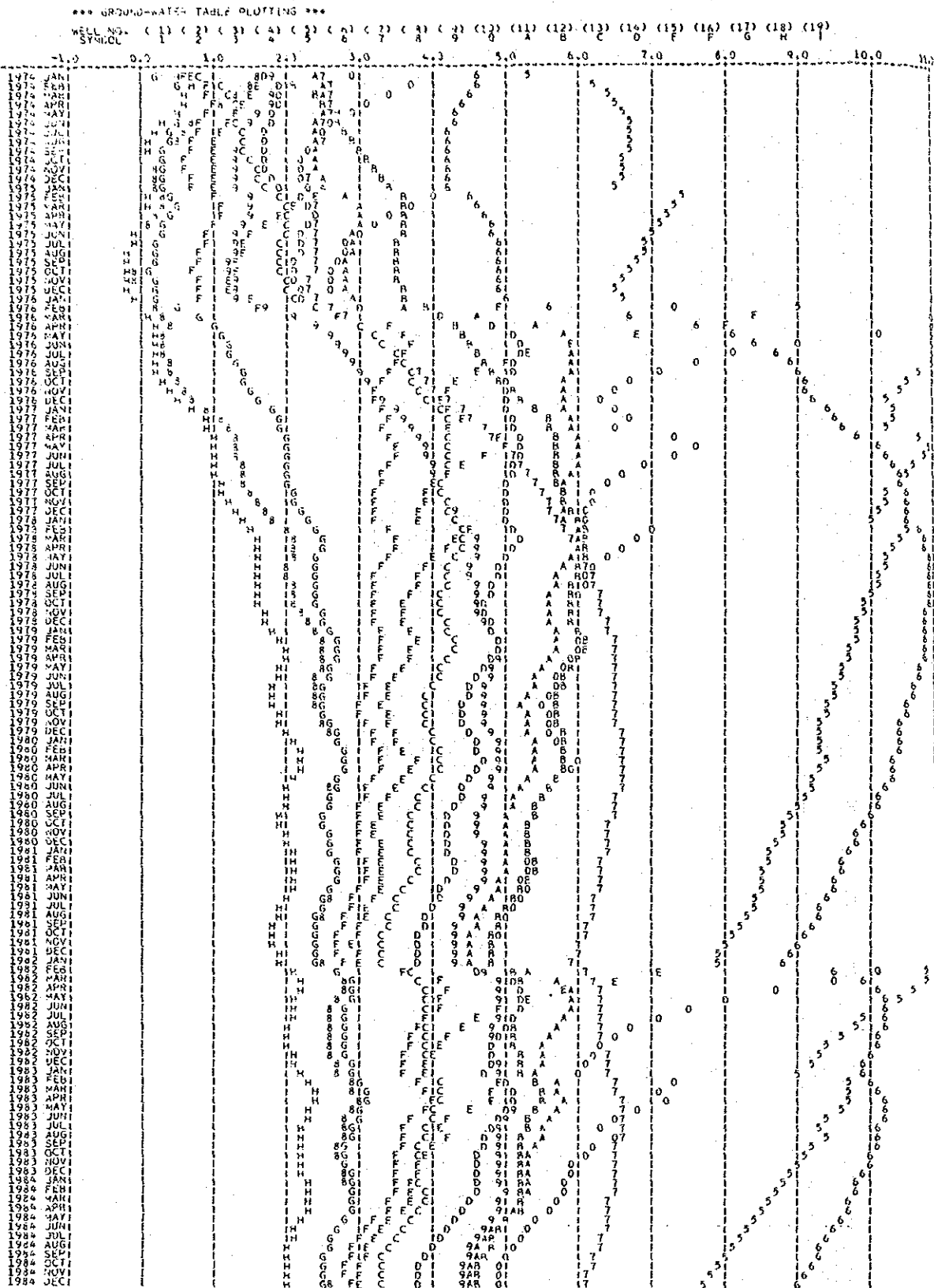
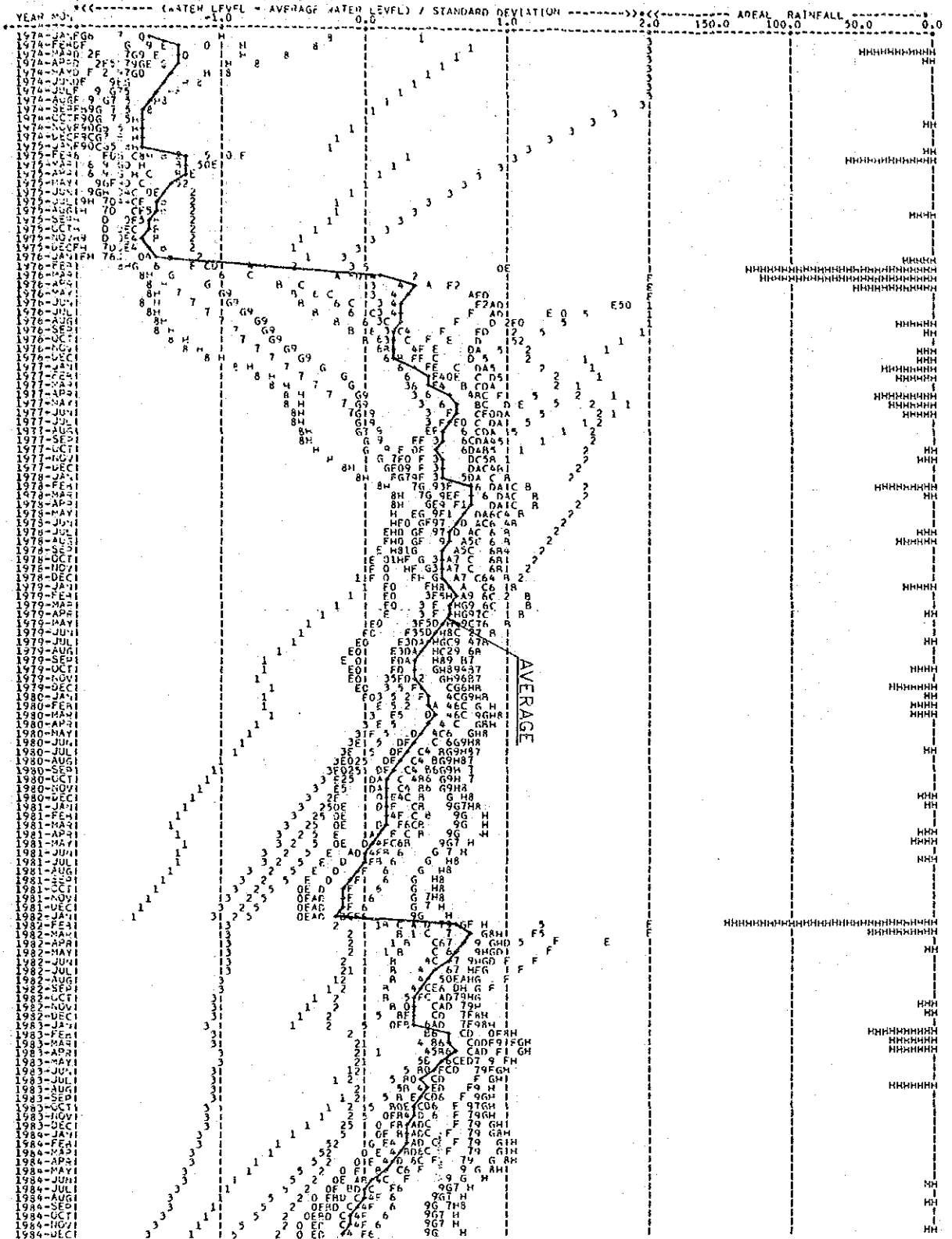


Figure B-27 Simulated Groundwater Tables (Case 2)



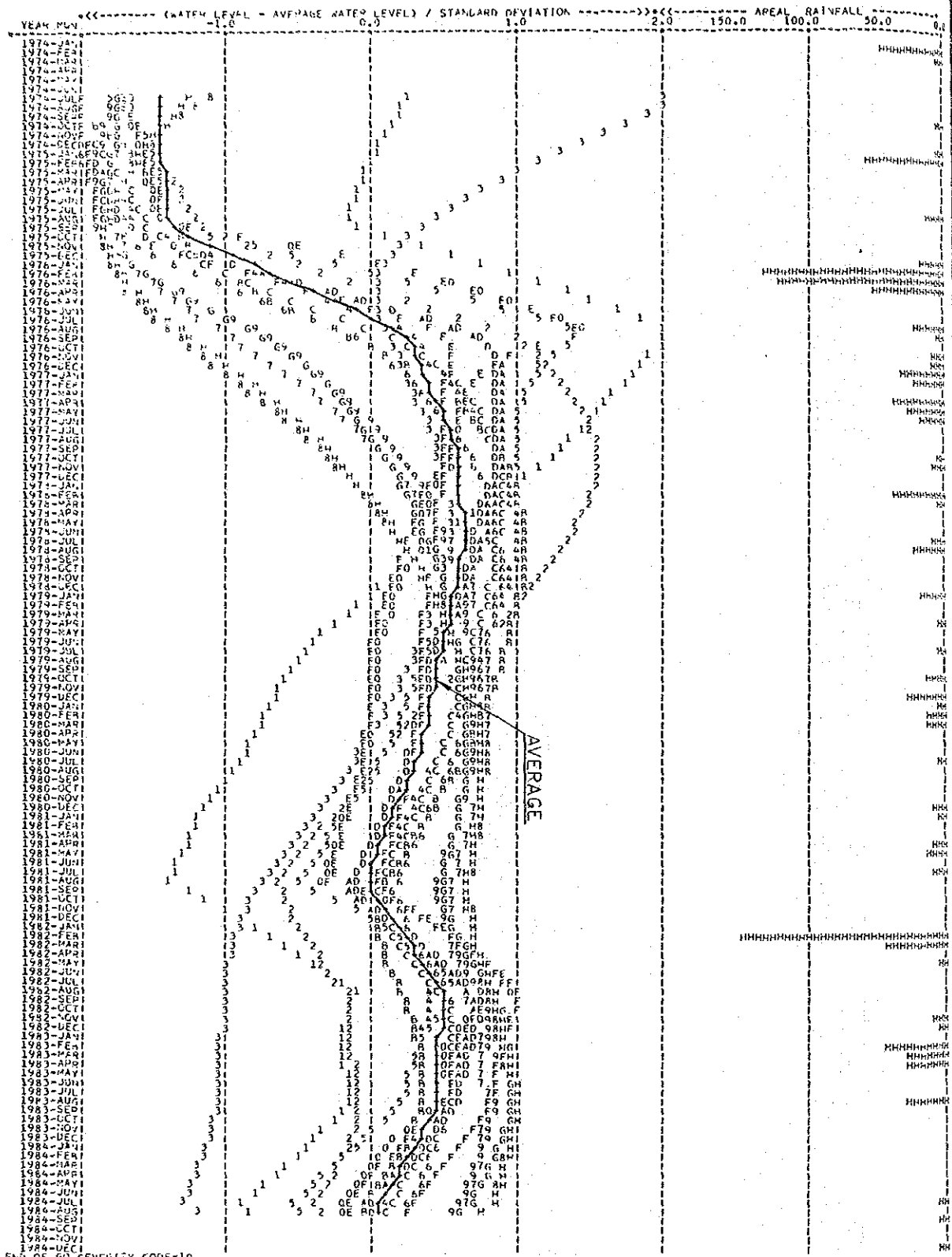
SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	OA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	EOS-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	OA-2	I	SEA		

Figure B-28 Deviation of Groundwater Level (Case 2)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	DA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	BOS-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	DA-2	I	SEA		

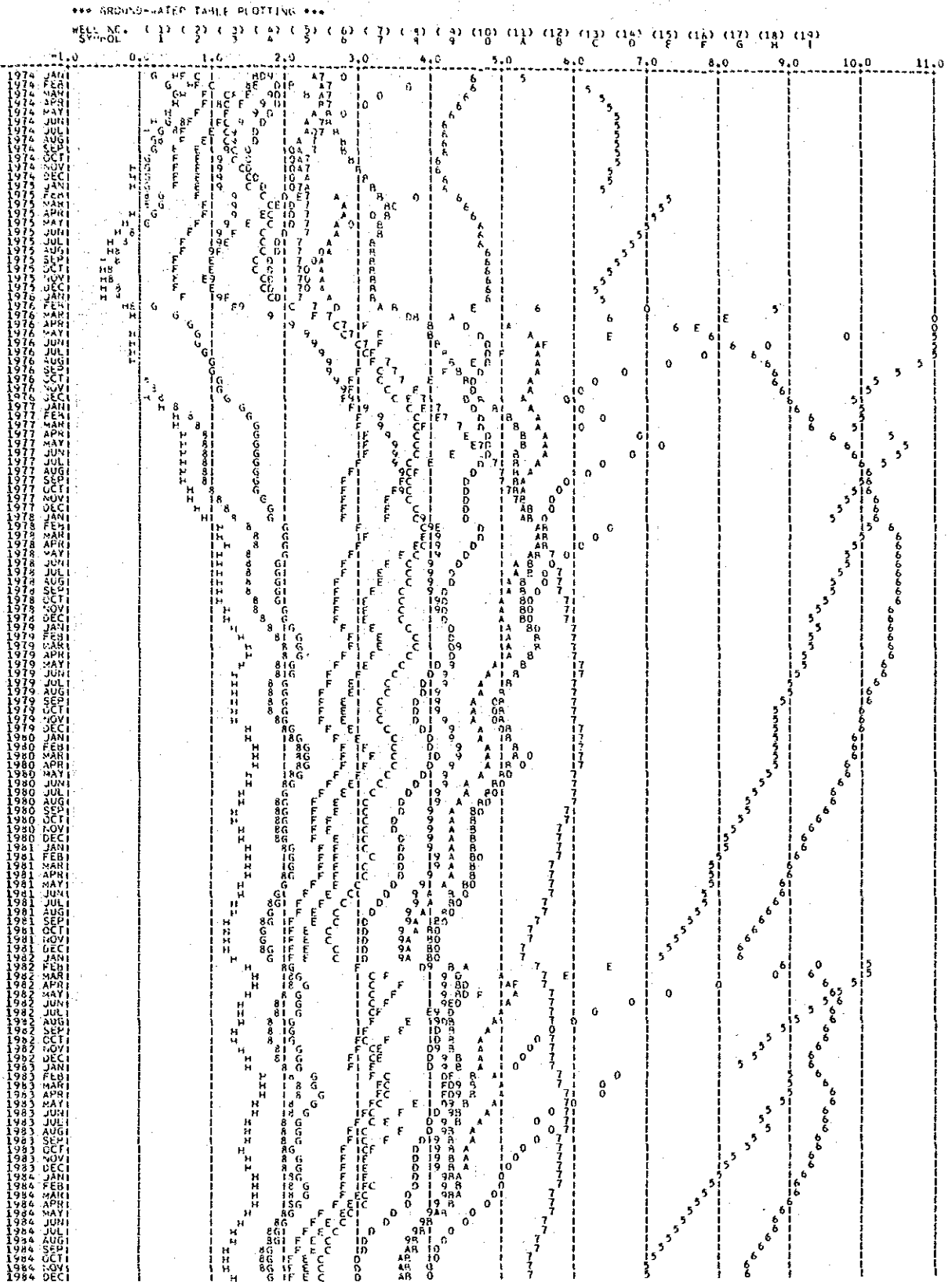
Figure B-29 Deviation of Groundwater Level (Case 2)
(12-months Moving Average)



END OF GO. SEVERITY CODE=10

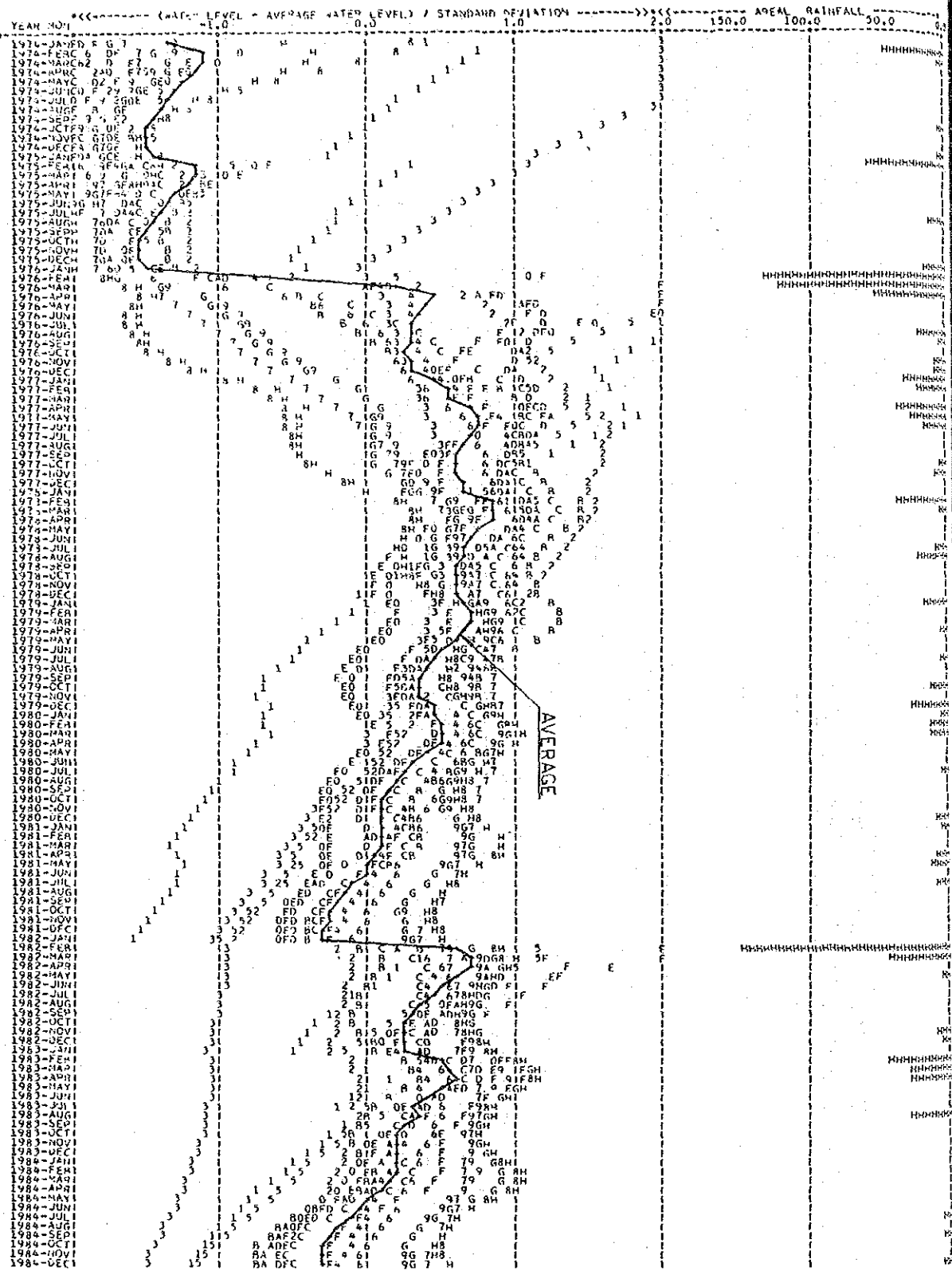
SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	DA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	NJ-1	8	BOS-2
9	WS1-26	0	JA-2	A	NJ-3	B	AE-61
C	NJ-4	D	AE-91	E	SEA	F	AE-99
G	14-M	H	DA-2	I			

Figure B-30 Simulated Groundwater Tables (Case 3)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
I	DA-1	2	JA-6	3	JA-4	4	JA-5
J	JA-3	6	EA-1	7	JA-1	8	BOS-2
K	WEI-26	0	JA-2	A	NJ-1	B	AE-61
L	NJ-4	D	AE-91	E	NJ-3	F	AE-99
M	14-M	H	GA-2	I	SEA		

Figure B-31 Deviation of Groundwater Level (Case 3)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
I	OA-1	2	JA-6	3	JA-4	4	JA-5
S	JA-3	6	EA-1	7	JA-1	8	ES-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	OA-2	I	SEA		

Figure B-32 Deviation of Groundwater Level (Case 3)
(12-months Moving Average)

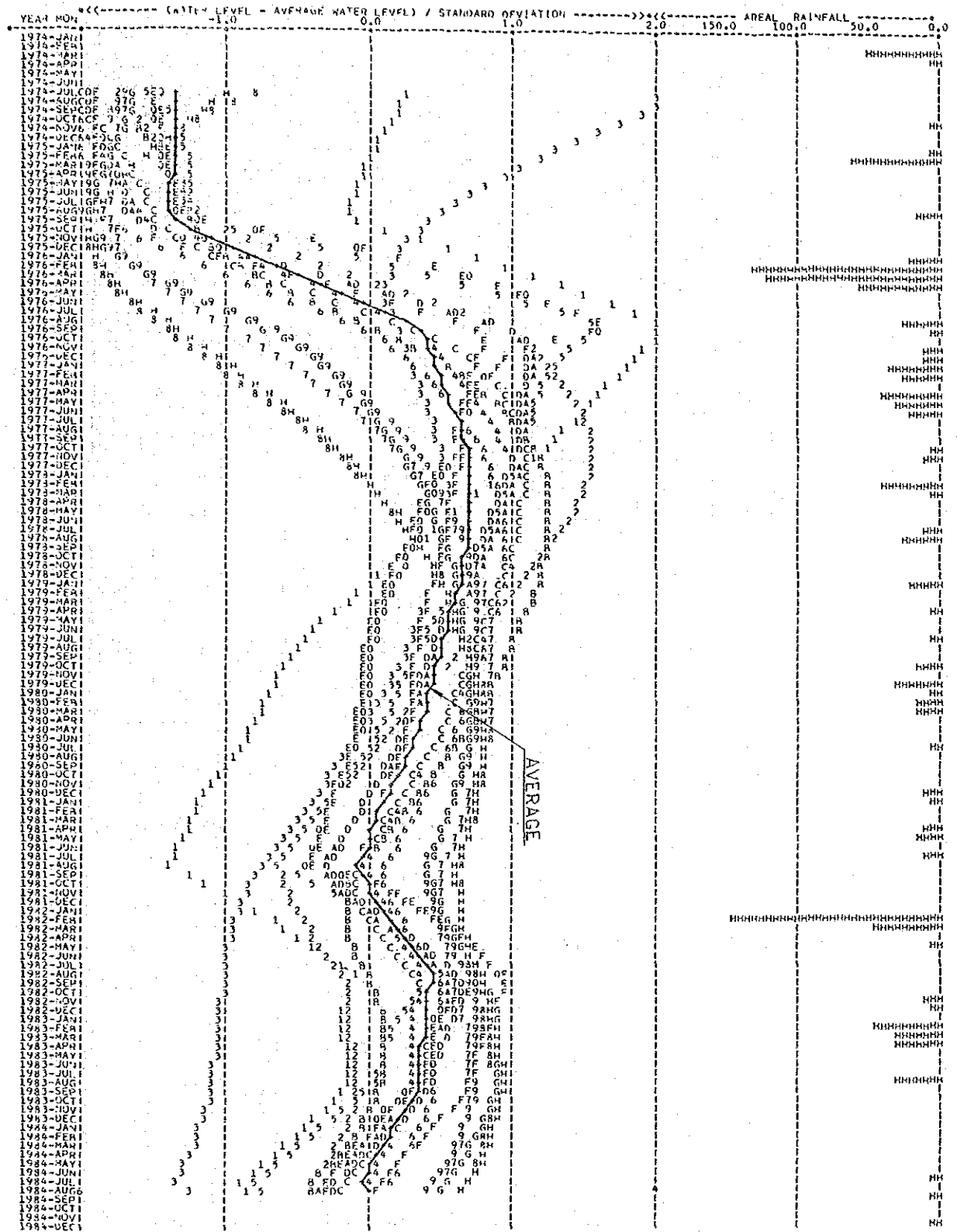


Table B-7 Input Data for Groundwater Simulation (Case 0)

DESCRIPTION	UNIT	(11) (12) (13) (14) (15)	(21) (22) (23) (24) (25)	(31) (32) (33) (34) (35)	(41) (42) (43) (44) (45)	(51) (52) (53) (54) (55)	(61) (62) (63) (64) (65)	(71) (72) (73) (74) (75)	(81) (82) (83) (84) (85)	(91) (92) (93) (94) (95)	(10) (11) (12) (13) (14) (15)
CAT: CATCHMENT AREA	SQ.KM	812.01	471.01	1283.0							
A : AREA OF BLOCK	SQ.KM	27.15 24.46	26.91 19.17	27.44 11.77	17.80 8.17	15.48 9.58	13.04 0.0	20.091	7.951	15.381	15.911
A2 : ADDITIONAL AREA FOR EACH BLOCK	SQ.KM	812.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A3 : ADDITIONAL AREA FOR EACH BLOCK	SQ.KM	190.00 1.00	7.00 0.0	12.00 0.0	-0.68 -1.92	0.0 -9.58	0.0 0.0	-4.501	-7.951	-7.331	0.0
RUI : RATE OF INFILTRATION		0.33 0.0	0.18 0.0	0.07 0.0	0.11 0.0	0.10 0.0	0.0 0.0	0.0	0.0	0.0	0.211
DEPP: ELEVATION OF ROCK FOUNDATION	M.AMSL	70.01 -20.01	20.01 -80.01	15.0 -80.0	-5.0 -80.0	-20.0 -80.0	-50.0 0.0	-40.01	-80.01	-80.01	-80.01
WRI : IRRIGATION WATER REQUIREMENT	MCM/MON.	0.522 0.732	0.396 0.840	0.801	0.9531	1.3281	1.242	1.1881	1.1221	1.0521	0.9281
WRO : OTHER WATER REQUIREMENT	MCM/YEAR	0.2001									
ROIA: RATE OF IRRIGATION APPLICATION		0.0 0.22	0.0 0.17	0.10 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.141
HUSA:RATE OF SUPPLY EXTRACTION		0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.0
H : WATER TABLE ELEVATION	M.AMSL	80.00 1.30	30.00 1.80	25.00 0.50	5.00 0.0	5.00 0.50	5.00 0.0	2.501	1.901	1.901	3.101
DIS : DISTANCE BETWEEN BLOCKS	KM	4.1 4.3 5.4 3.3	7.1 4.0 4.0 7.2	4.4 4.2 4.9 3.8	4.2 4.3 5.3 1.0	4.6 3.8 4.5 1.0	2.9 5.9 3.3 1.6	5.71 5.0 5.0	3.81 5.91 5.91	1.91 3.61	5.41 5.61 3.21
WID : CROSS-SECTIONAL WIDTH	KM	6.8 0.7 4.0	1.5 4.0 3.3	4.4 2.9 6.0	6.2 2.8 1.2	1.2 3.7 3.4	4.8 4.4 4.1	3.1 1.8 4.8	2.41 2.31 1.01	5.61 4.21 2.21	1.71 1.21 2.81
DEP : DEPTH OF ROCK FOUNDATION	M	70.0 -50.0 -80.0	70.0 -10.0 -80.0	30.0 -80.0 -17.5	30.0 -80.0 -17.5	7.0 -10.0 -17.5	6.0 -30.0 -17.5	25.0 -80.0 -80.0	-20.0 -70.0 -80.0	0.0 -80.0 -80.0	35.0 -80.0 -80.0
CON : PERMEABILITY COEFFICIENT	M/MIN.	0.020 0.020 0.020	0.020 0.020 0.020	0.020 0.020 0.020	0.020 0.020 0.020	0.020 0.020 0.020	0.020 0.020 0.020	0.020	0.020	0.020	0.020

Table B-11 Input Data for Groundwater Simulation (Case 1)

DESCRIPTION	UNIT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
		(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
		(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
CAT : CATCHMENT AREA	SQ.KM	812.01	471.01	1283.01							
A : ARFA OF BLOCK	SQ.KM	27.13	26.91	27.43	17.80	14.46	13.04	20.09	7.93	15.38	14.18
		9.82	19.49		7.61	5.84	8.94	8.17	9.23	0.0	
AZ : ADDITIONAL AREA FOR EACH BLOCK	SQ.KM	812.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AD : ADDITIONAL AREA FOR EACH BLOCK	SQ.KM	190.00	7.00	12.00	-0.68	0.0	0.0	-4.50	-7.92	-1.33	0.0
		0.0	1.00	0.0	0.0	0.0	0.0	-1.92	-9.23	0.0	
ROI : RATE OF INFILTRATION		0.33	0.18	0.0	0.11	0.10	0.0	0.0	0.0	0.0	0.21
		0.0	0.0	0.0	0.0	0.07	0.0	0.0	0.0	0.0	
DEPP: ELEVATION OF ROCK FOUNDATION	M.AMSL	70.0	20.0	15.0	-5.0	-20.0	-20.0	-20.0	-80.0	-80.0	-80.0
		-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0
WRI : IRRIGATION WATER REQUIREMENT	MCM/MON.	0.623	0.396	0.801	0.953	1.328	1.242	1.188	1.122	1.052	0.928
		0.732	0.640								
WRO : OTHER WATER REQUIREMENT	MCM/YEAR	0.700									
RUJA: RATE OF IRRIGATION APPLICATION		0.0	0.17	0.0	0.07	0.05	0.0	0.0	0.07	0.0	0.12
		0.09	0.0	0.07	0.0	0.0	0.0	0.0	0.08	0.0	
RUSA:RATE OF SUPPLY EXTRACTION		0.0	0.0	0.0	0.50	0.0	0.50	0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H : WATER TABLE ELEVATION	M.AMSL	80.00	30.00	25.00	5.00	5.00	5.00	2.50	1.90	1.90	3.10
		2.60	1.30	0.60	1.70	0.40	0.50	0.0	0.90	0.0	
DIS : DISTANCE BETWEEN BLOCKS	KM	4.1	7.1	4.4	4.2	4.6	2.9	3.8	1.9	6.7	6.0
		3.7	3.4	4.3	5.4	4.3	4.3	4.0	2.5	5.3	4.5
		3.7	3.3	4.9	4.0	5.4	3.1	3.3	4.0	4.5	4.5
		3.0	3.0	4.1	3.0	3.7	2.7	3.6	3.3	3.0	3.8
WID : CROSS-SECTIONAL WIDTH	KM	6.8	1.5	4.4	6.2	1.2	4.8	2.4	5.7	3.3	1.2
		3.3	2.2	0.9	1.8	0.7	2.2	4.2	4.2	2.3	1.2
		4.0	1.5	1.9	3.3	2.8	2.0	1.4	2.0	1.8	3.0
		9.6	3.2	2.2	4.0	2.2	2.3	2.2	2.8	4.8	1.4
DEP : DEPTH OF ROCK FOUNDATION	M	70.0	70.0	30.0	30.0	7.0	6.0	20.0	0.0	25.0	5.0
		-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-10.0	-80.0	-80.0	-80.0
		-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0	-80.0
		-17.5	-17.5	-17.5	-17.5	-17.5	-17.5	-80.0	-80.0	-80.0	-80.0
CON : PERMEABILITY COEFFICIENT	M/MIN.	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020

Table B-17 Simulated Groundwater Tables (Case 2)

DATE	NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																		
77.10	39.12	16.95	13.74	9.00	8.87	5.26	1.87	3.27	5.65	4.88	6.95	3.44	4.14	3.53	2.83	2.05	1.40																				
5.50	4.05	2.22	3.15	1.42	2.22	1.62	1.00	1.32	1.81	1.15	1.00	0.93	1.11	1.38	1.02	0.95	0.86																				
MEAN		S.D.		SYMBOL		WELL		SYMBOL		WELL		SYMBOL		WELL		SYMBOL		WELL																			
		(1)	OA-1	(2)	JA-6	(3)	JA-4	(4)	JA-5	(5)	JA-3	(6)	EA-1	(7)	EA-1	(8)	EOS-2	(9)	WTI-26	(10)	JA-2	(11)	NJ-1	(12)	AE-61	(13)	NJ-4	(14)	AE-21	(15)	NJ-3	(16)	AE-99	(17)	14-M	(18)	

Table B-19 Input Data for Groundwater Simulation (Case 3)

DESCRIPTION	UNIT	(1)	(2)	(3)	(4)	(5)	DATA	(6)	(7)	(8)	(9)	(10)
		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)
		(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)
CAT : CATCHMENT AREA	SW.FM	812.0	471.0	1283.0								
A : AREA OF BLOCK	SW.KM	27.15	26.91	27.44	17.80	14.46	13.04	20.09	7.95	15.38	14.18	
A2 : ADDITIONAL AREA FOR EACH BLOCK	SW.KM	9.82	19.48	7.48	7.61	5.84	8.94	8.17	0.0	0.0	0.0	
A3 : ADDITIONAL AREA FOR EACH BLOCK	SW.KM	812.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ROI : RATE OF INFILTRATION	SW.KM	190.00	7.00	12.00	0.0	0.0	0.0	4.50	7.95	7.33	0.0	
DEPP: ELEVATION OF ROCK FOUNDATION	M.AMSL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
WRI : IRRIGATION WATER REQUIREMENT	MCM/MON.	0.623	0.396	0.801	0.453	1.328	1.242	1.388	1.122	1.052	0.928	
WRO : OTHER WATER REQUIREMENT	MCM/YEAR	1.260										
ROIA: RATE OF IRRIGATION APPLICATION		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ROSA: RATE OF SUPPLY EXTRACTION		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
H : WATER TABLE ELEVATION	M.AMSL	80.00	30.00	25.00	5.00	5.00	5.00	2.50	1.90	1.90	3.10	
DIS : DISTANCE BETWEEN BLOCKS	KM	2.60	1.30	0.60	1.70	0.40	0.50	0.0	0.50	0.0	0.0	
		4.1	7.1	4.4	4.2	4.6	2.9	3.8	1.9	6.7	6.0	
		3.3	3.6	4.3	5.4	4.3	4.2	4.0	2.5	4.5	5.5	
		3.0	3.0	4.1	4.0	3.7	3.1	3.3	4.0	3.0	4.3	
WID : CROSS-SECTIONAL WIDTH	KM	6.8	3.2	4.0	3.0	3.0	2.7	2.7	3.3	3.0	3.8	
		2.3	1.6	1.9	2.3	2.2	2.3	2.2	2.8	2.8	2.4	
		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
DEP : DEPTH OF ROCK FOUNDATION	M	70.0	70.0	30.0	30.0	70.0	6.0	20.0	0.0	25.0	5.0	
		65.0	70.0	30.0	30.0	80.0	80.0	10.0	80.0	5.0	5.0	
		17.5	17.5	17.5	17.5	80.0	80.0	80.0	80.0	80.0	80.0	
CON : PERMEABILITY COEFFICIENT	M/MIN.	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	

Table B-20 Summary of Groundwater Simulation (Case 3)

*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY *** WADI JIZZI BASIN *** PROPOSED CONDITION = AFTER PROJECT *** (UNIT = MCM/MONTH)

YEAR	MON	AREA RAIN (1)	FALL USE (2)	A BASE FLOW (3)	V RIFT (4)	D A M P O U N T R A N S P I R A T I O N (5)	P R C T I C A L R E C H A R G E (6)	S T I L L A G E (7)	A R F A L R A I N (8)	K U N O F F (9)	P R C T I C A L R E C H A R G E (10)	M U N I C I P A L S E A R E A (11)	R E C H A R G E (12)	E L E V A T I O N (13)	S E A L E V E L (14)	D I R I G I O N (15)	O T H E R U S E S (16)	A D D I T I O N U S E S (17)	E X T R A C T I O N (18)	W A D I E R A R I O S (19)	
1994	1	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	2	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	3	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	4	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	5	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	6	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	7	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	8	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	9	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	10	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	11	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	12	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	1	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	2	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	3	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	4	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	5	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	6	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	7	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	8	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	9	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	10	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	11	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	12	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	1	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	2	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	3	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	4	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	5	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	6	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	7	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	8	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	9	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	10	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	11	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	12	32.4	7.7	0.0	0.0	2.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

9-8 Computer Programs

FACOM OSIV/X8 GEM V02L32 DATE 85.12.05 TIME 10.40.02 LIB=G1.S.V01

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-----1-----2-----3-----4-----5-----6-----7-R-----8
MODULE NAME OMANWADI          BLOCKS   57
LEVEL       46                DATE     85.11.14 TIME     13.35.08
    
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***** APPOINTED MODULE INFORMATION *****

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LEVEL       46                DATE     85.12.05 TIME     10.14.19
    
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C***** 00000100
C * 00000200
C GROUND-WATER SIMULATION FOR WADI JIZZI BASIN * 00000300
C (KASE=1 : PRESENT CONDITION...BEFORE PROJECT) * 00000400
C (KASE=2 : PROPOSED CONDITION...AFTER PROJECT) * 00000500
C * 00000600
C***** 00000700
C CHARACTER*36 TITLE(6),TITLE2(3) 00000800
C CHARACTER*40 DESC(15) 00000900
C CHARACTER*10 UNI(15) 00001000
C CHARACTER*8 UA(6),NDAM 00001100
C CHARACTER*3 MMON(12) 00001200
C CHARACTER*1 SYM(23),G(120) 00001300
C DIMENSION @OUT(30),NOIJ(50,2),DIS(50),ETC(12),XR(4),HH(15,12,20), 00001400
+ WID(50),DEP(50),UNIT(2),UNIT2(2),NDAY(12),@P(20), 00001500
+ R(12,31),Y(15),RT(12),RM(15,12),CA(3,6),RA(3,15,12,31), 00001600
+ A(30),A2(30),A3(30),HO(30),CON(50),@DAM(20),@RED(20), 00001700
+ RDAM(20),RRED(20),ROI(30),WRI(12),ROIA(30),RR(3,15,12), 00001800
+ CAT(3),RELAX(30),H(30),@T(30,30),ST(30),RES(30),@Q(30), 00001900
+ XE(10),@Y(20),X(4,10),DEPP(30),ROSA(30),CAP(50),@IN(30), 00002000
+ HP(20,132) 00002100
C***** 00002200
C DATA STATEMENT * 00002300
C NDAY...NO. OF DAYS IN THE MONTHS * 00002400
C MMON...NAME OF MONTH * 00002500
C XR....RAIN COORDINATE FOR EFFECTIVE RAIN CALCULATION * 00002600
C XE....ET-CROP COORDINATE FOR EFFECTIVE RAIN CALCULATION * 00002700
C ETC....AVERAGE MONTHLY ET-CROP * 00002800
C X.....EFFECTIVE RAIN DATA BY FAO PUBLICATION * 00002900
C DESC...DESCRIPTION FOR INPUT DATA * 00003000
C UNI...UNIT FOR INPUT DATA * 00003100
C***** 00003200
DATA NDAY/31,28,31,30,31,30,31,31,30,31,30,31/ 00003300
DATA MMON/3HJAN,3HFEB,3HMAR,3HAPR,3HMAY,3HJUN, 00003400
+ 3HJUL,3HAUG,3HSEP,3HOCT,3HNOV,3HDEC/ 00003500
DATA XR/12.5,25.0,37.5,50.0/ 00003600
DATA XE/25.0,50.0,75.0,100.0,125.0,150.0,175.0,200.0,225.0,250.0/ 00003700
DATA ETC/ 64.0, 68.8, 97.4,115.3,152.4,143.6, 00003800
+ 138.3,130.5,126.8,106.1, 72.2, 63.8/ 00003900
DATA X/ 8.,16.,24.,32., 8.,17.,25.,32., 9.,18.,27.,34., 00004000
+ 9.,19.,28.,35.,10.,20.,30.,37.,10.,21.,31.,39., 00004100
+ 11.,23.,32.,42.,11.,24.,33.,44.,12.,25.,35.,47., 00004200
+ 13.,25.,38.,50./ 00004300
DATA SYM/1H ,1HI,1H+,1HH,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9, 00004400
+ 1H0,1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI/ 00004500
DATA DESC/40HI CAT : CATCHMENT AREA 1, 00004600
+ 40HI A : AREA OF BLOCK 1, 00004700
+ 40HI A2 : ADDITIONAL AREA FOR EACH BLOCK 1, 00004800
    
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-----1-----2-----3-----4-----5-----6-----7-R-----
+          40HI A3 : ADDITIONAL AREA FOR EACH BLOCK 1/      00004900
+          40HI ROI : RATE OF INFILTRATION 1/                00005000
+          40HI DEPP: ELEVATION OF ROCK FOUNDATION 1/        00005100
+          40HI WR1 : IRRIGATION WATER REQUIREMENT 1/        00005200
+          40HI WRO : OTHER WATER REQUIREMENT 1/             00005300
+          40HI ROIA: RATE OF IRRIGATION APPLICATION 1/      00005400
+          40HI ROSA: RATE OF SUPPLY EXTRACTION 1/           00005500
+          40HI H : WATER TABLE ELEVATION 1/               00005600
+          40HI DIS : DISTANCE BETWEEN BLOCKS 1/            00005700
+          40HI WID : CROSS-SECTIONAL WIDTH 1/              00005800
+          40HI DEP : DEPTH OF IMPERMEABLE FOUNDATION 1/    00005900
+          40HI CON : PERMEABILITY COEFFICIENT 1/           00006000
+ DATA UNI/10H SQ.KM 1,10H SQ.KM 1,10H SQ.KM 1/          00006100
+          10H SQ.KM 1,10H 1,10H M.AMSL 1/                 00006200
+          10H MCM/MON.1,10H MCM/YEAR1,10H 1/              00006300
+          10H 1,10H M.AMSL 1,10H KM 1/                   00006400
+          10H KM 1,10H M 1,10H M/MIN. 1/                  00006500
C*****
C BASIC PARAMETERS FOR COMPUTATION * 00006600
C NOB...NO. OF POLYGONAL ZONES(GROUND-WATER BLOCK) * 00006800
C NOA...NO. OF WATER PASSES * 00006900
C KASE...NO. OF COMPUTATION CASES * 00007000
C KASE=1..PRESENT CONDITION * 00007100
C KASE=2..PROPOSED CONDITION * 00007200
C NENS...FIRST YEAR FOR RAIN COMPUTATION * 00007300
C MONS...FIRST MONTH FOR RAIN COMPUTATION * 00007400
C NENE...LAST YEAR FOR RAIN COMPUTATION * 00007500
C MONE...LAST MONTH FOR RAIN COMPUTATION * 00007600
C NENSA..FIRST YEAR FOR GROUND-WATER SIMULATION * 00007700
C MONSA.. -DO- MONTH * 00007800
C NENEA..LAST YEAR FOR GROUND-WATER SIMULATION * 00007900
C MONEA.. -DO- MONTH * 00008000
C NOSEA..NODAL NO. ASSIGNED FOR OPEN SEA BLOCK * 00008100
C IRSM...PARAMETER FOR MONTHLY SPOT RAINFALL LISTING * 00008200
C IRSY... -DO- YEARLY SPOT RAINFALL 1 IRSM,IRSY,IRAM,IRAY * 00008300
C IRAM... -DO- MONTHLY AREAL RAIN 1 =1 PRINTING RESULTS * 00008400
C IRAY... -DO- YEARLY AREAL RAIN 1 =0 NO PRINTING * 00008500
C*****
READ(5,1) KASE,NOB,NOA 00008700
READ(5,1) NENS,MONS,NENE,MONE 00008800
READ(5,1) NENSA,MONSA,NENEA,MONEA 00008900
READ(5,1) NOSEA 00009000
READ(5,1) IRSM,IRSY,IRAM,IRAY 00009100
C*****
C S...STORATIVITY * 00009300
C AO1..AREA OF IRRIGATION APPLICATION (HA) * 00009400
C AO12..AREA OF ADDITIONAL IRRIGATION APPLICATION(HA) * 00009500
C DAMCAP..CAPACITY OF DAM(MCM) * 00009600
C*****
READ(5,2) S,AO1,AO12,DAMCAP 00009800
NOB1=NOB-1 00009900
C*****
C INPUT DATA FORMAT * 00010100
C*****
1 FORMAT(16I5) 00010300
2 FORMAT(6F10.0) 00010400
3 FORMAT(15I4) 00010500

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-----1-----2-----3-----4-----5-----6-----7-R-----8
  4 FORMAT(10F5.1/10F5.1/11F5.1)                                00010600
  5 FORMAT(A36)                                                  00010700
  6 FORMAT(20A4)                                                00010800
  7 FORMAT(6A8)                                                  00010900
  8 FORMAT(12F5.0)                                              00011000
C*****
C INPUT DATA                                                    * 00011200
C CAT...CATCHMENT AREA(SQ.KM) AT DAM + BELOW DAM + ENTIRE      * 00011300
C CAT(1)...AT DAM                                              * 00011400
C CAT(2)...BELOW DAM                                          * 00011500
C CAT(3)...ENTIRE BASIN(AT RIVER-MOUTH)                       * 00011600
C A.....AREA OF GROUND-WATER BLOCK(SQ.KM)                    * 00011700
C A2.....AREAL CONTRIBUTION OF RECHARGE FROM UPSTREAM DAM(SQ.KM) * 00011800
C A3..... -DO- FROM RESIDUAL AREA BELOW DAM(SQ.KM)           * 00011900
C ROI..... -DO- OF DIRECT RECHARGE FROM SURFACE FLOW (*100%) * 00012000
C DEPP...ELEVATION OF ROCK FOUNDATION(M.AMSL)                 * 00012100
C WRI...MONTHLY IRRIGATION WATER REQUIREMENT(MCM/MONTH)      * 00012200
C WRO...WATER REQUIREMENT FOR OTHER USES(MCM/YEAR)           * 00012300
C ROIA...RATE OF IRRIGATION APPLICATION                       * 00012400
C ROSA...RATE OF SUPPLY EXTRACTION                            * 00012500
C H.....GROUND-WATER TABLE(M.AMSL)                          * 00012600
C DIS...DISTANCE BETWEEN GROUND-WATER BLOCKS(KM)             * 00012700
C WID...CROSS-SECTIONAL WIDTH BETWEEN BLOCKS(KM)            * 00012800
C DEP...DEPTH OF IMPERMEABLE FOUNDATION AT MID-POINT OF PASS * 00012900
C CON...PERMEABILITY COEFFICIENT(M/MIN.)                     * 00013000
C*****
  READ(5,2) (CAT(I),I=1,3)                                       00013200
  READ(5,2) (A(I),I=1,NOB)                                       00013300
  READ(5,2) (A2(I),I=1,NOB)                                       00013400
  READ(5,2) (A3(I),I=1,NOB)                                       00013500
  READ(5,2) (ROI(I),I=1,NOB)                                       00013600
  READ(5,2) (DEPP(I),I=1,NOB)                                       00013700
  READ(5,2) (WRI(I),I=1,12)                                       00013800
  READ(5,2) WRO                                                    00013900
  READ(5,2) (ROIA(I),I=1,NOB)                                       00014000
  READ(5,2) (ROSA(I),I=1,NOB)                                       00014100
  READ(5,2) (H(I),I=1,NOB)                                       00014200
  READ(5,2) (DIS(I),I=1,NOA)                                       00014300
  READ(5,2) (WID(I),I=1,NOA)                                       00014400
  READ(5,2) (DEP(I),I=1,NOA)                                       00014500
  READ(5,2) (CON(I),I=1,NOA)                                       00014600
C*****
C TITLE DATA FOR RAINFALL LISTING                               * 00014800
C TITLE,TITLE2...HEADING TITLE OF RAINFALL TABLE            * 00014900
C UNIT,UNIT2...UNITS                                           * 00015000
C*****
  READ(5,5) (TITLE(I),I=1,6)                                       00015200
  READ(5,5) (TITLE2(I),I=1,3)                                       00015300
  READ(5,6) UNIT                                                    00015400
  READ(5,6) UNIT2                                                  00015500
C*****
C UA...NAME OF RAINFALL STATION(SPOT)                          * 00015700
C CA...AREAL RATIO BY THIESSEN                                  * 00015800
C I=1...ABOVE DAM                                              * 00015900
C I=2...BELOW DAM                                              * 00016000
C I=3...ENTIRE BASIN(AT RIVER-MOUTH)                           * 00016100
C*****
  00016200

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-----1-----2-----3-----4-----5-----6-----7-R-----8-----
      READ(5,7) (UA(I),I=1,6)                                00016300
      READ(5,2) ((CA(I,J),J=1,6),I=1,3)                    00016400
C*****                                                    00016500
C NOIJ...NO. OF POLYGONAL ZONES TO BE CONNECTED BY EACH PASS * 00016600
C*****                                                    00016700
      READ(5,3) ((NOIJ(I,J),J=1,2),I=1,NOA)                00016800
C*****                                                    00016900
C DELTA...TIME INTERVAL FOR COMPUTATION(YEAR)             * 00017000
C ERROR...ALLOWABLE ERROR FOR RELAXATION                  * 00017100
C*****                                                    00017200
      DELTA=1.0/12.0                                         00017300
      ERROR=0.002                                           00017400
C*****                                                    00017500
C AREAL RAIN - RUNOFF RELATION (FROM HYDROLOGICAL ANALYSIS) * 00017600
C NO@D...NO. OF DATA AT DAM-SITE                         * 00017700
C RDAM...AREAL RAIN DATA AT DAM-SITE(MM)                 * 00017800
C @DAM...RUNOFF DATA AT DAM-SITE(MM)                    * 00017900
C NO@R...NO. OF DATA AT RIVER-MOUTH                     * 00018000
C RRED...AREAL RAIN DATA AT RIVER-MOUTH(MM)             * 00018100
C @RED...RUNOFF DATA AT RIVER-MOUTH(MM)                  * 00018200
C*****                                                    00018300
      READ(5,1) NO@D                                         00018400
      READ(5,8) (RDAM(I),@DAM(I),I=1,NO@D)                 00018500
      READ(5,1) NO@R                                         00018600
      READ(5,8) (RRED(I),@RED(I),I=1,NO@R)                 00018700
C*****                                                    00018800
C PRINTING OF INPUT DATA AND PARAMETER                    * 00018900
C*****                                                    00019000
      WRITE(6,90) (I,I=1,50)                                00019100
      WRITE(6,91)                                           00019200
      WRITE(6,92) DESC(1),UNI(1),(CAT(I),I=1,3)           00019300
      WRITE(6,91)                                           00019400
      WRITE(6,93) DESC(2),UNI(2),(A(I),I=1,NOB)           00019500
      WRITE(6,91)                                           00019600
      WRITE(6,92) DESC(3),UNI(3),(A2(I),I=1,NOB)          00019700
      WRITE(6,91)                                           00019800
      WRITE(6,93) DESC(4),UNI(4),(A3(I),I=1,NOB)          00019900
      WRITE(6,91)                                           00020000
      WRITE(6,93) DESC(5),UNI(5),(ROI(I),I=1,NOB)         00020100
      WRITE(6,91)                                           00020200
      WRITE(6,92) DESC(6),UNI(6),(DEPP(I),I=1,NOB)        00020300
      WRITE(6,91)                                           00020400
      WRITE(6,94) DESC(7),UNI(7),(WRI(M),M=1,12)          00020500
      WRITE(6,91)                                           00020600
      WRITE(6,94) DESC(8),UNI(8),WRO                       00020700
      WRITE(6,91)                                           00020800
      WRITE(6,93) DESC(9),UNI(9),(ROIA(I),I=1,NOB)        00020900
      WRITE(6,91)                                           00021000
      WRITE(6,93) DESC(10),UNI(10),(ROSA(I),I=1,NOB)      00021100
      WRITE(6,91)                                           00021200
      WRITE(6,93) DESC(11),UNI(11),(H(I),I=1,NOB)         00021300
      WRITE(6,91)                                           00021400
      WRITE(6,92) DESC(12),UNI(12),(DIS(J),J=1,NOA)       00021500
      WRITE(6,91)                                           00021600
      WRITE(6,92) DESC(13),UNI(13),(WID(J),J=1,NOA)       00021700
      WRITE(6,91)                                           00021800
      WRITE(6,92) DESC(14),UNI(14),(DEP(J),J=1,NOA)       00021900

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-----1-----2-----3-----4-----5-----6-----7-R-----8
    WRITE(6,91)                                00022000
    WRITE(6,94) DESC(15),UNI(15),(CON(J),J=1,NOA) 00022100
    WRITE(6,91)                                00022200
C***** 00022300
C   NEN=NO.OF YEARS FOR RAINFALL COMPUTATION * 00022400
C***** 00022500
    NEN=NENE-NENS+1                            00022600
    DO 101 I=1,31                              00022700
    DO 101 M=1,12                              00022800
    DO 101 N=1,NEN                              00022900
    DO 101 L=1,3                                00023000
    101 RA(L,N,M,I)=0.0                         00023100
C***** 00023200
C   LOOP FOR RAIN STATION * 00023300
    DO 200 K=1,6                                00023400
C***** 00023500
C***** 00023600
C   LOOP FOR YEAR * 00023700
    DO 180 N=NENS,NENE                          00023800
C***** 00023900
    NN=N-NENS+1                                00024000
C***** 00024100
C   LOOP FOR COMPUTATION CASE * 00024200
C   L=1...AREAL RAIN AT DAM-SITE * 00024300
C   L=2...AREAL RAIN BELOW DAM * 00024400
C   L=3...AREAL RAIN AT RIVER-MOUTH * 00024500
    DO 100 L=1,3                                00024600
C***** 00024700
    IF(L.EQ.1) READ(8,7) NDAM                   00024800
C***** 00024900
C   LOOP FOR MONTH * 00025000
    DO 100 M=1,12                              00025100
C***** 00025200
    IF(N.EQ.NENS.AND.M.LT.MONS) GO TO 110      00025300
    IF(N.EQ.NENE.AND.M.GT.MONE) GO TO 110     00025400
    IF(L.EQ.1) READ(8,4) (R(M,I),I=1,31)      00025500
    DO 130 I=1,31                              00025600
    130 RA(L,NN,M,I)=RA(L,NN,M,I)+R(M,I)*CA(L,K) 00025700
    GO TO 100                                  00025800
    110 DO 120 I=1,31                          00025900
    120 RA(L,NN,M,I)=999999.0                 00026000
    100 CONTINUE                              00026100
C***** 00026200
C   SUBROUTINE CALL FOR MONTHLY SPOT RAINFALL LISTING * 00026300
    CALL KTBLM(N,NN,TITLE(K),UNIT,R,RT,Y(NN),IRSM) 00026400
C***** 00026500
    DO 115 M=1,12                              00026600
    115 RM(NN,M)=RT(M)                        00026700
    180 CONTINUE                              00026800
C***** 00026900
C   SUBROUTINE CALL FOR YEARLY SPOT RAINFALL LISTING * 00027000
    CALL KTPLY(NENS,NENE,TITLE(K),UNIT2,RM,Y,IRSY) 00027100
C***** 00027200
    200 CONTINUE                              00027300
    DO 300 L=1,3                                00027400
    DO 319 N=NENS,NENE                        00027500
    NN=N-NENS+1                              00027600

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-----1-----2-----3-----4-----5-----6-----7-R-----
      DO 310 I=1,31
      DO 310 M=1,12
      310 R(M,I)=RA(L,NN,M,I)
C*****
C SUBROUTINE CALL FOR MONTHLY AREAL RAINFALL LISTING *
  CALL KTBLM(N,NN,TITLE2(L),UNIT,R,RT,Y(NN),IRAM)
C*****
      DO 311 M=1,12
      311 RR(L,NN,M)=RT(M)
      IF(IRAM.GT.0) WRITE(6,61) (UA(I),CA(L,I),I=1,6)
      DO 315 M=1,12
      315 RM(NN,M)=RT(M)
      319 CONTINUE
C*****
C SUBROUTINE CALL FOR YEARLY AREAL RAINFALL LISTING *
  CALL KTBLY(NENS,NENE,TITLE2(L),UNIT2,RM,Y,IRAY)
C*****
      IF(IRAY.GT.0) WRITE(6,61) (UA(I),CA(L,I),I=1,6)
      300 CONTINUE
      61 FORMAT(1H0,5X,'*** AREAL RATIO ***'/6X,6(A8,'=',F5.3,4X))
C*****
C SINGLE EVENT FLOOD RUNOFF CALCULATION *
C SRMA....ACCUMULATED RAINFALL AT DAM(MM) *
C SRMB....ACCUMULATED RAINFALL AT RIVER-MOUTH(MM) *
C SR.....MONTHLY TOTAL RAINFALL BELOW DAM(MM) *
C*****
      SRMA=0.
      SRMB=0.
      KQ=KASE+17
      IF(KASE.EQ.1) WRITE(6,621)
      IF(KASE.EQ.2) WRITE(6,622) (I,I=1,KQ)
      VOL0=0.
      DO 395 I=1,KQ
      395 QP(I)=0.
      QSEAP=0.
C*****
C INITIAL STORAGE OF GROUND-WATER BASIN *
C*****
      DO 390 I=1,NOB1
      390 VOL0=VOL0+(H(I)-DEPP(I))*S*A(I)
      MP=0
C*****
C LOOP FOR COMPUTATION YEAR *
C NN,..ORDERING NO.OF YEAR FOR RAIN ANALYSIS *
C NM... -DO- FOR GROUND-WATER SIMULATION *
      DO 400 N=NENS,NENE
C*****
      NN=N-NENS+1
      NM=N-NENSA+1
      NDAY(2)=28
      IF(MOD(N,4).EQ.0) NDAY(2)=29
      IF(N.LT.NENSA.OR.N.GT.NENEA) GO TO 400
      DO 408 I=1,KQ
      408 QY(I)=0.0
      QSEAY=0.
C*****
C LOOP FOR COMPUTATION MONTH *

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-----1-----2-----3-----4-----5-----6-----7-R-----8
      DO 410 M=1,12                                00033400
C*****                                           00033500
      IF(N.EQ.NENSA.AND.M.LT.MONSA) GO TO 410      00033600
      IF(N.EQ.NENEA.AND.M.GT.MONEA) GO TO 410      00033700
      MP=MP+1                                        00033800
C*****                                           00033900
C      Q(15)....MONTHLY TOTAL OF IRRIGATION WATER USE (MCM/MONYH) * 00034000
C      Q(16)....      -DO-      OTHER WATER USES (MCM/MONTH)      * 00034100
C      Q(17)....      -DO-      ADDITIONAL WATER USES (WHEN KASE=2) * 00034200
C      Q(18)....      -DO-      GROUND-WATER EXTRACTION (MCM/MONTH) * 00034300
C*****                                           00034400
      Q(15)=WRI(M)                                  00034500
      Q(16)=WRO*DELTA                                00034600
      IF(KASE=1) 411,411,412                          00034700
      411 Q(18)=Q(15)+Q(16)                          00034800
      GO TO 413                                       00034900
      412 Q(17)=Q(15)*AO12/AO1                        00035000
      Q(18)=Q(15)+Q(16)+Q(17)                       00035100
      413 CONTINUE                                    00035200
C*****                                           00035300
C      ND....NO. OF DAYS IN THE MONTH                * 00035400
C      RUNA..MONTHLY RUNOFF AT DAM (MM)                * 00035500
C      RUNB..      -DO-      AT RIVER-MOUTH (MM)      * 00035600
C      SR....MONTHLY AREAL RAINFALL BELOW DAM (MM)    * 00035700
C      SPILL..SPILLAGE FROM DAM(MCM) (WHEN KASE=2)    * 00035800
C*****                                           00035900
      ND=NDAY(M)                                     00036000
      RUNA=0.                                         00036100
      RUNB=0.                                         00036200
      SPILL=0.                                        00036300
      SR=0.0                                          00036400
C*****                                           00036500
C      LOOP FOR DAY                                  * 00036600
C      DO 420 I=1,ND                                 00036700
C*****                                           00036800
      SR=SR+RA(2,NN,M,I)                             00036900
      SRMA=SRMA+RA(1,NN,M,I)                         00037000
      IF(RA(1,NN,M,I)-0.1) 421,422,422              00037100
      421 IF(SRMA-RDAM(1)) 423,423,424               00037200
      423 SRMA=0.                                     00037300
      GO TO 422                                       00037400
      424 QAD=FUNQ(NOQD,RDAM,QDAM,SRMA)              00037500
      IF(KASE.EQ.1) GO TO 428                         00037600
      YY=QAD*CAT(1)*0.001                            00037700
      IF(YY.GT.DAMCAP) SPILL=SPILL+YY-DAMCAP         00037800
      428 RUNA=RUNA+QAD                               00037900
      SRMA=0.                                         00038000
      422 SRMB=SRMB+RA(3,NN,M,I)                     00038100
      IF(RA(3,NN,M,I)-0.1) 425,420,420              00038200
      425 IF(SRMB-RRED(1)) 426,426,427               00038300
      426 SRMB=0.                                     00038400
      GO TO 420                                       00038500
      427 QAD=FUNQ(NOQR,RRED,QRED,SRMB)              00038600
      RUNB=RUNB+QAD                                  00038700
      SRMB=0.                                         00038800
      420 CONTINUE                                    00038900
C*****                                           00039000

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-----1-----2-----3-----4-----5-----6-----7-R-----8
C  CALCULATION OF EFFECTIVE RAINFALL * 00039100
C  XX...MONTHLY EFFECTIVE RAINFALL (MCM/MONTH) * 00039200
C ***** * 00039300
    DO 431 I=1,4
      II=1
      IF(SR-XR(I)) 432,431,431 * 00039400
    431 CONTINUE * 00039500
    432 DO 433 J=1,10 * 00039600
      JJ=J
      IF(ETC(M)-XE(J)) 434,433,433 * 00039700
    433 CONTINUE * 00039800
    434 I=MAX0(II-1,1) * 00039900
      J=MAX0(JJ-1,1) * 0040000
      X1=X(I,J)+(XR(I)-SR)*(X(I+1,J)-X(I,J))/(XR(I)-XR(I+1)) * 0040100
      X2=X(I,J+1)+(XR(I)-SR)*(X(I+1,J+1)-X(I,J+1))/(XR(I)-XR(I+1)) * 0040200
      XX=X1+(X1-X2)*(XE(J)-ETC(M))/(XE(J+1)-XE(J)) * 0040300
      XX=AMAX1(XX,0.)*(AO1+AOI2)*1.0E-5 * 0040400
C ***** * 0040500
C  INITIALIZING INFLOW RATE INTO EACH POLYGONAL ZONE * 0040600
C ***** * 0040700
    DO 430 I=1,NOB * 0040800
      430 @IN(I)=0. * 0040900
C ***** * 0041000
C  WHEN KASE=1 (PRESENT CONDITION) * 0041100
C  @ (1)...AREAL RAINFALL AT DAM (MM) * 0041200
C  @ (2)...MONTHLY TOTAL RAIN WATER ABOVE DAM (MCM/MONTH) * 0041300
C  @ (3)...FALAJ USES ABOVE DAM (MCM/MONTH) * 0041400
C  @ (4)...BASE FLOW FROM UPSTREAM OF DAM (MCM/MONTH) * 0041500
C  @ (5)...DIRECT RUNOFF FROM DAM CATCHMENT (MCM/MONTH) * 0041600
C  @ (6)...EVAPOTRANSPIRATION LOSSES FROM DAM CATCHMENT (MCM/MONTH) * 0041700
C  @ (7)...AREAL RAINFALL BELOW DAM (MM) * 0041800
C  @ (8)...MONTHLY TOTAL RAIN WATER BELOW DAM (MCM/MONTH) * 0041900
C  @ (9)...DIRECT RUNOFF FROM CATCHMENT BELOW DAM (MCM/MONTH) * 0042000
C  @ (10)...DIRECT RECHARGE FROM CATCHMENT BELOW DAM (MCM/MONTH) * 0042100
C  @ (11)...DIRECT RUNOFF INTO SEA (MCM/MONTH) * 0042200
C  @ (12)...TOTAL RECHARGE INTO GROUND-WATER (MCM/MONTH) * 0042300
C  WHEN KASE=2 (PROPOSED CONDITION) * 0042400
C  @ (1)...MONTHLY TOTAL RAIN WATER ABOVE DAM (MCM/MONTH) * 0042500
C  @ (2)...FALAJ USES ABOVE DAM (MCM/MONTH) * 0042600
C  @ (3)...BASE FLOW FROM UPSTREAM OF DAM (MCM/MONTH) * 0042700
C  @ (4)...DIRECT RUNOFF FROM DAM CATCHMENT (MCM/MONTH) * 0042800
C  @ (5)...EVAPOTRANSPIRATION LOSSES FROM DAM CATCHMENT (MCM/MONTH) * 0042900
C  @ (6)...DIRECT RECHARGE FROM DAM STORAGE (MCM/MONTH) * 0043000
C  @ (7)...SPILLAGE FROM DAM (MCM/MONTH) * 0043100
C  @ (8)...MONTHLY TOTAL RAIN WATER BELOW DAM (MCM/MONTH) * 0043200
C  @ (9)...DIRECT RUNOFF FROM CATCHMENT BELOW DAM (MCM/MONTH) * 0043300
C  @ (10)...DIRECT RECHARGE FROM CATCHMENT BELOW DAM (MCM/MONTH) * 0043400
C  @ (11)...DIRECT RUNOFF INTO SEA (MCM/MONTH) * 0043500
C  @ (12)...TOTAL RECHARGE INTO GROUND-WATER (MCM/MONTH) * 0043600
C ***** * 0043700
    IF(KASE=1) 435,435,436 * 0043800
    435 @ (1)=RR(1,NN,M) * 0043900
      @ (2)=@ (1)*CAT(1)*0.001 * 0044000
      @ (3)=@ (2)*0.029565 * 0044100
      @ (4)=@ (2)*0.032029 * 0044200
      @ (5)=RUNA*CAT(1)*0.001 * 0044300
      @ (6)=@ (2)-@ (3)-@ (4)-@ (5) * 0044400

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-----1-----2-----3-----4-----5-----6-----7-R-----8
      Q(7)=RR(2,NN,M)                                00044800
      Q(8)=Q(7)*CAT(2)*0.001                          00044900
      Q(9)=0.                                          00045000
      IF(Q(1),LT,0.001) GO TO 438                     00045100
      Q(9)=Q(5)*CAT(2)/CAT(1)*Q(7)/Q(1)              00045200
438 CONTINUE                                          00045300
      Q(10)=Q(8)*0.0718182                            00045400
      Q(11)=RUNB*CAT(3)*0.001                         00045500
      Q(12)=Q(5)+Q(9)-Q(11)                          00045600
      GO TO 439                                        00045700
436 Q(1)=RR(1,NN,M)*CAT(1)*0.001                     00045800
      Q(2)=Q(1)*0.029565                              00045900
      Q(3)=Q(1)*0.032029                              00046000
      Q(4)=RUNA*CAT(1)*0.001                         00046100
      Q(5)=Q(1)-Q(2)-Q(3)-Q(4)                      00046200
      Q(7)=SPILL                                       00046300
      Q(6)=Q(4)-Q(7)                                  00046400
      Q(8)=RR(2,NN,M)*CAT(2)*0.001                  00046500
      Q(9)=0.                                          00046600
      IF(Q(1),LT,0.001) GO TO 437                    00046700
      Q(9)=Q(4)*CAT(2)/CAT(1)*RR(2,NN,M)/RR(1,NN,M) 00046800
437 CONTINUE                                          00046900
      Q(10)=Q(8)*0.0718182                           00047000
      Q(11)=0.0                                        00047100
      Q(12)=Q(7)+Q(9)                                00047200
439 CONTINUE                                          00047300
C*****                                              00047400
C WATER EXTRACTION FOR IRRIGATION (MCM/MONTH)      * 00047500
C*****                                              00047600
      DO 440 I=1,NOB                                  00047700
      440 @IN(I)=@IN(I)-WRI(M)*ROIA(I)                00047800
C*****                                              00047900
C WATER EXTRACTION FOR OTHER WATER USES (MCM/MONTH) * 00048000
C*****                                              00048100
      DO 442 I=1,NOB                                  00048200
      442 @IN(I)=@IN(I)-WRO*ROSA(I)*DELTA             00048300
      IF(KASE.EQ.1) GO TO 445                          00048400
C*****                                              00048500
C WATER EXTRACTION FOR ADDITIONAL WATER USES (MCM/MONTH)(WHEN KASE=2)* 00048600
C*****                                              00048700
      DO 443 I=1,NOB                                  00048800
      443 @IN(I)=@IN(I)-WRI(M)*ROIA(I)*AOI2/AOI      00048900
C*****                                              00049000
C SUBSURFACE FLOW ABOVE DAM (MCM/MONTH)            * 00049100
C*****                                              00049200
      445 DO 444 I=1,NOB                              00049300
      IF(KASE.EQ.1) @IN(I)=@IN(I)+Q(4)*A2(I)/CAT(1)  00049400
      IF(KASE.EQ.2) @IN(I)=@IN(I)+Q(3)*A2(I)/CAT(1)  00049500
      444 CONTINUE                                    00049600
C*****                                              00049700
C SUBSURFACE FLOW BELOW DAM (MCM/MONTH)            * 00049800
C*****                                              00049900
      DO 446 I=1,NOB                                  00050000
      446 @IN(I)=@IN(I)+(A(I)+AMAX1(A3(I),0.))*Q(10)/CAT(2) 00050100
C*****                                              00050200
C RECHARGE FROM SURFACE FLOW (MCM/MONTH)          * 00050300
C*****                                              00050400

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-----1-----2-----3-----4-----5-----6-----7-R-----8
      DO 448 I=1,NOB
      IF(KASE.EQ.1) QIN(I)=QIN(I)+Q(12)*ROI(I)
      IF(KASE.EQ.2) QIN(I)=QIN(I)+ROI(I)*(Q(6)+Q(12))
448 CONTINUE
C*****
C  CALCULATION OF CONDUCTANCE OF PASS BETWEEN NODES J1 & J2
C  UNIT...MCM/MONTH/M
C  TCON...NO. OF MINUTES IN THE MONTH
C  CAP...CONDUCTANCE
C*****
      TCON=FLOAT(NDAY(M))*1440.
      DO 451 J=1,NOA
      J1=NOIJ(J,1)
      J2=NOIJ(J,2)
      DEPS=0.5*(DEPP(J1)+DEPP(J2))
      IF(J1.EQ.NOSEA.OR.J2.EQ.NOSEA) DEPS=DEP(J)
451 CAP(J)=WID(J)*CON(J)*(0.5*(H(J1)+H(J2))-DEPS)*TCON*1.0E-6/DIS(J)
C*****
C  RELAXATION COEFFICIENT AT THE NODE I...RELAX(I)
C*****
      DO 450 I=1,NOB
      SY=0.
      DO 452 J=1,NOA
      J1=NOIJ(J,1)
      J2=NOIJ(J,2)
      IF(J1.NE.1.AND.J2.NE.1) GO TO 452
      SY=SY+CAP(J)
452 CONTINUE
      RELAX(I)=1.0/(SY+A(I)*S)
450 CONTINUE
C*****
C  INITIAL GROUND-WATER TABLE FOR RELAXATION (M.AMSL)
C*****
      DO 460 I=1,NOB
460 HO(I)=H(I)
      NCOUNT=0
450 CONTINUE
C*****
C  SUB-SURFACE FLOW RATE ALONG NODE-TO-NODE BRANCH : BETWEEN I & J
C  QT...SUB-SURFACE FLOW RATE (MCM/MONTH)
C*****
      DO 70 J=1,NOB
      DO 70 I=1,NOB
470 QT(I,J)=0.
      NCOUNT=NCOUNT+1
      IF(NCOUNT.GT.20) GO TO 520
      QSEA=0.
      DO 470 J=1,NOA
      J1=NOIJ(J,1)
      J2=NOIJ(J,2)
      QT(J1,J2)=CAP(J)*(H(J1)-H(J2))
      QT(J2,J1)=-QT(J1,J2)
      IF(J2.EQ.NOSEA) QSEA=QSEA+QT(J1,J2)
470 CONTINUE
C*****
C  STORAGE FLOW RATE AT NODE I (MCM/MONTH)
C*****

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-----1-----2-----3-----4-----5-----6-----7-R-----8
      DO 480 I=1,NOB                                00056200
      480 ST(I)=A(I)*S*(H(I)-HO(I))                  00056300
C*****00056400
C   NODAL FLOW RESIDUAL (MCM/MONTH)                 * 00056500
C   RES...NODAL FLOW RESIDUAL                       * 00056600
C   @OUT...OUTFLOW FROM EACH NODAL ZONE (MCM/MONTH) * 00056700
C*****00056800
      DO 490 I=1,NOB                                00056900
      RES(I)=0.                                      00057000
      @OUT(I)=0.                                     00057100
      DO 492 J=1,NOB                                00057200
      492 @OUT(I)=@OUT(I)+@T(I,J)                   00057300
      IF(I.EQ.NOSEA) GO TO 490                       00057400
      RES(I)=@IN(I)-@OUT(I)-ST(I)                   00057500
      490 CONTINUE                                   00057600
C*****00057700
C   GROUND-WATER TABLE AFTER MODIFICATION (M.AMSL) * 00057800
C*****00057900
      DO 500 I=1,NOB                                00058000
      H(I)=H(I)+RES(I)*RELAX(I)                     00058100
      500 CONTINUE                                   00058200
C*****00058300
C   SUM OF NODAL IMBALANCE (MCM/MONTH)              * 00058400
C*****00058500
      SUM=0.                                         00058600
      DO 510 I=1,NOB1                                00058700
      510 SUM=SUM+ABS(RES(I))                         00058800
      IF(SUM-ERROR) 520,520,530                     00058900
      520 CONTINUE                                   00059000
C*****00059100
C   AFTER RELAXATION                                * 00059200
C   HH...GROUND-WATER TABLE FOR MEMORY             * 00059300
C   VOL...GROUND-WATER STORAGE AT T=T+1            * 00059400
C   @ (13)...GROUND-WATER STORAGE INCREMENTATION (MCM/MONTH) * 00059500
C   @ (14)...GROUND-WATER RUNOFF INTO THE SEA (MCM/MONTH) * 00059600
C   @ (17)...EVAPOTRANSPIRATION FROM AREA BELOW DAM (WHEN KASE=1) * 00059700
C   @ (19)...EVAPOTRANSPIRATION FROM AREA BELOW DAM (WHEN KASE=2) * 00059800
C*****00059900
      DO 525 I=1,NOB                                00060000
      HH(NM,M,I)=H(I)                                00060100
      525 HP(I,MP)=H(I)                              00060200
      VOL=0.                                          00060300
      DO 418 I=1,NOB1                                00060400
      418 VOL=VOL+(H(I)-DEPP(I))*A(I)*S              00060500
      @ (13)=VOL-VOL0                                00060600
      VOL0=VOL                                        00060700
      IF(KASE=1) 414,414,415                          00060800
      414 @ (17)=@ (18)-@ (9)-@ (10)-XX              00060900
      @ (14)=@ (4)+@ (10)+@ (12)-@ (13)-@ (18)        00061000
      WRITE(6,631) N,MMON(M),(Q(I),I=1,KQ)           00061100
      GO TO 416                                       00061200
      415 @ (19)=@ (8)-@ (9)-@ (10)-XX               00061300
      @ (14)=@ (3)+@ (6)+@ (10)+@ (12)-@ (13)-@ (18) 00061400
      WRITE(6,632) N,MMON(M),(Q(I),I=1,KQ)           00061500
      416 CONTINUE                                   00061600
C*****00061700
C   ANNUAL TOTAL OF EACH ELEMENT                    * 00061800

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-----1-----2-----3-----4-----5-----6-----7-R-----8
C***** 00061900
  DO 419 I=1,K0 00062000
  419 QY(I)=QY(I)+Q(I) 00062100
  QSEAY=QSEAY+QSEA 00062200
  410 CONTINUE 00062300
  IF(KASE.EQ.1) WRITE(6,641) (QY(I),I=1,K0) 00062400
  IF(KASE.EQ.2) WRITE(6,642) (QY(I),I=1,K0) 00062500
C***** 00062600
C ANNUAL AVERAGE OF EACH ELEMENT * 00062700
C***** 00062800
  DO 660 I=1,K0 00062900
  660 QP(I)=QP(I)+QY(I) 00063000
  QSEAP=QSEAP+QSEAY 00063100
  400 CONTINUE 00063200
  DN=1.0/FLOAT(NENEA-NENSA+1) 00063300
  DO 670 I=1,K0 00063400
  670 QP(I)=QP(I)*DN 00063500
  IF(KASE.EQ.1) WRITE(6,651) (QP(I),I=1,K0) 00063600
  IF(KASE.EQ.2) WRITE(6,652) (QP(I),I=1,K0) 00063700
  WRITE(6,189) (I,I=1,NOB) 00063800
C***** 00063900
C PRINTING SIMULATED GROUND-WATER TABLE * 00064000
C***** 00064100
  DO 600 N=NENS,NENE 00064200
  IF(N.LT.NENSA.OR.N.GT.NENEA) GO TO 600 00064300
  NM=N-NENSA+1 00064400
  NN=N-NENS+1 00064500
  DO 650 M=1,12 00064600
  IF(N.EQ.NENSA.AND.M.LT.MONSA) GO TO 650 00064700
  IF(N.EQ.NENEA.AND.M.GT.MONEA) GO TO 650 00064800
  WRITE(6,88) N,MMON(M),(HH(NM,M,I),I=1,NOB) 00064900
  650 CONTINUE 00065000
  600 CONTINUE 00065100
C***** 00065200
C PLOTTING SIMULATED GROUND-WATER TABLE * 00065300
C***** 00065400
  IF(KASE.EQ.1) WRITE(6,951) (I,I=1,NOB),(SYM(I),I=5,NOB+4), 00065500
  + (J,J=-1,11) 00065600
  IF(KASE.EQ.2) WRITE(6,952) (I,I=1,NOB),(SYM(I),I=5,NOB+4), 00065700
  + (J,J=-1,11) 00065800
  DO 700 N=NENS,NENE 00065900
  IF(N.LT.NENSA.OR.N.GT.NENEA) GO TO 700 00066000
  NM=N-NENSA+1 00066100
  DO 750 M=1,12 00066200
  IF(N.EQ.NENSA.AND.M.LT.MONSA) GO TO 750 00066300
  IF(N.EQ.NENEA.AND.M.GT.MONEA) GO TO 750 00066400
  DO 760 I=1,120 00066500
  760 G(I)=SYM(1) 00066600
  DO 762 I=10,120,10 00066700
  762 G(I)=SYM(2) 00066800
  DO 770 I=5,NOB 00066900
  IG=HH(NM,M,I)*10.0+0.4 00067000
  IG=IG+10 00067100
  IG=MIN0(IG,120) 00067200
  IG=MAX0(IG,1) 00067300
  770 G(IG)=SYM(I+4) 00067400
  WRITE(6,96) N,MMON(M),(G(I),I=1,120) 00067500

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-----1-----2-----3-----4-----5-----6-----7-R-----8
750 CONTINUE
700 CONTINUE
    CALL SPLOT(NENS,NENSA,MONSA,NENEA,MONEA,NOB1,MP,HP,SYM,MMON,RR)
    CALL IPLOT(NENS,NENSA,MONSA,NENEA,MONEA,NOB1,MP,HP,SYM,MMON,RR)
    STOP
C*****
C  FORMATTING FOR OUTPUT LISTING
C*****
621 FORMAT(1H1,'*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY ***',
+         ' *** WADI JIZZI BASIN *** PRESENT CONDITION = BEFORE ',
+         'PROJECT ***//1X,1H*,2(5H-----),2H<<,7(1H-),' A B O V E ',
+         3X,'D A M ',7(1H-),'>>*<<',27(1H-),' B E L O W  D A M ',
+         27(1H-),3H>>*/13X,'AREAL AREAL FALAJ BASE RUN EVAPO ',
+         'AREAL AREAL RUN DRCT RUN RECHA STORA G.W IRRIGA',
+         2X,'OTHER EVAPO EXTRAC',2X,'YEAR MON RAIN RAIN ',
+         'USE FLOW -OFF -TRANS RAIN RAIN -OFF RECHR -SEA ',
+         'RGE -GE -SEA -TION USES -TRANS -TION',14X,'(MM)',
+         2X,'(MCM)',3(1X,5H(MCM)),2X,'(MCM)',3X,'(MM)',2X,'(MCM)',
+         6(1X,5H(MCM)),4(2X,5H(MCM))/1X,1H*,2(5H-----),2(7H-----),
+         3(6H-----),3(7H-----),6(6H-----),4(7H-----))
622 FORMAT(1H1,'*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY ***',
+         ' WADI JIZZI BASIN *** PROPOSED CONDITION = AFTER ',
+         'PROJECT ***//115X,'(UNIT = MCM/MONTH)'/1X,2(5H-----),'*<<'
+         10(1H-),' A B O V E  D A M ',10(1H-),'>>*<<',27(1H-),
+         ' B E L O W  D A M ',27(1H-),'>>*/13X,'AREAL FALAJ ',
+         'BASE RUN EVAPO DRCT SPILL AREAL RUN DRCT RUN ',
+         'RECHA STORA G.W IRRIGA OTHER ',5HADD-L,' EXTRAC ',
+         'EVAPO',2X,'YEAR MON RAIN USE FLOW -OFF -TRANS ',
+         'RECHR -AGE RAIN -OFF RECHR -SEA -RGE -GE -SEA',
+         '-TION USES USES -TION -TRANS',14X,1H(,12,1H),
+         3(2X,1H(,12,1H)),3X,1H(,12,1H),2(2X,1H(,12,1H)),3X,1H(,12,
+         1H),6(2X,1H(,12,1H)),5(3X,1H(,12,1H))/1X,1H*,2(5H-----),
+         6(1H-),1H*,3(6H-----),6(1H-),1H*,2(6H-----),6(1H-),1H*,
+         6(6H-----),5(7H-----))
631 FORMAT(1H ,15,2X,A3,F7.1,F7.2,3F6.2,F7.2,F7.1,F7.2,6F6.2,4F7.2)
632 FORMAT(1H ,15,2X,A3,F7.2,3F6.2,2F7.2,2F6.2,F7.2,6F6.2,4F7.2)
641 FORMAT(1H0, ' *T',8X,F7.1,F7.2,3F6.2,F7.2,F7.1,F7.2,6F6.2,4F7.2/)
642 FORMAT(1H , ' *T',8X,F7.2,3F6.2,2F7.2,2F6.2,F7.2,6F6.2,4F7.2/)
651 FORMAT(1H0, ' *M',8X,F7.1,F7.2,3F6.2,F7.2,F7.1,F7.2,6F6.2,4F7.2/)
652 FORMAT(1H , ' *M',8X,F7.2,3F6.2,2F7.2,2F6.2,F7.2,6F6.2,4F7.2/)
473 FORMAT(1H0,10X,19(2X,1H(,12,1H)))
88 FORMAT(1H ,14,2X,A3,2X,20F6.2)
189 FORMAT(1H1,10X,'*** GROUND-WATER TABLE ***'/12X,19(1X,1H(,12,2H) )
+         /11X,1H*,19(6H-----))
C*****
90 FORMAT(1H1,1H*,38(1H-),1H*,9(1H-),3H*<<,29(1H-),' NUMBER OF ',
+         'DATA ',28(1H-),3H>>*/2H 1,38X,1H1,9X,1H1,
+         10(3X,1H(,12,2H)I)/2H 1,38X,1H1,9X,1H1,10(3X,1H(,12,2H)I),
+         /2H 1,9X,'D E S C R I P T I O N',8X,1H1,4X,'UNIT 1',
+         10(3X,1H(,12,2H)I)/2H 1,38X,1H1,9X,1H1,10(3X,1H(,12,2H)I)/
+         2H 1,38X,1H1,9X,1H1,10(3X,1H(,12,2H)I))
91 FORMAT(1H ,1H*,38(1H-),1H*,9(1H-),1H*,10(8H-----*))
92 FORMAT(1H ,A40,A10,10(F7.1,1H1)/(1X,1H1,38X,1H1,9X,1H1,10(F7.1,1H1
+         )))
93 FORMAT(1H ,A40,A10,10(F7.2,1H1)/(1X,1H1,38X,1H1,9X,1H1,10(F7.2,1H1
+         )))
94 FORMAT(1H ,A40,A10,10(F7.3,1H1)/(1X,1H1,38X,1H1,9X,1H1,10(F7.3,1H1
+         )))

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-----1-----2-----3-----4-----5-----6-----7-R-----
+          ))) 0007330
951 FORMAT(1H1,10X,'*** GROUND-WATER TABLE PLOTTING ***'//11X, 0007340
+          'WELL NO. ',16(1X,1H(,12,1H))/12X,'SYMBOL ',16(3X,A1,1X) 0007350
+          //2X,13(6X,12,2H,0)/1X,13(10H-----+)) 0007360
952 FORMAT(1H1,10X,'*** GROUND-WATER TABLE PLOTTING ***'//11X, 0007370
+          'WELL NO. ',19(1X,1H(,12,1H))/12X,'SYMBOL ',19(2X,A1,2X) 0007380
+          //2X,13(6X,12,2H,0)/1X,13(10H-----+)) 0007390
96 FORMAT(1H ,15,1X,A3,1H,120A1) 0007400
C***** 0007410
END 0007420
C***** 0007430
C SUBROUTINE FOR DAILY RAINFALL TABLE MAKING * 0007440
C***** 0007450
SUBROUTINE KTBLM(NEN,N,T,U,X,XT,Y,IC) 0007460
CHARACTER*36 T 0007470
DIMENSION U(2),X(12,31),XT(12),XM(12),NDAY(12) 0007480
DATA NDAY/31,28,31,30,31,30,31,31,30,31,30,31/ 0007490
IF(IC.EQ.0) GO TO 1 0007500
WRITE(6,60) 0007510
WRITE(6,61) 0007520
WRITE(6,62) T 0007530
WRITE(6,61) 0007540
WRITE(6,63) U,NEN 0007550
WRITE(6,64) 0007560
WRITE(6,65) 0007570
WRITE(6,64) 0007580
1 CONTINUE 0007590
NDAY(2)=28 0007600
IF(MOD(NEN,4).EQ.0) NDAY(2)=29 0007610
Y=0. 0007620
NY=0 0007630
DO 100 M=1,12 0007640
ND=NDAY(M) 0007650
XT(M)=0. 0007660
NY=NY+ND 0007670
DO 200 I=1,ND 0007680
IF(X(M,I).GT.9000.0) GO TO 200 0007690
XT(M)=XT(M)+X(M,I) 0007700
200 CONTINUE 0007710
Y=Y+XT(M) 0007720
XM(M)=XT(M)/FLOAT(ND) 0007730
NDD=ND+1 0007740
IF(NDD.GT.31) GO TO 110 0007750
DO 120 I=NDD,31 0007760
120 X(M,I)=9999999. 0007770
110 CONTINUE 0007780
100 CONTINUE 0007790
YM=Y/FLOAT(NY) 0007800
IF(IC.EQ.0) RETURN 0007810
DO 300 I=1,31 0007820
300 WRITE(6,66) I,(X(M,I),M=1,12) 0007830
WRITE(6,64) 0007840
WRITE(6,67) (XT(M),M=1,12),Y 0007850
WRITE(6,68) (XM(M),M=1,12),YM 0007860
60 FORMAT(1H1////) 0007870
61 FORMAT(1H ,37X,42(1H*)) 0007880
62 FORMAT(1H ,37X,3H***,A36,3H***) 0007890

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-----1-----2-----3-----4-----5-----6-----7-R-----8
63 FORMAT(1H ,102X,'UNIT = ',2A4/7X,'YEAR = ',14) 00079000
64 FORMAT( 1H ,1H*,9(1H-),1H*,12(8H-----*),9(1H-),1H*) 00079100
65 FORMAT(1H ,6X,'DAY',5X,'JAN.',4X,'FEB.',4X,'MAR.',4X,'APR.', 00079200
+ 4X,'MAY ',4X,'JUNE',4X,'JULY',4X,'AUG.',4X,'SEP.',4X, 00079300
+ 'OCT.',4X,'NOV.',4X,'DEC.',4X,'ANNUAL') 00079400
66 FORMAT(1H ,18,2X,12(2X,F6.1)) 00079500
67 FORMAT(1H ,5X,'TOTAL',12F8.1,F10.1) 00079600
68 FORMAT(1H ,5X,'MEAN ',12F8.1,F10.1) 00079700
RETURN 00079800
END 00079900
C***** 00080000
C SUBROUTINE FOR MONTHLY RAINFALL TABLE MAKING * 00080100
C***** 00080200
SUBROUTINE KTBLY(NYS,NYE,T,U,XT,Y,IC) 00080300
CHARACTER*36 T 00080400
DIMENSION U(2),XT(15,12),Y(15),XX(12) 00080500
IF(IC.EQ.0) GO TO 1 00080600
WRITE(6,60) 00080700
WRITE(6,61) 00080800
WRITE(6,62) T 00080900
WRITE(6,61) 00081000
WRITE(6,63) U 00081100
WRITE(6,64) 00081200
WRITE(6,65) 00081300
WRITE(6,64) 00081400
1 CONTINUE 00081500
NN=0 00081600
YY=0. 00081700
DO 90 M=1,12 00081800
90 XX(M)=0. 00081900
DO 100 N=NYS,NYE 00082000
NN=NN+1 00082100
IF(IC.GT.0) WRITE(6,66) N,(XT(NN,M),M=1,12),Y(NN) 00082200
DO 110 M=1,12 00082300
110 XX(M)=XX(M)+XT(NN,M) 00082400
100 YY=YY+Y(NN) 00082500
IF(IC.EQ.0) GO TO 2 00082600
WRITE(6,64) 00082700
WRITE(6,67) (XX(M),M=1,12),YY 00082800
WRITE(6,64) 00082900
2 CONTINUE 00083000
DD=NYE-NYS+1 00083100
DO 200 M=1,12 00083200
200 XX(M)=XX(M)/DD 00083300
YY=YY/DD 00083400
IF(IC.EQ.0) RETURN 00083500
WRITE(6,68) (XX(M),M=1,12),YY 00083600
WRITE(6,64) 00083700
60 FORMAT(1H1////) 00083800
61 FORMAT(1H ,37X,42(1H*)) 00083900
62 FORMAT(1H ,37X,3H***,A36,3H***) 00084000
63 FORMAT(1H ,102X,'UNIT = ',2A4) 00084100
64 FORMAT(1H ,1H*,9(1H-),1H*,12(8H-----*),9(1H-),1H*) 00084200
65 FORMAT(1H ,5X,'YEAR',5X,'JAN.',4X,'FEB.',4X,'MAR.',4X,'APR.', 00084300
+ 4X,'MAY ',4X,'JUNE',4X,'JULY',4X,'AUG.',4X,'SEP.',4X, 00084400
+ 'OCT.',4X,'NOV.',4X,'DEC.',4X,'ANNUAL') 00084500
66 FORMAT(1H ,18,2X,12(2X,F6.1),F10.1) 00084600

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-----1-----2-----3-----4-----5-----6-----7-R-----8
67 FORMAT(1H ,5X,'TOTAL',12F8.1,F10.1) 00084700
68 FORMAT(1H ,5X,'MEAN ',12F8.1,F10.1) 00084800
RETURN 00084900
END 00085000
C***** 00085100
C FUNCTION FOR RUNOFF INTERPOLATION * 00085200
C***** 00085300
FUNCTION FUNQ(N,R,@,S) 00085400
DIMENSION R(N),@(N) 00085500
J=1 00085600
11 J=J+1 00085700
IF(J.EQ.N) GO TO 12 00085800
IF(R(J)-S) 11,12,12 00085900
12 FUNQ=@(J-1)+(@(J)-@(J-1))*(S-R(J-1))/(R(J)-R(J-1)) 00086000
RETURN 00086100
END 00086200
SUBROUTINE SPLOT(NSS,NS,MS,NE,ME,NOB,MP,HP,SY,MMON,RR) 00086300
CHARACTER*1 SY(23),A(121) 00086400
CHARACTER*3 MMON(12) 00086500
DIMENSION HP(20,132),HM(20),S2(20),DD(8),XX(20,132),RR(3,15,12) 00086600
DATA DD/-1.0,0.0,1.0,2.0,150.0,100.0,50.0,0.0/ 00086700
DMP=FLOAT(MP) 00086800
DO 100 I=1,NOB 00086900
HM(I)=0. 00087000
DO 110 N=1,MP 00087100
110 HM(I)=HM(I)+HP(I,N) 00087200
100 HM(I)=HM(I)/DMP 00087300
WRITE(6,64) (I,I=1,NOB) 00087400
DO 120 N=1,MP 00087500
120 WRITE(6,63) N,(HP(I,N),I=1,NOB) 00087600
WRITE(6,65) (HM(I),I=1,NOB) 00087700
DO 200 I=1,NOB 00087800
S2(I)=0. 00087900
DO 210 N=1,MP 00088000
210 S2(I)=S2(I)+(HP(I,N)-HM(I))*2 00088100
200 S2(I)=SQRT(S2(I)/DMP) 00088200
WRITE(6,66) (S2(I),I=1,NOB) 00088300
WRITE(6,64) (I,I=1,NOB) 00088400
DO 220 N=1,MP 00088500
DO 230 I=1,NOB 00088600
230 XX(I,N)=(HP(I,N)-HM(I))/S2(I) 00088700
220 WRITE(6,67) N,(XX(I,N),I=1,NOB) 00088800
WRITE(6,61) (DD(J),J=1,8) 00088900
NEN=NS 00089000
MON=MS 00089100
NN=NS-NSS+1 00089200
DO 300 N=1,MP 00089300
DO 310 K=1,121,20 00089400
310 A(K)=SY(1) 00089500
DO 320 K=1,121,20 00089600
320 A(K)=SY(2) 00089700
SS=0. 00089800
DO 330 I=1,NOB 00089900
X=XX(I,N)*20.0+0.4 00090000
IP=X+41. 00090100
IP=MIN0(IP,81) 00090200
IP=MAX0(IP,1) 00090300

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-----1-----2-----3-----4-----5-----6-----7-R-----8
  A(IP)=SY(I+4)
330 SS=SS+XX(I,N)
  SS=(SS/FLOAT(NOBS))*20.0+0.4
  IP=IFIX(SS)+41
  IP=MAX0(IP,1)
  IP=MIN0(IP,81)
  A(IP)=SY(3)
  IR=RR(3,NN,MON)*0.2+0.4
  IRR=121-IR
  IF(IR.LE.0) GO TO 331
  DO 333 K=IRR,121
333 A(K)=SY(4)
331 CONTINUE
  WRITE(6,62) NEN,MMON(MON),(A(K),K=1,121)
  MMON=MMON+1
  IF(MMON.LE.12) GO TO 300
  MMON=1
  NEN=NEN+1
  NN=NN+1
300 CONTINUE
  61 FORMAT(1H1,10X,3H*(<<,8(1H-),' (WATER LEVEL - AVERAGE WATER LEVEL'
+      ',) / STANDARD DEVIATION ',8(1H-),5H>>)*(<<,10(1H-),
+      ' AREAL RAINFALL ',10(1H-),1H*/3X,' YEAR MON',
+      2X,4(16X,F4.1),4(5X,F5.1)/2H *,9(1H-),1H*,6(19(1H-),1H*))
  62 FORMAT(1H ,16,1H-,A3,121A1)
  63 FORMAT(1H ,4X,14,2X,18F6.2)
  64 FORMAT(1H1,2X,'DATA NO.',18(2X,1H(,12,1H)))
  65 FORMAT(1H0,4X,'MEAN',2X,18F6.2)
  66 FORMAT(1H0,5X,'S.D',2X,18F6.2)
  67 FORMAT(1H ,4X,14,2X,18F6.2)
  RETURN
  END
  SUBROUTINE Iplot(NSS,NS,MS,NE,ME,NOB,MP,HP,SY,MMON,RR)
  CHARACTER*1 SY(23),A(121)
  CHARACTER*3 MMON(12)
  DIMENSION HP(20,132),HM(20),S2(20),DD(8),XX(20,132),RR(3,15,12)
  DIMENSION YY(20,132)
  DATA DD/-1.0,0.0,1.0,2.0,150.0,100.0,50.0,0.0/
  DMP=FLOAT(MP)
  DO 100 I=1,NOB
  HM(I)=0.
  DO 110 N=1,MP
110 HM(I)=HM(I)+HP(I,N)
100 HM(I)=HM(I)/DMP
  DO 200 I=1,NOB
  S2(I)=0.
  DO 210 N=1,MP
210 S2(I)=S2(I)+(HP(I,N)-HM(I))**2
200 S2(I)=SQRT(S2(I)/DMP)
  DO 220 N=1,MP
  DO 230 I=1,NOB
230 XX(I,N)=(HP(I,N)-HM(I))/S2(I)
220 CONTINUE
  DO 240 N=1,MP
  IF(N.LT.7.OR.N.GT.MP-4) GO TO 240
  DO 245 I=1,NOB
  YY(I,N)=0.
  
```

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-----1-----2-----3-----4-----5-----6-----7-R-----
DO 250 L=6,5                                00096100
250 YY(I,N)=YY(I,N)+XX(I,N+L)                00096200
245 YY(I,N)=YY(I,N)/12.0                    00096300
240 CONTINUE                                  00096400
WRITE(6,61) (DD(J),J=1,8)                   00096500
NEN=NS                                        00096600
MON=MS                                        00096700
NN=NS-NSS+1                                  00096800
DO 300 N=1,MP                                00096900
DO 310 K=1,121                                00097000
310 A(K)=SY(1)                                00097100
DO 320 K=1,121,20                            00097200
320 A(K)=SY(2)                                00097300
IF(N.LT.7.OR.N.GT.MP-4) GO TO 335           00097400
SS=0.                                         00097500
DO 330 I=1,NOB                                00097600
X=YY(I,N)*20.0+0.4                          00097700
IP=X+41.                                       00097800
IP=MIN0(IP,81)                                00097900
IP=MAX0(IP,1)                                 00098000
A(IP)=SY(I+4)                                 00098100
330 SS=SS+YY(I,N)                              00098200
SS=(SS/FLOAT(NOB))*20.0+0.4                 00098300
IP=FIX(SS)+41                                 00098400
IP=MAX0(IP,1)                                 00098500
IP=MIN0(IP,81)                                00098600
A(IP)=SY(3)                                 00098700
335 IR=RR(3,NN,MON)*0.2+0.4                 00098800
IRR=121-IR                                    00098900
IF(IR.LE.0) GO TO 331                        00099000
DO 333 K=IRR,121                              00099100
333 A(K)=SY(4)                                00099200
331 CONTINUE                                  00099300
WRITE(6,62) NEN,MMON(MON),(A(K),K=1,121)    00099400
MON=MON+1                                     00099500
IF(MON.LE.12) GO TO 300                     00099600
MON=1                                         00099700
NEN=NEN+1                                     00099800
NN=NN+1                                       00099900
300 CONTINUE                                  00100000
61 FORMAT(1H1,10X,3H* << ,8(1H-), ' (WATER LEVEL - AVERAGE WATER LEVEL' 00100100
+      ,') / STANDARD DEVIATION ',8(1H-),5H>> * << ,10(1H-), 00100200
+      ' AREAL RAINFALL ',10(1H-),1H*/3X,' YEAR MON', 00100300
+      2X,4(16X,F4.1),4(5X,F5.1)/2H *,9(1H-),1H*,6(19(1H-),1H*)) 00100400
62 FORMAT(1H ,16,1H-,A3,121A1)                00100500
63 FORMAT(1H ,4X,14,2X,18F6.2)                00100600
64 FORMAT(1H1,2X,'DATA NO.',18(2X,1H(,12,1H))) 00100700
65 FORMAT(1H0,4X,'MEAN',2X,18F6.2)           00100800
66 FORMAT(1H0,5X,'S.D',2X,18F6.2)           00100900
67 FORMAT(1H ,4X,14,2X,18F6.2)                00101000
RETURN                                         00101100
END                                             00101200

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ANNEX C GEOLOGY AND EMBANKMENT MATERIALS

ANNEX C

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C-1 GEOLOGY

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C-1 GEOLOGY

C-1-1 Introduction

The WADI JIZZI area is covered by the WADI JIZZI 1:10000,000 geological sheet (DEPARTMENT OF MINERAL, OMAN OPHIOLITE PROJECT, 1980). The area has also been mapped by JICA (THE WADI JIZZI AGRICULTURAL DEVELOPMENT PROJECT, 1982,83).

Figure C-1 is a geological plan of the project area. The geological units are based on existing geological maps above mentioned.

Geological investigations shown as follows was carried out;

- * Geological mapping of the dam area, scale 1:4000
- * Core drilling, 6 holes, total 208 meters
- * Water pressure test, 41 stages
- * Standard Penetration Test, 34 numbers
- * Test pits excavating, 9 holes

The locations of the holes and the pits are shown FIGURE C-1. The exploration aimed at obtaining general information for the detailed design of the dam.

C-1-2 Topography

The dam site is located in the conference of the WADI JIZZI and the WADI AWAINA. Near the dam site the streams are youthful U shaped vallies which are accumulating sands and gravels at present. They cut the wide spread terraces which is steep at the banks.

The terraces consist of cemented sand and gravels, and range in altitude from 160 - 175 meters. Gullies are formed on the terrace near the both banks. The terrace is recognized three faces around the dam area, namely, upper, middle and lower terrace.

The WADI JIZZI runs eastwards and the gradient is 1/140 near the dam axis.

The remnant hills of limestone lie at 1.5 kilometers upper stream of the dam axis. Because bed rocks are overlain widely by sands and gravels, the outcrops of them are very few except these hills.

C-1-3 Investigation

1) Geological Mapping

The mapping carried out at a scale of 1:2,000 and later compiled on contour plans on the scale of 1:4000.

Because bed rocks are overlain by terraces and alluvial deposits, the outcrops in the area are very few. But stratigraphic information can be obtained in bore-hole drilling and from few surface exposure, and from the relationship between geology and topography.

The main geological information is presented in the following figures;

- * geological plans, FIGURE C-2
- * geological section, FIGURE 4-1

2) Core Drilling

Core drilling carried out on the dam axis. Six bore holes were put down, numbered from BH-1 to BH-6, and of these, total length of 208 meters, are located as follows;

- * BH-1 on the left bank, near the emergency spill way area
- * BH-2,3,4,6 on the WADI bed
- * BH-5 on the right bank, in the spill way area near the dam crest

Drilling machines used hydraulically driven type. The type of the drilling equipments were shown as follows;

Drilling machine	Wirth - 81 reelius D 750
Core barrel	single tube and double tube
Casing tube	innerdiameter 116, 101, 86mm

Core losses were high in upper part of terrace deposits and recent river deposits, but useful information was obtained for determining the thickness of foundation stripping and permeability. The core recovery in middle and lower part of terrace deposits and bed rock was high.

Detailed log of all boreholes are shown FIGURE C-2.

Cores are stored at the office of SOHAR BRANCH of the WATER RESOURCES AND IRRIGATION, MAP

Water pressure test, such as lugeon test and permeability test, and Standard Penetration Test were carried out in the boreholes. The data sheets and summary are shown in Figure C-3, C-4, C-6 and Table C-2, C-3.

3) Test Pits and Permeability Test

Nine test pits, numbered from TP-1 to TP-9, were dug by a back hoe shovel in a depth of five meters in order to obtain samples of embankment materials. They are located as follows;

- * TP-1 in the emergency spill way area
- * TP-2,3 on the dam axis in the river bed
- * TP-4,9 on the left bank in the spill way area near the dam crest
- * TP-5,8 in the reservoir area
- * TP-6,7 on the upper terrace in the reservoir area

The test pit logs are shown in Figure C-3.

Permeability test was carried out in the test pits in a depth of two and five meters. The data sheets and the summary are shown in TABLE C-1 and TABLE C-2.

C-1-4 Rock Types and Stratigraphy

Rocks around the dam site consist of bed rocks, terrace deposits and recent river deposits.

1) Bed Rocks

Bed rocks consist of limestone, chert, sandstone and serpentine. The out-crops of these rocks are very few, and are overlain by widespread terrace deposits.

It seems that limestone constitutes the bed rock of the dam axis in the right bank. This is inferred from borehole BH-6 that it occurs in the depth 33.25 meters and a small outcrop in a gullie on the terrace of the right bank. It seems that limestone in the dam axis dips gently from the right bank to center of the WADI JIZZI. It unconformably overlies serpentine, and is overlain by terrace deposits.

It seems that surface of the bed is generally rolling from the investigation of topography and core drilling.

Limestone is pinkish white colour, silicious and hard, giving a clear ring when struck with the hammer. The limestone constituting remnant hills in the upperstream of the dam area is also hard and siliceous, and has opened joints.

There are few outstrops of serpentine. They occurs as scattered exposure being overlain by limestone in the upper stream of the dam axis. Serpentine constitutes the bed rock of the dam axis that was identified by boreholes of BH-1 and BH-2 on the left bank and BH-3 on the center of the WADI JIZZI. It dips gently from the left bank to center of the WADI JIZZI, and unconformably overlain

by the terrace deposits. The vertical scale of the geological section (FIGURE C-7) is greatly exaggerated, so that the surface appear to dip steeply; actually the surface mostly has dips of less than 10 degree. Serpentine is dark greenish grey and phenocrysts of pyroxenite and chlorite are embeded in abundance. It is generally slightly hard to hard. Partly it is soft by strong altered and weathered, especially in borehole BH-3.

There are few outcrops of sandstone in the floor of the gullies where the emergency spill way has been planning. Because it is overlain by terrace deposits, the distribution and the relation between other bed rocks are not clear. It seems that sandstone unconformably overlies serpentine. Sandstone is brownish grey and hard, giving a clear ring when it is stuck by a hammer.

2) Terrace Deposits

Terrace deposits are widespread around the dam area and consist of cemented sands and gravels. Gravels come from the Oman Ophiolite Composition that consists of mafic to ultramafic rocks and HAWASINA sediments. The quantities and the diameters of gravels have a wide variety, and also sands from fine to coarse. There are thin silt beds in the terrace deposit. The terraces around the dam area have been divided into three faces, namely, upper terrace, middle terrace and lower terrace. In spite of the deposits of Quaternary age, they are regarded as soft rock from the consolidated conditions.

Upper terrace deposits directly overlie the bed rocks, and are overlain by middle terrace deposits in the WADI channel. They are divided into four parts as shows FIGURE C-7 GEOLOGICAL SECTION, namely, breccia (Tu-br), gravely silt (Tu-sl), sand, silty sand (Tu-sd), sands and gravels (Tu-sg).

Breccia (TU-br)

Breccia consists of gravels and silt. It is greyish brown coloured, very dense and varies from moderately strong to strong. The distribution is limited.

Gravelly Silt (Tu-sl)

Gravelly silt consists of gravels and silt. It is well consolidated and strong. Gravels are weakly weathered. Core recovery is 95% and R.Q.D is 80%. Water leakage in the pressure tests is few.

Sand and Gravels (Tu-sg)

The both abutments consist of sand and gravel, and vary from weakly cemented to well cemented. The upper part (0 to 5m) is weakly cemented, and weakly weathered. Rock classification is C1. The middle part (5 to 15m) is very dense and well cemented. Joints are sparse, but opened and weathered. The lower part below 15.0m is very dense and strong consolidated.

Middle terrace deposits overlies on the upper terrace deposits in the river bed, and are overlain by recent river deposits. They are divided into two parts as shown in FIGURE C-3, namely, porosity sands and gravels (Tm-pr) and sands and gravels (Tm-sg).

Porosity Sands and Gravels (Tm-pr)

This layer is distributed in the lower part of middle terrace deposits in the river bed. It is weakly to well cemented, and porosity lacking fine grain size. Core recovery is 65%, R.Q.D is 25% and water leakage is high.

Sand and Gravels (Tm-sg)

This layer is directly overlain by recent river deposits, and 6 to 8 meters thick.

Gravels are granule to coble, occasionally including boulders. Sands are fine to coarse and occasionally including thin silt beds. The sand and gravel varies from dense to very dense. Joints are sparse, but opened and weathered. Core recovery is 40%, R.Q.D 0% and water leakage is high. This layer constitutes the dam foundation after the stripping of recent river bed.

Sand Silty Sand (Tu-sd)

The distribution of this layers are narrowly limited. They vary from moderately strong to strong and medium sand and medium silty sand.

3) Recent River Deposits

Recent river deposits have been explored by four boreholes, namely, BH-2, -3, -4, -6, and four test pits, namely, Tp-2, -3, -5, -8. Summary logs of these holes are shown in GEOLOGICAL SECTION. Recent river deposits unconformably overlies on the upper terrace deposits. The average depth of the deposits is 3.08 meter in all holes and 3.10 meter at the dam axis. The deposits consist of sands and gravels, and they are very loose.

C-1-5 Faults and Shears

No faults and shears have been revealed by the field investigation, reading of aerial photographs, and core drilling.

C-1-6 Groundwater and Permeability

Water pressure test was performed in the section of boreholes which were drilled through rocks. The water pressure test was made in principle 5 m stage in descending order using paker, but the section length was altered less than 5 m in case of strongly weathered rock.

1/ R.Q.D : Rock Quality Designation

The detail of the test is as follows,

After the deep of 5 meter has been drilled into rock bed, the hole is washed by flushing water through drilled rod inserted to the bottom till the returning water becomes clean. The packer is installed at the top of the section of the 5 meters and water is injected into the section through injected pipe. Under a certain water pressure that is kept constant by controlling return diversion flow at the neck of the hole, the injected water quantity is observed for ten minutes to obtain injection rate in terms of litres every minute. The ten minutes observation is started after the injection rate becomes nearly constant. During the ten minutes observation the injected water quantity is observed and recorded every minutes. The observation in the same procedure is made, in each stage of 5 m section for seven different pressures, that is, 1 kg/cm², 4 kg/cm², 7 kg/cm², 10 kg/cm², 7 kg/cm², 4 kg/cm², 1 kg/cm² in order.

After the above observation has been completed, the hole is drilled by another 5 m, and test is repeated with same procedures. In the same manner, the boreholes are drilled and water-pressure-tests are conducted up to the planned depths.

In case that the pressure cannot rise up to 10 kg/cm² because of much leakage from the test section, the test is made only for the attainable pressures.

The results are presented by dimensions of coefficient of permeability and Lugeon unit as calculated by the following formula.

Coefficient of permeability

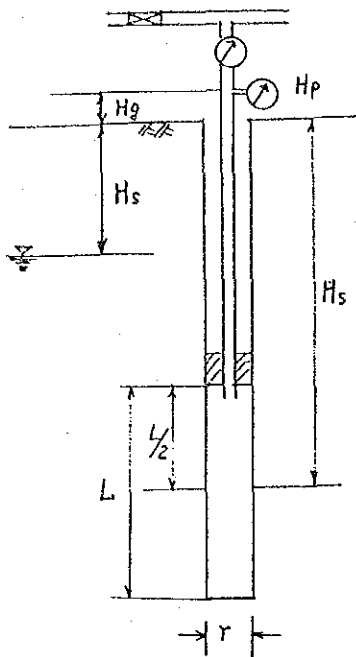
$$k = 2.3/2 \times 1/60 \times 1/L \times \log L/r \times Q/H$$

Lugeon unit

$$Lu = Q'/LH \times 10$$

where,

K : Coefficient of permeability (cm/sec.)



- Lu : Injection rate (cu.cm/min)
 Q : Injection rate (sq.cm/min)
 Q' : " (liter/min.)
 L : Length of test section (cm)
 r : Radius of hole (cm)
 H : Water pressure in head (cm)

$$H = H_p + H_s + H_g$$

H_p : Pumping head (cm)

H_s : Static water head from middle part of test section up to top of hole. If ground water level is higher than the middle part of test section, this is the head water level to top of hole. (cm)

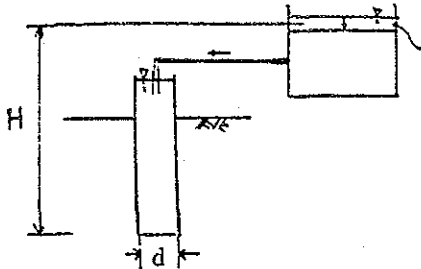
H_g : Height of water pressure gauge from the top of hole. (cm)

Permeability test by means of injection method was performed in the section of the test pits in order to evaluate seepage condition of alluvial deposit and surface area of terrace deposit. The detail of the test is as follows.

The permeability test is performed in 2 m and 5 m deep in each test pits. When test pit is dug into 2 m and 5 m deep, a casing pipe is installed at the bottom of the hole and the space between the casing pipe and the hole is cemented, and water is injected into the casing pipe. After injection of water is continued more than 30 minutes, quantity of water is measured during ten minutes. Quantity of injected water is measured from the water level of a water tank.

The result is presented in coefficient of permeability as calculated by the following formula.

$$k = Q/5.5rh$$



Where,

Q: Quantity of injected water (cu.cm/min)

d: Inner diameter of casing

H: Water head (cm)

The observation of groundwater table were made during and after completion of works.

The water pressure test of 39 numbers was carried out and the result is as follows;

- * leakage rate less than 1 Lugeon 4 nos
- * leakage rates from 1 to 10 Lugeons 21 "
- * leakage rates from 10 to 100 Lugeons 9 "
- * leakage rates greater than 100 Lugeons ... 5 "

FIGURE 4 LUGEON MAP shows the distribution of Lugeon value.

- * Zone 1 Recent river deposits
- * Zone 2 Leakage rates greater than 100 Lugeons
- * Zone 3 Leakage rate from 50 to 100 Lugeons
- * Zone 4 Leakage rates from 10 to 50 Lugeons
- * Zone 5 Leakage rates less than 10 Lugeons

FIGURE 4-3 SUMMARY OF PERMEABILITY made on the basis of the above mentioned zone, shows the distribution of permeabilities and its average values in each zone.

The features of each zone are as follows:

- * Zone 1 Average of permeability $k=9.77 \times 10^{-3}$ cm/sec.

The data of this zone depended on the permeability test in the test pits (shown FIG C-5).

This zone consists of very loose sands and gravels in the WADI.

- * Zone 2 Average of permeability $k=1.89 \times 10^{-3}$ cm/sec.
This zone is distributed in the upper part of middle terrace deposits (Tm-sq) and the both abutment (Tu-sg), and consists of weakly to well cemented sands and gravels. It varies from weakly to strong weathered, and core recovery and R.Q.D are poor, and water leakage is high. Complete losses of water returns were recorded at a depth of 5.0m in BH-1 and 8.5m in BH-4.
- * Zone 3 Average of permeability $k=5.12 \times 10^{-4}$ cm/sec.
This zone is distributed in lower part of middle terrace deposits (Tm-pr), and has abundant vesiculors. Core recovery is 65%, and R.Q.D is 25% and water leakage is high.
- * Zone 4 Average of permeability $k=1.30 \times 10^{-4}$ cm/sec.
This zone is narrowly distributed in surrounding Zone-2 and Zone-3.
- * Zone 5 Average of permeability $k=1.82 \times 10^{-5}$ cm/sec.
Both core recovery and R.Q.D are rich. This zone is impermeable layer.

Groundwater was mostly observed between 12m and 20m below the surface of the WADI bed. There are relatively small fluctuations with time. In general the water table in the river bed is found at or near the weathered base.

C-1-7 Standard Penetration Test

Standard Penetration Test was carried out in all boreholes (hereinafter referred to as SPT" in the following). SPT was carried out at every two meters of depth in the section of boreholes. The detail of the test is as follows,

SPT is carried out in accordance with JIS A-1219, that is the weight of hammer is 63.5kg and the dropping height is 75 cm above top collar of the rod. The hammer is dropped by the same drilling machine along the guide pipe or rod, vertically without any appreciable friction loss.

The knocking number by the hammer to penetrate the SPT sampler is counted for 30 cm penetration (recognized as "N value"). The penetration depth by each hammering is measured and recorded as accumulated number. The record is taken for every 10 cm of penetration. Because the layer consists of sand and gravel, SPT sampler shoes were broken by hammering. Therefore, cone shoes were used instead of SPT sampler and sampler shoe.

The result of the test is shown in Fig. C-6.

All of "N-value" are more than 100, and the average of "N-value" in each layers is as follows,

Middle terrace deposit (Tm)	N value = 209.6
Upper terrace deposit (Tu)	N average = 146.4

The data indicates that the layers are very dense and angle of internal friction is more than 50 degrees. This internal diameter, however, is high, because "N-value" in the layer is including not only hammering numbers of matrix part, but also hammering numbers of gravel part. The rocks are anisotropical because they consist of soft matrix of sand and hard gravel. Then shear strength of rocks is subject to the strength of matrix and it is infered to be lower than 50 degrees.

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C-1-3 Record of Water Pressure Test

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C-1-2 Drill Log (1-10)

C-1-3 Test Pit Log

C-1-4 P-Q Curve (BH-1 to BH-6)

C-1-5 Summary of Permeability Test in Test Pits

C-1-6 Summary of Cone Penetration Test

C-1-7 Geological Section

C-1-8 Lugeon Map

C-1-9 Profile of Sampling Point

TABLE C-1-1 SUMMARY OF PERMEABILITY TEST IN THE TEST PITS

(Unit: cm/sec)

DEPTH	TESTING METHOD	TP-1	TP-2	TP-3	TP-4	TP-5	TP-8	TP-9	AVERAGE
2.0m	CONSTANT HEAD	1.22×10^{-3}	$*9.3 \times 10^{-3}$	$*4.92 \times 10^{-3}$	2.08×10^{-3}	$*1.51 \times 10^{-2}$	6.20×10^{-3}	4.95×10^{-3}	$*9.77 \times 10^{-3}$ 3.61×10^{-3}
	FALLING HEAD	5.62×10^{-4}	$*2.30 \times 10^{-3}$	$*1.19 \times 10^{-3}$	1.60×10^{-3}	$*5.68 \times 10^{-3}$	3.21×10^{-3} 2.37×10^{-3}	1.63×10^{-3}	$*3.06 \times 10^{-3}$ 1.87×10^{-3}
5.0m	CONSTANT HEAD	3.10×10^{-3}	1.20×10^{-3}	3.01×10^{-4}	5.83×10^{-4}	1.15×10^{-4}	4.10×10^{-4}	6.73×10^{-3}	1.78×10^{-3}
	FALLING HEAD	1.27×10^{-3}	5.00×10^{-4}	2.10×10^{-4}	4.05×10^{-4}	1.65×10^{-5}	1.33×10^{-4}	2.25×10^{-3}	6.84×10^{-4}

* RECENT RIVER DEPOSITS

TABLE C-1-2 Record of Permeability Test

Sheet Nol to 4

TABLE C-1-2 (1) RECORD OF PERMEABILITY TEST (HOLE BOTTOM METHOD)

No. 1.

RECORD OF PERMEABILITY TEST (HOLE BOTTOM METHOD)

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	14' 7"		7.9	22.9	72.1	1.22 x 10 ⁻³	
	10'00"	3.6	"	21.1	70.6		5.62 x 10 ⁻⁴
5.0m	6'25"		"	21.0	169.6	3.10 x 10 ⁻³	
	10'00"	6.8	"	17.6			1.27 x 10 ⁻³

HOLE NO TP-1 DATE 11/Apr.

HOLE NO TP-2 DATE 15/April

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	9'39"		5.8	49.5	878.8	9.30 x 10 ⁻³	
	3'00"	12.5	"	43.3	440.0		2.30 x 10 ⁻³
5.0m	10'20"		"	49.5	113.7	1.20 x 10 ⁻³	
	21'00"	1.5	"	49.8	113.1		5.00 x 10 ⁻⁴

HOLE NO TP-2

TABLE C-1-2 (2)

No.2.

RECORD OF PERMEABILITY TEST (HOLE BOTTOM METHOD)

HOLE NO TP-3

DATE 18/Apr.

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	14'12"	11.5	5.9	46.8	447.9	4.92 x 10 ⁻³	
	5'00"		"	41.1	187.9		1.19 x 10 ⁻³
5.0m	41'20"	3.5	5.1	50.5	25.6	3.01 x 10 ⁻⁴	
	7'06"		"	50.5	40.3		2.10 x 10 ⁻⁴

HOLE NO TP-4

DATE 19/Apr.

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	20'00"	17.2	5.8	56.9	226.8	2.08 x 10 ⁻³	
	5'00"		"	52.0	363.8		1.60 x 10 ⁻³
5.0m	20'00"	4.5	5.2	50.7	42.0	5.83 x 10 ⁻⁴	
	5'00"		"	48.0	76.2		4.05 x 10 ⁻⁴

TABLE C-1-2 (8)

No. 3.

RECORD OF PERMEABILITY TEST (HOLE BOTTOM METHOD)

HOLE NO TP-5 DATE 17/Apr.

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	6'42"		5.9	53.8	1,582.1	1.51×10^{-2}	
	2'00"	20.2	"	43.7	1,104.5		5.68×10^{-3}
5.0m	5'00"		"	45.2	23.1	1.15×10^{-4}	
	20'00"	0.7	"	51.7	3.8		1.65×10^{-5}

HOLE NO TP-8 DATE 15/April.

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	10'00"		7.7	21.5	338.7	6.20×10^{-3}	
	4'51"	8.4	"	17.3	322.6		3.21×10^{-3}
	10'00"	11.6	"	15.7	216.1		2.37×10^{-3}
5.0m	10'00"		5.9	55.6	44.4	4.10×10^{-4}	
	16'20"	4.7	5.9	53.3	34.17		1.33×10^{-4}

TABLE C-1-2 (4)

RECORD OF PERMEABILITY TEST (HOLE BOTTOM METHOD) No. 4.

HOLE NO TP-9 DATE 20/Apr.

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m	10'26"		5.2	47.8	406.4	4.95 x 10 ⁻³	
	3'00"	10.8	"	47.8	305.8		1.63 x 10 ⁻³
5.0m	7'15"		5.9	55.8	731.0	6.73 x 10 ⁻³	
	3'00"	15.3	"	55.8	557.7		2.25 x 10 ⁻³

HOLE NO _____ DATE _____

STAGE	TIME (min)	HEAD DIFFERENCE (cm)	HOLE RADIUS r (cm)	WATER HEAD H (cm)	WATER LEAKAGE q (cm ³ /min)	PERMEABILITY	
						CONSTANT HEAD k (cm/sec)	FALLING HEAD k (cm/sec)
2.0m							
5.0m							

TABLE C-1-3 Record of Water Pressure Test

Sheet No1 to 20

TABLE C-1-3 (1) RECORD OF WATER PRESSURE TEST

RECORD OF WATER PRESSURE TEST

SHEET NO 1

HOLE NO 1 GROUND WATER LEVEL 25.85 m

STAGE NO	DATE	DEPTH m-	SECTION LENGTH L cm	HOLE RADIUS r cm	PRESSURE kg/cm ³	GUAGE HEIGHT Hg cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m
1	14/Apr.	8.0- 8.5	50.0	3.3	0	80.0	1.9	3.02×10^{-4}	
					1		4.6	3.44×10^{-4}	
					3		7.0	2.58×10^{-4}	35.6
					1		4.6	3.44×10^{-4}	
					0		2.5	3.97×10^{-4}	
2	16/Apr.	13.0- 14.0	100.0	3.3	1	0	0	-	
					2		0	-	
					3		0	-	
					5		0.76	1.08×10^{-5}	
					7		1.14	1.27×10^{-5}	1.4
					3		0.95	1.36×10^{-5}	
3	17/Apr.	17.4- 18.4	100.0	5.0	0	0	0	-	
					3		0	-	
					5		0.58	4.45×10^{-6}	
					7		0.83	7.54×10^{-6}	0.94
					5		0.76	8.89×10^{-6}	
					3		0.46	7.54×10^{-6}	
					1		0.08	1.29×10^{-5}	

RECORD OF WATER PRESSURE TEST

HOLE NO 1

GROUND WATER LEVEL 25.85

SHEET NO 2

TABLE C-1-3 (2)

STAGE NO	DATE	DEPTH m-	SECTION LENGTH L cm.	HOLE RADIUS r cm	PRESSURE kg/cm ³	GUAGE HEIGHT Hg cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m
4	19/Apr.	22.0- 24.8	280	5.0	1	0	0	-	
					4		0.49	2.97×10^{-6}	
					7		3.71	1.52×10^{-5}	
					10		4.74	1.46×10^{-5}	1.7
					7		3.64	1.49×10^{-5}	
					4		2.50	1.50×10^{-5}	
					1		0.61	6.90×10^{-6}	
5	21/Apr.	27.0- 30.0	300	5.0	0	0	0	-	
					1		0	-	
					4		0.38	2.17×10^{-6}	
					7		3.03	1.17×10^{-5}	
					10		6.06	1.78×10^{-5}	2.0
					7		4.27	1.65×10^{-5}	
					4		0	-	
					1		0	-	

TABLE C-1-3 (3)

RECORD OF WATER PRESSURE TEST

HOLE NO 1

GROUND WATER LEVEL 25.85

SHEET NO 3

STAGE NO	DATE	DEPTH m-	DEPTH m	SECTION LENGTH L cm	HOLE RADIUS r cm	PRESSURE kg/cm ³	GAUGE HEIGHT Hg cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m
6	26/Apr.	32.0-	35.8	380.0	5.0	0	0	0	-	
						1		0	-	
						4		0.76	3.59×10^{-6}	
						7		1.35	4.35×10^{-6}	
						10		1.82	4.44×10^{-6}	0.5
						7		0.76	2.45×10^{-6}	
						4		0.38	1.81×10^{-6}	
						1		0	-	
7	27/Apr.	37.0-	40.0	300.0	4.25	0	0	0	-	
						1		0.07	8.65×10^{-7}	
						4		0.46	2.71×10^{-6}	
						7		0.76	3.05×10^{-6}	
						10		0.80	2.41×10^{-6}	0.3
						7		0.85	3.38×10^{-6}	
						4		0.57	3.35×10^{-6}	
						1		0	-	

TABLE C-1-3 (4)

RECORD OF WATER PRESSURE TEST

HOLE NO 2

GROUND WATER LEVEL 18.80 m

SHEET NO 4

STAGE NO	DATE	DEPTH m-	SECTION LENGTH L cm	HOLE RADIUS r cm	PRESSURE kg/cm ³	GUAGE HEIGHT Hg cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m					
1	29/Apr.	4.0- 4.75	75.0	5.0	0	30	0	-						
					1		0	-						
					4		0.38	8.13×10^{-6}						
					7		1.67	2.13×10^{-5}						
					10		2.14	1.95×10^{-5}	2.9					
					7		1.89	2.42×10^{-5}						
					4		0.63	1.35×10^{-5}						
					1		0.04	2.48×10^{-5}						
					2	30/Apr.	8.0- 8.5	50.0	5.0	0	0	3.25	4.81×10^{-4}	
										2		7.20	3.11×10^{-4}	
4		13.87	3.51×10^{-4}											
7		26.49	4.07×10^{-4}											
10		40.93	4.61×10^{-4}	81.9										
7		30.38	4.74×10^{-4}											
4		16.43	4.15×10^{-4}											
1		5.46	3.65×10^{-4}											

TABLE C-1-3 (6)

RECORD OF WATER PRESSURE TEST

SHEET NO 6

GROUND WATER LEVEL 18.80 m

HOLE NO 2

STAGE NO	DATE	DEPTH m-	DEPTH m	SECTION LENGTH L cm	HOLE RADIUS r cm	PRESSURE kg/cm ³	GUAGE HEIGHT Hg cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m
5	4/May	22.6-	23.6	100.0	4.25	0	30.0	0	-	
						1		0	-	
						4		0.80	1.24×10^{-5}	
						7		1.90	1.90×10^{-5}	
						10		2.50	1.84×10^{-5}	2.5
						7		2.12	2.13×10^{-5}	
						4		1.44	2.24×10^{-5}	
						1		0.91	3.22×10^{-5}	
6	5/May	25.0-	30.0	500.0	4.25	0	30.0	0	-	
						1		0	-	
						4		0.57	2.68×10^{-6}	
						7		1.67	5.03×10^{-6}	
						10		2.27	5.06×10^{-6}	0.5
						7		1.82	5.49×10^{-6}	
						4		0.83	3.92×10^{-6}	
						1		0	-	

TABLE C-1-3 (7)

RECORD OF WATER PRESSURE TEST

SHEET NO 7

GROUND WATER LEVEL 19.45 m

HOLE NO 3

STAGE NO	DATE	DEPTH m-	DEPTH m	SECTION LENGTH L cm	HOLE RADIUS r cm	PRESSURE kg/cm ³	GAUGE HEIGHT lig cm	WATER LEAKAGE Q l/min	PERMEABILITY k cm/sec	LUGEON UNIT Lu l/min/m
1	6/May	6.0-	6.3	30.0	5.0	0	0	1.40	3.54×10^{-5}	
						1		1.59	1.55×10^{-4}	
						4		22.40	7.65×10^{-4}	
						7		80.70	1.67×10^{-3}	269.0
						4		30.01	1.03×10^{-3}	
						1		8.64	8.40×10^{-4}	
2	7/May	8.0-	8.5	50.0	5.0	0	25	1.22	1.75×10^{-4}	
						1		10.05	6.63×10^{-4}	
						4		27.14	6.83×10^{-4}	
						7		157.55	2.45×10^{-3}	401.4
						4		36.69	9.23×10^{-3}	
						1		1.74	1.15×10^{-4}	
3	7/May	10.0-	10.5	50.0	5.0	0	25	0	-	
						1		0	-	
						4		10.54	2.54×10^{-4}	
						7		16.56	2.51×10^{-4}	
						10		20.88	2.31×10^{-4}	41.8
						7		16.45	2.49×10^{-4}	