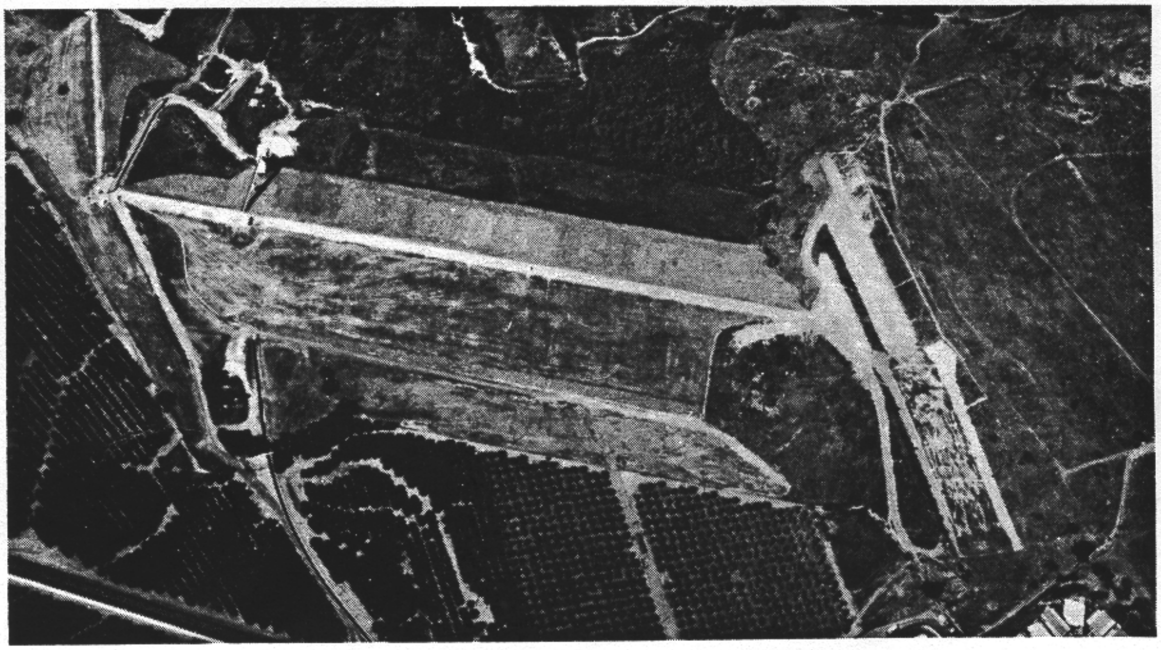
US Army Corps
of Engineers
Los Angeles District

Water Control Manual

CARBON CANYON DAM AND RESERVOIR

Carbon Canyon Creek, California



December, 1990

CARBON CANYON DAM AND RESERVOIR
CARBON CANYON CREEK, ORANGE COUNTY, CALIFORNIA
PERTINENT DATA
DECEMBER 1990

Completion date	May 1961
Stream system	Carbon Canyon Creek
Drainage area ... mi^2	19.3
Reservoir:	
Elevation	
Streambed at dam ... ft, NGVD	400
Debris pool ... ft, NGVD	419
Flood control pool (spillway crest) ... ft, NGVD	475
Original Spillway design surcharge level ... ft, NGVD	493.7
Revised PMF Spillway surcharge level ... ft, NGVD	491.9
Top of dam ... ft, NGVD	499
Area (based on original survey**)	
Debris pool ... ac	40.5
Spillway crest ... ac	223.5
Spillway design surcharge level (493.7) ... ac	308.5
Top of dam ... ac	343.0
Capacity, gross (based on original survey**)	
Debris pool ... ac-ft	298 (0.29*)
Spillway crest ... ac-ft	7033 (6.83*)
Spillway design surcharge level (493.7) ... ac-ft	12,063 (11.72*)
Top of dam ... ac-ft	13,781 (13.39*)
Allowance for sediment (50-year) ... ac-ft	1500 (1.46*)
Allowance for sediment (100-year) ... ac-ft	3000 (2.92*)
Area (based on 1969 survey***)	
Debris pool ... ac	33.8
Spillway crest ... ac	222.0
PMF Spillway surcharge level (491.9) ... ac	287.0
Top of dam ... ac	305.6
Capacity (based on 1969 survey***)	
Debris pool ... ac-ft	228 (0.23*)
Spillway crest ... ac-ft	6615 (6.43*)
PMF Spillway surcharge level (491.9) ... ac-ft	11,324 (11.0*)
Top of dam ... ac-ft	12,899 (12.53*)
Dam:	
Type	Earthfill
Height above original streambed ... ft	99
Top length ... ft	2610
Top width ... ft	20
Design Freeboard ... ft	5.3
PMF Freeboard ... ft	7.1
Spillway:	
Type	Ungated broad-crested weir
Crest width ... ft	125
Design discharge at surcharge elevation (493.7) ... ft^3/s	36,800
PMF discharge at surcharge elevation (491.9) ... ft^3/s	31,200
Outlets:	
Gates - type	Hydraulic slide
Number and size	2 - 5'W x 6.5'H
Entrance invert elevation ... ft, NGVD	403
Conduits - type	Rectangular
Number and size	1 - 4.75'W x 7'H
Length (including transition section) ... ft	549
Entrance invert elevation ... ft, NGVD	403
Maximum Discharge at spillway crest elevation ... ft^3/s	1270
Maximum Discharge at top of dam elevation ... ft^3/s	1480
Reservoir design flood (SPF):	
Total inflow volume (2-day) ... ac-ft	8030 (7.80*)
Inflow peak ... ft^3/s	9300
Spillway design flood:	
Design total inflow volume (1-day) ... ac-ft	10,600 (10.30*)
Design inflow peak ... ft^3/s	56,000
PMF total inflow volume (15-hour) ... ac-ft	11,800 (11.46*)
PMF inflow peak ... ft^3/s	52,000
Historic maximums:	
Maximum release(01 Mar 83) ... ft^3/s	703
Maximum water surface elevation(01 Mar 83) ... ft, NGVD	430.9
Maximum storage (26 Feb 69) ... ac-ft	891.7
Maximum peak inflow (1-hour)(02 Mar 83) ... ft^3/s	1727

* inches of runoff
** based on surveys of October 1937, August 1941, August 1949, and bottom resurvey of March 1961.
*** based on resurvey of September 1969.

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
630 Sansome Street, Room 720
San Francisco, California 94111-2206

REPLY TO
ATTENTION OF:

CESPD-ED-W (1110-2-240b)

MAR 20 1991

MEMORANDUM FOR Commander, Los Angeles District
Commander, Sacramento District

SUBJECT: Planned Deviations from Approved Water Control Plans

1. All planned deviations from approved water control plans for reservoir projects within the South Pacific Division must be coordinated with the Coastal Engineering and Water Management Division at CESPD. Approval must be given prior to implementation of the deviation.

2. Emergency deviations do not require prior approval but coordination must still be made as soon as is practical.

ROGER F. YANKOUPE
Brigadier General, U.S. Army
Commanding

WATER CONTROL MANUAL

CARBON CANYON DAM AND RESERVOIR

CARBON CANYON CREEK, ORANGE COUNTY, CALIFORNIA

DECEMBER 1990

Prepared

by

U.S. Army Corps of Engineers

Los Angeles District

Reservoir Regulation Section

Aerial photograph of Carbon Canyon Dam

NOTICE TO USERS OF MANUAL

Regulation specify that this Water Control Manual be published in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be reserved in good condition so that inserts can be made to keep the manual current.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event unusual conditions arise, the Reservoir Regulation, Los Angeles District office, can be contacted by telephone at 213-452-3527 or 213-452-3623. See Table 9-1 for other important telephone numbers for reservoir regulation assistance.

ORGANIZATION OF MANUAL

This manual is divided into chapters, indicated by Roman numerals. Within each chapter are numbered paragraphs, which are major topics discussed in the chapter. Tables and figures cited in the text of each chapter are presented at the end of that chapter. Plates cited are located in the back of the manual. Exhibits are included in the back as appendices.

WATER CONTROL MANUAL
CARBON CANYON DAM AND RESERVOIR
CARBON CANYON CREEK, ORANGE COUNTY, CALIFORNIA

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLES

FIGURES

TABLE OF CONTENTS (CONTINUED)

LIST OF PLATES

LIST OF EXHIBITS

ABBREVIATIONS USED

ac	acre
ac-ft	acre-feet
ALERT	Automatic Local Evaluation in Real-Time
COE	U.S. Army Corps of Engineers
ft	feet
ft^3/s	cubic feet per second
LAD	Los Angeles District, U.S. Army Corps of Engineers
NGVD	National Geodetic Vertical Datum
NWS	National Weather Service
OCEMA	Orange County Environmental Management Agency
OCFCD	Orange County Flood Control District
OCWD	Orange County Water District
PMF	Probable Maximum Flood
ppm	parts per million
RDF	Reservoir Design Flood
RRS	LAD Reservoir Regulation Section
SPD	Standard Project Flood
USGS	United States Geological Survey
VHF	Very High Frequency
WSE	Water Surface Elevation

I - INTRODUCTION

1-01 Authorization

This Carbon Canyon Dam and Reservoir Water Control Manual was prepared in compliance with the following directives: ER 1110-2-240, EM 1110-2-3600, and ETL 1110-2-251.

1-02 Purpose and Scope

This water control manual provides a detailed plan for regulation of Carbon Canyon Dam and Reservoir on Carbon Canyon Creek (also known as Carbon Creek) for the purpose of flood control. Carbon Canyon Dam is located approximately 4 miles east of the city of Brea, and approximately 12 miles north of the city of Santa Ana, in Orange County, California (see pl.1-1). Major topics in this manual include: authorization, history, and description of the project; watershed characteristics; hydrometeorology; data collection and communication networks; hydrologic forecasting; the water control plan; and responsibilities and coordination for water control management.

1-03 Related Manuals and Reports

Manuals and reports with data and information relevant to the information of this manual are listed in table 1-1.

1-04 Project Owner

Carbon Canyon Dam and Reservoir was constructed and is owned and operated by the U.S. Army Corps of Engineers, Los Angeles District (LAD).

1-05 Operating Agencies

a. LAD. LAD is responsible for the operation and maintenance of the dam, reservoir, and outlet works. The outlet gates are operated manually, as needed. LAD is also responsible for 4080 feet of Carbon Canyon Channel just below the dam.

b. OCEMA. The Orange County Environmental Management Agency (OCEMA) is responsible for operation and maintenance of the remainder of Carbon Canyon Channel, Carbon Creek Channel, and Carbon Canyon Diversion Channel.

1-06 Regulating Agency

LAD is responsible for developing the flood control regulation plan for Carbon Canyon Dam and Reservoir as well as operation of the dam.

Table 1-1. Related Manuals and Reports.

1. Hydrology for Carbon Canyon Dam, Design Memorandum No. 1, Santa Ana River Basin (and Orange County), California, Flood Control, U. S. Army Engineer District, Los Angeles, Corps of Engineers, April 1957.

2. General Design for Carbon Canyon Dam and Channel, Design Memorandum No. 2, Santa Ana River Basin (and Orange County), California, Flood Control, U.S. Army Engineer District, Los Angeles, Corps of Engineers, August 1957.

3. Real Estate for Carbon Canyon Dam and Channel, Design Memorandum No. 3, Santa Ana River Basin (and Orange County), California, Flood Control, U.S. Army Engineer District, Los Angeles, Corps of Engineers, December 1957.

4. Embankment Foundation for Carbon Canyon Dam, Design Memorandum No. 4, Santa Ana River Basin (and Orange County), California, Flood Control, U.S. Army Engineer District, Los Angeles, Corps of Engineers, August 1958.

5. Reservoir Regulation Manual for Carbon Canyon Flood Control Reservoir, Santa Ana River Basin (and Orange County), California, U.S. Army Engineer District, Los Angeles, Corps of Engineers, February 1964.

6. Carbon Canyon Regional Park Master Plan, Design Memorandum No. 6, Santa Ana River Basin, California, U.S. Army Engineer District, Los Angeles, Corps of Engineers, March 1974.

7. Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Carbon Canyon, San Antonio, and Tahchevah Dam, U.S. Army Engineer District, Los Angeles, Corps of Engineers, June, 1978.

8. Operation Manual, Carbon Canyon System, Orange County Environmental Management Agency, Revised February 1981.

9. Internal Report, Reservoir Elevation-Frequency, Carbon Canyon Dam, Brea, California, U.S. Army Engineer District, Los Angeles, Corps of Engineers, Reservoir Regulation Section , May 1981.

10. Internal Report, Revisions in Gate Operating Schedules of Los Angeles District, Corps of Engineers Dam, July 1982, preliminary draft.

11. Hydrology Documentation, Coyote Creek Tributaries, Santa Ana River Basin, Orange County, California, Interim 3, U.S. Army Engineer District, Los Angeles, Corps of Engineers, March 1984.

12. General Report, Flood Emergency Plan, Carbon Canyon Dam, Carbon Canyon Creek, Santa Ana River Basin, Orange County, California, U.S. Army Engineer District, Los Angeles, Corps of Engineers, December 1985.

13. Carbon Canyon Dam Seismic Evaluation of Embankment and Foundation, Phase II Report, Carbon Canyon Creek Improvement, Santa Ana River Basin, Orange County, California, U.S. Army Engineer District, Los Angeles, Corps of Engineers, June 1988.

II - DESCRIPTION OF PROJECT

2-01 Location

Carbon Canyon Dam is located near the northern edge of Orange County, California. The dam is approximately 4 miles east of the city of Brea and approximately 12 miles north of the city of Santa Ana (pl. 1-1). The drainage area above the dam is 19.3 square miles and is encompassed entirely within the Puente and Chino Hills (pl.2-1). Carbon Canyon Creek flows in a generally southwesterly direction onto the coastal Orange County Plain, joins Coyote Creek, and then flows into the San Gabriel River.

2-02 Purpose

Carbon Canyon Dam's primary purpose is for flood control in the Carbon Canyon Creek drainage basin. In conjunction with Brea and Fullerton Dams, Carbon Canyon Dam is vital for the flood protection of portions of the coastal plains in Orange County, including the cities of Brea, Fullerton, Placentia, and Anaheim. The storage allocation for debris and flood control purposes at Carbon Canyon Dam is shown on plate 2-2.

Currently, no facilities for the generation of hydroelectric power at Carbon Canyon Dam exist, nor are any contemplated. Furthermore, no navigation of any sort is allowed should the reservoir become full.

2-03 Physical Components

a. Embankment. The dam is a compacted impervious earth-fill structure. It is 2610 feet long at the crest, with a crest width of 20 feet. The maximum height above streambed is 99 feet. The crest of the dam extends from north to south for about 750 feet, then continues in a southeasterly direction for about 1860 feet. The upstream slope protection consists of a 6-inch filter blanket overlain by a layer of dumped stone 1.5 feet thick. The part of the downstream toe of the dam that extends across the valley floor has toe protection consisting of a 6-inch filter blanket overlain by a stone facing approximately 2 feet thick. Both upstream and downstream faces have a slope of 1 vertical on 3.25 horizontal. A 200-foot wide berm runs parallel to the axis of the dam on the upstream side, having side slopes of 1 vertical on 3 horizontal.

The general plan, typical sections, and real estate limits are shown on plate 2-3. Photographs of the embankment are shown in figure 2-1.

b. Spillway. The spillway is a detached, concrete, broad crested weir structure, trapezoidal in cross-section. Looking in the downstream direction, it is located on the left side of the canyon, with a crest elevation of 475 feet, NGVD. The discharge capacity of the spillway at the PMF surcharge elevation of 491.9 feet is 31,200 ft^3/s. The spillway structure consists of an approach channel, a reinforced-concrete control section, a reinforced-concrete chute, and flip bucket. The spillway approach channel is an unlined trapezoidal channel about 535 feet long. It has a bottom width of 100 feet and side slopes of 1 vertical on 1.5 horizontal. Grouted stone gutters are installed on the top of the side slopes to take care of side drainage. The control section, which connects the approach channel to the spillway chute and flip bucket, consists of a concrete lined trapezoidal channel 50 feet long. The bottom width varies from 100 feet wide at station 14+50 to 125 feet wide at station 15+00. The side slopes vary from 1 vertical on 1.5 horizontal at station 14+50 to 1 vertical on 2.25 horizontal at station 15+00. Grouted stone gutters at the top of side slopes, which take care of side drainage, terminate in the upper reach of the spillway chute. The spillway chute is a concrete-lined trapezoidal channel with a base width of 125 feet, a length of 500 feet (including flip bucket), and side slopes of 1 vertical on 2.25 horizontal. The downward slope of the invert from the spillway crest at station 15+00 to station 17+00 is 0.115, and from station 17+00 to the flip bucket at station 19+65.66 is 0.14. The flip bucket is an energy dissipator located at the base of the drop structure. Spillway seepage control measures consist of a concrete cutoff wall extending about 7 feet below the invert of the spillway approach channel and a concrete cutoff wall extending about 1.5 feet below the slab at the downstream end of the spillway channel. A steel sheet piling wall and a 10-foot deep apron of derrick stone protect the downstream end of the spillway against undermining. Details, dimensions, and other information related to the spillway are shown on plate 2-4. Figure 2-2 shows photographs of the spillway.

c. Reservoir Outlet. The outlet works are entrenched in the right abutment when looking in a downstream direction, and consists of an approach channel, an intake tower, a transition, an outlet conduit, a control room, a floatwell, an access bridge, and a standby generator house. The outlet works are founded on soft bedrock, except for a short length of conduit at the downstream end, which is founded on alluvium. The approach channel consists of reinforced-concrete retaining walls 15 feet apart and about 80 feet long. Rack bars are provided just upstream from the gates to prevent sunken logs and other material from entering the intake structure. The bars have been modified by the addition of hinges which allow them to be lifted for maintenance purposes. The intake tower is a reinforced concrete structure, 18 feet by 20 feet inside and approximately 82 feet high. It provides access to the gate cylinders and hydraulic pipe lines. A reinforced-concrete transition structure, 77.3 feet long, lies between the two rectangular gated passages and the single rectangular outlet conduit. The rectangular outlet conduit is a reinforced concrete structure 471.7 feet long. It is 4.75 feet wide and 7 feet high. The conduit is constructed in sections 20 feet long with a slope of 0.004444. Rubber water stops are provided between the sections. The maximum capacity of the outlet conduit is 1270 ft^3/s at a reservoir water surface elevation of 475 feet at the spillway crest with both gates open. Plate 2-5 shows pertinent information pertaining to the reservoir outlet works. Figure 2-3 is a photograph of the Carbon Canyon Dam outlet works.

d. Water Supply Facilities. Carbon Canyon Dam’s operational objective is to maximize flood protection. This objective is to be accomplished by operating Carbon Canyon Dam to release all flood waters as rapidly and safely as possible. Miller Retarding Basin Complex and other flood retarding basins are located further downstream. The operation of Carbon Canyon Dam in conjunction with this water conservation is discussed in section 7-09.

2-04. Related Control Facilities

OCEMA maintains a series of flood retarding basins along the Carbon Creek Channel downstream of Carbon Canyon Dam (pl.2-6). These basins are used to retard flood flows in the urbanized area downstream of Carbon Canyon Dam. The Carbon Canyon Diversion Channel serves to relay water from the Miller Basin Complex to the Santa Ana River. Miller Stilling Basin, the most upstream of the facilities, is the location point from which flow from Carbon Canyon Channel is diverted into Carbon Canyon Diversion Channel or Carbon Creek Channel. During periods of low flow, water is directed into the Diversion Channel, which flows into the lower Santa Ana River Channel and its attendant groundwater recharge facilities. Higher flows which fill Miller Basin are directed into Carbon Creek Channel and flow west into the next series of retarding basins on their way to the San Gabriel River Channel.

2-05 Real Estate Acquisition

Carbon Canyon Dam and Reservoir project lands comprise 321.76 acres as shown on Plate 2-3.

2-06 Public Facilities

A variety of recreation facilities exist within Carbon Canyon Reservoir, although none of these is dependent on a permanently maintained pool. Development is limited to the reservoir area outside of the 33.8 acre debris pool. Permanent buildings, such as the administration and maintenance buildings are constructed at or above the future condition 50-year flood elevation (439.5 ft, NGVD). Within the basin the existing facilities include: 3 multipurpose sand fields (volleyball), 3 general purpose fields (baseball, soccer), 8 tennis courts, and a tot lot and children’s play area. An equestrian, hiking, and biking trail system extends through the park. Three restrooms and 9 picnic areas are scattered throughout. A 0.75 mile long road provides access into the park area, with parking available in 6 separate areas. Table 2-1 indicates current facilities in the reservoir with their respective elevations.

Table 2-1

List of Recreational and Other Facilities, including elevations, in Carbon canyon Regional Park

NAME OF FACILITY OR REFERENCE	ACRES	RANGE OF ELEVATIONS (FT., NGVD)
1. Parking Areas:		
#1	-	457.5 - 459.5
#2	-	454.2 - 460.79
#3	-	445.5 - 454.0
#4	-	447.5 - 450.0
#5	-	420.0 - 424.0
#6	-	418.9 - 419.97
2. Visitor Center/ Administration Bldg	-	462.5
3. Tennis Courts	1.32	
4. Playlots	0.70	449.7 - 453.26
5. Lake	3.24	434.0 - 438.0
6. Group Picnic Area	-	431.0
7. Volleyball Courts	-	434.0
8. Bicycle/Hiking Trail	-	426.0
9. Equestrian/Hiking Trail	-	454.5 - 495.0
10. Picnic Ramadas:		
#1	-	448.5
#2	-	435.0
#3	-	438.5
#4	-	453.0
#5	-	453.0
#6	-	432.5
#7	-	432.5
#8	-	421.5
#9	-	435.0
11. Rest Rooms:		
#1	-	452.5
#2	-	453.0
#3	-	460.5
12. Maintenance Building		457.4
13. Oil Pumping Station*	-	440.0
14. Storage Shed	-	-
15. Multi-Purpose Field	6.5	420.0 - 428.0
16. Redwood Grove	10.0	-

* Flood Proofed.

III - HISTORY OF PROJECT

3-01 Authorization

Carbon Canyon Dam and Channel was authorized pursuant to two acts of Congress. The first of these, the Flood Control Act of 1936 (Public Law 738, 74th Congress, H.R. 8455, approved 22 June 1936), provided in part for the construction of reservoirs and related flood-control works for the protection of metropolitan Orange County, California. The second (Public Law 761, 75th Congress, approved 28 June 1938), amended the 1936 Act by providing for the acquisition by the United States of land, easements, and right-of-way for dam and reservoir projects, channel improvements, and channel rectification for flood control. The overall project was adopted in the Flood Control Act of 1936 on the basis of the 29 July 1935 report of the Orange County Flood Control District (OCFCD) in connection with an application for a grant under the Federal Emergency Relief Appropriation Act of 1935.

3-02 Planning and Design

Information generally pertaining to the dam was first presented in the OCFCD report mentioned above. In numerous subsequent conferences with LAD, the Orange County Board of Supervisors and OCFCD discussed the plan of improvement. A comprehensive report on a plan for flood control in Orange County, California, was prepared by OCFCD in March 1955. This plan included Carbon Canyon Dam and Carbon Canyon Creek channel improvements. Design of the dam, and a length of improved channel immediately downstream of the dam, was performed by LAD, and presented in “General Design for Carbon Canyon Dam and Channel, Design Memorandum No. 2, Santa Ana River Basin (and Orange County)”, dated August 1957, submitted 21 February 1958, and approved with comments 17 April 1958. This memorandum included design of the dam, outlet works, spillway, and a concrete-lined channel 4080 feet in length (see para. 3-04a), as well as construction of drainage structures, relocation of two highways, modification of bridges, the removal of school buildings and residences, and the relocation of utilities.

3-03 Construction

Construction of Carbon Canyon Dam started in April 1959 under contract DA 04-353-CIVENG-59-144, with work completed and accepted by the U.S. Army Corps of Engineers on 9 May 1961. Construction of the Corps project channel (para. 3-04a) started in April 1960 and was completed in May 1961. The project was constructed by Oberg Construction Company of Northridge, California.

3-04 Related Projects

Plate 1-1 shows projects related to Carbon Canyon Dam.

a. Carbon Canyon Channel. Carbon Canyon Channel (also called Carbon Canyon Creek) has been improved and partially lined from Carbon Canyon Dam to its juncture with Carbon Creek Channel. The LAD segment of this project is a 4080-foot concrete-lined rectangular channel extending downstream from Carbon

Canyon Dam partway to Miller Basin Complex, an OCEMA facility at the terminus of Carbon Canyon Channel. The remainder of Carbon Canyon Channel from the end of the LAD channel to Carbon Creek Channel has been partially improved, and is maintained by OCEMA. The Miller Basin Complex serves the functions of flood retarding basin, desilting basin, and stilling basin. At Miller Basin, Carbon Canyon Channel, becomes Carbon Creek Channel. Miller Basin also serves to divide flow between Carbon Creek Channel (which flows to Coyote Creek and then the San Gabriel River) and Carbon Canyon Diversion Channel (which flows to the Santa Ana River). The channel capacities and configurations for Carbon Canyon Channel from Carbon Canyon Dam to Miller Basin are shown on plate 3-1.

b. Carbon Canyon Diversion Channel. Carbon Canyon Diversion Channel is an unlined channel, built and maintained by OCEMA, extending from Miller Basin to the Santa Ana River. Carbon Canyon Diversion Channel was constructed to allow flow to be diverted away from Carbon Creek Channel into the Santa Ana River. Flow from Carbon Canyon Channel is normally directed into the diversion channel so that it may be used at groundwater recharge facilities on the Santa Ana River downstream. Once storage in Miller Basin reaches capacity, flow is then split between Carbon Creek Channel and Carbon Canyon Diversion Channel by means of a weir installed for that purpose. The channel capacities and configurations for the Carbon Canyon Diversion Channel are shown on plate 3-1.

3-05 Modification to Regulations

The original authorized reservoir regulation schedule for Carbon Canyon Dam called for a standby gate setting of both gates closed. In July 1982, the schedule (Exhibit A) was revised to call for a standby gate setting of one gate open to 0.5 feet to pass low flows. This change was adopted to prevent the formation of pools of stagnant water at the outlets. Additionally, the change was adopted to reduce sediment buildup at the outlet works, to reduce gate corrosion, and to maintain a drier reservoir bottom to allow heavy equipment access for silt clearing operations around the intake tunnels. The gate to be left open alternates, depending on sediment buildup, gate maintenance, and other conditions. Benefits from this mode of regulation are reduced gate corrosion and painting, and reduced insect propagation. The revised schedule also allows the reservoir pool below elevation 425 to be drained more rapidly with both gates set at 0.9 feet during falling stages. The standing instructions were also revised to call for wait-time of one hour after loss of communication with the LAD office before regulation is continued according to schedule. During falling stages, current downstream gauge height is to be maintained until communication is reestablished.

3-06 Principal Regulation Problem

Carbon Canyon Dam has never spilled, and there have never been any structural deficiencies or major hydraulic malfunctions. Based on the results of the 1969 reservoir sedimentation survey, sediment accumulated behind the dam at an average rate of 2.54 ac-ft per square mile per year during the 1961-1969 period (418 ac-ft in 8.5 years). This rate is somewhat higher than the 1.55 ac-ft per square mile per year expected over the life of the project. As of the 1969 survey, there was 6387 ac-ft of storage available above elevation

419 (top of debris pool) for flood control (6615 ac-ft remaining capacity below spillway crest minus 228 ac-ft capacity remaining in the debris pool), of which 5533 ac-ft (7033 ac-ft original capacity minus the 1500 ac-ft 50-year sediment allowance) is required to control the reservoir design flood (RDF) with the current regulation schedule (pl.2-2). Recent observations made by Corps personnel indicate that there is now very little sediment storage space remaining in the debris pool. Unless silt clearing is performed at Carbon Canyon Dam at needed intervals, impingement of sediment in the flood control pool will likely occur before the end of project life.

A limitation encountered in the regulation of Carbon Canyon Dam is that of downstream channel capacity in the segment of channel that runs through Alta Vista golf course. This segment of channel has an unknown capacity, is somewhat erosive, is overgrown with vegetation, and has numerous bridges which may impede flow during large events. The LAD Reservoir Regulation Section (RRS) would dispatch channel observers to this area if high flows are anticipated.

IV - WATERSHED CHARACTERISTICS

4-01 General Characteristics

Carbon Canyon Dam is located near the northern edge of Orange County, 4 miles east of the city of Brea, and approximately 12 miles north of the city of Santa Ana on Carbon Canyon Creek, a tributary of Coyote Creek. The drainage area above the dam is 19.3 square miles. The Puente and Chino Hills form the northern and eastern drainage divide of the watershed. The drainage divide on the west is formed by the ridge between the Tonner Canyon and Carbon Canyon watersheds. On the south, the drainage divide is formed by the ridge between Telegraph Canyon watershed and that of the Santa Ana River watershed. Carbon Canyon Creek flows generally southwest from the drainage divide for about 7.4 miles to the dam site, leaves the canyon mouth (becoming Carbon Canyon Channel), then flows south about 3.5 miles to Miller Basin, a flood retarding complex. At Miller Basin, the channel system divides into two channels: Carbon Canyon Diversion Channel, which flows south to the Santa Ana River; and Carbon Creek Channel, which flows west into Coyote Creek and on to the San Gabriel River. The average gradient of Carbon Canyon Creek is about 117 feet per mile above the dam site. The average gradient of Carbon Canyon and Carbon Creek Channels is about 55 feet per mile from the dam to the juncture with Coyote Creek. Telegraph Canyon Creek, the major tributary in the watershed above Carbon Canyon Dam, joins Carbon Canyon Creek within Carbon Canyon Reservoir.

4-02 Topography

Approximately 98% of the drainage area above Carbon Canyon Dam consists of steep, rugged terrain, dissected by deep, narrow ravines containing numerous watercourses tributary to Carbon Canyon and Telegraph Canyon Creeks. The remainder of the watershed consists of a relatively small valley fill area. Elevations in the mountains vary from 1781 feet at San Juan Hill (the highest point in the watershed) to about 403 feet at the dam site.

4-03 Geology and Soils

Carbon Canyon is located on the southwest side of the northwest-southeast trending Puente and Chino Hills, a structural block that has been uplifted as a wedge between the Whittier and Chino faults. The Puente and Chino Hills are composed of soft Tertiary sediments consisting of interbedded sandstones and siltstones with occasional beds of conglomerate. These rocks are covered by recently deposited alluvium in the stream channels and by patches of early Quaternary alluvium on lower elevation terraces. The tertiary bedrock has been folded and faulted into large anticlines and synclines by regional compression forces.

Carbon Canyon was formed by erosion of the uplifted relatively soft rocks of the Puente and Chino Hills. Downcutting of the canyon reached its maximum during the Pleistocene glaciation (approximately 10-20,000 years BP). Since then, the canyon has generally undergone a period of aggradation and contains approximately 100 feet of alluvium over the deepest sections of the canyon. The canyon floor at the dam is about 1000 feet wide and relatively flat except for a narrow wash which contains Carbon Canyon Creek. The slopes forming the canyon walls are moderate to steep. Immediately downstream of the dam, the canyon ends and the creek flows across the relatively flat alluvial fan surface of the coastal plain.

Soils in the mountains tend to be shallow, stony, and poorly-developed. Soil depths range from ten or more feet deep at the bases of steep slopes to a few inches near ridge crests. Soils tend to erode easily under raindrop impact, particularly when the watershed has suffered recently from the effects of wildfire.

4-04 Sediment

Sediment production within the Carbon Canyon watershed varies considerably, depending primarily on the terrain. In the lower sloped valley fill areas, sediment production is at a minimum. However, these areas comprise a very small part of the total drainage area above the dam and have historically served as storage sites for sediment transported by overbank flows during flood events. In the steep mountainous segment of the watershed sediment production can be quite high, particularly following periods in which wildfire impacts the watershed, and also following periods of high-intensity rainfall.

Reservoir surveys performed in March 1961 and September 1969 indicate a change in storage capacity at spillway crest from 7033 to 6615 ac-ft due to sediment inflow. This indicates a sediment yield for the watershed above Carbon Canyon Dam of 418 ac-ft for an 8.5 year period, or an average annual sediment yield of 2.54 ac-ft per square mile per year. This figure is generally consistent with that measured at reservoirs elsewhere in the area, but is somewhat higher than the 50-year sediment yield of 1.55 ac-ft per square mile per year originally allocated (1500 ac-ft over the 50 year economic life of the dam). The loss in storage capacity due to sediment deposition within Carbon Canyon Reservoir amounted to 6% of gross storage capacity as of September 1969.

4-05 Climate

The climate of the drainage area above Carbon Canyon Dam is generally temperate-subtropical and semi-arid, with warm dry summers and mild, moist winters.

a. Temperature. Average daily minimum and maximum temperatures (degrees Fahrenheit) in the vicinity of Carbon Canyon Dam range from about 42 and 66, respectively, in winter to about 59 and 90 in summer. Average winter maxima are generally 3-4 degrees lower near the top of the drainage basin. All-time low and high extremes of temperature are about 22 and 113, respectively. The area does not experience significant periods of freezing temperatures.

Table 4-1, reprinted from the National Weather Service Climatography of the United States No. 20, is a climatic summary for Yorba Linda (National Weather Service Station No. 9847), located about 2 miles southeast of Carbon Canyon Dam at 33E53'N, 117E49'W, elev. 350 ft NGVD. This table lists, among other items, the mean daily maximum and minimum temperature and record highest and lowest temperature for each month of the year.

b. Precipitation. Plate 4-1 shows the mean seasonal precipitation over the drainage area above Carbon Canyon Dam. This element ranges from about 16 inches at the dam to about 19 inches in the hills at the upper left portion of the watershed, and averages about 17 inches. Nearly all precipitation occurs during the months of December through March, in the form of rain. Rainless periods of several months during the summer are common. Most precipitation in the drainage area results from general winter storms that are associated with extra-tropical cyclones of North Pacific origin.

Table 4-1 shows the mean and maximum monthly and annual precipitation, as well as the maximum daily precipitation for each month of the year, for the Yorba Linda station. Also listed in table 4-1 are the probabilities (from 5 to 95 percent) for each month of the year that the monthly total precipitation at Yorba Linda will be equal to or less than the indicated amounts. This table shows that there can be great year-to-year variability in annual, monthly, and daily precipitation.

Table 4-2 is a precipitation depth-duration-frequency tabulation for the station at Yorba Reservoir, located about one-half mile south of the Yorba Linda weather station (table 4-1) at 33E52'N, 117E49'W, elev. 320 feet NGVD. Table 4-3 is a precipitation depth-duration-frequency tabulation for Carbon Canyon Workman, located near the north end of the drainage basin at 33E57'N, 117E48'W, elev. 1175 feet NGVD. In these tables are listed the computed point-value precipitation depths at each station for durations ranging from 5 minutes to 24 hours, and for return periods from 2 to 100 years. Data for this table were obtained from the State of California Department of Water Resources publication, Rainfall Depth-Duration Frequency for California, revised November 1982. These California Water Resources data are similar to those obtained from the National Oceanic and Atmospheric Administration publication, NOAA Atlas 2.

c. Snow. Snow in southern California is relatively uncommon at elevations below 4000 feet and is extremely rare below 2000 feet. Although even the valley floor has experienced light snow on isolated occasions, snowfall and snowmelt are not significant hydrologic factors in the Carbon Canyon Dam watershed.

d. Evaporation. No formal studies of evaporation have been made in the Carbon Canyon watershed; since Carbon Canyon Reservoir is normally dry, with any impoundments generally lasting less than 24 hours, evaporation is not a major consideration at this site. Studies for nearby locations indicate that mean monthly evaporation ranges from about 3 inches in winter to almost 9 inches in summer (table 4-4). On days of very strong, dry Santa Ana winds, evaporation can be considerably greater than one inch.

e. Wind. The prevailing wind in the Carbon Canyon watershed is the sea breeze. This gentle onshore wind is normally strongest during late spring and summer afternoons, with speeds in the Carbon Canyon watershed typically 10 to

15 miles per hour.

The Santa Ana is a dry desert wind that blows from out of the northeast, most frequently during late fall and winter. The characteristic low humidity and strong gusts of Santa Ana winds (which can exceed 70 miles per hour at times) usually create very high fire hazards, but can also be instrumental in drying a saturated watershed, thus reducing the flood hazard from later events.

Rainstorm-related winds are the next most common type in southern California. Winds from the southeast ahead of an approaching 20-30 mph, with occasional gusts to more than 40 mph. West to northwest winds behind storms can sometimes exceed 35 mph, with higher gusts.

4-06 Storms and Floods

a. Storm Types. General storms consist of one or more cyclonic disturbances, last a total of one to four or more days, and result in precipitation over large areas. Local thunderstorms result in intense precipitation over small areas for short periods of time, and may occur independently or in association with general storms. Tropical cyclones are infrequent, but occasionally occur in late summer. Snow seldom occurs over this drainage area. A description of storm types which may impact the project area follows:

(1) General Winter Storms. Most precipitation in southern California coastal drainages occurs during the cool season, primarily from November through early April, as mid-latitude cyclones from the northern Pacific Ocean move inland over the area. Most of these storms are the general winter type, characterized by hours of light-to-moderate precipitation, but with occasional heavy showers or thunderstorms embedded within the storm system.

(2) Local thunderstorms. Local thunderstorms can occur in southern California at any time of the year. They occur fairly frequently in the coastal areas in conjunction with general winter storms. They can also occur between early July and early October, when desert thunderstorms occasionally drift westward across the mountains into coastal areas, sometimes enhanced by moisture drifting northward from tropical storms off the west coast of Mexico. These local thunderstorms can at times result in very heavy rain for periods of one to three hours over small area, causing very rapid runoff from small drainages, such as the Carbon Canyon watershed.

(3) General Summer Storms. General summer storms in southern California are quite rare; but on occasion between mid-August and late October, a tropical storm from off the west coast of Mexico can drift far enough northward to bring rain, occasionally heavy, to southern California, sometimes with very heavy thunderstorms embedded. On very rare occasions, southern California has received light rain from general summer storms of non-tropical origin.

b. Floods. Information compiled from historical accounts, records of court cases, and statements of witnesses, indicate that large floods occurred in coastal southern California watersheds in 1811, 1815, 1825, 1851, 1852, 1859, 1860, 1862, and 1867. Available records since 1880 indicate that medium to large general floods occurred in February and March 1884, January 1886, December 1889, January 1890, February 1891, March 1905, March 1906, January 1910, March 1911, February 1914, January 1916, December 1921, April 1926, February 1927, January 1934, March 1938, January 1843, January and February 1969, February and March 1978, February 1980, February 1981, and March 1983. There was also a major tropical storm that occurred in September 1939, but no widespread flooding resulted in southern California from this event.

Brief summaries of the two floods producing the largest peak flows the Carbon Canyon Dam location (March 1938 and March 1983) and the December 1933-January 1934 flood, which was the basis for the standard project storm for Carbon Canyon Dam, follow:

(1) Storm and flood of 30 December 1933 - 2 January 1934. This storm caused the disastrous flood in the Glendale-Montrose-La Crescenta area of the Los Angeles River basin. Ground conditions were favorable to high runoff because of a fire in November 1933 that had burned over an area of 7.5 square miles of mountain area, and an antecedent storm that occurred in mid-December. Precipitation was general over a wide area. The ratio of valley precipitation to mountain precipitation was unusually high. Although the total storm rainfall and short-period intensities were not excessive, the 24-hour rates were the maximum of record at many stations. This storm was characterized by sharp bursts of rainfall. The depths of maximum 6-, 12-, 24-, and 48-hour precipitation at Mt. Wilson were estimated at 4.1, 7.8, 11.8, and 15.0 inches, respectively. The maximum 12-, 24-, and 48-hour total storm precipitation depths over the drainage area above Carbon Canyon Dam were estimated at 3.3, 5.9, and 6.9 inches, respectively. In the vicinity of the storm center, runoff was heavy in the foothills and valleys but only moderate in the mountains. For Carbon Canyon Creek, runoff was moderate; a peak discharge of 728 ft^3/s was recorded at the gauge on Rose Drive Bridge at Olinda.

This storm, transposed on the basis of mean annual precipitation and critically centered over the watershed above the Carbon Canyon Dam location, was used as the standard project storm in the design of Carbon Canyon Reservoir.

(2) Storm and Flood of 27 February-3 March 1938. The flood February-March 1938 was the most destructive of record on the Santa Ana River and many other streams in southern California, and its occurrence played a major role in the justification of the construction of Carbon Canyon Dam. The storm developed out of a series of low-latitude north Pacific disturbances, bringing several bands of intense rainfall to southern California during a 5-day period. The maximum 12-, 24-, and 48-hour total storm precipitation depths were estimated at 3.5, 4.8, and 9.5 inches, respectively, for the precipitation station at Carbon Canyon Summit, and 4.1, 5.8, and 10.5 inches, respectively, over the drainage area above the dam. The intense band of 1-2 March produced a peak flow of 1760 ft^3/s on Carbon Canyon Creek at the Golden

Avenue Bridge gauge (see table 4-5). This flow, combined with heavy runoff from Brea Creek and other tributaries, produced a very destructive flood on the Santa Ana River, Coyote Creek, and Carbon Canyon Creek.

(3) Storm and Flood of 28 February-3 March 1983. A low-latitude Pacific storm reminiscent of the major event exactly 45 years earlier in 1938 moved into southern California at the end of February and first of March 1983, with 5-8 inches of rain over portions of Orange County. The heaviest rainfall occurred with the passage of a strong occluded cold front during the late morning of 1 March, with peak intensities well in excess of 1 inch per hour.

The peak inflow of 1837 ft^3/s at Carbon Canyon Reservoir occurred on 1 March 1983.

c. Flood Damages. Damages resulting from floods on Carbon Canyon Creek prior to the construction of the dam and channel improvements were relatively severe. Most damages occurred in the highly developed overflow area in and near Anaheim. The March 1938 flood moved houses off their foundations, tore up paved streets, and caused damages estimated at $600,000 (1938 dollars). Since the completion of the dam in 1961, along with the downstream channel improvements, minimal damage has resulted from severe storm events. The more recent storm of March 1983 is comparable in severity to the March 1938 storm. Without the protection of the dam and channel improvements, tremendous damage would have resulted in this highly developed area.

4-07 Runoff Characteristics

Runoff from the watershed is characterized by high flood peaks of short duration that result from high-intensity rainfall on the Puente and Chino Hills. Flood hydrographs are typically of less than 12 hours duration and are almost always less than 48 hours duration. Inflow rates drop rapidly between storms, and inflow during the dry summer season is usually less than 10 cfs. Long-term average inflow to Carbon Canyon Dam for the period 1960 through 1987 is 753 acre-feet per year (or 1.04 ft^3/s).

Table 4-5 lists the historic peak discharges for gauges at, or downstream of, Carbon Canyon Dam site for the period 1931 through 1961. Table 4-6 lists annual maximum peak inflow, outflow, and storage at Carbon Canyon Dam from 1962 through 1985. The greater Orange County basin area has historically experienced long-term wet and dry periods. Plate 4-2 illustrates the historic regional response of flood peaks from the 1870's to the 1970's for the southern California area.

In general, antecedent precipitation is a prerequisite for the occurrence of large floods. With substantial antecedent precipitation resulting from a series of winter storms, precipitation loss rates may decrease to as low as 0.15 inch per hour by the climax of a major storm. The unit graph for the watershed above Carbon Canyon Dam is shown on Plate 4-3.

4-08 Water Quality

Because Carbon Canyon Reservoir is strictly a flood-control project that rarely impounds water for more than 24 hours, it has no appreciable effect on water quality. The nature of the storm runoff entering the reservoir is generally of good quality considering the location of the watershed in the highly developed southern California area. This is probably because of the mostly undeveloped nature of the watershed upstream of the dam. Outflow from Carbon Canyon Reservoir may be used for groundwater recharge purposes at several sites downstream of the dam.

4-09 Channel and Floodway Characteristics

Characteristics of the Carbon Canyon Channel downstream from Carbon Canyon Dam vary throughout its length (pl. 3-1). The segment extending from the dam downstream to the Miller Basin Complex begins as a rectangular concrete-lined open channel with a capacity of 1000 ft^3/s. At Alta Vista Golf Course, the Channel is unlined and of unknown capacity. From the golf course downstream to Miller Basin, the channel is concrete-lined and trapezoidal, with a capacity of 1730 ft^3/s. Carbon Canyon Diversion Channel, extending from Miller Basin to the Santa Ana River, is unlined, trapezoidal, and varies in capacity from 2275 to 2800 ft^3/s. Carbon Creek Channel, after leaving Miller basin, varies from an unlined trapezoidal channel with a capacity of 470 ft^3/s, to a concrete-lined rectangular channel with a capacity of 3100 ft^3/s, transitions through various cross sectional shapes and capacities, and ends up joining Coyote Creek as an unlined trapezoidal channel with capacity of 2100 ft^3/s. All capacities given above are shown on plate 3-1.

4-10 Upstream Structures

There are no significant impoundment structures upstream of Carbon Canyon Reservoir.

4-11 Downstream Structures

Numerous flood retarding basins exist along Carbon Canyon Creek below Carbon Canyon Dam (pl. 2-6). These basins are Miller, Placentia, Raymond, and Gilbert, in downstream order. These basins are occasionally used to infiltrate water; however, their main purpose is to reduce floodflows in the area downstream from Carbon Canyon Dam. Miller Basin Complex is approximately 3.5 miles downstream of the dam at the confluence of Carbon Canyon Channel and Atwood Channel. It consists of a small stilling basin, retarding basin, desilting basin, and flow diversion structure. Flows entering Miller Basin Complex first run through the stilling basin, then into the desilting basin where a set of overflow weirs split flows between Carbon Canyon Diversion Channel (diverting flows to the Santa Ana River) and the Miller Retarding Basin. The capacity of the stilling basin is 44 ac-ft, while the capacity of the retarding basin is 340 ac-ft. The weir separating the stilling basin from the desilting basin is small and nearly covered by sediment and vegetation. The desilting basin has two weirs which serve different purposes. The low-level weir at the south end of the basin acts to restrict and divert flows to the Santa Ana River via the Carbon Canyon Diversion Channel. This weir has a capacity of about 3200 ft^3/s. There is also a weir at the west end of the desilting basin at a higher elevation above which flows enter Miller Retarding Basin. The capacity of this weir is about 6000 ft^3/s. There is also an emergency spillway at the west and which empties into a ditch. This ditch eventually leads back into Carbon Creek, which flows toward Coyote Creek. Thus inflow to Miller Basin may be, when necessary or desired, split between the Carbon Canyon Diversion Channel and Carbon Creek Channel, and passed into the lower Santa Ana or San Gabriel Rivers, respectively. See plate 2-6 for a schematic of the flood retarding facilities downstream.

4-12 <u>Economic Data</u>

a. Population. Orange County has been one of the fastest growing areas in the nation since the end of World War II. The watershed of Carbon Canyon Dam is contained in the Chino Hills area of northeastern Orange County. The downstream floodplain runs through the cities of Brea, Placentia, Fullerton, Yorba Linda, and Anaheim. The State of California, Department of Finance, Population Research Unit estimates population as of January 1989 for these cities as:

Brea	33,500
Placentia	41,650
Fullerton	111,700
Yorba Linda	47,900
Anaheim	244,300

b. Agriculture. The floodplain below the dam was once primarily citrus groves. The postwar era has brought increasing urbanization to the area, virtually replacing all agriculture. Today, a small nursery and a small plot of citrus groves continue in the flood plain.

c. Industry. The explosive growth in population has been accompanied by corresponding growth in industry and commerce. Just north of the dam, within the watershed boundary but not in the reservoir, are oil fields. Housing is available further upstream from the dam but extensive development is limited by the steep topography of the Chino Hills. Chino Hills State Park and Carbon Canyon Regional Park are the extent of recreational development within the watershed. Below Carbon Canyon Dam, the downstream floodplain contains numerous industrial/business parks. Located within the floodplain is an ammonia chemical plant, scheduled to close in the early 1990's. Otherwise most of the manufacturing is light industry that specializes in highly technical fields, especially aerospace and electronics. Research and development, banks, and food processing firms have rapidly expanded into the floodplain over the past decade. The floodplain area is heavily residential and supports general office and commercial development. The California State University at Fullerton lies 3 miles southwest of the dam.

d. Flood Damages. Since completion of the project, cumulative flood damages prevented through fiscal year 1988 for Carbon Canyon Dam and channel have been estimated to be $205,569,000.

TABLE 4-1 CLIMATOLOGICAL SUMMARY AT YORBA LINDA, CA

PERIOD: 1951-80
ELEVATION: 350 FT

	TEMPERATURE (F)															PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS								SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	* MEAN	* GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	.10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	67.3	42.4	54.9	91+	76	17	23	60	2	0	0	2	0	320	7	3.58	12.58	69	5.20	56	26	.0	.0		5	2	1
FEB	69.3	43.1	56.2	92+	77	15	27+	56	17	0	0	1	0	253	7	2.78	11.69	80	3.01	69	24	.0	.0		4	2	1
MAR	70.4	43.6	57.0	93+	59	12	29	51	2	0	0	1	0	256	8	2.30	6.98	78	2.90	68	08	.0	.0		4	1	1
APR	73.7	46.0	59.9	99	66	15	32+	56	2	1	0	0	0	179	26	1.15	5.21	58	1.64	58	01	.0	.0		3	1	0
MAY	76.7	50.9	63.8	104+	79	13	38+	60	5	2	0	0	0	84	47	.27	2.42	77	1.38	77	08	.0	.0		1	0	0
JUN	81.8	54.5	68.2	111+	73	20	41+	53	3	5	0	0	0	26	122	.05	.51	76	.51	76	10	.0	.0		0	0	0
JUL	88.8	58.2	73.5	110+	57	4	46+	53	2	13	0	0	0	0	264	.02	.29	68	.22	68	27	.0	.0		0	0	0
AUG	89.2	59.0	74.1	108+	56	23	46	51	7	14	0	0	0	0	282	.15	2.61	77	2.41	77	17	.0	.0		0	0	0
SEP	87.4	56.7	72.0	114+	55	1	43+	54	21	11	0	0	0	0	215	.29	2.37	76	1.40	76	10	.0	.0		1	0	0
OCT	81.4	52.0	66.7	109+	58	16	30+	71	29	6	0	0	0	55	108	.23	1.96	57	.94	79	20	.0	.0		1	0	0
NOV	74.2	46.1	60.1	100+	76	4	29+	79	21	1	0	0	0	172	25	1.57	7.33	65	2.40	67	19	.0	.0		2	1	1
DEC	68.9	42.3	55.6	99+	58	3	22+	68	21	0	0	1	0	299	7	2.07	6.91	66	3.15	51	29	.0	.0		3	1	1
YEAR	77.4	49.6	63.5	114	SEP 55	1	22	DEC 68	21	53	0	5	0	1644	1118	14.46	12.58	JAN 69	5.20	JAN 56	26	.0	.0		24	8	5

*FROM 1951-80 NORMALS

ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	320	253	256	179	84	26	0	0	0	55	172	299	1644
60	187	138	132	86	19	0	0	0	0	12	80	168	822
57	126	88	79	46	6	0	0	0	0	0	41	110	496
55	92	60	51	27	0	0	0	0	0	0	23	78	331
50	30	16	11	6	0	0	0	0	0	0	0	22	85

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	89	94	113	174	273	396	574	592	510	363	176	96	3450
57	61	66	79	133	216	336	512	530	450	305	134	66	2888
60	29	31	39	83	137	250	419	437	360	220	83	31	2119
65	7	7	8	26	47	122	264	282	215	108	25	7	1118
70	0	0	0	6	7	41	118	145	93	36	5	0	451

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION (INCHES)

PROBABILITY LEVELS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.00	.00	.00	.00	.00	.00	**	.00	.00	.00	.00	.00
.10	.22	.04	.00	.00	.00	.00	**	.00	.00	.00	.02	.00
.20	.77	.29	.49	.06	.00	.00	**	.00	.00	.00	.15	.17
.30	1.31	.62	.88	.25	.01	.00	**	.00	.00	.00	.34	.47
.40	1.91	1.06	1.28	.46	.05	.00	**	.00	.00	.00	.59	.83
.50	2.59	1.61	1.73	.72	.10	.00	**	.00	.00	.03	.90	1.27
.60	3.41	2.32	2.25	1.02	.18	.01	**	.00	.01	.12	1.30	1.80
.70	4.42	3.26	2.89	1.42	.29	.03	**	.00	.12	.24	1.83	2.51
.80	5.83	4.64	3.75	1.97	.46	.07	**	.01	.38	.42	2.62	3.51
.90	8.20	7.08	5.19	2.90	.78	.16	**	.35	.98	.72	4.02	5.21
.95	10.53	9.58	6.60	3.84	1.11	.25	**	.86	1.67	1.03	5.45	6.93

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.
** STATISTICS NOT COMPUTED BECAUSE LESS THAN SIX YEARS OUT OF THIRTY HAD MEASUREABLE PRECIPITATION

CLIMATOGRAPHY OF THE UNITED STATES NO. 20
YORBA LINDA, CA

Table 4-2

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE
FOR THE STATION AT YORBA RESERVOIR 163

Station NO. BSN ORDER SUB	Station Name	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
U05 9847 21	Yorba Reservoir 163	320	34	03S	09W	C	S	33.872	117.81	30

Maximum Precipitation for Indicated Duration; M-Minutes, H-Hours, F-Fiscal

Return Period in Years	5M	10M	15M	30M	1H	2H	3H	6H	12H	24H	F-YR
2	N/A	0.22	0.26	0.36	0.50	.65	.81	1.16	1.63	2.12	13.04
5	N/A	0.32	0.39	0.53	0.73	.97	1.19	1.72	2.40	3.12	18.36
10	N/A	0.39	0.47	0.64	0.89	1.17	1.45	2.08	2.91	3.78	21.73
20	N/A	0.45	0.54	0.75	1.03	1.36	1.68	2.42	3.39	4.40	24.82
25	N/A	0.47	0.57	0.78	1.08	1.42	1.76	2.52	3.54	4.60	25.78
40	N/A	0.51	0.62	0.85	1.17	1.54	1.91	2.74	3.84	4.99	27.75
50	N/A	0.53	0.64	0.88	1.21	1.60	1.98	2.84	3.99	5.18	28.67
100	N/A	0.59	0.71	0.97	1.35	1.78	2.20	3.16	4.42	5.75	31.44

Source: State of California, Department of Water Resources, Rainfall-Depth-Duration-Frequency for California, November 1982

Table 4-3

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE FOR THE STATION AT CARBON CANYON WORKMAN

Station NO. BSN ORDER SUB	Station Name	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
UDS 1520 00	Carbon Canyon Workman	1175		025	09W		S	33.95	117.80	36

Maximum Precipitation for Indicated Duration; M-Minutes, H-Hours, C-Calendar

Return Period in Years	5M	10M	15M	30M	1H	2H	3H	6H	12H	24H	C-YR
2	0.14	0.20	0.28	0.40	0.51	0.74	0.92	1.36	1.88	2.42	14.19
5	0.21	0.31	0.42	0.60	0.77	1.11	1.39	2.06	2.83	3.65	20.02
10	0.26	0.37	0.51	0.73	0.94	1.36	1.69	2.51	3.45	4.45	23.72
20	0.30	0.44	0.59	0.85	1.10	1.59	1.98	2.93	4.04	5.21	27.11
25	0.31	0.46	0.62	0.89	1.14	1.66	2.07	3.07	4.22	5.44	28.16
40	0.34	0.50	0.67	0.97	1.25	1.81	2.25	3.34	4.60	5.93	30.32
50	0.35	0.52	0.70	1.01	1.29	1.88	2.34	3.47	4.77	6.16	31.33
100	0.39	0.57	0.78	1.12	1.44	2.09	2.60	3.86	5.31	6.85	34.37

Source: State of California, Department of Water Resources, Rainfall Depth-Duration-Frequency for California, November 1982

Table 4-4

EVAPORATION STATIONS IN THE VICINITY OF CARBON CANYON RESERVOIR

OCEMA NO.	STATION NAME	LATITUDE (Degrees-Minutes-Seconds)	LONGITUDE	ELEVATION (ft)	RECORD from-to
126	Fullerton Airport	33-52-23	117-58-24	96	1/35 6/77
174	Atwood	33-51-48	117-50-30	240	4/70 6/77

MONTHLY EVAPORATION

(inches)

Fullerton Airport (42 year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.92	3.57	2.69	2.74	3.04	4.41	5.43	5.57	7.20	8.69	7.98	6.67

Atwood (7 year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.93	3.35	3.02	2.73	3.20	4.64	5.71	5.88	7.19	8.76	8.27	6.31

Average Annual Evaporation: Fullerton 62.91", Atwood 63.99"

Note: Each evaporation station consists of a Weather Bureau Class A Pan. Readings are adjusted for observed rainfall to yield net evaporation.
Reservoir evaporation may be estimated by multiplying measured pan evaporation by a pan coefficient ranging from 0.6 to 0.8.

Table 4-5

MAXIMUM RECORDED PEAK DISCHARGES, STREAM GAUGING STATIONS, CARBON CANYON DAM AND CARBON CANYON CREEK

Water Year	Carbon Creek at Olinda*** (Drainage Area = 19.1 mi^2) USGS #11075730		Carbon Creek near Yorba Linda (Drainage Area = 20.4 mi^2) USGS #11075740	
	Peak Discharge (ft^3/s)	Date	Peak Discharge (ft^3/s)	Date
1931-32	279	8 February	....	....
1932-33	186	29 January	....	....
1933-34	728	1 January	....	....
1934-35	102	7 March	....	....
1935-36	330	12 February	....	....
1936-37	No record	....	....	....
1937-38	1760	2 March	....	....
	(Gauge Discontinued)		....	....
1949-50	....	....	1.0	6 February
1950-51	....	....	2.3	13 November
1951-52	....	....	616	18 January
1952-53	....	....	25	15 November
1953-54	....	....	180	25 January
1954-55	....	....	24	18 January
1955-56	....	....	776	26 January
1956-57	....	....	22	1 February
1957-58	....	....	935	3 April
1958-59	....	....	32	11 February
1959-60	....	....	50	1 February
1960-61	....	....	8.4	26 January
			(Gauge Discontinued)	

***Gauge at Rose Drive bridge, drainage area 19.1 mi^2, from water year 1932 to 1935; and at Golden Avenue bridge, drainage area 20.0 mi^2 from 1935 to 1938.

TABLE 4-6

ANNUAL MAXIMUM WATER SURFACE ELEVATION, STORAGE, INFLOW, AND OUTFLOW
AT CARBON CANYON DAM

WATER YEAR OCT - SEP	MAX WATER SURFACE ELEVATION	MAXIMUM STORAGE (AC-FT)	DATE	MAXIMUM INFLOW (CFS)	DATE	MAXIMUM OUTFLOW (CFS)	DATE
1961 - 1962	409.77	56.7	FEB 19	109	JAN 20	90	JAN 20
1962 - 1963	407.14	21.5	FEB 10	33	FEB 10	1	MAR 17
1963 - 1964	406.25	13.2	NOV 20	38	NOV 20	16	NOV 21
1964 - 1965	408.75	42.1	APR 10	29	APR 09	9	APR 02
1965 - 1966	412.00	94.6	NOV 23	180	NOV 23	122	JAN 03
1966 - 1967	419.35	312.7	DEC 07	349	JAN 24	71	DEC 06
1967 - 1968	415.63	180.3	MAR 08	587	MAR 08	35	FEB 01
1968 - 1969	429.05	891.7	FEB 26	425	JAN 25	518	FEB 25
1969 - 1970	408.89	20.3	MAR 05	98	MAR 05	5	MAR 06
1970 - 1971	409.66	28.9	DEC 21	67	DEC 21	9	DEC 23
1971 - 1972	410.15	34.9	DEC 27	62	DEC 27	0	
1972 - 1973	414.40	105.7	FEB 12	171	FEB 11	27	FEB 08
1973 - 1974	413.99	97.4	JAN 08	96	JAN 07	20	MAR 04
1974 - 1975	411.68	57.0	MAR 09	120	DEC 04	20	DEC 29
1975 - 1976	409.61	28.3	FEB 09	116	MAR 01	0	
1976 - 1977	411.10	48.0	JAN 07	59	JAN 03	14	MAR 30
1977 - 1978	429.30	718.4	MAR 04	1029	MAR 04	415	FEB 10
1978 - 1979	422.45	361.8	JAN 31	638	JAN 30	250	FEB 01
1979 - 1980	426.80	572.7	FEB 16	1122	FEB 17	504	FEB 11
1980 - 1981	420.75	292.1	MAR 01	1206	MAR 01	512	MAR 01
1981 - 1982	418.12	199.4	MAR 17	181	MAR 17	95	MAR 17
1982 - 1983	430.90	821.5	MAR 01	1727	MAR 02	703	MAR 01
1983 - 1984	403.00	0		0		0	
1984 - 1985	415.30	124.7	FEB 11	17	NOV 24	17	NOV 24
1985 - 1986	421.40	318.0	FEB 15	1153	FEB 14	221	FEB 15
1986 - 1987	417.09	169.0	JAN 04	---		---	
1987 - 1988	406.79	4.9	DEC 18	---		---	
1988 - 1989	411.21	49.7	JAN 06	---		---	

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 Hydrometeorological Stations

a. Facilities. A series of staff gauge boards are installed along the upstream face of the dam. The boards are graduated in 0.10 foot increments and are readable from the top of the dam. Plate 4-1 shows the locations of precipitation and stream gauges in and near the Carbon Canyon Dam watershed. These gauges, along with their latitudes, longitudes, and elevations, are listed in table 5-1.

b. Reporting. Hydrologic data are observed and reported in 3 different ways, as illustrated in table 5-2. Telemetry gauges report in real-time. Data from the gauges are either recorded locally onto charts or tapes (recording-type gauges) or are observed daily or more frequently (non-recording gauges). The types of gauges in the Carbon Canyon Dam vicinity are shown on table 5-1.

c. Maintenance. Generally, each operating agency is responsible for the maintenance of its own gauges and/or telemetry radio equipment. Some of the gauges located around Carbon Canyon Dam are cooperative. This means that the primary operating agency pays another agency to record and publish the data collected, maintain the gauge, and permit the primary agency access to this gauge information at all times. For these gauges the primary agency is either OCEMA or LAD, with the National Weather Service (NWS) or U.S. Geological Survey (USGS) being the secondary agency. Cooperative gauges are noted in table 5-1.

5-02 Water Quality Stations

No water quality stations exist in the watershed.

5-03 Sediment Stations

There are no sediment stations in the watershed. There are sediment ranges in Carbon Canyon Reservoir.

5-04 Recording Hydrologic Data

Each agency maintains records of its own data (section 5-1 above). NWS data are placed in archives at the National Climatic Center in Asheville, North Carolina. Precipitation and other data are published monthly by the National Climatic Center in Climatological Data and Hourly Precipitation Data.

OCEMA maintains their recording and non-recording data bases, and furnishes data to other agencies upon request. LAD maintains a data base from its recording and telemetry gauges and provides selected data to NWS for publication. Real Time Reports received from the Los Angeles Telemetry System gauges are stored in a database on the Water Control Data System Computer. LAD also enters data from its manual observations on various forms, which are maintained on file in the LAD RRS office. These forms are discussed further in section 9-4 and illustrated in figures 9-1 through 9-7.

5-05 Communication Network

LAD maintains a voice radio communication network for its entire regulation activities. This routinely includes communications between the District Office and the various dam operators, as well as vehicles in the field.

During periods of significant runoff, communication with the dam operators becomes vital. The existing radio network, which has proven itself reliable, is backed up by a second radio network; both of these are backed up by the local telephone system.

Power at the District Office is backed up by an emergency generator system; if all fails at the District Office, there is a complete radio system at LAD Base Yard. The Base Yard is located a few miles east of the District Office.

5-06 Communication with Project

a. Regulating Office with Project office. During the flood season (15 November through 15 April), a routine radio call is made a least once each weekday from LAD District Office to the dam operator at Carbon Canyon Dam. This “Morning Report” is usually made 0800 hours, Monday through Friday. Other routine or non-routine radio telephone calls are made as needed.

In the event that all communications with LAD office, including LAD Base Yard, should be interrupted, a set of “Standing Instructions to Dam Operator” has been compiled for Carbon Canyon Dam, and a copy of these instructions is included in this manual (exhibit A). LAD organization chart and important phone numbers for reservoir operations decisions at Carbon Canyon Dam are given in table 9-1.

b. Between Project Office and Others. No routine communication exists between Carbon Canyon Dam and other agencies.

c. Between Regulating Office and Others. Before and during the earliest stages of any reservoir impoundment, LAD notifies offices of other agencies and selected private interests of the impending rises in the reservoir water surface elevation and corresponding outflow. A list of the agencies to notify, with applicable office and home telephone numbers, is published annually in LAD’s “Instructions for Reservoir Regulation Section Personnel” (The so-called “Orange Book”). During major runoff events, LAD RRS is in constant contact with OCEMA Operations Division and Orange County Water District (OCWD) Forebay Operations to fully coordinate the operations of each agency. LAD RRS is also in direct radio contact with channel observers when dispatched to patrol Carbon Creek and/or Carbon Canyon Channel during large floods.

5-07 Project Reporting Instructions

During periods of water regulation, communications between LAD office and each affected dam operator are made on a frequent basis. Normal communications occur once each hour, and more frequent communications are sometimes required. If a gate change is required, RRS staff provides the radio operator at the LAD office with the gate change instructions. These instructions are then broadcast to the dam operator. When the gate change is completed, the dam operator calls back to the District Office radio operator with information on the change. The radio operator then informs the RRS engineer who initiated the change. The dam operator records pertinent information associated with the gate change on the form shown on figure 9-5. This report form is subsequently submitted to the LAD office. Other special instructions to dam operators are conducted in a similar manner. This network of radio communications is also used by the dam operator to report any failure of machinery or other equipment, or any other unusual conditions at the dam.

5-08 Warnings

The responsibility for issuing all weather watches and warnings, and all flood and flash flood watches and warnings, rests with NWS. Local emergency officials of cities and counties are responsible for issuing any other public safety warnings, including unusual overflows, evacuations, unsafe roads or bridges, and toxic spills. LAD is responsible for providing these officials with up-to-date information, and forecasts where possible, of water rises within Carbon Canyon Reservoir and release rates into the channel downstream of the dam. LAD RRS would notify the Fullerton and Placentia Police Departments to initiate evacuation if a dam break is imminent.

Table 5-1

Precipitation, Reservoir, and Stream Gauges In and Near Carbon Canyon Dam Watershed[1]

Designation	Name	Latitude	Longitude	Elevation	Description
RTU #19 USGS #11075720 *****	Carbon Creek below Carbon Canyon Dam	33-54-40	117-50-29	396	Flow recording
USGS 11075740 ***	Carbon Creek near Yorba Linda	33-53-18	117-50-42	289	Flow recording (1941-1961)
RTU #22 **	Carbon Canyon Dam	33-55-00	117-50-00	500	Precipitation non-recording Water Surface recording
OCEMA #185 NWS index 1518 *	Carbon Canyon Gilman	35-55-24	117-46-31	1500	Precipitation recording
OCEMA #20 ****	Carbon Canyon Summit	33-57-58	117-45-40	1100	Precipitation non-recording (1930-1961)
OCEMA #188 NWS index 1520 *	Carbon Canyon Workman	33-57-30	117-46-42	1080	Precipitation recording
OCEMA #26 ****	Yorba Linda	33-53-16	117-49-10	330	Precipitation non-recording (1912-1982)
USGS 11075730 ***	Carbon Creek at Olinda	33-54-12	117-50-42	350	Flow recording (1930-1938)

NOTE:
- * Cooperative gauge: OCEMA and NWS
- ** LAD, Gauge and Designation (Remote Telemetry Unit)
- *** USGS, Gauge and Designation
- **** OCEMA, Gauge and Designation
- ***** Part of the USGS Cooperative Stream Gauge System (accessible by LAD telemetry)
- 1 See plate 4-1 for location

Table 5-2. Methods of Reporting Hydrologic Data

	Precipitation	Reservoir Water Surface Elevation	Streamflow Water Surface Elevation	Gate Heights
<u>Manual</u>	Glass Tube Precipitation Gauge	Staff Gauge	Staff Gauge	Gate Height Indicators
<u>Recording</u>	Precipitation Digital Recorder	Water Surface Recorder	Gauge Height Digital Recorder	Gate Height Recorder
<u>Telemetry</u>				
Interrogated	Gauge data is accessible via computer at all times.			
Fixed-Time Self-Reporting	Data is reported in at a specified time(s) of day.			
Event-Reporting	Reports every 0.04 inch of rain	Reports every 0.25 inch of elevation change		
<u>Gauge Type at Carbon Canyon Dam</u>	Tipping Bucket[1]	Pressure Sensing System[1]		Gate Height Recorder[2]

1 Attatched to Telemetry System
2 Not attatched to Telemetry System

VI - HYDROLOGIC FORECASTS

6-01 General

a. Role of LAD. LAD does not make any formal hydrologic forecasts, published or unpublished, for Carbon Canyon Dam. Despite the lack of formal hydrologic forecasts, LAD does carefully monitor the reservoir water surface elevation in Carbon Canyon Reservoir, and does notify other agencies of any significant changes or anticipated changes as described in section 5-6. LAD continues to improve its monitoring capabilities of conditions not only at Carbon Canyon Dam, but in adjacent watersheds. Improved and increased numbers of automatic telemetry rain and stream gauges also help in the development of computerized rainfall-runoff forecast models. The long-term goal of LAD is to be able to provide relatively accurate predictions of inflows and reservoir water surface elevations as far in advance as possible. It is intended that these predictions will become accurate and reliable enough that they can be shared with NWS, OCEMA, city and county emergency officials, and others, to be used as a basis for reservoir systems regulation during the upcoming years.

The LAD Meteorologist prepares special quantitative precipitation forecasts for the Santa Ana River drainages and other watersheds including those in the immediate area of Carbon Canyon Dam watershed. These are used in determining the potential for significant runoff into Carbon Canyon and other reservoirs. Research is progressing into the direct incorporation of these quantitative precipitation forecasts into the rainfall-runoff forecast models being developed.

b. Role of Other Agencies. No other agency has any specific forecast responsibility for water surface elevations in Carbon Canyon Reservoir or for discharges in Carbon Canyon Reservoir or for discharges on Carbon Canyon Creek, either upstream or downstream of Carbon Canyon Dam. NWS issues Flash Flood Warnings for rivers and other watercourses in the Orange County coastal plain.

LAD does receive real-time weather reports and forecasts, as well as historical weather data, from NWS. This is accomplished by means of weather facsimile pictures and teletype data and forecasts transmitted by NWS and received by an LAD facsimile recorder and teletype printer. Close coordination is maintained with the NWS forecast office located in Los Angeles.

Historical precipitation and streamflow data are available from OCEMA and other sources. These data, while not of use in real-time, are important to studies of historical storms and floods which aid in the development and refinement of computerized rainfall-runoff forecast models.

6-02 Flood Conditions Forecasts

Forecasts of flood hydrographs are currently not made. However, routine evaluation of precipitation, resulting inflow, and forecast precipitation provides valuable subjective predictions of flood situations. Using such information, LAD RRS can evaluate if an ongoing flood will increase or decrease over the next 24 hours.

6-03 Conservation Purposes Forecasts

Since Carbon Canyon Dam is strictly a flood-control facility, forecasts for other purposes, including water conservation, are not made.

6-04 Long-Range Forecasts

Since the watershed above Carbon Canyon Dam is relatively small, and since water is impounded behind Carbon Canyon Dam for short time periods, there is little direct need for long-range forecasts in the regulation of Carbon Canyon Dam. Only in the event of major impoundment at Carbon Canyon Reservoir, as well as simultaneously at other reservoirs affecting the downstream channel, and the San Gabriel and Santa Ana Rivers, would a forecast of more than one day be of immediate significance to the regulation of Carbon Canyon Dam. In such a case, the forecast of another impending major storm or lack of such a storm might influence the release rate of water from Carbon Canyon Dam. The primary consideration of the release rate of water from all of the dams in the San Gabriel and Santa Ana River system is to prevent or minimize downstream damages.

VII - WATER CONTROL PLAN

7-01 General Objectives

The objective of Carbon Canyon Dam is flood control, specifically, the minimization of flood damages for portions of the coastal Orange County plain along Carbon Canyon and Carbon Creek Channels and Coyote Creek. In this regard, water is temporarily stored behind Carbon Canyon Dam during periods of high inflows and is released more slowly through the downstream channels.

There is no legal authority for the storage of impounded water for conservation purposes. However, the release rate from the gates may be adjusted provided the hydrologic forecast is favorable and there is not immediate threat to the dam or its regulation purpose.

There is no objective to operate the dam to reduce inundation damages to its reservoir lands. All usage of reservoir land is intended to have a purpose secondary to its role as the bottom of the flood control reservoir. All costs associated with reservoir inundation are intended to be routine maintenance costs associated with a clear understanding of risk and subsequent willingness to locate within the flood control reservoir.

7-02 Major Constraints

No major physical or regulation constraints exist at the project. Notable changes, however, have taken place or been made over the years, including:

a. Loss of storage space due to sedimentation. Based on the results of the 1969 reservoir sediment survey, current storage capacity below the spillway crest elevation of 475 feet approximately 6615 ac-ft, which is 6 percent less than the initial storage capacity of 7033 ac-ft. This represents an average sediment rate somewhat higher than the rate originally expected. However, the available storage was, as of 1969, still sufficient to control RDF to a maximum outflow of 1000 ft^3/s. See plate 7-1 for area-capacity curve reflecting 1969 conditions.

b. Sedimentation and clogging of gates from debris. Revisions to the reservoir regulation schedule have been made to alleviate sedimentation in the vicinity of the gates, and rack bar problems. Originally both gates remained closed during normal standby operations. The revised schedule has one gate open 0.5 foot to pass low flows during standby operations. This prevents the occurrence of small stagnant pools at the outlets, as well as reducing sediment build up, gate corrosion, and providing for an easier silt cleaning operation at the intake channel. The gates will be alternated as to which remains open.

c. Gate Operations. During falling stages, the original schedule called for a progressive gate closing from elevation 425 feet to the gate sill elevation 403 feet. The schedule was revised to keep both gates set at 0.9 feet during falling stages below elevation 425 feet so that the reservoir could be drained more rapidly.

d. Natural Channel through the Golf Course. Approximately 2.5 miles downstream from Carbon Canyon Dam, Carbon Canyon Channel is natural channel and runs through Alta Vista Golf Course. The channel is overgrown with saplings, bushes, and tall grasses. The channel capacity is unknown. With such overgrowth the flooding potential of this reach is undetermined. A channel observer should be sent out when there is any significant release from Carbon Canyon Dam. An estimate of channel capacity under given reservoir release rates for this segment can then be made. This channel capacity estimate will not alter the current release rate from the dam. The Gate Regulation Schedule and Standing Instructions to Dam Operator are to remain the same.

7-03 Overall Plan for Water Control

Carbon Canyon Dam is operated for flood control on Carbon Canyon Creek. Plate 2-2, which depicts the storage allocations for Carbon Canyon Reservoir, shows that the entire space of the reservoir below elevation 475 feet (spillway crest) is devoted to flood control (includes debris pool). Elevation 475 feet is also the maximum water surface elevation for RDF. The revised spillway surcharge pool is between elevations 475 and 491.9 feet. Once the elevation of 475 feet is reached, flood control is no longer the prime objective. Passing as much water out of the reservoir as is required to assure the safety of the dam becomes the major regulation concern. The space between elevation 491.9 and 499 feet is reserved for freeboard.

Extenuating circumstances downstream may create the need to decrease (or increase) releases from the dam. These conditions are discussed in section 7-13.

7-04 Standing Instructions to Dam Operator

In the event that all communication with the District Office, including the Base Yard, should be interrupted, a set of Standing Instructions to Dam Operator has been compiled for each District dam. A copy of these instructions for Carbon Canyon Dam is included in Exhibit A of this manual.

The original instructions have been changed. The revised instructions call for a wait time of one hour without communication with the District Office before regulation is continued according to the gate schedule.

7-05 Flood Control

a. General. The plan for controlling floods on Carbon Canyon Creek below Carbon Canyon Dam is presented in this section. The objective of the water control plan is to maximize flood control benefits. Project releases will be regulated to protect downstream communities and to avoid spillway flow. Although releases from Carbon Canyon Dam could affect downstream discharges in Coyote Creek and the Santa Ana River, the dam is not usually regulated as part of these systems. Release rates from the dam are not to exceed the downstream capacity of Carbon Canyon Channel between the outlet works and Golden Avenue.

b. No Forecast is Available. When no forecast information is available, the project should be operated according to the Regulation Schedule in Exhibit A. This is achieved by keeping one of two gates open 0.5 feet to pass low flows during normal standby. Once the reservoir water surface elevation reaches 419 feet, both gates are operated. Gate openings increase during rising stages until the water surface reaches elevation 455 feet, when downstream channel capacity of 1000 ft^3/s is reached. As the water surface elevation rises, the gates are progressively closed such that the downstream channel capacity is not exceeded. At a water surface elevation of 477.3 feet (2.3 feet above spillway crest), both gates are completely closed and only spillway flow exists. During falling stages, both gates remain open 0.9 feet as the water surface drops from elevation 425 to 403 feet. Exhibit A provides the reservoir regulation schedule. Section 7-13 describes situations when deviations from the normal regulation schedule may be permitted.

c. Forecast is Available.

(i) No Spillway Flow Forecast. When forecast information clearly indicates that Carbon Canyon Dam will not experience spillway flow (reservoir water surface will not exceed elevation 475 feet), both gates may be partially or fully closed in order to alleviate downstream emergencies (see Sec. 7-13), to prevent downstream damages, or to add an additional safety factor when the downstream channel is experiencing high flows.

(ii) Spillway Flow Forecast. The regulation schedule is to be followed when forecast information indicates that spillway flow will occur. If it becomes apparent that there will eventually be spillway flow that will exceed downstream channel capacity and cause flood damages, the gate outlet release rate may be increased to exceed downstream channel capacity, upon concurrence by the District Engineer. The purpose of this “pre-release” is to evacuate space within the reservoir more quickly, so that the peak of the eventual spillway flow would not exceed the maximum “pre-release”, thus minimizing downstream damages.

d. Reservoir Evacuation. Carbon Canyon Reservoir should be drained as rapidly as possible, consistent with the achievement of downstream flood control. The objective is to empty the reservoir in preparation for the next flood. When no additional storms are forecast, however, and flood control benefits can be achieved, both gates may be partially or fully closed.

e. Forecasts. A forecast, on which regulation decisions may be made, could be either a series of computer generated inflow hydrographs (expected in future years) or a reasonable judgmental assessment of ongoing rainfall and runoff, based upon available information. In either case, LAD RRS would be responsible for developing the forecast and for determining its usefulness in making reservoir water control decisions. The intent is to consider all appropriate information in implementing the water control plan described above.

7-06 <u>Recreation</u>

As mentioned previously, the sole purpose of Carbon Canyon Dam is flood control. No water is impounded behind the dam for the purposes of recreation.

Carbon Canyon Channel downstream of Carbon Canyon Dam is strictly a flood control channel, and provides no water oriented recreation use. Thus no releases are made for recreational purposes.

7-07 Water Quality

Carbon Canyon Dam has no ungated outlets and may be operated to contain contaminant spills, unless the WSE exceeds 475 feet (spillway crest). Carbon Canyon Dam is not operated for water quality objectives.

7-08 Fish and Wildlife

No Carbon Canyon Dam water control objectives exist for fish and wildlife, either within the reservoir, or within Carbon Canyon Channel downstream.

7-09 Drought Contingency Plan

Carbon Canyon Dam does not contain any storage allocation for water supply. However, the Water Resources Development Act of 1986, Report 99-1013, Section 847 authorizes the Secretary of the Army to facilitate water conservation and groundwater recharge measures at Carbon Canyon Dam in coordination with OCEMA, to the extent consistent with other project purposes. Carbon Canyon Channel downstream of the dam is concrete lined, but flow can be diverted at the Miller Basin Complex (see secs. 3-04a. And b.). Currently, no storage is used for water conservation. However, in the event of a drought, the possibility of impounding water for water conservation would be considered. Any such plan would be evaluated to ensure that the flood control purpose of the project would not be compromised.

7-10 Hydroelectric Power

No facilities for the generation of hydroelectric power at Carbon Canyon Dam exist, nor are any contemplated.

7-11 Navigation

No navigation of any sort is possible or allowed in Carbon Canyon Reservoir or in Carbon Canyon Channel; either upstream or downstream of Carbon Canyon Dam.

7-12 Other

Maintenance and construction on Carbon Canyon Channel downstream of the dam normally occurs during the dry season of late spring and summer. During such periods, both Carbon Canyon Dam gates may be closed in order to reduce releases in support of such downstream activities.

7-13 Deviation from Normal Operation

The release plan for Carbon Canyon Dam is outlined in Exhibit A and discussed in Sections 7-5, b and c. However, it is possible, and would be desirable under certain limited circumstances, for the release rate from Carbon Canyon Dam to be decreased below what is called for in Exhibit A.

In addition to the prevention of downstream damages (discussed in Sections 7-5, b and c), there are other reasons for deviation from the normal release plan at Caron Canyon Dam:

a. Emergencies. In the event of a potential drowning, toxic spill, or other accident in which high flows on Carbon Canyon Channel downstream of Carbon Canyon Dam could prevent rescue or could cause further injury, both gates at Carbon Canyon Dam could temporarily be partially or totally closed. This would reduce or eliminate the flow in the downstream channel. Such emergency action should be taken immediately, unless such action would likely result in worse conditions. Notifications to all concerned agencies of emergency actions must be made as soon as possible.

b. Unplanned Minor Deviations. Unplanned events that could create a temporary need for minor deviations from the schedule in Exhibit A include emergency bridge repairs, the restoration of utility lines across Carbon Canyon Channel, and certain unplanned necessary maintenance and inspection, Carbon Canyon Dam may be operated to support these activities, provided that flood protection is not jeopardized.

c. Planned Deviations. The same arguments apply to planned construction, maintenance, inspections, etc., as under Section 7-13. Such planned activities should be scheduled for the dry season, whenever possible. The dry season is normally May through October, although on a rare occasion, a tropical storm with heavy rain and high runoff potential can occur during the late summer or early fall.

7-14 Rate of Release Change

Gates at Carbon Canyon Dam are hydraulically operated and can generally be adjusted within a reasonable amount of time. During emergencies, or when downstream inflow has filled Carbon Canyon Channel, gradual increases or decreases in gate openings at Carbon Canyon Dam, based upon downstream reports, may be desirable. The normal maximum rate of increase indicated by the regulation plan shown in Exhibit A is less than 200 cfs. Sometimes it is necessary to release stored or incoming water even though weather conditions would not indicate runoff. It is important to alert people and agencies downstream that the dam will be releasing water in order to prevent damages and minimize a threat to both lives and property. In order to safely clear the area, the initial release rate should be small to provide a warning to people downstream.

7-15 Water Control Planning Tools

Specific planning tool have been utilized in the development of the flood control plan. These tools are also used to evaluate and set regulation rules for planned deviations and also facilitate regulation of the dam during emergencies and unplanned deviations. Water control planning tools used for Carbon Canyon Dam include:

a. Area-Capacity Curve (pl. 7-1)
b. Outlet Discharge Curve (pl. 7-2)
c. Spillway Discharge Curve (pl. 7-3)
d. Downstream Channel Capacity Plate (pl. 3-1).

VIII - EFFECT OF WATER CONTROL PLAN

8-01 General

The sole purpose of Carbon Canyon Dam is flood control, and by far the greatest effect and benefit of the dam is the protection of life and property downstream of the facility. The major aspects of flood control at Carbon Canyon Dam for the reservoir and spillway design floods, and other floods, are discussed in section 8-2. Any other effects or benefits of Carbon Canyon Dam are decidedly secondary to those of flood control, but they are briefly described in sections 8-3 through 8-8.

8-02 Flood Control

a. Standard Project Flood/Reservoir Design Flood. The standard project flood (SPF), selected as the reservoir design flood for Carbon Canyon Dam, was based on the assumed occurrence of a general winter type storm. The storm of December 1933-January 1934, which centered in the San Gabriel Mountains and foothills about 32 miles northwest of Carbon Canyon Dam, was transposed to the drainage area above Carbon Canyon Dam on the basis of rainfall amounts expressed as a percentage of mean seasonal rainfall. The maximum 24-hour rainfall of this two-day duration storm was 11.31 inches. A variable loss rate averaging in 0.20 inches per hour was used to determine rainfall excess. The unit hydrograph was determined from the average of two S-graphs: East Basin n-value was 0.04. An average base flow of 10 ft^3/s per square mile was considered appropriate. The resulting peak inflow was 9300 ft^3/s; the total inflow volume, including baseflow, was 8030 acre-feet.

The spillway crest elevation was determined by routing the SPF (reservoir design flood) through the reservoir, assuming the starting water surface elevation was at elevation 419 (top of debris pool) and the outlet gates initially closed. Above elevation 419, the outflow was controlled to a maximum of 1000 ft^3/s. Using the design sediment allowance (50-year accumulation) of 1500 acre-feet, the maximum water surface elevation was determined to be 474.7 feet. On this basis, the spillway crest elevation was set at 475 feet. For a 100 year sediment allowance (3000 acre-feet), the maximum water surface elevation is 479 feet, with a maximum outflow of 3720 ft^3/s (2720 ft^3/s spillway discharge).

Plate 8-1 depicts the standard project flood hyetograph, the SPF inflow and outflow hydrographs, and the water surface elevation for routings with both 50 and 100 year sediment allowances.

b. Spillway Design Flood.

(i). Original Design Criteria. The spillway at Carbon Canyon was designed in 1957 for a peak inflow of 56,000 ft^3/s, having a surcharge of 18.7 feet above spillway crest elevation. An additional 5.3 feet of freeboard to handle runup by waves set the top of dam elevation at 499 feet.

The original spillway design flood was based on a convective type storm using probable maximum precipitation provided by the Hydrometeorological Branch of the U.S. Weather Bureau (now the National Weather Service). The hypothetical 3-hour storm produce an average of 10.4 inches of rain (10.10 inches of effective rain) over the drainage area above Carbon Canyon Dam. The unit hydrograph was determined in the same manner as for SPF, except that basin lag was reduced by 15 percent and the loss rate was taken as a constant equal to 0.10 in/hr. The resulting flood produced a peak inflow of 56,000 ft^3/s and a total volume of 10,300 ac-ft including base of 15 ft^3/s per square mile.

The original spillway design flood routing assumed a starting water surface elevation at spillway crest with the outlet gates closed. The maximum water surface elevation reached was 493.7 feet, with peak outflow of 36,800 ft^3/s.

(ii). Revised Criteria (PMF). In a subsequent 1978 study (table 1-1, #7), the adequacy of the spillway was reviewed under modern criteria. This led to the development of a revised PMF.

The updated probable maximum precipitation (PMP) is based on a hypothetical 6-hour rain storm derived from the criteria published in a Hydrometeorological Report entitled, “Preliminary Draft - Probable Maximum Thunderstorm Precipitation Estimates - Southwest States”, (1972, revised 1973). This storm was critically centered over the drainage area above Carbon Canyon Dam. The 6-hour, basin-average PMP had maximum 1/4-, 1/2-, 1-, 3-, and 6-hour amounts of 2.20, 3.71, 5,92, 9.11, and 11.69 inches, respectively, compared with original 1/2-, 1-, and 3-hour amount of 2.7, 4,8, and 10.4 inches. The unit hydrograph and base flow assumptions were the same as those used originally.

The revised PMF generates a maximum inflow to Carbon Canyon Reservoir of 52,000 ft^3/s about 4-1/2 hours after the start of the storm. The runoff flood volume is 11,800 ac-ft of water. The maximum water surface elevation in the reservoir rises to 491.9 feet. The maximum outflow is 31,200 ft^3/s.

Plate 8-2 depicts the revised PMF hyetograph, the PMF inflow and outflow, and the water surface elevation or the PMF routing through Carbon Canyon Reservoir.

A comparison of the peak discharges and volumes for the standard project and probable maximum floods computed under original and revised criteria for Carbon Canyon Dam are give in table 8-1.

(iii). Freeboard. The freeboard allowance for wind tides and wave set up was determined using the procedure described in ETL 1110-2-221. Based on design speed of 45 mph from the northeast, the calculated freeboard was 1.9 feet. However, the required minimum freeboard for a Standard 1 dam without downstream slope protection is 5.0 feet. The available freeboard is 7.1 feet.

c. Other Floods. RDF and PMF were routed through the reservoir to test the adequacy of the flood operation plan. It was assumed the storage allocation for debris was full (1500 ac-ft). Observed floods were not large enough to warrant routing. For example, the largest flood of record on Carbon Canyon Creek, which occurred 27 February-3 March 1938, produced an estimated peak discharge of only 1760 ft^3/s at the gauge located at the Rose Drive Bridge, Olinda, California.

8-03 Recreation

None of the recreational facilities in Carbon Canyon Reservoir depend upon runoff water impounded behind the dam. Thus there are no direct recreation benefits that result from the dam or its regulation. The recreational facilities were constructed because the land within the reservoir could not be used for other purposes. Hence, there is an indirect recreation benefit associated with the project. The effects of the dam and its regulation upon the recreational facilities within the reservoir are by necessity all negative; that is, some of these facilities are occasionally flooded by the impoundment of water behind the dam for flood control. These recreational facilities, however, were constructed and are operated with this understanding.

8-04 Water Quality

There are no benefits of Carbon Canyon Dam to water quality of Carbon Canyon Creek. On the other hand, Carbon Canyon Dam and its regulation should not in any way contribute to the degradation of the water quality of the stream.

8-05 Fish and Wildlife

There are no benefits of Carbon Canyon Dam to any fish and wildlife activities.

8-06 Water Supply

Since Carbon Canyon Dam is not regulated for water supply, there are no direct effects or benefits of the dam or its regulation upon the water supply of the coastal plain of Orange County or other parts of Orange County. There are no practical indirect benefits of Carbon Canyon Dam upon the downstream groundwater spreading facilities even though the flow rates on Carbon Creek channel past these facilities are at times reduced, and the duration of runoff prolonged, by the dam.

8-07 Hydroelectric Power

There is no existing or contemplated hydroelectric power generating at Carbon Canyon Dam.

8-08 Navigation

There is no navigation on Carbon Canyon Creek nor in Carbon Canyon Reservoir at any time.

8-09 Frequencies

a. Peak Inflow and Outflow Probabilities. Plate 8-3 is a graph of the inflow frequency and plate 8-4 is a graph of the peak outflow frequency at Carbon Canyon Dam. The inflow volume-frequency curves for peak, and 1-, 2-, and 3-day maximum flows were determined using data from 39 years of record (1931-1980) which were ranked and plotted using median plotting positions. The outflow frequency curve is derived from the elevation frequency curve (pl. 8-5) and reflects the gate regulation schedule in Exhibit A. Table 1-1, #13 provides a more detailed description of the procedure followed. The addition of additional data accumulated since 1980 would not change the curves. Values of these curves at specific return periods are listed in table 8-2.

b. Pool Elevation Frequency. Plate 8-5 is the adopted elevation frequency curve for Carbon Canyon Dam. This curve was derived from 21 years of WSE data (1961-1980) and the results of balanced hydrograph routings (derived from the inflow volume-frequency curves), and reflects the water control plan in Exhibit A. The current conditions curve is derived from the elevation-storage curve using the 1969 sediment survey. The future conditions curve accounts for the 50-year design sediment allowance of 1500 ac-ft. Table 1-1, #13 describes in more detail the data used and procedures followed in determining these curves. The values of the present conditions curve at the specific return periods are listed in table 8-2.

c. Key Control Points. Table 8-3 is a stage/discharge rating table for the stream gauge just downstream from the dam, Carbon Creek below Carbon Canyon Dam.

8-10 Other Studies

The “Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Carbon Canyon, San Antonio, and Tahchevah Dams,” dated August 1978, presents the derivation of the PMF and SPF used in this manual.

Table 8-1

SUMMARY OF HYDROLOGY FOR CARBON CANYON DAM

	Original Design	Revised Design
Standard Project Flood		
Volume..................ac-ft	8030	no change
Time....................days	3	no change
Peak Outflow...........ft^3/s	1000	no change
Probable Maximum Flood		
Peak Inflow...........ft^3/s	56,000	52,000
Volume.................ac-ft	10,600	11,800
Time..................hours	8	15
Peak Outflow..........ft^3/s	36,800	31,200

Table 8-2

Inflow, Outflow, and Filling Frequency Values
Carbon Canyon Reservoir

Return Period (years)	Peak Inflow (ft^3/s)	Peak Outflow (ft^3/s)	Maximum Filling Elevation (present conditions) (feet, NGVD)
2	105	50	419.6
5	445	160	421.6
10	900	250	425.0
20	1650	525	429.5
50	3050	695	438.3
100	4600	880	448.3
200	6700	1000	460.4
500	10500	1000	477.0

NOTE: These values were obtained from the inflow and outflow frequency curves of plates 8-3 and 8-4, and from the filling frequency curve of plate 8-5.

Table 8-3

Stage/Discharge Rating Table For the Stream Gauge Downstream From Carbon Canyon Dam Along Carbon Creek

11075720 Carbon Cr. below Carbon Canyon Dam, CA

USGS Rating Table No. 6

Gauge Height (ft)	Discharge (ft^3/S)	Gauge Height (ft)	Discharge (ft^3/S)	Gauge Height (ft)	Discharge (ft^3/S)
2.00	0	3.70	254.100	5.40	619.700
2.10	0.553	3.80	274.100	5.50	642.500
2.20	2.600	3.90	294.400	5.60	665.500
2.30	6.000	4.00	315.000	5.70	688.700
2.40	11.100	4.10	335.200	5.80	712.000
2.50	19.300	4.20	355.800	5.90	735.500
2.60	31.900	4.30	376.500	6.00	759.100
2.70	48.800	4.40	397.600	6.10	782.800
2.80	70.500	4.50	418.800	6.20	806.800
2.90	97.600	4.60	440.300	6.30	830.800
3.00	124.000	4.70	462.100	6.40	855.000
3.10	143.000	4.80	484.000	6.50	879.000
3.20	160.400	4.90	506.200	6.60	903.000
3.30	178.300	5.00	528.600	6.70	927.000
3.40	196.600	5.10	551.200	6.80	951.000
3.50	215.000	5.20	574.000	6.90	975.000
3.60	234.600	5.30	597.000	7.00	999.000

IX - WATER CONTROL MANAGEMENT

9-01 Responsibilities and Organization

a. Corps of Engineers. Carbon Canyon Dam is owned, operated, and maintained by LAD, which has complete regulatory responsibility for the dam, reservoir, and the 4100 feet of channel downstream from the outlet works to Golden Avenue.

Water control decisions about reservoir regulation at Carbon Canyon Dam and other COE facilities in LAD are made by RRS. Table 9-1 shows an organizational chart depicting the chain of command for reservoir regulation.

Gate operation instructions to the dam operator are issued by RRS (see Section 5-6 and 5-7). In the event that communications between RRS and Carbon Canyon Dam are interrupted, a set of Standing Instructions to Dam Operator is included in Exhibit A. Dam operators are part of Operations Branch, Construction-Operations Division.

b. Other Federal Agencies. COE has complete responsibility for the regulation of Carbon Canyon Dam. Although COE receives data and information from other Federal and local agencies and informs these agencies of major decisions affecting Carbon Canyon Dam, no other agency has any responsibility in the regulation of Carbon Canyon Dam. USGS operates stream gauges in the watershed.

c. State and County Agencies. OCEMA has maintenance responsibility for Carbon Creek Channel, Carbon Canyon Channel between Golden Avenue and the Miller Retarding Basin Complex, and Carbon Canyon Diversion Channel. A number of projects downstream from the dam are also maintained and operated by OCEMA. These include flood retarding and groundwater recharge facilities.

The reservoir area is being developed as a recreational area by Orange County under a long term lease with the Federal Government. Existing recreational facilities are maintained by local interests.

d. Private Organizations. There is no involvement of private organizations in the regulation of Carbon Canyon Dam.

9-02 Interagency Coordination

LAD coordinates with other, Federal, State, County, and local organizations, as well as with the press (media), concerning water control at Carbon Canyon Reservoir.

a. Local Press and Corps of Engineers Bulletins. The Public Affairs Office of LAD is responsible for interfacing with the press regarding regulation at Carbon Canyon Dam and flows in the channel downstream of the dam. This in accomplished through interviews and the occasional issuance of press releases. LAD does not broadly issue flood watches or warnings or other status reports or forecasts to the general public. These are the responsibility of NWS.

b. National Weather Service. LAD utilizes NWS data and forecasts in the regulation of Carbon Canyon Dam. LAD shares data in the vicinity of Carbon Canyon Dam (as well as other areas) with NWS and USGS on real time basis and after the fact.

c. U.S. Geological Survey. LAD receives streamflow data from the USGS, primarily on a historical basis in southern California. LAD coordinates with USGS in many different ways, and shares its data with USGS.

d. OCEMA. OCEMA is responsible for maintenance and patrolling of Carbon Creek Channel, Carbon Canyon Diversion Channel, and the section of Carbon Canyon Channel between Golden Avenue and Miller Basin Complex. Release rates from Carbon Canyon Dam are not regulated by these channels. Changes can be made however, to assist in the groundwater recharge program of Miller Basin and the associated downstream channels, provided safety and operation of the dam are not hindered.

9-03 Interagency Agreements

No interagency agreements exist with the exception of the land leased to Orange County for recreational purposes.

9-04 Commissions, River Authorities, Compacts, and Committees

Carbon Canyon Dam is not involved in any commissions, compacts, or other formal multi-agency agreements.

9-05 Reports

LAD prepares and files several types of reports. Additionally, each month during the runoff season, November through April, a flood situation and runoff potential report is prepared and sent to South Pacific Division of COE.

Seven specific forms are prepared in conjunction with the District's reservoir regulation at Carbon Canyon Dam. A copy of each of these forms is included as figures 9-1 through 9-7. These include: Flood Control Basin Operation Report (prepared by each dam operator), Rainfall Record (from manual readings of glass tube rain gauges), Reservoir Operation Report (daily report prepared by RRS), Record of Data from Digital Recorders (precipitation, water surface elevation, and downstream gauge height), Reservoir Computations (prepared by RRS), Record of Calls (both radio and telephone), and Monthly Reservoir Operation (operational hydrographs).

LAD also collects and files charts from recording instruments at Carbon Canyon Dam (and other dams), including precipitation, reservoir water surface elevation, and gate opening. Daily precipitation totals and, as needed, other data (such as unusually high intensities) are manually extracted from the precipitation charts, and the charts are sent to the National Climatic Data Center of NOAA. The other charts are maintained on file at the LAD District Office in RRS.

Table 9-1

Chain of Command for Reservoir Regulation Decisions

Corps of Engineers

Los Angeles District

District Engineer

Office Phone Number

(213) 452-3961

Water Control Decisions	Gate Operations
Chief, Engineering Division	Chief, Construction-Operations Division
(213) 452-3629	(213) 452-3349
Chief, Hydrology and Hydraulic Branch	Chief, Operations Branch
(213) 452-3525	(213) 452-3385
Chief, Reservoir Regulation Section	Chief, Operations and Maintenance Section
(213) 452-3527	(626) 401-4008
Chief, Reservoir Regulation Unit	Dam Operator Foreman
(213) 452-3530	(818) 401-4006
	Carbon Canyon Dam Operator
	(714) 528-6822

FLOOD CONTROL BASIN OPERATION REPORT

Reports Control Symbol SPLCO – 7

Name		Month		Year	

Day	Reservoir W.S. Elev			Outlet channel		Gate operation																	OPERATOR
	Time	Type of Gage	Gage reading in feet	Time	Gage height in feet	Time	Gate opening in feet																
							No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.16	

REMARKS:

SPL FORM 1 DEC 72 19 — EDITION OF 1 MAR 55 MAY BE USED

FIGURE 9-1

RAINFALL RECORD

STATION					☐ HOURLY ☐ DAILY		DATE
HR	DA	TIME OF READING	GAGE READING	STORM TOTAL	SEASON TOTAL	OBSERVER	REMARKS (SNOW, TEMP., ETC.)
0000	1						
0100	2						
0200	3						
0300	4						
0400	5						
0500	6						
0600	7						
0700	8						
0800	9						
0900	10						
1000	11						
1100	12						
1200	13						
1300	14						
1400	15						
1500	16						
1600	17						
1700	18						
1800	19						
1900	20						
2000	21						
2100	22						
2200	23						
2300	24						
2400	25						
	26						
	27						
	28						
	29						
	30						
	31						
TOTAL							

SPL FORM OCT 65 31

FIGURE 9-2

RESERVOIR OPERATION REP[ORT]

DATE | TI[ME]

RADIO CALL SIGN WUK	DAM		WATER SURFACE ELEVATION *(FT. MSL)*	DIGITAL RECORDER READINGS	RAINFALL: DIGITAL RECORDER	RAINFALL: GLASS TUBE: SINCE LAST REPORT *(INCHES)*	RAINFALL: GLASS TUBE: STORM TOTAL *(INCHES)*	RAINFALL: GLASS TUBE: SEASON TOTAL *(INCHES)*	GATE SETTINGS *(Printed values show initial settings of gates prior to flood runoff)*
411	SEPULVEDA			WS GH					GATES OPEN 9.0 FT ☐
412	HANSEN			WS GH					GATES OPEN 8.0 FT. ☐
419	SANTA FE			WS GH					#14 OPEN 0.5 FT. ☐
416	BREA			WS GH					GATES OPEN 2.0 FT. ☐
417	FULLERTON			WS GH					GATES OPEN 1.1 FT. ☐
418	CARBON CANYON			WS GH					#1 OPEN 0.5 FT. ☐
421	PRADO			WS GH					GATES 1 & 6 OPEN 1.0 FT. REM. GATES CLOSED ☐
420	SAN ANTONIO			WS GH					GATES CLOSED ☐
415	WHITTIER NARROWS	RIO HONDO POOL	W. PIT E. PIT COMB.	GH					LACFCD DIVERSION GATE OPEN FT. GATE 1 OPEN FT. GATES 2, 3, & 4 OPEN FT. FT. ☐
		SAN GABRIEL POOL	TELEMARK W. STAFF E. STAFF COMB.	GH		XXXX	XXXX	XXXX	GATE #8 OPEN 0.30 FT. ☐
429	PAINTED ROCK		RES: S T B. PIT	XXXX	XXXX				GATES OPEN 0.5 FT ☐ HOOK: ANEMOMETER: TEMPERATURE:
437	ALAMO		RES: S T	XXXX	XXXX				GATES CLOSED ☐ GATE NO. 3 BYPASS CFS ☐ HOOK: ANEMOMETER: TEMPERATURE:

SPL FORM 1 APR 82 424 REPLACES EDITION JUL 75, WHICH IS OBSOLETE.

FIGURE 9-3

RECORD OF DATA FROM DIGITAL RECORDERS				NAME OF DAM	
DATE	TIME	WATER SURFACE	GAGE HEIGHT	PRECIPITATION	OPERATOR

SPL FORM 1 FEB 77 648

FIGURE 9-4

RESERVOIR COMPUTATIONS

☐ HOURLY ☐ DAILY

DAM	TIME OF READING (IF DAILY)	DATE

COMPUTED BY	CHECKED BY	DATA SOURCE

HR.	DA.	WATER SURFACE ELEV. FT.	STORAGE AC. FT.	GATE STEP NO.	INST. OUTFLOW			HRS.	STORAGE CHANGE		AV. OUT-FLOW CFS	AV. INFLOW CFS	GATE SETTINGS FT.
					OUT-LETS CFS	DOWNSTREAM G. HT. FT.	DOWNSTREAM FLOW CFS		ACRE-FEET	CFS			
PREVIOUS REPORT													
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												
	26												
	27												
	28												
	29												
	30												
	31												

REMARKS				
	TOTAL			
	MEAN			

SPL FORM MAY 67 30 PREVIOUS EDITIONS MAY BE USED: REPLACES SPL FORM 29 WHICH MAY BE USED

ARMY - C. OF E. - LOS ANGELES

FIGURE 9-5

RECORD OF CALLS ☐ Radio ☐ Telephone

DATE

LOCAL TIME	FROM		TO		CHECK REPTBLE CALLS*	MESSAGE OR REMARKS
	PERSON AND/OR CALL SIGN	TELEPHONE AND CITY	PERSON AND/OR CALL SIGN	TELEPHONE AND CITY		

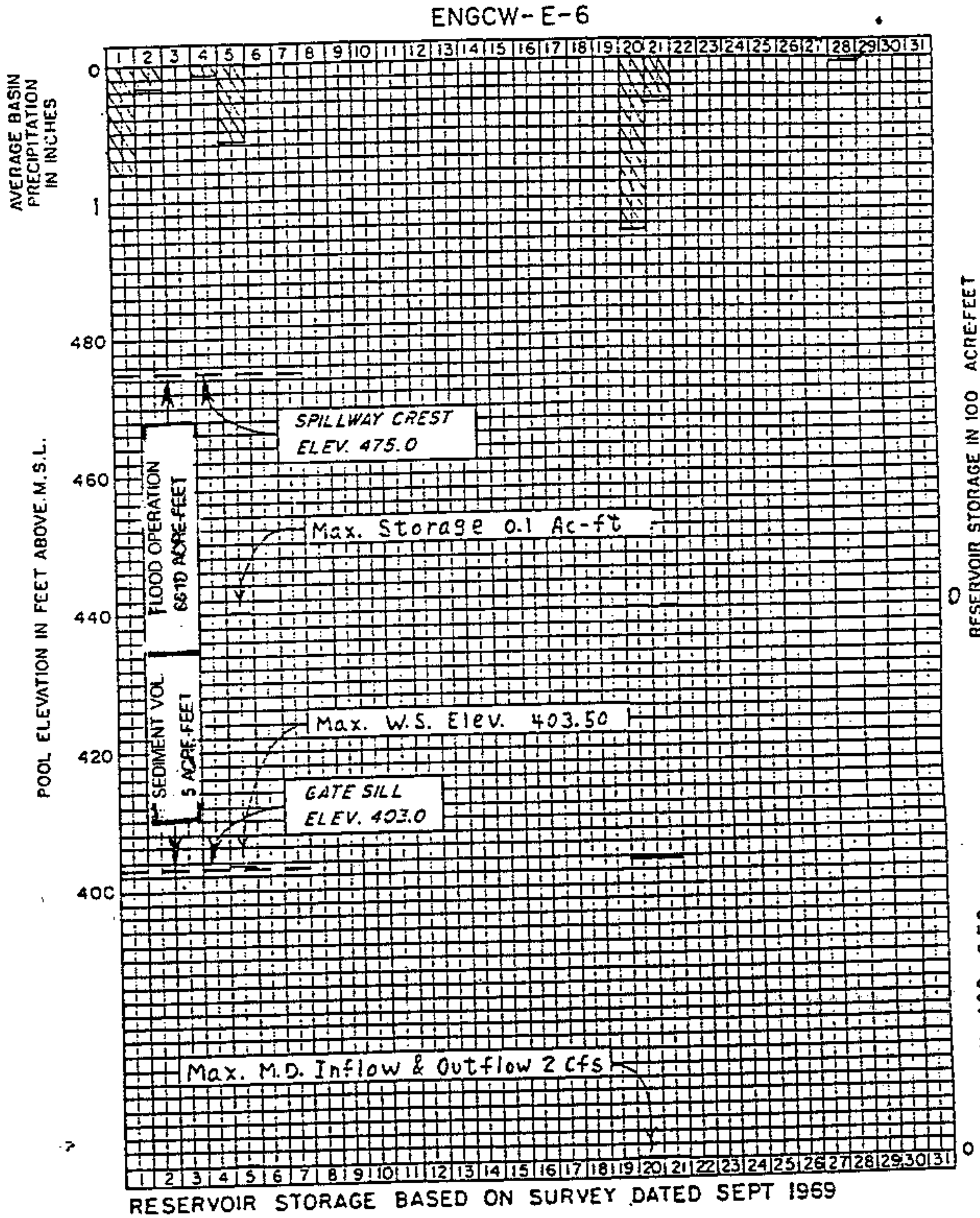
**Reportable telephone calls include collect calls, charge calls and long distance calls that can not be dialed without a code number. Calls are chargeable to MA 3-1311 unless otherwise indicated.*

SPL FORM 29 APR 59 188 PREVIOUS EDITIONS ARE OBSOLETE

FIGURE 9-6

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



RESERVOIR STORAGE BASED ON SURVEY DATED SEPT 1969

MONTH OF JAN 1982

	ELEV	GROSS STORAGE (ACRE-FT.)
Conservation Pool		NONE
Flood Control Pool	4750	6610

Outlet Capacity at Full Pool 1,270 c.f.s.

NOTE: Although project is in the San Gabriel River Basin, flood flows are diverted into the Santa Ana River.

MONTHLY RESERVOIR OPERATION

CARBON CANYON FLOOD-CONTROL BASIN

SANTA ANA RIVER BASIN

DRAINAGE AREA 19.3 SQ. MILES

SOUTH PACIFIC DIVISION

LOS ANGELES DISTRICT

FILE NO. RO 10/82-01

FIGURE 9-7

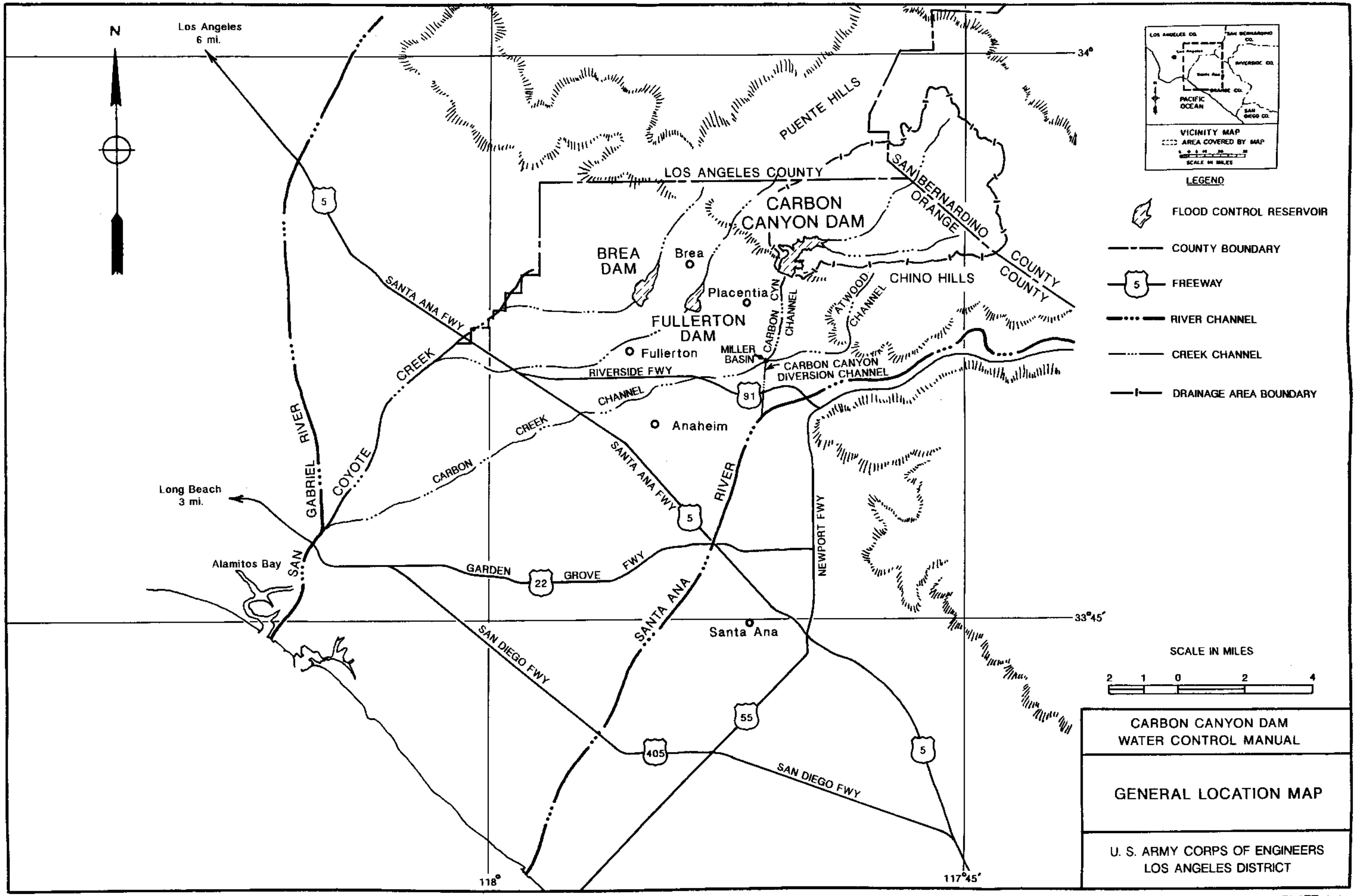
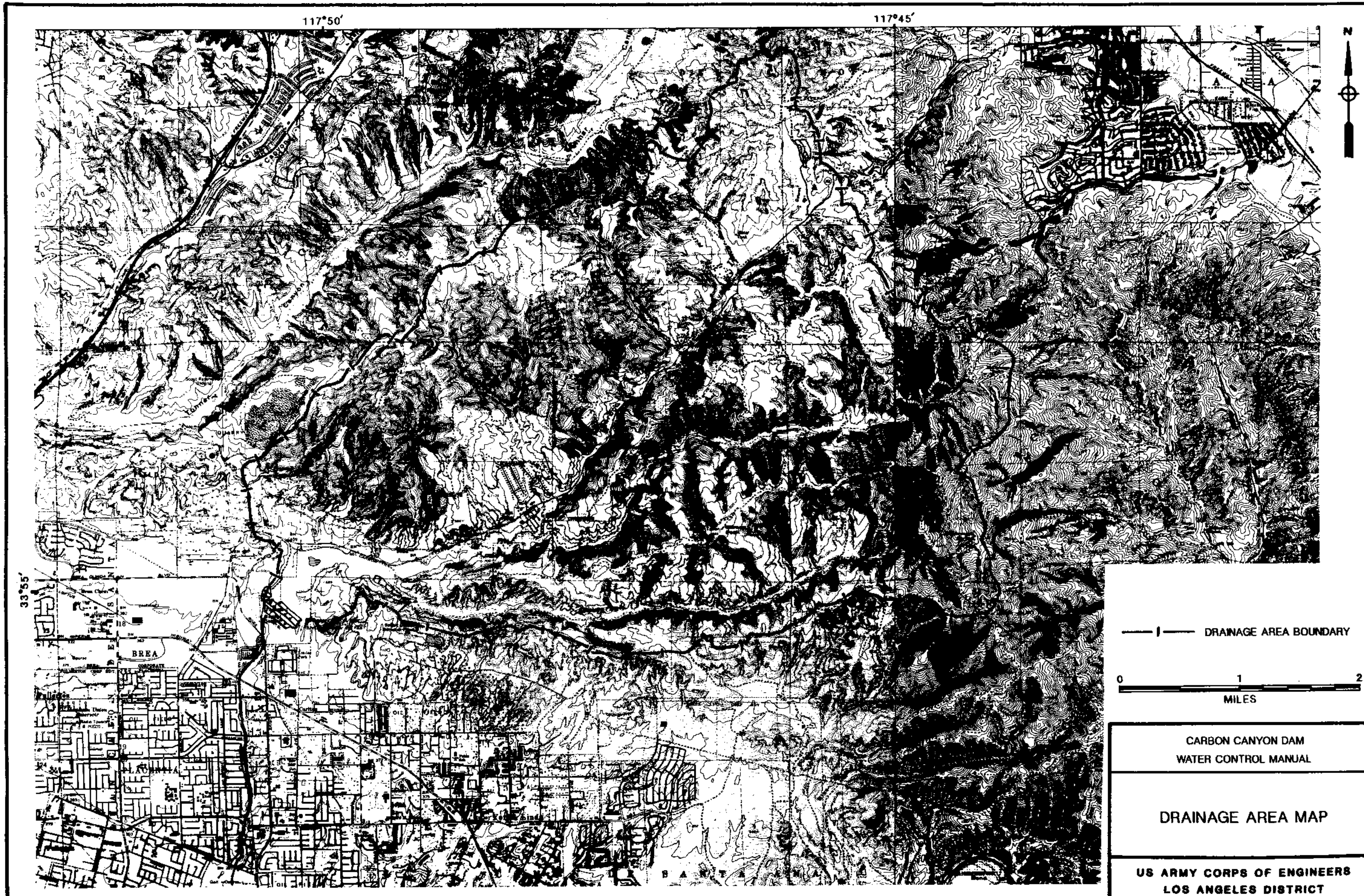

N
Los Angeles
6 mi.
34°
PUENTE HILLS
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
ORANGE COUNTY
CARBON CANYON DAM
BREA DAM
Brea
Placentia
FULLERTON DAM
Fullerton
MILLER BASIN
CARBON CYN CHANNEL
CARBON CANYON DIVERSION CHANNEL
ATWOOD CHANNEL
CHINO HILLS
RIVERSIDE FWY
91
SANTA ANA FWY
5
CARBON CREEK CHANNEL
Anaheim
COYOTE CREEK
SAN GABRIEL RIVER
Long Beach
3 mi.
Alamitos Bay
GARDEN GROVE FWY
22
SANTA ANA RIVER
NEWPORT FWY
Santa Ana
33°45′
SAN DIEGO FWY
405
55
118°
117°45′
VICINITY MAP
AREA COVERED BY MAP
PACIFIC OCEAN
LEGEND
FLOOD CONTROL RESERVOIR
COUNTY BOUNDARY
FREEWAY
RIVER CHANNEL
CREEK CHANNEL
DRAINAGE AREA BOUNDARY
SCALE IN MILES
2 1 0 2 4
CARBON CANYON DAM
WATER CONTROL MANUAL
GENERAL LOCATION MAP
U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 1-1

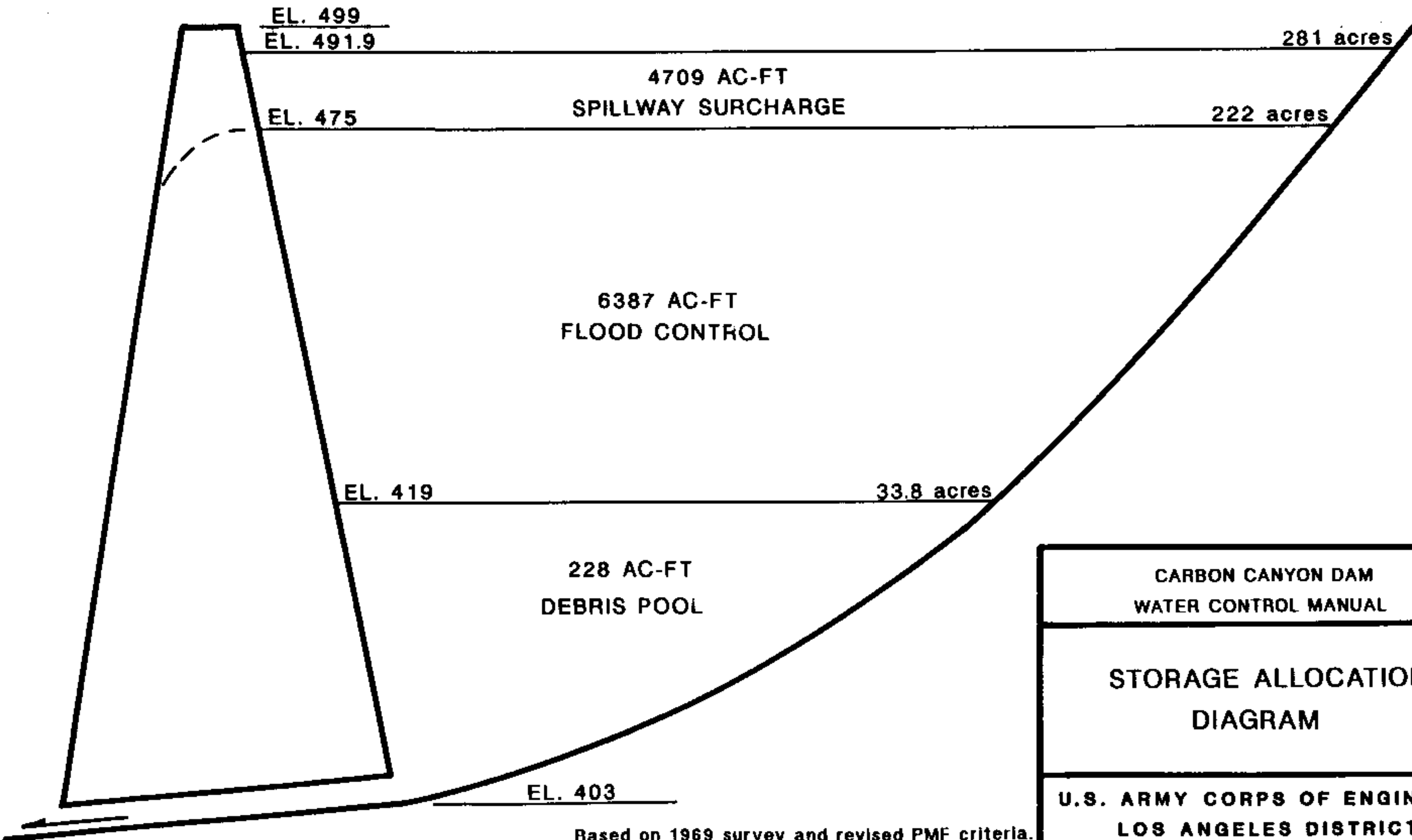


CARBON CANYON DAM
WATER CONTROL MANUAL

DRAINAGE AREA MAP

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

CARBON CANYON RESERVOIR, CALIFORNIA



Based on 1969 survey and revised PMF criteria.

CARBON CANYON DAM WATER CONTROL MANUAL
STORAGE ALLOCATION DIAGRAM
U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

The Plate you are attempting to access is not currently available.

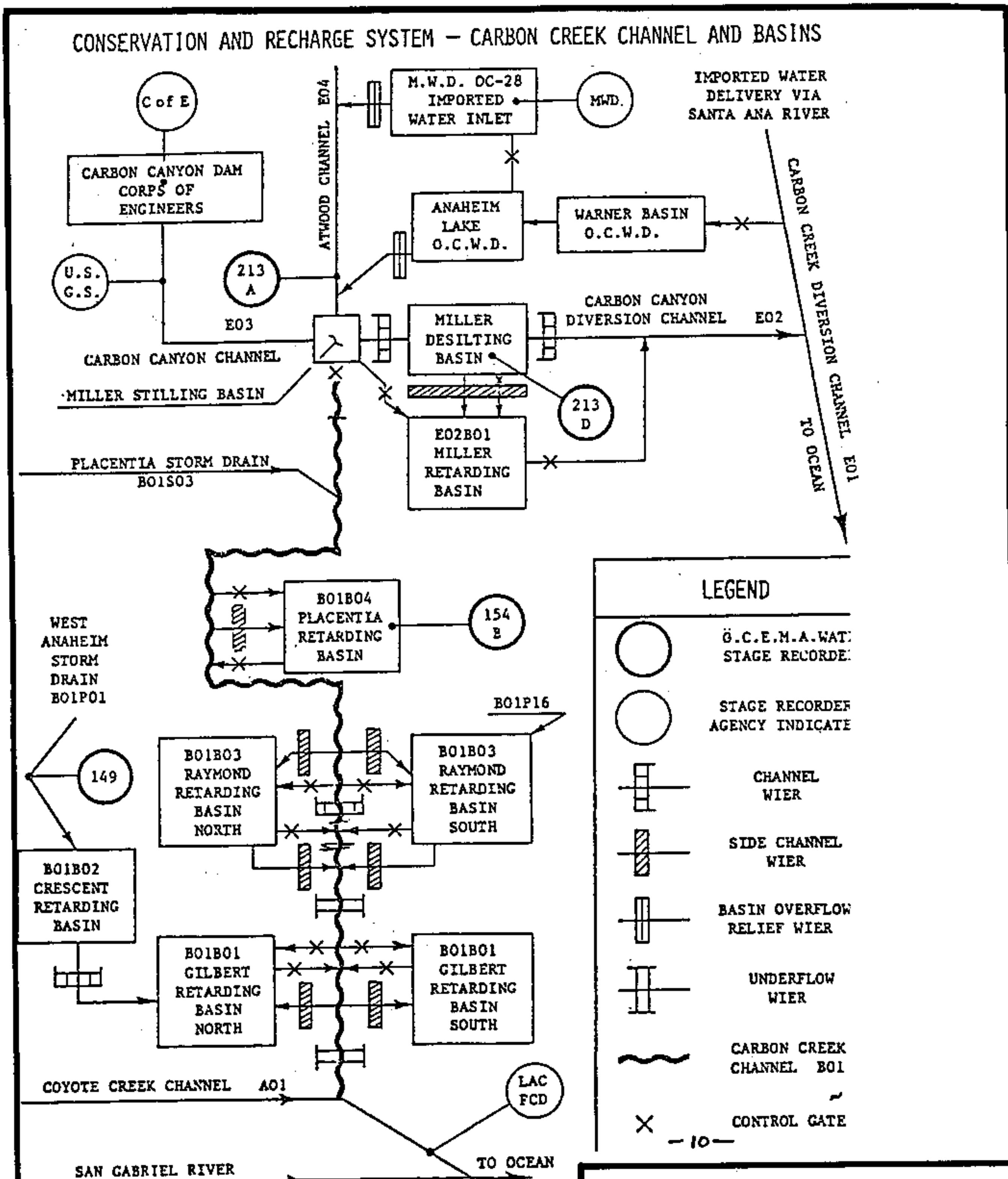
For additional information, please contact the Los Angeles District Public Affairs Office at (213) 452-3908.

The Plate you are attempting to access is not currently available.

For additional information, please contact the Los Angeles District Public Affairs Office at (213) 452-3908.

The Plate you are attempting to access is not currently available.

For additional information, please contact the Los Angeles District Public Affairs Office at (213) 452-3908.

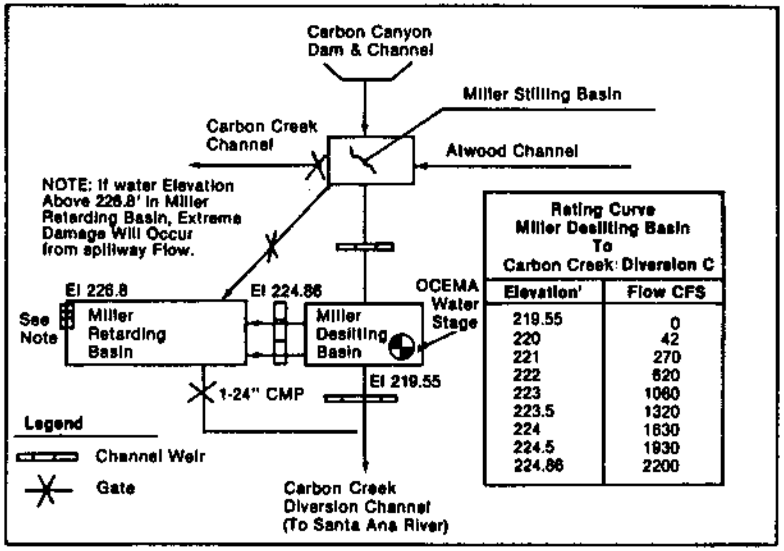


CARBON CANYON DAM
WATER CONTROL MANUAL

CARBON CANYON DAM
FLOOD RETARDING FACILITIES
DOWNSTREAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

	Significant Features	Miles	Remarks
1 (triangle)	Alta Vista Private Golf Course	1.9-2.8	Capacity Unknown, 5 footbridges-Erosive Channel
2 (stream gage)	Miller Basin (OCEMA)	1.5	See Diagram
(stream gage)	Carbon Creek Below Carbon Canyon Dam	5.0	Telemetry 042 CCYN



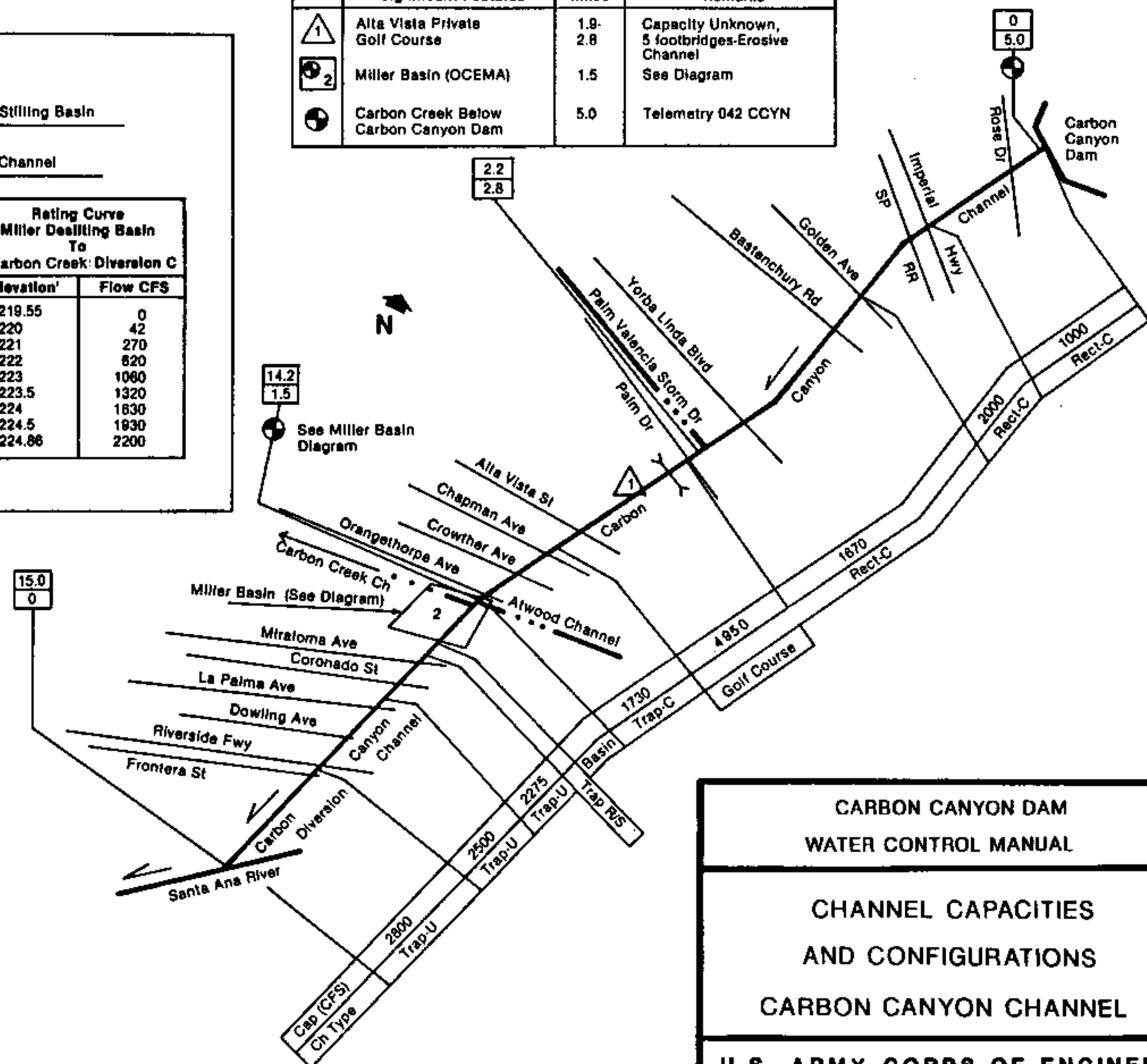
Rating Curve Miller Desilting Basin To Carbon Creek Diversion C

Elevation'	Flow CFS
219.55	0
220	42
221	270
222	620
223	1060
223.5	1320
224	1630
224.5	1930
224.86	2200

Miller Basin

Legend

- Dam
- Recharge Basin
- RD Rubber Dam
- Drop Structure
- Stream Gage
- Drainage Area
- Miles From Stream Mouth
- Travel Time (Hours)
- Foot Bridge
- U Channel Unlined
- R Rip Rap Side Slopes
- S Soft Bottom
- C Concrete
- G Grouted Stone
- G/C Side Slope / Bottom
- L Levee

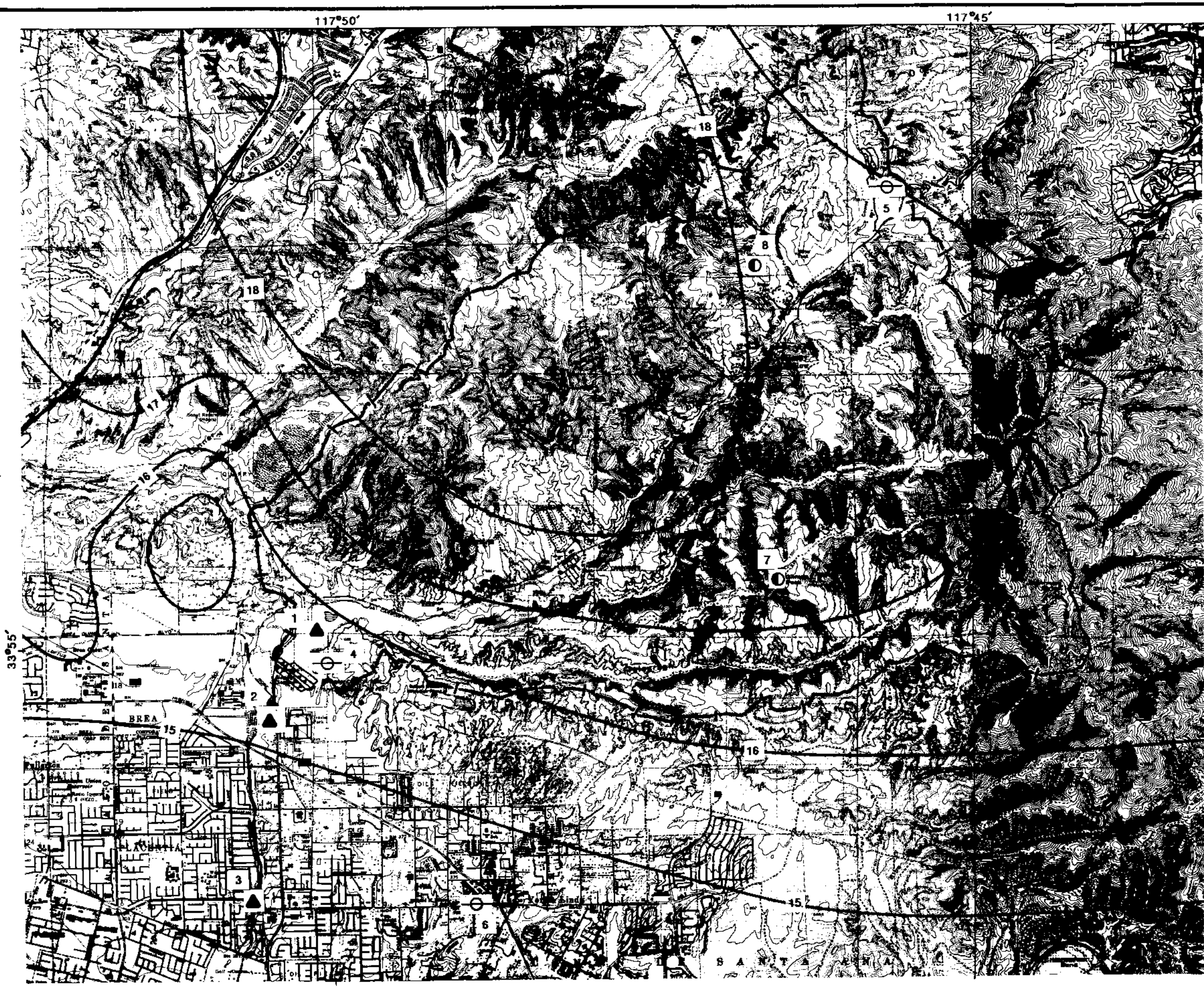


CARBON CANYON DAM
WATER CONTROL MANUAL

CHANNEL CAPACITIES
AND CONFIGURATIONS
CARBON CANYON CHANNEL

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

CHANNEL CAPACITIES AS OF SEPTEMBER 1979



LEGEND

- ▲ RECORDING STREAM GAUGE
  - 1 CARBON CREEK AT OLINDA
  - 2 CARBON CREEK BELOW CARBON CANYON DAM
  - 3 CARBON CREEK NEAR YORBA LINDA
- ⊖ STANDARD RAIN GAUGE
  - 4 CARBON CANYON DAM
  - 5 CARBON CANYON-SUMMIT
  - 6 YORBA LINDA
- ◐ RECORDING RAIN GAUGE
  - 7 CARBON CANYON-GILMAN
  - 8 CARBON CANYON-WORKMAN

——I—— DRAINAGE AREA BOUNDARY

——18—— ISOHYET OF MEAN SEASONAL PRECIPITATION IN INCHES

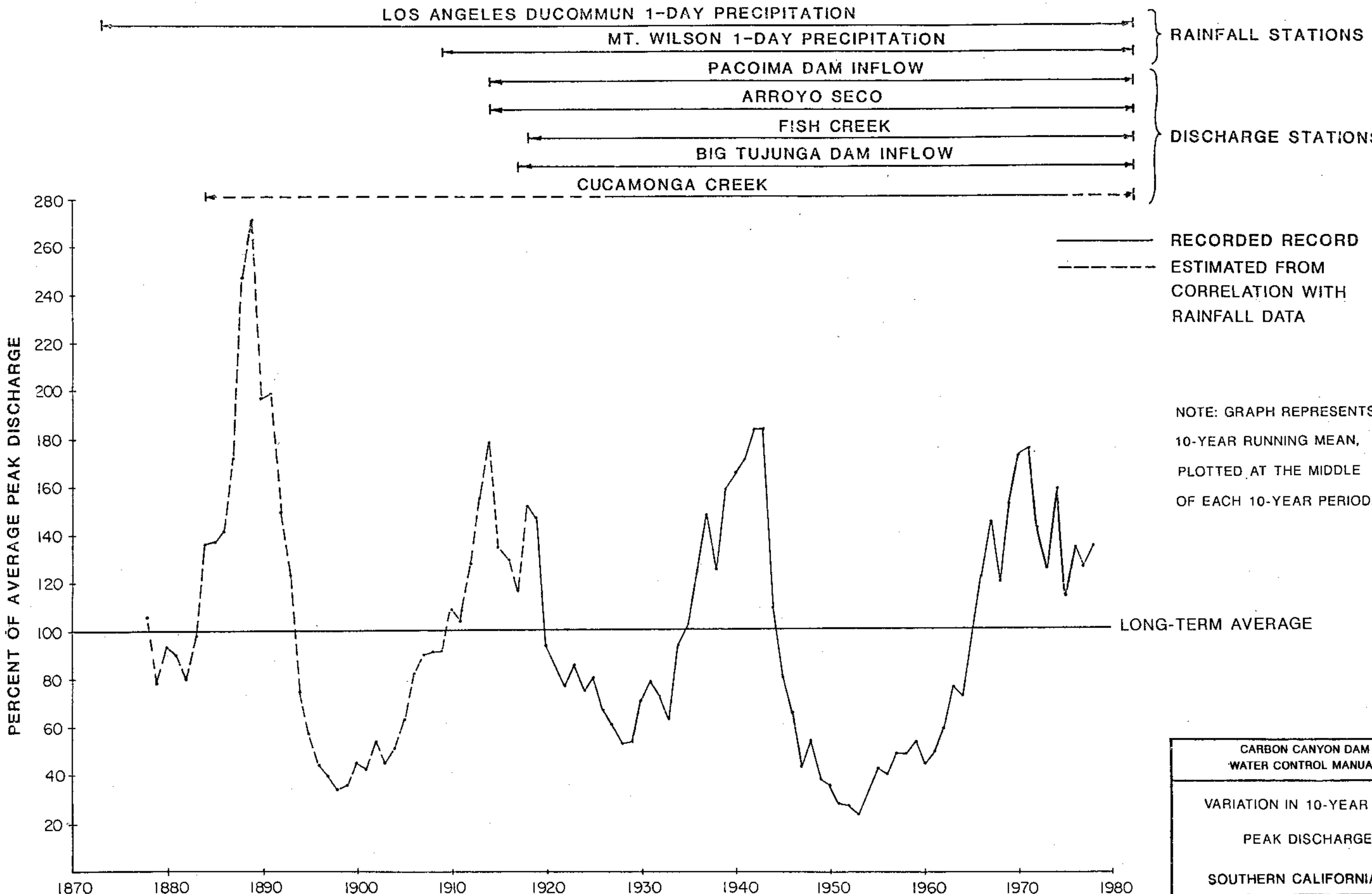
0 1 2

MILES

CARBON CANYON DAM
WATER CONTROL MANUAL

HYDROLOGIC MAP

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

VARIATION IN 10-YEAR MEAN
PEAK DISCHARGE
SOUTHERN CALIFORNIA AREA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SOURCE: SEPULVEDA DAM WATER CONTROL MANUAL

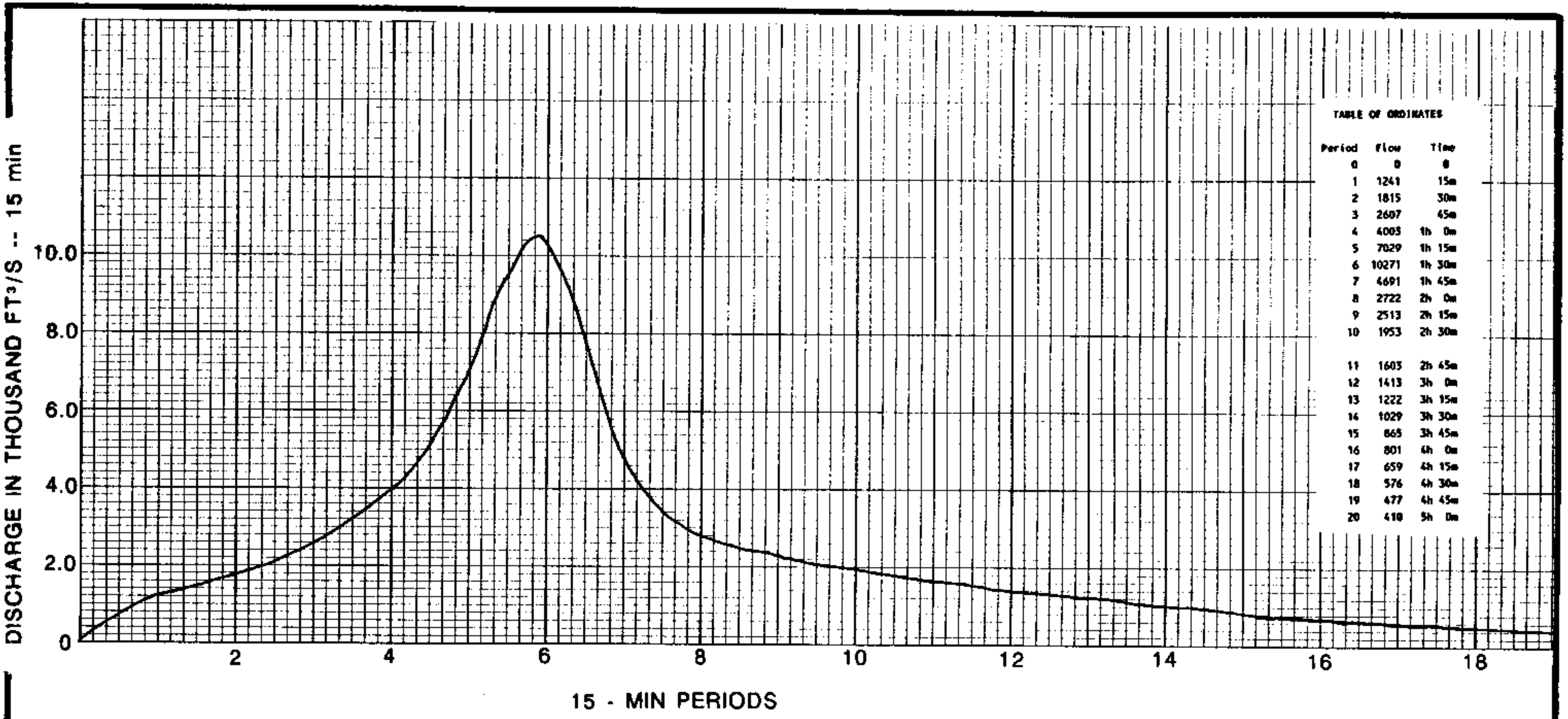


TABLE OF ORDINATES

Period	Flow	Time
0	0	0
1	1241	15m
2	1815	30m
3	2607	45m
4	4003	1h 0m
5	7029	1h 15m
6	10271	1h 30m
7	4691	1h 45m
8	2722	2h 0m
9	2513	2h 15m
10	1953	2h 30m
11	1603	2h 45m
12	1413	3h 0m
13	1222	3h 15m
14	1029	3h 30m
15	865	3h 45m
16	801	4h 0m
17	659	4h 15m
18	576	4h 30m
19	477	4h 45m
20	410	5h 0m

BASIN PARAMETERS

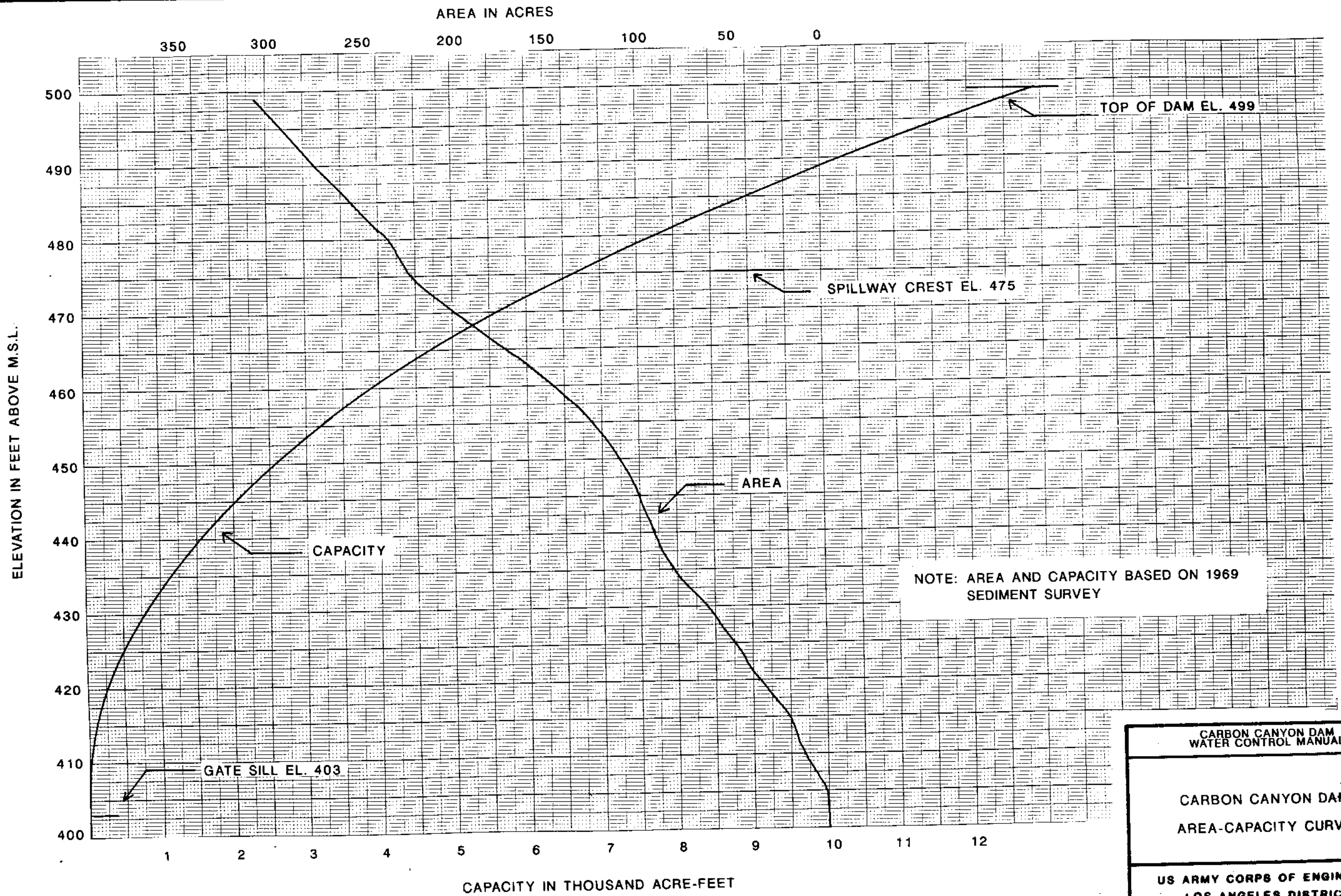
Drainage Area=19.30 sq mi
L=7.4 mi   LCA=4.0 mi
S=115.0
Basin N Value=0.040
Average Fullerton - San Jose S-Graph

CARBON CANYON DAM
WATER CONTROL MANUAL

(15 MINUTE)

UNIT HYDROGRAPH

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

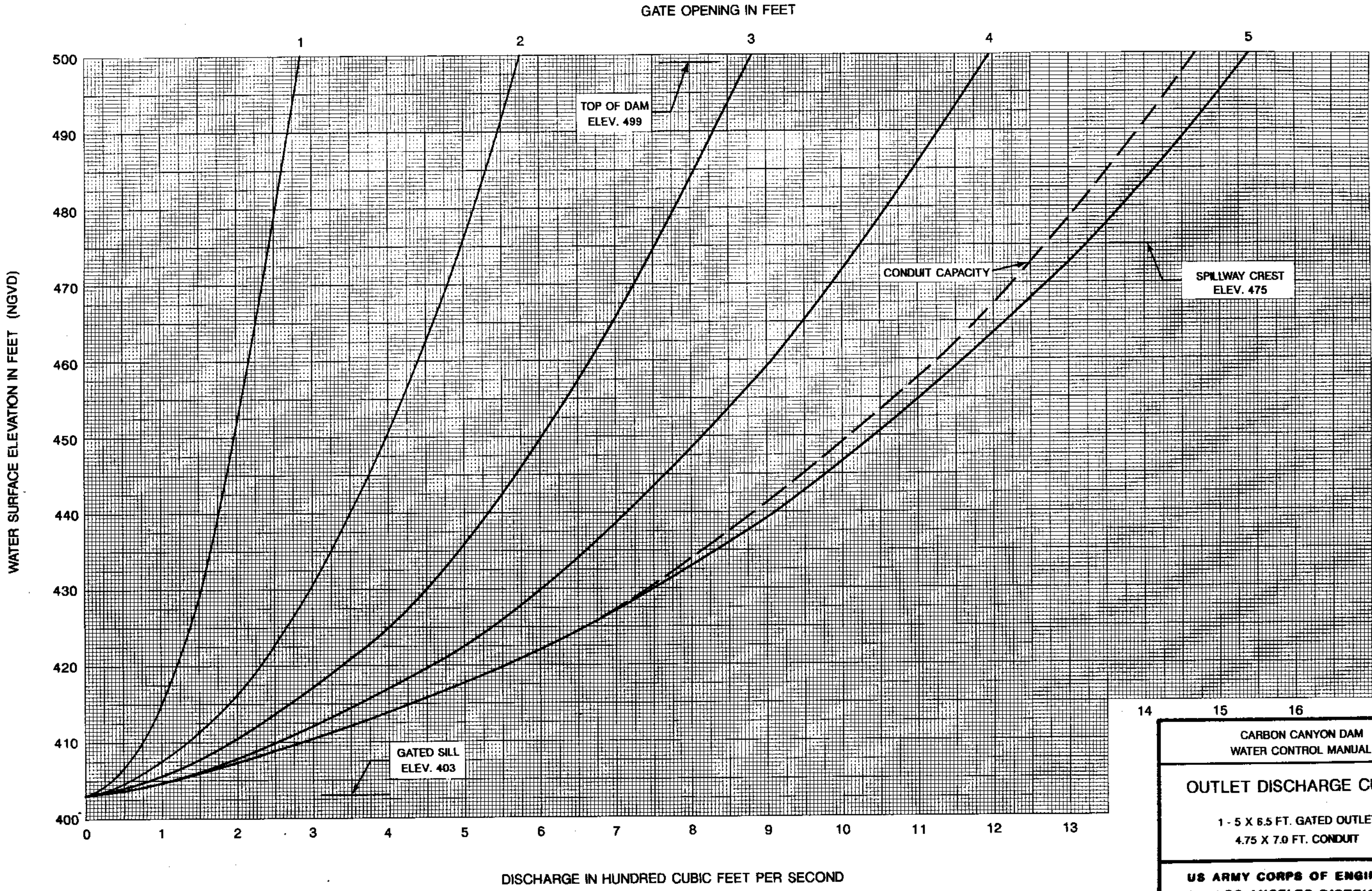
CARBON CANYON DAM

AREA-CAPACITY CURVE

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 7-1

NOTE: TO OBTAIN TOTAL OUTLET DISCHARGE, ADD THE DISCHARGE THROUGH EACH OF THE TWO IDENTICAL GATES. DISCHARGE IS NOT TO EXCEED CONDUIT CAPACITY INDICATED BY THE DASHED LINE.

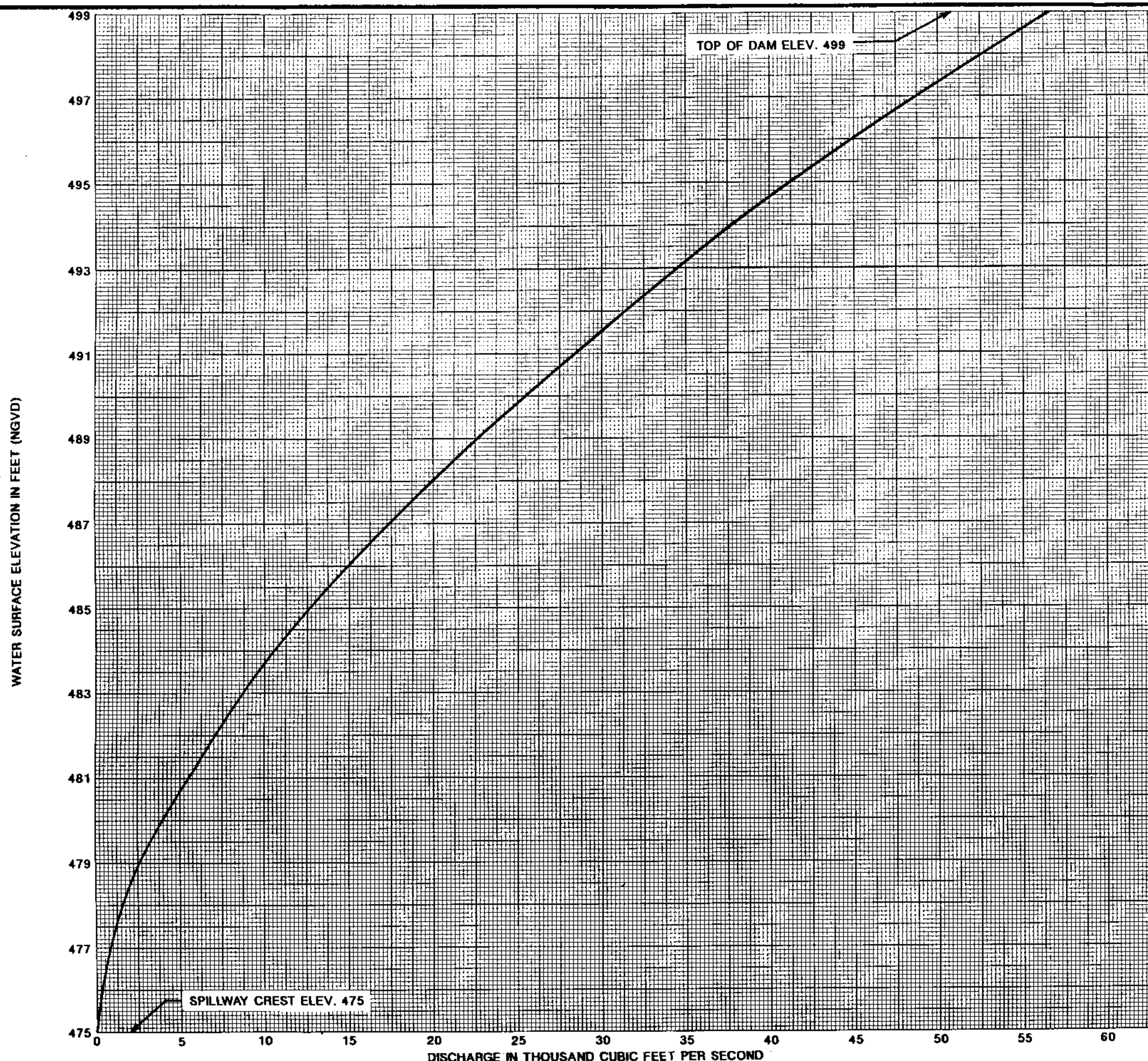


CARBON CANYON DAM
WATER CONTROL MANUAL

OUTLET DISCHARGE CURVE

1 - 5 X 6.5 FT. GATED OUTLET
4.75 X 7.0 FT. CONDUIT

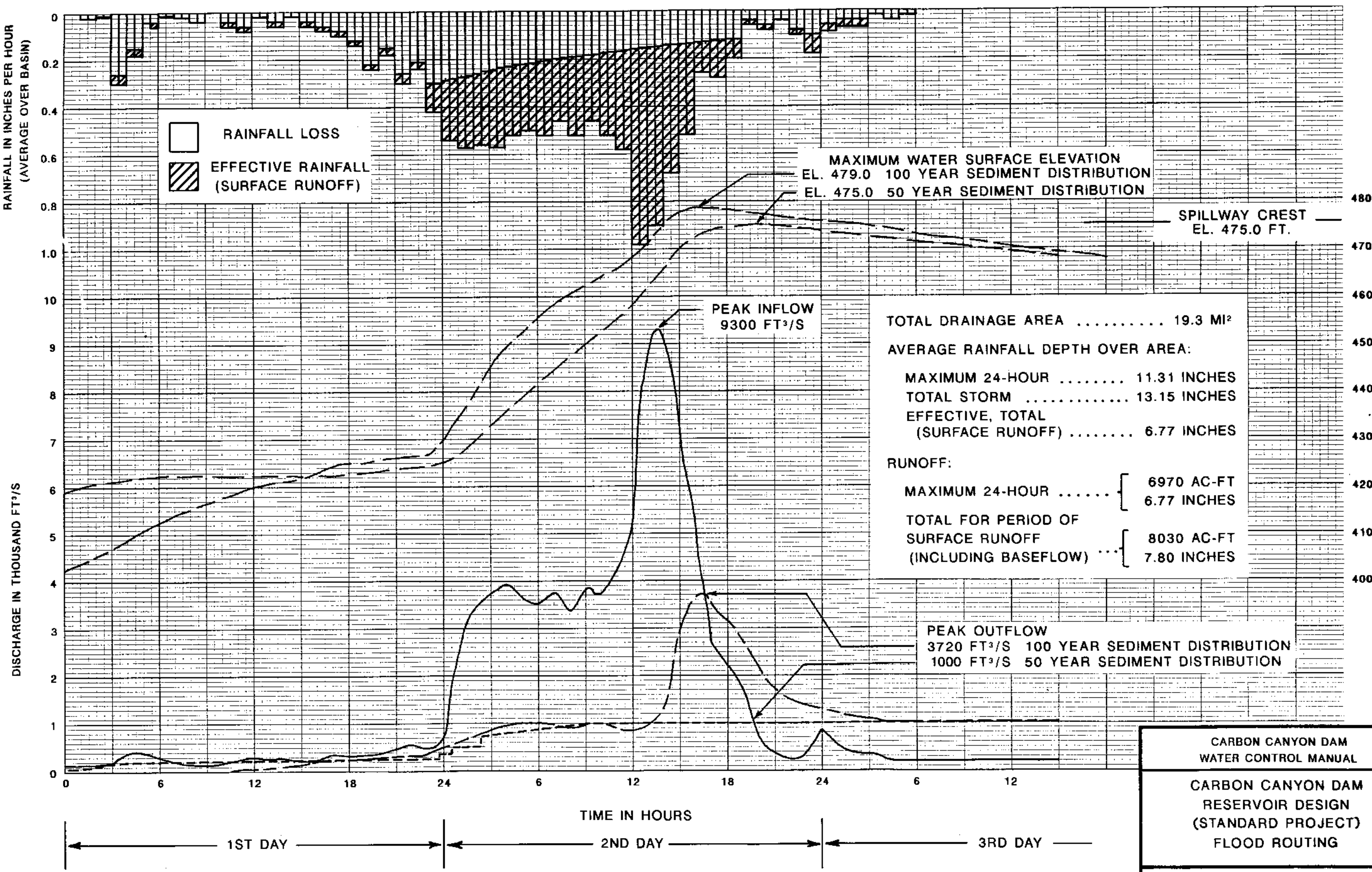
US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

SPILLWAY DISCHARGE CURVE

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

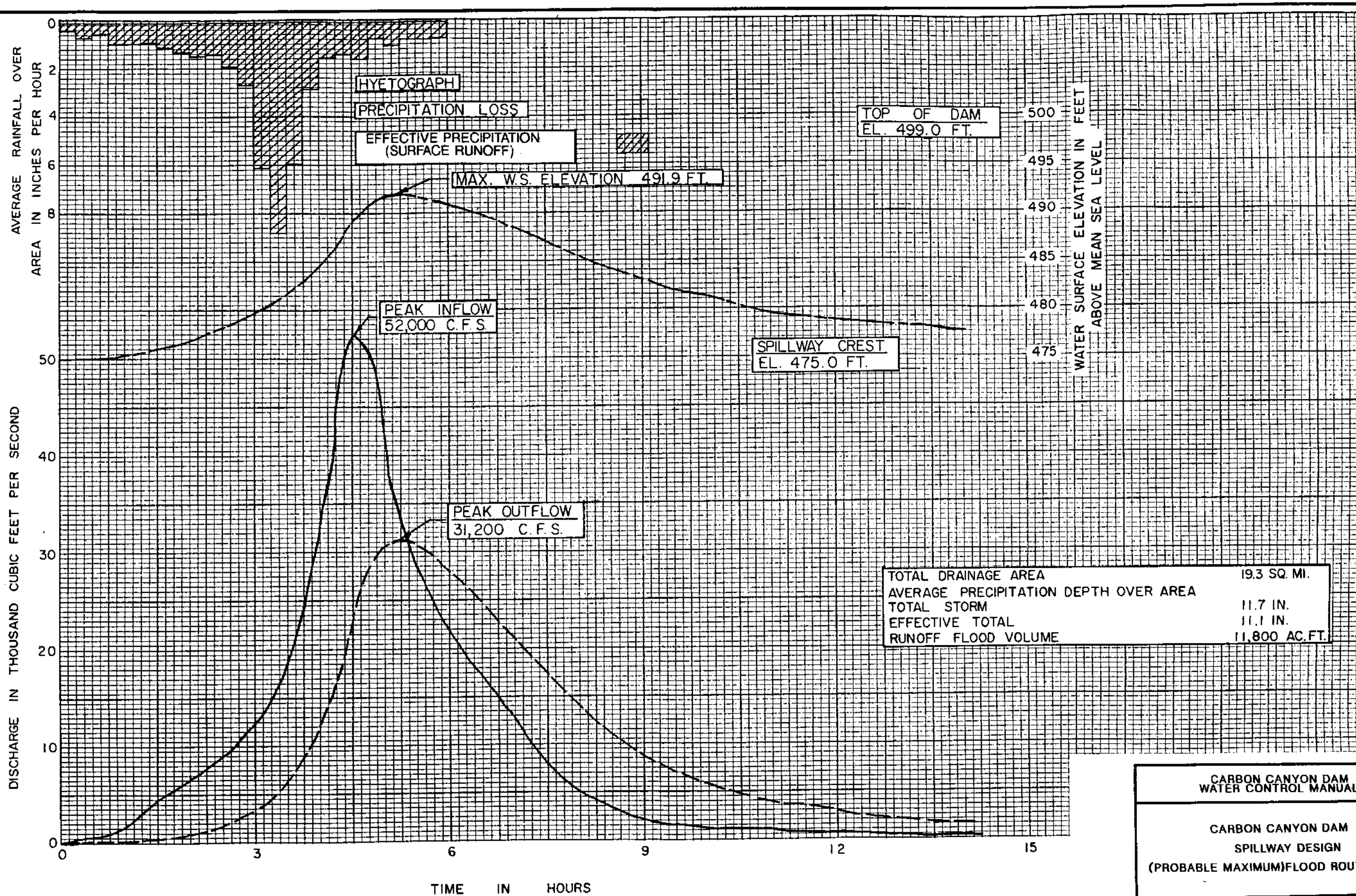


NOTE: NET CAPACITY USED IN COMPUTATIONS.

CARBON CANYON DAM
WATER CONTROL MANUAL

CARBON CANYON DAM
RESERVOIR DESIGN
(STANDARD PROJECT)
FLOOD ROUTING

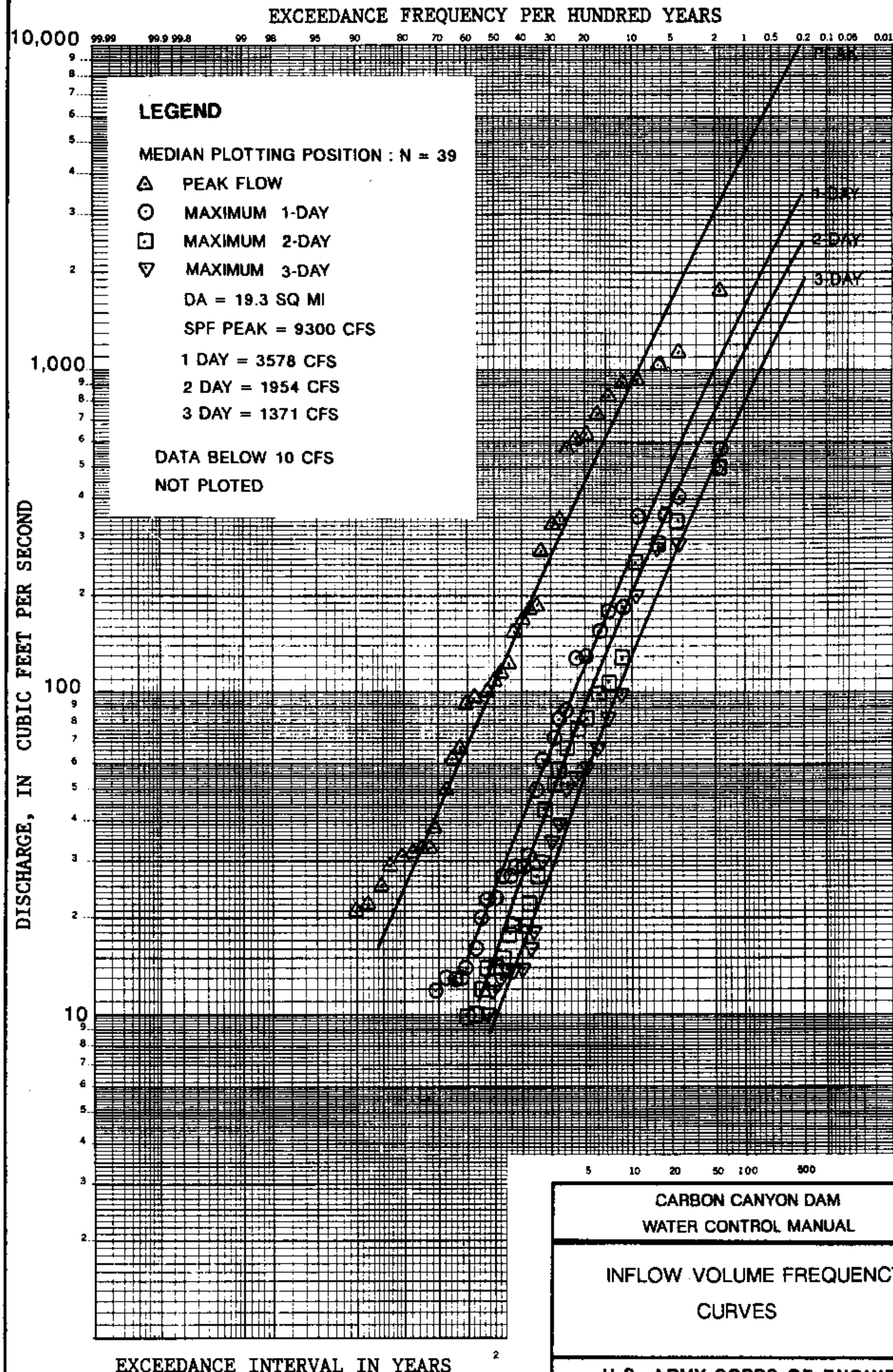
US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

CARBON CANYON DAM
SPILLWAY DESIGN
(PROBABLE MAXIMUM)FLOOD ROUTING

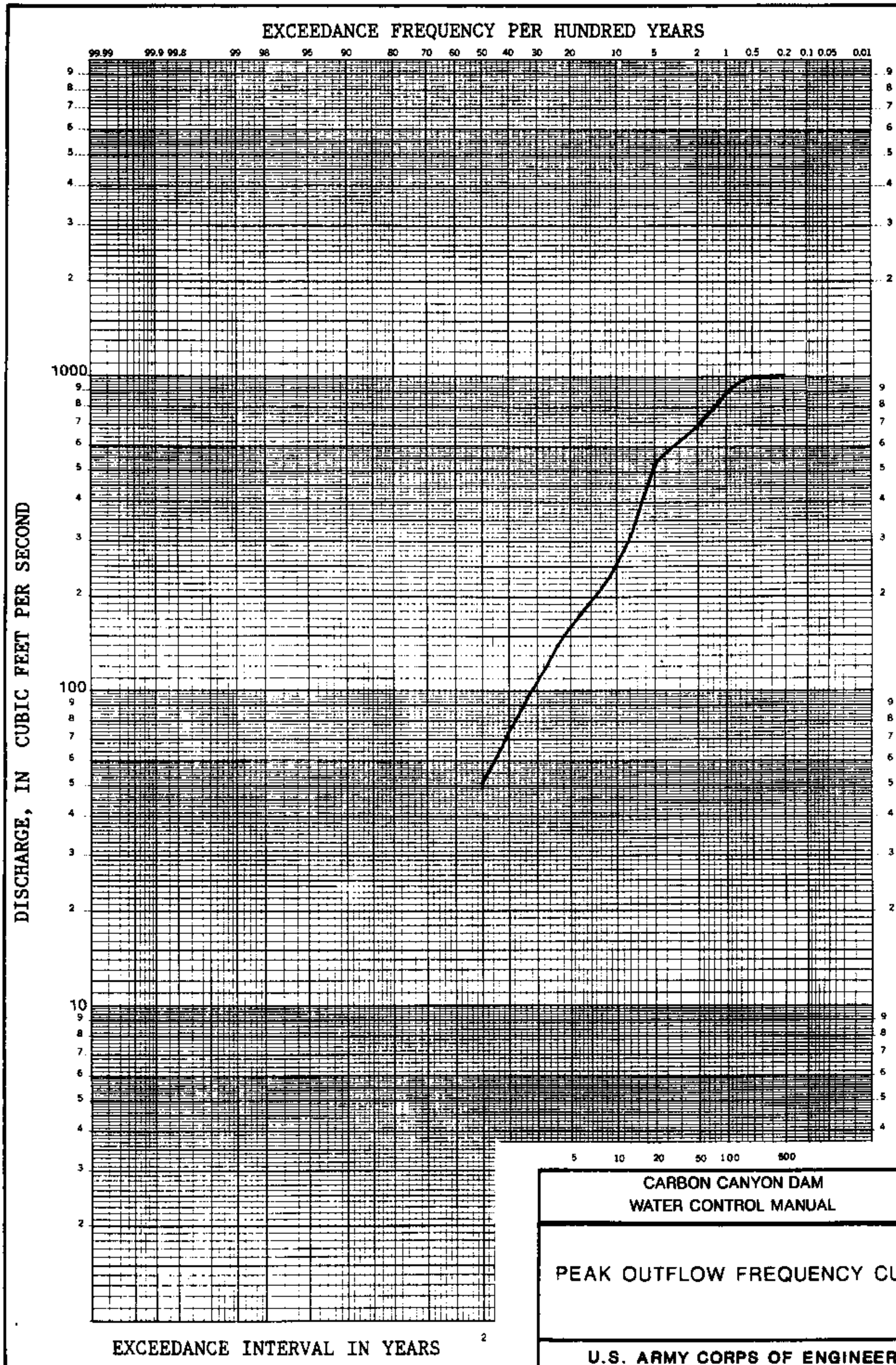
U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

INFLOW VOLUME FREQUENCY
CURVES

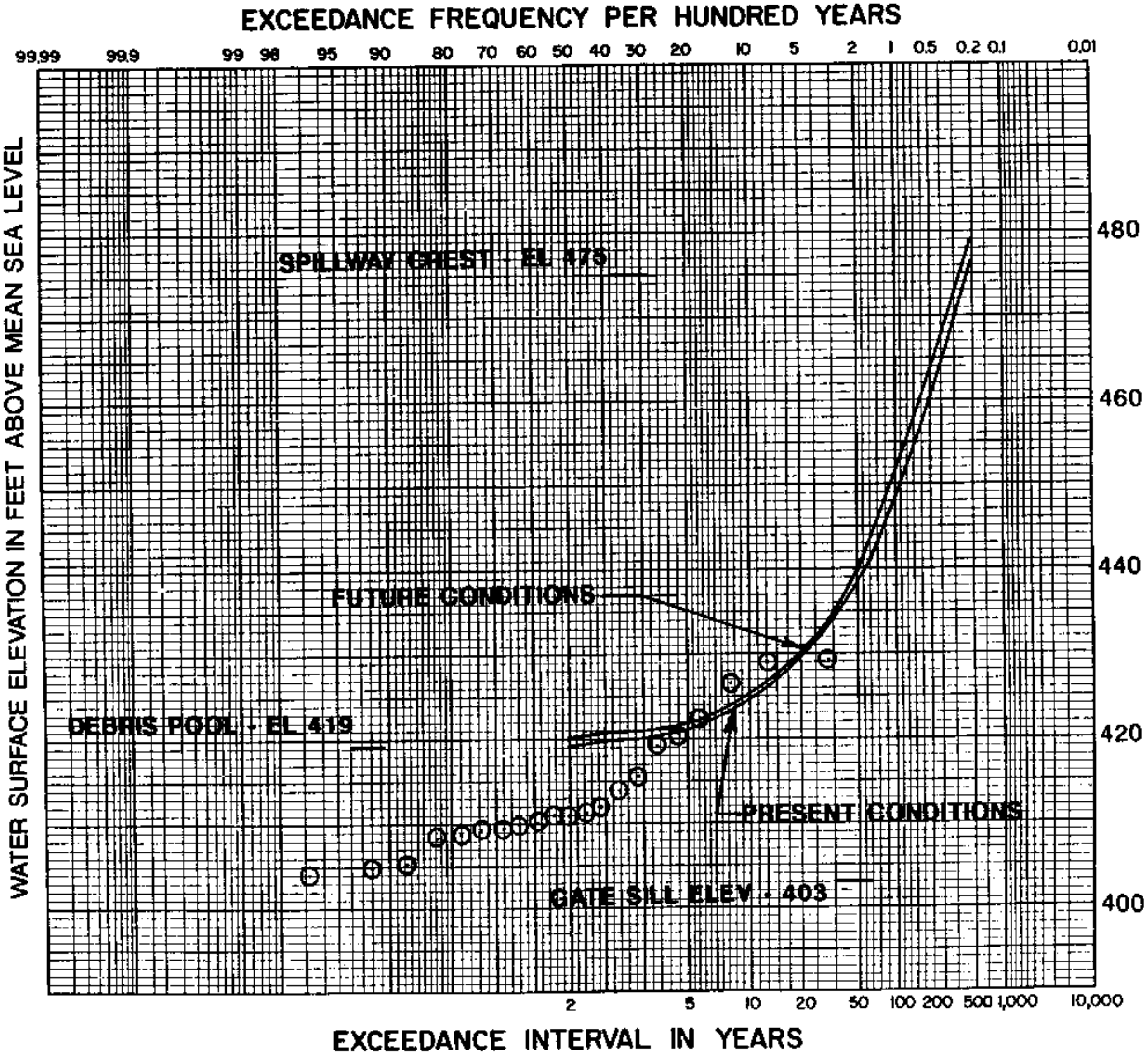
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CARBON CANYON DAM
WATER CONTROL MANUAL

PEAK OUTFLOW FREQUENCY CURVE

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LEGEND

MEDIAN PLOTTING POSITIONS FOR PERIOD 1961-1981 (N=21)

NOTE:

1. SPF ELEVATION=471.1 FOR PRESENT CONDITIONS.
2. SPF ELEVATION=475.0 FOR FUTURE CONDITIONS.
3. DRAINAGE AREA=19.3 SQ. MI.
4. BALANCED HYDROGRAPH ELEVATIONS IN FEET MSL (CURVE GOES THROUGH THESE VALUES) ARE LISTED BELOW.

FREQUENCY	PRESENT	FUTURE
500 - YR	477.1*	N/A*
200 - YR	460.4	463.2
100 - YR	448.3	450.4
50 - YR	438.3	439.5
25 - YR	431.3	431.7
10 - YR	425.0	425.5
5 - YR	421.6	422.0
2 - YR	419.6	420.3

* BASED ON A MAXIMUM RELEASE OF 1000 FT^3/S

CARBON CANYON DAM
WATER CONTROL MANUAL

ELEVATION FREQUENCY CURVE

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
TO ACCOMPANY REPORT DATED:

STANDING INSTRUCTIONS TO THE DAM OPERATOR

CARBON CANYON DAM

CARBON CANYON CREEK

San Gabriel River Basin

Exhibit A
to the
Water Control Manual for
Carbon Canyon Dam

U.S. Army Corps of Engineers
Los Angeles District

DECEMBER 1990

STANDING INSTRUCTIONS TO THE DAM OPERATOR

CARBON CANYON DAM

TABLE OF CONTENTS

LIST OF PLATES

STANDING INSTRUCTIONS TO THE PROJECT OPERATOR
FOR WATER CONTROL

CARBON CANYON DAM

A-I. BACKGROUND AND RESPONSIBILITIES.

1-01 General Information.

This exhibit is prepared in accordance with instruction contained in EM 1110-2-3600, paragraph 9-2 (Standing Instructions to the Project Operator for Water Control), and ER 1110-2-240, and pertains to duties and responsibilities of project operators (dam tenders) associated with the operation of Carbon Canyon Dam.

Operational instructions to dam tenders are outlined with specific emphasis on flood emergencies when communication between the dam tender and the Reservoir Operations Center (ROC) have been disrupted. This exhibit is designed to be used as an operational guide for the dam tender to use in implementing the Carbon Canyon Regulation Schedule (found at the end of this exhibit). Associated plates are contained in the main body of the water control manual.

The dam tender is required to have available at the damsite this water control manual and exhibit, and the current version of other manuals that complement these standing instructions. These manuals are: (a) “Instructions for Reservoir Operations Center Personnel” (the “Orange Book”); (b) “Operation and Maintenance Manual for Carbon Canyon Dam”; and (c) “Carbon Canyon Dam Emergency Plan.” Any deviation from standing instructions will require approval of the District Commander.

The primary purpose of Carbon Canyon Dam is to regulate flood flows down Carbon Canyon Creek, thereby minimizing flood damage in the flood plain downstream of the dam. The protected areas include the cities of Brea, Fullerton, Placentia, and Anaheim, as well as portions of the coast plain in Orange County.

Table 9-01 is an organizational chart depicting the chain of command for reservoir regulation decisions.

Gate operation instructions to the dam are issued by ROC. Dam tenders are part of the Operations Branch, Construction-Operations Division.

Carbon Canyon Dam is located on Carbon Canyon Creek near the northern edge of Orange County, as seen on plate 1-1. The dam is situated approximately 12 miles north of the city of Santa Ana and 4 miles east of the city of Brea. Carbon Canyon Dam consists of an earthfill embankment with outlet works and a detached spillway. A general plan of Carbon Canyon Dam is shown plate 2-3.

Carbon Canyon Dam is owned, operated, and maintained by the U.S. Army Corps of Engineers, Los Angeles District, which has complete regulatory responsibility. Carbon Canyon Dam is operated for local flood control on Carbon Canyon Creek.

1-02 Role of the Project Operator.

a. Normal (Non-Food) Conditions. The dam tender will be instructed by ROC, as necessary, for water control actions under normal conditions. The dam tender will verify that all equipment at the project is in good operating condition; test- gates and electrical facilities in the control house and inspect all structures and equipment according to schedule; and refer to the Operation and Maintenance Manual for instructions on actual operation procedures for all equipment.

b. Emergency Conditions. The dam tender will be pre-sent at the dam during periods of significant runoff, as instructed by the Operations Branch: operate the dam in accordance with instructions from ROC; and follow the Reservoir Regulation Schedule provided in this exhibit during periods of communication disruption.

A-II. DATA COLLECTION AND REPORTING.

2-01 Normal (Non-Flood) Conditions.

During normal conditions, measurements are made daily at 0800 hours local time by the dam tender to determine reservoir staff reading (water surface elevation), float well or manometer gauge “tape” reading, incremental precipitation since last report, total accumulated precipitation for the season, the settings of each outlet gate, and the times of these measurements. This information will be logged on the appropriate forms and reported by radio to ROC, radio call sign WUK 4ROC, as requested.

The dam tender will also maintain records, including water surface elevations, downstream gauge heights, precipitation amounts, outlet gate settings, and log all radio and telephone communications on forms prescribed below.

a. The Record of Calls Form (SPL-188). This form is used each time a message is transmitted or received by radio or telephone. The purpose of every call will be noted, whether for radio check, reservoir report, etc.

b. Flood Control Basin Operation Report Form (SPL-19). The dam tender should log all of the information on this form each time a water surface elevation measurement is taken or a gate change has been completed.

c. Rainfall Record Form (SPL-31). This form should be filled in each time a rainfall measurement is taken from a glass tube rainfall gauge.

d. Record of Data from Digital Recorders (SPD-648). This forms is used to tabulate water surface, downstream gauge height, and precipitation data from digital recorders.

All of these forms should be submitted monthly to the Water Control Data Unit CESPL-ED-HR (Baseyard) of ROC for archival storage. A copy of each of these forms is included in the Carbon Canyon Dam Water Control Manual in figures 9-01, 9-02, 9-04, and 9-06.

2-02 Emergency Conditions.

During flood events, the dam tender should follow instructions as issued by ROC on measurement type and frequency. Due to the speed with which events may occur at Carbon Canyon Dam, measurements at fifteen minute intervals are often necessary. When reporting to ROC, the dam tender should clearly describe the silt and debris situation at the rack bars, gates, and downstream gauge. When instruments are not working or are stuck in the silt, the dam tender should not report the erroneous reading, but should rather state the instrument or staff problem. Care should be taken to avoid issuing misleading reports due to siltation at the reservoir staff boards. When debris or silt causes flows to be deceptively perched above the invert, or cause a loss of contact with the staff board, the dam operator should report a descriptive message identifying on the radio the limitations, and quantifying the estimated reservoir depth. If the radio system, including the dam tender's mobile unit, malfunctions, ROC will contact the dam tender via telephone. It is especially important to maintain all records generated above during emergency conditions.

2-03 Regional Hydrometeorological Conditions.

The dam tender will be informed by ROC of regional hydro-meteorological conditions that could impact Carbon Canyon Dam.

A-III. WATER CONTROL ACTION AND REPORTING.

3-01 Normal (Non-Flood) Conditions.

Except during times of emergency when fast action is critical, ROC must approve all gate changes. ROC will originate the request for a gate change, and will provide settings for each gate whenever a gate change is necessary. Generally, gates will be set according to the instructions given in this exhibit. The dam tender should implement gate changes immediately following. The dam should implement gate changes immediately following acknowledgment of instructions. Delaying a gate change may have serious impacts on affected activities. If other concurrent activities cause a delay in implementation of a gate change, the dam tender should notify ROC by calling radio call sign WUK 4ROC and request guidance.

Once a gate change is completed, the dam operator should radio back to ROC on WUK 4ROC to report the time the change was completed, the staff and tape readings, the downstream gauge height, and the current settings of both gates.

The two vertical lift gates are hydraulically operated from the control house. The dam operator should refer to the O&M Manual for instructions on actual operating procedures.

3-02 Emergency Conditions.

During flood events and other emergency conditions, water control actions and reporting are vital to the successful operation of the dam.

If flooding conditions or some other emergency occurs at the dam, the dam tender should notify ROC as soon as possible with a description of the conditions.

During an emergency condition, such as a hazardous chemical spill or potential drowning where immediate action is necessary, the dam tender should make the appropriate gate changes and report in to ROC as soon as possible.

During a flood event, ROC will initiate gate changes, as is done during normal (non-flood) conditions. The dam tender will implement the gate change and report back the same information as during normal (non-flood) conditions.

ROC will keep the dam tender apprised of regulation objectives and critical regulation constraints whenever possible. This will afford the dam tender a greater opportunity to recognize and identify potential problems in the field. ROC may also provide additional water surface elevation criteria, instructing the dam tender to alert them via radio channel WUK 4ROC when the reservoir pool reaches the indicated level. Such an action would normally be conducted during periods of intense storm runoff, and would require the dam tender to remain at the control house.

3-03 Inquiries.

All significant inquiries received by the dam tender from citizens, constituents, or interest groups regarding water control procedures or actions must be referred directly to ROC.

3-04 Water Control Problems.

ROC must be contacted immediately by the most rapid means available in the event that an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.

Emergency departures from the operation instructions issued by ROC may be required, because of equipment failures, accidents, or other emergencies requiring immediate action. Under these situations, the dam tender should contact ROC via radio for instructions. When communications are broken and the situation demands immediate action, the dam tender may proceed independently. ROC should be notified of such actions as soon as possible. All other emergency deviations from normal procedure should be approved in advance by ROC. The District Engineer, Los Angeles District, U.S. Army Corps of Engineers, may make temporary modifications to the water control regulations. Permanent changes are subject to approval by the Division Engineer, South Pacific Division, U.S. Army Corps of Engineers.

The dam tender should immediately alert ROC via radio channel WUK 4ROC whenever the requested gate change cannot be fully implemented due to mechanical or other physical problems. For example, debris will occasionally prevent total gate closure. ROC will evaluate the problem and provide further instructions to the dam tender.

3-05 Communication Outage.

Coordination of flood control regulation is under the direction of ROC. During flood periods, close contact will be maintained between operating personnel at Carbon Canyon Dam and ROC. If communication is broken between the dam tender and ROC, initially continue releases in accordance with the last instructions from ROC, and make every attempt to re-establish communications. If this effort is unsuccessful for one hour, the dam operator will follow Instruction 2 of the Reservoir Regulation Schedule in this exhibit.

Emergency notifications are normally made by ROC. However, if the dam tender loses communications with ROC, and an emergency notification situation arises, such as an imminent dam failure or uncontrolled spillway flow (water surface elevation above 475 feet NGVD), the dam tender should make the necessary notifications.

The parties listed below are to be immediately notified upon declaration of an uncontrolled emergency:

Orange County Communications Center	(714) 834-2127
Placentia Police Department	(714) 993-8151
Fullerton Police Department	(714) 738-6719
California Office of Emergency Services, Sacramento	(916) 791-4305

Notifications should include: (a) description of the type and extent of the existing or impending emergency; (b) advisement for evacuation from the floodplain; (c) information on the time of the initial release of hazardous amounts of water; (d) the depth of water behind the dam; and (e) the dam tender’s name and telephone number.

Upon completing above notifications, attempt to re-establish communications with ROC. Document all notifications made, and refer to the “Orange Book” (Instructions for Reservoir Operations Center Personnel) for more information on additional emergency notifications. The dam tender should not leave the dam unless his or her safety is in jeopardy.

Carbon Canyon Dam Reservoir Regulation Schedule
(For rising and falling stages)

Step No.	When reservoir water surface is between elevations	Gate setting for gates as indicated No. 1	Gate setting for gates as indicated No. 2	Computed discharge	Downstream gauge height***
	Feet above mean sea level	Feet of opening	Feet of opening	Cubic feet per second	Feet
	Follow steps 1A to 1D during rising stages				
1A.......	403 - 419	0.5*	0	0 - 50	2.00 - 2.71
1B.......	419 - 420	.3	.3	70 - 75	2.80 - 2.82
1C.......	420 - 421	.6	.6	140 - 145	3.08 - 3.11
1D.......	421 - 425	.9	.9	230 - 250	3.58 - 3.68
	Follow step 2 during falling stages				
2........	403 - 425	.9	.9	0 - 250	2.00 - 3.68
	Follow steps 3 to 13 during rising or falling stages				
3........	425 - 426	1.4	1.4	375 - 380	4.29 - 4.32
4........	426 - 431	1.9	1.9	500 - 570	4.87 - 5.18
5........	431 - 455	2.4	2.4	719 - 1,000	5.83 - 7.00
6........	455 - 465	2.2	2.2	900 - 1,000	6.59 - 7.00
7........	465 - 475**	2.0	2.0	900 - 1,000	6.59 - 7.00
8........	475 - 475.3	1.8	1.8	900 - 1,000	6.59 - 7.00
9........	475.3 - 475.8	1.7	1.7	900 - 1,000	6.59 - 7.00
10........	475.8 - 476.1	1.5	1.5	900 - 1,000	6.59 - 7.00
11........	476.1 - 476.3	1.2	1.2	900 - 1,000	6.59 - 7.00
12........	476.3 - 476.5	0.9	0.9	900 - 1,000	6.59 - 7.00
13........	476.5 - 476.6	0.7	0.7	900 - 1,000	6.59 - 7.00
14........	476.6 - 476.8	0.5	0.5	900 - 1,000	6.59 - 7.00
15........	476.8 - 477.0	0.2	0.2	900 - 1,000	6.59 - 7.00
16........	477.0 and above	0	0	Spillway flow only	

* During normal standby either gate No. 1 or No. 2 will be opened to 0.5' to pass low flows (the other gate closed).
** Spillway crest elevation 475. Above this elevation, computed discharge = gated discharge + spillway discharge.
*** Derived from U.S.G.S. rating No. 6 (extrapolated above 855 cfs).

DAM OPERATOR INSTRUCTIONS

1. Communication with the District Office is available.

a. Notify the Reservoir Operations Center when a gate change will be required according to the schedule.

b. Notify the Reservoir Regulation Section if unable to set the gates as instructed.

2. Communication with the District Office is not available.

a. Try to reestablish communications through the Los Angeles County Flood Control District (WUK 4470) or by telephone.

b. (i) Rising Stages. Allow a period of one hour to pass to reestablish communication with the District Office. If after one hour communication is not reestablished follow the gate regulation schedule.

(ii) Falling Stages. Maintain current downstream gauge height until communication is reestablished.

c. If one of the gates cannot be operated, adjust the remaining gate gradually until the downstream gauge height agrees with scheduled values. Keep a close check on gauge height and change the gate opening as often as required. If the downstream gauge height is not obtainable, adjust the one gate that is functioning so that the gate opening is equal to the sum of the openings shown in the schedule.

OUTLETS

(Looking Downstream)

Elevation 403

Each outlet 5'W x 6.5'H

EXHIBIT B

Pertinent Data for Other Reservoirs in the Vicinity of Carbon Canyon Dam

BREA DAM AND RESERVOIR
ORANGE COUNTY, CALIFORNIA

PERTINENT DATA
AUGUST 1989

Construction Completed		March, 1942
Stream System		Brea Creek
Drainage Area	sq. miles	22
Reservoir:		
Elevation		
Sreambed at dam	ft., NGVD	208.0
Spillway crest	ft., NGVD	279.0
Spillway design surcharge level	ft., NGVD	292.2
Top of dam	ft., NGVD	295.0**
Area		
Spillway crest	acres	162.7
Spillway design surcharge level	acres	250.2
Top of dam	acres	272.8
Capacity, gross		
Spillway crest	acre-feet	4,008.5 (3.42*)
Spillway design surcharge level	acre-feet	6,688.6 (5.70*)
Top of dam	acre-feet	7,420.2 (6-32*)
Allowance for sediment (50-year)	acre-feet	1,200 (1.02*)
Dam: - Type		Earthfill
Height above original streambed	ft	87
Top length	ft	1,765
Top width	ft	20
Freeboard	ft	5.8+
Spillway: -Type		Ungated, overflow concrete ogee
Crest length	ft	150
Design surcharge	c.f.s	27,000
Outlets:		
Uncontrolled		
Number and size	ft	2 - 3.0'W x 2.51H
Entrance invert elevation	ft., NGVD	251
Controlled		
Gates - type		Vertical lift
Number and size	ft	2-5'W x 8'H
Entrance invert elevation	ft., NGVD	208
Conduits		
Number and size	ft	2-5'W x 8'H
Length	ft	484
Maximum capacity at spillway crest	c.f.s	3,800
Regulated capacity at spillway crest	c.f.s	1,500
Standard Project Flood:		
Duration (inflow)	days	2
Total volume	acre-feet	8,260 (7.04*)
Inflow peak	c.f.s	8,000
Outflow peak	c.f.s	5,060
Maximum water surface elevation	ft	283.2
Probable Maximum Flood:		
Duration (inflow)	hours	12
Total volume	acre-feet	8,200 (6.99*)
Inflow peak	c.f.s	37,000
Outflow peak	c.f.s	27,000
Maximum water surface elevation	ft	292.2
Historic Maximums		
Maximum mean hourly inflow	c.f.s	2,625
Date		3-1-83
Maximum release	c.f.s	1,440
Date		3-1-83
Maximum storage	acre-feet	1,073
Date		3-1-83
Maximum water surface elevation	ft	252.0
Date		3-1-83
Real Estate Taking Line:		
By fee	acres	236.65
By easements	acres	62.08

*Inch of runoff
**Top of parapet wall elevation 298.0 feet

FULLERTON DAM AND RESERVOIR
ORANGE COUNTY, CALIFORNIA

PERTINENT DATA
MARCH 1989

Construction Completed		May 1941
Stream System		Fullerton Creek
Drainage Area	sq. miles	5.0
Reservoir:		
Elevation		
Streambed at dam	ft., NGVD	260
Spillway crest	ft., NGVD	290
Spillway design surcharge level	ft , NGVD	298.4
Top of dam	ft., NCVD	307
Area		
Spillway crest	acres	62
Spillway design surcharge level	acres	92
Top of dam	acres	130
Capacity, gross		
Spillway crest	acre-feet	764 (2.84*)
Spillway design surcharge level	acre-feet	1394 (5.18*)
Top of dam	acre-feet	2306 (8.56*)
Original allowance for sediment	acre-feet	230
Dam: - Type		Earthfill
Height above original streambed	ft	46
Top length	ft	575
Top width	ft	15
Freeboard (PMF)	ft	8.6
Spillway: - Type		Ungated ogee
Crest length	ft	40
Crest elevation	ft	290
Design surcharge (modified Rational Method)	ft	8.4
Design discharge (modified Rational Method)	cfs	3380
Outlets:		
Uncontrolled		
Number and size		1 - 3'W x 2'H
Entrance invert elevation	ft., NGVD	275
Controlled		
Gate type		Vertical lift
Size	ft	2 - 3'W x 5'H
Entrance invert elevation	ft., NGVD	261
Conduits		
Number and size		1 - 41W x 6'H
Length	ft	346
Maximum capacity at spillway crest	cfs	590
Regulated capacity at spillway crest	cfs	500
Standard project flood:		
Duration (inflow)	days	1.75
Total volume	acre-feet	1750 (6.50**)
Inflow peak	cfs	2100
Outflow peak	cfs	1250
Maximum water surface elevation		
1969 reservoir regulation schedule	ft	293.75
Current reservoir regulation-schedule	ft	292.50
Probable maximum flood		
Duration (inflow) days		0.25
Total volume	acre-feet	1820 (6.76*)
Inflow peak	cfs	16000
Outflow peak	cfs	5650
Spillway outflow., peak	cfs	5650
Maximum water surface elevation	ft	301.44
Historic maximums:		
Maximum inflow	cfs	3800
Date		3-14-41
Maximum outflow	cfs	444
Date		3-1-83
Maximum water surface elevation	ft., NGVD	285.6
Maximum storage	acre-feet	522.5 (68% full)
Date		1-31-79

*Inches of runoff

PRADO DAM AND RESERVOIR
RIVERSIDE COUNTY,
CALIFORNIA
PERTINENT DATA
(REVISED JANUARY 1990)

Construction Completed		April 1941
Stream System		Santa Ana River
Drainage Area	sq-mi	2,255
Reservoir:		
Elevation		
Streambed at dam	ft., m.s.l.	460.0
Debris pool	ft., m.s.l	490.0
Buffer pool	ft., m.s.l.	494.0
Spillway Crest	ft., m.s.l.	543.0
Spillway Design Surcharge Level (1941)	ft., m.s.l.	556.0
Revised Standard Project Flood (1969)	ft., m.s.l.	558.7
Top of dam	ft., m.s.l.	566.0
Revised Probable Maximum- Flood (1969)	ft., m.s.l.	572.7**
Area		
Debris pool	acres	917.7
Buffer pool	acres	1,294.0
Spillway crest	acres	6,630.0
Spillway design surcharge Level (1941)	acres	8,769.5
Revised Standard Project Flood (1969)	acres	9,295.4
Top of dam	acres	10,885.0
Revised Probable Maximum Flood (1969)	acres	12,350.0**
Capacity, gross (March 1980 Survey)		
Debris pool	ac-ft	4,474 (0.04*)
Buffer pool	ac-ft	8,915 (0.07*)
Spillway crest	ac-ft	196,235 (1.63*)
Spillway design surcharge Level (1941)	ac-ft	295,581 (2.46*)
Revised Standard Project Flood (1969)	ac-ft	319,967 (2.66*)
Top of dam	ac-ft	393,806 (3.27-)
Revised Probable Maximum Flood (1969)	ac-ft	444,000 (3.69*)**
Allowance for sediment (50 year)	ac-ft	12,000 (0.10*)
Dam: - Type		Earth-fill
Height above original streambed	ft	106
Top length	ft	2,280
Top width	ft	30
Design Freeboard (1941)	ft	10
Spillway: - Type		Ungated ogee
Crest length	ft	1,000
Crest elevation	ft., m.s.l	543
Design surcharge (1941)	ft	13
Design discharge (1941)	cfs	181,000
Outlets:		
Uncontrolled (NOTE: Both uncontrolled outlets are plugged)		
Number and size		2-5.5' diameter
Entrance invert elevation	ft., m.s.l	462
Controlled		
Gate type		Vertical lift
Number and size		6- 7'W x 12'H
Entrance invert elevation	ft., m.s.l	460
Conduits		
Number and size		2-13.5'W x 13.5'B
Length	ft.	750
Maximum capacity at spillway crest	cfs	17,000
Regulated capacity at spillway crest	cfs	5,000
Revised Standard Project Flood (1969):		
Duration (inflow)	Days	4
Total volume	ac-ft	574,000 (4.77*)
Maximum Water Surface Elevation	ft., m.s.l	558.71
Inflow peak	cfs	317,000
Outflow peak	cfs	239,000
Revised Probable Maximum Flood (1969):		
Duration (inflow)	Days	6**
Total volume	ac-ft	1,543,000 (13.05*)**
Maximum Water Surface Elevation	ft., m.s.l	572.71**
Inflow peak	cfs	700,000**
Outflow peak	cfs	617,000**
Historic maximums:		
Maximum discharge on record	cfs	5,992
Date		2-22-80
Maximum water surface elevation	ft., m.s.l	528.0
Date		2-22-80
Maximum inflow (1 hour average)	cfs	76,918
Date		1-25-69

*   inches of runoff over watershed
** NOTE: Dam is over-topped

EXHIBIT C

Finding of No Significant Impact (FONSI)

DEPARTMENT OF THE ARMY

LOS ANGELES DISTRICT CORPS OF ENGINEERS

FINDING OF NO SIGNIFICANT IMPACT

CARBON CANYON DAM WATER CONTROL MANUAL

ORANGE COUNTY, CALIFORNIA

I have reviewed the attached Environmental Assessment (EA) prepared for the Carbon Canyon Dam Water Control Manual Project, Orange County, California. The current Water Control Manual (WCM) was revised in 1989 to allow for increasing flood elevation levels within the basin due to urbanization. The gate operation will still allow for 1,000 cubic feet per second (cfs) to pass through the outlet works based on an authorized release schedule, while not exceeding the capacity of the downstream channel.

No major physical or regulation constraints exist at the project. Notable changes, however, have taken place or been made in the past, mainly regarding sedimentation and clogging of gates from debris. Revisions to the reservoir regulation schedule have been made to alleviate sedimentation problems in the vicinity of the gates and trash rack. Originally both gates remained closed during normal standby operations. This prevented the occurrence of small stagnant pools at the outlets, as well as reducing sediment build up and gate corrosion, and provided for an easier silt cleaning operation at the intake channel. Gate openings were alternated.

During falling stages, the original schedule called for a progressive gate closing from elevation 425 feet to the gate sill elevation of 403 feet. The schedule was revised to keep both gates set at 0.9 feet during falling stages below elevation 425 feet so that the reservoir could be drained more rapidly.

I have considered possible impacts of implementation of the revised WCM on the environment, including those, associated with significant resources as discussed in the Environmental Assessment. No significant adverse impact to vegetation or wildlife at Carbon Canyon Dam will occur. Riparian and other habitats have been subjected to inundation under the previous operations schedule. These habitats will be susceptible to inundation of slightly greater depth and duration under the revised WCM. Under the proposed revisions, water surface elevation levels for a short period of time will generally be 0.4 to 3.9 feet greater than under existing conditions. For any given flood event this increased inundation will affect less than two additional acres of habitat in the basin; therefore, no significant adverse impacts will be associated with the revised schedule.

Implementation of the revised WCM will not affect the continued existence of any endangered or threatened wildlife or plant species.

The historic trash dump located within the debris pool has been previously subjected to temporary inundation and has not been affected. This situation only occurs in periods of extreme flooding conditions. Impacts to the trash dump are not expected to occur.

I have considered the available information contained in the EA, and it is my determination that the proposed project will not result in a significant effect on the existing environment. Therefore, preparation of an Environmental Impact Statement (EIS) is not required.

3 Dec 90
DATE

CHARLES S . THOMAS
Colonel, Corps of Engineers
District Engineer

EXHIBIT D

Chain of Correspondence for Approval of Water Control Manual

CESPD-ED-W (CESPL-ED-HR/22 Feb 90) (1110-2-240b) 1st End Krhoun/dh 705-1433
SUBJECT: Carbon Canyon Draft Water Control Manual

DA, South Pacific Division, Corps of Engineers, 630 Sansome Street, Room 720, San Francisco, Calif 94111-2206

30 APR 1990

FOR Commander, Los Angeles District, ATTN: CESPL-ED-HR

1. Subject manual has been reviewed and two editorial comments were furnished to Mr. Robert Stuart in a FONECON on 24 April 1990. The manual is approved for final printing. Please furnish this office four copies of the final manual.

2. It is noted that the manual indicates that there is a sediment deposition rate into the reservoir which has been greater than the design rate. The District should take appropriate action to ensure the sediment buildup does not impact the available flood control space.

3. In addition, this office is concerned that the emergency communications capability of Carbon Canyon Dam and the other Corps dam tenders are somewhat limited. The District should provide hand-held radios to each project. These hand-held radios should provide not only the capability to communicate with each other, but they should provide the ability to communicate with appropriate local authorities (Police, etc.). This would greatly improve upon the present system which allows only radio communication with the district office and back-up consisting of telephone.

FOR THE COMMANDER:

wd encl

Walter C. Day
for JAY K. SOPER
Director of Engineering

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325

REPLY TO
ATTENTION OF

CESPL-ED-HR (1110-2-240b) 22 February 1990

MEMORANDUM FOR Commander, South Pacific Division
Attn: CESPL-ED-W (Frank Krhoun)

SUBJECT: Carbon Canyon Draft Water Control Manual

1. Enclosed are three copies of the Carbon Canyon Dam Draft Water Control Manual prepared in accordance with ETL 1110-2-251.

2. The Finding of No Significant Impact (FONSI) and the Environmental Assessment for the Water Control Manual are being finalized and will be transmitted to you before March, 1990.

3. If there are any questions, please contact Boniface Bigornia of the Reservoir Regulation Unit at (213)894-6916.

FOR THE COMMANDER:

Encl

for ROBERT E. KOPLIN, PE
Chief, Engineering Division