RETAIN FILES

FEATURE HISTORY

EL CAPITAN DAM

VOLUME IV

STATE SUPERVISION OF DAMS

APPLICATION TO STATE

1-24-35
copy/p

Oct. 7, 1931.

To the Honorable, the Mayor and Common Council
Of The City of San Diego, California.

Gentlemen:

Pursuant to the direction of your Honorable Body as set forth in Resolution No. 56299, I proceeded to Sacramento for a conference with State Engineer Hyatt, in connection with your Resolution No. 57298 which directed the Hydraulic Engineer of the City to immediately submit to said State Engineer formal application and data necessary to securet the approval of the State Engineer on the matter of constructing a dam at El Capitan. The actual plans and specifications for such a dam were left with the State Engineer.

However, the State Engineer refused to accept the City's formal application and the fee accompanying it for the following reasons:

1. He desires a complete geological survey to be made and furnished in connection with the improvement, including a geological survey of the entire district in the vicinity of the damsite and definite report on the geology of the damsite itself.

2. A hydrographic report containing complete information on the area of the watershed, data on past runoff floods, etc., with an especially detailed and definite report concerning the size of the spillway so as to be assured of safety to an earth and rock fill dam in the event of a major flood.

3. An engineering report, preferably to be furnished separately from the data contained in the plans and specifications.

In connection with the above matter the State Engineer also intimated that it would be advisable to have furnished an engineering report on the structure by a consultant engineer.

The State Engineer indicated the desirability and his entire willingness of cooperation with The City of San Diego in the matter of pushing forward to completion and approval of the necessary data in order to enable the City to start construction. In view of the fact, however, that the structure contemplated is of an earth and rock fill type and is to be located on the main river, before any studies are made by the State Engineer's office complete and detailed information, as above outlined, must be submitted; and further, until such data is submitted his office cannot even make a preliminary report or recommendation on the structure.

In order to obtain the data necessary I am told that The City of San Diego must employ a geologist to make the geological report, and that such work will possibly take two to three weeks. I am further advised that such a report from any one of the following geologists, as well as from many others, would be acceptable: C. F. Tolman, F. L. Ransom or Dr. Chas. P. Berkey.

The State Engineer suggested that therefore as soon as the above reports have been obtained by The City of San Diego, that then the completed application could be filed and would be accepted for study and subsequent approval, if the facts so warrant.

Respectfully submitted,

C. L. Byers,
City Attorney.

CLB/M

9/6/34
copy/f

October 8, 1931

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL
OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: Resolution 57298 and Ordinance 13323
San Diego River Project, El Capitan
Reservoir Dam. Drawings and
Specifications - filing.

Gentlemen:

In compliance with the purport of Resolution No. 57298 dated September 30, 1931, reading as follows:

> "That the Hydraulic Engineer of The City of San Diego be, and he is hereby directed immediately to make and file with the State Engineer application for approval of plans and specifications for the construction of a hydraulic earth and rockfill dam, 197 ft. high above stream bed, to be constructed at El Capitan Dam site; and likewise immediately to submit to said Engineer all plans, specifications, information and data which may be required or necessary to such approval; and that said Hydraulic Engineer proceed at once to Sacramento for such purpose, taking all necessary steps to secure from the State Engineer the approval of such plans and specifications and permit to build said dam at the earliest possible date, pursuant to the terms of the Act of the Legislature, approved June 10, 1929 (Statutes of 1929, page 1505)."

supported by Ordinance No. 13323, dated October 1, 1931:

> "AN ORDINANCE APPROPRIATING THE SUM OF $7,305.00 OUT OF THE RESERVE FUND OF THE CITY OF SAN DIEGO IN PAYMENT OF FEE FOR FILING APPLICATION WITH THE DEPARTMENT OF PUBLIC WORKS, STATE OF CALIFORNIA, FOR APPROVAL OF PLANS AND SPECIFICATIONS FOR A DAM TO BE CONSTRUCTED AT THE EL CAPITAN DAM SITE."

Upon my return from Washington D.C. Friday P.M. October 2, and finding your Resolution No. 57298 and Ordinance No. 13323 as above, I immediately telegraphed to Honorable Edward Hyatt, State Engineer, Sacramento, California, for an appointment at his earliest date, to file formal application and required fee for approval of drawings and specifications for the construction of El Capitan reservoir dam.

I traveled to Sacramento Sunday October 4, accompanied by City Attorney C. L. Byers.

On October 5 A.M. there was submitted to the State Engineer the drawings and specifications for the projected El Capitan

reservoir dam, together with the necessary fee.

The State Engineer deemed it advisable, before accepting the formal application and the fee, to invite the City of San Diego to first employ a geologist of recognized ability, preferably with wide experience in Southern California and in reservoir dam foundation geology, to make a comprehensive and detailed study of the El Capitan reservoir damsite and adjacent territory and submit a report of his findings, conclusions and recommendations to the City with which to accompany the City's application for permit to construct the El Capitan reservoir dam at the site under consideration.

The State Engineer further requested that the City of San Diego employ a consulting engineer of recognized prominent ability and dependability to consider all the engineering investigations, tentative conclusions and reports which have been made by the City's engineers and used as a basis for designing the structure as set up in the drawings and specifications submitted to the State Engineer, and to make such further investigations as he may deem advisable and report his findings, conclusions and recommendations to the City.

The State Engineer further indicated a request that the City should also retain and employ the services of an outside consulting engineer thruout the construction of the dam.

The State Engineer further requested historical reports and statistics of the hydrography - annual runoff and flood runoff - of the San Diego River drainage basin tributary to the El Capitan reservoir as basis for the determination of the maximum spillway capacity which may be necessary to discharge not only the equivalent of the maximum runoff and floods which have occurred since runoff has been observed and recorded but, out of abundant caution, provide for the much greater flood runoff which may occur once in two hundred or more years. Prominent importance was attached by the State Engineer to this feature of the problem which he and his staff deemed of dominating importance to insure the safety of and other type of dam, than one of solid masonry which, if properly designed and constructed, might permit an extraordinary flood to discharge over its top without injury.

The State Engineer, in abundant cooperation, expressed the desire to have the drawings and specifications, as submitted informally, passed to him in order that he might have them before him for reference pending and including receipt and study of the reports of the City's geologist and consulting engineer.

The names of geologists of outstanding qualifications and reputations who have been generally employed by principals interested in corporate and municipal water districts in California and

by the State Engineer as consultants, were submitted to you yesterday in response to your request;

The names of some of the outstanding consulting engineers who have been employed by principals interested in corporate, municipal and water districts in California and also by the State Engineer as consultants in reporting on water conservation works and their major problems and including continued service thruout the installation of the dams, were also submitted to you.

It has been the State Engineer's practice to, in addition to requiring geological reports and the consulting engineer's reports to be made and submitted by the principals, to employ at his discretion additional geologists and consulting engineers at the expense of the State in order to further insure the life and property exposed to faulty foundation, design or construction of major reservoir dams.

The State Engineer's policy has also been to have an inspector, reporting direct to his office, resident on each of the larger structures, and frequent visits to the structures under construction are also made by the Deputy State Engineer in Charge of Division of Dams, and by Assistant Deputy State Engineers in the Division of Dams.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/p

9/6/34
copy /f

State of California
DEPARTMENT OF PUBLIC WORKS
Sacramento

Division of Water Resources
401 Public Works Building

November 21, 1931

Edward Hyatt, State Eng.
Chief of Division

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California.

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

This will acknowledge receipt of application for approval of the plans and specifications for the construction of the above dam, together with filing fee of $7,726.60. Kindly be advised that action on this application will be taken at an early date.

Receipt is also acknowledged of the following:

Complete set of revised drawings,

Detailed cost estimate,

Geological and Engineer Report on the Proposed Dam at El Capitan Dam Site Number 2 on the San Diego River by C. F. Marx and C. F. Tolman,

Record of core recovery borings,

Outline of methods of construction, and

Spillway and ponding performance.

Very truly yours,

Geo. W. Hawley
Deputy in Charge of Dams

cc-W.H. Holmes
E.W. Kramer

8/17/34
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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

Application No. D 8-7 Filed Nov. 21, 1931

APPLICATION FOR APPROVAL OF THE PLANS AND SPECIFICATIONS FOR THE CONSTRUCTION OR ENLARGEMENT OF A DAM

I, Hiram Newton Savage of 524 F Street, San Diego County of San Diego State of California, hereby made application for the approval of the plans and specifications for the construction of El Capitan Reservoir dam.

The owner of the dam is City of San Diego of San Diego County of San Diego State of California.

Is the owner a Public Utility? No.

If the owner is a corporation, give name and address of president and secretary -

The applicant is acting for the owner in the legal capacity of Hydraulic Engineer

LOCATION OF DAM

1. The dam is located on San Diego River which is a tributary of -- in San Diego County and in the NE 1/4, Sec. 7 Tp. 15 S R. 2 E, S.B.B. & M.

DESCRIPTION AND DIMENSIONS OF DAM

2. Type of dam Hydraulic fill-rock embankment. 3. Length of crest 1230 ft. 4. Height streambed to spillway crest 197 ft. 5. Height foundation of spillway crest 220+ ft. 6. Freeboard 20 ft.

7. Thickness at top 26.25 ft. 8. Thickness at bottom 1240+ ft.

9. Slope upstream 1 on 2 to 1 on 3. 10. Slope downstream 1 on 1.5 to 1 on 3. 11. Upstream facing rock hand placed on surface.

2158

12. Amount of material in dam 2,400,000± cu. yds.

13. Estimated cost $ 3,226,595.25 .

14. Spillway data 4 siphons at 4000 = 16000 cfs at normal pond level 400' overflow section ogee crest, capacity 39000 cfs .

15. Outlet data Independent wet tower 2-40" outlets about elevation 570.

16. Elevation of crest of dam 770 to top of Parapet / 750 to Spillway Crest (Sea level) above U.S.G.S. datum.

17. Area of reservoir at spillway level 1580 acres.

18. Capacity of reservoir 118,000 ac.ft.

19. Drainage area 178 (exclusive Cuyamaca reservoir drainage area) / 190 (inclusive " " " ") sq.mi.

20. Describe fish ladder None

21. State what provisions will be made to divert flood flows during construction 25 foot diameter diversion tunnel.

PRECIPITATION AND FLOOD DATA

22. Rainfall. If records of rainfall other than those published by the U. S. weather bureau are available, state the location and names of the stations and the maximum intensity of rainfall for 1, 12, 24 and 48 hours. (Use extra sheets or exhibits if necessary.)

at Cuyamaca

1-26-16	1.53"	2-16-27	12.81"	) in 24 hours
1-27-16	8.54"	2-17-27	6.35"	) in 24 hours

23. State the estimated maximum rainfall on watershed 19.16 / 12.81 / 48 inches of rain in 24 hours.

24. Flood data. If records of flood flow other than those published by the U.S.G.S. are available state: location and dates of measurements; maximum flow in cubic feet per second; duration in hours of crest flow and of the flood. (Use extra sheets or exhibits if necessary.)

Maximum discharge 1-27-16 38,000 cfs. 214 cfs per square mile

1927 flood maximum less than 1916 flood.

25. State the estimated maximum flood flow in cubic feet per second and duration of flood and of crest flow in hours.

40,000 cfs 4 hours. 50,000 cfs not exceeded with a probable frequency of once in 500 to 1000 years.

2159

GENERAL INFORMATION

26. State the purpose of the dam storage only.

27. State the use that is to be made of water Municipal.

28. Engineers H. N. Savage.

29. If the proposed dam is to be built under Federal license or permit, state what department has jurisdication.

U. S. Department of the Interior, Indian Service; U. S. Department of Agriculture, Forest Service.

30. The maps, plans and specifications and filing fee of $7,726.60 accompanying this application are a part thereof.

(SIGNED) HIRAM NEWTON SAVAGE

this 19 day of November 1931

APPROVAL OF APPLICATION NO. D 8-7, INCLUDING

THE PLANS AND SPECIFICATIONS

This is to certify that application No. D 8-7, including the general (E.H.) plans and specifications for the El Capitan dam has been examined and the same is hereby approved, subject to the following conditions.

1. Construction work shall be started within one year from date.

2. No foundation or abutments shall be covered by the material of the dam until the department has been given an opportunity to inspect the same.

Witness my hand and the seal of the Department of Public Works of the State of California

this 7th day of December 1931

EDWARD HYATT (Signature)
EDWARD HYATT, State Engineer

C I T Y O F S A N D I E G O

CALIFORNIA

B U R E A U O F W A T E R D E V E L O P M E N T

SAN DIEGO RIVER PROJECT

EL CAPITAN FEATURE

EXHIBIT "A"

PRECIPITATION AND FLOOD DATA

to accompany

APPLICATION FOR APPROVAL OF DRAWINGS AND SPECIFICATIONS

for the

EL CAPITAN RESERVOIR DAM

of the

CITY OF SAN DIEGO

October 1931

Hiram Newton Savage
Hydraulic Engineer in Charge

San Diego, California
October 9, 1931

From : Harold Wood

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Reservoir Dam
Data pertinent to El Capitan Reservoir Dam for State Engineer.

1. The following references have been selected from the "Report of H. N. Savage on San Diego Additional Water Supply 1923" and are deemed as pertinent to the El Capitan reservoir dam studies by the State Engineer.

2. Additional data references follow:

Hinds' method for determining spillway capacity
Vol. 86, Transactions American Society Civil Engineers

U.S.G.S. Water Supply Paper #426 page 52 January 27, 1916.

3. Pertinent data from Report on Additional Water Supply for the City of San Diego, by John R. Freeman, 1924 "The Freeman Report" newspaper copy.

paragraph		column	page
Choice of dam and reservoir sites		2	9
	also	3	9
Alternate trial designs for dams		4	9
Alternate trial designs for dams		1	10
Appendix No. 1 - Conditions controlling dam design on San Diego River, and estimates of cost of El Capitan No. 2		3-4	12
Special need of a core wall at El Capitan		4	12
Safety of dam against flood during construction		4	12
Safe permanent spillway		1	13
Reference to accompanying drawings		2	13
Siphon spillways		2 & 3	13
The Cuyamaca dam and reservoir		1	21
The Diverting dam		2	21

4. Drawings by John R. Freeman - considered pertinent:

El Capitan Site No. 2 - Study for highest dam practicable without flooding Cuyamaca flume — Sheet 1

El Capitan Site No. 2 - Study for dam of combined sluiced earth and rock fill of maximum height practicable without flooding flume of Cuyamaca Water Company — Sheet 2

San Diego Water Supply - studies of relation of rainfall to altitude - Diagram A-A — Sheet 25

HAROLD WOOD (Signature)
Harold Wood

HW/p

8/31/34
copy /f

October 15, 1931

Honorable Edward Hyatt
State Engineer
Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Reservoir Dam Feature. Flood and Pertinent Data, Exhibit A.

Dear Mr. Hyatt:

Accompanying this letter are flood and pertinent data marked "Exhibit A" which is intended to extend precipitation and flood data to support an application on your Form 3 which the City of San Diego proposes to formally file with you for approval of plans and specifications for the El Capitan Reservoir Dam of the City of San Diego.

The accompanying data herein is listed as follows:

References selected from "Report to the City of San Diego of H. N. Savage on San Diego Additional Water Supply dated August 8, 1923".

References selected from Report to the City of San Diego on Additional Water Supply for the City of San Diego, by John R. Freeman, 1924.

"The Freeman Report" newspaper copy

Additional references pertaining to flood potentialities of the drainage basin of El Capitan reservoir.

Copies of pertinent data as follows:

Estimated discharge of the Sweetwater River and from the Sweetwater reservoir during flood of January 1916, by J. F. Covert.

Summary of estimates of flood peak discharges, San Diego County, January 27, 1916, by J. F. Covert.

Letter from F. C. Finkle to Mr. H. C. McGlashan, May 27, 1916.

Statements by Mr. H. N. Savage on floods.

Comparison of El Capitan drainage basin and Sweetwater drainage basin.

El Capitan Spillway Capacity - Statement by John R. Freeman.

Basis for characterisitcs used in drawing anticipated flood runoff for El Capitan dam site.

Attached drawings as follows:

Sweetwater Water Company - Sweetwater Reservoir Hydrographs by H. N. Savage and J. F. Covert, May 1, 1916 - drawing S-2.

El Capitan Reservoir - flooded Area & Capacity Curves.

El Capitan Reservoir - Capacity above elevation 750.

Discharge of Sweetwater River at Sweetwater Dam - January 27, 1916.

Assumed characteristics of flood runoff of El Capitan Damsite.

Hydraulic Properties of 25 foot horseshoe tunnel.

Yours respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/p

From : Harold Wood

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan reservoir dam
Flood potentialities of the drainage basin of El Capitan reservoir.

1. ADDITIONAL REFERENCES.- The following data pertains to flood potentialities of the drainage basin of El Capitan reservoir. This data is tabulated in addition to tabulation of references made on October 9, 1931, which data was referred to your Report on Additional Water Supply, 1923 and Report by John R. Freeman, 1924.

Report of the Examination of the Dams of the Water Supply System of the City of San Diego, May 1928, by Louis C. Hill, C. R. Olberg, A. J. Wiley and C. F. Tolman.

Sweetwater Company Feature History of Repairs and Extensions to Sweetwater Water System, by H. N. Savage. The work made necessary in consequence of the unprecedented flood of January 27, 1916.

The pertinent data from this Feature History is hereto attached and consists of the following:

(a) Estimated discharge of the Sweetwater River and from the Sweetwater reservoir during flood of January 1916, by J. F. Covert.

(b) Summary of estimates of flood peak discharges, San Diego County, January 27, 1916, by J. F. Covert.

(c) Letter from F. C. Finkle to Mr. H. D. McGlashan May 27, 1916.

(d) Sweetwater Water Company - Sweetwater reservoir Hydrographs by H. N. Savage and J. F. Covert May 1, 1916, drawing S-2.

Volume 89 Transactions of the American Society of Civil Engineers, Paper 1587 by Julian Hinds, page 881. Side Channel Spillways.

Water Supply Paper 447:-

(a) San Diego River at Diverting Dam near Lakeside. Extremes of discharge 1912-1916: Maximum stage recorded January 28, 1916. (discharge 15,800 second feet)

(b) San Diego River Basin - General features - page 58.

(c) Sweetwater River Basin - General features - page 44.

Water Supply Paper 426:- Page 52, San Diego River at Capitan Grande Dam Site, near Lakeside. Maximum discharge January 27, 1916 "38,000 second feet, or 201 second feet per square mile of drainage area."

Statement of H. N. Savage in letter to D. W. Murphy dated December 12, 1929, page 2, Subject: Morena Reservoir and Spillway Performance.

> "There is no known recorded observation or indication of any flood peak runoff from any of the drainage basins in San Diego County continuing for over a period of more than two hours."

Statement by H. N. Savage in Morena Reservoir Spillway Enlargement Report and Recommendations, April 27, 1922, page 6.

> "A great variation within close geographical limits in hurricane storm precipitation and in intensity, duration and volume of runoff must be expected and provided for as was demonstrated at the time of the 1916 flood."

Rainfall records at Dulzura Summit show 9.90 inches on January 27, 1916. (See Page 224-San Diego Additional Water Supply, 1923 by H. N. Savage)

2. RECORDS OF FLOOD RUNOFF AVAILABLE ON EL CAPITAN DRAINAGE BASI
Water Supply Paper 426, page 52, gives maximum discharge in January 1916 as computed by W. S. Post at 38,000 second feet or 201 second feet per square mile of drainage area. Water Supply Paper 447, Page 59-
San Diego River at Diverting Dam near Lakeside. Extremes of Discharge.- 1912-1916: Maximum stage recorded, Jan. 28, 1916, discharge, 15,800 second feet.

3. COMPARISON OF EL CAPITAN DRAINAGE BASIN AND SWEETWATER DRAINAGE BASIN.- (See Water Supply Paper 426, pages 58 and 44).

EL CAPITAN DRAINAGE BASIN	SWEETATER DRAINAGE BASIN
San Diego River	Sweetater River
Rises on western slope of Cuyamaca Mountains	Rises on south and east slope of Cuyamaca Mountains
Flows southwesterly	Flows nearly due south for about 15 miles then west and southwest
Length above El Capitan damsite is about 16 miles	Length above Sweetwater Dam 36 miles
Area of drainage basin above El Capitan damsite including Cuyamaca ± 190 square miles	Area of drainage basin above Sweetwater dam = 186 square miles

Elevation of proposed maximum normal water surface = 750	Elevation maximum normal water surface = 235
Range of elevation of drainage basin = 5962 feet.	Range of elevation drainage basin = 6366 feet
Streambed at damsite = 553	Streambed at damsite = 149.1
Highest point in the basin is elevation 6515	Highest point in the basin is 6515
Average elevation of drainage basin above damsite is about 3000 feet	Average elevation of drainage basin is about 2200 feet
Character of basin is extremely rough and rugged	Character of basin "is not so rough as that of San Diego River basin."
"Timber is confined almost entirely to the valleys along the streams and to the higher mountain area."	"Timber is confined almost entirely to the immediate valleys of the streams and to the higher mountain regions."
"The mountain slopes are fairly well covered with brush."	"The mountain slopes are fairly well covered with brush but the lower foothills are almost bare; supporting only a sparse growth of low brush."
Maximum discharge January 27, 1916 (See Water Supply Paper 426 p. 52) 38,000 second feet or 201 second feet per square m mile of drainage area.	Maximum discharge January 27, 1916 (See Water Supply Paper 426 p. 49) 45,500 second feet or 245 second feet per square mile of drainage area.

4. EL CAPITAN SPILLWAY CAPACITY.- Notes on Sheet 2 of El Capitan Site No. 2 by John R. Freeman are as follows:

> "The siphon will keep flood level from rising above El. 750 in all but one or two greatest floods of a century. The siphon and weir combined will carry a flood double the record flood of 1916 on top of a full reservoir without overtopping dam."
>
> "Siphon Spillway, Capacity at Normal Pond level 16,000 ac. ft. per sec."

5. BASIS FOR CHARACTERISTICS USED IN DRAWING ANTICIPATED FLOOD RUNOFF CURVE FOR EL CAPITAN DAM SITE:-

(a) PEAK: 38,000 second feet same as given in Water Supply Paper 426, page 52, for flood of January 27, 1916.

Rise of Curve: Should be sharper than either curve of flood runoff assumed for Morena or curve of flood runoff at Sweetwater, January 27, 1916, because the drainage basin is much steeper and the average elevation is about 800 feet higher. This would tend to shorten the time element of the curve and thus steepen the rise.

(b) DURATION OF FLOOD PEAK.- The peak flood of January 27, 1916 at Sweetwater Dam lasted for 1 hour. - Water Supply Paper 426, page 49 Mr. Savage has statement that:

> "There is no known recorded observation or indication of any flood peak runoff from any of the drainage basins in San Diego County continuing for over a period of more than two hours."

The curve is drawn with a duration of flood peak of two hours.

(c) FALL OF CURVE.- The fall of the curve is considered to be on the same time scale as the flood runoff curve at Sweetwater Dam for the January 27, 1916 flood.

HARDLD WOOD (Signature)

Harold Wood.

HW/m

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Authority,- J. F. Covert
1/31/17

ESTIMATED DISCHARGE OF THE SWEETWATER RIVER AND FROM THE SWEETWATER RESERVOIR DURING THE FLOOD OF JANUARY 1916.

First Division, January 17 to 27, 1916:

Maximum Peak 9,322 sec. ft. Total Runoff 39,320 ac. ft.

Second Division, January 27 to 31, 1916:

Maximum Peak 45,500 sec. ft. Total Runoff 73,253 ac. ft.

Total " 112,573 ac. ft.

Maximum Discharge thru spillway and blow-offs of Sweetwater Reservoir, and		
"	" over Sweetwater Dam (3.64' depth	14,600 sec. ft.
"	" thru South Pass (after washout)	41,810 sec. ft. at Sutliff place.
Average maximum discharge of Sweetwater River for two hours preceding break of South Dam and erosion of abutment of Sweetwater Dam -		33,421.4 sec. ft.

NOTE: The rainfall at Sweetwater Dam for the storm beginning January 14, 1895 and ending January 20, was 8.25 inches; maximum peak discharge into Sweetwater Reservoir, 18,150 cubic feet per second; maximum discharge past Sweetwater Rewervoir, 6,500 sec. ft.; total runoff, 15 billion, 200 million gallons up to January 25.

H. N. Savage

8-7-17
10-15-31 - 9/5/34
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SUMMARY OF ESTIMATES OF FLOOD PEAK DISCHARGES SAN DIEGO COUNTY January 27, 1916

8/7/17
J. F. Covert

River	Location of Channel Sections	Mean Area (Sq.Ft.)	Mean Wet Perimeter (Ft.)	Mean Hydraulic Radius	Slope	Coefficient N	Coefficient C	Mean Velocity Ft.Per Sec	Discharge Sec.Ft.	Drainage Area Sq.Mil
Sweetwater	Ellis Rch.Descanso	964	164	5.9	.00595	.035	59.0	11.1	10600	43
"	Sloane Rch.Dehesa	1639	184	8.9	.0047	.035	63.5	13.1	21500	111
"	Rudolph Rch. "	2382	485	4.9	.0045	.030	65.5	9.7	23500	135
"	Jamacha Canyon	3006	410	7.3	.0057	.035	61.0	12.5	37500	172
"	Canyon Below Dam	1981	195	10.2	.0085	.045	51.0	14.95	29800	182
"	Quarry Camp #1	2508	380	6.6	.0075	.035	60.0	13.4	33600	192
"	Bonnie Brae	8824	1728	5.1	.0031	.035	57.0	7.3	64200	197
"	Linwood,1/4Sec.111	5148	1354	6.0	.0027	.035	59.0	7.5	61100	202
Sunnyside) Valley	Sutliff Ranch	4097	304	5.1	.0079	.035	56.5	11.4	46700	
San Diego	El of Rch.El Cajon	(2151	205	10.5	.0035	.030	74.0	14.2)		
		(480	118	4.1	.0035	.035	54.0	6.5)	34600	191
"	Mission Dam	5272	390	13.5	.0027	.035	67.5	12.8	67500	366
"	2 Mi.Below Mission Dam	4884	286	17.1	.0031	.040	63.0	14.5	70900	374
San Luis Rey	Oceanside - - - - - Eng.News,April 13,1916, C.H.Lee - - - - -								72000	534
"	Warner's Dam - - - from Volcan Water Company - - - - -								32700	200
Otay Creek	Otay Dam - - - - - Eng.News, April 13, 1916, by Geo. Cromwell, City Eng. --- -								23500	100

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2171

Los Angeles, Cal., May 27, 1916.

Mr. D. H. McGlashan,
District Hydrographer for California,
Hydrographic Branch U.S. Geological Survey,
Federal Building,
Los Angeles, Cal.

Dear Sir:

Referring to your conversation this afternoon, I herewith give you the following results of the flood determinations made by myself with the assistance of John F. Covert, Chief Engineer, and H. N. Savage, Consulting Engineer of the Sweetwater Water Company.

Ellis Ranch near Descanso--Mean Area, 964 Sq. Ft.; Mean Wet Perimeter 164 Ft.; Mean Hydraulic Radius 5.9; Slope .00595; Coefficient n, 0.035; Coefficient c, 59.0; Mean Velocity 11. ft. per second; Discharge 10,600 second ft.; and Area of Water Shed 43 Sq. Miles.

Sloane Ranch near Dehesa--Mean Area, 1639 Sq. Ft.; Mean Wet Perimeter 184 ft.; Mean Hydraulic Radius 8.9; Slope .0047; Coefficient n, 0.030; Coefficient c, 72.5; Mean Velocity 14.82 ft. per second; Discharge, 24,295 second ft.; Area of Water Shed 111 Sq. Miles.

Rudolph Ranch near Dehesa--Mean Area, 2382 Sq. Ft.; Mean Wet Perimeter 485 Sq. Ft.; Mean Hydraulic Radius 4.9 ft.; Slope, 0.0045; Coefficient n, 0.025; Coefficient C, 77.9; Mean Velocity 11.6 ft. per second; Discharge 27,530 second ft.; Area of Water Shed 135 Sq. Miles.

Jamacha Canyon--Mean Area, 3006 Sq. Ft.; Mean Wet Perimeter, 410 ft.; Mean Hydraulic Radium 7.3 ft.; Slope .0057; Coefficient N, 0.030; Coefficient c, 70.2; Mean Velocity 14.3 ft. per second; Discharge, 43,002 second ft.; Area of Water Shed 172 Sq. Miles.

The peak at Sweetwater Dam was determined in two ways, by adding 5-8/10% to the result at Jamacha Canyon for the difference in the drainage area, and also by computing the water at dam overflowing and otherwise discharged through outlets and breaks. Both of these methods give substantially the same result, namely, 45,500 second feet, as the peak flood at Sweetwater Dam.

On the San Diego River at Rancho El Cajon, the discharge was obtained by dividing the channel into two strips, using a different coefficient for each, as follows:

FIRST STRIP--Mean Area, 2151 Sq. Ft.; Mean Wet Perimeter 205 ft.; Mean Hydraulic Radius, 10.5 ft.; Slope .0035 ft.; Coefficient n .030; Coefficient c 74.0; Mean Velocity, 14.2 ft. per second.

SECOND STRIP--Mean Area, 480 Sq. Ft.; Mean Wet Perimeter, 118 ft.; Mean Hydraulic Radius, 4.1; Slope, .0035; Coefficient n, .035; Coefficient c, 54.0; Mean Velocity, 6.5.

The result of computing at these two areas was 34,600 second ft. discharged from drainage area of 191 Square Miles.

AT MISSION DAM--Mean Area, 5272 Sq. Ft.; Mean Wet Perimeter, 390 ft.; Mean Hydraulic Radius, 13.5; Slope, .0027; Coefficient n, 0.030; Coefficient c, 76.9; Mean Velocity, 14.7 ft. per second; Discharge, 77,390 Sec. Ft.; Area of Water Shed 366 Sq. Miles

TWO MILES BELOW MISSION DAM--Mean Area, 4884 Sq. Ft.; Mean Wet Perimeter, 286 ft.; Mean Hydraulic Radius 17.1; Slope, .0031; Coefficient n, 0.035; Coefficient c, 69.7; Mean Velocity, 16.1 ft. per second; Discharge 78,510 second ft; Area of Water Shed 374 Sq. Miles.

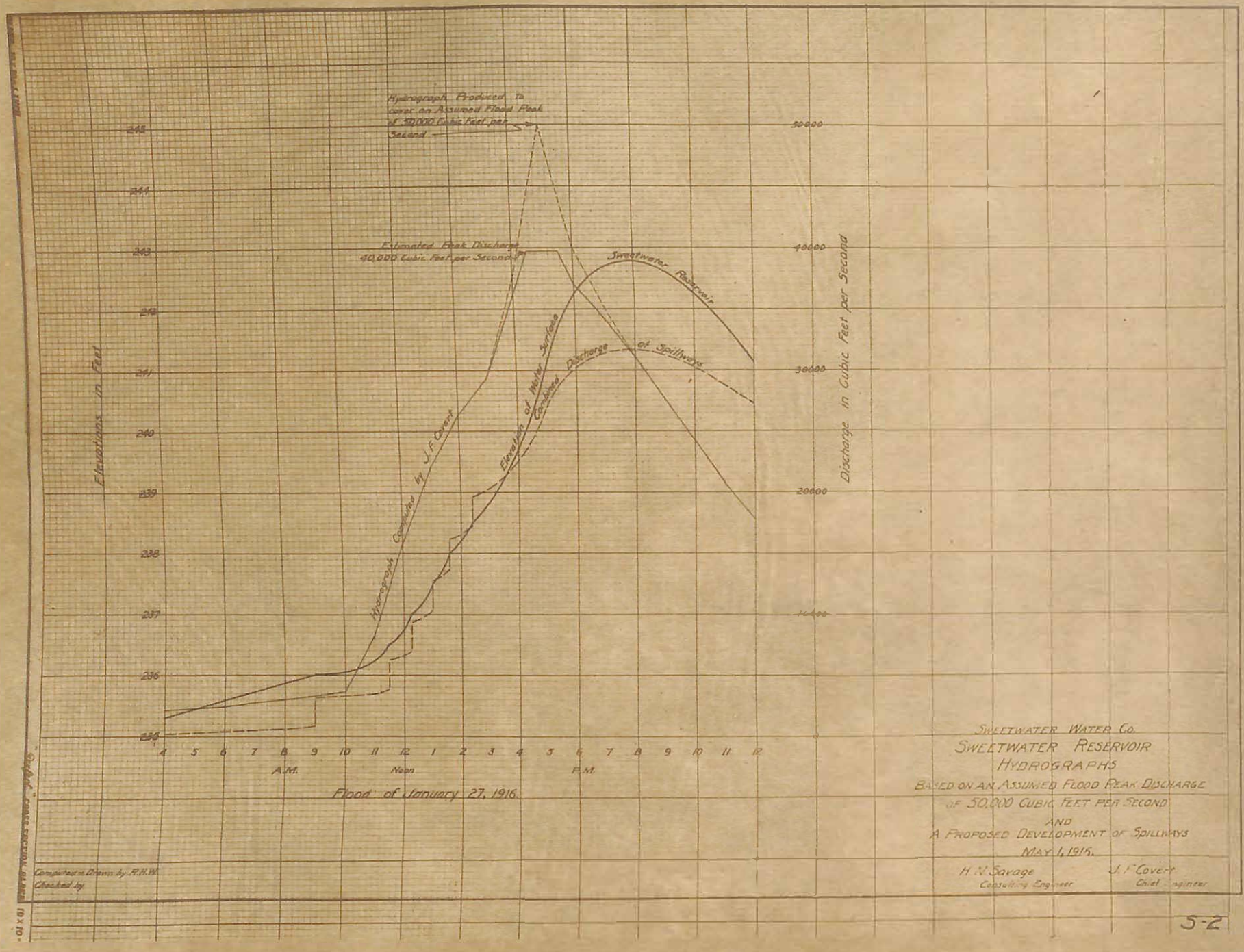
It is believed that all of the above results are closely approximate, as the records were carefully selected, and the work done with great care. The values assigned to the coefficient n were taken from experiments made by the writer, and other engineers assisting him in the measurement of floods on various rivers in Southern California, where channel conditions are the same as the points selected on Sweetwater and San Diego Rivers.

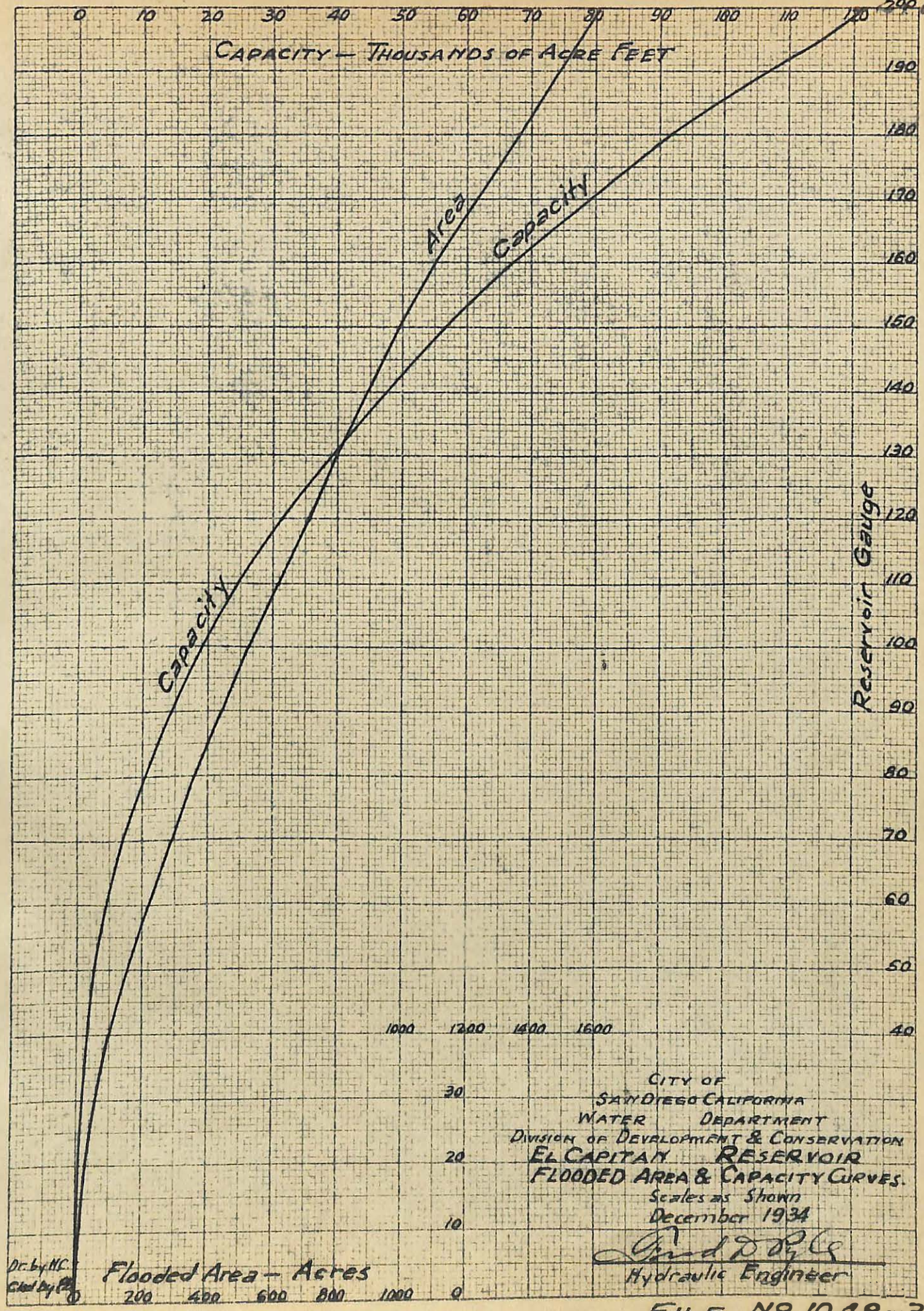
Trusting that the above information will be of service to you and that you will favor me with your own data when same is completed, I beg to remain,

Yours very truly,

F. C. FINKLE

fcf-me


Hydrograph Produced to coast on Assumed Flood Peak of 50000 Cubic Feet per Second
Estimated Peak Discharge 40,000 Cubic Feet per Second
Sweetwater Reservoir
Elevation of Water Surface
Combined Discharge of Spillways
Hydrograph Computed by J.F. Covert
Elevations in Feet
Discharge in Cubic Feet per Second
248
244
243
242
241
240
239
238
237
236
235
50000
40000
30000
20000
10000
A.M.
Noon
P.M.
Flood of January 27, 1916.
Computed & Drawn by F.H.W.
Checked by
Sweetwater Water Co.
Sweetwater Reservoir
Hydrographs
Based on an Assumed Flood Peak Discharge of 50,000 Cubic Feet per Second
and
A Proposed Development of Spillways
May 1, 1915.
H. N. Savage
Consulting Engineer
J. F. Covert
Chief Engineer
5-2
2178



Dr. by MC
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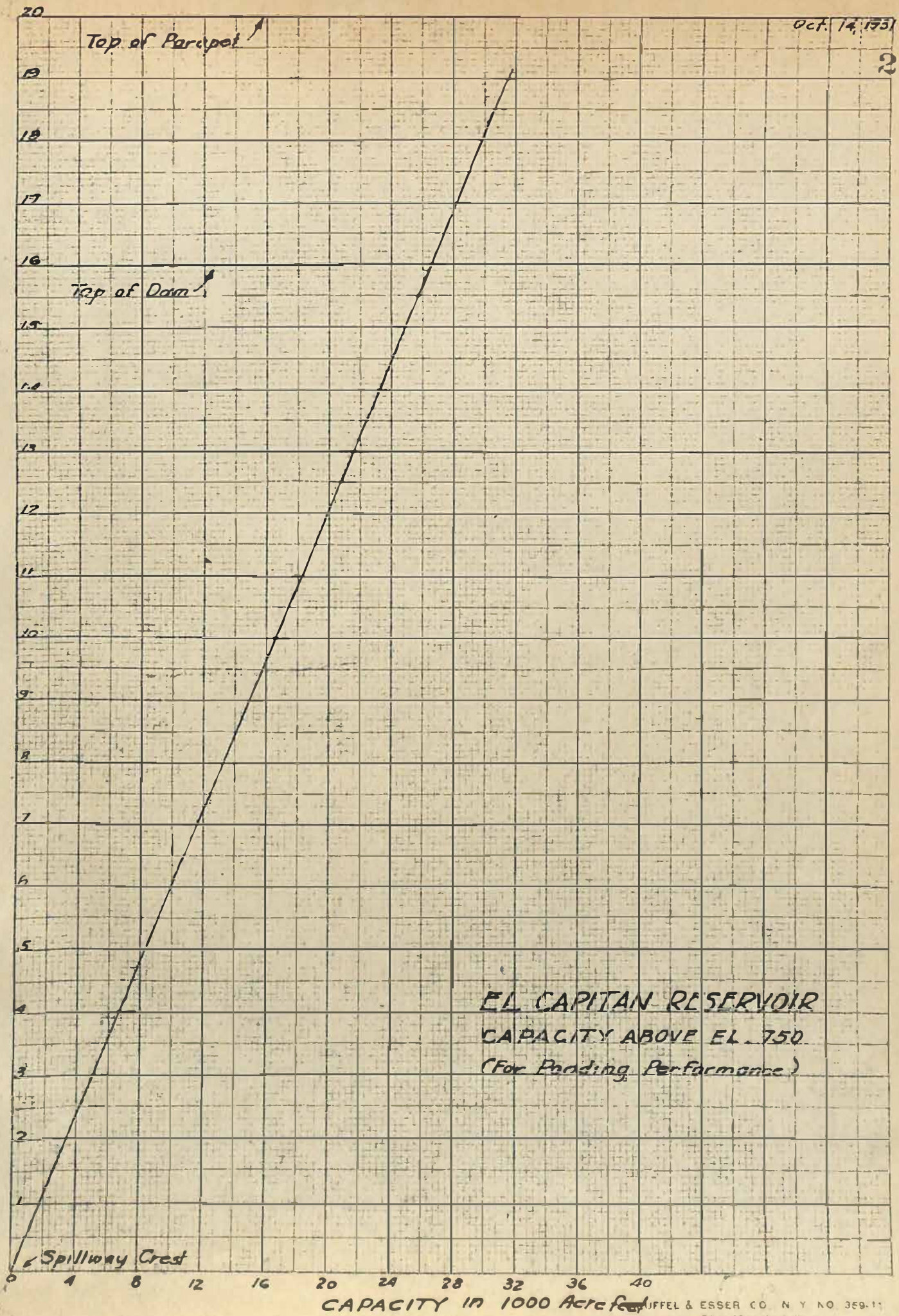
CITY OF
SAN DIEGO CALIFORNIA
WATER DEPARTMENT
DIVISION OF DEVELOPMENT & CONSERVATION
EL CAPITAN RESERVOIR
FLOODED AREA & CAPACITY CURVES.
Scales as Shown
December 1934

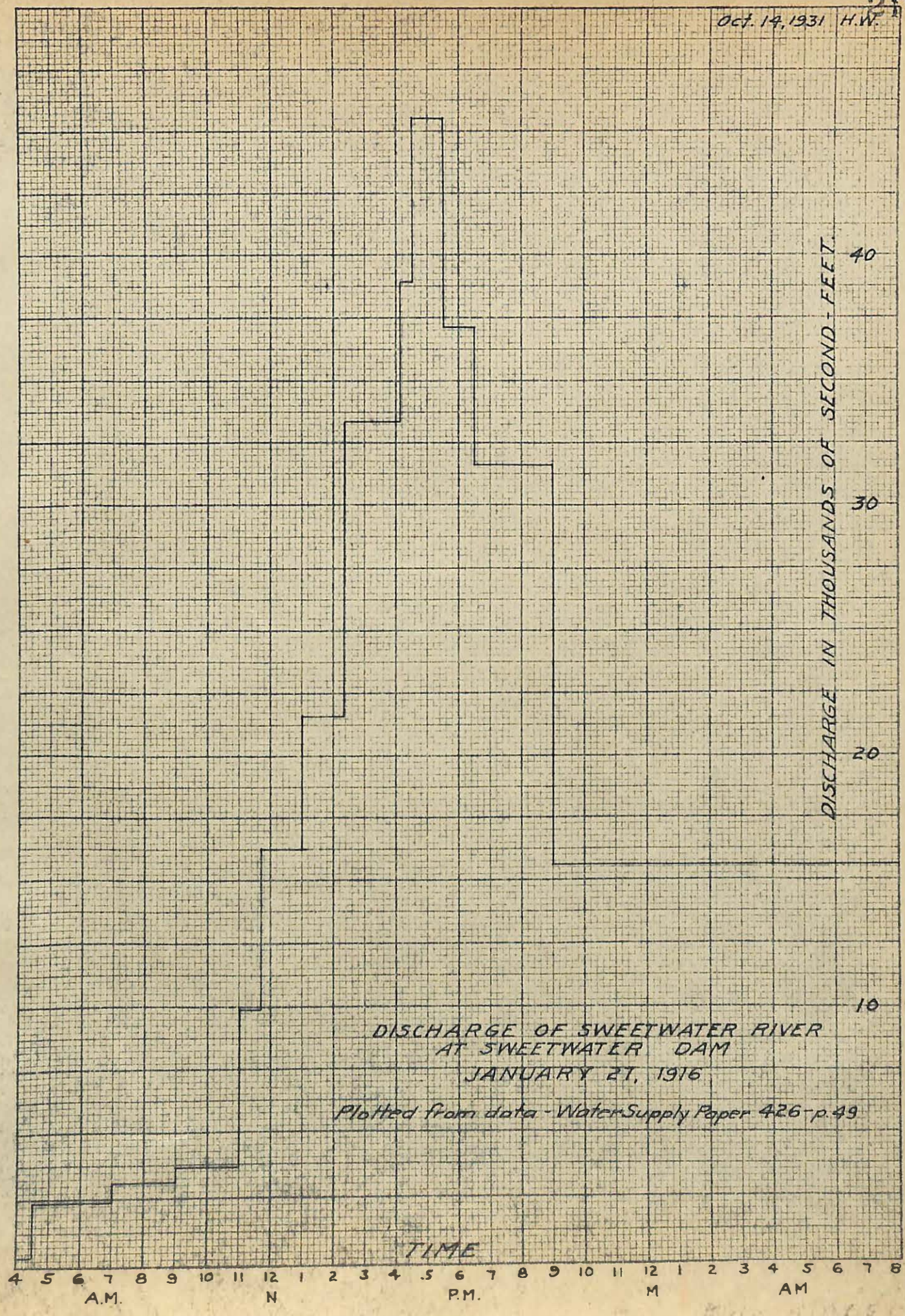
Hydraulic Engineer

FILE NO 1048-3

Oct. 14, 1931 PB

2175





DISCHARGE OF SWEETWATER RIVER
AT SWEETWATER DAM
JANUARY 21, 1916

Plotted from data - Water Supply Paper 426-p. 49

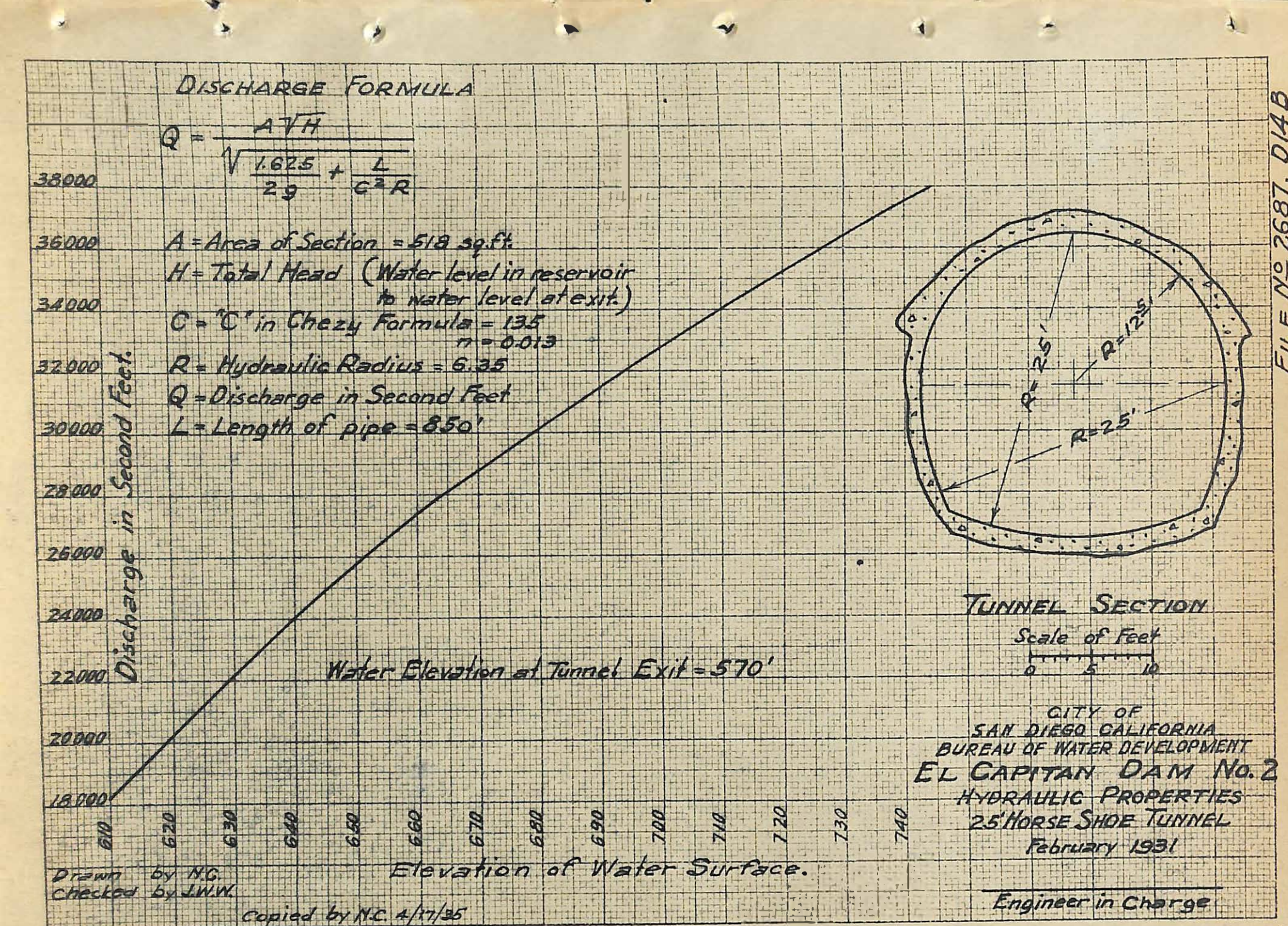
ASSUMED CHARACTERISTICS
OF FLOOD RUNOFF AT EL CAPITAN DAMSITE
TAMC 4/1/35
Time in Hours
2 4 6 8 10 12 14 16 18 20 22 24 26
10
20
30
40
50
60
Discharge in thousands of Second Feet.
January 27, 1916 Peak Flood
Runoff at El Capitan Damsite
with time element of same
Flood at Sweetwater Dam
adjusted for differences in
drainage basin characteristics.
Peak at 55,000 s.f
Oct 15, 1931 H.W.

2127

Discharge Formula

$$Q = \frac{A\sqrt{H}}{\sqrt{\frac{1.625}{2g} + \frac{L}{C^2 R}}}$$

A = Area of Section = 518 sq. ft.
H = Total Head (Water level in reservoir to water level at exit.)
C = "C" in Chezy Formula = 135
n = 0.013
R = Hydraulic Radius = 6.35
Q = Discharge in Second Feet
L = Length of pipe = 850'



Tunnel Section

Scale of Feet
0 5 10

City of
San Diego California
Bureau of Water Development

El Capitan Dam No. 2

Hydraulic Properties
25' Horse Shoe Tunnel
February 1931

Drawn by N.C.
Checked by J.W.W.

Copied by N.C. 4/17/35

Engineer in Charge

File No. 2687, 0148

82.12

SAN DIEGO RIVER PROJECT, EL CAPITAN FEATURE

Reports and Data made available to California State Engineer's office in connection with City of San Diego's application for the approval of Plans and Specifications for El Capitan Reservoir Dam, Spillway & Outlet Works.

Document No. 153128, San Diego Additional Water Supply Report of H. N. Savage, dated and filed August 8, 1923.

Notice Inviting Bids, Proposals, Drawings and Specifications El Capitan Reservoir Dam.

Extension of tables, H. N. Savage Report of August 8, 1923.

Document No. 160932, Report of John Ripley Freeman, C.E. on Additional Water Supply for the City of San Diego, California, filed May 24, 1924, including drawing sheets 1, 2 and 25.

Newspaper copy of John Ripley Freeman's Report.

Exhibit "A" Precipitation and Flood Data.

Document No. 140165, Report on Additional Municipal Water Supply San Diego River Resources, Conclusions, Recommendations, dated January 14, 1922, by H. N. Savage, Hydraulic Engineer.

Document No. 146596, Report on Additional Water Supply, San Diego River Resources, dated November 27, 1922, by H. N. Savage, Hydraulic Engineer.

C. F. Tolman's Preliminary Report on the Geology of Upper and Lower Pamo Damsites, Upper and Lower Roden Damsites, the San Vicente Damsite, and the Lower, Upper and No. 3 Damsites at El Capitan, dated August 22, 1927.

Document No. 264380, Report on El Capitan Dam Site No. 2, Foundation Geological Formation, dated December 29, 1930, by H. N. Savage, Hydraulic Engineer.

Photographs 9-15-31, Material area "A"; Material area "B"; Material area "C"

Photograph El Capitan Site, October 28, 1921.

Drawing WD-351, sheets 2 and 3.

Drawing WD-313, Sheets 1, 4 and 5

Drawing WD-290, Sheet 2

Supplementary drawings
WD-363 Spillway Plan and Sections
WD-364 Typical Retaining Wall Section
WD-367 Typical Retaining Wall Section and Core Wall Detail
WD-368 Outlet Tower

PROBABLE SIZE AND FREQUENCY OF FLOODS

AT

EL CAPITAN DAM SITE

ON

SAN DIEGO RIVER

IN

SAN DIEGO COUNTY

Prepared by
Robert L. Wing
Assistant Hydraulic Engineer

Approved by
A. D. Edmonston
Deputy State Engineer

November 23, 1931

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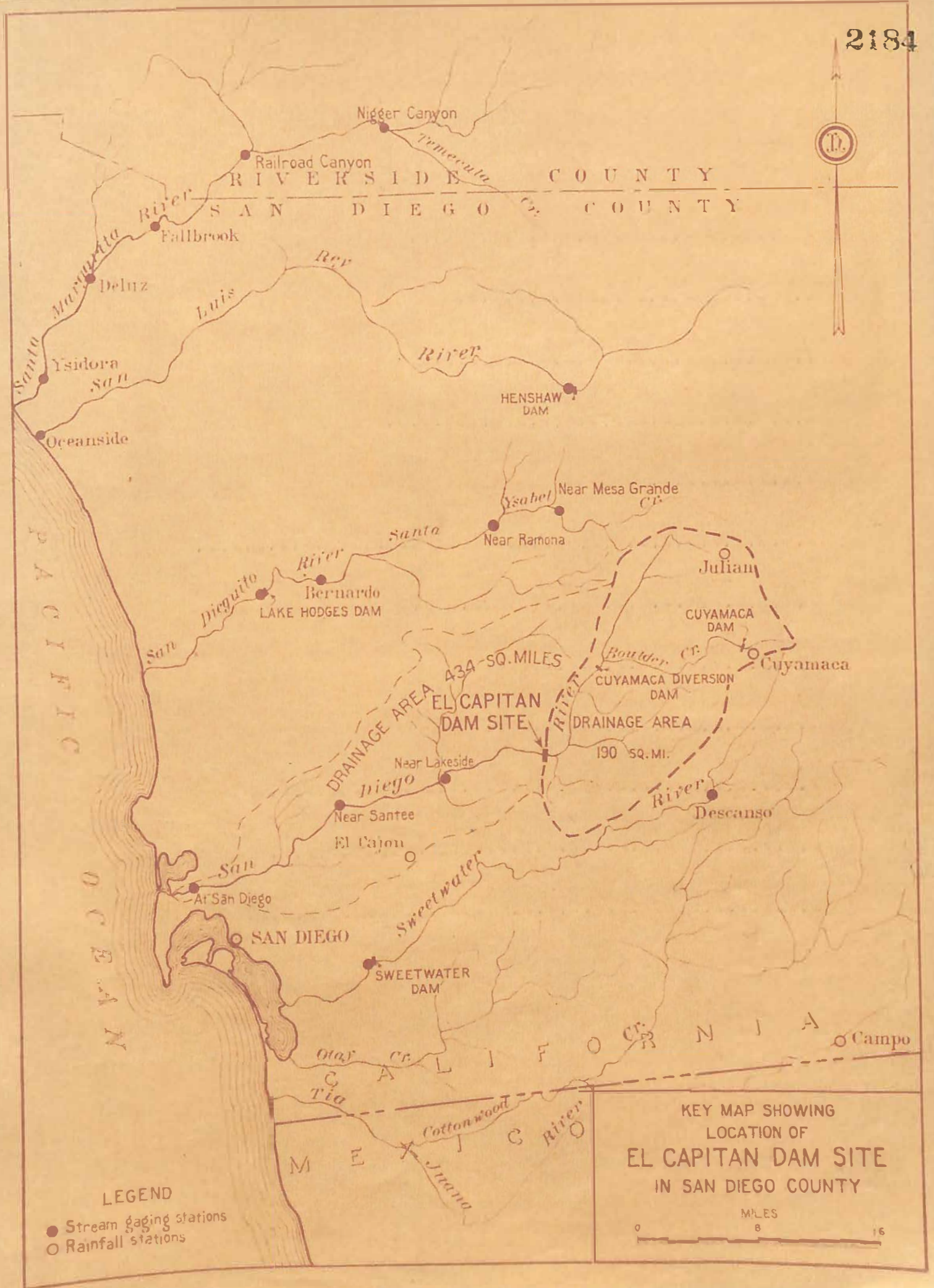

Nigger Canyon
Temecula
Railroad Canyon
RIVERSIDE COUNTY
SAN DIEGO CO. COUNTY
Santa Margarita River
Fallbrook
Deluz
San Luis Rey River
Ysidora
HENSHAW DAM
Oceanside
Ysabel
Near Mesa Grande
Cr.
Santa
Near Ramona
Julian
San Dieguito River
Bernardo
LAKE HODGES DAM
CUYAMACA DAM
Boulder Cr.
Cuyamaca
CUYAMACA DIVERSION DAM
DRAINAGE AREA 434 SQ. MILES
EL CAPITAN DAM SITE
DRAINAGE AREA 190 SQ. MI.
Near Lakeside
San Diego River
Descanso
Near Santee
El Cajon
San Diego
At San Diego
SAN DIEGO
Sweetwater
SWEETWATER DAM
Otay Cr.
Campo
Tia Juana
Cottonwood
River
MEXICO
LEGEND
Stream gaging stations
Rainfall stations
KEY MAP SHOWING
LOCATION OF
EL CAPITAN DAM SITE
IN SAN DIEGO COUNTY
MILES
0
8
16

PROBABLE SIZE AND FREQUENCY OF FLOOD FLOWS AT EL CAPITAN DAM SITE ON SAN DIEGO RIVER IN SAN DIEGO COUNTY

The study covered by this report has been directed to estimating the probable size, frequency of occurrence and characteristics of flood flows which may be expected to occur at the El Capitan dam site on the San Diego River. The information developed is to be used as a basis for determination of the adequacy of spillways designed for the proposed El Capitan dam. The report sets forth the data available, methods of analysis and results and conclusions of the study.

EL CAPITAN DAM AND RESERVOIR

The El Capitan dam site is situated on San Diego River in San Diego County, about 28 miles upstream from the mouth of the river, one mile downstream from the mouth of Chocolate Creek and eight miles above mouth of San Vicente Creek, tributaries of San Diego River. The town of Lakeside is about eight miles below the dam site. The diverting dam of the Cuyamaca flume is about eight miles above the dam site.

The El Capitan dam is a unit in a proposed project for increasing the municipally owned water supply of the City of San Diego. When completed the dam will create a reservoir with a surface area of 1,580 acres, and will store 118,000 acre-feet of water with the water surface of the reservoir at the spillway lip. The dam as proposed will be a combined rock and earth fill structure 216 feet high above streambed.

DRAINAGE AREA

The drainage area tributary to the San Diego River is 434 square miles. Of this total, 190 square miles or 44 per cent are tributary to the proposed El Capitan reservoir. The elevations of the watershed above the El Capitan dam site range from 750 feet at the dam site to 6515 feet on Cuyamaca Peak. The mean elevation of the watershed above the dam site is about 3,000 feet above sea level. The area is mountainous. The slopes are rough and rugged and are covered in most part with brush and, in some portions, tree growth is found, particularly along the streams and at the higher elevations. In the area not tributary to the El Capitan reservoir, elevations range from sea level to a maximum of 3680 feet.

DATA AVAILABLE

The information available and utilized in making the analyses for this report are:

(1) Measurements and estimates of stream flow on the San Diego River and on other Southern California streams.

(2) Testimony of inhabitants of San Diego County who have witnessed large floods on San Diego River.

The following stream flow measurements on the San Diego River taken and compiled by the United States Geological Survey are available and have been used in the study:

Stream	Location of Gage	Period of Record	Drainage Area in Sq. Mi.
San Diego River	near Lakeside	1905-1916	203
San Diego River	near Santee	1912-1930	375
San Diego River	at San Diego	1916	434
Santa Ysabel Creek	near Mesa Grande	1917-1922	53.4
Santa Ysabel Creek	near Ramona	1921-1922	110
San Luis Rey River	near Mesa Grande (Lake Henshaw)	1916-1927	209
San Luis Rey River	near Oceanside	1916	565
Temecula Creek	at Nigger Canyon	1925-1927	313
Temecula Creek	at Railroad Canyon	1925-1927	585
Santa Margarita River	at Fallbrook	1925-1927	638
" " "	at Deluz	1925-1926	695
" " "	at Ysidora	1925-1926	729

METHOD OF ANALYSIS

With the data and information from the foregoing list of sources, an analysis of the flood flows of the San Diego River at the El Capitan Dam Site was made as follows:

1. A flood frequency analysis of the flows of record on the San Diego River near Santee was made.

2. A flood frequency analysis of the flows of record on the San Diego River at Lakeside was made.

3. Factors for the conversion of the flood flows near Santee to flood flows at Lakeside were developed by a comparison of flood flows during the period of parallel record and by comparisons of areas of drainage basins.

4. A flood frequency analysis of the flows at Lakeside was made, utilizing records at both Lakeside and Santee.

5. The estimated floods at Lakeside were converted to flows at the El Capitan dam site by the ratio of the areas of the respective drainage basins.

6. An analysis of the characteristics of flood flows on streams in and adjacent to San Diego County was made and the probable characteristics of flood flows at the El Capitan dam site were estimated therefrom.

7. The flood flow characteristics developed under item 6 were applied to the mean daily flood flows, estimated under item 5, to obtain the hydrographs of flows at the El Capitan dam site.

FREQUENCY ANALYSIS OF FLOOD FLOWS OF SAN DIEGO RIVER NEAR SANTEE

The method of estimating the probable size and frequency of occurrence of flood flows of San Diego River at Santee is as follows:

1. The maximum mean daily flows of each flood of record were listed in the order of their magnitude.

2. The number of times or days mean daily flows of a given size or larger have occurred in the period of stream flow record was converted into the number of times such a mean daily flow would have occurred in 100 years by the ratio of the period of record to 100 years.

3. The values of mean daily flows in second-feet were then plotted on double logarithmic paper in accord with their proper frequency.

4. A smooth line was then drawn averaging the plotted points and extended beyond the plotted data, delineating the trend of the data and thus furnishing the probable size of mean daily flows at any desired frequency within the limits of the graph.

Records of flow near Santee are available for the period from 1912 to 1930. Unfortunately the records for the large floods of January 17th and 27th, 1916 were lost. However, the United States Geological Survey gives the following estimates of flow near Santee and at San Diego in Water Supply Paper No. 426.

"San Diego River near Santee, California

Maximum discharge in January, 1916 - On March 12, 1916 a cross section was taken 450 feet above the dam. The channel which is in sand, is straight for some distance above and below the section measured for slope. The high water removed practically all brush and trees along both banks and left the channel clean and smooth. It is believed that the remains of the old Mission dam acted as a control and prevented, at least to a considerable extent, the scour that would otherwise have occurred in the bed of this stream. On this account no allowance for scour has been made in computing the area at maximum stage.

The maximum gage height at the dam was 25.1 feet. The discharge is estimated as follows: Width, 310 feet; wet perimeter, 320 feet; area, 4,200 feet, hydraulic radius, 13.1; slope of water surface on March 12, 1916, 0.0037 (for 875 feet). If the value of n in Kutter's formula is assumed as 0.03, the discharge was 70,200 second feet,---."

"San Diego River at San Diego, California

Maximum discharge in January, 1916. The discharge was estimated at 75,000 second feet---."

Accuracy

"Daily discharge reported was computed from a hydrograph drawn through the discharge measurements and conforming in general shape with that determined for San Luis Rey River at Oceanside. The crest discharge on January 27, 1916 was estimated from the computed maximum discharge at Mission dam. Results considered fair."

The mean daily discharge for January 27th is given as 38,000 second feet and for January 17th as 13,400 second feet.

Assuming the relation of the crest flow to the mean daily flow at Santee was the same as that at San Diego for the flood of January 27th, 1916, the mean daily flow at Santee would have been about 35,000 second feet. If the relation of the flood of January 17th to the flood of January 27th at Santee is assumed as the same as at San Diego, the mean daily flow at Santee of January 17th would have been about 12,500 second feet.

In Table I, the maximum mean daily flows of each flood in excess of 1000 second feet are listed in the order of their magnitude together with the corresponding frequencies with which they might be expected to be exceeded for both the 18-year period record and of 100-year period. These floods have been plotted on Plate II and the frequency curve drawn.

The probable flows at selected frequencies as indicated by this curve are listed in Table II.

TABLE I

FREQUENCY OF OCCURRENCE OF MEAN DAILY FLOOD FLOWS
OF SAN DIEGO RIVER NEAR SANTEE

Drainage Area - 375 square miles
Period of Record, May 1912 - September 1930

Date of Flood	Mean daily flow in second feet	Frequency with which values will be equalled or exceeded: In period of record 18 years	Frequency with which values will be equalled or exceeded: In 100 years	Date of flood	Mean daily flow in second feet	Frequency with which values will be equalled or exceeded: In period of record 18 years	Frequency with which values will be equalled or exceeded: In 100 years
January 27,1916	35,000±	1	5.6	April 9,1922	472	30	167
February 16,1927	19,400	2	11.1	April 16,1917	430	31	172
December 26,1921	15,400	3	16.7	March 31,1927	430	32	178
January 17,1916	12,500±	4	22.2	May 5,1930	430	33	183
March 12,1918	5,350	5	27.8	March 31,1927	395	34	189
April 6,1926	4,240	6	33.3	April 12,1927	340	35	194
February 11,1915	3,410	7	38.9	March 16,1930	337	36	200
February 21,1914	2,300	8	44.4	March 11,1915	310	37	206
May 5,1915	2,120	9	50	January 20,1919	308	38	211
February 2,1915	1,840	10	56	April 17,1920	271	39	217
March 4,1927	1,820	11	61	December 10,1926	257	40	222
March 17,1922	1,500	12	67	May 10,1922	228	41	228
February 10,1922	1,440	13	72	March 30,1916	215	42	233
January 31,1922	1,260	14	78	March 4,1923	207	43	239
March 23,1922	1,160	15	83	May 8,1927	193	44	244
January 22,1922	1,160	16	89	April 19,1926	177	45	250
February 21,1922	1,080	17	94	May 9,1930	169	46	256
December 21,1921	1,050	18	100	February 18,1917	158	47	261
February 23,1917	980	19	106	January 2,1917	155	48	267
March 27,1920	934	20	111	April 5,1929	153	49	272
January 27,1914	930	21	117	December 25,1916	147	50	278
March 10,1927	890	22	122	January 10,1917	136	51	283
March 12,1922	846	23	128	January 31,1923	134	52	289
February 23,1920	775	24	133	December 14,1922	130	53	294
March 1,1915	738	25	139	February 14,1923	127	54	300
January 7,1922	650	26	144	March 10,1917	116	55	306
January 27,1922	622	27	150				
February 21,1915	530	28	156				
March 20,1918	475	29	161				

2190

Plate II

2191

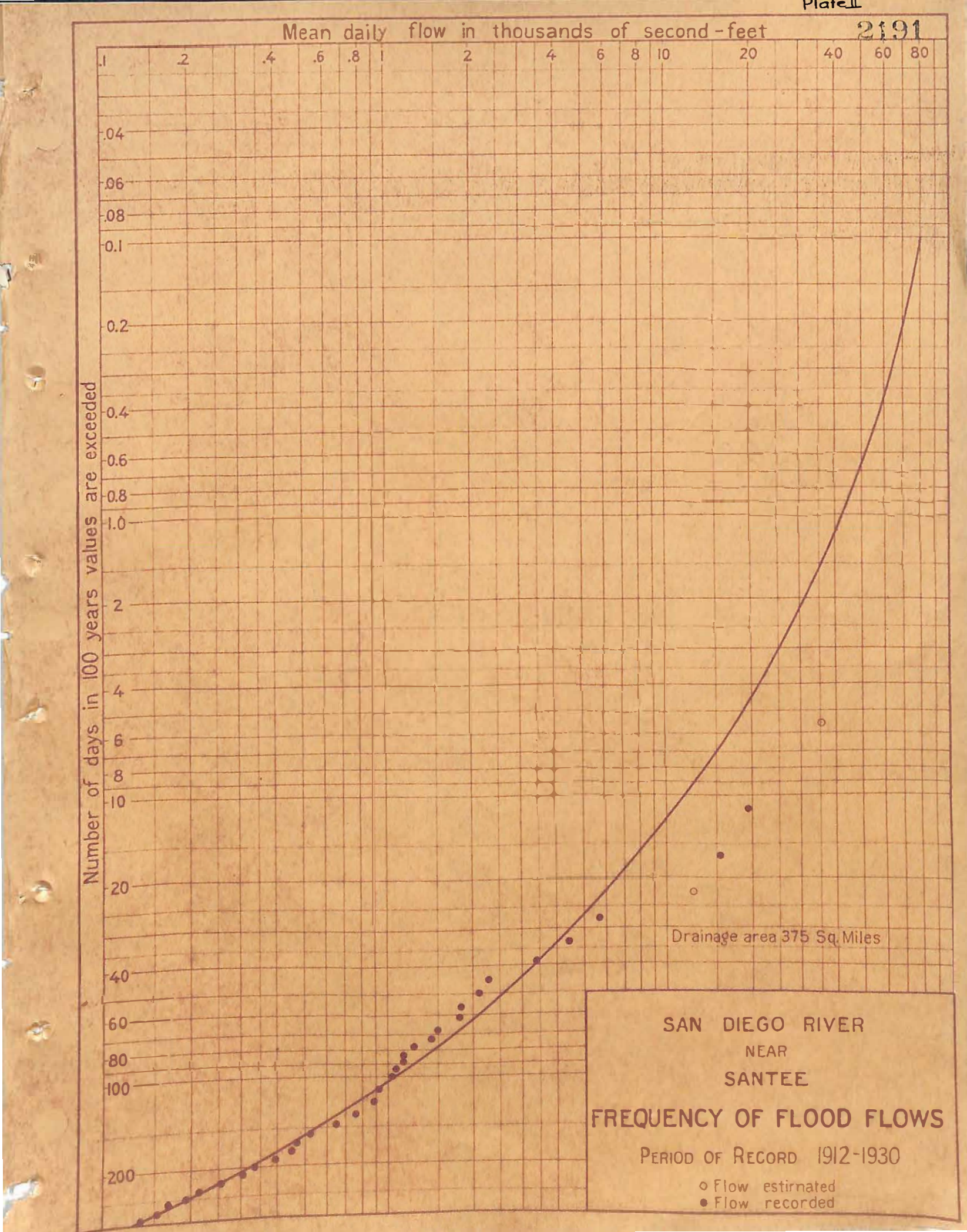


TABLE II

PROBABLE SIZE AND FREQUENCY OF MEAN DAILY FLOOD FLOWS
OF
SAN DIEGO RIVER AT SANTEE

(Data taken from flood frequency curve on Plate II)

Frequency with which values are exceeded	Probable mean daily flow in second-feet
1 in 1000 years	80,000
1 in 500 years	71,000
1 in 100 years	42,500
1 in 50 years	31,500
1 in 25 years	21,500
1 in 10 years	12,000

FREQUENCY ANALYSIS OF FLOOD FLOWS OF SAN DIEGO RIVER AT LAKESIDE

Records of the flood flows near Lakeside are available for the period from 1905 to 1916. The records for the large floods of January 17th and 27th, 1916, at this point also were lost. However, the United States Geological Survey gives the following estimates of flood flow at the Capitan Grande Dam Site, drainage area, 189 square miles:

"Maximum discharge in January, 1916."

'J. F. Covert, Chief Engineer, Sweetwater Water Company, measured cross sections and slope at this point and computed the maximum discharge as follows:'

'First section - Mean area, 2151 square feet; mean wet perimeter, 205 feet; mean hydraulic radius, 10.5; slope 0.0035; assumed value of n in Kutter's formula, 0.03; coefficient c, 74; mean velocity, 14.2 feet per second.'

'Second section - Mean area, 480 square feet; mean wet perimeter, 118 feet; mean hydraulic radius, 411; slope, 0.0035; assumed value of n in Kutter's formula, 0.035; coefficient c, 54; mean velocity, 6.5 feet per second.'

"Total discharge, 34,600 second feet' ----.

'W. S. Post, consulting engineer for Cuyamaca Water Company, obtained the following flood data at approximately the same location; Width, 187 feet; wet perimeter, 196 feet; area, 2020 square feet; hydraulic radius, 13.4; slope, 0.0035 (in 1600 feet). If the value of n in Kutter's formula is assumed as 0.035 the discharge is 38,000 second feet".

An average of these two values would indicate a flow of approximately 36,300 second feet, about one-half as large as the corresponding estimated flow at Santee. Applying this ratio to the estimated mean daily flows at Santee indicate mean daily flows of about 18,000 second feet on January 27th, 1916 and about 7,000 second feet on January 17th, 1916 near Lakeside. Although these values are only approximate, they serve to indicate the probable position those floods should be placed in the list of floods arranged in order of magnitude.

Since the eleven year period of record (1905-1916) at Lakeside is rather short, an effort has been made to extend this record by comparison with the flood flows at Santee, thus increasing the period of record at Lakeside from eleven years to twenty-five years (1905-1930).

The Lakeside gaging station as shown on the Plate I is about 8 miles downstream from the El Capitan Dam Site and above the mouth of San Vicente Creek. The drainage area comprises 203 square miles of an average elevation of about 2850 feet above sea level. The Santee gaging station measures the runoff from an area of about 375 square miles of an average elevation of about 1950 feet above sea level. The average elevation of the 172 square miles of drainage area between Lakeside and Santee is about 900 feet above sea level.

In selecting a factor for use in converting the flood flows at Santee to flood flows at Lakeside, consideration has been

given to comparisons of flood flows of record at these two points, areas of the respective drainage basins and precipitations on the two tributary drainage basins.

In Table III the flood flows at Lakeside and at Santee for the period of parallel record (1912-1916) have been compared, and ratios of flood flows computed. These ratios indicate that the flood flows at Lakeside average from about 48 to about 63 per cent of the flood flows at Santee. The minimum value is 40 per cent and the maximum 103 per cent. The values are based on comparatively small flood flows. It might be expected that a larger percentage of the flow would be lost in the gravels of the stream channel between the two stations in smaller floods than in larger floods. Consequently a ratio based on small flows should show a higher percentage of flow originating above the upper station than a ratio based on larger floods. In Table III the average percentage, based on all the floods considered, of the flood flow at Santee originating above Lakeside is 63 per cent, but the average percentage, based on the five largest floods only, is 48 per cent. In the flood of January 27th, 1916 the percentage, based on estimated crest flows, was about 50 per cent.

TABLE III

COMPARISON OF FLOOD FLOWS OF SAN DIEGO RIVER
AT LAKESIDE AND NEAR SANTEE

Date of Flood	Mean Daily Flow in Second Feet at Lakeside	near Santee	Ratio of Flows at Lakeside to Flows at Santee
January 27, 1914	908	930	0.98
February 21, 1914	922	2,300	0.40
January 30, 1915	910	2,060	0.44
February 3, 1915	911	1,840	0.50
February 11, 1915	1,580	3,410	0.46
February 21, 1915	282	530	0.53
March 3, 1915	288	660	0.44
April 23, 1915	442	430	1.03
May 5, 1915	1,300	2,120	0.61
May 18, 1915	250	269	0.93
Mean ratio			0.63
Mean ratio of 5 largest floods			0.48
Maximum ratio			1.03
Minimum ratio			0.40

A second comparison based on the ratio of the 375 square miles of drainage area above Santee to the 203 square miles of drainage area above Lakeside indicates that the flows at Lakeside should average about 54.1 per cent of the flows at Santee.

A third comparison, based on the ratio of the drainage areas with the areas of the valley lands deducted, 322 square miles at Santee and 188 square miles at Lakeside, indicates that the flows at Lakeside should average about 58.4 per cent of the flows at Santee.

In Table IV are listed the fifty-year mean seasonal precipitations for stations in or adjacent to the San Diego River drainage basin. These fifty-year means were taken from Bulletin No. 5, "Flow in California Streams," State of California, Department of Public Works, Division of Engineering and Irrigation.

TABLE IV

Fifty-Year Mean Seasonal Precipitation
in
San Diego River Drainage Basin

Station	Elevation in feet above sea level	Fifty-year mean seasonal precipitation in inches
Cuyamaca	4667	38.80
Julian	4500	32.10
Descanso	3400	25.40
El Cajon	482	13.70
San Diego	87	9.94

In Table V are listed the 20 largest daily valust of precipitation at each of the four stations, Cuyamaca, Julian, El Cajon and San Diego, together with the corresponding precipitation values at Descanso. These values are taken from records furnished by the United States Weather Bureau.

TABLE V

COMPARISON OF MAXIMUM DAILY PRECIPITATION AT STATIONS WITHIN THE SAN DIEGO RIVER DRAINAGE BASIN

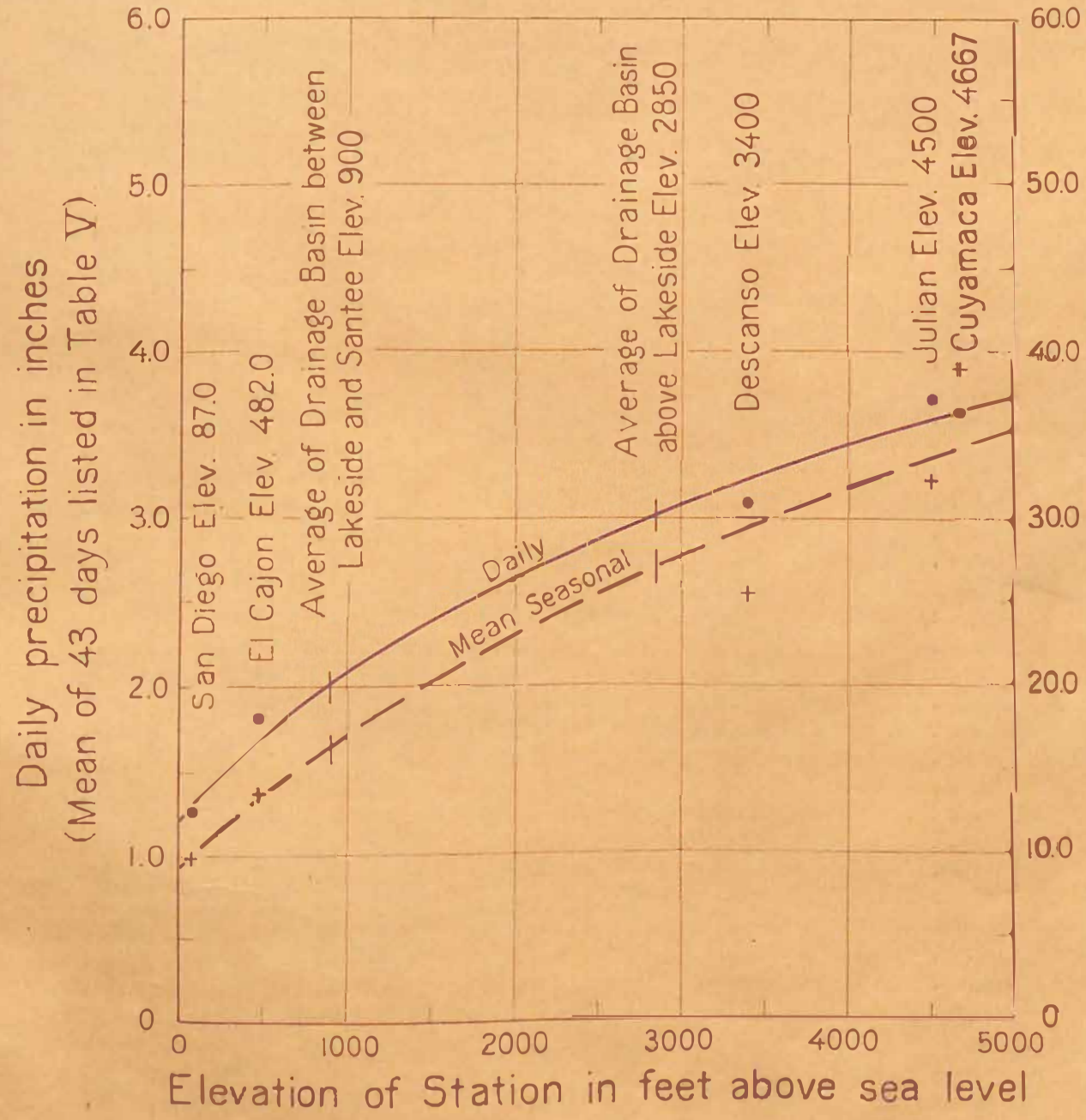
The 20 largest daily values of record (1899-1930) at each station are indicated by asterisks.

Date	Daily Precipitation in Inches at Cuyamaca Elev. 4667 feet	Julian Elev. 4500 feet	Descanso Elev. 3400 feet	El Cajon Elev. 482 feet	San Diego Elev. 87 feet
Feb. 9, 1901	2.22				2.39*
Feb. 26, 1902	4.22*			1.89*	1.14
Dec. 17, 1902	.80			.86	1.76*
Feb. 2, 1905	2.18			1.67	1.64*
Mar. 17, 1905	3.98			1.11	.98
Nov. 5, 1905	3.30			1.50	1.69*
Mar. 24, 1906	7.48*			2.65*	2.36*
Jan. 22, 1909	5.13*			2.48*	1.08
Jan. 23, 1909	4.09*			.18	.70
Feb. 21, 1909	3.67*			.89	.55
Jan. 10, 1911	3.11	4.30*	1.70	2.70*	1.76*
Feb. 27, 1911	.63	.80	1.00	.68	1.61*
Feb. 22, 1913	5.86*	.30	3.10	.93	1.00
Jan. 27, 1914	4.33*	5.14*	3.57	1.70	2.04*
Feb. 19, 1914	2.09	1.91	--	2.01*	.52
Jan. 22, 1915	2.18	1.76	1.78	1.93*	1.67*
Jan. 29, 1915	3.61*	4.40*	2.85	1.80	1.32
Jan. 16, 1916	3.35	1.58	2.12	1.86*	.95
Jan. 17, 1916	5.83*	5.95*	6.36	4.41*	1.55*
Jan. 18, 1916	5.27*	6.49*	4.98	1.24	.80
Jan. 27, 1916	8.54*	3.31*	3.11	5.00*	2.19*
Jan. 28, 1916	1.30	7.68*	7.07	.74	.06
Mar. 11, 1918	4.70*	2.89		1.95*	1.77*
Mar. 12, 1918	2.91	4.51*		1.81*	.74
Dec. 18, 1921	3.15	3.55*		2.26*	1.93*
Dec. 19, 1921	3.10	5.54*		1.13	.40
Dec. 20, 1921	2.00	1.87		.87	2.09*
Dec. 22, 1921	3.51*	2.60		.96	1.07
Dec. 25, 1921	2.21	4.46*		4.10*	1.90*
Jan. 19, 1923	0	3.20*		0	0
Mar. 27, 1924	2.07	1.17		1.87*	.72
Oct. 4, 1925	1.43	1.95		2.60*	2.95*
Oct. 5, 1925	2.04	2.41		1.82*	.55
Apr. 5, 1926	1.05	3.70*		3.57*	3.23*
Apr. 6, 1926m	5.33*	3.67*		1.31	.08
Dec. 10, 1926	5.68*	3.50*		.85	1.53*
Feb. 14, 1927	2.49	2.79		2.29*	1.84*
Feb. 15, 1927	3.79*	4.35*		2.51*	1.73*
Feb. 16, 1927	12.81*	10.37*		5.15*	1.48
Feb. 17, 1927	6.35*	1.66		.31	.01
Jan. 20, 1929	2.55	5.20*		.70	.25
Mar. 11, 1929	3.65*	3.25*		.95	.50
Jan. 16, 1930	1.17	4.92*		.15	.02
Mean-----	3.61	3.70/	3.08/	1.81	1.27

/ Based on comparison with Cuyamaca

Plate III

2198



SAN DIEGO RIVER DRAINAGE BASIN

RELATION OF PRECIPITATION TO ELEVATION

●—● Daily Precipitation

+---+ Mean Seasonal Precipitation

The mean seasonal precipitations in Table IV and the mean daily precipitations in Table V have been plotted against the elevations of the stations at which they were recorded on Plate III. Smooth curves interpreting the data have been drawn through the points. The probable mean precipitations over the area above Lakeside and the area between Lakeside and Santee as indicated by these curves are listed in Table VI.

TABLE VI

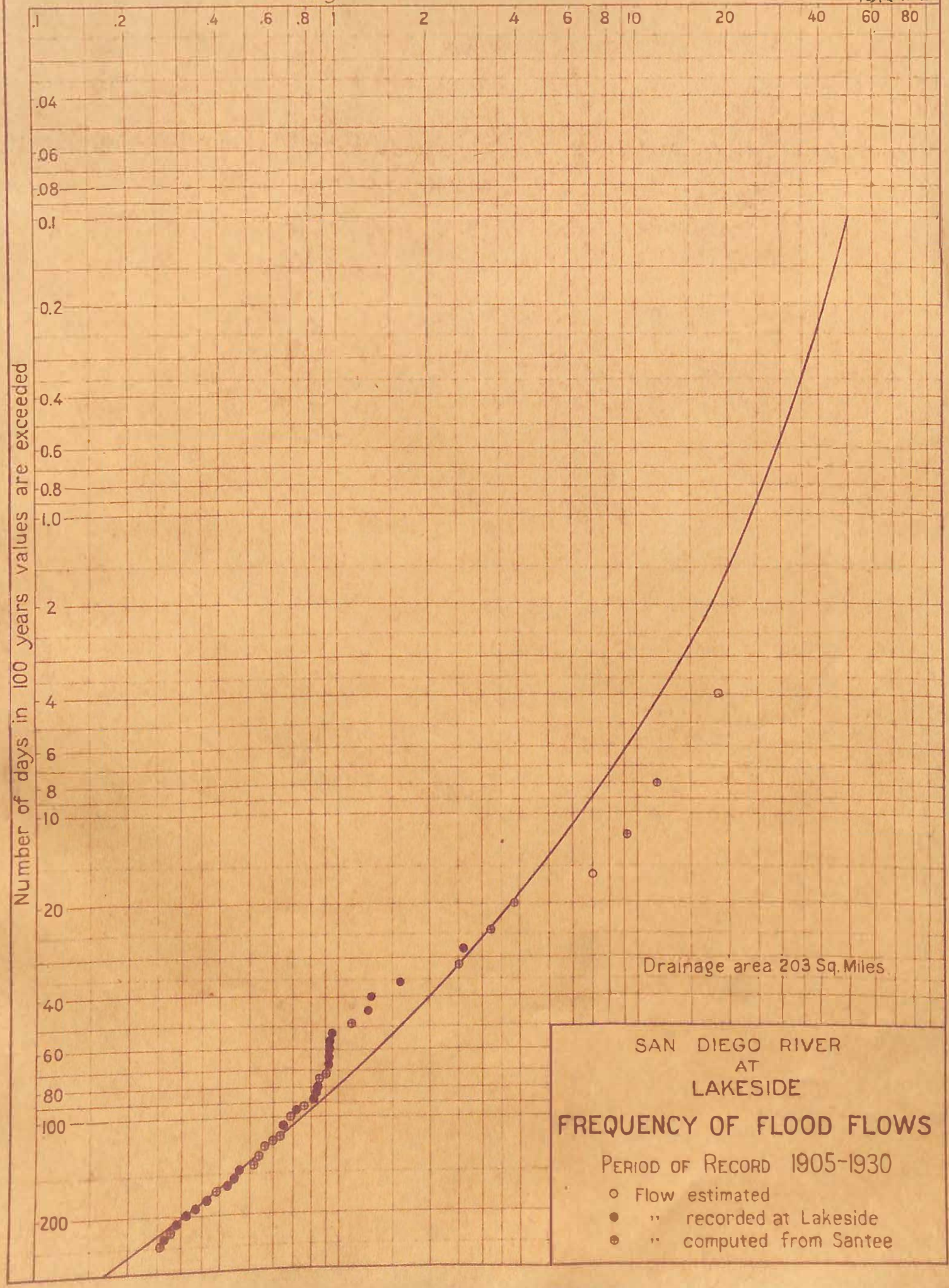
Estimated Precipitation on San Diego River Drainage Basins
Values taken from Curves on Plate III

Section of Drainage Basin	Average elevation in feet above sea level	Precipitation in Inches: Daily Mean of 43 days listed in Table V	Mean seasonal
Above Lakeside	2850	3.00	27.00
Between Lakeside and Santee	900	2.00	16.50
Ratio of Precipitation above Lakeside to precipitation between Lakeside and Santee	-----	1.50	1.64

Since the capacity of soil and forest cover to absorb precipitation has a definite limit it is logical to expect that the percentage of precipitation appearing as run-off would be higher for the heavier precipitation than for the lighter. However, assuming that the percentage of precipitation appearing as run-off would be higher for the heavier precipitation than for the lighter. However, assuming that the percentage of precipitation appearing as run-off is the same for both areas, the run-off per unit of area from the section of the basin above Lakeside, based on the foregoing analysis of fain-fall, should be at least fifty per cent larger than the run-off per unit of area from the section of the basin between the Lakeside and Santee gaging stations. Applied to the total areas of the two basins this

Plate II

2280



factor indicates that the flood flows at Lakeside should be at least 68 per cent of the flood flows near Santee. Summarizing the foregoing analyses of the probable percentages of flow near Santee originating above Lakeside, we find that the following percentages have been developed.

1. Based on comparisons of recorded flood flows -- 50 per cent.
2. Based on precipitation and the relative areas of the 64 per cent drainage basins.
3. Based on precipitation and the relative areas of the 68 per cent drainage basins less valley floor areas.

Based on the precipitation percentages and similar studies on other areas in Southern California it is believed that a value of 65 or 70 per cent would be reasonable. However, it is also believed that the value of 50 per cent deducted from comparisons of recorded flood flows including not only the smaller floods but also the crest flows of the flood of January 27, 1916, the largest of record, must be given considerable weight. Consequently it has been arbitrarily assumed that the flood flows at Lakeside will average 60 per cent of the flood flows near Santee.

In Table VII the flows at Lakeside and near Santee modified by the factor 0.6 have been listed in the order of their magnitude with the probable frequency of occurrence in the period of record (1905-1930) and in 100 years. These have been plotted on Plate IV and a smooth curve interpreting the data presented has been drawn. The probable flows at selected frequencies as indicated by this curve have been listed in Table VIII.

TABLE VII

FREQUENCY OF OCCURRENCE OF MEAN DAILY FLOOD FLOWS
OF SAN DIEGO RIVER NEAR LAKESIDE

Drainage area 203 square miles. Period of Record, 1905-1930.

*Records at Santee (1917-1930) converted to Lakeside by Factor 0.6.

Date of flood	Mean daily flow in second-feet	Frequency with which values will be equalled or exceeded: In period of record 25 years	Frequency with which values will be equalled or exceeded: In 100 years	Date of flood	Mean daily flow in second-feet	Frequency with which values will be equalled or exceeded: In period of record 25 years	Frequency with which values will be equalled or exceeded: In 100 years
Jan. 27, 1916	18,000 ±	1	4	Mar. 5, 1907	534	32	128
Feb. 16, 1927	11,600*	2	8	Mar. 10, 1927	534*	33	132
Dec. 26, 1921	9,200*	3	12	Feb. 21, 1916	532	34	136
Jan. 17, 1916	7,200 ±	4	16	Mar. 12, 1922	508*	35	140
Mar. 25, 1906	3,800	5	20	Jan. 11, 1907	477	36	144
Mar. 12, 1918	3,200*	6	24	Jan. 2, 1910	466	37	148
Jan. 22, 1909	2,350	7	28	Feb. 23, 1920	465*	38	152
Apr. 6, 1926	2,500*	8	32	Apr. 23, 1915	442	39	156
Feb. 11, 1915	1,580	9	36	Mar. 23, 1916	434	40	160
Feb. 8, 1909	1,320	10	40	Mar. 1, 1916	425	41	164
May 5, 1915	1,300	11	44	Mar. 28, 1909	394	42	168
Mar. 4, 1927	1,090*	12	48	Jan. 7, 1922	390*	43	172
Mar. 26, 1907	943	13	52	Jan. 27, 1922	373*	44	176
Feb. 21, 1914	922	14	56	Jan. 17, 1910	359	45	180
Feb. 3, 1915	911	15	60	Feb. 27, 1916	332	46	184
Jan. 30, 1915	910	16	64	Feb. 15, 1916	332	47	188
Jan. 27, 1914	908	17	68	Apr. 12, 1912	319	48	192
Mar. 17, 1922	900*	18	72	Jan. 27, 1922	318*	49	196
Feb. 10, 1922	864*	19	76	Feb. 4, 1908	306	50	200
Feb. 21, 1909	858	20	80	Feb. 14, 1911	306	51	204
Mar. 17, 1906	840	21	84	Mar. 21, 1907	294	52	208
Feb. 13, 1909	815	22	88	Mar. 4, 1911	292	53	212
Jan. 31, 1922	756*	23	92	Mar. 10, 1912	289	54	216
Mar. 13, 1906	714	24	96	Mar. 21, 1915	286	55	220
Mar. 23, 1922	696*	25	100	Mar. 20, 1918	285*	56	224
Jan. 22, 1922	696*	26	104	Apr. 9, 1922	283*	57	228
Feb. 4, 1911	660	26	108	Mar. 3, 1915	282	58	232
Feb. 21, 1922	648*	28	112	Feb. 1, 1907	261	59	236
Dec. 21, 1921	630*	29	116	Apr. 16, 1917	258*	60	240
Feb. 23, 1917	588*	30	120	Mar. 31, 1927	258*	61	244
Mar. 27, 1920	560*	31	124	May 5, 1930	258*	62	248

TABLE VIII

PROBABLE SIZE AND FREQUENCY OF FLOOD FLOWS ON SAN DIEGO RIVER AT LAKESIDE

Drainage Area 203 square miles

Frequency with which values are exceeded	Probable mean daily flow in second-feet
1 in 1000 years	50,000
1 in 500 years	42,000
1 in 100 years	23,500
1 in 50 years	17,500
1 in 25 years	12,000
1 in 10 years	6,400

PROBABLE FREQUENCY OF MAXIMUM FLOODS OF RECORD FROM TESTIMONY OF OLD INHABITANTS.

In the frequency analysis shown on Plates II and IV, it is noticeable that the larger floods do not conform to the trend indicated by the samller and more frequent floods. In drafting thr curves on these plates, these larger floods have been assigned frequencies considerably smaller than indicated by the period of record. The testimony of the older inhabitants of San Diego County on the relative sizes of these floods and floods occurring prior to the period of record is given in the following quotations from the United States Geological Survey, Water Supply Paper No. 426.

Tia Juana River.

"Mr. Campbell ....considers the flood of 1884 the greatest in total runoff that has occurred. The peak ..... was not as great as the peaks of the floods of 1891 and 1916, the only years, in which, since 1869, water from Tia Juana River overflowed into the Otay drainage basin. In February, 1891, snow was above the fences ..... one drift was 21 feet deep. This snow melted during a five day rain. The lower Tia Juana Valley was flooded about as much in 1891 ..... as in 1916."

Sweetwater River.

"Mr. C. H. Ellis, Sr., who has lived near Descanso for 35 years states that the floods of 1884 and 1916 were the largest on Sweetwater River in that period ..... It is his opinion that the flood of 1916 was approximately double that of 1884."

Dairy of William S. Gregg, Dehesa

"Feb. 16, 1884 - River higher than for 20 years."
"Jan. 16, 1895 - Higher than for 32 years."

San Diego River

"Mrs. Martha Swycaffer who came to San Diego in 1854 ..... the flood of 1862 was greater than any other within her time..... the flood of 1862 maintained approximately its peak for 24 hours ..... the flood of 1916 was next in magnitude to that of 1862 ..... knew everyong in Old Town in 1862 and no flood within the memory of any er in the traditions of the place was comparable with it.

San Luis Rey River.

"Mr. P. F. Hubbard ..... since 1873 ..... the only flood comparable with that of 1916 occurred in 1884."

"Mr. Edward Cantarini ..... since 1884 ..... there was more rain in 1884 than in 1916 and the flood was of longer duration but he does not consider that the maximum discharge was as great as in 1916. The river did not have a wall defined channel prior to 1891."

"Father Doyle of Pala Mission ..... after the flood of January 27, 1916 ..... The Indian stated that this flood was greater than that of 1862. The old mission ditch constructed more than 100 years ago was washed out ..... by the flood of 1916 previous floods had not injured it ..... considers the flood of 1916 the greatest ..... 1862 second ..... 1884 third."

Temecula Creek

"Mr. F. L. Fernold ..... The flood of 1891 rose to 2 feet on the trunk of an oak ..... very close to the peak of the flood of 1884 ..... washed out during the flood of 1916 after the water had risen about 12 feet on the trunk. Canyon in solid rock."

Excerpts from Historical Climatology of California by George Cromwell - Savage Report --- 1770 to date.

1786 - Copious rainfall.
1811 - Flood year in Southern part of State.
1915 - Flood year in Southern part of State.
1882 - Floods in Southern part of State.
1825 - The great flood changed the course of Santa Ana River.
1832 - Wet in Southern California
1841-2 - Wettest year ever known - similar to that of 10 years before.
1846-7 - Considerable rain.
1848-9 - Most snowy winter known.
1849-50- One of the wettest and most floody winters.
1853 - Big floods and snow (Northern California)
1850-6 - Flodd and good years.
1861-2 - "Noachian Flood".
1866-7 - Wet year in San Diego County.
1867-8 - Great flood in Los Angeles.
1868-9 - Flood Year.
1873-4 - Floods
1877-8 - Heavy rainfall in San Diego well distributed - low runoff rate.
1879-80- Wet year in San Diego County
1883-4 - Wettest winter ever known in San Diego County.
1890-1 - Very wet high peak flood.
1894-5 - Very wet high peak runoff.
1905-6 - Flood season - first since 1894-5.
1906-7 - Flood season.
1914-15- Wet season small floods.
1915-16- Greatest flodd since any dams were constructed or runoff measurements made.

From the foregoing testimony it would appearsthat in the 160 years since the advent of the Missionaries, there have been at least two other floods which were comparable with the flood of January 27th, 1916, on San Diego River. The flood of 1884 was probably as large or larger in total volume but not as high in crest flow. The flood of 1862 was probably larger in total volume and as high if not higher in crest flow. The flood of 1862 was probably higher than any which had occurred in the 90 years since 1770, however, it is probable that at least one flood, that of 1825 which changed the course of the Santa Ana River, was of a comparable size. Consequently it seems probable, based on this testimony, that the frequency of the 1916 flood should be between two or three times in 160 years of from or from 1.25 to 1.9 times in 100 years.

The frequencies of the flood of January 27th, 1916 as shown by the frequency curves developed on Plates II and IV are 1.6 times in 100 years near Santee, and 1.8 times in 100 years at Lakeside. These values appear to be confirmed by the testimony of old inhabitants.

PROBABLE MEAN DAILY FLOWS AT EL CAPITAN DAM SITE

The comparison of flood flows at Lakeside and near Santee indicated that the yield per unit of area was approximately the same at both stations. Consequently it is believed that flows at Lakeside may reasonably be converted to probable flows at El Capitan dam site by the ratio of their drainage areas, 190 to 203, a factor of 0.936. In Table IX this factor has been applied to the estimated flows in Table VIII, based on the combined record near Santee and

at Lakeside, to give the probable flows at the El Capitan dam site.

TABLE IX

PROBABLE SIZE AND FREQUENCY OF FLOOD FLOWS
ON
SAN DIEGO RIVER AT ELECAPITAN DAM SITE

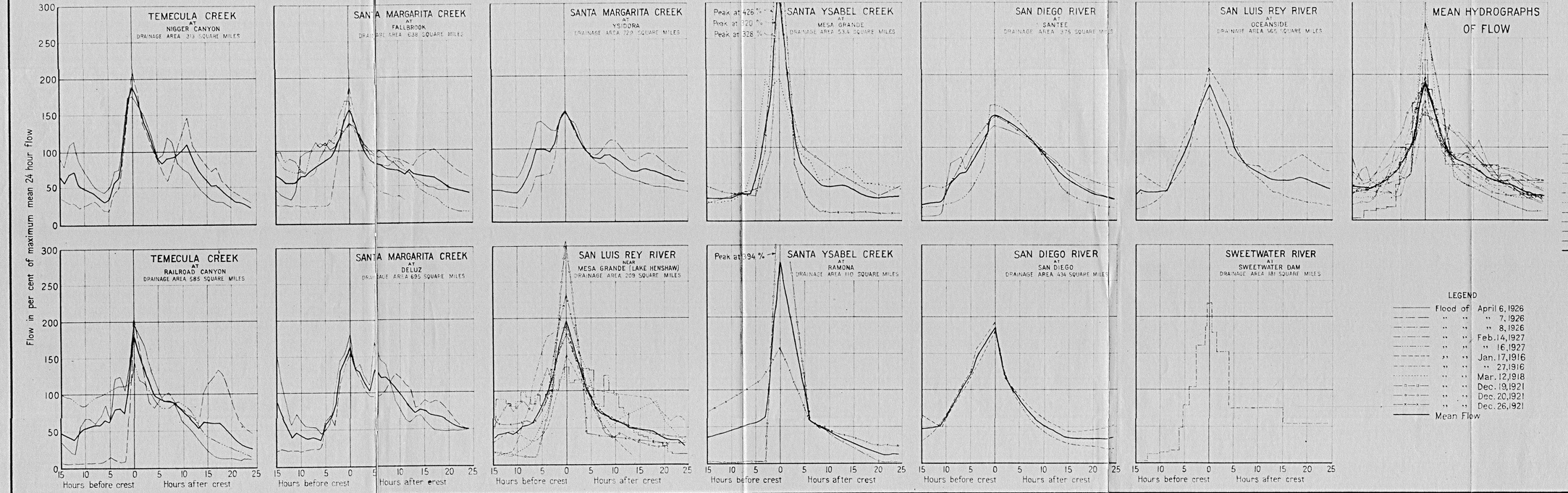
Drainage Area 190 square miles

Frequency with which values are exceeded	Probable mean daily flow in second-feet
1 in 1000 years	46,800
1 in 500 years	39,300
1 in 100 years	22,000
1 in 50 years	16,400
1 in 25 years	11,200
1 in 10 years	6,000

CHARACTERISTICS OF FLOW

On Plate V are shown thirty-three hydrographs of flood flows during 10 storm periods from 12 drainage areas in or adjacent to San Diego County. These areas range in magnitude from 53 to 729 square miles and represent practically all types of topography, soil and cover which may be found in San Diego County. The mean hydrographs for each drainage area and for all the areas are also shwon.

In Table X the mean crest mean daily flow ratios at each gaging station have been listed with the areas of the drainage basins above the respective stations.



TYPICAL FLOOD HYDROGRAPHS
OF
SOUTHERN CALIFORNIA STREAMS
SHOWING
RELATION OF FLOOD CREST
TO
MAXIMUM MEAN 24 HOUR FLOW

TABLE X

RELATION OF SIZE OR DRAINAGE AREA TO CREST-MEAN DAILY FLOW RATIO

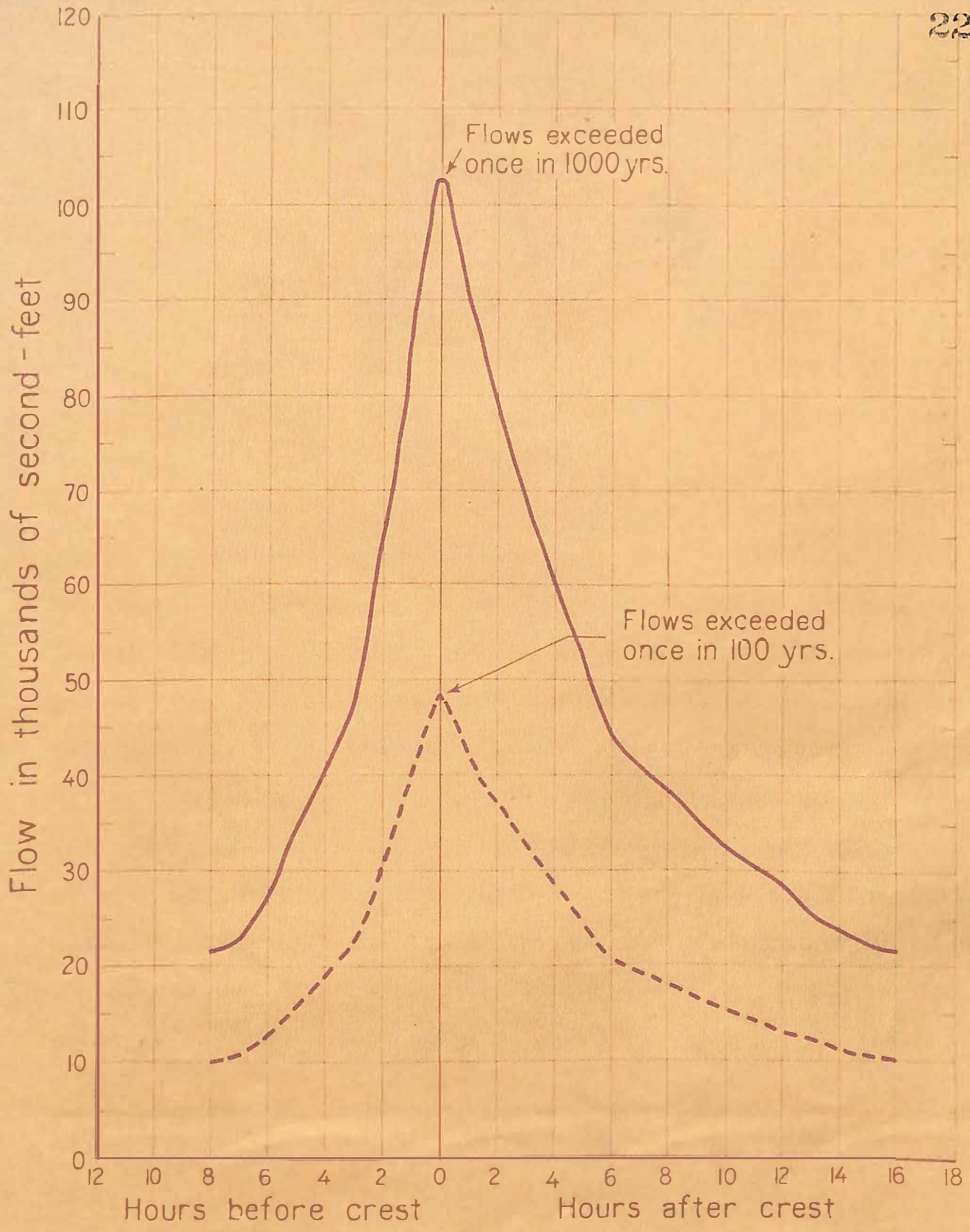
Stream and Gaging Stations	Drainage Area in square miles	No. of floods	Mean Crest-mean daily flow ratio
Santa Ysabel Creek near Mesa Grande	53.4	3	3.20
Santa Ysabel Creek at Ramona	110.0	2	2.76
Sweetwater River at Sweetwater Dam	181	1	2.19
San Luis Rey River near Mesa Grande	209	7	1.97
Temecula Creek at Nigger Canyon	313	2	1.91
San Diego River near Santee	375	3	1.43
San Diego River at San Diego	434	2	1.88
San Luis Rey River at Oceanside	565	2	1.86
Temecula Creek at Railroad Canyon	585	3	1.81
Santa Margarita River near Fallbrook	638	4	1.57
Santa Margarita River near Deluz	695	2	1.66
Santa Margarita River at Ysidora	729	2	1.50

The data presented in the foregoing table indicates a considerable reduction in the crest mean daily flow ratio with the increase in the drainage area. However a study of the hydrographs presented in Plate V shows that the mean values of the crest-mean daily flow ratios are not based on the same floods for the smaller drainage basins as for the larger. Although only two or three hydrographs of flow were available at the majority of the gaging stations, hydrographs of flow during seven of the ten flood periods shown on Plate V were available for the San Luis Rey near Mesa Grande. The crest-mean daily flow ratios for these floods are listed in Table X.

TABLE XI

CREST-MEAN DAILY FLOW RATIOS
ON
SAN LUIS REY RIVER NEAR MESA GRANDE

Date of Flood	Drainage Area 209 square miles: Maximum mean 24 hour flow in second-feet	Crest-mean daily flow ratio
January 17, 1916	16,330	1.50
January 27, 1916	31,050	1.88
March 12, 1918	4,190	1.90
December 19, 1921	1,000	1.79
December 20, 1921	2,104	3.08
December 26, 1921	4,720	2.33
February 16, 1927	21,550	1.33
Mean ratio		1.97



SAN DIEGO RIVER

AT

EL CAPITAN DAMSITE

PROBABLE HYDROGRAPHS OF FLOW

DRAINAGE AREA 190 SQUARE MILES

A comparison of these data with those presented on Plate V shows that the floods of December 20th and 26th, 1921 on which the mean ratios for the smaller drainage basins on Santa Ysabel Creek were based, had ratios considerably larger than the average on the San Luis Rey River near Mesa Grande. Consequently, it is believed that the extreme reduction in the crest-mean daily flow ratio as related to size of drainage basin shown in Table X is exaggerated.

Further study of the data in Table XI shows the wide variation which may be expected to occur in the values of the crest-mean daily flow ratios of floods from the same drainage basin. In the two smallest floods the ratios vary from 1.79 to 3.08 and in the two largest floods from 1.33 to 1.88. It is believed that these variations are the result of variations in the hourly distribution of the rainfall during the separate storms, and that this latter factor is the cause of the major variations in the crest-mean daily flow ratios of floods from drainage basins of only a few hundred square miles or less in extent. Therefore it is concluded that a hydrograph based on the mean hydrographs of floods occurring on the San Diego and adjacent rivers may be taken as the probable average hydrograph of the flow at the El Capitan dam site. Such a hydrograph has been developed from the hydrographs of the San Luis Rey River near Mesa Grande, Santa Ysabel Creek at Ramona, San Diego River near Santee, and Sweetwater River at Sweetwater Dam shown on Plate V. In Table XII this distribution of flow has been applied to the once in 100 and once in 1000 year floods listed in Table IX. The estimated hydrographs of flow are also shown on Plate VI.

TABLE XII

PROBABLE FLOOD FLOWS AT EL CAPITAN DAM SITE
ON
SAN DIEGO RIVER

Drainage Area 190 square miles

Hour	Estimated Flow in Second Feet exceeded	
	Once in 100 years	Once in 1000 years
0	10,100	21,500
1	10,800	22,900
2	13,000	27,600
3	16,100	34,200
4	19,100	40,700
5	22,700	48,200
6	30,800	65,500
7	40,300	85,600
8	48,200	102,500
9	42,200	89,900
10	37,200	79,100
11	32,800	69,700
12	28,400	60,400
13	24,600	52,400
14	20,700	44,000
15	19,400	41,200
16	18,000	38,400
17	16,500	35,100
18	15,200	32,300
19	14,300	30,400
20	13,400	28,500
21	12,100	25,700
22	11,200	23,900
23	10,600	22,500
24	10,100	21,500

CONCLUSIONS

1. A mean daily flood flow of 22,000 second feet equivalent to a runoff of 116 second feet per square mile with characteristics as shown in Table XII may be expected to be exceeded on an average of once in 100 years.

2. A mean daily flood flow of 46,800 second-feet equivalent to a runoff of 246 second-feet per square mile with characteristics as shown in Table XII may be expected to be exceeded on an average of once in 1000 years.

1-24-35
copy/p

November 30, 1931

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL
OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Dam Site No. 2, Application for Approval of Plans and Specifications for construction of hydraulic fill-rock embankment dam.

Gentlemen:

Enclosed is duplicate original copy of application for approval of the plans and specifications for the construction of a hydraulic fill-rock embankment dam at El Capitan Site No. 2 on the San Diego River, original of which was filed with the State Engineer November 21, 1931.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

F/f
Encls.-application

January 1, 1933

San Diego River Project, El Capitan Feature, Conference regarding application for construction of El Capitan Dam. December 5, 1931, Hydraulic Engineer's Office. State and City officials present.

STATE

Edward Hyatt, State Engineer
Geo. W. Hawley, Deputy State Engineer in Charge of Dams
W. H. Holmes, Assistant Deputy State Engineer
Chester Marliave, Geologist
L. C. Hill, Consulting Engineer

CITY

Walter W. Austin, Mayor
J. V. Alexander, Councilman
Ira S. Irey "
L. C. Maire "
J. J. Russo "
Alfred Stahel "
T. B. Cosgrove, Special Water Counsel
C. L. Byers, City Attorney
H. B. Daniel, Assistant City Attorney
H. N. Savage, Hydraulic Engineer
Fred D. Pyle, Assistant Hydraulic Engineer
Harold Wood, Engineer
P. Beermann, Assistant Engineer
C. F. Tolman, Consulting Geologist
C. D. Marx, Consulting Engineer
E. L. Burk, Water Development Office

PRESS

Henry Love, San Diego Union
Newell Jones, San Diego Sun

SAN DIEGUITO IRRIGATION DISTRICT

W. C. Brown, Engineer

NEWS RELEASE - DECEMBER 7, 1931

State Engineer Hyatt today approved the application of the City of San Diego to construct a dam on the San Diego River at the El Capitan site. The dam is to be an earth and rock fill type, two hundred feet high, with a storage capacity of 118,000 acre feet, is estimated to cost approximately three and a quarter million dollars, and is for the purpose of providing an additional water supply for the City of San Diego.

Application was made on behelf of the City of San Diego by H. N. Savage, hydraulic engineer, November 21st last. The geological and engineering features have been thoroughly investigated both by the City and the State. For the City, investigations have been made by Engineer Savage, Consulting Engineer Dr. C. D. Marx of Stanford University, and Consulting Geologist Dr. C.F. Tolman, also of Stanford, which supplement those and the report of some years ago submitted by Consulting Engineer John R. Freeman of Providence, R.I. For the State, the safety features of the proposed structure have been studied by Consulting Engineer Louis C. Hill, of Los Angeles; Deputy State Engineer George W. Hawley; Geologist Chester Marliave, and State Engineer Hyatt. All reports being favorable from the standpoint of safety, State approval has resulted, which means that in the opinion of these authorities a safe dam can be built.

10-6-32
p

2216

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

Division of Water Resources
401 Public Works Building

Edward Hyatt, State Engineer
Chief of Division

December 7, 1931

EL CAPITAN DAM 8-7

Mr. H. N. Savage,
Hydraulic Engineer
524 F Street
San Diego, California.

Dear Sir:

The following wire has just been sent you:

"Application City San Diego filed November twenty first El Capitan Dam approved this morning. Approved application with letter of transmittal will be forwarded you today airmail. You should receive these documents tomorrow."

The approved application is transmitted herewith and constitutes formal approval by the State Engineer under the law governing supervision of dams, Chapter 766, Statutes of 1929. In the opinion of the State Engineer a safe dam of the type and height proposed at the site selected can be constructed. This action, however, does not include at this time approval of all details of hydraulic and structural design, as modifications of some features may be found advisable or necessary either by the City itself or by the State.

With the approved application the City is free to proceed with construction so far as any action by the State is concerned. Enclosed also is oopy of a news item released in Sacramento today.

Very truly yours,

EDWARD HYATT (Signature)
State Engineer

Encls.

9/6/34
copy/f

December 9, 1931

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL

OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Reservoir and Dam Feature, Formal Approval by State Engineer.

Gentlemen:

Enclosed is duplicate original of the City of San Diego's application to the State of California, Department of Public Works, dated November 21, 1931, to construct a hydraulic fill-rock embankment dam at the El Capitan site on the San Diego River to store water to elevation 750, reservoir contour 197, bearing formal approval of Edward Hyatt, State Engineer, December 7, 1931.

Also enclosed is letter dated December 7, from Edward Hyatt, State Engineer, transmitting the approved application to construct the El Capitan Reservoir Dam, and a copy of news item released by him in Sacramento.

Very respectfully,

F. D. Pyle
Acting Hydraulic Engineer.

FDP/f
Encls.
Approved Application
Letter from State Engineer - 12/7/31
News Release - 12/7/31

SAN DIEGO RIVER PROJECT, EL CAPITAN FEATURE

Reports and Data made available to California State Engineer's Consulting Engineer Louis C. Hill in connection with his report to the State Engineer on Plans for El Capitan Dam Proposed by City of San Diego, dated December 12, 1931.

Drawings and Specifications for El Capitan Reservoir Dam, Spillway and Outlet Works.

San Diego Additional Water Supply Report by H. N. Savage August 8, 1923.

Report of John Ripley Freeman, C.E., on Additional Water Supply for the City of San Diego, California, Document No. 160932 filed May 24, 1924, including drawing sheets 1, 2 and 25.

The Freeman Report, newspaper copy.

Extension of Tables of Report on Additional Water Supply for City of San Diego, by H. N. Savage, August 8, 1923.

Preliminary Report on the Geology of Upper and Lower Pamo Damsites, Upper and Lower Roden Damsites, the San Vicente Damsite, the Lower, Upper and No. 3 Damsites at El Capitan. By C. F. Tolman, Stanford University, California.

Document No. 140165, City of San Diego, California, Report on Additional Municipal Water Supply San Diego River Resources, Conclusions, Recommendations, January 14, 1922, by H. N. Savage, Hydraulic Engineer.

San Diego River Project, El Capitan Feature Exhibit "A" Precipitation and Flood Data to accompany application for approval of drawings and specifications for El Capitan Dam, by Hiram Newton Savage, Hydraulic Engineer in Charge. October 1931.

Document No. 146956, City of San Diego, California, Additional Water Supply, San Diego River Resources, H. N. Savage, Hydraulic Engineer, November 27, 1922.

City of San Diego, California, San Diego River Project, Resolution No. 55214, El Capitan Dam Site No. 2, Foundation Geological Formation, December 29, 1930, H. N. Savage, Hydraulic Engineer, Document No. 264380.

San Diego River Project - El Capitan Feature
Cost of Water at San Diego
Letter from Geo. W. Goethals to F. A. Rhodes
News Item, San Diego Union - letter from M.M.O'Shaughnessy to Claus Spreckels, November 8, 1924.
Copy of letter from M. M. O'Shaughnessy to John D. Spreckels
Rainfall-Runoff Data, by H. N. Savage 1850-1930-1

Photographs 9-15-31 Material area "A"; Material area "B"; Material area "C", El Capitan Hydraulic Fill Dam.

Drawing WD-351, sheets 1, 2 and 3.

Notice Inviting Bids, Proposals, Drawings and Specifications El Capitan Reservoir Dam, Spillway and Outlet Works.

Drawing S-455 Watersheds of San Diego County

Drawing WD-290 Log of Core Borings, El Capitan

City of San Diego, California, San Diego River Project, El Capitan Reservoir Dam, outline of methods of construction dated November 14, 1931.

Morena Reservoir Spillway Enlargement Report and Recommendations April 27, 1922.

8-24-34
Copy/m

QUINTON, CODE AND HILL-LEEDS AND BARNARD

Los Angeles, California

December 12, 1931

Mr. Edward Hyatt
State Engineer
Sacramento, Calif.

Subject: El Capitan Dam

Dear Mr. Hyatt:

On November 13, 1931 Mr. Holmes brought to this office the preliminary plans and specifications of El Capitan Dam.

Tuesday, the 17th of November, was spent with Mr. Hawley and Mr. H. N. Savage on a trip to El Capitan Dam Site No. 2, where we inspected all the exploration tunnels and also the right abutment of the dam. The spillway is located in this abutment.

November 16th and 18th were spent in the office of the Bureau of Water Supply of the City of San Diego studying reports.

On December 2nd Mr. Hawley, Mr. Marliave, Mr. Holmes and myself spent the day at the dam site inspecting all tunnels and both abutments, and again on the 4th we studied the advisability of locating the diversion tunnel on the south side of the river, and inspected the site of and tested the materials proposed to be used in the hydraulic fill in the body of the dam. We also spent some time with Mr. J. Y. Jewett, who has made for the City

of San Diego the analyses and other tests on the materials proposed to be used in the hydraulic fill portion of the El Capitan Dam. Friday was spent in the office, as was Saturday morning.

El Capitan Dam and Reservoir

El Capitan Dam Site No. 2 is situated on San Diego River, San Diego County, about twenty-eight miles upstream from the mouth of the river and one mile downstream from the mouth of Chocolate Creek, and eight miles above the mouth of San Vicente Creek, tributaries of San Diego River.

It is proposed to build a rock and earth fill dam, with spillway crest at elevation 750, the top at elevation 766, with a parapet four feet higher. The storage will be about 117,000 acre feet and the area covered about 1570 acres, or about 75 acre feet stored for each acre of the surface of the reservoir. The drainage area tributary to the San Diego River above the dam site is 190 square miles. The elevations of the watershed above the El Capitan Dam Site range from 750 feet at the dam site to 6515 feet on Cuyamaca Peak. The mean elevation of the watershed above the dam site is about 3000 feet above sea level. The slopes are rough and rugged and are covered in most places with brush and tree growth.

The report of Prof. Tolman, the consulting geologist employed by the City of San Diego, was generally confirmed by the State Geologist, Mr. Marliave. Each geologist's report on the foundation indicates that a safe dam of the general type shown on the drawings accompanying the Notice Inviting Bids, Proposal, Drawings and Specifications for El Capitan Reservoir, Dam, Spillway

and Outlet Works, filed in your office by Mr. H. N. Savage, hydraulic engineer for the City of San Diego, can be built at the location shown on Drawing File No. 2391-D1.

Prof. Tolman states on page 14 of his report that the foundation rock is Biotite-granite, which when fresh is massive, dense, strong and elastic, and conetitutee a thoroughly satisfactory foundation material. The cores found near the road on the left side amply bear out this statement for any type of dam.

Prof. Tolman also states that no faults, at least of any magnitude, exist at the site, and that the few shear and joint planes constitute no appreciable weakness. It is also very improbable that any disatrous earthquakes or slides will effect the area at No. 2 Dam Site.

The granite at and near No. 2 site is weathered to unusual depth and for several feet below the surface the material is soil which gradually passes into very soft disintegrating granite, which hardens gradually with depth until the fresh, strong granite is reached.

The foundations should be prepared by removing all earthly material from the abutment, including the softer disintegrated rock. Much of this material can be used in the hydraulic fill.

Core Wall

It is not necessary to carry the core wall excavation to the fresh rock. The excavation should be carried to such depth as to enter reasonably firm material that is practically water-tight This depth will vary from point to point and must be fixed as the

excavation progresses. The trench must be filled with concrete poured into the trench without forms.

The drawings show the excavation in the streambed to extend but about 170 ft. downstream from the upstream toe, about 25 ft. on the downstream, and 50 ft. on the upstream side of the core wall, and about 150 ft. upstream from the downstream toe.

The rest of the riverbed material is apparently left in place. Some of this should undoubtedly be removed, but how much can only be determined after excavation starts.

A note on Drawing File No. 2391-D1, which shows the maximum cross section of the dam, directs the removal of the riverbed material for 50 ft. above and 25 ft. below the core wall, and its replacement by fine sand. Just what is the purpose of this fine sand underneath a supposedly impervious fill is not very evident.

It is suggested that the impervious fill be carried to practically water-tight material for a distance upstream of at least 75 ft. and on the downstream side for a distance of about 50 ft. The impervious portion of the hydraulic fill should gradually taper from this width to about 30 ft. as it approaches the top of the dam. If the material forming this supposedly impervious core could be made reasonably water-tight, it might not be necessary to extend the core wall to the top of the dam. In fact it would not be desirable, on account of the great difficulty in maintaining equal pressures on both sides of the core wall, to carry it any further above the bottom than is necessary to make a safe water-tight connection between the impervious clay core and bedrock.

On account of the uncertainty, however, as to the water-tightness of the material which is available, a final decision as to the necessity of the core wall extending to the top of the dam should probably not be made at this time.

Low Concrete Dams

Low concrete dams are shown near the upstream toe and the downstream toe of the dam. These show a top elevation of 575. If the diversion tunnel is placed on the south side of the river, as will be recommended later in this report, it will be unnecessary to put any concrete dam at the downstream end of the slope, but large rocks should be placed in this portion of the dam to protect it against backwash from the spillway. The only apparent object in building the concrete dam at the upstream end is for the purpose of diverting the water during construction. This, is my opinion, can be much better accomplished by building the upstream rock fill portion of the dam first and paving its face with a very thin covering of concrete, sufficient to make it water-tight. The top of this paved portion should then be extended about as high as is considered necessary in order to divert the largest flood anticipated during the short time the dam is being constructed. The cost of such a pavement, which need not be over an inch or two thick, would of course be far less than the cost of the concrete dam shown on the drawing.

Location of By-Pass Tunnel

A study of the cross section along the proposed line of the by-pass tunnel, as now located on the north abutment, indicates very clearly the danger which probably would result from undercutting the hillside. The material close to the surface on the left abutmen

appears to be much better and there is far less danger of any slides occurring on the left side. It is therefore recommended that the by-pass tunnel be located on the south or left side of the river. It is also recommended that the inlet tower be placed in the open at the head of the by-pass tunnel, and only the foundation of this inlet tower be built at first. During construction, however, the upstream end of this tunnel should be protected against floating debris by a temporary screen. As the tunnel is about 25 ft. in diameter, it will only be necessary to protect against trees. The tower and the entrance to the tunnel should of course beredesigned to fit the new location. It is noted that on Drawing File No. 2391-D1 the top of the tower, while above spillway elevation 750, is materially below the top of the dam and even below the probable flood level. It is therefore suggested that the top of this tower be located at such an elevation as to be above the highest probable high water; that is, it should be above elevation 764.

Siphon Spillway

The four-compartment siphon spillway is supposed, according to the various reports, to have a capacity of between 14,000 and 16,000 cu. ft. per sec. It appears also to be the intention to have the siphon spillway go into action before the side spillway, or at least to depend upon the siphon spillway to take care of practically any flood up to 15,000 cu. ft. per sec. There seems to be no good reason why the side spillway should not be used as much as possible. It is extremely dangerous to turn loose even, 4000 cu. ft. per sec. suddenly into a dry river channel, as will happen if but one siphon goes into action at one time. If one of the larger floods should occur at the time the reservoir was full, two or more sections of

the siphon spillway would go into action before the water from the first discharge got very far downstream. The result would probably be a flood of from 5000 to 10,000 sec. ft. flowing down a dry streambed. Considerable loss of life easily follow. If the first flows passed over the side channel spillway, the flow down the river would gradually increase, furnishing ample warning to people below before the siphon spillways went into action.

There is no experimental knowledge of the constants which should enter into the design of a siphon spillway having a 10 ft. depth of throat, and it is quite possible that the action of the siphon would be very uncertain. The present design of the siphon shows the lower edge of the lip at elevation 748, or 2 ft. below the spillway elevation. It is very doubtful if the siphons would work satisfactorily without making the entrance at least from 8 to 10 ft. below the surface of the water in the reservoir. No experimental evidence, so far as I am aware, exists to determine this point in siphons as large as this.

It has been estimated that the efficiency of the siphon is as high at least as 70%. Taking everything into consideration, it seems to be very doubtful whether 70% efficiency for a siphon of this size and shape could be obtained. Under any circumstances, on account of safety, it seems certainly desirable, if a siphon is to be used, that it be made up of smaller units. Two drum gates each 40 ft. long and 10 ft. high, having a crest elevation at 750 would cost less and carry more water. Each one of these gates would discharge about 5000 cu. ft. per sec. with the water in the reservoir at elevation 755,

and at elevation 762, which is the highest high water anticipated, over 14,000 sec. ft. The rate of increase in discharge could be made anything desired. When the water in the reservoir rose above 750, the gates would begin to depress and would gradually go down at any predetermined rate desired. If two gates were used, the side spillway capacity could be reduced in the proportion that the excess discharge through the drum gates exceeded the discharge through the siphon spillway. One of these gates could be set to discharge, with the water no higher in the reservoir than 751, over 4000 cu. ft. per sec. and with water standing in the reservoir at 762, it would discharge 14,000 cu. ft. per sec., or the two gates would carry about 28,000 cu.ft. per sec.

The U. S. Bureau of Reclamation has designed several of these gates; a Swiss firm has built many of them, even up to 125 ft. long; a battery of these gates is now about completed at Coolidge Dam and, as you know, there are to be three 70 ft. spillway gates of this type at Pine Canyon Dam. The cost of each gate would certainly not be more than $8000, including the concrete for the gate alone. I feel quite confident that a siphon spillway will cost materially more. Some type of gate of this kind I believe should be used rather than siphon spillways of such unprecedented size.

That side channel spillway, as shown on the plans, would drown out so that its maximum discharge would not exceed about 30,000 cu. ft. per sec. By re-designing the side channel, the discharge, with water in the reservoir at elevation 762, can easily be raised to 70,000 cu. ft. per sec. The whole spillway should be re-designed, whether siphons are used or not, so as to carry the maximum amount of water with the

length of spillway lip available.

The axis of the discharge channel should be straight and should be carried in cut to the flat below. Its discharge should then be so directed that no damage can result to the downstream toe of the dam.

The spillway should be re-designed both structurally and hydraulically. An endeavor should be made to have the discharge channel from the side spillway and the discharge channel from the drum gates or siphons merge in as short a distance below the dam as possible. If properly designed, there should be no need of a high wall between these two discharge channels. On account of the diffioulties arising from the combined operation of these two types of spillways, it seems most advisable that you should require the City of San Diego to make a model and test it, and then to modify the design until the results are satisfactory. Otherwise the cross currents that may arise below the gates may become very dangerous.

If the diversion tunnel is placed on the south side of the river, there would be no need of the concrete wall shown protecting the discharge end of the tunnel. The entrance to the by-pass tunnel should be lowered materially. The computations for the discharge capacity of this tunnel are based on a level tunnel, while the drawings show the upstream end of it at so high an elevation that there is not entrance head enough to provide the necessary entrance velocity.

Mr. Robert L. Wing, Assistant Engineer, has written a report dated November 23, 1931, approved by A. D. Edmonston, Deputy State Engineer, on the Probably Size and Frequency of

He has collected data on the size of the floods on the various streams in the southern part of the State and also the form of the flood discharge curves.

After studying this report I believe the flood curve shown on Plate VI, p. 30, of his report is as fair a representation of the maximum probable flood having a frequency of one in 1000 years as can be derived from the limited data available. This flood peaks at 102,500 sec. ft. or 540 sec. ft. per square mile of drainage area. The runoff in 24 hours is 92,500 ac.ft. or at the rate of about .76 ft. deep over the entire area. Your office has made a hydraulic study of the result of this flood, assuming the spillway to be built as designed.

The maximum level of the water in the reservoir was found to reach 765.5. If the side channel spillway is redesigned so it will not drown out, the maximum elevation reached by the water in the reservoir will be about 762. The curves on page 14 show the two cases.

A study was made for a maximum peak flow of 148,000 sec. ft. with a flood of the same general form as the one shown on Plage I. The water in the reservoir reached an elevation of 768. Even with such an extraordinary assumption there would have been about 2 feet of parapet above the water in the reservoir.

Further exploration

Mr. Savage expressed the intention of driving some more tunnels into the south abutment. It is suggested that the exploration tunnel in the spillway section should be extended until it reaches the plane of the cutoff wall and then a cross-

out should be driven in a northerly direction about under the proposed cut-off wall for a distance of about 150 ft., or until well outside of the spillway excavation. This exploration tunnel will provide information not now available as to the conditions under the spillway.

RECOMMENDATIONS

(1) The spillway should be re-designed so that with water surface in the reservoir at elevation 762 the combined spillway discharge will be at least 75,000 cu.ft. per sec.

(2) The diversion tunnel should be located on the south side of the river.

(3) The tower should be located at the head of the tunnel, be re-designed, and its top raised to at least elevation 764.

(4) If a siphon spillway is to be used, the present siphon spillway should be re-designed so that it will not begin to operate until the side spillway has been in operation some time. To give ample warning below, the siphon spillway should not go into action until the level of the water in the reservoir is about two feet higher than the side spillway lip. A throat opening 10 ft. high is so far beyond precedent that it should not be adopted without most careful study and experiment.

(5) A model of the proposed spillway should be made and tested.

(6) Exploration tunnels should be driven into the south abutment and the tunnel in the spillway section extended and a cross cut driven north about 150 ft.

(7) A proposed program of operations should be submitted by the City of San Diego.

Respectfully submitted,

LOUIS C. Hill

(Signed)

9/7/34
copy/f

2231

January 7, 1932

Honorable Edward Hyatt,
State Engineer,
Department of Public Works,
401 Public Works Building,
Sacramento, California.

Subject: San Diego River Project, El Capitan Dam, Drawings and Specifications.

My dear Mr. Hyatt:

Drawings and specifications for advertisement for proposals for bids for the construction of the El Capitan Dam have been completed, and except for a few very minor changes are identical with the drawings and specifications which I have the impression are already in your files.

I assume that your formal approval of the construction of the dam is sufficient, but if you require drawings and specifications for your approval before advertisement is made and will telegraph me to that effect, I will forward a copy to you immediately.

Although the City received no formal bids for its bonds Monday, January 4, there is over $900,000 of available funds in the Treasury, and contractors prominently qualified by successful experience and financial support are proffering competitive bids and guaranteeing to take the City's unsold bonds at par.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f

8/27/34
copy /f

2232

State of California
Department of Public Works
Sacramento

January 9, 1932

Mr. H. N. Savage, Engineer in Charge
Bureau of Water Supply
City of San Diego
524 F Street
San Diego, California.

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

Reference is made to your letter of January 7, reply to which has been made by telegram today as follows: "REFER YOUR LETTER JANAURY SEVENTH STOP LAW GOVERNING SUPERVISION OF DAMS PROVIDES FOR APPROVAL BY STATE ENGINEER OF DETAILED PLANS AND SPECIFICATIONS FOR CONSTRUCTION OF ANY DAM BEFORE COMMENCING ACTUAL CONSTRUCTION STOP APPROVAL GIVEN CITY DECEMBER SEVENTH WAS GENERAL ONLY AND AN APPROVAL OF THE PROPOSED HEIGHT AND TYPE OF DAM TO BE CONSTRUCTED AT THE SITE AS TO SAFETY ONLY STOP THIS PHASE OF APPROVAL WAS DISCUSSED IN DETAIL DURING CONFERENCE HELD IN YOUR OFFICE DECEMBER FIFTH STOP IT WAS UNDERSTOOD THAT IN THE EVENT THE BOND VOTE WAS FAVORABLE CITY WOULD PROCEED IMMEDIATELY TO CLEARING DAM SITE COMPLETING ACCURATE TOPOGRAPHICAL SURVEY AND COMPLETE ADDITIONAL EXPLORATORY WORK STOP ON BASIS OF THESE ACTIVITIES DETAILED STRUCTURAL AND HYDRAULIC PLANS WERE TO BE PREPABED FOR SUBMISSION TO THIS OFFICE FOR APPROVAL STOP STATE ENGINEER"

The law governing the supervision of dams, including the Rules and Regulations forming a part thereof, set up a detailed procedure for obtaining State approval of the detailed plans and specifications for the construction of any dam which under the law must be obtained before commencing actual construction. The approval given the City on December 7, for construction of the proposed El Capitan Dam, was general only and was an approval insofar as safety is concerned of the type and height of dam proposed in your application and shown in the preliminary plans accompanying the application. This action, when passing upon the application, was discussed in considerable detail and at length with the City officials and yourself during the conference held in your office on Saturday afternoon, December 5. It was understood that upon approval of the application and favorable vote for transference of funds for construction of the dam that the City would clear the dam site, make an accurate topographical survey of the site and complete certain exploratory and investigational work. These activities, when completed, were to form the basis for the preparation of detailed structural and hydraulic plans for construction of the proposed dam that must, in accordance with the law, be submitted to this office for review and approval.

The preliminary plans and specifications, accompanying application filed by the City on November 21, were carefully reviewed by this office and particularly by Mr. L. C. Hill, Consulting Engineer for the department, who, together with engineers and geologist of the department, examined the site and studied the various features of the proposed work from the standpoint of safety. Mr. Hill prepared and submitted to the State Engineer his report under date of December 12, 1931, copy of which was sent to you for your information and guidance in preparing the detailed plans for the El Capitan Dam on December 28. The suggestions and recommendations set forth in this report are in full accord with the department's recommendations and merit your serious consideration.

To facilitate final action on the plans and specifications, arrangements have been made for Mr. Holmes to confer with you on the technical features of the proposed work and the procedure of the department in obtaining approval of the plans and specifications during the middle of next week.

Enclosed herewith is a copy of the law governing the supervision of dams, including the Rules and Regulations, for your information and guidance.

Very truly yours,

EDWARD HYATT (Signature)
STATE ENGINEER

Encl. 1

9/7/34
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2234

January 9, 1932

Honorable Edward Hyatt,
State Engineer,
Department of Public Works,
Sacramento, California.

Subject: San Diego River Project, El Capitan Reservoir Dam Spillway and Outlet Works. Drawings and Specifications.

My dear Mr. Hyatt:

In compliance with telephone reply of Deputy State Engineer George W. Hawley to my letter dated January 7, 1932, regarding your policy in reviewing drawings and specifications for dams and accessory structures in California before they are published for distribution to contractors;

Enclosed is City of San Diego's drawings and specifications for El Capitan Reservoir Dam, Spillway and Outlet Works, reservoir storage to elevation 750, reservoir contour 197.

It is the present idea that the City will advertise for proposals from contractors, payment to be made in the City's bonds at par valuation.

It is understood that the Common Council intends to establish classifications and wage rates to govern the construction of the dam January 11.

On account of the advancing season it is of obvious urgent importance that your conclusions regarding the work be received at the earliest practicable date.

It is my understanding that your Deputy Engineer, W. H. Holmes will come to San Diego immediately for futhor conference and consideration of the details of the work covered by the drawings and specifications.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encl. Drawings & Specifications
1-9-32

8/24/34
copy /f

2235

January 12, 1932

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL

OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Dam, California State Engineer's Cooperative General Approval.

Gentlemen:

Enclosed is original letter dated January 9, just received from State Engineer Edward Hyatt restating his oral general approval at San Diego December 5, which he confirmed by telegram and letter dated December 7, of the City's El Capitan Dam designs and installation.

The State Engineer has further indicated his desires regarding amplification of understanding between his office and the City regarding the details of the designs and calling attention to the report of the State's Consulting Engineer, Louis C. Hill, copy of which is enclosed.

The State Engineer also advises that his Assistant Deputy State Engineer of the Division of Dams headquartered at Los Angeles, W. H. Holmes, will be in San Diego the middle of this week, which obviously is tomorrow, for conference regarding the technical features of the work.

The State Engineer's major requirements as understood at the time of his general approval have been substantially complied with.

The damsite has been cleared of trees, shrubs, brush and vegetable matter.

Topography has been taken of the damsite and is being completed of all the immediate adjacent territory.

The specific location of the dam, based on the new topography, has been determined upon and staked out on the ground.

Exploration tunnels and test pits have been advanced to determine the geological formation along the left and/or south side of the River with reference to the location of the by-pass tunnel on that side as indicated advisable by the State's Consulting Engineer.

Two sites for quarry have been investigated and indicated from which the required about 850,000 cubic yards of apparent durable rock may be acquired.

Application has been made to the U. S. Forest Service Supervisor in San Diego for Free Use Permit to use adjacent lands in the Cleveland National Forest from which to obtain materials of construction for the El Capitan Dam, and for the pipe conduit between El Capitan Reservoir and Lakeside, and for public roads.

Application has also been made to the local Forest Supervisor for permanent Free Use Permit for such Forest Lands in the Cleveland National Forest as will be permanently required by the City incident to the construction, operation and maintenance of the El Capitan Dam and Reservoir, pipe conduit, public highways and camp sites, temporary for the contractor, and permanent for the City's use.

The City's requirements for temporary and permanent use of Public Lands in the Cleveland National Forest incident to construction, operation and maintenance of the El Capitan Dam and Reservoir and allied features were taken up by me personally when last in Washington, D. C. with the higher officials of the Forest Service. Assurances of full cooperation were proffered to the City.

Very respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encls. (2)
Letter State Engineer - 1/9/32
Copy L. C. Hill's Report - 12/12/31

8/24/34
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2237

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

January 14, 1932

Mr. H. N. Savage, Engineer in Charge
Bureau of Water Supply
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

The plans and specifications, which accompanied your letter of January 9, 1932, for construction of the proposed El Capitan Dam, have from the standpoint of safety and safety alone been reviewed by this office. These plans do not differ materially from the preliminary plans submitted with application filed by you with the department on November 21, 1930, which application was approved, in general form only, on December 7, 1931. It was understood and agreed that this approval of the application covered general conditions of safety only, and indicated that in our opinion the type of dam to be constructed to the height proposed at the El Capitan site could safely be built. Furthermore, it was understood that detailed structural and hydraulic plans were to be prepared for submission, as required by law, to this office for review and approval subsequent to clearing the site and completion of additional investigational work.

Approval can not, at this time, be given to the plans as submitted for the reason that, in our opinion and that of our Consultant, the hydraulic properties and structural details of the composite spillways do not have a factor of safety commensurate with that deemed necessary for a structure of the magnitude and importance of the El Capitan Dam; that the location and technical features of the diversion tunnel do not provide ample safety and that certain modifications in the details of the dam are believed desirable. Discussion of these features are covered in Mr. L. C. Hill's report, copy of which was sent you, and will be further discussed in detail with you by Mr. Holmes on Friday, January 15.

Very truly yours,

EDWARD HYATT (Signature)
STATE ENGINEER

1-24-35
copy/p

February 1, 1932

From : Engineer F. D. Pyle

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Reservoir Dam Drawings and Specifications. Consideration by W. H. Holmes, Assistant Deputy State Engineer

1. On January 18, 1932 Assistant Deputy State Engineer W. H. Holmes reviewed the drawings for the El Capitan Reservoir Dam and discussed Mr. L. C. Hill's letter of December 12, 1931 to the State Engineer; also the State Engineer's letter of January 9 and 14.

2. Mr. Holmes permitted a copy to be made of probable flood flows at El Capitan Dam Site as prepared by Robert L. Wing.

3. Mr. Holmes made the following statements:

A free board of 4 to 5 feet not including parapet wall will be required.

The 10-foot siphons are not acceptable without full scale model tests.

In many cases siphon spillways had coefficient of efficiency much less than 70 per cent;a few about 40 per cent.

The spillway should be re-designed eliminating siphone a nd increasing capacity to provide for conditions as eet out in Mr. Wing's study of flood flows.

The City of San Diego should carefully consider the change of tunnel location to the south abutment.

The tunnel entrance grade should be lowered and exit grade raised.

A 25-foot tunnel was acceptable.

The outlet tower should not be located in embankment.

The outlet tower design had been checked for earthquakes and wind pressure and certain technical deficiencies had been found in reinforcing steel in side walls, supporting beam and foundation.

The high retaining walls of tunnel portals had been checked and deficiencies found in reinforcing steel.

A schedule of progress should be submitted showing height of dam expected during each flood season.

The advisability of placing any rolled embankment under hydraulic fill was questioned.

The upper exploratory tunnel in the north abutment should be extended to a line with the core wall and extended under the spillway.

3. Mr. Holmes gave me the opportunity to inspect the drawings for the City of Pasadena's concrete Pine Canyon Dam recently approved by the State Engineer, and of the rock fill dam 255 feet high then being considered for the Los Angeles County Flood Control District on West Fork of San Gabriel River.

4. Mr. Holmes informally discussed other items affecting the dam but not necessarily affecting the safety of the dam including:

Elimination of upper portion of concrete core wall.

Make round outlet tower instead of octagonal.

Elimina tion of toe walls.

Elimination of drains above lower toe wall.

Construction of model of spillway.

Spillway under-drainage.

Consideration of type of dam being submitted by Los Angeles County Flood Control District for San Gabriel dam No. 2.

Elimination of berms elevation 700 and up.

Fred D. Pyle
Engineer

FDP/p

1-24-35
copy/p

2240

February 2, 1932

M E M O R A N D U M

San Diego River Project, El Capitan Dam and Accessory Design. Telephone conference State Consulting Engineer L. C. Hill

1. Mr. Hill advises that:

Outlet Tunnel

1. The outlet tunnel definitely be located on the left and/or south side.

2. Location: That the elevation of the invert of the by-pass tunnel at the entrance end be about 5 feet above streambed, and

That the elevation of the invert of the by-pass tunnel at its discharge end be 10 feet below streambed.

Spillway

3. Spillway design may properly be omitted at this time as has been the accepted policy at a San Gabriel Dam.

Outlet Tower

4. No conference. But I see no objection to its location outside the cross section of the dam.

HNS/f
cc Engineer F. D. Pyle
Resident Engineer Harold Wood
Assistant Deputy State Engineer W. H. Holmes

8/20/34
copy /f

February 6, 1932

Honorable Edward Hyatt, State Engineer
Department of Public Works
Division of Water Resources
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature. Drawings and Specifications.

My dear Mr. Hyatt:

Enclosed for your consideration and approval, if found to be satisfactory, are three copies of drawings and specifications for the City of San Diego's El Capitan Reservoir Dam and accessory structures, which have been prepared in accordance with the suggestions contained in your letter dated January 14, 1932; the State Consulting Engineer Mr. L. C. Hill's letter to you dated December 12, 1931, and oral suggestions by Assistant Deputy State Engineer W. H. Holmes.

The diversion and outlet tunnel has been located under the south abutment.

The grade of the tunnel has been lowered at the entrance end and raised at the exit end.

The outlet tower has been located clear of the embankment.

The general design of the spillway has been changed.

The capacity of the spillway has been increased to about 70,000 cubic feet per second with about 4-foot freeboard not including parapet which, with pondage above spillway crest, will care for the maximum flood that your office has indicated may occur only once in 1000 years.

Upon receipt of your favorable reaction to the drawings and specifications, modifications, if deemed essential by you, will be made and tracings in duplicate will be furnished you for your official approval.

It is understood that your approval is not necessary of drawings WD-285 Geography; WD-290 Log of Drill Holes and WD-351 sheets 1, 2 and 3 of 3, showing material available for hydraulic fill. Prints of these drawings have heretofore been furnished your office.

It is understood that with your approval of the generic drawings submitted herewith, the City's drawings and specifications and call for bids may be issued and contract let.

It is also understood that it will be necessary to secure your approval of each drawing showing structural details of the tunnel portals, outlet tower and spillway, as and when finally designed, before construction is undertaken on each of the structures. The detail drawings of these structures will be advanced to completion for transmission to you at an early date.

Your earliest practicable consideration and tentative approval of the drawings and specifications will be appreciated.

It is assumed that you will send a copy of the drawings and specifications to the State Consulting Engineer.

A duplicate copy of the drawings and specifications is being sent to Regional Engineer of the U. S. Forest Service at San Francisco.

I anticipate being in Sacramento about February 11-13 for technical conference with you and/or your Deputy Engineers for the purpose of expediting your consideration and to provide and ascertain from you any further information which you may desire.

Very truly yours,

H. N. Savage
Hydraulic Engineer.

HNS/p
Encls. (18)
Drawings (15)
WD-382 Plan
WD-383 Cross Section
WD-384 Longitudinal Section
WD-385 Spillway
WD-386 Outlet Tunnel and Core Wall
Specifications El Capitan Reservoir Dam (3)

8/20/34
copy /f

February 6, 1932.

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL

OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Feature, Drawings and Specifications.

Gentlemen:

Drawings and specifications for the El Capitan Reservoir Dam, prepared in accordance with the suggestions contained in the State Engineer's letter dated January 14, 1932; the State Consulting Engineer L. C. Hill's letter to the State Engineer dated December 12, 1931, and oral suggestions of Assistant Deputy State Engineer W. H. Holmes, have been this day forwarded to each the State Engineer at Sacramento, the Assistant Deputy State Engineer at Los Angeles, and to E. W. Kramer, Regional Engineer U. S. Forest Service, San Francisco, California.

In transmitting the drawings and specifications, requests have been made for their consideration and approval at the earliest practicable date in order that the work may be advertised as soon as possible.

It is deemed important that the Hydraulic Engineer be in Sacramento and San Francisco about February 11-13 to concur with each the State Engineer and/or his Deputies and the U. S. Forest Service Regional Engineer, respectively, in order to advance as rapidly as practicable their understanding and consideration of the City's drawings and specifications.

Opportunity should also be accepted to contact the U. S. Land Office in Los Angeles and the U. S. Forest Service in San Francisco for the purpose of securing final approval of necessary rights of way for the El Capitan reservoir and accessory structures and camp grounds for City and contractor forces and for the installation and operation of the El Capitan Reservoir-Lakeside reach of the El Capitan Reservoir-San Diego main pipe line.

Very respectfully,

H. N. Savage,
Hydraulic Engineer

HNS/f
Encls.

8/20/34
copy /f

2244

February 13, 1932

Honorable Edward Hyatt
State Engineer
Department of Public Works
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature. Spillway capacity.

My dear Mr. Hyatt:

A study has been made of the discharge capacity of a 510 foot crest side channel spillway for the City of San Diego's El Capitan reservoir as indicated on Drawing WD-385 submitted to you nn February 6, 1932, and of the flood regulation of the reservoir pondage above the spillway crest elevation 750.

The discharge of the spillway was computed according to the method set forth by Mr. Julian Hinds in the Transactions of the American Society of Civil Engineers, page 881, Volume 89.

The study was based on an imaginary 1000 year flood flow characteristic as indicated in the report on Probable Size and Frequency of Floods at El Capitan Damsite prepared by Robert L. Wing of your office.

In making the computations the average discharge for each hour was computed and the spillway discharge and pondage computed on an hourly basis. It was assumed that the discharge previous to the zero hour as given by Mr. Wing was the same as the discharge for the zero hour, that is 21,500 cubic feet per second.

Even with such an imaginary flood (peak = 102,000 cubic feet per second or 540 cubic feet per second per square mile) the maximum reservoir level was estimated to be about elevation 763.

The results of the computations are as follows:

(1) Ponding at beginning of peak inflos 9,200 acre feet, water level at elevation 755.6 or 5.6 feet above spillway crest.

(2) Maximum water surface at end of 10th hour elevation 763 or 3 feet below top of dam and 7 feet below top of parapet and 13 feet above spillway crest.

(3) Maximum discharge about 75,000 cubic feet per second.

(4) Reservoir ponding at maximum reservoir level 21,700 acre feet.

Very truly yours,

H. N. Savage
Hydraulic Engineer.

HNS/p

8/9/34
copy/f

2245

February 23, 1932

Honorable Edward Hyatt
State Engineer
Sacramento, California.

Subject: San Diego River Project, El Capitan Dam Feature. Drawings.

My dear Mr. Hyatt:

Submitted herewith for your consideration and approval are duplicate tracings of drawings for the City of San Diego's San Diego River Project, El Capitan Reservoir Dam, Spillway and Outlet Works, as follows:

WD-382	Plan
WD-383	Cross Section
WD-384	Longitudinal Section
WD-385	Spillway
WD-386	Outlet Tunnel and Core Wall
WD-390 Sheet 1	Outlet Tunnel Approach
WD-390 Sheet 2	Outlet Tunnel Outlet

Drawings WD-382, WD-383, WD-385 and WD-386 have been modified and drawing WD-390 Sheets 1 and 2 have been prepared in accordance with request of H. N. Savage, Hydraulic Engineer, as contained in his letter of February 19, 1932, which was prepared after consultation with your office, copy of which was furnished you.

Your early consideration and official approval of the tracings is earnestly invited and will be appreciated.

Respectfully,

Fred D. Pyle
Acting Hydraulic Engineer

FDP/p
Encls. (21)
Duplicate tracings (14) WD-382,383,384,385,386 and 390 Sheets 1 and 2
Prints of above drawings (7)
cc Assistant Deputy State Engineer Los Angeles, with prints (7) of above drawings

cc Hydraulic Engineer, Washington, D.C.

8/9/34
copy /f

2246

February 23, 1932

TO THE HONORABLE, THE MAYOR AND COMMON COUNCIL
OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Feature
State Engineer's Approval of Drawings.

Gentlemen:

The minor changes suggested by the State Engineer's office in consultation with Mr. H. N. Savage on February 19, 1932 in connection with the drawings and specifications for the City of San Diego's San Diego River Project, El Capitan Reservoir Dam, Spillway and Outlet Works, have been made on the tracings and the tracings are ready for making the necessary mercury reproductions for filing with the State Engineer for his official approval.

The approval of the drawings may be expedited by having Mr. Harold Wood, Resident Engineer El Capitan Feature, take the drawings to Los Angeles Wednesday morning, February 24, 1932, discuss them with Assistant Deputy State Engineer W. H. Holmes, and proceed to Sacramento Wednesday evening to present them to the State Engineer Thursday, February 25, 1932, and to make any further minor adjustments that may be required.

RECOMMENDATION: It is respectfully recommended that Harold Wood be authorized to travel to Los Angeles and Sacramento in connection with securing the approval of the State Engineer of the drawings for the El Capitan Dam, and to incur such expenses as may be incident to said trip.

Respectfully,

Fred D. Pyle
Acting Hydraulic Engineer

FDP/p

8/9/34
copy/f

February 29, 1932

TO THE HONORABLE, THE MAYOR AND THE COMMON COUNCIL

OF THE CITY OF SAN DIEGO, CALIFORNIA.

Subject: San Diego River Project, El Capitan Feature, Drawings and Specifications, Approval by State Engineer.

Gentlemen:

This is to advise that Resident Engineer Harold Wood is leaving Sacramento this afternoon with the City's copy of duplicate tracings of the El Capitan Reservoir Dam which have been signed by the State Engineer.

Very respectfully,

Fred D. Pyle,
Acting Hydraulic Engineer.

FDP/f

STATE INSPECTION OF DAM

June 6, 1932

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Application No. 8-7. Excavation for foundation for masonry toe walls and for puddle core.

Dear Mr. Hyatt:

When designing the El Capitan Reservoir Dam it was planned to excavate down through the gravel bar of soil, sand and gravel, and trench well into the underlying decomposed granite to suitable rock foundation into and upon which to erect the upstream masonry toe wall as shown on contract drawing WD-383 (print enclosed), including an additional reach of excavation along the surface of the underlying decomposed granite from the base of the toe wall downstream about 15 feet. It is deemed not necessary to excavate along the surface of the underlying decomposed granite from the base of the toe wall upstream to exceed 10 feet.

It is planned to utilize the rocky material as excavated from the upstream one-half of the bypass tunnel, about 11,000 cubic yards will be available, to backfill adjacent to and upstream from the masonry toe wall to at least the elevation of the top of the wall.

The gravel bar material, of which a relatively large quantity, estimated about 35,000 cubic yards, is being excavated for the masonry toe wall foundation and stripping along the adjacent underlying and decomposed granite 15 feet downstream from the base of the toe wall and 10 feet upstream from the base of the toe wall is being dumped upstream but conveniently adjacent so if deemed required it can be spread back over the upstream toe of the dam.

It is planned to excavate for foundation for the puddle core of the hydraulic fill down through the gravel bar of soil, sand and gravel and well into the underlying decomposed granite (and to trench well and deeply into suitable rock foundation for core wall installation) and upon which to found the puddle core, including an additional reach along the underlying decomposed granite 50 feet upstream from the base of the puddle core, as shown on drawing WD-383; and

It is planned not to excavate or remove any of the gravel bar between 15 feet downstream from the base of the upstream masonry toe wall downstream to within 50 feet of the base of the puddle core.

All existing tree stumps and vegetable matter are being removed from the gravel bar to the depth existing, usually 7 feet or more, after which it is planned to level up the surface of the gravel bar upon which to dump the loose rock embankment material.

The contractor has outlined his construction policy to concurrently excavate for foundation for the upstream masonry toe wall; and

Haul material, install plant, and screen and stock-pile concrete aggregate; and

Drive and concrete line the bypass tunnel, wasting the suitable rock excavated therefrom adjacent to and upstream from the masonry toe wall; and

Quarry, haul and dump loose rock embankment in the upstream portion of the base of the dam to elevation about 640;

Thereby accomplishing by December 1932 an effective diversion dam and bypass tunnel with flood discharge carrying capacity of about 24,000 cubic feet per second.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encl. Drawing WD-383

cc Senior Engineer of Dam Inspection

1-31-35
copy/p

June 21, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State official inspection of dam foundation

1. The river bed portion of the El Capitan dam foundation was inspected on June 20, 1932 by Gerald McKinlay, Senior Engineer of Dam Inspection, California State Department of Public Works. The inspection had to do principally with the area of the riber bed fill and stripping being done between the toe wall excavations and the future excavation to be made for the puddle core.

2. On Page 2 of the Hydraulic Engineer's letter of June 6, 1932 to Edward Hyatt, State Engineer, the following appears:

> "All existing tree stumps and vegetable matter are being removed from the gravel bar to the depth existing, usually 7 feet or more, after which it is planned to level up the surface of the gravel bar upon which to dump the loose rock embankment material."

3. Mr. McKinlay opposes the idea of leveling up and states that he prefers to have us deposit the loose dumped rock directly on the river bed as stripped and as will be formally approved in the near future.

4. Mr. McKinlay seemed to be much concerned over material of a sandy clay nature existing in a lense with a maximum depth of about 3 feet lying immediately below the surface of the gravel bar and adjacent to the downstream edge of the upstream toe wall excavation. Mr. McKinlay stated that in his opinion this material was unsuitable to be under a rock fill structure. He withheld any definite statements relative to the necessity for its removal pending the contemplated inspection by George W. Hawley and himself on June 23.

5. In the meantime exploratory trench of this lense of clay is being undertaken to disclose something more of its downstream extent.

6. It is recommended that this apparently small quantity of material of sandy clay nature be removed and that the excavation thereby made be filled with loose dumped rock.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

June 25, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of dam foundation

1. On June 23, 1932 George W. Hawley, Deputy State Engineer in Charge of Dams, Gerald McKinlay Senior Engineer of Dam Inspection and Samuel A. Hart, Associate Engineer, State Supervision of Dams, visited the El Capitan damsite and inspected the excavations for the upstream and downstream toe wall, outlet tunnel, and location of outlet tower, and the stripping of the riverbed under the base of the dam.

2. H. M. Savage, Hydraulic Engineer, A. W. Albert Consulting Engineer for the contractor, and Harold Wood, Resident Engineer, were present.

3. Instructions were issued the contractor to sink an exploration pit at a point in the center of the old river channel and about 60 feet east of the axis of the dam. Also to continue the pit already opened at a point 250 feet south of the above pit and to proceed to unwater these two pits so inspection of the riverbed fill material could be made.

4. Mr. Hawley stated that any clay layers present under the foundation should be removed. Mr. Hawley stated that the top of the layer of cemented gravel and boulders was a satisfactory foundation for the rock fill.

5. Mr. Savage stated to the Resident Engineer and to Mr. Albert that he would probably be more insistent on quality of foundation than the State's inspectors and engineers.

6. There is enclosed a drawing showing to scale the 7 points at which clay has been uncovered in the foundation excavation work. Tabulated on this drawing are the elevations of the top and bottom of the various clay deposits.

7. There was no clay in the test pit No. 8 dug in the river channel on June 24.

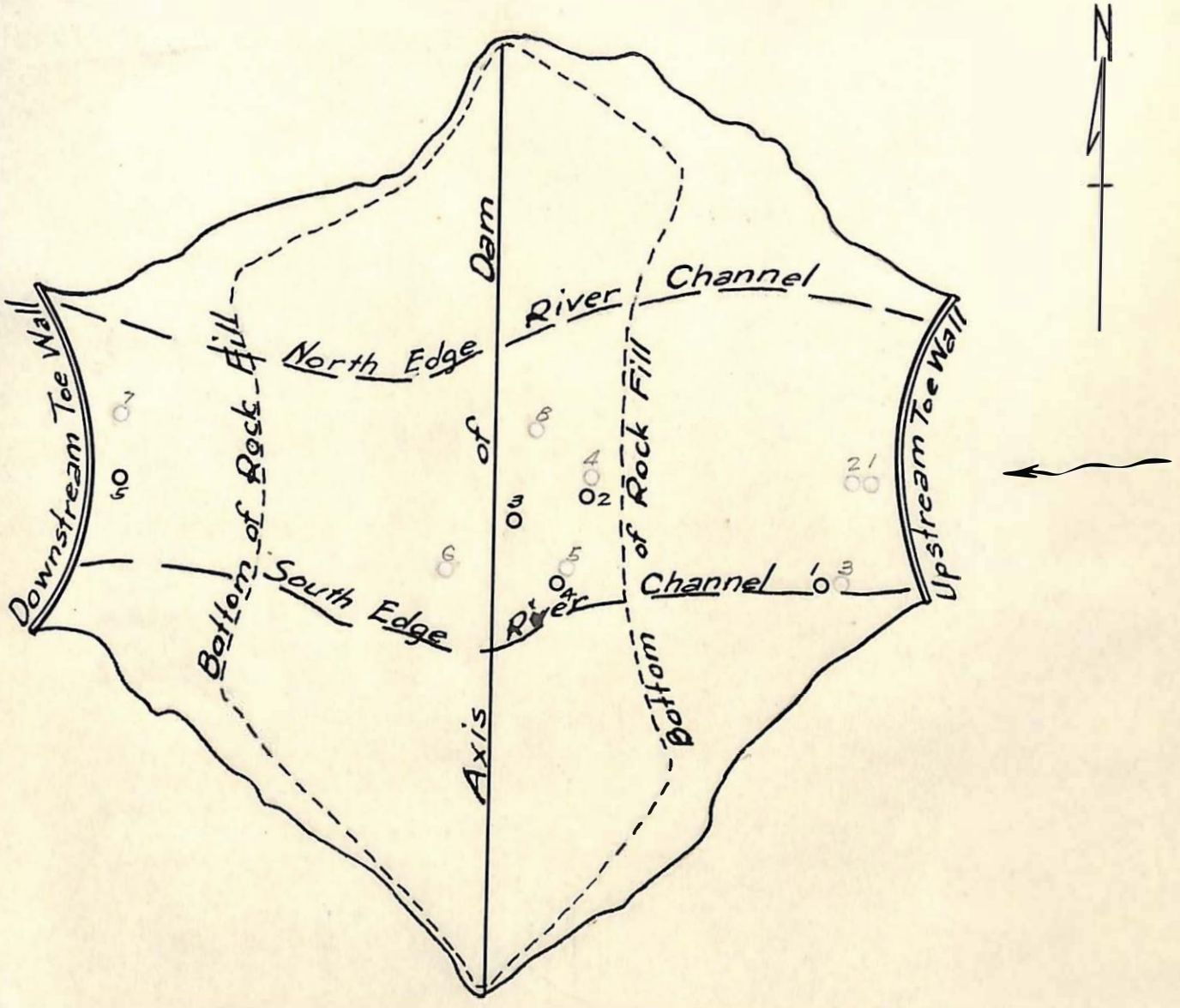
Harold Wood
Resident Engineer

HW/p
encl.

1-31-35
copy/p

SAN DIEGO RIVER PROJECT, EL CAPITAN FEATURE

Location and elevation of blue clay deposits exposed by excavations in dam area. Samples taken July 5, 1932.



Point No.	Natural Ground	Top Clay	Bottom	Remarks
1		553.0	552.0	
2	562.5	562.0	560.0	
3	563.0	560.5	559.0	
4	559.0	553.0	551.0	
5	560.0	551.0	549.5	
6	561.0	552.0	551.0	Gravel deposited in clay
7	555.5	548.0	546.0	75% gravel and sand
8				No clay

Samples taken July 5, 1932 indicated by ink figures.
H.W.

Scale of Feet
0 100 200

G.W.C.
6/24/32

2-20-35
copy/p

2254

July 6, 1932

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Reservoir
Application No. 8-7. Excavation for foundation for masonry toe walls and for puddle core.

Dear Mr. Hyatt:

Your attention is invited to my letter, subject as above, dated June 6, 1932, paragraph 5.

> "It is planned not to excavate or remove any of the gravel bar between 15 feet downstream from the base of the upstream masonry toe wall downstream to within 50 feet of the base of the puddle core."

Following the visit and inspection, June 23, 1932, by Deputy State Engineer George W. Hawley, Associate Engineer Samuel A. Hart, and Senior Engineer of Dam Inspection Gerald McKinlay, samples of materials were obtained from pits excavated down into sand, silt and clayey appearing subsurface lenses located as shown on attached drawing.

Preliminary physical analysis of the samples so obtained have been accomplished by the City's Testing Engineer Mr. J. Y. Jewett, with results shown in his letter dated July 6, copy enclosed.

Sample "A"		12% silt and clayey 88% sand and gravel
"	1	48% silt and clayey 52% sand
"	2	31% silt and clayey 69% sand
"	3	16% silt and clayey 84% sand
"	4	18% silt and clayey 82% sand
"	5	15% silt and clayey 85% sand

The Testing Engineer is continuing analyses of silt and clayey appearing material occurring in the samples containing portions of each therein.

The contractor's excavations have already removed in their entirety two of the detached lenses of sand, silt and clayey appearing material, areas of each less than one thousand square feet and a maximum thickness of less than two feet, and the lenses occurring at different elevations.

A survey shows that to remove all the material in which the detached lenses have been disclosed and which may occur will necessitate the removal of about 50,000 cubic yards of material in place and replacement by rock at a total cost of upwards of about $60,000.

No reason was originally seen or apprehended requiring the removal of "any of the gravel bar between 15 feet downstream from the base of the upstream masonry toe wall downstream to within 50 feet of the base of the puddle core."

The above explorations, samples taken and analyzed are believed to fully confirm and support the City Engineer's original conclusions and policies indicated in my letter to you above referred to and dated June 6, 1932.

Unless required by you and so advised by immediate telegram, it is deemed proper not to order the contractor to excavate this about 50,000 cubic yards of material in place.

Very truly yours,

H. N. Savage
Hydraulic Engineer

HNS/p
cc-Gerald McKinlay, Senior Engineer of Dam Inspection
encls.(3)
Drawing
Copy letter 7/6/32 J.Y.Jewett

1-31-35
copy/p

2256

July 11, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection of Foundation

1. On July 10, 1932, Deputy State Engineer Geo. W. Hawley, State Geologist Chester Marliave and Senior Engineer of Dam Inspection Gerald McKinlay inspected the foundation excavations at the El Capitan dam with particular reference to the necessity for stripping the river bed fill material under the rock embankment portions of the dam.

2. Fred D. Pyle, J. Y. Jewett and Paul Beermann were also present and made a similar inspection.

3. After the inspection, which lasted from about 1 P.M. to 4:30 P.M., a conference was held between the parties as above in the office of the Resident Engineer at the City's El Capitan camp.

4. At this conference Mr. Hawley stated it was the opinion of all three of the State's men making the examination that the river bed fill material under the rock embankment portions of the dam overlying the cemented gravel should be removed. Mr. Hawley stated that in their judgment the cemented gravel would be entirely satisfactory as a foundation for the rock embankment.

5. Mr. Hawley said there were three reasons in his opinion for making this requirement.

(1) The fine nature of the sandy silt was of such a character that it would tend to offer very little resistance to lateral pressures which would be developed from the puddle core pressure.

(2) The fact that the clay nature of these lenses would tend to permit local displacements and settlements due to the material being displaced laterally by the vertical pressures.

(3) The fact that the material was so fine that it might be transported and piped out into the larger sand and gravel interstices during the draining of the hydraulic fill either during construction or upon lowering of the reservoir water surface.

6. Mr. Pyle took the initiative in the various arguments in support of our contention that it was unnecessary to remove this material. He pointed out the fact that the material is in small lenses, has a high sand content and not entirely plastic, is in thin lenses and that the exceedingly flat and massive slopes of the rock embankment would preclude any possibility of lateral movements.

7. Mr. Hawley stated that the extent of stripping indicated on drawing WD-415 was what they considered as being required. That the excavation should remove the materials overlying the cemented gravel.

8. Mr. Hawley said they would incorporate a statement of their requirement for stripping in a letter to be written July 11 and that the work of stripping would be approved progressively in order not to delay the placing of rock embankment.

9. Not being able to get anything definite at this conference, I showed Mr. Hawley a copy of a telegram dated July 8, 1932 from State Engineer Edward Hyatt, as follows:

> "H. H. Savage, Engineer in Charge
> San Diego Water Supply 524 F St San Diego Calif.
>
> Refer your letter July sixth stop material found unsuitable or unsatisfactory for foundation El Capitan Dam from tests or field examination must be removed stop Hawley will arrive El Capitan Dam about noon Sunday July tenth for field inspection stop would appreciate your being there for conference and discussion with him.
>
> Edward Hyatt"

I asked Mr. Hawley if he had seen this telegram. He said he had concurred in this telegram and thereupon, at my request, put his initials in red pencil upon the copy. Mr. Pyle took this copy of the telegram to the San Diego office of the Hydraulic Engineer.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

July 11, 1932

From : Engineer Fred D. Pyle

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
Stripping under rock embankment

1. On July 10, 1932 in company with Harold Wood, Paul Beermann and J. Y. Jewett, I made an inspection of the El Capitan damsite including all excavation, tunnel work, contractor's rock quarry site, and contractor's concrete aggregate plant.

2. Geo. W. Hawley, Deputy State Engineer in Charge of Dams, Gerald McKinlay, Senior Engineer of Dam Inspection, and Chester Marliave, Geologist for State Engineer's office, arrived at the damsite about 1:30 P.M. and made a close inspection of all excavation, requiring about three hours.

3. In discussion following in the office of the Resident Engineer Mr. Hawley advised that the State's representatives gave their approval only when foundation was satisfactory for placing of materials, concrete, rock embankment or hydraulic fill, and could not say in advance what depth of excavation might be necessary in order to secure conditions which would be approved.

4. He stated that because of the height of the El Capitan Dam, and the characteristics of the material so far exposed in the various excavation areas, no areas except in the deeper excavation areas could be approved for foundation of rock embankment.

5. Mr. Hawley believed that it would be necessary to excavate for foundation of rock embankment to the top of the cemented gravel and more impervious material as exposed in the bottom of the first bench as excavated for the northerly two downstream drains, and to material similar to that exposed in the upstream slope of the upstream toe wall about where the water comes out of the overlying material.

6. Mr. Hawley was advised as to your desire for definite written approval or disapproval of the foundation for rock embankment and demurred to furnishing such statement but finally agreed to write you on his return to his office.

7. He was furnished prints of sheets 1 and 2 of drawing WD-415 showing location of foundation excavation and sections across river bottom at El Capitan Dam.

8. Mr. Marliave took Mr. Hawley and Mr. McKinlay into Tunnel No. 3 to show them some signs of slippage planes.

Fred D. Pyle
Engineer

FDP/p

2-20-35
copy/p

STATE OF CALIFORNIA
Department of Public Works

803 California State Bldg.
Los Angeles, California

July 12, 1932

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

Subject: El Capitan Dam No. 8-7

Dear Sir:

Responsive to your letter of July 6, 1932, and in accordance with Mr. Hyatt's telegram of July 8, 1932, Messrs. Marliave, McKinlay and myself visited the El Capitan Dam site on July 10, 1932, to inspect the work done to date, and more particularly observe the formations and materials which have been exposed to date.

As a result of our observations, a study of the tests of materials made under your direction and an examination of the materials disclosed in the various excavations, pits, etc., it is concluded that those materials whose physical properties and characteristics are such as to preclude their consideration as satisfactory or stable foundation materials for this dam will have to be excavated and removed in order to secure suitable foundation for the embankment. In general, all unsuitable and objectionable materials of questionable stability, consisting in large part of the sandy clays, silts and sands of fine grain size should be removed.

Those materials shown in hachure on your Drawing WD-415, dated July 1, 1932, insofar as we were able to ascertain from the work progressed to date, and from discussion had with your engineers, should be removed to and including the designated sandy clay layer. The extent of the necessary stripping cannot be specifically determined in detail at this time. As this excavation progresses, and only then, can competent final judgment be had as to the adequacy of the foundation materials encountered to safely sustain the dam.

Very truly yours,

DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

Geo. W. Hawley
Deputy in Charge of Dams

GWH:er

3-7-35
copy/f

2260

August 5, 1932

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature
Drains under downstream rock embankment.

Dear Mr. Hyatt:

Enclosed for your appropriate action and official approval if found satisfactory, are two prints of City of San Diego Water Department Division of Development and Conservation Drawing WD-421, showing the general structural and hydraulic features of the three drains to be constructed under the downstream portion of the City's El Capitan reservoir dam.

The general location and type of drains are indicated on Specification Drawings WD-382 and WD-386. The location of the drains has been changed slightly to better meet the requirements disclosed by the excavation and removal of the overburden material from the foundation area of the dam. It has been found necessary to make changes in the size and structural design of the drains to better serve the purpose for which their installation is required.

The excavation for the drains is now practically completed and the contractor hopes to commence forming the concrete masonry in a few days.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encl. Drawing WD-421 (2)

1-31-35
copy/p

2261

August 3, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of dam foundation

1. On August 2, 1932 Mr. Gerald McKinlay, Senior Engineer of Dam Inspection, State Department of Public Works, visited the damsite and inspected the area stripped for rock embankment; also foundation excavation for upstream and downstream toe walls. Mr. McKinlay took photos of upstream toe wall excavation and easterly face of area stripped for puddle core.

2. After Mr. McKinlay had completed his tour of dam inspection he stated before Hydraulic Engineer H. M. Savage, Construction Accountant A. D. Williams and Assistant Engineer L. M. Hill in the City Resident Engineer's office that entire area stripped for rock embankment is now satisfactory for placing rock upon.

3. Mr. McKinlay stated that he did not believe it would be necessary to carry toe wall excavation below grades established, he was of the opinion that same formation would be encountered to a considerable depth.

Harold Wood
Resident Engineer

HW/f

1-31-35
copy/p

August 19, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection of Dam Foundation.

1. On August 19, 1932, Deputy State Engineer, Geo. W. Hawley visited and inspected the foundation for the rock fill portion of the El Capitan Dam.

2. At this time stripping of the foundation under the rock embankment at the south or left abutment end of the downstream toe wall between the south drain and the north exit portal wall was in progress.

3. Deputy State Engineer Geo. W. Hawley directed that soil and overburden under the rock embankment above the toe wall at the left abutment be removed down to decomposed granite or c cemented gravel.

4. The Hydraulic Engineer accompanied the Deputy State Engineer on this inspection trip.

Harold Wood
Resident Engineer

8/24/32

When inspecting the dumping of rock for the rock embankment portion of the dam between the upstream toe wall and the cutoff wall location from the right and north roadway on August 19, 1932, Deputy State Engineer George W. Hawley stated to the Hydraulic Engineer that in his opinion there was no objection to the contractor using decomposed granite muck from the bypass tunnel excavation for smoothing up the surface of the dumped rock embankment to provide roadway for the rock hauling trucks to run over, and back over.

H. M. Savage,
Hydraulic Engineer.

1-31-35
copy/p

September 1, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection of dam foundation

1. On September 1, 1932, Assistant Deputy State Engineer W. H. Holmes, visited and inspected the core wall trench and outlet tunnel of the El Capitan Dam.

2. Mr. Holmes conferred with Hydraulic Engineer H. N. Savage on the ground and expressed the idea that there should be some finer material placed in the rock embankment adjacent to the downstream face of the upstream toe wall to insure there always being rock embankment contact with the vertical face of the upstream toe wall.

3. The matter of weir notches 2 feet deep and 4 feet wide being left in the top of the upstream toe wall was discussed; it was decided to leave 4 such notches.

4. Mr. Holmes emphasized the idea that the core wall would probably be quite deep before acceptable to the State.

5. Mr. Holmes and Mr. Savage discussed the San Dieguito dam situation.

Harold Wood
Resident Engineer

HW/p

2-14-35
copy/p

Lakeside, California
September 27, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of bottom portion of core wall

1. On September 26, 1932 Gerald McKinlay, Senior Engineer of Dams and Chester Marliave, State Geologist inspected the core wall trench between coordinates N 3470 and N 3760 at the El Capitan Dam.

2. Upon completion of their inspection as above, Mr. Marliave stated that "good rock" was exposed in the bottom at the ends of the trench. He also said there were two well defined "shear zones" disclosed which in his opinion would require special consideration.

3. On September 27, 1932 Mr. McKinlay, Mr. Marliave and Deputy State Engineer George W. Hawley inspected all the work underway at the dam and particularly the core trench.

4. Mr. Hawley stated that it was his opinion the bottom of the trench be squared up; that grout holes be drilled in the bottom, that final cleaning be done and that the Los Angeles office of the State Engineer be notified so that final inspection could be arranged. Upon the completion of this final inspection then definite instructions would be issued for the special treatment of the shear zones. This special treatment might be the addition of several extra grout holes or possibly a deep shaft would be required to be backfilled with concrete.

5. Mr. Hawley asked my opinion on grouting and I told him that a definite policy had not been outlined by the Hydraulic Engineer, but that I had considered grout holes at 10 foot intervals along the axis and to a depth as much as 20 feet as being what might be required. Mr. Hawley suggested the holes be at 5 foot spacing staggered on each side of the width of the trench and 25 foot depth be drilled for grouting.

6. I explained that the specifications provided for copper water stop at all vertical and horizontal construction joints.

7. Mr. Hawley asked about the placing of the fill adjacent to formed portion of the core wall. I explained that this might be done by rolled fill method as provided in the specifications. Mr. Hawley remarked that the State had given approval for a hydraulic fill.

Harold Wood
Resident Engineer

2-15-35
copy/p

El Capitan Dam

October 7, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of bottom portion of core wall

1. On October 6, 1932 at 4 P.M. Gerald McKinlay, Senior Engineer of Dam Inspection, inspected the core wall trench of the El Capitan dam between coordinates N 3470 and N 3760.

2. After inspecting the trench, he told the Resident Engineer in the presence of the contractor's superintendent Ben F. Wells that the core trench foundation was acceptable and ready for placing the concrete between coordinates N 3470 to N 3660.

3. Concreting was begun between coordinates N 3480 and N 3649 on October 7.

4. Grout holes will be drilled thru the concrete. This was explained to Mr. McKinlay and was orally approved.

Harold Wood
Resident Engineer

HW/p

2-14-35
copy/p

El Capitan Dam
October 14, 1932

2266

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of corewall foundation

1. On October 13, 1932, Mr. Gerald McKinlay, Senior Engineer of Dam Inspection for the State, inspected the core wall foundation at El Capitan dam in the afternoon.

2. The inspection covered the core wall trench excavation from coordinate N 3649 (north end of first concrete placed) to N 3770 or north end of the trench as excavated.

3. Upon completing the inspection Mr. McKinlay stated in the presence of the Hydraulic Engineer, Resident Engineer, H. W. Rohl and T. E. Connolly, that the core wall foundation was satisfactory and "go ahead and concrete".

4. The geological formations encountered in the core trench and inspected by Mr. McKinlay on October 13 are decomposed granite near the surface. The bottom about four feet of the trench is hard, residuary granite. Between the parts of this hard granite are seams and masses of decomposed granite. The bottom of the trench was in practically continuous hard rock.

The rock and decomposed granite shows half the drill holes where blasted along the sides of the trench.

Crossing the core trench from northeast to southwest at an angle of 33 degrees with the axis of the dam is an almost vertical plane of hard reddish material about 3/16 inch thick. This plane of red material intersects the upstream side of the 6 foot trench at coordinate N 3668 and E 5003. There is evidence on this seam of some geological movement in a nearly horizontal plane. For about four feet on both sides of this seam the granite is more decomposed and crushed. This area was referred to by Chester Marliave, State Geologist, as a "shear zone".

A similar shear zone crosses the axis of the dam at N 3439 in a northeast to southwest direction at an angle of about 38 degrees. The plane is about vertical and shows the same reddish material. This zone is not as extensive in width of crushed area and occurs in much harder rock. Grout holes are being located in an attempt to reach both the seams which show evidence of some movement. No special treatment has been requested by the State inspectors for either of these "shear zones".

5. At this visit Mr. McKinlay inspected the rock fill being placed adjacent to both sides of the upstream toe wall. Mr. McKinlay commented on this toe wall being good work to hold the water pressure. The water surface elevation then being within 6.5 feet of the top of the toe wall.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

October 15, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection

1. On October 15, 1932, State Engineer Edward Hyatt, accompanied by Colonel Ed Fletcher of San Diego, Assistant Hydraulic Engineer Fred D. Pyle, the contractor's Consulting Engineer D. W. Albert and the City's Resident Engineer Harold Wood, visited and inspected the El Capitan Dam.

2. Mr. Hyatt expressed himself as pleased with the progress being made and the excellent quality of rock embankment material. He was particularly impressed with the details of the core wall construction. He stated "There is no doubt about your getting a good job that way."

3. Mr. Albert explained the contractor's desire and plan to place rolled embankment in the base of the structure adjacent to the core wall on both sides thereof. The Resident Engineer also advised Mr. Hyatt of the City's favorable consideration of placing rolled embankment until sufficient elevation had been obtained to insure gravity drainage from the hydraulic placed material. This the Resident Engineer was instructed to do.

4. Mr. Hyatt said he expected to be able to return within a few weeks and spend a day on the job.

Harold Wood
Resident Engineer

HWS/p

2/2/34
copy/f

October 18, 1932

Mr. Edwerd Hyatt, State Engineer
401 Public Works Building,
Secramento, California.

Subject: San Diego River Project, El Capitan Feature
Embankment vicinity of corewall to
elevation 560. El Capitan Dam No. 3-7

Dear Mr. Hyatt:

The work at the City of San Diego's El Capitan reservoir dam has reached a stage where it is essential that the placing of rolled embankment material in the river bed area be progressed as rapidly as practicable in order to minimize the damage from flood water that may pass thru the upstream rock embankment.

The excavation under the central portion of the dam extends about twenty feet below original streambed level, except for twenty feet on each side of the concrete corewall and trench where it is about ten feet deeper.

The bottom portion of the corewall is being advanced rapidly and upon its completion the depositing in horizontal layers and compacting of the rolled embankment will be undertaken.

Owing to the impracticability of securing an adequate puddle core in this area below elevation 560 by hydraulic placement because of the short beaches and lack of drainage due to relative elevations, it was originally anticipated to be advisable and it is deemed proper to place the material by rolled embankment methods, as set forth in paragraph 64 of the contract specifications.

Enclosed is print of Drawing WD-433 on which is indicated a typical section as excavated and the location of the rolled embankment.

Weather permitting, it is expected that the foundation for this area will be ready for your approval about October 31, 1932.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/p

2/2/34
copy/f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

October 24, 1932

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

This will acknowledge receipt of your letter of October 18, 1932 and two copies of plan WD-433 showing the proposed extent of earthfill. I will discuss this proposed alteration and the plans with you personally when I visit San Diego on Wednesday or Thursday of this week.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

1-31-35
copy/p

October 28, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection

1. On October 26, 1932, Deputy State Engineer Geo. W. Hawley and Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan dam.

2. Inspection of core wall excavation and surface excavations was made and it was indicated that the core trench from N 3470 to about N 3370 might be ready for final inspection Monday October 31, 1932.

3. Deputy State Engineer Hawley and Inspector McKinlay indicated their impression that the core wall excavation in the north abutment might be necessarily deeper than the excavation in the south abutment.

4. The Deputy State Engineer and the Inspector advised that care be experienced in placing the rock embankment to prevent deposition of a major quantity of finer materials in a trough down the slopes.

5. The progress being made by the contractor was favorably commented upon by the Deputy State Engineer.

6. Hydraulic Engineer H. D. Savage arrived at the dam in advance of the Deputy State Engineer and the Inspector, and went over the work with them.

Harold Wood
Resident Engineer

HDS/p

2-13-35
copy/p

El Capitan Dam
November 2, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of core wall

1. On November 1, 1932, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan and particularly the core wall grouting being done, also the final trench excavation for the core wall foundation from coordinate N 3470 to N 3340.

2. There were three minor things to be done to complete this portion of the core wall excavation. Between coordinate N 3445 and N 3433 it was requested that an additional depth of about four feet be made. Between coordinate N 3349 and N 3353 a mass of decomposed granite on the floor be excavated. Rock splinters near coormainte N 3360 be barred out and removed.

3. Mr. McKinlay expressed himself as being of the opinion that the quantity of fine material being placed into the rock fill dam along with the rock had increased in quantity since his visit on October 27. He said that the quantity of this fine material was such that it would be necessary for the State to issue positive instructions.

4. Mr. McKinlay asked me if I had heard of the final decision relative to the matter of placing rolled embankment under the hydraulic fill. I told him I understood from the Hydraulic Engineer that a further conference was to be had and that nothing final had been decided upon. He, therefore, said he was very much surprised that I had not been informed it had been decided there would be no rolled embankment.

5. Mr. McKinlay noted that rock embankment was being placed along the north abutment and immediately east of the downstream toe wall. I told him that this area had been thoroughly stripped to decomposed granite in a manner which I had considered satisfactory for foundation, and that photographs of the foundation area as stripped had been taken and would be available for his review.

6. Mr. McKinlay left his home at 8 o'clock in the morning traveled by plane to San Diego and drove himself to and from San Diego in one of the City's cars, thus saving as much of his time as possible and saving the State considerable expense.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

November 16, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On November 15, 1932 Senior Engineer of Dam Inspection Gerald McKinlay, visited and inspected the work at El Capitan Dam.

2. Inspection of the downstream rock embankment toe was made and it was explained to Mr. McKinlay that the downstream toe trench had been excavated 10 feet into decomposed granite or to solid boulder formation. The trench was filled with water at the time. Mr. McKinlay was satisfied with this as a foundation and asked about the treatment of the slope along the south side adjacent to the channel. It was explained that this slope would be made 1 on 1 with hand placed rock. Mr. McKinlay expressed satisfaction with this.

3. Mr. McKinlay inspected the concrete placement of the core wall and asked about the grouting. It was explained that a full report of all grouting would be prepared later.

4. Mr. McKinlay inspected the rock embankment and stated that there was too much fine material being placed.

5. An inspection was made of the attempt to roughen the top surface of the first lift of the upstream rock embankment by blasting. This is ineffectual and scarifying is required by the State.

6. Inspection of the inlet portal structure was made. No comment was made.

7. An inspection of the quarry was made. An unusual amount of overburden and fines was present near the center of the quarry face. Several loads of this material were wasted while there.

8. Upon completion of the inspection Mr. McKinlay stated to Mr. Ben F. Wells in my presence that it would be necessary to reduce the amount of fine material entering the rock embankment very materially or an order would be issued demanding this be done. Mr. Wells was told to scarify the top surface of the rock embankment before placing additional rock. Mr. Wells said he would do this.

9. Mr. Wells advised me later that both quarry foremen had been given definite instructions relative to loading for wasting all the fines and overburden. These instructions were given subject to threat of dismissal if not complied with.

Harold Wood
Resident Engineer

HW/p

2/2/34
copy/f

WESTERN UNION TELEGRAM

NOVEMBER 16, 1932

EDWARD HYATT, STATE ENGINEER
FOUR NAUGHT ONE PUBLIC WORKS BUILDING
SACRAMENTO, CALIFORNIA

YOUR DEFINITE REACTION REGARDING THE
USE OF ROLLED EMBANKMENT IN
THE CONSTRUCTION OF THE ELCAPITAN
RESERVOIR DAM BELOW ELEVATION ABOUT
FIVE SIXTY AS SET FORTH
IN MY LETTER DATED OCTOBER
EIGHTEENTH NINETEEN THIRTY TWO IS
RESPECTFULLY INVITED AT YOUR EARLIEST
CONVENIENCE.

H. N. SAVAGE

2/2/34
copy/f

2274

POSTAL TELEGRAPH

S163 84-SC SACRAMENTO CALIF 18 218P 1932 NOV 18 PM 2 48

H N SAVAGE, HYDRAULIC ENGINEER
CITY OF SAN DIEGO CALIF 524 F ST SANDIEGO CALIF=

REFER YOUR TELEGRAM NOVEMBER SIXTEENTH STOP CAREFUL CONSIDERATION HAS BEEN GIVEN YOUR REQUEST OCTOBER EIGHTEENTH FOR MODIFICATION OF PLANS ELCAPITAN DAM APPROVED BY THIS OFFICE FEBRUARY SECOND STOP BASED ON FIELD INVESTIGATION AND EXHAUSTIVE STUDY OF PROPOSED CHANGE AND AFTER CONFERENCE AND DISCUSSION WITH YOU AT SITE BY HAWLEY AND MCKINLAY IT IS MY CONCLUSION THAT APPROVAL CANNOT BE GIVEN YOUR REQUEST TO MODIFY APPROVED PLANS TO PERMIT PLACING ROLLED FILL ELCAPITAN DAM AS PROPOSED TO ELEVATION FIVE SIXTY STOP LETTER FOLLOWS TODAYS MAIL=

EDWARD HYATT

2/2/34
copy/f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

November 18, 1932

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

Responsive to your telegram of November 16, requesting approval of a modification of the plans approved by this office February 2, 1932, for construction of the El Capitan Dam, the following telegram was sent you today -

"REFER YOUR TELEGRAM NOVEMBER SIXTEENTH STOP CAREFUL CONSIDERATION HAS BEEN GIVEN YOUR REQUEST OCTOBER EIGHTEENTH FOR MODIFICATION OF PLANS EL CAPITAN DAM APPROVED BY THIS OFFICE FEBRUARY SECOND STOP BASED ON FIELD INVESTIGATION AND EXHAUSTIVE STUDY OF PROPOSED CHANGE AND AFTER CONFERENCE AND DISCUSSION WITH YOU AT SITE BY HAWLEY AND MCKINLAY IT IS MY CONCLUSION THAT APPROVAL CAN NOT BE GIVEN YOUR REQUEST TO MODIFY APPROVED PLANS TO PERMIT PLACING ROLLED FILL EL CAPITAN DAM AS PROPOSED TO ELEVATION FIVE SIXTY STOP LETTER FOLLOWS TODAYS MAIL - EDWARD HYATT"

In response to your communication of October 18, advising that the foundation area at El Capitan dam would be ready for approval about October 31, and that upon completion of the bottom portion of the concrete core wall placement of the rolled embankment shown on your Drawing WD-433 would be undertaken, Messrs. Hawley and McKinlay visited the site on October 26th to inspect the work progressed to date, to examine the foundation conditions as disclosed, and to discuss with you the safety features of the proposed modification of the approved plans, namely, the placement of a rolled fill to elevation five sixty. During the conference at the site Mr. Hawley expressed the opinion that in the interests of safety it was felt inadvisable to place the rolled embankment as shown on your Drawing WD-433. As a result of the discussion had during this conference it was understood that further thought and study would be given this matter and that, if believed desirable, another conference would be arranged for in the event additional pertinent information or thought were to be developed.

Very careful consideration and thought has been given to the proposed change of the approved plans and after exhaustive study it is concluded that approval can not be given your request. This disapproval, based on consideration of the safety features of the proposed change and these alone, is without prejudice

as regards subsequent consideration of technical and construction detail involving safety features.

This action, taken after intensive study of the many elements involved, has included an exhaustive comparison of the merits of the type of construction proposed with that contemplated in the approved plans in the light of past experiences had in this type of construction and in view of the physical conditions which obtain at this site. In general, the combining of a wet and dry fill presents conditions which it is felt are not in accordance with the best engineering practice. The establishment of a smooth horizontal plane at elevation 560; the placement of puddle core, including the two "flanks" on this plane; the reduced frictional resistence of the plane; the bond between the rolled fill with the foundation, with the hydraulic fill and with the concrete cut-off; the effect of water and the hydraulic fill on the rolled fill as regards subsidence, movement, etc.; the material for and method of construction of the dry fill; the behavior of the dry fill when subjected to load and many other related problems are, after having been thoroughly and competently studied, the primary grounds on which our disapproval is based. We, likewise, feel that many advantages are to be had by constructing a puddle core to suitable sound bedrock such as homogenity of type, added stability, better bond, minimized seepage, added sealing of the foundation, all making for lesser uncertainties and indeterminate adverse results.

In other words, your request is disapproved on the grounds that the factor of safety of the dam if built in accordance with the requested modification would not be commensurate with that deemed advisable for so important a structure of such magnitude, nor would the dam, in our opinion, have as great a safety factor as it would if built as a "pure" hydraulic fill.

If, however, you have any additional pertinent data and information which you wish to submit and which you feel is applicable to a further consideration of this matter, kindly be assured that we shall be glad and willing to review and consider it.

Very truly yours,

EDWARD HYATT (Signature)
EDWARD HYATT, STATE ENGINEER

1-31-35
copy/p

El Capitan Dam
November 23, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection

1. On November 23, 1932, Senior Engineer of Dam Inspection Gerald McKinlay, visited and inspected the El Capitan Dam.

2. Mr. McKinlay confered with Ben F. Wells, superintendent for the contractor, relative to their plans for placing hydraulic fill. Mr. Wells said materials would be dumped dry from the rock embankments at either flank of the dam. Sluicing would be done with water from three giants or monitors mounted on three steel barges on the summit pool. Two barges would be placed downstream of the axis and one barge upstream. Mr. McKinlay agreed that this method would secure good results if operated carefully.

3. Mr. McKinlay stated that the decomposed granite surfacing material placed on the top of the rock embankment for roadway must either be more effectually scarified or removed.

4. The core wall trench from N 3762 to N 3795 was not down to elevation 517 as required by Mr. McKinlay and the Resident Engineer. The trench from N 3795 to N 3840 must be carried to greater depth into unshattered rock according to Mr. McKinlay. He stated that when the trench was excavated to elevation 517 as required from N 3762 to N 3792, that this could be concreted without further inspection by him.

5. Mr. McKinlay said he and Deputy State Engineer Geo. W. Hawley would visit the work November 30. If we required Mr. McKinlay's inspection before this date he would come if notified in advance.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

2278

December 2, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Projedt, El Capitan Feature
State inspection

1. On December 1, 1932, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the El Capitan Dam.

2. Mr. McKinlay inspected and approved for concrete placing the core wall trench from coordinate N 3762 (present end of concrete) to N 3840.

3. Mr. Fred D. Pyle, Assistant Hydraulic Engineer, and the Resident Engineer accompanied Mr. McKinlay over the work. The upstream rock embankment and the scarified surface at elevation 580 was inspected and stated to be acceptable by Mr. McKinlay. The strippint of abutments for the upstream rock embankment was inspected and portion completed was accepted. Certain rock numbered on the north abutment between the upstream and downstream rock embankments and between elevation 575 and 640 were indicated for removal and stated that well imbedded boulders need not be removed.

4. The gravel material between the puddle core and the downstream toe of the upstream rock embankment was inspected and Mr. McKinlay stated there was no need of removing this.

5. The gravel pile downstream of the puddle core area is to be removed and may be used to fill road ramps from this area. Its upstream slope shall be reduced. The excess gravel of this pile may be placed along the upstream toe of the downstream rock embankment.

6. Mr. McKinlay was furnished, as he requested, two sets of the four prints showing bottom portion of the core wall. (See letter of transmittal from Resident Engineer dated December 1, 1932). The prints are for his use in posting progress of work and records of portions of foundations already accepted by him.

7. It was expected that this inspection trip would be made November 30, 1932, at which time Geo. W. Hawley was also expected. Mr. Hawley was called north and Mr. McKinlay could not come until December 1.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

December 15, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On December 14, 1932, Deputy State Engineer George W. Hawley, and Senior Inspector of Dams, Gerald McKinlay, visited and inspected the work at El Capitan dam.

2. The inspection covered particularly the foundation stripping of the abutments and the height of the lower portion of the core wall across the river bed.

3. Engineer Fred D. Pyle and the Resident Engineer accompanied the State's engineers. H. M. Savage, Hydraulic Engineer was also present upon the arrival of the State's engineers.

4. The depth of stripping in general required for foundation areas on the south abutment was indicated on the ground by Mr. Hawley. Stakes were set marking these places at the time. The depth of stripping was marked on the upper cut slope of the bench along the south abutment at about elevation 590.

5. The depth under the hydraulic fill was indicated just west of the puddle core area at 3.5 feet. The depth under the puddle core was indicated near its easterly limit at 10 feet. The depth under the rock embankment was indicated at its easterly limit at 5.5 feet.

6. The depth of stripping required on the north abutment was said to be, in general, less than on the south abutment under puddle core and hydraulic fill. No points were indicated here. The stripping for the rock embankment on the north abutment would be about the same as for the south abutment. It was considered necessary to remove all rocks which would project into the puddle core.

7. It was stated by Mr. Hawley that the excavation along the top of the core wall trench should be cut back on side slopes about 1 on 1 for about 8 feet. The mass of boulders on the west side of the core wall trench at about N 3800 should be removed.

8. The bottom portion of the core wall, across the river bottom is to be carried up another 12 feet (one-half a column length) above the tops of the first columns now set. This will make the top of the core wall at elevation 559 or about 6 feet above the bottom of the original stream bed. Since our drawings WD-382 and WD-383 already approved by the State Engineer, show this core wall extending to elevation 770 at the center of the crest of the dam, it is stated by Mr. Hawley it will be necessary for the City to request this change in elevation by letter.

The core wall up the abutments should be in general built so that the top of the concrete will be about 12 feet above the original ground or one 24-foot column length.

9. The puddle core foundation area is required to be cleaned off to firm decomposed granite and should not be scarified as required by the specifications, paragraph 60.

10. The gravel under the hydraulic fill west of the core wall is to be made about level in a direction parallel with the core wall and with its easterly elevation down to elevation about 552 and carried on a straight grade to the downstream rock embankment to elevation 575. The material to be the coarse gravel excavated from the river bed stripping.

11. The gravel bar along the upstream marginal line of the hydraulic fill area in the river bed need not be removed.

Harold Wood
Resident Engineer

HW/p

1/12/34
copy /f

December 21, 1932

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Concrete Reinforced Core Wall, Height. Application No. 8-7

Dear Mr. Hyatt:

The City of San Diego's drawings WD-382 and WD-383 for the El Capitan dam approved by you February 29, 1932, indicate a concrete core wall as extending up through the puddle core to the top of the dam.

It is deemed advisable, and permission is hereby requested to limit the height of the concrete core wall across the base of the dam to Elevation 559. This is about 30 feet above the top of the 6-foot concrete cutoff wall and about 6 feet above the original streambed level and will be one-half of a 24-foot structure steel reinforcement unit higher than the top of the first set of reinforcement units now concreted in place.

The height of the concrete core wall at and up the abutments will be controlled by the conditions and foundation encountered as excavation proceeds.

Your early consideration and reply will be appreciated as it will be necessary to complete the wall across the base of the dam before hydraulic fill operations can be commenced.

Very truly yours,

H. M. Savage
Hydraulic Engineer.

HMS/f
cc Senior Engineer of Dam Inspection

1/12/34
copy /f

2282

Form 10A

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
401 PUBLIC WORKS BUILDING
SACRAMENTO

ORDER AUTHORIZING REVISION OF PLANS AND SPECIFICATIONS

Application No. 8-7
Name of Dam - El Capitan
Stream or Legal - San Diego River
Subdivision - NE-1/4, Sec. 7, T. 15 S., R. 2 E., SBB&M
County - San Diego

TO: Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

WHEREAS, the application of City of San Diego was filed with the State Engineer on November 21, 1931 for the approval of plans and specifications for construction of the above dam; whereas, the said plans and specifications were approved on December 7, 1931 by the State Engineer; and whereas, application has been made by H. N. Savage on December 21, 1932 for revision of said plans and specifications; that said application has been considered by the State Engineer and finds that a proper margin of safety will not be sacrificed by the adoption of such revision.

Now, therefore, you are hereby authorized to revise said plans and specifications as follows:

Limit the height of the concrete core wall across the base of the dam to elevation 559. The elevation of the wall at various points along the abutments shall be determined by conditions encountered as excavation proceeds.

It is understood that the concrete core wall throughout its length shall extent into the puddle section of the hydraulic fill a sufficient distance to assure proper bond with the same and down to and into sound bedrock for its entire length.

WITNESS my hand and the seal
of the Department of Public Works
of the State of California this
23rd day of December, 1932.

EDWARD HYATT (Signature)
EDWARD HYATT, STATE ENGINEER

Reg.
cc-W.H.Holmes (SEAL)

4/13/34
copy /f

December 24, 1932

Mr. Edward Hyatt
State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature. Foundation of hydraulic fill State inspection of December 14, 1932.

Dear Mr. Hyatt:

Deputy State Engineer George W. Hawley and Senior Engineer of Dam Inspection Gerald McKinlay, while inspecting the work at El Capitan reservoir dam on December 14, 1932, discussed with Engineer Fred D. Pyle and Resident Engineer Harold Wood surface grading of certain sand and gravel under the foundation of the hydraulic fill westerly of the cutoff wall.

As a result of this discussion it is deemed proper and in accord with the wishes of your staff as understood, to excavate upstanding portions of the porous sand and gravel westerly of the cutoff wall, and deposit it along and under the downstream side of the hydraulic fill in such manner as to provide a hydraulic beach having a reasonably even slope toward the puddle core and being in its lower reaches reasonably level parallel to the cutoff wall. The face of the water tight gravel under the puddle core to be excavated on a slope of about 1 on 4.

The slopes, outs and fills along coordinates N 3500 and N 3660 are shown on enclosed copy of Drawing WD-443.

Your immediate reaction to the above policy is important since the contractor desires to commence hydraulic placing the earth portion of the dam.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/p
encl. Drawing WD-443

4/13/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

December 28, 1932

Mr. H. N. Savage, Hydraulic Engineer,
City of San Diego,
San Diego, California.

Subject: El Capitan Dam #8-7

Dear Sir:

Referring to your letter of December 24 and prints submitted showing the method proposed for treating the base upon which the hydraulic fill is to be placed.

The only interest the state has in this matter is that grades will be such that proper segregation of materials will take place. The plan proposed would appear to satisfy this condition as far as can be determined prior to the beginning of hydraulic operations.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

1-31-35
copy/p

El Capitan Dam
January 4, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State Inspection

1. On January 3, 1933, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the El Capitan dam construction work.

2. The leveling and shaping of the west beach of the downstream hydraulic fill area which is being done in accordance with stakes set as per red lines drawn on drawing WD-443 was inspected. The slope adjacent to the puddle core area is considered too steep to enable the proper segregation of the hydraulic fill and puddle core materials. Mr. McKinlay stated that the slopes as being built were not as he had intended. He said that his idea was one continuous slope from the top of the decomposed granite under the west limit of the puddle core up to the downstream rock embankment.

3. The stripping of the south abutment was inspected. The stripping completed under the upstream rock embankment area and south of the contractor's river bypass pipe line is not considered complete by the State Inspector. The slopes stripped by the dragline between the power shovel ramps has not been excavated to sufficient depth.

4. Mr. McKinlay inspected the outlet tunnel but made no comments.

5. The top elevation of the core wall up the abutments as indicated by the steel columns now set, was approved as to being sufficiently high when concrete to the top of the columns.

Harold Wood
Resident Engineer

1/6/33

See paragraph 10 Wood's letter of December 15, 1932 where elevation next to the core wall is given as 552. I understood McKinlay on December 1 and McKinlay and Hawley on December 14 to say that the gravel next to core wall would have to be cut back on slope of 4:1 or 5:1 and gravel pile near south side removed and placed next to rock embankment.

F.D.P.

1-31-35
copy/p

January 12, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On January 10, 1933, Deputy State Engineer Geo. W. Hawley, Senior Engineer of Dam Inspection Gerald McKinlay, and the Hydraulic Engineer visited and inspected El Capitan dam and outlet tunnel.

2. The Resident Engineer explained to Mr. Hawley that the core wall was being built to the top of the steel columns up the abutments, and that steps with vertical faces would be formed midway between each column.

3. The stripped foundation area under the upstream rock embankment on the south abutment was inspected as was also the outlet tunnel, core wall and leveling up of the river bed gravel under the downstream portion of the hydraulic fill.

4. The Hydraulic Engineer reported to the Resident Engineer that Mr. Hawley told the Hydraulic Engineer that everything was to his satisfaction.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

January 30, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On January 30, 1933, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan dam and particularly that portion of the core wall trench between coordinates N3310 and N3340.

2. Mr. McKinlay reported that the bottom of the core wall trench between coordinates N3340 and N3316 was satisfactory for concrete. South of N3316 the concrete should not be brough up higher than 3 feet below the present top of concrete at N3340 or elevation 575 until the next southerly excavation is made which should be carried to elevation 575.

3. Mr. McKinlay requested that the grout hole at N3321 be drilled on the west side of the trench the same as at N3317.

4. Mr. McKinlay asked where the earth material being dumped over the west slope of the rock embankment was being obtained. The Resident Engineer told him this material was being obtained from the west side of borrow pit "A".

5. Mr. McKinlay inspected the numerous pools of surface drainage water about the work. These pools show the action of rain water in segregating out the fines present in this local top soil material. Mr. McKinlay stated that it was his belief that the two "stability sections" of the dam would, when being built, tend to drain quite freely.

6. Mr. McKinlay commented favorably upon the general cleaning up of the river bottom hydraulic fill area now under way. He also asked who was Superintendent. The Resident Engineer explained that an almost entire new organization had been effected since the first of January and that O.C.Steves was in charge.

Harold Wood
Resident Engineer

HW/p

4/20/34
copy /f

February 4, 1933

Mr. Edward Hyatt
State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Hydraulic Operations.

Dear Mr. Hyatt:

Enclosed is copy of letter from H. W. Rohl and T. E. Connolly dated February 1, 1933, purporting to state their proposed plan of operations in placing the hydraulic fill material in the El Capitan Dam, for your consideration and reactions as to adequacy of the plans.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encl.
Copy letter H.W.Rohl & T.E.Connolly

1-31-35
copy/p

February 6, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On February 6, 1933 Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan dam and particularly the foundation under the hydraulic fill and puddle core areas.

2. Mr. McKinlay approved the foundation for puddle core and hydraulic fill placement below elevation 575 except for three boulders in the puddle core area on north abutment and east of the core wall.

3. Fred D. Pyle and T. E. Connolly and the Resident Engineer were present during the inspection.

Harold Wood
Resident Engineer

HW/p

4/20/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

February 17, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

The plan of operation and construction methods proposed by the contractors for placement of the hydraulic fill materials in the El Capitan Dam, as set forth in their letter of February 1, copy of which accompanied your letter of February 4, have, in the light of our present rather meager and somewhat limited information relative to the many factors involved, been considered by this office.

It occurs to me that any comment as to the adequacy of the proposed plans of operation which might be made at this time could not be considered conclusive and would, of necessity, have to be general comment only subject to such modification and change as may be deemed necessary during the progress of the work. While it is believed that the method submitted to this office by you at the time application was filed for approval of the plans and specifications would yield a more thorough segregation and better distribution of the various types and classes of materials and would produce uniformly more satisfactory results with lesser uncertainty, no reason is now known why the method proposed will not, if properly executed and controlled, yield a satisfactory fill.

The final test of the adequacy and sufficiency of any method lies in critical observation of the progressively completed work. The characteristics of the materials and their behavior, when placed hydraulically, is still an uncertain and unknown quantity. Such factors as the physical properties of the materials, the quantity of water used in sluicing, the relative quantities of available and suitable puddle and flank materials, the rate of placing, the behavior of the materials when being placed and after having been placed, the degree of fill drainage and the rate of consolidation are all in large part related to the methods of handling and placing. It is conceivable that any method may, of necessity, have to be materially modified from time to time in order to accomplish the desired results. Likewise, it is conceivable that additional or different sluicing equipment might be required to secure unquestioned, thorough gradation and proper placement of all materials and to make certain that no hydraulic materials are permitted to go into the dam without having been properly worked over with sufficient quantities of water. In other words, in our opinion no substantial

and unquestioned basis for final approval of any detailed construction method now exists and only as the work progresses can judgment as to adequacy be had. Furthermore, our jurisdiction does not, as you well appreciate, extend to contractual matters, the selection or designation of specific construction methods or the direction of any particular construction program. Rather our interests are concerned with safety and on that score are interested in all matters which do affect or have a bearing on safety. It is therefore essential that at all times such methods of construction be pursued as will produce the desired results, namely, the building of a safe structure.

Wholly aside from the details of any particular method to be used in constructing the hydraulic portions of the dam, it is imperative that at all times as the work progresses such methods be used so that the results obtained will be in accordance with accepted sound engineering practice, in conformity with the approved plans and specifications and satisfactory in all respects necessary to assure the construction of a safe dam.

Kindly be assured that we stand at all times ready and willing to discuss with you the many technical complexities of this important work.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-E.H.Holmes
G.McKinlay

1-31-35
copy/p

February 25, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On February 25, 1933 Senior Engineer of Dam Inspection Gerald McKinlay, visited and inspected the work at El Capitan Dam.

2. The inspection was made of the core trench between coordinates N3316, present end of concrete, and N3275. This portion of the trench as excavated was approved by Mr. McKinlay as being satisfactory for placement of concrete.

3. The core trench on the north abutment between coordinates N3840, present end of concrete, and N3900 was inspected. Mr. McKinlay said this trench should be excavated from elevation 572 at N3840 to elevation 592 at N3875, then following the bottom of the present trench at elevation 592 to N3900; thence vertical to elevation to be determined.

4. Mr. McKinlay went over the pool with Mr. Albert in a barge and sounded the clay of the puddle core with a pole. He expressed satisfaction with the rate of deposition of the clay and was surprised at the rapidity of its consolidation. The clay was at this time up to about elevation 560. The summit pool was at elevation 566.5. The clay at an elevation 555 was sufficiently consolidated to support the sounding rod which was a "loading stick" 1-1/8 inches diameter and 26 feet long.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

March 2, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On March 1, 1933 Deputy State Engineer Geo. W. Hawley Senior Engineer of Dam Inspection Gerald McKinlay, and State Geologist Chester Marliave, visited and inspected the work at El Capitan dam.

2. The copy of letter to the contractor, dated March 1, 1933, was as requested shown to Mr. Hawley. He was shown the tracing of the hydraulic fill section showing progress and unsorted material.

3. Upon completion of inspection these men called at the office of the Resident Engineer and in the presence of D. W. Albert and the Resident Engineer outlined the result of this inspection and requested certain information.

4. Mr. Hawley asked if the width and elevation of the pool was being recorded. I explained this data was being reported daily for three shifts.

5. Mr. Hawley asked what samples had been taken. I showed him Mr. Jewett's report of February 28, 1933 on samples 223 an 234. I also showed him two jars of core material taken on February 11, 1933, the next day after hydraulicking began. It was explained to Mr. Hawley that at a conference between Mr. Jewett, Mr. Albert and the Resident Engineer on February 27, 1933 that it was arranged that puddle core samples would be taken every 10 days. Mr. Hawley was shown drawing of sampling device. Mr. Hawley asked about percolation tests and I explained that Mr. Jewett was arranging for equipment to make these tests.

6. Mr. Hawley asked what provision was contemplated for sampling core for test of consolidation. I explained that the contract and specifications provided for core drill holes and pipe. That I considered it possible to sample the core at any depth desired by core drill methods of sampling.

7. Mr. Hawley wants samples taken of the beach material and tests made to determine its clay content and frictional resistance.

8. Mr. Hawley stated that he considers it essential that we "go into mica phases of the material." We may have to pump mica content out or rig up some overflow method of its disposal.

9. The concrete placement into the south core wall trench coordinate N3290 to N3316 was commented upon by Mr. Hawley. He stated that this material was segregating.

Harold Wood
Resident Engineer

HW/p

2/15/34
copy /f

March 6, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Dam
Contract Construction, Hydraulic Fill
Portion, Correspondence.

Dear Mr. Hyatt:

Enclosed are copies of correspondence between the Hydraulic Engineer and H. W. Pohl & T. E. Connolly, Contractors, El Capitan Dam regarding hydraulic fill portion of the Dam, as follows:

Letter to the Contractor dated February 22, 1933, subject, "San Diego River Project, El Capitan Feature, Contract Construction Hydraulic Fill";

Letter to the Contrqctor dated February 25, 1933, subject "San Diego River Project, El Capitan Feature, Hydraulic Fill";

Letter to the Contractor dated March 1, 1933, subject "San Diego River Project, El Capitan Dam Contract Construction Hydraulic Fill Portion"; and

Letter from the Contractor dated March 2, 1933, subject "San Diego River Project, El Capitan Dam Contract Construction Hydraulic Fill Portion".

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

F/f
Encls. (4)

2/15/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

March 8, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

This will acknowledge receipt of your letter of March 6, 1933 enclosing copies of correspondence between you and H.W.Rohl & T.E.Connolly, Contractors at El Capitan Dam.

Very truly yours,

GEO. E. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes
G.McKinley

1-31-35
copy/p

El Capitan Dam
April 1, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On March 31, 1933, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan Dam.

2. Mr. McKinlay inspected the hydraulic fill operations and expressed satisfaction with the conditions and particularly with the large amount of gravel and large rock on the beaches and particularly on the downstream limit of the fill.

3. Mr. McKinlay inspected the core wall trench on the south or left abutment and approved the foundation as excavated between ordinates N 3182 and N 3234 except for extra depth required by the Resident Engineer between N 3230 and N 3234. The core wall trench on the north or right abutment was inspected. The lowest portion of this excavation north of ordinates N 3900 was at elevation about 622. The foundation between ordinates N 3900 and N 3910 will be acceptable when excavated to elevation 598, between N 3910 and N 3920 to elevation 610 and between N 3920 and N 3930 to elevation 620.

4. A request was made by Mr. McKinlay that certain pipes be placed in the hydraulic fill for determination of the hydraulic gradients in the fill. The Resident Engineer requested that this request be made in writing so there would be no misunderstanding. This Mr. McKinlay agreed to do. This request is made by the State in accordance with Section 15 of Rules and Regulations Governing the Supervision of Dams in California.

5. Mr. McKinlay was requested to call on the Hydraulic Engineer.

Harold Wood
Resident Engineer

4/20/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

April 7, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM # 8-7

Dear Mr. Savage:

In order that studies may be made which will reveal the hydraulic gradient or line of saturation within the flanks or stability sections of the above named dam, it is requested that vertical slotted pipes, similar to well casings, be installed at certain locations in the beaches.

These pipes should be of four or six inches diameter, jetted or driven to the foundation and carried up to the faces of the dam as the hydraulic fill progresses. Means should be provided to bail out sand or muck during the driving and from time to time as it accumulates. Some means should also be provided for measuring the elevation of the water table in the pipe.

These pipes should be seven in all, and located in two intersecting lines as follows:

On Lat. N 3620 at Dep. E 4760, 4840, 4920, 5080 and 5140.

On Dep. E 4840 at Lat 3450 and 3800.

It is believed that the presence of these pipes and the information which they will make available will be of great value both during and after construction, and that future progress or rate of construction may be largely influenced by such information.

Mr. McKinlay has already discussed the matter of installing these pipes with Mr. Wood and Mr. Albert, and is ready to be of further assistance if required.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-G.McKinlay
W.H.Holmes

1-31-35
copy/p

April 10, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On April 7, 1933, Deputy State Engineer Geo. W. Hawley visited and inspected the construction work at El Capitan Dam.

2. The Resident Engineer accompanied Mr. Hawley over the downstream embankment; pointed out the decomposed granite material on the rock embankment at about elevation 600.

3. Mr. Hawley and the Resident Engineer proceeded over the downstream embankment to the south abutment and thence back northerly over the beach.

4. Mr. Hawley's attention was directed to the stripping accomplished on the south abutment, and on the north abutment below road at elevation 640. Mr. Hawley commented favorably upon the stripping accomplished.

5. The beach had more clay on it than at any previous time. This fact was stated to Mr. Hawley who said we were not getting sufficient washing of the hydraulic fill material.

6. Mr. Hawley arrived on the job with J. B. Lippincott and Geo. Elliott.

Harold Wood
Resident Engineer

HW/f

1-31-35
copy/p

May 6, 1933

From : Engineer Fred D. Pyle

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

On May 1, 1933 California Deputy State Engineer in Charge of Dams Geo. W. Hawley and Senior Engineer of Dam Inspection Gerald McKinlay, visited and inspected the work at El Capitan Dam.

Accompanied by Engineer Fred D. Pyle and Engineer Hydraulic Fill D. W. Albert, they were shown over the top of the upstream and downstream rock embankments and both beaches. Their attention was particularly invited to the quantity of earthy material and decomposed granite on the upstream rock embankment and to the progress made by the contractor in removing a portion of the material about 40 feet wide and about 250 feet long along the upstream portion of the upstream rock embankment where the first about 200 feet had been put in fair condition for receiving additional rock by scarifying and washing with monitors;

Also to the next section of about 40 feet where, after scarifying, the monitors had removed the material that had been loosened by scarifying and the parallel ridges north and south showing the depth of scarifying, which indicated that the earthy material and decomposed granite could not be economically removed by the monitors alone.

Neither Mr. Hawley nor Mr. McKinlay would commit himself as to what might be a satisfactory removal of the earthy material and decomposed granite from the rock embankment.

The observation wells to be installed in the hydraulic fill portion of the dam were discussed with them and Mr. McKinlay stated that the well located farthest north, west of the puddle core, might well be moved south so that the bottom of it would be near the original river bed level.

Mr. Hawley advised that he desired copies of all gradation and other tests of hydraulic fill material sent to him and to Mr. McKinlay. He also desired to know what progress was being made on the frictional resistance tests that he had discussed with Resident Engineer Harold Wood on March 1, as reported by Mr. Wood on March 2, 1933. He was advised that no frictional resistance tests were being contemplated. He expressed the desire to have the tests made.

Fred D. Pyle
Engineer

FDP/p

1-31-35
copy/p

2300

May 10, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection March 1 to May 9, 1933

1. The State engineers inspected El Capitan dam and inspected particularly work on dates as follows:

Date	Engineer	Work inspected
March 1, 1933	Geo. W. Hawley; Gerald McKinlay	Hydraulic fill and core wall concrete
" 14 "	Gerald McKinlay	Hydraulic fill and cutoff trench
" 24 "	W. H. Holmes	Hydraulic fill and rock embankment. Made no comment.
" 31 "	Gerald McKinlay	Hydraulic fill and cutoff trench.
April 6 "	Gerald McKinlay	General, no comments made.
" 7 "	Geo. W. Hawley	Downstream rock embankment, hydraulic fill and stripping of abutments
May 1 "	Geo. W. Hawley; Gerald McKinlay	Hydraulic fill and rock embankments
" 9 "	Gerald McKinlay	Cutoff trench

2. The downstream rock embankment placement above elevation 600 was begun March 20, 1933. On March 22, 1933 a letter was addressed to the contractor, subject: "Rock embankment, removal of earth and disintegrated granite" and the contractor was directed that the earthy material and decomposed rock be removed from the surface of the dumped rock.

On March 30, 1933 a letter was addressed to the contractor subject: "Rock embankment, removal of earth and decomposed granite." This letter directed that the contractor remove and rebuild at his own expense portions of the rock embankment above elevation about 600. Placement of rock continued until 11:30 A.M. April 10, 1933, at which time the contractor stopped work. On April 27, May 6, and 8, 1933 the contractor again placed rock on the downstream rock embankment above elevation 600. On May 9, 1933 the following letter signed by the Resident Engineer was delivered to the contractor.

"You are hereby notified to place no rock on the downstream rock embankment above elevation 600."

3. In my knowledge no State engineer saw the top of the rock embankment about elevation 600 between March 14 and 31, 1933, during part of which time rock placement was going on.

Harold Wood
Resident Engineer

HW/p

2-18-35
copy/p

2301

DEPARTMENT OF PUBLIC WORKS

Sacramento

May 10, 1933

Mr. H. N. Savage, Engineer in Charge
City of San Diego
524 F Street
San Diego, California

Subject: El Capitan Dam #8-7

Dear Sir:

This simply to conform request previously made of your field engineers, more particularly that made of Mr. Pyle during my recent trip to the El Capitan Dam, that the results of field observations of the embankment materials of the dam, including the laboratory analyses of the specimens obtained from the dam, be made available to this office upon obtainment of the results by yourself. The data referred to are in general those obtained from observations and analyses of the puddle materials, including specific weight determinations, void content of the materials, sieve analysis, penetration and rates of consolidation or solidification. It is likewise desirable that the results of analyses of the flank materials which have to do with specific weight, void content, mechanical analysis, frictional resistance and all pertinent data pertaining to the water table in the flanks of the dam should be sent this office. A copy of these data should be sent the Los Angeles office.

Your early acquiescence in this request will be greatly appreciated.

Very truly yours,

Geo. W. Hawley
Deputy in charge of dams

cc-W.H.Holmes
C.McKinley

AFE
H. N. Savage 5/13/33

4/13/34
copy /f

C O P Y

Division of Water Resources
803 California State Building
Los Angeles

Edward Hyatt, State Engineer
Chief of Division

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO
May 16, 1933

Hon. John F. Forward, Mayor
City of San Diego
City Hall
San Diego, California

Honorable Sir:

On Saturday, May 13th, I stated before an informal meeting of the City Council of San Diego, held in your office, that in my opinion El Capitan Dam as constructed to date is a safe engineering structure. I am pleased to reiterate this statement in writing.

I further stated at that meeting that I was not sure the State Engineer would approve removal of portions of the downstream rock embankment at this time, giving as my reason that the material in question, at the 600 foot elevation, lies below the summit pool elevation at 616 feet, and that the beach slopes from this level to the top of the downstream embankment, elevation 654. In making this statement, I was guided by the fact that materials in the downstream rock embankment are supporting the beach, which in turn forms a part of the stability section to resist the pressure of the already placed puddle core and the water in the summit pool. It cannot definitely be stated that a distinct hazard will be created by the removal of this rock, but rather that a lessening of safety might possibly result to the structure, which to the present time has been pronounced entirely safe by many eminently qualified engineers who have visited the dam.

During the time the rock materials in question have been in place in the dam they have acquired which might be termed a "seasoning" due to readjustments in their position under the loads of the portions of the dam above, and to remove such materials probably would destroy to a large extent the integrity which the structure as a whole has attained by virtue of this settlement or "seasoning" effect.

While the State Engineer might not oppose the removal of a portion of these materials, it is certain that any proposal to make changes which might interfere with the safety of the dam would require his approval which could only be gained by making formal application for permission to make said changes.

Respectfully yours,
(Sg) Gerald McKinlay
Senior Engineer Dam Inspections

GMcK:ER

1/12/34
copy /f

2303

May 18, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project,
El Capitan Feature, core wall
grouting

Dear Mr. Hyatt:

Owing to the small amount of grout being taken by the grout holes under the concrete core wall up along the abutments of El Capiten reservoir dam, and the decrease of hydrostatic head on areas to be grouted as the dam heightens, it is deemed proper to increase the spacing of the grout holes from five feet to eight feet, unless advice to the contrary is received from your office.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/p
cc Mr. Gerald McKinley, Senior Engineer of
Dam Inspection

1/12/34
copy /f

2304

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

June 10, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California.

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

Responsive to your request of May 18, relative to core wall grouting El Capitan Dam, this will authorize your proposed increase in spacing of grout holes in the cut-off trench in the right abutment of the dam from 5 feet to 8 feet. In the left abutment it is believed advisable to continue the 5 foot spacing of grout holes well beyond the zone in which the outlet tunnel is located. In other words, the 5 ft. spacing should be continued to at least coordinate N 3200 at which coordinate the change in spacing of the holes from 5 feet to 8 feet will be satisfactory to this office.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes
G.McKinlay

1-31-35
copy/p

El Capitan Dam
July 13, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On July 12, 1933, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan Dam.

2. He inspected the cutoff trench from the north end of the concrete at ordinate N 3975 to the north end of the trench at N 4015. This portion of the foundation when cleaned up was stated by him to be satisfactory for the placement of concrete.

3. Inspection was made by Mr. McKinlay in the outlet tunnel and I was requested to secure measurements of the water flows in the north wall located about 5+80, 7+70 and 9+00.

4. The stripping being done on the south abutment was pointed out and commented upon favorably. This work was not completed at this time.

5. The formation within the spillway excavation was examined and a request was made that the cutoff under the floor near spillway station 5+10 be extended southerly to intersection with the cutoff under the crest structure.

6. Mr. McKinlay requested information on the beach material shear tests. I told him that samples had been taken but just what tests had been made I did not know. I referred him to the Hydraulic Engineer.

7. Mr. McKinlay inspected the top of the downstream rock embankment as washed preparatory to placement of rock lift above. This was commented upon favorably and was said to be very good.

Harold Wood
Resident Engineer

2-1-35
copy/p

August 10, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On August 9, 1933, Deputy State Engineer Geo. W. Hawley, and Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan Dam. They were accompanied on this inspection by Engineer Fred D. Pyle, Engineer Hydraulic Fill D. W. Albert and Resident Engineer Harold Wood.

2. At 2 P.M. the party drove to the south end of the downstream rock embankment. Inspection was made of the beach the south abutment and cutoff trench from N 3120, south end of concrete to N 3060. Mr. McKinlay said this trench was ready to concrete. This statement was made before O. C. Steves and the Resident Engineer, and the Resident Engineer asked Mr. Steves if he heard what McKinlay said. He replied that he had heard. I told him it was acceptable to me provided it was washed out before concrete was placed.

3. Inspection was made of the outlet tower, and tunnel and upstream embankment hydraulic operations and spillway excavation.

4. Mr. Hawley remarked that the work looked to be "in good shape". He said he would be glad to discuss method of building dam above present elevation if the data was ready to be presented. Mr. Pyle made an appointment to meet in Mr. Savage's office at 8:30 A.M. August 10, 1933.

Harold Wood
Resident Engineer

HW/p

1-31-35
copy/p

August 24, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection of dam foundation

1. On August 24, 1933, Gerald McKinlay, Senior Engineer of Dam Inspection, State Department of Public Works, visited the El Capitan damsite, gravel plant, quarry and inspected the concrete toe walls, drains, core wall excavation and location of outlet tunnel plug.

2. Mr. McKinlay expressed satisfaction with the quality of rock being placed in the embankment.

3. Mr. McKinlay explained that he was not satisfied with the stripping under the rock embankment area upstream from the puddle core area on the south abutment below elevation 575. He explained that Chester Marliave, State Geologist, was not satisfied with the red colored decomposed granite as a foundation for the rock. I explained that this excavation was not completed as yet as some hand work was contemplated. I told him the reddish colored soil would be removed.

4. There was no opinion expressed relative to possible depth of core trench, only the statement that there was no part of the work thus far in which the State was more vitally interested than the core wall.

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

August 25, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On August 23, 1933 California State Senior Engineer of Dam Inspection Gerald McKinlay, called at the office of the Resident Engineer at El Capitan Dam and there, in the presence of Hydraulic Fill Engineer B. W. Albert and the Resident Engineer Harold Wood, made suggestions for completion of El Capitan Dam above elevation 700.

2. Mr. McKinlay suggests elimination of berms at elevations 700 and 750 and extending the upstream slope to ordinate E 5020 at elevation 770 and the downstream slope to ordinate E4980 at elevation 770. He suggests a 10-foot, measured horizontally, thickness of rock on both upstream and downstream slopes above elevation 700.

He suggests building the dam above 700 by the semi-hydraulic fill method by disposition of fill material in 5-foot lifts and end washing as these 5-foot lifts are progressed across the dam.

Mr. McKinlay was told by the Resident Engineer he had better bring these suggestions thru the proper channels to the Hydraulic Engineer.

3. An inspection of the dam and spillway was made in company with Mr. Albert and Mr. Wood.

4. Upon completion of the inspection Mr. McKinlay commented that he was satisfied with the work and was well pleased with the puddle core material.

5. Mr. McKinlay left the City's camp and stated he was to confer with the contractor.

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

2309

October 23, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On October 6, 1933 Deputy State Engineer George W. Hawley and Senior Engineer of Dam Inspection Gerald McKinlay visited El Capitan dam and sat in on a conference between Hydraulic Engineer, Fred D. Pyle, Louis C. Hill, J. Y. Jewett, D. W. Albert and the Resident Engineer.

2. Mr. Hawley nicely summed up his position by stating:

(1) Additional clay should be brought in to build up the puddle core, and

(2) A safe structure had been built thus far.

3. Cooperation on the part of Mr. Hawley was very noticeable during this conference.

Harold Wood
Resident Engineer

HW/f

3-6-35
copy/p

POSTAL TELEGRAPH

S80 104 DL=SC SACRAMENTO CALIF 26 1202P

H H SAVAGE=
HYDRAULIC ENGINEER CITY OF SANDIEGO 524 F ST SANDIEGO CALIF=

1933 OCT 26 PM 12 26

FOLLOWING TELEGRAM RECEIVED QUOTE ENGINEER SAVAGE ADVISED YOUR OFFICE HAS FORBIDDEN ME TO USE PART OF ELCAPITAN SPILLWAY EXCAVATION AS A HOG BOX UNLESS SURROUNDED BY CONCRETE STOP IF THAT IS SO PLEASE ADVISE AND HAVE A REPRESENTATIVE HERE AS SOON AS POSSIBLE STOP UNTIL YESTERDAY I HAD OUTLINED MY PLANS TO NO ONE AND WOULD LIKE TO HAVE REASON FOR DENYING ME USE OF THIS STRUCTURE AND A CHANCE TO EXPLAIN TO ME ON THE GROUND H W ROHL T E CONNOLLY UNQUOTE WE REPLIED AS FOLLOWS QUOTE HYATT AWAY FROM OFFICE STOP YOUR TELEGRAM HAS BEEN REFERRED LOSANGELES OFFICE FOR MCKINLAYS ATTENTION=

S A HART.

POSTAL TELEGRAPH

S151 13=B LOSANGELES CALIF 26 500P 1933 OCT PM 5 05

H H SAVAGE=
524 F ST SANDIEGO CALIF=

WILL ARRIVE ELCAPITAN DAM FIRDAY MORNING IF CONVENIENT WOULD APPRECIATE MEETING YOU THERE=

G MCKINLAY.

2-1-35
copy/p

2311

November 18, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On November 13, 1933 Deputy State Engineer George W. Hawley and Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan dam. Mr. Hawley participated in conference with the Hydraulic Engineer H. M. Savage, Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert, Consulting Geologist J. P. Buwalda and City's Special Counsel T. E. Cosgrove.

2. After the above conference Mr. Hawley and Mr. McKinlay stopped at the office of the Resident Engineer, and in the presence of D. W. Albert Mr. Hawley was asked by the Resident Engineer what were the decisions reached relative to the three things which it was his understanding the State's Engineers were principally interested in. These were:

(1) Importation of clay for upbuilding the puddle core of the dam.

(2) The profile of the dam above elevation 700.

(3) The cutoff trench across the spillway channel opposite Station 5+10.

3. Mr. Hawley said the matter of importation of clay was up to the contractor and he was assuming that clay would be imported to accomplish the upbuilding of the puddle core before any other hydraulic placement of material would be undertaken. The Resident Engineer told Mr. Hawley letters to accomplish this had been sent the contractor.

Mr. Hawley said the matter of the profile of the dam above elevation 700 was not definitely decided but that Mr. Savage was to submit drawings.

Mr. Hawley said the cutoff trench across the spillway channel opposite Station 5+10 was not discussed. I told him Mr. McKinlay would be advised when this cutoff trench was ready for his inspection.

4. Mr. Hawley and Mr. McKinlay left for Los Angeles.

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

December 10, 1933 2312

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection and conference

1. On December 7, 1933 Deputy State Engineer Geo. W. Hawley, State's Consulting Engineer Fred C. Herrmann and State Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected El Capitan Dam. They arrived at 1 P.M.

2. Particular attention was paid to the puddle core. Samples were taken and shown to the State's engineers by Hydraulic Fill Engineer D. W. Albert in the presence of Engineer Fred D. Pyle, R.F.C.Agent J. H. Roper, Contractor T.E.Connolly and Contractor's Engineer E. Alan Howe.

3. Later a conference was held at the City's camp at which there were present: Hydraulic Engineer H. N. Savage, City Attorney C. L. Byers, Deputy City Attorney H. B. Daniel, Engineer Fred D. Pyle, R.F.C.Agent J. H. Roper, Deputy State Engineer Geo. W. Hawley, State Consulting Engineer Fred C. Herrmann, Senior Engineer of Dam Inspection Gerald McKinlay, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood.

4. The Hydraulic Engineer's letters to the contractor S-63 and S-70 were read at the conference. Contract specifications paragraph 53 was also read. Drawings WD-481 and 483 showing topography of the puddle core on October 25, 1933 and December 5, 1933 respectively were reviewed.

5. Messrs. Hawley and Herrmann suggested samples of puddle core be taken on 10-foot squares and additional soundings be taken to locate the limits of sand lenses. Mr. Hawley said "If lenses intersect or continuity of unsatisfactory material exists, the State's engineers want to know it."

6. A conference was decided upon at a later date after sufficient samples had been secured to determine extent and analyses of unsatisfactory material and after drawings showing this had been prepared.

7. The Hydraulic Engineer endeavored to have the City's Consulting Engineer Louis C. Hill present at the conference on December 7, 1933 but Mr. Hill was unable to attend as he had to go to Portland.

HW/p

Harold Wood
Resident Engineer

4/20/34
copy /f

2313

December 23, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Dam
Top Portion, Cross Section, Modification.

Dear Mr. Hyatt:

It is my understanding that the construction of the top portion of the El Capitan dam with rolled fill material and method is not approved of.

It is my further understanding that the completion of the top portion of the El Capitan dam with impervious puddle core is deemed essential.

It is seen that difficulty may be experienced by the Contractor in properly constructing the top portion of the El Capitan dam with impervious puddle core material on the cross section shown on the contract drawings.

It is my understanding that conference was initiated by State Inspector Gerald McKinlay with City's Resident Engineer Harold Wood making for the thickening of the upstream portion of the top seventy feet of the El Capitan dam.

An endeavor has been made to develop a minimum increased cross section which is assumed may meet with your approval and is shown on Drawing WD-485, "El Capitan Reservoir Feature, Hydraulic Fill and Rock Embankment Dam, Modified Cross Section of Top" enclosed. The design of the section on the contract drawing is shown in full black lines and a contemplated modification is shown in red dashed lines.

The Contractor's recent experience in endeavoring to advance the lagging impervious core section of the hydraulic fill material due somewhat to the shortened reaches of the beaches is an incentive for the adoption of a thickened cross section of the top of the dam as shown on the attached drawing.

The Contractor has advanced both rock embankments up to Elevation 700 and if the upstream portion of the dam is to be thickened it is important that a conclusion be reached at the earliest date practicable in your office and this office advised by telegram of your conclusions in order that the approval of the City of San Diego's Mayor and Councilmen may be invited to authorize the modification and expedite the Contractor's work.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encl. WD-485

4/20/34
copy /f

POSTAL TELEGRAPH

1933 DEC 28 PM 4 32

S218 16=SC SACRAMENTO CALIF 28 415P

H N SAVAGE, HYDRAULIC ENGINEER=
CITY OF SANDIEGO 524 F ST SANDIEGO CALIF=

REVISED SECTION OF CREST EL CAPITAN DAM SHOWN ON PLAN WD

FOUR EIGHT FIVE IS APPROVED=

GEO W HAWLEY.

4/20/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

December 29, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

Enclosed herewith is an ORDER AUTHORIZING REVISION OF PLANS AND SPECIFICATIONS for the El Capitan Dam, which revisions were requested in your letter of December 23, 1933.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

Encl.
cc-W.H.Holmes

4/20/34
copy /f

Form 10A

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
401 PUBLIC WORKS BUILDING
SACRAMENTO

ORDER AUTHORIZING REVISION OF PLANS AND SPECIFICATIONS

Application No. 8-7
Name of Dam - El Capitan
Stream or Legal - San Diego River
Subdivision - NE-1/4 Sec. 7, T. 15 S., R. 2 E., SBB&M
County - San Diego

TO: Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

WHEREAS, the application of City of San Diego was filed with the State Engineer on November 21, 1931 for the approval of plans and specifications for construction of the above dam; whereas, the said plans and specifications were approved on December 7, 1931 by the State Engineer; and whereas, application has been made by H. N. Savage on December 23, 1933 for revision of said plans and specifications; that said application has been considered by the State Engineer and finds that a proper margin of safety will not be sacrificed by the adoption of such revision.

Now, therefore, you are hereby authorized to revise said plans and specifications as follows:

The section of the dam from elevation 700 to the crest to be changed in accordance with Drawing No. WD-485, which drawing accompanied letter from Mr. H. N. Savage dated December 23, 1933.

WITNESS my hand and the seal of the Department of Public Works of the State of California this 29th day of December, 1933.

(SEAL)

EDWARD HYATT (Signature)
EDWARD HYATT, STATE ENGINEER

Reg.
cc-W.H.Holmes
G.McKinlay

4/20/34
copy /f

2317

January 2, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Dam Feature, Top Portion, orose section modification.

Dear Mr. Hyatt:

In accordance with my letter dated December 23, 1933 submitting print of drawing WD-485 showing modification of the cross section of the top portion of the El Capitan reservoir dam; and your telegram dated December 28, 1933 approving same, there are submitted herewith for your official approval two tracings of Drawing WD-485.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

FDP/f

2-1-35
copy/p

January 2, 1934 2318

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On December 19, 1934, Deputy State Engineer Geo. W. Hawley, State's Consulting Engineer Fred C. Herrmann and Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan Dam.

2. Mr. McKinlay and the Resident Engineer Harold Wood inspected the cutoff trench N 4088 and N 4168 bottom elevation 706. Mr. McKinlay said this was satisfactory to concrete.

3. After inspection at the puddle core in company with City's Consultant Louis C. Hill, the Hydraulic Engineer, Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood, a conference was held at the City's engineer headquarters. At this conference Fred C. Herrmann said that "evidence shows sand in puddle core." Mr. Hawley concurred in this and said "Evidence sufficient so far as State is concerned."

4. The State's engineers stayed at the City's guest house over night.

5. At 8:30 A.M. the State's engineers, L. C. Hill, Fred D. Pyle, D. W. Albert and Harold Wood met at the contractor's office with T. E. Connolly and E. Alan Rowe. They were shown charts and diagrams of the puddle core showing conditions according to the contractor. Mr. Connolly and Mr. Rowe outlined methods for removal of sand from the puddle core.

6. The conference was resumed at the City's engineer headquarters. The Hydraulic Engineer showed Mr. Hawley and Mr. Herrmann drawing WD-485 showing section proposed for top of dam elevation 700 to 770. This was tentatively and informally approved by Mr. Hawley and Mr. Herrmann. Copies of the drawing are to be sent to Mr. Hawley and State Engineer Edward Hyatt for formal approval.

7. Mr. Hawley in summarizing the situation as he was about to leave, said he "is convinced of necessity for corrections to puddle core. That any remedial measures used by the contractor to remove the sand from the puddle core will be trials only."

8. The Hydraulic Engineer stated he had given permission verbally to the contractor to try to remove the sand by use of dragline machines operating clamshell buckets. To this L. C. Hill said "no objection to contractor trying to remove sand strata from puddle core by means of clamshell bucket." "Results of these efforts to be decided by soundings."

9. The Hydraulic Engineer requested samples of puddle core be taken at 25-foot intervals north of N 3400 along the axis and at 20-feet apart up and downstream.

Harold Wood,
Resident Engineer

HW/p

2-1-35
copy/p

January 12, 1934

From : Engineer Fred D. Pyle

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature, Inspection

Deputy State Engineer George W. Hawley and Assistant Deputy State Engineer W. H. Holmes called at the office this morning about 8:30. Mr. Hawley advised that in the future we were to contact Mr. Holmes for inspection work in connection with the construction of the El Capitan Dam.

On reviewing the status of the work and learning that the Contractor had removed considerable material from the puddle core between N 3200 and N 3750, and that he was expecting to commence washing the material back into the summit pool, Mr. Hawley expressed a desire to visit the work.

I met Mr. Hawley and Mr. Holmes at the City's Resident Engineers' Camp shortly after 10 A.M. and with them and the Resident Engineer went to the east embankment of the dam where Hydraulic Fill Engineer D. W. Albert and crew were taking samples of the puddle core about N 3500.

The Contractor had commenced about 9 A.M. to wash the material from the south end of the west beach and was making rapid progress, using one of the regular monitors for that purpose.

Contractor T. E. Connolly and Engineer E. Alan Howe were on the monitor barge when we arrived and shortly came over to the beach where we were, and there was a general discussion of accomplishings.

The two draglines and the slack line had been removed. Mr. Connolly stated before the group that he had not asked for approval of the puddle core as he realized that there was considerable sand still in it, and that he was washing back the material from the west beach into the pool before it would dry and bake so that it would be difficult to handle.

Mr. Connolly stated that he intended to place a dragline on the top of the upstream rock embankment elevation about 700 and operate a dragline bucket on a slack line to again remove material from the puddle core. This material would be deposited on the upstream beach inside of the upstream rock embankment from where he intended to wash the fine material back into the puddle core and leave the coarser materials on the beach. He expected to raise the water considerably when this work was undertaken.

Mr. Connolly said that by having the slack line and operating equipment at a higher elevation he would be able to control the location and the depth of cutting to better advantage than he could when the equipment was on the beaches.

Examination of the records of samples taken by Mr. Albert indicated that considerable sand had been removed from various portions of the puddle core but that not sufficient had been removed to prove the method feasible.

The method was deficient in ability to reach all parts of the puddle core as there was a tendency for the dragline to cut shallow near the east side of the puddle core and deep on the west side. There was also a tendency for the west beach to slide into the pool. The overloading of the beaches with the material removed from the pool was also a disadvantage.

With Mr. Connolly's statement as to the condition of the Puddle core, his reasons for washing the material from the west beach and his plans to further remove material from the puddle core, it was not thought necessary to issue any stop order or instructions.

Soundings will be taken soon where the material has been washed back into the puddle core from the beaches to determine if there has been a restratification of the sand.

The remainder of the work is proceeding rather slowly, but satisfactorily.

The excavation for the east end of the spillway is nearing completion and the last portion of the west end of the ogee section has been poured within about 6 feet of the crest.

Fred D. Pyle
Engineer

FDP/f

2-1-35
copy/p

2321

January 15, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On January 12, 1934 Deputy State Engineer Geo. W. Hawley and Assistant Deputy State Engineer W. H. Holmes visited and inspected El Capitan Dam in company with Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood.

2. Mr. Hawley stated that in the future Mr. Holmes would take Gerald McKinlay's place as State Inspector.

3. The contractor had commenced about 9 A.M. to wash the material previously excavated by slack line from the puddle core from the downstream beach back into the puddle core.

4. Contractor T. A. Connolly and Engineer E. Alan Rowe were both on the dam and there was a general discussion of accomplishings. Mr. Connolly stated before the group that he had not asked for approval of the puddle core as he realized that there was considerable sand still in it, and that he was washing back the material from the west beach before it had time to dry out so it would be difficult to handle. Mr. Connolly stated he intended to place a dragline on top of the upstream rock embankment about elevation 700 and operate a slack line bucket and excavate the puddle core sand strata. The excavated material would be deposited on the upstream beach. Mr. Connolly said that by having the slack line and operating equipment at a higher elevation he would be able to control the location and the depth of excavation within the puddle core to better advantage than he could when the equipment was on the beach.

5. The State's Engineers examined the cross sections of the puddle core and cross sections showing work accomplished by first attempt at excavation with slack line between N 3200 and N 3550.

6. The State's Engineers examined the excavation in the north abutment for the core wall and the core wall as built to N 4160. They also examined the foundation and cutoff trench for the crest Station 0+00 to 0+48 and both expressed satisfaction with the foundation as excavated which was mostly in solid rock.

7. The State's Engineers arrived about 10 A.M. and left about 1 P.M.

Harold Wood
Resident Engineer

HW/p

4/20/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

January 18, 1934

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

We are returning under separate cover tracing #WD-485 which was approved by this office.

Very truly yours,

GEO. E. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes

copy /f

January 27, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Impervious Core Section, Removal of Sand Strata.

Dear Mr. Hyatt:

Since Assistant Deputy State Engineer W. H. Holmes inspected the El Capitan Reservoir Dam work on January 22, 1934, the Contractor has continued his operations in removing the sand strata from the puddle core section.

The Contractor expects to complete the removal of the sand strata from the impervious puddle core by January 31, 1934.

It is assumed that the State will desire to make a careful inspection before the Contractor is permitted to again undertake the construction of the hydraulic portion of the dam.

You will be advised by telegram when conditions are suitable for such inspection.

Very truly yours,

Fred D. Pyle
Acting Hydraulic Engineer.

FDP/f
cc Asst. Deputy State Engineer
Los Angeles, California

4/19/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

January 30, 1934

Mr. Fred D. Pyle, Acting Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

This will acknowledge receipt of your letter of January 27, 1934 stating that it is expected that the sand strata in the core will be entirely removed by January 31, 1934, and that you will notify us by telegram when the conditions are suitable for an inspection.

This procedure is satisfactory to this office.

We wish to thank you for keeping us informed in the matter.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes

2-1-35
copy/p

February 6, 1935

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On February 2, 1934 Assistant Deputy State Engineer W.H. Holmes visited and inspected the work at El Capitan Dam, accompanied by Engineer Fred D. Pyle. They arrived at the office of the Resident Engineer at 11:30 A.M. and after a short conference, proceeded to the contractor's camp for lunch.

2. At 12:45 P.M. a conference was held in the contractor's office between W. H. Holmes, Fred D. Pyle, D. W. Albert, Harold Wood, T. E. Connolly and E. Alan Howe. The results of analyses of samples of puddle core material and percolation and consolidation testswere discussed. Analyses of core materials in other hydraulic fill dams were discussed.

3. The above group then went to the top of the downstream rock embankment where the slack line was removing clay and sand from the core near N 3650. Considerable discussion followed as to results being accomplished by this work. Mr. T. E. Connolly stated that the hydraulic fill operations were left to Mr. J. C. Greely who was said to be experienced in hydraulic fill dam construction, that he had permitted Greely to get his own man to supervise placement of material in the dam, that on December 4, Greely had gone to Yuma on the All-American Canal bidding and that during Greely's absence the sand was washed into the puddle core and that Greely was responsible for the condition.

4. Messrs. Holmes, Albert, Connolly and Howe went in a boat and took soundings and samples of the puddle core. Mr. Holmes took a sample with him which he said was the sandiest sample he obtained. This sample later tested in the City's laboratory showed 60% sand and 39% silt and clay.

5. Mr. Holmes was satisfied with the condition of the puddle core except at the extreme southeast corner where the clamshell was removing material from the core and had not completed removal of the high sand content material.

6. It was generally agreed by the City's engineers that if the top of the puddle core as now cleaned, contained material having 40% of silt and clay that a tight dam would result.

7. Mr. Holmes and Mr. Pyle left camp about 5 P.M.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

2326

February 8, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On February 7, 1934 Deputy State Engineer Geo. W. Hawley, State Hydraulic Engineer W. H. Holmes, Engineer Fred D. Pyle, City's Consulting Engineer Louis C. Hill, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood met in conference at the City's guest house at El Capiten Dam.

2. Mr. Pyle explained that the contractor had removed material from the puddle core to a depth which makes the situation dangerous to go deeper.

3. A general discussion was had relative to percolation rates, quantities of seepage, etc. of puddle core material. Louis C. Hill stated that evaporation would be about four times greater than leakage through puddle core material having 40 percent combined silt and clay.

4. Those present reviewed the plans of the puddle core showing the analyses of samples taken from the puddle core following final cleaning work by the contractor. The percentages of silt and clay as reported by Mr. J. Y. Jewett were checked against the plant of the puddle core as plotted by Mr. Pyle.

5. D. W. Albert described the contractor's proposed method of building up the puddle core. Mr. Albert said some signal system between discharge end of pipes on the dam and the hog box is imperative.

6. Mr. Pyle asked Mr. Hill about effect of increased depth of summit pool by raising the water therein on the stability of the dam. Mr. Hill explained that sand wet or dry has about the same coefficient of friction. The unit weight of sand in stability section of the dam, would be greater when wet. This might increase 20 percent.

7. The group left to go to the dam where they were met by Contractor T. E. Connolly. All but the Resident Engineer went in the boats and samples of the puddle core were taken over the length of the same. A. Mr. Bob Paine, San Diego Sun reported, came out on the downstream beach and was met by the Resident Engineer who had him taken over the entire job. The group then had lunch at the contractor's mess.

8. After lunch the group went to inspect borrow pit "C". Mr. Holmes and Mr. Wood went to inspect the spillway excavation including the cutoff trench under the floor Station 7+10 for 70 feet north to 95 feet north of center line. Mr. Holmes commented on this as being satisfactory cutoff. Messrs. Holmes and Wood inspected the cutoff trench for the core wall from N 4166 to a point about 45 feet west of the west end of the spillway crest. Mr. Holmes was told that the grout holes under this section penetrated no boulders.

9. Mr. J. B. Lippincott and E. Alan Rowe joined Messrs. Hawley, Holmes, Pyle, Albert and Wood on the spillway crest after lunch. At Mr. Rowe's request Mr. Pyle showed Mr. J. B. Lippincott the results of analyses of puddle core material made by Mr. Jewett and as plotted in plan by Mr. Pyle. Mr. Lippincott asked about the minimum width of satisfactory core material and when told replied that in his judgment the existing puddle core material would make a tight dam.

10. About 2 P.M. the group assembled at the City's guest house again and were there joined by Hydraulic Engineer H. N. Savage.

11. Mr. L. C. Hill stated that the contractor had removed material from the puddle core to a depth which makes the situation dangerous and that slides of the sides are imminent.

12. Mr. Savage said it was his opinion that the puddle core situation now made it safe to go ahead from here up. Mr. Savage then asked Messrs. Hill, Albert, Wood and Pyle if a safe dam can be built up on the present puddle core. The City's engineers were in agreement that this could be done. Mr. Hawley concurred in the above also.

13. Mr. Hill read a statement that T. E. Connolly had made to him and which after writing he had read back to Mr. Connolly. This statement to Mr. Hill was made in the presence of Mr. Albert. Mr. Hill reads "Expects to separate some in hog box. Material pumped will leave part on beaches. If pool does not gain rapidly over beaches then he proposed to excavate the excess from the beaches."

14. Mr. Albert stated it was his opinion that a large amount but not all of the sand and coarse material could be removed from the material at the hog box.

15. Mr. Savage then said he would tell the contractor he might proceed with upbuilding the puddle core but that coarse material and sand must be deleted from the material at the hog box and not allowed to get to the dam. He stated he did not intend to be a party to letting the contractor get into trouble.

16. The conference ended. Mr. Savage, accompanied by Messrs. Albert and Wood, went to the dam and while standing on the road at elevation 745 on the north abutment and just upstream from the core wall Mr. Savage told Mr. Connolly as follows in the presence of Messrs. Albert and Wood:

"I do not deem it justifiable for me to assume for the City the responsibility for the conditions in the puddle core. There is no objection to you proceeding to the upbuilding of the puddle core with fines obtained from borrow pits A, B and/or C or similar material by full hydraulic method provided you remove and waste the coarse material at the hog box."

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

February 13, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On February 13, 1934 the Assistant Deputy State Engineer W. H. Holmes inspected the work at El Capitan dam.

2. Mr. Holmes inspected the excavation for and concrete in the floor of the spillway and also the cutoff trench at Station 7+10.

3. The Resident Engineer took Mr. Holmes in the City's car to the spillway crest where a view of the hydraulic fill operations was had. Trucks were hauling material from new borrow pit "K" located north of the old Henderson Ranch. A dragline was removing sand from the upstream beach at N 3590 and the 12 inch pipe was discharging material on the upstream beach at N 3620. Mr. Holmes met and confered with contractor T. E. Connolly and contractor's Engineer E. Alan Howe at the spillway crest.

4. The Resident Engineer and Mr. Holmes proceeded to the borrow pit "K" and there examined the borrow pit material and saw a shovel loading the trucks.

5. From borrow pit "K" we proceeded to the downstream beach where wer were met by Engineer Hydraulic Fill D. W. Albert who had been making soundings. Mr. Albert explained to Mr. Holmes the accomplishments of the contractor on upbuilding the puddle core since the morning of February 8 when the work was begun. Mr. Holmes, Mr. Albert and the Resident Engineer then went to the upstream embankment and there got data on settlement of the upstream embankment which was maximum of 0.02 foot since the points were established on the 700 foot level on February 3, 1934.

6. Mr. Holmes summarized his observations by saying it looks as if the contractor was accomplishing the upbuilding of the puddle core. His methods were slow but would produce satisfactory results.

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

March 6, 1934

2339

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection and conference

1. On March 5, 1934, Deputy State Engineer Geo. W. Hawley, Assistant Deputy State Engineer W. H. Holmes, State Consulting Engineer Fred D. Herrmann visited and inspected El Capitan Dam.

2. A conference was held upon their arrival at which there were present in addition to the three State's engineers above, the City's Hydraulic Engineer H. W. Savage, Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert, Resident Engineer Harold Wood and City Attorney C. L. Byers. At this conference the State's engineers were shown graphs, cross sections and data showing progress made in the upbuilding of the puddle core and its relation to the beaches.

3. After the conference the entire group, except the Hydraulic Engineer, proceeded to the dam where an inspection of hydraulic operations was made.

4. Upon completion of the inspection, the group returned to the City's camp and went into conference with the Hydraulic Engineer present. Mr. Hawley stated: "The situation remains unchanged or possibly accentuated as regards necessity of reducing the depth of the puddle or to put it the other way around to reduce the width of the puddle." Mr. Savage had the State's engineers read letters to the contractor S-88 dated February 8, 1934 and S-91 dated February 27, 1934. Mr. Hawley said that from conference with Mr. D. W. Albert and what we see the contractors are losing out both ways, I.E. the width of the beaches is being reduced and relation of elevation of puddle core to beaches is getting no better. A discussion then followed relative to answer to question asked by Mr. Savage as to maximum permissible water surface to puddle core as determined by depth to which 6-pound weight settles. Mr. Hawley said he considered about 6 feet sufficient for practical working. Mr. F. C. Herrmann said 5 feet.

5. A discussion followed led by City Attorney Byers as to what orders might be given the contractor. Mr. Pyle read draft of letter in which it was proposed to limit the height of beaches until the puddle core had been built up to a definite elevation only about 6 feet below the beaches. This method of instructing the contractor got away from any dictation of where material was to be obtained or what kind of material could be used.

6. In summing up the situation upon leaving, Mr. Hawley made the following statement to Mr. Savage:

"Something has to be immediately done to minimize width of summit pool and narrow the width of impervious core and increase the width of the beaches."

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

March 22, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On March 19, 1934 Assistant Deputy State Engineer W. H. Holmes visited the El Capitan dam and attended a conference with the Hydraulic Engineer, City's Consulting Engineer L. C. Hill, Engineer Fred D. Pyle, Engineer Hydraulic Bill D. W. Albert, Resident Engineer Harold Wood and RFC Agent James H. Roper. At this conference the conditions in the puddle core were discussed.

2. Mr. Holmes, accompanied by the Resident Engineer, inspected the dam and work at the spillway, core wall and the borrow pits.

3. Mr. Holmes inspected the cutoff trench as completed to elevation 706 from N 4190 northeasterly to station 5+26 and approved this last remaining reach on the north abutment as satisfactory for placement of concrete.

4. Mr. Holmes stated upon leaving that the only statement that could be made relative to his visit, aside from approval of the portion of the cutoff trench, was that he visited the job and sat in on the conference on conditions in the puddle core and made a general inspection. He stated he would call on the Hydraulic Engineer on March 20 at his office.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

2332

April 18, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On March 29, 1934 State Hydraulic Engineer W. H. Holmes visited and inspected the work at El Capitan Dam.

2. Mr. Holmes inspected and approved the foundation for the core wall between ordinates N 3037 and N 3060.

3. Mr. Holmes inspected the upstream slope of the north abutment adjacent to the spillway and the arrangement of the slope concrete to be placed here was explained by the Resident Engineer. Mr. Holmes considered this satisfactory.

4. Mr. Holmes reviewed the location for the concrete box to replace the flume on the south abutment. He commented "This seems satisfactory."

5. The core mixer machine was being operated in the puddle core near N 3210. It was being operated across the pool in an up and downstream direction.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

2333

June 6, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On June 5, 1934, Hydraulic Engineer for the State Department of Public Works, W. H. Holmes, visited and inspected work at El Capitan Reservoir Dam, Spillway and Spillway Extension.

2. Mr. Holmes reviewed the progress of the puddle core mixing operations as shown on two tracings being made in the field office. One tracing shows the extent of sand lenses and strata as surveyed March 1934 and the other tracing showed progress of core mixer from May 28 to June 4, 1934, being done in accordance with the Hydraulic Engineer's letter S-108.

3. Mr. Holmes requested that three prints be sent him of these two drawings to be used by the State's engineers in as review of the puddle core corrective work preparatory to its being passed upon for safety.

4. He was accompanied over the work by the Resident Engineer and inspected and photographed the spillway extension excavation, spillway side lining at east end and the puddle core mixing operations.

5. Mr. Holmes asked for an estimate of time for completion of the corrective work being done on the puddle core. The Resident Engineer told him it was his guess that this work would be completed in ten days or on June 15.

6. Mr. Fred D. Pyle, Assistant Hydraulic Engineer for the City, was advised by telephone by the Resident Engineer of Mr. Holmes' request for 6 prints referred to above. The two unfinished tracings were delivered to Mr. Pyle in the evening by the Resident Engineer.

7. Mr. Holmes was furnished the data on Resident Engineer's letter of May 29, 1934 on the construction of the hydraulic fill, and also statement of hydraulic fill placed as follows:

September 1 to October 16, 1933	177,000	cubic yards
November 27 to December 5	19,000	" "
February 5 to March 21, 1934	75,000	" "
(9100 cubic yards were deleted)		
Total to be placed	372,000	" "
of which puddle core is	112,000	" "

Harold Wood
Resident Engineer

HW/p

2-28-35
copy/p

June 9, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, Hydraulic fill section Importation of fines

Dear Mr. Hyatt:

Contractor H. W. Rohl and T. E. Connolly notified me yesterday that he had purchased three acres of land at Lakeside, located in the vicinity of Lindo Lake and nearly adjacent thereto on the north, from where he expects to obtain and haul material suitable in fines for the impervious puddle core section of the El Capitan Dam.

The City took a few samples from this vicinity several months ago which indicated the presence of over 60 per cent of suitable fines.

The Contractor has further indicated his policy of hauling and stockpiling in his hog box at the El Capitan Dam some 10,000 yards of the to be imported material in readiness for placing by full hydraulic method provided the trench excavation proves satisfactory to the City's Hydraulic Engineer and the results found to be safe in the opinion of the State Engineer.

Very truly yours,

H. M. Savage
Hydraulic Engineer

HMS/f
cc W. H. Holmes

2-28-35
copy/p

2335

June 9, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, contract construction

Dear Mr. Hyatt:

Notwithstanding the weaknesses of the rotator mixing device which Contractor H. W. Kohl and T. E. Connolly assembled and has been operating in the impervious puddle core section of the hydraulic fill area of the El Capitan Dam, relatively good progress has been made since the Contractor resumed trench excavating as provided for in my letter to him dated May 12, 1934, S-108, inviting him to correct the potential sand strata condition.

Provided the Contractor continues to make about the same progress he has during the past week, it is now indicated that he may finish the excavation of both trenches sometime the last of next week.

There now remains less than 500 feet of trench excavation to be accomplished and he has been averaging upwards of 70 feet a day, and is working the machine three shifts, or so much thereof as is possible incident to the delays while repairs are being made.

Very truly yours,

H. N. Savage
Hydraulic Engineer

HNS/f
cc W. H. Holmes

2/1/35
copy/f

2336

June 15, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On June 14, 1934, Deputy State Engineer Geo. W. Hawley, Assistant Deputy State Engineer W. H. Holmes and State Consulting Engineer Fred C. Herrmann visited and inspected El Capitan Dam. The party arrived at the dam at 1:20 P.M. and were joined by Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood. The party examined the downstream beach and the puddle core mixer, which was brought up to the downstream beach. Mr. Albert took the State's Engineers to the southerly portion of the upstream beach and an inspection was made of the entrapped clay strata.

2. The party assembled at the City's guest house at 2:45 P.M. where they were joined by the Hydraulic Engineer. A conference was held relative to the hydraulic fill. The Hydraulic Engineer showed a letter addressed to the contractors to Messrs. Hawley and Herrmann and Holmes. Resident Engineer Wood showed Messrs. Hawley and Herrmann Drawing WD-508 and WD-507 as posted to date, showing depth and extent of puddle core mixer operation from May 28 to date. Mr. Albert explained the operation of the puddle core mixer. Messrs. Hawley and Herrmann examined letter-size drawing given them by the Hydraulic Engineer showing in plan the sand strata and lenses in red, samples taken and percentage of fines as of April 30, 1934.

The Hydraulic Engineer asked Mr. Albert if he is satisfied with results of puddle core mixer operation and if it satisfies requirements of the Hydraulic Engineer's letter S-108 of May 12, 1934. Mr. Albert replied "yes".

3. Mr. Hawley said there had been more investigational work on this dam than on most dams. He further stated that "I am satisfied with the work accomplished." He turned to Mr. Herrmann and said "I take it this is your opinion." To this Mr. Herrmann said "I am satisfied."

4. The Hydraulic Engineer showed Mr. Hawley drawing WD-501 showing narrow puddle core above elevation 700, and told him that a tracing would be sent to him on June 15, 1934. Mr. Pyle was asked by the Hydraulic Engineer the increase in cost due to increase in crest width and rock thickness. Mr. Pyle reported $23,000. Mr. Hawley said "reduced width of core makes necessary closer control and supervision and that the summit pool is now about 105 feet wide and that it is proper to reduce this width."

5. Mr. Herrmann says "condition of oley on upstream beach wants to be cured." He further stated "The narrowing of the puddle is fussy job."

6. Mr. Albert says the contractor should be told what to do. To this the Hydraulic Engineer replied it would be better to say what the contractor may not do. He further said he has "seen no evidence of efficient sorting as 10 second feet of flow comes out onto beaches."

7. Mr. Albert favors semi-hydraulic operation for placement of material to build up the upstream beach as this operation is being more easily controlled. Mr. Hawley said that "material with 60 per cent fines will have to be closely handled."

8. The Hydraulic Engineer said "the contractor has been told he may, upon approval by the State, build the narrower puddle core." He further said "The semi-hydraulic placement will be permitted to get started off."

9. Mr. Hawley states as a general principal "the beach material should be coarse and with minimum of fines; in other words, the coarser the better."

10. Mr. Albert explains that he wants the contractor to introduce imported Lakeside silt directly into the summit pool by the dragline unloading the skips. Mr. Hawley said "there are two stages to corrective work before there ready to go ahead." Mr. Pyle asked Mr. Albert how corrective work at the upstream beach would be done. Mr. Herrmann said "this must be done."

11. At 4:05 P.M. T. E. Connolly and E. Alan Rowe came to the conference and were invited in by the Hydraulic Engineer. Mr. Connolly said he wants to introduce imported silt directly into the puddle core. Mr. Rowe explained that studies had been made of stability of the dam and a letter is being sent to Mr. J. B. Lippincott. He favors introduction of fines directly into the puddle core to eliminate fines on the beaches. The Hydraulic Engineer asked Mr. Connolly "when will the hog box be filled?" Mr. Connolly said that he "must start piling tomorrow." The Hydraulic Engineer said Mr. Connolly "could have our conclusions tomorrow." Mr. Connolly says he "would prefer not waiting for letter from Mr. Lippincott."

12. The conference terminated at 4:30 P.M. and those present except the Hydraulic Engineer examined a sample of Lakeside material settled in water in a jar for about a month. Messrs. Hawley and Herrmann each said they could see no objection to introduction of this material directly into the puddle core.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy /f

June 20, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On June 19, 1934, State's Assistant Deputy Engineer W. H. Holmes inspected the work at El Capitan dam and conferred with the Resident Engineer and D. W. Albert.

2. Mr. Holmes arrived at the Resident Engineer's office at 2 P.M. He requested that his progress section of the dam be posted. This was done to May 24, 1934, and the water levels as measured in the test wells on June 15, 1934 were plotted.

3. Mr. Holmes requested tabulation on movements measured in the dam. He was furnished this data in tabular form from records in the Resident Engineer's letters to the Hydraulic Engineer.

4. Mr. Holmes requested that shear tests be performed on beach material. He also requested that an absorption test be made on one of the remaining ungrouted grout holes in the south end of the core wall. He requested that a pipe be extended up the hill from the existing grout pipe and that water be added to fill the pipe and that the head of water on the hole and the quantity of water absorbed daily be measured.

5. The resident Engineer drove Mr. Holmes to and along the upstream beach and several test pits were dug in the upstream beach near N 3300. One pit was dug 16 feet east of the edge of the summit pool and a second pit was dug 24 feet east of the edge of the pool. After about 10 minutes water in the first pit stood 7½ inches below the water level in the pool and in the second pit the water stood 15 inches below the water level in the pool. This relationship of water levels was constant during the next few minutes the holes were left opened.

6. Mr. Holmes saw the first Lakeside silt added directly to the puddle core at 4:15 P.M. at N 3925-E 5035 and conferred with D. W. Albert relative to the method of placement from skips.

Harold Wood
Resident Engineer

HW/p

E/1/35
copy/f

2339

July 9, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On July 6, 1934 State Engineer Edward Hyatt and Deputy State Engineer Geo. W. Hawley inspected El Capitan Dam with Hydraulic Engineer Fred D. Pyle, Hydraulic Fill Engineer D. W. Albert and Resident Engineer Harold Wood. The inspection covered the period from 9:15 A.M. to 12:30 P.M.

2. The excavation for spillway extension was inspected and progress on the spillway noted.

3. Inspection from the spillway crest was made of the work on the hydraulic fill. Later the group went to the upstream beach and up onto the south abutment, and back to the downstream beach. A very thorough inspection was made of both beaches.

4. Mr. Albert conferred with the State's Engineers relative to work thus far accomplished and difficulties remaining to be met in construction of the hydraulic fill.

5. The State Engineer expressed himself as of the opinion that the dam thus far was a safe structure. This same statement was made to the Press on the evening of July 6, 1934.

Harold Wood
Resident Engineer

HW/p

8/6/34
copy/f

2340

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

July 11, 1934

Mr. Fred D. Pyle, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

We are sending under separate cover one tracing of drawing WD-501 which was approved by the State Engineer on July 10, 1934.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

2/1/35
copy/f

2341

July 13, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection.

1. On July 12, 1934, Assistant Deputy State Engineer W. H. Holmes inspected El Capitan Dam with the Resident Engineer in the afternoon.

2. Mr. Holmes requested information on the progress of absorption test being made on grout hole in the south abutment and on friction test being made on beach materials. A verbal progress report was given him on the two above tests. He also asked about recent samples taken of beach material and was told of the results of tests on samples 2852 to 2881 inclusive taken on July 3, 1934. He was told that the beach built by the full hydraulic method showed 5 per cent less fines present.

3. Mr. Holmes conferred with D. W. Albert at the dam and made depth soundings in the summit pool with the six pound weight. He also sounded with the sounding pole along the downstream puddle core limit line for the southerly half of the length of the summit pool.

4. Mr. Holmes took two samples of local borrow pit material and two samples of Lakeside material in the hog box.

5. Mr. Holmes requested the location of the outlet tunnel plug and the upper end of the rock section in the tunnel.

6. Mr. Holmes, upon leaving, said he had no special comment to make. He said he expected to visit the job next week.

7. Mr. Holmes took several photographs of the work and two from the south abutment.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

2342

July 30, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On July 21, 1934, Assistant Deputy State Engineer W. H. Holmes visited and inspected the work at El Capitan Dam in company with the Resident Engineer.

2. Mr. Holmes took several photographs and at 2:15 sat in on the conference at the City's guest house at which there were present T. E. Connolly, J. B. Lippincott, D. W. Albert, Fred D. Pyle, L. C. Hill, Fred Lockwood, C. L. Byers, G. Tillman and the Resident Engineer. For details of this conference see memorandum by Fred D. Pyle dated July 21, 1934.

3. Mr. Holmes made no comments at the conference nor afterwards to the Resident Engineer.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

August 9, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On August 9, 1934, Assistant Deputy State Engineer W. H. Holmes inspected El Capitan dam and conferred with the City's Consulting Engineer L. C. Hill.

2. Mr. Holmes, Mr. Fred D. Pyle and the Resident Engineer examined the puddle core and beaches. Particular note was made of the very apparent stiffening up of the puddle core since August 8. Also the sand strata at N 3200 was sounded and poked thru with the sounding rod.

3. The puddle core when sounded in several places with the 6-pound weight showed depths of 4 to 6 feet. Mud could be felt with the hand at depths of about 2 feet over considerable area of the pool. The water surface was about elevation 716.3.

4. Mr. Holmes expressed satisfaction with the way the core is consolidating and with the condition of the beaches. He also said he strongly favors the addition of Lakeside material to the puddle core.

5. Mr. L. C. Hill returned to Los Angeles with Mr. Holmes in the afternoon.

Harold Wood
Resident Engineer

HW/p

2/1/35
copy/f

2344

August 9,1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On August 2, 1934 Deputy State Engineer Geo. W. Hawley, State Consulting Engineer Fred C. Herrmann and Assistant Deputy State Engineer W. H. Holmes inspected El Capitan Dam and conferred with the City's engineers.

2. The State's engineers in company with City's engineers examined the south end of the upstream beach where the levee had been built up about 100 feet in length in advance of the rock embankment and for a height of about 8 feet. The upstream slope of this levee was saturated and tended to slough. Water had been off the beach 12 hours, at this location - N 3090. The water slope in the beach was 44 inches lower at the upstream slope of the levee than in the summit pool and at a distance of 48 feet from the edge of the summit pool.

3. Samples were taken for the State's engineers to examine.

4. An inspection was made of the downstream beach.

5. After lunch, at the contractor's camp, a conference was held at the City's guest house. At this conference Hydraulic Fill Engineer D. W. Albert explained to the State's engineers, Hydraulic Engineer Fred D. Pyle and the Resident Engineer, the difficulties and dangers to continuing full hydraulic method. Mr. Herrmann and Mr. Hawley both said that the City is facing necessity of change in method of building the top of the dam. Contractor T. E. Connolly joined the conference at 1:30 P.M. Mr. Albert explained his suggested method of building up rolled fill and forcing core upwards some 20 to 25 feet and then trenching the rolled fill and continuing a core of Lakeside clay up to above the spillway lip. Mr. Connolly said the City must get busy on plans and change the method of building to a rolled fill.

6. For further data on this inspection and conference, see memorandum by the Hydraulic Engineer dated August 3, 1934.

Harold Wood
Resident Engineer

HW/p

3-4-35
copy/p

August 13, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature
Hydraulic fill construction methods, changes

Dear Mr. Hyatt:

The construction of the hydraulic fill portion of the El Capitan Reservoir Dam has reached a point where the integrity of the impervious puddle core section of the dam can not be maintained if hydraulic operations are continued.

The progress of the work, results accomplished and difficulties encountered during the past month have been observed twice by City's Consulting Engineer Louis C. Hill, once by Contractor's Consulting Engineer J. B. Lippincott, once each by Deputy State Engineer in Charge of Dams Geo. W. Hawley and State's Consulting Engineer Fred C. Herrmann, and three times by Assistant Deputy State Engineer W. H. Holmes. The City's Hydraulic Fill Engineer D. W. Albert has been on the work practically night and day.

The water surface of the summit pool is now at elevation about 718, and the average elevation of the beaches about 720. The average depth of the pool as indicated by a six pound weight is about 5 feet. The hydraulic placing of material has been discontinued.

It is deemed advisable that no more material be placed by hydraulic methods and that the impervious puddle core on which the integrity of the dam will depend be carried up between two rolled fill embankments all as indicated on the enclosed print of drawing WD-511, which is submitted for your consideration and reaction.

Your very earliest consideration and approval is earnestly requested.

Very truly yours,

Fred D. Pyle
Hydraulic Engineer

FDP/f
encl. WD-511
cc-W. H. Holmes
City Manager
City Attorney
Special Water Counsel
Consulting Engineer L. C. Hill
Resident Engineer
Hydraulic Fill Engineer
Original and copy to Sacramento
(Prints with each copy)

3-4-35
copy/p

August 13, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, City's Resident Engineer

Dear Mr. Hyatt:

In order to facilitate action on the proposed change in construction methods at El Capitan Reservoir Dam, Mr. Harold Wood, Resident Engineer is personally delivering letter dated August 13, 1934 and is prepared to discuss with you the conditions as they now exist.

Very truly yours,

Fred D. Pyle
Hydraulic Engineer

FDP/f
cc W. H. Holmes

12/20/34
copy /f

2347

August 20, 1934

Mr. Edward Hyatt,
State Engineer
Department of Public Works,
Sacramento, California.

Subject: San Diego River Project, El Capitan Reservoir Dam - Top of dam - Puddle Core, and Rolled Fill Embankment (State) (#8-7)

Dear Mr. Hyatt:

In compliance with approval of the change in type of construction methods for the top portion of the El Capitan Reservoir Dam, as stated in your letter dated August 14, 1934 and signed by Mr. George W. Hawley, Deputy in Charge of Dams, submitted herewith are two mercury prints of Drawing WD-511 for your official approval.

Very truly yours,

Fred D. Pyle,
Hydraulic Engineer

FDP/m
Encl.

2/1/35
copy/f

August 23, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
Hydraulic fill - rolled fill - State Inspection

1. On August 18, 1934, Deputy State Engineer Geo. W. Hawley visited and inspected the work at El Capitan Dam.

2. Hydraulic placement operations had ceased on August 13 and at the time of Mr. Hawley's visit Lakeside pit material was being bulldozed directly into the puddle core. Some local material was being rolled on both the upstream and downstream stability sections preparatory to blading into the puddle core. Some decomposed granite from the spillway had been put on the downstream side to provide roadway for the trucks hauling the core material.

3. Mr. Hawley conferred with Mr. D. W. Albert and also with L. C. Hill.

4. He arrived about 11:15 A.M. in company with Fred H. Tibbetts, Civil Engineer of San Francisco and they left about 3 P.M.

5. Mr. Hawley expressed satisfaction with the start of the upbuilding of the dam by rolled fill method and with the behavior of the puddle core.

Harold Wood
Resident Engineer

HW/p

12/20/34
copy /f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

August 29, 1934

Mr. Fred D. Pyle,
Hydraulic Engineer,
City of San Diego,
Water Department,
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

We are sending under separate cover by registered mail, one copy of tracing No. WD 511, showing the top of the above dam which was approved by the State Engineer on August 27, 1934.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams.

2/1/35
copy/f

August 31, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

1. On August 30, 1934, Deputy State Engineer Geo. W. Hawley and Assistant Deputy State Engineer W. H. Holmes inspected the rolled fill work at El Capitan Dam.

2. They arrived at noon and left about 6:15 P.M. Mr. Pyle and the Resident Engineer were with them during their inspection. Mr. Hawley commented that there was too much moisture and that it was uneven in distribution. He also said there was insufficient compaction. He also objected to the lumps of red clay material from local borrow pits entering the puddle core.

3. Test holes were dug as follows:

(1) N 3750 E 5040 In wet material for 10 inches down

(2) N 3800 E 5040 In dry material

(3) N 3730 E 5065 In decomposed granite wet for 8 inches

(4) N 3640 E 4930 In decomposed granite wet for 12 inches

4. The State's Engineers conferred with Hydraulic Fill Engineer D. W. Albert from about 3:30 P.M. to 6 P.M.

Harold Wood
Resident Engineer

HW/p

3-1-35
copy/p

September 25, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature
Puddle core and rolled embankment

Dear Mr. Hyatt:

On September 20, 1934 field examination was made of the progress and condition of the puddle core, rolled embankment and rock embankment of the El Capitan reservoir dam with City's Consulting Engineer Louis C. Hill, Assistant Deputy State Engineer W.H.Holmes Hydraulic Fill Engineer D. W. Albert, and Acting Resident Engineer J. W. Williams.

At the time of examination the surface of the water in the summit pool was at elevation 744 and the top of the rolled embankment was at elevation 746.

Duplicate samples of materials taken from four deep sample wells at N 3500, in accordance with previous verbal requests of the State Engineer's representatives, were examined and compared with the laboratory analysis of the original set of samples.

Enclosed for your information is print of working drawing showing the location, depth, percentage of moisture and percentage of fines of sample wells Nos. 2-A, 3, 4 and 5. These wells varied from 40 to 58 feet in depth.

Mr. Holmes expressed his belief and Mr. Hill agreed that the rate of upbuilding of the dam should be materially reduced in order to permit drainage and consolidation of the puddle core.

After investigation and discussion in the field on September 20, 1934, supplemented by further discussion in the office on September 21, the following conclusions as to progress and methods of carrying on the work in order to maintain the safety of the dam were reached and will be followed unless otherwise advised by you:

(a) The rock embankments should be brought up as soon as possible and in the future kept up as close to the top of the rolled fill as practicable.

(b) The upbuilding of the puddle core and the rolled embankment section of the dam should not exceed half a foot a day.

(c) The addition of water in the puddle core should be discontinued excepting in the vicinity of the abutments and the puddle core constructed in such manner that saturated material will not exist above elevation 753.

(d) Between elevation 753 and elevation 763, the material in the puddle core area should be treated in the usual manner, that is, proper core materials be placed on rolled embankments, broken down with sheep foot tampers, water added to bring moisture content up to about 10 per cent, bulldozed into place and lightly compacted. Care to be exercised to see that the material does not become saturated.

(e) Above elevation 763 the rolled fill may extend across the puddle core section.

(f) Another deep samplew well should be placed at N 3500, preferably with a rotary drill. Samples should be taken from the top down to elevation about 650, or a depth of about 95 feet.

(g) The time of installation of the tunnel plug will be dependent upon satisfactory consolidation of the puddle core.

Very truly youre,

Fred D. Pyle
Hydraulic Engineer

FDP/f
encl.

cc W. H. Holmes,
Assistant Deputy State Engineer

10/1/34
copy /s

COPY

2353

POSTAL TELEGRAM

1934 OCT 1 PM 12 14

S 94 122 SC SACRAMENTO CALIF 1 1155A

FRED D PYLE, HYDRAULIC ENGINEER
CITY OF SAN DIEGO SAN DIEGO CALIF

CONFIRMING HOLMES REQUEST SEPTEMBER THIRTIETH STOP YOU ARE DIRECTED TO IMMEDIATELY AND EXPEDITIOUSLY ESTABLISH REFERENCE POINTS ON BOTH FACES EL CAPITAN DAM AT EACH ONE HUNDRED FOOT STATION ALONG AXIS OF DAM AND AT VERTICAL INTERVALS NOT GREATER THAN TWENTY FIVE FEET IN ELEVATION FROM ORIGINAL GROUND TO CREST ELEVATION OF DAM AT EACH STATION STOP OBSERVATIONS OF MOVEMENTS AT EACH MONUMENT ARE TO BE MADE AND SUBMITTED DAILY TO THIS OFFICE STOP YOU ARE FURTHER DIRECTED IN THE INTERESTS OF SAFETY TO DISPOSE OF EXCESSIVE AND SURPLUS WATER FROM CENTRAL PORTION OF DAM AND TO REFRAIN FROM PLACING ADDITIONAL MATERIALS IN PUDDLE SECTION PENDING REMOVAL OF WATER COMMA ANALYSIS OF OBSERVED MOVEMENT DATA AND ASSURANCE OF SATISFACTORY CONDITION OF PUDDLE CORE MATERIALS.

EDWARD HYATT STATE ENGINEER

2/1/35
copy/f

October 2, 1934 2354

From : Hydraulic Engineer

To : City Manager

Subject: San Diego River Project, El Capitan Feature Conference, Consultants

On September 30, 1934 Assistant Deputy State Engineer W. H. Holmes verbally requested that numerous monuments be placed on the embankments at El Capitan Dam to determine the movement both vertical and horizontal, and that the puddle core be dried up. This request was confirmed by the following telegram from the State Engineer:

"SACRAMENTO, CALIFORNIA, OCTOBER 1, 1934
"CONFIRMING HOLMES REQUEST SEPTEMBER THIRTIETH STOP YOU ARE DIRECTED TO IMMEDIATELY AND EXPEDITIOUSLY ESTABLISH REFERENCE POINTS ON BOTH FACES ELCAPITAN DAM AT EACH ONE HUNDRED FOOT STATION ALONG AXIS OF DAM AND AT VERTICAL INTERVALS NOT GREATER THAN TWENTY FIVE FEET IN EVEVATION FROM ORIGINAL GROUND TO CREST EVEVATION OF DAM AT EACH STATION STOP OBSERVATIONS OF MOVEMENTS AT EACH MONUMENT ARE TO BE MADE AND SUBMITTED DAILY TO THIS OFFICE STOP YOU ARE FURTHER DIRECTED IN THE INTERESTS OF SAFETY TO DISPOSE OF EXCESSIVE AND SURPLUS WATER FROM CENTRAL PORTION OF DAM AND TO REFRAIN FROM PLACING ADDITIONAL MATERIALS IN PUDDLE SECTION PENDING REMOVAL OF WATER COMMA ANALYSIS OF OBSERVED MOVEMENT DATA AND ASSURANCE OF SATISFACTORY CONDITION OF PUDDLE CORE MATERIALS.

EDWARD HYATT STATE ENGINEER"

It has been indicated that the State Engineer has been considering delaying the completion of the El Capitan Dam to permit additional drainage, and, therefore, the following telegram was sent to him yesterday, asking for conference of Consulting Engineers:

"SAN DIEGO, CALIFORNIA, OCTOBER 1, 1934
"CAN HAWLEY AND HERRMANN BE AT EL CAPITAN OCTOBER FOURTH FOR CONFERENCE WITH HILL AND ALBERT, URGENT

FRED D. FYLE"

The following reply was received from the State Engineer:

"SACRAMENTO, CALIFORNIA, OCTOBER 1, 1934
"REFER YOUR TELEGRAM OCTOBER FIRST STOP HERRMANN OUT OF STATE CONSEQUENTLY NOT AVAILABLE FOR SUGGESTED CONFERENCE STOP HAWLEY AND HOLMES WILL CONFER WITH

HILL ALBERT AND YOURSELF ON OCTOBER FOURTH STOP
THEY WILL ARRIVE ELCAPITAN ABOUT NOON THE FOURTH.

EDWARD HYATT"

Because of the Contractor's interest in the matter, it was deemedproper to send him the following telegram:

"SAN DIEGO, CALIFORNIA, OCTOBER 2, 1934
"H. W. ROHL & T. E. CONNOLLY
4351 ALHAMBRA AVENUE
LOS ANGELES, CALIFORNIA
"YOU ARE INVITED TO HAVE YOUR CONSULTING ENGINEER MEET WITH REPRESENTATIVES STATE AND CITY AT ELCAPITAN OCTOBER FOURTH TO CONSIDER MATTERS AFFECTING COMPLETION DAM.

FRED D. PYLE"

The City's Consulting Engineer has advised that he will be in San Diego early Thursday morning, October 4, 1934, for conference with the City's Engineers at El Capitan Dam before the representatives of the State arrive.

It appears desireble that you and the City Attorney be present at the last part of the conference at El Capitan Dam on the afternoon of October 4, 1934.

Fred D. Pyle
Hydraulic Engineer

FDP/f

1/31/35
copy /f

2356

October 2, 1934

From : Acting Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State inspection

1. On September 4, 1934 Assistant Deputy State Engineer W. H. Holmes visited the El Capitan Dam and stayed over to September 5. He requested two puddle core samples, located at N 3100 and E 5008, and N 3750 E 5000, to depth of 40 feet. Mr. Holmes left at 11 AM.

2. On September 11, the Hydraulic Engineer, Deputy State Engineer Geo. W. Hawley and Mr. Holmes were on the job at noon. The City's crew was working on the puddle core well No. 2 located at N 3750 E 5000. Samples were examined at 20-foot depth below elevation 733. No. 2 well casing broke. On September 13 the City's crew started drilling test well No. 2a at N 3750 E 5000 to check samples taken on test well No. 2, and continued to bottom elevation 696.5 completing the well September 14. On September 15 test well No. 3 was completed located at N 3500 E 5017 to bottom elevation about 708. September 16 test well No. 4 located at N 3500 E 5025 was completed to bottom elevation 695, and test well No. 5 located at N 3500 E 5035 was completed to bottom elevation 685. Wells 1 and 2 were ordered by the State Engineer September 4 and wells 3, 4 and 5 were ordered September 11.

3. On September 17, Mr. Holmes arrived at the dam about noon. After lunch he made an examination of the work being progressed on the dam and spillway. He stated he thought the summit pool now at elevation about 748 should be narrowed. He examined the rock embankment condition and stated it should be brought up to rolled embankment elevation and continued along on about the same elevation.

4. The Hydraulic Engineer arrived on the work and confered with Mr. Holmes, Hydraulic Fill Engineer D. W. Albert and Acting Resident Engineer J. W. Williams, until about 6 PM. Mr. Williams accompanied Mr. Holmes on inspection of work being carried on by Rohl and Connolly in tunnel repairs and grouting.

5. On September 20 at about 11:30 AM Mr. Holmes and the City's Consulting Engineer L. C. Hill arrived at the Resident Engineer's office. The Hydraulic Engineer had arrived at 10 o'clock and immediately contacted Mr. Albert and together they examined the work being progressed on the dam structure. At 1:00 PM Messrs. Holmes, Hill, Pyle, Albert and Williams made a thorough examination of the work. Consultation in the guest house was held until 6:30 PM when Messrs. Hill, Pyle and Holmes left for San Diego.

6. On September 21 at 1:00 a conference was held in the San Diego office attended by Messrs. Pyle, L. C. Hill, Holmes, Albert, Williams and Assistant Engineer Paul Beermann. Subject: Condition of El Capitan dam as constructed to elevation puddle core 744, upstream rolled embankment about 746, downstream rolled embankment about 745.5 as of this date; also weight and percentage of moisture in puddle core and beaches and rolled fill as disclosed by samples taken in the test wells; also rate of progress of construction of rolled fill and puddle core section to be slowed down by the contractor to about one-half foot lift in 24-hour period, and drawing in of summit pool and puddle core; decrease of moisture used until elevation 753 is reached from elevation 755 up to about elevation 760.

It was deemed proper to dump Lakeside pit or other suitable material into the puddle core section moistened but not compacted so that no bridging over would take place. The topping out of the dam was to be constructed of decomposed granite to about elevation 770 at the north and south abutments, and increased to about elevation 773+ as the maximum section above foundation was reached.

7. On September 22 Mr. Albert notified the contractor's superintendent O. C. Steves of the projected change of rate of daily placement of rolled fill and puddle core material.

8. September 26 Mr. Holmes arrived at 11:30 A.M. and examined the work being progressed on the dam.

9. September 27 State Engineer Edward Hyatt, Mr. Hawley and Mr. Pyle arrived at the dam about 10:30 A.M. and held a conference in the office of the Resident Engineer in regard to the stability of the dam at its present elevation - summit pool 747, upstream and downstream rolled embankment about 743. After the conference, accompanied by Mr. Albert, the party went over the main dam structure. Messrs. Hyatt, Hawley and Pyle left for San Diego at about 1:00 PM.

10. September 30 Messrs. Holmes and Pyle arrived at the dam and examined samples taken from test well No. 6 being progressed at N 3500 E 5025. Free water was encountered at elevations 710 and 700. Mr. Holmes left for Mr. Pyle's residence about 5 PM. Before leaving, Mr. Holmes checked up on all movements recorded to date on the monuments established in the dam and indicated he would require the City to set additional monuments at about 100 foot intergals north and south and at each 25 foot interval in elevation from elevation 575 up both upstream and downstream.

J. W. Williams
Acting Resident Engineer

JWW/p

1/31/35
copy /f

2358

November 3, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State Inspection

October 1, 1934.

Investigation Well No. 6, El Capitan Dam, was finished to a depth of 100 feet; bottom elevation about 650. Jar samples and core samples were taken at about 2½ foot intervals. This well was ordered by the State Engineer and was located on the dam at elevation about 750, coordinates N 3500 E 5025. One set of samples was sent to the testing laboratory at Balboa Park for moisture and fineness test and a duplicate set was kept in the Resident Engineer's office vault. The core samples were kept in cartons in the Resident Engineer's El Capitan office.

October 4, 1934

Deputy State Engineer George W. Hawley and Assistant Deputy State Engineer W. H. Holmes arrived at the dam about noon. They examined the construction work being progressed on the dam, and the core cylinders from Well No. 6. A conference was held in the El Capitan guest house.

October 10, 1934.

Hydraulic Engineer Fred D. Pyle and Assistant Deputy State Engineer W. H. Holmes arrived at the Resident Engineer's office at 9:30 A.M. Mr. Holmes and Chief of Party L. H. Hill took samples of puddle core section and rolled fill and checked over tabulation of movement of permanent dam points.

October 19, 1934

Assistant Deputy State Engineer W. H. Holmes arrived at the Resident Engineer's office at about 1:00 PM and covered all work being progressed on the dam and spillway and spillway extension.

October 30, 1934

Assistant Deputy State Engineer W. H. Holmes arrived at 12:30 PM and in company with Hydraulic Fill Engineer D. W. Albert and Resident Engineer made examination of dam construction, and cast iron outlet pipe being laid thru the tunnel plug section. Mr. Holmes requested copies of grouting records accomplished in the rock section around the tunnel plug section of the tunnel.

J. W. Williams
Resident Engineer

JWW/p

1/31/35
copy /f

2359

January 2, 1935

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature, Inspection.

November 14, 1934 - George W. Hawley, Deputy State Engineer in Charge of Dams and W. H. Holmes, Assistant Deputy State Engineer arrived at El Capitan Resident Engineer's office at 3 P.M. After a complete examination of the cast iron outlet pipes and tunnel plug they made examination of upstream slope of rock embankment from toe wall to top of dam, then proceeded to north end of dam and examined spillway transition sections. Mr. Hawley requested that pipe points be set on center line axis of dam at 100 foot intervals and at depths of 10 feet and 20 feet below top surface, the 1-1/4 inch 20 foot lenths to be driven inside of the 3 inch 10 foot length and free from contact for 10 foot depth. State Engineers and Hydraulic Engineer left for San Diego about 5 P.M.

November 20, 1934 - W. H. Holmes, Assistant Deputy State Engineer arrived at El Capitan about 10 A.M. accompanied by Andre Coyne, National Engineer of dams and bridges from Paris, France. Mr. Holmes and Mr. Coyne, accompanied by D. W. Albert, Hydraulic Fill Engineer and myself made examination of all work being progressed on spillway and tunnel plug. Mr. Holmes appeared to be well pleased with all work accomplished and work being progressed. About 11:20 A.M. Mr. Holmes and Mr. Coyne left for Hodges reservoir dam.

November 28, 1934 - J. H. Roper, Supervising Engineer, R.F.C. arrived at Resident Engineer's office at 12:45 P.M. I personally conducted him over the completed project. He appeared well pleased with the finished structure. Mr. Roper has shown a keen interest in the El Capitan Project and has made thorough inspection at regular intervals while construction was being progressed.

December 7, 1934 - Fred D. Pyle, Hydraulic Engineer and W. H. Holmes, Assistant Deputy State Engineer arrived at Resident Engineer's office at 9 A.M. and in company with D. W. Albert, Hydraulic Fill Engineer and myself made examination of section of old tunnel lining being sand blasted. Sand blasting not satisfactory in effectiveness or rate of progress. Examination was also made of dam and spillway and spillway extension. Hydraulic Engineer and State Engineer left for San Diego about 11 A.M. via Chocolate Creek road.

December 20, 1934 - Hydraulic Engineer and W. H. Holmes, Assistant Deputy State Engineer arrived at Resident Engineer's office about 8:30 A.M., made inspection of tunnel inner lining work being progressed just as concrete pumping operations started. Forms were being stripped from tunnel wall concrete from Station 1+31 to Station 2+11. Some rough concrete showed at points in wall section about three feet above invert line, the balance of concrete stripped very satisfactory. Hydraulic Engineer and Assistant Deputy State Engineer left for San Diego about 10 A.M.

J. W. Williams
Resident Engineer

JWW/f

2/6/35
copy/f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
401 PUBLIC WORKS BUILDING
SACRAMENTO

ORDER AUTHORIZING USE OF DAM

Application No. 8-7
Name of Dam - El Capitan
Stream - San Diego River
Legal Subdivision - NE 1/4, Sec. 7, T. 15 S., R. 2 E., S.B.B. & M.
County - San Diego

TO: Mr. Fred D. Pyle, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

WHEREAS, the City of San Diego, under date of January 23, 1935, applied to the State Engineer for permission to make use of the above named dam:

NOW, THEREFORE, you are hereby authorized to make use of said dam pending issuance of a certificate of approval thereof and until the further notice and order of the State Engineer, but said authorization shall be subject to revocation at any time in the discretion of the State Engineer, or for failure to diligently complete said dam, or file notice of completion thereof, or such tracings of the dam as constructed or other drawings, maps, data, records or information pertaining thereto as may be required, or for failure to file a duly authenticated statement of the cost of said dam as constructed, or for failure to pay any further or additional fee as may be due or for failure to comply with any requirements irrespective of their nature or character which may be hereafter imposed by the State Engineer, and further said permission to use said dam is and shall be subject to the terms, conditions and limitations, hereinbelow set forth and is and shall be subject to revocation for failure to observe or comply with any of said terms, conditions and limitations which are as follows, to wit:

1. The State Engineer shall be fully and promptly advised of any sudden and/or unprecedented flood and/or unusual or alarming circumstance or occurrence affecting said dam.

2. Full, complete and careful observations shall be taken and kept of any and all data, circumstances, occurrences and/or conditions which do or may

relate to or affect the stability, permanency and/or safety of said dam or the use thereof; or which affect, relate to or in anywise appertain to stream flow, whether under normal or flood conditions; or which affect, relate to or in anywise appertain to the foundations and abutments of said dam or the structures or other works appurtenant thereto; including the following:

(a) Readings and measurements on all established points upon the fill, at not greater than 10 day intervals.

(b) Readings of water elevation in all test wells located on the dam, at not greater than 10 day intervals.

(c) Measurements, at ten day intervals, of points in the tunnel lining to indicate movement or distortion of the same, said points to be established for that purpose as directed by the State Engineer.

(d) Separate measurements, at ten day intervals, of the amounts of seepage from the tunnel and from the dam foundations, at devices to be installed for that purpose as directed by the State Engineer.

(e) A daily record of gage heights at the reservoir, showing water surface elevations.

(f) The above observations, readings and measurements shall be forwarded to the State Engineer at not greater than ten day intervals.

3. Construction of the inner lining of the tunnel shall be diligently prosecuted to completion and the grouting thereof shall be undertaken and completed as soon thereafter as practicable.

WITNESS my hand and the seal of the Department of Public Works of the State of California this fourth day of February, 1935.

GEO. W. HAWLEY (Signature)
DEPUTY STATE ENGINEER

Reg.
cc-W.H.Holmes

(SEAL)

April 4, 1935

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature

Dear Mr. Hyatt:

In compliance with the requirements of the Act Governing Supervision of Dams in California, submitted herewith are drawings showing and describing the El Capitan Reservoir Dam as actually constructed.

WD-382		Plan and topography
400		Outlet tower
414		Timbered tunnel section
421		Drains at downstream toe
423	sheet 1 of 2	Connections from outlet tower
424	sheet 3 of 3	Tower platform detail
435	6 sheets	Core wall grouting detail
449	sheet 2,3,5, 6,7a of 7	Spillway plan profile and details
450		Spillway construction details
460		Spillway lower end
498		Spillway Extension structural details
482		Flume crossing thru dam
512		Plan and section of tunnel
513		Tunnel inner lining
520		Construction methods and section
521		Hydraulic fill drainage
526		Detail north end of dam
527		Tunnel grouting detail

Upon notification from you as to which drawings you will officially approve, duplicate original tracings will be submitted for your approval.

Please advise if any data in addition to the drawings will be required by you prior to the issuance of a certificate of approval authorizing the use of the El Capitan Dam.

Mr. Edward Hyatt -2 4/4/35

Attached is statement of cost of the El Capitan Reservoir Dam, Spillway and Outlet Works; Spillway Extension; and Tunnel Inner Lining, and miscellaneous items since April 1932.

Very truly yours,

Fred D. Pyle
Hydraulic Engineer.

FDP/p
encls.(23)
22 drawings
Cost statement

cc- W.H.Holmes, Assistant
Deputy State Engineer

4-4-35
FB/p

SAN DIEGO RIVER PROJECT

EL CAPITAN DAM

Statement of Cost from beginning of work April 1932 to February 28, 1935

Item		Subject to State Filing Fee	Not subject to State Filing Fee
El Capitan Reservoir Dam, Spillway and Outlet Works,	contract payments schedule items	$2,681,641.33	
	extra work orders Nos. 3 to 28	12,745.52	
	extra work orders Nos. 1 and 2 on roads		$10,616.96
El Capitan Reservoir Dam Spillway Extension	contract payments	197,836.66	
El Capitan Reservoir Dam Tunnel Inner Lining	contract payments	55,409.42	
Purchase of appurtenances		7,191.20	
Maintenance of roads			647.81
Road construction			1,653.24
Foundation exploration		955.07	
Construction of engineers camp			3,428.01
Labor investigation			6,469.02
Fire protection			2,862.24
Compensation insurance			1,572.58
Travel expense (sale of bonds to RFC etc.)			12,070.53
Legal and miscellaneous applications			2,052.52
Pumping water for Irrigation District			712.50
Purchase of rights of way			82,567.20
Clearing reservoir basin			35,047.41
Engineering		169,128.37	
Total		3,124,907.57	160,500.02
Fee based on estimated cost of		3,226,595.25	

No additional fee required.

Fred D. Pyle
Hydraulic Engineer

STATE INSPECTION OF SPILLWAY

1-31-35
copy/p

January 28, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspeotion

1. On January 27, 1933, Deputy State Engineer Geo. W. Hawley visited and inspeoted the work at El Capitan dam, and partucularly the spillway location now indicated by stakes set.

2. Fred D. Pyle and the Resident Engineer accompanied Mr. Hawley over the job.

3. Mr. Hawley inspected the core wall trench N3310 to N3340. He said he would send either Gerald McKinlay, Senior Engineer of Dam Inspection, or Chester Marliave, State Geologist, to look at this with a view of approval of same.

4. Mr. Hawley expressed himself as being satisfied with the location of the spillway in general but was withholding any final decision until the detail drawings were approved by his department.

5. Mr. Rawley requests that the spillway drawings include topography between end of structure and the river.

Harold Wood
Resident Engineer

HW/p

5/1/34
copy/f

2368

February 2, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, spillway.

Dear Mr. Hyatt:

Enclosed for your consideration and reaction are prints of Drawings WD-449, Sheets 1 to 7 inclusive, showing the details of the spillway structure for the El Capitan reservoir dam.

The drawings follow closely the general outline of the spillway as shown on Drawing WD-385 as submitted to you in February 1932.

Drawings are being prepared showing the topography between the end of the spillway and the channel of the San Diego River and the profile of the center line of spillway channel from the end of the structure to the river. Prints of these drawings will be furnished to you in the near future.

The contractor has requested that the spillway be staked soon for excavation purposes.

Your early consideration of the drawings submitted will be appreciated.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

FDP/p
encls.(14)
Drawing WD-449 Sheets 1 to 7 inclusive
(in duplicate)

5/1/34
copy/f

2369

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

February 15, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

The plans for the proposed El Capitan Spillway (Drawings #WD-449, Sheets 1 to 7, inclusive) received by this office February 4, 1933, have been reviewed by the office and found satisfactory in so far as hydraulic capacity, type and location are concerned and therefore have our approval of these features. However, before formal approval can be given, provision must be made to carry the discharge lip of the channel section to a greater distance beyond the dam (downstream) and to an elevation approaching that of the existing channel. It may also be found advisable to provide means for minimizing the energy of the spillway discharge and to design the lower reaches of the channel in such a way that no damage will result from an expected hydraulic jump of magnitude.

While our studies indicate that the structural and hydraulic features are in general satisfactory, the following details are brought to your attention for revision and modification -

1. Provide detailed designs for that portion of the concrete structure connecting the core wall of the dam with the ogee portion of the spillway structure. This structure is to be designed as a stable structure under full loads to which it will be subjected and with adequate construction joints and water seals at its junction with both the spillway and the core wall of the dam.

2. Provide contraction joints, including water seals, in the ogee spillway weir crest.

3. Redesign that portion of the left spillway side wall (transition section between the spillway ogee and the channel lining) between stations 5+10 and 5+60 in such a way that better hydraulic properties may be obtained.

4. Protection against erosion or movement is to be provided for the area immediately adjacent to and on the reservoir side of the ogee weir structure, the structure connecting the weir and core wall of the dam and the left abutment of the dam.

Our Mr. McKinlay is conversant with these features and will be glad to discuss them with you at your convenience.

With these design revisions and additions satisfactorily completed and incorporated in the plans and upon submission of tracings, in duplicate, to this office, formal approval can be given to the plans for the proposed El Capitan spillway.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-G.McKinlay
W.H.Holmes

5/1/34
copy/f

2371

March 11, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, spillway.

Dear Mr. Hyatt:

Enclosed for your consideration and reaction are prints of Drawing WD-449 Sheets 1 to 7a inclusive, edited to March 6, 1933, and WD-450, showing, except for the lower end, the detail of the spillway structure for El Capitan reservoir dam.

The revisions and modifications suggested in your letter dated February 15, 1933 of the drawings submitted to you on February 2, 1933, have been incorporated in the drawings except for the lower end of the spillway, drawings for which are now being developed.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

FDP/p
encle.(16)
Drawing WD-449 Sheets 1 to 7a (2 copies each)
Drawing WD-450 (2 copies)

5/1/34
copy/f

2372

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

March 15, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

We have oritioally reviewed the revised plans for the spillway on the above dam, submitted by you on March 13. We wish to oall to your attention the fact that in all probability certain revisions of the transition section between the ogee weir and the channel below will be necessary during construction. The connection between the out-off wall, the dam and the spillway will probably also require revision when the excavation at this point has been completed and it is our understanding that details of this work will be developed at that time. We further understand that you are at present developing plans for the continuation of the spillway channel beyond the points shown upon the plans submitted and when these are completed you will transmit them for our consideration.

With these stipulations, we find that the plans submitted are generally satisfactory and upon receipt of tracings, in duplicate, we will proceed to formal approval of the same.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes
G.McKinlay

5/1/34
copy/f

2373

March 17, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project,
El Capitan Feature, spillway

Dear Mr. Hyatt:

Transmitted herewith for formal approval are tracings in duplicate of WD-449 sheets 1 to 7a inclusive, edited to March 6, 1933, and WD-450, of the City of San Diego's San Diego River Project, El Capitan Dam, showing, except for the lower end, the detail of the spillway structure.

Prints from these tracings were discussed with your office by me personally on March 13, 1933, and indicated to be satisfactory to your office, except as to revisions of transition sections which may become advisable after the excavation is made, as set forth in letter from George W. Hawley, Deputy in Charge of Dams, dated March 15, 1933.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/p
encls.(16)
Tracing WD-449 Sheets 1 to 7a inclusive (in duplicate)
Tracing WD-450 (in duplicate)

5/1/34
copy/f

2374

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

March 21, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

We are forwarding under separate cover tracings for the spillway at the above dam #WD-449, Sheets 1 to 7a, inclusive, and WD-450, which were signed by the State Engineer on March 21, 1933.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes
G.McKinlay

12-4-34
copy/p

April 5, 1933

Mr. Edward Hyatt, State Engineer
Division of Water Resources
401 Public Works Building
Sacramento, California

Subject: San Diego River Project,
El Capitan Feature, spillway

Dear Mr. Hyatt:

Enclosed for your consideration and reaction are prints of drawings WD-449 sheet 7a of 7 edited to April 4, 1933; WD-453 and WD-454 showing respectively the drainage system, the detail layout and topography of the lower end of the spillway structure of the El Capitan Reservoir Dam.

Very truly yours,

H. N. Savage,
Hydraulic Engineer

WDP/p
encls.(6)
oo Gerald McKinlay, Senior Engineer Dam Inspection

12-4-34
copy/p

STATE OF CALIFORNIA

2376

DEPARTMENT OF PUBLIC WORKS
Sacramento

April 15, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

Responsive to your telephone request of yesterday, April 13, relative to plans submitted for outlet portion of the El Capitan Spillway, the following telegram was sent you today:

"CANNOT APPROVE PLANS SUBMITTED FOR OUTLET CHANNEL SECTION EL CAPITAN SPILLWAY STOP WE BELIEVE INTEGRITY OF DAM WILL BE JEOPARDIZED IF ADEQUATE PROTECTION IS NOT PROVIDED TO PREVENT EROSION DUE TO HIGH VELOCITIES AND LARGE FLOOD FLOWS STOP IT IS BELIEVED THAT PLANS AS SUBMITTED CAN BE CONSIDERED IF MODIFIED TO PROVIDE SUITABLE REINFORCED CONCRETE LINING TO BE CARRIED A SAFE DISTANCE BEYOND DAM AND AN ADEQUATE CUT-OFF CONSTRUCTED AT END OF LINING STOP CONSIDERATION SHOULD BE GIVEN TO REDUCING EXCEPTIONALLY HIGH VELOCITIES TO CONTROLLABLE ONES AND DISSIPATING ENERGY TO MINIMUM IN ORDER TO AFFORD AMPLE PROTECTION TO DAM STOP LETTER FOLLOWS".

Very serious consideration has been given the plans for the outlet portion of the El Capitan spillway, recently submitted by you, and based upon an intensive study of the plans it is not felt that approval can be given the plans as submitted.

Under these plans it is not believed that adequate protection has been afforded the dam. It is, however, believed that the plans can be so modified and revised that the integrity of the dam will not be seriously menaced during periods of large flood flows with consequent high channel velocities if the excavations as shown are properly paved with a well reinforced concrete lining and an adequate cut-off installed at the discharge end of the spillway channel. The velocities in the spillway during periods of flow are, as you know, of a very high order and sufficient in our opinion to cause extensive erosion with a possible attendant adverse effect upon the safety of the dam as well as the spillway structure itself. If the measures suggested are adopted, together with additional consideration of further minimizing the energy of the discharging stream, it is believed that while reasonable protection will be afforded the dam there still remains the probability of failure in part or in whole of the channel section of the spillway. In other words, while the plans, when modified will not be in full accord with accepted engineering practice for caring for the many factors involved, and while there probably will be damage or injury to the spillway structure necessitating the repair or reconstruction of this structure, we believe this dam will not be seriously endangered. If we can be of any assistance to you in expediting action on the plans, kindly be assured that we will be glad to confer with you at your convenience.

Very truly yours,
Geo. W. Hawley
Deputy in Charge of Dams

cc W.H.Holmes
G.McKinlay

12-4-34
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2377

POSTAL TELEGRAPH

S149 101=SC SACRAMENTO CALIF 15 1222P 1933 APR 15 PM 59

H N SAVAGE=

HYDRAULIC ENGINEER CITY OF SANDIEGO 524 F ST SANDIEGO

CANNOT APPROVE PLANS SUBMITTED FOR OUTLET CHANNEL SECTION ELCAPITAN SPILLWAY STOP WE BELIEVE INTEGRITY OF DAM WILL BE JEOPARDIZED IF ADEQUATE PROTECTION IS NOT PROVIDED TO PREVENT EROSION DUE TO HIGH VELOCITIES AND LARGE FLOOD FLOWS STOP IT IS BELIEVED THAT PLANS AS SUBMITTED CAN BE CONSIDERED IF MODIFIED TO PROVIDE SUITABLE REINFORCED CONCRETE LINING TO BE CARRIED A SAFE DISTANCE BEYOND DAM AND AN ADEQUATE CUTOFF CONSTRUCTED AT END OF LINING STOP CONSIDERATION SHOULD BE GIVEN TO REDUCING EXCEPTIONALLY HIGH VELOCITIES TO CONTROLLABLE ONES AND DISSIPATING ENERGY TO MINIMUM IN ORDER TO AFFORD AMPLE PROTECTION TO DAM STOP LETTER FOLLOWS=

GEO W HAWLEY..

12-4-34
copy/p

2378

June 19, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Spillway

Dear Mr. Hyatt:

Enclosed for your consideration and reaction are prints of Drawing WD-449, sheet 7a of 7, edited to June 15, 1933; WD-454 and WD-460, showing respectively the drainage system, the topography and a detail layout for the lower end of El Capitan reservoir dam spillway channel.

There also is enclosed print of Drawing WD-461 showing crose sections of the San Diego River channel below the spillway, for your use in determining the backwater as affecting the spillway discharge.

Very truly yours,

H. N. Savage
Hydraulic Engineer.

HNS/p
encls.(8)

cc-Gerald McKinlay, Senior Engineer of Dam Inspection

12-5-34
copy/p

2379

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS
Sacramento

July 7, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

We have reviewed the plans for the spillway on the above dam, submitted with your letter of June 19, (Plans WD-449, sheet 7a of 7; WD-454 and WD-460) and find them to satisfactory to this office. If, therefore, you will forward the tracings they will be formally approved.

Very truly yours,

Geo. W. Hawley
Deputy in Charge of Dams

cc-W.H.Holmes
G.McKinlay

12-5-34
copy/p

2380

July 13, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project,
El Capitan Feature, spillway

Dear Mr. Hyatt:

Enclosed for your formal approval in accordance with your letter dated July 7, 1933, are tracings, in duplicate, of Drawings WD-449 Sheet 7a of 7; WD-454 and WD-460, showing the lower end of El Capitan reservoir dam spillway channel.

Very truly yours,

H. N. Savage
Hydraulic Engineer

HNS/p
encls.(6)

12-5-34
copy/p

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
Sacramento

July 20, 1933

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

We are mailing under separate cover tracings of El Capitan Spillway Drawings WD-449, Sheet 7a of 7; WD-454 and WD-460, which have been approved by this office.

In considering the plans for construction of the spillway extension, the fact must be recognized that, during periods of considerable discharge or of continuing moderate flow, erosion will probably occur within and adjacent to the lower end of the channel necessitating repair of the resulting damage, if any, together with maintenance work sufficient to minimize the damage that might be caused by heavy flood flows. In approving these plans it is felt, however, that such damage as might reasonably be expected to occur will not be sufficient in any limited period of time to jeopardize the safety of the dam and the approval by the State Engineer of these plans extends primarily to the safety of the dam, rather than to repair or replacement or maintenance work that might be later found necessary in the channel.

Also, the following comment is submitted for your consideration.

The importance and magnitude of the spillway structure is such that we believe you would be fully justified in making a model of the prototype on such a scale that the hydraulic properties of the spillway, including the channel, could be carefully studied as a basis for such modifications in the structure as may be found desirable and necessary. It might be found from flow observations through such a model that training walls of moderate height and equally spaced in the entry section would materially improve the hydraulic properties of this section and tend to minimize the turbulence which it is believed will occur if such walls are not constructed. Likewise, more competent knowledge of the behavior of the discharge end of the spillway might result in a design that would very materially minimize the erosion that probably will occur during periods of peak flow.

While under the policy set forth in the preceding paragraph of this letter the model test can hardly be required, it is recommended, and if you follow this suggestion this office

will be more than willing to recite in greater detail its thoughts as to data to be obtained, methods, etc.

Discussion has previously been had relative to caring for local drainage above the channel and it is understood that this will be properly provided for during the construction period.

Very truly yours,

Edward Hyatt
State Engineer

3-12-35
copy/p

From : Engineer Fred D. Pyle

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature Spillway, State Engineer's reactions to design

October 5, 1931. The Hydraulic Engineer and City Attorney confered in Sacramento with the State Engineer with reference to the application of the City of San Diego for permission to construct El Capitan reservoir dam.

October 7, 1931. The City Attorney notified the Council he had attended the conference and that, in addition to other engineering and geological information, the State Engineer requested:

> "A hydrographic report containing complete information on the area of the watershed, data on past runoff floods, etc., with an especially detailed and definite report concerning the size of the spillway so as to be assured of safety to an earth and rock fill dam in the event of a major flood."

October 8, 1931. The Hydraulic Engineer advised the Mayor and Council in part that the State Engineer requested the City to employ a geologist and consulting engineer to report on the dam-site and the designs of the dam; also the City should retain and employ the services of an outside consulting engineer thruout the construction of the dam.

> "The State Engineer further requested historical reports and statistics of the hydrography - annual runoff and flood runoff - of the San Diego River drainage basin tributary to the El Capitan reservoir as basis for the determination of the maximum spillway capacity which may be necessary to discharge not only the equivalent of the maximum runoff and floods which have occurred since runoff has been observed and recorded but, out of abundant caution, provide for the much greater flood runoff which may occur once in two hundred or more years. Prominent importance was attached by the State Engineer to this feature of the problem which he and his staff deemed of dominating importance to insure the safety of any other type of dam, than one of solid masonry, which, if properly designed and constructed, might permit an extraordinary flood to discharge over its top without injury.

The State Engineer desired the above information and investigations before accepting the formal application and the accompanying filing fee, but desired a copy of the drawings and specifications to consider informally pending the receipt of the additional information.

It is indicated that the following drawings were included with the specifications informally delivered to the State Engineer;

WD-285 edited to 5-7-31
WD-313 sheet 1 of 5 edited to 9-5-31
WD-313 sheet 2 of 5 edited to 2-13-31
WD-313 sheet 3 of 5 edited to 9-5-31
WD-313 sheet 4 of 5 edited to 9-5-31
WD-313 sheet 5 of 5 edited to 9-5-31

Drawing WD-313 sheet 1 of 5 showed plan of side channel spillway 400 foot crest channel 150 feet wide opposite lower end of crest 100 feet wide near end of channel at elevation 720, and combined 4 compartment siphon spillway channel, of which ended at elevation 706.5 with indicated flood discharge channel ending below the overflow spillway channel.

Sheet 3 of 5 showed section along the core wall section thru the siphons and side channel spillway.

Sheet 5 of 5 showed section thru siphon spillway, siphon opening 12 feet wide 10 feet high.

October 15, 1931. The Hydraulic Engineer furnished the State Engineer exhibit "A" precipitation of and flood data to accompany the application for El Capitan dam, together with supplemental data. The spillway indicated on the drawings was the same as designed by John R. Freeman who stated: "The siphon and weir combined will take care, during the record flood of 1916 on top of future reservoir without overtopping the dam." Water Supply Paper 426 page 52 gives the peak flow January 27, 1916 as 38,000 cubic feet per second.

November 9, 1931. City's Engineer Harold Wood advised the Hydraulic Engineer that, during a conference held in the forenoon of November 9, 1931, George W. Hawley, Deputy State Engineer, stated that, among other things required by his department relative to the review of the drawings and specifications of El Capitan reservoir dam, was

"2. Hydraulic design of the siphon and side channel spillway."

November 13, 1931. Hydraulic Engineer furnished the State Engineer additional drawings WD-313 sheet 1 edited to 11-3-31; sheet 4 e dited to 11-10-31; sheet 5 edited to 11-13-31; WD-290 sheet 2 edited to 11-9-31; all to be substituted for the drawings then in the State Engineer's office; also the following supplemental drawings to be added WD-363 showing details of side channel and siphon spillways and of the lined spillway channel at elevation 720 for the side channel portion and 705.7 for the spillway section; WD-364 showing typical retaining wall sections between siphon spillway and side channel spillway; WD-367 showing typical retaining wall section south side of siphon spillway channel, also details of core wall.

November 10, 1931. Report of Dr. C. D. Marx and C. F. Tolman to be transmitted to the State Engineer in support of the City's application to construct El Capitan Dam, states:

> "Our investigation therefore covers: . . . III. An analysis of the flood flow provision made for the proposed spillway and its design. . . . CHAPTER I FOUNDATION GEOLOGY OF EL CAPITAN DAM SITE NUMBER 2 . . . Spillway. The spillway will be excavated in solid and impervious granite rendered somewhat friable by weathering. The walls of the excavation will stand well. In short, the bed rock for the spillway will be quite satisfactory. . . . . CHAPTER III SPILLWAY CAPACITY. . . The provision for flood flow seems to us to be ample. The drawings, however, for the spillway as shown in the plans submitted should be amplified. The State Engineer will require detailed drawings showing the structural features of the spillway so that its safety can be checked.. . . SUPPLEMENTARY STATEMENT. . . The calculations for the spillway show that ample spillway capacity has been provided."

November 20, 1931. Engineer Harold Wood furnished the Hydraulic Engineer a list of documents taken to the State Engineer's office in Los Angeles October 16, 1931.

November 19, 1931. Engineer Harold Wood advised that Consulting Engineer Louis C. Hill receipted reports and data pertinent to El Capitan Dam.

December 5, 1931. Conference in the Hydraulic Engineer's office with City officials State Engineer and representatives, including Edward Hyatt, Geo. W. Hawley, W. H. Holmes, Chester Marlia ve, L. C. Hill, T. B. Cosgrove, C. L. Byers, H. B. Daniel, C. F. Tolman, C. D. Marx, Fred D. Pyle, Harold Wood, H. N. Savage; regarding City's application to construct El Capitan Dam, filed 11-21-31.

December 7, 1931. State Engineer formally approved application 5-7 with the following reservation:

> "This action, however, does not include at this time approval of all details of hydraulic and structural design, as modifications of some features may be found advisable or necessary either by the City itself or by the State."

December 12, 1931. The State's Consultant L. C. Hill reported to the State Engineer and questioned the construction of siphon spillway of the size indicated on the drawings, and suggested the use of drum gates.

> "The whole spillway should be re-designed, whether siphons are used or not, so as to carry the maximum amount of water with the length of spillway lip available. The axis of the discharge channel should be

straight and should be carried in cut to the flat below. Its discharge should then be so directed that no damage can result to the downstream toe of the dam.

"The spillway should be re-designed both structurally and hydraulically. An endeavor should be made to have the discharge channel from the side spillway and the discharge channel from the drum gates or siphons merge in as short a distance below the dam as possible. If properly designed, there should be no need of a high wall between these two discharge channels. On account of the difficulties arising from the combined operation of these two types of spillways, it seems most advisable that you should require the City of San Diego to make a model and test it, and then to modify the design until the results are satisfactory. Otherwise the cross currents that may arise below the gates may become very dangerous."

Mr. Hill's recommendations contain the following:

"(1) The spillway should be re-designed so that with water surface in the reservoir at elevation 762 the combined spillway discharge will be at least 75,000 cu.ft.per sec.

"(5) A model of the proposed spillway should be made and tested."

January 9, 1932. The State Engineer wired the Hydraulic Engineer that approval given December 7, 1931 was general only.

January 14, 1932. The State Engineer advised the Hydraulic Engineer by letter of the insufficiency of the edited and additional drawings furnished him.

"In our opinion and that of our consultant the hydraulic properties and structural details of the composite spillways do not have the factor of safety deemed necessary for a structure of the magnitude and importance of the El Capitan Dam."

January 18, 1932. Deputy State Engineer W. H. Holmes visited the office of the Hydraulic Engineer and discussed with Engineer Pyle (Hydraulic Engineer to Washington D.C. 1-14-32) the designs of El Capitan reservoir dam as then before the State Engineer. He made available the report of R. L. Wing on probable size and frequency of floods at El Capitan damsite. He stated that the 10'x12' siphons were not acceptable without full scale model tests. He discussed the advisability of making a model test of the operation of the overflow spillway. He stated the spillway should be re-designed, eliminating siphons and increasing the capacity to provide for conditions as set out in R.L.Wing's study of flood flows.

February 2, 1932. In a telephone conference between the Hydraulic Engineer and L. C. Hill, Mr. Hill advised that

> "The spillway design may properly be omitted at this time as has been the accepted policy at a San Gabriel Dam."

This conference was reported to the State Engineer 2-4-32.

February 3, 1932. Assistant Deputy State Engineer W. H. Holmes reviewed and discussed with Engineer Pyle the drawings for El Capitan dam and stated:

WD-313 Omit siphons in spillway; indicate adequate spillway; modify spillway to conform to new design.

WD-363 Show sufficient outline of spillway to compute hydraulic functions. Structural details to follow.

February 6, 1932. The Hydraulic Engineer transmitted to the State Engineer drawings and specifications prepared in accordance with suggestions contained in the State Engineer's letter 1-14-32; L. C. Hill's letter to the State Engineer 12-12-31 and oral suggestions of W. H. Holmes.

February 13, 1932. The Hydraulic Engineer advised the State Engineer that the 510' crest wide channel spillway as indicated on drawing WD-385 submitted February 5, 1932, would, with reservoir ponding, provide for a flood of 102,000 cubic feet per second. With a maximum reservoir elevation of 763 maximum discharge of about 75,000 cubic feet per second.

February 19, 1932. The Hydraulic Engineer, in letter from Sacramento, advised Engineer Pyle in part as follows:

> "The following notes are to be incorporated on Drawing WD-382.
>
> 'Detailed structural and hydraulic drawings for the spillway channel discharge end are to be developed and submitted for approval.'
>
> 'Eliminate from this drawing the details shown at the junction between core wall and spillway and substitute this note: Detail designs for the junction between core wall and spillway will be developed and submitted for approval before construction.'

February 23, 1932. Acting Hydraulic Engineer Fred D. Pyle submitted duplicate tracings of drawings for El Capitan dam to the State Engineer. Resident Engineer Harold Wood the tracings to Sacramento where, after minor modifications and changes were

made, they were approved by the State Engineer.

February 29, 1932. Drawings WD-382, 383 and 390 sheets 1 and 2 as later used in the contract specifications, were approved by the State Engineer.

September 1, 1932. Resident Engineer Wood advised the Hydraulic Engineer as to the contractor's request that stakes be set for the spillway and the spillway channel.

January 6, 11, 25, 1933. Inter-office communications relative to the necessity for having detail spillway designs approved by the State Engineer before major spillway excavation undertaken.

January 27, 1933. Deputy State Engineer Geo. W. Hawley examined the work at El Capitan dam and went over the spillway location with Resident Engineer Wood, Engineer Pyle, and over the spillway designs in the office with Engineer Pyle. It was indicated that changes at the lower end of the spillway as to grade, length of channel and cutoff wall would be required. Mr. Hawley stated that he desired topography and profile to the river channel.

February 2, 1933. Hydraulic Engineer transmitted to the State Engineer prints of drawing WD-449 sheets 1 to 7 inclusive and advised that drawings were being prepared showing topography between ends of the spillway and the river channel.

February 15, 1933. The State Engineer advised the Hydraulic Engineer that drawing WD-449 sheets 1 to 7 had been reviewed and found satisfactory insofar as hydraulic capacity, type and location were concerned but that before formal approval could be given, provision must be made to carry the discharge lip of the channel section to a greater distance beyond the dam downstream and to an elevation approaching that of the existing channel;

Also that it might be found advisable to provide means for minimizing the energy of the spillway discharge and to design the lower reaches of the channel in such a way that no damage would result from an expected hydraulic jump of magnitude. Attention was also invited to other details such as connection between the core wall and the ogee portion of the spillway, contraction joints in the spillway weir crest, the re-design of left spillway side wall station 5+10 to 5+60, protection against erosion on the upstream side of the weir vicinity station 5+10.

March 11, 1933. The Hydraulic Engineer submitted to the State Engineer prints of drawing WD-449 sheets 1 to 7a, edited to March 6, and WD-450 showing the spillway to station 7+37, and indication that the spillway channel was to be further extended.

March 15, 1933. The State Engineer advised the Hydraulic Engineer that certain provisions of the transition section between the ogee weir and the spillway channel would be necessary during construction; also the connection between the cutoff wall of the dam and spillway would probably require provision when the excavation had been completed; also

"We further understand that you are at present developing plans for the continuation of the spillway channel beyond the points shown upon the plans submitted and when these are completed you will transmit them for our consideration."

March 17, 1933. The Hydraulic Engineer submitted to the State Engineer, in duplicate, tracings of WD-449 sheets 1 to 7a edited to March 6, 1933, and WD-450. These tracings were about the same as previously submitted, except the drawings were completed to station 7+37 only and it was indicated that there would be a further extension.

March 18, 1933. The Hydraulic Engineer advised the Council of the conference in Sacramento with the State Engineer in part as follows:

"The State Engineer and his technical staff announced their favorable reaction to the general designs and to detail designs for the El Capitan reservoir spillway as developed in this office, and it is justified to expect that the State Engineer's official approval will be forwarded back to the City of San Diego in the near future."

March 21, 1933. The State Engineer approved drawings WD-449 sheets 1 to 72, and WD-450.

April 5, 1933. The Hydraulic Engineer submitted to the State Engineer prints of drawing WD-449 sheets 7a of 7 edited to April 4, 1933.

April 15, 1933. The State Engineer wired the Hydraulic Engineer as follows:

"Cannot approve plans submitted for outlet channel section El Capitan spillway stop we believe integrity of dam will be jeopardized if adequate protection is not provided to prevent erosion due to high velocities and large flood flows stop it is believed that plans as submitted can be considered if modified to provide suitable reinforced concrete lining to be carried a safe distance beyond the dam and an adequate cutoff constructed at end of lining stop consideration should be given to reducing exceptionally high velocities to controllable ones and dissipating energy to minimum in order to afford ample protection to dam stop letter follows."

April 15, 1933. The State Engineer by letter to the Hydraulic Engineer confirmed the above telegram and stated:

"Very serious consideration has been given the plans for the outlet portion of the El Capitan spillway recently submitted by you, and based upon an intensive study of the plans it is not felt that approval can be given the plans as submitted.

"Under these plans it is not believed that adequate protection has been afforded the dam. It is, however, believed that the plans can be so modified and revised that the integrity of the dam will not be seriously menaned during periods of large flood flows with consequent high channel velocities if the excavations as shown are properly paved with a well reinforced concrete lining and an adequate cutoff installed at the discharge end of the spillway channel. The velocities in the spillway during periods of flow are, as you know, of a very high order and suffioient in our opinion to cause extensive erosion with a possible attendant adverse effect upon the safety of the dam as well as the spillway struoture itself. If the measures suggested are adopted, together with additional consideration of furthar minimizing the energy of the discharging stream, it is gelieved that while reasonable proteotion will be afforded the dam there still remains the probability of failure in part or in whole of the channel seotion of the spillway. In other words, while the plans, when modified, will not be in full accord with accepted engineering practice for caring for the many faotors involved, and while there probably will be damage or injury to the spillway struoture necessitating the repair or reconstruotion of this struoture, we believe this dam will not be seriously endangered."

April 17, 1933. Gerald McKinlay, State Senior Engineer of Dam Inspection, in the Water Development office during the absence of the Hydraulic Engineer, advised Engineer Pyle that the lining of the spillway channel 150 feet wide 15 feet deep should be carried to coordinate 5700 or station about 19. Mr. McKinlay referred to the capacity of the upper portion of the spillway channel as 84,000 oubic feet per second.

May 1, 1933. Examination was made on the ground of the spillway extension by Deputy State Engineer George W. Hawley, Senior Engineer of Dam Inspection Gerald McKinlay and Engineer Pyle. Mr. Hawley stated that the plan of the spillway channel as previously submitted was entirely too short and that the lining should be extended to at least station 15+50 where a deep cutoff wall should be oonetructed. He also suggested that provision be made in the floor of the spillway channel ti dissipate a portion of the velocity of the water and that a channel should be excavated from the end of the lined section to the river vicinity station 24.

June 19, 1933. Prints of drawing WD-449 sheet 7a of 7 edited to June 15, 1934, WD-454, 460 and 461 were forwarded to the State Engineer.

July 7, 1933. The State Engineer advised the Hydraulic Engineer that WD-449 sheet 7a, WD-454, and WD-460 were satisfactory and that upon receipt of the tracinge they would be formally approved.

July 18, 1933. The State Engineer approved drawings showing concrete lining extended to station 15+50, elevation of floor 542 and called attention to the importance of constructing a model of the spillway, and conducting experiments.

Fred D. Pyle
Engineer

FDP/p

2-1-35
copy/p

2392

September 13, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature State inspection

1. On September 9, 1933, Deputy State Engineer Geo. W. Hawley, Senior Engineer of Dam Inspection Gerald McKinlay, and State Geologist Chester Marliave visited and inspected the work at El Capitan Dam.

2. Particular interest was shown in the material above the north slope of the spillway. Mr. Marliave and the City's Consulting Geologist Dr. J. P. Buwalda, made an inspection over this slope and about this excavation in the afternoon.

3. The above State representatives sat in conference with the City's Consulting Engineer L. C. Hill, City's Consulting Geologist, Hydraulic Engineer, Engineer Fred D. Pyle Engineer Tom Allen and Resident Engineer.

4. At this conference the following matters pertaining to El Capitan dam were discussed by Mr. Hawley:

(1) 2 or 3 rings of extra deep grout holes should be drilled in the outlet tunnel on line with core wall.

(2) Cracks above spillway slope should be measured daily and records of movements recorded. Definite decision on changes in spillway slope, if any, will be made at a later date.

(3) Decision on elimination of steel anchors in spillway lining would be made after tests proposed by L. C. Hill are made and reported.

(4) No change in top of dam is to be made at this time.

Harold Wood
Resident Engineer

HW/p

2-1-35
copy/p

2393

October 3, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On September 29, 1933 California State Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan dam and particularly the foundation for the spillway crest west of Station 2+64.

2. Mr. McKinlay reported that the then completed portion of the cutoff trench between station 2+64 and 2+88 was satisfactory for the placement of concrete.

3. Mr. McKinlay and the Resident Engineer examined the portion of the foundation under the crest itself and decided that a greater depth of excavation would be required at this point and this work was begun.

4. Mr. McKinlay expressed satisfaction in general with the work.

5. Mr. Raymond Matthew, of the State Engineer's office, was with Mr. McKinlay and inspected the work.

Harold Wood
Resident Engineer

HW/p

October 23, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On October 17, 1933, Senior Engineer of Dam Inspection Gerald McKinlay visited and inspected the work at El Capitan Dam.

2. Mr. McKinlay inspected the foundation for the spillway crest 4+08 to 5+10 and approved same as being satisfactory.

3. Mr. McKinlay inspected the dam from the spillway and later drove to the top of the upstream rock embankment. He was much concerned over the borrow pit material being dumped dry over the inside slope of the upstream rock embankment which reduced the beach width so that in one place only 15 feet of beach remained. He asked what we were going to do. I told him the contractor had been given directions by letter (I referred to letter S-55). He said he understood we were going to insist on clay being brought into build up the puddle core and that this was decided on October 7, 1933. I told him no instruction relative to this other than letter of October 3, 1933 (S-50) had been given the contractor.

Harold Wood
Resident Engineer

HW/f

12-4-34
copy/p

2395

November 15, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, Contract Construction, Spillway Extension, State's Requirement for Safety of Structure.

Dear Mr. Hyatt:

Contractor T. E. Connolly at El Capitan Dam yesterday, November 14, 1933, told me that he had understood definitely from each Deputy State Engineer Geo. W. Hawley and State Senior Inspector of Dams Gerald McKinlay that the State Engineer was not requiring as a measure of safety the excavation of a projected about 900-foot long reach of unlined spillway extension from the end of the lined spillway channel at spillway station 15+50 to a connection with the present main channel of the San Diego River.

The Contractor's Attorney, John M. Martin, stated a few minutes ago in my presence to Judge Clarence Harden before whom a Declaratory Relief relative to the Contractor's obligation to construct and complete the El Capitan spillway channel as finally approved by the State Engineer July 18, 1933 is being heard, that Deputy State Engineer Hawley recently told him that the State was not requiring the City to extend the about 900-foot reach of unlined spillway channel from spillway station 15+50 to a connection with the San Diego River.

On receipt of this letter will you kindly favor me with a day telegram stating the State Engineer's requirement for the excavation of the about 900-foot reach of unlined spillway channel extension shown on drawing WD-454, or the State Engineer's opinion that the excavation of the about 900-foot reach of unlined spillway channel is not a necessary measure of safety for the El Capitan dam and that the City may omit the channel.

Your telegram will make of formal record, the results of a telephone conversation between myself and Mr. Hawley this afternoon.

Very truly yours,

H. M. Savage
Hydraulic Engineer

HMS/f

Postal Telegraph

(THE MACKAY SYSTEM)

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Patrons should check class of service desired, otherwise message will be transmitted as a full-rate communication

RECEIVER'S NUMBER 2396

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Send the following Message, subject to the terms on back hereof, which are hereby agreed to

Form 2

12-4-34
copy/p

COPY

NOV 16 1938

S 59 33 DL SC SACRAMENTO CALIF 16 946A

H N SAVAGE

HYDRAULIC ENGINEER CITY OF SAN DIEGO
524 F ST SAN DIEGO CALIF

THIS WILL CONFIRM TELEPHONE COMMUNICATION OF LAST EVENING REAFFIRMING JULY EIGHTEENTH APPROVAL ELCAPITAN SPILLWAY EXTENSION PLANS WITHOUT CHANGE OTHER THAN MINOR MODIFICATIONS WHICH MAY BE DEEMED ADVISABLE AFTER STUDY OF SPILLWAY MODEL PERFORMANCE

GEO W HAWLEY

Postal Telegraph

(THE MACKAY SYSTEM)

ALL AMERICA CABLES — COMMERCIAL CABLES

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CLASS OF SERVICE DESIRED			
DOMESTIC		CABLE	
TELEGRAM		FULL RATE	
DAY LETTER		DEFERRED	
NIGHT MESSAGE		NIGHT CABLE LETTER	
NIGHT LETTER		WEEK-END CABLE LETTER	

Patrons should check class of service desired, otherwise message will be transmitted as a full-rate communication

RECEIVER'S NUMBER 2397

CHECK

TIME FILED

STANDARD TIME

Send the following Message, subject to the terms on back hereof, which are hereby agreed to

Form 2

12-4-34
copy/p

1933 NOV 16 PM 3 28

S178 38=SC SACRAMENTO CALIF 16 315P

H N SAVAGE, HYDRAULIC ENGINEER CITY OF SANDIEGO=
524 F ST SANDIEGO CALIF=

REFER YOUR LETTER NOVEMBER FIFTEENTH STOP EXCAVATION UNLINED SPILLWAY CHANNEL EXTENSION SHOWN ON APPROVED DRAWING WD FOUR FIVE FOUR IS IN OUR OPINION AN ESSENTIAL REQUISITE FOR SAFETY STOP CONSEQUENTLY NO BASIS FOR ELIMINATING THIS NECESSARY CHANNEL EXTENSION=

EDWARD HYATT STATE ENGINEER.

3-12-35
copy/p

February 21, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, spillway extension structural details

Dear Mr. Hyatt:

The City of San Diego expects to issue notice inviting bids, drawings and specifications for the El Capitan Reservoir Dam Spillway Extension in the near future.

Drawings for the El Capitan Reservoir Dam, Spillway and Outlet Works already approved by you will be used insofar as practicable, but in order to avoid confusion, an additional drawing, WD-498, has been prepared showing sections and details of the spillway extension, all of which are in agreement with drawings already approved by you.

Enclosed is a full set of prints of drawings which it is proposed to include in the drawings and specifications for the El Capitan Reservoir Dam Spillway Extension.

It is understood that under the conditions your formal approval is not required on drawing WD-498.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

FDP/p
encls.(5)
Drawings WD-462, 449(2 sheets), 460, 498.
cc-W. H. Holmes, Assistant Deputy State Engineer (with encls.)

3-12-35
copy/p

February 28, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project,
El Capitan Reservoir Dam Spillway
Extension Feature, drawings

Dear Mr. Hyatt:

Enclosed for your information and files are prints of drawing WD-498, properly signed by the Hydraulic Engineer, showing details of the El Capitan Reservoir Dam Spillway Extension, which, excepting for slight modifications, are the same as those heretofore furnished you.

It is understood that in accordance with your letter dated February 24, 1934, your formal approval is not necessary on the tracings.

Very truly yours,

H. N. Savage
Hydraulic Engineer

FDP/p
encl. WD-498
cc-W.H.Holmes, Assistant Deputy State Engineer

12-4-34
copy/p

2400

May 10, 1934

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, Spillway Extension, unlined channel between Station 15+50 and San Diego River.

Dear Mr. Hyatt:

Enclosed is print of Drawing WD-454, as edited to May 8, 1934, showing the lower end of the El Capitan reservoir spillway channel.

On this drawing, as edited to June 15, 1933, and approved by you on July 18, 1933, a 50-foot wide unlined channel was indicated extending from the end of the concrete lining at Station 15+50 to coordinate N 3600 E 3200, the channel to be excavated as directed.

Investigation on the ground indicates the advisability of excavating this channel in the original location shown and down to elevation 546.

Three cross sections - A, B and C - are shown on the drawing as edited to May 8, 1934, showing the elevation of the bottom, the side slopes and the formation as exposed by test pit investigations suggested by Assistant Deputy State Engineer W. H. Holmes.

Your early approval of the elevation of the bottom and of the side slopes of this channel will be appreciated.

Very truly yours,

H. N. Savage
Hydraulic Engineer.

HNS/f
cc Asst. Deputy State Engineer
W. H. Holmes

2/1/35
copy/f

2401

May 14, 1934

From : Resident Engineer

To : Hydraulic Engineer

Subject: San Diego River Project, El Capitan Feature
State inspection

1. On May 7, 1934, State Hydraulic Engineer W. H. Holmes in company with the Hydraulic Engineer visited and inspected the El Capitan dam and spillway.

2. The centerline of the spillway extension channel 15+50 to river passing thru coordinates N 3600 - E 3200 was flagged with white flags. The southerly alignment passing thru coordinates N 3700 - E 3500 was flagged with red flags. Mr. Holmes favored the original alignment thru coordinates N 3600 - E 3200. He suggested bottom at elevation 548. Mr. Savage said a drawing would be prepared for the State Engineer to approve this alignment and grade of bottom at elevation 546 and with north side slope 2 on 1 and south side slope 1 on 1.

3. Mr. Holmes and the Resident Engineer inspected the cut-off trenoh on the south abutment from N 3000 to N 3011. Mr. Holmes suggested that step in bottom be cut south to about N 3006 or 5 feet at elevation 753.

4. Mr. Savage and Mr. Holmes conferred relative to sand strata and lenses in the puddle core. I did not learn what was finally decided, if anything, relative to the puddle core.

Harold Wood
Resident Engineer

HW/p

5/18/34
copy /f

2102

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SACRAMENTO

May 15, 1934

Mr. H. N. Savage, Hydraulic Engineer
City of San Diego
524 F Street
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Mr. Savage:

This will acknowledge receipt of your letter of May 10, 1934 enclosing a print of Drawing WD-454, as edited to May 8, 1934, showing dimensional data in the open channel from Station 15+50 to the river channel.

The proposed plan for the excavation of this section of the channel has the approval of this office.

Very truly yours,

GEO. W. HAWLEY (Signature)
Deputy in Charge of Dams

cc-W.H.Holmes

STATE INSPECTION

of

TUNNEL AND OUTLET WORKS

4/20/34
copy /f

2404

April 20, 1932

Honorable Edward Hyatt,
State Engineer
Sacramento, California.

Subject: San Diego River Project, El Capitan Reservoir Dam, Spillway and Outlet Works. Outlet Tower.

My dear Mr. Hyatt:

Enclosed for your appropriate action and official approval if found satisfactory, are two copies of Bureau of Water Development Drawing WD-400 showing the general structural and hydraulic features of the outlet tower for the El Capitan reservoir feature of the San Diego River Project.

Further study has indicated the advisability of offsetting the tower instead of its straddling the tunnel. This change permits the use of a smaller tower and is thought to result in a more efficient stress distribution and simplified operation.

Detail structural designs are being developed and will be completed soon after your official approval of drawing WD-400 is received.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/p
Encl. Drawing WD-400 (2)

3-7-35
copy/f

June 18, 1932

Mr. Edward Hyatt
State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Reservoir Dam Spillway and Outlet Works. Outlet Tower. Design.

Dear Mr. Hyatt:

City of San Diego's Drawing WD-400, El Capitan feature outlet tower design was forwarded to you in duplicate April 20 for your official consideration and the conclusions deemed by you appropriate.

Your reply letter dated April 25, acknowledged receipt of Drawing WD-400, and stated that you would give this matter your immediate attention.

The contractor has progressed the excavation of foundation for El Capitan Dam rapidly and on June 13, your attention was again invited to the importance of advancing your conclusions regarding the outlet tower design Drawing WD-400 since the contractor was opening up the by-pass tunnel and consequently outlet tower foundation excavation in connection therewith.

The Resident Engineer has requested immediate conclusions from me regarding the design and location of the tower in order not to delay the contractor's work in the vicinity and adjacent thereto.

The contractor advised me yesterday that he has excavated down practically to foundation for both the upstream masonry toe wall foundation and the downstream masonry toe wall foundation for the dam.

On June 17, I telephoned a request to Senior Engineer of Dam Inspection, Gerald McKinlay for a visit at his very earliest agreeable convenience and specified June 18, 19 or not later than June 20 if at all practicable on his part since the contractor had been progressing his work rapidly.

This morning when in telephone conference with Engineer Gerald McKinlay, he advised that Deputy State Engineer George W. Hawley and he would arrive at El Capitan dam site Thursday, June 23.

It is hoped that your Department will have reached a definite conclusion regarding the outlet tower in order that the tunnel work may be progressed expeditiously by the contractor, as he desires.

Very truly yours,

H. N. Savage,
Hydraulic Engineer.

HNS/f

3-7-35
copy/f

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
803 California State Building
Los Angeles, California

June 21, 1932

Mr. H. N. Savage,
Hydraulic Engineer,
City of San Diego,
San Diego, California.

Dear Mr. Savage:

The following teletype was received from Mr. Hawley on June 20, 1932:

"Will arrive Los Angeles Thursday morning June 23rd on Sunset Limited. Cannot arrive before that time. Received letter from Savage re El Capitan tower last night, a copy being sent you today. If inconvenient for you to go to San Diego at once suggest you telephone Savage giving tower location and type general approval. Formal approval will be given upon completion of structural and hydraulic detail after discussion and modification if necessary.

Geo. W. Hawley"

This is for your information.

Very truly yours,

GERALD McKINLAY (Signature)

Gerald McKinlay

GMcK:er

3-9-35
copy/p

August 26, 1932

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California

Subject: San Diego River Project, El Capitan Feature, outlet tunnel timbering

Dear Mr. Hyatt:

With my letter dated June 23, 1932, to you, there was enclosed in duplicate the City of San Diego's drawing WD-414 on which was indicated the San Diego River Project El Capitan Reservoir bypass tunnel timbering as being installed by the contractor, Rohl-Connolly Company. Copies of my letter and the drawing were mailed to Assistant Deputy State Engineer Gerald McKinlay.

The tunnel timbering is being installed as indicated in the drawing based on the assumption that had either you or your deputy engineers found any justified modifications you would have notified me thereof.

Very truly yours,

H. M. Savage
Hydraulic Engineer

HMS/p
cc Assistant Deputy State Engineer
Gerald McKinlay

11-14-33
copy/p

STATE OF CALIFORNIA
Department of Public Works
Sacramento

Division of
Water Resources

Edward Hyatt
State Engineer

August 29, 1933

Mr. H. N. Savage
Hydraulic Engineer
City of San Diego
San Diego, California

SUBJECT: EL CAPITAN DAM #8-7

Dear Sir:

We have reviewed the plans of the tower and outlet tunnel plug drawings WD-400, WD-423, sheets 1 and 2, WD-424, sheets 1, 2 and 3. We find the plans in general satisfactory and you are hereby authorized to proceed with the construction in accordance with these plans subject to any revisions which may become necessary due to the conditions revealed during excavation for the construction of the same.

It will not be necessary for you to submit tracings of these plans until after the work is completed when the tracings can incorporate any alterations or revisions which may become necessary during construction.

We wish to acknowledge receipt of your letter of August 26th referring to the drawing covering the details of timbering for the outlet tunnel. We do not feel that this is strictly a matter upon which we need express approval. However, we see no objection to the proposed method at this time. It will undoubtedly be discussed by our Mr. McKinley with Mr. Wood during construction.

Very truly yours,

Geo. W. Hawley (Signature)

Deputy in Charge of Dams

1-31-35
copy/p

June 16, 1933

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
State inspection

1. On June 15, 1933 Senior Engineer of Dam Inspection, Gerald McKinlay, visited and inspected the work at El Capitan Dam.

2. He inspected the foundation under the tower and approved this as proper foundation. He said to go ahead and concrete the footing. Contractor T. E. Connolly was present during the inspection.

3. Mr. McKinlay said he thought the shaft should be backfilled with concrete to elevation 573 to better bond the tower at the side walls of the shaft. I explained there was ample excess weight, about 1.5 million pounds, without machinery, pipes, valves or tower roof etc. I told Mr. McKinlay he had better confer with Engineer Fred D. Pyle on this detail. I telephoned this information to Mr. Pyle so he would be prepared to discuss this with Mr. McKinlay before McKinlay reached the San Diego office.

4. Mr. McKinlay asked about puddle core elevation and requested a sample from center line at about N 3870. He was given a sample four feet below top of puddle core at this location.

5. Mr. McKinlay requested that the hydraulic fill areas on each side adjacent to and outside of the puddle core be washed to remove the excess clay deposited there while pool was held high. This represented a depth of possibly 1/4 inch of clay which can be removed by washing.

6. Mr. McKinlay said he was establishing his residence at Monrovia to be near the San Gabriel Canyon work.

Harold Wood
Resident Engineer

HW/p

5/1/34
copy/f

July 25, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, By-Pass Tunnel.

Dear Mr. Hyatt:-

The Contractor's concrete reinforced lining of the City of San Diego's El Capitan Reservoir outlet by-pass tunnel was expedited and the work tolerated advisedly by the Engineer to secure maximum lining before the period of winter flood peak runoff. Material grouting work will be accomplished by the Contractor before the work will be offered to the Engineer for acceptance.

In response to an oral requisition from State Senior Inspector of Dams Gerald McKinlay for measurements of temporary water seepage through the north side wall of the by-pass tunnel, the following statistics were observed as of July 21, 1933:

Tunnel Station	Gallons per Minute	Location
9+04	6.00	Inner end exploration tunnel 7
6+30	.27 total 3 streams	14 feet west of axis of dam produced
5+15	.07	101 feet east of axis of dam produced
5+00	.05	116 feet east of axis of dam produced

The invert of the tunnel opposite the axis of the dam is at elevation 552.

Elevation of the water in the summit pool when the measurements were made was at Elevation 639.

Weep holes through the concrete reinforced lining have not been opened and many more remain to be drilled.

Very truly yours,

H. N. Savage
Hydraulic Engineer.

HNS/f

11-14-33
copy/p

2411

August 20, 1933

Mr. Edward Hyatt, State Engineer
401 Public Works Building
Sacramento, California.

Subject: San Diego River Project, El Capitan Feature, Outlet Tower.

Dear Mr. Hyatt:

Enclosed for your appropriate action and approval if deemed proper are two black line prints of each Drawing WD-400 edited to August 11, 1932; WD-423 sheets 1 and 2; WD-424 sheets 1, 2 and 3, all pertaining to the San Diego Project, El Capitan Feature, outlet tower.

The contractors are contemplating the purchase of reinforcing steel at the earliest opportunity, and, based on your approval of the generic drawing WD-400, it is presumed proper to transmit to the contractors copies of the above mentioned drawings for steel purchase as soon as your favorable reaction is received.

Respectfully,

H. M. Savage,
Hydraulic Engineer.

HMS/p
Encls. (12)
Drawings WD-400; WD-423 sheets 1 and 2;
WD-424 sheets 1, 2 and 3
cc and encls. to Gerald McKinley, Senior Engineer of Dam Inspection, Los Angeles

STATE INSPECTION

VISITS

February 9, 1935.

M E M O R A N D U M.

Subject: San Diego River Project, El Capitan Reservoir Feature. State Inspection.

1. Official representatives and consultants of the State of California, Department of Public Works, Division of Water Resources, who visited and inspected the El Capitan Dam during the period of construction were as follows:

November 17, 1931. George W. Hawley, Deputy State Engineer.

February 3, 1932. W. H. Holmes, Assistant Deputy State Engineer.

April 6, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

May 6, 1932. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

May 21, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

June 7, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

June 20, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

June 23, 1932. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Samuel A. Hart, Associate Engineer Division of Dams.

June 30, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

July 20, 1932. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

July 20, 1932. W. H. Holmes, Assistant Deputy State Engineer.

July 29, 1932. Chester Marliave, State Geologist.

August 2, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

August 19, 1932. George W. Hawley, Deputy State Engineer.

August 24, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 1, 1932. W. H. Holmes, Assistant Deputy State Engineer.

September 16, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 26, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

September 27, 1932. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

October 3, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

October 6, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

October 13, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

October 15, 1932. Edward Hyatt, State Engineer.

November 15, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

November 23, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

December 1, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

December 8, 1932. Gerald McKinlay, Senior Engineer of Dam Inspection.

December 14, 1932. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

January 3, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

January 10, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

January 27, 1933. George W. Hawley, Deputy State Engineer.

January 30, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

February 6, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.
A. D. Edmonston, Deputy State Engineer.
T. B. Waddell, State Hydraulic Engineer.

February 10, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

February 11, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

February 20, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

February 25, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

March 1, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marliave, State Geologist.

March 31, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

April 6, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

April 7, 1933. George W. Hawley, Deputy State Engineer.

May 1, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

May 19, 1933. B. A. Etcheverry, State Consulting Engineer.

May 20, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

July 11, 1933. Edward Hyatt, State Engineer.

July 12, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

August 9, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

August 23, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 6, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 7, 1933. P. H. Van Etten, State Hydraulic Engineer.

September 9, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
Chester Marlowe, State Geologist.

September 15, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 29, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

September 30, 1933. George W. Hawley, Deputy State Engineer.

October 6, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

October 17, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

October 27, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

November 13, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.

November 27, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

November 28, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

December 5, 1933. Gerald McKinlay, Senior Engineer of Dam Inspection.

December 7, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
F. C. Herrmann, State Consulting Engineer.

December 19, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
F. C. Herrmann, State Consulting Engineer.

December 20, 1933. George W. Hawley, Deputy State Engineer.
Gerald McKinlay, Senior Engineer of Dam Inspection.
F. C. Herrmann, State Consulting Engineer.

January 12, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

January 22, 1934. W. H. Holmes, Assistant Deputy State Engineer.

January 30, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

February 2, 1934. W. H. Holmes, Assistant Deputy State Engineer.

February 7, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

February 13, 1934. W. H. Holmes, Assistant Deputy State Engineer.

February 27, 1934. W. H. Holmes, Assistant Deputy State Engineer.

March 5, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.
F. C. Herrmann, State Consulting Engineer.

March 10, 1934. W. H. Holmes, Assistant Deputy State Engineer.

March 19, 1934. W. H. Holmes, Assistant Deputy State Engineer.

March 29, 1934. W. H. Holmes, Assistant Deputy State Engineer.

April 2, 1934. Chester Marliave, State Geologist.
P. H. Van Etten, State Hydraulic Engineer.

April 18, 1934. W. H. Holmes, Assistant Deputy State Engineer.

May 7, 1934. W. H. Holmes, Assistant Deputy State Engineer.

June 5, 1934. W. H. Holmes, Assistant Deputy State Engineer.

June 14, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.
F. C. Herrmann, State Consulting Engineer.

July 3, 1934. W. H. Holmes, Assistant Deputy State Engineer.

July 6, 1934. Edward Hyatt, State Engineer.
George W. Hawley, Deputy State Engineer.

July 12, 1934. W. H. Holmes, Assistant Deputy State Engineer.

July 21, 1934. W. H. Holmes, Assistant Deputy State Engineer.

July 29, 1934. T. B. Waddell, State Hydraulic Engineer.
P. H. Van Etten, State Hydraulic Engineer.

August 2, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.
F. C. Herrmann, State Consulting Engineer.

August 8, 1934. W. H. Holmes, Assistant Deputy State Engineer.

August 15, 1934. W. H. Holmes, Assistant Deputy State Engineer.

August 18, 1934. George W. Hawley, Deputy State Engineer.

August 25, 1934. W. H. Holmes, Assistant Deputy State Engineer.

August 30, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

September 4, 1934. W. H. Holmes, Assistant Deputy State Engineer.

September 11, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

September 17, 1934. W. H. Holmes, Assistant Deputy State Engineer.

September 20, 1934. W. H. Holmes, Assistant Deputy State Engineer.

September 23, 1934. W. H. Holmes, Assistant Deputy State Engineer.

September 27, 1934. Edward Hyatt, State Engineer.
George W. Hawley, Deputy State Engineer.

September 30, 1934. W. H. Holmes, Assistant Deputy State Engineer.

October 4, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

October 10, 1934. W. H. Holmes, Assistant Deputy State Engineer.

October 19, 1934. W. H. Holmes, Assistant Deputy State Engineer.

October 30, 1934. W. H. Holmes, Assistant Deputy State Engineer.

November 14, 1934. George W. Hawley, Deputy State Engineer.
W. H. Holmes, Assistant Deputy State Engineer.

November 20, 1934. W. H. Holmes, Assistant Deputy State Engineer.

December 7, 1934. W. H. Holmes, Assistant Deputy State Engineer.

December 20, 1934. W. H. Holmes, Assistant Deputy State Engineer.

January 2, 1935. W. H. Holmes, Assistant Deputy State Engineer.

January 22, 1935. W. H. Holmes, Assistant Deputy State Engineer.

February 13, 1935. W. H. Holmes, Assistant Deputy State Engineer.

February 28, 1935. W. H. Holmes, Assistant Deputy State Engineer.

RECONSTRUCTION FINANCE CORPORATION

RECONSTRUCTION FINANCE CORPORATION

4-16-35
PB/p

APPLICATION TO RECONSTRUCTION FINANCE CORPORATION FOR PURCHASE OF EL CAPITAN DAM BONDS

Attempts to sell the El Capitan bonds privately did not result in any bids at par or over and, therefore, on October 12, 1932, the City of San Diego made application to the Reconstruction Finance Corporation for purchase by them of $2,350,000 of El Capitan Dam Bonds at par and accrued interest in order to permit the completion of the work under contract.

The Reconstruction Finance Corporation approved the application and purchased all the bonds from the City.

In November 1934 the entire block of bonds was sold by the Reconstruction Finance Corporation to a syndicate headed by the First National Bank of New York and with a premium of about $78,000.

COPY

5-2-33 2421

Hydraulic Engineer

City Attorney
San Diego River Project, El Capitan Feature, Reconstruction Finance Corporation(Loan Docket No.119) Letter of April 13, 1933

Consideration has been given to letter of Mr. F. E. Lamphere Executive Engineer, Engineer's Advisory Board, U.S. Reconstruction Finance Corporation, dated April 13, 1933, as to requisition No. 1 of the City of San Diego for sale of $240,000 of El Capitan Bonds.

Mr. Lamphere, in commenting on Exhibit "C" of the requisition notes that with the contract for the construction of El Capitan dam less than 50 per cent completed to February 28, 1933, 20 per cent of the progress is represented by overrun above contract schedule quantities on schedule items 11, 12, 14, 16, 24, 25, 26 and 43 as indicated by the following statements:

(a) The Contractor's bid on the estimated quantities for El Capitan Reservoir Dam, Spillway and Outlet Works totaled	$2,332,860
(b) Incurred by the City to February 28, 1933 for Contractor's earnings and extra work under the specifications totaled.....	1,071,843
(c) Estimate of cost for schedule items 11, 12, 14, 16, 24, 25, 26 and 43.....	109,300
(d) Cost of work done under the above items to February 28, 1933.....	333,646
(e) Overrun to February 28, 1933 on above items.....	224,346

A material portion of the apparent increase in the items mentioned is due to the necessity of wasting material excavated instead of placing it in the dam. It was contemplated when the contract schedule was prepared that only about 300 cubic yards of tunnel excavation ($1,500) would be wasted, schedule item 14. To February 28, 1933 - 21,772 cubic yards ($108,860) had been wasted, or an apparent increase of $107,360, from which it necessarily follows that the amount of tunnel excavation placed in the dam, schedule item 9, was very materially decreased.

A material increase in the quantity of tunnel excavation wasted resulted from the requirements of the California State Engineer for additional excavation for the foundation