4.3. Agricultural Development

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4.3.1. Agricultural Project

The acreage of agricultural lands to be newly developed depends upon the water resources available for irrigation. In this Project, however, the water requirements necessary for the existing dates plantations and desirable vegetable cropping pattern were estimated first and then a plan of development acreage was proposed as vegetable lands and fruits plantations. The cropping pattern of vegetables determined according to priority given by their commercial values, while the fruits cropping pattern according to the recommendation by the UAE authorities concerned on its preference. Furthermore, the latest technology like land improvement and modern farming techniques introduced for vegetable cropping and desalination plant, if necessary for emergency case in the drought season.

TABLE A.4.3-1. AGRICULTURAL PRODUCTION COST IN DIBBA, JULY 1980

Crops	Costs DH/ton	Fruit	Costs DH/ton
Tomato	1,379	Citrus	3,455
Cabbage	1,929	Mango	2,571
Eggplant	1,493	Dates	5,316
Cucumber	3,255		
Sweet melon	2,080		
Pepper	3,283		
Watermelon	1,148		

TABLE A.4.3-2. AGRICULTURAL PRODUCTIONS (1)
(AGRICULTURAL STATISTIC DATA)

Crops	1977 t/Donum	1978 t/Donum	1979 t/Donum	Average t/Donum
Date	0.7	0.5	-	0.6
Lemon	1.2	0.7	-	0.95
Orange	1.0	0.8	-	0.9
Guave	4.0	1.0	-	2.5
Mango	1.5	0.3	-	0.9
Tomato	2.6	3.3	3.5	3.1
Eggplant	4.3	3.4	4.0	3.9
Okra	0.9	1.0	1.5	1.1
Beans	0.5	0.9	-	0.7
Cowpeas	0.9	1.4	-	1.2
Chard	1.7	1.7	-	1.7
Squash	1.6	1.2	2.0	1.6
Cucumber	2.4	2.4	1.5	2.1
Cabbage	2.9	1.9	2.5	2.4
Cauliflower	2.7	2.4	2.0	2.4
Potatoes	2.1	1.8	-	2.0
Onion	2.0	1.6	3.0	2.2
Watermelon	2.8	3.5	2.5	2.9
Sweet melon	2.6	1.8	2.0	2.1
Lettuce	4.9	0.8	-	2.9
Carrote	3.8	1.7	-	2.8
Pepper	2.7	1.5	1.5	1.9
Sweetpotato	-	-	3.5	3.5

Source: Ministry of Agriculture and Fisheries

TABLE A.4.3-3. AGRICULTURAL PRODUCTIONS (2)
(AL AIN EXPERIMENTAL STATION)

Crops	Organic Fertilizer kg/donum	Chemical Fertilizer kg/donum	Seed g/donum	Production ton/donum
Tomato	500	100	50	8-10
Eggplant	500	100	80	5- 6
Pepper	500	80-100	80	2
Cabbage	500	100	200	5- 6
Cauliflower	500	100	200	2- 3
Potapoes	500	100	280,000	3
Onion	500	100	100	5
Watermelon	500	100	500	3- 4
Melon	500	100	300	2- 3
Cucumber	500	100	500	2- 3
Beans	500	80-100	4,000-5,000	1- 1.5
Lettuce	500	80-100	100	2
Okra	500	80-100	2,000	1
Squash	500	80-100	750	2- 2.5

TABLE A.4.3-4. YIELD BY CROP AGE

Crops / Year after planted		5	6	7	8	9	10	11	12
Existing Farm									
Dates	kg/tree	0	20	25	25	30	30	30	35
	Kg/ha	0	5,556	6,945	6,945	8,334	8,334	8,334	9,723
	DH/ha	0	8,350	10,438	10,438	12,526	12,526	12,526	14,614
Citrus	kg/tree	25	25	25	30	30	30	35	35
	kg/ha	5,102	5,102	5,102	6,123	6,123	6,123	7,143	7,143
	DH/ha	17,627	17,627	17,627	21,155	21,155	21,155	24,679	24,679
Mango	kg/tree		30	35	35	40	40	55	55
	kg/ha		6,123	7,143	7,143	8,164	8,164	11,200	11,200
	DH/ha		15,742	18,365	18,365	20,990	20,990	28,795	28,795

TABLE A.4.3-5. MONTHLY LABOR REQUIREMENT (VEGETABLE FARM: 75 HA)

PLAN - A

Crops	Area (ha)	Jan. (hr)	Feb. (hr)	Mar. (hr)	Apr. (hr)	May (hr)	Jun. (hr)	Jul. (hr)	Aug. (hr)	Sep. (hr)	Oct. (hr)	Nov. (hr)	Dec. (hr)	Total
Sweet melon	25.5	-	-	563	2,052	4,596	5,175	3,586	2,816	-	-	-	-	18,788
Tomoto	16.0	1,935	912	1,280	-	-	-	321	1,727	3,328	5,006	3,886	3,583	21,978
Cabbage	16.0	2,304	8,923	8,542	-	-	-	-	-	3,024	2,993	2,927	2,351	31,064
Eggplant	16.0	3,103	2,734	3,103	2,399	959	-	-	-	1,935	6,047	3,839	3,103	27,222
Cucumber	16.0	320	-	-	-	-	-	-	1,721	1,567	1,504	3,886	2,079	11,077
Total	89.5	7,662	12,569	13,488	4,451	5,555	5,175	3,907	6,264	9,854	15,550	14,538	11,116	110,129
Man-Day		1,277	2,095	2,245	742	926	863	652	1,044	1,642	2,592	2,423	1,852	18,354
Requirement Man-Month		49	81	86	29	36	33	25	40	63	100	93	71	706
Permanent Employee		49	49	49	49	49	49	49	49	49	49	49	49	588
Temporary Employee		-	32	37	-	-	-	-	-	14	51	44	22	200

Notes: 1 Day = 6 hours, 1 Month = 26 days

TABLE A.4.3-6. FARM INPUTS (VEGETABLE FARM 75 HA)

PLAN - A

Crops		Compound S.F. Quantity (kg)	Compound S.F. Value (DH)	Urea Quantity (kg)	Urea Value (DH)	Pesticides Quantity (kg)	Pesticides Value (DH)	Herbicides Quantity (kg)	Herbicides Value (DH)
Sweet melong	25.5 ha	19,212	25,356	12,807	11,270	1,537	35,348	38	25,384
Tomato	16.0 ha	12,000	15,800	8,000	7,000	960	22,000	24	15,800
Cabbage	16.0 ha	8,000	10,500	8,000	7,000	960	22,000	24	15,800
Eggplant	16.0 ha	12,000	15,800	8,000	7,000	960	22,000	24	15,800
Cucumber	16.0 ha	8,000	10,500	8,000	7,000	720	16,500	-	-
Total	89.5	59,212	77,956	44,807	39,270	5,137	117,848	110	72,784

(cont'd)

(CONTINUED)

PLAN - A

Crops	Seed Quantity (kg)	Seed Value (DH)	Machinery Cost (DH)	Personnel Expenses & Labor Cost (DH)	Support (DH)	Total (DH)
Sweet melon	65	2,455	17,752	227,357		344,922
Tomato	28	3,300	14,700	267,100	1,960	347,660
Cabbage	35	1,700	14,700	337,500		409,200
Eggplant	32	1,500	14,700	331,300	2,600	410,700
Cucumber	57	1,380	14,700	133,500		184,080
Total	217	10,835	76,552	1,296,757	4,560	1,696,562

TABLE A.4.3-7. MONTHLY LABOR REQUIREMENT (FRUIT FARM: 65 HA)

PLAN - B

Fruits	Area (ha)	Jan. (hr)	Feb. (hr)	Mar. (hr)	Apr. (hr)	May (hr)	Jun. (hr)	Jul. (hr)	Aug. (hr)	Sep. (hr)	Oct. (hr)	Nov. (hr)	Dec. (hr)	Total
Dates	10.0	610	680	339	400	339	400	637	1,810	1,800	437	600	710	9,262
Citrus	19.5	1,536	1,186	1,440	2,784	5,144	836	1,440	4,504	4,679	800	540	1,537	26,526
Mango	10.0	439	309	737	928	1,137	400	738	2,309	2,399	410	327	437	10,570
Decidous Fruit	17.0	745	524	1,255	1,578	1,935	680	1,255	3,926	4,079	696	558	745	17,976
Total	56.5	3,330	2,699	4,271	5,690	8,555	2,316	4,070	12,549	12,957	2,343	2,125	3,429	64,334
Man-Day		555	450	712	948	1,426	386	678	2,092	2,160	390	354	571	10,722
Requirement Man-Month		21	17	27	37	55	15	26	80	83	15	14	22	412
Permanent Employee		26	26	26	26	26	26	26	26	26	26	26	26	312
Temporary Employee		-	-	1	11	29	-	-	54	57	-	-	-	152

Notes: 1 Day = 6 hours, 1 Month = 26 days

TABLE A.4.3-8. FARM INPUT (FRUIT FARM 65 HA)
PLAN - B

		Dates	Citrus	Mango	Deciduous Fruit	Total
		100 ha	19.5 ha	10.0 ha	17.0 ha	56.5 ha
Fertilizer	(kg)	5,000	9,750	5,000	8,500	28,250
	(DH)	6,600	12,870	6,600	11,200	37,270
Pesticide	(kg)	1,000	1,950	1,000	1,700	5,650
	(DH)	22,400	43,670	22,400	38,000	126,470
Nursery	(Unit)	1,720	5,800	1,660	2,800	11,980
	(DH)	5,170	17,400	5,000	8,300	35,870
Machinery	(DH)	8,470	16,500	8,470	14,400	47,840
Wage	(DH)	128,470	366,500	146,570	248,200	889,740
Total	(DH)	171,110	456,940	189,040	320,100	1,137,190

TABLE A.4.3-9. MONTHLY LABOR REQUIREMENT (FRUIT FARM: 40 HA)

PLAN - C

Fruits	Area (ha)	Jan. (hr)	Feb. (hr)	Mar. (hr)	Apr. (hr)	May (hr)	Jun. (hr)	Jul. (hr)	Aug. (hr)	Sep. (hr)	Oct. (hr)	Nov. (hr)	Dec. (hr)	Total
Dates	6.0	366	408	503	240	203	240	383	1,086	1,080	263	360	426	5,558
Citrus	12.0	946	730	886	1,714	3,166	514	886	2,771	2,880	492	394	946	16,325
Mango	6.0	263	185	443	557	683	240	443	1,386	1,440	246	197	263	6,346
Deciduous Fruit	10.0	439	309	738	929	1,138	400	738	2,310	2,400	409	329	439	10,578
Total	34.0	2,014	1,632	2,570	3,440	5,190	1,394	2,450	7,553	7,800	1,410	1,280	2,074	38,807
Man-Day		336	272	428	573	865	232	408	1,259	1,300	235	213	346	6,467
Requirement Man-Month		13	11	16	22	33	9	16	48	50	9	8	13	248
Permanent Employee		13	13	13	13	13	13	13	13	13	13	13	13	156
Temporary Employee		-	-	3	9	20	-	-	35	37	-	-	-	104

Notes: 1 Day = 6 hours, 1 Month = 26 days

TABLE A.4.3-10. MONTHLY LABOR REQUIREMENT (VEGETABLE FARM: 30 HA)

PLAN - C

Crops	Area (ha)	Jan. (hr)	Feb. (hr)	Mar. (hr)	Apr. (hr)	May (hr)	Jun. (hr)	Jul. (hr)	Aug. (hr)	Sep. (hr)	Oct. (hr)	Nov. (hr)	Dec. (hr)	Total
Sweet melon (Summer crop)	9.6	-	-	211	769	1,723	1,940	1,344	1,048	-	-	-	-	2,035
Tomato	6.0	726	342	480	-	-	-	120	648	1,248	1,878	1,458	1,344	8,244
Cabbage	6.0	864	3,347	3,204	-	-	-	-	-	1,634	1,123	1,098	882	11,652
Eggplant	6.0	1,164	1,026	1,164	900	360	-	-	-	726	2,268	1,440	1,164	10,212
Cucumber	6.0	120	-	-	-	-	-	-	645	588	564	1,458	780	4,155
Total	33.6	2,874	4,715	5,059	1,669	2,083	1,940	1,464	2,341	3,696	5,833	5,454	4,170	41,293
Man-Day		479	786	843	278	347	324	244	390	616	972	909	695	6,883
Requirement		18	30	32	11	13	12	9	15	24	37	35	27	263
Permanent Employee		18	18	18	18	18	18	18	18	18	18	18	18	216
Temporary Employee		-	12	13	-	-	-	-	-	6	19	17	9	76

Notes: 1 Day = 6 hours, 1 Month = 26 days

TABLE A.4.3-11. FARM INPUT (FRUIT FARM 40 HA)

PLAN - C

		Dates	Citrus	Mango	Deciduous Fruit	Total
		6 ha	12 ha	6 ha	10 ha	34 ha
Fertilizer	(kg)	3,000	6,000	3,000	5,000	17,000
	(DH)	3,960	7,920	3,960	6,600	22,440
Pesticide	(kg)	6,000	1,200	600	1,000	3,400
	(DH)	13,440	26,880	13,440	22,400	76,160
Nursery	(Unit)	1,033	3,567	1,000	1,633	7,233
	(DH)	3,100	10,700	3,000	4,900	21,700
Machinery	(DH)	5,080	10,160	5,080	8,470	28,790
Wage	(DH)	77,080	225,540	87,940	146,030	536,590
Total	(DH)	102,660	281,200	113,420	188,400	685,680

TABLE A.4.3-12. FARM INPUTS (VEGETABLE FARM 30 HA)

PLAN - C

Crops		Compound S.F. Quantity (kg)	Compound S.F. Value (DH)	Urea Quantity (kg)	Urea Value (DH)	Pesticides Quantity (kg)	Pesticides Value (DH)	Herbicides Quantity (kg)	Herbicides Value (DH)
Sweet melon	9.6 ha	7,200	9,510	4,800	4,230	576	13,255	14	9,500
Tomato	6.0 ha	4,500	5,940	3,000	2,640	360	8,280	9	5,940
Cabbage	6.0 ha	3,000	3,960	3,000	2,640	360	8,280	9	5,940
Eggplant	6.0 ha	4,500	5,940	3,000	2,640	360	8,280	9	5,940
Cucumber	6.0 ha	3,000	3,960	3,000	2,640	270	6,210	-	-
Total	33.6 ha	22,200	29,310	16,800	14,790	1,926	44,305	41	27,320

(cont'd)

PLAN - C

Crops	Quantity (kg)	Value (DH)	Machinery Cost (DH)	Personnel Expenses & Labor Cost (DH)	Support (DH)	Total (DH)
Sweet melon	42	920	6,660	85,260	-	129,335
Tamato	10	1,256	5,520	100,190	734	130,500
Cabbage	13	637	5,520	141,620	-	168,597
Eggplant	12	576	5,520	124,280	975	154,151
Cucumber	21	704	5,520	50,100	-	69,134
Total	80	4,093	28,740	501,450	1,709	651,757

TABLE A.4.3-13. BENEFIT (PLAN - A AND PLAN - B)

Farm	Crops	Area (ha)	Yield (ton/ha)	Dibba Price (DH/ton)	Gross Income (DH)	Input[2/] (DH)	Net Income (DH)	Net Income per ha (DH)
(A) Vegetable	Sweet melon[1/]	25.5	25	2,087	1,330,462	464,922	865,540	33,942
Farm	Tomato	16.0	63	1,379	1,390,032	488,660	901,400	56,300
	Cabbage	16.0	39	1,929	1,203,696	608,200	595,520	37,220
75 ha	Eggplant	16.0	39	1,493	931,632	555,200	346,400	21,650
	Cucumber	16.0	25	3,255	1,302,000	255,080	1,046,900	65,431
	Sub-total	89.5	-	-	6,157,822	2,402,062	3,755,760	41,960
(B) Fruit	Dates	10.0	16.6	5,316	882,456	230,410	652,000	65,200
Farm	Citrus	19.5	10.2	3,455	687,199	626,940	60,200	3,000
65 ha	Mango	10.0	11.2	2,571	287,952	256,740	31,200	3,100
	Decidus Fruit	17.0	10.7	4,937	898,040	435,300	462,700	27,200
	Sub-total	56.5	-	-	2,755,647	1,549,390	1,206,100	21,300

Note: 1/ Summer crop

2/ Except water cost

TABLE A.4.3-14. BENEFIT (EXCEPT WATER COST)

Farms	Crops	Area (ha)	Yield (ton/ha)	Dibba Price (DH/ton)	Gross Income (DH)	Input (DH) [1/]	Net Income (DH)	Net Income per ha (DH)
(C) Vegetable Farm 30 ha	Sweet melon	9.6	25	2,087	500,880	174,335	326,545	34,000
	Tomato	6.0	63	1,379	521,262	185,223	336,039	56,000
	Cabbage	6.0	39	1,493	349,362	239,266	110,096	18,300
	Eggplant	6.0	39	1,929	451,386	218,795	232,591	38,700
	Cucumber	6.0	25	3,255	488,250	98,098	390,152	65,000
	Sub-total	23.6	-	-	2,311,140	915,717	1,395,423	41,500
Fruit Farm 40 ha	Dates	6.0	16.6	* 5,316	529,474	138,217	391,257	65,200
	Citrus	12.0	10.2	3,455	422,892	389,116	33,776	800
	Mango	6.0	11.2	2,571	172,771	152,711	20,060	3,300
	Decidus Fruit	10.0	10.7	* 4,937	528,259	253,636	274,623	27,500
	Sub-total	34.0	-	-	1,653,396	933,680	719,716	21,200
Existing)	Dates	230.0	10.0	* 5,316	12,226,800	1,112,000	11,114,800	48,300
	Vegetables (melon)	50.0	20.0	2,080	2,080,000	885,400	1,194,600	23,900
	Sub-total	280.0	-	-	14,306,800	1,997,400	12,309,400	43,900
A + Existing 355 ha		369.5	-	-	20,464,622	4,399,462	16,065,160	43,500
B + Existing 345 ha		336.5	-	-	17,062,447	3,546,790	13,515,657	40,200
C + Existing 350 ha		347.6	-	-	18,271,336	3,846,797	14,424,539	41,500

Note: 1/ Except water cost
* Average wholesale price in 1979

TABLE A.4.3-15. BENEFIT (PLAN - A AND PLAN - B)

Farm	Crops	Area (ha)	Yield (ton/ha)	Dibba Price (DH/ton)	Gross Income (DH)	Input (DH)	Net Income (DH)	Net Income per ha (DH)
(A) Vegetable	Sweet melon 1/	25.5	25	2,087	1,330,462	1,477,842	Δ147,380	Δ5,800
Farm	Tomato	16.0	63	1,379	1,390,032	1,169,460	220,572	13,800
	Cabbage	16.0	39	1,929	1,203,696	1,088,900	114,796	7,200
75 ha	Eggplant	16.0	39	1,493	931,632	1,311,900	Δ380,268	Δ23,800
	Cucumber	16.0	25	3,255	1,302,000	691,160	610,840	38,200
	Sub-total	89.5	-	-	6,157,822	5,739,262	418,560	4,800
(B) Fruit	Dates	10.0	16.6	5,316	882,456	643,490	238,960	23,900
Farm	Citrus	19.5	10.2	3,455	687,199	2,143,560	Δ1,456,361	Δ74,700
65 ha	Mango	10.0	11.2	2,571	287,952	995,500	Δ707,548	Δ70,700
	Decidus Fruit	17.0	10.7	4,937	898,040	1,124,840	Δ226,800	Δ13,300
	Sub-total	56.5	-	-	2,755,647	4,907,390	2,151,743	Δ38,100

Note: 1/ Summer crop

Water cost is 4.6 DH per cu.m

TABLE A.4.3-16. BENEFIT

Farm	Crops	Area (ha)	Yield (ton/ha)	Dibba Price (DH/ton)	Gross Income (DH)	Input (DH)	Net Income (DH)	Net Income per ha (DH)
(C) Vegetable Farm 30 ha	Sweet melon	9.6	25	2,087	500,880	554,295	Δ53,415	Δ5,600
	Tomato	6.0	63	1,379	521,262	440,983	80,279	13,400
	Cabbage	6.0	39	1,493	349,362	420,046	Δ70,684	Δ11,800
	Eggplant	6.0	39	1,929	451,386	502,615	Δ51,229	Δ8,500
	Cucumber	6.0	25	3,255	488,250	261,398	226,852	37,800
	Sub-total	23.6	-	-	2,311,140	2,179,337	131,803	5,600
Fruit Farm 40 ha	Dates	6.0	16.6	*5,316	529,474	386,617	142,857	23,800
	Citrus	12.0	10.2	3,455	422,892	1,344,536	Δ921,644	Δ76,800
	Mango	6.0	11.2	2,571	172,771	597,071	Δ424,300	Δ70,700
	Decidus Fruit	10.0	10.7	*4,937	528,259	717,776	Δ189,517	Δ18,900
	Sub-total	34.0	-	-	1,653,396	3,046,000	Δ1,392,604	Δ40,900
	Total	57.6	-	-	3,964,536	5,225,337	Δ1,260,801	Δ21,900
Existing	Dates	230.0	10.0	*5,316	12,226,800	5,934,272	6,292,528	27,400
	Vegetables (melon)	50.0	20.0	2,080	2,080,000	2,265,400	Δ185,400	Δ3,700
	Sub-total	280.0	-	-	14,306,800	8,199,672	6,107,128	21,800
A + Existing 355 ha		369.5	-	-	20,464,622	13,938,934	6,525,688	17,700
B + Existing 345 ha		336.5	-	-	17,062,447	13,107,062	3,955,385	11,700
C + Existing 350 ha		347.6	-	-	18,271,336	13,425,009	4,846,327	13,900

Note: Water cost is 4.6 DH per cu.m

* Average whalesale price in 1979

4.3.2. Modernized irrigation facilities

The hydroponic culture system as illustrated in Drw 4.3-1 has been proposed. Vegetable seeds will be sown to a basin filled with a mat or gravels. Air-mixed water is supplied to crops to be grown in the basin bed. Fertilizers are mixed with the water when required to be supplied for growth of crops. The basin water is sent back to the liquid manure tank through the drainage pipes, and clafified in the way to mix it with air. In this system, no soils are used for crops culture, therefore, neither water loss due to the leakage of water to sub-soils nor soil salinization is worried. Furthermore, fertilizers are most effectively utilized without any loss. On the other hand, a high construction cost will be required for facilities specially for green houses, and water quality test shall be made once a two to three-day period. The construction cost of a green house with the coverage of 700 sq.m would amount at 500,000 Dirham, approximately.

(1) Green house

The green house is advantageous for the stabilized production of fresh vegetables covering all seasons. The temperature in the Project Area exceeds 35°C in the summer seasons. Therefore, a green house will be equipped with a cooler in order to upgrade the quality of products and to increase yield. The green house plan is outline below;

2) Scale

It is proposed to start with the small scaled green houses, and then to increase gradually the number and scale of such green houses. The standard acreage of one green house is 240 sq.m. (40 m x 60 m). Future target scale is a green house with the coverage of 3 ha.

3) Selection of crops

Crops to be grown in green houses should be selected in consideration of the market price trend of vegetables. Tomato, cucumber and lettuces have been selected as the major crops paying attention to their high market price as well as increasing demand.

4) Cropping schedule

Tomato (two croppings a year)

1st cropping	February to August (February)
2nd cropping	August to February (August)

Cucumber (four cropping a year)

1st cropping	January to April (January)
2nd cropping	April to July (April)
3rd cropping	July to October (July)
4th cropping	October to January (October)

Lettuces (five croppings a year)

One cropping: Two to three-month period (direct sowing)

5) Specifications of green houses

Covering material:	Fibre glass (durable period: about 10 years)
Air conditioner:	Air-cooled type
Irrigation and fertilization facilities:	Pipelines and drip irrigation system
Rough estimate of construction cost:	500 Dirham/sq.m (green house facilities and equipment)

4.3.3. Desalination plant

Recently, the sea water desalination has become more popular in the Middle and Near-East countries. And the information on the desalination plants now under planning or installation in the U.A.E. has been outlined in the previous paragraphs. The plant proposed herein is used for producing the irrigation use water from the saline water. The basic idea of the system is to utilize the solar energy with possibly simple mechanism, and it is recommended to pursue the practicability and applicability through further study.

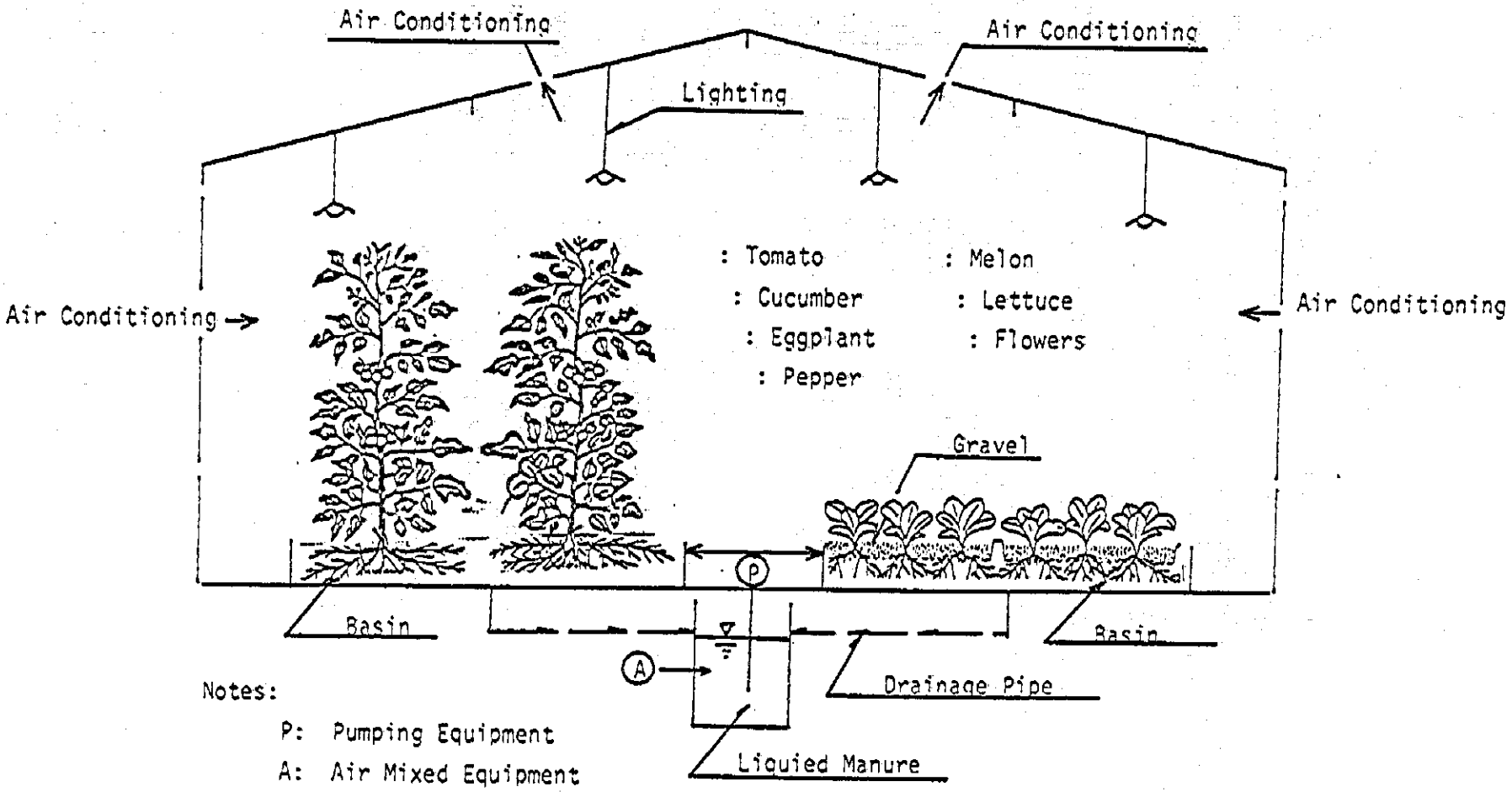
(1) Water production process

The process of sea water distillation by solar energy is illustrated in the figure below. Theoretically, the solar energy passing through inclined filtration walls (glass) heats the sea water stored in the basin by pump-lift. The water vapor emitted by solar heat rises to the glass surface of the inclined walls and changes into fresh water as dew drops. These dew drops run down the walls to be collected in the fresh water storage basins.

A particular attention should be paid to the fact that it is recommended in the report: Water and Soil Resources Survey, Phase I Study, Part I, Collection of Technical Data, October 1978 (Sogreah) that this method can produce unnegligible amount of fresh water by 3.0 $\ell/m^2/day$, equivalent to 1,000 mm rainfall per annum. Under the

circumstances, it is proposed to conduct further and detailed basic study on this method together with solar radiation measurement at Dibba meteorological station.

Drw. 4.3-1. HYDROPONIC CULTURE SYSTEM



4.3.4. Irrigation water requirements

The irrigation water requirements for the above-mentioned dates, vegetables and fruits growing estimated based on the Pan-evaporation method used by the UAE authorities concerned as crop water requirements by four districts, and review made in referring to the meteorological conditions in Dibba.

TABLE 4.3-17. IRRIGATION WATER REQUIREMENTS

(Unit: MCM)

Area		Use		Area	Water Requirement		
UAE		Existing	Plan	(ha)	A	B	C
		Date Palm	-	230	1.04	1.04	1.04
		Vegetable	-	50	0.30	0.30	0.30
	(1)	Sub-total	-	280	1.34	1.34	1.34
		-	FAO Farm	5	0.07	0.07	0.07
		-	Vegetable	30	-	-	0.30
		-	Vegetable	75	0.73	-	-
		-	Fruit	40	-	-	0.43
		-	Fruit	65	-	0.73	-
	(2)	Sub-total	-		0.80	0.80	0.80
	(3)	Total (1) + (2)			2.14	2.14	2.14
OMAN		Date Palm	-	210	0.96	0.96	0.96
	(4)	Total (3)			0.96	0.96	0.96
	(5)	Grand Total (3) + (4)			3.10	3.10	3.10

TABLE A.4.3-18. MONTHLY IRRIGATION WATER REQUIREMENT

Unit: 1,000 cu.m

Existing Farm (U.A.E. 280 ha, Oman 210 ha)

Farm	Crops	Area (ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total	
U.A.E. 280 ha	Dates	230	130.9	107.0	105.3	87.9	90.6	105.8	139.8	179.6	180.3	181.2	179.6	175.5	1,664	(1.664x0.63=1.04) 1/
	vegetable	50	55.4	64.7	60.1	32.9	37.0	31.8	17.6						300	
Sub-total			186.3	171.7	165.4	120.8	127.6	137.6	157.4	179.6	180.3	181.2	179.6	175.5	1,964	
Oman	Dates	210														
Sub-total			119.5	97.7	96.2	80.2	82.7	96.6	127.7	164.0	164.6	165.5	164.0	160.2	1,519	(1.519x0.63=0.96) 1/
Total			305.8	269.4	261.6	201	210.3	234.2	285.1	343.6	344.9	346.7	343.6	335.7	3,483	

Notes:

1/: 0.63 is proposed.

FIG. A.4.3-1. CROPPING PATTERN AND IRRIGATION CALENDAR (LOCAL FARM: 100 ha)

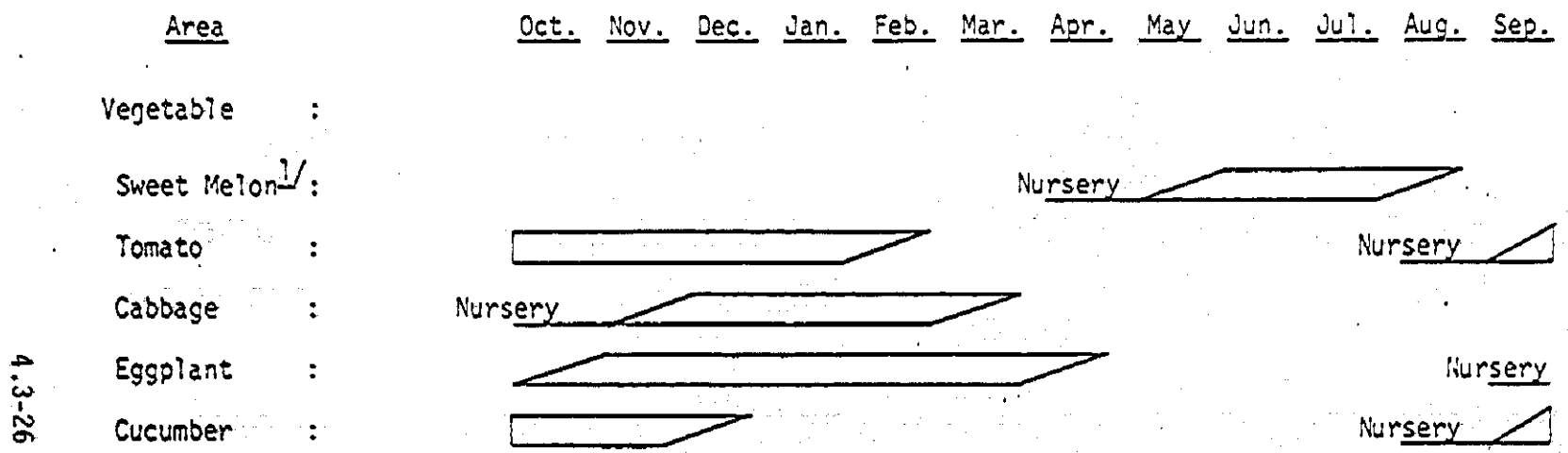


TABLE A.4.3-19. MONTHLY IRRIGATION WATER REQUIREMENT

PLAN - A

(Unit: 1,000 cu.m)

Crops	Area (ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Sweet melon	25.5	-	-	-	-	-	-	-	51.5	59.5	57.5	51.7	-	220.2 1/
Tomato	16.0	28.3	26.9	26.3	18.0	17.4	-	-	-	-	-	-	31.1	148.0
Cabbage	16.0	-	23.5	22.3	16.3	19.6	27.1	-	-	-	-	-	-	104.5
Eggplant	16.0	28.6	24.1	22.7	16.3	19.6	26.1	27.1	-	-	-	-	-	164.5
Cucumber	16.0	283.	24.9	21.1	-	-	-	-	-	-	-	-	20.5	94.8
Sub-total	89.5	85.2	99.4	92.4	50.6	56.6	48.9	27.1	51.5	59.5	57.5	51.7	51.6	732.0
FAO Sub-total	5.0	6.0	6.0	6.0	3.0	4.0	4.0	4.0	7.0	7.0	7.0	7.0	5.0	66.0
Total	94.5	91.2	105.4	98.4	53.6	60.6	52.9	31.1	58.5	66.5	64.5	58.7	56.6	798.0 ≒ 800

Note: 1/ Sweet melon is summer crop

TABLE A.4.3-21. MONTHLY IRRIGATION WATER REQUIREMENT

PLAN - C

(Unit: 1,000 cu.m)

PROPOSED VEGETABLE FARM OF 30 ha, FRUIT FARM OF 40 ha and FAO 5 ha

Crops	Area (ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Sweet melon	9.6	-	-	-	-	-	-	-	19.3	22.3	12.6	19.4	-	82.6
Tomato	6.0	10.6	10.1	9.9	6.8	6.5	-	-	-	-	-	-	11.7	55.6
Cabbage	6.0	-	8.8	8.4	6.1	7.4	8.6	-	-	-	-	-	-	39.3
Eggplant	6.0	10.7	9.0	8.5	6.1	7.4	9.8	10.2	-	-	-	-	-	61.7
Cucumber	6.0	10.6	9.3	7.9	-	-	-	-	-	-	-	-	7.7	35.5
Sub-total	33.6	31.9	37.2	34.7	19.0	21.3	18.4	10.2	19.3	22.3	21.6	19.4	19.4	274.7
Date plam	6.0	4.3	3.4	3.4	2.9	2.9	3.4	4.6	5.9	5.9	5.9	5.8	5.6	54.0
Citrus	12.0	18.0	15.2	13.6	10.0	12.2	14.9	16.7	19.9	30.1	19.1	19.5	18.5	207.7
Mango	6.0	8.8	7.4	6.7	4.9	6.0	7.3	8.2	9.7	9.8	9.3	9.5	9.0	96.6
Deciduous	5.0	8.0	6.5	6.4	5.3	5.5	6.4	8.5	10.9	10.9	11.0	10.9	10.6	100.9
Sub-total	29.0	39.1	32.5	30.1	23.1	26.6	32.0	33.0	46.4	56.7	45.3	45.7	43.7	459.2
FAO Sub-total	5.0	6.0	6.0	6.0	3.0	4.0	4.0	4.0	7.0	7.0	7.0	7.0	5.0	66.0
Total		77.0	75.7	70.8	45.1	51.9	54.4	52.2	72.7	86.0	73.9	72.1	68.1	799.9
														≒ 800

TABLE A.4.3-20. MONTHLY IRRIGATION WATER REQUIREMENT

PLAN - B

(Unit: 2,000 cu.m)

PROPOSED FURIT FARM OF 65 ha, AND FAO 5 ha.

Fruits	Area (ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Date Plam	10.0	7.1	5.7	5.6	4.8	4.8	5.7	7.6	9.8	9.8	9.8	9.7	9.4	89.8
Citrus	19.5	30.0	25.3	22.7	16.6	20.4	24.9	27.9	33.2	33.4	31.9	32.5	30.9	329.7
Mango	10.0	14.6	12.3	11.1	8.1	10.0	12.1	13.6	16.2	16.3	15.5	15.8	15.0	160.6
Deciduous	7.0	11.8	9.7	9.5	7.9	8.2	9.5	12.6	16.2	16.2	16.3	16.2	15.8	149.9
Sub-total	46.5	63.5	53.0	48.9	37.4	43.4	52.2	61.7	75.4	75.7	73.5	74.2	71.1	730.0
FAO Sub-total	5.0	6.0	6.0	6.0	3.0	4.0	4.0	4.0	7.0	7.0	7.0	7.0	5.0	66.0
Total	51.5	69.5	59.0	54.9	40.4	47.4	56.2	65.7	82.4	82.7	80.5	81.2	76.1	796.0
														≒ 800

4.3.5. Irrigation

To cover the agricultural land by 570 ha which consist of 360 ha for the UAE and 210 ha for the Oman, the following factors are applied for irrigation planning of this project.

(1) Agricultural Land: 570 ha

° UAE: 360 ha

280 ha: Existing Dates and vegetable lands along the coastal area

75 ha: Proposed Vegetable Farm in case of Plan A.

65 ha: Proposed Fruit Farm under the Ministry of Agriculture & Fihseries in case of Plan B.

70 ha: Proposed Vegetable Farm of 30 ha and Fruit Farm of 40 ha in case of Plan C.

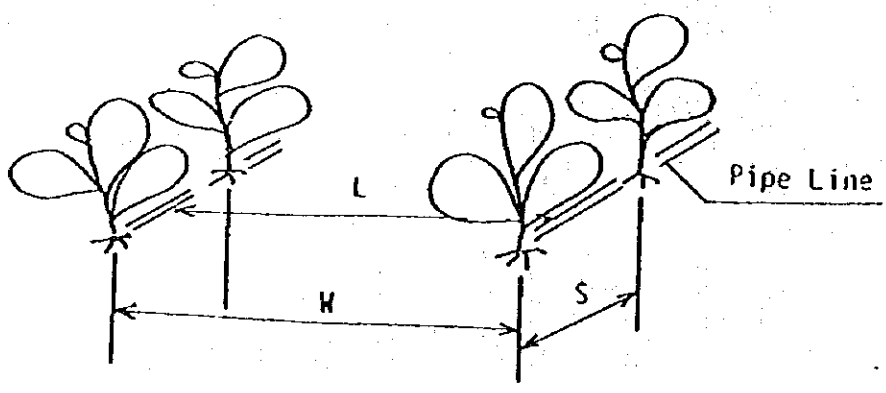
5 ha: FAO Experimental Farm

° Oman: 210 ha : Existing Dates Land

(2) Crops and Fruits

Crops	Plan A (ha)	Plan C (ha)	Fruits	Plan B (ha)
Tomato	16.0	6.0	Dates	10.0
Cabbage	16.0	6.0	Citrus	19.5
Eggplant	16.0	6.0	Mango	10.0
Cucumber	16.0	6.0	Deciduous	17.0
Total	64.0	24.0	Total	56.5

(3) Irrigation System



L: Space of drip irrigation pipe line

W: Wide of crop plantation

S: Space of crop plantation

Iw: Irrigation wide, Crops: 0.6 m, Fruits: 5.0 m

Description	W (m)	S (m)	Iw (m)	AR 0.6/w
Crops:				
Sweet Melon	1.70	1.5	0.6	0.353
Cabbage	1.70	0.5	0.6	0.353
Eggplant	1.35	0.6	0.6	0.444
Cucumber	1.70	0.5	0.6	0.353
Tomato	1.80	0.6	0.6	0.333
Fruits:				
Dates	6.0	6.0	19.6 1/	0.545=278x0.00196
Citrus/Mango	7.0	7.0	19.6	0.400=204x0.00196

Notes:

(1) 1/; Irrigation area of a tree (19.6 m^2) is calculated: $\pi D^2/4 = 3.14 \times 5^2/4 = 19.6\ m^2$

(2) Number of trees per ha; Dates: 278, Mango: 204

(3) AR; Ratio of irrigation area

(4) Consumptive Use of Water

Crop water requirement are estimated from:

$$ETcrop = Kc.ETo$$

where: ETcrop: Crop water requirement (mm)
Kc : Crop coefficient
ETo : Reference crop evapotranspiration

$$ETo = Kp.Epan \quad (mm)$$

where: Epan: Pan evaporation in mm/day
Kp : Pan coefficient

The estimated ETcrop values are listed in Table A.4.3-22 to 4.3-25.

(5) Irrigation Efficiency

Description	Existing Agricultural land	Development land
Ec: Conveyance Efficiency	90%	95%
Ef: Field Efficiency	50	85
Ep: Project Efficiency	45	81

Notes:

- 90% is planned to be constructed by concrete lined canal, and 95% is planned by a pipe line system.
- 50% is made in sand soils with basin irrigation and 85% is planned in medium soils with drip irrigation.

$$Ep = Ec.Ef$$

(6) Irrigation Water Requirement

$$IR = ETcrop.1/Ep.A$$

where: IR : Gross irrigation requirement (w.m)
ETcrop: Crop water requirement (mm)
Ep : Project efficiency
A : Proposed area

° Proposed vegetable farm

$$IR75\text{-}30 = ETcrop.1/0.81.A$$

° Proposed fruit farm

$$IR65\text{-}40 = ETcrop.1/0.81.A$$

° FAO experimental farm (5 ha)

$$IR5 = ETcrop.1/0.81A$$

° U.A E existing 280 ha (230 ha Dates, 50 ha vegetable)

$$IR230 = ETcrop.A$$
$$IR50 = ETcrop.1/0.81A$$

° Oman existing 210 ha (Dates)

IR210 = ETcrop.A

TABLE A.4.3-22. UNIT IRRIGATION REQUIREMENT

Ui = ETcrop.1/EP Ep = 0.81

Unit: mm

Fruits	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Citurs/Mango	144.2	121.4	109.5	80.1	98.2	120.2	134.3	160.1	160.8	153.6	156.1	148.7	1,587
Dates	70.0	57.2	56.3	47.0	48.5	56.6	74.8	96.1	96.4	96.9	96.1	93.8	890
Tomato	177.1	168.3	164.2	112.1	108.6							194.5	925
Eggplant	179.1	150.9	142.3	101.5	124.4	163.0	168.9						1,030
Cabbage		147.5	139.1	101.5	123.0	142.4							654
Sweet Melon								201.4	232.3	224.6	201.8		860
Cucumber	177.1	156.1	131.4									128.2	593

TABLE A.4.3-23. CROP WATER REQUIREMENT (1)

ET crop = Kc.ETo

Unit: mm

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Citrus/Mango													
ETo:	167.4	141.0	127.1	86.8	106.4	139.5	156.0	186.0	201.0	192.2	195.3	186.0	1,885
Kc:	0.70	0.70	0.70	0.75	0.75	0.70	0.70	0.70	0.65	0.65	0.65	0.65	
Kc.ETo:	117.2	98.7	89.0	65.1	79.8	97.7	109.2	130.2	130.7	124.9	126.9	120.9	1,290
Monthly mean:													108
Per day:	3.8	3.3	2.9	2.1	2.9	3.2	3.6	4.2	4.4	4.0	4.1	4.0	
Dates													
ETo:	167.4	141.0	127.1	86.8	106.4	139.5	156.0	186.0	201.0	192.2	195.3	186.0	1,885
Kc:	0.34	0.33	0.36	0.44	0.37	0.33	0.39	0.42	0.39	0.41	0.40	0.41	
Kc.ETo:	56.9	46.5	45.8	38.2	39.4	46.0	60.8	78.1	78.4	78.8	78.1	76.3	723
Monthly mean:													60
Per day:	1.8	1.4	1.5	1.2	1.4	1.5	1.8	2.5	2.4	2.5	2.5	2.3	

TABLE A.4.3-24. CROP WATER REQUIREMENT (2)

ET crop = Kc.ETo

Unit: mm

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Tomato													
Eto:	167.4	141.0	127.1	86.8	106.4							186.0	815
Kc:	0.86	0.97	1.05	1.05	0.83							0.85	
Kc.ETo:	144.0	136.8	133.5	91.1	88.3							158.1	752
Monthly mean:													126
Per day:	4.7	4.6	4.3	2.9	3.2							5.3	
Eggplant													
ETo:	167.4	141.0	127.1	86.8	106.4	139.5	156.0						924
Kc:	0.87	0.87	0.91	0.95	0.95	0.95	0.88						
Kc.ETo:	145.6	122.7	115.7	82.5	101.1	132.5	137.3						837
Monthly mean:													112
Per day:	4.7	4.1	3.7	2.7	3.6	4.3	4.6						

TABLE A.4.3-25. CROP WATER REQUIREMENT (3)

ET crop = Kc.ETo

Unit: mm

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Cabbage													
ETo:		141.0	127.1	86.8	106.4	139.5							601
Kc:		0.85	0.89	0.95	0.94	0.83							
Kc.ETo:		119.9	113.1	82.5	100.0	115.8							531
Monthly mean:													106
Per day:		4.0	3.7	2.7	3.6	3.7							
Sweet melon													
ETo:								186.0	201.0	192.2	195.3		775
Kc:								0.88	0.94	0.95	0.84		
Kc.ETo:								163.7	188.9	182.6	164.1		69.9
Monthly mean:													174
Per day:								5.3	6.3	5.9	5.3		

TABLE A.4.3-26. CROP WATER REQUIREMENT (4)

ET crop = Kc.ETo

Unit: mm

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Cucumber													
ETo:	167.4	141.0	127.1									124	560
Kc:	0.86	0.90	0.84									0.84	
Kc.ETo:	144.0	126.9	106.8									104.2	482
Monthly mean:													132
Per day:	4.6	3.8	3.4									5.2	

TABLE A.4.3-27. TOMATO: CONSUMPTIVE USE OF WATER

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
ETo:	86.8	106.4							186	167.4	141	127.1	814.7
Kc:	1.05	0.83							0.85	0.86	0.97	1.05	
Kc.ETo:	91.1	88.3							158.1	144.0	136.8	133.5	751.8
Monthly mean:													125.3
Per day:	2.9	3.2							5.3	4.7	4.6	4.3	

TABLE A.43-28. EGGPLANT: CONSUMPTIVE USE OF WATER

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
ETo:	86.8	106.4	139.5	156						167.4	141	127.1	656.9
Kc:	0.95	0.95	0.95	0.88						0.87	0.87	0.91	
Kc.ETo:	82.5	101.1	132.5	137.3						145.6	122.7	115.7	837.4
Monthly mean:													119.6
Per day:	2.66	3.61	4.27	4.58						4.70	4.09	3.73	

TABLE A.4.3-29. CABBAGE: CONSUMPTIVE USE OF WATER

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
ETo:	86.8	106.4	139.5								141	127.1	473.9
Kc:	0.95	0.94	0.83								0.85	0.89	
Kc.ETo:	82.5	100.0	115.8								119.9	113.1	531.3
Monthly mean:													106.3
Per day:	2.66	3.57	3.74								4.00	3.65	

TABLE A.4.3-30. CITRUS: CONSUMPTIVE USE OF WATER

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
ETo:	86.8	106.4	139.5	156	186	201	192.2	195.3	186	167.4	141	127.1	1,884.7
Kc:	0.75	0.75	0.70	0.70	0.70	0.65	0.65	0.65	0.65	0.70	0.70	0.70	
Kc.ETo:	65.1	79.8	97.7	109.2	130.2	130.7	124.9	127.0	120.9	117.2	98.7	89.0	1,290.4
Monthly mean:													107.5
Per day	2.1	2.85	3.15	3.64	4.20	4.36	4.03	4.10	4.03	3.78	3.29	2.87	

4.3.6. Measuring of Intake Rate

During the field survey, intake rate measurements were made at four site in the area (No.1 to No.4 plot), in order to pursue an adequate irrigation method and water amounts to be applied to the crop.

To measure the intake rate, a cylinder infiltrometer was used and the reading of water depth within the cylinder was made. The results of intake rate measurements are plotted on a logarithmic paper (see Figure A.4.3-2 to Figure A.4.3-5).

Usually, the intake rate potted against time on logarithmic scale shows a straight line and therefore, can be presented by the equation of $D = CT^n$ when the observation of intake rate extends over long time, a better representation of the data can usually be obtained by using the equation of $D = CT^n$ tb. Since n is negative, an accumulative intake rate (ID) decrease with an elapse in time of T. Therefore, the intake rate (D) will approach a constant value of b as time elapse. Generally the intake dose approach a constant rate, which will be referred to as basic intake rate (IBi) Causion should be observed in using the basic intake rate of irrigation design such as irrigation method.

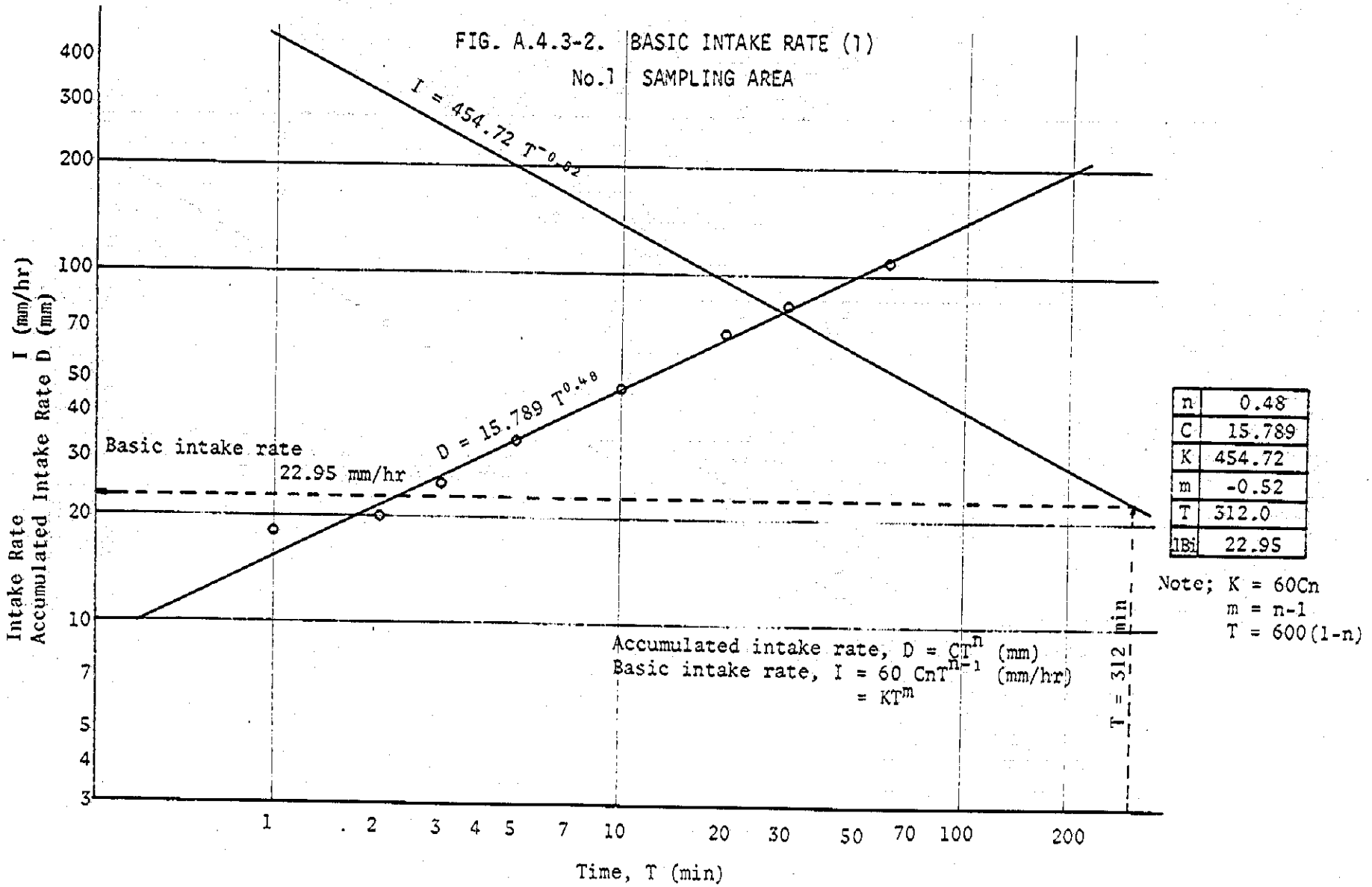
The following table gives the obtained basic intake rate, based upon each observation of the intake rate.

Obtained Basic Intake Rate

Site	Basic Intake Rate (mm/hr)
No.1	22.95
No.2	28.75
No.3	4.77
No.4	25.75

From the above figures, although further studies on upland irrigation will be needed, it could be considered in this stage that the follow or basin irrigation methods will be suitable for water supply to the upland crops during the growing season of them. However, drip irrigation method was proposed in the Project, taking into account the limmited water source for the Project.

FIG. A.4.3-2. BASIC INTAKE RATE (1)
No.1 SAMPLING AREA

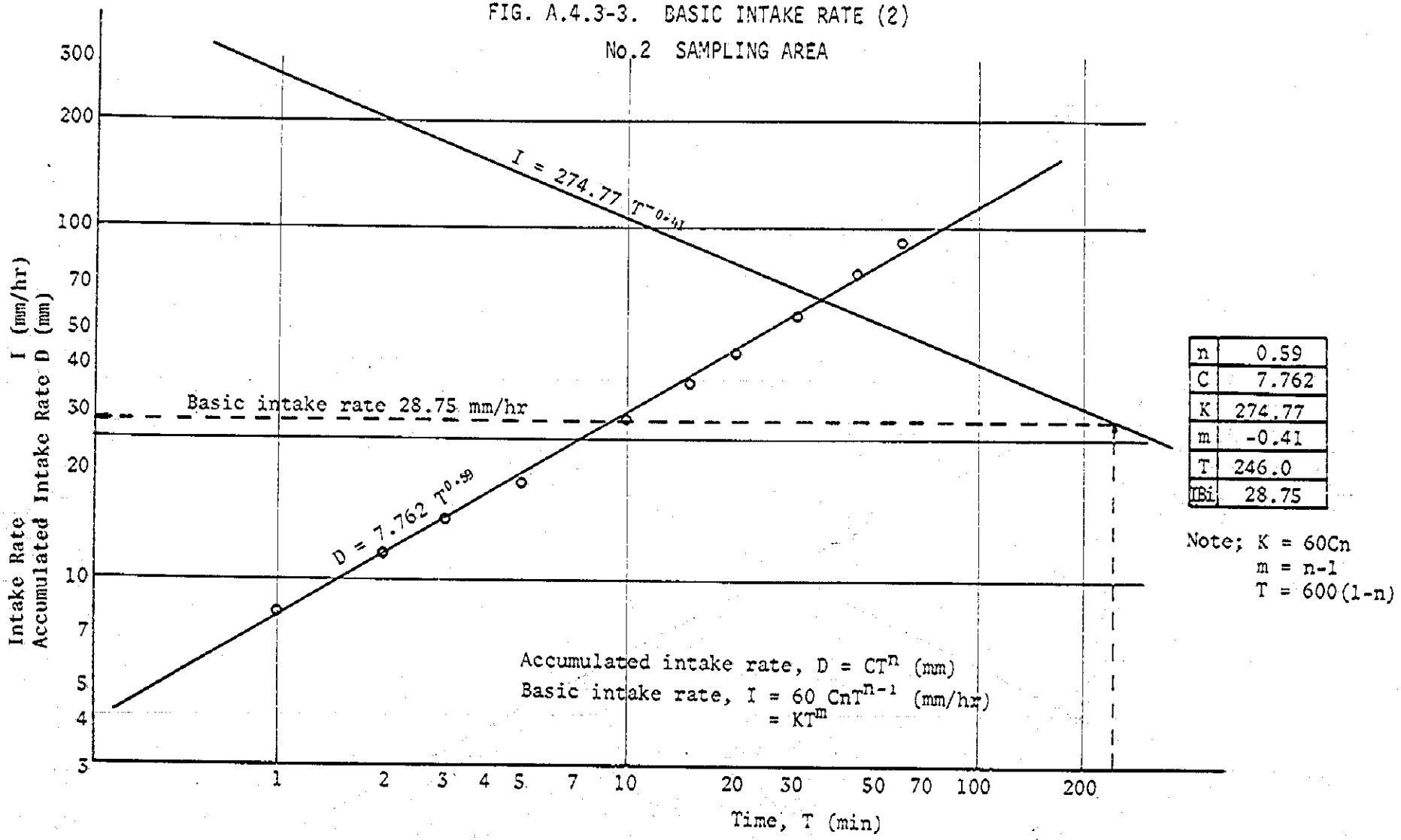


n	0.48
C	15.789
K	454.72
m	-0.52
T	312.0
IBi	22.95

Note; K = 60Cn
m = n-1
T = 600(1-n)

FIG. A.4.3-3. BASIC INTAKE RATE (2)

No.2 SAMPLING AREA

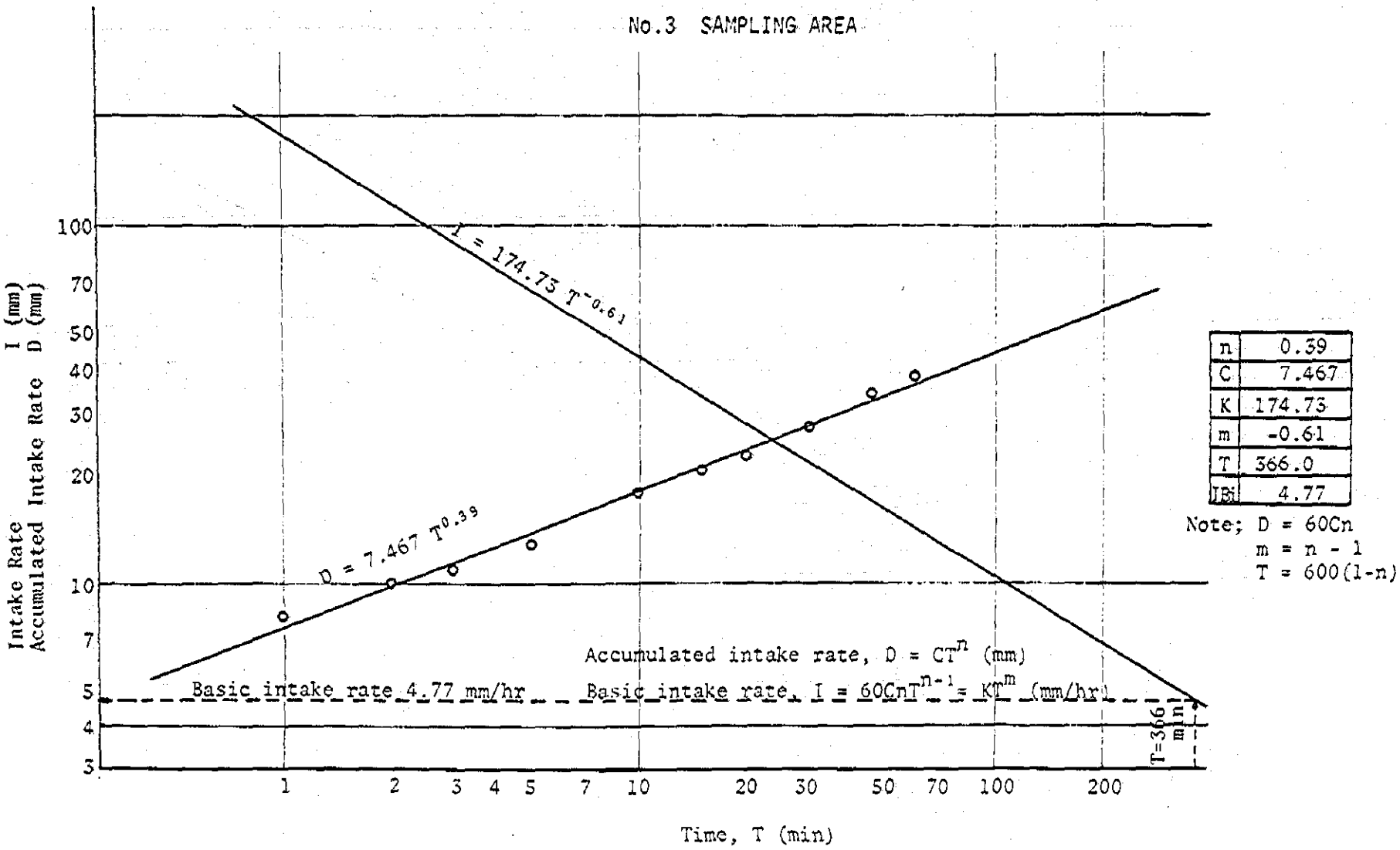


n	0.59
C	7.762
K	274.77
m	-0.41
T	246.0
IBi	28.75

Note; K = 60Cn
m = n-1
T = 600(1-n)

FIG. A.4.3-4. BASIC INTAKE RATE (3)

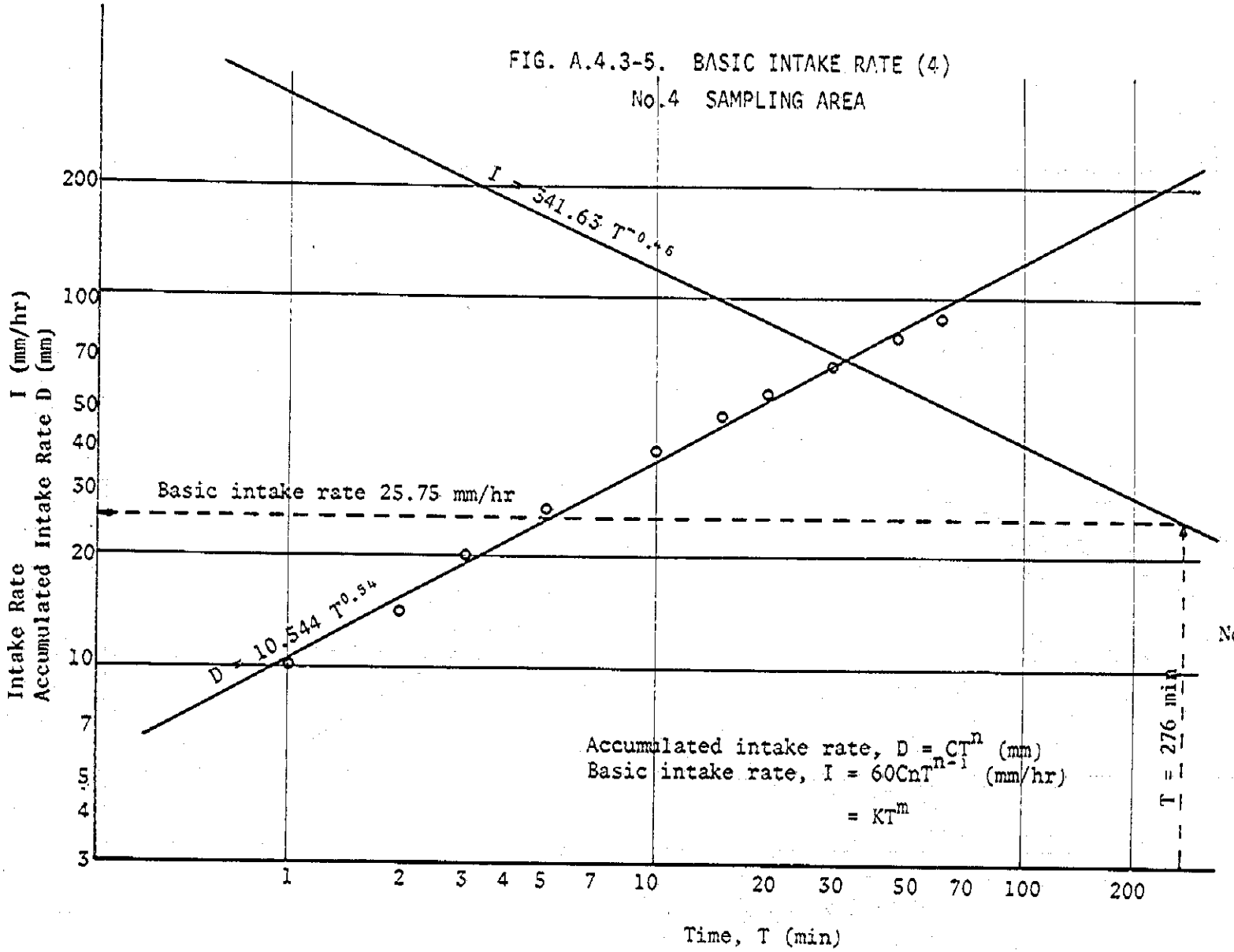
No.3 SAMPLING AREA



n	0.39
C	7.467
K	174.73
m	-0.61
T	366.0
Ib	4.77

Note; D = 60Cn
m = n - 1
T = 600(1-n)

FIG. A.4.3-5. BASIC INTAKE RATE (4)
No.4 SAMPLING AREA



n	0.54
C	10.544
K	341.63
m	-0.46
T	276.00
IBi	25.75

Note; K = 60Cn
m = n-1
T = 600(1-n)

4.4. Preliminary Design of Facilities and Cost Estimation

Contents

List of Tables

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List of Drawings

4.4.1 Design Criteria

The facilities which are to augment recharge of groundwater are dam for storaging flood temporarily and/or dike of low height. The design criteria of the International Large Dam Conference, and Ordinance for Construction of River Management Works and its Regulation of Application prevailing in Japan are applied in principle to these dam and dike.

At the design of spillway, the probable flood of once in 10,000 years is applied as design flood considering unexpected flood characteristics due to shortage of long term hydrological data and some examples applied for Wadi Bih and Wadi Ham projects in U.A.E. Accordingly, the the expected flood at damsite on main stream Wadi Al Bassierah is 2,320 cu.m/sec per 122 sq.km of catchment area, and that for Al Fay pond is 780 cu.m/sec per 26 sq.km.

The principal factors such as design of structures are as mentioned below.

(1) Dike

At the design of dike of low height, the central section of dike is designed as overflow type considering that the dike is to be embanked with river bed material mainly. The overflow section is to have at the maximum dike height of 6.0 m, overflow depth of 2.0 m and overflow discharge per unit length of 4.8 cu.m/sec to pass flood smoothly keeping stability of structures. The maximum height of non-overflow section is 9.0 m adding 2.0 m of overflow depth and 1.0 m of free board to the height of overflow section.

The typical sections of overflow and non-overflow sections of dike based on such design criteria are shown in Fig. 4.4-1 of the main report and other hydraulic dimensions are shown in Fig. A.4.4-1.

(2) Dam

The dam which is to be constructed on the main stream of Wadi Al Bassierah is planned as a zone type fill dam embanking the center zone with river bed material to save the construction cost. The upper and lower stream zones of the dam body are filled with rock material from viewpoint of stability of structure.

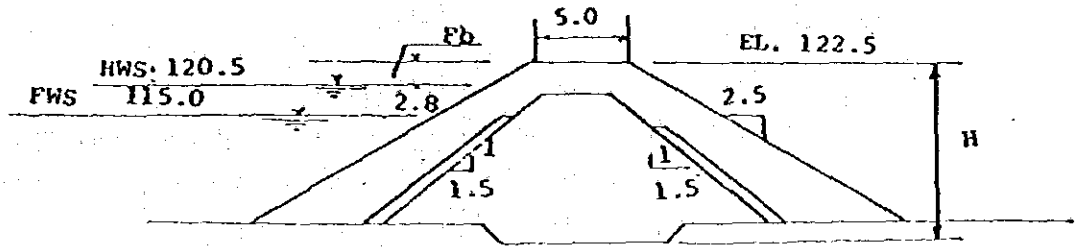
The center zone is embanked with sand and gravel material borrowed from river bed which consists of less than 200 mm diameter, and the expected permeability of zone is below 10^{-4} cm/sec, after compaction. The filter drain of 2.0 m horizontal thickness with screened sand and gravel material is to be provided between the center zone of sand and gravel and the rockfill zones of upper and lower stream sides to prevent the piping phenomenon of sand and gravel material and to decrease pore water pressure. At the bottom portion of down stream of the rockfill zone, a horizontal filter drain is to be provided with vertical thickness of 1.0 m for the same purpose as mentioned above.

The upper and downstream slopes of dam are to be riprapped in 0.5 m thickness with selected rock material of larger than 200 mm diameter considering wave erosion and weathering because the rock material available at the site contains the altered surpentinite.

The spillway is to be provided on the bedrock and separated from the dam body.

FIG. A.4.4-1 AL BASSIERAH DAM

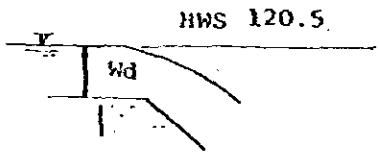
° Dam Body



v	: Reservoir Capacity	:	2.5 MCM
H	: Dam Height	:	19.5 m
Fb	: Free Board	:	2.0 m
HWS	: High Water Level -E.L.	:	120.5 m
FWS	: Full Water Level -E.L.	:	115.0 m

° Spillway

Design Flood Q: 2,320 m^3/s $\left(\frac{1}{10,000}\right)$



L : Width of Spillway : 70.5 m

Wd : Water Depth of Spilling: 5.5 m

° Conduit

ø : Diameter of Pipe : 1,420 mm one conduit

(3) Sediment Load for Al Bassierah

The specific sediment load of Al Bassierah Dam is estimated in accordance with the Design Criteria of Fill dam prevailing by the Ministry of Agriculture, Forestries and Fisheries, Japan.

The specific sediment load of a drainage basin, Y, is defined by the following equation;

$$Y = aX + b \pm c$$

Where, X: physiographic coefficient
a, b and c: the factors defined by the geology, topographic undulation, rainfall and air temperature as shown in Table A.4.4-1 and 4.4-2.

The physiographic coefficient, X, is decided by the following equation;

$$X = X_1 \cdot X_2 \qquad (2)$$

Where, X_1: topographic undulation factor which is estimated by the equation below;

$$X_1 = \Sigma fi \cdot xi/\Sigma fi \qquad (2\cdot1)$$

Where xi: specific undulation which is defined to be the height difference of undulation in an unit area of 4 km by 4 km.

fi: the number of undulation within the unit area.

X_1 of the Al Bassierah basin is estimated to be 4.097 as listed in Table A.4.4-3.

X_2: altitude is defined to be the weighted mean unit area altitude which is estimated as the mean value of the maximum and minimum altitude of the 16 - sq.km unit area, i.e.

$$X_2 = \Sigma x'i \cdot f'i / \Sigma f'i \qquad (2\cdot2)$$

Where x'i: the unit area altitude
f'i: the number of the equal unit area altitude

X_2 of the Basin is evaluated to be 4.935 as shown in Table A.4.4-4

Therefore,

$$X = 4.097 \times 4.935 \doteqdot 20.2$$

The factors a, b and c are selected from Table A.4.4-1 and 4.4-2 to be

$a = 4.5$
$b = 150$
$c = 69$

Applying the aforesaid factors into the equation (1), the specific sediment load of the Basin, y, is

$$y = 4.5 \times 20.2 + 150 \pm 69$$
$$= 310 - 172 \text{ (cu.m/sq.km/annum)}$$

The annual sediment load at the Al Bassierah Dam site is deemed to be

$$(310 - 172) \times 122 \text{ (sq.km)} = 38{,}000 - 21{,}000 \text{ (cu.m)}$$

Considering from the small rainfall depth of the Basin, the least amount of 21,000 cu.m/annum is taken to be the design sediment load of the dam.

TABLE A.4.4-1 Typical Grouping of Sediment Load

Group	Geology	Undulation	Rainfall	Air Temperature	Geomor-Phology
A	Plutonic, Semi-plutonic and Metamorphic rocks	high	high	low	Mountainous
B	-do-	medium	low	moderately high	-do-
C	-do-	low	-do-	high	hilly
D	Paleogoic	high	-	-	-
E	-do-	low	-	-	-

TABLE A.4.4-2 Assumed Equation for the Typical Group

Group	Sediment Load Factors		
	a	b	c
A	6.6	- 934	± 166
B	11.8	- 543	± 49
C	4.5	+ 150	± 69
D	10.1	+ 150	± 69
E	9.9	- 77	± 51

TABLE A.4.4-3 Undulation Factor

Altitude	xi	fi	xi·fi
100 - 199	2	4	8
200 - 299	3	8	24
300 - 399	4	9	36
400 - 499	5	5	25
500 - 599	6	3	18
600 - 699	7	1	7
700 - 799	8	0	0
800 - 899	9	1	9
Total		31	127

$$X_1 = \frac{\Sigma fi \cdot xi}{\Sigma fi} = \frac{127}{31} = 4.097$$

TABLE A.4.4-4 Altitude

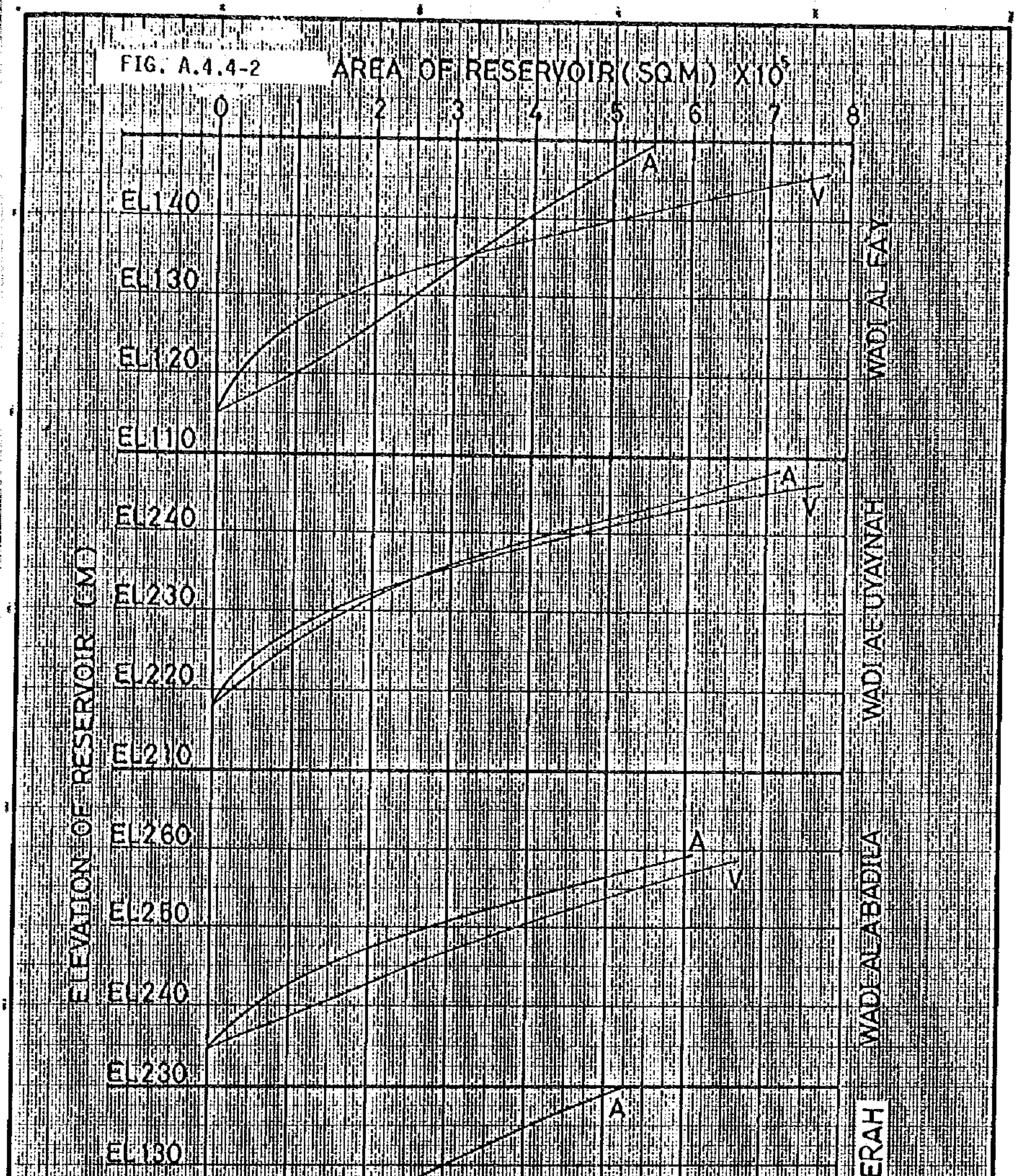
Altitude	xi'	fi'	xi'·fi'
100 - 199	2	1	2
200 - 299	3	4	12
300 - 399	4	6	24
400 - 499	5	9	45
500 - 599	6	9	54
600 - 699	7	0	0
700 - 799	8	2	16
Total		31	153

$$X_2 = \frac{\Sigma fi' \cdot xi'}{\Sigma fi'} = \frac{153}{31} = 4.935$$

TABLE A.4.4-5 The Unit Area Altitude

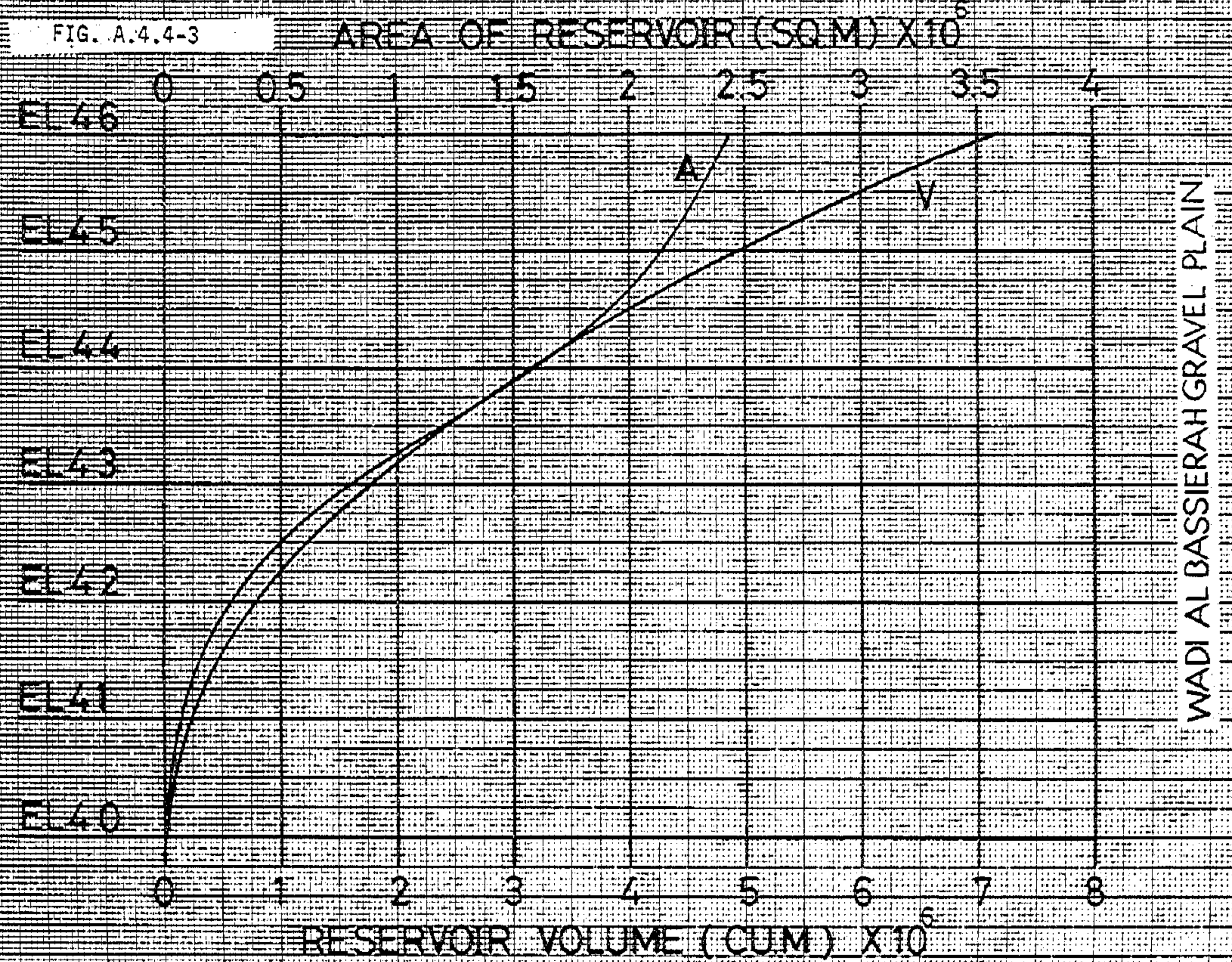
Unit Area No.	Max. Height (m)	Min. Height (m)	Undulation (m)	Altitude (m)
1	284	110	174	197
2	390	120	270	255
3	505	150	355	327.5
4	644	130	514	387
5	331	160	171	245.5
6	605	240	365	422.5
7	726	200	526	463
8	433	160	273	296.5
9	360	160	200	260
10	586	220	366	403
11	862	240	622	551
12	541	206	335	373.5
13	435	190	245	312.5
14	639	220	419	429.5
15	1,122	320	802	721.0
16	496	220	276	358
17	520	220	300	370
18	648	250	398	449
19	799	260	539	529.5
20	640	260	380	450
21	480	320	160	400
22	569	280	289	424.5
23	735	280	455	507.5
24	620	300	320	460
25	613	400	213	506.5
26	834	340	494	587
27	720	320	400	520
28	710	460	250	585
29	683	360	323	521.5
30	956	480	476	718
31	642	480	162	561
Mean			357	

FIG. A.4.4-2



AREA OF RESERVOIR (SQM) X10⁵
0
1
2
3
4
5
6
7
8
EL140
EL130
EL120
EL110
A
V
WADI AL FAY
EL240
EL230
EL220
EL210
A
V
WADI AL UYAYNAH
EL260
EL250
EL240
EL230
A
V
WADI AL ABADILA
EL130
EL120
EL110
EL100
A
V
WADI AL BASSIERAH
ELEVATION OF RESERVOIR (EM)
0
1
2
3
4
5
6
7
8
RESERVOIR VOLUME (CUM) X10⁶

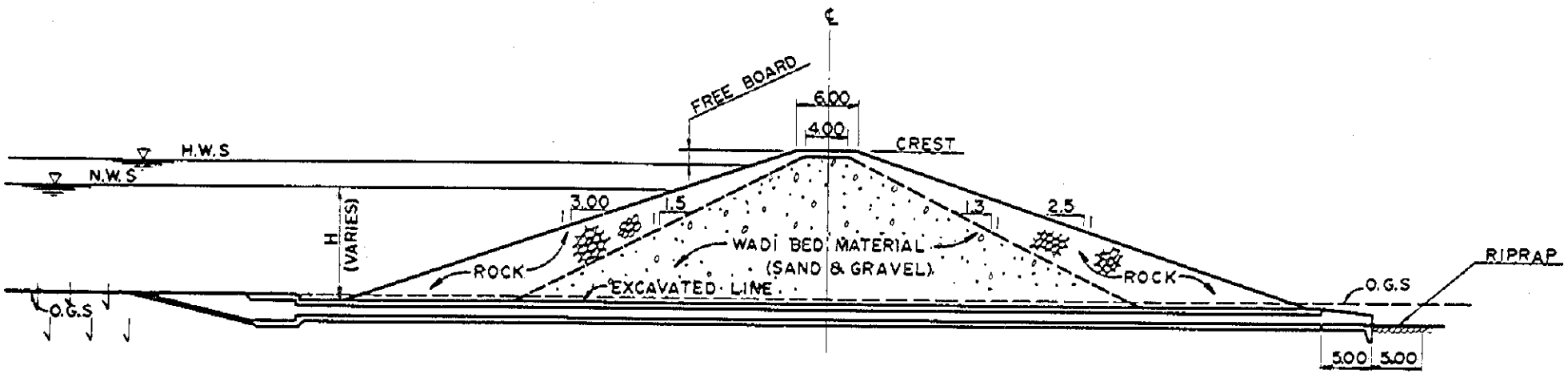
FIG. A.4.4-3



AREA OF RESERVOIR (SQ.M) X10^6
0 0.5 1 1.5 2 2.5 3 3.5 4
EL46
EL45
EL44
EL43
EL42
EL41
EL40
A
V
WADI AL BASSIERAH GRAVEL PLAIN
0 1 2 3 4 5 6 7 8
RESERVOIR VOLUME (CU.M) X10^6

FIG. A.4.4-4

DETENTION DAM
TYPICAL SECTION



Notes: (1) H.W.S. : High Water Surface
(2) N.W.S. : Normal Water Surface
(3) O.G.S. : Original Ground Surface
(4) Sand & Gravel materials in center core of dam shall be selected.
(5) Rock material in upstream and downstream shells shall be selected.

FIG. A.4.4-5 GRAIN CURVE OF WADI BED MATERIAL

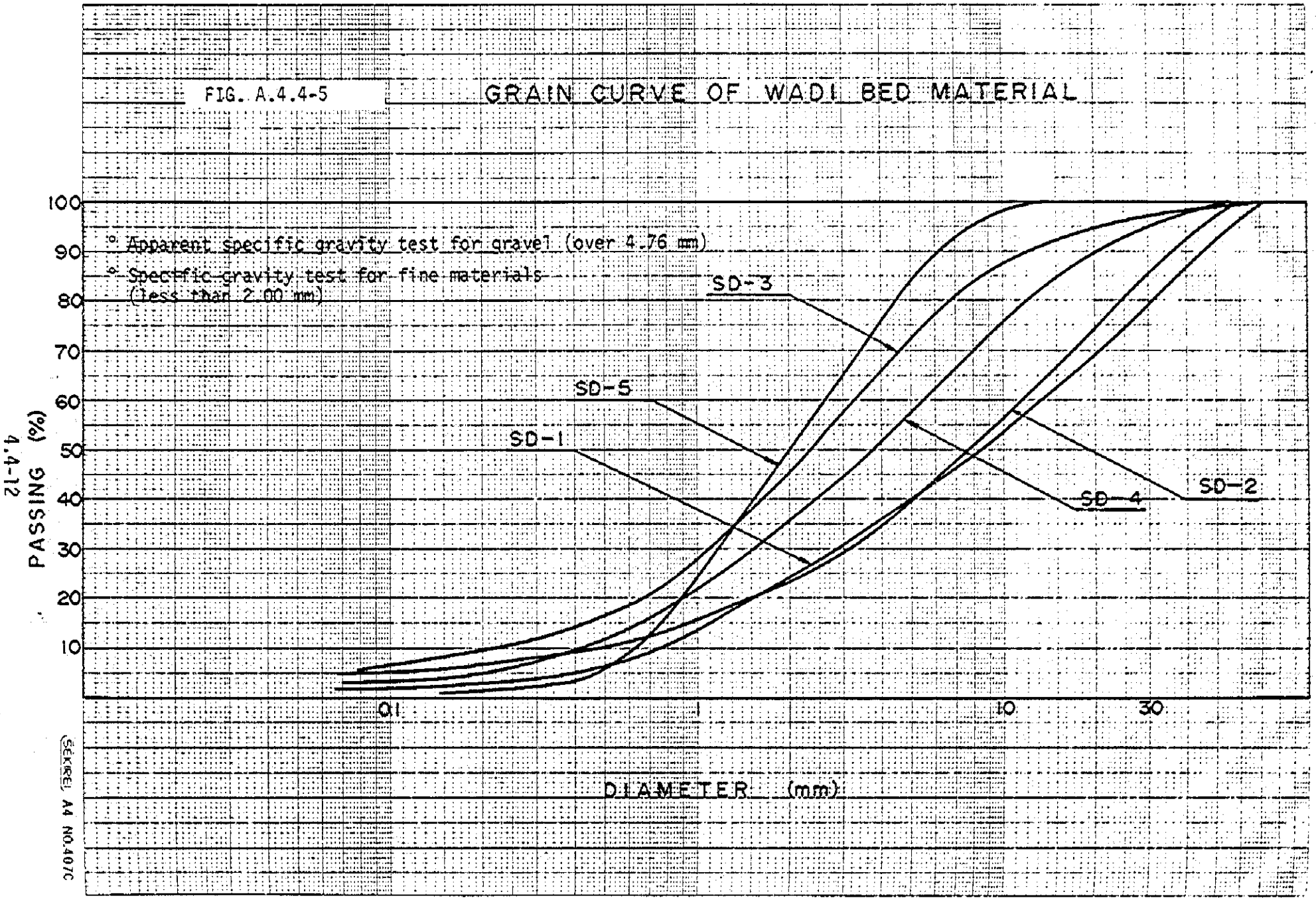


TABLE A.4.4-6 PROJECT COST

(Unit: 1,000 DH)

Item	Facilities for Augmentation of Recharge			Irrigation Facilities & Farm			Total		
	Bassierah Dam	Al Fay Pond	Sub-total	A	B	C	A	B	C
1) Direct Construction Cost	19,755	12,238	31,993	5,070	4,470	4,770	37,063	36,463	36,763
2) Administrative & Engineering Expenses									
Administrative Exp. (5% of 1)	988	612	1,600	254	223	239	1,854	1,823	1,839
Engineering Expenses (10% of 1)	1,976	1,224	3,200	507	447	477	3,707	3,647	3,677
Sub-total	2,964	1,836	4,800	761	670	716	5,561	5,470	5,516
3) Contingencies (15% of 1)	2,964	1,836	4,800	761	670	716	5,561	5,470	5,516
Total	25,683	15,910	41,593	6,592	5,810	6,202	48,185	47,403	47,795

TABLE A.4.4-7 PROJECT COST OF BASSIERAH DAM

(Unit: 1,000 DH)

Description	Unit	Quantities	Amount
1. Direction Construction Cost			
1) Dam Body			
Stripping	cu.m	110,000	850
Common Excavation	"	56,000	260
Rock Excavation	"	400	70
Embankment (S/G)	"	370,000	5,510
" (Rock)	"	210,000	5,260
" (Filter)	"	59,000	1,290
" (Riprap)	"	41,000	1,470
Concrete	"	300	90
Others			85
Sub-total			14,885
2) Spillway			
Rock Excavation	cu.m	73,000	1,630
Reinforced Concrete	"	2,000	750
Gabion	"	5,500	950
Others			250
Sub-total			3,580
3) Conduit			
Earth Works	cu.m	5,100	30
Concrete Works	"	700	730
Gabion	"	2,600	450
Others			80
Sub-total			1,290
4) Total			19,755
2. Administrative and Engineering Expenditures			
5)	(5% of (4))		988
6) Engineering Expenses	(10% of (4))		1,976
7) Total			2,964
3.Contingency			
8) Contingency (15% of (4))			2,964
Grand Total [(4) + (7) + (8)]			25,683

TABLE A.4.4-8 PROJECT COST OF AL FAY POND

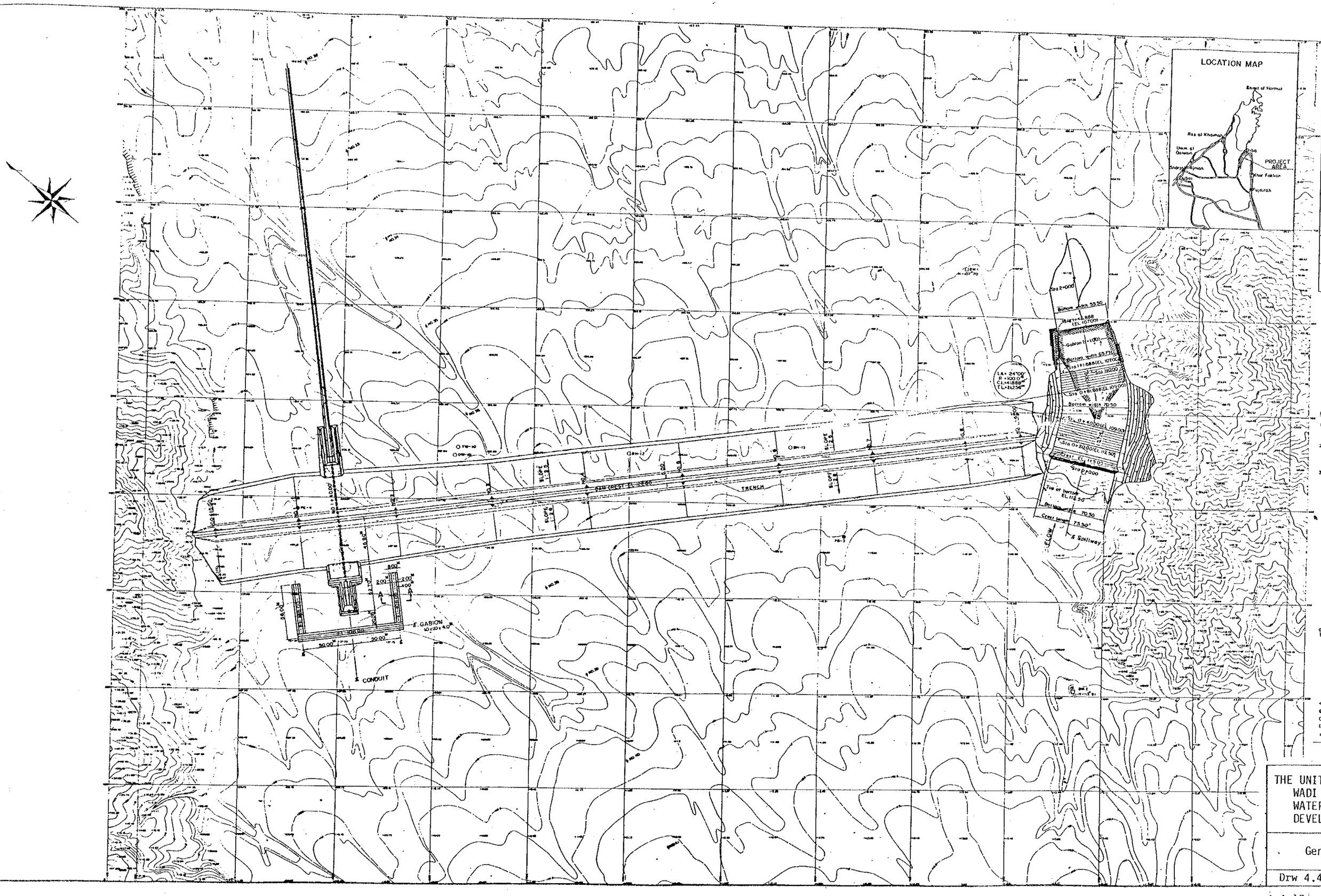
(Unit: 1,000 DH)

	Description	Unit	Quantity	Amount
1.	Direct Construction Cost			
	(1) Stripping	cu.m	71,120	566
	(2) S/G Embankment	"	398,560	6,098
	(3) Rock Embankment	"	15,280	458
	(4) Riprap (A)	"	67,600	3,042
	(5) Riprap (B)	"	1,280	442
	(6) Gabion	"	6,080	1,076
	(7) Filter	"	16,000	480
	(8) Gravel Paving	"	1,840	76
	(9) Sub-total			12,238
2.	Administrative and Engineering Expenditures			
	(10) Administrative Expenses	(5% of (9))		612
	(11) Engineering Expenses	(10% of (9))		1,224
	(12) Sub-total			1,836
3.	Contingency			
	(13) Contingency	(5% of (9))		1,836
	Total [(9) + (12) + (13)]			15,910

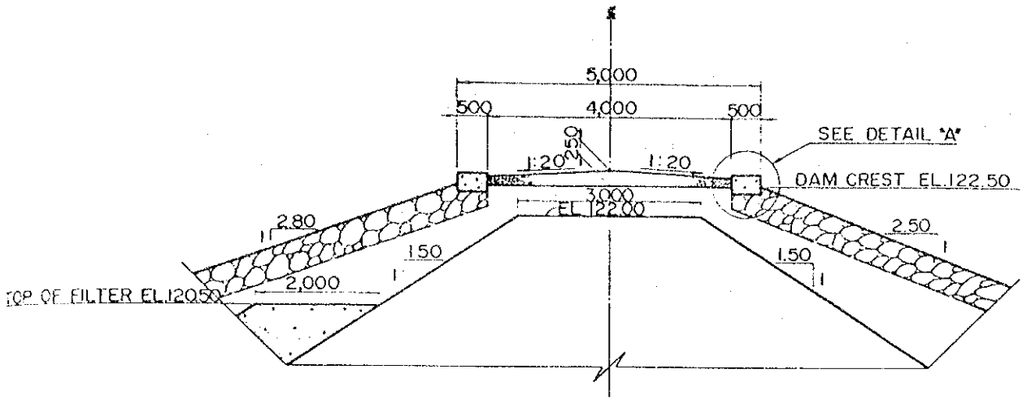
TABLE A.4.4-9 PROJECT COST OF PREPARATION AND IRRIGATION FASILITY

(Unit: 1,000 DH)

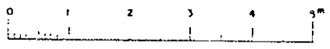
Description	Unit	Quantity			Amounts		
		Plan A	Plan B	Plan C	Plan A	Plan B	Plan C
1. Direct Construction Cost							
1) Well and Pumps	set	3	3	3	570	570	570
2) Land Preparation, and,							
3) Irrigation Facility	ha	75	65	70	4,500	3,900	4,200
4) Sub-total					5,070	4,476	4,770
2. Administrative and Engineering Expenses							
5) Administrative Expenses	(5% of (4))				254	223	239
6) Engineering Expenses	(10% of (4))				507	447	477
7)Sub-total					761	670	716
3. Contingency							
8) Contingency	(15% of (4))				761	670	716
Total	[(4) + (7) + (8)]				6,592	5,810	6,202


LOCATION MAP
Strait of Hormuz
Ras al Khaimah
Umm al Quwain
Dubai
Sharjah / Ajman
Khor Fakkan
Fujairah
PROJECT AREA
Sta 21+000
Bottom width 53.50
Sta 19+848.888
EL 107.00
Gabion
Bottom width 59.71
Sta 19+888 EL 107.00
Sta 19+000
Sta 0+818.888 EL 109.00
Bottom width 70.50
Sta 0+400 EL 109.00
Crest EL 113.00
Sta 0+000
Top of berm EL 114.50
Bottom width 70.50
Crest length 73.50
Spillway
FLOW
LA = 24.00°
R = 100.00
CL = 41.888
EL = 21.256
GAN CREST EL 112.60
TRENCH
SLOPE 1:2.5
SLOPE 1:2.0
E GABION
10.00 x 4.0
CONDUIT
THE UNITE
WADI A
WATER
DEVELO
Gene
Drw 4.4-

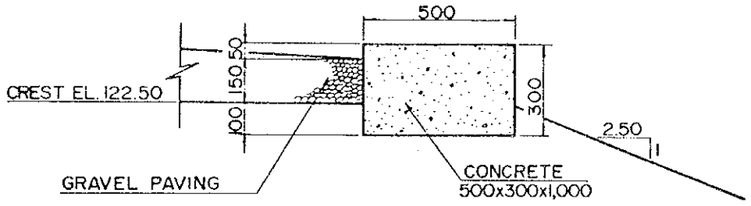

LOCATION MAP
Sea of Hormuz
Ras al Khaimah
Emirate of Ajman
Emirate of Sharjah
PROJECT AREA
Wadi Fakkan
Fujairah
TABLE OF DIMENSIONS
GENERAL
LOCATION
RIVER
GEOLOGY
DAM SITE
RESERVOIR
CATCHMENT AREA
F.W.L. AREA
F.W.S. EL.
EFFECTIVE CAPACITY
DAM BODY
TYPE
HEIGHT
CREST LENGTH
CREST WIDTH
CREST EL.
FOUNDATION TREATMENT
CONCRETE CUT-OFF TRENCH
SPILLWAY
TYPE
DESIGN FLOOD
CREST EL.
CONDUIT
NO.
DIA.
DESIGN OUT-FLOW
EL. 11500 M
EL. 10300 M
EL. 11500 M
m³/sec
BENCH MARK
BENCH MARK
ELEVATION (m)
NO. 1
EL. 107.70
NO. 2
EL. 113.91
NOTES
1. ALL STATIONS, ELEVATIONS AND DIMENSIONS ARE GIVEN IN METERS
2. THE STATION NUMBERS ARE READ FROM LEFT BANK TO RIGHT BANK.
3. DAM CREST ELEVATION ON THIS DRAWING ARE INCLUDING EXTRA BANKING (MAX. EXTRA BANKING IS 30m)
SCALE
LEGEND
POWER POST
FLOOD GAUGE
TEST WELL
BENCH MARK
BENCH MARK FOR PROPOSED DAM AXIS
SUPPLEMENTARY CONTOURLINE
THE UNITED ARAB EMIRATES
WADI AL BASSIERAH
WATER RESOURCES
DEVELOPMENT PROJECT
General Plan
Drw 4.4-1
JICA



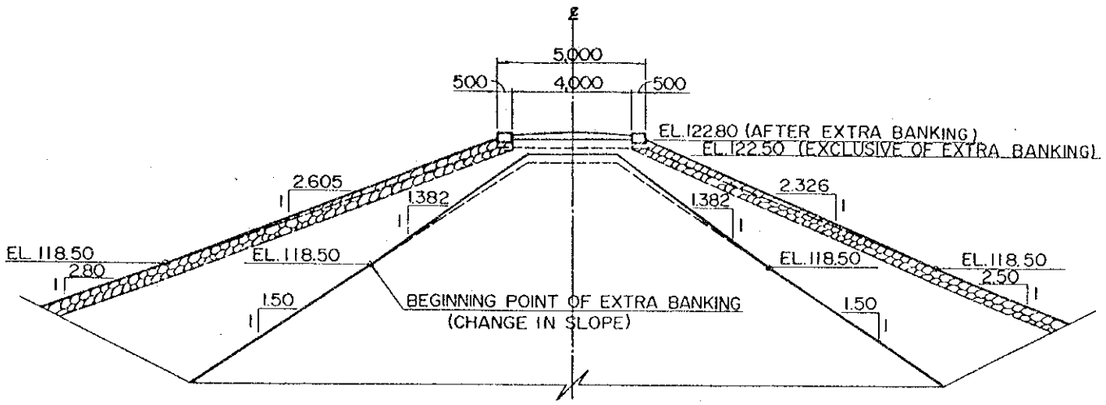
DETAIL OF CREST



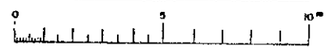
SCALE



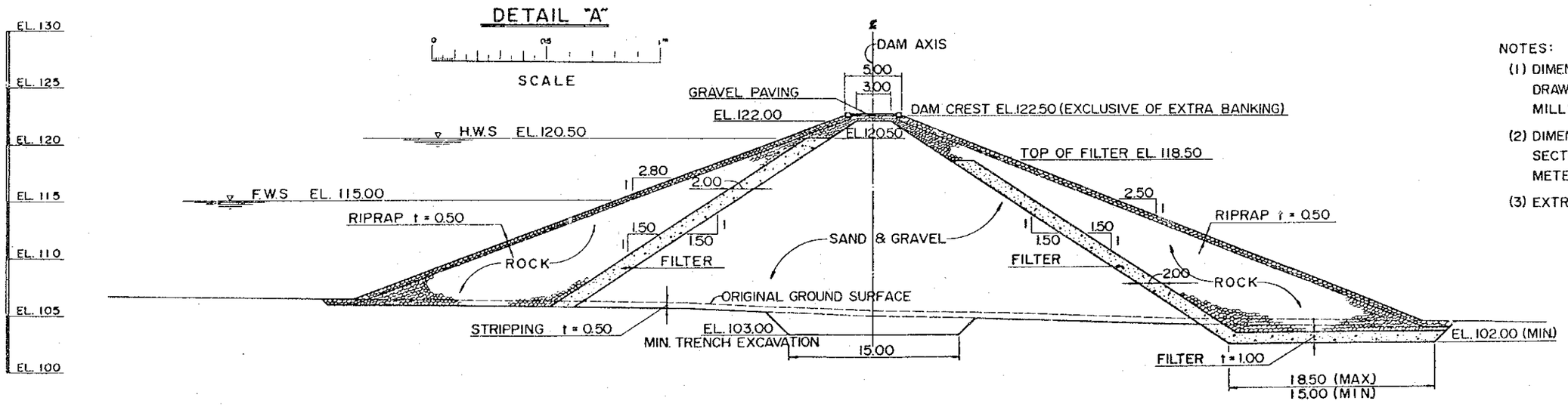
DETAIL "A"



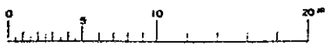
DETAIL OF EXTRA BANK



SCALE



TYPICAL SECTION



SCALE

NOTES:

(1) DIMENSIONS OF DETAIL DRAWINGS ARE GIVEN IN MILLIMETER.

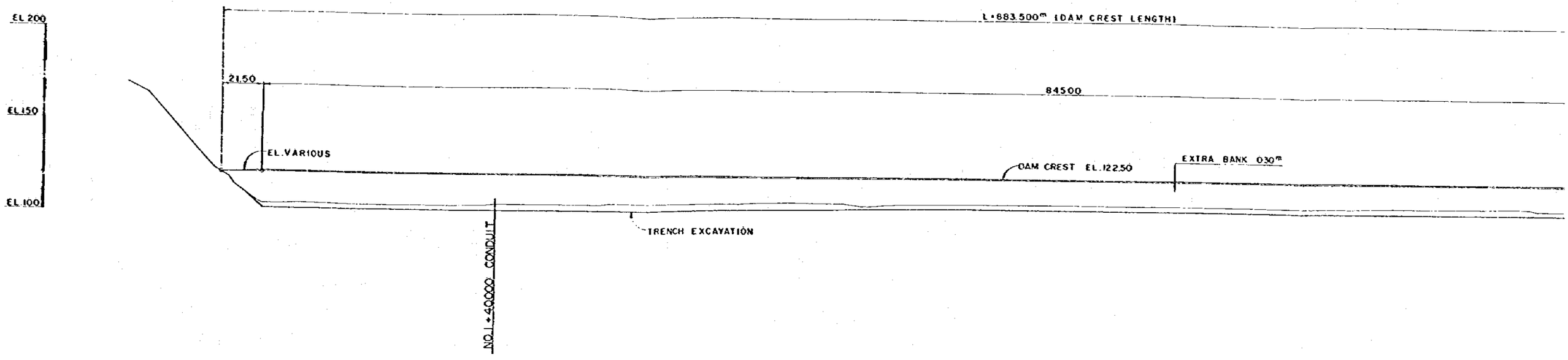
(2) DIMENSIONS OF TYPICAL SECTION ARE GIVEN IN METER.

(3) EXTRA BANKING IS MAX. 30cm

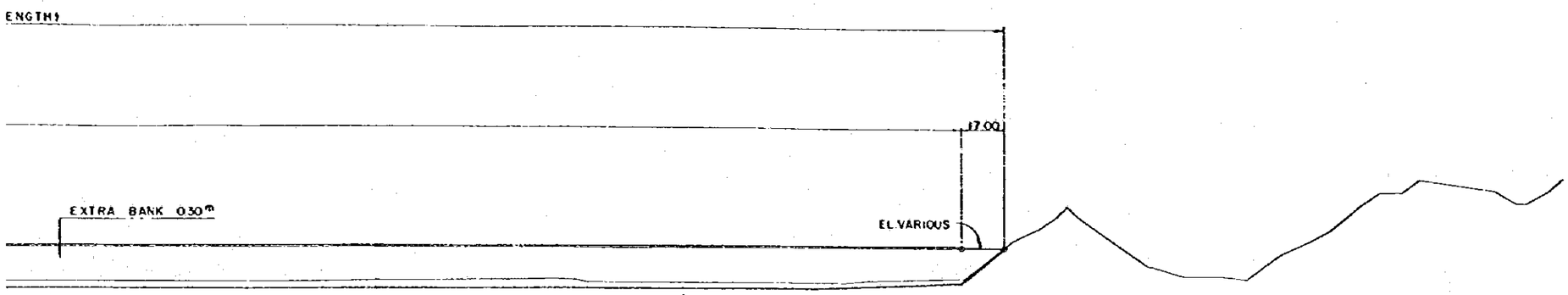
THE UNITED ARAB EMIRATES
WADI AL BASSIERAH
WATER RESOURCES
DEVELOPMENT PROJECT

Typical Section

Drw 4.4-2 | JICA



DAM CREST ELEVATION	122.500 122.590	122.800	122.800	122.800	122.800	122.800	122.800	122.800	122.800	122.800
TRENCH EXCAVATION ELEVATION	—	103.000	103.000	103.000	103.000	103.000	106.000	106.000	106.000	106.000
GROUND ELEVATION	122.500 115.500	105.000	106.000	106.000	108.500	108.500	108.500	108.500	108.500	109.500
TOTAL DISTANCE	0.000 10.000	25.000	110.000	150.000	210.000	310.000	410.000	510.000	610.000	710.000
DISTANCE	0.000 10.000	15.000	85.000	40.000	100.000	100.000	100.000	100.000	100.000	100.000
STATION	-6.500 NO. 0	+15.000	NO. 1	+40.000	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7



122.800	122.800	122.800	122.800	122.800	122.500				
106.000	106.000	106.000	106.000	106.000	123.500				
108.500	108.500	109.500	108.000	110.000	122.500	137.000		123.700	
510.000	610.000	710.000	810.000	870.000	887.000	910.000		1010.000	
100.000	100.000	100.000	100.000	60.000	17.000	20.000		100.000	
NO. 5	NO. 6	NO. 7	NO. 8	+60.000	+77.000	NO. 9		NO. 10	

NOTE : ALL DIMENSIONS ARE GIVEN IN METER

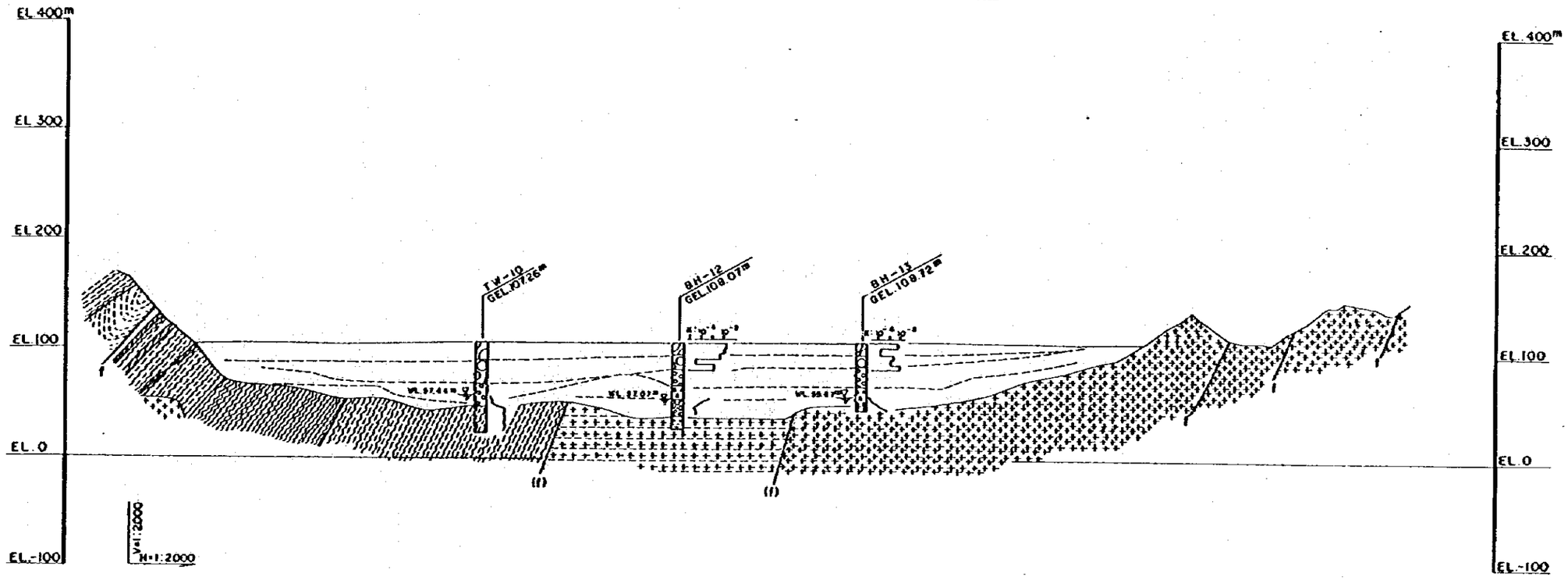
0 50 100M
SCALE 1:1000

THE UNITED ARAB EMIRATES
WADI AL BASSIERAH
WATER RESOURCES
DEVELOPMENT PROJECT

Longitudinal Profile of Dam Axis

Drw 4.4-3 | JICA

GEOLOGICAL PROFILE ALONG THE DAM AXIS



LEGEND

- RECENT WADIBED DEPOSIT
- LOWER TERRACE DEPOSIT
- UPPER TERRACE DEPOSIT
- TALUS DEPOSIT
- OLD TERRACE DEPOSIT (CONGLOMERATE FORMATION)
- SERPENTINITE
- SERPENTINITE/CLAY
- QUARTZ SCHIST/OTHER SCHISTS
- GREEN SCHIST
- QUARTZ SCHIST
- FAULT
- FAULT (ASSUMED)
- GEOLOGICAL BOUNDARY

T W TEST WELL
B H BORE HOLE

0 100 200m
SCALE 1:1000

THE UNITED ARAB EMIRATES
WADI AL BASSIEAH
WATER RESOURCES
DEVELOPMENT PROJECT

Geological Profile
along the Dam Axis

Drw 4.4-4 | JICA

FIG. A.4.4-6 TYPICAL MONITORING WELL FOR SALT-WATER INTRUSION

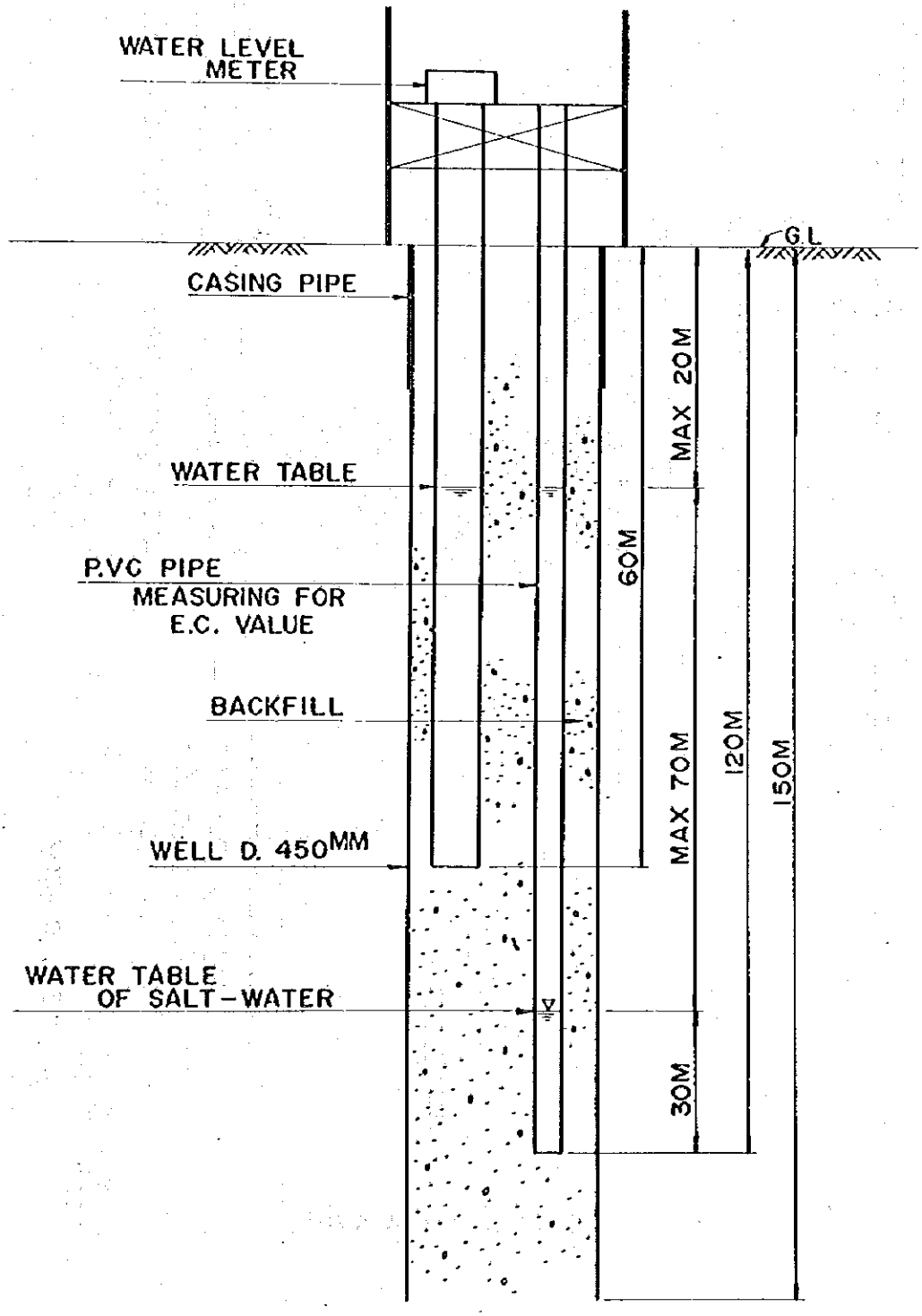


FIG. A.4.4-7 WELL AND TYPICAL PUMPING STATION FOR NEW LAND

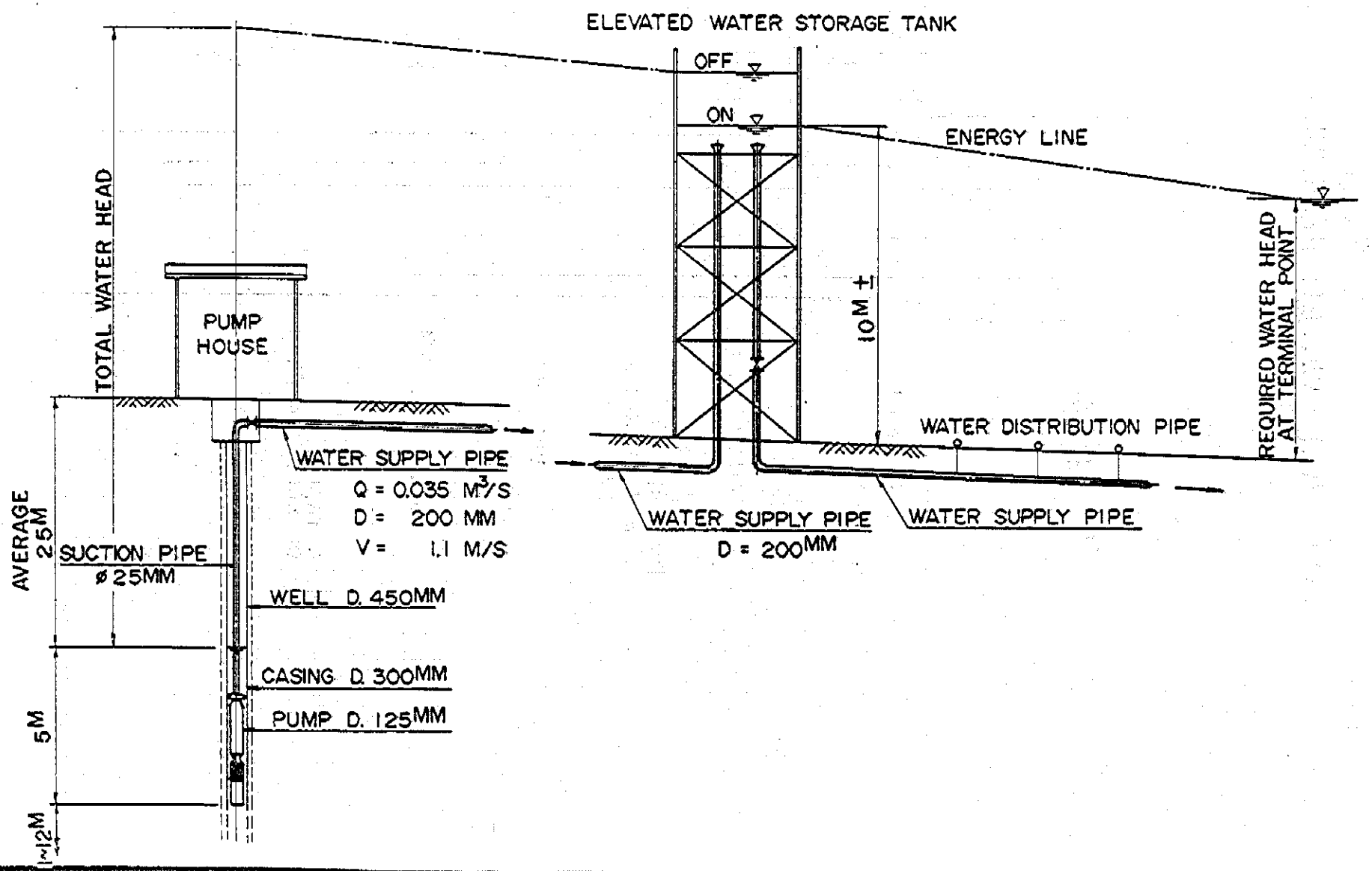


FIG. A.4.4-8 WELL AND TYPICAL PUMPING STATION FOR IMPROVEMENT IRRIGATION SYSTEM

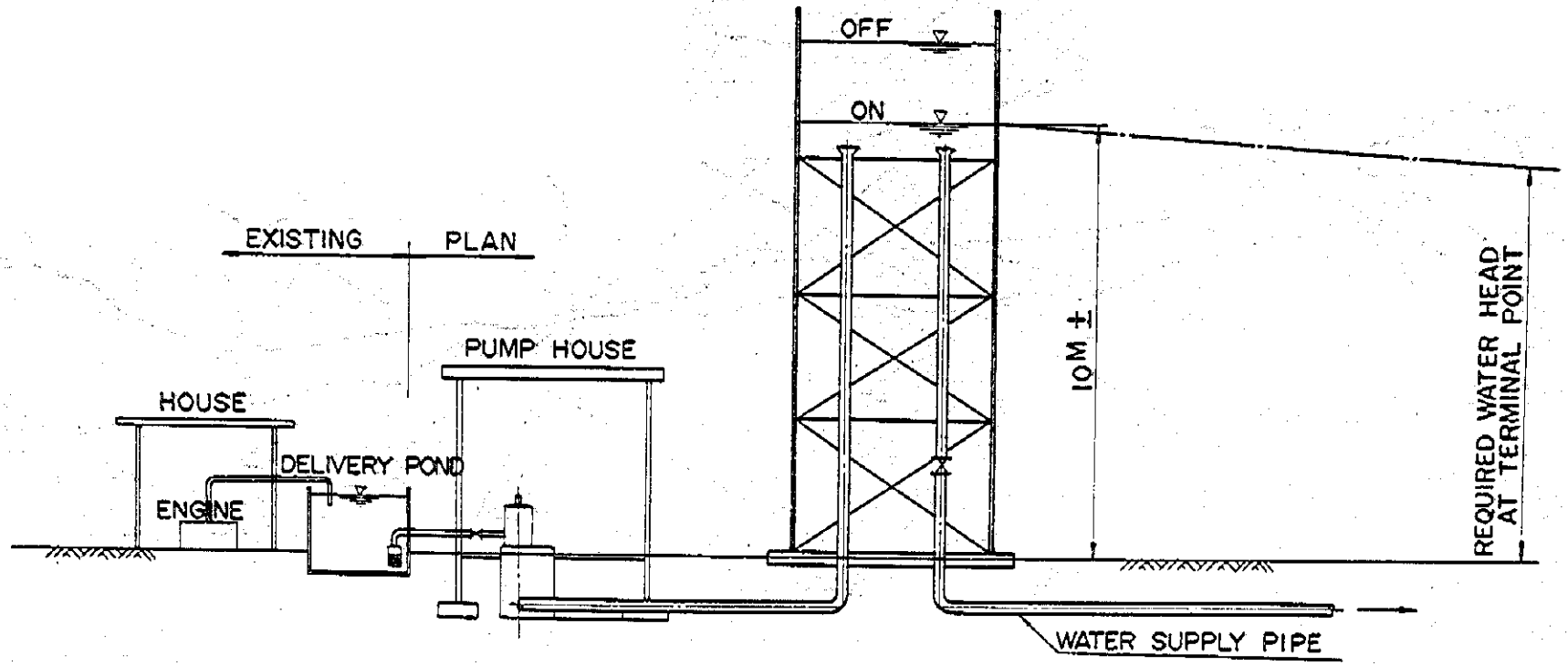
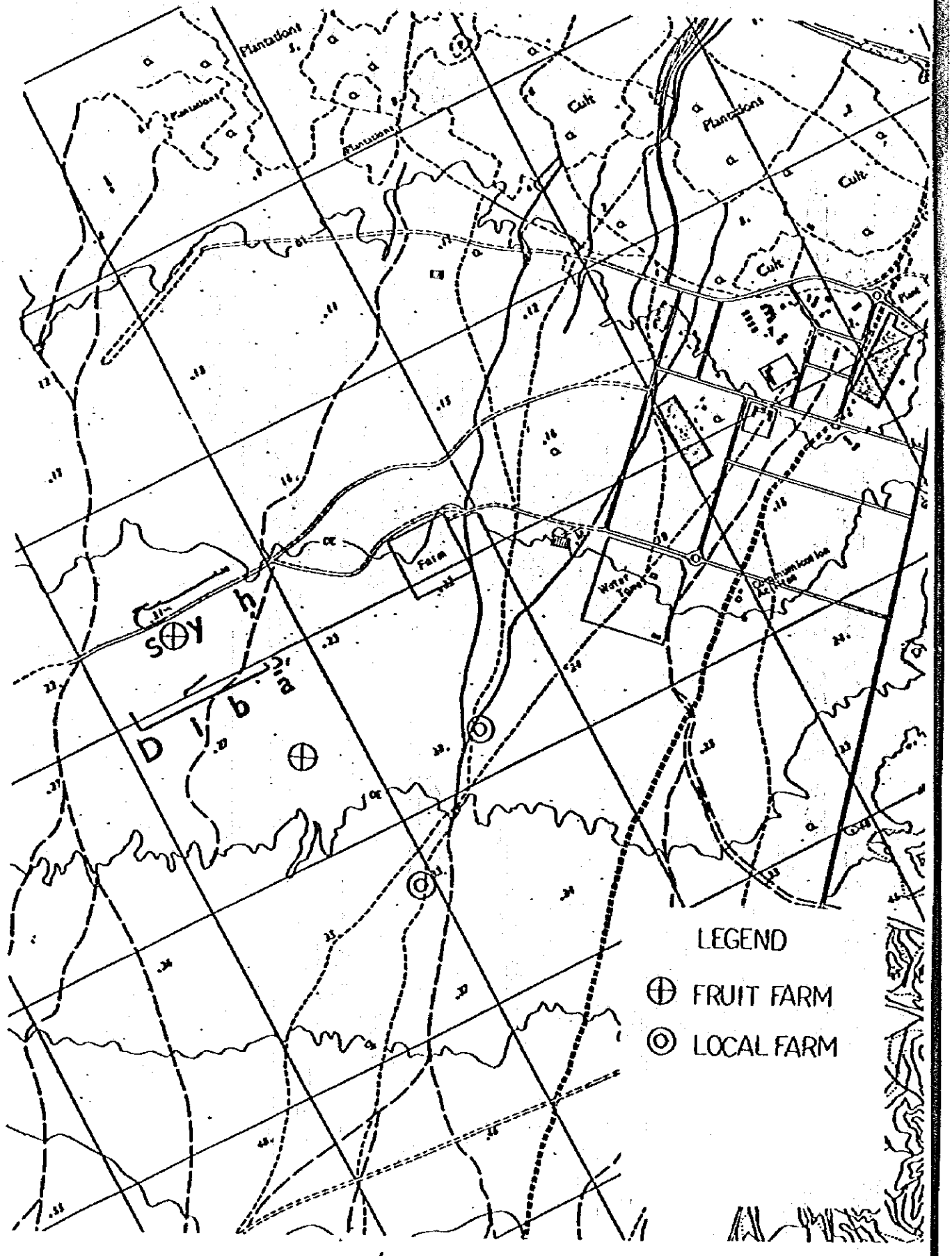
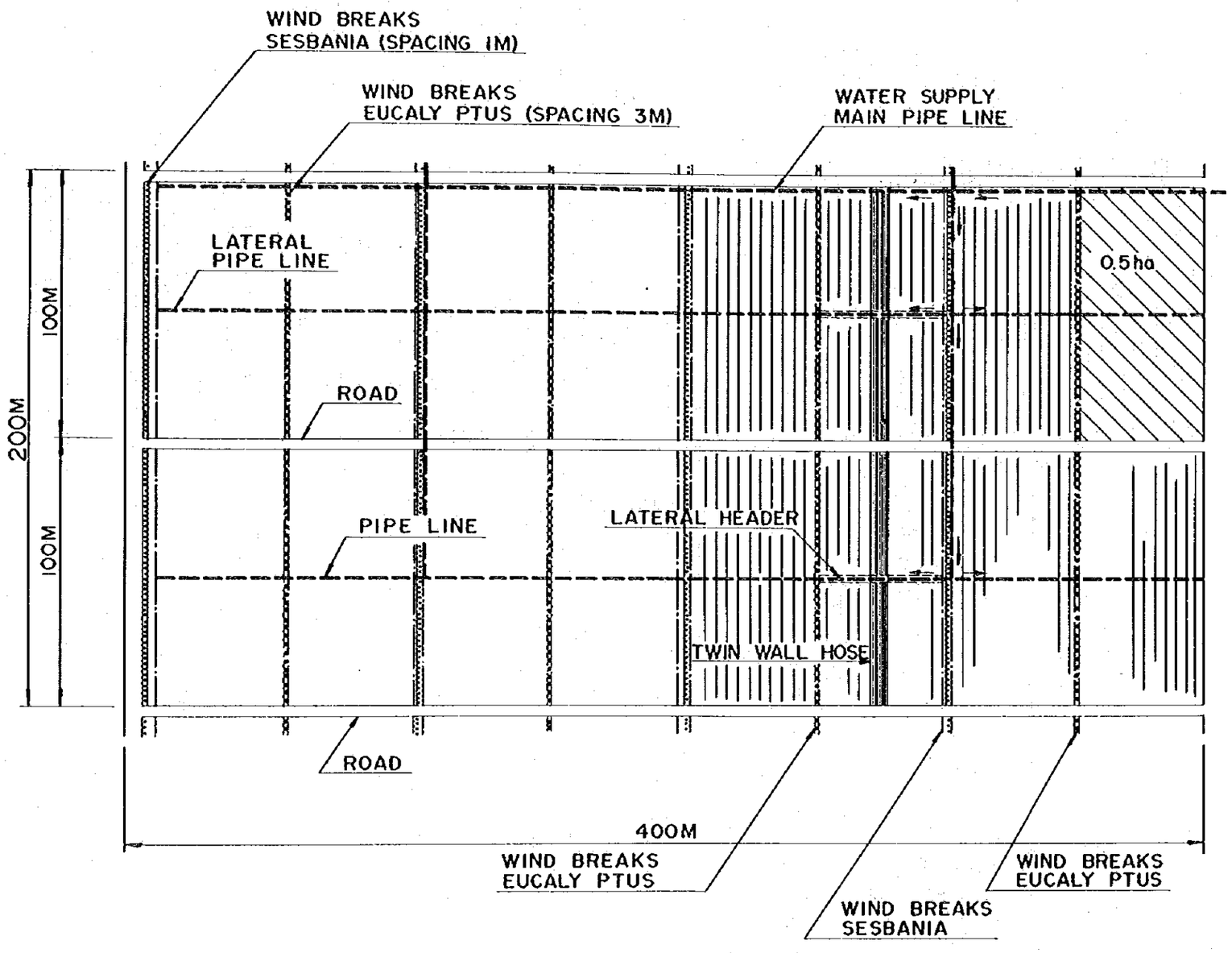


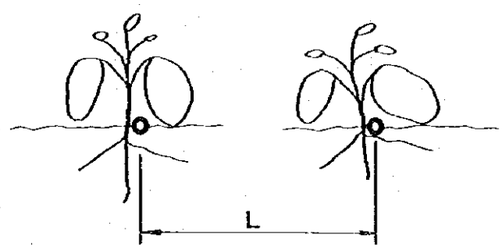
FIG. A.4.4-9 PRODUCTION WELL



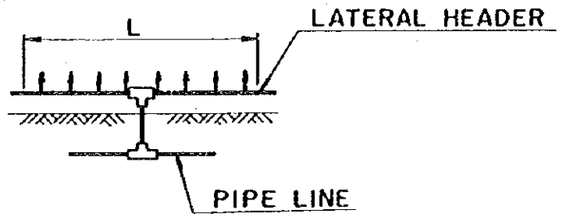
Drw 4.4-5

TYPICAL FARM OF VEGETABLE DRIP IRRIGATION SYSTEM



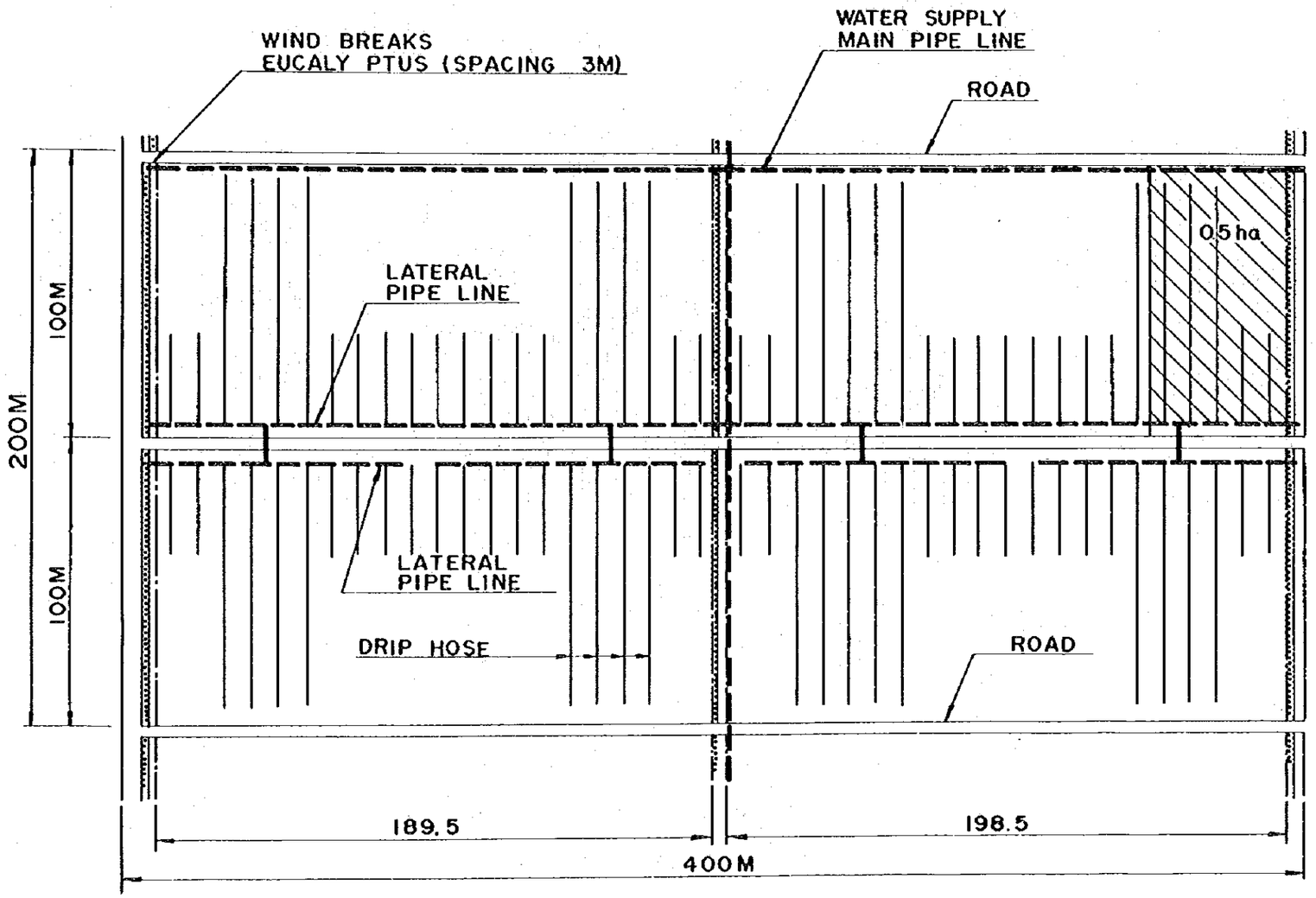


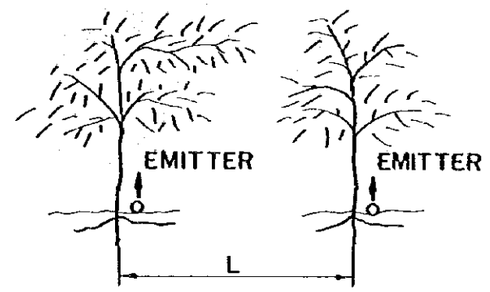
VEGETABLES	L = (M)
TOMATO	1.80
EGGPLANT	1.35
CABBAGE	1.70
CUCUMBER	1.70
MELON	1.70



Drw 4.4-6

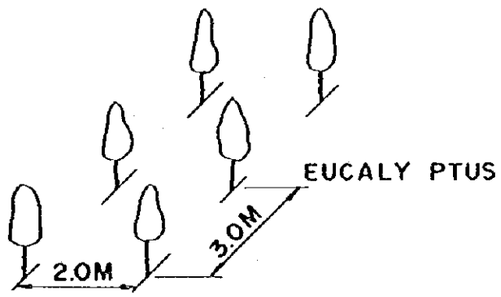
TYPICAL FARM OF CITRUS / MANGO DRIP IRRIGATION SYSTEM





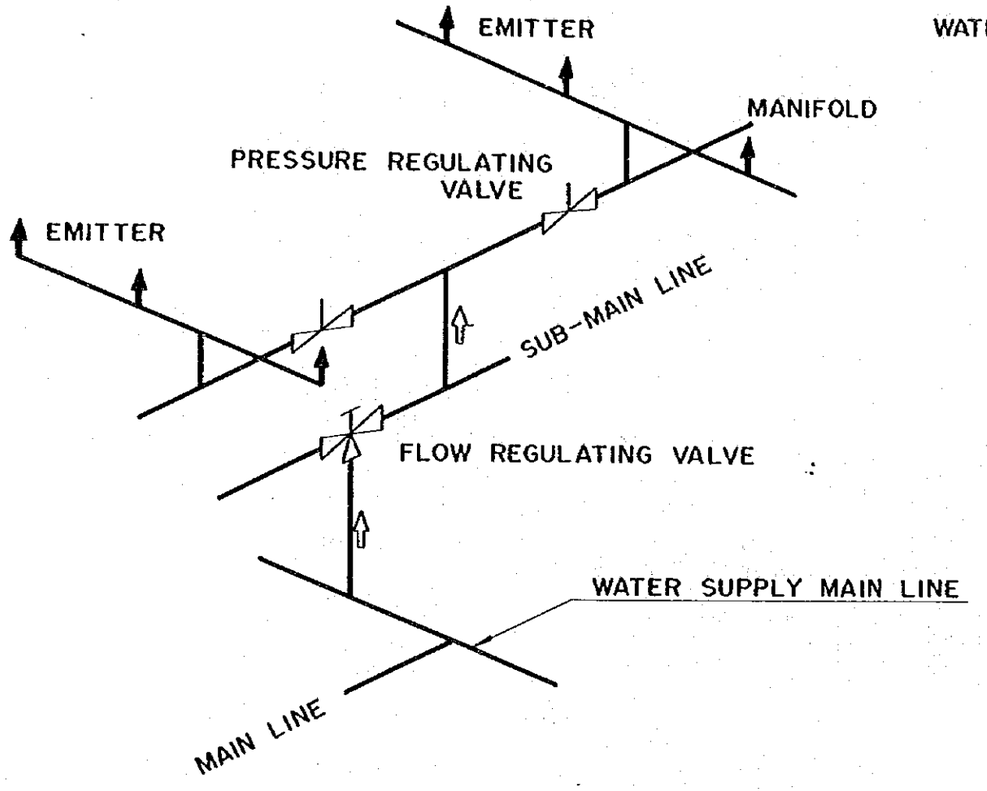
FRUITS	L = (M)
CITRUS	7.0 x 7.0
MANGO	7.0 x 7.0

WIND BREAKS

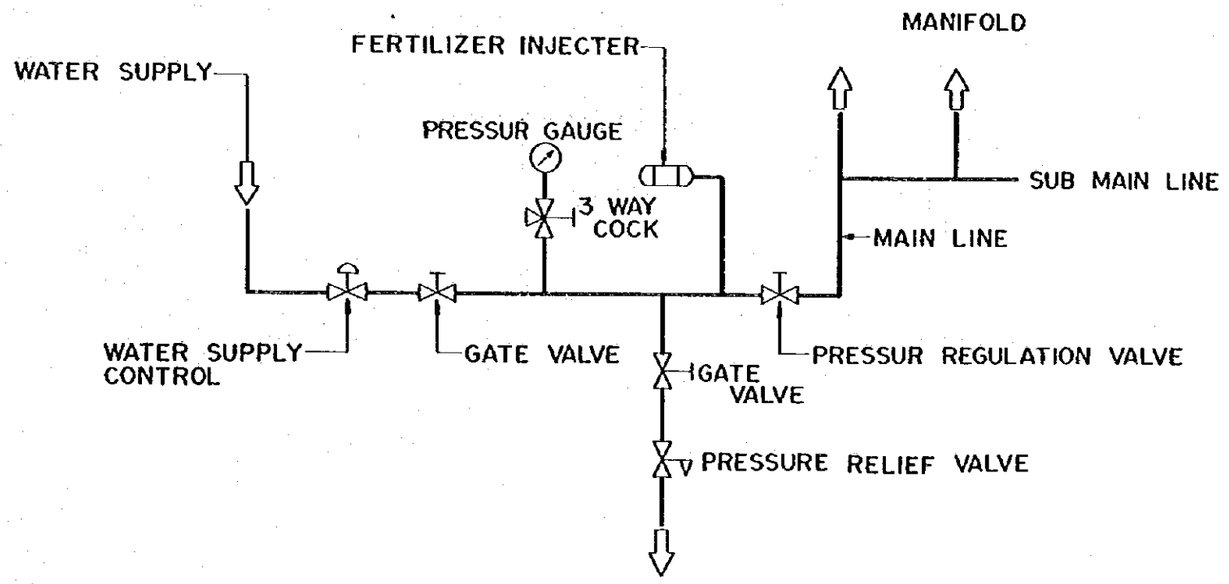


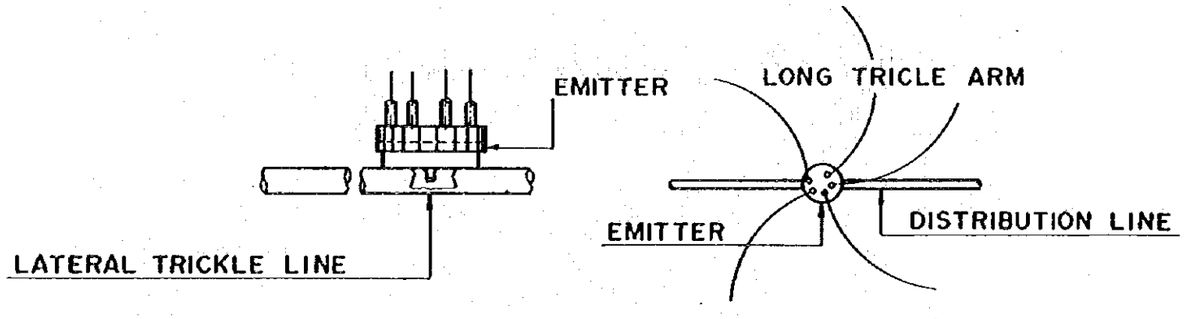
Drw 4.4-7 WATER SUPPLY DISTRIBUTION SYSTEM

EMITTER

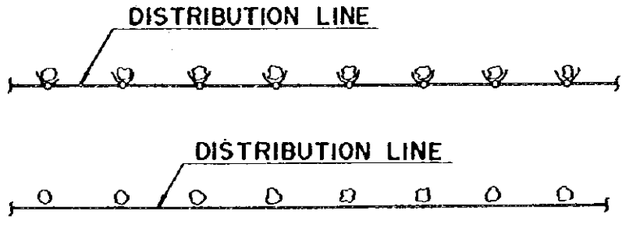


PIPE LINE





FRUITS



VEGETABLE

APPENDIX V PROJECT IMPLEMENTATION, OPERATION AND MAINTENANCE

List of Figures

FIG.A.5.1-2 PROJECT SCHEDULE FOR WADI AL BASSIERAH WATER RESOURCES DEVELOPMENT

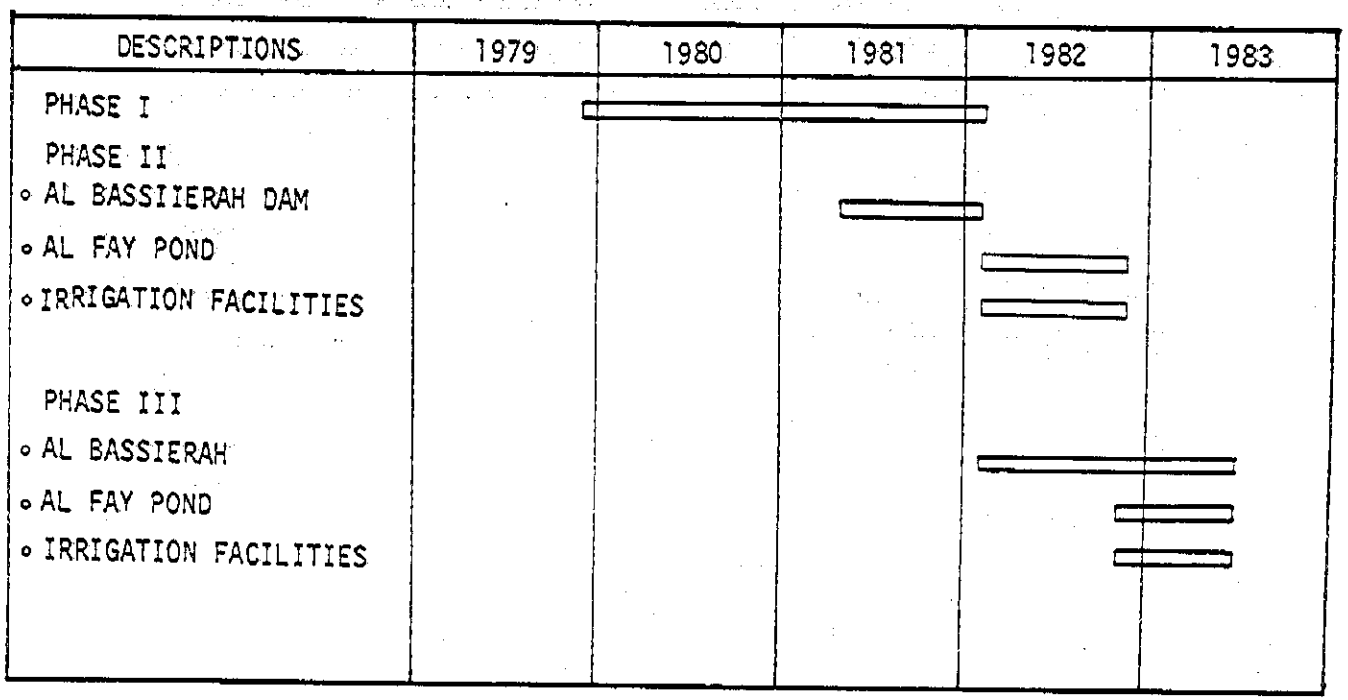
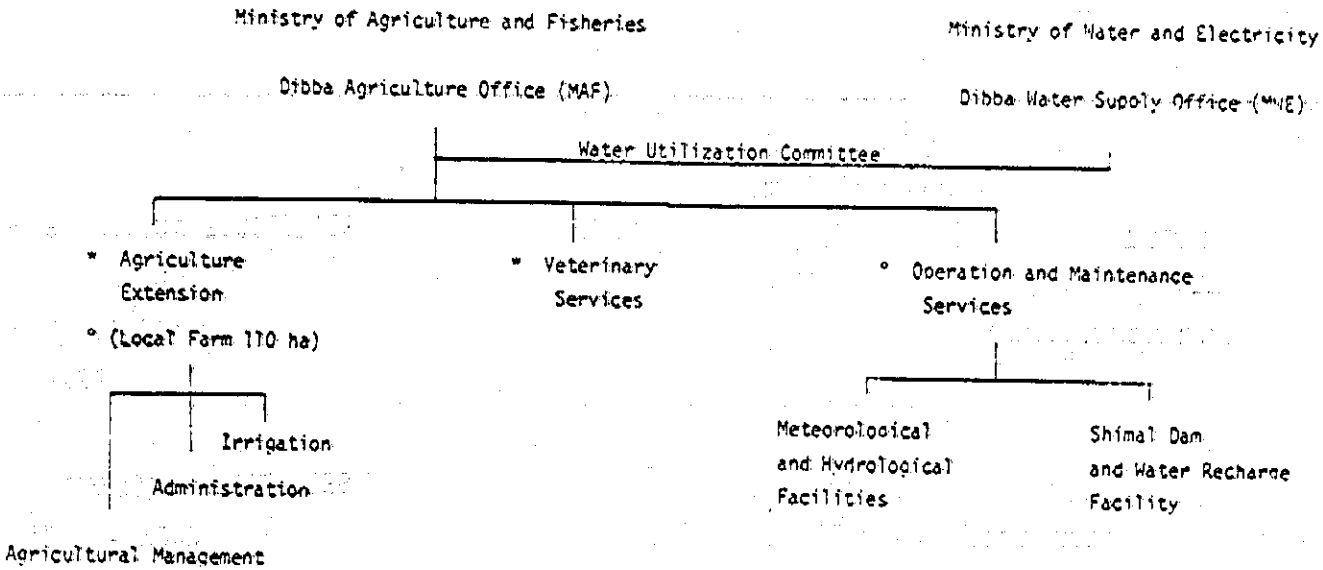


FIG. A.5.1-2 ORGANIZATION FOR OPERATION AND MAINTENANCE



Notes: (1) The mark * is existing organization.

(2) The mark ° is proposing new organization.

(3) The water utilization committee composed by the representatives of the MAF and MWE is proposing for the conservation of water utilization in the Wadi Shimal Basin.