4.2. Water Resources Development Plan

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4.2. Water Resources Development Plan

4.2.1. General

In accordance with the simulation by the storage model, the surface runoff of the Basin is estimated at 2.1 MCM/annum on an average of 21 years. The direct utilization of the runoff is deemed to be practically impossible, since the mode of runoff takes mostly a flush flood. The surface storage of runoff seems to be also not so effective due to a high evaporation potential, a high sediment load and the possiblity of putrefaction of stored water by algae.

The water resources development in the Basin is, therefore, only achieved by means of leading the flood runoff into the ground.

In order to control the flood runoff for groundwater augmentation, the types of facility are such to disperse the flood over the gravel plain and to store the flood temporarily for release the flood water in an appropriate pattern or for direct recharge from storage basin.

As for the proposed site of the later type of facility, the mountain wadis and gravel plains are considered.

In accordance with the preliminary study, the flood dispersion scheme is found out to be not effective due to only enforce the evapotranspilation losses. The storage type of facility is, therefore, studied hereinafter.

The evaluation of groundwater augment by a storage type of facility is made through simulations by the storage model. The modelling of storage facility in the simulation is carried out adding the storage depth which is equivalent to storage capacity

of facility onto the existing depth of the top tank of the sub-basin where the facility is built in. When a conduit is installed into the storage facility, an orifice with the same coefficient as the conduit is set up to the existing lowest runoff orifice of the top tank. Taking into consideration about the effect of sedimentation on the storage basin, the coefficient of infiltration orifice of the top tank is deducted to 15% lesser than the original one.

4.2.2. Storage Facility on the Mountain Wadis

The facility of flood control type can be proposed on the mountain wadis in the Basin. From the view of basin size, topography and geology, the proposed sites of such facility are deemed only adequate at the lower reach of Wadis Abadilah, Al Uyaynah and Al Fay. Since the slopes of the said wadi-bed are rather steep, the proposed storage capacities of facility are limited to be 1.0 MCM or less. The return period of flood at these volumes is about five years.

The proposed capacities of facility on three wadis are as follows:

Facility	Wadi	Catchment Area (sq.km)	Proposed Capacity (MCM)
Abadilah	Abadilah	42	1.3
Uyaynah	Uyayanah	18	0.5
Al Fay	Al Fay	24	0.7

The simulation result shows the total recharge of the Basin decreases for 0.2 MCM/annum from the present condition of 2.9 MCM/annum. The reason of decrease is supposed that the regulation of flood in such level makes only to supply the flood water for soil moisture, and then the evapotranspilation increases.

4.2.3. Storage Facility on the Gravel Plain

(1) General

The recharge facility on the gravel plain can be proposed so as to make the direct recharge from the facility by means of temporary storage.

The gravel plain in the Basin can be devided into the upper (No.5 sub-basin), the lower left bank (No.9 sub-basin) and the lower right bank (No.10 sub-basin).

The present surface runoffs on those gravel plains are described in the fore-going chapter and summarized as below:

Sub-basin No.	Surface runoff (MCM/annum) Max.	Min.	Mean
5	5.2	0	1.3
9	4.7	0	1.3
10	5.4	0	1.3

To lead the above surface runoffs into the ground, various storage facilities with different capacities at the said sub-basin are proposed.

The simulations by the storage model were conducted for 12 cases supposing various capacities and conduit sizes. The results of simulation are given in Table A.4.2-2 to 4.2-49 and their summaries is shown in Table A.4.2-1.

(2) Storage facility on the upper gravel plain

An appropriate dam site can be selected at the midstream of Wadi Al Bassierah proper, 12 km upstream from the sea coast. The proposed dam site is about one km wide with the bed-rock outcrops on the both abutmants, having comparatively large catchment

area of 122 sq.km and a widely and thickly spread gravel plain. From the said condition the site has been pointed out since before being adequate for a recharge dam.

The proposed type of dam shall be a high fill-dam with a spillway and a conduit in respect to the best adopted capacity, the large design flood, to prevent siltation onto storage basin and to control flood discharge.

The proposed storage capacity for the dam is decided by the simulation so as to maximize the recharge effect and to minimize the size of facility as explained in the following. The size and number of conduit are also decided by the simulation.

As shown in Table A.4.2-1, the simulated cases of C'-1 to C'-2 are the cases that the capacities of facility on No.5 sub-basin are 4.0 and 3.0 MCM with two 1,450 mm conduits. Since the recharge augment at the sub-basin of both cases are the same level being 0.6 MCM/annum, the capacity of 4.0 MCM is meaningless. In case C'-3, when the capacity is 2.0 MCM, since the recharge becomes 0.1 MCM/annum lesser than that of Case C'-2, the best capacity with two conduits seems to be between 3.0 and 2.0 MCM. Case C'-4 to C'-6 are the cases that capacities of facility on No.5 sub-basin are 2.0 2.5 and 3.0 MCM with a single conduit. The recharge augments at the sub-basin are 0.6, 0.7 and 0.7 MCM/annum respectively. The capacity of 3.0 MCM is ineffective.

Thus, as per the storage facility on No.5 sub-basin, the capacities of 2.0 or 2.5 MCM with a single 1,450 mm conduit are recommendable. The cases C'-4, C'-5 and C'-7 to C'11 are the recommendable ones. The finally proposed case will be determined with respect to combination of the adequate facilities on the other sub-basins.

(3) Storage facility on the lower gravel plain

No.9 sub-basin spread out at the lower reach of Wadi Al Fay and Zanhah which discharge comparatively large runoffs. Therefore, some storage facility could be effective.

The simulation case C'-1 to C'-5 try the recharge effects with the storage capacities of 2.0, 1.5, 1.0 and 0.5 MCM alternately. The results show the recharge augments at the sub-basin are 0.6 MCM/annum by 2.0 MCM capacity to 0.2 MCM/annum by 0.5 MCM capacity ranging about 0.1 MCM/annum difference for each 0.5 MCM capacity. A provisional water cost study indicated that the storage capacity of 2.0 or 1.5 MCM are more effective among others.

No.10 sub-basin lying immediately lower reach of No.5 sub-basin, receives the surplus runoff from No.5 sub-basin. Therefore, in case that some facility is constructed on No.5 sub-basin, the recharge effect on No.10 sub-basin is dependable upon the storage capacity of facility set on the upper basin.

Cases C'-4 to C'-10 simulate the recharge effects with 1.0, 0.5 MCM and zero capacities in accordance with the small to large capacities of facility on the upper basin.

In case without any facility onto No.10 sub-basin and a facility in some capacity set up on the upper basin, Cases C'-6, C'-9 and C'-10, the recharge of the basin decreases for 0.1 to 0.2 MCM/annum due to the shortage of runoffs from the upper reach. While, in case that a facility is built on the lower basin as well as on the upper, the recharge is augmented for 0.1 MCM/annum. The recharge effect of facilitation onto this basin is, therefore, deemed to be 0.2 to 0.3 MCM/annum only.

(4) Recommended alternative plans

As mentioned above, out of 12 cases studied, Cases C'-8, C'-9 and C'-10 are considered to be recommendable for the final alternatives of water resources development plan.

Case C'-8 proposes three facilities onto each gravel plain. Since the surface runoff to be reached to Dibba Oasis (No.11 sub-basin) is decreased due to cut off at the upper basins, the total recharge augment of whole Al Bassierah Basin might be 0.9 MCM/annum in this case.

Case C'-9 aims to set up two facilities, one facility on No.5 sub-basin, unifying the storage capacity of No.10 sub-basin in Case C'-8 to No.5 sub-basin, and another one on No.9 sub-basin. The total augment of groundwater is at the same level as Case C'-8, 0.9 MCM/annum.

Case C'-10 proposes one smaller facility onto No.5 basin and another one onto No.9 basin. The total groundwater augment becomes lesser than the former cases showing 0.8 MCM/annum.

The best adopted plan among the above three alternatives will be determined in the main report with the respect of water cost study.

TABLE A.4.2-1 Alternative Plans for Groundwater Development

Case No.	No.5 Sub Basin			No.10 Sub Basin			No.9 Sub Basin			Whole Basin		
	Storage Capacity (MCM)	G.W. Recharge (MCM/a)	G.W. Augment (MCM/a)	Storage Capacity (MCM)	G.W. Recharge (MCM/a)	G.W. Augment (MCM/a)	Storage Capacity (MCM)	G.W. Recharge (MCM/a)	G.W. Augment (MCM/a)	Storage Capacity (MCM)	G.W. Recharge (MCM/a)	G.W. Augment (MCM/a)
Present	-	1.4	-	-	0.4	-	-	0.9	-	-	2.9	-
C'-1	4.0 2/	2.0	0.6	1.0	0.5	0.1	2.0	1.5	0.6	7.0	3.9	1.0
C'-2	3.0 2/	2.0	0.6	1.0	0.5	0.1	2.0	1.5	0.6	6.0	3.9	1.0
C'-3	2.0 2/	1.9	0.5	1.0	0.5	0.1	1.5	1.4	0.5	4.5	3.8	0.9
C'-4	2.0 1/	2.0	0.6	1.0	0.5	0.1	1.0	1.3	0.4	4.0	3.7	0.8
C'-5	2.5 1/	2.1	0.7	0.5	0.3	-0.1	0.5	1.1	0.2	3.5	3.5	0.6
C'-6	3.0 1/	2.2	0.7	0.0	0.2	-0.2	1.5	1.4	0.5	4.5	3.8	0.9
C'-7	2.0 1/	2.0	0.6	0.5	0.4	0.0	1.5	1.4	0.5	4.0	3.8	0.9
C'-8	1.5 1/	1.9	0.5	1.0	0.5	0.1	1.5	1.4	0.5	4.0	3.8	0.9
C'-9	2.5 1/	2.1	0.7	0.0	0.3	-0.1	1.5	1.4	0.5	4.0	3.8	0.9
C'-10	2.0 1/	2.0	0.6	0.0	0.3	-0.1	1.5	1.4	0.5	3.5	3.7	0.8
C'-11	2.5 1/	2.1	0.7	0.0	0.2	-0.2	0.0	0.9	0.0	2.5	3.4	0.5
C'-12	0.0	1.4	0.0	0.0	0.4	0.0	1.5	1.4	0.5	1.5	3.3	0.4

Notes: 1/ 1 x φ1,400 mm conduit, 2/ 2 x φ1,400 mm conduit

TABLE A.4.2-2

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-1)

(BASIN AREA=260.050.KM)
UNIT; M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.57	0.08	0.50	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	55.68	53.61	0.25	2.80	1.92
1963/1964	46.17	41.65	0.29	4.26	1.99
1964/1965	46.14	38.59	0.69	6.86	2.75
1965/1966	16.47	16.09	0.03	0.34	3.01
1966/1967	6.77	6.76	0.0	0.00	2.23
1967/1968	28.93	25.33	0.23	3.37	2.03
1968/1969	57.27	39.60	1.44	16.23	3.72
1969/1970	19.62	19.59	0.0	0.03	4.74
1970/1971	5.30	5.27	0.01	0.03	3.59
1971/1972	54.37	47.99	0.41	5.97	3.16
1972/1973	30.49	20.01	1.79	8.69	4.58
1973/1974	3.87	3.86	0.0	0.01	4.46
1974/1975	23.56	22.07	0.16	0.80	3.43
1975/1976	64.95	54.67	2.23	8.54	3.33
1976/1977	80.21	55.63	2.82	21.79	6.67
1977/1978	31.43	31.32	0.04	0.07	7.88
1978/1979	29.42	27.60	0.15	1.66	5.97
1979/1980	29.09	28.93	0.03	0.13	4.59
1980/1981	24.54	24.39	0.03	0.12	3.39
M E A N	33.29	28.87	0.51	3.91	3.68
	(100.0)	(86.7)	(1.5)	(11.8)	(11.1)

TABLE A.4.2-3

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-1)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPIRATION	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.39	0.18	0.19	1.33
1961/1962	2.35	2.35	0.0	0.0	0.75
1962/1963	28.62	26.40	0.70	1.52	0.62
1963/1964	23.31	20.53	0.70	2.08	1.20
1964/1965	23.30	19.06	0.98	3.26	1.78
1965/1966	8.31	8.12	0.08	0.11	1.40
1966/1967	3.42	3.42	0.0	0.0	0.86
1967/1968	14.60	12.42	0.51	1.67	0.91
1968/1969	28.91	19.00	1.72	8.19	2.40
1969/1970	9.91	9.91	0.0	0.0	2.26
1970/1971	2.68	2.67	0.01	0.0	1.49
1971/1972	27.45	23.54	0.99	2.92	1.62
1972/1973	15.39	9.53	1.25	4.62	2.65
1973/1974	1.95	1.95	0.0	0.0	2.15
1974/1975	11.89	10.93	0.36	0.37	1.50
1975/1976	32.79	26.69	1.60	4.73	2.00
1976/1977	40.50	27.27	2.45	10.78	4.38
1977/1978	15.87	15.80	0.07	0.0	3.82
1978/1979	14.85	13.48	0.43	0.95	2.65
1979/1980	14.69	14.63	0.06	0.00	1.93
1980/1981	12.39	12.29	0.08	0.01	1.34
M E A N	16.97	14.38	0.60	1.98	1.87
	(100.0)	(84.8)	(3.6)	(11.7)	(11.0)

TABLE A.4.2-4

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-1)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.50	0.0	1.17	0.23
1963/1964	14.42	12.43	0.0	2.02	0.84
1964/1965	14.41	11.39	0.18	2.84	1.46
1965/1966	5.14	4.91	0.0	0.23	1.18
1966/1967	2.11	2.11	0.0	0.00	0.72
1967/1968	9.04	7.54	0.0	1.49	0.79
1968/1969	17.89	11.98	0.32	5.59	1.98
1969/1970	6.13	6.10	0.0	0.03	1.86
1970/1971	1.66	1.63	0.0	0.03	1.15
1971/1972	16.98	14.33	0.0	2.65	1.31
1972/1973	9.52	5.81	0.81	2.91	2.08
1973/1974	1.21	1.20	0.0	0.01	1.60
1974/1975	7.36	6.63	0.0	0.42	1.07
1975/1976	20.29	16.29	1.13	3.12	1.36
1976/1977	25.05	16.51	1.05	7.53	3.29
1977/1978	9.82	9.74	0.0	0.07	2.94
1978/1979	9.19	8.51	0.0	0.68	1.85
1979/1980	9.09	8.95	0.0	0.13	1.27
1980/1981	7.66	7.56	0.0	0.10	0.88
M E A N	10.67 (100.0)	8.94 (83.8)	0.22 (2.1)	1.51 (14.1)	1.36 (12.7)

TABLE A.4.2-5

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-1)

SUBBASIN NO.10 (BASIN AREA=171.050.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPIRATION	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.63	0.0	0.19	0.92
1961/1962	3.07	3.07	0.0	0.0	0.91
1962/1963	37.40	35.77	0.00	1.63	0.76
1963/1964	30.46	28.22	0.0	2.24	0.92
1964/1965	30.44	26.17	0.27	4.00	1.48
1965/1966	10.86	10.75	0.0	0.11	1.70
1966/1967	4.47	4.47	0.0	0.0	1.30
1967/1968	19.08	17.16	0.05	1.87	1.16
1968/1969	37.78	26.51	0.79	10.48	2.08
1969/1970	12.94	12.94	0.0	0.0	2.70
1970/1971	3.50	3.50	0.0	0.0	2.28
1971/1972	35.87	32.53	0.02	3.32	1.97
1972/1973	20.11	13.57	0.94	5.60	2.50
1973/1974	2.55	2.55	0.0	0.0	2.69
1974/1975	15.54	14.93	0.0	0.38	2.23
1975/1976	42.85	36.72	1.04	5.31	2.04
1976/1977	52.92	37.52	1.50	13.89	3.73
1977/1978	20.74	20.74	0.0	0.0	4.64
1978/1979	19.41	18.42	0.0	0.98	3.88
1979/1980	19.19	19.19	0.0	0.00	3.11
1980/1981	16.19	16.17	0.0	0.01	2.35
M E A N	22.47	19.79	0.23	2.45	2.22
	(100.0)	(88.1)	(1.0)	(10.9)	(9.9)

TABLE A.4.2-6

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-2)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.57	0.08	0.50	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.61	0.25	2.80	1.92
1963/1964	46.17	41.65	0.29	4.26	1.99
1964/1965	46.14	38.59	0.69	6.86	2.75
1965/1966	16.47	16.09	0.03	0.34	3.01
1966/1967	6.77	6.76	0.0	0.00	2.23
1967/1968	28.93	25.33	0.23	3.37	2.03
1968/1969	57.27	39.60	1.44	16.23	3.72
1969/1970	19.62	19.59	0.0	0.03	4.74
1970/1971	5.30	5.27	0.01	0.03	3.59
1971/1972	54.37	47.99	0.41	5.97	3.16
1972/1973	30.49	20.02	1.82	8.66	4.58
1973/1974	3.87	3.86	0.0	0.01	4.45
1974/1975	23.56	22.07	0.16	0.80	3.42
1975/1976	64.95	54.67	2.23	8.54	3.32
1976/1977	80.21	55.63	2.82	21.79	6.66
1977/1978	31.43	31.32	0.04	0.07	7.88
1978/1979	29.42	27.60	0.15	1.66	5.97
1979/1980	29.09	28.93	0.03	0.13	4.59
1980/1981	24.54	24.39	0.03	0.12	3.39
M E A N	33.29 (100.0)	28.87 (86.7)	0.51 (1.5)	3.91 (11.8)	3.68 (11.1)

TABLE A.4.2-7

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-2)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPT,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.39	0.18	0.19	1.33
1961/1962	2.35	2.35	0.0	0.0	0.75
1962/1963	28.62	26.40	0.70	1.52	0.62
1963/1964	23.31	20.53	0.70	2.08	1.20
1964/1965	23.30	19.06	0.98	3.26	1.78
1965/1966	8.31	8.12	0.08	0.11	1.40
1966/1967	3.42	3.42	0.0	0.0	0.86
1967/1968	14.60	12.42	0.51	1.67	0.91
1968/1969	28.91	19.00	1.72	8.19	2.40
1969/1970	9.91	9.91	0.0	0.0	2.26
1970/1971	2.68	2.67	0.01	0.0	1.49
1971/1972	27.45	23.54	0.99	2.92	1.62
1972/1973	15.39	9.52	1.30	4.57	2.64
1973/1974	1.95	1.95	0.0	0.0	2.13
1974/1975	11.89	10.93	0.36	0.37	1.49
1975/1976	32.79	26.69	1.60	4.73	2.00
1976/1977	40.50	27.27	2.45	10.78	4.38
1977/1978	15.87	15.80	0.07	0.0	3.82
1978/1979	14.85	13.48	0.43	0.95	2.65
1979/1980	14.69	14.63	0.06	0.00	1.93
1980/1981	12.39	12.29	0.08	0.01	1.34
M E A N	16.97	14.38	0.61	1.98	1.86
	(100.0)	(84.8)	(3.6)	(11.6)	(11.0)

TABLE A.4.2-8

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-2)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.50	0.0	1.17	0.23
1963/1964	14.42	12.43	0.0	2.02	0.84
1964/1965	14.41	11.39	0.18	2.84	1.46
1965/1966	5.14	4.91	0.0	0.23	1.18
1966/1967	2.11	2.11	0.0	0.00	0.72
1967/1968	9.04	7.54	0.0	1.49	0.79
1968/1969	17.89	11.98	0.32	5.59	1.98
1969/1970	6.13	6.10	0.0	0.03	1.86
1970/1971	1.66	1.63	0.0	0.03	1.15
1971/1972	16.98	14.33	0.0	2.65	1.31
1972/1973	9.52	5.91	0.81	2.91	2.08
1973/1974	1.21	1.20	0.0	0.01	1.60
1974/1975	7.36	6.63	0.0	0.42	1.07
1975/1976	20.29	16.29	1.13	3.12	1.36
1976/1977	25.05	16.51	1.05	7.53	3.29
1977/1978	9.82	9.74	0.0	0.07	2.94
1978/1979	9.19	8.51	0.0	0.68	1.85
1979/1980	9.09	8.95	0.0	0.13	1.27
1980/1981	7.66	7.56	0.0	0.10	0.88
M E A N	10.67	8.94	0.22	1.51	1.36

TABLE A.4.2-9

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-2)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT; M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPT.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.63	0.0	0.19	0.82
1961/1962	3.07	3.07	0.0	0.0	0.91
1962/1963	37.40	35.77	0.00	1.63	0.76
1963/1964	30.46	28.22	0.0	2.24	0.92
1964/1965	30.44	26.17	0.27	4.00	1.48
1965/1966	10.86	10.75	0.0	0.11	1.70
1966/1967	4.47	4.47	0.0	0.0	1.39
1967/1968	19.08	17.16	0.05	1.87	1.16
1968/1969	37.78	26.51	0.79	10.48	2.08
1969/1970	12.94	12.94	0.0	0.0	2.70
1970/1971	3.50	3.50	0.0	0.0	2.28
1971/1972	35.87	32.53	0.02	3.32	1.97
1972/1973	20.11	13.57	0.98	5.56	2.50
1973/1974	2.55	2.55	0.0	0.0	2.68
1974/1975	15.54	14.93	0.0	0.38	2.27
1975/1976	42.85	36.72	1.04	5.31	2.03
1976/1977	52.92	37.52	1.50	13.89	3.73
1977/1978	20.74	20.74	0.0	0.0	4.64
1978/1979	19.41	18.42	0.0	0.98	3.88
1979/1980	19.19	19.19	0.0	0.00	3.11
1980/1981	16.19	16.17	0.0	0.01	2.35
MEAN	22.47	19.79	0.23	2.45	2.22
	(100.0)	(88.1)	(1.0)	(10.9)	(9.9)

TABLE A.4.2-10

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-3)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.57	0.08	0.50	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.60	0.33	2.74	1.91
1963/1964	46.17	41.64	0.29	4.26	1.98
1964/1965	46.14	38.59	0.94	6.60	2.70
1965/1966	16.47	16.09	0.03	0.34	2.91
1966/1967	6.77	6.76	0.0	0.00	2.18
1967/1968	29.93	25.33	0.33	3.27	2.00
1968/1969	57.27	39.60	2.03	15.64	3.68
1969/1970	19.62	19.59	0.0	0.03	4.52
1970/1971	5.30	5.27	0.01	0.03	3.43
1971/1972	54.37	48.00	0.44	5.93	3.05
1972/1973	30.49	20.00	2.41	8.08	4.52
1973/1974	3.87	3.86	0.0	0.01	4.22
1974/1975	23.56	22.07	0.16	0.80	3.25
1975/1976	64.95	54.71	2.93	7.84	3.21
1976/1977	80.21	55.57	3.90	20.75	6.41
1977/1978	31.43	31.32	0.04	0.07	7.30
1978/1979	29.42	27.60	0.15	1.66	5.56
1979/1980	29.09	28.93	0.03	0.13	4.32
1980/1981	24.54	24.39	0.03	0.12	3.22
M E A N	33.29 (100.0)	28.96 (86.7)	0.67 (2.0)	3.75 (11.3)	3.53 (10.6)

TABLE A.4.2-11

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-3)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.39	0.18	0.19	1.33
1961/1962	2.35	2.35	0.0	0.0	0.75
1962/1963	28.62	26.40	0.70	1.52	0.62
1963/1964	23.31	20.53	0.70	2.08	1.20
1964/1965	23.30	19.06	1.04	3.20	1.76
1965/1966	9.31	8.12	0.08	0.11	1.38
1966/1967	3.42	3.42	0.0	0.0	0.85
1967/1968	14.60	12.42	0.51	1.67	0.91
1968/1969	28.91	18.97	2.20	7.75	2.26
1969/1970	9.91	9.91	0.0	0.0	2.12
1970/1971	2.68	2.67	0.01	0.0	1.41
1971/1972	27.45	23.54	0.99	2.92	1.57
1972/1973	15.39	9.48	1.80	4.11	2.47
1973/1974	1.95	1.95	0.0	0.0	1.98
1974/1975	11.89	10.93	0.36	0.37	1.41
1975/1976	32.79	26.63	2.11	4.29	1.85
1976/1977	40.50	27.24	3.18	10.08	3.98
1977/1978	15.87	15.80	0.07	0.0	3.50
1978/1979	14.85	13.48	0.43	0.95	2.48
1979/1980	14.69	14.63	0.06	0.00	1.84
1980/1991	12.39	12.29	0.09	0.01	1.29
M E A N	16.97	14.38	0.71	1.83	1.77
	(100.0)	(84.7)	(4.2)	(11.1)	(10.4)

TABLE A.4.2-12

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-3)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPIRATION	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
M E A N	10.67	8.91	0.35	1.40	1.25
	(100.0)	(83.6)	(3.3)	(13.1)	(11.7)

TABLE A.4.2-13

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN THROUGH STORAGE MODEL ANALYSIS (CASE C'-3)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.63	0.0	0.19	0.82
1961/1962	3.07	3.07	0.0	0.0	0.91
1962/1963	37.40	35.77	0.00	1.63	0.76
1963/1964	30.46	28.22	0.0	2.24	0.92
1964/1965	30.44	26.17	0.31	3.96	1.48
1965/1966	10.86	10.75	0.0	0.11	1.69
1966/1967	4.47	4.47	0.0	0.0	1.38
1967/1968	19.08	17.16	0.05	1.87	1.15
1968/1969	37.78	26.50	1.13	10.15	2.08
1969/1970	12.94	12.94	0.0	0.0	2.44
1970/1971	3.50	3.50	0.0	0.0	2.19
1971/1972	35.87	32.53	0.02	3.32	1.90
1972/1973	20.11	13.57	1.33	5.22	2.46
1973/1974	2.55	2.55	0.0	0.0	2.58
1974/1975	15.54	14.93	0.0	0.38	2.12
1975/1976	42.85	36.75	1.37	4.96	1.96
1976/1977	52.92	37.50	2.02	13.39	3.63
1977/1978	20.74	20.74	0.0	0.0	4.42
1978/1979	19.41	18.42	0.0	0.98	3.66
1979/1980	19.19	19.19	0.0	0.00	2.94
1980/1981	16.19	16.17	0.0	0.01	2.24
M E A N	22.47	19.78	0.31	2.37	2.15
	(100.0)	(88.0)	(1.4)	(10.6)	(9.6)

TABLE A.4.2-14

HYDROLOGIC BALANCE OF THE BASSTERAH BASIN THROUGH STORAGE MODEL ANALYSIS (CASE C'-4)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.52	0.08	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.39	0.55	2.75	1.91
1963/1964	46.17	41.45	0.47	4.25	1.93
1964/1965	46.14	38.46	1.19	6.49	2.59
1965/1966	16.47	16.07	0.03	0.36	2.83
1966/1967	6.77	6.76	0.0	0.00	2.21
1967/1968	28.93	25.20	0.50	3.22	1.97
1968/1969	57.27	39.50	2.37	15.40	3.57
1969/1970	19.62	19.59	0.0	0.03	4.37
1970/1971	5.30	5.27	0.01	0.03	3.42
1971/1972	54.37	47.78	0.66	5.93	3.04
1972/1973	30.49	19.88	2.66	7.95	4.42
1973/1974	3.87	3.86	0.0	0.01	4.15
1974/1975	23.56	21.94	0.22	0.83	3.27
1975/1976	64.95	54.49	3.28	7.76	3.21
1976/1977	80.21	55.41	4.42	20.38	6.18
1977/1978	31.43	31.32	0.04	0.07	7.04
1978/1979	29.42	27.46	0.20	1.76	5.54
1979/1980	29.09	28.92	0.03	0.14	4.39
1980/1981	24.54	24.39	0.03	0.12	3.31
M E A N	33.29	28.78	0.80	3.72	3.49
	(100.0)	(86.4)	(2.4)	(11.2)	(10.5)

TABLE A.4.2-15

HYDROLOGIC BALANCE OF THE BASSIFRAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-4)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.12	0.63	3.55	2.00
1965/1966	8.31	8.14	0.04	0.13	1.56
1966/1967	3.42	3.42	0.0	0.0	0.95
1967/1968	14.60	12.46	0.29	1.86	1.01
1968/1969	28.91	19.01	1.76	8.14	2.47
1969/1970	9.91	9.91	0.0	0.0	2.29
1970/1971	2.68	2.67	0.01	0.0	1.51
1971/1972	27.45	23.65	0.55	3.25	1.71
1972/1973	15.39	9.52	1.51	4.37	2.69
1973/1974	1.95	1.95	0.0	0.0	2.13
1974/1975	11.89	10.99	0.20	0.44	1.51
1975/1976	32.79	26.75	1.62	4.69	2.01
1976/1977	40.50	27.32	2.48	10.69	4.34
1977/1978	15.87	15.83	0.04	0.0	3.79
1978/1979	14.85	13.54	0.24	1.07	2.67
1979/1980	14.69	14.65	0.03	0.01	1.97
1980/1981	12.39	12.33	0.04	0.01	1.36
M E A N	16.97	14.42	0.51	2.03	1.92
	(100.0)	(85.0)	(3.0)	(12.0)	(11.3)

TABLE A.4.2-16

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-4)

SUBBASIN NO. 9 (BASIN AREA= 79.050.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.37	0.37	0.96	0.19
1963/1964	14.42	12.36	0.24	1.83	0.68
1964/1965	14.41	11.28	0.82	2.31	1.17
1965/1966	5.14	4.91	0.0	0.23	0.96
1966/1967	2.11	2.11	0.0	0.00	0.61
1967/1968	9.04	7.42	0.41	1.20	0.65
1968/1969	17.89	11.85	1.28	4.76	1.57
1969/1970	6.13	6.10	0.0	0.03	1.51
1970/1971	1.66	1.63	0.0	0.03	0.98
1971/1972	16.98	14.21	0.37	2.40	1.17
1972/1973	9.52	5.64	1.61	2.27	1.73
1973/1974	1.21	1.20	0.0	0.01	1.31
1974/1975	7.36	6.59	0.09	0.38	0.92
1975/1976	20.29	16.03	2.24	2.32	1.08
1976/1977	25.05	16.28	2.74	6.04	2.45
1977/1978	9.82	9.74	0.0	0.07	2.25
1978/1979	9.19	8.47	0.07	0.65	1.50
1979/1980	9.09	8.95	0.0	0.13	1.10
1980/1981	7.66	7.56	0.0	0.10	0.80
M E A N	10.67	8.87	0.54	1.26	1.11
	(100.0)	(83.1)	(5.1)	(11.8)	(10.4)

TABLE A.4.2-17

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-4)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT; M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.59	0.0	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.61	0.0	1.78	0.76
1963/1964	30.46	28.05	0.0	2.41	0.94
1964/1965	30.44	26.07	0.26	4.11	1.51
1965/1966	10.86	10.73	0.0	0.13	1.79
1966/1967	4.47	4.47	0.0	0.0	1.49
1967/1968	19.08	17.08	0.0	2.00	1.23
1968/1969	37.78	26.45	1.00	10.33	2.12
1969/1970	12.94	12.94	0.0	0.0	2.73
1970/1971	3.50	3.50	0.0	0.0	2.30
1971/1972	35.87	32.35	0.0	3.52	1.96
1972/1973	20.11	13.52	1.23	5.36	2.52
1973/1974	2.55	2.55	0.0	0.0	2.69
1974/1975	15.54	14.83	0.0	0.45	2.23
1975/1976	42.85	36.62	1.26	5.23	2.04
1976/1977	52.92	37.43	1.82	13.66	3.67
1977/1978	20.74	20.74	0.0	0.0	4.56
1978/1979	19.41	18.30	0.0	1.11	3.84
1979/1980	19.19	19.18	0.0	0.01	3.11
1980/1981	16.19	16.17	0.0	0.01	2.37
M E A N	22.47	19.72	0.29	2.46	2.22
	(100.0)	(87.8)	(1.3)	(10.9)	(9.9)

TABLE A.4.2-18

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-5)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPT.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.44	0.24	0.46	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.11	0.94	2.63	1.91
1963/1964	46.17	41.29	0.99	3.90	1.93
1964/1965	46.14	38.25	1.84	6.06	2.42
1965/1966	16.47	16.07	0.03	0.36	2.54
1966/1967	6.77	6.76	0.0	0.00	2.09
1967/1968	28.93	24.97	0.91	3.05	1.96
1968/1969	57.27	39.27	3.19	14.81	3.40
1969/1970	19.62	19.59	0.0	0.03	3.99
1970/1971	5.30	5.27	0.01	0.03	3.28
1971/1972	54.37	47.51	1.50	5.36	2.94
1972/1973	30.49	19.62	3.15	7.72	4.07
1973/1974	3.87	3.86	0.0	0.01	3.86
1974/1975	23.56	21.82	0.57	0.73	3.14
1975/1976	64.95	53.79	3.99	7.63	3.12
1976/1977	80.21	55.11	5.49	19.61	5.85
1977/1978	31.43	31.32	0.04	0.07	6.54
1978/1979	29.42	27.30	0.47	1.64	5.38
1979/1980	29.09	28.92	0.03	0.14	4.32
1980/1981	24.54	24.39	0.03	0.12	3.30
MEAN	33.29 (100.0)	28.63 (86.0)	1.11 (3.3)	3.54 (10.6)	3.33 (10.0)

TABLE A.4.2-19

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN THROUGH STORAGE MODEL ANALYSIS (CASE C'-5)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.13	0.54	3.63	2.02
1965/1966	8.31	8.14	0.04	0.13	1.58
1966/1967	3.42	3.42	0.0	0.0	0.96
1967/1968	14.60	12.46	0.29	1.86	1.02
1968/1969	28.91	19.04	1.41	8.46	2.58
1969/1970	9.91	9.91	0.0	0.0	2.40
1970/1971	2.68	2.67	0.01	0.0	1.56
1971/1972	27.45	23.65	0.55	3.25	1.74
1972/1973	15.39	9.55	1.19	4.66	2.80
1973/1974	1.95	1.95	0.0	0.0	2.23
1974/1975	11.89	10.99	0.20	0.44	1.57
1975/1976	32.79	26.80	1.20	5.06	2.13
1976/1977	40.50	27.35	1.97	11.17	4.64
1977/1978	15.87	15.83	0.04	0.0	4.02
1978/1979	14.85	13.54	0.24	1.07	2.79
1979/1980	14.69	14.65	0.03	0.01	2.04
1980/1981	12.39	12.33	0.04	0.01	1.40
M E A N	16.97	14.43	0.43	2.10	1.99
	(100.0)	(85.0)	(2.6)	(12.4)	(11.7)

TABLE A.4.2-20

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-5)

SUBBASIN NO. 9 (BASIN AREA= 79.050.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPIRATION	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.77	0.24	0.22	0.23
1961/1962	1.45	1.45	0.0	0.00	0.13
1962/1963	17.70	16.24	0.64	0.82	0.14
1963/1964	14.42	12.15	0.79	1.48	0.49
1964/1965	14.41	11.14	1.36	1.91	0.88
1965/1966	5.14	4.91	0.0	0.23	0.75
1966/1967	2.11	2.11	0.0	0.00	0.51
1967/1968	9.04	7.31	0.68	1.04	0.55
1968/1969	17.89	11.75	1.93	4.20	1.31
1969/1970	6.13	6.10	0.0	0.03	1.28
1970/1971	1.66	1.63	0.0	0.03	0.87
1971/1972	16.98	13.89	1.28	1.82	0.96
1972/1973	9.52	5.55	2.00	1.97	1.37
1973/1974	1.21	1.20	0.0	0.01	1.10
1974/1975	7.36	6.39	0.52	0.27	0.78
1975/1976	20.29	15.69	2.79	1.99	0.91
1976/1977	25.05	16.16	3.56	5.33	2.04
1977/1978	9.82	9.74	0.0	0.07	1.92
1978/1979	9.19	8.30	0.37	0.52	1.31
1979/1980	9.09	8.95	0.0	0.13	0.98
1980/1981	7.66	7.56	0.0	0.10	0.74
M E A N	10.67	8.77	0.83	1.07	0.93
	(100.0)	(82.2)	(7.7)	(10.1)	(8.7)

TABLE A.4.2-21

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN THROUGH STORAGE MODEL ANALYSIS (CASE C'-5)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.59	0.0	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.39	0.23	1.77	0.76
1963/1964	30.46	27.92	0.16	2.38	0.92
1964/1965	30.44	25.92	0.54	3.98	1.43
1965/1966	10.86	10.73	0.0	0.13	1.73
1966/1967	4.47	4.47	0.0	0.0	1.48
1967/1968	19.08	16.88	0.27	1.93	1.20
1968/1969	37.78	26.26	1.37	10.15	1.94
1969/1970	12.94	12.94	0.0	0.0	2.62
1970/1971	3.50	3.50	0.0	0.0	2.79
1971/1972	35.87	32.17	0.24	3.46	1.96
1972/1973	20.11	13.32	1.46	5.33	2.42
1973/1974	2.55	2.55	0.0	0.0	2.66
1974/1975	15.54	14.76	0.07	0.45	2.25
1975/1976	42.85	36.15	1.62	5.35	2.01
1976/1977	52.92	37.19	2.35	13.38	3.45
1977/1978	20.74	20.74	0.0	0.0	4.47
1978/1979	19.41	18.24	0.06	1.11	3.88
1979/1980	19.19	19.18	0.0	0.01	3.18
1980/1981	16.19	16.17	0.0	0.01	2.43
MEAN	22.47	19.61	0.44	2.42	2.18
	(100.0)	(87.3)	(1.9)	(10.8)	(9.7)

TABLE A.4.2-22

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-6)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.29	0.31	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	52.79	0.96	2.92	1.92
1963/1964	46.17	40.75	1.02	4.43	1.99
1964/1965	46.14	37.99	1.65	6.50	2.68
1965/1966	16.47	16.01	0.09	0.36	2.85
1966/1967	6.77	6.76	0.0	0.00	2.23
1967/1968	28.93	24.76	0.81	3.36	2.03
1968/1969	57.27	39.03	2.69	15.55	3.53
1969/1970	19.62	19.59	0.0	0.03	4.32
1970/1971	5.30	5.25	0.02	0.03	3.49
1971/1972	54.37	46.88	1.51	5.99	3.18
1972/1973	30.49	19.49	2.66	8.33	4.44
1973/1974	3.87	3.86	0.0	0.01	4.25
1974/1975	23.56	21.51	0.61	0.87	3.42
1975/1976	64.95	53.56	3.52	8.44	3.36
1976/1977	80.21	54.79	4.73	20.70	6.28
1977/1978	31.43	31.22	0.14	0.07	7.19
1978/1979	29.42	27.11	0.51	1.80	5.83
1979/1980	29.09	28.85	0.10	0.14	4.64
1980/1981	24.54	24.33	0.09	0.12	3.49
MEAN	33.29 (100.0)	28.45 (85.5)	1.02 (3.1)	3.82 (11.5)	3.57 (10.7)

TABLE A.4.2-23

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-6)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.13	0.54	3.63	2.02
1965/1966	8.31	8.14	0.04	0.13	1.58
1966/1967	3.42	3.42	0.0	0.0	0.96
1967/1968	14.60	12.46	0.29	1.86	1.02
1968/1969	28.91	19.06	0.97	8.88	2.71
1969/1970	9.91	9.91	0.0	0.0	2.53
1970/1971	2.68	2.67	0.01	0.0	1.63
1971/1972	27.45	23.65	0.55	3.25	1.78
1972/1973	15.39	9.57	0.82	5.00	2.93
1973/1974	1.95	1.95	0.0	0.0	2.35
1974/1975	11.89	10.99	0.20	0.44	1.63
1975/1976	32.79	26.84	0.89	5.33	2.23
1976/1977	40.50	27.37	1.41	11.72	4.92
1977/1978	15.87	15.83	0.04	0.0	4.25
1978/1979	14.85	13.54	0.24	1.07	2.92
1979/1980	14.69	14.65	0.03	0.01	2.11
1980/1981	12.39	12.33	0.04	0.01	1.43
M E A N	16.97	14.43	0.35	2.18	2.06
	(100.0)	(85.1)	(2.1)	(12.8)	(12.1)

TABLE A.4.2-24

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-6)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
M E A N	10.67	8.91	0.35	1.40	1.25
	(100.0)	(83.6)	(3.3)	(13.1)	(11.7)

TABLE A.4.2-25

HYDROLOGIC BALANCE OF THE BASSIERAM BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-6)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.26	0.32	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	34.76	0.86	1.77	0.76
1963/1964	30.46	27.07	1.01	2.38	0.92
1964/1965	30.44	25.46	1.21	3.76	1.35
1965/1966	10.86	10.64	0.10	0.13	1.67
1966/1967	4.47	4.47	0.0	0.0	1.44
1967/1968	19.08	16.49	0.69	1.91	1.18
1968/1969	37.78	25.87	1.97	9.95	1.73
1969/1970	12.94	12.94	0.0	0.0	2.50
1970/1971	3.50	3.47	0.03	0.0	2.28
1971/1972	35.87	31.10	1.47	3.30	1.93
1972/1973	20.11	13.05	1.64	5.43	2.32
1973/1974	2.55	2.55	0.0	0.0	2.65
1974/1975	15.54	14.18	0.65	0.45	2.29
1975/1976	42.85	35.50	2.12	5.49	2.03
1976/1977	52.92	36.61	3.11	13.20	3.28
1977/1978	20.74	20.58	0.16	0.0	4.41
1978/1979	19.41	17.83	0.47	1.11	3.94
1979/1980	19.19	19.05	0.13	0.01	3.25
1980/1981	16.19	16.09	0.08	0.01	2.49
M E A N	22.47	19.28	0.78	2.41	2.16
	(100.0)	(85.8)	(3.5)	(10.7)	(9.6)

TABLE A.4.2-26

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-7)

(BASIN AREA=260.0SQ.KM)
UNIT; M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.52	0.08	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.26	0.51	2.90	1.92
1963/1964	46.17	41.38	0.41	4.40	1.98
1964/1965	46.14	38.38	1.17	6.60	2.69
1965/1966	16.47	16.07	0.03	0.36	2.92
1966/1967	6.77	6.76	0.0	0.00	2.25
1967/1968	28.93	25.09	0.50	3.35	2.00
1968/1969	57.27	39.40	2.40	15.47	3.64
1969/1970	19.62	19.59	0.0	0.03	4.43
1970/1971	5.30	5.27	0.01	0.03	3.45
1971/1972	54.37	47.69	0.60	6.08	3.07
1972/1973	30.49	19.80	2.65	8.04	4.51
1973/1974	3.87	3.86	0.0	0.01	4.22
1974/1975	23.56	21.92	0.20	0.87	3.31
1975/1976	64.95	54.25	3.30	7.97	3.27
1976/1977	80.21	55.30	4.41	20.52	6.31
1977/1978	31.43	31.32	0.04	0.07	7.15
1978/1979	29.42	27.44	0.19	1.79	5.61
1979/1980	29.09	28.92	0.03	0.14	4.43
1980/1981	24.54	24.39	0.03	0.12	3.33
M E A N	33.29 (100.0)	29.73 (86.3)	0.79 (2.4)	3.78 (11.3)	3.54 (10.6)

TABLE A.4.2-27

HYDROLOGIC BALANCE OF THE BASSIRAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-7)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.12	0.63	3.55	2.00
1965/1966	8.31	8.14	0.04	0.13	1.56
1966/1967	3.42	3.42	0.0	0.0	0.95
1967/1968	14.60	12.46	0.29	1.86	1.01
1968/1969	28.91	19.01	1.76	8.14	2.47
1969/1970	9.91	9.91	0.0	0.0	2.29
1970/1971	2.68	2.67	0.01	0.0	1.51
1971/1972	27.45	23.65	0.55	3.25	1.71
1972/1973	15.39	9.52	1.51	4.37	2.69
1973/1974	1.95	1.95	0.0	0.0	2.13
1974/1975	11.89	10.99	0.20	0.44	1.51
1975/1976	32.79	26.75	1.62	4.69	2.01
1976/1977	40.50	27.32	2.48	10.69	4.34
1977/1978	15.87	15.83	0.04	0.0	3.79
1978/1979	14.85	13.54	0.24	1.07	2.67
1979/1980	14.69	14.65	0.03	0.01	1.97
1980/1981	12.39	12.33	0.04	0.01	1.36
M E A N	16.97	14.42	0.51	2.03	1.92
	(100.0)	(85.0)	(3.0)	(12.0)	(11.3)

TABLE A.4.2-28

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-7)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
M E A N	10.67	8.91	0.35	1.40	1.25
	(100.0)	(83.6)	(3.3)	(13.1)	(11.7)

TABLE A.4.2-29

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-7)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.59	0.0	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.39	0.23	1.77	0.76
1963/1964	30.46	27.92	0.16	2.38	0.92
1964/1965	30.44	25.92	0.60	3.92	1.43
1965/1966	10.86	10.73	0.0	0.13	1.72
1966/1967	4.47	4.47	0.0	0.0	1.46
1967/1968	19.08	16.88	0.27	1.93	1.19
1968/1969	37.78	26.27	1.60	9.92	1.94
1969/1970	12.94	12.94	0.0	0.0	2.57
1970/1971	3.50	3.50	0.0	0.0	2.23
1971/1972	35.87	32.17	0.24	3.46	1.91
1972/1973	20.11	13.35	1.63	5.13	2.40
1973/1974	2.55	2.55	0.0	0.0	2.60
1974/1975	15.54	14.76	0.07	0.45	2.19
1975/1976	42.85	36.22	1.84	5.05	1.97
1976/1977	52.92	37.20	2.65	13.06	3.39
1977/1978	20.74	20.74	0.0	0.0	4.32
1978/1979	19.41	18.24	0.06	1.11	3.73
1979/1980	19.19	19.18	0.0	0.01	3.05
1980/1981	16.19	16.17	0.0	0.01	2.34
M E A N	22.47	19.63	0.46	2.38	2.15
	(100.0)	(87.4)	(2.1)	(10.6)	(9.6)

TABLE A.4.2-30

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-8)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.52	0.08	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.47	0.33	2.87	1.91
1963/1964	46.17	41.49	0.29	4.41	1.99
1964/1965	46.14	38.52	0.98	6.65	2.74
1965/1966	16.47	16.07	0.03	0.36	2.97
1966/1967	6.77	6.76	0.0	0.00	2.24
1967/1968	28.93	25.25	0.32	3.35	2.01
1968/1969	57.27	39.57	2.11	15.59	3.73
1969/1970	19.62	19.59	0.0	0.03	4.55
1970/1971	5.30	5.27	0.01	0.03	3.45
1971/1972	54.37	47.85	0.45	6.07	3.05
1972/1973	30.49	19.98	2.47	8.04	4.54
1973/1974	3.87	3.86	0.0	0.01	4.25
1974/1975	23.56	21.96	0.16	0.87	3.28
1975/1976	64.95	54.71	2.99	7.81	3.25
1976/1977	80.21	55.54	4.02	20.66	6.45
1977/1978	31.43	31.32	0.04	0.07	7.28
1978/1979	29.42	27.48	0.15	1.79	5.54
1979/1980	29.09	28.92	0.03	0.14	4.33
1980/1981	24.54	24.39	0.03	0.12	3.24
M E A N	33.29	28.82	0.69	3.78	3.56
	(100.0)	(86.6)	(2.1)	(11.4)	(10.7)

TABLE A.4.2-31

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-8)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.51	0.43	1.68	0.66
1963/1964	23.31	20.61	0.42	2.29	1.33
1964/1965	23.30	19.11	0.83	3.36	1.92
1965/1966	8.31	8.14	0.04	0.13	1.49
1966/1967	3.42	3.42	0.0	0.0	0.91
1967/1968	14.60	12.46	0.35	1.80	0.98
1968/1969	28.91	18.99	2.17	7.76	2.32
1969/1970	9.91	9.91	0.0	0.0	2.16
1970/1971	2.68	2.67	0.01	0.0	1.43
1971/1972	27.45	23.62	0.67	3.16	1.65
1972/1973	15.39	9.49	1.85	4.06	2.54
1973/1974	1.95	1.95	0.0	0.0	2.01
1974/1975	11.89	10.99	0.20	0.44	1.45
1975/1976	32.79	26.67	2.13	4.25	1.87
1976/1977	40.50	27.28	3.23	9.99	3.95
1977/1978	15.87	15.83	0.04	0.0	3.48
1978/1979	14.85	13.54	0.24	1.07	2.50
1979/1980	14.69	14.65	0.03	0.01	1.88
1980/1981	12.39	12.33	0.04	0.01	1.31
M E A N	16.97	14.41	0.63	1.92	1.81
	(100.0)	(84.9)	(3.7)	(11.3)	(10.7)

TABLE A.4.2-32

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-8)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
MEAN	10.67 (100.0)	8.91 (83.6)	0.35 (3.3)	1.40 (13.1)	1.25 (11.7)

TABLE A.4.2-33

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-8)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.59	0.0	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.64	0.0	1.75	0.76
1963/1964	30.46	28.07	0.0	2.40	0.94
1964/1965	30.44	26.09	0.36	3.99	1.52
1965/1966	10.86	10.73	0.0	0.13	1.76
1966/1967	4.47	4.47	0.0	0.0	1.46
1967/1968	19.08	17.09	0.04	1.95	1.20
1968/1969	37.78	26.46	1.22	10.09	2.11
1969/1970	12.94	12.94	0.0	0.0	2.66
1970/1971	3.50	3.50	0.0	0.0	2.22
1971/1972	35.87	32.39	0.02	3.46	1.90
1972/1973	20.11	13.55	1.40	5.17	2.49
1973/1974	2.55	2.55	0.0	0.0	2.61
1974/1975	15.54	14.93	0.0	0.45	2.15
1975/1976	42.85	36.73	1.46	4.92	2.00
1976/1977	52.92	37.47	2.17	13.28	3.64
1977/1978	20.74	20.74	0.0	0.0	4.41
1978/1979	19.41	18.30	0.0	1.11	3.65
1979/1980	19.19	19.18	0.0	0.01	2.95
1980/1981	16.19	16.17	0.0	0.01	2.26
M E A N	22.47	19.74	0.33	2.40	2.17
	(100.0)	(87.8)	(1.5)	(10.7)	(9.7)

TABLE A.4.2-34

HYDROLOGIC BALANCE OF THE BASSYERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-9)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.34	0.26	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	52.96	0.80	2.91	1.92
1963/1964	46.17	40.92	0.86	4.42	1.98
1964/1965	46.14	38.07	1.55	6.52	2.68
1965/1966	16.47	16.07	0.03	0.36	2.86
1966/1967	6.77	6.76	0.0	0.00	2.23
1967/1968	28.93	24.86	0.72	3.35	2.02
1968/1969	57.27	39.17	2.71	15.39	3.58
1969/1970	19.62	15.59	0.0	0.03	4.33
1970/1971	5.30	5.27	0.01	0.03	3.44
1971/1972	54.37	47.07	1.32	5.98	3.11
1972/1973	30.49	19.58	2.78	8.13	4.44
1973/1974	3.87	3.86	0.0	0.01	4.19
1974/1975	23.56	21.59	0.52	0.87	3.34
1975/1976	64.95	53.74	3.56	8.21	3.31
1976/1977	80.21	54.96	4.79	20.48	6.28
1977/1978	31.43	31.29	0.07	0.07	7.10
1978/1979	29.42	27.19	0.43	1.80	5.69
1979/1980	29.09	28.89	0.06	0.14	4.52
1980/1981	24.54	24.37	0.04	0.12	3.40
MEAN	33.29 (100.0)	28.53 (85.7)	0.98 (2.9)	3.78 (11.4)	3.54 (10.6)

TABLE A.4.2-35

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-9)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.13	0.54	3.63	2.02
1965/1966	8.31	8.14	0.04	0.13	1.58
1966/1967	3.42	3.42	0.0	0.0	0.96
1967/1968	14.60	12.46	0.29	1.86	1.02
1968/1969	28.91	19.04	1.41	8.46	2.58
1969/1970	9.91	9.91	0.0	0.0	2.40
1970/1971	2.68	2.67	0.01	0.0	1.56
1971/1972	27.45	23.65	0.55	3.25	1.74
1972/1973	15.39	9.55	1.19	4.66	2.80
1973/1974	1.95	1.95	0.0	0.0	2.23
1974/1975	11.89	10.99	0.20	0.44	1.57
1975/1976	32.79	26.80	1.20	5.06	2.13
1976/1977	40.50	27.35	1.97	11.17	4.64
1977/1978	15.87	15.83	0.04	0.0	4.02
1978/1979	14.85	13.54	0.24	1.07	2.79
1979/1980	14.69	14.65	0.03	0.01	2.04
1980/1981	12.39	12.33	0.04	0.01	1.40
M E A N	16.97	14.43	0.43	2.10	1.99
	(100.0)	(85.0)	(2.6)	(12.4)	(11.7)

TABLE A.4.2-36

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-9)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
MEAN	10.67	8.91	0.35	1.40	1.25
	(100.0)	(83.6)	(3.3)	(13.1)	(11.7)

TABLE A.4.2-37

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'-9)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.33	0.26	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.00	0.62	1.77	0.76
1963/1964	30.46	27.28	0.80	2.38	0.92
1964/1965	30.44	25.56	1.09	3.80	1.36
1965/1966	10.86	10.73	0.0	0.13	1.68
1966/1967	4.47	4.47	0.0	0.0	1.45
1967/1968	19.08	16.60	0.57	1.91	1.18
1968/1969	37.78	26.01	1.99	9.78	1.79
1969/1970	12.94	12.94	0.0	0.0	2.49
1970/1971	3.50	3.50	0.0	0.0	2.23
1971/1972	35.87	31.33	1.23	3.31	1.88
1972/1973	20.11	13.13	1.79	5.20	2.31
1973/1974	2.55	2.55	0.0	0.0	2.58
1974/1975	15.54	14.29	0.53	0.45	2.22
1975/1976	42.85	35.68	2.18	5.26	1.97
1976/1977	52.92	36.81	3.15	12.95	3.26
1977/1978	20.74	20.68	0.05	0.0	4.31
1978/1979	19.41	17.93	0.37	1.11	3.81
1979/1980	19.19	19.13	0.05	0.01	3.14
1980/1981	16.19	16.15	0.02	0.01	2.41
M E A N	22.47	19.38	0.72	2.37	2.13
	(100.0)	(86.3)	(3.2)	(10.5)	(9.5)

TABLE A.4.2-38

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'10)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPIRATION	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.34	0.26	0.55	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	52.96	0.80	2.91	1.92
1963/1964	46.17	40.92	0.86	4.42	1.98
1964/1965	46.14	38.08	1.59	6.47	2.68
1965/1966	16.47	16.07	0.03	0.36	2.85
1966/1967	6.77	6.76	0.0	0.00	2.22
1967/1968	28.93	24.86	0.72	3.35	2.01
1968/1969	57.27	39.19	2.88	15.20	3.62
1969/1970	19.62	19.59	0.0	0.03	4.29
1970/1971	5.30	5.27	0.01	0.03	3.38
1971/1972	54.37	47.07	1.32	5.98	3.06
1972/1973	30.49	19.62	2.92	7.94	4.44
1973/1974	3.87	3.86	0.0	0.01	4.13
1974/1975	23.56	21.59	0.52	0.87	3.27
1975/1976	64.95	53.84	3.75	7.92	3.28
1976/1977	80.21	54.98	5.03	20.21	6.26
1977/1978	31.43	31.29	0.07	0.07	6.96
1978/1979	29.42	27.19	0.43	1.80	5.52
1979/1980	29.09	28.89	0.06	0.14	4.39
1980/1981	24.54	24.37	0.04	0.12	3.31
M E A N	33.29	28.54	1.01	3.73	3.50
	(100.0)	(85.7)	(3.0)	(11.2)	(10.5)

TABLE A.4.2-39

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'10)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.12	0.63	3.55	2.00
1965/1966	8.31	8.14	-0.04	0.13	1.56
1966/1967	3.42	3.42	0.0	0.0	0.95
1967/1968	14.60	12.46	0.29	1.86	1.01
1968/1969	28.91	19.01	1.76	8.14	2.47
1969/1970	9.91	9.91	0.0	0.0	2.29
1970/1971	2.68	2.67	0.01	0.0	1.51
1971/1972	27.45	23.65	0.55	3.25	1.71
1972/1973	15.39	9.52	1.51	4.37	2.69
1973/1974	1.95	1.95	0.0	0.0	2.13
1974/1975	11.89	10.99	0.20	0.44	1.51
1975/1976	32.79	26.75	1.62	4.69	2.01
1976/1977	40.50	27.32	2.48	10.69	4.34
1977/1978	15.87	15.83	0.04	0.0	3.79
1978/1979	14.85	13.54	0.24	1.07	2.67
1979/1980	14.69	14.65	0.03	0.01	1.97
1980/1981	12.39	12.33	0.04	0.01	1.36
M E A N	16.97	14.42	0.51	2.03	1.92
	(100.0)	(85.0)	(3.0)	(12.0)	(11.3)

TABLE A.4.2-40

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'10)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1981	7.66	7.56	0.0	0.10	0.84
M E A N	10.67 (100.0)	8.91 (83.6)	0.35 (3.3)	1.40 (12.1)	1.25 (11.7)

TABLE A.4.2-41

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'10)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.33	0.26	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.00	0.62	1.77	0.76
1963/1964	30.46	27.28	0.80	2.38	0.92
1964/1965	30.44	25.57	1.14	3.73	1.36
1965/1966	10.86	10.73	0.0	0.13	1.66
1966/1967	4.47	4.47	0.0	0.0	1.43
1967/1968	19.08	16.60	0.57	1.91	1.17
1968/1969	37.78	26.02	2.20	9.56	1.80
1969/1970	12.94	12.94	0.0	0.0	2.44
1970/1971	3.50	3.50	0.0	0.0	2.17
1971/1972	35.87	31.33	1.23	3.31	1.83
1972/1973	20.11	13.15	1.97	4.99	2.28
1973/1974	2.55	2.55	0.0	0.0	2.52
1974/1975	15.54	14.29	0.53	0.45	2.15
1975/1976	42.85	35.75	2.42	4.54	1.92
1976/1977	52.92	36.83	3.46	12.63	3.19
1977/1978	20.74	20.68	0.05	0.0	4.15
1978/1979	19.41	17.93	0.37	1.11	3.64
1979/1980	19.19	19.13	0.05	0.01	3.01
1980/1981	16.19	16.15	0.02	0.01	2.32
M E A N	22.47	19.39	0.76	2.31	2.08
	(100.0)	(86.3)	(3.4)	(10.3)	(9.3)

TABLE A.4.2-42

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'11)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.02	0.68	0.45	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	52.32	1.83	2.53	1.92
1963/1964	46.17	40.43	2.15	3.60	1.94
1964/1965	46.14	37.73	2.74	5.67	2.31
1965/1966	16.47	15.93	0.18	0.35	2.26
1966/1967	6.77	6.76	0.0	0.00	1.99
1967/1968	28.93	24.52	1.50	2.91	2.00
1968/1969	57.27	38.89	4.32	14.06	3.31
1969/1970	19.62	19.59	0.0	0.03	3.56
1970/1971	5.30	5.23	0.05	0.03	3.07
1971/1972	54.37	46.36	3.13	4.88	2.89
1972/1973	30.49	19.35	3.64	7.50	3.75
1973/1974	3.87	3.86	0.0	0.01	3.58
1974/1975	23.56	21.21	1.33	0.71	3.03
1975/1976	64.95	52.98	4.88	7.42	3.08
1976/1977	80.21	54.48	6.90	18.83	5.66
1977/1978	31.43	31.09	0.27	0.07	6.06
1978/1979	29.42	26.82	1.03	1.57	5.16
1979/1980	29.09	28.72	0.23	0.14	4.16
1980/1981	24.54	24.25	0.17	0.12	3.23
MEAN	33.29	28.25	1.67	3.38	3.18
	(100.0)	(84.9)	(5.0)	(10.1)	(9.6)

TABLE A.4.2-43

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'11)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.42	0.10	0.24	1.35
1961/1962	2.35	2.35	0.0	0.0	0.77
1962/1963	28.62	26.52	0.39	1.71	0.66
1963/1964	23.31	20.61	0.39	2.31	1.35
1964/1965	23.30	19.13	0.54	3.63	2.02
1965/1966	8.31	8.14	0.04	0.13	1.58
1966/1967	3.42	3.42	0.0	0.0	0.96
1967/1968	14.60	12.46	0.29	1.86	1.02
1968/1969	28.91	19.04	1.41	8.46	2.58
1969/1970	9.91	9.91	0.0	0.0	2.40
1970/1971	2.68	2.67	0.01	0.0	1.56
1971/1972	27.45	23.65	0.55	3.25	1.74
1972/1973	15.39	9.55	1.19	4.66	2.80
1973/1974	1.95	1.95	0.0	0.0	2.23
1974/1975	11.89	10.99	0.20	0.44	1.57
1975/1976	32.79	26.80	1.20	5.06	2.13
1976/1977	40.50	27.35	1.97	11.17	4.64
1977/1978	15.87	15.83	0.04	0.0	4.02
1978/1979	14.85	13.54	0.24	1.07	2.79
1979/1980	14.69	14.65	0.03	0.01	2.04
1980/1981	12.39	12.33	0.04	0.01	1.40
M E A N	16.97	14.43	0.43	2.10	1.99
	(100.0)	(85.0)	(2.6)	(12.4)	(11.7)

TABLE A.4.2-44

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'11)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT; M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.46	0.57	0.19	0.22
1961/1962	1.45	1.45	0.0	0.00	0.12
1962/1963	17.70	15.50	1.53	0.67	0.11
1963/1964	14.42	11.63	1.70	1.10	0.29
1964/1965	14.41	10.88	1.97	1.56	0.60
1965/1966	5.14	4.69	0.22	0.23	0.56
1966/1967	2.11	2.11	0.0	0.00	0.42
1967/1968	9.04	7.06	1.12	0.85	0.44
1968/1969	17.89	11.53	2.77	3.59	1.01
1969/1970	6.13	6.10	0.0	0.03	1.03
1970/1971	1.66	1.56	0.07	0.03	0.75
1971/1972	16.98	13.28	2.41	1.29	0.76
1972/1973	9.52	5.43	2.30	1.79	1.08
1973/1974	1.21	1.20	0.0	0.01	0.93
1974/1975	7.36	6.02	1.07	0.22	0.68
1975/1976	20.29	15.23	3.36	1.75	0.79
1976/1977	25.05	15.69	4.63	4.73	1.73
1977/1978	9.82	9.42	0.32	0.07	1.65
1978/1979	9.19	8.01	0.77	0.41	1.15
1979/1980	9.09	8.70	0.26	0.13	0.87
1980/1981	7.66	7.39	0.18	0.10	0.69
M E A N	10.67	8.50	1.26	0.91	0.77
	(100.0)	(79.7)	(11.8)	(8.5)	(7.2)

TABLE A.4.2-45

HYDROLOGIC BALANCE OF THE BASSIERAN BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'11)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.33	0.26	0.24	0.82
1961/1962	3.07	3.07	0.0	0.0	0.92
1962/1963	37.40	35.00	0.62	1.77	0.76
1963/1964	30.46	27.28	0.80	2.38	0.92
1964/1965	30.44	25.56	1.09	3.80	1.36
1965/1966	10.86	10.73	0.0	0.13	1.68
1966/1967	4.47	4.47	0.0	0.0	1.45
1967/1968	19.08	16.60	0.57	1.91	1.18
1968/1969	37.78	26.01	1.99	9.78	1.79
1969/1970	12.94	12.94	0.0	0.0	2.49
1970/1971	3.50	3.50	0.0	0.0	2.23
1971/1972	35.87	31.33	1.23	3.31	1.88
1972/1973	20.11	13.13	1.79	5.20	2.31
1973/1974	2.55	2.55	0.0	0.0	2.58
1974/1975	15.54	14.29	0.53	0.45	2.22
1975/1976	42.85	35.68	2.18	5.26	1.97
1976/1977	52.92	36.91	3.15	12.95	3.26
1977/1978	20.74	20.68	0.05	0.0	4.31
1978/1979	19.41	17.93	0.37	1.11	3.81
1979/1980	19.19	19.13	0.05	0.01	3.14
1980/1981	16.19	16.15	0.02	0.01	2.41
M E A N	22.47	19.37	0.76	2.34	2.11
	(100.0)	(86.2)	(3.4)	(10.4)	(9.4)

TABLE A.4.2-46

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'12)

(BASIN AREA=260.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	39.15	38.37	0.39	0.39	1.96
1961/1962	4.65	4.65	0.0	0.00	1.92
1962/1963	56.68	53.10	1.31	2.25	1.92
1963/1964	46.17	41.22	1.38	3.59	1.93
1964/1965	46.14	38.24	2.23	5.67	2.59
1965/1966	16.47	16.08	0.09	0.30	2.36
1966/1967	6.77	6.76	0.0	0.00	1.93
1967/1968	28.93	25.04	1.07	2.82	1.95
1968/1969	57.27	39.26	3.78	14.23	3.65
1969/1970	19.62	19.59	0.0	0.03	3.83
1970/1971	5.30	5.27	0.01	0.03	2.86
1971/1972	54.37	47.28	2.08	5.02	2.73
1972/1973	30.49	19.66	3.52	7.32	4.15
1973/1974	3.87	3.86	0.0	0.01	3.58
1974/1975	23.56	21.74	0.80	0.61	2.74
1975/1976	64.95	53.91	4.65	6.79	2.97
1976/1977	80.21	54.95	6.40	18.88	6.19
1977/1978	31.43	31.23	0.13	0.07	6.26
1978/1979	29.42	27.29	0.77	1.35	4.70
1979/1980	29.09	28.86	0.10	0.13	3.63
1980/1981	24.54	24.33	0.09	0.12	2.73
M E A N	33.29	28.60	1.37	3.32	3.17
	(100.0)	(85.9)	(4.1)	(10.0)	(9.5)

TABLE A.4.2-47

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'12)

SUBBASIN NO. 5 (BASIN AREA=122.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	19.76	19.20	0.49	0.07	1.30
1961/1962	2.35	2.35	0.0	0.0	0.71
1962/1963	28.62	25.90	1.73	1.00	0.51
1963/1964	23.31	20.19	1.74	1.38	0.76
1964/1965	23.30	18.82	2.25	2.23	1.12
1965/1966	8.31	8.03	0.22	0.07	0.90
1966/1967	3.42	3.42	0.0	0.0	0.58
1967/1968	14.60	12.22	1.21	1.17	0.61
1968/1969	28.91	18.76	3.81	6.34	1.57
1969/1970	9.91	9.91	0.0	0.0	1.55
1970/1971	2.68	2.63	0.05	0.0	1.10
1971/1972	27.45	23.08	2.39	1.98	1.17
1972/1973	15.39	9.32	2.78	3.29	1.79
1973/1974	1.95	1.95	0.0	0.0	1.50
1974/1975	11.89	10.69	0.92	0.18	1.10
1975/1976	32.79	26.10	3.69	3.10	1.36
1976/1977	40.50	26.85	5.53	8.12	2.85
1977/1978	15.87	15.64	0.23	0.0	2.60
1978/1979	14.85	13.23	1.01	0.60	1.91
1979/1980	14.69	14.50	0.18	0.00	1.46
1980/1981	12.39	12.17	0.21	0.01	1.08
M E A N	16.97	14.18	1.38	1.41	1.32
	(100.0)	(83.5)	(8.1)	(8.3)	(7.8)

TABLE A.4.2-48

HYDROLOGIC BALANCE OF THE BASSIRAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'12)

SUBBASIN NO. 9 (BASIN AREA= 79.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI.N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	12.23	11.92	0.0	0.31	0.26
1961/1962	1.45	1.45	0.0	0.00	0.16
1962/1963	17.70	16.47	0.10	1.11	0.22
1963/1964	14.42	12.42	0.0	2.02	0.81
1964/1965	14.41	11.35	0.45	2.61	1.37
1965/1966	5.14	4.91	0.0	0.23	1.10
1966/1967	2.11	2.11	0.0	0.00	0.68
1967/1968	9.04	7.50	0.13	1.40	0.74
1968/1969	17.89	11.93	0.72	5.24	1.82
1969/1970	6.13	6.10	0.0	0.03	1.72
1970/1971	1.66	1.63	0.0	0.03	1.08
1971/1972	16.98	14.31	0.06	2.61	1.27
1972/1973	9.52	5.73	1.21	2.58	1.94
1973/1974	1.21	1.20	0.0	0.01	1.47
1974/1975	7.36	6.63	0.0	0.42	1.01
1975/1976	20.29	16.18	1.69	2.71	1.23
1976/1977	25.05	16.39	1.89	6.78	2.87
1977/1978	9.82	9.74	0.0	0.07	2.59
1978/1979	9.19	8.51	0.0	0.68	1.68
1979/1980	9.09	8.95	0.0	0.13	1.19
1980/1991	7.66	7.56	0.0	0.10	0.84
M E A N	10.67 (100.0)	8.91 (83.6)	0.35 (3.3)	1.40 (13.1)	1.25 (11.7)

TABLE A.4.2-49

HYDROLOGIC BALANCE OF THE BASSIERAH BASIN
THROUGH STORAGE MODEL ANALYSIS (CASE C'12)

SUBBASIN NO.10 (BASIN AREA=171.0SQ.KM)
UNIT: M.C.M.

YEAR	RAINFALL	EVAPO-TRANSPI,N	SURFACE RUNOFF	GROUNDWATER RECHARGE	GROUNDWATER RUNOFF
1960/1961	25.82	25.32	0.43	0.07	0.81
1961/1962	3.07	3.07	0.0	0.0	0.88
1962/1963	37.40	35.00	1.32	1.08	0.71
1963/1964	30.46	27.45	1.49	1.52	0.72
1964/1965	30.44	25.65	1.96	2.83	1.05
1965/1966	10.86	10.71	0.08	0.07	1.15
1966/1967	4.47	4.47	0.0	0.0	0.93
1967/1968	19.08	16.73	1.02	1.33	0.79
1968/1969	37.78	26.03	3.35	8.40	1.54
1969/1970	12.94	12.94	0.0	0.0	1.95
1970/1971	3.50	3.50	0.0	0.0	1.65
1971/1972	35.87	31.39	2.22	2.27	1.45
1972/1973	20.11	13.13	2.73	4.25	1.86
1973/1974	2.55	2.55	0.0	0.0	1.95
1974/1975	15.54	14.36	0.90	0.18	1.63
1975/1976	42.85	35.66	3.58	3.71	1.52
1976/1977	52.92	36.66	5.23	11.03	2.84
1977/1978	20.74	20.58	0.16	0.0	3.39
1978/1979	19.41	17.96	0.81	0.64	2.81
1979/1980	19.19	19.07	0.12	0.00	2.28
1980/1981	16.19	16.09	0.08	0.01	1.78
M E A N	22.47	19.39	1.23	1.85	1.66
	(100.0)	(86.3)	(5.5)	(8.2)	(7.4)

4.2.4. Water-use Simulation

(1) General

The hydrologic balance in the present condition and the augmented groundwater recharges are clarified to some extent through the study in the previous chapters.

However, to utilize these groundwater resource to a full scale, it is necessary to grasp the groundwater behavier in the aquifers besides the hydrologic balance.

The groundwater flows are, in general, very slow comparing with the surface flow. Therefore, in a water use planning, it is indespensable to understand the respons between recharge and draft.

Moreover, since the groundwater demands in the Basin concentrates into the coastal strip, it is also needed to pay careful considerations to the sea water intrusion into the coastal aquifers.

The said view points introduce the necessity of groundwater basin management. And it is also needed to establish manners of control for the management.

In case to clarify such matters, it is more convenient and practical to construct a mathematical model for groundwater system, groundwater hydraulic model, and to make simulations on various water-use alternatives applying the model.

The construction of such a hydraulic model for the Basin and simulations are described in the following sections.

(2) Hydraulic model

The mathematical hydraulic model is constructed basing upon the two-dimensional finite element model for an unsteady seepage.

1) Finite elements

Fig. A.4.2-6 shows the divisioning of finite elements on the groundwater sub-basins of the Basin. The numbers of mode and element reach 113 and 176 respectively.

2) Conditions of aquifer and aquiclude

The aquifers in the Basin are under unconfined condition. In a seepage analysis by the finite element method, the parameter on permeability is treated to be a constant. Therefore, since it is, in general, defined by the transmissivity and solved through matrix, the problem is treated to be under a confined condition. On the other hand, the model should solve the phenomenon of sea water intrusion and also treat three aquifers in different transmissivities.

Then, the transmissivity matrix consist of those which are drived from the permeability and groundwater depth of each element. To estimate the water depth, the aquiclude height is needed. The bed-rock surface map which is given in the chapter of hydrogeology is applied for this purpose.

3) Vertical charge of permeability

Three aquifers which are different in permeability are spread out in the Basin as described already in the chapter of hydrogeology. Those aquifers incline gently toward the sea, and the height of each aquifer changes in place to place. The height of each aquifer and its permeability at the representative spot are given in Fig. A.4.2-8. The relationship shown in the figure means the mean permeability of an element changes in accordance with the position of water head.

In the model, representative spot of strips which are defined as shown in Fig. A.4.2-2 and the mean permeability of strip changes with the water head of the spot following the relationship. The fixed permeability of 0.005 cm/sec is, however, adopted for the elements in the coastal strip and sea.

4) Specific yield

The storage coefficients of aquifers in the Basin are known through the field aquifer test to be less than 0.01. However the basin wide specific yield for an exploitation in large scale is not always to meet the mean storage coefficient. Therefore the specific yield of the Basin is defined on the course of construction of model. The result shows that those in the strip commanded by Node 66 and the other strips are 0.06 and 0.03 respectively.

5) Sea water intrusion

In case solving the sea water intrusion under an unsteady condition, two-phase flows of fresh and salt waters should be taken into account in the strict sence. In the practical sense, since the flow component of salt water is remarkablly small to that of fresh water, the sea water is assumed, in many cases, not to flows. Moreover, when the fresh water flow is not so strong, the condition of two-phase flows could be deemed to be under the Ghyben-Herzberg principle.

From the observed depth of interface between fresh and salt waters at the test well TW-3, the ratio of specific gravities of fresh and salt waters is defined to be 25.

Thus, the depth of interface, hs is defined as the following equation;

$$hs = 25\ hf$$

Where, hf is the fresh water head above sea level.

It is supposed that both waters are neither mixed each other nor diffused. Therefore in this analysis the interface is deemed to be a variable aquiclude.

6) Timing of simulation

The simulation is conducted in each calendar month for the past 20 years.

7) Boundary conditions

The boundary of the model is defined to be impervious wall except sea coast. The fixed water heads of 0.05 m are given to the nodes of 98, 104, 108 and 111 and for the nodes of 99, 105, 109, 112 and 113, fixed water head of 0.00 m is defined.

8) Assignment of recharge and draft patterns

The recharge patterns, which are estimated by the storage model are assigned to the corresponding elements as shows in Fig. A.4.2-3. The elements to be draft by groundwater use are shown in Fig. A.4.2-4.

9) Identification of model

The identification of hydraulic model is carried out by the trial runs under the said condition. The major verifying data are the water table maps and the position of the interface of fresh and salt waters at TW-3 spot, Node 66.

The simulated groundwater regime map on 1st August, 1980, the simulated 20-year hydrographs of groundwater heads and salt water interface at the representative spots are shown in Fig. A.4.2-5 and 4.2-6 respectively.

The permeabilities finally adopted to the model are modified from the result of pumping test, and shown in Fig. A.4.2-8. To meet the flat groundwater table around the lower gravel plain which is seen in Fig. A.4.2-5, the permeability of the coastal strip is obliged to be as a small value as 0.005 cm/sec.

The specific yield of the basin becomes 0.03 to 0.06 taking into consideration of the balance of recharge and draft of groundwater and the salination into coastal strip.

10) Present groundwater balance

The simulated 20-year groundwater balance of the Basin through the hydraulic model is given in Table A.4.2-51.

The 20-year mean recharge is 2.7 MCM/annum. The groundwater draft upto 1979/71 year is assumed at 1.45 MCM/annum. It is supposed to gradually increase in the following years upto 2.9 MCM/annum at 1979/80 year. The groundwater runoff from the basis into the sea is different in each year, but the mean value is estimated to be about 2.0 MCM/annum. The 20-year sum of balance between the recharge and the draft plus runoff reaches - 24 MCM (- 1.2 MCM/annum). Taking into account that the influence of initial storage assumed, this value is deemed not be any important meaning.

The estimated groundwater storage in the basin comprises on much approximations, but changes around 120 MCM. It reaches 150 MCM at most in the wet year and decreases upto 70 MCM in the dry year. So far the groundwater storage of the basin is concerned, the extreme dry and wet years in recent are 1967/68 and 1976/77 respectively.

(3) Water-use simulation

1) Case study

Three cases of water-use simulation are conducted to clarify the groundwater behavier under the planned water use allocation of the Project applying the hydraulic model.

The groundwater drafts of the cases are as shown in Table A.4.2-50.

TABLE A.4.2-50 Water-use Allocation in Each Case

(Unit: MCM/annum)

Water Uses	Case A	Case B	Case C
Present water Use in UAE			
Domestic water supply	0.48	0.48	0.48
Industrial use	0.07	0.07	0.07
Agricultural use	1.34	1.34	1.34
Sub-total	1.89	1.89	1.89
Present Water Use in Oman Dibba			
Domestic water supply	0.05	0.05	0.05
Agricultural use	0.96	0.96	0.96
Sub-total	1.01	1.01	1.01
Planned Water Use			
Industrial use	0.10	0.10	0.10
FAO Farm	0.07	0.07	0.07
New Vegetable Farm	0.73	-	0.30
New Fruit Farm	-	0.73	0,43
Sub-total	0.90	0.90	0.90
Total	3.80	3.80	3.80

2) Groundwater management

The major priorities of groundwater management of the Basin shall be put at the prevention of sea water intrusion and conservation of groundwater resource.

As the natural phenomenon, the sea water wedge is formed and intruded deeply into the coastal aquifers of the Basin. In a part of the coast, the salt water interface is floated upward due to the over draft, and the alkalination of farm land takes place already.

To prevent these phenomenon, it is only necessary to keep the salt water interface down the bottom of production wells. It is clear in the Gheyben-Herzberg Principle that the position of interface can be controlled by the level of fresh water head.

Therefore as per the Basin, a control height of fresh water head at an appropriate location shall be established to manage the depth of sea water interface. In this manner the groundwater resource will be conserved at a level in the same time.

The location and the height of water head are determined at Node 66 (TW-3) and 1.5 m above sea level respectively in the simulation. When the groundwater head at the node reaches this level or less, the all drafts except the domestic water supplies in both UAE and Oman are stopped until the head recovers to the level.

The location of production wells both existing and under planning is desirous to be at as far as possible from the sea taking into consideration of the said condition.

In the simulation, the production wells under the Project are supposed to be at three km or more far from the sea as shown in Fig. A.4.2-7.

3) Groundwater balance in each case

The groundwater balances of each case are given in Table A. 4.2-52 to 4.2-54 and Fig. A.4.2-9 to 4.2-11 Since the water requirements of each cases are the same, 3.8 MCM/annum, the same results are shown.

Due to the groundwater head reached to the control level, the groundwater drafts are stopped before the satisfaction of requirement in seven years of 1966/67, 1967/68, 1968/69, 1972/73, 1975/76 and 1976/77 in Cases A and C. It is only six years in Case B with the exception of 1976/77 year.

The extreme shortage takes place in 1967/68 for around 2.7 MCM/annum successively from the shortage of around 2.1 MCM/annum in the previous year.

The shortages other years are deemed to be not so severe amounting 1.2 MCM/annum or less.

FIG. A.4.2-1 FINITE ELEMENTS

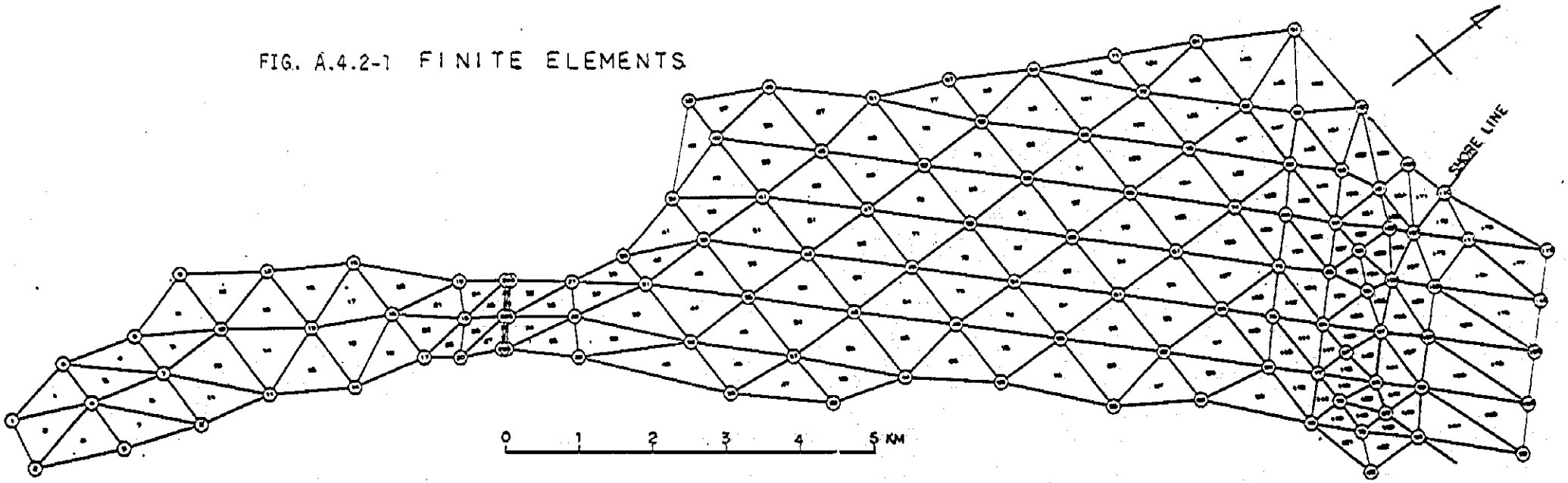


FIG. A.4.2-2 PERMEABILITY CONTROL NODES AND THEIR COMMANDING STRIPS

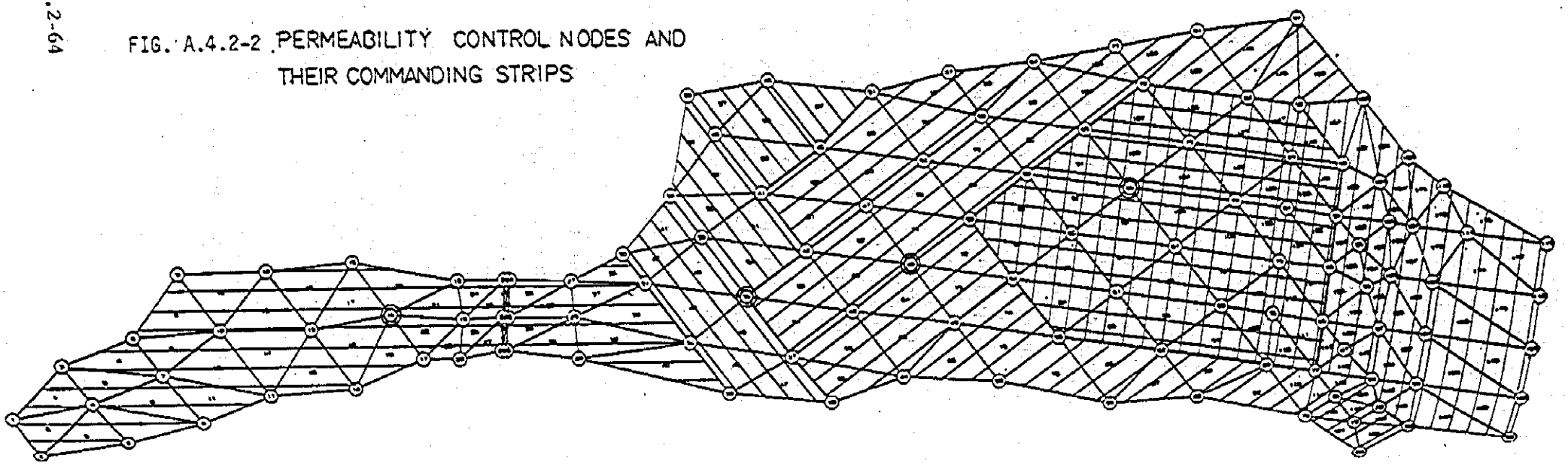


FIG. A.4.2-3 RECHARGE PATTERNS AND ASSIGNED ELEMENTS

NOTES: (1) ⑨; Area by vertical recharge.
(2) ⑥; Element additionally recharged by base flow of mountain wadi and its rate.
(3) Number in circle shows subbasin No. of storage model.

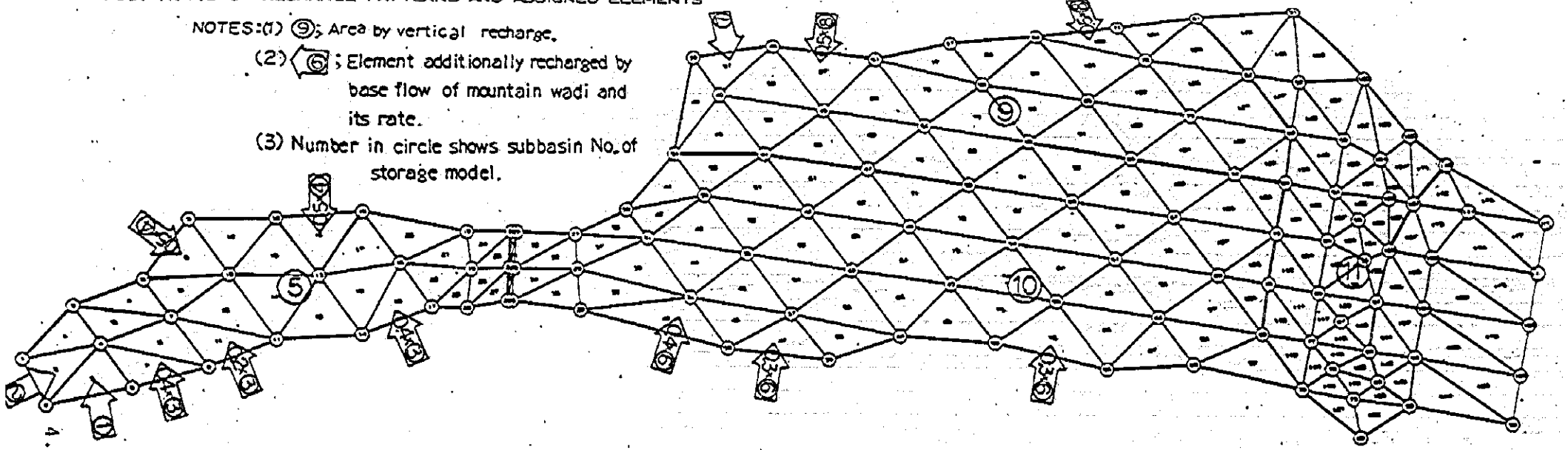


FIG. A.4.2-4 ELEMENTS AND AREAS FOR DRAFT

① Irrigation of Diba, U.A.E.
② —do— , Oman
③ Water supply for Diba, U.A.E.
④ —do— , Oman
⑤ FAO Farm
⑥ Tile Factory

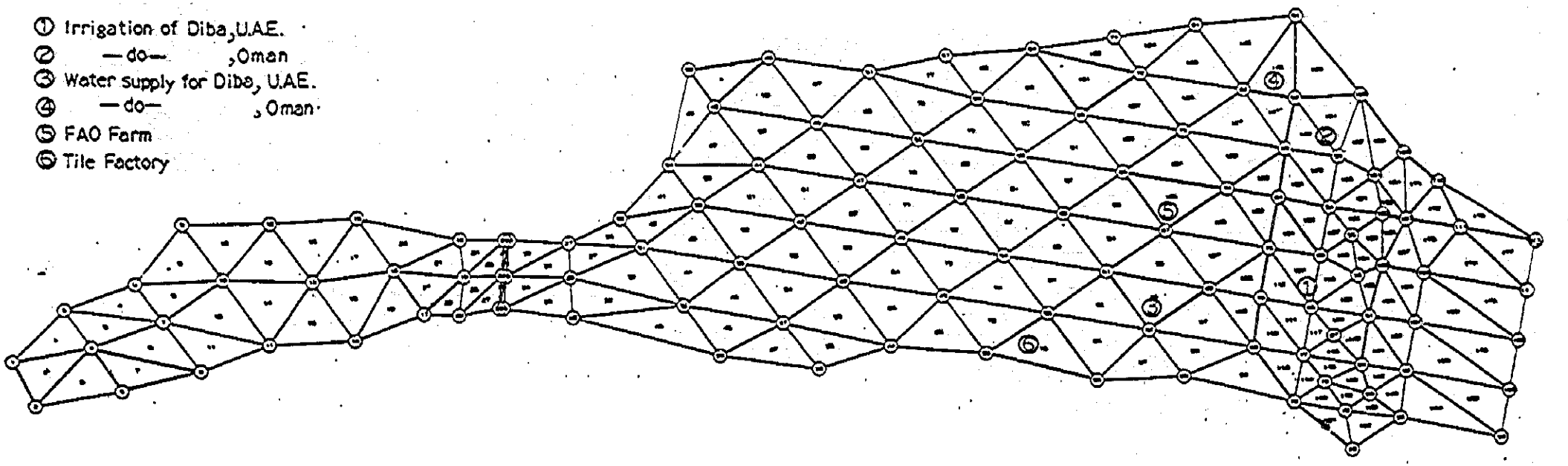


FIG. A.4.2-5 GROUNDWATER FLOW REGIME MAP (PRESENT CONDITION)

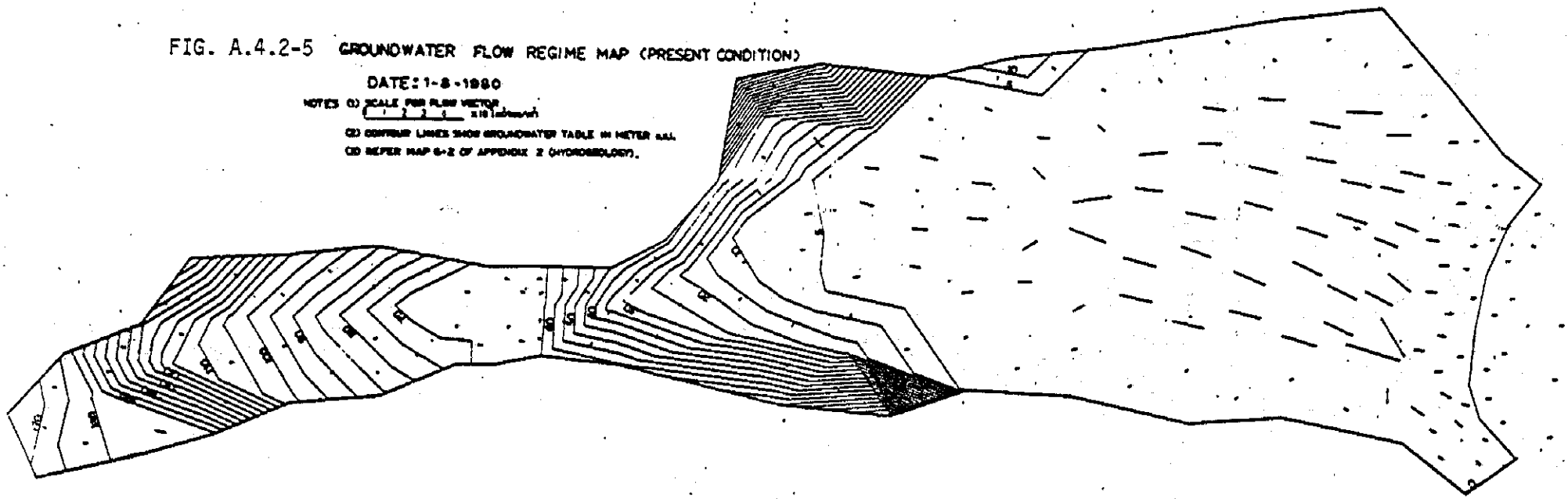


FIG. A.4.2-6

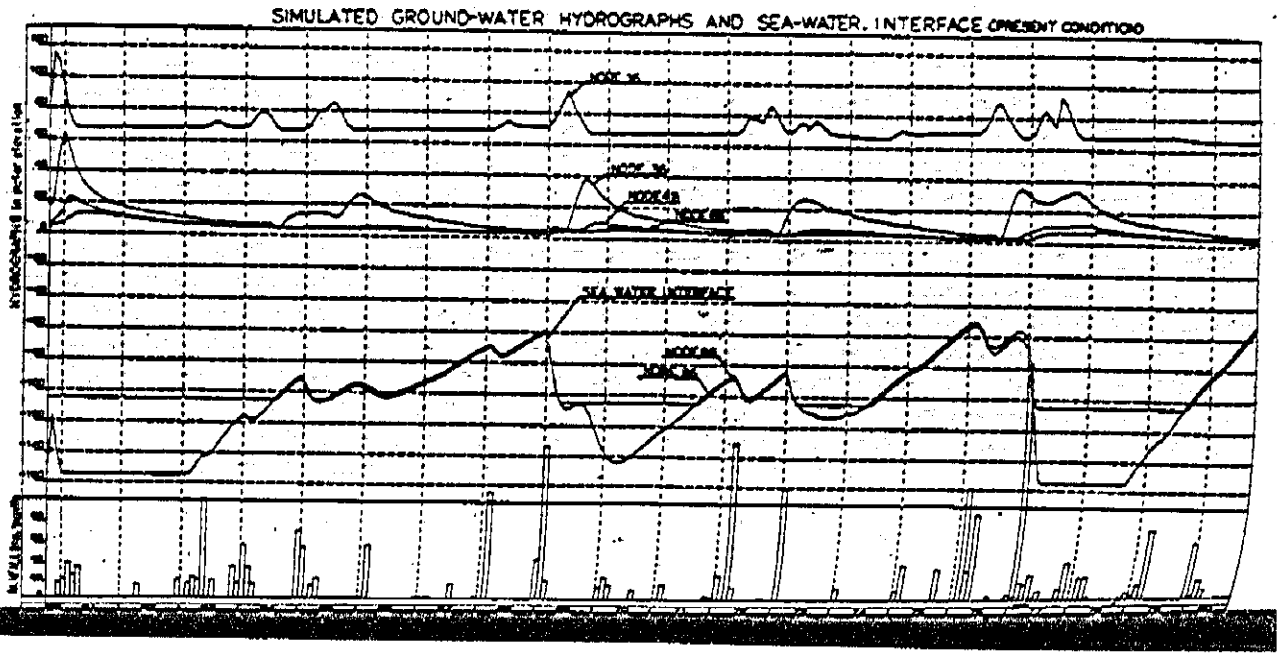
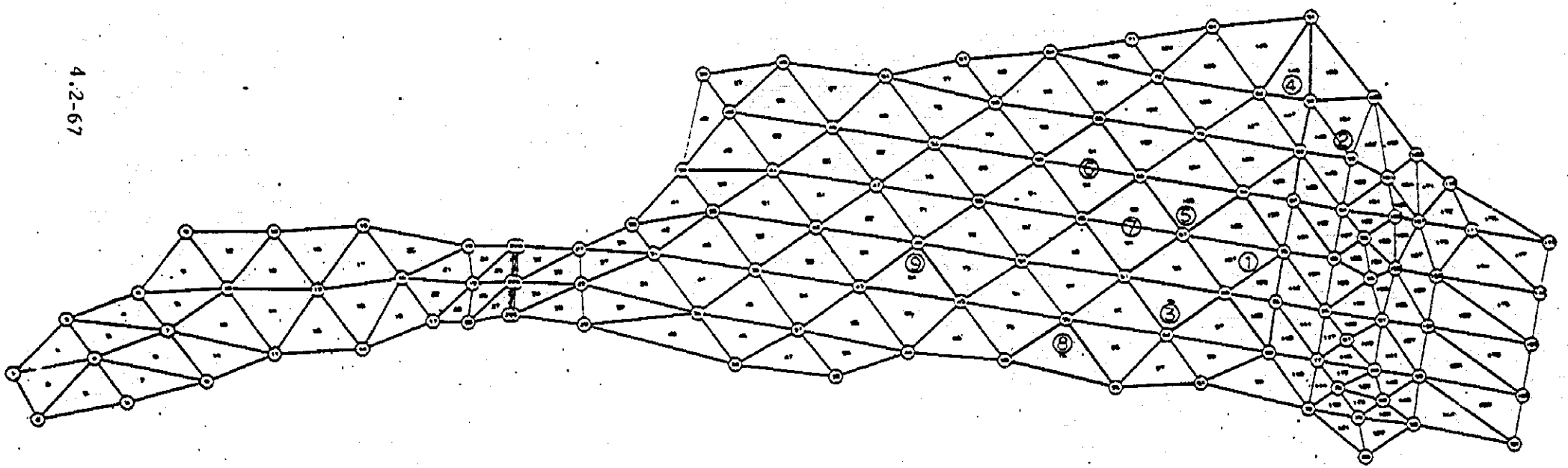


FIG. A.4.2-7

ELEMENTS AND AREAS FOR DRAFT OF SIMULATION

LEGEND

① Irrigation of Diba, U.A.E.
② —do— ,Oman
③ Water supply for Diba, U.A.E.
④ —do— ,Oman
⑤ FAO Farm
⑥ Fruit Farm
⑦ Local Farm
⑧ Tile Factory
⑨ Cement Factory



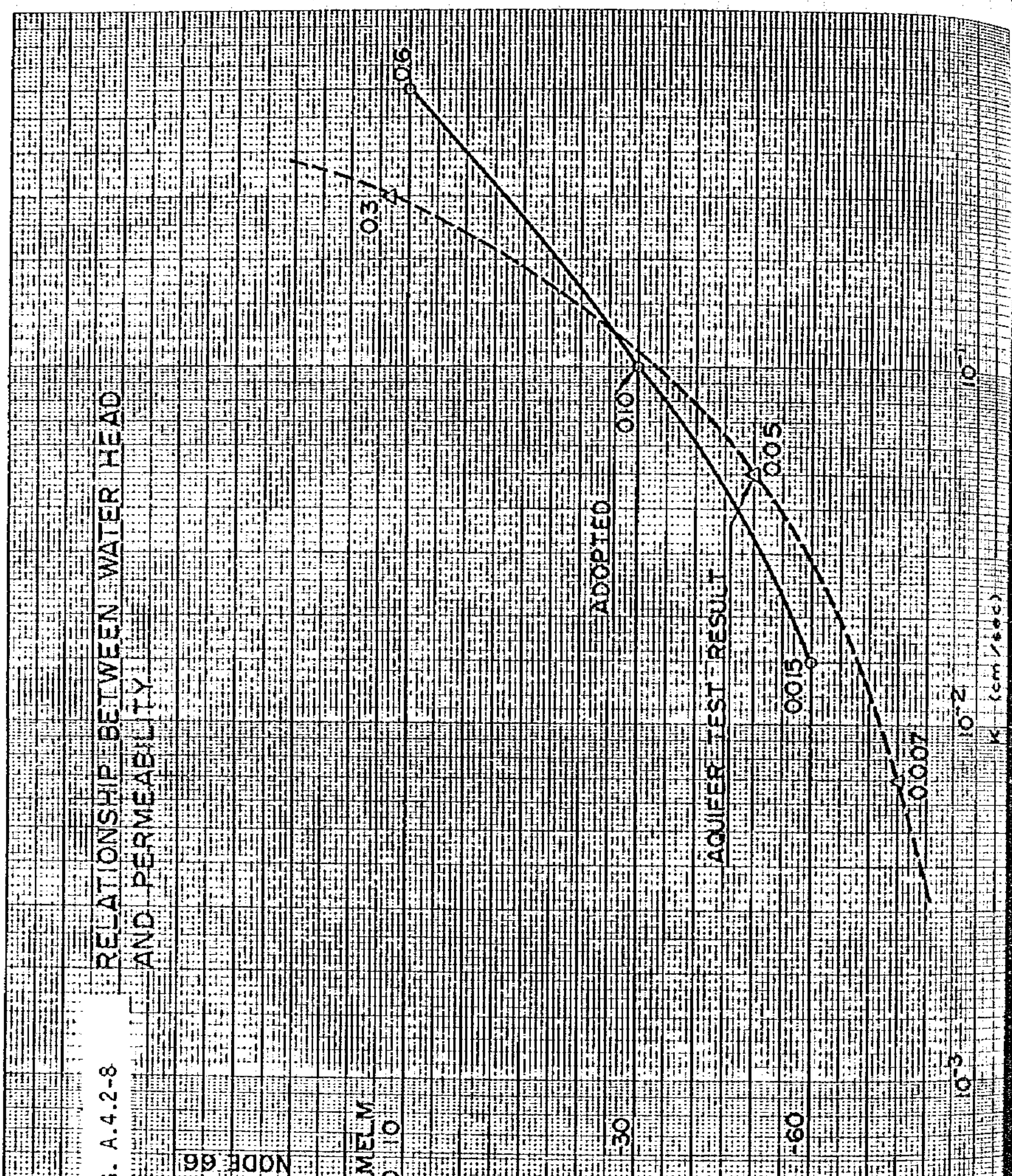


FIG. A.4.2-8 RELATIONSHIP BETWEEN WATER HEAD AND PERMEABILITY

TABLE A.4.2-51 GROUNDWATER BALANCE (Present Condition)

UNIT: MCM

YEAR		RECHARGE	WATER REQ.	SHORTAGE	DRAFT	G.W.RUNOFF	SUBTOTAL	BALANCE	STORAGE
60/	61	0.11 *	1.45	0.0	1.45	6.97	8.42 *	-8.31 *	164.40
61/	62	0.03 *	1.45	0.0	1.45	7.30	8.75 *	-8.72 *	155.22
62/	63	1.01 *	1.45	0.0	1.45	3.87	5.32 *	-4.31 *	146.39
63/	64	1.82 *	1.45	0.0	1.45	2.04	3.49 *	-1.67 *	129.25
64/	65	3.78 *	1.45	0.0	1.45	1.28	2.73 *	1.05 *	117.01
65/	66	0.58 *	1.45	0.0	1.45	0.79	2.24 *	-1.66 *	102.03
66/	67	0.48 *	1.45	0.0	1.45	0.50	1.95 *	-1.47 *	82.05
67/	68	1.86 *	1.45	0.0	1.45	0.29	1.74 *	0.12 *	69.99
68/	69	8.25 *	1.45	0.0	1.45	0.61	2.06 *	6.19 *	127.05
69/	70	1.26 *	1.45	0.0	1.45	1.96	3.41 *	-2.15 *	141.79
70/	71	1.05 *	1.45	0.0	1.45	1.66	3.11 *	-2.06 *	125.39
71/	72	3.61 *	1.93	0.0	1.93	1.02	2.95 *	0.66 *	110.69
72/	73	5.49 *	2.05	0.0	2.05	0.99	3.04 *	2.45 *	129.45
73/	74	1.14 *	2.16	0.0	2.16	1.13	3.29 *	-2.14 *	117.75
74/	75	1.18 *	2.28	0.0	2.28	0.71	2.99 *	-1.81 *	97.11
75/	76	5.03 *	2.39	0.0	2.39	0.44	2.83 *	2.20 *	97.44
76/	77	12.52 *	2.63	0.0	2.63	2.07	4.70 *	7.82 *	154.83
77/	78	1.80 *	2.72	0.0	2.72	3.86	6.57 *	-4.78 *	149.85
78/	79	2.06 *	2.91	0.0	2.91	2.30	5.21 *	-3.14 *	133.31
79/	80	1.37 *	2.91	0.0	2.91	0.92	3.82 *	-2.45 *	103.82
		54.45 *	37.93	0.0	37.93	40.69	78.62 *	-24.18 *	103.82

TABLE A.4.2-52 GROUNDWATER BALANCE (Case A)

UNIT: MCM

YEAR	RECHARGE	WATER REQ.	SHORTAGE	DRAFT	G.W.RUNOFF	SUBTOTAL	BALANCE	STORAGE
60/ 61	0.37 *	3.81	0.0	3.81	6.50	10.31 *	-9.94 *	162.56
61/ 62	0.03 *	3.81	0.0	3.81	5.96	9.77 *	-9.74 *	150.54
62/ 63	2.06 *	3.81	0.0	3.81	2.22	6.03 *	-3.97 *	118.43
63/ 64	3.47 *	3.81	0.0	3.81	0.67	4.48 *	-1.01 *	63.97
64/ 65	5.50 *	3.81	0.0	3.81	0.16	3.96 *	1.53 *	48.48
65/ 66	0.64 *	3.81	0.0	3.81	0.12	3.93 *	-3.29 *	47.77
66/ 67	0.48 *	3.81	2.07	1.73	0.05	1.79 *	-1.31 *	31.74
67/ 68	2.84 *	3.81	2.69	1.12	0.05	1.17 *	1.67 *	34.76
68/ 69	10.79 *	3.81	1.10	2.70	0.32	3.03 *	7.77 *	130.53
69/ 70	1.26 *	3.81	0.0	3.81	1.67	5.48 *	-4.22 *	123.05
70/ 71	1.05 *	3.81	0.0	3.81	0.72	4.53 *	-3.48 *	64.27
71/ 72	5.69 *	3.81	0.0	3.81	0.11	3.92 *	1.77 *	35.16
72/ 73	6.96 *	3.81	0.90	2.91	0.28	3.18 *	3.78 *	103.88
73/ 74	1.14 *	3.81	0.0	3.81	0.77	4.57 *	-3.43 *	92.79
74/ 75	1.60 *	3.81	0.0	3.81	0.31	4.12 *	-2.52 *	38.04
75/ 76	7.28 *	3.81	1.23	2.58	0.07	2.65 *	4.63 *	39.25
76/ 77	15.83 *	3.81	0.30	3.51	1.59	5.10 *	10.74 *	158.93
77/ 78	1.80 *	3.81	0.0	3.81	4.97	8.78 *	-6.99 *	150.57
78/ 79	2.75 *	3.81	0.0	3.81	2.30	6.11 *	-3.36 *	123.89
79/ 80	1.38 *	3.81	0.0	3.81	0.70	4.51 *	-3.14 *	70.24
	72.92 *	76.18	8.31	67.87	29.56	97.43 *	-24.51 *	70.24

TABLE A.4.2-53 GROUNDWATER BALANCE (Case B)

UNIT: MCM

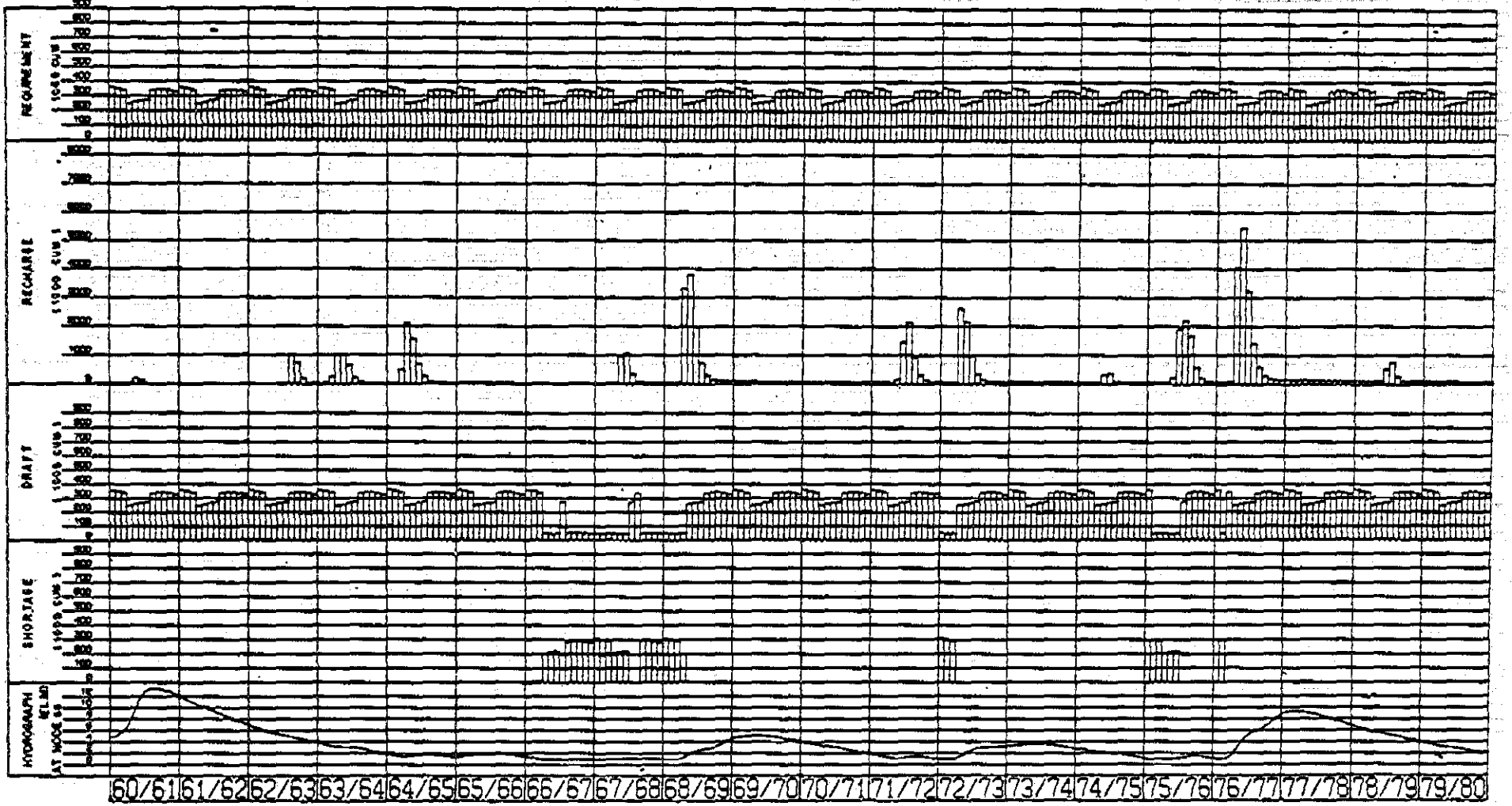
YEAR		RECHARGE	WATER REQ.	SHORTAGE	DRAFT	G.W.RUNOFF	SUBTOTAL	BALANCE	STORAGE
60/	61	0.37 *	3.81	0.0	3.81	6.54	10.35 *	-9.98 *	162.52
61/	62	0.03 *	3.81	0.0	3.81	5.98	9.79 *	-9.76 *	150.43
62/	63	2.06 *	3.81	0.0	3.81	2.23	6.04 *	-3.99 *	117.47
63/	64	3.47 *	3.81	0.0	3.81	0.67	4.48 *	-1.02 *	62.39
64/	65	5.50 *	3.81	0.0	3.81	0.16	3.97 *	1.53 *	46.73
65/	66	0.64 *	3.81	0.0	3.81	0.12	3.93 *	-3.29 *	45.95
66/	67	0.48 *	3.81	2.19	1.62	0.05	1.68 *	-1.20 *	32.27
67/	68	2.84 *	3.81	2.72	1.09	0.05	1.14 *	1.70 *	35.23
68/	69	10.79 *	3.81	0.98	2.83	0.32	3.15 *	7.64 *	129.77
69/	70	1.26 *	3.81	0.0	3.81	1.68	5.49 *	-4.23 *	122.10
70/	71	1.05 *	3.81	0.0	3.81	0.73	4.54 *	-3.48 *	62.58
71/	72	5.69 *	3.81	0.0	3.81	0.11	3.92 *	1.77 *	33.21
72/	73	6.96 *	3.81	0.98	2.83	0.29	3.11 *	3.85 *	102.38
73/	74	1.14 *	3.81	0.0	3.81	0.71	4.52 *	-3.37 *	87.07
74/	75	1.60 *	3.81	0.0	3.81	0.28	4.09 *	-2.49 *	33.69
75/	76	7.28 *	3.81	1.18	2.63	0.07	2.70 *	4.59 *	40.02
76/	77	15.83 *	3.81	0.0	3.81	1.68	5.49 *	10.35 *	157.93
77/	78	1.80 *	3.81	0.0	3.81	4.75	8.56 *	-6.76 *	149.99
78/	79	2.75 *	3.81	0.0	3.81	2.24	6.05 *	-3.30 *	121.75
79/	80	1.38 *	3.81	0.0	3.81	0.69	4.50 *	-3.12 *	68.57
		72.92 *	76.20	8.05	68.15	29.34	97.48 *	-24.56 *	68.57

TABLE A.4.2-54 GROUNDWATER BALANCE (Case C)

UNIT: MCM

YEAR		RECHARGE	WATER REQ.	SHORTAGE	DRAFT	G.W.RUNOFF	SUBTOTAL	BALANCE	STORAGE
60/	61	0.37 *	3.81	0.0	3.81	6.52	10.33 *	-9.96 *	162.54
61/	62	0.03 *	3.81	0.0	3.81	5.98	9.79 *	-9.75 *	150.47
62/	63	2.06 *	3.81	0.0	3.81	2.23	6.04 *	-3.98 *	117.83
63/	64	3.47 *	3.81	0.0	3.81	0.67	4.48 *	-1.01 *	62.99
64/	65	5.50 *	3.81	0.0	3.81	0.16	3.97 *	1.53 *	47.40
65/	66	0.64 *	3.81	0.0	3.81	0.12	3.93 *	-3.29 *	46.65
66/	67	0.48 *	3.81	2.12	1.69	0.05	1.74 *	-1.26 *	31.66
67/	68	2.84 *	3.81	2.66	1.15	0.05	1.20 *	1.64 *	33.88
68/	69	10.79 *	3.81	1.03	2.78	0.31	3.09 *	7.70 *	129.29
69/	70	1.26 *	3.81	0.0	3.81	1.65	5.46 *	-4.20 *	122.01
70/	71	1.05 *	3.81	0.0	3.81	0.72	4.53 *	-3.47 *	62.71
71/	72	5.69 *	3.81	0.0	3.81	0.11	3.92 *	1.77 *	33.46
72/	73	6.96 *	3.81	1.03	2.78	0.29	3.07 *	3.89 *	105.67
73/	74	1.14 *	3.81	0.0	3.81	0.83	4.64 *	-3.50 *	94.21
74/	75	1.60 *	3.81	0.0	3.81	0.34	4.15 *	-2.55 *	38.39
75/	76	7.28 *	3.81	1.16	2.65	0.08	2.72 *	4.56 *	39.45
76/	77	15.83 *	3.81	0.28	3.53	1.68	5.21 *	10.62 *	158.28
77/	78	1.80 *	3.81	0.0	3.81	4.79	8.60 *	-6.80 *	150.04
78/	79	2.75 *	3.81	0.0	3.81	2.23	6.04 *	-3.30 *	121.90
79/	80	1.38 *	3.81	0.0	3.81	0.68	4.40 *	-3.12 *	67.68
		72.92 *	76.20	8.28	67.92	29.48	97.40 *	-24.48 *	67.68

FIG. A.4.2-9 GROUNDWATER BALANCE (CASE A)



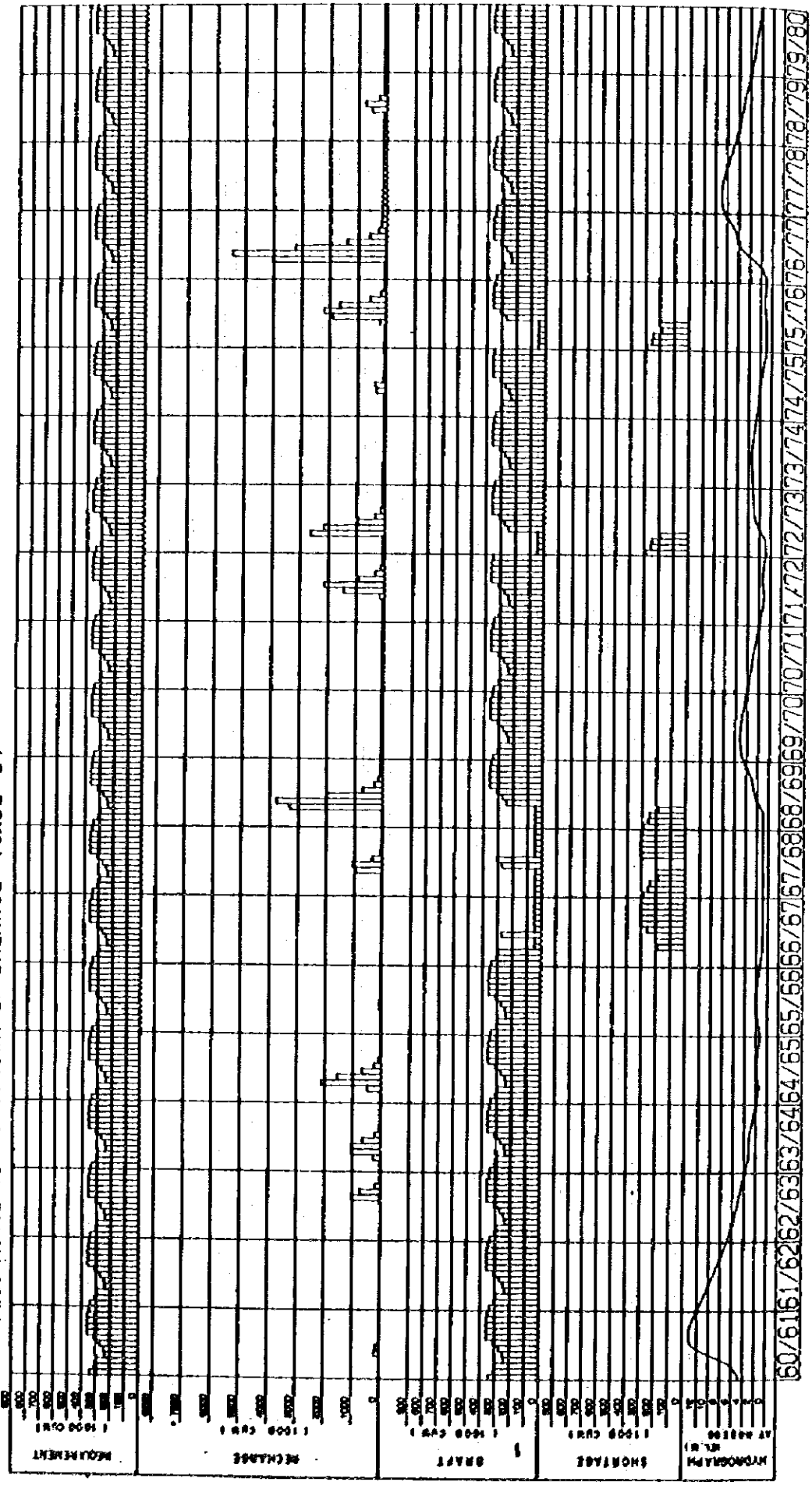
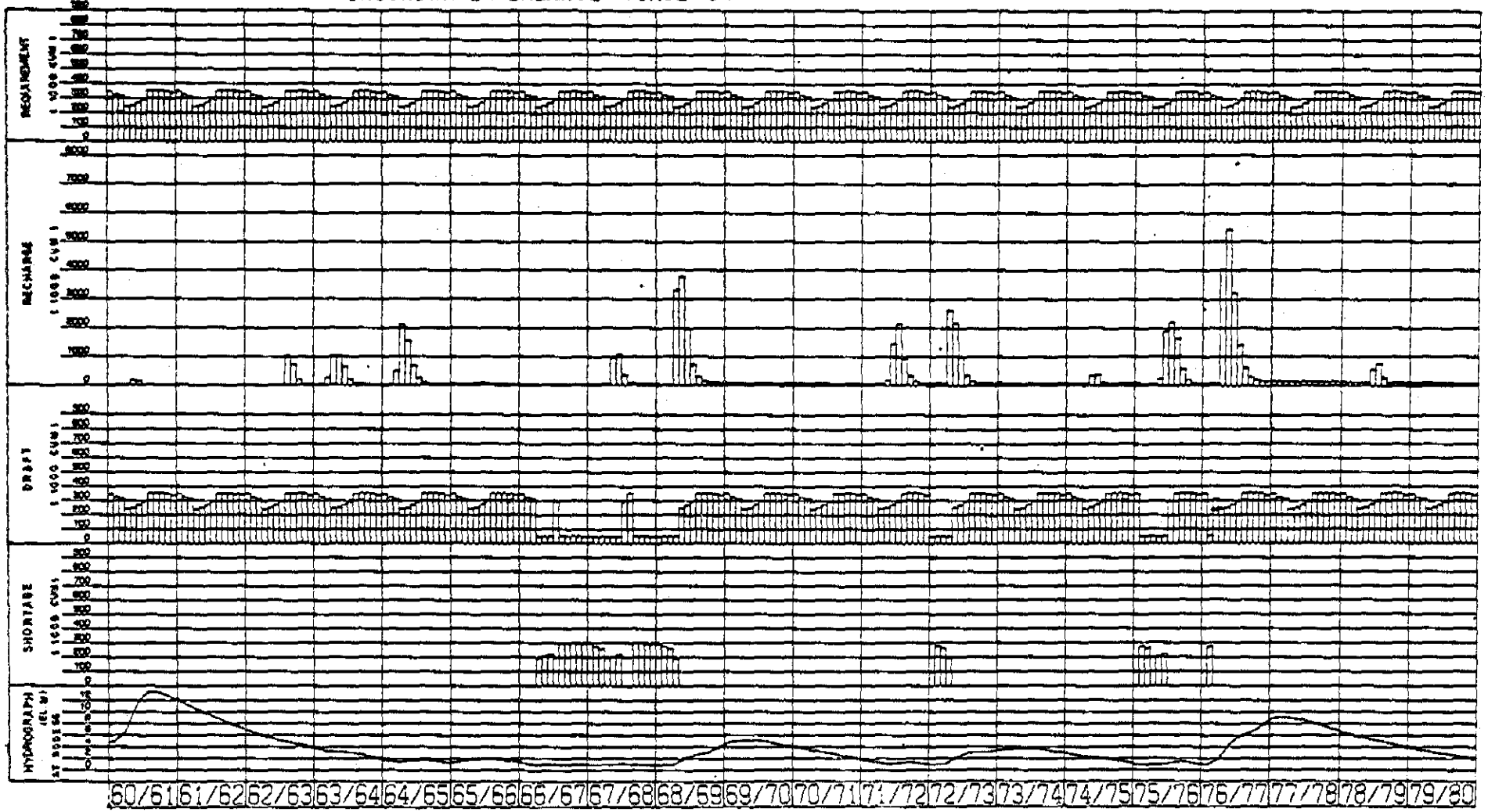


FIG. A.4.2-10 GROUNDWATER BALANCE (CASE B)

FIG. A.4.2-11 GROUNDWATER BALANCE (CASE C)



4.2.5. Conclusion and Recommendation

The water resource of Al Bassierah Basin is Clarified through the study and analysis described previously and the information and data available at the moment, at 2.9 MCM/annum in the present condition and at 3.8 MCM/annum when the planned facilities are constructed by the Project.

Since the applied information and data on hydrology and hydrogeology are relatively poor from the probability viewpoint, the time-series observations on the said data are very much recommendable to successively continue for at least another decade utilizing the hydrologic observatory network which is set up by JICA Team.

Two flood gauges set up at the proposed Al Bassierah Dam site should be removed since they stand on just the construction site of dam body.

The dam would be embanked crossing the whole flood plain and store, then release or spill the flood runoffs. Therefore the gauging of flood runoff at this site becomes very easy and reliable.

The automatic gauges are very recommended to remove and install newly at the exist of the conduit, the spillway crest and the inside of reservoir to observe the storaged water level. The gauge to be sep up in the reservoir shall be on the top of tower about 16 m high above the reservoir bed.

When the data are properly collected for first several years, another study as same as what carried out in this report shall be conducted again to confirm and verify the water resource eveluated.

The basic concept on the principle and manner of Wadi Al Bassierah Groundwater Basin is already described in the chapter on water-use simulation. The key-point to manage the basin is to control the

height of fresh groundwater head.

The control shall be performed observing the fresh water head and the depth of salt water interface in the observatory wells of TW-3 and BH-1 which are installed by JICA Team. Since the observatory Well of TW-3 is just nearby one of production wells for FAO Farm, it is recommended to remove it to an appropriate location where no interference of production wells is expected.

The coastal area are already affected the salination due to overdraft. The existing production wells for every purpose, particularly those for the existing gardens in Oibba Oasis, are preferably to the unified and remove to a location of three km far or more from the sea.

6) Timing of simulation

The simulation is conducted in each culender month for the past 20 years.

7) Boundary conditions

The boundary of the model is defined to be impervious wall except sea coast. The fixed water heads of 0.05 m are given to the nodes of 98, 104, 108 and 111 and for the nodes of 99, 105, 109, 112 and 113, fixed water head of 0.00 m is defined.

8) Assignment of recharge and draft patterns

The recharge patterns, which are estimated by the storage model are assigned to the corresponding elements as shows in Fig. 4-2-29. The elements to be draft by groundwater use are shown in Fig. 4-2-30.

9) Idenfification of model

The idenfification of hydraulic model is carried out by the trialruns under the said conditions. The major verifying data are the water table maps and the position of the interface of fresh and salt waters at TW-3 spot, Node 66.

The simulated groundwater regime map on 1st August, 1980, the simulated 20-year hydrographs of groundwater heads and salt water interface at the representative spots are shown in Figs. 4-2-31 and 4-2-32 respectively.

The permeabilities finally adopted to the model are modified from the result of pumping tests, and shown in Fig. 4-2-27. To meet the flat groundwater table around the lower gravel plain which is seen in Fig. 4-2-31, the permeability of the coastal strip is obliged to be as a small value as 0.005 cm/sec.