SUMMARY OF THE CONDITIONS OF SOUTH FLORIDA WATER STORAGE AREAS IN THE 1973-74 DRY SEASON

Introduction

This is the second supplement to the original summary report which compared meteorologic and hydrologic data for the 1970-71 dry season (considered to be a severe drought period) and the 1971-72 dry season. The first supplement presented similar data for the 1972-73 dry season. This second supplement presents data for the 1973-74 dry season and provides comparisons.

Rainfall

Table 1 summarizes monthly rainfall data for the four reservoir areas, and compares the monthly and seasonal values with long-term normals (excluding the 1970-74 values).

Over all reservoir areas the seasonal rainfall was deficient, the total deficiency largely representing an accumulation of monthly deficiencies. The pattern of monthly deficiences, area-wide, was approximately the same with December being the only month not experiencing a deficiency.

Seasonal deficiencies were comparable to those which occurred in the 1970-71 dry season, with somewhat higher deficiencies (about 2 inches) occurring in the Central and Southern Everglades Areas. In the northerly three areas the pattern of monthly deficiencies was about the same in 1973-74 as in 1970-71, the exception being that the mid-season heaviest rainfall occurred in December in the former period whereas it occurred in February in the latter period.

Figures 1-A through 1-D plot the accumulated rainfall over each area for the four dry seasons starting with 1970-71, together with the long-term normal rainfall. The similarity of monthly rainfall distribution and rainfall depths between 1973-74 and 1970-71 will be noted from these graphs.

Seasonal rainfall has been below normal in three of the past four dry seasons over all four reservoir areas.

Evaporation

Table 2 lists open pan evaporation data for Lake Okeechobee and at Pumping Station 7.

Both the Lake Okeechobee and S-7 values closely approximate those observed in 1970-71; 37.70 "vs 37.48" at the Lake, and 32.77 "vs 32.50" at S-7. These data further point up the rather marked similarity in meteorological conditions between the 1973-74 and 1970-71 dry seasons.

These data also lend support to the observation that greater evaporation rates are associated with periods of greater rainfall deficiency.

Table 3 lists the estimated monthly evaporation, supplemental water supply and total drafts on Lake Okeechobee storage. The 1973-74 values are compared with those for the previous three dry seasons in terms of the percentage which evaporation represents of the total monthly Lake storage depletion. The comparability of the 1973-74 data with that of the 1970-71 drought will again be noted. It bears out the fact that although absolute volumes are greater, evaporation represents a smaller share of the total draft during rainfall deficient seasons due to the larger drafts for supplemental water use.

Water Delivery and Use

Table 4 is a summary of the water deliveries to the service areas of all four reservoirs. Total estimated deliveries in 1973-74 were about 105,000 A.F., or 7%, greater in 1973-74 than in 1970-71. For each reservoir the comparisons are:

Reservoir	Volume (A.F.)	%
Lake Okeechobee	+ 40,000	+ 5%
C. A. #1	+ 53,000	+ 48%
C. A. #2A	+ 3,000	+ 3%
C. A. #3A	+ 25,000	+ 11%

Again, the water delivery data are quite comparable to those for 1970-71. It is not believed that the increased deliveries are necessarily reflective of an increased demand on these surface water sources. That is, assuming validly that meteorological conditions were about the same in 1973-74 as in 1970-71, these water delivery data should not be used to infer a 7% increase in water demand in the past four years. The accuracy of certain of the delivery measurements and the delivery estimates (seepage, etc.) is probably not better than 10%.

Tables 5 and 6 show the demands related to specific points of delivery, and estimated seepage values which are considered to serve a beneficial use demand.

The Lake Okeechobee deliveries show a different monthly pattern in 1973-74 than in 1970-71, particularly in the months of November, December, January and February. Total deliveries in the four months were about the same, but the distribution was different; this undoubtedly reflective of rainfall distribution, soil moisture content and cropping patterns in the Agricultural Area.

Table 6 for Conservation Area No. 1 shows high values for seepage in comparison with 1970-71. This is because of higher stages in the conservation area in 1973-74. This explains the estimated 48% increase in "deliveries" in 1973-74.

Figure 2 shows the mass total system delivery curves for the past four dry seasons.

Seasonal (October-May) deliveries to Everglades National Park were about 9,000 A.F., or 5%, short of scheduled minimum deliveries. The deficient deliveries occurred principally in November, due to low stage (compared with required delivery rate) in Conservation Area No. 3A. These deficiences were partially made up by somewhat greater than required deliveries in March, April and May.

Water Transfers to Lower East Coast

As noted in the previous section, eastward seepage from the conservation areas is considered to be a beneficial use demand for the maintenance of shallow water table aquifer elevations and maintenance of salinity control stages in the coastal canals. During rainfall deficient periods seepage rates, due to lowered stages in the conservation areas and in the groundwater table east of the levees, are insufficient to maintain salinity control stages. At that point it becomes necessary to make surface water releases into the coastal canals.

Specific locations for such releases are S-31, S-34, S-38, S-39 and S-5AE. In 1973-74 releases were made at these locations for the following periods:

Location	From	To
S-31	March 5, 1974	May 26, 1974
S-34	February 20, 1974	June 3, 1974
S-38	February 28, 1974	June 3, 1974
S-39	February 20, 1974	May 28, 1974
S-5AE	March 5, 1974	May 29, 1974

For all practical purposes the volume of water released at all these locations for the period indicated was taken from storage in Lake Okeechobee. The estimated draft on Lake Okeechobee is as follows:

Location	Volume (A.F.)				
	Feb.	Mar.	Apr.	May	Total
S-31	0	14,700	19,700	31,500	65,900
S-34	3,500	4,700	13,000	7,600	28,800
S-38	100	2,700	7,200	4,900	14,900
S-39	1,500	3,400	4,400	3,400	12,700
S-5AE	0	2,800	5,200	8,100	16,100
	5,100	28,300	49,500	55,500	138,400

In addition, during the period November through May, 1974, the City of West Palm Beach was withdrawing water from the L-8 canal to maintain water supply availability in its catchment area and lake system. The average monthly withdrawal volume is estimated at 7,500 A.F.; with the seasonal volume approximately 53,000 A.F. The major portion of this withdrawal volume was derived from Lake Okeechobee storage.

The estimated seasonal withdrawal from Lake Okeechobee to meet supplemental water needs in the lower east coast area in the 1973-74 dry season is 180,000 A.F. This represents about 23% of the total estimated seasonal draft on the Lake. During the critical March through May period the lower east coast demands represented approximately 36% of the withdrawals from Lake Okeechobee storage. This is explanation for the substantial increase in the March-May values for Lake demand shown in Table 5.

Surface water releases from Conservation Area No. 1 into the Lake Worth Drainage District were also made throughout the dry season at Structure 3 in Levee 40. During the February-May period these releases totalled about 15,000 A.F. The volume of water involved was taken from Conservation Area No. 1 storage, however, and not from Lake Okeechobee.

Affected by these water transfers from project storage were public water supply systems having a dry season average production rate of 350 MGD.

Reservoir Inflow

Table 7 lists selected data on inflow (surface runoff) into each of the four reservoir areas. The average seasonal discharges listed in the table exclude those for the past four dry seasons.

Kissimmee River inflow to Lake Okeechobee in 1973-74 approximated that during 1970-71, reflecting the rainfall deficiency in that tributary watershed. In 1973-74, Kissimmee River discharge was about one-third that of 1972-73, when rainfall was close to normal in the Kissimmee Basin. The difference represents nearly one foot of stage on Lake Okeechobee.

The Taylor Creek discharge values are no longer comparable, since upper Taylor Creek flows now enter the Lake at S-191, together with flows from Mosquito Creek, Nubbin Slough, Lettuce Creek, etc., as a result of completion of project works on the North and Northeast Shores of the Lake.

The Fisheating Creek flows are worthy of note. In the past four dry seasons these flows have been 29,000, 21,000, 28,000 and 23,000 A.F., respectively, in comparison with the 1956-70 average of 87,000 A.F. This is possibly an indication of increased water use within the basin affecting streamflow.

Inflows from the Everglades Agricultural Area into the Conservation Areas in 1973-74 were less than in 1970-71, and were closer to those values which were obtained in 1972-73. A reasonable explanation for this is that the rainfall which occurred in 1973-74 (and 1972-73) was distributed more effectively for meeting crop requirements than in 1970-71. That is, the canal-ditch-soil storage system was better prepared to accept and use the rainfall when it occurred, as against having to dump storage upon the advent of rainfall.

Figure 3 is a set of bar graphs, for each reservoir, showing the proportions of total inflow contributed by rainfall and by runoff. Of interest is the very narrow range of monthly total inflow amounts in all three conservation areas and, in particular, Conservation Area 2A. The same narrow range is evident for Lake Okeechobee from November through April. This indicates a high degree of uniformity of conditions over the entire region throughout the major portion of the dry season. A similar uniformity is not evident in the previous three dry seasons.

These graphs again show that throughout most of the dry season direct rainfall is the major element of reservoir replenishment. The low percentage of rainfall contribution to the total in Conservation Area 3A from February on is explainable by the deliberate drawdown of Conservation Area 2A (by discharge to 3A) for biological experimentation purposes.

Storage-Demand

Figures 4 through 8 are curves showing the relationships throughout the dry season between available storage and the estimated maximum demand. The demand curve, which at any point represents the remaining demand, is based on the actual demand during the 1970-71 drought.

The comparison with the 1970-71 condition, on an overall basis and in Lake Okeechobee (Figures 4 and 5) shows that, although meteorologic conditions were similar in 1973-74 to those in 1970-71, the approach of critical conditions occurred about one month later due to greater water storage in the system at the start of the 1973-74 dry season.

Lake Okeechobee Water Balance, October 1973-May 1974

The water balance equation is:

$$\Delta s = P + I - O - E$$

where:

Δs = change in storage
P = direct rainfall
I = tributary inflow
O = outflow
E = losses

For Lake Okeechobee the values for the above factors are obtained as follows:

Δs; from Figure 5
$P+I$; from Figure 3
O; from Table 5
E; from Table 3

The water balance (in A.F.) is:

$$\Delta s = 1,730,000 - 150,000 = (-)\ 1,580,000$$

then:

$$-1,580,000 = 656,000 - 774,570 - 1,276,500$$

$$-1,580,000 = -1,395,070$$

the imbalance is 184,930 A.F., or 11.7% of the observed change in storage.

The direction of the imbalance means that either less water than calculated entered the Lake or more water left the Lake than was calculated. The most likely explanation for much of the imbalance is that the rainfall stations used (on the adjacent land mass) do not reflect direct rainfall on the 720 sq.mi. area of the Lake. The imbalance, if attributed entirely to the rainfall component, represents a seasonal rainfall depth of 4.8". In this case the imbalance would be accounted for with a total rainfall over the Lake about 55% of the value given in Table 1.

TABLE 1

SUMMARY OF RAINFALL DATA (INCHES)

MONTH	LAKE OKEECHOBEE			N. EVERGLADES			C. EVERGLADES			S. EVERGLADES		
	NORMAL	1973-74	DEP.	NORMAL	1973-74	DEP.	NORMAL	1973-74	DEP.	NORMAL	1973-74	DEP.
OCTOBER	4.16	3.47	-0.69	5.01	2.25	-2.76	5.85	3.63	-2.22	6.84	3.16	-3.68
NOVEMBER	1.12	0.27	-0.85	1.51	0.47	-1.04	1.75	0.03	-1.72	1.74	0.56	-1.18
DECEMBER	1.16	1.35	+0.19	1.55	1.76	+0.21	1.54	1.62	+0.08	1.12	2.39	+1.27
JANUARY	1.08	0.56	-0.52	1.66	1.56	-0.10	1.72	0.34	-1.38	1.58	0.50	-1.08
FEBRUARY	1.84	0.53	-1.31	1.77	0.26	-1.51	1.83	0.23	-1.60	1.77	0.04	-1.73
MARCH	2.26	0.14	-2.12	2.70	1.12	-1.58	2.35	0.05	-2.30	2.01	0.08	-1.93
APRIL	2.75	1.40	-1.35	2.14	2.96	+0.82	2.84	0.50	-2.34	2.72	2.22	-0.50
MAY	3.87	3.07	-0.80	4.66	3.68	-0.98	5.05	2.66	-2.39	5.92	2.48	-3.44
	18.24	10.79	-7.45	21.00	14.06	-6.94	22.93	9.06	-13.87	23.70	11.43	-12.27

TABLE 2

MONTHLY EVAPORATION - LAKE OKEECHOBEE AND S-7 (INCHES)

MONTH	LAKE OKEECHOBEE			S-7		
	NORMAL	1973-74	DEP.	NORMAL	1973-74	DEP.
OCTOBER	4.50	5.09	+0.59	3.35	3.62	+0.27
NOVEMBER	3.70	4.23	+0.53	3.16	3.56	+0.40
DECEMBER	3.00	1.23	-1.77	2.67	2.91	+0.24
JANUARY	3.00	3.15	+0.15	2.51	2.66	+0.15
FEBRUARY	3.60	4.45	+0.85	3.06	4.06	+1.00
MARCH	5.00	6.23	+1.23	4.70	5.03	+0.33
APRIL	5.70	7.24	+1.54	5.80	5.65	-0.15
MAY	6.30	6.08	-0.22	5.20	5.28	+0.08
TOTAL	34.80	37.70	+2.90	30.45	32.77	+2.32

TABLE 3

LAKE OKEECHOBEE - RELATION OF EVAPORATION TO TOTAL DRAFT

MONTH	Q (AF)	EVAPORATION 1973-74 Inches	EVAPORATION 1973-74 AF	TOTAL DRAFT 1973-74	EVAPORATION DRAFT % 1973-74	1972-73	1971-72	1970-71
OCTOBER	38,295	5.1	190,604	228,899	83.3	66.7	91.0	80.7
NOVEMBER	135,728	4.2	156,135	291,863	53.5	66.6	77.9	53.3
DECEMBER	60,895	1.2	43,960	104,855	41.9	73.0	67.9	49.2
JANUARY	22,556	3.2	116,747	139,303	83.8	75.4	67.4	53.7
FEBRUARY	70,931	4.4	156,200	227,131	68.8	87.1	76.5	71.0
MARCH	117,228	6.2	208,010	325,238	63.9	77.3	70.4	63.9
APRIL	179,512	7.2	227,640	407,152	55.9	62.4	79.2	56.6
MAY	149,423	6.1	177.205	326,628	54.2	62.0	91.5	65.9
AVERAGE	-	-	-	-	62.2	71.3	77.7	61.8

TABLE 4

SUMMARY OF WATER DELIVERY - OCTOBER 1973 THROUGH MAY 1974

MONTH	LAKE OKEECHOBEE	CONSERVATION AREA 1	CONSERVATION AREA 2A	CONSERVATION AREA 3A	EVERGLADES NATIONAL PARK	MONTHLY TOTAL
OCTOBER	38,295	19,978	11,067	42,427	64,100	175,867
NOVEMBER	135,728	19,171	10,710	35,107	49,500	250,216
DECEMBER	60,895	17,507	11,067	30,744	30,000	150,213
JANUARY	22,556	19,934	9,838	27,669	21,830	101,827
FEBRUARY	70,931	21,252	10,304	22,770	12,350	137,607
MARCH	117,228	25,352	13,568	14,142	4,010	174,300
APRIL	179,512	23,605	27,905	39,660	2,800	273,482
MAY	149,423	16,227	19,828	33,338	2,400	221,216
TOTAL	774,568	163,026	114,287	245,857	186,990	1,484,728

TABLE 5

LAKE OKEECHOBEE SERVICE AREA DEMAND (ACRE FT.)

MONTH	LAKE SHORE AREA	HGS-3	HGS-4	HGS-5	ST. LUCIE CALOOSAHATCHEE CANALS	MARTIN CO. IRRIGATION	MONTHLY DEMAND
1973 OCTOBER	2,388	4,780	15,235	6,119	1,415	8,358	38,295
NOVEMBER	0	25,015	68,020	26,087	7,106	9,500	135,728
DECEMBER	1,140	8,062	20,701	17,663	5,739	7,590	60,895
1974 JANUARY	682	5,043	563	3,379	5,263	7,620	22,556
FEBRUARY	0	11,696	24,176	15,516	11,210	8,333	70,931
MARCH	3,106	20,360	40,572	20,555	22,102	10,533	117,228
APRIL	0	61,506	56,402	24,089	27,112	10,403	179,512
MAY	2,111	59,401	48,696	5,297	22,828	11,090	149,423
TOTAL	9,427	195,869	274,365	118,705	102,775	73,427	774,568

TABLE 6

DEMAND OF CONSERVATION AREAS (ACRE-FT)

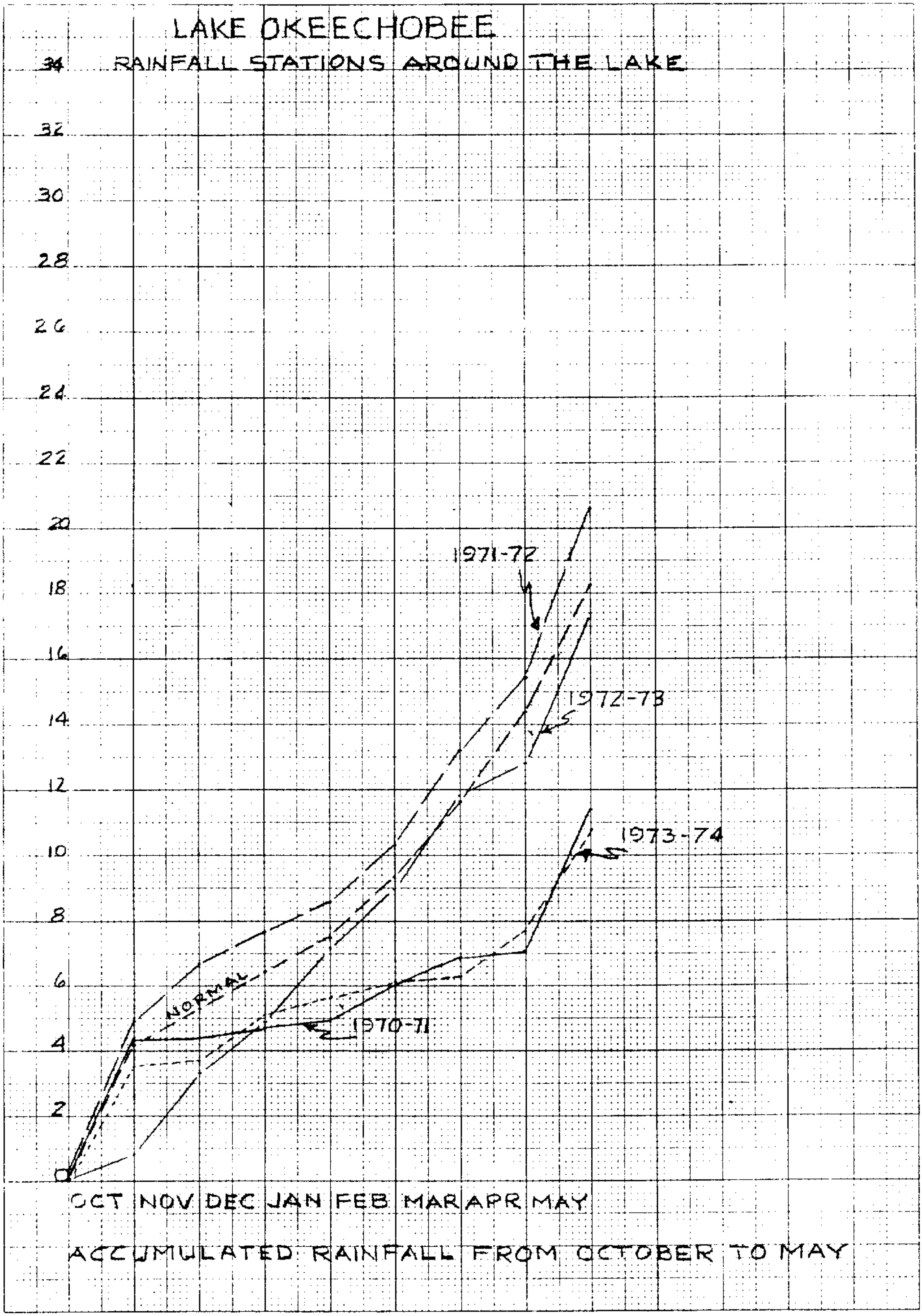
MONTH	CONSERVATION AREA 1			CONSERVATION AREA 2A				CONSERVATION AREA 3A			MONTHLY TOTAL
	S-39 & LWDD	SEEPAGE	SUB-TOTAL	S-34 & S-38	SEEPAGE	SUB-TOTAL	S-151	SEEPAGE	EVERG. NAT'L PARK	SUB-TOTAL	
1973 OCTOBER	760	19,218	19,978	0	11,067	11,067	0	42,427	64,100	106,527	137,572
NOVEMBER	800	18,371	19,171	0	10,710	10,710	0	35,107	49,500	84,607	114,488
DECEMBER	1,720	15,787	17,507	0	11,067	11,067	0	30,744	30,000	60,744	89,318
1974 JANUARY	350	19,584	19,934	0	9,838	9,838	0	27,669	21,830	49,499	79,271
FEBRUARY	4,510	16,742	21,252	3,640	6,664	10,304	0	22,770	12,350	35,120	66,676
MARCH	8,410	16,942	25,352	7,420	6,148	13,568	0	14,142	4,010	18,152	57,072
APRIL	8,920	14,685	23,605	20,170	7,735	27,905	30,140	9,520	2,800	42,460	93,970
MAY	5,740	10,487	16,227	12,450	7,378	19,828	25,960	7,378	2,400	35,738	71,793
TOTAL	31,210	131,816	163,026	43,680	70,607	114,287	56,100	189,757	186,990	432,847	710,160

TABLE 7

SELECTED INFLOW DATA - OCTOBER THROUGH MAY

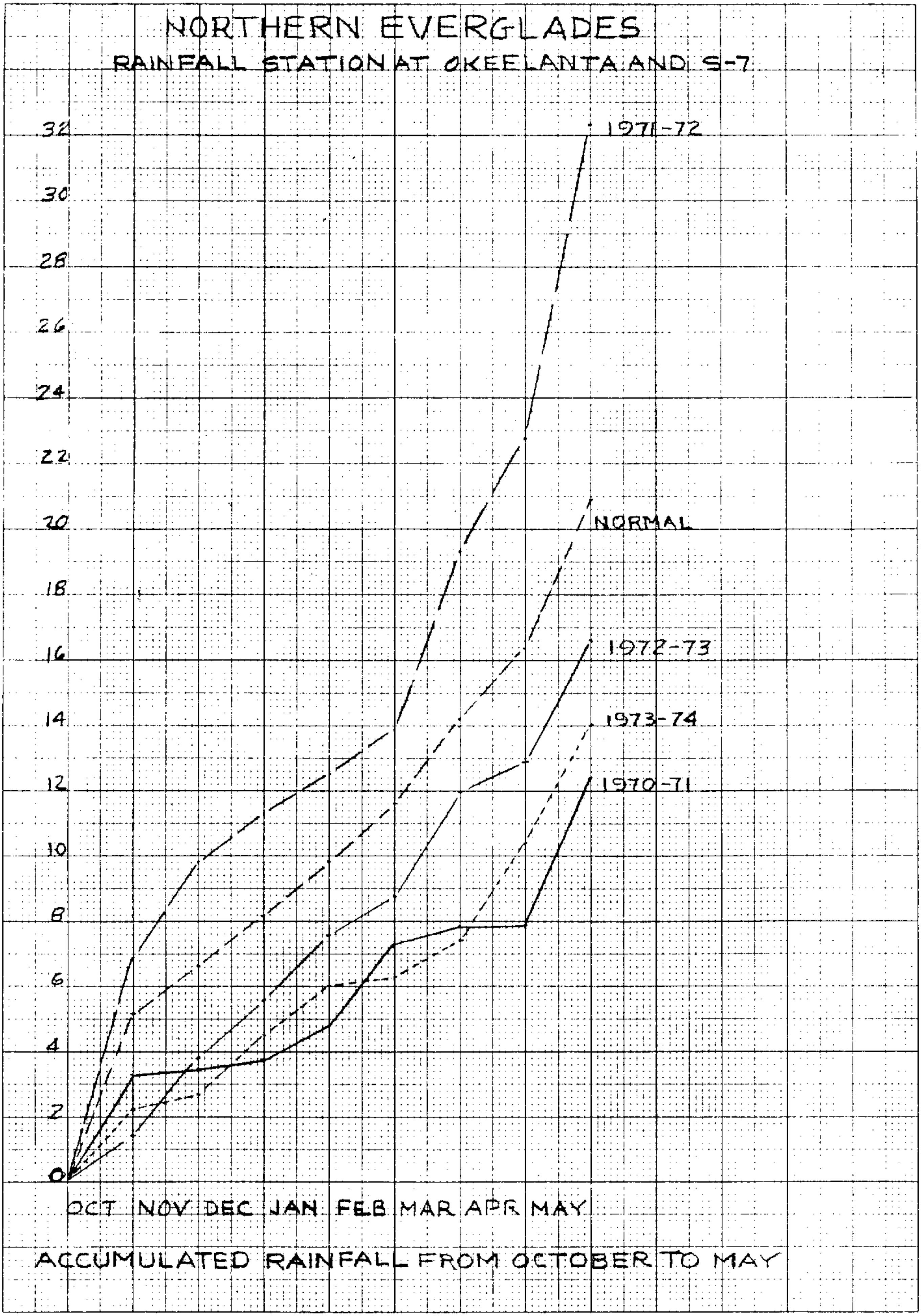
STATION	AVERAGE DISCHARGE OCT - MAY (ACRE-FT)	DISCHARGE OCT.'73 THRU MAY'74		
		TOTAL (ACRE-FT)	DEP. FROM NORMAL ACRE-FT	%
LAKE OKEECHOBEE				
Kissimmee River	771,570 (1964-70)	221,407	-550,163	-71.30
Taylor Creek	33,155 (1956-70)	* 40,000	+ 6,845	+20.64
Fisheating Creek	86,922 (1956-70)	23,397	- 63,525	-73.08
CONSERVATION AREA 1				
S-5A	130,460 (1958-70)	34,750	- 95,710	-73.36
S-6	81,744 (1960-70)	9,190	- 72,554	-88.76
CONSERVATION AREA 2A				
S-7	84,069 (1961-70)	36,660	- 47,409	-56.39
CONSERVATION AREA 3A				
S-8	105,676 (1962-70)	69,480	- 36,196	-34.25
S-9	50,101 (1958-70)	25,790	- 24,311	-48.52

*Now included in the discharge @ S-191 which also includes discharge from Mosquito Cr., Nubbins Slough and etc.



NO. 340-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH
EUGENE DIETZGEN CO.
MADE IN U.S.A.

FIGURE 1A



NORTHERN EVERGLADES
RAINFALL STATION AT OKEELANTA AND S-7
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1971-72
NORMAL
1972-73
1973-74
1970-71
OCT NOV DEC JAN FEB MAR APR MAY
ACCUMULATED RAINFALL FROM OCTOBER TO MAY

FIGURE 1B

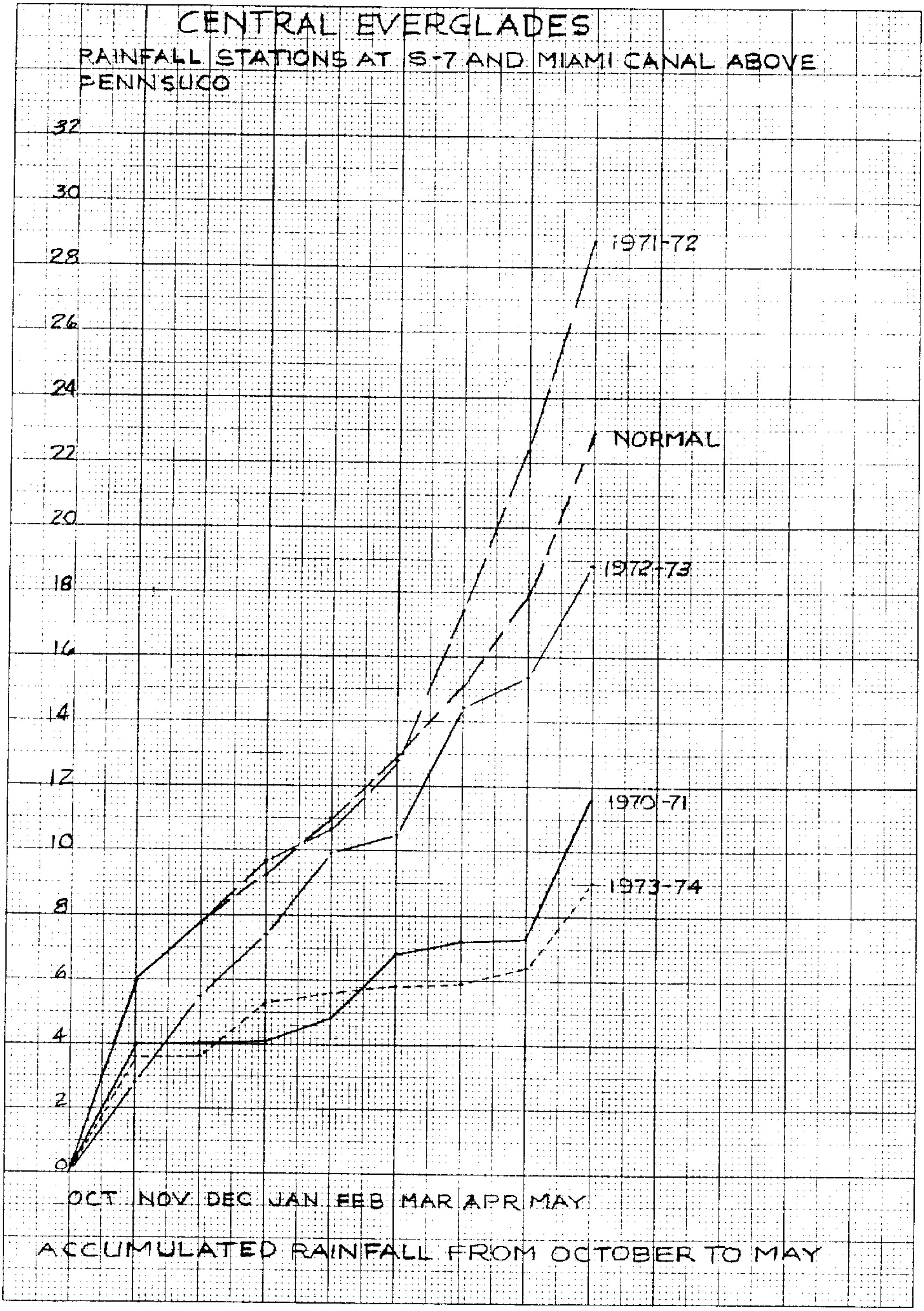

CENTRAL EVERGLADES
RAINFALL STATIONS AT S-7 AND MIAMI CANAL ABOVE PENNSUCO
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1971-72
NORMAL
1972-73
1970-71
1973-74
OCT NOV DEC JAN FEB MAR APR MAY
ACCUMULATED RAINFALL FROM OCTOBER TO MAY

FIGURE 1C

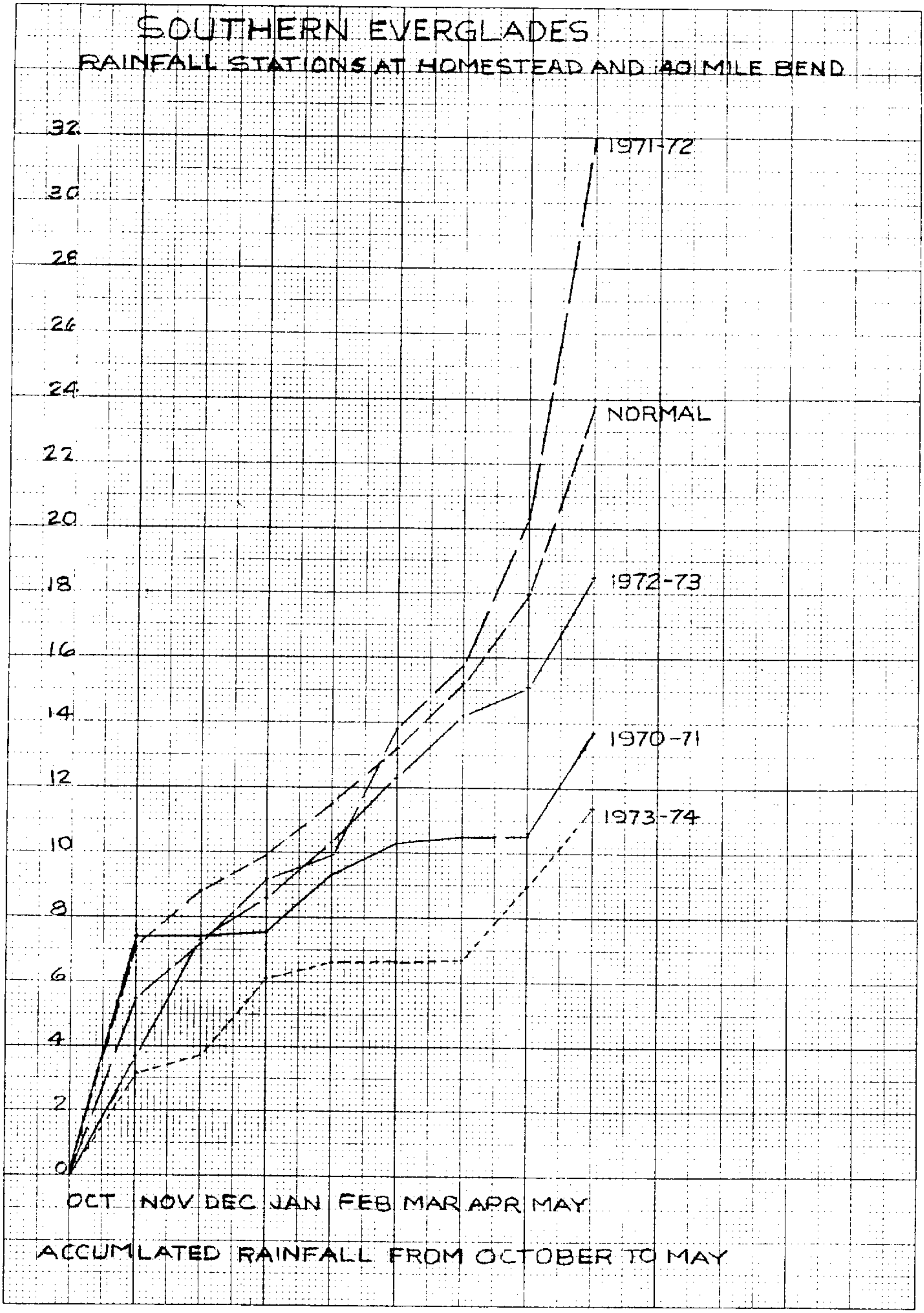


FIGURE 1D

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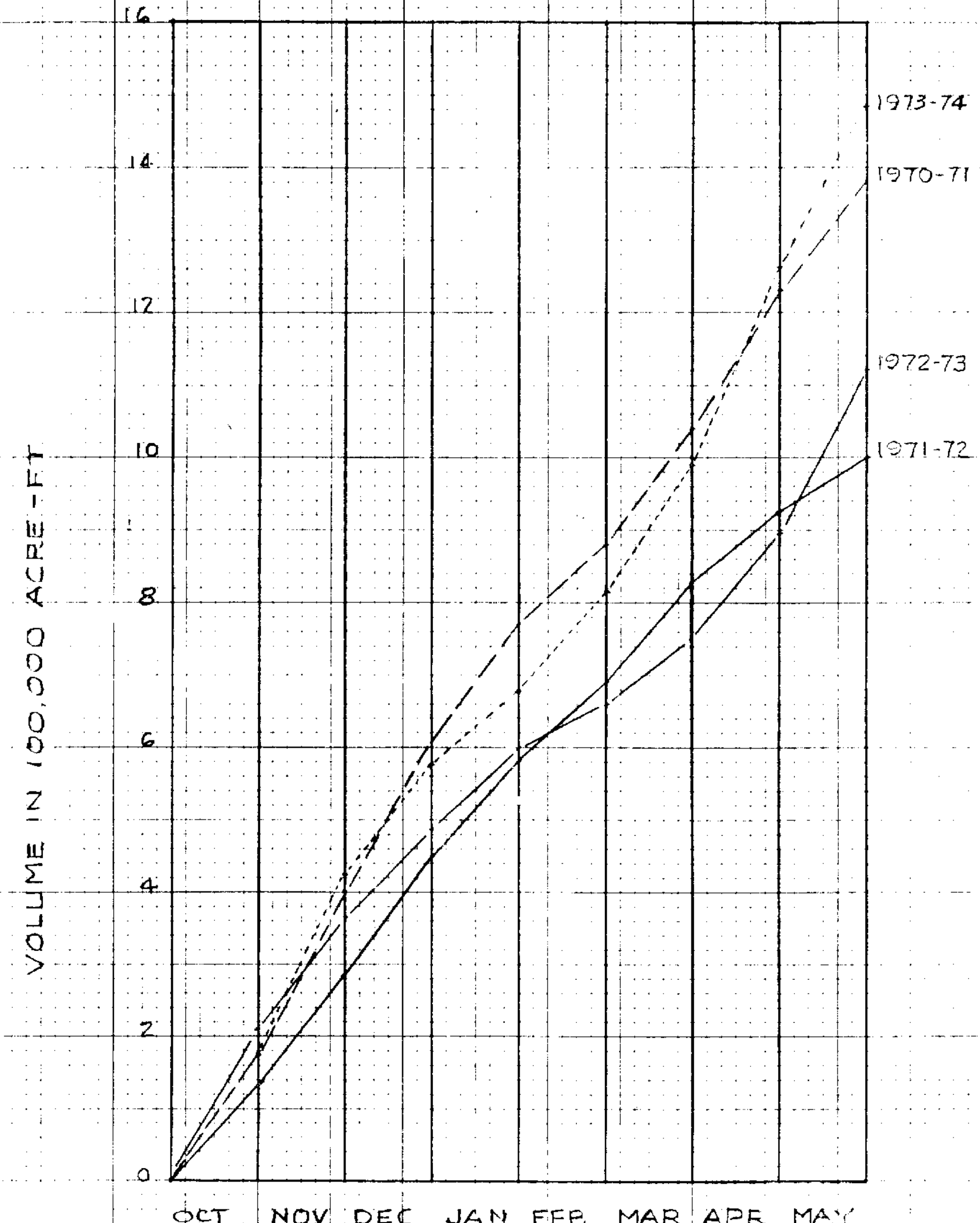
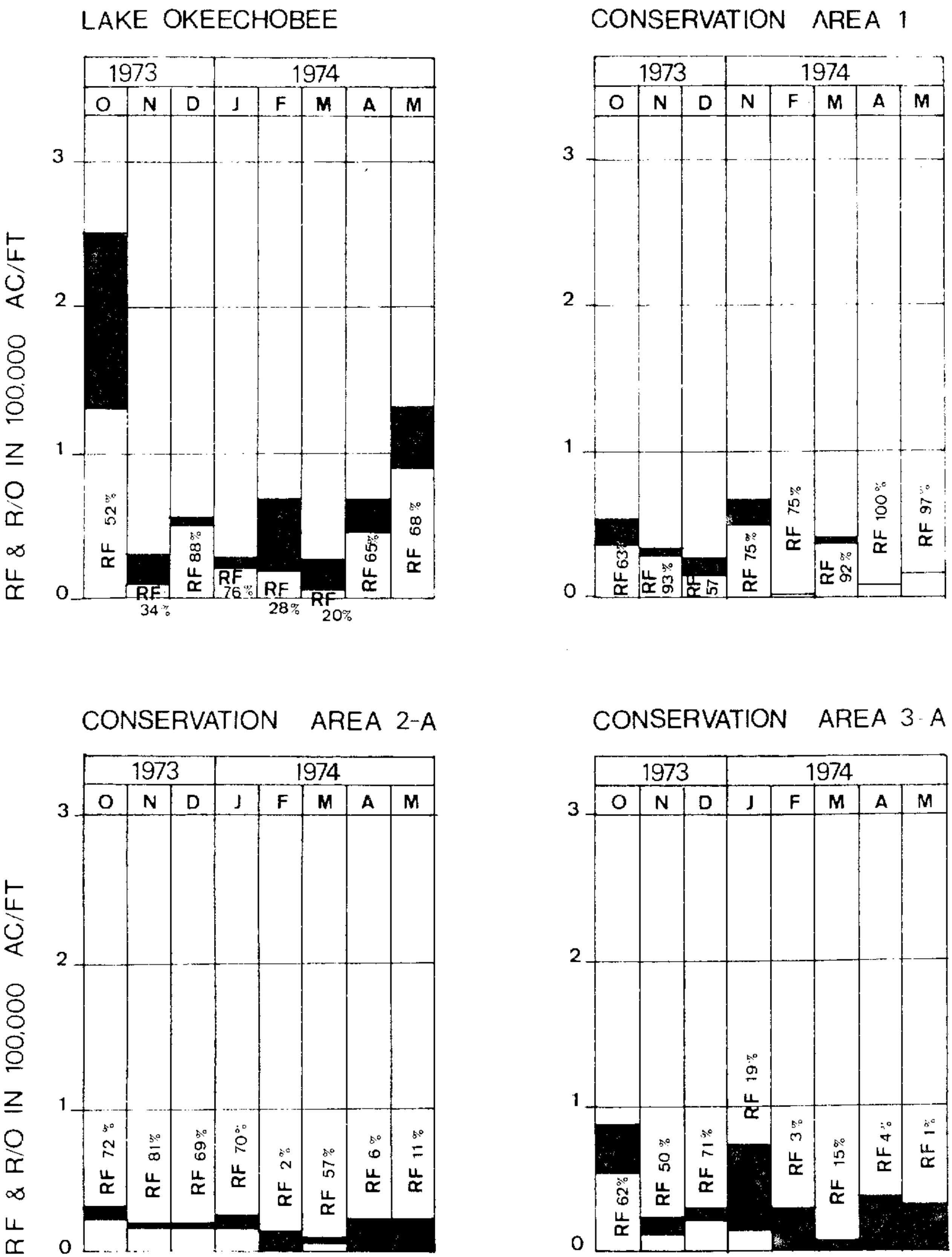


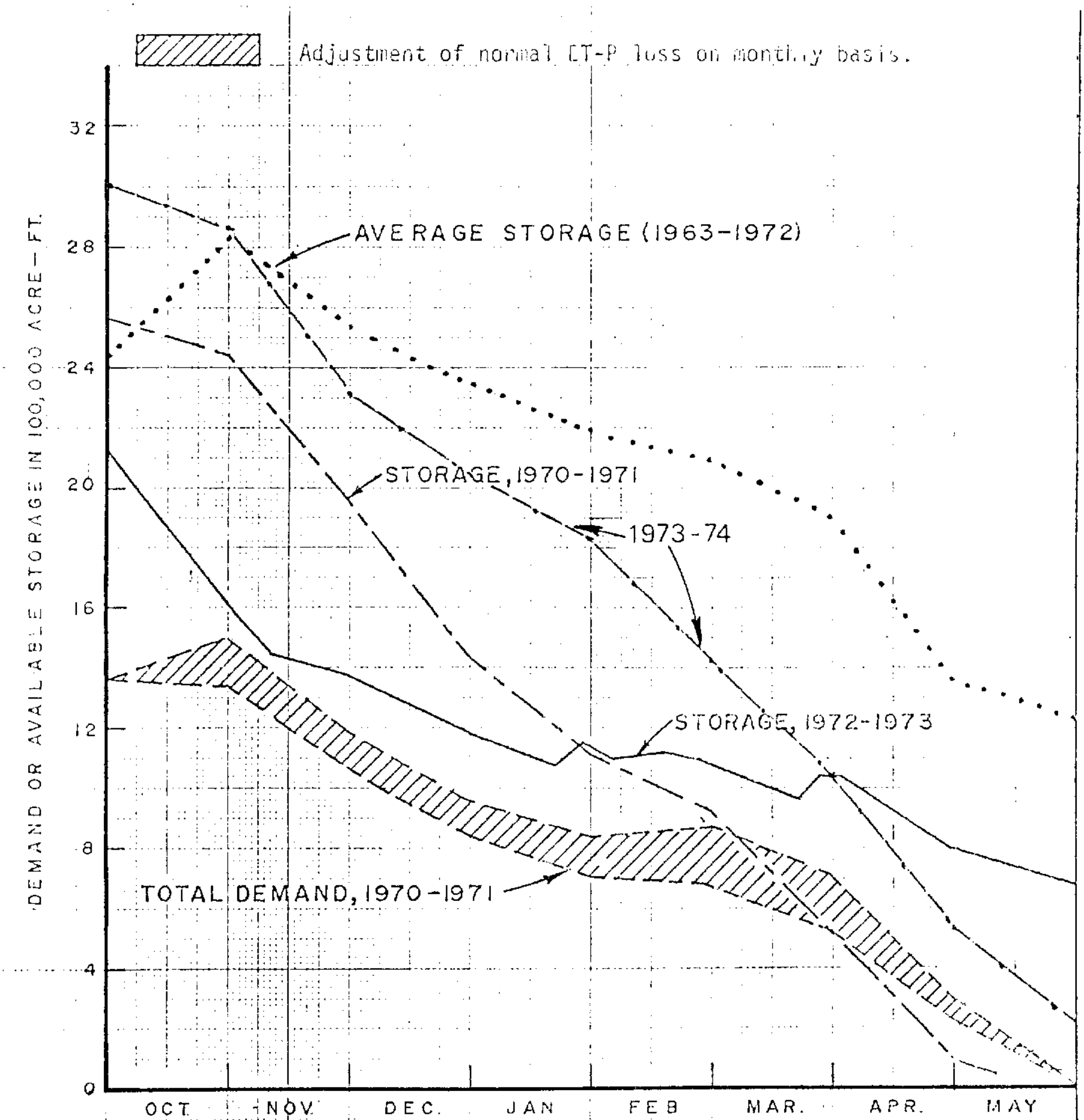
MASS CURVES OF WATER DELIVERY

FIGURE 2



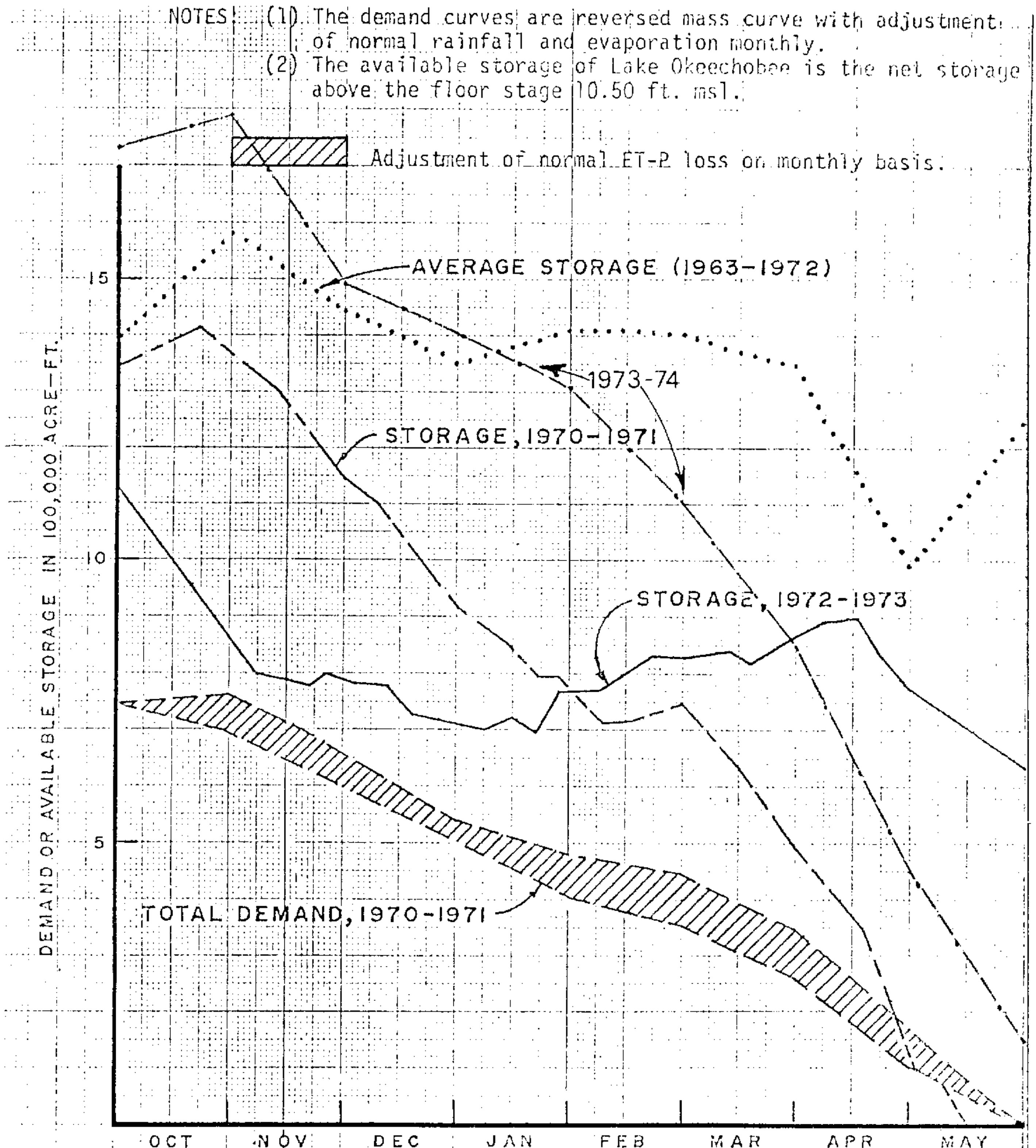
TOTAL INFLOW VOLUME FROM RAINFALL AND RUNOFF

FIGURE 3



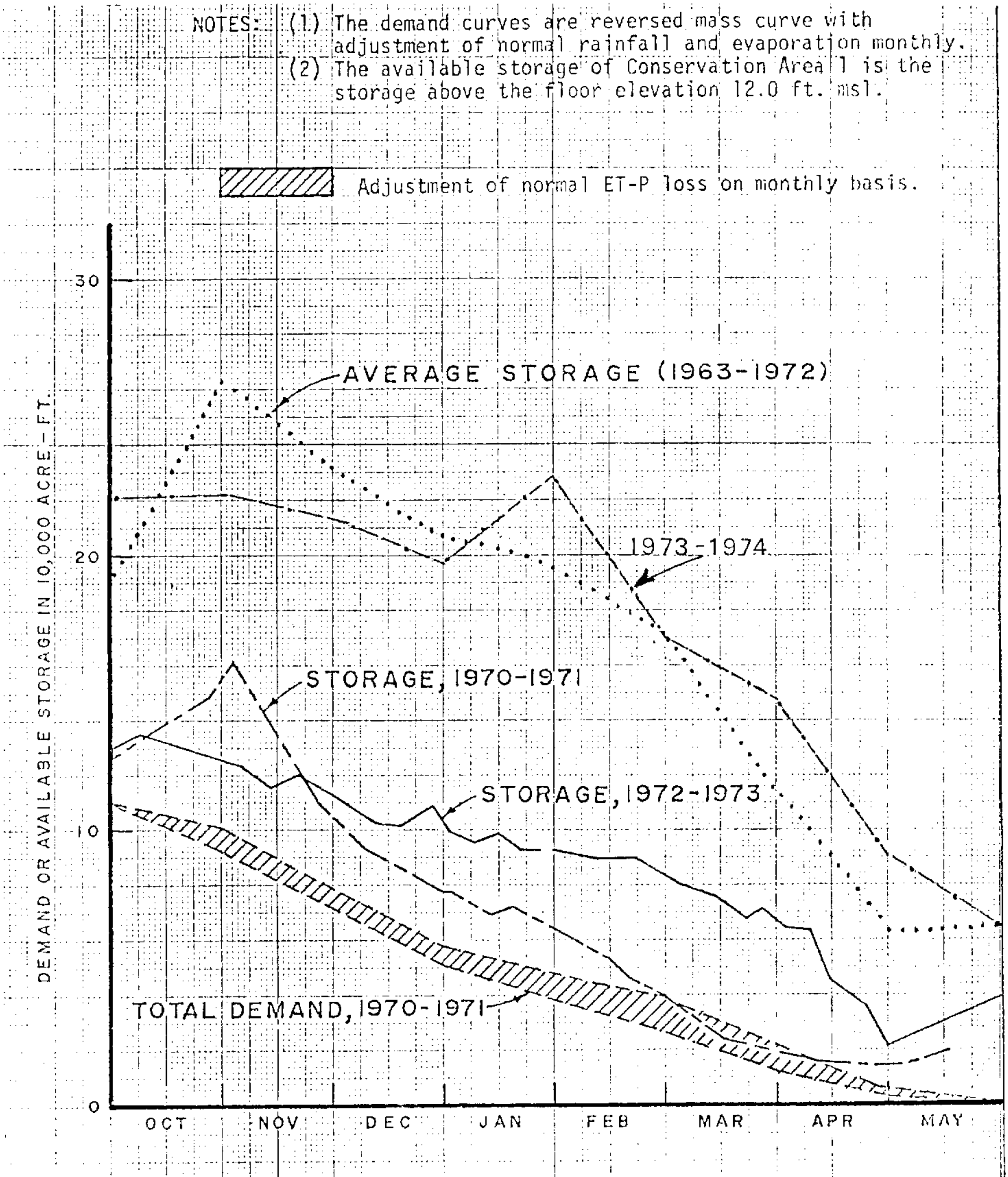
THE DISTRICT TOTAL STORAGE AND DEMAND CURVES

FIGURE 4



STORAGE AND DEMAND CURVES FOR LAKE OKEECHOBEE

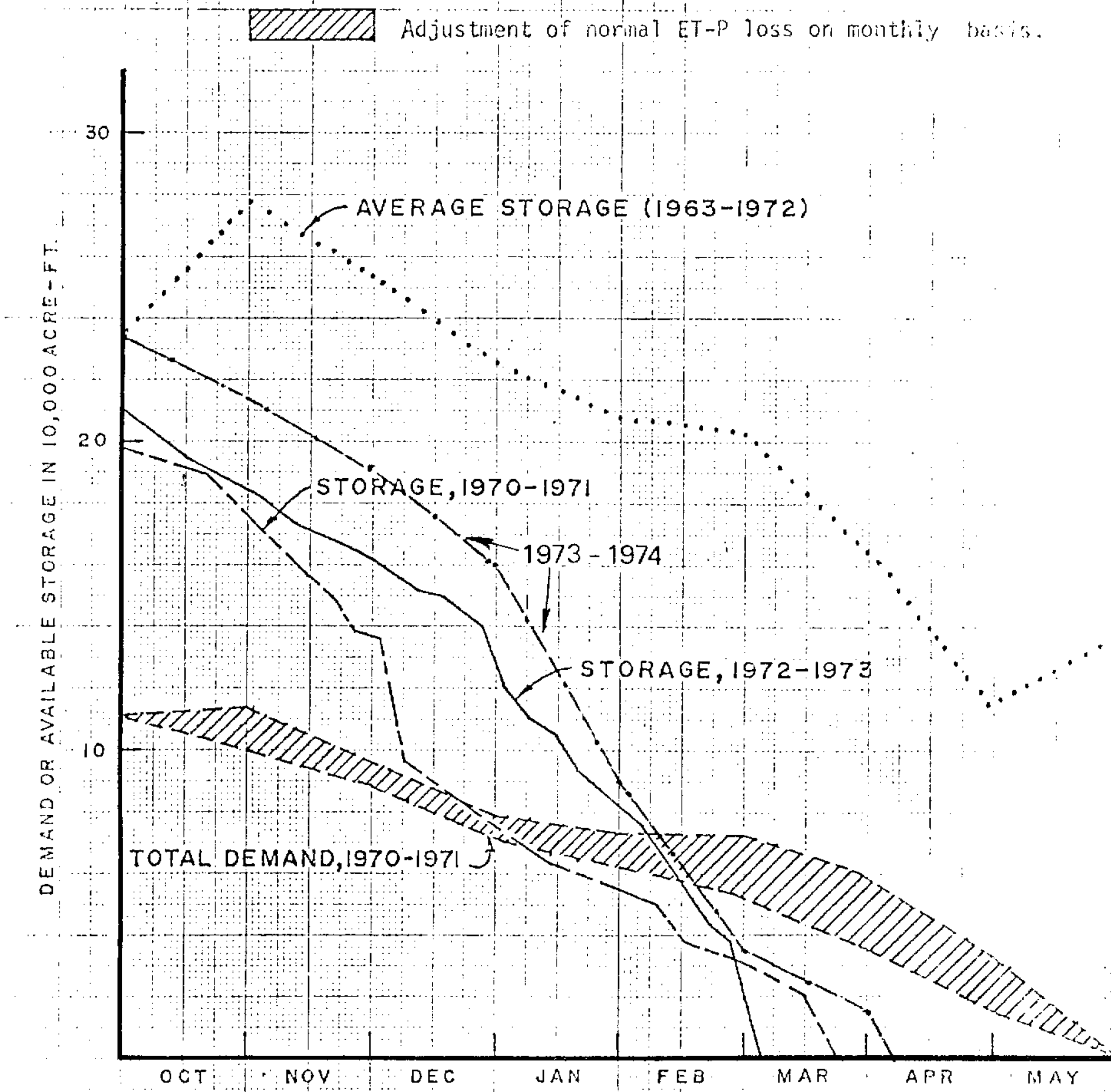
FIGURE 5



STORAGE AND DEMAND CURVES FOR CONSERVATION AREA I

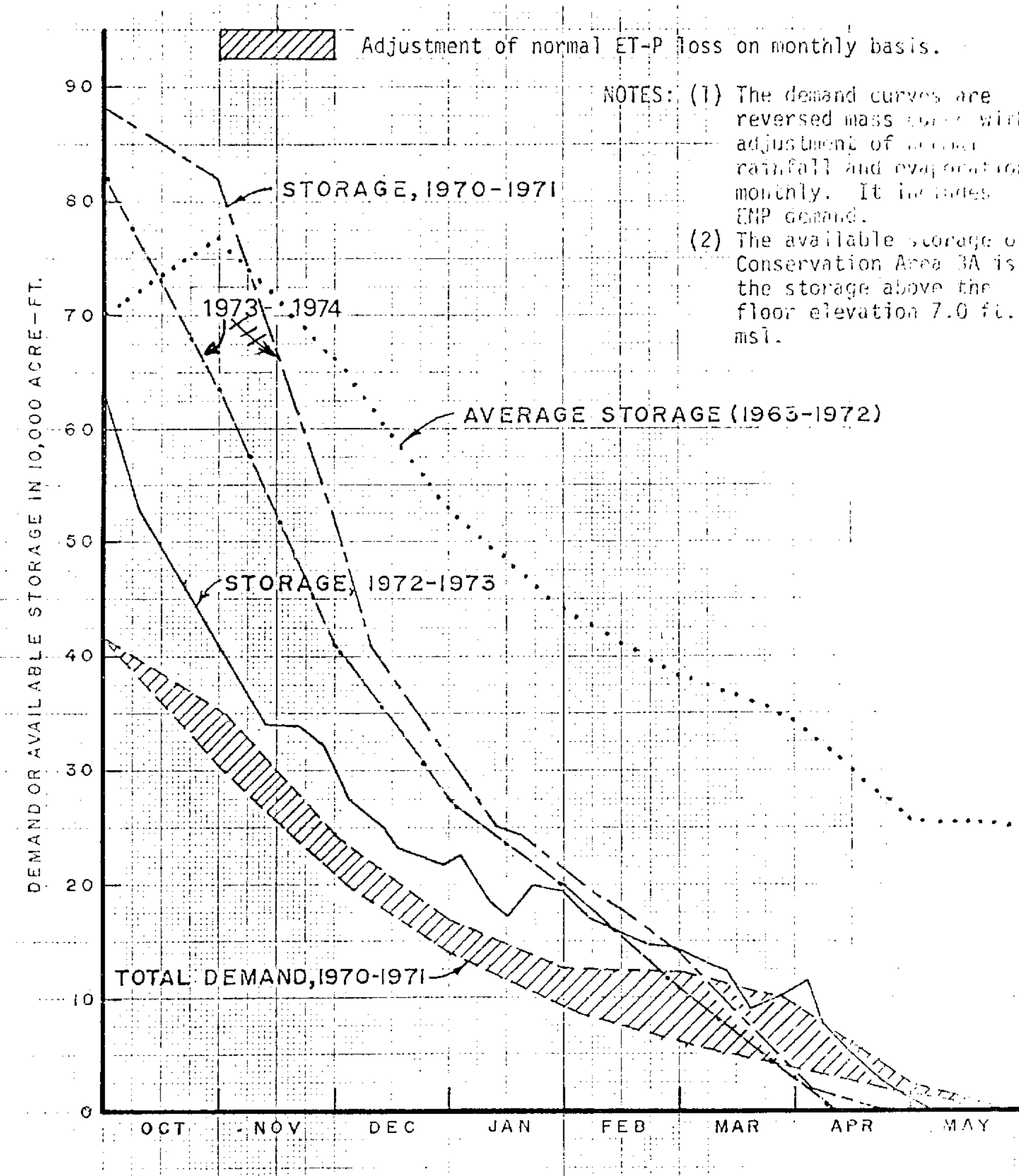
FIGURE 6

NOTES: (1) The demand curves are reversed mass curve with adjustment of normal rainfall and evaporation montaly.
(2) The available storage of Conservation Area 2A is the storage above the floor elevation 10.50 ft. msl.



STORAGE AND DEMAND CURVES FOR CONSERVATION AREA 2A

FIGURE 7



STORAGE AND DEMAND CURVES FOR CONSERVATION AREA 3A

FIGURE 8