ALBUQUERQUE, NEW MEXICO

PIEDRAS MARCADAS

DETENTION DAM

ALBUQUERQUE METROPOLITAN

ARROYO FLOOD CONTROL AUTHORITY

ENGINEERING REPORT

REV. OCT. 1983
JULY 1983

(83-507)

WILSON & COMPANY
ENGINEERS
ARCHITECTS

TABLE OF CONTENTS

SUMMARY AND RECOMMENDATIONS

Preliminary design of the Piedras Marcadas Detention Dam indicates the dam will have the following characteristics:

Maximum height above ground at centerline	28.0 feet
Length	1,300 feet
Maximum width at base	170 feet
Top of dam width	14 feet
Slope upstream face	3:1
Slope downstream face	2.5:1
Top of dam elevation	5,043.5
Principal spillway inlet elevation	5,016.0
Emergency spillway crest elevation	5,032.0
Width of emergency spillway	200 feet
Emergency spillway capacity at Elev. 5043.5	28,240 cfs
Principal spillway conduit size and type	36" RCP
Principal spillway capacity at Elev. 5032.0	90 cfs
Evacuation time after gate is opened	54 hours
Storage capacity at Elev. 5032.0	249 Ac. Ft.
Drainage area	3,419 Ac. (5.34 sq. mi.)
PMP design rainfall	11.0" in 1 hour
PMF peak inflow to dam	27,000 cfs
100 year design rainfall	2.2" in 6 hours
100 year peak inflow to dam	2,880 cfs

The detention dam is designed to contain all the 100 year inflow with the gate on principal spillway being in the closed position. The preliminary estimated construction cost of the Piedras Marcadas Dam is $1,200,000.

PURPOSE AND SCOPE OF REPORT

This Engineering Report is written to provide design documentation for the Piedras Marcadas Detention Dam. Methods of analysis and design criteria are discussed in detail to provide the basis of design for the proposed project.

GENERAL

Location

The site of the proposed project is located west of Coors Blvd. approximately two miles north of the I-40 Coors Blvd. interchange and is immediately north and west of the Alban Hills Subdivision, Bernalillo County, New Mexico.

Drainage Areas

Figure 1 shows the drainage area of the Piedras Marcadas Detention Dam. The total drainage area of 3,419 acres has been divided into sub-areas for hydrologic analysis.

Land Use

For purpose of design, it was assumed the basin is developed to its ultimate long range planned use. In general the land below the escarpment is estimated to develop 70 percent impervious, the land above the escarpment is estimated to develop 50 percent impervious, and the escarpment and major open space 0 percent impervious. For expanded discussion of land use please refer to "Piedras Marcadas Basin Drainage Management Plan" prepared by Tom Mann Associates, Inc.

Hydrological Data

The 100 year six hour rainfall is assumed to be 2.2 inches as presented in the City of Albuquerque "Design Procedure Manual" - Volume 2.

The Probable Maximum Precipitation (PMP) is assumed to be 11 inches in one hour and 16 inches in six hours. This data is obtained from a map published by USDA Soil Conservation Service, dated August 1981. U.S. Weather Bureau Technical Paper No. 38 "General Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian for Areas to 400 Square Miles and Durations to 24 Hours", dated 1960, gives distribution factors for obtaining four 15 minute increments of rainfall. Figure 3 shows these rainfall amounts used for Probable Maximum Precipitation (PMP) analysis.

HYDROLOGIC ANALYSIS

Estimation of Direct Runoff from Storm Rainfall

The USDA, Soil Conservation Service (SCS) method of estimating rainfall-runoff relationships is used to synthesize streamflow hydrographs from selected design rainfalls. This technique is based upon methods developed by SCS hydrologists over the last 40 years and is particularly adaptable for ungaged watersheds such as Piedras Marcadas.

A unique rainfall-runoff relationships exists for a particular soil cover and land use. Initial abstraction, which consists of interception, infiltration and surface storage, is taken into account in this relationship.

In equation form, the actual runoff (Q) can be stated as:

$$Q = \frac{(P-I_a)^2}{(P-I_a) + S} \qquad (1)$$

Where:

P - Maximum potential runoff or precipitation

I_a - Initial abstraction

S - Maximum potential difference between storm rainfall (P) and actual runoff (Q)

The relationship between S and I_a has been developed empirically from rainfall and runoff data from experimental small watersheds and can be stated as:

$$I_a = 0.2S \qquad (2)$$

Substituting equation (2) into (1) gives:

$$Q = \frac{(P-0.2S)^2}{P+0.8S} \qquad (3)$$

which is the rainfall-runoff relation used in the SCS method of estimating direct runoff from storm rainfall.

Hydrologic Soil Cover Complexes

Four major hydrologic soil groups are used to classify the native soil on the basis of infiltration and transmissibility. SCS soil scientist define these groups as follows:

(1) Group A. (Low runoff potential.) Soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well- to excessively-drained sands or gravels. These soils have a high rate of water transmission.

(2) Group B. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

(3) Group C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

(4) Group D. (High runoff potential) Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Figure 4 shows the soil classification for the Piedras Marcadas watershed.

A combination of a particular hydrologic soil group, land use and treatment class is a hydrologic soil-cover complex. A runoff curve number (CN) can be assigned to such complexes. This should not be confused with a "runoff coefficient" from the widely used rational method relating peak rates of runoff to rainfall intensity and drainage area. A runoff curve number (CN) indicates runoff potential; the higher the CN, the higher the runoff.

Tables exist in various SCS publications that provide guidance in selecting CN's for a particular hydrologic soil-cover complex.

Figure 1 shows the runoff curve numbers selected for the various sub-areas of Piedras Marcadas watershed. Future planned development was considered in the selection of curve numbers.

The relationship between S and CN is:

$$S = \frac{1000-10(CN)}{CN} \qquad (4)$$

Therefore, by selecting a runoff curve number (CN), S can be determined and Equation (3) can be solved to obtain direct stormwater runoff in inches.

Development of Hydrographs for 100 Year Flood

The 100 year flood hydrographs were developed by the method described in Volume 2 of the City of Albuquerque Design Procedure Manual. This method is basically the SCS method of triangular hydrographs with time distributions developed by the City of Albuquerque.

Development of Hydrographs for the Probable Maximum Flood

The SCS method of triangular hydrographs is used to develop the time distribution of runoff. The method is based upon determining several parameters for a particular watershed, such as drainage area and time of concentration. Time of concentration can be estimated by dividing the channel into reaches. Velocity of flow and travel time for each reach can be determined using Manning's equation for open-channel flow.

Any given storm can be analyzed by dividing the storm into increments of time, computing a hydrograph for each increment and combining all hydrographs into one composite hydrograph for each sub-area investigated.

The equation for peak discharge in CFS for an increment of runoff is:

$$q_p = \frac{45.4AQ_p}{T_p}$$

A = Drainage area in acres
Q_p = Runoff in inches during the increment
T_p = Time to peak in minutes = 1/2 increment time plus 0.6 concentration time

Hydrograph Routing

The hydrographs from the sub-areas are routed to the point of interest and combined with other sub-areas to obtain the total hydrograph for the basin. The method used for routing is the W.T. Wilson method, a rapid and simple graphical procedure that gives good results. Travel times (T_t) are computed for the various channel reaches and the inflow hydrograph is set back an amount equal to the travel time. A routing interval (Δt) is selected and the outfall hydrograph is obtained graphically. The equation for this routing process is:

$$O_2 = O_1 + K\ (I_1 + I_2 - 2O_1)$$

Where:

O_2 - Outflow at time 2

O_1 - Outflow at time 1

$$K = \frac{\Delta t}{2T_t + \Delta t}$$

I_1 = Inflow at time 1

I_2 = Inflow at time 2

Figure 5 shows the typical hydrograph routing. Figure 6 shows the combined composite hydrograph for the 100 year design rainfall. Figure 7 shows the combined composite hydrograph for the Probable Maximum Flood (PMF) for the Piedras Marcadas watershed at the dam site. These hydrographs are the basis for all hydraulic design and analysis.

Design Flow Rates

A comparison of peak design flow rates for Piedras Marcadas watershed at the dam site is shown below:

	WCEA	Tom Mann Associates
100-year Frequency	2,880 cfs	2,610 cfs
Probable Maximum Flood	27,000 cfs	15,130 cfs

Sizing Channels

Open-channels were analyzed using Manning's equation of uniform flow:

$$Q = \frac{1.49\ AR^{2/3}\ S_o^{\ 1/2}}{n}$$

Where:

Q - Design discharge in cubic feet per second, cfs
n - Manning's roughness coefficient
A - Cross-sectional area of flow in square feet
R - Hydraulic radius = Flow area divided by the wetted perimeter
S_o - Slope of the channel flow line

For concrete lined trapezoidal channels, an "n" value of 0.015 was used. An "n" value of 0.040 was used to evaluate non-paved channels.

The USDA Soil Conservation Service TR 39 "Hydraulics of Broad Crested Spillways" was used to evaluate the head in the reservoir above the crest elevation of the emergency spillway.

Dam and Detention Basin

The detention dam will be constructed of earth fill on natural ground foundation which has been wetted and compacted. A core trench will be excavated and backfilled with selected compacted material. It will be necessary to provide a detention basin with a storage capacity of 245 acre-feet below elevation 5032. All borrow material for construction of the dam will be taken from detention area.

Principal Spillway

The detention volume of 245 acre-feet was determined with the assumption the gate on the principal spillway is closed. A 36-inch diameter reinforced concrete pipe was selected as the size for the principal spillway. When the gate on the principal spillway is opened, the 100 year design runoff will be evacuated from the detention pond in 45 hours. Figure 6 shows the 100 year hydrograph for the principal spillway. The inlet of the principal spillway will be a headwall with a trash rack. The outlet will have an impact basin to dissipate the energy.

Emergency Spillway

The emergency spillway is sized to discharge the Probable Maximum Flood. The hydrograph for the PMF is shown on Figure 7.

The proposed emergency spillway will be a 200 foot wide bottom channel with a peak outflow of 26,500 cfs. Erosion control will be provided in the improved portion of the spillway, since maximum velocity is about 17 ft. per sec.

Cost Estimate and Recommendation

The estimated costs for the Piedras Marcadas Dam project are:

Construction	$1,200,000
Right-of-Way 50 Acres @ $20,000/Acre	1,000,000
Legal, Administration & Engineering	180,000
Total Estimated Project Cost	$2,380,000

It is recommended the Piedras Marcadas Dam be constructed at the site west of the electrical power transmission line with physical characteristics summarized at the beginning of the report.

FIGURE 1

PIEDRAS MARCADAS DAM SITE		
I.D. NO.	ACRE (SIZE)	WEIGHTED RUNOFF CURVE NO.
100	240	81
200	325	78
203	258	78
301	515	82
305	332	85
306	133	88
307	108	88
309	619	84
310	119	86
400	280	85
405	190	83
TOTAL	3419	83

SCALE: 1" = 2000' ±

W-S-C-E

DRAINAGE AREA FOR
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

WILSON & COMPANY ENGINEERS ARCHITECTS

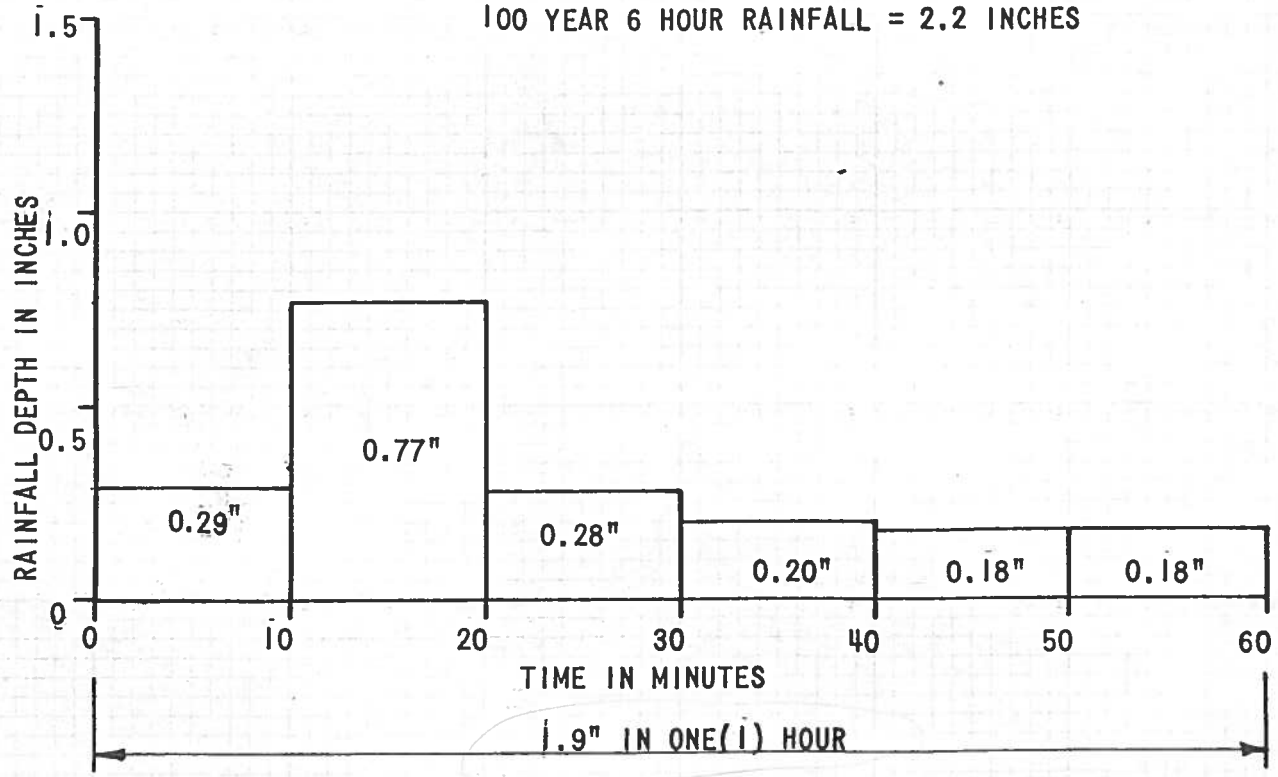
FILE M 83-507

DATE JULY 1983

SHEET /

FIGURE 2

100 YEAR 6 HOUR RAINFALL = 2.2 INCHES



DESIGN RAINFALL 100 YEAR STORM
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. _____ APP. _____

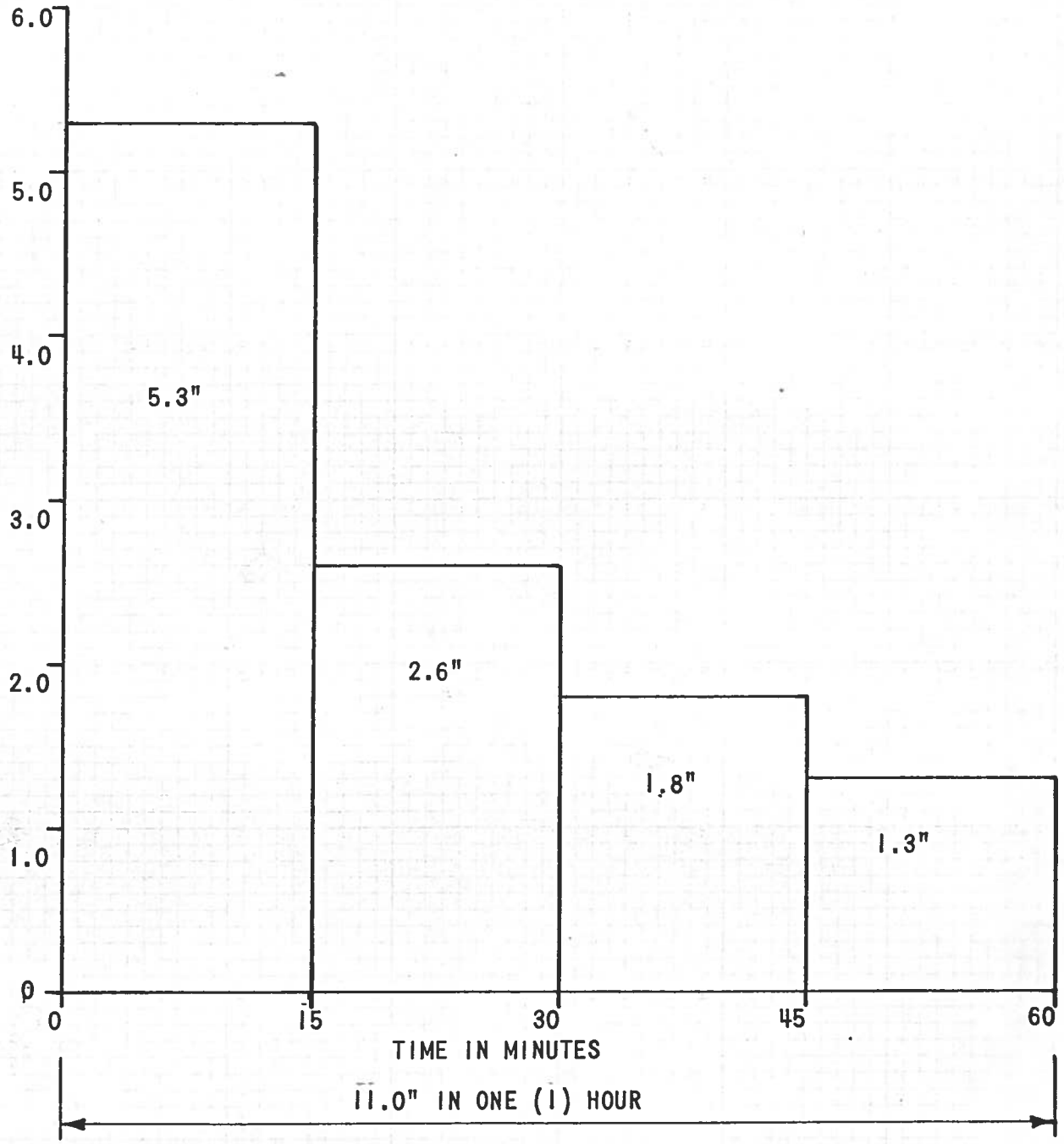
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 3



DESIGN RAINFALL PROBABLE MAXIMUM PRECIPITATION (PMP)
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

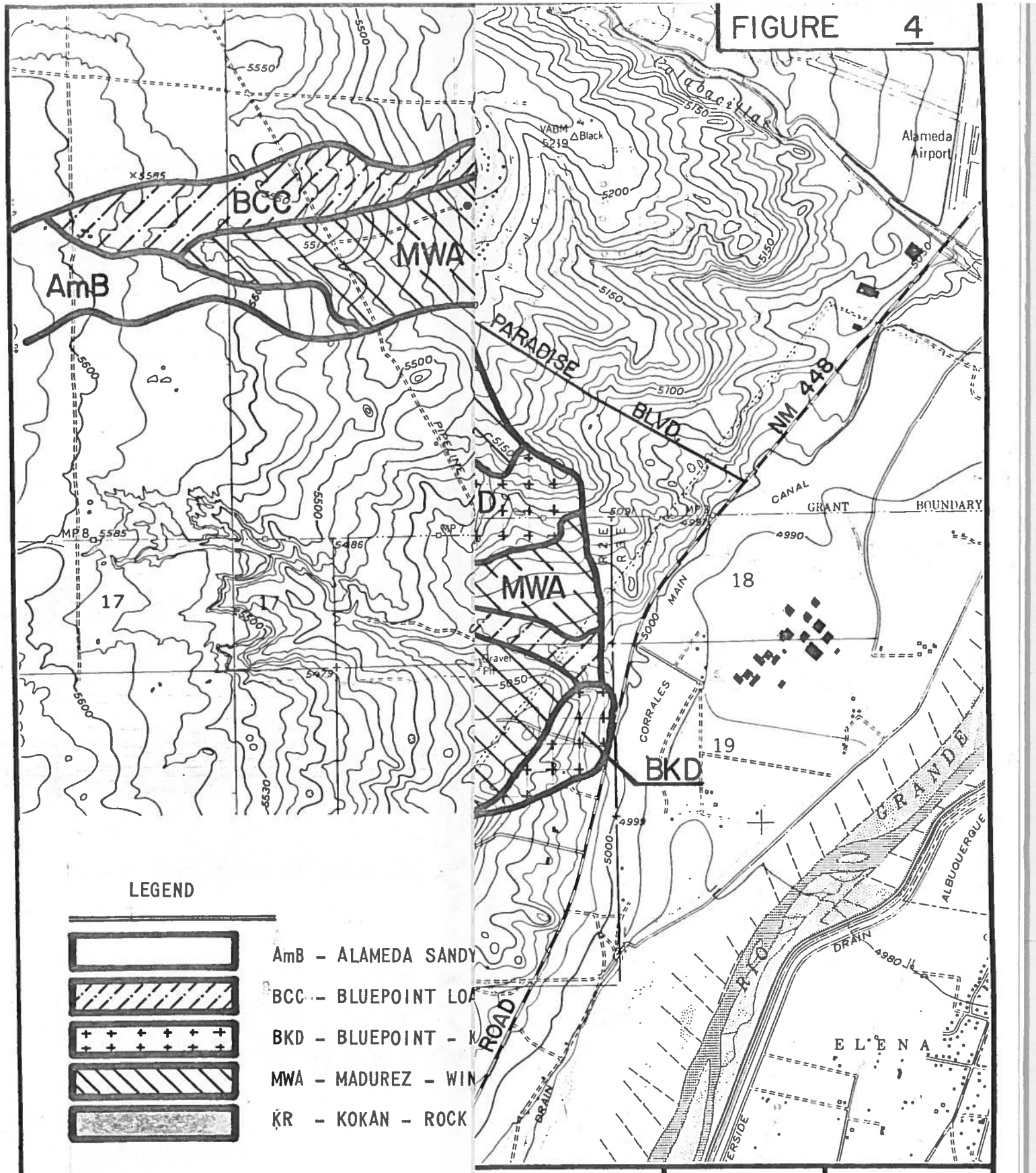
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1989

SHEET 1

FIGURE 4



LEGEND

AmB - ALAMEDA SANDY

BCC - BLUEPOINT LOA

BKD - BLUEPOINT - K

MWA - MADUREZ - WIN

KR - KOKAN - ROCK

CA

RAS MARCADAS DAM

WILSON & COMPANY ENGINEERS ARCHITECTS

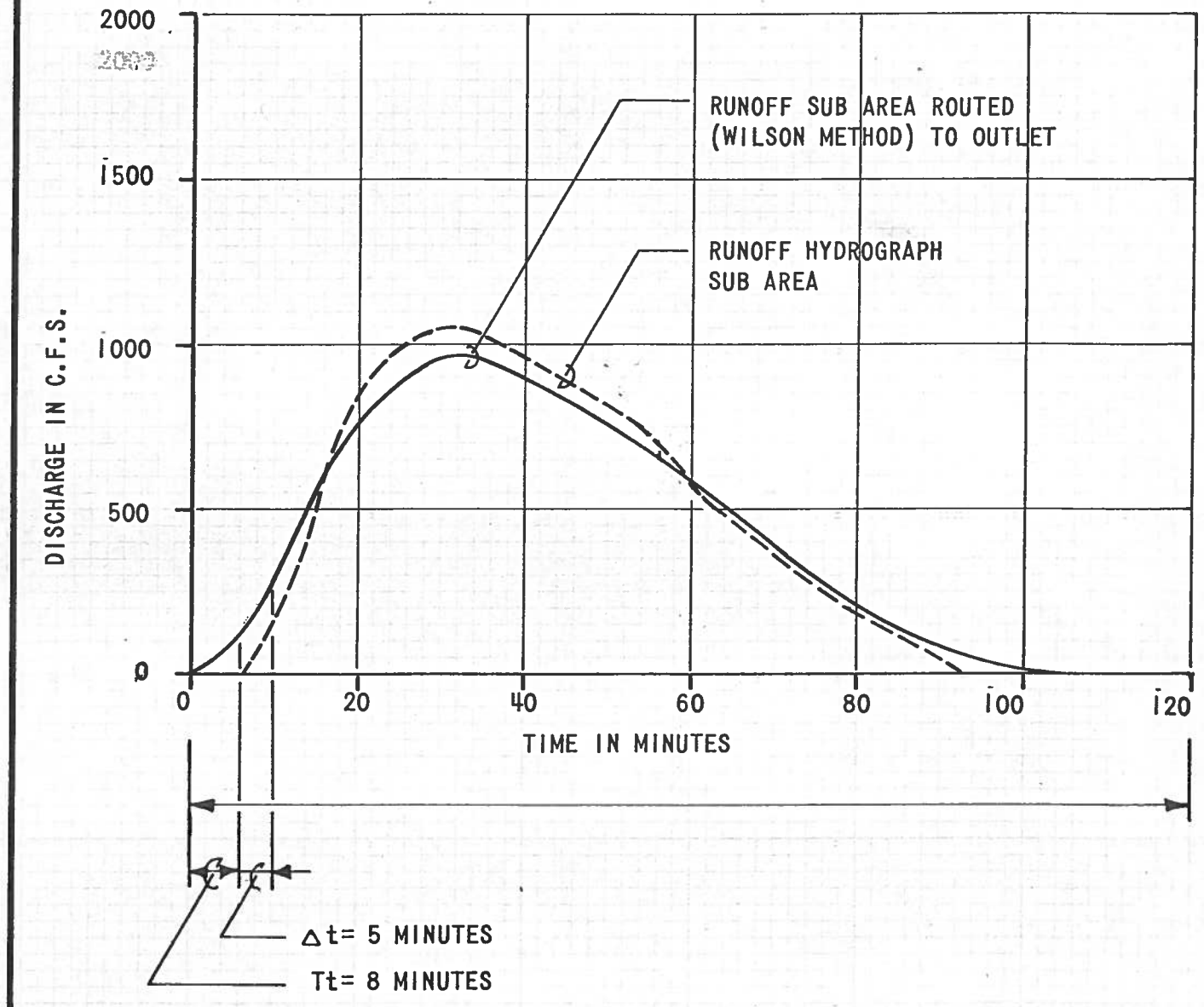
FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 5

NOTE;
1. TRAVEL TIME (Tt) FOR CHANNEL REACH IS 8 MINUTES
2. ROUTING INTERVAL (Δt) IS 5 MINUTES



TYPICAL ROUTED HYDROGRAPH, PMF ANALYSIS
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

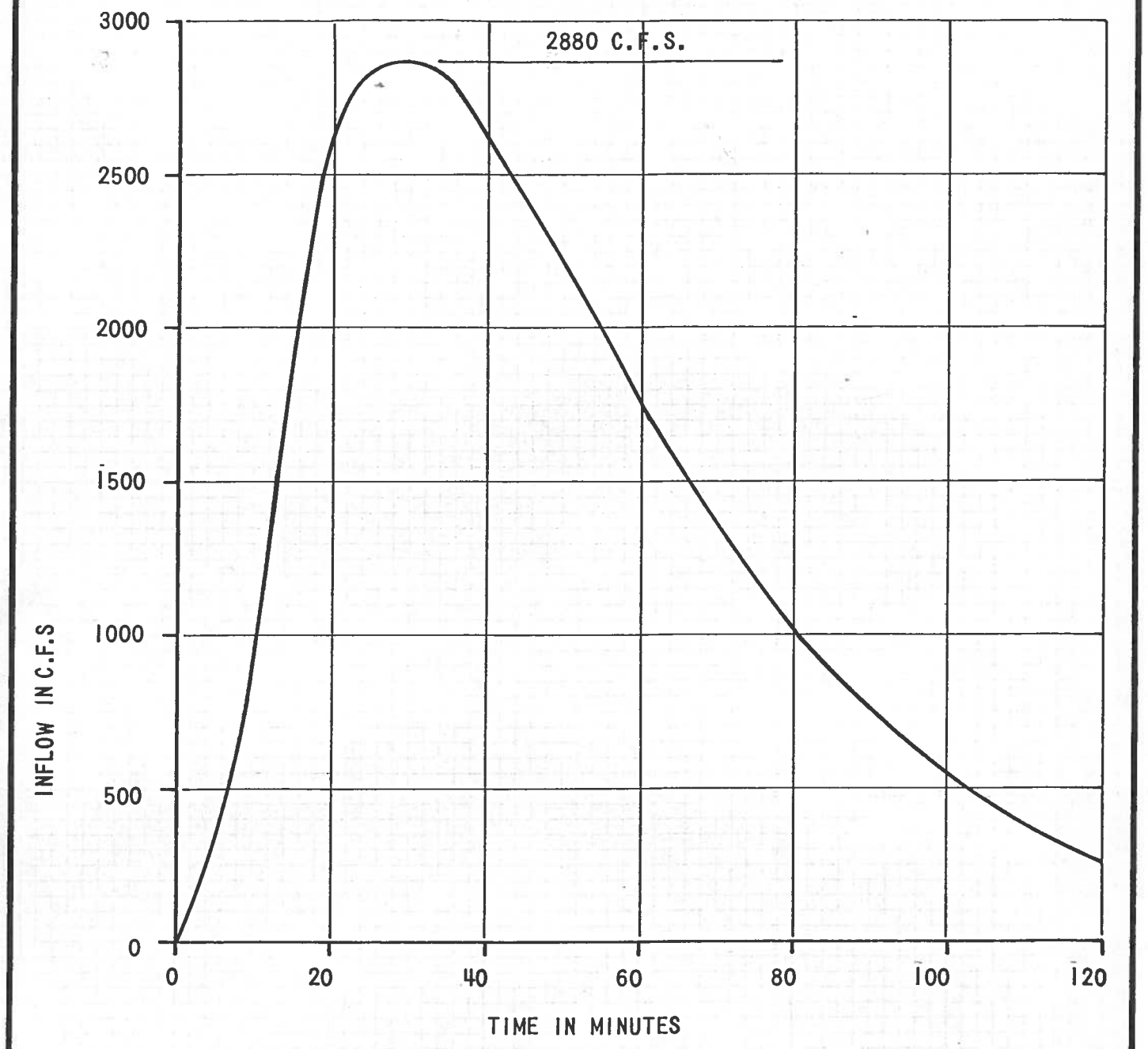
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

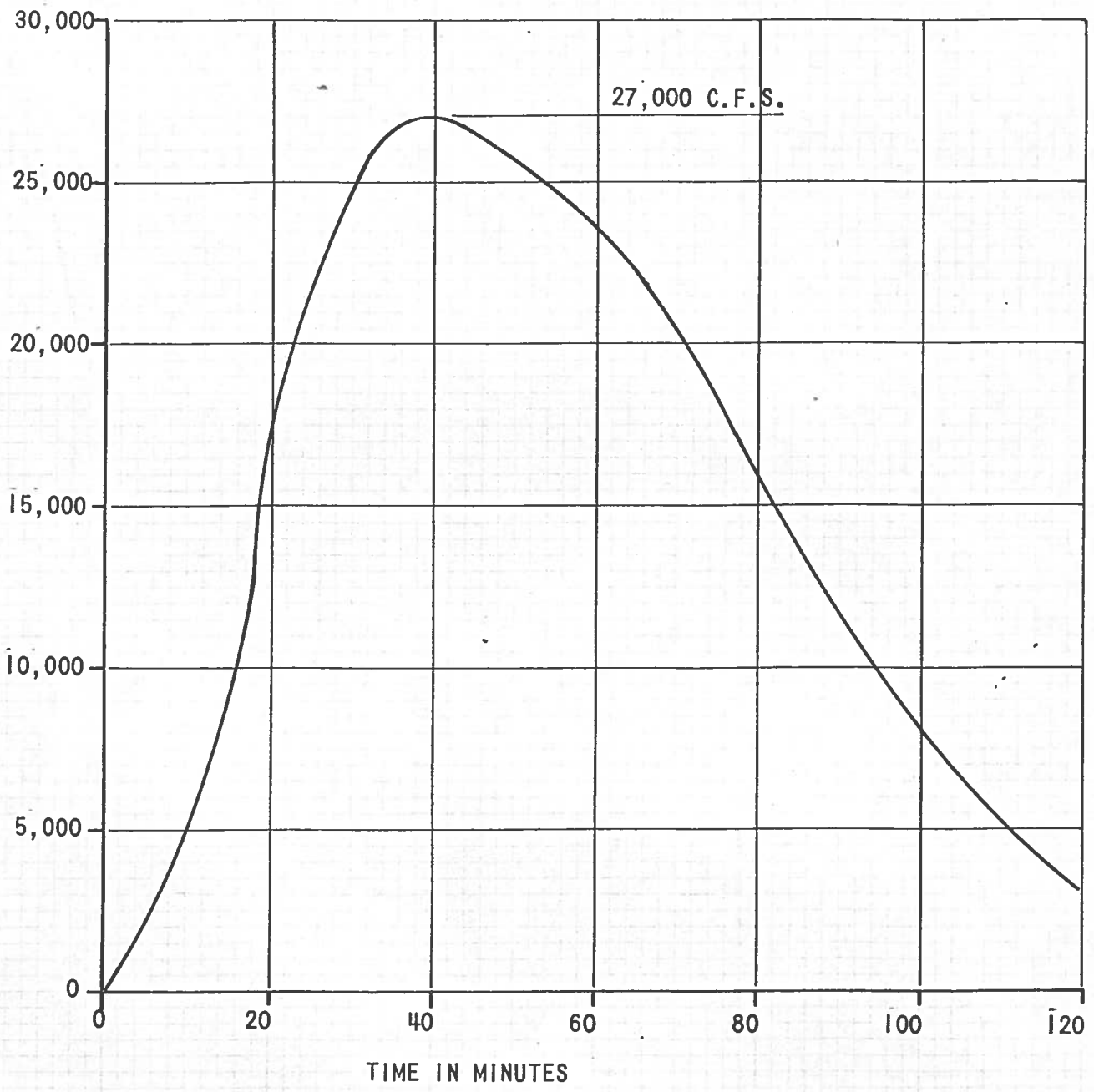
SHEET 1

FIGURE 6



100 YEAR INFLOW PIEDRAS MARCADAS DAM SITE - AMAFCA	WILSON & COMPANY ENGINEERS & ARCHITECTS	FILE 83-507
LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM		DATE JULY 1983
COMP. SJM/WFB CHK. APP.		SHEET 1

FIGURE 7



PMF INFLOW
PEIDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. _____ APP. _____

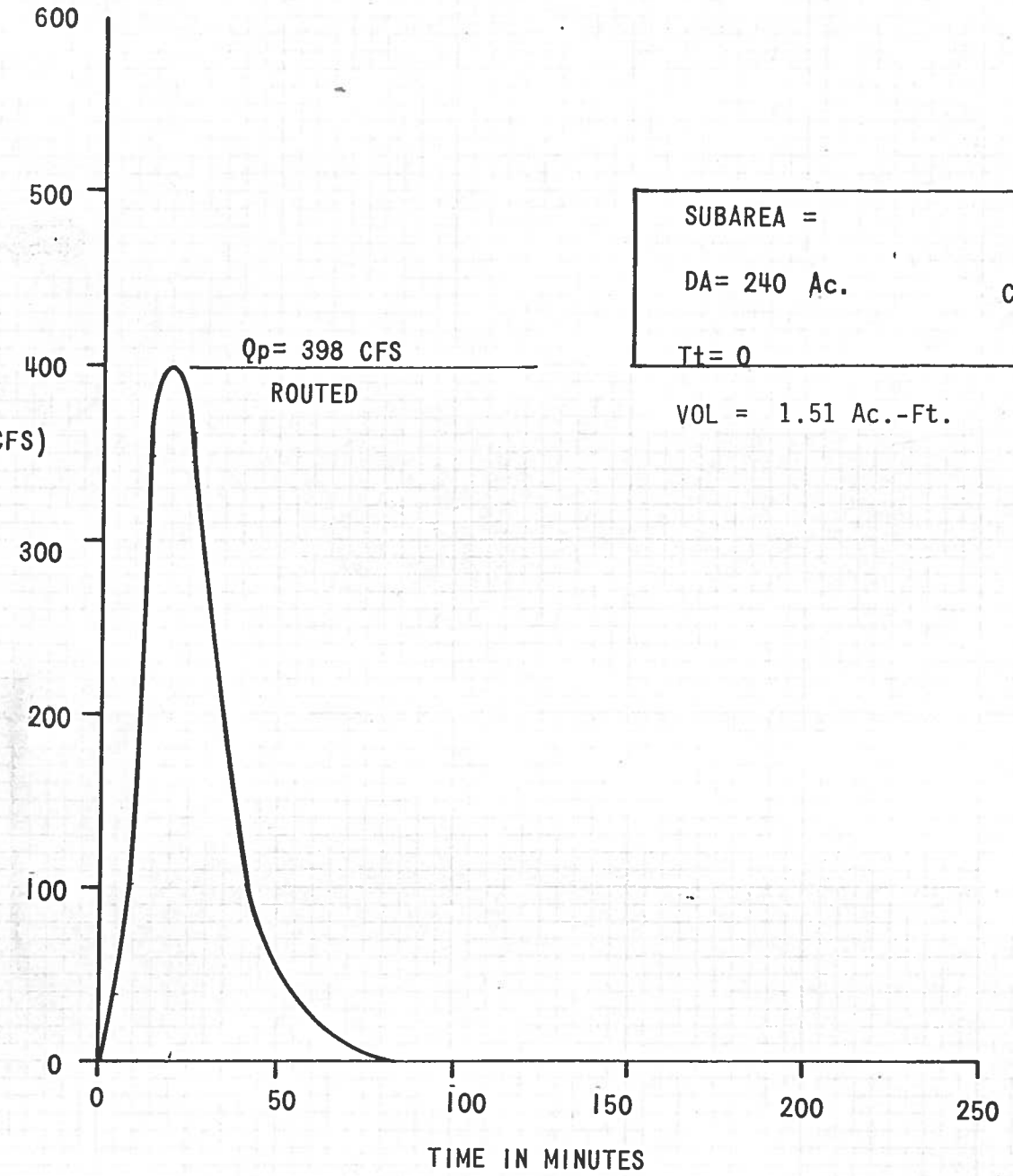
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 8



SUBAREA = 100

DA= 240 Ac. CN = 81

Tt= 0

VOL = 1.51 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PEIDRAS MARCADAS DAM SITE-AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

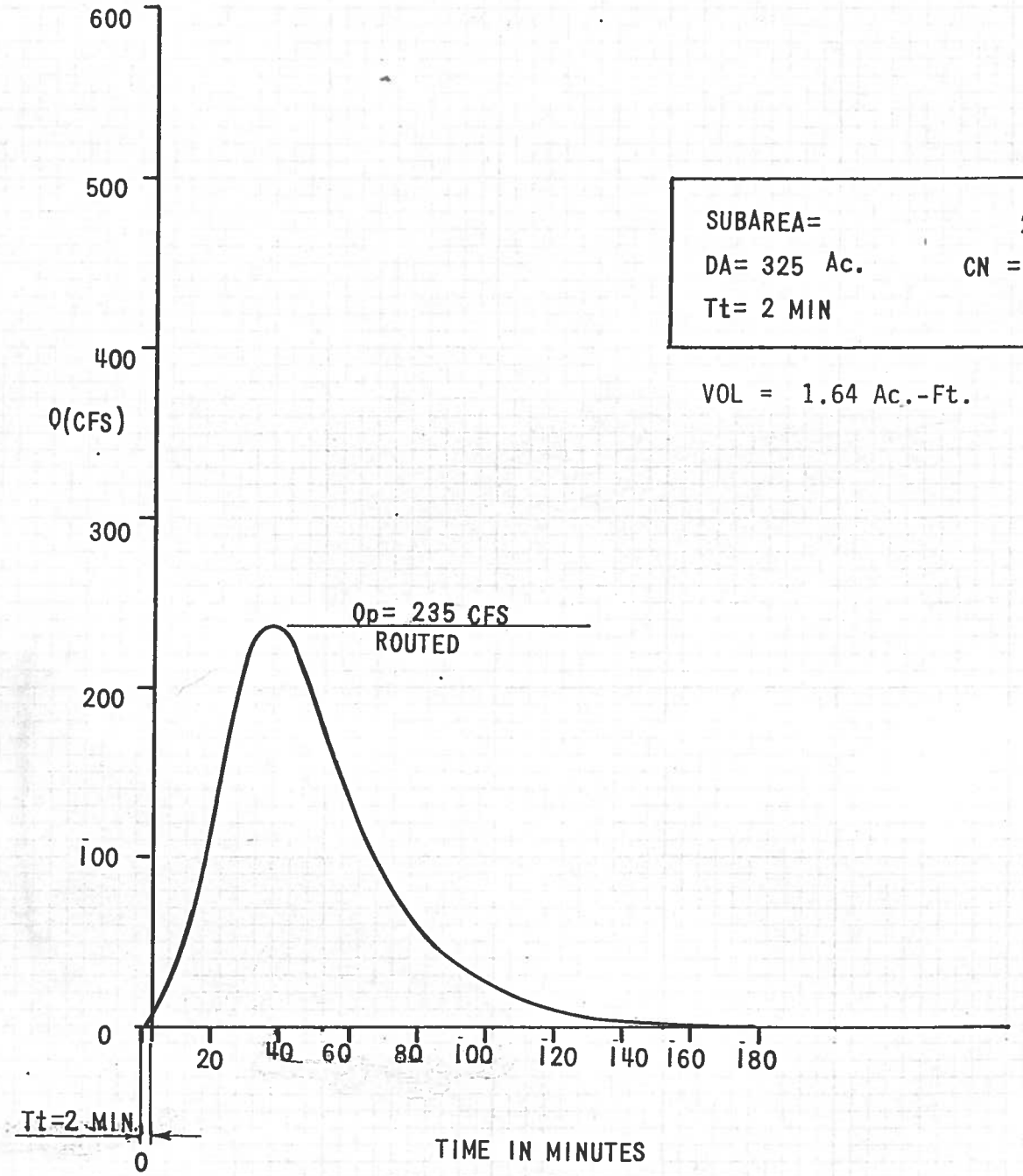
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET 1

FIGURE 9



SUBAREA= 200
DA= 325 Ac. CN = 78
Tt= 2 MIN

VOL = 1.64 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., PROJECT PIEDRAS MARCADAS

COMP. SJM/WFB CHK. APP.

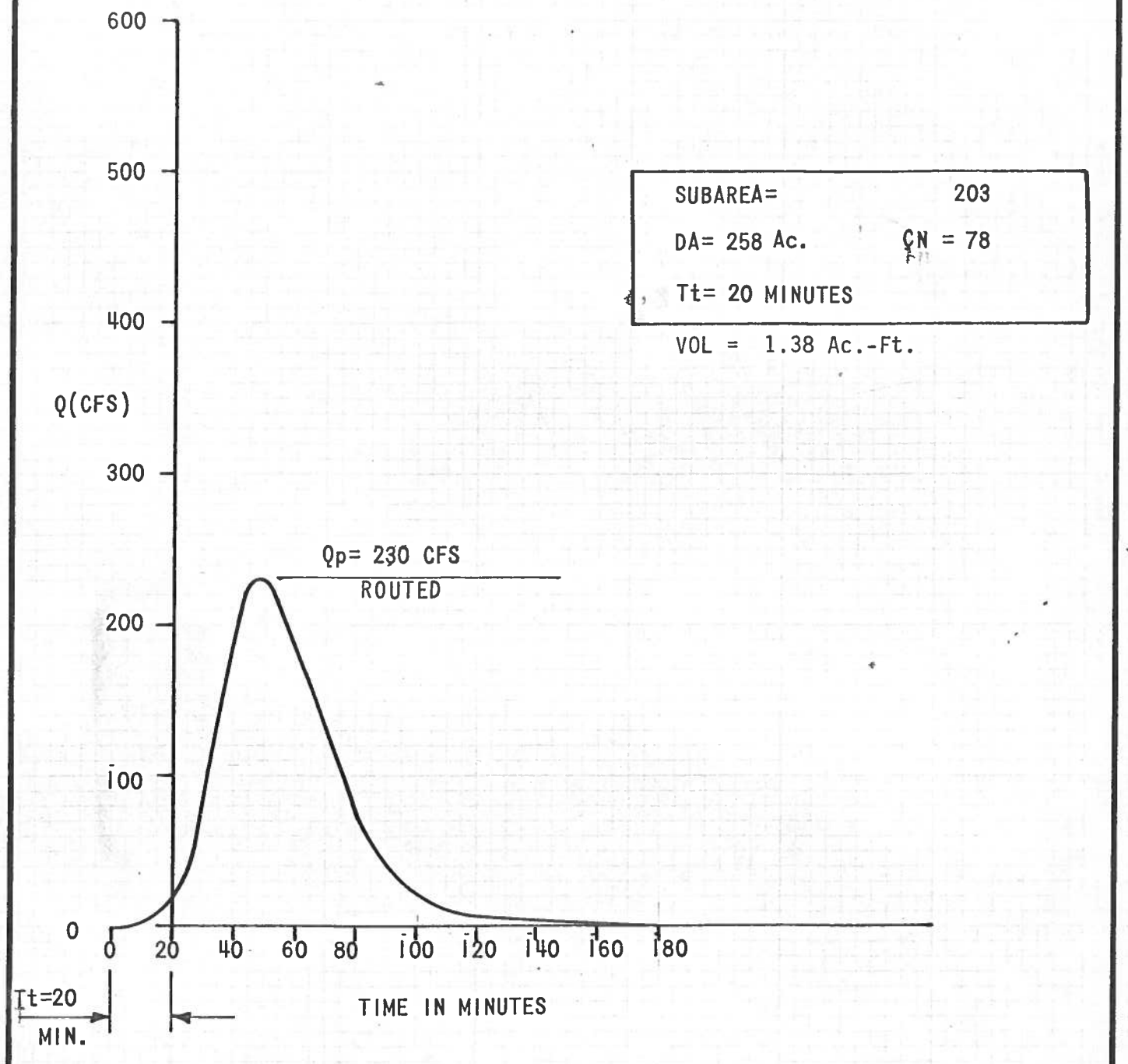
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 10



SUBAREA= 203

DA= 258 Ac. C_N = 78

Tt= 20 MINUTES

VOL = 1.38 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBQU., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. _____ APP. _____

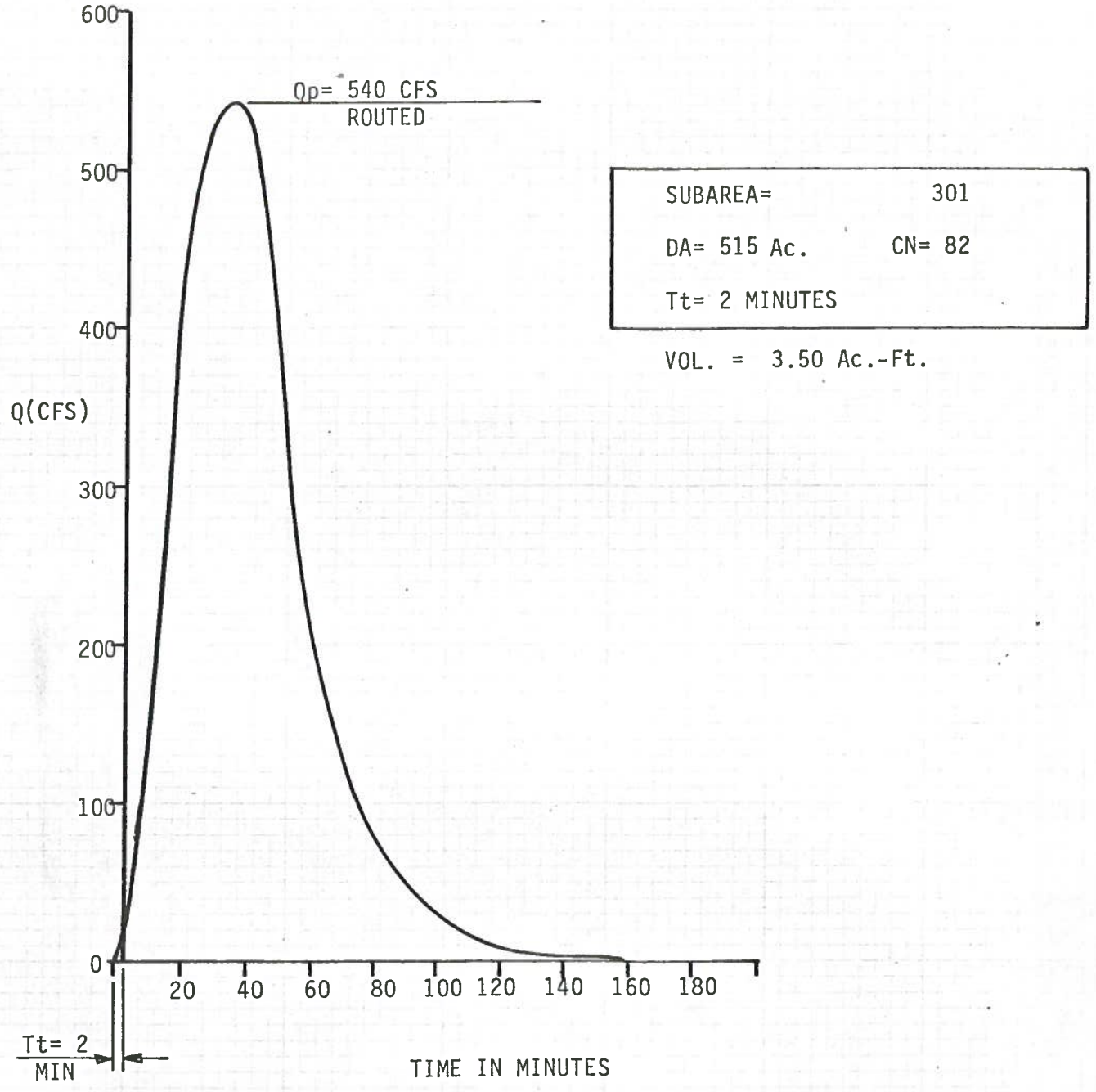
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE II



SUBAREA= 301

DA= 515 Ac. CN= 82

Tt= 2 MINUTES

VOL. = 3.50 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

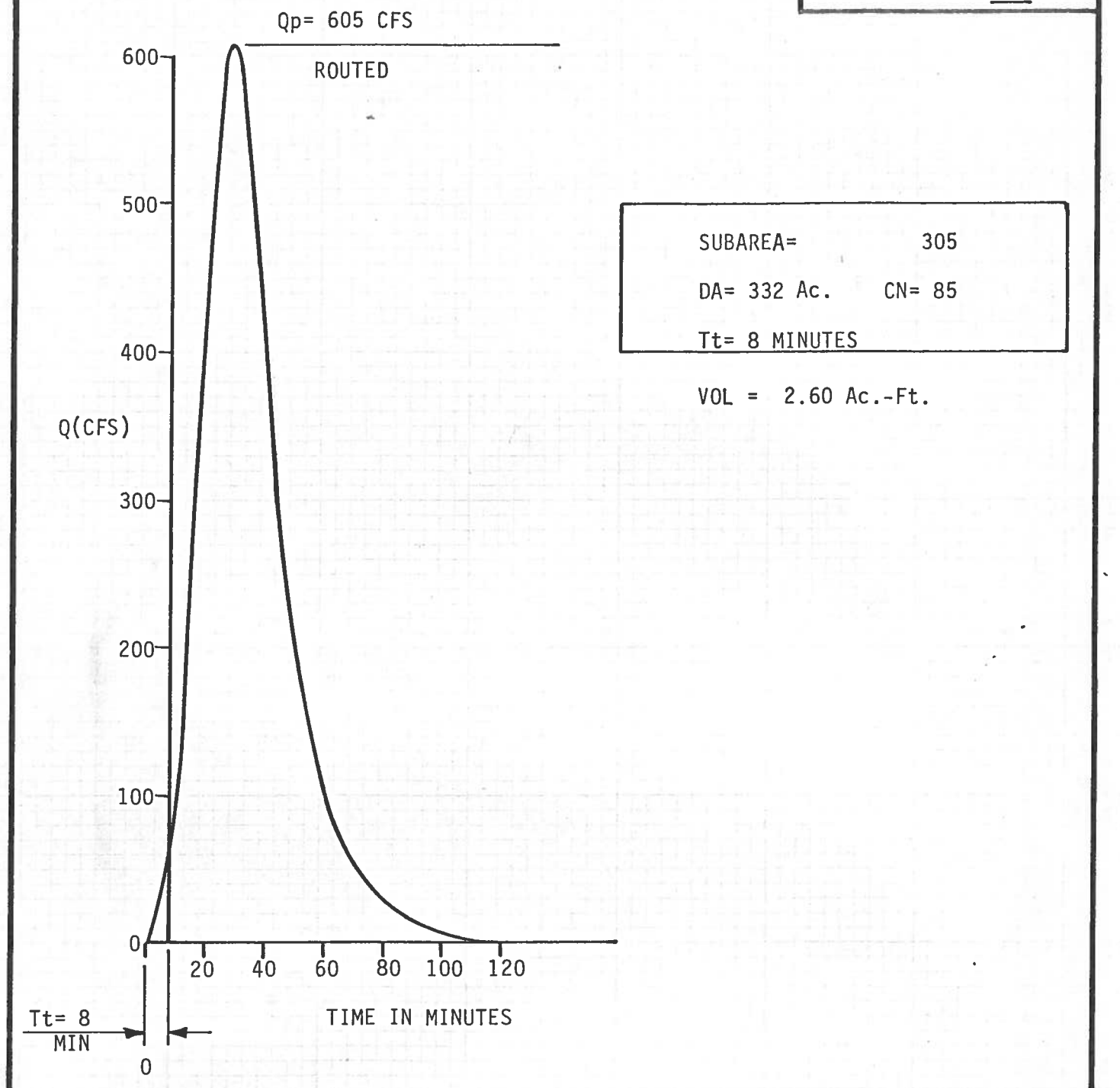
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET 1

FIGURE 12



SUBAREA= 305

DA= 332 Ac. CN= 85

Tt= 8 MINUTES

VOL = 2.60 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. APP.

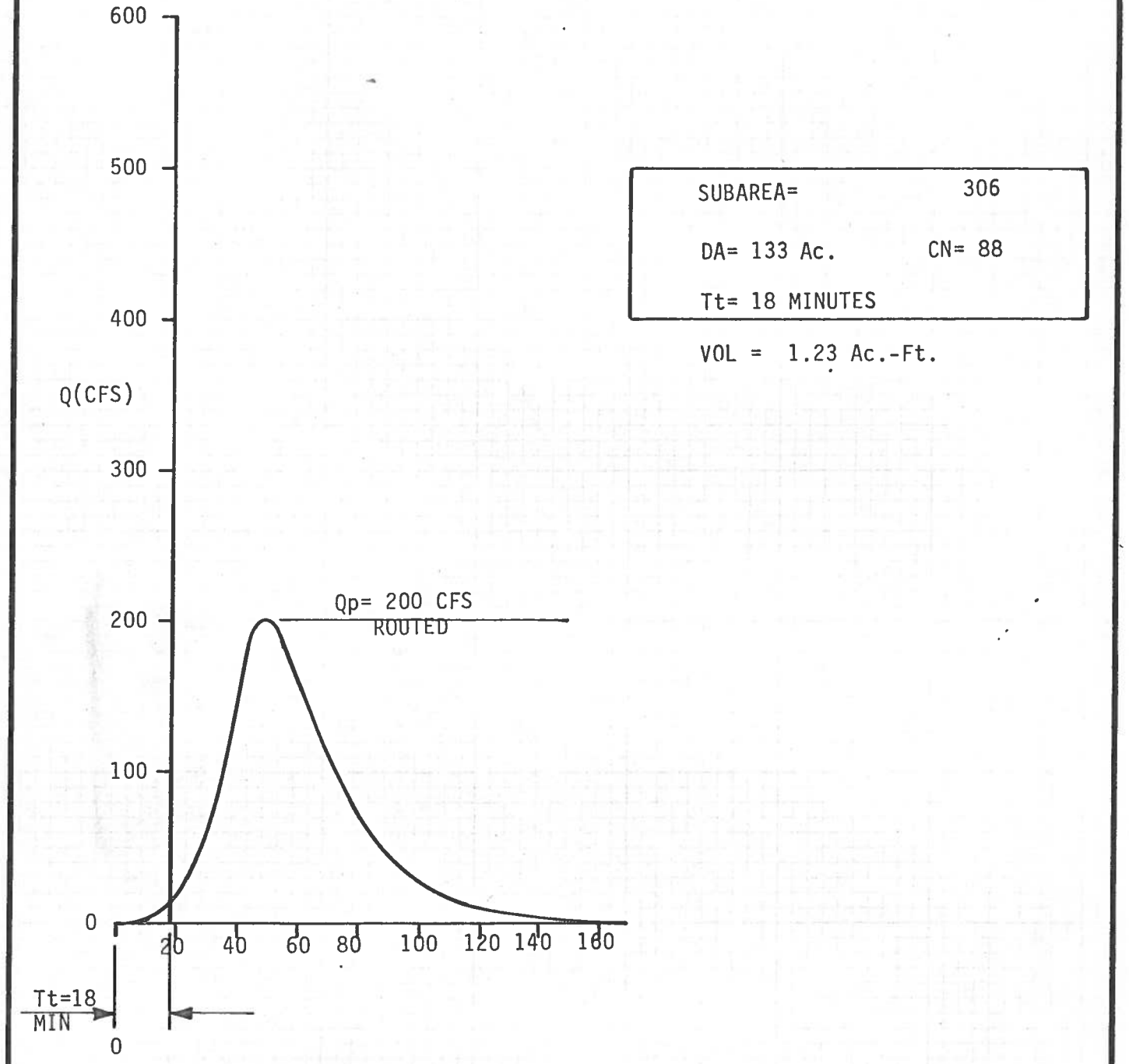
WILSON & COMPANY
ENGINEERS & ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 13



SUBAREA= 306

DA= 133 Ac. CN= 88

Tt= 18 MINUTES

VOL = 1.23 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/ WFB CHK. APP.

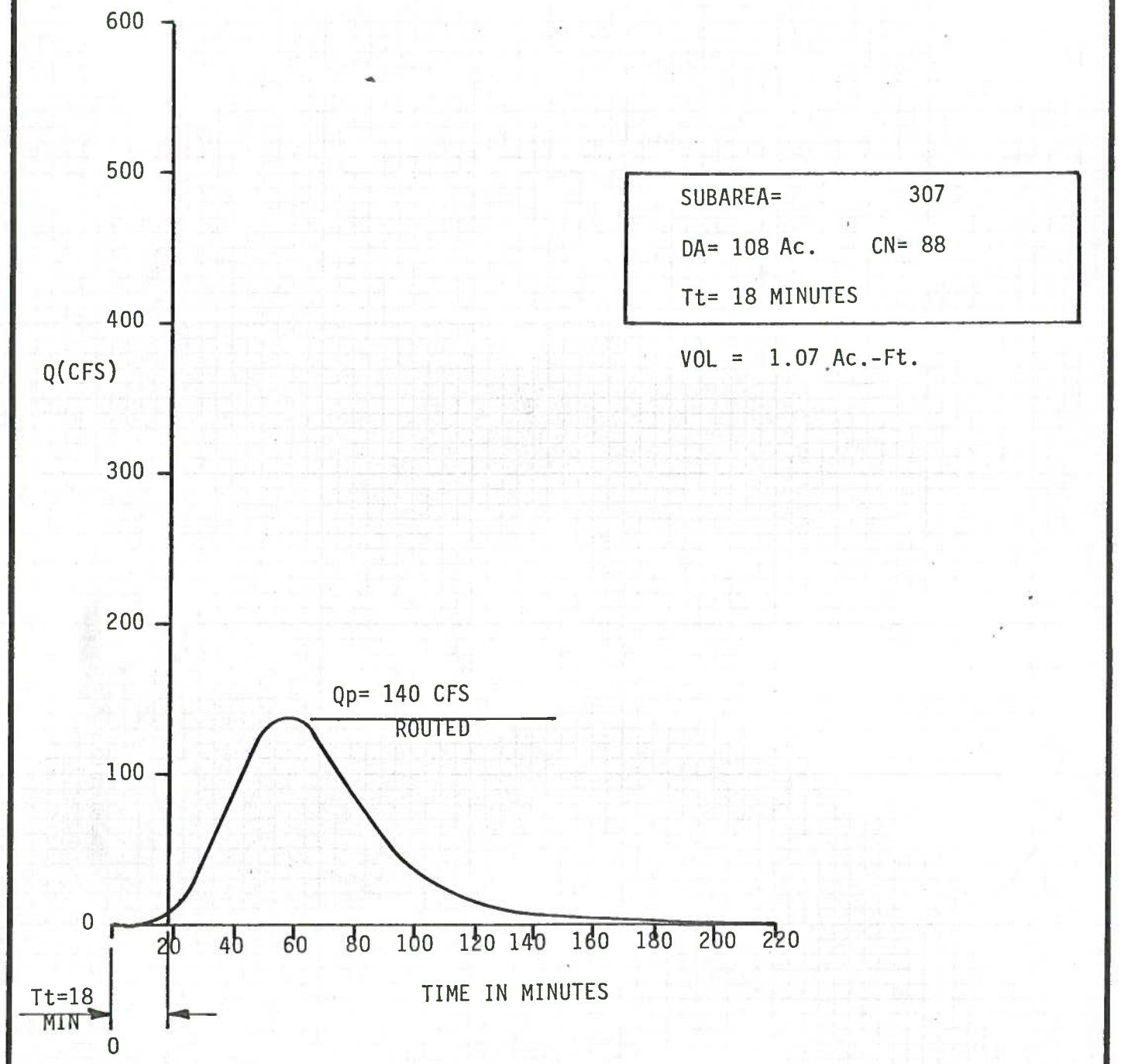
WILSON & COMPANY
ENGINEERS
ARCHITECTS

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 14



100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., NM PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/WFB CHK. _____ APP. _____

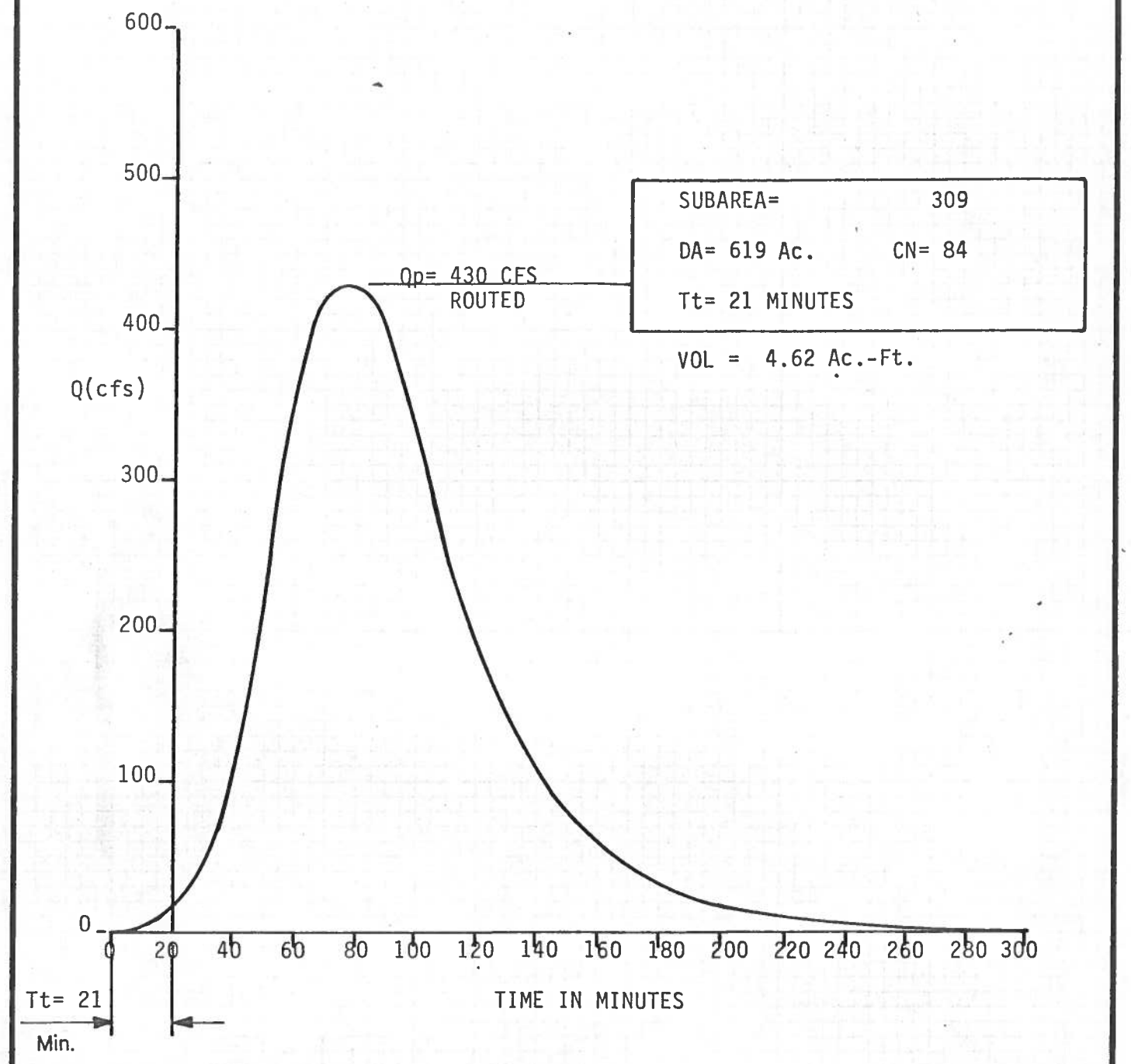
WILSON & COMPANY
ENGINEERS ARCHITECTS
SALINA
ATLANTA
ALBUQUERQUE

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 15



100 YEAR ROUTED HYDROGRAPHIC
PIEDRAS MARCADAS DAM SITE - AMAFCA

LOCATION ALBUQ., PROJECT PIEDRAS MARCADAS DAM

COMP. SJM/ WFB CHK. APP.

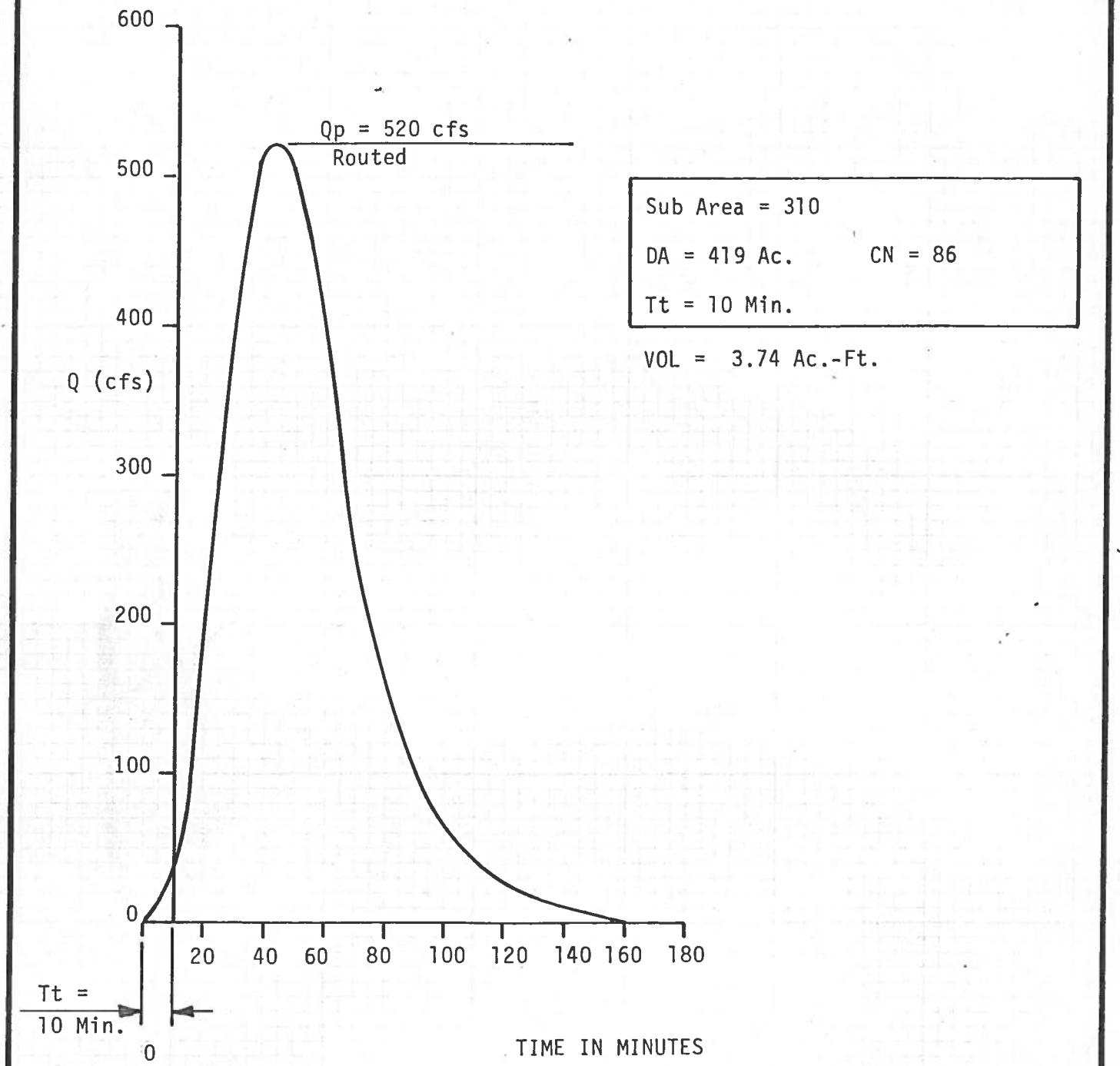
WILSON & COMPANY
ENGINEERS ARCHITECTS
SALINA
ATLANTA
ALBUQUERQUE

FILE 83-507

DATE JULY 1983

SHEET /

FIGURE 16



100 YEAR ROUTED HYDROGRAPH
PIEDRAS MARCADAS DAM SITE - A.M.A.F.C.A.

LOCATION Albuquerque, NM PROJECT Piedras Marcadas Dam

COMP. SJM/WFB CHK. _____ APP. _____

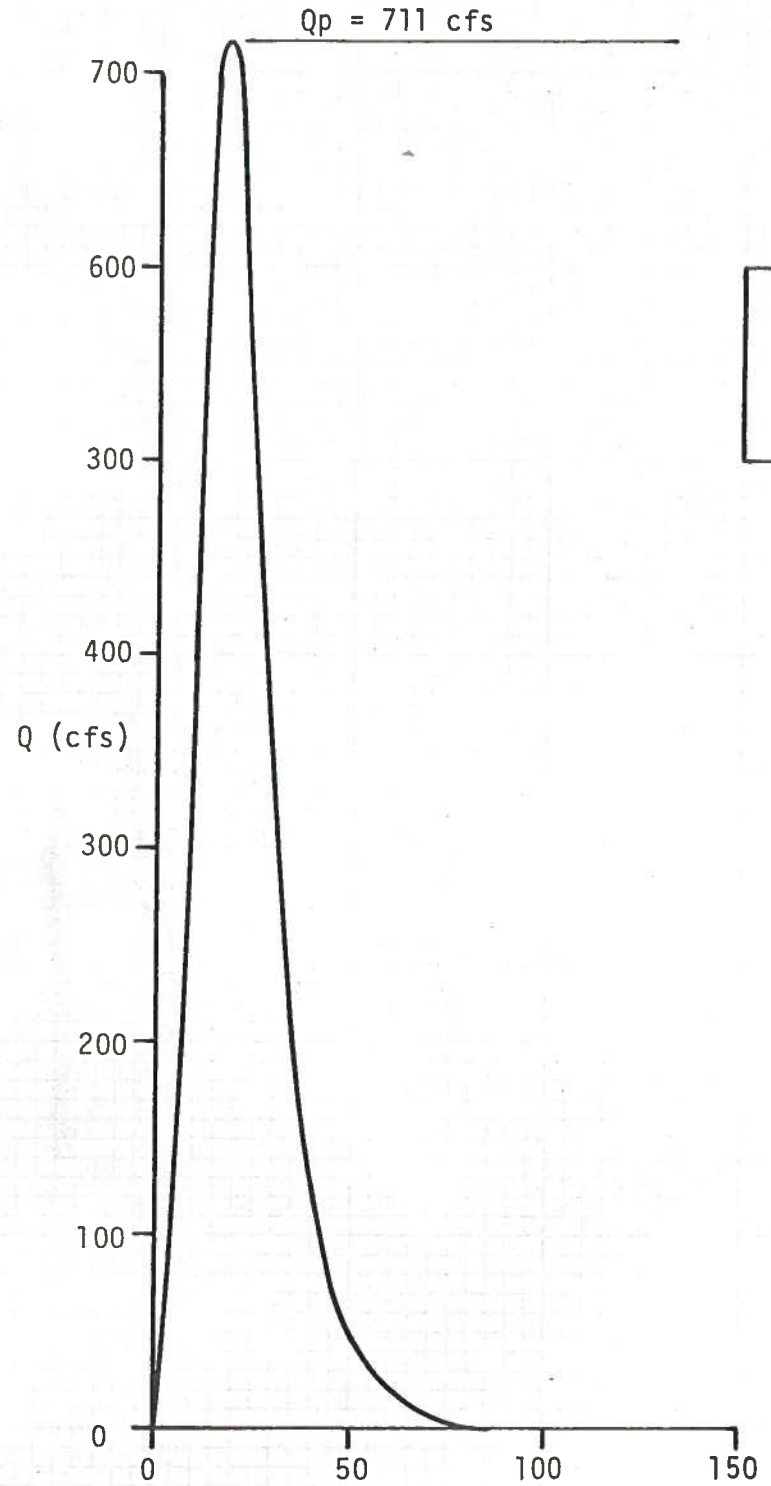
WILSON & COMPANY ENGINEERS & ARCHITECTS

FILE 83-507

DATE July 1983

SHEET /

FIGURE 17



Sub Area = 400

DA = 280 Ac. CN = 85

Tt = 0 Min.

VOL = 2.24 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPH
PIEDRAS MARCADAS DAM SITE - A.M.A.F.C.A.

LOCATION Albuquerque, NM PROJECT Piedras Marcadas Dam

COMP. SJM/WFB CHK. _____ APP. _____

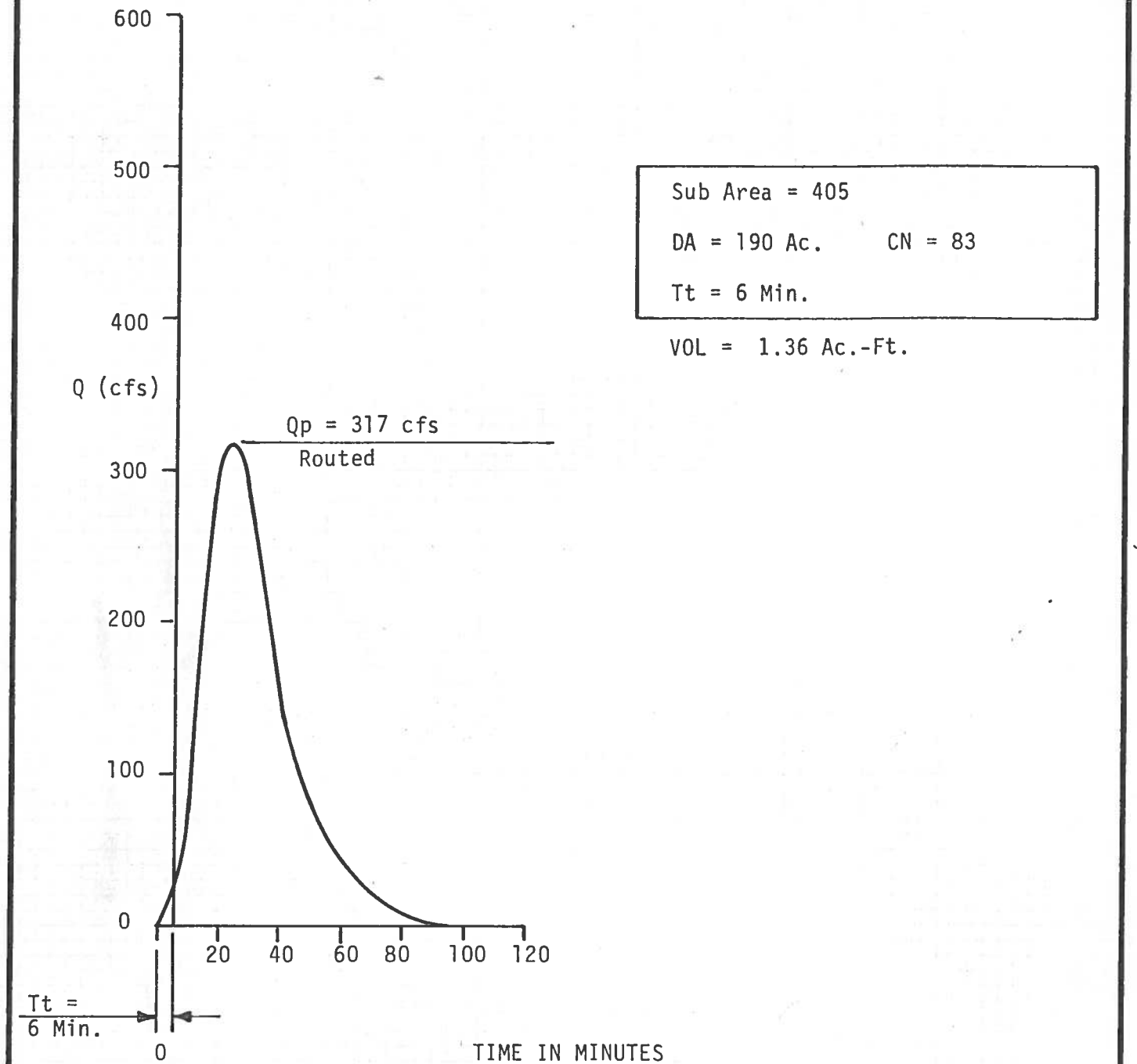
WILSON & COMPANY ENGINEERS ARCHITECTS

FILE 83-507

DATE July 1983

SHEET /

FIGURE 18



Sub Area = 405

DA = 190 Ac. CN = 83

Tt = 6 Min.

VOL = 1.36 Ac.-Ft.

100 YEAR ROUTED HYDROGRAPH
PIEDRAS MARCADAS DAM SITE - A.M.A.F.C.A.

LOCATION Albuquerque, NM PROJECT Piedras Marcadas Dam

COMP. SJM/WFB CHK. APP.

WILSON & COMPANY ENGINEERS & ARCHITECTS

FILE 83-507

DATE July 1983

SHEET /