EXHIBIT 12

PART 7

APPENDIX M

TRANSFERS OF IMPORTED WATER AND GROUND WATER WITHIN AND OUT OF UPPER LOS ANGELES RIVER AREA

APPENDIX M

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APPENDIX M

TRANSFERS OF IMPORTED WATER AND GROUND WATER WITHIN AND OUT OF UPPER LOS ANGELES RIVER AREA

The sources of waters imported to the area of investigation are primarily the Owens and Colorado Rivers. Owens River water first reached San Fernando Reservoir in 1913 through the Los Angeles Aqueduct and was exported to the City of Los Angeles for use. However, it was not until 1915 and after the major San Fernando Valley annexations to the City of Los Angeles had been completed that Owens River water was delivered to customers in the Owens water service area.

Beginning in 1940, water distributed by The Metropolitan Water District from the Colorado River was made available to its members in the Upper Los Angeles River area. At the present time those members are the Cities of Burbank, Glendale and Los Angeles and the Foothill Municipal Water District which redistributes Colorado River water to the Crescenta Valley County Water District and the La Canada Irrigation District.

Determination of quantities of imported water delivered to each service area from each of the two sources of imported water are discussed herein. The extent of each service area is shown on Plate 19.

Owens River Water

The quantities of Owens River water imported into the area are measured at a current meter-rated gaging station in the Los Angeles Aqueduct below Dry Canyon Reservoir for the years preceding 1933. From 1933, the discharge measurements consist of the sum of the discharges through the

Penstock meter at the San Fernando Power Plant, the Maclay Highline meter and the San Fernando bypass. The latter is a current meter-rated gaging station, except for the years prior to 1942 when the flow was estimated. The terminal storage reservoirs for imported Owens River water are the San Fernando and Chatsworth Reservoirs (see Plate 21).

From San Fernando Reservoir, a portion of the Owens River water is exported out of the Upper Los Angeles River area to Franklin, Hollywood, Stone Canyon and Silverlake Reservoirs. The latter reservoir did not receive Owens River water until the completion of the River Supply Conduit Extension in 1949. The quantity of exported Owens River water is metered at the inlet to Franklin and Stone Canyon Reservoirs and at the North Hollywood Pumping Plant which discharges into Hollywood and Silverlake Reservoirs (see Plate 21).

The major portion of the Owens River water remaining in the Upper Los Angeles River area is delivered to the Owens service area with small amounts to the Mission Wells and Sunland-Tujunga water service areas to supplement the ground water supply to these areas. During the base period the average amount of Owens River water remaining in the City of Los Angeles west of Burbank was approximately 125,000 acre-feet per year.

An inventory of the Owens River water was made for the area within the City of Los Angeles west of Burbank. Metered amounts of the water were utilized wherever possible. Items included in the inventory are the amounts of import to the area and transfers therefrom, sales to the consumers, water spread in spreading grounds, change in surface storage, estimated amounts of rain on reservoirs, runoff into the reservoirs, evaporation, spillage and water used for the generation of electricity in the River Power Plant.

Determination of precipitation and runoff are discussed in Appendixes E and F, respectively. Evaporation from the surface of reservoirs was determined by the use of the U. S. Weather Bureau pan and the Los Angeles County Flood Control District's 24-inch evaporation pan located at the City's terminal reservoirs, when records were available, or estimated by extending these records through the use of percent of daylight hours and mean temperature when no evaporation measurements were available.

Water used in the River Power Plant was estimated using the operational records of the plant and the quantity of water necessary to produce the power delivered by the plant. The operation of this plant was discontinued in 1940. The amounts of water used by the River Power Plant are included under operational spills as is water discharged from Chatsworth Reservoir for collection at the headworks and blowoffs from mains. Most of the spilled water was reclaimed at the headworks infiltration gallery and was exported out of the Upper Los Angeles River area as extracted ground water.

Table M-1 is an inventory of the Owens River water in the City of Los Angeles west of Burbank. The difference between the supply and disposal is termed unaccounted-for water.

TABLE M-1

INVENTORY OF OWENS RIVER WATER,
CITY OF LOS ANGELES WEST OF BURBANK

In Acre-Feet

Year	Supply: Import (1)	Supply: Export (2)	Supply: Residual[a] (1)-(2)=(3)	Supply: Change in reservoir storage (4)	Supply: Runoff to reservoirs (5)	Supply: Rain on reservoirs (6)	Supply: Total (3)+(4)+(5)+(6)=(7)	Disposal: Operational releases[b] (8)	Disposal: Spread (9)	Disposal: Sales (10)	Disposal: Evaporation from reservoirs (11)	Disposal: Total (8)+(9)+(10)+(11)=(12)	Unaccounted-for water (7)-(12)=(13)
1928-29	190,103	87,558	102,545	- 2,222	100	880	105,750	8,254	590	93,100	5,270	107,210	- 1,460
29-30	198,127	89,058	109,069	- 2,985	10	940	113,000	11,483	0	95,900	5,351	112,730	+ 270
1930-31	215,747	88,032	127,715	10,563	20	1,110	118,280	4,678	7,280	92,070	5,991	110,020	+ 8,260
31-32	238,195	112,182	126,013	5,100	2,550	1,360	124,820	3,291	31,743	70,390	4,597	110,020	+14,800
32-33	228,432	110,801	117,631	140	280	840	118,610	1,924	33,429	74,300	5,389	115,040	+ 3,570
33-34	185,579	85,556	100,023	- 3,230	730	970	104,950	2,008	20,855	79,220	5,237	107,320	- 2,370
34-35	194,924	94,528	100,396	- 1,590	250	1,410	103,650	486	30,804	71,130	4,293	106,710	- 3,060
1935-36	236,945	108,405	128,540	5,240	620	990	124,910	556	22,716	93,310	4,830	121,410	+ 3,500
36-37	206,673	113,876	92,797	- 1,330	3,430	1,710	99,270	1,922	9,307	83,710	4,698	99,640	- 370
37-38	209,081	124,536	84,545	- 1,970	5,070	1,660	93,240	1,761	7,315	73,110	4,501	86,690	+ 6,550
38-39	237,254	135,185	102,069	170	1,030	1,420	104,350	3,420	14,911	80,330	4,938	103,600	+ 750
39-40	217,158	130,302	86,856	2,580	500	1,150	85,930	762	3,407	71,260	4,801	80,230	+ 5,700
1940-41	200,976	126,998	73,978	5,270	6,470	2,670	77,850	0	3,446	66,220	4,172	73,840	+ 4,010
41-42	246,350	134,598	111,752	- 5,160	650	870	118,430	6,268	11,290	86,640	4,739	108,940	+ 9,490
42-43	264,396	143,918	120,478	- 5,750	2,320	1,650	130,200	8,702	12,130	96,320	4,718	121,870	+ 8,330
43-44	274,495	159,386	115,109	5,630	1,710	1,680	112,870	2,862	3,191	93,950	4,536	104,540	+ 8,330
44-45	267,238	156,446	110,792	- 5,640	510	1,000	117,940	1,305	0	99,920	4,441	105,670	+12,270
1945-46	283,968	158,069	125,899	- 1,920	170	970	128,960	7,869	0	108,220	4,560	120,650	+ 8,310
46-47	291,015	157,808	133,207	- 890	190	1,050	135,340	7,683	1,687	111,060	4,720	125,150	+10,190
47-48	306,458	160,875	145,583	3,030	40	530	143,120	2,935	0	121,330	4,970	129,240	+13,880
48-49	298,462	161,860	136,602	- 5,169	0	610	142,380	1,463	0	125,890	4,690	132,040	+10,340
49-50	305,398	158,241	147,157	7,611	70	870	140,490	1,337	762	121,110	4,624	127,830	+12,660
1950-51	317,374	163,481	153,893	- 7,114	50	730	161,790	3,942	2,354	135,960	4,571	146,830	+14,960
51-52	316,568	174,591	141,977	1,947	1,940	2,160	144,130	2,834	7,281	120,700	4,548	135,360	+ 8,770
52-53	320,924	162,664	158,260	- 2,121	180	890	161,450	5,408	0	137,740	4,758	147,910	+13,540
53-54	318,589	165,406	153,183	- 1,893	150	980	156,210	3,176	0	133,430	4,283	140,890	+15,320
54-55	316,319	161,081	155,238	860	130	960	155,470	7,863	0	129,780	4,680	142,320	+13,150
1955-56	321,256	164,449	156,807	6,010	240	1,310	152,350	4,003	1,610	131,640	4,047	141,300	+11,050
56-57	318,389	159,729	158,660	- 5,714	100	930	165,400	1,565	0	148,760	4,630	154,960	+10,450
57-58	325,387	165,911	159,476	3,225	1,430	2,150	159,830	90	0	143,090	4,800	147,980	+11,850
29-Year Average 1929-57	259,530	136,190	123,340	- 20	1,020	1,180	125,560	3,780	7,800	101,600	4,740	117,930	+ 7,630

a. Owens River water remaining in the City of Los Angeles west of Burbank.
b. Include water used in the River Power Plant.

Imported Waters in the Narrows Area

The completion of the River Supply Conduit Extension to Silverlake Reservoir in 1949 enabled the City of Los Angeles to transport Owens River water to Silverlake Reservoir. Thereafter, Owens River and well waters were commingled at the North Hollywood Pumping Plant and in the River Supply Conduit Extension (see Plate 21 for location).

The source of supply to the Narrows area is from Silverlake and Eagle Rock Reservoirs. Eagle Rock Reservoir is the distribution reservoir for Colorado River water received from The Metropolitan Water District. Eagle Rock Reservoir distributes water to the Narrows service area and the area to the east which is outside of the Upper Los Angeles River area. Through the Eagle Rock-Hollywood conduit, Colorado River water may be transferred to Hollywood Reservoir.

The annual amounts of water delivered to the Narrows service area from 1928-29 through 1957-1958 were estimated from the totals taken from field meter reading books or "Read Books" of the City of Los Angeles Department of Water and Power for each consumer and from trunk line metered consumption. When a book extended outside the area of investigation, the total amount of water recorded in the book was proportioned according to the area in and out of the area of investigation.

An estimate of the amount of water from each source was made by assuming that all the water commingled and the water was distributed uniformly over the area. The amount of water from each source was determined by summing up the amount of water supplied to various service zones served by Silverlake and Eagle Rock Reservoirs. The percent of Colorado River water was found by determining the percent of the total water which is supplied from Eagle Rock Reservoir.

The amount of Colorado River water delivered to the Narrows service area was obtained by applying the percent of Colorado River water calculated for the above area to the water delivered to the Narrows service area. The remaining amount of water is supplied from Silverlake Reservoir and consists of Owens River and ground water.

The amount of Owens River and ground water from Silverlake Reservoir delivered to the Narrows service area was proportioned according to the percentage of the inflow of each supplied to the reservoir.

The annual quantities of Owens River import delivered to each service area are shown in Table M-2.

TABLE M-2

IMPORTED OWENS RIVER WATER*

In Acre-Feet

Year	San Fernando Subarea					Sylmar Subarea	Verdugo Subarea	Total Upper Los Angeles River Area
	Owens Service Area	Sunland-Tujunga Service Area	Mission Wells Service Area	Narrows Service Area	Total	Owens Service Area	Sunland-Tujunga Service Area	
1928-29	98,790	0	0	0	98,790	3,760	0	102,550
29-30	105,860	0	0	0	105,860	3,210	0	109,070
1930-31	124,710	0	0	0	124,710	3,010	0	127,720
31-32	123,520	0	0	0	123,520	2,490	0	126,010
32-33	114,240	0	0	0	114,240	3,390	0	117,630
33-34	97,040	0	0	0	97,040	2,980	0	100,020
34-35	97,440	0	0	0	97,440	2,960	0	100,400
1935-36	124,460	0	0	0	124,460	4,080	0	128,540
36-37	89,410	0	0	0	89,410	3,390	0	92,800
37-38	81,980	0	0	0	81,980	2,570	0	84,550
38-39	98,990	0	0	0	98,990	3,080	0	102,070
39-40	84,180	0	0	0	84,180	2,680	0	86,860
1940-41	71,180	0	0	0	71,180	2,800	0	73,980
41-42	108,160	0	0	0	108,160	3,590	0	111,750
42-43	116,100	0	0	0	116,100	4,380	0	120,480
43-44	110,580	0	0	0	110,580	4,530	0	115,110
44-45	106,000	0	0	0	106,000	4,790	0	110,790
1945-46	120,610	0	0	0	120,610	5,290	0	125,900
46-47	127,050	0	0	0	127,050	6,160	0	133,210
47-48	139,080	0	0	0	139,080	6,500	0	145,580
48-49	130,190	0	0	0	130,190	6,410	0	136,600
49-50	141,410	0	0	1,300	142,710	5,750	0	148,460
1950-51	146,820	570	430	2,160	149,980	5,990	80	156,050
51-52	136,430	380	0	2,460	139,270	5,120	50	144,440
52-53	149,650	1,590	650	2,270	154,160	6,150	220	160,530
53-54	145,800	1,340	510	1,520	149,170	5,350	180	154,700
54-55	147,710	1,080	650	1,590	151,030	5,650	150	156,830
1955-56	149,010	1,020	1,160	1,770	152,960	5,480	140	158,580
56-57	149,670	1,080	1,230	2,250	154,230	6,530	150	160,910
57-58	151,260	630	1,880	2,540	156,310	5,620	90	162,020

* Gross amounts delivered to valley fill area and tributary hill and mountain areas.

Colorado River Water

Colorado River water was made available to the Cities of Burbank, Glendale and Los Angeles in 1940. The City of Burbank made immediate use of this water to supplement its primary water supply. The City of Los Angeles commenced using Colorado River water in the area south of Glendale in 1945 with the City of Glendale following in 1946. Upon formation of the Foothill Municipal Water District, Colorado River water was delivered to the Crescenta Valley County Water District and the La Canada Irrigation District in 1951.

The amount of Colorado River water delivered to each city or district, with the exception of the Narrows service area, Crescenta Valley County Water District and the La Canada Irrigation District, was compiled from the records of The Metropolitan Water District of Southern California. For Crescenta Valley County Water District and the La Canada Irrigation District, the amounts of Colorado River water purchased by them from the Foothill Municipal Water District were utilized. The locations where these cities and districts connect into The Metropolitan Water District and the Foothill Municipal Water District distribution lines are shown on Plate 21. Annual amounts of Colorado River import delivered to each service area are shown on Table M-3. The method used to determine the amount delivered to the Narrows service area has been previously discussed.

TABLE M-3

IMPORTED COLORADO RIVER WATER*

In Acre-Feet

Year	Los Angeles Narrows Service Area (1)	City of Burbank Service Area (2)	City of Glendale Service Area: San Fernando Subarea (3)	City of Glendale Service Area: Verdugo Sub-area (4)	City of Glendale Service Area: Total (3)+(4)=(5)	La Canada Service Area (6)	Crescenta Valley County Water District Service Area (7)	Total: San Fernando Subarea (1)+(2)+(3)=(8)	Total: Verdugo Subarea (4)+(6)+(7)=(9)	Total: Upper Los Angeles River Area (8)+(9)=(10)
1939-40	0	70	0	0	0	0	0	70	0	70
1940-41	0	250	0	0	0	0	0	250	0	250
41-42	0	420	0	0	0	0	0	420	0	420
42-43	0	1,200	0	0	0	0	0	1,200	0	1,200
43-44	0	710	0	0	0	0	0	710	0	710
44-45	150	610	0	0	0	0	0	760	0	760
1945-46	870	1,070	270	0	270	0	0	2,210	0	2,210
46-47	1,270	2,200	1,000	0	1,000	0	0	4,470	0	4,470
47-48	1,330	700	510	0	510	0	0	2,540	0	2,540
48-49	1,340	330	60	0	60	0	0	1,730	0	1,730
49-50	480	210	270	0	270	0	0	960	0	960
1950-51	660	840	920	70	990	0	0	2,420	70	2,490
51-52	890	1,660	1,230	80	1,310	30	0	3,780	110	3,890
52-53	1,180	2,570	1,080	80	1,160	110	0	4,830	190	5,020
53-54	4,500	2,430	1,550	150	1,700	120	0	8,480	270	8,750
54-55	6,530	1,430	780	60	840	280	490	8,740	830	9,570
1955-56	5,190	1,700	1,960	310	2,270	510	890	8,850	1,710	10,560
56-57	6,370	3,070	2,050	350	2,400	400	1,010	11,490	1,760	13,250
57-58	7,050	3,320	1,260	350	1,610	450	620	11,630	1,420	13,050

* Gross delivered to valley fill and tributary hill and mountain areas within the service area.

Water Transfers Between Hydrologic Subareas and Tributary Areas

The various water service areas in the Upper Los Angeles River area do not correspond with the boundaries of the three hydrologic subareas. The amount of water transferred from one subarea to another for each service area, with the exception of the Mission Wells service area, was estimated as discussed hereafter. Water transfers involving only ground water extracted in one subarea and transferred to another subarea are shown on Table M-4. Imported Owens River and Colorado River water were assumed to be delivered to the subarea regardless of the actual location of the point of delivery of these waters. This assumption was made to facilitate the calculations in determining the transfer of imported waters between subareas. It is reasonable to assume that when imported waters are supplied at a point in the system that this mixture is uniform over the entire service area.

City of San Fernando Service Area

A major portion of the water extracted from the Sylmar Hydrologic Subarea is exported to the San Fernando Hydrologic Subarea. The City of San Fernando's wells are located in Sylmar Hydrologic Subarea, while 91 percent of the service area of that city is in San Fernando Subarea. No measurements are available of the amount of water delivered to each subarea. Accordingly, an estimate was made of the amount of water delivered to each subarea, based on the percentage of the areal extent of the City of San Fernando service area within each subarea.

TABLE M-4

TRANSFERS OF GROUND WATER EXTRACTIONS BETWEEN HYDROLOGIC SUBAREAS[a]

In Acre-Feet

Year	Transfers from Sylmar Subarea to San Fernando Subarea			Transfers from Verdugo Subarea to San Fernando Subarea	Transfers from San Fernando Subarea to Verdugo Subarea		
	Mission Wells[b]	City of San Fernando	Total	City of Glendale	Sunland-Tujunga[b]	City of Glendale	Total
1928-29	2,460	1,150	3,610	1,800[c]	100		100
29-30	2,080	1,150	3,230	1,800[c]	100		100
1930-31	1,500	1,150	2,650	1,840	100		100
31-32	1,170	1,170	2,340	1,520	100		100
32-33	560	1,160	1,720	1,050	100		100
33-34	1,270	1,200	2,470	780	110		110
34-35	2,040	1,090	3,130	920	90		90
1935-36	2,260	1,300	3,560	1,030	100		100
36-37	2,010	1,310	3,320	920	110		110
37-38	2,380	1,280	3,660	1,320	110		110
38-39	2,270	1,400	3,670	2,590	120		120
39-40	2,220	1,380	3,600	2,370	120		120
1940-41	2,700	1,380	4,080	3,090	120		120
41-42	2,430	1,580	4,010	3,110	140		140
42-43	2,230	1,700	3,930	2,990	170		170
43-44	2,500	1,630	4,130	3,250	170		170
44-45	2,540	1,700	4,240	2,940	180		180
1945-46	2,900	1,800	4,700	2,570	220		220
46-47	2,990	1,890	4,880	3,310	220		220
47-48	2,900	2,160	5,060	1,420	270		270
48-49	2,540	2,290	4,830	760	280		280
49-50	2,460	2,240	4,700	0	280	10	290
1950-51	2,170	2,420	4,590	0	210	1,280	1,490
51-52	2,320	2,020	4,340	0	100	940	1,040
52-53	2,440	2,010	4,450	0	100	1,260	1,360
53-54	2,160	2,430	4,590	0	90	1,630	1,720
54-55	2,190	2,260	4,450	0	100	1,290	1,390
1955-56	1,930	2,120	4,050	0	30	2,740	2,770
56-57	2,430	2,160	4,590	0	200	3,150	3,350
57-58	1,690	2,530	4,220	0	200	3,670	3,870

a. Includes hill and mountain areas within the service area.
b. Water service areas of City of Los Angeles
c. Estimated.

Mission Wells Service Area

The Mission Wells service area receives a major portion of its supply from the Mission Wells in Sylmar Hydrologic Subarea. The total amount extracted from this field is exported from Sylmar Subarea to the Mission Wells service area in San Fernando Hydrologic Subarea.

Sunland-Tujunga Service Area

The Sunland-Tujunga service area in Verdugo Hydrologic Subarea was treated similarly to the City of San Fernando service area. All of the water extracted or diverted by the City of Los Angeles is in the San Fernando Hydrologic Subarea. A small portion of the service area, representing 12 percent of the areal extent of the service area, is in the Verdugo Hydrologic Subarea. The quantity of water transferred from San Fernando Subarea to supply the demands of the portion of San Fernando service area in Verdugo Subarea was proportioned according to the percentage of the service area in Verdugo Subarea.

City of Glendale Service Area

The amounts of water transferred into and out of the Verdugo Hydrologic Subarea were estimated by assuming that all of the water originating in Verdugo Subarea first supplied the demands of that subarea based on the meter readings of various booster pumps in the system necessary to supply the area. Any surplus water was exported from that subarea to San Fernando Subarea to serve the remainder of the City of Glendale. Also when the demand for water exceeded the supply originating in Verdugo Subarea, water was transferred from San Fernando Subarea to supplement the Verdugo supply.

Transfers into and from the Verdugo Subarea, estimated on the above assumptions, are listed in Table M-5. The amount of Colorado River water imported into the Verdugo Hydrologic Subarea was proportioned according to the percent of water from this source to the total Glendale/supply. The percentage of Colorado River water in the water transferred to Verdugo Subarea was assumed the same as in deliveries to the San Fernando Subarea, since the transfer is through the Glendale system wherein the two waters are commingled in that proportion.

Export of Ground Water

In addition to transfers of Owens River water by the City of Los Angeles, the ground water extracted from the River System wells of the City of Los Angeles is also exported to reservoirs outside of the Upper Los Angeles River area from which a portion returns to the Los Angeles Narrows area. The River System wells of the City of Los Angeles is comprised of the North Hollywood, Erwin, Whitnall, Verdugo, Deep Gallery, Headworks, Crystal Springs and the Pollock wells or well fields. The quantity of water extracted from this system is metered individually or as a well field and is shown in column 1 of Table M-6 as water transferred from the Upper Los Angeles River area.

The amount of the ground water thus transferred, which is returned for use in the City of Los Angeles Narrows water service area, has been estimated as discussed under Imported Waters in the Narrows Area, and the estimated amount is shown in column 2 of Table M-6.

Net export of ground water from the Upper Los Angeles River area has been computed as the difference between columns 1 and 2 of Table M-6 and is shown in column 3 of that table.

TABLE M-5

ESTIMATED TRANSFERS OF GROSS DELIVERED WATER BY THE CITY OF GLENDALE BETWEEN VERDUGO AND SAN FERNANDO SUBAREAS AND TRIBUTARY AREAS

In Acre-Feet

Year	Water demand in Verdugo	Supply originating in Verdugo	Amounts transferred		Colorado River water	
			Verdugo to San Fernando	San Fernando to Verdugo	Percent in transferred supply*	Transferred to Verdugo
1928-29		1,987	1,800			
29-30		2,134	1,800			
1930-31	639	2,480	1,841			
31-32	639	2,154	1,515			
32-33	730	1,781	1,051			
33-34	1,009	1,790	781			
34-35	900	1,824	924			
1935-36	1,025	2,059	1,034			
36-37	1,168	2,083	915			
37-38	1,186	2,507	1,321			
38-39	1,271	3,863	2,592			
39-40	1,481	3,850	2,369			
1940-41	1,306	4,399	3,093			
41-42	1,640	4,750	3,110			
42-43	1,721	4,712	2,991			
43-44	1,686	4,937	3,251			
44-45	1,836	4,778	2,942			
1945-46	2,152	4,723	2,571			
46-47	2,191	5,497	3,306			
47-48	2,151	3,575	1,424			
48-49	2,203	2,960	757			
49-50	2,338	2,333		5	1.7	1
1950-51	2,665	1,384		1,281	5.8	74
51-52	2,364	1,422		942	8.5	80
52-53	3,212	1,954		1,258	6.5	82
53-54	3,732	2,105		1,627	9.2	150
54-55	3,621	2,327		1,294	4.4	57
1955-56	4,669	1,930		2,739	11.2	307
56-57	4,814	1,667		3,147	11.1	349
57-58	5,596	1,929		3,667	9.4	345

* Percent of Colorado River water is the proportion of Colorado River water in transferred supply.

TABLE M-6

EXPORT OF GROUND WATER FROM UPPER LOS ANGELES RIVER AREA BY CITY OF LOS ANGELES[a]

In Acre-Feet

Year	Transfer of ground water from Upper Los Angeles River area	Ground water returned to Upper Los Angeles River area[b]	Net export of ground water from Upper Los Angeles River area
1928-29	61,220	6,410	54,810
29-30	63,680	6,490	57,190
1930-31	66,480	7,090	59,390
31-32	40,730	6,510	34,220
32-33	38,330	6,420	31,910
33-34	60,780	6,720	54,060
34-35	48,860	6,040	42,820
1935-36	55,660	6,150	49,510
36-37	50,700	6,430	44,270
37-38	45,420	6,870	38,550
38-39	43,800	7,540	36,260
39-40	45,070	7,210	37,860
1940-41	47,560	6,860	40,700
41-42	41,680	8,350	33,330
42-43	52,500	8,570	43,930
43-44	56,030	8,730	47,300
44-45	70,740	8,840	61,900
1945-46	77,070	9,040	68,030
46-47	82,210	9,040	73,170
47-48	76,990	9,180	67,810
48-49	76,160	9,270	66,890
49-50	81,610	8,870	72,740
1950-51	74,600	8,220	66,380
51-52	70,720	7,680	63,040
52-53	90,400	8,420	81,980
53-54	89,160	5,650	83,510
54-55	83,140	2,970	80,170
1955-56	87,910	3,910	84,000
56-57	93,630	2,880	90,750
57-58	84,320	1,040	83,280

a. Gross amounts.
b. To Narrows service area.

Export and Import of Water by La Canada Irrigation District

The La Canada Irrigation District transferred water out of and into the Upper Los Angeles River area due to the location of their water service area (see Plate 19). A portion of their water supply is obtained from surface diversions and a well in Verdugo Subarea. Their remaining supply is obtained from sources outside the area of investigation from ground water and the Foothill Municipal Water District.

An estimate of the amounts of water exported and imported from the Upper Los Angeles River area was determined by estimating the amount of water necessary to supply the portion of the service area in the Upper Los Angeles River area. Of their total service area, 42 percent of the areal extent of the district is in the Upper Los Angeles River area. This percentage was applied to the total water supply of the district and was assumed to be the demand of the service area in the Upper Los Angeles River area.

The portion of the district's water supply obtained in Verdugo Subarea was assumed to first supply the demand of the area and any amount in excess was exported out of the area of investigation. Conversely, water was imported when the demand was greater than the supply.

Table M-7 is an estimate of the amount of water exported and imported by the La Canada Irrigation District based on the above assumptions.

TABLE M-7

ESTIMATE OF GROSS DELIVERED WATER EXPORTED AND IMPORTED FROM THE UPPER LOS ANGELES RIVER AREA BY LA CANADA IRRIGATION DISTRICT

In Acre-Feet

Year	Total supply of: District	Water requirements: in Upper Los Angeles River area	Water supplied from Upper Los Angeles River area	Export	Import
1928-29	339	142	160	18	
29-30	361	152	227	75	
1930-31	353	148	217	69	
31-32	353	148	245	97	
32-33	350	147	246	99	
33-34	349	147	223	76	
34-35	277	116	199	83	
1935-36	389	163	256	93	
36-37	373	157	320	163	
37-38	421	177	391	214	
38-39	498	209	437	228	
39-40	473	199	424	225	
1940-41	499	210	476	266	
41-42	577	242	540	298	
42-43	661	278	619	341	
43-44	701	294	636	342	
44-45	647	272	567	295	
1945-46	844	354	559	205	
46-47	897	377	655	278	
47-48	1,023	430	712	282	
48-49	1,118	470	661	191	
49-50	1,191	500	554	54	
1950-51	1,310	550	469		81
51-52	1,362	572	545		27*
52-53	1,714	720	614		106*
53-54	1,802	757	633		124*
54-55	1,739	730	449		281*
1955-56	1,881	790	279		511*
56-57	1,997	839	435		404*
57-58	1,898	797	352		445*

* Imported Colorado River water purchased from Foothill Municipal Water District.

APPENDIX N

SEWAGE EXPORT, CESSPOOL RECHARGE AND WASTE DISCHARGE

APPENDIX N

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SEWAGE EXPORT, CESSPOOL RECHARGE AND WASTE DISCHARGE

History of Sewerage Systems

All of the sewage exported out of the area of investigation is conveyed through the City of Los Angeles sewerage system. Sewage treatment and disposal for the Cities of Burbank, Glendale and San Fernando is furnished by the City of Los Angeles through a contractual agreements. The North Outfall Sewer was the first trunk sewer constructed to convey sewage out of the Upper Los Angeles River area and was placed in operation in 1926. Its general alignment is shown on Plate 26. Areas sewered prior to the base period include portions of the Cities of Los Angeles south of Glendale, Burbank, Glendale and San Fernando.

The City of San Fernando, prior to 1952, maintained its own sewage treatment plant and discharged the effluent into Pacoima Wash. Since 1952, that city's sewage has been transported through the City of Los Angeles sewerage system and exported out of the area of investigation.

The City of Los Angeles west of Burbank did not have sewers installed until 1929. The rapid growth of this area soon caused the capacity of the North Outfall Sewer to be exceeded. Spot measurements made by the State Department of Public Health indicate that the North Outfall Sewer was overflowing into the Los Angeles River at various locations in 1952 and 1953. In 1954 the Valley Settling Basin was installed on the south bank of the Los Angeles River south of the City of Burbank. Its purpose was to store the peak flow until such time as it could be discharged back into the trunk sewer without exceeding the capacity of the sewer. On brief occasions when the capacity of the trunk sewer and the Valley Settling Basin were both exceeded, stored sewage was chlorinated and discharged into the Los Angeles River. The estimated amounts of sewage overflowing into the Los Angeles River during 1952-53 and 1953-54 and the measured amounts of sewage discharged from the Valley Settling Basin from 1954-55 through 1957-58 are listed in Table N-7.

In 1956, the San Fernando Valley Relief Sewer (see Plate 26) was constructed through the Santa Monica Mountains to intercept sewage originating west of the City of Burbank. No provision has been made for measurement of sewage through this sewer.

Source of Sewage Records

Sewage gaging stations, the locations of which are shown on Plate 26, are installed at strategic points for the purpose of determining the amount of sewage contributed to the City of Los Angeles sewerage system by the Cities of Burbank, Glendale and San Fernando. Whenever possible, the Referee determined the amount of sewage contributed by each city from measurements made at these gaging stations. The measurements at these gaging stations are from continuous recording devices which are in operation for a period of one week during the middle part of each month. By mutual agreement between the cities these measurements are accepted as being the average weekly flow for the month and billings for the cost of treating this sewage are based on these measurements. The period of record and source of data on sewage contributed to the City of Los Angeles sewerage system are shown in Table N-1.

TABLE N-1

RECORDS ON SEWAGE CONTRIBUTED
BY MUNICIPALITIES TO CITY OF LOS ANGELES
SEWERAGE SYSTEM

City	Period of record	Source
Burbank	October 1928-September 1958	Gaging charts and billings
Glendale	October 1928-September 1958	Billings
Los Angeles		
Upper Burbank gage	July 1930-March 1956	Gaging charts and billings
4th and Hubbard Streets gage	October 1930-September 1958	Billings
San Fernando Road and 4th Street gage	July 1958-September 1958	Billings
San Fernando	October 1930-September 1958	Billings
Valley Settling Basin (inflow)	September 1954-September 1958	Daily operational records
Discharges to Los Angeles River	September 1954-September 1958	Daily operational records

The amount of sewage exported from the City of Los Angeles west of Burbank prior to June 1956 was obtained from the records of the Upper Burbank sewage gaging station located west of the westerly city boundary of Burbank. After completion of the San Fernando Valley Relief Sewer Tunnel in June 1956, the sewage contributed by the City of Los Angeles west of Burbank was estimated as the number of sewer house connections multiplied by the expected sewage discharge per house connection. The number of sewer house connections was tabulated from sewer permits issued by the City of Los Angeles Valley District office. The mean sewage discharge per house connection (Table N-2) for each year of record, 1930-31 through 1954-55, was calculated by dividing the annual measured sewage originating in the area by the number of sewer house connections in service. The average sewage per sewer house connection computed for the period during which records were considered accurate, 1935-36 through 1954-55, was 0.30 acre-foot. This mean value, which appears reasonable when compared with the trend of values during the 1950's, was utilized as the expected sewage per house connection in the City of Los Angeles west of Burbank for the period after June 1956.

There are no records of sewage flow originating from the City of Los Angeles south of Glendale. Sewage from this area, which has been almost completely sewered since 1926, was estimated from a count of the number of sewer house connections shown on the City of Los Angeles "Y" maps for the area. The number of sewer house connections was enumerated for every five years within the base period and a straight line variation was used for the intervening years. The annual unit sewage flows per sewer house connection derived from the area west of the City of Burbank, discussed below, were utilized to estimate the sewage from this area.

The annual amounts of sewage exported from the Upper Los Angeles River area, based on measured and estimated values thus determined, are shown in Table N-7.

Annual Unit Sewage Flows

The City of Los Angeles west of Burbank was used as a study area to determine annual unit sewage discharge per house connection. This area contains a major portion of the area of investigation and receives a large amount of delivered water. The percentage of commercial development is relatively low in the area; thus, the unit values derived are believed applicable to sewage contributions from residential areas in all portions of the area of investigation.

Flow in a sewerage system originates generally from two main sources: (1) sanitary and industrial waste and (2) infiltration into the sewers from surface and ground waters. To separate the sewage flows as to each source, the amount of sewage discharged per house connection for each year was calculated for the study area by dividing the annual measured sewage discharge by the number of sewer house connections in service during the year. These annual values are shown in Table N-2 and plotted on Figure N-1. The wide range in values for the measured sewage per house connection occurred in the study area ranging from 0.17 acre-foot in 1933-34 to 0.47 acre-foot in 1943-44. The amount of water delivered per meter for domestic, combination and commercial and industrial meters was

TABLE N-2

COMPARISON OF UNIT SEWAGE AND WATER DELIVERIES,
CITY OF LOS ANGELES WEST OF BURBANK

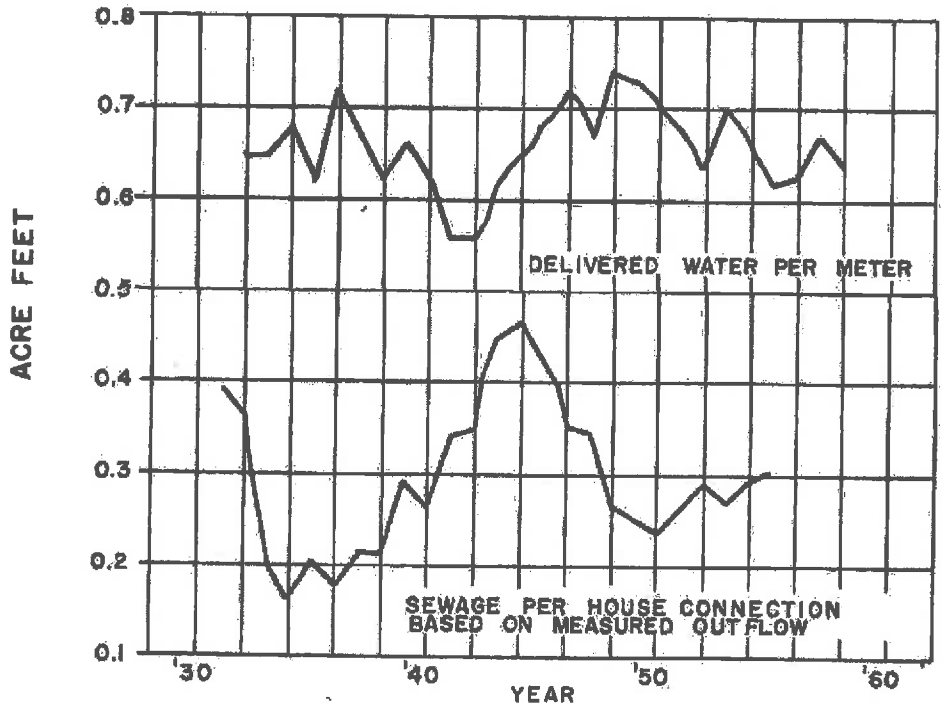
Year	Measured sewage per house connection, in acre-feet	Per capita delivered water, in gallons per capita day	Estimated sewage per house connection, in acre-feet
1928-29		94	0.17
29-30		93	0.17
1930-31	0.33	83	0.17
31-32	0.35	77	0.17
32-33	0.20	72	0.17
33-34	0.17	69	0.17
34-35	0.20	61	0.17
1935-36	0.18	68	0.17
36-37	0.21	70	0.18
37-38	0.21	79	0.18
38-39	0.29	90	0.18
39-40	0.27	93	0.18
1940-41	0.35	96	0.18
41-42	0.36	109	0.18
42-43	0.46	121	0.18
43-44	0.47	117	0.19
44-45	0.43	117	0.20
1945-46	0.35	125	0.20
46-47	0.34	125	0.21
47-48	0.26	127	0.21
48-49	0.24	131	0.21
49-50	0.23	126	0.22
1950-51	0.25	133	0.23
51-52	0.27	134	0.24
52-53	0.25	143	0.24
53-54	0.27	145	0.25
54-55	0.28	139	0.26
1955-56		139	0.27
56-57		150	0.27
57-58		142	0.28
29-year average 1929-57		108	0.20

also computed for the study area. The trends of the annual sewage discharge per house connection and delivered water per meter did not correspond with each other. Analysis of the data indicated that a large amount of water from combination meters was used for irrigation purposes. To adjust for this difference, only water delivered to domestic meters was utilized in computing the per capita delivered water.

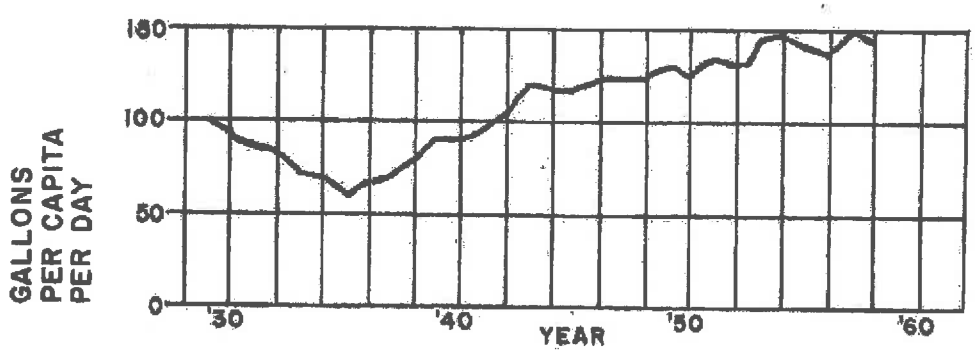
The population in the study area, as discussed in Appendix L, was utilized in determining the per capita delivery of water. It was assumed that the number of persons per meter was the same for both domestic and combination services. The annual population for the study area was derived from census values and was proportioned according to the percentage of domestic and combination meters in service for each year. The estimated annual population using domestic meters was divided into the amounts of water delivered to these meters to determine the per capita delivered water. The annual per capita delivered water thus computed is shown in Table N-2 and shown graphically on Figure N-1.

Comparison of the delivered water per meter curve (Figure N-1) with sewage flow per house connection curve (Figure N-1) for the City of Los Angeles west of Burbank shows that these two curves do not have the same long-time trend as expected, since an increase in water consumption should have a direct effect on sewage discharges. During the period of higher water levels the two curves have dissimilar short-time trends. Since infiltration is a source of flow in a sewer main, the water levels in the sewered area were compared with the annual sewage flow per house connection (Figure N-2). The records of water levels in well No. 3770

FIGURE N-1



DELIVERED WATER AND SEWAGE



ESTIMATED DELIVERED WATER PER CAPITA

SAN FERNANDO VALLEY REFERENCE

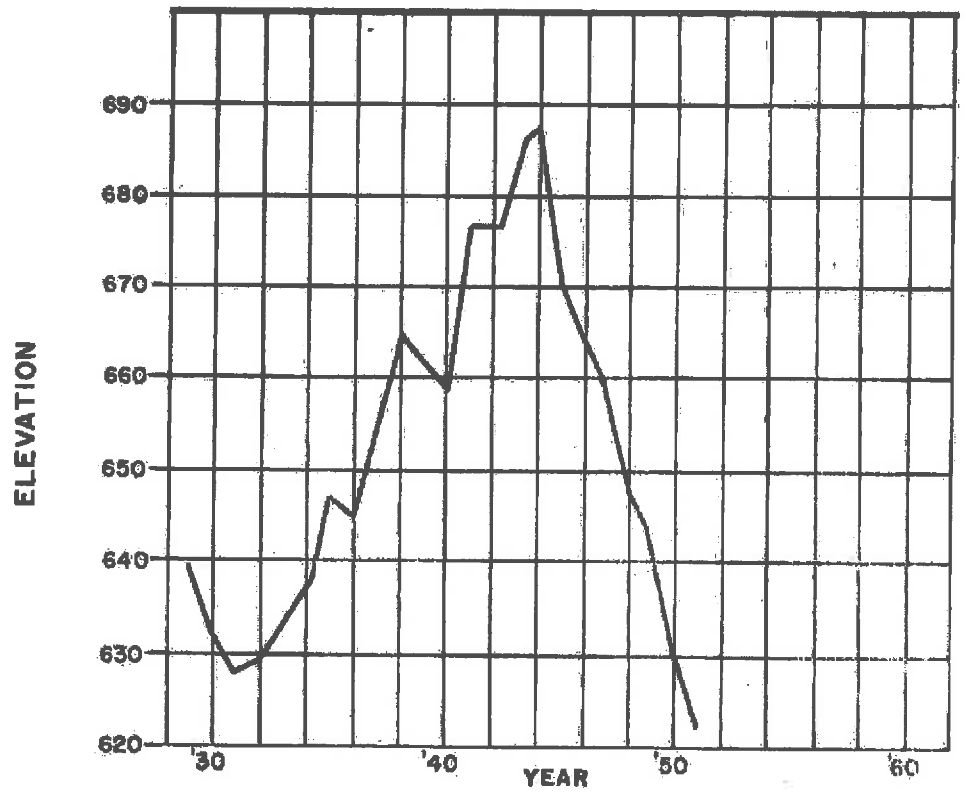
TRENDS OF DELIVERED WATER AND SEWAGE, CITY OF LOS ANGELES WEST OF BURBANK

STATE WATER RIGHTS BOARD

(Figure N-2) in the vicinity of Van Nuys were utilized for this purpose. Comparing the water level measurements and the annual sewage flow per house connection, it is apparent that the variation in unit sewage flows from 1933-34 to 1949-50 corresponds to the fluctuations of water levels. A sharp increase in the annual unit sewage discharge from 1937 to 1944 occurred concurrently with increasing ground water levels, and the recession of water levels was accompanied by a similar reduction in unit sewage discharges. This relationship, combined with the fact that certain reaches of the sewer trunk invert were below the water table during the period of high ground water elevations, leads to the conclusion that the higher unit values were caused by the infiltration of ground water into the sewerage system.

The contribution of ground water to sewage by infiltration was estimated by using the per capita delivered water as an indication of the increase in both the residential use within the home and the resulting increase in the annual unit sewage per house connection during the base period. On this basis, the annual unit value for sewage per house connection was a minimum in 1935 and gradually increased thereafter to the end of the base period. The amount that the measured unit value of sewage discharge exceeded the estimated value was assumed to be the amount contributed by infiltration. The portion of the sewage which is derived from delivered water was estimated by multiplying the estimated sewage flow per house connection in acre-feet by the number of existing sewer house connections. The difference between the calculated and the measured sewage export was assumed to have originated from ground water infiltrated

FIGURE N-2



SAN FERNANDO VALLEY REFERENCE

WATER LEVEL WELL 3770

STATE WATER RIGHTS BOARD

into the sewers. Table N-2 summarizes the annual measured and estimated sewage per house connection and the adjusted per capita delivered water for the City of Los Angeles west of Burbank.

The annual measured unit sewage flow per sewer house connection for the Cities of Burbank and Glendale is somewhat higher than that found in the City of Los Angeles west of Burbank. The data shown in Table N-3 and on Figure N-3 illustrate this relationship. The measured unit sewage value prior to 1944-45 for the City of Burbank is high as a result of industrial wastes being discharged into the sanitary sewers. This problem was recognized by the City of Burbank when the total annual amount of sewage being discharged was exceeding the contracted amount for sewage treatment with the City of Los Angeles. An industrial waste program was initiated to remove a large amount of industrial waste from the sanitary sewers into the storm drain after proper treatment. This effect was evaluated by comparing the City of Burbank's delivered water with the resulting sewage. Since 1937 residential, commercial and industrial meters in the Burbank system have been billed separately. Water delivered to industrial meters constitutes, on the average, approximately 20 percent of the total delivered water in the City of Burbank. An estimate of industrial sewage was made by deducting the consumptive use for industrial (see Appendix L) from the amount of industrial delivered water. The total sewage discharge was then adjusted for the above amount and the annual unit sewage discharge per house connection recalculated. The adjusted unit values for residential sewage thus computed were found to be

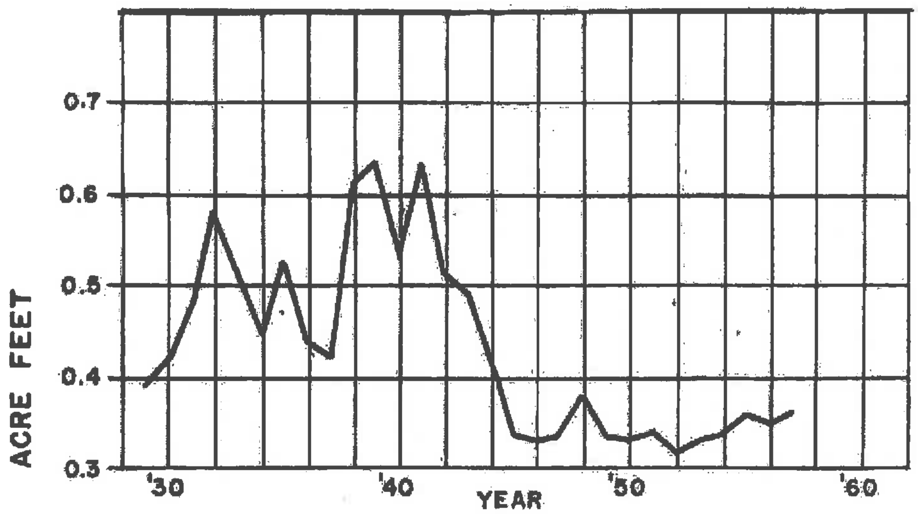
TABLE N-3

SUMMARY OF ANNUAL SEWAGE DISCHARGE PER HOUSE CONNECTION

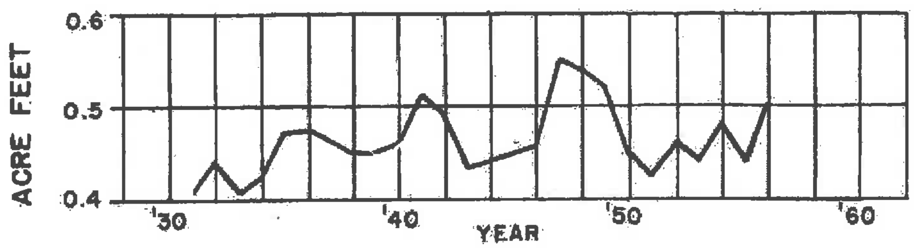
In Acre-Feet

Year	City of Los Angeles west of Burbank	City of Glendale		City of Burbank	
	Measured[a]	Measured[a]	Adjusted	Measured[a]	Adjusted
1928-29				0.39	
29-30				0.42	
1930-31	0.33	0.41		0.48	
31-32	0.35	0.44		0.58	
32-33	0.20	0.41		0.51	
33-34	0.17	0.42		0.45	
34-35	0.20	0.48		0.53	
1935-36	0.18	0.48		0.49	
36-37	0.21	0.46		0.47	
37-38	0.21	0.45	0.36	0.62	0.57
38-39	0.29	0.45	0.38	0.64	0.58
39-40	0.27	0.46	0.39	0.53	0.47
1940-41	0.35	0.51	0.44	0.64	0.55
41-42	0.36	0.49	0.42	0.51	0.39
42-43	0.46	0.43	0.36	0.49	0.35
43-44	0.47	0.44	0.38	0.42	0.30
44-45	0.43	0.45	0.36	0.35	0.25
1945-46	0.35	0.46	0.34	0.33	0.27
46-47	0.34	0.54	0.40	0.34	0.29
47-48	0.26	0.53	0.41	0.38	0.34
48-49	0.24	0.51	0.37	0.34	0.30
49-50	0.23	0.45	0.35	0.33	0.29
1950-51	0.25	0.42	0.30	0.34	0.29
51-52	0.27	0.46	0.36	0.32	0.27
52-53	0.25	0.44	0.32	0.33	0.27
53-54	0.27	0.48	0.33	0.35	0.29
54-55	0.28	0.44	0.30	0.36	0.31
1955-56		0.50		0.35	
56-57		0.48		0.36	
57-58		0.55		0.36	
18-year average 1938-55	0.31	0.47	0.36	0.42	0.35

a. Based on gaged sewage outflows.



CITY OF BURBANK



CITY OF GLENDALE

SAN FERNANDO VALLEY REFERENCE

SEWAGE FLOW PER HOUSE CONNECTION

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comparable to the values for the City of Los Angeles west of Burbank for the same period from 1937-38 through 1954-55.

In addition to the large amount of industrial waste being discharged into the sewers, ground and surface water contribute to the measured sewage from the City of Burbank. Sewer gaging stations are located along the north side of the Los Angeles River at the westerly and easterly boundaries of the city (see Plate 26). The period when the annual measured unit sewage values were high corresponds with the period when the water table was at an elevation equal to or above the invert of the trunk sewer line, making it possible for ground water to enter the sewer.

Annual measured unit sewage values for the City of Glendale were also larger than those of the study area. It was found that a large number of sewer flushing manholes had been installed in the city's sewerage system. These manholes were connected to the water mains with no means of measuring the amount of water used for flushing the sewers. Due to the lack of proper maintainence, flushing devices were soon flowing continuously thus increasing the amount of sewage discharged by the city. In 1957, the City of Glendale commenced removing the water connections from their flushing manholes. A rapid decrease in the water system losses became apparent. In 1954-55, the City of Glendale's water system loss was 25.3 percent. By 1958-59, the water system loss had been reduced to 7.2 percent. The reduction in percent of water system loss between 1955-56 and 1958-59, if considered as being caused entirely by faulty flushing devices, amounted to approximately 0.1 acre-foot per sewer house connection. An evaluation of the amount of flushing water entering the sewers is contained in the section on infiltration.

Unit sewage discharge values for the Cities of Burbank and Glendale, as measured and adjusted by removing industrial waste and flushing water amounts, are listed in Table N-3 for comparison purposes. For the 18-year period, 1937-38 through 1954-55, the average adjusted sewage discharge per house connection for the Cities of Burbank and Glendale agreed fairly well with the average value for the City of Los Angeles west of Burbank for the same period. This indicates that the values of unit domestic sewage contribution derived for the City of Los Angeles west of Burbank are comparable and may be utilized in determining the sewage contribution from residential areas.

Delivered Water and Sewage

The amount of sewage originating from delivered water may be estimated by assuming that none of the water delivered during months of prolonged rainfall is used outside for irrigation on lawns and gardens; thus, except for a small amount of water consumed by use within the household, the remaining water becomes sewage during these months.

Listed in Table N-4 are the amounts of water delivered to residential and commercial meters in the City of Los Angeles west of Burbank during months in which large amounts of precipitation have occurred over prolonged periods. Assuming that all of the water delivered during these months becomes sewage, the extension of this amount over a 12-month period (see line 6, Table N-4) results in the annual amount of sewage contributed. A comparison of actual total annual deliveries shown in line 7 of Table N-4

TABLE N-4

ESTIMATED PERCENT SEWAGE RESULTING FROM
USE OF WATER BY RESIDENTIAL AND COMMERCIAL AREAS
IN CITY OF LOS ANGELES WEST OF BURBANK

Item	Month						Mean
	February 1938	February 1941	March 1941	March 1943	February 1944	January 1952	
1. Precipitation (Rainfall Station No. 15) inches	8.95	11.25	11.41	4.10	10.94	12.97	
2. Number of water meters in thousands	24.71	34.13	34.13	39.82	40.96	110.65	
3. Water delivered, million cubic feet	20.82	28.42	30.61	37.67	40.22	122.92	
4. Water delivered, gallons per day per meter[a]	226	223	217	229	253	269	236
5. Water delivered, gallons per day per capita[b] equals estimated sewage, per day per capita	61	60	59	62	68	73	63
6. Estimated annual sewage,[c] acre-feet	5,735	7,828	8,432	10,376	11,079	33,861	
7. Total annual delivered water,[d] acre-feet	13,416	17,798	17,798	22,828	25,428	68,880	
8. Estimated sewage as percent of annual delivery = $\frac{(6)}{(7)} \times 100$	43	44	47	44	44	49	45

a. Gallons per day per meter equals (3) x 7.48 ÷ (2) x days in month.
b. Based on 3.7 persons per meter from population census and number of meters.
c. Estimated annual sewage is based on estimated sewage per day during wet months extended to 12-month period.
d. Annual metered amount.

and the estimated sewage for the year indicates that an average of 45 percent of the annual delivered water becomes sewage.

For comparison, during this period there was an average of 3.7 persons per residential water meter, as determined from data supplied by the United States Bureau of the Census. Based on the above criteria, the amount of sewage contributed from each person was 63 gallons per capita per day, or 0.26 acre-foot per year per meter. Increased sewage during the warmer summer months is believed countered by a decrease resulting from other factors such as vacancies during the summer period; thus, the 45 percent value was taken as representative of the average annual proportion of sewage to water delivered for an average residential lot.

Where the number of meters or consumers is unknown, an estimate of the amount of sewage originating from such an area was computed by multiplying the annual net residential and commercial delivered water to the area by 45 percent.

Cesspool Recharge

Individual sewage disposal units are scattered throughout the area of investigation. The number of these units in operation for any year must be estimated. The existence of a sewer line in an area does not necessarily imply that all the homes are connected to the sewer, since under present city and county ordinances the property owner is not required to connect to a sewer line to which he has access until his sewage disposal unit fails to function properly. Depending on the type of soil and the amount of sewage discharged, the sewage disposal unit may function properly indefinitely.

The number of individual sewage disposal units was estimated by calculating the difference between the number of consumer's water meters and the number of sewer house connections. These data were obtained from the various cities and agencies involved in this investigation. It was assumed that for every water meter there would be a connection draining the waste products into a sewer or an individual sewage disposal unit. With the number of individual sewage disposal units thus determined, an estimate of the amount of sewage was determined by multiplying the estimated annual unit sewage per house connection for each year, shown in Table N-2, by the number of individual sewage disposal units estimated to be in operation during the year.

When an area is partly sewered or contains individual sewage disposal units, the total amount of sewage is computed as 45 percent of the net residential and commercial delivered water. The amount of cesspool recharge from a partially sewered area was determined by proportioning the total sewage in the area according to the percentage of the areal extent sewered and unsewered. This method was utilized to determine the sewage originating in the Sylmar and Verdugo Hydrologic Subareas and the Mission Wells and Sunland-Tujunga water service areas. If measurements of the sewage discharge into a sewerage system were available, the amount measured was subtracted from the total amount of sewage originating in the area and the remainder was assumed to be cesspool recharge.

Effluent from sewage disposal units is usually discharged into a cesspool or leaching field. The effluent from cesspools is usually discharged at a depth that is below the root zone of most vegetation and becomes recharge to the ground water. Leaching fields are usually shallow and the effluent may be available for consumptive use by the vegetation on the surface. The number of disposal units using leaching fields in the area of investigation cannot be determined, but it is believed that due to the limited size of the residential lots in the area of investigation only a small number of leaching fields exist.

The annual amounts of cesspool recharge determined for each water service area and for each hydrologic subarea are listed in Table N-7, as hereinbefore discussed.

Infiltration and Sewer Flushing Water

Infiltration is water entering the sewer either through its joints, abandoned house connections, or manholes. Sewer flushing water is unmetered delivered water entering sewer lines of the City of Glendale through faulty flushing devices. Due to the limitations in construction, sewers are seldom laid with a watertight joint. If the sewers are laid below the ground water level a certain amount of ground water will enter through the joints or from poorly made and abandoned house connections. No attempt by the Referee or other agencies has been made to measure the amount of infiltration entering the sewers in the area of investigation. An estimate of the amount of sewer infiltration in the Burbank sewerage system and the amounts of infiltration and sewer flushing water in the Glendale system were determined in the same manner as for the City of Los Angeles west of Burbank, which has been discussed heretofore. The average unit sewage value per house connection thus determined for the Cities of Burbank and Glendale was 0.35 and 0.36 acre-foot per house connection, respectively. The difference between these average unit sewage values and the measured annual unit sewage values was assumed to be infiltration and sewer flushing water.

The amount of unmetered delivered water discharged into the City of Glendale's sewers constitutes a portion of the city's water system loss. The amounts of these discharges were required in the disposition of water system losses in the area of investigation. A comparison of the water distribution systems of the Cities of Burbank and Glendale indicates that the two systems are comparable and that the water system losses should be approximately the same for the two systems. This was demonstrated when the City of Glendale commenced removing the faulty flushing devices and the water system loss decreased to 7.2 percent in 1958-59. It was therefore assumed that an average water system loss over the base period of seven percent, which is equivalent to the City of Burbank loss, would have resulted if the flushing manhole mechanism had been properly maintained.

The annual amount of water discharged into the sewers was estimated as the difference between the actual water system loss and the average water system loss of seven percent of the gross delivered. If this difference was greater than the calculated amount of infiltration plus flushing water, the latter amount was taken and assumed to consist of sewer flushing water. Conversely, when the estimated amount of sewer flushing water was less than the calculated infiltration plus flushing water, it was assumed that the difference was contributed from the ground water infiltrating the sewers. Table N-5 shows the estimated amounts of infiltration entering the sewers, based on the preceding discussion.

The occurrence of ground water entering the sewers is dependent on the elevation water table. After 1952, the possibility of ground water entering the sewers east of the westerly boundary of the City of Burbank diminished due to the lowering of the ground water table below the invert of the sewers. However, infiltration from storm runoff can enter during the winter season through poorly constructed house connections or manholes.

The annual estimated amounts of infiltration shown in Table N-5 are reasonable if compared with the allowable infiltration in accordance to specifications under which sewers are constructed. The maximum allowable infiltration for newly laid sewers, according to the City of Los Angeles Standard Specification No. 151 for public improvements, is six-tenths of a gallon per minute per inch of diameter for sewer per 1,000 feet of sewer laid. For a new 8-inch sewer the maximum allowable infiltration for 1,000 feet amounts to 41 acre-feet per year. To obtain the maximum infiltration of 6,290 acre-feet per year as shown in Table N-5, it would require 153 miles of 8-inch sewers. In the area of investigation there are approximately 2,200 miles of sewers as of July, 1959. This consists of sewers whose diameter varies from 8 inches to over 48 inches. During the period prior to 1952, it appears that 153 miles of sewers could have been at or below the ground water table and infiltration into the sewers could have occurred.

TABLE N-5

ESTIMATED SEWER INFILTRATION AND FLUSHING WATER

In Acre-Feet

Year	Sewer Infiltration				Sewer Flushing
	Burbank	Glendale	Los Angeles[a]	Total	Glendale
1928-29	70	270	0	340	0
29-30	120	0	50	170	320
1930-31	230	0	200	430	490
31-32	400	120	360	880	810
32-33	320	0	110	430	610
33-34	220	70	20	310	700
34-35	390	1,170	140	1,700	450
1935-36	340	1,180	50	1,570	560
36-37	340	1,370	150	1,860	200
37-38	830	1,150	190	2,170	350
38-39	1,110	1,330	840	3,280	300
39-40	920	1,650	680	3,250	250
1940-41	1,790	2,840	1,660	6,290	150
41-42	1,360	2,500	1,870	5,730	170
42-43	1,360	1,280	3,150	5,790	0
43-44	930	1,680	3,500	6,110	0
44-45	220	1,800	3,290	5,310	90
1945-46	0	1,670	2,330	4,000	500
46-47	130	2,780	2,350	5,260	1,230
47-48	800	1,990	1,250	4,040	1,900
48-49	180	1,280	860	2,320	2,290
49-50	0	910	330	1,240	1,320
1950-51	200	0	970	1,170	1,520
51-52	0	0	2,090	2,090	2,530
52-53	0	0	950	950	2,090
53-54	0	0	1,840	1,840	2,620
54-55	0	0	1,950	1,950	2,240
1955-56	0	0	2,970	2,970	3,660
56-57	0	0	3,290	3,290	3,270
57-58	0	0	2,330	2,330	1,650

a. City of Los Angeles west of Burbank. Infiltration in Los Angeles South of Glendale assumed to be nil.

Sewage Exported from Sylmar Hydrologic Subarea

Part of the sewage originating in the Sylmar Hydrologic Subarea is exported to the San Fernando Subarea. From 1928 through August 1951, sewage originating in portions of Los Angeles and in San Fernando was treated in the City of San Fernando sewage treatment plant and discharged into Pacoima Wash. From September 1951 to the present, sewage discharged into sewers is exported from the Upper Los Angeles River area. Sewage from the City of Los Angeles is measured by a gage located at Fourth and Hubbard Streets in the City of San Fernando. An estimate of the sewage exported from the Sylmar Hydrologic Subarea, originating in the City of Los Angeles, was obtained by using the Fourth and Hubbard Streets gage, and commencing in July 1958, the San Fernando Road and Fourth Street gage. These gages are located in close proximity to the boundary of the Sylmar Subarea. With the exception of a few house connections located along the northeasterly boundary of the City of San Fernando and on San Fernando Road, these gages measure all the sewage exported from the City of Los Angeles in the Sylmar Subarea.

Sewage exported from the portion of the City of San Fernando in the Sylmar Subarea was estimated based on the percent of the areal extent of the city within each subarea.

Sewage Exported from Verdugo Hydrologic Subarea

The only area that is sewered in the Verdugo Subarea is within the City of Glendale (see Plate 26). The northerly boundary of the sewered area is approximately at the southerly boundary of the Crescenta Valley County

Water District service area. This area has had sewers available since 1926 and was assumed to have no individual sewage disposal units. Due to the lack of measurements of the amount of sewage from this area, an estimate was made by using 45 percent of the net delivered water to residential and commercial classifications as sewage exported from the Verdugo Hydrologic Subarea.

Imported Waters in Cesspool Recharge

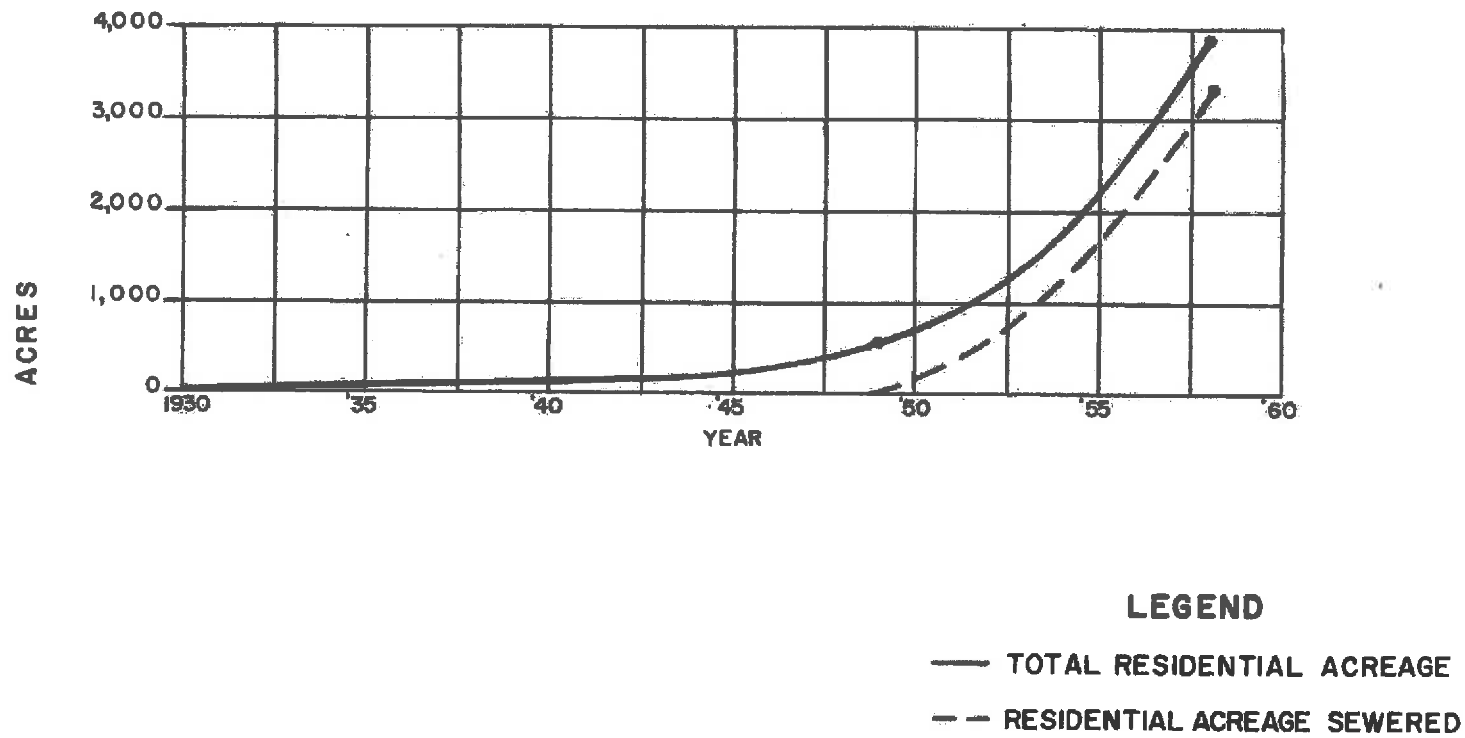
To account for the disposition of imported water in the area of investigation, an estimate of the amount of imported Colorado River water in sewage was determined by utilizing the percentage of imported water in each water service area. It was assumed that the imported water supplied to the service areas commingled with the native ground water used to supply the area and the amount of imported water in the sewage was proportional to the amount of imported water in the net delivered water.

Prior to the introduction of Colorado River water into their water supply, the Cities of Burbank and Glendale utilized extracted ground water for their supply and therefore cesspool recharge and sewage exported by these cities consisted entirely of ground water. The annual percent of Colorado River water in each city's supply was applied to their respective amounts of sewage export and cesspool recharge to determine the amounts supplied from Colorado River water. In the City of Los Angeles west of Burbank, Owens River water is used almost exclusively in the area and has been discussed previously.

Sewage from the Hill and Mountain Areas

The sewage measured at the various sewage gaging stations includes sewage originating in the hill areas. To obtain values for the valley floor areas, sewage originating from the hill areas had to be determined. Most of the residential acreage in the hill areas is in the Narrows water service area and in the Santa Monica Mountains. The acreage of residential in the hill areas is found in Appendix K. To utilize the annual unit sewage flow per house connection, the number of sewer house connections in the Narrows water service area was enumerated from the City of Los Angeles Engineer's sewer maps, as discussed previously. On the basis of this enumeration, it was found that over the base period there was an average of 3.4 sewer connections per acre in the hill area. The sewered areas in the Santa Monica Mountains were planimetered for 1955 and 1958 from Plate 26. The acreages thus determined were plotted on a graph showing the acreage of residential in the Santa Monica Mountains. A curve representing the acreage sewered was extrapolated using these two points and the total acreage curve for this area, as shown on Figure N-4. The sewage from the Santa Monica Mountains was estimated by utilizing the number of lots per acre found in the Narrows hill area and the annual unit sewage flow per house connection. Sewage from hillside residential areas in the other water service areas did not constitute any significant amount of sewage being exported. It was, therefore, assumed to all be on individual sewage disposal units.

FIGURE N-4



SAN FERNANDO VALLEY REFERENCE

RESIDENTIAL ACRES, SANTA MONICA MOUNTAINS

STATE WATER RIGHTS BOARD

Sewage Export and Cesspool Recharge

The methods of determining and evaluating sewage export and cesspool recharge for each service area and hydrologic subarea, as previously described, are presented in Table N-6. Summaries of sewage export and cesspool recharge for the area of investigation have been prepared for valley floor and hill and mountain areas. For convenience, these values are presented by water service areas and by hydrologic subareas. The summaries are presented in the following tables:

- N-7 Cesspool Recharge by Water Service Area
- N-8 Contribution of Sewage to Sewerage System by Water Service Area
- N-9 Sewage Exported from Hill and Mountain Areas

A summary of cesspool recharge in hill and mountain areas is not presented since it is believed that this recharge is not a contribution to the hydrologic subareas.

TABLE N-6

METHODS OF DETERMINING SEWAGE EXPORT AND CESSPOOL RECHARGE

Area	Cesspool recharge	Sewage export
CITY OF LOS ANGELES		
West of Burbank	Unit sewage discharge per cesspool.	Measured.
Owens Service Area in Sylmar Subarea	Total sewage based on 45 percent of delivered water* minus measured sewage export.	Measured.
Sunland-Tujunga Service Area	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	Total measured sewage export for the City of Los Angeles west of Burbank minus measured sewage export from the Owens Service Area in Sylmar. The remaining sewage is split by the areal extent of sewered areas within each service area.
Mission Walls Service Area	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	
Owens Service Area in San Fernando Subarea	Total cesspool recharge in Los Angeles west of Burbank minus the sum of the three areas above.	
Narrows Service Area	None.	Estimated, based on unit sewage discharge per house connection.
CITY OF SAN FERNANDO	Unit sewage discharge per cesspool.	Measured.
In San Fernando Subarea	Split by areal extent of the City in each subarea.	Split by areal extent of sewered area.
In Sylmar Subarea	Split by areal extent of the City in each subarea.	Split by areal extent of sewered area.
CITY OF GLENDALE	Unit sewage discharge per cesspool.	Measured.
In Verdugo Subarea	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	Split by areal extent of sewered area.
In San Fernando Subarea	Total cesspool recharge for the City less recharge in Verdugo Subarea.	Split by areal extent of sewered area.
CITY OF BURBANK	Unit sewage discharge per cesspool.	Measured.
LA CANADA IRRIGATION DISTRICT	Total sewage based on 45 percent of delivered water.*	None.
CRESCENTA VALLEY COUNTY WATER DISTRICT	Total sewage based on 45 percent of delivered water.*	None.

* Residential and commercial delivered water only.

TABLE N-7

CESSPOOL RECHARGE BY WATER SERVICE AREA

In Acre-Feet

Year	City of Burbank: San Fernando Subarea: Ground water	City of Burbank: San Fernando Subarea: Metropolitan Water District	City of Burbank: Total	City of San Fernando: Sylmar Subarea[a]: Ground water	City of San Fernando: San Fernando Subarea: Ground water	City of San Fernando: Sub-total[b]	City of San Fernando: Sylmar Subarea: Ground water	City of San Fernando: San Fernando Subarea: Ground water	City of San Fernando: Sub-total[c]	City of San Fernando: Total	Crescenta Valley County Water District[d]: Verdugo Subarea: Ground water	Crescenta Valley County Water District[d]: Verdugo Subarea: Metropolitan Water District	Crescenta Valley County Water District[d]: Total	La Canada Irrigation District: Verdugo Subarea: Ground water	La Canada Irrigation District: Verdugo Subarea: Metropolitan Water District	La Canada Irrigation District: Total
1928-29	550		550	40	380	420	10	100	110	530	190		190	30		30
29-30	560		560	40	420	460	10	90	100	560	210		210	40		40
1930-31	550		550	50	500	550	10	90	100	650	230		230	40		40
31-32	550		550	40	420	460	10	80	90	550	210		210	50		50
32-33	540		540	40	350	390	10	70	80	470	230		230	50		50
33-34	540		540	30	230	260	10	60	70	330	300		300	50		50
34-35	560		560	40	350	390	10	60	70	460	210		210	40		40
1935-36	560		560	40	380	420	10	50	60	480	190		190	50		50
36-37	640		640	40	420	460	10	60	70	530	220		220	50		50
37-38	790		790	50	440	490	10	50	60	550	250		250	60		60
38-39	1,020		1,020	60	560	620	10	50	60	680	290		290	70		70
39-40	1,090	0	1,090	60	570	630	0	50	50	680	310		310	70		70
1940-41	1,440	50	1,490	50	530	580	0	50	50	630	290		290	60		60
41-42	1,310	60	1,370	50	500	550	0	50	50	600	360		360	90		90
42-43	1,160	130	1,290	50	470	520	10	50	60	580	330		330	100		100
43-44	1,020	60	1,080	40	360	400	10	50	60	460	410		410	110		110
44-45	910	40	950	50	440	490	0	50	50	540	370		370	100		100
1945-46	800	70	870	50	500	550	10	100	110	660	490		490	130		130
46-47	960	170	1,130	60	530	590	10	110	120	710	580		580	140		140
47-48	860	40	900	60	620	680	10	90	100	780	790		790	140		140
48-49	530	10	540	60	620	680	10	90	100	780	670		670	150		150
49-50	480	10	490	80	600	680	10	140	150	830	740		740	170		170
1950-51	390	20	410	100	980	1,080	10	150	160	1,240	830		830	190		190
51-52	340	30	370				20	190	210	210	900		900	160	40	200
52-53	200	30	230				20	200	220	220	1,040		1,040	190	60	250
53-54	180	20	200				20	230	250	250	1,130		1,130	180	60	240
54-55	190	10	200				30	250	280	280	890	190	1,080	190	70	260
1955-56	130	10	140				30	260	290	290	840	340	1,180	90	180	270
56-57	50	10	60				20	240	260	260	860	380	1,240	80	220	300
57-58	30	10	40				30	240	270	270	970	230	1,200	80	200	280

CESSPOOL RECHARGE BY WATER SERVICE AREA
(continued)

In Acre-Feet

Year	City of Glendale: Verdugo Subarea: Ground water	City of Glendale: Verdugo Subarea: Metropolitan Water District	City of Glendale: San Fernando Subarea: Ground water	City of Glendale: San Fernando Subarea: Metropolitan Water District	City of Glendale: Total	City of Los Angeles West of Burbank: Sylmar Subarea: Owens River	City of Los Angeles West of Burbank: San Fernando Subarea: Owens River[e]	San Fernando Subarea: Mission Wells: Ground water	San Fernando Subarea: Mission Wells: Owens River	San Fernando Subarea: Sunland-Tujunga Service Area: Ground water	San Fernando Subarea: Sunland-Tujunga Service Area: Owens River	San Fernando Subarea: Owens Service Area: Owens River	San Fernando Subarea: Total	Verdugo Subarea: Sunland-Tujunga Service Area: Ground water	Verdugo Subarea: Sunland-Tujunga Service Area: Owens River	Verdugo Subarea: Total
1928-29	10		1,330		1,340	0	130	160		370		1,630	2,290	10		10
29-30	10		1,200		1,210	0	140	220		480		1,490	2,330	10		10
1930-31	10		1,080		1,090	0	150	170		380		1,660	2,360	10		10
31-32	10		940		950	0	150	110		240		1,740	2,240	10		10
32-33	10		800		810	0	170	120		240		1,520	2,050	10		10
33-34	10		690		700	0	160	120		250		1,570	2,100	10		10
34-35	10		600		610	0	160	110		210		1,580	2,060	10		10
1935-36	10		550		560	0	150	140		270		1,620	2,180	10		10
36-37	10		510		520	0	160	150		280		2,010	2,600	10		10
37-38	10		450		460	0	160	160		310		2,310	2,940	10		10
38-39	20		400		420	0	190	190		350		2,570	3,300	10		10
39-40	20		370		390	0	200	200		360		3,170	3,930	10		10
1940-41	20		350		370	0	190	210		370		3,670	4,440	10		10
41-42	30		420		450	70	180	250		440		4,100	4,970	10		10
42-43	40		350		390	170	160	300		510		4,250	5,220	20		20
43-44	40		280		320	160	220	390		580		4,200	5,390	20		20
44-45	50		300		350	240	190	400		560		4,680	5,830	20		20
1945-46	60		300	10	370	320	230	460		630		4,860	6,180	20		20
46-47	80		280	20	380	410	240	450		680		6,050	7,420	30		30
47-48	120		280	10	410	470	260	580		800		6,050	7,690	40		40
48-49	140		220	0	360	510	300	790		880		6,130	8,100	50		50
49-50	120	0	140	0	260	560	300	900		960		6,240	8,400	60		60
1950-51	130	10	60	10	200	680	290	880	180	800	280	7,450	9,880	50	20	70
51-52	120	10	60	10	190	670		1,200	0	720	350	9,720	11,990	50	20	70
52-53	160	0	90	10	260	830		1,090	290	430	890	9,780	12,480	30	60	90
53-54	160	10	80	10	260	1,070		1,150	270	470	840	11,180	13,910	30	60	90
54-55	190	0	100	10	300	1,220		1,140	350	530	780	12,390	15,190	40	60	100
1955-56	140	10	60	10	220	1,330		970	590	640	680	13,450	16,330	50	40	90
56-57	140	20	60	10	230	1,610		570	660	820	610	14,090	16,750	50	50	100
57-58	320	30	160	10	520	1,310		390	320	1,140	230	14,330	16,410	100	20	120

a. Measured sewage exported out of Sylmar Subarea.
b. Measured sewage treated at City of San Fernando Sewage Treatment Plant in San Fernando Subarea.
c. Estimated sewage discharged into private sewage disposal unit.
d. Including Mountain Water Company.
e. Exported to San Fernando Hydrologic Subarea from Sylmar Subarea.

TABLE N-8

CONTRIBUTION OF SEWAGE TO SEWERAGE SYSTEM BY WATER SERVICE AREA[a]

In Acre-Feet

Year	City of San Fernando: Sylmar Subarea[b] Ground water	City of San Fernando: San Fernando Subarea[b] Ground water	City of San Fernando: Total	City of Burbank, San Fernando Subarea[b]: Metropolitan Water District	City of Burbank, San Fernando Subarea[b]: Ground water	City of Burbank, San Fernando Subarea[b]: Total	City of Glendale, Verdugo Subarea[b]: Metropolitan Water District	City of Glendale, Verdugo Subarea[b]: Ground water	City of Glendale, San Fernando Subarea[b]: Metropolitan Water District	City of Glendale, San Fernando Subarea[b]: Ground water	City of Glendale: Total
1928-29					470	470		80		2,590	2,670
29-30					580	580		100		3,090	3,190
1930-31					720	720		120		3,960	4,080
31-32					930	930		110		4,800	4,910
32-33					890	890		140		4,830	4,970
33-34					830	830		230		5,160	5,390
34-35					1,020	1,020		240		6,220	6,460
1935-36					1,040	1,040		260		6,680	6,940
36-37					1,150	1.150		330		6,910	7,240
37-38					1,780	1,780		350		7,150	7,500
38-39					2,290	2,290		380		7,780	8,160
39-40					2,420	2,420		450		8,310	8,760
1940-41				130	3,780	3,910		410		9,750	10.160
41-42				160	3,680	3,840		500		9,570	10,070
42-43				400	3,750	4,150		570		8.390	8,960
43-44				240	4,120	4,360		580		8,630	9,210
44-45				180	3,980	4,160		600		8,830	9,430
1945-46				330	4,070	4,400		700	160	9.100	9,960
46-47				700	3,990	4,690		710	660	10,680	12,050
47-48				280	5,740	6.020		670	330	11,100	12,100
48-49				130	5,960	6,090		670	0	11,470	12,140
49-50				80	6,190	6,270		750	180	10,210	11,140
1950-51				330	6,710	7.040	20	830	560	9,170	10,580
51-52	120	1,150	1,270	610	6,370	6,980	30	760	920	9,940	11,650
52-53	180	1,700	1,880	920	6,580	7,500	20	930	760	9,770	11,480
53-54	140	1,360	1,500	900	7,490	8,390	40	1,120	1,050	10,320	12,530
54-55	130	1,260	1,390	560	8,050	8,610	20	1,050	470	10,240	11,780
1955-56	120	1,110	1,230	750	8,120	8,870	90	1,270	1,310	10,400	13,070
56-57	120	1,130	1,250	1,240	8,150	9,390	100	1,340	1,290	10,370	13,100
57-58	120	1,200	1,320	1,350	7.460	8,810	180	1,710	1,280	12,320	15,490

CONTRIBUTION OF SEWAGE TO SEWERAGE SYSTEM BY WATER SERVICE AREA[a]
(continued)

In Acre-Feet

Year	City of Los Angeles West of Burbank: Sylmar Subarea[b] Owens River	City of Los Angeles West of Burbank, San Fernando Subarea[b]: Owens River	City of Los Angeles West of Burbank, San Fernando Subarea[b]: Ground water	City of Los Angeles West of Burbank: Total	City of Los Angeles Narrows, San Fernando Subarea[b]: Metropolitan Water District	City of Los Angeles Narrows, San Fernando Subarea[b]: Owens River	City of Los Angeles Narrows, San Fernando Subarea[b]: Ground water	City of Los Angeles Narrows, San Fernando Subarea[b]: Total	Less Valley Settling Basins[c]	Total sewage export out of Upper Los Angeles River Area[e]
1928-29		0	0	0			3,180	3,180		6,320
29-30		50	50	100			3,230	3,230		7,100
1930-31		200	200	400			3,290	3,290		8,490
31-32		350	360	710			3,350	3,350		9,900
32-33		590	110	700			3,410	3,410		9,970
33-34		640	20	660			3,460	3,460		10,340
34-35		720	140	860			3,510	3,510		11,850
1935-36		830	50	880			3,590	3,590		12.450
36-37		1,020	150	1,170			3,670	3,670		13,230
37-38		1,140	190	1,330			3,750	3,750		14,360
38-39		1,350	840	2,190			3,830	3,830		16,470
39-40		1,660	680	2.340			3,920	3,920		17,440
1940-41		1,950	1,660	3,610			3,950	3,950		21.630
41-42		2,150	1,870	4,020			3,980	3,980		21,910
42-43		2,200	3,150	5,350			4,010	4,010		22,470
43-44		2,360	3,500	5,860			4,040	4,040		23.470
44-45		2,830	3,290	6,120	70		4,000	4,070		23,780
1945-46		3,200	2,330	5,530	360		3.780	4,140		24,030
46-47		3,780	2,350	6,130	520		3,690	4,210		27,080
47-48		5,240	1,250	6,480	540		3,740	4,280		28,880
48-49		6,900	860	7,760	550		3,800	4,350		30,340
49-50		9,790	330	10,120	200	540	3,680	4,420		31,950
1950-51		12,580	970	13,550	270	880	3,340	4,490		35,660
51-52	310	13,100	2,090	15,500	360	1,020	3,170	4,550		39,950
52-53	360	14,810	950	16,120	460	880	3,280	4,620	10[d]	41,590
53-54	270	18,230	1,840	20,340	1,810	610	2,270	4,690	190[d]	47,260
54-55	260	21,770	1,950	23,980	2,800	450	1,500	4,750	4,840	45,670
1955-56	260	25,220	2,970	28,450	2,280	440	2,060	4,780	4,540	51,860
56-57	280	28,010	3,290	31,580	2,660	570	1,570	4,800	60	60,060
57-58	340	31,040	2,330	33,710	3,230	680	960	4.870	240	63,960

a. Including infiltration.
b. Include tributary drainage area.
c. Discharged into Los Angeles River.
d. Overflow of North Outfall Sewer.
e. Does not include sewage flowing in Los Angeles River.

TABLE N-9

SEWAGE EXPORTED FROM
HILL AND MOUNTAIN AREAS

In Acre-Feet

Year	Water Service Area				Total
	Owens	Burbank	Glendale	Narrows	
1928-29	0	0	0	870	870
29-30	0	0	0	880	880
1930-31	0	0	0	900	900
31-32	0	0	0	910	910
32-33	0	0	0	920	920
33-34	0	0	0	940	940
34-35	0	0	0	960	960
1935-36	0	0	0	970	970
36-37	0	0	0	990	990
37-38	0	0	0	1,060	1,060
38-39	0	0	0	1,080	1,080
39-40	0	0	0	1,090	1,090
1940-41	0	0	0	1,170	1,170
41-42	0	0	0	1,190	1,190
42-43	0	0	0	1,200	1,200
43-44	0	0	0	1,220	1,220
44-45	0	0	10	1,310	1,320
1945-46	0	0	20	1,320	1,340
46-47	0	0	40	1,410	1,450
47-48	0	10	70	1,420	1,500
48-49	10	10	110	1,440	1,570
49-50	140	10	160	1,530	1,840
1950-51	300	10	230	1,620	2,160
51-52	490	20	320	1,710	2,540
52-53	730	30	400	1,730	2,890
53-54	1,090	30	520	1,830	3,470
54-55	1,490	40	640	1,930	4,100
1955-56	2,000	50	790	2,020	4,860
56-57	2,510	60	920	2,050	5,540
57-58	3,240	70	1,100	2,140	6,550

Waste Discharge

An estimate of the amount of industrial wastes being discharged into the Los Angeles River was made by using the quantity of industrial wastes permitted to enter into storm drains which discharge into the river. These amounts were in accordance with industrial waste permits issued by the City of Los Angeles, Bureau of Sanitation, Industrial Waste Division. The quantities being discharged under each permit were assumed to begin with the date of issuance of the permit during the period 1946-47 through 1957-58. For the prior years, a straight line extrapolation was used to extend these data back to 1939-40, at which time the amount of waste being discharged was assumed to be negligible.

Industrial waste discharges are also present in the flow from Burbank-Western Storm Drain. The low flow measurements of this storm drain were utilized to obtain an estimate of the amount of industrial waste tributary to Burbank-Western Storm Drain. Prior to 1951-52, no measurements were available and a straight line extrapolation was used assuming that waste discharges were negligible in 1939-40. The estimated amount of waste discharged into the Los Angeles River is shown in Table N-10.

TABLE N-10

ESTIMATED DISCHARGE OF INDUSTRIAL WASTE AND SEWAGE INTO RIVER SYSTEM

In Acre-Feet

Year	Low flow of Burbank-Western Storm Drain (1)	City of Los Angeles industrial waste permits (2)	Total waste (1)+(2)=(3)	Sewage* (4)	Total waste and sewage (3)+(4)=(5)
1939-40	0	0	0	0	0
1940-41	240	300	540	0	540
41-42	490	600	1,090	0	1,090
42-43	740	900	1,640	0	1,640
43-44	990	1,200	2,190	0	2,190
44-45	1,240	1,500	2,740	0	2,740
1945-46	1,490	1,800	3,290	0	3,290
46-47	1,740	2,100	3,840	0	3,840
47-48	1,990	2,100	4,090	0	4,090
48-49	2,240	2,420	4,660	0	4,660
49-50	2,320	2,420	4,740	0	4,740
1950-51	2,390	2,420	4,810	0	4,810
51-52	2,460	2,820	5,280	0	5,280
52-53	2,530	3,550	6,080	10	6,090
53-54	2,430	3,550	5,980	190	6,170
54-55	2,800	3,550	6,350	4,840	11,190
1955-56	2,330	3,550	5,880	4,540	10,420
56-57	2,030	3,550	5,580	60	5,640
57-58	2,200	3,550	5,750	240	5,990

* Overflow of North Outfall Sewer 1952-53 and 1953-54 and discharge from Valley Settling Basin 1954-55 through 1957-58.

APPENDIX O

SEPARATION OF SURFACE FLOW OF THE LOS ANGELES RIVER AT GAGE F-57

APPENDIX O

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APPENDIX O

SEPARATION OF SURFACE FLOW OF THE LOS ANGELES RIVER AT GAGE F-57

Gage F-57 measures the surface outflow of the Upper Los Angeles River area and is located approximately 0.2 mile above the confluence of the Arroyo Seco and the Los Angeles River.

The surface flow of the river originates from four sources:

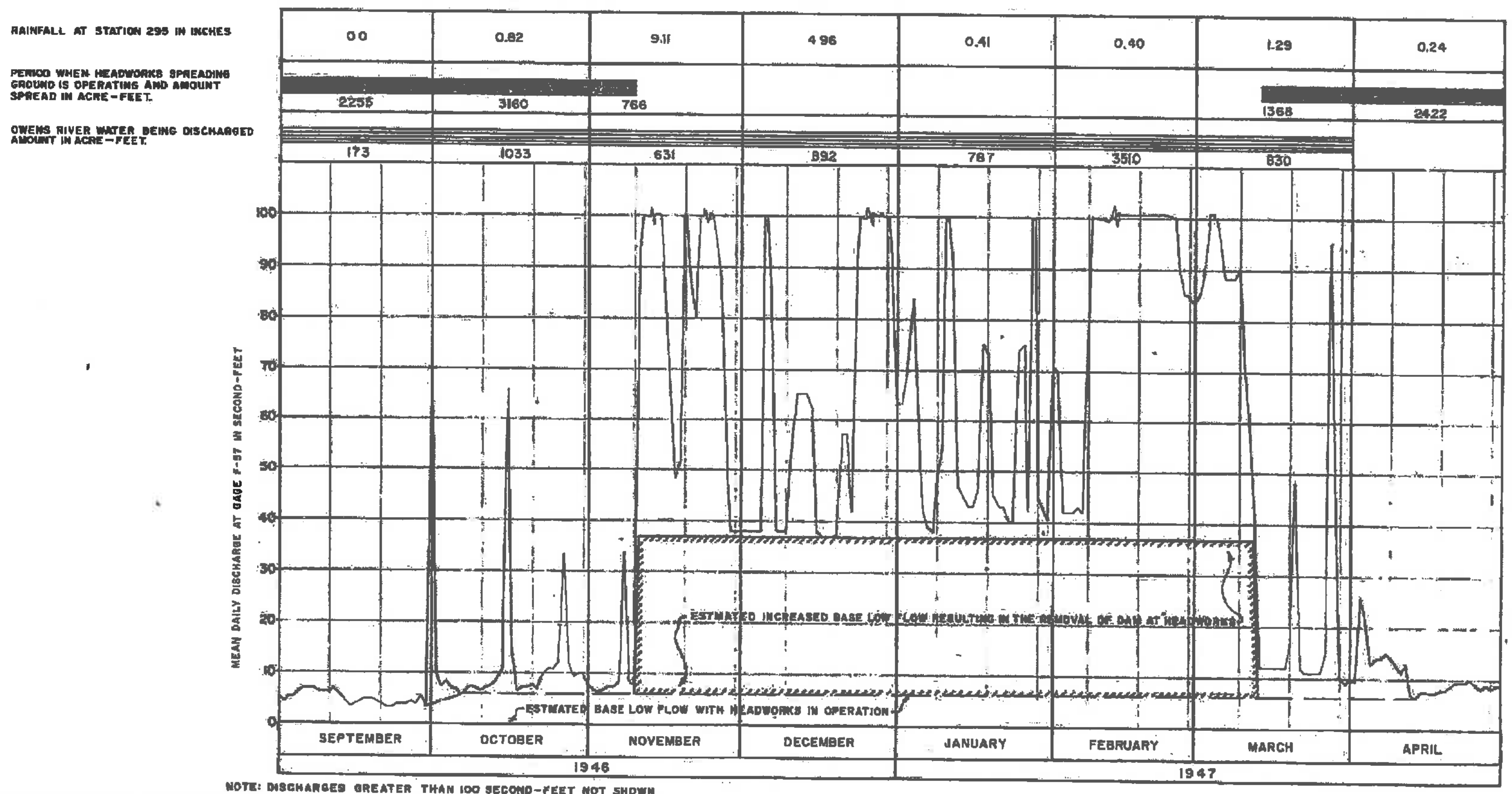
1. Storm runoff from precipitation.
2. Owens River water.
3. Rising water.
4. Industrial waste and sewage discharges.

Available Data

Surface outflow measurements at Gage F-57 are available from January 1929 through September 1958. Records for Gage F-57 from January 1929 through August 1929 were weekly measurements made at the approximate location of the present gage. Subsequent records for Gage F-57 were compiled from the charts of a continuous type recorder maintained by the Los Angeles County Flood Control District. This agency also rates the station with periodic current meter measurements. The mean daily flows computed from these records were utilized to construct a hydrograph of the surface flow passing the gage (see Figure O-1).

The occurrence of the surface flow passing the gage is influenced by the operation of the Headworks Infiltration Gallery and the amounts of Owens River water discharged into the Los Angeles River.

FIGURE O-1



SAN FERNANDO VALLEY REFERENCE

ILLUSTRATED EXAMPLE FOR SEPARATION OF FLOW AT GAGE F-57

STATE WATER RIGHTS BOARD

The location of the Headworks Infiltration Gallery is shown on Plate 12. The monthly amount of water diverted from the Los Angeles River into the headworks was compiled by the Los Angeles Department of Water and Power from October 1938 through September 1958. Diversion into the headworks inlet structure is made by the installation of a temporary dam across the river. Due to regulations established by the Corps of Engineers, this dam is required to be removed when the flow in the river increases due to storm runoff. Beginning in 1958-59, a permanent Imbertson collapsible rubber dam has been used. This dam remains in place and automatically collapses when there is sufficient flow in the river.

The discharge of Owens River water into the Los Angeles River from the River Power Plant, Chatsworth Reservoir and from blowoffs is discussed in Appendix M. The monthly amounts of water discharged from these sources from October 1928 through September 1958 have been recorded by the Los Angeles Department of Water and Power. Annual amounts of these discharges are shown in column 8, Table M-1.

Separation of the Surface Outflow

The total surface outflow of the Los Angeles River measured at Gage F-57 was divided into two basic parts, the base low flow and surface runoff. Base low flow is the discharge of the river when runoff from precipitation has ceased and includes rising ground water, industrial waste and sewage discharge. Surface runoff is the discharge derived from storm runoff and any Owens River water which may be discharged to the river during periods of high flow.

In order to determine the amount of each component derived from the four aforementioned sources, the monthly amount of Owens River water discharged into the river, the periods when the Headworks Infiltration Gallery was in operation and the monthly amount of rain occurring at Gage 295 in the City of Glendale were noted on hydrographs of the mean daily flow measured at Gage F-57. These various items were utilized to separate the base low flow and the storm runoff into their separate components.

Surface Runoff and Base Low Flow

It is assumed that during months of no rainfall the base low flow makes up the entire flow of the river measured at Gage F-57. In order to separate surface runoff due to precipitation from the total, a straight line was drawn on the hydrograph from the end of one dry period to the beginning of the following dry period. Allowance was made for a period of recession after a wet season as indicated by the rate of change in value of runoff subsequent to precipitation, as illustrated on Figure O-1.

From 1938-39 through 1957-58 when the headworks was in operation, this line was adjusted during periods of storm runoff to compensate for the increased amount of base low flow which would be measured at the gage when the headworks was not diverting. It was assumed that a major portion of the water diverted into the headworks would be measured at the gage when the headworks diversion was shut down. However, the amount of this increase in the base low flow was limited by the maximum monthly rate of diversion into the headworks for each year, less an estimated amount of Owens River water diverted by the headworks plus rate of flow measured at the gage when the headworks was in operation.

The base low flow for each month was then computed from the hydrograph and deducted from the total gaged amount, the remainder being the surface runoff.

Owens River Water

The discharge passing Gage F-57 is at times composed partly of Owens River water which has been discharged from the City of Los Angeles River Power Plant, spillage from Chatsworth Reservoir and blowoffs from Los Angeles City mains. It should be noted that the quantities of Owens River water from blowoff discharges are estimated and that the exact time and location where they occurred are not all known. An inspection of the record of the daily flows at F-57 indicates that portions of the aforementioned Owens River water discharges do not reach F-57 as surface flow.

Available data indicate that the disposition of Owens River water discharged into the river may be estimated under the following sets of conditions:

1. That all Owens River water discharged through the City of Los Angeles River Power Plant during periods of high river flow passed Gage F-57.

2. That all Owens River water released from Chatsworth Reservoir, when the headworks spreading grounds were in operation, was

diverted into the headworks and when the headworks was not in operation (i.e. during high flow periods) all such water would pass Gage F-57.

3. That all other Owens River water discharged into the Los Angeles River flowed past Gage F-57 except during periods of diversion to the headworks. At times of these diversions it was assumed that all available Owens River water up to the amount of the diversion was diverted to the spreading grounds and did not reach Gage F-57.

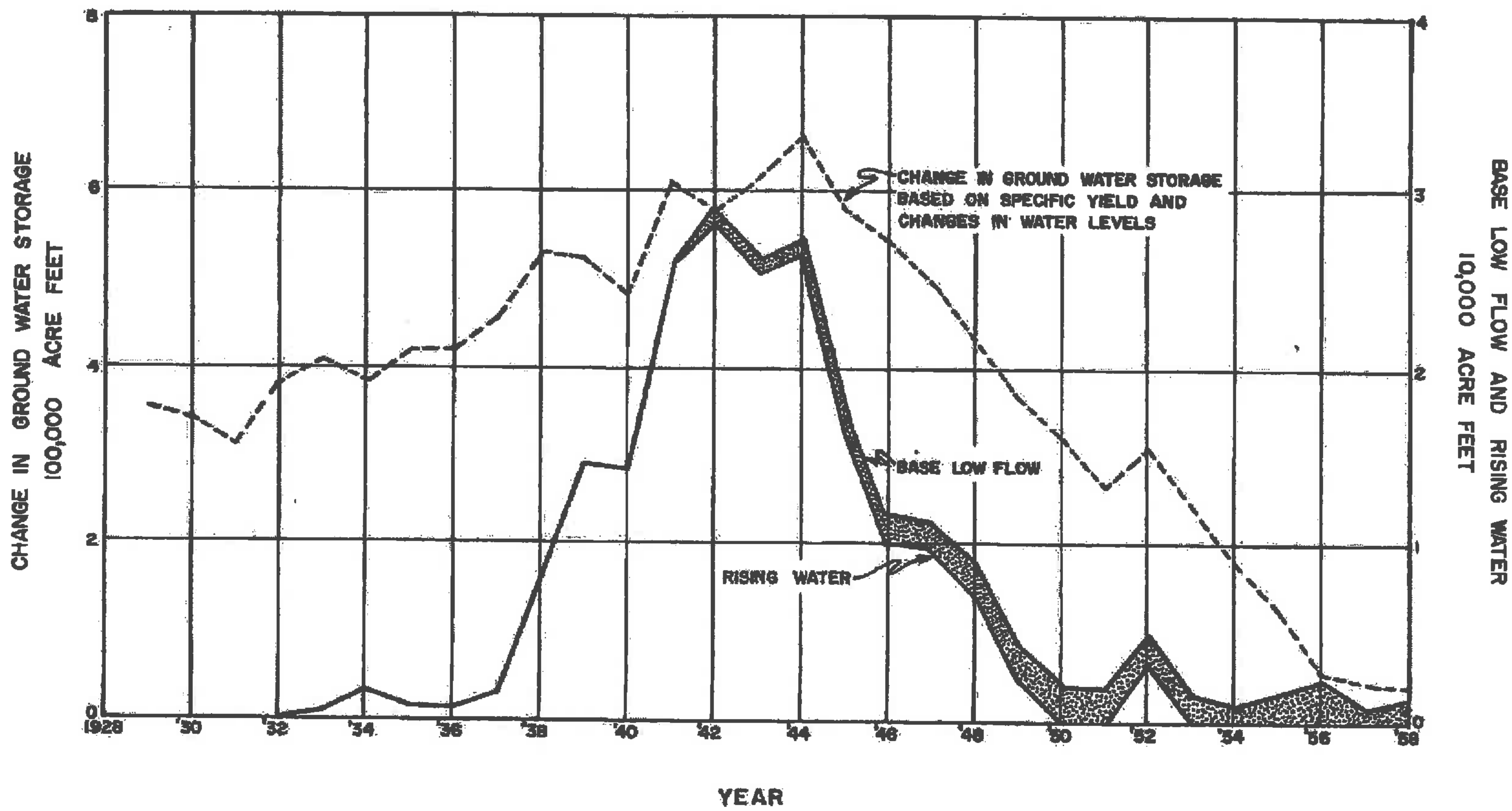
Prior to October 1938, available information indicates that Owens water releases were made predominantly during periods of high flow. These releases include discharges from the River Power Plant and blowoffs.

Base Low Flow

As mentioned previously, the base low flow at Gage F-57 originates from rising water and industrial waste and sewage discharges into the Los Angeles River. The relationship which exists between the water in storage in the valley fill and the amount of the base low flow is illustrated on Figure O-2.

Water in storage in the valley fill was plotted by taking an arbitrary value of 400,000 acre-feet in storage in 1927-28. The annual changes in storage, as computed from specific yield and water levels, were accumulated and plotted on Figure O-2. The base low flow was also plotted on Figure O-2 to illustrate the relationship with the change in storage.

FIGURE 0-2



SAN FERNANDO VALLEY REFERENCE

RELATIONSHIP OF RISING WATER AND CHANGE IN GROUND WATER STORAGE

STATE WATER RIGHTS BOARD

Inspection of the hydrographs of the mean daily flow at Gage F-57 indicates a rapid increase in the base low flow after the March 1938 flood coincident with the deepening of the river invert for its improvement by the Corps of Engineers.

The base low flow from 1949-50 through 1957-58, with the exception of 1951-52, appears to have little or no rising water. It was therefore assumed that no rising water could appear at Gage F-57 when storage in the valley fill was below the amount of water in storage in 1949-50, and that the amount of the base low flow measured at Gage F-57 during this period originated from industrial waste and sewage discharged into the river. Sewage discharge from the Valley Settling Basin began in 1954-55; however, the North Outfall Sewer is known to have been overloaded and discharging sewage to the Los Angeles River in 1952-53 and 1953-54.

There are no actual measurements of industrial waste discharged directly into the river. Waste water discharged into the Los Angeles River in any appreciable amount began during World War II with the expansion of industrial development in the San Fernando Valley. There are no records of significant amounts of industrial waste discharge prior to 1940 and it has therefore been assumed that the annual base flow was equal to the rising water at Gage F-57 prior to that date. The amount of industrial waste and sewage passing Gage F-57 was estimated by using a straight line relationship to extrapolate the amount of these waste discharges from 1940 through 1949. From 1950 through 1958 the amount of the base low flow is equal to the waste discharges, with the exception of 1951-52 when the amount of water in storage was greater than the amount of 1949-50. The amount of wastes for 1951-52 was estimated by utilizing the average amount of wastes estimated for 1950-51 and 1952-53.

The separation of the surface outflow measured at Gage F-57 into its four sources is shown in Table O-1.

TABLE O-1

SEPARATION OF SURFACE FLOW AT GAGE F-57

In Acre-Feet

Year	Base low flow		Surface runoff		Measured
	Rising water	Waste discharge[a]	Owens River water	Net storm runoff	Outflow
1928-29	0	0	650	2,950	3,600[b]
29-30	0	0	330	1,330	1,660
1930-31	0	0	260	3,710	3,970
31-32	60	0	1,550	13,630	15,240
32-33	440	0	0	10,200	10,640
33-34	1,670	0	1,750	26,400	29,820
34-35	760	0	440	11,350	12,550
1935-36	720	0	560	4,490	5,770
36-37	1,430	0	1,770	21,270	24,470
37-38	7,740	0	1,690	123,210	132,640
38-39	14,490	0	2,940	24,930	42,360
39-40	14,050	0	760	24,780	39,590
1940-41	25,770	200	0	138,990	164,960
41-42	28,600	410	5,160	20,630	54,800
42-43	25,490	620	8,680	89,600	124,390
43-44	26,500	830	2,850	79,650	109,830
44-45	16,610	1,040	1,210	18,130	36,990
1945-46	10,500	1,250	4,100	20,040	35,890
46-47	9,700	1,460	5,960	14,210	31,330
47-48	7,270	1,670	0	5,950	14,890
48-49	2,440	1,880	710	12,580	17,610
49-50	0	2,090	0	8,670	10,760
1950-51	0	1,890	1,080	4,870	7,840
51-52	3,110	1,750	1,430	101,750	108,040
52-53	0	1,400	1,650	15,430	18,480
53-54	0	960	290	19,750	21,000
54-55	0	1,550	0	16,720	18,270
1955-56	0	2,390	0	33,500	35,890
56-57	0	830	0	24,060	24,890
57-58	0	1,270	0	89,750	91,020
29-Year Average 1929-57	6,810	770	1,580	30,790	39,940

a. Includes industrial waste and sewage discharged into Los Angeles River.
b. Partially estimated.