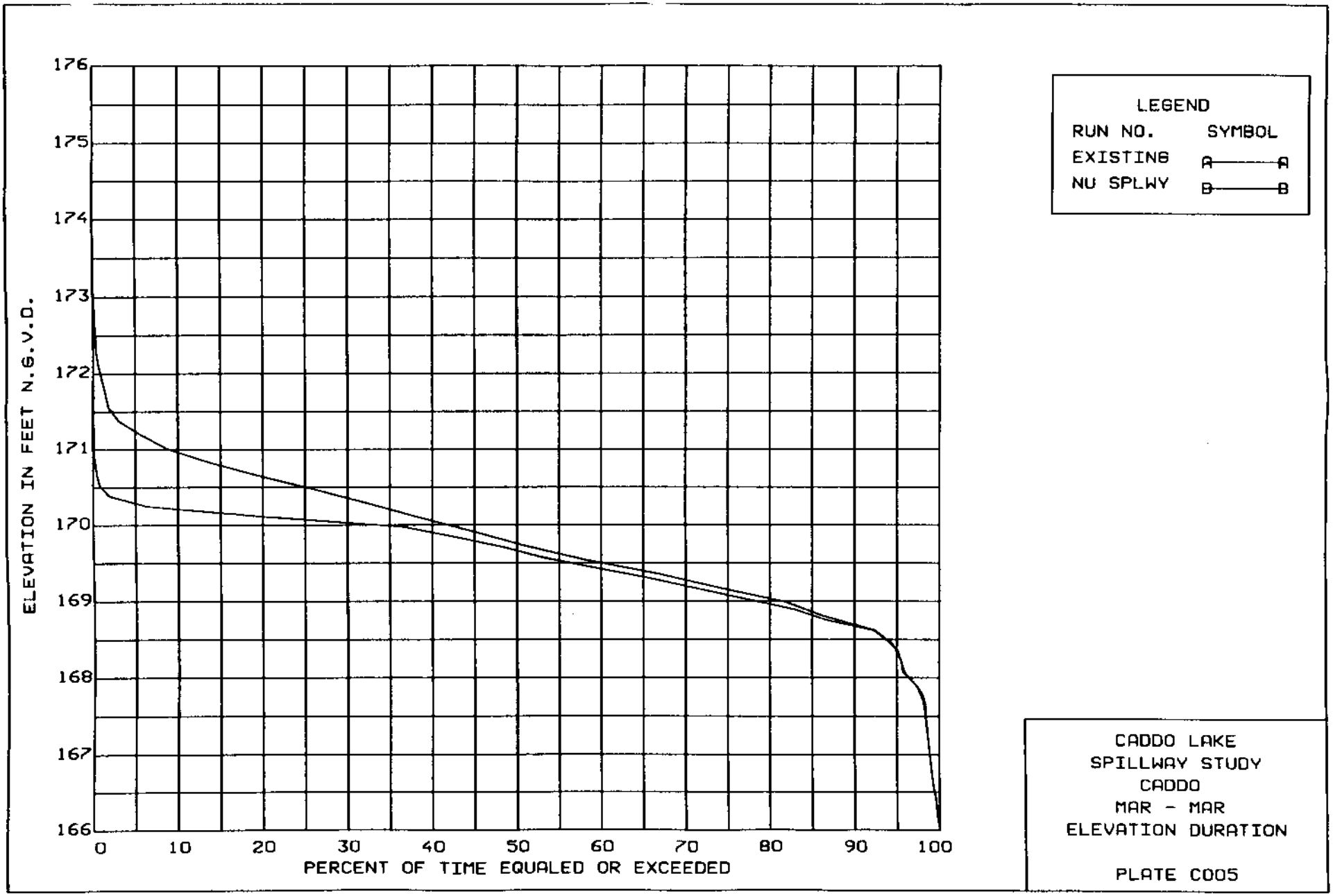
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO. SYMBOL
EXISTING A A
NU SPLWY B B
CADDO LAKE
SPILLWAY STUDY
CADDO
FEB - FEB
ELEVATION DURATION
PLATE C004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40
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60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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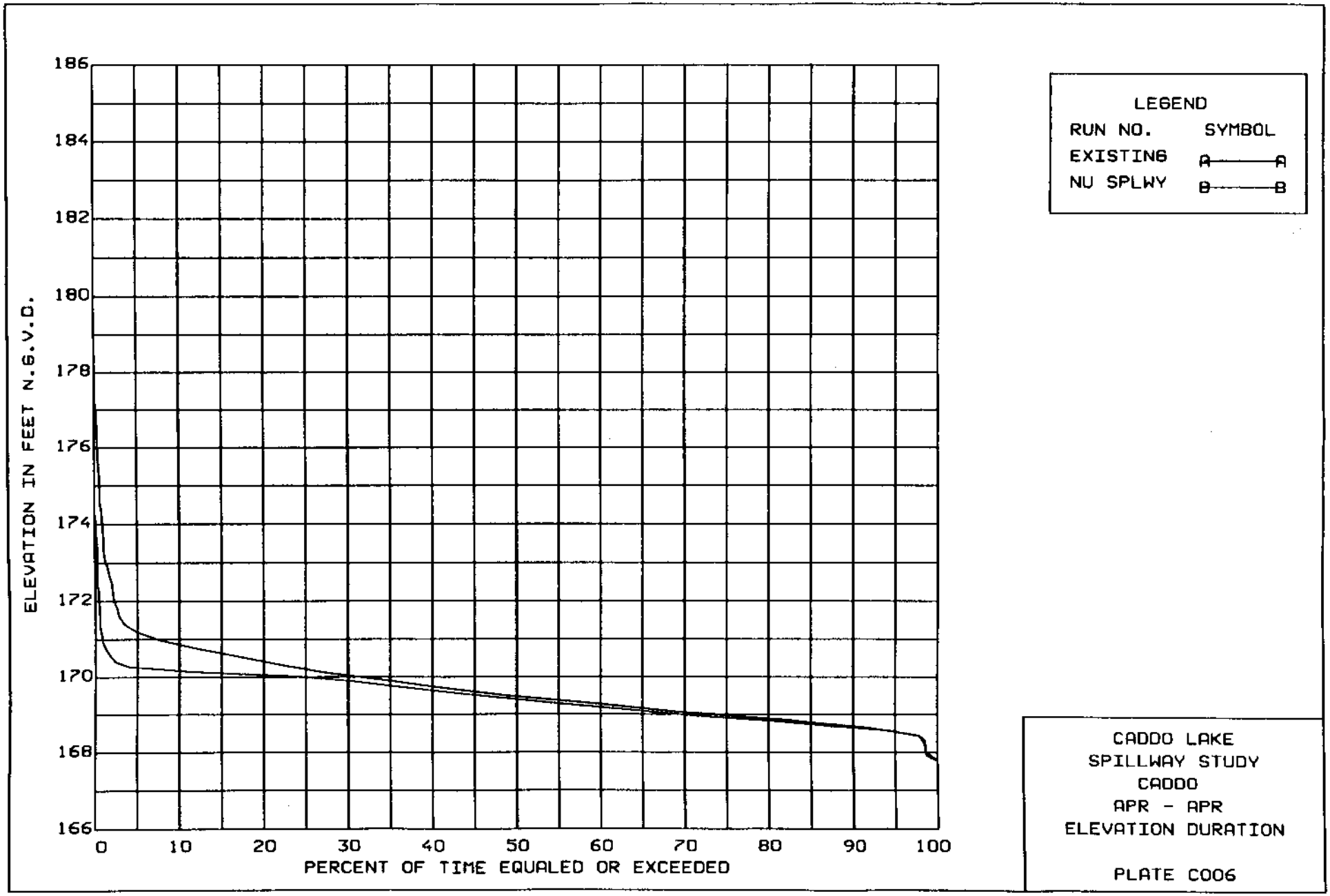
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
MAR - MAR
ELEVATION DURATION
PLATE C005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90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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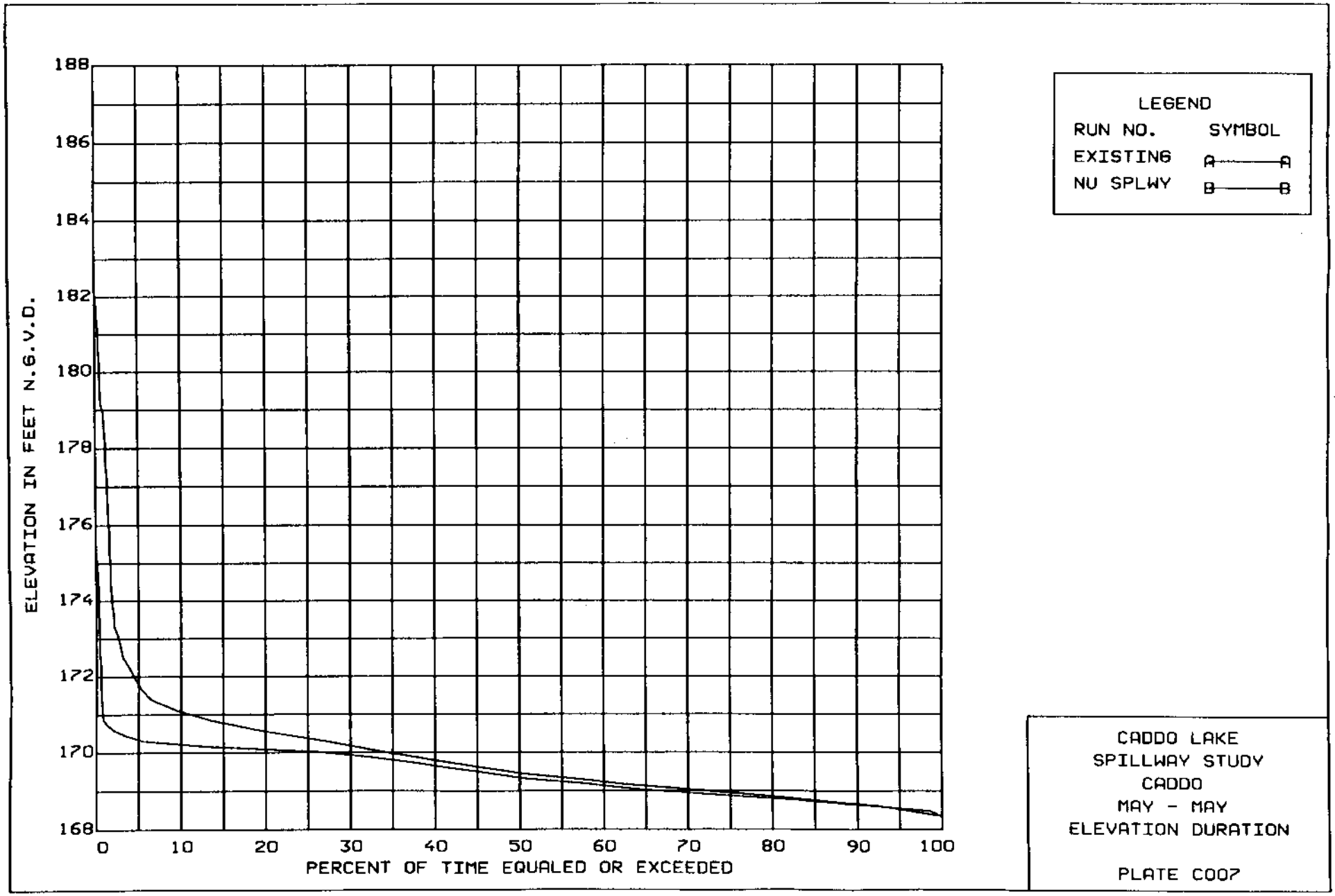
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
APR - APR
ELEVATION DURATION
PLATE C006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90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
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B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
MAY - MAY
ELEVATION DURATION
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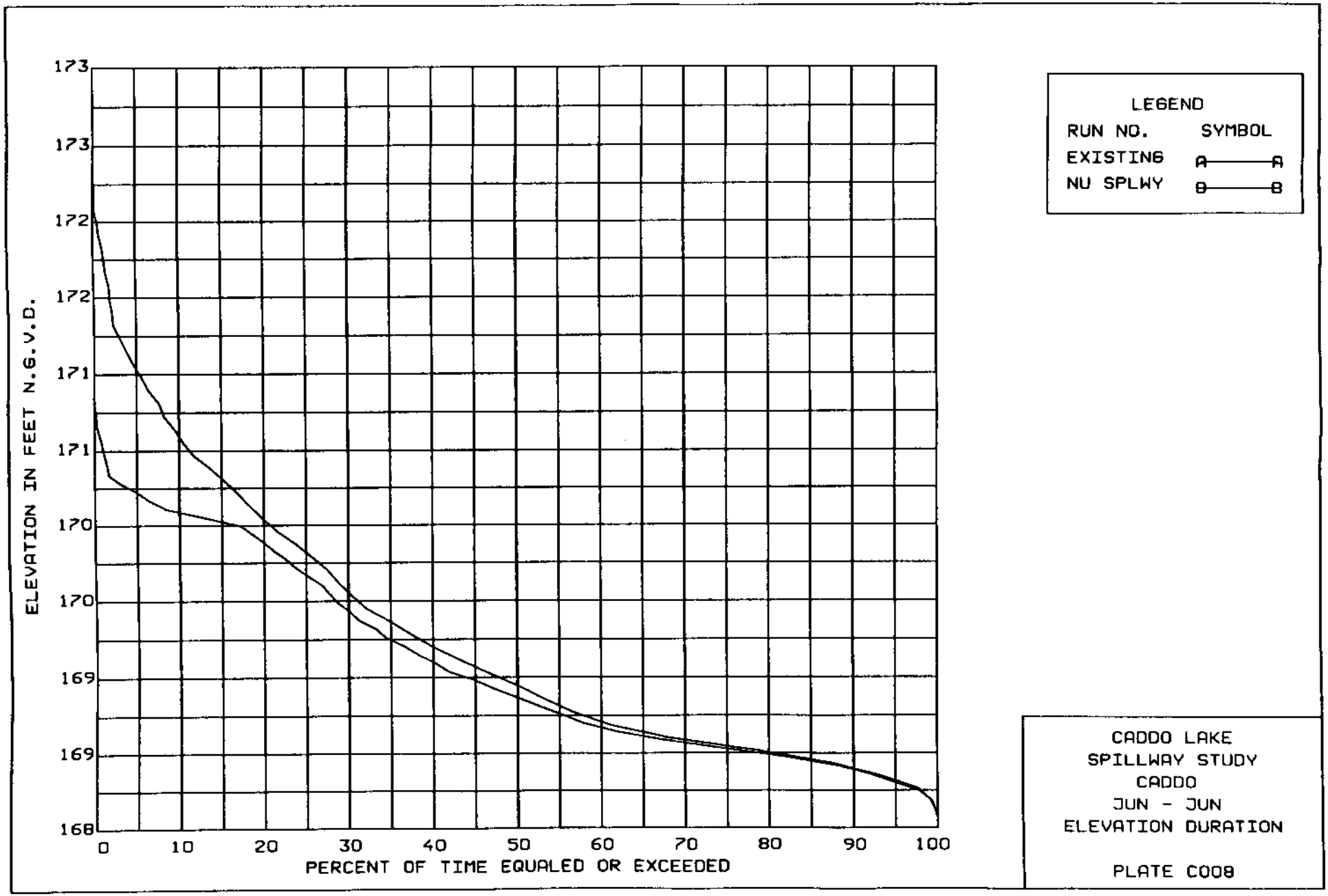
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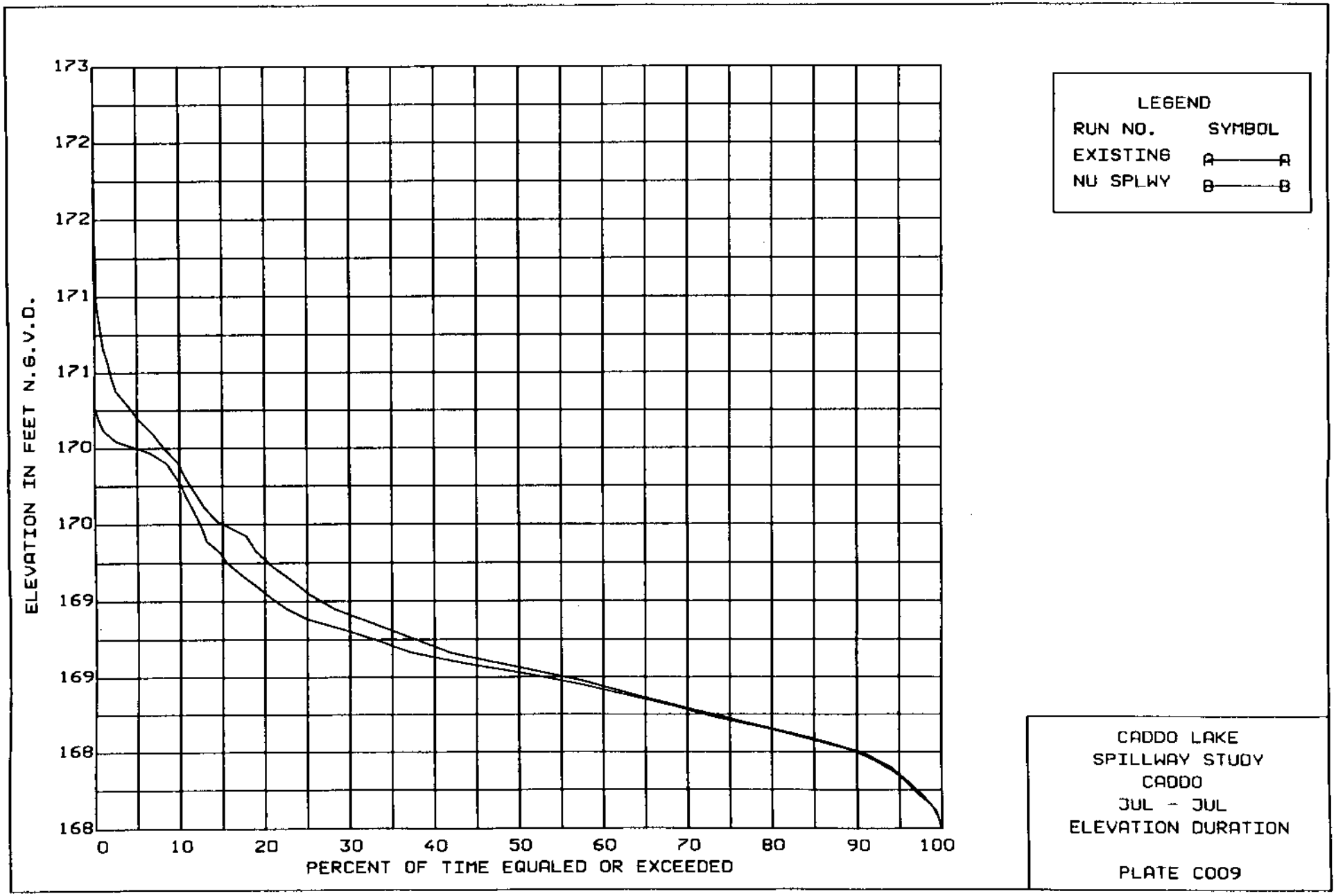
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO. SYMBOL
EXISTING A A
NU SPLWY B B
CADDO LAKE
SPILLWAY STUDY
CADDO
JUN - JUN
ELEVATION DURATION
PLATE C008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PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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NU SPLWY
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CADDO LAKE
SPILLWAY STUDY
CADDO
JUL - JUL
ELEVATION DURATION
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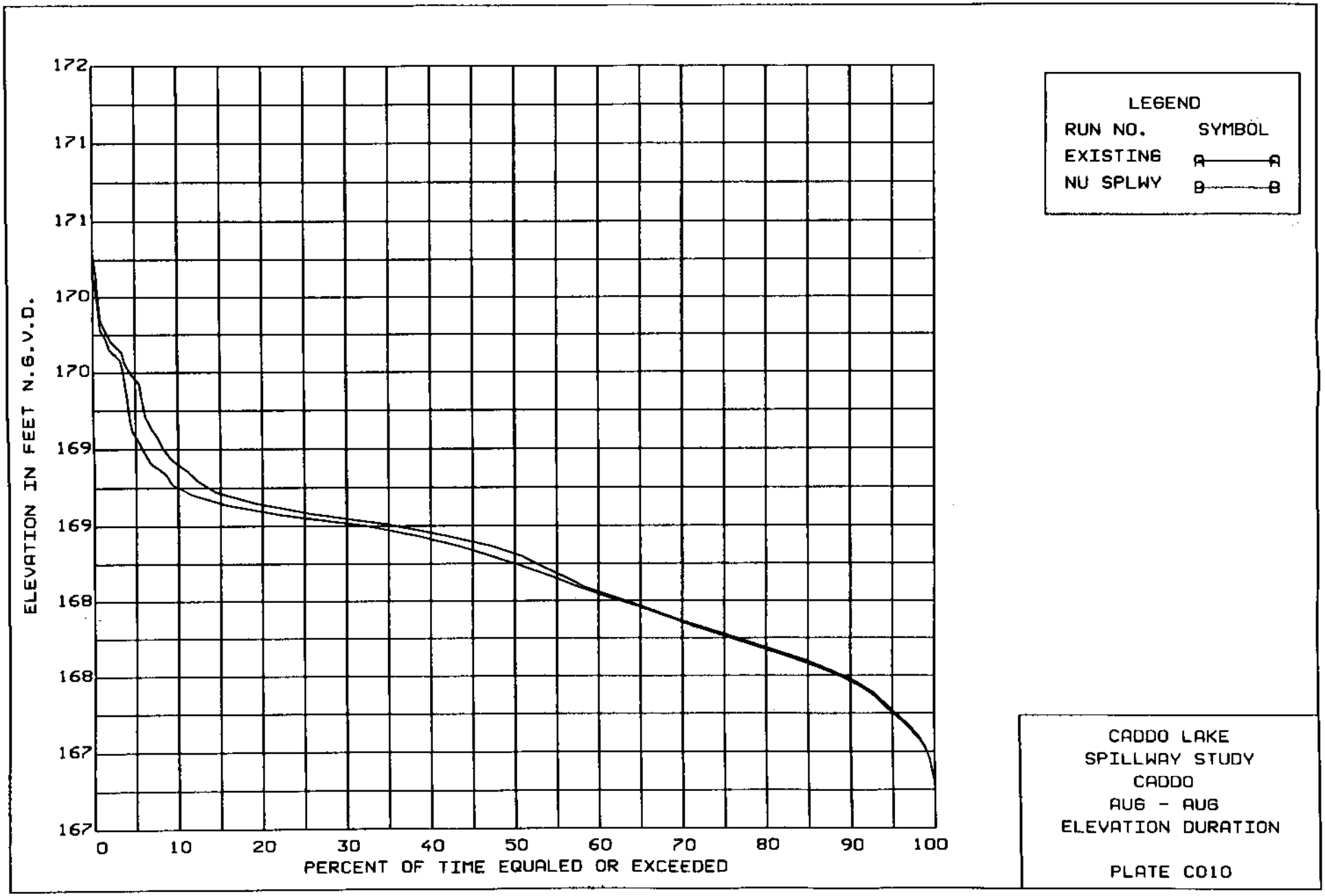
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100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
AUG - AUG
ELEVATION DURATION
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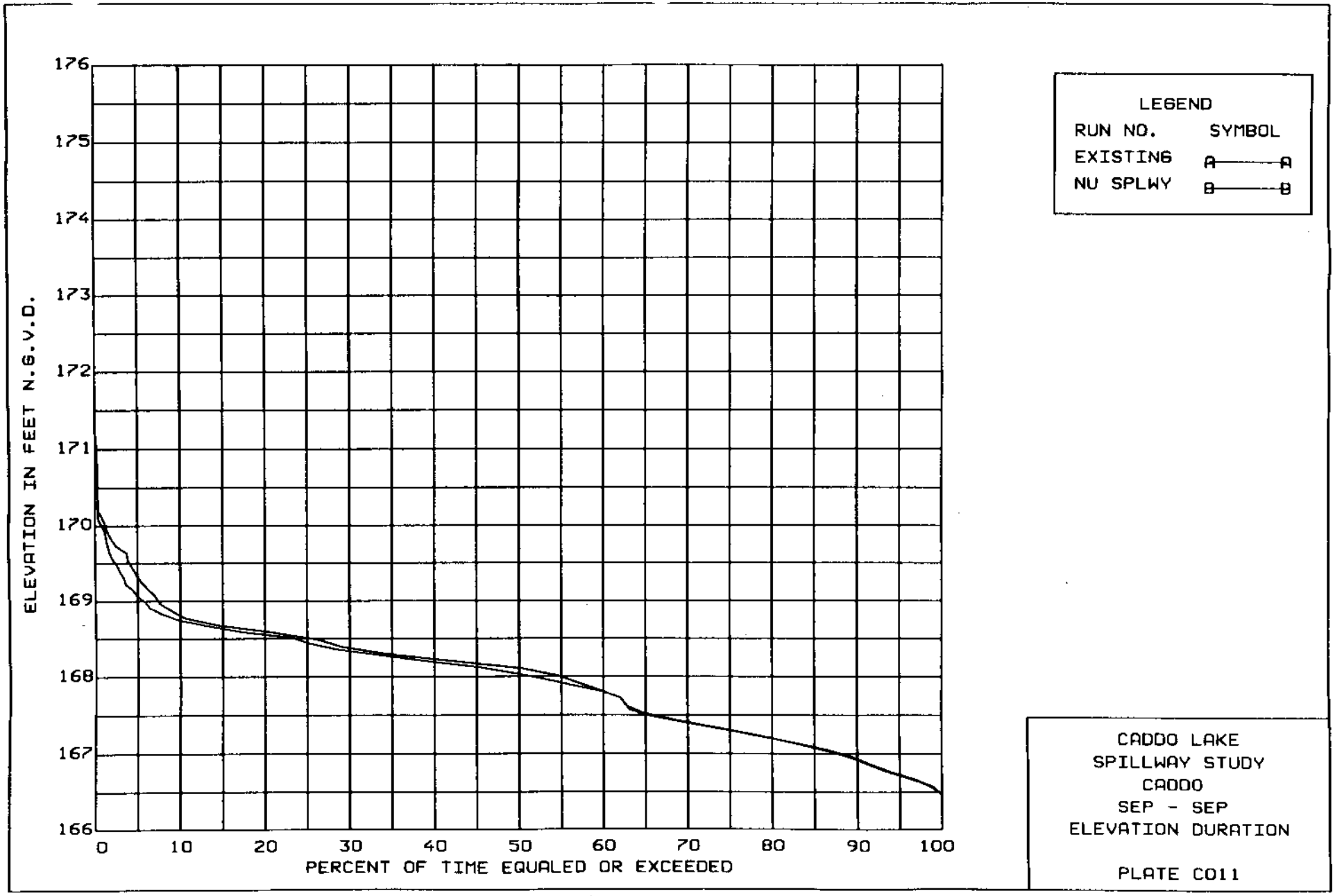
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PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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CADDO LAKE
SPILLWAY STUDY
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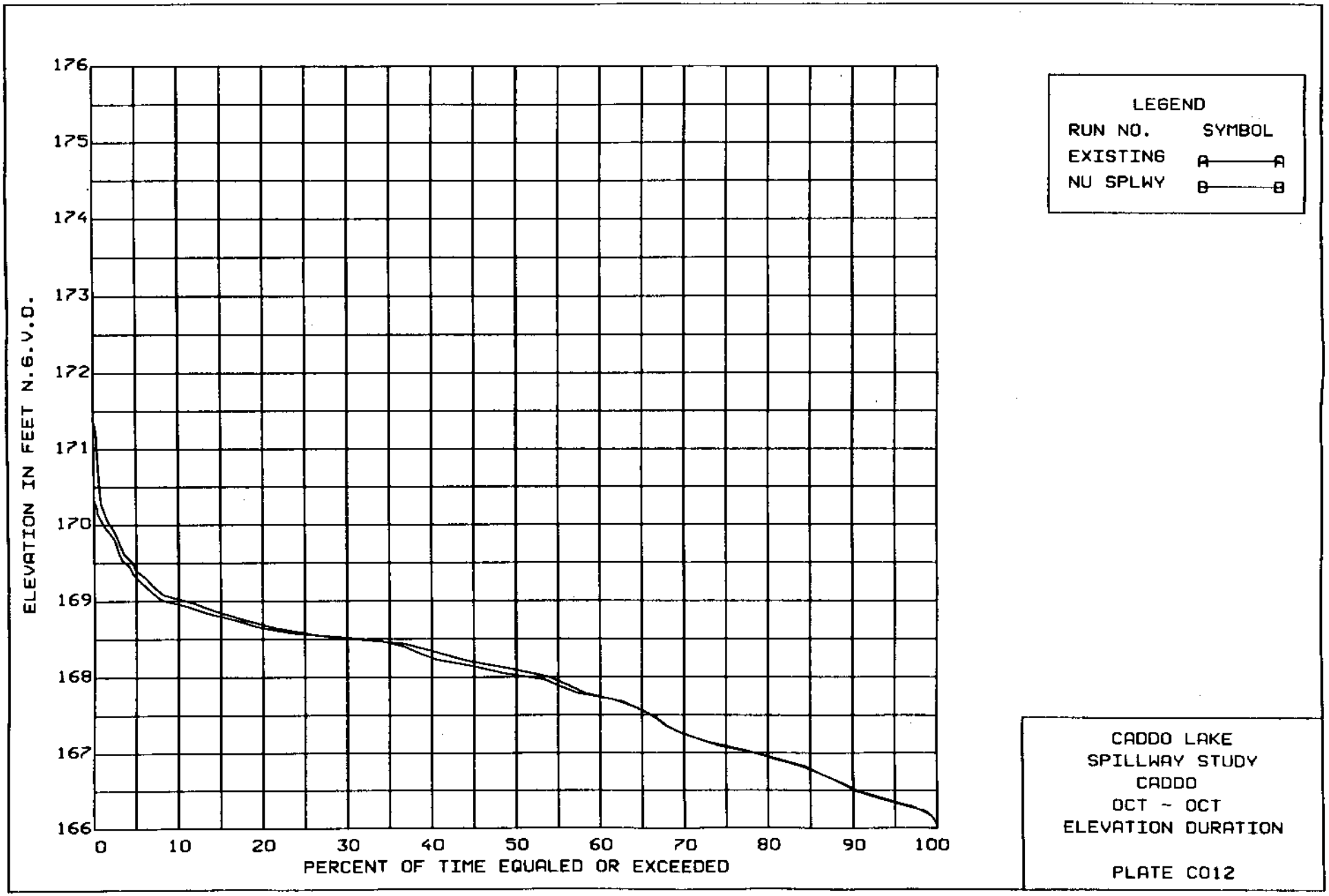
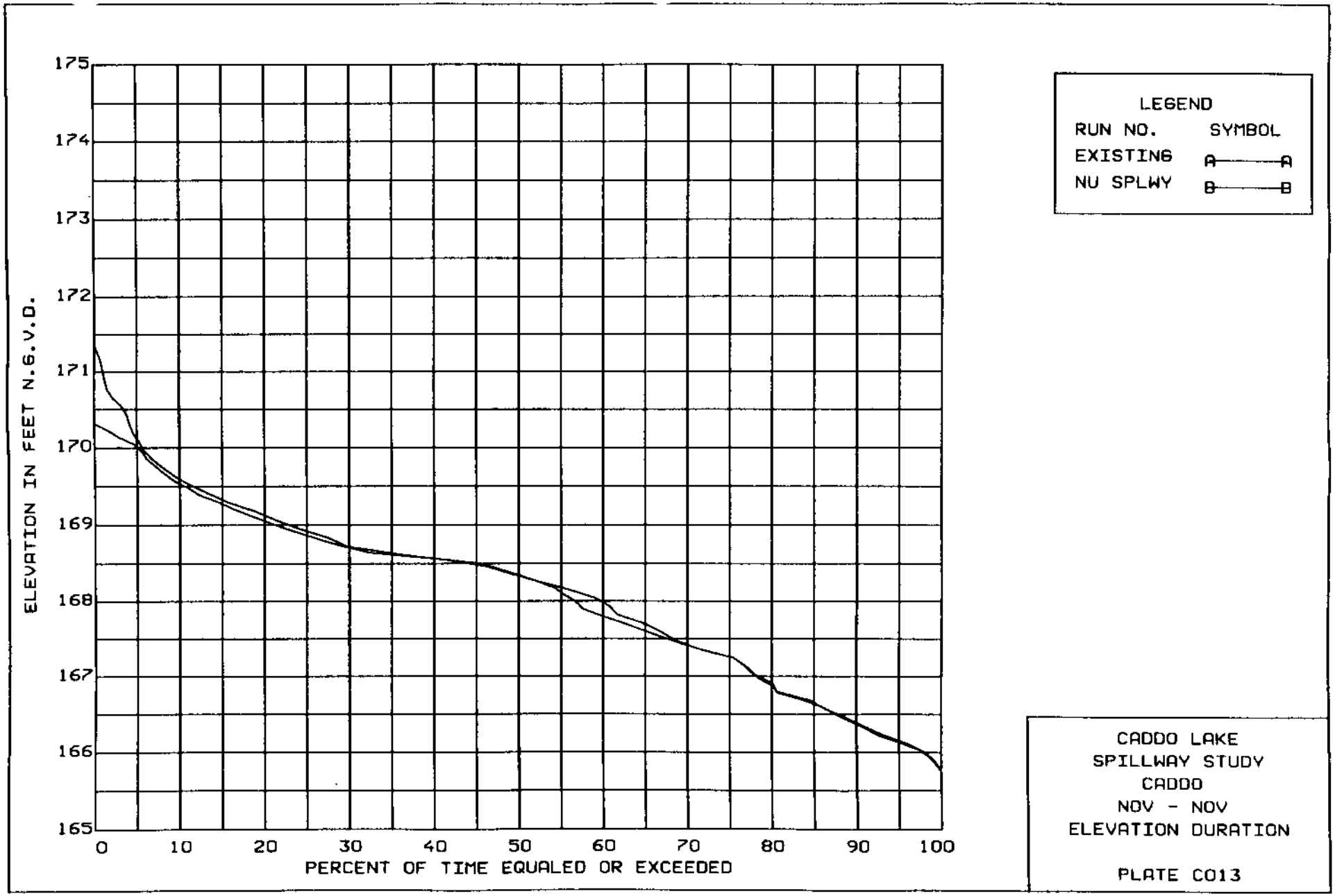
SEP - SEP
ELEVATION DURATION
PLATE C011



CADDO LAKE
SPILLWAY STUDY
CADDO
OCT ~ OCT
ELEVATION DURATION

PLATE C012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40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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NU SPLWY
B
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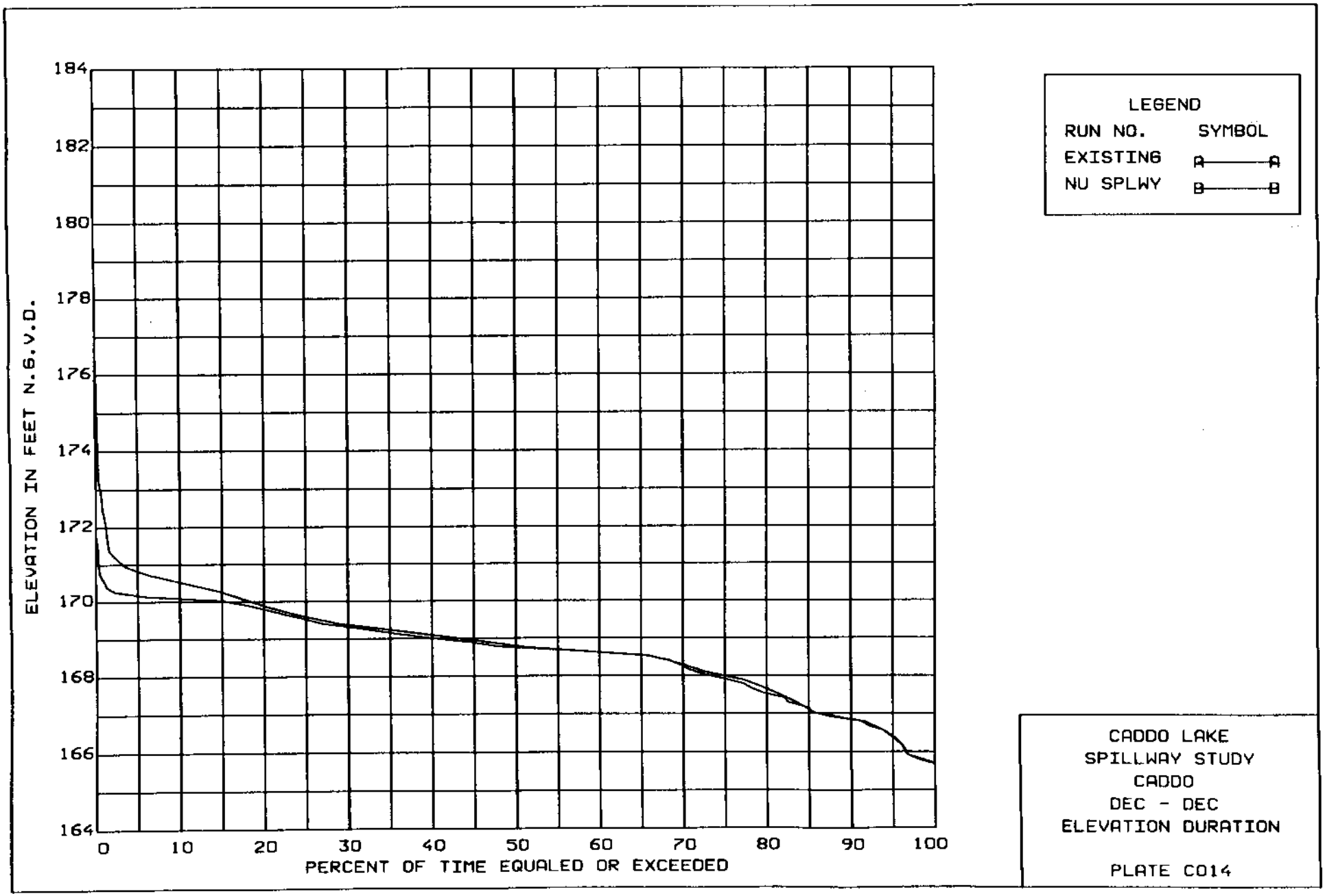
CADDO LAKE
SPILLWAY STUDY
CADDO
NOV - NOV
ELEVATION DURATION
PLATE C013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60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
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B
B
CADDO LAKE
SPILLWAY STUDY
CADDO
DEC - DEC
ELEVATION DURATION
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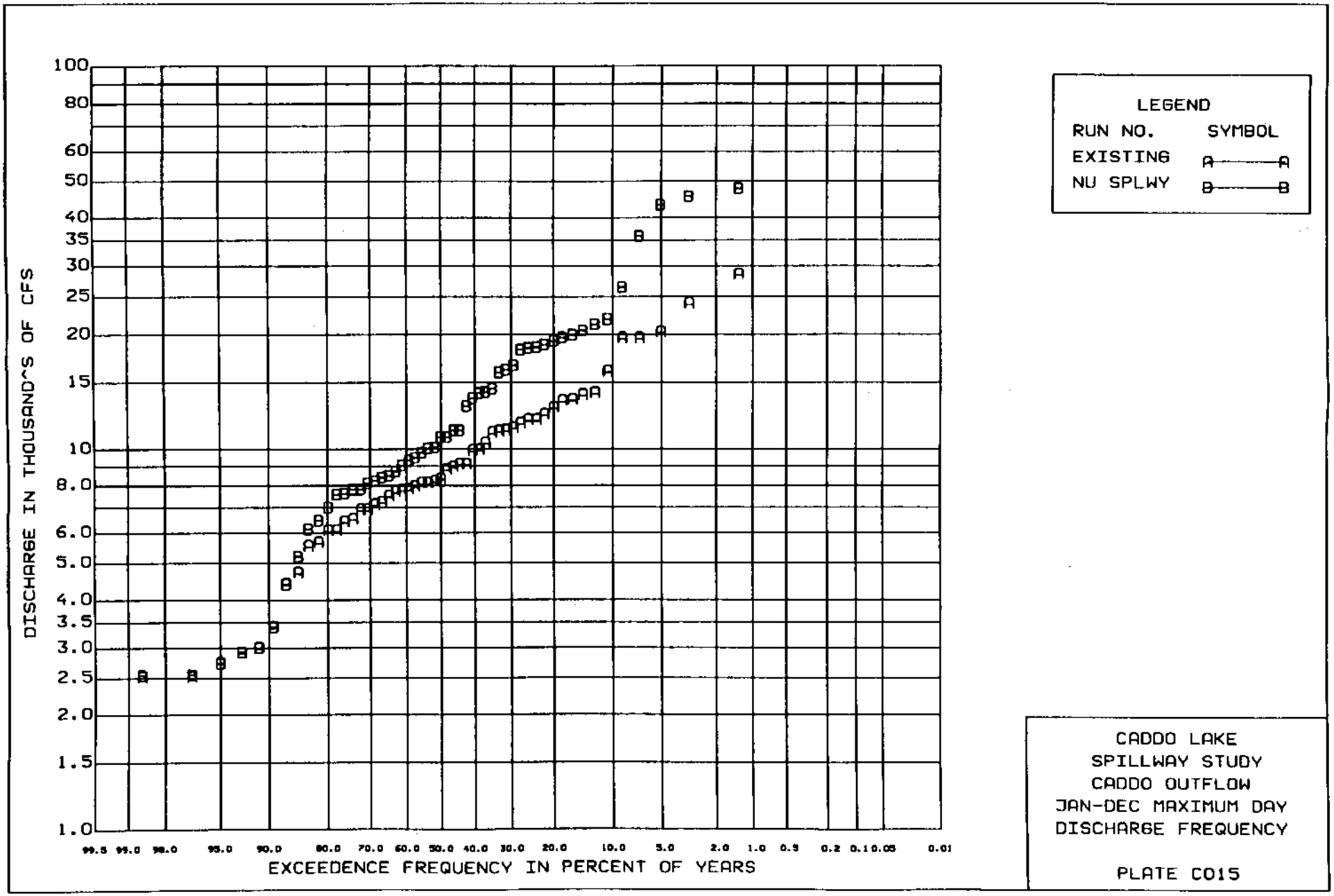
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25
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6.0
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3.5
3.0
2.5
2.0
1.5
1.0
99.5 99.0 98.0 95.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 5.0 2.0 1.0 0.5 0.2 0.1 0.05 0.01
EXCEEDENCE FREQUENCY IN PERCENT OF YEARS
LEGEND
RUN NO. SYMBOL
EXISTING A A
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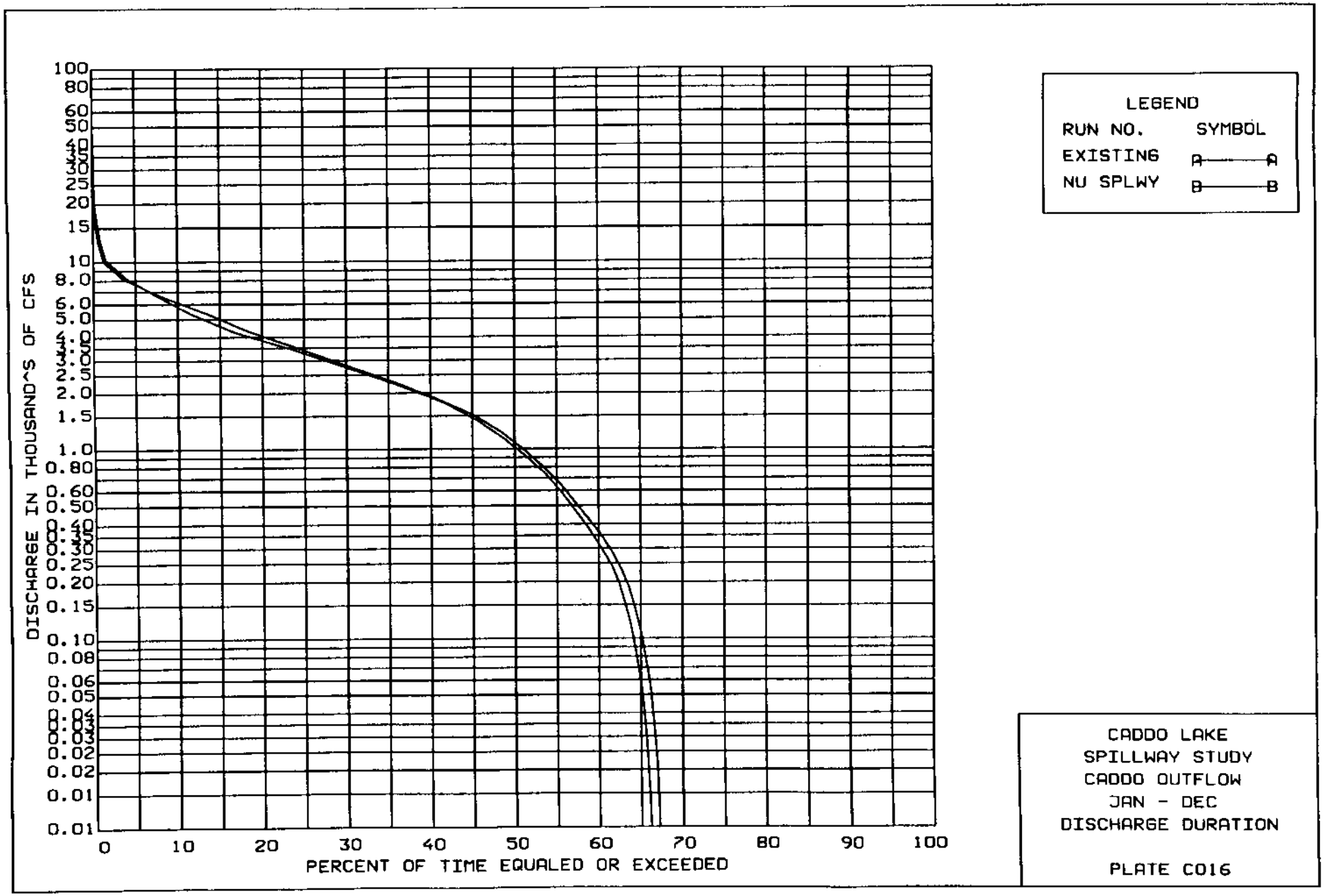
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
JAN-DEC MAXIMUM DAY
DISCHARGE FREQUENCY
PLATE C015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2.0
1.5
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0.60
0.50
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0.30
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0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.01
0
10
20
30
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50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
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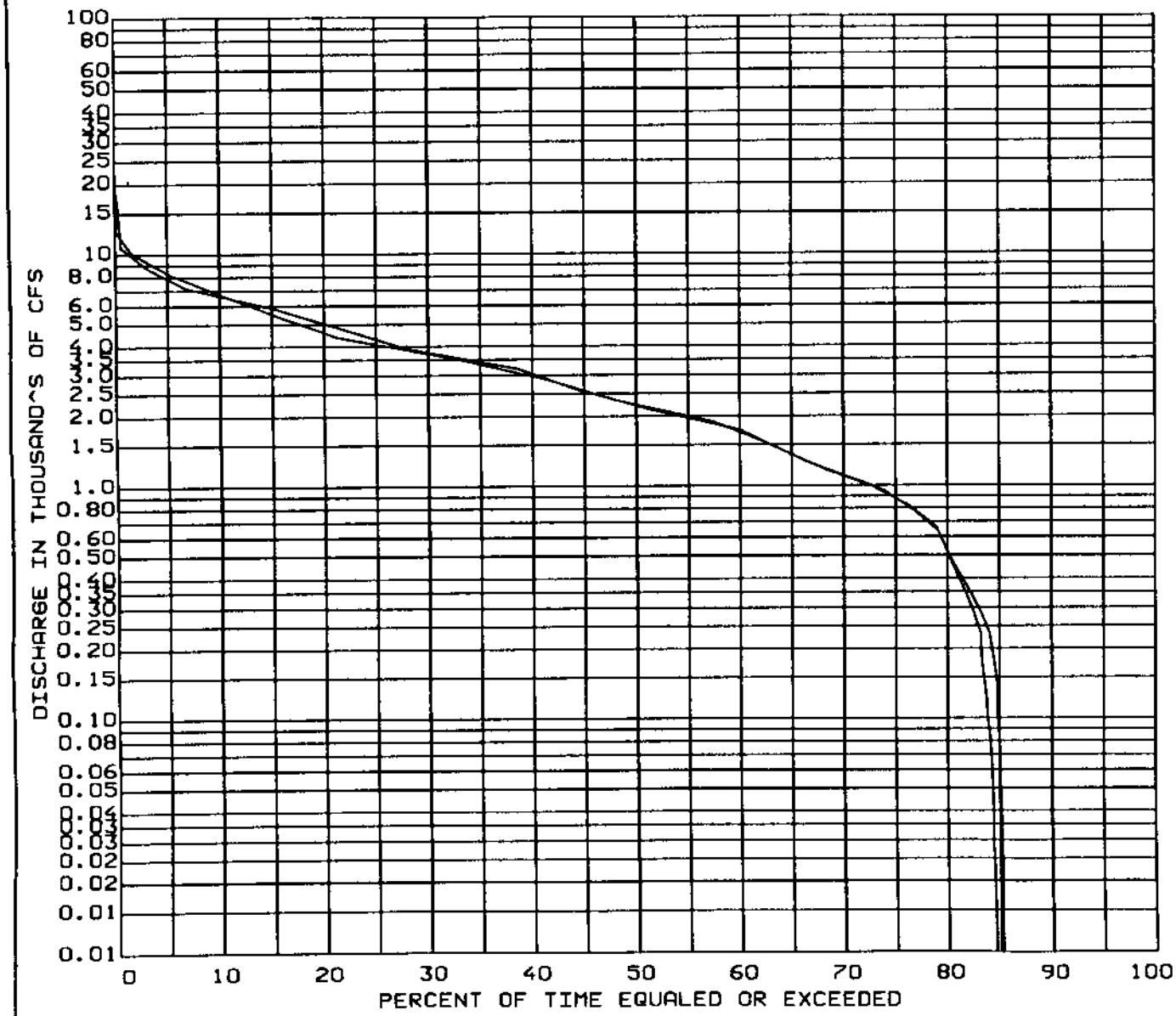
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
JAN - DEC
DISCHARGE DURATION
PLATE C016

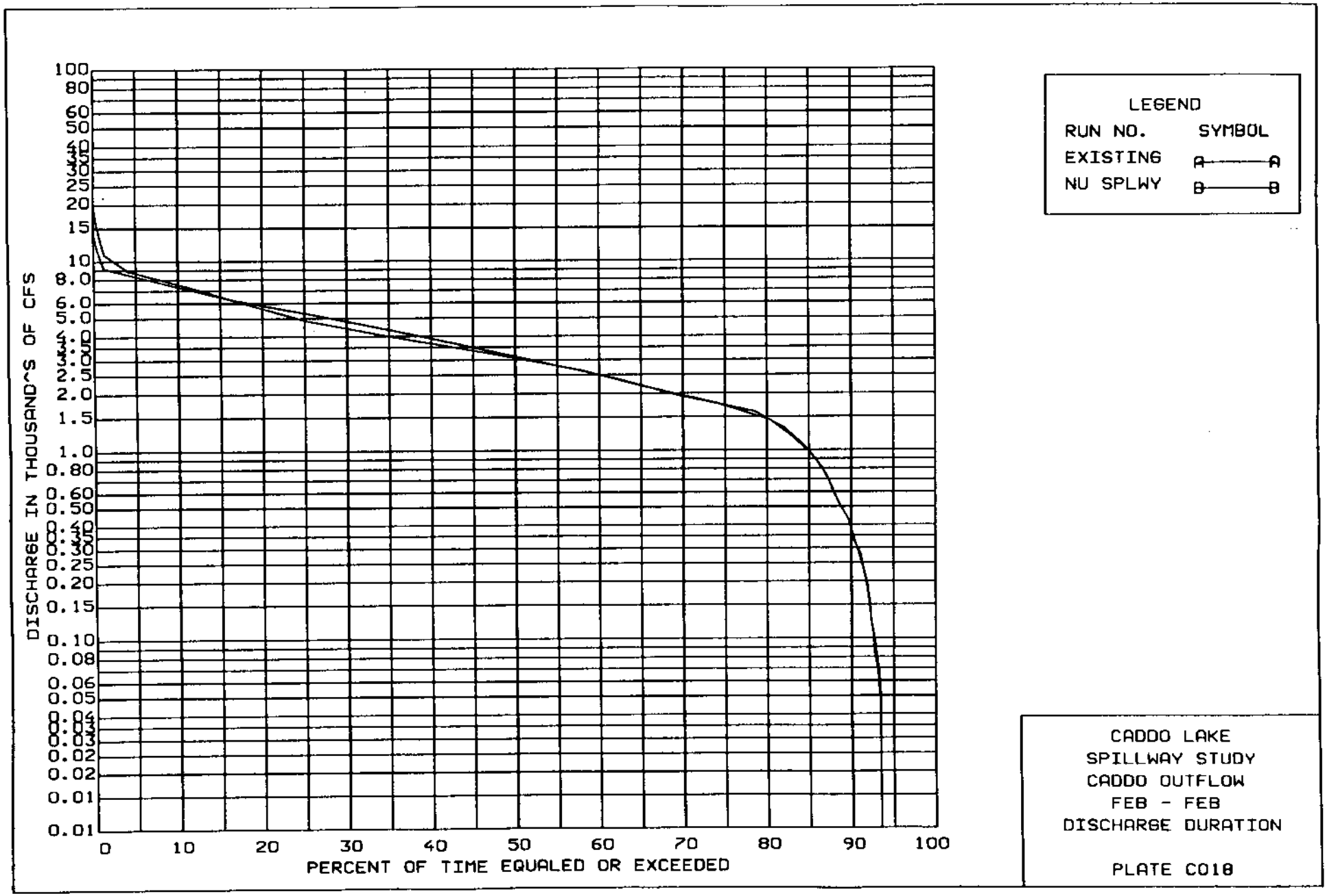


LEGEND

RUN NO.	SYMBOL
EXISTING	A——A
NU SPLWY	B——B

CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
JAN - JAN
DISCHARGE DURATION

PLATE C017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20
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0.60
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0.03
0.02
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10
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80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
NU SPLWY
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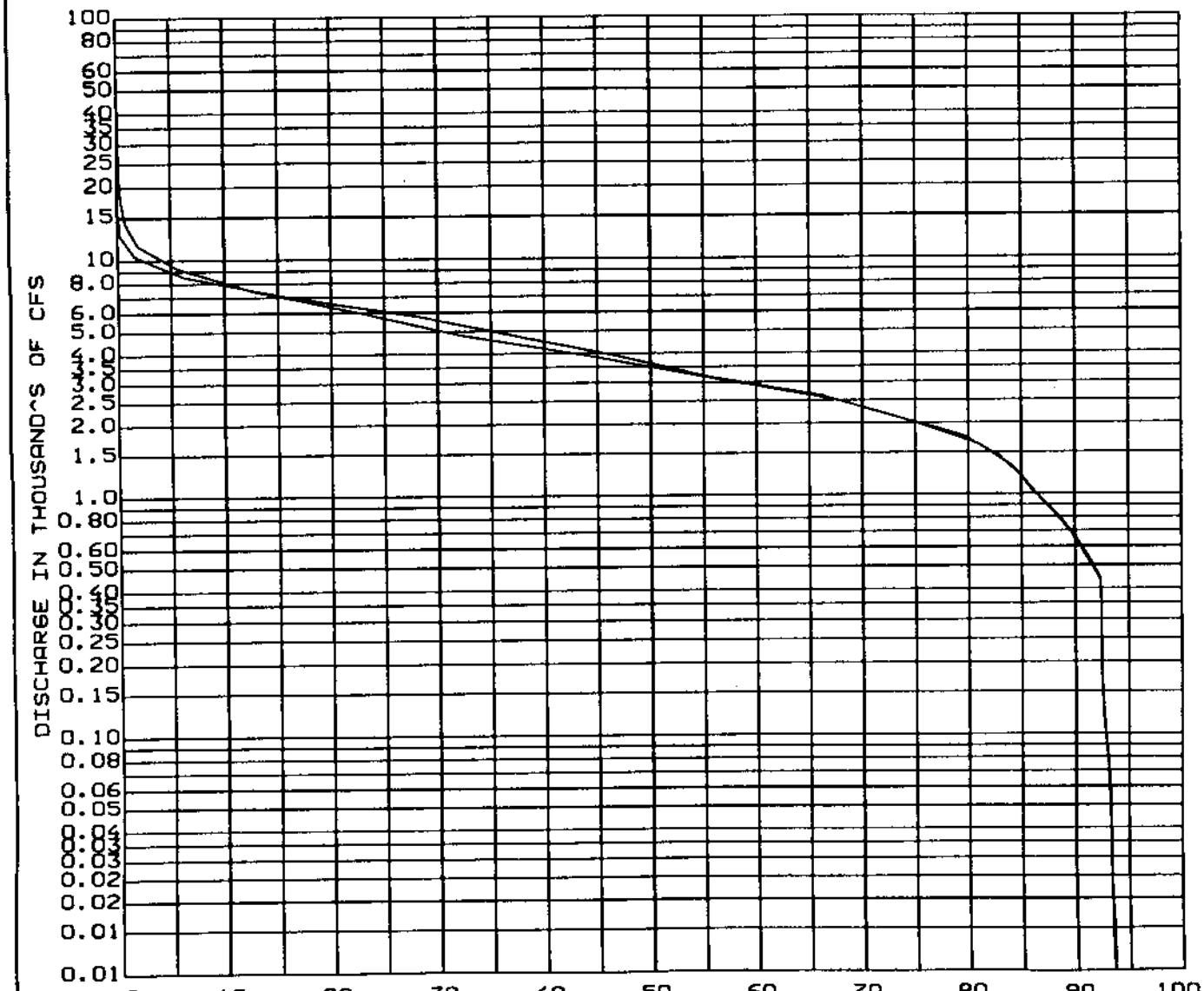
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
FEB - FEB
DISCHARGE DURATION
PLATE C018



LEGEND

RUN NO.	SYMBOL
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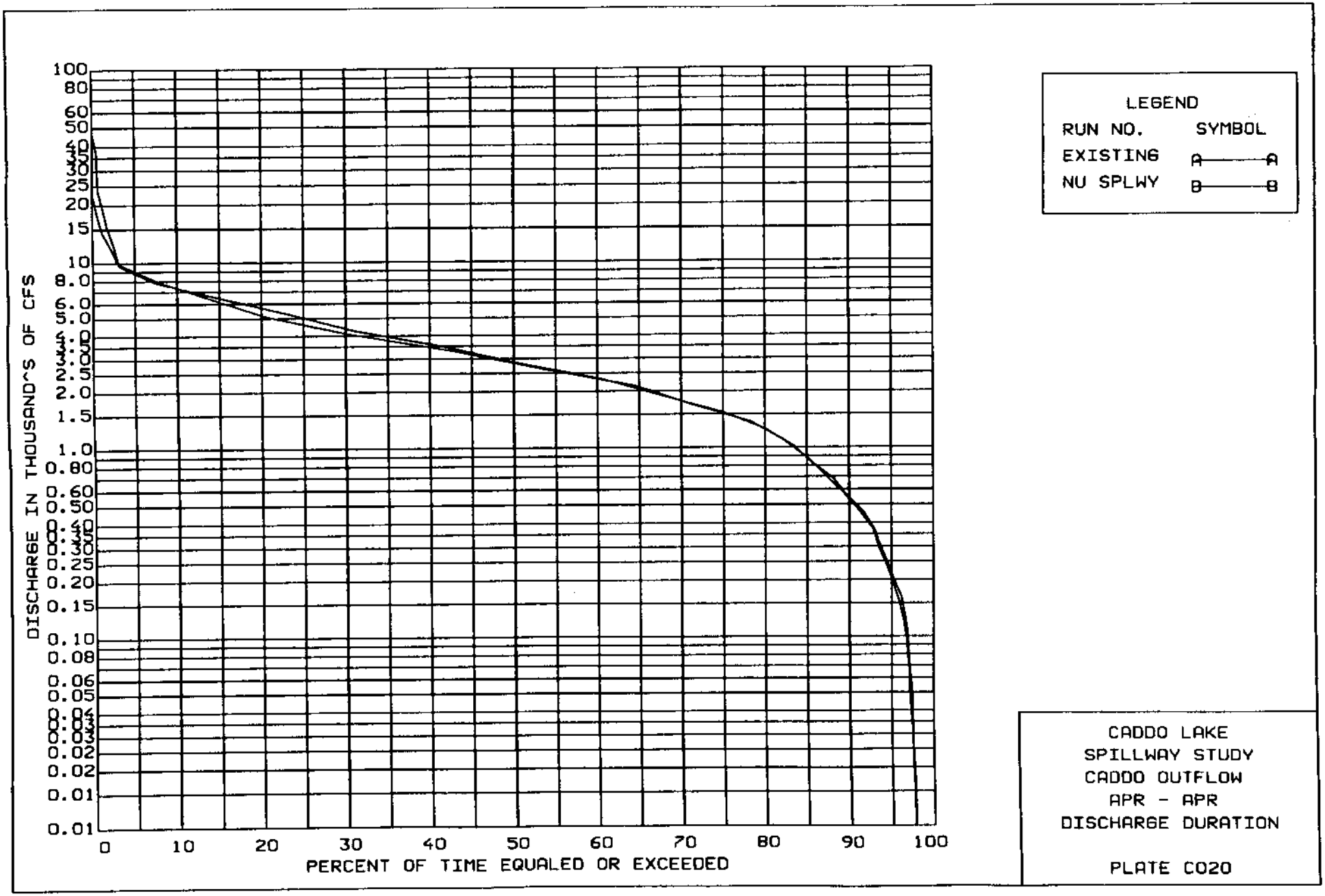
NU SPLWY	B——B

CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
MAR - MAR
DISCHARGE DURATION

PLATE C019


DISCHARGE IN THOUSAND'S OF CFS
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3.5
3.0
2.5
2.0
1.5
1.0
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0.60
0.50
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0.25
0.20
0.15
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0.06
0.05
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0.03
0.02
0.02
0.01
0.01
0
10
20
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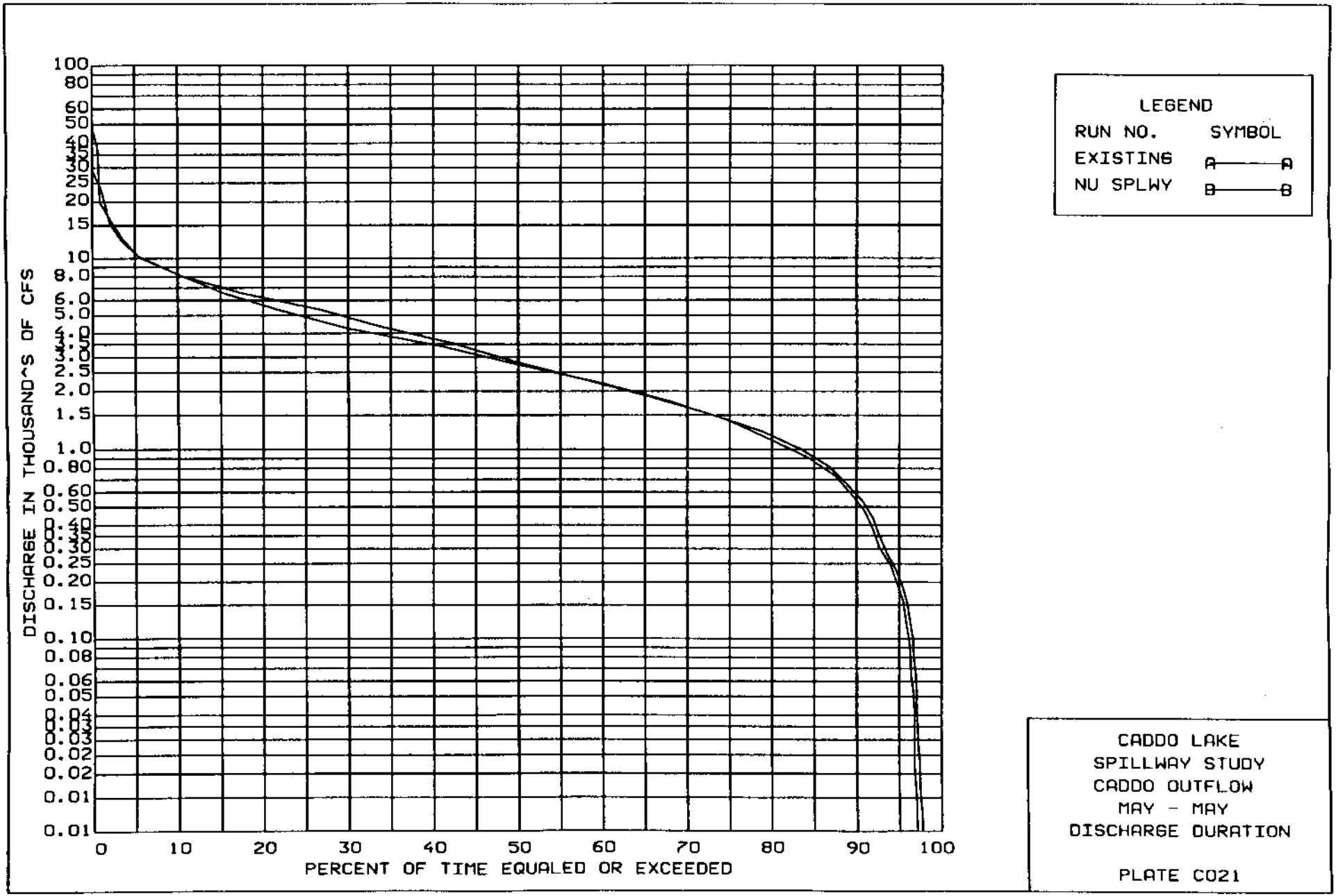
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
APR - APR
DISCHARGE DURATION
PLATE C020


DISCHARGE IN THOUSAND^S OF CFS
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2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
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B
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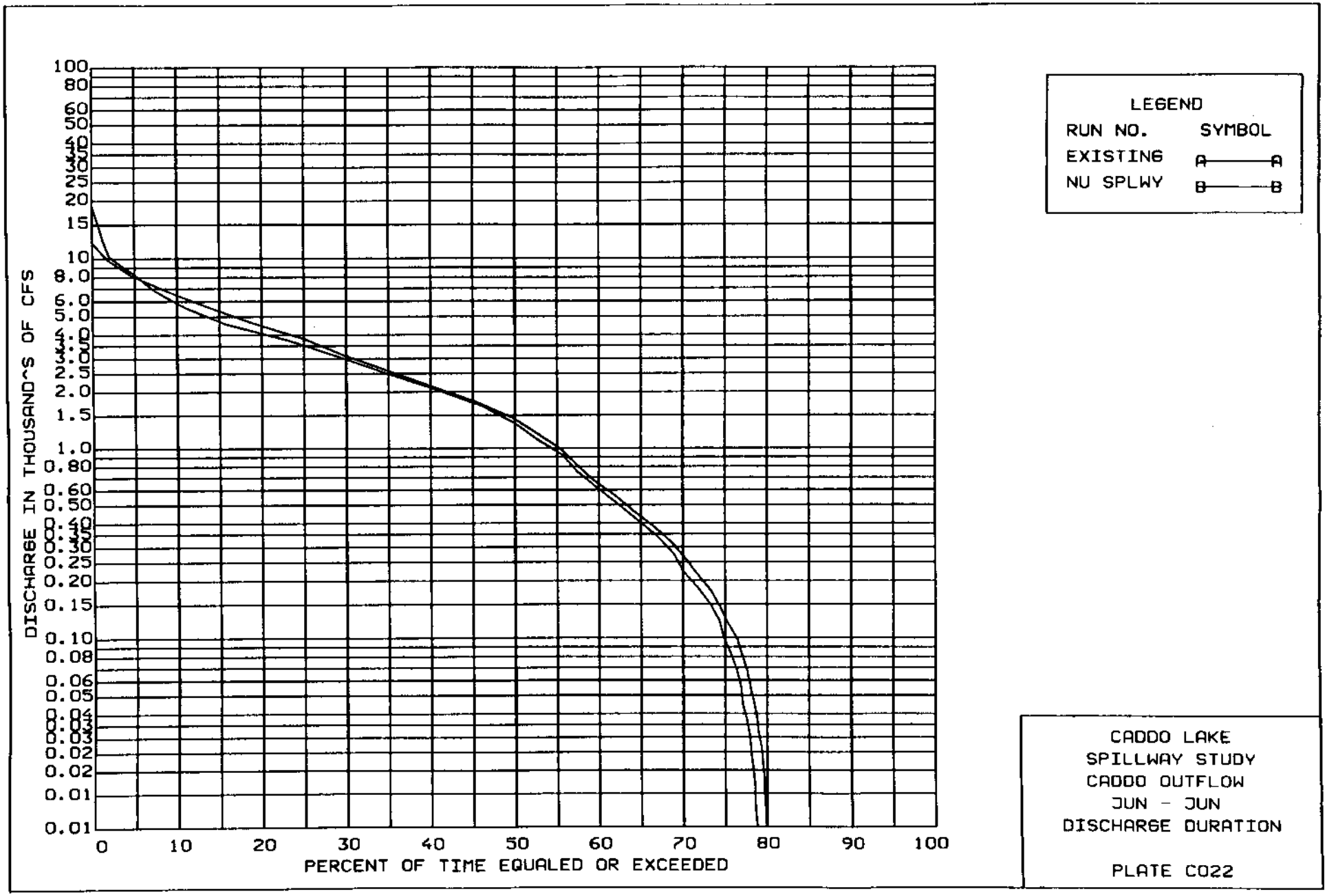
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
MAY - MAY
DISCHARGE DURATION
PLATE C021


DISCHARGE IN THOUSAND^S OF CFS
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25
20
15
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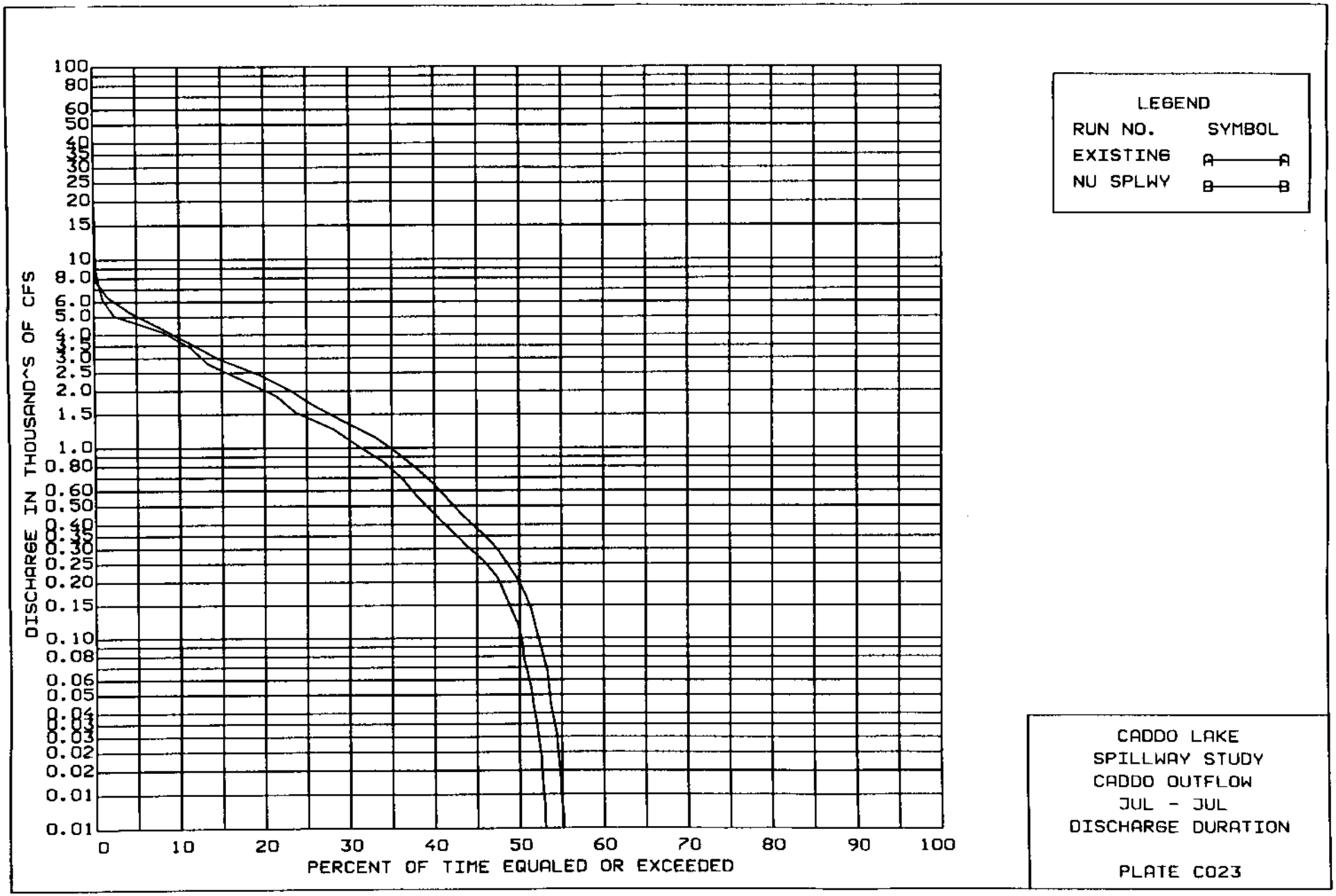
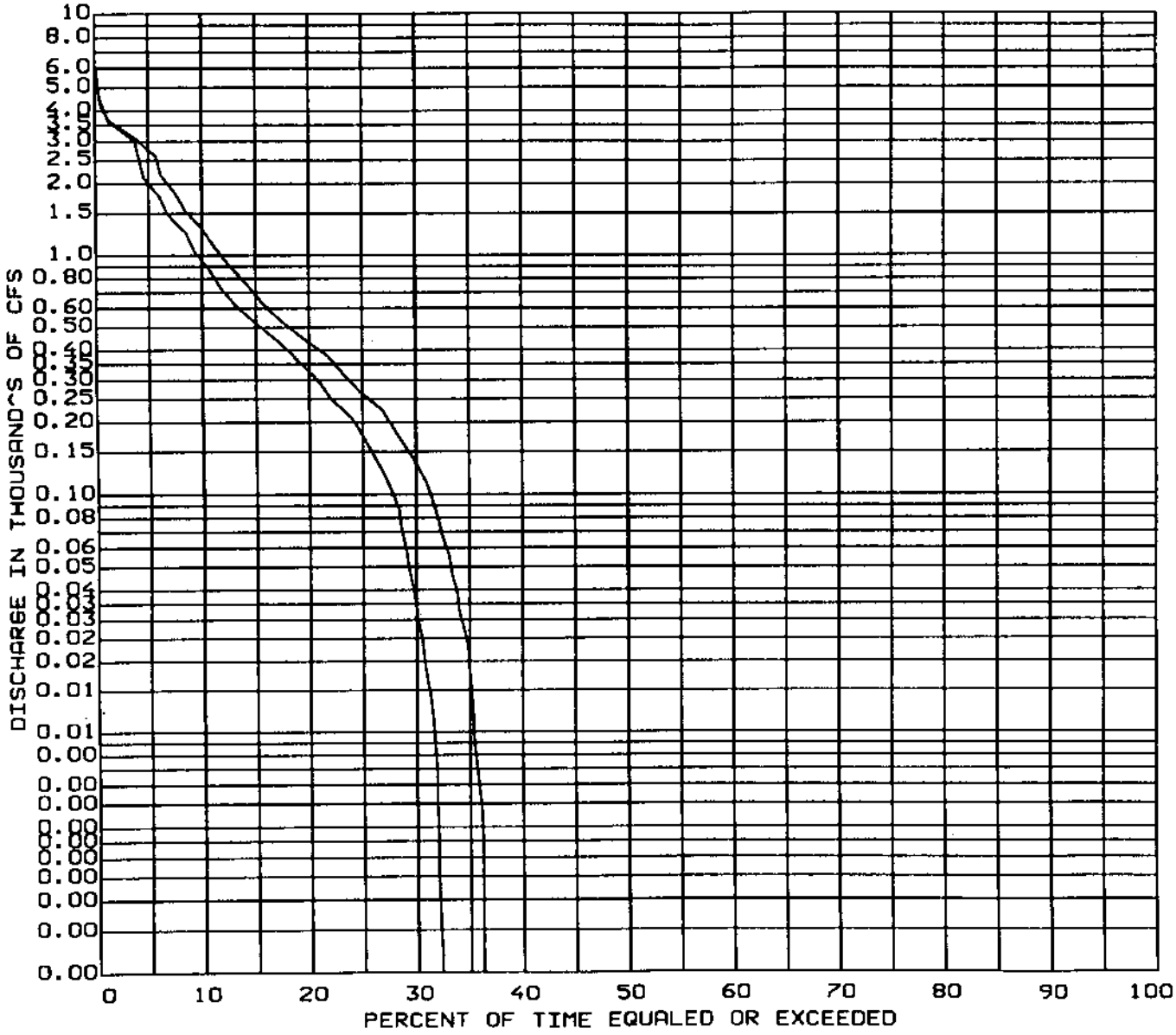
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
JUN - JUN
DISCHARGE DURATION
PLATE C022


DISCHARGE IN THOUSAND^S OF CFS
100
80
60
50
40
30
25
20
15
10
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
JUL - JUL
DISCHARGE DURATION
PLATE C023

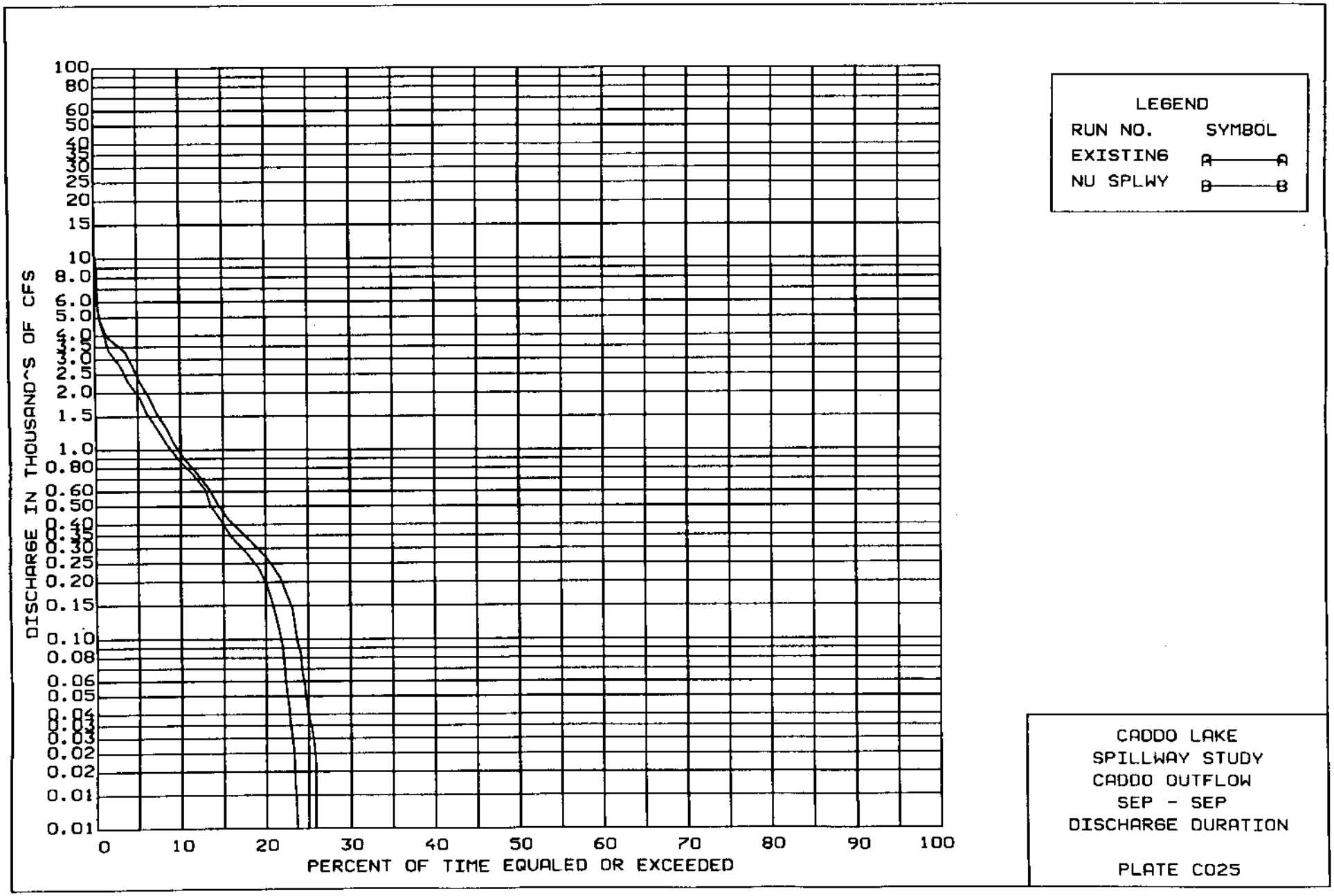


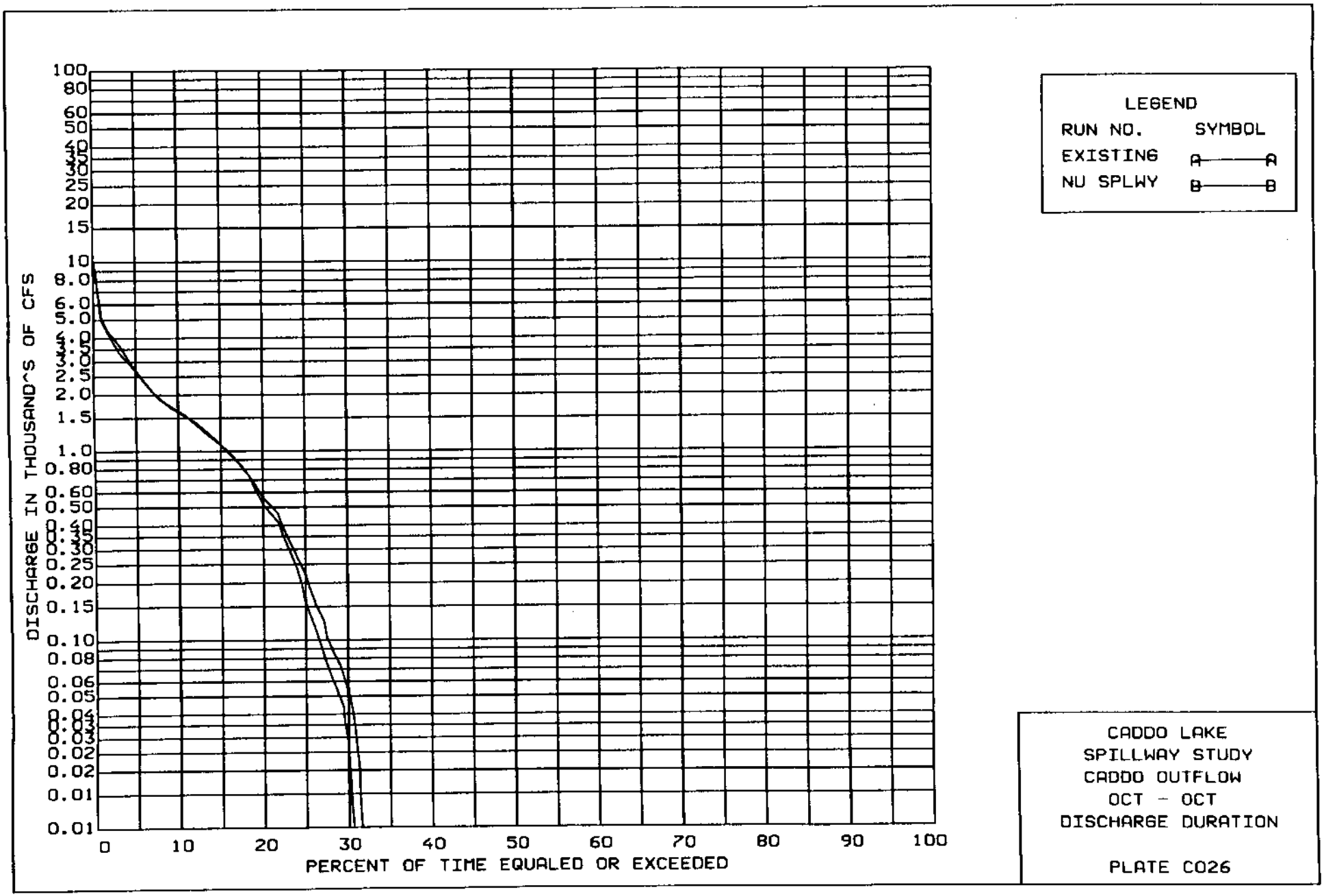
LEGEND

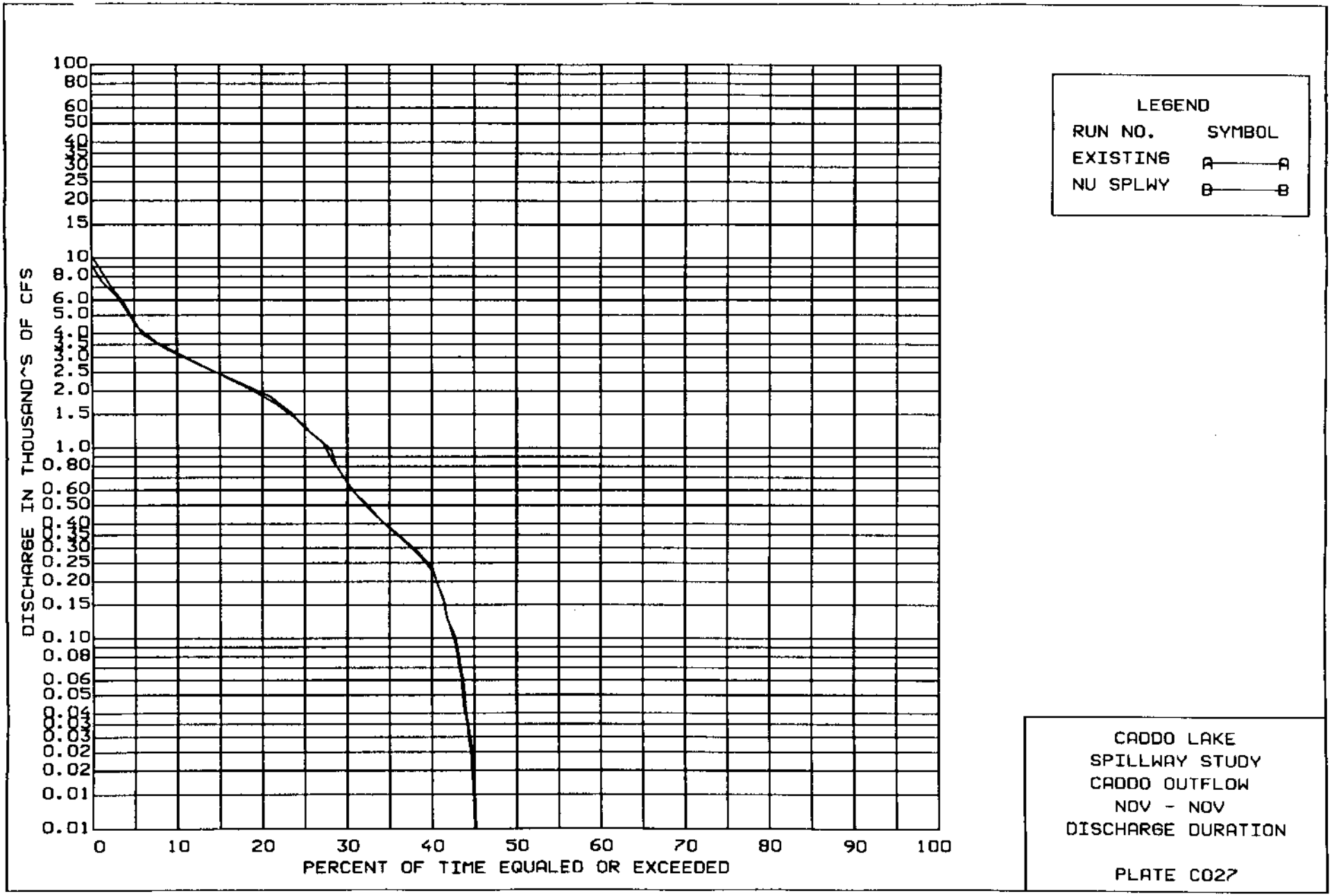
RUN NO.	SYMBOL
EXISTING	A——A
NU SPLWY	B——B

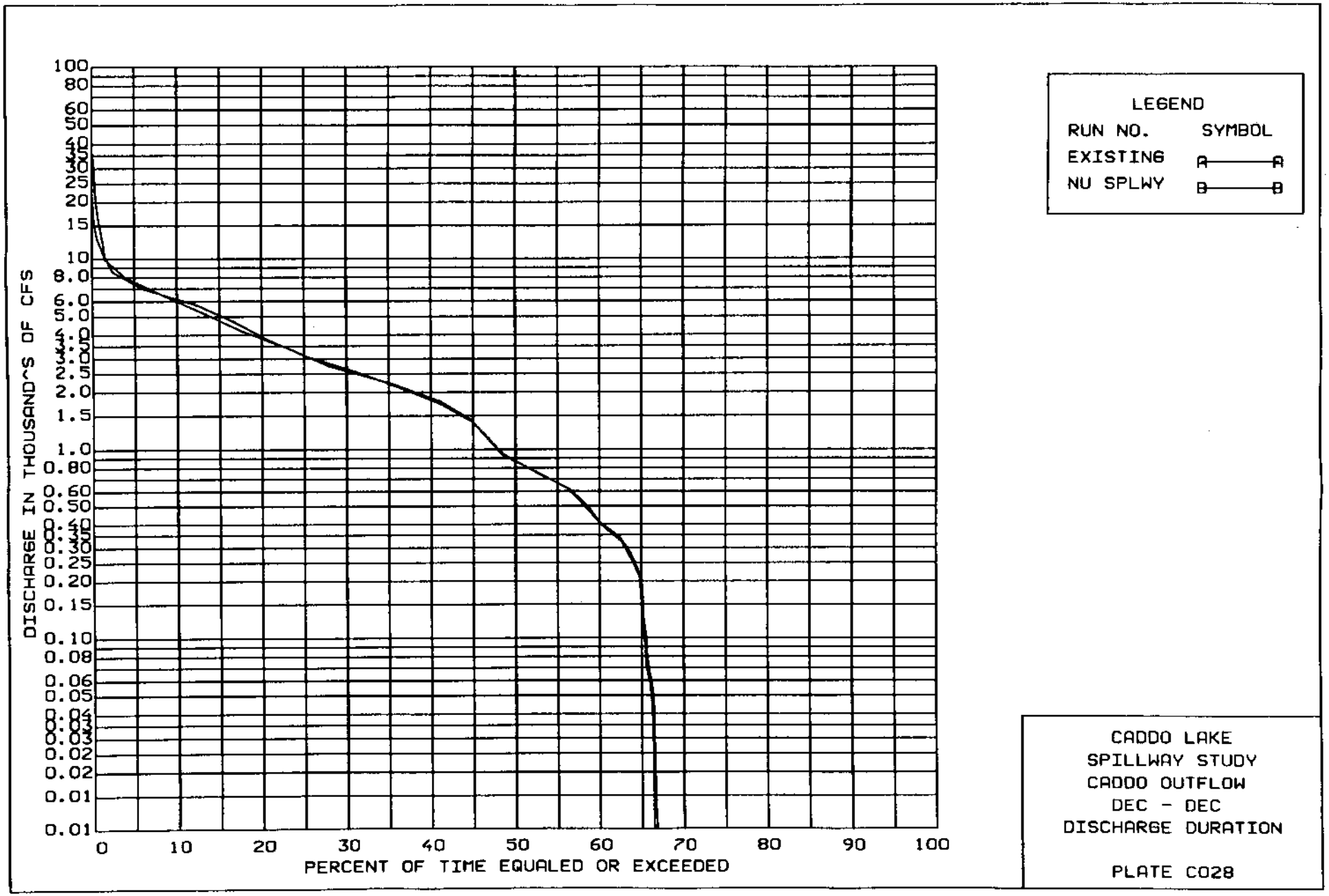
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
AUG - AUG
DISCHARGE DURATION

PLATE C024


DISCHARGE IN THOUSAND'S OF CFS
100
80
60
50
40
30
25
20
15
10
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
SEP - SEP
DISCHARGE DURATION
PLATE C025


DISCHARGE IN THOUSAND'S OF CFS
100
80
60
50
40
30
25
20
15
10
8.0
6.0
5.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
OCT - OCT
DISCHARGE DURATION
PLATE C026


DISCHARGE IN THOUSAND^S OF CFS
100
80
60
50
40
30
25
20
15
10
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
LEGEND
RUN NO.
SYMBOL
EXISTING
A
A
NU SPLWY
B
B
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
NOV - NOV
DISCHARGE DURATION
PLATE C027


LEGEND
RUN NO. SYMBOL
EXISTING A A
NU SPLWY B B
DISCHARGE IN THOUSAND^S OF CFS
100
80
60
50
40
35
30
25
20
15
10
8.0
6.0
5.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.80
0.60
0.50
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.02
0.01
0.01
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME EQUALED OR EXCEEDED
CADDO LAKE
SPILLWAY STUDY
CADDO OUTFLOW
DEC - DEC
DISCHARGE DURATION
PLATE C028

Hydraulics

Downstream of Caddo Lake, 12 Mile Bayou appears to be an old meander of the Red River. It is now separated from the Red River by an agricultural area surrounded by levees. The levees have an average crest of 185.M.S.L. immediately below Caddo Lake Dam. The 12 Mile Bayou channel runs south from Caddo Lake and enters the Red River above Shreveport, Louisiana. 12 Mile Bayou carries the flows out of Caddo Lake (drainage area 2744 square miles at the dam) and the runoff from Black Bayou (drainage area 231 Square Miles at Hosston, La.).

Caddo Lake is broad and very shallow. Originally formed as backwater of the Great Red River Log Jam, Caddo Lake now has a weir structure to control the water surface elevation. The lowest weir is at 168.5 M.S.L. and is 860 feet long. The next step in the weir is at 170 M.S.L. and provides an additional 1540 feet of length. Full flow across to total length of the dam takes place at 176.0 M.S.L. providing an additional 800 feet of opening. An earlier dam had an 800 foot opening at 168.5 M.S.L. with an additional crest length of approximately 2500 feet at 170.5 M.S.L.

In flood flow conditions, Caddo Lake will have an appreciable slope between the dam and the headwaters. The headwaters of Caddo Lake would be approximately at Karnack, Texas, however, backwater effects from the lake extend upstream as far as Jefferson, Texas. The embankments for Highway 1 and Highway 538 extend into the lake causing additional conveyance problems.

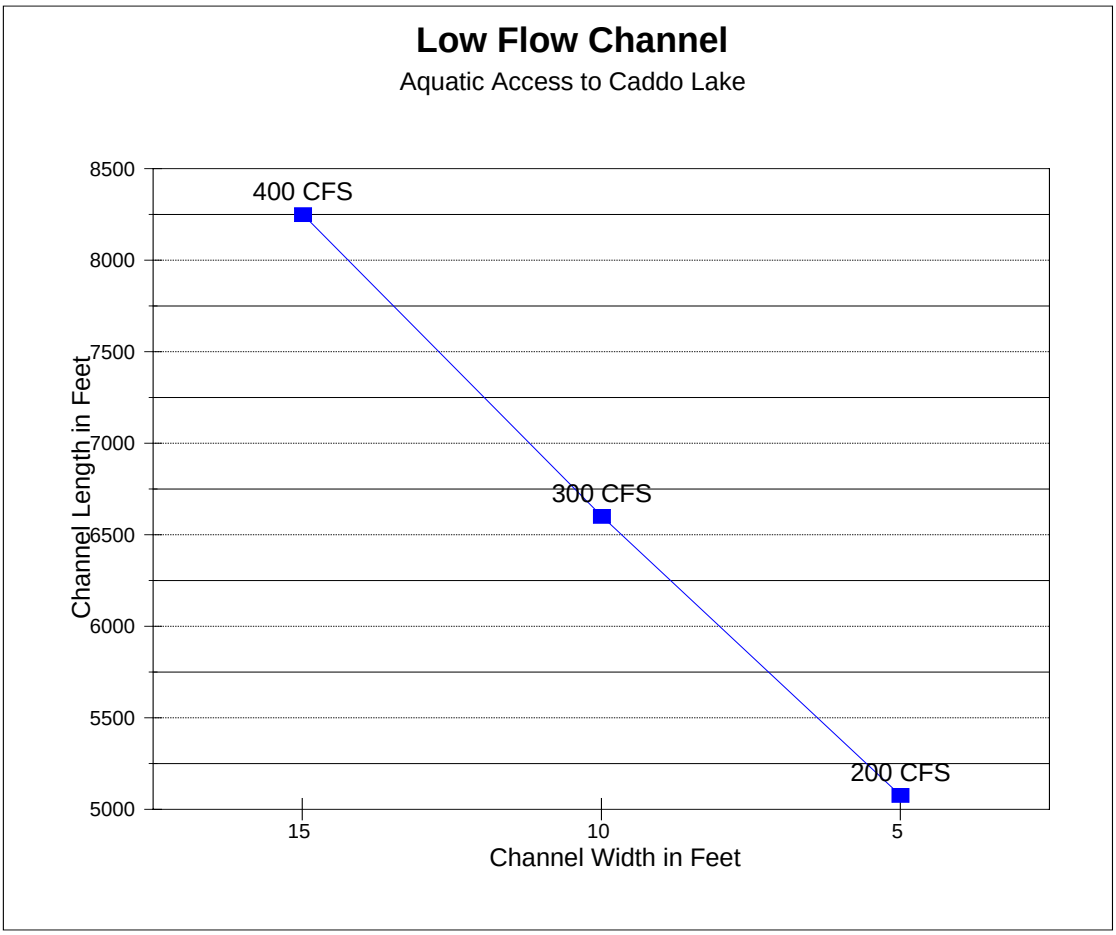
Between Caddo Lake and the City of Jefferson, Texas, Little Cypress Creek (drainage area 675 square miles) and Black Cypress Bayou (drainage area 365 square miles) combine with Big Cypress Bayou. While still at risk from backwater effects from Caddo Lake, Black Cypress Bayou and Little Cypress Creek, the City of Jefferson is protected from the flooding of Big Cypress Bayou by the flood control capabilities of Lake of the Pines that controls Big Cypress Bayou (drainage area of 850 square miles at the dam site).

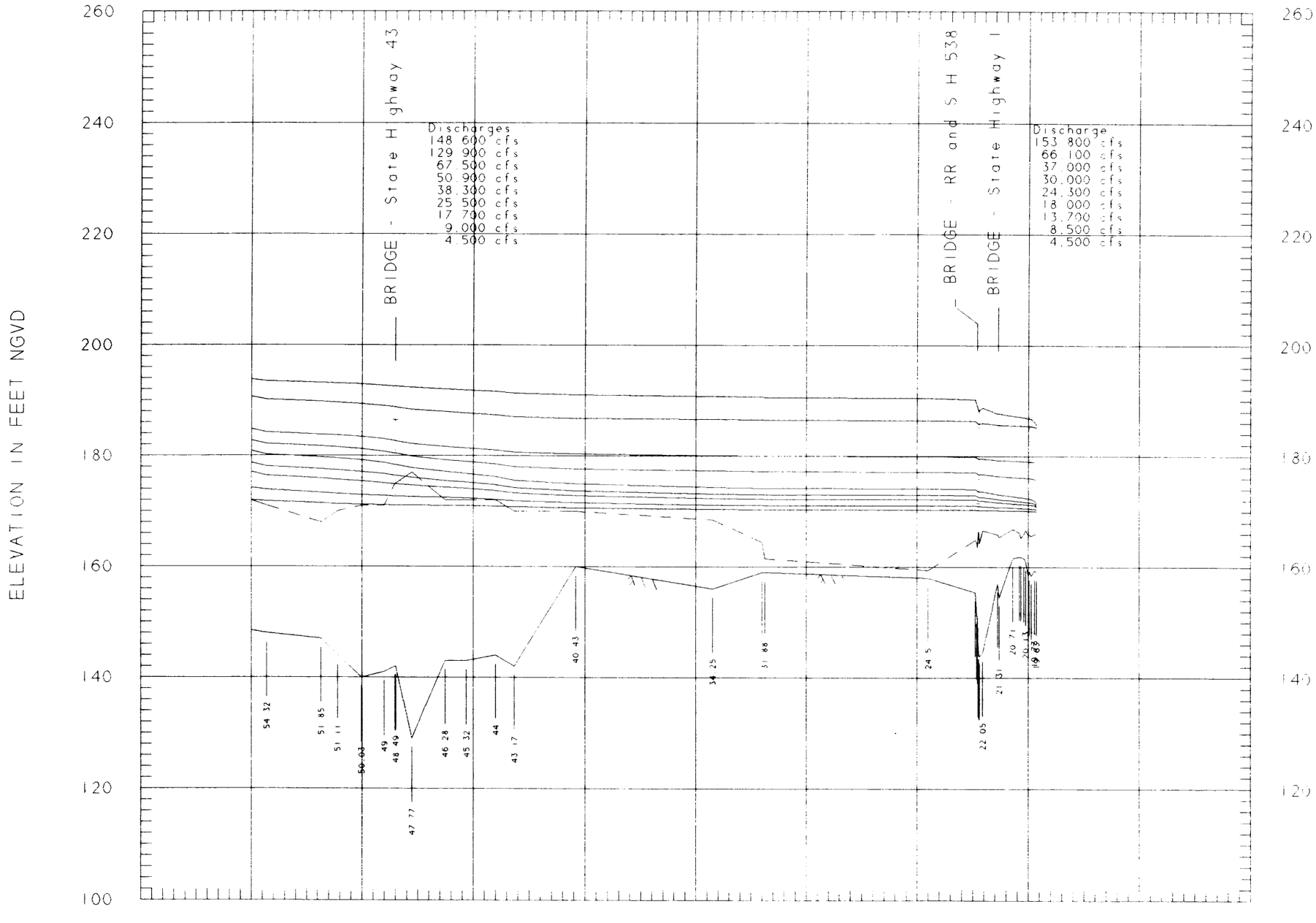
Field surveys revealed substantial amounts of development close to the water course of Big Cypress Bayou and around Caddo Lake. Even before economic analysis, it was assumed that any modification of Caddo Lake would have to maintain or reduce the frequency of flooding to avoid inducing damages.

Based upon hydrologic, hydraulic and the location of areas of potential flood damages, the hydraulic design efforts focused on the Caddo Lake Dam. Water surface profile studies showed that control of the water surface of Caddo Lake shifted from the dam to 12 Mile Bayou and the agricultural levee for events of a greater magnitude than the 25 year (4% probability) flood. For events occurring more frequently that the 25-year event, modifications to the Caddo Lake Dam could provide some reduction in flood damages. Two features were considered for increasing the release rate of Caddo Lake Dam. A labyrinth weir could be used to increase the rate of discharge for a given lake water surface, which would provide some flood relief for events less than the 25 year. Tainter gates set at a lower elevation could be used to draw down Caddo lake in anticipation of a flood event, which would make better use of the limited conveyance capabilities of 12 mile bayou.

A second object, after reduction of flood damages, was to provide a connection between Caddo Lake and 12 Mile Bayou, which would be traversable by aquatic organisms. Design constraints of velocity and depth were estimated. A velocity of 5 feet per second was estimated to be the maximum which aquatic organisms could stem. A depth of 3 feet would be required to retard aquatic vegetation. The entire system would have to fit between the existing dam and the channel of Black Bayou. Several possible trapezoidal channel configurations were found which meet the constraints. All configurations assumed a grass lined trapezoidal channel with 3 on 1 side slopes, variation of the width and slope of the bottom produced a design line.

With the proposed labyrinth weir an alternative which sacrificed some of the discharge of the existing weir becomes possible. By blocking the existing ogee weir and it=s outfall channel a sheet flow condition could be obtained downstream from the existing weir. This alternative would require minimal earthwork and could be view as a partial wetlands restoration.

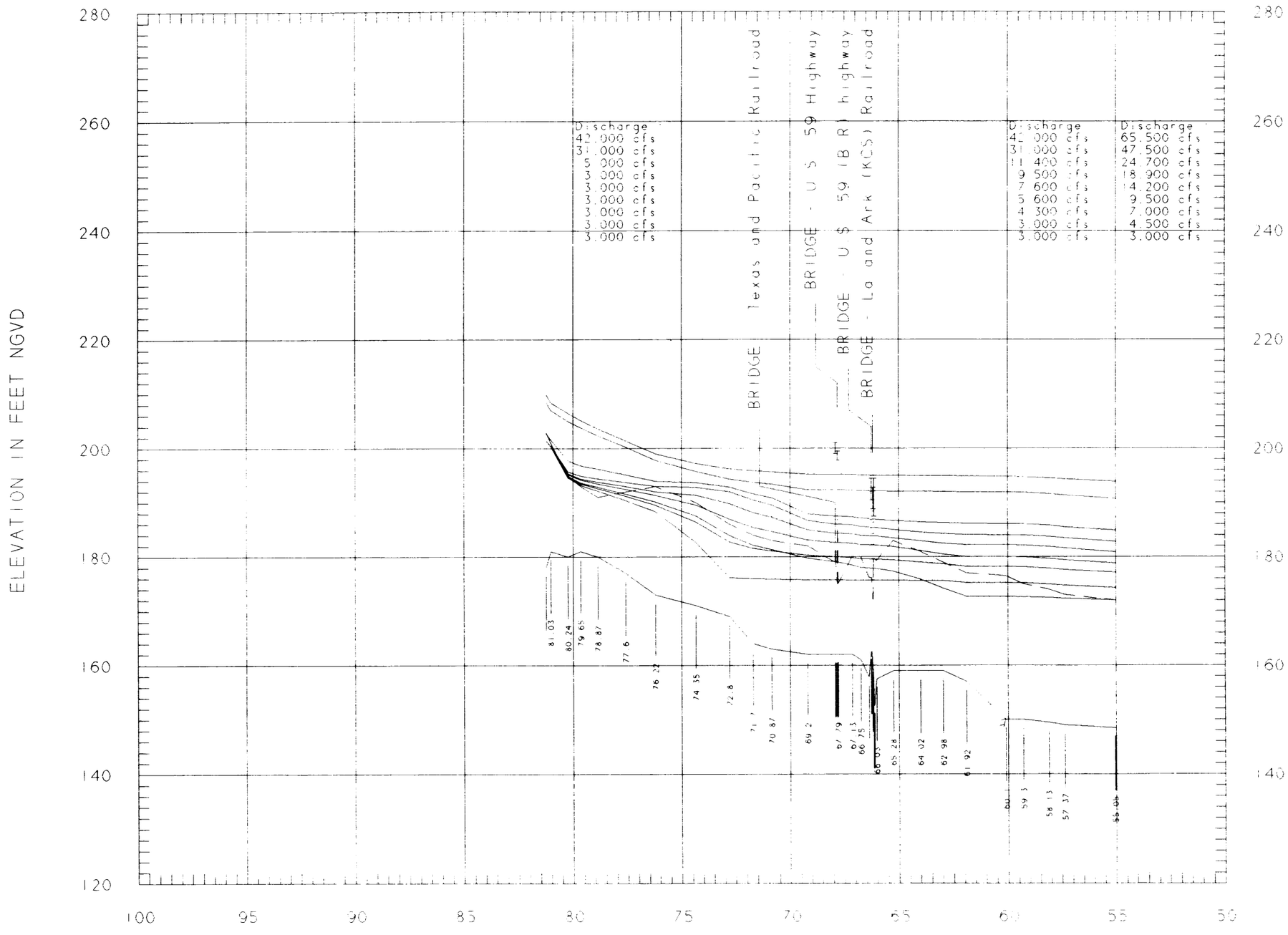

Low Flow Channel
Aquatic Access to Caddo Lake
8500
8000
7500
7000
6500
6000
5500
5000
Channel Length in Feet
400 CFS
300 CFS
200 CFS
15
10
5
Channel Width in Feet



Big Cypress Bayou
Cypress Valley Watershed
Caddo Lake - Lake of the Pines
EXISTING & WEIR DESIGN
Water Surface Profiles

U.S. ARMY ENGINEER DISTRICT FT WORTH

FIGURE 1



LEGEND

Existing Profiles

Design Profiles ————

For:

SPF

0.50% Exceedence

1.00% Exceedence

2.00% Exceedence

5.00% Exceedence

10.0% Exceedence

20.0% Exceedence

50.0% Exceedence

99.0% Exceedence

Big Cypress Bayou

Cypress Valley Watershed

Caddo Lake - Lake of the Pines

EXISTING & WEIR DESIGN

Water Surface Profiles

U.S. ARMY ENGINEER DISTRICT FT WORTH

FIGURE 2

```
   1 TI CADDO LAKE ANNUAL WATER SURFACE ELEVATION AT MOORINGSPORT
********* ABOVE IDENTIFICATION CODE IS INVALID, RECORD IGNORED
   2 TI CYPRESS BASIN STUDY
********* ABOVE IDENTIFICATION CODE IS INVALID, RECORD IGNORED
   3 TI G.R.PERRY
********* ABOVE IDENTIFICATION CODE IS INVALID, RECORD IGNORED

++++++++++++++++++++++++++++++++++++++++++++
+ STATISTICAL ANALYSIS OF TIME SERIES DATA  +
+ VERSION DATE             NOVEMBER  1985 +
+ THIS VERSION IS STILL SUBJECT TO REVISION +
++++++++++++++++++++++++++++++++++++++++++++



**JOB SPECIFICATIONS**
  JSTAT  NPRDS   NYRS  MONWY  JBEGN   JEND   JPPF  MONSS  LOGTM  NDECM
J1    3     1     57     1     1      0      2     0      0      2

**LOCATION IDENTIFICATION**
ID 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT, LA.

**LOCATION SPECIFICATIONS**
  IANAL   NAME   LOGT   NDEC   NSIG  IPRNT   TEST
LS    3ELEV,MSL     -1      2      5      0     0.

**INPUT TIME SERIES DATA**
IN  1921  174.
IN  1922  174.
IN  1923  170.
IN  1924  171.
IN  1925  169.
IN  1926  171.
IN  1927  173.
IN  1928  170.
IN  1929  174.
IN  1930  179.
IN  1931  170.
IN  1932  174.
IN  1933  173.
IN  1934  171.
IN  1935  172.
IN  1936  170.
IN  1937  172.
IN  1938  174.
IN  1939  171.
IN  1940  170.
IN  1941  173.
IN  1942  174.
IN  1943  169.
IN  1944  178.
IN  1945  182.
IN  1946  176.
IN  1947  171.
IN  1948  172.
IN  1949  170.
IN  1950  175.
IN  1951  170.
IN  1952  171.
IN  1953  176.
IN  1954  169.
IN  1955  170.
IN  1956  169.
IN  1957  178.
IN  1958  182.
IN  1959  170.
IN  1960  170.
```

IN 1961 173.
IN 1962 171.
IN 1963 170.
IN 1964 169.
IN 1965 170.
IN 1966 180.
IN 1967 170.
IN 1968 171.
IN 1969 171.
IN 1970 170.
IN 1971 170.
IN 1972 171.
IN 1973 175.
IN 1974 173.
IN 1975 174.
IN 1976 171.
IN 1977 171.
IN 1978 170.

- ANALYSIS OF MAXIMUMS -

-PLOTTING POSITIONS- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

MON	DAY	YEAR	ELEV,MSL	RANK	YEAR	ELEV,MSL	PLOT POS
-1	-1	1	174.30	1	38	182.50	1.20
-1	-1	2	174.10	2	25	181.80	2.91
-1	-1	3	170.30	3	46	180.10	4.62
-1	-1	4	170.90	4	10	178.70	6.34
-1	-1	5	169.30	5	24	178.50	8.05
-1	-1	6	171.30	6	37	178.00	9.76
-1	-1	7	173.40	7	26	176.30	11.47
-1	-1	8	170.10	8	33	176.20	13.18
-1	-1	9	173.80	9	30	175.30	14.90
-1	-1	10	178.70	10	53	175.30	16.61
-1	-1	11	169.90	11	1	174.30	18.32
-1	-1	12	174.20	12	12	174.20	20.03
-1	-1	13	172.70	13	22	174.10	21.75
-1	-1	14	171.50	14	2	174.10	23.46
-1	-1	15	172.50	15	18	173.90	25.17
-1	-1	16	170.10	16	9	173.80	26.88
-1	-1	17	171.90	17	55	173.70	28.60
-1	-1	18	173.90	18	41	173.50	30.31
-1	-1	19	171.30	19	7	173.40	32.02
-1	-1	20	170.30	20	54	173.30	33.73
-1	-1	21	172.60	21	13	172.70	35.45
-1	-1	22	174.10	22	21	172.60	37.16
-1	-1	23	169.40	23	15	172.50	38.87
-1	-1	24	178.50	24	17	171.90	40.58
-1	-1	25	181.80	25	28	171.80	42.29
-1	-1	26	176.30	26	14	171.50	44.01
-1	-1	27	171.30	27	49	171.50	45.72
-1	-1	28	171.80	28	19	171.30	47.43
-1	-1	29	170.10	29	6	171.30	49.14
-1	-1	30	175.30	30	27	171.30	50.86
-1	-1	31	170.20	31	32	171.00	52.57
-1	-1	32	171.00	32	48	171.00	54.28
-1	-1	33	176.20	33	4	170.90	55.99
-1	-1	34	169.30	34	56	170.80	57.71
-1	-1	35	170.10	35	42	170.70	59.42
-1	-1	36	169.40	36	57	170.70	61.13
-1	-1	37	178.00	37	52	170.60	62.84
-1	-1	38	182.50	38	40	170.30	64.55
-1	-1	39	170.10	39	45	170.30	66.27
-1	-1	40	170.30	40	3	170.30	67.98
-1	-1	41	173.50	41	20	170.30	69.69
-1	-1	42	170.70	42	31	170.20	71.40
-1	-1	43	169.80	43	39	170.10	73.12
-1	-1	44	169.50	44	35	170.10	74.83
-1	-1	45	170.30	45	16	170.10	76.54
-1	-1	46	180.10	46	50	170.10	78.25
-1	-1	47	169.80	47	29	170.10	79.97
-1	-1	48	171.00	48	8	170.10	81.68
-1	-1	49	171.50	49	11	169.90	83.39
-1	-1	50	170.10	50	43	169.80	85.10
-1	-1	51	169.60	51	47	169.80	86.82
-1	-1	52	170.60	52	58	169.80	88.53
-1	-1	53	175.30	53	51	169.60	90.24
-1	-1	54	173.30	54	44	169.50	91.95
-1	-1	55	173.70	55	36	169.40	93.66
-1	-1	56	170.80	56	23	169.40	95.38
-1	-1	57	170.70	57	5	169.30	97.09
-1	-1	58	169.80	58	34	169.30	98.80

**** GRAPHICAL FIT TO DATA *****

-FREQUENCY CURVE- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

.....ELEV,MSL.....	PERCENT	*...CONFIDENCE LIMITS...*	
* EXPECTED	* CHANCE	*	*
* COMPUTED	PROBABILITY *	EXCEEDANCE *	0.50 LIMIT 0.50 LIMIT *
* 183.37	183.37 *	0.2 *	-1.00 -1.00 *
* 182.94	182.94 *	0.5 *	-1.00 -1.00 *
* 182.60	182.60 *	1.0 *	-1.00 -1.00 *
* 182.19	182.19 *	2.0 *	-1.00 -1.00 *
* 179.73	179.73 *	5.0 *	-1.00 -1.00 *
* 177.83	177.83 *	10.0 *	-1.00 -1.00 *
* 174.20	174.20 *	20.0 *	-1.00 -1.00 *
* 171.30	171.30 *	50.0 *	-1.00 -1.00 *
* 170.10	170.10 *	80.0 *	-1.00 -1.00 *
* 169.62	169.62 *	90.0 *	-1.00 -1.00 *
* 169.40	169.40 *	95.0 *	-1.00 -1.00 *
* 169.30	169.30 *	99.0 *	-1.00 -1.00 *

***** ANALYTICAL FIT TO DATA *****

CAUTION FROM SUBROUTINE WTSKEW
***** NO GENERALIZED SKEW PROVIDED
ADOPTED SKEW SET TO COMPUTED SKEW

-FREQUENCY CURVE- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

.....ELEV,MSL.....	PERCENT	*...CONFIDENCE LIMITS...*	
* EXPECTED	* CHANCE	*	*
* COMPUTED	PROBABILITY *	EXCEEDANCE *	0.05 LIMIT 0.95 LIMIT *
* 187.40	188.66 *	0.2 *	190.22 185.30 *
* 184.97	185.87 *	0.5 *	187.37 183.18 *
* 183.12	183.77 *	1.0 *	185.20 181.56 *
* 181.24	181.70 *	2.0 *	183.01 179.90 *
* 178.71	178.95 *	5.0 *	180.07 177.65 *
* 176.73	176.87 *	10.0 *	177.80 175.86 *
* 174.67	174.74 *	20.0 *	175.51 173.95 *
* 171.70	171.70 *	50.0 *	172.39 170.97 *
* 169.82	169.80 *	80.0 *	170.57 168.94 *
* 169.21	169.18 *	90.0 *	169.99 168.26 *
* 168.85	168.81 *	95.0 *	169.66 167.85 *
* 168.44	168.42 *	99.0 *	169.29 167.40 *

* SYSTEMATIC STATISTICS	*
* NO TRANSFORM OF ELEV,MSL *	NUMBER OF EVENTS *
* MEAN 172.46 *	HISTORIC EVENTS 0 *
* STANDARD DEV 3.20 *	HIGH OUTLIERS 0 *
* COMPUTED SKEW 1.4816 *	LOW OUTLIERS 0 *
* GENERALIZED SKEW -99.0000 *	ZERO OR MISSING 0 *
* ADOPTED SKEW 1.5000 *	SYSTEMATIC EVENTS 58 *

- ANALYSIS OF MINIMUMS -

-PLOTTING POSITIONS- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

MON	DAY	YEAR	ELEV,MSL	RANK	YEAR	ELEV,MSL	PLOT POS
-1	-1	1	174.30	1	5	169.30	1.20
-1	-1	2	174.10	2	34	169.30	2.91
-1	-1	3	170.30	3	23	169.40	4.62
-1	-1	4	170.90	4	36	169.40	6.34
-1	-1	5	169.30	5	44	169.50	8.05
-1	-1	6	171.30	6	51	169.60	9.76
-1	-1	7	173.40	7	43	169.80	11.47
-1	-1	8	170.10	8	47	169.80	13.18
-1	-1	9	173.80	9	58	169.80	14.90
-1	-1	10	178.70	10	11	169.90	16.61
-1	-1	11	169.90	11	16	170.10	18.32
-1	-1	12	174.20	12	29	170.10	20.03
-1	-1	13	172.70	13	35	170.10	21.75
-1	-1	14	171.50	14	39	170.10	23.46
-1	-1	15	172.50	15	8	170.10	25.17
-1	-1	16	170.10	16	50	170.10	26.88
-1	-1	17	171.90	17	31	170.20	28.60
-1	-1	18	173.90	18	20	170.30	30.31
-1	-1	19	171.30	19	3	170.30	32.02
-1	-1	20	170.30	20	40	170.30	33.73
-1	-1	21	172.60	21	45	170.30	35.45
-1	-1	22	174.10	22	52	170.60	37.16
-1	-1	23	169.40	23	42	170.70	38.87
-1	-1	24	178.50	24	57	170.70	40.58
-1	-1	25	181.80	25	56	170.80	42.29
-1	-1	26	176.30	26	4	170.90	44.01
-1	-1	27	171.30	27	32	171.00	45.72
-1	-1	28	171.80	28	48	171.00	47.43
-1	-1	29	170.10	29	27	171.30	49.14
-1	-1	30	175.30	30	19	171.30	50.86
-1	-1	31	170.20	31	6	171.30	52.57
-1	-1	32	171.00	32	14	171.50	54.28
-1	-1	33	176.20	33	49	171.50	55.99
-1	-1	34	169.30	34	28	171.80	57.71
-1	-1	35	170.10	35	17	171.90	59.42
-1	-1	36	169.40	36	15	172.50	61.13
-1	-1	37	178.00	37	21	172.60	62.84
-1	-1	38	182.50	38	13	172.70	64.55
-1	-1	39	170.10	39	54	173.30	66.27
-1	-1	40	170.30	40	7	173.40	67.98
-1	-1	41	173.50	41	41	173.50	69.69
-1	-1	42	170.70	42	55	173.70	71.40
-1	-1	43	169.80	43	9	173.80	73.12
-1	-1	44	169.50	44	18	173.90	74.83
-1	-1	45	170.30	45	2	174.10	76.54
-1	-1	46	180.10	46	22	174.10	78.25
-1	-1	47	169.80	47	12	174.20	79.97
-1	-1	48	171.00	48	1	174.30	81.68
-1	-1	49	171.50	49	53	175.30	83.39
-1	-1	50	170.10	50	30	175.30	85.10
-1	-1	51	169.60	51	33	176.20	86.82
-1	-1	52	170.60	52	26	176.30	88.53
-1	-1	53	175.30	53	37	178.00	90.24
-1	-1	54	173.30	54	24	178.50	91.95
-1	-1	55	173.70	55	10	178.70	93.66
-1	-1	56	170.80	56	46	180.10	95.38
-1	-1	57	170.70	57	25	181.80	97.09
-1	-1	58	169.80	58	38	182.50	98.80

**** GRAPHICAL FIT TO DATA *****

-FREQUENCY CURVE- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

.....ELEV,MSL.....	PERCENT	*...CONFIDENCE LIMITS...*	
* EXPECTED	* CHANCE NON- *	*	
* COMPUTED	PROBABILITY *	EXCEEDANCE *	0.50 LIMIT 0.50 LIMIT *
* 169.30	169.30 *	0.2 *	-1.00 -1.00 *
* 169.30	169.30 *	0.5 *	-1.00 -1.00 *
* 169.30	169.30 *	1.0 *	-1.00 -1.00 *
* 169.30	169.30 *	2.0 *	-1.00 -1.00 *
* 169.40	169.40 *	5.0 *	-1.00 -1.00 *
* 169.62	169.62 *	10.0 *	-1.00 -1.00 *
* 170.10	170.10 *	20.0 *	-1.00 -1.00 *
* 171.30	171.30 *	50.0 *	-1.00 -1.00 *
* 174.20	174.20 *	80.0 *	-1.00 -1.00 *
* 177.83	177.83 *	90.0 *	-1.00 -1.00 *
* 179.73	179.73 *	95.0 *	-1.00 -1.00 *
* 182.60	182.60 *	99.0 *	-1.00 -1.00 *

***** ANALYTICAL FIT TO DATA *****

CAUTION FROM SUBROUTINE WTSKEW
***** NO GENERALIZED SKEW PROVIDED
ADOPTED SKEW SET TO COMPUTED SKEW

-FREQUENCY CURVE- 07346310 CADDO LK @ CADDO LK DAM NR. MOORINGSPORT

.....ELEV,MSL.....	PERCENT	*...CONFIDENCE LIMITS...*	
* EXPECTED	* CHANCE NON- *	*	
* COMPUTED	PROBABILITY *	EXCEEDANCE *	0.05 LIMIT 0.95 LIMIT *
* 168.29	168.27 *	0.2 *	169.15 167.23 *
* 168.36	168.34 *	0.5 *	169.22 167.31 *
* 168.44	168.42 *	1.0 *	169.29 167.40 *
* 168.57	168.54 *	2.0 *	169.41 167.54 *
* 168.85	168.81 *	5.0 *	169.66 167.85 *
* 169.21	169.18 *	10.0 *	169.99 168.26 *
* 169.82	169.80 *	20.0 *	170.57 168.94 *
* 171.70	171.70 *	50.0 *	172.39 170.97 *
* 174.67	174.74 *	80.0 *	175.51 173.95 *
* 176.73	176.87 *	90.0 *	177.80 175.86 *
* 178.71	178.95 *	95.0 *	180.07 177.65 *
* 183.12	183.77 *	99.0 *	185.20 181.56 *

* SYSTEMATIC STATISTICS *			
* NO TRANSFORM OF ELEV,MSL *	NUMBER OF EVENTS *		
* MEAN	172.46 *	HISTORIC EVENTS	0 *
* STANDARD DEV	3.20 *	HIGH OUTLIERS	0 *
* COMPUTED SKEW	1.4816 *	LOW OUTLIERS	0 *
* GENERALIZED SKEW	-99.0000 *	ZERO OR MISSING	0 *
* ADOPTED SKEW	1.5000 *	SYSTEMATIC EVENTS	58 *

++++++++++++++++++++++++
+ END OF RUN +
+ NORMAL STOP IN STATS +
+ HAVE A GOOD DAY +
++++++++++++++++++++++++

LAKE O' THE PINES NEAR JEFFERSON, TX

LOCATION.--Lat 32 45'04", long 94 29'59", Marion County, Hydrologic Unit 11140305, on left bank 1,500 ft upstream from left and of Ferrell's Bridge Dam on Big Cypress Creek, on Farm Road 726, 9.0 mi west of Jefferson, and 80.1 mi upstream from mouth.

DRAINAGE AREA.--850 mi2.

PERIOD OF RECORD.--August 1957 to current year.

GAGE.--Water-stage recorder. Datum of gage is National Geodetic Vertical Datum of 1929. Prior to Nov. 12, 1957, nonrecording gage at same site and datum.

REMARKS.-The lake is formed by a rolled earthfill dam 10,600 ft long, including a 200-foot-wide concrete spillway. Impoundment of water began Aug. 21, 1957, and the dam was completed June 25, 1958. Official operation began Dec. 11, 1959. The flood-control outlet works consist of two 10.0-foot-diameter conduits that are controlled by two 8.0- by 12.5-foot electrically driven broome-type gates. The low-flow outlet works consist of a controlled 14-inch pipe. Flow over the spillway is discharged into a 2,000-foot-long rectified channel and then into Cypress Creek. The capacity table is based on a survey made in 1950. The lake was built for flood control, conservation, and water supply. During the current year, an unknown amount of water was diverted from the lake for municipal and industrial uses. Figures given herein represent total contents. Data regarding the dam and lake are given in the following table:

	Elevation (feet)	Capacity (acre-feet)
Top of dam	277.0	
Crest of spillway	249.5	842,100
Top of conservation pool	228.5	254,900
Crest of intake to wet well (14 in)	202.5	5,760
Lowest gated outlet (invert)	200.0	2,860

COOPERATION.--Records furnished by the U.S. Army Corps of Engineers and reviewed by the Geological Survey.

EXTREMES FOR PERIOD OF RECORD.--Maximum contents, 694,360 acre-ft May 5, 1966 (elevation, 245.41); minimum since December 1959, 210,100 acre-ft Oct. 6, 1984 (elevation, 225.98 ft).

EXTREMES FOR CURRENT YEAR.--Maximum daily contents, 328,400 acre-ft Mar. 26 at 0800 hours (elevation, 232.17 ft); minimum daily, 210,100 acre-ft Oct. 6 (elevation, 225.98 ft).

Capacity Table
(Elevation in feet and total contents in acre-feet)

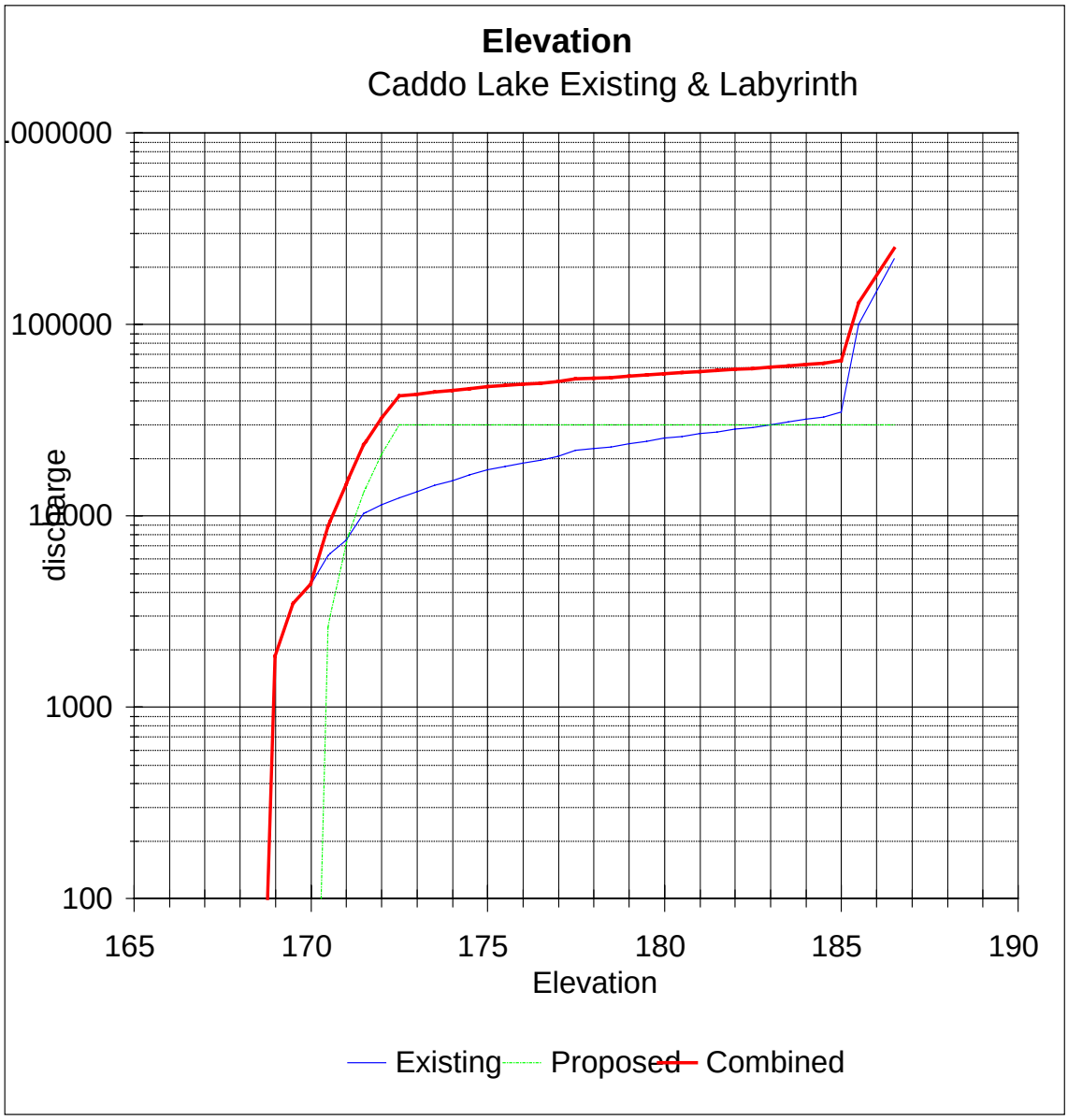
Elevation	Total Contents
225.0	194,300
228.0	245,600
230.0	283,700
232.0	324,800
233.0	346,500

Labyrinth Weir

Hydraulic design criteria of the labyrinth weir were based upon the estimates of the ability of the downstream channel to carry away flows, the elevation at which structural damages began to occur around Caddo Lake, the currently expected pool levels of Caddo Lake and the capability of Caddo Lake to deliver flows to the dam site. The hydraulic design criteria for the labyrinth weir were 20,000 cubic feet per second discharge at a reservoir elevation of 172.0 above mean sea level (M.S.L.) with the weir crest at 170.0 M.S.L. and an approach invert at 158.0 M.S.L.. Within the current guidance on design of labyrinth weirs, this design criteria yielded many acceptable design. A design was selected for further evaluation based upon length, volume of concrete and estimated earth work costs. The length criteria came from the requirement that the labyrinth be constructable in the south abutment of the Caddo Lake Dam without impinging on the existing weir, as one of the planning alternatives to be considered left the existing weir in place.

Design of Labyrinth Spillways
Journal of Hydraulic Engineering
Volume 121, Number 3, March 1995

20000	Design Discharge	15	Number of Cycles
172.00	Reservoir Elevation	77.64	Apron Length
158.00	Approach Channel Invert	751.03	Apron Width
170.00	Weir Crest Elevation	76.77	Weir Leg Length Effective
15.00	Labyrinth Side Leg Angle	78.31	Weir Leg Length Actual
2.00	Total Head on Crest	2303.13	Total Weir Length Effective
12.00	Height of Crest above Invert	2492.19	Total Weir Length Actual
4.00	Inside Apex Width	50.07	Cycle Width
5.53	Outside Apex Width	4.17	Cycle Width per height
0.17	Crest Head / Height Ratio	2215.28	Weir Concrete Volume
0.57	Crest Drag Coefficient	4319.11	Apron Concrete Volume
2303.13	Effective Crest Length	6534.39	Total Concrete Volume


Elevation
Caddo Lake Existing & Labyrinth
1000000
100000
10000
1000
100
discharge
165
170
175
180
185
190
Elevation
Existing
Proposed
Combined

Caddo Lake Labyrinth Weir Evaluation
Design of Labyrinth Spillways
Journal of Hydraulic Engineering
Volume 121, Number 3, March 1995

Discharge (cfs)	Total Head (ft)	Static Head (ft)	Lake Surface (msl)	Approach Velocity (fps)
0.00	12.00	12.00	170.00	0.00
1000.01	12.27	12.27	170.27	0.11
2000.01	12.43	12.43	170.43	0.21
3000.02	12.56	12.56	170.56	0.32
4000.02	12.68	12.68	170.68	0.42
5000.03	12.79	12.79	170.79	0.52
6000.04	12.90	12.89	170.89	0.62
7000.04	12.99	12.99	170.99	0.72
8000.05	13.09	13.08	171.08	0.81
9000.05	13.17	13.16	171.16	0.91
10000.06	13.26	13.24	171.24	1.01
11000.06	13.34	13.32	171.32	1.10
12000.07	13.42	13.40	171.40	1.19
13000.08	13.50	13.48	171.48	1.28
14000.08	13.58	13.55	171.55	1.38
15000.09	13.65	13.62	171.62	1.47
16000.09	13.72	13.69	171.69	1.56
17000.10	13.79	13.75	171.75	1.65
18000.11	13.86	13.82	171.82	1.73
19000.11	13.93	13.88	171.88	1.82
20000.12	14.00	13.94	171.94	1.91
21000.12	14.07	14.00	172.00	2.00
22000.13	14.13	14.06	172.06	2.08
23000.14	14.20	14.12	172.12	2.17
24000.14	14.26	14.18	172.18	2.25
25000.15	14.32	14.24	172.24	2.34

Note: All discharges greater than 25,000 cfs are controlled by the backwater effect of Twelvemile Bayou.

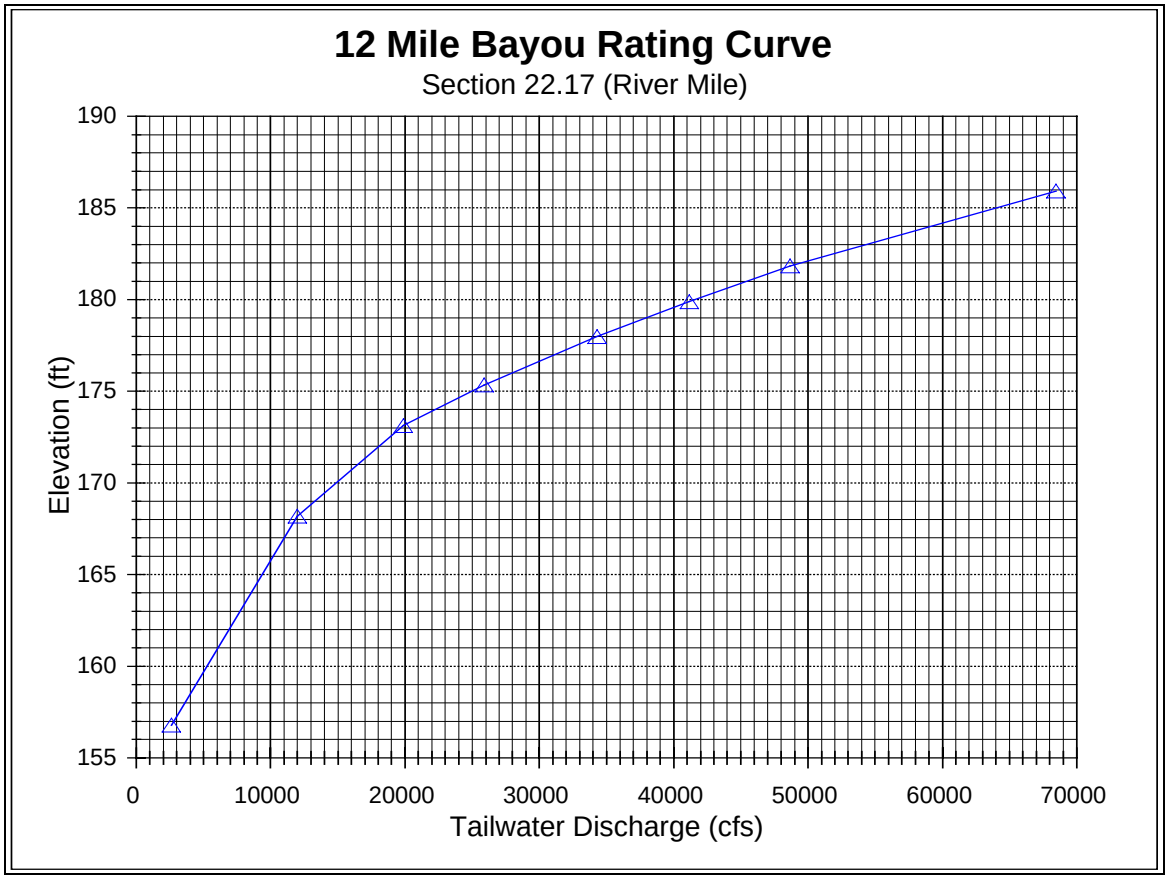
Tainter Gate

The tainter gate design criteria was derived from the Corps of Engineers Hydraulic Design Criteria 320-4 through 320-8/1 and assumed that the gates would compliment the proposed labyrinth weir. The tainter gates were designed to release up to 5000 cfs corresponding to a 2 year event and the conveyance capacity of the uninproved channel capacity downstream.

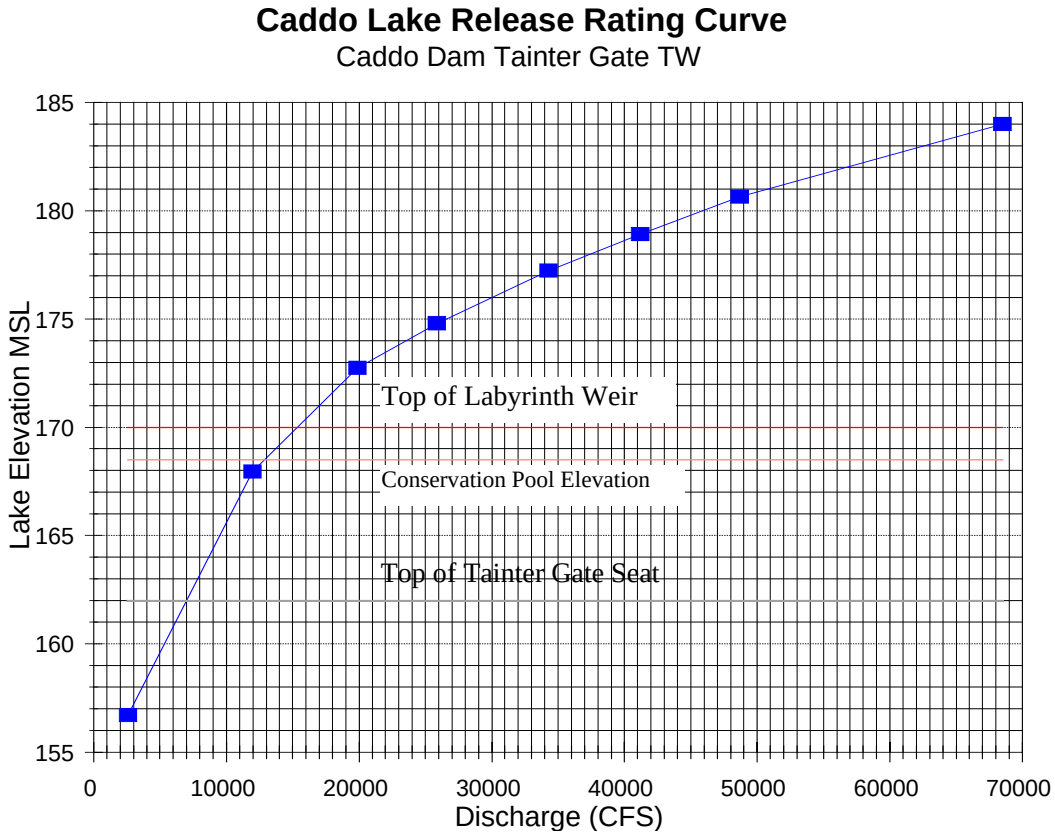
The Design Process

The design of the tainter gates began with the production of a rating curve shown below at the upstream end of State Highway 169 (Section 22.17 River Mile) from the Shreveport to Daingerfield

Navigation Feasibility Restudy HEC-2 model.



The above mentioned HEC-2 model provided a starting water surface elevation from which another HEC-2 channelization model of an assumed improved 2000 feet long and 85 feet wide rectangular channel beginning at the downstream side of Caddo dam to a perpendicular intersection of the natural channel. This was modeled to obtain a preliminary rating curve at the downstream end of the tainter gates. The above mentioned rating curve is depicted on the following page.



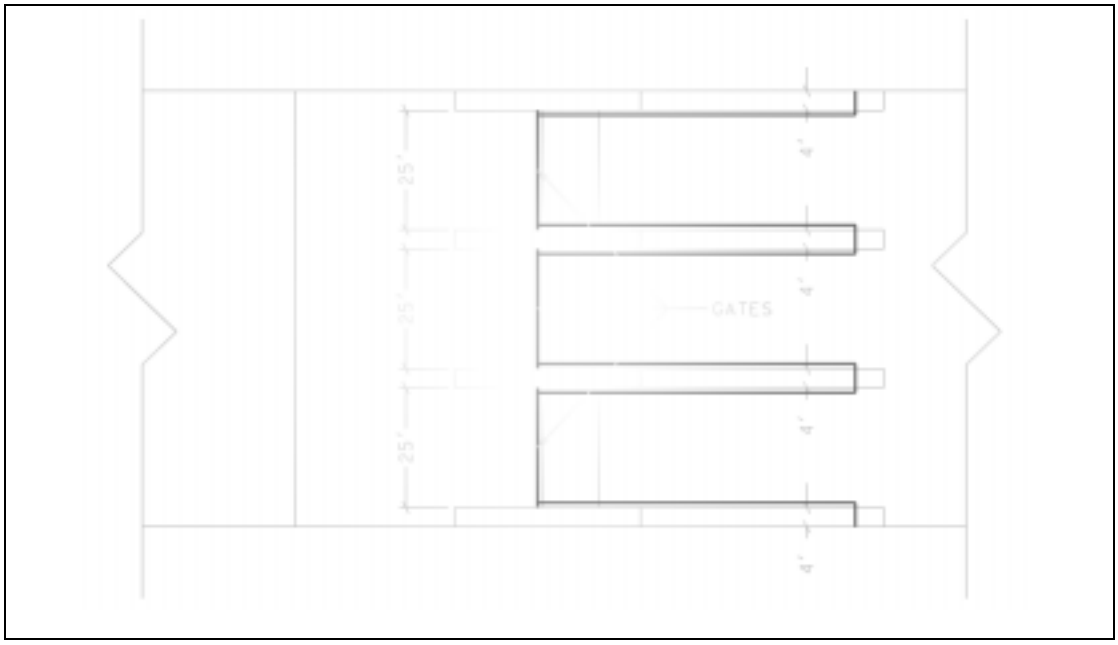
Based on a simplifying assumption that the losses through the gate at varying levels of gate opening are small, the energy head at the upstream and the downstream end of the the gate are approximately equal. Hence the equation for computing flows under gates on low sills with tailwater elevation greater than sill elevation was used to determine the conservation pool elevation at seven discrete levels of gate openings. The equation used is contained in HDC 320-8.

$$Q = C_s L h_s \sqrt{2gh}$$

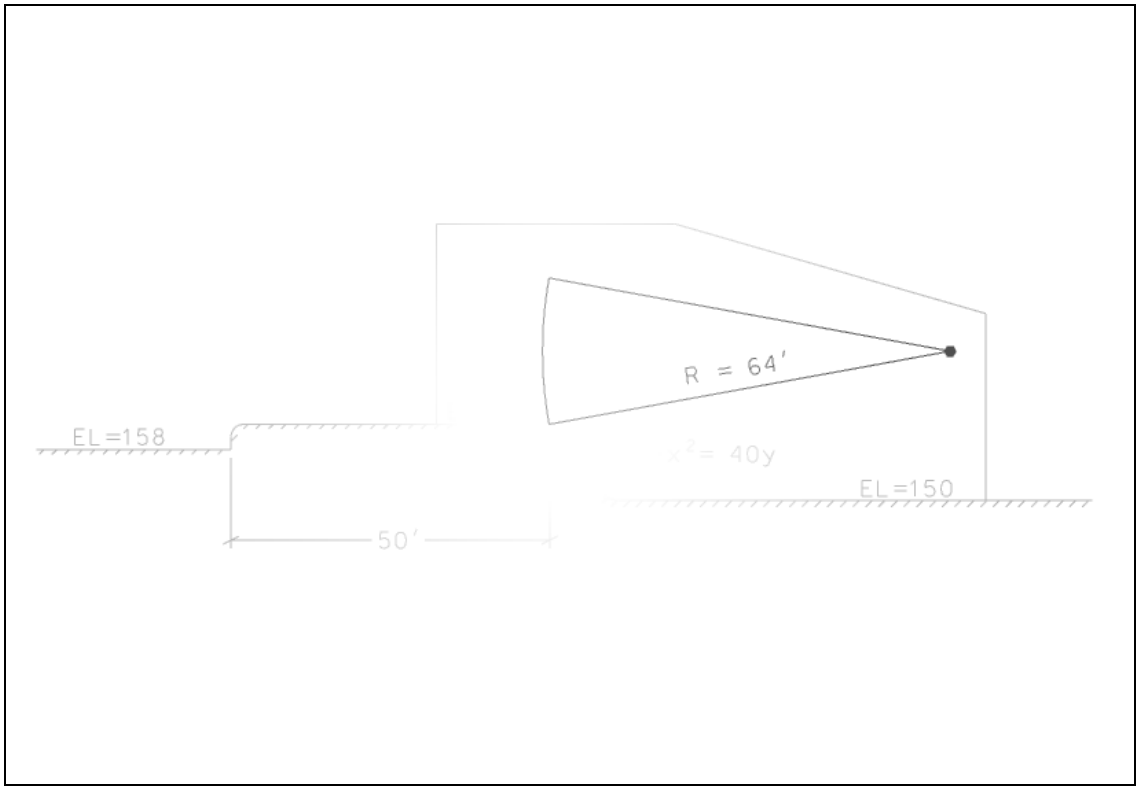
where

Q	=	discharge, (cfs)
C_s	=	submerged flow discharge coefficient, a function of the sill submergence-gate opening ratio
L	=	bay width, ft.
h_s	=	tailwater depth over sill, ft.
g	=	gravitational acceleration, ft. per sec^2
h	=	total head differential pool to tailwater (including approach velocity head), ft.

A schematic of the the tainter gates design are shown on the following page. Three 25' wide gates separated by 4' piers are employed.



Plan View 3 - 25 ft. tainter gates



Sectional View.

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************************************     ************************************
*           FFA              *     *                      *
*    FLOOD FREQUENCY ANALYSIS      U.S. ARMY CORPS OF ENGINEERS    *
*    PROGRAM DATE:  FEB 1995        THE HYDROLOGIC ENGINEERING CENTER *
*        VERSION:  3.1                  609 SECOND STREET        *
*    RUN  DATE   AND   TIME:            DAVIS, CALIFORNIA 95616     *
*       16 AUG 95    09:48:16           (916) 756-1104          *
*                          *     *                      *
************************************     ************************************



 INPUT FILE NAME: BLACKCYP.DAT
 OUTPUT FILE NAME: BLACKCYP.OUT
 DSS FILE NAME: BLACKCYP.DSS



   -----DSS---ZOPEN:  Existing File Opened,  File: BLACKCYP.DSS
                 Unit:  71;  DSS Version: 6-JB

**TITLE RECORD(S)**
TT     BLACK CYPRESS AND BIGCYPRESS BAYOUS AT JEFFERSON , TEXAS

**GENERALIZED SKEW**
    ISTN   GGMSE    SKEW
GS          .000    -.10

**CD FILE DATA**
CD BLACKCYP.TAB

   Station     BLACK CYPRESS BAYOU AT JEFFERSON, TX                      Id    07346045
   State       TX              Drainage Area          365.0        Hydrolog Unit 11140306
   County      315             Contribute Area          0.0        Years         1969-1993
   Latitude    32:46:40        Gage Datum             171.47       Continuous    Yes / No
   Longitude   094:21:26       Base Flow             4000.0        Ann/Part  Cnt 25  /13


**SYSTEMATIC EVENTS**
    25 EVENTS TO BE ANALYZED

**END OF INPUT DATA**
ED ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
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PRELIMINARY RESULTS

-SKEW WEIGHTING -

BASED ON 25 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .268
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

PRELIMINARY RESULTS

-FREQUENCY CURVE-BLACK CYPRESS BAYOU AT JEFFERSON, TX

COMPUTED CURVE FLOW IN CFS		EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	.95
22700.	27400.	0.2	45400.	14300.	
19200.	22300.	0.5	36800.	12500.	
16600.	18800.	1.0	30700.	11100.	
14100.	15600.	2.0	25000.	9630.	
10900.	11700.	5.0	18000.	7700.	
8570.	8930.	10.0	13300.	6220.	
6270.	6410.	20.0	9130.	4680.	
3250.	3250.	50.0	4320.	2460.	
1560.	1510.	80.0	2080.	1080.	
1030.	966.	90.0	1430.	649.	
717.	647.	95.0	1040.	414.	
349.	275.	99.0	567.	165.	

SYSTEMATIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.4879	HISTORIC EVENTS	0
STANDARD DEV	.3614	HIGH OUTLIERS	0
COMPUTED SKEW	-.7250	LOW OUTLIERS	0
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	-.4000	SYSTEMATIC EVENTS	25

FINAL RESULTS

-PLOTTING POSITIONS-BLACK CYPRESS BAYOU AT JEFFERSON, TX

EVENTS ANALYZED				ORDERED EVENTS			
			FLOW			WATER	FLOW WEIBULL
MON	DAY	YEAR	CFS	RANK	YEAR	CFS	PLOT POS
4	17	1969	3420.	1	1988	11600.	3.85
1	4	1970	1760.	2	1989	9630.	7.69
3	18	1971	362.	3	1990	7900.	11.54
1	7	1972	1380.	4	1974	7120.	15.38
4	28	1973	6170.	5	1975	6420.	19.23
4	25	1974	7120.	6	1991	6310.	23.08
2	5	1975	6420.	7	1973	6170.	26.92
3	12	1976	3480.	8	1993	4840.	30.77
2	16	1977	2320.	9	1980	3790.	34.62
5	18	1978	1330.	10	1979	3700.	38.46
4	3	1979	3700.	11	1981	3590.	42.31
1	26	1980	3790.	12	1992	3540.	46.15
5	19	1981	3590.	13	1976	3480.	50.00
5	20	1982	827.	14	1987	3430.	53.85
12	8	1983	1860.	15	1969	3420.	57.69
2	17	1984	836.	16	1986	3380.	61.54
2	28	1985	2420.	17	1985	2420.	65.38
6	27	1986	3380.	18	1977	2320.	69.23
3	21	1987	3430.	19	1983	1860.	73.08
12	28	1988	11600.	20	1970	1760.	76.92
3	29	1989	9630.	21	1972	1380.	80.77
3	11	1990	7900.	22	1978	1330.	84.62
5	6	1991	6310.	23	1984	836.	88.46
3	13	1992	3540.	24	1982	827.	92.31
12	18	1993	4840.	25	1971	362.	96.15

-OUTLIER TESTS -

LOW OUTLIER TEST

BASED ON 25 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.486

1 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 388.5

STATISTICS AND FREQUENCY CURVE ADJUSTED FOR 1 LOW OUTLIER(S)

HIGH OUTLIER TEST

BASED ON 24 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.467

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 19762.

-SKEW WEIGHTING -

BASED ON 25 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .227
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

FINAL RESULTS

-FREQUENCY CURVE-BLACK CYPRESS BAYOU AT JEFFERSON, TX

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	CONFIDENCE LIMITS .95 FLOW IN CFS
22200.	27600.	0.2	43000.	14500.
18500.	21900.	0.5	34000.	12400.
15900.	18100.	1.0	28000.	10900.
13400.	14800.	2.0	22500.	9450.
10300.	11000.	5.0	16200.	7540.
8120.	8460.	10.0	12000.	6110.
6020.	6160.	20.0	8380.	4670.
3320.	3320.	50.0	4260.	2590.
1770.	1720.	80.0	2280.	1270.
1250.	1190.	90.0	1670.	838.
936.	863.	95.0	1290.	583.
532.	443.	99.0	801.	285.

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.5103	HISTORIC EVENTS	0
STANDARD DEV	.3172	HIGH OUTLIERS	0
COMPUTED SKEW	--.3299	LOW OUTLIERS	1
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	-.2000	SYSTEMATIC EVENTS	25

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+ END OF RUN +
+ NORMAL STOP IN FFA +
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************************************     ************************************
*           FFA                *     *                                    *
*    FLOOD FREQUENCY ANALYSIS          U.S. ARMY CORPS OF ENGINEERS    *
*    PROGRAM DATE:  FEB 1995           THE HYDROLOGIC ENGINEERING CENTER *
*        VERSION:  3.1                 609 SECOND STREET         *
*    RUN  DATE   AND   TIME:             DAVIS, CALIFORNIA 95616     *
*       16 AUG 95    09:52:41           (916) 756-1104          *
*                          *     *                                    *
************************************     ************************************



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 OUTPUT FILE NAME: LITTLECY.OUT
 DSS FILE NAME: LITTLECY.DSS



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                 Unit:  71;  DSS Version: 6-JB

***** UNRECOGNIZABLE RECORD
12345678901234567890123456789012345678901234567890123456789012345678901234567890
UT   BLACK CYPRESS AND BIGCYPRESS BAYOUS AT JEFFERSON , TEXAS
RECORD IGNORED



**GENERALIZED SKEW**
    ISTN   GGMSE    SKEW
GS          .000    -.10

**CD FILE DATA**
CD LITTLECY.TAB

   Station     LITTLE CYPRESS CREEK NR JEFFERSON, TX                      Id    07346070
   State       TX             Drainage Area          675.0        Hydrolog Unit 11140307
   County      203            Contribute Area          0.0        Years        1946-1993
   Latitude    32:42:46       Gage Datum             174.60       Continuous    Yes /Yes
   Longitude   094:20:45      Base Flow              No value       Ann/Part  Cnt 48  /48


**SYSTEMATIC EVENTS**
    48 EVENTS TO BE ANALYZED

**END OF INPUT DATA**
ED ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
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PRELIMINARY RESULTS

-SKEW WEIGHTING -

BASED ON 48 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .131
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

PRELIMINARY RESULTS

-FREQUENCY CURVE-LITTLE CYPRESS CREEK NR JEFFERSON, TX

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	.95
50600.	57400.	.2	88900.	33300.
40600.	44800.	.5	68600.	27500.
33700.	36500.	1.0	55100.	23300.
27300.	29100.	2.0	43100.	19300.
19700.	20500.	5.0	29400.	14400.
14500.	14900.	10.0	20700.	11000.
9900.	10000.	20.0	13400.	7690.
4510.	4510.	50.0	5720.	3570.
1920.	1880.	80.0	2460.	1420.
1190.	1150.	90.0	1590.	828.
792.	748.	95.0	1100.	516.
355.	312.	99.0	542.	201.

SYSTEMATIC STATISTICS

LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.6329	HISTORIC EVENTS	0
STANDARD DEV	.4254	HIGH OUTLIERS	0
COMPUTED SKEW	-.3462	LOW OUTLIERS	0
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	-.3000	SYSTEMATIC EVENTS	48

FINAL RESULTS

-PLOTTING POSITIONS-LITTLE CYPRESS CREEK NR JEFFERSON, TX

EVENTS ANALYZED				ORDERED EVENTS			
			FLOW		WATER	FLOW	WEIBULL
MON	DAY	YEAR	CFS	RANK	YEAR	CFS	PLOT POS
6	4	1946	9500.	1	1966	35500.	2.04
11	15	1947	3100.	2	1958	23900.	4.08
5	17	1948	5400.	3	1989	20500.	6.12
5	7	1949	2260.	4	1957	18400.	8.16
2	16	1950	10200.	5	1988	12600.	10.20
2	20	1951	2260.	6	1961	12000.	12.24
4	21	1952	2900.	7	1953	11800.	14.29
5	19	1953	11800.	8	1973	11800.	16.33
5	13	1954	1490.	9	1974	10400.	18.37
3	26	1955	3810.	10	1950	10200.	20.41
5	6	1956	2080.	11	1979	9730.	22.45
4	27	1957	18400.	12	1946	9500.	24.49
4	30	1958	23900.	13	1968	8240.	26.53
4	26	1959	3420.	14	1987	8070.	28.57
1	20	1960	4500.	15	1991	7850.	30.61
12	11	1961	12000.	16	1975	7550.	32.65
12	23	1962	3940.	17	1993	6880.	34.69
5	3	1963	3680.	18	1980	5960.	36.73
5	3	1964	568.	19	1969	5480.	38.78
2	14	1965	1760.	20	1948	5400.	40.82
4	26	1966	35500.	21	1990	4900.	42.86
6	6	1967	4350.	22	1977	4780.	44.90
5	15	1968	8240.	23	1960	4500.	46.94
3	24	1969	5480.	24	1967	4350.	48.98
5	3	1970	3090.	25	1962	3940.	51.02
2	22	1971	279.	26	1955	3810.	53.06
1	11	1972	2290.	27	1963	3680.	55.10
4	27	1973	11800.	28	1959	3420.	57.14
6	10	1974	10400.	29	1947	3100.	59.18
2	6	1975	7550.	30	1986	3090.	61.22
7	6	1976	1710.	31	1970	3090.	63.27
2	17	1977	4780.	32	1992	3070.	65.31
3	18	1978	1170.	33	1952	2900.	67.35
5	7	1979	9730.	34	1983	2840.	69.39
1	27	1980	5960.	35	1981	2400.	71.43
5	25	1981	2400.	36	1972	2290.	73.47
2	11	1982	594.	37	1985	2280.	75.51
3	12	1983	2840.	38	1951	2260.	77.55
12	11	1984	1780.	39	1949	2260.	79.59
3	4	1985	2280.	40	1956	2080.	81.63
12	15	1986	3090.	41	1984	1780.	83.67
3	22	1987	8070.	42	1965	1760.	85.71
12	29	1988	12600.	43	1976	1710.	87.76
3	29	1989	20500.	44	1954	1490.	89.80
4	19	1990	4900.	45	1978	1170.	91.84
5	4	1991	7850.	46	1982	594.	93.88
3	10	1992	3070.	47	1964	568.	95.92
12	20	1993	6880.	48	1971	279.	97.96

-OUTLIER TESTS -

LOW OUTLIER TEST

BASED ON 48 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.753

1 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 289.7

STATISTICS AND FREQUENCY CURVE ADJUSTED FOR 1 LOW OUTLIER(S)

HIGH OUTLIER TEST

BASED ON 48 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.753

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 63670.

-SKEW WEIGHTING -

BASED ON 48 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .107
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

FINAL RESULTS

-FREQUENCY CURVE-LITTLE CYPRESS CREEK NR JEFFERSON, TX

COMPUTED CURVE FLOW IN CFS		EXPECTED PROBABILITY	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	.95
59600.	70100.	.2	106000.	39000.	
45400.	51300.	.5	77000.	30700.	
36300.	39900.	1.0	59100.	25200.	
28400.	30500.	2.0	44200.	20300.	
19600.	20500.	5.0	28700.	14600.	
14100.	14600.	10.0	19700.	10900.	
9520.	9660.	20.0	12600.	7550.	
4460.	4460.	50.0	5540.	3590.	
2090.	2060.	80.0	2630.	1580.	
1410.	1370.	90.0	1830.	1010.	
1010.	969.	95.0	1360.	692.	
549.	498.	99.0	789.	337.	

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.6494	HISTORIC EVENTS	0
STANDARD DEV	.3912	HIGH OUTLIERS	0
COMPUTED SKEW	.0017	LOW OUTLIERS	1
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	.0000	SYSTEMATIC EVENTS	48

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+ END OF RUN +
+ NORMAL STOP IN FFA +
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************************************     ************************************
*           FFA                *     *                                    *
*    FLOOD FREQUENCY ANALYSIS          U.S. ARMY CORPS OF ENGINEERS    *
*    PROGRAM DATE:  FEB 1995           THE HYDROLOGIC ENGINEERING CENTER *
*       VERSION:  3.1                  609 SECOND STREET         *
*    RUN  DATE   AND   TIME:           DAVIS, CALIFORNIA 95616     *
*      16 AUG 95    09:00:11           (916) 756-1104          *
*                         *     *                                    *
************************************     ************************************



 INPUT FILE NAME: BLACKFFA.DAT
 OUTPUT FILE NAME: BLACKFFA.OUT
 DSS FILE NAME: BLACKFFA.DSS



   -----DSS---ZOPEN:  Existing File Opened,  File: BLACKFFA.DSS
                 Unit:  71;  DSS Version: 6-JB

**TITLE RECORD(S)**
TT     12 MILE BAYOU NEAR MOORINGSPORT

**GENERALIZED SKEW**
    ISTN   GGMSE    SKEW
GS          .000    -.10

**CD FILE DATA**
CD BLACKHOS.TAB

   Station     BLACK BAYOU NEAR HOSSTON, LA.                          Id    07346500
   State       LA              Drainage Area          231.0       Hydrolog Unit 11140304
   County      017             Contribute Area          0.0       Years        1940-1951
   Latitude    32:52:55        Gage Datum             171.09       Continuous    Yes /Yes
   Longitude   093:53:55       Base Flow             No value      Ann/Part  Cnt 12  /12


**SYSTEMATIC EVENTS**
    12 EVENTS TO BE ANALYZED

**END OF INPUT DATA**
ED ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
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PRELIMINARY RESULTS

-SKEW WEIGHTING -

BASED ON 12 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .629
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

PRELIMINARY RESULTS

-FREQUENCY CURVE-BLACK BAYOU NEAR HOSSTON, LA.

COMPUTED CURVE FLOW IN CFS		EXPECTED PROBABILITY	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS FLOW IN CFS .05	.95
8710.	11600.	0.2	20600.	5520.
7810.	9820.	0.5	17500.	5060.
7090.	8560.	1.0	15100.	4690.
6340.	7360.	2.0	12800.	4280.
5290.	5850.	5.0	9880.	3690.
4450.	4750.	10.0	7710.	3190.
3550.	3680.	20.0	5630.	2610.
2180.	2180.	50.0	3030.	1600.
1240.	1180.	80.0	1690.	794.
900.	809.	90.0	1270.	505.
678.	564.	95.0	1000.	335.
382.	241.	99.0	636.	143.

SYSTEMATIC STATISTICS

LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.3161	HISTORIC EVENTS	0
STANDARD DEV	.2734	HIGH OUTLIERS	0
COMPUTED SKEW	-1.2253	LOW OUTLIERS	0
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	-.5000	SYSTEMATIC EVENTS	12

FINAL RESULTS

-PLOTTING POSITIONS-BLACK BAYOU NEAR HOSSTON, LA.

EVENTS ANALYZED				ORDERED EVENTS			
			FLOW	WATER		FLOW	WEIBULL
MON	DAY	YEAR	CFS	RANK	YEAR	CFS	PLOT POS
7	4	1940	3520.	1	1945	3980.	7.69
5	8	1941	2010.	2	1944	3780.	15.38
4	12	1942	2710.	3	1940	3520.	23.08
1	3	1943	491.	4	1950	2850.	30.77
5	4	1944	3780.	5	1946	2800.	38.46
4	3	1945	3980.	6	1947	2760.	46.15
1	11	1946	2800.	7	1942	2710.	53.85
11	13	1947	2760.	8	1941	2010.	61.54
2	15	1948	1520.	9	1948	1520.	69.23
1	31	1949	1380.	10	1949	1380.	76.92
1	17	1950	2850.	11	1951	950.	84.62
2	20	1951	950.	12	1943	491.	92.31

-OUTLIER TESTS -

LOW OUTLIER TEST

BASED ON 12 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.134

1 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 540.5

STATISTICS AND FREQUENCY CURVE ADJUSTED FOR 1 LOW OUTLIER(S)

HIGH OUTLIER TEST

BASED ON 11 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.088

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 6143.

-SKEW WEIGHTING -

BASED ON 12 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .496
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

FINAL RESULTS

-FREQUENCY CURVE-BLACK BAYOU NEAR HOSSTON, LA.

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	CONFIDENCE LIMITS .95 FLOW IN CFS
7410.	9670.	0.2	15100.	5080.
6710.	8270.	0.5	13000.	4700.
6150.	7290.	1.0	11500.	4390.
5570.	6360.	2.0	9930.	4050.
4770.	5200.	5.0	7910.	3570.
4120.	4350.	10.0	6410.	3150.
3410.	3510.	20.0	4920.	2660.
2290.	2290.	50.0	2970.	1780.
1470.	1410.	80.0	1880.	1030.
1140.	1050.	90.0	1510.	722.
920.	800.	95.0	1260.	526.
595.	422.	99.0	888.	276.

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.3458	HISTORIC EVENTS	0
STANDARD DEV	.2183	HIGH OUTLIERS	0
COMPUTED SKEW	-.9043	LOW OUTLIERS	1
REGIONAL SKEW	-.1000	ZERO OR MISSING	0
ADOPTED SKEW	-.4000	SYSTEMATIC EVENTS	12

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+ END OF RUN +
+ NORMAL STOP IN FFA +
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