US Army Corps
of Engineers®

WATER CONTROL MANUAL

SEVEN OAKS DAM & RESERVOIR
SANTA ANA RIVER, SAN BERNARDINO COUNTY, CALIFORNIA

September 2003

Seven Oaks Dam
Santa Ana River Basin, California
September 2003

Pertinent Data

Construction Completed		September 1999
Stream System		Santa Ana River
Drainage Area	sq. mi	177
Dam		
Type		Earth and Rock Fill
Height above Original Streambed	feet	550
Crest Length	feet	2,760
Design Freeboard	feet	5.3
Reservoir		
Elevation		
Streambed	feet, NGVD	2,060
Debris Pool	feet, NGVD	2,200*
Top of Flood Control	feet, NGVD	2,580
Top of Spillway	feet, NGVD	2,580
Top of Dam	feet, NGVD	2,610
Area - (Based on year 1999 survey)		
Debris Pool	acres	79.2
Top of Flood Control	acres	801.6
Top of Spillway	acres	801.6
Top of Dam	acres	1,066.8
Capacity - (Based on year 1999 survey)		
Debris Pool	acre-feet	3,127.66
Top of Flood Control	acre-feet	147,969.67
Top of Spillway	acre-feet	147,969.67
Top of Dam	acre-feet	174,609.23
Spillway		
Type		Trapezoidal Rockcut w/ Concrete Sill
Total Width	feet	500
Outlet Works - Multi-level Intake Structure (MLS)		
Controlled Outlet Gates		
Regulating Outlet (RO) Gate type		Vertical Lift
Number and size		2 - 5'W x 8.5'H
Emergency RO Gate type		Vertical Lift
Number and size		2 - 5'W x 8.5'H
Low Flow (LF) Gate type		Vertical Lift
Number and size		1 - 2'W x 3.5'H
Emergency LF Gate type		Vertical Lift
Number and size		1 - 2'W x 3.5'H
Conduits		
Pressure Conduit		1 - 7'W x 13.5'H / 18' Diameter
Conduit Length	feet	60 / 875
Horseshoe Section		1 - 23'W x 18'H
Conduit Length	feet	45
Downstream of RO Gates		1 - 24'W x 10'H / 18'W x 9'H
Conduit Length	feet	120 / 540
Exit Channel		
Channel Length	feet	220
High Level Intake Elevation	feet, NGVD	2,265
Diversion Intake Elevation	feet, NGVD	2,100
Outlet Works - Minimum Discharge Line (MDL)		
Controlled Outlet Valves		
Minimum Discharge Line (MDL) Gate type		Cone / Ball Valves
Number and size		1 - 24" Ball Valve
Number and size		1 - 14" Cone Valve
Number and size		1 - 8" Cone Valve
Minimum Discharge Line Extension (MDLE) Gate type		Ball Valve
Number and size		1 - 24" Ball Valve
Reservoir Design Flood (General Storm)		
Total Volume (4-day)	acre-feet	115,000
Peak Inflow	ft^3/s	85,000
Peak Outflow	ft^3/s	7,000
Peak Water Surface Elevation	feet, NGVD	2,580
Probable Maximum Flood (General Storm)		
Total Volume	acre-feet	326,000
Peak Inflow	ft^3/s	185,000
Peak Outflow	ft^3/s	180,000
Peak Water Surface Elevation	feet, NGVD	2,604.7

* Debris pool elevation at start of project life. It will be adjusted gradually to elevation 2,300 feet, NGVD as sediment deposition occurs throughout the life of the project.

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
333 Market Street, Room 923
San Francisco, California 94105-2195

REPLY TO
ATTENTION OF:

CESPD-MT-E

16 DEC 2003

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

SUBJECT: Seven Oaks Dam Water Control Manual

1. Reference CESPL-ED-HR, memorandum, dated 1 December 2003, SAB.

2. The subject document submitted in the referenced memo for review is approved

3. Please provide this office with one copy of the final document.

FOR THE COMMANDER:

Marda Q Stothers

MARDA Q. STOTHERS
Chief, Engineering & Construction Division

WATER CONTROL MANUAL

SEVEN OAKS DAM AND RESERVOIR
SANTA ANA RIVER, CALIFORNIA

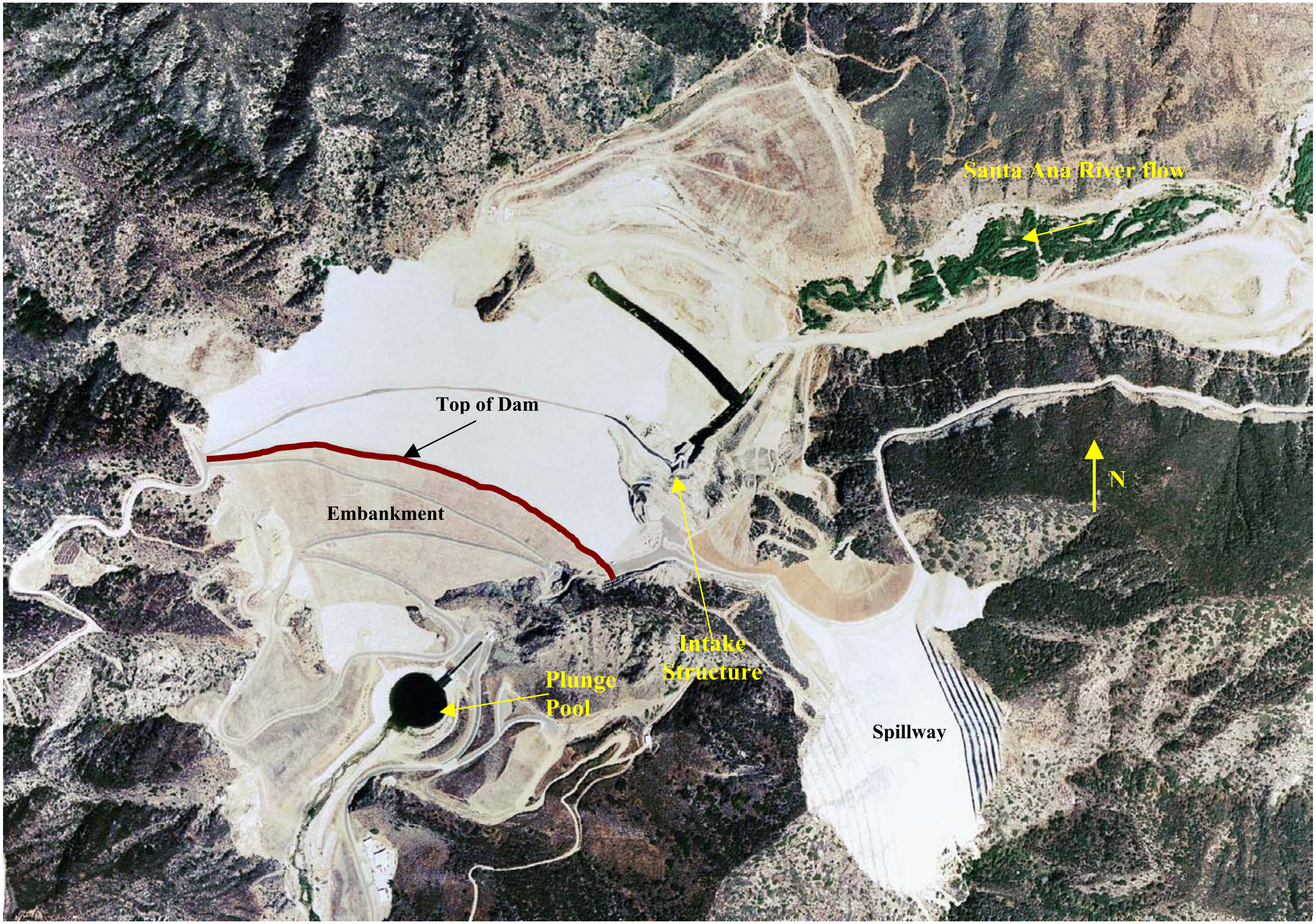
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SEPTEMBER 2003

Prepared by:

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Reservoir Regulation Section
CESPL-ED-HR



Aerial Photograph of Seven Oaks Dam and Reservoir

PREFACE

Seven Oaks Dam was constructed by the U.S. Army Corps of Engineers, which was completed in September 1999. The ownership of this project was turned over to the San Bernardino, Orange, and Riverside counties in October 2002.

About mid-way through the construction of the Seven Oaks Dam flood control project, the U.S. Fish and Wildlife Service listed the San Bernardino Kangaroo Rat (SBKR), which occupies the Santa Ana River downstream of the dam, in the Federal endangered species list. The listing prompted formal consultation with the U.S. Fish and Wildlife Service, in order to evaluate the possible effects of the dam's design and flood control operation plan on the SBKR and their habitat. During this time, the Interim Plan entitled " Seven Oaks Dam Interim Water Control Plan Prior to and During the Section 7 Consultation Period," was implemented, which was approved by the Corps' South Pacific Division in May 1999, and finalized in January 2000. Since Section 7 of the Federal Endangered Species Act prohibits the operation of the dam for its intended purpose of flood control during the consultation period, the Interim Plan's objectives were limited to dam safety and meeting the downstream water users' release requirements; however, due to the limited physical release capabilities of the dam, substantial incidental flood control benefits were still achieved during flood events.

The formal consultation with USFWS started in January 1998 and was concluded in the fall of 2002. In December 2002, the biological opinion was completed allowing official acceptance of the design document's water control plan as the final operation plan for Seven Oaks Dam, on the condition that the operation of the dam also include operation for sustaining the endangered species habitat. A discussion about "environmental operations" is included in section 7-05.h. A copy of the biological opinion has been included as part of this document as Exhibit J.

The San Bernardino County Flood Control District has the primary responsibility for the physical operation of the dam and the Orange County Public Facilities and Resources Department (OCPF&RD) will be mainly responsible for its regulation. The San Bernardino Flood Control District dam tenders reports to and receives instructions from the OCPF&RD water control managers. This manual was written to also reflect this arrangement. If a different working arrangement occurs at a later time, this document will be revised as necessary.

NOTICE TO USERS OF THIS MANUAL

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

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise, contact can be made by telephone to the U.S. Army Corps of Engineers, Los Angeles District Office, Reservoir Regulations Section at (213) 452-3623. During non-flood periods the contact can be made during regular business hours (0730 - 1600 Monday through Friday), during flood-events the office is staffed 24 hours a day, 7 days a week.

WATER CONTROL MANUAL

SEVEN OAKS DAM AND RESERVOIR
SANTA ANA RIVER, SAN BERNARDINO COUNTY, CALIFORNIA

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Exhibits

LIST OF ABBREVIATIONS

ac-ft	acre-feet
cfs	cubic feet per second
COE	Corps of Engineers
DOMSAT	Domestic Satellite
DSS	Data Storage System
EM	Engineering Manual
EOC	Emergency Operations Center of the U.S. Army Corps of Engineer (Constructions-Operations Division)
ER	Engineering Regulation
ERDC-WES	U.S. Army Engineering Research and Development Center
ETL	Engineering Technical Letter
ft	feet
GDM	General Design Memorandum
GOES	Geostationary Observational Environmental Satellite
HECDSS	Hydrologic Engineering Center Data Storage System
LAD	Los Angeles District
LATS	Los Angeles Telemetry System
LOU	Letter of Understanding
Manning's n	Manning's Roughness Coefficient
MOA	Memorandum of Agreement
OCPF&RD	Orange County Public Facilities and Resources Department (also known as Orange County Flood Control District)
OCWD	Orange County Water District
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
QPF	Quantitative Precipitation Forecast
RCFC&WCD	Riverside County Flood Control District and Water Conservation District
ROC	Reservoir Operation Center (LAD Engineering Division)
SAR	Santa Ana River
SARI	Santa Ana River Interceptor
SAWPA	Santa Ana Watershed Project Authority
SBCPW&FCD	San Bernardino County Public Works & Flood Control District (also known as San Bernardino County Flood Control District)
SPD	South Pacific Division
SPL	Corps of Engineers, Los Angeles District
SPF	Standard Project Flood
sq mi	square mile
TDS	Total Dissolved Solids
USACE	U.S. Army Corps of Engineers

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCDS	Water Control Data System
WSE	Water Surface Elevation
WSPA	Woolly Star Preserve Area Steering Committee

I. INTRODUCTION

I - INTRODUCTION

1-01 **Authorization**. This water control manual was prepared in compliance with the following authorities and directives:

Engineering Regulation (ER) 1110-2-240: Engineering and Design, Water Control Management, dated 8 October 1982.

Engineering Regulation (ER) 1110-2-241: Engineering and Design, Use of Storage For Flood Control and Navigation at Non-Corps Projects, dated May 1990.

Engineering Manual (EM) 1110-2-3600: Engineering and Design, Management of Water Control Systems, dated 30 November 1987.

Engineering Regulation (ER) 1110-2-8156: Engineering and Design, Preparation of Water Control Manuals, dated 31 August 1995.

Code of Federal Regulations, Title 33, Part 208.11, subparagraph d-4, entitled, "Water Control Plan and Manual".

The District Certification leading to approval of this manual is included in Exhibit K.

1-02 **Purpose and Scope**. The purpose of this manual is to provide the regulating policy for Seven Oaks Dam. This document also furnishes current information about the dam and reservoir and a description of the organizations responsible for collecting data and regulating the reservoir. This manual contains: (1) a brief description of the project and its history, (2) a description of the watershed characteristics, (3) a description of the data collection and communications network, (4) details of the reservoir regulation schedule, (5) a description of the U.S. Army Corps of Engineers, Los Angeles District's (SPL) organization, and (6) a description of the project owners' organizations, namely, the San Bernardino County Public Works and Flood Control District (SBCPW&FCD), the Orange County Public Facilities & Resource Department (OCPF&RD), and the Riverside County Flood Control District (RCFC&WCD). The project owners have joint ownership, regulation, and operation, and maintenance responsibilities for the project.

Issues that are directly or indirectly affected by the operation of Seven Oaks Dam are discussed in this water control manual. They include: (1) flood control, (2) dam safety, (3) mitigation of impacts to downstream water users, (4) environmental concerns and (5) the prototype testing program. Topics that are relevant to the operation of the dam under the plan contained in this manual are also discussed. They include (1) operational constraints, and (2) deviations from the approved water control plan.

The foregoing paragraphs set forth only the purposes and issues that are addressed in this Water Control Manual, in accordance with the regulations cited in paragraph 1-01 above. The U.S. Army Corps of Engineers does not intend the Water Control Manual to be used for any other purpose. As stated in paragraph 8-06 of this manual, "The Water Control Plan does not include regulation for water supply purposes." Any references in the manual to water supply, water conservation, or water rights should not be construed or used to imply any particular understanding or interpretation of water rights issues. This manual makes no determination of any water rights. This manual does not imply or intend to imply any rights by any agency or other party to water released through Seven Oaks Dam and the manual should not be applied for such purpose. This manual should not be construed or interpreted in any determination of prior or future water rights by any agency or other party and should not be applied in any adjudication of such water rights by any agency or other party. The U.S. Army Corps of Engineers does not endorse any use of the manual for any purpose beyond the purposes authorized in accordance with ER 1110-2-240, as stated in this section.

1-03 **Related Manuals and Reports**. Manuals and reports relevant to Seven Oaks Dam, Seven Oaks Reservoir, the drainage areas above and below Seven Oaks Dam, and significant hydraulic structures within these drainage areas are listed in Table 1-1. Copies of these reports are available in the Corps of Engineers, Los Angeles District (SPL) office in downtown Los Angeles.

1-04 **Project Owner**. Seven Oaks Dam was built by the Corps of Engineers for the purpose of flood control. Its ownership has been turned over to the local sponsors of the project, namely, San Bernardino, Riverside, and Orange Counties. These three counties are represented by their flood control agencies, as follows:

a. San Bernardino County Public Works and Flood Control District (SBCPWFCD). SBCPWFCD is responsible for providing public works including flood control and related services throughout San Bernardino County, California and its incorporated areas.

b. Riverside County Flood Control and Water Conservation District (RCFC&WCD). RCFC&WCD is responsible for the protection of people and property from flooding throughout Riverside County, California.

c. Orange County Public Facilities and Resource Department (OCPFRD). OCPFRD is responsible in providing, operating, and maintaining public facilities, and regional resources for the enjoyment, mobility, and protection of the people of Orange County, California.

1-05 **Operating Agencies**. The counties of San Bernardino, Orange, and Riverside are responsible for the operation and maintenance of the project. The operation, maintenance, repair, replacement, rehabilitation (OMRRR) and inspections of the dam and appurtenances, reservoir, and related facilities are to be performed in accordance with regulations and directions prescribed by the Secretary of the Army.

1-06 Regulating Agencies. The counties of San Bernardino, Orange, and Riverside will be jointly responsible for the regulation of Seven Oaks Dam. These counties are represented by their flood control agencies as listed in Section 1-04. As project regulators, the local sponsors are required to regulate the project in accordance with the Water Control Plan, which is contained in this manual. This regulation includes coordinating water control management efforts with the Corps of Engineers, and other federal, state and local agencies that are affected by impoundments within the reservoir or releases from Seven Oaks Dam. These agencies include, but are not limited to the following:

a. Corps of Engineers (COE). The COE was responsible for the design and construction of Seven Oaks Dam. Seven Oaks Dam falls under the jurisdiction of Section 7 of the Flood Control Act of 1944. Under Section 7 the COE is charged with the responsibility of prescribing regulations for the use of storage allocated for flood control at all reservoirs constructed wholly or in part with Federal funds. The COE is responsible for providing the flood control regulations and has the authority for final approval. During real-time operations, any deviation from the approved plan must be authorized by the COE.

b. U.S. Fish and Wildlife Service (USFWS). USFWS is responsible for the conservation, protection and enhancement of fish, wildlife, and their habitats within the Santa Ana River Basin.

c. California State Department of Fish and Game (CSDFG). CSDFG has regulatory responsibility for fishing and hunting activities as well as for protecting habitat and fauna within the Santa Ana River Basin.

d. Southern California Edison (SCE). SCE is one of the largest electric utilities in the United States and the largest subsidiary of Edison International. SCE provides electrical power to private homes, communities, cities, and businesses in Central and Southern California. SCE's power distribution network includes the Santa

Ana River Hydroelectric System, the operation of which affects small inflows into Seven Oaks Dam.

e. <u>California State Department of Water Resources Division of Safety of Dams (DSOD)</u>. DSOD was created by the California State Legislature in 1929 to provide supervision over non-federal dams in the State. DSOD has jurisdiction over all matters related to dam safety after the project is turned over and accepted by the local sponsors.

f. <u>Local Water Conservation Agencies and Water Users Groups.</u> The Bear Valley Mutual Water Company, San Bernardino Valley Water Conservation District, and the Northfork Water Company, along with other agencies, have immediate surface diversion water use downstream of the dam. The other agencies include the following: 1) Lugonia Water Company, 2) East Valley Water District, 3) Edwards Canal Company, 4) Redlands Water Company, 5) Crafton Water Company, 6) San Bernardino Valley Municipal Water District, 7) City of Redlands, 8) City of Highlands, 9) City of San Bernardino, 10) Arnott Citrus & Poultry, 11) Western Municipal Water District of Riverside County, and 12) numerous citrus growers and shareholders within the San Bernardino Valley.

Table 1-1. Seven Oaks Dam Water Control Manual Related Manuals, Reports and References

No.	Title	Date
1	Review Report on the Santa Ana River Mainstem, including Santiago Creek and Oak Street Drain	February 1976
2	Phase I General Design Memorandum on the Santa Ana River Mainstem, including Santiago Creek	January 1982
3	Upper Santa Ana River Flood Storage Alternative study, Supplement to Phase I GDM on the Santa Ana River Mainstem, including Santiago Creek	April 1989
4	Phase II GDM on the Santa Ana River Mainstem, including Santiago Creek, Volume 4, Mill Creek Levee	August 1988
5	Phase II GDM on the Santa Ana River Mainstem, including Santiago Creek, Volume 5, Oak Street Drain	August 1988
6	Phase II GDM on the Santa Ana River Mainstem, including Santiago Creek, Volume 7, Hydrology	August 1988
7	Phase II GDM on the Santa Ana River Mainstem, including Santiago Creek, Volume 9, Economics & Public Comment & Response	August 1988
8	Water Control Manual for Carbon Canyon Dam & Reservoir, Santa Ana River, California	December 1990
9	Water Control Manual for San Antonio Dam & Reservoir, Santa Ana River, California	May 1991
10	Feature Design - Seven Oaks Dam, Floodway Delineation	August 1991
11	Feature Design - Lower Santa Ana River, Interior Flood Control	December 1991
12	Feature Design - Seven Oaks Dam Outlet Works	July 1991
13	Feature Design - Lower Santa Ana River, Construction Materials	June 1991
14	Basis for Design – San Timoteo Creek	May 1994
15	Feature Design - Seven Oaks Dam, Embankment and Spillway	February 1993
16	Feature Design Memorandum No.2 Seven Oaks Dam Floodway Delineation (Including 500 Year and Seven Oaks Dam Failure Floodplains)	August 1991
17	Water Control Manual for Prado Dam & Reservoir Santa Ana River, California	September 1994
18	Santa Ana River, Seven Oaks and Prado Dams Probable Maximum Flood Update	August 2001
19	Final Biological Assessment Seven Oaks Dam, Santa Ana River Mainstem Project, San Bernardino County, California	August 2000

II. DESCRIPTION OF PROJECT

II - DESCRIPTION OF PROJECT

2-01 Location. Seven Oaks Dam is located at a narrowing of the Upper Santa Ana Canyon about 1 mile upstream from the canyon mouth, and is 8 miles northeast of the city of Redlands in San Bernardino County, California. The geographic coordinates of the dam are 34°07'04" North Latitude and 117°05'52" West Longitude. Plate 2-01 shows the general location of the dam.

2-02 Purpose. Seven Oaks Dam serves as a principal regulating structure located on the upper Santa Ana River. It was constructed for the purpose of providing flood control protection to portions of San Bernardino, Riverside, and Orange Counties, California. It has a design storage capacity of 147,970 acre-feet at the spillway crest elevation of 2,580 feet, NGVD, of which 32,000 acre-feet is allocated for 100 years of estimated sediment accumulation. Its flood control plan is designed to work in conjunction with the flood control plan of Prado Dam, a Corps owned project, located 36.7 miles downstream on the Santa Ana River within the Lower Santa Ana Canyon.

2-03 Physical Components. The Seven Oaks Dam project consists of an embankment, outlet works (multi-level intake structure, high level intake structure, minimum discharge line, gate chamber, outlet tunnel and exit channel, and plunge pool), spillway, and reservoir. General plans for these specific features are shown on Plate 2-02. The following paragraphs provide a brief description of specific components of the project.

a. Embankment. The embankment is a zoned earth-and-rock-fill dam with a maximum height of 550 feet above the pre-existing streambed at the dam axis and 650 feet above the lowest foundation bedrock contact. The dam crest is 40-feet wide, 2,760-feet long and has a minimum crest elevation of 2,610 feet, NGVD. The dam crest incorporates a 3-foot maximum camber in anticipation of crest settlement. The upstream slope of the dam is 1V on 2.2H, and the downstream slope is 1V on 1.8H, except where the slopes were made locally steeper to 1V:1.5H for the access roads across the embankment faces. The alignment of the embankment arches upstream to provide suitable abutment contacts to bedrock while optimizing the embankment geometry at the dam site.

Photo 2-1. Embankment Construction

The embankment section is designed to produce a conservatively safe dam while utilizing the materials available at the site (Photo 2-1). The impervious central core extends from bedrock to within 10 feet of the crest of the dam. The top width of the core is 16 feet and the base width is approximately one-third of the maximum hydrostatic head. Upstream of the core is a filter zone of minus 2-inch well-graded cohesionless alluvium to seal internal cracks which might develop due to differential settlement. The upstream shell consists of free-draining minus 12-inch alluvial materials processed from the downstream pervious borrow area, with an outer layer of oversized stones. The downstream transition zone consists of unprocessed rock excavated from the spillway and Government Canyon Ridge (photo 2-2), with an outer layer of oversized stones from the pervious borrow area. Embankment zoning provides resistance to concentrated leaks by placing high strength and erosion resistant materials at the outer shells. Embankment sections and details are shown on Plates 2-03 and 2-04.

Photo 2-2. Looking Upstream from Top of Intake Tower towards Government Canyon Ridge

b. <u>Outlet Works</u>. The outlet works is located in the left abutment (looking downstream) and includes the following features: intake structure, upstream outlet tunnel, mid-tunnel gate control chamber with emergency and service slide gates, downstream outlet tunnel and exit channel, access structure, plunge pool, valve structure, minimum discharge line (MDL), and MDL extension line (MDLE). The general plan and profile of the outlet works are shown on Plate 2-05. Plate 2-05A shows the plan view of the system layout of the entire outlet works.

(1) <u>Intake Structure</u>. The inclined concrete intake structure is approximately 200 feet high and consists of a high-level intake on the left side (looking downstream) and a multilevel intake on the right side. Other components of the intake structure are: 1) access bridge, 2) high-level intake and trash structure, 3) main wet well, 4) maintenance bulkhead gate, 5) aggregate sluice gate, 6) multilevel withdrawal system (MWS), 7) MWS trashracks, 8) MWS intake ports, 9) MWS stoplogs, 10) MWS stoplog lifting beam, 11) aggregate access passage, 12) maintenance bulkhead gate, 13) accelerograph chamber, 14) regulating outlet (RO) air vent, 15) minimum discharge line (MDL) air vent, 16) wet well inspection beam, 17) MDL bulkhead gate, and 18) anchorage system. Details of the intake structure are shown on Plate 2-06.

i. <u>Main Level Intake Structure (MLS)</u>. Also known as the high level intake structure, the MLS is a tower with a 36-foot inside diameter wet well and is designed for passing flows at high reservoir pool elevations during the initial life of the project. Flows enter the wet well through a trash structure at the top of the tower. As the expected sediment deposition in the forebay rises to elevation 2265 feet, NGVD, the multilevel withdrawal intake structure (MWS) will no longer be functional and the MLS will be used for all discharges. The MLS is shown on Photo 2-3.

Photo 2-3. Intake Tower - MLS (on left) and MWS (on right)

ii. <u>Multilevel Withdrawal System (MWS)</u>. The MWS consists of a wetwell with multiple levels of ports (as shown on Photo 2-3) to pass flows at low elevations and avoid dead storage prior to the expected sediment deposition reaching elevation 2265 feet, NGVD. There are 18 pairs of MWS ports and each port measures 27 inches in diameter. The port pairs are spaced vertically at 10-foot intervals starting at centerline elevation 2104.24 feet, NGVD. Over the life of the project, the ports will be blocked with stoplogs (stoplogged) as the sediment deposition level rises in order to minimize the amount of sediment entering the outlet works. The design documents recommend stoplogging the ports that are within 20 feet to 30 feet of the current sedimentation level. The stoplogs are designed to be removable, thus providing the capability of dewatering the sediment pool after each flood season. Prior to the flood season of 2000, the first two rows of ports were stoplogged. The invert of the next row of ports is at elevation 2120.24 feet, NGVD, so the initial sediment pool is about 20 feet deep. A 6-foot x 6-foot rectangular passage controlled by a sluice gate connects the MLS wet well and the MWS wet well at their invert elevations (see Plate 2-07).

iii. <u>Wet Well Sluice Gate</u>. The wet well sluice gate is located in the multilevel withdrawal system wet well at the entrance to the 6'x6' passage that leads to the main wet well. The sluice gate was incorporated into the design of the outlet works to minimize the amount of sediment entering the main tunnel. The steel MDL pipeline was designed to carry the majority of sediment laden flows, thus preserving the invert of the main tunnel. When the MDL is being used and releases from the main outlet gates (LF and RO gates) are not necessary, water is prevented from entering the main tunnel by the sluice gate. The sluice gate is to be open when the pool is below the high level intake (El 2265 feet, NGVD) and the required discharges are greater than 90 cfs. It is intended to be either fully closed or fully opened and it not designed for throttling. Section 7-06.b. outlines the procedures for operating the sluice gate prior to and after the use of the main tunnel for releases. Plate 2-08 shows the details of the sluice gate. (**Note:** *The sluice gate is operated only when no more than 2.5 feet of head differential exists between the MWS and MLS* *wet wells. Piezometer readings in each wet well are used to determine when the required head differential is achieved to operate the sluice gate, see Section 7-06.a.)*

(2) **<u>Gate Area</u>**. The gate area consists of a 50-foot diameter concrete gate chamber dome and the gate passages beneath it. This area is located in the bedrock of the abutment about 1,117 feet downstream of the intake. The main components in the gate area are: (1) RO passages, (2) main RO gates, (3) emergency RO gates, (4) low-flow trashracks, (5) low-flow passage, (6) low-flow main gate, (7) low-flow emergency gate, (8) MDL ball valve, (9) upstream outlet tunnel fill line, (10) airshaft, (11) airshaft access door, (12) 10-ton bridge crane, (13) 5-ton monorail hoist, (14) hydraulic power unit, (15) motor control center, and (16) drainage system. The gate chamber is shown in detail on Plates 2-09 to 2-10. Components relevant to water control operation are described as follows:

i. **<u>Regulating Outlet Gates (RO Gates)</u>**. Flows from the main pressure conduit are regulated by the RO gates and/or the low flow gate. Each of the two hydraulically operated service RO slide gates each control a gate passage that measures 5 feet wide by 8.5-feet high. Upstream of each service RO gate is an identical emergency RO gate that controls the same passage. The minimum gate opening for the service RO gates is 9 inches (0.75 ft) in order to eliminate the possibility of vibration damage due to shifting control at the gate lip caused by high velocities at low openings. Conversely, a maximum gate opening of 6.8 feet (roughly 80 percent opening) is required in order to maintain control at the gate and to minimize the possibility of pressurizing the downstream passage and causing cavitation damage to the concrete. A single service RO gate can pass approximately 58 percent of the 8,000 cfs design discharge with reservoir surface at elevation 2580 feet, NGVD at the maximum gate opening of 80 percent. The service RO gates are used for discharges ranging between 500 cfs to 8,000 cfs. The emergency RO gates are intended to either be fully open or completely closed. Plates 2-09A and 2-11 show the details of the RO gates.

Photo 2-4. RO and LF Gates - Hydraulic Cylinders Inside the Gate Chamber

ii. Low Flow Gate (LF Gate). The service low flow gate is a hydraulically operated slide gate controlling a passage that measures 2 feet wide by 3.5 feet high. The service low flow gate is designed to eliminate the need to operate the service RO gates at less than their required minimum opening of 9 inches (0.75 ft). In addition, the service low flow gate provides flexibility in gate operation since it can be used with the MDL for release during low flows. An identical low flow emergency gate is located in the same passage immediately upstream of the service low flow gate. The minimum gate opening for the service low flow gate is 6 inches, and its maximum opening is limited to 3.0 feet. The reasons for the minimum and maximum gate openings are the same as those given for the RO gates above. The low flow gate is intended to discharge flows ranging from 90 cfs to 500 cfs. Plates 2-09A and 2-12 show the details of the low flow gate.

iii. Minimum Discharge Line (MDL). The MDL is used for small discharge rates. The pipe component of the minimum discharge line is a 3-foot-diameter steel pressure pipe originating at the invert of the MWS wet well. The MDL is regulated by two, fixed cone valves (an 8-inch and a 14-inch) housed in a valve structure located at the downstream end of the MDL on the left side (looking downstream) of the exit chute. The MDL passes discharges up to a maximum of 90 cfs. A 24-inch-diameter ball valve is provided in the mid-tunnel gate chamber to provide emergency closure and to dewater the downstream portion of the conduit prior to inspection and/or maintenance. Refer to section 7-06.d. for procedures to dewater the MDL conduit downstream of the ball valve. Plates 2-09A, 2-13 and 2-14 show the layout and details of the MDL conduit.

iv. Upstream Outlet Tunnel Fill Line (Recharge Line). This is a 12-inch diameter steel pipe between the MDL and the upstream outlet tunnel. The line is opened and closed with a 12-inch diameter manual butterfly valve, which is located within the upstream portion of the gate chamber (Photo 2-5). The fill line is used to fill the upstream tunnel and the main intake wet well in order to balance the head between the MWS and MLS for sluice gate operation (refer to Section 7-06.b. for operating the sluice gate). The Fill Line is also used to equalize pressure for the maintenance bulkhead gate installation. Plate 2-09A shows the recharge line.

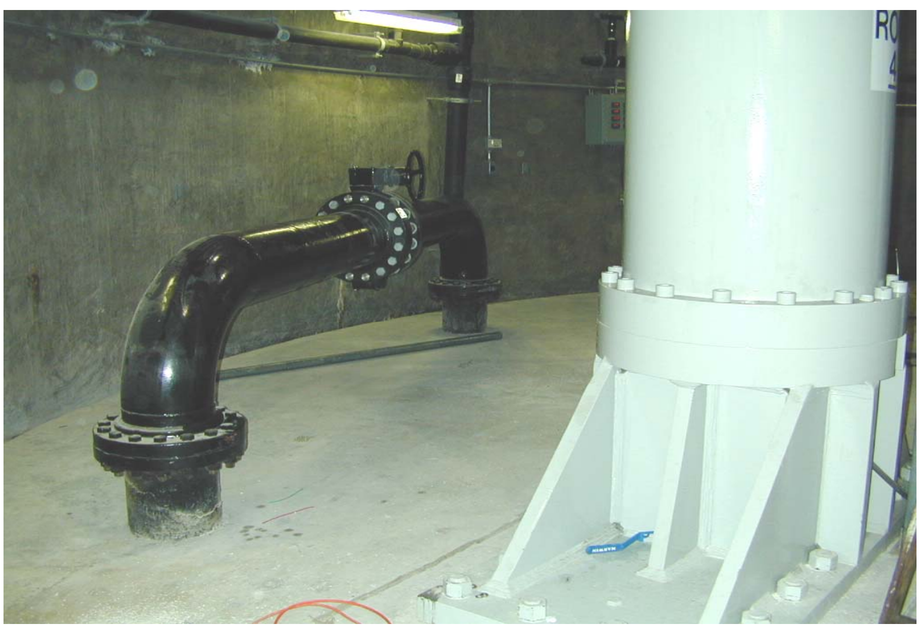


Photo 2-5. Upstream Outlet Tunnel Fill Line

(3) **Upstream Outlet Pressure Conduit, Mid-Tunnel Gate Passages (RO and LF Conduits)**. The tunnel conduit upstream of the gates is designed for an internal hydrostatic pressure due to an SPF event at El. 2575. The conduit transitions from a 7-foot-wide by 13.5-foot-high section at the intake tower to an 18-foot-diameter section over a length of 60 feet. The 18-foot-diameter circular portion has a total length of 875 feet. The conduit then transitions to an 18-foot-high by 23-foot-wide modified horseshoe section over 45 feet to the upstream ends of the splitter piers that separate the RO and low flow gate passages. At the maximum design discharge of 8,000 cfs, the average velocity in the 18-foot-diameter conduit is 31.4 feet per second. The absolute roughness value used for the design was 0.0005 feet. The two 5.5-foot-wide splitter piers divide the flow symmetrically into two 8.5-foot-high by 5-foot wide RO passages on the outsides and one 3.5-foot high by 2-foot wide low flow passage in the center over a length of 38.5 feet. Conventional one on three elliptical curves were used for the roof and inner side curves on the entrances to the gate passages. These curves form the pier end curves. The service RO gates are 34.5 feet downstream of the upstream end of the piers. The main outlet tunnel profile is shown on Plate 2-15. The upstream outlet conduit features are shown on Plate 2-16.

(4) **Downstream Conduit.** Downstream of the RO gates, the main tunnel conduit transitions from a 24-foot-wide by 10-foot-high channel to an 18-foot-wide 9-foot-high channel over a length of 120 feet. From this point the 18-foot-wide by 9-foot-high downstream conduit extends 540 feet. At station 28+60, the roof of the downstream conduit ends and the exit channel continues to station 30+80 where it terminates and the flow passes though baffle blocks before dropping into the plunge pool energy dissipator. Details of the downstream outlet conduit and exit channel are shown on Plates 2-17 to 2-19.

(5) **Access Structure**. The concrete access structure is located above the downstream outlet tunnel at the tunnel portal. This structure is 22-feet wide by 30-feet long, and 10.5-feet high, and serves as the entrance to the gate chamber via the access way. It also houses the intake and filters for the gate chamber ventilation

system; project power distribution panel boards; a remote control cabinet for remote operation of the RO gates, the LF gates, the MDL cone valves, and the MDLE ball valve; electric incinerating toilet, and other electrical control and communication items. The entrance door may be opened up to 8 feet wide to install or remove large items if necessary. The access structure is shown on Plate 2-18.

(6) Energy Dissipator. The energy dissipator consists of 1) a plunge pool apron located immediately downstream of the exit channel (Plate 2-19), and 2) a preformed plunge pool located immediately downstream of the plunge pool apron. The exit channel ends with an 8.7 foot vertical drop to the top of the plunge pool apron. From this point the 105 foot wide plunge pool apron slopes downwards on a 1V on 3H slope in the direction of flow. It is designed to prevent the undercutting of the outlet channel. A vertical wall at the toe of the apron extends from elevation 1,990 feet, NGVD to 1,980 feet, NGVD to prevent the undermining of the apron from return flows (see Plate 2-21). The preformed plunge pool was designed based on a maximum discharge of 8,000 cfs. It is composed of a roughly hemispherical excavation partially lined with 5-foot to 6-foot diameter rock protection. The rock protection covers the bottom and sideslopes of the plunge pool and extends from the apron downstream for about 100 feet. The protection has a blanket thickness of 10 to 12 feet from elevation 1986 feet, NGVD to 1974 feet, NGVD. Downstream of the rock protection, the preformed plunge pool runs for approximately 250 feet on a 1V to 10H slope, then daylights with the natural river channel. The left and right bank of the plunge pool between elevations 2,000 and 2,020 feet, NGVD are lined with a 4-foot thick layer of 1-foot to 3-foot diameter riprap stone from the apron top to the point of daylight with the natural river. The plunge pool apron and the plunge pool are shown on Plates 2-20 to 2-22.

Photo 2-6. Looking Downstream at the Plunge Pool from Top of Embankment

(7) <u>Valve Structure</u>. The concrete valve structure is located on the left (looking downstream) side of the end of the downstream exit channel. It is 20-feet wide by 23-feet long and houses the two MDL cone valves. The interior of the valve structure can be accessed by a steel stairway on the exterior of the building or by a roof hatch. The valve structure is shown on Plate 2-23.

(8) <u>Minimum Discharge Line Extension (MDLE)</u>. The MDLE extends the MDL from the retaining wall next to the valve structure to the MDL energy dissipation structure which is located downstream of the plunge pool. The components of the MDLE are: (1) MDLE extension pipeline, (2) MDLE 24-inch ball valve (3) MDLE orifices, and (4) MDLE dissipation structure. The MDLE allows flows to be diverted around the plunge pool. The 24-inch ball valve will either be fully open or fully closed, and cannot be operated like the cone valves for setting desired controlled releases. The MDLE ball valve shall not be operated for flood control.

(9) <u>Hydraulic Instrumentation</u>. Two systems of hydraulic instrumentation are installed at Seven Oaks Dam, namely: 1) operational instrumentation and 2) prototype testing instrumentation. The operational instrumentation system provides information that is used in real-time operation, while the prototype testing instrumentation system is used to collect information for a testing program developed to monitor and evaluate the hydraulic performance of the outlet works, and at the same time, verify the parameters used in its design. Both instrumentation systems consist of a combination of pressure transducers and piezometers. The pressure transducers measure pressure fluctuations with flush-mounted electronic pressure transmitters. The pressure transducers are installed in steel mounting boxes embedded flush with the concrete surface of the outlet conduit. The piezometers, which are connected to a manifold located in the gate chamber, measure piezometric head. The piezometer taps are installed in steel mounting plates embedded flush with the mass concrete of the outlet works. In some locations the shape of the piezometer mounting plate matches the shape of the curved concrete surface. The taps are connected to the piezometer manifold with ½-inch conduits.

During testing of the outlet releases, the transmitters for the prototype testing would be connected to a portable processing unit that is brought to the site by the Corps Research and Development Center (ERD-WES) personnel. The operational instrumentation transmitters are connected to digital display panels in the access structure in the valve structure and also relayed to the displays on the remote control cabinet (RCC) in the access structure for real-time operation. The layout for both operational and testing instrumentation system is shown on Plate 2-24.

i. <u>Operational Hydraulic Instrumentation</u>. The operational hydraulic instrumentation consists of eight piezometers connected to pressure transducers, and two of the pressure transducers are connected directly to the MDL immediately upstream of the cone valves. The piezometers measure the piezometric head in the forebay, the main wet well, the MWS wet well, and in the main conduit upstream of the RO and the low flow gates. The pressure transducers measure hydrostatic pressure immediately upstream of both cone valves in the MDL. As stated in the previous paragraph, readings obtained by the pressure transducers are transmitted to a digital display panel located in the gate chamber and in the remote control cabinet located in the access structure. Pressure transducer readings can be obtained from readouts in the valve structure and also in the remote control cabinet in the access structure. The operational instruments are listed on Table 2-1.

Table 2-1. Operational Instrumentation Facilities
Seven Oaks Dam Outlet Works

Instrument Number	Type of Instrument *	Location	Station	Elevation (Tap Inlets)	Elevation (Instrumentation)
O-1	Z	Forebay, Outside Face of Tower	11+47	2260	2099.1
O-2	Z		11+32.5	2190	2097.2
O-3	Z		11+05	2120	2099.1
O-4	Z	Main Wet Well	11+15	2120	2097.2
O-5	Z	MWS Wet Well	11+16	2120	2097.2
O-6	Z	ROG 1	21+87.0	2083.4	2099.1
O-7	Z	LF 1	21+82.5	2078.4	2097.2
O-8	Z	ROG 2	21+87.0	2083.4	2099.1
O-9	PT	@ 8-inch Valve	-	2048.4	2048.4
O-10	PT	@ 14-inch-Valve	-	2048.4	2048.4
* Z denotes piezometers. PT denotes pressure transducers.					

The piezometer pressure transmitters are located in the gate chamber and installed in two rows (Photo 2-7), the first row at elevation 2097.2 feet, NGVD, and the second row at 2099.1 feet, NGVD. These are the reference elevations of transmitters. Each transmitter is connected to the operational piezometer manifold by heavy Tygon tubing. The transmitter converts water pressure from the piezometer into digital data which is relayed by an electrical circuit to the electronic display panel. When a piezometer tap is not submerged, the digital display panel shows the reference elevation of the pressure transmitter for that particular piezometer. Once a piezometer tap is submerged during flood events, the digital display panel reads the measured piezometric head at that point in outlet works where the piezometer tap is located.

The fluctuation of the water level above and below a piezometer tap location could trap air in the piezometer line. Pockets of air will cause an error in the pressure reading and must be bled from the line prior to taking the initial piezometer reading. This procedure is called “Bleeding the Piezometer Lines” and is described in Exhibit E.

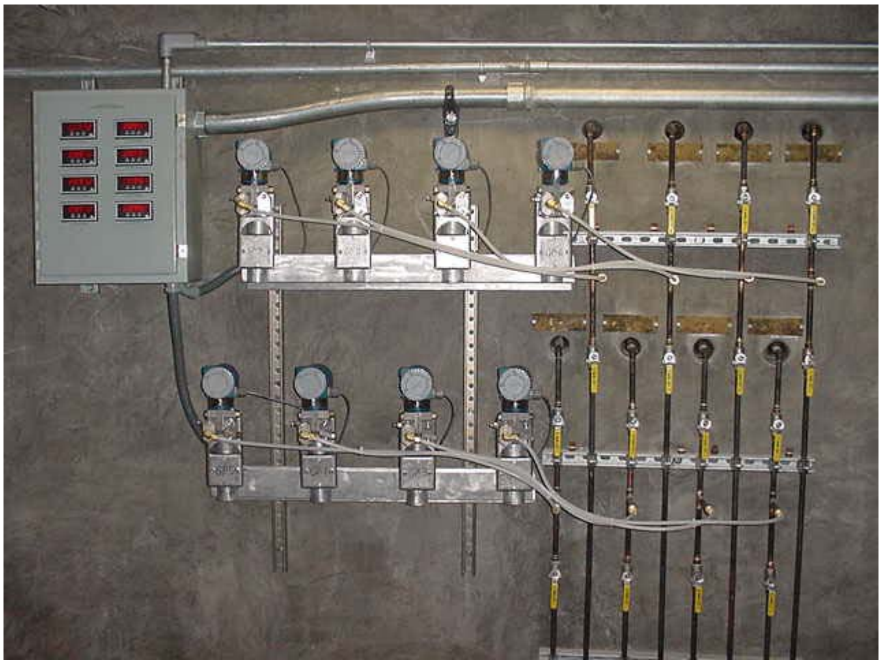


Photo 2-7. Piezometer Pressure Transmitters within Gate Chamber

ii. <u>Prototype Testing Instrumentation</u>. The second system of instrumentation is used in the prototype testing program developed and conducted by the Corps’ Waterways Experiment Station personnel. This instrumentation will allow the evaluation of the hydraulic performance of Seven Oaks Dam and to verify the parameters used in its design. The prototype testing instrumentation measures peizometric head, pressure fluctuations, air demand, and gate vibration in key locations of the outlet works structure. The layout of the prototype testing instrumentation is also shown on Plate 2-24. Exhibit F contains details of the prototype hydraulic instrumentation and the testing program.

c. <u>Spillway</u>. The spillway is 500-feet wide and 1,400-feet long, excavated into rock in a natural saddle on the east side of the dam. The trapezoidal spillway is unlined except for a 10-foot-wide by 10-foot-deep concrete control sill constructed transverse to the flow located 1,040 feet from the downstream end along the centerline. The sill is recessed across the spillway invert and extends up each side slope to elevation 2,610 feet, NGVD. The sill provides a control surface and a defense against degradation of the spillway invert in the event of spillway flow. The top of control sill across the invert is at elevation 2,580 feet, NGVD with an upstream approach channel adverse slope of 0.025 and a downstream channel slope of 0.02. The peak water surface elevation during a Probable Maximum Flood (PMF) event is estimated at elevation 2,604.7 feet, NGVD, which would produce a surcharge depth of 24.7feet. Plate 2-25 shows the spillway plan, profile and sections.

Photo 2-8. Looking Upstream During Spillway Excavation

d. <u>Reservoir</u>. The top of dam elevation of 2610 feet, NGVD was derived from routing the spillway design flood with the starting water surface elevation set at 50% of the flood control pool (EL 2604.4 feet, NGVD), plus 5 feet of freeboard. The calculated wave runup and wind setup were 3.6 feet, and 0.03 feet, respectively. The maximum fetch calculated for determining the wave runup was 1.10 miles long, resulting from a 72 mph wind of 15-minute duration. Based on the latest data (1999 survey), at the top of dam elevation of 2,610 feet, NGVD, the reservoir has a calculated area of approximately 1,066 acres and a gross capacity of approximately 174,609 acre-feet. Up to the spillway crest elevation of 2,580 feet, NGVD, the reservoir covers an area of approximately 801 acres, and has a calculated gross capacity of approximately 147,970 acre-feet. The gross capacity is the total reservoir storage capacity including the storage capacity allocated for sediment accumulation throughout the life of the project. The 100-year sediment allowance volume is approximately 32,000 acre-feet, which was determined based on data obtained from geomorphically similar areas within the San Gabriel Mountains. Plate 2-26 shows the Seven Oaks Dam reservoir, and Plate 2-27 shows the area and capacity curves computed based on the latest survey (1999). The latest storage capacity and area tables are included as part of Exhibit B.

2-04 <u>Related Control Facilities</u>. Big Bear Dam is the only existing structure that could affect flood flows in the Seven Oaks watershed. Big Bear Lake is a water conservation reservoir, owned by the Big Bear Municipal Water District. The lake has a drainage area of about 38 square miles and has storage of about 8,600 acre-feet between the top of the conservation pool and the top of the dam.

During times of low flow (generally the summer months), inflow and baseflow into the Seven Oaks reservoir can also be affected by the existing hydropower facilities located in the vicinity of the dam and reservoir. These facilities, which are owned and operated by Southern California Edison, include a system of flumes and hydropower plants, an access road, and transmission lines. At Edison Power House Number 1, the Santa Ana River flows upstream of Seven Oaks Dam are diverted into a new 42" dia. pressurized steel pipe buried 4 feet beneath the streambed upstream of the dam. At the dam, this flume line runs through the left abutment at elevation 2314 inside an existing Edison tunnel and daylights out downstream of the dam's embankment. Flows diverted through this pipeline bypass the dam and discharge at Edison Power House Number 3. When Southern California Edison does not divert water through this flume upstream of the dam, the flow is then received by the Seven Oaks reservoir. The diversion capacity of this flume is about 120 cfs.

2-05 Real Estate Acquisition. Approximately 2,736 acres of private land and 982 acres of Government lands were acquired for the overall project. The reservoir covers approximately 800 acres nearly all within the San Bernardino National Forest. A perpetual flowage easement that covers the reservoir and the area downstream of the spillway was acquired. It encumbers approximately 953 total acres, 892 of which are Government land owned by the U.S. Forest Service, and the balance of 61 acres are in three private ownerships. The approximate elevation at which the lands are owned in fee is 2599.3 feet, NGVD. The approximate taking line is at elevation 2603.9 feet, NGVD. All necessary lands for the flood control reservoir were acquired by a special use permit from the Forest Service without any transfer of accountability. The reservoir boundary is shown on Plate 2-26.

2-06 Public Facilities. Currently studies on recreational development at Seven Oaks Dam are not considered. This position is consistent with the U.S. Forest Service's Land and Resource Management plan. In the future, if there are any changes in the design operation and maintenance, especially in the even t of a water conservation pool being developed behind the dam, a re-evaluation of National Forest Management objectives within the project area will be undertaken.

The existing recreation setting of Seven Oaks is a relatively pristine natural area located within the San Bernardino National Forest. Recreational use of the canyon in the past has been low to moderate due to its restricted access. The site offers opportunities for hunting, fishing hiking, picnicking, backpacking and equestrian uses. The USFS recreation opportunities that will be compatible with the proposed design of an earth and rock filled dam with a seasonally operated debris pool. USFS prefers development with no hard structures such as picnic facilities and restrooms. The USFS plan emphasizes an ideal "natural" or "wilderness" recreation, accessible by foot traffic only. This bare minimum accessible trail will lead the public to hiking, fishing, and camping opportunities.

III. HISTORY OF PROJECT

III - HISTORY OF PROJECT

3-01 **Authorization**. Authorization for Seven Oaks Dam construction is contained in the Water Resources Development Act of 1986, 99th Congress, 2nd Session, P.L. 99-662. The authorization of the overall Santa Ana River Mainstem flood control project is contained in the report of the Chief of Engineers for the Santa Ana River Mainstem, including Santiago Creek, California, dated January 15, 1982. Except for the Mentone Dam feature of the project, the Secretary was authorized to plan, design and construct a flood control storage dam on the upper Santa Ana River. The authorization language in the PL 99-662 is as follows:

> *"The project for flood control, Santa Ana River Mainstem, including Santiago Creek, California: Report of the Chief of Engineers, dated January 15, 1982, at a total cost of $1,090,000,000, with an estimated first Federal cost of $809,000,000 and an estimated first non-Federal cost of $281,000,000, except that in lieu of the Mentone Dam feature of section 903(b) of this Act, the Secretary is authorized to plan, design, and construct a flood control storage dam on the upper Santa Ana River."*

3-02 **Planning and Design**. The Santa Ana River Phase I GDM submitted to Congress in September 1980 recommended in addition to other flood control features, the construction of a flood control dam (Mentone Dam), on the Santa Ana River. Mentone Dam was to be located just northwest of the City of Mentone and north of the City of Redlands, California. The estimated cost for Mentone Dam was $530,032,000 (October 1985 price levels). Due to considerable opposition to the dam based on project effects to existing water recharge facilities in the region, and esthetic considerations, the Assistant Secretary of the Army (Civil Works) recommended the authorization of the Santa Ana River Mainstem Project with the exception of Mentone Dam.

Congress directed the Corps to study alternatives to the previously proposed Mentone Dam under Section 1304 of the 1984 Supplemental Appropriations Bill. In accordance with further directives, the study was focused on upstream flood storage alternatives. Local interests also favored a study of upstream flood storage alternatives.

The Upper Santa Ana River Flood Storage Alternative Study, Supplement to Phase I GDM on the Santa Ana River Mainstem including Santiago Creek was completed in December 1985. The Upper Santa Ana River Dam, which was later renamed to Seven Oaks Dam, became the recommended alternative to Mentone Dam and was subsequently authorized. The recommended plan consisted of a dam in the Santa Ana River Canyon about 4 miles upstream from the previously proposed Mentone damsite and about 8 miles northeast of the City of Redlands.

The proposed design of the dam consisted of an earth-and-rock-fill structure with a height of about 550 feet above the existing streambed, crest width of 40 feet, crest length of about 3,000 feet, and the crest elevation at 2,610 feet, NGVD. The proposed upstream and downstream slopes were 1V on 2H. Based on the document entitled "Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 7, Hydrology", dated August 1988, the storage allocations for the reservoir behind Seven Oaks Dam below spillway crest are as follows: 1) a flood control storage of 113,600 acre-feet and 2) a 100-year sediment storage of 32,000 acre-feet. A detached spillway was proposed, to be located about 1,700 feet east of the dam, with a trapezoidal cross section, a base width of 500 feet and side slopes averaging 1V on 1H. The spillway would be unlined except for a concrete control sill across the invert at the crest.

The Seven Oaks Dam flood control project was designed to help control flooding on the Lower Santa Ana River below Prado Dam by reducing peak inflows into Prado Reservoir during large flood events. In addition, the project was designed to provide flood control protection on the Santa Ana River between Seven Oaks Dam and Prado Dam.

3-03 Construction. Construction of Seven Oaks Dam began in 1989. The embankment, outlet works and appurtenant structures were constructed under seven different construction contracts. The first three construction contracts involved site explorations, investigations and test fills of the foundation of the dam and at Government Canyon Ridge. The work from these contracts began in 1989 and completed in 1991. In 1992, the first substantial construction of permanent features began with the excavation and construction of the concrete lining for the outlet works tunnel and gate chamber. This work completed in July 1994. The embankment construction started in May 1994, and the dam topped out in June 1999. The overall embankment and outlet works construction were completed in November 1999. The last contract to construct the Minimum Discharge Line Extension was completed in March 2002. The project was turned over to the Local Sponsors for operation and maintenance in October 2002.

3-04 Related Projects. Two major flood control dams are located in the Santa Ana River Basin, downstream of Seven Oaks Dam. These structures are Prado Dam and San Antonio Dam, both of which were built and are operated by the Corps of Engineers. Other existing flood control improvements, including those on Cucamonga, Deer, Lytle, and Cajon Creeks, have been constructed by the Corps of Engineers and local interests. These improvements include channelization, debris basins, storm drains, levees, stone and wire-mesh fencing, and stone walls along the banks of stream channels. The principal existing water conservation improvements within the Santa Ana River Basin are spreading grounds and reservoirs. The more than 100 water conservation and recreation reservoirs within the basin have storage capacities ranging in volume from less than 4 to about 182,000 acre-feet in the case of Lake Mathews. Although most of the existing water-conservation improvements affect the regimen of the lesser floodflows, major floodflows are not appreciably affected. Lake Elsinore, the terminus for the San Jacinto River, has considerable potential influence on flood runoff, especially if its water surface elevation is low at the beginning of a storm. Lake Elsinore has a dead storage capacity of about 130,000 acre-feet. When full, Lake Elsinore overflows into Temescal Wash, which joins the

Santa Ana River just upstream of Prado Dam. Plate 2-01 shows location of all related projects.

a. <u>Spreading Facilities Downstream of Seven Oaks Dam</u>. Currently, San Bernardino Valley Water Conservation District (SBVWCD) operates groundwater recharge facilities, downstream of Seven Oaks Dam. The existing recharge basins and additional basins currently under construction are located at a borrow pit formerly used for Seven oaks Dam construction located west of Greenspot Road and north of the Santa Ana River. Some of the outflows from the Seven Oaks Dam outlet works are diverted at the SBVWCD diversion structure, located just downstream of the *USGS Santa Ana River near Mentone* stream gage (see Photos 3-1 and 3-2). From the diversion structure, the water flows through an underground box culvert, which is 10 feet wide by 9 feet high. The underground box culvert connects to a rectangular concrete channel, called a "sandbox," 400 feet downstream of the diversion structure. The purpose of the "sandbox" is to filter out excess sand carried in with streamflow. From the "sandbox", the water then continues to an unlined trapezoidal canal, flowing 2,300 feet to the west, crossing under Greenspot Road. The Parshall Flume, which is located at Greenspot Road, measures the flow as it continues west before finally entering the recharge basins at the borrow pit. At the present time, the Conservation District has 15 existing surface recharge basins, and additional recharge basins are now being constructed within the borrow pit. The SBVWCD groundwater recharge basins are shown on Plate 3-01.

Photo 3-1. Upstream View of SBVWCD Diversion Structure

Photo 3-2. Downstream View of SBVWCD Diversion Structure

3-05 **Future Projects**. Prado Dam, another major Corps' flood control dam on the Santa Ana River Basin is scheduled to be modified in the near future. This modification project, which is intended to increase the dam's storage and outlet capacity, is scheduled for completion within three years after the start of construction. The existing Prado Dam will undergo five construction stages, consisting of the following: 1) excavation/backfill for the installation of the new outlet conduit; 2) construction of the new intake structure; 3) partial excavation and restoration of the dam's embankment back to the current top of dam elevation of 566 feet, NGVD; 4) and the final raising of the embankment to the new height of 594.4 feet, NGVD. During the fifth stage, the existing spillway will also be raised from the current elevation of 543 feet, NGVD to 563 feet, NGVD. Detailed information concerning the Prado Dam modification features can be found in Design Memorandum No. 1, entitled Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 2 - Prado Dam, dated August 1988.

3-06 Modifications to Regulations. The original design operation plan for Seven Oaks Dam is contained a document entitled Phase II GDM – Santa Ana River Mainstem, including Santiago Creek, Volume 7- Hydrology, dated August 1988. However, the inclusion of a new species on the Federal endangered species list, namely, the San Bernardino Kangaroo Rat, in addition to the already listed Slender Horned Spine Flower and the Santa Ana Woolly Star, required the Corps of Engineers to enter into a Section 7 Consultation with the U.S. Fish and Wildlife Service. Because these endangered species co-exist in the floodplain of the Santa Ana River downstream of Seven Oaks Dam, the design document plan was evaluated for impacts. It was concluded during the Section 7 consultation that the water control plan specified in the design document could be implemented with provisions added to allow flexibility to make releases in order to support environmental mitigation and enhancement activities in the downstream channel. The flood control operations include operation in coordination with Prado Dam, which is located downstream of Seven Oaks Dam; Seven Oaks Dam, dam safety considerations; mitigating for project impacts to downstream water users; as well as, environmental mitigation.

3-07 Principal Regulation Problems. Since the completion and the initial operation of Seven Oaks Dam, several operational problems have been identified. Most of these problems are mechanical in nature and involve slight design modifications. Repair work to correct these mechanical problems have been completed. Other problems are minor and do not require physical modifications. However, since they pose minor operational constraints, procedures have been developed to circumvent them. These constraints and the developed procedures are described in Chapter 7 of this manual. All the observed problems are discussed in detail in the following paragraphs:

a. Improper Seating of the Outlet Gates. A storm on February 12, 2000 required the building of a debris pool for the first time since the completion of Seven Oaks Dam. Since significant inflow was anticipated prior to the actual storm event, the sluice gate was opened after the low flow and RO gates were closed. This was done in order to fill the main tunnel, thus making the dam ready for larger releases if necessary. As inflow filled the approach channel and began spilling over the stop logs into both conduits, the 8-inch and 14-inch valves were both closed in order stop all releases and build the debris pool. As the main wet well began to fill, the dam tenders reported severe leakage from the sides of RO gate Number 2, (the service gate on the right side looking downstream). Later on during the same event, the dam tenders reported hearing a loud bang. After this sound was heard, the leakage diminished considerably.

An investigation into this incident found that the gate had slid on the invert babbitt seal and sheared off a thin skin of the babbitt metal which was lodged between the gate and gate frame slot. The inspection concluded that the gates were not fully seated onto the gate frame during initial watering up of the upstream tunnel. As water enters the tunnel, the lack of seating causes leakage on the sides of the gates, as observed by the dam tender during this incident. The gates will initially resist the pressure acting on them with the static friction forces between the gate lips and the invert babbit seal resulting from their own weight and the pressure of the hydraulic cylinders. Eventually the increasing hydrostatic pressure on the gates overcame the friction forces, causing the gates to slam against the downstream gate slot, thus causing the loud bang and the shearing of the babbit seal metal. This inspection resulted in a recommendation that during watering up of the upstream tunnel, the control gates should be raised slightly to allow the pressure upstream of the gate to seat the gate onto the gate frame seal.

b. <u>Outlet Gate Latches</u>. As a mechanical safety feature, each hydraulic slide gate at Seven Oaks Dam was designed with a latch mechanism to hold them while they are in a fully open position without drifting downward. The latch mechanism consists of a latch pin, latch arms, and a long bolt (main RO gates only) that supports the weight of the gate when it is fully open, and prevents it from drifting downward due to its own weight when the hydraulic pressure bleeds off. For the main RO gates, the latch arms are closed to hold the pin that is connected to the gate stem by a long bolt. The bolt is the weakest link for the main RO gates. As the gate rises to fully open, the pin also rises through the latch arms. The latch arms are open when the gate is moving and closes when the gate is stopped. The end of the pin has a mushroom-shaped head, which prevents the pin from slipping back through the latch arms when they are closed.

When the gate is initially fully open, the head of the pin remains above the closed latch arms and does not rest on them; therefore, when closing the gate by pushing the "LOWER" button at the control panel, the latch arms would open and the head of the pin lowers with the gate. However, if the gate were kept fully open for a long period of time, the hydraulic pressure would bleed out, which would cause the head of the pin to fully rest on the closed latch arms, and in turn, fully support the weight of the gate. Pushing the "LOWER" button under this condition would not allow the latch arms to readily open due to the weight of the gate, and the hydraulic pressure would still force the gate to lower, causing the latch arms to fail.

The design problem stated above was initially discussed by the contractor in December 1999, after a broken bolt for the latch pin had been repaired following a testing of the gates. In February 2001, retrofit work was initiated to equip each gate with a proximity switch sensor to indicate when the latch arm is open or closed. The hydraulic controls were redesigned to include an automatic two-second delay from the time the “LOWER” button is pushed to activation of hydraulic pressure to move the gate. This feature would allow time for the latch arms to open. In addition, the electrical controls were redesigned to prevent the gate from lowering if the proximity switch sensor does not indicate the latch arms are open. The gate controls were also redesigned to automatically make the gate go up for a few seconds when the “LOWER” button is pushed before allowing the gates to go down from the full open position. This feature would further prevent any possibility of damaging the latch mechanism from lowering the gate. The latch control system was redesigned, and the retrofit completed in 2002. Testing of the completed modifications was conducted on 24 June 2002. Minor problems were observed with the synchronization of the indicator light illumination when the “LOWER” button was pushed. The problems were corrected and the system retested and officially accepted on 25 June 2002. The updated as-builts and equipment operation and maintenance manuals were submitted in September 2002.

c. <u>No Gate Indicator for the Hydraulic Sluice Gate</u>. The sluice gate will be operated either fully open or fully closed under a balanced head or to a 2.5 feet maximum head differential using a portable hydraulic operator. The design did not include a gate position indicator due to susceptibility to damage from weather or potential vandalism. Visual inspection of the gate position is not possible during real-time operation. Therefore, actual position of the sluice gate is not readily available to the dam tenders. Although dam tenders are required to record and report the position of the sluice gate during each gate change, the possibility of moving the sluice gate without recording it, especially during maintenance, exists. In addition, during construction, the contractor had reported that during its initial operation, the sluice had gate drifted down when left in an open position for an extended period of time; however, this condition has not recurred to date. Currently, the only available means of verifying the position of the sluice gate is through actual operation of the gate.

d. <u>Limited Release Capability at Elevations below the Stoplogs.</u> Over the design life of the project, stoplogs are placed, as necessary, along the upstream face of the multilevel withdrawal system (MWS) wetwell of the intake structure in order to minimize the amount of sediment entering the outlet works. The elevation range between the current reservoir invert and the crest of the stoplogs is defined as the sediment pool in the water control plan. Currently, the first two rows of ports have been stoplogged, and the invert elevation, which is the invert for the next row of ports, is at 2120.24 feet, NGVD. Within this elevation range, the dam is operated mainly to minimize impacts to downstream water users. However, since the dam is not equipped with any other release mechanism when the water level is within this range, releases within the sediment pool will be limited to the amount of leakage through the stoplogs.

e. Cavitation within the 12-inch RO Recharge Line (Filling Line). During the 8-10 November 2002 storm operation, the Seven Oaks Dam project operators noticed excessive noise, indicative of cavitation, coming from the 12-inch diameter filling line while the flow was being diverted to the RO tunnel from the MDL. The noise was described as sounding like pebbles bouncing rapidly within the pipe, and the intensity of the noise increased as the butterfly valve opening increased. The noise was first detected at elevation 2130 feet, NGVD, and as the water surface elevation rose, so did the noise levels. At elevation 2160, the noise became unbearable. It is suspected that the noise might be due to the trapped air pockets downstream of the valve due to lack of an air release valve. Currently, a permanent fix for cavitation is under development, but in the mean time, operational procedures, as provided in Section 7-06.b., have been developed to address this problem.

IV. WATERSHED CHARACTERISTICS

IV - WATERSHED CHARACTERISTICS

4-01 **General Characteristics**. The Santa Ana River Basin drains approximately 2,450 square miles, excluding an area of 32 square miles tributary to Baldwin Lake and 10 square miles tributary to Perris Reservoir. Of the total basin, 2,255 square miles of the drainage area is upstream from Prado Dam, which in addition to Seven Oaks Dam is the other major flood control structure on the Santa Ana River. Approximately 23 percent of the entire basin is within the San Gabriel and San Bernardino Mountains; about 9 percent is in the San Jacinto Mountains; and 5 percent is within the Santa Ana Mountains. Most of the remaining area is in the valleys formed by the broad alluvial fan along the base of these mountains. The upper Santa Ana River drainage area above Seven Oaks Dam is approximately 177 square miles, excluding the 32 square miles tributary to Baldwin Lake, and has its headwaters in the San Bernardino Mountains. The Santa Ana River basin is shown on Plate 2-01.

4-02 **Topography**. The damsite and reservoir area is within the steep-walled Santa Ana River Canyon along the southern margin of the San Bernardino Mountains. The elevation of the canyon floor at the damsite is approximately 2,060 feet, NGVD. The gradient of the canyon floor averages about 3 percent. Elevations of the ridgetops outlining the canyon range from about 3,500 feet directly above the damsite on the left (east) abutment, to almost 4,000 feet on the western flank of the canyon. The canyon walls at the right (west) abutment are very steep 1V on 0.6H just above the canyon floor and then flatten to 1V on 2H at higher elevations. The "ridge and swale" topography at the left abutment has more uniform slopes of about 1V on 1.5H. Several "hanging valleys," probably created by the rapid uplift of the San Bernardino Mountains and equally rapid down-cutting by the Santa Ana River, can be identified near the site.

The headwaters of the Seven Oaks Dam watershed lie within the rugged San Bernardino Mountains. Elevations vary from 10,664 feet, NGVD, at Anderson Peak and 11,502 feet, NGVD at San Gorgonio Peak to 2,060 feet, NGVD at the damsite, which is approximately 1 mile upstream from the canyon mouth. Generally trending southwesterly, the 27 miles of river upstream of the damsite has an average gradient of 300 feet per mile. Some smaller tributaries originating in the high mountains have gradients that exceed 1,900 feet per mile. Bear Creek, the principal tributary within the Seven Oaks canyon area, drains 55 square miles and possesses an average gradient of approximately 460 feet per mile. Well-developed growths of fir and pine occur above elevations of about 5,000 feet, NGVD. Many steep slopes within the watershed are covered with a moderate to dense growth of chaparral and sage scrub. Lower slopes carry a heavy cover of grasses and forbs. The drainage area above the dam is expected to remain largely undeveloped during the project life. The project location and topography are shown on Plate 2-02.

4-03 **<u>Geology and Soils</u>**. The entire Santa Ana River basin is underlain by a basement complex of crystalline metamorphic and igneous rocks, which only appear on the surface in the mountainous parts of the area. In the foothills and valleys, the basement complex is overlain by a series of sandstones and shales. Unconsolidated alluvial deposits range in depth from a few feet at the base of the mountains to more than 1,000 feet on the cones and in the valleys. The existence of several precipitous mountain ranges along the upper boundaries of the area indicates that the area has been subjected to extensive folding and faulting. The soils in the mountains, which are derived mainly from metamorphic and igneous rocks, are shallow and stony. On the lower slopes of the mountains and in the foothills, the soils are mainly loams and sandy loams, ranging from less than 1 foot to 6 feet in depth. In the valleys, where the soils are usually more than 6 feet deep, the surface soils range from light, sandy alluvium to fine loams and silty clays with heavier subsoils.

The Santa Ana River basin lies in a seismically active area and has several faults within its boundaries as shown on Plate 4-01. The San Andreas Fault zone, which is the best recognized, is also the one with the potential for the most severe earthquake. Other fault zones within the basin include: the San Jacinto fault zone; the

Banning fault; the Sierra Madre-Cucamonga fault zone; the Whittier fault; the Chino fault; the Elsinore Agua Caliente fault zone; and the Newport-Inglewood fault zone.

a. Seismicity. Seven Oaks Dam is located in a seismically active area and is designed to withstand an earthquake magnitude measuring 8+ on the Richter scale, occurring on the nearby San Andreas Fault. Numerous other active faults exist within a 50-mile radius of the dam, capable of generating an earthquake magnitude of 7 or 7.5 on the Richter scale. Two smaller active faults, were mapped within the footprint of the embankment. Other faults, believed to be inactive, were also mapped within the dam's footprint. Displacement in bedrock due to seismic events was conservatively estimated at 4 feet for design purposes. The displacements are assumed to occur in subsidiary faults and shear zones at the damsite in response to forces from the design earthquake on the San Andreas Fault. The faults underneath the dam are not expected to move independently. Predicted earthquake motions will subject the dam to peak horizontal accelerations of 0.7g and a bracketed duration at 0.5g of 40 to 50 seconds.

4-04 Sediment. Bed material in the Santa Ana River varies from a cobble bed, with material between two and four inches in diameter, along the upper reaches of the river to fine and medium sands along lower reaches. The Santa Ana River is generally considered a sand bed stream with sediment having a mean diameter of 0.5 mm. The median size of the bed material varies from 0.2mm to 0.8mm with an average gradation coefficient of 2.

Historically the river was braided in the upper portion of the basin and meandering along the lower portion. The riverbed and banks are highly erodible and over time the channel has wandered over significant portions of the floodplain. As the Santa Ana River basin has developed, the lower portion of the channel has been improved and controlled to its present location. However, the inherent instability of the river periodically manifests itself in the form of severe scour and bank erosion at various locations. The upper portion has been left in its natural condition.

The volume of sediment to be distributed in the Seven Oaks Reservoir was determined to be 32,000 acre-feet. This volume represents the amount of sediment that would be trapped in the reservoir after 100 years of service. At least three monumented sediment index ranges have been established within the reservoir areas of Seven Oaks Dam. These sediment ranges are used to indicate the need for updated topographic mapping of the reservoir area. Up-to-date topography is essential to accurate computations of reservoir storage, which in turn is used in the calculation of reservoir inflows. The most recent area-capacity relation for Seven Oaks Dam is based on the survey of 1999 and is presented on Plate 2-27. The area-capacity tables are shown in Exhibit B.

4-05 **Climate**. In general, the Santa Ana River Basin has a mild climate with warm, dry summers and cool, wet winters. Both temperature and precipitation vary considerably with distance from the ocean, elevation, and topography.

a. **Temperature**. At the city of Corona, about 26 miles from the ocean and 710 feet above sea level, the average temperature is about 63°F, with extremes of 22°F and 118°F recorded. At Squirrel Inn, located in the San Bernardino Mountains at elevation of 5,700 feet, NGVD, the average temperature is about 53°F, with extremes of 0°F and 97°F recorded.

b. **Precipitation**. Precipitation increases with elevation. The 97-year mean seasonal precipitation for the Santa Ana River basin, which averages about 20 inches, varies from 10 inches south of the city of Riverside to about 45 inches in the higher mountain areas. Nearly all precipitation occurs during the months of December through March. Rainless periods of several months during the summer are common. Plate 4-02 (reproduced from the Santa Ana River Mainstem Phase II GDM, Volume 7) shows the mean annual precipitation over the Santa Ana River basin.

c. **Snow**. Snow in southern California is relatively uncommon at elevations below 6,000 feet, but occurs frequently at the higher elevations, and often remains on the ground for many weeks during the winter and spring at elevations above 7,000 to 8,000 feet. Snowmelt is normally not a major hydrologic factor in terms of contributing to runoff in the Santa Ana River basin; but, on occasion, the runoff from a warm, heavy rainstorm that has followed a cold storm that had dropped over the Santa Ana River basin down to 2,000 or 3,000 feet can be significantly augmented by melting snow.

d. Evaporation. No formal studies of evaporation have been made in the Seven Oaks watershed. Water conservation is not part of the current operating plan; therefore, evaporation is not a major consideration for the Seven Oaks Dam water control plan. However, pan evaporation data have been collected for three stations located within the Santa Ana River Basin, as shown on Table 4-1. The mean monthly evaporation ranges from less than 1 inch in winter to about 8 inches in the summer in higher forested elevations, to about 2 to 3 inches in winter and 9 to 11 inches in summer in lower elevations. On days of very strong, dry Santa Ana winds, evaporation can be greater than one inch in 24 hours.

e. Wind. The prevailing wind in the Seven Oaks Watershed is the sea breeze. This gentle onshore wind is normally strongest during late spring and summer afternoons, with speeds in the Santa Ana River basin typically ranging from 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 humidities and strong gusts of Santa Ana winds usually create very high fire hazards, but can also be instrumental in drying a saturated watershed, thus reducing the flood hazard from later events. Santa Ana winds are often especially strong below Cajon Pass in the corridor from Devore to Fontana, where extreme gusts of more than 100 mph have been recorded. They can also be very strong in the vicinity of Prado Dam and downstream through the Santa Ana River Canyon and into northeast Orange County.

Rainstorm-related winds are the next most common type in southern California. Winds from the southeast ahead of an approaching storm average 20 to 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. Storms.

(1) Winter Storms. General winter storms usually occur from December through March. They originate over the Pacific Ocean as a result of the interaction between polar Pacific and tropical Pacific air masses and move eastward over the basin. These storms, which often last for several days, reflect orographic influences and are accompanied by widespread precipitation in the form of rain and, at higher elevations, some snow. The isohyets for the mean seasonal precipitation are shown on Plate 4-02.

(2) Local Storms. Local storms can occur at any time of the year, either during general storms or as isolated phenomena. Those occurring in the winter are generally associated with frontal systems. These storms cover comparatively small areas, but result in high-intensity precipitation for durations of up to 6 hours.

(3) Summer Storms. General summer storms in this area are usually associated with tropical cyclones and occur very infrequently. They are known to have occurred in the late summer and early fall months, but have not resulted in any major floods during the period of record.

b. Floods. Although historical reference to flood conditions in the general region date back to about 1769, little information is available regarding the magnitude of floods occurring prior to 1850. Historical references indicate that (from 1769 to 1850) medium-to-large floods occurred in 1825, 1833, 1840, and 1850. Some available quantitative data indicates that, from 1850 to 1897, medium-to-large winter floods occurred in 1859, 1862, 1867, 1876, 1884, 1886, 1889, and 1894. Recorded data from 1897 to the present indicate that medium-to-large winter floods occurred in 1903, 1920, 1914, 1916, 1921, 1922, 1927, 1938, 1943, 1965, 1966, 1969, 1978, 1980, 1983, and 1993. Following the historical floods of the 1800's and early 1900's, considerable changes have occurred in the drainage basin. Runoff characteristics of the majority of the valley areas have been changed by urbanization and agriculture. The mountain areas have remained relatively unchanged, although several small reservoirs, detention dams, and debris basins have been constructed at the canyon mouths. In the event that a large, historical storm occurred under present-day conditions, mountain runoff would be similar to that which occurred in the past since these small structures would have little effect on major floods on the mainstem of the Santa Ana River. Valley runoff would be considerably higher in both peak and volume because of increase in impervious cover due to development and channelization of flows. Additional information on the following storms and floods is given in the Review Report, Phase I General Design Memorandum (GDM), and the Phase I GDM Supplement.

(1) <u>Storm and Flood of January 1862</u>. An extreme flood event occurred in January 1862. Although very little data concerning the storm are available, it was possible to determine the flood characteristics that led to the peak discharge of January 22, 1862. According to historical accounts, nearly continuous rainfall began on December 24, 1861. An interrupted series of cold storms out of the north brought heavy snow to low elevations in the mountains. The storm track then changed, and a series of warm storms from east of Hawaii brought very heavy tropical rain to southern California. The combination of this rain, now falling on saturated ground, and massive snowmelt led to a flood with estimated peak discharge of 317,000 cfs at Riverside Narrows.

(2) <u>Storms and Floods of January 1916</u>. Two heavy storm series hit southern California in January 1916. The 14-19 January storm dropped southward along the coast, bringing deep snowfalls to the mountains and foothills. The second series dropped southward over water, then moved onshore with very heavy warm rain that melted the previously fallen snow. Heavy flooding resulted on 27-28 January. The peak discharge on the Santa Ana River near Prado Dam area was estimated at 45,000 cfs with a 24-hour maximum volume of 67,200 acre-feet. The direct and indirect flood damages resulting from this storm were estimated (1949 price levels) at $2,500,000 in Orange County and $5,080,000, in San Bernardino and Riverside Counties. These estimates according to the latest 2002 price levels were $41,250,000 for Orange County, and $83,820,000 for San Bernardino and Riverside Counties.

(3) <u>Storms and Floods of February 1927</u>. A series of heavy storms moved into southern California from the west during mid-February 1927, resulting in moderate flooding on the Santa Ana River and elsewhere throughout the coastal basins. The peak discharge on the Santa Ana River near Prado Dam area was estimated at 18,000 cfs with a maximum 24-hour maximum volume of 30,300 acre-feet. The direct and indirect damages resulting from this storm were estimated (1949 price levels) at $438,000 in Orange County and $594,000 in San Bernardino and Orange Counties. These estimates according to the latest 2002 price levels were $4,421,000 for Orange County, and $6,136,000 for San Bernardino and Riverside Counties.

(4) <u>Storm and Flood of 27 February - 3 March 1938</u>. The storm of February 27 - March 3, 1938 was and still is the most destructive of record since 1862 on the Santa Ana River and many other streams in Southern California. Its occurrence played a major role in the justification of many flood control structures including Prado Dam, a Corps owned and operated dam on the lower Santa Ana River. 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 of 27 February – 3 March. Several mountain stations in southern California reported precipitation equaling or exceeding 30 inches during the 5 days. Within the Santa Ana River basin, total rainfall ranged from 5 inches near Perris to 27 inches at Big Bear

Lake Dam. The heaviest rain fell on 2 March between 0000 to 1900 hours, during which Camp Baldy at the northwest edge of the basin reported nearly 8 inches in 6 hours and more than 12 inches in 12 hours.

At the beginning of the storm, there was snow on the ground at elevations above 6,000 feet. The snow cover at points of observation was not materially depleted at the end of the storm, indicating that snow melt probably did not contribute appreciably to the flood runoff. Although accumulated seasonal precipitation at the beginning of the storm was about normal, greater than normal precipitation occurred during the month of February preceding the storm, conditioning the ground for runoff. The resulting low precipitation-loss rates, along with the unusually large precipitation volume and high intensities, caused very high rates of runoff, especially in the mountains and foothills. The result was a peak flow estimated at 100,000 cfs on the Santa Ana River through the Santa Ana Canyon. The direct and indirect damages resulting from this storm were estimated (1949 price levels) at $6,826,000 in Orange County and $13,460,000 in San Bernardino and Riverside Counties. These estimates according to the latest 2002 price levels were $87,100,000 for Orange County, and $171,750,000 for San Bernardino and Riverside Counties.

(5) Storm and Flood of January 1943. The storm of 21-24 January 1943, which in many respects is the most severe storm of record in southern California, resulted when a series of warm Pacific cyclones moving generally eastward from the area north of Hawaii combined with an intense, cold storm moving down the west coast of North America from British Columbia. The deep, low pressure center that consequently developed over Northern California and Oregon generated unusually strong southerly and southwesterly winds over southern California and produced heavy precipitation over much of the area. Exceptionally large rainfall amounts fell in the mountain areas because of the powerful orographic uplift of these strong winds. Continuous precipitation, which included two periods of very high intense rainfall occurred from about noon on 21 January into the morning of 23 January. Two cold fronts, the first of which occurred about midnight on 21

January, and the second, about midnight on 22 January, caused this precipitation. Rainfall tapered off on 23 and 24 January, although certain mountain stations continued to receive substantial precipitation during these two days. Total rainfall recorded for the storm in the study area ranged from about 4.3 inches at Riverside to 29.7 inches at Glenn Ranch in the San Gabriel Mountains. The isohyets for the 21-24 January storm showing the maximum 24-hour precipitation are shown on Plate 4-03.

(6) <u>Storm and Flood March 1943</u>. The local storm that occurred between 2200 hours on 3 March and 0100 hours on 4 March 1943 resulted in short-period precipitation of near-record breaking magnitude for the southern California coastal region. The storm developed out of a moderate general storm, beginning over the southern part of Los Angeles and moving northeast toward the San Gabriel Mountains at about 7 miles an hour. Because automatic precipitation gages were in operation, the aerial distribution of precipitation was well defined. The highest observed intensities were at the Sierra Madre-Carter precipitation station located in Sierra Madre, where maximum 15-, 30-, and 60- minute intensities of 5.5, 3.6, and 2.7 inches an hour, respectively, were recorded. Runoff was moderately heavy from the local areas where high precipitation intensities occurred. However, as the thunderstorm did not extend appreciably into the Santa Ana River basin, no runoff of consequence was recorded there. The isohyets for the 3-4 March storm showing the maximum 3-hour precipitation are shown on Plate 4-04.

(7) <u>Storms and Floods of January 1969</u>. A series of storms that began on 18 January and continued through 27 January was caused by a strong flow into southern California of very warm, moist air originating over the tropical Pacific Ocean south and east of Hawaii. The series of storms was interrupted by a brief ridge of high pressure that moved through the area on 22 and 23 January and caused a short break in the rainfall. Except for this lull on January 22 and 23, heavy precipitation occurred during most of 18 – 26 January period. An intense downpour occurred on 25 January. Nine-day totals ranged from 10 to 20 inches in the lowlands and from 25 to more than 50 inches in the mountain areas of southern California. In the Santa Ana

River basin, total amounts for Lytle Creek Ranger Station and Big Bear Lake were 42.68 and 35.52 inches, respectively. A streamgage at Santa Ana River near Mentone measured a peak 1-hour average discharge of 15,300 cfs, which was recorded on 25 January.

(8) <u>Storms and Floods of February 1969</u>. The storm series that occurred in late February 1969 climaxed more than a month of extremely heavy, recurring rainfall in southern California. The storms occurred as a number of Pacific cyclones traveled southward off the west coast of the United States and then curved inland across California carrying copious quantities of moisture. Several cold fronts and other disturbances that moved across southern California from 22 February through 24 February dropped moderately heavy amounts of precipitation. Early on 25 February a strong cold front moved slowly southeastward across southern California; the front was accompanied by strong low-level winds that, when lifted by the mountains, resulted in great quantities of orographic precipitation. As a result, rainfall was generally heavy everywhere and particularly heavy in the mountains. A total storm amount of 10.03 inches was recorded at Idyllwild Ranger Station in the Santa Ana River Basin area.

(9) <u>Storm and Flood of February 1978</u>. After several moderately heavy storms during January and early February 1978, one low-latitude Pacific storm developed west of southern California and moved into the area during the night of 9-10 February. After a day of heavy rain in the San Gabriel and San Bernardino Mountains on 9 February, a major cloudburst struck portions of coastal southern California during the early hours of 10 February, with brief intensities exceeding 3 inches per hour. The very heaviest rain fell in Los Angeles County, but several stations in the Santa Ana River basin reported intense rainfall between 0200 and 0400 hours on 10 February, including 1-hour amounts of 1.2 inches at Running Springs and 0.89 inches at Prado Dam.

(10) <u>Storm and Flood of March 1978</u>. In a pattern very similar to that of exactly 40 years earlier, a series of low-latitude Pacific storms moved into southern

California at the end of February and beginning of March 1978. There were four major occurrences of rainfall during the storm period: 28 February, 1 March, 4 March, and 5 March. Total rainfall from 27 February through 6 March ranged from less than 5 inches in the Riverside-Corona area to 22-24 inches in the San Bernardino Mountains and more 28 inches in the San Gabriel Mountains. The heaviest sustained rain fell during the morning of 1 March and again during the mid-day of 4 March. With the ground highly saturated from the already very wet winter, runoff from these storms was very high, especially in terms of low volumes. At Prado reservoir, the inflow during the storm period was recorded at a maximum rate of 34,700 cfs.

(11) Storms and Floods of February 1980. The floods of February 1980 resulted from a series of low latitude Pacific storms that moved into southern California from out of the west. The heavy bursts of rain occurred on 14, 16, and 19 February. Rainfall intensities of 1 inch in one hour were observed in some of the upper areas of the Santa Ana River Basin. The water surface elevation for lake Elsinore reached 1265.7 feet and spilled down Temescal Creek into Prado reservoir, where the 1-hour average inflow was recorded at a maximum rate of 36,000 cfs on 17 February.

(12) Storms and Floods of February - March 1983. During the winter of 1982-1983, a series of low-latitude Pacific storms moved into southern California from the west from late November through February. These storms were the result of atmospheric flow patterns associated with the strongest El Nino condition since at least 1891. The rains climaxed between 25 February and 2 March 1983, during which a storm reminiscent of those of 5 to 45 years earlier moved into Southern California at the end of February and the first of March 1983. Up to 20 inches fell in the Lytle Creek area, and several cells of intense local precipitation were observed in the upper and lower Santa Ana River basin, including 1.72 inches in 1 hour in the City of Santa Ana. This and other local Orange County rainfall events with durations between 30 minutes and 6 hours experienced during the period have recurrence intervals of up to 100 years. One Los Angeles County cloudburst of 2 inches in 5 minutes (Bel Air Hotel, 1 March 1983) was more than 4 times the 100-year rainfall for that duration at that station. The rainfall through late February had saturated the ground everywhere, resulting in very favorable runoff conditions when the storm of 1-2 March dropped the highest volume of warm rain over the Santa Ana River Basin. Flow discharges in the lower Santa Ana River were 6,500 cfs just below Prado Dam; 11,000 cfs at E Street; and 26,200 cfs at the Metropolitan Water District crossing. Discharges of 4,000 cfs were observed at Lytle Creek near Fontana.

(13) Storms and Floods of January – February 1993. From 6 January to 28 February 1993, a series of storms produced 20 to 40 inches of rain over much of southern California coastal and mountain areas and more than 52 inches at some stations in the San Bernardino Mountains. These storms, which coincided with a reappearance of weak "El Nino" conditions in the tropical regions of the Pacific Ocean, were driven by a regional atmospheric low-pressure system off the coast of northern California and Oregon. The first major streamflows occurred on 6-7 January, as a result of heavy rainfall on a fairly substantial snowpack that had accumulated in December 1992. The recurrence intervals of flows in the Santa Ana River Basin were about 25 to 50 years. The rain continued, and a second major runoff peak occurred late on 16 January as the low pressure system moved slightly south before moving to the east on 18 January. A nearly identical storm pattern developed in early February as a stationary atmospheric low-pressure system off the Oregon coast again generated storms. Major storms and resultant runoff peaks occurred on 8 February, and 18-19 February. Although the peak streamflows were only in the 25- to 50-year recurrence interval range, significant local flooding occurred because of saturated conditions in the watershed due to the January storms.

4-07 Runoff Characteristics. Streamflow, which is perennial in the canyons of the Santa Ana River and in the headwaters of most of its tributaries, is generally ephemeral in most valley segments. Streamflow increases rapidly in response to effective precipitation. High-intensity precipitation, in combination with the effects of steep gradients and possible denudation by wildfire may result in intense sediment-laden floods, with some debris load in the form of shrubs and trees. Deposition of sediment occurs in the stream channels as they flow from the canyon mouths onto the lower-sloped valley floor surface. The urbanization that is taking place in the valley areas of the Santa Ana River Basin tends to make the basin more responsive to rainfall. Hence, the same rainfall occurring over an urbanized segment of the basin will result in higher peak discharges, with a shorter time to the peak and a greater volume than had it occurred over a natural basin without urbanization.

4-08 Water Quality. The quality of surface water and groundwater varies considerably throughout the Santa Ana River basin. Generally, the surface waters flowing out of the rugged and undeveloped mountains to the valley floors are of excellent quality. These waters recharge the groundwater in these areas; consequently, groundwater in these areas is also excellent. As one progresses downstream, however, water quality in these areas progressively deteriorates due in large part to heavy water use and waste disposal practices, and to the relatively poor quality of some of the imported water in the general area.

4-09 Channel and Floodway Characteristics. The Santa Ana River downstream of Seven Oaks Dam is divided into two major divisions, namely, 1) the reach that extends from Seven Oaks Dam to Prado Dam, and 2) the lower Santa Ana River, which extends from Prado Dam to the Pacific Ocean. The reach from Seven Oaks Dam to Prado Dam is further divided into three subreaches, namely 1) from Seven Oaks Dam to the upstream end of the Lytle-Warm Creek confluence, 2) the Lytle-Warm Creek confluence area from just upstream of the East Twin Creek confluence to the Lytle-Warm Creek confluence, and 3) from the downstream end of the Lytle-Warm Creek confluence to Prado Dam. While the lower Santa Ana River is mostly improved, the reach between Seven Oaks Dam and Prado Dam is largely unimproved, with the exception of Lytle-Warm Creek confluence, the Riverside levees, and the Norco Bluffs bank protection.

a. <u>Santa Ana River between Seven Oaks Dam and Prado Dam</u>. Since much of the channel in this reach is unimproved, it is subject to constant change in dimensions, and therefore it is difficult to define its capacities. In 1991, however, a channel floodway delineation was performed by the Corps of Engineers under the Santa Ana River Mainstem Project to determine the magnitude of flows that would be generated by the operation of Seven Oaks Dam during a 100-year event and a 500-year event. From this study, it was found that the discharges resulting from the 100-year event would be fully contained within the delineated channel floodway, except for a few breakouts at reaches immediately downstream of Seven Oaks Dam. Plate 4-05 is a map showing the reaches of the Santa Ana River between Prado Dam and Seven Oaks Dam. Plate 4-05A shows the 100-year discharge within these reaches that can be contained within the channel.

(1) <u>Seven Oaks Dam Site to Lytle-Warm Creek Confluence</u>. This subreach is about 12.7 miles long and extends from the Seven Oaks Dam site to the upstream end of the Lytle-Warm Creek confluence project. Throughout the subreach, channel slopes are fairly steep and bed material is generally coarse. Starting from the outlet of Seven Oaks Dam, the river in this area has a dimensionless invert slope of about 0.028. At the upper Santa Ana Canyon, the river is natural, and the representative width for the 100-year floodplain varies from 200 to 550 feet, with 350 feet being the average. The Mill Creek confluence with the Santa Ana River occurs just downstream of the upper Santa Ana Canyon mouth. The dimensionless invert slope of the Santa Ana River low flow channel increases to 0.022 at the upstream end of the wash. The wash narrows downs and enters the upper Santa Ana Canyon about 6.7 miles upstream from the downstream end of the wash. Approximately 8.3 miles downstream from the beginning of this reach, the river becomes part of a broad wash. This wash is up to 5,000 feet wide and is bounded by high ground on the north side and by well-defined high banks on the south side. The confluence of City Creeks with the Santa Ana River is approximately 8 miles downstream from the damsite. Located between these two streams are major gravel mining operations in the right (north) overbank. The low flow channel of the river runs along the southern side of the wash, and the low flow channels of Plunge and City Creeks run along the north side of the wash. The invert slope of the Santa Ana River low flow channel varies from about 0.022 from the upstream end of the wash and 0.017 at the downstream end of the wash. Towards the downstream end of this subreach, the channel consists of a soft bottom channel with uncompacted earthen berms on both banks. The channel is about 1,800 feet wide with an invert slope of about 0.006.

There are three major areas where the 100-year discharge breaks out or expands out into the overbanks. The first area, progressing upstream, is just upstream of the AT&SF Railroad Bridge. In this reach, approximately 1,200 cfs of the peak 100-year Santa Ana River floodflows (33,000 cfs) breaks out into the right (north) overbank. The initial breakout flows are diverted away from the river by an elevated bridge approach embankment. The flows then spread out; eventually overtop the same railroad; and re-enter the river after being intercepted by East Twin Creek. The second breakout area upstream is approximately between the state Route 30 and Orange Street crossings. Floodflows for the 100-year event exceed channel capacity just downstream of Orange Street and break out into the right (north) overbank. These escaping floodflows then proceed to inundate a large active sand and gravel mining operation. For this stretch of river, the effective conveyance of the 100-year flood was primarily restricted to the immediate channel area. The last upstream breakout area occurs in the right (north) overbank reach roughly bounded by the Church Street extension and an area just downstream of where the wash enters the upper Santa Ana Canyon. Within this approximate four-mile reach, the 100-year flood overtops the existing low flow channel banks and breaks out into a "semi-alluvial fan" type overbank area.

(2) <u>Lytle -Warm Creek Confluence</u>. This subreach extends from just upstream of the East Twin Creek confluence to the downstream side of the Lytle-Warm Creek confluence. This area encompasses approximately 2 miles of the long subreach of the Santa Ana River. The average dimensionless channel slope through this reach is 0.005. Within this subreach, the Los Angeles District Corps of Engineers has built substantial channel improvements to confine flows and protect ten bridges. Key improvement features within this subreach include:

- A grouted-stone stabilizer 700 feet wide
- Two trapezoidal sections of earth-bottom channel with stone revetted side slopes. The channel width varies from 484 feet to 700 feet along the lower and upper channels. Both lower and upper channels are approximately 22 feet deep and have side slope of 1H:1V.
- A reinforced concrete drop structure with an approximately 9-foot drop.
- A 20-35 foot deep concrete rectangular section channel that varies in topwidth from 440 feet to 650 feet.
- Thirteen rows of energy-dissipating concrete blocks

The 100-year discharge through this section ranges from 52,000 cfs to 140,000 cfs, and it would be fully contained within the floodway, if not within the improved channel.

(3) Lytle-Warm Creek Confluence to Prado Dam. This subreach extends from 1,000 feet downstream of the Mt. Vernon Avenue Bridge (at the Lytle-Warm Creek confluence), to 0.6 miles above River Road at the upstream end of the Prado Dam Flood Control Basin. It is about 22 miles long and the channel bottom throughout the subreach is generally sandy with some finer and coarser material present. In general, the associated 100-year floodplain varies in width from 700 to 7,000 feet with 2,500 feet being a representative average. The 100-year discharge within this subreach ranges from 140,000 cfs to 166,000 cfs, all of which would be contained within the delineated floodway. In the lower third of the subreach, however, much of the overbank has either been leveed or contains agricultural improvements. The dimensionless channel slopes range from 0.003 to 0.006 with an average of 0.004. The channel width in the project reach varies from 200 to 1,300 feet. Typically, through the Riverside Narrows area just upstream of River Road, the low flow channel winds back and forth between canyon slopes with the overall river channel usually staying 150 feet in width or less. In the remaining two-thirds of this subreach just upstream of Prado Dam basin, the overbank areas are basically unimproved and support fairly dense natural vegetation.

b. Lower Santa Ana River (Prado Dam to Pacific Ocean). The lower Santa Ana River, which extends from Prado Dam downstream to the Pacific Ocean, is approximately 30.5 miles in length. The upstream 2.5 miles are located in Riverside County, and the remaining 28 miles are within the Orange County limits. From Prado Dam the river winds through the narrow and relatively undeveloped lower Santa Ana Canyon for a distance of about 10 miles before it turns southwest at approximately Weir Canyon Road into the alluvial plain of the metropolitan area of northern Orange County. The Santa Ana River Mainstem flood control project also includes major improvements in the lower Santa Ana River. Within the lower Santa Ana River Canyon the project includes intermittent levee and bank protection, along with land acquisition. From downstream of the Weir Canyon Road crossing to the Pacific Ocean, the channel improvement project includes widening, deepening and reconstruction of the channel to carry project design flows ranging from 38,000 cfs to 47,000 cfs. Plate 4-06 is a schematic diagram of the lower Santa Ana River channel, showing its capacities and configurations.

4-10 Upstream Structures. Plate 4-05B shows a map of the upstream area and the inundation boundary within the reservoir. It currently remains undeveloped, therefore, no structures that would affect flood flows into the reservoir. Big Bear Dam is the only existing structure that would have any effect on the flood flows upstream of Seven Oaks Dam. Big Bear Lake is a water conservation reservoir, owned by the Big Bear Municipal Water District. Big Bear Lake has a drainage area of about 38 square miles and has surcharge storage of about 8,600 acre-feet between the top of the conservation pool and the top of the dam. Additional information about Big Bear Lake can be found in Exhibit C.

4-11 **Downstream Structures**.

a. From Seven Oaks Dam to Prado Dam. Two major flood-control dams are located in the Santa Ana River Basin, downstream of Seven Oaks Dam. These structures are Prado Dam and San Antonio Dam, both of which were built by the Corps of Engineers. Other existing flood control improvements, including those on Cucamonga, Deer, Lytle, and Cajon Creeks, were constructed by the Corps of Engineers and local interests. These improvements include channelization, debris basins, storms drains, levees, stone and wire-mesh fencing, and stone walls along the banks of stream channels. The principal existing water conservation improvements are spreading grounds and reservoirs. The more than 100 water conservation and recreation reservoirs within the basin have storage capacities ranging in volume from less than 4 to about 182,000 acre-feet in the case of Lake Mathews. Although most of the existing water-conservation improvements affect the regimen of the lesser floodflows, major floodflows are not appreciably affected. Lake Elsinore, the terminus for the San Jacinto River, has considerable influence on flood runoff, especially if its water surface elevation is low at the beginning of a storm. Lake Elsinore has a dead storage capacity of about 130,000 acre-feet. When full, Lake Elsinore overflows into Temescal Wash, which joins the Santa Ana River just upstream of Prado Dam.

(1) San Antonio Dam. San Antonio Dam is a flood control and water conservation project constructed, operated and maintained by the U.S. Army Corps of Engineers, Los Angeles District. The construction of the dam was completed in May 1956. San Antonio Dam is located approximately 30 miles east of Los Angeles in the Santa Ana River Basin. The dam is situated on San Antonio Creek about 10.5 miles upstream from its confluence with Chino Creek, which is tributary to Santa Ana River within the Prado Dam reservoir. Releases from San Antonio Dam range from 80 cfs to 5,000 cfs. As the water surface elevation of the reservoir approaches the spillway, releases are increased to an average of 7,500 cfs, not exceeding 8,000 cfs. Flood releases from the dam along with all local runoff downstream of the dam flow into

Prado Dam reservoir. More information about Prado Dam can be found within the latest Prado Dam and Reservoir Water Control Manual, dated September 1994.

(2) Mill Creek. Prior to recent improvements, the existing flood control structure in the Mill Creek drainage area was a levee system comprised of levee embankments and masonry walls. The main levee structure is a 13,600 feet compacted earthfill embankment built by the Corps of Engineers in 1960. The levees integrated two stone masonry floodwalls constructed immediately after the heavy flooding in 1938, by local interests with Work Progress Administration (WPA) funds. About 2,000 feet of masonry walls tie into the upstream end of the Corps' levee, and about 2,400 feet of guide levees to control low flows. These structures are protected by rock and wire revetments. The lower 1,800 feet of the Corps' levee is ungrouted stone revetment, with the remaining upstream length being protected by grouted stone revetment, which was built by the Corps. This levee system, however, was insufficient to contain flows of less than design capacity, which resulted in overtopping of the levee, and transport and deposition of large amounts of sediment on the levee slopes.

The improvements made to the original project assured conveyance of the standard project flood. This will contain the design discharge of 33,000 cfs, provide for long-term aggradation, degradation trends, and control local scour and deposition. The following are the improvements made to the original Mill Creek Levee project:

(a) Raising the top of the existing levee between station 70+00 and 88+70, the downstream end of the project, and station 88+70. The levee was raised 4 feet at station 70+00 and taper to a 0 height increase at station 88+70.

(b) Grouting the riprap levee face between station 70+00 and 88+70

(c) Extending the existing levee toe an average of 7.5 feet between stations 70+00 and 129+33.33, an average of 8.5 feet between stations 130+72 and 155+00 and an average of 10 feet between stations 155+00 and 196+25.37 the upstream end of the project.

(d) Constructing a vertical floodwall, average height of 6 feet, on top of the levee from stations 70+00 to 130+20 and from stations 130+72 to 196+25.37.

(e) Restoring a 100-foot strip of streambed vegetation, adjacent to the levee to within 7 to 10 feet of the top of the levee. This strip will be maintained after each flood event.

Further details about the Mill Creek Levee project improvements can be found within the Phase II GDM, Volume 4, Mill Creek Levee.

(3) Oak Street Drain. Within the Oak Street Drain watershed, two debris basins were constructed by the Riverside County Flood Control and Water District (RCFCWD). Mabey Canyon and Oak Street debris basins were completed in late 1973 and 1979, respectively. Together, these basins control debris emanating from Kroonen, Hagador, Tin Mine, and Mabey Canyons. Mabey Canyon debris basin was designed to provide debris storage of 108 acre-feet with a spillway capable of passing 3,100 cfs. Oak Street basin was designed to provide 253 acre-feet of debris storage with a spillway capable of passing 7,700 cfs. Other structures affecting runoff are Mangular Border Drain (downstream of Mabey Canyon debris basin), and Main Street Drain. Main Street Drain discharges flow into Oak Street Drain approximately 1,500 feet upstream of the confluence with Temescal Wash. Prior to recent improvements, the existing Oak Street Drain channel from the debris basin to the confluence with Temescal Wash was a well-defined channel that had been partly improved by the Riverside County Flood Control District. The channel had pipe and wire fencing for streambank protection in the upstream reach, a concrete channel within the City of Corona, and a trapezoidal earth channel in the lowlands downstream from the Atchison Topeka and Santa Fe (AT&SF) railroad bridge. The gradient of the stream varied from 0.030 at the upstream reach just below the debris basin to 0.001 at the outlet into Temescal Wash Channel. As the stream gradient decreased, the existing channel top width increased form 18 feet below the debris basin to about 90 feet at the outlet into Temescal Wash.

Following the latest improvements to this project, the Oak Street Drain channel can now convey the 100-year flood design discharge varying from 4,300 cfs at the debris basin to 8,000 cfs at the Temescal Wash confluence. The features of the improvements included the following:

(a) An entrenched rectangular channel 3-1/2 miles in length from the debris basin spillway to a point 500 feet downstream from the railroad bridge

(b) A leveed channel 1/2 mile in length in the lowland next to the water treatment ponds at the downstream outlet.

Further details about the improvements to the Oak Street Drain project are discussed within the Phase II GDM, Volume 5, Oak Street Drain.

b. <u>Lower Santa Ana River from Prado Dam to the Pacific Ocean</u>.

(1) <u>Prado Dam</u>. Prado Dam is a flood control and water conservation project constructed, operated, and maintained by the U.S. Army Corps of Engineers, Los Angeles District. Construction of the project was completed in April 1941. The project is located at the upper end of the Lower Santa Ana River Canyon, which is a natural constriction controlling 2,255 square miles of the 2,450 square mile Santa Ana River watershed. The dam is located on the Santa Ana River approximately 30.5 miles upstream of the Pacific Ocean. The dam embankment is located in Riverside County, California approximately 2 miles west of the City of Corona. Portions of the reservoir are in both Riverside and San Bernardino Counties. Authorization of the project construction is contained in the Flood Control Act of June 22, 1936 (PL 745-738).

Prado Dam provides flood control and water conservation storage for Orange County, California. It is the downstream reservoir element of the Santa Ana River flood control system. The purpose of the project is to collect runoff from the uncontrolled drainage areas upstream along with releases from other storage facilities. All water conservation releases made are coordinated with the Orange County Water District and are based upon the capacity of their groundwater recharge facilities and agreements with other agencies. When making flood control releases, releases are gradually increased to match inflow up to 5,000 cfs. If flood forecasting indicates that half or more of the reservoir storage may be used during a flood event, flood control releases will be increased up to 9,200 cfs. Inflows exceeding reservoir releases are stored behind the dam. Plans are underway to improve Prado Dam itself by increasing its storage and release capacities. These improvements will enable the dam to take full advantage of the improved channel capacity downstream and will greatly increase the level of flood protection it provides to the communities of Orange County in the Santa Ana River floodplain.

(2) Carbon Canyon Dam. Carbon Canyon Dam, completed by the Corps in 1961, is located on the Carbon Canyon Creek in the Chino Hills about 4 miles east of the city of Brea. It is currently operated and maintained by Los Angeles District of the Corps of Engineers. The drainage area controlled by the dam is 19.3 square miles. The reservoir release schedule allows a maximum average outflow of 1,000 cfs. The downstream channel is concrete lined for one mile at which point it becomes an improved earth channel, which diverts flows into the OCPF&RD's Miller Stilling Basin located a distance of 3.5 miles downstream from Carbon Canyon Dam.

The outflow from the retarding basin flows through the Carbon Creek Diversion Channel into the Santa Ana River between Lincoln Avenue and Glassell Street. Waters entering the Miller Basin Complex are normally diverted to the Santa Ana River via the Carbon Creek Diversion Channel. Under extreme conditions, flows will be split between the Carbon Creek Diversion Channel and Carbon Canyon Creek which flows into Coyote Creek and then into the San Gabriel River. Refer to Exhibit C of this manual and the Carbon Canyon Dam Water Control Manual for additional information.

(3) <u>Other Improvements</u>. Other existing flood control improvements were constructed by local interests. These improvements include channelization, storm drains, levees, rip-rap and concrete side slope protection, and drop structures. The principle existing water conservation improvements are spreading grounds, recharge basins, and Irvine Lake (i.e., Santiago Dam).

(4) <u>Santiago Creek</u>. Santiago Creek is a tributary which joins the Lower Santa Ana River from the east approximately 20 miles downstream of Prado Dam. Facilities on Santiago Creek include Villa Park Dam and Santiago Dam.

i. <u>Villa Park Dam</u>. Villa park Dam is located approximately 2 miles upstream of the Santiago Gravel Pits (i.e., Blue Diamond and Bond Pits) in the foothills of the Santa Ana Mountains. It has a drainage area of 83.4 square-miles including the 63.1 square-mile Santiago Dam drainage. Villa Park Dam was constructed by the Orange County Flood Control District in 1963. The Orange County Public Facilities and Resources Department (OCPF&RD), which assumed the administrative and operation obligations of the Flood Control District, currently maintains and operates the facility. Villa Park Dam is operated as a multipurpose reservoir with varying seasonal storages for both flood control and water conservation. Dam releases are scheduled according to the water surface elevations of both the Villa Park Dam and the uncontrolled Santiago Reservoir. The maximum scheduled release from Villa Park Dam is 6,000 cfs. The flood control and conservation storage allocations are scheduled on a seasonal basis. Refer to the Villa Park Dam Operation manual (an OCPF&RD document) for additional information.

ii. <u>Santiago Dam (Irvine Lake)</u>. Santiago Dam, located 3.2 miles upstream from Villa Park Dam, is a water conservation reservoir constructed by the Irvine Company in 1933. Its uncontrolled flood releases flow into Villa Park Dam. It has a drainage area of 63.2 square miles. The total storage capacity is 25,000 acre-feet.

iii. Other Improvements. The Santiago Creek channel has been improved over the years by local interests. During the 1930's, masonry walls were constructed from the Santa Ana Freeway crossing upstream through Hart Park. Within Hark Park, the channel bottom has been paved for use as a parking lot. Rip-rap has been placed along the west bank of the creek upstream from Chapman Avenue for the protection of adjacent homes. Downstream from Prospect Avenue, concrete side-slope-protection was placed to protect homes that were damaged by flooding in 1969. On Handy Creek, a concrete channel runs from just downstream of Orange Park Boulevard to its confluence with Santiago Creek. Large gravel pits (Blue Diamond and Bond Pits), downstream from Villa Park Dam, can act as reservoirs for floodwater. During minor floods, flows are completely contained within the pits and never reach the downstream channel. However, during major floods, water will fill the pits and overflow into the downstream channel.

4-12 Economic Data. In 2001, an economic study for the Seven Oaks Dam project was performed, where the methodology of the study was based on the current ER 1104-2-100 and ER 110-2-8156 regulations and is detailed throughout the following text. Backup data is on file with the Corps of Engineers, Los Angeles District. The compilation of demographic data was collected for the area within the watershed and the downstream area. The evaluation of flood damages was based on a 100-year project life using an interest rate of 5 7/8%. Flood damages were based on October 2002 price level reflecting damages prevented from the operation of Seven Oaks and Prado Dams.

a. Population. The California Department of Finance shows that the populations of San Bernardino, Riverside and Orange Counties as 1,833,000, 1,705,500, and 2,978,800, respectively in 2003. These figures when compared to the

U.S. Census populations taken in 1990 reflect increases of 29 percent in San Bernardino County, 46 percent in Riverside County and 24 percent in Orange County. Population projections from the Economic Research Department of the Southern California Association of Government (SCAG) indicate continuous increase of the population within the area, with the greater percentages to occur in San Bernardino and Riverside Counties. This is due to the fact that developable lands in Orange County are running out at a rapid rate due to the current level of urbanization. Since San Bernardino and Riverside Counties have extensive undeveloped acreage, accelerated urban growth is projected to extend inland from the now well-developed coastal areas of Orange County.

b. Agriculture. Land use for agriculture within the Santa Ana River floodplain amounts to a total of approximately 7,500 acres. Total agricultural acreage is projected to decrease in the area downstream of Prado Dam due to the intensity of the urbanization of the area. Agricultural crops produced in the area include wheat, barley, cotton, hay strawberries, citrus and variety of vegetables. Dairy farming exists mainly upstream of Prado Dam.

c. Industry. Commercial and Industrial developments in the Santa Ana River floodplain was estimated to cover approximately 17,000 acres and mostly concentrated below Prado Dam in the lower reach of the Santa Ana River. Industry data for the Year 2000 collected by the California Department of Finance indicate that the labor force in San Bernardino and Riverside Counties totaled to approximately 1,549,200 and the labor force in Orange County totaled to approximately 1,496,100. Total labor force for the three counties was widely distributed between manufacturing, trade, government, finance and services. Construction and public utilities, and transportation related industries make up a small portion of this labor force.

d. Damage-Discharge Curves. The damage discharge curves were derived using the expected annual flood damages program (HEC-EAD) models developed for two Corps studies. These studies were performed in 2001 and are documented in the report "The Limited Economic Re-evaluation Report for Santa Ana River Basin, California, dated April 1998, and also in a study performed by the LA District's Corps of Engineers Economics Section using HEC-EAD, entitled, Canyon Lands Economic Analysis. These analyses were recently updated to reflect 2002 and 2099 dollars. The damage discharge curves for 2002 and 2099 dollars are shown on Plates 4-07A and 4-07B, respectively.

Table 4-1. Evaporation within the Santa Ana River Basin

	Monthly Evaporation (inches)		
Month	**(712301) Prado Dam (40 year mean)**	**(747300) Riverside Citrus Exp. Sta. (54 year mean)**	**(060700) Beaumont Pumping Plant (21 year mean)**
Oct	5.67	5.24	5.79
Nov	4.21	3.62	3.54
Dec	3.39	2.68	3.11
Jan	3.42	2.83	3.15
Feb	3.50	3.23	3.43
Mar	4.72	4.57	4.41
Apr	6.14	5.79	5.31
May	7.68	7.05	6.61
Jun	8.62	8.19	8.39
Jul	10.71	9.88	10.67
Aug	10.00	9.25	10.08
Sep	7.91	7.05	8.11

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.

Location of Evaporation Stations

CA DWR No.	Latitude	Longitude	Elev (ft)	Period of Record
712301	33°53'30"	117°38'03"	565	7/30-6/69
747300	33°58'00"	117°20'05"	1,015	1/25-6/78
060700	33°58'50"	117°57'35"	3,045	1/55-9/75

V. DATA COLLECTION AND COMMUNICATION NETWORKS

V - DATA COLLECTION AND COMMUNICATION NETWORK

5-01 Hydrometeorological Stations.

a. Facilities. The Corps of Engineers, Los Angeles District (SPL) and San Bernardino County Public Works and Flood Control District (SBCPW&FCD), and U.S. Geological Survey (USGS) each maintain and collect data from precipitation, streamflow, and reservoir water level gages located throughout the Seven Oaks watershed, at the dam, and in adjacent areas. Most of the gages are equipped with radio telemetry that provides water control managers with real-time information about watershed conditions and the status of Seven Oaks Dam. The telemetry networks and all of these gaging stations are described in detail below.

(1) At Seven Oaks Dam. Hydrologic facilities that provide both useful and necessary information for operation of the dam consist of a reservoir level monitoring system, data logger, Automatic Local Evaluation in Real-Time (ALERT) transmitter, SPL Los Angeles Telemetry System (LATS) transmitter, and reservoir level staff gages. Table 5-1 provides a summary of the hydrologic instrumentation currently existing at Seven Oaks Dam. The instrumentation at the dam includes a Design Analysis Model H-350/355 pressure transducer/data logger, which is used to measure the reservoir pool elevation and record information on a linear flash card. A computer equipped with a standard PCMCIA card reader can read data stored on the flash card. A design Analysis Model H-500-XL, receiving the reservoir pool elevation from the H-350/355, operates the High Sierra Electronics ALERT radio. The LAD WCDU personnel and personnel from Design Analysis provided training to the San Bernardino County project operators, on site, for better understanding of the water surface measuring, data logging and telemetry features of the equipment.

A 4-inch conduit connects the instrument house to a series of orifice line termination points (pull boxes installed during construction) along the embankment. Six orifice lines have been installed inside the 4-inch conduit to connect the pressure transducer (H-350) to termination points on the upstream face of the embankment. The lowest termination point, and therefore, the lowest water level that can be sensed, is currently elevation 2120 feet, NGVD. The other termination points are located at elevations 2150, 2180, 2220, 2260, and 2300 feet, NGVD. As sediment deposition occurs over the life of the project, the lower orifice lines buried by sediment will be abandoned and orifice lines connected to higher termination points will be utilized. *[Note: It is the responsibility of the local sponsor to switch to higher orifice lines as needed to ensure that the orifice lines in use are always above the sediment level]*. In the instrument house, the orifice lines connect to a multi-port valve (Design Analysis H-390) that allows the H-350 pressure transducer to monitor up to 4 orifice lines at a time.

Besides logging the reservoir water level data on a flash card, output from the H-350/355 is fed into a SBCPW&FCD ALERT transmitter and into a SPL LATS remote telemetry unit (RTU) for radio transmission. This configuration provides two redundant sources of real-time data from the dam. The ALERT and LATS transmitters are co-located with the H-350/355 inside the instrument house on top of the dam.

Staff gages are located on the upstream face of the dam from elevation 2105 to 2610 feet, NGVD. The staff gages are positioned such that from elevation 2105 to 2300, the gages can be read by the dam tender from the service area behind the intake structure; from elevation 2305 to 2400, the gages can be read from top of dam at station 23+00; and from elevation 2405 to 2610, the gages can be read from the instrument house. A staff gage is also installed on the concrete intake structure from elevation 2264 to elevation 2301.

(2) <u>SBCPW&FCD Facilities Within and Near Seven Oaks Watershed</u>. San Bernardino County Public Works and Flood Control District (SBCPW&FCD) maintains a network of precipitation gages throughout the county. Precipitation data is collected from seven stations within the Seven Oaks Dam drainage area as shown on Plate 5-01. Table 5-4 provides a listing of these gages. The gage located at Manzanita Flat is co-located with the Corps of Engineers LATS stations. The precipitation gage located at Manzanita Flat is equipped with both ALERT and LATS transmitters that can provide real-time precipitation data to the Seven Oaks Dam water control managers. The Heart Bar station is located close to the Corps gaging station of the same name. The precipitation gages located at Big Bear Dam and Camp Angelus stations are operated in conjunction with the NWS.

(3) Corps Facilities Within and Near Seven Oaks Watershed. The Corps of Engineers, Los Angeles District maintains hydrometeorological gaging stations within and near the Seven Oaks Dam basin that are part of LATS, as shown on Plate 5-01. Covering the Seven Oaks Dam drainage area, these LATS stations consist of rain gages at Heart Bar, Converse Fire Station, Big Bear Ranger Station and Manzanita Flat and one other COE operated stream gage upstream of the dam at the Southern California Edison bridge crossing (Table 5-2). These gages collect and transmit real-time data using on-site remote terminal units (RTU).

(4) US Geological Survey (USGS) Stations. The USGS operates, maintains, and publishes data for two Santa Ana River stream gages located below the dam. These gages are equipped with GOES satellite telemetry Data Collection Platforms (DCP). Station 11051499 Santa Ana River near Mentone (River Only) measures flow in the main channel and Station 11051502 is a supplemental gage which measures flow diverted from the main channel about 250 feet upstream of Station 11051499. Station 11051499 is also equipped with a SPL LATS RTU which reports real-time stage and precipitation. The diverted water passes through the existing percolation basins, which are maintained by the San Bernardino Valley Water Conservation District.

b. Reporting.

(1) Manual. The dam tender observes water surface elevations, piezometer readings, and gate settings and logs them on a form similar to the one shown on Figure 5-01. These readings are reported to the water control managers via radio or telephone. During the non-flood season (April 15 through November 15), these readings may be taken as often as once a week, on a designated day. During the flood season (November 15 through April 15), they are taken daily Monday through Friday. During flood operations, they are taken as often as the water control managers deem necessary.

(2) ALERT. ALERT is a real-time flood warning system operated by local county agencies in cooperation with the National Weather Service. ALERT stations use line-of-sight radio to transmit real-time rainfall and water level data to agencies equipped with reception equipment. ALERT stations report at least once or twice a day during all conditions but report much more frequently in response to storm or runoff events. During an event, ALERT stations automatically sends reports after a threshold value is measured by the gage. The threshold criteria for event reporting from the ALERT stations is established by San Bernardino County Public Works and Flood Control District for the gages that are part of the San Bernardino County system. In the case of the station at Seven Oaks Dam, the threshold criteria is set based upon agreement with the Seven Oaks Dam water control managers, depending upon real-time operational requirements at the dam and for data collection.

(3) LATS. LATS is a radio telemetry system operated and maintained by the Corps of Engineers, Los Angeles District. LATS stations operate in three modes: self-time reports, event reporting, and polled. For the Los Angeles District's projects, the general criteria for reporting is every 0.04-inch of ran for rain gages or ±0.25 for reservoir and stream level gages. Stations may be programmed to report more frequently or following smaller changes in elevation. The information collected through LATS is transmitted by a line-of-sight radio contained in the RTU to a repeating station. The Keller Peak repeating station is used by the Seven Oaks basin gages except for the Converse and Santa Ana River at Mentone stations that use the Pleasants Peak repeater. The repeater relays the data to the Corps' Water Control Data System by microwave link. Any LATS gage can be polled (interrogated) by the LAD's Reservoir Operation Center (ROC) personnel for data at any time via the LATS Central Computer. All telemetry data collected by the Corps' LATS system is stored in databases and made available on the Internet at the Los Angeles District Reservoir Regulation Section Web Site (www.spl.usace.army.mil). In addition, this data is converted to the ALERT message format and sent to the Orange County Public Facilities and Resources Department for inclusion in their ALERT database.

(4) GOES. The GOES data collection system is satellite telemetry system that supports federal, state and local agencies. GOES Data Collection Platforms (DCPs) transmit stream levels and other data to satellites operated by the National Oceanic and Atmospheric Administration. The satellites relay the data to agencies equipped with either a DOMSAT or Direct Readout Ground Station. The stream levels for both USGS stream gages located below Seven Oaks Dam are collected at fifteen-minute intervals and transmitted every four-hours by GOES DCPs. The data is available to the public via the USGS web site (http://waterdata.usgs.gov/ca/nwis/rt).

(5) Weather Data. The National Weather Service (NWS) provides an array of weather data, including Quantitative Precipitation Forecasts, short and long-range forecasts, precipitation totals, watches and warnings, and severe weather statements. Weather information is provided in forecasted and real-time formats, which can be accessed on their web site.

c**. Maintenance**. All of the three Local Sponsors are responsible for the maintenance of all gages and/or telemetry radio or microwave equipment, with the exception of the of the LATS equipment, which is maintained by the Corps of Engineers, Los Angeles District.

5-02 Sediment Stations.

a. Facilities. The USGS maintains two sediment stations on the Santa Ana River. One is at E Street near San Bernardino (USGS #11059300) and the other is at 5th Street in Santa Ana (USGS #11078000). The periodic sediment stations use U.S. Depth Integrating Samplers, which accumulate a water-sediment sample as the sampler is lowered to the streambed and raised to the surface at a uniform rate.

b. Reporting. The USGS collects, compiles, and publishes sediment data on an annual basis in the publication: Water Resources Data for California.

c. Maintenance. The USGS has maintenance responsibilities with respect to sediment stations.

5-03 Water Quality Monitoring. The local sponsors perform water quality monitoring in the reservoir as part of their operation and maintenance responsibilities. Details of monitoring responsibilities are provided in the Seven Oaks Dam Operations and Maintenance Manual, Volume I, Part II, Chapter 4, entitled "Environmental Commitments and mitigation". The U.S. Fish and Wildlife Service, the Santa Ana Watershed Project Authority (SAWPA), the California Regional Water Control Board, and local water agencies monitor the various aspects of water quality in the Santa Ana River basin.

In 1991, the U.S. Geological Survey began a full-scale National Water-Quality Assessment (NAWQA) Program. The goals of the NAWQA Program are to: 1) Describe current water quality conditions for a large part of the Nation's freshwater stream and aquifers (water-bearing sediments and rocks); 2) Describe how water quality is changing over time; and, 3) Improve understanding of the primary human factors affecting water quality. The Santa Ana Basin is one of several NAWQA study units that began in 1997. The Santa Ana NAWQA study unit covers an area of about 2,700 square miles in parts of Orange, San Bernardino, Riverside, and Los Angeles

Counties. The study unit is home to more than 4 million people who not only rely on water resources that originate within the basin, but also on water imported form northern California and the Colorado River.

Other agencies studying the water quality within the Santa Ana Basin include, but not limited to, the following:

- California Air Resources Board
- California Department of Fish and Game
- California Regional Water Quality Control Board, Santa Ana
- California Department of Water Resources
- Chino Basin Water Master
- City of Corona City of Lake Elsinore, Lake Operations
- City of Riverside, Department of Public Works
- City of San Bernardino
- Eastern Municipal Water District
- Inland Empire Utilities Agency (IEUA)
- Lake Arrowhead Community Services District
- Metropolitan Water District
- Orange County Water District
- Riverside Highland Water Company
- Riverside Water Quality Control Plant
- San Bernardino Valley Municipal Water District
- San Bernardino Valley Water Conservation District
- Santa Ana Watershed Project Authority (SAWPA)
- Southern California Coastal Water Research Project

In general, the quality of surface and ground water in the Santa Ana Basin becomes progressively poorer as water moves along hydraulic flow paths. The highest quality water is typically associated with tributaries flowing from surrounding mountains and ground water recharged by these streams. Water quality is altered by a number of factors including consumptive use, importation of water high in dissolved solids, runoff from urban and agricultural areas, and the recycling of water within the basin.

a. __Facilities - USGS Basic Fixed Site Network__. In 1999 the Santa Ana NAWQA study team began a three-year intensive investigation of water quality conditions along the Santa Ana River and its tributaries. Water quality measurements are obtained at 7 locations, of which 5 are "basic-fixed sites" (BFS) and 2 are "intensive-fixed sites" (IFS). Five of the sites are located in the Inland Santa Ana Basin, and 2 are located in the Coastal Santa Ana Basin. No fixed sites are planned for the San Jacinto Basin due to the lack of surface-water flow during most of the year. The USGS currently monitors discharge at 5 sites. The Basic-Fixed sites network is shown on Plate 5-02, and the following are photos showing these sites where samples are taken.

South Fork Santa Ana River

Santa Ana River near Mentone

Warm Creek near San Bernardino

Santa Ana River at MWD

Cucamonga Creek near Mira Loma

Santa Ana River below Prado Dam

Santa Ana River SPRD Div below Imperial Highway

Basic-fixed and intensive-fixed sites are sampled for the analysis of major irons, nutrients, dissolved organic carbon, suspended organic carbon, and suspended sediment. At the IFS sites, the samples will also be analyzed for volatile organic compounds and pesticides. A continuous record for discharge, specific conductance, and water temperature will be measured at all sites. Field measurements will be taken at the time of water quality sampling for specific conductance, pH, dissolved oxygen, and alkalinity.

b. Reporting. The river basin and aquifer summary reports prepared by NAWQA as part of the NAWQA program is entitled, "Water Quality in Santa Ana

Basin." A new report is generated for every assessment that has been completed for water quality. There are currently 51 assessments for water quality. With every report generated, there are also summary reports that are part of the USGS Circular series of publications, which are posted on the USGS web site. The water quality reports may also be ordered free of charge upon request. The USGS data is also published each water year in Water Resources Data for California.

Outside of USGS, other agencies that collect water quality data publish annual summaries of their findings. Data collected by the DWR and the CRWQCB, are published annually on microfilm by the State of California Water Data Information System (WDIS).

c. Maintenance. The USGS has maintenance responsibility for the water quality station within the Santa Ana basin.

5-04 Recording Hydrologic Data. Each agency maintains records of its own data. Water surface and gate settings are observed by the project operators at the dam and recorded on a form such as the one shown on Figure 5-01. These observations are reported to the water control managers in the office either by telephone or radio. During flood events, the project operators report by radio or telephone, as often as is required by the water control managers. There is one ALERT station, located at Manzanita Flat, as shown on Plate 5-01, that records data at the same time that they are being sent via ALERT transmitters from the station site to the water control managers in the office. Rainfall data from SBCPW&FCD precipitation gages are published on their web site (www.co.san-bernardino.ca.us/trnsprtn/pwg) or can be requested through written correspondence.

The Corps of Engineers LATS telemetry data (i.e. precipitation, water surface, and river stage) collected for the Seven Oaks Dam basin can also be viewed on the Corps of Engineers, Los Angeles District Reservoir Regulation Section web site (www.spl.usace.army.mil).

Rainfall data at Big Bear Dam and Camp Angelus are published in the U.S. Weather Service's monthly publication entitled "Climatological Data" and annually on CD-ROM (hydrodata).

Daily flows at the downstream gaging station, "Santa Ana River near Mentone: are published annually in the "Water Resources Data California" and on the Hydrodata CD-ROM from Hydrosphere, Inc.

5-05 Communication Network. The Seven Oaks Dam water control managers' project operating center communicates with its project operators via either telephone or the San Bernardino County radio system. Project operators at Seven Oaks Dam also retain the capability to communicate with the Corps' Reservoir Operation Center using the Corps of Engineers' radio system.

5-06 Communication with Project.

a. Communication Between Water Control Managers and Seven Oaks Dam Project Operators. Communication between the Seven Oaks Dam water control managers and the project operators is accomplished via telephone or radio. In the event that all communications between the water control managers and the project operators are interrupted, a set of "Standing Instructions to the Project Operator for Water Control" have been compiled and included as part of this manual (See Exhibit A). A copy of this Water Control Manual should also be kept at Seven Oaks Dam.

b. Communication Between Seven Oaks Dam Water Control Managers and the Corps of Engineers. Seven Oaks Dam was designed to be operated in conjunction with Prado Dam to provide flood protection to the areas along the lower Santa Ana River. Since the operation of Seven Oaks Dam will affect the operation of Prado Dam, the Seven Oaks Dam water control managers must notify the Corps of Engineers, Los Angeles District, Reservoir Operation Center (ROC), of any changes in releases from Seven Oaks Dam that is beyond releases made for downstream water users. The ROC can also be reached for regulation consultation, if necessary, via telephone or by radio using the Corps of Engineers' radio system. The radio call sign for contacting the Reservoir Operation Center on the Corps of Engineers' radio system is "WUK 4ROC".

c. Communication Between Seven Oaks Dam Water Control Managers and Others. The Seven Oaks Dam water control managers are responsible for making telephone notifications to various in-house sections, county agencies, city authorities, private party stakeholders, or any entity with a legitimate need for the information, when any operations at Seven Oaks Dam may impact people or property. The Seven Oaks Dam water control managers shall maintain this list of notifications similar to the list included in Exhibit H, and shall update the points of contacts and phone numbers as needed, and at least annually. The water control managers shall maintain a record of all notifications made and store the records for the life of the project. All notifications must be made prior to making any adjustments that will impact the surroundings of the project. The notifications list should also include the U.S. Army Engineer Research and Development Center, Waterways Experiment Station (WES). WES requires notifications, as early in advance as possible, when target testing elevations will be achieved in the reservoir. This will provide an opportunity for WES to collect data for the prototype testing program to evaluate the performance of the outlet works during flood operations.

d. Communication Between Seven Oaks Dam Project Operators and Others. No routine communication is required between the Seven Oaks Dam project operators and other agencies. However, the Seven Oaks Dam water control managers and the project operators may agree that the project operators will make some of the notifications discussed above under the heading "Communication Between Seven Oaks Dam Water Control Managers and Others". If there is no such agreement, the responsibility remains with the water control managers. The project operators will maintain a record of all notifications made and furnish it to the water control managers, who shall maintain the comprehensive records of all notifications made and shall store them for the life of the project.

5-07 **Project Reporting Instructions**. The Seven Oaks Dam project operators observe water surface elevation and gate settings and report them to the Seven Oaks Dam water control managers via telephone or radio. Currently, there is no precipitation gage at the dam itself, other than the one located downstream of the dam. The data from this precipitation gage is available for real-time operation via telemetry. If an operation, such as, a change in discharge is required by the water control managers, the project operator will perform the operation and then report back to the water control managers to confirm that the operation has been completed. This confirmation will also be accompanied by a new gate setting and water surface elevation report. Any gate operation, for whatever reason, must be reported to the water control managers prior to the operation. No gate operation will be performed without the permission of the water control managers.

During the non-flood season (16 April through 14 November) the standard reservoir observation will be performed at least once a week. During the flood season (15 November through 15 April) this will be performed at least once a day during the project operators' normal work-week. At any time of the day or year, if, based upon meteorologic or hydrologic forecasts, the water control managers expect significant inflow into the reservoir, they shall request the presence of a project operator. A project operator is required to be present at the dam, furnish reports, and perform operations any time the water control managers request it. During flood events, the project operators perform the above described observations and operations and reports them by radio or telephone to the water control managers, as often as the water control managers require it. All reports called in by the project operators should be documented on a reservoir operation report form similar to the one shown on Figure 5-01, and the records kept by the OCPF&RD water control managers.

At the end of the water year (1 October to 30 November), the OCPF&RD water control managers are required to provide a compilation of all data collected during the water year, in a form of a report to the Corps of Engineers, Los Angeles District, Reservoir Regulation Section (SPL). The date(s) of the significant event(s), the water surface elevation(s), and inflow and outflow data must be provided in the report. In addition, some discussion should be provided to describe any problems that may have been encountered during the implementation of the water control plan, any coordination between agencies, and necessary notifications that have been made during the event(s). Information provided will be included as part of the Corps' annual water control management report that discusses the regulation of Corps owned and Section 7 reservoirs, including Seven Oaks Dam.

5-08 Warnings. The responsibility for issuing all weather watches and warnings and all flood flash flood watches and warnings rests with the National Weather Service. Local, state, county and city emergency management official are responsible for issuing any public warnings regarding unusual overflows, evacuations, unsafe roads or bridges, toxic spills, etc. The OCPF&RD water control managers will be required to make notifications to local authorities when critical water surface elevations are reached, and critical release rates are initiated. Notification requirements for coordinating releases with the Corps of Engineers, Reservoir Operation Center (ROC) are described in section 5-06.b. Notification requirements for operations that impact people or property are described in Section 5-06.c. In the event of a dam break, the water control managers should refer to the Emergency Action and Notification Subplan notebook for Seven Oaks Dam. This subplan must be available at the Storm Operation Center. Copies are also located in the ROC and the LAD's Emergency Operations Center (EOC), at the Corp of Engineers, Los Angeles District office.

Table 5-1
Hydrologic Instrumentation at Seven Oaks Dam

Parameter	Gage Type	Report Mode	Stored Record	Comments
WATER SURFACE ELEVATION	Staff Boards at Dam	Visual Inspection	Flood Control Basin Operation Report SPL 19 or Equivalent	
	Design Analysis H-350 Combination Pressure Transducer/Data Logger *	Data Logger	Flash Card	Bubbler System with Multiple Orifice Lines
		ALERT Telemetry	County ALERT Reception Systems	
		LATS Telemetry	Corps Telemetry Database	
DOWNSTREAM GAGE HEIGHT	Pressure Transducer	LATS and GOES Telemetry Visual Inspection	USGS Records Corps Telemetry Database	USGS Gage 11051500 USGS Gage 11051502** USGS Gage 11051499**
PRECIPITATION	Novalynx Tipping Bucket	LATS Telemetry and Data Logger	Corps Telemetry Database San Bernardino County Records	Precipitation gage is co-located with downstream stream gage

**Equipped with GOES DCP

Table 5-2
Streamgages Pertinent to Seven Oaks Dam

	Location	Drainage Area* (mi^2)	Latitude	Longitude	Elev (ft)	Period of Record	Remarks
1	Santa Ana River Near Mentone, CA #11051500** USGS (LATS) RTU 57	210	34-06-30	117-05-59	1,950	07/1896-pr	In San Bernardino County, on right bank near mouth of canyon, 1.6 mi. u/s from Mill Cr, 3.2 mi. NE of Mentone, 16 mi d/s from Big Bear L.
2	Santa Ana River above Seven Oaks Dam Corps of Engineers (LATS) RTU 85	161	34-08-33	117-04-08	2,550	10/1997-pr	Located on right bridge abutment of the S. Cal. Edison bridge crossing, just u/s of Alder Cr. confluence

See plate 5-01 for locations.

*Drainage area includes 38 sq. mi. non-contributing area from Baldwin Lake.

**Is a combination of two USGS gages #11051499 and #11051502 that monitor the downstream flow. Both of these gages are equipped with GOES DCPs.

Table 5-3
COE LATS Rain Gages Pertinent to Seven Oaks Dam

No.	Location	RTU ID	Latitude	Longitude	Elevation (ft)	Period of Record
1	Big Bear Lake Ranger Station	84	34-16-58	116-54-07	6,940	11/1995-pr
2	Manzanita Flat	82	34-09-36	117-02-47	3,920	11/1995-pr
3	Heart Bar	83	34-09-31	116-46-56	6,690	11/1995-pr
4	Converse Fire Station	25	34-11-38	116-54-49	5,600	1/1992-pr
5	Santa Ana R. nr Mentone	57	34-06-30	117-05-59	1,950	07/1896-pr

See plate 5-01 for locations.

Table 5-4
SBCFCD Active Rain Gages Pertinent to Seven Oaks Dam

No.	Location	SBFCD Station ID	ALERT ID	Latitude	Longitude	Elevation (ft)	Period of Record (WY)
1	Big Bear Community Svcs. Dist.	6091A	-	34-15-41	116-50-39	6,800	1950-pr
2	Big Bear Hospital	6363	-	34-14-46	116-53-09	6,800	1981-pr
3	Big Bear Dam	6032	-	34-14-29	116-58-31	6,815	1884-pr
4	Camp Angelus	3260	-	34-09-00	116-59-02	5,780	1967-pr
5	Santa Ana Powerhouse #3	3162	-	34-06-28	117-05-56	1,950	1922-pr
6	Manzanita Flat	3002	2833	34-09-36	117-02-47	3,920	11/1995-pr
7	Heart Bar	3259	-	34-09-31	116-46-56	6,690	11/1966-pr
8	Fawnskin	6334	-	34-16-01	116-57-10	6,280	1974-pr

See plate 5-01 for locations.
SBCFCD - San Bernardino County Public Works and Flood Control
COE - Corps of Engineers

VI. HYDROLOGIC FORECASTS

VI - HYDROLOGIC FORECASTS

6-01 <u>General</u>.

a. <u>Role of the Project Owners</u>. OCPFRD, SBCPWFCD, and the RCFCD do not prepare formal published hydrologic forecasts for Seven Oaks Dam.

b. <u>Role of the Corps of Engineers</u>. The Corps of Engineers does not prepare formal published hydrologic forecasts for Seven Oaks Dam, or any other Section 7 or Corps of Engineers, Los Angeles District operated projects.

c. <u>Role of Other Agencies</u>. Real-Time weather and flood runoff forecasts for the southern California region are issued by the NWS. Historical precipitation and stream flow data are available from OCPFRD, NWS, USGS, and San Bernardino County Water Resources Division. These data, while not of use in real-time operation, are important to studies of historical storms and floods that aid in the development and refinement of manual and computerized rainfall-runoff forecast models.

6-02 <u>Flood Condition Forecasts</u>. For the current approved water control plan for Seven Oaks Dam, forecasts of flood hydrographs are not required. However, routine evaluation of precipitation, resulting inflow, and forecast precipitation, provides valuable information for use in subjective evaluations of flood situations. Using such information, the project operator can evaluate if an ongoing flood will increase or decrease over the next 24 hours.

The Corps of Engineers uses forecasting methods to determine the inflow to Prado Dam, located downstream of Seven Oaks Dam on the lower Santa Ana River. The QPF/API algorithm is used to determine flood volume inflows. A Recession Limb Inflow Forecasting model is used to predict the recession limb of the inflow hydrograph. Details and procedure outlines for these forecasts methods are found in the Corps of Engineers Los Angeles District's current Prado Dam Water Control Manual.

More recently, the LA District has been developing a Santa Ana River watershed model through the Corps Water Management System (CWMS). The CWMS control and visualization interface (CAVI) consists of various hydrologic modeling programs and access to real-time data. Forecast alternatives are modeled through the CWMS CAVI, generating inflow, water surface elevation, and outflow information, which can be used to make reservoir regulation decisions. Currently, the CWMS model for the Santa Ana River watershed is in its testing and development stage.

6-03 **Conservation Purpose Forecasts**. The current approved water control plan does not include, or preclude, water conservation. The plan may be modified in the future to accommodate water conservation, but in the mean time, forecasts for water conservation are not prepared.

6-04 **Long Range Forecasts**. Long-range forecasts are not currently made for Seven Oaks Dam.

6-05 **Drought Forecasts**. Currently, drought forecasts are not made at Seven Oaks Dam and reservoir.

VII. WATER CONTROL PLAN

VII - WATER CONTROL PLAN

7-01 General Objectives. The overall objectives of the Seven Oaks Dam Water Control Plan are 1) to provide flood control on the lower Santa Ana River below Prado Dam by reducing peak inflow and volume into Prado reservoir, and to communities between Seven Oaks and Prado, 2) to mitigate for project impacts upon downstream water users, 3) to support downstream environmental mitigation and enhancement and 4) to support the prototype testing program.

7-02 Operation Constraints. There are no major constraints on the operation of Seven Oaks Dam under the Water Control Plan. Mechanical problems and other minor deficiencies have been observed since the completion of the dam and during its initial operation. These observed problems and their repairs are discussed in detail in Section 3-07. Minor operation constraints that have developed as a result of these problems are discussed as follows:

a. Improper Seating of Outlet Gates. As discussed in Section 3-07.a., the low flow and RO gates need hydrostatic pressure upstream of the gates to seat properly against the frame seals for tight closure. As water initially enters the main tunnel, severe leakage will develop around the sides of the unseated gates. Once the pressure that develops from water filling the tunnel upstream exceeds the friction between the gate and invert seal, the gate can suddenly slip downstream along the invert babbit seal and slam against the gate frame. This results in a loud bang and could cause damage to the gate system. In order to prevent the gates from slamming against the frame during filling of the main tunnel, the gates need to be raised slightly to allow the upstream hydrostatic pressure to properly seat the gate onto the gate frame. This step to properly seat the outlet gates is part of the procedure to water up the tunnel prior to the operation of the sluice gate (Section 7-06.c).

b. Hydraulic Sluice Gate - Observed Drift. The sluice gate was designed to be in either a fully opened or fully closed position. Its installation therefore did not include a gate indicator. It was reported during initial operation that the gate had drifted downward from a fully open position after an extended period of time. However, this drift problem has not recurred. Without a gate indicator, it will be difficult to determine the extent of any future drift if this problem recurs. Periodic monitoring, through actual operation of the gate, is necessary to ensure that the gate is open to pass flows into the main wet well. Visual inspection of the gate position is not possible during real-time operation.

c. Outflow Limited to Leakage at Stoplogs. As part of the design for sedimentation allowance, stop logs will be placed along the upstream face of the multilevel withdrawal system wet well at the intake structure in order to minimize the amount of sediment entering the outlet works. The elevation range between the current reservoir invert to the top of the stop logs is called the "Sediment Pool". When the water surface elevation drops to within the sediment pool the outflow from the dam becomes limited to leakage through the stoplogs. At the time the project was turned over from the Corps of Engineers to the project sponsors, six stop logs were installed, blocking the lowest two rows of intake ports. The top of stop log, or the bottom of the lowest open port at turnover of this project is at elevation 2120.24 feet, NGVD.

d. Gate Chamber Fill Line Cavitation Noise. The fill line at Seven Oaks Dam was operated in November and December 2002. The first time was with a reservoir level of elevation 2160 feet and the second was at elevation 2131 feet. In both cases, the operators observed excessive noise with the opening and operation of the fill line valve. The operators also observed that the noise moved downstream along the fill line as the valve was opened. After a period of about 3 to 4 hours while filling the upstream (RO) conduit, the noise subsided and then became unnoticeable. After preliminary evaluation, the Corps identified the problem as cavitation. Currently, an interim procedure for operation of the fill line must be followed until the Corps completes the analysis of the problem and provides further recommendations. The interim operation procedure for the fill line is provided in section 7-06.b.

7-03 **Overall Plan for Water Control**. The primary objective of the Seven Oaks Dam Water Control Plan is flood control. There are elements in the flood control plan that address the needs of downstream water users. These mitigation features are contained in the debris pool portion of the operation plan. When conditions warrant, the plan also allows for the adjustment of releases above the debris pool to support downstream environmental mitigation and enhancement plans, and the prototype-testing program. The details of the overall Water Control Plan are provided in section 7-05.

7-04 **Standing Instructions to Project Operator**. Exhibit A contains the standing instructions to the project operator for regulation of Seven Oaks Dam and Reservoir. During periods of normal communications, the dam operators will receive operating instructions from the water control managers. In the event that communication with the water control managers is interrupted, the dam operators should follow the standing instructions. The numerical gate settings provided are based on gate rating curves as shown on Plates 7-02 to 7-06.

7-05 **Water Control Plan**. The Water Control Plan contained in this document was based on the flood control operation plan contained in the report entitled Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 1- Seven Oaks Dam, dated August 1988, augmented to allow the modification of releases at water surface elevation ranges above the debris pool in order to operate for downstream environmental mitigation and enhancement plans when conditions warrant. In addition, when the opportunity exists, the regulation plan also allows minor modifications for the performance of the prototype-testing program. The Water Control plan is illustrated on Plate 7-01 and is described in detail as follows:

a. **Sediment Pool**. At the beginning of each flood season, stop logs will be added, as necessary, to block the lower inlet ports of the multilevel withdrawal system (MWS) wet well. This wet well leads to the minimum discharge line (MDL). Additional stop logs will be added as necessary to block the ports to a point about 20 to 30 feet above the active sediment level. This is done to prevent sediment from entering the intake structure and either blocking or damaging the MDL. The stop logs will form a "dead pool" and no operation will be possible, other than leakage through the stop logs when the water surface elevation is within the sediment pool. Additional stop logs may be installed during the flood season if sediment accumulation is greater than expected. During the initial years of operation, stop logs were installed to block the bottom two rows of intake ports at the MWS, making the invert elevation for the open row of ports 2120.24 feet, NGVD. As sediment accumulates and more stop logs are added, the Sediment Pool will shift upward. The elevation of the top of the sediment pool at turnover is shown also in Plate 7-01.

While the water surface is within the Sediment pool, outflow passes through the MDL. During the dry months, the minimum discharge extension line (MDLE) can be used to bypass the plunge pool. The MDLE is controlled by a 24-inch ball valve. This ball valve should not be used to regulate flows and must be either in a fully opened or fully closed position. Beginning 1 October of each year, releases from the dam within the sediment pool will be limited to a maximum of 3 cfs in order to allow the formation of the debris pool. Since this release rate can only be made through the MDL, the sluice gate is kept in a closed position in order to prevent sediment from entering the main tunnel.

b. Debris Pool. At the beginning of the project life, the design documents call for a debris pool up to elevation 2200 feet, NGVD. Throughout the project life, the allotted storage for sediment accumulation will be filled, new tops of debris pool elevation will be established. Towards the end of the project life, sediments will have accumulated up to the final invert elevation of the reservoir, which is 2265 feet, NGVD. The final top of debris pool elevation at the end of the project life will be the top of the trash rack structure elevation, which is at 2300 feet, NGVD. The adjustment of the debris pool during the project life is described in Section 7-06.a of this manual. Water stored within the debris pool is not available for environmental mitigation and enhancement plans.

As stated in the previous section, releases from the dam are reduced to a maximum of 3 cfs in order to form the debris pool starting 1 October of each year. This rate is to continue until the water surface elevation reaches the top of the debris pool elevation. During the first major storm of the year, if the water surface is expected to exceed the top elevation of the debris pool, preparation for releases through the main tunnel shall be made. This would entail equalizing the pressure between the main wet well and the MDL wet well, opening the sluice gate, and seating the RO and low flow gates. Procedures to perform these steps are outlined in Section 7-06.c. titled "Operating the Sluice Gate". Once opened, the sluice gate may remain open through the remainder of the flood season.

The debris pool is held until the end of the flood season, when it is drained on a schedule established in cooperation with the downstream water agencies during the development of the Phase II GDM. During the month of June, releases will equal inflow plus 10 cfs, and during the months of July and August, releases will equal inflow plus 20 cfs. The process of determining the proper release rate to drain the debris pool will involve trial and error, as the gates and valve settings will need to be constantly adjusted to release the calculated value. Also, these adjustments may be needed on a regular basis to accommodate varying inflow rates. By 1 September, the debris pool shall be completely drained, using higher than calculated release rates, if needed.

c. <u>The Intermediate Pool</u>. The intermediate pool elevations occur between the current top of the debris pool and the sill of the main intake, which is at elevation 2265 feet, NGVD. The Intermediate Pool is that portion of the flood control pool that lies below the sill of the main intake. The releases within this range should match inflow up to the maximum release capability of the project. The combined release capability of the low flow gate and the MDL in this range is approximately 400 to 500 cfs. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. If hydrologic conditions warrant (i.e., no forecasts indicating significant rainfall), releases can be modified/delayed in order to support operations for environmental mitigation and enhancement as discussed in section 7-05h.

d. <u>Main Trash Rack Pool (El. 2265 to 2299 feet, NGVD)</u>. The trash racks protecting the main intake are located between elevations 2265 and 2292.5 feet, NGVD. Within this range, releases are based only on the rising and falling pool elevations at Seven Oaks Dam. During the pool rising stages, releases, if required, will be cut back to a release that is considered to be the maximum safe rate through the MDL when the water surface elevation is between elevations 2265 and 2299 feet, NGVD. The reason for this is to avoid drawing floating debris into the trash racks and possibly rendering the main outlets inoperative. The 2299 elevation allows for sufficient submergence of the trash rack to avoid vortex formation. The maximum safe release rate, when the pool is rising, will be determined by project operating experience but is theoretically on the order of 50 cfs. During falling stages, releases will be made in accordance with the project design schedule as shown on Plate 7-01. These are theoretical maximum safe rates ranging up to 2000 cfs. If project experience indicates that floating debris is less of a problem than anticipated, the falling pool release rates may be increased. Conversely, if operational experience indicates that floating debris is more of a problem than anticipated then falling pool rates may be decreased. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. If hydrologic conditions warrant, releases can be modified/delayed in order to support operations for environmental mitigation and enhancement.

e. <u>Flood Control Pool (El 2299 to 2580 feet, NGVD)</u>. This is the pool between elevations 2299 feet, NGVD and the spillway crest at elevation 2580 feet, NGVD. Within the flood control pool, release rates from Seven Oaks Dam are based on concurrent conditions at Prado Dam. During flood events, Seven Oaks Dam will store water destined for Prado Dam as long as the reservoir pool at Prado reservoir is rising, and the pool at Seven Oaks Dam is not approaching the spillway. Once the reservoir water surface elevation at Prado Dam reaches its peak and starts to recede, Seven Oaks Dam releases will be made based upon the Seven Oaks Dam pool elevation, ranging from a minimum of 2,000 cfs at elevation 2299 feet, NGVD up to the maximum rate of 7,000 cfs at elevation 2580 feet, NGVD. Plate 7-01 contains the Water Control Diagram, which identifies the release schedule within this elevation range. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. It is important to note that within most of this range, the intake structure deck at elevation 2302 feet, NGVD, which is where the sluice gate control is located, will be submerged. If hydrologic conditions warrant, releases can be modified/delayed in order to support operations for environmental mitigation and enhancement.

f. Spillway Surcharge (El 2580 to 2604 feet, NGVD). Above elevation 2580 feet, NGVD uncontrolled releases over the spillway occur. During rising stages when uncontrolled releases are less than 7,000 cfs, releases from the outlet works will be adjusted so that the total project release (combination of spillway and outlet works releases) equals 7,000 cfs. When uncontrolled releases are greater than 7,000 cfs, no outlet works releases will be made. The spillway rating curve is shown on Plate 7-07. The maximum spillway design discharge is 180,000 cfs at elevation 2604.4 feet, NGVD, a surcharge depth of 24.4 feet. During falling stages, the outlet works gates can be adjusted to attempt to maintain the maximum spillway release rate resulting during the event, so as to assure the quickest evacuation of the remaining surcharge volume in anticipation of another significant flood.

g. Initial Reservoir Filling Plan. The Initial Reservoir Filling Plan is contained in a document entitled, "Initial Reservoir Filling Plan Seven Oaks Dam, San Bernardino County, California", dated July 2002. This plan presents a guide for surveillance of the Seven Oaks Dam project during periods of reservoir filling. It outlines inspection procedures, procedures for identifying warning signs of distress, actions to be taken, and data to be collected and analyzed. Visual inspections are required as new maximum reservoir water surface elevations or "critical elevations" are achieved. Geotechnical monitoring is then required to confirm the integrity of the embankment and the performance of the system of seepage monitors and controls. If these "critical elevations", which are determined prior to the start of each flood season, will be exceeded, the water control managers shall notify the personnel responsible for performing inspections as specified in the Initial Reservoir Filling Plan. A copy of the Initial Reservoir Filling Plan is included in this manual as Exhibit I.

h. <u>Seven Oaks Dam Environmental Regulation</u>. The construction, operation, and maintenance of Seven Oaks Dam required the determination of mitigation/enhancement for environmental impacts including those to endangered species. Due to limited knowledge of the habitat needs of endangered species downstream of the dam, and concerns related to what are the best measures to ensure survival of endangered species, Section 7 (of the Endangered Species Act) consultation with the USFWS resulted in a proposed array of alternative mitigation and enhancement measures. Therefore, operation of the dam includes mechanical movement of sediment deposited behind the dam to the downstream channel, physical measures in the downstream channel to generate periodic flooding of the overbank floodplain to mimic the pre-dam hydrologic processes (scour and deposition) upon which the endangered species are dependent, and monitoring of the ecological health of the endangered species.

A multi-agency steering committee such as the Woolly Star Preserve Area (WSPA) Steering Committee will use adaptive management techniques to annually determine and define for the project operator an environmental regulation to be followed should sufficient flood runoff occur. An example of this regulation may be that the pool within the reservoir will be held longer so that additional head will be available for releases greater than what is schedule in the water control plan. The WSPA, the Local Sponsors, and the U.S. Army Corps of Engineers will meet annually to adjust the environmental regulation plan as necessary. For instance, water might be retained during and immediately after a storm event for a period of several days, or a few weeks, while temporary diversion dikes are constructed downstream. Then, when the water is released, the temporary diversion dikes would direct flows onto specific areas of the WSPA or other target areas. Water may be stored behind the dam for a slightly longer period and, or at a higher elevation than would otherwise be required for flood control, to accomplish these mitigation aspects of the overall operation.

i. <u>Prototype-Testing Program and Instrumentation</u>. Because of the high head and complicated design of the structure, a model study was conducted at the U.S. Army Engineer Waterways Experiment Station (ERDC-WES) to evaluate the hydraulic design be measuring dynamic hydrostatic pressures in the outlet structure. In this study, zones of potential cavitation and air demand at the mid-tunnel were determined. At the same time, the adequacy of the intake tower, the outlet plunge pool, and the exit channel design was also evaluated. Also, the extent of scour and the need for protection downstream of the structure, and the discharge characteristics of the regulation outlet (RO) gates with various operating scenarios were determined from the model. As a result of this model study, a prototype testing program was developed.

Under the Water Control Plan, a prototype-testing program will be implemented, to gather data and verify actual performance of the outlet works with design parameters derived from the model study, once during a low reservoir condition as early in the project life as practical, and once during a high reservoir condition. The water control managers need to inform the Los Angeles District, Reservoir Regulation Section, so that coordination can be made with the Corps' Portland District Office in Portland, Oregon, in advance, every time that the opportunity for testing is expected to exist. The water control managers must maintain the Waterways Experiment Station (WES) POC's and telephone numbers each year prior to the start of the flood season. Exhibit F contains the details about the testing program and the instrumentation installed at the dam. A layout of the prototype hydraulic instrumentation is also on Plate 2-24.

7-06 Other Operational Requirements. The following are Seven Oaks Dam operational design criteria that need to be followed in the implementation of the Water Control plan in order to assure that the dam's safety is not jeopardized:

a. Adjustment of the Debris Pool. The debris pool was designed to accommodate estimated sediment accumulation, without the need for removal, through the 100-year service life of the project. According to the original design documents, the initial debris pool upper boundary is at elevation 2200 feet, NGVD, and the ultimate top elevation is at 2300 feet, NGVD. The design documents also show the initial debris pool to have a total storage volume of 2,968 acre-feet, and the ultimate debris pool to have a total storage volume of 839 acre-feet. During the life of the project, as the reservoir sediment level rises, stoplogs will be installed about 20 to 30 feet above the active invert. This will raise the elevation of the lower boundary of the debris pool. As a result, the top of the debris pool needs to be adjusted to maintain a storage volume between 839 and 2968 acre-feet until it reaches the ultimate elevation of 2300 feet, NGVD. At a minimum, the current top of debris pool elevation shall be adjusted whenever it is suspected that the current debris pool storage is reduced to near the ultimate storage value of 839 acre-feet. A reservoir survey should be conducted and the upper debris pool boundary shall be set to an elevation where the new debris pool storage will be approximately equal to the initial storage (2,968 acre-feet). Beyond the minimum, the debris pool may be adjusted as often as is desired by the water control managers in consultation with the Corps of Engineers, but shall in no case be less than 800 acre-feet nor exceed 3,000 acre-feet.

b. Procedures for Avoiding Cavitation at the 12-inch Recharge Line (Filling Line). As mentioned in section 7-02.d., a problem with noise in association with cavitation was discovered at the 12-inch recharge line when the water surface elevation within the MWS wet-well exceeded elevation 2130 feet, NGVD. An interim procedure, until the Corps completes the analysis of the problem and provides further recommendation, shall be followed to temporarily relieve this problem. The procedure is as follows:

1. Monitor the head in the MDL using either of the cone valve piezometers with all flows shut off.
2. As soon as there is sufficient head in the MDL for the filling line to operate (approximately 2095-2100 feet, NGVD), open the filling line to pressurize the upstream portion of the main tunnel. When the RO gates are sufficiently submerged, seat the RO and LF service gates by opening them one at a time to 0.1 ft for a few seconds then closing them.
3. Leave the filling line open for the remainder of the flood season. Keep the service gates closed for the remainder of the flood season except

when making releases when the pool is above 2130 feet, NGVD. The pool inside the main wet well should match the pool inside the MWS wet well fairly well even with the sluice gate closed. This should maintain sufficient back-pressure to avoid or minimize cavitation in the filling line. Releases from the cone valves will need to be adjusted in coordination with the downstream water users to compensate for leakage through the service gates.

4. When the MWS wet well water surface elevation is below elevation 2130, the sluice gate should be closed to avoid having sediment and floating debris enter the main tunnel.
5. When the MWS wet well water surface elevation is above 2130, the sluice gate should be open so that the outlet works will be capable of passing releases greater than 90 cfs. [Note: As a precaution, prior to opening the sluice gate, ensure that the heads between the MWS wet well and the main wet well are balanced. Refer to section 7-06.c.4.]
6. When emptying the debris pool after a flood event, as the pool drops below 2130, NGVD, make sure that the main gates are closed before closing the sluice gate. This will assure that there is sufficient pressure to seat the gates.
7. If cavitation in the fill line becomes significant even with the fill line valve open, the fill line valve should then be closed. If fill line valve is closed, it should be reopened as part of step 6, after closing the main gates and before closing the sluice gate. The dam tenders should keep detailed notes of any cavitation that occurs in the filling line, including the start times, stop times, readings from all the piezometers and a qualitative description of the cavitation (i.e., minor, severe, etc.). These notes should be entered into the operations report form (Figure 5-01) and also reported to the water control managers.

c. Operating the Sluice Gate. The procedure for operating the sluice gate can be found within the Seven Oaks Dam Operation, Maintenance, Repair, Replacement &

Rehabilitation (OMRR&R) Manual, Appendix C (Standard Operating Procedures), and also summarized within this section. The wet well sluice gate is located in the multi-level withdrawal system wet well at the entrance to a 6'x6' conduit that leads to the main wet well (Plate 2-08). During periods of low flow, the MDL is used to pass flows and the sluice gate is normally closed to prevent flow and damaging sediment from entering into the main wet well and the main tunnel. As inflow increases and the water surface elevation rises, the RO and LF gates in the main tunnel are needed to discharge at rates higher than the MDL alone can pass. In order to use the main tunnel when the water surface elevation is lower than 2265 feet, NGVD, the sluice gate needs to be opened. Prior to opening the sluice gate, however, a head differential of no more than 2.5 feet between the MWS wet well and the main wet well should exist[1]. If the 12-inch Recharge Line (filling line) has been closed, and the tunnel is dry, the following outlined procedures must be followed for operating the sluice gate prior to and after the use of the main tunnel for releases (as project experience is gained, this procedure shall be modified, if necessary):

1. Verify that the RO and LF gates are in a closed position. Cut off MDL releases using either the two cone valves located in the valve structure, or the 24-inch MDL ball valve located in the gate chamber. Normally the cone valves will be used as the ball valve is for emergency shut off only.
2. As soon as there is sufficient head in the MDL for the filling line to operate (approximately 2095-2100 feet, NGVD), open the filling line to pressurize the upstream portion of the main tunnel. When the RO gates are sufficiently submerged (approximately 2109.1 feet, NGVD), seat the RO and LF service gates by opening them one at a time to 0.1 ft for a few seconds then closing them.

[1] When balancing the head below elevation 2120 ft, NGVD, piezometers located just upstream of the MDL valves and the main tunnel outlet gates can be used to determine when the required head differential is achieved prior to operating the sluice gate, as described. Piezometers located within the main wet well and the MWS wet well can read the head differential starting at elevation 2120 ft, NGVD.

3. Allow the tunnel to fill completely and let the water surface elevation within the main wet well build in order to balance the head with the MWS wet well.
4. The dam tenders are able to determine water surface elevations within the main wet well and the MWS wet well through the digital readout of the transducers that sense the pressure in the piezometer tubes located just upstream of the MDL valves and the main tunnel outlet gates. *[Notes: 1) All gates must be closed in order to obtain proper digital readouts from the transducers that sense pressure from the piezometer tubes; 2) the piezometer lines need to be bled of air in order to obtain an accurate reading. Refer to Exhibit E for instructions on bleeding piezometer lines; 3) Refer to Table 2-1 for determining which operational piezometer can be used for taking readings.]*
5. Upon achieving a balanced head where the water surface differential does not exceed 2.5 feet between the main tunnel wet well and the MWS wet well, open the sluice gate completely.
6. The LF and/or the RO gates can now be used for discharging higher flows. The rate of release change restrictions and the minimum and maximum allowable gate opening restrictions described in sections 7-16 and 7-17 should be followed.

d. <u>Dewatering the Main Tunnel</u>. At the end of the flood season when it is expected that the RO and LF gates will no longer be needed, the sluice gate should be closed and the main tunnel drained. The following procedures shall be followed:

1. Close the MDL valves.
2. Close the RO and LF gates.
3. Close the sluice gate.
4. Close the filling line valve.
5. Open the LF or RO to drain the remaining water in the tunnel, at a rate that is as close as possible to the required release rate until the tunnel is drained.

6. Open the MDL valves to the required release rate.

There is a 12-inch diameter RO air vent pipe that serves as the vacuum breaker if the main tunnel is dewatered while the bulkhead is in place. The air vent pipe extends from the RO gate to the top of the intake structure. The air intake contains a float to prevent debris from plugging the air pipe when the intake structure is inundated. No operation is required for the air vent pipe function.

e. <u>Dewatering the Downstream MDL Conduit</u>. For maintenance, inspection and emergency purposes, dewatering of the MDL conduit downstream of the ball valve is accomplished as follows:

1. Shut off flow in the MDL using the two cone valves located in the valve structure.
2. Close the ball valve located in the gate chamber.
3. Open the two cone valves in the valve structure to dewater the downstream end of the MDL.

Note: A combination vacuum breaker/air release valve is located downstream of the ball valve to provide relief during emptying or filling of the downstream MDL conduit. The siphon breakers function automatically, allowing air to enter the MDL during closure of the ball valve to prevent collapse of the MDL pipe.

The 4-inch diameter embedded air vent pipe serves as the vacuum breaker if the MDL is dewatered while the MDL bulkhead is in place. The MDL air vent pipe extends from the upstream portion of the 3-foot diameter MDL pipe, and connects with the RO air pipe just below the top of the intake structure. No operation is required for the air vent pipe function.

f. <u>Procedures for Installing and Removing the Bulkhead Gate for the Upstream Main Conduit</u>. Outlet bulkhead guide slots are located in the wet well at the entrance to the main conduit. When not in use, a bulkhead is stored inside the storage slot on the intake structure. The bulkhead provides the capability to seal and drain the main tunnel to allow inspection or maintenance activities in the portion of the main tunnel upstream of the RO gates. The bulkhead is lowered into or raised from the bulkhead guide slots using a truck mounted mobile crane positioned on the deck of the intake structure. A balanced head condition must exist on either side of the bulkhead gate when installing or removing the bulkhead gate. The elevation of the deck of the intake structure is at 2302 feet NGVD, which is the highest water surface elevation at which the bulkhead can be installed or removed. The bulkhead has been designed to withstand a maximum of 202 feet of head behind the reservoir, however, if the bulkhead is in place and there is a possibility of the water surface exceeding elevation 2302, it should be removed immediately. If installation of the bulkhead gate is not possible, then the emergency gates (ROG3, ROG4, and LF2) can be lowered in order to inspect the service gates.

The following are steps to be followed for installing the RO maintenance bulkhead. Reference must be made to the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-2, for detailed installation procedures.

1. If the sluice gate is open, close it in preparation for dewatering the main tunnel, as outlined in section 7-06.d.
2. If the reservoir water surface elevation is below elevation 2265 feet, NGVD, allow the main conduit to drain by opening either the RO or LF gates. If the reservoir water surface elevation is above elevation 2265 feet, NGVD, close the RO and LF gates to create a still water condition.
3. Once the conduit is empty or a still water condition exists, lower the bulkhead into the wet well using a truck mounted mobile crane positioned on the deck of the intake structure.

If there is water in the upstream conduit, drain the upstream portion of the tunnel. In order to do this, first check the vent line to make sure it is clear and then gradually open the RO and/or LF gates.

Once inspection or maintenance is complete and the bulkhead needs to be removed. The following are steps, depending on the conditions of the reservoir and the main wet well, to be followed for installing the RO maintenance bulkhead. Reference must be made to the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-2, for detailed removal procedures:

Condition A – No Water in the Main Wet Well

1. If the main wet well is dry, remove the bulkhead using a truck mounted mobile crane positioned on the deck of the main intake structure.

Condition B – Water in the Main Wet Well – Pool above 2265 feet NGVD

1. If there is water in the main wet well close RO and LF gates. Make sure the sluice gate is open.
2. Cut off MDL releases using the cone valves located in the valve structure.
3. Fill the upstream tunnel using the 12-inch filling line (Refer to section 7-06.b.)
4. Pressure between the main wet well and the conduit downstream of the bulkhead gate will be equal when there is no more flow through the filling line and/or when the piezometer in the main wet well reads the same as the piezometer just upstream of the gates. The dam tenders are able to obtain readouts for these piezometers which are located at the gate chamber and at the control house downstream of the outlet tunnel.
5. When pressure is equal between the main wet well and the conduit downstream of the bulkhead gate, remove the bulkhead gate using a

truck mounted mobile crane positioned on the deck of the intake structure.

Condition C -- Water in the Main Wet Well - Pool below elevation 2265

There are two scenarios where this condition could occur: 1) The main wet well was initially drained but leakage has partially filled it, and 2) The main wet well water surface elevation has fallen below 2265 while the bulkhead has been in place. If the difference in elevation between the main wet well and the MWS wet well is less than 2.5 feet, then the sluice gate can be opened and the procedures for Condition B can be followed. If the difference is greater than 2.5 feet, then two further scenarios can occur: 1) the water surface in the main wet well is higher than in the MWS wet well and 2) the water surface in the main wet well is lower than in the MWS wet well.

It is possible, but unlikely that the water surface in the main wet well will be more than 2.5 feet higher than the water surface in the MWS. This scenario can be avoided if the valves in the MDL are closed and or the sluice gate is opened if the reservoir pool falls below 2265 feet, NGVD while the bulkhead is in place. If for some reason this scenario does occur, there is no direct way to balance the water surfaces in the main wet well and the MWS. The valves in the MDL should be closed and then water control managers will have to wait until leakage through the aggregate access bulkhead, the sluice gate and the bulkhead gate equalize the two water surfaces. If this doesn't work then other possible solutions would be: 1) to pump water out of the main wet well until the water surfaces come within 2.5 feet of each other and 2) use the filling line to fill the main tunnel, close the filling line valve, then pump additional water into the air vent line to increase the pressure in the upstream tunnel to match the main wet well. Then the bulkhead gate could be removed.

A more likely scenario would be that the water surface in the main wet well is more than 2.5 feet lower than that of the MWS. This could happen if the reservoir pool is below elevation 2265 and significant amounts of water leak from the sluice gate and the aggregate access bulkhead into the main wet well. In this case the following procedure should be used:

1. Close the MDL valves and the LF and RO service gates.
2. Open the filling line valve.
3. Carefully monitor the piezometers that measure the water surface elevation in the main tunnel (O-6, O-7, and O-8). Close the filling line valve when the head in the tunnel matches the water surface in the main wet well.
4. Use a truck mounted crane to remove the bulkhead gate.

g. Procedures for Installing and Removing the Bulkhead Gate for the Upstream Conduit of the MDL. The procedure for installing and removing the MDL bulkhead gate can be found within the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-3, and also summarized within this section. Bulkhead guide slots are located in the MWS wet well at the entrance to MDL conduit in order to allow inspection and maintenance of the upstream portion of the MDL conduit. Since the elevation of the deck of the MWS is at 2276 feet NGVD, this is the highest water surface elevation at which the bulkhead can be installed or removed. The bulkhead has been designed to withstand a maximum 202 feet of head behind the reservoir should the water surface start to rise after it is in place. If there is a possibility of the water surface rising to elevation 2276 feet NGVD while the bulkhead is in place, it should be removed immediately. Additional information regarding the bulkhead is provided within the Seven Oaks Dam Operation and Maintenance Manual, dated August 2002.

1) Installing the MDL Bulkhead. When installing the bulkhead, a dry or still water condition must exist. If there is water in the reservoir a still water condition can be achieved by closing the cone valves controlling the MDL and by closing the RO and LF gates controlling the main conduit. Note that the sluice gate must be open while the MWS bulkhead is in place. If the sluice gate is not open it will not be possible to balance head between the two wet wells with the MDL out of service. If head between the wet wells cannot be balanced, then the sluice gate cannot be opened and the filling line cannot be used to balance heads upstream and downstream of the bulkhead. If these heads cannot be balanced, then it will not be possible to remove the bulkhead. Refer to Section 7-06.c. for procedures to open the sluice gate. Once a still water condition has been achieved and the sluice gate is open, the bulkhead can be installed in its guides just above the intake and can be lowered by a truck mounted crane positioned on the intake structure deck. The MDL can then be drained by opening one or more of the cone valves. A 3-inch-diameter vent line connects to the MDL conduit just downstream of the bulkhead for air to enter when emptying the MDL conduit.

2) Removing the MDL Bulkhead. In order to remove the MWS bulkhead, a balanced head condition must exist upstream and downstream of the bulkhead. This is achieved by watering up the MDL, and connecting it hydraulically with the MWS wet well. In order to do this, first the cone valves controlling the MDL and the LF and RO gates controlling the main conduit are closed. Then the butterfly valve controlling the 12-inch filling line is opened. When flow through the filling line ceases a balanced head condition will exist. A 3-inch-diameter vent line connects to the MDL conduit just downstream of the bulkhead to allow air to escape when filling the MDL conduit. If, for some reason it is not possible to water up the MDL with the filling line it can also be watered up by pumping water in through the air vent. If hydraulic communication cannot be achieved between the MWS wet well and the MDL, piezometers O-5, O-9 and O-10 can be used to determine when a balanced head condition has been achieved. Once a balanced head condition has been achieved, the bulkhead can be raised by a truck mounted crane positioned on the intake structure deck.

h. Operational Hydraulic Instrumentation. Table 2-1 and Plate 2-24 individually list and show, respectively, the operational hydraulic instruments, their locations, types, intake elevations, and elevations of the pressure transducers. These piezometers and pressure transducers can be utilized to verify reservoir water surface elevation, head differential between the wet well and the MWS wet well, check for trash blockage, among other uses. If the tap for a piezometer dries out between readings, air will enter the line and the piezometer will have to be "bled" before the next reading can be taken. Exhibit E contains the procedures for bleeding piezometer lines.

i. Channel Observation. Prior to making significant releases, the Seven Oaks Dam water control managers will notify the San Bernardino and Riverside Flood Control Districts. Each respective flood control districts will assign channel observers at their discretion. The downstream flood control districts will be asked to report any downstream problem areas, the available channel capacities, and other observed information that is vital to the operation of Seven Oaks Dam.

7-07 Recreation. The Water Control Plan does not include regulation of the dam for recreational purposes.

7-08 Water Quality. The Water Control Plan does not include operation for water quality. During emergencies, however, the water control manager can operate Seven Oaks Dam to contain pollution spills either in or dilute spills downstream of Seven Oaks Dam and reservoir. The local sponsors perform water quality monitoring in the reservoir as part of their operation and maintenance responsibilities. Details of this monitoring may be found in the Seven Oaks Dam Operations and Maintenance Manual. The U.S. Fish and Wildlife Service, the Santa Ana Watershed Project Authority (SAWPA), the California Regional Water Control Board, and local water agencies monitor the various aspects of water quality in the Santa Ana River basin.

7-09 Fish and Wildlife. The Water Control Plan includes provisions to allow operation above the debris pool for environmental mitigation and enhancement, specifically for the listed species downstream. The water used for this purpose would come from the flood flows stored in the intermediate, main trash rack, and the flood control pools. Details of this operation are contained in section 7-05h.

7-10 Water Supply. The operational objectives of the Seven Oaks Dam Water Control Plan include flood control, dam safety, mitigating for impacts to downstream water users and environmental mitigation and enhancement. Water supply is not an operational objective of the Seven Oaks Dam Water Control Plan. Details of how the water control plan mitigates impacts to downstream water users may be found in section 7-05.b.

7-11 Hydroelectric Power. Seven Oaks Dam is not operated for the generation of hydroelectric power.

7-12 Navigation. There is no navigation possible at Seven Oaks Dam reservoir or on the Santa Ana River.

7-13 Drought Contingency Plans. Seven Oaks Dam is a Section 7 project. It does not require a Drought Contingency Plan.

7-14 Emergency Action Plans. The Emergency Action Plan for Seven Oaks Dam is contained in a document entitled "Emergency Action Plan for Seven Oaks Dam, San Bernardino County, California", dated June 2001. The scenarios developed include a dam breach and spillway flow conditions. Flood inundation maps downstream of Seven Oaks Dam are included in the document. The plan also covers identification of impending and existing emergencies, notification of other parties about impending or existing emergencies, emergency operations and repairs, and post earthquake response procedures. Copies of this plan are maintained in the OCPF&RD Storm Operation Center and also in the Corps of Engineers, Reservoir Regulation Section, Reservoir Operation Center.

7-15 Deviation from Normal Regulation. Deviations from the approved Water Control Plan contained in this manual may be necessary at times because every possible circumstance cannot be anticipated by the plan. Deviations from the approved water control plan are allowed under some circumstances to address unforeseen and unique circumstances. They are not intended as a means for identifying or initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs.

Because of the often competing goals and complex interactions of interested groups and agencies, even seemingly inconsequential deviations from an approved plan can lead to unforeseen environmental and legal complications. Therefore, except during emergencies, all deviations from this Water Control Plan require prior approval from the U.S. Army Corps of Engineers' South Pacific Division office in San Francisco, California (SPD). Requests for Deviations from the approved Water Control Plan will be submitted to SPD through the U.S. Army Corps of Engineers Los Angeles District office (SPL). The SPD regulation "Guidance on the Preparation of Deviations from Approved Water Control Plans" (CESPD R 1110-2-8) dated 12 September 2002 provides guidance for preparing deviation requests, and outlines a minimum set of considerations that need to be addressed when requesting a deviation from the approved plan contained in this manual. Exhibit G contains a copy of CESPD R 1110-2-8. This guidance defines two forms of deviations, namely, emergency deviations and planned deviations. These two types of deviations are summarized below.

a. Emergency Deviations. An emergency deviation from the approved Water Control Plan is one that is required due to an emergency situation. An emergency situation is defined in CESPD R 1110-2-8 as a situation in which there is a potential for injury, loss of life, threat to the project, or other serious hazards; but furthermore, also demanding immediate action, such that time constraints render impractical notification to the Corps. Depending upon the need for immediate action, an emergency situation could include: drowning and other accidents, assistance to local authorities responding to an emergency (e.g., police and fire departments), failure of operations facilities, chemical spills, treatment plant failures, and other temporary pollution or water quality problems. Since water control actions necessary to abate the problem are to be taken immediately, emergency deviations do not require prior approval from SPD. However even in an emergency situation, the Corps needs to be notified of the action as soon as possible, and the notification shall comply with all the applicable requirements as outlined in CESPD R 1110-2-8 (Exhibit G). Notifications shall be made by the Seven Oaks Dam water control managers to the SPL Reservoir Regulation Section, which will in turn notify SPD.

b. Planned Deviations. Planned deviations cover all other deviations not addressed by an emergency deviation. Planned deviations require prior approval from the Corps' Division Office. Deviation requests are to be made by the project owner through the SPL Reservoir Regulation Section. Costs incurred by the Corps of Engineers associated with the processing of a deviation request are the responsibility of the local sponsors. Information and analysis required in a deviation request package are outlined SPD R 1110-2-8 (Exhibit G).

7-16 Rate of Release Change. The maximum permissible rate of change in the release rate depends upon the magnitude of the current release. When increasing or decreasing the release, consideration shall be given to the possibility of downstream impacts such as structural damage to downstream improvements, levee or bank sloughing due to rapid bank de-watering and public safety. Furthermore, the water control managers, or project operators, prior to any significant changes in releases, must notify other government agencies, and affected parties (refer to sample notifications list in Exhibit H). Table 7-1 outlines the recommended maximum permissible rate based on SPL experience with similar projects having unimproved downstream channels. Note that conditions in the downstream channel (erosion, overbank flow, etc.) may require a slower rate of change of release. The project operators and/or channel observation teams may be directed by the water control managers to observe the effects of increased flows upon downstream channel conditions in order to determine if any adjustments are necessary in the rate at which releases are changed.

7-17 Minimum and Maximum Gate Openings. The minimum and maximum gate openings for both the RO and LF gates are shown on Table 7-2 below. A minimum gate opening is required to avoid gate vibration. Small gate openings coupled with high velocities can result in a water surface that remains close to the bottom surface of the gate lip. This flat water surface can intermittently contact the bottom of the gate lip causing the point of control to shift rapidly, resulting in vibration and damage to the gate. A maximum gate opening is required in order to minimize the possibility of pressurizing the downstream gate passage and losing control at the gates. If the downstream passage pressurizes it could result in zones of low pressure and interference with the aeration of the gate discharges. This would increase the risk of cavitation damage.

Table 7-1. Maximum Permissible Rate of Release Change at Seven Oaks Dam

Discharge (cfs)	To Increase Flow (cfs/hour)	To Decrease Flow (cfs/hour)
0 – 200	NO RESTRICTION	NO RESTRICTION
UP TO 500	250	250
500 - 4,000	500	500
4,000 - 8,000	1000	1000

Table 7-2. Minimum and Maximum Gate Openings Seven Oaks Dam

Gate Type	Minimum Gate Opening (ft)	Maximum Gate Opening (ft)
Main Regulation Outlet (RO)	0.75	6.8
Low Flow (LF)	0.5	2.8

VIII. EFFECT OF WATER CONTROL PLAN

VIII - EFFECT OF WATER CONTROL PLAN

8-01 **General**. The Water Control Plan contained in this manual is an adapted version of the design document plan as specified in the Phase II GDM, which provides objectives for flood control, dam safety, and mitigating for impacts to downstream water users. If hydrologic conditions warrant, flexibility has been added to this plan to allow measures for environmental mitigation and enhancement purposes. These measures will be further defined and overseen by a collaborative multi-agency committee of environmental experts and agency officials and will be modified periodically based on species and habitat monitoring.

8-02 **Flood Control**. Seven Oaks Dam was designed to help provide flood protection on the lower Santa Ana River below Prado Dam by reducing the peak inflow and volume into Prado reservoir. In addition, Seven Oaks Dam provides flood control protection to the communities between Seven Oaks and Prado Dams. The dam was designed to control the Reservoir Design Flood (RDF)) without spilling, and to pass the Probable Maximum Flood without overtopping the dam embankment. These theoretical floods are discussed as follows:

a. **Reservoir Design Flood (RDF)**. The RDF generally is based on the results of a planning study that establishes the project level of protection that provides the maximum net project benefits. In the case of Seven Oaks Dam, trial RDFs were based upon ratios of the Standard Project Flood (SPF).

The SPF represents the flood that would result from the most severe combination of meteorologic and hydrologic conditions considered reasonably characteristic of the geographical area. The SPF is normally larger than any past-recorded flood in the area and would be exceeded in magnitude only on rare occasions. The SPF, therefore, constitutes a standard for design that provides a high degree of flood protection.

The SPF is generally computed by determining the following: (a) unit-time precipitation for each subarea; (b) effective precipitation by subtraction of loss rates considering imperviousness cover as applicable; (c) subarea surface-runoff hydrograph by application of subarea synthetic unit-hydrograph values to the effective unit period precipitation; (d) subarea total-runoff hydrograph by addition of base flow; and (e) total flood hydrograph by reservoir and channel routing, subtraction of percolation losses, and combining subarea hydrographs as required. The SPF peak discharge for the Seven Oaks Dam drainage area was computed using pertinent subarea drainage characteristics, and by critically centering the January 1943 general standard project storm over the San Bernardino Mountains upstream of the damsite. The SPF peak inflow for this site was calculated to be 82,000 cfs with a 4-day volume of 110,500 acre-feet.

Routing of the SPF itself results in a calculated maximum reservoir pool elevation of 2,574.3 feet, NGVD. After the SPF was derived, a benefit-cost analysis was conducted using ratios of the SPF to represent events of various frequencies in order to determine the optimum level of protection. The result of this analysis determined that a project that controls an event resulting in a maximum pool elevation of 2,580 would provide the maximum net benefits. This event was therefore the RDF and established the project spillway crest elevation. The elevation of 2580 feet, NGVD, is 5.3 feet higher than the SPF's maximum water surface elevation. The RDF, therefore, is slightly larger than the SPF. The RDF peak inflow, peak outflow, and total volume were linearly adjusted from the SPF values to 85,000 cfs and 7,000 cfs, and 115,000 acre-feet respectively. Plates 8-01 and 8-01A show the SPF and RDF inflow and outflow hydrographs for Seven Oaks Dam.

b. Probable Maximum Flood. The probable maximum flood (PMF) is defined as the flood that can be expected from the most severe combination of meteorologic and hydrologic conditions considered to be reasonably possible in the region. The probable maximum flood, as the name implies, is an estimate of the upper boundary of flood potential for a drainage area. This hypothetical flood was used for designing the spillway and setting the top of dam elevation for Seven Oaks Dam.

The description of the official Probable Maximum Flood and the reservoir routing used in the design of the Seven Oaks Dam and the Prado Dam spillways is contained in a Corps' document entitled, <u>Probable Maximum Flood Update, Supplement No. 1 to Design Memorandum No. 1, Phase II GDM on the Santa Ana River Mainstem including Santiago Creek</u>, dated August 2001 and is summarized as follows:

The Probable Maximum Precipitation (PMP) for the drainage areas for both dams was based on a general winter storm, with average depths for 1-hr, 12-hr, 24-hr, 48-hr, and 72-hr of 3.68 inches, 22.68 inches, 30.65 inches, 42.30 inches and 45.97 inches for Seven Oaks Dam, and 1.36 inches, 11.21 inches, 24 inches, 23.77 inches, and 25.98 inches for Prado Dam. Routing of this PMF resulted in a peak inflow of 185,000 cfs and a total inflow volume of 326,000 acre-feet at Seven Oaks Dam, and a peak inflow of 630,000 cfs and a total inflow volume of 1,300,000 acre-feet at Prado Dam. At Seven Oaks Dam, the resulting maximum water surface elevation was 2604.7 feet, NGVD with the peak outflow of 180,000 cfs. At Prado Dam, the resulting maximum water surface elevation was 587.3 feet, NGVD, with the peak outflow of 480,000 cfs. Plate 8-02 shows the PMF routing at Seven Oaks Dam.

8-03 <u>Recreation</u>. Seven Oaks Dam is not operated for recreation purposes, and since there is very limited public access, recreation opportunities in the area in and around Seven Oaks reservoir are limited to hiking, backpacking, and other nature related activities, to be consistent with the San Bernardino National Forest management plan. The Seven Oaks Dam Water Control Plan has a no significant effect on recreation.

8-04 <u>Water Quality</u>. Due to the hydrology of its watershed, long-term impoundment of water at Seven Oaks reservoir is unlikely. The reservoir is expected to be empty during many months for the majority of an average year. The Water Control Plan includes the formation and maintenance of a debris pool during the flood season. The top elevation of the debris pool will be periodically adjusted to provide sufficient pool volume and water depth to induce sediment to deposit away from the intake structure and to at least partially protect the multi-level withdrawal structure trash racks from floating debris. As a result, the reservoir forms a still (low velocity) impoundment that avoids the movement of heavy bedload material into the outlet works. Starting on 1 October of each year, releases will be limited to a maximum of 3 cfs, creating an impoundment for the debris pool. The debris pool is to be drained starting in June and should be drained by the end of August of each year. In theory, an impoundment could exist for eleven months during a very wet year.

In general, there is no significant effect on long-term water quality anticipated at Seven Oaks Reservoir. However, during a very wet year, water quality could be degraded by extended impoundment in long, deep storage pools, primarily within the debris pool, especially during the summer months when higher temperatures cause stratification and associated low levels of dissolved oxygen (DO). Along with severe anaerobic conditions, the generation of hydrogen sulfide typically commences when materials containing sulphur (biological detritus and mineral sulfides) are available. Trace metals found in bottom sediments may be released by the lowering of pH, which occurs as a result of anaerobic conditions. Local nuisance conditions, such as algal blooms and mosquito breeding may also occur. Mitigating these adverse effects of impoundment are benefits to water quality including the settling out of suspended solids and detritus. These factors may outweigh those detriments associated with the potential low levels of dissolved oxygen and pH.

The extent to which adverse effects to water quality are realized is highly dependent on the length of retention within the debris pool. During an average runoff year, the debris pool retention may experience stratification if wind action is not strong enough to induce mixing. Also, the frequency of flood flows into the reservoir during the summer will not be sufficient to disrupt the stratification process. Should stratification develop, however, the hypolimnion (layer near the lake bottom) is not likely to become anaerobic. The main reason for this premise is that water from levels at or near the hypolimnion will be released to satisfy downstream requirements during the summer months. Also, the quality of water flowing into the reservoir is good, biological oxygen demand and chemical oxygen demand are generally low, and dissolved oxygen is high. If a portion of the retained water becomes anaerobic, acidic conditions would tend to be counteracted by the buffering capability (high pH) of the inflowing water.

As part of their operation and maintenance tasks, the Local Sponsors will perform water quality monitoring as detailed in the Seven Oaks Dam Operations and Maintenance Manual, Volume I, Part II, Chapter 4, entitled "Environmental Commitments and Mitigation". The results of the water quality monitoring program shall be analyzed each year to determine necessary changes to the following year's monitoring program.

8-05 **Fish and Wildlife**. The U.S. Fish and Wildlife Service has listed the Slender Horned Spine Flower, the Santa Ana Woolly Star, and the San Bernardino Kangaroo Rat, as endangered species. As these species inhabit areas affected by the construction and operation of Seven Oaks Dam, this prompted the need for official consultation with the U.S. Fish and Wildlife Service, as required by Section 7 of the Federal Endangered Species Act to determine what actions could be taken to avoid jeopardizing the continued existence of these species. The operation of Seven Oaks Dam is expected to alter the quality of habitat due to a reduction in flood processes of scour and sand deposition, which are important to the renewal and succession of listed species habitat. The Water Control Plan is mainly based on the original flood control operation as described in the 1988 Phase II GDM/SEIS. That design document included several compensating measures for impacts to the Santa Ana Woolly Star, the Slender Horned Spine Flower, and other listed species. Flexibility was added to this plan, however, to operate the dam to allow additional conservation measures that will further avoid, minimize, or compensate for impacts to these species, as well as newly listed species such as the San Bernardino Kangaroo Rat.

Throughout the effective period of the Water Control Plan, further evaluation and adjustment to the regulation for environmental mitigation and enhancement will be made, as necessary so effects to the endangered species are kept to a minimum. An example of this adjustment may be that the pool within the reservoir will be held longer so that additional head will be available for releases greater than what is scheduled in the water control plan. The Woolly Star Preserve Area (WSPA) Steering Committee, the Local Sponsors, and the U.S. Army Corps of Engineers will meet annually to evaluate and adjust the environmental regulation plan as necessary. The annual environmental regulation will utilize water stored in the Intermediate Pool, the Trash Rack Pool, and the Flood Control Pool, and be consistent with the project flood control operation and safety objectives. For instance, the frequency, duration, and extent of water diversions on the WSPA may be changed over time.

8-06 Water Supply. The Water Control Plan currently does not include or preclude regulation[*] for water supply purposes. The plan may be modified in the future to accommodate water conservation. The contemplated operation of the dam within the debris pool was negotiated with the downstream water users during the preparation of the Phase II GDM in order to mitigate potential impacts of the flood control operation on those users. Releases made from the debris pool during the flood season, and the draining of the debris pool during the summer months mitigates the estimated impacts to downstream water users caused by building the debris pool during the flood season. Above the debris pool, temporary impoundment of water occurs during the wet years. This water, which would have discharged from the canyon at much larger rates under natural conditions, could also incidentally enhance water conservation.

[*] In this manual, the term "regulation" is limited to the decision making process for water control operations at the dam performed by the water control managers.

At this time, neither the Sponsors nor the corps has actively pursued implementation of a program to store water for water conservation purposes. In any given year, water may or may not be available for such purpose after Seven Oaks Dam flood control operation requirements, including biological and endangered species mitigation (i.e., habitat inundation), are met. Implementation of a water conservation program at Seven Oaks Dam would be subject to various conditions, as generally summarized in the "Seven Oaks Dam Water Conservation Feasibility Report and Environmental Impact Statement/Environmental Impact Report, dated June 1997, ("Feasibility Report"), which includes, but is not limited to, the following:

- All hydrological requirements for flood control and related environmental mitigation purposes for Seven Oaks Dam are met before water conservation is implemented. The Corps and Sponsors must ensure that flood control operations, including endangered species requirements, are not adversely affected by any water conservation proposals.
- The interested water agencies, and not the Sponsors or the Corps, are responsible for the costs for assessing the potential impacts of their proposed water conservation program, and to pay for all costs, including potential mitigations costs, associated with a proposed program.
- The water agencies must ensure that all permits and any other applicable authorization necessary to implement their proposed water conservation program have been issued, and pay all Federal and non-Federal costs, including but not limited to all costs associated with acquiring permits and other applicable authorizations, conducting new feasibility studies and further environmental review. A list of permits or other requirements that may be necessary may be found at pages 6-7 and 6-8 of the Feasibility Report.
- The water agencies must ensure that existing water rights are not impacted by their proposed water conservation program, and must acquire additional rights, if necessary, in accordance with existing law and decisions by the SWRCB.
- As the Sponsors are responsible for Seven Oaks Dam operations and maintenance, the Corps will not consider supporting implementation of water

conservation unless requested by the Sponsors. Therefore, the water agencies must enter into an agreement with the Sponsors to implement a water conservation program at Seven Oaks Dam. The Sponsors may require conditions or terms in addition to those listed above.

It appears that existing Congressional authorities are fairly broad and that additional congressional authorization may not be required. It should be noted that implementing water conservation at Seven Oaks Dam requires both congressional authorization for water conservation (which appears to be in place) and approval of a specific water conservation plan at Seven Oaks Dam. The foregoing conditions relate to approval of water conservation at Seven Oaks Dam.

Through one of the Sponsors, the San Bernardino County Flood control District (SBCPW&FCD), two water agencies paid for a feasibility study on the potential for future water conservation at Seven Oaks Dam. This feasibility study was completed in June 1997 and resulted in the Feasibility Report, but a Record of Decision was not signed, pending resolution of the Section 7 consultation on Seven Oaks Dam operations and an official requires from the Sponsors. Per Corps requirements, it was necessary for the Sponsors to request the study, rather than the water agencies. Therefore, the two water agencies requested that SBCPW&FCD act on their behalf in participating with the Corps in the water conservation feasibility study. The purpose of this study, however, was only the evaluation of hypothetical water conservation at Seven Oaks Dam after completion of construction and all requisite environmental compliance. This feasibility study does not contain any non-Federal requests for water conservation approval, nor connote any such approvals for water conservation operation. Rather, this document concluded that water conservation would be physically and economically feasible, based on the circumstances existing at the time, and offers technical information to the Sponsors.

During construction of the dam, the same two water agencies determined that, if at some time in the future, a water conservation program was requested approved, and implemented at Seven Oaks Dam, it would be significantly more cost effective to construct certain improvements needed for water conservation during dam construction. Such improvements, however, did not constitute approval for water conservation, nor do they preclude other uses of the dam or uses of water behind the dam in the future. The two water agencies were willing to take the risk to expend funds for the modification (extension of a blanket drain), even though a water conservation program might never be approved at Seven Oaks Dam. Pursuant to Corps regulations, SBCPW&FCD requested the modification on their behalf. Any request for Corps approval of specific projects for water conservation can be made only by the Sponsors. It is anticipated that such requests will be handled in the same fashion as the blanket drain; i.e., that the Sponsors will transmit proposals from the water agencies to the Corps.

The water agencies have maintained a strong interest in water conservation at Seven Oaks Dam, and are actively pursuing necessary permits and appropriations from the State Water Resources Control Board.

8-07 <u>Hydroelectric Power</u>. The Water Control Plan does not include hydroelectric power objectives nor does it have any effect upon hydroelectric power generation. The original construction of Seven Oaks Dam resulted in the removal of one hydroelectric power generating facility in the Santa Ana Canyon and relocation of Southern California Edison's electrical transmission lines to above the reservoir rim. An access road along the streambed was also relocated over the dam. Edison's water flume/tunnel was replaced by a 42-inch diameter pressurized steel pipeline along the streambed and through the dam's left abutment. Upstream of the dam the pipeline runs along high ground in the left bank of the streambed. The depth of the pipeline is about four feet below ground. At the dam, the pipeline goes through the left abutment, into Edison's old tunnel, which is at elevation 2314 feet, NGVD, and daylights out downstream of the dam embankment. Edison's tunnel is sealed around the new pipeline. Bear Valley Mutual Water Company also had a water wheel at the old powerhouse #2, which was removed and the water company compensated.

8-08 Navigation. There is no navigation on the Santa Ana River or in the Seven Oaks Reservoir.

8-09 Downstream Water Users. The construction of Seven Oaks Dam resulted in the interruption of groundwater flow to the downstream aquifer by forcing this flow to the surface behind the dam. During the development of the Phase II GDM, a consensus between the Corps, the local sponsors and downstream water agencies was reached that, in general, the dam will be operated at all times, to pass this flow through the project. Therefore, the Water Control Plan includes releases to minimize impacts to downstream water uses. Several design features were incorporated in the Seven Oaks Dam project in order to allow the continuous delivery of water to replenish the downstream aquifer as under the pre-project condition. The minimum downstream release requirement was determined to be 3 cfs. During the start of the flood season, releases are cut back to the release requirement rate of 3 cfs, until the debris pool is filled. At the end of the flood season, the debris pool is drained consistent with the rates coordinated with the downstream water users, and the release schedule as defined by the Phase II GDM. During the month of June, the required releases will equal inflow plus 10 cfs, and during the months of July and August, the required releases will equal inflow plus 20 cfs. The process of determining the proper release rate to drain the debris pool will involve trial and error, as the gates and valve settings will need to be constantly adjusted to release the calculated value. Also, these adjustments may be needed on a regular basis to accommodate varying inflow rates. By 1 September, the debris pool shall be completely drained, using higher than calculated release rates, if needed.

8-10 Drought Contingency Plan. The ownership and operation responsibility for Seven Oaks Dam was turned over to the Local Sponsors on October 1, 2001. According to the guidance for preparation of Drought Contingency Plans (ER 1110-2-335, dated September 2002), it is required only for Corps owned projects.

8-11 Flood Emergency Action Plan. The operation of the dam incorporates the activation of the Flood Emergency Action plan when there is an emergency condition. Potential emergency conditions identified within the Emergency Action Plan include, but are not limited to, the following: emergency spillway discharge and dam failure, post-earthquake conditions, and security alert conditions. Details of the Emergency Action Plan are provided within the document entitled, "Seven Oaks Dam, Emergency Action Plan", dated June 2001.

8-12 Flood Frequency.

a. Peak Inflow and Outflow Probabilities. Plate 8-02 presents the inflow and outflow discharge frequency curves for Seven Oaks Dam. The curves were taken from the Phase II GDM, Volume 7, Hydrology, on the Santa Ana River Mainstem dated August 1988. The frequency curves were derived from a discharge-frequency analysis of historical flows on the Santa Ana River.

b. Filling Frequency. Plate 8-03 presents the estimated present and future condition filling frequency curve. These curves are from the Phase II GDM, Volume 7, Hydrology report. The future condition curve accounts for the estimated sediment deposition within the reservoir area after 100 years.

8-13 Other Studies.

a. Additional Conservation Measures/Proposed Compensation Plan. A biological assessment addressing endangered species and their habitat with the flood control operation plan for Seven Oaks Dam was submitted in August 2000 to the U.S. Fish and Wildlife Service as required by the Section 7 consultation process. The U.S. Fish and Wildlife Service, in return issued a biological opinion, dated December 2002. The biological opinion contains recommended conservation measures, in addition to the conservation measures already identified in the 1988 Phase II GDM, to mitigate for project impacts that may jeopardize the existence of the listed species. The additional conservation measures, also called the proposed compensation plan in the biological opinion, will focus on providing means to 1) further evaluate the impacts from the operation of the dam, 2) test and select appropriate management actions, and 3) implement management action (if warranted) with the Woolly Star Preserve Area (WSPA) and other historic floodplain areas within the local sponsors jurisdiction to sustain the endangered species. The proposed compensation plan has six distinct elements, namely 1) Memorandum of Understanding (MOU) among the appropriate stakeholders, 2) development of a multi-species Habitat Management Plan, 3) directed studies of population trends and habitat relationships, threats to the species, and life requirements, 4) experimental studies of the effectiveness of different habitat management techniques, 5) implementation of habitat management on the WSPA, and 6) expansion of habitat management measures. Details of this compensation plan and required studies are also contained in the Corps' Biological Assessment, dated August 2000, and Qualitative Assessment, dated June 2001. A copy of the December 2002 Biological Opinion is included in this document as Exhibit J.

b. Water Conservation Study. A study for the operation of Seven Oaks Dam for water conservation was completed during the construction of the dam and is documented in the Seven Oaks Dam Water Conservation Study, Final Feasibility Report EIS/EIR, dated June 1997. This report was completed prior to the listing of San Bernardino Kangaroo Rat as an endangered species, and the Record of Decision has not been signed. The Sponsors have not yet requested to implement the results of this study.

c. Prototype-Testing Program. A prototype-testing program that will evaluate the hydraulic performance of the project, identify and analyze potential operation problems, and provide data that can used to evaluate any necessary operation changes, will be performed. When an opportunity for collecting measurements exists, such as when there is a large impoundment behind the dam, or when large releases are made, data necessary for this evaluation will be collected. The water control managers notifies the Corps of Engineers, Reservoir Regulation Section, so that proper personnel from the U.S. Army Engineers Research and Development Center, Waterways Experiment Station (WES) can be called out for data collection. This testing program was developed, based on a model study conducted by WES. Details of the model study can be found within Technical Report, HL-92-14, Outlet Works for Seven Oaks Dam, Santa Ana River, San Bernardino County, California, Hydraulic Model investigation by Deborah R. Cooper, Hydraulics Laboratory, WES, final report dated October 1992. A description of the testing program can be found in Exhibit F.

IX. WATER CONTROL MANAGEMENT

IX - WATER CONTROL MANAGEMENT

9-01 Responsibilities and Organization.

a. Corps of Engineers. The role of the U.S. Army Corps of Engineers, Los Angeles District (SPL), in the regulation of Seven Oaks Dam is based on the Flood Control Act of 1944, which reads in part:

> *"Hereinafter it shall be the duty of the Secretary of War to prescribe regulations for the use of allocated storage for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations."*

In practice, SPL's role consists of developing the water control plan for the project; preparing and updating the water control manual; monitoring compliance with the water control plan; collecting data, editing and forwarding reports from the project owners; and processing requests for deviations from the approved water control plan.

Deviations from the water control plan contained in this manual require approval from the U.S. Army Corps of Engineers, South Pacific Division office. Deviations are discussed in Section 7-15.

Personnel from the SPL Reservoir Regulation Section are available for consultation on flood-related operations. During storm events, these personnel are working in SPL's Reservoir Operations Center and are available 24 hours a day, 7 days a week. Otherwise they may be contacted using phone numbers provided in the annual publication "Instructions for Reservoir Operation Center Personnel" (Orange Book). Table 9-1 is an organizational chart depicting the chain of command for reservoir regulation decisions.

SPL is responsible for preparing the annual water control management reports concerning the regulation of Corps owned and Section 7 reservoirs, including Seven

Oaks Dam. Data for the Seven Oaks Dam portions of these reports will be furnished by the project sponsor as detailed in Section 5-07 of this water control manual. The reports prepared by SPL are described in Section 9-05.

b. Other Federal Agencies. There are no other Federal agencies with direct water control responsibilities at Seven Oaks Dam and reservoir. Indirectly, it is expected that the US Fish and Wildlife Service will participate in the Wooly Star Preserve Area Steering Committee which will use adaptive management techniques to annually determine and define for the water control managers, the environmental operation to be followed consistent with the project flood control operation, mitigation for project impacts to water users, and dam safety objectives.

c. Project Owners. The ownership, operation and maintenance, including the regulation of Seven Oaks Dam has been turned over to the local sponsors of the project which consist of the Orange County Public Facilities and Resource Department, the San Bernardino County Public Works and Flood Control District, and the Riverside County Flood Control and Water Conservation District. The project owners are required to operate the dam in accordance with the currently approved water control plan. The project owners are also required to dispatch channel observation teams to evaluate the performance of the downstream channel and report possible regulation problems. If a deviation from the plan is necessary, the project owners are required submit a request for the deviation to SPL and obtain approval before proceeding with the deviation as described in Section 7-15. Costs incurred by the Corps of Engineers associated with the processing of deviation requests are the responsibility of the project owners. In addition, the project owners are required to provide SPL any information related to the operation of the dam, upon request and on an annual basis. Information that is required on an annual basis shall be formally transmitted in a report to the SPL Reservoir Regulation Section office. The report shall include all information necessary for the preparation of the Corps reports outlined in Section 9-05. The water control responsibilities are documented in the

Sponsors' Operation and Maintenance Agreement. These responsibilities and additional Corps requirements are summarized as follows:

(1) <u>Orange County Public Facilities and Resource Department (OCPF&RD)</u>. The OCPF&RD is charged with water control management responsibilities for Seven Oaks Dam. The OCPF&RD Storm Operation Center is staffed with water control managers, who direct all water control operation at the dam in accordance with the water control plan. The OCPF&RD coordinates with all other government agencies and private individuals that are affected by each operation of the dam. The OCPF&RD is required to provide any information related to the operation of the dam, upon request by the Corps of Engineers.

(2) <u>San Bernardino County Public Works and Flood Control District (SBCPW&FCD)</u>. SBCPW&FCD is charged with the responsibility of performing the required physical operation of the dam, outlet gates, and other components. SBCPW&FCD will furnish the project operators/dam tenders whose duties and responsibilities are outlined in Exhibit A, "<u>Standing Instructions to Project Operator for Water Control</u>". During normal operation, including flood events, gate regulation instructions will be issued by the OCPF&RD water control managers to the SBCPW&FCD dam tenders. In the event that communications between the dam and the OCPF&RD Storm Operation Center are interrupted, a set of instructions is also available in Exhibit A, section 3-05, entitled "Communications Outage" for the project operators/dam tenders to follow.

(3) <u>Riverside County Flood Control & Water Conservation District (RCFC&WCD)</u>. RCFC&WCD is not directly charged with any specific task necessary for the operation or regulation of Seven Oaks Dam.

d. <u>Private Organizations</u>. There are no private agencies charged with water control responsibilities at Seven Oaks Dam.

9-02 Interagency Coordination. The U.S. Army corps of Engineers coordinates with other Federal, State, County, and local organizations concerning water control operations of its projects and Section 7 dams. With regard to Seven Oaks Dam, the OCPF&RD coordinates with the SPL ROC, and has primary responsibility for coordination with other government and private agencies, the Wooly Star Preserve Area Steering Committee, and individuals affected by the operation of the dam. This coordination is done once every year through pre-storm season meetings, to identify all points of contacts for emergencies or non-emergencies, to discuss the status of all water control projects, and any changes to regulation/operation plans for following flood year.

a. Local Press and Corps of Engineers Bulletins. The Public Affairs Office of the Corps of Engineers, SPL, (after coordination with OCPF&RD) coordinates with the local press regarding floods and other aspects of project operations. This is accomplished through both telephone and in-person interviews and occasional issuance of press releases. It should be noted that the Corps of Engineers does not publicly issue flood watches or warnings, or other status reports or forecasts to the general public.

b. National Weather Service (NWS). The NWS has the responsibility for issuing flood watches and warnings to the public. The project water control managers can utilize NWS data to aid in making real-time operation decisions. Conversely, the real-time and post-event data regarding the operation of the dam can be shared to the NWS.

c. U.S. Geological Survey (USGS). The USGS cooperates with several agencies along the Santa Ana River, including the Corps, the SBCPW&FCD, RCFC&WCD, and OCPF&RD, in the operation of stream gaging stations. The USGS maintains and services many of the stations under contract with other agencies. Data from many of these gages are published annually by the USGS in its Water Supply Papers.

d. U.S. Fish and Wildlife Service. In accordance with the Endangered Species Act of 1973 (PL 93-205) and the Fish and Wildlife Coordination Act (PL 85-624), the project owners are required to coordinate with the U.S. Fish and Wildlife Service if project operations may jeopardize the continued existence of any endangered species listed by the Service.

9-03 Interagency Agreements. The Local Cooperation Agreement (LCA) is the Corps official agreement with the sponsors for project responsibilities and cost sharing. A signed copy of the LCA is included in this manual as Exhibit D. It can also be found in Appendix B of the Operation & Maintenance Manual for Seven Oaks Dam, dated August 2002, between the Local Sponsors. The Operation and Maintenance Agreement between the Local Sponsors for Seven Oaks Dam is also included in Exhibit D, however, this agreement has not yet been finalized. This agreement outlines the understandings and responsibilities the project owners. San Bernardino County Flood Control District performs operation and maintenance on behalf of the project owners. Orange County Flood Control District is the lead agency for preparing the project annual Operation and Maintenance budget. Operation, maintenance, repair, replacement, rehabilitation (OMRRR) and inspections of the dam and appurtenances, reservoir and related facilities will be the responsibility of the project owners, but in overall accordance with regulations and directions prescribed by the Secretary of the Army. Operation of Seven Oaks Dam shall be in accordance with the current water control plan approved by the U.S. Army Corps of Engineers, South Pacific Division.

As documented in the Phase II GDM, Volume 1, Seven Oaks Dam, the Corps of Engineers and the project owners agreed with the downstream water users groups to keep the required discharge from the outlet works of Seven Oaks Dam at a minimum of 3 cfs while holding or building the debris pool behind the dam. This discharge is the estimated amount of base flow forced to the surface by the construction of the dam. By releasing this flow through the outlet works and percolating it in the plunge pool, the downstream aquifer is maintained in its pre-project condition. In addition, outside the flood season when there is no active pool in the reservoir the MDL extension line can be used to bypass the plunge pool at the request of downstream water users so that there will not be any interruptions to the flow of water back into the Santa Ana River downstream of the dam.

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

a. Santa Ana River Watermaster. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs. City of Chino et al. The judgment, which became effective on October 1, 1970, contained a declaration of rights of the entities in the Lower Area of the Santa Ana River basin (i.e., the Orange County Water District) as against those in the Upper Area (i.e., the San Bernardino Valley Municipal Water District, the Western Municipal Water District, and the Chino Basin Municipal Water District). The arrangement leaves to each of the major hydrologic units in the watershed the determination of its own basin management plans. A court appointed Watermaster documents and accounts for flows within the Santa Ana River.

b. Multi-Species Habitat Management Plan Steering Committee.
A multi-agency steering committee such as the Woolly Star Preserve Area (WSPA) Steering Committee (AKA Advisory Committee) will use adaptive management techniques to annually determine and define for the project operator an environmental operation to be followed should sufficient flood runoff occur. Decisions will be made by consensus among the various participating agencies, which will include at a minimum the Corps, the three Local Sponsors, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game. It is envisioned that the existing WSPA Steering Committee will serve that function by expanding their responsibilities to include multi-species management, and possibly expanding their membership to include additional technical experts. The Local Sponsors will continue to have lead responsibility for administering the implementation of the management plan. On

behalf of the Sponsors, the SBCFCD will be the designated Administrator for all management activities, contracts and other administrative matters. The Corps will have lead responsibility to monitor and ensure that the Local Sponsors implement the management plan in a satisfactory manner, and advise the Local Sponsors if changes to the implementation program are necessary. The Corps, as Lead Agency responsible for the SARP and management of mitigation lands, will have final decision-making responsibility on recommendations of the Steering Committee regarding plan implementation.

The Corps and Local Sponsors may opt to fund the management plan implementation in one of two ways: (1) deposit their respective shares of the estimated net present value of the total expenditure commitment into an interest-bearing account established by San Bernardino County's Treasurer or other entity (such as The Nature Conservancy); or (2) elect to fund their respective share of costs annually, based on an approved annual implementation program. The Corps and resource agencies prefer the first option.

9-05 **Reports**. As required by Engineering Regulation (ER) 1110-2-240 entitled, "Water Control Management," the SPL prepares reports for transmittal to the South Pacific Division Office concerning the regulation of SPL owned and Section 7 projects. The project owners are required to provide SPL the Seven Oaks Dam data and information necessary to complete these reports.

a. Daily Reservoir Report. SPL prepares this report each morning. The report covers the status of Section 7 dams and SPL operated projects. This report is made available to the public on SPL's Reservoir Regulation Section Web Site. The status of Seven Oaks Dam must be made available to SPL for inclusion in this report.

b. Annual Water Control Management Report. This report is prepared by SPL on an annual basis and submitted to the Corps South Pacific Division Office. The report includes a summary of the operation of SPL owned and Section 7 Projects, and other issues that affected reservoir regulation during the previous water year. This report is usually submitted to the Corps' Division office during the month of January. The project owners are required to provide necessary Seven Oaks Dam information to SPL for inclusion in this report during its preparation.

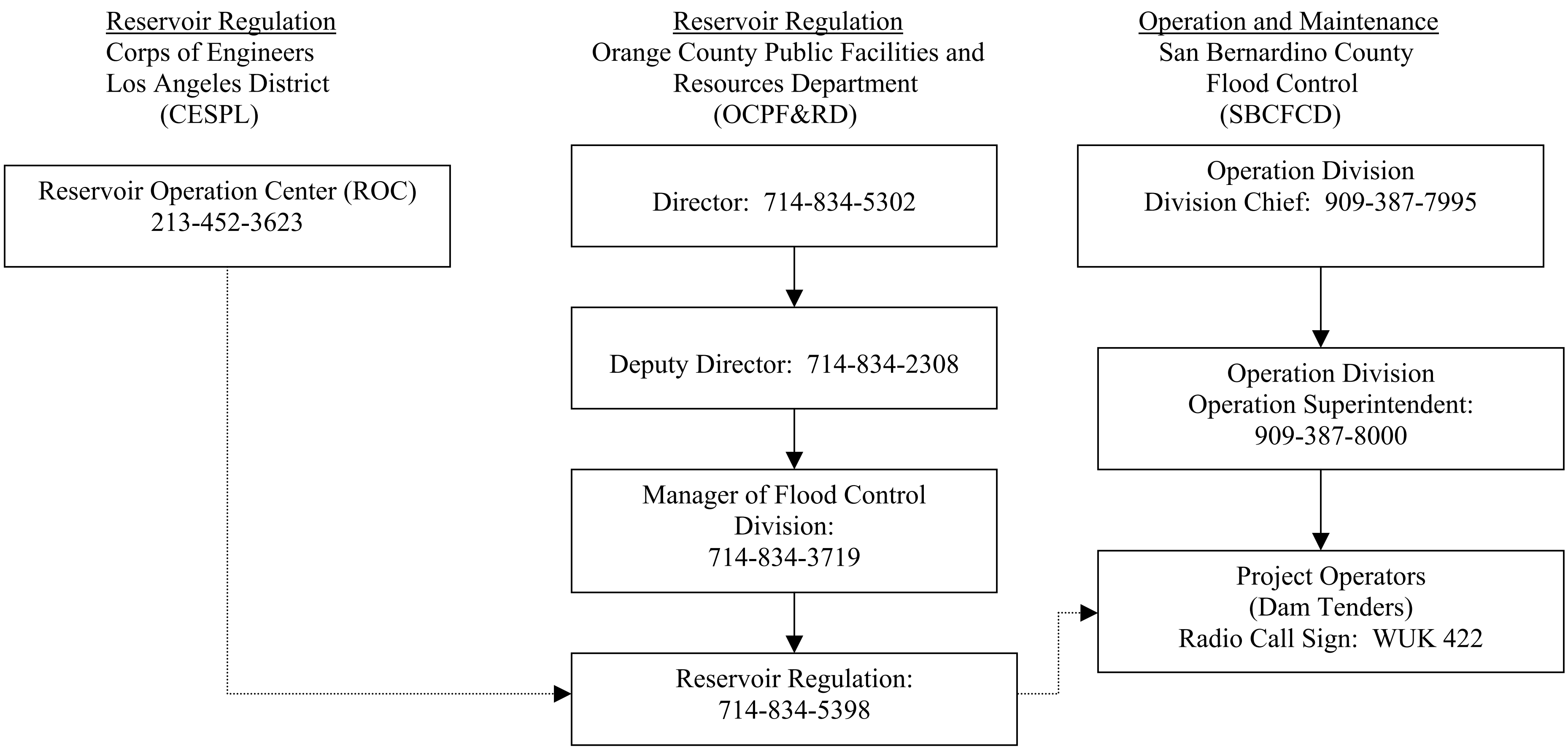
c. Current Flood Situation. This report is prepared by SPL upon request from the Corps South Pacific Division. Such requests are generally made during or in anticipation of significant flood events. The project owners are required to provide necessary Seven Oaks Dam information when requested by SPL.

d. Annual Flood Damages Report. This report is prepared annually and in conjunction with the preparation of the Annual Water Control Management Report. This report provides an estimate of the damages prevented by the flood control operations of Corps owned and Section 7 dams. The project owners are required to provide necessary Seven Oaks Dam information to SPL for inclusion in this report. Details and information useful for the preparation of this report are contained in Section 4-12.

e. Notes on Sedimentation Activities. This report outlines sedimentation activities, such as sediment removal or surveys and recent estimates of sediment deposited in Corps reservoirs during the previous calendar year. This report is prepared on an annual basis and submitted to the Corps South Pacific Division office in January of each year. If any activity occurred at Seven Oaks Dam, the project owners are required to submit Seven Oaks Dam information for inclusion in this report.

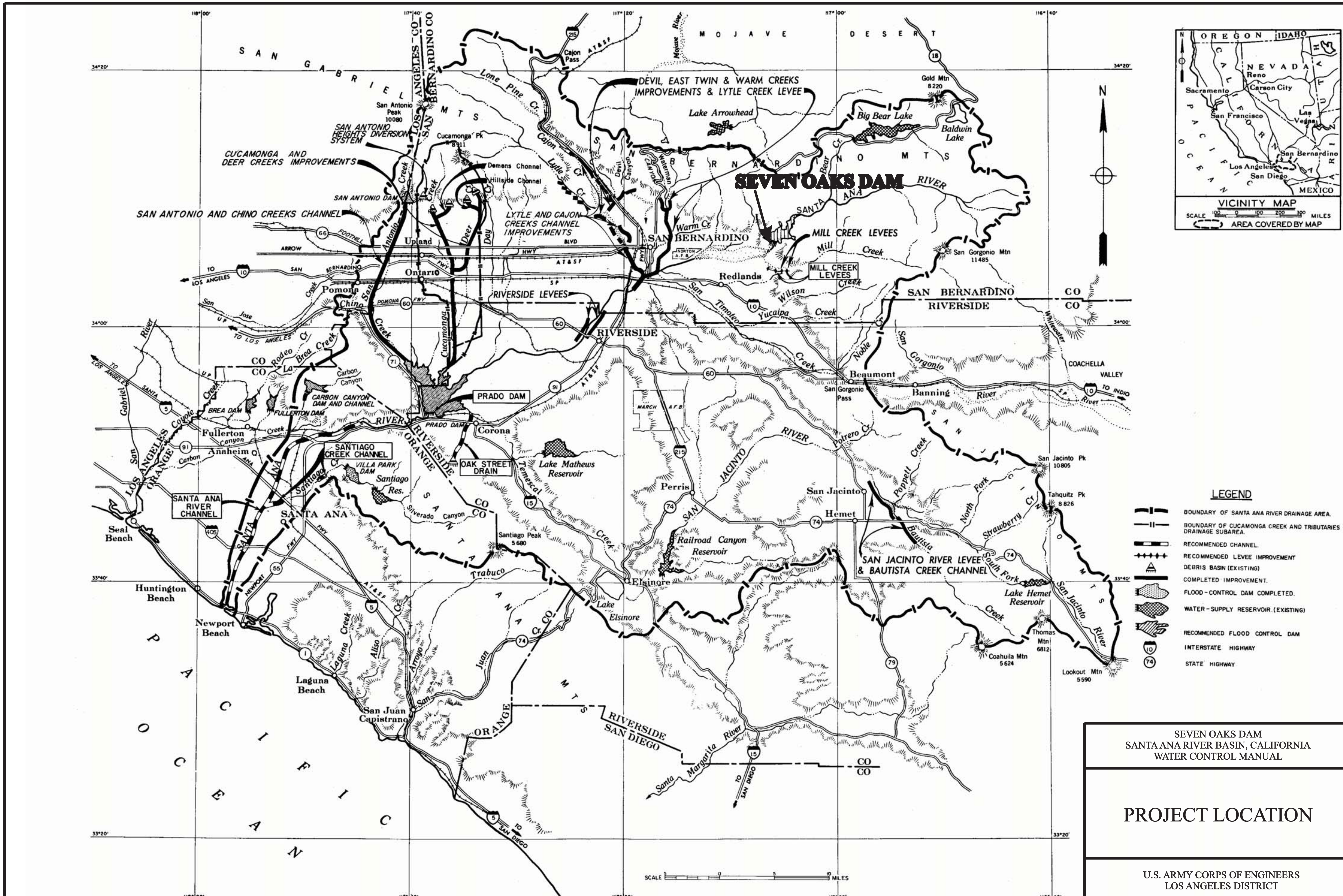
f. Annual Water Quality Management Report. This report outlines the water quality management activities performed by the Corps and other Federal and local agencies in the watersheds affected or controlled by the SPL owned and operated projects and Section 7 dams. The project owners are required to provide necessary information to SPL regarding activities and water quality issues that occurred during the previous calendar year for inclusion in this report. This report is submitted to the Corps South Pacific Division in January of each year.

Figure 9-01. Chain of Command for Reservoir Operations of Local Sponsors



Communication Line between Corps Water Control Managers, OCPF&RD Water Control Managers, and the SBCFCD Dam Tenders

PLATES



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

PROJECT LOCATION

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

The Plate you are attempting to access (Plate 2-02) is not currently available.

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

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The Plate you are attempting to access (Plate 2-23) 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 (Plate 2-24) is not currently available.

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

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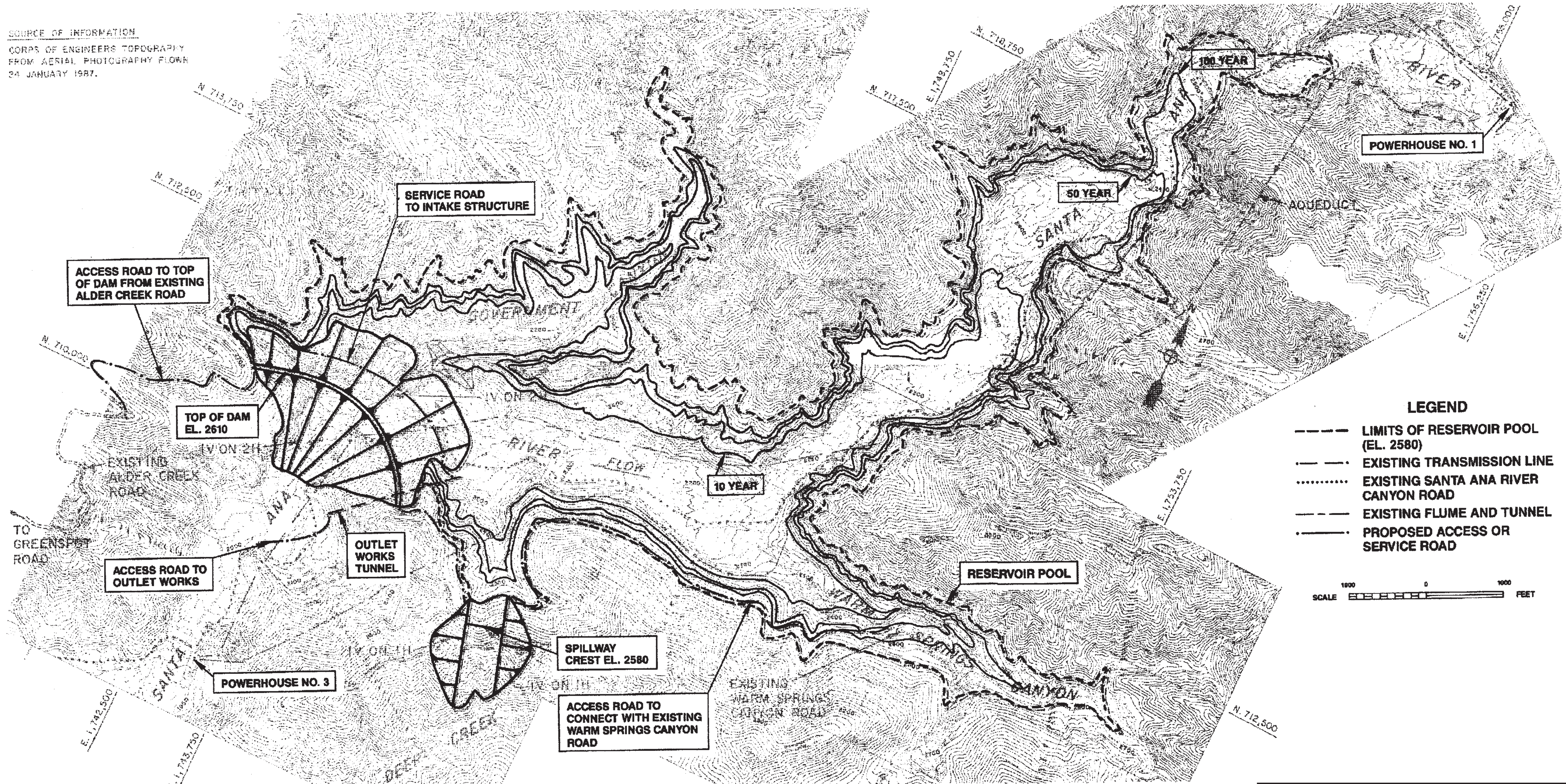
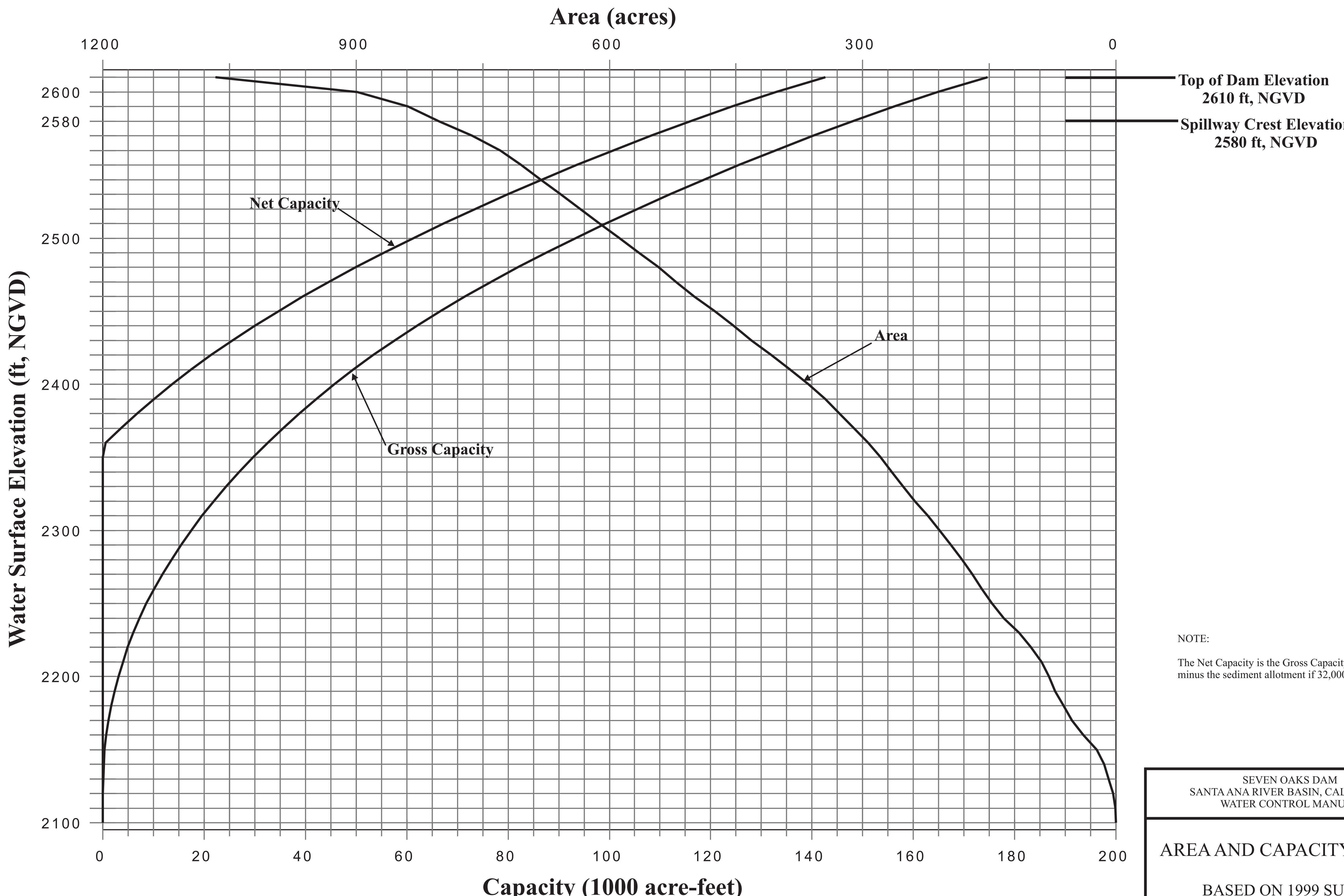
For additional information, please contact the Los Angeles District Public Affairs Office at (213) 452-3908.



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

RESERVOIR FILLING FREQUENCY INUNDATION MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



NOTE:

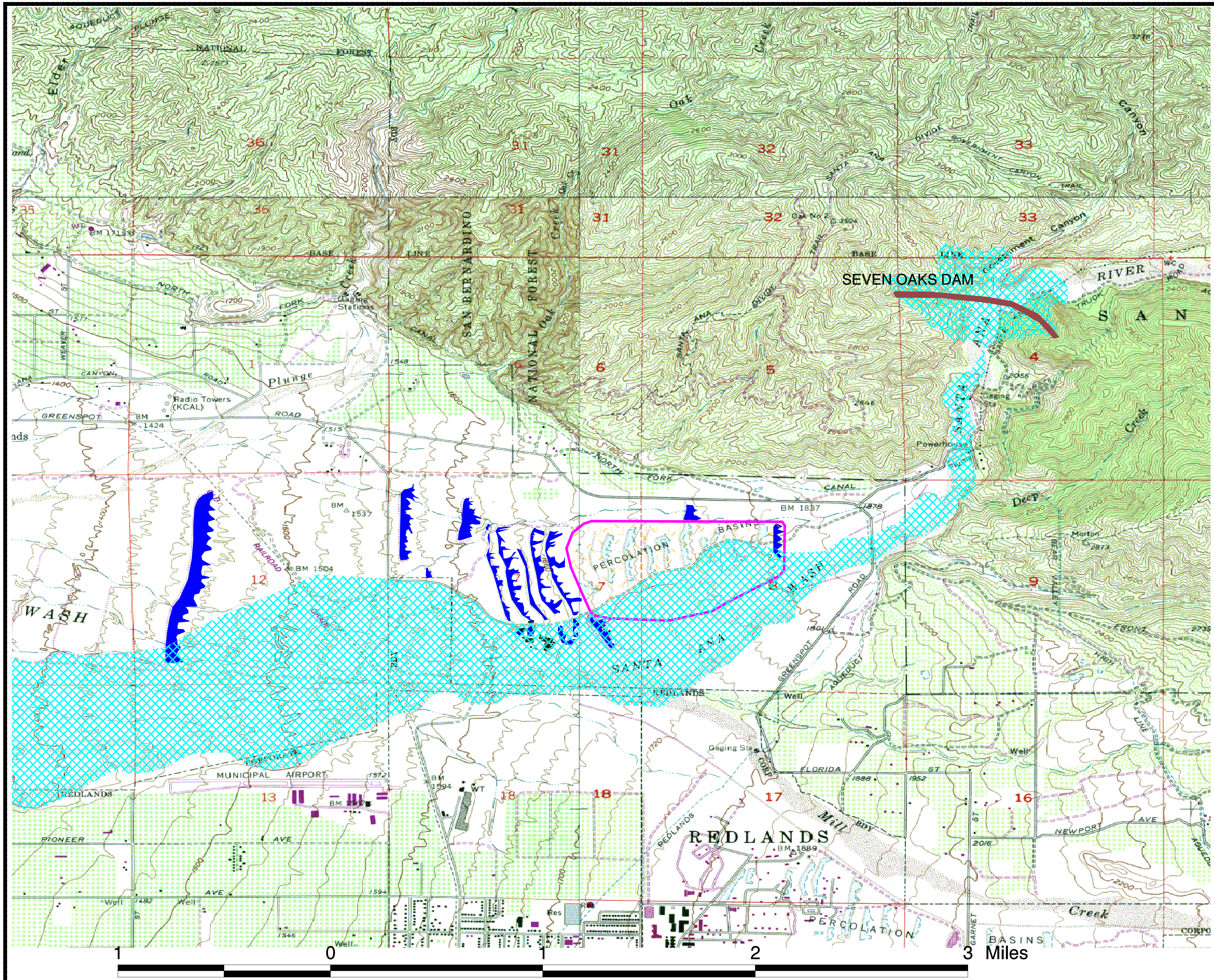
The Net Capacity is the Gross Capacity minus the sediment allotment if 32,000 ac-ft.

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

AREA AND CAPACITY CURVES

BASED ON 1999 SURVEY

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



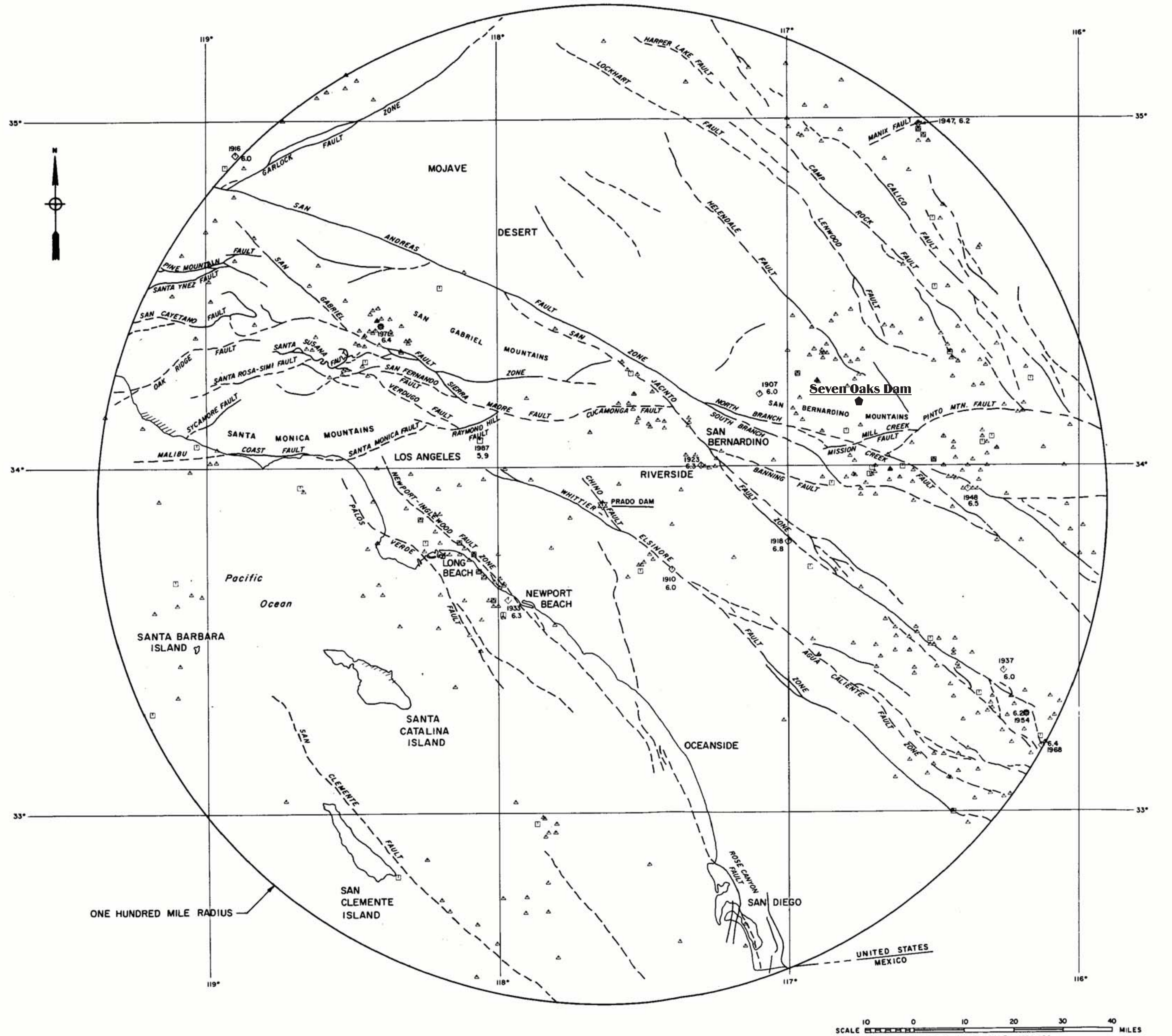
N
W E
S

Seven Oaks Dam
100-yr Overflow
with Seven Oaks Dam
Basins Under Construction
Existing Basins

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

SBVWCD SPREADING BASINS DOWNSTREAM OF SEVEN OAKS DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LEGEND

- △ EARTHQUAKE WITH MAGNITUDE 4.0 THRU 4.89
- ◻ EARTHQUAKE WITH MAGNITUDE 5.0 THRU 5.89
- ◇ EARTHQUAKE WITH MAGNITUDE 6.0 THRU 6.89
- ✡ LOCATION OF PROJECT AREA
- TRACE OF FAULT DASHED WHERE INFERRED OR CONCEALED

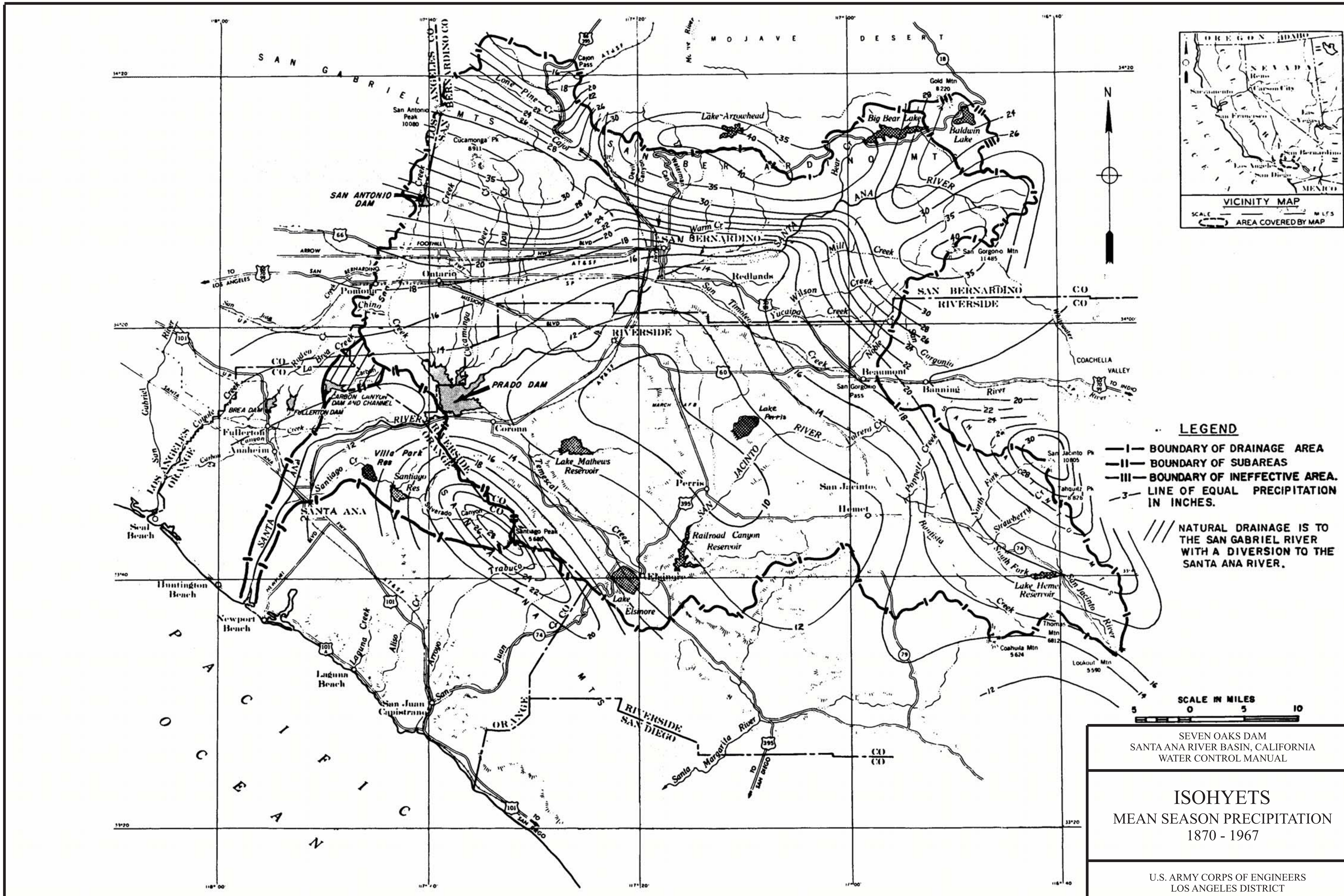
NOTES:

1. Richter scale magnitudes are a measure of the energy released at the focus (center of the earthquake) as determined by the amplitudes produced on a seismogram.
2. The epicenter is the point on the earth's surface directly above the focus.
3. Earthquake epicenters plotted are from 1932 to 1987, unless earlier dates are shown.
4. Base map modified from state of California (South Half) 1:500,000 topographic map; United States Geological Survey, 1981.
5. Locations of faults are approximate. Data derived from various California Division of Mines and Geology and United States Geological Survey publications.
6. Earthquake epicenter locations are from California Institute of Technology's seismologic data base for Southern California, Nevada, and Arizona; from Toppozada and others (1981), and from Toppozada and Parke (1982).

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

EARTHQUAKE EPICENTER AND FAULT LOCATION

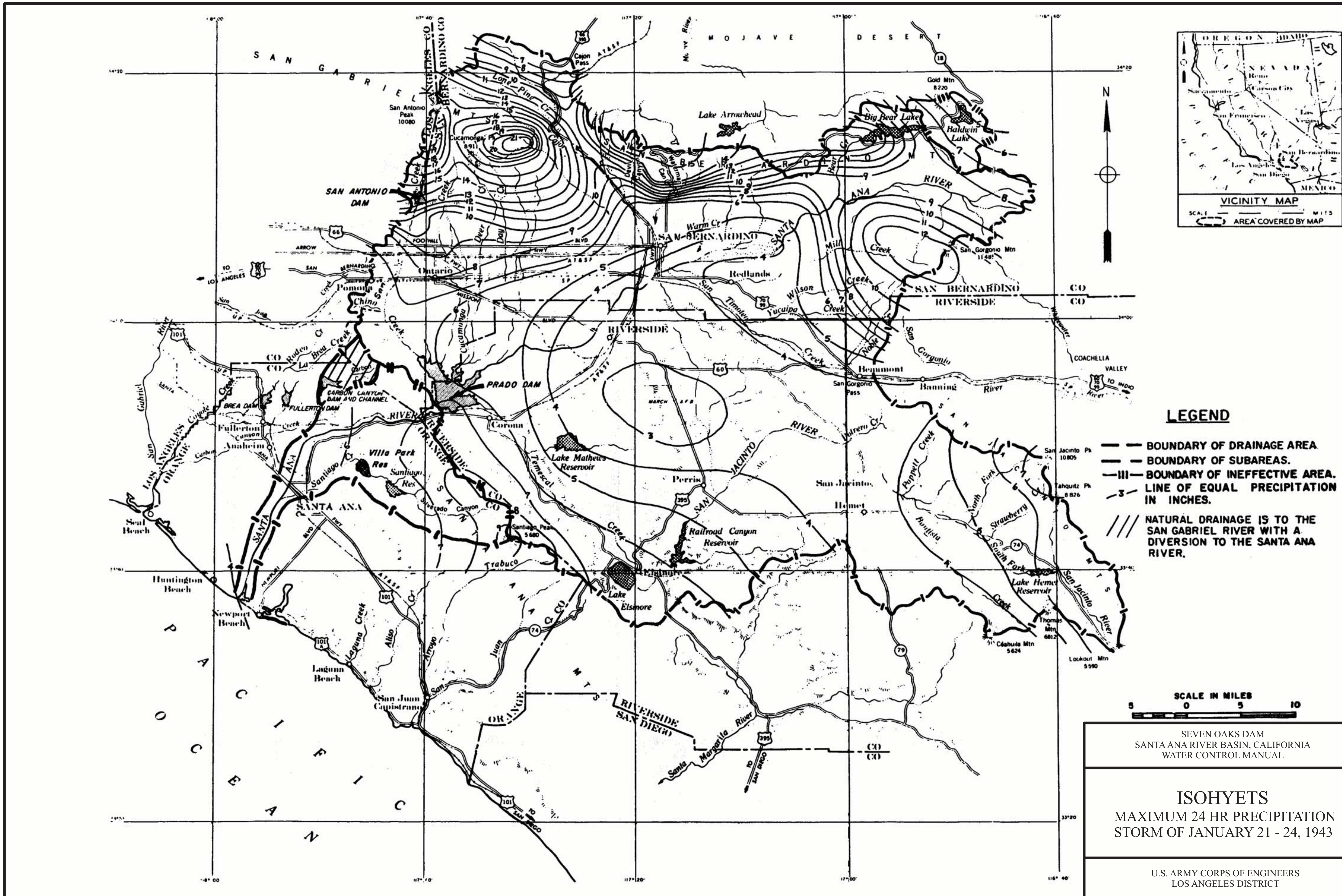
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELELS DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

ISOHYETS
MEAN SEASON PRECIPITATION
1870 - 1967

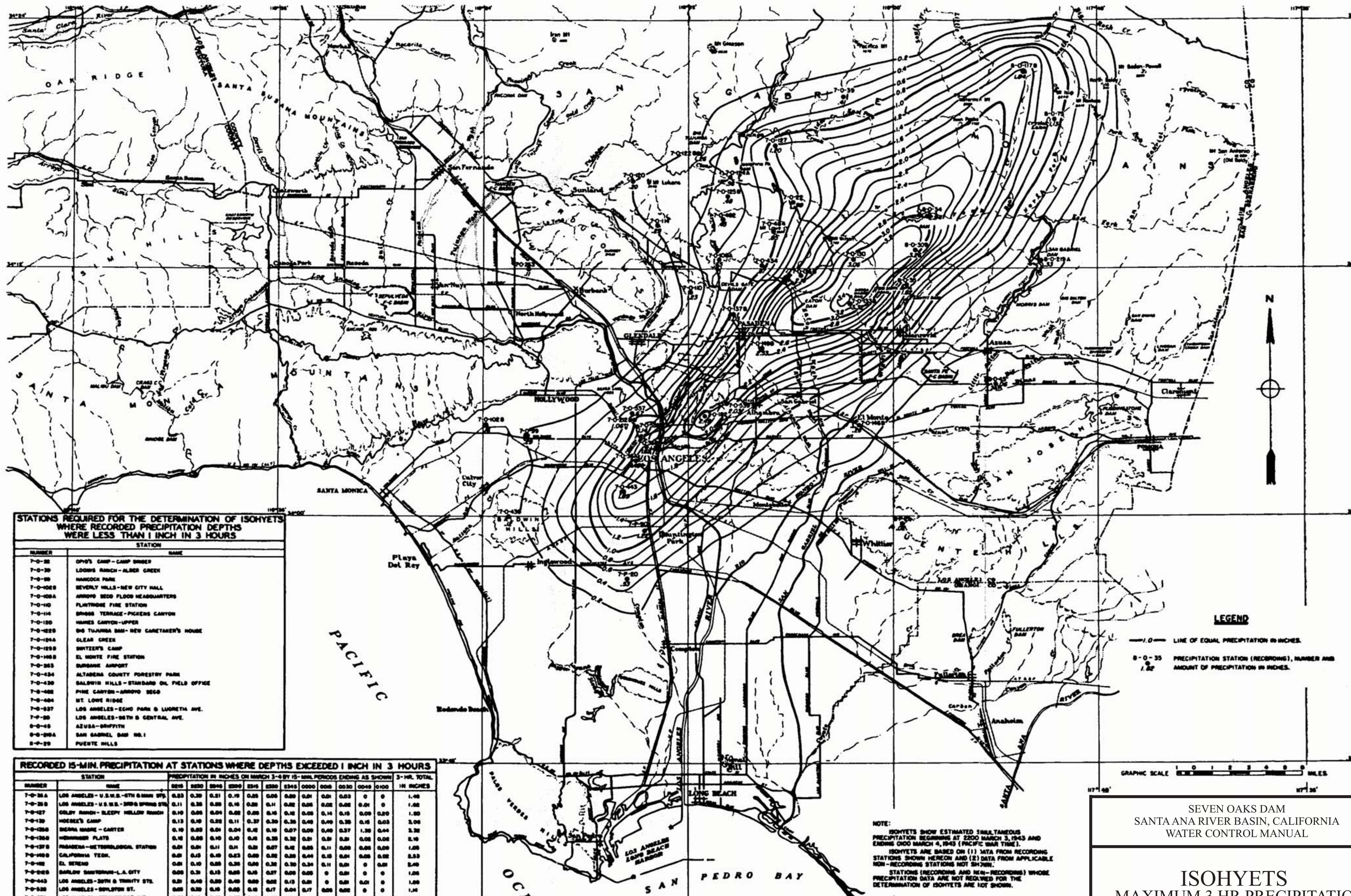
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

ISOHYETS
MAXIMUM 24 HR PRECIPITATION
STORM OF JANUARY 21 - 24, 1943

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



STATIONS REQUIRED FOR THE DETERMINATION OF ISOHYETS WHERE RECORDED PRECIPITATION DEPTHS WERE LESS THAN 1 INCH IN 3 HOURS	
STATION	
NUMBER	NAME
7-0-32	OPID'S CAMP - CAMP BINDER
7-0-39	LOOMIS RANCH - ALDER CREEK
7-0-89	HANCOCK PARK
7-0-102B	BEVERLY HILLS - NEW CITY HALL
7-0-108A	ARROYO SECO FLOOD HEADQUARTERS
7-0-110	FLINTRIDGE FIRE STATION
7-0-114	BRIGGS TERRACE - PICKENS CANYON
7-0-120	HAINES CANYON - UPPER
7-0-122B	BIG TUJUNGA DAM - NEW CARETAKER'S HOUSE
7-0-124A	CLEAR CREEK
7-0-125B	SWITZER'S CAMP
7-0-146B	EL MONTE FIRE STATION
7-0-363	BURBANK AIRPORT
7-0-434	ALTADENA COUNTY FORESTRY PARK
7-0-436	BALDWIN HILLS - STANDARD OIL FIELD OFFICE
7-0-462	PINE CANYON - ARROYO SECO
7-0-464	MT. LOWE RIDGE
7-0-537	LOS ANGELES - ECHO PARK & LUCRETIA AVE.
7-P-20	LOS ANGELES - 56TH & CENTRAL AVE.
8-0-45	AZUSA - GRIFFITH
8-0-210A	SAN GABRIEL DAM NO. 1
8-P-29	PUENTE HILLS

RECORDED 15-MIN. PRECIPITATION AT STATIONS WHERE DEPTHS EXCEEDED 1 INCH IN 3 HOURS														
STATION		PRECIPITATION IN INCHES ON MARCH 3-4 BY 15-MIN. PERIODS ENDING AS SHOWN												3-HR. TOTAL IN INCHES
NUMBER	NAME	2215	2230	2245	2300	2315	2330	2345	0000	0015	0030	0045	0100	
7-0-35A	LOS ANGELES - U.S.W.B. - 5TH & MAIN STS.	0.23	0.30	0.21	0.19	0.25	0.05	0.03	0.01	0.01	0.03	0	0	1.40
7-0-35B	LOS ANGELES - U.S.W.B. - 3RD & SPRING STS.	0.11	0.35	0.28	0.16	0.28	0.11	0.02	0.05	0.02	0.02	0.01	0	1.42
7-0-127	COLBY RANCH - SLEEPY HOLLOW RANCH	0.10	0.05	0.04	0.02	0.05	0.15	0.12	0.08	0.14	0.15	0.09	0.20	1.30
7-0-130	HOEGEE'S CAMP	0.13	0.10	0.22	0.11	0.37	0.30	0.35	0.46	0.49	0.38	0.15	0.03	3.06
7-0-125B	SIERRA MADRE - CARTER	0.10	0.03	0.01	0.04	0.12	0.10	0.07	0.09	0.46	0.37	1.30	0.44	3.32
7-0-126B	HENNINGER FLATS	0.12	0.05	0.10	0.10	0.16	0.35	0.32	0.21	0.51	0.21	0.02	0.05	2.10
7-0-137B	PASADENA - METEOROLOGICAL STATION	0.01	0.01	0.11	0.11	0.21	0.07	0.12	0.05	0.11	0.08	0.05	0.09	1.05
7-0-140B	CALIFORNIA TECH.	0.01	0.13	0.16	0.23	0.09	0.02	0.35	0.44	0.13	0.01	0.05	0.02	2.53
7-0-142	EL SERENO	0.01	0.10	0.25	0.36	0.06	0.32	0.30	0.34	0.11	0.01	0	0.01	2.40
7-0-212B	BARLOW SANITORIUM - L.A. CITY	0.05	0.31	0.13	0.05	0.16	0.27	0.05	0.05	0	0.01	0	0	1.06
7-0-443	LOS ANGELES - 30TH & TRINITY STS.	0.21	0.40	0.30	0.40	0.60	0.02	0.13	0.01	0	0.01	0.01	0	1.90
7-0-530	LOS ANGELES - BOYLSTON ST.	0.05	0.30	0.16	0.09	0.15	0.17	0.04	0.17	0.05	0.02	0	0	1.14
7-0-520	LOS ANGELES - STOCKBRIDGE AVE.	0.05	0.16	0.42	0.29	0.16	0.30	0.34	0.12	0	0	0	0.01	2.05
7-P-90	LOS ANGELES - SLAUSON & LONG BEACH AVE.	0.12	0.03	0.05	0.16	0.20	0.25	0.15	0.14	0.03	0	0	0	1.22
8-0-34	SAN GABRIEL DAM NO. 2	0.10	0.04	0.16	0.14	0.14	0.42	0.32	0.12	0.14	0.25	0.32	0.36	2.94
8-0-35	MONROVIA FALLS	0.03	0.12	0.10	0.10	0.27	0.13	0	0.01	0	0.24	0.70	0.04	1.82
8-0-75	CRYSTAL LAKE CO. PARK - E. PINE FLAT	0.07	0.05	0.05	0.10	0.12	0.15	0.30	0.25	0.07	0.02	0.01	0.03	1.13
8-0-117B	STATE PRISON CAMP NO. 37	0.09	0.03	0.15	0.14	0.05	0.09	0.15	0.23	0.14	0.17	0.16	0.10	1.84
8-0-300	SANTA ANITA - SPRING CAMP	0.11	0.25	0.14	0.31	0.35	0.05	0.05	0.12	0.90	0.90	0.02	0.15	3.26

NOTE:

ISOHYETS SHOW ESTIMATED SIMULTANEOUS PRECIPITATION BEGINNING AT 2200 MARCH 3, 1943 AND ENDING 0100 MARCH 4, 1943 (PACIFIC WAR TIME).

ISOHYETS ARE BASED ON (1) DATA FROM RECORDING STATIONS SHOWN HEREON AND (2) DATA FROM APPLICABLE NON-RECORDING STATIONS NOT SHOWN.

STATIONS (RECORDING AND NON-RECORDING) WHOSE PRECIPITATION DATA ARE NOT REQUIRED FOR THE DETERMINATION OF ISOHYETS ARE NOT SHOWN.

LEGEND

1.0 — LINE OF EQUAL PRECIPITATION IN INCHES.

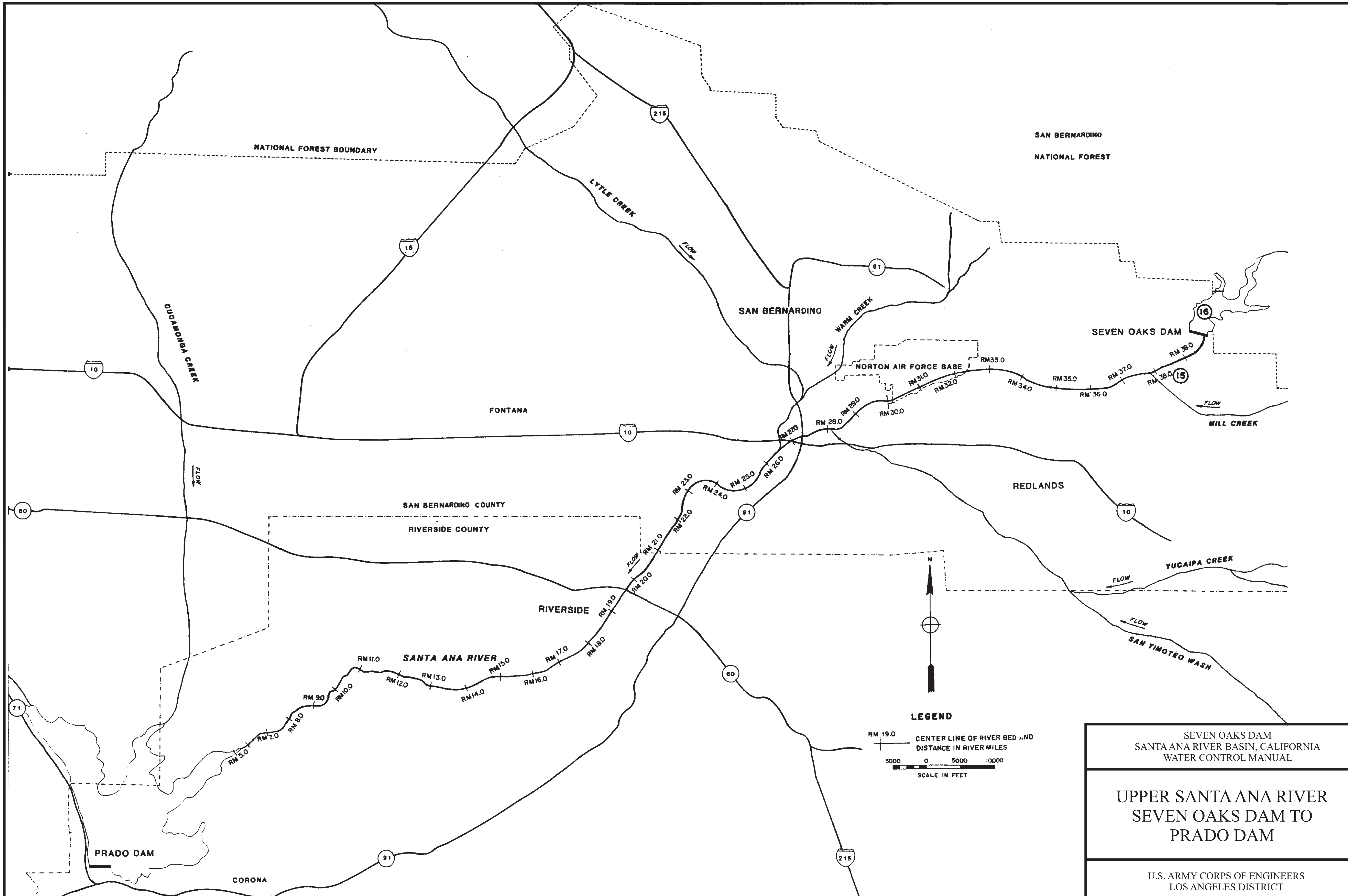
8-0-35 / 1.82 — PRECIPITATION STATION (RECORDING), NUMBER AND AMOUNT OF PRECIPITATION IN INCHES.

GRAPHIC SCALE 1 0 1 2 3 4 5 6 MILES

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

ISOHYETS
MAXIMUM 3 HR PRECIPITATION
THUNDERSTORMS OF MARCH 3 - 4, 1943

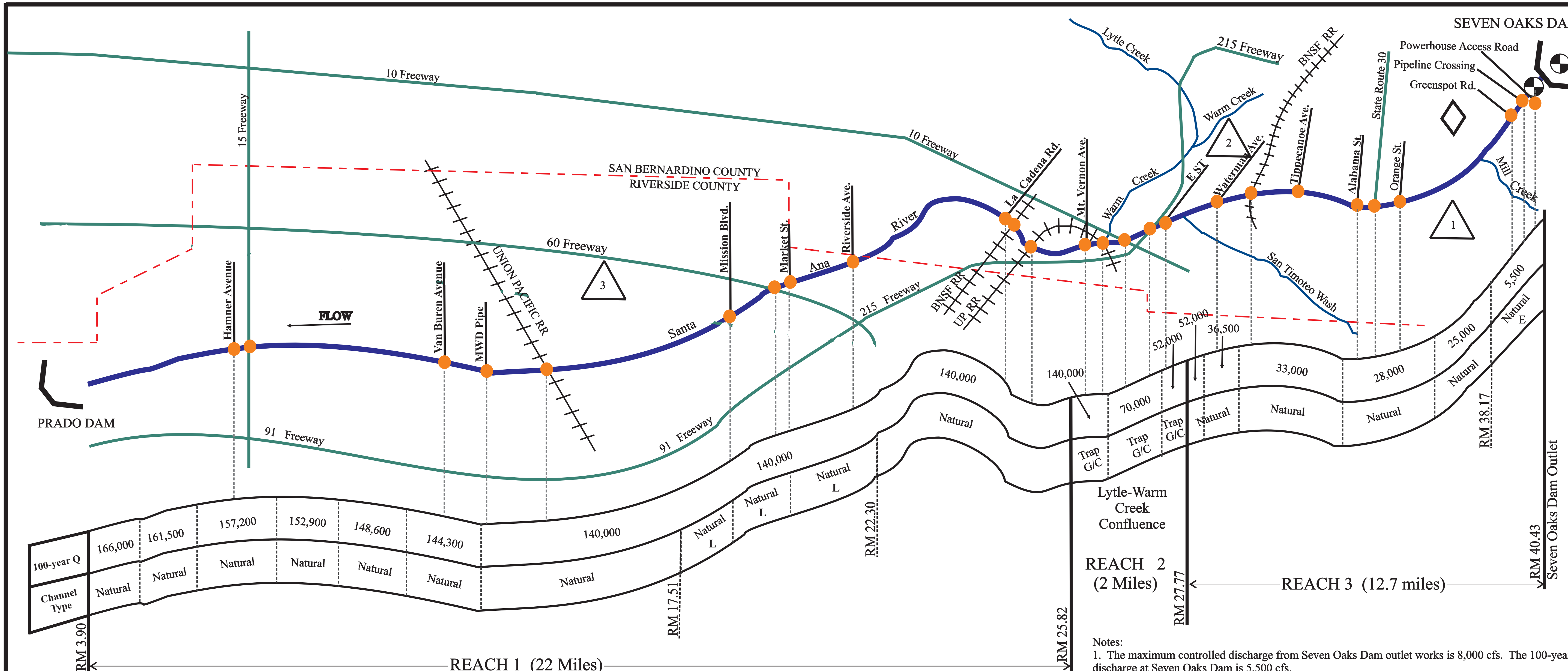
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

UPPER SANTA ANA RIVER SEVEN OAKS DAM TO PRADO DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Notes:

1. The maximum controlled discharge from Seven Oaks Dam outlet works is 8,000 cfs. The 100-year discharge at Seven Oaks Dam is 5,500 cfs.

2. Discharge values shown in the channel configuration are based on the post project 100-year flood plain and floodway delineation for the upper Santa Ana River. This information is contained in a report entitled, Feature Design memorandum No.2, Seven Oaks Dam, Floodway Delineation, dated August 1991. The discharges shown can be contained within the channel limits.

3. The delineated floodway (for the specified discharges above) is exceeded at 3 major parts of Reach 3: 1) AT&SF Railroad Bridge, 2) State Route 30 and Orange Street, and 3) Church Street extension. The 100-year discharge is fully contained within the delineated floodway channel for Reaches 1 and 2.

Legend

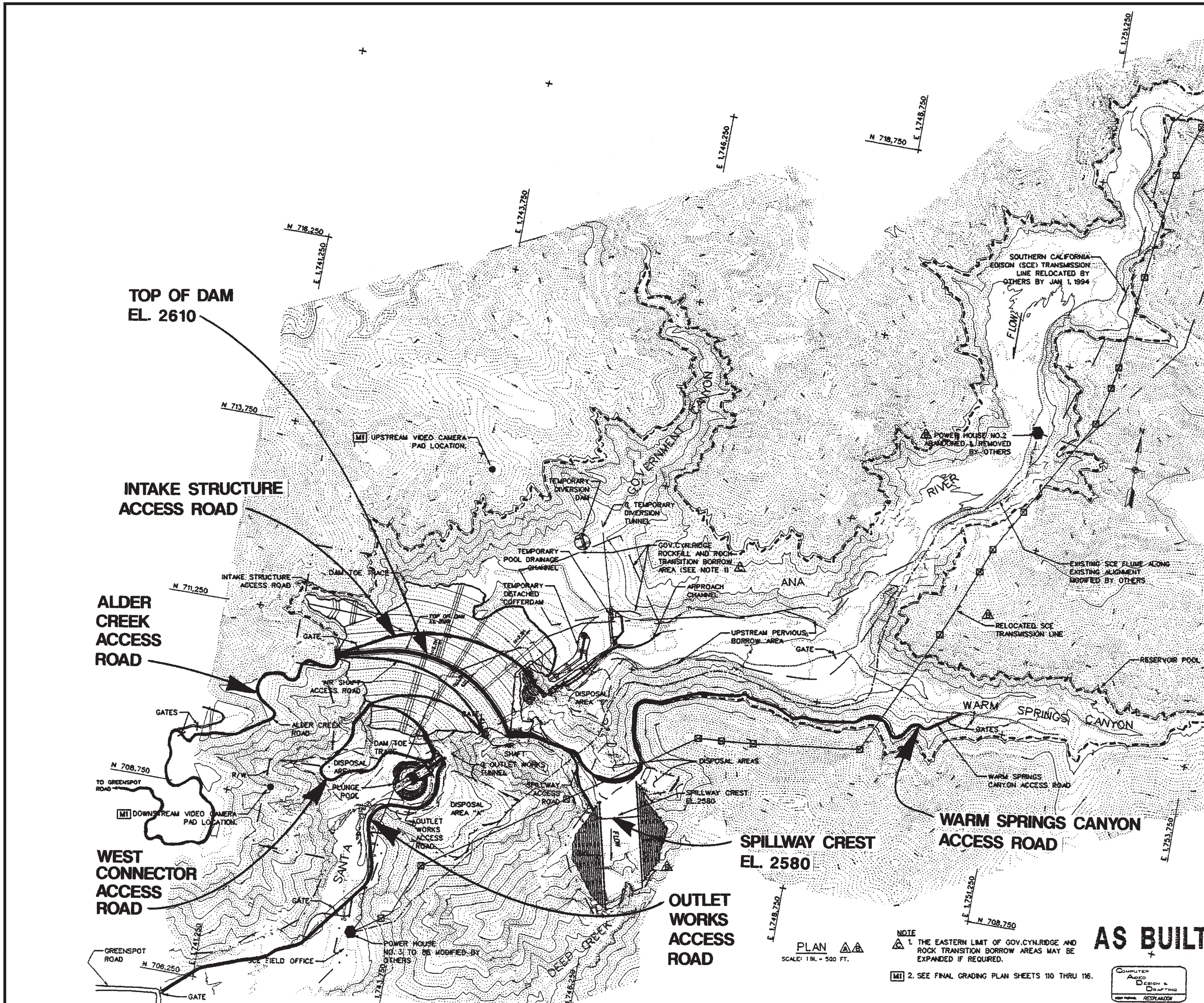
- Dam
- Recharge Basin
- Stream Gage
- Bridge Locations
- U Unlined Channel
- C Concrete
- G Grouted Stone
- G/C Side Slope/Bottom
- L Levee
- E Earth Berm

	Significant Features	River Miles (RM)	Remarks
Stream Gage	Santa Ana River above Seven Oaks Dam		Located on right bridge abutment of the Southern California Edison bridge crissing, just u/s of Alder Creek confluence
Stream Gage	Santa Ana River near Mentone		In San Bernardino County, on right bank near mouth of canyon, 1.6 miles u/s from Mill Creek, 3.2 miles, NE of Mentone, 16 miles d/s from Big Bear Lake.
1	Redlands Municipal Airport	0.5	**This distance is relative to Seven Oaks Dam.**
2	Norton Airforce Base	4.4	**This distance is relative to Seven Oaks Dam.**
3	Flabob Airport	18.4	**This distance is relative to Seven Oaks Dam.**

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

CHANNEL CONFIGURATIONS
SEVEN OAKS DAM TO PRADO DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

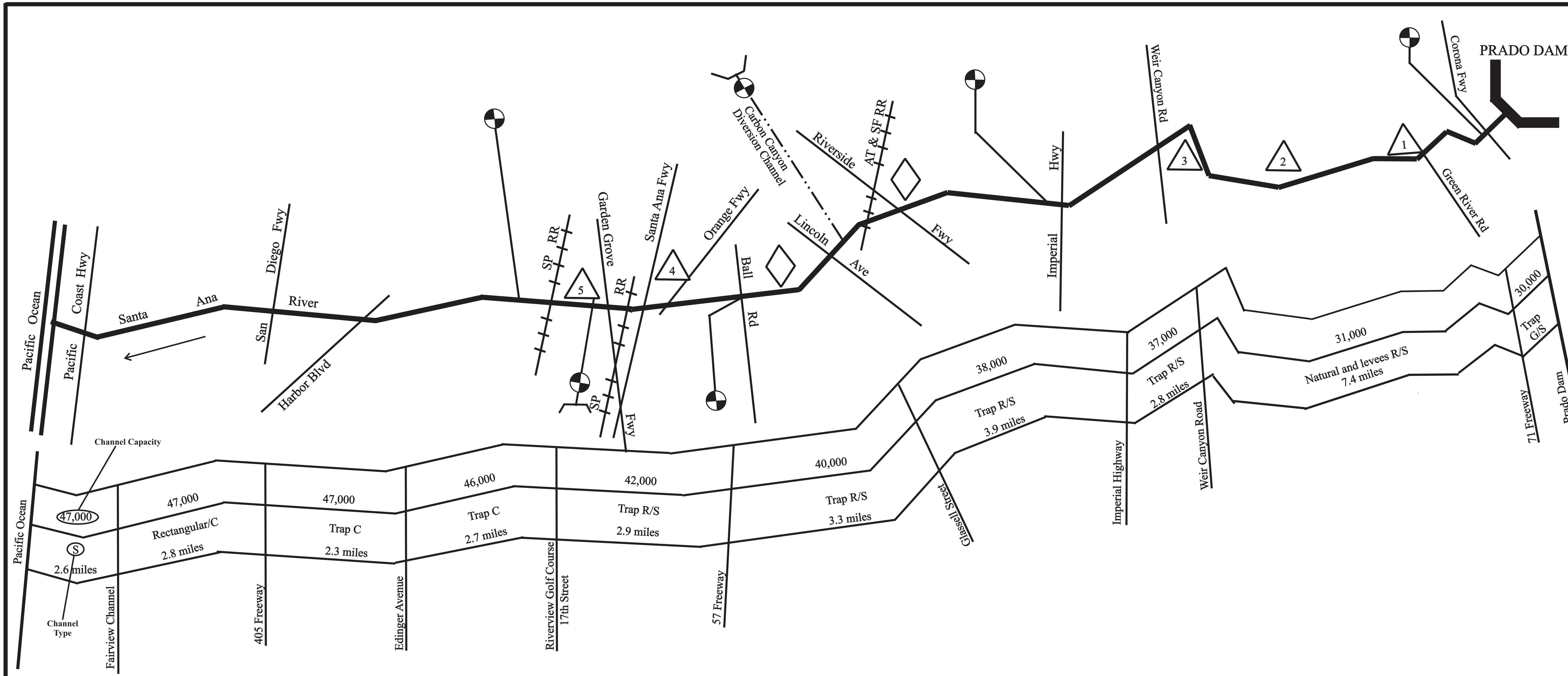


DATUM IS NATIONAL GEODETIC VERTICAL DATUM OF 1929

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

UPPER SANTA ANA RIVER
UPSTREAM OF
SEVEN OAKS DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



	Significant Features	Miles	Remarks
	Santa Ana River at Prado	31.2	Telemetry 052 PRAO
1	Green River Golf Course, Mobile Homes	20.4 - 27.2	
2	Featherly Park	25.7 - 24.2	
3	Horseshoe Bend	23.6	Orchards, Savi and Bryant Levees
	Santa Ana River at Imperial	19.9	
	Santa Ana River Spreading Grounds	19.8 -13.8	All Flood discharges less than 2200 cfs flows into the Santa Ana River
	Carbon Canyon Diversion Channel	16.1	Flows exceeding 2200 cfs will split at Miller Retarding Basin
	Santa Ana River at Ball Road	14.2	
4	Anaheim Stadium	12.8	Flows Regulated by Santiago Dam and Villa
5	Riverview Golf Course	11.9 - 9.9	
	Santiago Creek at Santa Ana	10.4	
	Santa Ana River at Fifth Street	8.7	Telemetry 011 SAR5

Legend

- Dam
- Recharge Basin
- Stream Gage
- U Channel Unlined
- R Rip Rap Side Slopes
- C Concrete
- G Grouted Stone
- G/C Side Slope/Bottom
- L Levee
- S Soft Bottom

Notes:

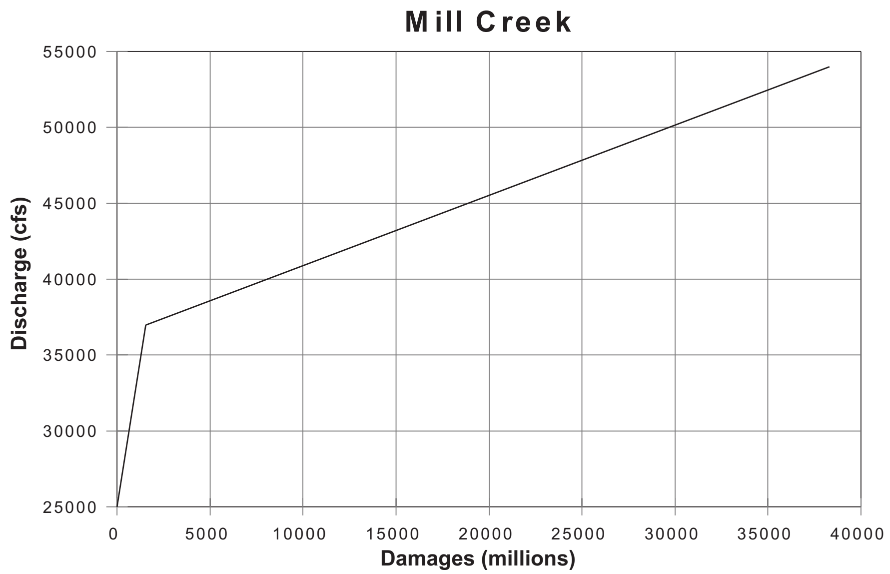
1. Schematic of the channel is not to scale.
2. Channel Capacities shown above are based on the design Q specified within the Phase II GDM, Vol 3, dated August 1988.
3. Design disharge values are in cubic feet per second.

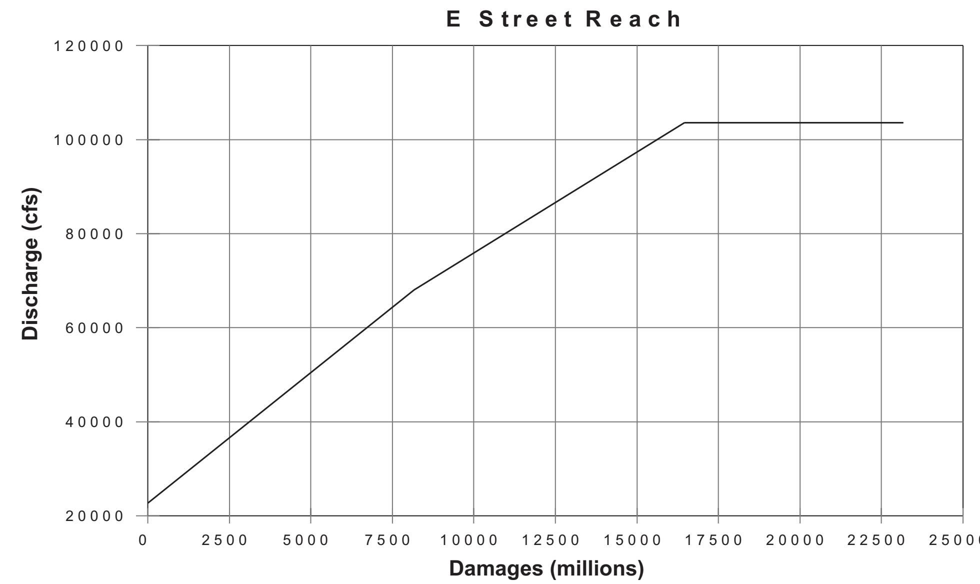
N

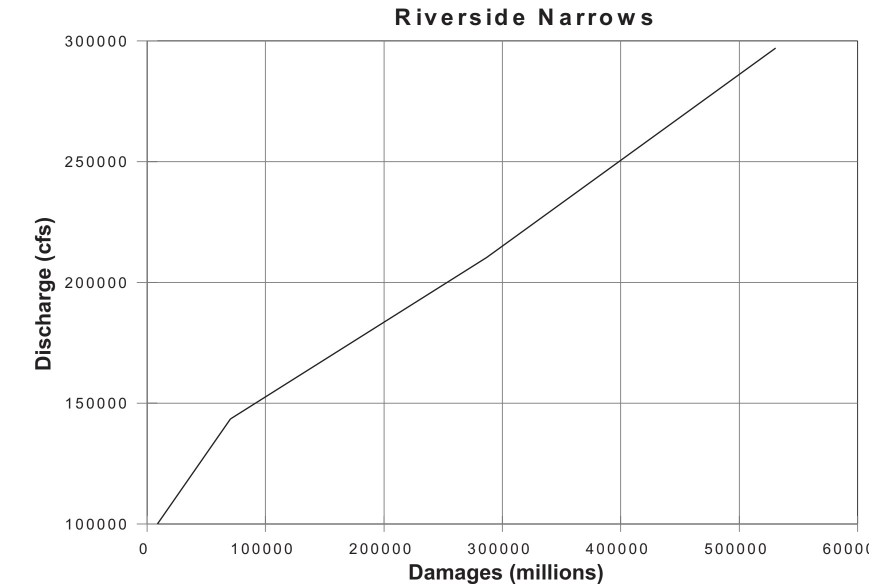
SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

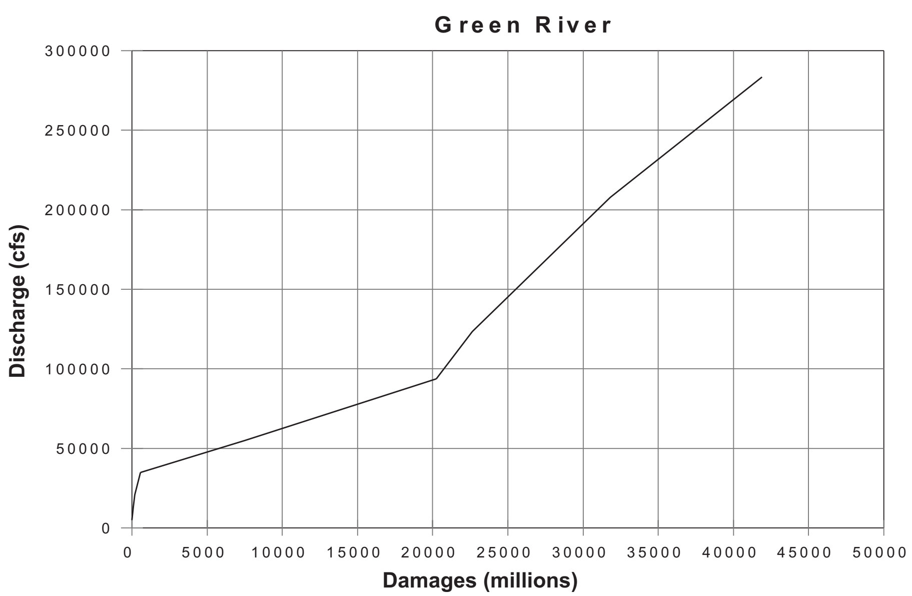
DOWNSTREAM CHANNEL
PRADO DAM TO PACIFIC OCEAN

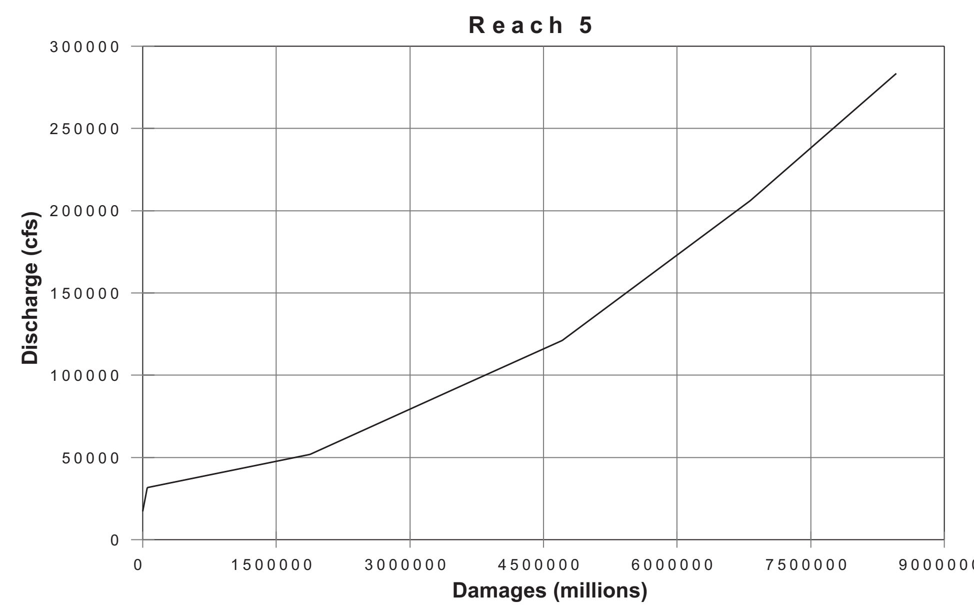
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

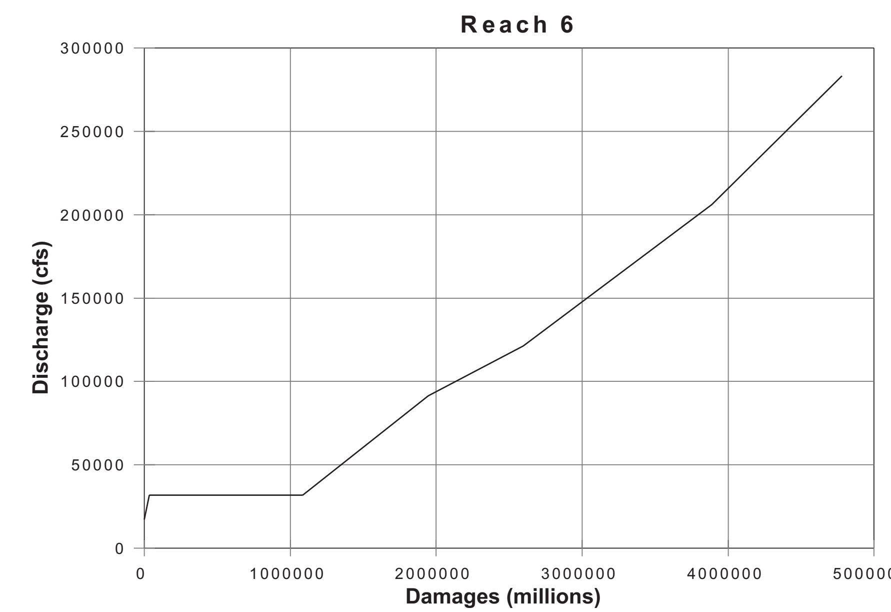


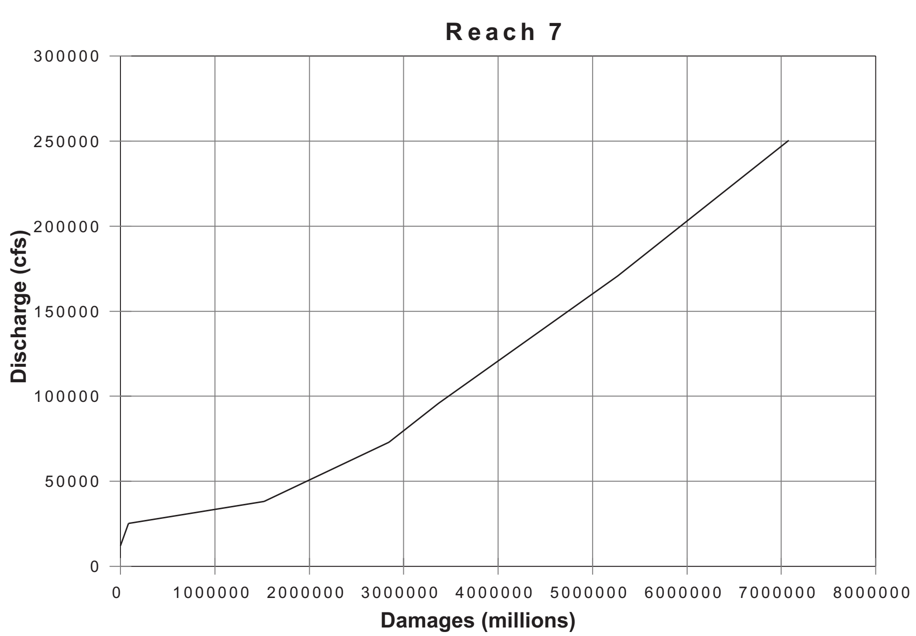


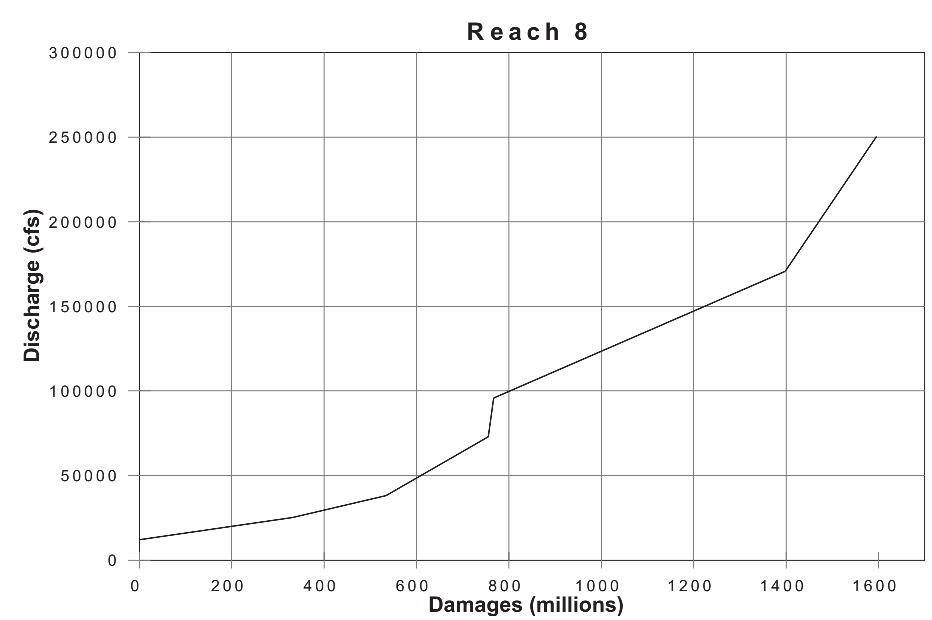












Note:

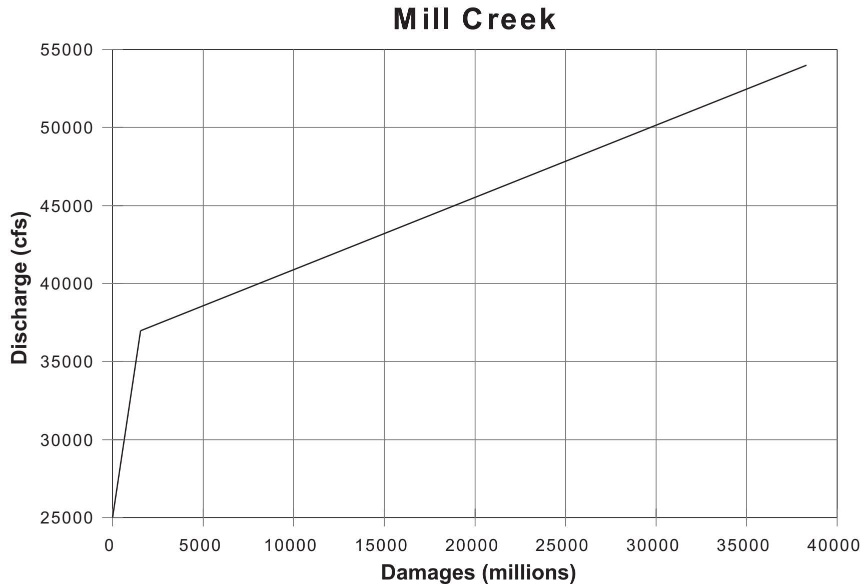
These curves were generated by the Los Angeles District Corps of Engineers, Economics Section through their annual flood damages program HEC-EAD. Models were generated for the Seven Oaks Dam economic study based on 2001 and 2099 dollars. This study was recently updated to reflect 2002 dollars.

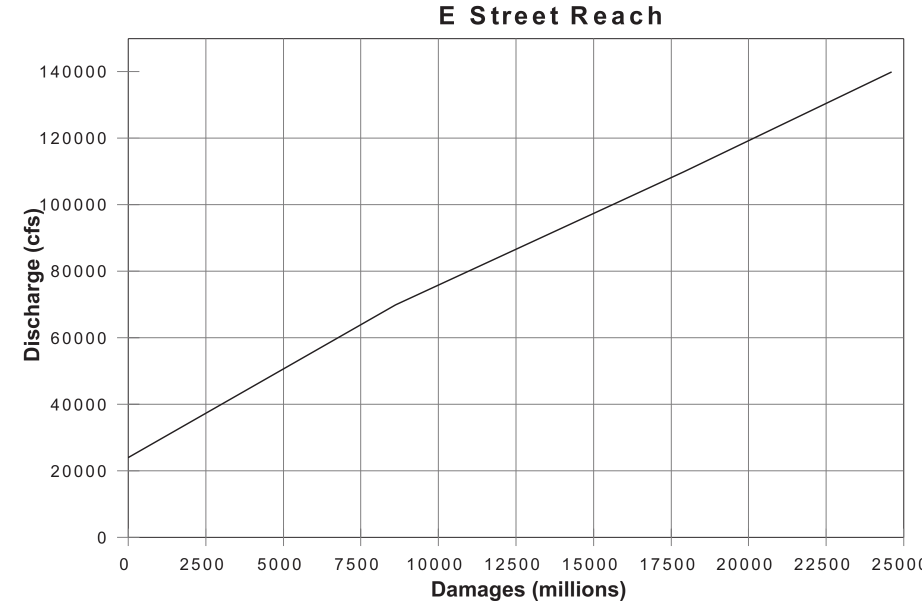
SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

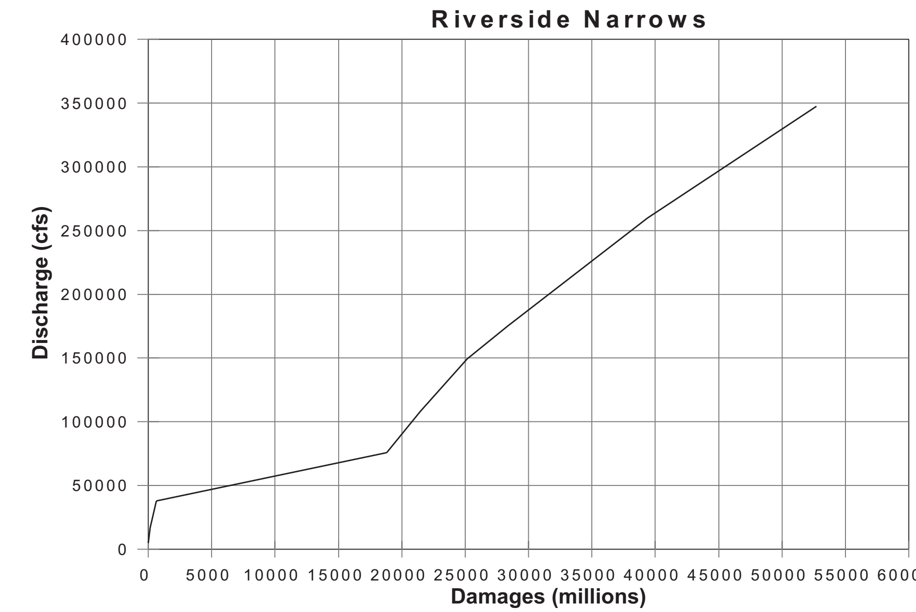
DAMAGE vs. DISCHARGE 2002 DOLLARS

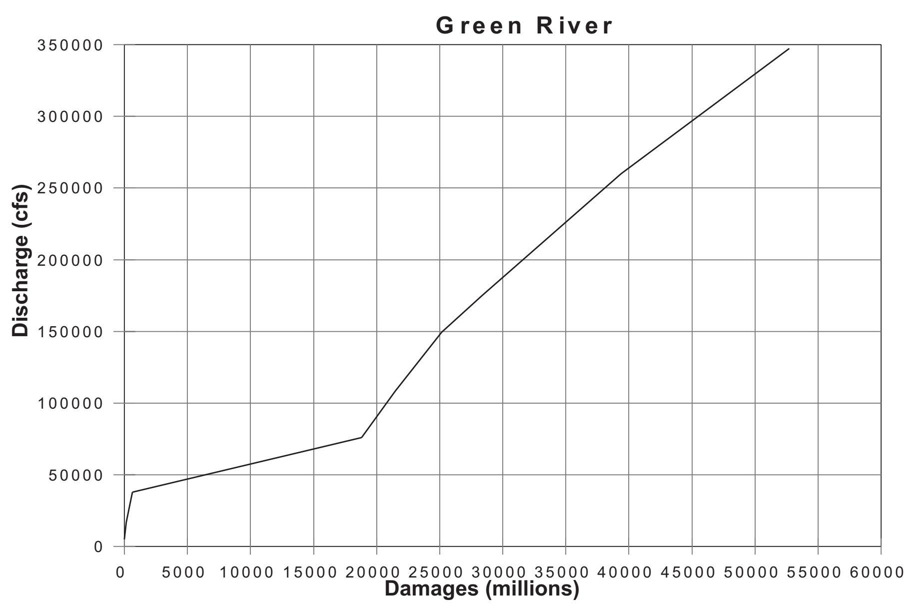
(SEVEN OAKS DAM IN CONJUNCTION WITH PRADO DAM)

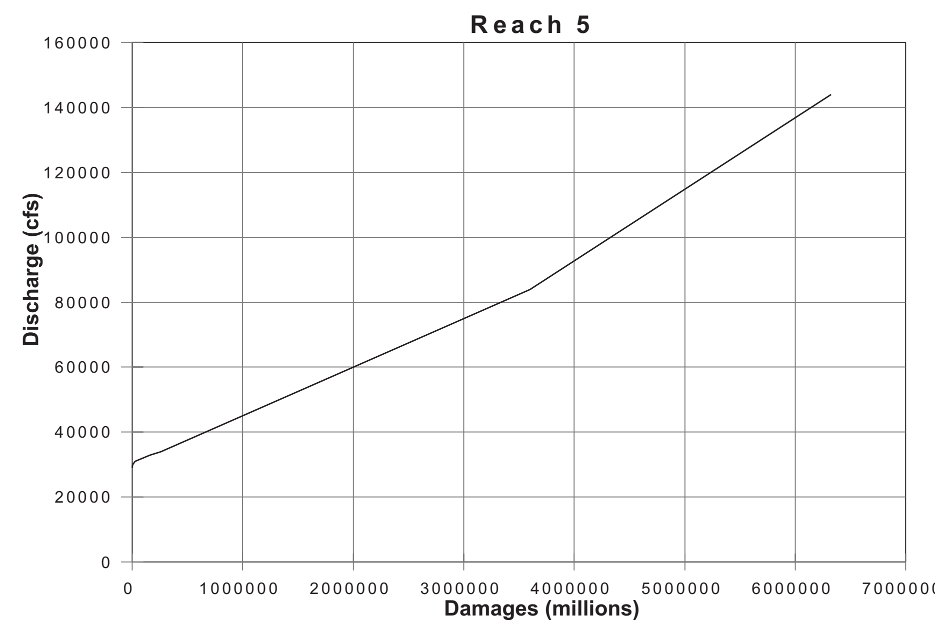
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

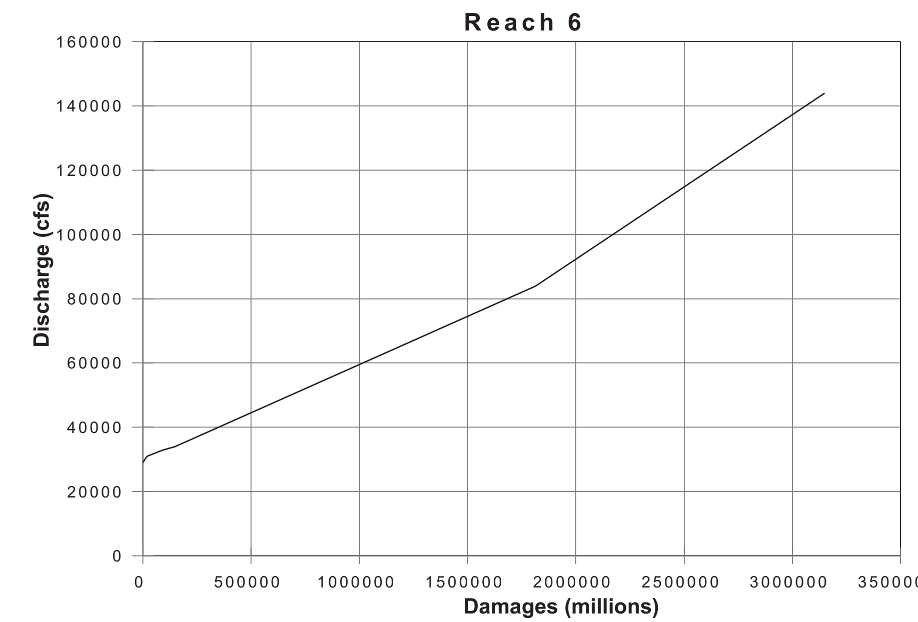


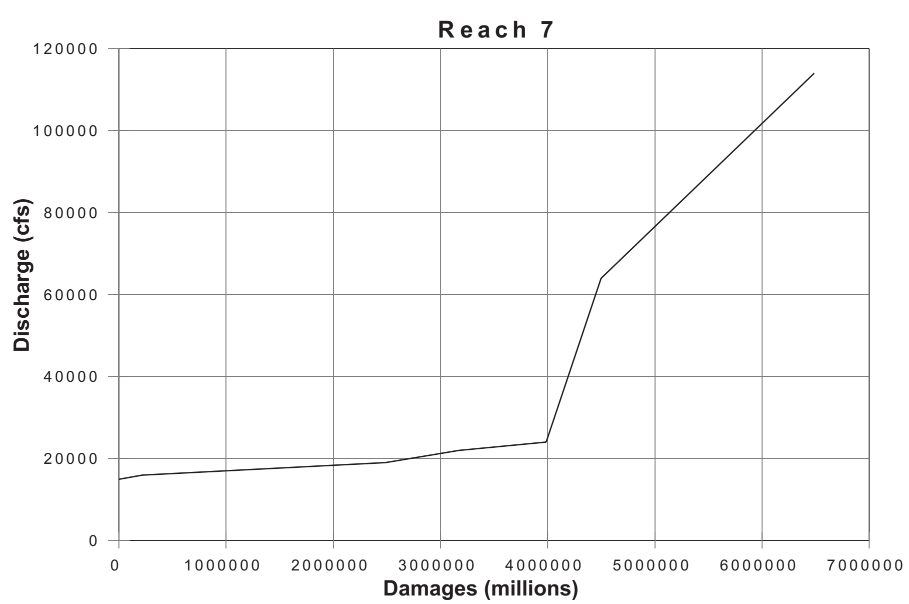


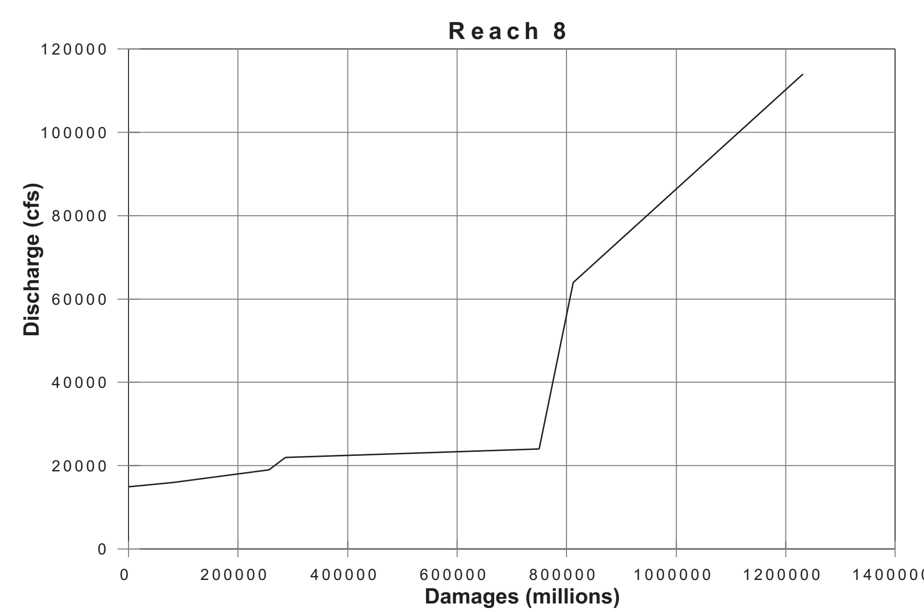












Note:

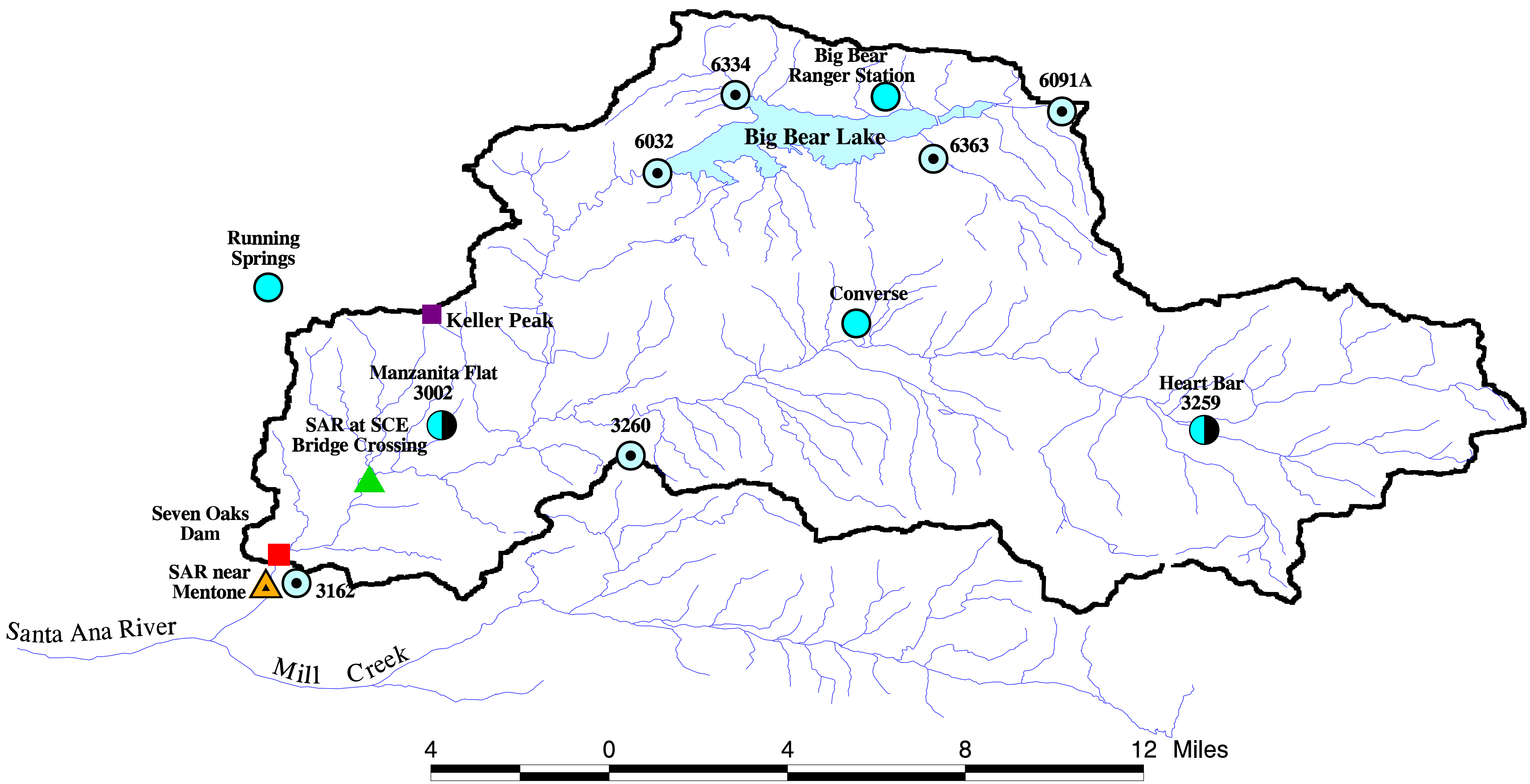
These curves were generated by the Los Angeles District Corps of Engineers, Economics Section through their annual flood damages program HEC-EAD. Models were generated for the Seven Oaks Dam economic study based on 2001 and 2099 dollars. This study was recently updated to reflect 2002 dollars.

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

DAMAGE vs. DISCHARGE 2099 DOLLARS

(SEVEN OAKS DAM IN CONJUNCTION WITH PRADO DAM)

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



San Bernardino County Precipitation Gage (No Telemetry)

COE Precipitation Gage co-located or adjacent to San Bernardino County Gage
(Note: Manzanita Flat gage is equipped with ALERT telemetry.
Heart Bar gage is not equipped with telemetry.)

COE Precipitation Gage with ALERT Telemetry

USGS Stream and Precipitation Gage

COE Stream Gage

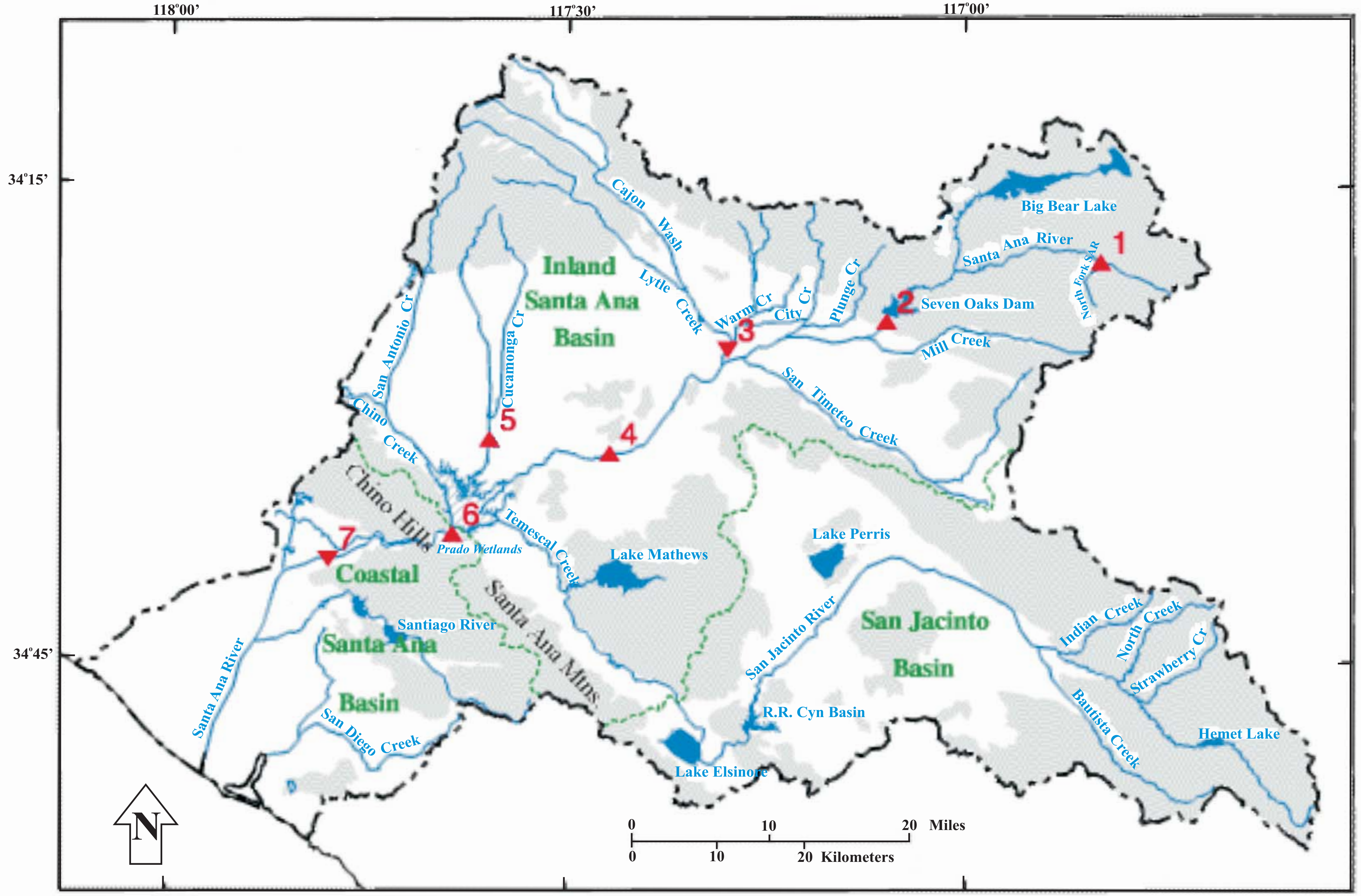
Water Level Gage at Seven Oaks Dam

COE Repeater

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
INTERIM WATER CONTROL MANUAL

GAGING STATIONS IN SEVEN OAKS BASIN

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Consolidated Rock - Areas conducive to higher surface runoff.

Subunit Boundaries - Inland Santa Ana Basin consists of 5 Basic Fixed Sites for Water Quality Sampling. Coastal Santa Ana Basin consists of 2 Intensive Fixed Sites.

Basic Fixed Site - Sampled by the USGS for the analysis of major irons, nutrients, dissolved organic carbon, suspended organic carbon, and suspended sediment.

Intensive Fixed Site - Sampled for Water Quality like the Basic Fixed Sites, and also analyzed for volatile orgainc compounds and pesticides.

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

USGS WATER QUALITY MONITORING STATIONS BASIC-FIXED SITES

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Table 1. MINIMUM AND MAXIMUM GATE OPENING REQUIREMENTS

GATE TYPE	MINIMUM GATE OPENING (FEET)	MAXIMUM GATE OPENING (FEET)
REGULATION OUTLET (R.O.)	.75	6.8
LOW FLOW (L.F.)	.5	2.8

Table 2. RECOMMENDED MAXIMUM RATE OF RELEASE CHANGE

DISCHARGE	TO INCREASE FLOW	TO DECREASE FLOW
0 - 200	NO RESTRICTION	NO RESTRICTION
UP TO 500	250 CFS/HOUR	250 CFS/HOUR
500 - 4,000	500 CFS/HOUR	500 CFS/HOUR
4,000 -8,000	1000 CFS/HOUR	1000 CFS/HOUR

MDL - Minimum Discharge Line
LF - Low Flow Gate
RO - Regulation Outlet Gates (Main Gates)
MDLE - Minimum Discharge Line Extension *

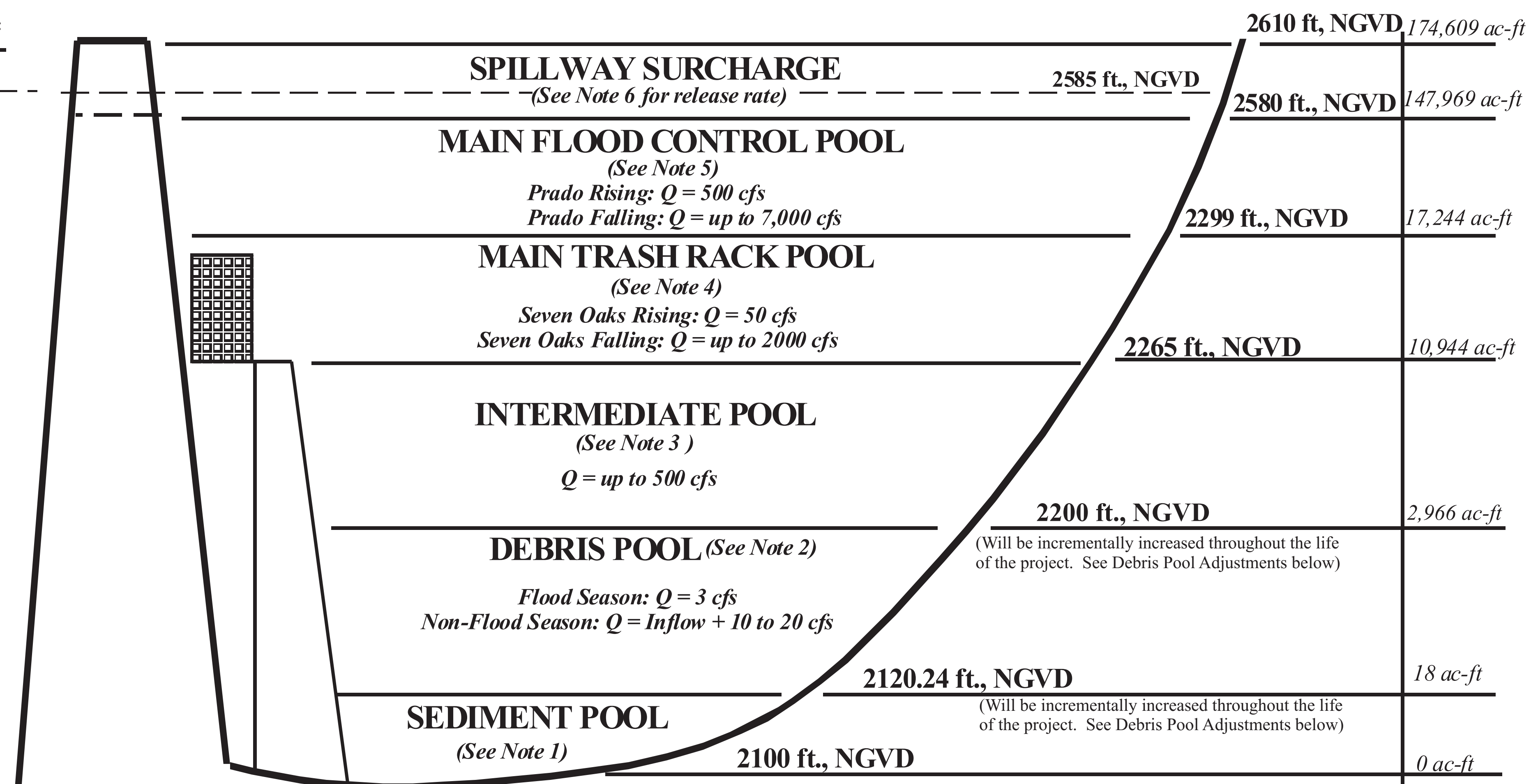
* During the dry months, the MDLE will usually be used to bypass the plunge pool. The MDLE is controlled by a 30-inch ball valve. This ball valve cannot be used to regulate flows and must be either in a fully open or fully closed position.

Storage values shown were acquired from year 1999 survey data.

DESIRED GATES TO USE	REQUIRED SLUICE GATE POSITION **
MDL, LF, RO	RISING: OPEN * FALLING: OPEN *
PRADO RISING: MDL, LF PRADO FALLING: LF, RO	RISING: OPEN * FALLING: OPEN *
SEVEN OAKS RISING: MDL SEVEN OAKS FALLING: MDL, LF, RO	OPEN
MDL & LF	OPEN
MDL & LF	OPEN Once the water level approaches the top of debris pool elevation, sluice gate should be opened, and should remain open throughout the flood season (Refer to Section 7-05.b. for details).
MDL	CLOSED

*** May be closed if necessary. Prior to closure during high flows, however, the LF and RO gates must be temporarily closed to avoid the possibility of damaging the sluice gate.**

**** Refer to Section 7-06.b. for procedures in operating the sluice gate.**



(For detailed drawings of the outlet works features, see Plates 2-06 to 2-24 of this document)

DEBRIS POOL ADJUSTMENTS:

- The maximum allowance for Debris Pool storage is about 3,000 ac-ft. The minimum required Debris Pool storage by the end of project life is about 800 ac-ft.

- As sediments accumulate and additional stop logs are placed within the multilevel withdrawal structure, the top of sediment pool will rise and the debris pool storage will diminish.

- When it is suspected that the debris pool storage is approaching the minimum of 800 ac-ft, the reservoir should be re-surveyed and the top of debris pool elevation raised to re-establish the 3,000 ac-ft of debris pool storage.

- Continue raising the top of debris pool elevation over project life until the top of debris pool reaches the final elevation of 2300 ft, NGVD.

NOTES:

1. SEDIMENT POOL:
- Additional stop logs are installed as necessary prior to each flood season. Sediment pool elevation may vary in any given year. Additional stop logs may be installed during the flood season, if necessary. When reservoir water surface elevation is within this pool, releases are generally made through the MDLE.

2. DEBRIS POOL:
- Prior to using LF and or RO gates sluice gate needs to be opened. See Section 7-06.b. of this document for procedures.

3. INTERMEDIATE POOL:
- Maximum combined capacity of LF and MDL in this elevation range is 500 cfs.

- May delay releases and modify release rates if hydrologic conditions warrant to support mitigation and enhancement plans.

4. MAIN TRASH RACK POOL:
- During Rising Stages: Release 50 cfs through the MDL only.

- During Falling Stages: Release theoretical maximum safe rates. The theoretical maximum Q's at different elevation ranges are:

- @2265 ft, NGVD ---- Q = 500 cfs
- @2269 ft, NGVD ---- Q = 1,000 cfs
- @2273 ft, NGVD ---- Q = 1,500 cfs
- @2299 ft, NGVD ---- Q = 2,000 cfs

- Note that the rates shown can be adjusted depending upon the amount of trash observed, the proximity of the next storm, the time required to clean the trash racks, and operation of the dam.

- May delay releases and modify release rates if hydrologic conditions warrant to support mitigation and enhancement plans.

- See Table 1 for max & min allowable gate openings.

5. MAIN POOL:
- During Falling Stages: The Q's at different elevation ranges are:

- @2299 ft, NGVD ---- Q = 2,000 cfs
- @2300 ft, NGVD ---- Q = 2,030 cfs
- @2400 ft, NGVD ---- Q = 4,340 cfs
- @2500 ft, NGVD ---- Q = 6,560 cfs
- @2580 ft, NGVD ---- Q = 7,000 cfs

- May delay releases and modify release rates if hydrologic conditions warrant to support mitigation and enhancement plans.

- See Table 1 for max & min allowable gate openings.

6. SPILLWAY SURCHARGE:
- During Rising Stages below el 2585 ft, NGVD, maintain a combined release total of 7,000 cfs. Above el. 2585 ft, NGVD, all gates shall be closed.

- During Falling Stages: Gates may be adjusted to maintain the resulting maximum spillway flow for quicker evacuation of the remaining surcharge pool.

7. OPERATIONAL CONSIDERATIONS:
- For all release adjustments, see Tables 1 and 2.

- Scheduled releases will be curtailed, if necessary, in order to assure the safe operation of the dam (i.e., exceedance of downstream channel capacity, or any other emergencies.

- All release ranges shown can be cut or increased, as necessary, in order to allow safety inspection for inspection or for maintenance purposes.

- Instrumentation Testing Program: Collection of data to verify the dam's performance may be done if the opportunity exists.

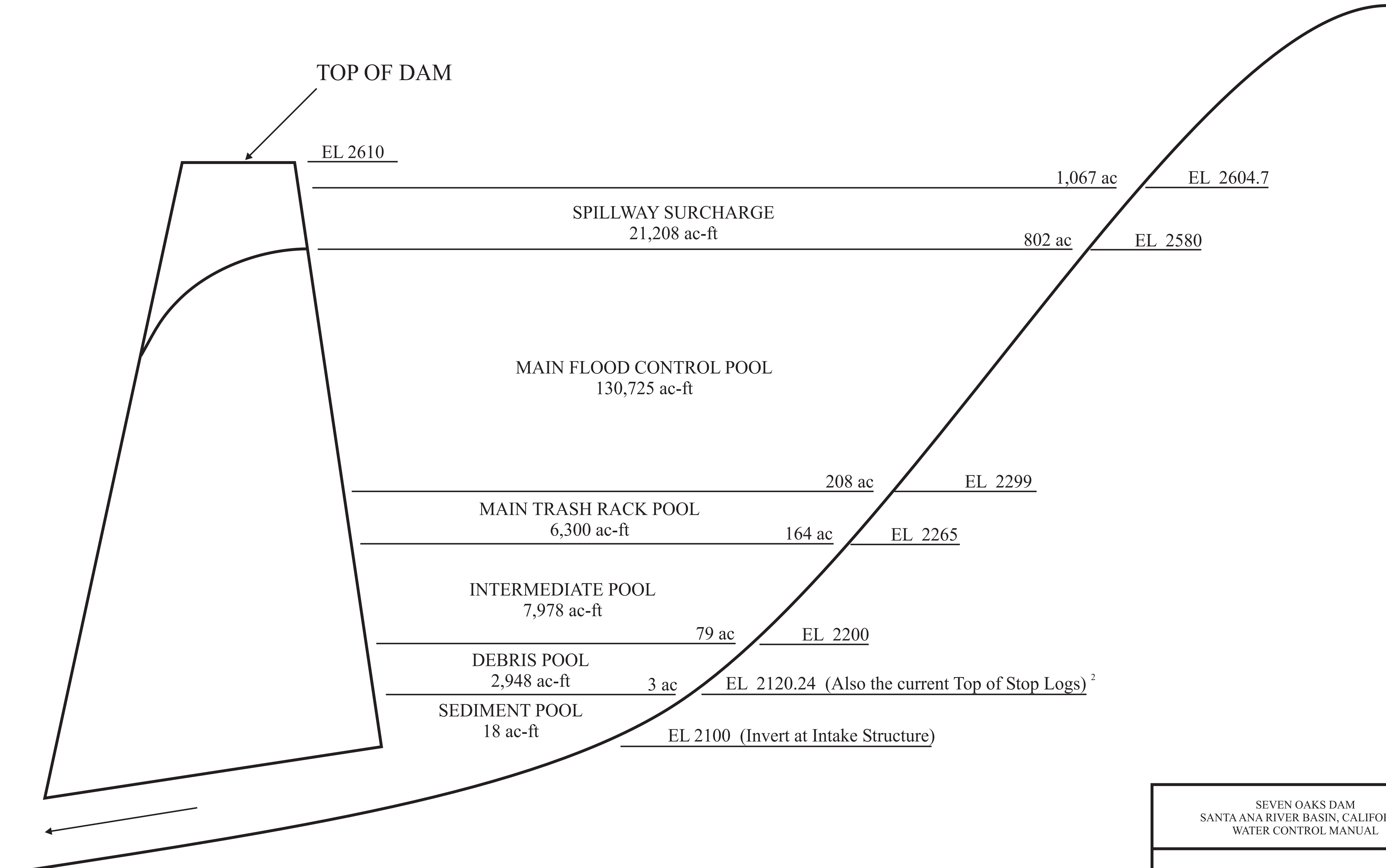
SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

WATER CONTROL PLAN

Revised: October 2002

(Note: Revise Plate every time debris pool elevation is increased)

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



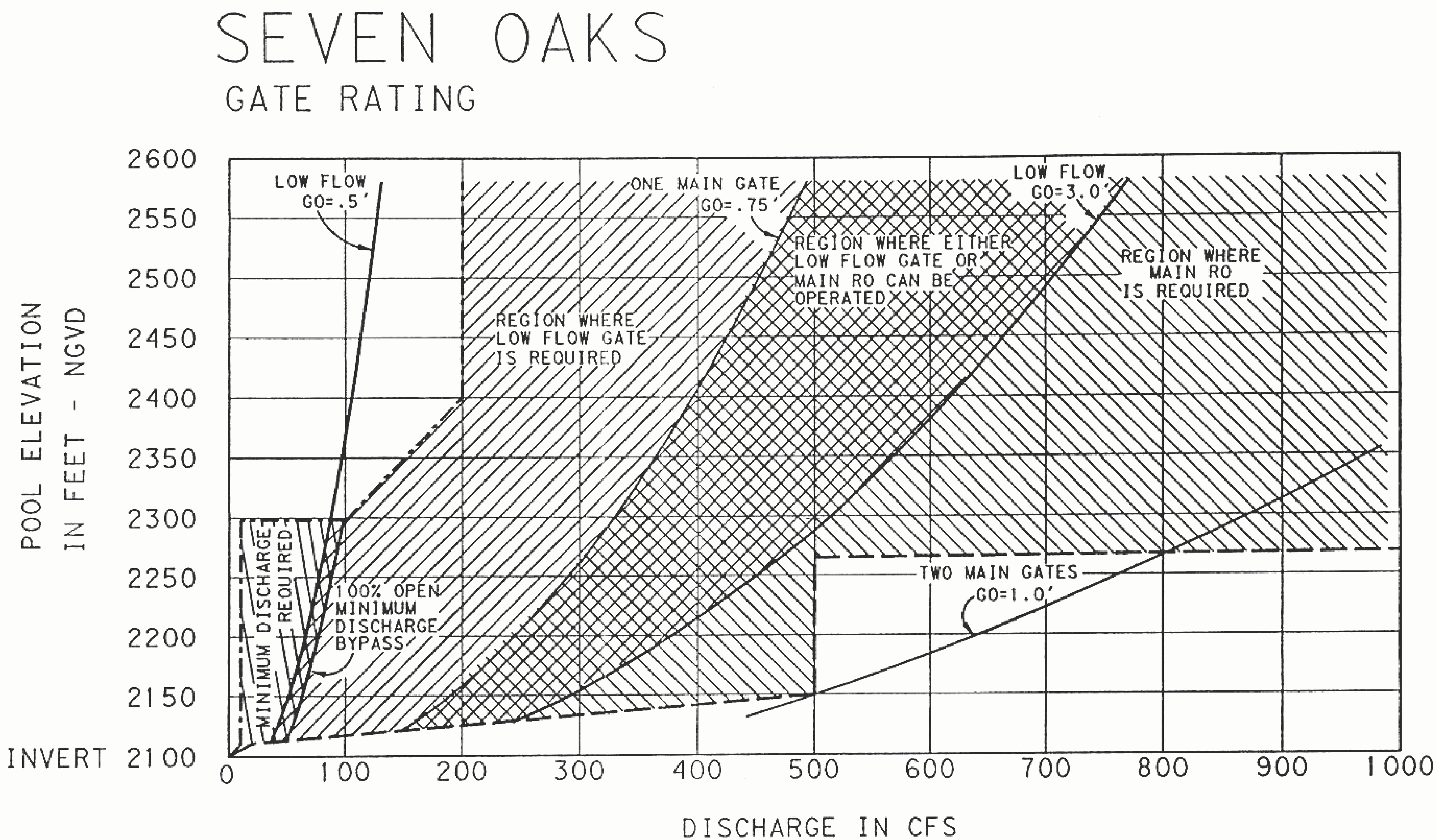
Notes:

1. Storage and Area values based on year 1999 survey
2. The top of sediment pool is determined by the current top of stop logs elevation. Additional stop logs will be placed as additional sediment accumulates over the life of the project.

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

SEVEN OAKS DAM STORAGE ALLOCATION DIAGRAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

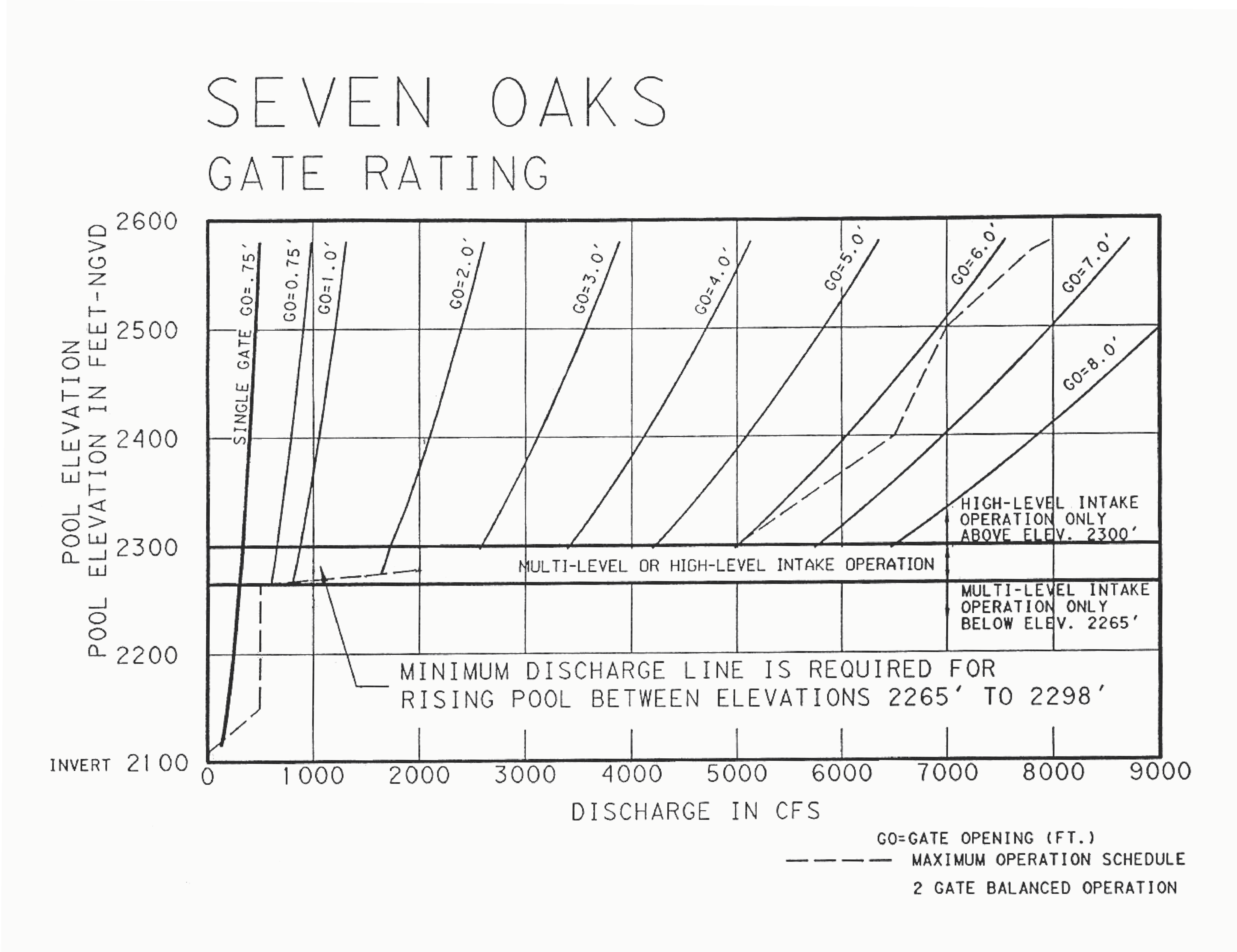


HIGH-LEVEL INTAKE OPERATION ONLY ABOVE ELEV. 2300'
MULTI-LEVEL OR HIGH-LEVEL INTAKE OPERATION BETWEEN ELEV. 2300' AND 2265'
MULTI-LEVEL INTAKE OPERATION ONLY BELOW ELEV. 2265'

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

GATE OPERATING REQUIREMENTS

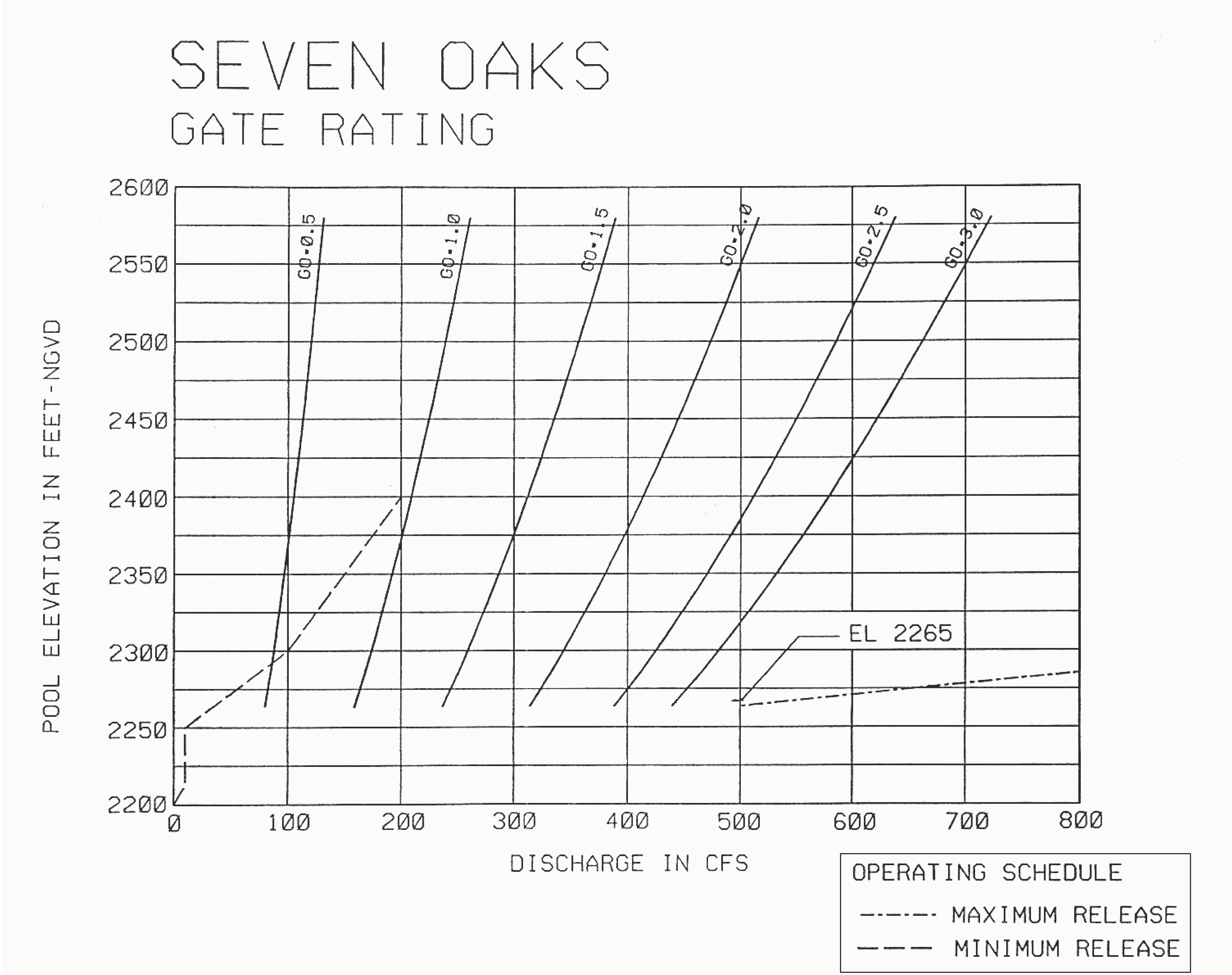
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

HIGH LEVEL INTAKE RO GATE RATING CURVES

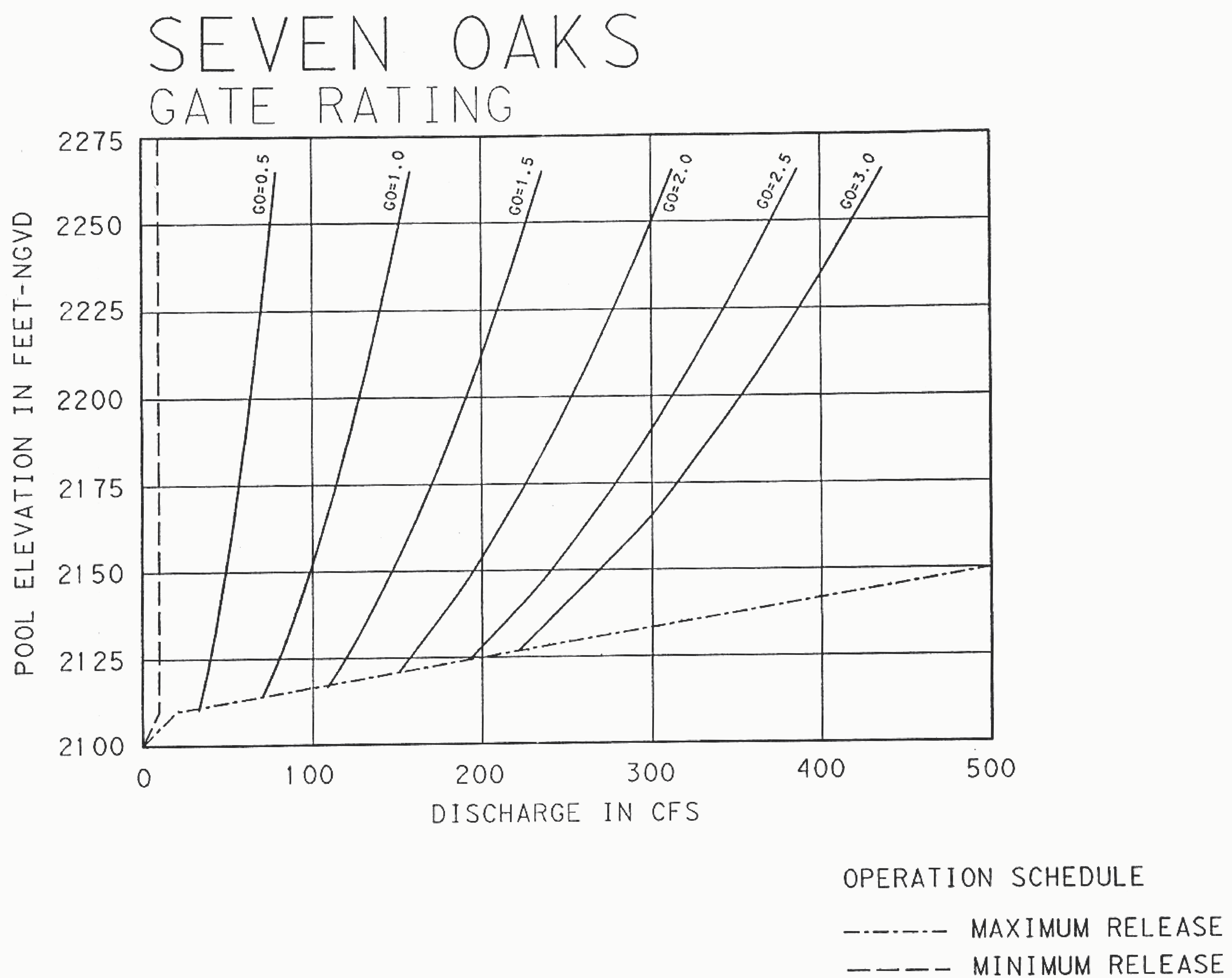
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

HIGH LEVEL INTAKE LOW FLOW GATE RATING CURVES

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



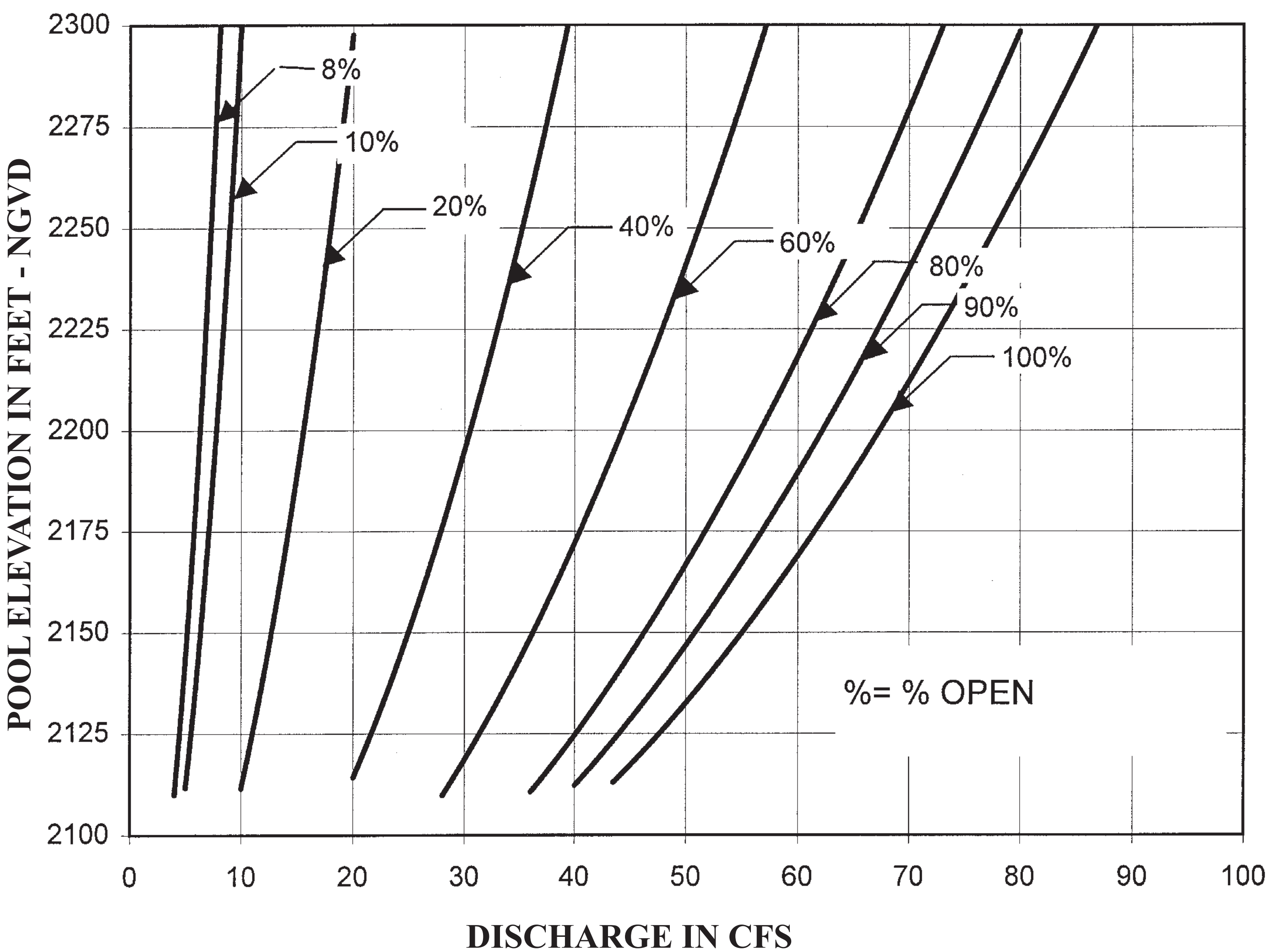
SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

MULTI-LEVEL WITHDRAWAL SYSTEM LOW FLOW GATE RATING CURVES

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELEL DISTRICT

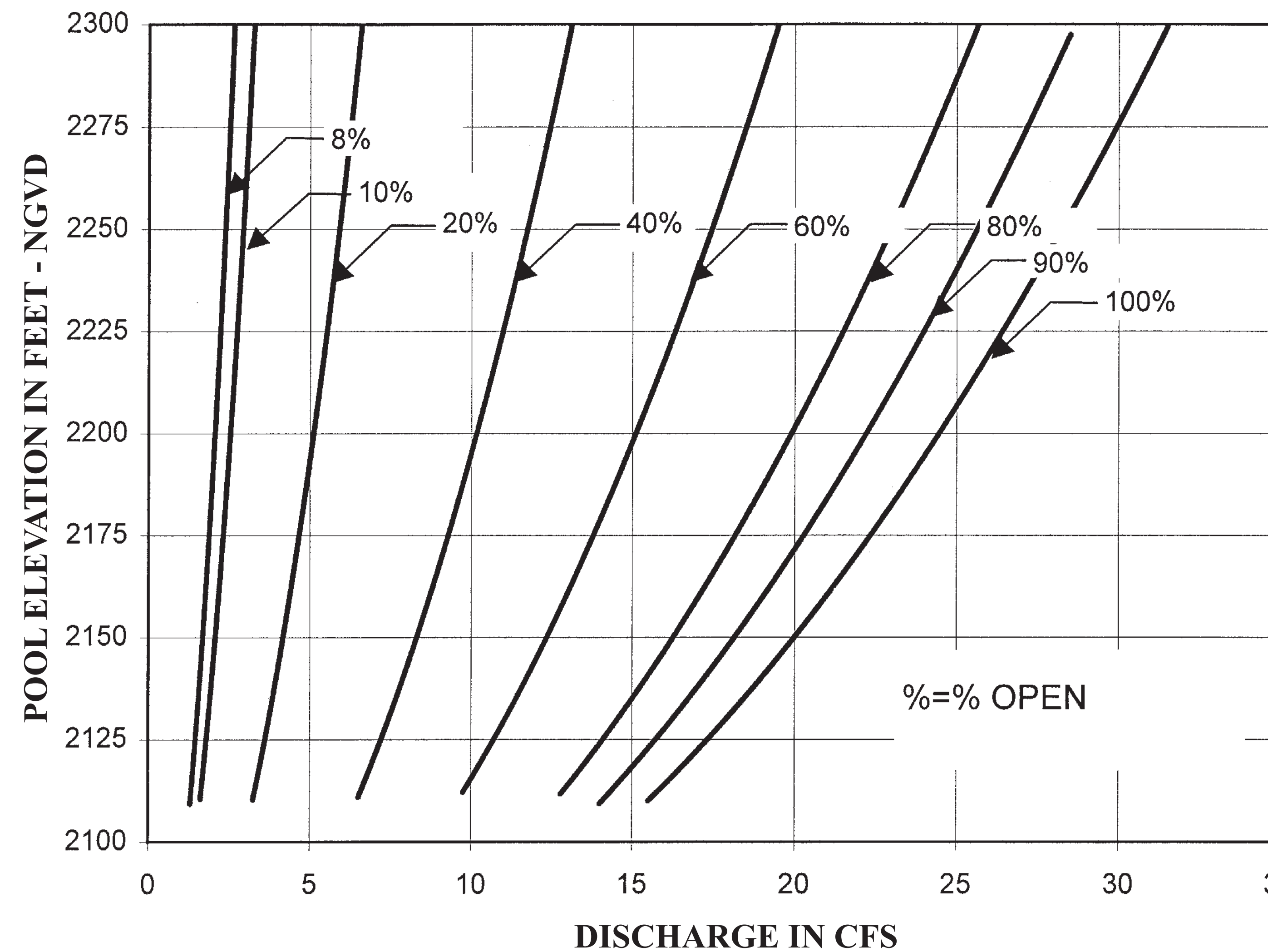
SEVEN OAKS

14-INCH VALVE RATING



SEVEN OAKS

8-INCH VALVE RATING

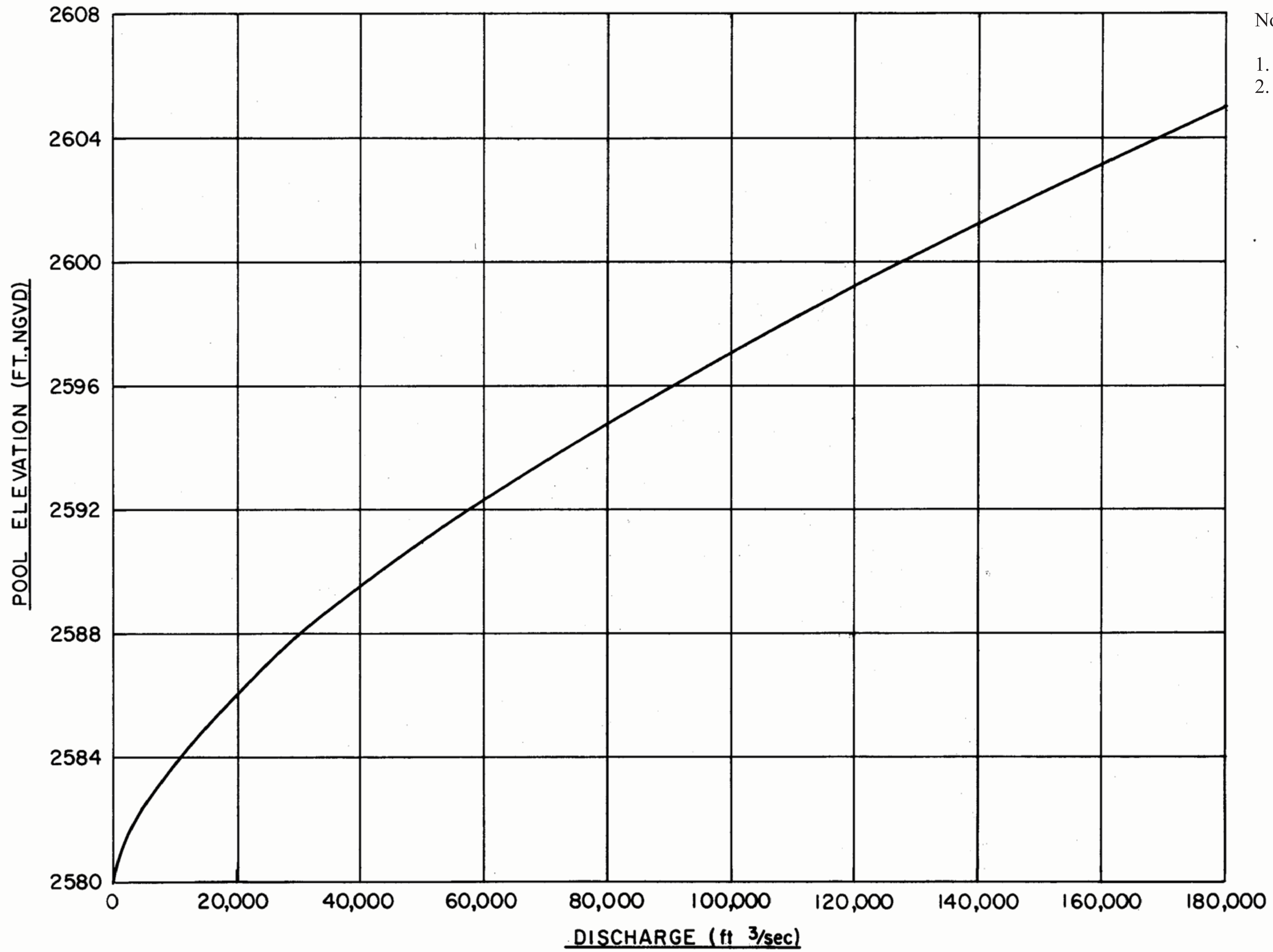


Note: Rating curves provided by the U.S. Army Engineering Research and Development Center (ERDC-WES), Portland District

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

MINIMUM DISCHARGE LINE RATING CURVES 14 - INCH AND 8 - INCH CONE VALVES

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



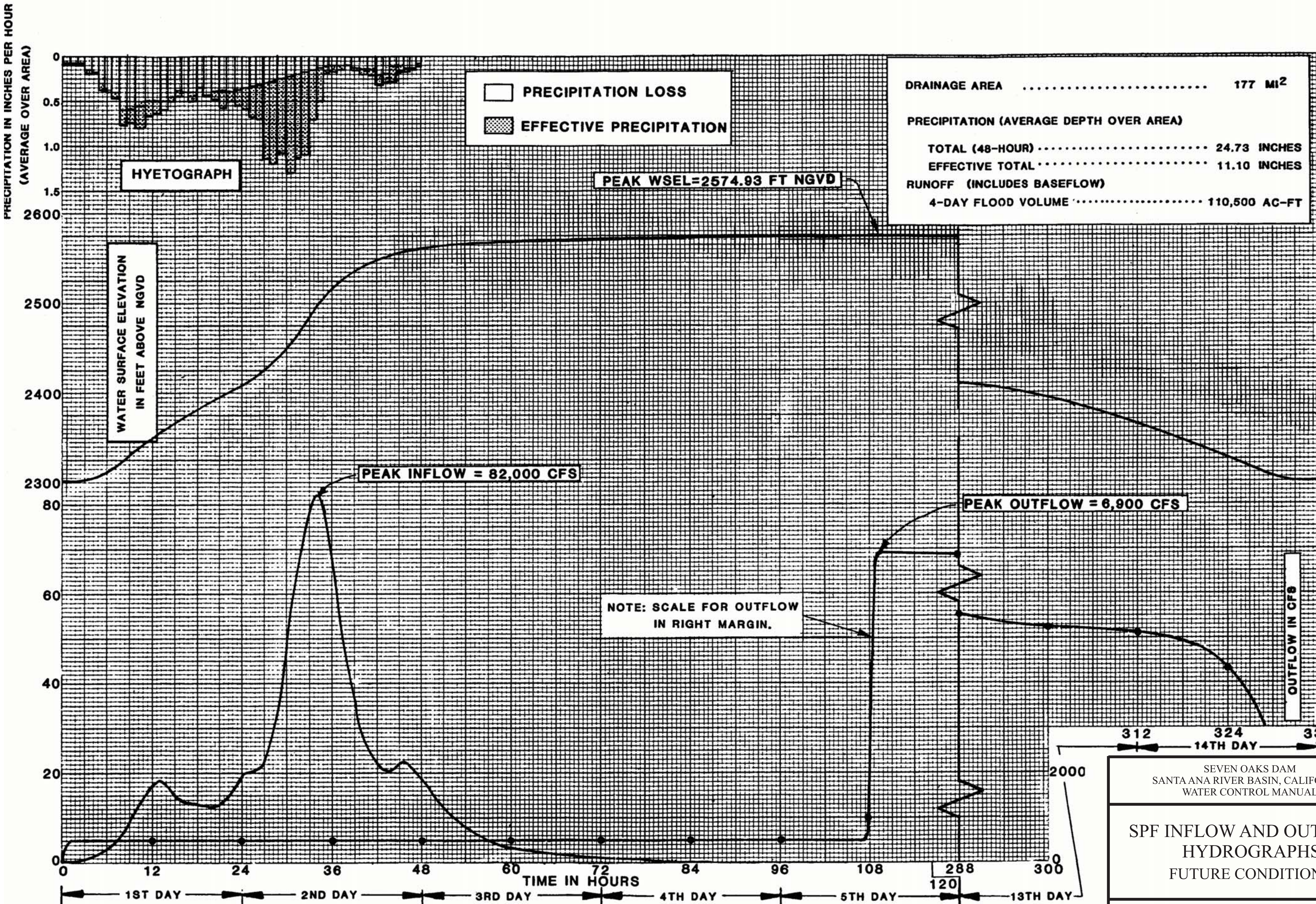
Notes:

1. The top of dam elevation is at 2610 ft, NGVD
2. Refer to Plate 2-25 for details of the spillway.

SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

SPILLWAY RATING CURVE

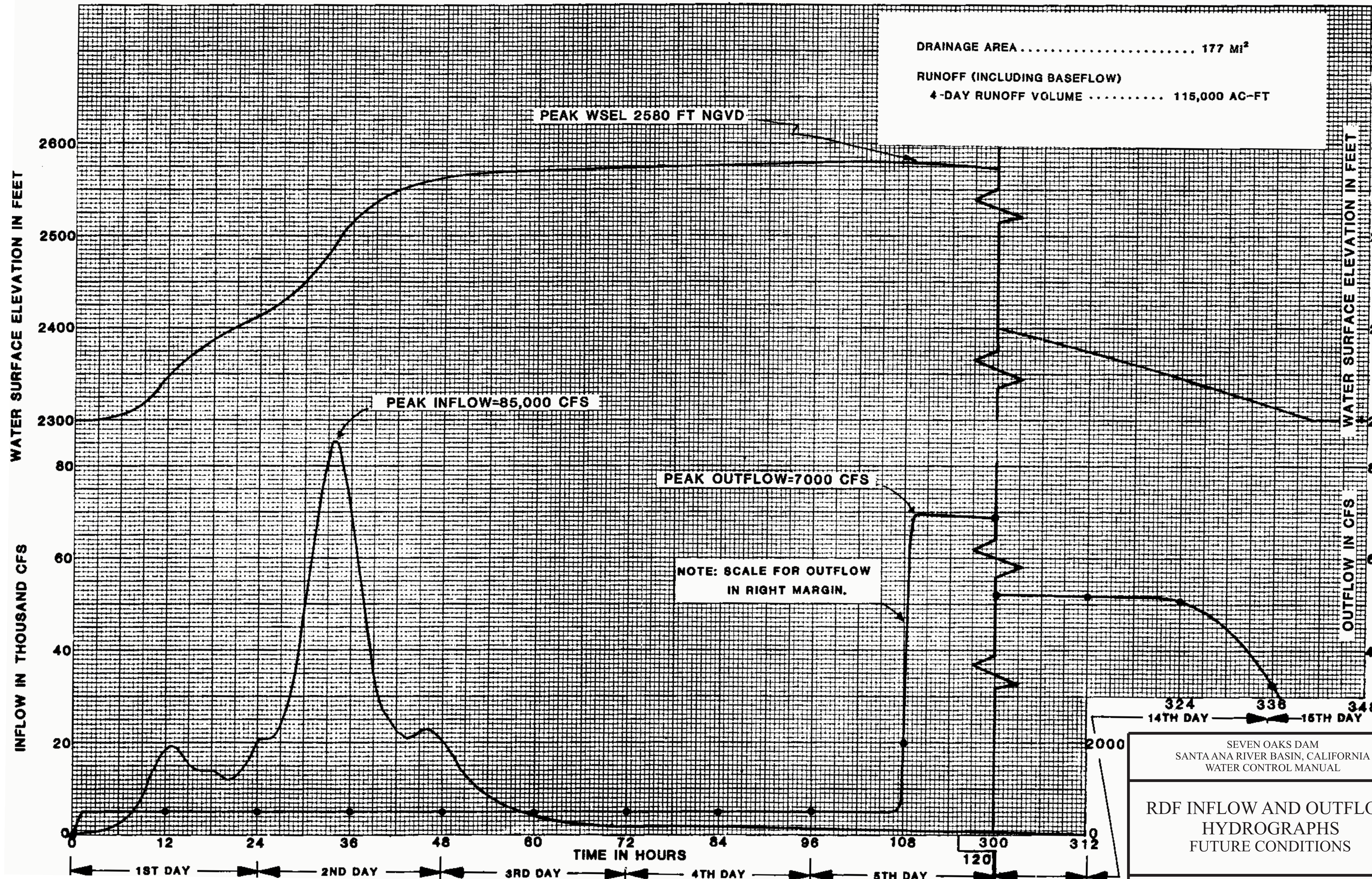
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELELS DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

SPF INFLOW AND OUTFLOW HYDROGRAPHS
FUTURE CONDITIONS

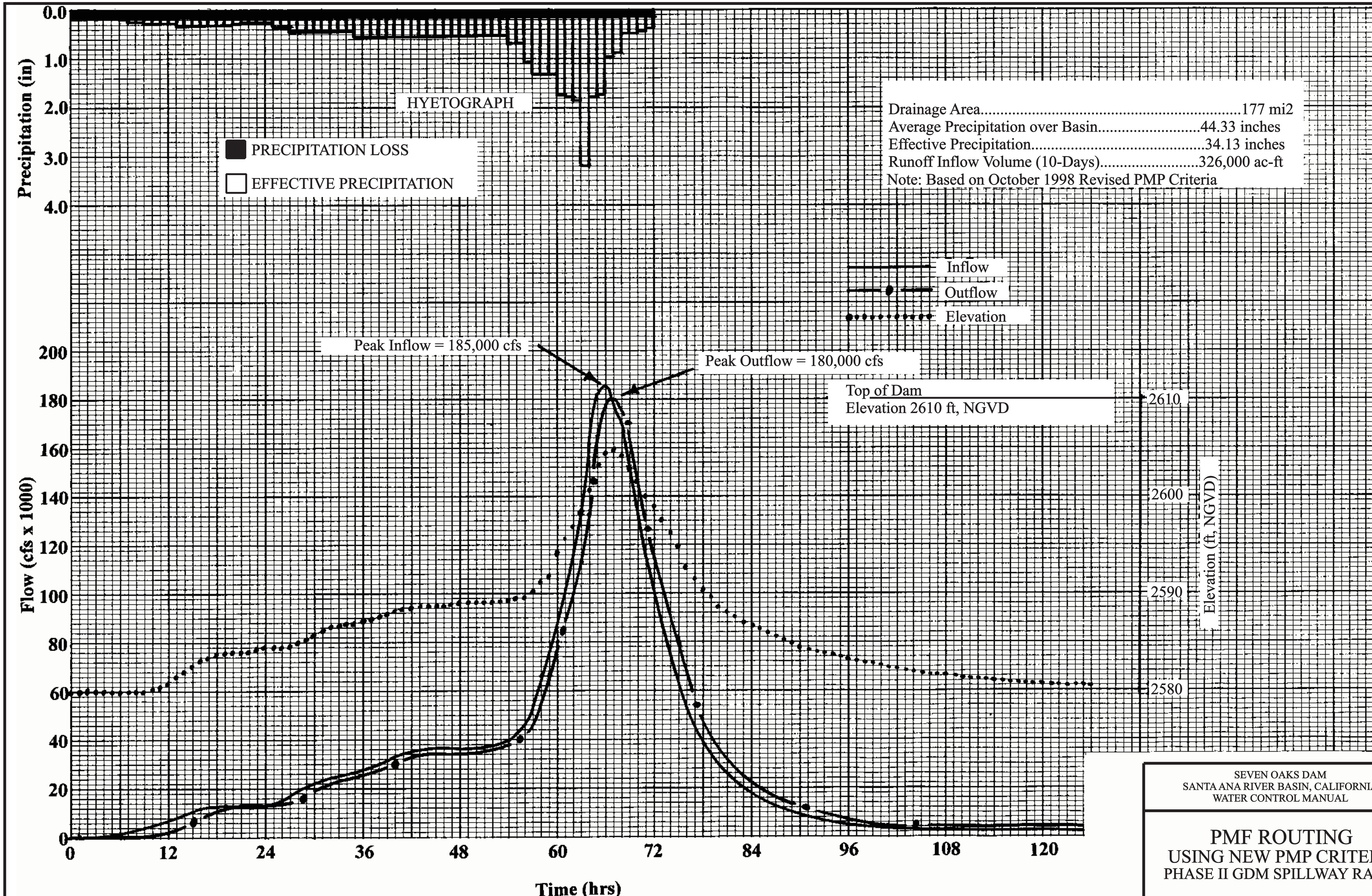
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELELS DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

RDF INFLOW AND OUTFLOW HYDROGRAPHS
FUTURE CONDITIONS

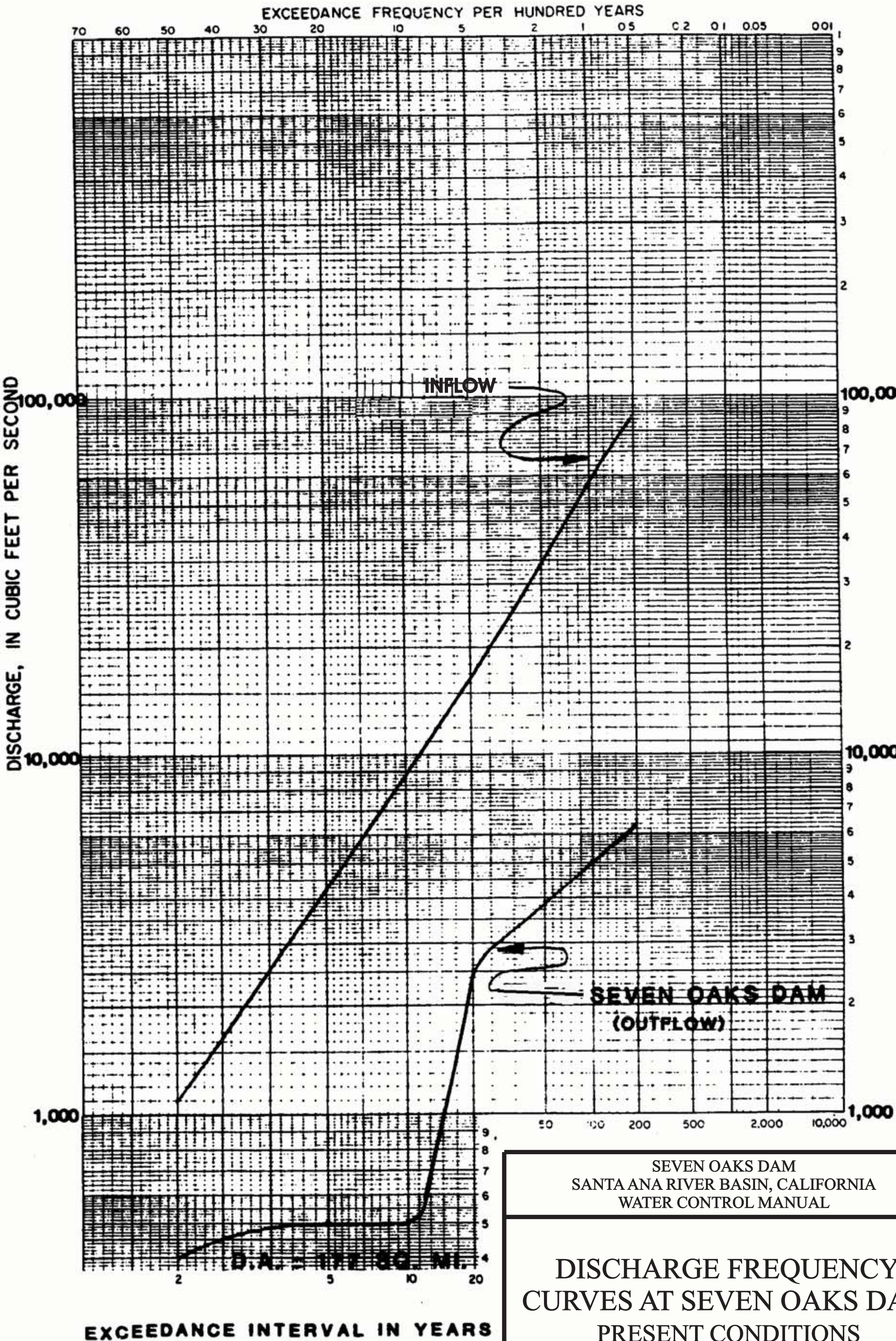
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

PMF ROUTING
USING NEW PMP CRITERIA
PHASE II GDM SPILLWAY RATING

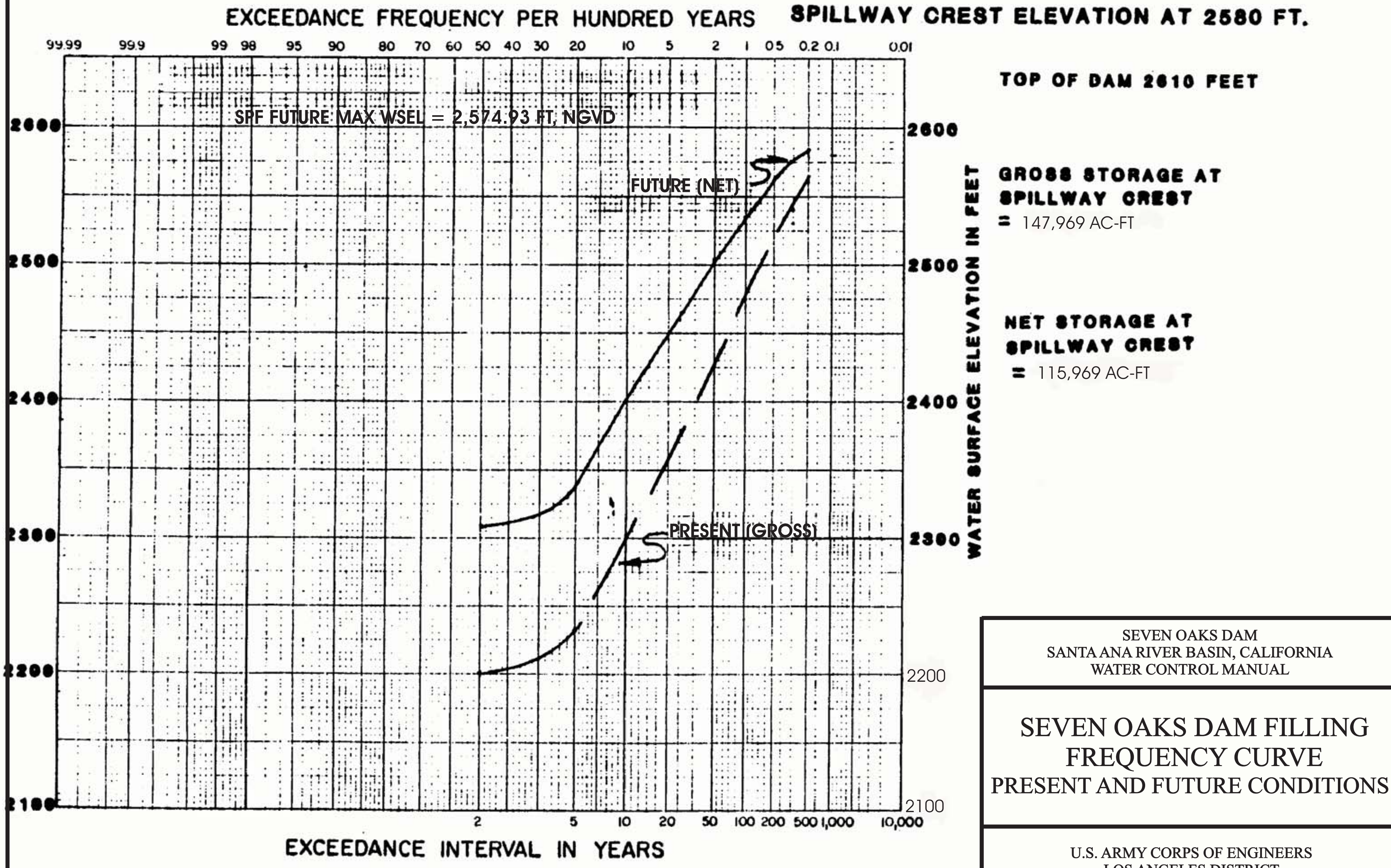
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

DISCHARGE FREQUENCY CURVES AT SEVEN OAKS DAM
PRESENT CONDITIONS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

SEVEN OAKS DAM FILLING FREQUENCY CURVE
PRESENT AND FUTURE CONDITIONS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

EXHIBIT A.

STANDING INSTRUCTIONS TO PROJECT OPERATOR (DAM TENDER) FOR WATER CONTROL

STANDING INSTRUCTIONS TO THE

PROJECT OPERATORS (DAM TENDER)

FOR WATER CONTROL

SEVEN OAKS DAM

SANTA ANA RIVER

SAN BERNARDINO COUNTY, CALIFORNIA

Los Angeles District Office

U.S. Army Corps of Engineers

May 2003

STANDING INSTRUCTIONS TO THE PROJECT OPERATORS
FOR WATER CONTROL

SEVEN OAKS DAM WATER CONTROL MANUAL

TABLE OF CONTENTS FOR EXHIBIT A

Exhibit A

I – BACKGROUND AND RESPONSIBILITIES

1-01 General Information.

a. General. This exhibit is prepared in accordance with instructions contained in the Corps of Engineers, Engineering Manual, (EM) 1110-2-3600, paragraph 9-2, (Standing Instructions to Project Operators for Water Control), and Engineering Regulation, (ER) 1110-2-240. This exhibit outlines the duties and responsibilities of the project operators (dam tenders) in connection with the operation of Seven Oaks Dam and the reporting of required hydrologic data.

Operational instructions to the project operators are outlined with specific emphasis on flood emergencies when communications between the project operators and the Orange County Public Facilities & Resources Department (OCPF&RD), Storm Operation Center have been disrupted. This exhibit is to be used in conjunction with the rest of the Seven Oaks Dam Water Control Manual. Plate 7-01 of the Water Control Manual shows the approved water control plan for Seven Oaks Dam.

The project operators are required to have these standing instructions and the following two manuals available at the dam site: 1) the current year's list of notifications for during normal and emergency operation; 2) the "Operation and Maintenance Manual for Seven Oaks Dam."

b. Project Purpose. The overall objectives of the Seven Oaks Dam Water Control Plan are 1) to provide flood control, 2) dam safety, 3) mitigation of impacts to downstream water users, 4) environmental operation, and 5) the prototype testing program. The details of the water control plan is illustrated in Plate 7-01 and described in section 7-05. The flood control operation plan within the debris pool is designed to mitigate for project impacts upon downstream water users. In addition, when conditions warrant, the plan also allows modifications of releases to support downstream environmental mitigation and enhancement plans and the prototype-testing program as described in section 7-05.i. and Exhibit F, respectively, of the Water Control Manual.

c. Reservoir Regulation. The OCPF&RD Storm Operation Center conducts regulation of Seven Oaks Dam. Figure 9-01 of the water control manual is an organizational chart depicting the chain of command for reservoir regulation decisions.

d. Project Location. Seven Oaks Dam is located on the Santa Ana River, in the upper Santa Ana Canyon about 8 miles (13 km) northeast of the City of Redlands, in San Bernardino County California. This project is planned to operate in conjunction with Prado Dam, which is located 40.3 miles (54.9 km) downstream. The Santa Ana River watershed has an area of 2,450 sq-mi. The upper Santa Ana River drainage area for Seven Oaks Dam is 177 sq-mi, excluding the 32 sq-mi tributary to Baldwin Lake, and has its headwaters in the San Bernardino Mountains. Plate 2-01 of the water control manual shows the Santa Ana River drainage basin and the location of Seven Oaks Dam.

e. Project Description. Seven Oaks Dam consists of an earth-filled embankment with a natural rock spillway, a multi-level withdrawal (MWS) structure, a main intake structure, a minimum discharge line, and gated outlet works. The general plan and elevation of the dam are shown on Plate 2-06 of the water control manual.

Seven Oaks Dam has three outlets: the main regulating outlet (RO) tunnel, a low flow bypass and a minimum discharge line. The RO tunnel is control by two 5'W X 9'H vertical slide gates, and the low flow bypass is controlled one 2'W X 3.5H vertical slide gate. The minimum discharge line (MDL), which is part of the MWS structure, equipped with a 14-inch and 8-inch cone valves. The invert elevation of all outlets is at 2,100 feet, NGVD. The spillway is a natural rock saddle structure located just east of the dam. The spillway crest elevation is at 2,580 feet, NGVD. The discharge rating curves for the outlet gates and the spillway are shown within the water control manual on Plates 7-02 to

7-07 and 2-25, respectively. The spillway general plan and profile is shown on Plate 2-25.

The reservoir capacity below the spillway crest is 147,969 ac-ft, which is designed for flood control. The area and gross capacity relationships of the Seven Oaks Flood Control Basin are shown on Plate 2-27. The area and gross capacity tables are provided in Exhibit B of the water control manual.

f. Downstream Channel Constraints. The maximum release capacity at Seven Oaks Dam is 8,000 cfs. The Water Control Plan allows a maximum release of 7,000 cfs. Currently, there are no identified channel constraints downstream of Seven Oaks Dam that would not allow these maximum release rates.

g. Ownership. Seven Oaks Dam is jointly owned and maintained by San Bernardino, Riverside, and Orange Counties. San Bernardino County Flood Control District (SBCFCD) is charged with the responsibility for physical operation of the dam. The OCPF&RD is charged with the reservoir regulation responsibilities of the dam.

1-02 Role of the Project Operators.

a. Normal Conditions. The project operators will be instructed by the Storm Operation Center, as necessary, for water control actions under normal hydrometeorological conditions.

The project operators are responsible for the physical operation of the project. This includes ensuring that all the equipment is in good operating condition, and that the gates and electrical facilities in the control house are periodically inspected and tested according to the pre-established schedule. A minimum of two project operators will be required for day-to-day operations of the dam.

b. <u>Emergency Conditions .</u> The project operators will be instructed by the Storm Operation Center regarding water control actions during flood events and other emergency conditions.

The Project Operators' responsibilities include:

(1) Be present at the dam when rainfall or runoff is occurring or furnish the Storm Operation Center a telephone number through which he or she can be reached.

(2) See that all equipment at the reservoir such as recorders, indicating gages, gate mechanisms, power units, radios, etc., is in operating conditions.

(3) Operate gates in accordance with instructions from the Storm Operation Center.

(4) Keep the Storm Operation Center notified of any unusual developments such as trash accumulation, power failure, mechanical difficulties, etc.

(5) Follow the no-communication schedule shown in Plate A-01 during periods of no-communication with the Storm Operation Center.

(6) Assist engineers dispatched by the Storm Operation Center during flood emergencies in every way possible.

(7) Maintain routine records such as water surface elevations, outflow gage heights, precipitation amounts, gate openings and a daily log on prescribed forms.

(8) Notify local authorities and interested agencies of anticipated releases from the reservoir when instructed to do so by the Storm Operation Center or if communications are interrupted.

(9) Obtain hydrologic and hydraulic data from other agencies upon request of the Storm Operation Center.

II – DATA COLLECTION AND REPORTING

2-01 **Normal Conditions During Flood Season.** Normal operation during flood seasons, measurements are made daily by the project operators to determine the water surface elevation (staff and digital reading), the setting of each outlet gate (RO, LF and Cone Valves), the position of the sluice gate, and the times of these measurements. Normal conditions during non-flood seasons, measurements are made once a week.

The project operators maintain the records of measurements, and log all radio and telephone communication. The following forms are used by the Corps for reservoir operations, and may be used for the operation of Seven Oaks Dam, if desired: the Flood Control Basin Operation Report, SPL Form 19 (Plate A-03); Rainfall Record, SPL Form 31 (Plate A-04).

2-02 **Emergency Conditions.** During flood operations or emergency operations, the project operators should follow instructions, as issued by the Storm Operation Center. Measurements may be required at one-hour intervals from the staff gage, and other instruments as specified by the Storm Operation Center personnel.

When reporting to the Storm Operation Center the project operators should clearly describe any silt and debris situation at the intake structure, gates and downstream gages. When instruments are not working, or are stuck in silt, the project operators should not report the erroneous reading, but should 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 cause the flow to be deceptively perched above the invert, or cause a loss of contact with the staff board, the project operators should report a descriptive message identifying the limitations, and quantifying the estimated reservoir depth.

If the radio system fails, the project operators should try to re-establish communication via telephone.

2-03 Regional Hydrometeorological Conditions. The project operators will be informed by the Storm Operation Center of regional hydrometeorological conditions that may impact the project.

III – WATER CONTROL ACTION AND REPORTING

3-01 <u>Normal Conditions.</u> During normal hydrometeorological conditions, the project operators will be instructed by the Storm Operation Center for the appropriate water control action. A minimum of two project operators will be required during operation of the dam. The project operators should:

1. Establish communication with the Storm Operation Center.
2. Implement instructions.
3. Notify the Storm Operation Center on the status of the water control action.

The project operators should not implement any gate change, even if the change will have no effect on the reservoir operation, without first obtaining approval from the Storm Operation Center. The project operators may request gate-setting changes for reasons of maintenance etc., and the request must first be approved by the Storm Operation Center.

3-02 <u>Emergency Conditions.</u> During emergency conditions, the project operators will be instructed by the Storm Operation Center regarding any necessary water control action. During flood conditions, the project operators will be instructed according to the approved water control plan and will be required to notify the Storm Operation Center for upcoming gate changes. The project operators should:

1. Establish communication with the Storm Operation Center.
2. Implement the instructions.
3. Notify the Storm Operation Center on the status of the water control action.

3-03 **Inquiries.** All significant inquiries received by the project operators from citizens, constituents, or interested groups regarding water control procedures or actions must be referred directly to the Storm Operation Center.

3-04 **Water Control Problems.** The Storm Operation Center 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 regulation instructions issued by the Storm Operation Center may be required, because of water control equipment failures, accidents, or other emergencies requiring immediate action. Under these situations, the project operators should contact the Storm Operation Center via radio for instructions. When communications are broken, or the situation demands immediate action, the project operators may proceed independently. The Storm Operation Center should be notified of such action as soon as possible. All other non-emergency deviations from normal procedures should be approved in advance through the Corps of Engineers, Los Angeles District. Permanent changes to the water control plan are subject to approval by the Division Engineer, South Pacific Division of the U.S. Army Corps of Engineers.

The project operators should immediately alert the Storm Operation Center (call via radio or telephone, whenever the requested gate change cannot be fully implemented due to mechanical or physical problems. For example, debris could prevent total gate closure. The Storm Operation Center will evaluate the problem and provide further instructions to the Project operators.

3-05 **Communication Outage.** The Storm Operation Center maintains close contact with the project operators at Seven Oaks Dam. During flood periods, communication between the project operators and Storm Operation Center may be broken. The project operators should try to re-establish communication with the Storm Operation Center at the project first by telephone, and if contact is not successful, then contact the San

Bernardino County Flood Control District at (909) 387-7995. The project operators should **not** leave the immediate vicinity of the project.

During the rising stages of the flood, the project operators should maintain the last gate setting as instructed by the Storm Operation Center and try to re-establish communication with the Storm Operation Center. Reservoir water surface elevation staff readings should be obtained hourly and logged. If communication cannot be re-established while inflow is still high and the reservoir pool is continuously rising, the dam tenders should not make any attempt to move the gates in order to increase or decrease the releases, unless there is an emergency that requires such gate change. If reservoir water surface elevation drops for 8 consecutive hours or more, and communication with the storm operation center is still not available, project operators should follow the schedule under "falling pool in the "no communication" plan as outlined on Plate A-01. Adhere to the rate of change of release limitations give in Table 2 of Plate 7-01 when increasing releases.

Emergency notifications are normally made by the Storm Operation Center. However, if the project operators lose communication with the Storm Operation Center and an emergency notification situation arises, such as an imminent dam failure or uncontrolled spillway flow (water surface elevation above 2,580 feet), the project operators should make the necessary notifications. The notification list is updated each year by the Storm Operation Center personnel and should be made available at the dam site.

The notifications should include: (a) description of the type and extent of existing or impending emergency; (b) advisement for evacuation from the flood plain; (c) information on the estimated time of initial release of hazardous amounts of water; (d) the depth of water behind the dam; and (e) the project operators' name and telephone number.

Upon completing the above notifications, attempt to re-establish communications with the Storm Operation Center. Document all notifications made on SPL Form 188 (Plate A-02). The project operators should not leave the dam unless their safety is in jeopardy.

Seven Oaks Dam Standing Instructions
No-Communication Schedule

(To be Used by the Dam Operators Only If the Communication with the Storm Operation Center is Disrupted)

<table>
<tr><th>RISING POOL
(If Seven Oaks Dam Elevation is Rising)</th><th>WSE RANGE
(Feet, NGVD)</th><th colspan="3">FALLING POOL
(If Seven Oaks Dam Elevation is Falling)</th><th>Approximate Discharge
(cfs)</th></tr>
<tr><td rowspan="17">MAINTAIN CURRENT GATE SETTING;

DO NOT MAKE GATE CHANGES UNTIL COMMUNICATION WITH THE STORM OPERATION CENTER IS ESTABLISHED.</td><td>2100 – 2200</td><td colspan="3">Maintain gate setting; Do not make adjustments</td><td rowspan="2">VARIES</td></tr>
<tr><td></td><td colspan="3">Gate Setting
(Opening in Feet)</td></tr>
<tr><td></td><td>ROG1</td><td>LF</td><td>ROG2</td><td></td></tr>
<tr><td>2200 - 2265</td><td>0</td><td>2.8</td><td>0</td><td>500</td></tr>
<tr><td>2265 - 2267</td><td>0</td><td>2.8</td><td>0.75</td><td>750</td></tr>
<tr><td>2267 - 2269</td><td>.75</td><td>2.8</td><td>0.75</td><td>1000</td></tr>
<tr><td>2269 – 2273</td><td>1.2</td><td>2.8</td><td>1.2</td><td>1500</td></tr>
<tr><td>2273 - 2298</td><td>1.8</td><td>2.8</td><td>1.8</td><td>2000</td></tr>
<tr><td>2298 - 2325</td><td>2.2</td><td>2.8</td><td>2.2</td><td>2500</td></tr>
<tr><td>2325 - 2350</td><td>2.6</td><td>2.8</td><td>2.6</td><td>3000</td></tr>
<tr><td>2350 - 2375</td><td>3.0</td><td>2.8</td><td>3.0</td><td>3500</td></tr>
<tr><td>2375 – 2400</td><td>3.3</td><td>2.8</td><td>3.3</td><td>4000</td></tr>
<tr><td>2400 - 2433</td><td>4.0</td><td>2.8</td><td>4.0</td><td>5000</td></tr>
<tr><td>2433 - 2466</td><td>4.8</td><td>2.8</td><td>4.8</td><td>6000</td></tr>
<tr><td>2466 – 2500</td><td>5.1</td><td>2.8</td><td>5.1</td><td>6500</td></tr>
<tr><td>2500 – 2585</td><td>5.0</td><td>2.8</td><td>5.0</td><td>7000</td></tr>
<tr><td>>2585</td><td>0</td><td>0</td><td>0</td><td>SPILLWAY FLOW</td></tr>
</table>

RECORD OF CALLS ☐ Radio ☐ Telephone						Date
Local Time	From		To		Check Repeatable 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.

PLATE A-02

SEVEN OAKS DAM

FLOOD CONTROL BASIN OPERATION REPORT

(RADIO CALL SIGN: WUK 422)

Month:

Year:

Date	Time	Reservoir Water Surface Elevation					GATE and VALVE OPERATION																Wet Wells Piezometer Reading (W.S.E in feet)		Filling Line Butterfly Valve	Notes
		Staff (feet)	Digital (feet)	Forebay Piezometer Reading (feet)			Service Gates						Emergency Gates (C/O)			MDL						Sluice Gate				
							Gate Settings (feet)			Piezometer Reading (feet)						24" Emerg Ball Valve (C/O)	Cone Valve (% open)		Piezometer Reading (feet)		24" MDLE Ball Valve					
				O-1 (El. 2099.1)*	O-2 (El. 2097.2)*	O-3 (El. 2099.1)*	ROG 1	ROG 2	LF1	O-6 (ROG1 El. 2099.1)*	O-8 (ROG2 El. 2099.1)*	O-7 (LF El. 2097.2)*	ROG 3	ROG 4	LF 2	C/O	8"	14"	O-9 (8-inch El. 2048.4)*	O-10 (14-inch El. 2048.4)*	C/O	C/O	O-4 (MainWW El. 2097.2)*	O-5 (MWS El. 2097.2)*	C/O	

Notes: C/O - Turn handwheel 32 rotations to fully close or open Filling Line Butterfly Valve; Clockwise to close, counter-clock wise to open.

* Elevations noted for the Piezometers indicate the elevation of the transducers, not the elevation of the piezometer inlet.

ROG - Regulating Outlet Gate
LF - Flow FLow
C/O - Closed or Open
MDL - Minimum Discharge Line
MDLE - Minimum Discharge Line Extension

Plate A-03

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

PREV. ED. OF THIS FORM MAY BE USED
REPLACES SPL FORM 32 WHICH MAY BE USED

EXHIBIT B.

AREA-CAPACITY TABLES
(BASED ON 1999 SURVEY)

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2102	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2103	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2104	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
2105	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6
2106	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8
2107	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1
2108	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.5
2109	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.1
2110	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.7	2.8
2111	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9
2112	4.0	4.1	4.2	4.3	4.5	4.6	4.7	4.9	5.0	5.1
2113	5.3	5.4	5.6	5.7	5.8	6.0	6.1	6.3	6.4	6.6
2114	6.8	6.9	7.1	7.3	7.4	7.6	7.8	8.0	8.1	8.3
2115	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.2	10.4
2116	10.6	10.6	10.6	10.6	10.6	10.7	10.7	10.7	10.8	10.9
2117	10.9	11.0	11.1	11.3	11.5	11.7	11.9	12.1	12.4	12.6
2118	12.8	13.1	13.3	13.5	13.8	14.0	14.3	14.5	14.8	15.0
2119	15.3	15.6	15.9	16.1	16.4	16.7	17.0	17.3	17.6	17.9
2120	18.2	18.5	18.9	19.2	19.5	19.8	20.2	20.5	20.9	21.2
2121	21.6	21.9	22.3	22.7	23.0	23.4	23.8	24.2	24.6	25.0
2122	25.4	25.8	26.2	26.7	27.1	27.5	28.0	28.4	28.9	29.4
2123	29.8	30.3	30.8	31.3	31.9	32.4	32.9	33.5	34.0	34.6
2124	35.1	35.7	36.3	36.9	37.5	38.1	38.7	39.4	40.0	40.7
2125	41.3	42.0	42.7	43.3	44.0	44.7	45.4	46.1	46.8	47.5
2126	48.2	48.9	49.7	50.4	51.1	51.9	52.6	53.4	54.1	54.9
2127	55.6	56.4	57.2	57.9	58.7	59.5	60.3	61.1	61.9	62.6
2128	63.4	64.2	65.0	65.8	66.7	67.5	68.3	69.1	69.9	70.7
2129	71.6	72.4	73.3	74.1	74.9	75.8	76.6	77.5	78.4	79.2
2130	80.1	81.0	81.9	82.7	83.6	84.5	85.4	86.3	87.2	88.1
2131	89.0	89.9	90.9	91.8	92.7	93.7	94.6	95.6	96.5	97.5
2132	98.4	99.4	100	101	102	103	104	105	106	107
2133	108	109	110	111	112	113	114	115	116	118
2134	119	120	121	122	123	124	125	126	127	128
2135	129	130	132	133	134	135	136	137	138	139
2136	141	142	143	144	145	146	148	149	150	151
2137	152	154	155	156	157	158	160	161	162	163
2138	165	166	167	169	170	171	172	174	175	176
2139	178	179	180	182	183	184	186	187	189	190
2140	191	193	194	196	197	198	200	201	203	204
2141	206	207	209	210	212	213	215	216	218	219
2142	221	222	224	225	227	228	230	232	233	235
2143	236	238	240	241	243	244	246	248	249	251
2144	253	254	256	258	259	261	263	264	266	268
2145	270	271	273	275	277	278	280	282	284	285
2146	287	289	291	293	294	296	298	300	302	304
2147	306	307	309	311	313	315	317	319	321	323
2148	325	327	329	331	333	335	337	339	341	343
2149	345	347	349	352	354	356	358	360	362	365
2150	367	369	371	374	376	378	381	383	385	388
2151	390	392	395	397	400	402	405	407	410	412
2152	415	417	420	422	425	428	430	433	435	438
2153	441	444	446	449	452	455	457	460	463	466
2154	469	471	474	477	480	483	486	489	492	495
2155	498	501	504	507	510	513	516	519	522	526
2156	529	532	535	538	541	545	548	551	554	558
2157	561	564	568	571	574	578	581	585	588	592
2158	595	598	602	606	609	613	616	620	623	627
2159	631	634	638	642	646	649	653	657	661	665
2160	669	672	676	680	684	688	692	696	700	704
2161	708	712	716	720	724	729	733	737	741	745

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2162	750	754	758	762	767	771	775	780	784	788
2163	793	797	802	806	811	815	820	824	829	833
2164	838	842	847	852	856	861	865	870	875	879
2165	884	889	893	898	903	907	912	917	922	926
2166	931	936	941	945	950	955	960	965	969	974
2167	979	984	989	994	999	1,004	1,009	1,013	1,018	1,023
2168	1,028	1,033	1,038	1,043	1,048	1,053	1,058	1,063	1,068	1,073
2169	1,078	1,084	1,089	1,094	1,099	1,104	1,109	1,114	1,119	1,125
2170	1,130	1,135	1,140	1,145	1,151	1,156	1,161	1,166	1,171	1,177
2171	1,182	1,187	1,192	1,198	1,203	1,208	1,214	1,219	1,224	1,230
2172	1,235	1,240	1,246	1,251	1,256	1,262	1,267	1,273	1,278	1,283
2173	1,289	1,294	1,300	1,305	1,311	1,316	1,322	1,327	1,333	1,338
2174	1,344	1,349	1,355	1,360	1,366	1,371	1,377	1,382	1,388	1,394
2175	1,399	1,405	1,411	1,416	1,422	1,428	1,433	1,439	1,445	1,450
2176	1,456	1,462	1,468	1,473	1,479	1,485	1,491	1,497	1,502	1,508
2177	1,514	1,520	1,526	1,532	1,537	1,543	1,549	1,555	1,561	1,567
2178	1,573	1,579	1,585	1,591	1,597	1,603	1,609	1,615	1,621	1,627
2179	1,633	1,639	1,646	1,652	1,658	1,664	1,670	1,676	1,683	1,689
2180	1,695	1,701	1,707	1,714	1,720	1,726	1,733	1,739	1,745	1,752
2181	1,758	1,764	1,771	1,777	1,784	1,790	1,796	1,803	1,809	1,816
2182	1,822	1,829	1,835	1,842	1,848	1,855	1,861	1,868	1,874	1,881
2183	1,887	1,894	1,901	1,907	1,914	1,920	1,927	1,934	1,940	1,947
2184	1,953	1,960	1,967	1,973	1,980	1,987	1,993	2,000	2,007	2,014
2185	2,020	2,027	2,034	2,041	2,047	2,054	2,061	2,068	2,075	2,081
2186	2,088	2,095	2,102	2,109	2,116	2,123	2,129	2,136	2,143	2,150
2187	2,157	2,164	2,171	2,178	2,185	2,192	2,199	2,206	2,213	2,220
2188	2,227	2,234	2,241	2,248	2,255	2,262	2,269	2,276	2,283	2,290
2189	2,297	2,304	2,311	2,319	2,326	2,333	2,340	2,347	2,354	2,361
2190	2,369	2,376	2,383	2,390	2,397	2,405	2,412	2,419	2,426	2,434
2191	2,441	2,448	2,456	2,463	2,470	2,478	2,485	2,492	2,500	2,507
2192	2,514	2,522	2,529	2,537	2,544	2,551	2,559	2,566	2,574	2,581
2193	2,589	2,596	2,604	2,611	2,619	2,626	2,634	2,641	2,649	2,656
2194	2,664	2,671	2,679	2,686	2,694	2,701	2,709	2,717	2,724	2,732
2195	2,739	2,747	2,755	2,762	2,770	2,778	2,785	2,793	2,801	2,808
2196	2,816	2,824	2,831	2,839	2,847	2,854	2,862	2,870	2,877	2,885
2197	2,893	2,901	2,908	2,916	2,924	2,932	2,939	2,947	2,955	2,963
2198	2,971	2,978	2,986	2,994	3,002	3,010	3,017	3,025	3,033	3,041
2199	3,049	3,057	3,065	3,072	3,080	3,088	3,096	3,104	3,112	3,120
2200	3,128	3,136	3,144	3,151	3,159	3,167	3,175	3,183	3,191	3,199
2201	3,207	3,215	3,223	3,231	3,239	3,247	3,255	3,263	3,271	3,279
2202	3,287	3,295	3,303	3,312	3,320	3,328	3,336	3,344	3,352	3,360
2203	3,368	3,376	3,384	3,393	3,401	3,409	3,417	3,425	3,434	3,442
2204	3,450	3,458	3,466	3,475	3,483	3,491	3,499	3,508	3,516	3,524
2205	3,532	3,541	3,549	3,557	3,566	3,574	3,582	3,591	3,599	3,607
2206	3,616	3,624	3,633	3,641	3,650	3,658	3,666	3,675	3,683	3,692
2207	3,700	3,709	3,717	3,726	3,734	3,743	3,752	3,760	3,769	3,777
2208	3,786	3,794	3,803	3,812	3,820	3,829	3,838	3,846	3,855	3,864
2209	3,872	3,881	3,890	3,899	3,907	3,916	3,925	3,934	3,942	3,951
2210	3,960	3,969	3,978	3,986	3,995	4,004	4,013	4,022	4,031	4,040
2211	4,049	4,057	4,066	4,075	4,084	4,093	4,102	4,111	4,120	4,129
2212	4,138	4,147	4,156	4,166	4,175	4,184	4,193	4,202	4,211	4,220
2213	4,229	4,239	4,248	4,257	4,266	4,275	4,285	4,294	4,303	4,313
2214	4,322	4,331	4,340	4,350	4,359	4,368	4,378	4,387	4,397	4,406
2215	4,415	4,425	4,434	4,444	4,453	4,463	4,472	4,482	4,491	4,501
2216	4,510	4,520	4,529	4,539	4,549	4,558	4,568	4,578	4,587	4,597
2217	4,607	4,616	4,626	4,636	4,646	4,655	4,665	4,675	4,685	4,695
2218	4,704	4,714	4,724	4,734	4,744	4,754	4,764	4,774	4,784	4,794
2219	4,804	4,814	4,824	4,834	4,844	4,854	4,864	4,874	4,884	4,894
2220	4,904	4,914	4,924	4,934	4,944	4,955	4,965	4,975	4,985	4,995
2221	5,006	5,016	5,026	5,037	5,047	5,057	5,068	5,078	5,088	5,099
2222	5,109	5,119	5,130	5,140	5,151	5,161	5,172	5,182	5,193	5,203
2223	5,214	5,224	5,235	5,245	5,256	5,266	5,277	5,287	5,298	5,309

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2224	5,319	5,330	5,341	5,351	5,362	5,373	5,383	5,394	5,405	5,415
2225	5,426	5,437	5,448	5,458	5,469	5,480	5,491	5,502	5,513	5,523
2226	5,534	5,545	5,556	5,567	5,578	5,589	5,600	5,611	5,622	5,633
2227	5,644	5,655	5,666	5,677	5,688	5,699	5,710	5,721	5,732	5,743
2228	5,754	5,765	5,777	5,788	5,799	5,810	5,821	5,833	5,844	5,855
2229	5,866	5,878	5,889	5,900	5,912	5,923	5,935	5,946	5,957	5,969
2230	5,980	5,992	6,003	6,015	6,026	6,038	6,049	6,061	6,072	6,084
2231	6,096	6,107	6,119	6,130	6,142	6,154	6,165	6,177	6,189	6,201
2232	6,212	6,224	6,236	6,248	6,259	6,271	6,283	6,295	6,307	6,319
2233	6,331	6,343	6,355	6,367	6,379	6,391	6,403	6,415	6,427	6,439
2234	6,451	6,463	6,475	6,487	6,499	6,512	6,524	6,536	6,548	6,560
2235	6,573	6,585	6,597	6,610	6,622	6,634	6,647	6,659	6,671	6,684
2236	6,696	6,709	6,721	6,734	6,746	6,759	6,771	6,784	6,797	6,809
2237	6,822	6,835	6,847	6,860	6,873	6,886	6,899	6,911	6,924	6,937
2238	6,950	6,963	6,976	6,989	7,002	7,015	7,028	7,041	7,054	7,067
2239	7,080	7,093	7,106	7,119	7,132	7,145	7,158	7,172	7,185	7,198
2240	7,211	7,224	7,238	7,251	7,264	7,278	7,291	7,304	7,318	7,331
2241	7,345	7,358	7,371	7,385	7,398	7,412	7,425	7,439	7,452	7,466
2242	7,480	7,493	7,507	7,520	7,534	7,548	7,561	7,575	7,589	7,602
2243	7,616	7,630	7,644	7,657	7,671	7,685	7,699	7,713	7,727	7,740
2244	7,754	7,768	7,782	7,796	7,810	7,824	7,838	7,852	7,866	7,880
2245	7,894	7,908	7,922	7,936	7,950	7,964	7,978	7,992	8,006	8,020
2246	8,035	8,049	8,063	8,077	8,091	8,105	8,120	8,134	8,148	8,162
2247	8,177	8,191	8,205	8,219	8,234	8,248	8,262	8,277	8,291	8,306
2248	8,320	8,334	8,349	8,363	8,378	8,392	8,407	8,421	8,436	8,450
2249	8,465	8,479	8,494	8,508	8,523	8,537	8,552	8,567	8,581	8,596
2250	8,611	8,625	8,640	8,655	8,669	8,684	8,699	8,713	8,728	8,743
2251	8,758	8,773	8,787	8,802	8,817	8,832	8,847	8,862	8,876	8,891
2252	8,906	8,921	8,936	8,951	8,966	8,981	8,996	9,011	9,026	9,041
2253	9,056	9,071	9,086	9,101	9,116	9,131	9,146	9,161	9,177	9,192
2254	9,207	9,222	9,237	9,252	9,267	9,283	9,298	9,313	9,328	9,344
2255	9,359	9,374	9,389	9,405	9,420	9,435	9,451	9,466	9,481	9,497
2256	9,512	9,528	9,543	9,558	9,574	9,589	9,605	9,620	9,636	9,651
2257	9,667	9,682	9,698	9,713	9,729	9,744	9,760	9,775	9,791	9,806
2258	9,822	9,838	9,853	9,869	9,885	9,900	9,916	9,932	9,947	9,963
2259	9,979	9,995	10,010	10,026	10,042	10,058	10,073	10,089	10,105	10,121
2260	10,137	10,153	10,168	10,184	10,200	10,216	10,232	10,248	10,264	10,280
2261	10,296	10,312	10,328	10,344	10,360	10,376	10,392	10,408	10,424	10,440
2262	10,456	10,472	10,488	10,504	10,521	10,537	10,553	10,569	10,585	10,601
2263	10,618	10,634	10,650	10,666	10,683	10,699	10,715	10,731	10,748	10,764
2264	10,780	10,797	10,813	10,829	10,846	10,862	10,878	10,895	10,911	10,927
2265	10,944	10,960	10,977	10,993	11,010	11,026	11,043	11,059	11,076	11,092
2266	11,109	11,125	11,142	11,158	11,175	11,191	11,208	11,225	11,241	11,258
2267	11,275	11,291	11,308	11,325	11,341	11,358	11,375	11,391	11,408	11,425
2268	11,442	11,458	11,475	11,492	11,509	11,526	11,542	11,559	11,576	11,593
2269	11,610	11,627	11,644	11,660	11,677	11,694	11,711	11,728	11,745	11,762
2270	11,779	11,796	11,813	11,830	11,847	11,864	11,881	11,898	11,915	11,932
2271	11,950	11,967	11,984	12,001	12,018	12,035	12,052	12,070	12,087	12,104
2272	12,121	12,139	12,156	12,173	12,190	12,208	12,225	12,242	12,260	12,277
2273	12,294	12,312	12,329	12,346	12,364	12,381	12,399	12,416	12,434	12,451
2274	12,469	12,486	12,503	12,521	12,539	12,556	12,574	12,591	12,609	12,626
2275	12,644	12,662	12,679	12,697	12,714	12,732	12,750	12,767	12,785	12,803
2276	12,821	12,838	12,856	12,874	12,892	12,909	12,927	12,945	12,963	12,981
2277	12,998	13,016	13,034	13,052	13,070	13,088	13,106	13,124	13,142	13,159
2278	13,177	13,195	13,213	13,231	13,249	13,267	13,286	13,304	13,322	13,340
2279	13,358	13,376	13,394	13,412	13,430	13,448	13,467	13,485	13,503	13,521
2280	13,539	13,558	13,576	13,594	13,612	13,631	13,649	13,667	13,686	13,704
2281	13,722	13,741	13,759	13,778	13,796	13,814	13,833	13,851	13,870	13,888
2282	13,907	13,925	13,944	13,962	13,981	14,000	14,018	14,037	14,055	14,074
2283	14,093	14,111	14,130	14,149	14,167	14,186	14,205	14,224	14,242	14,261
2284	14,280	14,299	14,318	14,336	14,355	14,374	14,393	14,412	14,431	14,450
2285	14,468	14,487	14,506	14,525	14,544	14,563	14,582	14,601	14,620	14,639

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2286	14,658	14,677	14,696	14,715	14,734	14,754	14,773	14,792	14,811	14,830
2287	14,849	14,868	14,888	14,907	14,926	14,945	14,964	14,984	15,003	15,022
2288	15,042	15,061	15,080	15,099	15,119	15,138	15,158	15,177	15,196	15,216
2289	15,235	15,255	15,274	15,293	15,313	15,332	15,352	15,371	15,391	15,410
2290	15,430	15,450	15,469	15,489	15,508	15,528	15,548	15,567	15,587	15,606
2291	15,626	15,646	15,666	15,685	15,705	15,725	15,745	15,764	15,784	15,804
2292	15,824	15,844	15,863	15,883	15,903	15,923	15,943	15,963	15,983	16,003
2293	16,023	16,043	16,063	16,083	16,103	16,123	16,143	16,163	16,183	16,203
2294	16,223	16,243	16,263	16,283	16,303	16,324	16,344	16,364	16,384	16,404
2295	16,424	16,445	16,465	16,485	16,505	16,526	16,546	16,566	16,587	16,607
2296	16,627	16,648	16,668	16,689	16,709	16,729	16,750	16,770	16,791	16,811
2297	16,832	16,852	16,873	16,893	16,914	16,934	16,955	16,975	16,996	17,017
2298	17,037	17,058	17,078	17,099	17,120	17,140	17,161	17,182	17,203	17,223
2299	17,244	17,265	17,286	17,306	17,327	17,348	17,369	17,390	17,411	17,431
2300	17,452	17,473	17,494	17,515	17,536	17,557	17,578	17,599	17,620	17,641
2301	17,662	17,683	17,704	17,725	17,746	17,767	17,788	17,809	17,830	17,852
2302	17,873	17,894	17,915	17,936	17,957	17,979	18,000	18,021	18,042	18,064
2303	18,085	18,106	18,128	18,149	18,170	18,192	18,213	18,234	18,256	18,277
2304	18,299	18,320	18,342	18,363	18,385	18,406	18,428	18,449	18,471	18,492
2305	18,514	18,536	18,557	18,579	18,600	18,622	18,644	18,665	18,687	18,709
2306	18,731	18,752	18,774	18,796	18,818	18,839	18,861	18,883	18,905	18,927
2307	18,949	18,971	18,992	19,014	19,036	19,058	19,080	19,102	19,124	19,146
2308	19,168	19,190	19,212	19,234	19,256	19,279	19,301	19,323	19,345	19,367
2309	19,389	19,411	19,434	19,456	19,478	19,500	19,522	19,545	19,567	19,589
2310	19,612	19,634	19,656	19,679	19,701	19,723	19,746	19,768	19,791	19,813
2311	19,836	19,858	19,880	19,903	19,925	19,948	19,971	19,993	20,016	20,038
2312	20,061	20,083	20,106	20,129	20,151	20,174	20,197	20,219	20,242	20,265
2313	20,288	20,310	20,333	20,356	20,379	20,402	20,424	20,447	20,470	20,493
2314	20,516	20,539	20,562	20,585	20,608	20,631	20,654	20,677	20,700	20,723
2315	20,746	20,769	20,792	20,815	20,838	20,861	20,884	20,908	20,931	20,954
2316	20,977	21,000	21,024	21,047	21,070	21,094	21,117	21,140	21,163	21,187
2317	21,210	21,234	21,257	21,280	21,304	21,327	21,351	21,374	21,398	21,421
2318	21,445	21,468	21,492	21,515	21,539	21,562	21,586	21,610	21,633	21,657
2319	21,680	21,704	21,728	21,751	21,775	21,799	21,823	21,846	21,870	21,894
2320	21,918	21,942	21,965	21,989	22,013	22,037	22,061	22,085	22,109	22,133
2321	22,157	22,180	22,204	22,228	22,252	22,276	22,300	22,324	22,349	22,373
2322	22,397	22,421	22,445	22,469	22,493	22,517	22,542	22,566	22,590	22,614
2323	22,638	22,663	22,687	22,711	22,735	22,760	22,784	22,808	22,833	22,857
2324	22,881	22,906	22,930	22,955	22,979	23,003	23,028	23,052	23,077	23,101
2325	23,126	23,150	23,175	23,199	23,224	23,249	23,273	23,298	23,322	23,347
2326	23,372	23,396	23,421	23,446	23,471	23,495	23,520	23,545	23,569	23,594
2327	23,619	23,644	23,669	23,694	23,718	23,743	23,768	23,793	23,818	23,843
2328	23,868	23,893	23,918	23,943	23,968	23,993	24,018	24,043	24,068	24,093
2329	24,118	24,143	24,168	24,193	24,218	24,244	24,269	24,294	24,319	24,344
2330	24,369	24,395	24,420	24,445	24,470	24,496	24,521	24,546	24,572	24,597
2331	24,622	24,648	24,673	24,698	24,724	24,749	24,775	24,800	24,826	24,851
2332	24,877	24,902	24,928	24,953	24,979	25,004	25,030	25,055	25,081	25,107
2333	25,132	25,158	25,183	25,209	25,235	25,261	25,286	25,312	25,338	25,363
2334	25,389	25,415	25,441	25,466	25,492	25,518	25,544	25,570	25,596	25,622
2335	25,647	25,673	25,699	25,725	25,751	25,777	25,803	25,829	25,855	25,881
2336	25,907	25,933	25,959	25,985	26,011	26,037	26,063	26,089	26,116	26,142
2337	26,168	26,194	26,220	26,246	26,272	26,299	26,325	26,351	26,377	26,404
2338	26,430	26,456	26,482	26,509	26,535	26,561	26,588	26,614	26,641	26,667
2339	26,693	26,720	26,746	26,773	26,799	26,826	26,852	26,879	26,905	26,932
2340	26,958	26,985	27,011	27,038	27,064	27,091	27,118	27,144	27,171	27,198
2341	27,224	27,251	27,278	27,304	27,331	27,358	27,385	27,411	27,438	27,465
2342	27,492	27,519	27,545	27,572	27,599	27,626	27,653	27,680	27,707	27,734
2343	27,761	27,787	27,814	27,841	27,868	27,895	27,922	27,949	27,976	28,004
2344	28,031	28,058	28,085	28,112	28,139	28,166	28,193	28,220	28,248	28,275
2345	28,302	28,329	28,356	28,384	28,411	28,438	28,466	28,493	28,520	28,547
2346	28,575	28,602	28,630	28,657	28,684	28,712	28,739	28,767	28,794	28,822
2347	28,849	28,876	28,904	28,932	28,959	28,987	29,014	29,042	29,069	29,097

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2348	29,125	29,152	29,180	29,207	29,235	29,263	29,291	29,318	29,346	29,374
2349	29,401	29,429	29,457	29,485	29,513	29,540	29,568	29,596	29,624	29,652
2350	29,680	29,708	29,736	29,763	29,791	29,819	29,847	29,875	29,903	29,931
2351	29,959	29,987	30,015	30,044	30,072	30,100	30,128	30,156	30,184	30,212
2352	30,240	30,269	30,297	30,325	30,353	30,382	30,410	30,438	30,466	30,495
2353	30,523	30,551	30,580	30,608	30,636	30,665	30,693	30,722	30,750	30,778
2354	30,807	30,835	30,864	30,892	30,921	30,949	30,978	31,006	31,035	31,064
2355	31,092	31,121	31,149	31,178	31,207	31,235	31,264	31,293	31,322	31,350
2356	31,379	31,408	31,437	31,465	31,494	31,523	31,552	31,581	31,610	31,638
2357	31,667	31,696	31,725	31,754	31,783	31,812	31,841	31,870	31,899	31,928
2358	31,957	31,986	32,015	32,044	32,074	32,103	32,132	32,161	32,190	32,219
2359	32,248	32,278	32,307	32,336	32,365	32,395	32,424	32,453	32,483	32,512
2360	32,541	32,571	32,600	32,629	32,659	32,688	32,718	32,747	32,777	32,806
2361	32,836	32,865	32,895	32,924	32,954	32,984	33,013	33,043	33,072	33,102
2362	33,132	33,161	33,191	33,221	33,251	33,280	33,310	33,340	33,370	33,399
2363	33,429	33,459	33,489	33,519	33,549	33,579	33,609	33,639	33,669	33,698
2364	33,728	33,758	33,789	33,819	33,849	33,879	33,909	33,939	33,969	33,999
2365	34,029	34,059	34,090	34,120	34,150	34,180	34,211	34,241	34,271	34,301
2366	34,332	34,362	34,392	34,423	34,453	34,484	34,514	34,544	34,575	34,605
2367	34,636	34,666	34,697	34,727	34,758	34,788	34,819	34,850	34,880	34,911
2368	34,941	34,972	35,003	35,033	35,064	35,095	35,126	35,156	35,187	35,218
2369	35,249	35,280	35,310	35,341	35,372	35,403	35,434	35,465	35,496	35,527
2370	35,558	35,589	35,620	35,651	35,682	35,713	35,744	35,776	35,807	35,838
2371	35,869	35,900	35,932	35,963	35,994	36,025	36,057	36,088	36,120	36,151
2372	36,182	36,214	36,245	36,277	36,308	36,340	36,371	36,403	36,434	36,466
2373	36,497	36,529	36,560	36,592	36,624	36,655	36,687	36,719	36,750	36,782
2374	36,814	36,846	36,877	36,909	36,941	36,973	37,005	37,037	37,068	37,100
2375	37,132	37,164	37,196	37,228	37,260	37,292	37,324	37,356	37,388	37,420
2376	37,452	37,484	37,516	37,549	37,581	37,613	37,645	37,677	37,709	37,742
2377	37,774	37,806	37,838	37,871	37,903	37,935	37,968	38,000	38,032	38,065
2378	38,097	38,130	38,162	38,194	38,227	38,259	38,292	38,324	38,357	38,389
2379	38,422	38,455	38,487	38,520	38,552	38,585	38,618	38,650	38,683	38,716
2380	38,748	38,781	38,814	38,847	38,880	38,912	38,945	38,978	39,011	39,044
2381	39,077	39,110	39,142	39,175	39,208	39,241	39,274	39,307	39,340	39,373
2382	39,406	39,439	39,473	39,506	39,539	39,572	39,605	39,638	39,671	39,705
2383	39,738	39,771	39,804	39,838	39,871	39,904	39,938	39,971	40,004	40,038
2384	40,071	40,104	40,138	40,171	40,205	40,238	40,272	40,305	40,339	40,372
2385	40,406	40,439	40,473	40,507	40,540	40,574	40,608	40,641	40,675	40,709
2386	40,742	40,776	40,810	40,844	40,877	40,911	40,945	40,979	41,013	41,047
2387	41,080	41,114	41,148	41,182	41,216	41,250	41,284	41,318	41,352	41,386
2388	41,420	41,454	41,488	41,522	41,557	41,591	41,625	41,659	41,693	41,727
2389	41,762	41,796	41,830	41,864	41,899	41,933	41,967	42,002	42,036	42,070
2390	42,105	42,139	42,174	42,208	42,242	42,277	42,311	42,346	42,380	42,415
2391	42,450	42,484	42,519	42,553	42,588	42,623	42,657	42,692	42,727	42,762
2392	42,796	42,831	42,866	42,901	42,936	42,971	43,005	43,040	43,075	43,110
2393	43,145	43,180	43,215	43,250	43,285	43,320	43,355	43,390	43,426	43,461
2394	43,496	43,531	43,566	43,601	43,637	43,672	43,707	43,742	43,778	43,813
2395	43,848	43,884	43,919	43,955	43,990	44,026	44,061	44,096	44,132	44,167
2396	44,203	44,239	44,274	44,310	44,345	44,381	44,417	44,453	44,488	44,524
2397	44,560	44,596	44,631	44,667	44,703	44,739	44,775	44,811	44,847	44,883
2398	44,919	44,955	44,991	45,027	45,063	45,099	45,135	45,171	45,208	45,244
2399	45,280	45,316	45,352	45,389	45,425	45,461	45,498	45,534	45,570	45,607
2400	45,643	45,680	45,716	45,753	45,789	45,826	45,862	45,899	45,936	45,972
2401	46,009	46,046	46,082	46,119	46,156	46,192	46,229	46,266	46,303	46,340
2402	46,377	46,413	46,450	46,487	46,524	46,561	46,598	46,635	46,672	46,709
2403	46,746	46,783	46,820	46,858	46,895	46,932	46,969	47,006	47,044	47,081
2404	47,118	47,155	47,193	47,230	47,267	47,305	47,342	47,380	47,417	47,455
2405	47,492	47,530	47,567	47,605	47,642	47,680	47,718	47,755	47,793	47,831
2406	47,868	47,906	47,944	47,982	48,020	48,057	48,095	48,133	48,171	48,209
2407	48,247	48,285	48,323	48,361	48,399	48,437	48,475	48,513	48,551	48,589
2408	48,627	48,666	48,704	48,742	48,780	48,818	48,857	48,895	48,933	48,972
2409	49,010	49,048	49,087	49,125	49,164	49,202	49,241	49,279	49,318	49,356

EXIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2410	49,395	49,433	49,472	49,511	49,549	49,588	49,627	49,666	49,704	49,743
2411	49,782	49,821	49,860	49,898	49,937	49,976	50,015	50,054	50,093	50,132
2412	50,171	50,210	50,249	50,288	50,327	50,367	50,406	50,445	50,484	50,523
2413	50,563	50,602	50,641	50,680	50,720	50,759	50,798	50,838	50,877	50,917
2414	50,956	50,996	51,035	51,075	51,114	51,154	51,193	51,233	51,273	51,312
2415	51,352	51,392	51,432	51,471	51,511	51,551	51,591	51,631	51,670	51,710
2416	51,750	51,790	51,830	51,870	51,910	51,950	51,990	52,030	52,070	52,111
2417	52,151	52,191	52,231	52,271	52,312	52,352	52,392	52,432	52,473	52,513
2418	52,553	52,594	52,634	52,675	52,715	52,756	52,796	52,837	52,877	52,918
2419	52,958	52,999	53,040	53,080	53,121	53,162	53,203	53,243	53,284	53,325
2420	53,366	53,406	53,447	53,488	53,529	53,570	53,611	53,652	53,693	53,734
2421	53,775	53,816	53,857	53,898	53,939	53,980	54,021	54,063	54,104	54,145
2422	54,186	54,227	54,269	54,310	54,351	54,393	54,434	54,476	54,517	54,558
2423	54,600	54,641	54,683	54,724	54,766	54,808	54,849	54,891	54,932	54,974
2424	55,016	55,058	55,099	55,141	55,183	55,225	55,267	55,308	55,350	55,392
2425	55,434	55,476	55,518	55,560	55,602	55,644	55,687	55,729	55,771	55,813
2426	55,855	55,898	55,940	55,982	56,024	56,067	56,109	56,152	56,194	56,236
2427	56,279	56,321	56,364	56,406	56,449	56,492	56,534	56,577	56,620	56,662
2428	56,705	56,748	56,790	56,833	56,876	56,919	56,962	57,005	57,047	57,090
2429	57,133	57,176	57,219	57,262	57,305	57,348	57,391	57,435	57,478	57,521
2430	57,564	57,607	57,650	57,694	57,737	57,780	57,823	57,867	57,910	57,953
2431	57,997	58,040	58,084	58,127	58,171	58,214	58,258	58,301	58,345	58,388
2432	58,432	58,475	58,519	58,563	58,607	58,650	58,694	58,738	58,782	58,825
2433	58,869	58,913	58,957	59,001	59,045	59,089	59,133	59,177	59,221	59,265
2434	59,309	59,353	59,397	59,441	59,485	59,529	59,573	59,618	59,662	59,706
2435	59,750	59,795	59,839	59,883	59,928	59,972	60,016	60,061	60,105	60,150
2436	60,194	60,239	60,283	60,328	60,372	60,417	60,461	60,506	60,551	60,595
2437	60,640	60,685	60,729	60,774	60,819	60,864	60,909	60,953	60,998	61,043
2438	61,088	61,133	61,178	61,223	61,268	61,313	61,358	61,403	61,448	61,493
2439	61,538	61,584	61,629	61,674	61,719	61,764	61,810	61,855	61,900	61,945
2440	61,991	62,036	62,081	62,127	62,172	62,218	62,263	62,309	62,354	62,400
2441	62,445	62,491	62,536	62,582	62,627	62,673	62,719	62,764	62,810	62,856
2442	62,902	62,947	62,993	63,039	63,085	63,131	63,177	63,222	63,268	63,314
2443	63,360	63,406	63,452	63,498	63,544	63,590	63,636	63,683	63,729	63,775
2444	63,821	63,867	63,913	63,960	64,006	64,052	64,098	64,145	64,191	64,237
2445	64,284	64,330	64,377	64,423	64,470	64,516	64,563	64,609	64,656	64,702
2446	64,749	64,795	64,842	64,889	64,935	64,982	65,029	65,076	65,123	65,169
2447	65,216	65,263	65,310	65,357	65,404	65,451	65,498	65,545	65,592	65,639
2448	65,686	65,733	65,780	65,827	65,874	65,921	65,969	66,016	66,063	66,110
2449	66,158	66,205	66,252	66,300	66,347	66,394	66,442	66,489	66,537	66,584
2450	66,632	66,679	66,727	66,775	66,822	66,870	66,917	66,965	67,013	67,061
2451	67,108	67,156	67,204	67,252	67,300	67,347	67,395	67,443	67,491	67,539
2452	67,587	67,635	67,683	67,731	67,780	67,828	67,876	67,924	67,972	68,020
2453	68,069	68,117	68,165	68,214	68,262	68,310	68,359	68,407	68,456	68,504
2454	68,553	68,601	68,650	68,698	68,747	68,796	68,844	68,893	68,942	68,990
2455	69,039	69,088	69,137	69,186	69,235	69,283	69,332	69,381	69,430	69,479
2456	69,528	69,577	69,626	69,676	69,725	69,774	69,823	69,872	69,921	69,971
2457	70,020	70,069	70,119	70,168	70,217	70,267	70,316	70,365	70,415	70,464
2458	70,514	70,563	70,613	70,663	70,712	70,762	70,811	70,861	70,911	70,960
2459	71,010	71,060	71,110	71,159	71,209	71,259	71,309	71,359	71,409	71,459
2460	71,509	71,559	71,609	71,659	71,709	71,759	71,809	71,859	71,909	71,959
2461	72,009	72,060	72,110	72,160	72,210	72,260	72,311	72,361	72,411	72,462
2462	72,512	72,563	72,613	72,663	72,714	72,764	72,815	72,865	72,916	72,967
2463	73,017	73,068	73,118	73,169	73,220	73,270	73,321	73,372	73,423	73,473
2464	73,524	73,575	73,626	73,677	73,728	73,779	73,830	73,880	73,931	73,982
2465	74,033	74,085	74,136	74,187	74,238	74,289	74,340	74,391	74,442	74,494
2466	74,545	74,596	74,647	74,699	74,750	74,801	74,853	74,904	74,955	75,007
2467	75,058	75,110	75,161	75,213	75,264	75,316	75,367	75,419	75,471	75,522
2468	75,574	75,626	75,677	75,729	75,781	75,833	75,884	75,936	75,988	76,040
2469	76,092	76,144	76,195	76,247	76,299	76,351	76,403	76,455	76,507	76,559
2470	76,612	76,664	76,716	76,768	76,820	76,872	76,924	76,977	77,029	77,081
2471	77,134	77,186	77,238	77,291	77,343	77,395	77,448	77,500	77,553	77,605

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2472	77,658	77,710	77,763	77,815	77,868	77,921	77,973	78,026	78,079	78,131
2473	78,184	78,237	78,289	78,342	78,395	78,448	78,501	78,554	78,606	78,659
2474	78,712	78,765	78,818	78,871	78,924	78,977	79,030	79,083	79,136	79,189
2475	79,243	79,296	79,349	79,402	79,455	79,509	79,562	79,615	79,668	79,722
2476	79,775	79,828	79,882	79,935	79,989	80,042	80,096	80,149	80,202	80,256
2477	80,310	80,363	80,417	80,470	80,524	80,578	80,631	80,685	80,739	80,792
2478	80,846	80,900	80,954	81,008	81,061	81,115	81,169	81,223	81,277	81,331
2479	81,385	81,439	81,493	81,547	81,601	81,655	81,709	81,763	81,817	81,872
2480	81,926	81,980	82,034	82,088	82,143	82,197	82,251	82,306	82,360	82,415
2481	82,469	82,523	82,578	82,632	82,687	82,741	82,796	82,850	82,905	82,960
2482	83,014	83,069	83,124	83,178	83,233	83,288	83,343	83,397	83,452	83,507
2483	83,562	83,617	83,672	83,727	83,782	83,837	83,892	83,947	84,002	84,057
2484	84,112	84,167	84,222	84,277	84,333	84,388	84,443	84,498	84,554	84,609
2485	84,664	84,719	84,775	84,830	84,886	84,941	84,997	85,052	85,108	85,163
2486	85,219	85,274	85,330	85,385	85,441	85,497	85,552	85,608	85,664	85,720
2487	85,776	85,831	85,887	85,943	85,999	86,055	86,111	86,167	86,223	86,279
2488	86,335	86,391	86,447	86,503	86,559	86,615	86,672	86,728	86,784	86,840
2489	86,897	86,953	87,009	87,066	87,122	87,178	87,235	87,291	87,348	87,404
2490	87,461	87,517	87,574	87,630	87,687	87,743	87,800	87,857	87,913	87,970
2491	88,027	88,084	88,140	88,197	88,254	88,311	88,368	88,425	88,482	88,538
2492	88,595	88,652	88,709	88,766	88,823	88,881	88,938	88,995	89,052	89,109
2493	89,166	89,223	89,281	89,338	89,395	89,453	89,510	89,567	89,625	89,682
2494	89,739	89,797	89,854	89,912	89,969	90,027	90,084	90,142	90,200	90,257
2495	90,315	90,373	90,430	90,488	90,546	90,603	90,661	90,719	90,777	90,835
2496	90,893	90,950	91,008	91,066	91,124	91,182	91,240	91,298	91,356	91,414
2497	91,473	91,531	91,589	91,647	91,705	91,763	91,822	91,880	91,938	91,996
2498	92,055	92,113	92,172	92,230	92,288	92,347	92,405	92,464	92,522	92,581
2499	92,639	92,698	92,757	92,815	92,874	92,933	92,991	93,050	93,109	93,168
2500	93,226	93,285	93,344	93,403	93,462	93,521	93,580	93,638	93,697	93,756
2501	93,815	93,874	93,934	93,993	94,052	94,111	94,170	94,229	94,288	94,348
2502	94,407	94,466	94,525	94,585	94,644	94,704	94,763	94,822	94,882	94,941
2503	95,001	95,060	95,120	95,179	95,239	95,299	95,358	95,418	95,478	95,537
2504	95,597	95,657	95,717	95,776	95,836	95,896	95,956	96,016	96,076	96,136
2505	96,196	96,256	96,316	96,376	96,436	96,496	96,556	96,616	96,677	96,737
2506	96,797	96,857	96,917	96,978	97,038	97,098	97,159	97,219	97,280	97,340
2507	97,400	97,461	97,521	97,582	97,643	97,703	97,764	97,824	97,885	97,946
2508	98,006	98,067	98,128	98,189	98,249	98,310	98,371	98,432	98,493	98,554
2509	98,615	98,676	98,737	98,798	98,859	98,920	98,981	99,042	99,103	99,164
2510	99,225	99,286	99,348	99,409	99,470	99,531	99,593	99,654	99,715	99,777
2511	99,838	99,899	99,961	100,022	100,084	100,145	100,207	100,268	100,330	100,392
2512	100,453	100,515	100,576	100,638	100,700	100,762	100,823	100,885	100,947	101,009
2513	101,071	101,132	101,194	101,256	101,318	101,380	101,442	101,504	101,566	101,628
2514	101,690	101,752	101,814	101,877	101,939	102,001	102,063	102,125	102,188	102,250
2515	102,312	102,375	102,437	102,499	102,562	102,624	102,687	102,749	102,811	102,874
2516	102,937	102,999	103,062	103,124	103,187	103,250	103,312	103,375	103,438	103,500
2517	103,563	103,626	103,689	103,752	103,814	103,877	103,940	104,003	104,066	104,129
2518	104,192	104,255	104,318	104,381	104,444	104,507	104,570	104,634	104,697	104,760
2519	104,823	104,886	104,950	105,013	105,076	105,140	105,203	105,266	105,330	105,393
2520	105,457	105,520	105,584	105,647	105,711	105,774	105,838	105,902	105,965	106,029
2521	106,092	106,156	106,220	106,284	106,347	106,411	106,475	106,539	106,603	106,667
2522	106,731	106,795	106,859	106,923	106,987	107,051	107,115	107,179	107,243	107,307
2523	107,371	107,435	107,499	107,564	107,628	107,692	107,756	107,821	107,885	107,949
2524	108,014	108,078	108,143	108,207	108,272	108,336	108,400	108,465	108,530	108,594
2525	108,659	108,723	108,788	108,853	108,917	108,982	109,047	109,112	109,176	109,241
2526	109,306	109,371	109,436	109,501	109,565	109,630	109,695	109,760	109,825	109,890
2527	109,955	110,021	110,086	110,151	110,216	110,281	110,346	110,411	110,477	110,542
2528	110,607	110,673	110,738	110,803	110,869	110,934	110,999	111,065	111,130	111,196
2529	111,261	111,327	111,392	111,458	111,523	111,589	111,655	111,720	111,786	111,852
2530	111,918	111,983	112,049	112,115	112,181	112,247	112,312	112,378	112,444	112,510
2531	112,576	112,642	112,708	112,774	112,840	112,906	112,973	113,039	113,105	113,171
2532	113,237	113,304	113,370	113,436	113,502	113,569	113,635	113,701	113,768	113,834
2533	113,901	113,967	114,034	114,100	114,167	114,233	114,300	114,366	114,433	114,500

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2534	114,566	114,633	114,700	114,767	114,833	114,900	114,967	115,034	115,101	115,168
2535	115,234	115,301	115,368	115,435	115,502	115,569	115,636	115,703	115,771	115,838
2536	115,905	115,972	116,039	116,106	116,174	116,241	116,308	116,375	116,443	116,510
2537	116,578	116,645	116,712	116,780	116,847	116,915	116,982	117,050	117,118	117,185
2538	117,253	117,320	117,388	117,456	117,523	117,591	117,659	117,727	117,795	117,862
2539	117,930	117,998	118,066	118,134	118,202	118,270	118,338	118,406	118,474	118,542
2540	118,610	118,678	118,746	118,815	118,883	118,951	119,019	119,087	119,156	119,224
2541	119,292	119,361	119,429	119,497	119,566	119,634	119,703	119,771	119,840	119,908
2542	119,977	120,045	120,114	120,183	120,251	120,320	120,389	120,457	120,526	120,595
2543	120,664	120,733	120,801	120,870	120,939	121,008	121,077	121,146	121,215	121,284
2544	121,353	121,422	121,491	121,560	121,629	121,699	121,768	121,837	121,906	121,975
2545	122,045	122,114	122,183	122,252	122,322	122,391	122,461	122,530	122,599	122,669
2546	122,738	122,808	122,877	122,947	123,017	123,086	123,156	123,226	123,295	123,365
2547	123,435	123,504	123,574	123,644	123,714	123,784	123,853	123,923	123,993	124,063
2548	124,133	124,203	124,273	124,343	124,413	124,483	124,553	124,624	124,694	124,764
2549	124,834	124,904	124,975	125,045	125,115	125,185	125,256	125,326	125,397	125,467
2550	125,537	125,608	125,678	125,749	125,819	125,890	125,961	126,031	126,102	126,172
2551	126,243	126,314	126,385	126,455	126,526	126,597	126,668	126,739	126,809	126,880
2552	126,951	127,022	127,093	127,164	127,235	127,306	127,377	127,448	127,519	127,591
2553	127,662	127,733	127,804	127,875	127,947	128,018	128,089	128,161	128,232	128,303
2554	128,375	128,446	128,518	128,589	128,660	128,732	128,804	128,875	128,947	129,018
2555	129,090	129,162	129,233	129,305	129,377	129,449	129,520	129,592	129,664	129,736
2556	129,808	129,880	129,952	130,024	130,096	130,168	130,240	130,312	130,384	130,456
2557	130,528	130,600	130,672	130,745	130,817	130,889	130,961	131,034	131,106	131,178
2558	131,251	131,323	131,396	131,468	131,540	131,613	131,686	131,758	131,831	131,903
2559	131,976	132,049	132,121	132,194	132,267	132,339	132,412	132,485	132,558	132,631
2560	132,704	132,777	132,849	132,922	132,995	133,069	133,142	133,215	133,288	133,361
2561	133,434	133,507	133,581	133,654	133,727	133,800	133,874	133,947	134,021	134,094
2562	134,167	134,241	134,314	134,388	134,462	134,535	134,609	134,682	134,756	134,830
2563	134,904	134,977	135,051	135,125	135,199	135,273	135,347	135,421	135,495	135,569
2564	135,643	135,717	135,791	135,865	135,939	136,014	136,088	136,162	136,237	136,311
2565	136,385	136,460	136,534	136,609	136,683	136,758	136,832	136,907	136,982	137,056
2566	137,131	137,206	137,281	137,355	137,430	137,505	137,580	137,655	137,730	137,805
2567	137,880	137,955	138,030	138,106	138,181	138,256	138,331	138,407	138,482	138,558
2568	138,633	138,709	138,784	138,860	138,935	139,011	139,087	139,162	139,238	139,314
2569	139,390	139,466	139,542	139,618	139,694	139,770	139,846	139,922	139,998	140,074
2570	140,150	140,226	140,303	140,379	140,456	140,532	140,608	140,685	140,761	140,838
2571	140,915	140,991	141,068	141,145	141,222	141,298	141,375	141,452	141,529	141,606
2572	141,683	141,760	141,837	141,914	141,992	142,069	142,146	142,223	142,301	142,378
2573	142,455	142,533	142,610	142,688	142,765	142,843	142,921	142,998	143,076	143,154
2574	143,231	143,309	143,387	143,465	143,543	143,621	143,699	143,777	143,855	143,933
2575	144,011	144,089	144,168	144,246	144,324	144,402	144,481	144,559	144,638	144,716
2576	144,795	144,873	144,952	145,031	145,109	145,188	145,267	145,346	145,425	145,504
2577	145,583	145,662	145,741	145,820	145,899	145,978	146,057	146,136	146,216	146,295
2578	146,374	146,454	146,533	146,613	146,692	146,772	146,851	146,931	147,010	147,090
2579	147,170	147,250	147,330	147,409	147,489	147,569	147,649	147,729	147,809	147,890
2580	147,970	148,050	148,130	148,210	148,291	148,371	148,451	148,532	148,612	148,693
2581	148,774	148,854	148,935	149,016	149,096	149,177	149,258	149,339	149,420	149,501
2582	149,582	149,663	149,744	149,825	149,906	149,987	150,068	150,150	150,231	150,312
2583	150,393	150,475	150,556	150,638	150,719	150,801	150,882	150,964	151,045	151,127
2584	151,208	151,290	151,372	151,454	151,535	151,617	151,699	151,781	151,863	151,945
2585	152,027	152,109	152,191	152,273	152,355	152,437	152,520	152,602	152,684	152,766
2586	152,849	152,931	153,014	153,096	153,178	153,261	153,344	153,426	153,509	153,591
2587	153,674	153,757	153,840	153,922	154,005	154,088	154,171	154,254	154,337	154,420
2588	154,503	154,586	154,669	154,752	154,836	154,919	155,002	155,086	155,169	155,252
2589	155,336	155,419	155,503	155,586	155,670	155,753	155,837	155,921	156,005	156,088
2590	156,172	156,256	156,340	156,424	156,508	156,592	156,676	156,760	156,844	156,929
2591	157,013	157,097	157,181	157,266	157,350	157,435	157,519	157,604	157,688	157,773
2592	157,857	157,942	158,027	158,111	158,196	158,281	158,366	158,451	158,536	158,621
2593	158,706	158,791	158,876	158,962	159,047	159,132	159,217	159,303	159,388	159,474
2594	159,559	159,645	159,730	159,816	159,902	159,988	160,073	160,159	160,245	160,331
2595	160,417	160,503	160,589	160,676	160,762	160,848	160,934	161,021	161,107	161,194

EXHIBIT B. SEVEN OAKS DAM STORAGE CAPACITY TABLE (acre-feet)

Survey Year 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2596	161,281	161,367	161,454	161,541	161,628	161,715	161,802	161,889	161,976	162,063
2597	162,150	162,238	162,325	162,413	162,500	162,588	162,676	162,764	162,851	162,939
2598	163,028	163,116	163,204	163,292	163,381	163,469	163,558	163,647	163,736	163,824
2599	163,913	164,002	164,092	164,181	164,270	164,360	164,449	164,539	164,628	164,718
2600	164,808	164,898	164,988	165,078	165,169	165,259	165,349	165,440	165,531	165,621
2601	165,712	165,803	165,895	165,986	166,077	166,169	166,260	166,352	166,444	166,536
2602	166,628	166,720	166,813	166,905	166,998	167,091	167,184	167,277	167,370	167,464
2603	167,557	167,651	167,745	167,839	167,934	168,028	168,123	168,218	168,313	168,408
2604	168,504	168,599	168,695	168,791	168,887	168,984	169,081	169,177	169,275	169,372
2605	169,469	169,567	169,665	169,763	169,861	169,960	170,058	170,157	170,256	170,356
2606	170,455	170,555	170,655	170,755	170,855	170,956	171,057	171,158	171,259	171,361
2607	171,463	171,565	171,667	171,770	171,873	171,976	172,079	172,183	172,287	172,391
2608	172,495	172,599	172,704	172,808	172,913	173,018	173,123	173,229	173,334	173,440
2609	173,546	173,652	173,758	173,864	173,970	174,076	174,183	174,289	174,396	174,503
2610	174,609									

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
2102	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2103	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2104	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
2105	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2106	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
2107	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2108	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2109	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7
2110	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9
2111	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.2
2112	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.4
2113	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6
2114	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9
2115	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3
2116	2.3	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6
2117	0.8	0.9	1.0	1.9	2.0	2.1	2.1	2.2	2.2	2.2
2118	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.6
2119	2.7	2.7	2.8	2.8	2.8	2.9	2.9	3.0	3.0	3.1
2120	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5
2121	3.5	3.6	3.6	3.7	3.8	3.8	3.8	3.9	4.0	4.0
2122	4.1	4.1	4.2	4.3	4.3	4.4	4.5	4.5	4.6	4.7
2123	4.8	4.9	5.0	5.1	5.2	5.3	5.3	5.4	5.5	5.6
2124	5.6	5.7	5.8	6.0	6.1	6.2	6.2	6.3	6.4	6.5
2125	6.6	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.0	7.1
2126	7.1	7.2	7.3	7.3	7.4	7.4	7.5	7.5	7.5	7.6
2127	7.6	7.6	7.7	7.7	7.8	7.8	7.8	7.9	7.9	7.9
2128	8.0	8.0	8.0	8.1	8.1	8.1	8.2	8.2	8.2	8.3
2129	8.3	8.3	8.4	8.4	8.5	8.5	8.6	8.6	8.6	8.7
2130	8.7	8.7	8.8	8.8	8.8	8.9	8.9	9.0	9.0	9.1
2131	9.1	9.2	9.2	9.3	9.3	9.4	9.4	9.5	9.5	9.6
2132	9.6	9.7	9.7	9.8	9.8	9.8	9.9	9.9	10.0	10.0
2133	10.0	10.1	10.1	10.2	10.2	10.2	10.3	10.3	10.4	10.4
2134	10.5	10.5	10.6	10.6	10.7	10.7	10.8	10.8	10.9	10.9
2135	11.0	11.0	11.1	11.1	11.2	11.2	11.3	11.3	11.4	11.4
2136	11.5	11.5	11.6	11.6	11.7	11.7	11.8	11.9	11.9	12.0
2137	12.0	12.1	12.1	12.2	12.3	12.3	12.4	12.5	12.5	12.6
2138	12.7	12.7	12.8	12.9	12.9	13.0	13.0	13.1	13.2	13.2
2139	13.3	13.4	13.4	13.5	13.6	13.6	13.7	13.8	13.8	13.9
2140	13.9	14.0	14.1	14.1	14.2	14.3	14.3	14.4	14.5	14.5
2141	14.6	14.7	14.8	14.8	14.9	15.0	15.0	15.1	15.2	15.2
2142	15.3	15.3	15.4	15.5	15.5	15.6	15.7	15.7	15.8	15.9
2143	15.9	16.0	16.1	16.1	16.2	16.2	16.3	16.4	16.4	16.5
2144	16.6	16.6	16.7	16.8	16.9	16.9	17.0	17.1	17.1	17.2
2145	17.3	17.3	17.4	17.5	17.5	17.6	17.7	17.7	17.8	17.9
2146	18.0	18.0	18.1	18.2	18.2	18.3	18.4	18.5	18.6	18.6
2147	18.7	18.8	18.9	18.9	19.0	19.1	19.2	19.3	19.4	19.5
2148	19.7	19.8	19.9	20.0	20.1	20.3	20.5	20.6	20.8	20.9
2149	21.1	21.2	21.4	21.5	21.6	21.8	21.9	22.0	22.1	22.2
2150	22.4	22.5	22.6	22.7	22.9	23.0	23.1	23.2	23.4	23.5
2151	23.7	23.8	24.0	24.2	24.3	24.5	24.7	24.9	25.1	25.2
2152	25.4	25.5	25.7	25.8	25.9	26.1	26.2	26.4	26.6	26.7
2153	26.9	27.1	27.3	27.4	27.6	27.7	27.9	28.0	28.2	28.3
2154	28.5	28.6	28.8	28.9	29.0	29.2	29.3	29.5	29.6	29.8
2155	30.0	30.1	30.3	30.4	30.6	30.8	30.9	31.1	31.2	31.4
2156	31.5	31.7	31.8	32.0	32.1	32.2	32.4	32.5	32.7	32.8
2157	33.0	33.2	33.3	33.5	33.7	33.9	34.1	34.2	34.4	34.6
2158	34.7	34.9	35.1	35.2	35.4	35.6	35.8	36.1	36.3	36.5
2159	36.7	37.0	37.2	37.4	37.6	37.8	37.9	38.1	38.2	38.4
2160	38.5	38.7	38.8	39.0	39.2	39.4	39.5	39.7	39.9	40.1
2161	40.3	40.6	40.8	41.0	41.2	41.4	41.6	41.8	42.0	42.2

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2162	42.3	42.5	42.7	42.9	43.1	43.2	43.4	43.6	43.7	43.9
2163	44.1	44.3	44.4	44.6	44.8	44.9	45.0	45.2	45.3	45.4
2164	45.5	45.7	45.8	45.9	46.0	46.1	46.2	46.3	46.4	46.5
2165	46.6	46.7	46.8	46.9	47.0	47.1	47.2	47.3	47.4	47.5
2166	47.6	47.7	47.8	47.9	48.0	48.1	48.2	48.3	48.4	48.5
2167	48.6	48.7	48.8	48.9	49.0	49.1	49.2	49.3	49.4	49.5
2168	49.6	49.7	49.8	49.9	50.0	50.1	50.2	50.3	50.5	50.6
2169	50.7	50.8	50.9	51.0	51.1	51.2	51.3	51.4	51.5	51.6
2170	51.7	51.8	51.9	52.0	52.0	52.1	52.2	52.3	52.4	52.4
2171	52.5	52.6	52.7	52.8	52.9	53.0	53.0	53.1	53.2	53.3
2172	53.4	53.5	53.6	53.7	53.8	53.9	54.0	54.1	54.2	54.2
2173	54.3	54.4	54.5	54.6	54.7	54.7	54.8	54.9	55.0	55.1
2174	55.1	55.2	55.3	55.4	55.5	55.6	55.7	55.8	55.9	56.0
2175	56.1	56.2	56.3	56.5	56.6	56.7	56.9	57.0	57.1	57.3
2176	57.4	57.5	57.6	57.7	57.8	57.9	58.0	58.1	58.2	58.3
2177	58.4	58.5	58.6	58.8	58.9	59.0	59.1	59.2	59.4	59.5
2178	59.6	59.7	59.8	60.0	60.1	60.3	60.4	60.5	60.7	60.8
2179	61.0	61.1	61.2	61.3	61.5	61.6	61.7	61.8	61.9	62.1
2180	62.2	62.3	62.4	62.6	62.7	62.8	63.0	63.1	63.3	63.4
2181	63.6	63.7	63.9	64.0	64.1	64.2	64.3	64.5	64.6	64.6
2182	64.7	64.8	64.9	65.0	65.1	65.2	65.3	65.3	65.4	65.5
2183	65.6	65.7	65.8	65.8	65.9	66.0	66.1	66.2	66.3	66.3
2184	66.4	66.5	66.6	66.7	66.8	66.9	67.0	67.0	67.1	67.2
2185	67.3	67.4	67.6	67.7	67.7	67.8	67.9	68.0	68.1	68.2
2186	68.3	68.4	68.5	68.6	68.7	68.7	68.8	68.9	69.0	69.1
2187	69.2	69.3	69.4	69.5	69.5	69.6	69.7	69.8	69.9	70.0
2188	70.1	70.2	70.2	70.3	70.4	70.5	70.6	70.7	70.8	70.9
2189	70.9	71.0	71.1	71.2	71.3	71.4	71.5	71.5	71.6	71.7
2190	71.8	71.9	72.0	72.1	72.2	72.3	72.4	72.5	72.6	72.7
2191	72.8	72.9	73.0	73.1	73.2	73.3	73.4	73.5	73.6	73.7
2192	73.7	73.8	73.9	74.0	74.1	74.2	74.3	74.4	74.4	74.5
2193	74.6	74.7	74.8	74.9	74.9	75.0	75.1	75.2	75.2	75.3
2194	75.4	75.5	75.5	75.6	75.7	75.7	75.8	75.9	75.9	76.0
2195	76.1	76.1	76.2	76.3	76.3	76.4	76.4	76.5	76.6	76.6
2196	76.7	76.7	76.8	76.9	76.9	77.0	77.1	77.1	77.2	77.3
2197	77.3	77.4	77.4	77.5	77.6	77.6	77.7	77.7	77.8	77.9
2198	77.9	78.0	78.0	78.1	78.2	78.2	78.3	78.4	78.4	78.5
2199	78.5	78.6	78.7	78.7	78.8	78.9	78.9	79.0	79.0	79.1
2200	79.2	79.2	79.3	79.4	79.4	79.5	79.6	79.6	79.7	79.8
2201	79.8	79.9	79.9	80.0	80.1	80.1	80.2	80.3	80.3	80.4
2202	80.4	80.5	80.6	80.6	80.7	80.8	80.9	81.0	81.1	81.2
2203	81.2	81.3	81.4	81.5	81.6	81.7	81.7	81.8	81.9	82.0
2204	82.1	82.1	82.2	82.3	82.4	82.5	82.6	82.6	82.7	82.8
2205	82.9	83.0	83.1	83.2	83.3	83.4	83.5	83.6	83.7	83.8
2206	83.9	84.0	84.1	84.2	84.3	84.4	84.5	84.6	84.7	84.9
2207	85.0	85.1	85.2	85.3	85.4	85.5	85.6	85.7	85.8	85.9
2208	86.0	86.1	86.2	86.3	86.4	86.5	86.6	86.7	86.8	86.9
2209	87.0	87.1	87.2	87.3	87.4	87.5	87.6	87.7	87.8	87.9
2210	88.0	88.1	88.2	88.3	88.4	88.5	88.6	88.7	88.9	89.0
2211	89.1	89.2	89.3	89.5	89.6	89.7	89.9	90.0	90.1	90.3
2212	90.4	90.5	90.7	90.8	90.9	91.1	91.2	91.3	91.4	91.6
2213	91.7	91.8	91.9	92.0	92.2	92.3	92.4	92.5	92.6	92.8
2214	92.9	93.0	93.1	93.2	93.3	93.5	93.6	93.7	93.8	94.0
2215	94.1	94.3	94.5	94.6	94.7	94.9	95.0	95.2	95.3	95.5
2216	95.6	95.8	95.9	96.0	96.2	96.4	96.5	96.6	96.8	96.9
2217	97.0	97.2	97.3	97.4	97.5	97.7	97.8	97.9	98.1	98.2
2218	98.3	98.5	98.6	98.7	98.9	99.0	99.1	99.3	99.4	99.6
2219	99.7	99.8	99.9	100	100	100	100	101	101	101
2220	101	101	101	101	102	102	102	102	102	102
2221	102	103	103	103	103	103	103	103	104	104
2222	104	104	104	104	104	105	105	105	105	105
2223	105	105	105	105	106	106	106	106	106	106

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2224	106	106	106	107	107	107	107	107	107	107
2225	107	108	108	108	108	108	108	108	108	108
2226	109	109	109	109	109	109	109	109	110	110
2227	110	110	110	110	111	111	111	111	111	111
2228	111	112	112	112	112	112	112	112	113	113
2229	113	113	113	113	114	114	114	114	114	114
2230	115	115	115	115	115	115	115	116	116	116
2231	116	116	116	116	117	117	117	117	117	117
2232	117	118	118	118	118	118	118	119	119	119
2233	119	119	120	120	120	120	120	120	121	121
2234	121	121	121	121	121	122	122	122	122	122
2235	123	123	123	123	123	123	124	124	124	124
2236	125	125	125	125	125	126	126	126	126	127
2237	127	127	127	127	128	128	128	128	128	129
2238	129	129	129	129	129	130	130	130	130	130
2239	131	131	131	131	131	132	132	132	132	132
2240	132	133	133	133	133	133	133	134	134	134
2241	134	134	134	135	135	135	135	135	135	136
2242	136	136	136	136	136	136	137	137	137	137
2243	137	137	138	138	138	138	138	138	139	139
2244	139	139	139	139	139	139	140	140	140	140
2245	140	140	140	140	141	141	141	141	141	141
2246	141	142	142	142	142	142	142	142	142	143
2247	143	143	143	143	143	143	143	144	144	144
2248	144	144	144	144	144	145	145	145	145	145
2249	145	145	145	146	146	146	146	146	146	146
2250	147	147	147	147	147	147	147	147	148	148
2251	148	148	148	148	148	148	149	149	149	149
2252	149	149	149	149	150	150	150	150	150	150
2253	150	150	150	151	151	151	151	151	151	151
2254	151	152	152	152	152	152	152	152	152	152
2255	153	153	153	153	153	153	153	153	154	154
2256	154	154	154	154	154	154	154	155	155	155
2257	155	155	155	155	155	155	156	156	156	156
2258	156	156	156	156	157	157	157	157	157	157
2259	157	157	157	158	158	158	158	158	158	158
2260	158	159	159	159	159	159	159	159	159	160
2261	160	160	160	160	160	160	160	161	161	161
2262	161	161	161	161	161	161	162	162	162	162
2263	162	162	162	162	162	163	163	163	163	163
2264	163	163	163	163	164	164	164	164	164	164
2265	164	164	164	165	165	165	165	165	165	165
2266	165	165	166	166	166	166	166	166	166	166
2267	166	167	167	167	167	167	167	167	167	167
2268	168	168	168	168	168	168	168	168	168	169
2269	169	169	169	169	169	169	169	169	170	170
2270	170	170	170	170	170	170	171	171	171	171
2271	171	171	171	171	172	172	172	172	172	172
2272	172	172	173	173	173	173	173	173	173	173
2273	174	174	174	174	174	174	174	174	175	175
2274	175	175	175	175	175	175	175	176	176	176
2275	176	176	176	176	176	177	177	177	177	177
2276	177	177	177	178	178	178	178	178	178	178
2277	178	179	179	179	179	179	179	179	179	180
2278	180	180	180	180	180	180	180	181	181	181
2279	181	181	181	181	181	182	182	182	182	182
2280	182	182	182	183	183	183	183	183	183	183
2281	184	184	184	184	184	184	184	185	185	185
2282	185	185	185	186	186	186	186	186	186	186
2283	187	187	187	187	187	187	187	187	188	188
2284	188	188	188	188	188	188	189	189	189	189
2285	189	189	189	189	190	190	190	190	190	190

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2286	190	190	191	191	191	191	191	191	191	191
2287	192	192	192	192	192	192	192	192	193	193
2288	193	193	193	193	193	194	194	194	194	194
2289	194	194	194	195	195	195	195	195	195	195
2290	195	196	196	196	196	196	196	196	197	197
2291	197	197	197	197	197	197	198	198	198	198
2292	198	198	198	199	199	199	199	199	199	199
2293	200	200	200	200	200	200	200	200	201	201
2294	201	201	201	201	201	202	202	202	202	202
2295	202	202	202	203	203	203	203	203	203	203
2296	203	204	204	204	204	204	204	204	205	205
2297	205	205	205	205	205	206	206	206	206	206
2298	206	206	206	207	207	207	207	207	207	207
2299	207	208	208	208	208	208	208	208	209	209
2300	209	209	209	209	209	209	210	210	210	210
2301	210	210	210	211	211	211	211	211	211	211
2302	211	212	212	212	212	212	212	212	213	213
2303	213	213	213	213	213	214	214	214	214	214
2304	214	215	215	215	215	215	215	215	216	216
2305	216	216	216	216	216	217	217	217	217	217
2306	217	217	218	218	218	218	218	218	218	219
2307	219	219	219	219	219	219	220	220	220	220
2308	220	220	220	221	221	221	221	221	221	221
2309	222	222	222	222	222	222	222	223	223	223
2310	223	223	223	224	224	224	224	224	224	224
2311	225	225	225	225	225	225	225	226	226	226
2312	226	226	226	226	227	227	227	227	227	227
2313	227	228	228	228	228	228	228	229	229	229
2314	229	229	229	229	230	230	230	230	230	230
2315	231	231	231	231	231	231	231	232	232	232
2316	232	232	232	233	233	233	233	233	233	233
2317	234	234	234	234	234	234	235	235	235	235
2318	235	235	235	235	236	236	236	236	236	236
2319	236	237	237	237	237	237	237	238	238	238
2320	238	238	238	238	239	239	239	239	239	239
2321	239	240	240	240	240	240	240	240	241	241
2322	241	241	241	241	241	242	242	242	242	242
2323	242	242	243	243	243	243	243	243	243	244
2324	244	244	244	244	244	244	245	245	245	245
2325	245	245	245	246	246	246	246	246	246	246
2326	247	247	247	247	247	247	247	248	248	248
2327	248	248	248	248	249	249	249	249	249	249
2328	249	250	250	250	250	250	250	250	250	251
2329	251	251	251	251	251	251	252	252	252	252
2330	252	252	252	253	253	253	253	253	253	253
2331	253	254	254	254	254	254	254	254	255	255
2332	255	255	255	255	255	256	256	256	256	256
2333	256	256	257	257	257	257	257	257	257	257
2334	258	258	258	258	258	258	258	258	259	259
2335	259	259	259	259	259	259	260	260	260	260
2336	260	260	260	261	261	261	261	261	261	261
2337	261	262	262	262	262	262	262	262	262	263
2338	263	263	263	263	263	263	264	264	264	264
2339	264	264	264	264	265	265	265	265	265	265
2340	265	266	266	266	266	266	266	266	266	267
2341	267	267	267	267	267	267	268	268	268	268
2342	268	268	268	268	269	269	269	269	269	269
2343	269	270	270	270	270	270	270	270	270	271
2344	271	271	271	271	271	271	271	272	272	272
2345	272	272	272	272	273	273	273	273	273	273
2346	273	274	274	274	274	274	274	274	275	275
2347	275	275	275	275	275	275	276	276	276	276

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2348	276	276	276	277	277	277	277	277	277	277
2349	277	278	278	278	278	278	278	278	279	279
2350	279	279	279	279	279	280	280	280	280	280
2351	280	280	281	281	281	281	281	281	281	282
2352	282	282	282	282	282	282	283	283	283	283
2353	283	283	283	284	284	284	284	284	284	284
2354	285	285	285	285	285	285	285	286	286	286
2355	286	286	286	286	287	287	287	287	287	287
2356	288	288	288	288	288	288	288	289	289	289
2357	289	289	289	289	290	290	290	290	290	290
2358	290	291	291	291	291	291	291	291	292	292
2359	292	292	292	292	293	293	293	293	293	293
2360	294	294	294	294	294	294	294	295	295	295
2361	295	295	295	296	296	296	296	296	296	297
2362	297	297	297	297	297	298	298	298	298	298
2363	298	298	299	299	299	299	299	299	300	300
2364	300	300	300	300	301	301	301	301	301	301
2365	302	302	302	302	302	302	303	303	303	303
2366	303	303	303	304	304	304	304	304	304	305
2367	305	305	305	305	305	306	306	306	306	306
2368	306	307	307	307	307	307	307	308	308	308
2369	308	308	309	309	309	309	309	310	310	310
2370	310	310	311	311	311	311	311	311	312	312
2371	312	312	312	313	313	313	313	313	314	314
2372	314	314	314	314	315	315	315	315	315	316
2373	316	316	316	316	316	317	317	317	317	317
2374	317	318	318	318	318	318	318	319	319	319
2375	319	319	319	320	320	320	320	320	320	321
2376	321	321	321	321	321	322	322	322	322	322
2377	322	323	323	323	323	323	323	323	324	324
2378	324	324	324	324	325	325	325	325	325	325
2379	326	326	326	326	326	326	327	327	327	327
2380	327	327	328	328	328	328	328	328	329	329
2381	329	329	329	329	330	330	330	330	330	330
2382	331	331	331	331	331	331	332	332	332	332
2383	332	332	333	333	333	333	333	333	334	334
2384	334	334	334	334	335	335	335	335	335	335
2385	336	336	336	336	336	336	337	337	337	337
2386	337	337	338	338	338	338	338	338	338	339
2387	339	339	339	339	339	340	340	340	340	340
2388	340	341	341	341	341	341	341	342	342	342
2389	342	342	343	343	343	343	343	343	344	344
2390	344	344	344	344	345	345	345	345	345	346
2391	346	346	346	346	347	347	347	347	347	347
2392	348	348	348	348	348	349	349	349	349	349
2393	350	350	350	350	350	351	351	351	351	351
2394	352	352	352	352	352	353	353	353	353	353
2395	353	354	354	354	354	354	355	355	355	355
2396	356	356	356	356	356	357	357	357	357	358
2397	358	358	358	358	359	359	359	359	360	360
2398	360	360	360	361	361	361	361	362	362	362
2399	362	362	363	363	363	363	364	364	364	364
2400	364	365	365	365	365	365	366	366	366	366
2401	366	367	367	367	367	367	368	368	368	368
2402	369	369	369	369	369	370	370	370	370	370
2403	371	371	371	371	372	372	372	372	372	373
2404	373	373	373	373	374	374	374	374	375	375
2405	375	375	375	376	376	376	376	377	377	377
2406	377	377	378	378	378	378	379	379	379	379
2407	379	380	380	380	380	380	381	381	381	381
2408	382	382	382	382	382	383	383	383	383	383
2409	384	384	384	384	385	385	385	385	385	386

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2410	386	386	386	386	387	387	387	387	388	388
2411	388	388	388	389	389	389	389	390	390	390
2412	390	390	391	391	391	391	392	392	392	392
2413	392	393	393	393	393	394	394	394	394	394
2414	395	395	395	395	396	396	396	396	396	397
2415	397	397	397	398	398	398	398	399	399	399
2416	399	399	400	400	400	400	401	401	401	401
2417	401	402	402	402	402	403	403	403	403	404
2418	404	404	404	404	405	405	405	405	406	406
2419	406	406	406	407	407	407	407	407	408	408
2420	408	408	408	409	409	409	409	410	410	410
2421	410	410	411	411	411	411	411	412	412	412
2422	412	413	413	413	413	414	414	414	414	414
2423	415	415	415	415	416	416	416	416	417	417
2424	417	417	418	418	418	418	419	419	419	419
2425	420	420	420	420	421	421	421	421	422	422
2426	422	422	423	423	423	423	424	424	424	424
2427	425	425	425	425	426	426	426	426	427	427
2428	427	427	428	428	428	428	428	429	429	429
2429	429	430	430	430	430	431	431	431	431	431
2430	432	432	432	432	433	433	433	433	433	434
2431	434	434	434	435	435	435	435	435	436	436
2432	436	436	437	437	437	437	437	438	438	438
2433	438	439	439	439	439	439	440	440	440	440
2434	441	441	441	441	441	442	442	442	442	442
2435	443	443	443	443	443	444	444	444	444	445
2436	445	445	445	445	446	446	446	446	446	447
2437	447	447	447	448	448	448	448	448	449	449
2438	449	449	450	450	450	450	450	451	451	451
2439	451	451	452	452	452	452	452	453	453	453
2440	453	453	454	454	454	454	454	455	455	455
2441	455	456	456	456	456	456	457	457	457	457
2442	457	458	458	458	458	459	459	459	459	459
2443	460	460	460	460	460	461	461	461	461	461
2444	462	462	462	462	462	463	463	463	463	464
2445	464	464	464	464	465	465	465	465	466	466
2446	466	466	467	467	467	467	467	468	468	468
2447	468	469	469	469	469	470	470	470	470	470
2448	471	471	471	471	472	472	472	472	472	473
2449	473	473	473	474	474	474	474	475	475	475
2450	475	475	476	476	476	476	477	477	477	477
2451	478	478	478	478	479	479	479	479	480	480
2452	480	480	481	481	481	481	482	482	482	482
2453	483	483	483	483	484	484	484	484	485	485
2454	485	485	486	486	486	486	487	487	487	487
2455	488	488	488	488	489	489	489	489	490	490
2456	490	491	491	491	491	492	492	492	492	492
2457	493	493	493	493	494	494	494	494	495	495
2458	495	495	495	496	496	496	496	497	497	497
2459	497	498	498	498	498	498	499	499	499	499
2460	499	500	500	500	500	501	501	501	501	501
2461	502	502	502	502	502	503	503	503	503	504
2462	504	504	504	504	505	505	505	505	506	506
2463	506	506	506	507	507	507	507	507	508	508
2464	508	508	508	509	509	509	509	510	510	510
2465	510	510	511	511	511	511	512	512	512	512
2466	512	513	513	513	513	513	514	514	514	514
2467	514	515	515	515	515	515	516	516	516	516
2468	517	517	517	517	517	518	518	518	518	518
2469	519	519	519	519	520	520	520	520	520	521
2470	521	521	521	521	522	522	522	522	523	523
2471	523	523	523	524	524	524	524	524	525	525

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2472	525	525	526	526	526	526	526	527	527	527
2473	527	527	528	528	528	528	528	529	529	529
2474	529	529	530	530	530	530	530	531	531	531
2475	531	532	532	532	532	532	533	533	533	533
2476	533	534	534	534	534	534	535	535	535	535
2477	535	536	536	536	536	536	537	537	537	537
2478	538	538	538	538	538	539	539	539	539	539
2479	540	540	540	540	541	541	541	541	541	542
2480	542	542	542	543	543	543	543	543	544	544
2481	544	544	545	545	545	545	545	546	546	546
2482	546	547	547	547	547	548	548	548	548	548
2483	549	549	549	549	550	550	550	550	551	551
2484	551	551	551	552	552	552	552	553	553	553
2485	553	553	554	554	554	554	555	555	555	555
2486	556	556	556	556	557	557	557	557	557	558
2487	558	558	558	559	559	559	559	560	560	560
2488	560	561	561	561	561	562	562	562	562	563
2489	563	563	563	563	564	564	564	564	565	565
2490	565	565	566	566	566	566	566	567	567	567
2491	567	568	568	568	568	568	569	569	569	569
2492	570	570	570	570	570	571	571	571	571	572
2493	572	572	572	573	573	573	573	574	574	574
2494	574	574	575	575	575	575	576	576	576	576
2495	576	577	577	577	577	578	578	578	578	579
2496	579	579	579	579	580	580	580	580	581	581
2497	581	581	581	582	582	582	582	583	583	583
2498	583	584	584	584	584	584	585	585	585	585
2499	586	586	586	586	587	587	587	587	587	588
2500	588	588	588	589	589	589	589	589	590	590
2501	590	590	591	591	591	591	592	592	592	592
2502	593	593	593	593	594	594	594	594	595	595
2503	595	595	595	596	596	596	596	597	597	597
2504	597	598	598	598	598	599	599	599	599	600
2505	600	600	600	600	601	601	601	601	602	602
2506	602	602	603	603	603	603	604	604	604	604
2507	605	605	605	605	606	606	606	606	607	607
2508	607	607	607	608	608	608	608	609	609	609
2509	609	609	610	610	610	610	611	611	611	611
2510	612	612	612	612	613	613	613	613	613	614
2511	614	614	614	615	615	615	615	615	616	616
2512	616	616	617	617	617	617	618	618	618	618
2513	618	619	619	619	619	620	620	620	620	620
2514	621	621	621	621	622	622	622	622	623	623
2515	623	623	624	624	624	624	624	625	625	625
2516	625	626	626	626	626	627	627	627	627	627
2517	628	628	628	628	629	629	629	629	629	630
2518	630	630	630	631	631	631	631	631	632	632
2519	632	632	633	633	633	633	634	634	634	634
2520	635	635	635	635	635	636	636	636	636	637
2521	637	637	637	638	638	638	638	639	639	639
2522	639	639	640	640	640	640	641	641	641	641
2523	641	642	642	642	642	643	643	643	643	643
2524	644	644	644	644	645	645	645	645	646	646
2525	646	646	646	647	647	647	647	648	648	648
2526	648	648	649	649	649	649	650	650	650	650
2527	651	651	651	651	651	652	652	652	652	653
2528	653	653	653	653	654	654	654	654	655	655
2529	655	655	656	656	656	656	656	657	657	657
2530	657	658	658	658	658	659	659	659	659	660
2531	660	660	660	660	661	661	661	661	662	662
2532	662	662	663	663	663	663	663	664	664	664
2533	664	665	665	665	665	666	666	666	666	667

EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2534	667	667	667	667	668	668	668	668	669	669
2535	669	669	670	670	670	670	670	671	671	671
2536	671	672	672	672	672	673	673	673	673	674
2537	674	674	674	675	675	675	675	676	676	676
2538	676	676	677	677	677	677	678	678	678	678
2539	679	679	679	679	680	680	680	680	680	681
2540	681	681	681	682	682	682	682	683	683	683
2541	683	683	684	684	684	684	685	685	685	685
2542	686	686	686	686	687	687	687	687	687	688
2543	688	688	688	689	689	689	689	690	690	690
2544	690	691	691	691	691	691	692	692	692	692
2545	693	693	693	693	694	694	694	694	694	695
2546	695	695	695	696	696	696	696	697	697	697
2547	697	697	698	698	698	698	699	699	699	699
2548	700	700	700	700	701	701	701	701	702	702
2549	702	702	703	703	703	703	703	704	704	704
2550	704	705	705	705	705	706	706	706	706	707
2551	707	707	707	708	708	708	708	708	709	709
2552	709	709	710	710	710	710	711	711	711	711
2553	712	712	712	712	713	713	713	713	713	714
2554	714	714	714	715	715	715	715	716	716	716
2555	716	717	717	717	717	718	718	718	718	719
2556	719	719	719	720	720	720	720	721	721	721
2557	721	722	722	722	722	723	723	723	723	724
2558	724	724	724	725	725	725	725	726	726	726
2559	726	727	727	727	727	728	728	728	728	729
2560	729	729	730	730	730	730	731	731	731	731
2561	732	732	732	733	733	733	733	734	734	734
2562	735	735	735	735	736	736	736	737	737	737
2563	738	738	738	739	739	739	739	740	740	740
2564	741	741	741	742	742	742	743	743	743	744
2565	744	744	745	745	745	746	746	746	747	747
2566	747	748	748	748	749	749	749	750	750	750
2567	751	751	752	752	752	753	753	753	754	754
2568	755	755	755	756	756	757	757	757	758	758
2569	758	759	759	759	760	760	761	761	761	762
2570	762	763	763	763	764	764	765	765	765	766
2571	766	767	767	768	768	768	769	769	769	770
2572	770	771	771	771	772	772	772	773	773	774
2573	774	774	775	775	775	776	776	777	777	777
2574	778	778	778	779	779	780	780	780	781	781
2575	781	782	782	783	783	783	784	784	785	785
2576	786	786	786	787	787	787	788	788	789	789
2577	790	790	790	791	791	792	792	792	793	793
2578	794	794	794	795	795	795	796	796	797	797
2579	797	798	798	799	799	800	800	800	801	801
2580	802	802	802	803	803	804	804	805	805	806
2581	806	807	807	807	808	808	808	809	809	809
2582	810	810	810	811	811	811	812	812	812	813
2583	813	813	814	814	814	815	815	816	816	816
2584	817	817	817	818	818	818	819	819	819	820
2585	820	820	821	821	821	822	822	822	823	823
2586	823	824	824	824	825	825	826	826	826	827
2587	827	827	828	828	828	829	829	829	830	830
2588	831	831	831	832	832	832	833	833	834	834
2589	834	835	835	836	836	836	837	837	838	838
2590	838	839	839	839	840	840	841	841	842	842
2591	842	843	843	844	844	844	845	845	846	846
2592	846	847	847	848	848	849	849	849	850	850
2593	851	851	852	852	852	853	853	854	854	855
2594	855	856	856	857	857	858	858	859	859	860
2595	860	861	861	862	862	863	864	864	865	865

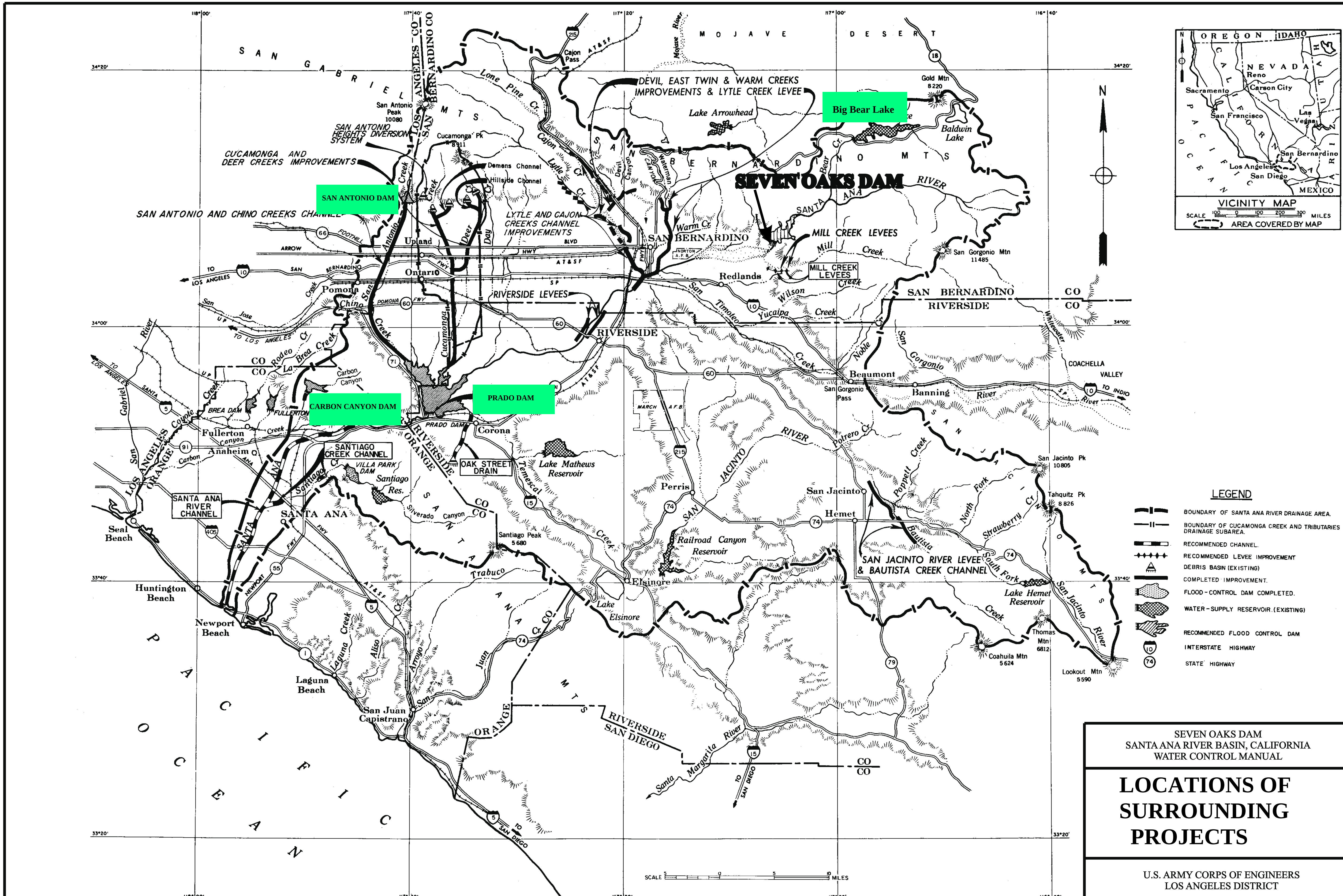
EXHIBIT B. SEVEN OAKS DAM AREA TABLE (acres)

Survey Year: 1999

ELEV.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2596	866	867	867	868	869	869	870	871	871	872
2597	873	874	874	875	876	877	878	879	879	880
2598	881	882	883	884	884	885	886	887	888	889
2599	890	891	892	892	893	894	895	896	897	898
2600	899	900	901	902	903	904	905	906	907	908
2601	909	910	911	912	914	915	916	917	919	920
2602	921	923	924	926	927	929	930	932	933	935
2603	936	938	940	942	944	945	947	949	951	953
2604	955	957	959	961	963	965	967	969	971	973
2605	975	977	979	981	983	985	987	989	991	993
2606	995	997	1,000	1,002	1,004	1,007	1,009	1,011	1,014	1,016
2607	1,019	1,021	1,024	1,026	1,029	1,031	1,033	1,035	1,038	1,040
2608	1,042	1,044	1,046	1,047	1,049	1,051	1,052	1,054	1,055	1,057
2609	1,058	1,059	1,060	1,061	1,062	1,063	1,064	1,065	1,066	1,066
2610	1,067									

EXHIBIT C.

SUPPLEMENTARY PERTINENT DATA OF SURROUNDING PROJECTS



SEVEN OAKS DAM
SANTA ANA RIVER BASIN, CALIFORNIA
WATER CONTROL MANUAL

LOCATIONS OF SURROUNDING PROJECTS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

EXHIBIT C PLATE

Approved 1/22/98

BEAR VALLEY DAM EMERGENCY ACTION PLAN

PREPARATION REPORT

INTRODUCTION

This report was written in conjunction with the preparation of the Bear Valley Dam Emergency Action Plan (EAP) in order to document the assumptions and conclusions necessary for preparation of that document. The report describes the project, regulatory jurisdiction, dam stability, hazard classification, failure modes, flood hydrology and inundation, early warning and contains photographs of facilities that would be at risk in the event of a dam failure.

The EAP was prepared by reviewing all documentation at the BBMWD offices, telephone conversations with the U.S. Forest Service (USFS), U.S. Army Corps of Engineers (COE) and the State of California, Office of Emergency Services (OES), and included a visit to the office of the California Department of Water Resources, Division of Safety of Dams (DSOD). The EAP adheres to guidelines set by OES, DSOD and the federal government.

PROJECT DESCRIPTION

Bear Valley Dam is a 91-foot(ft) high, concrete, multiple arch structure with a crest length of 360-ft. The dam was constructed in 1911 as a replacement of an old masonry arch dam located about 200-ft upstream. The dam impounds a reservoir with a volume of 73,320 acre-feet(ac-ft), covering an area of 2,973-acres(ac) at a normal maximum water level (NMWL) of El 6743.2. The service spillway consists of five 4.0 x 6.0-ft rectangular openings located in bays 1 and 10, with a sill at El 6736.2 and a maximum discharge of 2,630 cubic feet per second (cfs) at reservoir El 6743.33. The openings are controlled by wooden slide gates which are raised by hand wheels. The outlet works consists of one 36-inch diameter conduit regulated by two gate valves, a 14" and a 24" gates, located at El 6666.0, and has a discharge capacity of 250 cfs. In 1924, the State Department of Transportation (CALTRANS) built a bridge across the crest of the dam. The dam was rehabilitated in 1988 to meet DSOD safety requirements by filling in the multiple arch barrels with mass concrete, thereby converting the dam into a virtual gravity structure. As part of the rehabilitation, the construction of an emergency spillway was begun in three bays near the center of the dam, with a sill at El 6731. This spillway will not be fully operational until the state highway is removed from the dam. It will include the installation of three (3) gates, each approximately 13' x 19', which will provide for the release of approximately 15,000 cfs. It is estimated that Caltrans will construct a new bridge by the year 2002, at which time this spillway can be completed. Management of the dam, bottom of the reservoir and Lake level are by Big Bear Municipal Water District. However, the water rights remain with Bear Valley Mutual Water Company in Redlands.

REGULATORY AUTHORITY

U.S. Forest Service (USFS)

Since Bear Valley Dam is located within San Bernardino National Forest, it falls within the jurisdiction of the USFS. The EAP was prepared in response to a letter from the USFS to the General Manager of the BBMWD, dated 28 February 1994. The USFS was consulted as to the scope and content of the EAP.

State of California, Department of Water Resources, Division of Safety of Dams

All privately owned dams in the state of California fall within the jurisdiction of the Division of Safety of Dams (DSOD). The DSOD is responsible for assigning a hazard classification to each dam and Bear Valley Dam has been classified as High Hazard. The state requires that all high hazard dams, have a breach analysis performed, the resulting flood routed downstream and flood inundation maps prepared. This work was done for Bear Valley Dam in 1974 and the work was accepted by the DSOD. Since that time the responsibility for flood inundation mapping has passed to the State Office of Emergency Services (OES).

State of California Office of Emergency Services

The EAP was prepared in accordance with the Standard Emergency Management System (SEMS) Regulations, California Regulations, Title 19, Division 2, OES.

U.S. Corps of Engineers (COE)

The COE is currently constructing Seven Oaks Dam approximately 15 miles downstream from Bear Valley Dam on the Santa Ana River. When completed the dam will be 550-ft high with a crest length of 2,630-ft and a width of 40-ft at El 2610. The dam is a zoned rockfill embankment with an upstream slope of 2.2:1 and a downstream slope of 1.8:1. The outlet works is 18" in diameter and has a discharge capacity 7,000 cfs. The ogee type ungated spillway is located in the right abutment with a crest length of 560-ft at El 2580. The dam is designed to safely pass the probable maximum flood (PMF) with a peak discharge of 180,000 cfs and a maximum reservoir level at El 2605. The reservoir is sized for 32,000 ac-ft of sediment storage, 145,600 ac-ft of active storage to spillway elevation, and a flood surcharge of 145,600 ac-ft.

DAM STABILITY

The stability of the rehabilitated Bear Valley Dam was verified in the Report on Structural Analysis of Rehabilitation by R.W. Beck and Associates in December 1987. It determined that the factor of safety during the two extreme loading conditions is as follows:

	Factor of Safety	Required
Seismic Loading	>2.1	1.0
PMF Loading	>2.0	1.0

This means that the likelihood of Bear Valley Dam failing in either an extraordinary seismic event or flood is extremely remote.

HAZARD CLASSIFICATION

Bear Valley Dam is classified as High Hazard by DSOD and the USFS which is defined as "failure, no matter how improbable, would result in the loss of life or excessive economic loss". Although the hazard posed by a dam break at Bear Valley will be reduced once Seven Oaks Dam is completed in 1999, more than likely the dam will maintain its High Hazard classification because of the continued threat posed to campers and recreational users in Bear Creek Canyon between the dam and Seven Oaks Dam.

MODE OF FAILURE

Concrete dams can fail due to sliding along the foundation, shearing through the dam, excessive cracking, overturning or failure of an abutment. In any of these modes failure must be considered to be instantaneous. There would be few, if any, precursors of dam failure. Extreme loads that could induce failure through one of the modes described above could be imparted by a large earthquake or during overtopping of the dam during a large flood.

DOWNSTREAM IMPACTS

An inspection of the canyon formed by Bear Creek and the Santa Ana River downstream of Bear Valley Dam as far as the site of Seven Oaks Dam revealed it to be devoid of permanent human habitation. However the following facilities exist in this stretch of the canyon which would certainly be affected by the failure of Bear Valley Dam:

<u>Campgrounds</u>

The USFS maintains several campgrounds for public use along Bear Creek downstream of Bear Valley Dam:

> <u>Siberia Creek Campground</u>
> The campground consists of one metal firepit and is located on a small terrace on the left bank of Bear Creek about 20-ft above stream bed, at approximately El 4760. The campground is very remote and can only be reached on foot, however there are signs that the campsite is being frequented.
>
> <u>Slide Lake Campground</u>
> The campground consists of several rock ringed fire pits and, is located on the right bank of Bear Creek just above boulder strewn stream bed at approximately El 3860. The site is accessible by vehicle. The campground was unoccupied at the time of the inspection, however it showed signs of frequent visitation and vandalism. The campground would be inundated by a flood of moderate size with or without the failure of Bear Valley Dam,

as it is located upstream of a large rock slide emanating from Slide Peak which has formed a natural dam across the creek. A high water mark can be observed along the banks of the creek upstream indicating the level the water in the lake reaches during large flood events of around El 4000.

Bear Creek Campground
Bear Creek Campground is a poorly defined collection of rock ringed fire pits in the flood plain of Bear Creek at about El 3520, just upstream of the confluence with the Santa Ana River. It is accessible by vehicle and shows signs of frequent visitation and vandalism. The campground would be flooded by moderate floods irrespective of failure of the dam.

Santa Ana River Hydroelectric System

The Santa Ana River Hydroelectric System consists of a sequence of interconnected intakes, aqueducts and powerhouses. The project was built in the late 1800's and early 1900's. The system is owned and operated by Southern California Edison (SCE).

Intake, Aqueduct and Powerhouse No. 1
The intake is located on the left bank of Bear Creek and the aqueduct, consisting of a steel pipe, immediately bridges the creek before entering a series of flumes and tunnels on the right bank of the creek. It is likely that this pipe crossing would be destroyed by any large flood irrespective of the failure of Bear Valley Dam.

It was not possible to visit powerhouse No.1 during the site visit, however judging from its location near the river, heavy damage could be expected during a large flood. The powerhouse is unmanned but occasionally visited by SCE operation and maintenance personnel.

Intake, Aqueduct and Powerhouse No.2
Powerhouse No. 2 and a portion of the aqueduct are located below El 2605, the maximum water level of Seven Oaks Reservoir during passage of the PMF. Therefore this facility is scheduled to be abandoned and would no longer be impacted by a flood caused by the failure of Bear Valley Dam.

FLOOD HYDROLOGY AND INUNDATION

Various reports on flood hydrology were reviewed including "Dam Inundation Study" prepared by CM Engineering Associates in 1974, and the following observations were made:

- The maximum flow (Q_{max}) used in the 1974 inundation study agrees well with current OES criteria.
- Current OES criteria calls for superimposing the failure hydrograph on a concurrent 10-year discharge in the downstream channel. The 1974 inundation study assumed no downstream

inflow. Inflow to Bear Creek and the Santa Ana River downstream of the dam can be assumed to be less than 1% of the peak flow and therefore would have an insignificant impact on flooding.

- Information on the dam breach hydrograph modeled in 1974 was not available, although the report states that it was computed using OES criteria. Since the current and 1974 Qmax values agree well, it can be assumed that the hydrograph criteria from OES were properly applied and would be consistent with current criteria.
- Results of hydrograph routings were not included in the 1974 report. Routing was performed using the Convex Method and the Storage-Indication Method according to the text. A current analysis would use HEC-1 and apply the Modified Puls (normal depth) or Muskingum-Crage Methods. All are based on the same theory and should give similar results if properly applied. The narrow valley between Bear Valley Dam and Seven Oaks Reservoir will not produce large flood routing attenuation, so this part of the analysis is not expected to be critical.
- Volume of Big Bear Lake is 73,320 ac-ft at the spillway crest. Volume of Seven Oaks Reservoir is 112,000 ac-ft at the spillway elevation and 138,000 ac-ft at the crest elevation. Therefore, it can be concluded that Seven Oaks Dam would not overtop if Bear Valley Dam were to fail. Therefore, BBMWD should not be responsible for analyzing flood inundation downstream of Seven Oaks Reservoir. Such flood inundation responsibility rests with the COE.
- The inundation map in the 1974 study only indicates flood boundaries. Current OES criteria requires maps to contain the following information:

  - flood boundaries
  - flood elevations at cross sections
  - peak discharge at cross sections
  - flood peak travel time at cross sections
  - flooding time and deflooding time at cross sections (when flow leaves the channel on the rising hydrograph limb and returns to the channel on the falling limb)

  It is impossible to generate this information from the data included in the report, although other backup data (e.g., computer runs) may be available somewhere to provide some of the required information.

- Campgrounds, gauging stations and hydropower facilities are the only impacted facilities shown in the flooded area on the USGS map. Therefore, there does not appear to be sufficient reason to re-do the dam break inundation analysis.
- The James M. Montgomery report on spillway routing gives a PMF outflow of 36,400 cfs. This is about 10 percent of the dam failure peak. Increasing the dam break peak by this 10% in the case of a dam break caused by the PMF would have little impact on the flood boundaries and inundation elevations in the canyon downstream of the dam. Therefore, it does not appear necessary to simulate a concurrent PMF and dam failure event for purposes of the EAP.

Emergency Preparedness and Early Warning

If the dam were to fail in a seismic event, failure would be instantaneous and there would be no time to warn anyone at the campgrounds or along the river downstream even if it was possible to determine that the dam had breached. Furthermore there are no communications facilities in the canyon. Early warning sirens at the dam would be ineffective more than a few miles downstream and recreational users would probably not know what the sirens meant if they heard them.

In the event of failure during an extreme flood event such as the PMF, the storm would be a tropical cyclone off the Pacific Ocean with a duration of several days. The intense rainfall accompanying such a storm would wash out trails and roads leading to the campgrounds and it is highly unlikely that there would be people in the canyon during such an event.

CONCLUSIONS:

- Bear Valley Dam is safe even under extreme loading conditions resulting from a large earthquake or overtopping by the PMF.
- The dam is correctly classified as "High Hazard" because in the event of failure it is remotely possible that there could be loss of human life or excessive economic loss (e.g., SCE Powerhouse No. 1).
- It is extremely unlikely that there would be anyone in the canyon during a dam failure caused by the PMF. Therefore, the only situation where people might be at risk would be a sunny day failure caused by a large earthquake.
- If the dam were to fail, failure would be instantaneous and there would be no time to warn people downstream.
- It would be impractical to install an early warning system.
- The Seven Oaks reservoir management plan identifies the maximum storage at any given time to be no more than 25% of its 145,600 acre feet capacity (36,400 acre feet). The Seven Oaks reservoir would therefore contain the flood volume released by the failure of the Bear Valley Dam, even at Big Bear Lake's maximum capacity of 73,370 acre feet, and there would be no further risk downstream.

PHOTOGRAPHS

BEAR VALLEY DAM

EMERGENCY ACTION PLAN (EAP)

ADOPTED JANUARY 1998
Revised December 1998

NAME: Bear Valley Dam Number 803 **OWNER:** Big Bear Municipal Water District (BBMWD)

FOREST: San Bernardino **RANGER DISTRICT:** Big Bear

LOCATION OF DAM: SW S22, T2N, R1W, San Bernardino Base and Meridian

ROUTE TO DAM: Approximately 4 miles west of the town of Big Bear Lake via State Highway 18 or approximately 24 miles east of the intersection of State Highways 18 and 330.

HEIGHT: 91 feet **ADMINISTRATIVE CLASS:** A **HAZARD RATING:** High

STORAGE VOLUME (NWL): 73,320 acre-feet **SURFACE AREA:** 2,973 acres

NORMAL MAXIMUM WATER LEVEL (NMWL): El 6743.2

TYPE OF STRUCTURE: Concrete Multiple Arch. Ten arches (bays) ranging in height from 15 to 91-feet founded on a foundation of sound crystalline rock. Total crest length is 360-feet. Bays have been filled with mass concrete to form a virtual gravity dam with an upstream slope of 0.75:1 and a vertical downstream face from the crest to El 6691.0 below which the face slopes 0.25:1. The downstream side of the dam is further stabilized by 11, 1.5-foot to 5.0-foot wide buttresses located between each bay.

OUTLET WORKS: One 36-inch diameter conduit controlled by two gate valves (14" and 24") location in bay no. 7 at El 6666.0. Discharge capacity is 250 cfs.

SERVICE SPILLWAY: Five 4.0 x 6.0 rectangular openings located at the end bays (nos. 1 and 10) on either abutment with a sill at El 6736.2. Wood slide gates are operated by hand wheels. Discharge capacity is 2,630 cubic feet per second with the reservoir at El 6742.33.

EMERGENCY SPILLWAY: Total of 108-feet wide, ungated, ogee type located in bay nos. 5, 6 and 8. Discharge capacity will be approximately 15,000 cfs at reservoir El 6742.33 when emergency spillway construction is completed. Overtopping rates at a free overflow situation of current structure are:

OVERTOPPING DEPTH (feet-inches)	DISCHARGE (cubic feet per second)
0-1	28
0-6	416
1-0	1,188
2-0	3,362
3-0	6,178
4-0	9,504
5-0	13,282
6-0	17,464
7-0	22,002
8-0	26,884
9-0	32,076
9-6.8	36,400

BRIDGE: State Highway 18 crosses the dam on a bridge located on the crest of the dam.

COMMUNICATION CONDITIONS: The BBMWD headquarters in the town of Big Bear Lake is equipped with 6 telephone ground lines. In addition, headquarters operates a VHF radio base station that is in communication with BBMWD vehicles (total of 16 units). The General Manager and key personnel are equipped with cellular telephones and pagers.

PURPOSE OF EAP: Establish responsibility, communication, and emergency action guidelines for four potential dam emergency conditions (scenarios).

AUTHORITY: The EAP has been prepared in accordance with the requirements of the State of California, Offices of Emergency Services (OES); Department of Water Resources, Division of Safety of Dams (DSOD); and federal emergency action plan guidelines.

TESTING AND UPDATING OF EAP: The EAP should be updated any time there is a change affecting the plan, such as a change in responsible persons at BBMWD or one of the other key organizations in the EAP. The EAP will be reviewed and updated yearly as a minimum. Likewise the EAP should be tested on a yearly basis by simulating one of the emergency conditions described.

DISSEMINATION OF EAP: The BBMWD will send a copy of the EAP along with flood inundation mapping to each of the organizations listed therein. It will be the responsibility of each organization to disseminate the EAP plan to those persons within their organization with a need to know and especially those who would be responsible for implementing the plan. A copy of the EAP should be posted on a bulletin board or other prominent location at each of these organizations.

PRADO DAM AND RESERVOIR
RIVERSIDE COUNTY, CALIFORNIA
PERTINENT DATA
(REVISED January 1993)

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 (Flood Season)	ft., m.s.l.	494.0
(Non-flood Season)	ft., m.s.l.	505.0
Spillway Crest	ft., m.s.l.	543.0
Revised Standard Project Flood Level (1969)	ft., m.s.l.	554.6
Spillway Design Surcharge Level (1941)	ft., m.s.l.	556.0
Top of dam	ft., m.s.l.	566.0
Revised Probable Maximum Flood Level (1969)	ft., m.s.l.	570.3**
Area		
Debris pool	acres	768
Buffer pool (Flood Season)	acres	1,081
(Non-flood Season)	acres.	2,123
Spillway crest	acres	6,566
Revised Standard Project Flood Level (1969)	acres	8,485.3
Spillway design surcharge Level (1941)	acres	8,769.5
Top of dam	acres	11,030
Revised Probable Maximum Flood Level (1969)	acres	11,900.0**
Capacity, gross (1988 Survey)		
Debris pool	ac-ft(in.)	4,689 (0.04*)
Buffer pool (Flood Season)	ac-ft(in.)	8,437 (0.07*)
(Non-flood Season)	ac-ft (in.).	25,760 (0.2*)
Spillway crest	ac-ft(in.)	187,700 (1.50*)
Revised Standard Project Flood Level (1969)	ac-ft(in.)	283,414 (2.36*)
Spillway design surcharge Level (1941)	ac-ft(in.)	295,581 (2.46*)
Top of dam	ac-ft(in.)	383,500 (3.10*)
Revised Probable Maximum Flood Level (1969)	ac-ft(in.)	436,000 (3.62*)**
Allowance for sediment (50 year)	ac-ft(in.)	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
Design surcharge/ discharge (1941)	ft/cfs.	13/181,000
Outlets:		
Uncontrolled (NOTE: Both uncontrolled outlets are plugged)		
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'H
Length	ft.	750
Maximum capacity at spillway crest	cfs	17,000
Maximum regulated reservoir release	cfs	5,000
Revised Standard Project Flood (1969):		
Duration (inflow)	Days	4
Total volume	ac-ft(in.)	488,000 (4.05*)
Maximum Water Surface Elevation	ft., m.s.l.	554.59
Inflow peak	cfs	282,000
Outflow peak	cfs	150,000
Revised Probable Maximum Flood (1969):		
Duration (inflow)	Days	6**
Total volume	ac-ft(in.)	1,447,000 (12.24*)**
Maximum Water Surface Elevation	ft., m.s.l.	570.3**
Inflow peak	cfs	670,000**
Outflow peak	cfs	603,000**
Historic maximums:		
Maximum discharge on record	cfs	5,992
Date		2-22-80
Maximum water surface elevation	ft., m.s.l.(ac-ft)	528.0(111,316)
Date		2-22-80

* inches of runoff over watershed

** NOTE: Dam is over-topped

NEW PRADO DAM AND RESERVOIR
RIVERSIDE COUNTY, CALIFORNIA
PERTINENT DATA
(EXISTING PROJECT - Revised January 1993)

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 Poll (Flood Season)	ft., m.s.l.	494.0
(Non-flood Season)	ft., m.s.l.	505.0
Spillway Crest	ft., m.s.l.	543.0
Revised Standard Project Flood Level (1969)	ft., m.s.l.	554.6
Spillway Design Surcharge Level (1941)	ft;. m.s.l.	556.0
Top of Dam	ft., m.s.l.	566.0
Revised Probable Maximum Flood Level (1969)	ft., m.s.l.	570.3**
Area		
Debris Pool	acres	768
Buffer Pool (Flood Season)	acres	1,081
(Non-flood Season)	acres	2,123
Spillway Crest	acres	6,566
Revised Standard Project Flood Level (1969)	acres	8,485.3
Spillway Design Surcharge Level (1941)	acres	8,769.5
Top of Dam	acres	11,030
Revised Probable Maximum Flood Level (1969)	acres	11,900**
Capacity, Gross (1988 Survey)		
Debris Pool	ac-ft(in.)	4,689 (0.04*)
Buffer Pool (Flood Season)	ac-ft(in.)	8,437 (0.07*)
(Non-flood Season)	ac-ft(in.)	25,760 (0.2*)
Spillway Crest	ac-ft(in.)	187,700 (1.50*)
Revised Standard Project Flood Level (1969)	ac-ft(in.)	283,414 (2.36*)
Spillway Design Surcharge Level (1941)	ac-ft(in.)	295,581 (2.46*)
Top of Dam	ac-ft(in.)	383,500 (3.10*)
Revised Probable Maximum Flood Level (1969)	ac-ft(in.)	436,000 (3.62*)**
Allowance for Sediment (50-year)	ac-ft(in.)	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
Design Surcharge/Discharge (1941)	ft/cfs	13/181,000
Outlets:		
Uncontrolled (Note: Both uncontrolled outlets are plugged)		
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'H
Length	ft., m.s.l.	750
Maximum Capacity at Spillway Crest	cfs	17,000
Maximum Regulated Reservoir Release	cfs	5,000
Revised Standard Project Flood (1969):		
Duration (Inflow)	days	4
Total Volume	ac-ft(in.)	488,000 (4.05*)
Maximum Water Surface Elevation	ft., m.s.l.	554.59
Inflow Peak	cfs	282,000
Outflow Peak	cfs	150,000
Revised Probable Maximum Flood (1969):		
Duration (Inflow)	days	6**
Total Volume	ac-ft(in.)	1,447,000 (12.24*)**
Maximum Water Surface Elevation	ft., m.s.l.	570.3**
Inflow Peak	cfs	670,000**
Outflow Peak	cfs	603,000**
Historic Maximums:		
Maximum Discharge on Record	cfs	5,992
Date		2-22-80
Maximum Water Surface Elevation	ft., m.s.l. (ac-ft)	528.0 (111,316)
Date		2-22-80

* Inches of Runoff over Watershed
** Note: Dam is Over-topped

FIGURE 3-1. NEW PRADO DAM EMBANKMENT AND OUTLET WORKS
CONSTRUCTION SCHEDULE

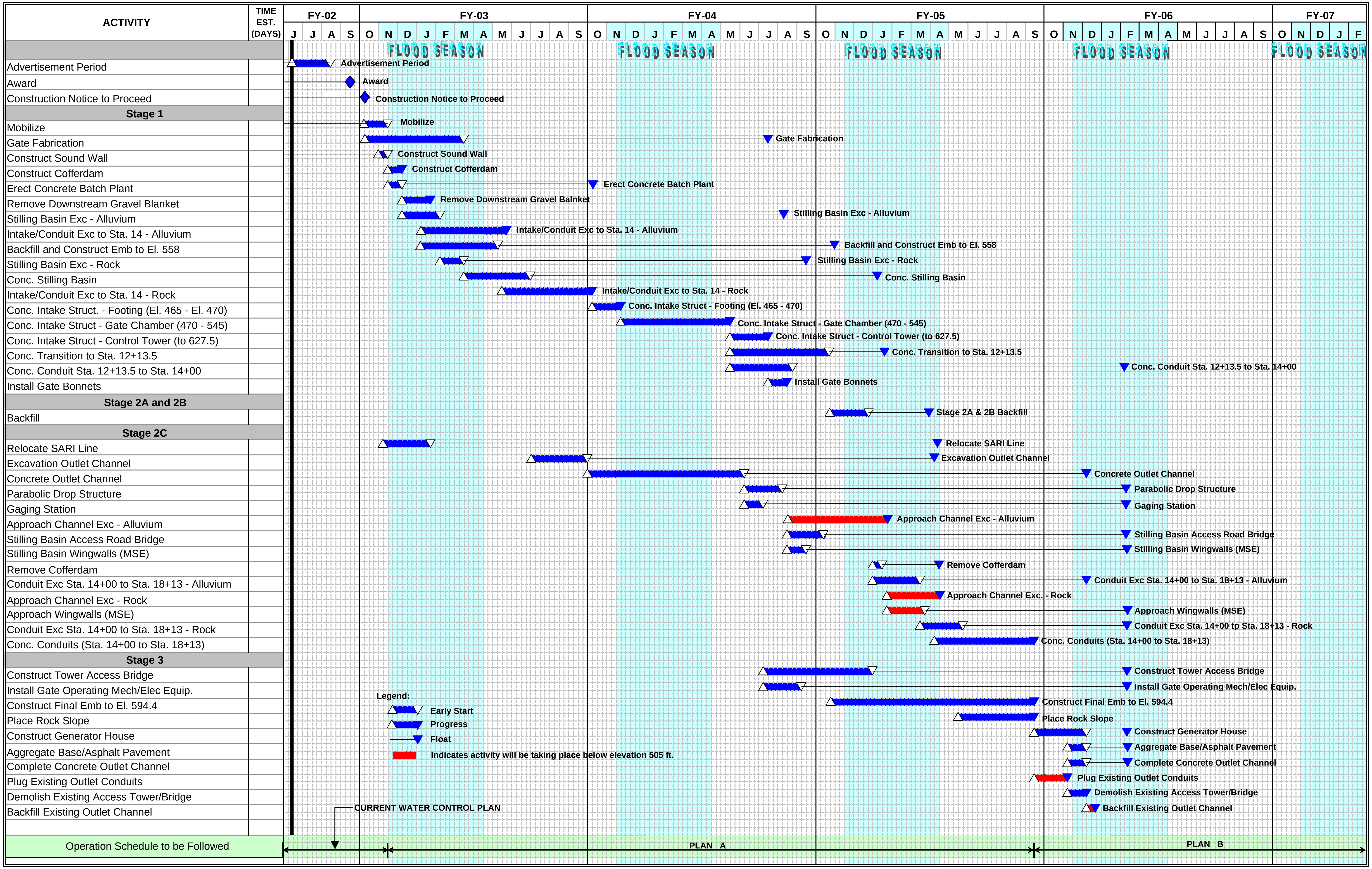
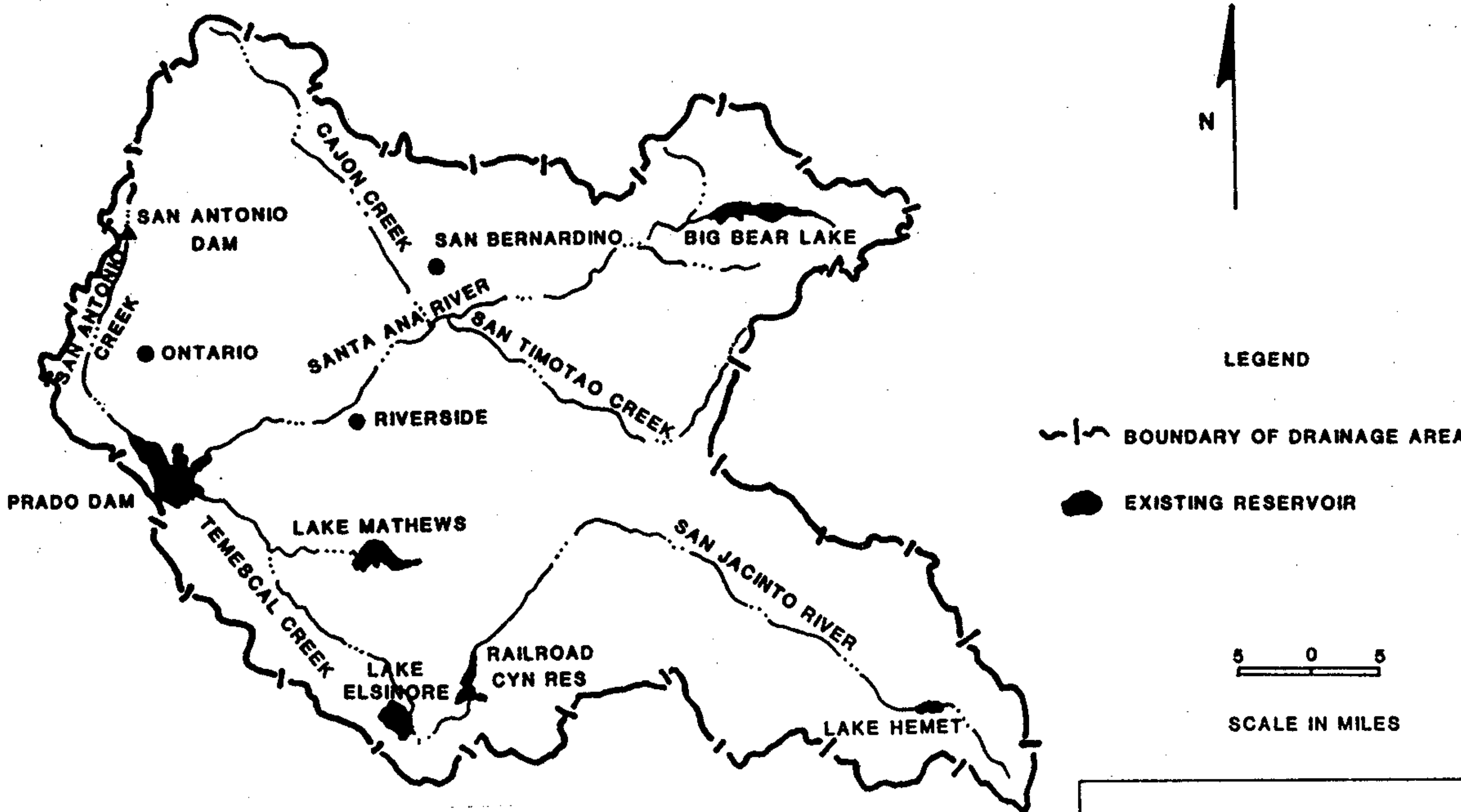


FIGURE 3-1

Notes:

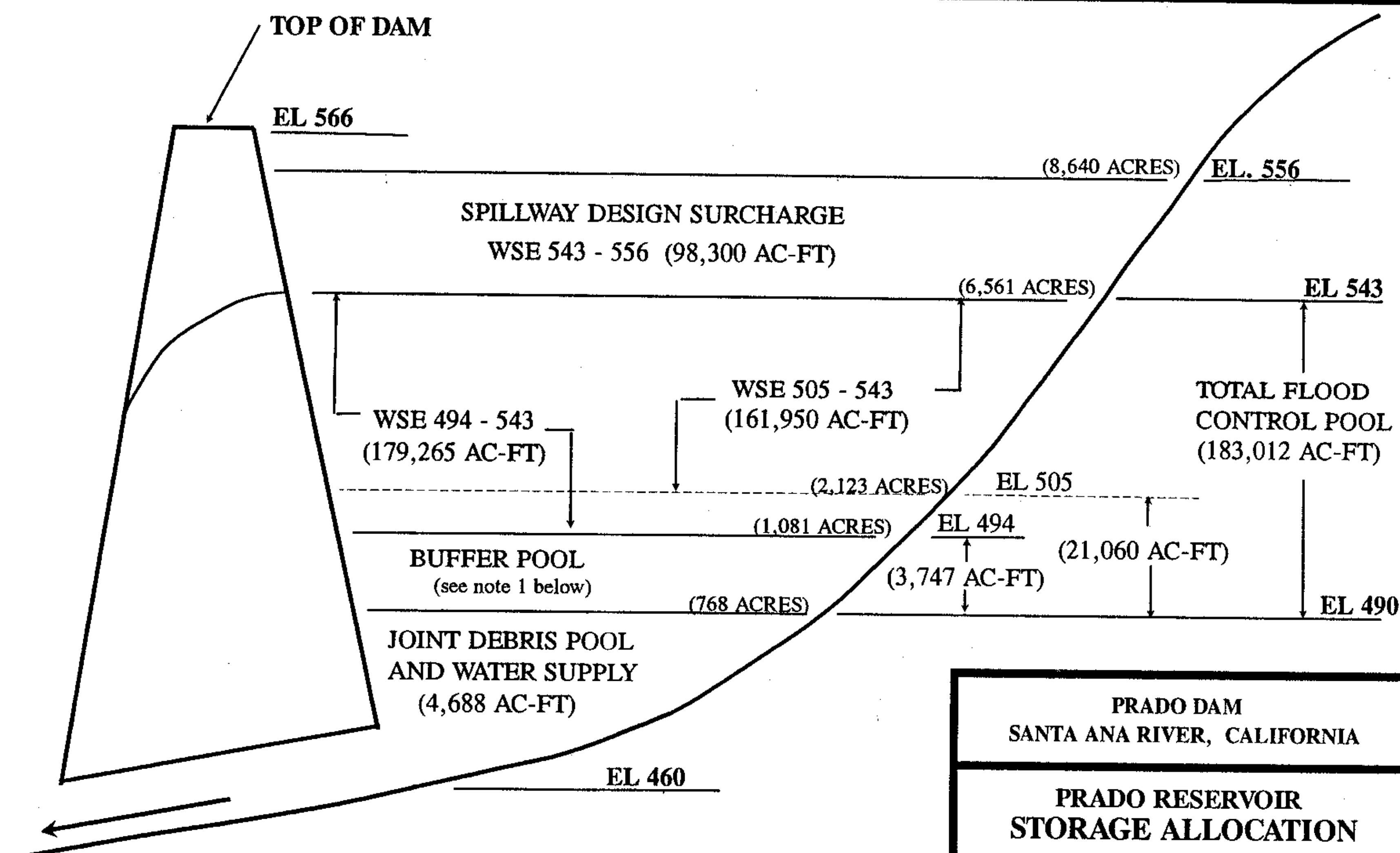
1. During the construction period when "PLAN A" will be followed, operation of the dam will be performed by using the existing outlet works and the height of the dam's embankment limited by the height of the coffer dam (El 525 ft).
2. During the construction period when "PLAN B" will be followed, operation of the dam will be performed by using the new outlet works and the dam's embankment restored back up to elevation 566 ft.
3. Construction years shown in this figure are independent from construction years shown on Figure 3-2.



PRADO DAM

DRAINAGE AREA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



NOTES:

1. BUFFER POOL - EL 494 DURING FLOOD SEASON (1 OCT - 28 FEB)
   - EL 505 DURING NON FLOOD SEASON (1 MAR - 30 SEP)
2. AREA AND STORAGE FIGURES - BASED ON 1988 RESERVOIR SURVEY.

PRADO DAM
SANTA ANA RIVER, CALIFORNIA

PRADO RESERVOIR
STORAGE ALLOCATION DIAGRAM

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Table 3-3

Elevations of Sites/Facilities at Prado Reservoir

Description	Elevation (ft)
OUTLET INVERT	**** 460 ****
Least Bell's vireo Nesting Habitat	460 - 566
Archeological and Historic Sites	480 - 566
Raahauge's Hunting Club	485 - 525
Club House	611
Splatter S Duck Club	485 520
Club House	520
TOP OF DEBRIS POOL	**** 490 ****
Prado Recreation, Inc. (Dog Training Facility)	490 - 504
Kennel/Trailer	554
Oil Wells	492 - 508
TOP OF BUFFER POOL	**** 494 ****
El Prado Golf Course	510 - 567
Club House	554
City of Corona Municipal Airport	514 - 534
Tiro Shooting Range	516 - 518
Prado Regional Park (San Bernardino Co.)	520 - 560
Camping Area	550 - 552
Archery Range	520 - 560
Prado Basin Park (Developed Area) Riverside Co.	525 - 573
Interpretation Center	573
Butterfield Park (City of Corona)	527 - 550
Bandini Adobe	534
Kobe Power Fluid Station	536
Chino Basin Water District (Waste Water Treatment Plant #2)	537 - 546
City of Corona Waste Water Percolation Ponds (Perimeter Levee)	540
SPILLWAY CREST	**** 543 ****
12 Unauthorized Dwellings	550 - 554
City of Corona Waste Water Treatment Plant (Road Entrance)	556
Oil Treating Facilities	560
California Institution for Women (State Prison)	560 - 572
Yorba Slaughter Adobe	560.2
2 Dwellings within the Corona National Tract	561 - 566
TOP OF DAM	**** 566 ****

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
467.0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.2	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.3	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.4	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.5	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.6	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
467.7	0	0	0	0	0	0	0	0	0	0
	0	0	1	1	1	1	1	1	1	1
467.8	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	1	1	1	1	1
467.9	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	1	1	1	1	1
468.0	0	0	0	0	0	0	0	0	0	0
	1	1	2	2	2	2	2	2	2	2
468.1	0	0	0	0	0	0	0	1	1	1
	2	2	2	2	2	2	2	2	2	2
468.2	1	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2	2
468.3	1	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2	2
468.4	1	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2	2
468.5	1	1	1	1	1	1	1	2	2	2
	2	2	2	2	2	2	2	2	2	2
468.6	2	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2
468.7	2	2	2	2	2	2	2	2	2	2
	2	2	3	3	3	3	3	3	3	3
468.8	2	2	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3	3	3
468.9	3	3	3	3	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3
469.0	3	3	3	3	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3
469.1	3	3	3	3	3	3	3	3	3	4
	3	3	3	3	3	3	3	3	3	3
469.2	4	4	4	4	4	4	4	4	4	4
	3	3	3	3	3	3	3	3	3	3
469.3	4	4	4	4	4	4	4	4	4	4
	3	3	3	3	3	3	3	3	3	3
469.4	4	4	4	4	4	5	5	5	5	5
	3	3	3	3	3	3	4	4	4	4

1988 SURVEY **Prado Dam**

ELEV FEET	AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09	CAP
469.5	5 4	5 4	5 4	5 4	5 4	5 4	5 4	5 4	5 4	5 4	
469.6	5 4	5 4	5 4	5 4	5 4	5 4	5 4	5 4	5 4	6 4	
469.7	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	
469.8	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	6 4	
469.9	6 4	6 4	7 4	7 4	7 4	7 4	7 4	7 4	7 4	7 4	
470.0	7 4	7 4	7 4	7 4	7 4	7 4	7 4	7 4	7 4	7 4	
470.1	7 4	7 5	7 5	8 5	8 5	8 5	8 5	8 5	8 5	8 5	
470.2	8 5	8 5	8 5	8 5	8 5	8 5	8 5	8 5	8 5	8 5	
470.3	8 5	8 5	9 5	9 5	9 5	9 5	9 5	9 5	9 5	9 5	
470.4	9 5	9 5	9 5	9 5	9 6	9 6	9 6	9 6	9 6	10 6	
470.5	10 6	10 6	10 6	10 6	10 6	10 6	10 6	10 6	10 6	10 6	
470.6	10 6	10 6	10 6	10 6	11 6	11 6	11 6	11 6	11 6	11 6	
470.7	11 6	11 6	11 6	11 6	11 6	11 7	11 7	11 7	11 7	12 7	
470.8	12 7	12 7	12 7	12 7	12 7	12 7	12 7	12 7	12 7	12 7	
470.9	12 7	12 7	13 7	13 7	13 7	13 7	13 7	13 7	13 7	13 7	
471.0	13 7	13 7	13 7	13 7	13 7	14 8	14 8	14 8	14 8	14 8	
471.1	14 8	14 8	14 8	14 8	14 8	14 8	14 8	15 8	15 8	15 8	
471.2	15 8	15 8	15 8	15 8	15 8	15 8	15 8	15 8	15 8	16 8	
471.3	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8	
471.4	16 8	17 8	17 8	17 8	17 8	17 8	17 8	17 8	17 8	17 8	
471.5	17 8	17 8	18 8	18 8	18 8	18 8	18 8	18 9	18 9	18 9	
471.6	18 9	18 9	18 9	19 9	19 9	19 9	19 9	19 9	19 9	19 9	
471.7	19 9	19 9	19 9	19 9	20 9	20 9	20 9	20 9	20 9	20 9	
471.8	20 9	20 9	20 9	20 9	20 9	21 9	21 9	21 9	21 9	21 9	
471.9	21 9	21 9	21 9	21 9	21 9	22 9	22 9	22 9	22 9	22 9	

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
472.0	22 9	22 9	22 9	22 9	22 9	23 10	23 10	23 10	23 10	23 10
472.1	23 10	23 10	23 10	23 10	23 10	24 10	24 10	24 10	24 10	24 10
472.2	24 10	24 10	24 10	24 10	24 10	25 10	25 10	25 10	25 10	25 10
472.3	25 10	25 10	25 10	25 10	26 10	26 10	26 10	26 10	26 10	26 10
472.4	26 11	26 11	26 11	27 11	27 11	27 11	27 11	27 11	27 11	27 11
472.5	27 11	27 11	28 11	28 11	28 11	28 11	28 11	28 11	28 11	28 11
472.6	28 11	29 11	29 11	29 11	29 11	29 11	29 11	29 11	29 11	30 11
472.7	30 11	30 11	30 11	30 12	30 12	30 12	30 12	30 12	31 12	31 12
472.8	31 12	31 12	31 12	31 12	31 12	31 12	32 12	32 12	32 12	32 12
472.9	32 12	32 12	32 12	32 12	33 12	33 12	33 12	33 12	33 12	33 12
473.0	33 12	33 12	34 12	34 12	34 12	34 13	34 13	34 13	34 13	35 13
473.1	35 13	35 13	35 13	35 13	35 13	35 13	35 13	36 13	36 13	36 13
473.2	36 13	36 13	36 13	36 13	37 13	37 13	37 13	37 13	37 13	37 13
473.3	37 13	38 13	38 13	38 14	38 14	38 14	38 14	38 14	38 14	39 14
473.4	39 14	39 14	39 14	39 14	39 14	39 14	40 14	40 14	40 14	40 14
473.5	40 14	40 14	41 14	41 14	41 14	41 14	41 14	41 14	41 14	42 14
473.6	42 15	42 15	42 15	42 15	42 15	42 15	43 15	43 15	43 15	43 15
473.7	43 15	43 15	44 15	44 15	44 15	44 15	44 15	44 15	44 15	45 15
473.8	45 15	45 15	45 15	45 15	45 15	46 15	46 16	46 16	46 16	46 16
473.9	46 16	47 16	47 16	47 16	47 16	47 16	47 16	48 16	48 16	48 16
474.0	48 16	48 16	48 16	49 16	49 16	49 17	49 17	49 17	49 17	50 17
474.1	50 17	50 17	50 17	50 17	50 18	51 18	51 18	51 18	51 18	51 18
474.2	52 18	52 18	52 18	52 19	52 19	52 19	53 19	53 19	53 19	53 19
474.3	53 19	54 19	54 20	54 20	54 20	54 20	55 20	55 20	55 20	55 20
474.4	56 20	56 21	56 21	56 21	56 21	57 21	57 21	57 21	57 21	57 21

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
474.5	58	58	58	58	59	59	59	59	59	60
	22	22	22	22	22	22	22	22	23	23
474.6	60	60	60	61	61	61	61	62	62	62
	23	23	23	23	23	23	24	24	24	24
474.7	62	63	63	63	63	64	64	64	64	65
	24	24	24	24	25	25	25	25	25	25
474.8	65	65	65	66	66	66	66	67	67	67
	25	25	26	26	26	26	26	26	26	26
474.9	67	68	68	68	69	69	69	69	70	70
	27	27	27	27	27	27	27	28	28	28
475.0	70	71	71	71	71	72	72	72	73	73
	28	28	28	28	28	28	28	28	28	29
475.1	73	73	74	74	74	75	75	75	75	76
	29	29	29	29	29	29	29	29	29	29
475.2	76	76	77	77	77	78	78	78	78	79
	29	29	29	30	30	30	30	30	30	30
475.3	79	79	80	80	80	81	81	81	82	82
	30	30	30	30	30	30	30	30	31	31
475.4	82	82	83	83	83	84	84	84	85	85
	31	31	31	31	31	31	31	31	31	31
475.5	85	86	86	86	87	87	87	88	88	88
	31	31	32	32	32	32	32	32	32	32
475.6	89	89	89	90	90	90	91	91	91	92
	32	32	32	32	32	32	33	33	33	33
475.7	92	92	93	93	93	94	94	94	95	95
	33	33	33	33	33	33	33	33	33	34
475.8	95	96	96	96	97	97	97	98	98	98
	34	34	34	34	34	34	34	34	34	34
475.9	99	99	99	100	100	100	101	101	102	102
	34	34	34	35	35	35	35	35	35	35
476.0	102	103	103	103	104	104	104	105	105	106
	35	35	35	36	36	36	36	36	36	37
476.1	106	106	107	107	107	108	108	109	109	109
	37	37	37	37	38	38	38	38	38	38
476.2	110	110	110	111	111	112	112	112	113	113
	39	39	39	39	39	39	40	40	40	40
476.3	114	114	115	115	115	116	116	117	117	117
	40	41	41	41	41	41	41	42	42	42
476.4	118	118	119	119	120	120	120	121	121	122
	42	42	43	43	43	43	43	44	44	44
476.5	122	123	123	124	124	124	125	125	126	126
	44	44	44	45	45	45	45	45	46	46
476.6	127	127	128	128	129	129	130	130	131	131
	46	46	46	47	47	47	47	47	48	48
476.7	132	132	133	133	134	134	134	135	135	136
	48	48	48	49	49	49	49	49	50	50
476.8	136	137	138	138	139	139	140	140	141	141
	50	50	50	51	51	51	51	51	52	52
476.9	142	142	143	143	144	144	145	145	146	146
	52	52	52	53	53	53	53	53	54	54

1988 SURVEY **Prado Dam**

ELEV FEET	AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
477.0	147	148	148	149	149	150	150	151	151	152
	54	54	54	54	55	55	55	55	55	55
477.1	153	153	154	154	155	155	156	156	157	158
	55	55	55	56	56	56	56	56	56	56
477.2	158	159	159	160	160	161	162	162	163	163
	56	57	57	57	57	57	57	57	57	57
477.3	164	164	165	166	166	167	167	168	169	169
	58	58	58	58	58	58	58	58	58	59
477.4	170	170	171	172	172	173	173	174	175	175
	59	59	59	59	59	59	59	60	60	60
477.5	176	176	177	178	178	179	179	180	181	181
	60	60	60	60	60	61	61	61	61	61
477.6	182	182	183	184	184	185	186	186	187	187
	61	61	61	61	62	62	62	62	62	62
477.7	188	189	189	190	191	191	192	192	193	194
	62	62	63	63	63	63	63	63	63	63
477.8	194	195	196	196	197	198	198	199	200	200
	64	64	64	64	64	64	64	64	64	65
477.9	201	202	202	203	203	204	205	205	206	207
	65	65	65	65	65	65	65	66	66	66
478.0	207	208	209	209	210	211	212	212	213	214
	66	66	67	67	68	68	68	69	69	69
478.1	214	215	216	216	217	218	219	219	220	221
	70	70	71	71	71	72	72	73	73	73
478.2	222	222	223	224	225	225	226	227	228	228
	74	74	75	75	75	76	76	77	77	77
478.3	229	230	231	232	232	233	234	235	236	236
	78	78	79	79	79	80	80	81	81	81
478.4	237	238	239	240	241	241	242	243	244	245
	82	82	83	83	84	84	84	85	85	86
478.5	246	246	247	248	249	250	251	252	253	254
	86	86	87	87	88	88	89	89	90	90
478.6	254	255	256	257	258	259	260	261	262	263
	90	91	91	92	92	93	93	93	94	94
478.7	264	265	266	267	268	269	270	271	272	273
	95	95	96	96	97	97	98	98	98	99
478.8	274	275	276	277	278	279	280	281	282	283
	99	100	100	101	101	102	102	103	103	104
478.9	284	285	286	287	288	289	290	291	292	293
	104	105	105	105	106	106	107	107	108	108
479.0	294	296	297	298	299	300	301	302	303	304
	109	109	109	109	110	110	110	110	110	110
479.1	305	307	308	309	310	311	312	313	314	316
	111	111	111	111	111	112	112	112	112	112
479.2	317	318	319	320	321	322	323	325	326	327
	113	113	113	113	113	113	114	114	114	114
479.3	328	329	330	332	333	334	335	336	337	338
	114	115	115	115	115	115	116	116	116	116
479.4	340	341	342	343	344	346	347	348	349	350
	116	116	117	117	117	117	117	118	118	118

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
479.5	351	353	354	355	356	357	359	360	361	362
	118	118	119	119	119	119	119	120	120	120
479.6	363	365	366	367	368	369	371	372	373	374
	120	120	121	121	121	121	121	122	122	122
479.7	376	377	378	379	380	382	383	384	385	387
	122	122	123	123	123	123	123	123	124	124
479.8	388	389	390	392	393	394	395	397	398	399
	124	124	124	125	125	125	125	125	126	126
479.9	400	402	403	404	406	407	408	409	411	412
	126	126	126	127	127	127	127	127	128	128
480.0	413	414	416	417	418	420	421	422	424	425
	128	129	129	130	130	131	132	132	133	133
480.1	426	428	429	430	432	433	435	436	437	439
	134	134	135	136	136	137	137	138	139	139
480.2	440	441	443	444	446	447	449	450	451	453
	140	140	141	142	142	143	143	144	145	145
480.3	454	456	457	459	460	462	463	465	466	468
	146	146	147	148	148	149	149	150	151	151
480.4	469	471	472	474	475	477	479	480	482	483
	152	153	153	154	154	155	156	156	157	158
480.5	485	486	488	490	491	493	495	496	498	499
	158	159	160	160	161	161	162	163	163	164
480.6	501	503	504	506	508	509	511	513	514	516
	165	165	166	167	167	168	169	169	170	171
480.7	518	520	521	523	525	527	528	530	532	534
	171	172	173	173	174	175	175	176	177	177
480.8	535	537	539	541	543	544	546	548	550	552
	178	179	179	180	181	181	182	183	183	184
480.9	554	555	557	559	561	563	565	567	569	571
	185	185	186	187	187	188	189	190	190	191
481.0	572	574	576	578	580	582	584	586	588	590
	192	192	192	192	193	193	193	194	194	194
481.1	592	594	596	598	600	602	604	606	607	609
	194	195	195	195	196	196	196	196	197	197
481.2	611	613	615	617	619	621	623	625	627	629
	197	198	198	198	198	199	199	199	200	200
481.3	631	633	635	637	639	641	643	645	648	650
	200	201	201	201	201	202	202	202	203	203
481.4	652	654	656	658	660	662	664	666	668	670
	203	203	204	204	204	205	205	205	206	206
481.5	672	674	676	678	680	682	685	687	689	691
	206	206	207	207	207	208	208	208	209	209
481.6	693	695	697	699	701	703	706	708	710	712
	209	209	210	210	210	211	211	211	212	212
481.7	714	716	718	720	723	725	727	729	731	733
	212	212	213	213	213	214	214	214	215	215
481.8	735	738	740	742	744	746	748	751	753	755
	215	215	216	216	216	217	217	217	218	218
481.9	757	759	761	764	766	768	770	772	775	777
	218	218	219	219	219	220	220	220	221	221

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
482.0	779 221	781 222	784 222	786 223	788 224	790 224	793 225	795 225	797 226	799 227
482.1	802 227	804 228	806 228	808 229	811 230	813 230	815 231	818 231	820 232	822 233
482.2	825 233	827 234	829 234	832 235	834 236	836 236	839 237	841 237	844 238	846 239
482.3	848 239	851 240	853 240	856 241	858 242	860 242	863 243	865 243	868 244	870 245
482.4	873 245	875 246	878 247	880 247	882 248	885 248	887 249	890 250	892 250	895 251
482.5	897 252	900 252	903 253	905 253	908 254	910 255	913 255	915 256	918 257	920 257
482.6	923 258	926 258	928 259	931 260	933 260	936 261	939 262	941 262	944 263	947 264
482.7	949 264	952 265	954 265	957 266	960 267	962 267	965 268	968 269	971 269	973 270
482.8	976 271	979 271	981 272	984 273	987 273	990 274	992 275	995 275	998 276	1001 277
482.9	1004 277	1007 278	1009 278	1012 279	1015 280	1018 280	1021 281	1023 282	1026 282	1029 283
483.0	1032 284	1035 284	1038 284	1040 285	1043 285	1046 285	1049 286	1052 286	1055 286	1058 287
483.1	1061 287	1063 287	1066 288	1069 288	1072 288	1075 289	1078 289	1081 289	1084 290	1087 290
483.2	1089 290	1092 291	1095 291	1098 291	1101 292	1104 292	1107 292	1110 293	1113 293	1116 294
483.3	1119 294	1122 294	1125 295	1128 295	1130 295	1133 296	1136 296	1139 296	1142 297	1145 297
483.4	1148 297	1151 298	1154 298	1157 298	1160 299	1163 299	1166 299	1169 300	1172 300	1175 300
483.5	1178 301	1181 301	1184 301	1187 302	1190 302	1193 302	1196 303	1199 303	1202 303	1205 304
483.6	1209 304	1212 304	1215 305	1218 305	1221 306	1224 306	1227 306	1230 307	1233 307	1236 307
483.7	1239 308	1242 308	1245 308	1248 309	1252 309	1255 309	1258 310	1261 310	1264 310	1267 311
483.8	1270 311	1273 311	1276 312	1279 312	1283 312	1286 313	1289 313	1292 314	1295 314	1298 314
483.9	1301 315	1305 315	1308 315	1311 316	1314 316	1317 316	1320 317	1324 317	1327 317	1330 318
484.0	1333 318	1336 319	1340 320	1343 321	1346 322	1349 323	1352 324	1356 325	1359 326	1362 327
484.1	1366 329	1369 330	1372 331	1375 332	1379 333	1382 334	1385 335	1389 336	1392 337	1396 338
484.2	1399 339	1402 340	1406 341	1409 342	1413 343	1416 344	1420 345	1423 346	1426 348	1430 349
484.3	1433 350	1437 351	1440 352	1444 353	1448 354	1451 355	1455 356	1458 357	1462 358	1465 359
484.4	1469 361	1473 362	1476 363	1480 364	1484 365	1487 366	1491 367	1495 368	1498 369	1502 370

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
484.5	1506	1509	1513	1517	1521	1524	1528	1532	1536	1540
	372	373	374	375	376	377	378	379	381	382
484.6	1543	1547	1551	1555	1559	1563	1567	1571	1574	1578
	383	384	385	386	387	388	390	391	392	393
484.7	1582	1586	1590	1594	1598	1602	1606	1610	1614	1618
	394	395	396	398	399	400	401	402	403	404
484.8	1622	1626	1630	1635	1639	1643	1647	1651	1655	1659
	406	407	408	409	410	411	413	414	415	416
484.9	1664	1668	1672	1676	1680	1685	1689	1693	1697	1702
	417	418	420	421	422	423	424	426	427	428
485.0	1706	1710	1714	1719	1723	1727	1732	1736	1740	1745
	429	429	430	430	431	431	431	432	432	433
485.1	1749	1753	1758	1762	1766	1771	1775	1779	1784	1788
	433	433	434	434	435	435	435	436	436	437
485.2	1793	1797	1801	1806	1810	1814	1819	1823	1828	1832
	437	437	438	438	438	439	439	440	440	440
485.3	1837	1841	1845	1850	1854	1859	1863	1868	1872	1876
	441	441	442	442	442	443	443	444	444	444
485.4	1881	1885	1890	1894	1899	1903	1908	1912	1917	1921
	445	445	446	446	446	447	447	448	448	448
485.5	1926	1930	1935	1939	1944	1948	1953	1957	1962	1966
	449	449	450	450	450	451	451	452	452	452
485.6	1971	1975	1980	1984	1989	1993	1998	2003	2007	2012
	453	453	454	454	454	455	455	456	456	456
485.7	2016	2021	2025	2030	2035	2039	2044	2048	2053	2058
	457	457	458	458	458	459	459	460	460	461
485.8	2062	2067	2071	2076	2081	2085	2090	2095	2099	2104
	461	461	462	462	463	463	463	464	464	465
485.9	2109	2113	2118	2123	2127	2132	2137	2141	2146	2151
	465	465	466	466	467	467	467	468	468	469
486.0	2155	2160	2165	2169	2174	2179	2184	2188	2193	2198
	469	470	471	472	473	474	475	476	477	478
486.1	2203	2208	2212	2217	2222	2227	2232	2237	2241	2246
	479	480	481	482	483	484	485	486	487	488
486.2	2251	2256	2261	2266	2271	2276	2281	2286	2291	2296
	489	490	491	492	493	494	495	496	497	498
486.3	2301	2306	2311	2316	2321	2326	2331	2336	2341	2346
	499	500	501	502	503	504	505	506	507	508
486.4	2351	2356	2361	2366	2371	2377	2382	2387	2392	2397
	509	510	511	512	513	514	515	516	517	518
486.5	2402	2408	2413	2418	2423	2429	2434	2439	2444	2450
	519	520	521	522	523	524	525	526	527	528
486.6	2455	2460	2465	2471	2476	2481	2487	2492	2498	2503
	529	530	531	532	533	534	535	536	537	538
486.7	2508	2514	2519	2525	2530	2535	2541	2546	2552	2557
	540	541	542	543	544	545	546	547	548	549
486.8	2563	2568	2574	2579	2585	2591	2596	2602	2607	2613
	550	551	552	553	554	555	556	557	558	559
486.9	2618	2624	2630	2635	2641	2647	2652	2658	2664	2669
	561	562	563	564	565	566	567	568	569	570

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
487.0	2675	2681	2687	2692	2698	2704	2709	2715	2721	2727
	571	572	572	572	573	573	574	574	575	575
487.1	2732	2738	2744	2750	2756	2761	2767	2773	2779	2784
	576	576	576	577	577	578	578	579	579	580
487.2	2790	2796	2802	2808	2814	2819	2825	2831	2837	2843
	580	580	581	581	582	582	583	583	584	584
487.3	2849	2854	2860	2866	2872	2878	2884	2890	2896	2901
	584	585	585	586	586	587	587	588	588	588
487.4	2907	2913	2919	2925	2931	2937	2943	2949	2955	2961
	589	589	590	590	591	591	592	592	593	593
487.5	2966	2972	2978	2984	2990	2996	3002	3008	3014	3020
	593	594	594	595	595	596	596	597	597	597
487.6	3026	3032	3038	3044	3050	3056	3062	3068	3074	3080
	598	598	599	599	600	600	601	601	602	602
487.7	3086	3092	3098	3104	3110	3116	3122	3128	3135	3141
	602	603	603	604	604	605	605	606	606	607
487.8	3147	3153	3159	3165	3171	3177	3183	3189	3195	3202
	607	607	608	608	609	609	610	610	611	611
487.9	3208	3214	3220	3226	3232	3238	3244	3251	3257	3263
	612	612	612	613	613	614	614	615	615	616
488.0	3269	3275	3281	3288	3294	3300	3306	3313	3319	3325
	616	617	618	619	620	622	623	624	625	626
488.1	3331	3338	3344	3350	3356	3363	3369	3375	3382	3388
	627	628	629	630	631	632	633	635	636	637
488.2	3395	3401	3407	3414	3420	3427	3433	3440	3446	3452
	638	639	640	641	642	643	644	646	647	648
488.3	3459	3465	3472	3478	3485	3492	3498	3505	3511	3518
	649	650	651	652	653	654	655	657	658	659
488.4	3524	3531	3538	3544	3551	3558	3564	3571	3578	3584
	660	661	662	663	664	665	667	668	669	670
488.5	3591	3598	3604	3611	3618	3625	3632	3638	3645	3652
	671	672	673	674	675	677	678	679	680	681
488.6	3659	3666	3672	3679	3686	3693	3700	3707	3714	3721
	682	683	685	686	687	688	689	690	691	692
488.7	3728	3735	3741	3748	3755	3762	3769	3776	3783	3790
	694	695	696	697	698	699	700	702	703	704
488.8	3798	3805	3812	3819	3826	3833	3840	3847	3854	3861
	705	706	707	708	710	711	712	713	714	715
488.9	3869	3876	3883	3890	3897	3905	3912	3919	3926	3934
	717	718	719	720	721	722	723	725	726	727
489.0	3941	3948	3956	3963	3970	3977	3985	3992	3999	4007
	728	728	729	729	730	730	730	731	731	732
489.1	4014	4021	4029	4036	4043	4051	4058	4065	4073	4080
	732	732	733	733	734	734	734	735	735	735
489.2	4087	4095	4102	4110	4117	4124	4132	4139	4146	4154
	736	736	737	737	737	738	738	739	739	739
489.3	4161	4169	4176	4183	4191	4198	4206	4213	4221	4228
	740	740	741	741	741	742	742	743	743	743
489.4	4236	4243	4250	4258	4265	4273	4280	4288	4295	4303
	744	744	745	745	745	746	746	746	747	747

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
489.5	4310	4318	4325	4333	4340	4348	4355	4363	4370	4378
	748	748	748	749	749	750	750	750	751	751
489.6	4385	4393	4400	4408	4415	4423	4430	4438	4445	4453
	752	752	752	753	753	754	754	754	755	755
489.7	4461	4468	4476	4483	4491	4498	4506	4514	4521	4529
	756	756	756	757	757	758	758	758	759	759
489.8	4536	4544	4552	4559	4567	4574	4582	4590	4597	4605
	760	760	760	761	761	762	762	762	763	763
489.9	4613	4620	4628	4636	4643	4651	4658	4666	4674	4681
	764	764	764	765	765	766	766	766	767	767
490.0	4689	4697	4705	4712	4720	4728	4735	4743	4751	4759
	768	769	770	771	772	773	774	775	776	777
490.1	4766	4774	4782	4790	4798	4806	4813	4821	4829	4837
	778	779	780	781	782	783	784	785	786	787
490.2	4845	4853	4861	4869	4876	4884	4892	4900	4908	4916
	788	789	790	791	792	793	794	795	796	797
490.3	4924	4932	4940	4948	4956	4964	4972	4980	4988	4996
	798	799	800	801	802	803	804	805	807	808
490.4	5005	5013	5021	5029	5037	5045	5053	5061	5070	5078
	809	810	811	812	813	814	815	816	817	818
490.5	5086	5094	5102	5111	5119	5127	5135	5144	5152	5160
	819	820	821	822	823	824	825	826	827	828
490.6	5168	5177	5185	5193	5202	5210	5218	5227	5235	5244
	829	830	832	833	834	835	836	837	838	839
490.7	5252	5260	5269	5277	5286	5294	5303	5311	5320	5328
	840	841	842	843	844	845	846	847	848	850
490.8	5337	5345	5354	5362	5371	5379	5388	5396	5405	5414
	851	852	853	854	855	856	857	858	859	860
490.9	5422	5431	5439	5448	5457	5465	5474	5483	5491	5500
	861	862	863	864	866	867	868	869	870	871
491.0	5509	5518	5526	5535	5544	5553	5561	5570	5579	5588
	872	872	873	873	874	874	875	875	876	876
491.1	5596	5605	5614	5623	5632	5640	5649	5658	5667	5676
	877	877	878	878	878	879	879	880	880	881
491.2	5684	5693	5702	5711	5720	5728	5737	5746	5755	5764
	881	882	882	883	883	884	884	885	885	886
491.3	5773	5782	5791	5799	5808	5817	5826	5835	5844	5853
	886	887	887	887	888	888	889	889	890	890
491.4	5862	5871	5879	5888	5897	5906	5915	5924	5933	5942
	891	891	892	892	893	893	894	894	895	895
491.5	5951	5960	5969	5978	5987	5996	6005	6014	6023	6032
	896	896	897	897	897	898	898	899	899	900
491.6	6041	6050	6059	6068	6077	6086	6095	6104	6113	6122
	900	901	901	902	902	903	903	904	904	905
491.7	6131	6140	6149	6158	6167	6177	6186	6195	6204	6213
	905	906	906	907	907	908	908	908	909	909
491.8	6222	6231	6240	6249	6258	6268	6277	6286	6295	6304
	910	910	911	911	912	912	913	913	914	914
491.9	6313	6322	6332	6341	6350	6359	6368	6377	6387	6396
	915	915	916	916	917	917	918	918	919	919

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Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
492.0	6405	6414	6423	6433	6442	6451	6460	6470	6479	6488
	920	921	922	923	924	925	926	927	928	929
492.1	6498	6507	6516	6526	6535	6544	6554	6563	6572	6582
	931	932	933	934	935	936	937	938	939	940
492.2	6591	6601	6610	6620	6629	6638	6648	6657	6667	6676
	942	943	944	945	946	947	948	949	950	951
492.3	6686	6696	6705	6715	6724	6734	6743	6753	6763	6772
	953	954	955	956	957	958	959	960	961	963
492.4	6782	6792	6801	6811	6821	6830	6840	6850	6859	6869
	964	965	966	967	968	969	970	971	973	974
492.5	6879	6889	6898	6908	6918	6928	6938	6947	6957	6967
	975	976	977	978	979	980	982	983	984	985
492.6	6977	6987	6997	7007	7017	7026	7036	7046	7056	7066
	986	987	988	989	991	992	993	994	995	996
492.7	7076	7086	7096	7106	7116	7126	7136	7146	7156	7166
	997	998	1000	1001	1002	1003	1005	1006	1007	1008
492.8	7177	7187	7197	7207	7217	7227	7237	7247	7258	7268
	1009	1010	1011	1013	1014	1015	1016	1017	1018	1019
492.9	7278	7288	7298	7309	7319	7329	7339	7350	7360	7370
	1021	1022	1023	1024	1025	1026	1027	1029	1030	1031
493.0	7381	7391	7401	7412	7422	7432	7443	7453	7463	7474
	1032	1032	1033	1033	1034	1034	1035	1035	1036	1036
493.1	7484	7494	7505	7515	7526	7536	7546	7557	7567	7578
	1037	1037	1038	1038	1039	1039	1040	1040	1041	1041
493.2	7588	7598	7609	7619	7630	7640	7651	7661	7672	7682
	1042	1042	1043	1043	1044	1044	1045	1045	1046	1046
493.3	7692	7703	7713	7724	7734	7745	7755	7766	7776	7787
	1047	1047	1047	1048	1048	1049	1049	1050	1050	1051
493.4	7797	7808	7818	7829	7839	7850	7861	7871	7882	7892
	1051	1052	1052	1053	1053	1054	1054	1055	1055	1056
493.5	7903	7913	7924	7934	7945	7956	7966	7977	7987	7998
	1056	1057	1057	1058	1058	1059	1059	1060	1060	1061
493.6	8009	8019	8030	8040	8051	8062	8072	8083	8094	8104
	1061	1062	1062	1063	1063	1064	1064	1065	1065	1066
493.7	8115	8126	8136	8147	8158	8168	8179	8190	8200	8211
	1066	1067	1067	1068	1068	1069	1069	1070	1070	1071
493.8	8222	8233	8243	8254	8265	8275	8286	8297	8308	8318
	1071	1071	1072	1072	1073	1073	1074	1074	1075	1075
493.9	8329	8340	8351	8362	8372	8383	8394	8405	8415	8426
	1076	1076	1077	1077	1078	1078	1079	1079	1080	1080
494.0	8437	8448	8459	8470	8480	8491	8502	8513	8524	8535
	1081	1082	1083	1084	1085	1085	1086	1087	1088	1089
494.1	8546	8557	8567	8578	8589	8600	8611	8622	8633	8644
	1090	1091	1092	1093	1094	1094	1095	1096	1097	1098
494.2	8655	8666	8677	8688	8699	8710	8721	8732	8743	8754
	1099	1100	1101	1102	1103	1104	1104	1105	1106	1107
494.3	8765	8777	8788	8799	8810	8821	8832	8843	8854	8866
	1108	1109	1110	1111	1112	1113	1114	1115	1115	1116
494.4	8877	8888	8899	8910	8921	8933	8944	8955	8966	8978
	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
494.5	8989	9000	9011	9023	9034	9045	9057	9068	9079	9091
	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135
494.6	9102	9113	9125	9136	9148	9159	9170	9182	9193	9205
	1136	1137	1138	1138	1139	1140	1141	1142	1143	1144
494.7	9216	9228	9239	9250	9262	9273	9285	9296	9308	9319
	1145	1146	1147	1148	1149	1150	1150	1151	1152	1153
494.8	9331	9343	9354	9366	9377	9389	9400	9412	9424	9435
	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163
494.9	9447	9459	9470	9482	9494	9505	9517	9529	9540	9552
	1164	1164	1165	1166	1167	1168	1169	1170	1171	1172
495.0	9564	9575	9587	9599	9611	9622	9634	9646	9658	9669
	1173	1173	1174	1174	1175	1175	1176	1176	1177	1177
495.1	9681	9693	9705	9717	9728	9740	9752	9764	9776	9787
	1177	1178	1178	1179	1179	1180	1180	1181	1181	1182
495.2	9799	9811	9823	9835	9847	9858	9870	9882	9894	9906
	1182	1183	1183	1184	1184	1185	1185	1185	1186	1186
495.3	9918	9930	9941	9953	9965	9977	9989	10000	10010	10020
	1187	1187	1188	1188	1189	1189	1190	1190	1191	1191
495.4	10040	10050	10060	10070	10080	10100	10110	10120	10130	10140
	1192	1192	1193	1193	1193	1194	1194	1195	1195	1196
495.5	10160	10170	10180	10190	10200	10220	10230	10240	10250	10260
	1196	1197	1197	1198	1198	1199	1199	1200	1200	1201
495.6	10280	10290	10300	10310	10320	10340	10350	10360	10370	10380
	1201	1201	1202	1202	1203	1203	1204	1204	1205	1205
495.7	10400	10410	10420	10430	10440	10460	10470	10480	10490	10500
	1206	1206	1207	1207	1208	1208	1209	1209	1210	1210
495.8	10520	10530	10540	10550	10570	10580	10590	10600	10610	10630
	1210	1211	1211	1212	1212	1213	1213	1214	1214	1215
495.9	10640	10650	10660	10670	10690	10700	10710	10720	10740	10750
	1215	1216	1216	1217	1217	1218	1218	1219	1219	1220
496.0	10760	10770	10780	10800	10810	10820	10830	10850	10860	10870
	1220	1222	1223	1225	1226	1228	1229	1231	1232	1234
496.1	10880	10900	10910	10920	10930	10940	10960	10970	10980	10990
	1235	1237	1238	1240	1242	1243	1245	1246	1248	1249
496.2	11010	11020	11030	11040	11060	11070	11080	11100	11110	11120
	1251	1252	1254	1255	1257	1258	1260	1261	1263	1265
496.3	11130	11150	11160	11170	11180	11200	11210	11220	11230	11250
	1266	1268	1269	1271	1272	1274	1275	1277	1279	1280
496.4	11260	11270	11290	11300	11310	11320	11340	11350	11360	11380
	1282	1283	1285	1286	1288	1289	1291	1293	1294	1296
496.5	11390	11400	11420	11430	11440	11450	11470	11480	11490	11510
	1297	1299	1300	1302	1303	1305	1307	1308	1310	1311
496.6	11520	11530	11550	11560	11570	11590	11600	11610	11630	11640
	1313	1314	1316	1318	1319	1321	1322	1324	1326	1327
496.7	11650	11670	11680	11690	11710	11720	11730	11750	11760	11770
	1329	1330	1332	1333	1335	1337	1338	1340	1341	1343
496.8	11790	11800	11810	11830	11840	11850	11870	11880	11890	11910
	1345	1346	1348	1349	1351	1353	1354	1356	1357	1359
496.9	11920	11930	11950	11960	11980	11990	12000	12020	12030	12040
	1361	1362	1364	1365	1367	1369	1370	1372	1373	1375

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
497.0	12060	12070	12090	12100	12110	12130	12140	12150	12170	12180
	1376	1377	1378	1378	1379	1379	1380	1380	1381	1381
497.1	12200	12210	12220	12240	12250	12260	12280	12290	12310	12320
	1382	1383	1383	1384	1384	1385	1385	1386	1387	1387
497.2	12330	12350	12360	12380	12390	12400	12420	12430	12450	12460
	1388	1388	1389	1389	1390	1390	1391	1392	1392	1393
497.3	12470	12490	12500	12520	12530	12540	12560	12570	12580	12600
	1393	1394	1394	1395	1396	1396	1397	1397	1398	1398
497.4	12610	12630	12640	12650	12670	12680	12700	12710	12720	12740
	1399	1399	1400	1401	1401	1402	1402	1403	1403	1404
497.5	12750	12770	12780	12800	12810	12820	12840	12850	12870	12880
	1405	1405	1406	1406	1407	1407	1408	1409	1409	1410
497.6	12890	12910	12920	12940	12950	12960	12980	12990	13010	13020
	1410	1411	1411	1412	1413	1413	1414	1414	1415	1415
497.7	13040	13050	13060	13080	13090	13110	13120	13130	13150	13160
	1416	1416	1417	1418	1418	1419	1419	1420	1420	1421
497.8	13180	13190	13210	13220	13230	13250	13260	13280	13290	13310
	1422	1422	1423	1423	1424	1424	1425	1426	1426	1427
497.9	13320	13330	13350	13360	13380	13390	13410	13420	13430	13450
	1427	1428	1428	1429	1430	1430	1431	1431	1432	1432
498.0	13460	13480	13490	13510	13520	13530	13550	13560	13580	13590
	1433	1434	1435	1437	1438	1439	1440	1441	1442	1443
498.1	13610	13620	13640	13650	13660	13680	13690	13710	13720	13740
	1445	1446	1447	1448	1449	1450	1451	1453	1454	1455
498.2	13750	13770	13780	13800	13810	13820	13840	13850	13870	13880
	1456	1457	1458	1460	1461	1462	1463	1464	1465	1466
498.3	13900	13910	13930	13940	13960	13970	13990	14000	14020	14030
	1468	1469	1470	1471	1472	1473	1475	1476	1477	1478
498.4	14050	14060	14070	14090	14100	14120	14130	14150	14160	14180
	1479	1480	1482	1483	1484	1485	1486	1487	1489	1490
498.5	14190	14210	14220	14240	14250	14270	14280	14300	14310	14330
	1491	1492	1493	1494	1496	1497	1498	1499	1500	1501
498.6	14340	14360	14370	14390	14400	14420	14430	14450	14460	14480
	1503	1504	1505	1506	1507	1508	1510	1511	1512	1513
498.7	14490	14510	14520	14540	14550	14570	14590	14600	14620	14630
	1514	1515	1517	1518	1519	1520	1521	1523	1524	1525
498.8	14650	14660	14680	14690	14710	14720	14740	14750	14770	14780
	1526	1527	1528	1530	1531	1532	1533	1534	1536	1537
498.9	14800	14810	14830	14850	14860	14880	14890	14910	14920	14940
	1538	1539	1540	1541	1543	1544	1545	1546	1547	1549
499.0	14950	14970	14980	15000	15020	15030	15050	15060	15080	15090
	1550	1550	1550	1551	1551	1552	1552	1553	1553	1553
499.1	15110	15120	15140	15160	15170	15190	15200	15220	15230	15250
	1554	1554	1555	1555	1556	1556	1556	1557	1557	1558
499.2	15260	15280	15300	15310	15330	15340	15360	15370	15390	15400
	1558	1559	1559	1559	1560	1560	1561	1561	1562	1562
499.3	15420	15440	15450	15470	15480	15500	15510	15530	15550	15560
	1562	1563	1563	1564	1564	1565	1565	1565	1566	1566
499.4	15580	15590	15610	15620	15640	15660	15670	15690	15700	15720
	1567	1567	1568	1568	1568	1569	1569	1570	1570	1571

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
499.5	15730	15750	15770	15780	15800	15810	15830	15840	15860	15880
	1571	1571	1572	1572	1573	1573	1574	1574	1574	1575
499.6	15890	15910	15920	15940	15950	15970	15990	16000	16020	16030
	1575	1576	1576	1577	1577	1578	1578	1578	1579	1579
499.7	16050	16060	16080	16100	16110	16130	16140	16160	16180	16190
	1580	1580	1581	1581	1581	1582	1582	1583	1583	1584
499.8	16210	16220	16240	16250	16270	16290	16300	16320	16330	16350
	1584	1584	1585	1585	1586	1586	1587	1587	1587	1588
499.9	16370	16380	16400	16410	16430	16450	16460	16480	16490	16510
	1588	1589	1589	1590	1590	1590	1591	1591	1592	1592
500.0	16520	16540	16560	16570	16590	16600	16620	16640	16650	16670
	1593	1594	1596	1597	1598	1600	1601	1603	1604	1605
500.1	16680	16700	16720	16730	16750	16770	16780	16800	16810	16830
	1607	1608	1610	1611	1612	1614	1615	1617	1618	1619
500.2	16850	16860	16880	16890	16910	16930	16940	16960	16980	16990
	1621	1622	1624	1625	1626	1628	1629	1631	1632	1633
500.3	17010	17030	17040	17060	17070	17090	17110	17120	17140	17160
	1635	1636	1638	1639	1641	1642	1643	1645	1646	1648
500.4	17170	17190	17210	17220	17240	17260	17270	17290	17310	17320
	1649	1650	1652	1653	1655	1656	1658	1659	1660	1662
500.5	17340	17360	17370	17390	17410	17420	17440	17460	17470	17490
	1663	1665	1666	1668	1669	1670	1672	1673	1675	1676
500.6	17510	17520	17540	17560	17570	17590	17610	17620	17640	17660
	1678	1679	1680	1682	1683	1685	1686	1688	1689	1690
500.7	17670	17690	17710	17730	17740	17760	17780	17790	17810	17830
	1692	1693	1695	1696	1698	1699	1700	1702	1703	1705
500.8	17840	17860	17880	17900	17910	17930	17950	17960	17980	18000
	1706	1708	1709	1711	1712	1713	1715	1716	1718	1719
500.9	18020	18030	18050	18070	18080	18100	18120	18140	18150	18170
	1721	1722	1724	1725	1726	1728	1729	1731	1732	1734
501.0	18190	18210	18220	18240	18260	18280	18290	18310	18330	18340
	1735	1735	1736	1736	1737	1737	1738	1738	1739	1739
501.1	18360	18380	18400	18410	18430	18450	18470	18480	18500	18520
	1740	1740	1741	1741	1742	1742	1743	1743	1744	1744
501.2	18540	18550	18570	18590	18610	18620	18640	18660	18680	18690
	1744	1745	1745	1746	1746	1747	1747	1748	1748	1749
501.3	18710	18730	18750	18760	18780	18800	18820	18830	18850	18870
	1749	1750	1750	1751	1751	1752	1752	1753	1753	1753
501.4	18890	18900	18920	18940	18960	18970	18990	19010	19030	19040
	1754	1754	1755	1755	1756	1756	1757	1757	1758	1758
501.5	19060	19080	19100	19110	19130	19150	19170	19190	19200	19220
	1759	1759	1760	1760	1761	1761	1762	1762	1763	1763
501.6	19240	19260	19270	19290	19310	19330	19340	19360	19380	19400
	1764	1764	1764	1765	1765	1766	1766	1767	1767	1768
501.7	19410	19430	19450	19470	19490	19500	19520	19540	19560	19570
	1768	1769	1769	1770	1770	1771	1771	1772	1772	1773
501.8	19590	19610	19630	19640	19660	19680	19700	19720	19730	19750
	1773	1774	1774	1775	1775	1775	1776	1776	1777	1777
501.9	19770	19790	19800	19820	19840	19860	19880	19890	19910	19930
	1778	1778	1779	1779	1780	1780	1781	1781	1782	1782

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
502.0	19950	19970	19980	20000	20020	20040	20050	20070	20090	20110
	1783	1784	1785	1786	1787	1788	1790	1791	1792	1793
502.1	20130	20140	20160	20180	20200	20220	20230	20250	20270	20290
	1794	1795	1796	1797	1799	1800	1801	1802	1803	1804
502.2	20310	20320	20340	20360	20380	20400	20410	20430	20450	20470
	1805	1807	1808	1809	1810	1811	1812	1813	1815	1816
502.3	20490	20510	20520	20540	20560	20580	20600	20610	20630	20650
	1817	1818	1819	1820	1821	1823	1824	1825	1826	1827
502.4	20670	20690	20710	20720	20740	20760	20780	20800	20820	20830
	1828	1829	1831	1832	1833	1834	1835	1836	1837	1839
502.5	20850	20870	20890	20910	20930	20950	20960	20980	21000	21020
	1840	1841	1842	1843	1844	1845	1847	1848	1849	1850
502.6	21040	21060	21070	21090	21110	21130	21150	21170	21190	21200
	1851	1852	1853	1855	1856	1857	1858	1859	1860	1862
502.7	21220	21240	21260	21280	21300	21320	21340	21350	21370	21390
	1863	1864	1865	1866	1867	1868	1870	1871	1872	1873
502.8	21410	21430	21450	21470	21490	21500	21520	21540	21560	21580
	1874	1875	1877	1878	1879	1880	1881	1882	1884	1885
502.9	21600	21620	21640	21650	21670	21690	21710	21730	21750	21770
	1886	1887	1888	1889	1890	1892	1893	1894	1895	1896
503.0	21790	21810	21830	21840	21860	21880	21900	21920	21940	21960
	1897	1898	1899	1899	1900	1901	1901	1902	1902	1903
503.1	21980	22000	22020	22030	22050	22070	22090	22110	22130	22150
	1904	1904	1905	1906	1906	1907	1908	1908	1909	1909
503.2	22170	22190	22210	22230	22240	22260	22280	22300	22320	22340
	1910	1911	1911	1912	1913	1913	1914	1915	1915	1916
503.3	22360	22380	22400	22420	22440	22460	22470	22490	22510	22530
	1916	1917	1918	1918	1919	1920	1920	1921	1922	1922
503.4	22550	22570	22590	22610	22630	22650	22670	22690	22710	22720
	1923	1923	1924	1925	1925	1926	1927	1927	1928	1929
503.5	22740	22760	22780	22800	22820	22840	22860	22880	22900	22920
	1929	1930	1930	1931	1932	1932	1933	1934	1934	1935
503.6	22940	22960	22980	23000	23010	23030	23050	23070	23090	23110
	1936	1936	1937	1938	1938	1939	1939	1940	1941	1941
503.7	23130	23150	23170	23190	23210	23230	23250	23270	23290	23310
	1942	1943	1943	1944	1945	1945	1946	1947	1947	1948
503.8	23330	23350	23360	23380	23400	23420	23440	23460	23480	23500
	1948	1949	1950	1950	1951	1952	1952	1953	1954	1954
503.9	23520	23540	23560	23580	23600	23620	23640	23660	23680	23700
	1955	1956	1956	1957	1957	1958	1959	1959	1960	1961
504.0	23720	23740	23760	23780	23800	23810	23830	23850	23870	23890
	1962	1963	1965	1966	1968	1970	1971	1973	1974	1976
504.1	23910	23930	23950	23970	23990	24010	24030	24050	24070	24090
	1977	1979	1981	1982	1984	1985	1987	1989	1990	1992
504.2	24110	24130	24150	24170	24190	24210	24230	24250	24270	24290
	1993	1995	1997	1998	2000	2001	2003	2005	2006	2008
504.3	24310	24330	24350	24370	24390	24410	24430	24450	24470	24490
	2010	2011	2013	2014	2016	2018	2019	2021	2022	2024
504.4	24510	24530	24550	24570	24600	24620	24640	24660	24680	24700
	2026	2027	2029	2030	2032	2034	2035	2037	2039	2040

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
504.5	24720	24740	24760	24780	24800	24820	24840	24860	24880	24900
	2042	2043	2045	2047	2048	2050	2052	2053	2055	2056
504.6	24920	24940	24960	24980	25000	25030	25050	25070	25090	25110
	2058	2060	2061	2063	2065	2066	2068	2069	2071	2073
504.7	25130	25150	25170	25190	25210	25230	25250	25270	25300	25320
	2074	2076	2078	2079	2081	2083	2084	2086	2087	2089
504.8	25340	25360	25380	25400	25420	25440	25460	25480	25510	25530
	2091	2092	2094	2096	2097	2099	2101	2102	2104	2106
504.9	25550	25570	25590	25610	25630	25650	25670	25700	25720	25740
	2107	2109	2110	2112	2114	2115	2117	2119	2120	2122
505.0	25760	25780	25800	25820	25840	25870	25890	25910	25930	25950
	2123	2124	2125	2125	2126	2127	2127	2128	2129	2129
505.1	25970	25990	26010	26040	26060	26080	26100	26120	26140	26160
	2130	2131	2131	2132	2133	2133	2134	2135	2135	2136
505.2	26180	26210	26230	26250	26270	26290	26310	26330	26360	26380
	2137	2137	2138	2138	2139	2140	2140	2141	2142	2142
505.3	26400	26420	26440	26460	26480	26510	26530	26550	26570	26590
	2143	2144	2144	2145	2146	2146	2147	2148	2148	2149
505.4	26610	26640	26660	26680	26700	26720	26740	26760	26790	26810
	2150	2150	2151	2152	2152	2153	2154	2154	2155	2156
505.5	26830	26850	26870	26890	26920	26940	26960	26980	27000	27020
	2156	2157	2158	2158	2159	2159	2160	2161	2161	2162
505.6	27040	27070	27090	27110	27130	27150	27170	27200	27220	27240
	2163	2163	2164	2165	2165	2166	2167	2167	2168	2169
505.7	27260	27280	27300	27330	27350	27370	27390	27410	27440	27460
	2169	2170	2171	2171	2172	2173	2173	2174	2175	2175
505.8	27480	27500	27520	27540	27570	27590	27610	27630	27650	27670
	2176	2177	2177	2178	2179	2179	2180	2181	2181	2182
505.9	27700	27720	27740	27760	27780	27810	27830	27850	27870	27890
	2183	2183	2184	2185	2185	2186	2187	2187	2188	2189
506.0	27920	27940	27960	27980	28000	28020	28050	28070	28090	28110
	2189	2191	2193	2195	2196	2198	2200	2201	2203	2205
506.1	28140	28160	28180	28200	28220	28250	28270	28290	28310	28330
	2206	2208	2210	2212	2213	2215	2217	2218	2220	2222
506.2	28360	28380	28400	28420	28450	28470	28490	28510	28530	28560
	2224	2225	2227	2229	2230	2232	2234	2236	2237	2239
506.3	28580	28600	28620	28650	28670	28690	28710	28740	28760	28780
	2241	2243	2244	2246	2248	2249	2251	2253	2255	2256
506.4	28800	28830	28850	28870	28900	28920	28940	28960	28990	29010
	2258	2260	2261	2263	2265	2267	2268	2270	2272	2274
506.5	29030	29050	29080	29100	29120	29150	29170	29190	29210	29240
	2275	2277	2279	2281	2282	2284	2286	2288	2289	2291
506.6	29260	29280	29310	29330	29350	29370	29400	29420	29440	29470
	2293	2294	2296	2298	2300	2301	2303	2305	2307	2308
506.7	29490	29510	29540	29560	29580	29610	29630	29650	29680	29700
	2310	2312	2314	2315	2317	2319	2321	2322	2324	2326
506.8	29720	29750	29770	29790	29820	29840	29860	29890	29910	29930
	2328	2329	2331	2333	2335	2336	2338	2340	2342	2344
506.9	29960	29980	30000	30030	30050	30070	30100	30120	30140	30170
	2345	2347	2349	2351	2352	2354	2356	2358	2359	2361

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
507.0	30190	30210	30240	30260	30290	30310	30330	30360	30380	30400
	2363	2363	2364	2365	2365	2366	2366	2367	2368	2368
507.1	30430	30450	30470	30500	30520	30550	30570	30590	30620	30640
	2369	2370	2370	2371	2371	2372	2373	2373	2374	2375
507.2	30660	30690	30710	30740	30760	30780	30810	30830	30860	30880
	2375	2376	2377	2377	2378	2378	2379	2380	2380	2381
507.3	30900	30930	30950	30970	31000	31020	31050	31070	31090	31120
	2382	2382	2383	2384	2384	2385	2385	2386	2387	2387
507.4	31140	31170	31190	31210	31240	31260	31280	31310	31330	31360
	2388	2389	2389	2390	2390	2391	2392	2392	2393	2394
507.5	31380	31400	31430	31450	31480	31500	31520	31550	31570	31600
	2394	2395	2396	2396	2397	2397	2398	2399	2399	2400
507.6	31620	31640	31670	31690	31720	31740	31760	31790	31810	31840
	2401	2401	2402	2403	2403	2404	2404	2405	2406	2406
507.7	31860	31880	31910	31930	31960	31980	32000	32030	32050	32080
	2407	2408	2408	2409	2410	2410	2411	2411	2412	2413
507.8	32100	32130	32150	32170	32200	32220	32250	32270	32290	32320
	2413	2414	2415	2415	2416	2417	2417	2418	2418	2419
507.9	32340	32370	32390	32420	32440	32460	32490	32510	32540	32560
	2420	2420	2421	2422	2422	2423	2424	2424	2425	2426
508.0	32590	32610	32630	32660	32680	32710	32730	32760	32780	32800
	2426	2428	2430	2431	2433	2434	2436	2437	2439	2440
508.1	32830	32850	32880	32900	32930	32950	32980	33000	33020	33050
	2442	2444	2445	2447	2448	2450	2451	2453	2455	2456
508.2	33070	33100	33120	33150	33170	33200	33220	33250	33270	33300
	2458	2459	2461	2462	2464	2466	2467	2469	2470	2472
508.3	33320	33350	33370	33390	33420	33440	33470	33490	33520	33540
	2473	2475	2477	2478	2480	2481	2483	2485	2486	2488
508.4	33570	33590	33620	33640	33670	33690	33720	33740	33770	33790
	2489	2491	2492	2494	2496	2497	2499	2500	2502	2503
508.5	33820	33840	33870	33890	33920	33940	33970	33990	34020	34040
	2505	2507	2508	2510	2511	2513	2515	2516	2518	2519
508.6	34070	34090	34120	34150	34170	34200	34220	34250	34270	34300
	2521	2523	2524	2526	2527	2529	2531	2532	2534	2535
508.7	34320	34350	34370	34400	34420	34450	34480	34500	34530	34550
	2537	2539	2540	2542	2543	2545	2547	2548	2550	2551
508.8	34580	34600	34630	34650	34680	34700	34730	34760	34780	34810
	2553	2555	2556	2558	2559	2561	2563	2564	2566	2567
508.9	34830	34860	34880	34910	34940	34960	34990	35010	35040	35070
	2569	2571	2572	2574	2575	2577	2579	2580	2582	2583
509.0	35090	35120	35140	35170	35190	35220	35250	35270	35300	35320
	2585	2586	2586	2587	2588	2589	2589	2590	2591	2592
509.1	35350	35380	35400	35430	35450	35480	35510	35530	35560	35580
	2592	2593	2594	2595	2595	2596	2597	2598	2598	2599
509.2	35610	35640	35660	35690	35710	35740	35770	35790	35820	35840
	2600	2601	2601	2602	2603	2604	2604	2605	2606	2606
509.3	35870	35900	35920	35950	35970	36000	36030	36050	36080	36100
	2607	2608	2609	2609	2610	2611	2612	2612	2613	2614
509.4	36130	36160	36180	36210	36240	36260	36290	36310	36340	36370
	2615	2615	2616	2617	2618	2618	2619	2620	2621	2621

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
509.5	36390	36420	36450	36470	36500	36520	36550	36580	36600	36630
	2622	2623	2624	2625	2625	2626	2627	2628	2628	2629
509.6	36660	36680	36710	36730	36760	36790	36810	36840	36870	36890
	2630	2631	2631	2632	2633	2634	2634	2635	2636	2637
509.7	36920	36950	36970	37000	37020	37050	37080	37100	37130	37160
	2637	2638	2639	2640	2640	2641	2642	2643	2643	2644
509.8	37180	37210	37240	37260	37290	37320	37340	37370	37390	37420
	2645	2646	2646	2647	2648	2649	2649	2650	2651	2652
509.9	37450	37470	37500	37530	37550	37580	37610	37630	37660	37690
	2652	2653	2654	2655	2655	2656	2657	2658	2658	2659
510.0	37710	37740	37770	37790	37820	37850	37870	37900	37930	37950
	2660	2662	2663	2665	2666	2668	2669	2671	2672	2674
510.1	37980	38010	38030	38060	38090	38110	38140	38170	38190	38220
	2675	2677	2678	2680	2681	2683	2684	2686	2687	2689
510.2	38250	38280	38300	38330	38360	38380	38410	38440	38460	38490
	2690	2692	2693	2695	2696	2698	2699	2701	2702	2704
510.3	38520	38550	38570	38600	38630	38650	38680	38710	38740	38760
	2705	2707	2708	2710	2712	2713	2715	2716	2718	2719
510.4	38790	38820	38840	38870	38900	38930	38950	38980	39010	39040
	2721	2722	2724	2725	2727	2728	2730	2731	2733	2734
510.5	39060	39090	39120	39140	39170	39200	39230	39250	39280	39310
	2736	2737	2739	2740	2742	2743	2745	2747	2748	2750
510.6	39340	39360	39390	39420	39450	39470	39500	39530	39560	39580
	2751	2753	2754	2756	2757	2759	2760	2762	2763	2765
510.7	39610	39640	39670	39700	39720	39750	39780	39810	39830	39860
	2766	2768	2770	2771	2773	2774	2776	2777	2779	2780
510.8	39890	39920	39950	39970	40000	40030	40060	40090	40110	40140
	2782	2783	2785	2786	2788	2789	2791	2793	2794	2796
510.9	40170	40200	40230	40250	40280	40310	40340	40370	40390	40420
	2797	2799	2800	2802	2803	2805	2806	2808	2810	2811
511.0	40450	40480	40510	40530	40560	40590	40620	40650	40670	40700
	2812	2813	2814	2815	2815	2816	2817	2817	2818	2819
511.1	40730	40760	40790	40820	40840	40870	40900	40930	40960	40990
	2820	2820	2821	2822	2822	2823	2824	2825	2825	2826
511.2	41010	41040	41070	41100	41130	41150	41180	41210	41240	41270
	2827	2827	2828	2829	2830	2830	2831	2832	2832	2833
511.3	41300	41320	41350	41380	41410	41440	41470	41500	41520	41550
	2834	2835	2835	2836	2837	2837	2838	2839	2840	2840
511.4	41580	41610	41640	41670	41690	41720	41750	41780	41810	41840
	2841	2842	2842	2843	2844	2845	2845	2846	2847	2848
511.5	41860	41890	41920	41950	41980	42010	42040	42060	42090	42120
	2848	2849	2850	2850	2851	2852	2853	2853	2854	2855
511.6	42150	42180	42210	42240	42260	42290	42320	42350	42380	42410
	2855	2856	2857	2858	2858	2859	2860	2860	2861	2862
511.7	42440	42460	42490	42520	42550	42580	42610	42640	42670	42690
	2863	2863	2864	2865	2866	2866	2867	2868	2868	2869
511.8	42720	42750	42780	42810	42840	42870	42890	42920	42950	42980
	2870	2871	2871	2872	2873	2873	2874	2875	2876	2876
511.9	43010	43040	43070	43100	43130	43150	43180	43210	43240	43270
	2877	2878	2879	2879	2880	2881	2881	2882	2883	2884

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
512.0	43300 2885	43330 2886	43360 2888	43380 2889	43410 2891	43440 2892	43470 2894	43500 2896	43530 2897	43560 2899
512.1	43590 2900	43620 2902	43650 2903	43670 2905	43700 2907	43730 2908	43760 2910	43790 2911	43820 2913	43850 2914
512.2	43880 2916	43910 2918	43940 2919	43970 2921	43990 2922	44020 2924	44050 2925	44080 2927	44110 2929	44140 2930
512.3	44170 2932	44200 2933	44230 2935	44260 2936	44290 2938	44320 2940	44350 2941	44380 2943	44410 2944	44430 2946
512.4	44460 2948	44490 2949	44520 2951	44550 2952	44580 2954	44610 2955	44640 2957	44670 2959	44700 2960	44730 2962
512.5	44760 2963	44790 2965	44820 2967	44850 2968	44880 2970	44910 2971	44940 2973	44970 2975	45000 2976	45030 2978
512.6	45060 2979	45090 2981	45120 2983	45150 2984	45180 2986	45210 2987	45240 2989	45270 2991	45300 2992	45330 2994
512.7	45360 2995	45390 2997	45420 2998	45450 3000	45480 3002	45510 3003	45540 3005	45570 3006	45600 3008	45630 3010
512.8	45660 3011	45690 3013	45720 3014	45750 3016	45780 3018	45810 3019	45840 3021	45870 3023	45900 3024	45930 3026
512.9	45960 3027	45990 3029	46020 3031	46050 3032	46080 3034	46110 3035	46140 3037	46170 3039	46200 3040	46230 3042
513.0	46260 3043	46290 3044	46320 3045	46350 3046	46380 3047	46410 3047	46440 3048	46470 3049	46500 3050	46540 3051
513.1	46570 3051	46600 3052	46630 3053	46660 3054	46690 3055	46720 3056	46750 3056	46780 3057	46810 3058	46840 3059
513.2	46870 3060	46900 3061	46930 3061	46960 3062	46990 3063	47020 3064	47050 3065	47090 3066	47120 3066	47150 3067
513.3	47180 3068	47210 3069	47240 3070	47270 3071	47300 3071	47330 3072	47360 3073	47390 3074	47420 3075	47450 3076
513.4	47480 3076	47520 3077	47550 3078	47580 3079	47610 3080	47640 3081	47670 3081	47700 3082	47730 3083	47760 3084
513.5	47790 3085	47820 3086	47850 3086	47890 3087	47920 3088	47950 3089	47980 3090	48010 3091	48040 3091	48070 3092
513.6	48100 3093	48130 3094	48160 3095	48190 3096	48230 3096	48260 3097	48290 3098	48320 3099	48350 3100	48380 3101
513.7	48410 3101	48440 3102	48470 3103	48500 3104	48530 3105	48570 3106	48600 3106	48630 3107	48660 3108	48690 3109
513.8	48720 3110	48750 3111	48780 3111	48810 3112	48850 3113	48880 3114	48910 3115	48940 3116	48970 3116	49000 3117
513.9	49030 3118	49060 3119	49100 3120	49130 3121	49160 3121	49190 3122	49220 3123	49250 3124	49280 3125	49310 3126
514.0	49340 3127	49380 3128	49410 3129	49440 3131	49470 3132	49500 3134	49530 3135	49560 3136	49600 3138	49630 3139
514.1	49660 3141	49690 3142	49720 3143	49750 3145	49780 3146	49820 3148	49850 3149	49880 3150	49910 3152	49940 3153
514.2	49970 3155	50000 3156	50040 3157	50070 3159	50100 3160	50130 3162	50160 3163	50190 3164	50230 3166	50260 3167
514.3	50290 3169	50320 3170	50350 3171	50380 3173	50420 3174	50450 3176	50480 3177	50510 3179	50540 3180	50570 3181
514.4	50610 3183	50640 3184	50670 3186	50700 3187	50730 3188	50770 3190	50800 3191	50830 3193	50860 3194	50890 3195

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
514.5	50930	50960	50990	51020	51050	51090	51120	51150	51180	51210
	3197	3198	3200	3201	3203	3204	3205	3207	3208	3210
514.6	51250	51280	51310	51340	51370	51410	51440	51470	51500	51540
	3211	3212	3214	3215	3217	3218	3220	3221	3222	3224
514.7	51570	51600	51630	51660	51700	51730	51760	51790	51830	51860
	3225	3227	3228	3229	3231	3232	3234	3235	3237	3238
514.8	51890	51920	51960	51990	52020	52050	52090	52120	52150	52180
	3239	3241	3242	3244	3245	3247	3248	3249	3251	3252
514.9	52220	52250	52280	52310	52350	52380	52410	52440	52480	52510
	3254	3255	3256	3258	3259	3261	3262	3264	3265	3266
515.0	52540	52570	52610	52640	52670	52700	52740	52770	52800	52840
	3268	3269	3269	3270	3271	3272	3272	3273	3274	3275
515.1	52870	52900	52930	52970	53000	53030	53060	53100	53130	53160
	3276	3276	3277	3278	3279	3279	3280	3281	3282	3283
515.2	53200	53230	53260	53290	53330	53360	53390	53430	53460	53490
	3283	3284	3285	3286	3286	3287	3288	3289	3290	3290
515.3	53520	53560	53590	53620	53660	53690	53720	53760	53790	53820
	3291	3292	3293	3294	3294	3295	3296	3297	3297	3298
515.4	53850	53890	53920	53950	53990	54020	54050	54090	54120	54150
	3299	3300	3301	3301	3302	3303	3304	3304	3305	3306
515.5	54180	54220	54250	54280	54320	54350	54380	54420	54450	54480
	3307	3308	3308	3309	3310	3311	3312	3312	3313	3314
515.6	54520	54550	54580	54610	54650	54680	54710	54750	54780	54810
	3315	3315	3316	3317	3318	3319	3319	3320	3321	3322
515.7	54850	54880	54910	54950	54980	55010	55050	55080	55110	55150
	3322	3323	3324	3325	3326	3326	3327	3328	3329	3330
515.8	55180	55210	55250	55280	55310	55350	55380	55410	55450	55480
	3330	3331	3332	3333	3333	3334	3335	3336	3337	3337
515.9	55510	55550	55580	55610	55650	55680	55710	55750	55780	55810
	3338	3339	3340	3341	3341	3342	3343	3344	3345	3345
516.0	55850	55880	55910	55950	55980	56010	56050	56080	56120	56150
	3346	3347	3349	3350	3351	3352	3353	3355	3356	3357
516.1	56180	56220	56250	56280	56320	56350	56380	56420	56450	56490
	3358	3359	3361	3362	3363	3364	3365	3367	3368	3369
516.2	56520	56550	56590	56620	56650	56690	56720	56750	56790	56820
	3370	3371	3373	3374	3375	3376	3377	3379	3380	3381
516.3	56860	56890	56920	56960	56990	57030	57060	57090	57130	57160
	3382	3383	3385	3386	3387	3388	3389	3391	3392	3393
516.4	57190	57230	57260	57300	57330	57360	57400	57430	57470	57500
	3394	3395	3397	3398	3399	3400	3401	3403	3404	3405
516.5	57530	57570	57600	57640	57670	57710	57740	57770	57810	57840
	3406	3407	3409	3410	3411	3412	3414	3415	3416	3417
516.6	57880	57910	57940	57980	58010	58050	58080	58120	58150	58180
	3418	3420	3421	3422	3423	3424	3426	3427	3428	3429
516.7	58220	58250	58290	58320	58360	58390	58420	58460	58490	58530
	3430	3432	3433	3434	3435	3437	3438	3439	3440	3441
516.8	58560	58600	58630	58670	58700	58730	58770	58800	58840	58870
	3443	3444	3445	3446	3447	3449	3450	3451	3452	3454
516.9	58910	58940	58980	59010	59040	59080	59110	59150	59180	59220
	3455	3456	3457	3458	3460	3461	3462	3463	3465	3466

1988 SURVEY   Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
517.0	59250	59290	59320	59360	59390	59430	59460	59500	59530	59570
	3467	3468	3468	3469	3470	3471	3471	3472	3473	3473
517.1	59600	59630	59670	59700	59740	59770	59810	59840	59880	59910
	3474	3475	3476	3476	3477	3478	3478	3479	3480	3481
517.2	59950	59980	60020	60050	60090	60120	60160	60190	60230	60260
	3481	3482	3483	3484	3484	3485	3486	3486	3487	3488
517.3	60300	60330	60370	60400	60440	60470	60510	60540	60580	60610
	3489	3489	3490	3491	3492	3492	3493	3494	3494	3495
517.4	60640	60680	60710	60750	60780	60820	60850	60890	60920	60960
	3496	3497	3497	3498	3499	3500	3500	3501	3502	3502
517.5	60990	61030	61060	61100	61130	61170	61210	61240	61280	61310
	3503	3504	3505	3505	3506	3507	3508	3508	3509	3510
517.6	61350	61380	61420	61450	61490	61520	61560	61590	61630	61660
	3511	3511	3512	3513	3513	3514	3515	3516	3516	3517
517.7	61700	61730	61770	61800	61840	61870	61910	61940	61980	62010
	3518	3519	3519	3520	3521	3521	3522	3523	3524	3524
517.8	62050	62080	62120	62150	62190	62230	62260	62300	62330	62370
	3525	3526	3527	3527	3528	3529	3530	3530	3531	3532
517.9	62400	62440	62470	62510	62540	62580	62610	62650	62680	62720
	3532	3533	3534	3535	3535	3536	3537	3538	3538	3539
518.0	62760	62790	62830	62860	62900	62930	62970	63000	63040	63070
	3540	3542	3543	3545	3547	3548	3550	3552	3553	3555
518.1	63110	63150	63180	63220	63250	63290	63320	63360	63390	63430
	3557	3558	3560	3562	3563	3565	3567	3569	3570	3572
518.2	63470	63500	63540	63570	63610	63650	63680	63720	63750	63790
	3574	3575	3577	3579	3580	3582	3584	3585	3587	3589
518.3	63820	63860	63900	63930	63970	64000	64040	64080	64110	64150
	3591	3592	3594	3596	3597	3599	3601	3602	3604	3606
518.4	64180	64220	64260	64290	64330	64360	64400	64440	64470	64510
	3607	3609	3611	3613	3614	3616	3618	3619	3621	3623
518.5	64550	64580	64620	64650	64690	64730	64760	64800	64840	64870
	3624	3626	3628	3630	3631	3633	3635	3636	3638	3640
518.6	64910	64950	64980	65020	65050	65090	65130	65160	65200	65240
	3642	3643	3645	3647	3648	3650	3652	3653	3655	3657
518.7	65270	65310	65350	65380	65420	65460	65490	65530	65570	65600
	3659	3660	3662	3664	3665	3667	3669	3671	3672	3674
518.8	65640	65680	65710	65750	65790	65820	65860	65900	65940	65970
	3676	3677	3679	3681	3683	3684	3686	3688	3689	3691
518.9	66010	66050	66080	66120	66160	66190	66230	66270	66300	66340
	3693	3695	3696	3698	3700	3701	3703	3705	3707	3708
519.0	66380	66420	66450	66490	66530	66560	66600	66640	66680	66710
	3710	3711	3711	3712	3713	3714	3714	3715	3716	3716
519.1	66750	66790	66820	66860	66900	66940	66970	67010	67050	67090
	3717	3718	3719	3719	3720	3721	3721	3722	3723	3724
519.2	67120	67160	67200	67230	67270	67310	67350	67380	67420	67460
	3724	3725	3726	3727	3727	3728	3729	3729	3730	3731
519.3	67490	67530	67570	67610	67640	67680	67720	67760	67790	67830
	3732	3732	3733	3734	3734	3735	3736	3737	3737	3738
519.4	67870	67910	67940	67980	68020	68060	68090	68130	68170	68210
	3739	3739	3740	3741	3742	3742	3743	3744	3745	3745

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
519.5	68240	68280	68320	68350	68390	68430	68470	68500	68540	68580
	3746	3747	3747	3748	3749	3750	3750	3751	3752	3752
519.6	68620	68650	68690	68730	68770	68800	68840	68880	68920	68960
	3753	3754	3755	3755	3756	3757	3758	3756	3759	3760
519.7	68990	69030	69070	69110	69140	69180	69220	69260	69290	69330
	3760	3761	3762	3763	3763	3764	3765	3765	3766	3767
519.8	69370	69410	69440	69480	69520	69560	69600	69630	69670	69710
	3768	3768	3769	3770	3771	3771	3772	3773	3773	3774
519.9	69750	69780	69820	69860	69900	69930	69970	70010	70050	70090
	3775	3776	3776	3777	3778	3778	3779	3780	3781	3781
520.0	70120	70160	70200	70240	70280	70310	70350	70390	70430	70460
	3782	3783	3785	3786	3787	3788	3790	3791	3792	3793
520.1	70500	70540	70580	70620	70650	70690	70730	70770	70810	70840
	3795	3796	3797	3798	3800	3801	3802	3803	3805	3806
520.2	70880	70920	70960	71000	71030	71070	71110	71150	71190	71230
	3807	3808	3810	3811	3812	3813	3815	3816	3817	3818
520.3	71260	71300	71340	71380	71420	71450	71490	71530	71570	71610
	3820	3821	3822	3823	3825	3826	3827	3828	3830	3831
520.4	71650	71680	71720	71760	71800	71840	71880	71910	71950	71990
	3832	3833	3835	3836	3837	3838	3840	3841	3842	3843
520.5	72030	72070	72110	72150	72180	72220	72260	72300	72340	72380
	3845	3846	3847	3848	3850	3851	3852	3853	3855	3856
520.6	72420	72450	72490	72530	72570	72610	72650	72690	72720	72760
	3857	3858	3860	3861	3862	3864	3865	3866	3867	3869
520.7	72800	72840	72880	72920	72960	72990	73030	73070	73110	73150
	3870	3871	3872	3874	3875	3876	3877	3879	3880	3881
520.8	73190	73230	73270	73310	73340	73380	73420	73460	73500	73540
	3882	3884	3885	3886	3887	3889	3890	3891	3892	3894
520.9	73580	73620	73660	73690	73730	73770	73810	73850	73890	73930
	3895	3896	3898	3899	3900	3901	3903	3904	3905	3906
521.0	73970	74010	74050	74090	74120	74160	74200	74240	74280	74320
	3908	3908	3909	3909	3910	3911	3911	3912	3912	3913
521.1	74360	74400	74440	74480	74520	74550	74590	74630	74670	74710
	3914	3914	3915	3915	3916	3917	3917	3918	3918	3919
521.2	74750	74790	74830	74870	74910	74950	74990	75020	75060	75100
	3920	3920	3921	3921	3922	3923	3923	3924	3924	3925
521.3	75140	75180	75220	75260	75300	75340	75380	75420	75460	75500
	3926	3926	3927	3927	3928	3929	3929	3930	3930	3931
521.4	75540	75570	75610	75650	75690	75730	75770	75810	75850	75890
	3932	3932	3933	3933	3934	3935	3935	3936	3936	3937
521.5	75930	75970	76010	76050	76090	76130	76160	76200	76240	76280
	3938	3938	3939	3939	3940	3941	3941	3942	3942	3943
521.6	76320	76360	76400	76440	76480	76520	76560	76600	76640	76680
	3944	3944	3945	3945	3946	3947	3947	3948	3948	3949
521.7	76720	76760	76800	76840	76880	76910	76950	76990	77030	77070
	3950	3950	3951	3951	3952	3953	3953	3954	3954	3955
521.8	77110	77150	77190	77230	77270	77310	77350	77390	77430	77470
	3956	3956	3957	3957	3958	3959	3959	3960	3960	3961
521.9	77510	77550	77590	77630	77670	77710	77750	77790	77830	77860
	3962	3962	3963	3963	3964	3965	3965	3966	3966	3967

1988 SURVEY

Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
522.0	77900 3968	77940 3969	77980 3970	78020 3972	78060 3973	78100 3975	78140 3976	78180 3977	78220 3979	78260 3980
522.1	78300 3982	78340 3983	78380 3984	78420 3986	78460 3987	78500 3989	78540 3990	78580 3991	78620 3993	78660 3994
522.2	78700 3996	78740 3997	78780 3998	78820 4000	78860 4001	78900 4003	78940 4004	78980 4005	79020 4007	79060 4008
522.3	79100 4010	79140 4011	79180 4012	79220 4014	79260 4015	79300 4017	79340 4018	79380 4019	79420 4021	79460 4022
522.4	79500 4024	79540 4025	79580 4026	79620 4028	79660 4029	79700 4031	79740 4032	79780 4033	79820 4035	79860 4036
522.5	79910 4038	79950 4039	79990 4040	80030 4042	80070 4043	80110 4045	80150 4046	80190 4047	80230 4049	80270 4050
522.6	80310 4052	80350 4053	80390 4054	80430 4056	80470 4057	80510 4059	80550 4060	80590 4061	80630 4063	80670 4064
522.7	80720 4066	80760 4067	80800 4068	80840 4070	80880 4071	80920 4073	80960 4074	81000 4076	81040 4077	81080 4078
522.8	81120 4080	81160 4081	81200 4083	81250 4084	81290 4085	81330 4087	81370 4088	81410 4090	81450 4091	81490 4092
522.9	81530 4094	81570 4095	81610 4097	81650 4098	81690 4099	81740 4101	81780 4102	81820 4104	81860 4105	81900 4107
523.0	81940 4108	81980 4109	82020 4109	82060 4110	82110 4111	82150 4111	82190 4112	82230 4113	82270 4114	82310 4114
523.1	82350 4115	82390 4116	82430 4116	82480 4117	82520 4118	82560 4118	82600 4119	82640 4120	82680 4120	82720 4121
523.2	82760 4122	82810 4123	82850 4123	82890 4124	82930 4125	82970 4125	83010 4126	83050 4127	83090 4127	83140 4128
523.3	83180 4129	83220 4130	83260 4130	83300 4131	83340 4132	83380 4132	83420 4133	83470 4134	83510 4134	83550 4135
523.4	83590 4136	83630 4136	83670 4137	83710 4138	83750 4139	83800 4139	83840 4140	83880 4141	83920 4141	83960 4142
523.5	84000 4143	84040 4143	84090 4144	84130 4145	84170 4146	84210 4146	84250 4147	84290 4148	84330 4148	84380 4149
523.6	84420 4150	84460 4150	84500 4151	84540 4152	84580 4153	84630 4153	84670 4154	84710 4155	84750 4155	84790 4156
523.7	84830 4157	84870 4157	84920 4158	84960 4159	85000 4159	85040 4160	85080 4161	85120 4162	85170 4162	85210 4163
523.8	85250 4164	85290 4164	85330 4165	85370 4166	85420 4166	85460 4167	85500 4168	85540 4169	85580 4169	85620 4170
523.9	85670 4171	85710 4171	85750 4172	85790 4173	85830 4173	85870 4174	85920 4175	85960 4176	86000 4176	86040 4177
524.0	86080 4178	86120 4179	86170 4181	86210 4182	86250 4183	86290 4185	86330 4186	86380 4188	86420 4189	86460 4191
524.1	86500 4192	86540 4193	86590 4195	86630 4196	86670 4198	86710 4199	86750 4201	86790 4202	86840 4204	86880 4205
524.2	86920 4206	86960 4208	87010 4209	87050 4211	87090 4212	87130 4214	87170 4215	87220 4217	87260 4218	87300 4219
524.3	87340 4221	87380 4222	87430 4224	87470 4225	87510 4227	87550 4228	87600 4230	87640 4231	87680 4232	87720 4234
524.4	87760 4235	87810 4237	87850 4238	87890 4240	87930 4241	87980 4243	88020 4244	88060 4245	88100 4247	88150 4248

1988 SURVEY

Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
524.5	88190	88230	88270	88320	88360	88400	88440	88490	88530	88570
	4250	4251	4253	4254	4256	4257	4259	4260	4261	4263
524.6	88610	88660	88700	88740	88790	88830	88870	88910	88960	89000
	4264	4266	4267	4269	4270	4272	4273	4275	4276	4277
524.7	89040	89080	89130	89170	89210	89260	89300	89340	89380	89430
	4279	4280	4282	4283	4285	4286	4288	4289	4291	4292
524.8	89470	89510	89560	89600	89640	89690	89730	89770	89810	89860
	4293	4295	4296	4298	4299	4301	4302	4304	4305	4307
524.9	89900	89940	89990	90030	90070	90120	90160	90200	90250	90290
	4308	4309	4311	4312	4314	4315	4317	4318	4320	4321
525.0	90330	90370	90420	90460	90500	90550	90590	90630	90680	90720
	4323	4323	4324	4325	4326	4326	4327	4328	4329	4329
525.1	90760	90810	90850	90890	90940	90980	91020	91070	91110	91150
	4330	4331	4332	4332	4333	4334	4335	4335	4336	4337
525.2	91200	91240	91280	91330	91370	91410	91460	91500	91540	91590
	4338	4338	4339	4340	4341	4341	4342	4343	4344	4344
525.3	91630	91670	91720	91760	91810	91850	91890	91940	91980	92020
	4345	4346	4347	4347	4348	4349	4350	4350	4351	4352
525.4	92070	92110	92150	92200	92240	92280	92330	92370	92410	92460
	4353	4353	4354	4355	4356	4356	4357	4358	4359	4359
525.5	92500	92550	92590	92630	92680	92720	92760	92810	92850	92890
	4360	4361	4362	4362	4363	4364	4365	4365	4366	4367
525.6	92940	92980	93030	93070	93110	93160	93200	93240	93290	93330
	4368	4368	4369	4370	4371	4371	4372	4373	4374	4374
525.7	93380	93420	93460	93510	93550	93590	93640	93680	93730	93770
	4375	4376	4377	4377	4378	4379	4380	4380	4381	4382
525.8	93810	93860	93900	93940	93990	94030	94080	94120	94160	94210
	4383	4383	4384	4385	4386	4386	4387	4388	4389	4389
525.9	94250	94300	94340	94380	94430	94470	94510	94560	94600	94650
	4390	4391	4392	4392	4393	4394	4395	4395	4396	4397
526.0	94690	94730	94780	94820	94870	94910	94950	95000	95040	95090
	4398	4399	4400	4402	4403	4405	4406	4407	4409	4410
526.1	95130	95180	95220	95260	95310	95350	95400	95440	95480	95530
	4412	4413	4414	4416	4417	4419	4420	4422	4423	4424
526.2	95570	95620	95660	95710	95750	95790	95840	95880	95930	95970
	4426	4427	4429	4430	4431	4433	4434	4436	4437	4439
526.3	96020	96060	96100	96150	96190	96240	96280	96330	96370	96420
	4440	4441	4443	4444	4446	4447	4448	4450	4451	4453
526.4	96460	96510	96550	96590	96640	96680	96730	96770	96820	96860
	4454	4456	4457	4458	4460	4461	4463	4464	4466	4467
526.5	96910	96950	97000	97040	97090	97130	97170	97220	97260	97310
	4468	4470	4471	4473	4474	4475	4477	4478	4480	4481
526.6	97350	97400	97440	97490	97530	97580	97620	97670	97710	97760
	4483	4484	4485	4487	4488	4490	4491	4493	4494	4495
526.7	97800	97850	97890	97940	97980	98030	98070	98120	98160	98210
	4497	4498	4500	4501	4503	4504	4505	4507	4508	4510
526.8	98250	98300	98340	98390	98430	98480	98520	98570	98610	98660
	4511	4513	4514	4515	4517	4518	4520	4521	4523	4524
526.9	98700	98750	98800	98840	98890	98930	98980	99020	99070	99110
	4525	4527	4528	4530	4531	4533	4534	4535	4537	4538

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
527.0	99160	99200	99250	99290	99340	99390	99430	99480	99520	99570
	4540	4541	4541	4542	4542	4543	4544	4544	4545	4546
527.1	99610	99660	99700	99750	99790	99840	99890	99930	99980	100000
	4546	4547	4548	4548	4549	4550	4550	4551	4552	4552
527.2	100100	100100	100200	100200	100200	100300	100300	100400	100400	100500
	4553	4554	4554	4555	4556	4556	4557	4558	4558	4559
527.3	100500	100600	100600	100700	100700	100800	100800	100800	100900	100900
	4560	4560	4561	4562	4562	4563	4564	4564	4565	4566
527.4	101000	101000	101100	101100	101200	101200	101300	101300	101300	101400
	4566	4567	4567	4568	4569	4569	4570	4571	4571	4572
527.5	101400	101500	101500	101600	101600	101700	101700	101800	101800	101800
	4573	4573	4574	4575	4575	4576	4577	4577	4578	4579
527.6	101900	101900	102000	102000	102100	102100	102200	102200	102300	102300
	4579	4580	4581	4581	4582	4583	4583	4584	4585	4585
527.7	102400	102400	102400	102500	102500	102600	102600	102700	102700	102800
	4586	4587	4587	4588	4589	4589	4590	4591	4591	4592
527.8	102800	102900	102900	102900	103000	103000	103100	103100	103200	103200
	4593	4593	4594	4595	4595	4596	4597	4597	4598	4599
527.9	103300	103300	103400	103400	103500	103500	103500	103600	103600	103700
	4599	4600	4601	4601	4602	4602	4603	4604	4604	4605
528.0	103700	103800	103800	103900	103900	104000	104000	104100	104100	104100
	4606	4608	4610	4612	4614	4616	4617	4619	4621	4623
528.1	104200	104200	104300	104300	104400	104400	104500	104500	104600	104600
	4625	4627	4629	4631	4633	4635	4637	4639	4641	4643
528.2	104700	104700	104700	104800	104800	104900	104900	105000	105000	105100
	4645	4647	4649	4651	4653	4655	4657	4659	4661	4663
528.3	105100	105200	105200	105300	105300	105400	105400	105400	105500	105500
	4665	4667	4669	4671	4673	4675	4677	4679	4681	4683
528.4	105600	105600	105700	105700	105800	105800	105900	105900	106000	106000
	4685	4687	4689	4691	4693	4695	4697	4699	4701	4703
528.5	106100	106100	106200	106200	106200	106300	106300	106400	106400	106500
	4705	4707	4709	4711	4713	4715	4717	4719	4721	4723
528.6	106500	106600	106600	106700	106700	106800	106800	106900	106900	107000
	4725	4727	4729	4731	4733	4735	4737	4739	4741	4743
528.7	107000	107000	107100	107100	107200	107200	107300	107300	107400	107400
	4745	4747	4749	4751	4753	4755	4757	4759	4761	4763
528.8	107500	107500	107600	107600	107700	107700	107800	107800	107900	107900
	4765	4767	4769	4771	4773	4775	4777	4779	4781	4783
528.9	108000	108000	108000	108100	108100	108200	108200	108300	108300	108400
	4785	4787	4789	4791	4793	4795	4797	4799	4801	4803
529.0	108400	108500	108500	108600	108600	108700	108700	108800	108800	108900
	4805	4806	4807	4808	4809	4810	4811	4812	4812	4813
529.1	108900	109000	109000	109100	109100	109200	109200	109300	109300	109300
	4814	4815	4816	4817	4818	4819	4820	4821	4822	4822
529.2	109400	109400	109500	109500	109600	109600	109700	109700	109800	109800
	4823	4824	4825	4826	4827	4828	4829	4830	4831	4832
529.3	109900	109900	110000	110000	110100	110100	110200	110200	110300	110300
	4832	4833	4834	4835	4836	4837	4838	4839	4840	4841
529.4	110400	110400	110500	110500	110600	110600	110700	110700	110800	110800
	4842	4843	4843	4844	4845	4846	4847	4848	4849	4850

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
529.5	110800	110900	110900	111000	111000	111100	111100	111200	111200	111300
	4851	4852	4853	4853	4854	4855	4856	4857	4858	4859
529.6	111300	111400	111400	111500	111500	111600	111600	111700	111700	111800
	4860	4861	4862	4863	4864	4864	4865	4866	4867	4868
529.7	111800	111900	111900	112000	112000	112100	112100	112200	112200	112300
	4869	4870	4871	4872	4873	4874	4875	4875	4876	4877
529.8	112300	112400	112400	112500	112500	112500	112600	112600	112700	112700
	4878	4879	4880	4881	4882	4883	4884	4885	4886	4886
529.9	112800	112800	112900	112900	113000	113000	113100	113100	113200	113200
	4887	4888	4889	4890	4891	4892	4893	4894	4895	4896
530.0	113300	113300	113400	113400	113500	113500	113600	113600	113700	113700
	4897	4898	4900	4901	4903	4905	4906	4908	4910	4911
530.1	113800	113800	113900	113900	114000	114000	114100	114100	114200	114200
	4913	4915	4916	4918	4920	4921	4923	4925	4926	4928
530.2	114300	114300	114400	114400	114500	114500	114600	114600	114700	114700
	4929	4931	4933	4934	4936	4938	4939	4941	4943	4944
530.3	114800	114800	114900	114900	115000	115000	115100	115100	115200	115200
	4946	4948	4949	4951	4953	4954	4956	4958	4959	4961
530.4	115300	115300	115400	115400	115500	115500	115600	115600	115700	115700
	4963	4964	4966	4968	4969	4971	4973	4974	4976	4978
530.5	115800	115800	115900	115900	116000	116000	116100	116100	116200	116200
	4979	4981	4983	4984	4986	4988	4989	4991	4993	4994
530.6	116300	116300	116400	116400	116400	116500	116600	116600	116700	116700
	4996	4998	4999	5001	5003	5004	5006	5008	5009	5011
530.7	116800	116800	116900	116900	117000	117000	117100	117100	117200	117200
	5013	5014	5016	5018	5019	5021	5023	5024	5026	5028
530.8	117300	117300	117400	117400	117500	117500	117600	117600	117700	117700
	5029	5031	5033	5034	5036	5038	5039	5041	5043	5044
530.9	117800	117800	117900	117900	118000	118000	118100	118100	118200	118200
	5046	5048	5049	5051	5053	5054	5056	5058	5059	5061
531.0	118300	118300	118400	118400	118500	118500	118600	118600	118700	118700
	5063	5064	5065	5066	5066	5067	5068	5069	5070	5071
531.1	118800	118800	118900	118900	119000	119000	119100	119100	119200	119200
	5072	5073	5074	5075	5076	5077	5077	5078	5079	5080
531.2	119300	119300	119400	119400	119500	119500	119600	119600	119700	119700
	5081	5082	5083	5084	5085	5086	5087	5088	5088	5089
531.3	119800	119800	119900	119900	120000	120000	120100	120100	120200	120200
	5090	5091	5092	5093	5094	5095	5096	5097	5098	5099
531.4	120300	120300	120400	120400	120500	120500	120600	120700	120700	120800
	5099	5100	5101	5102	5103	5104	5105	5106	5107	5108
531.5	120800	120900	120900	121000	121000	121100	121100	121200	121200	121300
	5109	5110	5111	5111	5112	5113	5114	5115	5116	5117
531.6	121300	121400	121400	121500	121500	121600	121600	121700	121700	121800
	5118	5119	5120	5121	5122	5122	5123	5124	5125	5126
531.7	121800	121900	121900	122000	122000	122100	122100	122200	122200	122300
	5127	5128	5129	5130	5131	5132	5133	5134	5134	5135
531.8	122300	122400	122400	122500	122500	122600	122600	122700	122800	122800
	5136	5137	5138	5139	5140	5141	5142	5143	5144	5145
531.9	122900	122900	123000	123000	123100	123100	123200	123200	123300	123300
	5146	5146	5147	5148	5149	5150	5151	5152	5153	5154

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
532.0	123400	123400	123500	123500	123600	123600	123700	123700	123800	123800
	5155	5156	5157	5159	5160	5162	5163	5165	5166	5168
532.1	123900	123900	124000	124000	124100	124100	124200	124200	124300	124400
	5169	5170	5172	5173	5175	5176	5178	5179	5180	5182
532.2	124400	124500	124500	124600	124600	124700	124700	124800	124800	124900
	5183	5185	5186	5188	5189	5191	5192	5193	5195	5196
532.3	124900	125000	125000	125100	125100	125200	125200	125300	125300	125400
	5198	5199	5201	5202	5203	5205	5206	5208	5209	5211
532.4	125400	125500	125500	125600	125600	125700	125800	125800	125900	125900
	5212	5214	5215	5216	5218	5219	5221	5222	5224	5225
532.5	126000	126000	126100	126100	126200	126200	126300	126300	126400	126400
	5227	5228	5229	5231	5232	5234	5235	5237	5238	5240
532.6	126500	126500	126600	126600	126700	126700	126800	126900	126900	127000
	5241	5242	5244	5245	5247	5248	5250	5251	5253	5254
532.7	127000	127100	127100	127200	127200	127300	127300	127400	127400	127500
	5255	5257	5258	5260	5261	5263	5264	5266	5267	5268
532.8	127500	127600	127600	127700	127700	127800	127900	127900	128000	128000
	5270	5271	5273	5274	5276	5277	5279	5280	5281	5283
532.9	128100	128100	128200	128200	128300	128300	128400	128400	128500	128500
	5284	5286	5287	5289	5290	5292	5293	5295	5296	5297
533.0	128600	128600	128700	128800	128800	128900	128900	129000	129000	129100
	5299	5300	5301	5302	5303	5304	5305	5306	5307	5308
533.1	129100	129200	129200	129300	129300	129400	129400	129500	129500	129600
	5309	5310	5311	5312	5312	5313	5314	5315	5316	5317
533.2	129700	129700	129800	129800	129900	129900	130000	130000	130100	130100
	5318	5319	5320	5321	5322	5323	5324	5325	5326	5327
533.3	130200	130200	130300	130300	130400	130500	130500	130600	130600	130700
	5328	5329	5330	5331	5332	5333	5334	5335	5336	5337
533.4	130700	130800	130800	130900	130900	131000	131000	131100	131100	131200
	5338	5339	5339	5340	5341	5342	5343	5344	5345	5346
533.5	131300	131300	131400	131400	131500	131500	131600	131600	131700	131700
	5347	5348	5349	5350	5351	5352	5353	5354	5355	5356
533.6	131800	131800	131900	132000	132000	132100	132100	132200	132200	132300
	5357	5358	5359	5360	5361	5362	5363	5364	5365	5366
533.7	132300	132400	132400	132500	132500	132600	132600	132700	132800	132800
	5367	5367	5368	5369	5370	5371	5372	5373	5374	5375
533.8	132900	132900	133000	133000	133100	133100	133200	133200	133300	133300
	5376	5377	5378	5379	5380	5381	5382	5383	5384	5385
533.9	133400	133500	133500	133600	133600	133700	133700	133800	133800	133900
	5386	5387	5388	5389	5390	5391	5392	5393	5394	5395
534.0	133900	134000	134000	134100	134200	134200	134300	134300	134400	134400
	5396	5397	5399	5400	5402	5404	5405	5407	5408	5410
534.1	134500	134500	134600	134600	134700	134800	134800	134900	134900	135000
	5412	5413	5415	5417	5418	5420	5422	5423	5425	5426
534.2	135000	135100	135100	135200	135200	135300	135300	135400	135500	135500
	5428	5430	5431	5433	5435	5436	5438	5440	5441	5443
534.3	135600	135600	135700	135700	135800	135800	135900	135900	136000	136100
	5445	5446	5448	5449	5451	5453	5454	5456	5458	5459
534.4	136100	136200	136200	136300	136300	136400	136400	136500	136500	136600
	5461	5463	5464	5466	5468	5469	5471	5472	5474	5476

1988 SURVEY

Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
534.5	136700	136700	136800	136800	136900	136900	137000	137000	137100	137200
	5477	5479	5481	5482	5484	5486	5487	5489	5491	5492
534.6	137200	137300	137300	137400	137400	137500	137500	137600	137600	137700
	5494	5495	5497	5499	5500	5502	5504	5505	5507	5509
534.7	137800	137800	137900	137900	138000	138000	138100	138100	138200	138300
	5510	5512	5514	5515	5517	5519	5520	5522	5524	5525
534.8	138300	138400	138400	138500	138500	138600	138600	138700	138800	138800
	5527	5528	5530	5532	5533	5535	5537	5538	5540	5542
534.9	138900	138900	139000	139000	139100	139100	139200	139200	139300	139400
	5543	5545	5547	5548	5550	5552	5553	5555	5557	5558
535.0	139400	139500	139500	139600	139600	139700	139700	139800	139900	139900
	5560	5561	5562	5563	5564	5565	5566	5567	5567	5568
535.1	140000	140000	140100	140100	140200	140300	140300	140400	140400	140500
	5569	5570	5571	5572	5573	5574	5575	5576	5576	5577
535.2	140500	140600	140600	140700	140800	140800	140900	140900	141000	141000
	5578	5579	5580	5581	5582	5583	5584	5585	5586	5586
535.3	141100	141100	141200	141300	141300	141400	141400	141500	141500	141600
	5587	5588	5589	5590	5591	5592	5593	5594	5595	5596
535.4	141600	141700	141800	141800	141900	141900	142000	142000	142100	142200
	5596	5597	5598	5599	5600	5601	5602	5603	5604	5605
535.5	142200	142300	142300	142400	142400	142500	142500	142600	142700	142700
	5606	5606	5607	5608	5609	5610	5611	5612	5613	5614
535.6	142800	142800	142900	142900	143000	143000	143100	143200	143200	143300
	5615	5616	5616	5617	5618	5619	5620	5621	5622	5623
535.7	143300	143400	143400	143500	143600	143600	143700	143700	143800	143800
	5624	5625	5626	5626	5627	5628	5629	5630	5631	5632
535.8	143900	143900	144000	144100	144100	144200	144200	144300	144300	144400
	5633	5634	5635	5636	5636	5637	5638	5639	5640	5641
535.9	144500	144500	144600	144600	144700	144700	144800	144900	144900	145000
	5642	5643	5644	5645	5646	5647	5647	5648	5649	5650
536.0	145000	145100	145100	145200	145200	145300	145400	145400	145500	145500
	5651	5652	5654	5655	5656	5658	5659	5660	5662	5663
536.1	145600	145600	145700	145800	145800	145900	145900	146000	146000	146100
	5664	5666	5667	5669	5670	5671	5673	5674	5675	5677
536.2	146200	146200	146300	146300	146400	146400	146500	146600	146600	146700
	5678	5679	5681	5682	5683	5685	5686	5688	5689	5690
536.3	146700	146800	146800	146900	146900	147000	147100	147100	147200	147200
	5692	5693	5694	5696	5697	5698	5700	5701	5702	5704
536.4	147300	147300	147400	147500	147500	147600	147600	147700	147700	147800
	5705	5707	5708	5709	5711	5712	5713	5715	5716	5717
536.5	147900	147900	148000	148000	148100	148100	148200	148300	148300	148400
	5719	5720	5722	5723	5724	5726	5727	5728	5730	5731
536.6	148400	148500	148500	148600	148700	148700	148800	148800	148900	149000
	5732	5734	5735	5736	5738	5739	5741	5742	5743	5745
536.7	149000	149100	149100	149200	149200	149300	149400	149400	149500	149500
	5746	5747	5749	5750	5751	5753	5754	5756	5757	5758
536.8	149600	149600	149700	149800	149800	149900	149900	150000	150000	150100
	5760	5761	5762	5764	5765	5767	5768	5769	5771	5772
536.9	150200	150200	150300	150300	150400	150400	150500	150600	150600	150700
	5773	5775	5776	5777	5779	5780	5782	5783	5784	5786

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
537.0	150700	150800	150900	150900	151000	151000	151100	151100	151200	151300
	5787	5788	5789	5790	5791	5792	5793	5793	5794	5795
537.1	151300	151400	151400	151500	151500	151600	151700	151700	151800	151800
	5796	5797	5798	5799	5800	5801	5801	5802	5803	5804
537.2	151900	152000	152000	152100	152100	152200	152200	152300	152400	152400
	5805	5806	5807	5808	5809	5809	5810	5811	5812	5813
537.3	152500	152500	152600	152700	152700	152800	152800	152900	152900	153000
	5814	5815	5816	5817	5817	5818	5819	5820	5821	5822
537.4	153100	153100	153200	153200	153300	153400	153400	153500	153500	153600
	5823	5824	5825	5825	5826	5827	5828	5829	5830	5831
537.5	153600	153700	153800	153800	153900	153900	154000	154100	154100	154200
	5832	5833	5833	5834	5835	5836	5837	5838	5839	5840
537.6	154200	154300	154300	154400	154500	154500	154600	154600	154700	154800
	5841	5842	5842	5843	5844	5845	5846	5847	5848	5849
537.7	154800	154900	154900	155000	155000	155100	155200	155200	155300	155300
	5850	5850	5851	5852	5853	5854	5855	5856	5857	5858
537.8	155400	155500	155500	155600	155600	155700	155700	155800	155900	155900
	5858	5859	5860	5861	5862	5863	5864	5865	5866	5867
537.9	156000	156000	156100	156200	156200	156300	156300	156400	156500	156500
	5867	5868	5869	5870	5871	5872	5873	5874	5875	5875
538.0	156600	156600	156700	156700	156800	156900	156900	157000	157000	157100
	5876	5878	5879	5881	5883	5884	5886	5888	5889	5891
538.1	157200	157200	157300	157300	157400	157500	157500	157600	157600	157700
	5893	5894	5896	5898	5899	5901	5903	5904	5906	5908
538.2	157700	157800	157900	157900	158000	158000	158100	158200	158200	158300
	5909	5911	5912	5914	5916	5917	5919	5921	5922	5924
538.3	158300	158400	158500	158500	158600	158600	158700	158800	158800	158900
	5926	5927	5929	5931	5932	5934	5936	5937	5939	5941
538.4	158900	159000	159100	159100	159200	159200	159300	159300	159400	159500
	5942	5944	5946	5947	5949	5951	5952	5954	5956	5957
538.5	159500	159600	159600	159700	159800	159800	159900	159900	160000	160100
	5959	5961	5962	5964	5966	5967	5969	5971	5972	5974
538.6	160100	160200	160200	160300	160400	160400	160500	160500	160600	160700
	5976	5977	5979	5981	5982	5984	5986	5987	5989	5991
538.7	160700	160800	160800	160900	161000	161000	161100	161100	161200	161300
	5992	5994	5996	5997	5999	6001	6002	6004	6006	6007
538.8	161300	161400	161400	161500	161600	161600	161700	161700	161800	161900
	6009	6011	6012	6014	6016	6017	6019	6021	6022	6024
538.9	161900	162000	162000	162100	162200	162200	162300	162300	162400	162500
	6026	6027	6029	6031	6032	6034	6036	6037	6039	6041
539.0	162500	162600	162600	162700	162800	162800	162900	162900	163000	163100
	6042	6044	6045	6045	6046	6047	6048	6049	6050	6051
539.1	163100	163200	163300	163300	163400	163400	163500	163600	163600	163700
	6052	6053	6054	6055	6056	6057	6058	6059	6060	6061
539.2	163700	163800	163900	163900	164000	164000	164100	164200	164200	164300
	6062	6062	6063	6064	6065	6066	6067	6068	6069	6070
539.3	164300	164400	164500	164500	164600	164600	164700	164800	164800	164900
	6071	6072	6073	6074	6075	6076	6077	6078	6079	6080
539.4	164900	165000	165100	165100	165200	165300	165300	165400	165400	165500
	6080	6081	6082	6083	6084	6085	6086	6087	6088	6089

1988 SURVEY — Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
539.5	165600	165600	165700	165700	165800	165900	165900	166000	166000	166100
	6090	6091	6092	6093	6094	6095	6096	6097	6098	6099
539.6	166200	166200	166300	166400	166400	166500	166500	166600	166700	166700
	6099	6100	6101	6102	6103	6104	6105	6106	6107	6108
539.7	166800	166800	166900	167000	167000	167100	167100	167200	167300	167300
	6109	6110	6111	6112	6113	6114	6115	6116	6117	6118
539.8	167400	167500	167500	167600	167600	167700	167800	167800	167900	167900
	6118	6119	6120	6121	6122	6123	6124	6125	6126	6127
539.9	168000	168100	168100	168200	168200	168300	168400	168400	168500	168600
	6128	6129	6130	6131	6132	6133	6134	6135	6136	6137
540.0	168600	168700	168700	168800	168900	168900	169000	169000	169100	169200
	6137	6139	6140	6142	6144	6145	6147	6148	6150	6151
540.1	169200	169300	169400	169400	169500	169500	169600	169700	169700	169800
	6153	6155	6156	6158	6159	6161	6162	6164	6166	6167
540.2	169800	169900	170000	170000	170100	170200	170200	170300	170300	170400
	6169	6170	6172	6173	6175	6177	6178	6180	6181	6183
540.3	170500	170500	170600	170600	170700	170800	170800	170900	171000	171000
	6184	6186	6188	6189	6191	6192	6194	6195	6197	6199
540.4	171100	171100	171200	171300	171300	171400	171500	171500	171600	171600
	6200	6202	6203	6205	6206	6208	6210	6211	6213	6214
540.5	171700	171800	171800	171900	172000	172000	172100	172100	172200	172300
	6216	6217	6219	6221	6222	6224	6225	6227	6229	6230
540.6	172300	172400	172400	172500	172600	172600	172700	172800	172800	172900
	6232	6233	6235	6236	6238	6240	6241	6243	6244	6246
540.7	172900	173000	173100	173100	173200	173300	173300	173400	173400	173500
	6248	6249	6251	6252	6254	6255	6257	6259	6260	6262
540.8	173600	173600	173700	173800	173800	173900	173900	174000	174100	174100
	6263	6265	6267	6268	6270	6271	6273	6274	6276	6278
540.9	174200	174300	174300	174400	174500	174500	174600	174600	174700	174800
	6279	6281	6282	6284	6286	6287	6289	6290	6292	6294
541.0	174800	174900	175000	175000	175100	175100	175200	175300	175300	175400
	6295	6296	6297	6298	6299	6300	6301	6302	6303	6304
541.1	175500	175500	175600	175600	175700	175800	175800	175900	176000	176000
	6305	6306	6307	6308	6309	6310	6311	6312	6313	6314
541.2	176100	176200	176200	176300	176300	176400	176500	176500	176600	176700
	6315	6316	6317	6318	6319	6320	6321	6322	6323	6324
541.3	176700	176800	176800	176900	177000	177000	177100	177200	177200	177300
	6325	6326	6327	6328	6329	6330	6331	6332	6333	6334
541.4	177400	177400	177500	177500	177600	177700	177700	177800	177900	177900
	6335	6336	6337	6338	6339	6339	6340	6341	6342	6343
541.5	178000	178100	178100	178200	178200	178300	178400	178400	178500	178600
	6344	6345	6346	6347	6348	6349	6350	6351	6352	6353
541.6	178600	178700	178700	178800	178900	178900	179000	179100	179100	179200
	6354	6355	6356	6357	6358	6359	6360	6361	6362	6363
541.7	179300	179300	179400	179400	179500	179600	179600	179700	179800	179800
	6364	6365	6366	6367	6368	6369	6370	6371	6372	6373
541.8	179900	180000	180000	180100	180100	180200	180300	180300	180400	180500
	6374	6375	6376	6377	6378	6379	6380	6381	6382	6383
541.9	180500	180600	180700	180700	180800	180900	180900	181000	181000	181100
	6384	6385	6386	6387	6388	6389	6390	6391	6392	6393

.1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
542.0	181200	181200	181300	181400	181400	181500	181600	181600	181700	181700
	6394	6395	6397	6399	6400	6402	6404	6405	6407	6409
542.1	181800	181900	181900	182000	182100	182100	182200	182300	182300	182400
	6411	6412	6414	6416	6417	6419	6421	6423	6424	6426
542.2	182500	182500	182600	182600	182700	182800	182800	182900	183000	183000
	6428	6430	6431	6433	6435	6436	6438	6440	6442	6443
542.3	183100	183200	183200	183300	183400	183400	183500	183500	183600	183700
	6445	6447	6448	6450	6452	6454	6455	6457	6459	6461
542.4	183700	183800	183900	183900	184000	184100	184100	184200	184300	184300
	6462	6464	6466	6468	6469	6471	6473	6474	6476	6478
542.5	184400	184500	184500	184600	184600	184700	184800	184800	184900	185000
	6480	6481	6483	6485	6487	6488	6490	6492	6493	6495
542.6	185000	185100	185200	185200	185300	185400	185400	185500	185600	185600
	6497	6499	6500	6502	6504	6506	6507	6509	6511	6513
542.7	185700	185800	185800	185900	185900	186000	186100	186100	186200	186300
	6514	6516	6518	6520	6521	6523	6525	6526	6528	6530
542.8	186300	186400	186500	186500	186600	186700	186700	186800	186900	186900
	6532	6533	6535	6537	6539	6540	6542	6544	6546	6547
542.9	187000	187100	187100	187200	187300	187300	187400	187500	187500	187600
	6549	6551	6553	6554	6556	6558	6560	6561	6563	6565
543.0	187600	187700	187800	187800	187900	188000	188000	188100	188200	188200
	6566	6568	6569	6570	6571	6572	6573	6575	6576	6577
543.1	188300	188400	188400	188500	188600	188600	188700	188800	188800	188900
	6578	6579	6580	6581	6582	6583	6584	6586	6587	6588
543.2	189000	189000	189100	189200	189200	189300	189400	189400	189500	189600
	6589	6590	6591	6592	6593	6594	6596	6597	6598	6599
543.3	189600	189700	189800	189800	189900	190000	190000	190100	190200	190200
	6600	6601	6602	6603	6604	6606	6607	6608	6609	6610
543.4	190300	190400	190400	190500	190500	190600	190700	190700	190800	190900
	6611	6612	6613	6614	6615	6617	6618	6619	6620	6621
543.5	190900	191000	191100	191100	191200	191300	191300	191400	191500	191500
	6622	6623	6624	6625	6627	6628	6629	6630	6631	6632
543.6	191600	191700	191700	191800	191900	191900	192000	192100	192100	192200
	6633	6634	6635	6637	6638	6639	6640	6641	6642	6643
543.7	192300	192300	192400	192500	192500	192600	192700	192700	192800	192900
	6644	6645	6647	6648	6649	6650	6651	6652	6653	6654
543.8	192900	193000	193100	193100	193200	193300	193300	193400	193500	193500
	6655	6657	6658	6659	6660	6661	6662	6663	6664	6665
543.9	193600	193700	193700	193800	193900	193900	194000	194100	194100	194200
	6667	6668	6669	6670	6671	6672	6673	6674	6675	6677
544.0	194300	194300	194400	194500	194500	194600	194700	194700	194800	194900
	6678	6679	6681	6682	6684	6686	6687	6689	6691	6692
544.1	194900	195000	195100	195100	195200	195300	195300	195400	195500	195500
	6694	6696	6697	6699	6701	6702	6704	6706	6707	6709
544.2	195600	195700	195700	195800	195900	195900	196000	196100	196100	196200
	6711	6712	6714	6716	6717	6719	6721	6722	6724	6726
544.3	196300	196300	196400	196500	196500	196600	196700	196800	196800	196900
	6727	6729	6731	6732	6734	6736	6737	6739	6741	6743
544.4	197000	197000	197100	197200	197200	197300	197400	197400	197500	197600
	6744	6746	6748	6749	6751	6753	6754	6756	6758	6759

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
544.5	197600	197700	197800	197800	197900	198000	198000	198100	198200	198200
	6761	6763	6764	6766	6768	6769	6771	6773	6774	6776
544.6	198300	198400	198400	198500	198600	198600	198700	198800	198800	198900
	6778	6779	6781	6783	6784	6786	6788	6789	6791	6793
544.7	199000	199100	199100	199200	199300	199300	199400	199500	199500	199600
	6794	6796	6798	6799	6801	6803	6805	6806	6808	6810
544.8	199700	199700	199800	199900	199900	200000	200100	200100	200200	200300
	6811	6813	6815	6816	6818	6820	6821	6823	6825	6826
544.9	200300	200400	200500	200600	200600	200700	200800	200800	200900	201000
	6828	6830	6831	6833	6835	6836	6838	6840	6842	6843
545.0	201000	201100	201200	201200	201300	201400	201400	201500	201600	201600
	6845	6846	6847	6849	6850	6851	6852	6853	6854	6855
545.1	201700	201800	201900	201900	202000	202100	202100	202200	202300	202300
	6856	6857	6859	6860	6861	6862	6863	6864	6865	6866
545.2	202400	202500	202500	202600	202700	202700	202800	202900	203000	203000
	6868	6869	6870	6871	6872	6873	6874	6875	6876	6878
545.3	203100	203200	203200	203300	203400	203400	203500	203600	203600	203700
	6879	6880	6881	6882	6883	6884	6885	6887	6888	6889
545.4	203800	203800	203900	204000	204100	204100	204200	204300	204300	204400
	6890	6891	6892	6893	6894	6895	6897	6898	6899	6900
545.5	204500	204500	204600	204700	204700	204800	204900	204900	205000	205100
	6901	6902	6903	6904	6906	6907	6908	6909	6910	6911
545.6	205200	205200	205300	205400	205400	205500	205600	205600	205700	205800
	6912	6913	6914	6916	6917	6918	6919	6920	6921	6922
545.7	205800	205900	206000	206100	206100	206200	206300	206300	206400	206500
	6923	6925	6926	6927	6928	6929	6930	6931	6932	6934
545.8	206500	206600	206700	206700	206800	206900	207000	207000	207100	207200
	6935	6936	6937	6938	6939	6940	6941	6943	6944	6945
545.9	207200	207300	207400	207400	207500	207600	207700	207700	207800	207900
	6946	6947	6948	6949	6950	6952	6953	6954	6955	6956
546.0	207900	208000	208100	208100	208200	208300	208300	208400	208500	208600
	6957	6959	6960	6962	6964	6966	6968	6970	6972	6973
546.1	208600	208700	208800	208800	208900	209000	209000	209100	209200	209300
	6975	6977	6979	6981	6983	6985	6987	6988	6990	6992
546.2	209300	209400	209500	209500	209600	209700	209700	209800	209900	210000
	6994	6996	6998	7000	7001	7003	7005	7007	7009	7011
546.3	210000	210100	210200	210200	210300	210400	210400	210500	210600	210700
	7013	7015	7016	7018	7020	7022	7024	7026	7028	7030
546.4	210700	210800	210900	210900	211000	211100	211100	211200	211300	211400
	7031	7033	7035	7037	7039	7041	7043	7045	7046	7048
546.5	211400	211500	211600	211600	211700	211800	211900	211900	212000	212100
	7050	7052	7054	7056	7058	7060	7061	7063	7065	7067
546.6	212100	212200	212300	212300	212400	212500	212600	212600	212700	212800
	7069	7071	7073	7075	7076	7078	7080	7082	7084	7086
546.7	212800	212900	213000	213100	213100	213200	213300	213300	213400	213500
	7088	7090	7091	7093	7095	7097	7099	7101	7103	7105
546.8	213600	213600	213700	213800	213800	213900	214000	214100	214100	214200
	7107	7108	7110	7112	7114	7116	7118	7120	7122	7123
546.9	214300	214300	214400	214500	214500	214600	214700	214800	214800	214900
	7125	7127	7129	7131	7133	7135	7137	7139	7140	7142

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
547.0	215000	215000	215100	215200	215300	215300	215400	215500	215500	215600
	7144	7146	7147	7148	7149	7151	7152	7153	7154	7156
547.1	215700	215800	215800	215900	216000	216100	216100	216200	216300	216300
	7157	7158	7159	7160	7162	7163	7164	7165	7166	7168
547.2	216400	216500	216600	216600	216700	216800	216800	216900	217000	217100
	7169	7170	7171	7173	7174	7175	7176	7177	7179	7180
547.3	217100	217200	217300	217300	217400	217500	217600	217600	217700	217800
	7181	7182	7184	7185	7186	7187	7188	7190	7191	7192
547.4	217800	217900	218000	218100	218100	218200	218300	218300	218400	218500
	7193	7194	7196	7197	7198	7199	7201	7202	7203	7204
547.5	218600	218600	218700	218800	218900	218900	219000	219100	219100	219200
	7205	7207	7208	7209	7210	7212	7213	7214	7215	7216
547.6	219300	219400	219400	219500	219600	219600	219700	219800	219900	219900
	7218	7219	7220	7221	7223	7224	7225	7226	7227	7229
547.7	220000	220100	220200	220200	220300	220400	220400	220500	220600	220700
	7230	7231	7232	7234	7235	7236	7237	7238	7240	7241
547.8	220700	220800	220900	220900	221000	221100	221200	221200	221300	221400
	7242	7243	7245	7246	7247	7248	7249	7251	7252	7253
547.9	221500	221500	221600	221700	221700	221800	221900	222000	222000	222100
	7254	7256	7257	7258	7259	7260	7262	7263	7264	7265
548.0	222200	222300	222300	222400	222500	222500	222600	222700	222800	222800
	7267	7268	7270	7272	7274	7276	7278	7280	7282	7285
548.1	222900	223000	223100	223100	223200	223300	223300	223400	223500	223600
	7287	7289	7291	7293	7295	7297	7299	7301	7303	7305
548.2	223600	223700	223800	223900	223900	224000	224100	224200	224200	224300
	7307	7309	7311	7313	7315	7317	7319	7321	7323	7325
548.3	224400	224400	224500	224600	224700	224700	224800	224900	225000	225000
	7327	7330	7332	7334	7336	7338	7340	7342	7344	7346
548.4	225100	225200	225300	225300	225400	225500	225500	225600	225700	225800
	7348	7350	7352	7354	7356	7358	7360	7362	7364	7366
548.5	225800	225900	226000	226100	226100	226200	226300	226400	226400	226500
	7369	7371	7373	7375	7377	7379	7381	7383	7385	7387
548.6	226600	226700	226700	226800	226900	226900	227000	227100	227200	227200
	7389	7391	7393	7395	7397	7399	7401	7404	7406	7408
548.7	227300	227400	227500	227500	227600	227700	227800	227800	227900	228000
	7410	7412	7414	7416	7418	7420	7422	7424	7426	7428
548.8	228100	228100	228200	228300	228400	228400	228500	228600	228700	228700
	7430	7432	7434	7437	7439	7441	7443	7445	7447	7449
548.9	228800	228900	229000	229000	229100	229200	229200	229300	229400	229500
	7451	7453	7455	7457	7459	7461	7463	7465	7468	7470
549.0	229500	229600	229700	229800	229800	229900	230000	230100	230100	230200
	7472	7473	7475	7476	7478	7479	7481	7482	7483	7485
549.1	230300	230400	230400	230500	230600	230700	230700	230800	230900	231000
	7486	7488	7489	7490	7492	7493	7495	7496	7497	7499
549.2	231000	231100	231200	231300	231300	231400	231500	231600	231600	231700
	7500	7502	7503	7504	7506	7507	7509	7510	7512	7513
549.3	231800	231900	231900	232000	232100	232200	232200	232300	232400	232500
	7514	7516	7517	7519	7520	7521	7523	7524	7526	7527
549.4	232500	232600	232700	232800	232800	232900	233000	233100	233200	233200
	7529	7530	7531	7533	7534	7536	7537	7538	7540	7541

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
549.5	233300	233400	233500	233500	233600	233700	233800	233800	233900	234000
	7543	7544	7545	7547	7548	7550	7551	7553	7554	7555
549.6	234100	234100	234200	234300	234400	234400	234500	234600	234700	234700
	7557	7558	7560	7561	7562	7564	7565	7567	7568	7570
549.7	234800	234900	235000	235000	235100	235200	235300	235300	235400	235500
	7571	7572	7574	7575	7577	7578	7580	7581	7582	7584
549.8	235600	235600	235700	235800	235900	235900	236000	236100	236200	236300
	7585	7587	7588	7589	7591	7592	7594	7595	7597	7598
549.9	236300	236400	236500	236600	236600	236700	236800	236900	236900	237000
	7599	7601	7602	7604	7605	7606	7608	7609	7611	7612
550.0	237100	237200	237200	237300	237400	237500	237500	237600	237700	237800
	7614	7615	7616	7618	7619	7621	7622	7624	7625	7626
550.1	237900	237900	238000	238100	238200	238200	238300	238400	238500	238500
	7628	7629	7631	7632	7633	7635	7636	7638	7639	7640
550.2	238600	238700	238800	238800	238900	239000	239100	239100	239200	239300
	7642	7643	7645	7646	7648	7649	7650	7652	7653	7655
550.3	239400	239500	239500	239600	239700	239800	239800	239900	240000	240100
	7656	7657	7659	7660	7662	7663	7665	7666	7667	7669
550.4	240100	240200	240300	240400	240500	240500	240600	240700	240800	240800
	7670	7672	7673	7675	7676	7677	7679	7680	7682	7683
550.5	240900	241000	241100	241100	241200	241300	241400	241500	241500	241600
	7684	7686	7687	7689	7690	7692	7693	7694	7696	7697
550.6	241700	241800	241800	241900	242000	242100	242100	242200	242300	242400
	7699	7700	7702	7703	7704	7706	7707	7709	7710	7711
550.7	242500	242500	242600	242700	242800	242800	242900	243000	243100	243100
	7713	7714	7716	7717	7719	7720	7721	7723	7724	7726
550.8	243200	243300	243400	243500	243500	243600	243700	243800	243800	243900
	7727	7729	7730	7731	7733	7734	7736	7737	7739	7740
550.9	244000	244100	244200	244200	244300	244400	244500	244500	244600	244700
	7741	7743	7744	7746	7747	7749	7750	7751	7753	7754
551.0	244800	244800	244900	245000	245100	245200	245200	245300	245400	245500
	7756	7757	7759	7760	7762	7763	7765	7766	7768	7769
551.1	245500	245600	245700	245800	245900	245900	246000	246100	246200	246200
	7771	7772	7774	7775	7777	7778	7780	7781	7783	7784
551.2	246300	246400	246500	246600	246600	246700	246800	246900	246900	247000
	7786	7787	7789	7790	7792	7793	7795	7796	7798	7799
551.3	247100	247200	247300	247300	247400	247500	247600	247700	247700	247800
	7801	7802	7804	7805	7807	7808	7810	7811	7813	7814
551.4	247900	248000	248000	248100	248200	248300	248400	248400	248500	248600
	7816	7817	7819	7820	7822	7823	7825	7826	7828	7829
551.5	248700	248700	248800	248900	249000	249100	249100	249200	249300	249400
	7831	7832	7834	7835	7837	7838	7840	7841	7843	7844
551.6	249500	249500	249600	249700	249800	249800	249900	250000	250100	250200
	7846	7847	7849	7850	7852	7853	7855	7856	7858	7859
551.7	250200	250300	250400	250500	250600	250600	250700	250800	250900	250900
	7861	7862	7864	7865	7867	7868	7870	7871	7873	7874
551.8	251000	251100	251200	251300	251300	251400	251500	251600	251700	251700
	7876	7877	7879	7880	7882	7883	7885	7886	7888	7889
551.9	251800	251900	252000	252000	252100	252200	252300	252400	252400	252500
	7891	7892	7894	7895	7897	7898	7900	7901	7903	7905

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
552.0	252600 7906	252700 7908	252800 7910	252800 7912	252900 7914	253000 7916	253100 7918	253200 7920	253200 7922	253300 7924
552.1	253400 7926	253500 7928	253600 7930	253600 7932	253700 7934	253800 7936	253900 7938	253900 7939	254000 7941	254100 7943
552.2	254200 7945	254300 7947	254300 7949	254400 7951	254500 7953	254600 7955	254700 7957	254700 7959	254800 7961	254900 7963
552.3	255000 7965	255100 7967	255100 7969	255200 7971	255300 7973	255400 7975	255500 7977	255500 7979	255600 7981	255700 7983
552.4	255800 7985	255900 7987	255900 7989	256000 7991	256100 7993	256200 7995	256300 7997	256300 7999	256400 8001	256500 8003
552.5	256600 8005	256700 8007	256700 8009	256800 8011	256900 8013	257000 8015	257100 8017	257100 8019	257200 8021	257300 8023
552.6	257400 8025	257500 8027	257500 8029	257600 8031	257700 8033	257800 8035	257900 8037	257900 8039	258000 8041	258100 8043
552.7	258200 8045	258300 8047	258300 8049	258400 8051	258500 8053	258600 8055	258700 8057	258700 8059	258800 8061	258900 8063
552.8	259000 8065	259100 8067	259100 8069	259200 8071	259300 8073	259400 8075	259500 8077	259600 8079	259600 8081	259700 8083
552.9	259800 8085	259900 8087	260000 8089	260000 8091	260100 8093	260200 8095	260300 8097	260400 8100	260400 8102	260500 8104
553.0	260600 8106	260700 8107	260800 8109	260800 8110	260900 8111	261000 8113	261100 8114	261200 8115	261300 8117	261300 8118
553.1	261400 8119	261500 8121	261600 8122	261700 8123	261700 8125	261800 8126	261900 8127	262000 8129	262100 8130	262100 8131
553.2	262200 8132	262300 8134	262400 8135	262500 8136	262600 8138	262600 8139	262700 8140	262800 8142	262900 8143	263000 8144
553.3	263000 8146	263100 8147	263200 8148	263300 8150	263400 8151	263400 8152	263500 8154	263600 8155	263700 8156	263800 8158
553.4	263900 8159	263900 8160	264000 8162	264100 8163	264200 8164	264300 8166	264300 8167	264400 8168	264500 8170	264600 8171
553.5	264700 8172	264800 8174	264800 8175	264900 8176	265000 8178	265100 8179	265200 8180	265200 8182	265300 8183	265400 8184
553.6	265500 8185	265600 8187	265700 8188	265700 8189	265800 8191	265900 8192	266000 8193	266100 8195	266100 8196	266200 8197
553.7	266300 8199	266400 8200	266500 8201	266600 8203	266600 8204	266700 8205	266800 8207	266900 8208	267000 8209	267000 8211
553.8	267100 8212	267200 8213	267300 8215	267400 8216	267500 8217	267500 8219	267600 8220	267700 8221	267800 8223	267900 8224
553.9	268000 8225	268000 8227	268100 8228	268200 8229	268300 8231	268400 8232	268400 8233	268500 8235	268600 8236	268700 8237
554.0	268800 8239	268900 8240	268900 8243	269000 8245	269100 8247	269200 8250	269300 8252	269400 8255	269400 8257	269500 8260
554.1	269600 8262	269700 8264	269800 8267	269800 8269	269900 8272	270000 8274	270100 8276	270200 8279	270300 8281	270300 8284
554.2	270400 8286	270500 8288	270600 8291	270700 8293	270800 8296	270800 8298	270900 8300	271000 8303	271100 8305	271200 8308
554.3	271300 8310	271300 8313	271400 8315	271500 8317	271600 8320	271700 8322	271800 8325	271800 8327	271900 8329	272000 8332
554.4	272100 8334	272200 8337	272300 8339	272300 8342	272400 8344	272500 8346	272600 8349	272700 8351	272800 8354	272800 8356

1988 SURVEY Prado Dam

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
554.5	272900	273000	273100	273200	273300	273300	273400	273500	273600	273700
	8358	8361	8363	8366	8368	8371	8373	8375	8378	8380
554.6	273800	273800	273900	274000	274100	274200	274300	274300	274400	274500
	8383	8385	8388	8390	8392	8395	8397	8400	8402	8405
554.7	274600	274700	274800	274900	274900	275000	275100	275200	275300	275400
	8407	8409	8412	8414	8417	8419	8422	8424	8426	8429
554.8	275400	275500	275600	275700	275800	275900	275900	276000	276100	276200
	8431	8434	8436	8439	8441	8443	8446	8448	8451	8453
554.9	276300	276400	276500	276500	276600	276700	276800	276900	277000	277000
	8456	8458	8460	8463	8465	8468	8470	8473	8475	8478
555.0	277100	277200	277300	277400	277500	277600	277600	277700	277800	277900
	8480	8482	8484	8485	8487	8489	8490	8492	8493	8495
555.1	278000	278100	278100	278200	278300	278400	278500	278600	278700	278700
	8496	8498	8500	8501	8503	8504	8506	8507	8509	8511
555.2	278800	278900	279000	279100	279200	279300	279300	279400	279500	279600
	8512	8514	8515	8517	8518	8520	8522	8523	8525	8526
555.3	279700	279800	279900	279900	280000	280100	280200	280300	280400	280400
	8528	8530	8531	8533	8534	8536	8537	8539	8541	8542
555.4	280500	280600	280700	280800	280900	281000	281000	281100	281200	281300
	8544	8545	8547	8549	8550	8552	8553	8555	8556	8558
555.5	281400	281500	281600	281600	281700	281800	281900	282000	282100	282200
	8560	8561	8563	8564	8566	8568	8569	8571	8572	8574
555.6	282200	282300	282400	282500	282600	282700	282800	282800	282900	283000
	8575	8577	8579	8580	8582	8583	8585	8587	8588	8590
555.7	283100	283200	283300	283400	283400	283500	283600	283700	283800	283900
	8591	8593	8594	8596	8598	8599	8601	8602	8604	8606
555.8	284000	284100	284100	284200	284300	284400	284500	284600	284700	284700
	8607	8609	8610	8612	8614	8615	8617	8618	8620	8621
555.9	284800	284900	285000	285100	285200	285300	285300	285400	285500	285600
	8623	8625	8626	8628	8629	8631	8633	8634	8636	8637
556.0	285700	285800	285900	285900	286000	286100	286200	286300	286400	286500
	8639	8641	8643	8646	8648	8651	8654	8656	8659	8661
556.1	286600	286600	286700	286800	286900	287000	287100	287200	287200	287300
	8664	8667	8669	8672	8674	8677	8679	8682	8685	8687
556.2	287400	287500	287600	287700	287800	287900	287900	288000	288100	288200
	8690	8692	8695	8697	8700	8703	8705	8708	8710	8713
556.3	288300	288400	288500	288600	288600	288700	288800	288900	289000	289100
	8716	8718	8721	8723	8726	8729	8731	8734	8736	8739
556.4	289200	289300	289300	289400	289500	289600	289700	289800	289900	290000
	8741	8744	8747	8749	8752	8754	8757	8760	8762	8765
556.5	290000	290100	290200	290300	290400	290500	290600	290700	290700	290800
	8767	8770	8773	8775	8778	8780	8783	8786	8788	8791
556.6	290900	291000	291100	291200	291300	291400	291400	291500	291600	291700
	8793	8796	8799	8801	8804	8806	8809	8812	8814	8817
556.7	291800	291900	292000	292100	292100	292200	292300	292400	292500	292600
	8819	8822	8825	8827	8830	8832	8835	8838	8840	8843
556.8	292700	292800	292900	292900	293000	293100	293200	293300	293400	293500
	8845	8848	8851	8853	8856	8858	8861	8864	8866	8869
556.9	293600	293700	293700	293800	293900	294000	294100	294200	294300	294400
	8871	8874	8877	8879	8882	8884	8887	8890	8892	8895

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ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
557.0	294500	294500	294600	294700	294800	294900	295000	295100	295200	295300
	8898	8900	8902	8903	8905	8906	8908	8910	8911	8913
557.1	295300	295400	295500	295600	295700	295800	295900	296000	296100	296100
	8914	8916	8917	8919	8921	8922	8924	8925	8927	8929
557.2	296200	296300	296400	296500	296600	296700	296800	296900	297000	297000
	8930	8932	8933	8935	8937	8938	8940	8941	8943	8945
557.3	297100	297200	297300	297400	297500	297600	297700	297800	297800	297900
	8946	8948	8949	8951	8953	8954	8956	8957	8959	8961
557.4	298000	298100	298200	298300	298400	298500	298600	298700	298700	298800
	8962	8964	8965	8967	8969	8970	8972	8973	8975	8977
557.5	298900	299000	299100	299200	299300	299400	299500	299600	299600	299700
	8978	8980	8981	8983	8984	8986	8988	8989	8991	8992
557.6	299800	299900	300000	300100	300200	300300	300400	300500	300500	300600
	8994	8996	8997	8999	9000	9002	9004	9005	9007	9008
557.7	300700	300800	300900	301000	301100	301200	301300	301400	301400	301500
	9010	9012	9013	9015	9016	9018	9020	9021	9023	9025
557.8	301600	301700	301800	301900	302000	302100	302200	302300	302300	302400
	9026	9028	9029	9031	9033	9034	9036	9037	9039	9041
557.9	302500	302600	302700	302800	302900	303000	303100	303200	303200	303300
	9042	9044	9045	9047	9049	9050	9052	9053	9055	9057
558.0	303400	303500	303600	303700	303800	303900	304000	304100	304200	304200
	9058	9060	9062	9065	9068	9070	9073	9075	9078	9080
558.1	304300	304400	304500	304600	304700	304800	304900	305000	305100	305200
	9083	9085	9088	9090	9093	9095	9098	9100	9103	9105
558.2	305200	305300	305400	305500	305600	305700	305800	305900	306000	306100
	9108	9110	9113	9116	9118	9121	9123	9126	9128	9131
558.3	306200	306200	306300	306400	306500	306600	306700	306800	306900	307000
	9133	9136	9138	9141	9143	9146	9149	9151	9154	9156
558.4	307100	307200	307300	307300	307400	307500	307600	307700	307800	307900
	9159	9161	9164	9166	9169	9171	9174	9176	9179	9182
558.5	308000	308100	308200	308300	308400	308400	308500	308600	308700	308800
	9184	9187	9189	9192	9194	9197	9199	9202	9204	9207
558.6	308900	309000	309100	309200	309300	309400	309500	309600	309600	309700
	9209	9212	9215	9217	9220	9222	9225	9227	9230	9232
558.7	309800	309900	310000	310100	310200	310300	310400	310500	310600	310700
	9235	9238	9240	9243	9245	9248	9250	9253	9255	9258
558.8	310800	310800	310900	311000	311100	311200	311300	311400	311500	311600
	9260	9263	9266	9268	9271	9273	9276	9278	9281	9283
558.9	311700	311800	311900	312000	312100	312100	312200	312300	312400	312500
	9286	9289	9291	9294	9296	9299	9301	9304	9306	9309
559.0	312600	312700	312800	312900	313000	313100	313200	313300	313400	313500
	9312	9314	9315	9317	9318	9320	9321	9323	9324	9326
559.1	313500	313600	313700	313800	313900	314000	314100	314200	314300	314400
	9327	9329	9330	9332	9333	9335	9336	9338	9339	9341
559.2	314500	314600	314700	314800	314900	314900	315000	315100	315200	315300
	9342	9343	9345	9346	9348	9349	9351	9352	9354	9355
559.3	315400	315500	315600	315700	315800	315900	316000	316100	316200	316300
	9357	9358	9360	9361	9363	9364	9366	9367	9369	9370
559.4	316300	316400	316500	316600	316700	316800	316900	317000	317100	317200
	9371	9373	9374	9376	9377	9379	9380	9382	9383	9385

1988 SURVEY

Prado Dam

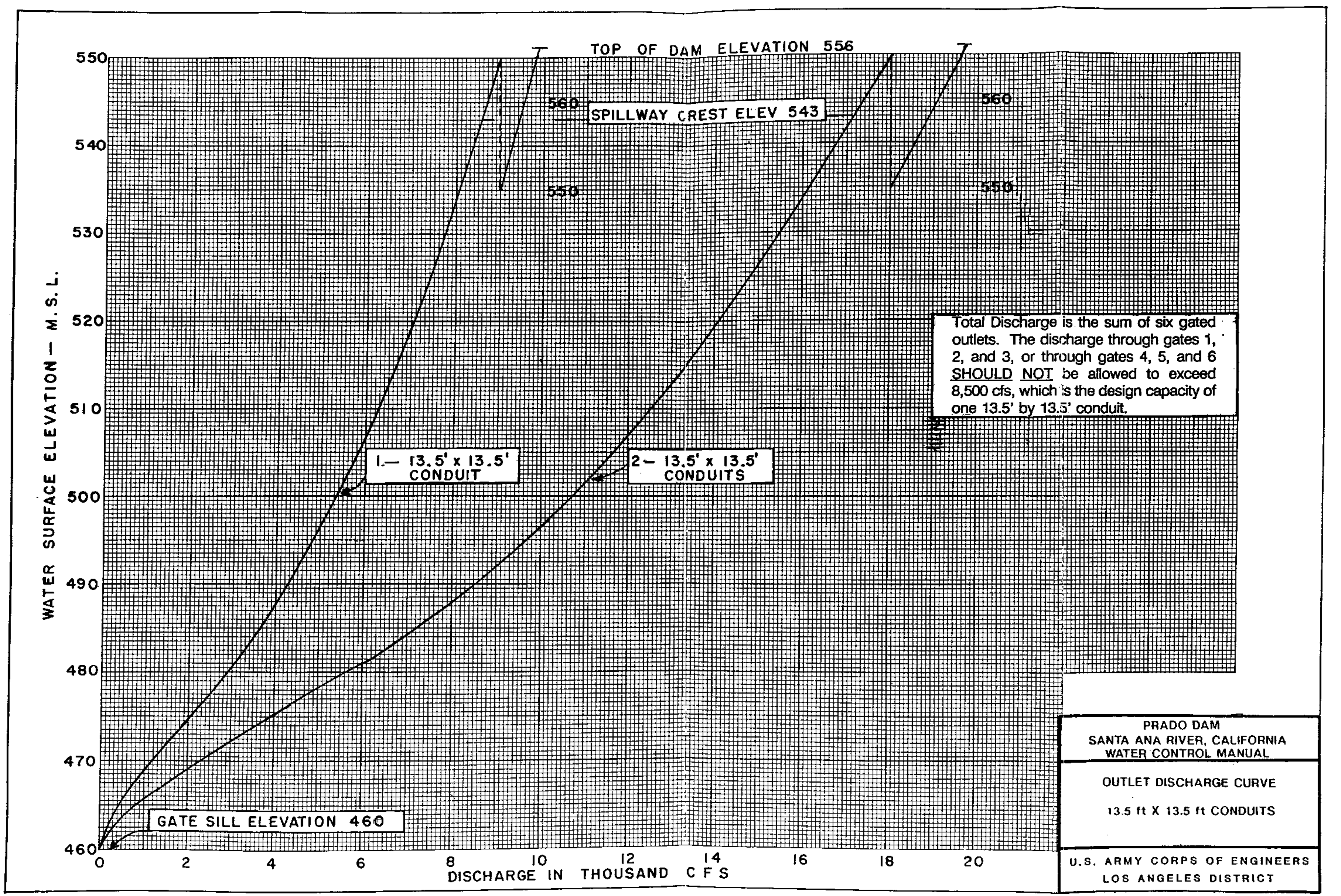
ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
559.5	317300	317400	317500	317600	317700	317800	317800	317900	318000	318100
	9386	9388	9389	9391	9392	9394	9395	9397	9398	9400
559.6	318200	318300	318400	318500	318600	318700	318800	318900	319000	319100
	9401	9403	9404	9405	9407	9408	9410	9411	9413	9414
559.7	319200	319300	319400	319400	319500	319600	319700	319800	319900	320000
	9416	9417	9419	9420	9422	9423	9425	9426	9428	9429
559.8	320100	320200	320300	320400	320500	320600	320700	320800	320900	321000
	9431	9432	9434	9435	9437	9438	9440	9441	9442	9444
559.9	321100	321100	321200	321300	321400	321500	321600	321700	321800	321900
	9445	9447	9448	9450	9451	9453	9454	9456	9457	9459
560.0	322000	322100	322200	322300	322400	322500	322600	322700	322800	322800
	9460	9462	9465	9469	9472	9475	9479	9482	9485	9489
560.1	322900	323000	323100	323200	323300	323400	323500	323600	323700	323800
	9492	9495	9499	9502	9506	9509	9512	9516	9519	9522
560.2	323900	324000	324100	324200	324300	324400	324500	324600	324700	324800
	9526	9529	9532	9536	9539	9542	9546	9549	9553	9556
560.3	324800	324900	325000	325100	325200	325300	325400	325500	325600	325700
	9559	9563	9566	9569	9573	9576	9580	9583	9586	9590
560.4	325800	325900	326000	326100	326200	326300	326400	326500	326600	326700
	9593	9596	9600	9603	9607	9610	9613	9617	9620	9623
560.5	326800	326900	327000	327100	327200	327200	327300	327400	327500	327600
	9627	9630	9634	9637	9640	9644	9647	9650	9654	9657
560.6	327700	327800	327900	328000	328100	328200	328300	328400	328500	328600
	9661	9664	9667	9671	9674	9678	9681	9684	9688	9691
560.7	328700	328800	328900	329000	329100	329200	329300	329400	329500	329600
	9694	9698	9701	9705	9708	9711	9715	9718	9722	9725
560.8	329700	329800	329900	330000	330100	330200	330300	330400	330400	330500
	9728	9732	9735	9739	9742	9745	9749	9752	9756	9759
560.9	330600	330700	330800	330900	331000	331100	331200	331300	331400	331500
	9762	9766	9769	9773	9776	9779	9783	9786	9790	9793
561.0	331600	331700	331800	331900	332000	332100	332200	332300	332400	332500
	9796	9800	9802	9803	9805	9807	9809	9811	9813	9815
561.1	332600	332700	332800	332900	333000	333100	333200	333300	333400	333500
	9816	9818	9820	9822	9824	9826	9828	9829	9831	9833
561.2	333600	333700	333800	333900	334000	334100	334200	334300	334400	334500
	9835	9837	9839	9841	9842	9844	9846	9848	9850	9852
561.3	334600	334700	334800	334900	335000	335100	335200	335300	335400	335500
	9854	9855	9857	9859	9861	9863	9865	9867	9868	9870
561.4	335600	335700	335800	335800	335900	336000	336100	336200	336300	336400
	9872	9874	9876	9878	9880	9881	9883	9885	9887	9889
561.5	336500	336600	336700	336800	336900	337000	337100	337200	337300	337400
	9891	9893	9895	9896	9898	9900	9902	9904	9906	9908
561.6	337500	337600	337700	337800	337900	338000	338100	338200	338300	338400
	9909	9911	9913	9915	9917	9919	9921	9922	9924	9926
561.7	338500	338600	338700	338800	338900	339000	339100	339200	339300	339400
	9928	9930	9932	9934	9936	9937	9939	9941	9943	9945
561.8	339500	339600	339700	339800	339900	340000	340100	340200	340300	340400
	9947	9949	9950	9952	9954	9956	9958	9960	9962	9964
561.9	340500	340600	340700	340800	340900	341000	341100	341200	341300	341400
	9965	9967	9969	9971	9973	9975	9977	9979	9980	9982

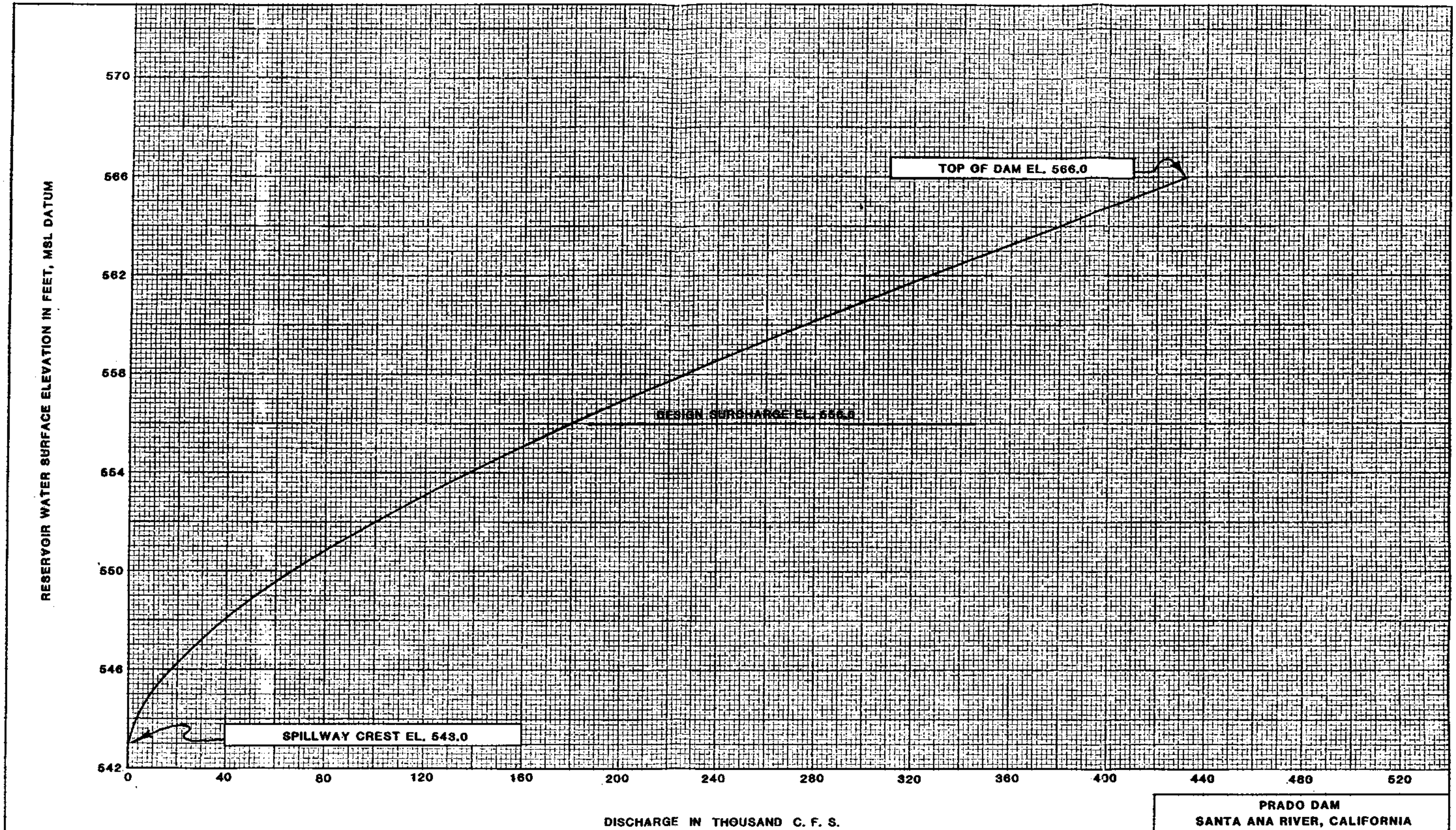
1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
562.0	341500	341600	341700	341800	341900	342000	342100	342200	342300	342400
	9984	9986	9989	9992	9995	9998	10000	10000	10010	10010
562.1	342500	342600	342700	342800	342900	343000	343100	343200	343300	343400
	10010	10020	10020	10020	10020	10030	10030	10030	10040	10040
562.2	343500	343600	343700	343800	343900	344000	344100	344200	344300	344400
	10040	10040	10050	10050	10050	10060	10060	10060	10060	10070
562.3	344500	344600	344700	344800	344900	345000	345100	345200	345300	345400
	10070	10070	10080	10080	10080	10080	10090	10090	10090	10100
562.4	345500	345600	345700	345800	345900	346000	346100	346200	346300	346400
	10100	10100	10110	10110	10110	10110	10120	10120	10120	10130
562.5	346500	346600	346700	346800	346900	347000	347100	347200	347300	347400
	10130	10130	10130	10140	10140	10140	10150	10150	10150	10150
562.6	347500	347700	347800	347900	348000	348100	348200	348300	348400	348500
	10160	10160	10160	10170	10170	10170	10180	10180	10180	10180
562.7	348600	348700	348800	348900	349000	349100	349200	349300	349400	349500
	10190	10190	10190	10200	10200	10200	10200	10210	10210	10210
562.8	349600	349700	349800	349900	350000	350100	350200	350300	350400	350500
	10220	10220	10220	10230	10230	10230	10230	10240	10240	10240
562.9	350600	350700	350800	350900	351000	351100	351200	351300	351400	351500
	10250	10250	10250	10250	10260	10260	10260	10270	10270	10270
563.0	351600	351700	351800	351900	352000	352100	352300	352400	352500	352600
	10280	10280	10280	10280	10280	10290	10290	10290	10290	10290
563.1	352700	352800	352900	353000	353100	353200	353300	353400	353500	353600
	10300	10300	10300	10300	10300	10310	10310	10310	10310	10310
563.2	353700	353800	353900	354000	354100	354200	354300	354400	354500	354600
	10320	10320	10320	10320	10320	10330	10330	10330	10330	10330
563.3	354700	354800	354900	355000	355100	355200	355300	355500	355600	355700
	10340	10340	10340	10340	10340	10350	10350	10350	10350	10350
563.4	355800	355900	356000	356100	356200	356300	356400	356500	356600	356700
	10360	10360	10360	10360	10360	10370	10370	10370	10370	10370
563.5	356800	356900	357000	357100	357200	357300	357400	357500	357600	357700
	10380	10380	10380	10380	10380	10390	10390	10390	10390	10390
563.6	357800	357900	358000	358100	358300	358400	358500	358600	358700	358800
	10400	10400	10400	10400	10400	10410	10410	10410	10410	10410
563.7	358900	359000	359100	359200	359300	359400	359500	359600	359700	359800
	10420	10420	10420	10420	10420	10430	10430	10430	10430	10430
563.8	359900	360000	360100	360200	360300	360400	360500	360600	360800	360900
	10440	10440	10440	10440	10440	10450	10450	10450	10450	10450
563.9	361000	361100	361200	361300	361400	361500	361600	361700	361800	361900
	10460	10460	10460	10460	10460	10470	10470	10470	10470	10470
564.0	362000	362100	362200	362300	362400	362500	362600	362700	362800	363000
	10480	10480	10480	10480	10490	10490	10490	10500	10500	10500
564.1	363100	363200	363300	363400	363500	363600	363700	363800	363900	364000
	10510	10510	10510	10510	10520	10520	10520	10530	10530	10530
564.2	364100	364200	364300	364400	364500	364600	364700	364800	365000	365100
	10540	10540	10540	10550	10550	10550	10550	10560	10560	10560
564.3	365200	365300	365400	365500	365600	365700	365800	365900	366000	366100
	10570	10570	10570	10580	10580	10580	10590	10590	10590	10600
564.4	366200	366300	366400	366500	366600	366800	366900	367000	367100	367200
	10600	10600	10600	10610	10610	10610	10620	10620	10620	10630

1988 SURVEY **Prado Dam**

ELEV FEET	CAP AREA .00	CAP AREA .01	CAP AREA .02	CAP AREA .03	CAP AREA .04	CAP AREA .05	CAP AREA .06	CAP AREA .07	CAP AREA .08	CAP AREA .09
564.5	367300	367400	367500	367600	367700	367800	367900	368000	368100	368200
	10630	10630	10640	10640	10640	10650	10650	10650	10650	10660
564.6	368300	368500	368600	368700	368800	368900	369000	369100	369200	369300
	10660	10660	10670	10670	10670	10680	10680	10680	10690	10690
564.7	369400	369500	369600	369700	369800	369900	370100	370200	370300	370400
	10690	10700	10700	10700	10700	10710	10710	10710	10720	10720
564.8	370500	370600	370700	370800	370900	371000	371100	371200	371300	371500
	10720	10730	10730	10730	10740	10740	10740	10750	10750	10750
564.9	371600	371700	371800	371900	372000	372100	372200	372300	372400	372500
	10760	10760	10760	10760	10770	10770	10770	10780	10780	10780
565.0	372600	372700	372900	373000	373100	373200	373300	373400	373500	373600
	10790	10790	10790	10790	10800	10800	10800	10800	10810	10810
565.1	373700	373800	373900	374000	374100	374300	374400	374500	374600	374700
	10810	10810	10820	10820	10820	10820	10830	10830	10830	10830
565.2	374800	374900	375000	375100	375200	375300	375400	375600	375700	375800
	10830	10840	10840	10840	10840	10850	10850	10850	10850	10860
565.3	375900	376000	376100	376200	376300	376400	376500	376600	376800	376900
	10860	10860	10860	10870	10870	10870	10870	10880	10880	10880
565.4	377000	377100	377200	377300	377400	377500	377600	377700	377800	377900
	10880	10890	10890	10890	10890	10890	10900	10900	10900	10900
565.5	378100	378200	378300	378400	378500	378600	378700	378800	378900	379000
	10910	10910	10910	10910	10920	10920	10920	10920	10930	10930
565.6	379100	379300	379400	379500	379600	379700	379800	379900	380000	380100
	10930	10930	10940	10940	10940	10940	10940	10950	10950	10950
565.7	380200	380400	380500	380600	380700	380800	380900	381000	381100	381200
	10950	10960	10960	10960	10960	10970	10970	10970	10970	10980
565.8	381300	381400	381600	381700	381800	381900	382000	382100	382200	382300
	10980	10980	10980	10990	10990	10990	10990	11000	11000	11000
565.9	382400	382500	382700	382800	382900	383000	383100	383200	383300	383400
	11000	11010	11010	11010	11010	11010	11020	11020	11020	11020
566.0	383500	383600								
	11030	11030								


TOP OF DAM ELEVATION 556
SPILLWAY CREST ELEV 543
560
550
560
550
1.— 13.5' x 13.5' CONDUIT
2 — 13.5' x 13.5' CONDUITS
GATE SILL ELEVATION 460
Total Discharge is the sum of six gated outlets. The discharge through gates 1, 2, and 3, or through gates 4, 5, and 6 SHOULD NOT be allowed to exceed 8,500 cfs, which is the design capacity of one 13.5' by 13.5' conduit.
WATER SURFACE ELEVATION — M. S. L.
460
470
480
490
500
510
520
530
540
550
0
2
4
6
8
10
12
14
16
18
20
DISCHARGE IN THOUSAND C F S
PRADO DAM
SANTA ANA RIVER, CALIFORNIA
WATER CONTROL MANUAL
OUTLET DISCHARGE CURVE
13.5 ft X 13.5 ft CONDUITS
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



PRADO DAM
SANTA ANA RIVER, CALIFORNIA
WATER CONTROL MANUAL

SPILLWAY DISCHARGE CURVE

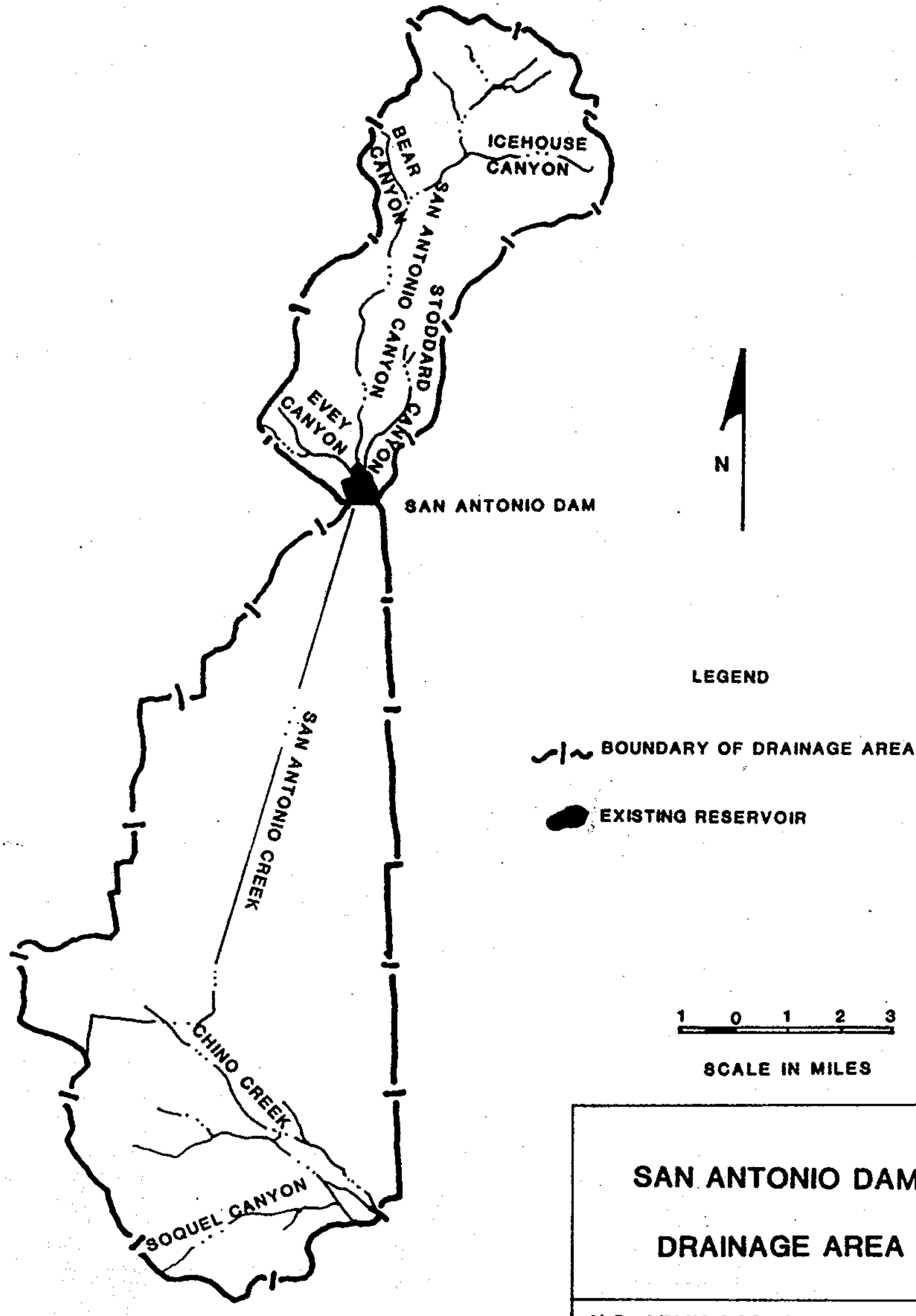
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SAN ANTONIO DAM AND RESERVOIR
LOS ANGELES COUNTY AND SAN BERNARDINO COUNTY, CALIFORNIA

PERTINENT DATA
JULY 1990

Stream System...	San Antonio Creek
Drainage Area...............................sq. mi...	26.7
Reservoir:	
Elevation	
Streambed at upstream toe of dam.........ft, NGVD...	2,125
Debris Pool..............................ft, NGVD...	2,164
Flood control pool (spillway crest)......ft, NGVD...	2,238
Spillway design surcharge level..........ft, NGVD...	2,254.4
Top of dam...............................ft, NGVD...	2,260
Area	
Debris pool..................................acres..	59
Spillway crest...............................acres..	145
Spillway design surcharge level..............acres..	163
Top of dam...................................acres..	168
Capacity, gross	
Debris pool...............................acre-ft..	953 (0.67*)
Spillway crest............................acre-ft..	8,535 (6.02*)
Spillway design surcharge level...........acre-ft..	11,063 (7.83*)
Top of Dam................................acre-ft..	11,992 (8.46*)
Allowance for sediment	
50-year...................................acre-ft..	2,000
Reservoir design flood....................acre-ft..	1,350
Dam: - Type..	Earth
Height above original streambed.................ft..	160
Top length......................................ft..	3,850
Top width.......................................ft..	30
Freeboard.......................................ft..	5.1
Spillway: - Type.............................Ungated overflow concrete ogee	
Crest length....................................ft..	200
Design surcharge................................ft..	16.4
Design discharge..............................c.f.s..	51,160
Outlets:	
Gates - type..	Vertical lift
Number and size.....................................	3 - 5'-8"W x 10'H
Gate sill elevation.................ft., NGVD...	2,125
Conduits	
Number and size - diameter..................ft..	1 - 14.5
Length..ft..	508
Maximum capacity at spillway crest.......c.f.s..	11,800
Regulated capacity at spillway crest.....c.f.s..	8,000
Reservoir design flood:	
Duration (inflow)..........................Days..	2
Total volume..............................acre-ft..	22,500 (15.81*)
Inflow peak...................................c.f.s..	19,000
Spillway design flood:	
Duratioon (inflow).........................Days..	1
Total volume..............................acre-ft..	18,200 (11.90*)
Inflow peak...................................c.f.s..	60,000
Historic maximums:	
Maximum release...............................c.f.s..	8,420
Date..	1-25-69
Maximum water surface elevation.........ft., NGVD...	2225.6
Date..	2-19-80

* inches of runoff

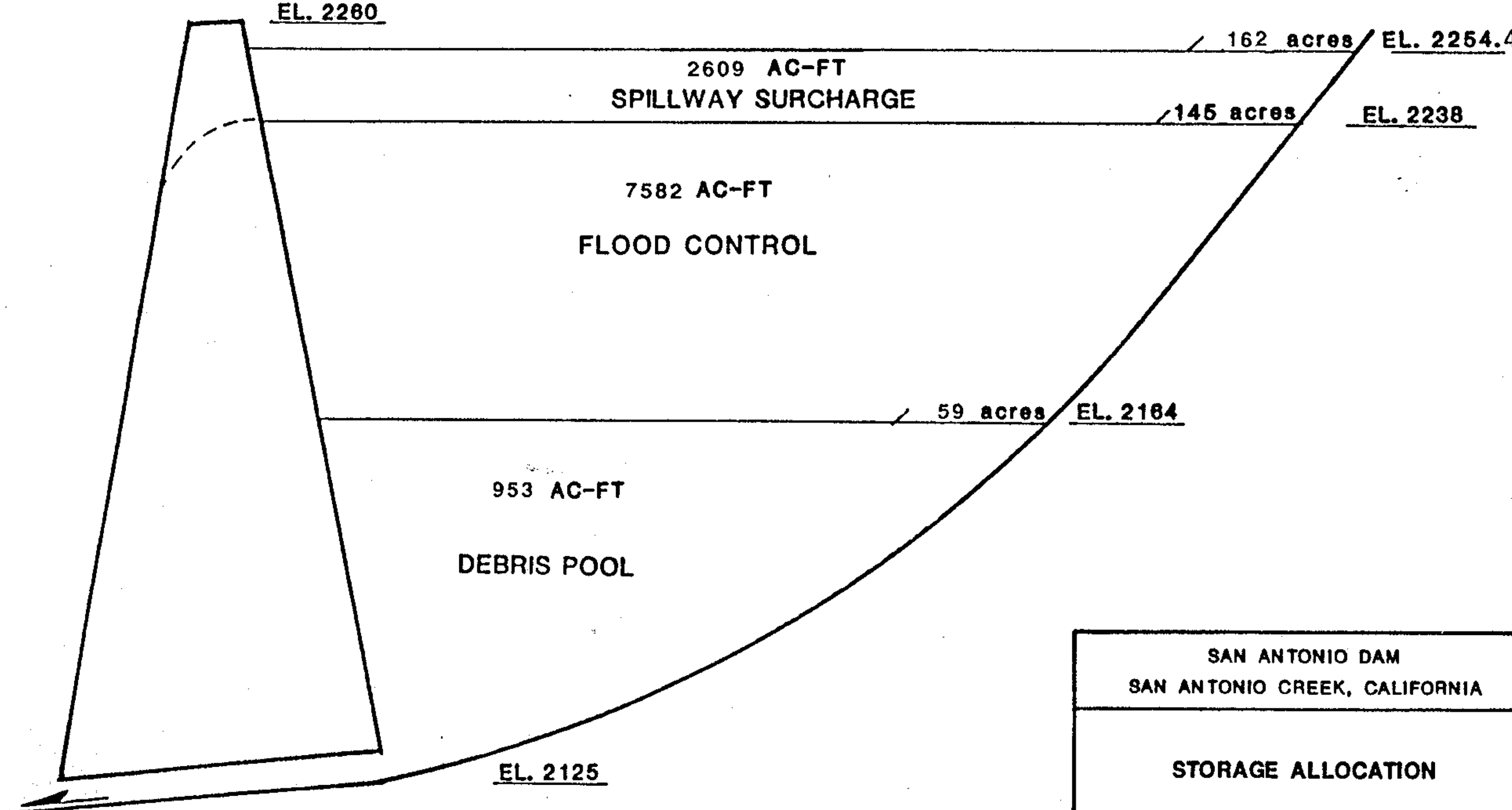


SAN ANTONIO DAM DRAINAGE AREA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

CORPS O. _NGINEERS U.S. ARMY

SAN ANTONIO RESERVOIR, CALIFORNIA

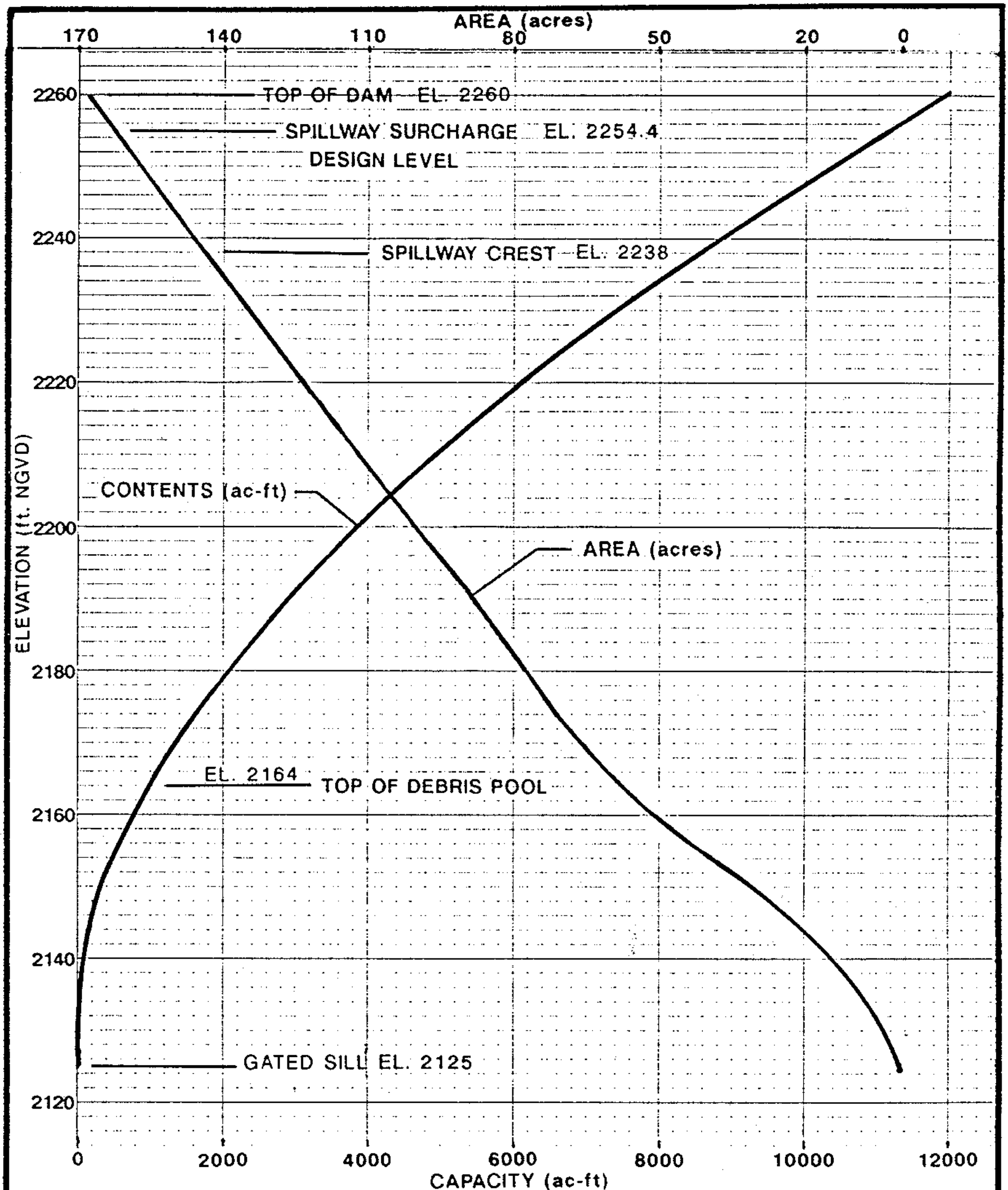


SAN ANTONIO DAM
SAN ANTONIO CREEK, CALIFORNIA

STORAGE ALLOCATION

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SOURCE:
LAD RESERVOIR REGULATION FROM SURVEY OF 21 FEBRUARY 1990



SAN ANTONIO DAM
SAN ANTONIO CREEK, CALIFORNIA

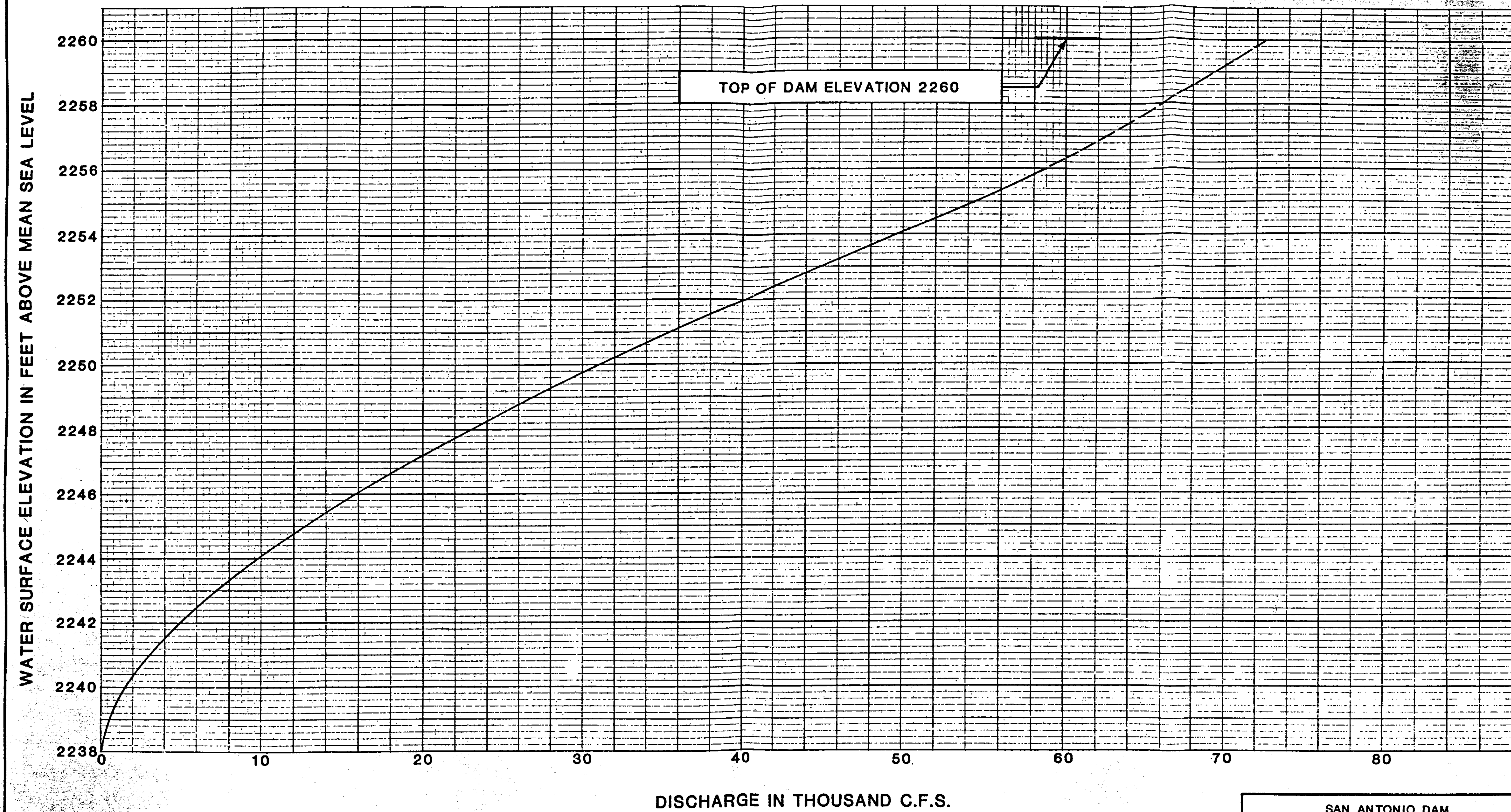
SAN ANTONIO DAM

ELEVATION-AREA-CAPACITY CURVES

SURVEY OF 21 FEBRUARY 1990

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

SOURCE:
LAD RESERVOIR REGULATION



NOTE:
CURVE BASED ON 1:36 SCALE MODEL STUDY
SPILLWAY LENGTH = 200 FEET

SAN ANTONIO DAM SAN ANTONIO CREEK, CALIFORNIA
SPILLWAY DISCHARGE CURVE
U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

SAN ANTONIO DAM ..... ELEVATION VS. CAPACITY ..... SURVEY DATE: 21 FEB 1990

ELEV FEET	CAP .0	CAP .1	CAP .2	CAP .3	CAP .4	CAP .5	CAP .6	CAP .7	CAP .8	CAP .9
2125.0	0	0	0	0	0	0	0	0	0	0
2126.0	0	0	0	0	0	0	0	0	0	0
2127.0	0	0	0	0	0	0	0	1	1	1
2128.0	1	1	1	2	2	2	2	2	3	3
2129.0	3	3	4	4	4	5	5	5	6	6
2130.0	6	7	7	8	8	9	9	10	10	10
2131.0	11	11	12	12	13	13	14	14	15	15
2132.0	15	16	16	17	17	18	18	19	19	20
2133.0	20	21	21	22	23	23	24	24	25	25
2134.0	26	26	27	27	28	28	29	30	30	31
2135.0	31	32	33	33	34	34	35	36	36	37
2136.0	37	38	39	39	40	41	41	42	43	44
2137.0	44	45	46	47	47	48	49	50	50	51
2138.0	52	53	54	55	55	56	57	58	59	60
2139.0	61	62	64	65	66	67	68	69	71	72
2140.0	73	74	76	77	79	80	81	83	84	86
2141.0	87	89	90	92	93	95	97	98	100	102
2142.0	103	105	107	109	110	112	114	116	118	120
2143.0	122	123	125	127	129	131	133	135	137	139
2144.0	141	143	146	148	150	152	154	156	159	161
2145.0	163	165	168	170	172	175	177	179	182	184
2146.0	187	189	192	194	197	199	202	205	207	210
2147.0	213	215	218	221	224	227	230	232	235	238
2148.0	241	244	247	250	253	256	260	263	266	269
2149.0	272	275	278	282	285	288	291	295	298	301
2150.0	305	308	311	315	318	321	325	328	332	335
2151.0	339	342	346	349	353	356	360	363	367	370
2152.0	374	378	381	385	388	392	396	399	403	407
2153.0	411	414	418	422	426	430	433	437	441	445
2154.0	449	453	457	461	465	469	473	477	481	485
2155.0	489	493	497	502	506	510	514	519	523	527
2156.0	532	536	540	545	549	554	558	563	567	572
2157.0	576	581	586	590	595	600	605	609	614	619
2158.0	624	629	633	638	643	648	653	658	663	668
2159.0	673	679	684	689	694	699	704	710	715	720
2160.0	726	731	736	742	747	753	758	764	769	775
2161.0	780	786	791	797	802	808	814	819	825	831
2162.0	836	842	848	854	859	865	871	877	883	888
2163.0	894	900	906	912	918	924	929	935	941	947
2164.0	953	959	965	971	977	983	989	995	1001	1008
2165.0	1014	1020	1026	1032	1038	1044	1051	1057	1063	1069
2166.0	1075	1082	1088	1094	1101	1107	1113	1120	1126	1132
2167.0	1139	1145	1151	1158	1164	1171	1177	1184	1190	1197
2168.0	1203	1210	1216	1223	1230	1236	1243	1249	1256	1263
2169.0	1269	1276	1283	1289	1296	1303	1309	1316	1323	1330
2170.0	1337	1343	1350	1357	1364	1371	1377	1384	1391	1398
2171.0	1405	1412	1419	1426	1433	1439	1446	1453	1460	1467
2172.0	1474	1481	1488	1495	1503	1510	1517	1524	1531	1538
2173.0	1545	1552	1559	1567	1574	1581	1588	1595	1603	1610
2174.0	1617	1624	1632	1639	1646	1654	1661	1668	1676	1683
2175.0	1690	1698	1705	1713	1720	1728	1735	1743	1750	1758
2176.0	1765	1773	1780	1788	1795	1803	1810	1818	1826	1833
2177.0	1841	1849	1856	1864	1872	1879	1887	1895	1902	1910
2178.0	1918	1925	1933	1941	1949	1956	1964	1972	1980	1988
2179.0	1995	2003	2011	2019	2027	2034	2042	2050	2058	2066
2180.0	2074	2082	2090	2098	2106	2113	2121	2129	2137	2145
2181.0	2153	2161	2169	2177	2185	2193	2201	2210	2218	2226
2182.0	2234	2242	2250	2258	2266	2274	2282	2291	2299	2307
2183.0	2315	2323	2332	2340	2348	2356	2364	2373	2381	2389
2184.0	2397	2406	2414	2422	2431	2439	2447	2456	2464	2472
2185.0	2481	2489	2497	2506	2514	2523	2531	2540	2548	2556
2186.0	2565	2573	2582	2590	2599	2607	2616	2624	2633	2641
2187.0	2650	2658	2667	2676	2684	2693	2701	2710	2719	2727
2188.0	2736	2745	2753	2762	2770	2779	2788	2797	2805	2814
2189.0	2823	2831	2840	2849	2858	2866	2875	2884	2893	2902
2190.0	2910	2919	2928	2937	2946	2955	2964	2972	2981	2990
2191.0	2999	3008	3017	3026	3035	3044	3053	3062	3071	3080
2192.0	3089	3098	3108	3117	3126	3135	3144	3153	3162	3171
2193.0	3181	3190	3199	3208	3218	3227	3236	3245	3255	3264
2194.0	3273	3283	3292	3301	3311	3320	3329	3339	3348	3358

SAN ANTONIO DAM ..... ELEVATION VS. CAPACITY ..... SURVEY DATE: 21 FEB 1990

ELEV FEET	CAP .0	CAP .1	CAP .2	CAP .3	CAP .4	CAP .5	CAP .6	CAP .7	CAP .8	CAP .9
2195.0	3367	3376	3386	3395	3405	3414	3424	3433	3443	3452
2196.0	3462	3472	3481	3491	3500	3510	3520	3529	3539	3549
2197.0	3558	3568	3578	3587	3597	3607	3616	3626	3636	3646
2198.0	3656	3665	3675	3685	3695	3705	3714	3724	3734	3744
2199.0	3754	3764	3774	3784	3794	3804	3814	3824	3834	3844
2200.0	3854	3864	3874	3884	3894	3904	3914	3924	3934	3944
2201.0	3955	3965	3975	3985	3995	4006	4016	4026	4036	4047
2202.0	4057	4067	4077	4088	4098	4108	4119	4129	4139	4150
2203.0	4160	4171	4181	4192	4202	4212	4223	4233	4244	4254
2204.0	4265	4275	4286	4297	4307	4318	4328	4339	4350	4360
2205.0	4371	4382	4392	4403	4414	4424	4435	4446	4456	4467
2206.0	4478	4489	4500	4510	4521	4532	4543	4554	4565	4576
2207.0	4586	4597	4608	4619	4630	4641	4652	4663	4674	4685
2208.0	4696	4707	4718	4729	4740	4751	4763	4774	4785	4796
2209.0	4807	4818	4829	4841	4852	4863	4874	4885	4897	4908
2210.0	4919	4930	4942	4953	4964	4976	4987	4998	5010	5021
2211.0	5032	5044	5055	5067	5078	5090	5101	5112	5124	5135
2212.0	5147	5158	5170	5181	5193	5205	5216	5228	5239	5251
2213.0	5263	5274	5286	5298	5309	5321	5333	5344	5356	5368
2214.0	5379	5391	5403	5415	5427	5438	5450	5462	5474	5486
2215.0	5498	5509	5521	5533	5545	5557	5569	5581	5593	5605
2216.0	5617	5629	5641	5653	5665	5677	5689	5701	5713	5725
2217.0	5737	5749	5761	5774	5786	5798	5810	5822	5834	5846
2218.0	5859	5871	5883	5895	5908	5920	5932	5944	5957	5969
2219.0	5981	5994	6006	6018	6031	6043	6056	6068	6080	6093
2220.0	6105	6118	6130	6143	6155	6168	6180	6193	6205	6218
2221.0	6230	6243	6255	6268	6281	6293	6306	6318	6331	6344
2222.0	6356	6369	6382	6394	6407	6420	6433	6445	6458	6471
2223.0	6484	6497	6509	6522	6535	6548	6561	6574	6587	6599
2224.0	6612	6625	6638	6651	6664	6677	6690	6703	6716	6729
2225.0	6742	6755	6768	6781	6794	6807	6821	6834	6847	6860
2226.0	6873	6886	6899	6913	6926	6939	6952	6965	6979	6992
2227.0	7005	7018	7032	7045	7058	7072	7085	7098	7112	7125
2228.0	7138	7152	7165	7179	7192	7206	7219	7232	7246	7259
2229.0	7273	7286	7300	7314	7327	7341	7354	7368	7381	7395
2230.0	7409	7422	7436	7449	7463	7477	7491	7504	7518	7532
2231.0	7545	7559	7573	7587	7600	7614	7628	7642	7656	7669
2232.0	7683	7697	7711	7725	7739	7753	7767	7780	7794	7808
2233.0	7822	7836	7850	7864	7878	7892	7906	7920	7934	7948
2234.0	7963	7977	7991	8005	8019	8033	8047	8061	8076	8090
2235.0	8104	8118	8132	8147	8161	8175	8189	8204	8218	8232
2236.0	8246	8261	8275	8289	8304	8318	8333	8347	8361	8376
2237.0	8390	8405	8419	8433	8448	8462	8477	8491	8506	8520
2238.0	8535	8550	8564	8579	8593	8608	8622	8637	8652	8666
2239.0	8681	8696	8710	8725	8740	8754	8769	8784	8798	8813
2240.0	8828	8843	8857	8872	8887	8902	8917	8932	8946	8961
2241.0	8976	8991	9006	9021	9036	9051	9065	9080	9095	9110
2242.0	9125	9140	9155	9170	9185	9200	9215	9230	9245	9260
2243.0	9275	9291	9306	9321	9336	9351	9366	9381	9396	9412
2244.0	9427	9442	9457	9472	9488	9503	9518	9533	9549	9564
2245.0	9579	9594	9610	9625	9640	9656	9671	9686	9702	9717
2246.0	9732	9748	9763	9779	9794	9810	9825	9840	9856	9871
2247.0	9887	9902	9918	9933	9949	9965	9980	9996	10011	10027
2248.0	10043	10058	10074	10089	10105	10121	10136	10152	10168	10183
2249.0	10199	10215	10231	10246	10262	10278	10294	10309	10325	10341
2250.0	10357	10373	10388	10404	10420	10436	10452	10468	10484	10499
2251.0	10515	10531	10547	10563	10579	10595	10611	10627	10643	10659
2252.0	10675	10691	10707	10723	10739	10755	10771	10787	10803	10820
2253.0	10836	10852	10868	10884	10900	10916	10933	10949	10965	10981
2254.0	10998	11014	11030	11046	11063	11079	11095	11111	11128	11144
2255.0	11160	11177	11193	11210	11226	11242	11259	11275	11292	11308
2256.0	11325	11341	11357	11374	11390	11407	11424	11440	11457	11473
2257.0	11490	11506	11523	11539	11556	11573	11589	11606	11623	11639
2258.0	11656	11673	11689	11706	11723	11739	11756	11773	11790	11806
2259.0	11823	11840	11857	11874	11890	11907	11924	11941	11958	11975
2260.0	11992									

CAPACITY IN ACRE-FEET

SAN ANTONIO DAM
SAN ANTONIO CREEK, CALIFORNIA

RESERVOIR
ELEVATION-CAPACITY TABLES
1990 SURVEY

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

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

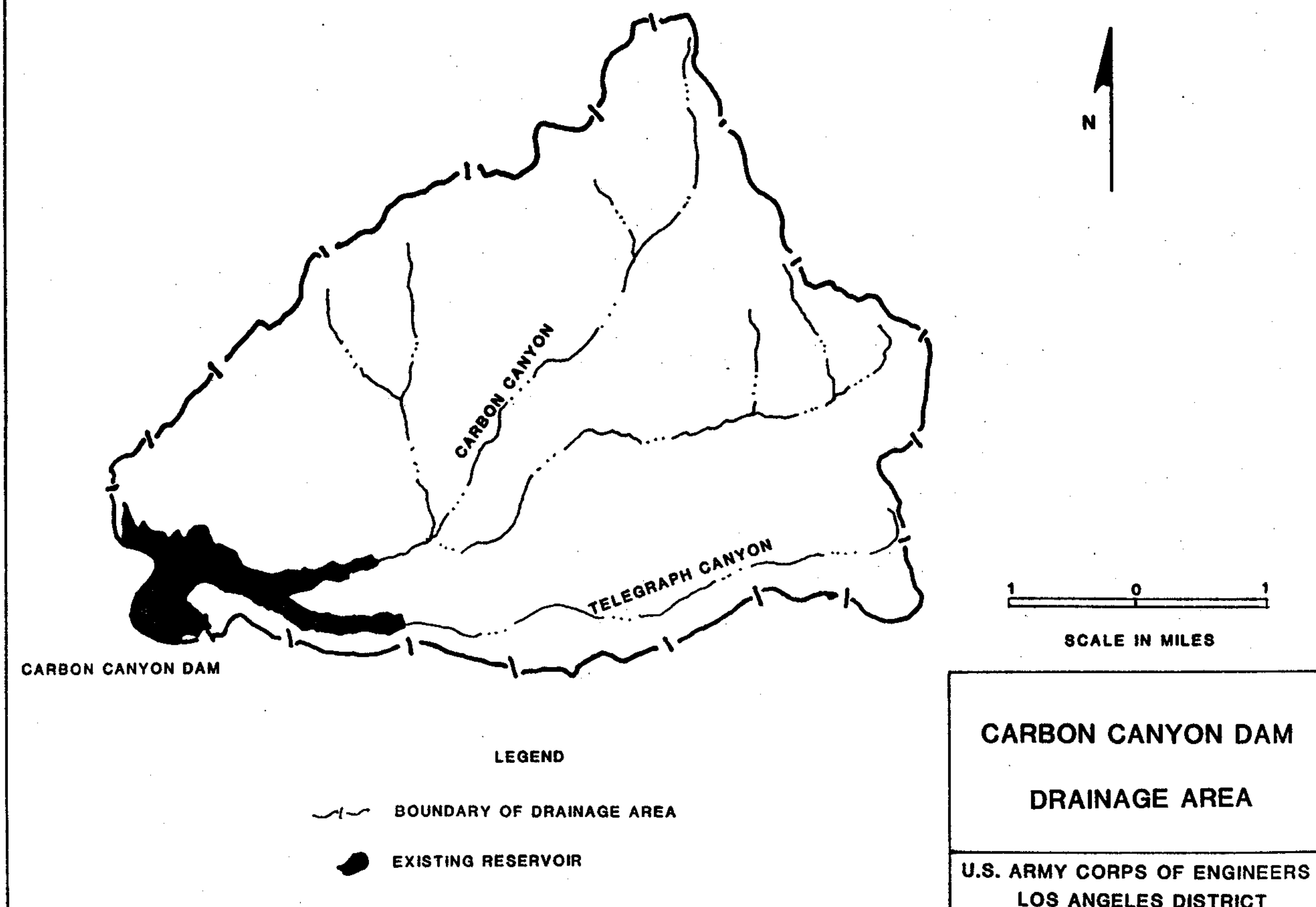
* inches of runoff
** based on surveys of October 1937, August 1941, August 1949, and bottom resurvey of March 1961.
*** based on resurvey of September 1969.

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 Bdlg	-	462.5
3. Tennis Courts	1.32	449.7 - 453.26
4. Playlots	0.70	434.0 - 438.0
5. Lake	3.24	431.0
6. Group Picnic Area	-	434.0
7. Volleyball Courts	-	426.0
8. Bicycle/Hiking Trail	-	454.5 - 495.0
9. Equestrian/Hiking Trail	-	-
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	-

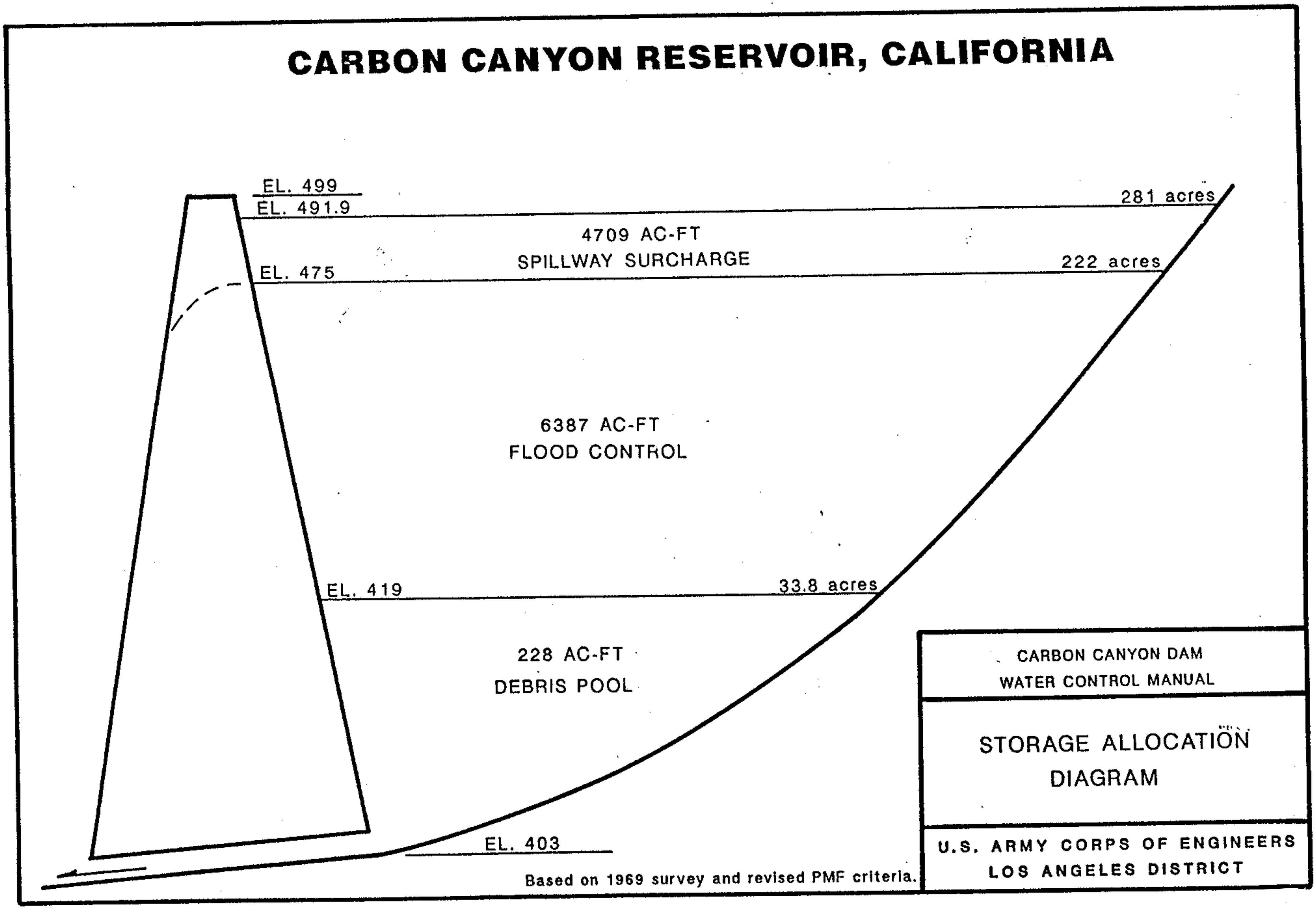
*Flood proofed.



CARBON CANYON DAM

DRAINAGE AREA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



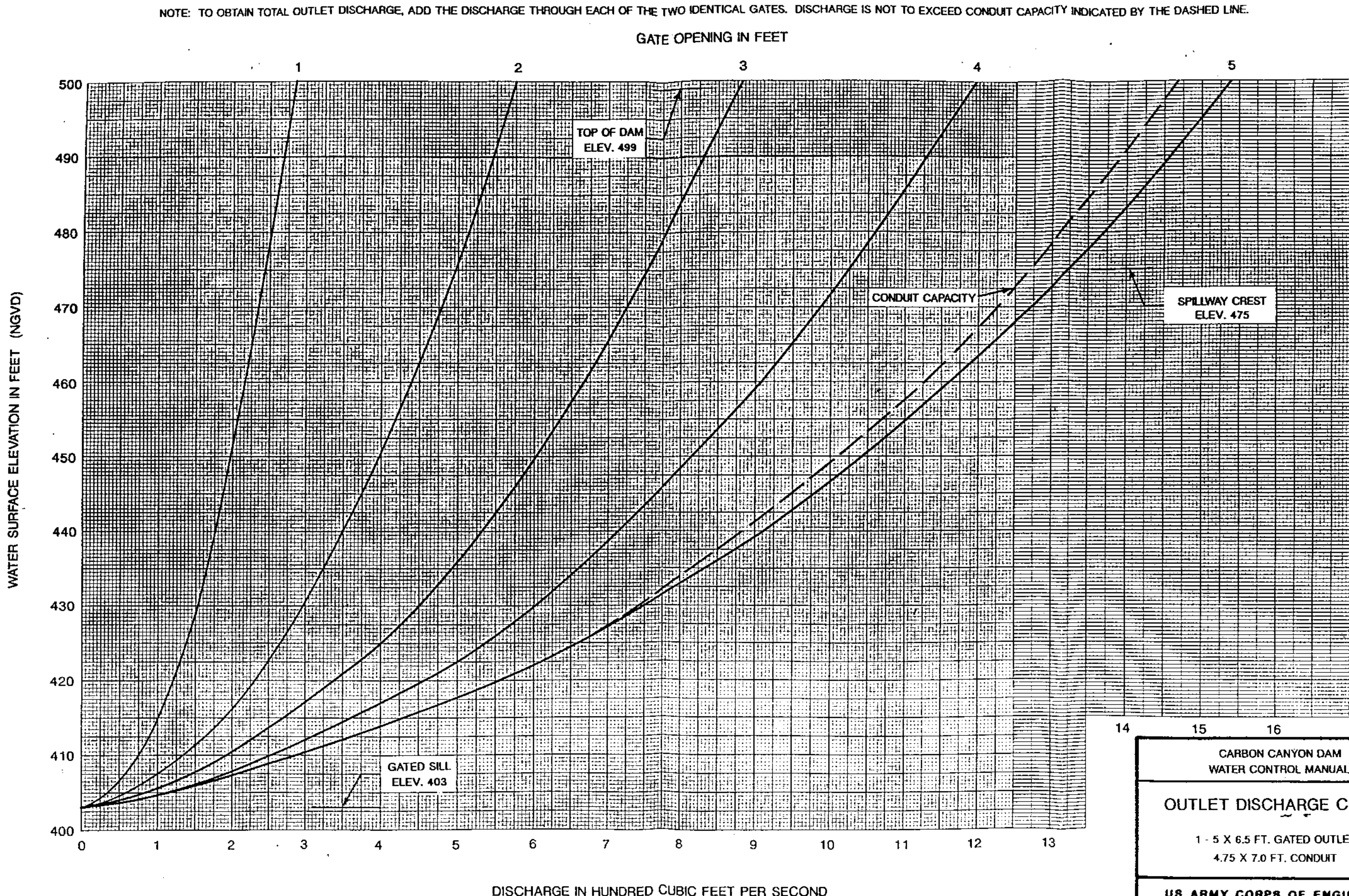
CARBON CANYON RESERVOIR, CALIFORNIA
EL. 499
EL. 491.9
4709 AC-FT
SPILLWAY SURCHARGE
281 acres
EL. 475
222 acres
6387 AC-FT
FLOOD CONTROL
EL. 419
33.8 acres
228 AC-FT
DEBRIS POOL
EL. 403
Based on 1969 survey and revised PMF criteria.
CARBON CANYON DAM
WATER CONTROL MANUAL
STORAGE ALLOCATION
DIAGRAM
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

CARBON CANYON DAM

ELEVATION IN FEET VS STORAGE IN ACRE-FEET

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
403	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
404	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
405	0.2	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.4
406	1.7	2.0	2.3	2.6	3.0	3.3	3.8	4.2	4.7	5.2
407	5.7	6.2	6.8	7.4	8.0	8.6	9.3	10.0	10.7	11.4
408	12.2	13.0	13.8	14.6	15.5	16.4	17.3	18.3	19.2	20.2
409	21.3	22.3	23.4	24.5	25.6	26.7	27.9	29.1	30.3	31.6
410	32.8	34.1	35.5	36.8	38.1	39.5	40.9	42.3	43.7	45.1
411	46.5	48.0	49.5	51.0	52.5	54.0	55.5	57.1	58.7	60.3
412	61.9	63.5	65.2	66.8	68.5	70.2	71.9	73.6	75.4	77.1
413	78.9	80.7	82.5	84.3	86.2	88.0	89.9	91.8	93.7	95.6
414	97.6	99.5	101.5	103.5	105.5	107.5	109.5	111.6	113.7	115.8
415	117.9	120.0	122.2	124.4	126.6	128.8	131.1	133.5	135.8	138.2
416	140.6	143.1	145.5	148.1	150.6	153.2	155.8	158.4	161.1	163.8
417	166.5	169.3	172.1	174.9	177.8	180.7	183.6	186.6	189.6	192.6
418	195.7	198.7	201.9	205.0	208.2	211.4	214.7	217.9	221.2	224.6
419	228.0	231.4	234.8	238.3	241.8	245.3	248.9	252.5	256.1	259.8
420	263.4	267.2	270.9	274.7	278.5	282.3	286.1	290.0	293.9	297.8
421	301.7	305.7	309.7	313.7	317.7	321.8	325.9	330.0	334.1	338.3
422	342.4	346.6	350.9	355.1	359.4	363.7	368.0	372.4	376.8	381.1
423	385.6	390.0	394.5	399.0	403.5	408.0	412.6	417.2	421.8	426.5
424	431.1	435.8	440.5	445.2	450.0	454.8	459.6	464.4	469.3	474.2
425	479.1	484.0	489.0	494.0	499.0	504.0	509.1	514.2	519.4	524.5
426	529.7	535.0	540.2	545.5	550.8	556.2	561.6	567.0	572.4	577.9
427	583.4	588.9	594.5	600.0	605.7	611.3	617.0	622.7	628.4	634.2
428	640.0	645.8	651.7	657.6	663.5	669.4	675.4	681.4	687.4	693.5
429	699.6	705.7	711.9	718.1	724.3	730.5	736.8	743.1	749.4	755.8
430	762.2	768.6	775.1	781.6	788.1	794.7	801.3	807.9	814.6	821.4
432	897.8	905.0	912.2	919.5	926.8	934.1	941.5	948.9	956.3	963.8
434	1048.5	1056.5	1064.4	1072.4	1080.5	1088.6	1096.7	1104.8	1113.0	1121.3
436	1213.3	1221.8	1230.3	1238.8	1247.3	1255.9	1264.5	1273.1	1281.7	1290.3
438	1386.4	1395.3	1404.1	1413.0	1421.9	1430.8	1439.8	1448.7	1457.7	1466.7
440	1566.8	1576.1	1585.3	1594.5	1603.8	1613.1	1622.4	1631.7	1641.0	1650.4
442	1754.3	1763.8	1773.4	1783.0	1792.6	1802.2	1811.8	1821.5	1831.1	1840.8
444	1948.4	1958.3	1968.2	1978.1	1988.0	1998.0	2007.9	2017.9	2027.9	2037.9
446	2149.4	2159.7	2170.0	2180.3	2190.6	2200.9	2211.3	2221.7	2232.1	2242.6
448	2358.8	2369.5	2380.2	2390.9	2401.7	2412.5	2423.3	2434.1	24444.9	2455.8
450	2576.7	2587.9	2599.0	2610.2	2621.4	2632.7	2643.9	2655.2	2666.6	2677.9
452	2804.7	2816.4	2828.2	2839.9	2851.7	2863.5	2875.3	2887.2	2899.1	2911.0
454	3044.1	3056.4	3068.7	3081.0	3093.3	3105.7	3118.1	3130.6	3143.0	3155.5
456	3295.5	3308.4	3321.4	3334.5	3347.6	3360.7	3373.9	3387.1	3400.3	3413.6
458	3562.5	3576.3	3590.1	3603.9	3617.8	3631.8	3645.8	3659.8	3673.8	3687.9
460	3845.7	3860.3	3875.0	3889.7	3904.4	3919.2	3934.1	3949.0	3963.9	3979.0
462	4147.4	4163.0	4178.7	4194.4	4210.2	4226.0	4241.9	4257.8	44273.8	4289.8
464	4469.5	4486.1	4502.8	4519.6	4536.4	4553.2	4570.1	4587.1	4604.1	4621.1
466	4812.3	4830.0	4847.7	4865.5	4883.4	4901.3	4919.3	4937.3	4955.4	4973.6
468	5176.8	5195.6	5214.4	5233.3	5252.3	5271.3	5290.4	5309.5	5328.7	5347.9
470	5563.2	5583.1	5603.0	5623.0	5643.0	5663.1	5683.2	5703.4	5723.6	5743.9
472	5969.8	5990.6	6011.5	6032.4	6053.3	6074.3	6095.4	6116.4	6137.6	6158.8
474	6394.8	6416.5	6438.3	6460.1	6482.0	6503.9	6525.8	6547.9	6569.8	6592.0
476	6837.0	6859.5	6881.9	6904.4	6926.9	6949.4	6971.9	6994.5	7017.1	7039.7
478	7290.0	7312.9	7335.8	7358.8	7381.8	7404.8	7427.8	7450.8	7473.9	7497.0
480	7752.6	7776.0	7799.4	7822.9	7846.4	7870.0	7893.6	7917.2	7940.9	7964.6
482	8228.0	8252.2	8276.4	8300.7	8325.0	8349.3	8373.7	8398.1	8422.6	8447.1
484	8719.2	8744.2	8769.2	8794.3	8819.4	8844.5	8869.7	8894.9	8920.2	8945.5
486	9226.3	9252.1	9277.9	9303.7	9329.6	9355.5	9381.5	9407.5	9433.5	9459.6
488	9748.9	9775.4	9802.0	9828.6	9855.3	9881.9	9908.7	9935.4	9962.2	9989.1
490	10287	10314	10342	10369	10396	10424	10451	10479	10506	10534
499	12898.7									

SURVEY DATE AUGUST 1977

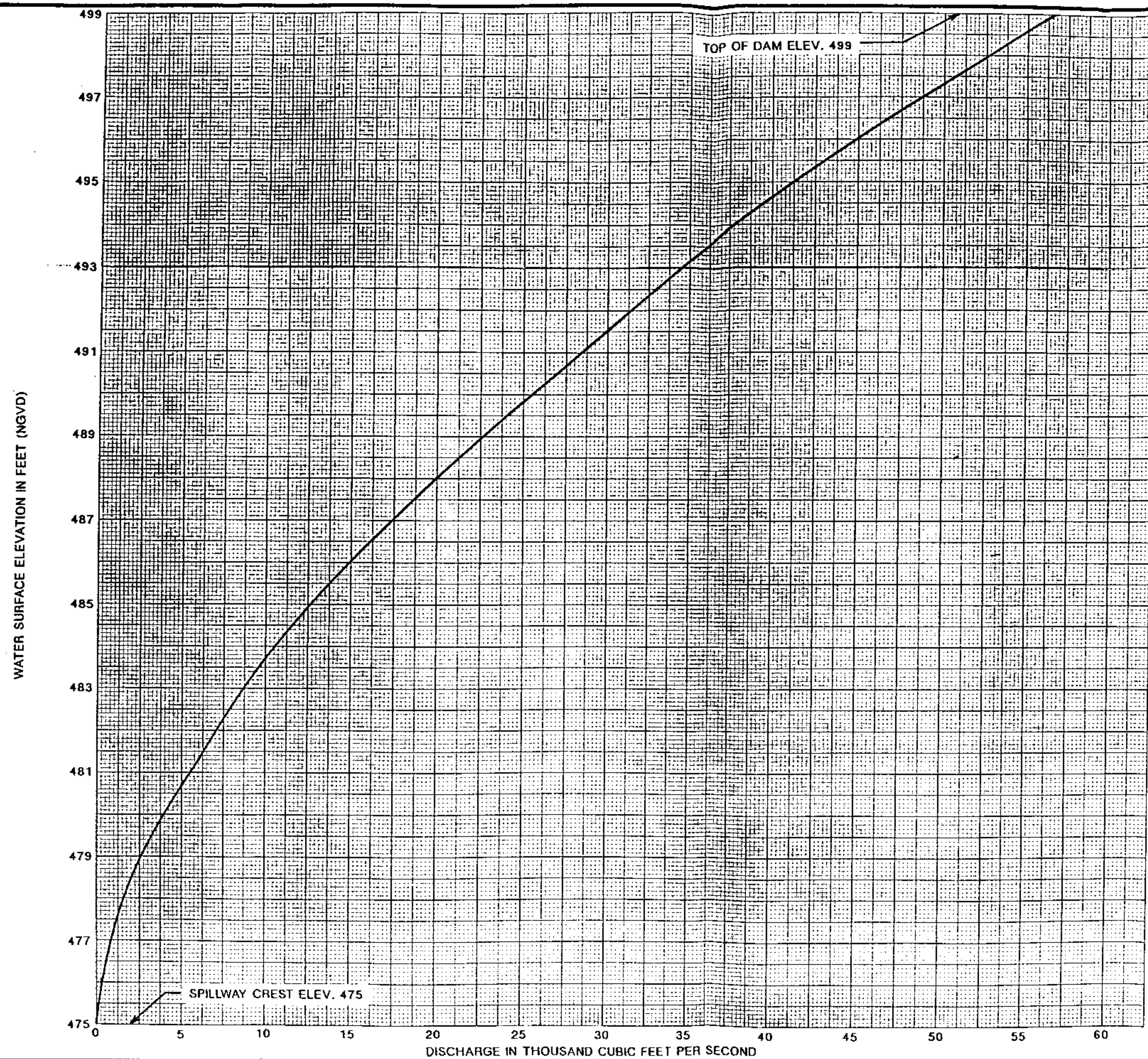


CARBON CANYON DAM
WATER CONTROL MANUAL

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

EXHIBIT D.

INTERAGENCY AGREEMENTS

EXHIBIT D

LOCAL COOPERATION AGREEMENT

Version of 12/13/89

LOCAL COOPERATION AGREEMENT
AMONG THE DEPARTMENT OF THE ARMY,
ORANGE COUNTY FLOOD CONTROL DISTRICT,
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT AND
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
FOR CONSTRUCTION OF THE
SANTA ANA RIVER MAINSTEM, INCLUDING SANTIAGO CREEK,
CALIFORNIA FLOOD CONTROL PROJECT

THIS AGREEMENT, entered into this 14TH day of DECEMBER, 1989, by and between the DEPARTMENT OF THE ARMY (hereinafter referred to as the "Government"), acting by and through the Assistant Secretary of the Army (Civil Works), and the Santa Ana River Mainstem sponsors, comprised of the Orange County Flood Control District, the Riverside County Flood Control and Water Conservation District, and the San Bernardino County Flood Control District in California (hereinafter referred to as "Orange," "Riverside," "San Bernardino" or as "the Sponsors" when considered collectively),

WITNESSETH, THAT:

WHEREAS, the Santa Ana River Mainstem, including the Santiago Creek, California project (hereinafter referred to as "the Project") was authorized by the Water Resources Development Act of 1986, P.L. 99-662 (hereinafter referred to as "the Act") substantially in accordance with the plans and recommendations of the Chief of Engineers contained in his reports dated 15 January 1982 and 9 July 1987; and

WHEREAS, construction of recreation features is an authorized project purpose under the Act and, if implemented, will be the subject of a separate agreement between the Government and appropriate non-federal interests other than the Sponsors herein; and

WHEREAS, water conservation at Prado is the subject of a separate study and any facilities, quantities of storage, and/or changes in operation, and the cost sharing for any such items resulting from that study, if implemented, will be part of a separate agreement between the Government and non-Federal interests; and

WHEREAS, Section 103 of the Act specifies the cost-sharing requirements of non-Federal interests applicable to the Project; and

WHEREAS, on June 1, 1988, the Assistant Secretary of the Army (Civil Works) approved a credit with an estimated value of

B-1

$3,315,000 for Orange towards Orange's share of Project cost in accordance with Section 104 of the Act; and

WHEREAS, on 2 October 1989 the Department of the Army entered into an agreement with the Orange County Flood Control District pursuant to Section 215 of 90-483 (42 U.S.C.1962d-5a), as amended, to credit or reimburse the costs of certain work accomplished by local interests which later is incorporated into an authorized project; and

WHEREAS, Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, provides that the construction of any water resources project by the Secretary of the Army shall not be commenced until each non-federal interest has entered into a written agreement to furnish its required cooperation for the Project; and

WHEREAS, the Sponsors do not qualify for a reduction of the maximum non-Federal cost share pursuant to the guidelines which implement Section 103(m) of the Act, published in 33 C.F.R., sections 241.1 - 6, entitled "Flood Control Cost-Sharing Requirements Under the Ability to Pay Provision"; and,

WHEREAS, it is to the benefit of the Sponsors and Government to construct this project; and

WHEREAS, the Sponsors have the authority and capability to furnish the cooperation hereinafter set forth and are willing to participate in project cost-sharing and financing, in accordance with the terms of this Agreement;

NOW, THEREFORE, the parties agree as follows:

ARTICLE I - DEFINITIONS

For purposes of This Agreement:

A. The term "Project" shall mean the Santa Ana River Mainstem project, including Santiago Creek, as described in the Phase II General Design Memorandum and shall include the construction, acquisition, or regulation of the following flood control features: Seven Oaks Dam and Basin; regulation of the 100-year flood plain between Seven Oaks Dam and Prado Basin; modifications to the existing Federal Mill Creek levee project; modifications to Prado Dam and acquisition of additional reservoir lands; construction of the Oak Street Drain from the existing debris basin to Prado reservoir, flood plain acquisition and structural improvements to the Santa Ana River channel between Prado Dam and the Pacific Ocean; Talbert Channel relocation; channelization of the lower reach of Santiago Creek and provision of an upstream detention facility with outlet structure; regulation of the 100-year floodplain between the Santiago Channe and the detention facility, and provision of mitigation and enhancement lands and improvements, as illustrated in the Phase II General Design Memorandum (GDM). The term "Project" shall not include recreation features and facilities.

B. The term "total project costs" shall mean all costs incurred by the Sponsors and the Government directly related to construction of the Project, excluding any costs for betterments or operation and maintenance. Such costs shall include but not necessarily be limited to, actual construction costs, the value of lands, easements, and rights-of-way, including excavated material disposal areas made available for the Project, relocation and alteration costs, relocations or new construction of railroad bridges and approaches thereto, costs of applicable planning, engineering and design, incurred after October 1, 1985 (including, but not limited to preconstruction engineering and design costs, as defined in C. below), supervision and administration costs, and costs of project construction contract dispute settlements or awards. The term "total project costs" also includes the amount of the credit that will be given to Orange for the flood control work carried out by Orange which has been determined to be compatible with the Project.

C. The term "preconstruction engineering and design costs" (PED) shall mean all continuing expenditures for planning, engineering, and design incurred after 1 October 1985 towards completion of the Phase II GDM, the plans and specifications for the first phases of the project, and any feature design memoranda necessary to produce those plans and specifications.

D. The term "Santa Ana River Mainstem Project" shall include the construction described in Subparagraph A. of this Article and also the construction of the San Timoteo project, which was authorized by the Energy and Water Development Appropriations Act of 1988, P.L. 100-202, as part of the Santa Ana River Mainstem project, including Santiago Creek project and, for purposes of economic justification, the benefits and costs of the San Timoteo Creek project shall be included together with the benefits and costs of the entire Santa Ana Mainstem, including Santiago Creek. The San Timoteo Creek project, if implemented, will be the subject of a supplement to this agreement between the Government and San Bernardino, sponsor for San Timoteo Creek.

E. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time of acceptance of the Project by the Contracting Officer.

F. The term "Contracting Officer" shall mean the Commander of the U.S. Army Engineer District, Los Angeles, or his designee.

G. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public or private road or way.

H. The term "relocations" shall mean alterations, modifications, lowering or raising in place, and/or new construction related to, but not limited to, existing: railroads, highways, bridges other than railroad bridges and approaches thereto, buildings, commercial and gas pipelines, public utilities (such as municipal water and sanitary sewer lines, and telephone lines), storm drainage facilities, recreation trails, cemeteries, and other facilities, structures, and improvements determined by the Government to be necessary for the construction, operation and maintenance of the project. The term "relocations" does not include construction and alteration of railroad bridges and approaches thereto (including temporary detours for use while the new bridges are being constructed), and alterations to foundations and abutments for bridges that are to remain in place. Said costs shall be considered part of the total project costs and are not included in determining relocation costs borne by the Sponsors.

I. The term "betterments" shall mean any work beyond that necessary to provide a substitute structure or usage to current design standards of the State of California or the agency having jurisdiction.

J. The term "features" shall mean each of the following portions of the Project including mitigation therefore: Seven Oaks Dam and Basin; Mill Creek Levee; regulation of the flood plain between Seven Oaks Dam and Prado Basin; Prado Dam and Basin; Oak Street Drain; Santa Ana Canyon between Prado Dam and Weir Canyon Road; Santa Ana River Channel from Weir Canyon Road to the Pacific Ocean; Santiago Creek including channel work and detention basin and regulation of the floodplain between the channel work and the detention basin; and enhancement lands at the mouth of the Santa Ana River.

K. The term "phase" shall mean all or a portion of a feature, which is under a construction contract.

L. The term "enhancement" shall mean those activities to enhance fish and wildlife resources, including acquisition of lands or interests in lands, from which national economic fish and wildlife benefits are derived, or for species that have been listed as threatened or endangered under the Endangered Species Act, 16 U.S.C. Sections 1531 et. seq.

M. The term "fish and wildlife mitigation" (hereinafter referred to as "mitigation") shall refer to those activities, including acquisition of lands or interests in lands, to compensate for project impacts to fish and wildlife resources.

N. The term "involuntary acquisitions" shall mean acquisition of lands, easements, and rights-of-way by condemnation proceedings.

O. The term "Government Fiscal Year" shall mean one fiscal year of the United States Government. The Government fiscal year begins on October 1 and ends on September 30.

P. The term "Sponsors' Fiscal Year" shall mean one fiscal year of the Sponsors. The Sponsors' fiscal year begins on 1 July and ends on 30 June.

ARTICLE II - OBLIGATIONS OF THE PARTIES

A. The Government, subject to and using funds provided by the Sponsors and funds appropriated by the Congress, shall expeditiously construct the Project (including alterations or relocations of railroad bridges and approaches thereto) applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The Sponsors shall be afforded the opportunity to review and comment on all contracts, including relevant plans, specifications and special provisions prior to the issuance of invitations for bids. The Sponsors also shall be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the Contractor of a Notice to Proceed for such modification or change order unless an emergency exists or immediate action is required, in which case the Government will direct the change without review by the Sponsors. The Government will consider the views of the Sponsors, but award of the contracts including change orders and performance of the work thereunder shall be exclusively within the control of the Government.

B. When the Government determines that a feature or phase of the Project is complete and appropriate for operation and maintenance by a Sponsor or Sponsors, the Government shall turn the completed feature or phase over to the responsible Sponsor or Sponsors, who shall accept the feature or phase of the Project and all responsibility for operating, repairing, maintaining, replacing, and rehabilitating the feature or phase in accordance with Article VIII hereof. The Sponsors shall share the cost for operation, maintenance, replacement, and rehabilitation of the features and phases of the Project in accordance with the following subparagraphs:

1. Orange shall provide 100 percent of the costs of operation, maintenance, replacement and rehabilitation of Santiago Creek, Santa Ana River Channel, and Santa Ana Canyon within Orange County, and 87.70 percent of the cost of Seven Oaks Dam and Basin. Orange shall be responsible on an annual basis (Government Fiscal Year) for 24.8 percent of the costs for operation, maintenance, replacement, and rehabilitation of Prado Dam and Basin. The Government shall be responsible on an annual basis for 75.2 percent of the costs for operation, maintenance, replacement, and rehabilitation of Prado Dam and Basin.

2. Riverside shall provide 100 percent of the costs of operation, maintenance, replacement, and rehabilitation of Oak Street Drain and the portion of the Santa Ana Canyon within Riverside County and 5.27 percent of the cost of the operation, maintenance, and rehabilitation of Seven Oaks Dam and Basin.

3. San Bernardino shall provide 100 percent of the costs of operation, maintenance, replacement, and rehabilitation of Mill Creek Levee and the portion of the Santa Ana Canyon within San Bernardino County and 7.03 percent of the cost of operation, maintenance, and rehabilitation of Seven Oaks Dam and Basin.

C. Pursuant to Section 103(a)(1) of the Act, 33 U.S.C. 2213(a)(1) and in accordance with Article III of this agreement the sponsors shall provide all lands, easements, rights-of-way, excavated material disposal areas, and perform relocations (excluding railroad bridges and approaches thereto) required for construction of the project as determined by the Government, except that acquisition and restoration of enhancement lands shall be the sole responsibility of the Government. In the event any such lands, easements, or rights-of-way required for the Project (e.g. haul roads, borrow sites, or disposal areas) are common to more than one feature, acquisition of said lands, easements, and rights-of-way will be performed by the Sponsors in the counties in which they are situated, unless otherwise agreed to among the Sponsors. The Sponsors shall share costs for lands, easements, rights-of-way and disposal areas and relocations, as specified in the following subparagraphs:

1. Orange shall provide 100 percent of such costs for Santiago Creek, Santa Ana River Channel within Orange County, Santa Ana Canyon below Prado Dam within Orange County, the Prado Features, and mitigation lands located in Orange County and at Prado basin; and 87.70 percent of such costs of Seven Oaks Dam and Basin, and its associated mitigation.

2. Riverside shall provide 100 percent of such costs for the Oak Street Drain, and the Santa Ana Canyon below Prado Dam within Riverside County; and 5.27 percent of such costs of Seven Oaks Dam and its associated mitigation.

3. San Bernardino shall provide 100 percent of such costs of the Mill Creek levee and the Santa Ana Canyon below Prado Dam in San Bernardino County and 7.03 percent of such costs of Seven Oaks Dam and basin and its associated mitigation.

4. The acquisition costs for lands, easements, or rights-of-way common to more than one feature shall be shared by the sponsors in proportion to the use of said lands, easements, or rights-of-way for each feature.

D. Pursuant to Section 103(a)(1)(A) of the Act, 33 U.S.C. 2213(a)(1)(A) and as further specified in Article IV hereof, the Sponsors shall provide, during the period of construction, a cash contribution of 5 percent of the total project costs. The Sponsors shall share the required cash contribution based on the features being acquired or constructed, as specified in the following subparagraphs.

1. Orange shall provide 100 percent of such contribution for Santiago Creek, Santa Ana River Channel, Santa Ana River Canyon below Prado Dam within Orange County, and Prado Dam and Basin; 87.70 percent of such contribution for Seven Oaks Dam and Basin; and 94.95 percent of such contribution for PED costs incurred after 1 October 1985.

2. Riverside shall provide 100 percent of such contribution for the Oak Street Drain, and Santa Ana Canyon below Prado Dam within Riverside County; 5.27 percent of such contribution for Seven Oaks Dam and Basin; and 3.61 percent of such contribution for PED costs incurred after 1 October 1985.

3. San Bernardino shall provide 100 percent of such contribution for Mill Creek Levee, and Santa Ana Canyon below Prado Dam within San Bernardino County; 7.03 percent of such contribution for Seven Oaks Dam and Basin; and 1.44 percent of such contribution for PED costs incurred after 1 October 1985.

E. The Government shall afford credit for external compatible work performed by Orange toward Orange's project contributions in accordance with Section 104 of the Act. Such credit shall not exceed $3,315,000. The credit shall be afforded against Orange's cost sharing requirements for the Project, less Orange's share of the five percent cash contribution required under Article II.D. of this Agreement. Orange's cost sharing requirements are presently estimated to be $408,800,000. Orange's share of the five percent cash contribution is presently estimated to be $57,800,000. Accordingly, Orange's cost sharing requirements against which credit can be applied are currently estimated to be $351,000,000.

F. If the value of the contributions provided under paragraph D. of this Article when added to the value of any items provided pursuant to paragraph C. of this Article is less than twenty-five (25) percent of total project costs, the Sponsors shall provide, during the period of construction, an additional cash contribution in the amount necessary to make the Sponsors' total contribution equal to twenty-five (25) percent of total project costs. The Sponsors shall share such costs based on the features being acquired or constructed, as specified in Article II.D.

G. The amount of Orange's contribution required herein may be reduced by the amount of credit Orange receives for the work it performed pursuant to the Section 215 Agreement dated 2 October 1989. However any credit allowed will not reduce the 5 percent cash contribution required in paragraph D. of this Article.

H. The Sponsor shall inform affected interests of the limitations of the protection afforded by the project. Each of the Sponsors shall provide said notice to affected interests within its county by announcement in a local newspaper of general circulation upon completion of each feature of the project, but no less than once each year. In the event that the level of protection is also dependent upon completion of another project feature, the Government shall inform the Sponsors of the level of protection provided until all such dependent features are completed. Each of the Sponsors shall also publicize floodplain information relevant to the area affected within its county and shall provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

I. Orange shall operate and maintain, without cost to the Government, the existing Villa Park Dam on Santiago Creek in accordance with regulations prescribed by the Secretary of the Army.

J. Riverside shall operate and maintain, without cost to the Government, the existing Oak Street Drain debris basin in accordance with regulations prescribed by the Secretary of the Army.

K. The responsibility for administering the operation, maintenance and rehabilitation of the mitigation and enhancement features of the project shall be in accordance with a management plan to be developed by the Government in coordination with the Sponsors. Management of mitigation and enhancement areas may be turned over to resource agencies, organizations or local groups that can demonstrate capability and experience, and meet the approval of the Government, the Sponsors, and resource agencies.

L. The Sponsors shall be solely responsible for the costs for operating, maintaining and rehabilitating mitigation lands. With regard to mitigation applicable to the Seven Oaks feature, costs shall be shared by the Sponsors in relation to benefits received by each Sponsor, 87.70 percent by Orange, 5.27 percent by Riverside, and 7.03 percent by San Bernardino. The costs for operation, maintenance, and rehabilitation for mitigation related to the construction at Prado Dam and Basin, and the construction of the channel downstream of Prado shall be paid entirely by Orange.

M. The Government shall be responsible for operation and maintenance of the enhancement lands; however, the Sponsors shall be responsible for paying for 25 percent of the costs of such operation and maintenance on an annual basis. Each of the sponsors shall provide a portion of the Sponsors' share equal to the estimated portion of total flood control project benefits received by each of the Sponsors at the end of project construction, namely, 94.95 percent by Orange, 3.61 percent by Riverside, and 1.44 percent by San Bernardino.

N. The Sponsors shall manage the post-project floodway and flood plain fringe as designated by the Secretary of the Army from Seven Oaks Dam to Prado Basin and along Santiago Creek from Walnut Avenue to Benton Way for the future 100-year flood in accordance with the Federal Emergency Management Agency (FEMA) regulations ar shall participate in and comply with applicable Federal flood pla management and flood insurance programs.

O. The Government shall coordinate with the Sponsors and develop and implement a management plan for open space wildlife habitat in the Santa Ana Canyon below Prado Dam. Each Sponsor shall be responsible for the maintenance costs of the habitat located with the sponsor's boundaries. Maintenance of said habitat shall be the responsibility of the Sponsors, in accordance with the plan.

P. No Federal funds may be used to meet the Sponsors' share of project costs under this agreement unless the expenditure of such funds is expressly authorized by statute as verified in writing by the granting agency.

ARTICLE III - LANDS, FACILITIES, AND PUBLIC LAW 91-646 RELOCATION ASSISTANCE

A. The Sponsors shall furnish to the Government all lands, easements, and rights-of-way, including suitable borrow and dredged material disposal areas, as may be determined by the Government to be necessary for the construction, operation, and maintenance of the Project, and shall furnish to the Government evidence supporting the sponsors' legal authority to grant rights-of-entry to such lands. The necessary lands, easements, and rights-of-way may be provided incrementally, but all lands, easements, and rights-of-way determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to advertisement of the construction contract.

B. Upon notification from the Government, the Sponsors shall accomplish or arrange for accomplishment at no cost to the Government, all relocations determined by the Government to be necessary for construction of the project.

C. The Sponsors shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

D. Title or rights to lands acquired or necessary for project purposes which are currently held for the Project by the Sponsors or the United States shall remain in the current holder of such rights or title, except that the Government may accept title and rights to lands at Seven Oaks Dam and Basin and Prado Dam and Basin provided by the Sponsors for the Project

ARTICLE IV - VALUE OF LANDS AND FACILITIES

A. The value of the lands, easements, and rights-of-way to be included in total flood control project costs and credited toward the Sponsors' share of total flood control project costs will be determined in accordance with the following procedures:

1. If the lands, easements, or rights-of-way are owned by the Sponsor(s) prior to the award of the first construction contract, the credit shall be the fair market value of the interest as of the date of the award of that construction contract. The fair market value shall be determined by an appraisal, to be obtained by the Sponsor(s), which has been prepared by a qualified appraiser who is acceptable to both the Sponsor(s) and the Government. The appraisal shall be reviewed and approved by the Government.

2. If the lands, easements, or rights-of-way are to be acquired by the Sponsor(s) after award of the first construction contract, the credit shall be the fair market value of the interest as of the date of acquisition. The fair market value shall be determined as specified in subparagraph 1. above. If the Sponsors pay an amount in excess of the appraised fair market value, they may be entitled to a credit for the excess if the Sponsor(s) have secured prior written approval from the Government of its negotiated offer to purchase such interests.

3. Credit for lands, easements, and rights-of-way in the case of involuntary acquisitions which occur within a one-year period preceding the date this Agreement is signed or wh: occur after the date this Agreement is signed will be based on cou awards, or on stipulated settlements which have received prior Government approval.

4. If the Sponsor(s) acquire more lands, easements, or rights-of-way than are necessary for project purposes, as determined by the Government, then only the value of such portions of the acquisitions as are necessary for project purposes shall be included in total project costs and credited to the Sponsor(s)' share.

5. For lands, easements, or rights-of-way acquired by the Sponsors within a 5-year period preceding the date this Agreement is signed, or any time after this Agreement is signed, credits provided under paragraph A. of this Article will also include the actual incidental costs of acquiring the interest, e.g., closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for any payment of any Public Law 91-646 relocation assistance benefits provided in accordance with the obligations under this Agreement.

B. The costs of relocations which will be included in total project costs and credited towards the Sponsor(s)' share of total project costs shall be that portion of the actual costs incurred by the Sponsor(s) as set forth below and approved by the Government:

1. Highways and Highway Bridges: Only that portion of

the cost as would be necessary to construct substitute bridges and highways to the current design standard that the State of California, or the public agency which has applicable jurisdiction, would be used in constructing a new bridge, or highway under similar conditions of geography and traffic loads.

2. Utilities and Facilities (Including Railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the cost of betterments. With respect to betterments, new materials shall not be used in any relocation or alteration if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If despite the availability of used material, new material is used, where the use of such material represents an additional cost, such cost will not be included in total project costs.

3. The costs of relocations that the Sponsors have accomplished within 5 years preceding the date of this Agreement may be included in total project costs and credited towards the Sponsors share as such relocations are determined by the Government to be necessary for project purposes.

ARTICLE V - CONSTRUCTION PHASING AND MANAGEMENT

A. To provide for consistent and effective communication between the Sponsors and the Government during the period of construction, each of the Sponsors, and the Government shall appoint representatives to coordinate on scheduling, plans, specifications, modifications, contract costs, and other matters relating to construction of the project.

B. The representatives appointed shall meet as necessary during the period of construction and shall make such recommendations as they deem warranted to the Contracting Officer.

C. The Contracting Officer shall consider the recommendations of the representatives in all matters relating to the Project, but the Contracting Officer, having ultimate responsibility for construction of the Project, has complete discretion to accept, reject, or modify the recommendations.

ARTICLE VI - METHOD OF PAYMENT

A. The Sponsors shall provide, over the period of construction, the amounts required under Article II.D. and II.F. of this Agreement. Total project costs are presently estimated to be $1,293,000,000. In order to meet their share, the Sponsors must provide a cash contribution presently estimated to be $63,700,000. The dollar amounts set forth in this Article are based upon the

Government's best estimates which will reflect projections of costs, price level changes, and anticipated inflation. Such estimates are subject to adjustments based on the costs actually incurred and are not to be construed as the total financial responsibilities of the Government and the Sponsors.

B. The Sponsors shall provide their required cash contribution in proportion to the rate of Government expenditures over the period of the construction in accordance with the following provisions:

1. For purposes of budget planning, the Government shall notify each of the Sponsors of the estimated funds that will be required from the Sponsors to meet each Sponsor's shares of project costs for the upcoming Government fiscal year following submittal of the President's Budget to the Congress.

2. For the first Government fiscal year of construction, at least 90 days prior to the award of the first construction contract, the Government shall notify each of the Sponsors of its estimated share of project costs, including each Sponsor's share of costs attributable to the project incurred prior to the initiation of construction. Forty-five days thereafter, each of the Sponsors shall provide its share of the local contribution by verifying to the satisfaction of the Government that it has deposited the requisite amount in an escrow account acceptable to the Government, with interest accruing to the Sponsor(s).

3. For the second and subsequent Government fiscal years of project construction, the Government shall notify each of the Sponsors of its estimated share of project costs for that fiscal year following submittal of the President's Budget to the Congress. No later than 30 days prior to the beginning of that fiscal year, each of the Sponsors shall make the necessary funds available to the Government through the funding mechanism specified in Article VI.B.2. of this agreement.

4. As Project proceeds, the Government shall adjust the amounts required to be provided from each of the Sponsors to reflect actual project costs. If the Government determines that additional funds will be needed from the Sponsors to meet their required share of project costs, the Government shall so notify the Sponsors, and the Sponsors, within sixty (60) days from receipt of notice, shall make the necessary funds available through the funding mechanism specified in Article VI.B.2. of this Agreement.

C. Each month, the Government will draw on the funds in the escrow accounts provided by the Sponsors such sums as the Government deems necessary to cover anticipated contractual and in-house fiscal obligations attributable to the project in advance of their being incurred, except that the Government will withdraw an amount equal to the Sponsors' share of total project costs incurred by the Government prior to the initiation of construction of the Project the time of the first withdrawal from the escrow accounts.

D. Upon completion of the Project and resolution of all relevant contract claims and appeals, the Government shall compute the total project costs and tender to the Sponsors a final accounting of the Sponsors share of total project costs. In the event the total contribution by the Sponsors is less than their minimum required share of total project costs, the Sponsors shall, no later than 90 calendar days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet their minimum required share of total project costs.

E. In the event the Sponsors have made cash contributions in excess of 5 percent of total project costs which result in the sponsors having provided more than their required share of total project costs, the Government shall, no later than 90 calendar days after the final accounting is complete, subject to the availability of appropriations for that purpose, return said excess to the Sponsors; however, the Sponsors shall not be entitled to any refund of the 5 percent cash contribution required pursuant to Article II.D. of this Agreement.

F. If the Sponsors' total contribution under this Agreement (including lands, easements, rights-of-way, utility and facility alterations or relocations, and dredged material disposal areas provided by the Sponsors) exceeds 50 percent of total project costs, the Government shall, subject to the availability of appropriations for that purpose, refund the excess to the Sponsors no later than 90 calendar days after the final accounting is complete.

ARTICLE VII - DISPUTES

A. Disputes among the Sponsors: Disputes between two or more of the Sponsors in respect to this Agreement, or to any breach thereof, shall be resolved by the methods hereinafter set forth. For the purposes of the following subparagraphs, a dispute is defined to mean a determination by the District Engineer, Los Angeles District, United States Army Corps of Engineers, that the Sponsors have failed to timely agree on action required by the Sponsors under this Agreement or with respect to this Agreement.

1. When the District Engineer determines that a dispute exists between two or more Sponsors, the flood control engineer for every Sponsor to this Agreement shall meet and confer to resolve the dispute within a period of 20 calendar days of written notice of the existence of the dispute by the Government. A unanimous decision of the flood control engineers within this 20-day period shall resolve the dispute and be binding on every Sponsor.

2. Should the flood control engineers fail to reach a unanimous decision within this 20-day period, the flood control engineers shall present the dispute within the next 10 calendar days to the Chairmen of the Boards of Supervisors for every Sponsor

or to their designees, who also shall be members of the Boards of Supervisors. The Chairmen of the Boards of Supervisors or their designees shall meet and confer to resolve the dispute within a period of 20 calendar days of presentation of the dispute. A unanimous decision of the Chairmen of the Boards of Supervisors or their designees within this 20-day period shall resolve the dispute and be binding on every Sponsor.

3. If a dispute is not resolved pursuant to these procedures within the 20-calendar day time frames set forth above, the Sponsors shall refer the dispute within the next 5 calendar days to Judicial Arbitration and Mediation Services, Inc., or to another arbitration service mutually agreeable to the Sponsors. All parties agree that time is of the essence in resolving disputes relating to this Agreement and that the Sponsors shall expedite the presentation of disputes for arbitration. The Sponsors shall present the dispute to Judicial Arbitration and Mediation Services, Inc., or the mutually agreed on arbitration service, within 15 calendar days of referral of the dispute for resolution. Judicial Arbitration and Mediation Services, Inc., or the mutually agreed on arbitration service, shall decide the dispute within 15 calendar days after presentation. The Government may, in its sole discretion, bypass the procedures set forth in subparagraphs 1. and 2. above and, upon written notice, require that the Sponsors present any dispute directly for arbitration in order to arrive at an expedited decision. In such event, the referral, presentation, a. resolution of the dispute will be conducted within the time frames set forth in this subparagraph.

4. The Sponsors agree that they shall accept any arbitrator assigned by the arbitration service to resolve the dispute. The Sponsors further agree that they will be bound by any award made by the arbitration service and that any award made shall conclusively resolve the dispute. All costs incurred in presenting a dispute, including the costs of any arbitration service, shall be divided equally among the Sponsors unless some other division of costs is made as part of the arbitrator's award. In no event, shall the Government bear any of the costs of presenting and resolving a dispute.

5. The arbitration conducted pursuant to the subparagraphs above shall in all respects be conducted in accordance with California Code of Civil Procedure, Section 1280, et seq., unless otherwise provided herein. The Sponsors agree that the Government may at its discretion enforce any award made pursuant to these subparagraphs in any Federal Court having jurisdiction over this Agreement.

B. Disputes between the Government and the Sponsors: Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE, REPLACEMENT, AND REHABILITATION

A. After the Government has turned a completed feature or phase over to the responsible Sponsor or Sponsors, the Sponsor(s) in whose county the feature or phase is located shall be responsible for its operation, maintenance, replacement, and rehabilitation of that feature or phase, except that Orange shall also be responsible for the operation, maintenance, replacement, and rehabilitation of Prado Dam and Basin. All such operation, maintenance, replacement, and rehabilitation shall be in accordance with regulations or directions prescribed by the Government. During the life of the Project, the Sponsors may make recommendations to the Government concerning the operation, maintenance, replacement, and rehabilitation of the Project. The Government has complete discretion to accept, reject, or modify the Sponsor's recommendations regarding such operation, maintenance, replacement, and rehabilitation. The costs of said operation, maintenance, replacement, and rehabilitation shall be shared in accordance with Article II.B. of this Agreement.

B. The Sponsors hereby give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the Sponsors own or control for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. If an inspection shows that any of the Sponsors is, for any reason, are failing to fulfill its obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to each of the Sponsors. If any of the Sponsors persist in such failure for thirty (30) calendar days after receipt of the notice, then the Government shall have a right to enter, at reasonable times and in a reasonable manner, upon lands the Sponsor or Sponsors own or control for access to the project for the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. No completion, operation, repair, maintenance, replacement, or rehabilitation by the Government shall operate to relieve any of the Sponsor of responsibility to meet its obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy of law or equity to assure faithful performance pursuant to this Agreement.

ARTICLE IX - RELEASE OF CLAIMS

Orange, Riverside and San Bernardino shall hold and save the Government free from all damages arising from the construction, operation and maintenance of the project except for damages due to the fault or negligence of the Government or its contractors. Orange, Riverside, and San Bernardino shall separately hold and save the Government free from all damages arising from the construction, operation, and maintenance of the Project features for which they pay 100% of the construction cost sharing. For the remaining project features for which more than one of the Sponsors is responsible, Orange, Riverside, and San Bernardino shall hold and save the Government free from all damages arising from the construction, operation, and maintenance of those features in proportion to the share of construction costs borne by each of the Sponsors for that feature in accordance with Article II of this Agreement.

ARTICLE X - HAZARDOUS SUBSTANCES

A. After execution of this Agreement and upon direction by the Contracting Officer, the Local Sponsors shall perform, or cause to be performed, such environmental investigations as are determined necessary by the Government to identify the existence of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 USC 9601-9675, on lands necessary for Project construction, operation, and maintenance. All actual costs incurred by the Local Sponsors which are properly allowable and allocable to performance of any such environmental investigations shall be included in total project costs and cost shared as a construction cost in accordance with Section 103 of Public Law 99-662.

B. In the event it is discovered through an environmental investigation or other means that any lands, easements, rights-of-way, or disposal areas to be acquired or provided for the Project contain any hazardous substances regulated under CERCLA, the Local Sponsors shall provide prompt notice to the Government and shall not proceed with the acquisition of lands, easements, rights-of-way, or disposal areas until so directed by the Government.

C. The Government shall, after consultation with the Local Sponsors, but in its sole discretion, determine whether to initiate construction of the Project, or if already in construction, to continue with construction of the Project, or to terminate construction of the Project for the convenience of the Government in any case where hazardous substances regulated under CERCLA are found to exist on any lands necessary for the Project. Should the Government determine to proceed or continue with construction after considering any liability that may arise under CERCLA, the Local Sponsors shall be solely responsible for any and all necessary clean up and response costs, to include the costs of any studies and investigations necessary to determine the extent of and appropriate response to the contamination. Such costs shall not be considered a part of total project costs as defined in this Agreement. In the event the Local Sponsors fail to provide any funds necessary to pay for clean up and response costs or to otherwise discharge its responsibilities under this paragraph upon direction by the

Government, the Government may either terminate or suspend work on the Project or proceed with further work as provided in Article XVII.

D. The Local Sponsors and the Government shall consult with each other under the Construction Phasing and Management Article of this Agreement to assure that responsible parties bear all necessary cleanup and response costs as defined in CERCLA. Any decision made pursuant to paragraph c. of this Article shall not relieve any party from any liability that may arise under CERCLA.

E. The Local Sponsors shall operate, maintain, repair, replace, and rehabilitate the Project in a manner so that liability will not arise under CERCLA.

F. In the event such liability does arise in the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project, the Local Sponsors shall indemnify the Government for any cleanup costs or response costs for which the Government is found liable under CERCLA.

ARTICLE XI - MAINTENANCE OF RECORDS

The Government and the Sponsors shall keep books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total project costs. The Government and the Sponsors shall maintain such books, records, documents, and other evidence for each project feature for a minimum of three (3) years after completion of construction of the the feature and resolution of all relevant claims arising therefrom, and shall make available at their offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

ARTICLE XII - GOVERNMENT AUDITS

The Government shall conduct audits of the Sponsors' records upon completion of each feature of the Project to ascertain the allowability, reasonableness, and allocability of each of the Sponsors' costs for inclusion as credit against each of the Sponsors' shares of cost pertaining to that feature. When the Government determines that the Project is complete, the Government shall conduct a final audit, based upon the audits of each feature, to ascertain the final credit for each of the Sponsors against each of the Sponsors' obligations in Article II of this Agreement.

ARTICLE XIII - FEDERAL AND STATE LAWS

In acting under its rights and obligations hereunder, the

Sponsors agree to comply with all applicable Federal and State Laws and Regulations, including Section 601 of Title VI of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Direction 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, as well as Army Regulation 600- 7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

ARTICLE XIV - RELATIONSHIP OF PARTIES

The parties to this Agreement shall act in an independent capacity in the performance of their respective functions under this Agreement, and no party is to be considered the officer, agent, or employee of the other.

ARTICLE XV - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XVI - COVENANT AGAINST CONTINGENT FEES

The Sponsors warrant that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Sponsors for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability or, in its discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XVII - TERMINATION OR SUSPENSION

A. If at any time a Sponsor or Sponsors fail to make the payments required under this Agreement, the Secretary of the Army shall, after notice to the Sponsors, terminate or suspend work on the Project until the Sponsor or Sponsors are no longer in arrears, unless the Secretary of the Army determines that continuation of work on the project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to one hundred fifty (150) per centum of the average bond equivalent rate of the 13-week treasur bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds three (3) months.

B. If the Government fails to receive annual appropriations for the Project in amounts sufficient to meet project expenditures for the then-current or upcoming fiscal year, the Government shall so notify the Sponsors. After sixty (60) calendar days the Sponsors or the Government may elect without penalty to terminate this Agreement or to defer future performance thereunder; however deferral of future performance under this Agreement shall not affect existing obligations or relieve the parties of liability for any obligation previously incurred. In the event that either The Sponsors or the Government elect to terminate this Agreement pursuant to this Article, the parties shall conclude their activities relating to the project and proceed to a final accounting in accordance with Article VI. In the event that either the Sponsors or the Government elect to defer future performance under this Agreement such deferral shall remain in effect until such time as the Government receives sufficient appropriations or until either party elects to terminate this Agreement.

ARTICLE XVIII - MAXIMUM PROJECT COST

The Sponsors have reviewed the provisions set forth in Section 902 of the Act, and understand the limitations placed on this Project. For purposes of this Agreement, the Section 902 limit is $1,536,000,000. This is based on October 1989 price levels and shall be adjusted to allow for appropriate increases in inflation and cost changes in the Project as provided in Section 902.

ARTICLE XIX - OBLIGATION OF FUTURE APPROPRIATIONS

Each Sponsor shall use its best efforts to utilize the alternatives set forth in Article XIII.B., et seq. of the California State Constitution (the "Gann Amendment") or to modify its budget, if necessary, in any Sponsors' fiscal year to timely meet its obligations to produce additional funds required by the Government for a fiscal year pursuant to Article VI.B.4. and Article VI.D. of this Agreement. However, if subsequent to the utilization of such best efforts a Sponsor is precluded by the Gann Amendment to the California State Constitution from timely producing such additional funds, the payment to liquidate any such obligations pursuant to Article VI.B.4. and Article VI.D. of this Agreement may be deferred to the Sponsors' next fiscal year. Any increased project costs occurring as a result of the deferral of such payments, including interest on unpaid amounts which shall be calculated as provided in Section 106 of the Act, shall be borne by the Sponsors alone and shall not be subject to cost sharing by the Government. It is specifically recognized that the deferral of the payment to liquidate any such obligations pursuant to Article VI.B.4. and Article VI.D. of this Agreement shall not in any way be considered or construed as a suspension of these obligations or conditioning of said obligations in any manner, except as provided herein.

ARTICLE XX - NOTICES

A. All notices, requests, and other communications required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally, given by prepaid telegraph, or mailed by first- class (postage-prepaid), registered, or certified mail, as follows:

If to the Sponsors:

Orange County Flood Control District
12 Civic Center Plaza
P.O. Box 4048
Santa Ana, CA 92702-4048

Riverside County Flood Control and
Water Conservation District
1995 Market Street
P.O. Box 1033
Riverside, CA 92502-1033

San Bernardino County Flood Control District
825 East Third Street
San Bernardino, CA 92415-0835

If to the Government:

Los Angeles District
U.S. Army, Corps of Engineers
300 N. Los Angeles
P.O. Box 2711
Los Angeles, CA 90053-2325

B. A party may change the address to which such communications are to be directed by giving written notice to the others in the manner provided in this section.

C. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at such time as it is personally delivered or on the third business day after it is mailed, as the case may be.

ARTICLE XXI - CONFIDENTIALITY

To the extent permitted by the laws governing each of the parties, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XXII - ENTIRE AGREEMENT

This Agreement is intended by the parties hereto as a final expression of their understanding with respect to the subject matter hereof and as a complete and exclusive statement of the provisions thereof and supersedes any and all prior and contemporaneous agreements and understandings, oral or written, in connection therewith. This Agreement may be changed or modified only upon the written consent of the parties hereto.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the date first written above.

RIVERSIDE COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT

Date: By: Mellia Dunlap
Chairman of the Board of Supervisors

Attest: Gerald A. Maloney
Gerald A. Maloney, Clerk of the Board

Date: DECEMBER 19, 1989 By: ______________________
Deputy

Seal

Date: APPROVED AS TO LEGAL FORM
By: Peter H. Lyon
County Counsel, Riverside County

SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT

89-1087 (Revised)

Date: DEC 18 1989

By: Barbara Cram Riordan
Chairman of the Board of Supervisors

ATTEST:

Date: DEC 18 1989

By: Mary Louise Levario
Deputy Clerk of the Board of Supervisors
of San Bernardino County, California

APPROVED AS TO LEGAL FORM

Date: 12-19-89

By: ______________________
Deputy County Counsel, San Bernardino County

ORANGE COUNTY FLOOD CONTROL DISTRICT

Date: DEC 14 1989

By: Thomas F. Riley
Chairman of the Board of Supervisors

SIGNED AND CERTIFIED THAT A COPY OF THIS AGREEMENT HAS BEEN DELIVERED TO THE CHAIRMAN OF THE BOARD

Date: DEC 19 1989

By: Linda D. Ruth
Linda D. Ruth
Clerk of the Board of Supervisors
of Orange County, California

APPROVED AS TO LEGAL FORM

Date: DEC 14 1989

By: ____________________
Benjamin P. de Mayo
County Counsel, Orange County

THE DEPARTMENT OF THE ARMY

Date: 13 DEC 1989

By:____________________
Robert W. Page
Assistant Secretary of the Army
(Civil Works)

CERTIFICATE OF AUTHORITY

I, Peter H. Lyons, do hereby certify that I am the County Counsel for the Riverside County Flood Control and Water Conservation District, California, that said Riverside County Flood Control and Water Conservation District is a legally constituted public body with full authority and capability to perform the terms of this Local Cooperation Agreement between the Department of the Army and the Riverside County Flood Control and Water Conservation District, California, in connection with the Santa Ana River Mainstem, including Santiago Creek, California Flood Control Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, and that the persons who have executed the Agreement on behalf of the Riverside County Flood Control and Water Conservation District have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this Certificate this 7th day of December, 1989.

Peter H. Lyons
County Counsel

CERTIFICATE OF AUTHORITY

I, ________________________, do hereby certify that I am the County Counsel for the San Bernardino County Flood Control District, California, that said San Bernardino County Flood Control District is a legally constituted public body with full authority and capability to perform the terms of this Local Cooperation Agreement between the Department of the Army and the San Bernardino County Flood Control District, California, in connection with the Santa Ana River Mainstem, including Santiago Creek, California Flood Control Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, and that the persons who have executed the Agreement on behalf of the San Bernardino County Flood Control District have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this Certificate this 14 day of December, 1989.

Deputy County Counsel

CERTIFICATE OF AUTHORITY

I, Bryan P. deMays, do hereby certify that I am the County Counsel for the Orange County Flood Control District, California, that said Orange County Flood Control District is a legally constituted public body with full authority and capability to perform the terms of this Local Cooperation Agreement between the Department of the Army and the Orange County Flood Control District, California, in connection with the Santa Ana River Mainstem, including Santiago Creek, California Flood Control Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, and that the persons who have executed the Agreement on behalf of the Orange County Flood Control District have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this Certificate this 14th day of December, 1989.

County Counsel

SPONSORS' AGREEMENT FOR

OPERATION AND MANTENANCE

Agreement D99-199

for

Operation and Maintenance of the Seven Oaks Dam

by and among

The Orange County Flood Control District

and

The San Bernardino County Flood Control District

and

The Riverside County Flood Control and Water Conservation District

August 2002

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AGREEMENT

This agreement ("AGREEMENT") is made and entered into this ____________ day of ______________, 2002,

BY and AMONG

The Orange County Flood Control District, hereinafter referred to as "ORANGE",

AND

The San Bernardino County Flood Control District, hereinafter referred to as "SAN BERNARDINO",

AND

The Riverside County Flood Control and Water Conservation District, hereinafter referred to as "RIVERSIDE".

ORANGE, SAN BERNARDINO, and RIVERSIDE are referred to collectively as the "SPONSORS".

RECITALS

WHEREAS, in the Water Resources Development Act of 1986, P. L. 99-662, the Congress of the United States authorized construction of certain flood control improvements on the Santa Ana River, including Santiago Creek, California, (hereinafter referred to as the "PROJECT"); and

WHEREAS, effective December 14, 1989, a Local Cooperation Agreement ("LCA") was entered into by the Department of the Army ("GOVERNMENT") and the SPONSORS, for construction of the Project, including Seven Oaks Dam ("DAM"); and

WHEREAS, the DAM is located in San Bernardino County and is depicted on Exhibit A, ("LOCATION MAP"), which is incorporated as though fully set forth herein; and

WHEREAS, Articles II. B. and VIII of the LCA, establish the SPONSORS' cost-share responsibilities for the operation, maintenance and rehabilitation of the DAM ("O&M"), including mitigation lands and borrow areas purchased for the construction of the DAM, once the DAM has been completed and responsibility for O&M has been turned over to the SPONSORS by the Government ("TURNOVER"); and

WHEREAS, SPONSORS entered into Agreement No. D93-035 which clarifies responsibilities and procedures for the operation, maintenance, management, rehabilitation, development, lease, sale or other disposition of property rights acquired for the dam; and

WHEREAS, the Government has scheduled the TURNOVER of the DAM to SPONSORS in August 2002; and

WHEREAS, it is understood that water conservation at the DAM is the subject of a separate study and any facilities, quantities of storage, and/or changes in operation, and the cost sharing for water conservation, if implemented, shall be addressed in a separate agreement; and

WHEREAS, the SPONSORS hereto have the authority and capability to furnish the cooperation hereinafter set forth and are willing to participate in the cost-sharing of O&M responsibilities for the DAM, in accordance with the terms of this AGREEMENT.

NOW, THEREFORE, THE SPONSORS MUTUALLY AGREE AS FOLLOWS:

A. PURPOSE

The purpose of this AGREEMENT is to prescribe the methodology for implementing the responsibilities including the procedures for budgeting and tracking costs among the SPONSORS for the O&M of the DAM as specified in the LCA and in accordance with the approved O&M Manual provided by GOVERNMENT.

B. EFFECTIVE DATE/TERM

1. The term of this AGREEMENT shall become effective upon the signature date of the last of the SPONSORS to sign this AGREEMENT and shall, upon mutual agreement of all SPONSORS, remain in effect until further notice, subject to Subparagraph B. 2. below or unless terminated in accordance with Paragraph P (TERMINATION), below.

2. SPONSORS agree to review this AGREEMENT every three (3) years, or earlier as described below, to determine what, if any, changes or modifications should be made to this AGREEMENT, as follows:

   a. In the event that the SPONSORS' respective Chief Engineers representing the respective SPONSORS ("CHIEF ENGINEERS") agree that no changes or modifications are necessary, the AGREEMENT shall remain in effect, with no further action required by the SPONSORS' respective Boards' of Supervisors; however

b. In the event that one (1) or more CHIEF ENGINEER(S) requests changes to this AGREEMENT, the SPONSORS' CHIEF ENGINEERS or respective Board of Supervisors representative agree to meet within thirty (30) calendar days of the mailing of written notice, to determine the extent of the changes required, and to prepare the amendment(s) accordingly.

c. Amendments prepared shall be in accordance with Paragraph Y (AMENDMENTS), below, and must be approved by the SPONSORS' respective Boards of Supervisors.

C. DEFINITIONS

For the purposes of this AGREEMENT, the following definitions shall apply:

1. The term "GOVERNMENT" shall mean the Department of the Army.

2. The term "PROJECT" shall mean construction of certain flood control improvements on the Santa Ana River, including Santiago Creek.

3. The term "LCA" shall mean the Local Cooperation Agreement between the GOVERNMENT and the SPONSORS, effective December 14, 1989, for construction of the Project.

4. The term "DAM" shall mean the Seven Oaks Dam, reservoir area and appurtenances, along with mitigation lands, U. S. Forest Services lands, the impervious borrow areas, and other lands purchased in fee or permanent easement for the construction of the DAM, as identified in Exhibit A, attached hereto.

5. The term "GDM" shall mean the General Design Memorandum, and in the context used herein, refers specifically to the Phase II of the Document dated August 1988, which specifies the general requirements for mitigation and enhancement lands and structural improvements.

6. The term "SEVEN OAKS TRIAD" shall mean the Ad Hoc committee formed by representatives of the Government, the State of California, Department of Water Resources

- Division of Safety of Dams (DSOD), and the SPONSORS who have the responsibility to provide direction on, monitor the construction of, and operate and maintain the DAM.

7. The term "O&M" shall mean the operation, maintenance, repair, replacement and rehabilitation activities for the DAM.

8. The term "TURNOVER" shall mean the time when GOVERNMENT determines the DAM is complete and turns completed DAM over to SPONSORS, who shall accept the DAM and its O&M responsibility in accordance with LCA, Article II, Paragraph B and Article VIII.

9. The term "APPROVED DAM OPERATION SCHEDULE" shall mean the Water Control Plan prepared by GOVERNMENT.

10. The term "ANNUAL BUDGET" shall mean the budget, prepared annually by the SPONSORS (based upon SPONSORS' fiscal year) for the DAM's O&M activities. SPONSORS' fiscal year shall be defined as the period beginning July 1 and ending June 30.

11. The term "DISPUTE(S)" shall mean a determination that the SPONSORS have failed to agree on action(s) in a timely manner, as required by the SPONSORS under this AGREEMENT, or with respect to this AGREEMENT.

12. The term "CHIEF ENGINEER(S)" shall mean the respective Chief or Flood Control Engineer for ORANGE, SAN BERNARDINO or RIVERSIDE.

13. The term "COST SHARE" shall mean the SPONSORS' sharing of expenses for DAM's O&M activities, as defined in Articles II. B. and VIII. of the LCA.

D. TURNOVER

TURNOVER of DAM O&M responsibilities to SPONSORS is expected to occur when the following requirements, as well as requirements stated in the LCA and GDM, and those outlined through the Seven Oaks Triad, have occurred. GOVERNMENT will inform SPONSORS of the requirements for mitigation of impacts to the San Bernardino Kangaroo Rat and other new endangered species pending GOVERNMENT's consultations with the U.S. Fish and Wildlife Service:

1. Notification in writing by the GOVERNMENT that the DAM and all appurtenances have been completed, as well as all lands and mitigation areas required for O&M are made available to SPONSORS (If not already in SPONSORS' possession). Written notification of such action shall provide for SPONSORS' concurrence that the DAM has been completed and ready for TURNOVER.
2. Verification in writing from DSOD, that DSOD's requirements have been fulfilled. (Note: DSOD certification can only occur after the DAM has been turned over to SPONSORS.)
3. DAM's O&M Manual, has been completed and provided to SPONSORS by GOVERNMENT.
4. GOVERNMENT's construction contractor has completed the "Punch List" of items or their disposition identified in GOVERNMENT's turn-over letter.
5. As-Built drawings, including one set full size mylars, one set half size mylars, one set full size bluelines, three sets half size bluelines and electronic files of the As-Built drawings on CD-ROM disks have been completed and provided to SPONSORS by GOVERNMENT.
6. Foundation Report, Embankment Criteria and Performance Reports have been completed and provided to SPONSORS by GOVERNMENT.
7. Assignment of SPONSORS as agents for GOVERMENT, for matters concerning certain rights-of-way or lands under the jurisdiction of the U.S. Forest Service, as described in the Memorandum of Understanding between the Chief, United States Department of Agriculture Forest Service and GOVERNMENT, regarding construction and O&M of the DAM.
8. A Water Control Plan which contains the "APPROVED DAM OPERATIONS SCHEDULE" has been completed and provided to SPONSORS by GOVERNMENT.
9. Emergency Action Plan (EAP) which prescribes the monitoring, reporting, remediation, notification, evacuation and recovery procedures for imminent or actual failure conditions due to flood flows at the DAM, has been completed and provided to SPONSORS by GOVERNMENT.

E. COST SHARE

1. SPONSORS acknowledge that their respective annual COST SHARE for O&M of the DAM as established in the LCA, are as follows:

   a. ORANGE -87.70%

   b. SAN BERNARDINO - 7.03%

   c. RIVERSIDE - 5.27%

2. SPONSORS further acknowledge that portions of their respective COST SHARE responsibilities are subject to the payment conditions outlined in, Subparagraph F.1. k., below.

F. SPONSORS' RESPONSIBILITIES

1. SPONSORS' shall jointly be responsible for:

   a. Operating and maintaining the DAM, adhering to the O&M Manual and The Water Control Plan. Physical operation of DAM is assigned to ORANGE and SAN BERNARDINO.

   b. Implementing a Maintenance Management System or equivalent.

   c. Employing operation and maintenance staff including dam tenders.

   d. Employing security services as needed, to monitor and resolve potential trespassing violations and to secure area from potential acts of vandalism.

   e. In accordance with the DAM's O&M Manual, performing the activities including but not limited to: Survey and reading of all operation instruments including settlement monuments, inclinometers, piezometers, tunnel pressure transducers, intake load cells, joint meters, tunnel strain meters, strong motion (seismic) instrumentation, reservoir index range lines monuments, and tunnel alignment surveys; as well as monitor water quality, exercise the gates, perform debris removal, including access road debris removal and maintenance.

f. Maintaining lands that were purchased by SPONSORS in fee or permanent easement, and lands transferred to GOVERNMENT for DAM construction and operation and maintenance, as identified in Exhibit A, unless such lands/sites are properly disposed of through sale or otherwise.

i. Performing mitigation land management tasks, including but not limited to the following:

1) Implement, and account separately for GOVERNMENT credit purposes, for tasks defined in the Santa Ana River "Woolly Star" (Eriastrum densifulium ssp. Sanctorum) Management Plan, dated November 1993, or as updated, including but not limited to:

(a) Monitoring for exotic species, encroachments, and dumping of debris.

(b) Removing exotic species and dumping of alien soils and other material.

(c) Installing and maintaining human intrusion controls, and patrolling the site.

(d) Acquiring and managing contracts for studies, (e.g. population and habitat monitoring, habitat renewal and population expansion).

2) Determine during the months of November and March of each year, which land management responsibilities will be assigned to either ORANGE or SAN BERNARDINO,

3) Acquire permits, as applicable, for tasks in Subparagraphs 1) (a), (b), (c), and (d) above.

4) Coordinate other tasks as may be required in the future pursuant to future direction by GOVERNMENT.

5) Coordinate with the GOVERNMENT, resource agencies, and others as applicable.

6) Prepare an Annual Report on management activities for distribution to GOVERNMENT, resource agencies, and others as applicable.

7) Prepare and update public information documents (pamphlets, reports, press releases), for the "Woolly Star", and distribute such documents to local schools, museums, libraries, and newspapers as needed.

8) Conduct or arrange for public information programs as needed.

9) Organize and host an annual "Woolly Star Preserve Tour" as needed. (Area shown in EXHIBIT A.)

10) Undertake any other actions as required by Agreement No. D93-035 and Management Plan for the Santa Ana River Woolly Star and Woolly Star Mitigation Budget, Exhibit 'C'.

j. Preparing the Annual O&M Budget

1) During March and November of each year, determine activities to be accomplished by each of the SPONSORS, and GOVERNMENT if applicable, for the upcoming fiscal year (July 1 through June 30), as well as to estimate requirements for the proposed annual budgets for the subsequent three (3) years (4 years total), as follows:

(a) Identify which activities will be accomplished by SPONSORS' personnel (direct costs) or by contractors (indirect costs).

(b) Identify costs in the next annual and next three (3) annual projected budgets for land management tasks (including estimated direct and contract costs), which are to be included in the O & M budget.

(c) Include applicable costs for labor burden and overhead.

2) Submit to one another in writing, by January 1st (with revisions due by February 1st) SPONSORS' respective proposed annual O&M budget for the next fiscal year. These proposed budgets shall include requirements for tasks specified in Subparagraph 10 (a), (b) and (c), above.

3) Obtain tentative approval of proposed annual budgets by each SPONSORS' respective Chief Engineer. SPONSORS' costs shall be included in each SPONSORS' respective proposed annual budget, for approval by the SPONSORS' respective Boards of Supervisors.

4) As applicable, budget separately every fifteen (15) to twenty-five (25) years, for the "major replacement" items shown in Exhibit B ("ESTIMATED ANNUAL OPERATION AND MAINTENANCE BUDGET"), attached hereto as though fully incorporated herein, based on the cost-share formula specified in Paragraph E (COST SHARE), above.

5) Should a disagreement occur among the SPONSORS regarding O&M costs or service delivery for the DAM, ORANGE, because of its responsibility for payment of the majority of O&M costs, shall have the option, at its sole discretion, of accomplishing work task(s) with its own forces or by contracting out for the services and include such expenses in determining the annual costs for each SPONSOR.

6) Review and/or discuss invoices for actual costs and expenditures for prior years' expenditures, as deemed necessary by ORANGE, in accordance with Subparagraphs k. 5) (a) and l. 2), below.

k. Invoicing and Payments

1) Beginning July 1 of each fiscal year, and no later than ninety (90) days thereafter, SAN BERNARDINO shall invoice SPONSORS as follows:

(a) Invoice ORANGE, for an advancement of funds equal to 25% of ORANGE's share (87.7%) of SAN BERNARDINO'S total estimated annual O&M budget (for direct costs, contract costs and land Management costs).

(b) Invoice RIVERSIDE, for an advancement of funds equal to 50% of RIVERSIDE'S share (5.27%) of SAN BERNARDINO'S total estimated annual O&M budget (for direct costs, contract costs and land management costs).

2) Within ninety (90) days after the end of each fiscal quarter, SAN BERNARDINO shall submit a Quarterly Expense Report, and invoice SPONSORS as follows:

(a) Invoice ORANGE for 87.7% of the actual expenses incurred by SAN BERNARDINO for O&M costs for the fiscal quarters ending September, December, and March.

(b) For the final fiscal quarter ending June 30th, invoice ORANGE, for 87.7% of the actual expenses incurred by SAN BERNARDINO for O&M costs, subtracting ORANGE's initial 25% pre-payment and adding the next year's estimated 25% pre-payment.

3) Within 90 days after the end of the fiscal year, invoice RIVERSIDE for 5.27% of the actual expenses incurred by SAN BERNARDINO for O&M costs during the fiscal year, subtracting RIVERSIDE's initial 50% previous pre-payment and adding the next year's estimated 50% pre-payment.

4) ORANGE and RIVERSIDE shall pay invoice(s) referenced in Sub paragraphs k. 1) and 2) above, within sixty (60) days of receipt.

5) SAN BERNARDINO shall provide copies of all the SPONSORS' invoices to ORANGE, so that:

(a) ORANGE has the opportunity to review all previously submitted invoices for "appropriateness of costs", as deemed necessary, and to make adjustments and/or corrections to the amounts billed in accordance with the Annual Expense Reports/Final Accounting procedures described in Subparagraph l, below.

(b) ORANGE can present any discrepancies to SAN BERNARDINO and/or RIVERSIDE in March or November, for discussion, in accordance with Subparagraph l. 2) (b), below.

l. Preparing Annual Expense Reports and Final Accounting

1) SAN BERNARDINO and RIVERSIDE shall each submit their respective "Annual Expense Reports" to ORANGE, itemizing their fiscal year's expenses including labor burden and overhead, by August 31st of each fiscal year.

2) ORANGE shall reconcile all the SPONSORS' respective expenses, in order to determine the final annual accounting, based on the COST-SHARE, and as follows:

(a) Amounts already paid by ORANGE and RIVERSIDE will be deducted to determine final amounts owed, or due each SPONSOR for the fiscal year of the final accounting.

(b) Any changes or adjustments to costs/expenditures previously invoiced or paid by SPONSORS, as deemed necessary by ORANGE, shall be presented by ORANGE for discussion in November or March to determine appropriateness of costs/expenditures.

(c) ORANGE will invoice SAN BERNARDINO and RIVERSIDE, or provide reimbursement of funds accordingly, for those funds previously paid by SAN BERNARDINO and RIVERSIDE, based upon the results of the final accounting.

(d) If payment is due ORANGE, SAN BERNARDINO and RIVERSIDE will pay amounts owed, respectively, within sixty (60) days of receipt of ORANGE'S invoice.

2. ORANGE shall be responsible for:

a. Operating and maintaining the DAM gates in cooperation with SAN BERNARDINO, and in accordance with Paragraph F, above.

b. Implementing a Maintenance Management System, or equivalent, in cooperation with SAN BERNARDINO.

c. Paying 87.7% of the O&M costs for the DAM.

d. Contracting out and supervising contract(s) for infrequent maintenance activities beyond the resources of the normal public works maintenance equipment and personnel. These activities may include but not be limited to gate removal and repair, outlet works tunnel invert overlay and major intake tower maintenance.

e. Contracting for reading and maintaining the seismometers and accelographs.

f. Performing chemical herbicide weed control for DAM and appurtenances.

g. Performing water quality testing and/or monitoring in accordance with the O&M Manual.

h. Participating in all post-earthquake, pre-flood, periodic routine and non-routine inspections of DAM and appurtenances.

i. Performing all survey work other than that performed by GOVERNMENT.

j. Administering contract items estimated to cost more than twenty five thousand dollars ($25,000), including but not limited to inspections (i.e. annual inspections), instrument monitoring, monitoring survey settlement monumentation and interpreting the data, and if necessary, contracting for "Woolly Star" biological services and security services.

k. Being the lead SPONSOR for preparation of current and future Annual Budgets for DAM O&M operations.

l. Reconciling annual expense reports received form SAN BERNARDINO and RIVERSIDE, and invoicing or providing reimbursements to SAN BERNARDINO and RIVERSIDE, based upon results of final accounting.

3. SAN BERNARDINO shall be responsible for:

a. Operating and maintaining the DAM gates in cooperation with ORANGE, and in accordance with, above.

b. Implementing a Maintenance Management System, or equivalent, in cooperation with ORANGE.

c. Performing O&M on behalf of the SPONSORS, unless otherwise agreed upon by SPONSORS.

d. Maintaining "Woolly Star" habitat and other mitigation lands, as applicable or otherwise agreed upon by SPONSORS in accordance with Agreement No. D93-035.

e. Maintaining the borrow sites, as applicable in accordance with Agreement No. D93-035.

f. Perform rodent control.

g. Administering contract(s) for work under twenty-five thousand dollars ($25,000).

h. Invoicing ORANGE and RIVERSIDE for their COST-SHARE.

i. Paying its COST SHARE per Section E, above.

4. RIVERSIDE shall be responsible for:

a. Paying its cost share per Section E, above.

G. PROPERTY TAXES

There are currently no property taxes ("Taxes") levied on the former impervious borrow area ("Property"), which SPONSORS own in fee, with each SPONSOR holding an interest in the Property in accordance with their cost share for DAM construction. However, in the event Taxes are levied, ORANGE shall pay Taxes, and invoice SAN BERNARDINO and RIVERSIDE for their respective cost share as all other O&M costs, pursuant to Section E. and Section F. SAN BERNARDINO shall endeavor to have Taxes reduced or eliminated based on the fact that SPONSORS jointly own the property.

H. OTHER TASKS AND SERVICES

Other tasks and services that are deemed necessary for DAM management and authorized in writing by the Sponsor's respective Chief Engineers, shall be cost shared pursuant to Section 'E' and budgeted for pursuant to Section F. Such tasks and services may include but are not limited to, tasks associated with property disposition, evaluation of water conservation proposals, or any requests for permits associated with the Woolly Star preserve.

I. ESTIMATED ANNUAL BUDGET(S)

1. The O&M cost for the initial year of DAM operation (excluding O&M for environmental mitigation) is estimated at one million one hundred twenty six thousand six hundred dollars ($1,126,600) and is shown in Exhibit B.

2. Future O&M annual budget(s) shall be established by SPONSORS prior to July 1st of each fiscal year, in accordance with Section F above. ORANGE will be the lead SPONSOR for establishing projected annual budget(s) for DAM's O&M activities.

3. Figures and/or costs from each SPONSOR used to prepare annual budget(s) shall, in addition to direct labor costs, include applicable costs for labor burden and overhead. The established rates used to calculate these costs shall not exceed fifty-five (55%) percent each. Supporting documentation for these rates shall be maintained and available at the request of any SPONSOR.

J. AUDITS

The SPONSORS shall be allowed to audit each other's expenses. SAN BERNARDINO and ORANGE, as applicable, shall maintain all records and supporting source documents for five (5) years after each audit.

K. INSPECTIONS BY THE GOVERNMENT

GOVERNMENT may, at its own prerogative, periodically inspect the DAM to ensure the SPONSORS are operating and maintaining the DAM in accordance with the O&M Manual and to the satisfaction of the Government. Government may prepare list of items for improvement, if any, regarding SPONSORS' O&M.

L. NOTICES

1. Notices or other communications which may be required or provided under the terms of this AGREEMENT shall be given as follows.

ORANGE COUNTY: Orange County Flood Control District
Public Facilities and Resources Department
300 N. Flower
P.O. Box 4048
Santa Ana, CA 92702-4048

Attn: Director

SAN BERNARDINO
COUNTY: San Bernardino County Flood Control District
825 East Third Street
San Bernardino, CA 92415-0835
Attn: Chief Engineer

RIVERSIDE
COUNTY: Riverside County Flood Control and Water Conservation District
1995 Market Street
Riverside, CA 92501
Attn: General Manager-Chief Engineer

2. All notices shall be in writing and deemed effective when delivered in person or deposited in the United States mail, first class, postage prepaid and addressed as above. Notwithstanding the above, SPONSORS may also provide notices by facsimile transmittal, and any such notice so given shall be deemed to have been given upon receipt during normal business hours, or in the event of receipt after business hours, the following business day. Any notices, correspondence, reports and/or statements authorized or required by this AGREEMENT, addressed in any other fashion shall be deemed not given.

3. SPONSORS may change the address to which such communications are to be directed by giving written notice to the other SPONSORS in the manner provided in this section.

M. WORKERS' COMPENSATION AND LIABILITY INSURANCE

1. SPONSORS agree to be responsible for providing workers' compensation insurance for their respective staff employed at the DAM.

2. Sponsors COST SHARE of any liability insurance will be addressed in a separate agreement or MOU, or an amendment to this agreement.

N. INDEMNIFICATION

1. <u>Indemnification by ORANGE:</u>

ORANGE hereby agrees to indemnify, defend (with counsel acceptable to SAN BERNARDINO and RIVERSIDE), release and hold harmless SAN BERNARDINO and

RIVERSIDE, their elected and appointed officials, officers, employees, agents (including their contractors and subcontractors), licensees, and representatives (collectively, the "SAN BERNARDINO AND RIVERSIDE INDEMNITEES"), and each of them, and their property from all loss, liability, damages, claims, costs and expenses (including attorneys' fees and court costs) arising out of, based upon or relating to a breach of this AGREEMENT by ORANGE or the willful misconduct or negligent acts or omissions of ORANGE, or its elected and appointed officials, officers, employees, agents (including contractors and subcontractors), licensees, and representatives (collectively, the "ORANGE INDEMNITEES") in connection with this AGREEMENT; provided, however, that nothing contained in this subparagraph shall operate to relieve SAN BERNARDINO and RIVERSIDE from any loss, liability, damages, claims, costs, or expenses to the extent determined by a court of competent jurisdiction to have been proximately caused by the willful misconduct or negligent acts or omissions of SAN BERNARDINO and RIVERSIDE, the SAN BERNARDINO AND RIVERSIDE INDEMNITEES, or any of them. Payment shall not be a condition precedent to recovery under the foregoing indemnity.

2. **Indemnification by SAN BERNARDINO:**

SAN BERNARDINO hereby agrees to indemnify, defend (with counsel acceptable to ORANGE and RIVERSIDE), release and hold harmless ORANGE and RIVERSIDE, their elected and appointed officials, officers, employees, agents (including their contractors and subcontractors), licensees, and representatives (collectively, the "ORANGE AND RIVERSIDE INDEMNITEES"), and each of them, and their property from all loss, liability, damages, claims, costs and expenses (including attorneys' fees and court costs) arising out of, based upon or relating to a breach of this AGREEMENT by SAN BERNARDINO or the willful misconduct or negligent acts or omissions of SAN BERNARDINO, or its elected and appointed officials, officers, employees, agents (including contractors and subcontractors), licensees, and representatives (collectively, the "SAN BERNARDINO INDEMNITEES") in connection with this AGREEMENT; provided, however, that nothing contained in this subparagraph shall operate to relieve ORANGE and RIVERSIDE from any loss, liability, damages, claims, costs, or expenses to the extent determined by a court of competent jurisdiction to have been proximately caused by the willful misconduct or negligent acts or omissions of ORANGE AND RIVERSIDE, the ORANGE AND RIVERSIDE INDEMNITEES, or any of them. Payment shall not be a condition precedent to recovery under the foregoing indemnity.

3. Indemnification by RIVERSIDE:

RIVERSIDE hereby agrees to indemnify, defend (with counsel acceptable to ORANGE and SAN BERNARDINO), release and hold harmless ORANGE and SAN BERNARDINO, their elected and appointed officials, officers, employees, agents (including their contractors and subcontractors), licensees, and representatives (collectively, the "ORANGE AND SAN BERNARDINO INDEMNITEES"), and each of them, and their property from all loss, liability, damages, claims, costs and expenses (including attorneys' fees and court costs) arising out of, based upon or relating to a breach of this AGREEMENT by RIVERSIDE or the willful misconduct or negligent acts or omissions of RIVERSIDE, or its elected and appointed officials, officers, employees, agents (including contractors and subcontractors), licensees, and representatives (collectively, the "RIVERSIDE INDEMNITEES") in connection with this AGREEMENT; provided, however, that nothing contained in this subparagraph shall operate to relieve ORANGE and SAN BERNARDINO from any loss, liability, damages, claims, costs, or expenses to the extent determined by a court of competent jurisdiction to have been proximately caused by the willful misconduct or negligent acts or omissions of ORANGE and SAN BERNARDINO, the ORANGE AND SAN BERNARDINO INDEMNITEES, or any of them. Payment shall not be a condition precedent to recovery under the foregoing indemnity.

O. DISPUTES

DISPUTES, as defined in Paragraph C (DEFINITIONS), above, between two or more of the SPONSORS in respect to the terms of this AGREEMENT, or to any breach thereof, shall be resolved by the methods hereinafter set forth:

1. When a dispute exists between two or more SPONSORS, the respective CHIEF ENGINEERS shall meet and confer to resolve the dispute within a period of twenty (20) calendar days of written notice by the disputing SPONSOR or SPONSORS, of the existence of the dispute. A unanimous decision of the CHIEF ENGINEERS within this twenty (20) day period shall resolve the dispute and shall be binding on every SPONSOR.

2. Should the CHIEF ENGINEERS fail to reach a unanimous decision within the twenty (20) day period, the CHIEF ENGINEERS shall present the dispute within the next ten (10) days to the SPONSORS' respective Chair of the Boards of Supervisors for each SPONSOR, or to their designees. The SPONSORS' respective Chair of the Boards of Supervisors, or their designees, shall meet and confer to resolve the dispute within a period of twenty (20) calendar days of presentation of the dispute. A unanimous decision of the respective Chairs, or their designees within this twenty (20) day period shall resolve the dispute and be binding on every SPONSOR.

3. If a dispute is not resolved pursuant to Sub paragraphs 1. and 2. above, within the time frames set forth above, the SPONSORS shall refer the dispute within the next five (5) calendar days to an arbitration service mutually agreeable to the SPONSORS. SPONSORS agree that time is of the essence in resolving disputes relating to this AGREEMENT and that the SPONSORS shall expedite the presentation of the disputes for resolution. The mutually agreed upon arbitration service shall be requested to decide the dispute within fifteen (15) calendar days after presentation.

4. The SPONSORS agree that they shall accept any arbitrator assigned by the arbitration service to resolve the dispute. The SPONSORS further agree that they will be bound by any

award made by the arbitration service, and that any award made shall conclusively resolve the dispute. All costs incurred in presenting a dispute, including the costs of any arbitration service, shall be divided equally among the SPONSORS unless some other division of costs is made as part of the arbitrator's award.

5. SPONSORS shall agree that before any party to this AGREEMENT may bring suit in any court concerning an issue relating to this AGREEMENT, such party must first seek in good faith to resolve the issue through negotiation or other forms of non-binding alternative dispute resolution mutually acceptable to the other SPONSORS.

P. TERMINATION

1. Any SPONSOR may propose to terminate this AGREEMENT, subject to and effective upon mutual agreement of all SPONSORS, following delivery of a written notice to the other SPONSORS, one hundred eighty (180) days prior to the date the SPONSOR giving notice desires the termination to be effective, and in accordance with conditions and procedures described in subparagraphs 2, 3, 4, and 5 below.

2. In the event of proposed termination of this AGREEMENT pursuant to Subparagraph 1 above, the SPONSORS further agree to take the opportunity to meet, for the purpose of discussing and resolving any outstanding issues, or curing any alleged breach of this AGREEMENT, in accordance with Paragraph O (DISPUTES) above, prior to the effective date of any such termination.

3. Notice of Termination shall be in writing and shall state the cause for termination, if required, and the proposed date upon which such termination is to be effective. Notice shall be served as provided in Paragraph L (NOTICES), above.

4. If this AGREEMENT is terminated, each SPONSOR shall be liable for payment of its COST SHARE of expenses incurred while the AGREEMENT was in effect, in accordance with COST SHARE provisions herein within 45 days of receipt of a final accounting by ORANGE.

5. Termination of this AGREEMENT is subject to agreement among the SPONSORS on an alternative approach to perform and pay for O & M and environmental mitigation tasks in accordance with the LCA and Agreement No. D93-035.

Q. SUCESSORS AND ASSIGNS

This AGREEMENT shall be binding upon the successors and assigns of the SPONSORS hereto, and shall not be assigned without the prior written consent and approval of the SPONSORS. Failure to obtain SPONSORS' written approval of any proposed transfer or assignment will be deemed to be a proposal to terminate this AGREEMENT within the meaning of Paragraph P (TERMINATION) above.

R. WAIVER AND INTERPRETATION

Titles or captions contained herein are inserted as a matter of convenience and for reference, and in no way define, limit, extend, or describe the scope of this AGREEMENT or any provisions hereof. No provision in this AGREEMENT is to be interpreted for or against a SPONSOR because that SPONSOR or his legal representative drafted such provision.

S. WAIVER OF RIGHTS

The failure of any SPONSOR to insist upon strict performance of any of the terms, covenants or conditions of this AGREEMENT shall not be deemed a waiver of any right or remedy that SPONSOR may have, and shall not be deemed a waiver of the right to require strict performance of all the terms, covenants and conditions of this AGREEMENT thereafter, nor a waiver of any remedy for the subsequent breach or default of any term, covenant or condition of this AGREEMENT.

T. SEVERABILITY

If any part of this AGREEMENT is held, determined or adjudicated to be illegal, void or unenforceable by a court of competent jurisdiction, the remainder of this AGREEMENT shall be given effect to the fullest extent reasonably possible.

U. ATTORNEY FEES/COSTS

Should litigation be necessary to enforce any terms or provisions of this AGREEMENT, then each SPONSOR shall bear its own litigation and collection expenses, witness fees, court costs and attorney's fees, unless as otherwise provided for in this AGREEMENT.

V. GOVERNING LAW AND VENUE

This AGREEMENT has been negotiated and executed in the State of California and shall be governed by and construed under the laws of the State of California. In the event of any legal action to enforce or interpret this AGREEMENT, the sole and exclusive venue shall be a court of competent jurisdiction located in Orange County, California, and the SPONSORS hereto agree to and do hereby submit to the jurisdiction of such court, notwithstanding Code of Civil Procedure section 394.

W. CONFIDENTIALITY

To the extent permitted by the laws governing each of the SPONSORS, the SPONSORS agree to maintain the confidentiality of exchanged information when requested to do so by the providing SPONSOR.

X. AUTHORITY

The SPONSORS to this AGREEMENT represent and warrant that this AGREEMENT has been duly authorized and executed and constitutes the legally binding obligation of their respective organization or entity, enforceable in accordance with its terms.

Y. AMENDMENTS

This AGREEMENT may be changed or modified only upon the written consent of the SPONSORS hereto.

Z. ENTIRE AGREEMENT

This document sets forth the entire AGREEMENT between the SPONSORS and may be modified only by further written amendment between the SPONSORS hereto, in accordance with Paragraph Y (AMENDMENTS), above.

///

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IN WITNESS WHEREOF, each SPONSOR hereto has executed this AGREEMENT by a duly authorized representative as of the date set forth above.

ORANGE COUNTY FLOOD CONTROL DISTRICT,
a body corporate and politic

DATE:______________

BY: ______________________________
Chairman of the Board of Supervisors of
Orange County, California

SIGNED AND CERTIFIED THAT A COPY OF THIS DOCUMENT HAS BEEN DELIVERED TO THE CHAIRMAN OF THE BOARD

____
Darlene J. Bloom
Clerk of the Board of Supervisors of the Orange County Flood Control District of Orange County, California

APPROVED AS TO FORM:
LAURENCE M. WATSON,
COUNTY COUNSEL

BY: ______________________________
Deputy Date

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT, a body corporate and politic

DATE:______________ BY: ________________________________
Chairman of the Board of Supervisors of
San Bernardino County, California

ATTEST:

DATE:______________ BY: ________________________________
Deputy Clerk of the Board of Supervisors of
San Bernardino County, California

APPROVED AS TO LEGAL FORM:

DATE:______________ BY: ________________________________
County Counsel, San Bernardino County

RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT,
a body corporate and politic

RECOMMENDED FOR APPROVAL:

Date:_______________ BY: ________________________________
General Manager/Chief Engineer
Riverside County Flood Control
and Water Conservation District

DATE:_______________ BY: ________________________________
Chairman, Riverside County Flood Control and Water Conservation District Board of Supervisors

ATTEST:
Nancy Romero, Clerk of the Board

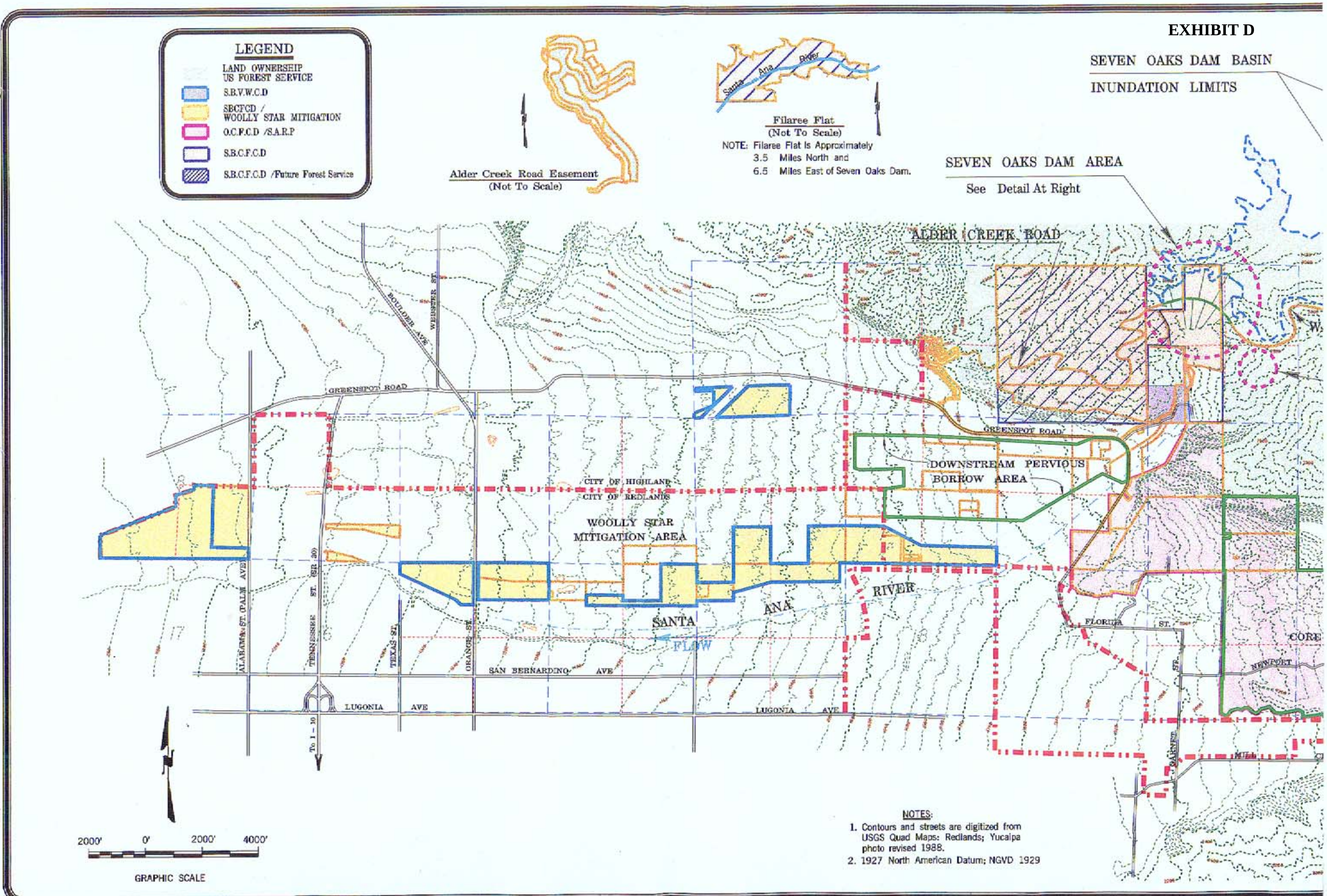
DATE:_______________ BY: ________________________________
Deputy

SEAL

APPROVED AS TO LEGAL FORM:

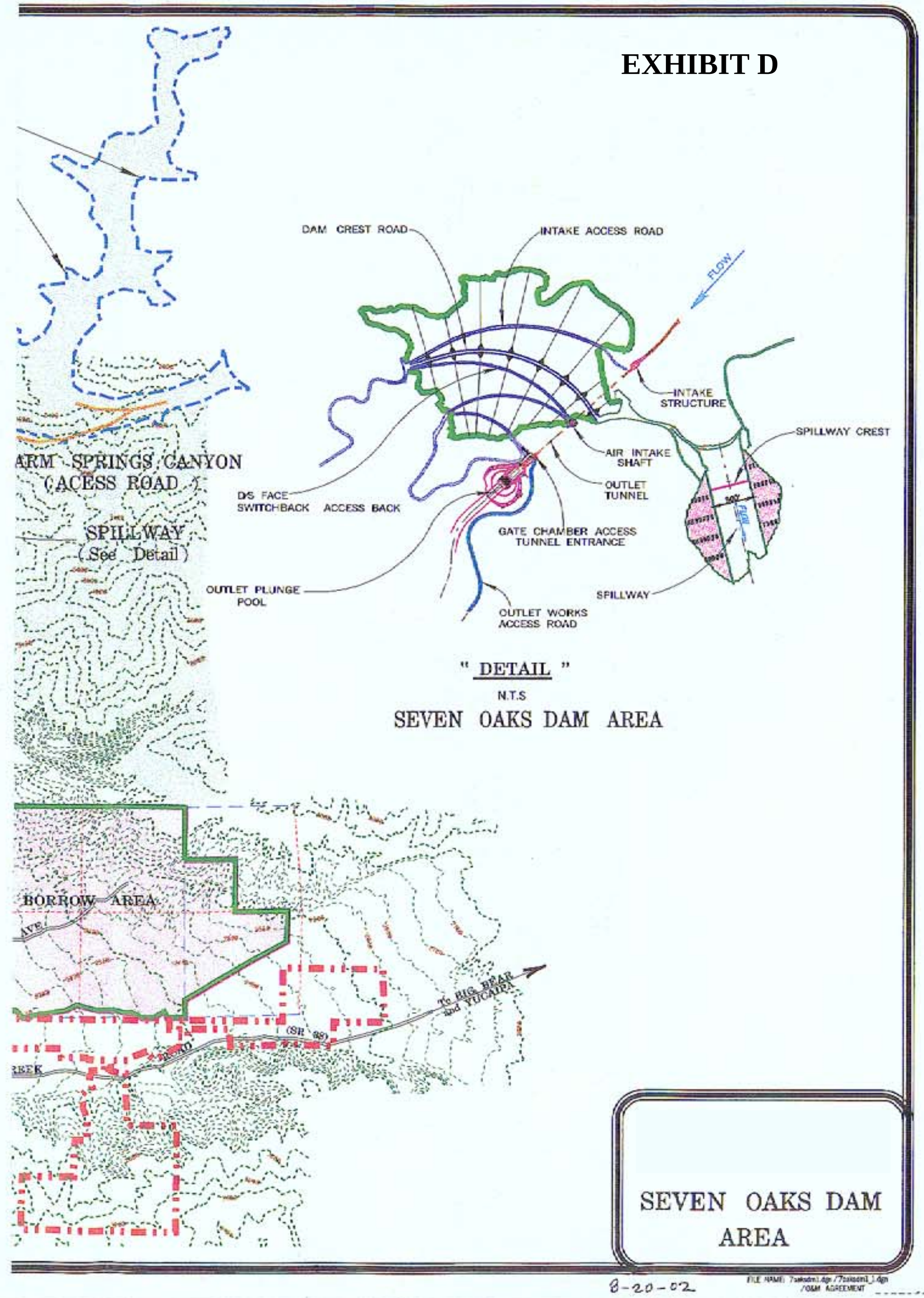
DATE:_______________ BY: ________________________________
Assistant County Counsel, Riverside County

EXHIBIT D



SEVEN OAKS DAM BASIN
INUNDATION LIMITS
LEGEND
LAND OWNERSHIP
US FOREST SERVICE
S.B.V.W.C.D
SBCFCD / WOOLLY STAR MITIGATION
O.C.F.C.D /S.A.R.P
S.B.C.F.C.D
S.B.C.F.C.D /Future Forest Service
Alder Creek Road Easement
(Not To Scale)
Santa Ana River
Filaree Flat
(Not To Scale)
NOTE: Filaree Flat Is Approximately
3.5 Miles North and
6.5 Miles East of Seven Oaks Dam.
SEVEN OAKS DAM AREA
See Detail At Right
ALDER CREEK ROAD
GREENSPOT ROAD
BOULDER AVE
WEBSTER ST.
DOWNSTREAM PERVIOUS
BORROW AREA
CITY OF HIGHLAND
CITY OF REDLANDS
WOOLLY STAR
MITIGATION AREA
SANTA ANA RIVER
FLOW
ALABAMA ST. (PALM AVE)
TENNESSEE ST. (SR 30)
TEXAS ST.
ORANGE ST.
SAN BERNARDINO AVE
LUGONIA AVE
To I - 10
FLORIDA ST.
CORE
NEWPORT
GARNET ST.
MILL
2000' 0' 2000' 4000'
GRAPHIC SCALE
NOTES:
1. Contours and streets are digitized from USGS Quad Maps; Redlands; Yucaipa photo revised 1988.
2. 1927 North American Datum; NGVD 1929

EXHIBIT D



DAM CREST ROAD
INTAKE ACCESS ROAD
FLOW
INTAKE STRUCTURE
SPILLWAY CREST
AIR INTAKE SHAFT
OUTLET TUNNEL
D/S FACE SWITCHBACK ACCESS BACK
GATE CHAMBER ACCESS TUNNEL ENTRANCE
OUTLET PLUNGE POOL
SPILLWAY
OUTLET WORKS ACCESS ROAD
" DETAIL "
N.T.S
SEVEN OAKS DAM AREA
ARM SPRINGS CANYON (ACESS ROAD)
SPILLWAY (See Detail)
BORROW AREA
To BIG BEAR and YUCAIPA
(SR 38)
SEVEN OAKS DAM AREA
8-20-02

EXHIBIT D

COUNTY OF ORANGE

PUBLIC FACILITIES & RESOURCES DEPARTMENT

Vicki L. Wilson, Director
300 N. Flower Street
Santa Ana, CA

P.O. Box 4048
Santa Ana, CA 92702-4048

Telephone: (714) 567-6300
Fax: (714) 567-6340

DATE: November 13, 2001

TO: Herb Nakasone, Manager, PFRD/Program Development

FROM: Bill H. Tidwell, Manager, PFRD/Operations and Maintenance

SUBJECT: Proposed Operation and Maintenance Budget for Seven Oaks Dam, Mid-year Adjustment

This is in response to a request that we provide an adjusted estimate for the operation and maintenance budget for the Seven Oaks Dam Project.

As you know, our initial estimate for the O&M budget for Seven Oaks Dam during FY 2000-2001 (Attachment 1), was for approximately $750,000. That estimate was subsequently increased to $867,000 (Attachment 2), based upon the addition of liability insurance costs estimated at approximately $115,000 per year. We indicated, that a number of potentially costly items had not yet been thoroughly defined and were therefore excluded from those earlier estimates.

It was recently determined that PFRD engineering staff will assume the responsibility for the oversight of reservoir operations. This oversight was formerly accomplished by Corps' staff for an estimated cost of approximately $50,0000 per year. In addition we have received more accurate information relating to the cost of liability insurance for this project. It now appears that annual insurance costs will be approximately $324,600. Accordingly, the estimated annual O&M budget for the Seven Oaks Dam facility is currently being adjusted as follows:

Salaries	$348,000
Reservoir Operations	$50,000
Overtime	$24,000
Equipment	$125,000
Materials	$110,000
Security	$65,000
Training	$5,000
Contracts	$75,000
Liability Insurance	$324,600
Adjusted Estimate:	**$1,126,600**

EXHIBIT D

It is again noted that this estimate does not include potentially significant costs associated with aspects of Wooly Star and K. Rat management programs still being finalized. Nor does this estimate reflect the cost of undetermined operation and maintenance activities that may be required by the Corps' O&M Manual still being finalized.

Please contact me at (714) 567-6230 or Max Bridges at (714) 567-6286 if you have any questions regarding this matter.

Bill Tidwell

Bill H. Tidwell

MB:as/jd(1317)
S:\O&M Folders\Clerical\O&M Typing\BridgesM\M Nakasone-Proposed O&M Budget for 7 Oaks Dam Mid Yr Adj.doc

cc: A. Olomi
A. Eftekhari
B. Hisey
R. Benites

EXHIBIT D

COUNTY OF ORANGE

PUBLIC FACILITIES & RESOURCES DEPARTMENT

Vicki L. Wilson, Director
300 N. Flower Street
Santa Ana, CA

P.O. Box 4048
Santa Ana, CA 92702-4048

Telephone: (714) 834-2300
Fax: (714) 834-5188

DATE: FEB 11 2000

TO: Bill Tidwell, Manager
PFRD/Operations and Maintenance

FROM: H. I. Nakasone, Manager
PFRD/Program Development Division

SUBJECT: Seven Oaks Dam Budget for Woolly Star Mitigation

The Attachment 1 Woolly Star Management Program/Five Year Plan (Plan) and corresponding budget has been approved by the Santa Ana River Mainstream Project Local Sponsors, the U. S. Army Corps of Engineers (Corps), the U. S. Fish and Wildlife Service (USFWS), and the State of California Fish and Game Service (FGS). Assuming that an agreement for Seven Oaks Dam Operations and Maintenance (O&M) is approved by the Local Sponsors by June 30, 2000, estimated FY 2000-2001 budget requirements are:

		Estimated Cost	OCFCD Cost Share @ 87.7%
Requirement #1	Biological Services (Consultant contract, currently managed by SBCFCD)	$55,000	$48,240
Requirement #2	SBCFCD Staff Services (For Control of Exotic Species and Human Intrusion, Public Education, Administration)	$25,000	$21,920
Total Requirement		$80,000	$70,160
Note:	SBCFCD/RCF&WCD Cost Share	$9,840	NA

EXHIBIT D

Task	Assigned To	Estimated Cost Over 5 Years
4. Human Intrusion Controls	Local Sponsors	
a. Mark Mitigation Lands boundaries—aesthetic treatment barriers and elements off-road vehicle access		$ 25,000
b. Patrol and maintenance of site boundaries		$ 25,000
5. Public Awareness Program	Corps/Local Sponsors	$ 15,000
a. Update Management Plan to be provided as a Habitat Protection Plan to city and county agencies		
b. Press release to media		
c. Information updates to educational institutions		
d. Contact with local citizen groups		
Estimated 5-Year Costs		$360,000

EXHIBIT D

SBCFCD has a contract with Psomas, on behalf of the Local Sponsors, for biological services (see Budget Requirement #1 above), and invoices OCFCD and RCFC&WCD on a quarterly basis for their respective cost share of Psomas contract expenses. David Lovell of SBCFCD manages the contract. Mr. Lovell has also been responsible for updating the Plan and corresponding budget, and for arranging meetings (at least one per year) among the Local Sponsors, the Corps, USFWS and FGS to discuss Plan progress, updates, etc. Upon approval of the O & M Agreement, we anticipate that you will directly coordinate with Mr. Lovell on responsibilities related to Budget Requirement #1, and authorize SBCFCD field staff to conduct specific Woolly Star lands management tasks per Budget Requirement #2, above.

Please contact Elayne Rail of my staff (834-6060) if you have questions regarding this memo.

H. I. Nakasone

ER:bs:\\Pfr188\Memo re SOKD Budget Woolly Star Mitigation.doc

Attachment

cc: Debra Lakin, PFRD/Mgmt. Services
David Lovell, SBCFCD
Dick Runge, PFRD/PDD
Terrie Meideiros, PFRD/PDD
Ashok Tahilramani, PFRD/Mgmt Services
Steve Thomas, RCF & WCD
Mike Wellborn, PSD

EXHIBIT D

SCOPE OF WORK
SANTA ANA RIVER WOOLLY STAR MANAGEMENT PROGRAM
(Five-Year Plan for Program Years 4-8)

Tasks to be performed for the five-year program:

Task	Assigned To	Estimated Cost Over 5 Years
1. Population and Habitat Monitoring	Local Sponsors/Consultant	
a. Model life span data of sample unit plants		$125,000
b. Aerial photographs following each 10-year magnitude, or on ground survey flood event for comparison to management plan sample photos (1" = 2000')		$ 5,000
2. Habitat Renewal and Population Expansion		
a. Experimental treatment plots for plant seedlings	Local Sponsors/Consultant	$ 90,000
b. Seed collection viability testing		$ 50,000
3. Control of Exotic Species	Local Sponsors	
a. Removal of Eucalyptus, Peruvian Pepper, Tree of Heaven, Salt Cedar, Giant Cane in 1993 and each year thereafter		$ 25,000
b. Regular patrol for, and removal of, dumps of alien soils and/or organic materials		$ 25,000

EXHIBIT E.

PROCEDURES FOR BLEEDING PIEZOMETER LINES

Exhibit E

PROCEDURES FOR BLEEDING THE PIEZOMETER LINES

Prior to taking piezometer readings, the piezometer lines must be bled of air to prevent any erroneous readings. The following provide step-by-step instructions for bleeding the piezometer lines for the main operational gates and the MDL. These procedures can also be found with the Seven Oaks Dam Operations and Maintenance Manual, dated August 2002.

1) Gate Chamber Operational Instrumentation Manifold. The gate chamber operation area at Seven Oaks Dam has been equipped with state-of-the-art instrumentation to assist the dam operator(s) with the task of monitoring water level elevations in the fore bay of the dam, the intake structure, the upper conduit and the cone valves. The instrumentation consists of a series of gage pressure transmitters installed at the operation manifold as shown in Photo 7-1. The operational piezometer manifold is an array of copper pipes, valves and fittings, mounted to the wall of the gate chamber, that route piezometer lines to the proper pressure transmitter. These pressure transmitters, mounted just to the left of the manifold, are calibrated for a specific range of water level elevations that the dam may experience. Each transmitter is connected to the operational piezometer manifold by heavy Tygon tubing and to an electronic display panel, which provides the operator with the water elevation reading in ft.

At Seven Oaks Dam, the existing regulations specify that water retention periods at specific elevations will be short in duration. The fore bay water level will rise above and fall below the piezometer port locations placed throughout the intake structure and the main conduit. As a result, many of the operational piezometer pressure lines will trap air in the line as the water rises above the elevation of the piezometer port. Pockets of air in the piezometer line will cause an error in the pressure reading and must be evacuated from the line. The procedure for evacuating the air from the piezometer lines are as illustrated in the following example:

Exhibit E

Example: Water has begun to rise in the reservoir due to significant rain and snowmelt in the higher elevations. Pressure transmitter O-4 is being used to monitor the lower water level elevation main wet well of the intake structure. Normally, when the water level is low in the reservoir, below the intake elevation of piezometer line O-4, the manifold valves (V1-O4 and V2-O4) are in the positions shown in Figure 1 to drain the water out of the piezometer lines. However, because the water level in the reservoir is rising above the O-4 intake port, water is now flowing out of the drainpipe at the bottom of the manifold.

Bleeding procedures for the operational pressure transmitters:

1. Close the valve V2-O4 (see Photo E-1). Do not close valve V1-O4. This should stop the water flowing from the bottom of the manifold. If water continues to flow from the manifold, then the water level must be above another piezometer intake elevation. Determine which piezometer line that it might be and close the lower of the two valves to that pressure transmitter.

2. As the valve is closed the electronic readout corresponding to O-4 should show a change in elevation.

3. At this time, carefully open the bleed port screw on the left side of the pressure transmitter, as shown in Photo E-2. The screw has been lightly tightened with a box-end wrench to prevent leakage. Once the screw has been loosened, begin opening the screw in ¼ turn increments, up to 1-1/2 turns of the vent screw. This should allow sufficient water to escape from the transmitter. Watch the flowing water for spurts and sputters of water flow, as this is usually an indication of air escaping from the line. Inspect the tubing for the presence of air bubbles. If any are present and appear to be adhering to the side of the tubing, tap the tubing with the fingernail or small screwdriver, to move them through the tubing.

4. After three minutes of letting the water flow from the pressure transmitter, the stream of water from the bleed vent should appear to be steady, close the screw to finger tight position. Using a box-end wrench, securely tighten the vent screw, not tightening more than ¼ turn from the finger tight position.

5. Repeat steps 1-4 for each pressure transmitter (O1 – O8) on the operational manifold as the water level continues to rise in the reservoir and cover the other piezometer intakes.

2) <u>Cone Valve Operation Room Pressure Transmitters</u>. Gage pressure transmitters and digital displays were also installed to monitor pressures for the low flow cone valve operations. The digital display meters for the cone valve operational instrumentation (O9 – O10) are located in the large display panel adjacent to the gate control panel in the entrance to the RCC and also in the cone valve operating room. A pressure tap with a single valve was installed on each pipe upstream of the cone valves (See Photo E-3A). Rigid Tygon tubing connects the pressure tap valve with the pressure transmitter. The pressure transmitters for each cone valve are located at the bottom of the pit in the cone valve operation room as shown in Photo E-3B.

The procedures for removing the air from the pressure lines are as follows:

1. Check that the valve on the pressure tap at the side of the pipe (Photo E-3A) is open. If it is not open, open it up.

2. At this time, carefully open the bleed port screw on the left side of the pressure transmitter, as shown in Photo E-2. The screw has been lightly tightened with a box-end wrench to prevent leakage. Once the screw has been loosened, begin opening the screw in ¼ turn increments, up to 1-1/2 turns of the vent screw. This should allow sufficient water to escape from the transmitter. Watch the flowing water for spurts and sputters of water flow, as this is usually an indication of air escaping from the line. Inspect the tubing for the presence of air bubbles.

If any air bubbles are present and appear to be adhering to the side of the tubing, tap the tubing to keep them moving through to the vent.

3. After three minutes of letting the water flow from the pressure transmitter, the stream of water from the bleed vent should appear to be steady, close the screw to the finger tight position. Using a box-end wrench, securely tighten the vent screw, not tightening more than ¼ turn from the finger tight position.

4. Repeat steps 1-3 for each pressure transmitter (O9 – O10) in the cone valve area.

Exhibit E

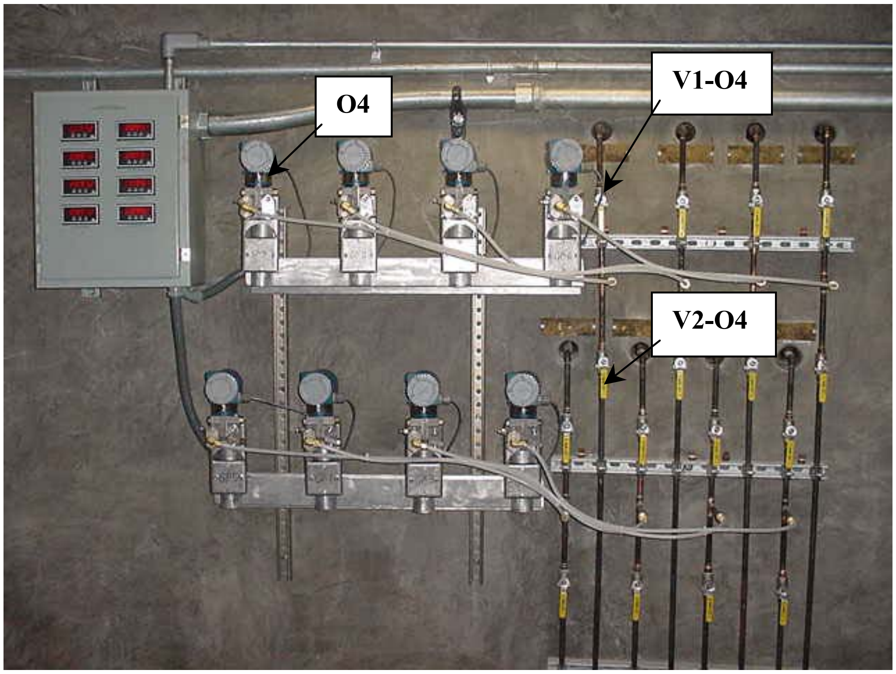


Photo E-1. Operational Piezometer Manifold, Pressure Transmitters, and Display.

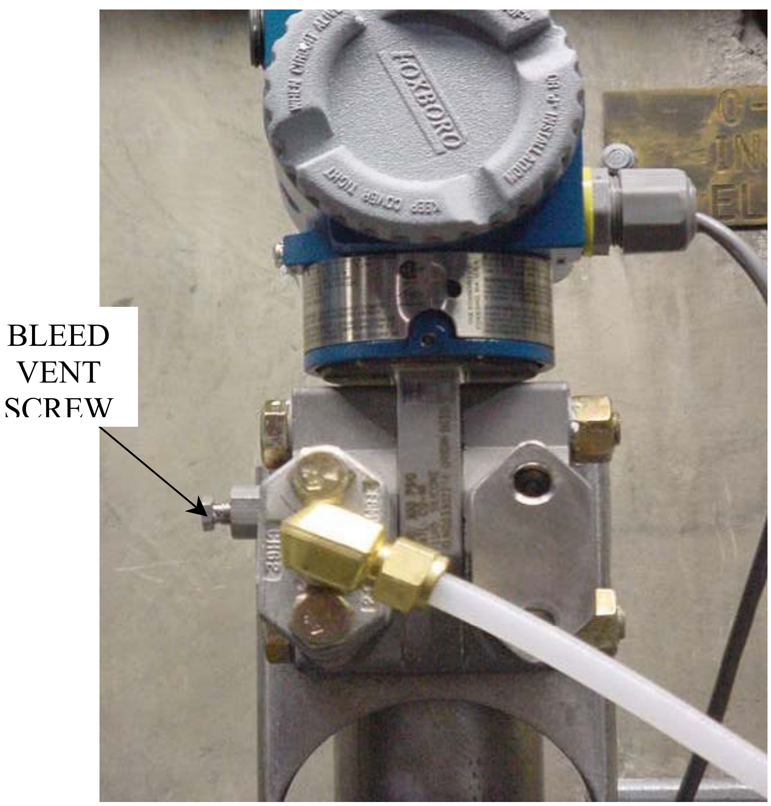


Photo E-2. Pressure transmitter bleed vent screw location

Exhibit E

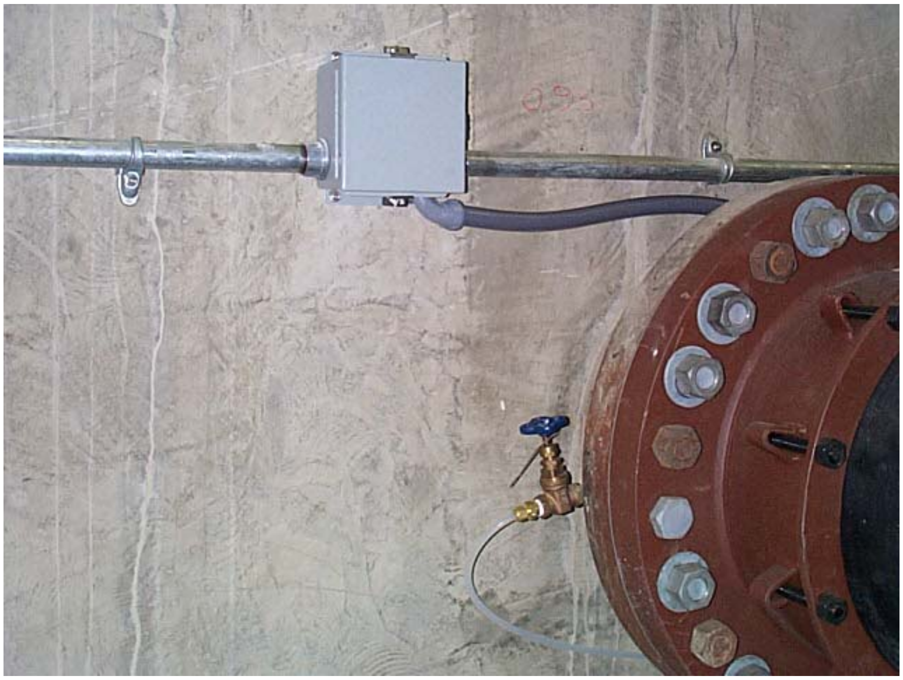


Photo E-3A. Pressure Tap on Cone Valve Pipe

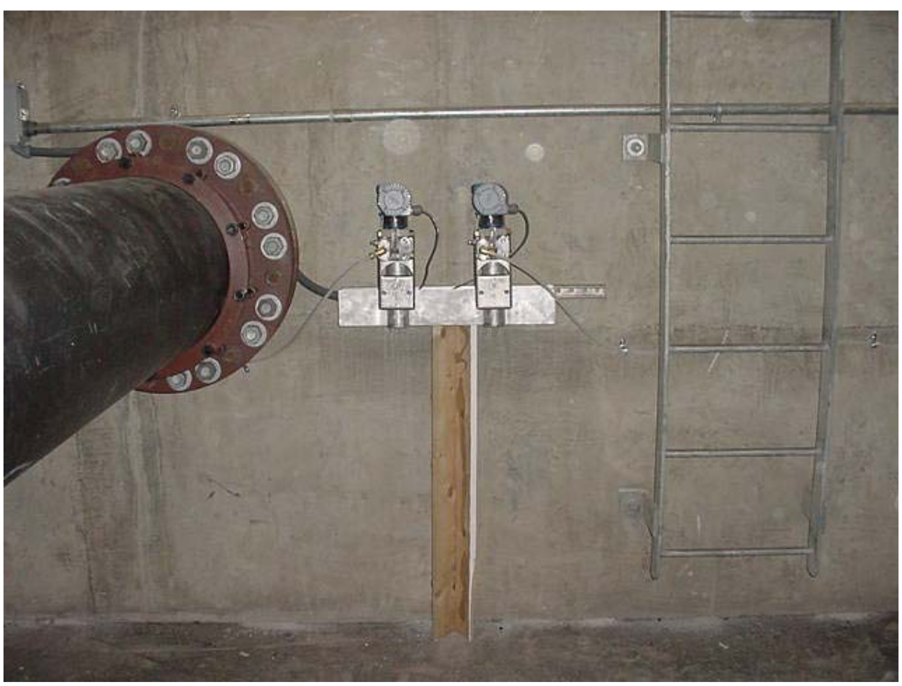


Photo E-3B. Cone Valve Pressure Transmitters O-9 and O-10

EXHIBIT F.

PROTOTYPE TESTING PROGRAM AND INSTRUMENTATION

Exhibit F

PROTOTYPE TESTING PROGRAM AND INSTRUMENTATION

Because of the high head and complicated design of the structure, a model study was conducted at the U.S. Army Engineer Waterways Experiment Station (ERDC-WES) to evaluate the hydraulic design by measuring dynamic hydrostatic pressures in the outlet structure. In this study, zones of potential cavitation and air demand at the mid-tunnel were determined. At the same time, the adequacy of the intake tower, the outlet plunge pool, and the exit channel design was also evaluated, extent of scour and the need for protection downstream of the structure, and the discharge characteristics of the regulation outlet (RO) gates with various operating scenarios were determined from the model.

As a result of this model study, a prototype testing program was developed and is to be implemented during operations to monitor the actual performance of Seven Oaks Dam and verify the design parameters derived form the model study. Hydraulic instrumentation has been installed for testing the entire outlet works. The instrumentation is listed defined in Table F-1 and shown on Plate 2-24 of this Water Control Manual. The instrumentation measures piezometric head, pressure fluctuations, and air demand. Data collected from the testing instrumentations will be used to evaluate the hydraulic performance of the project, analyze potential operation problems, and design repairs and/or project modifications, if necessary. The instrumentation for piezometric head and pressure fluctuations are concentrated at critical areas located in the vicinity of the offsets, of the jet impact, and along the curves in the roof and walls in the transition downstream of the intake tower and in the transition upstream of the gate chamber. The pressure instrumentation will allow early detection upstream of high positive or negative pressure as well as extreme fluctuations in pressure, conditions which could damage the concrete surfaces. The air demand instrumentation will determine the quantity of air supplied to aerate the flow.

During the implementation of the Water Control Plan, an opportunity may arise allowing the collection of data for the prototype-testing program. This testing program involves five types of tests which will be carried out in three phases: 1) The installation of the operation and prototype test instrumentation, purchased by U.S. Army Engineer Research and Development Center, Waterways Experiment Station (WES) prior to impoundment of water; 2) Testing of the performance of the main tunnel during the first significant flow period; 3) Project design flood testing. Phase 1 has been completed. Testing Phases 2 and 3 can only be performed when there is a significant impoundment behind the dam to accommodate larger releases through the LF and the RO gates.

The OCPF&RD water control managers have the responsibility of contacting the Los Angeles District, Corps of Engineers, Reservoir Regulation Section, so that WES can be notified when dam have the potential of meeting pre-established testing conditions. Such conditions could include key or new maximum water surface elevations, and new maximum releases, etc. Since these conditions will change as new maximum elevations and releases are achieved, continuous coordination between the water control managers and WES is necessary. It is advisable that such coordination be made prior to the start of every flood season in order to establish the test conditions, to update phone numbers, POC's, and other pertinent information. All new information should be included in the notifications list that is updated by the water control mangers prior to the start of every flood season.

A complete documentation of the model study for the prototype testing program is contained in the technical report (HL-92-14) titled, Outlet Works for Seven Oaks Dam, Santa Ana River, San Bernardino County, California, dated October 1992. Table F-1 lists and defines the prototype instrumentation facilities (Types A, B, C, CC, D, E, F, G, and H) at Seven Oaks Dam outlet works. The following discusses the five types of tests to be performed:

1) <u>Test Type 1: Head Loss Determinations</u>. Head losses are determined by measuring piezometric head throughout the project during steady-state flow conditions. These tests are to be performed for both low flow and main tunnel discharges. The primary measurements are with the Type G facilities, however, measurements are also needed for Type C and F. Test results will provide much needed model-prototype correlation and overall evaluation of project performance.

2) **Test Type 2: Entrance Geometry Evaluation**. Pressures in the tunnel entrances of both the intake and the mid-tunnel outlet works are measured to evaluate the entrance geometry performance. Any flow separation combined with micro-turbulence at the surface could result in excessive pressure fluctuations and cavitation/erosion problems. This is most critical at the intake tower due to this concrete lined surface, whereas the mid-tunnel section has a steel liner extending from the entrance to the aerator offsets. Measurements are to be obtained from the Type F facilities for the intake tower and Types D and E for the main tunnel and low-flows tunnels, respectively. Results will provide model-prototype correlation and prototype performance evaluation.

3) **Test Type 3 and 4: Cavitation Monitoring and Air Demand**. Providing aeration along the flow boundaries downstream of the regulating gates is critical to the prevention of cavitation damage. Analysis has shown the cavitation index to be well below incipient just downstream of the gates. Horizontal and vertical offsets have been designed to draw air into the flow to cushion the very low pressures. Air is supplied to the main tunnel aerators through a bifurcated vertical airshaft. Air to the low-flow tunnel is supplied by interconnected shafts tapped into the main shaft just below the bifurcation of the primary airshaft. Airflow measurements are to be obtained at the very top of the airshafts to quantify actual air demand.

Another area of concern is at the tunnel boundary in the vicinity of the jet impact zone. Preliminary analyses indicate that this is to be in the vicinity of Station 22+23 through 22+50 in the main tunnel (see Plate 2-24 of this Water Control Manual). High pressure fluctuations could result, thus affecting the long term stability of the tunnel lining. Pressure along the invert centerline and lower walls are measure so as these conditions can be monitored.

Types 3 and 4 tests are to be performed with the Type A, B, C, and CC measurement facilities. As stated above, the main tunnel is the most critical and these tests would have to be performed during flood events. A prototype evaluation of the performance of the aeration system will be used so as model-prototype comparisons can be made. These comparisons will provide valuable information that can be used to for improving present Corps design guidance of aeration systems.

4) <u>Test Type 5: MDL Head Loss and Orifice Losses</u>. Pressure measurements in the MDL tunnel intake and outlet pipe are necessary as the MDL performance can be evaluated. Head losses and orifice losses are best determined by measuring piezometric head throughout the MDL during steady-state flow conditions. These tests are to be performed for both low flow and high flow discharges. Test results will provide much needed model-prototype correlation and overall evaluation of project performance.

Table F-1. Prototype Instrumentation Facilities, Seven Oaks Dam Outlet Works

Prototype Location No.	Model Location [4]	Instrument Type [2]	Location [4]			Type			Comment
						Flush-Mount		Pitot-	
			Code [3]	Station	Elev.	Piez	Gage	Static	
T-1		A	AR1	22+12	2077.5		X		Instrument Type A measures Pressures for the main tunnel Low Flow Tunnel wall and floor offsets.
T-2		A	AR2	22+12	2074.4		X		
T-3		A	AR3	22+05	2075.9		X		
T-4		A	AR4	22+05	2074.1		X		
T-5		B	AVR					X	Instrument Type B measures Air Velocities for the left and right airshafts and the tunnel.
T-6		B	AVL					X	
T-7		B	AVRC					X	
T-8		B	AVLC					X	
T-9		B	AVT					X	
T-10		C	TPF1	22+27	Invert		X		Instrument Type C measures Pressures for the tunnel invert and wall.
T-11		C	TPW1	22+27	Invert + 2-ft		X		
T-12		C	TPF2	22+42	Invert		X		
T-13		C	TPW2	22+42	Invert + 2-ft		X		
T-14		C	TPF3	22+57	Invert		X		
T-15		C	TPW3	22+57	Invert + 2-ft		X		
T-16		CC	LPF1		Invert		X		Instrument Type CC measures Pressures for the Low Flow tunnel invert and wall.
T-17		CC	LPW1		Invert + 2-ft		X		
T-18		CC	LPF2		Invert		X		
T-19		CC	LPW3		Invert + 2-ft		X		
T-20		CC	LPF3		Invert		X		
T-21		CC	LPW3		Invert + 2-ft		X		
T-22	X	D	PR1	21+75.5	2082.9	X			Instrument Type D measures Pressures at the roof and wall Entrance
T-23	X	D	PW1	21+75.5	2078.4	X			
T-25	X	D	PW2	21+78.5	2078.4	X			
T-27	X	D	PW3	21+81.5	2078.4	X			
T-28	X	D	PR4	22+03.0	2082.9	X			
T-32	X	E	PL4	22+00.5	2077.4	X			Instrument Type E measures the Low flow tunnel roof pressure between emergency and operating gates
T-33	X(5)	F	IP0	Tower	2180	X			Instrument Type F measures Pressures at the Intake Tower entrance
T-34	X(7)	F	IP1	11+33.01	2212.54	X			
T-35	X(8)	F	IP2	11+37.41	2116.03	X			
T-36	X(9)	F	IP3	11+45.91	2113.76	X			
T-37	X(10)	F	IP4	11+50.41	2113.75	X			
T-38	X(11)	F	IP5	11+27.01	2106.88	X			
T-39	X(12)	F	IP6	11+30.26	2106.88	X			
T-40	X(13)	F	IP7	11+34.01	2106.88	X			
T-41	X(16)	F	IP8	11+67.91	Roof	X			
T-42	X	G	HGL1	14+00	Roof	X			Instrument Type G provides the Piezometric head elevations.
T-43	X	G	HGL2	16+00	Roof	X			
T-44	X	G	HGL3	19+00	Roof	X			
T-45	X	G	HGL4	21+00	Roof	X			
T-46	X	G	HGL5	24+00	Invert + 2-ft	X			
T-47	X	G	HGL6	25+00	Invert + 2-ft	X			
T-48	X	G	HGL7	26+00	Invert + 2-ft	X			
T-49	X	G	HGL8	27+00	Invert + 2-ft	X			
T-50	X	G	HGL9	28+00	Invert + 2-ft	X			

1. Numbers in parentheses identify model numbers.
2. Denotes measurement type.
3. Transducer code names used in as-built drawings.
4. Refer to Plate 2-24 of this Water Control Manual to show the locations of these piezometers.

EXHIBIT G.

GUIDANCE ON PREPARATION OF DEVIATIONS FROM APPROVED WATER CONTROL PLANS (CESPD R 1110-2-8)

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION CORPS OF ENGINEERS
333 Market Street
San Francisco, California 94105-2195

CESPD-MT-E

REGULATION
No. 1110-2-8

12 September 2002

Engineering and Design
GUIDANCE ON THE PREPARATION OF DEVIATIONS
FROM APPROVED WATER CONTROL PLANS

1. PURPOSE. This document establishes the protocol for reporting deviations from approved Water Control Plans for water control projects within the South Pacific Division. It defines coordination, review, and approval procedures between the Division and District offices. Approval from Division must be obtained from all deviations (reference e., paragraph 6.b.) [1]

2. APPLICABILITY. The following is applicable to all South Pacific Division Districts and field-operating activities having civil works responsibilities.

3. REFERENCES. Authority and guidance can be found in:

a. ER 200-2-2 (33 CFR 230), 4 March 1988, subject: Procedures for Implementing NEPA.

b. ER 1105-2-100, 22 April 2000, subject: Guidance for Conducting Civil Works Planning Studies.

c. ER 1110-2-240 (33 CFR 222.5), 8 October 1982, subject: Water Control Management.

d. ER 1110-2-241 (33 CFR 208.1), 24 May 1990, subject: Use of Storage Allocated for Flood Control and Navigation at Non-Corps Projects.

e. ER 1110-2-1400, 30 September 1993, subject: Reservoir Water Control Centers.

f. ER 1110-2-8156, 31 August 1995, subject: Preparation of Water Control Manuals.

g. ER 1165-2-501, 30 September 1999, subject: Civil Works Ecosystem Restoration Policy.

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[1] This regulation supercedes CESPD-ET-EW Regulation, Subject: Guidance On The Preparation Of Deviations From Approved Water Control Plans dated 1 August 1999.

h. EP 1165-2-502, 30 September 1999, subject: Ecosystem Restoration – Supporting Policy Information.

i. EM 1110-2-3600, 30 November 1987, subject: Management of Water Control Systems.

j. CESPD R 1110-2-8, August 1999, subject: Guidance on the Preparation of Deviations From Approved Water Control Plans.

4. OVERVIEW.

a. Water Control Plans are prepared for all Corps projects and non-Corps projects within Federal flood control space. For Corps projects, the Water Control Plan is all encompassing in that it covers regulation of the project over the entire regime of pool elevations and conditions. The Corps' responsibility regarding non-Corps reservoirs is defined by Section 7 of the Flood Control Act of 1944 (58 Stat 890), which directs the Secretary of the Army to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds.

b. Water Control Plans define the regulation criteria and guidelines that govern how and when water will be stored and released from a project. The process of formulation and eventual approval of the Water Control Plan is a complex and time-consuming process because the plan must account for diverse goals (flood control, the environment, water quality, recreation, water supply, hydropower, etc.) and situations (e.g. normal, flood, drought, and emergency operations). Formulation of these plans requires a comprehensive knowledge of such diverse items as: project goals, project history, authorizing legislation, Corps policies and regulations, how a project interacts with other reservoirs within a basin, the role of other water interests/agencies, the effects to the general public in relation to environmental and aesthetic considerations, basin meteorology and hydrology, changing conditions (e.g. sedimentation, channel capacity, scour, etc.), and the physical capabilities of project features, such as outlet works, spillways, flood routing characteristics, etc.). Prior to approval and implementation, the proposed Water Control Plan is released for public review and comment. The public review process normally occurs concurrently with the NEPA public review process.

c. Deviations from approved Water Control Plans occur because every possible circumstance cannot be accounted for in a Water Control Plan. The competing goals and complex interactions of interested groups/agencies can cause even seemingly inconsequential deviations from an approved plan to lead to unforeseen environmental and legal complications. This regulation serves to assist a District in preparing their deviation requests. It outlines a minimum set of considerations that need to be addressed when making a recommendation to deviate from an approved Water Control Plan.

d. Deviations from approved Water Control Plans are intended, therefore, to address unforeseen and unique circumstances. They are not intended as a means for identifying or initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs.

5. DEFINITIONS.

a. Emergency Deviations. An emergency deviation from an approved Water Control Plan is one that is required due to an emergency situation. An emergency situation is defined herein as a situation in which there is a potential for injury, loss of life, threat to the project, or other serious hazards; but furthermore, also demanding immediate action, such that time constraints render impractical notification to the division. Depending upon the need for immediate action, an emergency situation could include: drowning and other accidents, assistance to local authorities responding to an emergency (e.g. police and fire departments), failure of operations facilities, chemical spills, treatment plant failures, and other temporary pollution or water quality problems. Water control actions necessary to abate the problem are taken immediately unless such action would create equal or worse conditions.

b. Planned Deviations. Planned deviations cover all other deviations not addresses by an emergency deviation.

6. OFFICE OF RECORD. The originating District's water control management office will be responsible for maintaining all relevant records documenting the deviation.

7. GENERAL INFORMATION FOR PREPARING ALL DEVIATIONS.

a. Approval of Deviations. Approval for all deviations must be obtained from the Division Commander or delegated representative prior to their implementation. As noted in paragraph 5.a, an emergency deviation situation may warrant an immediate action, delegated to the Leader, Water Management Team or his designated representative. The Leader of the Water Management Team shall consult with the Chief of Engineering and Construction and appropriate SPD staff and subsequently advise the Director, Military and Technical Services Directorate of the temporary change. Approval may be made by telephone, E-mail, or FAX.

b. Preparation of Deviations. Processing of a deviation request originates at the District water control management office. The District Commander may delegate signature authority for requesting deviations from approved water control plans to the appropriate functional division head or designated representative. Consultation with the District staffs, including engineering, planning, environmental, economics, operations, construction and legal must take place.

c. Costs and Charges for Preparing Deviations. Deviations from approved Water Control Plans require a similar level of scrutiny as applied to permanent changes to a water control plan. Any District charges incurred for processing a deviation are to be assessed and collected from the agency/entity requesting the deviation. The District should estimate the cost to process the deviation and provide that estimate to the requesting agency/entity. The District must collect the funds (in a revolving fund advance account under Support for Others) prior to processing the deviation request. Examples of costs for which the requesting entity would be responsible include costs for any required reviews or studies concerning associated hydrologic, water control, legal, real estate, and environmental maters. After the deviation work is completed, any amount of funds left over in the account would be paid back to the requesting entity.

d. Fees for Water Supply Deviations. Deviations that result in Corps project flood control space being used for water supply purposes must address reimbursement by the sponsor to the Federal government for use of the flood control space. The district's deviation request package must include an economic analysis that determines a value for the reallocated flood control space. Section 7 projects will not require the economic analysis, as water supply charges are under the authority of the project owner.

e. Time to Prepare Deviations. District offices should also inform potential agencies/entities that the lead time required to assemble the necessary information required to evaluate a deviation request may be on the order of months (normally due to the required environmental analysis and the public review process). Thus, the request to the District should be made well in advance of the proposed initiation date fro the deviation. The requesting agency/entity should also be made aware that approval of the deviation request would depend upon such things as a review of the impacts (e.g., environmental, hydrologic, legal, etc.).

f. Coordinating with Division Staff. Preparation of a deviation package is a time consuming and costly undertaking, and incomplete or inadequate package can delay approval, District personnel are encouraged to coordinate any questions or concerns about potential deviations and to discuss any atypical situations with their Division counterparts early in the process and before the package submittal. All technical review will be conducted at the District level and will provide a review certification. In an emergency situation, a formal quality certification will most likely not be required. Appendix D lists the Division staff with which deviation-related issues are to be coordinated Division will provide updates to Appendix A as needed.

g. Non-Corps Projects. Deviation requests fro non-Corps (Section 7) projects must be prepared with the approval of the project owner. This is required because project owners are responsible for assuring that the project is operated as prescribed in the Water Control Plan developed in concert with the Corps' flood control interest. The owner is also ultimately responsible for dam safety at the project and for funding the project.

h. Environmental Requirements. Each deviation request shall include a summary of the environmental effects of the proposed deviation and a statement of how the proposal is in compliance with pertinent environmental requirements, including but not limited to the National Environmental Policy Act (NEPA), Endangered Species Act, the Clean Water Act, and the Clean Air Act and Section 176 Conformity Determination. NEPA documentation requirements ordinarily are met by an Environmental Assessment (EA) of the proposed action with a Finding of No Significant Impact (FONSI) signed by the District Commander. If an existing Environmental Impact Statement/Record of Decision or EA/FONSI accurately covers the action, and if there have been no environmental changes since that documentation, this can be cited. Supporting environmental documents shall be included in the deviation request package when it is submitted. Typically these will include an EA, a signed FONSI, a Biological Assessment, and a final Biological Opinion or a letter from Fish & Wildlife or National Marine and Fishery

Service concurring that there is not likely to be adverse effect on listed species. Sometimes other documents, such as 404(b)(1) evaluation are required. In the case of emergency deviation, the emergency provisions and requirements of he various environmental laws should be followed.

i. Required Information/Analysis. Table 1 outlines the information and analysis that are required in a deviation request package that is submitted to Division.

TABLE 1
Information and Analysis Required in a Deviation Request Package

a. Copy of sponsor's/project owner's letter requesting a deviation.
b. A description of the deviation.
c. Its effects on the operational objectives or project purposes.
d. A description of the potential flood threat over the period of the deviation.
e. The current and predicted maximum reservoir storage and elevation.
f. Documentation that the proposed deviation is in compliance with all pertinent environmental laws.
g. The effect on other agencies and individual interest.
h. The coordination that has taken place with other agencies.
i. Alternative measures that could be taken.
j. Recommendation/rationale on whether a permanent change to the Water Control Plan for this situation is warranted.
k. A District legal opinion.
l. Any recommended fees or reimbursements to the Federal Government.
m. Any other information that may be pertinent to the deviation request.
n. The District Commander's recommendation.
o. Quality Control Certification

8. PREPARING EMERGENCY DEVIATIONS

a. Emergency deviations are the only type of deviation that do not require prior approval from Division, and must only be used if events warrant an immediate emergency action, such that time constraints render impractical notification to the Division. However, even in an emergency situation, the District shall notify the Division of the action as soon as possible, and shall comply with all applicable requirements.

b. A record of the emergency deviation shall be developed at the district office and transmitted to the Division office within a day of the action taken.

c. Procedures for emergency deviations:

(1) Take the necessary action.

(2) Contact Division as soon as possible (See Appendix A for telephone numbers) to describe the action taken and the cause (NOTE: The order of (1) and (2) may be reversed depending on the nature of the emergency). Continuation of the deviation will require Division approval.

(3) The District shall provide written conformation to the Division office within 7 days of the deviation. The correspondence shall include the items outlined in Table 1 (as applicable).

(4) The Division shall respond within 3 days of the district's notification of the emergency deviation.

9. PREPARING PLANNED DEVIATIONS.

a. The District shall inform Division within 2 days of receiving a request for a proposed deviation.

b. At least 7 days prior to the proposed action, the District shall transmit a deviation request package to the Division office. The deviation request package shall include the items in Table 1. This package may be initially transmitted electronically.

c. The Division shall review the proposal and approve or disapprove the District's deviation request within 5 days, assuming a complete package with all required documentation has been received. Early, detailed, coordination and transmittal of documents to Division may reduce the processing time.

d. The District and Division shall follow-up with formal correspondence within 3 days of their electronically transmitted request (District) and approval/disapproval (Division).

10. SPECIAL CIRCUMSTANCES.

Per reference 3.c, Water Control Plans are subject to continuing and progressive study in order to keep them current. Should a new re-operation or reallocation opportunity be identified for a Corps project, then it should be addressed under authority of Section 216 of Public Law 911-611, an Initial Appraisal Report can be conducted with O&M funding to determine whether or not a study, if deemed appropriate, among other things, could initiate the process to incorporate the new opportunity in the project's Water Control Plan. Re-operation or reallocation studies for non-Corps projects would need to be initiated by the project owner.

FOR ROBERT L. DAVIS COL, EN
BG, USA DEPCDR
Commanding

1 Appendix
APP A – CESPD Phone list for Coordination of Water Control Plan Deviations
APP B - Quality Control Certification

DISTRIBUTION:
Electronic Copy Available

APPENDIX A

CESPD Phone List for Coordination of Water Control Plan Deviations

Note: Initial District notification to the Division shall be made to Water Management.

	Water Management	Office
	Donald Bergner	(415) 977-8101
	Boni Bigornia	(415) 977-8102
	Terry Mendoza	(415) 977-8106
	Tom Wang	(415) 977-8120
	Frank Khroun	(415) 977-8111
	Ed Sing	(415) 977-8117

Internal SPD Coordination with Respective District Support Team Members

	Legal	
(SPN/SPA)	Mary Gillespie	(415) 977-8214
(SPL/SPK)	Dan Dykstra	(415) 977-8211
	Planning & Environmental	
(SPL/SPN)	Les Tong	(415) 977-8170
(SPA)	Jim Conley	(415) 977-8108
(SPK)	Clark Frentzen	(415) 977-8164
	Real Estate	
(SPL/SPN)	Marilyn Rodriguez	(415) 977-8188
(SPK/SPN)	Richard Guthrie	(415) 977-8186
	Operations	
(SPL/SPN)	George Domurat	(415) 977-8050
(SPK)	Phil Turner	(415) 977-8058
(SPA)	Jonathan Yip	(415) 977-8057
	Program Management	
(SPN)	Jeannie Hritz	(415) 977-8228
(SPK)	Marcelo Pascua	(415) 977-8232
(SPA)	Hoa Ly	(415) 977-8229

APPENDIX B

DISTRICT ENGINEER'S QUALITY CERTIFICATION

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed the review/analysis of the water control deviation from the Approved Water Control Plan for *(Project Name and Location).* Certification is hereby given that all quality control activities appropriate to the level of risk and complexity inherent in this analysis have been completed.

GENERAL FINDINGS

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality control certification for this deviation request.

(Signature)   *(Date)*
Chief, Responsible Functional Element

CERTIFICATION OF LEGAL REVIEW*

The request f or a water control deviation from the approved Water Control Plan report for *indicate name of project*, has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature)   *(Date)*
District Counsel

QUALITY CERTIFICATION

All issues and concerns resulting from technical review of the water control deviation have been resolved. This deviation is recommended for approval.

(Signature)   *(Date)*
District Commander

EXHIBIT H.

NOTIFICATIONS LIST MAINTAINED BY THE LOS ANGELES DISTRICT, CORPS OF ENGINEERS, RESERVOIR REGULATION SECTION PRIOR TO PROJECT TURNOVER

EXHIBIT H

Seven Oaks Dam

A. Temporary Restrictions

Refer to Restriction List

B. Any change in water rights releases

1. San Bernardino Valley Water Conservation District — Location: Redlands

Tom Crowley

Title: Asst. General Manager
Office Phone: 909-793-2503
Comment: During business hours.

Randy Carlisle

Office Phone: 909-313-1815
Home Phone: 909-794-5925
Cellular Phone: 909-313-1815
Comment: call outside normal business hours

Walter Christiansen

Office Phone: 909-313-1815
Comment: During business hours.

Reason for Notification: Release change may affect ability to meet downstream demand

2. WES — Location: Vicksburg

Call WES when a new maximum water surface elevation will be achieved.

Tim Faperburg

Office Phone: 601-634-2257

Brad Bird

Office Phone: 503-808-4878
Comment: Portland District may also need notification for collecting data.

Reason for Notification: Need to notify WES when a new maximum water surface elevation will be achieved. They need to set up for testing.

C. Each time a new maximum WSE is reached:

1. LA District Special Dam Inspection Team — Location: Los Angeles

James Farley

Office Phone: 213-452-3600
Home Phone: 310-257-6834
Comment: Dam Inspection Team Coordinator

Seven Oaks Dam

C. Each time a new maximum WSE is reached:

1. LA District Special Dam Inspection Team Location: Los Angeles

(Agency continued from previous page)

Chris Sands

Office Phone: 213-452-3605
Home Phone: 626-289-1616

Reason for Notification: Inspection team may need to be formed and sent to the dam to monitor embankments performance.

D. Prior to flood control releases (1,000 CFS or greater), notify:

1. County of San Bernardino Location: San Bernardino

David Lovell

Office: Flood Control District
Office Phone: 909-387-7964
Home Phone: 909-794-2397

Reza Fatemi

Office: Flood Control District
Office Phone: 909-387-7964

Reason for Notification: Preparation for possible emergency evacuation.

2. County of San Bernardino Disaster Preparedness Div Location: San Bernardino

Mike Tuttle

Title: Sgt
Office Phone: 909-387-0662

Bill Fertig

Title: Corporal
Office Phone: 909-387-0681

24-HR Dispatch

Office Phone: 909-356-3854

Reason for Notification: Preparation for possible emergency evacuation.

3. County of Riverside Location: Riverside

Office of Emergency Services

During Office Hours

Office Phone: 909-955-4700

Fire Department

Office Phone: 909-940-6900

Seven Oaks Dam

D. Prior to flood control releases (1,000 CFS or greater), notify:

3. County of Riverside Location: Riverside

(Agency continued from previous page)

Office of Emergency Services

24-HR Dispatch

Office Phone: 800-228-9645

Alt Office: 800-253-6990

Reason for Notification: Preparation for possible emergency evacuation.

4. Riverside County Sheriff's Alerting Control Point Location: Riverside

Allied Agency

Office Phone: 909-780-9894

Comment: Talk to Alex. This number has more wide reach for emergency contacts in Riv Co.

Radio Dispatcher

Office Phone: 909-776-1099 Ext: 5

Comment: Press option 9 for office phone.

Reason for Notification: Preparation for possible emergency evacuation.

5. City of San Bernardino Location: San Bernardino

Miguel Ascarruz

Office: Emergency Preparedness

Office Phone: 909-384-5115

Home Phone: 909-887-1794

Reason for Notification: Preparation for possible emergency evacuation.

6. City of San Bernardino Fire Department Location: San Bernardino

Dispatch

Office Phone: 909-384-5777

Fax: 909-388-4815

Reason for Notification: Preparation for possible emergency evacuation.

7. City of Colton Location: Colton

General Information

Office: Public Works Department

Office Phone: 909-370-5066

Alt Office: 909-370-5194

Seven Oaks Dam

D. Prior to flood control releases (1,000 CFS or greater), notify:

7. City of Colton Location: Colton

(Agency continued from previous page)

Mike Musgraves

Office: Fire Dept Emer Preparedness
Title: Battalion Chief
Office Phone: 909-370-5100

Reason for Notification: Preparation for possible emergency evacuation.

8. City of Highland Location: Highland

Ernie Wong

Office: Dept of Public Works
Title: Dept Head
Office Phone: 909-864-8732 Ext: 212
Home Phone: 909-864-7169

Reason for Notification: Preparation for possible emergency evacuation.

9. City of Loma Linda Location: Loma Linda

General Information

Office Phone: 909-799-2810

Michael Hatfield

Office: Disaster Preparedness
Office Phone: 909-799-2855

Carl Morgan

Office Phone: 909-799-2815

24-HR Line

Office Phone: 909-799-2868
Comment: Direct line to Fire Dept dispatch.

Reason for Notification: Preparation for possible emergency evacuation.

10. City of Redlands Location: Redlands

General Information

Office Phone: 909-798-7500

Mitchell McKee

Office: Redlands Fire Department
Office Phone: 909-798-7600
Comment: Disaster Preparedness

For Emergencies

Office Phone: 909-356-3811

Seven Oaks Dam

D. Prior to flood control releases (1,000 CFS or greater), notify:

10. City of Redlands Location: Redlands

(Agency continued from previous page)

Non-Emergencies

Office Phone: 909-356-3805

Reason for Notification: Preparation for possible emergency evacuation.

E. If WSE will reach 2418, notify:

1. LA District Special Dam Inspection Team Location: Los Angeles

James Farley

Office Phone: 213-452-3600
Home Phone: 310-257-6834
Comment: Dam Inspection Team Coordinator

Chris Sands

Office Phone: 213-452-3605
Home Phone: 626-289-1616

Reason for Notification: Dam inspection team needs to be formed and sent to the dam.

F. If WSE will reach spillway crest elevation (WSE 2580 feet) or if dam break is imminent, notify:

1. All agencies listed in Section C Location: -----

See Section C

Reason for Notification: -----

2. US Army Corps of Engineers Location: Los Angeles

Ed Andrews

Office: Emergency Management
Title: Branch Chief
Office Phone: 213-452-3441
Home Phone: 310-459-6961
Pager: 818-541-3083
Temp. Phone: 213-452-3623

Bijan Nooranbakt

Title: Acting Chief EOC
Office Phone: 213-452-3441
Home Phone: 310-230-1902

Seven Oaks Dam

F. If WSE will reach spillway crest elevation (WSE 2580 feet) or if dam break is imminent, notify:

2. US Army Corps of Engineers Location: Los Angeles

(Agency continued from previous page)

Reason for Notification: Notification for emergency procedures.

3. National Weather Service Location: Oxnard

Lead Forecaster

Office Phone: 805-988-6619
Alt Office: 805-988-6620
Comment:
Phones are 24 hr.

Reason for Notification: Notification for emergency situation.

EXHIBIT I.

SEVEN OAKS DAM
INITIAL FILLING PLAN
DATED, JULY 2002

EXHIBIT I

SEVEN OAKS DAM

SAN BERNARDINO COUNTY, CALIFORNIA

INITIAL RESERVOIR FILLING PLAN

U.S. Army Corps of Engineers
Los Angeles District
Los Angeles, California

July 2002

EXHIBIT I

SEVEN OAKS DAM
SAN BERNARDINO COUNTY, CALIFORNIA

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EXHIBIT I

ATTACHMENT I – WATER CONTROL PLAN (Latest Approved Plan is Titled “Interim Water Control Plan Prior to and During Section 7 Consultation Period”, dated January 2000)

ATTACHMENT II - EMERGENCY ACTION PLAN (Under Separate Cover Transmitted Previously)

ATTACHMENT III – CORPS OF ENGINEERS PUBLICATIONS (ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Structures, Dated 15 March 1996; ETL 1110-2-231, Engineering and Design - Initial Reservoir Filling Plan, Dated 30 March 1979)

EXHIBIT I

SEVEN OAKS DAM
INITIAL RESERVOIR FILLING PLAN

SAN BERNARDINO COUNTY, CALIFORNIA

PURPOSE

This plan presents a guide for surveillance of the Seven Oaks Dam project during periods of reservoir filling as required by Corps of Engineers Engineer Technical Letter (ETL 1110-2-231) dated 30 March 1979, Engineering and Design Initial Reservoir Filling Plan. Also, this plan should be followed during the flood season as successively higher pools are attained for flood control that exceed the historical maximum reservoir level. The plan defines the following: inspection procedures to be used, warning signs, actions to be taken in case serious signs of distress are discovered, and data to be collected and analyzed.

PRINCIPLES UNDERLYING THE PLAN

Flood control is the primary purpose of the Seven Oaks Dam project. The project is located in a region of sporadic but sometimes intense rainfall which produces intermittent flows characterized by their extreme variability. The reservoir has filled to various levels since becoming operational; however, the maximum pool (flood control pool at spillway crest) level has not been reached to date.

This document provides a general plan to be implemented during future flood periods when the historical maximum reservoir level may be exceeded. Since it is impossible to predict the occurrence of flood flows that will result in a reservoir level that exceeds the previous historical maximum, this plan should be implemented in accordance with the visual inspections schedule (presented in Appendix II).

Although the embankments have been constructed to minimize adverse effects due to rapid pool rise, any distress during the period that the reservoir is filling at an uncontrolled rate must be detected at the earliest possible time if mitigative action is to be effective. Early detection will allow for activation of the Emergency Action Plan (EAP) if needed.

Thus, this Reservoir Filling Plan is essentially a reservoir monitoring or surveillance plan. In order to be effective, this plan must be carried out during the entire flood season each year until the maximum pool is reached. If this is not carried out on a regular basis, early warning signs of distress may go undetected. Repeated exposure to reservoir load during subsequent floods may cause the undetected problem to deteriorate with possible catastrophic consequences.

The Water Control Plan, as described in Attachment I, is different from this Reservoir Filling Plan in that the Water Control Plan details the regulation of the project for controlling the downstream discharges to non-damaging flow rates. This type of flood control operation would then induce project storage and the initiation of the Reservoir Filling Plan.

EXHIBIT I

SCOPE

The impoundment of water behind the reservoir, as discussed in the Water Control Plan in Attachment I, sets forth the general plan for the operation of the Seven Oaks Dam reservoir. Safety measures to be taken before and during filling are noted in Appendix IV and in the separate Emergency Action Plan referenced as Attachment II. The public must be informed at regular intervals as the pool is being filled under normal conditions. Various government agencies, including the public, are to be notified by the Operations Manager. This notification process will be part of normal operation of the dam project. The Operations Manager is responsible to maintain a current notification list of agencies, names, and phone numbers similar to the Notification Subplan of the separate Emergency Action Plan. As the pool is filling, project personnel must maintain surveillance in accordance with Appendix II. Should something occur which might in any way be hazardous to the structure or the safety of the public, the Emergency Action Plan must be put into effect. Additional appendices covering such information as cultural site surveillance and environmental considerations are included for referral by the Seven Oaks Dam Operations Manager.

a. <u>Appendix I - Pertinent Project Data</u>. This appendix contains all pertinent data concerning the project.

b. <u>Appendix II - Project Surveillance</u>. This appendix discusses instrumentation, visual inspection, and instrument monitoring. Various criteria are listed that would call for an unscheduled inspection.

c. <u>Appendix III - Environmental and Cultural Site Surveillance</u>. This is a discussion of the observation of historical properties and the procedures to be taken if a site is found or if damage is discovered on an existing site.

d. <u>Appendix IV - Safety Plan</u>. This appendix discusses safety procedures to be followed when implementing this plan.

e. <u>Appendix V – Checklist of Conditions Affecting Dam Safety</u>. This appendix contains a checklist to be used in discovering and correcting problems.

f. <u>Attachment I - Water Control Plan</u>. This attachment provides a detailed plan for the safe and effective operation of Seven Oaks Dam. Due to the listing of the San Bernardino Kangaroo Rat (SBKR) to the endangered species list in January 1998, the Corps is in Section 7 consultation with the U.S. Fish and Wildlife Service to assess operation impacts and mitigation plans. The water control plan that is approved and currently implemented is titled “Interim Water Control Plan Prior to and During Section 7 Consultation Period”, dated January 2000. The plan remains in force until the consultation process is complete and a water control plan for normal flood control operation is approved. The final water control plan may differ from the original plan contained in the project documents depending upon the results of the Section 7 consultation.

g. Attachment II - Emergency Action Plan (under separate cover). In case of emergency, this attachment sets forth a specific plan of action and designates key personnel to be notified. It also designates the responsibilities of various personnel during an emergency. The latest plan is dated June 2001 and distributed to the local sponsors in a separate report. The Emergency Action Plan will be referenced throughout this Initial Reservoir Filling Plan.

h. Attachment III - Corps of Engineers Publications. Included is a copy of the publications (ER 1110-2-101, dated 15 March 1996, subject: "Reporting of Evidence of Distress of Civil Works Structures" and ETL 1110-2-231, dated 30 March 1979, subject: "Engineering and Design - Initial Reservoir Filling Plan").
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PREFERRED FILLING RATE

Once a reservoir has been safely filled to a certain level and subsequently evacuated, it can be refilled safely to that level at a rapid rate if no signs of distress were noted since the previous filling. The term "safely" is defined as behaving as designed, not simply the fact that failure did not occur. Signs or evidence of distress which could result in problems during subsequent filling if undetected are discussed in Attachment III, ER 1110-2-101, dated 15 March 1996, subject: "Reporting of Evidence of Distress of Civil Works Structures".
(http://www.usace.army.mil/inet/usace-docs/eng-regs/er1110-2-101/entire.pdf)

IMPLEMENTATION

The responsibility to see that the procedures outlined herein are carried out shall rest with the Operations Manager for the Seven Oaks Dam project, who is responsible for the daily operation and maintenance of the project. Based on the local sponsors' mutual agreement, San Bernardino County Flood Control District sponsor is designated as the lead operational agency for physical operations and maintenance. Orange County Flood Control District sponsor is responsible for the water control management (Reservoir Regulation) functions. Therefore, San Bernardino County Flood Control District, in coordination with Orange County Flood Control District, is responsible for the duties of the Operations Manager. The Operations Manager will keep the Corps of Engineers Los Angeles District Office, Reservoir Regulation Section informed of sponsors' implementation of the program. He will also keep the Los Angeles Corps of Engineers District Office, Emergency Management advised as to progress, problems and actions being undertaken by the sponsors. The Seven Oaks Dam Operations Manager and his staff will hereinafter be referred to as the project personnel.

The Operations Manager for the Seven Oaks Dam project will be responsible for determining the dates or events by which the reservoir filling monitoring and surveillance plan should be commenced and terminated each year. The time to implement the plan would most likely overlap the flood season. He will also ensure adequate technical and material resources are available to implement the plan.

EXHIBIT I

REFERENCES

The following Corps of Engineers publications were used in the preparation of this Reservoir Filling Plan. They may be accessed via the Internet: (http://www.usace.army.mil/inet/usace-docs/eng-regs/er1110-2-101/entire.pdf)

a. ETL 1110-2-231, 30 Mar 79, Engineering and Design - Initial Reservoir Filling Plan.

b. ER 1130-2-530, 30 Oct 96, Flood Control Operations and Maintenance Policies.

c. ER 1110-2-1150, 31 Aug 99, Engineering and Design for Civil Works Projects.

d. ER 1110-2-101, 15 Mar 96, Reporting of Evidence of Distress of Civil Works Structures.

EXHIBIT I

APPENDIX I

PERTINENT PROJECT DATA

Appendix I

Seven Oaks Dam
Pertinent Data Sheet

Stream System		Santa Ana River
Drainage Area	sq. miles	177
Dam		
Crest Width	feet	40
Design Freeboard	feet	5.3
Reservoir		
Elevation		
Original Streambed	feet, NGVD	2,060
Debris Pool (Year 1)	feet, NGVD	2,200
Top of Flood Control	feet, NGVD	2,580
Top of Spillway	feet, NGVD	2,580
Top of Dam	feet, NGVD	2,610
Area		
Debris Pool (Year 1)	acres	79
Top of Flood Control	acres	802
Top of Spillway	acres	802
Top of Surcharge	acres	969
Top of Dam	acres	1,067
Capacity		
Debris Pool (Year 1)	acre-feet	3,128
Top of Flood Control	acre-feet	147,970
Top of Spillway	acre-feet	147,970
Top of Dam	acre-feet	174,609
Allowance for Sedimentation	acre-feet	32,000
Spillway		
Type		Unlined Trapezoid w/ Concrete Sill
Crest Invert Length	feet	1,400
Crest Width	feet	500
Crest Elevation	feet, NGVD	2,580
Outlet Works		
Upstream Tunnel Diameter	feet	18
Downstream Tunnel Width	feet	18
Length of Tunnel (Sta.11+44.25 to Sta.28+00, including gate chamber)	feet	1,655.75

Intake Structure Deck Elevation	feet, NGVD	2,302
High Level Intake Elevation	feet, NGVD	2,265
Diversion Intake Elevation	feet, NGVD	2,100
Gate Type	Vertical Hydraulic	
Main Gate Dimensions (Width x Height, dual tandem)	feet	5 x 8.5
Low-Flow Gate Dimensions (Width x Height, single tandem)	feet	2 x 3.5

Reservoir Design Flood (General Storm)

Total Volume (4-day)	acre-feet	115,000
Peak Inflow	ft^3/s	85,000
Peak Outflow	ft^3/s	7,000
Peak Water Surface Elevation	feet, NGVD	2,580

Probable Maximum Flood (General Storm)

Total Volume	acre-feet	326,000
Peak Inflow	ft^3/s	185,000
Peak Outflow	ft^3/s	180,000
Peak Water Surface Elevation	feet, NGVD	2,604.7

APPENDIX II

PROJECT SURVEILLANCE

EXHIBIT I

APPENDIX II

PROJECT SURVEILLANCE

1. General

General surveillance of Seven Oaks Dam will be carried out by project personnel under the direction of the Seven Oaks Dam Operations Manager. Technical Specialists, under the direction of the Seven Oaks Dam Operations Manager will make regular inspections. The Operations Manager will report observed conditions to the Water Control Manager. Report of observed conditions should also be made to the Los Angeles Corps of Engineers District, Engineering Division, Reservoir Regulation Section by voice and in written document.

2. Visual Inspection

During the flood season, when this Reservoir Filling Plan is in effect, visual inspections of the project shall be performed in accordance with the following schedule.

a. A thorough visual inspection should be performed on or before September 15 of each year prior to the beginning of the flood season. This should be accomplished sufficiently early to allow remedial actions to be taken prior to the onset of the flood season, if such actions are required.

b. When the reservoir level is below the historical maximum level, inspections should be made once per week.

c. When the reservoir is being filled at or below the preferred filling rate, inspections should be made once per week.

d. When the reservoir is above the historical maximum pool level, inspections should be made daily. The inspectors shall contact the Operations Manager and Water Control Manager if unusual conditions exist at the project so the dam can be operated accordingly.

This schedule of inspections assumes that no unusual conditions exist. If signs of distress are discovered, the schedule should be revised to monitor the potential problem area more often.

In general, the visual inspections include critical areas discussed in ER 1110-2-101, dated 15 March 1996, subject: "Reporting of Evidence of Distress of Civil Works Structures." The inspections will identify the critical areas, as noted in the following paragraph 3.

In addition, the following elevation-based events will initiate a geotechnical specialist response. The purpose of the elevation-based geotechnical response will be to confirm the integrity of the embankment, and the function of the system of seepage monitors and controls.

1. Elevation 2300 feet, NGVD. The stability of the slopes below the Intake access Road will be assessed by geotechnical specialists.

2. Elevation 2375 feet, NGVD. The downstream toe of the embankment, adjacent to the right abutment, will be assessed by personnel from the geotechnical specialists for any local seepage effects related to the grouting of the exposed rock nose at the right abutment.

3. Elevation 2418 feet, NGVD. The downstream instrumentation will be monitored by geotechnical specialists as water is impounded above the abutment drain material.

4. Elevation 2580 feet, NGVD. The spillway condition will be assessed by geotechnical specialists.

3. Warning Signs

The following tabulation presents conditions, which provide an indication that undesirable behavior is taking place.

a. Embankment Structures

Crest:

Distortion of alignment
Depressions or sink holes
Cracks

Slopes (upstream and downstream):

Depressions or sink holes
Cracks
Sloughs
Animal burrows
Seepage exiting on the downstream slope or at the toe
Bulges on the slope or at the toe

b. Concrete Structures

Inlet Structure:

Tilting
Cracking or crushing
Monolith displacement
Offsets at joints
Clogging with debris

Outlet Structure:

Distortion of alignment
Seepage

Cracking or crushing
Opening of joints or cracks
Monolith displacement
Unusual flow from drains
Misalignment of handrails
Misalignment of guardrails

c. Spillway Crest:

Distortion of sill contacts
Surface cracks of sill
Slope failures in spillway walls

d. Downstream Area:

Sand boils
Depressions or sinkholes
Seepage
Bulges

e. Abutments Adjacent to Structure:

Animal burrows
Seeps
Sloughs
Cracks

4. Instrumentation

Project instrumentation can be valuable in identifying signs of distress, which cannot be visually observed. It is important, therefore, to obtain accurate instrument readings on a regular basis throughout the flood season. Monitoring of instrumentation is not intended to eliminate the need for visual surveillance of the project but is intended to provide supplemental information which is necessary to evaluate the overall performance of the project.

The embankment surface settlement and horizontal movement points should be measured periodically during flood control detention and drawdown. If measurements should produce readings, which differ from historical trends or if the rate of reservoir rise significantly exceeds the preferred filling rate, then the frequency of observation should be increased to suit the circumstances. The embankment geotechnical instrumentation reading schedule is presented in Table II-2-4. The outlet works geotechnical and hydraulic instrumentation reading schedule is presented in Table II-2-10. These tables are excerpted from the project Operation, Maintenance, Repair, Replacement & Rehabilitation (OMRR&R, or O&M) Manual. These schedules should be used in conjunction with the requests of the Los Angeles Corps of Engineers District, Engineering Division, Reservoir Regulation Section regarding frequency of readings under unusual conditions.

Note that the piezometers in the embankment downstream shell are not expected to detect water. If they do, this is a signal for concerns, and the Seven Oaks Dam Operations Manager should immediately notify their Water Control Manager and the Los Angeles Corps of Engineers District, Engineering Division, Reservoir Regulation Section.

Project personnel should be especially diligent in discovering and reporting any seepage. If such discharges increase suddenly or show signs of turbidity, the Seven Oaks Dam Operations Manager should immediately institute continuous monitoring and simultaneously notify their Water Control Manager and the Los Angeles Corps of Engineers District, Engineering Division, Reservoir Regulation Section.

5. Emergency Decision Conditions

a. Documentation. Visual inspection will be made of the dams and principal appurtenances for any evidence of distress that could lead to unsatisfactory performance or potential failure. Any abnormal occurrence should be closely monitored and thoroughly documented. A detailed record of pertinent information is to be maintained, including, but not limited to, description of occurrence, cause if known, whether or not the problem is worsening with time, severity of problem, location, date, time, weather conditions, pool elevation, and remedial actions, if any. The collection of all factual and technical information is important. Photographs are particularly valuable for documenting an abnormal occurrence and should be used extensively to record such conditions visually.

b. Abnormal Occurrences The following summarizes items that may require emergency action and should be considered serious enough to warrant immediate notification of the Water Control Manger and engineering office for assistance and direction:

Reservoir:

* Development of whirlpools
* Development of a constant stream of air bubbles for no apparent cause
* Indication of impending landslides in the reservoir rim

Dam Section and Foundation (Embankment Section):

* Development of cracks or enlargement of existing cracks in the dam crests or along the dam slopes
* Slides or sloughs in the dam sections on either face of the dams
* Development of bulges or depressions on the dam crest or slopes or at the toes of the embankments
* Development of depression on the dam crests or slopes

* Misalignment of roadways, guard rail or other appurtenant structures that could be evidence of movement within the dam sections

* Development of seeps on the downstream slope of the dams

* Undesirable changes in existing seeps such as significant increases in quantity or turbidity of the seepage water

* Abnormal readings from project instrumentation

Abutments and Contacts:

* Development of cracks or enlargement of existing cracks on the abutment slopes

* Development of bulges at the toe of a slope

* Development of large slides on the abutments

* Distortion of abutment slopes that indicate the potential for large slides

* Evidence of serious seepage along or through the abutment

* Undesirable changes in seepage conditions such as significant increases in seepage quantity or increase in turbidity of seepage water

Concrete Structures:

* Signs of significant cracking or movement of joints and/or cracks

* Seepage through joints or cracks

* Abnormal increases in flow quantity and/or turbidity of discharges from foundation drains

* Abnormal changes in magnitude of readings from foundation drains

6. Reporting

Any abnormal or critical occurrences will be reported immediately by the Seven Oaks Dam Operations Manager to their Water Control Manager for further instructions or advice, and so that any additional specialists can be mobilized. Operations Manager should also report the occurrences to the Los Angeles Corps of Engineers District Office, Engineering Division, Reservoir Regulation Section.

EXHIBIT I

TABLE II-2-4 (From O&M Manual): EMBANKMENT GEOTECHNICAL INSTRUMENTATION READING SCHEDULE

EMBANKMENT GEOTECHNICAL INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
STRONG MOTION ACCELEROGRAPHS	Embankment crest, right abutment, free-field (A-1 to A-4, A-7 and A-8)	6	Post-earthquake condition – read as soon as possible if any of the following conditions applies: - Richter 4.0 or greater within 3 miles radius, or - Richter 5.0 or greater within 30 miles radius, or - Richter 6.0 or greater within 50 miles radius, or - Damage reported at project, or - Acceleration of 0.1g.	Semi-annually	Semi-annually	Semi-annually
EMBANKMENT PIEZOMETERS (VWP & PNP)[(2)]	Embankment drain zones interface	24	Pool level between El. 2150 & 2200; weekly. Pool level between El. 2200 & 2300; daily. Pool level between El. 2300 & 2400; one reading at every 10 foot increase in pool level. Pool level above 2400; one reading at every 5-10 foot increase in pool level.	Quarterly	Semi-annually	Annually
OBERVATION WELLS	Downstream toe of dam (OW-1 and OW-2)	2	Same as specified for embankment piezometers.	Quarterly	Semi-annually	Annually

EXHIBIT I

EMBANKMENT GEOTECHNICAL INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
INCLINOMETERS SETTLEMENT & HORIZONTAL MOVEMENT	Embankment (SI-1 to SI-6)	6	Pool level between El. 2150 & 2200; one reading when pore pressure is detected. Pool level between El. 2200 & 2300; one reading every 2 weeks on SI-3, SI-4, & SI-5. Pool level between El. 2300 & 2400; one reading at every 50 foot increase in pool level on SI-1 thru SI-6. Pool level above 2400; one reading at every 20 foot increase in pool on all inclinometers. Post-earthquake condition (see strong motion accelerographs); read as soon as possible.	Quarterly	Semi-annually	Annually
SETTLEMENT MONUMENTS	Embankment (SM-100 to SM-177)	78	Pool level between El. 2150 & 2200; one reading when pore pressure is detected. Pool level between El. 2200 & 2300; one reading every 2 weeks on all monuments except for monuments inundated. Pool level between El. 2300 & 2400; one reading at every 50 foot increase in pool on all monuments except for monuments inundated. Pool level above 2400; one reading at every 20 foot increase in pool on all monuments except for monuments inundated. Post-earthquake condition (see strong motion accelerographs); read as soon as possible.	Semi-annually(3)	Semi-annually(3)	Annually

EXHIBIT I

EMBANKMENT GEOTECHNICAL INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
RESERVOIR INDEX RANGE LINES MONUMENTS	Reservoir (7000 to 7054, 8000 to 8024, and 9000 to 9023)	104	After major flooding or sediment inflow.	Initial	5 years	5 years
STAFF GAGES	Along upstream left abutment groin	102	As required during reservoir operations			

(1) See Table II-2-10 for Outlet Works Geotechnical and Hydraulic Instrumentation Reading Schedule.
(2) VWP is vibrating Wire Piezometers. PNP is Pneumatic Piezometers.
(3) 100% of the embankment settlement monuments and inclinometers should be read for vertical and horizontal displacement at each monitoring session, except as indicated as follows:
A reduced number of settlement monuments may be read for horizontal displacement during the first 5 years at 6th month, 18th month, 30th month, 42nd month, and 54th month periods. See O&M Manual, Part II, Chapter 2, paragraph 2.2.2.8.

EXHIBIT I

TABLE II-2-10 (From O&M Manual): OUTLET WORKS GEOTECHNICAL AND HYDRAULIC INSTRUMENTATION READING SCHEDULE

OUTLET WORKS GEOTECHNICAL & HYDRAULIC INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
OUTLET WORKS STRONG MOTION ACCELEROGRAPHS	Intake structure and gate chamber (A-5 and A-6)	2	Post-earthquake condition – read as soon as possible if any of the following conditions applies: - Richter 4.0 or greater within 3 miles radius, or - Richter 5.0 or greater within 30 miles radius, or - Richter 6.0 or greater within 50 miles radius, or - Damage reported at project, or - Acceleration of 0.1g.	Semi-annually	Semi-annually	Semi-annually
JOINT METERS	Rock/concrete interface of intake structure backslope (JM-1, JM-2, JM-2A, JM-4, JM-4A, JM-5, JM-6, JM-7, and JM-8)	9	Initial filling – daily for a week; weekly for a month; monthly. Subsequent Fill/Empty Cycles – based on results of initial fill monitoring; same reading as initial filling for subsequent filling exceeding previous maximum reservoir level. Post-earthquake condition (see strong motion accelerographs)– read as soon as possible. If readings represent a change from previous readings, continue daily for 1 week, or until readings return to pre-earthquake readings, whichever is less. Return to normal reading schedule.	Monthly to establish baseline values.	Quarterly	Quarterly

EXHIBIT I

OUTLET WORKS GEOTECHNICAL & HYDRAULIC INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
STRAIN METERS	Upstream tunnel and upstream gate chamber transition (SM-1 to SM-3, SM-6, and SM-7)	8	Initial pressure flow in tunnel – daily. Partial flow in tunnel during reservoir fill/empty – weekly for a month, then monthly. Post-earthquake condition (see strong motion accelerographs)– read as soon as possible. If readings represent a change from previous readings, continue daily for 1 week, or until readings return to pre-earthquake readings, whichever is less. Return to normal reading schedule.	Monthly readings to establish baseline.	Quarterly	Quarterly
LOAD CELLS	Intake structure rockslope (LC-1 to LC-12)	12	Initial filling – daily for a week; weekly for a month; monthly. Subsequent Fill/Empty Cycles – based on results of initial fill monitoring; same reading as initial filling for subsequent filling exceeding previous maximum reservoir level. Post-earthquake condition (see strong motion accelerographs)– read as soon as possible. If readings represent a change from previous readings, continue daily for 1 week, or until reaings return to pre-earthquake readings, whichever is less. Return to normal reading schedule.	Monthly readings to establish baseline.	Quarterly	Quarterly
VOLUME-TIME FLOW DEVICE	One gate chamber gutter, and two accerss tunnel gutters	3	Pool at 5-year or greater event elevation.	Monthly and for any high pool above normal debris pool elevation.	Twice a year at minimum and maximum pool.	Twice a year at minimum and maximum pool.

EXHIBIT I

OUTLET WORKS GEOTECHNICAL & HYDRAULIC INSTRUMENTATION	LOCATION	NUMBER OF INSTRUMENTS	MINIMUM READING SCHEDULE			
			TRIGGERING EVENT	NORMAL OPERATION		
				FIRST 2 YEARS	2 TO 5 YEARS	MORE THAN 5 YEARS
SURVEY MONUMENTS	Intake structure (SO2001-3 and SO2001-4) and access tunnel (SM200 to SM222)	25	Post-earthquake condition (see strong motion accelerographs); read as soon as possible.	Semi-annually[(2)]	Semi-annually[(2)]	Annually[(2)]
HYDRAULIC OPERATIONAL PIEZOMETERS	Intake structure, outlet tunnel, minimum discharge line (O-1 to O-10)	10	As required during reservoir operations			

(1) See Table II-2-4 for Embankment Geotechnical Instrumentation Reading Schedule.
(2) When embankment dam settlement monuments are read, also read 100% of outlet works survey instruments for horizontal and vertical displacement.

APPENDIX III

ENVIRONMENTAL AND CULTURAL SITE SURVEILLANCE

APPENDIX III

ENVIRONMENTAL AND CULTURAL SITE SURVEILLANCE

1. Environmental Considerations

All environmental commitments made in the 1988 Supplemental Environmental Impact Statement (SEIS) prior to project construction have been complied with during design and construction. Post-construction mitigation monitoring will be performed on remaining required environmental commitments. Project personnel are required to continue to adhere to the environmental commitments and mitigation measures that were developed during preparation of the SEIS, Section 7 (Endangered Species Act) consultations, and subsequent coordination and NEPA/CEQA (National Environmental Policy Act/California Environmental Quality Act) documentation. NEPA compliance will be required if environmental conditions or future operation and maintenance activities change. Monitoring of reservoir water quality is required in accordance with environmental commitments in the SEIS. Refer to project OMRR&R Manual for water quality testing parameters and frequency.

Environmental problems associated with filling Seven Oaks Dam Reservoir to levels in excess of historical maximum floods are minor. The highly variable flow rates characteristic of the Santa Ana River have allowed the development of local plant and animal communities which are adapted to alternating conditions of drought and flood. Area trees and shrubs are tolerant or intermediately tolerant to flooding and should not be adversely affected by short-term flood storage. Following floodwater recession, increased soil moisture should allow rapid germination and re-vegetation of the area by grasses and other herbaceous plants. Colonists from the surrounding area will replace animal resources lost due to flooding. Tumbleweeds have typically been the first and most abundant species to re-establish after any retention of flood waters, often so dense as to be an operational problem in that they plug channel areas and preclude growth of other species.

2. Cultural Resources Surveillance

Cultural resources investigations for the project area were conducted for the SEIS in 1988. It involved an overview study (Altschul, Rose and Lerch 1984), extensive historic archival research, oral historical interviews, and a sample field survey (Brock, et al. 1986). The surveys located 39 cultural resources in the area of potential effect, including the damsite, reservoir area, borrow areas, and haul roads and staging areas. Historic properties subject to impacts of reservoir inundation included the Southern California Edison Santa Ana River Hydroelectric System, the Santa Ana Canyon Road, and multiple historic refuse scatters. The Edison Hydroelectric System was determined eligible for inclusion in the National Register of Historic Places and concurred by the State Historic Preservation Officer. The effected facilities have been relocated or modified for inundation as mitigation measure.

EXHIBIT I

Any change noticed in prehistoric or historic archeological sites during routine inspection of the reservoir, especially those attributed to water erosion, shall be reported by Operations Manager to the sponsors' District archeologists within two (2) working days of their discovery. The District archeologists will be responsible for determining the nature and severity of the damage and coordinate with the State Historic Preservation Officer and Advisory Council on Historic Preservation.

APPENDIX IV

SAFETY PLAN

APPENDIX IV

SAFETY PLAN

1. All personnel in the field will wear hard hats for identification and will be fully authorized to act on any matter dealing with safety.

2. All instances of safety violations, hazardous conditions, or incidents will be documented and logged.

3. Personnel should be firm, but tactful, in dealing with the public to protect them from hazards. If cooperation cannot be obtained, the situation should be reported immediately to the operations manager.

4. If assistance is required to remove the public from the pool rise area, assistance will be available from the operations manager's office and the local authorities will be dispatched.

5. All personnel are cautioned to be alert during surveillance activities due to the increased dangers of falls due to steep terrain, mud, and banks caving in from wave action. These dangers should be pointed out to any of the public observed near the reservoir.

6. The Seven Oaks Dam Operations Manager will take action to inform the public during pool rise of hazards expected.

7. All access roads into the expected pool area will be closed to the public. Standard reflectorized signs and barricades will be used. Cable gates will not be used to close roads.

APPENDIX V

CHECKLIST OF CONDITIONS AFFECTING DAM SAFETY

APPENDIX V

CHECKLIST OF CONDITIONS AFFECTING DAM SAFETY

The Seven Oaks Dam Operations Manager and technical staff will make routine inspections of the dam at intervals that will assure safety and operating reliability. This Appendix contains a checklist which is to be used to aid in discovering and correcting problems which could lead to dam failure or uncontrolled release of water.

EXHIBIT I

TABLE V-1

ENGINEERING PROBLEMS

OBSERVANCE - SINKHOLES IN CREST OF DAM, SLOPES OF DAM, OR DOWNSTREAM OF DAM

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Piping (internal erosion), either in the embankment or foundation, has eroded a cavity causing the earthen material above to collapse.	Fault in embankment foundation -- fine material migrating due to excessive seepage pressure.	Constant, until condition stabilized and/or cause is established and corrected, if possible.	Outlet works should be opened to full capacity immediately. Walkover inspection of entire dam searching for additional sinkholes, muddy discharges downstream, whirlpools upstream. Read all piezometers. Advise lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC) immediately, regardless of time of day. In extreme cases where the sinkhole is very large and/or rapidly enlarging, especially if accompanied by large muddy discharge and/or upstream sinkhole or whirlpool, the dam should be considered in imminent danger and immediate action must be taken. Warn downstream areas and notify lead Sponsor's Operations Center and Corps of Engineers ROC as soon as possible. Implement Emergency Action Plan notifications.

OBSERVANCE - CRACKS OR SLIDES IN EMBANKMENT, FOUNDATION, OR NATURAL MATERIAL OR RESERVOIR RIM

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Shrinkage due to drying. Movement resulting from shear failure could be due to seepage, surface runoff entering cracks, wet season, or rapid reservoir drawdown.	Dry weather, high pool, low pool, pool quickly drawn down, earthquake.	Continuous until cause is established.	Check for enlargement of cracks due to erosion. Determine if movement is still occurring. Check for seepage, boils, etc. Walkover inspection of entire dam. Observe alignment of dam crest, bulging of toe of dam, displacement of riprap, or slope protection. If crack is small and not enlarging and not carrying material (clear water), notify lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC) during normal business hours. In all new instances, notify lead Sponsor's Operations Center and Corps of Engineers ROC immediately. Determine if slide is moving and the extent of slide, if possible. If crack is enlarging due to seepage or effluent from the crack is carrying a large amount of material, warn downstream areas and notify lead Sponsor's Operations Center and Corps of Engineers ROC as soon as possible. When the dam is being over-topped or is in danger of being overtopped, the dam is in imminent danger. Warn downstream residents and lead Sponsor's Operations Center and Corps of Engineers ROC as soon as possible. Implement

Emergency Action Plan. Sandbags or other means should be used to increase freeboard where feasible, and the outlet fully opened.

OBSERVANCE - LEAKAGE: WATER SEEPAGE

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Faulty seepage barrier in foundation, abutments, or embankment	Higher pool levels than previously impounded, rapid filling of the reservoir	Constant until cause is established.	Walkover inspection of entire area downstream of dam. Report all seeps to lead Sponsor's Operations Center and Corps of Engineers ROC. Try to determine source of seepage. Unless the muddy water is due to surface erosion, muddy seepage should be considered serious and lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC) notified immediately. If the discharge is large or increasing rapidly, the dam should be considered in imminent danger of failure. Place gravel or rock materials in the seepage area to stop migrating soil (but not the water). Use filter cloth if available. Warn downstream areas and lead Sponsor's Operations Center and Corps of Engineers ROC as soon as possible. Implement Emergency Action Plan. If upstream entrance point is known, try to plug area in a manner discussed below for "upstream, whirlpool." Outlet should be fully open.

OBSERVANCE - UPSTREAM WHIRLPOOL

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Piping (internal erosion) uncontrolled seepage had eroded a substantial cavity through which a large volume of water is escaping either through the embankment or foundation.	Sinkholes, cracks, boils, or seepage through the embankment, foundation, or abutments.	Continuous, or as frequent as practicable.	The dam is in imminent danger of failure. Warn downstream areas and notify lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC) as soon as possible. Implement Emergency Action Plan. Search abutments, dam and downstream area for seepage, sinkholes, boils, and/or if there is discharge of water somewhere downstream. Attempt should be made to plug the entrance with large rock or anything that is available. Use riprap off the face of the dam if practicable. Vehicles may also be useful. If the large material appears to reduce the flow, follow with progressively smaller material.

OBSERVANCE - OVERFLOWING PIEZOMETERS

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Increase in water pressure in foundation or embankment.	High pool. Increase in ground water elevation due to wet weather. Crack or piping through impervious zone.	Frequently until cause is determined.	Look for boils and wet areas. Note change in seepage or relief well flow. Unless severe or accompanied by other problems, notify lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC) during normal business hours. Add pressure gage or increase piezometer elevations, if possible.

OBSERVANCE - CONDUIT FLOWS GREATER THAN NORMAL FOR A SET GATE OPENING

Probable Cause	Contributing Factors	Surveillance Frequency	Action
Structural or stability failure in the outlet works.	Lake water has percolated through the embankment and is entering the outlet works passageway.	Constant until cause is determined.	Close the conduit gates and observe discharge in stilling basin. If original observance is confirmed, keep gates in closed position and notify lead Sponsor's Operations Center and Corps of Engineers Reservoir Operations Center (ROC).

TABLE V-2
EXTREME CONDITION CHANGES

RADICAL CHANGE IN CONDITIONS - EARTHQUAKE

Observe	Check	Frequency	Action
Dams and abutments	All engineering problems.	Constantly.	See appropriate engineering Problem.
Outlet works	Determine if gates are operational		Put gates into operation as soon as possible.
Conduit	Opening of joints.		Determine location and extent of opening if possible.
	If electric power is disrupted.		Provide emergency power by means of portable generator.

RADICAL CHANGE IN CONDITIONS - HIGH WIND

Observe	Check	Frequency	Action
Waves overtopping dam.	Downstream slope for erosion.	Continuous, or as frequent as practicable.	Any time dam is likely to be overtopped, notify lead Sponsor's Operations Center and Corps of Engineers ROC.
Condition of riprap.	Upstream slope for erosion of waterline.		If practicable, try to control erosion with sandbags or other means.

RADICAL CHANGE IN CONDITIONS - FLOOD POOLS

	Observe	Check	Frequency	Action
	Abutments and downstream area.	Seepage areas, boils, cracks, slides, bulging at toe.	Frequent.	See appropriate action under Engineering Problems.
	Crest.	Cracks, slides, over-topping, alignment of guardrail posts, settlement.		
	Upstream slope.	Condition of riprap, alignment of waterline, upstream whirlpool.		
Spillway discharge	Spillway.	Erosion, slides, stability of spillway structure.	Frequent.	Improve stability. Place rock or other material to control erosion and direction of flow where practicable.
	Downstream toe.	Erosion, eddy currents, direction of flow.		Warn downstream areas of flows that will exceed channel capacity.

ATTACHMENT I

WATER CONTROL PLAN

EXHIBIT I

Refer to the latest
WATER CONTROL PLAN

ATTACHMENT II

EMERGENCY ACTION PLAN

EXHIBIT I

Refer to the latest EMERGENCY ACTION PLAN under separate cover

ATTACHMENT III

CORPS OF ENGINEERS PUBLICATIONS

ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Structures, Dated 15 March 1996

ETL 1110-2-231, Engineering and Design - Initial Reservoir Filling Plan, Dated 30 March 1979

EXHIBIT J.

SEVEN OAKS DAM
BIOLOGICAL OPINION
DATED
DECEMBER 2002

COPY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Carlsbad Fish and Wildlife Office
6010 Hidden Valley Road
Carlsbad, California 92009

In Reply Refer To:
FWS-SB-1000.10

DEC 1 9 2002

Ruth Villalobos
Chief, Planning Branch
U.S. Army Corps of Engineers
P.O. Box 532711
Los Angeles, California 90053-2325

Attn: Joy Jaiswal and Hayley Lovan

Re: Section 7 Consultation for Operations of Seven Oaks Dam, San Bernardino County, California (1-6-02-F-1000.10)

Dear Ms. Villalobos:

This document transmits our biological opinion on operations for Seven Oaks Dam, San Bernardino County, California, and the possible effects on the federally endangered San Bernardino kangaroo rat (*Dipodomys merriami parvus*, "SBKR") and its designated critical habitat, slender-horned spineflower (*Dodecahema leptoceras*, "spineflower"), and Santa Ana River woolly star (*Eriastrum densifolium* ssp. *sanctorum*, "woolly star"), least Bell's vireo (*Vireo bellii pusillus*, "vireo"), southwestern willow flycatcher (*Empidonax traillii extimus*, "flycatcher"), and arroyo toad (*Bufo californicus*, "toad") and the federally threatened coastal California gnatcatcher (*Polioptila californica californica*, "gnatcatcher"), California red-legged frog (*Rana aurora draytonii*, "frog"), and Santa Ana sucker (*Catostomus santaanae*, "sucker") in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*). Your request for formal consultation was received on August 14, 2000. We have determined that the proposed operation of Seven Oaks Dam is not likely to adversely affect the vireo, flycatcher, toad, gnatcatcher, frog, or sucker; therefore, these species will not be addressed further in this biological opinion.

This biological opinion is based on the (1) *Biological Assessment Seven Oaks Dam, Santa Ana River Mainstem Project* (BA) dated August 2000 (MEC 2000a); (2) the *Qualitative Assessment; Adequacy of assumptions and first order cost estimates associated with mitigation monitoring Seven Oaks Dam* dated June 2001 (MEC 2001); (3) the *General Design Memorandum No. 1, Phase II on the Santa Ana River Mainstem* (GDM) dated August1988 (U.S. Army Corps of Engineers 1988a); and (4) other correspondence, notes and information compiled during the course of our consultation with your staff. This information and other references cited in this biological opinion constitute the best available scientific information on the status and biology of the species considered. The complete administrative record for this consultation is on file at the Carlsbad Fish and Wildlife Office.

Consultation History

The operation of Seven Oaks Dam is one component of the greater Santa Ana River Mainstem Project ("Mainstem") undertaken by the U.S. Army Corps of Engineers (COE) to address flood control on the Santa Ana River. The U.S. Fish and Wildlife Service (Service) issued a biological opinion (1-1-80-F-75) to COE on October 1, 1980, which assessed effects to listed species including the California least tern (*Sterna antillarum browni*), the light footed clapper rail (*Rallus longirostris levipes*) and California brown pelican (*Pelecanus occidentalus*) from the construction of downstream sections of Mainstem. On June 22, 1989, we issued another biological opinion (1-6-88-F-6) to address effects to the vireo and woolly star from the raising of Prado Dam and Mill Creek Levee and construction of Seven Oaks Dam.

Construction of Seven Oaks Dam began in March of 1994. The SBKR was emergency listed in January 1998, and dam construction was stopped until our issuance of a biological opinion (1-6-98-F-21) dated February 4, 1998, which addressed effects to SBKR from continued use of the Pervious Borrow Site for dam construction. That biological opinion stressed that the operation of the dam was of "utmost importance due to the reliance of the plant and animal community of the Santa Ana Wash on periodic flood events," and that consultation on operation of the dam would be required in the future. The 2000 BA (pg. 15) provides a summary of informal consultation that took place between our agencies from January 1998 and January 2000.

On October 12, 2000, we sent your agency a letter acknowledging initiation of formal consultation on August 14, 2000. Our agencies held a meeting on Oct 31, 2000, to discuss conservation measures and other outstanding issues. On November 16, 2000, the Service sent your agency a letter requesting an extension of formal consultation to February 26, 2001 (erroneously February 26, 2000, in the letter) to allow receipt and analysis of information that had been asked of COE at the meeting on October 31, 2000.

On December 11, 2000, the Service sent a letter to COE commenting on the Final Biological Assessment. On February 9, 2001, we sent COE a letter again requesting information discussed at the meeting on October 31, 2000, and requesting another 60-day extension to April 27, 2001. In that letter we suggested that COE conference on proposed critical habitat for SBKR.

On March 14, 2001, our agencies and the local sponsors met to discuss Mainstem projects including Seven Oaks Dam. On April 17, 2001, we met with your agency to discuss habitat and species monitoring for Seven Oaks Dam. In a letter dated April 20, 2001, the Service sent your agency a letter again requesting information discussed at the meeting on October 31, 2000. We stated that an opinion would be issued 45 days from receipt of the complete information request. Our agencies met to discuss Mainstem projects on May 22, 2001, where we discussed interdependency of the components of Mainstem and conservation measures for Seven Oaks Dam operations impacts. In your letter dated May 29, 2001, which included the information we previously requested, you also requested formal conference on proposed critical habitat for the SBKR.

On June 8, 2001, we received your *Qualitative Assessment* document. On August 2, 2001, our agencies met to further discuss issues associated with mitigation and monitoring. On August 8, 2001, the Service sent a letter to COE requesting an extension of formal consultation for another 90 days to allow completion of the biological opinion for the Prado Basin and Norco Bluffs components of Mainstem and to address monitoring and management issues at Seven Oaks Dam.

On September 4, 2001, the Service sent a letter to COE with comments and information requests based on our review of the *Qualitative Assessment*. On December 5, 2001, the Service issued a biological opinion on the Prado Basin and Norco Bluffs components of Mainstem.

Our agencies met on May 3, 2002, to discuss funding assurances, monitoring plans, statistical analyses, and other issues for Seven Oaks Dam. On July 19, 2002, we received a letter from your agency requesting completion of formal consultation by September 20, 2002. In our meeting on July 23, 2002, we discussed outstanding issues including the multiple species management plan development, management action triggers, water appropriations, and sediment transport. In an electronic mail correspondence to your staff on August 6, 2002, we requested a written response to our comments and information requests on the *Qualitative Assessment*.

On August 19, 2002, we sent a letter to COE stating that the September 20, 2002, biological opinion deadline would not be met due to meetings scheduled for September 10-12, 2002, where it was hoped that resolution on outstanding issues would be achieved. We met on September 10 and 11, 2002, to discuss those outstanding issues. In that meeting, COE committed to responding to our comments on the *Qualitative Assessment* and providing a draft project description. The Service committed to providing a draft biological opinion on November 12, 2002. We received COE's response to our comments on the *Qualitative Assessment* on September 26, 2002, and the draft project description on September 30, 2002. A draft biological opinion was provided on November 12, 2002. We received your comments on the draft biological opinion on November 20, 2002, and a further analysis of effects to listed species from future conservation actions on December 3, 2002. We provided a revised draft biological opinion on December 12, 2002.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Seven Oaks Dam, located on the Santa Ana River near the City of Highland, is a major feature of the Santa Ana River Mainstem Project. This dam is designed to provide flood protection along the Santa Ana River. The Seven Oaks Dam watershed drains an area of about 177 square miles. Seven Oaks Dam is a 550-foot high earthen dam with a gross retention capacity of 145,600 acre-feet at the spillway crest elevation. Specific dam features are described in detail in the 2000 BA. The dam is intended to be operated for flood control purposes by temporarily retaining water and attenuating peak flows until the downstream flood threat has passed. The hydrologic effect of Seven Oaks Dam is to reduce peak flood flows downstream to Prado Dam, which controls floods downstream to the Pacific Ocean. Construction began in March 1994, and the dam became operable in December 1999.

Since its completion, the dam has been operated in accordance with an interim operation plan that was developed in coordination with, and approved by, the Service. The purpose of this interim plan was to avoid impacts to the SBKR and other species while the long-term operation plan, including conservation measures, was being developed and undergoing consultation. The interim plan involved passing as much inflow as physically possible without risk to public safety and/or the dam itself. The dam was also operated so as not to interfere with downstream water rights. In general, the dam has been operated so that during non-flood conditions, releases match inflows as closely as possible. The plan is fully described in the Interim Water Control Plan (COE 1999a).

The proposed project involves operating the dam fully for flood control, including use of the gated outlet structure, as described in the GDM. COE and local flood control districts of Orange, San Bernardino and Riverside counties (local sponsors) propose to initiate long-term operation of Seven Oaks Dam in a manner consistent with the original flood control objectives described in the 1988 GDM. The GDM, and its supporting environmental documents, also included conservation measures to offset impacts to the woolly star and other species. The 1988 GDM operation plan, however, has been and will continue to be revised to incorporate additional conservation measures that will further avoid, minimize, or offset impacts to listed species. These measures will be further defined and overseen by a collaborative multi-agency committee of environmental experts and agency officials. The plan also may be modified periodically based on species and habitat monitoring.

Therefore, the long-term operation plan will consist of the 1988 GDM flood control operation plan, plus additional operations and conservation measures intended to support affected listed species and their habitats, as directed by the proposed Steering Committee. Presently, additional conservation measures, including the Multi-Species Habitat Management Plan (MSHMP), the structure of its managing Steering Committee, and other necessary documents are not fully refined, completed, or concurred upon by responsible agencies. However, to be able to request Federal funding necessary for further multi-species plan development and finalization, COE requested that the Service complete a biological opinion that addressed full flood control operation of Seven Oaks Dam and the current and proposed additional conservation while those conservation measures, in particular the MSHMP, are finalized.

Based on information provided by your agency in the August 2000 BA, the 1988 Phase II GDM/SEIS, and other project documents, the Service, COE and local sponsors have developed conservation measures for long-term operation and maintenance of Seven Oaks Dam. The conservation measures described in the BA will be further refined in the MSHMP. The Corps and local sponsors have agreed to prepare the MSHMP and appropriate environmental documentation, perform studies, and implement experimental treatments and management measures to protect the species. The MSHMP preparation will be initiated within six months of issuing this biological opinion. It is anticipated that completion of the MSHMP and environmental document may take two years. However, even if the documents are not completed within that time frame, the measures identified in the biological opinion will remain in effect and dam operations as defined in the Phase II GDM will continue. Upon completion of the MSHMP, the Corps may request an amendment to the BO to address any potential effects of the specific conservation measures that were not addressed fully in this biological opinion.

Long-Term Operation Plan for Flood Control

The water control plan for Seven Oaks Dam (based on the 1988 GDM) was originally designed to achieve flood control objectives. When significant flood inflow into the dam reservoir occurs, floodwaters would be temporarily retained, while a small release (500 cubic feet per second [cfs] or less) is made until the reservoir pool level at Prado Dam begins to recede. Water retained at Seven Oaks Dam would then be released at higher rates to evacuate the reservoir pool in a controlled manner to regain retention capacity for subsequent flood events. Storing water for longer periods for the purpose of water conservation is not currently authorized or proposed (Letter from COE to San Bernardino County Flood Control Department dated May 29, 2001).

Long-term flood control operations include the following main elements:

Sediment Pool (2,100 to 2,120 feet National Geodetic Vertical Datum [NGVD]) - At the beginning of each flood season, stop logs will be added to block the lower inlet ports of the intake structure to about 20 to 30 feet above the current invert. This is to be done to minimize the amount of sediment entering the minimum discharge line (MDL). The two lowest rows of ports have already been blocked, so the initial sediment pool will be about 20 feet deep. The stop logs will form a "dead pool," and no operation will be possible other than leakage. As sediment deposition occurs in the future, additional stop logs will be added to maintain the 20-30 foot sediment pool above the sediment deposition level at intake tower.

Debris Pool (2,120 to 2,200 feet NGVD) - At the beginning of each flood season, using inflow in excess of minimum downstream water rights, a debris pool will be formed above the sediment pool. The debris pool is designed to protect outlet facilities from debris damage. Water will be retained in the debris pool until the end of the flood season, when it will be released at a rate of 10 to 20 cfs as agreed upon during the preparation of the GDM. The operation plan for filling and draining the debris pool was negotiated with downstream water users during the preparation of the 1988 GDM to mitigate for the impacts of the flood season operations upon downstream water rights. Water stored in the debris pool should not be considered available for conservation measures.

Intermediate Pool Elevations (2,200 to 2,265 feet NGVD) - The intermediate pool elevations occur between the top of the debris pool and the sill of the main intake. Early in the project life the elevation range of the intermediate pool is between 2,200 and 2,265 feet NGVD. Within this range, the pool will be evacuated at a rate consistent with the 1988 Phase II GDM flood control operation plan, except if water is retained for periodic release in the flood plain for federally listed species conservation. The maximum combined capacities of the MDL and low-flow gate may be used, which are about 400 to 500 cfs at this range.

Main Trash Rack (2,265 to 2,299 feet NGVD) - The trash racks protecting the main intake are located between 2,265 and 2,299 feet NGVD. During rising flood stages, no releases will be made through the main regulation outlet or low-flow gate to avoid drawing floating debris into the trash racks. Instead, releases will be made through the MDL in this elevation range at the maximum safe rate (theoretically on the order of 50 cfs). During falling stages, releases will be made up to a maximum of 2,000 cfs depending on the potential blockage of the trash rack by floating debris and potential for additional near-term flood inflow.

Main Pool (2,299 to 2,580 feet NGVD) - This is the pool between 2,299 feet and the spillway crest at elevation 2,580 feet NGVD. Between these elevations, water will be released at a rate consistent with the 1988 Phase II GDM flood control operation plan. The maximum flood control release rate is 7,000 cfs.

Spillway Surcharge (2,580 to 2,604 feet NGVD) - Above elevation 2,580 feet NGVD, releases are uncontrolled over the spillway. During rising stages, releases from the outlet works will be adjusted so the total project release equals 7,000 cfs. Above 2,585 feet NGVD, no controlled releases will be made. During falling stages, the outlet works gates will be adjusted to maintain the resulting maximum spillway release rate to assure quick evacuation of the remaining surcharge volume in anticipation of another major storm.

1988 GDM Conservation Measures

Conservation measures were identified in the 1988 Final Supplemental Environmental Impact Statement (FSEIS) and subsequent biological opinions to avoid, minimize or offset direct and indirect impacts associated with construction of Seven Oaks Dam. The 1988 FSEIS conservation commitments and status of each are summarized in Table 1.

Table 1. Status of conservation measures for Seven Oaks Dam construction based on commitments made in 1988 FSEIS (COE 1988b).

Resources Impacted	Commitment	Status
Upland habitat (chaparral); deer migration and general wildlife	Acquire and preserve Section 5 (596 acres); acquire Filaree Flats (139 acres, of which 119 is upland habitat)	Complete. Both Filaree Flats and Section 5 have been purchased.
Aquatic habitat; brown trout	Acquire Filaree Flats; 1 mile of aquatic habitat preserved and 20 acres of the total 139 are riparian	Complete; see above.
Woodland riparian habitat	Acquire and revegetate 60 acres of Santa Ana River Wash	Complete (Note: In lieu of planting 60 acres of riparian habitat, $1.35 million was contributed to an endowment for giant reed (*Arundo donax*) management in the Santa Ana River watershed.)
Santa Ana River woolly star	Acquire 700 acres of wash lands below Greenspot Road. Incorporate endangered species management into the LCA as part of the local sponsors' O&M responsibility	Complete. The 764-acre Woolly Star Preserve Area (WSPA) has been purchased in fee or conservation easement and set aside for wildlife in perpetuity. A Management Plan has been prepared, funded, and implemented by the local sponsors. The Steering Committee reviews work and approves budget and actions.
Alluvial fan sage scrub	Re-seed disturbed areas (borrow areas, haul roads, access roads) with native seed mix	Complete.

Additional Conservation Measures

Operation of Seven Oaks Dam is expected to change the quality of downstream habitat due to a reduction in flood processes of scour and sand deposition that are important to the renewal and succession of the alluvial scrub habitat. The primary objective of both the existing Woolly Star Preserve Area (WSPA) and the additional conservation measures outlined in the BA is to compensate for potential changes in floodplain characteristics and listed species' habitat brought about by construction and operation of Seven Oaks Dam.

It is difficult to predict whether habitat quality associated with succession would proceed to a point beyond suitability for spineflower and SBKR within the 100-year project life of the dam. Estimates of time required for succession to a mature alluvial scrub community differ by an order of magnitude, from a few hundred to thousands of years. Additionally, there are substantial data gaps in knowledge of relationships between habitat characteristics and quality for these species and how that may relate to flood processes. Despite these uncertainties, there is evidence of a relationship between the abundance and distribution of spineflower and SBKR relative to recent and historic flood flows. Operation of the dam will reduce overflows in these areas.

Therefore, in addition to operation for flood control, it is anticipated that water releases will be made to maintain and enhance habitat for listed species under a finalized MSHMP for listed species as outlined in the BA. It is anticipated that the water used for controlled releases, for both experimental treatments and management measures, would come from flood flows stored in the intermediate, main trash rack, and main pools. The objective would be to mimic historic conditions without compromising public safety or dam integrity. If there is no immediate need to release the water for flood control reasons, and if directed by the Steering Committee, releases could be temporarily retained for some period time (up to several weeks) while diversion dikes are constructed. Some or all of the controlled releases could then be diverted onto the WSPA and/or other areas within the historic Santa Ana River floodplain to produce the hydrologic erosion and sediment deposition believed to be necessary to sustain species' habitat. During the period immediately following issuance of the biological opinion, while the MSHMP and appropriate NEPA documentation are being prepared, the dam will be operated for flood control purposes as described in the 1988 Phase II GDM.

Controlled releases are not expected to occur with every storm event or even every year. Flood events that produce sufficient runoff to operate the dam to flood and scour habitat outside of the main channel, but within the historic floodplain, occur with an estimated frequency of every 5-10 years. The actual frequency of controlled releases may depend on a number of factors, including rain events, the results of directed studies and experimental treatments, and direction from the Steering Committee.

The proposed additional conservation measures focus on providing the means to: (1) further evaluate the impacts from dam operation; (2) test and select appropriate management actions; and (3) implement habitat management actions within the WSPA and other historic floodplain areas within the local sponsors' jurisdiction to sustain SBKR, woolly star and spineflower.

The additional conservation measures are described in the 2000 BA and *Qualitative Assessment* and are briefly summarized below. These elements may change and be refined subsequent to discussions between COE, local sponsors, the Service and other resource agencies.

The additional conservation measures have six elements:

(1) A Memorandum of Understanding (MOU) among appropriate stakeholders. The MOU (mistakenly referred to as a "Memorandum of Agreement" in the 2000 BA) will establish the responsibilities of the various stakeholders. It will describe the manner in which the MSHMP will be developed, how the directed studies will be managed, and how the habitat management measures will be funded and directed. It is anticipated that participants (agency staff and technical experts) will serve on a Steering Committee that will semi-annually review and make decisions regarding the MSHMP. It is envisioned that the existing WSPA Steering Committee could serve that management function by expanding its membership and responsibilities to include multi-species management.

(2) Development of a Multi-Species Habitat Management Plan. The MSHMP will detail the habitat management measures, as well as the decision-making process, for implementing management measures or changes in design. The MSHMP will be adaptive and allow flexibility to institute changes in study designs and/or implementation of habitat management measures based on experimental studies and monitoring results and the decisions of the Steering Committee. The MSHMP will be developed by COE and the local sponsors in coordination with resource agencies (including the Service and California Department of Fish and Game [CDFG]) and technical experts. The MSHMP will be reviewed by the resource agencies for their concurrence prior to implementation.

(3) Directed studies of population trends and habitat relationships, threats to the species, and life requirements. These will include studies of habitat succession, spineflower and SBKR population abundance and distribution and will include wash-wide habitat and exotic species mapping. The 2000 BA and *Qualitative Assessment* proposed the number, duration, and types of studies. The Service and COE have not yet agreed on all aspects of the study design; however, the COE has provided information (letter to the Service dated September 25, 2002) to respond to Service concerns (letter to the COE dated September 4, 2001) that will provide a basis for further discussion with technical experts on topics such as detection and significance of percent population change, power, alpha level and other statistical considerations, and cost comparisons. Both agencies anticipate coming to resolution on these points during preparation of the MSHMP. Therefore, the 2000 BA, *Qualitative Assessment*, and subsequent correspondence between our agencies provide a good basis for the MSHMP, which will be finalized to incorporate the comments, concerns, and agreements of all the agencies.

(4) Experimental studies of the effectiveness of different habitat management techniques. The purpose of the experimental studies will be to test the effectiveness of hydraulic renewal and on-ground techniques to slow habitat succession that is due to lack of fluvial processes. The various techniques will be applied to degraded habitat areas, with pre-

and post-monitoring and surveys to document changes in habitat and population dynamics.

a) Operation of Seven Oaks Dam coupled with construction of diversion dikes to provide periodic controlled releases to flood designated areas of the WSPA or other lands within local sponsors' jurisdiction. Temporary dikes will be constructed to confine flooding to an area of approximately 5-10 acres. If necessary, sediment will be placed next to the river to be picked up and conveyed by flood flows. This experiment may include two types of tests:

- Controlled water release only,
- Controlled release with vegetation clearing (to mimic scouring).

b) On-ground habitat renewal experiments using equipment (rather than flood flows from the dam) to clear vegetation and spread sand and/or water. This experiment may include two types of tests:

- Sand spread with light equipment in cleared areas and green waste debris removed;
- Sand placed in a pile and dispersed using water from a water truck. Temporary training dikes will be used to control flooding.

c) Monitoring of experimental trials, as described in the 2000 BA.

(5) Implementation of habitat management on the WSPA and on a larger-scale over the Santa Ana Wash (covering more area) than the experimental treatments. This element, described in the 2000 BA Section 9.1.2 as "Option 1," also includes replenishment of downstream sediment. Habitat management measures will be selected for implementation once their feasibility is determined, potential benefit is understood, and disturbance judged to be acceptable. Proposed habitat management measures (flooding and active manipulation of the floodplain) will be done on the WSPA and other lands within the local sponsors' jurisdiction but may be expanded to other lands if appropriate rights are provided. The proposed MSHMP includes a fund to augment management actions within the WSPA or on other floodplain lands to include benefits for spineflower and SBKR, as directed by the Steering Committee.

COE has agreed to request a single appropriation which, combined with the local sponsor share, will total $5,690,000 (the estimated cost of habitat management measures included in the 2000 BA) and to seek approval to establish an escrow account through a willing third party (i.e., San Bernardino County Flood Control District or The Nature Conservancy). The escrow account will generate interest that could be used as an added contingency fund, should directed studies or management measures prove more expensive than currently anticipated, or should the Steering Committee recommend additional measures.

It is envisioned that with implementation of the MSHMP approximately 25% of the "flow target area" (the total area subject to target flows from the diversion dikes) will be rejuvenated during each controlled flow release (about 10 acres of area with one temporary dike). Flows will follow topography and occupy existing and historic flow paths. It will take several (about 20) controlled releases over the life of the project to provide flows to the entire area. Flood events that produce sufficient runoff to operate the dam to flood and scour habitat outside of the main channel occur with an estimated frequency of every 5-10 years. More detailed design will be developed during preparation and implementation of the MSHMP. Decisions concerning the release schedule, locations, discharge volumes and sediment volumes will require additional information from the proposed directed studies. In concept, each release could require:

- A 400 foot long, 50 foot wide, 10 foot high temporary diversion dike in the main channel (0.5 acre footprint, 2 acres construction footprint);
- Small training dikes, approximately 0.1-acre footprint each;
- Possibly a protective levee, 25,000 feet long, 40-50 feet wide, 10 feet high, to prevent water from leaving the WSPA, unless hydraulic analysis demonstrates that this is not necessary;
- Avoidance measures, including:
  a) Prior to construction of any dikes and/or controlled releases, surveys will be conducted for target and sensitive species within access routes, construction footprints, and target flow areas, and specific avoidance measures will be recommended and implemented;
  b) Adverse impacts to high-quality habitat will be avoided;
  c) If necessary, and recommended by the Steering Committee, exclusionary fencing will be constructed and individual listed species will be relocated.

The operation plan includes sand recharge into the Santa Ana River below the dam to the confluence of Mill Creek as part of a sediment management plan for the river. The sand could be conveyed to the river by a conveyor belt system running through the dam, excavated from behind the dam and trucked to the river on access roads, or provided from another source. Regardless of the source, the sand that is recharged into the river will have the same physical characteristics as under pre-dam conditions. Sand will be spread over about a 10-acre area in the river channel by bulldozer. Sand will be recharged to the river at a frequency of every 10 to 20 years over the life of the project. During a sediment management year, sand placement will occur over about a six-month period.

Other potential management measures involve use of equipment, instead of dam operations, to simulate the processes of scour and sand deposition. These measures will consist of two different aspects. The first involves scraping away (or "brushing") areas in channels supporting older growths of vegetation or invasive exotic weeds. The second phase will be to deposit new sand in the areas brushed. These management techniques may be considered for applications to maintain suitability of existing habitat and/or to reclaim currently unoccupied habitat.

(6) Expansion of habitat management measures beyond current boundaries, if approved, authorized and funded. This element can also include other measures such as non-native grass control to enhance habitat in the floodplain. COE has agreed to work with the Service to seek conservation or other easements from the Bureau of Land Management to permit habitat management measures, including flooding, on areas currently outside of

the agencies' jurisdiction. This commitment assumes that water appropriations will not be required. This commitment also assumes that funding for such easements or land acquisitions, if required, will be provided by an entity other than COE or local sponsors, and that the local sponsors bear no obligation to implement, fund, acquire lands and easements, obtain water appropriations and/or any other action as may be required for the expansion of habitat management measures beyond current WSPA boundaries. If easements are granted and the assumptions noted above occur, COE has agreed to seek additional approval, authorization, and funding to implement habitat management measures within those areas. This element can also include other measures to enhance listed-species habitat within the WSPA or other areas, potentially improving habitat over existing or pre-dam conditions, as described in Section 10 of the 2000 BA.

STATUS OF THE SPECIES

San Bernardino Kangaroo Rat (SBKR) and its designated critical habitat

The SBKR is one of 19 recognized subspecies of Merriam's kangaroo rat (*Dipodomys merriami*), a widespread species distributed throughout the arid regions of the western United States and northwestern Mexico (Hall 1981, Williams *et al.* 1993*a*). There are three recognized subspecies of Merriam's kangaroo rat within California: *Dipodomys merriami merriami*, *Dipodomys merriami collinus*, and the SBKR. Based on morphological evidence, Lidicker (1960) noted that the SBKR is one of the most highly differentiated subspecies of *Dipodomys merriami*, and stated that "it seems likely that it has achieved nearly species rank." This differentiation may be due to the SBKR's nearly complete isolation from other members of *Dipodomys merriami* (Lidicker 1960). No genetic analyses have been conducted to confirm this apparent differentiation.

The historical range of the SBKR extended from the San Bernardino Valley in San Bernardino County to the Menifee Valley in Riverside County (Lidicker 1960, Hall 1981). Within this range, the SBKR was known from over 25 localities (McKernan 1997). From the early 1880s to the early 1930s, the SBKR was a common resident of the San Bernardino and San Jacinto Valleys (Lidicker 1960). By 1997, however, the SBKR was only known to occupy a total of approximately 3,247 acres (1,299 hectares) in six widely separated sites (McKernan 1997). Three sites (i.e., Etiwanda alluvial fan, Reche Canyon, Jurupa Hills) supported only small, remnant populations, while three sites (Santa Ana River and its tributaries, Lytle and Cajon creeks, San Jacinto River and Bautista Creek) had higher densities of kangaroo rats and were estimated to contain larger blocks of occupied habitat (McKernan 1997). More-recent surveys and research indicate that the SBKR may occupy a greater range of soil and vegetation types, and is more widely distributed, than previously thought (Braden and McKernan 2000, MEC 2000b).

The SBKR appears to have a strong preference for well-drained, sandy substrates where they are able to dig simple, shallow burrows (McKernan 1997, MEC 2000b). Historically, the SBKR was distributed across a mosaic of areas with sandy soils, including dry washes, braided river channels, terraces, and alluvial deposits (McKernan 1997). SBKR also occupy gravelly soils (McKernan 1993) and areas where sandy soils were at least partially deposited by winds (e.g., Jurupa Mountains; McKernan 1997). Areas with silt-clay soils appear to be associated with lower abundance of the SBKR (MEC 2000b).

The SBKR appears to reach its highest densities in areas with low to moderate (30 to 50 percent) perennial vegetative cover and greater than 40 percent bare ground, although this species can occur within areas supporting higher or lower shrub cover. Areas with a dense cover (greater than 60 percent) of nonnative annual plants and/or litter are typically either unoccupied by the SBKR or occupied at low densities. Within otherwise suitable shrub habitat for the SBKR, the percent cover of herbaceous vegetation and sand depth can range from very low to very high (McKernan 1997, MEC 2000b).

Favorable conditions for the SBKR frequently occur in Riversidean alluvial sage scrub. This vegetation type is characterized by low growing shrubs and other perennial species tolerant of a relatively sterile, rapidly draining substrate, and includes elements from chaparral, coastal sage scrub, and desert communities (Holland 1986). Three phases (pioneer, intermediate, and mature) of Riversidean alluvial sage scrub have been described. These phases appear to correlate with factors indicative of fluvial disturbance such as time since last flood with significant overbank flows, elevation and distance from the main river channel, and substrate features such as texture and moisture (Smith 1980, Hanes *et al.* 1989). Under natural conditions, flood waters periodically overtop or "break out" of alluvial river channels in unpredictable spatial and temporal patterns, scouring vegetation and transporting and depositing sands. These geomorphological processes contribute to a braided mosaic of pioneer, intermediate, and mature associations of Riversidean alluvial sage scrub on the flood plain.

High densities of the SBKR have been documented in pioneer and intermediate phases of Riversidean alluvial sage scrub, which generally correlate with areas that have been more-recently disturbed by floods (within the last 40 to 70 years; McKernan 1997; MEC 2000b). The pioneer or earliest phase has sparse vegetation with low diversity and structure. This phase is typically found within and adjacent to active river channels or recently scoured streambeds (Smith 1980, Hanes *et al.* 1989). The intermediate phase, which represents the progressive development of the Riversidean alluvial sage scrub community in terms of density and diversity, is typically found between the active river channel and mature flood plain terraces at higher elevations. Areas with intermediate Riversidean alluvial sage scrub are subject to periodic flooding at longer intervals than the pioneer phase. The mature or latest phase occurs in areas infrequently affected by flooding (e.g., upper alluvial terraces) and, as a result, has the highest structure and densest cover (Smith 1980, MEC 2000b). These areas with mature, dense vegetation are generally occupied at low densities by the SBKR, with animals found in scattered microsites (pockets or patches) with more-open shrub cover and loose, sandy soils (Braden and McKernan 2000). Such areas may be critical to the long-term survival of the species, providing a source of animals for recolonization following catastrophic floods that may drown kangaroo rats inhabiting lower areas of the flood plain.

Due to their shallow burrow systems, the SBKR generally does not persist in highly degraded habitats, such as areas that are frequently disced, graded, or inundated. However, the SBKR can recolonize some degraded areas once disturbance activities cease and the vegetation begins to recover. Also, some SBKR successfully survived translocation to a revegetated reclamation site in the Cajon Creek wash that was restored following sand mining activities and contained a complement of native rodents (O'Farrell 1999).

Few specifics are known about the life history and ecology of the SBKR because few species-specific studies have been conducted. SBKR are primarily nocturnal and active throughout the year. They reside in burrow systems, each of which appears to be occupied by a single adult. The burrow systems of many adults are often clustered in a given area. SBKR typically emerge from their burrows after sunset and may be active at any time during the night.

Though few specifics are known about the diet of the SBKR, they are granivorous and feed primarily on the seeds of grasses and forbs that they harvest from the soil. They often cache seeds in small surface pits for later consumption. This behavior may enable them to endure temporary shortages of food, as has been documented for other species of *Dipodomys* (Williams *et al.* 1993b as cited in Goldingay *et al.* 1997). Green vegetation and insects may be important seasonal food sources. The closely related Merriam's kangaroo rat is known for its ability to live indefinitely without water on a diet consisting entirely of dry seeds (Reichman and Price 1993).

Virtually nothing is known about the spatial requirements of the SBKR. In other species of *Dipodomys*, the sizes of home ranges vary owing to habitat features, season, food availability, population density, and sex. Behrends *et al.* (1986) reported that home ranges for the Merriam's kangaroo rat in Riverside County, California, averaged 0.8 acre (0.33 hectare) for males and 0.8 acre (0.31 hectares) for females. However, the sizes of home ranges for Merriam's kangaroo rats in New Mexico were much larger, averaging 4.1 acres (1.7 hectares) for males and 3.9 acres (1.6 hectares) for females (Blair 1943). Outlying areas of the home ranges of neighboring kangaroo rats may overlap, but adults actively defend small core areas near their burrows (Jones 1993). Overlap between the home ranges of neighboring male kangaroo rats, or between neighboring male and female kangaroo rats, is often extensive. In contrast, overlap between the home ranges of neighboring female kangaroo rats is usually slight (Jones 1993).

Little is known about the mating system of the SBKR. Females are capable of having more than one litter per year, and litter sizes probably average between two and three young (M. O'Farrell, Las Vegas, Nevada, as cited in MEC 2000b). Reproductive activities peak in June and July, although the SBKR appears to have a prolonged breeding season. Pregnant or lactating females have been captured between January and November, while males in scrotal condition have been captured between January and August (McKernan 1997).

No estimates of age-specific survival rates, age structures, sex ratios, or dispersal rates are available from populations of the SBKR. Definitive information on their life span is lacking. Maximum longevity in free-ranging short-nosed kangaroo rats (*Dipodomys nitratoides brevinasus*) is probably 3 to 5 years (Williams *et al.* 1993b cited in Goldingay *et al.* 1997). Free-ranging Stephens' kangaroo rats (*Dipodomys stephensi*) only lived as long as 18 months, however, and the average life span observed at various sites was only 3.7 to 7.5 months (McClenaghan and Taylor 1991). Likewise, most juvenile Fresno kangaroo rats (*Dipodomys nitratoides exilis*) do not survive to breed the following spring (Williams *et al.* 1993b cited in Goldingay *et al.* 1997).

Long-range dispersal and population expansion by the SBKR is likely hampered by the presence of other rodents owing to its small body size relative to other species. Also, it is unlikely that SBKR faced with a catastrophic disturbance such as a large-scale flood or discing activities could successfully relocate to upland or offsite refugia. Rather, the persistence of the species in such locations is likely dependent upon recolonization by dispersing animals (or their offspring) from adjacent areas that survived the disturbance.

Little is known about factors that cause mortality or adversely affect birth rates in the SBKR. The availability of suitable sites for burrows, free from winter flooding, may limit densities of kangaroo rats in some areas, especially near active river channels. Prolonged droughts of more than 1 year are known to induce rapid population decreases in kangaroo rats once their seed caches are depleted (Williams *et al.* 1993b as cited in Goldingay *et al.* 1997). A number of pathogens and parasites are associated with the genus *Dipodomys,* and these factors could be major threats under the current conditions of small, isolated and, possibly, inbred populations.

Competition and predation could pose major threats to remnant populations of kangaroo rats because they directly affect population growth rates and indirectly affect the structure of the community. Competition occurs when individuals of the same or different species utilize common resources (food, space, burrows) that are in short supply; or, if the resources are not in short supply, competition occurs when organisms seeking the resources nevertheless harm one or other in the process. Many territorial interactions ensued after Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*) were translocated into habitat that was already occupied by this species; to the detriment of the relocated animals (Goldingay *et al.* 1997).

The range of the SBKR is partially overlapped by the distribution of Stephens' kangaroo rats, and is entirely overlapped by the range of the Pacific kangaroo rat (*Dipodomys simulans*). Where these species occur in proximity, competition could occur if one or more resources became limiting. However, differences in habitat selection among these species may minimize the likelihood of competition. The SBKR primarily occurs in sage scrub habitats with open, low shrub cover and sandy soils (McKernan 1997). In contrast, the Stephens' kangaroo rat typically is associated with open, arid, grassland associations (O'Farrell *et al.* 1986, O'Farrell and Uptain 1987, O'Farrell 1990), and occurs on a variety of soil types. The Pacific kangaroo rat typically inhabits denser shrub cover on a variety of soil types.

Specific information on the types and abundances of predators that feed on the SBKR is lacking. However, natural predators of the nearby Stephens' kangaroo rats include the common barn owl (*Tyto alba*), great horned owl (*Bubo virginianus*), long-eared owl (*Asio otus*), San Diego gopher snake (*Pituophis melanoleucus annectens*), California king snake (*Lampropeltis getulus californiae*), red diamond rattlesnake (*Crotalus ruber*), southern Pacific rattlesnake (*Crotalus viridis helleri*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), badger (*Taxidea taxus*), long-tailed weasel (*Mustela frenata*), and bobcat (*Felis rufus*). Also, continued urban development and fragmentation of habitat is likely to promote higher levels of predation by urban-associated animals, as the interface between natural habitat and urban areas is increased (Church and Lawton 1987). Domestic or feral cats are known to be predators of native rodents, and predation by cats has been documented for the SBKR (R. McKernan, San Bernardino Natural History Museum, Redlands, California, unpublished data).

Populations of kangaroo rats (*Dipodomys*) are characterized by marked instability in population size, with density often varying 5-fold or more from year to year (McClenaghan and Taylor 1993, Price and Kelly 1994, Goldingay *et al.* 1997, White and Garrott 1999). A population of *Dipodomys nitratoides* in central California declined 99 percent (from 87 rats per hectare to less than one rat per hectare) in 2½ years (Goldingay *et al.* 1997). High frequency fluctuations in abundance appear to be intrinsic to many populations of kangaroo rats owing to the unpredictable weather of the desert systems they inhabit. Arid regions of California are subject to considerable environmental variation; particularly in year-to-year precipitation that occurs primarily as winter rains (White and Garrott 1999). During droughts, plant production is poor and rodents that subsist on seeds and vegetation often reproduce poorly or not at all once their seed caches are exhausted. Hence, their numbers may decrease substantially (White and Ralls 1993, Cypher and Spencer 1998). Unusually high precipitation may also contribute to catastrophic decreases in rodent populations, although the causal mechanism(s) have not been identified (U.S. Fish and Wildlife Service 1998). These rapid decreases in abundance render small populations even more susceptible to chance extinctions.

McKernan (1997) used mark-recapture sampling on 1-hectare grids to estimate the densities of the SBKR at six locations in the San Bernardino Valley over a 5 year period (1988-1993). Mean density estimates ranged from 2.6 to 31.6 animals per hectare for the six sites, and differences among sites appeared to reflect variations in environmental conditions and the amount, quality, and structure of the habitat. Sites with larger proportions of the pioneer and intermediate phases of Riversidean alluvial sage scrub had higher densities of the SBKR than sites in which fluvial actions were disrupted, Riversidean alluvial sage scrub was mature, or nonnative annual plants comprised a higher proportion of the vegetation cover (McKernan 1997). Similar results were obtained by MEC Analytical Systems (2000b) during sampling along the Santa Ana River.

The SBKR was emergency listed as endangered on January 27, 1998 (62 FR 49401) because its historic range had been reduced by approximately 95 percent. All remaining populations were threatened by habitat loss, degradation, and fragmentation from urban development, sand and gravel mining, flood control projects, groundwater recharge activities, and vandalism. Upon expiration of the emergency rule, we listed the species as endangered on September 24, 1998 (63 FR 51005).

We proposed critical habitat for the SBKR on December 8, 2000 (65 FR 77178). Primary constituent elements for the SBKR consist of those habitat components that are essential for their primary biological needs: foraging, reproducing, rearing of young, intraspecific communication, dispersal, genetic exchange, and/or sheltering. The primary constituent elements occur in areas influenced by historic and/or current geomorphological processes and areas of wind-blown sand that support Riversidean sage scrub or a mosaic of this and other associated vegetation types (coastal sage scrub, chaparral) in San Bernardino and Riverside counties. Primary constituent elements are also found in areas that provide connectivity or linkage between or within larger core areas, including open space and disturbed areas containing introduced plant species.

Loss and fragmentation of habitat for the SBKR continues as the human population increases and urbanization expands in southern California. In the 1950s, the population of Riverside and San Bernardino counties totaled approximately 400,000 people. The current population estimate for this region is approximately 1.8 million, an increase of approximately 60 percent. Forecasts by the Southern California Association of Governments indicate that the population in San

Bernardino County may reach 2.8 million by the year 2020. Approximately 339,900 houses will be built to support this population growth. Further habitat losses resulting from development or alteration of the landscape will likely have a significant adverse effect on the viability of remaining populations of the SBKR.

Sand and aggregate mining continue to destroy or degrade hundreds of acres of habitat occupied by the SBKR along the Santa Ana and San Jacinto rivers, and City, Cajon, and Lytle creeks. Also, flood control and water spreading structures have significantly altered the natural hydrology of all alluvial areas occupied by the SBKR by decreasing the magnitude and distribution of flooding, scouring, and sand transport and deposition. In the absence of flood scouring, sediments and organic matter accumulate over time and contribute to the maturation of Riversidean alluvial sage scrub, increased vegetation cover, and increased density of nonnative grasses. These conditions do not provide the open environment favored by the SBKR and, therefore, reduce the suitability of the habitat for this species. Within channelized areas, confined flood events often scour too frequently to maintain suitable habitat for the SBKR. In addition, many areas that would normally revegetate following flood events and, thereby, provide suitable habitat for the SBKR have been denuded of vegetation by ongoing flood control and maintenance activities within spreading basins and channels. Channelization also predisposes local populations of the SBKR to extirpation during large floods by drowning animals within channelized areas that confine flood waters, and eliminating or isolating upland terraces essential for recolonization. In general, groundwater recharge areas are unsuitable for the SBKR because of the periodic presence of standing water and the degradation of alluvial scrub communities. Hundreds of acres along the Santa Ana and San Jacinto rivers, and San Antonio, Etiwanda, and Lytle creeks are potentially affected by ongoing water percolation and associated activities.

The open structure of Riversidean sage scrub encourages recreational activities within these areas that threaten the survival and recovery of the SBKR. Examples of these activities include off-highway vehicle use, dumping, scavenging, and commercial collection of yucca stalks. Off-highway vehicle use directly damages plant communities, the soil crust, and the burrow systems of kangaroo rats. Trespass by off-highway vehicles continues to destroy and degrade hundreds of acres of Riversidean sage scrub communities occupied by the SBKR in and near the Santa Ana and San Jacinto rivers, and City, Plunge, Lytle, and Cajon creeks.

All remaining populations of the SBKR are at risk due to their small size. Small populations have a higher probability of extinction than larger populations because their low abundance renders them susceptible to stochastic (random, naturally occurring) events such as inbreeding, the loss of genetic variation, demographic problems like skewed variability in age and sex ratios, and catastrophes such as floods, droughts, or disease epidemics (Lande 1988, Frankham and Ralls 1998, Saccheri *et al.* 1998). These chance events can affect small populations with devastating results. Extirpation can even occur when the members of a small population are healthy because whether the population increases or decreases in size is less dependent on the age-specific probabilities of survival and reproduction than on raw chance (sampling probabilities). Due to the probabilistic nature of extinction, some small populations will survive when faced with these demographic, environmental, and genetic stochastic risks; however, many will eventually go extinct (Caughley and Gunn 1996).

Another factor that renders populations of SBKR vulnerable to stochastic events is isolation, which often acts in concert with small population size to increase the probability of extinction for endangered populations. Altered fluvial processes, urbanization, and land conversion have fragmented the historic range of the SBKR such that remaining blocks of occupied habitat now function independently of each other. Isolated populations are more susceptible to extirpation by accidental or natural catastrophes because their recolonization has been precluded. Hence, the extirpation of remnant populations during local catastrophes will continue to become more probable as land development further constricts remaining populations.

Because the status of the SBKR is precarious and declining, remaining occurrences should be secured and managed to increase the distribution and abundance of the species. Populations should be independently viable with stable or increasing numbers (exhibiting demonstrable long-term reproductive success). The natural ecosystem processes necessary to maintain viable, dynamic mosaics of habitat for the SBKR must be maintained in each conservation area. This includes a natural fluvial regime or a managed alternative that periodically results in scouring, sand transport and deposition, and plant community responses similar to those expected under a natural fluvial regime.

Santa Ana River Woolly Star

Woolly star is a short-lived, woody perennial, subshrub of the phlox family (Polemoniaceae). It has a basally branched, generally erect or spreading form, reaching 75 centimeters (30 inches) in height. The entire plant, including the inflorescence, is covered with woolly pubescence, giving it a silvery-white appearance. The inflorescence is dense and spiny bracted with about 20 flowers. The flowers have blue to violet-blue, elongate, funnel shaped corollas that are usually longer than 25 millimeters (1.0 inch), although occasionally as short as 20 millimeters (0.8 inch). The light gray-green leaves generally curve upward. The leavers are irregularly divided to the midrib into two to six narrow lobes, and are up to 50 millimeters (2.0 inches) long.

Woolly star is a pioneer species that colonizes washed sand deposits created by sporadic stream flow action. Between major flood events, these deposits typically exist as terraces above the high water mark of the river and associated braided streams (Zembal 1985). Woolly star grows primarily in Riversidean alluvial fan sage scrub habitat in sandy soils from 378 to 579 meters (1,240 to 1,900 feet) in elevation (Chambers Group 1993, Skinner and Pavlik 1994). It thrives in the nutrient poor sands of early seral stage habitat that have more than 97 percent sand (i.e., 0.5 to 2 millimeters; 0.02 to 0.08 inches) particles. The dominant species on young substrates include California buckwheat (*Erigonum fasciculatum*), scalebroom (*Lepidospartum squamatum*), fastigiate golden aster (*Heterotheca fastigiata*), and California croton (*Croton californica*). Woolly star also remains competitive on intermediate-aged substrates that have between 90 and 97 percent sand particles. The dominant species on intermediate substrates include California buckwheat, scalebroom, California juniper (*Juniperus californica*), valley cholla (*Opuntia californica* var. *parkeri* - formerly *Opuntia parryi*), and coastal prickly pear (*Opuntia littoralis*). In the few locations where woolly star occurs in mature seral stages, stands are relatively small and appear to be declining; probably because competition from shrubs and annual herbs limits the establishment of the subspecies. The dominant species on older substrates include sugar bush, holly-leaved cherry (*Prunus ilicifolia*) and chamise. Total vegetative cover at sites supporting woolly star ranges from 42 to 48 percent at younger sites and 66 to 88 percent at older sites (Wheeler 1991).

Woolly star is a short-lived perennial species. The average life span of this perennial is 5 years, with a maximum life expectancy of 10 years (Burk *et al.* 1988). Woolly star begins reproduction in the second season of growth. The blooming period is from late May through mid-August; with heaviest blooms occurring in June (Muñoz 1991, Erickson 1993), Stone 1995). Total seasonal rainfall and time of rainfall may have an effect on the time of flowering (Erickson 1993).

Woolly star is primarily an outcrosser, and depends on pollinators for dispersal because seeds typically fall within 10 centimeters (4 inches) of the parent plant (Muñoz 1991, Wheeler 1991, Jones and Burk 1996). The flowers of woolly star mature and release pollen prior to the maturation and receptivity of the stigma. Jones and Burk (1996) documented a "drastic reduction" in fruit an seed set in 1995, corresponding to a reduction in observed pollinator populations that year. Identified pollinators of woolly star are the solitary digger bee (*Micranthophora flavocinta*), giant flower-lover fly (*Rhaphiomidas acton acton*), California bumblebee (*Bombus californicus*), white -lined sphinx moth (*Hyles lineata*), the black-chinned hummingbird (*Arhilochus alexandri*), and Anna's hummingbird (*Calipte anna*) (Muñoz 1992, Erickson 1993, Stone 1995). The digger bee is an important pollinator at early seral stage sites whereas hummingbirds and the giant flower-loving fly are important pollinators at intermediate stage sites (Muñoz 1991, Erickson 1993). Also, Stone (1995) reported that the California bumblebee and giant flower-loving fly were primary pollinators in both the Santa Ana River and Cajon Creek washes; although overall pollinator assemblages differed among sites.

Burk *et al.* (1989) reported that when seeds of woolly star are wetted, the outer seed coat forms a mucilaginous mass that readily attaches the seed to the surrounding soil particles. Hence it is unlikely that woolly star efficiently disperses into new habitats unless floods carry the seeds greater distances (Burk *et al.* 1989) the optimum temperature for germination is about sixty degrees Fahrenheit and no scarification or other treatment of any kind was necessary to stimulate germination (Burk *et al.* 1989). During demographic studies in the late 1980s, seedlings germinated simultaneously with the first major autumn storms (Burk *et al.* 1989). The median survival time of woolly star seedlings was determined to be significantly longer in early seral phase sites than in older sites. Mortality oat early seral sites was not negatively correlated with seedling density, whereas at older sites mortality was density-dependent (Wheeler 1991).

Historically, habitat for woolly star likely occurred in a mosaic pattern shifting in time and space across alluvial floodplains. Woolly star habitat still exists in a mosaic pattern within remaining patches of alluvial fan scrub along the Santa Ana River and Lytle and Cajon Creeks. The pattern of distribution of subpopulations, combined with current knowledge of the genetic diversity and pollinator ecology, suggest that the subspecies functions as a metapopulation.

Wheeler (1991) determined that woolly star has a standing seed bank. Those seeds not immediately shed from the fruits are stored within the capsules. In times of flooding, long distance movement of encapsulated seeds down the floodplain is possible' thereby facilitating some gene flow between subpopulations (Wheeler 1991).

Brunell (1991) used enzyme electrophoresis to investigate genetic diversity and partition of genetic information among woolly star stands across the Santa Ana Wash. Results of this investigation indicated the population is not threatened by inbreeding, and that there was a high rate of pollen migration among subpopulations. Brunell (1991) speculated that pollinators occasionally migrate among subpopulations; thereby dispersing genes and limiting the genetic substructuring of the population . Another possible explanation for the low genetic partitioning exhibited by woolly star subpopulations in the Santa Ana wash could relate to population characteristics. Massive floods, in the past, may have caused widespread seed migration. Over time, woolly star habitat would then recede as a function of succession. Pollen exchange across the range of patches may have been extremely rare. However the genetic variation expected from isolated patches might not exist because the last major flood (population- mixing event) occurred recently on an evolutionary scale (Brunell 1991)

Woolly star was listed as endangered on September 28, 1987 (Service 1987), after we determined the remaining 10 percent of its range was threatened by encroaching developments within the floodplain, sand and gravel, grazing by domestic animals, competition from exotic plants and other factors. We determined that destination of critical habitat was warranted because such an action was unlikely to provide a net benefit to the conservation of the subspecies.

Historically, woolly star occupied about 110 kilometers (60 miles) of habitat along the Santa Ana River from an elevation of about 600 meters (2,000 feet) at the base of the San Bernardino Mountains, through Riverside County to about 150 meters (500 feet) in the vicinity of Santa Ana Canyon in Orange County. Woolly star may have occupied alluvial habitats in Orange County as far downstream as Santiago Canyon (Craig 1934, Mason 1945, Zembal and Kramer 1984). Today, the subspecies is known from one extended, fragmented population in San Bernardino County on alluvial terraces along the Santa Ana River and its tributaries (Chambers Group 1993, Skinner and Pavlik 1994). No individuals have been located Riverside or Orange Counties during recent decades (Zembal 1985).

Since its listing, the status for woolly star "has been one of continuing decline" (CDFG 1990), with land development responsible for a significant portion of the loss of habitat. Current threats include urban development, off-road vehicles, flood control activities, sand and gravel mining operations, and competition from non-native plants.

Slender-horned Spineflower

Spineflower is a diminutive annual herb of the buckwheat (Polygonaceace) family. From its basal rosette of glabrous oblanceolate leaves, spineflower has prostrate to decumbent (reclining, but rising at the growing tips) stems ascending out of a basal rosette. Initial flower stems are erect, out of which the branching stems spread openly (Reveal and Hardham 1989a,b). During its flowering period, the ruddy coloration of the stems and involucres (whorl of leaf-like structures originating below and, in this case, encompassing the flowers) is similar to other seasonal colors in the surrounding landscape. This camouflages the plant from view. During this period, the plant is most readily detected by its distinctive basal rosette, whose leaves exhibit a characteristic shade of green often tinged with red. The leaves frequently become completely reddish at maturity. Despite the striking appearance, the basal rosette is quite small, ranging form 6 to 25 millimeters (0.3 to 1.0 inch) in diameter (Ferguson *et al.* 1994). Plants are more distinguishable in the field outside the growing period when dried into a dark skeletal form.

Spineflower has broad, flat flower clusters borne on branching stems that are composed of numerous, closely congested, but solitary involucres. These cylindrical involucres are composed of six free or weakly fused lobes, each bearing a terminal and basal awn (Reveal and Hardham 1989a). It is the six hooked basal awns that distinguish spineflower and are used as a key character. Within the characteristic involucres, the minute flowers are composed of six petal-like parts, that are generally pinkish but may grade to white. The nine exerted stamens (male flower parts) bear oblong anthers (pollen-bearing tips), colored deep red to maroon, on glabrous filaments (Reveal and Hardham 1989a). The stigma (female flower part) is a rectangular box-shaped structure with four filamentous projections extending from the corners (N. Ferguson, pers. comm. 1995).

Spineflower is generally restricted to sandy terraces of floodplains and washes within the Riversidean alluvial fan sage scrub natural community. Spineflower is typically associated with the intermediate seral stage, and occurs on relatively flat (0 to 2 percent slopes) silty benches and terraces 100 to 5,000 years old (Barbour and Wirka 1997, Woods and Wells 1997). Spineflower gros primarily in sandy to gravelly soils that are slightly acidic and have low salinities, low nitrogen and phosphorus contents, low percentages of organic matter, low electrical conductivities, and low cation exchange capacities (Allen 1996, Ferguson *et al.* 1996). In the Santa Ana River wash, areas occupied by spineflower have low shrub cover and total forb and grass cover of 15 to 30 percent (Metropolitan Water District 1998). Microhabitats for spineflower are typically basins filled with silty soil and surrounded by rounded cobbles. Associated species include California juniper, California buckwheat, scalebroom, and laurel sumac (*Malosma laurina)*; although there is no consistent indicator species for spineflower. However a t least one population in Riverside County occupies an upland redshank chaparral association (S. Boyd, pers. comm., 1991). This non-typical population exists within close proximity to alluvial fan scrub (V. Jigour, pers. obs., 1994).

Recent surveys have also located spineflower in slight depressions adjacent to braided stream channels in the Santa Ana Wash (Jigour and McKernan 1992). Some of these depressions were created by scouring during the floods of 1938 and 1969. The 1938 storm was a 50-year event (a probability of happening once every 50 years) that had a peak flow approximately 1481 cubic meters per second (52,300 cubic feet per second) at the Santa Ana River near Mentone (COE 1988a). The 1969 storm was a 20-year event that had a peak discharge of 793 cubic meters per second (28,000 cubic feet per second) on the Santa Ana River at E Street near San Bernardino (downstream of Mentone) (COE 1988a). Movement of fine sediment into these depressions, upon which spineflower plants grow, may occur primar8ily by local overland flow during rain events (Wood and Wells 1997). Also, most populations of spineflower occur on microsites where the movement of fine-grained, aeolian (windblown) sediment may contribute to deposition (Woods and Wells 1997).

In some areas, spineflower occurs on or between patches of cryptogamic soils (Jigour and McKernan 1992). Cryptogamic crusts bind surface soil particles together, and are composed of associations of algae, bryophytes (mosses), lichens, xerophytic liverworts, and cyanobacteria.. These crusts are slow to recover from disturbance, and estimates for time to unaided recovery may be as high as 100 years (Belnap 1993). The reliability of this apparent association appears weak, however, because ground cover of cryptogamic crusts in areas supporting spineflower ranged from zero to 90 percent at sites throughout the distribution of this species (Allen 1996). Also Metropolitan Water District (1998) found only 3 to 17 percent cryptogamic cover in areas occupied by spineflower along the Santa Ana River alignment of the Inland Feeder Project.

Because spineflower is generally associated with undisturbed habitats on older, stabilized alluvium, this species is not resilient when faced with disturbance (Woods and Wells 1997; S. Eliason, pers. comm. 1999). Recovery occasionally occurs, however, as evidenced by a population on the Santa Wash that was destroyed during land clearing by a sand and gravel mining company in 1983. This population persisted in small colonies consisting of as few as two individuals that were dispersed across portions of the graded area (V. Jigour, pers. obs. 1990).

Spineflower is an annual species with a distinctive basal rosette that appears in March. Germination may begin in late February and continues throughout the growing season (Ferguson *et al.* 1996). Although germination does not appear to be influenced by the environment, survivorship to reproduction and subsequent seed rain appear to be strongly influenced by available moisture (Ferguson *et al.* 1996). During rainfall early in the season vegetal growth is favored; later as moisture lessons, plants produce flowering stalks without a rosette (Ferguson *et al.* 1996).

Spineflower appears to be mostly self-incompatible and an outcrosser (Ferguson *et al.* 1996). The level of genetic diversity in this species is higher than that typical for either annuals or endemics. Most of this genetic variation occurs within populations, as opposed to being partitioned among populations (Ferguson *et al.* 1996).

Little is known about the pollinators of this plant. During a late May survey of a Riverside County population, three flying insect species were observed visiting the flowers. The most abundant of these was identified as a wasp (*Plenoculus davisii*) (Ferguson *et al.* 1994). It is not known whether this or any of the other insect species observed functions as a pollinator. Seeds are tightly retained in the involucres, and up to five seeds were found in each involucre. There appears to be a moisture related mechanism for seed release (Ferguson *et al.* 1994). The longevity of spineflower seeds in the soil is unknown, but there is some evidence that it is a t least seven years (V. Jigour, pers. obs., 1990). Dormancy and germination-triggering mechanisms in the greenhouse (Ferguson *et al.* 1996).

Evidence suggest alluvial fan scrub seed banks are characteristic of desert scrub associations. In desert seed banks, "from 80 to 90 percent of soil seeds are in the upper 2 cm of soil... and of these, most are in the litter or top few millimeters of soil" (Kemp 1989). The near-surface desert seed banks commonly exhibit a clumped distribution. The seed banks are dependent on parent plant distribution and are correlated with small topographic variations. Natural depressions and wind shadows have been shown to be major locations of the soil seed bank in the Sonoran Desert near Ajo, Arizona (Kemp 1989). This pattern is similar to the distribution of spineflower populations and individual plants (V. Jigour, pers. obs., 1995).

Spineflower typically forms spatially distinct populations in small isolated areas lacking any evidence of surface disturbance on a stabilized alluvium (Wood and Wells 1997). Some patches appear to be stable in abundance over several years, varying in their density with annual precipitation, while others virtually disappear in dry years. The survivorship and fecundity of spineflower can vary substantially among years, and appear to be significantly and positively correlated with the occurrence of wet conditions (Ferguson *et al.* 1996, Wood and Wells 1997). In other words, the population dynamics of spineflower are most strongly influenced by stochastic factors such as precipitation, rather than seed rain from the previous year, the type of co-occurring species, or percent ground cover (Ferguson *et al.* 1996).

Predation of spineflower leaves has rarely been observed, but predation of floral stems was observed at all 21 sites studied by Ferguson *et al.* (1996). This type of predation occurred early in the season while the stems were still green, and the stems were bitten off close to the ground. The number of stems predated varied widely among sites and years, but generally accounted for a low percentage of the total plants (Ferguson *et al.*1996). Grasshoppers appeared to be responsible for high stem predation during 1994 at Dripping Springs in the Cleveland National Forest near Vail Lake (Ferguson *et al.* 1996). If predation occurred early in the reproductive cycle, plants grew new floral stems; although the reproductive output was undoubtably reduced as stems produced later had fewer involucres (Ferguson *et al.* 1996).

Seed dispersal mechanisms for spineflower are unknown. Patterns of flooding and plant locations observed on the Santa Ana Wash suggest that floods facilitate long range dispersal (Jigour and McKernan, 1992; Woods and Wells 1997). Given that the locations of spineflower populations remain fairly constant from year to year, seed dispersal during climatic periods without major floods is likely within occupied microsites. Wind probably functions to help disperse seeds within the vicinity of the originating population since strong Santa Ana winds generally occur during autumn and winter in this region (Woods and Wells 1997).

Spineflower was listed as endangered on September 28, 1987 (Service 1987), after we determined that the remaining 25 percent of its range was threatened by habitat loss and degradation owing to encroaching developments within the floodplain, sand and gravel mining, grazing by domestic animals, competition from exotic plants, and other factors. We determined that designation of critical habitat was not warranted because such an action was unlikely to provide a net benefit to the conservation of the species.

Spineflower is found from 700 to 2,500 feet in elevation in central and eastern southern California, adjacent to foothills of the Transverse (San Gabriel) and Peninsular (San Bernardino and San Jacinto) Ranges (Allen 1996; Wood and Wells 1997). Historic records indicate that spineflower formerly occupied the following locations:

<u>Los Angeles County</u>: Along the foothills of the San Gabriel Mountains, including Mint Canyon, Newhall, San Fernando Wash, Pacoima Canyon Wash, Limekiln Canyon (San Fernando), Big Tujunga Wash, Rubio Wash (Altadena), Santa Anita Wash, and the West Fork of the San Gabriel River.

Riverside County: Temescal Canyon, Elsinore, Vicinity of Vail Lake, Vicinity of San Jacinto (north of Hemet), vicinity of Sage (South of Hemet), along the San Jacinto River floodplain, and Bautista Canyon in the foothills of the San Jacinto Mountains.

San Bernardino County: Along the foothills of the San Bernardino Mountains, including Cajon Canyon, Arrowhead Springs, Colton, San Bernardino, City Creek, San Bernardino Valley/Santa Ana Wash, and Yucaipa Valley (Reveal and Hardham 1989a, CNDDB 1993; R. McKernan, pers. comm., 1998).

Today, spineflower is restricted eight sites in Los Angeles, Riverside and San Bernardino Counties, including the Bee Canyon tributary to the Santa Clara River, Big Tujunga Wash, the vicinity of Vail Lake, Temescal Canyon, Bautista Canyon, the San Jacinto River floodplain, the Santa Ana Wash, the Lytle Creek wash and Cajon Creek near Devore. The latter population has not been located in the past decade (Rey-Vizgirdas 1994).

Although several previously undocumented populations have been discovered since spineflower was listed as endangered, its extant distribution tin the northern part of its range (Los Angeles County) has declined substantially. Approximately 75 percent of the historical extent of spineflower populations has been extirpated by drainage modification and sand and gravel mining that caused habitat loss and fragmentation (Ferguson *et al.* 1996). Continued threats to spineflower include urban development, off-road vehicles, flood control activities, and sand and gravel mining operations (Allen 1996; Wood and Wells 1997). Another serious concern is the increasing prevalence of Mediterranean annual grasses (e.g., *Bromus* spp.) in alluvial fan scrub communities. Although spineflower can withstand some low level of exotic grass competition, a high percentage cover of non-native grass species appears to limit its presence (Allen 1996).

ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present effects of all Federal, State, or private actions and other human activities in the action area, the anticipated effects of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the effects of State or private actions that are contemporaneous with the consultation in progress (50 CFR § 402.02). According to 50 CFR § 402.02, the "action area" means all areas that will be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. Subsequent analyses of the environmental baseline, effects of the action, and levels of incidental take are based upon the action area as determined by our agency.

We have described the action area in this consultation to encompass the area of impoundment behind Seven Oaks Dam and areas of historic flow downstream of the dam. The Seven Oaks Dam action area includes three subareas. Subarea 1 includes the area behind the dam and the reservoir pool/inundation area encompassing the 100-year floodplain to an elevation of about 2,580 feet. Subarea 2 extends from the upper Santa Ana River to San Bernardino International Airport (the former Norton Air Force Base). Greenspot Road and the lower reaches of Plunge and City Creeks occur along the northern border of Subarea 2; the creeks are tributaries to the Santa Ana River. Redlands Municipal Airport, the lower reach of Mill Creek, and lands immediately south of the Santa Ana River occur along the subarea's southern boundary. Subarea 3 extends downstream from San Bernardino International Airport to the eastern or upstream limit of Prado Basin at the 566-foot elevation.

The historical distribution of the three species covered in this biological opinion apparently did not occur in Subarea 1; few occurrences, mostly for SBKR, have been found in Subarea 3. Subarea 2 is the primary area of effects from Seven Oaks Dam operations on SBKR, woolly star and spineflower. The Santa Ana River Wash (Subarea 2) is an alluvial fan formed by gravity-driven transport of sand, gravel, and rocks from the mountain slopes to the valley floors during floods and debris flows that periodically emanated from the principal drainage mouths within the action area (e.g., Santa Ana River and Mill, Plunge, and City creeks). Water percolation structures and sand mining operations have significantly altered the natural hydrology of this area by altering the magnitude and distribution of flooding, scouring, and sand transport and deposition. In the absence of flood scouring, sediments and organic matter accumulate over time and contribute to the maturation of Riversidean alluvial fan sage scrub.

San Bernardino Kangaroo Rat and its designated critical habitat

We estimated the current range of SBKR to include about 6,500 acres on the Santa Ana River alluvial fan, lower fan of Mill Creek, and lower reach of City Creek (Service, unpublished February 1998 GIS map). This range was based on records from the San Bernardino County Museum as communicated by Robert McKernan. Not all habitat within the current range is considered suitable for SBKR. The final rule to list the SBKR as endangered estimated that the Santa Ana River Wash contains about 5,224 acres, of which about 1,363 acres was considered unsuitable for SBKR due to excessive cover or disturbance. Just prior to the emergency listing for the species, the Service estimated that 3,679 acres was suitable (Service, unpublished December 1997 GIS map). Lands considered unsuitable included the active channel of the Santa Ana River, agricultural and residential land, some of the chamise chaparral, and heavily disturbed areas associated with sand and gravel mining, percolation basins, and the pervious borrow site. The areas of unsuitable habitat relative to those land and habitat types were determined by overlaying the unpublished GIS map onto the vegetation habitat base map.

SBKR are expected to occur throughout Subarea 2 west of Greenspot Road in all but the most severely disturbed habitats, including ephemeral use of the active channel (BA 2000). Relative abundance appears to be higher in pioneer and pioneer-intermediate Riversidean alluvial fan sage scrub based on available reports. That habitat generally dates from 1969 to more recent floods. Abundance in areas with intermediate through juniper-dominated Riversidean alluvial fan sage scrub exhibits considerable variability in SBKR abundance. Those habitats date from the 1860s to 1938 floods and, therefore, range from about 60 to 140 years old. Several authors, as well as the 1999 field survey, strongly suggest that non-native grasses may contribute to a lowering of the quality of habitat for SBKR within intermediate and mature Riversidean alluvial fan sage scrub successional phases. The possibility that higher elevation terraces with mature vegetation act as important refugia for the species also should be considered and is under current investigation by R. McKernan and G. Braden of the San Bernardino County Museum. SBKR abundance in chamise chaparral appears to be low based on existing reports. That habitat typically has dense grass cover (COE 1996, MEC 2000a). Narrow unvegetated channels and dirt paths that cross the chamise chaparral in some areas may contribute to some of the records of occurrence within that habitat. That habitat is thought to pre-date the major floods of the 1860s (MEI 1999).

Potential habitat for SBKR is limited downstream of Subarea 2. The transition from alluvial scrub in the Santa Ana River Wash area to a more defined channel with riparian vegetation is not abrupt, and some potentially suitable habitat extends into the upper portion of Subarea 3. SBKR have been noted at the Tippecanoe Avenue crossing with the Santa Ana River (S. Montgomery, 2000 pers. comm.). Habitat south of Waterman Avenue to 8th Street is unsuitable because of the high levels of disturbance. A small patch of potential low-quality habitat occurs directly surrounding 8th Street, but remaining downstream reaches are unsuitable because of the wet substrate.

Santa Ana River Woolly Star and Slender-horned Spineflower

Current distribution of woolly star is limited to the sand deposits of the Santa Ana River between approximately Tippecanoe Avenue at the west end of San Bernardino International Airport and the base of the San Bernardino Mountains. There also is a population between the southwest limits of the main population and where the Santa Ana River becomes channelized. Management of the WSPA includes population monitoring and experimental treatments of late-successional habitat to determine the best mechanical means of rejuvenating the habitat in the absence of a natural flood regime. A 1999 spring season survey recorded 17 spineflower sub-populations consisting of 2,622 individuals within the action area. The recent survey noted that each spineflower sub-population occupied a relatively small area (COE 1999b). Four data sets from the 1999 survey can be grouped into three general areas: Group 1 that potentially lies within the 1938 floodplain originating from Plunge Creek; Group 2 in the disturbed area within the sand and gravel mining limits; and Group 3 within the area referred to as Section 12 of the U.S. Geological Survey quad map for Redlands, California (T1S, R.3.W.).

The listed species in the action area continue to be threatened by habitat loss, degradation, and fragmentation due to sand and gravel mining operations, water conservation activities, and the alteration of ecosystem processes, particularly scouring, transport, and deposition of sediment materials caused by the dam and interim operations. Suitable habitat conditions were created over thousands of years by water transporting coarse sediments out of the mountains, depositing sediments on the fan, and scouring vegetation to create a patchwork of pioneer, intermediate, and mature conditions. Flood control and water spreading structures have significantly altered the natural hydrology of this area by decreasing the magnitude and distribution of flooding, scouring, sand transport and deposition. In the absence of flood scouring, sediments and organic matter accumulate over time and pioneer phases of Riversidean alluvial fan sage scrub are not often restored. Eventually, these communities tend to mature and become more dense, thereby eliminating the early and intermediate seral stages favored by SBKR and woolly star, while allowing establishment of non-native grasses, which may have a negative effect on spineflower. In addition, many areas that would normally revegetate following flood events, and thereby provide suitable habitat, have been denuded of vegetation by ongoing activities within spreading basins and channels.

Existing land uses in the Santa Ana River Wash in Subarea 2 include mining, water conservation and supply, flood control, and open space and habitat preserves. In 1993, representatives of numerous agencies, including water, mining, flood control, wildlife and municipal interests, formed a committee to address local mining issues. Subsequently, the role of the committee was expanded to address all the land functions within the wash. The committee began meeting in 1997 to determine how to use the land to accommodate all of these important functions.

The Service has been involved in discussions with the committee to develop a cooperative agreement among these stakeholders for land use compatible with environmental resource needs. The plan based on this cooperative agreement is known as the "Upper Santa Ana River Land Management and Habitat Conservation Plan" or "Plan B," and has not yet undergone review under either the California Environmental Quality Act or the National Environmental Policy Act. Conceptual land use "Plan B" addresses areas owned by private interests, sand and gravel mining operators, water conservation districts, as well as public owned lands, and land set-aside for environmental purposes. Section 12 (U.S. Geological Survey quad map, Redlands, T1S, R.3.W.) contains the primary land available for the plan to create, maintain, or enhance habitat for listed species. The land area addressed in "Plan B" covers approximately 5,200 acres in the Santa Ana River Wash. It is anticipated that, if it is finalized, "Plan B" or some alternate plan will coordinate and accommodate the existing ongoing activities, anticipated future planned activities, and establish habitat preserve areas. These existing and future activities include:

- Water conservation of both native and (when necessary) imported water resources for groundwater basin replenishment to augment public water supplies;
- Flood control;
- Aggregate extraction and processing;
- Protection of sensitive and listed species and habitat;
- Recreation planning of the Santa Ana River trail system.

The "Plan B" process, although it will likely be compatible with Seven Oaks Dam conservation measures, will not be used to establish or implement any of the additional conservation measures or any other measures to offset impacts to federally listed species and their habitats that may be required in this biological opinion, including any measures that might arise out of the MSHMP process.

EFFECTS OF THE ACTION

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the proposed action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time but are still reasonably certain to occur.

The action area is defined as all those areas subject to direct and indirect effects of the project. Areas subject to direct effects include all those areas within the project footprint, for example, construction vehicle access routes, staging areas, and grading areas. Indirect effects include, for example, degradation of occupied habitat through edge effects, habitat isolation, and fragmentation.

Direct Effects

On-going management actions on the WSPA and future conservation measures over the 200-acre area, as directed by the Steering Committee to enhance habitat for the woolly star could have an immediate direct adverse effect if individual plants or the seed bank are disturbed and/or destroyed during the process. However, effects will likely be of a similar magnitude on the WSPA as that of current management activities which have been covered under previous section 7 consultation; minimal impacts on the 200-acre habitat manipulation area are anticipated since those future conservation activities will be directed to areas of low woolly star density. We anticipate a net beneficial effect for woolly star from such activities in the long term, with habitat renewed to conditions more suitable for the species' persistence. Due to their low incidence of occurrence in the WSPA, and presuming the WSPA Steering Committee will not direct management activities to areas potentially occupied by SBKR and spineflower, direct effects to SBKR and spineflower are not anticipated from on-going WSPA management activities.

Additional conservation measures for spineflower and SBKR include surveys to determine population status and distribution, experimental trials to assess habitat rejuvenation techniques, and larger scale habitat manipulations to be implemented based on the results of the surveys and experimental trials. Surveys and experimental trials are not anticipated to have a significant direct effect on spineflower. While individual plants could be crushed or damaged during surveys, it is anticipated that survey personnel will be experienced with the species and will take the appropriate care during their work to avoid and minimize such damage. Habitat rejuvenation experiments and larger scale habitat manipulations may remove spineflower plants through flooding and/or spreading of sand; however, these activities will generally be undertaken in areas with no or low density of plants so few individuals would be affected.

SBKR will be affected by the additional conservation measures through trapping studies to understand population factors across the wash, during trapping to remove animals from an area where experimental or larger scale habitat manipulations will be conducted, and by dike construction, sediment spreading and/or flooding during the experimental and larger scale habitat manipulations. While animals trapped during the demographic study or for relocation outside of an area to be flooded are anticipated to be released after data on the individuals is collected, some injury or mortality may occur with trapping (e.g., exposure, attack by ants while in the trap, injury from the trap mechanism). However, the incidence of injury or mortality from trapping is anticipated to be very low, because only SBKR experienced biologists approved by the Service will be conducting the studies using Service trapping protocols. It cannot be assured that all

SBKR will be captured for relocation prior to habitat manipulation; those not trapped may be crushed by equipment spreading sediment or building dikes or drowned while in their burrows during flooding. The number of individuals affected by those activities cannot be quantified, but the loss is anticipated to be minimal since these activities will be undertaken in areas of low density of SBKR (anticipated to be 0-5 animals per hectare) and trapping and relocation of animals to an area outside of the flood area will be implemented prior to the manipulation. Thus, only animals remaining within the areas to be manipulated after relocation trapping will be impacted.

The entire 200-acre area of additional conservation measures falls within and will affect designated SBKR critical habitat. Sediment spreading and dike building by heavy equipment may bury or remove alluvial fan sage scrub and compact soils thereby removing shrub cover for SBKR and making soil unsuitable for burrows. Therefore, some constituent elements of SBKR critical habitat will be impacted by habitat manipulations. However, we anticipate that the experimental and larger scale manipulations that require sediment and dikes will replace the natural processes that would have taken place, absent the dam, to periodically rejuvenate habitat to maintain its suitability for SBKR.

Indirect Effects

If the dam was operated in the long term for flood control in the absence of the additional conservation measures, we would anticipate a decline in the quality and quantity of suitable habitat for SBKR, woolly star and spineflower. Such a decline would result from a reduction in the frequency, magnitude, and extent of flood events due to the operation of the dam. These flood events would normally serve to rejuvenate intermediate and late succession alluvial sage scrub; however, the presence of the dam and its operations will prevent flood flows from reaching at least approximately 15 percent of alluvial scrub habitats on the Santa Ana Wash area. The dam will trap sediment and release water that is relatively free of sand and gravel, thus reducing the amount and quality of sediment that is also necessary for fluvial processes. Therefore, in the absence of additional conservation measures over the life of the dam, we would anticipate that succession of habitat would have an adverse effect on SBKR and spineflower by precluding flood and scour processes necessary for rejuvenation of their habitats. In addition, flood control operation may contribute to further downcutting of the main channel of the Santa Ana River, which may limit SBKR from crossing the channel and thus hamper species dispersal.

However, the flood control operations, in the absence of the additional conservation measure of larger-scale habitat manipulations for SBKR and spineflower, will only occur for a short interim period during experimental trials and finalization of the MSHMP. Therefore, we do not anticipate loss of individuals or other significant impacts to these species this interim period.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future

Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The 2000 BA identified 17 cumulative projects in the Santa Ana River Wash, some of which have been completed in the interim. Two bridge projects would span the river at Alabama and Orange streets in the City of Redlands and may affect habitat for woolly star and SBKR. Sand and gravel mining and water conservation operations will continue in the future; these operations may adversely affect habitat for all three species. However, we anticipate that these mining and water conservation operations will be addressed through finalization and implementation of "Plan B" discussed above and, therefore, are not considered in this analysis. The City of Redlands is pursuing the necessary environmental mitigation for the bridge projects separately from the "Plan B" effort.

CONCLUSION

After reviewing the status of the species, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is our biological opinion that implementation of the proposed project is not likely to jeopardize the continued existence of woolly star, spineflower, or SBKR or adversely modify SBKR critical habitat.

We reached these conclusions by considering the following:

Direct effects to woolly star from the proposed flood control operations and additional conservation measures are anticipated to be of similar magnitude as that already occurring from management activities authorized by the WSPA Steering Committee and covered under prior section 7 consultation. Direct effects to woolly star and spineflower are anticipated to be minimal from experimental and larger scale habitat manipulation, as are direct effects to SBKR from trapping for demographic study and relocation and from experimental and larger scale habitat manipulation. The loss of SBKR that are not relocated out of the habitat manipulation areas is anticipated to be low. The indirect effects due to a lack of fluvial processes to rejuvenate intermediate and mature alluvial sage scrub will be for a short period while experimental trials are conducted and MSHMP finalized. Habitat succession is not anticipated to progress in that short a timeframe so as to make areas unsuitable for SBKR or spineflower. Over the long-term, conservation measures will replace habitat impacted and contribute to recovery of these species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act, and Federal regulations issued pursuant to section 4(d) of the Act, prohibit take of endangered and threatened species without a special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that actually kills or injures a listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an action that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), such incidental taking is not considered to be a prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

The measures described below are non-discretionary and must be implemented by COE in order for the exemption in section 7(o)(2) to apply. COE has a continuing duty to regulate the activity that is covered by this incidental take statement. If COE (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

AMOUNT OR EXTENT OF TAKE

Over the 100-year life of the project, 200 acres of SBKR habitat will be manipulated (10-20 acres every 5-10 years). This includes 169 acres of existing habitat that will lose the natural fluvial processes due to presence of the dam and an additional 31 acres that COE has agreed to include in its management area.

During population research and habitat manipulation activities it is anticipated that SBKR will be trapped or captured and released or relocated within the action area. Take of SBKR during these population studies and habitat manipulation is authorized as follows:

Service-approved biologists conducting SBKR population studies and relocation activities are authorized to capture, handle, and release individuals within the Santa Ana Wash.

We also anticipate that SBKR within the area subject to experimental and larger scale habitat manipulations that are not captured and relocated will be killed or injured during each manipulation over the 100-year life of the project. We are unable to quantify this incidental take of SBKR because not all animals will be captured and finding a dead or impaired animal is unlikely. Therefore, take of SBKR is authorized during each habitat manipulation event within the 200-acre management area for those animals remaining after relocation trapping.

EFFECT OF TAKE

In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to SBKR or adversely modify its critical habitat.

REASONABLE AND PRUDENT MEASURE

COE and/or local sponsors and their project contractors shall implement the following reasonable and prudent measure.

1. During population studies, relocation trapping and habitat manipulations, impacts to SBKR will be minimized.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the Act, COE is responsible for compliance with the following terms and conditions, which implement the reasonable and prudent measure described above.

1.1 During trapping, individual SBKR may be held for up to 1 hour after removal from the trap, and then shall be released at the capture site provided that:

a. At each survey site, traps must be located in areas that typify SBKR habitat, and placed in sufficient numbers to provide adequate coverage of suitable habitat. Trapping shall continue for a minimum of 5 consecutive trapping nights at each trap station, line, or grid, unless animals are captured, or unless an alternate trapping regime is agreed to during preparation of the MSHMP.

b. Only 12-inch Sherman or wire-mesh live traps shall be used to trap in habitats that are known or suspected to accommodate SBKR. Models 9 inches in length may be used only if they were purchased before March 13, 1990. All trap models shall be modified to eliminate or substantially reduce the risk of injury (e.g., tail lacerations or excisions) to the animals.

c. No batting shall be used in the traps, and traps must be checked at least twice per night, once near midnight and again at sunrise. Trapping shall not be conducted if the nightly low temperature is forecast to be below 50 degrees Fahrenheit or if extended wind, rain, fog, or other inclement weather make (or have made) conditions unsuitable for trapping or would unduly jeopardize the lives of the animals.

d. No mutilation marking scheme (e.g., toe-clipping, ear-clipping) is authorized. No invasive technique (e.g., PIT-tagging) is permitted, unless specifically authorized by the Portland Regional Fish and Wildlife Office. Other marking schemes (e.g., hair clipping, ear-tagging) are permitted with prior approval by the Service.

e. Traps used for trapping small mammals outside of San Bernardino County shall be sterilized before use in San Bernardino County.

f. Plastic bags shall be used only for removing SBKR from the traps (for extraction and processing). Trapped individuals shall be processed as quickly as possible to reduce stress to the animals. Under no circumstances shall the individual be kept in plastic bags beyond 5 minutes. Trapped SBKR that must be kept for longer periods of time shall be transferred into a clean, structurally sound, breathable container with adequate ventilation. At no time shall the individual be allowed to become stressed due to temperature extremes (either hot or cold).

g. Each time the traps are placed, set, and baited, the traps shall be adjusted and set by hand at a sensitivity level appropriate for capturing SBKR. When closing traps, each trap shall be visually inspected and closed by hand.

h. Translocation activities are not authorized, i.e., animals may not be translocated outside of the Santa Ana River Wash.

i. Measures to prevent inadvertently missing traps shall, at a minimum, include:

   i. All trap locations shall be identified with a unique identification code.

   ii. While checking traps, a log sheet shall be used. Each time the trap is checked, the surveyor shall note the action on the log sheet. Periodically, the surveyor shall review the log sheet to ensure that no traps were inadvertently missed.

   iii. The log sheet shall be in addition to (or incorporated into) other field notes or data sheets that are used for noting trap contents. The log sheet and field notes/data sheets (collectively, the "field documentation") shall be formatted to ensure the surveyor, trap (as identified by the unique identification code), and date/time checked are documented. Field documentation shall be available to Service personnel upon request (including during compliance inspections in the field).

   iv. In the field, all trap locations shall be marked with flagging, reflective tape, or other technique that allows the surveyor to readily locate the traps under daytime and nighttime conditions. To the maximum extent possible, the markings shall be visible at a distance of at least 5 meters (16.3 feet).

1.2 The number of individuals, of any life stage, allowed to be incidentally injured or killed during performance of SBKR population research and/or relocation trapping activities is zero SBKR in any calendar year. In the event that an individual SBKR is injured or killed, the biologist must:

a. Immediately cease the activity until re-approved by the Carlsbad Fish and Wildlife Office, which may, after analysis of the circumstances of injury or mortality, revoke or amend this approval.

b. Immediately notify the Carlsbad Fish and Wildlife Office. Within 3 working days, the biologist shall follow up such verbal notification in writing. With the written notification, the biologist shall include a report of the circumstances that led to the injury or mortality. A description of the changes in activity protocols that will be implemented to reduce the likelihood of such injury or mortality from happening again shall be included, if appropriate. The incident shall also be discussed in the annual report that is subsequently submitted.

c. Preserve any dead specimens in accordance with standard museum practices. Before expiration of the permit, all preserved specimens shall be properly labeled and deposited with one of the designated depositories. The biologist shall supply the depository with a copy of this biological opinion to validate that the specimens supplied to the museum were taken pursuant to that biological opinion.

d. The biologist is authorized to salvage all SBKR carcasses.

e. Annual reports of activities shall be submitted to the Carlsbad Fish and Wildlife Office by January 31 following each year this approval is in effect. The report shall be in the following format: (a) an introduction section addressing reasons and objectives for taking the species; (b) a methodology section addressing data collection and analysis procedures; c) a results section that summarizes the data collected, including information on any other federally listed species detected while conducting activities authorized under this permit; and (d) a conclusion section that specifically provides recommendations for recovery of the species. If no activities occurred over the course of a year, indication of such shall be submitted as an annual report. The annual report shall include, but not be limited to:

   i. Summary presentations and brief discussions of significant research results;

   ii. Maps and/or descriptions of locations sampled (1:24000, 1:2000 scale);

   iii. The results of all sampling efforts, including estimates of population sizes;

   iv. Numbers of individuals incidentally killed, including dates, locations, circumstances, and depository receiving the preserved specimen(s);

   v. Other pertinent observations made during sampling efforts regarding the status or ecology of the species; and

   vi. Planned future activities if authorized under this permit.

The reasonable and prudent measure, with its implementing terms and conditions, is designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The COE must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measure.

Disposition of Sick, Injured, or Dead Specimens: Upon locating dead, injured, or sick SBKR, initial notification must be made to Jill Terp at (760) 431-9440 within one working day of discovery. Written notification must be made within five calender days and include the date, time, and location of the animal and any other pertinent information. The location where the animal was found should be marked in an appropriate manner and photographed. Care must be taken in handling sick or injured animals to ensure effective treatment and care. Injured animals should be transported to a qualified veterinarian. Should any treated animals survive, we should be contacted regarding the final disposition of the animals. Dead specimens should be sealed in an appropriately sized container and refrigerated to preserve biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's responsibility for this species, pursuant to section 7(a)(1) of the Act.

1. We recommend that COE work with resource agencies, local sponsors, and land owners to obtain permission to manage habitat for listed species on additional lands adjacent to those that will be actively managed in the future under the MSHMP.

2. We recommend that COE work with local landowners to identify habitats that have been degraded by past COE actions or other activities and may have supported listed species and initiate 1135 and/or 206 programs to remediate such habitat.

REINITIATION NOTICE

This concludes formal consultation on the proposed action. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is reached; (2) new information reveals effects of the agency action that may adversely affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is reached, any operations causing such take must cease pending reinitiation.

We look forward to continuing our cooperation on the development of additional conservation measures. If you have any questions regarding this letter, please contact Supervisory Fish and Wildlife Biologist Jill Terp of this office at (760) 431-9440.

Sincerely,

Karen A. Evans

Karen A. Evans
Assistant Field Supervisor

cc:
Lance Natsuhara and Matthew Blinstrub, Orange County Flood Control District
David Lovell and Jim Borcuk, San Bernardino County Flood Control District
Steve Thomas, Riverside County Flood Control District

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Winston H. Hickox
Secretary for Environmental Protection

State Water Resources Control Board

Division of Water Rights
1001 I Street, 14th Floor • Sacramento, California 95814 • (916) 341-5300
Mailing Address: P.O. Box 2000 • Sacramento, California • 95812-2000
FAX (916) 341-5400 • Web Site Address: http://www.waterrights.ca.gov

Gray Davis
Governor

In Reply Refer
to:332:KDL:266.0

AUG 1 6 2001

Ms. Anne J. Schneider
Ellison, Schneider & Harris, LLP
2015 H Street
Sacramento, CA 95814-3109

Dear Ms. Schneider:

SEVEN OAKS DAM FLOOD CONTROL PROJECT - SANTA ANA RIVER

Thank you for your letter dated July 27, 2001, which provided us with additional information to determine whether a water right is needed for the Seven Oaks Dam Flood Control Project. The project you described is for the attenuation of peak flood flows only, and does not involve diversion of water to storage for later beneficial use or diversion to areas outside the Santa Ana River channel. Based on the information provided, it appears that a water right permit is not needed. However, if the project is modified to facilitate water storage for diversion after the flood season, a water right permit may be required.

If you have any questions please contact Mitchell Moody at (916) 341-5383.

Sincerely,

David R. Bunger
for Edward C. Anton, Chief
Division of Water Rights

EXHIBIT K.

DISTRICT CERTIFICATION
FOR APPROVAL OF THE
WATER CONTROL MANUAL

DISTRICT ENGINEER'S QUALITY CONTROL CERTIFICATION

WATER CONTROL MANUAL
SEVEN OAKS DAM & RESERVOIR
Santa Ana River, San Bernardino County, California

COMPLETION OF QUALITY CONTROL ACTIVITIES
The District has completed the **Water Control Manual** for **Seven Oaks Dam & Reservoir, Santa Ana River, San Bernardino County, California**. Certification is hereby given that all quality control activities defined in the Quality Control Plan appropriate to the level of risk and complexity inherent in the product have been completed. Documentation of the quality control process is enclosed. An independent review of the **Water Control Manual** has been completed. The document has been reviewed for technical and functional adequacy. Review team comments have been addressed, and appropriate revisions have been incorporated as necessary.

Robert Kwan 9-15-03	for Rose Vann 9-29-2003
Robert Kwan, PE Date Review Team Leader	Joseph Evelyn, PE Date Chief, Hydrology and Hydraulics Branch

GENERAL FINDINGS
Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, has been verified. This includes assumptions; methods, procedures and materials used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy. The undersigned recommends certification of the quality control process for this product.

for 9/29/03	9/30/2003
Robert E. Koplin, PE Date Chief, Engineering Division	Brian M. Moore Date Deputy District Engineer for Project Management

QUALITY CONTROL CERTIFICATION
As noted above, all issues and concerns resulting from technical review of the product have been resolved. The document is recommended for approval.

for RICHARD G. THOMPSON
COL, EN
Commanding

30 Sep 03
Date