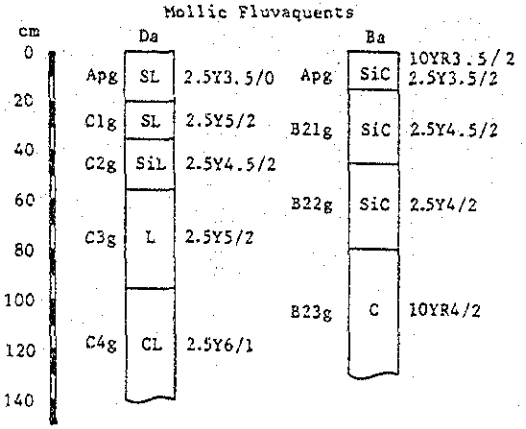
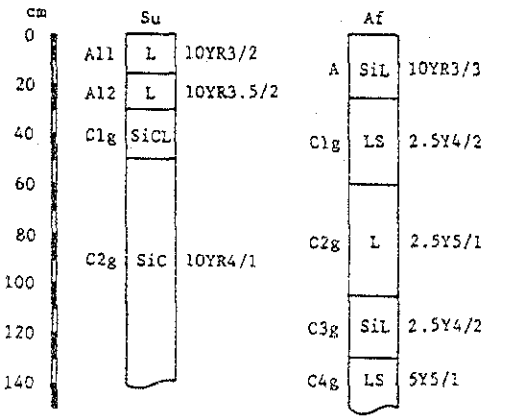
Table A.4.3. Morphological & Chemical Properties of Prevailing Soils



Soil Series	Depth	Horizon	Size Classes of Particles				SP	ECe×10³	pHs	OC	ava P	ava K	T.N.V.	C.E.C	Gypsum
			Sand	Silt	Clay	Texture									
	cm		%	%	%		%	ms/cm		%	ppm	ppm	%		me/100g
Darzikola	0-20	Apg	49	34	17	SL	50	1.09	7.9	0.74	5.0	80	20		1.56
(Da)	20-35	C1g	44	38	18	SL	49	0.72	8.1	0.65	2.5	96	20		1.79
	35-55	C2g	28	50	22	SiL	59	0.64	8.0	0.67			16		1.79
	55-95	C3g	29	49	22	L	50	0.57	8.0	0.50			16.5		1.77
	95-140	C4g	42	30	28	CL	45	0.57	8.1	0.30			19.5		1.90
Babol	0-15	Apg	11	42	47	SiC	80	1.38	7.5	2.40		190	2.0		
(Ba)	15-45	B21g	9	41	50	SiC	64	0.60	7.7	1.44		190	1.5		
	45-80	B22g	11	40	49	SiC	67	0.44	7.9	0.86			2.0		
	80-130	B23g	16	38	46	C	70	0.43	8.0	0.60			4.5		



Soil Series	Depth	Horizon	Size Classes of Particles				SP	ECe×10³	pHs	OC	ava P	ava K	T.N.V.	C.E.C	Others
			Sand	Silt	Clay	Texture									
	cm		%	%	%		%	ms/cm		%	ppm	ppm	%	me/100g	
Sufimaheleh	0-15	A11	42	46	12	L	91	0.43	7.7	6.21	14	70		55	
(Su)	15-30	A12	33	43	24	L	92	1.60	7.0	1.06	15	60		50	
	30-50	C1g	7	54	39	SiCL	63	1.30	7.9	0.90	4	50		17	
	50-140	C2g	4	55	41	SiC	67	0.51	7.9	0.99				17.5	
Afrarakht	0-25	A	29	50	21	SiL	48	2.4	8.0	1.15		90	17.5		
(Af)	25-60	C1g	84	10	6	LS	39	1.85	7.8	0.30		50	21		
	60-105	C2g	48	38	14	L	34	5.0	8.0	0.60			24.5		
	105-130	C3g	19	60	21	SiL	58	5.6	8.0	0.45			15		
	130-150	C4g	81	13	6	LS	35	7.75	7.8	0.35			22		

Table A.4.4. Result of Soil Classification

Suborder	Mapping Unit	Area		Remarks
		Ha	%	
Udolls	Mt	2,450	2.3	
Xerolls	Bn-Gl	1,860	1.7	
Aquolls	Af	790		
	Ga	840		
	Af-Da	9,520		including Aquents
	Ba-Ga-Af	2,510		" "
	Sub-total	13,660	13.0	
Aquents	Da	7,840		
	Ba	8,700		
	Fo	890		
	Da-Su	44,890		including Aqualls
	Da-Nu-Su	15,010		" Aqualfs & Aquolls
	Sub-total	77,330	73.5	
Fluvents	Bo	2,510		
	Ke-Su	2,620		including Aquolls
	Sub-total		4.9	
Psamments	Kz	3,970	3.8	
	Marsh	820	0.8	
Total		105,220	100.0	

Note: Area was measured from the Soil Map prepared by the Soil & Water Research Institute of Iran.

Table A.4.5. Land Classification Specification

Land Characteristics	For Paddy Rice Production			For Upland Crop Production		
	Class R1	Class R2	Class R3	Class U1	Class U2	Class U3
Soil						
Soil texture Surface, 0-30 cm	Clay loam to very slowly permeable clay	Fine sandy loam to very slowly permeable clay	Loamy fine sand to very slowly permeable clay	Fine sandy loam to friable clay loam	Loamy fine sand to permeable clay	Loamy coarse sand to slowly permeable clay
Subsurface	Silty clay loam to slowly permeable clay	Fine sandy loam to very slowly permeable clay	Loamy fine sand to very slowly permeable clay	Coarse sandy loam to clay loam	Loamy fine sand to permeable clay	Loamy coarse sand to slowly permeable clay
Soil depth	> 90cm	> 60 cm	> 30 cm	> 120 cm	> 90 cm	> 60 cm
Soil stoniness % vol, topsoil	<15%	<35%	<75%	<15%	<35%	<75%
Soil pH	5.0 - 7.5	4.5 - 8.0	4.0 - 8.5	5.5 - 7.5	5.0 - 8.0	4.5 - 8.5
Soil salinity, $EC_e \times 10^3$	< 4 mS/cm	< 8 mS/cm	< 16 mS/cm	< 4 mS/cm	< 8 mS/cm	< 16 mS/cm
Cation exchange capacity	> 10 meq/100g	> 3 meq/100g	> 3 meq/100g	> 10 meq/100g	> 5 meq/100g	> 5 meq/100g
Soil permeability				2 - 6 cm/hr	0.1 - 25 cm/hr	> 25 cm/hr < 0.1 cm/hr
Infiltration rate	not applicable	not applicable	not applicable	> 2 cm/hr	1 - 2 cm/hr	0.2 - 1 cm/hr
Topography						
Overall slope	< 1%	< 2%	< 5%	0.25 - 2%	< 5%	< 8%
Micro-relief	smooth	smooth	uneven	smooth	uneven	rough
Present erosion status	no apparent	slight	moderate	no apparent	slight	moderate
Drainage						
Surface	good	fair	poor	good	good-fair	fair-poor
Internal	fair-somewhat poor	good-poor	good-very poor	good	good-fair	fair-poor
Groundwater table	not applicable	not applicable	not applicable	> 2m	> 1.2m	> 0.75m
Flooding and ponding	occasional damaging	periodic damaging	annual damaging	none	occasional damaging	periodic damaging

Class 6 Non-arable includes lands which do not meet the minimum requirements for other land classes.

Table A.4.6. Land Classes of Soil Series

Soil Symbol	Limitation Symbol Formula	Land Classes	
		Paddy Rice	Upland Crop
Mt	$\frac{4H}{B1\text{-}EO\text{-}01}$ IIIST	2Rt	2Ut
Bn-Gl	$\frac{4H}{A\text{-}EO} \sim \frac{4H}{A\text{-}EO\text{-}W1\text{-}02}$ IIS-IIIW	1R	1U∿2Ud
Af	$\frac{3M}{A1\text{-}E1\text{-}W2\text{-}02}$ IIITW	2Rd	2Ud
	$\frac{3M}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	2Rd	3Ud
Ga	$\frac{4H}{A\text{-}EO\text{-}W1\text{-}02}$ IIIW	2Rd	3Ud
Da-Nu-Su	$\frac{3H}{A1\text{-}EO\text{-}W1\text{-}01} \sim \frac{4H}{A1\text{-}EO\text{-}W1\text{-}01}$ IITW-IISTW	1R	1U∿2Ud
Da-Su	$\frac{3M}{A\text{-}EO\text{-}W2\text{-}02} \sim \frac{4H}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	1R∿2Rd	1U∿3Ud
Af-Da	$\frac{3H}{A\text{-}EO\text{-}W2\text{-}01}$ IIIW	2Rd	3Ud
	$\frac{3M}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	1R∿2Rd	2Ud∿3Ud
Ba-Ga-Af	$\frac{3H}{A\text{-}EO\text{-}W2\text{-}02} \sim \frac{4H}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	2Rd	3Ud
Ke-Su	$\frac{3M}{A1\text{-}EO} \sim \frac{4H}{A1\text{-}EO\text{-}W2\text{-}02}$ IIT-IIIW	1R	2Ud
Da	$\frac{3M}{A\text{-}EO\text{-}W1\text{-}02}$ IIIW	2Rd	3Ud
	$\frac{3M}{A1\text{-}EO\text{-}W1\text{-}01}$ IITW	1R	1U
Ba	$\frac{4H}{A\text{-}EO\text{-}W2\text{-}03}$ VW	3Rd	3Ud
	$\frac{4H}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	2Rd	3Ud
Fo	$\frac{4H}{A\text{-}EO\text{-}W2\text{-}02}$ IIIW	2Rd	3Ud
Bo	$\frac{3M}{A\text{-}EO}$ I	2Rs	1U
Kz	$\frac{1C}{A2\text{-}(d2)}$ IIIST	6st	3Us
	$\frac{1L}{A1\text{-}(d1)}$ IIIS	3Rs	1U
Marsh	$\frac{V}{M}$	6sd	6sd

Table A.4.7. Result of Inplace Soil Test (1)

Hole No.	Hydraulic conductivity k (cm/sec)	Percolation (mm/day)	Bearing capacity F (kg/cm^2)	Depth(m) to Barrier	Depth(m) to Subsurface Groundwater	Sub Area
1	6.60×10^{-4}		3.1 dry	0	0.15	H.L. Low
2	1.00×10^{-2}		2.8 wet	1.60	0.08	H.R. Low
3	4.23×10^{-3}		3.4 wet	1.10	0.08	H.R. Low
4	very high		3.2 -	0.45		K. Low
5	2.26×10^{-2}	1.6	2.8 wet	0.80	0.05	K. Low
6	1.04×10^{-3}		1.6 wet	∞	0.04	K. Low
7	3.54×10^{-3}	-0.2	4.6 wet	∞	0.06	H.L. Low
8	8.75×10^{-3}	-3.5	4.5 dry	∞	0.18	H.L. Low
9	2.97×10^{-3}	2.2	3.2 -	∞	0.08	H.L. Low
10	2.03×10^{-3}		7.4 -	∞	0.10	H.L. Low
11	4.20×10^{-3}		4.6 -	∞	0.16	H.L. Low
12	2.78×10^{-3}		2.9 -	∞	0.10	H.R. Low
13	2.20×10^{-3}		2.6 -	∞	0.21	H.R. Low
14	2.78×10^{-3}	-6.6	2.9 dry	∞	0.11	K. Low
15	5.56×10^{-3}	2.0	6.0 dry	1.70	0.48	K. Low
16	very high		4.9 wet	∞	-	K. Low
17	very high		1.7 humid	∞	0.35	H.L. Low
18	2.53×10^{-2}		1.7 wet	∞	0.18	H.L. Low
19	3.75×10^{-2}		2.2 dry	∞	0.22	H.L. Mid
20	1.56×10^{-3}		2.4 dry	0.20	0.46	H.L. Mid
21	4.29×10^{-4}		4.1 dry	∞	0.63	H.L. Mid
22	6.49×10^{-3}		3.6 humid	∞	0.43	H.L. Mid
23	2.56×10^{-3}		3.3 dry	0.20	0.24	H.R. Mid
24	2.02×10^{-3}	1.2	1.7 humid	∞	0.17	H.R. Mid
25	6.37×10^{-3}		3.3 wet	2.30	0.10	K. Mid
26	9.26×10^{-3}	4.7	4.3 wet	∞	0.13	K. Mid
27	1.04×10^{-2}		5.0 wet	∞	0.41	K. Mid
28	2.15×10^{-3}		2.2 humid	∞	0.92	H.L. Mid
29	4.63×10^{-3}		4.1 dry	∞	0.63	H.L. Mid
30	1.09×10^{-3}	1.0	3.1 humid	∞	0.21	H.L. Mid
31	4.13×10^{-3}		3.0 wet	∞	0.30	H.L. Mid
32	3.94×10^{-3}		1.4 -	∞	0.24	H.R. Mid
33	6.94×10^{-3}	0.2	0.5 wet	∞	0.10	H.R. Mid
34	very high		2.1 wet	∞		K. Mid
35	1.55×10^{-3}		1.2 wet	0	0.12	K. Mid
36	7.04×10^{-3}	-3.6	1.2 humid	1.15	0.31	K. Mid
37	9.26×10^{-3}		3.8 wet	∞	0.41	K. Mid
38	very low		2.4 humid	0		H.L.High
39	-		4.4 dry			H.L.High
40	-		4.3 dry			H.L.High
41	-		6.6 dry			H.R.High
42	very low	-4.2	2.8 wet			H.R.High
43	1.93×10^{-3}		3.1 dry	∞	0.04	H.R.High
44			1.5 humid			K. Mid

Table A.4.7. Result of Inplace Soil Test (2)

Hole No.	Hydraulic conductivity k (cm/sec)	Percolation (mm/day)	Bearing capacity F (kg/cm^2)	Depth(m) to Barrier	Depth(m) to Subsurface Groundwater	Sub Area
45			1.3 humid			K. Mid
46			3.0 humid			K. Mid
47			2.2 humid			K. Mid
48			4.3 humid			H.L.High
49			3.9 dry			H.L.High
50		2.3	3.2 dry			H.R.High
51	-		6.6 dry			H.R.High
52	-		8.2 dry			K. High
53	-		3.4 dry			K. High
54	-		3.8 -			K. Mid
55	-		3.3 humid			K. Mid
56	-	3.4	4.6 dry			H.L.High
57	-		3.7 dry			K. High
58	-		7.9 dry			K. High
Ave.	1.1×10^{-2}	2.1	3.5	-		
S.D.	1.5×10^{-2}	1.3	1.6	-		
Max.	5×10^{-2}	4.7	8.2	∞		
Min.	1×10^{-4}	0.2	0.5	0		

Remarks:

Bearing capacity : Average of 4 values at each 5 cm from ground surface to 15cm depth.

1. Hydraulic conductivity: Very high is assumed at 5×10^{-2} cm/sec and very low is assumed at 1×10^{-4} cm/sec.
2. Percolation : Negative value means uplift. Negative values are not counted for culculating average percolation rate.

Notes: H ..... Haraz
L ..... Left
R ..... Right
K ..... Kari

Table A.4.8. Area by Hydraulic Conductivity

(Unit: ha)

Sub-Area	Hydraulic Conductivity (cm/sec)						Sand dune	Total
	$< 1\times10^{-4}$	$1\times10^{-4} \leq < 1\times10^{-3}$	$1\times10^{-3} \leq < 5\times10^{-3}$	$5\times10^{-3} \leq < 1\times10^{-2}$	$1\times10^{-2} \leq < 5\times10^{-2}$	$5\times10^{-2} \leq$		
Haraz Left								
High Land	8,540	3,080	310	0	0	0	0	11,930
Middle Land	0	1,970	6,680	3,080	1,610	0	0	13,340
Low Land	0	330	7,200	2,230	3,380	730	730	14,600
Sub-total	8,540	5,380	14,190	5,310	4,990	730	730	39,870
Haraz Right								
High Land	3,870	1,270	1,440	0	0	0	0	6,580
Middle Land	0	200	5,090	1,260	0	0	0	6,550
Low Land	0	0	4,080	1,060	570	40	340	6,090
Sub-total	3,870	1,470	10,610	2,320	570	40	340	19,220
Kari Rud								
High Land	7,480	2,420	410	0	0	0	0	10,310
Middle Land	0	1,040	8,230	6,400	2,900	1,390	0	19,960
Low Land	0	0	4,340	3,460	4,340	1,990	870	15,000
Sub-total	7,480	3,460	12,980	9,860	7,240	3,380	870	45,270
Total								
High Land	19,890	6,770	2,160	0	0	0	0	28,820
Middle Land	0	3,210	20,000	10,740	4,510	1,390	0	39,850
Low Land	0	330	15,620	6,750	8,290	2,760	1,940	35,690
Total	19,890	10,310	37,780	17,490	12,800	4,150	1,940	104,360

Table A.4.9. Area by Soil Bearing Force

(Unit: ha)

Sub-Area	Soil Bearing Force (kg/cm^2) 0≦ <1	1≦ <2	2≦ <3	3≦ <4	4≦	Sand Dune	Total
Haraz Left							
High Land	0	0	1,300	3,080	7,550	0	11,930
Middle Land	0	30	7,820	3,770	1,720	0	13,340
Low Land	0	1,360	3,740	3,410	5,360	730	14,600
Sub-total	0	1,390	12,860	10,260	14,630	730	39,870
Haraz Right							
High Land	0	730	840	3,370	1,640	0	6,580
Middle Land	1,270	3,750	700	830	0	0	6,550
Low Land	0	710	3,600	1,440	0	340	6,090
Sub-total	1,270	5,190	5,140	5,640	1,640	340	19,220
Kari Rud							
High Land	0	0	350	2,090	7,870	0	10,300
Middle Land	0	8,190	3,200	4,560	4,010	0	19,960
Low Land	0	3,230	3,440	4,290	3,170	870	15,000
Sub-total	0	11,420	6,990	10,940	15,050	870	45,270
Total							
High Land	0	730	2,490	8,540	17,060	0	28,820
Middle Land	1,270	11,970	11,720	9,160	5,730	0	39,850
Low Land	0	5,300	10,780	9,140	8,530	1,940	35,690
Total	1,270	18,000	24,990	26,840	31,320	1,940	104,360

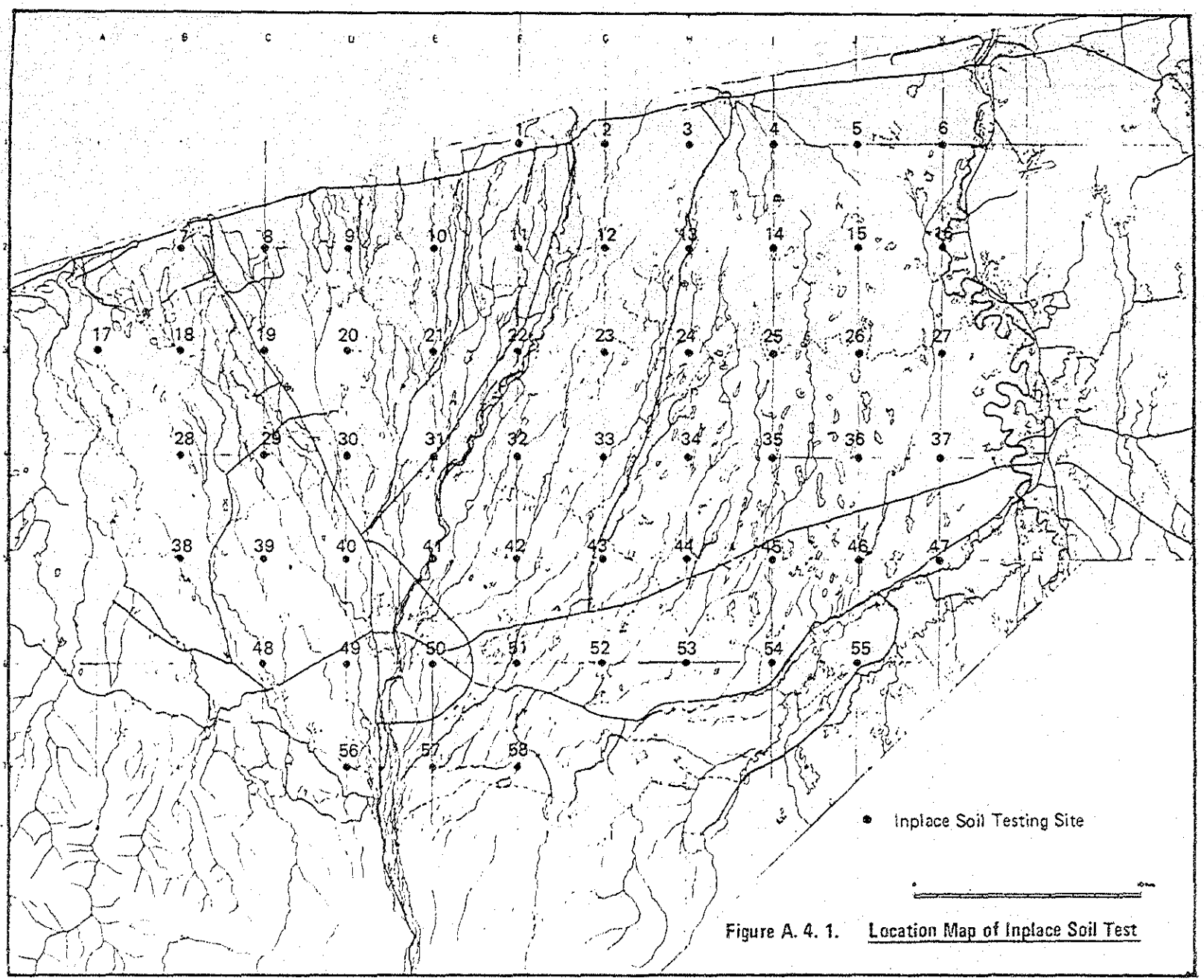


Figure A. 4. 1. Location Map of Inplace Soil Test

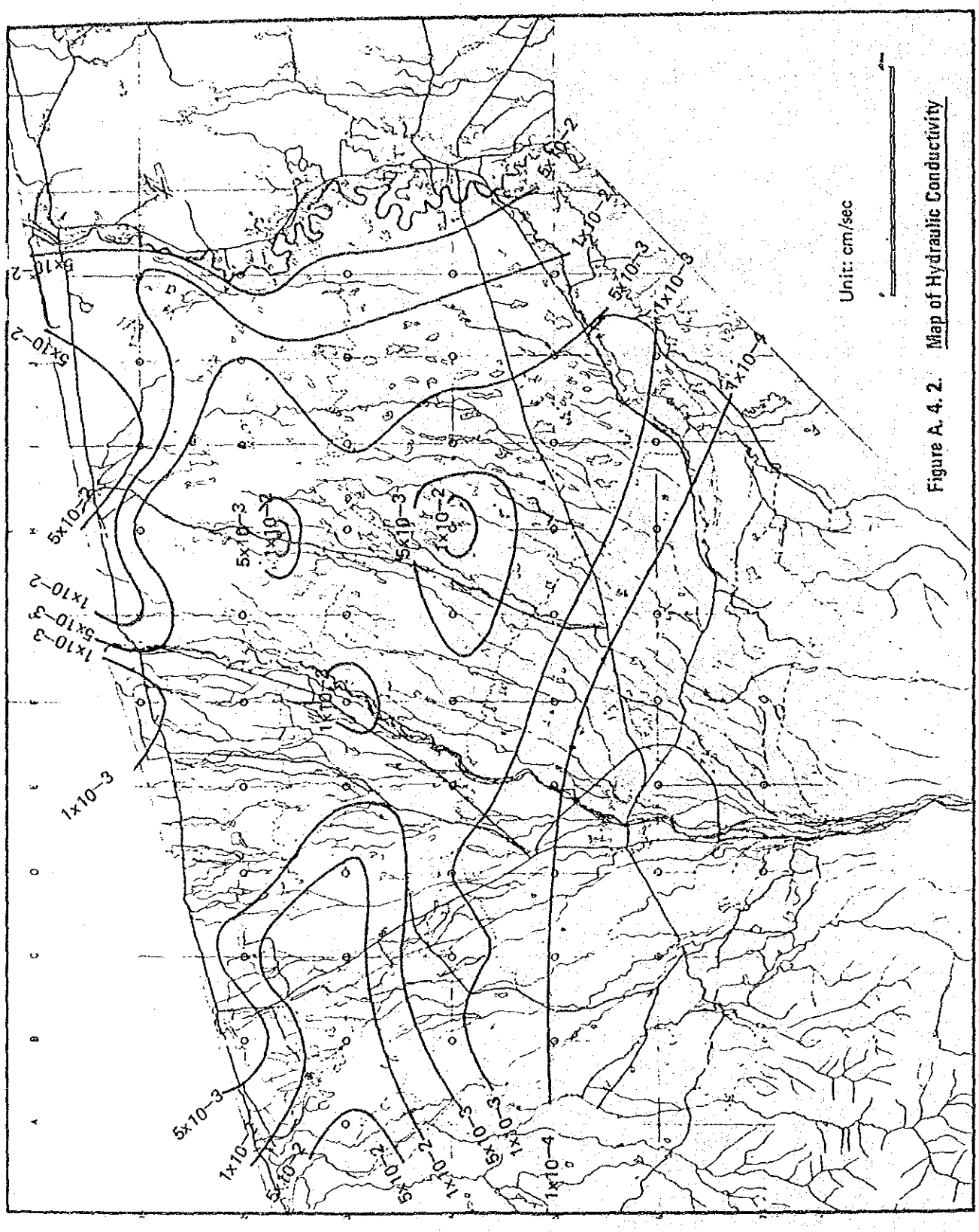


Figure A. 4. 2. Map of Hydraulic Conductivity

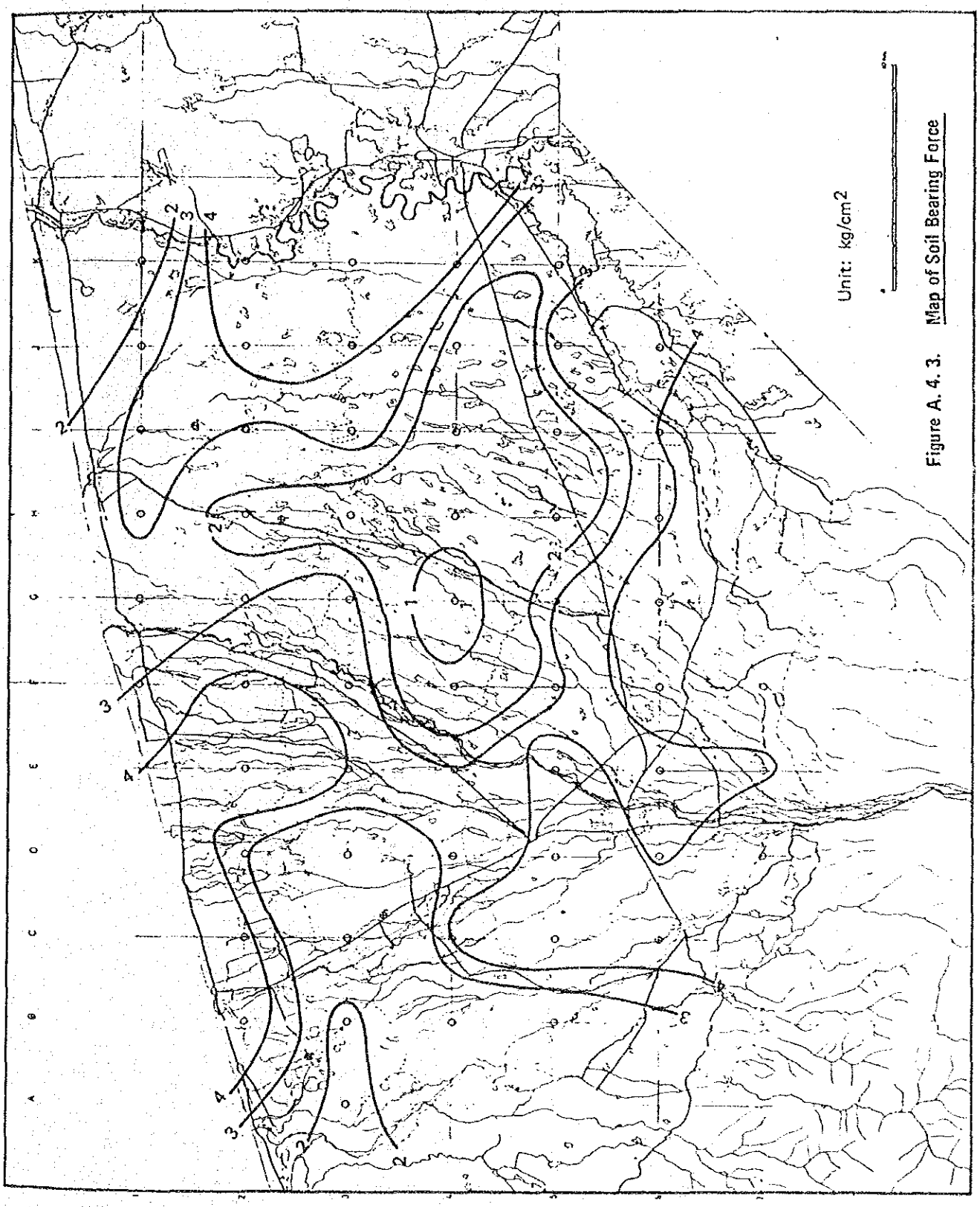


Figure A. 4. 3. Map of Soil Bearing Force

APPENDIX B

DEVELOPMENT, IMPROVEMENT AND CONSERVATION OF AGRICULTURAL INFRASTRUCTURE

APPENDIX B. I.

IRRIGATION

CONTENTS

LIST OF TABLES

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B.1.1. Present Irrigation Conditions

1) Irrigation Area

Out of whole paddy area of 72,610 ha, irrigation is conducted for 68,120 ha which is 94% to the whole paddy area. Remaining 6% of paddy is under fallow presently. Upland field and orchards are not commanded by the surface irrigation system but by domestic wells or portable pumps when irrigation seriously needed. In this study, therefore, upland field and orchards are not considered as irrigation area presently. Details of present irrigation area are summarized in Table B.1.1.

2) Irrigation Water Source

Irrigation water source is classified into five sources such as canals, abbandans (irrigation ponds), return flow, springs and wells. Former three are under surface irrigation system, and latter two are under groundwater irrigation system. Other than above five sources, river pump irrigations are existing in the area. However, river pump irrigations are rather small in area, only 22 river pumps are located in the area (8 along the Kharan Rud, 9 along the left bank of the Babol river and 5 in the lower reach of the Haraz river). Table B.1.1 also shows irrigation areas irrigated by different sources. Out of whole irrigation area, 57,160 ha (84%) are under surface irrigation and 10,960 ha (16%) are under groundwater irrigation.

3) Irrigation Facilities

In the project area, main canals of 2,834 km, diversions of 2,052, abbandans of 241 and wells of 6,877 are existing as shown in Table B.1.2. As see in Table B.1.3 and B.1.4, secondary irrigation canals are totally 94 canals in the project area, of which 72 canals are in the Kari Rud Command area and only 22 canals are in the Haraz

command area. However, secondary irrigation canals are generally rather small and only few canals have a large command area in the kari Rud command area.

4) Water Shortage

Water shortage is concentrated mostly in the low lands according to the Village Survey-1985. Details are presented in Appendix F Village Survey-1985.

5) Land Occupation of Canals

As see in Table B.1.5, land occupation is legally defined by flow capacity of canals. This definition is applied also for drainage canals.

Table B.1.1 Present Irrigation Areas by Irrigation Sources

(Unit: ha)

Command Area	High Land	Middle Land	Low Land	Total
Haraz Left Bank	6,710	9,080	9,310	25,100
Canals	5,120	6,700	7,410	19,230
Abbandans	0	430	850	1,280
Return Flow	370	460	220	1,050
Springs	940	900	20	1,860
Wells	280	590	810	1,680
Haraz Right Bank	4,560	5,230	3,850	13,640
Canals	3,960	3,480	2,700	10,140
Abbandans	0	90	550	640
Return Flow	30	180	410	620
Springs	410	590	0	1,000
Wells	160	890	190	1,240
Sub-total of Haraz	11,270	14,310	13,160	38,740
Canals	9,080	10,180	10,110	29,370
Abbandans	0	520	1,400	1,920
Return Flow	400	640	630	1,670
Springs	1,350	1,490	20	2,860
Wells	440	1,480	1,000	2,920
Kari Rud	7,790	13,390	8,200	29,380
Canals	6,170	7,410	5,420	19,000
Abbandans	110	1,880	1,320	3,310
Return Flow	270	1,270	350	1,890
Springs	400	650	0	1,050
Wells	840	2,180	1,110	4,130
Ground Total	19,060	27,700	21,360	68,120
Canals	15,250	17,590	15,530	48,370
Abbandans	110	2,400	2,720	5,230
Return Flow	670	1,910	980	3,560
Springs	1,750	2,140	20	3,910
Wells	1,280	3,660	2,110	7,050

Note: 1) This table is compiled by the survey team from the Village Survey - 1985.

Table B.1.2 Present Irrigation Facilities

Command Area		High Land	Middle Land	Low Land	Total
Haraz Left Bank					
Secondary Canals	(km)	79	71	53	203
Tertiary Canals	(km)	310	187	277	774
Diversions (1)	(plc)	53	16	35	104
Diversions (2)	(plc)	157	80	90	336
Outlets	(plc)	140	130	85	355
Abbandans	(plc)	-	24	79	103
Wells	(plc)	193	636	1,070	1,899
Haraz Right Bank					
Secondary Canals	(km)	82	57	32	170
Tertiary Canals	(km)	125	138	110	373
Diversions (1)	(plc)	14	29	21	64
Diversions (2)	(plc)	103	65	27	195
Outlets	(plc)	100	70	40	210
Abbandans	(plc)	-	10	9	19
Wells	(plc)	188	727	221	1,136
Sub-total of Haraz					
Primary Canals	(km)	22	7	10	39
Secondary Canals	(km)	161	128	85	373
Tertiary Canals	(km)	435	325	387	1,147
Diversions (1)	(plc)	67	45	56	168
Diversions (2)	(plc)	260	145	126	531
Outlets	(plc)	240	200	125	565
Abbandans	(plc)	-	34	88	122
Wells	(plc)	381	1,363	1,291	3,035
Kari Rud					
Primary Canals	(km)	26	19	19	64
Secondary Canals	(km)	108	165	49	321
Tertiary Canals	(km)	175	399	315	889
Diversions (1)	(plc)	49	40	60	149
Diversions (2)	(plc)	51	72	96	219
Outlets	(plc)	165	180	75	420
Abbandans	(plc)	-	56	63	119
Wells	(plc)	656	1,861	1,325	3,842
Ground Total					
Primary Canals	(km)	48	26	29	103
Secondary Canals	(km)	269	293	134	695
Tertiary Canals	(km)	610	724	702	2,036
Diversions (1)	(plc)	116	85	116	317
Diversions (2)	(plc)	311	217	222	750
Outlets	(plc)	405	380	200	985
Abbandans	(plc)	-	90	151	241
Wells	(plc)	1,037	3,224	2,616	6,877

Note: 1) Abbandans are counted by the data from the District water Offices of Amol and Babol.
2) Wells are counted by the result of the Village Survey-1985.
3) Others are counted in the selected areas in the map of present irrigation network map Exhibits 2.3.1 in Main Report.

Table B.1.3 List of Secondary Canals in the Haraz Command

Secondary Canal	Irrigated Area (ha)	Water Duty (cms)	Unit Water Duty (ℓ/S/ha)	Number of Terminal Blocks
Haraz Left Bank				
1. Zarke Band	50	1.0	20.00	1
2. Mohamad Abad Rud	40	0.5	12.50	1
3. Valekan	700	1.5	2.10	9
4. Shalephat	4,000	3.5	0.88	31
5. Taj Rud	3,000	3.0	1.00	20
Darham Kola Rud	-	-	-	-
6. Lakoni	2,000	2.0	1.00	12
7. Sha Rud	2,500	2.0	0.80	22
8. Ahi Rud	4,000	3.0	0.75	17
9. Ahangar Kola Rud	300	1.0	3.33	1
10. Ali Rud	3,400	2.0	0.59	34
11. Molla Rud	5,000	4.0	0.80	7
12. Zangi Rud	2,100	1.5	0.71	31
Sub-total	27,090	25.0	0.92	186
Haraz Right Bank				
1. Zan-e-Mard	2,480	3.5	1.41	24
2. Sag Rud	467	1.5	3.21	12
3. Tork Kola Rud	350	1.0	2.86	1
4. Rush Rud	600	1.0	1.67	2
5. Khoshke Haraz	2,640	3.0	1.14	19
6. Ali Kola Rud	950	1.0	1.05	12
7. Valik Rud	660	0.75	1.14	6
8. Jamshid Rud	60	0.5	8.33	1
9. Kachab Rud	1,338	2.0	1.49	15
10. Margi Rud	1,480	2.0	1.35	6
Sub-total	11,025	16.25	1.47	98
Total 22 Canals	38,115	41.25	1.08	284

Note: 1) Darham Kola Rud is not used at present due to no command area occupied by recent expansion of Amol urban area.

2) This table is compiled by the survey team adjusting the data from the Amol District Water Office.

3) Irrigated area may include the areas irrigated by springs and wells.

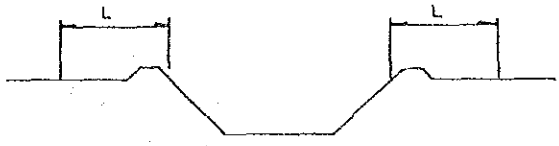
Table B.1.4 List of Secondary Canals in the Kari Rud Command

Kari Rud Left Bank Command				Kari Rud Left Bank Command				Kari Rud Right Bank Command			
No.	Secondary Canal	Irrigated Area (ha)	Number of Terminal Blocks	No.	Secondary Canal	Irrigated Area (ha)	Number of Terminal Blocks	No.	Secondary Canal	Irrigated Area (ha)	Number of Terminal Blocks
1.	Bozminam (Sang Rud)	320	1	26.	Sorakh Rud Canal	180	3	1.	Zia Rud	290	2
2.	Miaki Rud	180	1	27.	Big Ar Chi Rud Canal	499	9	2.	Rostam Rud	360	3
3.	No Rud	500	2	28.	Bosra Rud Canal	185	4	3.	Mileh Rud	1,500	3
4.	Katel Kesh Rud	3,290	29	29.	Actige Rud	40	2	4.	Charsin	2,610	18
5.	Maliard Rud	3,105	21	30.	Gar Mig Rud Canal	70	1	5.	Tahshon	750	4
6.	Small Pasha Rud	40	1	31.	Chemazin Canal	130	1	6.	Big Khatib Rud	100	1
7.	Pasha Rud	200	1	32.	Chemazin Band	30	1	7.	Said Rud	1,850	10
8.	Shikh Rud	100	1	33.	Katisar Canal	100	1	8.	Hamzeh Kola Band	50	1
9.	Vezra Rud	300	1	34.	Kamangar Canal	20	1	9.	Espeh Kola Rud Band	15	1
10.	Mazafar Rud	1,100	7	35.	Kar Rud Canal	70	1	10.	Espeh Kola Rud Band	15	2
11.	Small Khatib Rud Canal	60	1	36.	Safelahe Amini Canal	4	1	11.	Espeh Kola Rud	140	2
12.	Tarigh Chi Rud Canal	460	3	37.	Ollia Rud	140	2	12.	Marzan Rud	360	3
13.	Kazembigi Rud	100	1	38.	Upper Rah Kola Canal	100	1	13.	Kamangar	60	1
14.	Cro Canal	730	5	39.	Lower Rah Kola Canal	70	1	14.	Upper Barsemnan Band	50	1
15.	Zahed Kola Canal	100	1	40.	Tajadoleh	130	1	15.	Lower Barsemnan Band	50	1
16.	Shin Rud Canal	150	1	41.	Rekon Bagher Kola	150	1	16.	Fulad Kola Band	10	1
17.	Sang Rud Canal	215	3	42.	Kari Kola	300	1	17.	Barsemnan	50	1
18.	Zard Rud Canal	10	1	43.	Hendo Kileh	10	1	18.	Kaleh Bast	60	1
19.	Hendogh Kileh	10	1	44.	Rais Rud Canal	100	1	19.	Babolsar Rud	80	1
20.	Golo Rud	2,310	19	45.	Valeh Kileh Canal	440	2	20.	Ajaksar	150	1
21.	Matkeh Rud	175	4	46.	Kohi Rud Canal(Kar Rud)	100	1	21.	Laleh Mahaleh	180	1
22.	Orange Rud	115	3	47.	Esfandiar Mahaleh Canal	70	1	22.	Saadat Mahaleh	80	1
23.	Ebrahim Nejafi Band	4	1	48.	Kikha Mahaleh Canal	60	1	23.	Gavazun Mahaleh	210	1
24.	Saltan Big Rud Canal	366	13	49.	Garzan Mahaleh Rodbast	60	1				
25.	Ar Chi Rud Canal	190	3								
					Total	17,188	165		Total	9,020	61
									Grand-total	26,208	226

Note: 1) This table is compiled by the survey team from the data provided by the Babol District Water Office.

Table B.1.5 Land Occupation of Canals

Capacity of Canal (m^3/sec)		Occupation L(m)
0.001 ≦	< 1.0	1
1 ≦	< 1.5	1.5
1.5 ≦	< 2.0	2
2 ≦	< 3	3
3 ≦	< 4	4
4 ≦	< 6	5
6 ≦	< 8	6
8 ≦	<10	7
10 ≦	<11	8
11 ≦	<12	9
12 ≦	<13	10
13 ≦	<14	11
14 ≦	<15	12
15 ≦	<16	13
16 ≦	<17	14
17 ≦		15



Note: 1) This table is according to the Article 5 of the Guide Direction No.17060 dated on 10/9/58 (1 Dec. 1979).

B.1.2. Irrigation Demand

Irrigation demand has been estimated in accordance with following procedure mainly based on "Irrigation and Drainage Paper, No.24, FAO".

i) Reference Crop Evapotranspiration (ETo)

Reference crop evapotranspiration has been estimated by the Modified Penman Method with the climatological data at Babolsar and Amol.

ii) Cropping Calendar and Irrigation Criteria

Present cropping calendar is shown in Section 2.4.2 in Main Report. The following irrigation criteria are set;

First Crop

Amol-3:	Growing period	120 days
Haraz :	Growing period	115 days
Tarom :	Growing period	90 days

- Nursery bed : 5% of planting field
- Nursery period : 40 days on an average
- Puddling period: 3 days on an average
- Irrigation : to end at 15 days before harvesting

Second Crop

Berseem Clover

- Non-irrigation

iii) Crop Water Requirement (ETcrop)

Crop water requirement is estimated by each growing stage as shown below;

ETcrop = ETo Kc

Kc : crop coefficient

Crop coefficient (Kc) is assumed as follows:

Rice: in the Mediterranian Climate

Amol-3

Kc = 1.1	transplanting -	60th day
Kc = 1.2	61th -	90th
Kc = 0.95	91th -	120th

Haraz

Kc = 1.1	transplanting -	60th day
Kc = 1.2	56th -	85th
Kc = 0.95	86th -	115th

Tarom

Kc = 1.1	transplanting -	60th day
Kc = 1.2	31th -	60th
Kc = 0.95	61th -	90th

Nursery

Kc = 1.1 shallow depth with free water surface

Berseem Clover: on an average under humid climate

Kc = 1.0

iv) Percolation (P)

Puddling period: 5 mm/day

Growing period : 2 mm/day

Average infiltration recharge (0.73 mm/day) in irrigation period to be supplied from paddy field, river and pond.

v) Puddling Water (Lp)

Puddling water (Lp) is assumed to be 150 mm. The break-down of it is as follows;

° Water to saturate soil of 30 cm depth	75 mm estimated from soil characteristic
° Standing water	50 mm
° Percolation during puddling 5 mm/day x 3 days =	15 mm
° Crop water requirement ETo·Kc·n day 4.7 mm/day x 1.1 x 3 days =	16 mm
Total	150 mm

Note: Observed puddling water of 237 mm in the Amol Rice Research Station is considered to be more than required.

vi) Effective Rainfall (Re)

For estimating effective rainfall, various methods have been established. Applicable methods are as follows;

1. Technical Release No.21 Soil Conservation Service, USDA
2. Mekong Committee (for Mekong basin)
3. Thailand(1) Study by JICA in Thailand
4. Thailand(2) Royal Irrigation Department

Above methods are explained in Figure B.1.1 and B.1.2 Estimation gives, however, almost similar value in all methods as see in above figures. Although method 1 is commonly applied in Iran, estimation needs rather complicate computation.

Therefore, this study applies method 3 for estimating effective rainfall. Effective rainfall by method 3 is as follows;

Paddy field : Monthly rainfall x 0.75 (Upper limit 200 mm)
Upland field: Monthly rainfall x 0.75 (Upper limit 120 mm)

Probable monthly rainfall is applied to estimate effective rainfall.

vii) Irrigation Efficiency (Eo)

Irrigation efficiency varies depending on size of irrigation area, source of water maintenance level of irrigation facilities, water management, crops and terminal irrigation method. Considering irrigation-cum-drainage system in the Project Area, irrigation efficiency is assumed at 71%.

Surface Water Irrigation

Conveyance Efficiency (Ec)		Estimation Condition
Main Irrigation Canal	Ec1=0.85	Unlined (heavy soil) Continuous supply Some substantial charge in flow
Terminal Irrigation Canal	Ec2=0.90	Same to above conditions (Short conveyance distance)
Ec=Ec1 · Ec2=0.85x0.90=0.765=0.75		
Field Application Efficiency (Ea)		
Height Land, Middle and Low Land	Ea1=0.95 Ea2=0.85	reuse in downstream no change of reuse
Ea=Ea1 · A1 + Ea2 A2 = 0.95x2/3+0.80x1/3=0.90		Area Ratio A1 = 2/3 A2 = 1/3
Overall Irrigation Efficiency (Eos)		
EOs = Ec · Ea = 0.75 x 0.90 = 0.675		

Groundwater Irrigation

Since groundwater irrigates nearby field from source, higher efficiency can be achieved. Efficiency is assumed at Eog = 0.90 in consideration of field application.

Overall Irrigation Efficiency

Overall efficiency has been estimated by the ratio of surface water irrigation and groundwater irrigation.

	Surface	:	Groundwater
Irrigation Area	84%	:	16%
Water Source	82%	:	18%

Area ratio has been applied to estimate overall irrigation efficiency conservatively;

Overall irrigation efficiency (Eo) = 0.675 x 0.84 + 0.9 x 0.16 = 0.71

viii) Net Irrigation Requirement (In)

Net irrigation requirement is computed subtracting effective rainfall from field requirement as computed below;

Net Irrigation Requirement of Rice

Amol-3: crop water requirement - Re = 980 mm - Re
Haraz : " = 907 mm - Re
Tarom : " = 760 mm - Re

Net Irrigation Requirement of Berseem Clover

ETcrop - Re = 336 mm - Re

Detailed estimations are presented Table B.1.12 to Table B.1.16.

ix) Irrigation Requirement (Ir)

Irrigation requirement is estimated by net irrigation requirement and irrigation efficiency.

$$Ir = In/Eo = In/0.71$$

On the consideration of probable monthly rainfall, irrigation requirement is estimated as follows;

Table B.1.6 Irrigation Requirement by Crops

(Unit: mm)

Probability of Exceedance	Amol -3	Haraz	Tarom	Berseem Clover
10%	1,228	1,151	957	23
20%	1,205	1,129	933	15
50%	1,152	1,075	884	7
80%	1,093	1,016	843	0
90%	1,055	979	817	0

Note: Details are mentioned in Table B.1.8 to Table B.1.11.

As see in above table, since berseem clover needs almost no irrigation, berseem will not be irrigated. Irrigation requirement at exceedance of 50% will be applied for water balance study, because irrigation requirement at other exceedance does not differ so much from at 50% exceedance.

x) Irrigation Demand

Irrigation demand will be considered on following three cases of crop ratio to the total paddy field of 68,460 ha;

Case 1	Amol-3	60%
	Tarom	40%
Case 2	Amol-3	80%
	Tarom	20%
Case 3	Amol-3	100%
	Tarom	0%

Case 1 considers present crop ratio, and case 3 considers to make rice production maximum. Irrigation demand of each case is as follows;

Case 1	716 MCM/year
Case 2	753 MCM/year
Case 3	789 MCM/year

In case of case 3, irrigation demand increases to 789 MCM by 73 MCM from case 1. Consequently, available water resources are to be examined carefully to increase the crop ratio of Amol-3.

Detailed estimations are presented in Table B.1.7.

Table B.1.7. Total Irrigation Demand by Case

Net Irrigation Requirement (mm) In

	Far Apr.	Ord May	Kho Jun.	Tir Jul.	Mor Aug.	Sha Total
Amol-3	28	192	221	228	150	819
Tarom	28	192	229	179	-	628

Combined Net Irrigation Requirement (mm) In

A(60%), T(40%)	28	192	224	208	90	742
A(80%), T(20%)	28	192	223	218	120	781
A(100%)	28	192	221	228	150	819

Irrigation Requirement (mm) Ir = In/Eo = In/0.71

A(60%), T(40%)	39	270	315	293	127	1,044
A(80%), T(20%)	39	270	314	307	169	1,099
A(100%)	39	270	311	321	211	1,152

Irrigation Demand (MCM) Id = Ir x Paddy Area = Ir x 68,460 ha x 10^{-5} (MCM)

A(60%), T(40%)	27	185	216	201	87	716
A(80%), T(20%)	27	185	215	210	116	753
A(100%)	27	185	213	220	144	789

Table B. 1. 8. Irrigation Requirement of Amol--3

	Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Annual
	Cropping Pattern															
	ET crop		(mm)			3	61	211	242	251	185	27				980
Irrigation Amount	% 10	Rainfall (mm)	r	98	87	79	55	41	45	49	76	83	121	103	120	957
			re	74	65	59	41	31	34	37	57	62	91	77	90	
		In	(mm)				20	180	208	214	128					750
		Ir	(mm)				28	253	293	301	180					1,055
	% 20	Rainfall (mm)	r	90	81	73	51	35	38	42	65	80	117	99	115	886
			re	68	61	55	38	26	29	32	49	60	88	74	86	
		In	(mm)				23	185	213	219	136					776
		Ir	(mm)				32	261	300	308	192					1,093
	% 50	Rainfall (mm)	r	79	70	63	44	25	28	30	46	75	109	92	108	769
			re	59	53	47	33	19	21	23	35	56	82	69	81	
		In	(mm)				28	192	221	228	150					819
			(mm)				39	270	311	321	211					1,152
	% 80	Rainfall (mm)	r	69	61	55	39	17	18	20	31	70	103	87	102	672
			re	52	46	41	29	13	14	15	23	53	77	65	77	
		In	(mm)				32	198	228	236	162					856
		Ir	(mm)				45	279	321	332	228					1,205
	% 90	Rainfall (mm)	r	65	57	51	36	13	14	16	24	68	100	85	99	628
			re	49	43	38	27	10	11	12	18	51	75	64	74	
		In	(mm)				34	201	231	239	167					872
		Ir	(mm)				48	283	325	337	235					1,228
Peak Irrigation Capacity	% 50	Rainfall (mm)	r	73	68	62	36	20	21	13	32	61	80	88	92	
			re	55	51	47	27	15	16	10	24	46	60	66	69	
		In	(mm)				34	196	226	241	161					
		Ir	(mm)				48	276	318	339	227					
	% 80	Rainfall (mm)	r	45	42	41	19	9	10	3	12	29	34	52	51	
			re	34	32	31	14	7	8	2	9	22	26	39	38	
		In	(mm)				47	204	234	249	176	5				
		Ir	(mm)				66	287	330	350	248	7				
	% 90	Rainfall (mm)	r	34	31	32	14	6	6	1	6	19	22	36	36	
			re	26	23	24	11	5	5	1	5	14	17	27	27	
		In	(mm)				50	206	237	250	180	13				
		Ir	(mm)				70	290	334	352	254	18				

ET crop : Crop Water Requirement (including nursery, land preparation and percolation in case of rice)

In : Net Irrigation Requirement (In = ET crop – re)
re: effective rainfall

Ir : Irrigation Requirement (Ir = In/Eo)
Eo : Overall irrigation efficiency = 0.71

Table B.1.9 Irrigation Requirement of Haraz

				Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
				Cropping Pattern														
				ET crop	(mm)			3	61	211	244	249	130	9				907
Irrigation Amount	% 10		Rainfall (mm)	r		98	87	79	55	41	45	49	76	83	121	103	120	957
				re		74	65	59	41	31	34	37	57	62	91	77	90	
			In		(mm)				20	180	210	212	73					695
			Ir		(mm)				28	253	296	299	103					979
	% 20		Rainfall (mm)	r		90	81	73	51	35	38	42	65	80	117	99	115	886
				re		68	61	55	38	26	29	32	49	60	88	74	86	
			In		(mm)				23	185	215	217	81					721
			Ir		(mm)				32	261	303	306	114					1,016
	% 50		Rainfall (mm)	r		79	70	63	44	25	28	30	46	75	109	92	108	769
				re		59	53	47	33	19	21	23	35	56	82	69	81	
			In		(mm)				28	192	223	226	95					764
			Ir		(mm)				39	270	314	318	134					1,075
	% 80		Rainfall (mm)	r		69	61	55	39	17	18	20	31	70	103	87	102	672
				re		52	46	41	29	13	14	15	23	53	77	65	77	
			In		(mm)				32	198	230	234	107					801
			Ir		(mm)				45	279	324	330	151					1,129
	% 90		Rainfall (mm)	r		65	57	51	36	13	14	16	24	68	100	85	99	628
				re		49	43	38	27	10	11	12	18	51	75	64	74	
			In		(mm)				34	201	233	237	112					817
			Ir		(mm)				48	283	328	334	158					1,151
Peak Irrigation Capacity	% 50		Rainfall (mm)	r		73	68	62	36	20	21	13	32	61	80	88	92	
				re		55	51	47	27	15	16	10	24	46	60	66	69	
			In		(mm)				34	196	228	239	106					
			Ir		(mm)				48	276	321	337	149					
	% 80		Rainfall (mm)	r		45	42	41	19	9	10	3	12	29	34	52	51	
				re		34	32	31	14	7	8	2	9	22	26	39	38	
			In		(mm)				47	204	236	247	121					
			Ir		(mm)				66	287	332	348	170					
	% 90		Rainfall (mm)	r		34	31	32	14	6	6	1	6	19	22	36	36	
				re		26	23	24	11	5	5	1	5	14	17	27	27	
			In		(mm)				50	206	239	248	125					
			Ir		(mm)				70	290	327	349	176					

ET crop : Crop Water Requirement (including nursery, land preparation and percolation in case of rice)

In : Net Irrigation Requirement (In = ET crop − re)
re: effective rainfall

Ir : Irrigation Requirement (Ir = In/Eo)
Eo : Overall irrigation efficiency = 0.71

Table B.1.10 Irrigation Requirement of Tarom

				Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Month																
Cropping Pattern																
ET crop			(mm)			3	61	211	250	202	33					760
Irrigation Amount	% 10	Rainfall (mm)	r	98	87	79	55	41	45	49	76	83	121	103	120	957
			re	74	65	59	41	31	34	37	57	62	91	77	90	
		In	(mm)				20	180	216	165						581
		Ir	(mm)				28	253	304	232						817
	% 20	Rainfall (mm)	r	90	81	73	51	35	38	42	65	80	117	99	115	886
			re	68	61	55	38	26	29	32	49	60	88	74	86	
		In	(mm)				23	185	221	170						599
		Ir	(mm)				32	261	311	239						843
	% 50	Rainfall (mm)	r	79	70	63	44	25	28	30	46	75	109	92	108	769
			re	59	53	47	33	19	21	23	35	56	82	69	81	
		In	(mm)				28	192	229	179						628
		Ir	(mm)				39	270	323	252						884
	% 80	Rainfall (mm)	r	69	61	55	39	17	18	20	31	70	103	87	102	672
			re	52	46	41	29	13	14	15	23	53	77	65	77	
		In	(mm)				32	198	236	187	10					663
		Ir	(mm)				45	279	332	263	14					933
	% 90	Rainfall (mm)	r	65	57	51	36	13	14	16	24	68	100	85	99	628
			re	49	43	38	27	10	11	12	18	51	75	64	74	
		In	(mm)				34	201	239	190	15					679
		Ir	(mm)				48	283	337	268	21					957
Peak Irrigation Capacity	% 50	Rainfall (mm)	r	73	68	62	36	20	21	13	32	61	80	88	92	
			re	55	51	47	27	15	16	10	24	46	60	66	69	
		In	(mm)				34	196	234	192	9					
		Ir	(mm)				48	276	330	270	13					
	% 80	Rainfall (mm)	r	45	42	41	19	9	10	3	12	29	34	52	51	
			re	34	32	31	14	7	8	2	9	22	26	39	38	
		In	(mm)				47	204	242	200	24					
		Ir	(mm)				66	287	341	282	34					
	% 90	Rainfall (mm)	r	34	31	32	14	6	6	1	6	19	22	36	36	
			re	26	23	24	11	5	5	1	5	14	17	27	27	
		In	(mm)				50	206	245	201	28					
		Ir	(mm)				70	290	345	283	39					

ET crop : Crop Water Requirement (including nursery, land preparation and percolation in case of rice)

In : Net Irrigation Requirement (In = ET crop − re)
re: effective rainfall

Ir : Irrigation requirement (Ir = In/Eo)
Eo : Overall irrigation efficiency = 0.71

Table B.1.11 Irrigation Requirement of Berseem Clover

			Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
			Cropping Pattern														
			ET crop	(mm)	31	40	52	16					53	74	42	28	336
Irrigation Amount	% 10		Rainfall (mm)	r	98	87	79	55	41	45	49	76	83	121	103	120	957
				re	74	65	59	41	31	34	37	57	62	91	77	90	
			In	(mm)													
			Ir	(mm)													
	% 20		Rainfall (mm)	r	90	81	73	51	35	38	42	65	80	117	99	115	886
				re	68	61	55	38	26	29	32	49	60	88	74	86	
			In	(mm)													
			Ir	(mm)													
	% 50		Rainfall (mm)	r	79	70	63	44	25	28	30	46	75	109	92	108	769
				re	59	53	47	33	19	21	23	35	56	82	69	81	
			In	(mm)			5										5
			Ir	(mm)			7										7
	% 80		Rainfall (mm)	r	69	61	55	39	17	18	20	31	70	103	87	102	672
				re	52	46	41	29	13	14	15	23	53	77	65	77	
			In	(mm)			11										11
			Ir	(mm)			15										15
	% 90		Rainfall (mm)	r	65	57	51	36	13	14	16	24	68	100	85	99	628
				re	49	43	38	27	10	11	12	18	51	75	64	74	
			In	(mm)			14						2				16
			Ir	(mm)			20						3				23
Peak Irrigation Capacity	% 50		Rainfall (mm)	r	73	68	62	36	20	21	13	32	61	80	88	92	
				re	55	51	47	27	15	16	10	24	46	69	66	69	
			In	(mm)			5						7	14			
			Ir	(mm)													
	% 80		Rainfall (mm)	r	45	42	41	19	9	10	3	12	29	34	52	51	
				re	34	32	31	14	7	8	2	9	22	26	33	38	
			In	(mm)		8	21	2					31	48	3		
			Ir	(mm)													
	% 90		Rainfall (mm)	r	34	31	32	14	6	6	1	6	19	22	36	36	
				re	26	23	24	11	5	5	1	5	14	17	27	27	
			In	(mm)	5	17	28	5					39	57	15	1	
			Ir	(mm)													

ET crop : Crop Water Requirement (including nursery, land preparation and percolation in case of rice)

In : Net Irrigation Requirement (In = ET crop − re)
re: effective rainfall

Ir : Irrigation requirement (Ir = In/Eo)
Eo : Overall irrigation efficiency = 0.71

Table B. 1. 12. Crop Water Requirement of Nursery

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.	Total
Reference Crop Evapo. (ETo mm/month)			31	40	62	93	136	165	164	146	105	74	42	28	1,086
Cropping Pattern															
First	Crop Coefficient	(Kc)				1.1									
	Period	(days)													
	Nursery	(mm)			(10)	(8)									
	Land Preparation	(mm)			150										150
	Crop Water Requirement	(mm)			22	102									124
	Percolation	(mm)			20	60									80
	Total (1)	(mm)			192	162									354
Middle	Crop Coefficient	(Kc)				1.1									
	Period	(days)													
	Nursery	(mm)				(14)	(5)								
	Land Preparation	(mm)				150									150
	Crop Water Requirement	(mm)				85	72								152
	Percolation	(mm)				50	30								80
	Total (2)	(mm)				285	102								387
Late	Crop Coefficient	(Kc)					1.1								
	Period	(days)													
	Nursery	(mm)				(10)	(11)								
	Land Preparation	(mm)				150									150
	Crop Water Requirement	(mm)				34	150								184
	Percolation	(mm)				20	62								82
	Total (3)	(mm)				204	212								416
Average [(1) + (2) + (3)]÷3		(mm)			64	217	105								386

Note: ( ) shows crop water requirement to whole cropped area, in consideration of nursery area of 1/20 to whole cropped area

Table B. 1. 13. Crop Water Requirement of Amol--3

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Reference Crop Evapo. (ETo mm/month)			31	40	62	93	136	165	164	146	105	74	42	28	1,086
Cropping Pattern															
First	Crop Coefficient	(Kc)				LP	1.1		1.2	0.95					
	Period	(days)					31	30	31	15					
	Nursery	(mm)			10	8									18
	Land Preparation	(mm)				150									150
	Crop Water Requirement	(mm)					150	182	197	69					598
	Percolation	(mm)					62	60	62	30					214
	Total (1)	(mm)			10	158	212	242	259	99					980
Middle	Crop Coefficient	(Kc)				LP	1.1		1.2	0.95					
	Period	(days)					15	30	15	16	15	16			
	Nursery	(mm)				14	5								19
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)					75	182	189	157					603
	Percolation	(mm)					30	60	62	62					214
	Total (2)					14	260	242	251	219					986
Late	Crop Coefficient	(Kc)					LP	1.1		1.2	0.95				
	Period	(days)						30	31	31	15				
	Nursery	(mm)				10	11								21
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)						182	180	175	50				587
	Percolation	(mm)						60	62	62	30				214
	Total (3)					10	161	242	242	237	80				972
Average [(1)+(2)+(3)] ÷ 3		(mm)			3	61	211	242	251	185	27				980

Table B. 1. 14. Crop Water Requirement of Haraz

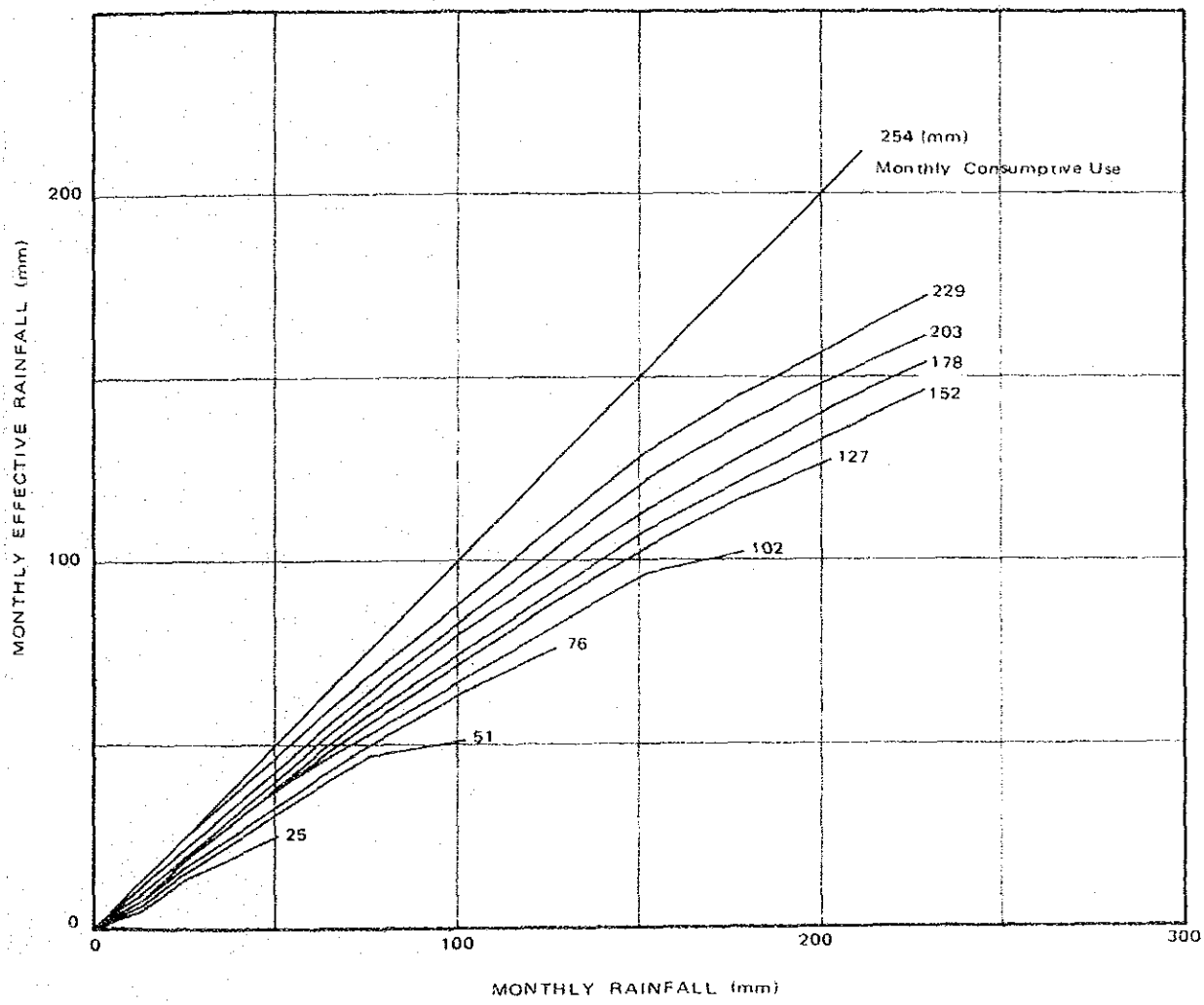
Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.	Total
Reference Crop Evapo. (ETo mm/month)			31	40	62	93	136	165	164	146	105	74	42	28	1,086
Cropping Pattern															
First	Crop Coefficient	(Kc)				L.P	1.1		1.2	0.95					
	Period	(days)					31	20	10	20	1	5			
	Nursery	(mm)			10	8									18
	Land Preparation	(mm)				150									150
	Crop Water Requirement	(mm)					150	187	182	22					541
	Percolation	(mm)					62	60	62	10					194
	Total	(mm)			10	158	212	247	244	32					903
Middle	Crop Coefficient	(Kc)				L.P		1.1		1.2	0.95				
	Period	(days)					15	30	5	26	5	15			
	Nursery	(mm)				14	5								19
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)					75	182	194	95					546
	Percolation	(mm)					30	60	62	40					192
	Total (2)	(mm)				14	260	242	256	135					907
Late	Crop Coefficient	(Kc)					L.P	1.1		1.2	0.95				
	Period	(days)						30	20	11	20	11	5		
	Nursery	(mm)				10	11								21
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)						182	186	162	17				547
	Percolation	(mm)						60	62	62	10				194
	Total (3)	(mm)				10	161	242	248	224	27				912
Average [(1)+(2)+(3)] ÷ 3		(mm)			3	61	211	244	249	130	9				907

Table B. 1. 15. Crop Water Requirement of Tarom

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Reference Crop Evapo. (ETo mm/month)			31	40	62	93	136	165	164	146	105	74	42	28	1,086
Cropping Pattern															
First	Crop Coefficient	(Kc)				LP	1.1	1.2	0.95						
	Period	(days)					31	30	15						
	Nursery	(mm)			10	8									18
	Land Preparation	(mm)				150									150
	Crop Water Requirement	(mm)					150	198	78						426
	Percolation	(mm)					62	60	30						152
	Total (1)	(mm)			10	158	212	258	108						746
Middle	Crop Coefficient	(Kc)				LP	1.1	1.2	0.95						
	Period	(days)					15	15	15	15	16				
	Nursery	(mm)				14	5								19
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)					75	190	176						441
	Percolation	(mm)					30	60	62						152
	Total (2)	(mm)				14	260	250	238						762
Late	Crop Coefficient	(Kc)					LP	1.1	1.2	0.95					
	Period	(days)													
	Nursery	(mm)				10	11								21
	Land Preparation	(mm)					150								150
	Crop Water Requirement	(mm)						182	197	69					448
	Percolation	(mm)						60	62	30					152
	Total (3)	(mm)				10	161	242	259	99					771
Average [(1) + (2) + (3)] ÷ 3		(mm)			3	61	211	250	202	33					760

Table B. 1. 16. Crop Water Requirement of Berseem

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.	Total
Reference Crop Evapo. (ETo mm/month)			31	40	62	93	136	165	164	146	105	74	42	28	1,086
Cropping Pattern															
First	Crop Coefficient	(Kc)		1.0									1.0		
	Period	(days)													
	Nursery	(mm)													
	Land Preparation	(mm)													
	Crop Water Requirement	(mm)	31	40	31						105	74	42	28	351
	Percolation	(mm)													
	Total (1)	(mm)													
Middle	Crop Coefficient	(Kc)		1.0									1.0		
	Period	(days)													
	Nursery	(mm)													
	Land Preparation	(mm)													
	Crop Water Requirement	(mm)	31	40	62						53	74	42	28	330
	Percolation	(mm)													
	Total (2)														
Late	Crop Coefficient	(Kc)		1.0									1.0		
	Period	(days)													
	Nursery	(mm)													
	Land Preparation	(mm)													
	Crop Water Requirement	(mm)	31	40	62	47						74	42	28	324
	Percolation	(mm)													
	Total (3)	(mm)													
Average [(1) + (2) + (3)] ÷ 3		(mm)	31	40	52	16					53	74	42	28	336



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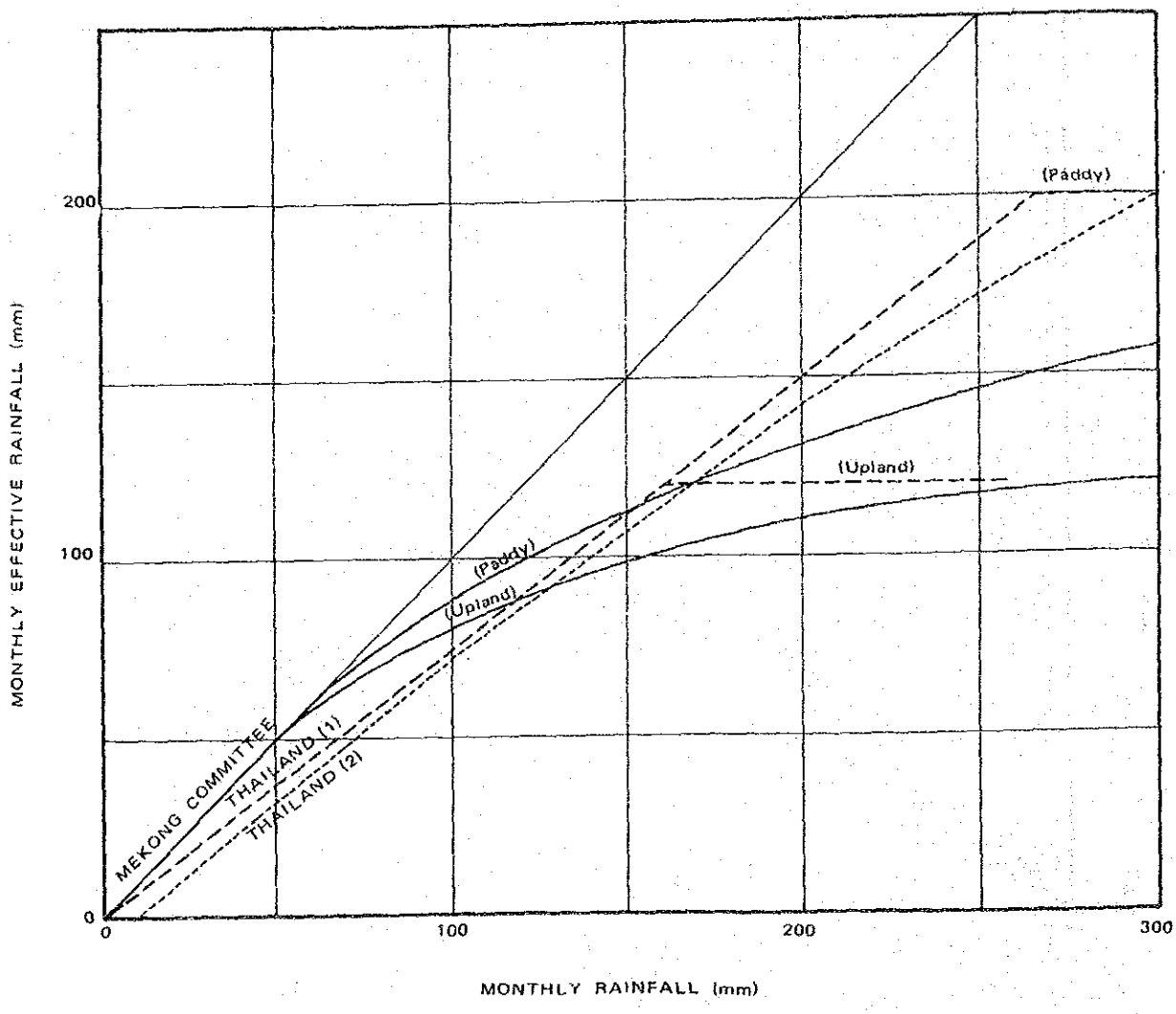
ISLAMIC REPUBLIC OF IRAN MINISTRY OF AGRICULTURE	
CASPIAN SEA COASTAL AREA AGRICULTURAL DEVELOPMENT PROJECT	
ESTIMATION METHOD OF EFFECTIVE RAINFALL	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	FIGURE B.1.1



ISLAMIC REPUBLIC OF IRAN MINISTRY OF AGRICULTURE	
CASPIAN SEA COASTAL AREA AGRICULTURAL DEVELOPMENT PROJECT	
ESTIMATION METHOD OF EFFECTIVE RAINFALL	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	FIGURE B.1.2

B.1.3. Water Balance

i) Case Study

Water balance has been studied on two cases of water supply and three cases of water demand, thus on six cases totally. For evaluating the roles of abbandans in water resources, cases have been also studied additionally, namely with and without abbandans. In case of water supply with abbandans after Lar dam, water balance has been also examined in different two ways on usage of abbandans.

Cases on Water Supply

1. Before Lar Dam (BL)

    1-1 Without abbandans
    1-2 With abbandans

2. After Lar Dam (AL)

    2-1. Without abbandans
    2-2. With abbandans under fixed schedule of usage of abbandans
    2-3. With abbandans under usage only when Lar dam is empty

Cases on Water Demand

1. Cropped ratio : 60% of Amol-3 and 40% of Tarom
2. Cropped ratio : 80% of Amol-3 and 20% of Tarom
3. Cropped ratio : 100% of Amol-3

ii) Water Demand

Water demand has been considered only for irrigation, since domestic water is negligible small to irrigation water. For the study of water balance, irrigation demand has been classified into two cases in accordance with water supply systems such as with and without abbandans. Groundwater supply is same in both cases. Details are described in Table B.1.18 and B.1.19.

iii) Procedure of Water Balance Study

Water balance study has been conducted in accordance with following procedure;

a) Water Demand

- Irrigation Demand
  579 MCM to 652 MCM : without abbandans ..(Table B.1.18)
  522 MCM to 595 MCM : with abbandans .....(Table B.1.19)
- Tehran Water Supply
  160 MCM .....(Table B.1.22)
  Water demand is distributed equally to each month, because no informations are available on this.

b) Water Release from Lar Dam

Lar dam has been operated to release Tehran water supply prior to irrigation demand to the project area. When storage water is available to release irrigation water to the project area, necessary water is released to meet irrigation demand when residual flow is not sufficient for irrigation. H-A, H-V and monthly evaporation data of the Lar Reservoir are shown in Tables B.1.20 and B.1.21.

c) Operation of Abbandans

For using abbandans, two different operation systems are examined. One is to operate them under fixed schedule to use storage water from beginning of irrigation and to fill up them when residual water exceed irrigation demand. The other is to operate them only when Lar dam becomes empty.

iv) Result of water Balance Study

Water balance has been studied for 32 years from 1329-30 (1950-51) to 1360-61 (1981-82) in 10 day interval basis. The results are summarized in Table B.1.17.

In case before Lar dam, water shortage happens almost every year in any case. The shortage concentrates in late irrigation stage due to decrease of flow of the Haraz river. The reason of this shortage is considered to be resent expansion of Amol-3 in the high and middle lands, since Amol-3 has a longer growing period than Tarom.

In case after Lar dam, water shortage will be rather improved from before Lar dam. However, water shortage exceeds allowable level of once in 10 years, even in this case when abbandans are abolished or used only at the time when Lar dam becomes empty. Recommendable case is at cropped ratio of 80% of Amol-3 and 20% of Tarom, and to keep abbandans remaining. Abbandans are to be used under scheduled water release in accordance with irrigation demand in this case. Abbandans may be filled up by excess flow of the Haraz when residual flow is abundant. The summary is illustrated in Exhibit B.1.1 to B.1.3 for three cases of cropped ration in this case.

Table B.1.17 Summary of Water Balance Study

Water Shortage	Cropped Ratio A(60),T(40)	A(80),T(20)	A(100)
Before Lar Dam			
BL W/OA (without abbandans)			
Drought years for 32 years(1329-1360)	30 yrs	31 yrs	31 yrs
Frequency (1/years)	1/1.1 yrs	1/1 yr	1/1 yr
Annual shortage in drought years			
Minimum (MCM)	2	2	14
Average (MCM)	120	146	178
Maximum (MCM)	288	327	363
BL W/A (with abbandans)			
Drought years for 32 years(1329-1360)	25 yrs	29 yrs	30 yrs
Frequency (1/years)	1/1.3 yrs	1/1.1 yrs	1/1.1 yrs
Annual shortage in drought years			
Minimum (MCM)	3	4	1
Average (MCM)	91	108	136
Maximum (MCM)	233	271	306
After Lar Dam			
AL W/OA (without abbandans)			
Drought years for 32 years(1329-1360)	6 yrs	11 yrs	14 yrs
Frequency (1/years)	1/5 yrs	1/3 yrs	1/2.3 yrs
Annual shortage in drought years			
Minimum (MCM)	7	4	8
Average (MCM)	136	139	170
Maximum (MCM)	274	313	349
AL W/A1 (with abbandans) ... abbandans used under fixed schedule			
Drought years for 32 years(1329-1360)	1 yr	3 yrs	8 yrs
Frequency (1/years)	1/32 yrs	1/11 yrs	1/3.5 yrs
Annual shortage in drought years			
Minimum (MCM)	219	122	15
Average (MCM)	219	209	143
Maximum (MCM)	219	257	292
AL W/A2 (with abbandans) ... abbandans used only when Lar dam is empty.			
Drought years for 32 years(1329-1360)	4 yrs	9 yrs	11 yrs
Frequency (1/years)	1/8 yrs	1/3.5 yrs	1/3 yrs
Annual shortage in drought years			
Minimum (MCM)	21	2	14
Average (MCM)	134	108	152
Maximum (MCM)	217	256	292

Note: 1) BL = Before Lar dam
2) AL = After Lar dam
3) W/A = with Abbandans
4) W/OA = without Abbandans

Table B.1.18 Irrigation Demand to Surface Water

(Unit: MCM)

	Far			Ord			Kho			Tir			Mor			Sha	Total
	Apr.			May			Jun.			Jul.			Aug.				
A(60%), T(40%)		27			185			216			201			87			716
Groundwater		9.2			33.9			38.8			36.4			18.6			136.8
Springs		(4.9)			(4.9)			(4.9)			(4.9)			(4.9)			(24.6)
Wells		(4.3)			(29.0)			(33.9)			(31.5)			(13.7)			(112.2)
Demand to Surface Water		17.8			151.1			177.2			164.6			68.4			579.1
	5.9	5.9	5.9	50.4	50.4	50.4	59.1	59.1	59.1	54.9	54.9	54.9	22.8	22.8	22.8		
A(80%), T(40%)		27			185			215			210			116			753
Groundwater		8.9			32.5			37.0			36.2			22.1			136.8
Springs		(4.9)			(4.9)			(4.9)			(4.9)			(4.9)			(24.6)
Wells		(4.0)			(27.6)			(32.1)			(31.3)			(17.2)			(112.2)
Demand to Surface Water		18.1			152.5			178.0			175.8			93.9			616.5
	6.0	6.0	6.0	50.8	50.8	50.8	59.3	59.3	59.3	57.9	57.9	57.9	31.3	31.3	31.3		
A(100%)		27			185			213			220			144			789
Groundwater		8.7			31.2			35.2			36.2			25.4			136.8
Springs		(4.9)			(4.9)			(4.9)			(4.9)			(4.9)			(24.6)
Wells		(3.8)			(26.3)			(30.3)			(31.3)			(20.5)			(112.2)
Demand to Surface Water		18.3			153.8			177.8			183.8			118.6			652.3
	6.1	6.1	6.1	51.3	51.3	51.3	59.3	59.3	59.3	61.3	61.3	61.3	39.5	39.5	39.5		

Table B.1.19 Irrigation Demand to the Haraz River(with Abbandans)

(Unit: MCM)

	Far			Ord			Kho			Tir			Mor			Sha	Total
	Apr.			May			Jun.			Jul.			Aug.				
A(60%), T(40%)	27			185			216			201			87				716
Groundwater	9.2			33.9			38.8			36.4			18.6				136.8
Abbandans	2.2			14.7			17.2			16.0			6.9				57.0
Demand to Haraz River	15.6	5.2	5.2	136.4	45.5	45.5	160.0	53.3	53.3	148.6	49.5	49.5	61.5	20.5	20.5	20.5	522.1
A(80%), T(20%)	27			185			215			210			116				753
Groundwater	8.9			32.5			37.0			36.2			22.1				136.8
Abbandans	2.1			14.0			16.3			15.9			8.7				57.0
Demand to Haraz River	16.0	5.3	5.3	138.5	46.2	46.2	161.7	53.9	53.9	157.9	52.6	52.6	85.2	28.4	28.4	28.4	559.3
A(100%)	27			185			213			220			144				789
Groundwater	8.7			31.2			35.2			36.2			25.4				136.8
Abbandans	1.9			13.3			15.4			15.9			10.5				57.0
Demand to Haraz River	16.4	5.5	5.5	140.5	46.8	46.8	162.4	54.1	54.1	167.9	56.0	56.0	108.1	36.0	36.0	36.0	595.3

Table B.1.20 H-A, H-V of the Lar Reservoir

Elevation (m)	Gross Capacity (MCM)	Live Capacity (MCM)	Surface Area (sq.km)	Remarks
2531 [1]	960	860	29.0	FSL
2523 [1]	735	635	25.5	
2520 [1]	650	550	23.4	
2510 [1]	460	360	17.0	
2480 [1]	200	100	7.0	
2478		(92)	(6.5)	LWL
2475 [2]		79	5.75	
2450 [2]		6	1	
2425 [2]		0	0	

Note: 1) Reference 4
2) Information from Lar Dam Office
3) ( ) estimated

FSL; Full Surface Level, LWL; Low Water Level

Table B.1.21 Monthly Evaporation from the Lar Reservoir

(Unit: mm)

Mehr	Aban	Azar	Dey	Bah	Est	Far	Ord	Kho	Tir	Mor	Sha	Total
70	12	-16	-34	-32	-25	7	82	159	178	173	141	715

Note: Data Source; Reference 4
Negative evaporations have not been considered in water balance study.

Table B.1.22 Monthly Water Demand of Tehran Water Supply

(Unit: MCM)

Mehr	Aban	Azar	Dey	Bah	Esf	Far	Ord	Kho	Tir	Mor	Sha	Total
13.33	13.33	13.33	13.33	13.33	13.33	13.33	13.33	13.33	13.33	13.33	13.33	160

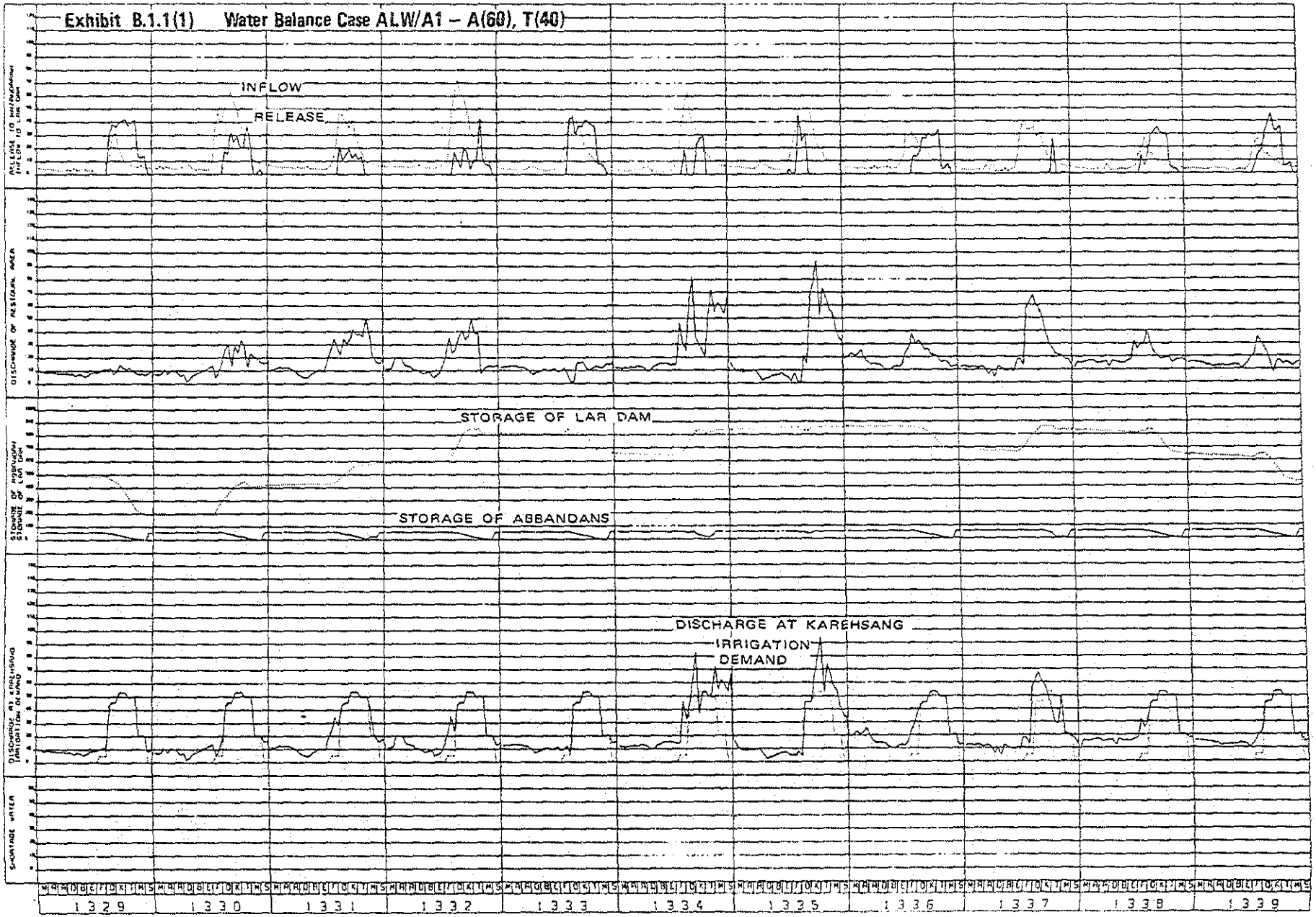


Exhibit B.1.1(1) Water Balance Case ALW/A1 – A(60), T(40)
INFLOW
RELEASE
STORAGE OF LAR DAM
STORAGE OF ABBANDANS
DISCHARGE AT KAREHSANG
IRRIGATION DEMAND
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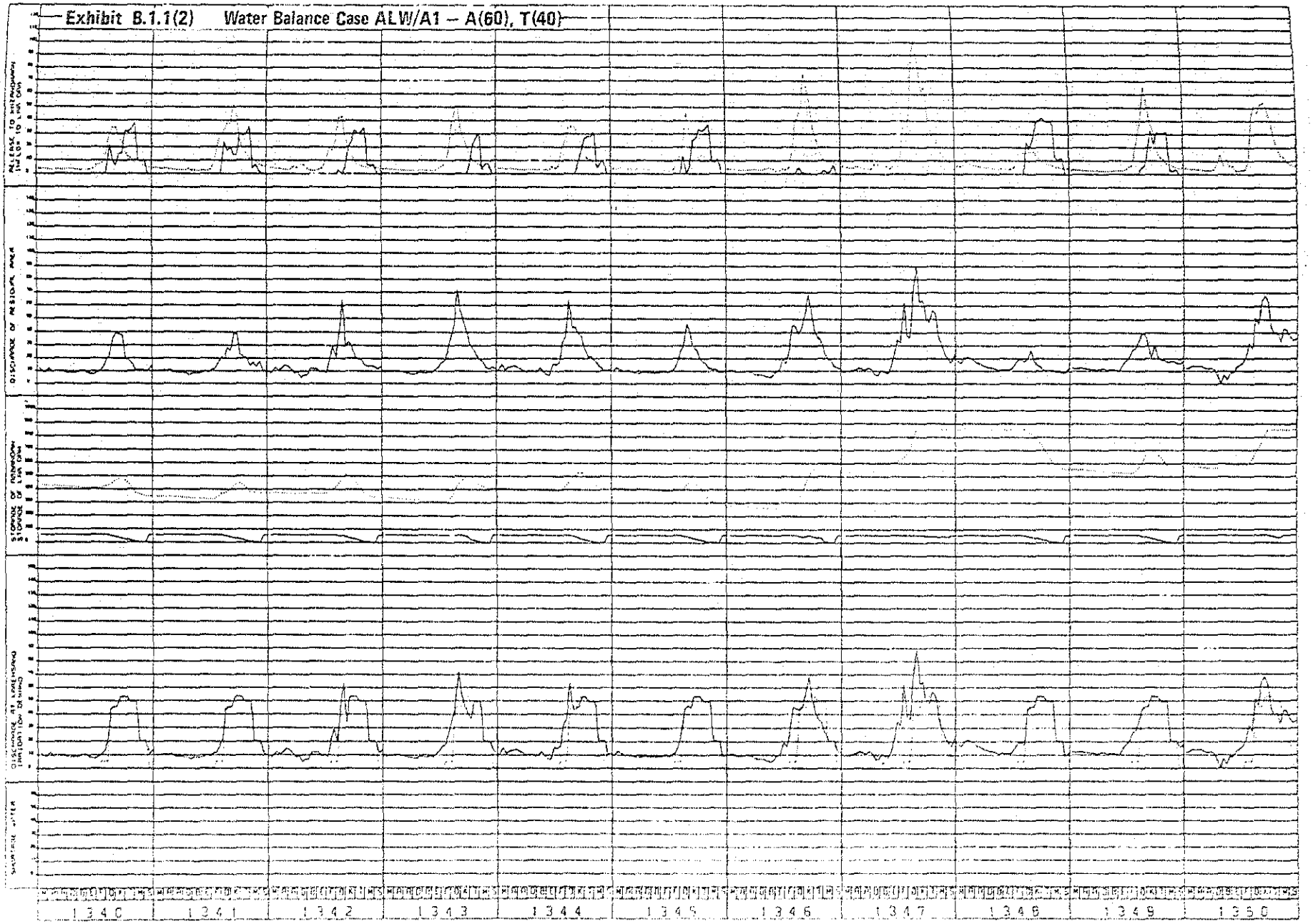
Exhibit B.1.1(2) Water Balance Case ALW/A1 – A(60), T(40)
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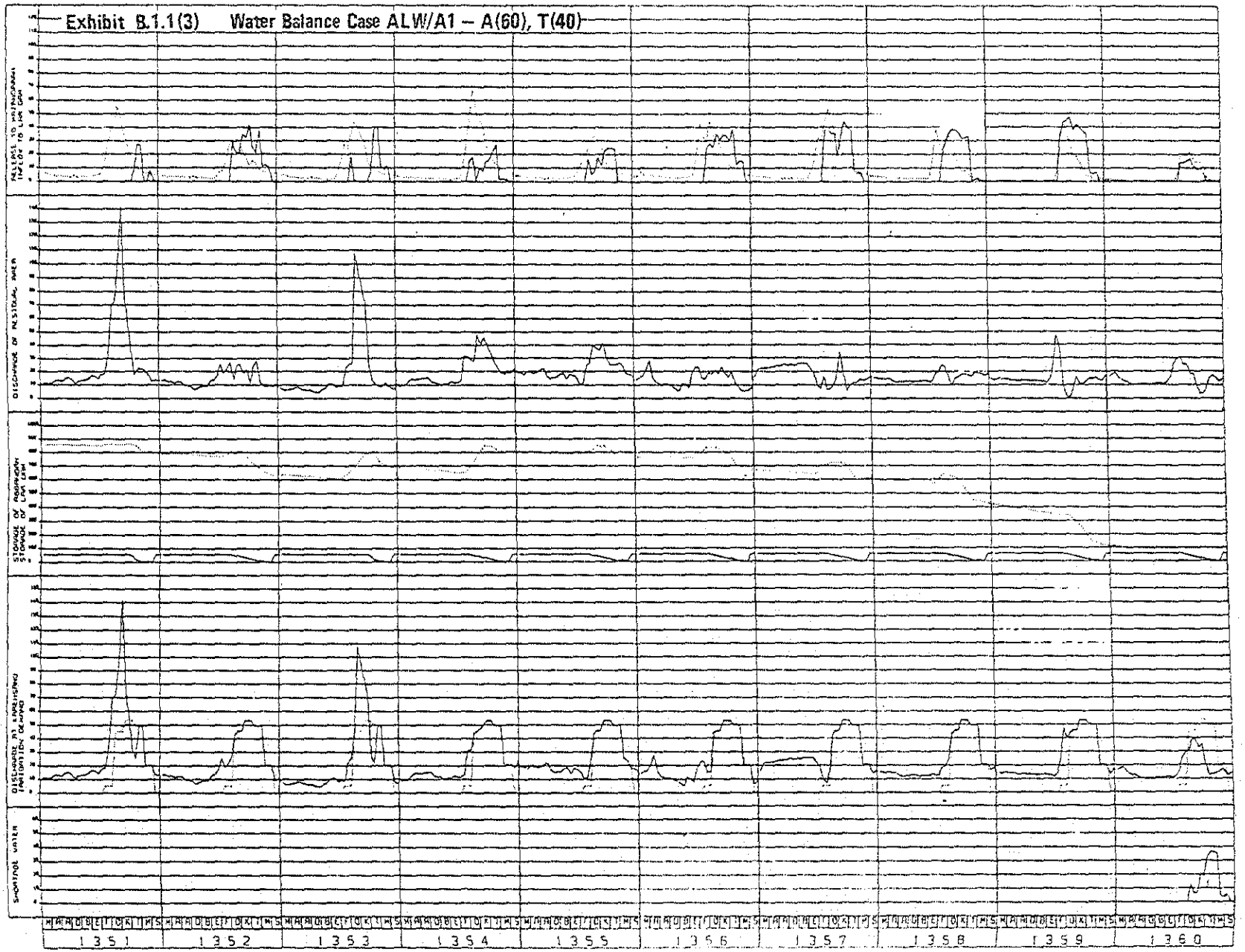
Exhibit B.1.1(3) Water Balance Case ALW/A1 – A(60), T(40)
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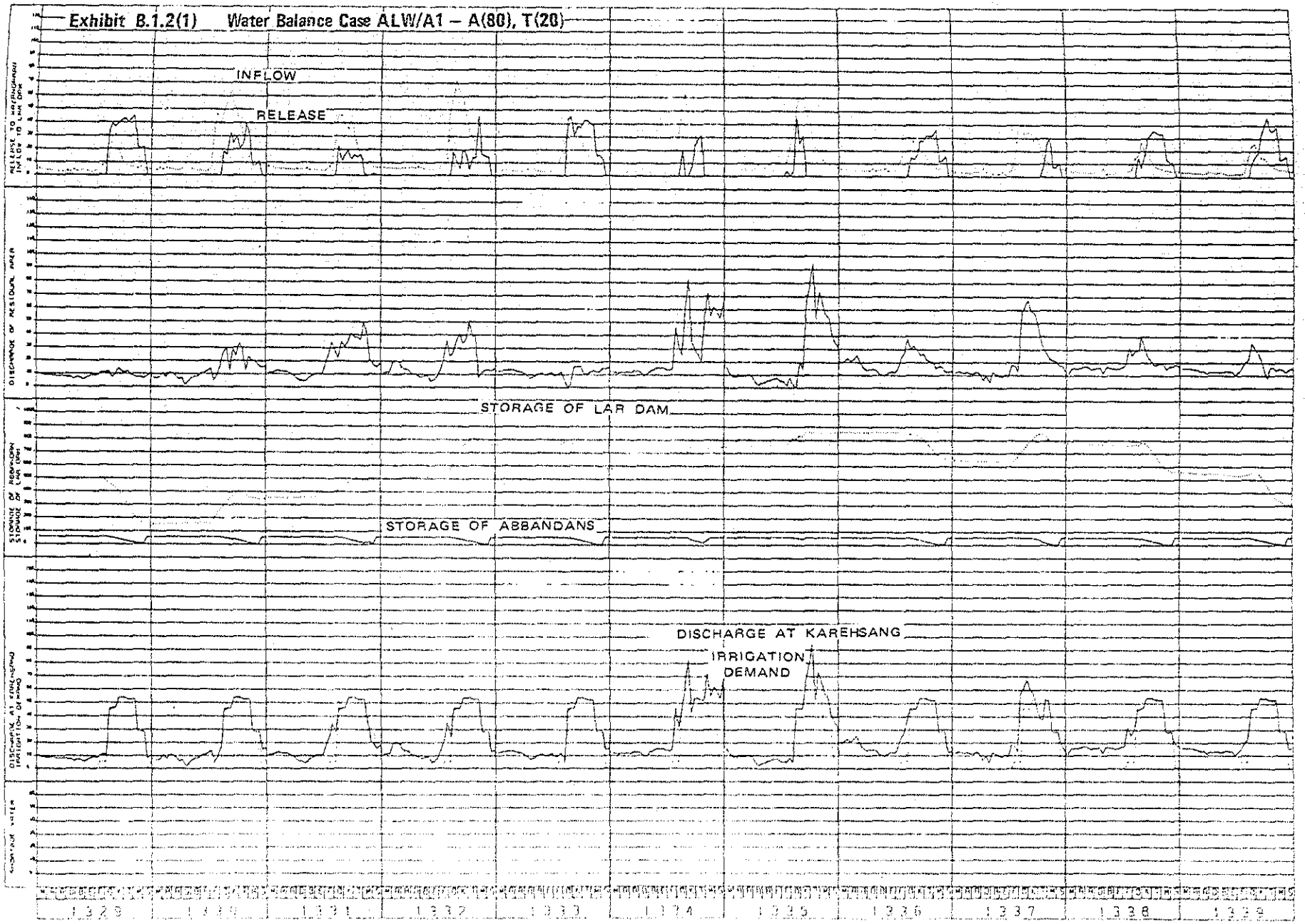
Exhibit B.1.2(1) Water Balance Case ALW/A1 – A(80), T(20)
INFLOW
RELEASE
STORAGE OF LAR DAM
STORAGE OF ABBANDANS
DISCHARGE AT KAREHSANG
IRRIGATION DEMAND
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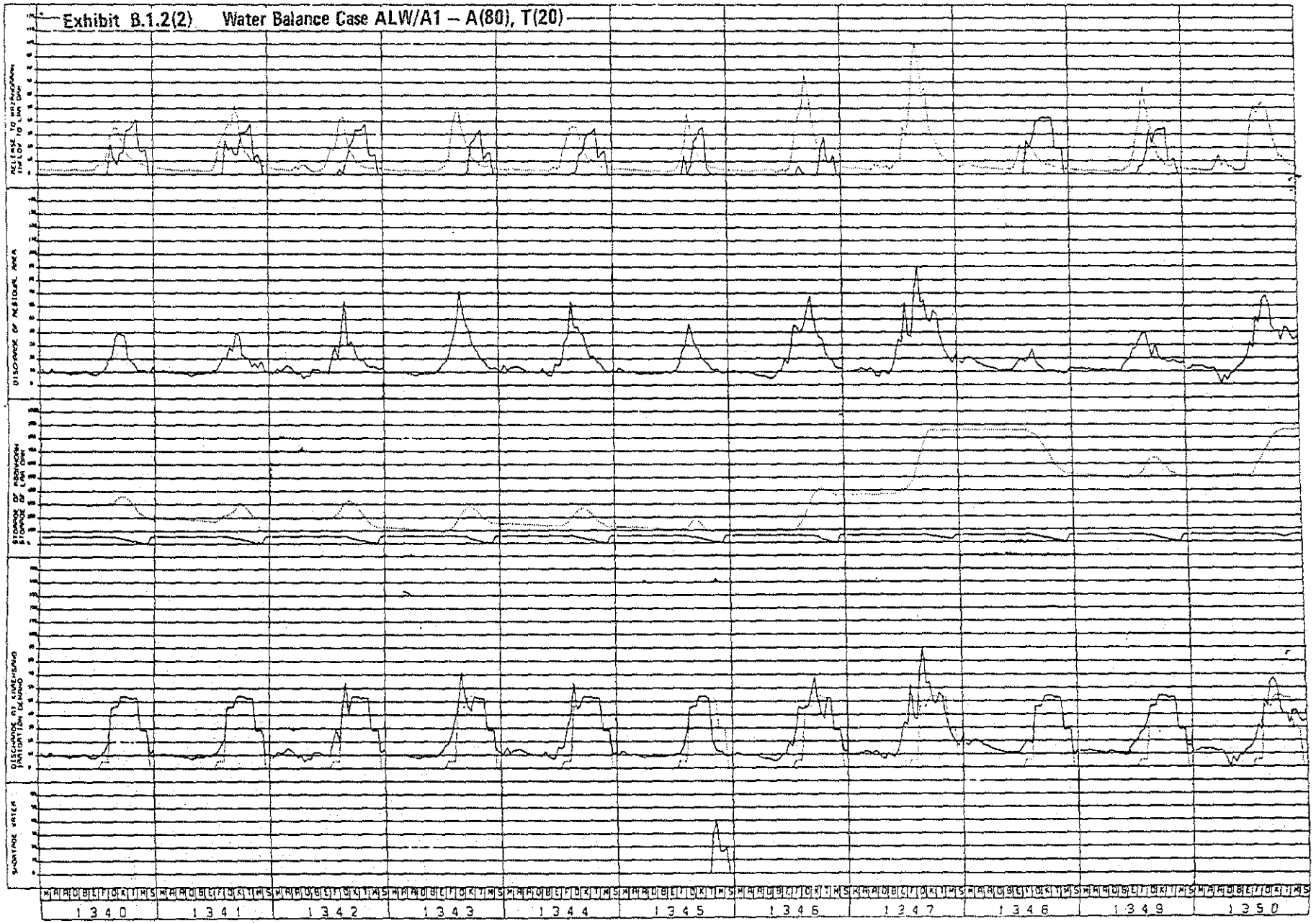
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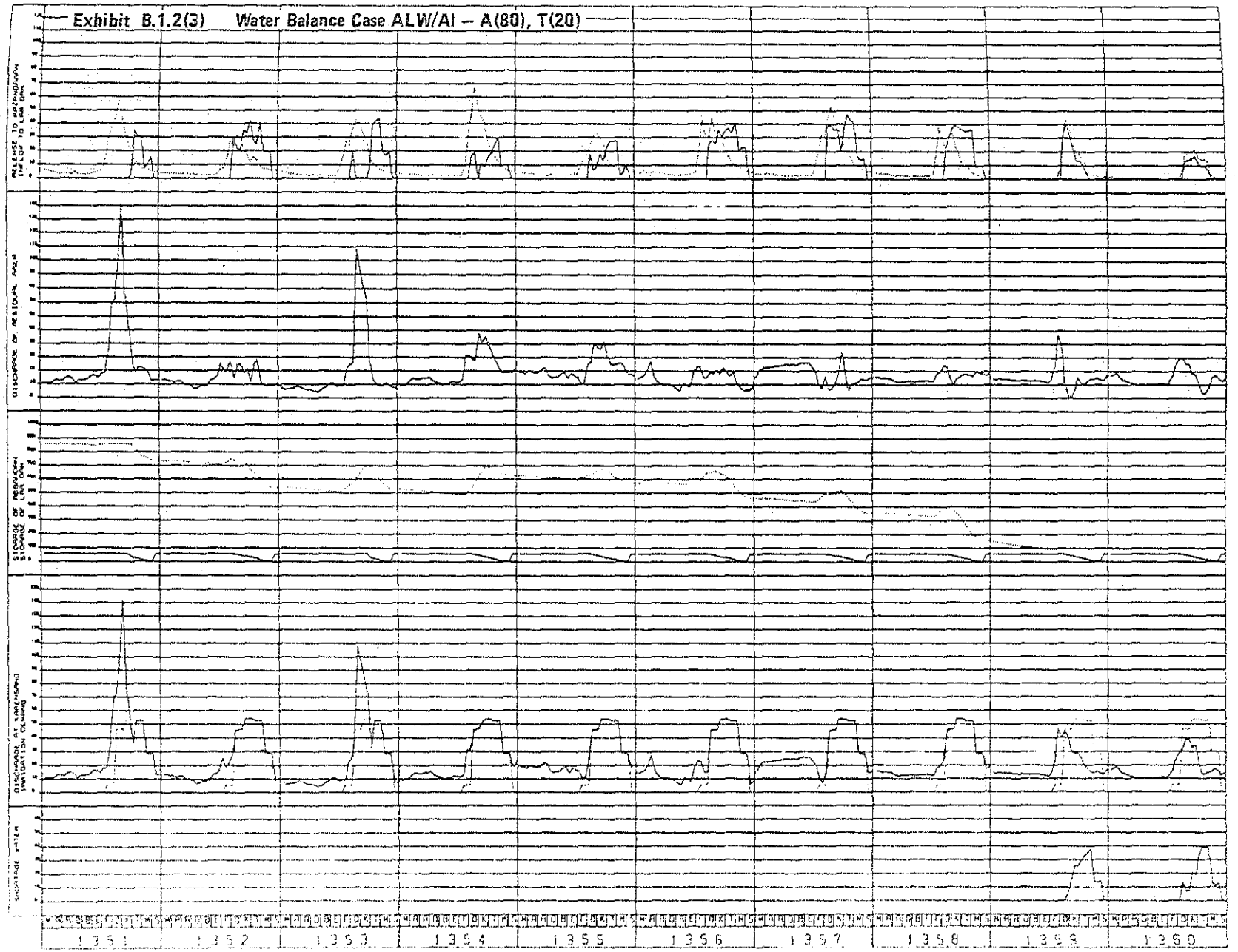
Exhibit B.1.2(3) Water Balance Case ALW/AI – A(80), T(20)
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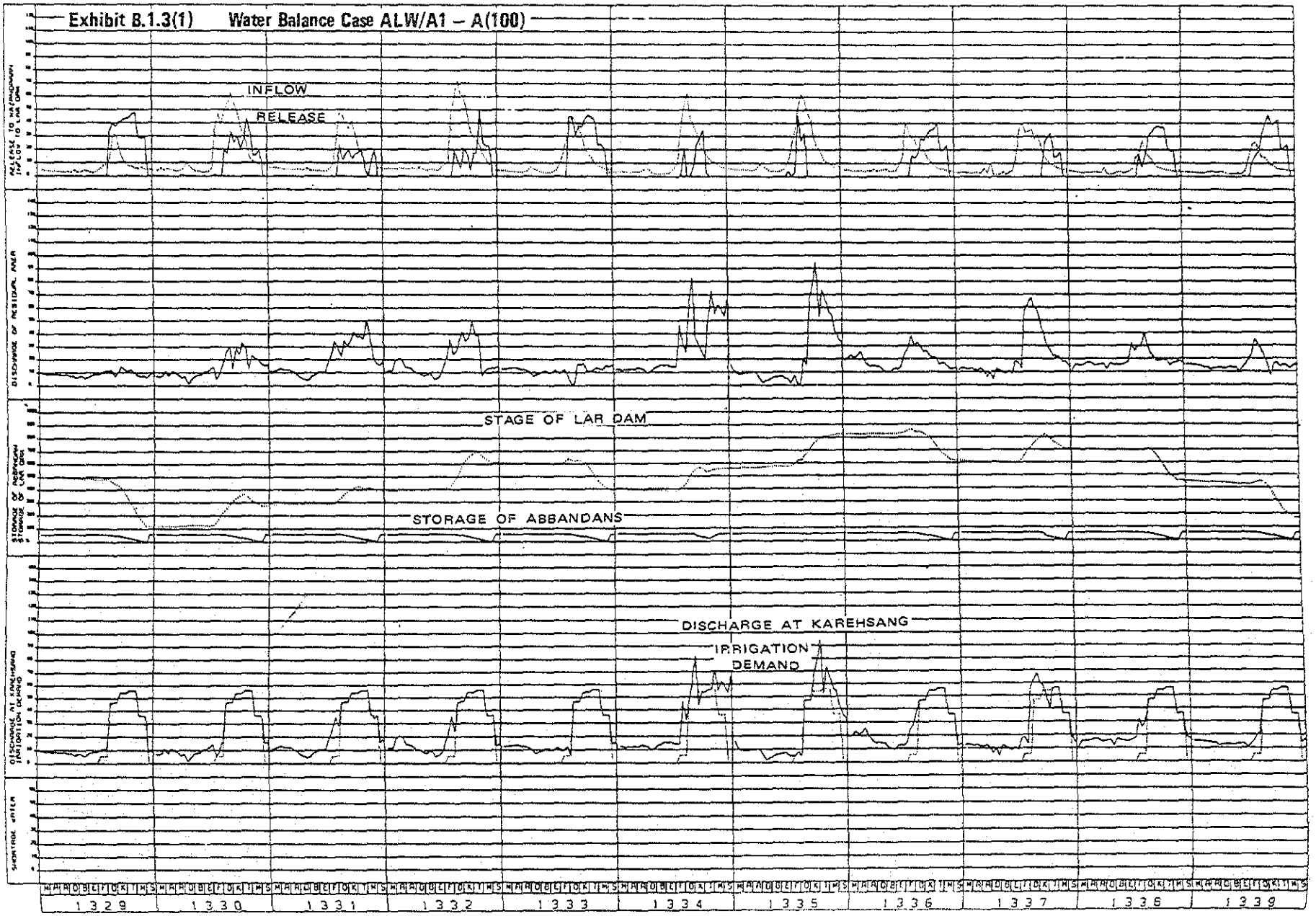
Exhibit B.1.3(1) Water Balance Case ALW/A1 – A(100)
INFLOW
RELEASE
STAGE OF LAR DAM
STORAGE OF ABBANDANS
DISCHARGE AT KAREHSANG
IRRIGATION DEMAND
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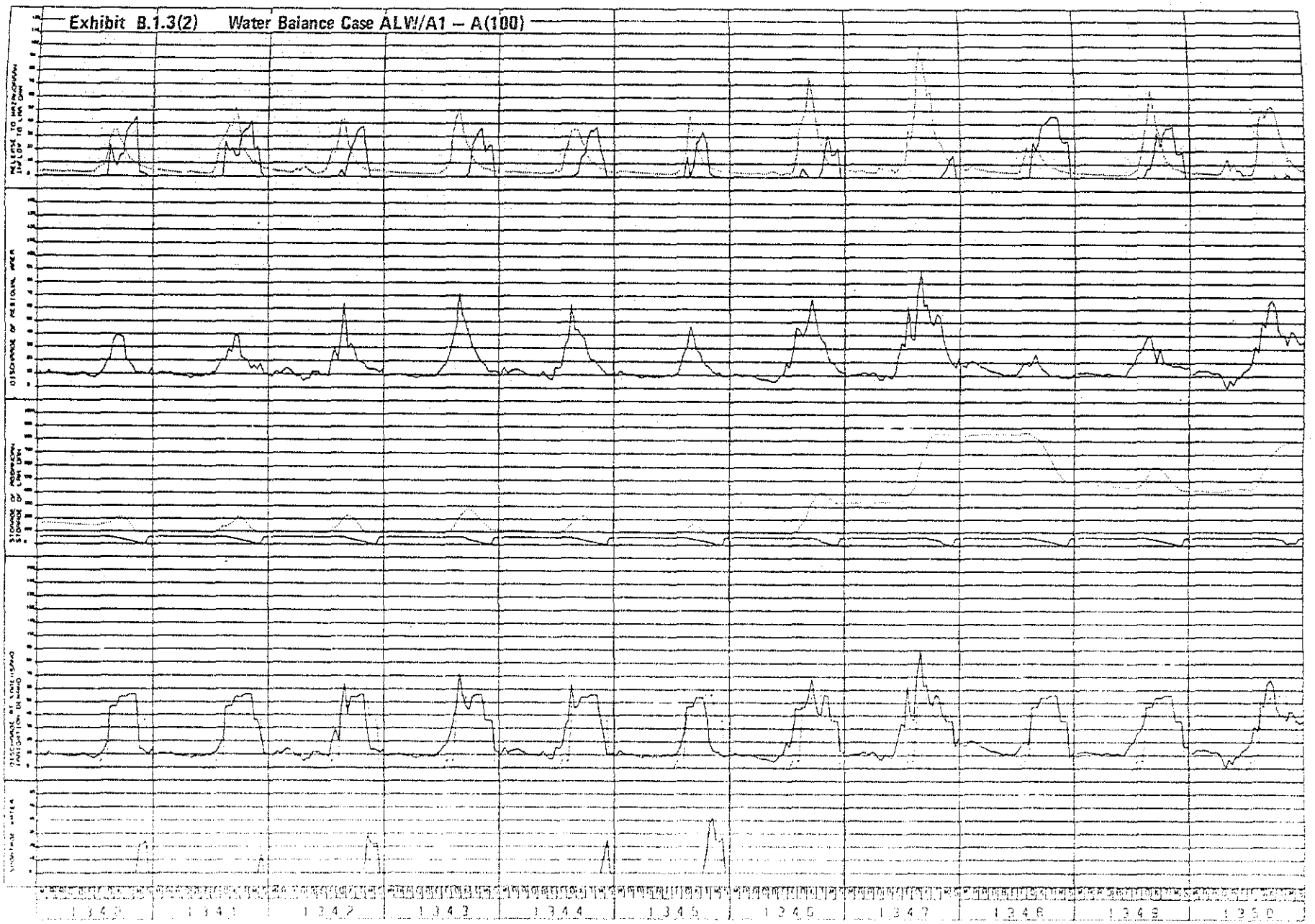
Exhibit B.1.3(2) Water Balance Case ALW/A1 – A(100)
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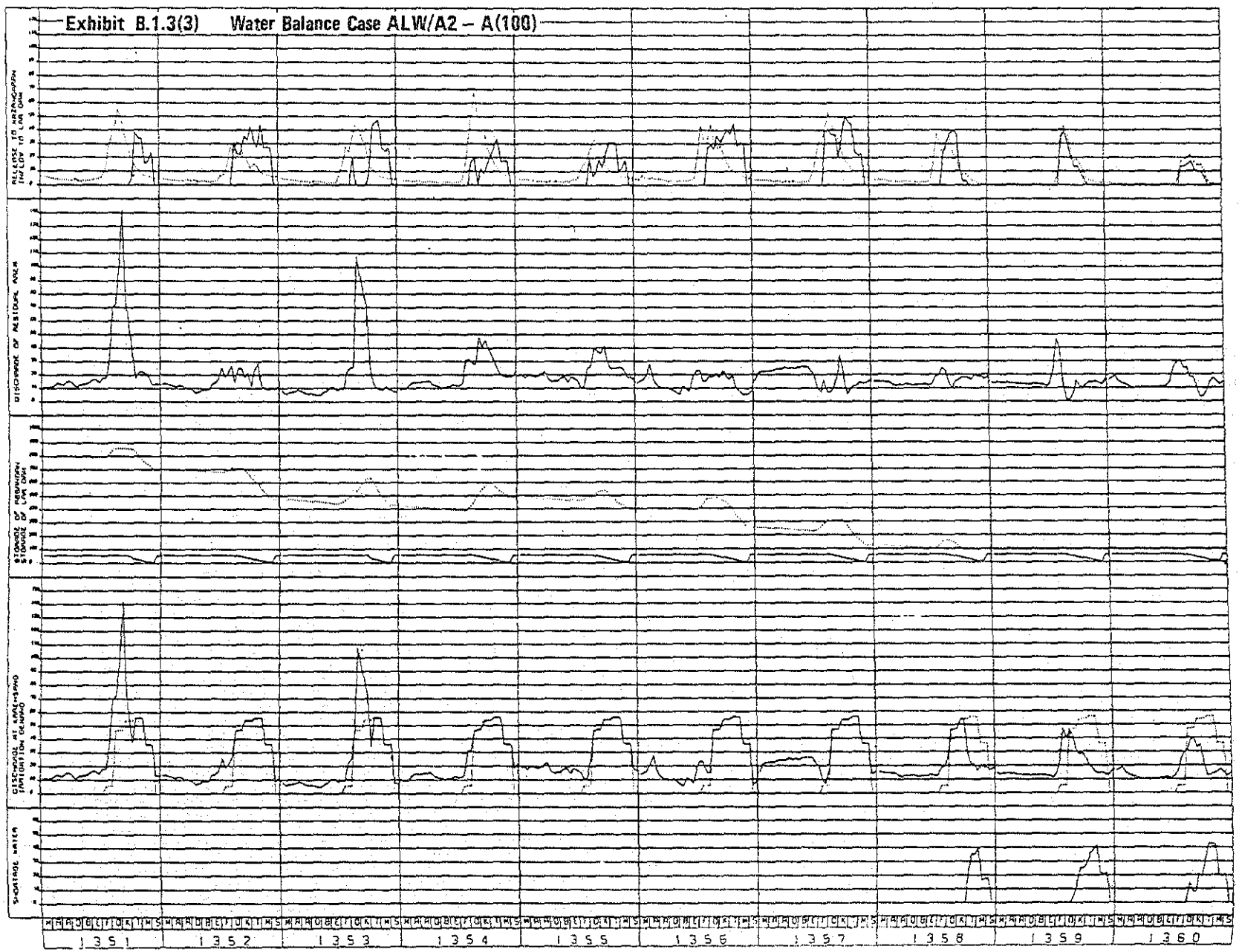
Exhibit B.1.3(3) Water Balance Case ALW/A2 – A(100)
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B.1.4. Temperature of Irrigation Water

Temperature of irrigation water is observed by staffs of the MOA both at inlet and outlet at three terminal irrigation blocks in the high, the middle and the low lands. According to the observation shown in Table B.1.23, water temperature is kept more than 18.5°C at inlet even in early irrigation period. Temperature increases about by 6°C at outlet after plot-to-plot irrigation, but does not exceed 34°C even in clear day. This temperature is not harmful for the paddy growing.

Table B.1.23. Water Temperature in the Paddy Field

Date	Weather	Temperature (°C)		High Land		Middle Land		Low Land	
				Tajanjar		Ceiird		Aradaun	
				Plot-to-Plot=100m		Plot-to-Plot=100m		Plot-to-Plot=120m	
		Haraz River at Kaci Diversion	Amol Rice Research Station (12:30)	Temperature (°C) Inlet	Outlet	Temperature (°C) Inlet	Outlet	Temperature (°C) Inlet	Outlet
10 May'86 (65.2.20)		13.8	23.5	-	-	-	-	18.5	26.4
20 May'86 (65.2.30)		16.4	23.0	-	-	18.5	28.0	20.0	26.0
1 Jun'86 (65.3.11)	Clear	16.0		21.0	29.0	23.5	32.0	21.0	33.0
11 Jun'86 (65.3.21)	Semi-cloudy	18.0		19.9	33.5	20.5	30.8	22.5	28.0
20 Jun'86 (65.3.30)	Rainy	19.5		19.0	23.0	19.5	22.0	19.8	20.0
30 Jun'86 (65.4. 9)	Cloudy	20.0		23.0	24.5	23.0	28.0	23.0	27.5
9 Jul'86 (65.4.18)	Clear	20.0		25.0	28.0	25.0	30.0	26.0	29.0
Average		17.7		21.6	27.6	21.7	28.5	21.5	27.1

Data Source: Amol Agricultural Office

APPENDIX B. 2.

DRAINAGE

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B.2.1. Lands under Poor Drainage

Table B.2.2 shows the areas under poor drainage. According to this table, poor drainage is caused in the area of 51,130 ha out of 68,120 ha of total paddy land which is 75% to total. From topographically, percentage of poor drainage area is 32%, 100% in high land and in middle and low lands respectively.

B.2.2. Hydraulic Conductivity

Hydraulic conductivity has been observed by auger-hole testing method (Reference 10) by the staffs of MOA at 40 sites in the Project Area. As far as results obtained so far, hydraulic conductivity ranges from 1×10^{-3} to 2×10^{-2} cm/sec and is assumed at 5×10^{-3} cm/sec in average in the middle and the low land. (see Figure B.2.2.)

Table B.2.1. Area by Hydraulic Conductivity in the Middle and the Low Lands

	Hydraulic Conductivity (cm/sec)						
	$<1\times10^{-4}$	$1\times10^{-4}\leq$ $<1\times10^{-3}$	$1\times10^{-3}\leq$ $<5\times10^{-3}$	$5\times10^{-3}\leq$ $<1\times10^{-2}$	$1\times10^{-2}\leq$ $<5\times10^{-2}$	$5\times10^{-2}\leq$	Total
Area (ha)	0	3,540	35,620	17,490	12,800	4,150	73,600
Area Ratio (%)	0	4.8	48.4	23.8	17.4	5.6	100
	0	4.8	53.2	77.0	94.4	100	100

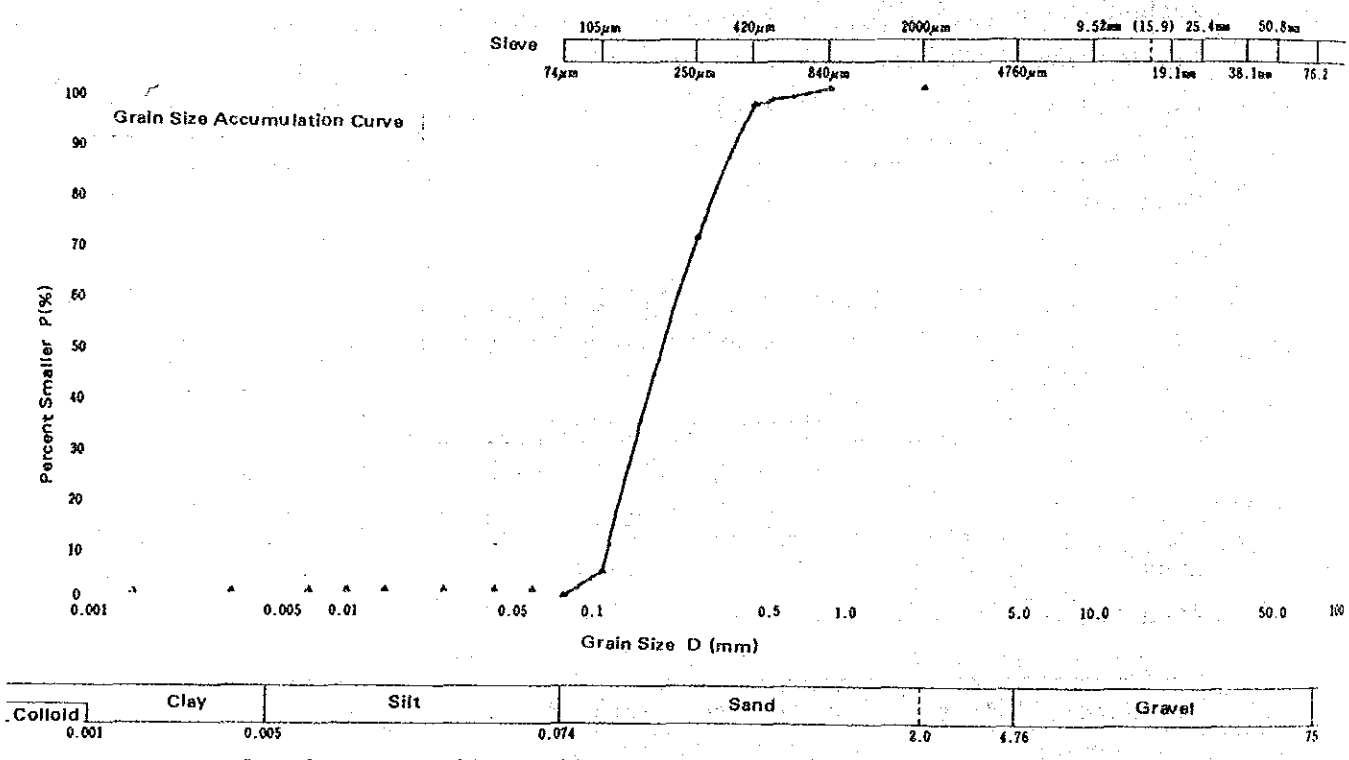
Note: This table derived from Table A.4.8.

B.2.3. Coastal Sand Dunes

Sand dunes are formed along the coast of the Caspian Sea. They obstruct the smaller drainage channels passing.

Their grain size in graded uniformly as see in Figure B.2.1, and is concentrated from 0.1 mm to 0.4 mm. Specific gravity is 2.81 which is considerably heavy.

Figure B.2.1. Grain Size of Coastal Sand Dune



Sample : Obtained from coastal sand dune in Babolsar

Grain Size: Maximum Grain Size = 0.84 mm

60% Grain Size D60 = 0.21 mm

30% Grain Size D30 = 0.14 mm

10% Grain Size D10 = 0.11 mm

Coefficient of Uniformity $\sqrt{Uc}$ = 1.89

Coefficient of Curvature Uc' = 0.84

Uc = 1.37

Unified Soil Classification SP

Specific Gravity Gs = 2.81

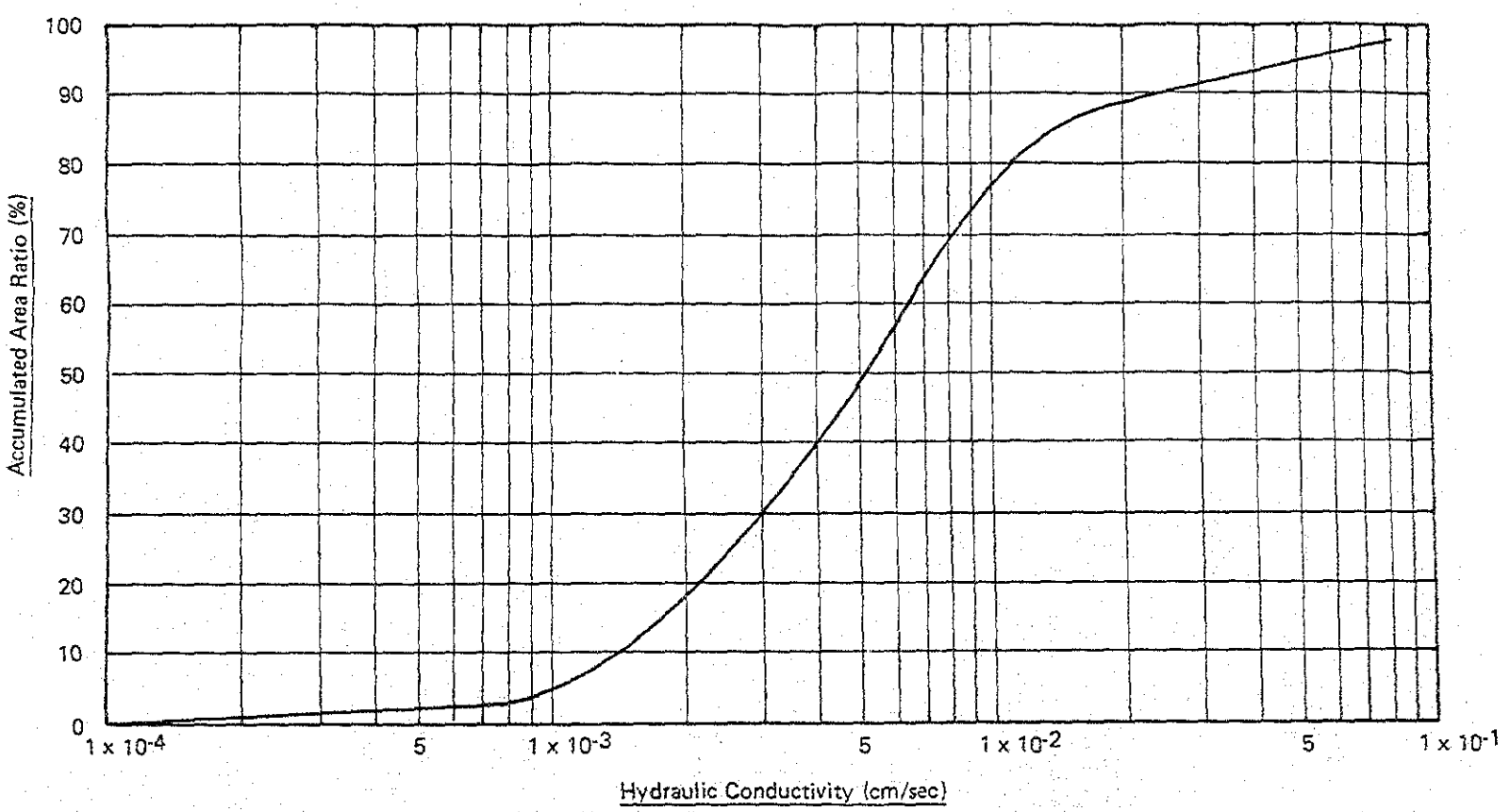
Table B.2.2 Paddy Land under Poor Drainage

(Unit: ha)

Drainage Block	Total Drainage Area	Total Paddy Land	Paddy Land under Poor Drainage			
			1R/2Ud	2Rd/3Ud	3Rd/3Ua	Total
Haraz Left Bank	39,870	25,100	15,650	6,210	0	21,860
High Land	11,930	6,710	3,470	0	0	3,470
Middle Land	13,340	9,080	8,270	810	0	9,080
Low Land	14,600	9,310	3,910	5,400	0	9,310
Kari Rud D.A.	64,490	43,020	12,970	16,770	3,530	33,270
High Land	16,890	12,350	2,600	0	0	2,600
Middle Land	26,510	18,620	9,480	5,930	3,210	18,620
Low Land	21,090	12,050	890	10,840	320	12,050
Haraz Right Bank	19,220	13,640	6,680	3,800	0	10,480
High Land	6,580	4,560	1,400	0	0	1,400
Middle Land	6,550	5,230	4,390	840	0	5,230
Low Land	6,090	3,850	890	2,960	0	3,850
Kari Rud	45,270	29,380	6,290	12,970	3,530	22,790
High Land	10,310	7,790	1,200	0	0	1,200
Middle Land	19,960	13,390	5,090	5,090	3,210	13,390
Low Land	15,000	8,200	0	7,880	320	8,200
Total	104,360	68,120	28,620	22,980	3,530	51,130
High Land	28,820	19,060	6,070	0	0	6,070
Middle Land	39,850	27,700	17,750	6,740	3,210	27,700
Low Land	35,690	21,360	4,800	16,240	320	21,360

Note: This table is drived from Exhibit 1.2.5, Table 1.2.5 in the Main Report.

Figure B. 2. 2. Area Ratio by Hydraulic Conductivity in the Middle and Low Lands



Note: This figure is derived from Table B. 2. 1.

APPENDIX B. 3.

ON-FARM FACILITIES

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Table B.3.1 Required Soil Bearing Capacity (by Cone-Penetrometer)

Kinds of Machinery	Name of machine or work	Soil bearing	Remarks
Farm Machinery	1. Plowing & Harvesting	mean 4 kg/cm^2 more than 2 kg/cm^2	(mean): Average of four-point measurement at 5 cm intervals for the depth from 0 cm to 15 cm below the field surface
	2. Puddling	more than 2 kg/cm^2	Average of four-point measurement at 5 cm intervals for the depth from immediately below the plowing layer (from "Design Criteria" - Ministry of Agriculture, Forestry & Fisheries, Japan)
Construction Machinery	Ultra-marshy-type Bulldozer	more than 1 - 4 kg/cm^2	At least three of the measurements, which are obtained from ten-point measurement at 5 cm intervals from the machine's running surface, should be within the value shown in the table and it is to be desired that the measurement at 10 cm depth from the ground surface is more than 1.5 kg/cm^2.
	Marshy-type Bulldozer	more than 2 - 6 kg/cm^2	
	Standard-type Bulldozer or Marshy-type Scrapedozer	more than 5 kg/cm^2	
	Crawler-type Tractor and Scraper	more than 8 kg/cm^2	
	Dump Truck or Motor-Scraper	more than 12 kg/cm^2	

(from "Construction Work - for agricultural reclamation - by Y. Maeda -")

Table B.3.2 Soil Bearing Test

Sample Area	Farm Machinery: Plowing & Harvesting (1)		Farm Machinery: Puddling (2)		Construction Machinery: Marshy-type & Standard-type Bulldozer (3)		Construction Machinery: Crawler-type Tractor (4)		Thickness of Plowing Layer	
Upland										
No.1	6.8 kg/cm²	O	7.77 kg/cm²	O	Construction surface - 20 cm under the ground surface	O	Construction surface - 20 cm under the ground surface	O	20 cm	O
No.2	4.2	O	5.8	O	- ditto -	O	- ditto -	O	20	O
Middle Land										
No.1	1.05	X	2.0	O	Construction surface - 25 cm •0 place for more than 5 kg/cm² W Δ •7 places for more than 2 kg/cm² D X 10 cm under the ground surface 0.4 kg/cm²		Construction surface - 25 cm	X	25	O
No.2 (inundated)	1.70	X	2.47	O	Construction surface - 15 cm W Δ •9 places for more than 2 kg/cm² 10 cm under the ground surface 1.3 kg/cm² D •0 place for more than 5 kg/cm²		(Same as left)	X	15	X
No.3	2.17	X	4.23	O	Construction surface - 15 cm	O	(Same as left)	O	15	O
No.4	2.90	X	4.17	O	Construction surface - 15 cm •5 places for more than 5 kg/cm² 10 cm under the ground surface 1.6 kg/cm²	O	(Same as left) 1 place for more than 8 kg/cm²	X	15	X
Low Land										
No.1	3.56	X	4.00	O	Construction surface - 15 cm •5 places for more than 5 kg/cm² 10 cm under the ground surface 4 kg/cm²	O	(Same as left) 0 place for more than 8 kg/cm²	X	15	X
No.2 (inundated)	2.53	X	2.65	O	Construction surface 15 cm	O	(Same as left) 0 place for more than 8 kg/cm²	X	15	X

Notes: O .... suitable, X.... unsuitable, Δ.... suitable but no so good, lacking desirable conditions
Suffix "W" means in inundated condition and "D" means in non-inundated condition.

Source: Soil Bearing Test by JICA Team in 1985.

Table B.3.3 Outline of Farm Economic Survey - 1985 (re, Land Consolidation) & On-Farm Survey in the Sample Area

Items	Area: High Land	Middle Land	Low Land	Notes
1. Nos. of Farmers	8	11	11	Upper: Farm Economic Survey
	13	12	29	Lower: On-Farm Survey
Total	21	23	40	
2. Acreage of Paddy Fields (ha)	25.8	44.1	24.6	
	28.2	25.1	94.0	
Total	54.0	69.2	118.6	
3. Average Acreage per a Farmer (Mean)	3.23	4.01	2.20	
	2.17	2.00	3.24	
Total	2.57	3.01	3.00	
4. - ditto - (median)	2.65	3.00	2.00	
	2.00	2.00	2.00	
5. Size of a Lot (m^2)				
(max.)	7,000	9,000	9,000	Babol No.9 neglected
	7,000	4,000	7,000	
(min.)	200	200	100	
(mean)	1,700	1,420	1,770	
	1,900	1,600	2,100	
Total	1,800	1,500	2,000	
6. Farmers' Intensions to Improvement	No. of Farmers	No. of Farmers	No. of Farmers	
(Irrigation system)	2 (25%)	4 (36%)	8 (72%)	
	-	8 (67%)	28 (97%)	
Total	2 (9%)	12 (52%)	36 (90%)	
(Drainage system)	1 (13%)	3 (27%)	9 (82%)	
	-	11 (92%)	20 (69%)	
Total	1 (5%)	14 (61%)	29 (73%)	
(Block Reformation)	8(100%)	10 (90%)	11(100%)	
	8 (61%)	12(100%)	28 (96%)	
Total	16 (76%)	22 (96%)	39 (98%)	
(Roads)	4 (50%)	5 (45%)	10 (91%)	
	7 (54%)	10 (83%)	1 (3%)	
Total	11 (52%)	15 (65%)	11 (28%)	
(Mechanization)	8(100%)	11(100%)	11(100%)	
	10 (77%)	1 (8%)	-	
Total	18 (86%)	12 (52%)	11 (28%)	
7. Ratio of Possession of Water Right	102%	89%	100%	the Sample Area Only

The above table is summarization from "Farm Economic Survey - 1985 - (30 Farmers" and "On-Farm Survey in the three Sample Areas (Ejibar Kola, Barik Mahaleh, Suteh)".

From the result the following matters can be infered.

1. Size of a lot
   - There is a tendency for the size of a lot to be larger from High Land to Low Land in order.
   - The size in High Land is larger than that in Middle Land in On-Farm Survey.
2. Farmers' expectation of improvement for terminal facilities
   - The farmers want the implementation of block reformation/land leveling first.
   - Improvement of irrigation and drainage is expected mainly in Middle and Low Land.
   - Improvement of roads is expected mainly in Middle Land and High Land.

Table B.3.4 Expenditure for Agricultural Land Improvement by Babol Agriculture Rural Service Center (Within the Project Area)

Kinds of Works	Amounts 1983 (1000 Rls)	Amounts 1984 (1000 Rls)	Subsidiary Ratio
1. Land Leveling	13,762	14,207	50 - 70 %
2. Wells	16,864	-	100% (Digging only)
3. Dredging Ponds	14,425	-	70%
4. Diversion Weirs & Retaining Wall for Canals	9,483	-	100 - 70 %
5. Farm Roads	45,274	6,369	70%
6. Drainage Canals	-	13,111	100% (for public properties)
7. Irrigation Canals	7,412	12,286	70%
Total	107,220	45,973	

Table B.3.5 Present Condition in Sample Areas

Items	Sample Area		
	Ejibar Kola	Barik Mahaleh	Sutch
1. Location	High Land	Middle Land	Low Land
2. Area	50.0 ha	45.5 ha	126.3 ha
3. Irrigation System			
·Source of irrigation water	tertiary canal	tertiary canal	tertiary canal
·Intake method	intake without diversion weir & with weir	through small size pipes led from irrigation ditches	intake without diversion weir
·No. of canals	4	20 (No. of pipes)	4
·Total length of canal	2,300 m	-	4,020 m
4. Drainage System			
·Effluent stream	exist	Nil	exist
·No. of canals	-	1	-
·Total length of canal	-		-
·Drainage condition	good	poor	poor
5. Farm Roads			
·No. of farm roads (inside)	1	Nil	Nil
·No. of farm roads (along the boundary)	·east side ·part of west side	·west side ·part of east side ·part of north side	·south side

Note: · Driving channels along boundaries are excluded from the total length of irrigation canals in the above table.

· All farm roads are too narrow and too little in their bearing capacity for large agriculture machinery to pass through and only small machinery such as hand-tillers can pass.

▲ Farmer's intentions are described in Appendix Table B.3.3.

Table B.3.6 Layout of the Terminal Drainage Canal

1. Design Rainfall

- Non-irrigation period 1/10 probable daily rainfall
  130 mm/day

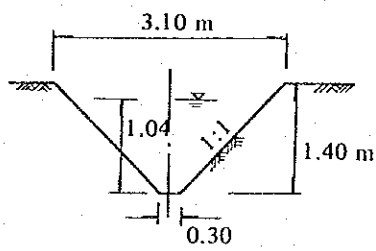
2. Design Drainage Discharge (per 1 KM^2)

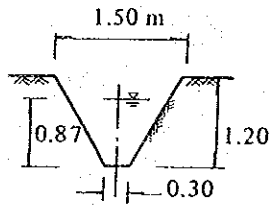
- One-day drainage of daily rainfall calculated by Rational Method
  $Q = 1.20\ m^3/sec./KM^2$
  $(f = 0.8)$

3. Control Area

- Drain ditch 24 ha
- Lateral drain canal 70 ha

4. Section[1/]





V = 0.60 m/sec.
A = 1.39 m^2
Q = 0.84 m^3/s

Lateral drain canal

V = 0.46 m/s
A = 0.64 m^2
Q = 0.29 m^3/s

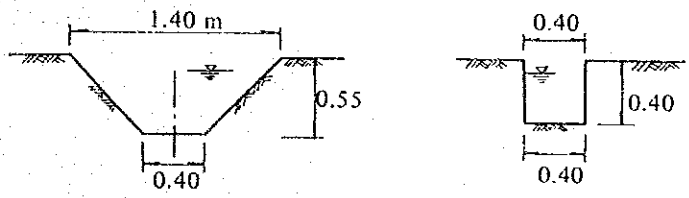
Drain ditch

Note: • By Manning's formula
n = 0.03 I = 1/1000

• The depth of canal is determined by considering underdrainage.

Table B.3.7 Layout of the Terminal Irrigation Canal

1. Unit duty of water[1/]
   - Water for puddling 125 mm/day
   - Evapo-transpiration & percolation during puddling 10.3 mm/day
   - Unit duty of water per hectare 0.0029 $m^3/s/ha$
2. Control Area
   - Irrigation ditch 24 ha
   - Lateral irrigation canal 70 ha
3. Capacity[2/]
   - Irrigation ditch 0.07 m^3/s
   - Lateral irrigation canal 0.20 m^3/s
4. Section[3/]



Lateral irrig. canal	Irrig. ditch
A = 0.49 m^2	A = 0.16 m^2
V = 0.42 m/s	V = 0.55 m/s
Q = 0.20 m^3/s	Q = 0.09 m^3/s
Earth canal	Concrete flume

Note: 1/ ... • 1.25 ha/day - 1 set
• Days for puddling 16 days

2/ ... Control Area x Unit duty of per hectare($0.029 m^2/s/ha$)

3/ ... By Manning's formula
n = 0.03 (for Lat. Canal)
n = 0.015 (for Irri. ditch)
I = 1/1000

Table B.3.8 Comparison of three cases of Land Consolidation Design in Sample Areas

Items	Ejibar Kola				Barik Mahaleh				Suteh			
	Present	A	B	C	Present	A	B	C	Present	A	B	C
I. Natural Condition												
1) Place	---- High Land ----				---- Middle Land ----				---- Low Land ----			
2) Average topographic gradient	---- 1/100 ----				---- 1/250 ----				---- 1/1300 ----			
II. Area												
1) Field (ha)	48.96	48.18	48.34	48.25	44.44	42.92	43.26	43.47	125.41	121.81	122.39	121.39
2) Road (ha)	0.61	1.19	1.19	1.28	0.58	1.69	1.69	1.02	0.29	1.85	1.85	2.09
3) Irrigation canal (ha)	0.43	0.52	0.36	0.47	-	0.45	0.11	0.52	0.60	1.21	0.63	2.01
4) Drainage canal (ha)	-	0.11	0.11	-	0.48	0.44	0.44	0.49	-	1.43	1.43	0.81
Total (ha)	50.0	50.0	50.0	50.0	45.5	45.5	45.5	45.5	126.3	126.3	126.3	126.3
5) Ratio of every facilities lots (ha)	2.1	3.6	3.1	3.5		5.7	4.0	4.5	0.7	3.6	3.1	3.9
III. Block												
1) No. of lots	313	79	79	313	269	99	99	269	570	206	206	570
2) Average acreage per a lot (ha)	0.16	0.61	0.61	0.15	0.17	0.43	0.44	0.16	0.22	0.59	0.59	0.21
3) No. of lots faced on irrigation canal directly	74	76	76	66	16	99	12	48	102	195	36	462
4) Ratio of 3) to total lots (%)	24	96	96	21	6	100	12	18	18	95	17	81
5) No. of lots faced on drainage canal directly	-	4	4	-	79	97	97	132	74	190	190	448
6) Ratio of 5) to total lots (%)	-	5	5	-	29	98	98	49	13	92	92	79
7) No. of lots faced on farm road directly	90	76	76	90	42	99	89	44	30	198	198	416
8) Ratio of 7) to total lots (%)	29	96	96	29	16	100	90	16	15	96	96	73
IV. Facilities												
1) Total length of Roads (m)	2,430	2,700	2,700	2,910	2,310	3,830	3,830	2,310	950	4,200	4,200	4,760
2) Road density (m/ha)	48.6	54.0	54.0	58.2	50.8	84.2	84.2	50.8	7.5	33.2	33.2	37.7
3) Toal length of irrigation canals (m)	2,300	2,180	1,160	1,910	-	2,260	540	2,620	4,020	5,080	2,190	6,850
4) Irrigation canal density (m/ha)	46.0	43.6	23.2	38.2	-	49.7	11.9	57.6	31.9	40.2	17.3	54.2
5) Total length of drainage canals (m)	-	480	480	-	1,900	1,930	1,930	2,130	1,630	5,560	5,560	3,000
6) Drainage canal density (m/ha)	-	9.6	9.6	-	41.8	42.4	42.4	46.8	12.9	44.0	44.0	23.8

Table B.3.9 Cost of Consolidation Work for Each Case

Area & Kinds of Works	Unit Price Rls/m	Case-A Quantity m	Case-A Amount 1000 Rls	Case-B Quantity m	Case-B Amount 1000 Rls	Case-C Quantity m	Case-C Amount 1000 Rls
Ejibar Kola							
1) Roads	1,027	2,700	2,773	2,700	2,773	2,910	2,998
2) Irrigation Canal							
(A)	525	860	452	860	452	860	452
(B)	741	1,320	978	300	222	1,050	778
3) Drainage Canal	550	480	264	480	264	-	-
4) Block Reformation	195,000 (Rls/ha)	50.0	9,750	50.0	9,750	-	-
5) Others			893		742		846
Total			15,110		14,203		5,074
Cost per hectare			302		284		101
Barik Mahaleh							
1) Roads	1,027	3,830	3,933	3,830	3,933	2,310	2,372
2) Irrigation Canal							
(A)	525	70	37	-	-	800	420
(B)	741	2,190	1,623	540	400	1,820	1,349
3) Drainage Canal	550	1,930	1,062	1,930	1,062	2,130	1,172
4) Block Reformation	160,000 (Rls/ha)	45.5	7,280	45.5	7,280	-	-
5) Others			1,331		1,079		1,063
Total			15,266		13,754		6,376
Cost per hectare			335		302		140
Sutch							
1) Roads	1,027	4,200	4,313	4,200	4,313	4,760	4,889
2) Irrigation Canal							
(A)	525	1,950	1,024	1,950	1,024	4,400	2,310
(B)	741	3,130	2,319	240	178	2,450	1,815
3) Drainage Canal							
(A)	741	1,670	1,237	1,670	1,237	1,200	889
(B)	550	3,890	2,140	3,890	2,140	1,800	990
4) Block Reformation	160,000 (Rls/ha)	126.3	20,208	126.3	20,208	-	-
5) Others			2,207		1,778		2,178
Total			33,448		30,878		13,071
Cost per hectare			265		244		103

Figure B.3.1 Distribution of Size of a Lot on every Farmer (Farm Economic Survey)

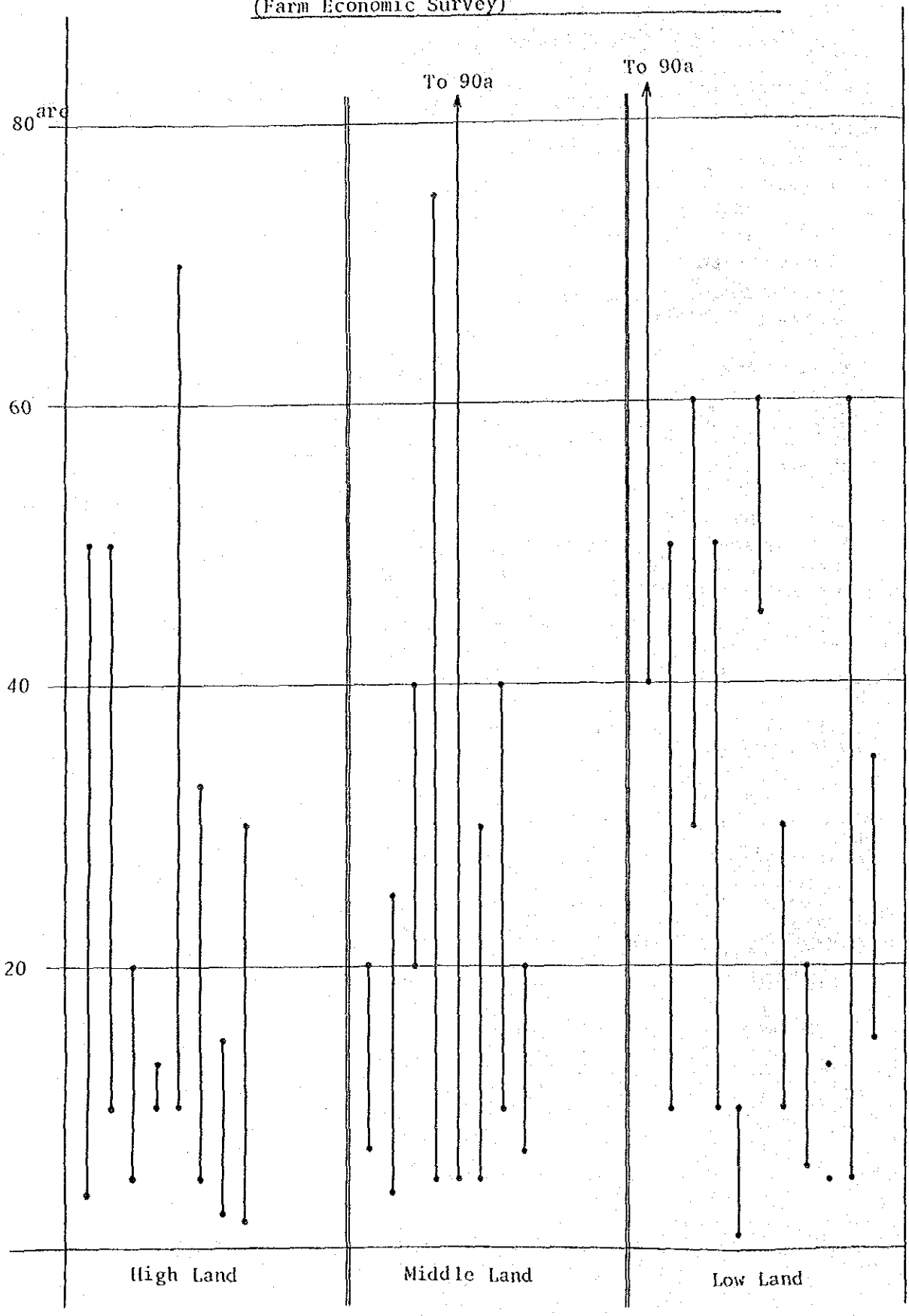
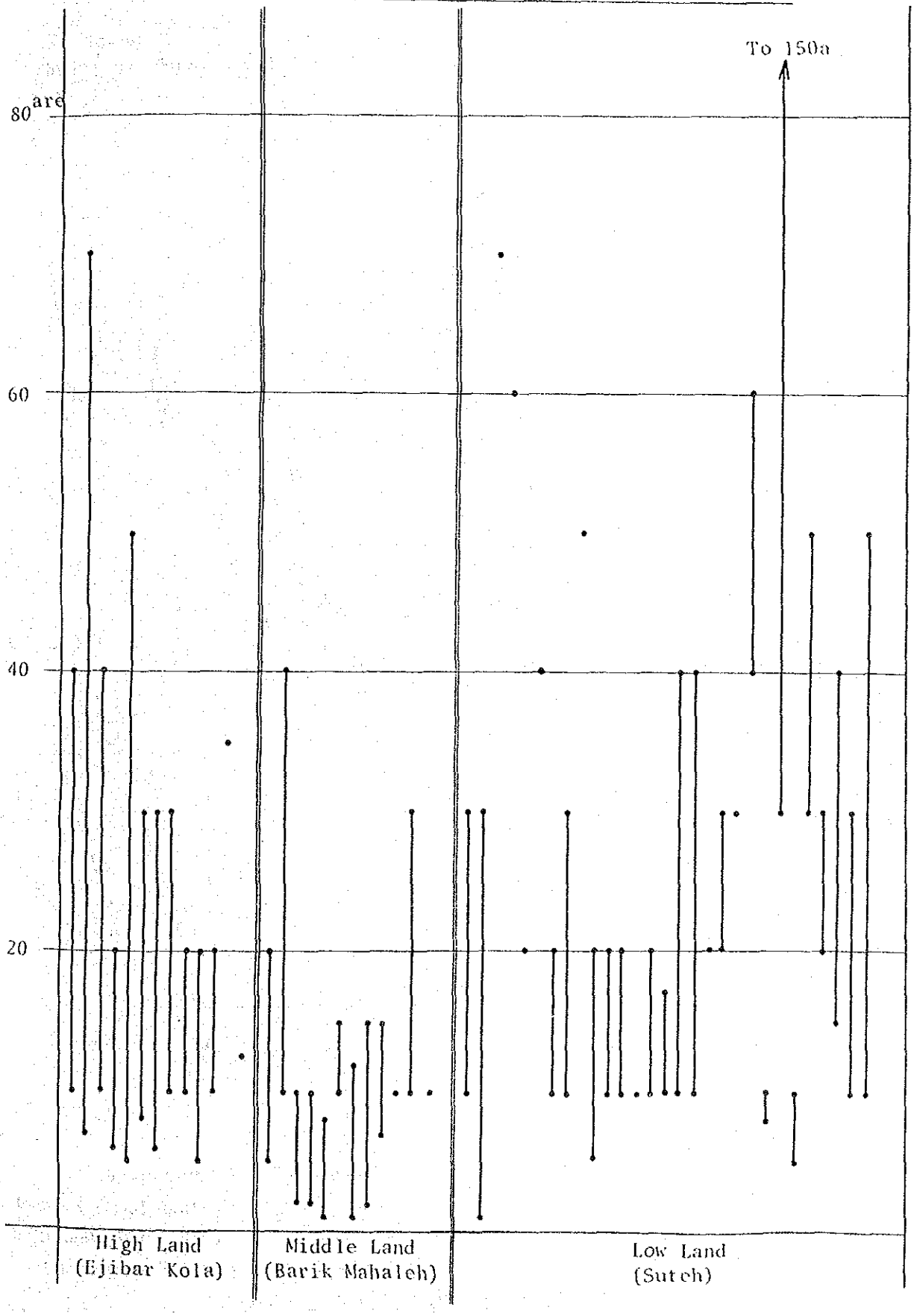


Figure B.3.2 Distribution of Size of a Lot on every Farmer (On-Farm Survey)



Ejibar Kola (Present Condition)

----- Contour line 1.0m Interval
(Elevation is shown in relative height)

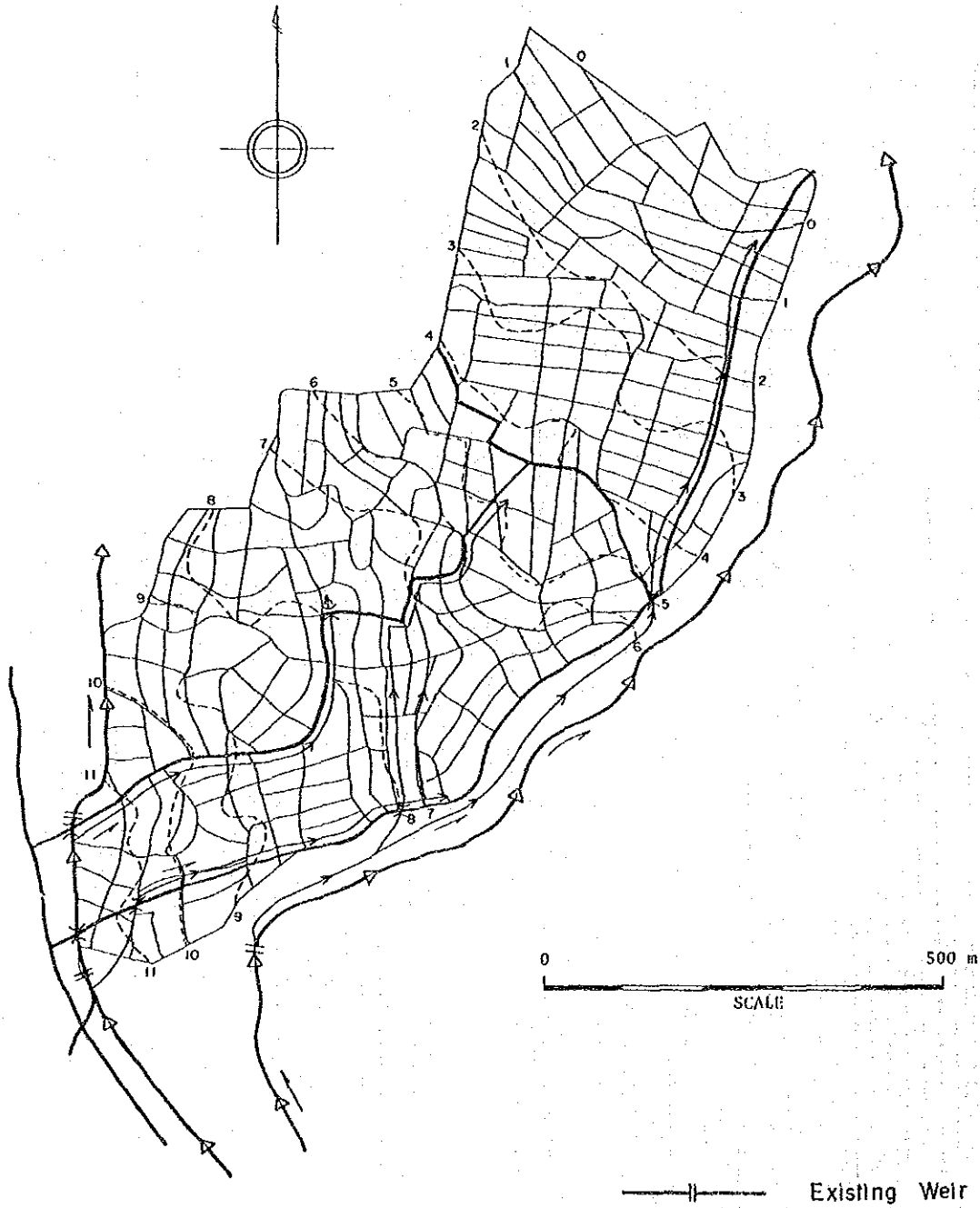


Figure B.3.3. Existing On-Farm Facilities in Sample Areas (1)

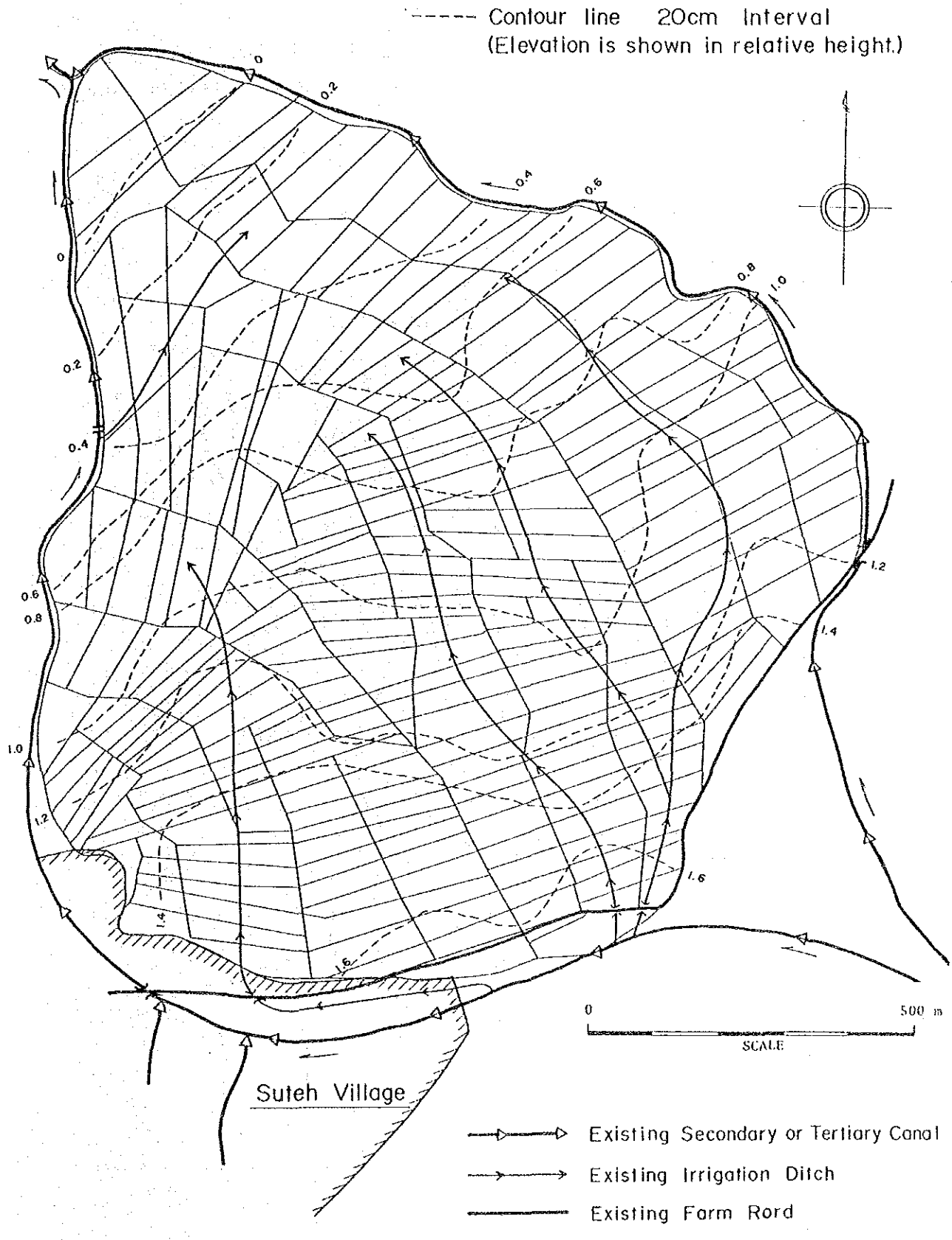


Figure B.3.3. Existing On-Farm Facilities in Sample Areas (2)

Barikmahaleh (Present Condition)

----- Contour line 0.5m Interval
(Elevation is shown in relative height)

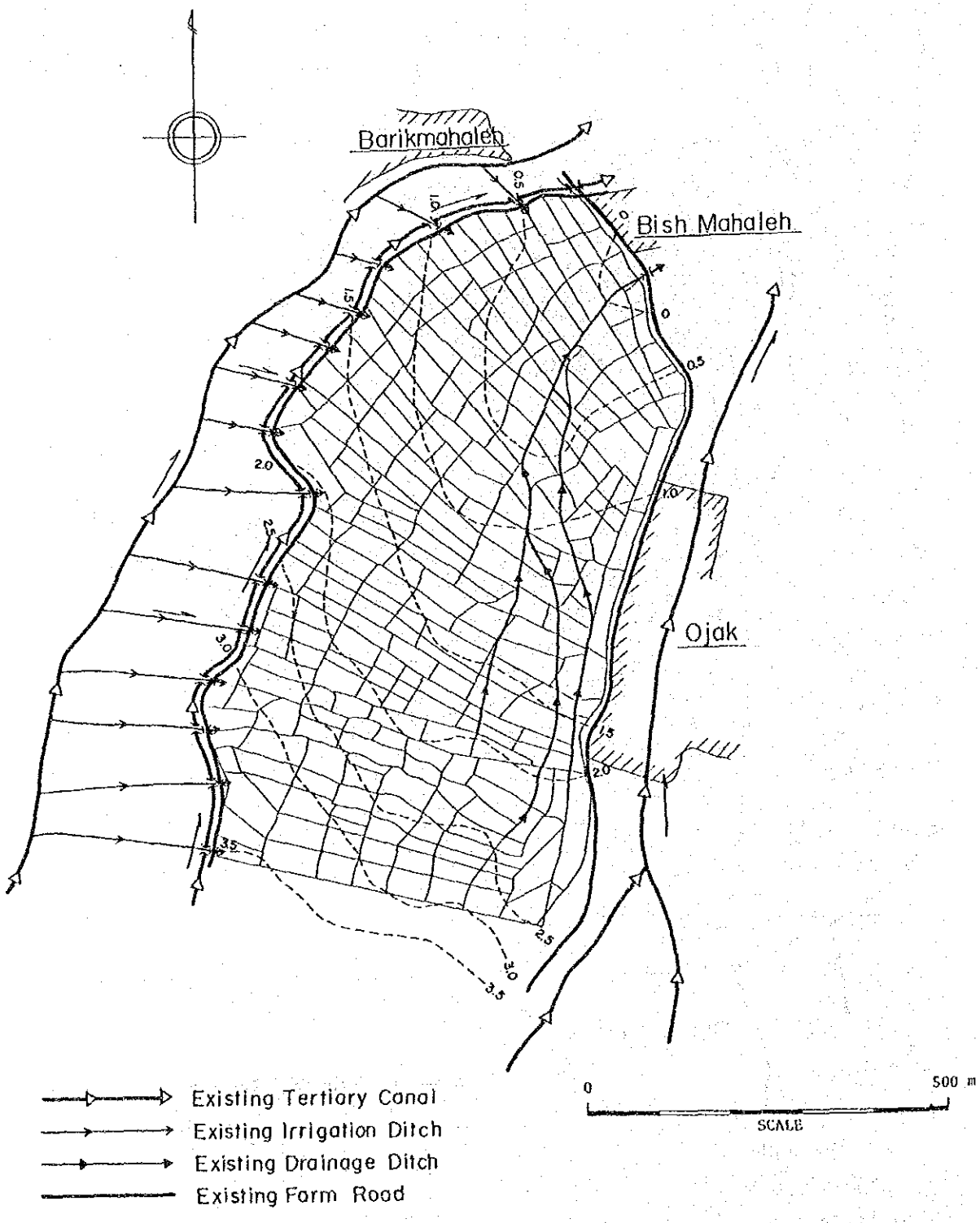


Figure B.3.3. Existing On-Farm Facilities in Sample Areas (3)

Ejibar Kola Case – A

----- Contour line 1.0m Interval
(Elevation is shown in relative height)

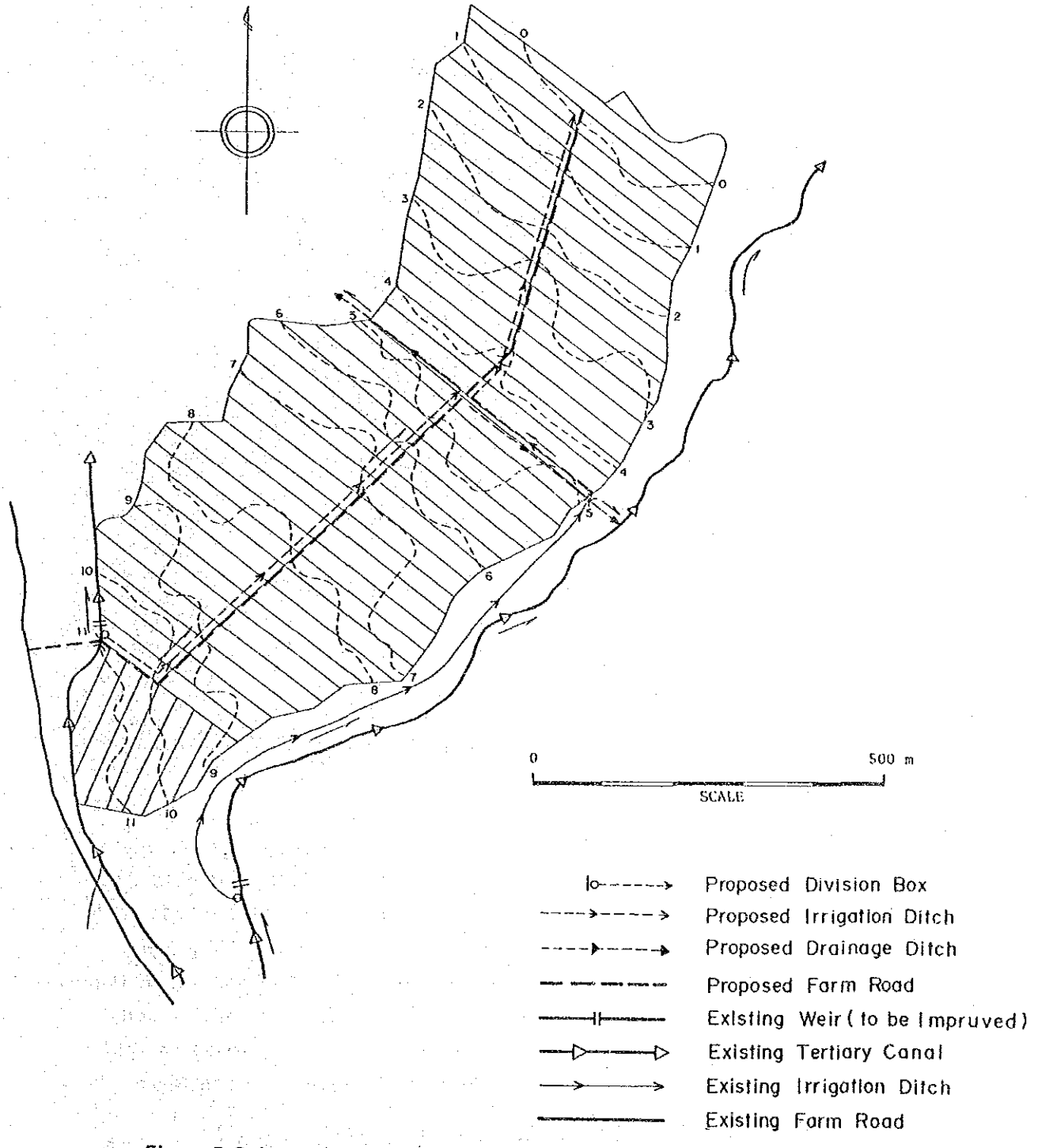


Figure B.3.4. Layout of the Land Consolidation in Three Cases (1)

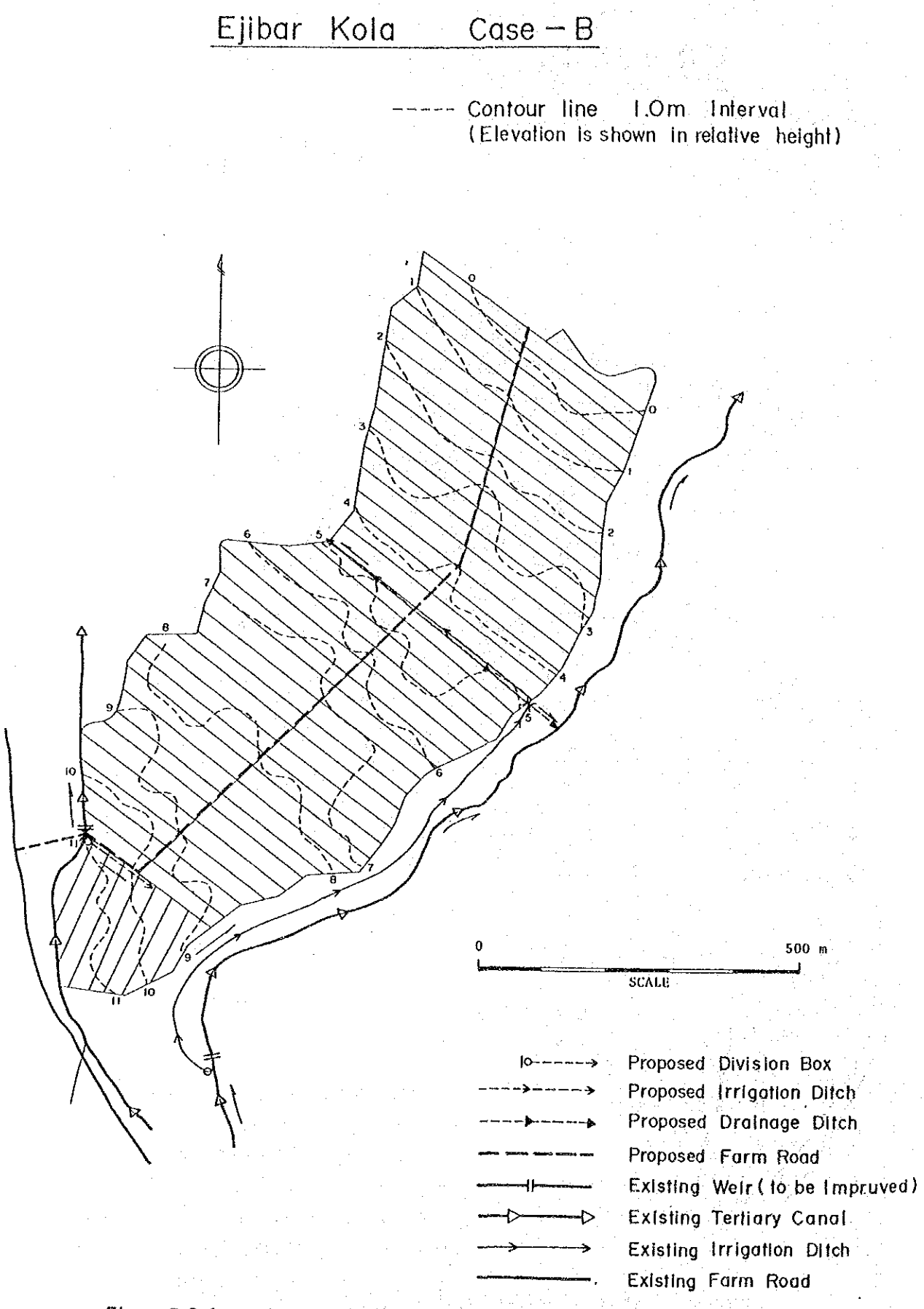


Figure B.3.4. Layout of the Land Consolidation in Three Cases (2)

Ejibar Kola Case – C

----- Contour line 1.0m Interval
(Elevation is shown in relative height)

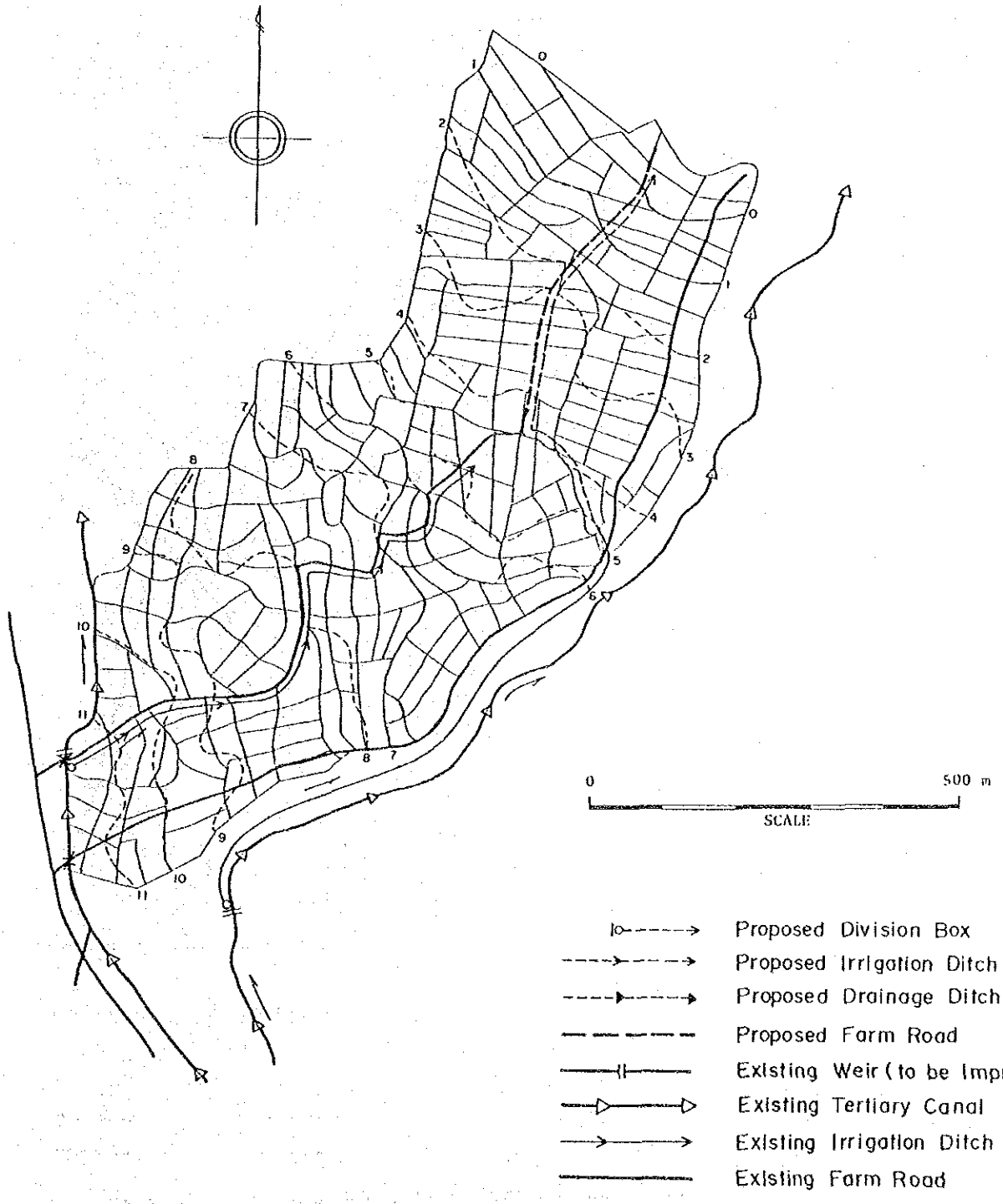


Figure B.3.4. Layout of the Land Consolidation in Three Cases (3)

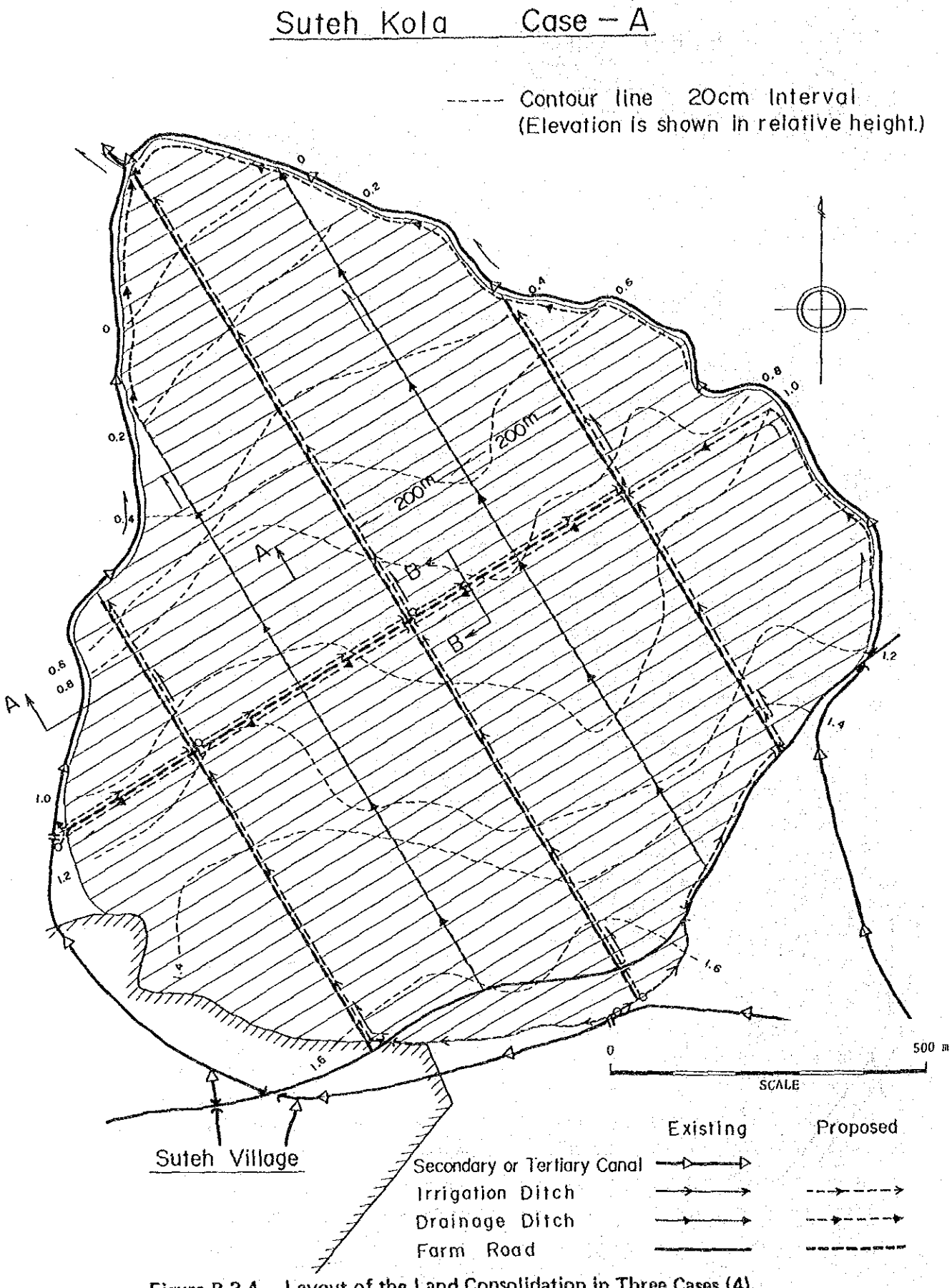


Figure B.3.4. Layout of the Land Consolidation in Three Cases (4)

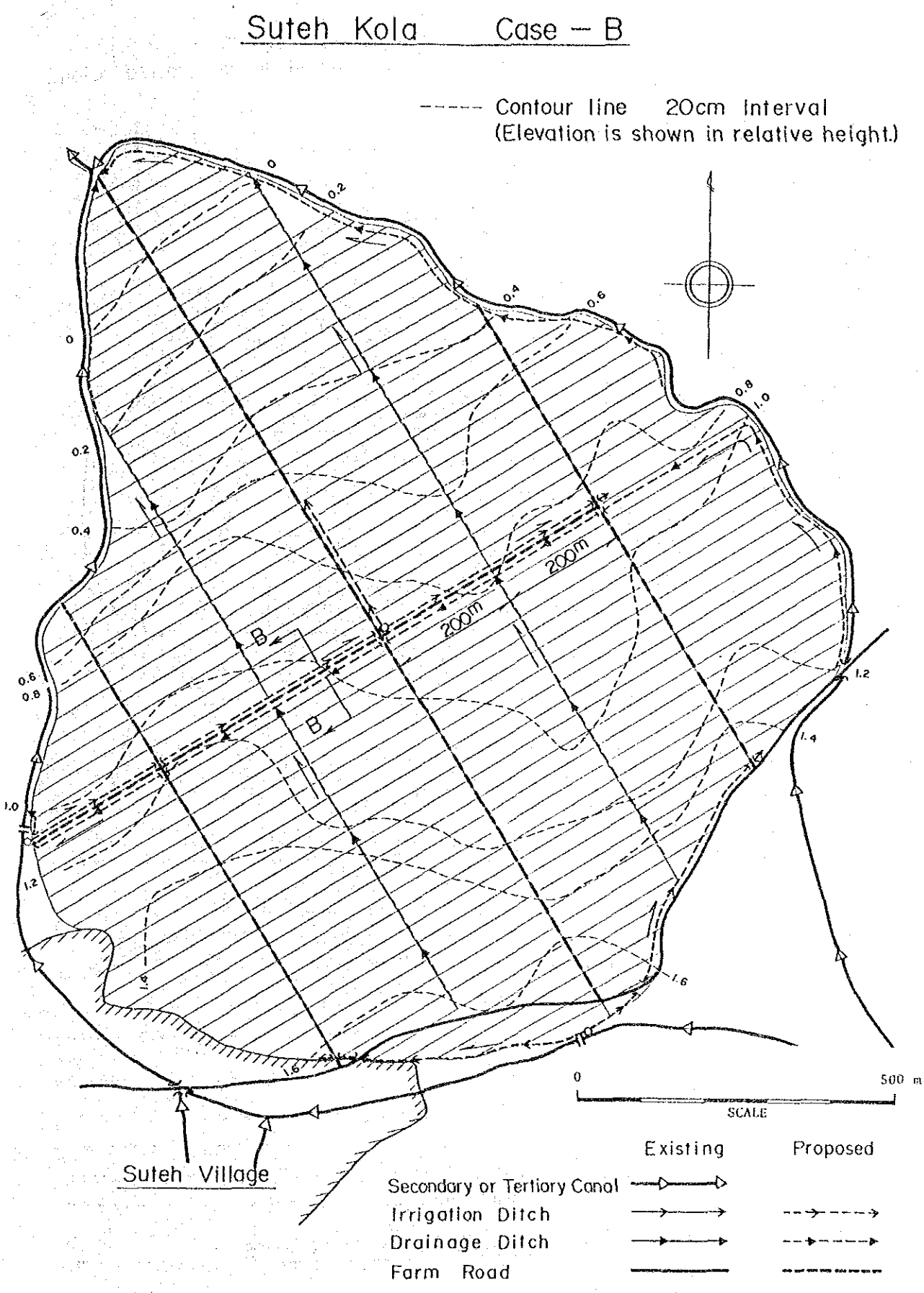


Figure B.3.4. Layout of the Land Consolidation in Three Cases (5)

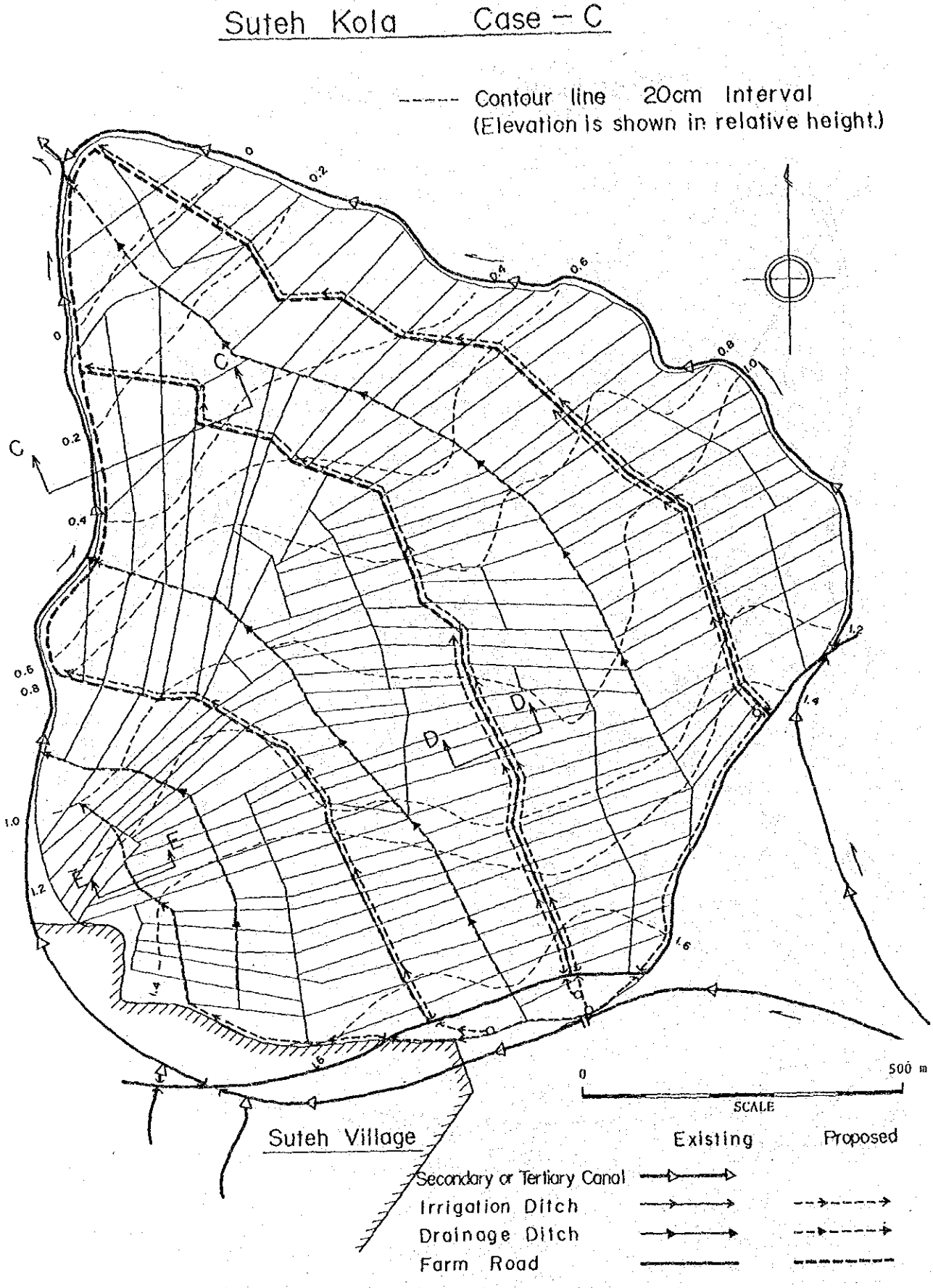


Figure B.3.4. Layout of the Land Consolidation in Three Cases (6)

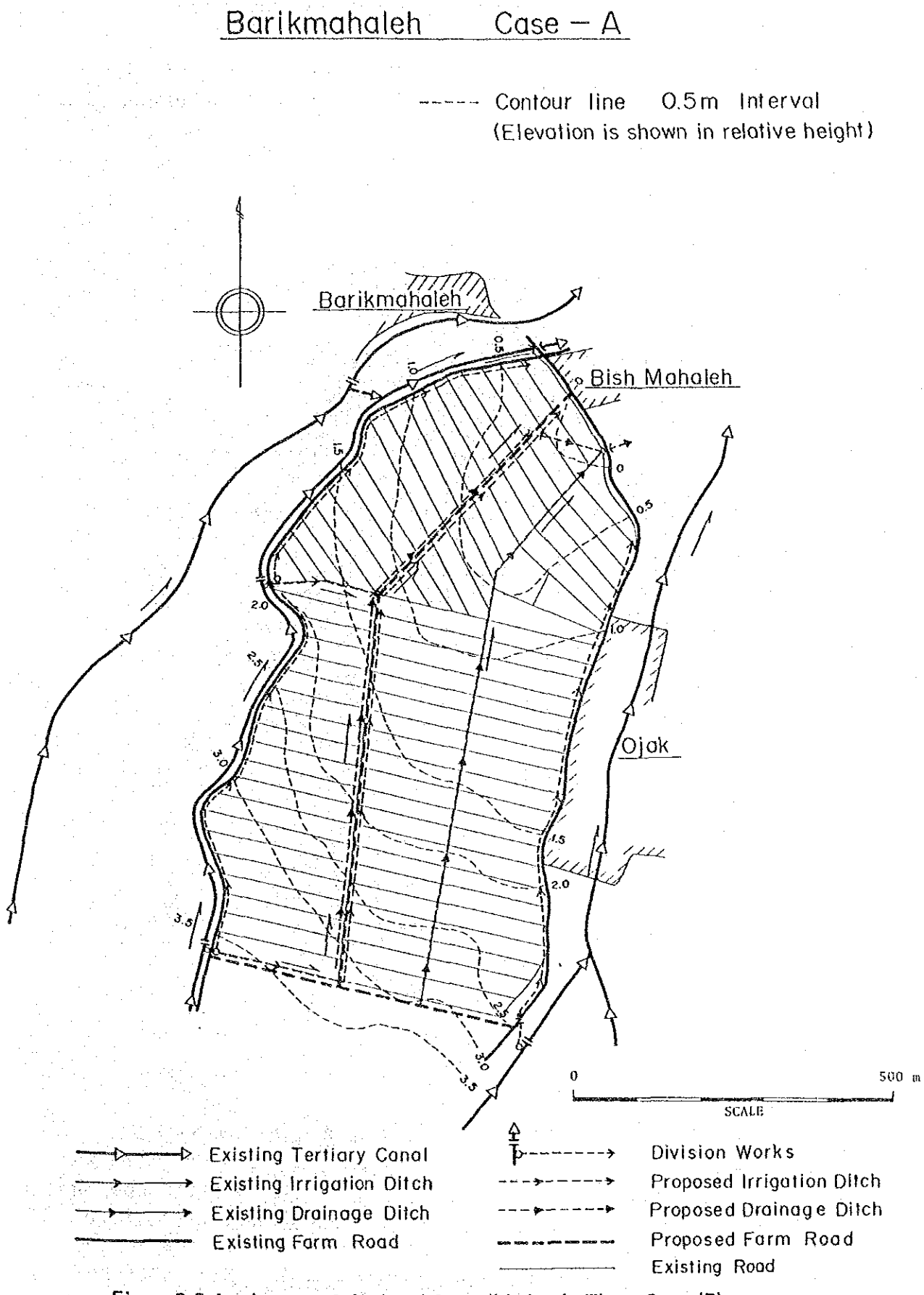


Figure B.3.4. Layout of the Land Consolidation in Three Cases (7)

Barikmahaleh Case – B

----- Contour line 0.5m Interval
(Elevation is shown in relative height.)

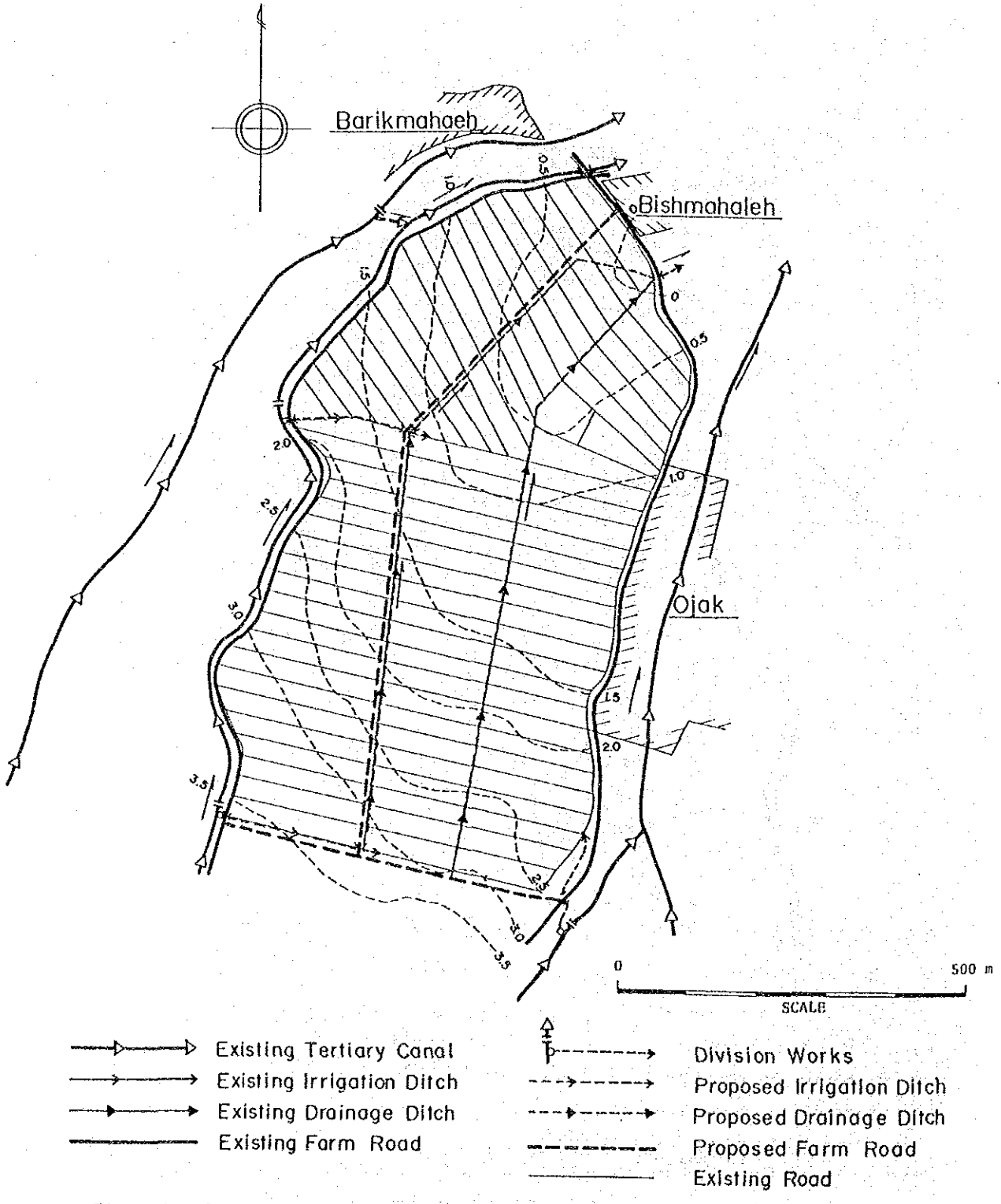
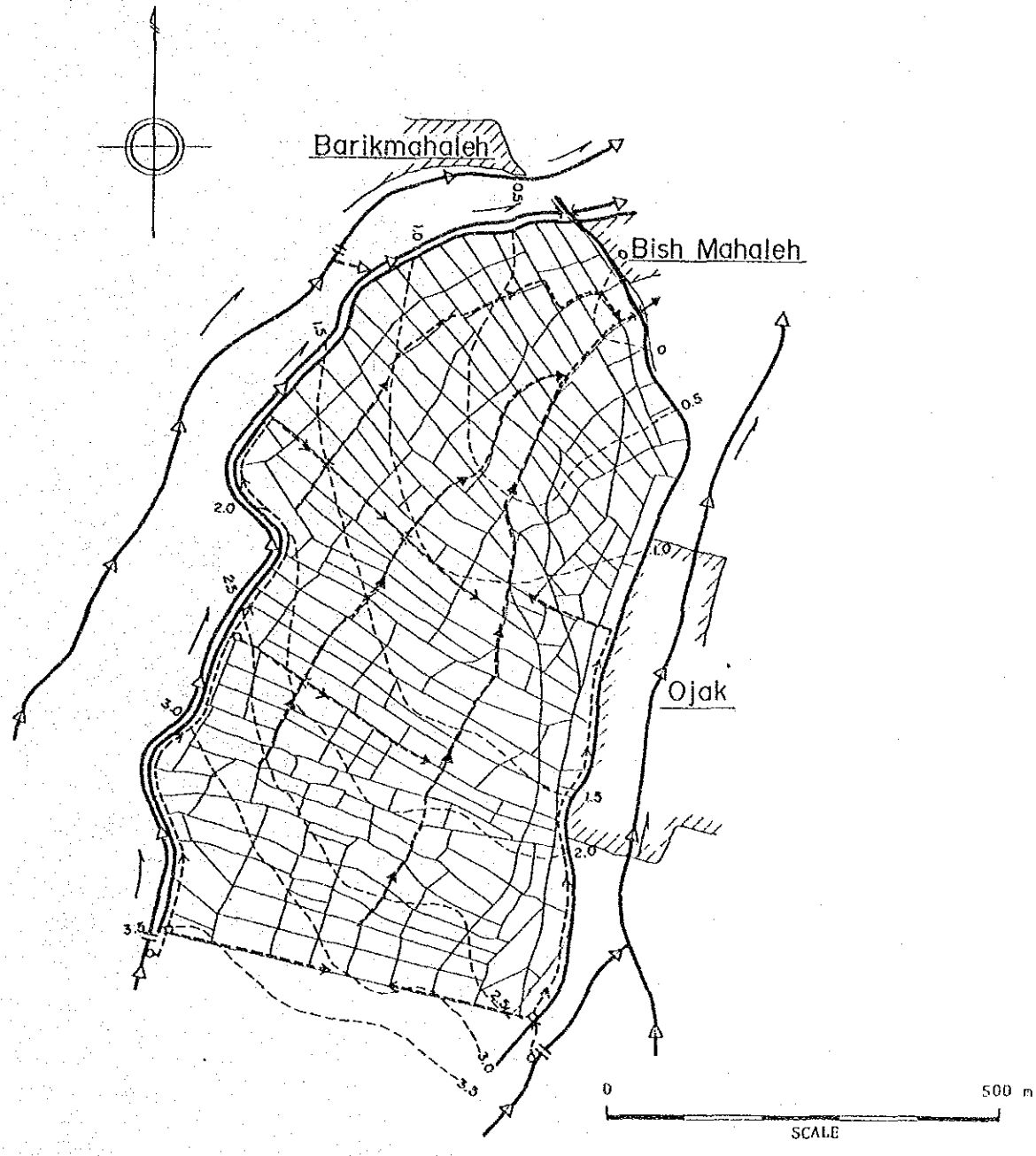


Figure B.3.4. Layout of the Land Consolidation in Three Cases (8)

Barikmahaleh Case – C

----- Contour line 0.5m Interval
(Elevation is shown in relative height)



Existing Tertiary Canal
Existing Irrigation Ditch
Existing Drainage Ditch
Existing Farm Road
Division Works
Proposed Irrigation Ditch
Proposed Drainage Ditch
Proposed Farm Road
Existing Road

Figure B.3.4. Layout of the Land Consolidation in Three Cases (9)