L. STRUCTURE DESIGN

1. Roads

A road network is planned in conjunction with the proposed housing ares (Central, Service and Satelite village) and canal network.

Housing area is mainly located along the irrigation canals.

Proposed width of the road is as followings.

Name of road	Location	Proposed width
Connection road	Route 44 to project area	12.00 m
Trunk road	Along main and secondary canal and drain	10.00 m
O & M road	Along canal and drain	5.00 m

2. Irrigation Canals

Irrigation canals comprise three (3) types of the main, the secondary, and the tertiary canals.
The main canal, drawing irrigation water directly from El Salam Canal along which the source water for irrigation is running, will have 1,000 to 2,000 feddan of land as its beneficiary area. The spacing between the main canals will be 4-10 km, according to the location of the secondary canals, scale of satellite villages, and topographical conditions prevailing in the site. The main canals will be aligned at high altitude.

The secondary canal will be provided in right angle to the main canal, running for the distance of 2 - 5 km per line, with some 2 km interval between each other.

The tertiary canal will be provided with an interval of approx. 200m, each line commanding about 50 feddan.

Typical cross section of the main as well as secondary canal is shown in Fig.L-2-1. The minimum height of bank above water surface which is to be determined in reference to various factors such as storm-water inflow, water table fluctuation caused by checks, wind action, velocity, etc., may not require to be of very big value since these factors are generally found in favorable conditions. Respective values which have been arrived at by use of the graph adopted by the U.S. Bureau of

Reclamation (see Fig.L-2-2) are as follows:

Capacity	Height
0 - 1.5 m^3/sec	0.5 m
1.5 - 6.0	0.75
6.0 - 20.0	1.00
20.0 -	1.25

The main as well as secondary canals will be provided with maintenance road for operation and maintenance by use of back-hoe or drag-line.

Concrete-lining of the canal serves for prevention of percolation, weed control, and erosion control. The estimated amount of percolation from unlined canals (main and secondary canals inclusive) out of the total volume of irrigation water remains rather small at about 2%. Concrete-lining may be useful for weed-control purpose since the design velocity of water is 0.3 - 0.5 m/sec only. However, weed growth does not result solely from slow velocity of discharge as will be known from the fact that weeds grow on the mud deposited along the concrete-lined canals. Canal cleaning at the frequency of once or twice a year will solve weed problem along the canals, instead of spending some 47 million L.E. for concrete-lining of canal system (30 million L.E. for the main canals and 17 million L.E. for the secondary canals) which roughly corresponds to more than 20% of the total construction cost.

Proposed canal design criteria are as follows;

Shape of canal cross section............Trapezoidal shape
Side slope of canal......................3 (Horizontal) : 2 (vertical)
Adopted formula for discharge...........Manning formula
Roughness coefficient...................0.025
Unit discharge..........................44.6 m^3/day/fed.=0.516ℓ/sec/fed.

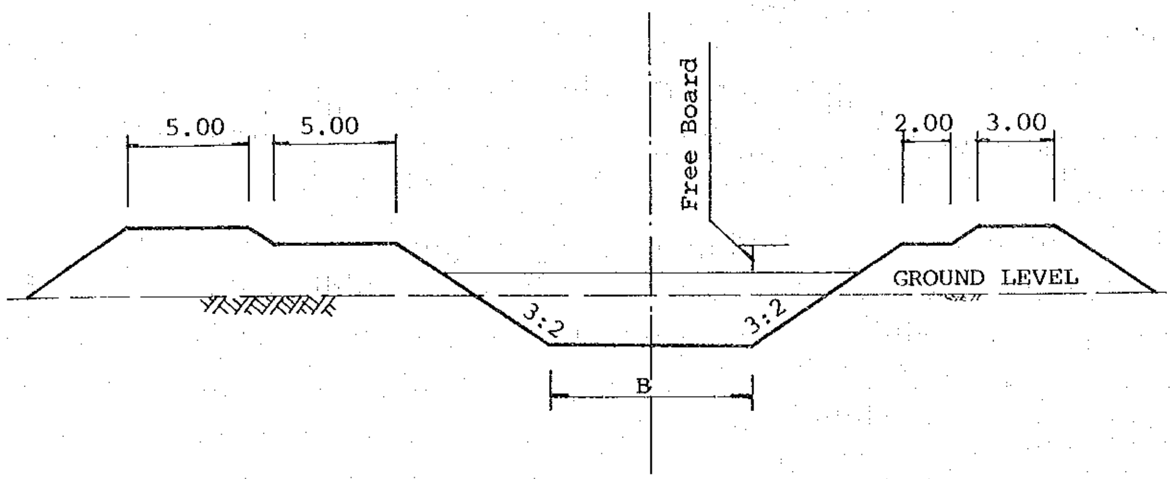


Fig. L-2-1 Typical Cross Section for Irrigation Canal

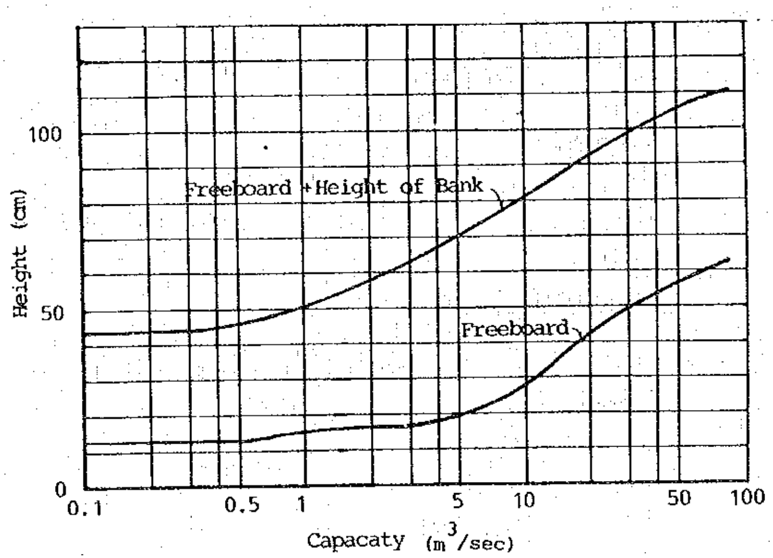


Fig.L-2-2 Recommended freeboard and height of bank of lined channels. (U.S. Bureau of Reclamation.)

3. Gravity vs. Lifting Irrigation

Main canal slope and its design height need to be determined by taking into consideration the following items:

i) Velocity

The minimum velocity required to control weed-growth would be 0.7 m/sec., while the maximum velocity permissible in protecting the canal from erosion could be 1.0 m/sec.

ii) Earthwork

Volume of earth obtainable from canal cutting will have to be equated to the volume of earth required for banking of dykes and roads. This is important to minimize construction cost.

iii) In-take Control & Management

To guarantee an equitable distribution of irrigation water towards peripheral parts of the beneficiary area, excessive intake of irrigation water will have to be prevented at each diversion point. This can be effected by use of various facilities including intake-gates along the canals as well as pumps to be installed at the canal terminals.

By combining the above considerations with the flat terrain obtainable in the Project area, three (3) alternative cases have been designed as follows:

Case 1: <u>Gravity irrigation through small sloped canals</u>
On the condition that the entire area will come under gravity irrigation; small velocity.

Case 2: <u>Gravity and Lifting Irrigation through large sloped canals</u>
Canal slope will be so arranged as to assure velocity of 0.4 - 0.5m/sec; majority of the beneficiary area will be covered by lifting irrigation.

Case 3 : <u>Lifting Irrigation through small sloped canals</u>

On the condition that the entire area will come under lifting irrigation; small velocity

Canal longitudinal section in each case is shown in Fig. L-3-1(1) thru. (6), its particualrs including slope, velocity, earthwork and economicality are given in Table L-3-1~3: Detailed Information pertaining to Three Alternative Cases.

a) Velocity

It is desirable to arrange the canal slope so that velocity will be increased over 0.7 m/sec. This is feasible by making the canal slope approx. 0.0002, but it must result in 6 m canal depth at the terminal of Main Canal M4, which is not satisfactory from the viewpoint of either safety or economicality. Therefore, alternative slope and velocity designed as Case 2 are 0.00014 - 0.0001 and 0.4 - 0.5 m/sec, respectively.

Consequently, the velocity at the important points along the main canal will be 0.29 - 0.49 m/sec with Case 1 and Case 3, and 0.44 - 0.55 m/s with Case 2. These velocities fall in the values which cannot adequately prevent weed-growth.

b) Earthwork

When shortage in earth volume occurs, the balance will need to be transported from outside which is rather costly. Economicality involving this problem will, however, be judged from the total cost including pump installation cost.

Shortage of earth occurs with Case 1 of each of M1 through M6 but not with Cases 2 and 3.

An adverse balance of earth resulting from Case 1 per 1 meter of canal would be 3 m^3/m at the minimum and 27 m^3/m at the maximum, averaging at 12 m^3/m. When shortage of earth is a confined one, the earth nearby the canal can be scraped by use of bulldozer; for instance, a shortfall of earth upto 12 m^3/m can be replenished by scraping 10 cm-deep earth to the width of 60 m along both sides of the canal.

c) Pump

Pump can be installed at each entrance of either the main, secondary or tertiary canals. Keeping intake regulation in mind, economicality of lifting irrigation has been evaluated on the condition that pump will be installed at the entrance of tertiary canal.

d) Cost

Lifting irrigation cost, including construction cost and annual O&M cost, towards the entire Project area has been estimated 20-30 times bigger than gravity irrigation cost, as is shown in TableL-3-4: Construction Cost of Gravity or Lifting Irrigation.

Table L-3-4 : Construction Cost of Gravity or Lifting Irrigation (LE/year/110,000 fed.)

Case	Irrigation	Earth work	Pump	Operation	Total
1	Gravity	39,000	-	-	39,000
2	Gravity & Lifting	27,000	317,000	518,000	862,000
3	Lifting	33,000	429,000	934,000	1,396,000

Note: Durable period - Canal = 50 years
Pump = 7 years

Ultimately, Case 1 is recommendable on the following grounds:

i) Total cost is the lowest with Case 1, and the cost-gaps between Case 2 and Case 3 are enormous;

ii) Although Case 1 results at shortage of earth, most of such shortage can be recovered from nearby the canal and the balance can be met by 4.8 million m^3 spoils available from drainage canals;

iii) Topographic feature (slope) on one hand and economicality, on the other, do not justify larger velocity than 0.7 m/sec. Weed-control along the canal may be effected by either concrete-lining of the canal or periodical canal clearings; the latter is more advisable from cost aspect. Weeds grown on canal-slope above the water-level and mud sedimented on the bottom of the canal should be removed at least once a year, and

iv) Only a sound and efficient water management system can prevent pilferage of irrigation water by use of pumps owned by individual farmers.

v) The total amount of seepage water from irrigation canals both Main canals and Secondary canals has been estimated at 5.02 m^3/day/fed.. Based on the rotation irrigation programme, the actual seepage water amounts will be 2.51 m^3/day/fed. as 4 days on 4 days off irrigation. This value is estimated in the water conveyance loss.

Seepage water amount from irrigation canals can be calculated by using of the following formula.

$$q = k \times yo + k1 \times \frac{h}{d} \times H$$

where: q ; Seepage water amount (m^3/sec)

k : Water conductivity of Embankment soils

k1: Water conductivity of foundation soils

h : Canal Water Heads (m)

H : Depth from surface to foundation clay soil (m)

d : Embankment width (m).

$yo = \sqrt{h^2 + d^2} - d$

Table L-3-1 Velocity and Earthwork (Case 1)

Name	Discharge (m^3/sec)	Length (m)	Slope (1/I)	Width (m)	Velocity (m/sec)	Earthwork (m^3/m)		
						Cut	Bank	Shortage
M-1	0.99	3,500	10,000	2.00	0.29	2.26	16.67	-14.41
M-2	3.78	5,500	10,000	3.00	0.41	6.30	19.91	-13.61
M-3-1	10.46	4,100	10,000	9.00	0.49	11.84	32.96	-21.12
-2	8.09	3,100	"	7.00	0.47	12.52	23.85	-11.33
-3	5.15	4,400	"	4.00	0.44	6.73	24.66	-17.93
-4	3.13	3,500	"	2.00	0.39	3.21	30.18	-26.97
-5	0.86	2,100	"	1.00	0.28	2.62	27.98	-25.36
M-4-1	16.38	7,700	30,000	15.00	0.36	27.64	36.09	-8.45
-2	11.14	4,100	"	9.50	0.34	22.11	30.42	-8.31
-3	7.66	6,400	"	6.00	0.32	17.76	26.23	-8.47
-4	5.35	5,000	"	3.50	0.30	14.66	17.94	-3.29
-5	2.05	4,500	"	1.00	0.23	6.28	27.74	-21.46
M-4-1	1.83	4,750	10,000	2.00	0.34	4.79	14.38	-9.60
M-4-2	3.00	4,000	10,000	3.00	0.38	2.94	28.22	-25.29
-2	1.02	3,750	"	1.00	0.30			
M-5-1	9.25	2,400	40,000	9.50	0.29	26.25	23.85	2.40
2	7.96	5,100	"	8.00	0.28	24.42	21.76	2.67
3	5.25	4,900	"	4.50	0.26	18.63	14.59	4.04
4	2.65	3,950	"	2.00	0.22	12.27	15.83	-3.56
M-6-1	10.32	5,000	40,000	11.00	0.29	20.81	34.26	-13.45
-2	7.40	5,000	"	7.50	0.28	16.83	31.18	-14.34
-3	4.26	2,400	"	3.50	0.25	11.88	22.14	-10.26
-4	2.90	4,500	"	2.00	0.23	9.76	20.13	-10.37
-5	1.63	6,500	"	1.00	0.20	5.50	21.46	-15.96

Table L-3-2 Velocity and Earthwork (Case 2)

Name	Discharge (m^3/sec)	Length (m)	Slope (1/I)	Width (m)	Velocity (m/sec)	Earthwork (m^3/m)		
						Cut	Bank	Shortage
M-1	0.99	3,500	2,500	2.00	0.48	4.50	9.70	-5.20
M-2	3.78	5,500	7,000	3.00	0.46	10.51	5.79	4.72
M-3-1	10.46	4,100	7,000	9.00	0.56	13.72	21.98	-8.26
-2	8.09	3,100	"	7.00	0.54	17.34	11.67	5.67
-3	5.15	4,400	"	4.00	0.50	11.97	12.44	-0.47
-4	3.13	3,500	"	2.00	0.45	9.06	8.86	0.20
-5	0.86	2,100	"	1.00	0.33	8.21	11.18	-2.97
M-4-1	16.38	7,700	9,000	15.00	0.54	19.97	28.43	-8.46
-2	11.14	4,100	"	9.50	0.52	23.62	12.23	11.39
-3	7.66	6,400	"	6.00	0.50	25.91	2.86	23.05
-4	5.35	5,000	"	3.50	0.46	33.17	0	33.17
-5	2.05	4,500	"	1.00	0.37	44.54	0	44.54
M-4-1	1.83	4,750	4,000	2.00	0.48	5.19	6.51	-1.32
M-4-2	3.00	4,000	5,000	3.00	0.49	6.78	9.26	-2.48
2	1.02	3,750	"	1.00	0.38	3.13	8.33	-5.20
M-5-1	9.25	2,400	8,000	9.50	0.51	3.30	20.62	-17.32
2	7.96	5,100	"	8.00	0.50	2.45	14.50	-12.05
3	5.25	4,900	"	4.50	0.47	22.61	0	27.61
4	2.65	3,950	"	2.00	0.41	31.26		31.26
M-6-1	10.32	5,000	7,000	11.00	0.54	11.94	26.72	-14.80
-2	7.40	5,000	"	7.50	0.52	17.59	9.36	8.23
-3	4.26	2,400	"	3.50	0.48	17.72	0	17.72
-4	2.90	4,500	"	2.00	0.44	33.92	0	33.92
-5	1.63	6,500	"	1.00	0.38	40.41	0	40.41

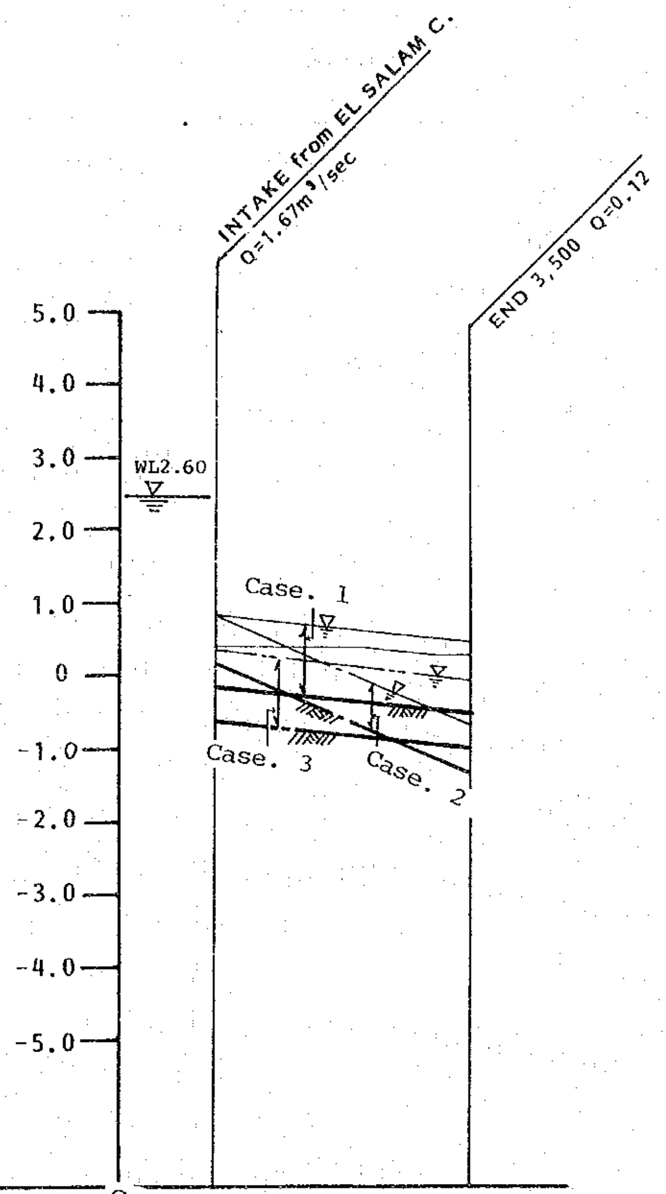
Table L-3-3 Velocity and Earthwork (Case 3)

Name	Discharge (m^3/sec)	Length (m)	Slope (1/I)	Width (m)	Velocity (m/sec)	Earthwork (m^3/m)		
						Cut	Bank	Shortage
M-1	0.99	3,500	10,000	2.00	0.48	4.56	7.41	-2.85
M-2	3.78	5,500	10,000	3.00	0.46	12.00	5.61	6.39
M-3-1	10.46	4,100	10,000	9.00	0.56	25.52	10.42	1.51
-2	8.09	3,100	"	7.00	0.54	25.44	4.75	20.69
-3	5.15	4,400	"	4.00	0.50	16.06	3.87	12.19
-4	3.13	3,500	"	2.00	0.45	18.42	2.19	16.23
-5	0.86	2,100	"	1.00	0.33	8.00	4.29	3.71
M-4-1	16.38	7,700	30,000	15.00	0.54	53.76	4.75	49.01
-2	11.14	4,100	"	9.50	0.52	42.00	4.75	37.25
-3	7.66	6,400	"	6.00	0.50	34.56	4.75	29.81
-4	5.35	5,000	"	3.50	0.46	29.24	2.19	35.95
-5	2.05	4,500	"	1.00	0.37	15.52	3.87	11.65
M-4-1	1.83	4,750	10,000	2.00	0.48	13.44	2.19	11.29
M-4-2	3.00	4,000	10,000	3.00	0.49 }	11.12	3.87	7.25
-2	1.02	3,750	"	1.00	0.38 }			
M-5-1	9.25	2,400	40,000	9.50	0.51	33.13	14.50	18.63
2	7.96	5,100	"	8.00	0.50	32.54	11.54	21.00
3	5.25	4,900	"	4.50	0.47	23.09	7.41	15.68
4	2.65	3,950	"	2.00	0.41	16.34	7.41	8.92
M-6-1	10.32	5,000	40,000	11.00	0.54	35.04	14.50	20.54
-2	7.40	5,000	"	7.50	0.52	28.13	12.43	15.70
-3	4.26	2,400	"	3.50	0.48	20.39	5.61	14.78
-4	2.90	4,500	"	2.00	0.44	17.36	3.87	13.49
-5	1.63	6,500	"	1.00	0.38	11.04	5.61	5.43

Table L-3-5 Detailed Information Pertaining to Three Alternative Cases

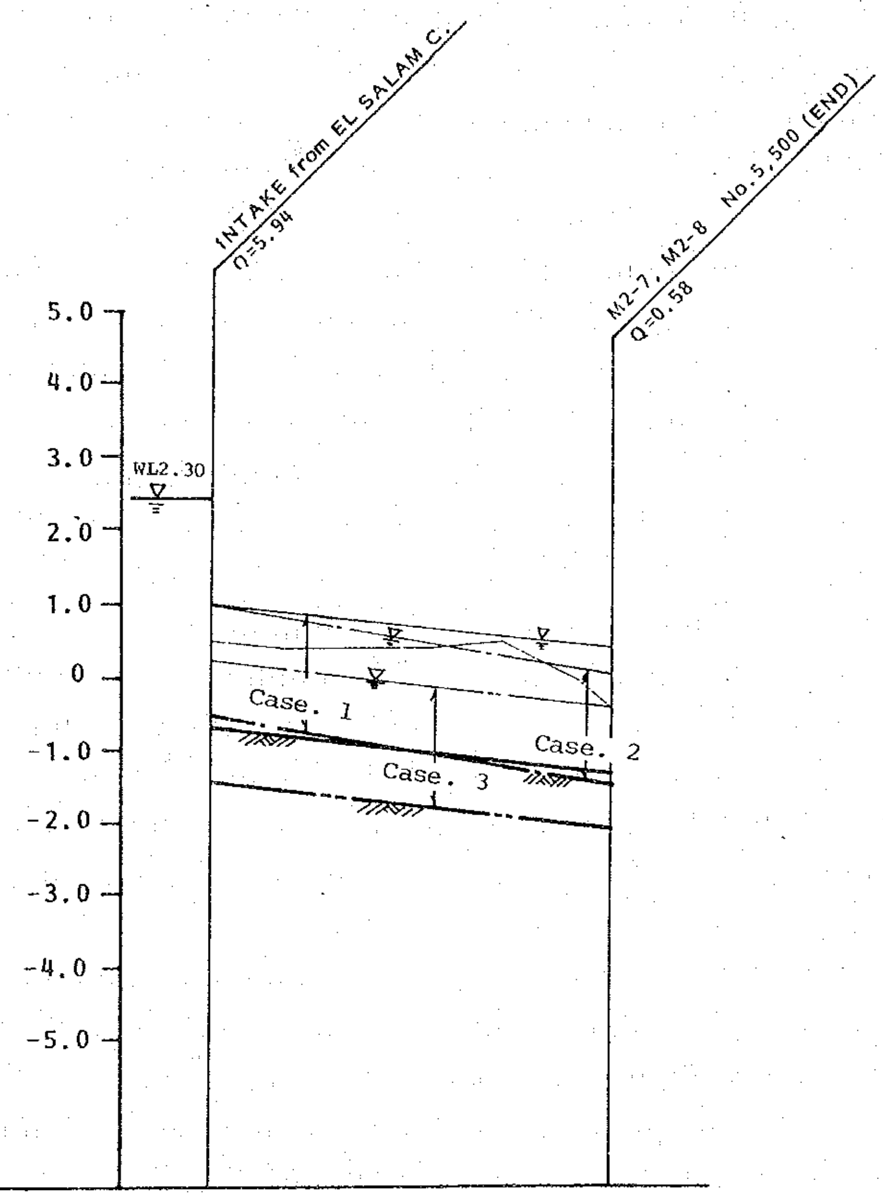
Main Canal	Case	Slope	Velocity	Earthwork			Ir. Area (fed.)		Construction Cost (,000 LE)			Cost per Year (LE/year)			
				Cut	Bank	Short-age	Total	Pump	Earth-work	Pump	Total	Earth-work	Pump	Mainte-nance	Total
			m/sec	$000m^3$	000m	$000m^3$									
M_1	1	1/10,000	0.29	7.9	58.3	-50.4	2,512	0	43.4	0	43.4	868	0	0	868
	2	1/2,500	0.48	17.6	34.0	-16.4	"	1,489	24.7	52.1	76.8	494	7,443	16,215	24,152
	3	1/10,000	0.29	16.0	25.9	- 9.9	"	2,512	18.7	87.9	106.6	374	12,557	27,356	40,287
M_2	1	1/10,000	0.41	34.7	109.5	-74.8	8,775	0	80.6	0	80.6	1,612	0	0	1,612
	2	1/7,000	0.46	57.8	31.8	26.0	"	0	39.0	0	39.0	780	0	0	780
	3	1/10,000	0.41	66.0	30.9	35.1	"	8,975	44.2	314.8	359.0	884	44,971	97,956	143,811
M_3	1	1/10,000	0.49-0.39	133.7	482.0	348.3	17,088	0	355.5	0	355.5	7,110	0	0	7,110
	2	1/7,000	0.56-0.45	211.6	235.5	-239	"	15,152	167.1	551.3	718.4	3,342	78,757	171,539	253,638
	3	1/10,000	0.49-0.39	335.4	91.1	244.3	"	17,088	220.1	598.1	818.2	4,402	85,442	186,088	275,932
M_4	1	1/30,000 1/10,000	0.39-0.36	564.2	1,072.0	-507.8	25,225	0	778.6	0	778.6	15,572	0	0	15,572
	2	1/9,000 1/4,000	0.54-0.46	829.0	368.7	460.3	"	20,519	553.6	718.2	1,271.8	11,072	102,600	223,452	337,124
	3	1/30,000	0.39-0.36	1,173.4	155.2	1,018.2	"	25,225	759.0	882.9	1,641.9	15,180	126,129	274,700	416,009
M_5	1	1/40,000	0.29-0.26	327.3	302.2	25.1	14,885	0	229.1	0	229.1	4,582	0	0	4,582
	2	1/8,000	0.51-0.47	254.7	123.4	131.3	"	12,009	170.8	420.3	591.9	3,416	60,043	130,778	194,237
	3	1/40,000	0.29-0.26	423.2	159.2	264.0	"	14,885	280.7	521.0	801.7	5,614	74,429	162,098	242,141
M_6	1	1/40,000	0.29-0.23	296.4	610.4	314.0	17,095	0	444.5	0	444.5	8,890	0	0	8,890
	2	1/7,000	0.54-0.44	605.5	180.4	425.1	"	13,589	398.4	475.6	874.0	7,968	67,943	147,984	90,895
	3	1/40,000	0.29-0.23	514.7	202.0	312.7	"	17,095	341.9	598.3	940.2	6,838	85,471	186,165	278,474
												38,624	0	0	38,624
												27,072	316,786	519,929	900,826
												33,292	428,999	934,363	1,396,654

M-1



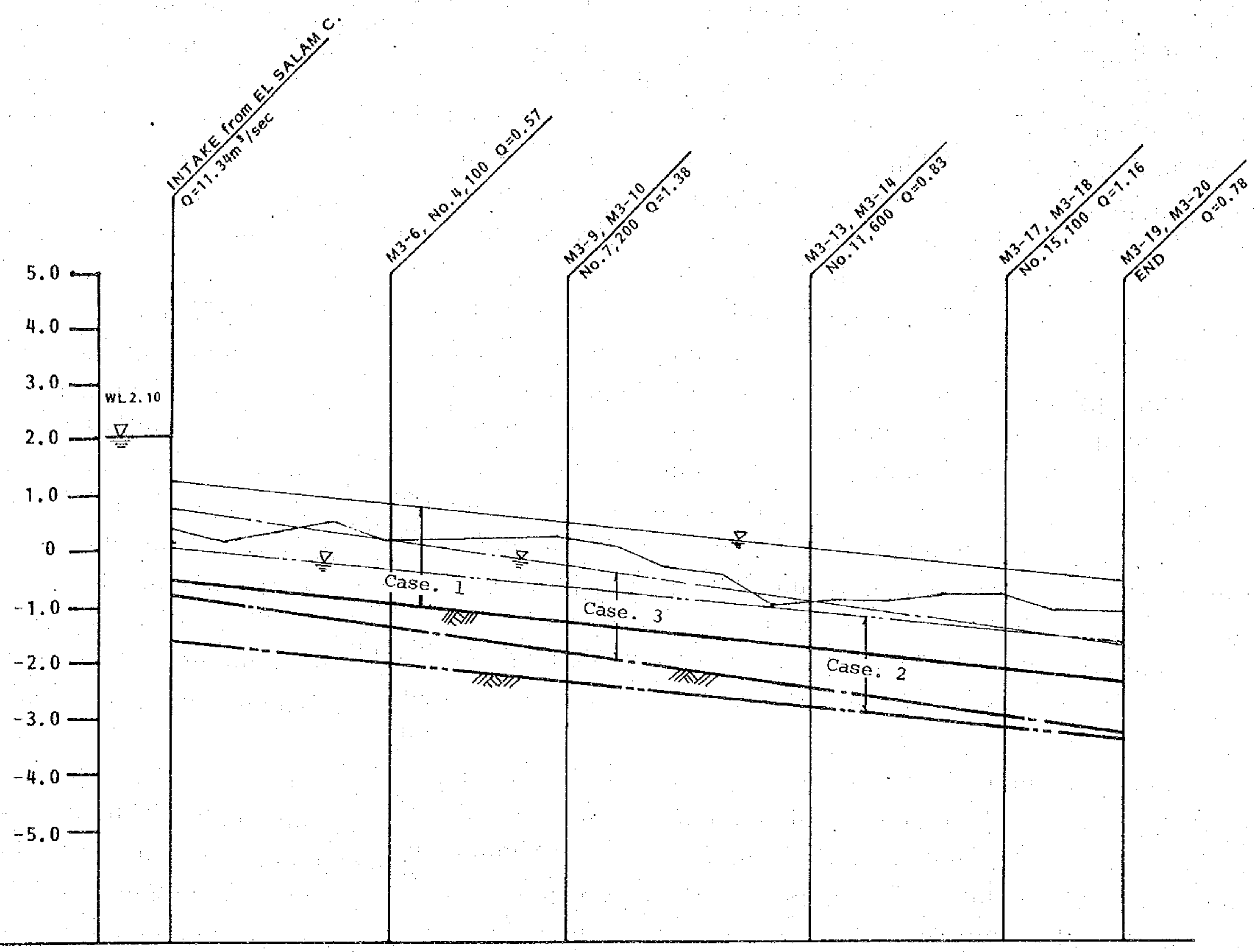
GRADIENT	Case.1;1/10,000 Case.2;1/2,500 Case.3;1/10,000				
BOTTOM ELEVATION OF CANAL (m)					
GROUND LEVEL (m)	0.4	0.4	0.4	0.3	0.3
STATION NO.(m)	0	1,000	2,000	3,000	3,500

M-2



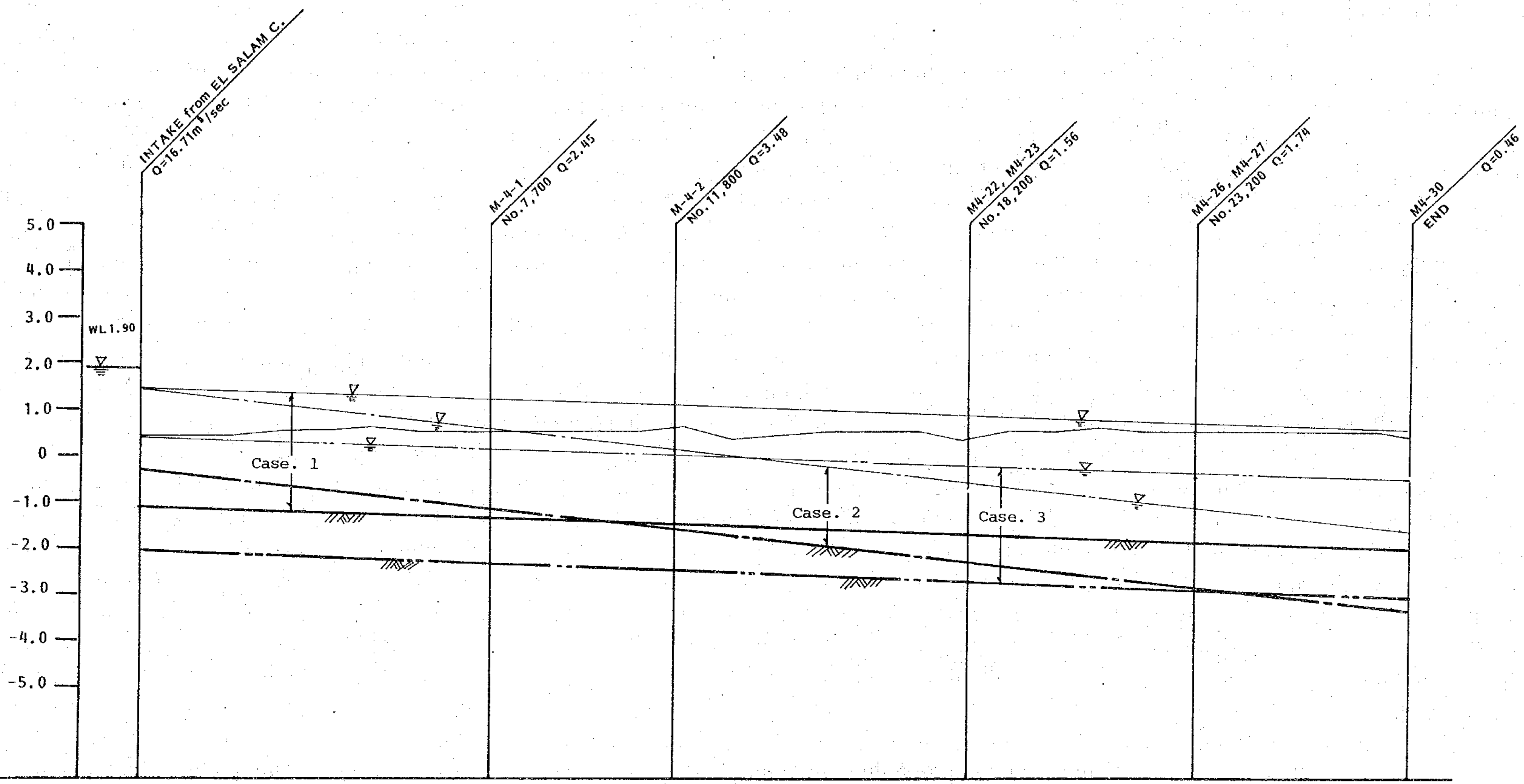
GRADIENT	Case.1;1/10,000 Case.2;1/7,000 Case.3;1/10,000						
BOTTOM ELEVATION OF CANAL (m)							
GROUND LEVEL (m)	0.5	0.4	0.4	0.4	0.5	0.0	0.0
STATION NO.(m)	0	1,000	2,000	3,000	4,000	5,000	5,500

Fig. L-3-1(1) Longitudinal Section in each Case.



GRADIENT	Case.1;1/10,000 Case.2;1/7,000 Case.3;1/10,000																		
BOTTOM ELEVATION OF CANAL (m)																			
GROUND LEVEL (m)	0.4	0.2	0.3	0.5	0.2	0.2	0.2	0.2	-0.1	-0.3	-0.4	-1.0	-0.9	-0.9	-0.8	-0.8	-1.1	-1.1	-1.1
STATION NO. (m)	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000	17,000	17,200

Fig. L-3-1(2) Longitudinal Section in each Case.

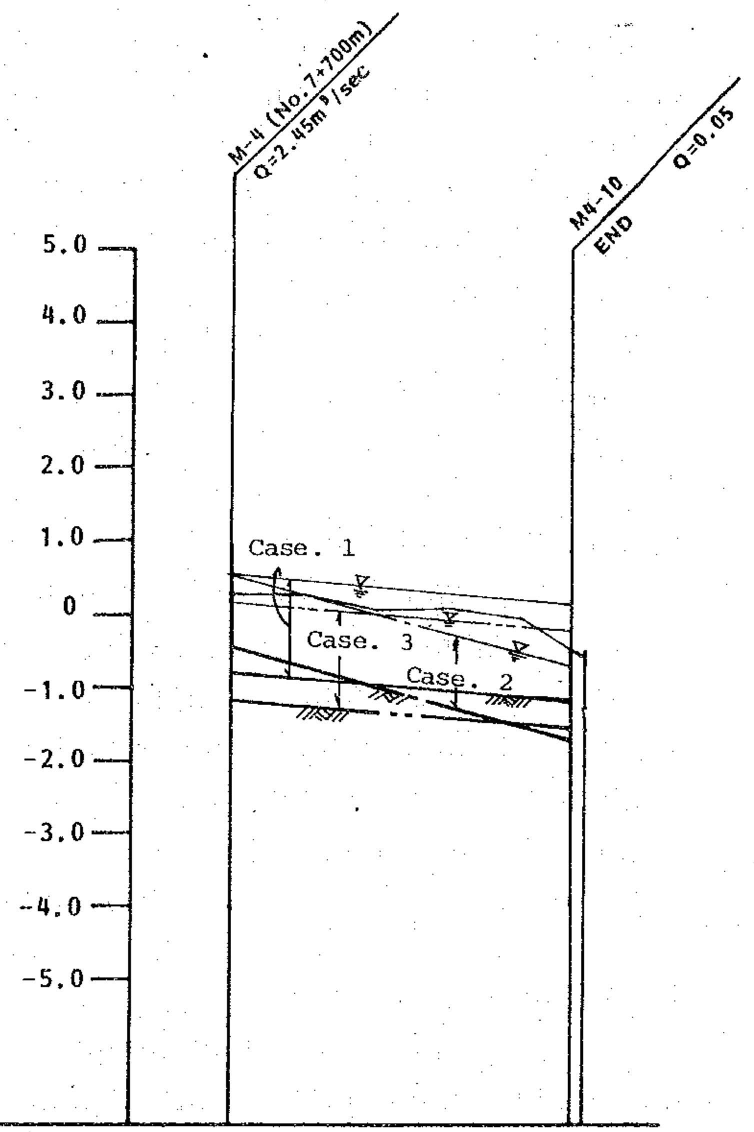


GRADIENT	Case.1;1/30,000 Case.2;1/9,000 Case.1;1/30,000 Case.2;1/4,000
BOTTOM ELEVATION OF CANAL (m)	

STATION NO.(m)	GROUND LEVEL (m)
0	0.4
1,000	0.4
2,000	0.4
3,000	0.5
4,000	0.5
5,000	0.6
6,000	0.5
7,000	0.5
8,000	0.5
9,000	0.5
10,000	0.5
11,000	0.5
12,000	0.6
13,000	0.3
14,000	0.4
15,000	0.5
16,000	0.5
17,000	0.5
18,000	0.3
19,000	0.5
20,000	0.5
21,000	0.6
22,000	0.5
23,000	0.5
24,000	0.5
25,000	0.5
26,000	0.5
27,000	0.5
27,700	0.4

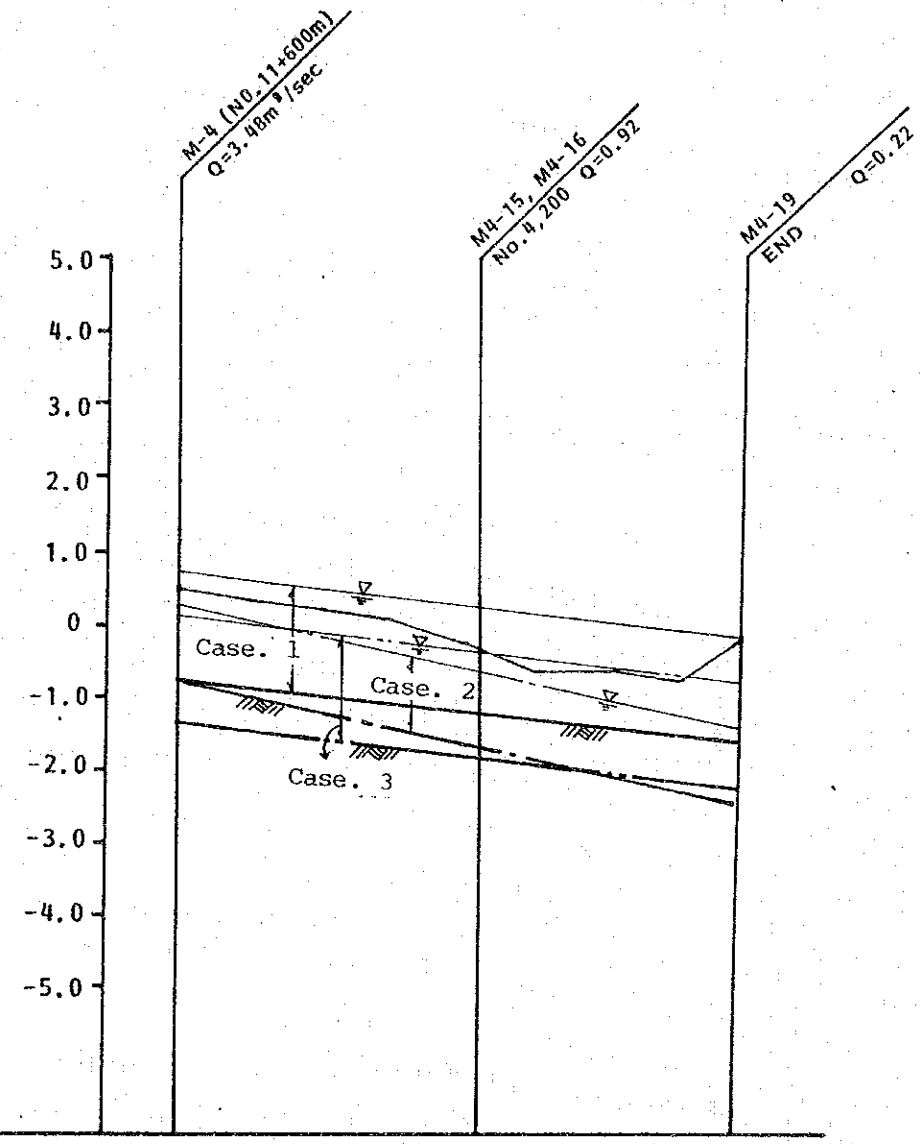
Fig. L-3-1(3) Longitudinal Section in each Case.

M-4-1



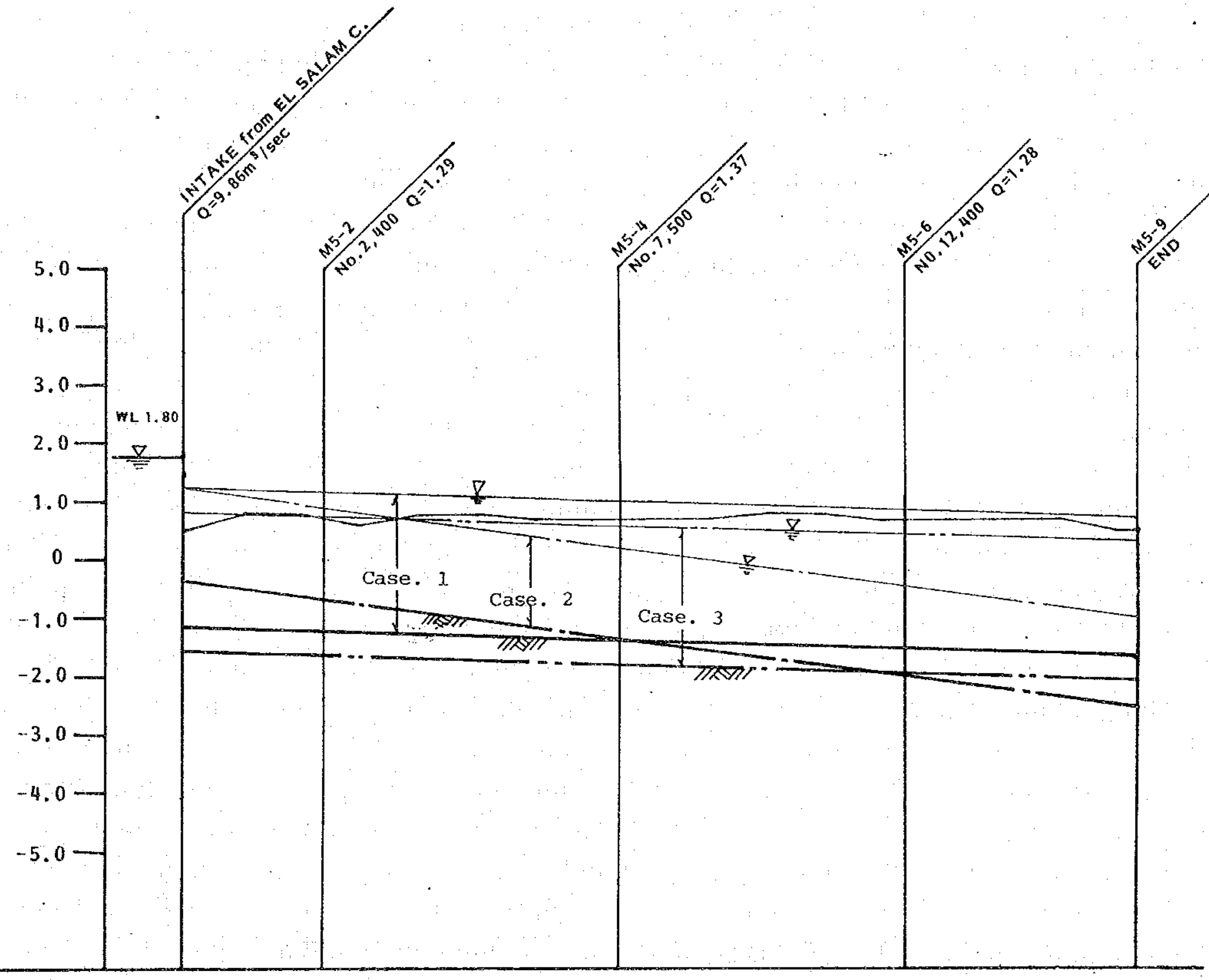
GRADIENT	Case.1;1/10,000 Case.2;1/4,000 Case.3;1/10,000					
BOTTOM ELEVATION OF CANAL (m)						
GROUND LEVEL (m)	0.3	0.3	0.1	0.1	0.0	0.5
STATION NO.(m)	0	1,000	2,000	3,000	4,000	4,750

M-4-2



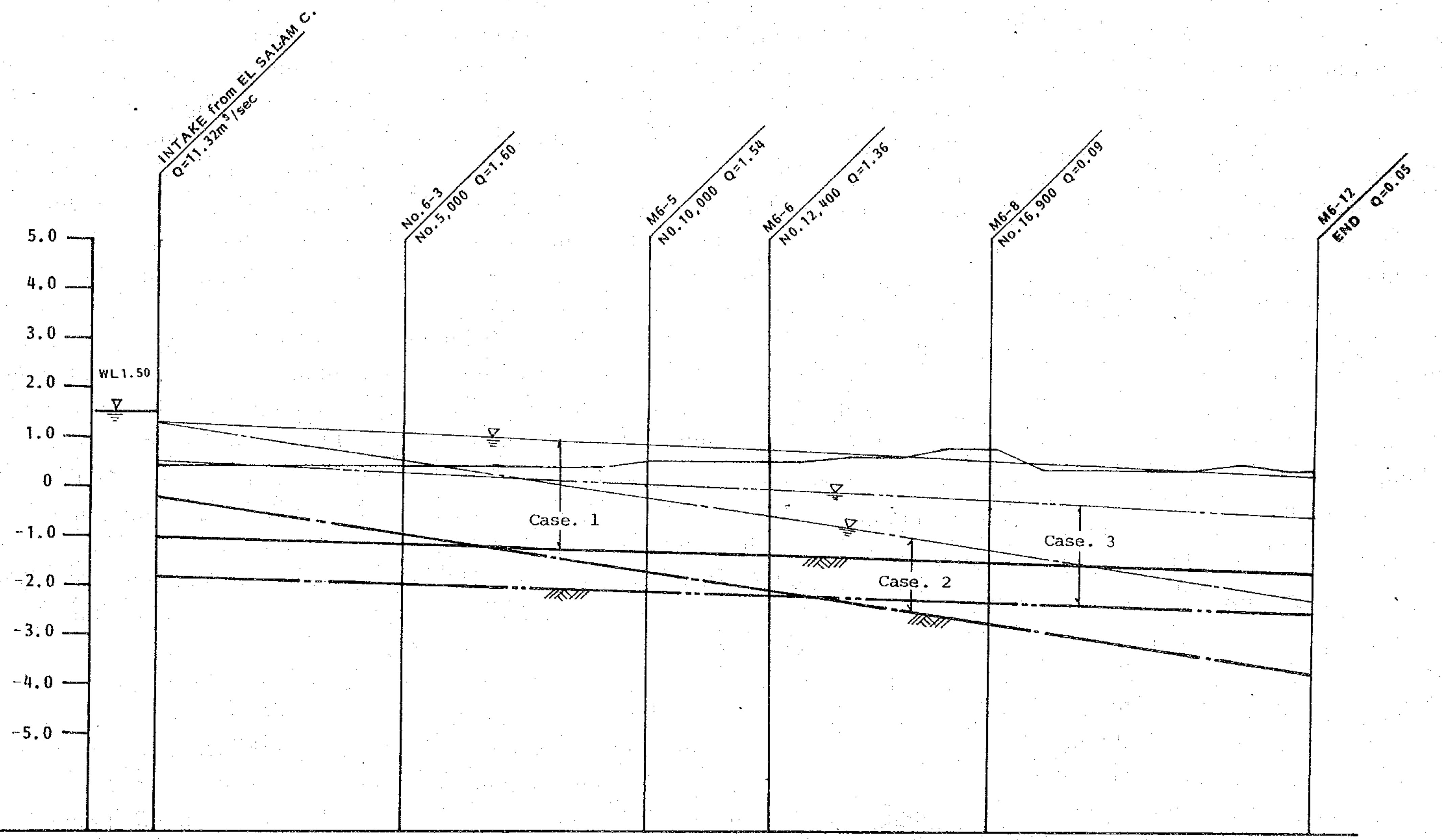
GRADIENT	Case.1;1/10,000 Case.2;1/5,000 Case.3;1/10,000								
BOTTOM ELEVATION OF CANAL (m)									
GROUND LEVEL (m)	0.5	0.3	0.2	0.1	-0.2	-0.6	-0.6	-0.7	-0.3
STATION NO.(m)	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	7,750

Fig. L-3-1 (4) Longitudinal Section in each Case.



GRADIENT	Case.1;1/40,000 Case.2;1/8,000 Case.3;1/40,000																	
BOTTOM ELEVATION OF CANAL (m)																		
GROUND LEVEL (m)	0.5	0.8	0.8	0.6	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.5	0.5
STATION NO.(m)	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000	16,300

Fig. L-3-1(5) Longitudinal Section in each Case.



GRADIENT: Case.1;1/40,000 Case.2;1/7,000 Case.3;1/40,000

BOTTOM ELEVATION OF CANAL (m):

STATION NO. (m)	GROUND LEVEL (m)
0	0.4
1,000	0.4
2,000	0.4
3,000	0.4
4,000	0.4
5,000	0.4
6,000	0.4
7,000	0.4
8,000	0.4
9,000	0.4
10,000	0.5
11,000	0.5
12,000	0.5
13,000	0.5
14,000	0.6
15,000	0.6
16,000	0.8
17,000	0.8
18,000	0.4
19,000	0.4
20,000	0.4
21,000	0.4
22,000	0.5
23,000	0.4
23,400	0.4

Fig. L-3-1(6) Longitudinal Section in each Case.

4. Drainage Canals

Drainage canals comprise three (3) types of the main, the secondary, and the tertiary. Main drainage canal will be provided along the lowest possible terrain and connected to each one Pump Station to be established in both North Hussinia Section and South Port Said Section.

Secondary drainage canal will be 2 - 5 km long, each commanding 1,000 - 2,000 feddan. Tertiary canal will be provided with an interval of about 200 m and each line of it will command approx. 50 feddan of land. Standard cross section of the drainage canal is shown in Fig. L-4-1.

The depth of drainage canal will be so designed that the free board between the ground surface and water-level will be not less than 2.0 m with the main canals and not less than 1.6 m with the secondary-canals.

Similarly with irrigation canal system, maintenance road with 5 m-width will be provided on one side of the main as well as secondary drainage canals.

Proposed drainage canal design criteria are as follows;

Shape of canal cross section.....Trapezoidal shape
Side slope of canal.............3 : 2
Adopted formula for discharge....Manning formula
Roughness coefficient...........0.025
Unit discharge..................27.5 m^3/day/feddan=0.318ℓ/sec/feddan

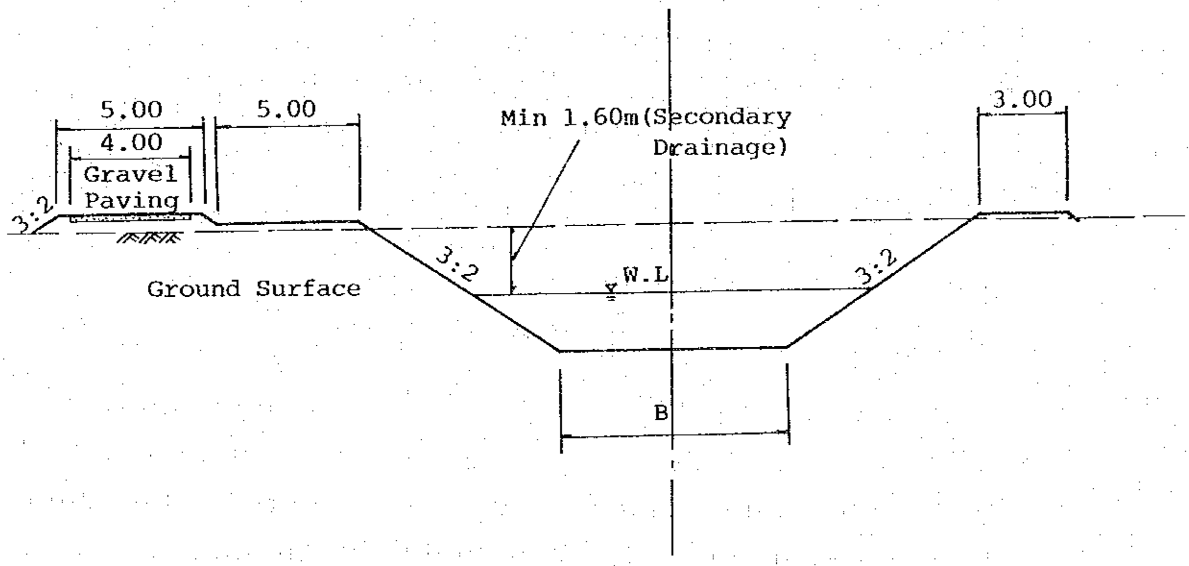


Fig. L-4-1 Typical Cross Section for Drainage Canal

5. Pump Station

Since a majority of the project area lies below the water-level of the Lake Manzala, drainage needs to be effected by use of pumps.

The drainage pump station will be ideally located at low terrain in the central part of the drainage area. In our case, two drainage pump stations will be provided, the one in the north-western part of North Hussinia Section and another in the central part of the western block of South Port Said Section, along the extension line of Baqar Drain.

(1) Bore and Number of Drainage Pumps

Drainage discharge from North Hussinia Section and South Port Said Section is estimated as follows;

Project Area	Area	Discharge Amount	
North Hussinia Section	69,000 feddan	1,318m^3/min	254 million m^3/year
South Port Said Section	41,000	783	151

Pump will be equipped with enough capacity to deal with peak season discharge which is estimated to be 25% more than the mean value. Every drainage pump will have the same bore to facilitate its maintenance. The number of pumps required for drainage purpose would depend upon the frequency of their service all through the year. Actual drainage discharge per unit will be maximum of 22m^3/day/feddan at the peak season and minimum of 3m^3/day/feddan in April. This implies that 7 pumps will attain the most efficient operation all through the year with least loss in the minimum discharge month of April.

When 7 pumps should be installed, per unit capacity and bore would be 188m^3/min and 1,200 mm, respectively (see Fig. L-5-1), for North Hussinia Section but, for South Port Said Section which is smaller in size by 40%, per unit bore should accordingly be 1,000 mm only. Since these two Sections are neighboring upon each other, it is desirable from their maintenance point-of-view that the pumps meant for South Port Said Section will have the same bore of 1,200 mm. Consequently, four (4) pumps of 1,200 mm bore with $196m^3$/min capacity each are recommended for South Port Said Section.

Each one stand-by pump will have to be installed as an emergency measures to meet any trouble or mishap.

(2) Type of Pump

Type and specifications of the pump to be studied for the Project are as follows:
(See Fig. L-5-2)

Axial flow pump	:	Head, less than 4m
		Bore, more than ø300
Mixed flow pump	:	Head, 4m to 12m
		Bore, more than ø200
Volute pump	:	Head, more than 4m
		Bore, more than ø50

Total head of the pump to be planned for the Project is 7m, so that the mixed flow pump or the volute pump can be used. Since the former is cheaper than the latter in terms of the cost of facilities, the former (mixed flow pump) is taken for the Project.
Of the mixed flow pump, there are some types such as horizontal axle, vertical axle and incline type.
Head of the horizontal axle type is 4.0 to 4.5m, so that it can not be used for the Project.
Incline type has the advantage of cheapness of facilities. However, bore of this type is ø200 to ø1,000, so that large numbers of pump should be necessary.
Consequently, Mixed flow vertical type has been selected for the Project.

(3) Power of Pump

Output of power in KW will be calculated by the following formula;

$$P = \frac{0.163\ r\ Q.H}{\eta p.\eta g} \cdot (1 + R)$$

P: Power required for the prime mover, in KW

r: Specific weight of pumped liquid (=1.0)

Q: Capacity (m^3/min)

H: Total head (m)

ηp: Pump efficiency (=0.83)

ηg: Transmission efficiency (=0.97)

R: Excess (=0.15)

	North Hussinia	Port Said
Capacity	188 m^3/min	196 m^3/min
Actual head	0.5-(55)=6.0m	0.5-(-5.5)=6.0m
Total head(H)	7.0 m	7.0 m
Power	306≒320KW	319≒320KW
	≒420PS	≒420PS
No. of Pumps	7(8) sets	4(5) sets
Total Power	2,240KW	1,280KW

Dimensions of the drainage pump will be as shown in Table L-5-1.

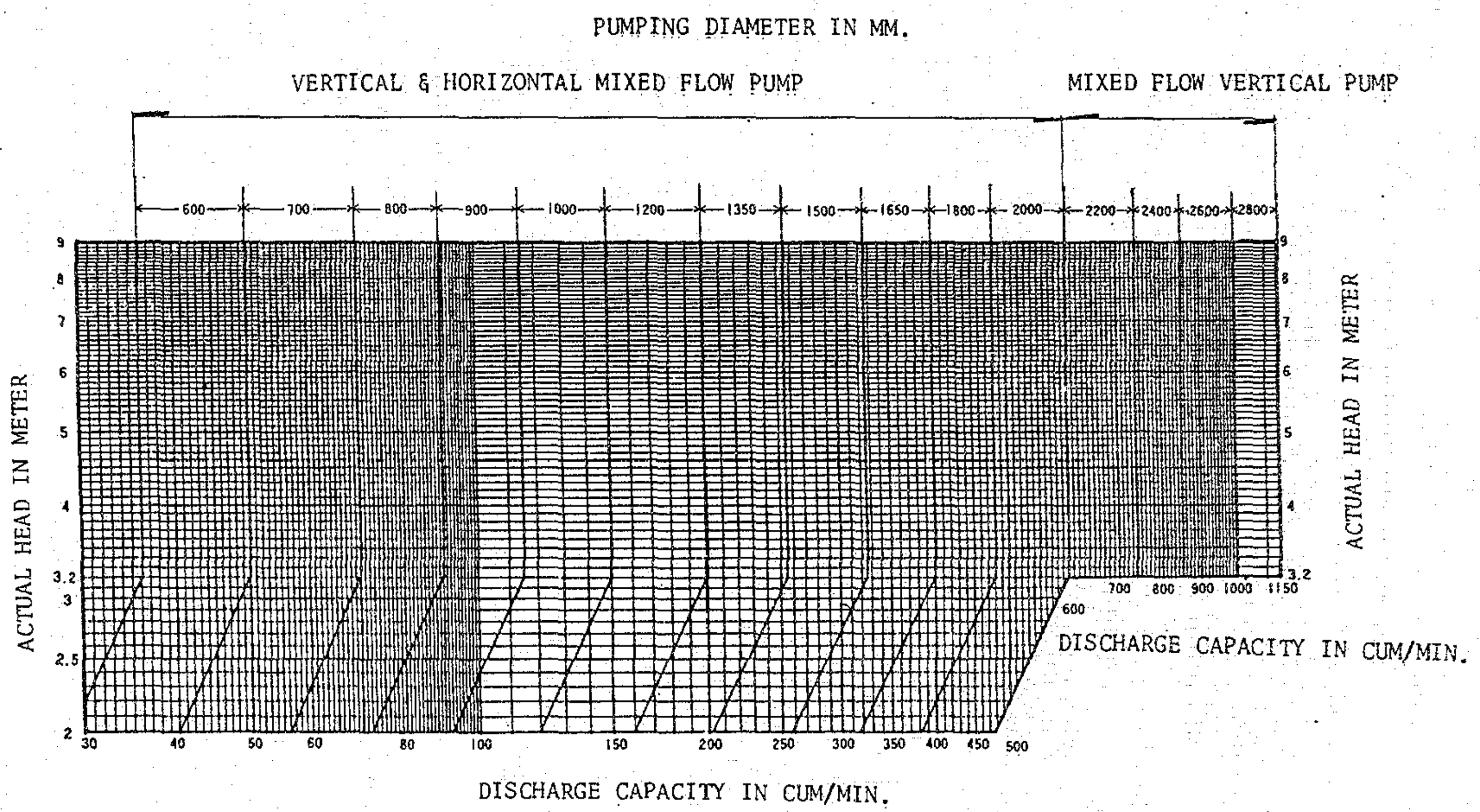


Fig. L-5-1 Pump Diameter-Actual Head-Discharge Diagram

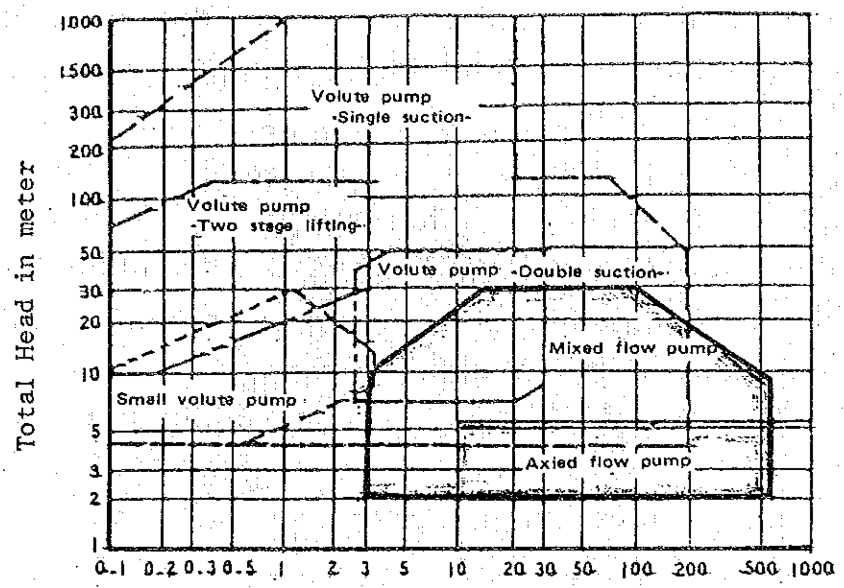


Fig. L-5-2 Discharge Capacity-Total Head Diagram by Pump Type

Table L-5-1 Dimensions Table of Pumping Station

Station Name / Items	NORTH HOSSINIA PUMPING STATION	SOUTH PORT SAID PUMPING STATION
DISCHARGE AREA	68.970 feddan	40.970 feddan
UNIT DISCHARGE CAPACITY	27.5 cum/day/fed.	27.5cum/day/fed.
TYPE OF PUMP	MIXED FLOW VERTICAL PUMP	MIXED FLOW VERTICAL PUMP
DIAMETER & UNIT	1,200mm x 8	1,200mm x 5
KW and HP	320KW	320KW
TOTAL HEAD	7.0m	7.0m
ACTUAL HEAD	6.0m	6.0m
SUCTION WATER HEAD	EL. -5.50m	EL. -5.50m
DISCHARGE WATER HEAD	EL. 0.50m	EL. 0.50m
PUMPING STATION AREA	12.00 x 55.00m	12.00m x 43.00m

6. Appurtenant Structures

(1) Water Intake

Six (6) Water Intakes, 4 in North Hussinia Section and 2 in South Port Said Section, will be installed along El Salam Canal to draw the design discharge into the main irrigation canals. The volume of intake water will be controlled by sluice gate and conducted into the field through box-culvert.

Intake gate equipped with water measuring gage will be provided at each intake point from the main canal to the secondary canal.

(2) Check Gate

Intake water level will need to be maintained by necessary number of check-gates along both the main canal and the secondary canal. They will be installed at an interval of 2 km along the secondary canal.

Various types of check-gate, each with its own characteristics, are in use such as: sluice-, Tainter-, radial-, Amil- and Flap-gates. Their particulars are described by type in Table L-6-1. Eventually, radial gate has been selected on the ground of reasonable installation cost and hydrological stability.

(3) Crossing Works

Closed pipe-conduit, box culvert and bridge are three (3) types of the works usually provided at road's crossing over the irrigation/drainage canal.

Closed pipe-conduit can be installed at low cost, but it does not facitate for smooth water flow and its O&M is not very easy. From such reasons, the closed pipe-conduit will be used only for small-scale canal. When canal-width is within 10 m or so, either box-culvert or bridge is used.

Fig. L-6-1 shows that box-culvert is less expensive, but as it sometimes happen to cause trouble in proper water-flow, bridge is preferred on important canals.

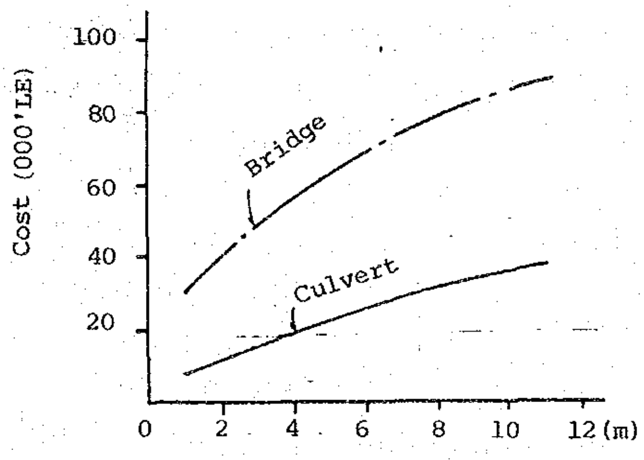


Fig. L-6-1 Cost Comparison by Canal Width

Judging from the importance, assured passage of water, and easiness in O&M, bridges shall be the crossing works over the main irrigation/drainage canals. Since O&M along the secondary canal would be more easily done than along the main canal, box-culvert is recommended for secondary irrigation/drainage canals because of its less expensive installation cost. Closed pipe conduit will be used in the field.

(4) Water Measuring Gage

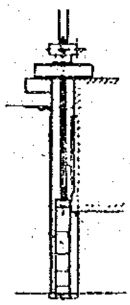
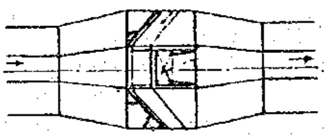
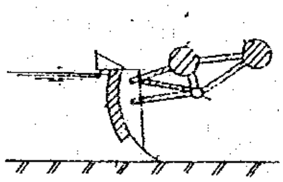
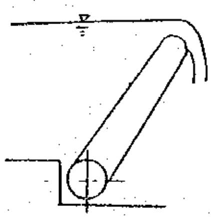
For equitable distribution of irrigation water to peripheral fields, its diversion at two strategical points, the one at the diversion work from El Salam Canal to the main canal and the other at the diversion work from the main canal to the secondary canal, needs to be carefully controlled. Since diversion from the main canal to the secondary can be controlled through visual observation, no mechanical device will be required. However, at each of the diversion works from El Salam Canal to the main canal will need to be equipped with water measuring gage.

Among (1) Parshal flume, (2) measuring weir, (3) measuring gage equipped with a propeller, etc., (2) is not suitable because of big diversion discharge, and (3) is not adoptable due to small velocity of discharge. Consequently, (1) Parshal flume is the only reasonable choice even though its installation cost is somewhat high.

(5) Spillway

Spillway, an essential engineering device for operation and maintenance of the canals, will have to be established at each terminal point of the main as well as the secondary canals to divert excessive water into the nearby drainage canals.

Table L-6-1 : Characteristics of Various Types of Check-gate

Name	Diagram	Characteristics
Stop Log		Usually used for construction of weir along a small canal or cut-off purpose during main gate repairing. Low installation cost but poor performance in water-level control.
Slide Gate		Often used where canal-width and water-level gap is comparatively small; big winch load under high water pressure; vibration occurs when the gate is not wide open; poor performance in water level control but small installation cost. (130,000LE)*
Radial Gate		Usually used for a large canal; hydrologically maintains stabilized streamline and develops less vibration, its installation cost is somewhat bigger. (180,000LE)*
Amil Gate		Automatic operation to regulate water level both upstream-ward as well as downstream-ward; water level control function is satisfactory but installation cost is high. (100,000)*
Flap Gate		Gate needs rotary operation; irrigation water flows over the gate; suitable for a comparatively large canal; does not require pier unlike slide gate. (170,000LE)*

* : Values are shown for unit construction cost(6 meter bottom width).

7. Farm Consolidation

(1) Farmland Block

There are two units of farmland: one is the Field Lot which is the smallest unit for farming being encircled by irrigation/drainage cannels, borders and roads, and another is Farm Block which is comprised of several field lots. Size and form of these two units of farmland have important bearings on farm labour, irrigation/drainage and productive use of the given land.

a) Length of Field Lot

The factors to decide the shape of farm lots and tile drains are, in general, operating efficiency of farming machinery, working efficiency of labours, maintenance of irrigation and drainage facilities, topographic conditions, farm management method, construction costs and area left for utilities.

The shape of the farm lot was decided according to the following studies.

i) Use of Farm Machinery: Use of the tractor (90 HP and 40HP), harvestor and power-driven sprayers are envisaged in the project area. In this case, for instance, land preparation by use of 90 HP tractor would require 150 to 200 m length for efficient operation.

Also for other farm machinery, it can generally be said that the longer the length of the field becomes, the better the working efficiency gets.

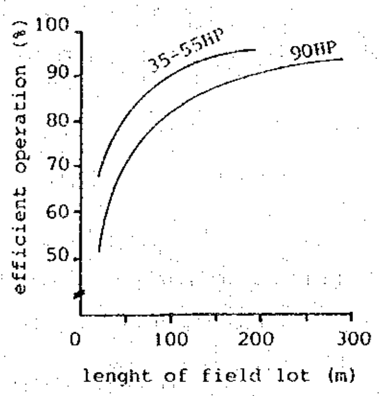


Fig.L-7-1 Efficient operation of farm machinery

ii) Efficiency of labor work

For the vegetable cultivation especially tomato, manual labor would occupy about 80% of the total required labor. In case of the standard 5 feddan farmers, 50% of the total farming work is by manpower.

The long side of the farm lot is desired to be less than 100 m for the manpower farming especially for picking and carrying of the products.

iii) Irrigation : Field application efficiency will be tolerably maintained with several hundred meters in length for furrow irrigation of poorly permeable soil and upto 200 m ro so in case of permeable soil.

iv) For the surface water drainage in the paddy farm, the shorter, the better.

Tile drain requires 1 to 500 slope for smooth drainage, therefore the length of unit tile drain shall be 150 m. at its maximum.

For effective leaching, the field open drain would be maximum 120 m.

v) Topographic Condition:

If the field is located on a slope and needs levelling, its length will naturally be limited to facilities for manual labour but will need to be maintained at an appropriate length since mechanized farming is being planned.

As a result of the length of standard lot is adopted as a maximum of 100m involving workability for vegetable cropping and efficiency of the drainage system.

b) Width of Field Lot

In will need to be adjusted according to the scale of land holding, deployment of farm machinery, flooding of irrigation water for cultivation of paddy rice, and drainage facilities.

For flooding irrigation water into paddy field with a considerable length, its width will have to be so limited as each paddy field will have 1 to 1.5 feddans in total.

For mechanized farming by use of heavy machinery, the minimum width should be 45 to 50 m.

Based on the 3 year rotation cultivation of paddy and other crops, the farmers' unit lot is divided into 3 equal parts of 1.67 feddan each.

Therefore, the configuration of the farmer's land is 210 m x 100 m at the lot is 100 m x 70 m.

c) Length of Farm Block

Density of secondary canals and drains, the costs required for their construction, efficient farm labour, and the shortness of interval between farm roads (300 m) are studied, and thus, the length of Farm Block will be standardized at about 1,000 m.

d) Ridge Direction and Farm Road Arrangement

There are two alternative plans for the configuration of the land. One is the length (210 m) of the farmers' land which will take the tertiary canal. The second is the width (100 m), which will take the tertiary canal.

The comparison between the 2 plans are shown below;

Road:
1. Branch road lies along the tertiary canal
2. Each lot abuts along the Branch road or access to the Branch road is necessary
3. Branch roads lies along the width of each lot

Canals and drains
1. Each lot is abutted on a tertiary canal or having a intake structure.
2. Each lot is abutted on a tertiary drain or having a outlet structure.
3. Length of a tertiary canal is 1,000 m approximatery.

(See Fig. L-7-2, L-7-3, L-7-4, L-7-5
Table L-7-1, L-7-2, L-7-3)

Table L-7-1 Alternative plan for the Farm Configuration

Items	Alternative No. 1	Alternative No.2
1. Farm block shape (m)	1,050 x 100	1,000 x 210
area (feddan)	25	50
2. Farmer's land shape (m)	210 x 100	210 x 100
area (feddan)	5	5
3. Field lot shape (m)	100 x 70	100 x 70
area (feddan)	1.67	1.67
4. Cultivated area (%)		
(1) On farm road Tertiary canal and drain	13.3	14.1
(2) Cultivated area	86.7	85.9
Total	100	100
5. Construction Cost (LE/feddan)	1,839	1,932

As the result of comparison between two alternative plans, alternative No.1 is adopted for this Project on the following reasons :

(1) Higher arable ratio and lower construction cost.

(2) Extension of the scale is easier.

(3) More numbers of the on-farm intake is required, however, one canal is managed by only 10 households so that there is no problem on water management.

Table L-7-2 Arable Land in Field Block

Items		No. 1	No. 2
(1) Field block area		100 feddan (42 ha)	100 feddan (42 ha)
(2) Arable land in field lot			
Road	(m^2)	6,300	11,760
Levee or ditch	(m^2)	4,964	28,224
Total	(m^2)	11,264	39,984
Unusable land	(%)	2.7	9.5
Arable ratio	(%)	97.3%	90.5
(3) Arable land in field block			
Tertiary canal	(m^2)	23,940	13,400
Tertiary drainage	(m^2)	27,300	9,000
Total	(m^2)	51,240	22,400
Unusable land	(%)	10.9	5.1
Arable ratio	(%)	89.1	94.9
(4) Total arable land			
Unusable land	(%)	13.3 [1]	14.1
Arable ratio	(%)	86.7 [1]	85.9

1/ Arable ratio before providing the tile drain on Type 1 is as follows:

Unusable land : 19.7%

Arable ratio (Field block): 80.3%

Arable ratio on Project Area basis will be 72.3%

Table L-7-3 Construction Cost of On-Farm Facilities

Description	Unit	Unit Cost	No.1		No.2		Remarks
			Volume	Cost	Volume	Cost	
Tertiany Canal (A)	m	4.7	1,050	4,935	1,000	4,700	
Tertiany Canal (B)	"	2.9	1,050	3,045	-	-	
Field Canal	"	(1.4)	-	-	2,000	2,800	
Tertiany Drainage	"	3.4	2,100	7,140	-	-	
"	"	1.8	-	-	1,000	1,800	
Open Ditch	"	1.3	17,248	22,422	15,680	20,384	
Farm Ditch	"	1.7	-	-	2,050	3,485	
Tile Drain	"	2.22	17,248	38,291	15,680	34,810	
Intake	PS	1,750.00	2	3,500	-	-	
"	"	2,600.00	-	-	1	2,600	
On Farm Intake	"	660.00	30	19,800	5	3,300	
"	"	150.00	-	-	60	9,000	
Cross Culvert	"	5,300.00	4	21,200	2	10,600	
"	"	1,800.00	4	7,200	15	27,200	
Rough Leveling	m^2	0.04	420,000	16,800	420,000	16,800	
Sub Soil Breaking	"	0.037	420,000	15,540	378,000	13,986	
Sub Total	"			159,873	-	151,265	
Other				23,980		22,690	Arable area
Total (LE)				183,853		173,955	Type 1 : 100 feddan
(LE/feddan)				1,839		1,932	Type 2 : 90 feddan

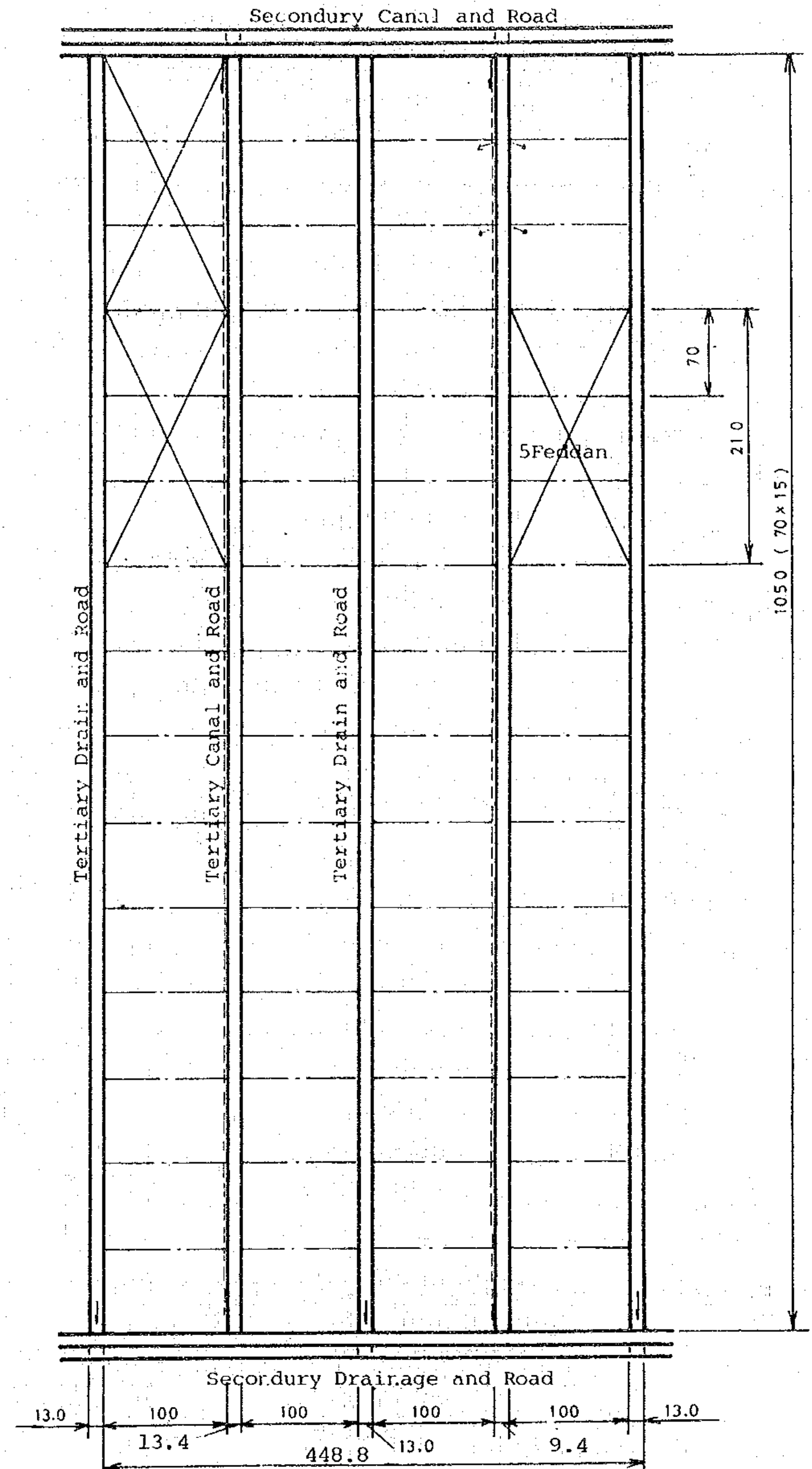


Fig. L-7-2 Standard Lot (No. 1)

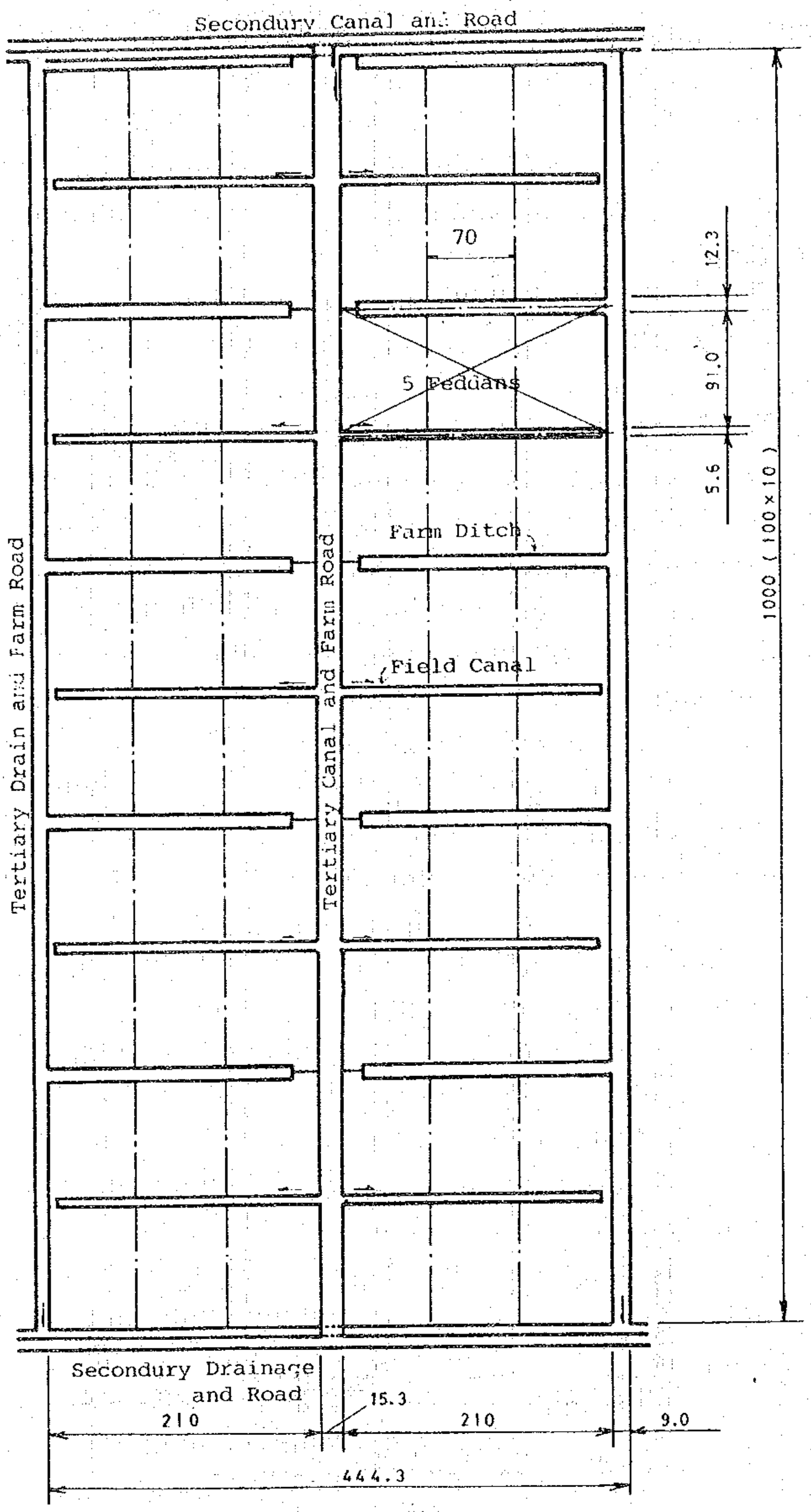
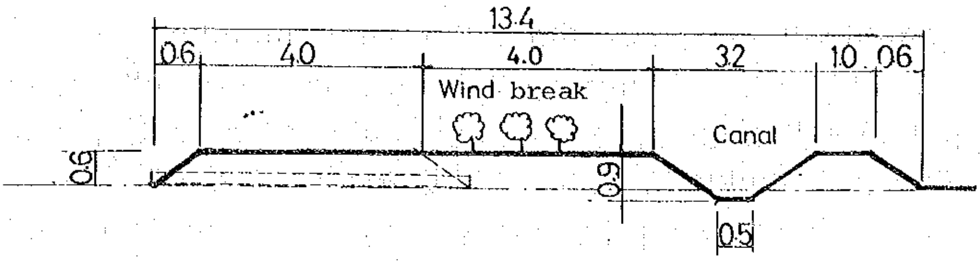
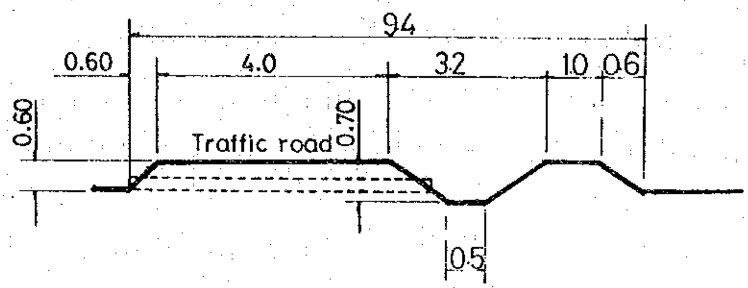


Fig. L-7-3 Standard Lot (No.2)

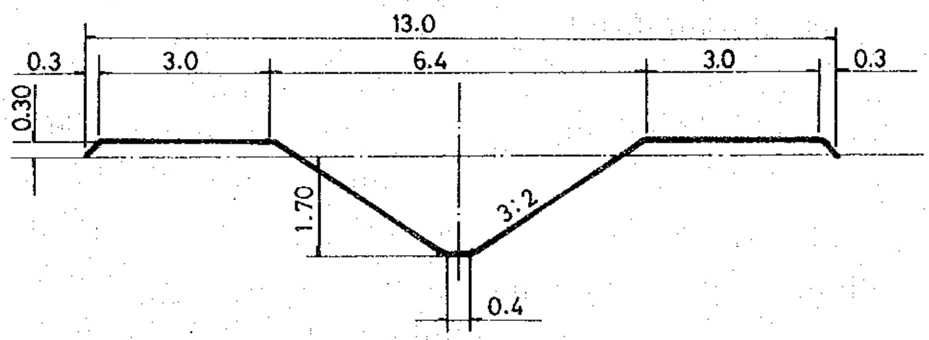
Tertiary Canal (1)



Tertiary Canal (2)



Tertiary Drain



Farm Ditch

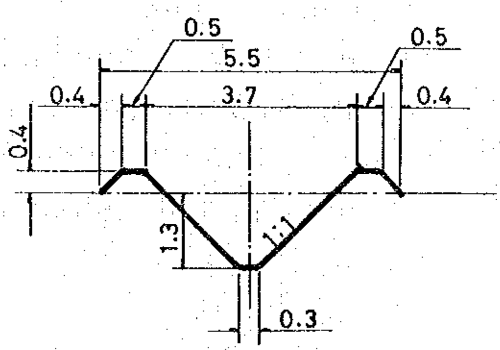


Fig. L-7-4 Canal Cross Section No.1

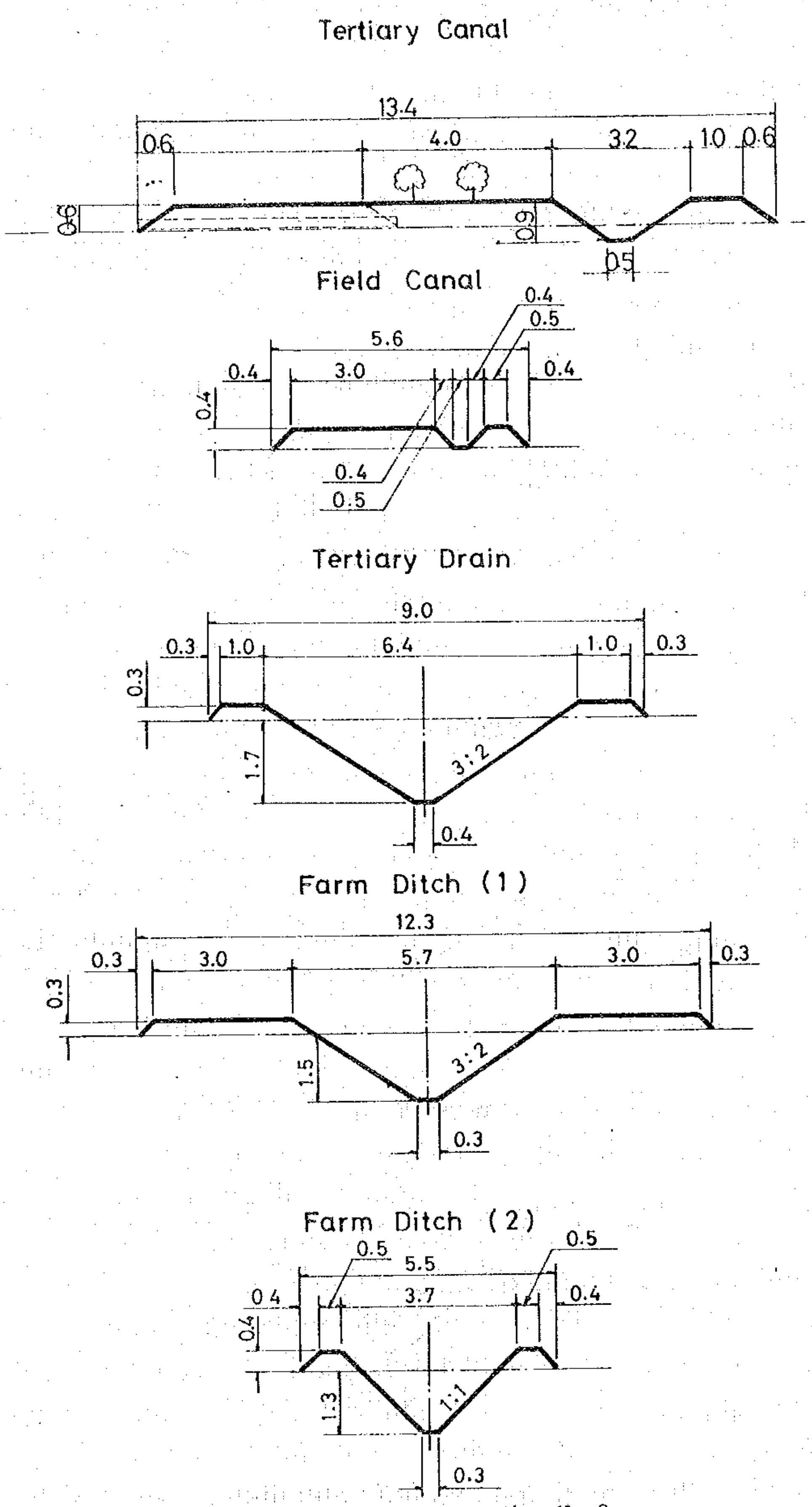


Fig. L-7-5 Canal Cross Section No.2

(2) On-Farm Facilities

a) Tertiary Canals

The dimensions of the tertiary canal are planned based on the rotational irrigation of 4 days on and 4 days off, and are decided according to the period of time required for irrigating one Farm Block.

There are 4 plans of 1 day, 2 days, 3 days and 4 days.

The cross section of the canal becomes larger to complete irrigation within the short period of time, but the compulsory working hours spent for water management on the field become shorter.

In case of 4 days irrigation, the amount of discharge is estimated at $0.03m^3$/sec, but in case of 1 day irrigation, it is estimated at 0.23 m^3/sec.

However, there is little difference in the size of corss section. Therefore, the tertiary canal has to have capacity for discharging 8 days' worth water within one day.

b) Diversion from Irrigation Canals

Turnouts are required to control the flow rate at diversion points, from the secondary canal into tertiary canals and from the tertiary canal into plots. The structure of turnouts should be simple to assure proper water amangement. Stop log with a diversion box is used in the secondary canal, and only a stop log is used in the tertiary canal.

c) Drainage Canal

Drainage canals are classified into tertiary drain, farm-ditch and tile drain. Farm-ditch is used only for the period of primary leaching and the trial cropping which follows. After that it will be replaced to tile drain. Unit drainage water requirement is 3 mm/day. In accordance with the drain spacing of 23 m in field lots, the flow rate is 0.08 ℓ/sec. for farm-ditch and tile drain, and 0.08 ℓ/sec. for tertiary drain.

The depth of farm dietch is minimum 1.2 m in order to keep the groundwater level below 1.0 m. In case of tertiary drain, its depth is minimum 1.4 m.

(3) Windbreak

a) Objectives

According to the climatological data, monthly mean wind velocity in the Project area is from 3 to 6 meters per second throughout the year. Strong wind called 'Khamasine' blows between mid-March and early April from the Western or Southwestern directions.

Functions of windbreak are to protect the strip of adjacent land from soil erosion, to decrease evapotranspiration, and to control temperature, through diminution of wind velocity.

b) Effectiveness of Windbreak

The area which can be effectively protected by the windbreak is relative to its height and also depends on the formation of the trees and their location. U.S. Forest Service, Denmark's Technical College, and the Reclamation Handbook of Japan agree that the effectiveness of the windbreak is roughly as follows :

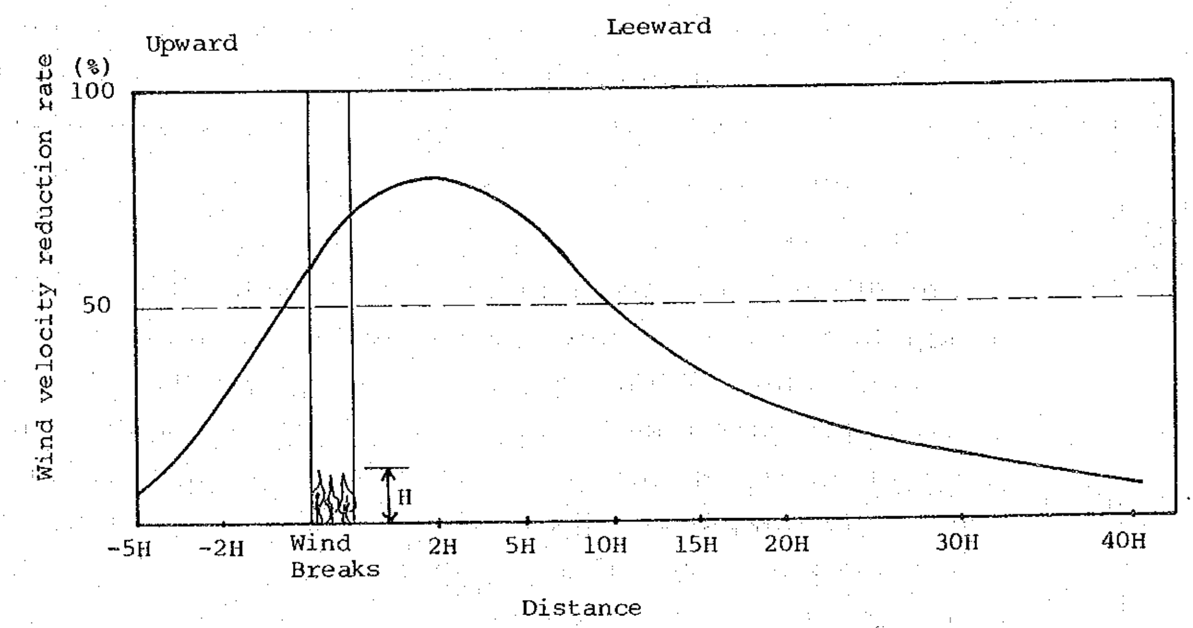


Fig. L-7-6 Relation between windbreak height and wind velocity reduction

Toward the upward, windbreak is not effective beyond -2H. However, in the leeward direction, it is effective even at 10H where the wind velocity can be reduced to 50%. H means the average windbreak height.

c) Allocation of Windbreak

i) Position and Direction

The windbreak will be located where it displays the greatest efficiency with occupancy of a relatively small area. Wind break is generally located around the Farm Block and its direction is set at a right angle to the prevailing wind direction. In the project, the standard interval is 200 m on an average based on Farm Consolidation Plan as shown in Fig. L-7-8, assuming that an average height of trees is 15 m.

ii) Width of Windbreak

The optimum width of the windbreak is between 2 and 4 times of its height, having 1 to 7 rows of tree planted. In the Project, the width and rows of the windbreak are designed as shown in Fig. L-7-7.

d) Plant Varieties and Planting Pattern

i) Plant Varieties

Based on resistance to drought and salinity, the selected plant varieties are as follows :

- Casurina Equisetiolia
- Eucalyptus Camaldulensis
- Tamarix

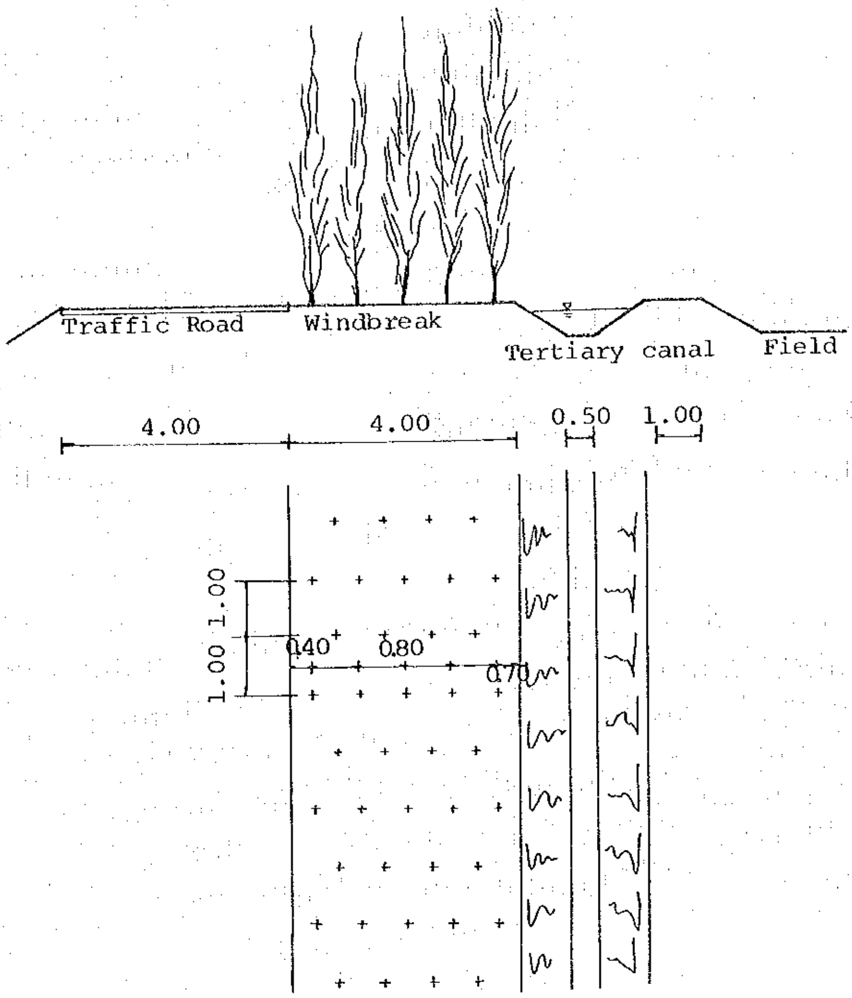


Fig.L-7-7 Disposition of windbreak

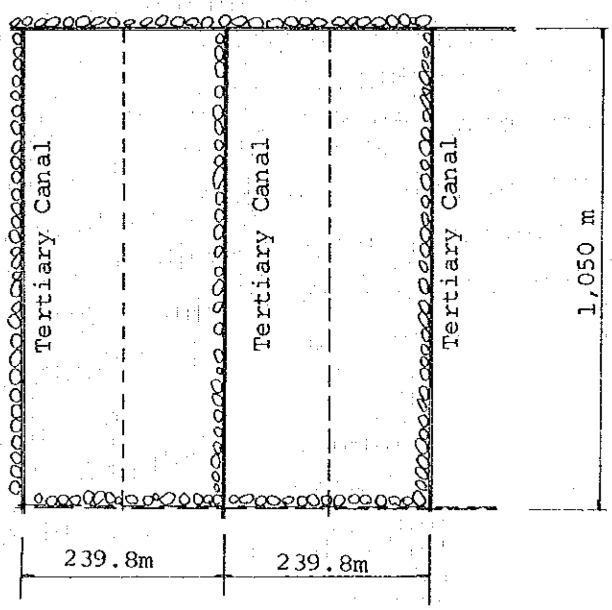


Fig. L-7-8 Plan of windbreak

ANNEX

M. RURAL DEVELOPMENT

CONTENTS

List of Tables

List of Figures

Page

M. RURAL DEVELOPMENT

1. Rural Conditions

1-1 Transportation Network

(1) Transportaion - Road

There is one national highway running between Port Said and Ismailia parallel to the eastern boundary of the project area. Also, one provincial road runs to the north-eastern direction, reaching Matariya through Mansura.

There are two branch roads: one branches off from the Port Said - Ismailia highway to Assam Village in the southern part, and the other connects Hadous with Matariya in the western part; the former is asphalted and about 10 km in length and the latter is unpaved for its entire length of 6 km.

Out of the two motorable roads running in the project area, one is running along Bahr El Baqar Drain through Assam Village and the other is running along Hadous Drain; both roads are unpaved and extending for about 5 km each.

A part from these road network, dykes of the drainage canals are being utilized as feeder roads connecting houses and villages.

Principal Roads in Project Area

Distance	Width (m)	Road Surface
Port Said - Ismailia	12.0	Asphalt paved
Port Said Highway - Assam	9.0	Macadam paved
Matariya - Benha	9.0	Asphalt paved
Hadous - Matariya	6.0	Unpaved

(2) Transportation - Navigation

Boats are the principal means of traffic and transporation for the local residents. Main courses of navigation are almost always running along the drainage canals with depth of 2.0 to 2.5 m being maintained by dredging.

Important features of navigation such as the length of each course, are shown in the following table.

Courses of Navigation on and Their Distance

Section	Distance (km)
Assam - Matariya	26.6
Matariya - Port Said	23.5
Hadous - Matariya	16.0
Ramsis - Matariya	20.5
Bashtir Canal	13.8
Port Said Highway - Bashtir Canal	9.5

1-2 Rural Conditions

The rural conditions of the project area are summarised as follows:

(1) Local Residents

The result of population survey is as follows:

Population Survey

Locality	Household	Population	Length of Settlement (year)
Bahr El Bagar Drain	850	5,100	50 - 100
Ramsis Drain	170	1,020	20 - 50
Hadous Drain	350	2,100	20 - 50
Bashtir Canal	50	300	5 - 10
Tributary of Bashtir Canal	30	180	5 - 10
Port Said-Matariya Channel	50	300	10 - 20
Islands in the Lake Manzala	100	600	-
Total	1,600	9,600	

Note : Average number of the household-members is 6.

(2) Water Supply

There is no system in the proposed project area. Yet, as the water taken from wells and/or drainage canals contains too much salt and is very badly polluted, drinking water needs to be carried to each house by boat from Matariya.

(3) Electric Power Supply

A supply of electricity for lighting as well as power is being enjoyed by a small number of people living along Hadous Drain. The total length of lines is limited to about 5 km. The majority of the project area residents still depend on kerosene oil or batteries, and diesel engine for operating drainage apparatus and processing.

(4) Schools

In the entire project area there are only two schools which combine both primary and secondary education. Their scale and structure are as follows.

School in the Project Area

Location	Building	Area	Structure	No. of Students
Assam	450 (m^2)	10,000 (m^2)	Reinforced concrete	400
Assam	200	5,000	Brick	200

(5) Post, Telephone, etc.

Communication services such as post, telegraph and telephone are not provided and there is neither a police station nor fire station in this locality.

(6) Public Health

There is a hospital with a full-time doctor in Assam Village but none in the other districts or islands. Residents can obtain health services at hospitals in the nearby cities and towns (Matariya, Qantara, and Port Said).

(7) Religious Facilities (Mosque and Cemetery)

The mosques are as follows :

Mosque in the Project Area

Scale	Structure (m^2)	Compound (m^2)	Number of Existing Mosques
Large	200	600	2
Small	60	180	10

(8) Others

There are two warehouses serving as distribution-points of Agricultural Co-operatives in Assam Village. They had a considerable stock of fertilizer at the time of the team is survey. There are also three 'relics' in this area, the most significant one is on Kom Ibun Salam (an island in the Lake Manzala to the northwestern corner of the project area).

2. Rural Development Plan

2-1 General

This project is one of the major projects in Egypt which aims at an overall agricultural development through large-scale land reclamation. Agricultural and agriculture-based activities in the Project Area will be initiated, pushed forward, and completed by different categories of settlers.

The facilities necessary to accomodate the new settlers will be provided, stage by stage, in accordance with the progress of project implementation. While every amenity indispensable for wholesome living should be furnished on the standards which are considerably higher than those prevailing among the ordinary rural villages, settlement plans will have to take into full consideration the existing social, economica and local administrative aspects as well as the agricultural development aspects.

2-2 Settlement Plan

Based on the intensive survey of the existing villages and towns in the neighbouring Governorates and a series of discussions with GARPAD, the settlement plan in the project Area is formulated as below.

(1) Organization of Settlement

The settlement plan proposed hereinafter comprises a part of a comprehensive development plan covering about 240,000 feddans which includes 110,000 feddan of North Hussinia Project area, 80,000 feddans of the South Hussinia Project Area and 50,000 feddans of South Port Said South Project Area (henceforth referred to as the "greater area") and about 230,000 people will settle down in this wide area in future. Such being the case, social and technical services shall be appropriately rendered to assure a wholesome living of the new settlers.

To serve for a balanced development and a good administration of the "greater area", town will be established in its center at the crossing of El Salam Canal and Bahr El Baqar in the North Hussinia Project Area.

The settlements in the Project Area shall be established in groups of inhabitants according to their farming level and social activities so that the social and technical services can be rendered more effectively and efficiently. Under the Town, the settlement pattern is considered to be a three-tiered and systematic setup of; a) sattelite villages; b) service villages, and c) central villages. The project will employ clustered village community planning.

a) Satellite Villages

Satellite villages will be established in moderately clustered formation as the core of the local activity zone and will be located within a 2 km walking distance from the farmland of its owners.

The social function of the communities should be maintained by limiting the size of the communities to 300 households and to 2,000 in population. Consequently, satellite villages will have an average size of approximately 2,000 feddans.

Satellite villages of smaller size than the above-mentioned village size may have more advantages for farm management, but will bring some disadvantages in rendering efficient public services.

b) Service Villages

Each one service village will be established for every four to six satellite villages at a service position among them. It will have the role of catering for the benefits of the satellite villages encircling it.

The service village will be furnished with intermediate facilities for public and amenities on behalf of the satellite villages under its umbreaila.

c) Central Village

Central village will be located at a pivotal position in the settlement area and serves for so many service villages and their satellite villages, and will have the necessary facilities to meet the demand arising in its settlement area.

Fig. M-2-1 illustrates the hierarchy of settlements.

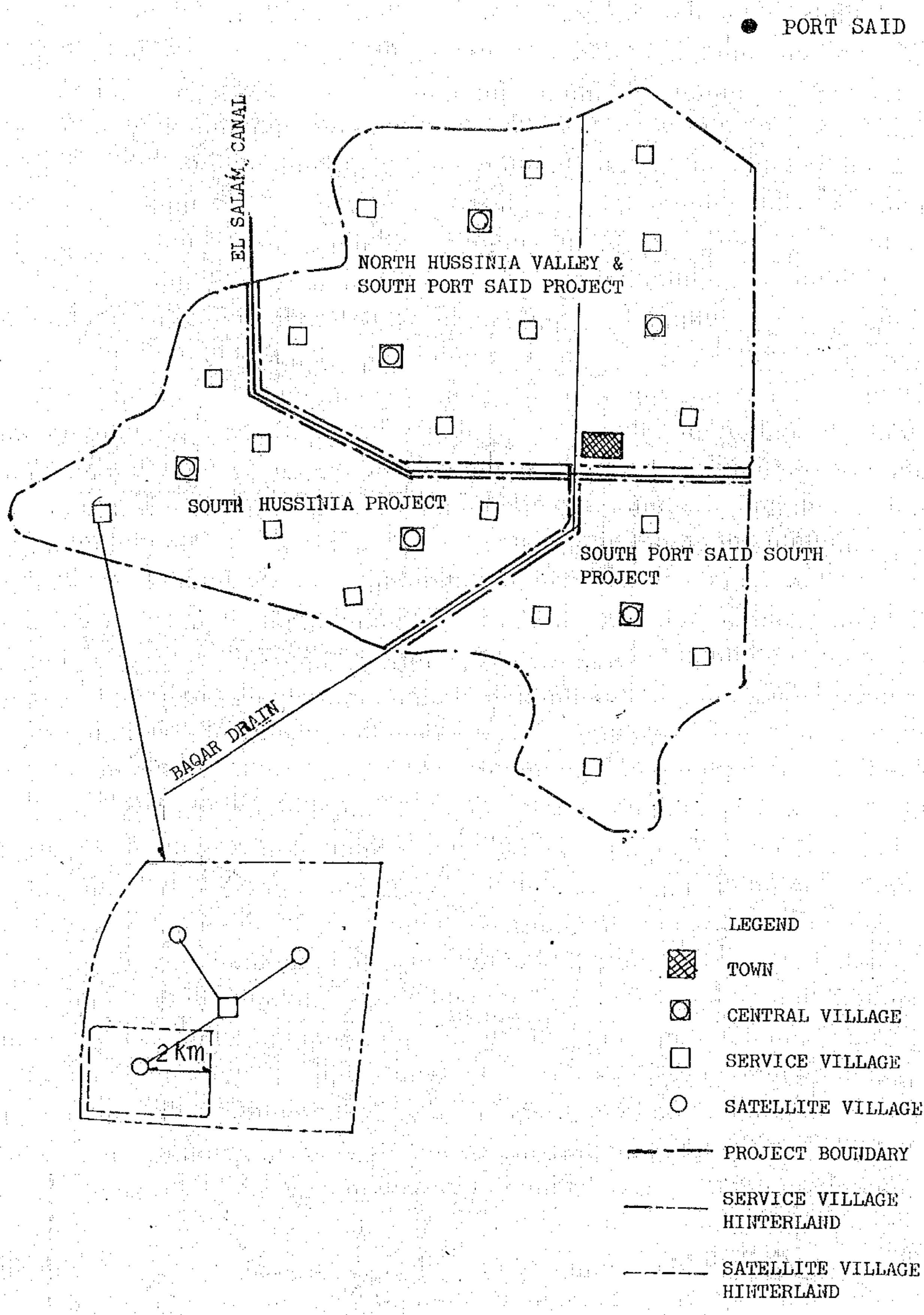


Fig. M-2-1 Hierarchy of Settlement of Rural Development

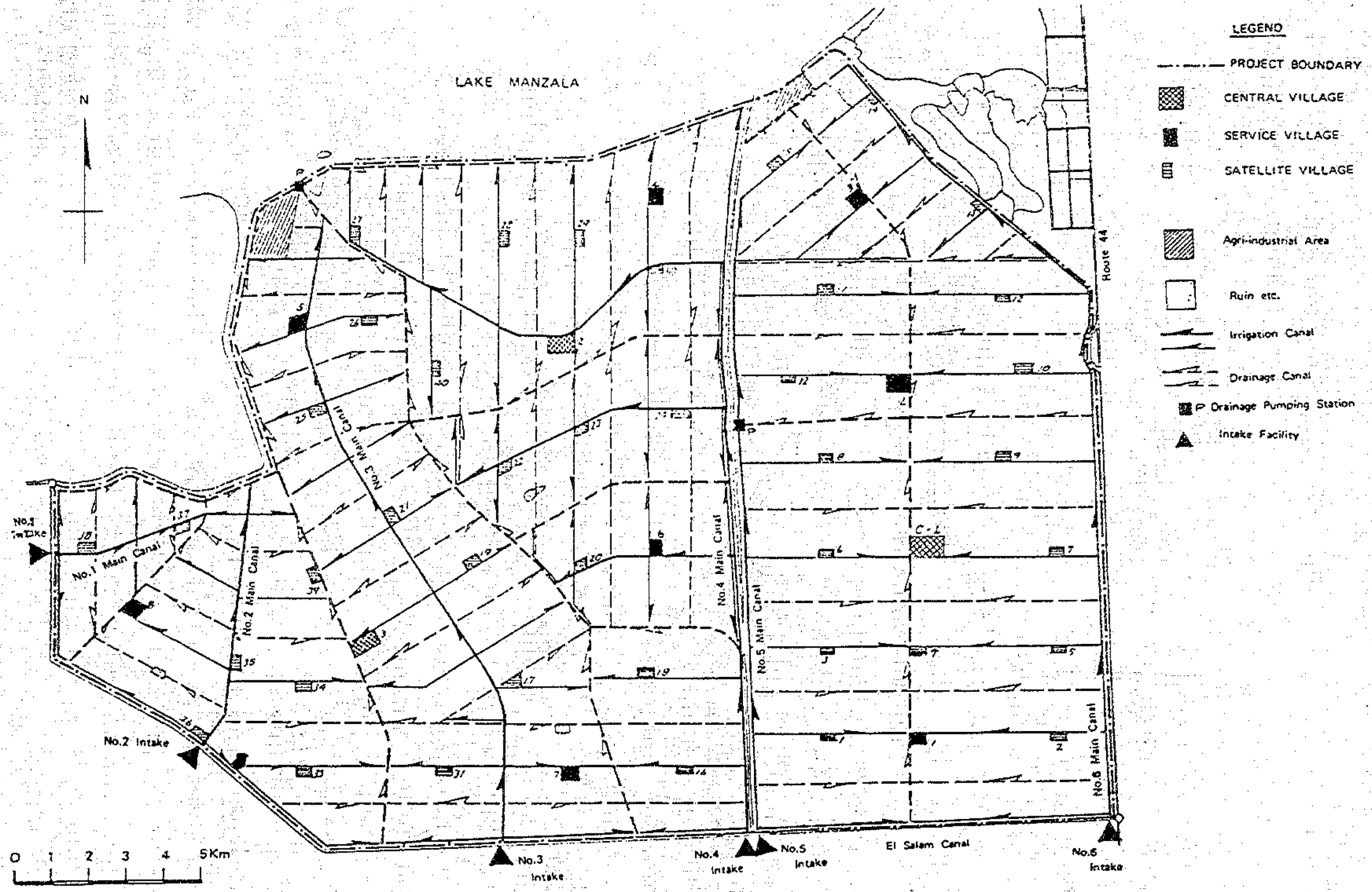


Fig. M-2-2 Villages Location Plan

(2) Location of Villages

The settlements should be located along the irrigation canals as much as possible so that roads to be constructed along canals can be utilized for the dual purpose's village roads and canals operation and maintenance roads. It has been also taken into consideration that water management will be easier if villages are located along irrigation canals. (See Fig. M-2-2)

A settlement pattern has been so designed as to let all farmers have their houses within a walking distance of about 2 km from their farm fields. The settlements will be arranged in a hierarchy consisting of three types of settlements. Satellite villages are the smallest among them, and have the greatest number. For every three to four satellite villages, one service village will be provided, and for every three service villages, one central village will be founded. The town will function for administration of the "greater area". The proposed number of villages classified by type is as follows:

Settlement	Port Said	North Hussinia	Total
Satellite village	16	24	40
Service village	3	5	8
Central village	1	2	3
Town	1	-	1
Total	21	31	52

(3) Number of Settlers and Population

The number of settlers and the population in the established settlement hierarchy can be estimated as follows;

a) Settlers

The approximate number of farm and non-farm household for respective village and town will be as follows;

Satellite village: 250 farm households, 33 owner households
and 45 non-farm households

Service village: 230 farm households, 30 owner households
and 95 non-farm households

Central village: 187 farm households, 18 owner households
and 422 non-farm households

Town : 2,000 non-farm households

* Farm households are small holders, and landowner households are large holders.

b) Population

Assuming that a household consists of five members on an average, the population by village types is computed as follows;

- Satellite village: 1,700 persons
- Service village: 1,800 persons
- Central village: 3,000 persons
- Town : 10,000 persons

The total number of households and population after settlement is summarized as follows;

	Households	Population
Farm households	12,400	62,000
Owner households	1,573	7,865
Non-farm households	5,827	29,135
Total	19,800	99,000

2-3 Housing

About 99,000 persons are estimated to be settled in the project area in its full development stage. Therefore it will be necessary to provide 52 villages with 19,800 houses assuming that one household consists of five members. In villages, several housing types will be intermixed to promote social integration. In this connection six house types will be built to accommodate the project residents: farmers' houses, land owners' houses, apartments, technical laborers' houses, assistant directors' houses and diroctor's houses.

Details are explained follows;

- Farmers house

  A building area of 54 m^2 on 200 m^2 lot will be built by simple techniques.

  Tap wayer supply is provided in the village and is commonly utilized. Electricity to individual switch boxes and one pit flush latrine are also provided, and other basic facilities will be furnished by the farmer himself. The typical farmer's house is illustrated in Fig. M-2-3.

- Owners' house

  A house area of 60 m^2 on 500 m^2 lot, individual tap for water supply, electricity and sewage works will be provided.

- Technical laborers' house

  A house area of 58 m^2 with all public utilities.

- Apartment

  General clerks and laborers will live in apartments which are provided with all public utilities.

- Directors' and Assistant Directors' houses

  This category of housing will be of fairly high standard one such as concrete building furnished with all public utilities and private telephone.

  The total number of these houses required for the project is shown in Table M-2-1.

Table M-2-1 Houses Required by Village Types

Houses	Satellite Village	Service Village	Central Village	Town
Directors	-	1	8	24
Assist Directors	-	1	8	24
Technical Laborers	8	20	60	180
Apartment	2	3	9	30
Owners	33	30	18	-
Farmers	260	230	187	-
Total	303	285	281	258

Brick and concrete-block are two commonly used materials for construction of houses. Pre-fabricated sets may also be used. As a large number of houses are required including some 20,000 in the sttlement areas and necessary number of houses for those engaged in agro-industries and such requirements would better be fulfilled in a wider region covering the South Hussinia and other project areas. A large demand for bricks might encourage limitless scraping of fretile surface soil for burning which is quite detrimental from agricultural development viewpoint. Hence concrete-block is recommended as the main building material which may be purchased from outside or self-supplied from the concrete workshop to be established within the Project Area.
Among the roofing materials such as wooden board or plank, corrugated concrete slate, reinforced concrete slab, etc,, the corrugated concrete slate would be the best choice; its supply would be made easier at cheaper rate if the Project Area could have its own concrete workshop.

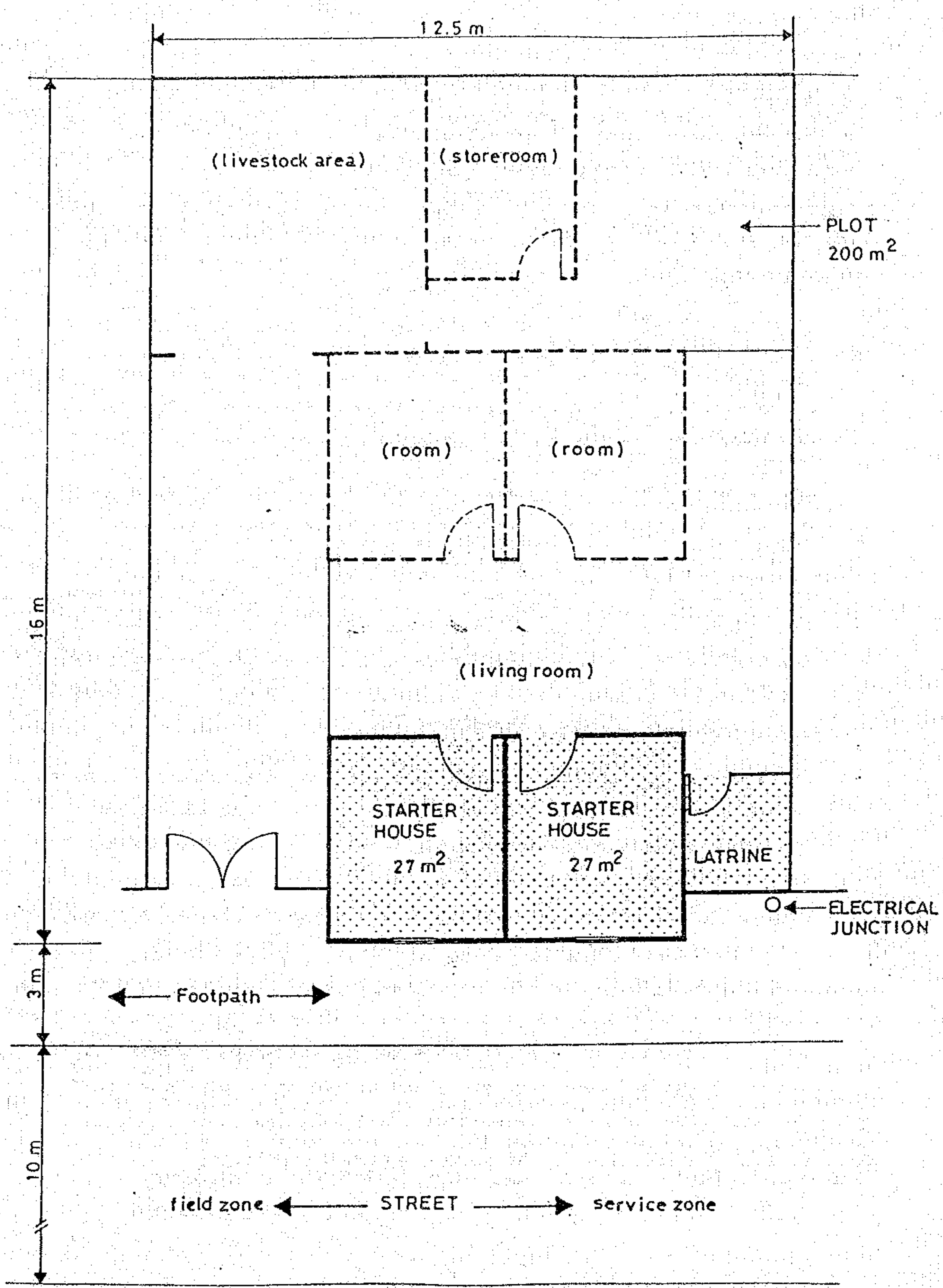


Fig. M-2-3 Typical Design of Farmers' House