FEATURE HISTORY

EL CAPITAN DAM

VOLUME I

TABLE OF CONTENTS

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EL CAPITAN FEATURE HISTORY

TABLE OF CONTENTS

VOLUME I. PAGE

INDEX OF DRAWINGS..... 1

INDEX OF PHOTOGRAPHS..... 7

INTRODUCTORY STATEMENT..... 57

PRELIMINARY ACCOMPLISHINGS..... 63

Preliminary Engineering Reports - Savage..... 67

Preliminary Engineering Reports - Tolman - Marx..... 132

DAM, SPILLWAY AND OUTLET WORKS, CONSTRUCTION BY CONTRACT

Drawings, specifications and contract bids and supplemental data..... 184

Ordinances and Resolutions..... 299

Excavation and stripping for dam..... 577

Hydraulic fill - modification top of dam..... 598

VOLUME II.

Rock embankment..... 783

Rolled fill..... 798

Quarry and borrow pits..... 829

Core wall..... 839

Tunnel..... 860

Outlet works..... 908

Spillway..... 992

Miscellaneous appurtenances..... 1030

Accidents..... 1032

Safety..... 1041

Equipment..... 1058

Camp..... 1077

TABLE OF CONTENTS
(Continued)

VOLUME II (Continued) PAGE

Construction policies and methods..... 1081

Definition of terms..... 1094

Contractor's organization..... 1100

Progress estimates and payments..... 1146

Extra work orders..... 1167

Contractor's costs..... 1212

Progress..... 1215

MATERIALS - SAMPLING AND TESTING

Materials sampling and testing - general..... 1221

Concrete and aggregates..... 1225

Cement..... 1248

Hydraulic fill - friction tests..... 1264

Percolation and consolidation tests... 1277

Rolled fill..... 1413

Reinforcing steel..... 1428

DRAINAGE AND SETTLEMENT..... 1437

VOLUME III.

CONTROVERSIES - LITIGATION

Controversies - Rock embankment..... 1459

Hydraulic fill..... 1530

Monthly estimates..... 1539

Litigation - Spillway extension..... 1853

Hydraulic fill..... 1864

Excavation classification..... 1908

Daley-Fenton-Crouch..... 1962

TABLE OF CONTENTS
(Continued)

VOLUME III (Continued) PAGE

CITY'S CONSULTANTS

J. P. Buwalda..... 1979

T. B. Cosgrove..... 1992

D. C. Henny..... 2016

L. C. Hill..... 2084

C. F. Tolman and C. D. Marx..... 2134

VOLUME IV.

STATE SUPERVISION OF DAMS

Application to State..... 2150

State inspection of dam..... 2248

State inspection of spillway..... 2366

State inspection of tunnel and outlet works..... 2403

State inspection - visits..... 2412

RECONSTRUCTION FINANCE CORPORATION..... 2419

SPILLWAY EXTENSION

Spillway extension..... 2447

Drawings and specifications..... 2448

Bids..... 2453

Contract..... 2458

Ordinances and Resolutions..... 2533

Spillway excavation..... 2546

Spillway concrete and steel..... 2559

Camp..... 2568

Progress estimates and payments..... 2571

Contractor's costs..... 2574

TABLE OF CONTENTS
(Continued)

VOLUME IV. Spillway Extension (Continued) PAGE

Reconstruction Finance Corporation..... 2577

TUNNEL INNER LINING

Tunnel inner lining..... 2589

Drawings and specifications - design..... 2590

Bids..... 2604

Contract..... 2609

Ordinances and Resolutions..... 2679

Equipment..... 2683

Construction policies and methods..... 2690

Progress estimates and payments..... 2695

Extra work orders..... 2699

Contractor's costs..... 2703

Progress..... 2705

State inspection..... 2707

Reconstruction Finance Corporation..... 2716

Consultants - L. C. Hill..... 2720

VOLUME V.

GENERAL

City Personnel..... 2727

Official visitors..... 2773

Miscellaneous..... 2786

Reservoir basin clearing..... 2799

Rights of way U.S. Forest Service..... 2821

Rights of Way Capitan Grande Indian Reservation..... 2862

TABLE OF CONTENTS
(Continued)

VOLUME V. General (Continued) PAGE

Rights of Way Summary and cost..... 2942

Cost of Project..... 2944

Changes in design during construction..... 2955

Water rights..... 2959

Publicity..... 3000

Agreement with La Mesa, Lemon Grove & Spring Valley Irrigation District..... 3005

Bibliography..... 3059

Dedication..... 3082

Ten Day Reports with photographs 1931-32..... 3102

VOLUME VI.

Ten Day Reports with photographs 1933-34-35..... 3266

INDEX DRAWINGS

SAN DIEGO RIVER PROJECT, EL CAPITAN FEATURE

Drawings

Number WD-	File	Description	Remarks
247	2314-D1	Lands-contour elevation 788	5 sheets
248	2315-D1	Lands index map to tracts	
249	2316-D14B	Lands individual tracts in reservoir basin	36 sheets
250	2317-D1	Lands recap. of tract sheets	2 "
252	2320-D15E	Net safe yield at reservoir contours 100, 160, 190, 197	
253	2321-D1	Reservoir basin to 160	
254	2322-D1	Reservoir basin to 160	
255	2323-D14B	Mission and El Capitan dams-comparative features	
290	2360-D1	Masonry dam-general drawings to elevation 743	5 sheets obsolete
305	2377-D1	Hydraulic fill dam general drawings to elevation 766	2 " "
307	2379-D1	Hydraulic fill dam general drawings to elevation 713	4 " "
308	2380-D1	Mission and El Capitan dams-comparative sections	
310	2388-D1	NE 1/4 Sec. 7, T. 14 S. R. 2 E. 50' contours	
313	2391-D1	Hydraulic fill dam, general drawings spillway elevation 750	3 " "
314	2392-D1	Hydraulic fill dam general drawings spillway El. 713	3 " "
315	2393-D1	Hydraulic fill dam general drawings spillway El. 788	4 " "
351	2435-D2	Material for hydraulic fill-location	3 "
363	2462-D2	Spillway plan and profile to Elevation 720	
364	2463-D2	Spillway retaining wall	obsolete
367	2466-D2	Corewall and retaining wall	"
368	2467-D2	Outlet tower	"
372	2487-D2	Lands granted and required	
371	2488-D14B	Analysis of borrow pit material	
373	2489-D2	Property-ownership-roads	
374	2490-D2	Classification of lands	
375	2491-D2	R/W in Cleveland Nat'l. Forest	
377	2493-D2	Property-Ownerships-roads	

Number WD-	File	Description	Remarks
378	2494-D2	Tunnels, alternative	
380	2496-D2	Hydraulic fill dam-plan to elevation 766	obsolete
382	2498-D2	Hydraulic fill dam-plan to elevation 766 10' contour interval	
383	2499-D2	Hydraulic fill dam-cross section elevation 766	
384	2500-D2	Hydraulic fill dam longitudinal section	
385	2501-D2	Spillway	
386	2502-D2	Core wall and tunnel outlet	
387	2503-D2	City camp layout	
389	2505	Lands	large map
390	2509-D2	Outlet tunnel-approach and outlet	2 sheets
400	2528-D2	Outlet tower & tunnel connection	
402	2530-D2	Bids, tabulation of	
403	2531-D2	R/W County road #512	
407	2534-D2	Reservoir-pipeline-roads	
408	2535	Contour survey of damsite	large map
409	2536-D2	R/W over public lands	4 sheets
410	2537-D14B	Tunnel section-excavation	
412	2539-D2	Chocolate Creek road-R/W over private lands	
414	2544-D2	Tunnel section, timbered	
415	2545-D2	Stripping under fill	2 sheets
417	2550-D2	Drainage structures at toe of dam	
420	2551-D2	City camp layout	
421	2552-D2	Drains at toe of dam	
418	2555-D2	Tunnel approach-steel details	7 sheets
419	2556-D2	Tunnel outlet-steel details	7 "
423	2557-D2	Tunnel-outlet tower connection	2 "
424	2558-D2	Outlet tower-top detail	3 "
426	2559-D2	Outlet tower appurtenances	5 "

Number WD-	File	Description	Remarks
427	2560-D15C	Flood bypass tunnel sections	
425	2562-D2	Outlet tower footing-steel detail	
430	2568-D2	Spillway location	
431	2569-D2	Core wall (steel column)	
432	2570-D2	Clearing basin	6 sheets
433	2571-D2	Typical excavated section	
434	2572-D14B	Cast iron specials	2 "
435	2574-D2	Core wall, profile of bottom	
436	2575-D2	Rights of way	
440	2579-D2	Core wall detail	
441	2580-D2	Rock embankment surface	
443	2582-D2	Foundation under hydraulic fill	
444	2583-D2	South abutment foundation stripping	
448	2587-D2	Rock quarry layout	
447	2588-D2	Spillway plan and profile	7 sheets
450	2589-D2	Spillway connection to cutoff wall	
451	2590-D2	Contractor's construction plant	
453	2591-D2	Spillway, lower end	
454	2592-D2	Spillway, lower end	
459	2596-D2	Outlet tower appurtenances	
460	2597-D2	Spillway, lower end	
461	2598-D2	Spillway cross section of river channel	
462	2599-D2	Plan and section (small scale)	
463	2600-D2	R/W over public lands	
465	2602-D2	Outlet tower appurtenances	
466	2603-D2	Outlet tower appurtenances	
467	2604-D3	Alteration top of dam	void
470	2670-D3	Spillway material	
491	2608-D3	Drain well covers	

Number WD-	File	Description	Remarks
472	2609-D3	Toe wall progress record	
474		Spillway details	void
476	2611-D3	Spillway steel	6 sheets
477	2613-D3	Spillway	
478	2614-D3	Spillway steel	5 "
479		Top of dam	void
480	2615-D3	Reservoir road	
481	2616-D3	Hydraulic fill plan and section	
482	2619-D3	Concrete flume crossing	
483	2616-1D3	Plan and section	
485	2621-D3	Top of dam	
488		Lindo Lake silt and clay deposit	
496	2616-2D3	Hydraulic fill plan and section	
498	2628-D3	Spillway Extension, Section and details	
501	2630-D3	Top of dam	
503	2632-D3	Spillway Extension Tabulation of Bids	
505	2616-3D3	Hydraulic fill	
506	2681-D3	Spillway steel	
507	2635-D3	Puddle core plan and profile	
508	2634-D3	Puddle core plan and section sand strata	
510	2641-D14B	Rolled fill, compaction tests	4 sheets
511	2642-D3	Top of dam	
512	2676-1D3	Outlet tunnel	
513	2676-D3	Tunnel plug	
515	2648-D3	Fish screen & saucer valve Extension	
517	2632-1D3	Tunnel Inner Lining Tabulation of Bids	
518	2679-D14B	Reservoir areas and capacities	
519	2632-1D3	Spillway excavation	8 sheets

Number WD-	File	Description	Remarks
520	2638-D3	Hydraulic fill	
521	2638-1D3	Hydraulic fill	
522	2544-1D2	Outlet tunnel areas	
523	2682-D3	Outlet Tower Steel	3 sheets

INDEX PHOTOGRAPHS

3/28/33.
ELB.

EL CAPITAN DAM - LIST OF PHOTOGRAPHS.

NUMBER.	DATE.	DESCRIPTION.
E.C.-1.	9/15/31.	El Capitan Hydraulic Fill Dam. Material area "A".
E.C.-2.	9/15/31.	El Capitan Hydraulic Fill Dam. Material area "B".
E.C.-3.	9/15/31.	El Capitan Hydraulic Fill Dam. Material area "C".
E.C.-4.	12/23/31.	El Capitan Dam. Inauguration of work. First laborers arriving.
E.C.-5.	12/23/31.	El Capitan Dam. Inauguration of work.
E.C.-6.	12/23/31.	El Capitan Dam. Inauguration of work. Clearing streambed at damsite.
E.C.-7.	12/30/31.	El Capitan Dam. City camp site looking east showing clearing. Office site in foreground.
E.C.-8.	12/30/31.	El Capitan Dam. Clearing on upstream portion of riverbed at damsite.
E.C.-9.	12/30/31.	El Capitan Dam. Clearing on downstream portion of riverbed at damsite.
E.C.-10.	12/30/31.	El Capitan Dam. Clearing scrub oak around boulders on south abutment of damsite.
E.C.-11.	12/30/31.	El Capitan Dam. Blacksmith and tool sharpening shop for clearing work.
E.C.-12.	1/6/32.	El Capitan Dam. Start of exploration tunnel No. 5 in south abutment of damsite.
E.C.-13.	1/9/32.	El Capitan Dam - El Monte park road clearing work by City forces, looking east from about mile 1.75.
E.C.-14.	1/9/32.	El Capitan Dam - El Monte Park road clearing work with city forces, looking west from about mile 1.75.
E.C.-15.	1/9/32.	El Capitan Dam - El Monte Park Road clearing work with City forces, looking north from about mile 1.95. County power shovel and Cape Horn in distance.
E.C.-16.	1/14/32.	El Capitan Dam - El Monte Park Road. County removing their equipment at about mile 1.7.
E.C.-17.	1/14/32.	El Capitan Dam - El Monte Park Road. County power shovels at side of road at about mile 1.98.
E.C.-18.	1/16/32.	El Capitan Dam - El Monte Park Road. Dangerous boulder above road at rock cut about mile 1.

E.C.-19.	1/18/32.	El Capitan Dam. Erecting wash house at City Camp. Looking Easterly.
E.C.-20.	1/18/32.	El Capitan Dam. Constructing road to guest house at City camp.
E.C.-21.	1/21/32.	El Capitan Damsite No. 2. Looking westerly from rock point above exploration tunnel at south abutment of damsite No. 1.
E.C.-22.	1/21/32.	El Capitan Damsite No. 2. Looking westerly from rock point about 700 feet west of Irrigation District conduit patrolman's residence and about 150 feet below flume bench.
E.C.-23.	1/22/32.	El Capitan Dam. North abutment of damsite looking northerly from flume bench on south abutment about on axis of dam.
E.C.-24.	1/22/32.	El Capitan Damsite No. 2. Looking westerly from rock point about 800 feet east of damsite and about 100 feet above flume bench.
E.C.-25.	1/23/32.	El Capitan Dam. South abutment showing exploration tunnels Nos. 1, 4 and 6, taken from about toe of slope on north side of river.
E.C.-26.	1/25/32.	El Capitan Damsite. Looking west from rock point on north side of river about 1500 feet east of damsite.
E.C.-27.	1/25/32.	El Capitan Dam. Looking easterly from north bank of river at damsite.
E.C.-28.	2/2/32.	El Capitan Damsite No. 2. Looking westerly from rock point above exploration tunnel at south abutment of damsite No. 1.
E.C.-29.	2/2/32.	El Capitan Dam. Looking easterly upstream from bridge near dam axis.
E.C.-30.	2/2/32.	El Capitan Dam. Looking westerly downstream from bridge near dam axis.
E.C.-31.	2/4/32.	El Capitan Dam. Start of office building construction at City camp.
E.C.-32.	2/17/32.	El Capitan Dam - El Monte Park road. Repairs to road by City Forces at about mile 1.5.
E.C.-33.	2/21/32.	El Capitan Dam. Foot bridge across San Diego River near Chocolate Creek erected for use of clearing forces.
E.C.-34.	3/1/32.	El Capitan Dam. Guest house and Resident Engineer' house, City camp.
E.C.-35.	3/1/32.	El Capitan Dam. Close up view of entrance of exploration tunnel No. 8 at damsite.
E.C.-36.	3/1/32.	El Capitan Dam. Exploration tunnel No. 8.

E.C.-37.	3/1/32.	El Capitan Dam. Foot bridge across San Diego River at damsite No. 2.
E.C.-38.	3/1/32.	El Capitan Dam. Entrance to exploration tunnel No. 7 at damsite.
E.C.-39.	3/1/32.	El Capitan Dam. Looking easterly up San Diego River from vicinity Chocolate Creek showing reservoir clearing work.
E.C.-40.	3/14/32.	El Capitan Dam. City camp construction work.
E.C.-41.	3/14/32.	El Capitan Damsite. Looking westerly downstream from about 2000 feet upstream from damsite.
E.C.-42.	3/14/32.	El Capitan Dam. Looking easterly upstream from about 2000 feet upstream from damsite.
E.C.-43.	3/14/32.	El Capitan Dam. Looking westerly from flume bench about 600 feet north of east end of Chocolate Creek syphon. Material area "A" in foreground.
E.C.-44.	3/14/32.	El Capitan Dam. Looking northerly from about center of Chocolate Creek syphon.
E.C.-45.	3/14/32.	El Capitan Dam. Looking southerly from about center of Chocolate Creek syphon.
E.C.-46.	3/29/32.	El Capitan Dam. Foot bridge across Chocolate Creek, looking northwesterly.
E.C.-47	3/29/32.	El Capitan Dam. Foot bridge across Chocolate Creek, looking easterly.
E.C.-48.	3/29/32.	El Capitan Dam. Foot bridge across Chocolate Creek, looking northeasterly.
E.C.-49.	3/29/32.	El Capitan Dam. Foot bridge across Chocolate Creek, Looking northerly.
E.C.-50.	3/29/32.	El Capitan Dam. Foot bridge across Chocolate Creek, looking westerly.
E.C.-51.	4/6/32.	El Capitan Damsite No. 2. Looking westerly from high point above damsite No. 1.
E.C.-52.	4/6/32.	El Capitan Dam. Chocolate Creek foot bridge looking northerly.
E.C.-53.	4/6/32.	El Capitan Dam. Resident Engineer's office, City camp.
E.C.-54.	4/15/32.	El Capitan Dam. Removal of wood from reservoir basin by the Public, vicinity damsite No. 1.
E.C.-55.	4/15/32.	El Capitan Dam. Removal of wood from reservoir basin by the public, vicinity damsite No. 1.
E.C.-56.	4/15/32.	El Capitan Damsite No. 2. Looking downstream from north side of river at damsite No. 1.

E.C.-57.	4/15/32.	El Capitan Damsite No. 2. Looking downstream from north side of river at damsite No. 1.
E.C.-58.	4/28/32.	El Capitan Dam - El Monte Park Road. Compressor and jackhammers at work at rock cut about mile 1.6
E.C.-59.	4/28/32.	El Capitan Dam - El Monte Park Road. Start of widening work, shovel at about mile 1.8.
E.C.-60.	4/28/32.	El Capitan Dam. Contractor's trucks parked at Cape Horn.
E.C.-61.	4/28/32.	El Capitan Dam. Workmen's and applicants' cars parked at Cape Horn.
E.C.-62.	4/28/32.	El Capitan Dam. Contractor's field office under construction, El Capitan Dam - El Monte Park Road about mile 2.0
E.C.-63.	4/28/32.	El Capitan Dam - El Monte Park Road. Compressor and jackhammers at work at rock cut about mile 1.6.
E.C.-64.	4/29/32.	El Capitan Damsite No. 2. Looking downstream from north side of river vicinity damsite No. 1.
E.C.-65.	4/29/32.	El Capitan Damsite No. 2. Looking downstream from north side of river vicinity damsite No. 1.
E.C.-66.	4/29/32.	El Capitan Dam. Chocolate Creek Road location from State Highway 80.
E.C.-67.	4/29/32.	El Capitan Dam. Chocolate Creek Road location. Gulch crossed at about Sta. 2.
E.C.-68.	4/30/32.	El Capitan Dam. Looking back on located line of Chocolate Creek Road, from Sta. 6+50.
E.C.-69.	4/30/32.	El Capitan Dam. Facing line ahead from Sta. 7+75 of Chocolate Creek Road location, showing chicken house and yard at Wiley's.
E.C.-70.	4/30/32.	El Capitan Dam. Mr. Wiley's residence from Sta. 8+90 of Chocolate Creek Road location.
E.C.-71.	4/30/32.	El Capitan Dam. Facing line ahead from Sta. 9+15 of Chocolate Creek Road location.
E.C.-72.	4/30/32.	El Capitan Dam. Wiley property from head of draw about ¼ mile north.
E.C.-73.	4/30/32.	El Capitan Dam - El Monte Park Road. Shovel working in cut about mile 1.6.
E.C.-74.	5/5/32.	El Capitan Dam. Constructing road across river near City Camp.
E.C.-75.	5/5/32.	El Capitan Dam. Constructing road across river near City Camp.

E.C.-76.	5/5/32.	El Capitan Dam - El Monte Park Road. Shovel working in rock cut about mile 1.5.
E.C.-77.	5/5/32.	El Capitan Dam. Contractor's camp site.
E.C.-78.	5/9/32.	El Capitan Dam. River crossing near City Camp completed.
E.C.-79.	5/9/32.	El Capitan Dam - El Monte Park Road. Shovel working in cut at about mile 1.2.
E.C.-80.	5/14/32.	El Capitan Dam. Contractor's camp under construction.
E.C.-81.	5/16/32.	El Capitan Dam. Commencing stripping operations at damsite.
E.C.-82.	5/18/32.	El Capitan Dam. San Diego Consolidated Gas & Electric Company's power line construction camp at El Monte Park.
E.C.-83.	5/18/32.	El Capitan Dam. Chocolate Creek Road from point near Wiley residence.
E.C.-84.	5/19/32.	El Capitan Dam. Upstream toe wall excavation.
E.C.-85.	5/19/32.	El Capitan Dam. Looking downstream from north abutment of damsite No. 1.
E.C.-86.	5/26/32.	El Capitan Dam. Looking downstream from north abutment of damsite No. 1.
E.C.-87.	5/26/32.	El Capitan Dam. Flood by-pass tunnel entrance approach.
E.C.-88.	5/26/32.	El Capitan Dam. Upstream toe wall excavation looking upstream from exploration tunnel No. 9.
E.C.-89.	5/26/32.	El Capitan Dam. Contractor's camp looking westerly from damsite north abutment.
E.C.-90.	5/26/32.	El Capitan Dam. Contractor's warehouse and shop under construction.
E.C.-91.	5/26/32.	El Capitan Dam. Discharge end of flood by-pass tunnel.
E.C.-92.	5/27/32.	El Capitan Dam. San Diego Consolidated Gas & Electric Company's power line construction camp at El Monte Park.
E.C.-93.	5/31/32.	El Capitan Dam. Trench for laying of 24 inch corrugated iron pipe along toe of south abutment. Pipe to be used to carry river flow past damsite. Looking downstream.
E.C.-94.	5/31/32.	El Capitan Dam. Spoil bank of material from toe wall excavation, located about 1000 feet upstream from axis of dam.
E.C.-95.	6/7/32.	El Capitan Dam. Tunnel excavator.

E.C.-96.	6/7/32.	El Capitan Dam. Dragline working on construction of road to borrow pit area "A". About 3000 feet upstream from dam.
E.C.-97.	6/7/32.	El Capitan Dam. San Diego Consolidated Gas & Electric Company's transformer station located about 600 feet west of discharge end of tunnel.
E.C.-98.	6/9/32.	El Capitan Dam. Start of excavation at flood by-pass tunnel entrance.
E.C.-99.	6/9/32.	El Capitan Dam. Washing plant for concrete aggregate.
E.C.-100.	6/9/32.	El Capitan Dam. Start of excavation at flood by-pass tunnel., discharge end.
E.C.-101.	6/11/32.	El Capitan Dam. Junction of Chocolate Creek road and County Highway #389.
E.C.-102.	6/15/32.	El Capitan Dam. Contractor's yard and shops from east end of mess house.
E.C.-103.	6/23/32.	El Capitan Dam. Contractor's fleet of trucks parked in yards vicinity shop.
E.C.-104.	6/23/32.	El Capitan Dam. Contractor's fleet of trucks parked in yards vicinity shop.
E.C.-105.	6/25/32.	El Capitan Dam. Erecting sand and gravel recovery plant on river bar about one mile upstream from dam.
E.C.-106.	6/25/32.	El Capitan Dam. Upstream toe wall excavation looking south from north abutment.
E.C.-107.	6/27/32.	El Capitan Dam. Junction of Chocolate Creek road and County Road # 389.
E.C.-108.	6/27/32.	El Capitan Dam. Looking downstream from north abutment of damsite No. 1.
E.C.-109.	6/28/32.	El Capitan Dam. Contractor's Employees' cars. Looking westerly from front of shop.
E.C.-110.	6/29/32.	El Capitan Dam. Slope stakes set by Contractor's Engineer in upstream toe wall excavation. Looking easterly from south-westerly bank.
E.C.-111.	6/30/32.	El Capitan Dam. Excavating for upstream toe wall looking northerly from south abutment.
E.C.-112.	7/1/32.	El Capitan Dam. Puddle core excavation, looking south from north abutment.
E.C.-113.	7/11/32.	El Capitan Dam. Contractor's camp looking northerly from trail leading up to top of projected dam on south abutment.
E.C.-114.	7/11/32..	El Capitan Dam. Contractor's compressor plant located about 250 feet west of discharge end of flood by-pass tunnel.

E.C.-115.	7/11/32.	El Capitan Dam. Contractor's sand and gravel recovery plant located on river bar about one mile upstream from damsite.
E.C.-116.	7/11/32.	El Capitan Dam. Damsite excavation looking upstream from spoil bank below downstream toe of dam.
E.C.-117.	7/19/32.	El Capitan Dam. Damsite looking westerly from north abutment of damsite No. 1.
E.C.-118.	7/21/32.	El Capitan Dam. Typical section of cut showing character and depth of stripping excavation between puddle core area and upstream toe wall.
E.C.-119.	7/25/32.	El Capitan Dam. Damsite excavation operations looking northeasterly from south abutment midway between core wall and downstream toe wall.
E.C.-120.	7/25/32.	El Capitan Dam. Commencing rock embankment between puddle core area and upstream toe wall. Looking north from south abutment.
E.C.-121.	7/30/32.	El Capitan Dam. Contractor's concrete mixing plant located on north side of river about 900 feet easterly from dam axis.
E.C.-122.	7/30/32.	El Capitan Dam. Excavating cutoff trench for upstream toe wall. Looking northerly from near south abutment.
E.C.-123.	7/30/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-124.	7/30/32.	El Capitan Dam. Damsite excavation looking easterly from spoil bank below downstream toe of dam.
E.C.-125.	7/30/32.	El Capitan Dam. Visiting Engineers Club of San Diego in front of Contractor's mess house.
E.C.-126.	7/30/32.	El Capitan Dam. Visiting Engineers Club of San Diego in front of Contractor's mess house.
E.C.-127.	8/4/32.	El Capitan Dam. Easterly bank of upstream toe wall excavation from toe wall station 3+35.
E.C.-128.	8/5/32.	El Capitan Dam. Commencement of concrete pouring at northerly end of upstream toe wall foundation.
E.C.-129.	8/5/32.	El Capitan Dam. Looking south along excavation for upstream toe wall from about toe wall station 2+00.
E.C.-130.	8/5/32.	El Capitan Dam. Placing concrete in upstream toe wall foundation from about station 1+75.
E.C.-131.	8/10/32.	El Capitan Dam. Northerly end of upstream toe wall.
E.C.-132.	8/10/32.	El Capitan Dam. Southerly end of upstream toe wall.

E.C.-133.	8/10/32.	El Capitan Dam. Northerly side of puddle core excavation.
E.C.-134.	8/10/32.	El Capitan Dam. Portal cut at discharge end of flood by-pass tunnel.
E.C.-135.	8/12/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-136.	8/12/32.	El Capitan Dam. Area stripped ready for placing rock embankment. Looking easterly along toe of north abutment from east side of puddle core area.
E.C.-137.	8/19/32.	El Capitan Dam. Constructing forms and placing concrete in upstream toe wall, looking north from south abutment.
E.C.-138.	8/20/32.	El Capitan Dam. Contractor's sand and gravel recovery plant looking northeasterly from east bank of river.
E.C.-139.	8/20/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-140.	8/22/32.	El Capitan Dam. Placing concrete for floor of downstream drain No. 3, looking upstream from downstream toe wall.
E.C.-141.	8/22/32.	El Capitan Dam. Rock quarry looking east from westerly end.
E.C.-142.	8/22/32.	El Capitan Dam. Excavation of approach to flood by-pass tunnel, discharge end.
E.C.-143.	8/29/32.	El Capitan Dam. Placing concrete in upstream toe wall looking north from south abutment.
E.C.-144.	9/1/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-145.	9/1/32.	El Capitan Dam. Commencement of flood by-pass tunnel enlargement, entrance portal.
E.C.-146.	9/1/32.	El Capitan Dam. Constructing forms at upstream toe wall, looking northerly from south abutment.
E.C.-147.	9/1/32.	El Capitan Dam. Upstream rock embankment construction at north abutment.
E.C.-148.	9/1/32.	El Capitan Dam. Rock quarry looking west from easterly end.
E.C.-149.	9/1/32.	El Capitan Dam. Enlargement of outlet tunnel discharge end.
E.C.-150.	9/8/32.	El Capitan Dam. Hydraulic Engineer H. N. Savage and party on downstream spoil bank.
E.C.-151.	9/8/32.	El Capitan Dam. Looking easterly from downstream spoil bank showing construction of drains, downstream toe wall and discharge end of tunnel.

E.C.-152.	9/9/32.	El Capitan Dam. Excavation of core wall trench looking north from south abutment.
E.C.-153.	9/9/32.	El Capitan Dam. Placing concrete in downstream toe wall, looking northwesterly from south abutment.
E.C.-154.	9/12/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-155.	9/14/32.	El Capitan Dam. Core wall trench excavation looking southerly from north end.
E.C.-156.	9/14/32.	El Capitan Dam. Core wall trench excavation looking northerly from south abutment.
E.C.-157.	9/19/32.	El Capitan Dam. Area stripped ready for rock embankment after removal of concrete hopper, northwesterly end of upstream toe wall.
E.C.-158.	9/20/32.	El Capitan Dam. Excavating core wall trench looking north from about mid-way.
E.C.-159.	9/20/32.	El Capitan Dam. Quarry looking easterly from west end showing face after heavy blast.
E.C.-160.	9/20/32.	El Capitan Dam. Quarry from hill above westerly end showing well drilling machines in left foreground.
E.C.-161.	9/20/32.	El Capitan Dam. Well drilling machine on bench above quarry.
E.C.-162.	9/21/32.	El Capitan Dam. Electric powered shovel at quarry equipped with new 3½ cubic yard rock bucket.
E.C.-163.	9/21/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-164.	9/21/32.	El Capitan Dam. Upstream toe wall after completion, looking south from north abutment.
E.C.-165.	9/21/32.	El Capitan Dam. Discharge portal of flood by-pass tunnel showing enlargement operations.
EIC.-166.	9/21/32.	El Capitan Dam. Dam construction operations looking upstream from downstream spoil bank.
E.C.-167.	10/1/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-168.	10/1/32.	El Capitan Dam. Excavating for upstream portal walls of flood by-pass tunnel.
E.C.-169.	10/1/32.	El Capitan Dam. Quarry looking easterly from west end.
E.C.-170.	10/1/32.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-171.	10/3/32.	El Capitan Dam. Core wall trench excavation at south abutment.

E.C.-172.	10/3/32.	El Capitan Dam. Placing concrete in downstream toe wall, looking southerly from north abutment.
E.C.-173.	10/7/32.	El Capitan Dam. Outlet tunnel entrance.
E.C.-174.	10/7/32.	El Capitan Dam. Outlet tunnel entrance.
E.C.-175.	10/7/32.	El Capitan Dam. Completed core wall trench in river bed.
E.C.-176.	10/7/32.	El Capitan Dam. Completed core wall trench excavation in river bed.
E.C.-177.	10/7/32.	El Capitan Dam. Discharge end of flood by-pass tunnel.
E.C.-178.	10/8/32.	El Capitan Dam. Part of quarry face after heavy blast of October 6.
E.C.-179.	10/10/32.	El Capitan Dam. River overflowing road to gravel plant opposite Chocolate Creek.
E.C.-180.	10/10/32.	El Capitan Dam. Dyke across riverbed about 700 feet upstream from tunnel entrance. Looking downstream from road to tunnel.
E.C.-181.	10/10/32.	El Capitan Dam. River overflowing road to gravel plant about midway between dam and plant.
E.C.-182.	10/10/32.	El Capitan Dam. River overflowing road to gravel plant about midway between dam and plant.
E.C.-183.	10/10/32.	El Capitan Dam. River just breaking through dyke across riverbed about 700 feet upstream from tunnel entrance.
E.C.-184.	10/10/32.	El Capitan Dam. River rushing in to tunnel entrance.
E.C.-185.	10/11/32.	El Capitan Dam. River rushing in to tunnel entrance. Photo taken from gravel plant road.
E.C.-186.	10/11/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-187.	10/11/32.	El Capitan Dam. Backwater of river looking downstream from south abutment of damsite No. 1.
E.C.-188.	10/11/32.	El Capitan Dam. Dragline rebuilding river crossing on gravel plant road looking northerly from near mouth of Chocolate Creek.
E.C.-189.	10/11/32.	El Capitan Dam. Water from tunnel flowing into excavation below downstream toe wall.
E.C.-190.	10/11/32.	El Capitan Dam. Flood by-pass tunnel discharging river flow.
E.C.-191.	10/13/32.	El Capitan Dam. Truck containing 14 inch pump unit purchased at Oakland, California, by Contractors Consulting Engineer D. W. Albert. Photo taken on rock embankment.

E.C.-192. 10/19/32. El Capitan Dam. Dam foundation stripped ready for State inspection indicated by flags. Junction of rock embankment and south abutment near upstream toe wall.

E.C.-193. 10/19/32. El Capitan Dam. Looking north from south abutment showing structural and reinforcing steel in core wall footing.

E.C.-194. 10/21/32. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-195. 10/22/32. El Capitan Dam. Pump installed above dyke about 800 feet upstream from tunnel entrance. Byron-Jackson 18" - 14" centrifical pump, capacity 7000 gallons per minute at 1140 R.P.M. Operated by 400 H.P. General Electric motor.

E.C.-196. 10/22/32. El Capitan Dam. Rock quarry looking westerly from quarry shop.

E.C.-197. 10/28/32. El Capitan Dam. Rock line painted on portal face at discharge end of tunnel by Contractor's Engineer

E.C.-198. 10/28/32. El Capitan Dam. Rock line painted on portal face at discharge end of tunnel by Contractor's Engineer

E.C.-199. 10/31/32. El Capitan Dam. Upstream end of tunnel showing wing reinforcement and rock line painted on portal excavation by Contractor's Engineer.

E.C.-200. 10/31/32. El Capitan Dam. Commencing rock embankment at north abutment near downstream toe wall. Looking easterly from northerly end of downstream toe wall.

E.C.-201. 10/31/32. El Capitan Dam. Commencing rock embankment at north abutment near downstream toe wall. Looking northerly from about midway on downstream toe wall.

E.C.-202. 10/31/32. El Capitan Dam. Applying 100 lbs. air pressure on grout pipe at core wall. Note water flowing from adjacent pipes.

E.C.-203. 10/31/32. El Capitan Dam. Water flowing from adjacent pipes as 100 lbs. air pressure is applied to grout pipe in core wall footing. Looking southerly from north end.

E.C.-204. 10/31/32. El Capitan Dam. Water bubbling up through ground as 100 lbs air pressure is applied to grout pipe in core wall footing about 50 feet distant.

E.C.-205. 10/31/32. El Capitan Dam. Water bubbling up through ground as 100 lbs. air pressure is applied to grout pipe in core wall footing, about 50 feet distant. Close up view.

E.C.-206. 11/2/32. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-207. 11/2/32. El Capitan Dam. Rock line painted on north portal cut at upstream end of tunnel by Contractor's Engineer.

E.C.-208.	11/2/32.	Construction operations looking upstream from downstream spoil bank.
E.C.-209.	11/10/32.	El Capitan Dam. Seen along south side of approach cut at tunnel entrance.
E.C.-210.	11/10/32.	El Capitan Dam. Tunnel entrance showing wing reinforcement and revised rock line painted on portal cut.
E.C.-211.	11/11/32.	El Capitan Dam. Tunnel discharge end showing revised rock line painted on portal cut.
E.C.-212.	11/11/32.	El Capitan Dam. Showing proximity of reinforcing steel to timber segments at tunnel discharge portal.
E.C.-213.	11/11/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-214.	11/11/32.	El Capitan Dam. Construction operations looking upstream from downstream spoil bank.
E.C.-215.	11/21/32.	El Capitan Dam. Commencement of rock embankment from higher bench at easterly end of north abutment.
E.C.-216.	11/21/32.	El Capitan Dam. Close up of wing excavation showing rock line, north side of tunnel entrance.
E.C.-217.	11/21/32.	El Capitan Dam. Cut at downstream extremity of puddle core area looking northwesterly from near south abutment.
E.C.-218.	11/21/32.	El Capitan Dam. Cut at upstream extremity of puddle core area looking northeasterly from near south abutment.
E.C.-219.	11/22/32.	El Capitan Dam. Rock pockets back of south concrete wing wall at tunnel entrance.
E.C.-220.	11/22/32.	El Capitan Dam. Core wall construction looking northerly from south abutment.
E.C.-221.	11/22/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-222.	11/23/32.	El Capitan Dam. Upper road cut on north abutment at Elev. 640 showing outcropping of boulders in decomposed granite. Photo taken about 150 feet downstream from core wall.
E.C.-223.	11/23/32.	El Capitan Dam. Upper road cut on north abutment at Elev. 640 showing outcropping of boulders in decomposed granite. Photo taken about 100 feet downstream from core wall.
E.C.-224.	11/23/32.	El Capitan Dam. Rock line on north portal face of discharge end of tunnel. Photo taken from southerly end of downstream toe wall.

E.C.-225.	11/23/32.	El Capitan Dam. Rock line at south wing of discharge end of tunnel. Looking southerly from south end of toe wall.
E.C.-226.	12/1/32.	El Capitan Dam. Rock Line of south wing cut about 100 feet west of discharge end of tunnel.
E.C.-227.	12/2/32.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-228.	12/3/32.	El Capitan Dam. Quarry looking westerly from east end.
E.C.-229.	12/3/32.	El Capitan Dam. Shovels working in westerly end of quarry.
E.C.-230.	12/3/32.	El Capitan Dam. Construction operations looking upstream from downstream spoil bank.
E.C.-231.	12/3/32.	El Capitan Dam. Core wall trench excavation at north abutment.
E.C.-232.	12/27/32.	El Capitan Dam. Stripping operations on north abutment about 100 feet downstream from core wall.
E.C.-233.	12/27/32.	El Capitan Dam. Core wall construction looking southerly from near north abutment.
E.C.-234.	12/27/32.	El Capitan Dam. Depositing rock removed in stripping operations on downstream rock embankment. Looking south from north abutment.
E.C.-235.	12/27/32.	El Capitan Dam. Portion of stripped area on north abutment downstream from core wall. Looking northeasterly from downstream rock embankment.
E.C.-236.	12/27/32.	El Capitan Dam. Construction operations looking upstream from downstream spoil bank.
E.C.-237.	1/5/33.	El Capitan Dam. Reservoir portal of tunnel.
E.C.-238.	1/5/33.	El Capitan Dam. Reservoir portal of tunnel.
E.C.-239.	1/5/33.	El Capitan Dam. Upstream section of rock embankment looking westerly.
E.C.-240.	1/5/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-241.	1/5/33.	El Capitan Dam. Logs and dead wood piled in river bottom for burning above Sand Creek.
E.C.-242.	1/5/33.	El Capitan Dam. Leveling ground surface for placing downstream section of hydraulic fill.
E.C.-243.	1/14/33.	El Capitan Dam. Tunnel entrance from sand stock pile near mixing plant.
E.C.-244.	1/14/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-245.	1/14/33.	El Capitan Dam. Road construction looking westerly from knoll at borrow pit area A.
E.C.-246.	1/14/33.	El Capitan Dam. Stripped area at westerly toe of north abutment looking easterly from rock embankment.
E.C.-247.	1/14/33.	El Capitan Dam. Mounting pumps and monitors on barges for hydraulic fill construction.. Photo taken near tunnel discharge end.
E.C.-248.	1/14/33.	El Capitan Dam. Section of core wall near south abutment showing faulty construction work.
E.C.-249.	1/21/33.	El Capitan Dam. Rock pocket in concrete in core wall near south abutment.
E.C.-250.	1/21/33.	El Capitan Dam. Core wall looking northerly from south abutment.
E.C.-251.	1/23/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-252.	1/23/33.	El Capitan Dam. Tunnel entrance portal.
E.C.-253.	1/23/33.	El Capitan Dam. Core wall looking southerly from upstream rock embankment at north abutment.
E.C.-254.	1/23/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-255.	1/27/33.	El Capitan Dam. Commencing excavation of hydraulic fill material at westerly side of borrow pit "A".
E.C.-256.	1/27/33.	El Capitan Dam. Blanketing west slope of upstream rock embankment with hydraulic fill material from borrow pit "A".
E.C.-257.	1/30/33.	El Capitan Dam. Water overflowing road at San Diego River crossing of borrow pit road.
E.C.-258.	1/30/33.	El Capitan Dam. River flow at discharge end of tunnel.
E.C.-259.	2/1/33.	El Capitan Dam. Reconstructing river crossing to borrow pit "A" after washout of January 30.
E.C.-260.	2/1/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-261.	2/2/33.	El Capitan Dam. Looking northerly from about 100 feet east of core wall on south abutment.
E.C.-262.	2/6/33.	El Capitan Dam. Westerly face of upstream rock embankment showing flags set to mark toe of 10 foot earth covering.
E.C.-263.	2/6/33.	El Capitan Dam. Looking southerly from about 75 feet east of core wall on north abutment.
E.C.-264.	2/6/33.	El Capitan Dam. Power shovels excavating hydraulic fill material in borrow pit "C".

E.C.-265. 2/9/33. El Capitan Dam. Trucks placing hydraulic fill material on westerly face of upstream rock embankment.

E.C.-266. 2/9/33. El Capitan Dam. Stripping operations on south abutment.

E.C.-267. 2/10/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-268. 2/10/33. El Capitan Dam. Trying out monitor at upstream side of core wall.

E.C.-269. 2/10/33. El Capitan Dam. Lower flags mark extremities of puddle core. Upper row are set in earth covering of rock embankment at same elevation as rock embankment toe. Looking northeasterly from N3340, E5040.

E.C.-270. 2/10/33. El Capitan Dam. Looking upstream from downstream spoil bank.

E.C.-271. 2/10/33. El Capitan Dam. Commencing hydraulic operations at westerly toe of upstream embankment.

E.C.-272. 2/11/33. El Capitan Dam. Pumping water into puddle core area downstream of core wall. Looking southerly from near north abutment.

E.C.-273. 2/14/33. El Capitan Dam. Hydraulic operations upstream from corewall, looking southerly from north abutment.

E.C.-274. 2/14/33. El Capitan Dam. Hydraulic operations upstream from core wall, looking southerly from north abutment.

E.C.-275. 2/14/33. El Capitan Dam. Hydraulic operations looking northeasterly from downstream from south abutment.

E.C.-276. 2/14/33. El Capitan Dam. Hydraulic operations looking northeasterly from downstream from south abutment.

E.C.-277. 2/15/33. El Capitan Dam. Looking southwesterly from about 800 feet upstream from north abutment.

E.C.-278. 2/15/33. El Capitan Dam. Looking southwesterly from about 1000 feet east of north abutment.

E.C.-279. 2/15/33. El Capitan Dam. Hydraulic operations at upstream embankment, looking southerly from north abutment.

E.C.-280. 2/15/33. El Capitan Dam. Hydraulic operations at downstream embankment looking southwesterly from bench near north abutment.

E.C.-281. 2/15/33. El Capitan Dam. Monitor in operation at upstream extremity of puddle core looking upstream from westerly end of north abutment.

E.C.-282. 2/15/33. El Capitan Dam. Construction operations looking northeasterly from flume bench about 800 feet west of dam axis.

E.C.-283. 2/15/33. El Capitan Dam. Construction operations looking northwesterly from flume bench about 300 feet easterly of dam axis.

E.C.-284. 2/20/33. El Capitan Dam. Contractor's powder house on quarry road.

E.C.-285. 2/20/33. El Capitan Dam. Constructing road to spillway area looking easterly from northwest of spillway.

E.C.-286. 2/20/33. El Capitan Dam. Looking upstream from downstream spoil bank.

E.C.-287. 2/22/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-288. 2/22/33. El Capitan Dam. Power shovel at work at westerly end of spillway. Note bucket teeth marks in face of cut.

E.C.-289. 2/22/33. El Capitan Dam. Excavating hydraulic fill material in borrow pit "A". Looking southeasterly from junction of borrow pit and gravel plant roads.

E.C.-290. 2/23/33. El Capitan Dam. Downstream embankment showing thickness of earth material placed in hydraulic fill area. Line of flags marks top of rock embankment slope. Looking southerly from north abutment.

E.C.-291. 2/23/33. El Capitan Dam. Upstream embankment showing thickness of earth material placed in hydraulic fill area. Line of flags marks top of rock embankment slope. Looking northerly from south abutment.

E.C.-292. 2/23/33. El Capitan Dam. Upstream embankment showing thickness of earth material placed in hydraulic fill area. Line of flags marks top of rock embankment slope. Looking northerly from south abutment.

E.C.-293. 2/24/33. El Capitan Dam. Downstream embankment showing thickness of earth material placed in hydraulic fill area. Line of flags marks top of rock embankment slope. Looking northerly from south abutment. Thickness of earth material increased from 62 feet to 94 feet since taking of photo number E.C.-290.

E.C.-294. 3/1/33. El Capitan Dam. Downstream embankment after sluicing by monitors. Note line of flags marking top of rock embankment slope. Looking north from south abutment.

E.C.-295. 3/1/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-296. 3/2/33. El Capitan Dam. Chocolate Creek road at about station 58+85, showing disintegrated granite cut made by gasoline power shovel without the use of powder.

E.C.-297. 3/2/33. El Capitan Dam. Resuming the placement of unsorted hydraulic fill material in downstream embankment. Looking northerly from south abutment.

E.C.-298.	3/2/33.	El Capitan Dam. Placing surface rock on upstream face of upstream embankment.
E.C.-299.	3/2/33.	El Capitan Dam. Placing surface rock on upstream face of upstream embankment. Looking northerly from south abutment.
E.C.-300.	3/2/33.	El Capitan Dam. Constructing road to east end of spillway, showing gasoline power shovel working up north abutment of Damsite No. 1 from road to borrow pit.
E.C.-301.	3/3/33.	El Capitan Dam. Power shovel excavating at westerly end of spillway at N4400, E4750. Note bucket teeth marks in face of cut.
E.C.-302.	3/4/33.	El Capitan Dam. Sloping upstream face of upstream rock embankment preparatory to hand placing of surface rock.
E.C.-303.	3/6/33.	El Capitan Dam. Hydraulic operations looking northeasterly from flume bench near axis of dam.
E.C.-304.	3/6/33.	El Capitan Dam. Hydraulic operations looking northwesterly from flume bench near axis of dam.
E.C.-305.	3/6/33.	El Capitan Dam. Construction operations looking northeasterly from flume bench about 500 feet west of dam.
E.C.-306.	3/7/33.	El Capitan Dam. Hydraulic operations looking northwesterly from about 150 feet above flume bench near line of axis of dam.
E.C.-307.	3/7/33.	El Capitan Dam. Hydraulic operations looking northwesterly from about 150 feet above flume bench near line of axis of dam.
E.C.-308.	3/7/33.	El Capitan Dam. San Diego Chamber of Commerce party inspecting hydraulic operations from downstream embankment. Looking northerly from south abutment.
E.C.-309.	3/7/33.	El Capitan Dam. San Diego Chamber of Commerce party inspecting hydraulic operations from downstream embankment. Looking northwesterly from south abutment.
E.C.-310.	3/7/33.	El Capitan Dam. San Diego Chamber of Commerce party inspecting hydraulic operations from downstream embankment. Looking northwesterly from east end of south abutment.
E.C.-311.	3/7/33.	El Capitan Dam. San Diego Chamber of Commerce party inspecting hydraulic operations from downstream embankment. Looking northwesterly from southeast corner of hydraulic fill area.
E.C.-312.	3/7/33.	El Capitan Dam. Monitors in operation at upstream embankment. Looking northerly from south abutment.
E.C.-313.	3/7/33.	El Capitan Dam. Pumping water into puddle core at westerly end of south abutment.

E.C.-314.	3/9/33.	El Capitan Dam. Hydraulic Engineer H. N. Savage explaining construction operations to visiting womens civic clubs representatives. Photo taken at downstream embankment.
E.C.-315.	3/9/33.	El Capitan Dam. Visiting womens civic clubs representatives leaving downstream embankment for inspection of borrow pit areas.
E.C.-316.	3/10/33.	El Capitan Dam. Showing method now used in placing unsorted hydraulic fill material on downstream embankment.
E.C.-317.	3/10/33.	El Capitan Dam. Spillway excavation looking easterly from near contractor's shops.
E.C.-318.	3/11/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-319.	3/11/33.	El Capitan Dam. Hydraulic operations at north end of downstream embankment.
E.C.-320.	3/13/33.	El Capitan Dam. Looking easterly from quarry road northwest of contractors camp.
E.C.-321.	3/13/33.	El Capitan Dam. Hydraulic operations at northerly end of downstream embankment.
E.C.-322.	3/15/33.	El Capitan Dam. Rock pockets in concrete core wall near south abutment.
E.C.-323.	3/16/33.	El Capitan Dam. Looking westerly from about N3200, E5200. Note proximity of power shovels in left foreground to downstream embankment where material is placed.
E.C.-324.	3/16/33.	El Capitan Dam. Power shovel loading material for hydraulic fill in downstream spoil bank.
E.C.-325.	3/16/33.	El Capitan Dam. Power shovel loading material for hydraulic fill in downstream spoil bank.
E.C.-326.	3/21/33.	El Capitan Dam. Downstream embankment looking southerly from north abutment.
E.C.-327.	3/21/33.	El Capitan Dam. Spillway excavation looking northeasterly from N4100, E4730. Note character of material in face of cut.
E.C.-328.	3/21/33.	El Capitan Dam. Spillway excavation looking southeasterly from N4460, E4760.
E.C.-329.	3/23/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-330.	3/23/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-331.	3/27/33.	El Capitan Dam. Commencing sand and gravel lift at elevation 634 at northerly end of downstream embankment.

E.C.-332.	3/27/33.	El Capitan Dam. Constructing concrete core wall at south abutment.
E.C.-333.	3/27/33.	El Capitan Dam. Bluff from core wall trench excavation at south abutment. Note material piled up against bulkhead in foreground.
E.C.-334.	3/27/33.	El Capitan Dam. Bluff from core wall trench excavation at north abutment.
E.C.-335.	3/29/33.	El Capitan Dam. Power shovel excavating at easterly end of spillway.
E.C.-336.	3/31/33.	El Capitan Dam. Grave of Dan Wilkins located about 400 feet northerly from boulder creek gauging station at about elevation 850.
E.C.-337.	3/31/33.	El Capitan Dam. Grave of Dan Wilkins.
E.C.-338.	3/31/33.	El Capitan Dam. Ruins of old adobe dwelling occupied by Dan Wilkins at the time of his death, 1899, about 400 feet north of Boulder Creek road crossing and 50 feet east of Eagle Peak road. Home is about 900 feet south of northerly line of Indian Reservation. Grave is about 200 feet east of dwelling.
E.C.-339.	4/1/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-340.	4/1/33.	El Capitan Dam. Looking southwesterly from north side of canyon about 500 feet east of axis of dam.
E.C.-341.	4/1/33.	El Capitan Dam. Placing rock on face of downstream embankment from gravel lift at elevation 634. Looking north from south abutment.
E.C.-342.	4/1/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-343.	4/6/33.	El Capitan Dam. Caterpillar tractor with scarifier breaking up earth road surface at 615 foot level of downstream rock embankment.
E.C.-344.	4/6/33.	El Capitan Dam. Surface of 615 foot level of downstream rock embankment after completion of scarifier work. Looking north from south abutment.
E.C.-345.	4/7/33.	El Capitan Dam. Depth of clay bearing material in borrow pit "A" at about N2200, E10100. Bottom of 12 foot rod is held at top of decomposed granite.
E.C.-346.	4/7/33.	El Capitan Dam. Depth of clay bearing material in borrow pit "A" at about N2580, E11050. Note that depth of material here extends to pit floor.
E.C.-347.	4/10/33.	El Capitan Dam. Dam from east approach to spillway about 800 feet easterly from axis of dam. Photo taken after suspension of work.
E.C.-348.	4/10/33.	El Capitan Dam. Trucks used for transporting hydraulic fill material parked near borrow pit "A". Photo taken after suspension of work.

E.C.-349.	4/10/33.	El Capitan Dam. Borrow pit "A" looking easterly from near junction of gravel plant and borrow pit roads. Photo taken after suspension of work.
E.C.-350.	4/10/33.	El Capitan Dam. Downstream embankment from south abutment near core wall. Photo taken after suspension of work.
E.C.-351.	4/10/33.	El Capitan Dam. Upstream embankment from south abutment near core wall. Photo taken after suspension of work.
E.C.-352.	4/10/33.	El Capitan Dam. Spillway excavation near axis of dam. Photo taken after suspension of work.
E.C.-353.	4/10/33.	El Capitan Dam. Downstream embankment from tunnel spoil bank. Photo taken after suspension of work.
E.C.-354.	4/10/33.	El Capitan Dam. Contractor's trucks parked vicinity shop. Photo taken after suspension of work.
E.C.-355.	4/11/33.	El Capitan Dam. Quarry looking westerly from east end.
E.C.-356.	4/11/33.	El Capitan Dam. Rock hauling trucks parked near quarry shops.
E.C.-357.	4/11/33.	El Capitan Dam. Contractor's shops at quarry.
E.C.-358.	4/11/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-359.	4/13/33.	El Capitan Dam. Road gate constructed near Contractor's office building.
E.C.-360.	4/13/33.	El Capitan Dam. View of dam from east approach to spillway.
E.C.-361.	4/21/33.	El Capitan Dam. Temporary diversion dam and spillway above entrance to tunnel. Looking southeasterly from road near north abutment of dam.
E.C.-362.	4/24/33.	El Capitan Dam. Monitor stripping south abutment west of core wall.
E.C.-363.	4/24/33.	El Capitan Dam. Monitor stripping south abutment west of core wall.
E.C.-364.	4/26/33.	El Capitan Dam. Drilling boulders above and north of spillway. View from south side of spillway cut.
E.C.-365.	4/26/33.	El Capitan Dam. Close up of drilling boulders above spillway.
E.C.-366.	4/26/33.	El Capitan Dam. Drilling boulders above spillway looking northeasterly from spillway cut.
E.C.-367.	5/2/33.	El Capitan Dam. Upstream embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3660, E5210.

E.C.-368. 5/2/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3580, E5190.

E.C.-369. 5/2/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3390, E5200.

E.C.-370. 5/2/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3360, E5190.

E.C.-371. 5/3/33. El Capitan Dam. Downstream embankment at elevation 634 showing upstream face. Photo taken from N3800 E4860.

E.C.-372. 5/3/33. El Capitan Dam. Downstream embankment at elevation 634. Photo taken from about N3810, E4840.

E.C.-373. 5/3/33. El Capitan Dam. Downstream embankment at elevation 634. Photo taken from about N3600, E4870.

E.C.-374. 5/3/33. El Capitan Dam. Downstream embankment looking south from road on north abutment at about N3880, E4850.

E.C.-375. 5/3/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3760, E5185.

E.C.-376. 5/3/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3685, E5185.

E.C.-377. 5/3/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3540, E5190.

E.C.-378. 5/3/33. El Capitan Dam. Upstream rock embankment at elevation 625 showing thickness of earth covering placed for roadway. Photo taken from about N3460, E5190.

E.C.-379. 5/3/33. El Capitan Dam. Upstream beach looking south from road on north abutment.

E.C.-380. 5/3/33. El Capitan Dam. Upstream rock embankment after sluicing by monitors. Looking southerly from road on north abutment.

E.C.-381. 5/9/33. El Capitan Dam. Well drilling machine sinking well No. 5 on upstream beach.

E.C.-382. 5/10/33. El Capitan Dam. Hydraulic Engineer H. N. Savage, Assistant Hydraulic Engineer F. D. Pyle, Consulting Engineer Louis C. Hill, Contractor's Superin-

tendent O.C. Steves and Contractors Foreman J. L. Connolly on downstream rock embankment.

E.C.-383. 5/10/33. El Capitan Dam. Hydraulic Engineer H. H. Savage, Assistant Hydraulic Engineer F. D. Pyle, Contractor's Superintendent O. C. Steves and Contractor's Foreman J. L. Connolly on downstream rock embankment.

E. C-384. 5/12/33. El Capitan Dam. Shovel opening up roadway on 600 foot elevation lift to reach rock ordered removed by Hydraulic Engineer on downstream rock embankment. Looking south from road on north abutment.

E.C.-385. 5/12/33. El Capitan Dam. Shovel opening up roadway on 600 foot elevation lift to reach rock ordered removed by Hydraulic Engineer on downstream rock embankment. Looking south from road on north abutment.

E.C.-386. 5/13/33. El Capitan Dam. Downstream rock embankment at elev-600 showing lift partially uncovered at ordinate N3820.

E.C.-387. 5/15/33. El Capitan Dam. Downstream rock embankment at elevatbn 600. Looking south from north abutment.

E.C.-388. 5/15/33. El Capitan Dam. Downstream rock embankment at elevation 600. Looking southerly form north abutment.

E.C.-389. 5/25/33. El Capitan Dam. Constructing new road from borrow pit "A" to higher level at dam. Looking westerly from south side of river near mouth of Chocolate Creek.

E.C.-390. 5/25/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-391. 5/25/33. El Capitan Dam. Constructing new road from borrow pit "A" to higher level at dam. Looking westerly from north abutment of damsite No. 1.

E.C.-392. 5/25/33. El Capitan Dam. New road from quarry to 720 foot elevation at dam. Looking easterly from road above Contractor's camp.

E.C.-393. 5/26/33. El Capitan Dam. Sluicing earth roadway material from upstream rock embankment.

E.C.-394. 5/31/33. El Capitan Dam. View showing new approach roads to south abutment from flume bench about 1000 feet westerly from axis of dam.

E.C.-395. 5/31/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-396. 5/31/33. El Capitan Dam. Core wall at north abutment looking northwesterly from about center of upstream beach.

E.C.-397. 5/31/33. El Capitan Dam. Core wall at south abutment looking southwesterly from near south end of upstream beach

E.C.-398.	6/1/33.	El Capitan Dam. Road gate constructed by contractor about midway between San Diego River crossing and Contractor's camp.
E.C.-399.	6/2/33.	El Capitan Dam. Contractor resuming operations after shutdown. Rock being placed from elevation 634 lift on downstream rock embankment.
E.C.-400.	6/2/33.	El Capitan Dam. Contractor resuming operations after shutdown. Rock being placed from elevation 634 lift on downstream rock embankment.
E.C.-401.	6/6/33.	El Capitan Dam. Flashlight photo of defective concrete work in arch of tunnel at station 3+00.
E.C.-402.	6/6/33.	El Capitan Dam. Flashlight photo of defective concrete work in arch of tunnel at station 3+00.
E.C.-403.	6/6/33.	El Capitan Dam. Placing rock lift to elevation 650 on elevation 625 of upstream rock embankment. Looking northerly from about ordinate N3700.
E.C.-404.	6/7/33.	El Capitan Dam. City of San Diego's fire truck in action.
E.C.-405.	6/7/33.	El Capitan Dam. Close up of fire truck. U.S. Fire Warden W. E. Mann at wheel.
E.C.-406.	6/9/33.	El Capitan Dam. Placing elevation 650 lift on elevation 634 of downstream rock embankment. Looking northerly from about ordinate N3750.
E.C.-407.	6/10/33.	El Capitan Dam. Looking westerly downstream from north abutment of dameite No. 1.
E.C.-408.	6/12/33.	El Capitan Dam. Sluicing 625 foot elevation of upstream rock embankment. Looking northwesterly from about ordinate N3500.
E.C.-409.	6/14/33.	El Capitan Dam. Sluicing below downstream toe wall near northerly end.
E.C.-410.	6/15/33.	El Capitan Dam. Sluicing 634 foot elevation of downstream rock embankment looking northerly from south abutment.
E.C.-411.	6/15/33.	El Capitan Dam. Sluicing with monitor attached to 8" pipeline on 634 foot elevation of downstream rock embankment. Looking northeasterly from near south abutment.
E.C.-412.	6/16/33.	El Capitan Dam. Sprinkling system installed on face of downstream rock embankment in operation.
E.C.-413.	6/16/33.	El Capitan Dam. Hydraulic operations resumed at northerly end of upstream embankment. Looking southeasterly from road near core wall.
E.C.-414.	6/19/33.	El Capitan Dam. Reinforcing steel in base of outlet tower.

E.C.-415.	6/19/33.	El Capitan Dam. Power shovels at quarry.
E.C.-416.	6/19/33.	El Capitan Dam. Sprinkling system in operation on face of downstream rock embankment looking northerly from south abutment.
E.C.-417.	6/19/33.	El Capitan Dam. Placing concrete in footing of outlet tower looking down from top of shaft.
E.C.-418.	6/20/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
EIC.-419.	6/20/33.	El Capitan Dam. Looking upstream from downstream spoil bank. Sprinkling system in operation upon face of downstream rock embankment.
E.C.-420.	6/26/33.	El Capitan Dam. Spillway excavation looking northerly from south abutment.
E.C.-421.	6/26/33.	El Capitan Dam. Spillway cut from about N4300, E5200.
E.C.-422.	6/26/33.	El Capitan Dam. Power shovel excavating in spillway cut. Photo taken from near dam axis.
E.C-423.	6/30/33.	El Capitan Dam. Looking upstream from downstream spoil bank. Sprinkling system in operation upon face of downstream rock embankment.
E.C.-424.	7/1/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-425.	7/1/33.	El Capitan Dam. Power shovel excavating in spillway cut at about station 0+75.
E.C.-426/	7/7/33.	El Capitan Dam. Dam looking southwesterly from east approach to spillway.
E.C.-427.	7/7/33.	El Capitan Dam. Power shovels excavating in spillway looking westerly from east approach road.
E.C.-428.	7/10/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-430.	7/11/33.	El Capitan Dam. Commencing rock lift to elevation 662 on downstream embankment. Looking northerly from near north abutment.
E.C.-429.	7/11/33	El Capitan Dam. Looking westerly downstream from north abutment of damsite no 1.
E.C.-431.	7/11/33.	El Capitan Dam. Sluicing surface of downstream rock embankment at elevation 650 preparatory to placing rock lift to elevation 662.
E.C.-432.	7/13/33.	El Capitan Dam. Quarry face before shooting coyote hole, looking northeasterly from westerly end.
E.C.-433.	7/13/33.	El Capitan Dam. Quarry face after shooting coyote hole.

E.C.-434. 7/15/33. El Capitan Dam. Commencing rock lift to elevation 662 at upstream rock embankment.

E.C.-435. 7/18/33. El Capitan Dam. Constructing rock lift to elevation 662 downstream rock embankment. Looking north from south abutment.

E.C.-436. 7/19/33. El Capitan Dam. Constructing rock lift to elevation 662 upstream rock embankment. Looking northerly from near south abutment.

E.C.-437. 7/20/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-438. 7/21/33. El Capitan Dam. Looking upstream from downstream spoil bank.

E.C.-439. 7/22/33. El Capitan Dam. Flashlight photo showing defective concrete in south side of tunnel lining at about station 9+60.

E.C.-440. 7/22/33. El Capitan Dam. Flashlight photo showing defective concrete in south side of tunnel lining at about station 9+60.

E.C.-441. 7/22/33. El Capitan Dam. Looking southwesterly from 650 foot elevation of downstream rock embankment at about N3600.

E.C.-442. 7/25/33. El Capitan Dam. Spillway cut looking northerly from about axis of dam.

E.C.-443. 7/27/33. El Capitan Dam. Looking southwesterly from 650 foot elevation at north abutment of downstream rock embankment.

E.C.-444. 7/27/33. El Capitan Dam. Flashlight photo showing defective concrete in south side of tunnel lining at about station 9+10.

E.C.-445. 7/27/33. El Capitan Dam. Flashlight photo showing defective concrete in south side of tunnel lining at about station 8+90.

E.C.-446. 7/27/33. El Capitan Dam. Power shovels excavating in spillway upstream from axis of dam at about elevation 750.

E.C.-447. 7/27/33. El Capitan Dam. Spillway excavation spoil bank along road to borrow pit about ½ mile upstream from dam.

E.C.-448. 8/2/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-449. 8/2/33. El Capitan Dam. Looking upstream from downstream spoil bank.

E.C.-450. 8/5/33. El Capitan Dam. Spillway excavation. Power shovels Nos. 8 and 12, looking northeasterly.

E.C.-451. 8/5/33. El Capitan Dam. Spillway excavation. Power shovels Nos. 8 and 12, looking northeasterly.

E.C.-452.	8/5/33.	El Capitan Dam. Spillway excavation. Power shovels Nos. 7 and 8, looking northerly.
E.C.-453.	8/5/33.	El Capitan Dam. Spillway excavation. Power shovel No. 7 and drill hole No. 6, looking northerly.
E.C.-454.	8/5/33.	El Capitan Dam. Spillway excavation. Power shovel No. 7, looking northeasterly.
E.C.-455.	8/5/33.	El Capitan Dam. Spillway excavation. Power shovel No. 8, looking northeasterly.
E.C.-456.	8/5/33.	El Capitan Dam. Spillway excavation. Power shovel No. 12, looking easterly.
E.C.-457.	8/5/33.	El Capitan Dam. Spillway excavation. Boulders near east end of spillway, looking northerly.
E.C.-458.	8/5/33.	El Capitan Dam. Spillway excavation. East end of spillway looking easterly.
E.C.-459.	8/5/33.	El Capitan Dam. East spillway spoil bank looking easterly.
E.C.-460.	8/5/33.	El Capitan Dam. West spillway spoil bank looking easterly.
E.C.-461.	8/5/33.	El Capitan Dam. Spillway excavation. West end of spillway looking easterly.
E.C.-462.	8/12/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-463.	8/12/33.	El Capitan Dam. Quarry face after coyote hole shot of August 12. Looking northeasterly from west end.
E.C.-464.	8/14/33.	El Capitan Dam. Placing concrete in outlet tower.
E.C.-465.	8/15/33.	El Capitan Dam. Sluicing top soil from south abutment at downstream rock embankment.
E.C.-466.	8/15/33.	El Capitan Dam. Placing rock on 662 foot elevation of downstream embankment. Looking southerly from north abutment.
E.C.-467.	8/15/33.	El Capitan Dam. Commencing rock lift to elevation 675 of upstream rock embankment.
E.C.-468.	8/16/33.	El Capitan Dam. Tunnel spoil bank below discharge end of tunnel.
E.C.-469.	8/17/33.	El Capitan Dam. Quarry face at about mid-point.
E.C.-470.	8/18/33.	El Capitan Dam. Spillway cut looking northeasterly from about N4430, E5400.
E.C.-471.	8/18/33.	El Capitan Dam. Tree fallers at work in reservoir basin.
E.C.-472.	8/18/33.	El Capitan Dam. Reservoir basin area cleared by City forces. Looking downstream from near South Fork.

E.C.-473.	8/19/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-474.	8/19/33.	El Capitan Dam. Spillway excavation looking northeasterly.
E.C.-475.	8/19/33.	El Capitan Dam. Spillway excavation looking northerly.
E.C.-476.	8/19/33.	El Capitan Dam. Spillway excavation looking Northerly.
E.C.-477.	8/19/33.	El Capitan Dam. Spillway excavation looking northeasterly.
E.C.-478.	8/19/33.	El Capitan Dam. Spillway excavated material placed for hydraulicking. Looking easterly.
E.C.-479.	8/21/33.	El Capitan Dam. Spillway cut looking northerly from about N4160, E4860.
E.C.-480.	8/22/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-481.	8/22/33.	El Capitan Dam. Looking westerly in spillway from about N4270, E5220. Ground elevation at kodak about 745 feet.
E.C.-482.	8/22/33.	El Capitan Dam. Looking northwesterly in spillway from N4370, E5500. Elevation of kodak about 745 feet.
E.C.-483.	8/28/33.	El Capitan Dam. Construction operations looking upstream from downstream spoil bank.
E.C.-484.	8/31/33.	El Capitan Dam. Looking northeasterly in spillway from about N4450, E5030. Elevation of kodak about 780 feet.
E.C.-485.	9/1/33.	El Capitan Dam. Looking northwesterly in spillway from about N4410, E5500. Elevation of kodak about 745 feet.
E.C.-486.	9/2/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-487.	9/2/33.	El Capitan Dam. Stripping operations on north abutment. Looking northerly from near center of dam.
E.C.-488.	9/2/33.	El Capitan Dam. Spillway looking easterly from spillway station 3+00. Ground elevation at kodak about 785 feet.
E.C.-489.	9/2/33.	El Capitan Dam. Looking northwesterly in spillway from about N4240, E5020. Elevation of ground at kodak about 780 feet.
E.C.-490.	9/2/33.	El Capitan Dam. Looking northerly in spillway from about N4240, E5020. Elevation of ground at kodak about 780 feet.

E.C.-491.	9/2/33.	El Capitan Dam. Looking northeasterly in spillway from about N4240, E5020. Elevation of ground at kodak about 780 feet.
E.C.-492.	9/8/33.	El Capitan Dam. Boulders from north abutment after shooting. Looking northeasterly from downstream beach.
E.C.-493.	9/8/33.	El Capitan Dam. Boulders from north abutment after shooting. Looking northeasterly from downstream beach.
E.C.-494.	9/9/33.	El Capitan Dam. Sloping upper side of spillway cut at about station 3+50. Looking northwesterly from about station 2+50.
E.C.-495.	9/11/33.	El Capitan Dam. Excavating cutoff trench at OG section of spillway. Looking easterly from west end.
E.C.-496.	9/11/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-497.	9/11/33.	El Capitan Dam. Spillway construction looking northeasterly from about N4260, E4960. Kodak at about elevation 770 feet.
E.C.-498.	9/12/33.	El Capitan Dam. Sloping spillway cut at about station 3+75. Looking easterly from about station 4+50.
E.C.-499.	9/15/33.	El Capitan Dam. Commencing rock lift on downstream embankment to elevation 687.
E.C.-500.	9/15/33.	El Capitan Dam. Sluicing earth roadway material from 675 foot level of downstream rock embankment. Crew cleaning out well #7 in left foreground. Looking south from about mid-point of embankment.
E.C.-501.	9/15/33.	El Capitan Dam. Power shovel operating in spillway at about station 3+00. Looking easterly from about station 4+50.
E.C.-502.	9/16/33.	El Capitan Dam. Crack in north side of spillway cut at about station 5+00.
E.C.-503.	9/16/33.	El Capitan Dam. Crack along north face of spillway cut looking northeasterly from about 50 feet west of axis of dam.
E.C.-504.	9/16/33.	El Capitan Dam. Looking easterly in spillway from about axis of dam.
E.C.-505.	9/17/33.	El Capitan Dam. Brace to support south bank at spillway crest elevation.
E.C.-506.	9/17/33.	El Capitan Dam. Spillway crest excavation and bracing.
E.C.-507.	9/18/33.	El Capitan Dam. Toe of spillway spoil bank northwest of dam.

E.C.-508.	9/18/33.	El Capitan Dam. Commencing rock lift on 675 foot level of upstream rock embankment. Looking northerly.
E.C.-509.	9/18/33.	El Capitan Dam. Cleaning out observation well No. 5, and sluicing upstream rock embankment elevation 675. Looking northerly.
E.C.-510.	9/19/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-511.	9/19/33.	El Capitan Dam. Pouring concrete in cutoff trench at spillway crest, using new 5 cubic yard capacity agitating concrete trucks.
E.C.-512.	9/20/33.	El Capitan Dam. Reservoir basin clearing looking upstream from about center of southerly ½ of section 33.
E.C.-513.	9/20/33.	El Capitan Dam. Spoil bank opposite east end of spillway looking easterly from upstream rock embankment.
E.C.-514.	9/21/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-515.	9/21/33.	El Capitan Dam. Excavating for spillway crest and placing concrete in ogee section of spillway.
E.C.-516.	9/22/33.	El Capitan Dam. Downstream embankment looking northerly from about mid-point.
E.C.-517.	9/24/33.	El Capitan Dam. Clay deposited on inside slope of downstream rock embankment.
E.C.-518.	9/24/33.	El Capitan Dam. North abutment from downstream edge of pool.
E.C.-519.	9/24/33.	El Capitan Dam. North abutment from downstream edge of pool.
E.C.-520.	9/28/33.	El Capitan Dam. Pouring concrete in outlet tower.
E.C.-521.	9/29/33.	El Capitan Dam. Spillway cut looking northerly from about axis of dam.
E.C.-522.	9/30/33.	El Capitan Dam. Looking easterly in spillway from about station 3+90.
E.C.-523.	9/30/33.	El Capitan Dam. Looking southeasterly in spillway from about station 5+50. Shovel excavating on bench at elevation 735. Elevation of upper bench 750 feet.
E.C.-524.	10/5/33.	El Capitan Dam. Looking northwesterly in spillway from about N4270, E5230.
E.C.-525.	10/10/33.	El Capitan Dam. Boulders stock piled in westerly end of spillway cut at about station 6+50.
E.C.-526.	10/10/33.	El Capitan Dam. Looking southwesterly in spillway from about station 4+25.

E.C.-527. 10/11/33. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-528. 10/12/33. El Capitan Dam. Constructing ogee section of spillway looking northeasterly from about station 5+50.

E.C.-529. 10/12/33. El Capitan Dam. Power shovel excavation unshot material in spillway. Looking easterly from about station 5+75.

E.C.-530. 10/13/33. El Capitan Dam. Lower end of spillway excavation looking easterly from about station 13+50.

E.C.-531. 10/14/33. El Capitan Dam. Placing concrete in ogee section of spillway at about station 4+00.

E.C.-532. 10/14/33. El Capitan Dam. Drilling at south side of spillway cut at about station 6+00. Looking southerly from near north side.

E.C.-533. 10/15/33. El Capitan Dam. Pulling spillway test anchors with hydraulic press.

E.C.-534. 10/18/33. El Capitan Dam. Constructing rock lift to elevation 700, downstream rock embankment. Dragline placing material excavated from beach on easterly face of rock embankment.

E.C.-535. 10/18/33. El Capitan Dam. Constructing rock lift to elevation 700, upstream rock embankment. Looking northerly from south abutment.

E.C.-536. 10/18/33. El Capitan Dam. Constructing rock lift to elevation 700, downstream rock embankment. Looking southerly from north abutment.

E.C.-537. 10/18/33. El Capitan Dam. Spillway excavation looking southeasterly from about station 6+75.

E.C.-538. 10/24/33. El Capitan Dam. Power shovel #7 excavating in north side of spillway cut at about station 2+00.

E.C.-539. 10/24/33. El Capitan Dam. Power shovel #7 excavating in north side of spillway cut at about station 2+00. Photo taken from ogee section of spillway.

E.C.-540. 10/25/33. El Capitan Dam. Excavation made by dragline in beach west of puddle core to widen easterly side of downstream rock embankment at elevation 700.

E.C.-541. 10/25/33. El Capitan Dam. Excavation made by dragline in beach west of puddle core to widen easterly side of downstream rock embankment at elevation 700. Looking northerly.

E.C.-542. 10/25/33. El Capitan Dam. Downstream rock embankment at elevation 700. Looking northerly from about midpoint of fill.

E.C.-543. 10/25/33. El Capitan Dam. Downstream rock embankment at elevation 700. Looking southeasterly from north abutment.

E.C.-544.	10/25/33.	El Capitan Dam. Exploration tunnel No. 3 at about station 4+90 of ogee section of spillway.
E.C.-545.	10/25/33.	El Capitan Dam. Summit pool and upstream beach looking southerly from north abutment.
E.C.-546.	10/26/33.	El Capitan Dam. Removing spillway test anchors set "B" at about N4150, E4640. Ground elevation 634. Bottom of pit elevation 627. Original ground elevation 648. This excavation made with pick and shovel.
E.C.-547.	10/28/33.	El Capitan Dam. Excavation at south side of spillway at about station 3+75.
E.C.-548.	10/30/33.	El Capitan Dam. Excavating for spillway floor looking westerly from about station 0+50.
E.C.-549.	11/1/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-550.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 1 of 7.
E.C.-551.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 2 of 7.
E.C.-552.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 3 of 7.
E.C.-553.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 4 of 7.
E.C.-554.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 5 of 7.
E.C.-555.	11/2/33.	El Capitan Dam. Panorama of spillway looking northerly. View 6 of 7.
E.C.-556.	11/3/33.	El Capitan Dam. Panorama of spillway looking northerly. View 7 of 7.
E.C.-557.	11/2/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-558.	11/3/33.	El Capitan Dam. Looking westerly from about 600 feet upstream from tunnel entrance.
E.C.-559.	11/3/33.	El Capitan Dam. Looking westerly from about 600 feet upstream from tunnel entrance.
E.C.-560.	11/3/33.	El Capitan Dam. Looking upstream from about 350 feet downstream from discharge end of tunnel.
E.C.-561.	11/3/33.	El Capitan Dam. Looking upstream from about 350 feet downstream from discharge end of tunnel.
E.C.-562.	11/4/33.	El Capitan Dam. Looking downstream.
E.C.-563.	11/4/33.	El Capitan Dam. Looking upstream.

E.C.-564.	11/7/33.	El Capitan Dam. Spillway looking westerly from about station 0+50.
E.C.-565.	11/9/33.	El Capitan Dam. Spillway looking northeasterly from about station 4+80.
E.C.-566.	11/9/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-567.	11/10/33.	El Capitan Dam. Placing concrete in floor of spillway. In foreground drilling holes for floor anchors Looking southwesterly from about station 2+00.
E.C.-568.	11/10/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-569.	11/10/33.	El Capitan Dam. Spillway looking southeasterly from about station 6+80.
E.C.-570.	11/20/33.	El Capitan Dam. Group picture o f Judge Harden's Court at spillway station 2, south of ogee section. Looking easterly.
E.C.-571.	11/20/33.	El Capitan Dam. Group picture of Judge Harden's Court at spillway station 2, south of ogee section. Looking easterly.
E.C.-572.	11/20/33.	El Capitan Dam. Looking across spillway north to south about station 7, elevation 700.
E.C.-573.	11/20/33.	El Capitan Dam. Group picture of Judge Harden's Court at north side of spillway station 7, elevation 700.
E.C.-574.	11/20/33.	El Capitan Dam. Looking westerly along line of spillway extension from station 7, elevation 700.
E.C.-575.	11/20/33.	El Capitan Dam. South abutment from upstream rock embankment about N3400, elevation 700.
E.C.-576.	11/22/33.	El Capitan Dam. North abutment showing pipe lines to spillway hog box for full hydraulic method of construction. Looking northerly from upstream rock embankment about N3800, elevation 700.
E.C.-577.	11/23/33.	El Capitan Dam. Spillway looking westerly from east end about elevation 800 showing hog box and monitor for full hydraulic method of construction.
E.C.-578.	11/23/33.	El Capitan Dam. Spillway looking northerly from ogee section station 4+75 showing slide from north slope of spillway cut about station 5+00.
E.C.-579.	12/1/33.	El Capitan Dam. Spillway hog box in operation looking northeasterly from spillway ogee section station 3+60.
E.C.-580.	12/1/33.	El Capitan Dam. Spillway hog box in operation looking northeasterly from spillway ogee section about station 5+20.

E.C.-581.	12/2/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-582.	12/2/33.	El Capitan Dam. Hydraulic operations on upstream beach looking northerly from south abutment.
E.C.-583.	12/2/33.	El Capitan Dam. Downstream beach looking northerly from south abutment.
E.C.-584.	12/2/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-585.	12/4/33.	El Capitan Dam. Power shovel operating in south side of spillway at about station 7+00.
E.C.-586.	12/4/33.	El Capitan Dam. Power shovel operating near northerly side of spillway at about station 6+40.
E.C.-587.	12/6/33.	El Capitan Dam. San Diego Realty Board members at spillway. Looking easterly from about N4210, E5000.
E.C.-588.	12/7/33.	El Capitan Dam. Flashlight photo of floor slab fracture in tunnel. Looking northerly from south side of tunnel at about station 1+95.
E.C.-589.	12/7/33.	El Capitan Dam. Flashlight photo of floor slab fracture in tunnel. Looking westerly along northerly side of tunnel at about station 1+85.
E.C.-590.	12/7/33.	El Capitan Dam. Flashlight photo of floor slab fracture in tunnel. Looking easterly along northerl side of tunnel from about station 2+25.
E.C.-591.	12/10/33.	El Capitan Dam. Crack developed in beach along west edge of summit pool about center of dam.
E.C.-592.	12/10/33.	El Capitan Dam. Operating puddle core sampling device.
E.C.-593.	12/10/33.	El Capitan Dam. Discharging sample from puddle core sampling device.
E.C.-594.	12/10/33.	El Capitan Dam. Discharging sample from puddle core sampling device.
E.C.-595.	12/10/33.	El Capitan Dam. Operating puddle core sampling device.
E.C.-596.	12/12/33.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-597.	12/12/33.	El Capitan Dam. Looking southwesterly in spillway from about N4400, E5100.
E.C.-598.	12/18/33.	El Capitan Dam. South abutment from upstream beach.
E.C.-599.	12/18/33.	El Capitan Dam. North abutment from upstream beach.
E.C.-600.	12/26/33.	El Capitan Dam. Looking westerly from north abutment of damsite No. 1.
E.C.-601.	12/26/33.	El Capitan Dam. North abutment from upstream beach.

E.C.-602.	12/26/33.	El Capitan Dam. Looking upstream from downstream spoil bank.
E.C.-603.	1/5/34.	El Capitan Dam. Ramp at easterly end of spillway.
E.C.-604.	1/5/34.	El Capitan Dam. Cranes with clamshell buckets removing sand from puddle core at about E3720.
E.C.-605.	1/5/34.	El Capitan Dam. Top of dam and north abutment looking northerly from south abutment.
E.C.-606.	1/5/34.	El Capitan Dam. Dam and spillway from above northwesterly end of Contractor's camp.
E.C.-607.	1/9/34.	El Capitan Dam. Outlet tower.
E.C.-608.	1/9/34.	El Capitan Dam. Draglines removing sand strata from southerly end of puddle core.
E.C.-609.	1/11/34.	El Capitan Dam. Draglines removing sand strata from near central part of puddle core.
E.C.-610.	1/12/34.	El Capitan Dam. Monitor sluicing material excavated and deposited on bench by draglines.
E.C.-611.	1/12/34.	El Capitan Dam. Log piled for burning in reservoir basin.
E.C.-612.	1/13/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-613.	1/18/34.	El Capitan Dam. Removing sand strata from southerly end of puddle core.
E.C.-614.	1/25/34.	El Capitan Dam. Removing sand strata from puddle core looking northerly from south abutment.
E.C.-615.	1/30/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-616.	1/30/34.	El Capitan Dam. Looking upstream from quarry road.
E.C.-617.	1/31/34.	El Capitan Dam. Spillway looking easterly from Contractor's Camp.
E.C.-618.	1/31/34.	El Capitan Dam. Constructing forms for spillway channel lining on south side.
E.C.-619.	2/2/34.	El Capitan Dam. Removing sand strata from puddle core at about N3500.
E.C.-620.	2/2/34.	El Capitan Dam. Constructing ramp to upstream beach at south abutment.
E.C.-621.	2/6/34.	El Capitan Dam. Sluicing sand from easterly face of upstream rock embankment.
E.C.-622.	2/6/34.	El Capitan Dam. Sluicing hydraulic fill material in spillway hog box.
E.C.-623.	2/6/34.	El Capitan Dam. Loading hydraulic fill material at northerly end of borrow pit "C".

E.C.-624.	2/6/34.	El Capitan Dam. Sand and gravel stock piles near concrete mixing plant.
E.C.-625.	2/6/34.	El Capitan Dam. Placing and sluicing hydraulic fill material in spillway hog box.
E.C.-626.	2/7/34.	El Capitan Dam. Spillway excavation at about station 7400.
E.C.-627.	2/8/34.	El Capitan Dam. Panorama of dam looking upstream from downstream spoil bank. View 1 of 2.
E.C.-628.	2/9/34.	El Capitan Dam. Panorama of dam looking upstream from downstream spoil bank. View 2 of 2.
E.C.-629.	2/9/34.	El Capitan Dam. Hydraulic operations on downstream beach.
E.C.-630.	2/10/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-631.	2/16/34.	El Capitan Dam. Shovel loading hydraulic fill material in borrow pit "K".
E.C.-632.	2/17/34.	El Capitan Dam. Monitors sluicing hydraulic fill material in spillway hog box.
E.C.-633.	2/28/34.	El Capitan Dam. Power shovel loading hydraulic fill at south end of borrow pit "A".
E.C.-634.	3/1/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-635.	3/1/34.	El Capitan Dam. Outlet tower.
E.C.-636.	3/1/34.	El Capitan Dam. Power shovel loading hydraulic fill material in spillway extension area near south end of borrow pit "C".
E.C.-637.	3/3/34.	El Capitan Dam. Removing sand from spillway hog box.
E.C.-638.	3/3/34.	El Capitan Dam. Placing concrete fro spillway floor slab at extreme westerly end.
E.C.-639.	3/7/34.	El Capitan Dam. Hydraulic operations on downstream beach.
E.C.-640.	3/7/34.	El Capitan Dam. Looking northerly along upstream beach from south abutment.
E.C.-641.	3/9/34.	El Capitan Dam. 6 pound 3½ ounce weight used for sounding summit pool.
E.C.-642.	3/9/33.	El Capitan Dam. 6pound 3½ ounce weight used for sounding summit pool.
E.C.-643.	3/17/34.	El Capitan Dam. Borrow pit excavation at south-easterly end of pit "C".
E.C.-644.	3/19/34.	El Capitan Dam. Assembling agitating device for breaking up sand strata in puddle core.

E.C.-645.	11/7/33.	El Capitan Dam. Looking downstream.
E.C.-646.	11/7/33.	El Capitan Dam. Looking upstream.
E.C.-647.	3/19/34.	El Capitan Dam. Agitating device for breaking up sand strata in puddle core.
E.C.-648.	3/20/34.	El Capitan Dam. Agitating device for breaking up sand strata in puddle core in operation.
E.C.-649.	3/22/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-650.	3/22/34.	El Capitan Dam. Ramp connecting spillway with road to downstream rock embankment.
E.C.-651.	3/27/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+00.
E.C.-652.	3/27/34.	El Capitan Dam. Spillway extension looking westerly from about station 8+00.
E.C.-653.	3/30/34.	El Capitan Dam. Summit pool looking northerly from south abutment, agitator in foreground.
E.C.-654.	4/9/34.	El Capitan Dam. Looking north along top of upstream embankment from south abutment. Line of flags denotes westerly shoulder of rock embankment.
E.C.-655.	4/9/34.	El Capitan Dam. Southeasterly end of spillway after shot.
E.C.-656.	4/9/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-657.	4/13/34.	El Capitan Dam. Power shovel excavating in easterly end of spillway.
E.C.-658.	4/13/34.	El Capitan Dam. Crane placing surface rock at downstream toe of dam near discharge end of tunnel
E.C.-659.	4/14/34.	El Capitan Dam. Commencing new rock lift at elevation 708 at northerly end of upstream rock embankment.
E.C.-660.	4/16/34.	El Capitan Dam. Transporting form lumber to flume bench to construct concrete by-pass through dam.
E.C.-661.	4/18/34.	El Capitan Dam. New agitating device operating at about N3450.
E.C.-662.	4/18/34.	El Capitan Dam. Constructing forms for flume by-pass through dam.
E.C.-663.	4/18/34.	El Capitan Dam. Building sand levee on westerly face of upstream rock embankment.
E.C.-664.	4/18/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-665.	4/20/34.	El Capitan Dam. Sluicing surface of upstream rock embankment at elevation 700.
E.C.-666.	4/20/34.	El Capitan Dam. South abutment looking southerly from about N3350, on upstream rock embankment.
E.C.-667.	4/20/34.	El Capitan Dam. Looking southeasterly toward dam from CCC road near El Cajon mountain.
E.C.-668.	4/21/34.	El Capitan Dam. Sluicing surface of downstream rock embankment at elevation 700.
E.C.-669.	4/23/34.	El Capitan Dam. Sluicing upstream bench near south abutment.
E.C.-670.	4/23/34.	El Capitan Dam. Contractor obtaining samples of spillway material from north side of cut at about station 0+25.
E.C.-671.	4/24/34.	El Capitan Dam. Contractor obtaining material sample from north spillway slope at about station 4+00.
E.C.-672.	4/24/34.	El Capitan Dam. Sample of spillway material from north spillway slope at about station 5+50.
E.C.-673.	4/26/34.	El Capitan Dam. Location change in spillway extension, looking westerly from about station 19+50. Line of flags in left of picture denotes top of north slope of revised location. Line of flags on right about on fence line indicate top of north slope of original location.
E.C.-674.	4/26/34.	El Capitan Dam. Contractor's method of extracting samples from north side of spillway cut about station 3+00.
E.C.-675.	4/28/34.	El Capitan Dam. Removing rock previously stock piled along road bench in spillway extension about station 8+50. This rock being placed on upstream rock embankment elevation 708 lift.
E.C.-676.	4/28/34.	El Capitan Dam. Spillway extension looking westerly from north side at about station 13+50.
E.C.-677.	5/1/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-678.	5/3/34.	El Capitan Dam. Contractor resuming hydraulic operations on upstream bench about N3300.
E.C.-679.	5/3/34.	El Capitan Dam. Sluicing hydraulic fill material previously placed in hog box.
E.C.-680.	5/8/34.	El Capitan Dam. Spillway extension contractor breaking ground at about station 13+00. Caterpillar 75 tractor and Le Turneau rooter.
E.C.-681.	5/9/34.	El Capitan Dam. Caterpillar 75 tractor with Le Turneau carryall excavating in spillway extension at about station 12+00.

E.C.-682.	5/9/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-683.	5/17/34.	El Capitan Dam. Spillway extension excavation looking southwesterly from north side of spillway about station 7+00.
E.C.-684.	5/17/34.	El Capitan Dam. Excavating in spillway extension looking northerly from near tunnel discharge end.
E.C.-685.	5/21/34.	El Capitan Dam. Completing concrete core wall on south abutment.
E.C.-686.	5/23/34.	El Capitan Dam. Constructing road through downstream spillway excavation spoil bank. Looking easterly from near contractor's shops.
E.C.-687.	5/23/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-688.	5/26/34.	El Capitan Dam. Placing steel for spillway side lining at easterly end.
E.C.-689.	5/28/34.	El Capitan Dam. Constructing sack dam at tunnel entrance to recover seepage water from temporary dam.
E.C.-690.	5/28/34.	El Capitan Dam. Agitator operating in puddle core at about N3850.
E.C.-691.	5/31/34.	El Capitan Dam. Agitator operating in puddle core near south abutment.
E.C.-692.	5/31/34.	El Capitan Dam. Placing concrete in spillway channel side lining at east end.
E.C.-693.	5/31/34.	El Capitan Dam. Drilling boulders in spillway extension at about station 9+00.
E.C.-694.	5/31/34.	El Capitan Dam. Spillway extension looking easterly from about station 18+00.
E.C.-695.	6/1/34.	El Capitan Dam. Earth slide at north side of spillway about station 4+75.
E.C.-696.	6/1/34.	El Capitan Dam. Loading sand near gravel plant for concrete operations.
E.C.-697.	6/4/34.	El Capitan Dam. Agitators operating in puddle core at about N3600.
E.C.-698.	6/4/34.	El Capitan Dam. Summit pool looking southerly from north abutment. Agitators operating in foreground.
E.C.-699.	6/9/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-700.	6/9/34.	El Capitan Dam. Spillway extension looking easterly from about station 15+50.
E.C.-701.	6/11/34.	El Capitan Dam. Loading hydraulic fill material at Lakeside borrow pit.

E.C.-702.	6/11/34.	El Capitan Dam. Depositing material from Lakeside pit in hydraulic fill hog box.
E.C.-703.	6/14/34.	El Capitan Dam. Lakeside borrow pit looking easterly from west end.
E.C.-704.	6/15/34.	El Capitan Dam. Monitor unit washing upstream beach near south abutment.
E.C.-705.	6/15/34.	El Capitan Dam. Sloping south side of spillway extension at about station 11+50.
E.C.-706.	6/18/34.	El Capitan Dam. Caterpillar 60 bulldozer operating on upstream beach at about N3500.
E.C.-707.	6/18/34.	El Capitan Dam. Core wall at south abutment.
E.C.-708.	6/19/34.	El Capitan Dam. Irrigation District replacing Chocolate Creek syphon on slope west of creek.
E.C.-709.	6/20/34.	El Capitan Dam. Building up downstream beach at about N3200.
E.C.-710.	6/20/34.	El Capitan Dam. Drilling boulders at south side of spillway extension at about station 8+00.
E.C.-711.	6/20/34.	El Capitan Dam. Placing hydraulic fill material from Lakeside borrow pit in summit pool, at about N3850.
E.C.-712.	6/21/34.	El Capitan Dam. Placing material from Lakeside borrow pit in summit pool. Looking southerly from north abutment.
E.C.-713.	6/21/34.	El Capitan Dam. Placing material from Lakeside borrow pit in summit pool. Looking southerly from north abutment.
E.C.-714.	6/22/34.	El Capitan Dam. Spillway extension looking easterly from about station 16+50.
E.C.-715.	6/23/34.	El Capitan Dam. Caterpillar tractor bulldozing material from Lakeside borrow pit into pool from downstream beach.
E.C.-716.	6/23/34.	El Capitan Dam. Placing material from Lakeside borrow pit in summit pool.
E.C.-717.	6/23/34.	El Capitan Dam. Downstream beach looking southerly from about N3850. Material from Lakeside borrow pit deposited at edge of pool.
E.C.-718.	6/23/34.	El Capitan Dam. Placing blanket fill of borrow pit "A" material over westerly face of upstream rock embankment.
E.C.-719.	6/27/34.	El Capitan Dam. Upstream beach looking southerly from north abutment.
E.C.-720.	6/27/34.	El Capitan Dam. Hydraulic operations on downstream beach, looking northerly from south abutment.

E.C.-721.	6/27/34.	El Capitan Dam. Upstream bench looking southerly from north abutment.
E.C.-722.	6/27/34.	El Capitan Dam. Excavating with power shovel at north side of spillway extension at about station 14+50.
E.C.-723.	6/27/34.	El Capitan Dam. Spillway extension looking easterly from about station 14+00.
E.C.-724.	6/28/34.	El Capitan Dam. Scarifier operating in spillway extension at about station 13+00.
E.C.-725.	6/28/34.	El Capitan Dam. Scarifier and carryall operating in spillway extension at about station 13+00.
E.C.-726.	7/3/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-727.	7/9/34.	El Capitan Dam. Spillway extension looking easterly from about station 15+50.
E.C.-728.	7/10/34.	El Capitan Dam. Sloping north side of spillway channel at about station 3+00.
E.C.-729.	7/10/34.	El Capitan Dam. Summit pool looking southerly from north abutment.
E.C.-730.	7/11/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+50.
E.C.-731.	7/11/34.	El Capitan Dam. New hog box arrangement for sluicing material into pump suction line.
E.C.-732.	7/11/34.	El Capitan Dam. Hog box looking northeasterly from spillway lip.
E.C.-733.	7/16/34.	El Capitan Dam. Spillway extension looking easterly from about station 13+50.
E.C.-734.	7/18/34.	El Capitan Dam. Summit pool looking southerly from north abutment.
E.C.-735.	7/18/34.	El Capitan Dam. Carryall excavating in spillway extension at about station 8+00.
E.C.-736.	7/19/34.	El Capitan Dam. Rooter loosening decomposed granite in spillway extension at about station 8+00.
E.C.-737.	7/19/34.	El Capitan Dam. Rooter and carryall operating in spillway extension between stations 7+40 and 8+20.
E.C.-738.	7/19/34.	El Capitan Dam. Constructing 708 foot elevation rock lift on downstream rock embankment. Looking northerly from south abutment.
E.C.-739.	7/24/34.	El Capitan Dam. By-pass for Irrigation District flume through dam, looking westerly.
E.C.-740.	7/24/34.	El Capitan Dam. Puddle core and beaches looking northerly from south abutment.

E.C.-741.	7/24/34.	El Capitan Dam. Wasting excess water from puddle core. Looking northerly.
E.C.-742.	7/24/34.	El Capitan Dam. Summit pool and beaches looking southerly from north abutment.
E.C.-743.	7/24/34.	El Capitan Dam. Summit pool and beaches looking southerly from north abutment.
E.C.-744.	7/24/34.	El Capitan Dam. Power shovel excavating at south side of spillway extension about station 7+60 elevation 668.
E.C.-745.	7/27/34.	El Capitan Dam. Looking westerly downstream from north abutment of dumsite No. 1.
E.C.-746.	7/28/34.	El Capitan Dam. Hoster and carryall operating in spillway extension at about station 8+00 elevation 655.
E.C.-747.	7/28/34.	El Capitan Dam. Sloping north side of spillway extension between stations 7+90 and 8+30.
E.C.-748.	7/31/34.	El Capitan Dam. Excavating at east end of spillway.
E.C.-749.	8/1/34.	El Capitan Dam. Spillway extension looking easterly from about station 13+50.
E.C.-750.	8/1/34.	El Capitan Dam. Summit pool looking southerly from north abutment. Surface elevation of pool 712.6 feet.
E.C.-751.	8/4/34.	El Capitan Dam. Downstream bench looking southerly from north abutment.
E.C.-752.	8/8/34.	El Capitan Dam. Upstream beach looking northerly from south abutment.
E.C.-753.	8/8/34.	El Capitan Dam. Downstream beach looking northerly from south abutment.
E.C.-754.	8/10/34.	El Capitan Dam. Looking westerly downstream from north abutment of dumsite No. 1.
E.C.-755.	8/10/34.	El Capitan Dam. Spillway extension looking easterly from about station 13+50. Concrete mixing plant in right foreground.
E.C.-756.	8/14/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+25.
E.C.-757.	8/15/34.	El Capitan Dam. Placing material from Lakeside borrow pit on upstream bench. Looking southerly from north abutment.
E.C.-758.	8/15/34.	El Capitan Dam. Looking westerly downstream from north abutment of dumsite No. 1. Placing rock to elevation 725 upstream embankment.
E.C.-759.	8/15/34.	El Capitan Dam. Lakeside borrow pit looking westerly from southeast corner.

E.C.-760.	8/16/34.	El Capitan Dam. Summit pool looking northerly from south abutment.
E.C.-761.	8/16/34.	El Capitan Dam. Pontoon bridge across summit pool.
E.C.-762.	8/17/34.	El Capitan Dam. Looking westerly downstream from north abutment of dam site No. 1.
E.C.-763.	8/17/34.	El Capitan Dam. Summit pool and beaches looking northerly from south abutment.
E.C.-764.	8/17/34.	El Capitan Dam. Summit pool looking southerly from pontoon bridge about center of dam.
E.C.-765.	8/17/34.	El Capitan Dam. Summit pool looking northerly from pontoon bridge about center of dam.
E.C.-766.	8/17/34.	El Capitan Dam. Summit pool and beaches looking southerly from north abutment.
E.C.-767.	8/17/34.	El Capitan Dam. Looking easterly along spillway lip from about axis of dam.
E.C.-768.	8/17/34.	El Capitan Dam. Spillway extension looking easterly from about station 15+50.
E.C.-769.	8/17/34.	El Capitan Dam. Looking upstream from near Contractor's residence.
E.C.-770.	8/17/34.	El Capitan Dam. Dam and spillway looking upstream from flume bench above and easterly from City Camp.
E.C.-771.	8/28/34.	El Capitan Dam. Spillway extension looking easterly from about station 15+50.
E.C.-772.	8/28/34.	El Capitan Dam. Downstream face of dam looking southeasterly.
E.C.-773.	8/28/34.	El Capitan Dam. Spillway extension looking westerly from about station 7+00.
E.C.-774.	8/28/34.	El Capitan Dam. Summit pool and beaches looking southerly from north abutment.
E.C.-775.	9/5/34.	El Capitan Dam. Lakeside borrow pit looking westerly from northeast corner.
E.C.-776.	9/5/34.	El Capitan Dam. Spillway extension looking easterly from about station 15+50.
E.C.-777.	9/6/34.	El Capitan Dam. Rolled embankment construction operations looking southerly from north abutment.
E.C.-778.	9/8/34.	El Capitan Dam. Sheepsfoot tamper hauled by tractor in operation on upstream rolled embankment.
E.C.-779.	9/8/34.	El Capitan Dam. Sheepsfoot tamper hauled by tractor in operation on upstream rolled embankment.
E.C.-780.	9/8/34.	El Capitan Dam. City forces sinking test well in puddle core section at N3160, E5008.

E.C.-781.	9/11/34.	El Capitan Dam. Dragline removing ramp from south side of spillway channel at about station 7+00 to station 7+40.
E.C.-782.	9/15/34.	El Capitan Dam. Upstream rock embankment looking northerly from south abutment. Elevation of rolled embankment 742. Elevation of lower rock bench about 720.
E.C.-783.	9/15/34.	El Capitan Dam. Downstream rock embankment looking northerly from south abutment. Elevation of rolled embankment about 742. Elevation of rock bench about 716.
E.C.-784.	9/15/34.	El Capitan Dam. Downstream rock embankment looking southerly from about N3750. Elevation of rock bench about 716.
E.C.-785.	9/15/34.	El Capitan Dam. Downstream rock embankment looking northerly from about N3750.
E.C.-786.	9/15/34.	El Capitan Dam. Placing concrete in floor of spillway extension looking westerly from north side at about station 14+00.
E.C.-787.	9/14/34.	El Capitan Dam. Evidence of overshooting at north side of spillway at about station 4+25.
E.C.-788.	9/14/34.	El Capitan Dam. Evidence of overshooting at north side of spillway at about station 4+25. View from about station 4+00.
E.C.-789.	9/16/34.	El Capitan Dam. Sinking test wells in upstream bench at about N3500.
E.C.-790.	9/20/34.	El Capitan Dam. Spillway extension looking westerly from about station 7+00.
E.C.-791.	9/20/34.	El Capitan Dam. Looking westerly downstream from north abutment of dumsite No. 1.
E.C.-792.	9/20/34.	El Capitan Dam. Placing concrete in spillway extension looking easterly from about station 15+80.
E.C.-793.	9/26/34.	El Capitan Dam. Looking southerly from top of core wall on north abutment at about elevation 748.
E.C.-794.	9/26/34.	El Capitan Dam. Placing concrete in spillway extension at about station 13+60.
E.C.-795.	9/26/34.	El Capitan Dam. Placing reinforcing steel in spillway extension at about station 11+50.
E.C.-796.	9/26/34.	El Capitan Dam. Placing concrete in north wall of spillway channel lining at about station 1+00.
E.C.-797.	9/28/34.	El Capitan Dam. Looking westerly downstream from north abutment of dumsite No. 1.
E.C.-798.	10/2/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+50.

E.C.-799.	10/3/34.	El Capitan Dam. Dam at elevation 753 looking northerly from south abutment.
E.C.-800.	10/3/34.	El Capitan Dam. Placing concrete in spillway extension lining at about station 14+40, south side.
E.C.-801.	10/8/34.	El Capitan Dam. Placing concrete in spillway extension floor looking easterly from about station 12+50.
E.C.-802.	10/11/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+50.
E.C.-803.	10/11/34.	El Capitan Dam. Spillway looking northeasterly from junction of core wall and spillway lining.
E.C.-804.	10/19/34.	El Capitan Dam. Dam at about elevation 763 looking northerly from south abutment.
E.C.-805.	10/20/34.	El Capitan Dam. Placing rock on easterly face of upstream rock embankment.
E.C.-806.	10/20/34.	El Capitan Dam. Spillway extension looking westerly from about station 7+00.
E.C.-807.	10/25/34.	El Capitan Dam. Hand placing rock on easterly face of upstream rock embankment near north abutment.
E.C.-808.	10/25/34.	El Capitan Dam. Spillway looking northeasterly from about N4190, E4950.
E.C.-809.	10/26/34.	El Capitan Dam. Placing concrete in north side wall of spillway extension looking northeasterly from about station 15+50.
E.C.-810.	11/2/34.	El Capitan Dam. Outlet tower and tunnel entrance looking westerly.
E.C.-811.	11/2/34.	El Capitan Dam. Reservoir basin looking upstream from top of dam.
E.C.-812.	11/2/34.	El Capitan Dam. Outlet tower and south end of dam looking northeasterly from south abutment about 75 feet westerly from dam.
E.C.-813.	11/2/34.	El Capitan Dam. Top of dam looking northerly from south abutment.
E.C.-814.	11/2/34.	El Capitan Dam. Top of dam looking southerly from north abutment.
E.C.-815.	11/2/34.	El Capitan Dam. Easterly end of spillway.
E.C.-816.	11/2/34.	El Capitan Dam. Spillway looking westerly from above east end.
E.C.-817.	11/2/34.	El Capitan Dam. Uncompleted spillway floor looking westerly.
E.C.-818.	11/2/34.	El Capitan Dam. Uncompleted portion of spillway north side wall lining looking northerly.

E.C.-819.	11/2/34.	El Capitan Dam. South side of spillway extension looking southeasterly.
E.C.-820.	11/2/34.	El Capitan Dam. North side of spillway extension looking northeasterly.
E.C.-821.	11/2/34.	El Capitan Dam. Downstream toe of dam looking northeasterly.
E.C.-822.	11/2/34.	El Capitan Dam. Downstream toe of dam looking easterly.
E.C.-823.	11/2/34.	El Capitan Dam. Center portion of quarry looking northerly.
E.C.-824.	11/2/34.	El Capitan Dam. Easterly end of quarry looking northeasterly.
E.C.-825.	11/2/34.	El Capitan Dam. Dam looking southeasterly from ccc road.
E.C.-826.	11/2/34.	El Capitan Dam. Dam looking southeasterly from CCCroad near foot of grade.
E.C.-827.	11/2/34.	El Capitan Dam. D. W. Albert, Hydraulic Fill Engineer.
E.C.-828.	10/29/34.	El Capitan Dam. Easterly end of spillway.
E.C.-829.	10/29/34.	El Capitan Dam. Easterly end of spillway.
E.C.-830.	10/30/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-831.	11/2/34.	El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.
E.C.-832.	11/3/34.	El Capitan Dam. Dam at elevation 770. Looking northerly from south abutment.
E.C.-833.	11/5/34.	El Capitan Dam. Concrete warped section at easterly end of spillway.
E.C.-834.	11/6/34.	El Capitan Dam. Top of dam looking northerly from south abutment.
E.C.-835.	11/6/34.	El Capitan Dam. Spillway extension looking westerly from about station 6+00.
E.C.-836.	11/6/34.	El Capitan Dam. Spillway looking easterly from about station 5+50.
E.C.-837.	11/14/34.	El Capitan Dam. Top of dam looking northerly from south abutment.
E.C.-838.	11/16/34.	El Capitan Dam. Dam looking southeasterly upstream from quarry road.
E.C.-839.	11/17/34.	El Capitan Dam. Earth slide in spillway looking westerly from about station 4+00.

E.C.-840. 11/17/34. El Capitan Dam. Earth slide in spillway looking easterly from about station 6+40.

E.C.-841. 11/17/34. El Capitan Dam. Earth slide in spillway looking northerly from spillway lip about station 4+75.

E.C.-842. 11/17/34. El Capitan Dam. Earth slide in spillway looking northerly from spillway lip about station 4+75.

E.C.-843. 11/17/34. El Capitan Dam. Earth slide in spillway from spillway lip about station 3+25.

E.C.-844. 11/17/34. El Capitan Dam. Power shovel removing slide from spillway looking northerly from about station 4+75.

E.C.-845. 11/21/34. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-846. 11/21/34. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-847. 11/23/34. El Capitan Dam. Spillway extension looking easterly from about station 15+50.

E.C.-848. 11/24/34. El Capitan Dam. North side wall of spillway looking easterly from about station 6+70.

E.C.-849. 11/24/34. El Capitan Dam. North side wall of spillway looking easterly from about station 6+70.

E.C.-850. 11/26/34. El Capitan Dam. Ten inch centrifical pump installed by M. M. Golden, tunnel inner lining contractor. Pump located about 300 feet downstream from discharge end of tunnel.

E.C.-851. 12/19/34. El Capitan Dam. City personnel.

E.C.-852. 12/19/34. El Capitan Dam. City personnel.

E.C.-853. 12/19/34. El Capitan Dam. Outlet tower sliding gate at elevation 569.

E.C.-854. 12/19/34. El Capitan Dam. Dam and spillway lip looking northeasterly from hillside about 500 feet west of south abutment of dam.

E.C.-855. 12/19/34. El Capitan Dam. Dam and spillway looking northwesterly from flume bench vicinity damsite No. 1.

E.C.-856. 12/19/34. El Capitan Dam. Dam and spillway looking southeasterly upstream from road to quarry.

E.C.-857. 12/19/34. El Capitan Dam. Dam and spillway looking southeasterly from CCC road vicinity El Cajon mountain.

E.C.-858. 12/19/34. El Capitan Dam. Dam looking upstream from vicinity quarry.

E.C.-859. 12/19/34. El Capitan Dam. Looking westerly downstream from above easterly end of spillway.

E.C.-860. 12/21/34. El Capitan Dam. Panorama of north side of spillway cut. View 1 of 5.

E.C.-861. 12/21/34. El Capitan Dam. Panorama of north side of spillway cut. View 2 of 5.

E.C.-862. 12/21/34. El Capitan Dam. Panorama of north side of spillway cut. View 3 of 5.

E.C.-863. 12/21/34. El Capitan Dam. Panorama of north side of spillway cut. View 4 of 5.

E.C.-864. 12/21/34. El Capitan Dam. Panorama of north side of spillway cut. View 5 of 5.

E.C.-865. 12/21/34. El Capitan Dam. Looking westerly downstream from north abutment of damsite No. 1.

E.C.-866. 12/21/34. El Capitan Dam. Dam and spillway extension looking easterly upstream from vicinity contractor's residence.

E.C.-867. 12/21/34. El Capitan Dam. Dam looking easterly upstream from flume bench about ½ mile westerly from city camp.

E.C.-868. 12/21/34. El Capitan Dam. Dam looking easterly upstream from hillside about 75 feet higher than flume bench about ½ mile westerly from city camp.

E.C.-869. 12/21/34. El Capitan Dam. Dam looking easterly upstream from hillside high up and south of Cape Horn.

E.C.-870. 12/21/34. El Capitan Dam. Tunnel inner lining contractor's construction plant looking northwesterly from downstream toe wall of dam near tunnel portal.

E.C.-871. 1/29/35. El Capitan Dam. Flashlight photo of tunnel inner lining forms in place looking westerly from about station 4+00.

E.C.-872. 1/29/35. El Capitan Dam. Flashlight photo of tunnel inner lining arch forms looking easterly. Forms in place to about station 5+80.

E.C.-873. 1/29/35. El Capitan Dam. Flashlight photo of tunnel inner lining invert forms looking westerly.from about station 6+00.

E.C.-874. 1/29/35. El Capitan Dam. Flashlight photo of tunnel inner lining invert forms looking easterly. Forms in place to about station 6+40.

E.C.-875. 2/6/35. El Capitan Dam. Flashlight photo of tunnel inner lining looking westerly from about station 5+00.

E.C.-876. 2/6/35. El Capitan Dam. Flashlight photo of tunnel inner lining arch forms looking westerly from scaffolding about station 5+90.

E.C.-877.	2/6/35.	El Capitan Dam. Flashlight photo of tunnel inner lining looking easterly from about station 7+40. Pumperete machine in operation placing concrete in arch.
E.C.-878.	2/6/35.	El Capitan Dam. Police department reconditioning camp looking westerly from spoil bank north of spillway station about 7+00.
E.C.-879.	2/6/35.	El Capitan Dam. Police department reconditioning camp looking northwesterly. Panorama view 1 of 2.
E.C.-880.	2/6/35.	El Capitan Dam. Police department reconditioning camp looking northeasterly. Panorama view 2 of 2.
E.C.-881.	2/22/35.	El Capitan Dam. Dedication. General parking area below dam looking northwesterly from vicinity south abutment of dam.
E.C.-882.	2/22/35.	El Capitan Dam. Dedication. General parking area below dam looking southwesterly from vicinity spillway.
E.C.-883.	2/22/35.	El Capitan Dam. Dedication. Spillway parking area looking southeasterly from hillside north of spillway.
E.C.-884.	2/22/35.	El Capitan Dam. Dedication. Looking northerly from above south abutment on axis of dam.
E.C.-885.	2/22/35.	El Capitan Dam. Dedication. Looking northeasterly from above south abutment about 220 feet west of axis of dam.
E.C.-886.	2/22/35.	El Capitan Dam. Dedication. Looking westerly from hillside above easterly end of spillway.
E.C.-887.	2/22/35.	El Capitan Dam. Dedication. Looking southerly from hillside north of spillway on axis of dam.
E.C.-888.	2/22/35.	El Capitan Dam. Dedication. Looking northerly from top of dam about 200 feet south of north abutment.
E.C.-889.	2/22/35.	El Capitan Dam. Dedication. Close up view of exercises. Chairman Albert V. Mayrhofer at the microphone.
E.C.-890.	2/22/35.	El Capitan Dam. Dedication. Bronze plaque mounted on large rock at north end of dam.
E.C.-891.	2/7/35.	El Capitan Dam. Concrete mixing plant of M. H. Golden, tunnel inner lining contractor.
E.C.-892.	2/7/35.	El Capitan Dam. Pumperete machine for placing concrete in tunnel inner lining, in operation. Flashlight photo.
E.C.-893.	2/7/35.	El Capitan Dam. Flashlight photo of final crown pour in tunnel inner lining.

E.C.-894.	2/12/35.	El Capitan Dam. Prepcrete machine used for placing concrete in tunnel inner lining.
E.C.-895.	2/27/35.	El Capitan Dam. City forces grouting at northerly end of upstream rock embankment at junction of rock embankment and spillway approach lining.
E.C.-896.	4/4/35.	El Capitan Dam. Earth slide in spillway. Panorama view 1 of 2.
E.C.-897.	4/4/35.	El Capitan Dam. Earth slide in spillway. Panorama view 2 of 2.
E.C.-898.	4/4/35.	El Capitan Dam. Earth slide in spillway looking westerly.
E.C.-899.	4/4/35.	El Capitan Dam. Looking westerly downstream from north abutment of dam toward road construction work on south side of river. Work being done with City police camp labor.

INTRODUCTORY STATEMENT

4-18-35
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INTRODUCTORY STATEMENT

El Capitan Dam is located on the San Diego River about eight miles easterly of Lakeside, California.

The first step in the development of the El Capitan Project was taken in 1914 when the then City Attorney T. B. Cosgrove gave his opinion that the City had the "Prior and Paramount Right to the Waters of the San Diego River".

Successive litigation finally resulted in the confirmation by the California State Supreme Court June 20, 1929 of the City's prior and paramount right to the waters of the San Diego River.

Mr. John R. Freeman, Consulting Engineer, Providence Rhode Island, made the preliminary design for the El Capitan Dam, as shown in his report on "Additional Water Supply" dated May 16, 1924. A number of changes were made and the adopted designs are shown on the contract drawings and their respective editions.

Following the voting of $4,500,000 El Capitan bonds in 1924, the Riverview pumping plant with wells at Riverview and Lakeside was constructed and the Lakeside-University Heights pipe line installed.

Hydraulic Engineer H. N. Savage, after his return to the City's service in 1928, recommended the construction of a dam at Mission #2 damsite to conserve the runoff of the San Diego River. This proposal failed to attain the required majority at an election held on August 11, 1931, and on December 15, 1931 the citizens voted to transfer certain funds and to construct a high hydraulic fill and rock embankment at El Capitan damsite #2.

A detail of the various steps which made possible the construction of the El Capitan dam will be found in a printed article by Hydraulic Engineer Fred D. Pyle, in the section entitled "DEDICATION".

The application for approval of plans for the construction of the El Capitan Dam were submitted to the State Engineer and general approval given by him December 15, 1931. Detail plans were subsequently approved.

Bids for the construction of the El Capitan Dam were called for and contract was awarded to the low bidder - H. W. Mohl and T. E. Connolly - on April 23, 1932.

During construction a number of legal suits and claims were instituted by Contractor H. W. Mohl and T. E. Connolly to determine their rights. The California State Supreme Court ruled that the contractor for the dam was under no obligation to construct the spillway extension beyond station 7+40 and a separate contract therefor was let to Bodenhamer Construction Company.

Considerable controversy occurred during construction and a number of claims were filed by Contractor H. W. Mohl and T. E. Connolly, but who finally accepted the City's estimate for final payment and gave a complete release to the City of San Diego.

3-19-35
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SAN DIEGO RIVER PROJECT
EL CAPITAN FEATURE

PERTINENT FACTS AND DATES.

January 5, 1914	City Attorney T B Cosgrove rendered opinion that City had prior and paramount right to the waters of the San Diego River.
February 28, 1919	Grant by United States Government, 1940 acres land in Capitan Grande Indian Reservation; 141 acres in Cleveland National Forest. Consideration later determined by the courts and the Secretary of the Interior to be $75,000 plus $286,428 for moving and re-establishing Indians.
November 18, 1924	Bond issue $4,500,000 for construction of a masonry dam to store water to elevation 713, reservoir contour 160. Vote 18,131 for; 6,624 against.
June 20, 1929	Decision of the California State Supreme Court confirming the City's paramount right to the use of all the water, surface and subsurface, of the San Diego River, including its tributaries, from its source to its mouth.
October 13, 1930	The Supreme Court of the United States refused to review the decisionof the Supreme Court of the State of California, thereby completely terminating the Paramount Water Rights Case in favor of the City.
September 14, 1931	Hydraulic Engineer notified Council estimated cost to construct hydraulic fill-rock embankment dam to store water to elevation 750, reservoir contour 197, $2,805,735 plus 15% for contingencies or $420,860. Total $3,226,595.
November 18, 1931	Favorable reports by the City's Consulting Geologist, Professor C. F. Tolman and Consulting Engineer C. D. Marx on the safety of a dam at El Capitan if constructed in accordance with drawings and specifications submitted by the Hydraulic Engineer for hydraulic fill rock embankment dam.

November 30, 1931 — Acceptance by City of suggested basis of Agreement (Note 5, 11-27-31) between the City and La Mesa, Lemon Grove & Spring Valley Irrigation District:

Irrigation District to grant and convey to City: About 152.72 acres of El Capitan reservoir and dam site lands. About 420 acres in Mission reservoir site. Storage rights in Murray reservoir not exceeding 5,000 acre feet at any one time.

City to grant to the Irrigation District the right to continue to take its water supply from the natural flow of the San Diego River, and storage rights in El Capitan reservoir not to exceed 10,000 acre feet at any one time. City to increase size of pipe line from El Capitan to District's El Monte pumping plant for use of the District; District to pay for cost of enlargement.

December 7, 1931 — After favorable report from the State's Consulting Engineer L. C. Hill and Geologist Chester Marliave, general approval of El Capitan reservoir dam was given by State Engineer Edward Hyatt.

December 15, 1931 — Electors authorized construction of a dam at El Capitan site, changed type and height to store water to elevation 750, reservoir contour 197; also transferred $893,873.43 remaining in Pipeline and Reservoir Bond Fund after the completion of Morena Reservoir Dam and Spillway and Safe Duty Enlargement, the installation of the Otay Reservoir-San Diego Second Main Pipeline and abandonment of Chollas reservoir enlargement. Vote - 17,295 for; 3,460 against.

December 23, 1931 — Work inaugurated at El Capitan damsite by Mayor W. W. Austin.

February 29, 1932 — Approval by State Engineer of general construction drawings for the dam.

April 11, 1932 — Proposals received for construction of El Capitan Reservoir Dam, Spillway and Outlet Works.

April 23, 1932 — Contract awarded H. W. Rohl & T. E. Connolly 4351 Alhambra Avenue, Los Angeles, California, Contract bid $2,332,860.

May 4, 1932	Second grant by the United States Government of 920 acres additional lands in the Capitan Grande Indian Reservation to permit reservoir storage to elevation 788, reservoir contour 235. $35,567.20.
December 12, 1932	Reconstruction Finance Corporation agreed to purchase $2,350,000 of El Capitan Bonds at par plus accrued interest.
January 30, 1933	Agreement with La Mesa, Lemon Grove & Spring Valley Irrigation District consummated; suggested basis of Agreement dated November 27, 1931 and accepted by City November 30, 1931.
July 18, 1933	Drawings for El Capitan spillway to Station 15+50 and 80 foot channel from Station 15+50 to San Diego River approved by State Engineer.
October 9, 1933	Semi-hydraulic operations ceased, with surface of pool at elevation 668 or 115 feet above streambed.
November 29, 1933	Full hydraulic operations commenced.
December 5, 1933	Superior Court, Judge Clarence Harden, adjudged and decreed that the construction of the spillway channel extension west of Station 7+40 was not covered by the existing contract with H W Rohl & T E Connolly.
April 9, 1934	Proposals received for construction of El Capitan Reservoir Dam Spillway Extension.
April 23, 1934	Contract for Spillway Extension awarded to Bodenhamer Construction Company, 354 Hobart Street, Oakland, California. Contract bid $197,700.
June 24, 1934	Hydraulic Engineer H N Savage died.
July 1, 1934	Frod D. Pyle appointed Hydraulic Engineer.
August 17, 1934	Rolled fill operations commenced in hydraulic fill portion of dam. Average elevation 719.
October 30, 1934	Bids received for El Capitan Reservoir Dam Tunnel Inner Lining.
November 20, 1934	Contract for Tunnel Inner Lining awarded to M H Golden, 404 California Bank Building, San Diego, California. Contract bid $53,177.75.

November 27, 1934	H. W. Rohl & T. E. Connolly contract work completed.
December 1, 1934	Bodenhamer Construction Company contract work completed.
December 4, 1934	H. W. Rohl & T. E. Connolly and Bodenhamer Construction Company contract work officially accepted by Council.
December 23, 1934	Tunnel plug completed, except for grouting.
January 12, 1935	Final estimate and holdback payment accepted by both H. W. Rohl & T. E. Connolly and Bodenhamer Construction Company and release of all claims against the City under and by virtue of the contracts executed and delivered to the City. Total amount paid H. W. Rohl & T. E. Connolly $2,705,003.81. Total amount paid Bodenhamer Construction Company, $197,836.00.
February 23, 1935	M. H. Golden contract work completed.
February 26, 1935	M. H. Golden contract work officially accepted by Council.
April 8, 1935	Final estimate and holdback payment accepted by M. H. Golden and release of all claims against the City under and by virtue of the contract executed and delivered to the City. Total amount paid M. H. Golden, $55,409.42.

Fred D. Pyle
Hydraulic Engineer

PRELIMINARY ACCOMPLISHINGS

PRELIMINARY ENGINEERING REPORTS

H. N. SAVAGE

MARX - TOLMAN

4-24-35
copy/p

April 25, 1932

From : Resident Engineer

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Feature
Completion of exploration tunnels

1. The driving of exploration tunnels at the El Capitan dam-site was completed on April 19, 1932. The work was started under John R. Freeman in 1924 at which time three tunnels were driven. These three tunnels are numbers 1, 2 and 3 and the details are tabulated below. Tunnel work by City forces was begun January 4, 1932 when the approach cut for tunnel 5 was begun. The work has been continuous until April 19, 1932.

2. Exploration tunnel 3 was continued further than the other tunnels to disclose the material to be encountered in the spillway excavation. This tunnel penetrated the hill to a point 88 feet from the northerly end of the top of the dam, thence along the line of the axis of the dam produced for 73 feet and then angled 25 degrees to the right and carried on for 47 feet. This latter direction in accordance with instructions received from State Geologist Chester Marliave by telephone on April 8.

3. It is a significant fact that these tunnels disclosed subsurface conditions as were indicated in a general way by the core recovery drill borings. Also that in the south or left abutment the granite is much less weathered than on the north or right abutment.

4. It was fortunate that so much of the tunnel driving was done in advance of the inspection by prospective contract bidders.

5. There was excavated a total of 1035.5 linear feet with City forces in 81 working days, or an average of about 12.8 linear feet per day. There were 1957 holes drilled and 1075 pounds of 40 percent Trojan powder used. All muck was carried out by wheelbarrow. The drilling in the rock was done by jack-hammers. The soft ground at the approach cuts and the portals was drilled with hand augers. The compressed air was supplied by a Rix portable air compressor belonging to the City. The force used on this work averaged 10 men for the full time.

Harold Wood
Resident Engineer

HW/p
encls.
Materials encountered in exploration tunnels
Data on exploration tunnels as of April 20, 1932

SAN DIEGO RIVER PROJECT - EL CAPITAN FEATURE

Exploration Tunnels - Data as of April 20
1932

Tunnel No.	Length Open cut	Length Tunnel	Coordinates Hub North	Coordinates Hub East	Coordinates Portal North	Coordinates Portal East	Coordinates Face North	Coordinates Face East	Elevation Portal	Elevation Face	Remarks
1	31	96	3357.2	4970.4	3336.0	4967.6	3240.8	4954.9	582.5	582.9	124° from hub to face
2	13	97	3838.6	5062.1	4850.2	5056.2	3936.4	5011.8	569.7	571.6	110° " " " "
3	21	242.5	4198.0	5135.0	4205.3	5115.3	4363.2	5020.2	726.7	731.2	N69°46'W-143.5 from hub to angle; N73°to angle, N25°E, 47° to face, sl 1st angle = 727.4, 2d = 728.9
4	17	30	3214.0	5000.0	3197.0	5000.0	3167.0	5000.0	650.6	651.0	47° from hub to face
5	18	106	3483.2	5276.2	3462.6	5286.4	3367.6	5333.4	565.1	566.5	130.5 " " " "
6	22	406	3125.0	5000.0	3093.0	5000.0	3052.5	5000.0	700.6	700.8	62.5 " " " "
7	6	161	3440.0	4810.0	3434.6	4807.4	3289.3	4738.1	560.0	563.4	167 " " " "
8	27	75	3777.4	4714.1	3804.2	4717.2	3878.7	4725.9	577.6	579.3	102 " " " "
9	14	15	3910.1	5270.5	3923.9	5272.3	3938.8	5274.3	588.9	589.6	29 " " " "
Totals		169									1035.5
1	31	50									
2	13	92									
3	21	86									

Work under John A. Freeman

SAN DIEGO RIVER PROJECT - EL CAPITAN FEATURE

Exploration Tunnels - Materials

Tunnel No.	Brown top soil	Brownish decomposed granite	Gray decomposed granite	Boulders with seams decomposed granite	Hard granite	Remarks
	Feet from hub at natural ground surface at floor elevation					
1	12	12 - 22		22 - 44	44 - 124	At 74 feet a seam of decomposed granite 1 foot in thickness at tunnel floor and extends to 105 feet running out at tunnel roof A 5-inch seam of decomposed granite lying at an angle of 45 degrees, at 110 feet, several small seams between portal and face.
2	2		2 - 110			Roots penetrate the roof near the portal. Some small boulders between portal and face.
3	7		7-263.5			Roots in seams at 31 feet. A few boulders 21 - 263.5
4	13	13 - 32		32 - 45	45 - 47	
5	16	16 - 44		44 - 58	58-130.5	A 4-inch seam of gray decomposed granite begins at 80 feet and runs out at 100 feet. A 4-inch seam lying at an angle of about 60° with the horizontal at 110 feet. Several small seams between portal and face.
6	12	12 - 33		33 - 52	52-62.5	
7	6	6 -131			131-167	Water encountered at 85 feet.
8	12		12-102	102		Roots penetrated roof at 23 feet
9	3		3 - 29			Roots penetrated roof at 29 feet

EL CAPITAN PROJECT DAMSITE NO. 2

SUPPLEMENT NUMBER 1.

NOTE: These conclusions are from study of the El Capitan Project as given in the report on San Diego Additional Water Supply by H.H. Savage, dated August 8, 1923. Reservoir capacities have later been revised. The net safe duty of El Capitan reservoir as now constructed (1935) to store water to elevation 750, reservoir contour 197, is taken as 11.6 million gallons daily and the capacity is 38 billion gallons.

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Study #5
4-14-23 G.C.

EL CAPITAN PROJECT DAMSITE NO. 2.

SUPPLEMENT NO. 1.

The following computations of maximum safe duty and reservoir performance of the El Capitan Reservoir Basin were based upon the assumption that the rainfall upon the surface of the reservoir is in addition to and not a part of the runoff values used in this study. The net evaporation loss was used instead of the gross evaporation as used in the previous computations of reservoir performance in this study, where net evaporation = gross evaporation less the rainfall upon the surface of the reservoir. It is thought that the values of maximum safe duty arrived at in this way, while not as conservative as the values obtained by the first method, are probably safe.

EL CAPITAN PROJECT DAMSITE NO. 2.

RAINFALL AND EVAPORATION ON THE SURFACE OF

EL CAPITAN RESERVOIR.

SEASON	GROSS EVAP. INCHES	RAINFALL ON SURF. RESERV'R INCHES	NET EVAPORATION INCHES	NET EVAPORATION FEET	RAINFALL CONTROL INDEX % OF MEAN	REMARKS
1883-84	55.6	39.0	16.6	1.4	235	
1884-85	55.6	12.6	43.0	3.6	76	Note:- The Gross evaporation from the surface of El Capitan Reservoir is assumed equal to the mean gross evaporation on Lower Otay Reservoir = 55.6" per season.
1885-86	55.6	24.1	31.5	2.6	145	
1886-87	55.6	11.8	43.8	3.7	71	
1887-88	55.6	17.9	37.7	3.1	108	
1888-89	55.6	21.2	34.4	2.9	128	
1889-90	55.6	25.4	30.2	2.5	153	
1890-91	55.6	20.4	35.2	2.9	123	
1891-92	55.6	16.0	39.6	3.3	96	
1892-93	55.6	17.3	38.3	3.2	104	
1893-94	55.6	10.2	45.4	3.8	61	
1894-95	55.6	21.6	34.0	2.8	130	
1895-96	55.6	9.8	45.8	3.8	59	The rainfall upon the surface of El Capitan Reservoir is assumed to be equal to the rainfall at the San Diego River Diverting Dam.
1896-97	55.6	18.1	37.5	3.1	109	
1897-98	55.6	9.8	45.8	3.8	59	
1898-99	55.6	9.0	46.6	3.9	54	
1899-00	55.6	11.1	44.5	3.7	67	
1900-01	55.6	16.0	39.6	3.3	96	
1901-02	55.6	12.5	43.1	3.6	75	
1902-03	55.6	18.3	37.3	3.1	110	
1903-04	55.6	8.5	47.1	3.9	51	
1904-05	55.6	24.46*	31.1	2.6	150	* Indicates observed values.
1905-06	55.6	25.59*	30.0	2.5	152	
1906-07	55.6	24.38*	31.2	2.6	119	
1907-08	55.6	15.05*	40.5	3.4	88	
1908-09	55.6	16.38*	39.2	3.3	114	
1909-10	55.6	16.85*	38.8	3.2	98	
1910-11	55.6	15.79*	39.8	3.3	103	
1911-12	55.6	17.16*	37.4	3.1	100	
1912-13	55.6	10.18*	45.4	3.8	69	
1913-14	55.6	17.94*	37.7	3.1	112	
1914-15	55.6	25.53*	30.1	2.5	154	
1915-16	55.6	21.30*	34.3	2.9	163	
1916-17	55.6	16.20*	39.4	3.3	105	
1917-18	55.6	13.87*	41.7	3.5	82	
1918-19	55.6	17.21*	38.4	3.2	84	
1919-20	55.6	18.24*	37.4	3.1	109	
1920-21	55.6	12.13*	43.5	3.6	74	
1921-22	55.6	32.97*	22.6	1.9	180	

18 Year (1904-5 to 1921-2) Obs.Mean Seasonal Rainfall = 18.95"=
114%. 100% long time mean = 16.6".

EL CAPITAN PROJECT DAMSITE NO. 2

RESERVOIR PERFORMANCE

Draft = 5.7 m.g.d. = 6384 ac.ft. per season.

Storage to 140' Res.Contour = 55,780 ac.ft.

SEASON	RUNOFF ACRE FEET	NET EVAP. AC.FT.	DRAFT ACRE FEET	NET INCREM. + OR - ACRE FEET	IN STORAGE BEG.SEASON ACRE FEET	NET EVAP. DEPTH FEET	AVE. EVAP. AREA ACRES	SPILL WASTE AC.FT.
1883-84	280000	1120	6384	+ 55780	0	1.4	800	216716
1884-85	14000	3744	6384	0	55780	3.6	1040	3872
1885-86	57000	2704	6384	0	55780	2.6	1040	47912
1886-87	14000	3848	6384	0	55780	3.7	1040	3768
1887-88	8800	3224	6384	- 808	55780	3.1	1040	0
1888-89	17300	3016	6384	+ 808	54972	2.9	1040	7092
1889-90	32000	2625	6384	0	55780	2.5	1050	22991
1890-91	54000	3045	6384	0	55780	2.9	1050	44571
1891-92	23300	3465	6384	0	55780	3.3	1050	13451
1892-93	12200	3360	6384	0	55780	3.2	1050	2456
1893-94	3900	3914	6384	- 6398	55780	3.8	1030	0
1894-95	83000	2884	6384	+ 6398	49382	2.8	1030	67334
1895-96	0	3914	6384	- 10298	55780	3.8	1030	0
1896-97	12500	3069	6384	+ 3047	45482	3.1	990	0
1897-98	0	3610	6384	- 9994	48529	3.8	950	0
1898-99	0	3354	6384	- 9738	38535	3.9	860	0
1899-00	0	2775	6384	- 9159	28797	3.7	750	0
1900-01	2000	1914	6384	- 6298	19638	3.3	580	0
1901-02	1600	1620	6384	- 6404	13340	3.6	450	0
1902-03	7800	868	6384	+ 548	6936	3.1	280	0
1903-04	0	780	6384	- 7164	7484	3.9	200	0
1904-05	32400	1118	6384	+ 24898	320	2.6	430	0
1905-06	67005	2300	6384	+ 30562	25218	2.5	920	27759
1906-07	44796	2730	6384	0	55780	2.6	1050	35682
1907-08	9099	3536	6384	- 821	55780	3.4	1040	0
1908-09	39448	3432	6384	+ 821	54959	3.3	1040	28811
1909-10	18326	3360	6384	0	55780	3.2	1050	8582
1910-11	10991	3465	6384	0	55780	3.3	1050	1142
1911-12	12005	3255	6384	0	55780	3.1	1050	2366
1912-13	1691	3876	6384	- 8569	55780	3.8	1020	0
1913-14	10452	3069	6384	+ 999	47211	3.1	990	0
1914-15	48977	2550	6384	+ 7570	48210	2.5	1020	32473
1915-16	194335	3045	6384	0	55780	2.9	1050	184906
1916-17	25900	3465	6384	0	55780	3.3	1050	16051
1917-18	7800	3640	6384	- 2224	55780	3.5	1040	0
1918-19	3900	3232	6384	- 5716	53556	3.2	1010	0
1919-20	37600	3224	6384	+ 7940	47840	3.1	1040	20052
1920-21	1535	3672	6384	- 8521	55780	3.6	1020	0
1922-22	100231	1938	6384	+ 8521	47259	1.9	1020	83388
1922-23					55780			
39 Year Total	1289891	113760	248976		55780			871375

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EL CAPITAN PROJECT DAMSITE NO. 2 Study #5 4-18-23 G.C.

Summary of theoretical reservoir performance of El Capitan Reservoir for 39 year period extending from Oct. 1, 1883 to Oct. 1, 1922. Storage to 140' Reservoir Contour = 55,780 acre feet. Maximum safe duty = 5.7 m.g.d. = 6,384 acre feet per season.

39 Year Draft (5.7 m.g.d.)	248,976 ac.ft.	= 19.3%
39 Year Increment in Storage	55,780 " "	= 4.3%
39 Year Net Evaporation Loss	113,760 " "	= 8.8%
39 Year Spillway Waste	871,375 " "	= 67.6%
39 Year Total Runoff	1,289,891 " "	=100.0%

The following are the principal facts brought out by the summary of the El Capitan reservoir performance with storage to 140' reservoir contour = 55,780 acre feet:

(1) The maximum safe duty of the El Capitan drainage basin with a storage capacity of 55,780 acre feet is 5.7 m.g.d. = 6,384 acre feet per season.

(2) The spillway waste of 67.6% of the total runoff during the 39 year period indicates that the drainage basin is still greatly under reservoired with only 55,780 acre feet of storage. The reservoir performance table shows that there would have been spillway waste during 21 seasons out of the 39.

(3) The efficiency factor of the El Capitan Reservoir with storage capacity of 55,780 acre feet = $\frac{\text{Max. Safe Annual Duty}}{\text{Mean Seasonal Runoff}} = \frac{6384}{26000}$ = 24.6%.

(4) The critical or low point in storage would have occurred at the end of season 1903-4 when the reservoir would have been practically empty.

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Study #5
4-14-23 G.C. 72

EL CAPITAN PROJECT DAMSITE NO. 2.

RESERVOIR PERFORMANCE

Draft = 11.0 mg.d. = 12,320 ac.ft. Storage to 190' Res.Cont.= 122,000 ac.ft.

SEASON	RUNOFF ACRE FEET	NET EVAP. AC.FT.	DRAFT ACRE FEET	NET INCREM. + OR - ACRE FEET	IN STORAGE BEG.SEASON ACRE FEET	NET EVAP. DEPTH FEET	AVE. EVAP. AREA ACRES	SPILLWAY WASTE ACRE FEET
1883-84	280000	1540	12320	+ 122000	0(a)	1.4	1100	144140
1884-85	14000	5760	12320	- 4080	122000	3.6	1600	0
1885-86	57000	4160	12320	+ 4080	117920	2.6	1600	36440
1886-87	14000	5920	12320	- 4240	122000	3.7	1600	0
1887-88	8800	4805	12320	- 8325	117760	3.1	1550	0
1888-89	17300	4408	12320	+ 572	109435	2.9	1520	0
1889-90	32000	3925	12320	+ 11993	110007	2.5	1570	3762
1890-91	54000	4727	12320	0	122000	2.9	1630	36953
1891-92	23300	5379	12320	0	122000	3.3	1630	5601
1892-93	12200	5120	12320	- 5240	122000	3.2	1600	0
1893-94	3900	5814	12320	- 14234	116760	3.8	1530	0
1894-95	83000	4340	12320	+ 19474	102526	2.8	1550	46866
1895-96	0	5890	12320	- 18210	122000	3.8	1550	0
1896-97	12500	4526	12320	- 4346	103790	3.1	1460	0
1897-98	0	5168	12320	- 17488	99444	3.8	1360	0
1898-99	0	4758	12320	- 17078	81956	3.9	1220	0
1899-00	0	3996	12320	- 16316	64878	3.7	1080	0
1900-01	2000	3102	12320	- 13422	48562	3.3	940	0
1901-02	1600	2880	12320	- 13600	35140	3.6	800	0
1902-03	7800	1953	12320	- 6473	21540	3.1	630	0
1903-04	0	1170	12320	- 13490	14067	3.9	300	0
1904-05	32400	962	12320	+ 19118	1577(b)	2.6	370	0
1905-06	67005	2450	12320	+ 52235	20695	2.5	980	0
1906-07	44796	3484	12320	+ 28992	72930	2.6	1340	0
1907-08	9099	4862	12320	- 8083	101922	3.4	1430	0
1908-09	39448	4851	12320	+ 22877	93839	3.3	1470	0
1909-10	18326	5056	12320	+ 950	116116	3.2	1580	0
1910-11	10991	5115	12320	- 6444	117066	3.3	1550	0
1911-12	12005	4681	12320	- 4996	110622	3.1	1510	0
1912-13	1691	5396	12320	- 16025	105626	3.8	1420	0
1913-14	10452	4123	12320	- 5991	89601	3.1	1330	0
1914-15	48977	3625	12320	+ 33032	83610	2.5	1450	0
1915-16	194335	4611	12320	+ 5358	116642	2.9	1590	172046
1916-17	25900	5379	12320	0	122000	3.3	1630	8201
1917-18	7800	5530	12320	- 10050	122000	3.5	1580	0
1918-19	3900	4768	12320	- 13188	111950	3.2	1490	0
1919-20	37600	4711	12320	+ 20569	98762	3.1	1520	0
1920-21	1535	5508	12320	- 16293	119331	3.6	1530	0
1921-22	100231	2945	12320	+ 18962	103038	1.9	1550	66004
1922-23					122000			
39 Year Total	1259891	167398	480480		122000			520013

(a) Start with reservoir empty Oct. 1, 1883.
(b) Low point in storage about Oct. 1, 1904.

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EL CAPITAN PROJECT DAMSITE NO. 2.

Study #8
4-17-23 G.C.

Summary of theoretical reservoir performance of El Capitan Reservoir for 39 year period extending from Oct. 1, 1883 to Oct. 1, 1922. Storage to 190' reservoir contour = 122,000 acre feet. Maximum safe duty = 11.0 m.g.d. = 12,320 acre feet per season.

39 Year Draft (11.0 m.g.d.)	480,480 ac.ft.	= 37.2%
39 Year Increment in Storage	122,000 " "	= 9.5%
39 Year Net Evaporation Loss	167,398 " "	= 13.0%
39 Year Spillway Waste	520,013 " "	= 40.3%
39 Year Total Runoff	1,289,891 " "	= 100.0%

The following are the principal facts brought out by the summary of the El Capitan Reservoir performance, with storage to 190' reservoir contour = 122,000 acre feet:

(1) The maximum safe duty of the El Capitan drainage basin with storage capacity of 122,000 acre feet = 11.0 m.g.d. = 12,320 acre feet per season.

(2) The spillway waste of 40.3% of the runoff entering the reservoir basin during the 39 year period indicates that the drainage basin is still greatly under reservoired with a storage capacity of only 122,000 acre feet.

(3) The efficiency factor of the El Capitan Reservoir with storage capacity of 122,000 acre feet = $\frac{\text{Max. Safe Annual Duty}}{\text{Mean Annual Runoff}} = \frac{12320}{26000}$ = 47.5%.

(4) The critical or low point in storage would have occurred at the end of season 1903-4 when the reservoir would have been practically empty.

CONCLUSIONS.

The computations in the study which are based upon the assumption that the rainfall upon the surface of the reservoir is not included in the values used for tributary runoff, indicate that the maximum safe duty of the El Capitan drainage basin (exclusive of Cuyamaca storage and diversion) with storage to 140' reservoir contour = 55,780 acre feet capacity in El Capitan Reservoir, is 5.7 m.g.d. = 6,384 acre feet per season.

The maximum safe duty of the El Capitan drainage basin (exclusive of Cuyamaca storage and diversion) with storage to 190' reservoir contour = 122,000 acre feet in El Capitan Reservoir is 11.0 m.g.d. = 12,320 acre feet per season. This is the greatest duty that can be obtained by storage in the El Capitan Reservoir Basin without interferring with the operation of the Cuyamaca Water Company's flume. The spillway waste of 40.3% of the entire runoff during the 39 year period indicates that the El Capitan drainage basin is still greatly under reservoired with a storage capacity of 122,000 acre feet.

In order to develop the ultimate maximum safe duty of the El Capitan drainage basin, it will be necessary to provide storage for about 200,000 acre feet of water in El Capitan Reservoir. This will necessitate the construction of a dam capable of storing water to about the 235 foot reservoir contour. It will also necessitate the flooding of the entire length of about nine miles of the Cuyamaca Water Company's flume between the El Capiten Damsite and the Cuyamaca Diverting Dam, and will involve the acquisition of the Cuyamaca Water System with its obligations and assets which will create an entirely different problem in connection with

CONCLUSIONS (CONT'D)

the development of the San Diego River at the El Capitan Damsite.

Owing to the various problems involved in the development of the ultimate duty of the San Diego River at the El Capitan Damsite, no attempt will be made in this study to determine the ultimate duty or the probable cost of such a development.

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December 29, 1930

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

Subject: Resolution No. 55214, San Diego River Project, El Capitan Dam Site No. 2, foundation, geological formation.

Gentlemen:

In response to and in compliance with your resolution Number 55214, reading as follows:

"That the Hydraulic Engineer be and he is hereby requested to furnish this Council with a report in writing as to the foundations at the damsite known as El Capitan Number 2."

I have to report as follows:

During and throughout my employment by the City of San Diego, 1917-1923, I initiated and accomplished in compliance with the then Common Council's Resolutions Nos. 26731 and 27239, a comprehensive and relatively exhaustive research, survey, assembly, compilation and study of all the potential water resources in San Diego County and adjacent in Orange County, California; and also adjacent in the northern District of Lower California, and submitted a report of my conclusions and specific recommendations, dated August 8, 1923.

Since the City of San Diego's activities to accomplish a legal determination, allocation and final decree of the paramount water rights of the San Diego River drainage basin, had featured the conservation of the tributary portion of the water resources of the San Diego River in the El Capitan Reservoir basin; and, notwithstanding the obviously relatively excessive cost of erecting a high and relatively safe impounding dam to utilize the required storage capacity of the El Capitan reservoir basin, it was deemed advisable to first investigate the surface and subsurface geological formation of the foundation at the previously publicly proclaimed El Capitan Dam Site No. 1.

EL CAPITAN DAM SITE NO. 1

Twenty-five core borings were made between September 26, 1919 and February 17, 1921, comprehending an entire cross section of the San Diego River canyon at El Capitan Dam Site No. 1

up to elevation 788, reservoir basin contour 235, up to which contour the capacity of the reservoir basin would be required to impound the maximum flood runoff from the one hundred seventy-eight (178) square miles of the river drainage basin area above and tributary thereto. Reservoir basin contour 235, however, is quite above the La Mesa, Lemon Grove & Spring Valley Irrigation District's flume which at the dam site is at reservoir contour 201, elevation 754.

Borings were made to depths below the surface of the ground varying from 65 feet to 265 feet and the aggregate depth of all the borings at this site totaled 3201 feet.

The material encountered by the core borings was classified as sand, soil and decomposed or decomposing granite, which yielded no core;

Medium hard granite, which indicated decomposition and yielded only partial core; and

Hard granite, which yielded nearly full core.

FLOOR OF CANYON: The core borings across the floor of the canyon comprehending the width of streambed encountered hard granite at reasonable depths below the surface, although the surface of the subsurface apparently hard granite rock trended sloping downward toward the rightor north abutment.

LEFT, OR SOUTH ABUTMENT: The geological formation encountered by the core borings in the left, or south abutment in general disclosed broken up geological structure or boulders of hard granite surrounded by decomposed granite of varying hardness. A tunnel, which had previously been driven from an elevation about 40 feet above the streambed, horizontally a length of about 50 feet into the left abutment and which had previously been reported to have ended in ledge rock, was disclosed by the borings to have ended in a detached boulder.

RIGHT, OR NORTH ABUTMENT: The geological formation encountered by the core borings in the right, or north abutment continuously disclosed decomposed granite from the surface of the ground to an entirely unexpected depth; hard rock was not encountered until well below the level of the streambed. A tunnel driven from about 40 feet above the streambed horizontally a length of about 50 feet into the north abutment encountered only decomposed granite.

EL CAPITAN CANYON REACH, TOPOGRAPHIC SURVEYS

Failing to find a foundation deemed suitable upon which to found and construct a relatively high masonry impounding

reservoir dam at El Capitan Dam Site No. 1, comprehensive topographic surveys were made throughout the entire reach of the vicinity canyon, including both above and comprehensively below Dam Site No. 1. The most promising dam site, as indicated by the surface topography and outstanding geological indications, was found about three-fourths of a mile downstream from Site No. 1 and has been designated as No. 2.

EL CAPITAN DAM SITE NO. 2

Twenty-two core borings were made at dam site No. 2 between February 26, 1921 and March 24, 1922, comprehending an entire cross section of the San Diego River Canyon at El Capitan Dam Site No. 2, up to elevation 788, reservoir basin contour 235. Borings were made to depths below the surface of the ground varying from 41 feet to 350 feet and the aggregate depth of all the borings at this site totaled 3443 feet.

FLOOR OF CANYON: The borings across the floor of the canyon comprehending the width of the streambed ended in granite, which was encountered at about twice as great depths as hard rock had been encountered across the streambed at dam site No. 1.

LEFT ABUTMENT: The formation disclosed by the core borings in the left, or south abutment at Site No. 2 did not differ materially from the formation indicated by the borings in the left, or south abutment at dam site No. 1. A tunnel driven from an elevation about 50 feet above the streambed, horizontally a length of about 50 feet, into the left, or south abutment, encountered fairly hard, but indicated to be decomposing granite.

RIGHT ABUTMENT: The great majority of the formation disclosed by the core borings in the right, or north abutment of Dam Site No. 2 consisted of soil, decomposed and decomposing granite with intermittent reaches of medium hard, but also indicated to be decomposing granite, yielding only partial core; intermittent reaches of granite yielding practically full core were encountered in all but one of the holes, but the granite encountered was not homogeneous, but was indicated to be either boulders or broken up geological structure. Only eight of the ten holes terminated in hard rock.

Soil, decomposed granite and medium hard granite, yielding only partial core, was encountered throughout the great majority of the length of each of the ten holes and continued down to entirely unexpected depths; hard rock was not encountered in two of the holes until well below the elevation of streambed, as had been the case of practically all the holes in the north abutment at Dam Site No. 1.

A tunnel driven from an elevation about 20 feet above the streambed, horizontally a length of about 100 feet in the north abutment, encountered only decomposing granite throughout its length. A second tunnel driven from an elevation about 175 feet above streambed, horizontally a length of about 100 feet in the north abutment, also encountered only decomposing granite throughout its length.

Enclosed herewith is drawing No. WD-290, showing the location of the drill holes and tunnels and the log of the material encountered in each of the twenty-two core boring holes at El Capitan Dam Site No. 2.

EL CAPITAN RESERVOIR AND DAM SITES 1 AND 2, CONCLUSIONS.

The results of the investigations disclosed by the core borings at both El Capitan Dam Site No. 1 and No. 2 constrained to the conclusion that it would be economically impossible to build at either Site No. 1 or No. 2 a surely safe masonry dam to the required height to impound all the water in the tributary San Diego River drainage basin area of 178 square miles in the El Capitan Reservoir basin; and, while it may be physically possible to construct a rock embankment dam or a combination rock and earth embankment dam with an impervious concrete reinforced flexible core or an upstream concrete reinforced face wall at either Site No. 1 or No. 2 to the height required, it was, and is deemed to be relatively and financially economically impracticable, and certainly unwise to undertake to do so.

SAN DIEGO RIVER PROJECT: GENERAL CONCLUSIONS

If an impounding dam be constructed at either the El Capitan dam sites up to even elevation 350, reservoir contour 197, it will not impound all of the maximum flood runoff from the 178 square miles of drainage basin area tributary thereto. It is, therefore, obvious that during a maximum flood runoff period a material amount of water will escape over the spillway from the El Capitan reservoir and that this water, together with the flood runoff which will occur from the 197 square miles of drainage basin area below and independent of that tributary to the El Capitan drainage basin will continue to be wasted in the Pacific Ocean, unless conserved and impounded in a reservoir as low down in the San Diego River drainage basin as economically possible.

Notwithstanding the unsatisfactory geological formation encountered by the core borings, upon which to construct a high dam at El Capitan Dam Sites No. 1 or No. 2; and

The difficulties, uncertainties, long time required and the indicated unknown additional cost of several hundred thousand dollars above the $75,000 condemnation award by the local courts to El Capitan Band of Mission Indians obviously necessary to accomplish the transfer of the Indians from the Capitan Grande Indian Reservation; and the acquisition of a large additional area of Indian land above the 160 foot reservoir contour; and

The long time required and unknown additional cost to the City of acquiring by condemnation under the right of eminent domain of the left or south half from the center of the river of the El Capitan Dam Site No. 2, and of adjacent reservoir lands both in private ownership;

It was deemed proper in my report dated August 8, 1923, for purposes of comparative estimation to view optimistically all the difficulties, physical, administrative, legal and excessive cost involved in the conservation of water in the El Capitan Reservoir basin, since it was obvious that the cost to the City of San Diego per thousand gallons of conserving the water resources tributary thereto and its delivery into the municipal distribution system would amount to more than twice per thousand gallons, the necessary cost of conserving the water resources of the San Diego River drainage basin in the Mission reservoir basin.

MISSION RESERVOIR BASIN AND DAM SITE.

The geological formation encountered by the core borings at the El Capitan Canyon Dam Sites No. 1 and 2, constrained to a comprehensive investigation of the San Diego River Mission reservoir basin, which has an abundant capacity below its reservoir contour 156 to impound the flood runoff from not only the 178 square miles of river drainage basin above and tributary to the El Capitan dam sites, but also the runoff from the entire tributary San Diego River drainage basin of 375 square miles which would include the 197 square miles of drainage basin area tributary to the El Capitan Reservoir Basin.

The exposed and indicated geological formation at the outlet of the Mission reservoir basin, vicinity the head of the Mission Gorge is outstandingly favorable and dependable upon which to found and construct a high masonry dam.

In order to avail of the required storage capacity in the Mission reservoir basin to construct, however, a dam storing water only up to the 156 foot reservoir contour, will be sufficient to impound in the Mission reservoir basin practically the entire flood runoff from the total of 378 square miles of drainage basin area tributary thereto, which includes the drainage basin area tributary to the El Capitan reservoir basin.

Respectfully,
H. N. Savage,
Hydraulic Engineer.

HNS/P

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March 20, 1931

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

Subject: San Diego River Project. Estimated cost of water production at El Capitan and San Vicente Projected Reservoirs. Resolution No. 55891.

Gentlemen:

Estimates of cost of production of water at El Capitan and San Vicente reservoir sites are respectfully submitted herewith in accordance with your Resolution No. 55891, as follows:

> "That H. N. Savage, hydraulic engineer in charge of water development, be and he is hereby authorized and instructed to meet with C. Harritt, of the La Mesa, Lemon Grove & Spring Valley Irrigation District, and these two to select a third engineer, the services of the latter to be paid for jointly by the city and the district, the three thereupon to compile and submit to this Common Council estimates of the cost of production of water at the El Capitan site at elevations of 140, 160, 197 and 235 foot contour, and at San Vicente site at 160 and 250 foot contour elevations, such estimates to cover costs at El Capitan by itself and also in conjunction with the San Vicente project this data to be furnished at the earliest possible date."

In preparing the estimates consideration was given to the net safe yield of the reservoirs with storage to the various elevations as determined by Mr. Savage and by Mr. Freeman.

In determining the type of dam at El Capitan consideration was given to both the arched, gravity section, masonry type, for which bonds were voted, and to the hydraulic fill-rock embankment type as proposed by Mr. Freeman. Owing to the foundation requirements for a concrete dam and the foundation conditions as disclosed at El Capitan damsite No. 2 by the borings, it was not considered proper to prepare estimates on the basis of a concrete dam at El Capitan.

The unsatisfactory foundation conditions at the north abutment of El Capitan damsite No. 2 introduce many uncertainties relative to the quantities used in the estimates for determining the cost of any type of dam at this site. This is especially true in connection with the estimates of cost of the relative high dams.

The recent fiasco in connection with the attempted construction of the San Gabriel dam, which cost the County of Los Angeles about $4,000,000, without accomplishing any benefit, resulted from unsatisfactory foundations which were not fully disclosed until a large amount of excavation had been accomplished.

The failure of the St. Francis dam demonstrates very clearly the results of the improper construction of a relatively high dam on a poor foundation.

Estimates were prepared on the basis of hydraulic fill-rock embankment type of dam. There are also certain features even for this type of dam which are questionable, such as the foundation for the concrete core wall, the location and capacity of the diversion tunnel and the requirement for lining more of the wasteway channel than indicated on the Freeman design. The diversion tunnel as designed by Freeman will not

handle, during construction, such floods as occurred in 1916 and 1927. To remove all possible risk of the dam failing during construction by reasons of floods of equal size to those occurring in 1916 and 1927, would require a tunnel capacity much greater than provided by the tunnel shown on the drawings and as used in preparing these estimates, and would increase the cost.

In deciding upon the unit costs of the hydraulic earth fill-embankment required in the construction of the El Capitan dam, consideration was given to the scarcity of suitable material in the vicinity of the damsite.

Estimates were made from drawings showing the spillway and diversion tunnel located on the north side of the dam as indicated by Freeman. Further investigation may indicate the advisability of constructing the spillway and tunnel on the south side of the dam where better foundation may be secured.

In preparing the estimates for El Capitan reservoir and dam, consideration was given to the area and cost of damsite and reservoir flowage lands required, and to the cost of reconstruction of the County road now located thru the reservoir site, and the cost of reconstruction of the Irrigation District's flume, trestles and other works in such a way that their future use by the District would not be interfered with.

In considering the cost of damsite and reservoir flowage lands to be acquired from the Irrigation District, it was assumed that the necessary lands would be obtained from the District on a basis of mutual agreement, otherwise the cost of acquiring the lands would be problematical.

In connection with the items of the cost of lands to be acquired from the Irrigation District, Mr. Harritt of this Board wishes it understood that he does not subscribe to the figures used.

Following is a summary of the estimates of the cost of water production under the several plans considered. In order that there be no misunderstanding in the matter, it has been deemed proper to indicate the cost of water per 1000 gallons both in respective reservoirs, and delivered to the City of San Diego. The cost of water delivered to the City of San Diego includes necessary pipelines and filtration.

FEATURE				ESTIMATES OF COST			
				In Reservoirs			At City of San Diego
Elevation	Reservoir Contour	Duty mgd	Expended to date	To Complete	Annual	per 1000 gallons	per 1000 gallons
El Capitan (hydraulic fill-rock embankment dam)							
			$	$	$	cents	cents
693	140	5.2	29,850	2,906,255	169,975	8.96	15.04
713	160	7.0	29,850	3,596,352	211,000	8.26	14.49
743	190	11.0	29,850	4,760,971	280,099	6.97	11.17
750	197	11.6	29,850	4,980,403	293,367	6.93	10.93
788	235	15.0	29,850	7,306,900	429,259	7.84	12.74
San Vicente (concrete, arched gravity dam)							
620	160	3.0	213,700	2,202,250	142,213	12.99	10.40
El Capitan and San Vicente (combined with 72 inch pipe)							
713 710	160 250	20.0	243,550	10,433,102	671,160	9.19	12.62

In the event that the above El Capitan and San Vicente combination development were made there will be a material decrease in the subsurface water supply available in the El Monte area now developed and being used by the Irrigation District; also a decrease in the available subsurface supply of the Lakeside and Riverview areas now developed and being used

by the City. The total decrease would amount to about 5 million gallons daily.

Submitted herewith are 7 detail estimates from which the above summary was compiled, also drawings used for estimating purposes, of El Capitan reservoir dam to store water to elevation 713, 750 and 788, reservoir contour 160, 197 and 235 respectively; and of San Vicente reservoir dam to elevation 635 and 720, reservoir contours 175 and 260 respectively.

Respectfully submitted,

H. N. Savage (Signed)
H. N. Savage
Hydraulic Engineer in Charge
Bureau of Water Development
City of San Diego

C. Harritt (Signed)
C. Harritt
General Manager
La Mesa, Lemon Grove and
Spring Valley Irrigation District

George Cromwell (Signed)
George Cromwell
Consulting Engineer

Enclosures
Drawings (30)
Costs (7)
Photographs (3)

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March 23, 1931.

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

Subject: San Diego River Project. El Capitan, San Vicente and Mission Reservoir Basins. Comparative cost of water development.

Gentlemen:

Supplementing the report submitted by the Board of Engineers in accordance with Resolution No. 55891, wherein they give estimates of the cost of production of water in El Capitan and San Vicente reservoirs and the cost of the water delivered to the City of San Diego. The same method of obtaining the estimated cost of the production of water has been applied to Mission reservoir development, with the following comparative results:

FEATURE			ESTIMATES OF COST				
			In Reservoirs			At City of San Diego	
Elevation	Reservoir Contour	Duty mgd	Expended to date	To Complete	Annual	per 1000 gallons	per 1000 gallons
El Capitan (hydraulic fill-rock embankment dam)							
			$	$	$	cents	cents
693	140	5.2	29,850	2,906,265	169,975	8.96	15.04
713	160	7.0	29,850	3,596,852	211,000	8.26	14.49
743	190	11.0	29,850	4,760,971	280,099	6.97	11.17
750	197	11.6	29,850	4,980,403	293,367	6.93	10.93
788	235	16.0	29,850	7,306,900	429,259	7.84	12.74

To deliver water up to net safe yield of 11.6 million gallons daily from El Capitan reservoir to the City of San Diego will require the construction of about 8 miles of 36 inch pipe line to connect El Capitan reservoir with the existing Lakeside-University Heights pipe line. Estimated cost about $460,000.

To deliver a net safe yield of 15 million gallons daily will ultimately require, in addition to the above, the construction of a second pipe line consisting of 25 miles of 30 inch pipe connecting El Capitan reservoir to the City of San Diego, cost about $1,078,125; and additional filter plant, estimated cost about $72,450; total estimated cost about $1,610,575.

FEATURE			ESTIMATES OF COST				
			In Reservoirs				At City of San Diego
Elevation	Reservoir Contour	Duty mgd	Expended to date	To Complete	Annual	per 1000 gallons	per 1000 gallons
San Vicente (concrete, arched gravity dam)							
620	160	3.0	$13,700	$2,202,250	$142,213	cents 12.99	cents 18.40

To deliver water from San Vicente reservoir to the City of San Diego will require the construction of about 4 miles of 36 inch pipe line to connect San Vicente reservoir with the existing Lakeside-University Heights pipe line. Estimated cost about $230,000.

El Capitan and San Vicente (combined with 72 inch pipe)							
713 710	160 250	20.0	$243,550	$10,433,102	$671,160	cents 9.19	cents 12.62

To deliver water from El Capitan and San Vicente reservoirs, if interconnected with a 72 inch pipe line, to the City of San Diego will require the construction of 1-1/2 miles of 36 inch pipe line

connecting the 72 inch pipe line to the existing Lakeside-University Heights pipe line, and of a second pipe line consisting of 18-1/2 miles of 36 inch pipe from the 72 inch pipe line to the City of San Diego, estimated cost about $1,150,000. Additional filter plant, estimated cost about $134,550. Total estimated cost about $1,284,550.

FEATURE				ESTIMATES OF COST			
				In Reservoir			At City of San Diego
Elevation	Reservoir Contour used	Duty	Expended to date	To Complete	Annual	per 1000 gallons	per 1000 gallons
Mission (concrete, arched gravity dam)							
			$	$	$	cents	cents
360	116	6.0	30,000	2,094,616	120,153	5.49	8.75
390	146	12.2	59,120	3,742,346	210,025	4.72	8.03
400	156	15.0	59,120	4,106,225	230,707	4.21	7.22

To deliver water from Mission reservoir constructed to store water to elevation 360, reservoir contour 116, to the City of San Diego, thru the existing Lakeside-University Heights pipe line, will require only the installation of a pumping plant, estimated cost about $23,000.

To deliver water from Mission reservoir constructed to store water to elevation 390, reservoir contour 146, to the City of San Diego, thru the existing Lakeside-University Heights pipe line, will also require only the installation of a pumping plant, but of larger capacity, estimated cost about $40,250.

To deliver one-half of the water from Mission reservoir constructed to store water to elevation 400, reservoir contour 156, to the City of San Diego by gravity to serve that portion of the City below elevation about 200, will require the construction of 9 miles of

36 inch pipe line, 5.5 miles of 24 inch pipe line, 1000 feet of tunnel, and additional filter plant; estimated cost of pipe lines and tunnel about $646,875, estimated cost of filter plant about $77,625. To deliver the remaining half of the water thru the existing Lakeside-University Heights pipe line to University Heights reservoir will require the installation of a pumping plant, estimated cost about $23,000. Total estimated cost about $747,500.

The above statements are indicative of the relative merits of the three reservoir basins on a basis of the expenditures required to develop the reservoirs and deliver the water to the City of San Diego thru the present facilities insofar as practicable.

It is economically impracticable to construct a hydraulic fill-rock embankment type of dam at El Capitan to store water at first only to elevation 713, reservoir contour 160, net safe duty about 7 million gallons daily, and later to raise the dam to store water to elevation 743, reservoir contour 190, net safe duty about 11 million gallons daily. If the dam at El Capitan were constructed to store water to elevation 743, reservoir contour 190, the cost, including pipe line to connect with the existing Lakeside-University Heights pipe line, would be about $5,220,971, which would require an additional bond issue.

A study of the cost of power for pumping from Mission reservoir constructed to store water to elevation 360, reservoir contour 116, net safe duty 6 million gallons daily, based on the runoff of the period from 1883-84 to 1921-22, and water delivered to University Heights filter plant by pumping through the about nine mile reach of the existing 36 inch Lakeside-University Heights pipe line, shows that on a basis of 75 per cent combined motor and pump efficiency, and power

delivered at one cent per kilowatt hour, the annual power bill would range from a minimum of about $6,000 to a maximum of about $11,000.

Submitted herewith are three detail estimates of the cost of Mission reservoir development prepared on the same basis as those prepared by the Board of Engineers in estimating the cost of production of water at El Capitan and San Vicente reservoirs, also drawings upon which the estimates were based for Mission reservoir dam.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/p

Enclosures
Drawings (7)
Costs (3)

SAN DIEGO RIVER PROJECT, EL CAPITAN RESERVOIR AND DAM FEATURE

STATEMENT OF COSTS OF WATER IN EL CAPITAN RESERVOIR.

Hydraulic fill-rock embankment dam, to store water to elevation 703, reservoir contour 150; capacity 56,000 acre feet; area 1,000 acres; net safe duty 6 million gallons daily.

EXPENDED TO DATE

Purchase of flowage lands in private ownership 660 acres		$29,850
Paid to Federal Government for 1941.4 acres in Capitan Grande Indian Reservation and 140 acres in Cleveland National Forest		361,428
Right of way for reservoir purposes granted by Department of the Interior	9.5 acres	0
Special use permit granted by Supervisor of Cleveland National Forest	67.2 acres	0
Total		$391,278

ESTIMATED COST TO COMPLETE

1. RESERVOIR BASIN

(a) Damsite and flowage lands belonging to La Mesa, Lemon Grove and Spring Valley Irrigation District and to Cuyamaca Water Company, 190 acres. Condemnation proceedings were initiated by City of San Diego for this land on May 20, 1924 and resulted in an award of $600,000 on August 9, 1925, which was set aside as excessive. Litigation pending. Nominal value 19,000

(b) Dam site lands belonging to Cuyamaca water Co., 50 acres. No proceedings for acquisition initiated. Nominal value 5,000

(c) Reservoir flowage lands belonging to La Mesa, Lemon Grove and Spring Valley Irrigation District about 30 acres; to Cuyamaca Water Co., about 50 acres of which a portion is under option to Irrigation District. Only the 30 acre tract belonging to the Irrigation District required for dam up to Reservoir Contour 150 feet. (As the development of the initial major reservoir on the San Diego River at El Capitan would result in great damage to the Irrigation District, the City would no doubt have to initiate condemnation proceedings

	for any lands or rights of way required from the District and as the District delivers water to the incorporated cities of La Mesa and Lemon Grove, many years may be required to complete the litigation and the City may not be successful in securing the land.) Nominal value	8,000
(d)	Flume and conduit rights of way belonging to the La Mesa, Lemon Grove and Spring Valley Irrigation District. (Included in cost of reconstruction of Irrigation District flumes and siphons. However there may be long and costly litigation before the City can reconstruct the flume and siphons.) Nominal value	0
(e)	Reconstruct County Road 11 miles at $13,000	143,000
(f)	Reconstruct Irrigation District flumes and siphons	215,000
(g)	Clear reservoir basin	20,000
	Total reservoir basin	$410,000
2.	DAM, HYDRAULIC FILL-ROCK EMBANKMENT	2,019,613
	Sub-total cost	$2,429,613
	Contingencies and engineering 15 per cent	364,442
	Estimated cost	$2,794,055
	Total annual cost at El Capitan Reservoir	$187,963
	Cost per 1000 gallons at El Capitan Reservoir	8.59 cents

COSTS DELIVERED TO CITY OF SAN DIEGO

EXPENDED TO DATE

Purchase of flowage lands in private ownership, 560 acres	$ 29,850
Paid Federal Government for flowage lands required for reservoir content 160	361,428
Portion existing Lakeside-University Heights 17 miles long pipe line	1,000,000
Portion existing University Heights Filter Plant	22,000
Total expended to date	$1,413,278

ESTIMATED COST TO COMPLETE

1. Reservoir Basin as above	$ 410,000
2. Dam as above	2,019,613
3. Conduit: use existing 17 mile Lakeside-University Heights pipe line and 8 miles 36" pipe line El Capitan to Lakeside	400,000
4. Filter Plant Use existing University Heights Filter Plant	0
Sub-total cost to complete	$2,829,613
Contingencies and Engineering 15%	424,442
Estimated cost to complete	$3,254,055
Total annual cost	$ 322,345
Cost per 1000 gallons carried, filtered and delivered into University Heights Reservoir	14.72

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October 23, 1930.

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

Subject: City of San Diego, California, additional water development of the San Diego River-Recommendations.

Gentlemen:

In compliance with your Resolution No. 51772 reading as follows:

> "That H. N. Savage, Hydraulic Engineer in charge of Water Development, be and he is hereby authorized and directed to file at his earliest convenience his recommendations regarding future water development on the San Diego River; including in his recommendation the site for the first dam on this river, and his views on how the project should be financed; either by transferring existing bond funds or the issuance of new bonds; as suggested by Councilman Louis C. Maire, under date of October 14th, 1929."

it is now deemed timely to report my conclusions and to make specific recommendations for the construction of additional water development works on the San Diego River.

HISTORICAL

During my employment as Hydraulic Engineer to the City of San Diego from July 2, 1917 to August 8, 1923, in addition to designing and constructing the Lower Otay Dam, I conceived and accomplished the acquisition of necessary rights of way from the U.S. Land Office for reservoirs, dams and conduits and accomplished the construction and completion of the Barrett Reservoir Dam, and projected, designed and advanced the Morena Reservoir Dam and Spillway and Safe Duty

enlargement up to the time of my separating from the City's service August 8, 1923, and initiated and accomplished from savings from funds provided for operation and maintenance of the Water Development System, without appropriation or allocation of additional funds therefor, a comprehensive research, survey, assembly, compilation, and determination of all the water resources in San Diego County and adjacent thereto on the north and south, tributary to the City of San Diego, and compiled a complete report and recommendations for the orderly development by the Municipality of additional water supply then urgently required, and filed a complete report of over eight hundred pages thereon, dated August 8, 1923, addressed to the Honorable, the Mayor and Common Council of the City of San Diego.

My findings and conclusions were that the conservative net safe duty of available water in San Diego River drainage basin area, 375 square miles, tributary to and above the Mission reservoir basin would be at least twelve and one-half million gallons a day and that the probable net safe duty would be seventeen and one-half million gallons a day.

My recommendations were that the City of San Diego proceed at the earliest possible legal permissible date to conserve all the available water of the San Diego River drainage basin by means of a reservoir above and adjacent to the head of the Mission Gorge, and a gravity pipe line therefrom to a connection with the Municipal distribution system.

Pending the availability, to the City of San Diego, of the San Diego River water resources for conservation, my recommendation was that the Barrett dam be heightened about seventy-five feet, sufficient to conserve the total additional water supply available from the tributary drainage basin, and thereby secure a total net safe duty of about ten million gallons of water a day from this reservoir.

Incident to my separation from the City of San Diego's service, August 8, 1923, Mr. John Ripley Freeman, Consulting Engineer of Providence, Rhode Island, was engaged to make a comprehensive investigation, determination and recommendation to the City of San Diego for the conservation of additional water supply.

Mr. Freeman has been for many years recognized as one of the most outstanding, highly qualified, broadly and responsibly experienced and most efficient hydraulic engineers in the world. He has been officially employed and to a large extent has dominated the design and layout of many of the most notable municipal water supply projects in America.

Mr. Freeman, after a comprehensive investigation, survey and study of the water resources tributary to the City of San Diego, which continued over a period approaching a year, reported his specific concurrence with my findings and conclusions and recommendations for the utilization and conservation of the San Diego River water resources in the Mission Reservoir Basin. He, however, amplified my study of net safe duty of water to be made available by the construction of the Mission Reservoir Dam and his investigations justify a conclusion that the net safe duty of the reservoir basin, if utilized up to elevation 400, reservoir contour 156, would be fifteen million gallons per day, which is midway between my conservative net safe duty and my probable net safe duty.

NARRATIVE

Upon my return and resumption of duties as Hydraulic Engineer to the City of San Diego, July 2, 1928, I found the following outstanding conditions confronting the City of San Diego's water supply:

That no additional water had been conserved by the construction of reservoirs since my report and recommendations dated August 8, 1923, although the population of the City had greatly increased.

That the City of San Diego was dependent for its water supply from the Cottonwood-Otay interconnected reservoirs on the single Otay Reservoir-San Diego pipe line, sixteen miles of which was practically worn out wooden stave pipe and was not only seriously undependable, but for several years previous had not been deemed safe to expose to even the static water pressure head in the Otay Reservoir, with the consequent restriction of its carrying capacity to the City of San Diego.

The pipe was supported on forty-one wooden trestles, some of them relatively high and all subject to destruction by fire. The pipe was also installed and being operated through four tunnels, aggregating a total length of about one and one-third miles, the major portion of which was unlined and subject to frequent falling roof and caving sides, and further exposed to eminent danger of major falling roof and caving sides, which continuously threatened to put the pipe line out of commission for weeks.

The $400,000 pipe line bond issue which the electors authorized, before I separated from the City's service, had, in place of being expended in replacing the most defective portions of the wooden stave pipe line, been transferred and used elsewhere.

Chollas Heights standby reservoir, storage capacity ninety million gallons, while sufficient for thirty days municipal water consumption for the population when it was constructed in 1900, was barely sufficient for four days' consumption July 2, 1928, and the City was dependent largely for its domestic water supply and fire protection upon the defective wooden stave pipe line and insuffi-

cient Chollas Heights standby reservoir capacity.

Consequently the importance of the immediate construction of an adequate capacity dependable pipe line from the Lower Otay Reservoir to the City of San Diego, also enlargement of Chollas Heights Reservoir capacity was paramount.

The City of San Diego's right to conserve the waters of the San Diego River drainage basin was involved in obviously lengthy litigation and the availability for the City of San Diego's use of the Murray Reservoir was very doubtful. Therefore, the construction of an independent pipe line, of adequate size, from the Lower Otay Reservoir to the City of San Diego and the enlargement of the Chollas Heights standby reservoir was recommended which resulted, after one unsuccessful bond election March 9, 1929, in bonds being authorized by the Electors July 16, 1929, for the construction of the pipe line and of the Chollas Heights reservoir enlargement.

The Supreme Court of the State of California, on June 20, 1929, for the second time confirmed the decision of the Superior Court in granting the City of San Diego the paramount right to the waters of the San Diego River drainage basin, both surface and subsurface, which decision was far-reaching in effect upon the economical development of additional water supply for the City of San Diego, including standby reservoir requirements and development of San Diego River resources. The Irrigation District, on July 28, 1930, filed with the Supreme Court of the United States an application for a writ of review of the decision of the Supreme Court of the State of California.

In view of the paramount water decision of the Supreme Court of the State of California, in favor of the City of San Diego, it has been thought proper to defer the enlargement of Chollas Heights reservoir until the full effect of the Court of highest jurisdic-

tion's final decision regarding San Diego River water resources should become effective.

The Supreme Court of the United States on October 13, 1930, refused to review the decision of the Supreme Court of the State of California and thereby completely terminated the Paramount Water Rights Case in favor of the City of San Diego, and made it legal for the City to fully develop and utilize all the water resources of the San Diego River drainage basin.

The La Mesa, Lemon Grove & Spring Valley Irrigation District has formally advised the City of San Diego, by resolution, dated October 14, 1930, of its willingness to permit the City to acquire and/or use jointly its Murray Reservoir on terms fair alike to each the City of San Diego and the Irrigation District, and by communication dated May 22, 1930, has offered to transfer to the City the about four hundred thirty-four acres of land, which it owns in Mission Reservoir Basin below elevation 400, reservoir contour 156, at a price not to exceed that to be paid by the City for similar adjacent lands.

Murray Reservoir is nearly one hundred feet higher in elevation than the City of San Diego's Chollas Heights standby reservoir. The capacity of Murray Reservoir is two billion gallons, which is more than triple the capacity deemed required for the projected enlargement of Chollas Heights Reservoir. The Murray Reservoir water will serve by gravity the fast developing higher areas within and adjacent to the City of San Diego on the east, which cannot be served by gravity from Chollas Heights reservoir.

Immediately upon my return and resumption of responsible duties as Hydraulic Engineer, the Otay Reservoir-San Diego wooden stave pipe line was very materially strengthened throughout its length. The tunnels were all cleared out, defective timbering was repaired

and every precaution was taken to insure the reasonably safe operation and maintenance in service of the first main pipe line until the second Otay Reservoir-San Diego main pipe line could be completed and put into service.

The new second main pipe line, now practically completed, is supported on concrete piers, and the tunnels through which it passes are all lined with masonry, the floors of concrete and the roof and sides of cement gunite reinforced; therefore, interruption of service is no longer to be feared, nor likely. The capacity of the new pipe line will be upwards of once and a half as much as the first pipe line. The first main pipe line, due to the extensive strengthening throughout its length, may be kept in service until additional water supply can be conserved and brought in from the San Diego River resources.

Additional investigation and studies made by me during the past two years, and consideration of Mr. Freeman's report, have strengthened my conclusions as to the advisability of constructing a masonry dam at the head of Mission Gorge; the dam to be designed for construction to successive heights as funds are made available, by transfer from existing bond funds, and to be ultimately completed to impound water to elevation 400 which is 156 feet above stream bed-reservoir contour 156. All of the water impounded in the reservoir may be delivered by gravity to the City distribution system.

The conservation and carrying of additional water from the unregulated discharge of the San Diego River to the City of San Diego's distribution system, which can be accomplished quickly and economically after funds are made available, together with the now dependable service through the new pipe line from the Lower Otay reservoir, supplemented by reasonably dependable service from the

wooden stave pipe line, will serve to postpone the requirement for Chollas Heights standby reservoir enlargement permanently, since when the Murray Reservoir is utilized for standby storage there will be no requirement for the very material enlargement of Chollas Heights Reservoir.

Therefore, in view of the paramount importance of husbanding all City funds and avoiding the necessity for authorizing more bond funds, it is deemed not advisable to utilize the bond funds authorized for the enlargement of Chollas Heights standby reservoir, but instead to use the funds, if it pleases the officials and electors to do so, for the successive conservation and carrying of additional water supply from the San Diego River resources into the City of San Diego. Owing to the dependability and the comparatively short length of the pipe line from the Mission reservoir to the City, funds spent on the construction of the Mission Reservoir will accomplish the same service and protection to the City as if expended on the enlargement of Chollas Heights Reservoir.

MUNCIPAL WATER CONSUMPTION

The average daily delivery of water from the City of San Diego's resources increased from one million gallons in 1902 to 4.5 million gallons in 1910, to 10.1 million gallons in 1920, and to 13.4 million gallons in 1925. It is estimated that the average daily consumption will be 17 million gallons in 1930.

The maximum daily delivery of water from the City of San Diego's resources increased from 15 million gallons in 1920 to 21.4 million gallons in 1925, to 28.4 million gallons July 14, 1930, from which it is indicated that the accelerating annual requirement for the delivery of water from the City's resources may amount to over ten billion gallons in 1940; the average daily requirement to thirty million

MUNICIPAL DEVELOPED AVAILABLE WATER SUPPLY

The City's developed net safe duty of reservoir water is:

From the San Dieguito River Project - 3 million gallons a day;

From the Morena, Barrett and Otay interconnected reservoirs - about ten million gallons a day, which will be increased by upwards of one million gallons a day whenever the recently very materially enlarged Morena reservoir is filled from flood runoff.

The City of San Diego has been dependent for three years, for sufficient water for its daily consumption, upon additional emergency water pumped from the sub-surface water-bearing sands in the San Diego River Valley at Lakeside, Riverview and Mission Valley, which has amounted to a daily average of about three million gallons of water during the calendar years 1929 and 1930.

MUNICIPAL WATER CARRYING SYSTEM

The quantity of water possible to bring, from the Morena-Barrett and Otay interconnected reservoir system, to the City, has heretofore been restricted to the capacity of the wooden stave pipe line, which is about 12.5 million gallons a day. Out of abundant caution, this pipe line should be kept in operation until a considerable amount of water is available in Mission Reservoir.

The Otay Reservoir-San Diego Second Main Pipe Line, now approaching completion, will have a carrying capacity about once and a half times that of the first main pipe line.

Until the storage reservoirs - Morena, Barrett and Otay - are again filled, it will not be prudent to materially exceed the present rate of draft therefrom.

The maximum quantity of water possible to obtain from the San Dieguito River project, Hodges Reservoir, through the existing

carrying conduit to the City of San Diego, is limited by the capacity of the conduit and is fixed by the City of San Diego's agreement with the San Dieguito Mutual Water Company to three million gallons a day. The carrying system consists of a 22 mile conduit made up of successive reaches of open canal, reinforced concrete pipe and a long reach of undependable wooden stave pipe. There is also involved a pumping lift, at the base of Torrey Pines Hill, against a pressure head of 270 feet, and also booster pump actuation is required in the vicinity of each, Pacific Beach and Old Town.

The City's Lakeside-San Diego pipe line is capable of carrying fifteen million gallons of water a day to the City, if that amount were available at the pumping areas at Riverview and Lakeside. The wells and pumps are now capable of producing up to twelve million gallons a day when the subsurface sands are completely saturated. However, the water level draws down with continuous pumping, and the supply has to be carefully conserved in order to prevent serious shortage even when the supply is partly replenished as in the past two years.

As operated in the past, the water has been drawn from the interconnected reservoir systems to the capacity of the pipe lines and, during the summer season of heavy draft, additional water from the pumping areas has been drawn on as needed.

The Mission Valley pipe line, pumps and pumping area have a capacity of 4.5 million gallons a day when the subsurface sands are completely saturated, but owing to the high, costly pumping lift, against a head of about 500 feet, and to the rapid depletion of the water of the area when pumped, the use of water from this source is held to a minimum.

MUNICIPAL ADDITIONAL WATER SUPPLY DEVELOPMENT POLICY

The outstanding additional water supply development policy for the City of San Diego to adopt is deemed to be to immediately initiate the conservation and delivery of the additional water supply from the San Diego River resources, now necessary for the City's present requirements, and to plan in advance for the development of water for the City's future requirements.

It is advisable and economically practicable to utilize to the fullest extent the present constructed water conservation and carrying works, including the Lakeside-San Diego Pipe Line and the University Heights Filter Plant.

It is of paramount importance that construction be prescribed and additional water works be designed strong enough to insure the required impounding and carrying capacity, and dependability, at the lowest possible cost.

Provided the City of San Diego increases in population at the accelerating rate during the following years that it has during the past ten years, it is indicated that the entire available supply of undeveloped water resources in San Diego County, tributary to the City of San Diego, will be required for consumption in the Municipality within twenty-five or thirty years and that the maximum flood runoff from the tributary drainage basins must be conserved and occasionally carried over from two cycles.

It is a fact, supported by observations and statistics of rainfall and runoff, that the reservoir basins situated lowest down in each tributary river's drainage basin, if of sufficient storage capacity and accompanied by a suitable and economical-to-develop damsite, are outstandingly the most economical and advisable for development.

Examination of the flood runoff data of San Diego County shows that unusually large winter seasonal runoff occurs in about eleven year cycles. Because of this condition, it is necessary to construct reservoirs to impound and conserve for use during the years of little runoff or drouth the economic maximum amount of runoff occurring during the periods of large runoff. The safe duty of a reservoir is the amount of water that can be drawn therefrom continuously each year without entirely depleting it before the end of the period. It is necessary to carry over water in storage, when possible, from one eleven year period to the next.

It is paramountly important for the City of San Diego to immediately construct an additional storage reservoir, to impound and carry over the maximum flood runoff, in order to insure the net safe duty of water as it is required, and also to enlarge and to construct filter plants as required to insure the delivery of a sufficient quantity of sanitary, healthful water.

TRIBUTARY ADDITIONAL WATER RESOURCES - UNDEVELOPED

The undeveloped additional water resources, geographically and topographically tributary to the City of San Diego are:

1. San Dieguito River Project, when fully developed, surface and subsurface, will, in addition to providing for the City's obligation under its agreement with the two Irrigation Districts and the Water Light and Power Company, produce an additional net safe duty of fifteen million gallons of water a day for delivery to the City's distribution system.

2. The San Diego River Project, when fully developed, surface and subsurface, may be depended upon to provide a total net safe duty of twenty-five million gallons of water a day, of which the

La Mesa, Lemon Grove and Spring Valley Irrigation District is now delivering to irrigation and domestic water users 3.5 million gallons daily, although to do this it is wasting, by evaporation from Cuyamaca Reservoir, by percolation down Boulder Creek and from the flume carrying and distribution system and other reservoirs, an additional 3.5 million gallons a day.

3. Cottonwood River Project - Barrett reservoir feature, when further developed by heightening the present Barrett dam by about 75 feet, will have a total net safe duty of about ten million gallons a day.

4. Cottonwood River Project - International Marron feature, when all the tributary water resources are conserved, will develop a net safe duty of about ten million gallons of water a day, a portion of which may be allocated by International treaty to the Republic of Mexico.

ADDITIONAL WATER SUPPLY DEVELOPMENT

The City of San Diego should proceed in the most aggressive manner economically possible to conserve the entire available San Diego River tributary water resources by acquiring the necessary reservoir flowage lands in the Mission Reservoir basin below elevation 400, reservoir contour 156, and by the construction of a dam at the outlet of this great natural reservoir basin near the head of the gorge, one-third of a mile below the Mission Fathers' Dam.

The storage capacity of the reservoir projected is 295,000 acre feet, which will impound the economical-to-conserve maximum seasonal runoff of record from the 375 square miles of tributary drainage basin.

A gravity pipe conduit will ultimately be required to carry stored water from the reservoir to the City of San Diego's distribution system. This conduit may be located along the public highway down to Sixth Street Extension, where it can divide, one branch extending down the valley along the highway to Old Town and the other branch extending to 11th and A Streets. The construction of this line will save the City the cost of installing additional distribution system pipes from University Heights Reservoir to the lower portion of the City.

The Lakeside-University Heights reservoir, 36" steel pipe conduit constructed in 1926-7, will be used to carry water developed by pumping from the subsurface water-bearing sands in the upper portion of the Mission reservoir basin and adjacent thereto. This will provide for the delivery of the emergency water required for consumption by the City of San Diego until a considerable amount of water is in storage in the reservoir.

The entire available discharge of the San Diego River can be conserved in the Mission reservoir basin and carried to the City of San Diego at not to exceed one-half the cost of conserving and carrying the same quantity of water from any other location in the San Diego River drainage basin. A total net safe duty of fifteen million gallons of water a day can be depended upon from the Mission reservoir when it is adequately developed and once filled by flood runoff.

The lowest water level from which it will be practicable to draw water in any quantity from the Mission reservoir is at elevation 285. Over one-half of all water delivered in the City of San Diego is used below elevation 200 feet. Therefore, all of the stored water may be delivered to the City distribution system by gravity.

The net safe duty may be increased three million gallons a day by pumping from subsurface water-bearing sands in the Mission reservoir basin once the City has secured title to the lands in the reservoir basin and to the water-bearing sands immediately adjacent to the upstream portion of the reservoir.

This conclusion is in concurrence with my previous report dated August 8, 1923, and has been strongly corroborated by the comprehensive and exhaustive investigation made by Mr. Freeman. My additional investigation and studies made during the past two years have strengthened my first conclusions.

Drawings and specifications are being completed and advertisement for proposals for the construction of a dam by contract can be made available immediately. They provide for the progress of work, by the contractor, at the rate and to the extent that funds may be made available therefor by the Officials and Electors of the City of San Diego.

MISSION RESERVOIR

The Mission reservoir basin, above the head of Mission Gorge, has ample capacity to impound the maximum recorded flood runoff from the entire tributary San Diego River drainage basin of 375 square miles, provided only a dam of sufficient height is constructed at the outlet of the San Diego River drainage basin, near the head of Mission Gorge. Outstanding in this connection is the relatively low height of dam, only 156 feet, required to provide storage for 295,000 acre feet of water and also the favorable narrow cross section of the canyon at the damsite and the prominently suitable ledge rock in place for foundation and for abutments.

The combination of geographic, topographic and hydraulic factors make this the most adequate and economical site in San Diego County for the storage of water for the City of San Diego. Comprehensive core recovery borings and test pit explorations have been made at this damsite, which disclosed hard ledge bedrock in place throughout the cross section of the damsite, and at no place to exceed about 10 feet below the surface, and bedrock is not only exposed but in some cases prominently outcrops above the streambed channel.

By utilizing the maximum Mission reservoir basin, it will be possible to conserve and secure for the City of San Diego a total surface and subsurface net safe duty of eighteen million gallons of water a day.

As the construction of the Mission Reservoir dam progresses, and as the unregulated discharge of the river and water impounded in the reservoir becomes available, it will be economically practicable, by the installation and operation at the Dam of a booster pump and the utilization of the lower 8.9 mile reach of the City's Lakeside-San Diego pipe line, to divert and carry water as it becomes available up to about fifteen million gallons per day to the University Heights Filter Plant; and at a less cost than the interest and amortization of the cost of a new gravity conduit, and thus delay the construction thereof until the net safe duty of water impounded in Mission Reservoir exceeds the economic carrying capacity of the Lakeside-San Diego pipe line.

Comprehensive study has disclosed that with only limited storage there may be available for diversion, from the unregulated discharge of the San Diego River, vicinity the head of the Mission Gorge, an average of over three million gallons of water per day.

The pipe line between Lakeside and the City of San Diego's University Heights reservoir and filter plant, when not carrying water stored in and diverted from Mission reservoir, will be available and required to carry emergency water pumped from the sub-surface water-bearing sands in the Mission reservoir basin and adjacent thereto, as has been necessary during the past three seasons.

To secure the sub-surface water resources in the Mission reservoir basin and adjacent thereto for the City of San Diego, from which sources an available supply of three million gallons of water a day has been obtained during the past three years, it is essential that the City of San Diego purchase ultimately all the water-bearing lands in the Mission reservoir basin and adjacent to and upstream therefrom, and this is deemed to be necessary irrespective of whether or not the City of San Diego utilizes the Mission reservoir basin for impounding the surface runoff.

MISSION RESERVOIR BASIN - SANITATION

A 1922 census of the inhabitants of the 375 square miles of the San Diego River drainage basin tributary to the Mission reservoir indicated the total population to be about 11 per square mile. It is now estimated that the population does not exceed 15 per square mile.

A tabulation made by Metcalf and Eddy of Boston, Massachusetts, shows an average population of 90 per square mile on the drainage basins from which sixty of the eastern cities in the United States take their water supply, including Albany, Baltimore, Boston, Harrisburg, Minneapolis, New York, Philadelphia, Pittsburgh and Washington, D. C.

Proper recreational use of drainage basin areas in California is tolerated by the State Board of Health. Those who store, carry and deliver water for domestic use are considered responsible for the purity of the water delivered, which is rapidly evolving into a policy of filtration and chlorination of all water furnished and delivered for human consumption.

MISSION RESERVOIR BASIN LAND VALUES

The flowage lands and improvements in the Mission reservoir basin below elevation 400, reservoir contour 156, which it is recommended that the City acquire, were appraised in 1921-22 by Messrs. William Herbert, Allen F. Hawley and Charles Engebretson. The appraisal was based on the total lands involved and took into account the water then being used and available for irrigation.

Following is copy of petition initiated by the land owners in the Mission reservoir basin and formally delivered to the Mayor and Common Council of the City of San Diego:

"Document #142090
Filed April 17, 1922

COMMUNICATION FROM RANCH OWNERS IN RE
DEVELOPMENT OF SAN DIEGO RIVER WATER SUPPLY ETC.

Dated April 1922.

"To the Honorable Common Council
of San Diego, California.

"We, the property owners, whose property would be flooded by the building of a dam at the Mission Gorge Dam Site number two to its full height, request that the City of San Diego build a dam at Mission Gorge, as the waters of the San Diego River are of far more value to the City and County of San Diego than the property is for dairy or agricultural purposes, and therefore we are willing to dispose of our property at a fair and reasonable price. We further believe that the total valuation placed by Engineer Savage on the lands that would be flooded, in his report, to be a fair one."

{71 signatures, reporting to represent
over 90 percent of the then land owners.}

The California Tax Factors in 1928-29 appraised all the lands and improvements in the Mission reservoir basin, using the same method as Messrs. William Herbert, Allen T. Hawley and Charles Engebretson did in 1921-22, i.e., taking into consideration crops being produced and potential condition for growing alfalfa and other crops in consequence of the available water supply, at a total of $1,547,870. The total taxes assessed in San Diego County 1929-30 against all the lands and improvements in the Mission reservoir basin below elevation 400, reservoir contour 156, was $16,309.61, which is less than the taxes assessed against a single major building in the City of San Diego.

The Irrigation District, on May 22, 1930, signified its willingness to transfer to the City of San Diego all lands owned by it in Mission reservoir basin, amounting to 450 acres of which 434 acres are below elevation 400, the price not to exceed that to be paid by the City for similar adjacent lands.

The City of San Diego owns 310 acres of land at the Mission reservoir damsite where construction of a dam is recommended in this report, including the entire damsite and the flowage lands adjacent thereto and above up to the west boundary line of the El Cajon Rancho and may, without let or hindrance, begin the construction of a dam thereupon, across the San Diego River, whenever it elects to do so. The City also owns 246 acres of water bearing lands in the reservoir flowage basin.

All Mission reservoir basin lands below elevation 400, reservoir contour 156, have been surveyed and classified, and over four hundred individual drawings have been made thereof.

The Tax Factors valuations, less the amount included therein because of the then available water supply, affords a uniform basis of values throughout. In case any material delay should be encountered in acquiring the reservoir flowage lands, through negotiation or other proceedings, the City of San Diego may give bond and secure permission from the Courts to proceed with the work.

The California State Supreme Court has twice decreed the paramount water rights of the San Diego River in their entirety to the City of San Diego, thereby reducing the value of the lands in Mission reservoir basin and their improvements to the basic value of dry lands.

METHOD OF DEVELOPMENT OF WATER IN MISSION RESERVOIR

It may not be found advisable for a number of years to provide for the impounding of water in the reservoir basin higher than elevation 390, reservoir contour 146; in which event it would not be necessary to acquire residence lands in Lakeside or immediate vicinity at this time for reservoir flowage lands. However, in view of the probability of a water shortage due to lack of precipitation and flood runoff, the City of San Diego, out of abundant caution, should proceed to acquire title to water-bearing lands in the reservoir basin located adjacent to and upstream from the lands to be covered by the reservoir.

It will be a very simple and inexpensive matter to install and operate a booster pump in connection with the dam, immediately after construction has been started, and lift all water available, upwards of ten million gallons a day, into the Lakeside-University Heights pipe line through which it can be carried to the University Heights filter plant.

EL CAPITAN FEATURE

Comprehensive investigation and study have been carried on in connection with the El Capitan reservoir feature. The damsite is located about 25 miles from the City of San Diego's University Heights reservoir. The City has purchased 564 acres of land in the reservoir basin. An Act of the United States Congress, approved February 28, 1919, granted to the City of San Diego, a conditional permit to condemn for reservoir purposes, Capitan Grande Mission Indian Reservation lands in the El Capitan reservoir basin up to elevation 713, reservoir contour 160, subject among others to the provision:

> "That said reservoir, when constructed, shall be maintained and controlled by the City of San Diego for the use and benefit of said city and the inhabitants thereof and of such other municipalities within the County of San Diego, State of California, as may be now or hereafter furnished with water by said City of San Diego, and for the use and benefit of riparian owners along the San Diego River below the lands herein described and for the benefit of persons, corporations or municipalities situated along or adjacent to the pipe lines of said City of San Diego for the conservation and storage of water for domestic, irrigation, or municipal uses."

The Secretary of the Interior, on December 22, 1922, fixed the total amount he required at that time to be paid by the City of San Diego to accomplish the transfer of the Capitan Grande band of Mission Indians from that portion of their reservation which is below elevation 713, reservoir contour 160, including the $75,000 land condemnation award by the San Diego Superior Court, at $361,428. In a letter dated October 23, 1929, in response to an inquiry the Commissioner of Indian Affairs, C. J. Rhoads, advised as follows:

"Washington
October 23, 1929

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

My dear Mr. Savage:

The receipt is acknowledged of your letter of October 15, 1929, making request for certain data and information regarding the proceedings instituted by the City of San Diego, California, under the Act of February 28, 1919 (40 Stat.L.,1206), to acquire certain lands within the El Capitan Indian Reservation, in that State, for dam and reservoir purposes, for the conservation of water and for other purposes.

A pamphlet copy of the Act cited is inclosed herewith, and your attention is particularly invited to the limitation and forfeiture provisions contained in section four thereof.

There is no record here of the promulgation of any legal or Federal proceedings or official documents subsequent to the approval December 22, 1922, by the then Secretary of the Interior of the decree of the Superior Court of the State of California mentioned in your letter, nor of the payment of the sum of $361,428.00 required of the City by the terms of such decree and approval.

It is understood that the City has encountered considerable legal difficulty in acquiring the land and water rights of the Cuyamaca Water Company and others (278 Pac.840), which are involved in this project, and that further court proceedings will be necessary in connection therewith; also, that bonds for the purpose of defraying the cost of the project have been voted and issued, but that their sale is being deferred until the City is in a position to proceed with construction work. Under these circumstances there is no disposition at present to question the right of the City to proceed under the Act cited. However, it is pointed out that seven years have elapsed since the amount to be paid by the City was fixed by this Department, and it seems only fair to expect that the City should agree to a reopening of the proceedings supplemental to the condemnation heretofore had in the State court so as to permit a modification of the finding of December 22, 1922, should it be found that the sum of $361,428.00 is now inadequate to enable this Department to comply with sections three and four of the Act.

A memorandum copy of schedule dated August 19, 1922, showing the then estimated cost of carrying out the provisions of sections three and four of the Act cited relating to the Indians; also, memoranda showing itemized appraisement of the then value of the lands, improvements, water rights and other property of the Indians, upon which this Department's finding of December 22, 1922, was based, are inclosed.

Sincerely yours,

C. J. Rhoads,
Commissioner."

Approved: Jos. M. Dixon
First Assistant Secretary.

Provided water is impounded in the El Capitan Reservoir basin up to elevation 713, reservoir contour 160, the maximum flood flow line provided for in the Act of the United States Congress, approved February 28, 1919, the net safe duty is estimated to be about seven million gallons a day.

It will also be necessary to acquire about 270 acres of additional land in the reservoir basin, now in private and corporate ownership, including the south half of the El Capitan damsite.

Provided water is impounded in El Capitan reservoir basin up to elevation 743, reservoir contour 190, it will be necessary to acquire about 250 acres of additional land in the Indian Reservation above elevation 713, reservoir contour 160.

Provided water is impounded in the El Capitan reservoir basin to elevation 743, reservoir contour 190, the net safe duty will be about eleven million gallons a day.

The cost of acquiring reservoir flowage lands and constructing the El Capitan dam and the eight miles of pipe conduit therefrom to a connection with the present Lakeside-San Diego pipe line at

Lakeside, will be about twice the cost of acquiring at a fair price the flowage lands in the Mission reservoir basin, and constructing a dam at the head of Mission Gorge for the Mission reservoir. If a dam is constructed at El Capitan it will be absolutely necessary ultimately to also construct a dam at Mission Gorge to conserve the water from the 197 square miles of San Diego River drainage basin below El Capitan reservoir and the spill from El Capitan reservoir during the larger floods.

Furthermore, the net safe duty of water to be obtained from Mission reservoir drainage basin surface and sub-surface water-bearing lands therein will be approaching twice the quantity which is practicable to obtain from El Capitan reservoir feature, and at about one-half the cost per thousand gallons delivered to the City of San Diego. No reason is seen to justify the about-double cost of utilizing the El Capitan reservoir basin which, because of the magnitude of the excavation and masonry required in building the dam, is so great as to require a long period of time and a second bond issue for its completion to insure any very material net safe duty of water a day, while there are sufficient bond funds already authorized, if transferred, to acquire the flowage lands required for the Mission reservoir at a fair price, and construct the dam, which construction work can be accomplished in a relatively short period of time.

RECOMMENDATIONS

It is respectfully recommended that:

1. The City of San Diego authorize and direct the conservation of the available water resources of the San Diego River and initiate the construction of a masonry dam across the San Diego River, located at the outlet of the San Diego River Mission reservoir basin and about 1/3 mile below the Mission Fathers' Dam on the Fitzherbert-West tract of 310 acres of reservoir and damsite land owned by the City of San Diego. The work to be put under construction at the earliest practicable date and advanced as funds are made available. The dam to be designed for completion ultimately to impound water up to elevation 400, reservoir contour 156; and

2. The acquisition of the flowage lands required in the Mission reservoir basin below elevation 400, reservoir contour 156; and

3. The transfer, by the Honorable, the Mayor and Common Council, to the Mission Reservoir Fund of the about $350,000 which will not be required for expenditure to complete the work, but will be saved from the bond funds authorized for the Otay Reservoir-San Diego second main pipe line; and that

4. The electors be given an opportunity at the next general election in April 1931 of authorizing the transfer to the Mission Reservoir Fund of the about $500,000 of bond funds authorized for the enlargement of Chollas Heights reservoir, and that

5. The electors be given an opportunity at the next general election in April 1931 of authorizing the transfer to the Mission

Reservoir Fund of the about $3,250,000 authorized but unexpended bond funds for the El Capitan dam and pipe line; and that

6. The electors be given an opportunity to transfer to the Mission Reservoir Fund, whenever available, the remaining about $600,000 authorized and unexpended from the Sutherland Dam Bond Fund; and

7. The acquisition of Murray Reservoir in its entirety or of major storage rights therein, on terms fair alike to each, the City of San Diego and the La Mesa, Lemon Grove & Spring Valley Irrigation District; and

8. The installation and temporary operation of a booster pump in connection with the Mission Reservoir Dam, to utilize the unregulated water of the San Diego River and the water as it is impounded from the flood runoff in the reservoir and as it becomes increasingly available, and discharge and carry this water, so diverted and stored, temporarily through the lower nine mile reach of the City's Lakeside-San Diego pipe line to the University Heights filter plant and reservoir.

SUPPLEMENTAL STATEMENT

The total funds recommended to be made available for the Mission Reservoir Fund should provide sufficient money to acquire Reservoir Basin and flowage lands at prices deemed to be fair alike to the owners and to the City of San Diego, and to construct a dam to elevation 400, reservoir contour 156, and to provide the City of San Diego with an additional net safe duty of about fifteen million gallons of water a day when the work is completed and the water impounded from the next flood runoff period of consequence.

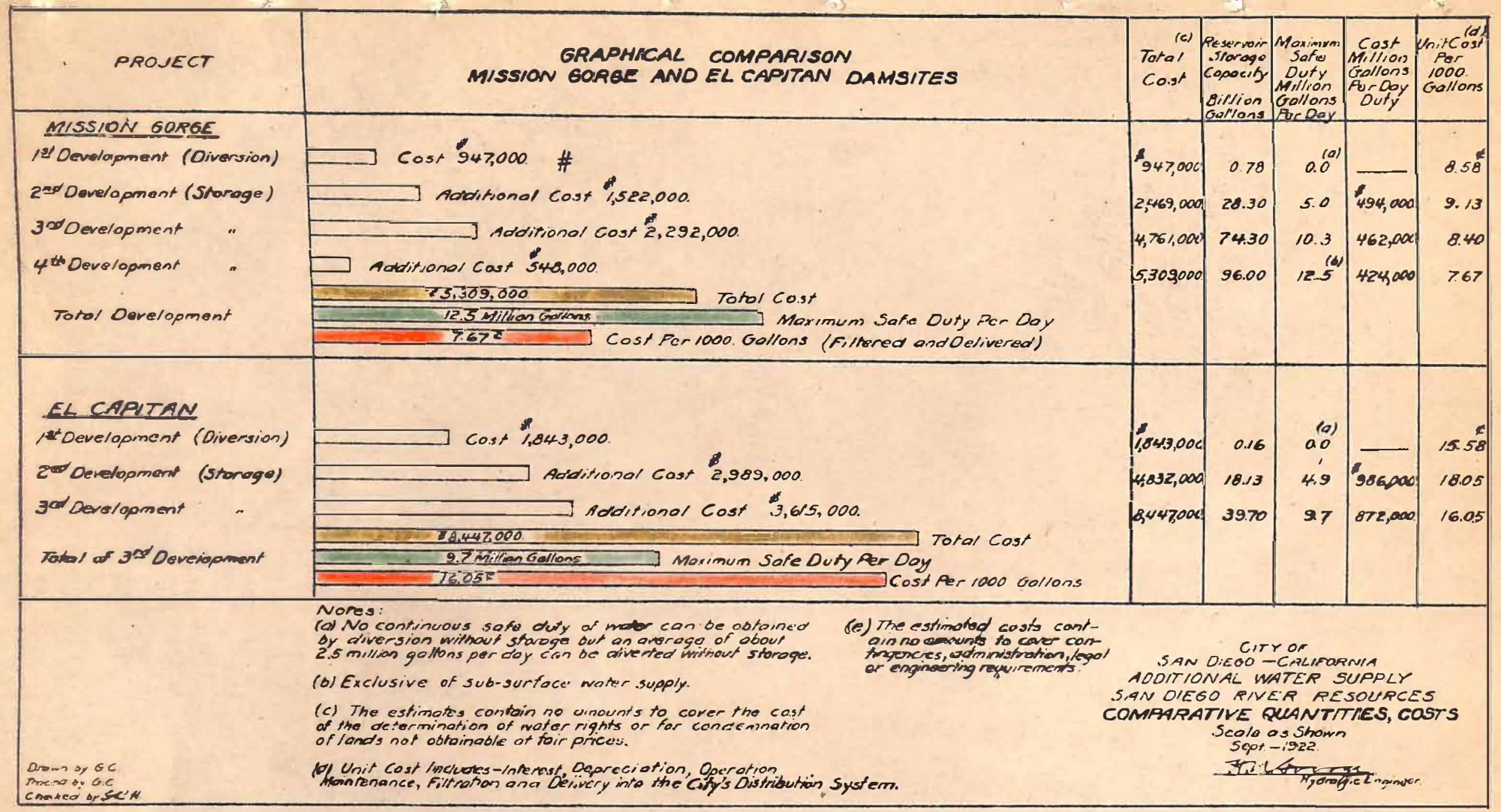
The transfer of the $350,000 remaining unexpended in the Otay Reservoir-San Diego second main pipe line bond fund to the Mission Reservoir fund will make it possible to initiate the acquisition of flowage lands and to construct the upstream portion of the Mission reservoir dam to a height that will make available the unregulated flow of the river and of some impounded water for delivery to the City through the existing Lakeside-San Diego pipe line.

Drawings are being printed and specifications are being typewritten for the construction of Mission reservoir dam to impound water ultimately to reservoir contour 156.

Detail estimates of cost of the Mission Reservoir Feature are being compiled. Estimates are being obtained from the County of San Diego of the cost of moving and reconstructing its highway around Mission Reservoir basin, and from the San Diego & Arizona Railway Company of the cost of moving and reconstructing its San Diego-Lakeside Branch line around the Mission Reservoir Basin, or for the abandonment of the reach in the reservoir basin.

Respectfully submitted,

H. N. Savage,
Hydraulic Engineer.



S-445

The transfer to the Mission Reservoir Fund of the about $350,000 which will be saved from the Otay Reservoir-San Diego second main pipe line bond fund, will make entirely practicable the construction of the upstream portion of the base of the Mission reservoir dam, together with outlet and control works, to a height which will make available for carrying through the City's Lakeside-San Diego pipe line from Mission reservoir to the City's University Heights reservoir upwards of 2.5 million gallons of water a day in perpetuity.

The transfer of all the funds recommended will provide about $4,700,000 for the Mission reservoir fund which should be sufficient at fair prices to secure the flowage lands required, move highways, pipe line and railroad and construct a dam to store water to elevation 400, reservoir contour 156, and thus increase the net safe duty of reservoir impounded water available to the City by about fifteen million gallons a day when water is impounded from the next flood runoff period of consequence.

EL CAPITAN PROJECT

DAMSITE NO. 2.

C O N C L U S I O N S

The following are the principal facts brought out by this study:

1. A continuous safe supply of 4.9 m.g.d. can be obtained from the San Diego River Drainage Basin (without interfering with the continued diversion for storage and direct delivery by the Cuyamaca Water Co. as heretofore) by constructing a dam of sufficient height at the El Capitan Damsite No. 2 to impound water to the 140' reservoir contour with a reservoir capacity of 55,780 acre feet. The estimated cost of this development complete is $4,807,000.00

2. A continuous safe supply of 9.7 m.g.d. can be obtained from the San Diego River Drainage Basin (without interfering with the continued diversion for storage and direct delivery by the Cuyamaca Water Co. as heretofore) by constructing a dam of sufficient height at the El Capitan Damsite No. 2 to impound water to the 190' reservoir contour with a storage capacity of 122,000 acre feet. The estimated cost of this development including the cost of the first development is $8,422,000.00.

3. In order to develop the ultimate safe duty of the San Diego River Drainage Basin at the El Capitan Damsite No. 2, it will be necessary to provide about 200,000 acre feet of storage, which will require a dam of sufficient height to impound water up to about the 235' reservoir contour and will flood practically the entire length of the Cuyamaca Water Company's flume between the diverting dam and the El Capitan Damsite No. 2. As stated heretofore in this study, the problem of the Ultimate Development of the San Diego River Drainage Basin at the El Capitan Damsite No. 2 involves the

EL CAPITAN PROJECT

DAMSITE NO. 2.

CONCLUSIONS (Continued)

assumption of the Cuyamaca Water Company's obligations and the operation of the two projects combined.

9/12/32
copy /f

CITY OF SAN DIEGO, CALIFORNIA

San Diego, California
January 14, 1922.

To the Honorable, the Mayor,
The Common Council, and the
Board of Water Commissioners of
The City of San Diego, California.

Subject: Additional Municipal Water Supply.
San Diego River Resources,
Conclusions, Recommendations.

Herewith is progress and preliminary report on the San Diego River Additional Water Supply Resources, which it is deemed timely to present.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/PJK
pjk 2-16-22

CITY OF SAN DIEGO, CALIFORNIA

San Diego, California, January 14, 1922.

To the Honorable, the Mayor,
The Common Council, and the
Board of Water Commissioners of the
City of San Diego, California.

Subject: Additional Municipal Water Supply.
San Diego River Resources,
Conclusions, Recommendations.

In compliance with the requirements of the Board of Water Commissioners' Resolution No. 111 dated August 11, 1921.

"BE IT RESOLVED By the Board of Water Commissioners of the City of San Diego, that the Hydraulic Engineer be, and he is hereby authorized and directed to receive and assemble available reports and data relative to the water resources of the San Diego River, to analyze same, to make investigations and surveys and perform such other work as may be necessary to amplify this data, to hire such assistance as may be required, and to make a report with recommendations to this Commission.",

and with the requirements of the Common Council's Resolution No. 26731 dated August 15, 1921.

"That the Hydraulic Engineer be requested to furnish the City Council for consideration, as soon as possible, a proposed outline for the development of the water system."

Comprehensive investigations, surveys, designs, computations and relative estimates have been made covering the two possible alternative Reservoir Basins and alternative locations of dams for each basin for the conservation and conduction of water from the San Diego River Drainage Basin to the City of San Diego.

There are two outstanding reservoir basins on the San Diego River; El Capitan and Mission Gorge.

El Capitan Reservoir Basin, located 30 miles up the San Diego River from San Diego has a total drainage basin area of 192 square miles. Mission Gorge Reservoir Basin, located 10 miles up the San Diego River from San Diego has a total drainage basin area of 387 square miles.

The following are the various developments considered at each of the reservoir basins and their several respective damsites in the order of their discussion herein below.

1. El Capitan Basin Damsite No. 1.
2. El Capitan Basin Damsite No. 2.
   (a) First Development
   (b) Second Development
3. Mission Gorge Basin - Mission Damsite No. 1.
   (a) First Development
   (b) Ultimate Development
4. Mission Gorge Basin - Damsite No. 2.
   (a) First Development
   (b) Ultimate Development
5. Mission Gorge Basin - Damsite No. 3.
   (a) Initial Development

El Capitan Basin Damsite No. 1 is located on the San Diego River eight miles above Lakeside. The total tributary drainage area is 192 square miles. Two damsites have been investigated for the El Capitan Basin. Exhaustive core drill recovering borings have been made at Site No. 1 which disclosed the existence of continuous solid granite bedrock foundation and abutments, but at such considerable depths below the surface as to render the construction of a dependable dam at this site prominently expensive.

El Capitan Basin Damsite No. 2 is located on the San Diego River seven and one half miles above Lakeside and one half mile below damsite No. 1. Comprehensive core drill recovery borings are about being concluded at Damsite No. 2, and have so far disclosed continuous solid granite bedrock suitable for foundation and abutments for a high masonry dam and at relatively less depth below surface than at Site No. 1. A few additional borings are required before the depth of the bedrock can be determined up the left or South abutment. The first development provides for a dam of sufficient height to impound water to the 140' reservoir contour, providing storage capacity for 56,000 acre feet of water. This storage will provide a continuous safe duty of 5 million gallons of water per day at the reservoir.

The estimated cost of the first development includes an initial payment of $75,000 for the Indian lands, the construction of a standard gravity type of masonry overflow dam, a filtration plant and a conduit of 10 million gallons daily capacity to the City of San Diego's University Heights Reservoir. The estimated cost of the first development is $4,500,000.

The second development provides for a gravity type masonry dam of sufficient height to impound water to the 190' reservoir contour, providing a storage capacity of 122,000 acre feet. This storage will provide a continuous safe duty of 10 million gallons per day of water at the reservoir. The estimated cost of

the second development includes an initial payment of $75,000 for the Indian lands, the construction of a gravity type masonry dam, a filtration plant and a conduit of 20 million gallons daily capacity to the City of San Diego's University Heights Reservoir.

The estimated cost of the first and second development is $8,000,000.

No provision in the foregoing estimates has been made for the payment of any additional sums that the Secretary of the Interior may require in compliance with the Act of Congress granting to the City of San Diego permission to condemn lands in the Indian Reservation for reservoir flowage purposes.

No amount has been included in the estimates for the purchase of flowage lands and damsites in private ownership, and no amount has been included to cover the cost of impending litigation, nor is it deemed practical to estimate the time required to conclude the litigation.

No reduction has been made in the estimated duty of the water for delivery to the City of San Diego on account of the quantity of water required by the Act of Congress to be delivered by the City of San Diego to riparian land owners along the River below the reservoir basin and to applicants along the conduit to San Diego.

The estimates safe duty of the 192 square miles of the San Diego River Drainage Basin runoff above El Capitan Damsite does, however, contemplate a continued diversion for storage and for direct delivery by the Cuyamaca Water Company as heretofore.

Mission Gorge Basin, Mission Damsite No. 1 is located on the San Diego River at the site of the Old Mission Dam 10 miles above the City of San Diego. The total tributary drainage area is 337 square miles. The first development at the Mission Damsite No. 1 provides for a gravity type masonry dam of sufficient height to impound water up to the 190' reservoir contour, providing storage for 85,000 acre feet. This storage will provide a continuous safe duty of 5 million gallons per day of water at the reservoir. The estimated cost of the first development of Mission Damsite No. 1 includes provision for the estimated cost of the flowage and damsite lands and combination gravity type masonry overflow dam, extended with a concrete core wall embankment at the right or north end, filtration plant and a gravity conduit of 10 million gallons per day capacity to the City of San Diego, located down through Cabrillo Canyon to a connection with the City's distributing system at the South line of Balboa Park at 11th Street. The estimated cost of the first development is $3,000,000.

The ultimate development of Mission Damsite No. 1 provides for a gravity type dam of sufficient height to impound water up to the 130' reservoir contour, providing storage for 282,000

acre feet. This storage will provide a continuous safe duty of 12½ million gallons of water per day at the reservoir. The estimated cost of the ultimate development of Mission Damsite No. 1, includes provision for the estimated cost of flowage and damsite lands, a gravity type dam, filtration plant, and gravity conduit of 20 million gallons daily capacity to the City of San Diego, located down through Cabrillo Canyon to a connection with the City's distributing system at the South line of Balboa Park at 11th street. The estimated cost of the first and ultimate development of Mission Damsite No. 1 is $6,500,000.

Mission Gorge Damsite No. 2 is located on the San Diego River nine and one half miles above San Diego and one half mile below Mission Damsite No. 1. The total tributary drainage area is 387 square miles. The first development at the Mission Damsite No. 2 provides for a dam of sufficient height to impound water up to the 116' reservoir contour, providing storage for 87,000 acre feet. This storage will provide a continuous safe duty of 5 million gallons of water per day at the reservoir. The estimated cost of the first development of Mission Damsite No. 2 includes provision for the estimated cost of the flowage and damsite lands, and gravity type masonry overflow dam, filtration plant and a gravity flow conduit of 10 million gallons per day capacity to the City of San Diego, located down through Cabrillo Canyon to a connection with the City's distributing system at the South line of Balboa Park at 11th street. The estimated cost of the first development of Mission Damsite No. 2 is $2,500,000.

The ultimate development of Mission Gorge Damsite No. 2 provides for a masonry dam of sufficient height to impound water up to the 156' reservoir contour, providing storage for 285,000 acre feet. This storage will provide a continuous safe duty of 12½ million gallons of water per day at the reservoir. The estimated cost of the ultimate development of Mission Damsite No. 2 includes provision for the estimated cost of flowage and damsite lands, a gravity type masonry dam, filtration plant, and gravity conduit of 20 million gallons daily capacity to the City of San Diego, located down through Cabrillo Canyon to a connection with the City's distributing system at the South line of Balboa Park at 11th street. The estimated cost of the first and ultimate development of Mission Damsite No. 2 is $5,250,000.

Mission Gorge Damsite No. 3 is located on the San Diego River seven and one half miles above San Diego and about two and one half miles below Mission Damsite No. 1. The total tributary drainage area is 392 square miles, the first development at the Mission Gorge Damsite No. 3 provides for a dam of sufficient height to impound water up to the 210' reservoir contour, providing storage for 25,000 acre feet. This storage will provide a continuous safe duty of 4½ million gallons of water per day at the reservoir. The estimated cost of the first development of Mission Gorge Damsite No. 3 includes provision for the estimated

cost of the flowage and damsite lands and gravity type masonry overflow dam, filtration plant, pumping plant and a conduit of 10 million gallons per day capacity to the City of San Diego, located down through Cabrillo Canyon to a connection with the City's distributing system at the South line of Balboa Park at 11th street. The estimated cost of the first development of Mission Damsite No. 3 is $3,250,000.

Core recovering borings are essential at both the Mission Gorge Damsite No. 1 and Site No. 2 before supported final conclusions can be reached.

The surface out-cropping of apparent continuous bedrock at Site No. 2 and core recovering borings at Site No. 3 however justify favorable assumptions.

SUMMARY OF QUANTITIES AND ESTIMATES

ALTERNATIVE PROJECTS UNDER CONSIDERATION	MAXIMUM DUTY OF RESERVOIRS MILLION GALLONS PER DAY	ESTIMATED COST COMPLETE	RESERVOIR CAPACITY ACRE FEET	RESERVOIR CAPACITY BILLION GALLONS	FLOODED AREA, ACRES	RESERVOIR GAGE HEIGHTS	ELEVATION OF STREAMBED AT DAMSITE
El Capitan 1st Development	5.0	$4,500,000	56,000	18-1/4	1052	140	553
El Capitan 2nd Development	10.0	$8,000,000	122,000	39-3/4	1625	190	553
Mission Gorge Site #1 1st Development	5.0	$3,000,000	85,000	27-3/4	3280	90	270
Mission Gorge Site #1 Ultimate Development	12.5	$6,500,000	282,000	91-3/4	6530	130	270
Mission Gorge Site #2 1st Development	5.0	$2,500,000	87,000	28-1/4	3320	116	244
Mission Gorge Site #2 Ultimate Development	12.5	$5,250,000	285,000	92-3/4	6580	156	244
Mission Gorge Site #3 1st Development	4.5	$3,250,000	25,000	8-1/4	575	210	100

MUNICIPAL RESERVOIRS - SUMMARY OF QUANTITIES

	MAXIMUM SAFE DUTY ALL RESERVOIRS MILLION GALLONS DAILY	RESERVOIR CAPACITY ACRE FEET	RESERVOIR CAPACITY BILLION GALLONS	FLOODED AREA ACRES	RESERVOIR TOP HEIGHTS
Upper Otay		3,100	1	164	77
Lower Otay, if radial gates installed		57,000	19	1300	145
Barrett (When completed)	9.2	43,000	14-1/3	862	169
Morena, if ample spillway provided		47,000	15-2/3	1380	150

Recommendations:

It is recommended that the City of San Diego proceed immediately to:

1. Acquire the necessary lands and rights of way for the conservation of water at Mission Gorge Reservoir Basin and Damsite No. 2.

2. Construct a dependable overflow section masonry dam (designed for enlargement to ultimate capacity), of sufficient height to create a reservoir of 87,000 acre feet capacity.

3. Construct a filter plant.

4. Construct a gravity conduit of 10 million gallons daily capacity from Mission Gorge Reservoir to the City of San Diego to connect with the City distributing system at the south line of Balboa Park at 11th street, San Diego.

Respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/PJK
EIF

SAN DIEGO RIVER PROJECT, EL CAPITAN FEATURE

Reports and Data made available to Consulting Engineer C. D. Marx and Consulting Geologist C. F. Tolman in connection with their report to the Mayor and Common Council dated November 10, 1931 on the Geology of El Capitan Dam Site Number 2 on the San Diego River.

San Diego Additional Water Supply Report by H. N. Savage, August 8, 1923, Document No. 153128.

Additional Water Supply for the City of San Diego, Report of John Ripley Freeman, C.E. Document No. 160932 filed May 24, 1924 including drawings 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 F. C. 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 the El Capitan Reservoir Dam of the City of San Diego October, 1931, H. N. Savage, Hydraulic Engineer in Charge.

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

San Diego River Project, Resolution No. 55214, El Capitan Damsite No. 2, Foundation Geological Formation, December 29, 1930, H. N. Savage, Hydraulic Engineer. Document 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 - The San Diego Union - Letter from M.M.O'Shaughnessy to Claus Spreckels dated 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", "B", "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

Log record of core recovery drilling operations carried on at El Capitan damsite No. 2 by C. O. Johnson.

Photograph copy of composite aerial map showing topography vicinity El Capitan damsite No. 2.

Contract Drawings and Specifications for Lower Otay Dam, Spillway and Outlet Tower.

Drawings
WD-313 sheets 1, 4 and 5
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

Letter 11-13-31 on spillway studies.

10/15/32
Copy /f

November 18, 1931

I HEREBY CERTIFY that the hereto attached document is a full, true and correct copy of Document No. 272758 of the files of this office, entitled "Geological and Engineering Report on the Proposed Dam at El Capitan Dam Site Number 2 on the San Diego River, by C. D. Marx and C. F. Tolman.

Allen H. Wright
City Clerk, City of San Diego, Cal.

GEOLOGICAL REPORT

On the Suitability of the Foundation Rocks at El Capitan Dam Site Number 2 for the Proposed Earth and Rock Fill Dam, the preliminary plans and specifications of which have been furnished us by Hydraulic Engineer, H. N. Savage,

ENGINEERING REPORT

On the Type of Dam Proposed,

and

AN ANALYSIS

Of the Flood Flow Provision for the Spillway and its Design.

by

C. D. Marx,
Consulting Engineer

C. F. Tolman,
Consulting Geologist

November 10, 1931.

TABLE OF CONTENTS

	Page
FRONTISPIECE	5
Panorama of San Diego River in Vicinity of El Capitan Dam Site No. 2 showing boulder-like massive outcrops of granite which will be used for the rock fill at the location of the dam site, and material areas "A", "B" and "C".	
LETTER OF TRANSMITTAL	7
CHAPTER I, FOUNDATION GEOLOGY OF EL CAPITAN DAM SITE NO. 2	9
INTRODUCTION	9
Type of Dam under Consideration	9
Foundation Necessary for the Hydraulic Fill Dam	9
Variation with Depth in Strength and Perviousness of Foundation Rock	9
Location of the Dam Site	9
Selection of Dam Site No. 2 by your Chief Engineer	10
SCOPE OF THE GEOLOGICAL INVESTIGATIONS	10
Investigation Prior to the Present Studies	10
Conclusions reached in a Previous Examination of El Capitan Dam Site No. 2	11
Scope of the Recent Examination of the Dam Site	11
CONCLUSIONS REACHED FROM THE PRESENT INVESTIGATION	12
FOUNDATION ROCK AT EL CAPITAN DAM SITE NO. 2	12
Bed Rock	12
Technical Microscopic Description of the Biotite-Granite	13

Page

RESUME OF FOUNDATION FLAWS THAT HAVE BEEN NOTED IN THE STUDY OF DAM SITES IN SAN DIEGO COUNTY 13

Foundation Flaws 13
Faults cutting a proposed dam site 13
Landslide material 13
Shear zones, shear planes and joint systems 13
Weathering 14
Deep Weathering on the slopes of a dam site 14

STATUS OF EL CAPITAN DAM SITE NO. 2 AS TO THE ABOVE MENTIONED BED ROCK FLAWS 14

Faults 14
Geologic Stability of the Region 15
Earthquakes 15
Landslides 15
Shear Plane and Joint Plane 16
Weathering on the Hillside above the San Diego River at El Capitan Dam Site No. 2 16
Effects produced by weathering 16
Character of this Alteration (Disaggregation) as shown by the Microscope 17
Weathering on the Granite as shown in the Drill Holes 18
Graphic logs shown on the cross section 18
Weathered granite will not core 18
Conditions below the stream bed 19
Conditions on the valley slopes above stream bed 19
Conclusions 20
Spillway 20
Drain tunnel 20

CHAPTER II, DAM DESIGN AND CONSTRUCTION 21

CHAPTER III, SPILLWAY CAPACITY 22

MAP SHOWING ACTIVE SEISMIC FAULT ZONES ACCORDING TO H. O. WOOD 23

Page

APPENDIX I, SEISMIC HISTORY 24

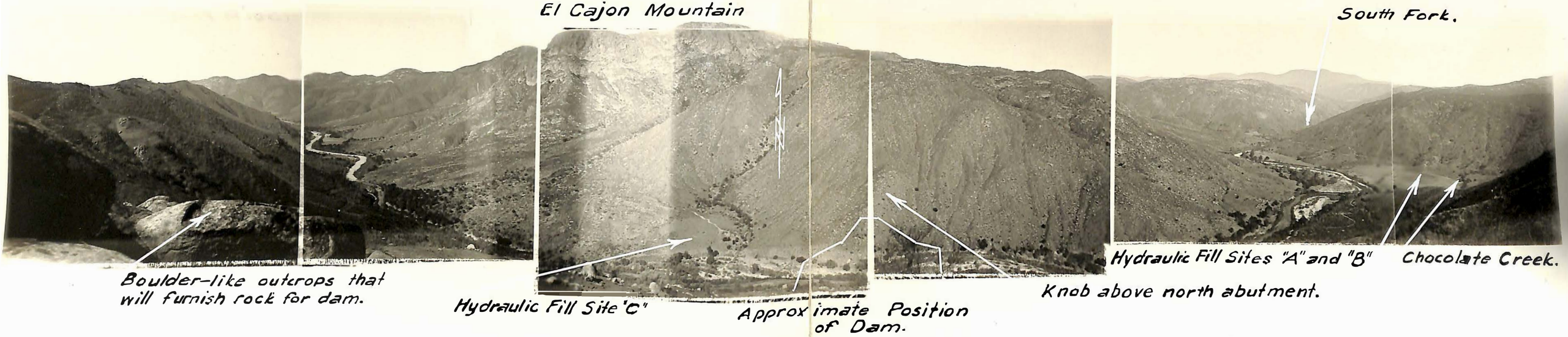
Discussion of Earthquake Record 30

APPENDIX II, Official Reports, Documents and Statistics made Available to us by Mr. H. N. Savage 31

APPENDIX III

Resolution No. 57397 33
Resolution No. 57398 34

FRONTISPIECE



EL CAPITAN DAMSITE NO. 2
IN
SAN DIEGO RIVER VALLEY.

LETTER OF TRANSMITTAL

Stanford University, Calif.,
November 10, 1931.

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

Gentlemen:

As per your resolutions numbers 57397 and 57398, copies of which are attached, the undersigned submit the following report to be transmitted to the State Engineer in support of the application to be filed by the City of San Diego for the construction of a dam at the El Capitan Site No. 2. We understand that the preliminary plans and specifications for this structure were submitted informally to the State Engineer, but that no formal application to construct the dam has been filed to date.

It became our duty under your resolutions to pass upon the preliminary plans and specifications, and to make suggestions as to additions to them as will be required to enable the State Engineer to pass favorably upon the application to construct when the final plans and specifications are submitted for his approval.

Since the function of the State Engineer is merely to pass on the safety of any dam which an applicant proposes to construct, the work of your Consulting Board has been merely to pass upon the plans and specifications and upon supplementary information placed at their disposal by the Engineering Department (a list of the data examined by us is attached as Appendix 2).

Our investigation therefore covers:

I. The geological examination of the dam site for the purpose of determining whether a dam of the proposed type and of the required dimensions can safely be built at the proposed site.

II. A study of the type of dam proposed for the site.

III. An analysis of the flood flow provision made for the proposed spillway and its design.

The factors above enumerated are the only ones that affect the safety of the structure, and are the only ones considered by us in our study.

CHAPTER I

FOUNDATION GEOLOGY

OF EL CAPITAN DAM SITE NUMBER 2.

INTRODUCTION

Type of Dam Under Consideration

In the geological study we have confined our investigations to the foundation conditions necessary for the hydraulic fill dam designed by your Engineer, Mr. H. N. Savage, the plans and specifications of which will appear in the application to the State Engineer.

Foundation Necessary for the Hydraulic Fill Dam

This type of structure does not demand a strength of foundation that would be necessary for a rigid structure of the same size. In this particular locality the strength of foundation increases with depth from surface and reaches the maximum where the effects of weathering disappear. Therefore, to obtain bed rock of fresh unweathered granite of maximum strength, it is necessary to excavate to the bottom of the zone affected by weathering. According to the results of core drilling, this is very deep.

However, a hydraulic fill dam calls for a foundation sufficient merely to sustain the weight of the overlying structure. The core wall must rest on rock that will sustain the weight of the overlying structure without yielding, and the foundation rock must be fully as impervious as the core wall itself. This involves, therefore, deeper excavation for the core wall than for the remainder of the structure.

Variation with Depth in Strength and Perviousness of Foundation Rock at the El Capitan Site

The variation in strength and perviousness of the foundation rock from the surface downward is the important feature and is discussed in detail.

Location of the Dam Site

El Capitan Dam Site No. 2 is located about 25 miles northeast of the City of San Diego on the San Diego River, as shown in the map accompanying the

application to be filed with the State Engineer. The site in question is the more southerly of the two sites explored in 1921 and 1922.

Selection of Dam Site No. 2 by your Chief Engineer

After careful examination and drilling, the lower site was found to be far superior to the upper site, and was rightly selected by your engineer as the more satisfactory location for the dam.

SCOPE OF THE GEOLOGICAL INVESTIGATIONS

Investigations Prior to the Present Studies

In addition to the joint detailed studies at El Capitan Dam Site No. 2, the results of which are summarized in this report, the geologist of the board has examined the geological environment of all the dams owned by the City of San Diego, and all of the dam sites that have been considered in connection with your plans for water development except the Mission Dam Site. He has also submitted to the Honorable Mayor and Council of the City of San Diego through Mr. J. W. Williams, the Assistant Manager of Operations then in charge of your water development, geological reports on the natural rock foundation of the following dams and proposed dam sites:

Upper and Lower Sutherland Dam Sites
Reported August 22, 1927
Upper and Lower Pamo Dam Sites
Upper and Lower Roden Dam Sites
San Vicente Dam Site
The El Capitan Dam Sites, including the Lower El Capitan Dam Site No. 2, the Upper El Capitan Dam Site No. 1, and El Capitan Dam Site No. 3
Reported August 28, 1927
Lower and Upper Otay Dam Sites
Barrett Dam
Morena Dam
Cuyamaca Dam
Sutherland Dam
Murray Dam
San Dieguito Dam
Hodges Dam
Cholla Dam
Reported May 21, 1928

The general geology of the granitic complex of San Diego County is outlined in the report on the two Sutherland Dam Sites, and the character and origin of

bed rock flaws that may affect dam sites in this region and in this type of rock are disoussed therein.

In the report on the safety of the various dams owned by the City of San Diego by a Consulting Board consisting of engineers, Louis C. Hill, C. R. Oldberg, A. J. Wiley, and the geologist signing this report, the topographic history and general geology of the region in which these dams are situated are discussed in so far as they have a bearing on the character of foundation and the safety of these dams.

Conclusions Reached in a Previous Examination of El Capitan Dam Site No. 2

The following summary appears in the report of August 28, 1927 on the Lower El Capitan Dam Site No. 2.

"The El Capitan Damsites:"

"The geological formations at the two sites are similar. The lower site has been favored over the upper on account of the shallower depth of the zone of rock alteration. The bed rock formation is a mica-rich granite (younger phase) without shear zones or fissuring. The lower site has not been affected by landslides. There are no visible active faults in the vicinity.

"The deep belt of weathering that occurs at both damsites is due to the extreme ease with which this mica-rich, even-grained granite disintegrates in the belt of a fluctuating water table. Below this zone of fluctuation sound rock has been found by drilling and the depth of fresh granite is known. A properly designed structure, going down to sound bed rock where necessary, can be constructed."

Scope of the Recent Examination of the Dam Site

In the recent geological investigation of this site, the geologist has re-studied the area in detail. Special attention was paid to the possibility of faults that might affect the safety of the dam and to landsliding on the slope north of the river. He also has analyzed critically and in more detail the results of the core drilling on the site, and had the opportunity of conference with the driller, Mr. Johnson, who explained the character of the material encountered in the drill holes much more in detail than appears in the log books. He also was offered all the data collected by your Chief Engineer in his long study of the situation.

CONCLUSIONS REACHED FROM THE PRESENT INVESTIGATIONS

These additional studies have in no way changed the opinion formed during the preliminary and brief investigation in 1927. The site affords a satisfactory support for the hydraulic fill structure and will not slide or yield under the weight of the dam.

The relatively shallow sands and gravels in the river bed and the thin veneer of residuary soil which lies on the granite will be more pervious than the dam, and all the other material will be far less pervious than the hydraulic dam itself.

The bed rock, whether of disintegrated granite or of fresh granite, is insoluble and will not suffer softening or disintegration under the dam. The structure, therefore, can be laid directly on the disintegrated granite with safety.

The foundation for the core wall will involve excavation in the weathered granite to the depth at which the rock will have sufficient strength to support the wall, and have an imperviousness equal to that of the cement structure. From the meager evidence shown in the tunnels on each side of the river, it is probable that this excavation will not be on the average more than 15 or 20 feet deep. The specifications covering the depth of trench read: (Page 37)

"61. CUTOFF TRENCH.- The excavation for the cutoff walls under the dam and spillway structures shall be made to such depth and width as directed by the engineer, and by means of open out, tunneling or stoping."

These specifications appear satisfactory and will not involve excessive excavation.

FOUNDATION ROCK AT EL CAPITAN DAM SITE NO. 2

Bed Rock

The particular rock formation at the El Capitan Dam Sites is biotite-granite. Fresh unaltered granite occurs below the capping of weathered material. This rock is massive, dense, strong and elastic and constitutes a thoroughly satisfactory foundation material, far stronger than any man-built structure that could be placed upon it.

A similar foundation rock occurs at the Barrett Dam Site where the massive granite is well exposed, and is perhaps the best foundation rock to be found in the county.

Technical Microscopic Description of the Biotite-Granite

Viewed with unaided eye, the individual minerals can be recognized as feldspar, quartz and biotite. An examination of samples of core show a general parallel arrangement of the biotite, otherwise the rock is a normal even-grained granite.

Viewed under the microscope, the feldspar is orthoclase, microcline and acid plagioclase. Quartz is abundant. Highly pleochroic biotite is the principal dark mineral. Hornblende altered to calcite and chlorite is occasionally present. Magnetite and apatite are the common accessory minerals. In some specimens pyroxene and magnetite are abundant. Pyroxene is occasionally surrounded by a rim of hornblende. This variety would be denominated biotite-pyroxene granite. The best technical name for the rock as a whole is biotite-granite.

RESUME OF FOUNDATION FLAWS THAT HAVE BEEN NOTED IN THE STUDY OF DAM SITES IN SAN DIEGO COUNTY

Foundation Flaws

Detailed study of the dams and proposed dam sites of the City of San Diego has shown that certain flaws may occur in the "massive granite type" of foundation rock, and should be carefully looked for in any foundation study in this locality and in this type of rock. These are mainly of the four following types:

1. Faults cutting a proposed site. A. These may constitute a weak and leaky member under the dam. B. An "active" fault may greatly increase the earthquake hazard at that particular locality.

2. Landslide material. If slide material is perched on the steep slope of the canyon or gorge at or above a proposed dam site, it constitutes a serious flaw and menace, and may make the site unsuitable for any type of dam. Hence, the first question that arises in the mind of the geologist who is investigating a dam site in this region is whether or not a protruding mass of rock on the hillside is "in place" or has been moved by landslide action.

3. Shear Zones. Shear Planes and Joint Systems. These are commonly denominated "secondary" types of fractures and are never completely absent in granitic rock. They do not seriously weaken the foundation rock below the zone of weathering. Planes of shear and jointing

are planes of "closed" or "tight" fracture at depth, and are opened up at and near the surface by weathering.

Weathering. Rock decomposition due to weathering may be carried down to great depths along a strong shear zone. If this zone is wide, the amount of weathered and weakened material may be so great that the cost of a dam at such a locality would be prohibitive. This was true at the original "Lower Sutherland Dam Site".

4. Deep weathering on the slopes of a dam site. Where the granite is massive and joint planes, shear planes and fractures are largely absent, weathering may attack the rock along the contact planes of the constituent minerals. The adhesion between the individual crystals of the rock is weakened and finally completely destroyed, and the granite crumbles and becomes incoherent sand. This is the major weakness at El Capitan Dam Site No. 2, and is discussed in detail in subsequent paragraphs.

STATUS OF EL CAPITAN DAM SITE NO. 2

AS TO THE ABOVE MENTIONED BED ROCK FLAWS

Faults

No major fault was discovered at or near the dam site. The homogeneous granite at the dam site affords no key beds or reference strata which might register fault movement by the dislocation of the identifiable formations. The investigation, therefore, was limited to the search for an exposure of a strong fault or fissure accompanied by gouge and movement scratches, and a study of the topography to find out if a zone of faulting or fracture was indicated by the alignment of cliffs, draws or other topographic features.

No exposure of any fault was found at or near the dam site. Alignment of cliffs suggest a joint or shear pattern cutting the rocks at a considerable distance from the site, but no major structure or one on which movement has taken place recently was found.

An aeroplane map usually shows the lines of "topographic weakness" which in turn may correspond with the main structural lines of the region.

The composite aeroplane picture of the region has a regular rhombic topographic pattern which indicates two main structural trends. One has a north-easterly direction and is probably parallel to a regular system of broadly spaced joints or shears and to the pronounced gneissic structure of the older igneous rocks which occur at some distance from the dam site. The other ex-

tends in a northwest-southeast direction and is parallel to a second joint system. A strong topographic line cuts the eastern side of El Capitan Dam Site No. 1 about one half mile east of the No. 2 Site. This may either represent a fault or shear zone or joint system. It does not extend continuously far enough to suggest a through fault. It may account for the poor bed rock conditions at the No. 1 site. It is too far away from Site No. 2 to constitute a flaw.

Geologic Stability of the Region.

The coastal region and the western mountain ranges of San Diego County have not suffered the intense folding, faulting and crushing that has affected the region to the north and east.

The Cretaceous, Tertiary, Quaternary and Recent formations that underlie the great terraces along the coast lie in a horizontal and undisturbed attitude, while in contrast, rocks of these ages farther to the north are faulted, closely folded, and in some places even overturned.

The granitic formations of the mountains of this region show no crushing and faulting comparable with that observed, for example, in the San Gabriel Mountains east of Los Angeles. Hence the region in general is of greater geological stability than the region to the north, and sound dam sites are far more numerous.

Earthquakes

The seismic history of the region (see Appendix I) shows that San Diego and vicinity have suffered many small shocks and a few strong ones. These are believed to have originated along certain distant fault zones, and it seems improbable that any disastrous shock will affect the region in the vicinity of the dam site.

Landslides

No loose landslide material was found on or above the abutment of the proposed dam.

The north (right) abutment of the dam will rest against a protruding knob of granite (see photograph). The location of this knob at the foot of a steep slope suggested the possibility that it was a landslide mass. If this exposure were slide material, the slip plane should be exposed in the gullies on each side of the knob. No exposure of ground-up material or any suggestion of a landslide slip plane was discovered. Moreover, the undisturbed and unfractured condition of the granite in the tunnels of this side of the site indicates that no slip movement has occurred.

The upper tunnel would be in the slip plane back of the slide is such had occurred. The granite in this tunnel is not only undisturbed, but also even joint planes are unusually infrequent.

Shear Plane and Joint Plane

Only a few minor shear and joint planes are exposed at the surface and in the exploratory tunnels. They constitute no appreciable weakness at the site.

Weathering on the Hillsides above the San Diego River at El Capitan Dam Site No. 2

The deep weathering on the slopes above stream bed is the principal foundation weakness at the dam site. The depth of weathered material is small directly under the canyon, but increases remarkably on the sides of the canyon.

The unusual depth of the weathered zone under the hill slopes may be explained by topographic and climatic conditions. The minute openings and fractures in the rock are filled with water only during wet seasons which occur once in a few years. In the intervening time all the water drains out of the rock on the steep slope and allows weathering and exposure to air to proceed to great depth.

Weathering occurs where rock is alternately wet and dry. For example, a knife will rust if left out in the open and occasionally wet by rains and dew, but if it lies under water and is protected from the air, there is practically no rust, oxidation, or weathering of the knife blade.

As is shown by the results of core drilling, the hillslope north of the river has been affected by this type of weathering to unusually great depths.

Effects produced by weathering. The result of this process, beginning at the surface, is as follows:

1. At the surface is a residuary soil consisting of fresh or but slightly altered crystals or fragments of crystals which were the original constituents of the granite. Chemical action has produced a minor amount of iron compounds which locally give a red coloration to the residuary soil.

2. Spheroidal weathering is invariably more prominent on the north-facing slope than on the southerly exposures. It developes rounded masses or boulders of fresh granite set in granite that has been completely disintegrated, and in extreme cases chemically changed. These hard residuary boulders may be brought to the surface by erosion and by the washing away of the disintegrated granite.

Often the hill slopes are thickly studded by these great boulders and in some cases these deposits have been wrongly interpreted as a result of stream or flood action, whereas they are merely the accumulation of the hard residuery boulders too large to be moved by the processes of erosion. Such residuary, boulder-shape masses of fresh rock are encountered on the northerly-facing, south slope at the El Capitan Dam Sites. In some of the reports on the sites, this material has been described as a deposit of boulders and sand. This material does not represent stream deposits or alluvial material, but cores of unweathered granite in a weathered matrix, and it is underlain at a moderate depth by solid, sound granite.

3. The residuary soil described above grades downward into material almost soft enough to deserve the classification of "granitic sand", to a crumbly granite that can be disaggregated by pounding or rubbing, finally to a material that has lost little of the original strength of fresh, sound granite.

In the exploration tunnels the rocks break down into individual grains under the hammer rather than fracturing, and one notices a hollow or muffled sound when the rock is struck sharply with the hammer which contrasts with the ringing note returned by fresh, sound granite. Where weathering is more advanced, the granite which appears fresh and undisturbed in candle light, can be crumbled down by rubbing with the fingers.

Character of this Alteration (Disaggregation) as shown by the Microscope

As described above, the fresh rock obtained from core samples is a normal biotite (and pyroxene) granite. Specimens slightly softened register a microscopic separation along the boundaries of individual crystals, especially around the quartz, feldspar and pyroxene. In one thin rock section only out of 16 prepared for the study of this type of alteration, the contact between the minerals showed a minute band of altered material (chlorite?), although the constituent minerals are not decomposed, and the mass remains fresh and unaltered even when the rock is reduced to sand.

Further action develops closed fractures along the cleavage planes of the minerals especially of the feldspar and pyroxene. The final disaggregated product also shows conchoidal fractures cutting the feldspar and quartz crystals.

On account of the unaltered character of the mineral fragments produced by this type of weathering, it would

commonly be classified as mechanical although it is produced by chemical action along the mineral contacts. The quartz and feldspar are as fresh in the completely disaggregated rock as in the solid granite. In the last stages of the process, pyroxene and biotite are altered and some compounds of iron are leached out and stain the adjacent unaltered minerals.

This process, which consists largely in "loosening the bond" between the crystals that constitute the granite, has been denominated "disaggregation" by the writer.

Weathering of the Granite as shown in the Drill Holes.

Graphic logs shown on the cross section. Graphic logs of the drill holes have been assembled by Mr. H. N. Savage, Engineer in charge, on a cross section taken approximately throughout the center of the dam site. This appears as page 83 of the plans and specifications submitted to us for examination.

The logs are plotted on the cross section according to the elevation at which the wells were started. Therefore they are not shown in their relative position on the site, and the drawing is not strictly a cross section, but rather a composite view which gives a general idea of the relation of weathering to position on the hillside and depth below the surface.

The material is classified by Mr. Savage into three groups.

1. Sand, soil and decomposed granite
2. Medium hard granite; partial core
3. Hard granite; full core

Comparison of the graphic logs with the drilling records shows that he put all materials that did not core in the first classification which is the only material of interest here, as it will not be necessary to place the dam or the core wall on fresh unaltered granite.

Weathered granite will not core. Very moderate weakening of the bond between the constituent minerals renders it impossible to recover a solid core in drilling. Complete disaggregation of weathered granite of considerable strength and solidity into sand is accomplished by the twist of the bit and the flow of water.

The depth, therefore, of the material designated as "sand, soil and disintegrated granite" on the cross section is far in excess of any depth of excavation necessary for the type of dam here considered.

Conditions below the stream bed. The records of the driller show that the bore holes drilled within the canyon bottom covered by stream deposits penetrate a minimum of 12 feet, a maximum of 30 feet and an average of 22-1/2 feet of stream sand, gravel and boulders. This material must be removed. Depth below the stream gravels to granite which was sufficiently solid to furnish some core varies from 0 to 36 feet.

Conditions on the valley slopes above stream bed. On the south hillside above the stream gravels "earth and soft granite" (materials which did not core) varies from 19 to 41 feet deep. The depth of "the earth" was reported only in the log of one hole. On this slope all earth and loose material must be removed.

On the north slope the granite is softened to an extraordinary depth. For example, log of Hole No. 9 at elevation 975 feet in the draw above the massive outcrops of solid rock, and approximately 225 feet above the water line of the reservoir, reads as follows:

"Hole No. 9 Formation"

" 0'0"	to 140'	Earth & soft granite - no core
140'	to 220'	Hard dec. granite - no core
220'	to 240'	Soft granite - 1% core
240'	to 265'	Soft granite - 2% core
265'	to 280'	Soft granite - 1% core
280'	to 305'	Soft granite - 5% core
305'	to 312'	Streak of Kaoline - no core
312'	to 320'	Fairly hard granite - 25% core
320'	to 330'	Fairly hard granite - 50% core
330'	to 350'	Hard granite - 100% core"

The average depth of material that did not core in all the north side holes exceeds 120 feet.

This record furnishes no information as to the depth below the surface at which the weathered granite is sufficiently solid and impervious to sustain the dam fill and the core wall. Surface cuts uncover impervious and sufficiently compacted weathered granite to support the fill.

Two tunnels on the north side about 100 feet long penetrate the material that did not core when drilled.

In both tunnels the rock is weathered and will crumble when rubbed smartly with the hand. The granite is undisturbed and shows unusually few joint planes. In the lower tunnel these joint planes are partially opened by weathering for a distance of about 50 feet in from the portal or 20 feet ± from the surface. From this point in, the rock would constitute a satisfactory support for a cutoff wall.

The upper tunnel shows fewer joints, but the granite crumbles somewhat more easily on rubbing. The material is impervious. A satisfactory support for a core wall is encountered 25 feet in or 15 feet from the surface.

Conclusions. Removal of surface soil and loose sand and boulders will uncover material sufficiently strong and impervious to support the dam.

Excavation of moderate depth will expose a satisfactory foundation for the core wall.

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.

Drain tunnel. The drain tunnel will be driven through friable weathered granite which will become harder as depth is gained. Unweathered fresh granite will be encountered in the portion under deepest cover.

Occasional joint and shear planes will be encountered, but probably no serious fractures or faults that might require special engineering treatment. The geological conditions are satisfactory.

CHAPTER II

DAM DESIGN AND CONSTRUCTION

El Capitan Dam is designed as per plans to be submitted to the State Engineer as a combined earth and rock fill dam. The original design for this dam was made by Mr. John R. Freeman and has been incorporated by your hydraulic engineer in the plans submitted to us.

The structure is one that can be built with safety on the proposed site. It is of an elastic type that possesses special advantages in an earthquake country.

The section of the dam, as shown in the plans, is ample for stability.

Great care must be shown in depositing the hydraulic fill as a large quantity of material will be required. Careful surveys and estimates of available material as to quantity were made as per Sheets 1, 2 and 3, Drawing 3 to be submitted to the State Engineer. Physical analysis of the material as to its suitability for a hydraulic fill remains to be made. From mere inspection we are inclined to believe that it will be suitable.

The quantity required is large and can not be placed in one working season. Provision has therefore been made to construct a large by-pass channel to take care of flood flow during construction so as to prevent over-topping of the dam while under construction. Location of the by-pass tunnel and cross sectional dimensions are shown on Sheets 4 and 5 of 5 in the plans and specifications appearing on pages 80 and 81, and in Exhibit A to be submitted to the State Engineer. The calculations for the tunnel capacity are given.

CHAPTER III

SPILLWAY CAPACITY

San Diego County has learned by bitter experience that the provision of ample spillway capacity in a large reservoir is of the utmost importance. The careful studies made by your engineers as to maximum flood runoff to be provided for, based on available precipitation and flood data, are shown in before mentioned exhibit.

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. This also applies to the outlet tower which is only shown in general outlines.

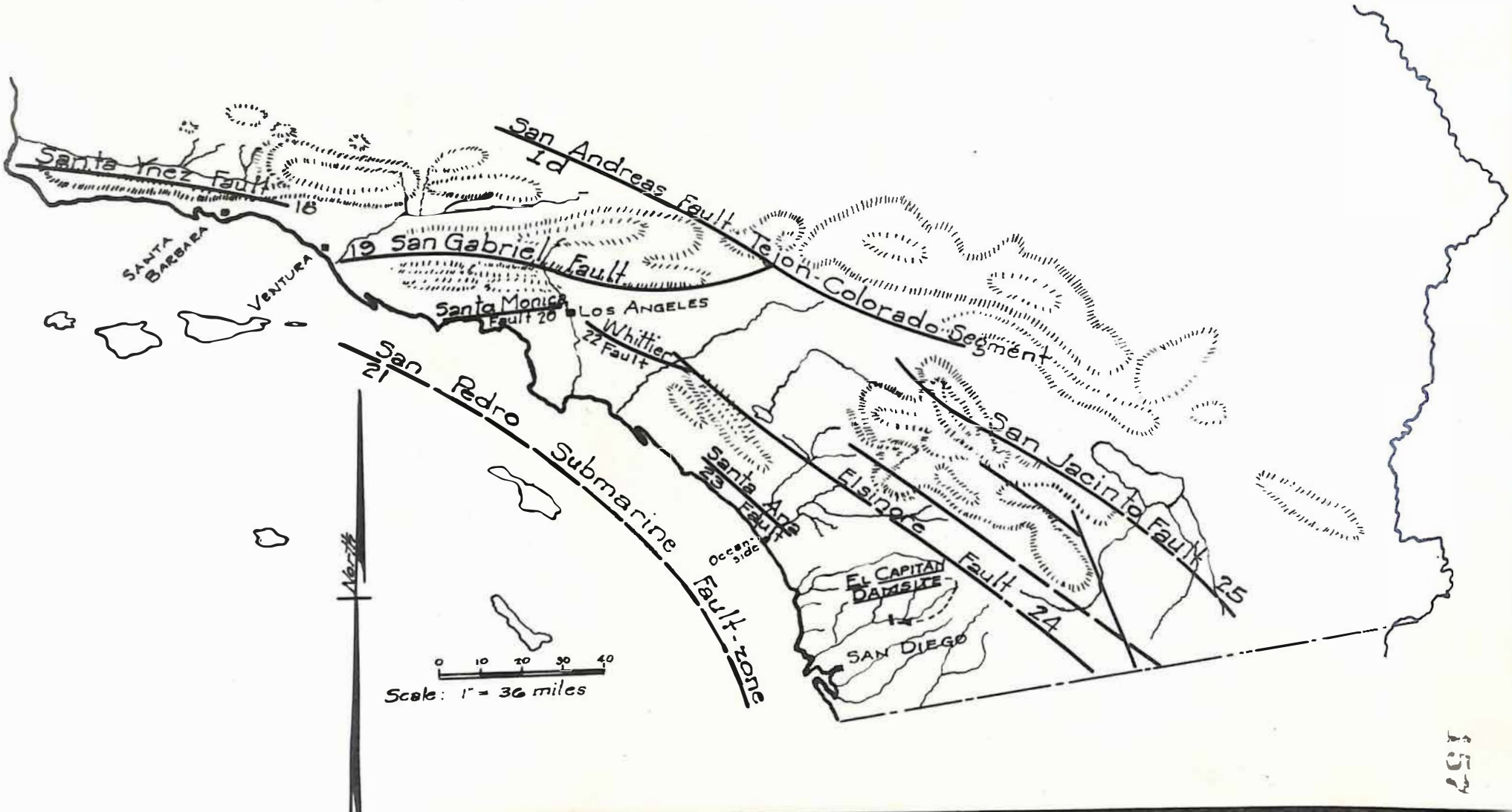
The plans submitted contemplate the permanent plugging of the by-pass tunnel. The State Engineer, on the ground of safety, may require that this by-pass tunnel be not permanently plugged, but be made available as another safety outlet in addition to the large spillway capacity provided.

Bearing in mind, therefore, the function of the State Engineer in passing on your application, we beg to report that in our opinion the plans proposed by your Engineering Department, when supplemented by more detailed plans as suggested, and with the work carried out in conformity with the specifications, will provide for the construction of a safe dam at El Capitan Site No. 2 on the San Diego River.

C. D. Marx (Signature)
C. D. Marx,
Consulting Engineer

C. F. Tolman (Signature)
C. F. Tolman,
Consulting Geologist

Portion of a map accompanying article on California Earthquakes, by H.O. Wood, showing active earthquake zones on which principal earthquakes of the region have originated.



APPENDIX I

SEISMIC HISTORY

List of Earthquakes in San Diego and vicinity

Compiled by A. C. Stipp, November 5, 1931 from the following references:

McAdie, A.G., Catalogue of Earthquakes on the Pacific Coast 1897-1906, Smithsonian Misc. Coll. No. 1721.

Wood, H. O., California Earthquakes, Bull.Seis.Soc.Amer, Vol. VI, p. 6.

Holden, E. S., A Catalogue of Earthquakes on the Pacific Coast, 1769-1897.

Earthquakes Recorded in Southern California, an unpublished article by B. Willis.

Bulletins of the Seismological Society of America.

Determination of faults causing earthquakes after Harry O. Wood. Rossi-Forel Scale of Intensities.

Date	Location & Intensities	Reference	Faults Causing Earthquakes
1769 Apr. 11	San Diego. Record affords no basis for judging intensity.	Wood	Source estimated only in vaguest way
1803 May 25	San Diego. Mission damaged. VIII.	"	San Pedro Submarine fault-zone, San Jacinto, Elsinore, or Santa Ana faults in order most probable sources
1850 Aug. 15	San Diego & on Gila R.	"	
1852 Apr. 12	San Diego	Holden	
1852 Oct. 26	Shocks at intervals during last 6 days throughout So.Calif. 11 shocks at San Simeon, Los Angeles San Gabriel. Also noted at San Diego. Inten. X		San Juan-Tejon & Tejon-Colorado segments probable source. San Luis Obispo Templeton, Santa Ynez, San Gabriel, Elsinore, San Jacinto faults possible

Date	Location & Intensities	Reference	Faults Causing Earthquake
1852 Nov. 27 -30	Distributed over 300 sq. miles, east from San Luis Obispo to Colorado R. and south to San Diego. IX (X)?	Wood	Slipping of considerable extent along San-Juan-Tejon & Tejon-Colorado segments of San Andreas F.
1852 Nov. 29	Recorded only at San Diego One of a series of shocks in So. Calif. in autumn of this year. IX	"	Origin probably at considerable distance. Probably not confined to San Andreas F. San Jacinto & Elsinore faults possible & Carizo not impossible. San Pedro Submarine fault-zone most probable of all.
1856 Sept. 22	Light shock in evening at San Diego, III	Holden	
1857 Jan. 8-9	Perhaps strongest recorded on coast Mt. Province in Calif. Widely separated localities affected, Visalia to San Diego.	Wood	San Andreas F. and probable contributory activity on San Gabriel, San Pedro Submarine fault-zone Elsinore or possibly San Jacinto fault.
1859 Mar. 21	San Diego	Holden	Probably San Pedro Submarine fault-zone or Elsinore or San Jacinto Faults. Santa Ana F. doubtful.
1862 June 13	San Diego	"	Origin same as above.
1862 Oct. 21	Violent shock at San Diego, VI. Seven shocks at this point since May 28th	"	
1863 Jan.	Severe shock at San Diego, VI.	"	
1863 Apr. 15	Severe shock at San Diego, VI.	"	

Date	Location & Intensities	Reference	Faults Causing Earthquakes
1867 Feb. 1	Three shocks at San Diego	Holden	Probably San Pedro fault-zone or Elsinore or San Jacinto faults. Santa Ana F. doubtful.
1872 Mar. 23	San Diego	"	Same as above
1873 Oct. 12	San Diego, V	"	
1877 Jan. 13	45 miles southeast of San Diego, VI.	Wood	Not far from SE prolongation of Elsinore F. Agua Caliente & San Jacinto faults extended would pass not far from place of report
1880 Aug. 29	Slight shock at San Diego, III.	Holden	Probably San Pedro Submarine fault-zone or Elsinore or San Jacinto faults. Santa Ana F. Doubtful.
1882 Mar. 11	Slight shock at San Diego, III	"	Same as above.
1882 Oct. 8	Heavy shock at San Diego, V.	"	
1883 Feb. 6	Slight shock at San Diego, III	"	Probably San Pedro Submarine fault-zone or Elsinore or San Jacinto faults. Santa Ana F. doubtful.
1887 Aug. 24	San Diego felt 2 slight shocks, III	"	Same as above.
1892 Feb.23-24	Carizo, San Diego, etc. (IX)? VII	Wood	Beal (Bull.Seis.Soc. Am. V. 5, 138) puts origin on Agua Caliente F. Reports from Ensenada & San Quentin indicate San Pedro Submarine fault-zone equally probable.
1892 June 14	Perceptible shock in city & county of San Diego. No damage.	Holden	

Date	Location & Intensities	Reference	Faults Causing Earthquake
1893 Apr. 4	Slight shock at San Diego, III.	Holden	
1893 Aug. 9	Two slight shocks at San Diego.	"	
1897 May 15	San Diego felt light shock at 4 A.M.	McAdie	Probably San Pedro Submarine fault-zone or Elsinore or San Jacinto faults. Santa Ana F. doubtful.
1897 May 22	Sharp shock at San Diego lasted 2 seconds	"	Same as above
1899 July 22	San Diego, III, vibration east to west.	"	
1899 Aug. 21	San Diego	"	Same as above
1899 Dec. 25	San Diego, IV, Felt through out So. Calif. Most serious shock for years. 2 shocks felt at Los Angeles.	"	
1900 July 23	San Diego	"	Probably San Pedro Submarine fault-zone or Elsinore or San Jacinto faults. Santa Ana F. doubtful.
1903 Jan. 23	San Diego, III. Vibrations northeast to southwest.	"	
1905 Apr. 24	Point Loma		Same as above.
1906 Mar. 8	San Diego, II, Southwest to northeast. Also reported at Calexico, Camp Cuyamaca, El Cajon, Riverside & Point Loma	"	
1906 Apr. 18	San Diego, Brawley, Yuma, Wood etc. IX (IX-X) Strong shock in evening. Brawley IX place of greatest intensity.		Both San Andreas & San Jacinto Faults have histories of action. An unnamed fault heads directly for place of gr. intensity.
1906 June 27	Point Loma	McAdie	

Date	Location & Intensities	Reference	Faults Causing Earthquake
1906 Oct. 18	Point Loma, IV. Lasted about 2 sec. Recorded also at Santa Clara	Bull. Seis. Soc. Am.	
1912 Apr. 14	Light tremors at Pt. Loma, III. Slight tremors recorded from Apr. 18th to May 20th.	"	
1912 May 15	Slight tremor at San Diego IV.	"	
1913 Apr. 21 May 8 - 15	Slight tremors at Pt. Loma	"	
1915 Sept. 7	San Diego, II, Pt. Loma, V.	Willis	
1915 Nov. 20	Rocking movement at Blythe II, Brawley, El Cajon V, Trembling movement Los Angeles, San Bernardino & San Diego, II	"	
1916 May 27	San Diego, II	"	
1916 Sept. 29	San Diego, II. Greatest intensity at Coachella, Julian, Palm Springs, Valley Center, V; Beaumont, Cahuilla, Etc., IV.	"	
1917 May 27	Pt. Loma, III, Barrett Dam, Calexico, Coachella, Julian etc., V. Greatest at Brawley, VI.	"	
1918 Apr. 21	San Diego VI, Hemet X; Banning Cahuilla, Winchester, etc. IX; Aguanga, Beaumont, Imperial, Los Angeles, etc. VIII. Large area affected.	"	
1919 June 24	San Diego, IV	"	
1919 Dec. 31	San Diego, IV, Aguanga, Elsinore, Escondido, Mesa Grande, etc., V.	"	
1920 May 20	Two shocks at San Diego V & IV,	"	
1921 Sept. 8	Slight shock at San Diego	Bull. Seis. Soc. Am.	

Date	Location & Intensities	Reference	Faults Causing Earthquake
1923 July 20	San Diego, II	Willis	
1923 Nov. 5	San Diego, II	"	
1923 Nov. 7	San Diego, III	"	
1925 Aug. 8	San Diego, slight shock throughout So. California	Bull. Seis. Soc. Am.	
1926 Apr. 19	San Diego and Calexico report slight shock in vicinity of these two cities.	"	
1927 Oct. 5	Two minor shocks and two more severe. Felt also in Imperial Valley cities. Lasted 4 seconds.	"	
1927 Nov. 6	Slight shock in San Diego and vicinity.	"	
1928 Oct. 2	Two slight tremors at San Diego. Felt by few people.	"	
1930 Feb. 7	San Diego. Three slight shocks lasting from 12 to 18 seconds in close succession. Felt also in Agua Caliente.	"	

Discussion of the Earthquake Record

The accompanying map shows the location of the active earthquake fault zones according to H. O. Wood. The main group of active faults extends southeasterly across the northeastern corner of San Diego County. The majority of shocks felt in San Diego have originated in this zone. The remainder are assigned by Mr. Wood to the San Pedro Submarine fault-zone.

The El Capitan dam site is situated midway between these two zones and is in a favorable position in so far as earthquake hazard is concerned.

APPENDIX II

The following official reports, documents and statistics were made available to us by Mr. H. N. Savage:

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. Copy Document No. 160932 filed May 24, 1924, including drawings sheets 1, 2 and 25.

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.

Copy Document 140165 (Files of H. N. Savage)
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 the El Capitan Reservoir Dam of the City of San Diego, October, 1931. Hiram Newton Savage, Hydraulic Engineer in Charge.

The Freeman Report

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

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. Copy 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 - The San Diego Union - Letter from M. M.

O'Shaughnessy to Claus Spreckels dated November 8, 1924
Copy of letter from M. M. O'Shaughnessy to John D. Spreckels
Rainfall-Runoff data by H. N. Savage 1850 to 1930-1

3 photographs 9-15-31 El Capitan Hydraulic Fill Dam Material area "A"
9-15-31 " " " " "
Material area "B"
8-15-31 " " " " "
Material area "C"

3 drawings File 2435 - D2)
2435 - D2) WD 351
2435 - D2)

City of San Diego, California. Bureau of Water Development Notice Inviting Bids, Proposals, Drawings and Specifications El Capitan Reservoir Dam, Spillway and Outlet Works, Storage to elevation 750, Hiram Newton Savage, Hydraulic Engineer. (Files of H. N. Savage)

APPENDIX III

RESOLUTION NO. 57397

BE IT RESOLVED by the Common Council of The City of San Diego, as follows:

That C. D. Marx of Palo Alto, California, be, and he is hereby employed by The City of San Diego as the Consulting Engineer in connection with a dam to be built at the El Capitan damsite, County of San Diego.

That he is to furnish such reports in the capacity of consulting engineer on the construction of El Capitan Dam as may be required by the State Engineer of the State of California; and shall commence work on such study and report on the 23rd day of October, 1931, or as near thereafter as possible, and shall complete the same in not to exceed fifteen (15) days thereafter.

That his compensation shall be One Hundred Dollars ($100.00) per day, plus expenses from Palo Alto to San Diego and return, and current expenses while in the City of San Diego.

BE IT FURTHER RESOLVED that a majority of the members of the Common Council be, and they are hereby authorized to enter into a contract with C. D. Marx, which contract shall contain the above conditions and terms.

I HEREBY CERTIFY that the above and foregoing is a full, true and correct copy of Resolution No. 57397, as adopted by the Common Council of the city of San Diego on Oct. 19, 1931.

Allen H. Wright
City Clerk

By Clark M. Foote, Jr.
Deputy

RESOLUTION NO. 57398

BE IT RESOLVED By the Common Council of The City of San Diego, as follows:

That C. F. Tolman of Palo Alto, California, be, and he is hereby employed to furnish The City of San Diego a geological report in connection with the damsite known as the El Capitan, in the County of San Diego; and he shall make such studies and report as may be necessary in order to fulfill the requirements of the State Engineer in ascertaining, compiling and submitting the geological data necessary to enable the State Engineer to have full information concerning same; and shall commence work on said study and report on the 23rd day of October, 1931, or as near thereafter as possible, and shall complete the same in not to exceed fifteen (15) days thereafter.

That his compensation shall be One Hundred Dollars ($100.00) per day, plus expenses from Palo Alto to San Diego and return, and current expenses while in the City of San Diego.

BE IT FURTHER RESOLVED that a majority of the members of the Common Council be, and they are hereby authorized to enter into a contract with C. F. Tolman, which contract shall contain the above conditions and terms.

I HEREBY CERTIFY that the above and foregoing is a full, true and correct copy of Resolution No. 57398, as adopted by the Common Council of the City of San Diego on Oct. 19, 1931.

Allen H. Wright
City Clerk

Clark M. Foote, Jr.
Deputy

SUPPLEMENTARY STATEMENT

To be Attached to

Geological Report on the Suitability of Foundation Rock and Engineering Report of the Proposed Earth and Rock Fill Dam at El Capitan Dam Site Number 2.

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

Since the date of our report of November 10th, 1931 we have received on November 15th, 1931 from your Hydraulic Engineer, Mr. Savage, supplementary information asked for as follows:

WD-313	Sheet 1	Plan	Edited to date
WD-313	" 4	Section of Dam	" " "
WD-313	" 5	Siphon Section	" " "
WD-363	Spillway Plan and Section		
WD-364	Typical Retaining Wall Section		
WD-367	Typical Retaining Wall Section and Core Wall Detail		
WD-368	Outlet Tower		
Results of Spillway Studies			

These supplementary drawings to be added to those to be submitted to the State Engineer contain the necessary information to enable him to check the structural details of the proposed side channel spillway and the siphons.

The calculations for the spillway show that ample spillway capacity has been provided.

Objection to plugging the by-pass tunnel has been met by providing two 40 inch drain pipes through the plug, as shown in Sheet WD-368.

In our opinion the supplementary information now furnished is sufficient to meet the requirements of the State Engineer and confirms our opinion previously rendered that the plans proposed by your Engineering Department, now supplemented by more detailed plans, and with the work carried out in conformity with the specifications, will provide for the construction of a safe dam at El Capitan Site No. 2 on the San Diego River.

Chas. D. Marx (Signature)
C. D. Marx
Consulting Engineer

C. F. Tolman (Signature)
C. F. Tolman,
Consulting Geologist

November 16, 1931

GEOLOGICAL AND ENGINEERING REPORT ON THE PROPOSED DAM AT EL CAPITAN DAM SITE NUMBER 2 ON THE SAN DIEGO RIVER

C. D. MARX

C. F. TOLMAN

9/3/32
copy /f

November 18, 1931.

I HEREBY CERTIFY that the hereto attached document is a full, true and correct copy of Document No. 272758 of the files of this office, entitled "Geological and Engineering Report on the Proposed Dam at El Capitan Dam Site Number 2 on the San Diego River, by C. D. Marx and C. F. Tolman.

Allen H. Wright
City Clerk, City of San Diego, Cal.

LETTER OF TRANSMITTAL

Stanford University, Calif.,
November 10, 1931.

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

Gentlemen:

As per your resolutions numbers 57397 and 57398, copies of which are attached, the undersigned submit the following report to be transmitted to the State Engineer in support of the application to be filed by the City of San Diego for the construction of a dam at the El Capitan Site No. 2. We understand that the preliminary plans and specifications for this structure were submitted informally to the State Engineer, but that no formal application to construct the dam has been filed to date.

It became our duty under your resolutions to pass upon the preliminary plans and specifications, and to make suggestions as to additions to them as will be required to enable the State Engineer to pass favorably upon the application to construct when the final plans and specifications are submitted for his approval.

Since the function of the State Engineer is merely to pass on the safety of any dam which an applicant proposes to construct, the work of your Consulting Board has been merely to pass upon the plans and specifications and upon supplementary information placed at their disposal by the Engineering Department (a list of the data examined by us is attached as Appendix 2).


SAN BERNARDINO
173
SAN VICENTE DAMSITE
Muth Valley
Foster
San Vicente Creek
Moreno
Lawlor Lake
SAN DIEGO RIVER
MONTE TUNNEL
LOS COCHES TUNNEL
Coches Creek
CAPE HORN TUNNEL
PADRE BARONA VALLEY
Padre Barona Creek
Featherstone
Wright
Canyon
Canyon
El Cajon Mt. 3690
LOWER EL CAPITAN DAMSITE — #2
UPPER EL CAPITAN DAMSITE — #1
Chocolate Creek
Peutz Valley
No 3 DAMSITE
El Capitan
CAPITAN GRANDE INDIAN RESERVATI

9/12/32
copy /f

Excerpts from

PRELIMINARY REPORT ON THE GEOLOGY

of

Upper and Lower Ramo Damsites
Upper and Lower Roden Damsites
The San Vicente Damsite
The Lower, Upper and No. 3 Damsites
at El Capiton

by

C. F. Tolman

Stanford University

California.

9/2/32
copy/f

Mr. J. W. Williams,
Hydraulic Engineer,
City of San Diego, California.

Dear Sir:-

After completing the detailed geological investigation of the Sutherland damsites August 20, 21, 22, 1927, I made a preliminary geological study of the two Pamo damsites, the two Roden damsites, the San Vicente damsite and the lower and upper El Capitan damsites and the El Capitan No. 3 damsite on August 23-27 inclusive.

The accompanying brief report on these sites deals solely with bed rock geology. A knowledge of bed rock conditions is equally important to a satisfactory solution of your water problems and the determination of the best plan for water development as is the understanding of the hydraulic data regarding storage and flood control conditions of the main drainage systems, and the topography of the damsites and reservoir sites, and the data regarding water distributing systems.

Respectfully submitted

C. F. TOLMAN (Signature)

Sutherland Camp, August 22, 1927.

SUMMARY AND RECOMMENDATIONS

* * * * * *

The El Capiten Damsites.

The geological formation at the two sites are similar. The lower site has been favored over the upper on account of the shallower depth of the zone of rock alteration. The bed rock formation is a mica-rich granite (younger phase) without shear zones or fissuring. The lower site has not been affected by landslides. There are no visible active faults in the vicinity.

The deep belt of weathering that occurs at both damsites is due to the extreme ease with which this mica-rich, even-grained granite disintegrates in the belt of a fluctuating water table. Below this zone of fluctuation sound rock has been found by drilling and the depth to fresh granite is known. A properly designed structure, going down to sound bed rock where necessary, can be constructed.

El Capitan No. 3 Damsite.

This low damsite can be utilized to hold the water during seasons of low precipitation, and is easily built, and hence can furnish an early available supply of water to the City of San Diego and allow time for the adjustment of the legal difficulties in connection with the main damsite, and also for the solution of the engineering difficulties that must be met in the construction of the main dam.

The damsite is on a solid dike of hornblende granite 100 to 200 yards wide. No zone of decomposed material is to be expected under the granite, and its presence or absence can easily be determined by the drill.

The site is favorable for the construction of a low dam which may be of value after the construction of the main structure, in holding back the silt from the lower portion of the reservoir.

THE EL CAPITAN DAMSITES

The various sites.

These are the lower damsite, the upper damsite and the No. 3 damsite shown on the accompanying map. The great importance of a structure either at the lower or upper damsite has long been recognized, as it will control the large water crop of the San Diego river and stop the disastrous floods in the river below the damsite. Surveys and explorations by tunnels, pits and drill holes have been made on both damsites.

Weathering.

The upper damsite (number one) shows an astonishing depth of decomposed granite, over 200 feet deep, under the ridge north of the river and actually lower than the bed rock at the stream.

The lower damsite (number two) has a somewhat shallower depth of decomposition averaging about 150 feet according to the charts of drill holes furnished me, and bed rock is higher than, and slopes toward, the stream bed rock. The upper site has rightly been rejected for the lower on account of the greater depth of decomposed granite.

Importance of a dam in this location.

The dam structure will be expensive but it must be built, and it will call for engineering work of the highest character to determine what portion of the structure must extend down to the entirely fresh granite, and what portion, if any, can rest on somewhat softened bed rock.

Scope of the geological examination.

On account of the interest that has rightly centered on this important project, and because of the suggestions that the lower damsite is weakened by the presence of faults and that the ridge to the north of the damsite may have been affected by landslide action, it seemed desirable to examine the site with reference to these points and if possible to determine the cause of the deep weathering of the granite at this locality.

The country rock.

The country rock of the damsites is an unusually mica-rich (biotite) granite (younger type). It is massive, free from pronounced shear joints and develops craggy outcrops of fresh massive granite, which appear along the apex of the ridge on the north side of the damsite, and occur as irregular boulder-like masses on the hill slopes to the south especially above the road.

Character of weathering.

Exposures along the road and especially along the river banks, washed clean by the great floods of last winter, show

that the underlying granite is completely softened (disaggregated) and crumbles under the touch of the hand. This weathering consists of a loosening of the bond between the individual minerals of the granite and does not involve the decomposition of the constituent minerals.

Sub-surface blanket of weathering.

The reason for this band of decomposed rock, sloping towards the river and lying underneath masses of fresh granite of the same type, is that this type of granite is peculiarly susceptible to weathering in the zone of a fluctuating water plane or moisture table. The slopes above the river become saturated after the heavy rains. This water is drained out during the dry season and the water plane sinks to position where it slopes gently towards the river. The decomposition is not complete and lenses of undecomposed rock, exposed by erosion at the surface, will retain their hardness although exposed to the air, and give a false appearance of dikes of solid rock cutting the decomposed portion of the granite. The base of the decomposed zone can be seen in the lower tunnel of site number one north of the river, and the lense shaped boulders of fresh granite surrounded by weathered material are well exposed in the tunnel on the south side at the same site.

In the tunnels north of the river on site number two there is no disturbance, fissuring or fracturing of the granite. The bond between the constituent minerals has been weakened. Otherwise the bed rock has been unaffected.

Landsliding.

There has been no slumping or landsliding of material. Careful examination of the ridge north of site number two indicated this, and the absence of disturbance of the weathered material in the tunnels confirmed this conclusion.

Faulting.

No faulting was recognized in the vicinity of the damsites. The notches on the ridge to the north of the damsite were examined with the possibility in view, and the undisturbed character of the granite on each side of the saddles disproved this suggestion.

On the geological map accompanying water supply paper 445 two "lines of topographic expression which suggest the presence of faults" are shown. They cross at the junction of the San Diego river and the North Fork and one extends westerly along the course of the river below the junction. These faults were drawn in by the author of the paper, Mr. Ellis, on account of an erroneous notion of the topographic development of the region, and do not exist.

Conclusions.

No landsliding or faulting endangers a structure built on this lower El Capitan damsite. Completely sound bed rock will be found under the layer of softened granite. The depth to this sound granite has been determined by the drill.

UPPER EL CAPITAN NO. 3 DAMSITE

Location.

The location of a low dam has been suggested at a point approximately two miles above the lower El Capitan damsite.

Geology.

At this point a massive dike of hornblende granite 100 yards (+) wide cuts the biotite granite of the region. This forms a massive continuous ridge on the north side of the site. The dike or rib is made up of fresh unweathered rock. It forms a subsurface dam under the stream bed as shown by rising water above the dike.

Engineering problems.

The engineering problems are easily solved. Drilling of the dike will be easy. Handling of the large joint mass of rock on the surface will be somewhat of a problem. Good bed rock should be relatively near the surface.

If the plan of water development and control calls for the prompt construction of a low dam in order to give time for the solution of the legal and engineering problems in connection with the construction of the main El Capitan dam below, this location is the logical place for the dam. After the building of the main dam the upper dam will hold back silt, sand and gravel brought into the reservoir site by the South Fork of San Diego river. This may be of some advantage when the problem of the silting up of the damsite becomes acute fifty years from now.

Respectfully submitted,

C. F. TOLMAN (Signature)

APPENDIX II

The following official reports, documents and statistics were made available to us by Mr. H. N. Savage:

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. Copy Document No. 160932 filed May 24,
1924, including drawings sheets 1, 2 and 25.

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.

Copy Document 140165 (Files of H. N. Savage)
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 Appli-
cation 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.

The Freeman Report

Copy Document No. 146956, City of San Diego, California
Additional Water Supply. San Diego River Resources,
H. N. Savage, Hydraulic Engineer. November 27, 1928,
(Files of H. N. Savage)

City of San Diego, California. San Diego River Project
Resolution No. 55214, El Capitan Dam Site No. 2, Founda-
tion Geological Formation, December 29, 1930. H. N.
Savage, Hydraulic Engineer. Copy 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 - The San Diego Union - Letter from M. M.
O'Shaughnessy to Claus Spreckels dated November 8, 1924

Copy of letter from M. M. O'Shaughnessy to John D. Spreckels
Rainfall-Runoff data by H. N. Savage 1850 to 1930-1

3 photographs 9-15-31 El Capitan Hydraulic Fill Dam
Material area "A" " " " " "
9-15-31
Material area "B" " " " " "
8-15-31
Material area "C" " " " " "

3 drawings File 2435 - D2)
2435 - D2) WD 351
2435 - D2)

City of San Diego, California, Bureau of Water Development Notice Inviting Bids, Proposals, Drawings and Specifications El Capitan Reservoir Dam, Spillway and Outlet Works, Storage to elevation 750, Hiram Newton Savage, Hydraulic Engineer. (Files of H. N. Savage)

APPENDIX III

RESOLUTION NO. 57397

BE IT RESOLVED by the Common Council of The City of San Diego, as follows:

That C. D. Marx of Palo Alto, California, be, and he is hereby employed by The City of San Diego as the Consulting Engineer in connection with a dam to be built at the El Capitan damsite, County of San Diego.

That he is to furnish such reports in the capacity of consulting engineer on the construction of El Capitan Dam as may be required by the State Engineer of the State of California; and shall commence work on such study and report on the 23rd day of October, 1931, or as near thereafter as possible, and shall complete the same in not to exceed fifteen (15) days thereafter.

That his compensation shall be One Hundred Dollars ($100.00) per day, plus expenses from Palo Alto to San Diego and return, and current expenses while in the City of San Diego.

BE IT FURTHER RESOLVED that a majority of the members of the Common Council be, and they are hereby authorized to enter into a contract with C. D. Marx, which contract shall contain the above conditions and terms.

I HEREBY CERTIFY that the above and foregoing is a full, true and correct copy of Resolution No. 57397, as adopted by the Common Council of the city of San Diego on Oct. 12, 1931.

Allen H. Wright
City Clerk

By Clark M. Foote, Jr.
Deputy

DAM, SPILLWAY and OUTLET WORKS

CONSTRUCTION BY CONTRACT

DRAWINGS, SPECIFICATIONS and CONTRACT

BIDS and SUPPLEMENTAL DATA

1-24-35
copy/p

September 14, 1931

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

Subject: San Diego River Project, El Capitan Feature, Submission of Drawings, Specifications and Costs in Accordance with Resolution No. 57121.

Gentlemen:

Enclosed is drawings, specifications and estimates of cost for the construction of a hydraulic fill-rock embankment dam as the El Capitan reservoir feature of the San Diego River Project to store water to Elevation 750 feet, Reservoir Contour 197 in accordance with the requirements of your Resolution No. 57121, as follows:

> "That the hydraulic engineer in charge of water development be and he is hereby directed to bring in immediately plans, specifications and estimates of cost for the construction of an hydraulic earth and rock fill dam at El Capitan site on the San Diego River; also the necessary extension of the recently constructed pipe line and the construction of a tunnel of sufficient capacity to serve a dam of not less than 197 feet in height, and that the legal department be and it is hereby instructed to take the necessary steps immediately to clear the way for the City's work to proceed."

The specifications have been completed subject to changes and additions which may become necessary to conform to the State Engineer's requirements and to the State law regarding wage scales.

The specifications have not been submitted to the City Attorney for approval as to either form or legal requirements.

The cost estimates are materially less than those previously submitted since contract prices as influenced by cost of materials and equipment are less than heretofore.

Very respectfully,

H. N. Savage,
Hydraulic Engineer.

HNS/f
Encls.
Drawings & Specifications
Cost Estimate

5-18-33
Copy/m

SAN DIEGO RIVER PROJECT EL CAPITAN FEATURE

COST OF WATER AT SAN DIEGO

Hydraulic fill-rock embankment dam, to store water to elevation 750, reservoir contour 197; capacity 118,000 acre feet; area 1,580 acres; net safe duty about 11.6 million gallons daily; water delivered to University Heights filter plant thru present Lakeside-University Heights pipeline and new connection thereto from El Capitan to Lakeside.

ESTIMATED COST TO COMPLETE

RESERVOIR BASIN:						
(a)	Capitan Grande Indian Reservation flowage rights additional for storage to contour 197					$ 38,572
(b)	Flowage lands in private ownership 320 acres at $100					32,000
(c)	Reconstruction County road, 13 miles at $13,000					169,000
(d)	Reconstruction Irrigation District flume, siphons					250,000
(e)	Clearing reservoir basin					35,000
	Total reservoir basin					$ 524,572
DAM: Hydraulic fill-rock embankment. Spillway north side of dam.						
(a)	Dam:					
	Hydraulic fill	1,557,000	cubic yards	at	$0.50	778,500
	Rockfill and riprap	850,000	" "	"	1.00	850,000
(b)	Stripping surface	204,000	" "	"	0.625	127,500
(c)	Tunnel:					
	Excavation					
	solid rock	17,300	" "	"	9.00	155,700
	Cut and cover	12,500	" "	"	3.75	46,875
	earth	4,000	" "	in embankment		
	Concrete lining	3,350	" "	at	10.50	35,175
	Concrete walls	17,300	" "	"	7.50	129,750
(d)	Spillway:					
	Excavation placed and charged in rockfill & embankment					
	Trimming	14,000	cubic yards	at	0.375	5,250
	Concrete					
	siphon spillway	5,000	" "	"	15.00	75,000
	overflow section	10,000	" "	"	11.25	112,500
	lining	7,800	" "	"	13.50	105,300
	Steel anchor rods for lining	50	tons	"	75.00	3,750
(e)	Core Wall:					
	Concrete	10,300	cubic	"	11.25	115,875
	Steel posts and brackets	248	tons		120.00	29,760
	Steel reinforcement	1,064	"		75.00	79,800
	Excavation	13,000	cubic	"	5.00	65,000
(f)	Outlet works					40,000
(g)	Drainage system					25,000
(h)	Grouting under core wall and spillway					25,000
						2,805,735

CONDUIT:
Use existing Lakeside-University Heights pipeline and
(a) 8 miles 36" pipeline El Capitan to Lakeside at $50,000 400,000

FILTER PLANT:
Use existing University Heights filter plant

Sub-total cost to complete	$3,730,307
Contingencies and engineering - 15 per cent	559,546
Estimated cost to complete	$4,289,853
Expended to date, lands, pipeline and filter plant	$1,723,778

29,850
1,284,500
48,000
361,428

1,723,778

Total annual cost at San Diego $416,093

Cost per 1000 gallons 9.83 cents

1-24-35
copy/p

December 29, 1931

From : Harold Wood

To : Hydraulic Engineer

Subject : San Diego River Project, El Capitan Reservoir Dam and Pipe Line Feature. Coordinate system for dam.

1. As soon as the axis of the El Capitan dam has been fixed and monumented, cross sections of the damsite should be taken on about 10 foot by 10 foot squares. All cross sections should be taken on an established system of coordinates the origin of which should be sufficiently removed to enable all coordinates to be plus.

2. By fixing the south end of the axis of the dam at elevation 766 at coordinates east 5000 and north 3000 we would be able to refer all works at the City Camp, contractors camp, borrow pit areas, and gravel pit areas to the same system of coordinates which would facilitate reporting progress and giving instructions.

3. It is recommended that this system of coordinates be adopted and that the axis of the dam fall along the center line of the core wall.

Harold Wood

HW/p

A.F.E. 12/29/31
HHS

copy/f

GENERAL POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS:

That we, H. W. ROHL and T. E. CONNOLLY, have made, constituted and appointed, and by these presents do make, constitute and appoint T. E. CONNOLLY, of the City of San Francisco, State of California, our true and lawful attorney for us, and in our names, place and stead, and for our use and benefit, to sign, execute and deliver a contract with the City of San Diego for the construction of the El Capitan Reservoir, Dam, Spillway, and Outlet Works in accordance with the Notice Inviting Bids as made by A. V. Goeddel, Superintendent of the Purchasing Department of the City of San Diego, California, which bids were called for opening for 10:00 o'clock A.M., April 11, 1932, in accordance with the drawings and specifications contained in Document No. 474415 on file in the office of the City Clerk of the City of San Diego, California, and to do any and all things, perform any and all acts, execute any and all instruments, papers and other documents incident to the execution of such contract and the performance thereof, to execute all bonds and undertakings of any and every kind and nature in conjunction with said contract as may be necessary, or advisable; to execute assignments of said contract, including the right to offer to assign such contract to whatever person, firm or corporation he may see fit, but particularly the power to offer to assign and to assign to Rohl-Connolly Co., a corporation in the process of organization under the laws of the State of Nevada, also to do any and all things, perform any and all acts, execute any and all papers, documents and/or instruments for and in our behalf and in our names, place and stead as may to such attorney in fact appear necessary or expedient.

GIVING AND GRANTING unto said attorney full powerand authority to do and perform all and every act and thing whatsoever requisite to be done in and about the premises, as fully to all intents and purposes as we might or could do if personally present, with full power of substitution or revocation, hereby retifying and confirming all that our said attorney in fact, or his substitute or substitutes, shall lawfully do or cause to be done by virtue of these presents.

IN WITNESS WHEREOF, they have hereunto set their hands and seals the 15th day of April, nineteen hundred and thirty-two.

H. W. ROHL (signature)

T. E. CONNOLLY (signature)

STATE OF CALIFORNIA)
)
County Alameda)

On this 21st day of April, A.D., 1932, before me,

_____, a Notary Public in and for said County and State personally appeared T. E. CONNOLLY, known to me to be the person whose name is subscribed to the within Instrument, and acknowledged to me that he executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

(SEAL) James D. Glenn (Signature)

Notary Public in and for said County and State.

STATE OF CALIFORNIA) SS
County of Los Angeles)

On this 15th day of April, A.D., 1932, before me,

Irma F. Dickey a Notary Public in and for said County and State personally appeared H. W. ROHL, known to me to be the person whose name is subscribed to the within Instrument, and acknowledged to me that he executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

Irma F. Dickey (Signature)

(SEAL)

Notary Public in and for said County and State

CITY OF SAN DIEGO

CALIFORNIA

BUREAU OF WATER DEVELOPMENT

HIRAM NEWTON SAVAGE

Hydraulic Engineer in Charge

NOTICE INVITING BIDS, PROPOSAL, DRAWINGS and SPECIFICATIONS

EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS

Storage to Elevation 750

Proposals will be received at San Diego, California, until 10 o'clock A. M. April 11th, 1932.

CITY OF SAN DIEGO

CALIFORNIA

BUREAU OF WATER DEVELOPMENT

HIRAM NEWTON SAVAGE

Hydraulic Engineer in Charge

NOTICE INVITING BIDS, PROPOSAL, DRAWINGS and SPECIFICATIONS

EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS

Storage to Elevation 750

Proposals will be received at San Diego, California, until 10 o'clock A. M.

April 11th, 1932.

CONTENTS

Notice Inviting Bids
Information for Bidders
Proposal
Affidavit
Guaranty of Bonds
Bidder's Statement of Experience and References
Bidder's Statement of Equipment
Schedule
Form of Contract
Form of Faithful Performance Bond
Form of Labor and Materialmen's Bond

SPECIFICATIONS—

General Conditions:

1. Form of Proposal and Signature
2. Proposal
3. Certified check
4. The contract
5. Contractor's bonds
6. Transfers
7. Engineer
8. Contractor
9. Samples or specimens
10. Material and workmanship
11. Delays
12. Suspension of contract
13. Changes
14. Extra work or material
15. Delays—no extra compensation
15½ Arbitration
16. Changes at contractor's request
17. Inspection
18. Contractor's financial obligations
19. Experience
20. Specifications and drawings
21. Local conditions
22. Data to be furnished by the contractor
23. Restrictions on disposition of plant, etc.
24. Damages
25. Character of workmen
26. Staking out work
27. Methods and appliances
28. Climatic conditions
29. Quantities and unit prices
30. Removal and rebuilding of defective work
31. Protection of work and cleaning up
32. Road and fences
33. Bench marks and survey stakes
34. Right of way
35. Sanitation
36. Subcontractors
37. Infringement of patents
38. Workmen's compensation and indemnity insurance
39. Compliance with laws

DETAIL SPECIFICATIONS—

Special Conditions:

40. Requirement
41. List of drawings
42. Commencement, prosecution and completion of work
43. Failure to complete the work in the time agreed upon
44. Meals furnished
45. Water for plant, construction and domestic use
46. Two daily shifts of labor
47. Removal of temporary works
48. Maintaining flow in flume
49. Use of public highway
50. Progress estimates and payments

Excavation:

51. Excavation and embankment
52. Construction program
53. Pits and quarries
54. Classification
55. Measurement of and payment for excavation and embankment
56. Utilization and wasting of excavated material
57. Blasting
58. Backfill
59. Stripping and excavation for embankment
60. Plowing foundations
61. Cutoff trench

Hydraulic Fill, Rolled Embankment and Rock Embankment:

62. General
63. Hydraulic fill
64. Rolled embankment
65. Rock embankment
66. Foundation

Concrete:

67. Erection of structures
68. Cement
69. Concrete composition
70. Sand
71. Crushing rock for sand
72. Broken rock and gravel
73. Water
74. Mixing
75. Placing
76. Finishing
77. Forms
78. Supports for forms
79. Reinforcing steel
80. Structural steel in core wall
81. Preparation of foundation
82. Foundation pit water control
83. Contraction joints
84. Copper water stop
85. Construction joints
86. Bonding
87. Concrete to be kept moist
88. Protection of concrete
89. Building metal into concrete
90. Inspection and drainage galleries

CONTENTS—Continued

91. Measurement of concrete
92. Basis of payments
93. Payment for concrete
94. Concrcete in overflow spillway
95. Concrete in main core wall
96. Concrete in cut off walls under spillway
97. Concrete retaining walls and drains at toes of dam
98. Concrete in outlet tower
99. Concrete classification
100. Cement mortar

Tunnel:

101. Excavation
102. Lines and grades
103. Adits and shafts
104. Disposal of materials
105. Timbering
106. Overbreakage
107. Concrete—general
108. Concrete lining
109. Reinforcing steel
110. Forms and finish
111. Curing
112. Tunnel floor
113. Concrete in tunnel approach and outlet
114. Concrete pipe embedment
115. Tunnel plugs
116. Masonry in tunnel
117. Tile drains
118. Backfill

Grout and Drainage:

119. Grout
120. Mixing and placing grout
121. Payment
122. Drilling tunnel, foundation rock or concrete
123. Pipes for grouting and drainage
124. Laying drain tile and pipe

Appurtenances:

125. Appurtenances
126. Steel parts
127. Cast iron parts
128. Pipe railing
129. Steel and covers for outlet tower
130. Ladder rungs and guards
131. Cast iron pipe and special castings
132. Placing cast iron pipe and special castings
133. Yarning
134. Lead joints
135. Trash racks
136. Coating and painting
137. Materials
138. Shop details

NOTICE INVITING BIDS
CITY OF SAN DIEGO

San Diego, California, ..., 1932.

Sealed proposals will be received at the office of the City Clerk of the City of San Diego, California, until 10 o'clock A. M., April 11th, 1932, for the construction of the El Capitan Reservoir Dam, Spillway and Outlet Works, involving about 1,350,000 cubic yards of excavation and hydraulic placing in dam, about 120,000 cubic yards of excavation and placing in rolled embankment, about 840,000 cubic yards of rock excavation and placing in dam, about 61.100 cubic yards of concrete of all classes, about 67,000 barrels of cement, about 2,400,000 pounds reinforcing steel, about 496,000 pounds of structural steel, about 25,000 cubic feet of grout, furnishing and installing outlet works, etc., all as more particularly and in detail set forth in those certain drawings and specifications contained in Document No. 274415, on file in office of the City Clerk of said City.

The proposed work is located on the San Diego River, about eight miles northeasterly from the town of Lakeside, which is the terminal of the Lakeside branch of the San Diego and Arizona Railway. The town of Lakeside is about twenty-one miles northeasterly from the City of San Diego.

In accordance with the provisions of the Charter of the City of San Diego, and of the Public Works Wage Rate Act of California (Statutes of 1931, Chapter 397), the Common Council of The City of San Diego has ascertained the general prevailing rate of wages applicable to the work to be done to be as follows:

Classification	Per Diem Wage
Auto Mechanics	$6.40
Blacksmiths	6.40
Blacksmith Helpers	5.00
Blade Men	5.00
Bricklayers	9.60
Cableway Operators	8.00
Caulkers	5.00
Carpenter Foremen	6.40
Carpenters	6.40
Cement Finishers	6.40
Clerks	5.00
Compressor Operators	6.00
Concrete Finishers	6.40
Concrete Finisher Helpers	5.00
Concrete Foremen	5.00
Concrete Form Builders	6.00
Concrete Spreaders	5.00
Concrete Tampers	5.00
Concrete Mixermen	7.20
Cooks	5.50
Crane Operators	6.00
Derrick Operators	6.00
Dinkey Operators	6.00
Dragline Operators	6.00
Drillers	5.50
Drill Sharpeners	6.00
Electricians	8.00
Electrician Helpers	6.40
Excavation Foremen	5.50
Flunkeys	5.00
General Foremen	7.00
Hodcarriers, Brick	5.60
Hodcarriers, Plaster	7.20
Hoist Operators	6.00
Laborers, Common	5.00
Laborers, Skilled	5.50
Lathers	8.00
Locomotive Engineers	7.50
Locomotive Firemen	6.00
Materialmen	5.00
Mechanics	6.40
Mechanic Helpers	5.00
Mechanic Trouble Shooters	6.00

Classification	Per Diem Wage
Mortar Men	$5.00
Muckers, Tunnel	5.50
Plumbers	8.00
Pipe Layers	5.00
Plasterers	9.60
Painters	6.40
Powdermen	6.00
Powdermen Helpers	5.00
Pump Men	5.00
Quarry Foremen	7.00
Reinforcing Steel Foremen	7.00
Reinforcing Steel Workers	6.45
Rigger Foremen	8.00
Riggers	7.20
Rigger Helpers	6.00
Road Grader Operators	5.50
Roofers	6.40
Sheet Metal Workers	6.80
Shovel Operators	8.00
Shovel Operators Underground	8.80
Shovel Cranesmen	6.80
Shovel Cranesmen Underground	7.60
Shovel Firemen	5.60
Shovel Watchmen	5.00
Shovel Oilers	5.00
Shovel Pitmen	5.00
Stone Setters	9.60
Stone Cutters	7.20
Stone Derrickmen	7.20
Superintendents	9.00
Teamsters	5.00
Tractor Operators over 50 H.P.	7.20
Tractor Operators under 50 H.P.	6.80
Timekeepers	5.00
Trenching Machine Operators	6.00
Truck Drivers under 15,500 pounds	5.00
Truck Drivers over 15,500 pounds	5.00
Tunnel Foremen	7.00
Watchmen	5.00
Welders	6.00
Yarners	5.50
Other classes not less than	5.00

For over-time work when the same is permitted by law, one and one-half times the foregoing rates. For work performed on Sundays and legal holidays as set forth in Section 10 of the Political Code of the State of California, one and one-half times the above rates.

It is required that no labor other than citizens of the City of San Diego shall be employed on all construction work contemplated hereunder.

Work shall be commenced by the contractor within ten (10) days after the execution of the contract on behalf of the City of San Diego and the work must be completed on or before October 31, 1934.

Each proposal must be accompanied by an unconditional certified check for an amount not less than ten per cent of the aggregate sum of the bid payable to the Order of the City Clerk, of the City of San Diego, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish bonds for the faithful performance of the work as required by paragraph five of these specifications.

All proposals shall be made upon printed forms which will be furnished gratuitously by the Superintendent of the Purchasing Department of said City, or same may be more properly made upon the bid schedule which forms a part of the bound booklet which contains drawings and specifications, and which is referred to in the paragraph immediately following and all such proposals must be accompanied by the affidavit appearing upon said form, and no bid will be considered that does not contain such affidavit. Each bidder is directed to endorse on the envelope containing his bid, his name and the character of work or material upon which the bid enclosed is submitted.

Copies of information for bidders, drawings and specifications, proposal, guaranty of bond, bidding schedule and form of contract may be inspected at the office of the Hydraulic Engineer in Charge, Bureau of Water Development, 524 F Street, San Diego, California. Copies of the drawings and specifications may be obtained at the above office for the sum of twenty-five ($25.00) dollars which will be returned to the successful bidder, and to all others upon the return by them of the drawings and specifications in good and acceptable condition, within 14 days after opening of bids.

For further particulars address H. N. Savage, Hydraulic Engineer in Charge Bureau of Water Development, 524 F Street, San Diego, California.

A. V. GOEDDEL,

Superintendent of the Purchasing Department.

H. N. SAVAGE,

Hydraulic Engineer in Charge.

INFORMATION FOR BIDDERS

The sealed envelope containing the proposal must be endorsed with the bidder's name, marked "Proposal for El Capitan Reservoir Dam, Spillway and Outlet Works" and addressed "The City Clerk of the City of San Diego, California."

No bidder will be permitted to withdraw his proposal after the hour fixed in the notice inviting bids without rendering his certified check subject to forfeiture to the City of San Diego as liquidated damages as in case of refusal to execute contract and bond award.

Bidders must present satisfactory evidence as to their responsibility and that they are fully prepared with necessary capital, machinery and material to begin work promptly and to conduct it as required by these specifications.

Bidders must satisfy themselves as to local conditions affecting the work, and no information derived from the maps, plans, specifications, profiles, or drawings, or from the engineer or his assistants, will relieve the contractor from any risk or from fulfilling all of the terms of his contract. The accuracy of the interpretation of the facts disclosed by borings or other preliminary investigations is not guaranteed. Each bidder or his representative should visit the site of the work and familiarize himself with local conditions.

The quantities stated in the schedule are estimates and for comparing bids only, and no claim shall be made for excess or deficiency therein, actual or relative. Payment at the prices agreed upon will be in full for the completed work and will cover materials, supplies, labor, tools, machinery, and all other expenditures incidental to satisfactory compliance with the contract, unless otherwise specifically provided.

The proposal and schedule submitted must not be detached from the notice inviting bids, drawings and specifications.

The successful bidder will be required to furnish the City of San Diego with a bond, with a satisfactory surety company, in a sum equal to seventy-five per cent of the amount of the contract price conditioned upon the faithful performance of said contract.

The successful bidder will also be required to furnish the City of San Diego with a labor and materialmen's bond with a satisfactory surety company in an amount not less than fifty per cent of the amount of the contract, conditioned upon the payment by said contractor of all material or supplies furnished in the performance of the work contracted to be done by the terms of the contract, and for any work or labor done thereon of any kind.

All bidders are hereby referred to the drawings and specifications on file in the office of the Hydraulic Engineer, or in the office of the City Clerk of said City, for full details and description of said work.

The right is reserved to reject any and all bids.

198

PROPOSAL

To the Common Council of the ..... April 11th ....., 1932.

City of San Diego, California.

Sirs:

Pursuant to the foregoing notice inviting bids and information for bidders, the undersigned bidder herewith submits proposal on the schedule attached hereto and made part hereof, and binds himself on award by the Common Council under this proposal to execute in accordance with such award, a contract, with necessary bonds, of which this proposal, and the said notice inviting bids and specifications shall be a part, for performing and completing said contract within the time required and at the prices named in the specifications and in the schedule hereto annexed.

The bidder furthermore agrees that, in case of his default in executing said contract with necessary bonds, the certified check accompanying this proposal and the money payable thereon shall become and remain the property of the City of San Diego.

This proposal is made with a full knowledge of the kind, quantities and quality of the work, and of the materials and plant required; and after complete, careful and independent examination and investigation of the site of the work, local conditions affecting the same, character of formation and materials to be encountered.

Signature ..... H. W. ROHL .....

T. E. CONNOLLY

(Corporate Seal) .....

Address .....

H. W. Rohl

T. E. Connolly

4351 Alhambra Ave.

Los Angeles

Calif.

Names of individual members of firm or names and titles of all officers of corporation and their addresses.

Corporation organized under the laws of the State of .....

Affidavit as required by Section 6 of City Ordinance No. 5051 (Page 10 of printed copy) must be attached hereto.

AFFIDAVIT

State of California }
County of San Diego } ss.

H. W. Rohl and T. E. Connolly and each of them, being first duly sworn, says that ~~he is~~ they are joint bidder~~s~~ under the notice of the Superintendent of the Purchasing Department, hereto attached, inviting sealed proposals for El Capitan Reservoir Dam, Spillway and Outlet Works, that the proposal herewith presented is genuine and not sham or collusive, or made in the interest or on behalf of any person, firm or corporation not herein named; that they nor either of them have ~~has~~ not directly or indirectly induced or solicited any other bidder to put in a sham proposal, or any other person or firm or corporation to refrain from bidding, and that the said bidder~~s~~ have not in any manner sought by collusion to secure to themselves or either of them an advantage over other bidders.

Signed H. W. Rohl
T. E. Connolly

Subscribed and sworn to before me this 11th day of April, 19 32.

Edith G. Benjamin

An affidavit can be signed only by an individual before an officer authorized to administer oaths.

Notary Public in and for the

County of San Diego

(SEAL)

State of California

200

GUARANTY OF BONDS

We hereby agree to furnish bonds for this bidder as required by these specifications and the regulations of the City of San Diego, in event contract is awarded on the basis of this proposal.

(SEAL)

Signatures and addresses of guarantors of bonds.

(SEAL)

The Metropolitan Casualty Insurance Company of New York

by Jno. T. Drumm
Attorney in Fact

Commercial Casualty Insurance Company

by Jno. T. Drumm
Attorney in Fact

600 Lane Mortgage Bldg.

Los Angeles, Cal.

Surety companies, to be acceptable to the City of San Diego, must be on the accredited list of the United States Treasury Department and hold certificates under the Acts of Congress of August 13, 1894, and March 23, 1910, and their bonds will be limited to such amounts as would be acceptable to the Treasury Department.

BIDDER'S STATEMENT OF EXPERIENCE AND REFERENCES

The bidder is required to state below what work of similar character to that included in the proposed contract he has successfully performed, and give references which will enable the Common Council to judge of his responsibility, experience, skill and business standing.

Works Constructed

Puddingstone Dam

Owyhee Tunnel

Big Dalton Dam

Hetch Hetchy Tunnel

Peters Dam

Walnut Creek Tunnel

Chenery Reservoir

Bucker Creek Tunnel

City of Riverside Reservoir

College Hill Tunnel

Beverly Hills Reservoir

Don Pedro Power House

Bay Shore Highway

References

U. S. Bureau of Reclamation

Dept. of Public Works, State of Calif.

L. A. County Board of Supervisors

B'd of Works City & Co. of San Francisco

East Bay Municipal Utility Dist.

BIDDER'S STATEMENT OF EQUIPMENT

If contract is awarded under this proposal, the bidder proposes to do the work with equipment of the following character and quantity:

6 Power Shovels

40 Trucks

10 Tractors

Concrete Mixing Plant

Pumping equipment

4 Compressors

Cableways etc.

STATE OF CALIFORNIA)
) SS
County of Los Angeles)

On this 11th day of April in the year One Thousand Nine Hundred and thirtytwo before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Jno. T. Brunn known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of COMMERCIAL CASUALTY INSURANCE COMPANY (a Corporation) and acknowledged to me that he subscribed the name of said COMMERCIAL CASUALTY INSURANCE COMPANY thereto as surety and his own name as attorney in fact.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

(SEAL)

My Commission expires
December 1, 1933.

Irma C. Swain
Notary Public in and for the County of Los Angeles, California.

STATE OF CALIFORNIA)
) SS.
County of Los Angeles)

On this 11th day of April in the year One Thousand Nine Hundred and Thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Jno. T. Brunn known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of

THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK

(a Corporation) and acknowledged to me that he subscribed the name of said Corporation thereto as surety and his own name as attorney in fact.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

(SEAL)

Irma C. Swain
Notary Public in and for the County of Los Angeles, California.

My Commission expires December 1, 1933.

SCHEDULE

EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS

Item No.	Work or Material	Quantity and Price	Amount
1.	Excavation Class 1 solid rock originating in structure excavation including placing and sorting in dam.		
	40,000 cubic yards at One dollar (words) ($ 1.00) per cubic yard		$ 40,000
2.	Embankment Class 1 rock originating in borrow pit only, including placing and sorting in dam, measured in embankment.		
	800,000 cubic yards at One dollar (words) ($ 1.00) per cubic yard		$ 800,000
3.	Excavation Class 2, earth, overburden, sand, gravel and other excavation originating in structure excavation, including placing and sorting in hydraulic fill.		
	350,000 cubic yards at Forty cents (words) ($ 0.40) per cubic yard		$ 140,000
4.	Excavation Class 2, earth, overburden, sand, gravel and other excavation originating in structure excavation, including placing and compacting in rolled embankment.		
	50,000 cubic yards at Thirty five cents (words) ($ 0.35) per cubic yard		$ 17,500
5.	Embankment Class 2, clay, earth, sand, gravel and other embankment originating in borrow pit only, including sorting and placing in hydraulic fill, measured in embankment.		
	1,000,000 cubic yards at Forty cents (words) ($ 0.40) per cubic yard		$ 400,000
6.	Embankment Class 2, clay, earth, sand, gravel and other embankment originating in borrow pit only, including placing and compacting in rolled embankment, measured in embankment.		
	70,000 cubic yards at Thirty five cents (words) ($ 0.35) per cubic yard		$ 24,500
7.	Excavation Class 3 cutoff trench excavation under dam including placing and sorting in dam.		
	12,000 cubic yards at Three dollars (words) ($ 3.00) per cubic yard		$ 36,000
8.	Excavation Class 4 cutoff trench excavation under spillway including placing and sorting in dam.		
	5,000 cubic yards at Two dollars (words) ($ 2.00) per cubic yard		$ 10,000
9.	Excavation Class 5 outlet tunnel excavating, excepting open cut excavation and including placing and sorting in dam.		
	30,000 cubic yards at Five dollars (words) ($ 5.00) per cubic yard		$ 150,000

Item No.	Work or Material	Quantity and Price	Amount

10. Excavation Class 1 solid rock originating in structure excavation and wasted.

20,000 cubic yards at One dollar (words) ($ 1.00) per cubic yard $ 20,000

11. Excavation Class 2 earth overburden, sand, gravel and other excavation originating in structure excavation and wasted.

34,000 cubic yards at Twenty five cents (words) ($ 0.25) per cubic yard $ 8,500

12. Excavation Class 3 cutoff trench excavation under dam, and wasted.

1,000 cubic yards at Three dollars (words) ($ 3.00) per cubic yard $ 3,000

13. Excavation Class 4 cutoff trench excavation under spillway and wasted.

500 cubic yards at One dollar & fifty cents (words) ($ 1.50) per cubic yard $ 750

14. Excavation Class 5 outlet tunnel excavation excepting open cut excavation, but wasted.

300 cubic yards at Five dollars (words) ($ 5.00) per cubic yard $ 1,500

15. Rock Masonry in place between tunnel plugs.

4,000 cubic yards at Six dollars (words) ($ 6.00) per cubic yard $ 24,000

16. Backfill.

1,000 cubic yards at Fifty cents (words) ($ 0.50) per cubic yard $ 500

17. Mass concrete Class 1 in overflow spillway, outlet tower base and elsewhere.

18,000 cubic yards at Four dollars & eighty cents (words) ($ 4.80) per cubic yard $ 86,400

18. Concrete Class 2 in spillway, side lining and retaining walls.

3,000 cubic yards at Nine dollars (words) ($ 9.00) per cubic yard $ 27,000

19. Concrete Class 3 in floor lining of spillway.

6,000 cubic yards at Four dollars & eighty cents (words) ($ 4.80) per cubic yard $ 28,800

20. Concrete Class 4 in unformed portion of main core wall.

3,000 cubic yards at Four dollars & eighty cents (words) ($ 4.80) per cubic yard $ 14,400

21. Concrete Class 5 in formed portion of main core wall.

7,300 cubic yards at Four dollars & eighty cents (words) ($ 4.80) per cubic yard $ 35,040

22. Concrete Class 6 in cutoff walls under spillway.

1,200 cubic yards at Four dollars & eighty cents (words) ($ 4.80) per cubic yard $ 5,760

Item No.	Work or Material	Quantity and Price	Amount
23.	Concrete Class 7 in outlet tower.		
	2,000 cubic yards at Fifteen dollars (words)	($ 15.00) per cubic yard	$ 30,000
24.	Concrete Class 8 in retaining walls at upstream and downstream toes of dam.		
	10,500 cubic yards at four dollars & eighty cents (words)	($ 4.80) per cubic yard	$ 50,400
25.	Concrete Class 9 in drains at toe of dam.		
	400 cubic yards at Twelve dollars (words)	($ 12.00) per cubic yard	$ 4,800
26.	Concrete Class 10 in tunnel lining and cut and cover section excepting tunnel floor.		
	3,300 cubic yards at Twelve dollars (words)	($ 12.00) per cubic yard	$ 39,600
27.	Concrete Class 11 in floor of tunnel, excepting floor of outlet and inlet.		
	1,500 cubic yards at four dollars & eighty cents (words)	($ 4.80) per cubic yard	$ 7,200
28.	Concrete Class 12 in floor of tunnel approach and outlet.		
	1,000 cubic yards at four dollars & eighty cents (words)	($ 4.80) per cubic yard	$ 4,800
29.	Concrete Class 13 in retaining and guide and cut-off walls of tunnel approach and outlet.		
	2,000 cubic yards at Twelve dollars (words)	($ 12.00) per cubic yard	$ 24,000
30.	Concrete Class 14 in tunnel plugs.		
	600 cubic yards at four dollars & eighty cents (words)	($ 4.80) per cubic yard	$ 2,880
31.	Concrete Class 15 in place in pipe embedment in tunnel.		
	125 cubic yards at four dollars & eighty cents (words)	($ 4.80) per cubic yard	$ 600
32.	Cement mortar used in laying up rock including shaping of rock and laying.		
	100 cubic yards at twenty dollars (words)	($ 20.00) per cubic yard	$ 2,000
33.	Cement in place in the work.		
	67,000 barrels at one dollar & ninety cents (words)	($ 1.90) per barrel	$ 127,300
34.	Reinforcing steel in place in the work.		
	2,400,000 pounds at three cents (words)	($ 0.03) per pound	$ 72,000
35.	Structural steel in place in the work.		
	496,000 pounds at four cents (words)	($ 0.04) per pound	$ 19,840
36.	4" drain tile in place in the work.		
	6,000 linear feet at forty cents (words)	($ 0.40) per linear foot	$ 2,400
37.	6" drain tile in place in the work.		
	2,000 linear feet at fifty cents (words)	($ 0.50) per linear foot	$ 1,000

Item No.	Work or Material	Quantity and Price	Amount

38. 8" drain tile in place in the work.

1,000 linear feet at Sixty cents (words) ($ 0.60) per linear foot $ 600

39. 12" drain tile in place in the work.

1,000 linear feet at Seventy five cents (words) ($ 0.75) per linear foot $ 750

40. 2" steel grout and drain pipe in place in the work.

3,000 linear feet at Twenty five cents (words) ($ 0.25) per linear foot $ 750

41. 4" steel grout pipe and connections in place in rock between tunnel plugs.

1,000 linear feet at One dollar (words) ($ 1.00) per linear foot $ 1,000

42. Pressure grouting rock masonry in tunnel between plugs .

20,000 cubic feet at One dollar (words) ($ 1.00) per cubic foot $ 20,000

43. Holes drilled in rock or concrete with concussion drill.

1,000 linear feet at One dollar (words) ($ 1.00) per linear foot $ 1,000

44. Holes drilled in rock or concrete with core recovery drill.

1,000 linear feet at Five dollars (words) ($ 5.00) per linear foot $ 5,000

45. Grouting by air pressure, except in masonry of tunnel plug.

5,000 cubic feet at One dollar (words) ($ 1.00) per cubic foot $ 5,000

46. Copper water stop complete in place.

9,000 pounds at Thirty cents (words) ($ 0.30) per pound $ 2,700

47. 2" inside diameter pipe railing complete in place.

300 linear feet at Thirty cents (words) ($ 0.30) per linear foot $ 90

48. Cast iron pipe and special castings complete in place.

800,000 pounds at Four cents (words) ($ 0.04) per pound $ 32,000

49. Placing castings and metal work, not furnished by the contractor, in place in concrete.

30,000 pounds at Five cents (words) ($ 0.05) per pound $ 1,500

FORM OF CONTRACT

THIS AGREEMENT, made and entered into at The City of San Diego, County of San Diego, State of California, this 23 day of April, 19 32, by and between THE CITY OF SAN DIEGO, a municipal corporation in the County of San Diego, State of California, the party of the first part, by and through its Common Council, hereinafter sometimes designated as the City, and H. W. Kohl and T. B. Connolly

party of the second part, and hereinafter sometimes designated as the Contractor, WITNESSETH:

ARTICLE I. That for and in consideration of the covenants and agreements hereinafter contained on the part of the City, and the sums of money hereinafter designated to be paid to the contractor by the City, in manner and form as hereinafter in attached specifications provided, the contractor hereby covenants and agrees to and with the City, to furnish all labor, tools, appliances, equipment, plant and transportation, and any and all other expense necessary or incidental to the performance of certain work hereinafter specified, and to build, erect, construct, complete and install the El Capitan Reservoir Dam, Spillway and Outlet Works

in the County of San Diego, State of California, being and as per Schedule all as more particularly and in detail set forth in those certain plans and specifications filed in the office of the City Clerk of The City of San Diego on the 8th day of February, 19 32, marked "Document No. 274418," and endorsed "Notice Inviting Bids, Proposal, Drawings and Specifications, El Capitan Reservoir Dam Spillway and Outlet Works"

said plans consisting of 10 sheets and said specifications consisting of 104 sheets; true copies of the notice inviting bids, proposal of contractor, and plans and specifications are hereunto annexed marked "Exhibit A" by reference thereto incorporated herein and made a part hereof as though in this paragraph fully set forth.

ARTICLE II. In consideration of the construction and completion of the work by the contractor herein undertaken, according to the terms of this contract, and the faithful performance of all the obligations and covenants by the contractor herein undertaken and agreed upon, the contractor shall be paid as is provided in the specifications attached hereto.

ARTICLE III. The contractor hereby agrees that he will be bound by each and every part of the plans and specifications, and do and cause to be done all of said work and improvement as specified in the specications and as shown upon the plans, as the same may be interpreted by the Hydraulic Engineer in Charge Bureau of Water Development of said City, subject to approval by the Common Council.

ARTICLE IV. No interest in this agreement shall be transferred by the Contractor to any other party, and any such transfer shall cause annulment of this contract, so far as The City of San Diego is concerned. All rights of action, however, for any breach of this contract are reserved to said City.

ARTICLE V. The Contractor shall keep harmless and indemnify The City of San Diego, its officers and agents, from all damage, cost or expense that arises or is set up for infringement of patent rights of any one for use by The City of San Diego, its officers or agents, of articles supplied by the Contractor under this contract, of which he is not patentee, or which he is not entitled to use or sell.

ARTICLE VI. The Contractor further agrees and covenants that neither the Contractor, nor any subcontractor, doing work or performing labor pursuant to the terms of this contract, who directs or controls the work of any laborer, workman or mechanic upon any of the work provided for in this contract to be done,

shall require or permit any such laborer, workman or mechanic to labor more than eight (8) hours during any one calendar day, in violation of the provisions of Section 653c of the Penal Code of the State of California; and that the Contractor shall forfeit as a penalty to the City ten dollars ($10.00) for each laborer, workman or mechanic employed by the Contractor or by any subcontractor upon any of the work by this contract provided to be done, for each calendar day during which such laborer, workman or mechanic is required or permitted to labor more than eight (8) hours in violation of the provisions of said Section of the Penal Code; and that the Contractor will not knowingly employ or cause or allow to be employed upon any of the work provided in this contract to be done by any alien, contrary to the provisions of the Public Works Alien Employment Act of the State of California (Statutes of 1931, Chapter 398); and that the Contractor shall forfeit as a penalty to the City ten dollars ($10.00) for each alien knowingly employed upon any of the work provided in this contract to be done, by the Contractor or any subcontractor, contrary to the provisions of said statute, for each calendar day, or portion thereof, during which such alien is permitted or required to labor in violation thereof.

It is further required, and the Contractor hereby expressly agrees that no labor other than citizens of The City of San Diego shall be employed on all construction work contemplated by this contract.

ARTICLE VII. The Contractor further agrees that in the performance of the work contemplated by this contract, he will conform to and abide by all the requirements and provisions of the Charter of The City of San Diego, and of the Public Works Wage Rate Act of the State of California (Statutes of 1931, Chapter 397); and that not less than the prevailing rate of per diem wages hereinafter specified shall be paid to all laborers, workmen and mechanics employed by the Contractor, or any subcontractor, in the performance of the work contemplated by this contract; and that the contractor shall forfeit as a penalty to the City ten dollars ($10.00) for each laborer, workman or mechanic employed, for each calendar day, or portion thereof, such laborer, workman or mechanic is paid less than the following specified rate for any work done under this contract by the contractor, or by any subcontractor:

Classification	Per Diem Wage	Classification	Per Diem Wage
Auto Mechanics	$6.40	Lathers	8.00
Blacksmiths	6.40	Locomotive Engineers	7.50
Blacksmith Helpers	5.00	Locomotive Firemen	6.00
Blade Men	5.00	Materialmen	5.00
Bricklayers	9.60	Mechanics	6.40
Cableway Operators	8.00	Mechanic Helpers	5.00
Caulkers	5.00	Mechanic Trouble Shooters	6.00
Carpenter Foremen	6.40	Mortar Men	$5.00
Carpenters	6.40	Muckers, Tunnel	5.50
Cement Finishers	6.40	Plumbers	8.00
Clerks	5.00	Pipe Layers	5.00
Compressor Operators	6.00	Plasterers	9.60
Concrete Finishers	6.40	Painters	6.40
Concrete Finisher Helpers	5.00	Powdermen	6.00
Concrete Foremen	5.00	Powdermen Helpers	5.00
Concrete Form Builders	6.00	Pump Men	5.00
Concrete Spreaders	5.00	Quarry Foremen	7.00
Concrete Tampers	5.00	Reinforcing Steel Foremen	7.00
Concrete Mixermen	7.20	Reinforcing Steel Workers	6.45
Cooks	5.50	Rigger Foremen	8.00
Crane Operators	6.00	Riggers	7.20
Derrick Operators	6.00	Rigger Helpers	6.00
Dinkey Operators	6.00	Road Grader Operators	5.50
Dragline Operators	6.00	Roofers	6.40
Drillers	5.50	Sheet Metal Workers	6.80
Drill Sharpeners	6.00	Shovel Operators	8.00
Electricians	8.00	Shovel Operators Underground	8.80
Electrician Helpers	6.40	Shovel Cranesmen	6.80
Excavation Foremen	5.50	Shovel Cranesmen Underground	7.60
Flunkeys	5.00	Shovel Firemen	5.60
General Foremen	7.00	Shovel Watchmen	5.00
Hodcarriers, Brick	5.60	Shovel Oilers	5.00
Hodcarriers, Plaster	7.20	Shovel Pitmen	5.00
Hoist Operators	6.00	Stone Setters	9.60
Laborers, Common	5.00	Stone Cutters	7.20
Laborers, Skilled	5.50	Stone Derrickmen	7.20

Classification	Per Diem Wage
Superintendents	9.00
Teamsters	5.00
Tractor Operators over 50 H.P.	7.20
Tractor Operators under 50 H.P.	6.80
Timekeepers	5.00
Trenching Machine Operators	6.00
Truck Drivers under 15,500 pounds	5.00
Truck Drivers over 15,500 pounds	5.00
Tunnel Foremen	7.00
Watchmen	5.00
Welders	6.00
Yarners	5.50
Other classes not less than	5.00

For over time work when the same is permitted by law, one and one-half times the foregoing rates. For work performed on Sundays and legal holidays as set forth in Section 10 of the Political Code of the State of California, one and one-half times the above rates.

ARTICLE VIII. It is mutually agreed between the parties hereto that in no case unauthorized by the Charter of The City of San Diego or the general laws in effect in said City, shall said City, or any department, board or officer thereof be liable for any portion of the contract price.

IN WITNESS WHEREOF, this contract is executed by a majority of the members of the Common Council of The City of San Diego, under and pursuant to a resolution authorizing such execution, and the contractor has caused these presents to be executed, and its corporate name and seal to be hereunto attached, by its proper officers, thereunto duly authorized, the day and year first hereinabove written.

THE CITY OF SAN DIEGO.

By Joseph J. Quinn

L. C. Moire

A. Stahel Jr.

Ira J. Gray

Members of the Common Council.

ATTEST:

Allen H. Wright
by Fred W. Dick
Deputy

City Clerk.

(Seal)

H. W. Rohl and T. E. Connolly

by T. E. Connolly
Attorney in fact

Contractor.

ATTEST:

(If executed by an individual or partnership contractor, appropriate changes shall be made in the last preceding paragraph.)

I hereby approve the form of the foregoing contract, this 23 day of April, 19 32

C. L. Byers

City Attorney of the City of San Diego.

FORM OF FAITHFUL PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, That .....

.....

as principal, and.....

a corporation organized and existing under and by virtue of the laws of the State of..... as surety, are held and firmly bound unto the City of San Diego, a municipal corporation in the County of San Diego, State of California, in the sum of..... Dollars ($.....) (not less than seventy-five per cent of estimated contract price), lawful money of the United States of America, to be paid to The City of San Diego, for the payment of which, well and truly to be made, we hereby bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

Signed by us and dated this.....day of....., 19.....

The condition of the above and foregoing obligation is such that whereas, the said principal has entered into the annexed contract with the City of San Diego to furnish all materials, and all labor, tools, appliances, transportation and other expenses necessary or incidental to the construction, completion and installation of .....in the County of San Diego, State of California, all as more particularly and in detail shown upon those certain plans and specifications filed in the office of the City Clerk of The City of San Diego on the.....day of....., 19....., marked Document No. _____ and endorsed .....; said plans consisting of.....sheets, and said specifications consisting of.....sheets, copies of which plans and specifications are attached to said contract and made a part thereof as in said contract provided; and reference is hereby made to said contract and to said plans and specifications for a particular description of the work to be done.

Now, therefore, if the said principal shall faithfully perform the said contract, then the above obligation to be void, otherwise to remain in full force and effect.

In WITNESS WHEREOF, the said principal and surety have caused these presents to be executed and their corporate names and seals to be hereunto attached by their proper officers, thereunto duly authorized, the day and year first hereinabove written.

.....
Principal.

ATTEST: By.....

.....
Surety.

ATTEST: By.....

If executed by an individual or partnership contractor, appropriate changes shall be made in the last preceding paragraph.

I hereby approve the form of the within Bond this.....day of....., 19.....

.....
City Attorney of the City of San Diego.

Approved by a majority of the members of the Common Council of The City of San Diego, California, this.....day of....., 19.....

.....

.....

.....

.....

.....
Members of the Common Council.

4/10/34
copy /f

FORM OF FAITHFUL PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, That H. W. ROHL and T. E. CONNOLLY, as Principal, and THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK, a New York corporation; COMMERCIAL CASUALTY INSURANCE COMPANY, a New Jersey corporation; HARTFORD ACCIDENT AND INDEMNITY COMPANY, a Connecticut corporation, and MASSACHUSETTS BONDING AND INSURANCE COMPANY, a Massachusetts corporation, as Sureties, are held and firmly bound unto the CITY OF SAN DIEGO, a municipal corporation in the County of San Diego, State of California, in the sum of ONE MILLION SEVEN HUNDRED FORTY NINE THOUSAND SIX HUNDRED SEVENTY FIVE and NO/100 ($1,749,675.00).....DOLLARS, (not less than seventy-five per cent of estimated contract price), lawful money of the United States of America, to be paid to The City of San Diego, for the payment of which, well and truly to be made, we hereby bind ourselves, our heirs, administrators, executors, successors and assigns, firmly by these presents, as follows:

The Principal and THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK, as Surety, jointly and severally in the sum of SEVEN HUNDRED TWENTY NINE THOUSAND THIRTY ONE and 25/100 ($729,031.25) DOLLARS, and no more;

The principal and the COMMERCIAL CASUALTY INSURANCE COMPANY, as Surety, jointly and severally in the sum of SEVEN HUNDRED TWENTY NINE THOUSAND THIRTY ONE and 25/100 ($729,031.25) DOLLARS, and no more;

The Principal and the HARTFORD ACCIDENT AND INDEMNITY COMPANY, as Surety, jointly and severally in the sum of ONE HUNDRED FORTY FIVE THOUSAND EIGHT HUNDRED SIX and 25/100 ($145,806.25) DOLLARS, and no more;

The Principal and the MASSACHUSETTS BONDING AND INSURANCE COMPANY, as Surety, jointly and severally in the sum of ONE HUNDRED FORTY FIVE THOUSAND EIGHT HUNDRED SIX and 25/100 ($145,806.25) DOLLARS, and no more.

Signed by us and dated this 23 day of April 1932.

The condition of the above and foregoing obligation is such that whereas, the said Principal has entered into the annexed contract with the City of San Diego to furnish all materials, and all labor, tools, appliances, transportation and other expenses necessary or incidental to the construction, completion and installation of the EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS, in the County of San Diego, State of California, all as more particularly and in detail shown upon those certain plans and specifications filed in the office of the City Clerk of The City of San Diego on the 8th day of February 1932, marked Document No. 274415 and endorsed Notice inviting bids; said plans consisting of 10 sheets, and said specifications consisting of 104 sheets, copies of which plans and specifications are attached to said contract and

made a part thereof as in said contract provided; and reference is hereby made to said contract and to said plans and specifications for a particular description of the work to be done.

Now, therefore, if the said Principal shall faithfully perform the said contract, then the above obligation to be void, otherwise to remain in full force and effect.

The Obligors herein expressly agree that, for the purpose of allowing a joint action against any or all of them, and for that purpose only, this bond shall be treated as the joint and several as well as the several obligations of each of the Obligors.

IN WITNESS WHEREOF, the said Principal and Sureties have caused these presents to be executed and their corporate names and seals to be hereunto attached by their proper officers, thereunto duly authorized, the day and year first hereinabove written.

H. W. Rohl and T. E. Connolly
Principal

By T. E. Connolly
Principal
Attorney in Fact

THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW

By Jno T Brunn
Attorney-in-Fact Surety

COMMERICAL CASUALTY INSURANCE COMPANY

By Jno T Brunn
Attorney-in-Fact Surety

HARTFORD ACCIDENT AND INDEMNITY COMPANY (SEAL)

By Dick W. Graves
Attorney-in-Fact Surety

MASSACHUSETTS BONDING AND INSURANCE COMPANY (SEAL)

By Donald B. Goldsmith
Attorney-in-Fact Surety

I hereby approve the form of the within Bond this 25th day of April 1932

C. L. Byers
City Attorney of the City of San Diego

Approved by a majority of the members of the Common Council of the City of San Diego, California, this 25 day of April 1932.

Joseph J. Russo — L. C. Maire

(SEAL)

A. Stahel Jr. — Ira S. Irey

Members of the Common Council

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred and thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Jno. T. Brunn known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of COMMERCIAL CASUALTY INSURANCE COMPANY (a Corporation) and acknowledged to me that he subscribed the name of said COMMERCIAL CASUALTY INSURANCE COMPANY, thereto as surety and his own name as attorney in fact.

(SEAL)

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

Irma C. Swain
Notary Public in and for the County of Los Angeles California.

My commission expires Dec. 1, 1933

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred and thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Jno. T. Brunn known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK (a Corporation) and acknowledged to me that he subscribed the name of said Corporation thereto as surety and his own name as attorney in fact.

(SEAL)

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

Irma C. Swain
Notary Public in and for the County of Los Angeles California.

My commission expires Dec. 1, 1933

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred and thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Donald B. Goldsmith known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of

(SEAL) MASSACHUSETTS BONDING AND INSURANCE COMPANY (a Corporation) and acknowledged to me that he subscribed the name of said Corporation thereto as surety and his own name as attorney in fact.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

Irma C. Swain
Notary Public in and for the County of Los Angeles, California.

My Commission expires Dec. 1, 1933.

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April, 1932, before me, OPAL GRAVES, a Notary Public, in and for the said County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared

DICK W. GRAVES, known to me to be the Attorney-in-Fact, of the HARTFORD ACCIDENT AND INDEMNITY COMPANY

(SEAL) the Corporation that executed the within instrument and acknowledged to me that he subscribed the name of the HARTFORD ACCIDENT AND INDEMNITY COMPANY thereto and his own name as Attorney-in-Fact.

Opal Graves
Notary Public in and for the County of Los Angeles, California.

My Commission Expires June 18, 1934

4/11/34
copy /f

FORM OF LABOR AND MATERIALMEN'S BOND

KNOW ALL MEN BY THESE PRESENTS, That H. W. ROHL and T. E. CONNOLLY, as Principal, and THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK, a New York corporation; COMMERCIAL CASUALTY INSURANCE COMPANY, a New Jersey corporation; HARTFORD ACCIDENT AND INDEMNITY COMPANY, a Connecticut corporation, and MASSACHUSETTS BONDING AND INSURANCE COMPANY, a Massachusetts corporation, as Sureties, are held and firmly bound unto THE CITY OF SAN DIEGO, a municipal corporation in the County of San Diego, State of California, in the sum of ONE MILLION ONE HUNDRED SIXTY SIX THOUSAND FOUR HUNDRED FIFTY and NO/100 DOLLARS ($1,166,450.00), (not less than fifty per cent of estimated contract price), lawful money of the United States of America, to be paid to The City of San Diego, for the payment of which, well and truly to be made, we hereby bind ourselves, our heirs, administrators, executors, successors and assigns, firmly by these presents, as follows:

The Principal and THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK as Surety, jointly and severally in the sum of FOUR HUNDRED EIGHTY SIX THOUSAND TWENTY and 85/100 ($486,020.85) DOLLARS, and no more;

The Principal and the COMMERICAL CASUALTY INSURANCE COMPANY, as Surety, jointly and severally in the sum of FOUR HUNDRED EIGHTY SIX THOUSAND TWENTY and 85/100 ($486,020.85) DOLLARS, and no more;

The Principal and the HARTFORD ACCIDENT AND INDEMNITY COMPANY, as Surety, jointly and severally in the sum of NINETY SEVEN THOUSAND TWO HUNDRED FOUR and 17/100 ($97,204.17) DOLLARS, and no more;

The Principal and the MASSACHUSETTS BONDING AND INSURANCE COMPANY, as Surety, jointly and severally in the sum of NINETY SEVEN THOUSAND TWO HUNDRED FOUR and 17/100 ($97,204.17) DOLLARS, and no more.

Signed by us and dated this 23 day of April 1938.

The condition of the above and foregoing obligation is such that whereas, the said Principal has entered into the annexed contract with The City of San Diego to furnish all materials, and all labor, tools, appliances, transportation and other expenses necessary or incidental to the construction, completion and installation of the EL CAPITAN DAM, SPILLWAY AND OUTLET WORKS in the County of San Diego, State of California, all as more particularly and in detail shown upon those certain plans and specifications filed in the office of the City Clerk of said The City of San Diego on the 8th day of February 1938, marked Document No. 274415 and endorsed Notice inviting bids; said plans consisting of 10 sheets and said specifications consisting of 104 sheets, copies of which plans and specifications are

attached to said contract and made a part thereof as in said Contract provided; and reference is hereby made to said contract and to said plans and specifications for a particular description of the work to be done.

And, whereas, the aforesaid penal sum of ONE MILLION ONE HUNDRED SIXTY SIX THOUSAND FOUR HUNDRED FIFTY AND NO/100 ($1,166,450.00) DOLLARS, being not less than one-half of the total amount payable by the terms of said contract, is intended and is hereby made to inure to and for the use of any and all persons, companies or corporations who perform labor on or furnish materials to be used in the said work.

The Obligors herein expressly agree that, for the purpose of allowing a joint action against any or all of them, and for that purpose only, this bond shall be treated as the joint and several as well as the several obligations of each of the Obligors.

NOW, THEREFORE, should the above bounden Principal well and truly pay or cause to be paid all claims against them for such labor or materials, or either, or both, so performed or furnished, as the case may be, then this obligation to be null and void; otherwise to be and remain in full force and effect and the same is hereby expressly made to inure to the benefit of any and all persons who perform labor upon or furnish materials to be used in the work described in said contract, or in any modification thereof; and any and all such persons shall have and are given a right of action to recover upon this bond against the said Principal and Sureties, or either of them, in any suit brought to foreclose mechanics' liens, which may be filed by such persons, or either of them, upon the property mentioned in said contract, or in a separate suit brought upon this bond, and may recover in such action or actions, the value of such labor done or materials furnished, or both, together with a reasonable attorney's fee to be fixed by the Court, not exceeding, however, in the aggregate of said recoveries, the amount of this bond as above specified.

IN WITNESS WHEREOF, the said Principal and Sureties have caused these presents to be executed and their corporate names and seals to be hereunto attached by their proper officers thereunto duly authorized, the day and year first hereinabove written.

H. W. Rohl and T. E. Connolly,
Principal

By T. E. Connolly
Principal
Attorney in Fact

THE METROPOLITAN CASUALTY INSURANCE COMPANY OF NEW YORK

By Jno T. Brunn
Attorney-in-Fact Surety

COMMERCIAL CASUALTY INSURANCE COMPANY

By Jno. T. Burn
Attorney-in-Fact Surety

HARTFORD ACCIDENT AND INDEMNITY COMPANY

By Dick W. Graves (SEAL)
Attorney-in-Fact Surety

MASSACHUSETTS BONDING AND INSURANCE COMPANY

By Donald B. Goldsmith (SEAL)
Attorney-in-Fact Surety

I hereby approved the form of the within Bond this 25th day of April 1932.

C. L. Byers
City Attorney of the City of San Diego

Approved by a majority of the members of the Common Council of the City of San Diego, California, this 25 day of April 1932.

Joseph J. Russo

L. C. Maire

(SEAL) A. Stabel Jr

Ira S. Irey

Members of the Common Council

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred and thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared

Jno. T. Brunn

known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of

THE METROPOLITN CASUALTY INSURANCE COMPANY OF NEW YORK (a Corporation)

and acknowledged to me that he subscribed the name of said Corporation thereto as surety and his own name as attorney in fact.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

Irma C. Swain

Notary Public in and for the County of Los Angeles, California

My Commission Expires Dec. 1, 1933

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared Jno. T. Brunn known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of COMMERCIAL CASUALTY INSURANCE COMPANY (a Corporation) and acknowledged to me that he subscribed the name of said COMMERCIAL CASUALTY INSURANCE COMPANY thereto as surety and his own name as attorney in fact.

(SEAL)

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

Irma C. Swain
Notary Public in and for the County of Los Angeles, California.

My Commission Expires Dec. 1, 1933

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April in the year One Thousand Nine Hundred and thirty two before me, Irma C. Swain, a Notary Public in and for the County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared

Donald B. Goldsmith

known to me to be the person whose name is subscribed to the within instrument as the attorney in fact of

Massachusetts Bonding and Insurance Company

(a Corporation) and acknowledged to me that he subscribed the name of said Corporation thereto as surety and his own name as attorney in fact.

(SEAL)

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the said County of Los Angeles, the day and year in this certificate first above written.

My Commission
Expires Dec. 1, 1933

Irma C. Swain
Notary Public in and for the County of Los Angeles, California

STATE OF CALIFORNIA)SS
County of Los Angeles)

On this 23rd day of April 1932, before me, Opal Graves, a Notary Public in and for the said County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared DICK W. GRAVES, known to me to be the Attorney-in-Fact of the HARTFORD ACCIDENT AND INDEMNITY COMPANY, the Corporation that executed the within instrument, and acknowledged to me that he subscribed the name of the HARTFORD ACCIDENT AND INDEMNITY COMPANY thereto and his own name as Attorney-in-Fact.

(SEAL)

Opal Graves
Notary Public in and for the County of Los Angeles, State of California

My Commission Expires June 18, 1934.

FORM OF LABOR AND MATERIALMEN'S BOND

KNOW ALL MEN BY THESE PRESENTS, That .....

.....

as principal, and.....

.....

a coporation organized and existing under and by virtue of the laws of the State of ....., as surety, are held and firmly bound unto The City of San Diego, a municipal corporation in the County of San Diego, State of California, in the sum of..... Dollars ($.....), (not less than fifty per cent of estimated contract price), lawful money of the United States of America, to be paid to The City of San Diego for the payment of which, well and truly to be made, we hereby bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

Signed by us and dated this.....day of....., 19.....

The condition of the above and foregoing obligation is such that whereas, the said principal has entered into the annexed contract with The City of San Diego to furnish all materials, and all labor, tools, appliances, transportation and other expenses necessary on incidental to the construction, completion and installation of .....in the County of San Diego, State of California, all as more particularly and in detail shown upon those certain plans and specifications filed in the office of the City Clerk of said The City of San Diego on the.....day of....., 19....., marked Document No....., and endorsed.....; said plans consisting of.....sheets and said specifications consisting of.....sheets, copies of which plans and specifications are attached to said contract and made a part thereof as in said Contract provided; and reference is hereby made to said contract and to said plans and specifications for a particular description of the work to be done.

And, whereas, the aforesaid penal sum of..... Dollars ($.....), being not less than one-half of the total amount payable by the terms of said contract, is intended and is hereby made to inure to and for the use of any and all persons, companies or corporations who perform labor on or furnish materials to be used in the said work;

NOW, THEREFORE, should the above bounden principal well and truly pay or cause to be paid all claims against.....for such labor or materials, or either, or both, so performed or furnished, as the case may be, then this obligation to be null and void; otherwise to be and remain in full force and effect and the same is hereby expressly made to inure to the benefit of any and all persons who perform labor upon or furnish materials to be used in the work described in said contract, or in any modification thereof; and any and all such persons shall have and are given a right of action to recover upon this bond against the said principal and Surety, or either of them. in any suit brought to foreclose mechanics' liens, which may be filed by such persons, or either of them, upon the property mentioned in said contract, or in a separate suit brought upon this bond, and may recover in such action or actions, the value of such labor done or materials furnished, or both. together with a reasonable attorney's fee to be fixed by the Court, not exceeding, however, in the aggregate of said recoveries, the amount of this bond as above specified.

IN WITNESS WHEREOF, the said principal and surety have caused these presents to be executed and their corporate names and seals to be hereunto attached by their proper officers thereunto duly authorized, the day and year first hereinabove written.

.....

Principal.

ATTEST: By.....

.....

Surety.

ATTEST: By.....

.....

If executed by an individual or partnership contractor, appropriate changes shall be made in the last preceding paragraph.

I hereby approve the form of the within Bond this.....day of....., 19.....

.....

City Attorney of the City of San Diego.

Approved by a majority of the members of the Common Council of the City of San Diego, California, this.....day of....., 19.....

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Members of the Common Council.

SPECIFICATIONS

GENERAL CONDITIONS

1. **Form of Proposal and Signature.**—The proposal shall be made on the form provided therefor and shall be enclosed in a sealed envelope marked and addressed as required in the information for bidders. The bidder shall state in words and figures the unit prices or the specified sums, as the case may be, for which he proposes to supply the materials or machinery and perform the work required by these specifications. If the proposal is made by an individual it shall be signed with his full name, and his address shall be given; if it is made by a firm it shall be signed with the copartnership name by a member of the firm, who shall also sign his own name, and the name and address of each member and the address of the firm shall be given; and if it is made by a corporation, it shall be signed by an officer with the corporate name attested by the corporate seal, and the names, addresses and titles of all officers of the corporation and the address of the corporation shall be given. No telegraphic proposal or telegraphic modification of a proposal will be considered.

2. **Proposal.**—Blank spaces in the proposal should be properly filled. The phraseology of the proposal must not be changed, and no additions should be made to the items mentioned therein. Unauthorized conditions, limitations, or provisos attached to a proposal will render it informal and may cause its rejection. Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder. If the unit price and the total amount named by a bidder for any item do not agree, the unit price alone will be considered as representing the bidder's intention. A bidder may withdraw his proposal before the expiration of the time during which proposals may be submitted, without prejudice to himself, by submitting a written request for its withdrawal to the officer who holds it. No proposals received after said time or at any place other than the place of opening as stated in the notice inviting bids will be considered. Bidders, their representatives, and others interested, are invited to be present at the opening of proposals. The right is reserved to reject any or all proposals, to accept one part of a proposal and reject the other, and to waive technical defects, as the interest of the City of San Diego may require.

3. **Certified Check.**—Each bidder shall submit with his proposal an unconditional certified check for the sum stated in the Notice Inviting Bids, payable to the order of "The City Clerk of the City of San Diego" (hereinafter styled City Clerk). Any condition or limitation placed upon a certified check will render it informal and may result in the rejection of the proposal under which such check is submitted. If the bidder to whom an award is made fails or refuses to execute the required contract and bond within the time specified in paragraph four, or such additional time as may be allowed by the engineer, the proceeds of his check shall become subject to deposit in the Treasury of the City of San Diego as moneys belonging to the City of San Diego, the proceeds of said check being agreed upon as liquidated damages to the City of San Diego on account of the delay in the execution of the contract and bond and the performance of work thereunder, and the necessity of accepting a higher or less desirable bid resulting from such failure or refusal to execute contract and bond as required. The check of the successful bidder will be returned after the execution of his contract and the approval of his bond on behalf of the City of San Diego; and the checks of the other bidders will be returned at the expiration of forty-five days from the date of opening proposals, or sooner if contract is executed prior to that time.

4. **The Contract.**—The bidder to whom award is made shall execute a written contract with the City of San Diego and, if bonds are required, furnish good and approved bonds within ten days after award of contract is made. The contract shall be made in the form adopted by the City of San Diego. This form may be examined at the offices of the City Clerk, or copies will be furnished on request to parties proposing to bid. If the bidder to whom award is made fails to enter into contract as herein provided, the award will be annulled, and an award may be made to the next lowest responsible bidder, and such bidder shall fulfill every stipulation embraced herein as if he were the party to whom the first award was made. The notice inviting bids, information for bidders, proposal, general conditions, and detail specifications will be incorporated in the contract. A corporation to which an award is made will be required, before the contract is finally executed, to furnish evidence of its corporate existence and evidence that the officer signing the contract and bond for the corporation is duly authorized to do so.

5. **Contractor's Bonds.**—Unless another sum is specified in the information for bidders, the contractor shall furnish a labor and materialmen's bond in an amount of not less than fifty per cent of the estimated contract price, lawful money of the United States of America, to be paid to the City of San Diego, conditioned upon the payments by said contractor of all materials or supplies furnished in the performance of the work contracted to be done by the terms of said contract, and for any work or labor of any kind done thereon.

The contractor shall also furnish a faithful performance bond in an amount not less than seventy-five per cent of the estimated contract price, lawful money of the United States of America, to be paid to the

City of San Diego, conditioned upon the faithful performance by the contractor of all covenants and stipulations in the contract.

If, during the continuance of the contract, any of the sureties die, or, in the opinion of the Common Council, are or become irresponsible, the Common Council may require additional sufficient sureties, which the contractor shall furnish to the satisfaction of said Common Council within ten days after notice, and in default thereof the contract may be suspended by the Common Council and the materials purchased or the work completed as provided in paragraph 12.

6. **Transfers.**—No interest in this agreement shall be transferred to any other party, and any such transfer shall cause annulment of the contract so far as the City of San Diego is concerned; all rights of action, however, for breach of this contract are reserved to the City of San Diego.

7. **Engineer.**—The word "Engineer" used in these specifications or in the contract means the Hydraulic Engineer in Charge Bureau of Water Development of the City of San Diego. He will be represented by assistants and inspectors authorized to act for him. On all questions concerning the acceptability of material, machinery, the classification of material, the execution of the work, conflicting interests of contractors performing related work, and the determination of costs, the decision of the said engineer shall be final, and binding upon both parties.

8. **Contractor.**—The word "Contractor" used in these specifications or in the contract, means the person, firm, or corporation with whom the contract is made by the City of San Diego. The contractor shall at all times be represented on the works in person or by a foreman or duly designated agent. Instructions and information given by the engineer to the contractor's foreman or agent on the work shall be considered as having been given to the contractor. When two or more contractors are engaged on installation or construction work in the same vicinity the engineer shall be authorized to direct the order, manner and rate in which each shall conduct his work so far as it affects other contractors.

9. **Samples or Specimens.**—The contractor shall submit samples or specimens of such material to be furnished or used in the work as the engineer may require.

10. **Materials and Workmanship.**—All materials must be of the specified quality and equal to approved samples if samples have been submitted. All work shall be done and completed in a thorough, workmanlike manner, notwithstanding any omission from these specifications or the drawings, and it shall be the duty of the contractor to call the engineer's attention to apparent errors or omissions and request instructions before proceeding with the work. The engineer may by appropriate instructions correct errors and supply omissions, which instructions shall be as binding upon the contractor as though contained in the original specifications or drawings. All materials furnished and all work done must be satisfactory to the engineer. Work, material, or machinery not in accordance with these specifications, in the opinion of the engineer, shall be made to conform thereto. Unsatisfactory material will be rejected, and, if so ordered by the engineer, shall, at the contractor's expense, be immediately removed from the vicinity of the work.

11. **Delays.**—If any delay is caused the contractor by specific orders of the engineer to stop work, or by the performance of extra work ordered by the engineer, or by the failure of the City of San Diego to provide material, or necessary instructions for carrying on the work, or to provide the necessary right of way, or site for installation, or by unforeseen causes beyond the control of the contractor, such delay will entitle the contractor to an equivalent extension of time, except as otherwise provided in paragraph 28. Application for extension of time must be approved by the engineer and shall be accompanied by the formal consent of the sureties, but an extension of time, whether with or without such consent, shall not release the sureties from their obligations, which shall remain in full force until the discharge of the contract. If delays from any of the above-mentioned causes occur after the expiration of the contract period no liquidated damages shall accrue for a period equivalent to such delay.

12. **Suspension of Contract.**—If the contractor fails to begin the delivery of the material, or to commence work as provided in the contract, or fails to make delivery of material promptly as ordered, or to maintain the rate of delivery of material or progress of the work in such manner as in the opinion of the engineer will insure a full compliance with the contract within the time limit, or if in the opinion of the engineer the contractor is not carrying out the provisions of the contract in their true intent and meaning, written notice will be served on him to provide within a specified time for a satisfactory compliance with the contract, and if he neglects or refuses to comply with such notice the engineer may with the written consent of the Common Council suspend the operation of all or any part of the contract, or he may in his discretion after such notice perform any part of the work or purchase any or all of the material included in the contract or required for the completion thereof without suspending the contract. Upon suspension of contract the engineer may in his discretion take possession of all or any part of the machinery, tools, appliances, animals, materials, and supplies used in the work covered by the contract or that have been delivered by or on account of the contractor for use in connection therewith, and the same may be used either directly by the City of San Diego or by other parties for it, in the completion of the work suspended; or the City of

San Diego may employ other parties to perform the work, or may substitute other machinery or materials, purchase the material contracted for in such manner as it may deem proper, or hire such force and buy such machinery, tools, appliances, animals, materials and supplies at the contractor's expense as may be necessary for the proper conduct and completion of the work. Any cost to the City of San Diego in excess of the contract price arising from the suspension of the contract, or from work performed or purchases made by the City of San Diego either before or after suspension, and required on account of the failure of the contractor to comply with his contract or the orders of the engineer issued in pursuance thereof, will be charged to the contractor and his sureties, who shall be liable therefor. A special lien to secure the claims of the City of San Diego in the event of suspension of the contract is hereby created against any property of the contractor taken into the possession of the City of San Diego under the terms hereof, and such lien may be enforced by a sale of such property under the direction of the Common Council of the City of San Diego, and the proceeds of the sale, after deducting all expenses thereof, and connected therewith, shall be credited to the contractor. If the net credits shall be in excess of the claims of the City of San Diego against the contractor the balance will be paid to the contractor or his legal representatives. If, in the opinion of the engineer, an emergency exists for the furnishing of certain material or the performance of certain work in order to insure compliance with the terms of the contract and if the contractor fails to furnish such material or to perform such work within a reasonable time fixed by written notice from the engineer to the contractor, then the engineer shall have the power to furnish such material or to perform such work at the expense of the contractor and his sureties, who shall be liable therefor. In the determination of the question whether there has been such non-compliance with the contract as to warrant its suspension or the furnishing of material or the performance of work by the City of San Diego as herein provided, the decision of the engineer shall be final and binding upon both parties. Suspension of the contract, or any part thereof, shall operate only to terminate the right of the contractor to proceed with the work covered by the contract or the suspended portions thereof. The provisions of the contract permitting the City of San Diego to make changes and to make proper adjustment of acounts to cover any increase or decrease of cost on account of such changes, and all other stipulations of the contract except those giving the contractor the right to proceed with work on the items covered by the suspension, shall be and remain in full force and effect after such suspension and until the contract shall have been completed and final payment or final adjustment of accounts made.

13. **Changes.**—The engineer may, without notice to the sureties on the contractor's bonds, make changes; (a) in the designs or material or machinery; (b) in the plans for installation or construction; (c) in quantities or character of the work or material required. The changes in plans for installation or construction may also include (a) modifications of shapes and dimensions of canals, dams and other structures and excavations therefor; (b) the shifting of locations to suit conditions disclosed as work progresses. No changes affecting the cost in excess of $1,000 will be made by the engineer without the approval of the Common Council. If such changes result in an increase or decrease of cost to the contractor, the engineer will make such additions or deductions on account thereof as he may deem reasonable and proper, and such action thereon, subject to approval by the Common Council, shall be final. Extra work or material shall be charged for as hereinafter provided.

14. **Extra Work or Material.**—In connection with the work covered by this contract, the engineer may, at any time during the progress of the work, order work or material not covered by the specifications. Such work or material will be classed as extra work and will be ordered in writing. No extra work of material will be paid for unless ordered in writing by the engineer. No extra work or material costing in excess of $1.000 will be ordered by the engineer without the approval of the Common Council. Extra work or material shall be charged for at actual necessary cost, as determined by the engineer, pluss fifteen per cent for profit, superintendence,, and general expenses. The actual necessary cost will include all expenditures for materials, labor, additional premiums on "Faithful Performance" and "Labor and Materialmen's" bonds, and on "Workmen's Compensation and Indemnity Insurance," and supplies furnished by the contractor, and in connection with the manufacture of machinery a reasonable allowance for the use of shop and field equipment where required, but will in no case include any allowance for office expenses, general superintendence or other general expenses. At the end of each month the contractor shall present in writing any claims for extra work performed during that month and extra material delivered during that month and, when requested by the engineer, shall furnish itemized statement of the cost and shall permit examination of accounts, bills, and vouchers relating thereto. No such claim will be allowed which is not presented to the engineer in writing within thirty days after the close of the calendar month, during which the extra work or material covered by such claim is alleged to have been furnished, and any such claim not so presented will be deemed to have been waived by the contractor.

15. **Delays—No Extra Compensation.**—The contractor shall receive no compensation for delays or hinderances to the work except, when in the judgment of the engineer, direct and unavoidable extra cost to the contractor is caused by the failure of the City of San Diego to provide necessary information, material. right of way, or site for installation. When such extra compensation is claimed a written itemized statement setting forth in detail the amount thereof shall be presented by the contractor not later than thirty days

after the close of the calendar month during which extra cost is claimed to have been incurred. Unless so presented the claim shall be deemed to have been waived. Any such claim, if found correct, will be approved and the amount found due as actual extra cost will be covered by the next estimate thereafter paid under the contract. The decision of the engineer whether extra cost has been incurred and the amount thereof, subject to approval by the Common Council, shall be final.

15½. **Arbitration.**—In the event that The City of San Diego at any time shall for any cause or reason, not occasioned by or due to the fault of the contractor, be forced or compelled to require a complete suspension of the work, and the City and the Contractor cannot reach an agreement as to what, if any, additional compensation the contractor may be entitled to receive, by virtue of said suspension, in excess of the contract earnings accrued to the date of said suspension, then the question as to whether or not the contractor is entitled to such additional compensation, together with the rate or total amount thereof, as the case may be, shall, as soon as the probable duration of said suspension can de determined, but in any case where the suspension shall have continued for thirty days, be submitted to arbitration in the following manner: A Board of nine arbitrators shall be chosen. The City and the contractor shall each, upon five days' written notice to the other, appoint three arbitrators, and the six so appointed shall agree upon and select three additional arbitrators. The concurrence of six of said arbitrators shall be necessary to an award. Except as herein otherwise provided, the provisions of Part III, Title X of the Code of Civil Procedure of the State of California shall be applicable to the arbitration proceedings, and shall govern and control the rights of the parties.

16. **Changes at Contractor's Request.**—If the contractor, on account of conditions developing during the progress of the work, finds it impracticable to comply strictly with these specificatitons and applies in writing for a modification of requirements or of methods of work, such change may be authorized by the engineer if not detrimental to the work and if without additional cost to the City of San Diego.

17. **Inspection.**—All materials furnished and work done under this contract will be subject to rigid inspection. The contractor shall furnish without cost to the City of San Diego complete facilities, including the necessary labor for the inspection of all material and workmanship. The engineer, or his authorized agent, shall have at all times access to all parts of the shop where such material under his inspection is being manufactured. Work or material that does not conform to the specifications, although accepted through oversight or otherwise, may be rejected at any state of the work. Whenever the contractor on installation or construction is permitted or directed to do night work or to vary the period during which work is carried on each day, he shall give the engineer due notice so that inspection may be provided. Such work shall be done without extra compensation and under regulations to be furnished in writing by the engineer.

18. **Contractor's Financial Obligations.**—The contractor shall promptly make payments to all persons supplying labor and materials in the execution of the contract, and a condition to this effect shall be incorporated in the contractor's bond.

19. **Experience.**—Bidders, if required, shall present satisfactory evidence as to their responsibility and that they are fully prepared with necessary capital, machinery and material to begin the work promptly and to conduct it as required by these specifications.

20. **Specifications and Drawings.**—The contractor shall keep on the work a copy of the specifications and drawings and shall at all times give the engineer access thereto. Any drawings or plans listed in the detail specifications shall be regarded as part thereof and of the contract. Anything mentioned in these specifications and not shown on the drawings or shown on the drawings and not mentioned in these specifications shall be of like effect as though shown or mentioned in both. The engineer will furnish from time to time such detail drawings, plans, profiles, and information as he may consider necessary for the contractor's guidance, unless otherwise provided in the proposal, agreement or detail specifications.

21. **Local Conditions.**—Bidders shall satisfy themselves as to local conditions affecting the work, and no information derived from the maps, plans, specifications, profiles, or drawings, or from the engineer or his assistants, will relieve the contractor from any risk or from fulfilling all of the terms of his contract. The accuracy of the interpretation of the facts disclosed by borings or other preliminary investigations is not guaranteed. Each bidder or his representative should visit the site of the work and familiarize himself with local conditions.

22. **Data To Be Furnished By The Contractor.**—The contractor shall furnish the engineer reasonable facilities for obtaining such information as he may desire respecting the character of the materials and the progress and manner of the work, including all information necessary to determine its cost, such as the number of men employed, their pay, the time during which they worked on the various classes of construction, etc. The contractor shall also furnish the engineer copies of all invoices for materials and supplies and copies of freight bills on all machinery, materials, and supplies, shipped to or from the project in connection with the work under the contract.

23. **Restrictions on Disposition of Plant, Etc.**—The contractor shall not make any disposition of the

plant, machinery, tools, appliances, supplies, materials, or animals used on or in connection with the work, either by sale, conveyance, or incumbrance, inconsistent with the special lien of the City of San Diego expressly created by this contract.

24. **Damages.**—The contractor will be held responsible for and required to make good, at his own expense, all damage to person or property caused by carelessness or neglect on the part of the contractor or subcontractor, or the agents or employees of either, during the progress of the work and until its final acceptance.

25. **Character of Workmen.**—The contractor shall not allow his agents or employees, his subcontractors, or any agent or employee thereof to trespass on premises or lands in the vicinity of the work. None but skilled foreman and workmen shall be employed on work requiring special qualifications, and when required by the engineer, the contractor shall discharge any person who commits trespass or is in the opinion of the engineer disorderly, dangerous, insubordinate, incompetent, or otherwise objectionable. Such discharge shall not be the basis of any claim for compensation or damages against the City of San Diego or any of its officers.

26. **Staking Out Work.**—The work to be done will be staked out for the contractor who shall without cost to the City of San Diego provide such material and give such assistance as may be required by the engineer.

27. **Methods and Appliances.**—The methods and appliances adopted by the contractor shall be such as will, in the opinion of the engineer, secure a satisfactory quality of work and will enable the contractor to complete the work in the time agreed upon. If at any time the methods and appliances appear inadequate, the engineer may order the contractor to improve their character or efficiency, and the contractor shall conform to such order, but failure of the engineer to order such improvement of methods or efficiency will not relieve the contractor from his obligation to perform satisfactory work and to finish it in the time agreed upon.

28. **Climatic Conditions.**—The engineer may order the contractor to suspend any work that may be subject to damage by climatic conditions. When delay is caused by an order to suspend work given on account of climatic conditions which, in the opinion of the engineer could have been reasonably foreseen, the contractor will not be entitled to any extension of time on account of such order.

29. **Quantities and Unit Prices.**—The quantities noted in the schedule of proposal are estimates for comparing bids, and no claim shall be made against the City of San Diego for excess or deficiency therein, actual or relative. Payment at the prices agreed upon will be in full for the completed work and will cover materials, supplies, labor, tools, machinery, and all other expenditures incidental to satisfactory compliance with the contract, unless otherwise specifically provided.

30. **Removal and Rebuilding of Defective Work.**—The contractor shall remove and rebuild at his own expense any part of the work that has been improperly executed, even though it has been included in the monthly estimates. If he refuses or neglects to replace such defective work, it may be replaced by the City of San Diego at the expense of the contractor, and the contractor and his sureties shall be liable therefor.

31. **Protection of Work and Cleaning Up.**—The contractor shall be responsible for any material furnished him and for the care of all work until its completion and final acceptance, and he shall at his own expense replace damaged or lost material and repair damaged parts of the work, or the same may be done at his expense by the City of San Diego, and the contractor and his sureties shall be liable therefor. He shall take all risks from floods and casualties and shall make no charge for detention from such causes. He may, however, be allowed a reasonable extension of time on account of such detention, subject to the conditions hereinbefore specified. The contractor shall remove from the vicinity of the completed work all plant, buildings, rubbish, unused material, concrete forms, etc., belonging to him or used under his direction during construction, and in the event of his failure to do so the same may be removed by the City of San Diego at the expense of the contractor, and the contractor and his sureties shall be liable therefor.

32. **Roads and Fences.**—Streets and roads subject to interference from the work covered by this contract shall be kept open, and the fences subject to interference shall be kept up by the contractor until the work is finished.

33. **Bench Marks and Survey Stakes.**—Bench marks and survey stakes shall be preserved by the contractor, and in case of their destruction or removal by him or his employees, they will be replaced by the engineer at the contractor's expense, and the contractor and his sureties shall be liabe therefor.

34. **Right of Way.**—The right of way for the works to be constructed under this contract will be provided by the City of San Diego.

35. **Sanitation.**—The engineer may establish sanitary and police rules and regulations for all forces employed under this contract, and if the contractor fails to enforce these rules the engineer may enforce them at the expense of the contractor.

36. **Subcontractors.**—The contractor shall not subcontract in excess of 20% of the total amount of the contract, except by express permission in writing of the Engineer. The contractor shall advise the Engineer in advance and in detail of all portions of the work that he contemplates subcontracting. The contractor shall also furnish the City of San Diego the name and address of each subcontractor contracting directly with him, together with a statement showing the character and location of work, time limit, if any, and amount of money involved in each subcontract. Each subcontract shall contain a reference to the agreement between The City of San Diego and the principal contractor, and the terms of that agreement and all parts thereof shall be made a part of such subcontract insofar as applicable to the work covered thereby. Each subcontract shall provide for its annulment at the order of the engineer if, in his opinion, the subcontractor fails to comply with the requirements of the principal contract in so far as the same may be applicable to his work, and all work or material furnished by a subcontractor shall be guaranteed by the contractor and the City of San Diego will hold the contractor responsible therefor.

37. **Infringement of Patents.**—The contractor shall hold and save the City of San Diego, its officers, agents, servants and employees harmless from and against all and every demand, or demands, of any nature or kind for or on account of the use of any patented invention, article, or appliances included in the material or supplies hereby agreed to be furnished under this contract, and should the contractor, his agents, servants, or employees, or any of them, be enjoined from furnishing or using any invention, article, material, or appliance supplied or required to be supplied or used under this contract, the contractor shall promptly substitute other articles, materials, or appliances in lieu thereof, of equal efficiency, equality, finish, suitability and market value, and satisfactory in all respects to the engineer. Or in the event that the engineer elects, in lieu of such substitution, to have supplied, and to retain and use, any such invention, article, material or appliance, as may by this contract be required to be supplied, in that event the contractor shall pay such royalties and secure such valid licenses as may be requisite and necessary to enable the City of San Diego, its officers, agents, servants and employees, or any of them, to use such invention, article. material, or appliance without being disturbed or in any way interefered with by any proceeding in law or equity on account thereof. Should the contractor neglect or refuse promptly to make the substitution hereinbefore required, or to pay such royalties and secure such licenses as may be necessary and requisite for the purpose aforesaid, then in that event the engineer shall have the right to make such substitution, or the City of San Diego may pay such royalties and secure such licenses and charge the cost thereof against any money due the contractor from the City of San Diego, or recover the amount thereof from him and his sureties, notwithstanding final payment under this contract may have been made. The provisions of this paragraph do not apply to articles which the contractor is required to manufacture or furnish in accordance with detail drawings furnished by the City of San Diego included in this contract. They shall apply, however, where such drawings and the specifications cover only the type of device without restriction as to details.

38. **Workmen's Compensation and Indemnity Insurance.**—The contractor shall furnish the City of San Diego with a certificate of the insurance carrier with whom said contractor is carrying a policy of insurance, acknowledging full liability, and covering all employees connected with the work specified in this contract, and insuring said contractor against loss or liability by reason of the Workmen's Compensation Insurance and Safety Act of 1917, said certificate of the insurance carrier to bear the date of the expiration of said policy.

39. **Compliance With Laws.**—The contractor shall conduct the work in compliance with all laws and regulations of the United States, and of the State of California, ordinances of the County of San Diego and ordinances of the City of San Diego, limiting or controlling the work in any manner.

DETAIL SPECIFICATIONS

SPECIAL CONDITIONS.

40. **Requirement.**—It is required that there be constructed and completed in accordance with the drawings hereinbelow listed, and these specifications, the El Capitan Reservoir Dam, Spillway and Outlet Works. The proposed work is located on the San Diego River, about eight miles northeasterly from the town of Lakeside. The latter is about twenty-one miles northeasterly from the City of San Diego, and is the terminal of the Lakeside branch of the San Diego and Arizona Railway.

41. **List of Drawings.—**

WD-285		Geography
WD-382		Plan
WD-290		Log of Core Drills
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
WD-351		Areas of material available for Hydraulic fill

42. **Commencement, Prosecution and Completion of Work.**—Work shall be commenced by the contractor within ten days after the execution of the contract on behalf of the City of San Diego and shall be completed on or before October 31, 1934. If the City of San Diego occupies more than fifteen days time after the opening of bids in awarding and executing contract, exclusive of the time occupied in transmitting contract and bonds to and from the contractor and in the execution of such papers by him, the contractor will be entitled to an extension of time for a period equivalent to the excess time so used by the City of San Diego. The contractor shall, at all times during the continuance of the contract, prosecute the work with such force and equipment as, in the judgment of the engineer, are sufficient to complete the different portions of the work in the order required and the entire work within the specified time.

43. **Failure to Complete the Work in the Time Agreed Upon.**—Should the contractor fail to complete the work or any part thereof in the time agreed upon in the contract, or within such extra time as may have been allowed for delays by extensions granted as provided in the contract, a deduction of $100.00 per day will be made for each and every day, including Sundays and holidays, that the contract remains uncompleted after the date required for completion. The said amounts are hereby agreed upon as liquidated damages for the loss to the City of San Diego on account of the expense due to the employment of engineers, inspectors, and other employes, after the expiration of the time for completion, and on account of the value of the operation of the domestic works dependent thereon, and will be deducted from any money due the contractor under his contract, and the contractor and his sureties shall be liable for any excess.

44. **Meals Furnished.**—The contractor, during the period he maintains a mess in connection with the work, shall furnish suitable meals, satisfactory in quality, quantity, and service, at usual hours, to all employes and officials and official guests of the City of San Diego, single meals at fifty cents per meal. Requisitions will be issued in advance by the engineeer for all meals, and at the end of each month the contractor shall present bills to the engineer for meals served in accordance with requisition, showing the names, dates and number of meals furnished each person. These bills when approved by the engineer will be paid by the City.

45. **Water for Plant, Construction and Domestic Use.**—Water for all of the mechanical, construction and domestic requirements of the work in so far as it is available in the river channel or bed, shall be obtained therefrom, and there shall be pumped and stored a sufficient quantity at an elevation which will insure at all times a continuous adequate supply under ample pressure for the work.

46. **Two Daily Shifts of Labor.**—There shall be employed upon the work two daily shifts of eight hours each when required by the engineer. There shall be provided by the contractor an ample number of electric lights to effectively illuminate all work in progress at night.

47. **Removal of Temporary Works.**—All temporary structures shall be removed from the work at the contractor's own expense whenever they have served their purpose or upon completion of the work, but not until permitted by the engineer.

48. **Maintaining Flow in Flume.**—The water supply flume along the south or left side of the damsite shall be maintained in its existing condition of service or in a manner satisfactory to the engineer. Care shall be exercised in blasting not to injure the flume and any injury thereto shall be repaired to the satisfaction of the engineer. All cost of maintaining the flume and service through it shall be borne by the contractor and at no additional expense to the City.

49. **Use of Public Highway.**—Within thirty days after due notice by the engineer the contractor shall cease to use such portions of the public highway along the south side of the San Diego River between Lakeside and El Capitan dam site and for such period of time as the City may require for the installation of the El Capitan-Lakeside pipe line. The contractor shall make such provision as may be necessary to provide for his own use access to the damsite, and the cost thereof shall be at his own expense.

50. **Progress Estimates and Payments.**—At the end of each calendar month the engineer will make an estimate of the amount earned to that date, under the terms of the contract, for completed work, classified and computed on the basis of the items and unit prices named in the contract. To the estimate made as above set forth will be added the amounts earned for extra work to the date of the progress estimate. From the total thus computed a deduction of twenty-five per cent will be made, and from the remainder a further deduction will be made of all amounts due to the City of San Diego from the contractor for supplies or materials furnished or services rendered and any other amounts that may be due to the City of San Diego as damages for delays or otherwise under the terms of the contract. From the balance thus determined will be deducted the amount of all previous payments and the remainder will be paid to the contractor upon the approval of the accounts. The twenty-five per cent deducted as above set forth shall not become due and payable until the completion of the work to the satisfaction of the Engineer and its acceptance by The City of San Diego, and until release shall have been executed and filed as hereinafter provided, and until five days shall have elapsed after the expiration of the period within which liens may be filed under the provisions of Title 4, Part 3 of the Code of Civil Procedure of the State of California. In case of suspension of the contract, the said twenty-five per cent shall be and become the sole and absolute property of the City of San Diego to the extent necessary to repay to the City of San Diego any excess in the cost of the work above the contract price. When the terms of the contract shall have been fully complied with to the satisfaction of the engineer and when a release of all claims against the City of San Diego, under or by virtue of the contract, shall have been executed by the contractor, and when five days shall have elapsed after the expiration of the period within which liens may be filed, as hereinabove provided, final payment will be made, at such time and in such manner as provided by law, of any balance due, including the percentage withheld as above stated, or such portion thereof as may be due the contractor.

EXCAVATION AND EMBANKMENT

UNDER THIS HEAD ARE INCLUDED ALL EXCAVATION AND EMBANKMENT INVOLVED AND INCLUDED IN THE CONSTRUCTION OF THE EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS.

51. **Excavation and Embankment.**—The price bid for excavation and/or embankment shall include the cost of all power and appliances, of all labor and hauling and of all material for excavation and/or embankment, placing and sorting material in the hydraulic fill, rolled embankment and rock embankment of the dam, including clearing site, blasting, coffer or diversion dams, flume to carry the flow of water in the river past the damsite, and other temporary structures, all pumping, bailing, draining and all other work necessary to maintain the excavation in good order during construction and to protect the materials of construction involved, and the work under construction until its completion. Unless shown on the drawings or prescribed by the engineer, excavation for structures will be measured for payment to neat lines shown in the drawings or prescribed by the engineer. The excavated material shall be deposited in the vicinity of the work and/or as directed by the engineer. No payment will be made for material coming from outside or fill beyond the lines shown on the drawings or prescribed by the engineer. Payment will be made at the respective unit prices bid.

52. **Construction Program.**—The construction program shall at all times be subject to the approval of the engineer. The capacity of the construction plant, sequence of operations, and method of operation shall be such as to insure the completion of the work within the time of completion specified. Suitable material from the structure excavation shall be used for the dam and this material, in so far as practicable, shall be moved directly from its original position to its final position in the dam.

53. **Pits and Quarries.**—All clay, sand, gravel, decomposed granite, cobbles, rock and quarried rock required in the construction of the hydraulic fill, rolled embankment and rock embankment and the appurtenant works shall be taken from required excavations or if not suitable therefrom in the opinion of the engineer shall be secured and furnished by the contractor from borrow pits or quarries approved by the engineer. Borrow pits and quarries may be located at points approved by the engineer on the property of the City of San Diego or upon private lands at the option of the contractor. The contractor shall carefully clear the sites of all pits and quarries of trees, roots, brush, sod, loam and other objectionable matter and shall develop and maintain them in a condition suitable for the excavation of the required materials, and in a manner satisfactory to the engineer. The contractor will not be required to make payment to the City for the privilege of taking materials from pits and quarries located on property owned by the City of San Diego. Any royalties or other payments required to be made for materials taken from pits or quarries located elsewhere than on City property, shall be made by the contractor, and the cost thereof shall be included in the unit prices bid for embankment material originating in borrow pits.

54. **Classification Excavation.**—Class 1. Solid rock which shall include except class 3, 4 and 5 excavation, all ledge rock in place that cannot be loosened except by wedging, barring or blasting and all detached masses of solid rock more than one cubic yard in volume.

Class 2. All earth, overburden, sand, gravel and other excavation not included in class 3, 4 and 5.
Class 3. Excavation in main cutoff trench under dam.
Class 4. Excavation in cutoff trenches under spillway.
Class 5. Excavation in outlet tunnel excepting excavation in cut and cover section and approach and outlet sections.

Embankment—Class 1. Rock embankment originating in borrow pit only.

Class 2. Clay, earth, sand, gravel and other embankment, except Class 1, originating in borrow pit only.

Excavation and embankment or fill will be required to side slopes as indicated on the drawings or as deemed by the engineer essential to the work. No payment will be made for materials of any class coming from outside of, or filled beyond, lines and grades indicated on the drawings or established by the engineer in the field. It is desired that the contractor or his representative be present during the measurement of the material excavated. On written request by the contractor, made by him within ten days after the receipt of any monthly estimate, a statement of the quantities and classification between successive stations included in said estimate will be furnished him within ten days after the receipt of such request. This statement will be considered as satisfactory to the contractor unless he files with the engineer in writing specific objections thereto with reasons therefor. within ten days after receipt of said statement by the contractor or his representative on the work. Failure to file such written objections, with reasons therefor, within said ten days, shall be considered a waiver of all claims based on alleged erroneous estimates of quantities or incorrect classification of materials for the work covered by such statement.

55. **Measurement Of and Payment For Excavation and Embankment.**—All excavation for the dam or

structures shall be measured to the neat lines shown on the drawings or prescribed by the engineer. Measurement and payment for the various items of excavation and embankment, classified in accordance with these specifications will be as follows:

(a) All approved material excavated from the dam, foundations, tunnel and shaft, cutoff trenches, spillway or other structures, for the dam, stripping for the base of the dam, etc., excepting borrow pits, if placed and sorted in the dam, in accordance with the engineer's directions, will be measured for payment in excavation. The quantity of materials placed in embankment will be computed by subtracting spoil bank material measured in spoil bank from excavated materials measured in excavation. Payment will be made at the respective unit prices bid which shall include the cost of excavation, conveying, placing, sorting and compacting in hydraulic fill, rolled embankment or rock embankment.

(b). All approved material excavated from the dam, foundation, tunnel and shaft, cutoff trench, spillway or other structures, for the dam or stripping for base of dam, etc., excepting borrow pits, but wasted will be measured for payment in spoil bank. Payment will be made at the unit prices bid which shall include the cost of excavation and wasting where directed by the engineer.

(c) All approved material excavated from borrow pits, if placed and sorted in the dam in accordance with the engineer's directions, will be measured for payment in embankment in the dam to the lines and grades shown on the drawings or established by the engineer in the field, and payment will be made at the respective unit prices bid which shall include the cost of excavation, conveying, placing, sorting and compacting in the dam and all labor and operations. No payment will be made for materials wasted from borrow pits.

56. **Utilization and Wasting of Excavated Material.**—The contractor may at his option utilize, in constructing the concrete, sand and rock occurring in the material excavated when such material, in the judgment of the engineer, is suitable for such use and not required in the dam embankment or fill. In no case will excavated materials be paid for twice if moved directly from their original location to their final location in the dam. Materials originating in required excavations for structures, and if not suitable for or required in the dam in the opinion of the engineer, but suitable for concrete in the opinion of the engineer, will be paid for at the respective unit prices bid for excavation wasted. All material excavated and not utilized in construction of the dam or concrete shall be wasted with uniform and sightly surfaces by the contractor where directed by the engineer. No extra payment will be made for backfilling, hauling and dumping excavated material in the vicinity where directed by the engineer.

57. **Blasting.**—Any blasting which, in the opinion of the engineer may injure the work will not be permitted and any damage done to the work by blasting shall be repaired to the satisfaction of the engineer by the contractor at his expense. Whenever, in the opinion of the engineer, blasting is liable to injure any foundation rock, the required excavation shall be accomplished by drilling, plug and feathers, wedging and gadding, or other methods approved by the engineer. Caps, detonators and fuses shall in no case be stored or kept in the same place in which dynamite or other explosives are stored. The location and design of powder magazines, methods of transporting explosives and in general all precautions taken to prevent accidents must be satisfactory to the engineer, but the contractor shall be liable for all damages to persons or property caused by blasts or explosives.

58. **Backfill.**—The contractor shall backfill around structures, wherever required within the limits prescribed by the engineer, with materials conveniently located to the work and selected by the engineer. So far as practicable, the material moved in excavating for structures and not used in the dam shall be used for backfill, but when sufficient suitable material is not available from this source, additional material shall be obtained from borrow pits selected by the engineer. Material used for backfill if obtained from borrow pits will be measured in backfill, and payment therefor will be made at the price bid per cubic yard for backfill, which shall include the cost of all work connected therewith, including the excavation, hauling and placing of the borrowed material.

59. **Stripping and Excavation For Embankment.**—The entire base under the rock embankment and hydraulic fill rolled embankment shall be cleared of all rubbish, brush, scattered trees, stumps, and roots as well as all other perishable or objectionable material. These materials shall be burned or otherwise disposed of as directed by the engineer. This area shall then be stripped and excavated to such lines and grades as directed by the engineer. The material shall be wasted or otherwise disposed of as directed by the engineer. Payment for stripping will be made at the respective unit prices bid for excavation which shall include the cost of all materials, equipment and operations.

60. **Plowing Foundation.**—After stripping, the entire foundation of the dam shall be, wherever practicable, scored with a plow making open furrows not less than eight inches deep at the intervals of not more than three feet, or such other methods may be used as may be satisfactory to the engineer. The cost of this work shall be included in the unit prices bid for excavation.

61. **Cutoff Trench.**—The excavation for the cutoff trenches under the dam and spillway structures shall be made to such depth and width as directed by the engineer, and by means of open cut, tunnelling or stoping. Where required, timbering shall be placed in a manner satisfactory to the engineer, but the contractor shall be liable for its sufficiency and for any damage to life or property. All such timbering shall be completely removed before concrete is placed. The cost of labor, materials, and operations for timbering shall be included in the unit prices bid for cutoff trench excavation. All loose material shall be removed from the bottom of the trench before concrete is placed therein. No payment will be made for overbreakage or cavities excavated beyond the prescribed lines. All suitable material, as determined by the engineer, required to be excavated in the cutoff trenches and not used for backfilling shall be placed in the dam in the locations directed by the engineer. All other material shall be wasted where directed. Payment will be made at the unit prices bid in the schedule which shall include the cost of all operations, labor and materials.

224

HYDRAULIC FILL, ROLLED EMBANKMENT AND ROCK EMBANKMENT

UNDER THIS HEAD ARE INCLUDED ALL HYDRAULIC FILL, ROLLED EMBANKMENT AND ROCK EMBANKMENT INVOLVED AND INCLUDED IN THE CONSTRUCTION OF EL CAPITAN RESERVOIR DAM, SPILLWAY AND OUTLET WORKS.

62. **General.**—Hydraulic fill, rolled embankment and rock embankment shall be constructed to the heights designated and dimensions shown on the drawings or as directed by the engineer, and proper allowance shall be made for settlement. The contractor shall care for and maintain all embankments in a manner satisfactory to the engineer until the completion and final acceptance of the work. Any fill or embankment material lost before the completion of the contract, by floods, by river actions, by weathering, by any operation of the contractor, or by any other causes that, in the opinion of the engineer, is avoidable or under the control of the contractor, shall be replaced by the contractor in a manner satisfactory to the engineer, without cost to the City of San Diego. Each portion of the fill or embankment shall be constructed in accordance with the specifications therefor, and the cost of all work required by this paragraph shall be included in the respective unit prices bid in the the schedule for excavation and/or embankment.

63. **Hydraulic Fill.**—Fine materials in the central portion of the dam, as indicated on the drawings, or prescribed by the engineer, shall be sorted and placed by hydraulic means or such methods as may be acceptable to the engineer. In hydraulicking the materials, they shall be run through properly constructed transporting equipment onto the embankment. The materials, their gradation, their disposition and manner of transportation and equipment shall be subject to the engineer's approval. Materials not satisfactory in the opinion of the engineer will be rejected and the contractor shall waste such materials and they shall not be used in the dam. Hydraulic fill material shall be derived from the excavation for the dam, stripping of foundation, structures, tunnel, spillway, or borrow pits, as may be directed by the engineer.

The width and slope of the outer flanks and the depth and width of the settling pool will largely control the gradation of materials and shall be subject at all times to the direction of the engineer. The materials for the main body of the embankment shall be delivered near the outer edge of the embankment slopes and so manipulated that the coarser material, free from clay and silt, will remain near the outer slopes and the finer materials carried toward the center, the impervious materials being deposited next to the core wall so as to form an impervious core. Str-atification in the hydraulic fill section will not be permitted. Care shall be taken to place the coarse materials next to the rock embankment. No strata or lenses of sand. gravel or other open or porous material will be permitted in the central section. The delivery and manipulation of the materials shall be so regulated as to obtain the best distribution of material and to keep the water surface of the settling pool as nearly uniform in width as possible. The bottom of the settling pool shall be kept about level longitudinally to prevent undue flow of silt to one end. Care shall be taken to maintain the elevation of the hydraulic fill about equal on the two sides of the core wall. The contractor shall take care of excess water from the settling pools in a manner satisfactory to the engineer. All operations shall be subject at all times to the approval of the engineer. Subject to the direction of the engineer, sufficient time shall be allowed for proper drainage of the core materials, and the contractor shall not be entitled to additional compensation on account of delay occasioned thereby. Payment will be made at the unit prices bid for excavation and/or embankment if originating in borrow pits, which shall include the cost of all labor and materials and operations.

64. **Rolled Embankment.**—Embankment below streambed and/or elsewhere, other than rock embankment, and which does not require hydraulic sorting or placing, shall be deposited by teams, scrapers. dump wagon, dump trucks or other means satisfactory to the engineer. The materials shall be deposited in horizontal layers not exceeding eight inches in thickness when compacted. The materials shall be thoroughly wetted to make the densest mass practicable, in the opinion of the engineer, and shall be compacted with sheep foot tampers, weighing not less than 2,000 pounds per linear foot of tread, in layers not exceeding eight inches in thickness when compacted. The sheep foot tampers shall be kept in continuous operation on each spread layer until at no place thereon shall the tamper penetrate more than two inches, and no succeeding layer shall be placed thereon until the minimum penetration has been attained, provided that in no case shall the roller pass over each layer of embankment less than three times. All rock large enough to interfere with rolling or compacting shall be placed in the rock embankment. If, in the opinion of the engineer, the rolled surface of any layer of material is too smooth to bond properly with the succeeding layer it shall be roughened or loosened by harrowing or otherwise to the satisfaction of the engineer before the succeeding layer is placed thereon. No brush, roots, or other perishable material shall be placed in the embankment. The contractor shall take every precaution to keep any rolled embankment from becoming saturated and he shall install such drainage or pumping system at his own expense to accomplish such result in a manner satisfactory to the engineer. The cost of depositing, spreading, wetting and compacting of all materials, pumping, draining and all other operations required shall be included in the respective unit prices bid for excavation or embankment. Material for rolled embankment shall be derived from the excavation

for the dam, stripping for foundation, structures, tunnel, spillway or borrow pit, as may be directed by the engineer.

65. **Rock Embankment.**—The outer portions of the dam shall be carried ahead of the central portion and shall consist of loose rock embankment placed as directed by the engineer. This rock fill shall be the most durable rock available in the opinion of the engineer. It shall be obtained from rock excavation for structures, tunnel, spillway or borrow pits, and shall be approved by the engineer. No compacting of rock embankment will be required. The exposed surface of rock embankment shall consist of sound, hard, durable rock, carefully selected, faced, hand-placed, bedded and chinked and shall present a neat uniform appearance, all satisfactory to the engineer. Where shown on the drawings, or where directed by the engineer, cement mortar shall be poured into the spaces of the surface and smoothed even with the face of the stones as directed. Payment will be made at the unit prices bid for excavation and/or embankment if originating in borrow pits, which shall include the cost of all labor and materials and operations excepting cement which will be paid for as a separate item.

66. **Foundation.**—Excavation for foundations for the spillway, cutoff walls and structures shall be to a sufficient depth, in the opinion of the engineer to secure a suitable foundation. To preserve the rock outside of the lines shown on the drawings, or prescribed by the engineer, in the soundest practicable condition, unusual precautions will be required.

with the crushing machinery, and shall closely approach, by laboratory test, the following sizes and per cents:

Passing 3/8" screen	100%
Retained on # 4 screen	20%
" " # 20 "	60%
" " # 40 "	70%
" " #100 "	95%

Any excess of fine particles shall be wasted by the contractor as directed by the engineer.

72. **Broken Rock and Gravel.**—Rock if satisfactory for crushing for concrete, in the opinion of the engineer, may be selected from any excavated material if not used for the dam. Any rock which is unsatisfactory for use in the concrete shall be wasted by the contractor as directed by the engineer. Broken rock or gravel for concrete must be hard, dense, strong, durable rock fragments or pebbles. Rock to be broken and used for concrete shall, before being run through the crusher, be clean and free from all loamy and other deleterious matter. The rock shall either be picked from the excavation or just before entering the crusher, shall be run over a suitable grizzly screen, installed to operate at the flattest slope practicable and not steeper than an angle of sixty degrees with the horizontal, and having long spaces about one inch wide between bars to separate all objectionable matter which shall be wasted by the contractor. All crushed rock to be used for making concrete shall contain the entire run of the crusher and shall all be screened and separated into five sizes and stocked in separate bins. The screens shall be equal in efficiency to a machine having for its essential parts revolving, circular, metal cylinders, suitably perforated, and with their axes inclined to the horizontal at an angle closely approaching seven degrees. The sizes shall be as follows:

(1) Rock passing a two and one-half inch ring and retained on a one and one-half inch ring.
(2) Rock passing a one and one-half inch ring and retained on a three-quarters inch ring.
(3) Rock passing a three-quarters inch ring and retained on a three-eighths inch ring.
(4) Rock passing a three-eighths inch ring.

All of the foregoing sized rock shall be so graded in size that in no case by laboratory test, will more than ten per cent pass the smaller opening mentioned. The engineer will, from time to time, determine the exact proportions of each of the various sizes for assembly in a batch to be mixed into concrete, the object being to secure the densest practicable mixture. For reinforced concrete and for concrete whose least dimension is less than 18 inches, the larger sizes of rock shall not be used. In case there is a shortage of any one size, it shall be promptly supplied by the contractor and he shall not be entitled to payment for surplus of any graded size of material. In case suitable rock in sufficient quantities cannot be obtained for concrete from the excavation contemplated, additional rock may be obtained from quarry sites or gravel pits to be approved by the engineer. The cost of all sites, material and operations connected with the furnishing and using of rock or gravel aggregate for concrete required in the work shall be included in the price bid per cubic yard for concrete in place.

73. **Water.**—The water used in mixing concrete must be clean and free from objectionable quantities of organic matter, alkali, salts and other impurities. Suitable means shall be provided and employed for controlling and measuring accurately the water in each bach of concrete mixture.

74. **Mixing.**—Cement, sand and broken rock or gravel shall be so mixed and the quantities of water added shall be such as to produce a homogeneous mass of uniform consistency. Dirt and other foreign substances shall be carefully excluded. Concrete shall be mixed by an approved machine of the "batch" type, which admits of the accurate measuring of the materials. The use of a "continuous" mixer will not be permitted. All the materials to be mixed shall be separately measured in type and size and in boxes of proper size to secure the desired proportions, or by some method which will secure exact results. Measuring devices which depend for their operation upon the flow of materials from hoppers or other approximate methods will not be allowed. The entire batch after being assembled in the mixer shall remain in the mixer and be mixed for not less than one and one-half minutes and longer if necessary to secure a satisfactory mix. The machine and its operation shall be subject to the approval of the engineer. In general, only enough water shall be used in mixing to give the concrete the consistency ordinarily designated as "workable." Concrete containing a minimum amount of water, ordinarily designated as "dry" concrete, will be permitted only where the nature of the work renders the use of "workable" concrete impracticable. Care shall be taken that a uniform mixture of the concrete is at all times maintained in the handling of the concrete. The contractor shall have a responsible foreman continuously in charge of each mixing gang, who shall see that all instructions issued by the engineer as to the matter of proportioning, mixing, handling, and placing concrete are carried out.

75. **Placing.**—Concrete shall be placed in the work before the cement takes its initial set. No concrete shall be placed in water except by permission of the engineer and the method of its depositing shall be subject

to his approval. Foundation surfaces upon which concrete is to be placed must be scrupulously clean. When the placing of concrete is to be interrupted long enough for the concrete to take its final set, the working face shall be given a shape, by the use of forms or other means, at the option of the engineer, that will insure proper union with subsequent work. All concrete surfaces upon which, or against which concrete is to be placed, and to which the new concrete is to adhere shall be roughened, laitance removed, thoroughly cleaned and wet before the concrete is deposited. "Dry" concrete shall be deposited in layers not exceeding six inches in thickness, each of which shall be tamped until water appears on the surface. "Workable" concrete shall be poured and immediately spaded to place with suitable tamping bars, shovels, or forked tools until it completely fills the forms, closes snugly against all surfaces and is in perfect and complete contact with any steel used for reinforcement. Where smooth surfaces are required a suitable tool shall be worked up and down next to the form until the coarser material is forced back and a mortar layer is brought next to the form. Both placing and tamping shall be done with a special view to obtaining the densest concrete and smoothest surfaces practicable. No concrete shall be placed except in the presence of a duly authorized inspector. When concrete is conveyed by chuting, the plant shall be of such size and design as to insure a practically continuous flow in the chute. The angle and design of the chute shall be such as to allow the concrete to flow without separation of the ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. When the operation is intermittent, the spout shall discharge into a hopper. The addition of water over and above that required for the mix will not be permitted. The chute shall be thoroughly flushed with water before and after each run; the water used for this purpose shall be discharged outside the forms. Concrete shall be deposited continuously and as rapidly as practicable until the unit of operation, approved by the engineer, is complete. The contractor will not be permitted to pour concrete to a height greater than six feet in any one day unless directed by the engineer.

76. **Finishing.**—The surface of concrete finished against forms must be smooth, free from projections and thoroughly filled with mortar. Immediately upon the removal of forms all voids shall be neatly filled with cement mortar, irregularities in exposed surfaces shall be removed, and minor imperfections of finish shall be smoothed to the satisfaction of the engineer, after which one coat of thin grout shall be applied with brushes. Exposed surfaces of concrete not finished against forms, such as horizontal or sloping surfaces, shall be brought to a uniform surface and worked with suitable tools to a smooth mortar finish. All sharp angles shall, where required, be rounded or beveled by the use of moulding strips, or finishing tools. The outlet tower deck and roof, curved spillway, spillway channel and parapets shall be given a wood float finish. The cost of this work shall be included in the unit price bid for concrete.

77. **Forms.**—Form to confine the concrete and shape it to the required lines shall be used wherever necessary. Forms shall be sufficiently tight to prevent leakage of mortar. Where the character of the material cut into to receive a concrete structure is such that it can be trimmed to the prescribed lines, the use of forms will not be required. The forms shall be of sufficient strength and rigidity to hold the concrete and to withstand the necessary pressure and tamping without deflection from the prescribed lines. For concrete surfaces that will be exposed to view, and for all other concrete surfaces that are to be finished smooth, the lagging of forms must be surfaced, sized or matched and oiled; provided that smooth metal forms may be used if desired. All forms shall be removed by the contractor, but not until the engineer gives permission. Forms may be used repeatedly provided they are maintained in serviceable condition and thoroughly cleaned and repainted with lubricating oil before being used again. The cost of all forms, their use and removal from the work shall be included in the unit prices bid for concrete in place.

78. **Supports For Forms.**—The contractor shall provide suitable steel tie rods and "she" bolts or cone washers and bolts properly anchored, or other means, satisfactory to the engineer, to hold the forms rigidly in place to specified line, thickness of wall and grade, as indicated in drawings, or as directed by the engineer. The contractor shall, immediately upon removal of the form, fill the bolt or washer holes even with the wall face and leave the exposed surface smooth and in good condition to be finished as required. The cost of supporting forms shall be included in the unit prices bid for concrete in place.

79. **Reinforcing Steel.**—Reinforcing steel shall be deformed or plain bars from new billet stock of structural grade in accordance with the Standard Specifications for Billet-steel Concrete Reinforcement Bars, Serial Designation: A 15-14 of the American Society for Testing Materials, and shall be of required sizes and shapes. The contractor shall furnish, clean, haul, store, cut, bend, place and secure in position the steel required by the drawings or as directed by the engineer. All metal reinforcement before being placed shall be thoroughly cleaned of mill and rust scale and coatings. If the exact position of reinforcing steel is not shown on the drawings accompanying these specifications, the contractor will be furnished or shall submit for approval supplementary detail drawings and lists which will give him the necessary information for cutting, bending and spacing. The steel used for concrete reinforcement shall be so secured in position that it will not be displaced during the depositing of concrete, and special care shall be exercised by the contractor to prevent any disturbance of the steel in concrete already placed. Payment for reinforcing steel in place in the work will be made at the unit price bid which shall include the cost of furnishing, hauling, storing, cutting, bending, placing, wiring, furnishing the wire, and securing in place.