

SAN DIEGO, CALIFORNIA, November 20, 1917

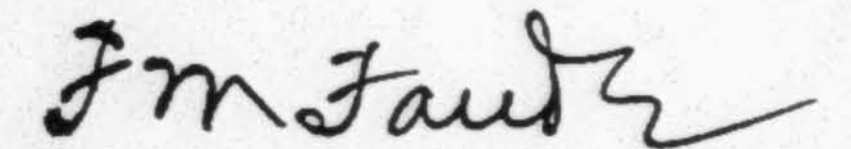
Col. Ed Fletcher,
Mgr Cuyamaca Water Co.
San Diego, Calif.

Dear Sir:-

In accordance with your instructions I have made an investigation of the net safe yield of the Cuyamaca Water Company's System with special reference to the amount of water available for sale to others than your present consumers.

My conclusions appear on the following pages.

Very truly yours,



Assoc. Mem. Am. Soc. Civil Engineers

FLF: BK

BRIEF DESCRIPTION OF SYSTEM

Cuyamaca Reservoir

At the head of the system is the Cuyamaca Reservoir located in the Cuyamaca Mountains, about 40 miles, in an air line, from San Diego.

Area Flooded -----	978 acres
Capacity -----	11,595 acre feet
Area of Watershed -----	12 square miles
Elevation of Outlet above sea level -----	4,600 feet
Outlet tower -----	Brick
Outlet Tunnel -----	Masonry
Dam -----	Earth Fill

The reservoir remains closed during the greater part of the year only being drawn upon when the free flow of the San Diego River is insufficient to take care of service requirements. Water from Cuyamaca Reservoir flows down the channel of Boulder Creek, about 12½ miles to the junction with the San Diego River, immediately above the Diverting Dam.

Diverting Dam

Area Flooded -----	10 acres
Capacity -----	69 acre feet
Elevation of outlet above sea level -----	803
Elevation of spillway -----	813
Area of Water shed -----	92 square miles
Dam -----	Masonry

At the diverting dam begins the flume, which is the main transmission line of the system.

Main Flume

Width -----	5 ft. 10 in.
Depth (Minimum) -----	22 inches
Grade per mile -----	4.75 feet
Redwood Flume, Length -----	30.37 miles
Steel Flume, Length -----	0.48 "
Concrete Conduits, Length -----	0.32 "
Tunnel Approaches, Square Masonry Conduits, Length -----	0.10 "
Tunnels, Masonry Lined, Length -----	0.79 "
Steel Syphons, Length -----	0.77 "
Concrete Syphons, Length -----	0.24 "
Total Length of Main Flume -----	33.07 "
Capacity of Flume -----	31 Second Feet

At about the sixth mile the main flume is joined by the South Fork Feeder, bringing in the waters of the South Fork Creek, which has a drainage area of 44 square miles.

South Fork Feeder

Redwood Flume	} Parallel lines - length 0.48 miles
20 inch Steel Pipe	
Steel Flume -----	0.47 "
Total Length -----	0.95 "
Capacity -----	18 second feet

El Monte Pumping Plant

At the sixteenth mile is located the El Monte Pumping Plant, having a capacity of 2 million gallons daily. The plant consists of a 200 H.P. electric motor direct connected to an 8 inch, 3 stage, centrifugal pump. The suction lines are connected to 22 3-inch cased wells and to 3 open curbed wells, 12 feet in diameter. This pumping plant discharges directly into the main flume.

Eucalyptus and Murray Hill Reservoirs

At the end of the main flume are located the Eucalyptus and Murray Hill Reservoirs, having a combined capacity of 153 acre feet.

	<u>Eucalyptus</u>	<u>Murray Hill</u>
Area Flooded in Acres -----	3	12
Capacity in acre feet -----	26	127
Elevation of outlets above sea level -----	620	620

Dams are both of earth fill type.

These reservoirs serve as regulating reservoirs for flume water.

La Mesa Reservoir

At the end of the main flume there is located the inlet of the La Mesa Ditch, 3-3/4 miles long, which conveys flume water to the La Mesa Reservoir.

Area Flooded-----	205 acres
Capacity -----	6,750 acre feet
Area of water shed -----	4½ sq. miles
Elevation of outlet above sea level	440 feet

Type of Dam - Concrete Multiple Arch.

Distribution Pipe System

From the Eucalyptus, Murray Hill and La Mesa Reservoirs the distribution mains extend for a total of over 50 miles. The pipes vary in size from 24 to 1 inch in diameter.

Territory Served

The territory served includes the El Cajon Valley, City of El Cajon, City of La Mesa, City of East San Diego, and a large unincorporated territory lying east of the limits of the City of San Diego.

Net Safe Yield

The most exhaustive and reliable determinations of the net safe yield of the system were made in 1912 by P. E. Harroun, Hydraulic Engineer of the Railroad Commission of the State of California, and by Charles H. Lee, of the Los Angeles Aqueduct Engineering Staff and of the United States Geological Survey; also again in 1915 by Mr. Lee.

The 1912 determination, made independently by Messrs. Harroun and Lee, showed almost identical findings by both engineers, that is, 3,707 acre feet or 256 miners inches continuous flow.

The 1915 determination, made by Mr. Lee, shows a net safe yield of 3,472 acre feet or 320 nine months miners inches; and in addition, that 3,872 acre feet or 356 nine months miners inches of winter flood water could be delivered at the end of the system, making a total of 7,344 acre feet per year. At the time of this determination, there was no available reservoir capacity for this 3,872 acre feet of flood water, and it was therefore necessary to divide the yield as shown. Now that the construction of the concrete multiple arched dam at La Mesa Reservoir is

practically completed, and the reservoir capacity increased from 1,187 to 6,750 acre feet, there is ample storage room for all flood waters delivered to the end of the system and the yield becomes an available one of 7,344 acre feet.

It should be borne in mind that since the 1912 determinations were made, the system has been improved by the construction of the El Monte Pumping Plant with a capacity of 2 million gallons daily, and a second syphon at South Fork which increases the capacity of the main flume from 18 to 31 second feet.

After a study of Mr. Lee's 1915 determination, I see no reason why it should not be accepted as safe and conservative, and believe a revised and detailed mass curve study of the entire question would give only slightly different results even when the large flood discharges of 1916 are taken into consideration. It is however probable that the yield would be increased somewhat by a more extended use of the El Monte Pumping plant than Mr. Lee makes in his determination.

The probable requirements of present consumers will have to be determined by a study of use in previous years. The use during 1916 probably furnishes as nearly a fair average as could be obtained except for the fact that an increase in rates was granted the Company by the Railroad Commission and became effective April 1, 1917. This increase in rates has worked out to decrease the use of water by consumers and for the six months from April to September, 1917, the use was only 73 percent of the

use during the same months during 1916, in spite of the fact that 1917 was a year of less rainfall than 1916. It is therefore probable that a requirement of 80 percent of the 1916 use will give a very fair average allowance to take care of requirements of present consumers.

The following table gives by months the actual use in acre feet during the season 1916-1917 and the probable average requirement for consumers for the same period.

	Total Actual Use	Probable Average Requirement of Consumers
October 1916	296 Ac. Ft.	237 Ac. Ft.
November 1916	357 "	286 "
December 1916	296 "	237 "
January 1917	133 "	107 "
February	133 "	107 "
March	199 "	160 "
April	$\frac{\#}{\#}$ 181 "	$\frac{\#}{\#}$ 181 "
May	$\frac{\#}{\#}$ 195 "	$\frac{\#}{\#}$ 195 "
June	$\frac{\#}{\#}$ 372 "	$\frac{\#}{\#}$ 372 "
July	$\frac{\#}{\#}$ 447 "	$\frac{\#}{\#}$ 447 "
August	$\frac{\#}{\#}$ 400 "	$\frac{\#}{\#}$ 400 "
September	$\frac{\#}{\#}$ 346 "	$\frac{\#}{\#}$ 346 "
Totals	3,355 "	3,075 "

$\frac{\#}{\#}$ = Use under new rates. Taken without deduction.

In view of the foregoing I conclude that

The Net Safe Yield of the System is --- 7,344 acre feet

The average requirement of present consumers is ----- 3,075 " "

The water available for sale to others than present consumers is ----- 4,269 " "

Expressed in gallons, the amount available for sale to outsiders is 3,800,000 gallons per day.

A small scale map of the system and a print of Mr. Lee's final tabulation for his 1915 determination are attached.

J M Gault

Assoc. Mem. Am. Soc. Civil Engineers.

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SAN DIEGO RIVER

LAMESA RES.
LAMESA DITCH

DIVERTING DAM

CAPITAN

SOUTH

PALME MAN

North Island

WESTWATER

MURRAY

LUGAS

Padre Barona Valley

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SEASON	SOURCES OF SUPPLY				LOSSES		
	Cuyamaca Reservoir Draft	Run-off of San Diego River at Diverting Dam	Run-off of South Fork of San Diego River	Pumped from sands of San Diego River	Boulder Creek	Transmission in system	La Mesa Reservoir Evaporation
1894-95	1653	10804	281	0	497	1226	31
1895-96	1949	6199	199	0	586	779	30
1896-97	2159	6650	503	0	649	869	29
1897-98	1962	2560	215	0	590	417	30
1898-99	1723	909	0	1993	518	321	23
1899-00	257	609	0	3262	77	240	27
1900-01	433	2951	645	1475	130	464	29
1901-02	1551	2690	432	303	467	438	27
1902-03	1391	4705	1322	296	418	719	24
1903-04	1575	470	0	2155	473	268	27
1904-05	0	7063	1736	1651	0	965	24
1905-06	1144	9601	2098	0	344	1250	27
1906-07	0	13636	1682	0	0	1532	34
1907-08	947	9640	1960	0	285	1227	34
1908-09	1531	9200	594	0	460	1087	33
1909-10	1453	7727	1497	0	437	1026	31
1910-11	1643	5607	1603	0	494	837	28
1911-12	1905	5238	1057	0	572	764	26
1912-13	1643	4396	736	0	494	630	32
1913-14	1334	5564	1287	0	401	780	28
1914-15							
Average	1313	5811	892	568	394	792	29
Average including La Mesa Runoff							

NOTES: This tabulation is a summary of the results of a detailed mass curve study, by months, of supply system, assuming that the system exists as it is to-day, with the exception that South Fork siphon feet, and that South Fork feeder is increased to 8 second-feet capacity.

The following data was used: Capacity of Cuyamaca Reservoir, 10,800 acre-feet; Combined capacity of Reservoirs, 1,539 acre-feet; Gross annual evaporation from Cuyamaca Reservoir 79.55 inches, and Boulder Creek, 30% of Cuyamaca draft; Loss in transmission through system, 10%; draft for high and low service September and 1.12 million gallons daily October to May; Draft for flume consumers, 2.1 million gallons daily October to April; Full annual service requirement 3,471 acre-feet, of which 1,804 acre-feet is high and low service consumption; Daily flow of San Diego River at Diverting Dam 1898-99 to 1913-14 (summarized on Exhibit 4-6); Monthly run-off of San Diego River 1894-95 to 1897-98 and South Fork Cuyamaca Reservoir as per Exhibit 4-5; Maximum pumping capacity 3 million gallons daily (9 ac.ft. per day). Average dry year run-off 70 acre-feet.

It was assumed that Cuyamaca Reservoir is only drawn upon when run-off at Diverting Dam is in excess of the capacity of the reservoir. Cuyamaca Reservoir dry May 1, 1899 to Feb. 1, 1901; July 1, 1904 to Jan. 1, 1905. Water in storage throughout the 20 years.

La Mesa Reservoir never without water in storage during whole 20 year period.

C O N C L U S I O N S

NET SAFE GRAVITY YIELD, Season 1897-98	-----
NET SAFE GRAVITY YIELD, Season 1901-02	-----
AVERAGE NET SAFE GRAVITY YIELD	-----
NET SAFE YIELD LA MESA RUN-OFF	-----
NET SAFE GRAVITY YIELD OF SYSTEM	-----
NET SAFE YIELD OF SYSTEM INCLUDING 27 MINERS INCHES PUMPING CAPACITY FOR 9 MONTHS	-----
PRESENT INSTALLED PUMP CAPACITY	-----

HENCE SYSTEM IS ADEQUATE TO DELIVER IN THE AVERAGE DRY YEAR A SERVICE REQUIREMENT OF 320 - 9 months miners inches, (151,259,740 cubic feet per annum.)

ALSO THERE CAN BE DELIVERED AT THE END OF THE SYSTEM IN EXCESS OF THIS SERVICE REQUIREMENT, AN AVERAGE OF 356 - 9 months Miners Inches, (5,872 acre-feet, or 3.36 million gallons per day), of winter or flood water.

SEASON	SOURCES OF SUPPLY				LOSSES		
	Cuyamaca Reservoir Draft	Run-off of San Diego River at Diverting Dam	Run-off of South Fork of San Diego River	Pumped from sands of San Diego River	Boulder Creek	Transmission in system	La Mesa Reservoir Evapora
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1898-99	1723	909	0	1993	518	321	23
1899-00	257	609	0	3262	77	240	27
1900-01	433	2951	645	1475	130	464	29
1901-02	1551	2690	432	303	467	438	27
1902-03	1391	4705	1322	296	418	719	24
1903-04	1575	470	0	2155	473	268	27
1904-05	0	7063	1736	1651	0	965	24
1905-06	1144	9601	2098	0	344	1250	27
1906-07	0	13636	1682	0	0	1532	34
1907-08	947	9640	1960	0	285	1227	34
1908-09	1531	9200	594	0	460	1087	33
1909-10	1453	7727	1497	0	437	1026	31
1910-11	1643	5607	1603	0	494	837	28
1911-12	1905	5238	1057	0	572	764	26
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1913-14	1334	5564	1287	0	401	780	28
1914-15							
Average	1313	5811	892	568	394	792	29
Average including La Mesa Runoff							

NOTES: This tabulation is a summary of the results of a detailed mass curve study, by months, of supply system, assuming that the system exists as it is to-day, with the exception that South Fork siphon feet, and that South Fork feeder is increased to 8 second-feet capacity.

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It was assumed that Cuyamaca Reservoir is only drawn upon when run-off at Diverting Dam is in excess of its capacity. Cuyamaca Reservoir dry May 1, 1899 to Feb. 1, 1901; July 1, 1904 to Jan. 1, 1905. Water in storage throughout the 20 years.

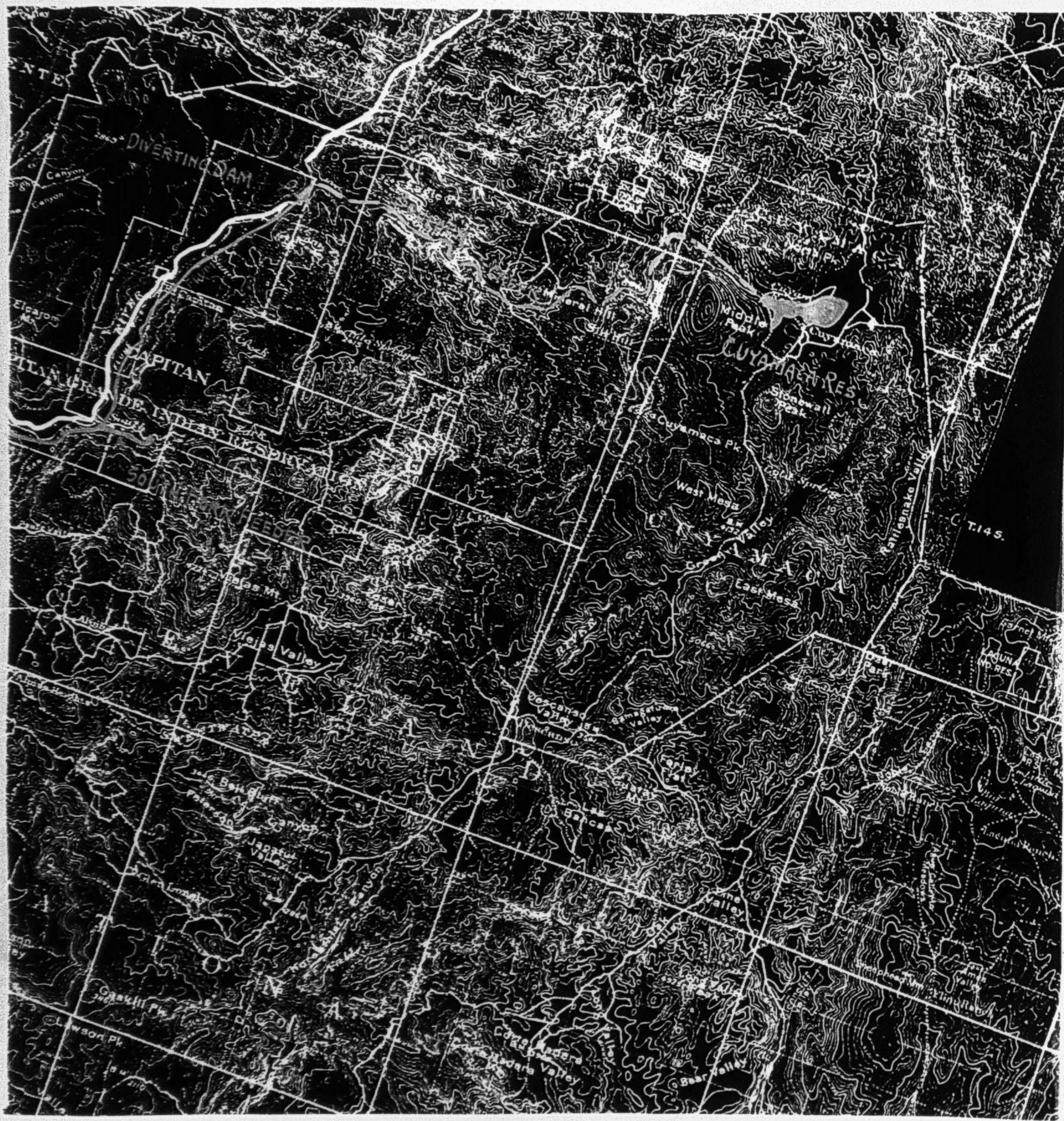
La Mesa Reservoir never without water in storage during whole 20 year period.

C O N C L U S I O N S

- NET SAFE GRAVITY YIELD, Season 1897-98 -----
- NET SAFE GRAVITY YIELD, Season 1901-02 -----
- AVERAGE NET SAFE GRAVITY YIELD -----
- NET SAFE YIELD LA MESA RUN-OFF -----
- NET SAFE GRAVITY YIELD OF SYSTEM -----
- NET SAFE YIELD OF SYSTEM INCLUDING 27 MINERS INCHES PUMPING CAPACITY FOR 9 MONTHS -----
- PRESENT INSTALLED PUMP CAPACITY -----

HENCE SYSTEM IS ADEQUATE TO DELIVER IN THE AVERAGE DRY YEAR A SERVICE REQUIREMENT OF 320 - 9 months miners inches, (151,259,740 cubic feet per annum.)

ALSO THERE CAN BE DELIVERED AT THE END OF THE SYSTEM IN EXCESS OF THIS SERVICE REQUIREMENT, AN AVERAGE OF 356 - 9 months Miners Inches, (3,872 acre-feet, or 3.36 million gallons per day), of winter or flood water.



CUYAMACA WATER COMPANY

ESTIMATED YIELD OF CUYAMACA SYSTEM WITH FLUME CAPACITY OF 31 SECOND FEET THROUGHOUT.

QUANTITIES IN ACRES-FEET.

SOURCES OF SUPPLY			LOSSES			YIELD OF SYSTEM					Character of Runoff year and Remarks
Run-off of San Diego River at Diverting Dam	Run-off of South Fork of San Diego River	Pumped from sands of San Diego River	Boulder Creek	Transmission in system	La Mesa Reservoir Evaporation	Delivery to Consumers	9 mos. M. I.	Acres-Feet	Excess Winter Water 9 mos. M. I.	Mill. Gal. Daily	
10804	881	0	497	1226	326	3471	320	7157	660	6.37	Very wet year Moderately dry year Average or normal year Average dry year - safe net gravity yield 520 - 9 mos. miners inches Very dry year - gravity yield 146 - 9 mos. miners inches
6199	199	0	586	779	303	3471	320	3168	292	2.82	
6650	503	0	649	869	299	3471	320	3985	367	3.55	
2560	216	0	590	417	308	3471	320	172	16	0.15	
909	0	1993	518	321	231	3471	320	0	0	0	Very dry year - gravity yield 34 - 9 mos. miners inches Very dry year - gravity yield 284 - 9 mos. miners inches Average dry year - safe net gravity yield - 293 - 9 mos. miners inches Moderately dry year - gravity yield - 542 - 9 mos. miners inches Very dry year - gravity yield, 152 - 9 mos. miners inches
609	0	3262	77	840	277	3471	320	0	0	0	
2951	646	1475	130	464	293	3471	320	1023	94	0.91	
2690	432	303	467	438	276	3471	320	324	30	0.29	
4705	1322	296	418	719	249	3471	320	2690	248	2.40	Very wet year Very wet year Very wet year Little above normal year Very wet year
470	0	2155	473	268	276	3471	320	0	0	0	
7063	1736	1651	0	965	249	3471	320	5275	486	4.70	
9601	2098	0	344	1250	275	3471	320	7503	691	6.70	
13636	1682	0	0	1532	342	3471	320	9973	919	8.88	Little above normal year Moderately dry year Little above normal year Moderately dry year - gravity yield, 514 - 9 mos. miners inches Moderately dry year.
9640	1960	0	285	1227	346	3471	320	7307	673	6.56	
9200	594	0	460	1087	330	3471	320	5975	650	5.32	
7727	1497	0	437	1026	310	3471	320	5592	514	4.98	
5607	1603	0	494	837	288	3471	320	3721	343	3.32	Little above normal year Moderately dry year Little above normal year Moderately dry year - gravity yield, 514 - 9 mos. miners inches Moderately dry year.
5238	1057	0	572	764	260	3471	320	2929	270	2.61	
4595	736	0	494	630	324	3471	320	2106	194	1.88	
5564	1267	0	401	780	287	3471	320	3153	290	2.80	
5811	892	568	394	792	292	3471	320	3602	332	3.12	
						3471	320	3872	356	3.36	

This is a summary of the results of a detailed mass curve study, by months, of supply, losses, reservoir storage and draft for the system as it exists as it is to-day, with the exception that South Fork siphon is increased to full flume capacity of 31 second feet and South Fork feeder is increased to 8 second-feet capacity.

Data used: Capacity of Cuyamaca Reservoir, 10,800 acre-feet; Combined capacities of La Mesa, Eucalyptus and Murray Hill Reservoirs, 9,000 acre-feet. Gross annual evaporation from Cuyamaca Reservoir 79.55 inches, and from La Mesa Reservoir 72.0 inches; Loss in Boulder Creek draft; Loss in transmission through system, 10%; draft for high and low service consumers 2.21 million gallons daily June to October, 12 million gallons daily October to May; Draft for flume consumers, 8.1 million gallons daily March to September, and 1.3 million gallons daily October to April; Full annual service requirement 3,471 acre-feet, of which 1,804 acre-feet is flume consumption and 1,667 acre-feet is transmission loss; Daily flow of San Diego River at Diverting Dam 1898-99 to 1913-14 as per company's and U.S.G.S. records (Exhibit 4-4); Monthly run-off of San Diego River 1894-95 to 1897-98 and South Fork as per Exhibits 4-6 and 4-7; Monthly run-off of San Diego River as per Exhibit 4-5; Maximum pumping capacity 3 million gallons daily (9 ac.ft. per day); and La Mesa average run-off 270 acre-feet per year.

and that Cuyamaca Reservoir is only drawn upon when run-off at Diverting Dam is insufficient to supply the Flume Consumers.

Reservoir dry May 1, 1899 to Feb. 1, 1901; July 1, 1904 to Jan. 1, 1905. Water in reservoir at all times except these periods.

Reservoir never without water in storage during whole 20 year period.

C O N C L U S I O N S

NET SAFE GRAVITY YIELD, Season 1897-98	320 - 9 months miners inches
NET SAFE GRAVITY YIELD, Season 1901-02	293 - " " " "
AVERAGE NET SAFE GRAVITY YIELD	306 - " " " "
NET SAFE YIELD LA MESA RUN-OFF	7 - " " " "
NET SAFE GRAVITY YIELD OF SYSTEM	313 - " " " "
NET SAFE YIELD OF SYSTEM INCLUDING 27 MINERS INCHES PUMPING CAPACITY FOR 9 MONTHS	320 - " " " "
PRESENT INSTALLED PUMP CAPACITY	230 - Miners Inches

HENCE SYSTEM IS ADEQUATE TO DELIVER IN THE AVERAGE DRY YEAR A SERVICE REQUIREMENT OF 320 - 9 months miners inches, (151,269,740 cubic feet per annum.)

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This is a summary of the results of a detailed mass curve study, by months, of supply, losses, reservoir storage and draft for the system as it exists as it is to-day, with the exception that South Fork siphon is increased to full flume capacity of 31 second feet and South Fork feeder is increased to 8 second-feet capacity.

Data used: Capacity of Cuyamaca Reservoir, 10,800 acre-feet; Combined capacities of La Mesa, Eucalyptus and Murray Hill Reservoirs, 9,000 acre-feet. Gross annual evaporation from Cuyamaca Reservoir 79.55 inches, and from La Mesa Reservoir 72.0 inches; Loss in Boulder Creek draft; Loss in transmission through system, 10%; draft for high and low service consumers 2.21 million gallons daily June to October, 1.2 million gallons daily October to May; Draft for flume consumers 8.1 million gallons daily March to September, and 1.3 million gallons daily to April; Full annual service requirement 3,471 acre-feet, of which 1,804 acre-feet is flume consumption and 1,667 acre-feet is transmission; Daily flow of San Diego River at Diverting Dam 1898-99 to 1913-14 as per company's and U.S.G.S. records (Exhibit 4-4); Monthly run-off of San Diego River 1894-95 to 1897-98 and South Fork as per Exhibits 4-6 and 4-7; Monthly run-off of San Diego River as per Exhibit 4-5; Maximum pumping capacity 3 million gallons daily (9 ac.ft. per day); and La Mesa average run-off 270 acre-feet per year.

and that Cuyamaca Reservoir is only drawn upon when run-off at Diverting Dam is insufficient to supply the Flume Consumers. Reservoir dry May 1, 1899 to Feb. 1, 1901; July 1, 1904 to Jan. 1, 1905. Water in reservoir at all times except these periods. Reservoir never without water in storage during whole 20 year period.

C O N C L U S I O N S

NET SAFE GRAVITY YIELD, Season 1897-98	320 - 9 months miners inches
NET SAFE GRAVITY YIELD, Season 1901-02	293 - " " " "
AVERAGE NET SAFE GRAVITY YIELD	306 - " " " "
NET SAFE YIELD LA MESA RUN-OFF	7 - " " " "
NET SAFE GRAVITY YIELD OF SYSTEM	313 - " " " "
NET SAFE YIELD OF SYSTEM INCLUDING 27 MINERS INCHES PUMPING CAPACITY FOR 9 MONTHS	320 - " " " "
PRESENT INSTALLED PUMP CAPACITY	230 - Miners Inches

HENCE SYSTEM IS ADEQUATE TO DELIVER IN THE AVERAGE DRY YEAR A SERVICE REQUIREMENT OF 320 - 9 months miners inches, (151,259,740 cubic feet per annum.)

ALSO THERE CAN BE DELIVERED AT THE END OF THE SYSTEM IN EXCESS OF THIS SERVICE REQUIREMENT, AN AVERAGE OF 356 - 9 months Miners inches, (3,872 acre-feet, or 3.36 million gallons per day), of winter or flood water.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 36 Folder: 18

Business Records - Reports - Faude, F.M - "Net safe yield Cuyamaca Water Company's system and amount available for safe sale to others than present consumers"



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