

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

- - APPENDIX TO REPORT - -

* BY W. S. POST *

COMPILATION OF ENGINEERING DATA.

Feb 28th 1914 -

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

Table No. 1.

a) Rainfall - Authorities - U. S. Weather

Bureau, California Hydrography - U. S. Geol. Survey.
 Bulletin #81.

Season	San Diego El. 95 Rainfall - of % Inches - Average	Cuyamaca El. 4600 Rainfall Inches	% of Average	Julien El. 4200 Rainfall of % Inches - Average
1879 -80	14.77		155%	30.65
1880-81	9.26		97%	25.89
81-82	9.50		100%	29.88
82-83	4.92		49%	41.31
83-84	25.97		260%	61.52
84-85	8.80		92%	
85-86	16.83		174%	
86-87	8.33		87%	
87-88	9.82	22.19	59	
88-89	11.05	53.57	142	
89-90	14.98	60.79	162	
1890-91	10.47	63.19	169	37.64
91-92	8.75	39.27	102	36.25
92-93	9.21	40.71	108	30.14
93-94	5.01	14.05	37	22.39
94-95	11.86	54.28	144	36.85
95-96	6.34	25.54	68	17.11
96-97	11.71	36.80	98	
97-98	4.98	29.01	77	16.50
98-99	5.31	22.07	39	11.50
1899-00	5.90	26.72	71	19
1900-01	10.45	42.62	114	28
01-02	7.09	35.65	95	27.60
02-03	10.84	36.83	96	24.75
03-04	4.40	23.49	61	14.80
04-05	14.48	56.34	147	37.75
05-06	14.64	59.34	155	48.75
06-07	10.54	40.81	108	32
07-08	9.11	33.22	87	26.60
08-09	9.59	44.28	115	27.65
09-10				
AVERAGE	9.58	38.25		29.75

10.05

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

RAINFALL.

In the appendix is given ^{This} a comparative table of long period rainfall stations, which illustrate the following rules:

- a) Recurring dry seasons - in cycles of 5 to 12 years.
- b) Constancy in these variations - Meteorologists state that where a rainfall record has been kept for 33 years, the average or mean rainfall will ^{not} be changed (within 1%) by further observations.
- c) Increase of rainfall with altitude.

It will be observed that the year of least rainfall the "driest year" gives 37% of the average. Any two successive dry years are about 52% each.

That is there will be at long intervals one driest year with about 37% of the average rainfall, always preceded by an average year in which storage must be reserved.

The character of seasons will be indicated in the following tables by percentage by which is meant

A Driest Year	is a 37% year
A Dry Year	is a 50% "
An Average Year	is a 100% "
A Wet Year	is a 150% "

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

DRAINAGE AREAS AND WATER SUPPLY.

The following measurements of the annual discharge of the San Luis Rey River have been made near Bala by U. S. Hydrographic Service.

Drainage Area 318 sq. miles.

Season	S. L. Rey at Pala	Add Escondido Diversion	Total
1903-04	7,677	5000	13,000 Acre ft.
1904-05	41,988	5000	47,000 "
1905-06	107,825	5000	113,000 "
1906-07	82,860	5000	88,000 "
1907-08	24,891	5000	30,000 "

Also at WARNER'S DAM - Drainage Area 210 sq. miles

1905-06	68,500 "
---------	----------

Also by U. S. Hydrographic Branch - on Santa Isabel

Creek at San Pasqual - Drainage Area 155 sq. miles. *vicinity = 128 per US G. S.*

1905-06	62,080 Acre ft.
1906-07	35,680 "
1907-08	10,240 "

These measurements are analysed in the following table.

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

TABLE 2.

of 2/3 of Pala

Season	Character of Season's Rain-fall in % of general average.	Total Acre ft.	Area sq. M.	Acre ft. per sq. m.	% Run Off	Corresponds a Run-off at Warner's Dam of (Acre ft)
<u>San Luis Rey</u>						
1903-04	53%	13,000	318	41	5%	9,000
1904-05	140%	47,000	318	148	6%	36,000
1905-06	156%	113,000	318	359	15%	{75,000}
1905-06	"	68,500	210	326	13%	{68,500}
1906-07	110%	88,000	318	276	16%	59,000
1907-08	91%	30,000	318	94	6%	20,000
						1903-05 - Total Runoff Warner's Dam - 192,500
						Average Runoff per year 38,500
<u>Santa Isabel -</u>						
1905-06	156%	62,080	155	404 ?	20% ?	
1906-07	110%	35,580	155	230	16%	
1907-08	91%	10,240	155	66	5%	

Drainage Area Pano Dam. 117 sq miles

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

The evidence of these water measurements, as shown in Table 2 is that during the period of 1903-1908, the average runoff per year was 38,500 acre-ft.

subtract an average evaporation from the reservoir surface of 2,500 " "

Net available supply, per year, during 1903-1908 36,000 " "

36,000 acre feet, is equivalent to 50 cubic feet per second or 2,500 Miner's Inches, continuous flow, for this period 1903 - 1908, a period during which the rainfall is slightly above the average.

Further, using the information of Table 1, and applying the Runoff of Table No. 2, I find that for such a period as 1896-1900 which is notoriously our lowest series of dry years, and often applied as a test in determining minimum power, the minimum runoff would have been approximately

1897 - 1898	9,000 Acre ft.
1898 - 1899	10,000 " "
1899 - 1900	<u>11,000</u> " "
	30,000 " "
Yield of 3 minimum years	
Average Yield (without considering storage) per year	10,000 " "

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

2) In my opinion during this period 1896-1900 introducing the storage of Warner's Dam to the amount of 80,000 acre ft. as a factor, you would have been assured of 80,000 Acre foot, 42 cubic feet second or 2100 Miner's Inches, and this would I consider your absolute minimum, provided storage capacity of 80,000 to 130,000 acre feet is supplied in Warner's Dam. Under these circumstances "over year" storage and equalization would cover five years which I consider ample.

It should be understood that the preceding is a discussion of minimums, and that in my opinion say three years out of every ten you would have an average supply for those three years of 3,000 M. I. , over and above the water which would be stored and reserved for dry seasons.

To Tabulate my conclusions.

Dry Years (such as 1896-1900) - Regulated (with ample storage)	Dependable- Supply M.I.	Salable- K. W.	Salable peak K. W.
	2100	4000	7,500
Average years (such as 1903-08)	2500	4500	7,500
Wet years (such as the 80's excess water going into reserve.	3000	5200	7,500

The storage provided in the estimates for a 90 foot dam, capacity about 100,000 acre feet is believed to be an adequate for all conditions, as "over year"; but to be on the safe side foundations should provided for 100 feet.

78
85
95
2.691
2703
2715

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

B) WARNER'S RESERVOIR CAPACITY.

Elevation of High Water Surface	Depth	Acre Acres	Capacity in Acre Feet.
2618	0	0	0
2630	12	20	110
2640	22	51	460
2648 -	30 -	- 100	- 1060
2650 - - -	32 -	- 111 -	- 1270
2658 .	40	1095	7300
2668 -	50	1398	19760
2678 -	60	1840	35950
2688 .	70	2456	57470
2698 .	80	3498	87210
2708	90	4315	126260
2718 -	100 .	5042	173040

Computed between Elevation 2618 to 2650 from
 survey by W. S. Post, February 1911, and extended for
 higher elevations from contour map of early surveys.

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

Santa Isabel Creek is limited practically by the capacity of the Pamo Reservoir viz; 41,000 acre feet with the 176 foot Dam. As the measured yield in a 110% year is 35,000 acre feet, it is obvious that a certain amount of flood waters will go over the spillway in wet years, unless other storage is provided either higher in the drainage area or in the distribution system. In this case it is believed that it can be counted on for 2,000 acre feet a year or 30 cu. feet or 1500 Miner's Inches continuous flow.

~~WARNER'S RESERVOIR CAPACITY.~~

Elevation of High Water Surface	Depth	Acre Acres	Capacity in Acre Feet.
2618	0	0	0
2630	12	20	110
2640	22	51	460
2648	30	100	1060
2650	32	110	1270
2658	40	1095	7300
2668	50	1798	19760
2678	60	1840	35950
2688	70	2456	57470
2698	80	3498	87210
2708	90	4315	126260
2718	100	5042	173040

~~Computed between elevation 2616 to 2650 from survey by W. S. Post, February 1911, and extended for higher elevations from contour map of early surveys.~~

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

POWER STATION.

"Accepting the figure of 42 cu. ft. per second or 2100 Minor's Inches as the constant dependable yield of Warner's Dam we have at 70% efficiency 5000 Horse Power or 4000 K. W. delivered on switchboard at San Diego. It will be necessary to install a sufficient conduit to take care of "peak" loads.

The attached diagram from the Los Angeles Aqueduct may serve as a guide, showing a load factor of 53%. The maximum load then would be $\frac{4000}{53}$ K. W. or 7500 K. W. The electrical and hydraulic installation should be for 10,000 K. W. and requires a conduit of at least 100 cu. ft. per second or 5000 M. I. unless a forebay existed large enough to equalize the daily variations, which is not the case on the estimated line.

Alternate Line.

The topographic map shows such a forebay possibility on the west side of the Temescal and lying partly on the Gajito Ranch in sections 28 and 33, T. 11 S R 1 E.

This apparently would sacrifice 100 feet of power drop, but should be examined when surveys are taken up.

The amount of saleable power with such a forebay is the full 4000 K. W. for 24 hours, generated however to follow the demand or 96,000 K. W. hours per day.

WILLIAM S. POST
 CIVIL ENGINEER
 ASSOC. MEM. AM. SOC. C. E.
 1218 UNION TRUST BLDG.
 LOS ANGELES, CALIFORNIA

f) CONDUIT - WARNER'S DAM TO
 POWER HOUSE . *In Cement.*

6 feet wide bottom 4 ft. deep 5000 M. I.

Mile	Excavation ou. yds.		Tunnel lined	Bridges lin. ft.	Plastered Conduit lin. ft.
	Earth	Medium-Soiled Rock			
1	6000	8000	1000	400	4300
2	2500	3000	6000	230	5000
3	5000	2000	7000	315	5000
4	1000	11500	3000	3500 ?	1800
5	5000	5000	2000	200	5300
6			5280		
7	2000	3000	4000	1280	4000
7½	1000	1000	4000	2000	700
	<u>22,000</u>	<u>25,500</u>	<u>27,000</u>	<u>12,615</u>	<u>1,800</u>
					<u>26,100</u>

Total @ .15 @ .40 @ .80 @ .15 @ \$20 @ \$2

\$312,500-3300 - 9,400 -21,600 -190,000 - 36,000 - 58,200

Estimate for Mile 7½ to 13½ is based on above excluding tunnels as follows:

Subtract $\frac{7\frac{1}{2} \text{ miles}}{\frac{2\frac{1}{2}}{5} \text{ "}}$ tunnels $\frac{\$312,500}{190,000} = \$20,500 \text{ per mile.}$
 $\frac{122,500}{190,000}$

Remainder of Canal - 6 Miles @ \$20,500 \$123,000

Add - Upper 7½ miles 312,500

Total - Warner's to Head of Pipe Line 435,500

Add Pipe Line 6000 feet @ \$20 120,000

" Fore bay 10,500

Total Hydraulic Construction to Power House Exclusive of Dam \$ 576,000

Warner's Dam \$ 234,000

All hydraulic Construction up to Power House. \$ 810,000

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

- CONDUIT.-

The estimate shows a cost of \$4.00 per foot for cement conduit or ~~about \$3.50~~ ^{\$2.73} for flume. If tunnels are taken at \$15.00 per foot it will pay to tunnel whenever the distance around is from $3\frac{1}{2}$ to four times greater. This is the case on the 1985 foot tunnel shown on the plans and nearly so for the other. Considerations of permanency and maintenance would seem to justify a closer margin.

The difference between the estimate of cement lined conduit and flume construction is \$ 152,000.

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

* - PAMO DAM SITE *

The great height to which Pamo Dam is expected to be carried 175 feet would seem to indicate a masonry dam.

Alverson's original estimates for rock fill type were

for 145 ft. dam	\$227,000
for 175 " "	\$375,000

WILLIAM S. POST
CIVIL ENGINEER
ASSOC. MEM. AM. SOC. C. E.
1218 UNION TRUST BLDG.
LOS ANGELES, CALIFORNIA

c) PAMO RESERVOIR CAPACITY,
compiled from Alverson's Report.

Depth	Capacity Acre Ft.
40	204
50	436
70	1238
100	5068
120	10400
140	18480
150	23738
160	30000
175	41000

d) Santa Maria Reservoir ,
compiled from Alverson's Report.

Depth	Acres	Capacity Acre Ft.
10	1	1
20	8	45
30	23	100
40	41	522
50	80	1,108
60	154	2,305
70	286	4,500
80	561	8,736

Ed Fletcher Papers

1870-1955

MSS.81

Box: 40 Folder: 7

**Business Records - Reports - Post,
W.S - "Appendix to Report"**



Copyright: UC Regents

Use: This work is available from the UC San Diego Libraries. This digital copy of the work is intended to support research, teaching, and private study.

Constraints: This work is protected by the U.S. Copyright Law (Title 17, U.S.C.). Use of this work beyond that allowed by "fair use" requires written permission of the UC Regents. Permission may be obtained from the UC San Diego Libraries department having custody of the work (<http://libraries.ucsd.edu/collections/mscl/>). Responsibility for obtaining permissions and any use and distribution of this work rests exclusively with the user and not the UC San Diego Libraries.