DRAFT

MEMORANDUM

Date: March 1, 1972

TO: Director, Department of Engineering

FROM: N. N. Khanal

SUBJECT: Hydrologic Data for Phase II of the Economic Model Study

This memorandum will summarize the work done on analysis of the hydrologic variables for the second phase of the economic model study for the Kissimmee River Basin.

Basin Yield: - Basin yield was computed simply as the difference between the basin rainfall and the total loss from the basin (seepage, infiltration, evaporation and interception). In order to cover the whole drainage area of the Kissimmee River Basin fairly well by raingages, the following stations, listed in Table 1, were used. Ten years (1961-1970) of daily rainfall values from these stations were used in this study.

Table 1. Rainfall Stations and Station Names

Station	Station Name
1.	Avon Park
2.	Bithlo
3.	Cornwell
4.	Fort Drum
5.	Lake Hart
6.	Isleworth
7.	Indian Lake Estates
8.	Kissimmee II
9.	Lake Alfred
10.	Lake Placid
11.	Mountain Lake
12.	Nittaw
13.	Okeechobee H.G. #6
14.	Orlando W.B.

The daily rainfall values were summed-up to monthly values for each station. The simple average values from these fourteen stations were used as the basin rainfall values. The average monthly rainfall values are presented in Table 2.

Table 2. Average Monthly Rainfall Values for Kissimmee River Basin for each Month of the Year

	MONTH											
YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1961	2.01	2.12	2.42	1.58	2.99	5.65	3.97	7.24	3.08	1.73	0.73	0.62
1962	.90	1.32	2.59	1.47	2.76	9.40	6.32	8.03	6.54	.87	2.81	.74
1963	1.81	5.68	1.98	.79	5.32	4.98	3.91	4.72	6.07	.89	5.38	2.71
1964	3.93	3.85	2.75	2.34	3.61	4.08	7.45	9.54	7.65	1.83	.62	1.58
1965	1.22	3.97	3.22	1.83	.98	7.64	9.22	6.36	5.77	4.65	.99	2.27
1966	4.96	5.38	1.51	2.14	5.23	8.48	6.45	8.30	7.02	2.57	.41	.98
1967	.83	4.00	.81	.23	1.58	9.19	8.70	7.97	5.04	1.02	.28	2.35
1968	.65	1.98	1.48	.56	6.55	14.76	7.43	5.33	5.25	5.04	2.21	.41
1969	2.39	1.85	6.40	2.28	3.10	5.58	6.10	8.45	7.32	7.27	2.31	4.05
1970	3.61	3.18	5.29	.52	3.45	5.44	7.60	5.08	3.97	2.70	.41	.95
Mean	2.32	3.34	2.84	1.37	3.55	7.52	6.71	7.10	5.77	2.85	1.61	1.67
Std. Dev.	1.50	1.52	1.84	.76	1.72	3.07	1.75	1.67	1.44	2.14	1.60	1.16

The 55-year yearly average for the State of Florida is 52.77" (1), 52.80" is the 30-year yearly average for Kissimmee Station (2) and the 10-year yearly average (1961-1970) for the whole Kissimmee River Basin is 46.64".

(1) Tannehill, Iva Ray. 1956. Drought, Its Causes and Effects.

(2) Butson, K. D. and R. M. Prine. April 1968. Weekly Rainfall Frequencies in Florida. Agr. Exp. Station, Univ. of Florida, Gainesville.

A plot of the 55-year monthly average for Florida and the 10-year monthly average for the whole Kissimmee River Basin is shown in Figure 1. It can be seen that the 10-year monthly average follows the same trend as the 55-year monthly average trend for Florida.

Weighted average values for each rainfall station covering up to S-65 was also used to compute the basin runoff. The percentage weights of each of the rainfall stations up to S-65 is presented below in Table 2A.

Table 2A. Percentage weights of each of the rainfall stations up to S-65

Station Name	Percentage Weight
Lake Alfred	3.40
Lake Kissimmee	27.50
Isleworth	9.10
Orlando	4.90
Bithlo	0.40
Lake Hart	16.70
Indian Lake Estates	26.20
Mountain Lake	11.80
	100.00

Basin Rainfall = .034* Lake Alfred + .275* Lake Kissimmee + .091* Isleworth +.490* Orlando +.004* Bithlo + .167* Lake Hart + .262* Indian Lake Estates + .118* Mountain Lake (1)

The basin rainfall up to S-65, estimated by use of equation (1) is presented in Table 2B.

* A comparison of Table 2 and 2B shows that the mean monthly values from Table 2B are a bit lower than those from Table 2, which is expected. Table 2B will not be used to compute yield values, as the mean of the ten yearly values is much lower than the normal yearly mean.

FIG 1. AVERAGE BASIN RAINFALL FROM 9 STATIONS LOCATED ABOVE S-65, & 14 STATIONS LOCATED ABOVE LAKE OKEECHOBEE

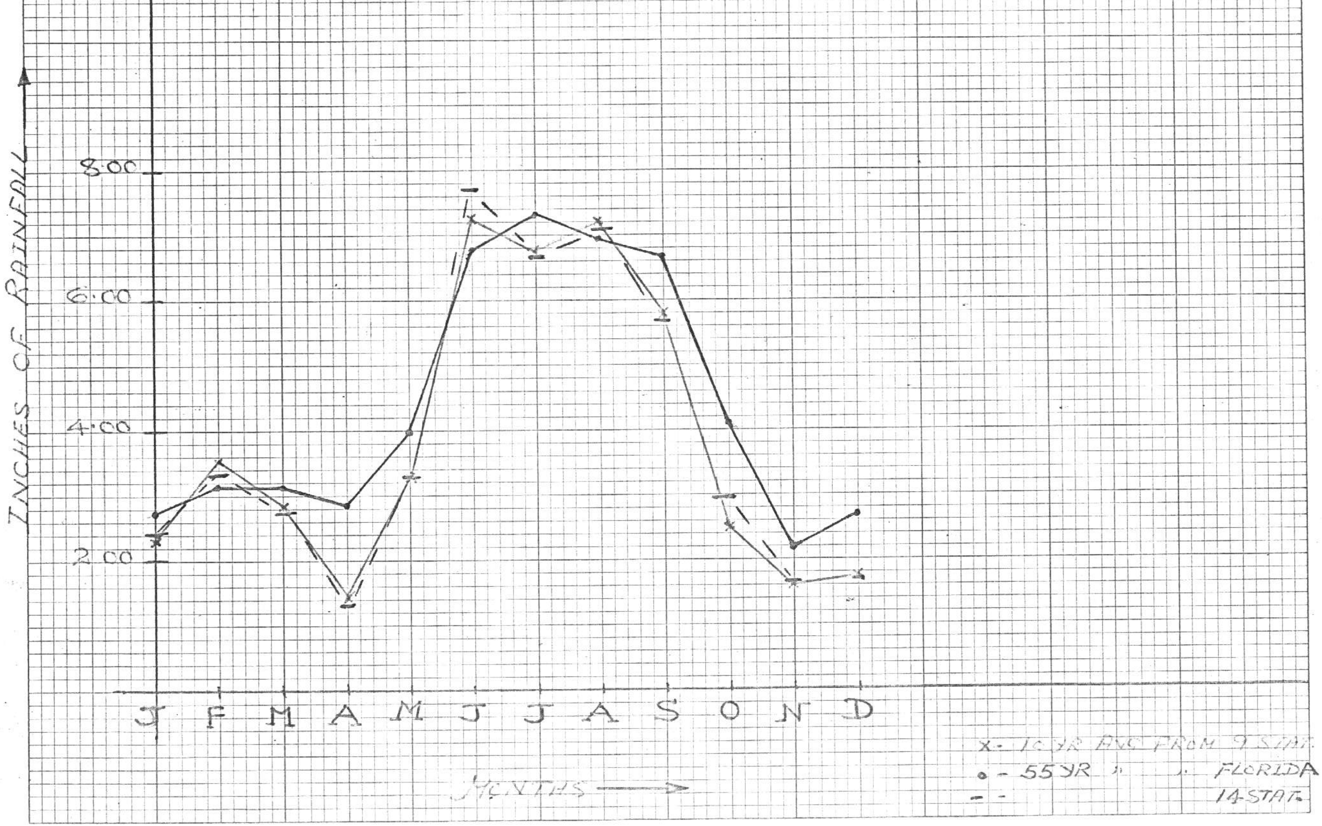


Table 2B. Weighted Average Monthly Rainfall Values up to S-65 for the Kissimmee River Basin

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1961	1.50	2.40	1.90	1.20	2.40	4.75	3.30	3.70	1.90	.85	.50	1.25
1962	.55	1.05	1.45	.70	3.90	4.55	6.85	6.10	6.55	1.00	2.75	1.00
1963	1.60	6.75	1.55	1.05	5.40	3.70	2.75	3.60	3.75	1.35	4.90	2.45
1964	4.20	3.00	3.10	2.80	3.30	2.40	9.50	12.90	9.60	1.25	.60	1.35
1965	1.60	4.10	2.80	1.55	1.50	8.55	9.45	6.65	5.75	4.30	1.15	2.45
1966	5.35	6.65	1.50	1.95	5.10	8.90	5.10	7.65	6.70	1.65	.15	1.35
1967	.80	4.10	.60	.10	.60	8.50	10.50	8.35	5.15	.60	.10	2.70
1968	.30	2.00	1.15	.30	4.05	12.90	6.35	3.90	4.65	3.45	2.00	.35
1969	2.90	1.90	6.10	2.40	2.65	4.95	6.20	9.15	9.72	7.30	2.30	4.40
1970	2.40	3.00	5.00	.60	3.90	4.90	7.55	4.45	3.10	2.40	.50	1.25
MEAN	2.12	3.49	2.51	1.26	3.28	6.41	6.75	6.64	5.69	2.41	1.49	1.85

In order to derive the basin yield (runoff) from basin rainfall, the Corps of Engineers monthly rainfall-total loss curve was used.* The curve for each month of the year is presented in Figures 2, 3 and 4. Functional equations, both logarithmic and linear in form, were fitted to the curve. The equations for logarithmic and linear fittings are presented in Tables 3 and 4.

Table 3. Monthly Total Loss Equation Fitted to Corps of Engineers Rainfall-Total Loss Curve. (Logarithmic Form).

Month	Monthly Loss $Y = a \cdot x^b$
January	$2.15 \times \text{R'fall}^{.226}$
February	$1.24 \times \text{R'fall}^{.612}$
March	$1.54 \times \text{R'fall}^{.529}$
April	$1.94 \times \text{R'fall}^{.510}$
May	$1.35 \times \text{R'fall}^{.728}$
June	$2.35 \times \text{R'fall}^{.487}$
July	$2.54 \times \text{R'fall}^{.425}$
August	$2.34 \times \text{R'fall}^{.476}$
September	$2.35 \times \text{R'fall}^{.417}$
October	$1.96 \times \text{R'fall}^{.466}$
November	$1.45 \times \text{R'fall}^{.588}$
December	$1.20 \times \text{R'fall}^{.691}$

*(see Pg. 6)

Table 4. Monthly Total Loss Equation Fitted to Corps of Engineers Rainfall-Total Loss Curve (Linear Form).

Month	Monthly Loss (Y = a+b x)
January	.927 + .429 x R'fall
February	1.132 + .455 x R'fall
March	1.220 + .504 x R'fall
April	1.720 + .457 x R'fall
May	1.530 + .530 x R'fall
June	2.220 + .520 x R'fall
July	2.600 + .470 x R'fall
August	1.890 + .580 x R'fall
September	2.460 + .370 x R'fall
October	1.970 + .360 x R'fall
November	1.110 + .470 x R'fall
December	.740 + .530 x R'fall

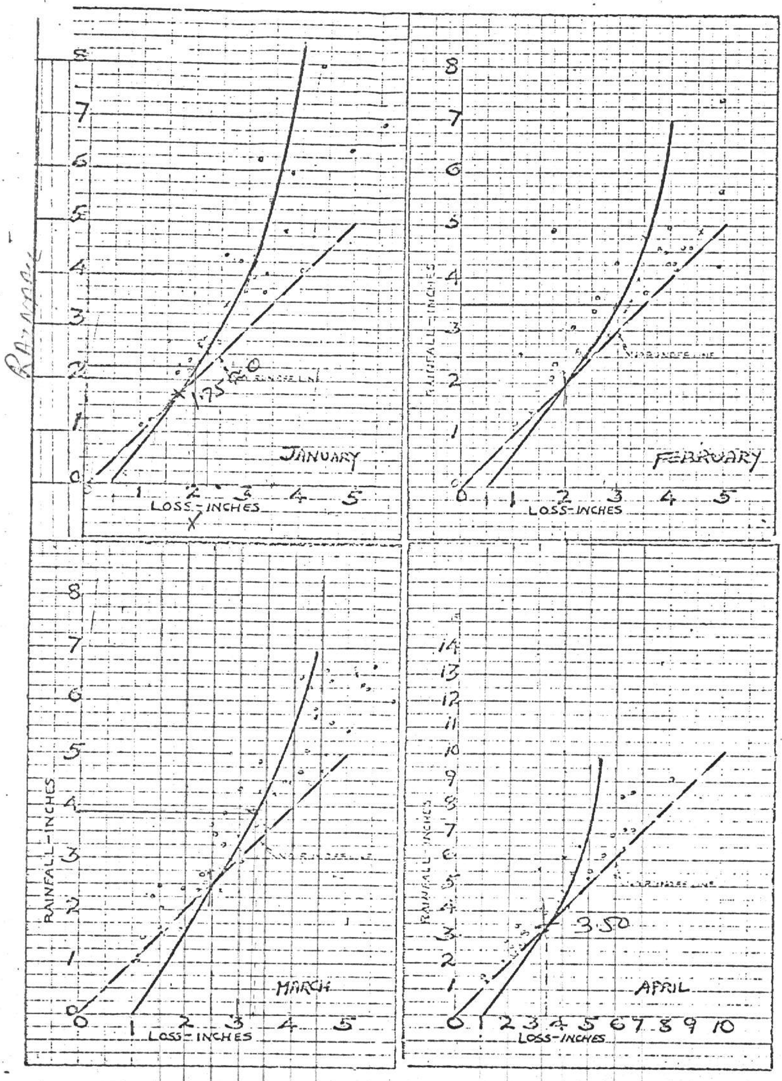
*(from page 5)
Desigm Memorandum, Part VI, Supp. 8, "General Studies and Reports, Rainfall Excess Evaluation."

The R square, δ, standard error and F test values for both fittings are presented in Table 5.

Table 5. Statistical Properties of the Logarithmic and Linear Equation Fitting for Corps of Engineers Rainfall - Total Loss Curve.

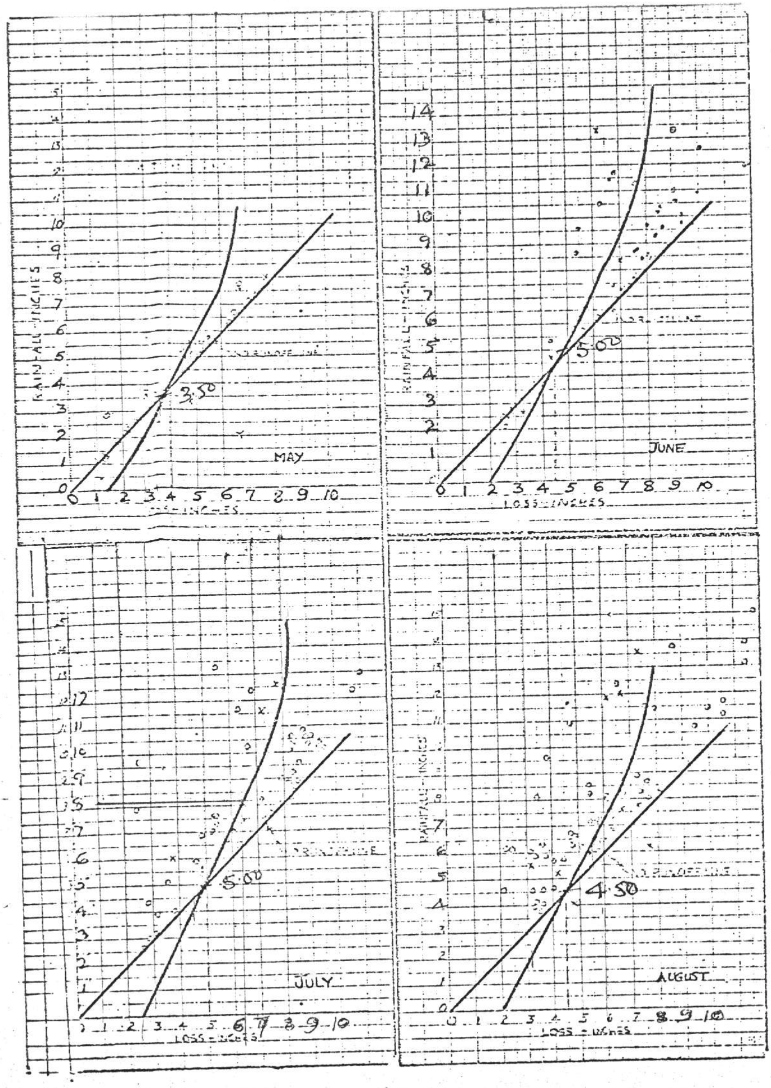
Months	R Square	δ	Std. Error	F(95%)	R Square	δ	Std. Error	F(95%)
January	.882	.248	.031	52.64	.940	.300	.038	122.48
February	.983	.059	.035	296.08	.930	.280	.054	69.94
March	.998	.015	.010	2634.01	.990	.090	.023	473.14
April	.988	.042	.021	584.53	.960	.270	.035	169.43
May	.923	.162	.073	97.24	.920	.490	.054	96.16
June	.987	.043	.018	693.58	.990	.160	.015	1060.75
July	.969	.060	.023	314.88	.990	.110	.009	2289.33
August	.972	.061	.061	209.30	.990	.060	.010	3271.13
September	.986	0.38	.015	749.26	.960	.280	.023	252.62
October	.992	.032	.012	1302.33	.960	.240	.020	317.53
November	.992	.037	.037	699.80	.960	.210	.040	139.29
December	.991	.047	.047	463.43	.960	.200	.047	127.30

Both the equations were used to generate basin yield on a monthly basis. The monthly basin yield values generated by use of the logarithmic and linear equations are presented in Tables 6 and 7.



TOTAL LOSS

FIG 2. Total Rainfall- Loss



RAINFALL INCHES
MAY
3.50
LOSS INCHES
JUNE
5.00
JULY
5.00
LOSS INCHES
AUGUST
4.50
LOSS INCHES

Fig 3.

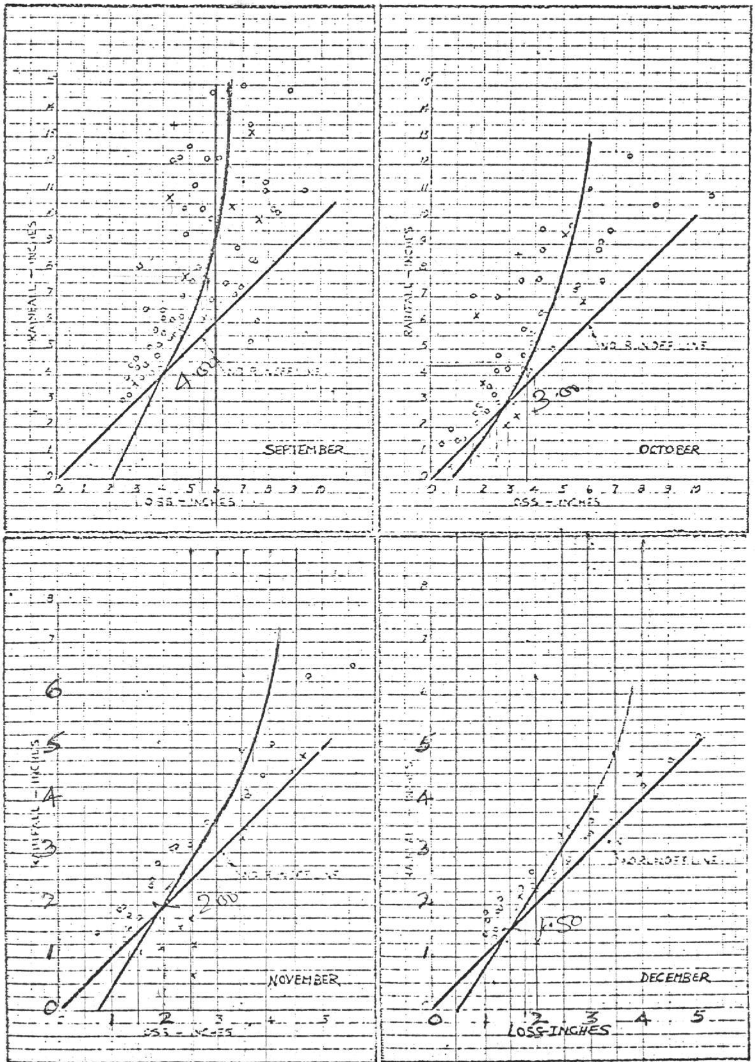

SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
RAINFALL — INCHES
LOSS — INCHES
NO RUNOFF LINE
4.00
3.00
2.00
1.50

Fig 4.

Table 6. Monthly Yield Values for Kissimmee River Basin by Use of the Logarithmic Loss Equation $Y = ax^b$ (D.A. 1,600 sq. miles, or 1,024,000 Acre Feet).

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1961	0	13	0	0	0	15	0	104	0	0	0	0	132
1962	0	0	3	0	0	208	64	146	119	0	12	0	551
1963	0	183	0	0	65	0	0	0	92	0	126	27	493
1964	85	87	8	0	14	0	130	180	200	0	0	0	704
1965	0	92	30	0	0	112	229	61	75	54	0	13	666
1966	159	162	0	0	62	155	71	158	147	0	0	0	914
1967	0	94	0	0	0	193	198	143	36	0	0	15	679
1968	0	8	0	0	106	515	125	8	47	74	0	0	883
1969	0	3	195	0	2	12	53	168	164	198	0	76	871
1970	62	56	134	0	10	6	135	0	0	0	0	0	403
MEAN	30.6	69.8	37.0	0	25.9	121.6	100.5	96.8	88.0	32.6	13.8	13.1	
Std. Dev.	54.8	66.0	69.3	0	37.8	160.3	76.2	82.8	64.7	64.1	39.3	23.9	

Table 7. Monthly Yield Values for Kissimmee River Basin by Use of the Linear Loss Equation $Y = a+b\cdot x$

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1961	84	2	0	0	0	43	0	97	0	0	0	0	226
1962	0	0	5	0	0	205	61	126	141	0	30	0	568
1963	9	172	0	0	79	16	0	7	116	0	145	43	587
1964	112	82	10	0	11	0	115	182	200	0	0	0	712
1965	0	88	32	0	0	125	191	66	100	85	0	25	712
1966	162	153	0	0	75	159	67	134	167	0	0	0	917
1967	0	89	0	0	0	188	167	124	61	0	0	29	658
1968	0	0	0	0	127	416	110	27	72	106	4	0	862
1969	37	0	166	0	0	40	51	140	183	227	8	59	911
1970	96	51	119	0	5	35	118	20	3	0	0	0	447
MEAN	50.0	63.7	33.2	0	29.7	122.7	88.0	91.3	105.1	41.8	18.7	15.6	
Std. Dev.	59.7	64.4	59.5	0	46.3	125.8	63.4	60.1	69.5	76.4	45.3	22.1	

The LP model is designed to accept the yield values on a seasonal basis. The year is divided into four seasons, or periods; season, or period 1, being the months of June, July, August and September. Period 2 is October and November. Period 3 is December and January. Period 4 is February, March, April and May. The yield into the Kissimmee River Basin for these four periods for each year is presented in Table 8.

Table 8. Seasonal Yield into the Kissimmee River Basin From Logarithmic Fitting

YEAR	June, July August & September PERIOD 1	October, November PERIOD 2	December January PERIOD 3	February, March April & May PERIOD 4
	Yield (1000 Ac. Ft.)			
1961	119	0	0	13
1962	537	12	0	3
1963	92	126	27	248
1964	510	0	85	109
1965	477	54	13	122
1966	531	0	159	224
1967	570	0	15	94
1968	695	74	0	114
1969	397	198	76	200
1970	141	0	62	200
MEAN	406.9	46.4	43.7	132.7
Std. Dev.	212.59	68.38	51.80	84.56

Table 9. Seasonal Yield into the Kissimmee River Basin from Linear Fitting

YEAR	June, July August & September PERIOD 1	October November PERIOD 2	December January PERIOD 3	February, March April & May PERIOD 4
	Yield (1000 Ac. Ft.)			
1961	140	0	0	2
1962	533	30	0	5
1963	139	145	52	251
1964	495	0	112	103
1965	482	85	25	120
1966	527	0	162	228
1967	540	0	29	89
1968	625	110	0	127
1969	474	235	96	166
1970	176	0	96	175
MEAN	413.1	60.5	57.2	126.6
Std. Dev.	181.4	81.5	56.4	82.9

The difference in the mean yield values arrived at from both logarithmic and linear equations is very close, the difference being about 18,000 acre feet. Therefore, it can be concluded that either one of the seasonal yield values can be used in the L. P. Model.

Storage Computations:

A list of the lakes which are within the Kissimmee River Basin is presented below. They are:

Lake Kissimmee
Lake Hatchineha
Cypress Lake
Lake Tohopekaliga
East Lake Tohopekaliga
Lake Hart
Lake Mary Jane
Lake Myrtle
Lake Alligator
Lake Gentry
Lake Marian
Lake Jackson
Lake Tiger
Lake Rosalie
Lake Marion
Lake Weohyakapka

The U. S. G. S. publishes the daily stages for these lakes. Ten years (1961 - 1970) of end-of-month stages were used for the storage computation. Lagendre Polynomial equations for storage, as a function of stage, were fitted for each of the lakes listed above. The equations developed for each of the lakes are presented in Table 10 below.

Table 10. Lagendre Polynomial Equation Fitted for Each Storage as a Function of Stage.

Lakes	Functional Equation
Kissimmee	$Stor = 725.24 - 6078.5 \times Stage + 19038.0 \times Stage^2 - 26472 \times Stage^3 + 13855.0 \times Stage^4$.
Hatchineha	$Stor = -674.0 + 5799.2 \times Stage - 18633.0 \times Stage^2 - 26495.0 \times Stage^3 - 14059 \times Stage^4$.
Cypress	$Stor = 1266.0 - 10945.0 \times Stage + 35439.0 \times Stage^2 - 50903.0 \times Stage^3 + 27417 \times Stage^4$.
Tohopekaliga	$Stor = -699.22 + 5240.4 \times Stage - 14702.0 \times Stage^2 + 18258.0 \times Stage^3 - 8437.2 \times Stage^4$.

East Tohopekaliga	$Stor = 266.67 + 1817.55 \times Stage - 4660.0 \times Stage^2 + 5293.5 \times Stage^3 - 2230 \times Stage^4$.
Hart	$Stor = 4.79 + 39.76 \times Stage - 121.48 \times Stage^2 + 160.97 \times Stage^3 - 77.20 \times Stage^4$.
Mary Jane	$Stor = 51.81 - 373.95 \times Stage + 1011.9 \times Stage^2 - 1218.3 \times Stage^3 + 551.66 \times Stage^4$.
Myrtle	$Stor = 21.84 - 152.10 \times Stage + 397.80 \times Stage^2 - 463.81 \times Stage^3 + 203.85 \times Stage^4$.
Alligator	$Stor = 5.94 - 51.50 \times Stage + 167.26 \times Stage^2 - 242.7 \times Stage^3 + 134.10 \times Stage^4$.
Gentry	$Stor = -90.13 + 532.02 \times Stage - 1144.5 \times Stage^2 + 1048.8 \times Stage^3 - 335.33 \times Stage^4$.
Tiger	$Stor = 39.54 - 318.4 \times Stage + 957.0 \times Stage^2 - 1278.2 \times Stage^3 + 645.2\ Stage^4$.
Rosalie	$Stor = -2.4 + 10.3 \times Stage - 7.3 \times Stage^2 - 24.1 \times Stage^3 + 39.26 \times Stage^4$.
Marion	$Stor = -293.91 \times 1708.8 \times Stage - 3716.0 \times Stage^2 + 3577.6 \times Stage^3 - 1283.3 \times Stage^4$.
Weohyakapka	$Stor = 324.15 - 2191.0 \times Stage + 5531.8 \times Stage^2 - 6195.0 \times Stage^3 + 2606.0 \times Stage^4$.
Marian	$Stor = 383.37 - 2763.2 \times Stage + 7452.0 \times Stage^2 - 8918.0 \times Stage^3 + 4002.7 \times Stage^4$.
Jackson	$Stor = -412.72 + 2095.7 \times Stage - 8080.7 \times Stage^2 + 9692.5 \times Stage^3 - 4344.5 \times Stage^4$.
Istokpoga	$Stor = -623560.0 + 89302 \times Stage - 5297.1 \times Stage^2 + 166.54 \times Stage^3 - 2.93 \times Stage^4 + .03 \times Stage^5 - 0001.0 \times Stage^6$.

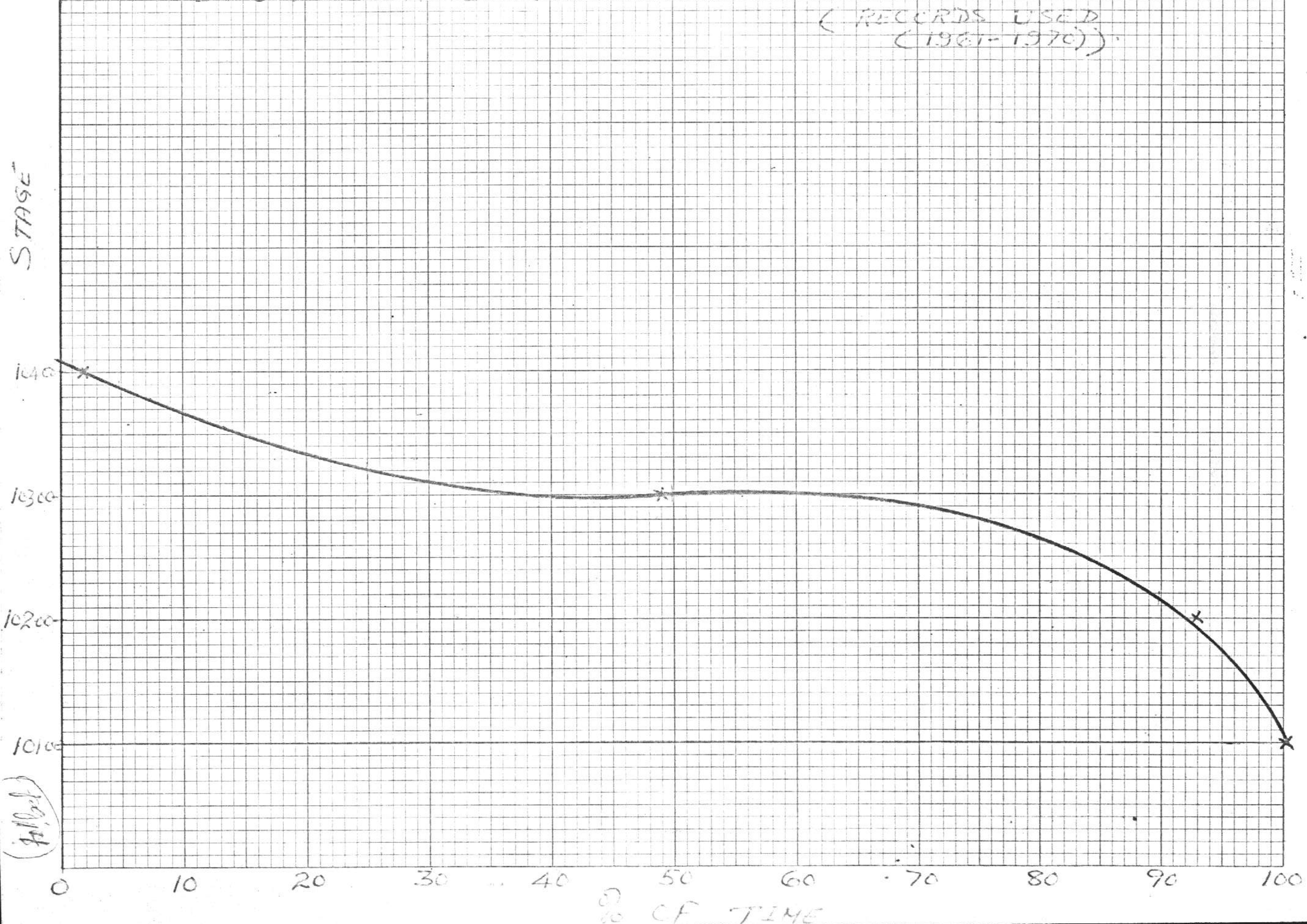
Where

Stage = original stage/100.0 in feet

Stor = computed storage

Actual Stor = computed storage x 100,000 Ac. Ft.

Fig. 5 LAKE JACKSON



Total Basin Storage

Total basin storage for the entire Kissimmee Basin was estimated by combining the storage of each individual lake at different frequency levels. Stage - frequency curves prepared by the District were utilized for the computation.

Table II. Lake Stages at Difference Frequency Levels

	Frequency % of Time					
Lakes	1	5	10	25	50	90
Kissimmee	55.6	54.2	53.2	51.8	50.4	47.1
Hatchineha	56.4	55.0	53.9	52.4	53.3	48.7
Cypress	56.8	55.5	54.6	53.9	52.5	50.0
Tohopekaliga	58.0	56.4	55.8	54.8	53.4	50.8
East Tohopekaliga	60.8	59.8	58.8	57.4	55.9	53.8
Hart	63.8	62.0	61.1	60.1	59.2	57.9
Mary Jane	63.8	62.0	61.1	60.4	60.0	59.0
Myrtle	63.3	62.4	61.9	61.0	60.3	59.1
Alligator	66.0	65.3	65.0	64.3	63.3	61.4
Gentry	62.0	61.2	60.9	59.7	58.7	57.0
Marion	67.6	67.0	66.8	66.4	66.1	65.5
Marian	61.0	60.5	60.3	59.8	59.5	59.2
Jackson	104.0	103.9	103.7	103.2	103.0	102.2
Rosalie	55.9	54.9	54.8	54.3	53.2	52.0
Tiger*						
Weohyakapka	62.8	62.4	62.2	61.9	61.5	60.2
Istokpoga	41.8	40.8	40.0	39.0	38.4	37.0

*No stage record available for Lake Tiger; therefore, it was combined with Kissimmee lake stages.

The stages listed in Table 11 were converted to storages by use of the polynomial equation and are presented in Table 12.

Table 12. Lake Storage at Different Frequency Levels

	Frequency %					
Lakes	1	5	10	25	50	90
Kissimmee, Hatchineha, Cypress, Tiger	700	560	484	400	328	184
Tohopekaliga	222	182	160	130	108	65
East Tohopekaliga	172	154	140	123	104	80
Hart	7	7	7	7	7	7
Mary Jane	13	10	7	6	6	6
Myrtle	4	3	3	3	2	2
Alligator	47	40	38	35	32	25
Gentry	17	15	15	14	12	9
Marion	27	26	24	23	23	21
Marian	65	64	63	62	60	48
Jackson	8	7	6	5	4	4
Rosalie	66	58	58	56	47	45
Weohyakapka	73	70	68	67	64	52
Istokpoga	250	217	185	155	149	100
Total	1,676	1,413	1,258	1,186	946	648

Individual storage - duration curves for Kissimmee, Hatchineha and Cypress combined, Lake Tohopekaliga, East Tohopekaliga, Istokpoga and Weohyakapka were drawn and are presented in Figure 6. The total storage-duration curve for the whole Kissimmee Basin was also drawn and is presented in Figure 7.

FIG. 6 IND. LAKE STORAGE AT DIFF. FREQ LEVELS

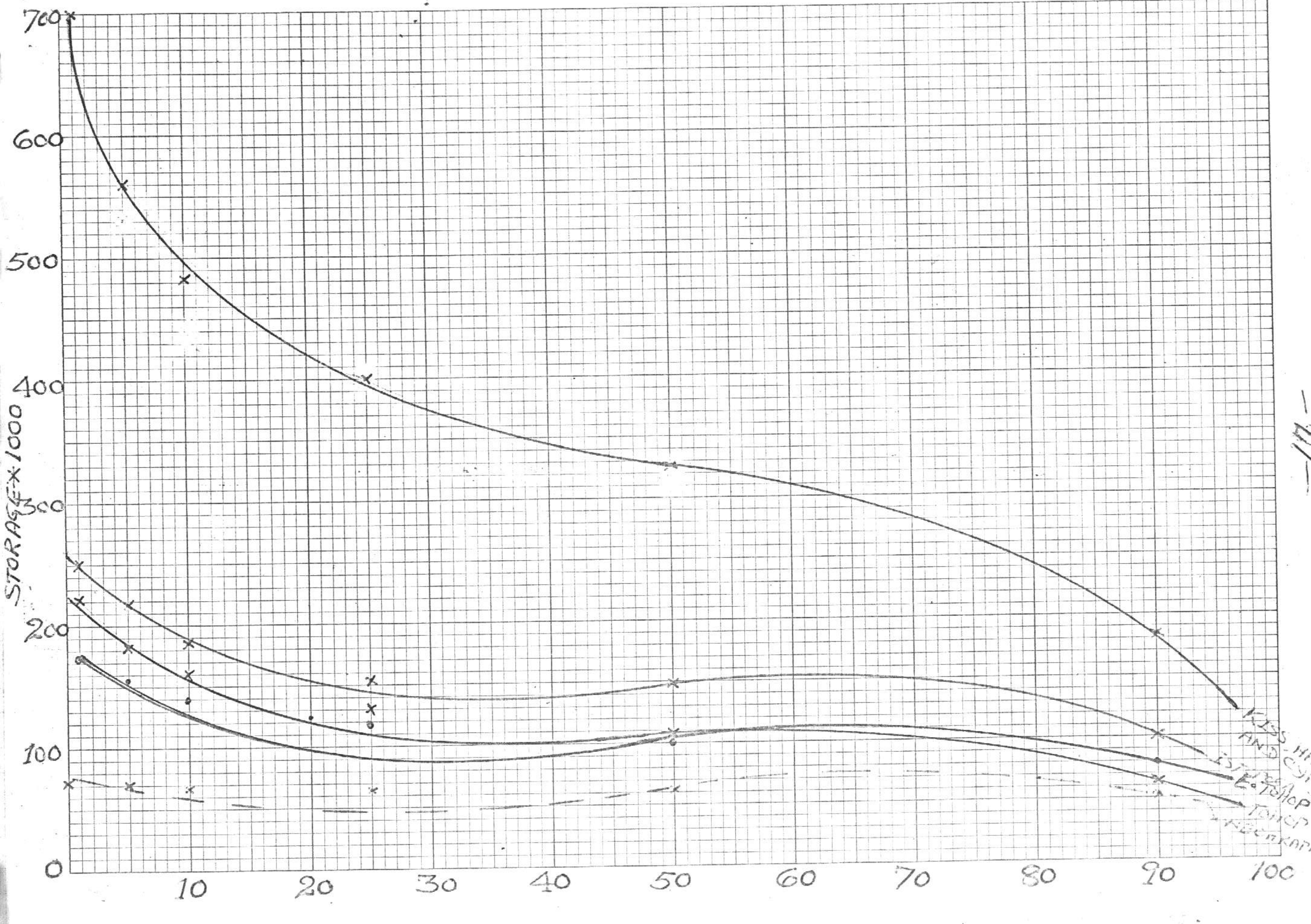
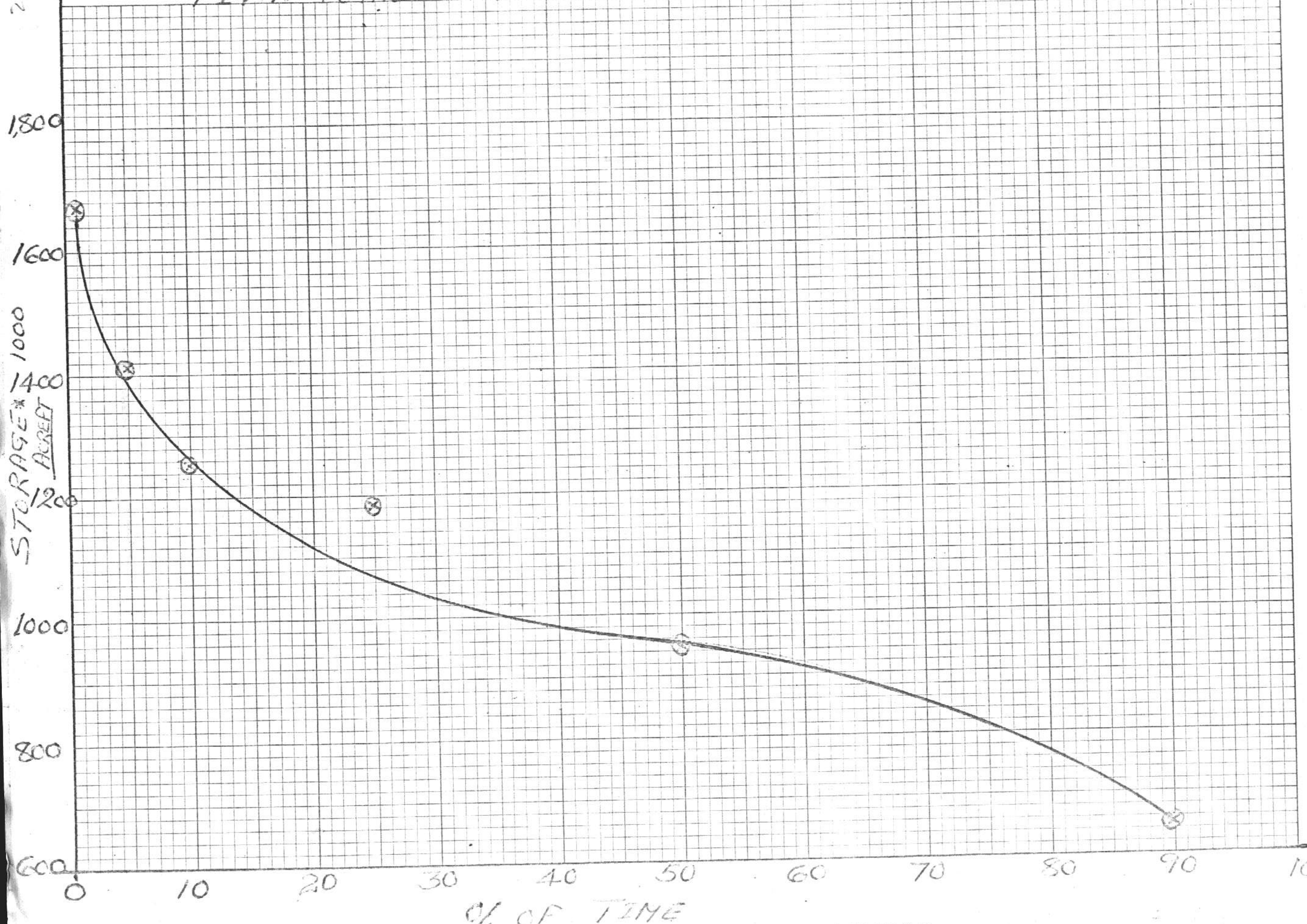


FIG 7. TOTAL BASIN STORAGE FOR THE WHOLE KISS BASIN



Top of regulation is the lake level where the maximum allowable storage occurs. In order to estimate the maximum allowable basin storage, top of regulation stage from each individual lake was converted to storage by use of the polynomial equation listed in Table 10. Top of regulation stage for each lake is listed in Table 13.

Table 13. Top of Regulation Stages and Associated Storages.

Lake	Top of Regulation (Stage)	Top of Regulation (Storage) X 1000 Acre Ft.
Kissimmee) Hatchineha) Cypress)	52.5	440
Tohopekaliga	55.0	144
East Tohopekaliga	58.0	130
Hart	61.0	7
Mary Jane	61.0	7
Myrtle	63.0	4
Alligator	64.0	43
Gentry	62.0	17
Marion *		23
Marian *		60
Jackson *		4
Rosalie *		47
Weohyakapka		64
Istokpoga	40.0-39.5	185
		1,175

*Lakes Marion, Marian, Jackson and Rosalie have no control structures, so 50% frequency level was taken as the top of regulation stage for which top of regulation storage was computed.

Top of regulation storage, and 50 and 90 percent frequency storages were used as the maximum allowable, mean and minimum storages for the whole Kissimmee Basin. These storages are presented in Table 14. (See Figure 8).

Table 14. Maximum Allowable, Mean and Minimum Storages for the Kissimmee River Basin (1,000 acre feet).

Maximum Storage	Mean Storage	Minimum Storage
1,175	945	650

Flood Damage Computation

In order to arrive at the dollar figures from flood damage in the Kissimmee River Basin, the following lakes with the highest frequencies were supplied to the Planning Department. Based on the 1 ft. contour interval map of the River Basin and the current agricultural land use, flood damage in terms of dollars was estimated. The lakes, highest stages, and the damage in dollars are presented in Table 15.

Table 15. Lakes, Stages and the Damage in Dollars

Lake	Stages and Damages (1000 Ac. Ft. and $1000)				
Kissimmee	53(140)	54(155)	55(170)	56(185)	57(200)
Istokpoga	39(50)	40(100)	41(200)	42(425)	43(500)
Tohopekaliga	55(0)	56(225)	57(575)	60(1,200)	
East Tohopekaliga	58(0)	60(350)	63(1,500)	65(2,500)	
Gentry	62(0)	63(25)	65(100)		
Alligator	64(0)	65(65)	68(450)	70(750)	
Hart & Mary Jane	61(0)	62(25)	63(125)	65(350)	

( ) Damage in $1,000.

Fig. 8 Maximum, Mean and Minimum Storage
Kissimmee Basin

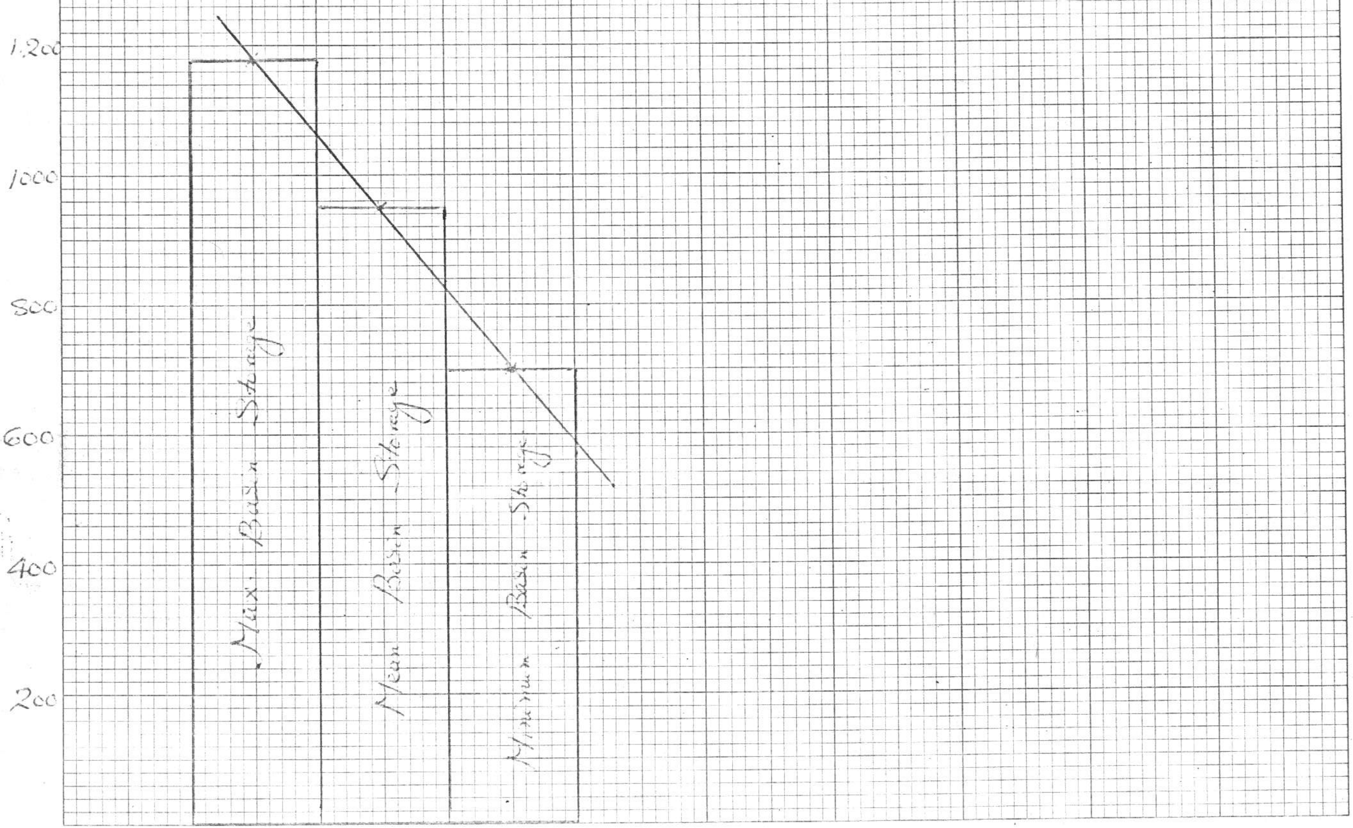


Table 16. Damage \$ = f (Stage/Storage) fitted to each of the lakes presented above.

Lakes	Damage Equation
Istokpoga	Damage (\$) = -4767500.0 + 122500.0 x Stage R^2 = .949, F = 56.71, δ = 51.437 Std. error = 16266.0
Kissimmee	Damage (\$) = -655.0 + 15 x Stage R^2 = 1.00, F = 9999.0
Tohopekaliga	\$ = -1235.0 + 8.78 x Storage R^2 = 0.983, F = 122.3, δ = 81.26, Std. error = .794
East Tohopekaliga	\$ = -2878 + 21.17 x Storage R^2 = .988, δ = 157.7, F = 166.94 Std. error = 1.638
Alligator	\$ = -664.42 + 17.53 x Storage R^2 = 0.966, δ = 78.66, F = 57.65 Std. error = 2.309
Gentry	\$ = -144.57 + 8.44 x Storage R^2 = .999, δ = 993, F = 5489.4 Std. error = .1139
Hart & Mary Jane	\$ - -304.22 + 38.40 x Storage R^2 = 0.967, δ = 35.38, F = 58.91 Std. error = 5.004

Table 17. Mandatory Release - Discharge Through S-65

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1961	97	71	67	55	41	30	30	26	30	25	18	13
1962	9	6	5	3	1	1	1	2	6	20	19	17
1963	13	12	31	30	24	24	29	27	26	30	32	40
1964	67	154	143	84	66	47	27	27	101	96	15	14
1965	42	60	90	55	21	18	59	92	77	80	45	29
1966	42	90	219	144	90	67	72	114	109	100	27	9
1967	9	7	8	10	31	23	14	88	108	54	11	11
1968	11	10	10	8	8	80	195	168	118	36	15	12
1969	60	18	151	122	77	35	2	2	60	310	89	115
1970	136	76	109	80	10	12	25	10	6	15	3	8
MEAN	48.6	50.4	83.3	59.1	36.9	33.7	45.4	55.6	64.1	76.6	27.4	26.8
Std. Dev.	42.6	48.8	72.6	48.6	30.9	24.6	57.1	56.5	44.2	87.8	24.6	32.5

FIG. 9. DISCHARGE – FREQ. FOR S-65 (1961-70)
JULY – DECEMBER

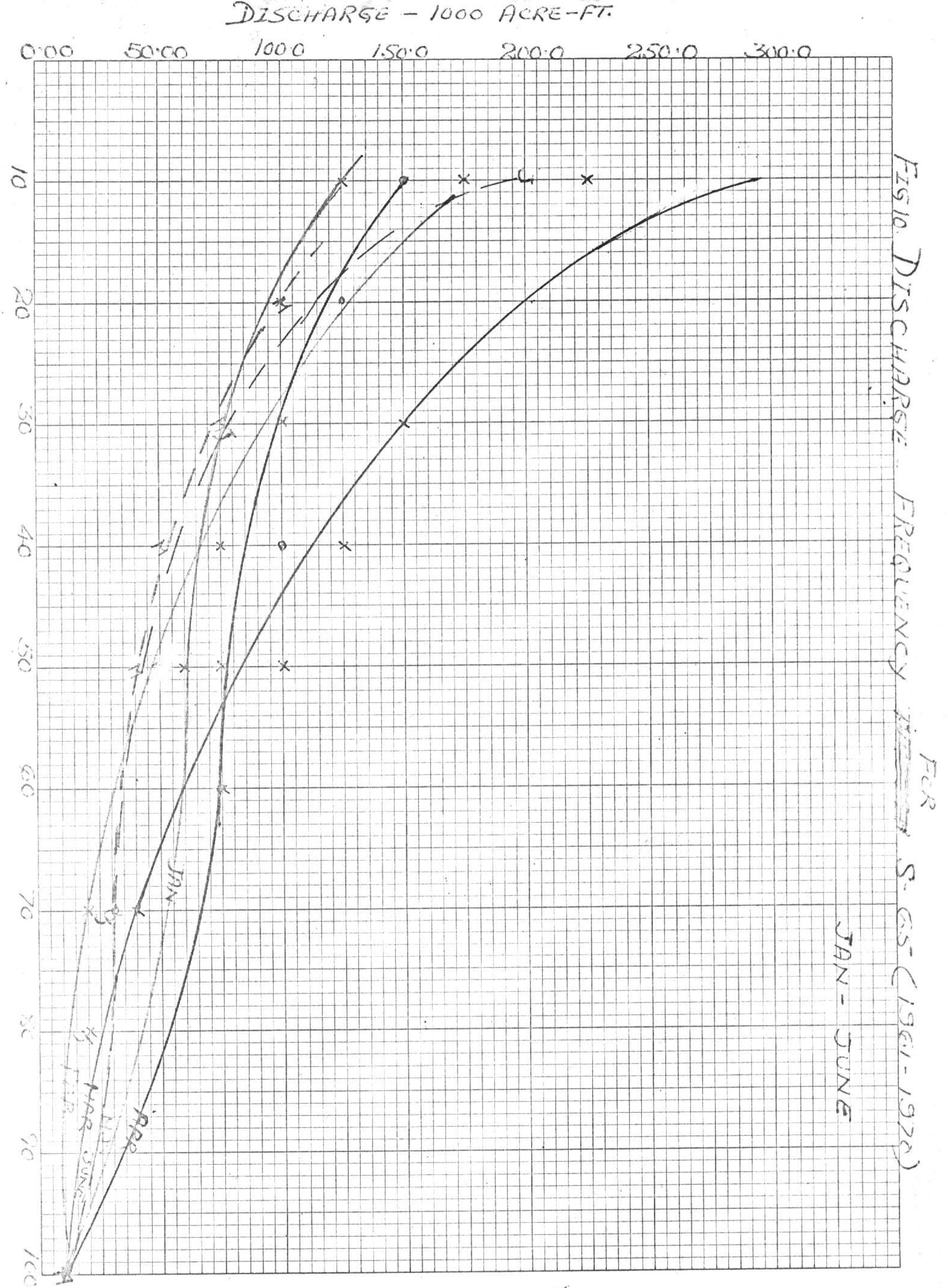
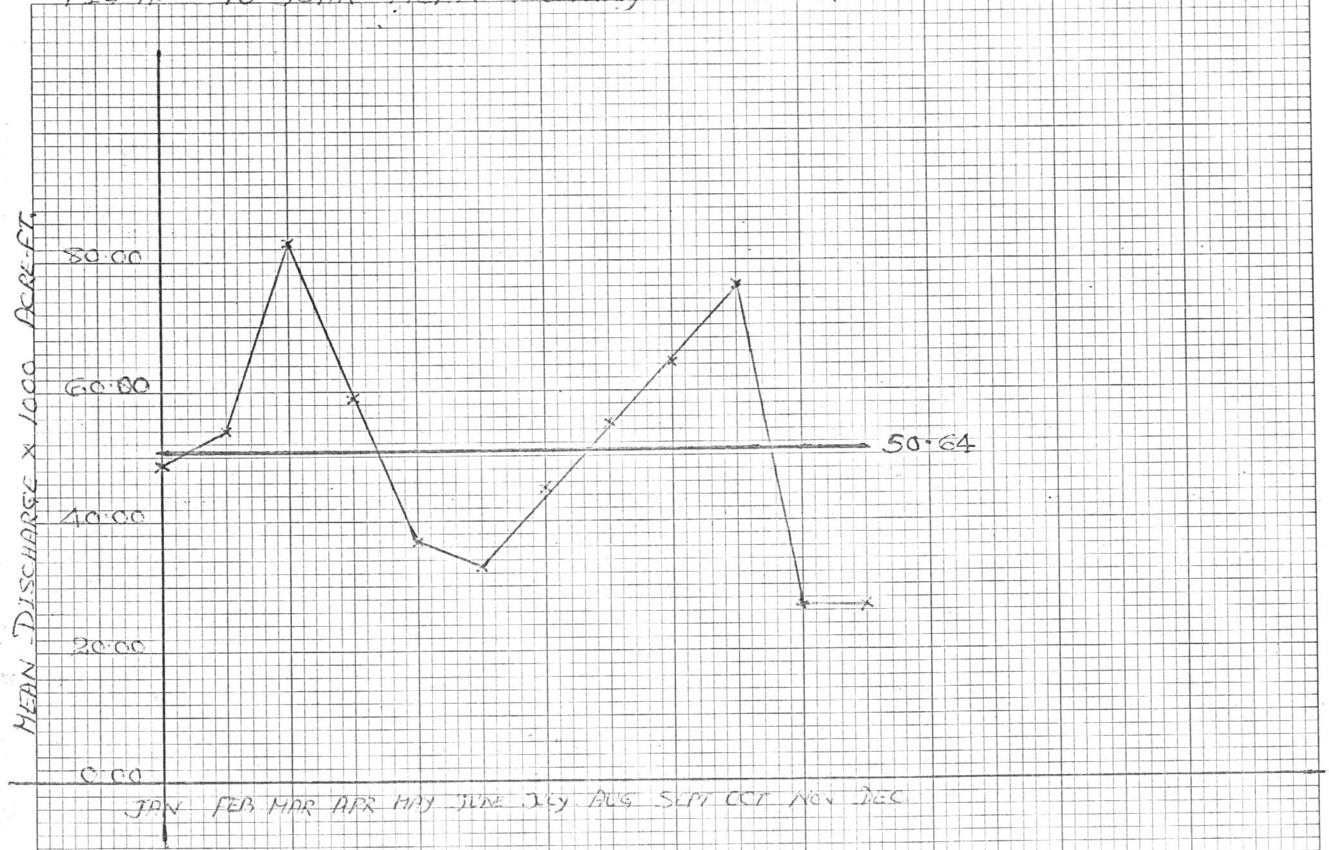


Fig 10. Discharge Frequency for S. 65 (1961-1970) Jan - June

FIG 11. 10 YEAR MEAN MONTHLY DISCHARGE THRU S-65



Mandatory Releases

Based on the discharge duration curve for S-65, 90% discharge-duration was taken as the mandatory discharge through the Kissimmee River Basin. Monthly mandatory discharge is presented in Table 18.

Table 18. Mandatory Discharge Through the Kissimmee River Basin.

Month	M. Discharge x 1000 Acre Feet
January	27
February	10
March	15
April	34
May	22
June	22
July	25
August	24
September	17
October	15
November	20
December	20
TOTAL	251

Water Balance

In order to check the accuracy of the various hydrologic variables that were used in this study, a water balance for the Upper Kissimmee River Basin was made. The inflow to the basin was derived from the rainfall-runoff curve fitted to logarithmic and linear functional equations. The outflow from the basin is the measured discharge through S-65. In the first water balance only 9 lakes (Tohopekaliga, East Tohopekaliga, Kissimmee, Hatchineha, Cypress, Alligator, Gentry, Hart and Mary Jane) were included. The difference between the monthly change in storage levels together with the difference between inflow and outflow is presented in Tables 19 and 20. For the water balance presented in Table 20 four more lakes (Marion, Marian, Rosalie and Weohyakapka) were included in order to minimize the difference between the change in storage levels and inflow and outflow. The lake stages were converted to lake storages by use of the polynomial equations. The maximum difference between the storage volume and inflow and outflow is 204,000 acre feet. Corps of Engineers Part II, Supp. 5, gives a figure of 7,100 acre ft/foot change of lake level for East Chain of Lakes; 38,000 for West Chain of Lakes, and 78,000 for Kissimmee, Hatchineha and Cypress. Together they total 125,000 acre feet. Therefore, the maximum error which occurred once in 10 years is 1 1/2 ft. of change in storage for all the lakes.

This error resulted by using the rainfall-runoff relationship used by the Corps of Engineers. Other errors are within the 1 foot change of lake level limit.

Table 19. Water Balance of Kissimmee River Basin up to S-65 (Includes Lakes Tohopekaliga, East Tohopekaliga, Kissimmee, Cypress, Hatchineha, Alligator, Gentry, Hart, and Mary Jane).

YEAR		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1961	A	-54	-31	-44	-43	-59	-32	-13	-11	-5	-37	-31	-22
	B	-97	-53	-67	-55	-41	-7	-30	73	-30	-25	-18	-13
1962	A	-7	-12	-13	-25	-18	25	15	43	71	-16	1	-17
	B	-9	-6	-5	-3	-1	94	76	137	175	-20	-4	-17
1963	A	-2	87	65	-39	1	8	-3	-2	28	-17	102	35
	B	7	173	-31	-30	32	-7	-29	-27	83	-30	143	4
1964	A	90	49	-123	-121	-47	-51	5	103	152	-56	-15	-1
	B	69	-88	-111	-84	-66	-47	69	150	98	-96	-15	-13
1965	A	-41	-2	-35	-68	-45	27	74	27	-17	53	-7	-6
	B	-42	30	-60	-55	-21	108	153	-13	12	-8	-45	5
1966	A	67	127	-68	-138	-168	1	25	65	16	-16	-30	-11
	B	129	84	-219	-144	2	112	-49	3	76	-100	-27	-9
1967	A	-7	24	-19	-60	-71	50	68	94	-9	-52	-27	-1
	B	-9	104	-8	-10	-31	195	213	86	-71	-54	-11	28
1968	A	-18	-9	-23	-25	-13	264	69	-137	-39	27	46	1
	B	-11	-3	-10	-8	60	368	-48	-148	-62	69	2	-12
1969	A	7	-30	21	-98	-90	-37	1	50	122	60	43	-23
	B	-3	-16	-7	-122	-77	-15	44	159	159	-147	-89	-10
1970	A	-48	-17	-31	-118	-33	-3	47	22	1	-16	-16	-16
	B	-51	-8	-5	-80	-4	5	41	-5	-6	-15	-3	-8

A - Calculated difference in monthly storage.
B - Difference; inflow to the basin, outflow from Structure 65.

Table 20. A Water Balance for the Kissimmee River Basin up to S-65. (Includes Lakes Tohopekaliga, East Tohopekaliga, Kissimmee, Cypress, Hatchineha, Alligator, Gentry, Hart, Mary Jane, Marion, Marian, Rosalie, and Weohyakapka).

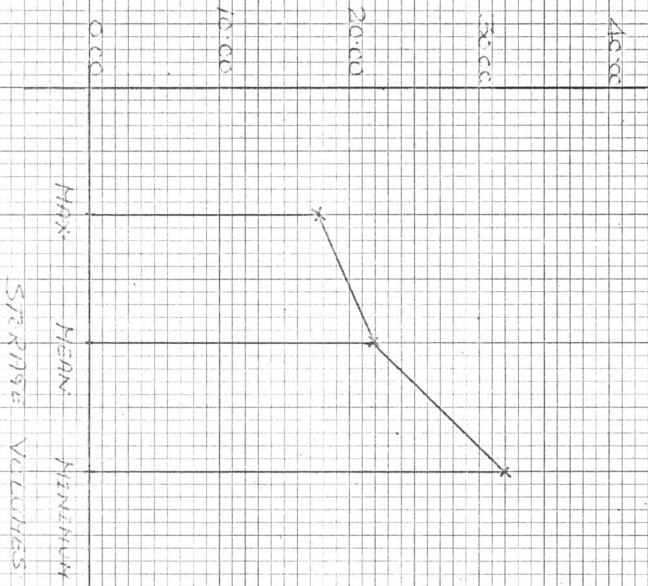
YEAR		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1961	A	-50	-31	-45	-69	-64	-32	-7	15	-8	-42	-34	-24
	B	-97	-53	-67	-55	-41	-7	-30	73	-30	-25	-18	-13
1962	A	-7	-12	-12	-26	-23	40	14	57	80	-27	0	-20
	B	-9	-6	-5	-3	-1	94	76	137	175	-20	-4	-17
1963	A	-1	103	60	-51	7	21	-4	-6	32	-24	104	34
	B	7	173	-31	-30	32	-7	-29	-27	83	-30	143	4
1964	A	102	54	-90	-88	-49	-57	8	131	149	-67	-22	1
	B	69	-88	-111	-84	-66	-47	69	150	98	-96	-15	-13
1965	A	-49	1	-55	-62	-54	45	96	31	-17	55	-21	-9
	B	-42	30	-60	-55	-21	108	153	-13	12	-8	-45	5
1966	A	78	149	-80	-150	-66	4	33	74	10	-23	-37	-16
	B	129	84	-219	-144	2	112	-49	3	76	-100	-27	-9
1967	A	-8	25	-25	-71	-80	15	78	116	-6	-61	-33	0
	B	-9	104	-8	-10	-31	195	213	86	-71	-54	-11	28
1968	A	-20	-10	-27	-43	-12	306	76	-148	-34	26	43	-5
	B	-11	-3	-10	-8	60	368	-48	-148	-62	69	2	-12
1969	A	10	-33	36	-108	-100	-35	2	73	129	57	36	-22
	B	-3	-16	-7	-122	-77	-15	44	159	159	-147	-89	-10
1970	A	-53	-20	-25	-129	-42	-6	54	25	-2	-16	-19	-17
	B	-51	-8	-5	-80	-4	5	41	-5	-6	-15	-3	-8

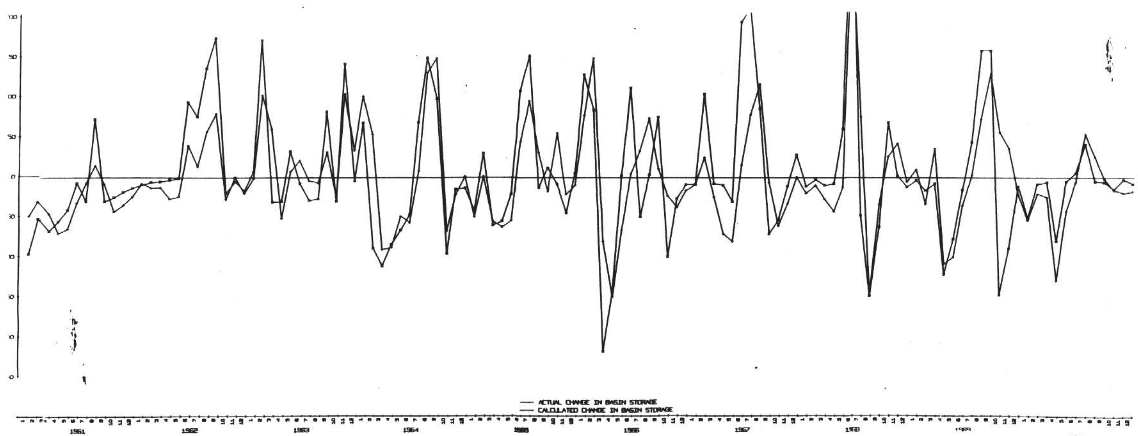
A - Calculated difference in monthly storage.
B - Difference - inflow to the Basin, outflow from Structure 65.

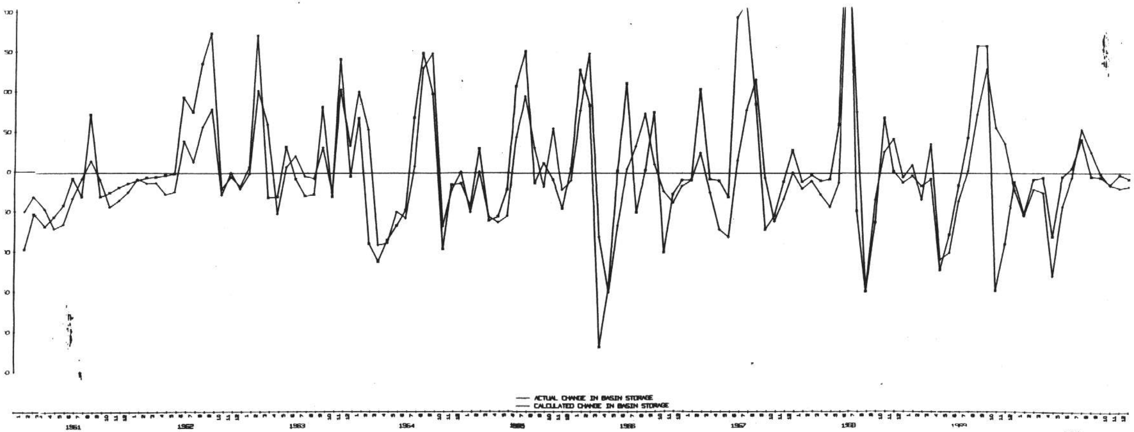
Conclusion: The seasonal basin yield, mandatory discharge together with the minimum, mean and maximum storage for the whole Kissimmee Basin is estimated to be:

	Period I (June, July, Aug., Sept.)	Period II (Oct., Nov.)	Period III (Dec., Jan.)	Period IV (Feb., Mar., April, May)
Yield (1000 ac.ft.)	413.10	60.5	57.2	126.6
Mandatory Discharge (1000 ac. ft.)	88.0	35.0	47.0	91.0
Storage (1000 ac. ft.)	Maximum 1,175	Mean 945	Minimum 650	

W.B ERROR % OF DIFF. STORAGE LEVEL




ACTUAL CHANGE IN BASIN STORAGE
CALCULATED CHANGE IN BASIN STORAGE
1961
1962
1963
1964
1966
1967



ACTUAL CHANGE IN BASIN STORAGE
CALCULATED CHANGE IN BASIN STORAGE
1961
1962
1963
1964
1966
1967
1968