Since the main season paddy uses a basin irrigation system, the irrigation operation is designed to be 24 hours. Design irrigation water requirement for the facilities is estimated at 1.34 lit/ sec/ha.

To irrigate each 10 ha of vegetable cultivation area, a drip and pipe line system with a pump station, and an other pipe line using gravity flow from the farm pond are designed. Each irrigation area for vegetables is divided into two (2) irrigation blocks. Irrigation water is to be supplied to one (1) irrigation block for 12 hours and the other one (1) for the other 12 hours, during the peak requirement. Therefore, each 10 ha of vegetable area has two (2) irrigation rotation blocks.

Under the conditions of the irrigation rotation system mentioned above, the design irrigation water requirement for the facilities is 0.43 lit/ sec /ha, and the design discharge of all main pipe lines is 4.6 lit / sec.

2.2.4 Reservoir Capacity

Reservoir operations of the Lembu pond and Ketapang dam are calculated for monthly periods based on the estimated runoff at the proposed pond and dam sites, irrigation requirements and water loss from the reservoir such as seepage and evaporation. Runoff of 30 years from 1961 to 1990 is applied in the reservoir operation calculation.

As a result of these calculations, the following reservoir capacities designed to cope with a drought year with a return period of 5 years, is clarified for the Project.

Pilot Project/Reservoir	Type of Reservoir	Capacities(1,000 m3)
Lembu	Excavated Pond in a Depression	120
Ketapang	Homogenous Earthfill Dam	150

Detailed calculations of the reservoir operations are described in Tables.3.2.2 and 3.2.3.

2.2.5 Drainage Water Requirement

The drainage water requirement is computed under the condition of 3 consecutive days rainfall with an exceeding probability of 80 %, and 3 days of drainage period. The 3 consecutive days rainfall with a return period of 5 years is adopted based on 39 years of rainfall data from Langkawi station.

The 3 consecutive days rainfall with a return period of 5 years is 236 mm, and the design discharge of the drainage canals is estimated at 9.1 lit/sec/ha.

2.2.6 Water Resource Development Facilities

Water resource development facilities are basically designed using a draft design standard discussed between the DID and the JICA Study Team during the Feasibility Study and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

(1) Lembu excavated pond

The general lay out of water resources development is shown in DWG 2001 and DWG 2006

The area to be excavated is 7.8 ha, and delineation of this area is done considering the location of existing irrigation and drainage facilities, topographical conditions, and excavated depth.

The area to be excavated is lower than EL 5.0 m, because the lowest elevation of the bund axis is around EL 4.0 m, and the area ranging in elevation from EL 4.0 m to EL 5.0 m expands in the upper reaches of bund axis. The area to be excavated is divided into 2 areas depending on the excavated depth, EL 3.5 m with an excavation depth of nearly 1.5 m and EL 4.0 m with an excavation depth of nearly 1.0 m. This is done in order to save costs. Therefore, the total excavated area consists 4.2 ha to be excavated at EL 3.5 m and 3.6 ha to be excavated at EL 4.0 m.

The bund has a crest width of 5 m and 3 m wide laterite pavement. Since 0.5 m of top soils is stripped, the average height of the bund is 2.0 m from the bottom of the original ground, and the slope of bund is 1 : 1.5. Crest elevation of the bund is EL 6.5 m.

The bund of the pond has an emergency spillway to release a design flood discharge of 18.4 m3 / sec and an intake structure for the irrigation water supply.

The design water level for gravity irrigation to the main season paddy field is EL 5.5.m at the intake gate.The useful water level in the pond is designed to be EL 4.0 m, because irrigation water level of the downstream sustains the required water level at the turnout by gate and/or stop log operation. The intake structure is a gate structure with a measuring devices, and a head race of 38 m is designed to connect to the existing canal courses.

Storage water in a pond of less than EL 4.0 m is designed for vegetable cultivation by using pump and pipe lines.

The type of emergency spillway is a broad crest weir with a width of 24 m and height of 2.5 m. The emergency spillway also has 2 gate structures to be used for maintenance of the pond. Since the foundation of the spillway site is weak, concrete piles of about 5 m long are designed to be driven to a depth at EL - 3.0 m.

Design of the major structures are illustrated in DWG.2006 to DWG. 2007, and their salient features of are described below.

Lembu Excavated Pond

Excavated pond in depression	
Total storage capacity	130,000 m3
Effective storage capacity	120,000 m3
Dead storage capacity	10,000 m3
Excavated area	7.8 ha
Bund of pond	
Crest elevation of bund	EL 6.5 m
Crest width of bund	5 m
Length of bund	546 m
Height of bund	1.5 m
Excavated depth of pond	1.5 m - 1.0 m
Emergency spillway	
Type of spillway	broad crest weir with gate structures
Design flood discharge	18.4 m3/sec
Width of spillway	27.2 m

Height of spillway 2.5 m

(2) Ketapang Dam and reservoir

The general lay out of the water resources development is shown in DWG 2001 and DWG 2002.

Dead storage of the reservoir is designed to be about 10,000 m3 which is the sedimentation volume for 30 years.

Based on the reservoir storage volume curve, the designed low water level (L.W.L.), which is the surface elevation of sedimentation is EL 17.5 m. The reservoir storage volume curve is shown in Fig.3.2.1. Since effective storage of the reservoir is 150,000 m3, the normal high water level (N.H.W.L.) is EL 25.70 m.

The dam has a culvert spillway and an emergency spillway. The design flood discharge of the spillway is estimated as half of the probable maximum flood in accordance with the Engineer Guidelines US Army Corps, because the proposed dam has a storage capacity of less than 1.0 million m3 and a height of less than 15 m, furthermore, a potential hazard down stream from the dam exists as there are a few houses and a small scale paddy fields.

The design flood discharge of both spillways is estimated at 13.2 m3 /sec, based on PMF of the Sg. Malut dam located in the neigbouring river basin. The flood discharge is shared by both spillways, 5.3 m3 /sec for the culvert spillway and 7.9 m3/ sec for the emergency spillway. The design flood water level (D.F.W.L.) is EL 26.49 m.

The freeboard of the dam and teh thickness of the pavement at the crest of the dam are 1.0 m and 0.3 m respectively, and the crest elevation of the dam is EL 27.80 m.

As a foundation treatment of dam, based on the geological information, the top soils will be excavated to a depth of 2 m. The lowest elevation of the excavation is EL 13.00 m. Therefore dam height is 14.8 m.

The dam is homogenous earth fill type with a horizontal drain of 1.5 m thick laid at EL 13.00 m.

Slopes of the dam are designed to be 1 : 3.0 upstream and 1 : 2.5 downstream. Stability analysis of the dam slope is made using geological data obtained through the boring survey and soil mechanical test. The analyses are made for three (3) cases, (i) full water storage case with normal high water level, (ii) sudden draw down case from N.H.W.L. to L.W.L. and (iii) no storage case. The result of the stability analyses are shown below (Figures 3.2.2 to 3.2.4).

Case / Slope	Type of Stress	Min.S.F.
Full Water Storage		
upstream	effective stress	1.5
downstream	effective stress	2.36
Sudden draw down		
upstream	effective stress	1.76
No Storaged		
upstream	effective stress	2.29
downstream	effective stress	1.94

The stability analyses are made as sample calculations for the dam design based on the current geological data obtained in the feasibility study. The geological data are still insufficient for the detailed design of the dam.

Therefore, further geological investigations, especially obtaining data from the foundation layer of the dam, and soil mechanical tests shall be necessary for future design.

Stone covering with a thickness of 0.8 m on the upstream slope of the dam, sod facing on the downstream slope and laterite pavement at the crest of the dam are designed to prevent erosion.

Seepage water loss from the dam body and foundation are also examined using geological data of the dam foundation. Daily seepage loss from the reservoir is estimated at about 130 m3/ day, equivalent to 0.09 % of the storage capacity of the reservoir.

Therefore, a blanket of impervious soils is designed for the bottom of reservoir to decease seepage loss to 0.04 % of the storage capacity. The blankets are divided into two (2) types, the bottom blanket which is placed from EL 16 m to the bottom of the reservoir, and the slope blanket with a thickness of 1 m, which covers the hill slope from EL 16 m to EL. 18 m.

The emergency spillway is a grass spillway designed to be placed 7 m apart on the original hill portion of the dam embankment body. The spillway has a low channel rectangular section. Height and width of the low channel are 1 m and 8 m, respectively, and the inside slope is 1 : 1.5.

The culvert spillway has drop type inlet in tower section and one box type barrel. The barrel is designed to be placed on, and varied in, the original hill slope. At the outlet of the box section, a concrete box with a drop is designed to off take irrigation water through the pipe line. The culvert spillway also functions as an outlet, It has an operation bridge which is designed to give access from the right bank of the dam. It is a T beam bridge, 18 m in length.

An access road to the dam is laid in the hill slope of the right bank. It is designed to have laterite pavement 3-m wide, and the maximum longitudinal slope of the road is 5 %. Total length of the access road is 400 m.

Designs of the major structures are illustrated in DWG.2002 to DWG. 2005, and the salient features of these facilities are described below.

Ketapang Dam and Reservoir

Reservoir	
Total storage capacity	160,000 m3
Effective storage capacity	150,000 m3
Dead storage capacity	10,000 m3
Dam	
Type of dam	Homogenous earthfill and Horizontal & toe drain
Height of dam	14.8 m
Crest width of dam	5 m
Length of dam including grass spillway	175 m
Dam slope	
upstream	1 : 3.0
downstream	1 : 2.5
Crest elevation of dam	EL 27.80 m

Design flood water level	EL 26.49 m
Normal water level	EL 25.70 m
Low water level	EL 17.50 m
Thickness of blanket	area of less than EL. 16 m, 1 m to 3 m area of EL 16 - 18 m, 1 m

Emergency spillway

Type of spillway	Grass spillway (trapizoidal, chute type)
Design flood discharge	7.9 m3/sec
Base elevation of chute channel	EL 26.06 m
Total length	129 m
Base width of spillway	13 m
Inside slope of lower channel	1 : 1.5
Gradient of channel	1 / 200
Height of lower channel	1 m

Culvert spillway

Type of spillway	Tower type (box type)
Design flood discharge	5.3 m3/sec
Crest elevation of spillway	EL 25.70 m
Height of spillway	9 m
Type of barrel	box barrel 1.8 m x 1.5 m x 1 no.
Total length of barrel	91 m
Incident l facilities	Operation bridge, total length 18 m of 3 spans

Access road

Type of road	Pavement road with laterite (w = 3 m)
Total length	400 m
Width of road	5 m

2.2.7 Irrigation and Drainage Facilities

Irrigation and drainage development facilities are basically designed using the draft design standard discussed between the DID and the JICA Study Team during the Feasibility Study and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

(1) Lembu Project area

The general lay out of the irrigation and drainage development is shown in DWG 2001 and DWG 2008.

(a) Irrigation facilities

The irrigation and drainage system in the Project area is basically separated, except for the recycling system which uses return flow from paddy fields totalling nearly half of the Lembu Project area.

The irrigation system is divided into a gravity irrigation canal system for the main season paddy down stream from the Lembu excavated pond and a pump and pipe line system for vegetable cultivation in the upper reaches of the pond.

The gravity irrigation system uses earth canals with trapezoidal sections, designed to cover an area of 146 ha. The system consists of one (1) head race at the section from the intake structure to the existing irrigation canal, 6 earth canals and 38 related structures. The design discharge of the canals ranges from 0.3 m3/sec to about 0.2 m3/sec, and the total length is 9.5 km.

The recycling system has one (1) intake structure at the main drain section, 15 m downstream from the existing state road, as shown in DWG. 2010. The design flood discharge at the intake structure is estimated at 19.3 m3/sec. There is a movable weir with 10 hard wooden gates driven by motors. Height and width of the gate is 2.5 m and 1.2 m respecively. Since the intake foundation is weak, a concrete pile, 7 m in length, is planned.

Since the suction head of the pumps range from 2 m to 3 m and the design discharge is 0.26 m3/min, an ordinary volute pump is adopted for vegetable cultivation. Two pumps are required including one (1) standby pump.

Since the water head of the pipe line is about 6 m to 10 m, and the majority of the area has topographically flat., PVC pipes are selected. Design velocity in the pipe is designed with a range from 0.8 m/sec to 0.9 m/sec, and the diameter of the pipe is 60 mm.

(b) Drainage facilities

The drainage system in the Project area consists of 5.5 km of main drains and 10 drop structures.

The design discharge of the main drains ranges from 0.1 m3/sec to 20 m3/sec, and the main drain divides into a large drain, which has a design discharge of more than 5.0 m3/sec, and a smaller drain. All main drain are designed with a trapezoidal section with an inside slope of 1 : 1.5. The base width of the main drain is designed to range from 0.5 m to 0.8 m in the smaller drains and from 6 m to 10 m of bigger drains.

(c) Land levelling

Land levelling work in the paddy field will total about 35 ha based on local requests obtained during the field survey.

Design of the typical structures are illustrated in DWG.2009 to DWG.2011, and salient features of these facilities are described below.

Lembu Project area

Irrigation area	110 ha (paddy 100 ha in main season and vegetable 10 ha in all seasons)
Pump station	1 site 20 m2
Pump	Volute pump 1.5 kw (h=10 m) 2 units.
Pipeline	PVC pipe line, 1.85 km
Irrigation canal	8.0 km of 6 nos.
Related structures	
Intake structure	2 nos.
Turnout	4 nos.
Siphon	3 nos.

Cross drain	25 nos.
Demolishing of existing structures	3 nos.
Drainage canals	5.5 km of 8 nos.
Related structures	
Drop structure	10 nos.
On farm facilities	Drip and / or micro jet sprinkler irrigation facilities 10 ha
Land levelling	35 ha of paddy field

(2) Ketapang Project area

The general lay out of irrigation and drainage development is shown in DWG 2001.

(a) Irrigation facilities

The irrigation and drainage system in the Project area is the same as the Lembu Project. The system is divided into a gravity irrigation canal system for the main season paddy and a pipe line system for vegetable cultivation.

Earth irrigation canals with trapezoidal sections are designed to cover 60 ha. The system consists of 2 earth canals and 5 related structures. The design discharge of the canals is about 0.03 m3/sec, and the total length of the canals is 2.8 km.

Irrigation water for vegetable cultivation is directly supplied from the farm pond designed at outlet portion of culvert spillway. Since the difference of topographical elevation is more than 15 m, a booster pump station is not required.

Since the water head of the pipe line is about 15 m, and topographical condition from the farm pond to the irrigation area has a gentle slope with a small undulation of less than 4 m, water hammer is not assumed to occur, and PVC pipes are selected. The design velocity in the pipes is designed with a ranges from 0.8 m/sec to 0.9 m/sec, and the diameter of the pipe is selected 60 mm.

(b) Drainage facilities

Drainage system in the Project area consists of 2.8 km of main drains and 2 drop structures.

The design discharge of the main drain ranges from 5.8 m3/sec to 6.1m3/sec, and drain is designed to have trapezoidal section with a inside slope of 1 : 1.5. Base width of the main drain is 6 m.

(c) Land levelling

Land levelling work in the paddy field will total about 13 ha based on local requests obtained during the field survey.

Design of the typical structures are illustrated in DWG.2008 to DWG.2009 and DWG.2011, and salient features of these facilities are described below.

Ketapang Project area

Irrigation area	70 ha (paddy 60 ha in main season and vegetable 10 ha in all seasons)
Pipeline	PVC pipe line, 2.4 km
Irrigation canal	2.8 km of 2 nos.
Related structures	
Intake structure	1 nos.
Cross drain	6 nos.
Drainage canals	2.8 km of 1 no.
Related structures	
Drop structure	2 nos.
On farm facilities	Drip and/or micro jet sprinkler irrigation facilities 10 ha
Land levelling	13 ha of paddy field

2.2.8 Construction Plan

Mechanical construction methods will be applied. Main structures of construction are the dam and related structures, the excavated pond and related facilities to the pond.

Diversion works of river flow during construction of the Ketapang dam will be entrusted to the culvert spillway. Prior to the commencement of the embankment of the dam, construction of the barrel portion of culvert spillway shall be completed. The construction program of the dam body is scheduled to start from both hillsides to the centre of the dam.

Diversion works during the excavation of the Lembu pond and bund, will be entrusted to the DB-2 main drain for the pond and to the gate structures of the emergency spillway for the bund. Therefore, construction of main drain and emergency spillway shall be given priority in the construction schedule.

Main construction works include the embankment of the Ketapang dam and the Lembu pond bund, excavation of the pond, the main drain and emergency spillway of the Ketapang dam, and concrete work and piling works of the Lembu emergency spillway etc..The volume of these works are estimated at about 122,000 m3 of embankment, about 226,000 m3 of excavation, about 1,400 m3 of concrete works, and about 950 m of piling works.

Taking the above into consideration, the construction schedule is assumed at 11 months, consisting of 2 months for mobilisation, preparatory work and demobilisation periods, and 9 months for the construction period.

2.3 Estimate of Project Cost

2.3.1 Unit Price Analyses

Unit prices of the respective works of the project are estimated by up-dating the bidding prices of similar works in the Langkawi, and using the Government price schedule issued in 1993, and the annual inflation rate of commodity issued by

the Central Bank of Malaysia. The unit prices of these works are estimated at 1994 price levels.

Reference data of bidding prices for silimar works of other projects are as follows:

1) Sng. Kuala Melaka Bridge project 1990, Langkawi
2) Membina dan Menyiapkan project 1990, Langkawi
3) Pekan Kuah Drainage project 1992, Langkawi
4) Irrigation project 1994, Langkawi

The updated unit prices of the respective works are shown in Table 3.2.4.

2.3.2 Estimate of Quantity

All quantities are estimated, based on designed mentioned above. The quantities estimated are shown in Table 3.2.5 to Table 3.2.6.

2.3.3 Estimate of Construction Cost

Total construction cost consisting of direct construction cost, land acquisition cost and physical contingency is estimated at about RM 10,616,800 for the Lembu Project and at about RM 5,222,300 for Ketapang Project, at 1994 price levels, as shown below.

Physical contingency is estimated at 15 % of direct construction cost.

	Description	Cost (RM)	
		Lembu	Ketapang
1	Direct construction cost	4,541,400	3,486,300
2	Land Acquisition	4,713,000	689,700
3	Physical Contingency	681,200	523,000
4	Engineering cost	454,200	349,000
5	Administration cost	227,000	174,300
	Total	10,616,800	5,222,300

The detailed costs are shown in Tables 3.2.5 to 3.2.6.

Table 3.2.1 Irrigation Water Requirement (Kedawang Project KH4&5)

Langkawi (KH4&5)	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Paddy (off season)													
										Presaturation			
Horticulture													
Monthly Rainfall (1977)	13.5	0.0	0.0	85.5	217.5	189.5	219.0	474.0	447.0	469.0	77.0	5.0	2,197
Potential Evapotranspiration	127.2	118.7	131.1	121.5	108.5	107.1	104.8	106.6	91.1	99.2	106.8	121.2	1343.9
Percolation	93.0	0.0	155.0	150.0	124.0	120.0	124.0	124.0	150.0	93.0	90.0	93.0	1316.0
Paddy (off season)													
Gross Irrigation Requirement								360	237	262	254	93	1,206 **1
Horticulture													
Rozelle													
Crop coefficient (Kc)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Crop Evapotranspiration (ETcrop)	97.3	90.8	100.3	92.9	83.0	81.9	80.2	81.6	69.7	75.9	81.7	92.7	1,028
Effective Rainfall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Net Irrigation Requirement	97	91	100	93	83	82	80	82	70	76	82	93	1,028
Irrigation Efficiency	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Conveyance efficiency													
Application Efficiency													
Gross Irrigation Requirement	114	107	118	109	98	96	94	96	82	89	96	109	1,210
Total Gross Irrigation Requirement	114	107	118	109	98	96	94	456	319	351	350	202	2,416

Note : **1 Figure of irrigation water requirement compited based on MADA report No. 86014 for direct sowing .

Table 3.2.2 Water Balance Calculation of Lembu Reservoir (10ha of horticulture and 100ha of main season paddy)

unit : 1000m3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
												120
1961	115	105	93	120	120	120	120	120	120	120	120	118
1962	113	102	91	80	120	120	120	120	120	120	120	58
1963	47	36	25	14	4	19	120	120	120	120	120	120
1964	112	101	89	78	120	120	120	120	120	120	120	120
1965	113	102	91	80	70	60	120	120	120	120	120	120
1966	118	108	120	120	120	120	120	120	120	120	120	120
1967	120	110	98	113	120	120	120	120	120	120	120	28
1968	16	6	-6	-17	120	120	120	120	120	120	120	105
1969	94	83	72	61	120	120	120	120	120	120	120	112
1970	104	94	82	71	120	120	120	120	120	120	120	120
1971	120	120	120	114	120	120	120	120	120	120	120	120
1972	116	105	93	83	73	120	120	70	120	120	120	120
1973	120	111	100	89	120	120	120	120	120	120	120	120
1974	120	110	98	87	120	120	120	120	120	120	120	67
1975	58	47	35	69	120	120	120	120	120	120	120	120
1976	120	110	120	120	120	120	120	120	120	120	120	103
1977	94	83	72	61	51	120	120	120	120	120	120	39
1978	28	17	5	-6	120	120	120	120	120	120	117	26
1979	15	4	-8	-19	32	120	120	120	120	120	120	35
1980	24	13	2	66	120	120	120	120	120	120	120	120
1981	120	110	98	120	120	120	120	120	120	120	120	120
1982	114	104	92	120	120	120	120	120	120	120	120	120
1983	120	110	98	87	120	120	120	120	120	120	120	111
1984	104	93	81	120	120	120	120	120	120	120	55	50
1985	39	28	61	81	120	120	120	120	120	120	120	120
1986	115	105	93	120	120	120	120	120	120	120	120	120
1987	113	102	90	79	120	120	120	120	120	120	120	120
1988	120	110	99	120	120	120	120	120	120	120	120	120
1989	118	108	96	85	120	120	120	120	120	120	120	30
1990	20	9	-3	-14	120	120	120	120	120	120	120	120

Table 3.2.3 Water Balance Calculation of Ketapang Reservoir
(10ha of horticulture and 60ha of main season paddy cultivation)

unit : 1000m3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
												150
1961	140	129	117	126	150	150	150	76	150	150	111	87
1962	77	66	54	43	98	150	150	85	106	150	120	69
1963	58	47	35	24	14	9	48	45	150	150	150	122
1964	111	100	89	78	103	136	150	99	150	150	150	150
1965	139	129	117	106	96	87	150	150	150	150	150	150
1966	140	130	150	150	150	150	150	150	150	150	150	150
1967	141	131	119	112	150	150	150	150	150	150	73	8
1968	-3	-14	-26	-36	14	150	150	139	150	150	117	94
1969	83	72	60	50	130	150	150	150	150	150	150	105
1970	94	83	72	61	92	150	150	111	150	150	150	150
1971	150	142	148	137	150	150	150	150	150	150	124	135
1972	125	114	103	92	82	150	150	43	150	150	150	150
1973	147	137	125	114	146	150	150	109	150	150	150	150
1974	142	131	120	109	150	150	150	150	150	150	150	94
1975	83	72	61	57	146	150	150	150	150	150	150	150
1976	141	130	127	129	148	150	150	150	150	150	150	106
1977	95	84	72	62	52	56	120	150	150	150	98	37
1978	26	15	4	-7	89	135	150	129	150	150	70	5
1979	-6	-17	-29	-40	-39	22	150	150	150	150	89	26
1980	14	4	-8	-6	38	150	150	150	150	150	150	150
1981	143	132	121	143	150	150	150	75	150	150	150	117
1982	106	96	84	131	150	150	150	150	150	150	150	150
1983	141	131	119	108	150	150	150	150	150	150	150	100
1984	89	78	66	100	150	150	150	50	77	139	44	34
1985	22	12	8	2	55	72	84	150	150	150	150	138
1986	128	117	105	122	150	150	150	150	150	150	150	113
1987	102	92	80	69	117	150	150	150	150	150	150	150
1988	143	133	121	141	150	150	150	150	150	150	150	147
1989	137	126	114	103	140	150	150	150	150	150	73	8
1990	-3	-14	-26	-36	32	72	119	38	150	150	150	118

Table 3.2.4 Unite Price Analysis (KH-4&5)

Description	Unit	Tender Price	Tender Year	Infration Rate (%)	Up-dated Price (RM)	Adopted Price (RM)	Remarks Data sources
1 Dam and Reservoirs							
Ketapang Dam							
Land crearing	ha	900.0	1991	1.131	1,017.9	1,272.4	JPS Price List 1993 Average price *
Excavation	m3	15.6	1990	1.166	18.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.3	1993	1.035	9.6	15.1	JPS Schedule of Rate 1993
Embankment	m3	46.0	1990	1.166	53.6		Membina dan Menyiapkan Project, Langkawi
		27.5	1992	1.084	29.8	41.7	Pekan Kuah Drainage Project, Langkawi
Stone Covering	m3	40.0	1991	1.131	45.2	45.0	JPS Price List 1993 Average price
Horizontal Drain Filter &	m3	30.0	1991	1.131	33.9	34.0	JPS Price List 1993 Average price
Toe drain	m3	30.0	1991	1.131	33.9	34.0	JPS Price List 1993 Average price
Truting	m2	1.8	1992	1.084	2.0	2.0	Pekan Kuah Drainage Project, Langkawi
Excavation for storaged load	m3	6.5	1991	1.131	7.4	9.2	JPS Price List 1993 July
including dumping of < 5 km							
Lembu Reservoir							
Excavation	m3	10.5	1990	1.166	12.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.3	1993	1.035	9.6	12.1	JPS Schedule of Rate 1993
Embankment	m3	46.0	1990	1.166	53.6		Membina dan Menyiapkan Project, Langkawi
		27.5	1992	1.084	29.8	41.7	Pekan Kuah Drainage Project, Langkawi
Reinforced Concrete	m3	455.9	1990	1.166	531.6	531.6	Sng. Kuala Melaka Bridge project, Langkawi
Plain Concrete	m3	300.8	1992	1.084	326.1		Pekan Kuah Drainage Project, Langkawi
	m3	240.0	1991	1.131	271.4	332.7	JPS Price List 1993
Foundation Concrete	m3	80.0	1991	1.131	90.5	113.1	JPS Price List 1993
Concrete Pile dia. 200	m	90.0	1991	1.131	101.8	127.5	JPS Price List 1993
Slide Gate							
1m x 1.2m	nos.	1,140.0	1991	1.131	1,289.3	4,029.3	JPS Price List 1993
Gabion	m3	250.0	1994	1.000	250.0		Irrigation project Langkawi, 1994
		90.0	1991	1.131	101.8	188.6	JPS Price List 1993 Average price)
Demolishing of existing str.	m3	90.0	1991	1.131	101.8	127.3	JPS Price List 1993 Average price)
Truting	m2	1.8	1992	1.084	2.0	2.0	Pekan Kuah Drainage Project, Langkawi
subtotal							
Culvert Spillway & Operation Bridge							
Stripping	m3	2.0	1993	1.035	2.1	2.6	JPS Schedule of Rate 1993
Excavation	m3	10.5	1990	1.166	12.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.3	1993	1.035	9.6	12.1	JPS Schedule of Rate 1993
Backfill	m3	15.0	1991	1.131	17.0	21.3	JPS Price List 1993
Embankment	m3	46.0	1990	1.166	53.6		Membina dan Menyiapkan Project, Langkawi
		27.5	1992	1.084	29.8	41.7	Pekan Kuah Drainage Project, Langkawi
Reinforced concrete	m3	474.7	1990	1.166	553.5	553.5	Sng. Kuala Melaka Bridge project, Langkawi

Foundation concrete	m3	80.0	1991	1.131	90.5	112.5	JPS Price List 1993
Concrete Pile dia. 200	m	90.0	1991	1.131	101.8	127.5	JPS Price List 1993
Gabion	m3	90.0	1991	1.131	101.8		JPS Price List 1993 Average price)
		250.0	1994	1.000	250.0	188.6	Irrigation project Langkawi, 1994
Steel slide gate							
2m x 2m	nos.	3,800.0	1991	1.131	4,297.8	5,372.3	JPS Price List 1993 Average price)
0.4m x 0.4m	nos.	105.0	1991	1.131	118.8	148.4	JPS Price List 1993 Average price)
Other steel accessary(hand rail)	m	35.0	1990	1.166	40.8	40.8	Sng. Kuala Melaka Bridge project, Langkawi
subtotal							
Emergency Spillway							
Excavation	m3	10.5	1990	1.166	12.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.3	1993	1.035	9.6	12.1	JPS Schedule of Rate 1993
Gabion	m3	90.0	1991	1.131	101.8		JPS Price List 1993 Average price)
		250.0	1994	1.000	250.0	188.6	Irrigation project Langkawi, 1994
subtotal							
Access Road							
Stripping	m3	2.0	1993	1.035	2.1	2.6	JPS Schedule of Rate 1993
Excavation	m3	3.6	1990	1.166	4.2		Membina dan Menyiapkan Project, Langkawi
		5.2	1990	1.166	6.1		Sng. Kuala Melaka Bridge project, Langkawi
		4.0	1992	1.084	4.3	4.9	Pekan Kuah Drainage Project, Langkawi
Embankment	m3	7.9	1990	1.166	9.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.9	1992	1.084	10.7		Pekan Kuah Drainage Project, Langkawi
		15.0	1991	1.131	17.0	13.7	JPS Price List 1993
Literite pavement	m3	8.0	1990	1.166	9.3		Membina dan Menyiapkan Project, Langkawi
		9.9	1992	1.084	10.7	10.0	Pekan Kuah Drainage Project, Langkawi
subtotal							
Pump Station							
Stripping	m3	2.0	1993	1.035	2.1	2.6	JPS Schedule of Rate 1993
Excavation	m3	3.6	1990	1.166	4.2		Membina dan Menyiapkan Project, Langkawi
		4.8	1990	1.166	5.6		Membina dan Menyiapkan Project, Langkawi
		5.2	1990	1.166	6.1		Sng. Kuala Melaka Bridge project, Langkawi
		4.0	1992	1.084	4.3		Pekan Kuah Drainage Project, Langkawi
		4.5	1992	1.084	4.9	5.0	Pekan Kuah Drainage Project, Langkawi
Embankment	m3	7.9	1990	1.166	9.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.9	1992	1.084	10.7		Pekan Kuah Drainage Project, Langkawi
		15.0	1991	1.131	17.0	12.3	JPS Price List 1993
Backfill	m3	15.0	1991	1.131	17.0	11.9	JPS Price List 1993
Reinforced concrete	m3	474.7	1990	1.166	553.5	553.5	Sng. Kuala Melaka Bridge project, Langkawi
Foundation concrete	m3	80.0	1991	1.131	90.5	113.1	JPS Price List 1993
Gabion	m3	90.0	1991	1.131	101.8		JPS Price List 1993 Average price)
		250.0	1994	1.000	250.0	188.6	Irrigation project Langkawi, 1994
Trash screen	m2	560.0	1990	1.166	653.0		Membina dan Menyiapkan Project, Langkawi
		225.0	1992	1.084	243.9		Pekan Kuah Drainage Project, Langkawi

		444.4	1991	1.131	502.7	508.4	JPS Price List 1993
Volute pump							
1.5 kw H 10 m	nos.	4,000.0	1994	1.000	4,000.0	4,000.0	Supplyers' price
Pump House	m2	1,000.0	1994	1.000	1,000.0	1,000.0	
subtotal							
Pipe line							
Excavation for pipe line	m3	3.6	1990	1.166	4.2		Membina dan Menyiapkan Project, Langkawi
		4.5	1992	1.084	4.9	4.5	Pekan Kuah Drainage Project, Langkawi
Excavation for anchor block	m3	4.8	1990	1.166	5.6		Membina dan Menyiapkan Project, Langkawi
		5.2	1990	1.166	6.1	5.8	Sng. Kuala Melaka Bridge project, Langkawi
Backfill	m3	15.0	1991	1.131	17.0	11.9	JPS Price List 1993
Sand bed	m3	24.5	1990	1.166	28.6	28.6	Membina dan Menyiapkan Project, Langkawi
Reinforeced Concrete	m3	437.1	1990	1.166	509.7	509.7	Sng. Kuala Melaka Bridge project, Langkawi
Foundation Concrete	m3	80.0	1991	1.131	90.5	113.1	JPS Price List 1993
Plain concrete	m3	240.0	1991	1.131	271.4		JPS Price List 1993
		300.8	1992	1.084	326.1	332.7	Pekan Kuah Drainage Project, Langkawi
PVC pipe							
dia. less than 75 mm	m	17.0	1992	1.084	18.4	18.8	Sg.Melaka Flood Alleviation Project
dia. 150 mm	m	22.5	1991	1.131	25.4	35.6	JPS Price List 1993
Sluice valve	nos.				0.0		
subtotal							
Canal & Drain							
Canal							
Stripping	m3	2.0	1993	1.035	2.1	2.6	JPS Schedule of Rate 1993
Excavation	m3	3.6	1990	1.166	4.2		Membina dan Menyiapkan Project, Langkawi
		4.8	1990	1.166	5.6		Membina dan Menyiapkan Project, Langkawi
		5.2	1990	1.166	6.1		Sng. Kuala Melaka Bridge project, Langkawi
		4.0	1992	1.084	4.3		Pekan Kuah Drainage Project, Langkawi
		4.5	1992	1.084	4.9	5.0	Pekan Kuah Drainage Project, Langkawi
Embankment	m3	7.9	1990	1.166	9.2		Sng. Kuala Melaka Bridge project, Langkawi
		9.9	1992	1.084	10.7	10.0	Pekan Kuah Drainage Project, Langkawi
Drain							
Excavation for big drain B > 5 m	m3	15.6	1990	1.166	18.2	18.2	Sng. Kuala Melaka Bridge project, Langkawi
Excavation for small drain B < 5 r	m3	5.2	1990	1.166	6.1	6.1	Sng. Kuala Melaka Bridge project, Langkawi
Related Structures							
Reinforeced Concrete	m3	437.1	1990	1.166	509.7	509.7	Sng. Kuala Melaka Bridge project, Langkawi
Foundation Concrete	m3	80.0	1991	1.131	90.5	113.1	JPS Price List 1993
Concrete Pile dia. 200	m	90.0	1991	1.131	101.8	127.5	JPS Price List 1993
Concrete Pipe							
dia. 300	m	120.0	1991	1.131	135.7	169.7	JPS Price List 1993
dia. 400	m	135.0	1991	1.131	152.7	190.9	JPS Price List 1993
Sulice Gate							

0.3m x 0.9m	nos.	175.0	1991	1.131	197.9	247.4	JPS Price List 1993
0.5m x 1.3m	nos.	533.0	1991	1.131	602.8	753.5	JPS Price List 1993
1.0m x 1.3m	nos.	1,070.0	1991	1.131	1,210.2	1,512.7	JPS Price List 1993
Trush Screen	m2	560.0	1990	1.166	653.0		Membina dan Menyiapkan Project, Langkawi
		225.0	1992	1.084	243.9		Pekan Kuah Drainage Project, Langkawi
		444.4	1991	1.131	502.7	508.4	JPS Price List 1993
Hand rail	m	35.0	1990	1.166	40.8	40.8	Sng. Kuala Melaka Bridge project, Langkawi
Hard wooden gate							
2.5m x 1.5m	nos.	881.3	1991	1.131	996.7	1,245.9	JPS Price List 1993
subtotal							
On-farm irrigation facilities							
(drip & Sprinkler facilities)							
Upper Lembu area	ha	4,300.0	1994	1.000	4,300.0	5,375.0	Supplyers' price
Ketapang area	ha	4,300.0	1994	1.000	4,300.0	5,375.0	Supplyers' price
Land Leveling	ha	4,200.0	1993	1.035	4,347.0	4,347.0	JPS &DOA Langkawi information
subtotal							
Rain shelter							
Upper Lembu area	ha				0.0		
Ketapang area	ha				0.0		
subtotal							
SUBTOTAL							
Land acquisition cost	ha	550,000.0	1994	1.000	550,000.0	550,000.0	JPS Langkawi information

Table 3.2.5 Estimate of Construction Cost (Lembu)

	Work Item	Unit	Quantity	Unit Price(RM)	Amount(RM)
1	Dam and Reservoirs				
	Ketapang Dam				
	Land crearing	ha		1,272.4	0.0
	Excavation	m3		15.1	0.0
	Embankment	m3		41.7	0.0
	Stone Covering	m3		45.0	0.0
	Horizontal Drain Filter & Toe di	m3		34.0	0.0
	Trufing	m2		2.0	0.0
	subtotal				0.0
	Lembu Reservoir				
	Excavation	m3	130,047.7	12.1	1,573,577.4
	Embankment	m3	8,266.0	41.7	344,690.1
	Trufing	m2	1,356.5	2.0	2,713.0
	Reinforced Concrete	m3	129.8	531.6	69,001.7
	Plain Concrete	m3	267.6	332.7	89,040.5
	Foundation Concrete	m3	37.0	113.1	4,186.4
	Concrete Pile dia. 200	m	702.2	127.5	89,535.6
	Slide Gate				
	1m x 1.2m	nos.	2.0	4,029.3	8,058.6
	Gabion	m3	209.4	188.6	39,487.9
	Demolishing of existing str.	m3	46.2	127.3	5,881.3
	subtotal				2,226,172.5
2	Culvert Spillway & Operation Bridge				
	Stripping	m3		2.6	0.0
	Excavation	m3		12.1	0.0
	Backfill	m3		21.3	0.0
	Embankment	m3		41.7	0.0
	Reinforced concrete	m3		553.5	0.0
	Foundation concrete	m3		112.5	0.0
	Concrete Pile dia. 200	m		127.5	0.0
	Gabion	m3		188.6	0.0
	Steel slide gate				
	2m x 2m	nos.		4,297.8	0.0
	0.4m x 0.4m	nos.		118.8	0.0
	Other steel accessary(hand ra	m		40.8	0.0
	subtotal				0.0
3	Emergency Spillway				
	Excavation	m3		12.1	0.0
	Gabion	m3		188.6	0.0
	subtotal				0.0
4	Access Road				
	Stripping	m3		2.6	0.0
	Excavation	m3		4.9	0.0
	Embankment	m3		13.7	0.0
	Literite pavement	m3		10.0	0.0
	subtotal				0.0
5	Pump Station				
	Stripping	m3	19.8	2.6	51.5
	Excavation	m3		5.0	0.0
	Embankment	m3		10.0	0.0
	Backfill	m3		11.9	0.0
	Reinforced concrete	m3	11.9	553.5	6,575.6
	Foundation concrete	m3	0.7	113.1	74.6
	Gabion	m3	41.3	188.6	7,779.8

	Trash screen	m2	8.0	508.4	4,067.2
	Volute pump				
	1.5 kw H 10 m	nos.	2.0	4,000.0	8,000.0
	Pump House	m2	19.8	1,000.0	19,800.0
	subtotal				46,348.7
6	Pipe line				
	Excavation for pipe line	m3	244.2	4.5	1,098.9
	Backfill	m3	183.7	11.9	2,186.0
	Sand bed	m3	61.6	28.6	1,761.8
	Reinforced Concrete	m3	0.3	509.7	157.0
	Foundation Concrete	m3	0.1	113.1	6.0
	PVC pipe				
	dia. less than 75 mm	m	2,035.0	18.8	38,258.0
	Sluice valve	nos.			0.0
	subtotal				43,467.6
7	Canal & Drain				
	Canal				
	Stripping	m3	9,795.8	2.6	25,469.2
	Excavation	m3	1,869.3	5.0	9,346.7
	Embankment	m3	54,536.5	10.0	545,364.6
	Drain				
	Excavation B>5 m	m3	55,012.1	18.2	1,001,220.2
	Excavation B<5 m	m3	1,060.4	6.1	6,468.4
	Related Structures				
	Reinforeced Concrete	m3	443.3	509.7	225,964.0
	Foundation Concrete	m3	67.5	113.1	7,635.7
	Concrete Pile dia. 200	m	231.0	127.5	29,452.5
	Concrete Pipe				
	dia. 300	m	157.1	169.7	26,656.5
	dia. 400	m	159.1	190.9	30,364.6
	Sulice Gate				
	0.3m x 0.9m	nos.	3.0	247.4	742.2
	0.5m x 1.3m for TO	nos.	3.0	753.5	2,260.5
	1.0m x 1.3m	nos.	4.0	1,512.7	6,050.8
	0.5m x 1.5m	nos.	1.0	869.5	869.5
	dia.0.5m	nos.	2.0	229.0	458.0
	Trush Screen	m2	19.0	508.4	9,646.9
	Hand rail	m	111.5	40.8	4,550.8
	Hard Wooden Gate				
	2.5m x 1.5m	nos.	10.0	1,245.9	12,459.0
	Gabion	m3	392.7	188.6	74,063.2
	subtotal				2,019,043.3
8	On-farm irrigation facilities				
	(drip & Sprinkler facilities)				
	Upper Lembu area	ha	10.0	5,375.0	53,750.0
	Ketapang area	ha	0.0	5,375.0	0.0
	Land leveling	ha	35.1	4,347.0	152,579.7
	subtotal				206,329.7
9	Rain shelter				
	Upper Lembu area	ha			0.0
	Ketapang area	ha			0.0
	subtotal				0.0
	SUBTOTAL				4,541,361.8
	Land acquisition cost	ha	8.6	550,000.0	4,712,950.0

7 Physical Contingency (15 % of Subtotal)	681,204.3
8 Engineering Cost (10 % of Subtotal)	454,136.2
9 Administration cost (5 % of Subtotal)	227,068.1
TOTAL	10,616,720.4

Table 3.2.6 Estimate of Construction Cost (Ketapang)

	Work Item	Unit	Quantity	Unit Price(RM)	Amount(RM)
1	Dam and Reservoirs				
	Ketapang Dam				
	Land crearing	ha	1.9	1,272.4	2,417.6
	Excavation	m3	9,651.8	15.1	145,742.8
	Embankment	m3	49,454.6	41.7	2,062,255.6
	Stone Covering	m3	2,775.9	45.0	124,913.3
	Horizontal Drain Filter & Toe di	m3	264.7	34.0	8,998.4
	Trufing	m2	4,345.0	2.0	8,690.0
	subtotal				2,353,017.6
	Lembu Reservoir				
	Excavation	m3		12.1	0.0
	Embankment	m3		41.7	0.0
	Trufing	m2		2.0	0.0
	Reinforced Concrete	m3		531.6	0.0
	Plain Concrete	m3		332.7	0.0
	Foundation Concrete	m3		113.1	0.0
	Concrete Pile dia. 200	m		127.5	0.0
	Slide Gate				
	1m x 1.2m	nos.		4,029.3	0.0
	Gabion	m3		188.6	0.0
	Demolishing of existing str.	m3		127.3	0.0
	subtotal				0.0
2	Culvert Spillway & Operation Bridge				
	Stripping	m3	178.8	2.6	464.8
	Excavation	m3	1,041.3	12.1	12,599.2
	Backfill	m3	55.1	21.3	1,173.8
	Embankment	m3	34.3	41.7	1,431.1
	Reinforced concrete	m3	442.6	553.5	244,982.7
	Foundation concrete	m3	114.3	112.5	12,856.4
	Concrete Pile dia. 200	m	20.0	127.5	2,550.0
	Gabion	m3	16.4	188.6	3,091.2
	Steel slide gate				
	2m x 2m	nos.	2.0	4,297.8	8,595.6
	0.4m x 0.4m	nos.	2.0	118.8	237.6
	Other steel accessary(hand ra	m	90.0	40.8	3,672.0
	subtotal				291,654.4
3	Emergency Spillway				
	Excavation	m3	12,401.4	12.1	150,056.9
	Gabion	m3	200.0	188.6	37,720.0
	subtotal				187,776.9
4	Access Road				
	Stripping	m3	205.8	2.6	535.0
	Excavation	m3	216.3	4.9	1,059.9
	Embankment	m3	1,431.0	13.7	19,605.3
	Literite pavement	m3	60.0	10.0	600.0
	subtotal				21,800.2
5	Pump Station				
	Stripping	m3		2.6	0.0
	Excavation	m3		5.0	0.0
	Embankment	m3		10.0	0.0
	Backfill	m3		11.9	0.0
	Reinforced concrete	m3		553.5	0.0
	Foundation concrete	m3		113.1	0.0
	Gabion	m3		188.6	0.0

	Trash screen	m2		508.4	0.0
	Volute pump				
	1.5 kw H 10 m	nos.		4,000.0	0.0
	Pump House	m2		1,000.0	0.0
	subtotal				0.0
6	Pipe line				
	Excavation for pipe line	m3	316.8	4.5	1,425.6
	Backfill	m3	238.3	11.9	2,835.9
	Sand bed	m3	79.9	28.6	2,285.5
	Reinforced Concrete	m3	0.4	509.7	203.7
	Foundation Concrete	m3	0.1	113.1	7.7
	PVC pipe				
	dia. less than 75 mm	m	2,640.0	18.8	49,632.0
	Sluice valve	nos.			0.0
	subtotal				56,390.5
7	Canal & Drain				
	Canal				
	Stripping	m3	1,600.1	2.6	4,160.2
	Excavation	m3	306.5	5.0	1,532.3
	Embankment	m3	8,936.2	10.0	89,361.8
	Drain				
	Excavation B>5 m	m3	15,950.0	18.2	290,290.0
	Excavation B<5 m	m3	0.0	6.1	0.0
	Related Structures				
	Reinforeced Concrete	m3	122.1	509.7	62,220.4
	Foundation Concrete	m3	33.4	113.1	3,772.7
	Concrete Pile dia. 200	m	0.0	127.5	0.0
	Concrete Pipe				
	dia. 300	m	22.4	169.7	3,808.1
	dia. 400	m	0.0	190.9	0.0
	Sulice Gate				
	0.3m x 0.9m	nos.	0.0	247.4	0.0
	0.5m x 1.3m	nos.	1.0	753.5	753.5
	1.0m x 1.3m	nos.	0.0	1,512.7	0.0
	0.5m x 1.5m	nos.	0.0	869.5	0.0
	dia.0.5m	nos.	0.0	229.0	0.0
	Trush Screen	m2	0.0	508.4	0.0
	Hand rail	m	0.0	40.8	0.0
	Hard Wooden Gate				
	2.5m x 1.5m	nos.	0.0	1,245.9	0.0
	Gabion	m3	66.4	188.6	12,530.6
	subtotal				468,429.5
8	On-farm irrigation facilities				
	(drip & Sprinkler facilities)				
	Upper Lembu area	ha	0.0	5,375.0	0.0
	Ketapang area	ha	10.0	5,375.0	53,750.0
	Land leveling	ha	12.3	4,347.0	53,468.1
	subtotal				107,218.1
9	Rain shelter				
	Upper Lembu area	ha			0.0
	Ketapang area	ha			0.0
	subtotal				0.0
	SUBTOTAL				3,486,287.2
	Land acquisition cost	ha	2.1	330,000.0	689,700.0

7 Physical Contingency (15 % of Subtotal)	522,943.1
8 Engineering Cost (10 % of Subtotal)	348,628.7
9 Administration cost (5 % of Subtotal)	174,314.4
TOTAL	5,221,873.4

Fig.3.2.1 Reservoir Storage Volume Curve

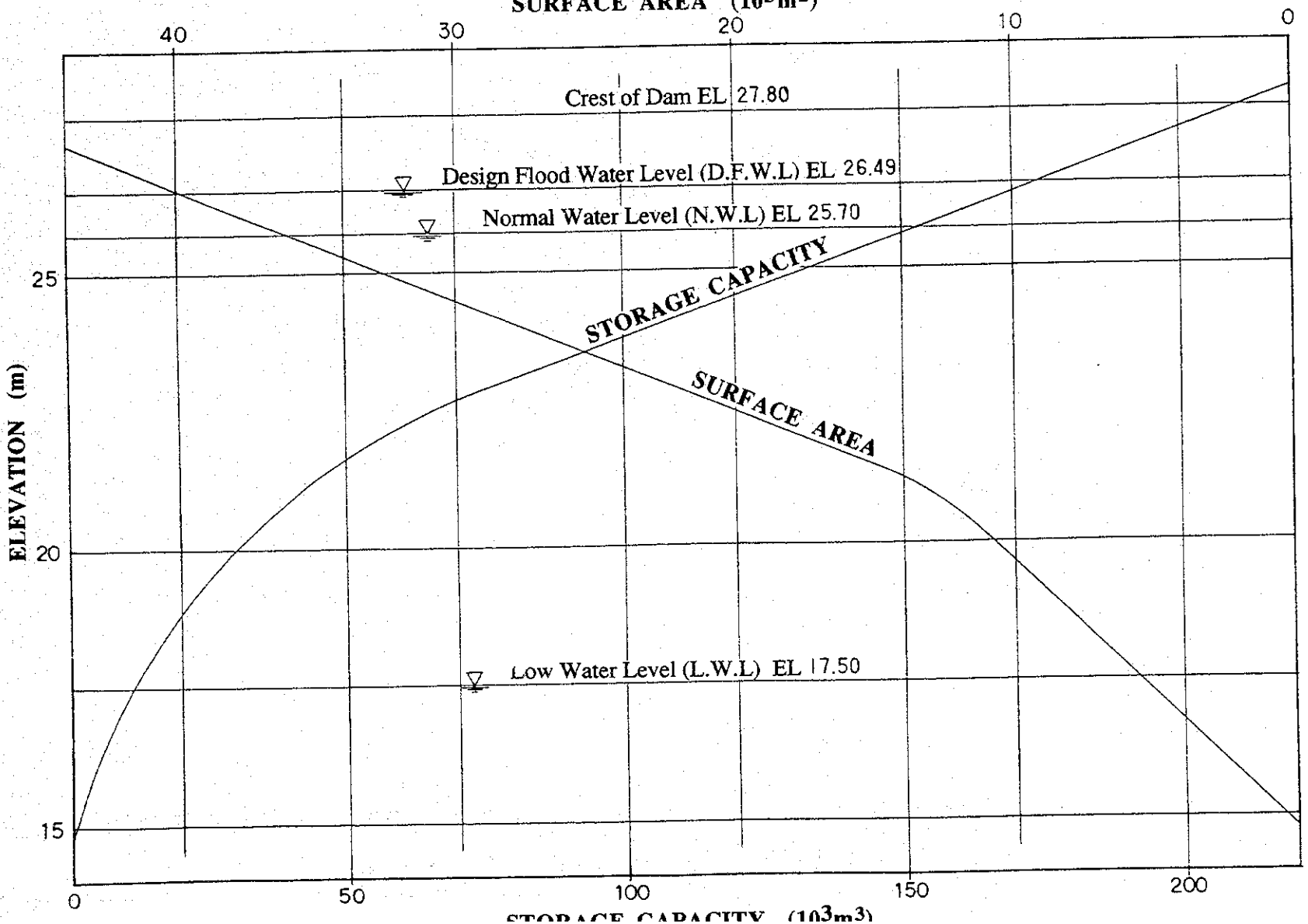


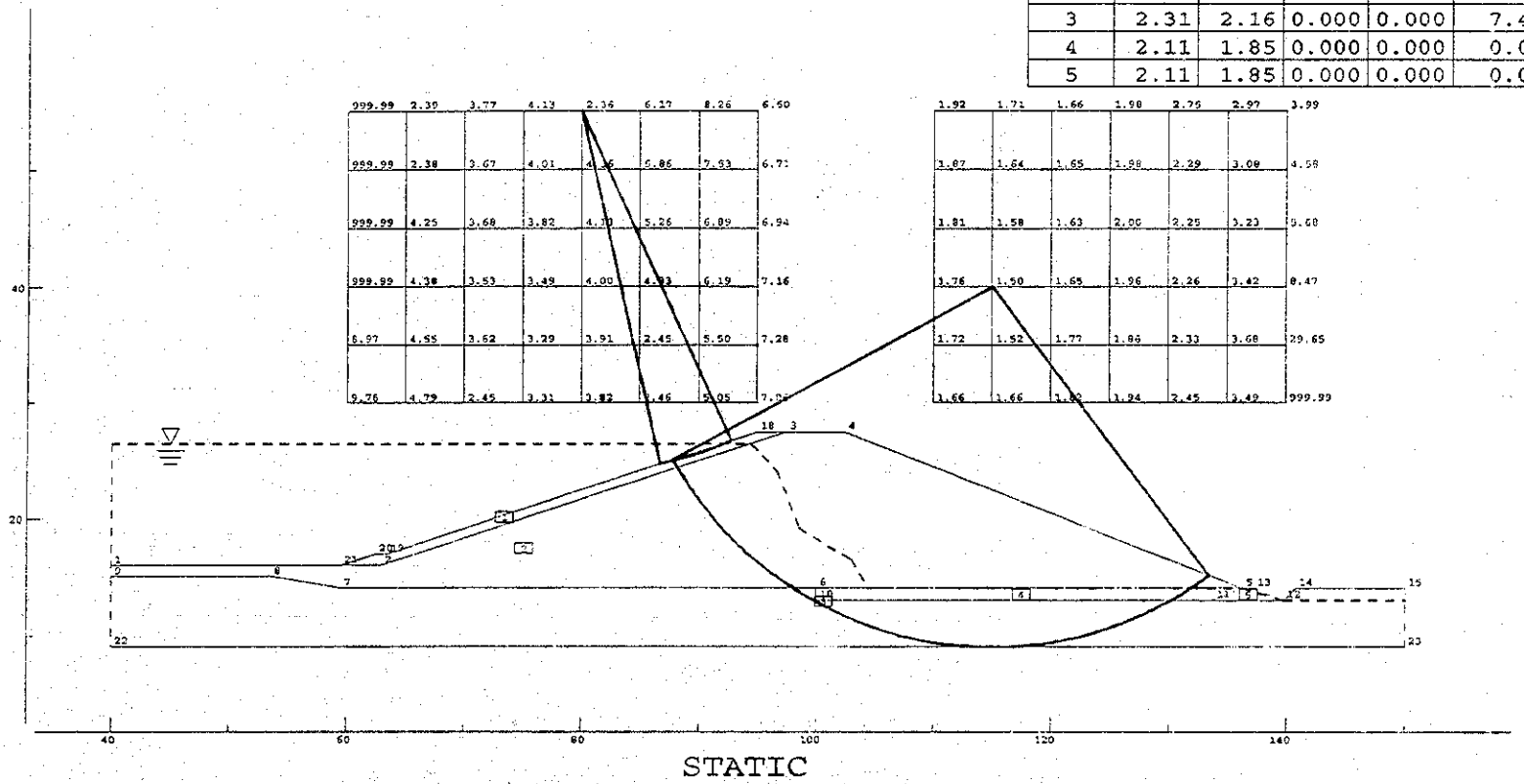
Fig. 3.2.2 Stability Analysis of Ketapang Dam (Full Storage)

KETAPANG DAM (FULL)

SCALE 1 / 600

Fs MIN	=	1.50
X	=	115.00 (M)
Y	=	40.00 (M)
R	=	31.00 (M)
MR	=	10017.17 (T*M)
Mo	=	6656.59 (T*M)

LAYER	Ws (T/M^3)	Ww (T/M^3)	KH	KV	C (T/M^2)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.22	2.07	0.000	0.000	1.5	38.0
3	2.31	2.16	0.000	0.000	7.4	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.000	0.0	35.0



STATIC

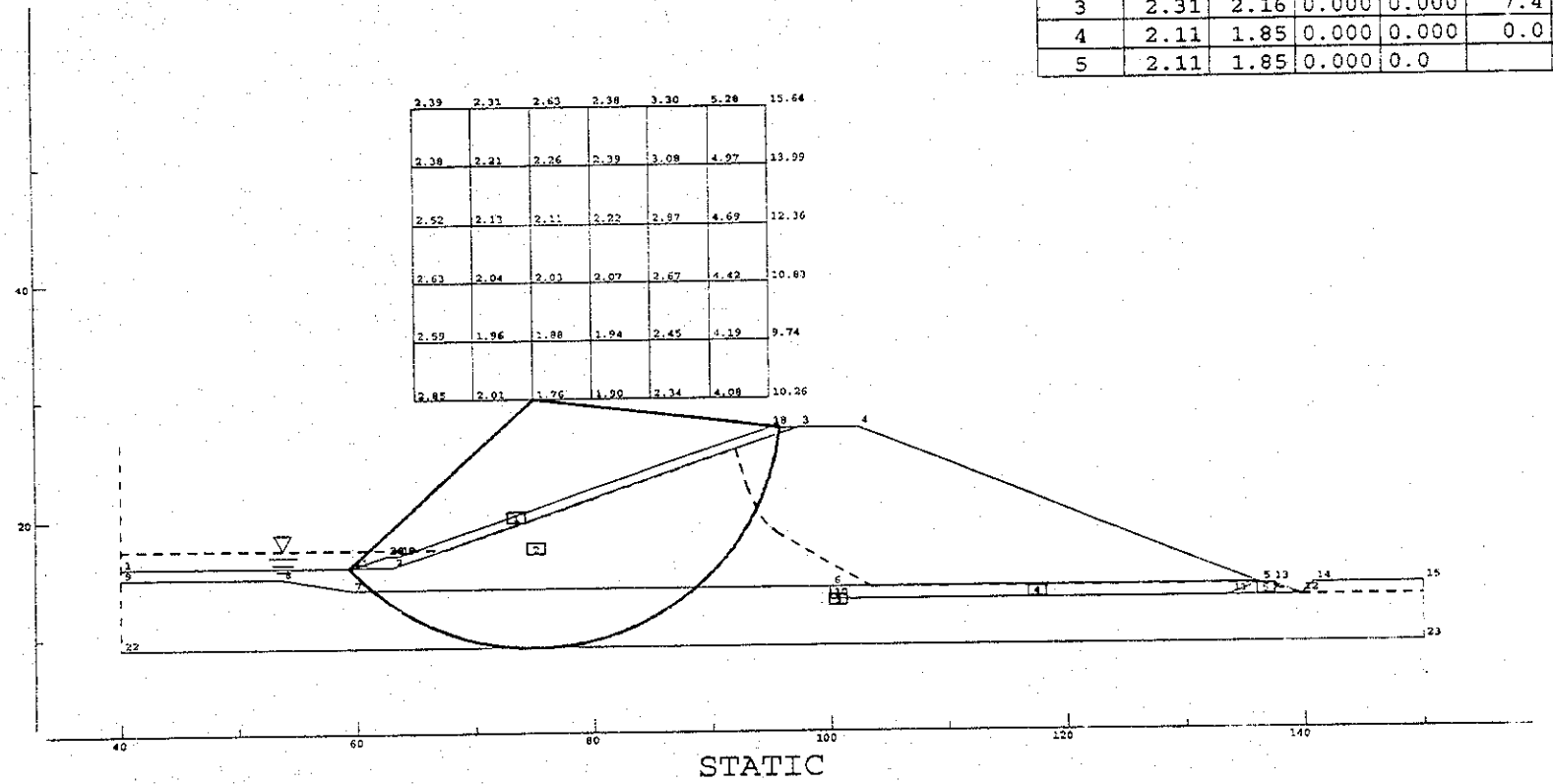
Fig. 3.2.3 Stability Analysis of Ketapang Dam (Draw Down)

KETAPANG DAM (DRAW DOWN)

SCALE 1 / 600

Fs MIN	=	1.76
X	=	75.00 (M)
Y	=	30.00 (M)
R	=	21.00 (M)
MR	=	6160.22 (T*M)
Mo	=	3491.92 (T*M)

LAYER	Ws (T/M³)	Ww (T/M³)	KH	Kv	C (T/M²)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.22	2.07	0.000	0.000	1.5	38.0
3	2.31	2.16	0.000	0.000	7.4	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.0		35.0



STATIC

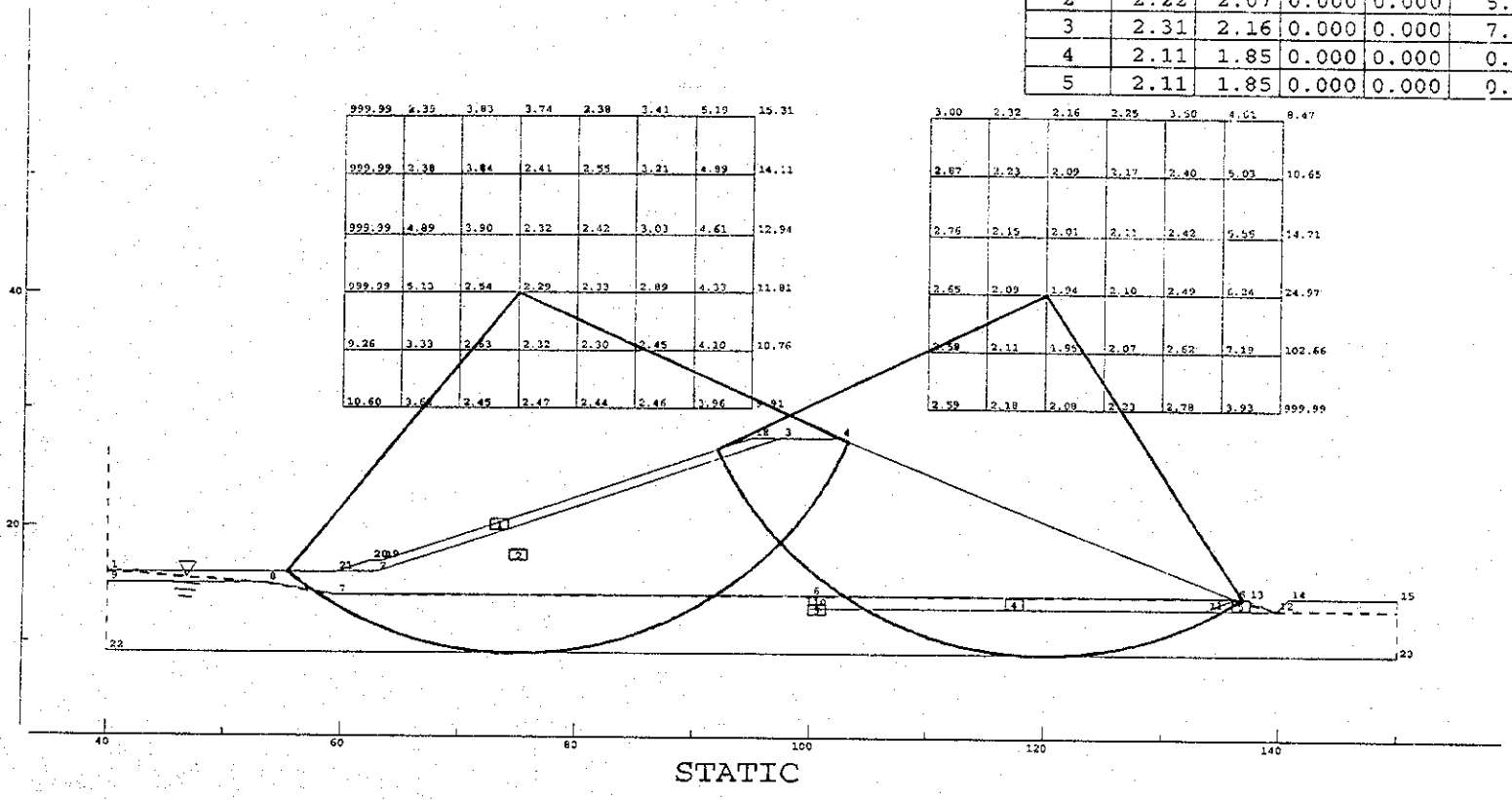
Fig. 3.2.4 Stability Analysis of Ketapang Dam (No Storage)

KETAPANG DAM (EMPTY)

SCALE 1 / 600

Fs MIN	=	1.94
X	=	120.00 (M)
Y	=	40.00 (M)
R	=	31.00 (M)
MR	=	12854.78 (T*M)
Mo	=	6598.67 (T*M)

LAYER	Ws (T/M³)	Ww (T/M³)	KH	KV	C (T/M²)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.22	2.07	0.000	0.000	5.6	24.0
3	2.31	2.16	0.000	0.000	7.4	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.000	0.0	35.0



LEGEND

○	Turnout
□	Siphon
▭	Intake Structure
△	Drop
●	Cross Drain
Ⓟ	Pump Station
———	Canal
- - -	Drain
—·—·—	Pipe Line

KH4&5

KEY MAP

Malacca Straight

N

Lembu Irrigation Area (100 ha)

DB-1

B-2

DB-2

DB-3

B-4

B-3

B-5

B-3

Lembu Excavated Pond

Pump Station

DUB-3

Main Pipe Line

DUB-1

DUB-2

Vegetable Area 10 ha

DB-4

B-6

Ketapang Irrigation Area (70 ha)

K-1

K-2

Vegetable Area 10 ha

Main Pipe Line

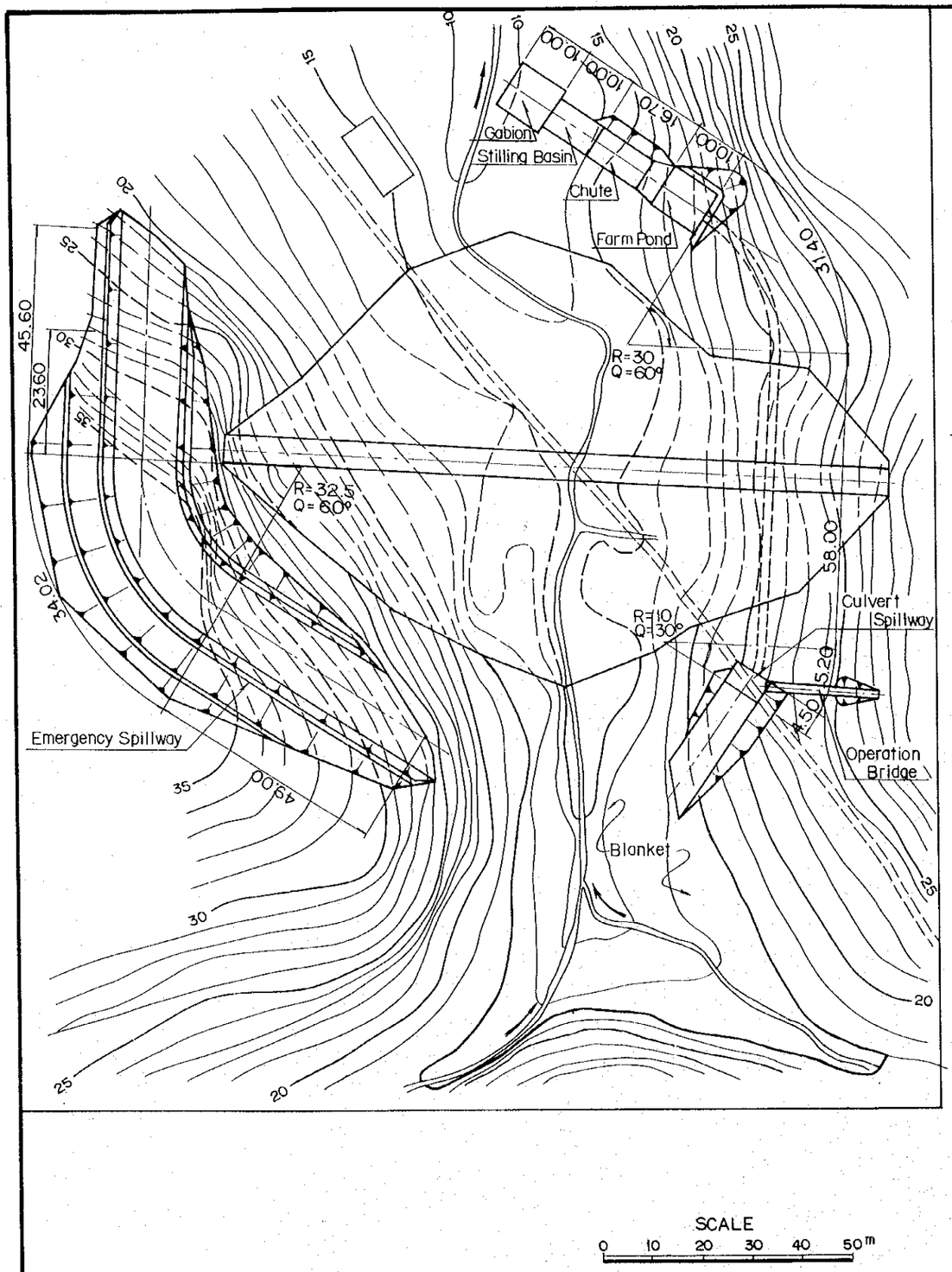
DK-1

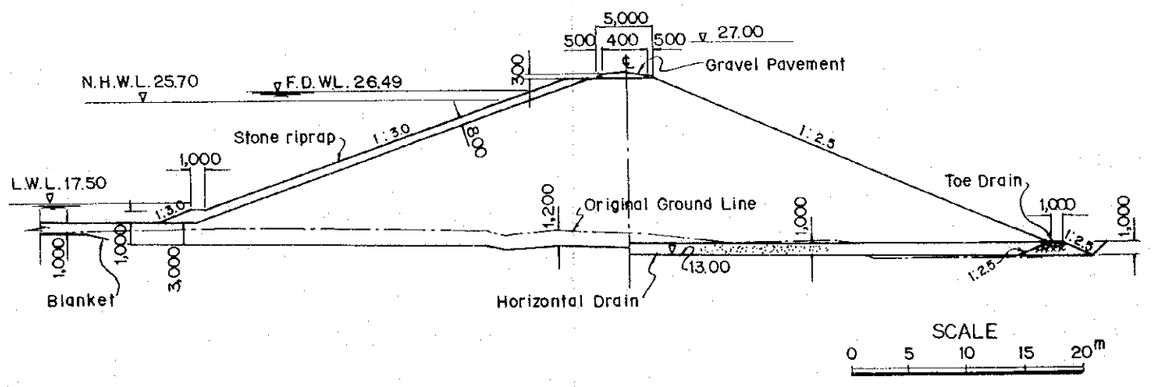
Ketapang Dam

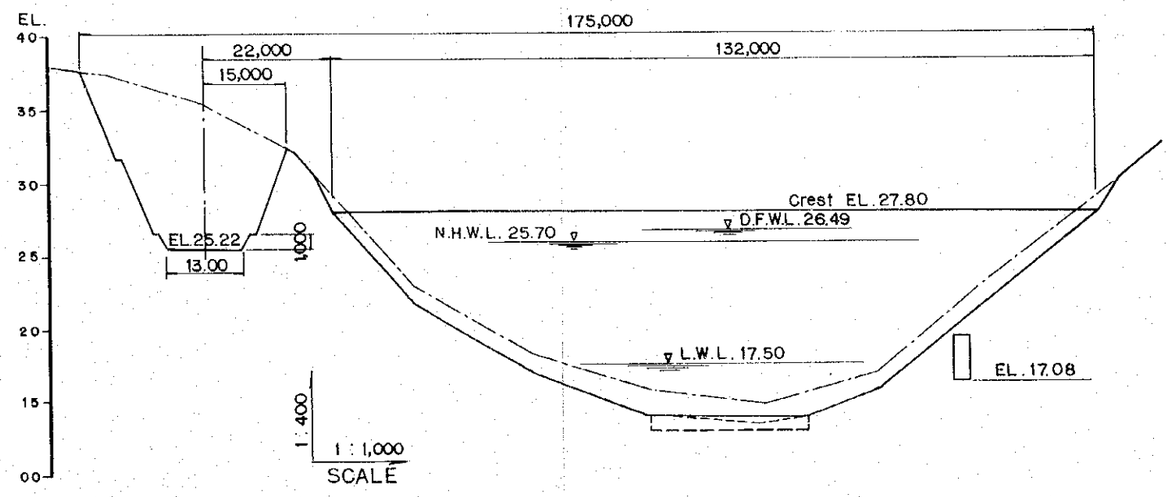
SCALE

0 100 200 300 400 500 600 METRE

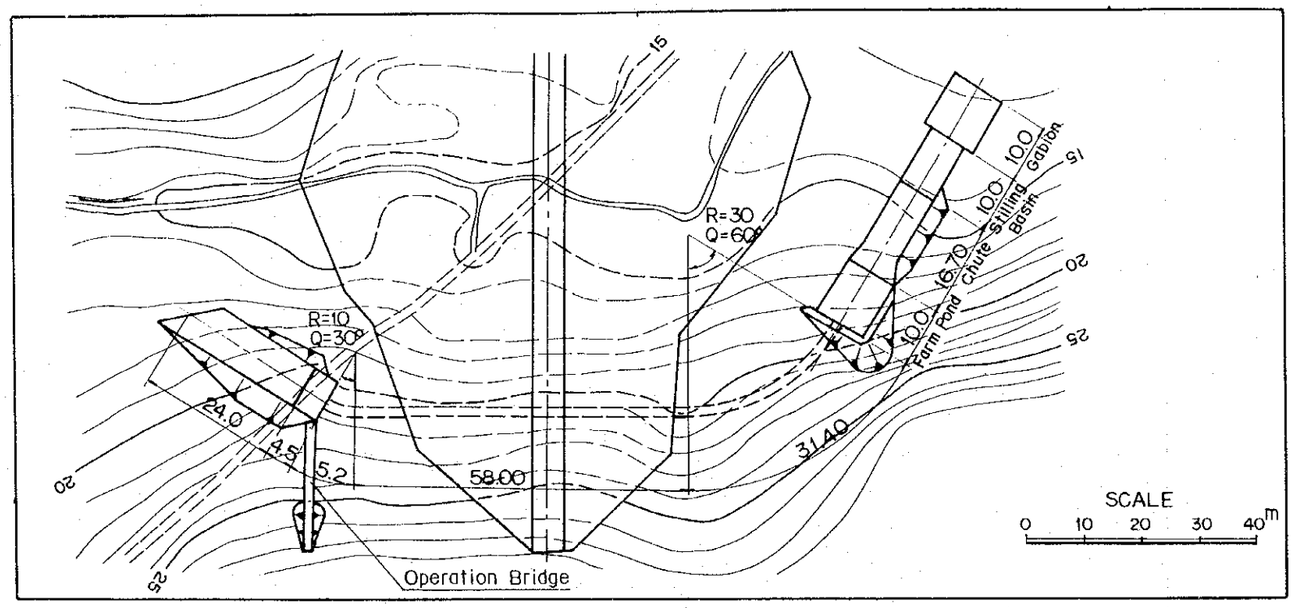
DWG2001 Gerneral Layout of Kedawang Project

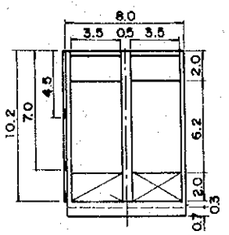


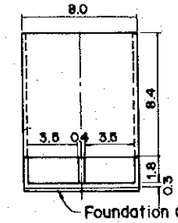


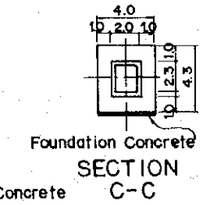


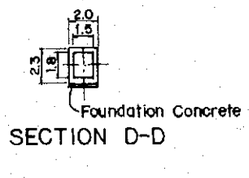
DWG 2002 General Plan & Sections of Ketapang Dam
Kedawang Project (KH 4 & 5)

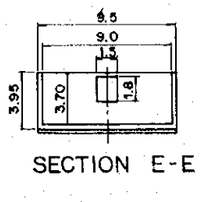


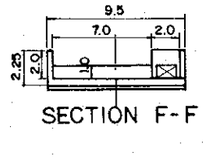


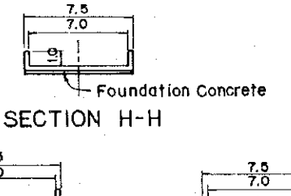


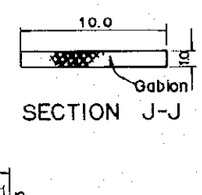


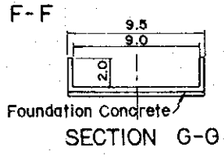


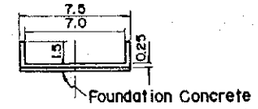


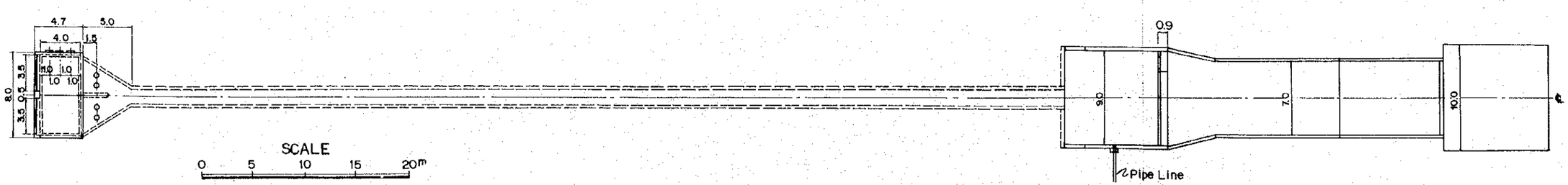




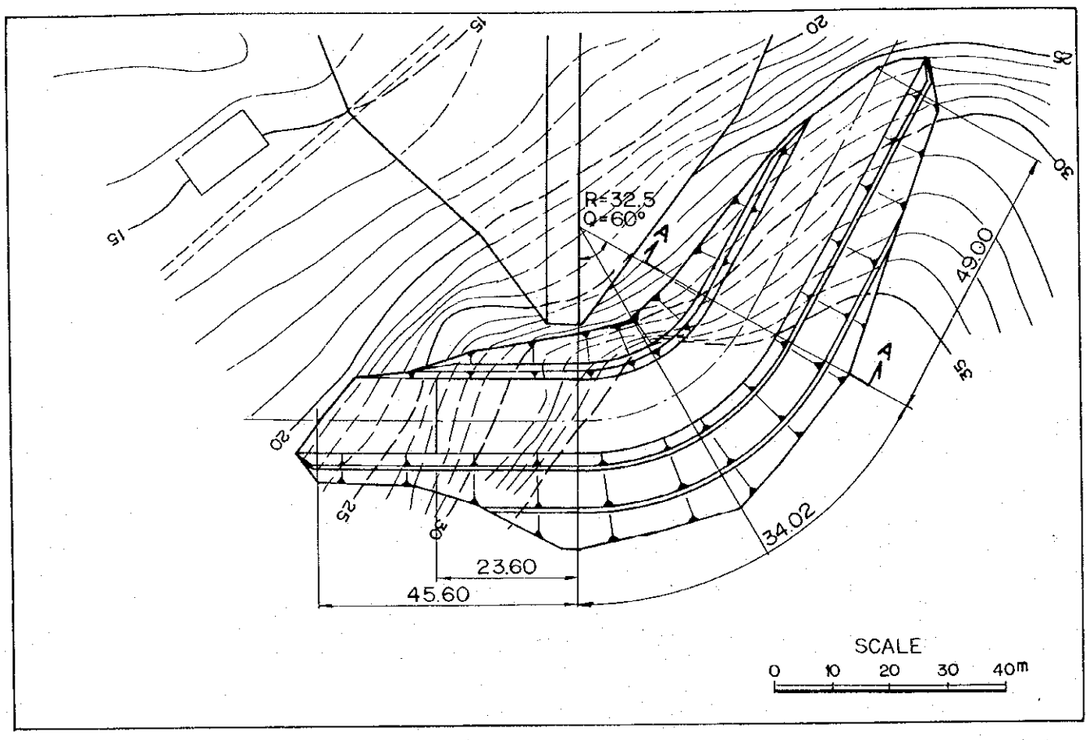


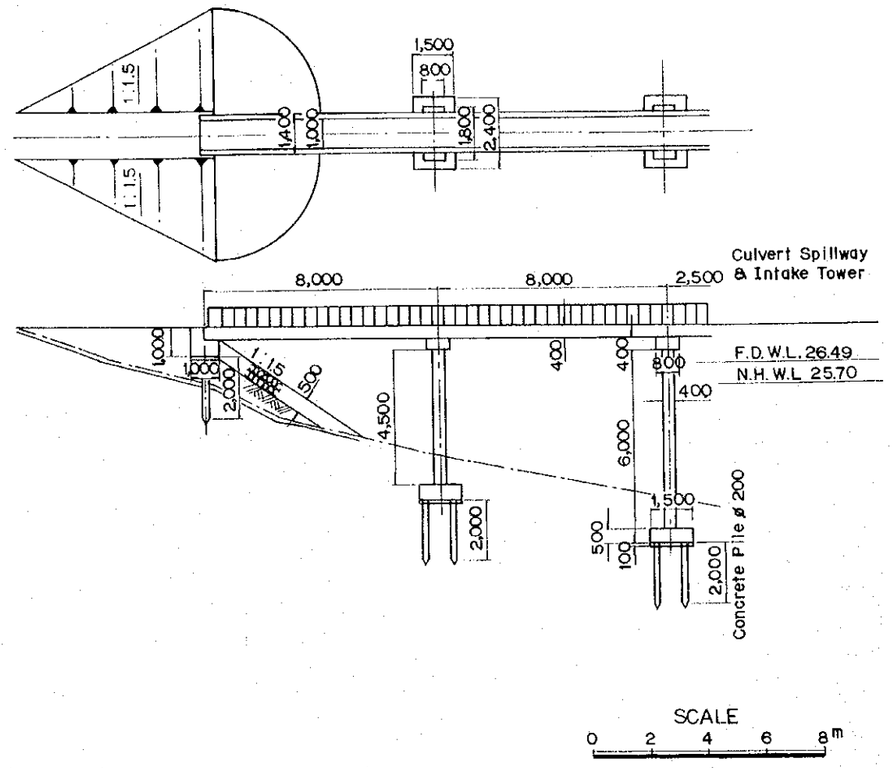




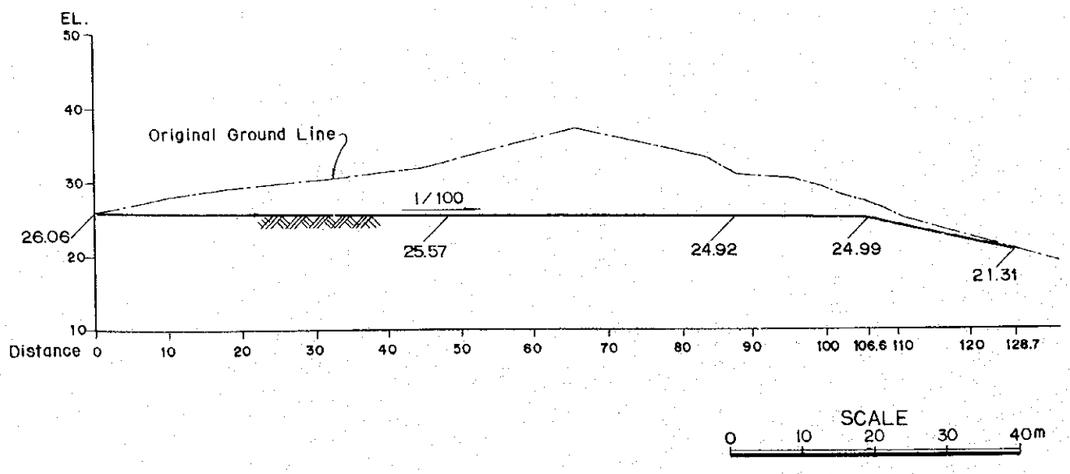


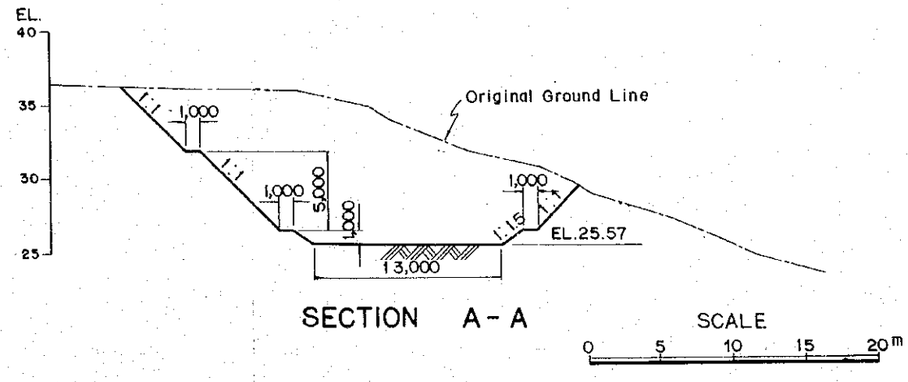
DWG2003 General Plan & Sections of Culvert Spillway of Ketapang Dam Kedawang Project (KH.4&5)



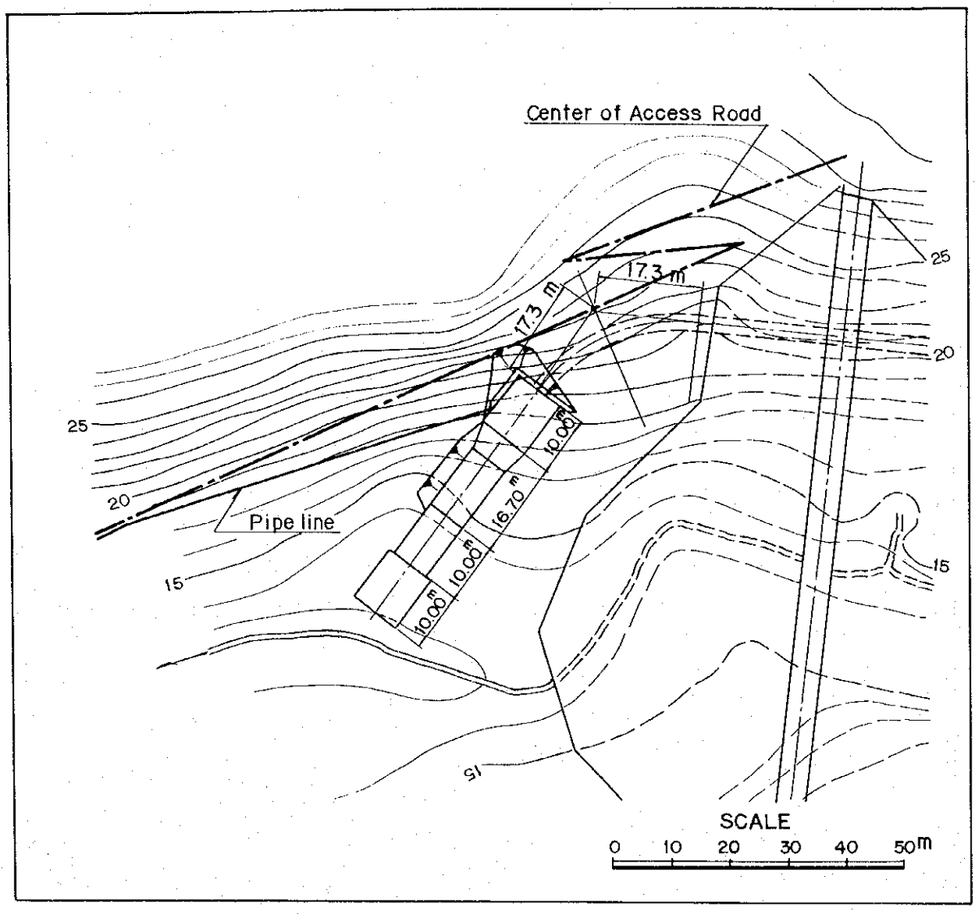


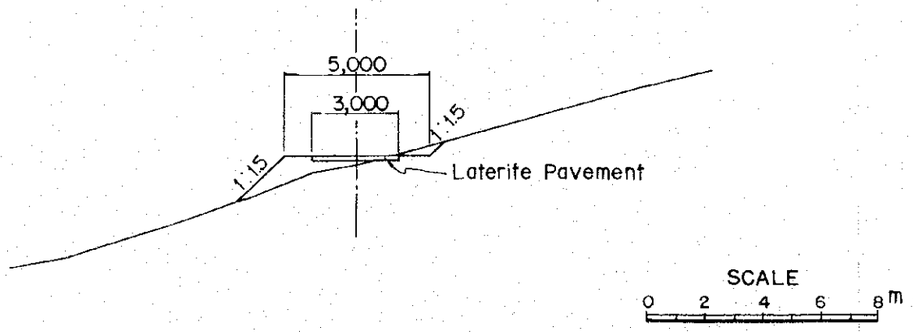
Longitudinal Section of Emergency Spillway





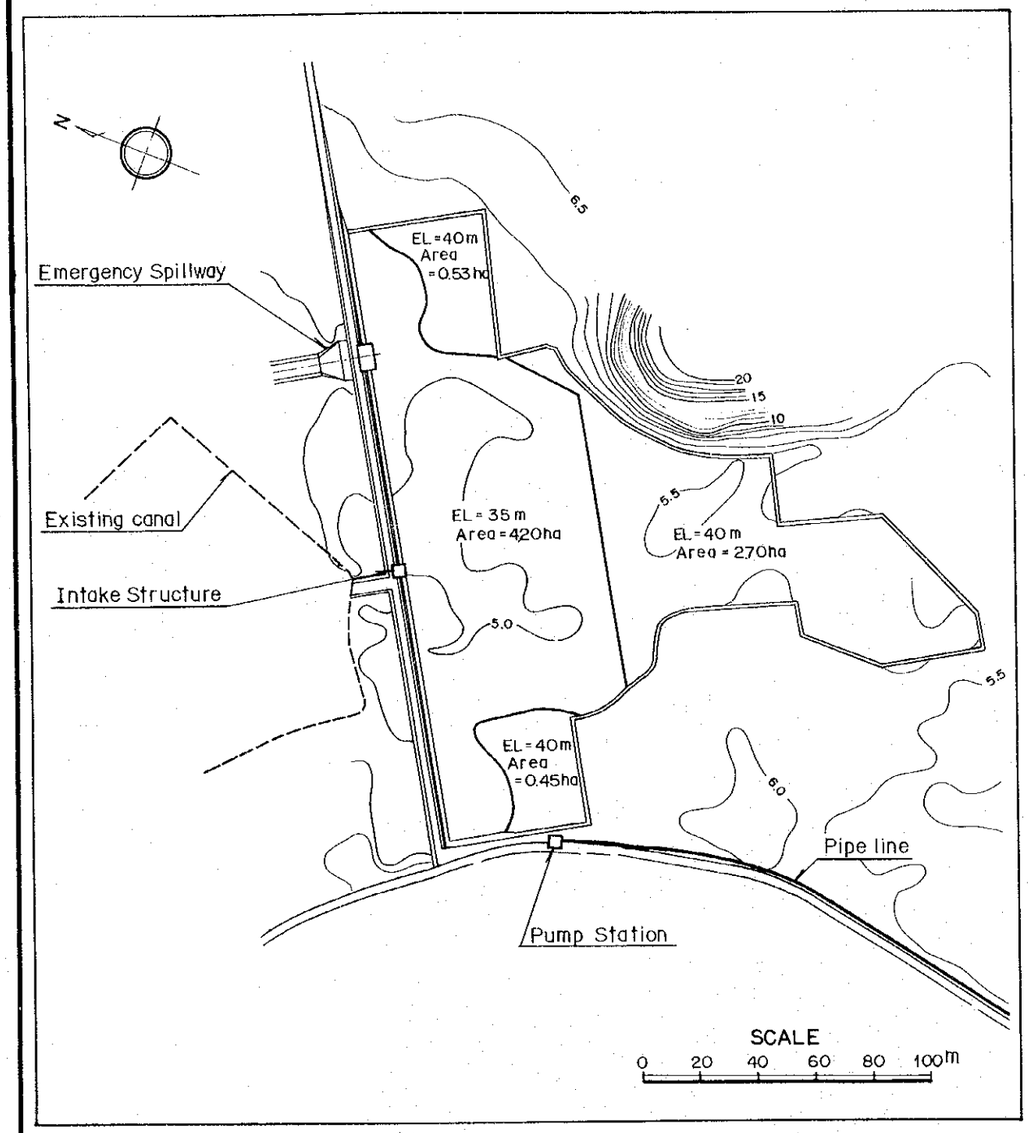
DWG. 2004 General Plan & Sections of Emergency Spillway and Operation Bridge of Culvert Spillway Ketapang Dam, Kedawang Project (KH 4 & 5)

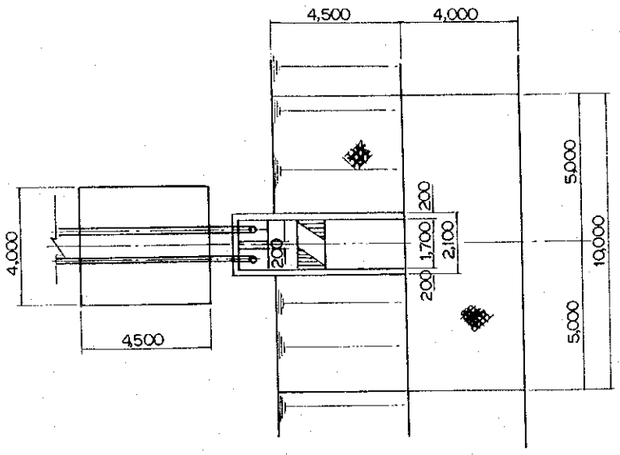




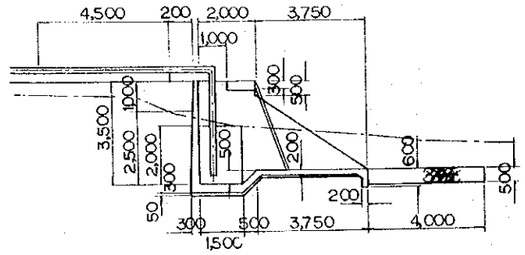
TYPICAL SECTION OF
ACCESS ROAD

DWG2005 General Layout and Typical Section of Access Road of Ketapang Dam Kedawang Project (KH.4&5)

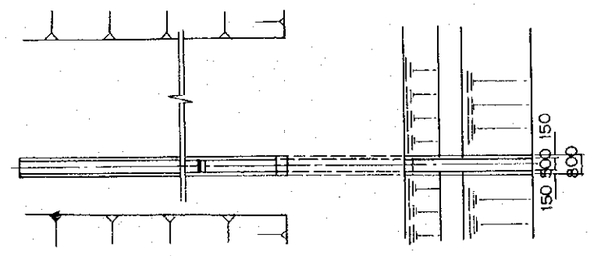




PLAN



PUMP STATION



SCALE
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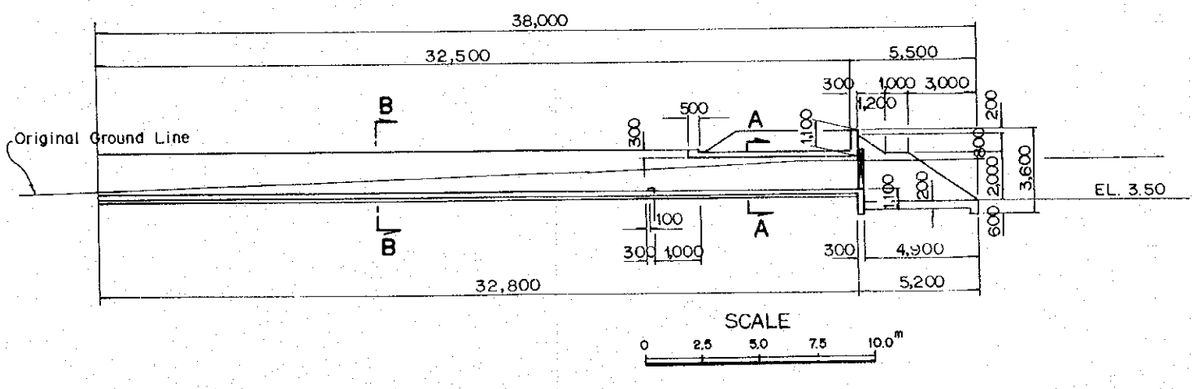
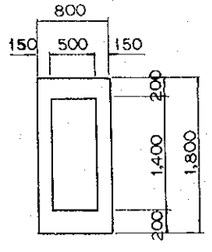
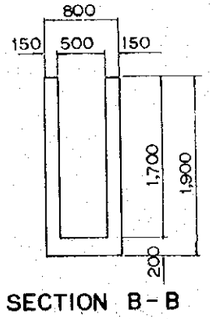


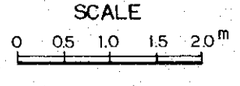
INTAKE STRUKTURE No.1



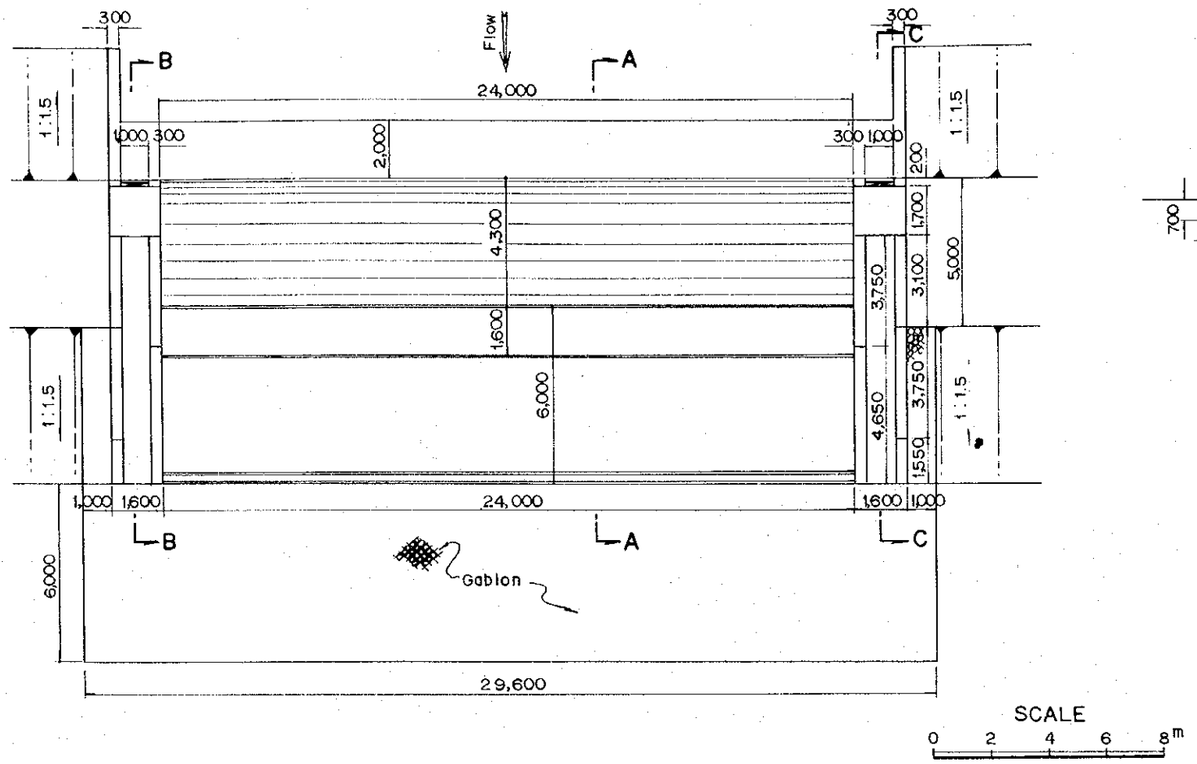
SECTION A-A



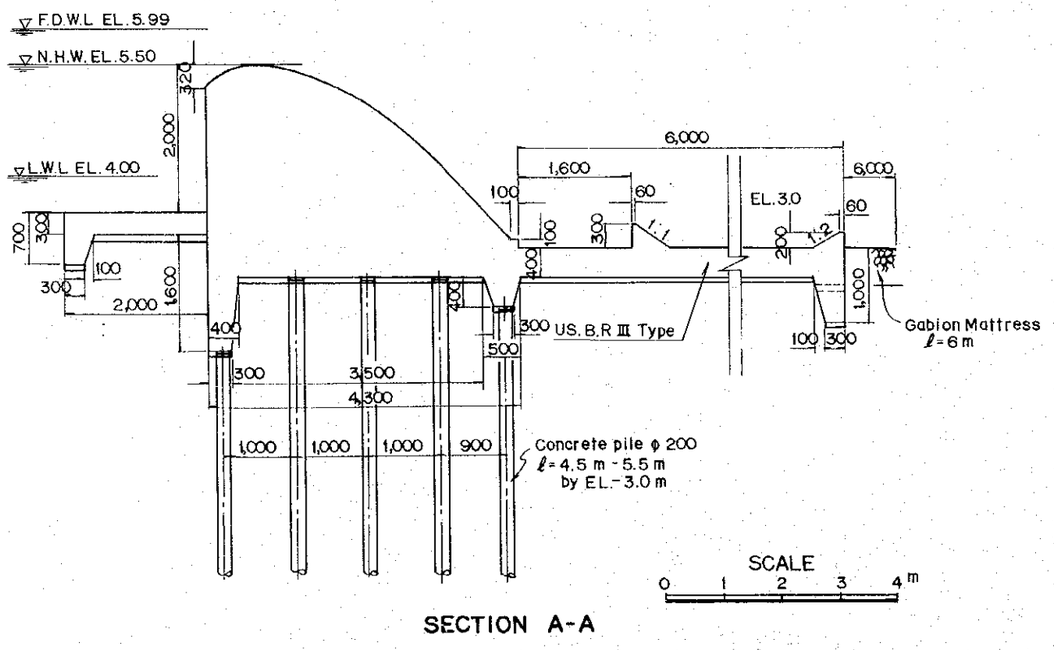
SECTION B-B



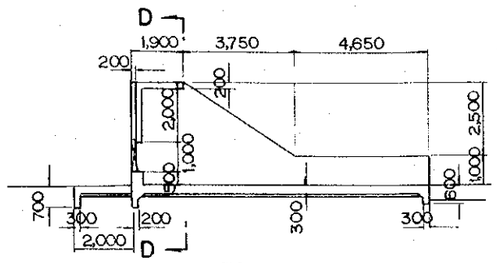
DWG 2006 General Layout of Lembu Reservoir, Intake Structure No.1 and Pump Station
Lembu, Kedawang Project (KH.4&5)



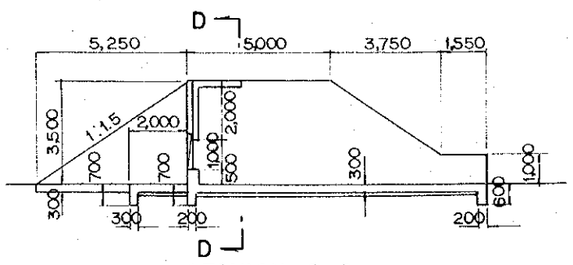
EMERGENCY SPILLWAY



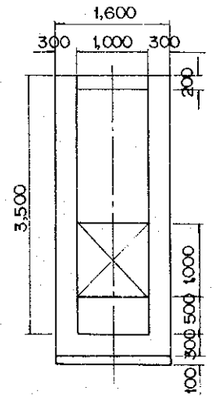
SECTION A-A



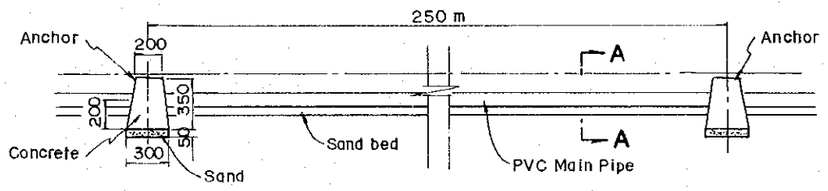
SECTION B-B



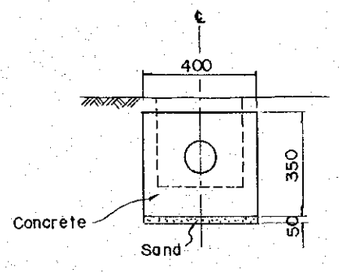
SECTION C-C

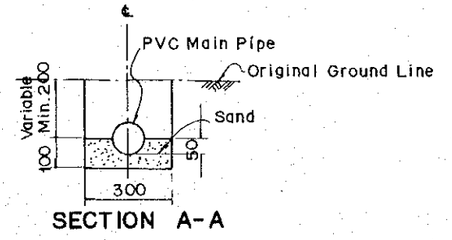


SECTION D-D



PIPE LINE SCALE 0 0.5 1.0 1.5 m



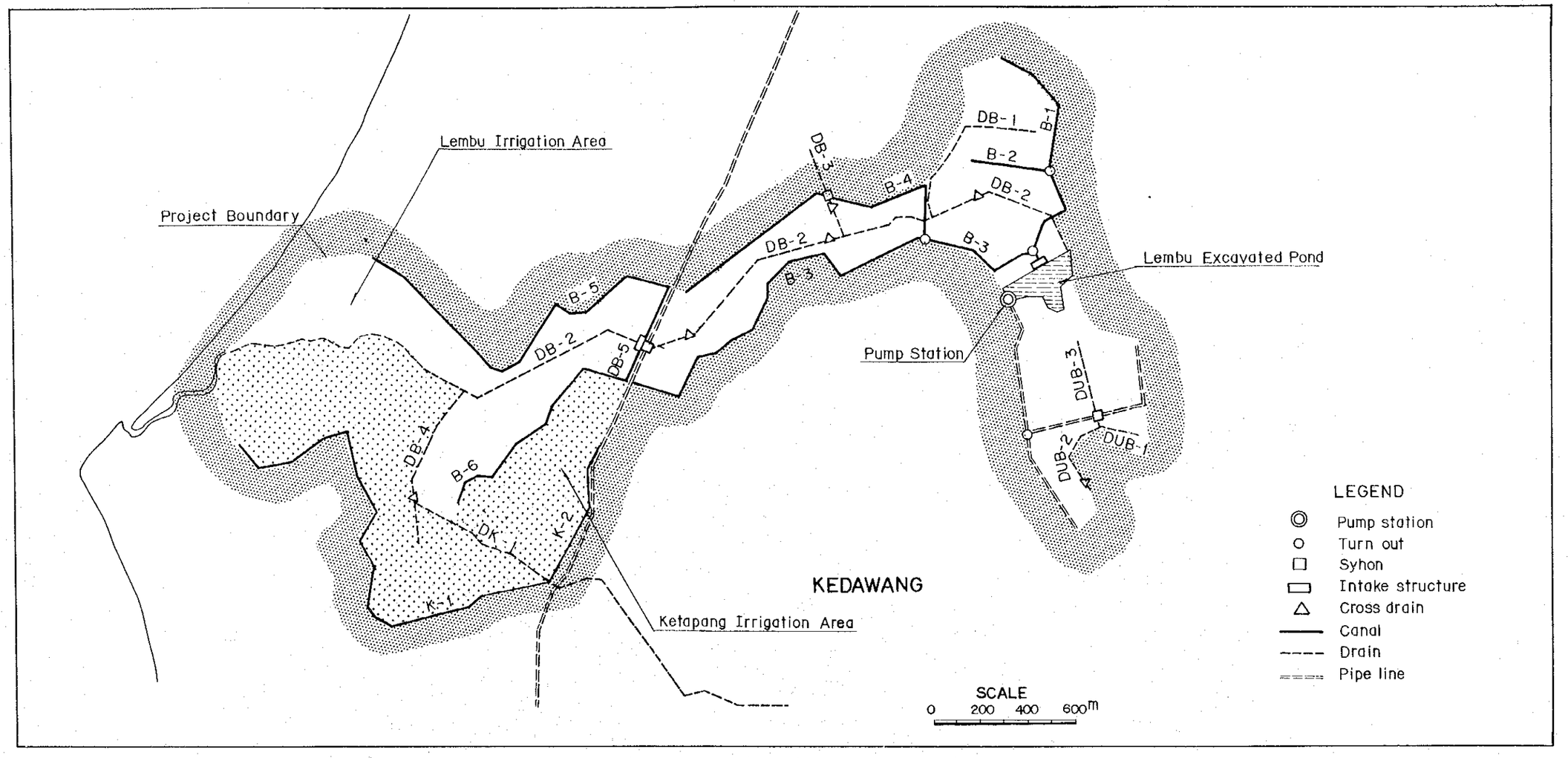


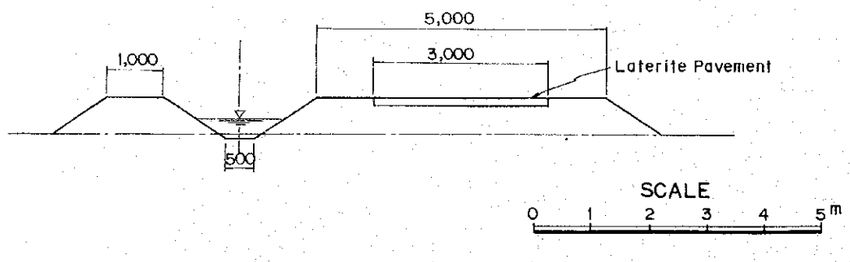
SECTION A-A

SCALE 0 0.2 0.4 0.6 0.8 m

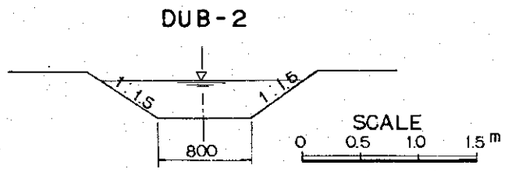
PIPE LINE

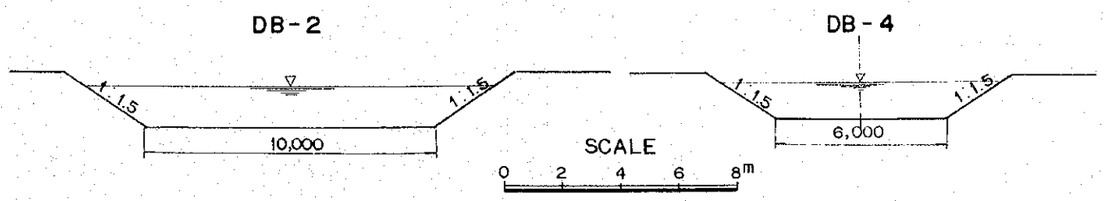
DWG2007 Plan and Sections of Emergency Spillway and Pipe line
Lembu, Kedawang Project (KH.4&5)



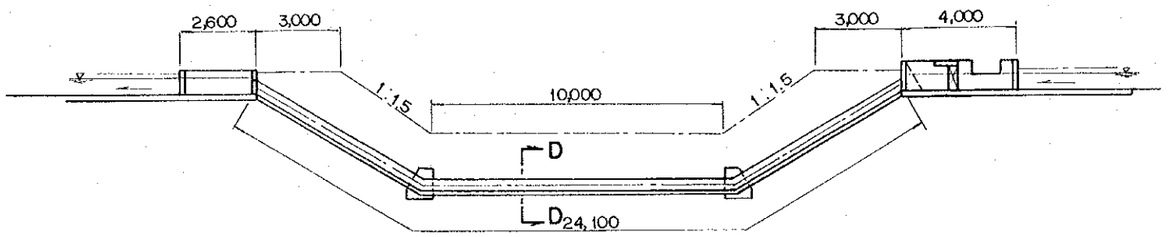


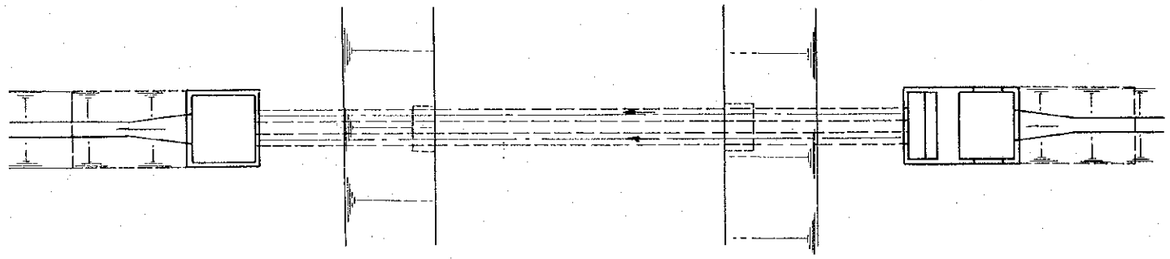
TYPICAL SECTION OF IRRIGATION CANAL





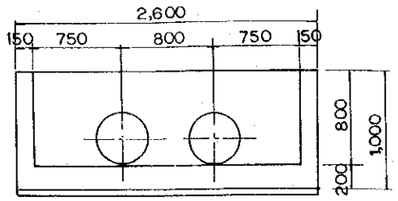
DWG.2008 General layout of Canals, Pipe line and Drain and Typical Sections of Canals and Drains
Lembu, Kedawang Project (KH 4 & 5)



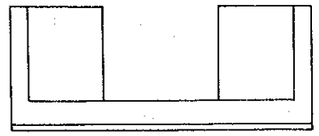


SYPHON

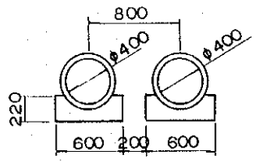
SCALE
0 2 4 6 8m



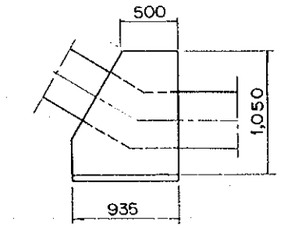
SECTION B-B

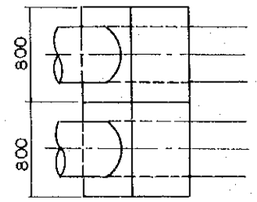


SECTION C-C



SECTION D-D





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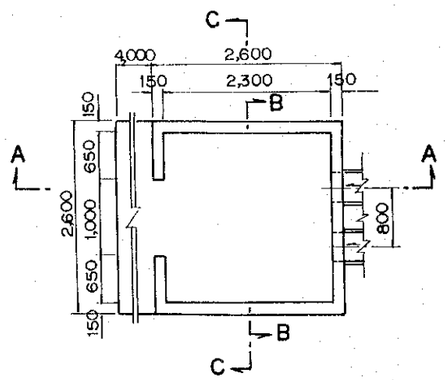

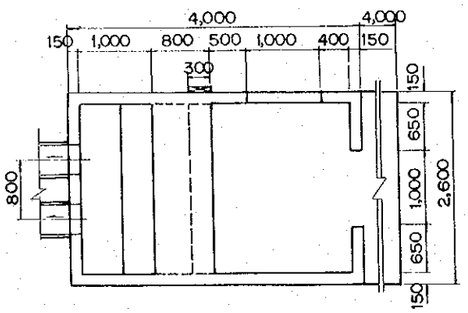

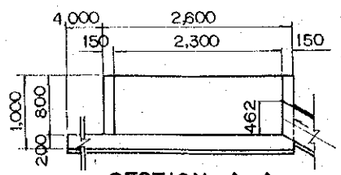

SECTION A-A

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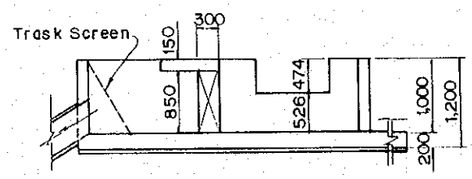

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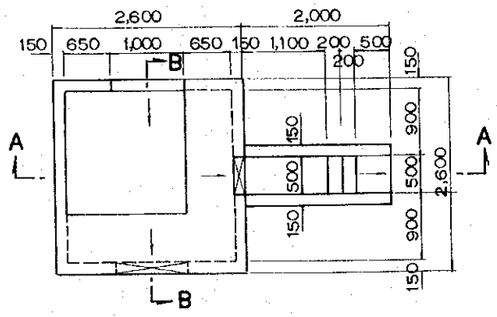
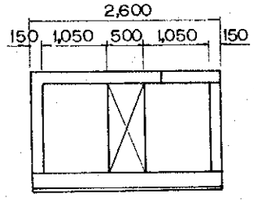
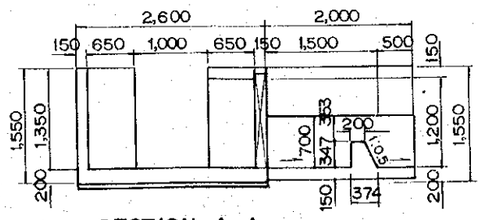




SECTION B-B



SECTION A-A

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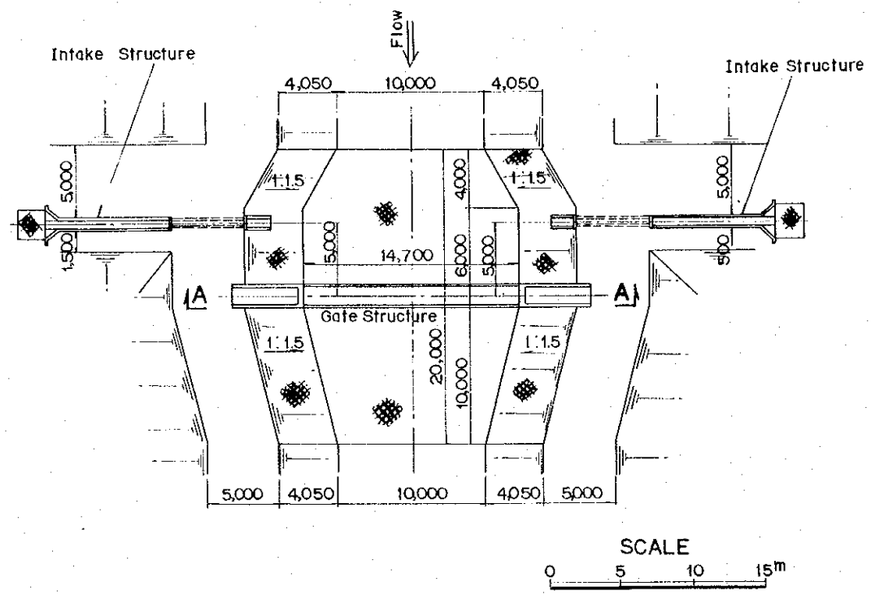
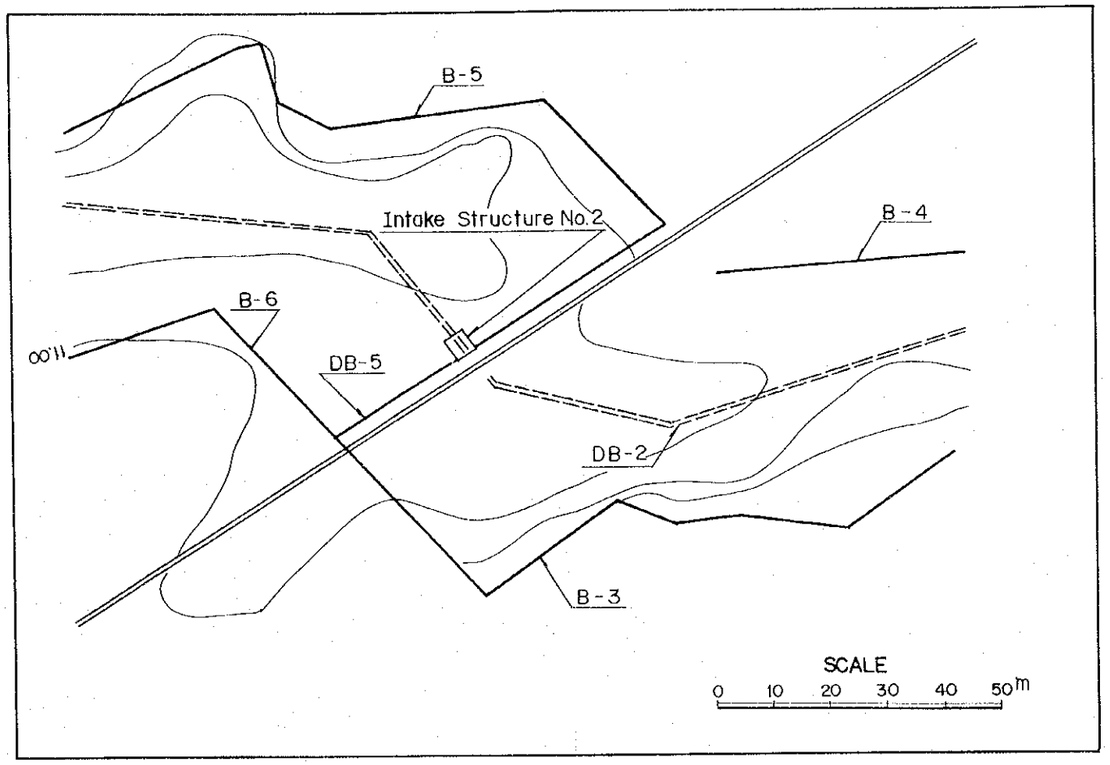
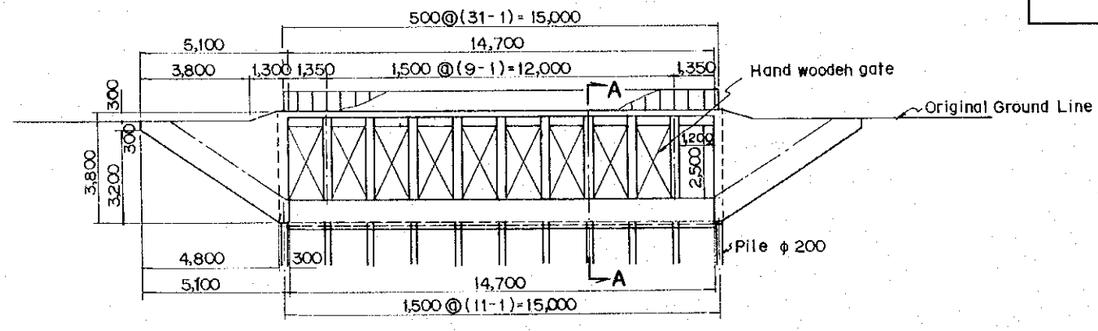
TURNOUT

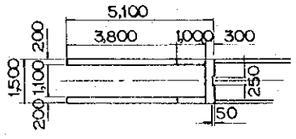
DWG2009 Syphon & Turnout
Lembu, Kedawang Project (KH.4&5)

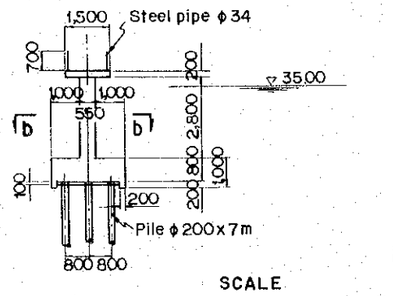


GATE STRUCTURE

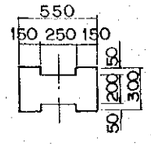








SECTION A-A



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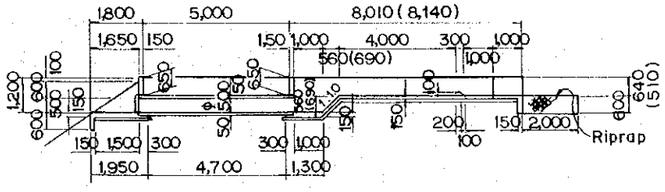
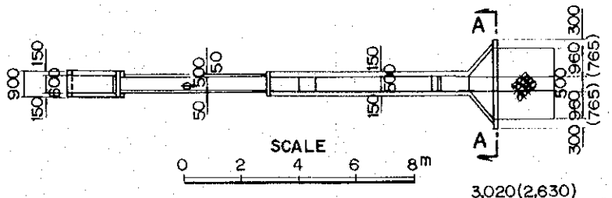
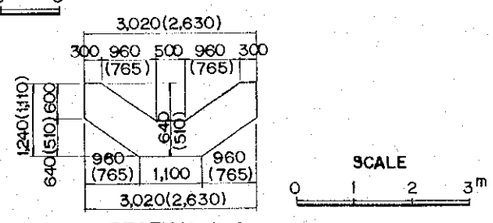
PIER SECTION



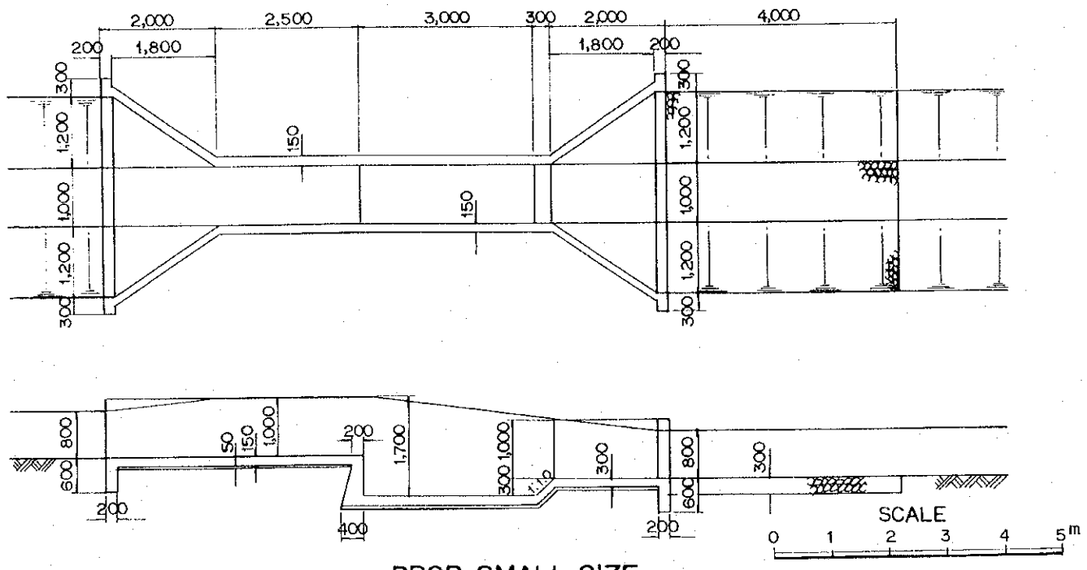


INTAKE STRUCTURE

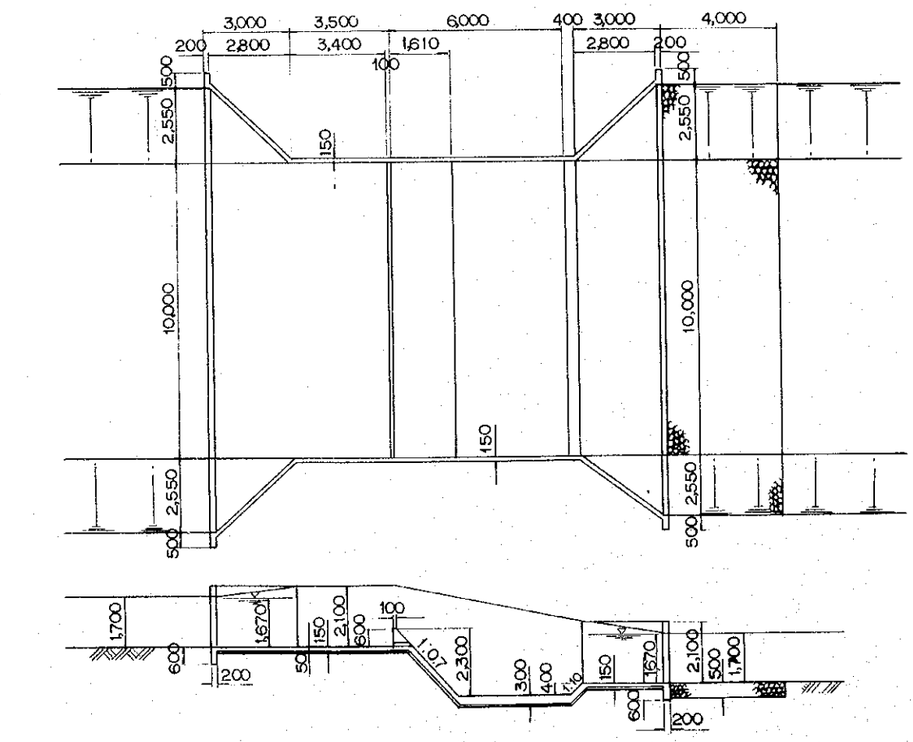


SECTION A-A

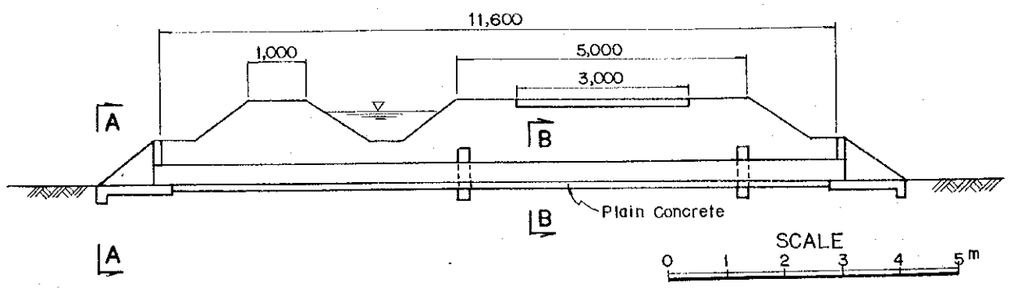
DWG2010 General Layout and Sections of Intake Structure No.2
Lembu, Kedawang Project (KH.4&5)

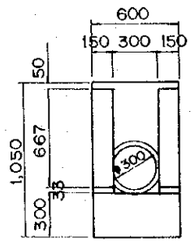


DROP SMALL SIZE

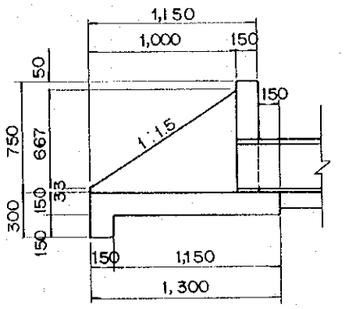


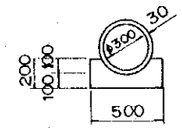
DROP BIG SIZE





SECTION A-A





SECTION B-B

SCALE
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CROSS DRAIN

DWG2011 Drop Structure for Drain and Cross Drain
Lembu, Kedawang Project (KH.4&5)

3 Bukit Sedanan Project (MA-16)

3.1 Present Condition

3.1.1. Project Area

The Project area is located in hilly areas with undulation about 10 km Northwest from Jasin town. Mentangor river, with a small watershed of about 2.4 km^2 flows out in a valley surrounded by irrigation areas. The irrigation areas are divided into FELCRA and MIADP areas and expand in the hilly slopes with a range from 10^{o} to 30^{o}.

A resettlement program for sea fishermen is being implemented in the FELCRA area, and the MIADP area of about 240 ha is scheduled to implement a new agro tourism development program under the State Government's supervision. The FELCRA area is covered by an orchard experimental farm of 97 ha, and some areas are irrigated by the existing farm pond, a simple pipe line system, and a simple drip irrigation system. However, the majority of the areas require irrigation water to sustain the fine growth of orchard.

3.1.2 Irrigation and Drainage Facilities

The FELCRA area has existing irrigation facilities such as a mini-dam with a height of 7 m, a small reservoir of about 20, 000 m^3, and a pump and simple pipe line system for a few hectares. On-farm irrigation is also carried out in some orchard areas and orchid house using drip irrigation system.

The MIADP area has no existing irrigation facilities.

3.1.3 Social Facilities

Since the resettlement project for sea fishermen has been implemented in the FELCRA area, social infrastructures in and around the FELCRA area, such as access and farm roads, electric distribution lines, domestic water supply facilities, and accommodation, have been constructed and are well maintained.

3.2 The Project

3.2.1 Background of the Project

FELCRA is currently implementing a resettlement program for fishermen and intends to up-grade the implementation program through the rehabilitation of existing irrigation facilities and the new development of an irrigation system and irrigation area, including a new water resources development, in order to successfully achieve the goals of the implementation program.

In the line with FELCRA' implementation program, Malacca Agriculture Integration Development Project (MAIDP) has a schedule to develop an agro tourism area on the oposite bank of FELCRA area. MAIDP 's agro tourism development program includes a new horticulture area, a deer farm, and a demonstration farm for agriculture research centres and/or institutes.

New water resource development for irrigation in both areas are requested.

3.2.2 Proposed Irrigation Area

FELCRA has planned an alternative program and schedule for its crop area, and detailed subjects are still being discussed at present. Therefore, the crop area for the water resources development is 36.9 ha of durian farm based on discussions among FELCRA, State DID and JICA Study Team during the Feasibility Study.

The proposed areas for durian cultivation are separated in 2 hilly areas 15.5 ha upstream from reservoir and 21.4 ha downstream of the reservoir, as shown in DWG 3001. Both areas expand in hill slope and have a more higher elevation than the surface water elevation of the reservoir.

MIADP is a horticulture area of 25 ha, and located on the left bank of the reservoir. The area expands in a hill slope with a higher elevation than the surface water elevation of the reservoir.

3.2.3 Irrigation Water Requirement

(1) Seasonal irrigation water requirement of durian and vegetable

Based on discussions with FELCRA, the State DID and JICA Study Team during the Feasibility Study, durian is adopted as typical type and /or kind of orchard for calculation of irrigation water requirement. Horticulture cultivation in MIADP area consists of general types and / kinds of vegetables for all seasons.

The irrigation water requirement for durian and vegetables are basically calculated following the procedure of FAO Irrigation and Drainage Paper No. 24, and the requirement for durian is also calculated to refer to MARDI's paper "Estimated water requirement of some Malaysian commercial fruit crops" in Prosiding Sinposium Buah-buahan Kebangsaan 1991. Potential evapo transpiration (ETo) is estimated at 1,354 mm / year by the modified Penman method, using meteorological data from Malacca airport station. The potential evapo transpiration for vegetable cultivation is estimated at 90 % of the above, because the cultivation method uses a rain shelter.

The crop coefficient of durian in FELCRA area is adopted as the highest figure during the mature growing stage, and vegetable crop coefficient is also high because the forecast of the selective type and kind of vegetable and cropping pattern will be difficult. Cropping patterns of vegetables are assumed as all season cultivation throughout each year.

Effective rainfall for durian is estimated by the USDA SCS method, using monthly rainfall. The effective rainfall for vegetable cultivation is not required because rain shelter facilities are used.

Irrigation methods are designed as drip irrigation for durian and drip and/or micro jet sprinkler irrigation for both the crops, and the overall irrigation efficiency adopted is 85 %.

The seasonal irrigation water requirement is 492 mm/year for durian under the drought year with a return period of 5 years, and 483 mm/year for vegetables. Detailed calculations of the irrigation water requirement are described in Table.3.3.1.

(2) Design irrigation water requirement for facilities

The design irrigation water requirement for durian is adopted as the peak irrigation water requirement based on the seasonal irrigation water requirement for

crops using a probable rainfall with a return period of 5 years. The requirement for vegetables is also the peak irrigation water requirement.

The peak irrigation water requirement for both Projects are calculated at 0.39 lit / sec / ha of durian and 0.42 lit./ sec / ha of vegetable, as shown in Table 3.3.1.

The design irrigation water requirements for irrigation facilities are calculated as follows, taking into consideration rotation of the irrigation water supply and the design conditions of the facilities.

The proposed irrigation areas of FELCRA are separately located in the 2 hilly slopes. Irrigation water supply for the 2 areas is applied the rotation system. For rotation of water supply, irrigation areas is broadly divided into two (2) sub irrigation areas, (i) the sub irrigation area located between EL 55 m and EL 70 m, and (ii) the other area between EL 70 m and EL 100 m.

The sub irrigation areas are further divided into unit irrigation blocks to be served by main pipeline lines, and the hectares of unit irrigation blocks range from 5.9 ha to 8.2 ha.

Irrigation water is scheduled to be supplied to one (1) sub irrigation area for 12 hours and the other sub irrigation area for the other 12 hours, during the peak requirement of irrigation water.

Using the above irrigation rotation system, the design irrigation water requirement for the facilities is 0.76 lit / sec /ha. The design discharge is 6.4 lit / sec of the main pipe line in the upstream area and 4.6 lit / sec to 10 6 lit / sec of 3 main pipe lines in the downstream area.

Since the location of the irrigation area is still being discussed in the MIADP area, the design concept for water supply is only to supply irrigation water to the farm pond located near the top of the hill by pump and pipe line. Therefore, design irrigation requirement for facilities is 0.42 lit / sec /ha, and the design discharge of main pipe line is 10.5 lit / sec.

3.2.4 Reservoir Operation Calculation

The reservoir operations of the Mentangor dam are calculated forhalf month periods based on the estimated runoff of the proposed dam site, the irrigation requirement, and water loss from the reservoir by seepage and evaporation, involving the effective storage of the existing farm pond in the FELCRA area. Reservoir operation calculations are made using runoff data from 1960 to 1990.

As a result of these calculations, the reservoir capacity to cope with the drought year with a return period of 5 years is clarified as follows :

Pilot Project/Reservoir	Type of Reservoir	Capacities(1,000 m3)
MA-16 / Montangor	Homogenous Earth fill Dam	230

The detailed calculation and explanation of reservoir operations are described in Table 3.3.2.

3.2.5 Water Resource Development Facilities

Water resources development facilities are basically designed using the draft design standard discussed between DID and JICA Study Team during Feasibility

Study, and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of the water resources development is shown in DWG 3001 and DWG 3002.

Dead storage of the reservoir is designed to be about 20,000 m3 which is the sedimentation volume for 30 years.

Based on reservoir storage volume curve, the low water level (L.W.L.), which is the surface elevation of sedimentation is determined EL 49.00 m. The reservoir storage volume curve is shown in Fig.3.3.1. Since the effective storage of the reservoir is 230,000 m3, normal high water level (N.H.W.L.) is EL 54.00 m.

The dam has a culvert spillway and an emergency spillway. The design flood discharge of the spillways is 12.7 m3 /sec of the 100-year flood, and the flood discharge is shared by both spillwayss, 4.3 m3 /sec of the 20-year flood discharge for the culvert spillway and the remaining 8.4 m3/ sec for the emergency spillway. The design flood water level (D.F.W.L.) is EL 55.20 m.

The freeboard of the dam and the thickness of the pavement at the crest of the dam are given 1.0 m and 0.3 m respectively, and the crest elevation of the dam is EL 56.50 m.

The top soils is designed to excavate to a depth of 1.0 m, based on geological information. The lowest elevation of the dam is EL 45.00 m. Therefore,the dam height is 11.5 m.

The dam is homogenous earth fill type with a horizontal drain of 1.5 m thick laid at EL 45.00 m.

Slopes of the dam are designed to be 1 : 3.0 upstream and 1 : 2.5 downstream. Stability analysis of the dam slope is made using geological data obtained through the boring and soil mechanical test. The analyses are made for the three (3) cases, (i) full water storage case with normal hight water level, (ii) sudden draw down case from N.H.W.L. to L.W.L and (iii) no storaged case. The result of the stability analyses are shown below (refer to Fig. 3.3.2 to Fig. 3.3.4).

Case / Slope	Type of Stress	Min.S.F.
Full Water Storage		
upstream	effective stress	2.35
downstream	effective stress	1.45
Sudden draw down		
upstream	effective stress	1.85
No storaged		
upstream	effective stress	2.12
downstream	effective stress	1.89

The stability analyses are made as sample calculations for the dam design based on the current geological data obtained in the feasibility study. The geological data are still insufficient for the detailed design of the dam.

On the other hand, since the proposed dam site could be subject to landsliding in regard to the topography, further geological investigation, especially data & information of the foundation layer and soil mechanical tests, shall be carried out for future design of the dam.

Stone covering with a thickness of 0.8 m at the upstream slope of the dam, sod facing on the downstream slope, and laterite pavement at the crest of the dam, are designed to prevent erosion.

Seepage water loss from the dam body and foundation are also examined using geological data of the foundation. Daily seepage loss from the reservoir is estimated at about 100 m3/ day, equivalent to 0.045 % of the storage capacity of the reservoir. Since daily seepage loss is less than the allowable ratio of 0.05 %, a blanket of impervious soils is not designed in the bottom of the reservoir.

The emergency spillway is a grass spillway designed to be placed 10 m apart on the original hill portion of the dam embankment body. The spillway has a low channel of rectangular section. Height and width of the low channel are 1 m and 8 m, respectively, and the inside slope is 1 : 1.5.

The culvert spillway has a drop type inlet in the tower section and one (1) box type barrel . The barrel is designed to be placed on, and varied in, the original hill slope. The culvert spillway has an operation bridge which is designed to give the access from the right bank side of the dam.It is a T beam bridge, 20 m in length.

An access road to the dam is laid in the hill slope of the left bank. It is designed to have laterite pavement 3-m wide, and the maximum longitudinal slope of the road is 5 %. Total length of the access road is 260 m.

Design of major structures are illustrated in DWG.3002 to DWG. 3005, and salient features of these facilities are described below.

Montangor Dam and Reservoir

Reservoir	
Total storage capacity	250,000 m3
Effective storage capacity	230,000 m3
Dead storage capacity	20,000 m3
Dam	
Type of dam	Homogenous earth fill and Horizontal & toe drain
Height of dam	11.5 m
Crest width of dam	5. 0 m
Length of dam including grass spillway	246 m
Dam slope	
upstream	1 : 3.0
downstream	1 : 2.5
Crest elevation of dam	EL 56.50 m
Deign flood water level	EL 55.20 m
Normal water level	EL 54.00 m
Low water level	EL 49.00 m

Emergency spillway	
Type of spillway	Grass spillway (trapizoidal, chute type)
Design flood discharge	8.4 m3/sec
Base elevation of chute channel	EL 54.54 m
Total length	212 m
Base width of spillway	8 m
Inside slope of lower channel	1 : 1.5
Gradient of channel	1 / 200
Height of lower channel	1 m
Culvert spillway	
Type of spillway	Tower type (box type)
Design flood discharge	4.3 m3/sec
Crest elevation of spillway	EL 54.00 m
Height of spillway	9 m
Type of barrel	box barrel 1.8 m x 1.5 m x 1 no.
Total length	88.5 m
Incidental facilities	Operation bridge, total length 20 m of 3 spans
Access road	
Type of road	Pavement road with laterite (w =3 m)
Total length	260 m
Width of road	5 m

3.2.6 Irrigation Development Facilities

Irrigation development facilities are basically designed using the draft design standard discussed between DID and the JICA Study Team during the Feasibility Study, and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of irrigation development is shown in DWG 3001 and DWG 3006.

Irrigation areas of durian and horticulture are expanded in the hill slope with an average slope of about 10 °, and the areas are covered by agriculture forest and virgin forest. These hill slopes also have many natural streams which function as drains during heavy rainfall, and orchard trees are planted apart from these stream. Therefore, evacuation of exceeding rain water from the irrigation area is entrusted to natural steam, and a special drainage system is not designed.

The irrigation system in the Project area is a pump and pipe line system for durian & vegetable cultivation. Since irrigation areas are scattered in the 3 hill slope areas, 3 irrigation systems consisting of pump, main pipe line and/or farm pond are designed.

For durian areas, FELCRA use the pump and main pipe line system, and irrigation rotation is made 2 times/day during the peak irrigation as mentioned above. MAIDP area has a pump, main pipe line, and farm pond system, and rotation irrigation is entrusted to the operation method of the farm pond.

Since the irrigation area of durian and horticulture are expanded on hill slopes with a wide range of elevation, from EL 55.00 m to EL 100.00 m, the required water head of pump including suction head of pumps vary also widely.

The design discharge of the pumps and main pipes vary from 0.36 m3/min to 0.64 m3/min, and the maximum sunction head of the pump is about 8 m, by the L.W.L of the reservoir.

Taking into consideration the elevation of the irrigation area and the design discharge & suction head of the pumps, a submergible pump is selected for the Project. The required number of pumps are as follows, including one (1) unit for standby.

Pump Station	D.discharge (m3/min)	Max. Head (m)	Unit of pump (nos.)
FELCRA area			
Upstream/			
Station No.1	0.39	50	2
	0.35	20	1
Downstream/			
Station No.3	0.64	30	2
	0.36	20	1
MAIDP area			
Station No.2	0.62	30	2

Since the water head of the pipe line is about 20m to 60 m, and the majority area has a gentle topographical slope of about 10 °, high quality grade PVC pipe is designed. The design velocity of the pipe ranges from 0.7 m/sec to 1.1 m/sec, and diameter of pipe is selected from 60 mm to 120 mm.

The occurrence of water hammer in the main pipe line is not studied because the topographical maps are not sufficient scale, but since hill slope is less than 10 °, and there is little radical undulation, water hammer in the pipe line is not expected to occur.

Design of typical structures are illustrated in DWG.3007 to DWG.3008, and salient features of these facilities are described below.

Irrigation area	61.9 ha (durian 36.9 ha in the FELCRA area, and vegetable 25 ha in the MIADP area)
Pump station	3 sites (FELCRA area 2 sites, MAIDP area site)
Pump(Submergible pump)	
2.5 kw (h=20 m)	2 units
4.0 kw (h=30 m)	4 units
7.0 kw (h=50 m)	2 units
Pipeline	PVC pipe line, FELCRA area 3.6 km and MIADP area 0.2 km
Farm pond	I site (MIADP area), 300 m3
On farm facilities	Drip irrigation facilities 61.9 ha

3.2.7 Necessary Infrastructures for the Project

The state road located about 500 m down stream from the Mentangor dam has a small culvert. In the line with the construction of the dam, a new culvert with a capacity to release flood discharge of 12.7 m3/sec is designed.

Demolishing and reconstruction of existing culvert	1 no.
	new box culvert of 9 barrels
	H 1.5 m x W 1.5 m x W 8 m

3.2.8 Construction Plan

A mechanical construction method will be applied to the construction of the Project. Major structures for construction are the Mentangor dam and related structures, a pump station, and a farm pond.

Diversion works of river flow during construction of dam will be entrusted to the culvert spillway. Prior to the commencement of the embankment of the dam, construction of the barrel portion of the culvert spillway shall be completed. The construction program of the dam body is scheduled to start from both hillsides to the centre of the dam.

The main construction volume for the embankment of the dam body and the excavation of the emergency spillway of the Mentangor dam and concrete work of the culvert spillway. are roughly estimated at about 55,000 m3 of embankment, about 33,000 m3 of excavation, and about 500 m3 of concrete works.

Taking into consideration the above construction volume, the construction schedule is assumed at 9 months, consisting of 1 month for mobilisation, preparatory work, and demobilisation periods, and 8 months for the construction period.

3.3 Estimate of Project Cost

3.3.1 Unit Price Analysis

Unit prices of the respective works of the project are estimated by up-dating the bidding prices of similar works in Malacca, and using the Government price schedule issued in 1993, and the annual inflation rate of commodity issued by the Central Bank of Malaysia. The unit prices of these works are estimated at 1994 price levels.

Reference data of bidding prices for similar works of other projects are as follows:

1) Sng. Melaka Flood Alleviation project 1992,
2) Pipe line project Tannga Batu 1990,
3) Bkt Bakul -Melaka Pindah Pipe line project 1994
4) Bkt Asu reservoir -Petronas Pipe line 1990

The updated unit prices of the respective works are shown in Table 3.3.3.

3.3.2 Estimate of Quantity

All quantities are estimated, based on the design mentioned above. The quantities estimated are shown in Table 3.3.4.

3.3.3 Estimate of Construction Cost

Total construction cost consisting of direct construction cost, land acquisition cost and physical contingency is estimated at about RM 4,795,500 at 1994 price levels, as shown below.

Physical contingency is assumed at 15 % of direct construction cost.

	Description	Cost (RM)
		Bukit Sedanang
1	Direct construction cost	3,688,800
2	Land Acquisition	0
3	Physical Contingency	553,300
4	Engineering cost	368,900
5	Administration cost	184,500
	Total	4,795,500

The detailed costs are shown in Table 3.3.4.

Table 3.3.1 Irrigation Water Requirement of Durian and Horticulture

Bukit Sedanan Project

MA-16	Jan(1)	Jan(2)	Feb(1)	Feb(2)	Mar(1)	Mar(2)	Apr(1)	Apr(2)	May(1)	May(2)	June(1)	June(2)	July(1)	July(2)	Aug(1)	Aug(2)	Sept(1)	Sept(2)	Oct(1)	Oct(2)	Nov(1)	Nov(2)	Dec(1)	Dec(2)	
EXISTING RESERVIOR (FELCRA area)																									
Durian																									
Horticulture (orchid & others)																									
Chekin Farm																									
NEW DEVELOPMENT (FELCRA area)																									
Durian																									
(MIADP area)																									
Horticulture (orchid & others)																									
Rainfall	20.0	0.0	85.0	60.0	10.0	85.0	210.0	95.0	60.0	55.0	35.0	0.0	35.0	50.0	5.0	40.0	190.0	60.0	65.0	135.0	90.0	65.0	70.0	0.0	1,520
Potential Evapotranspiration	55.5	59.2	60.0	52.0	58.5	62.4	58.5	58.5	57.0	60.8	55.5	55.5	55.5	59.2	54.0	57.6	51.0	51.0	52.5	56.0	49.5	49.5	51.0	54.4	1334.6
Durian																									
Crop Coefficient (Kc)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	Average Kc 0.85
Crop Evapotranspiration (ETcrop)	47.2	50.3	51.0	44.2	49.7	53.0	49.7	49.7	48.5	51.7	47.2	47.2	47.2	50.3	45.9	49.0	43.4	43.4	44.6	47.6	42.1	42.1	43.4	46.2	1134.4
Effective Rainfall	11.8	0.0	53.6	37.8	6.0	51.0	111.3	50.4	36.0	33.0	23.1	0.0	22.1	31.5	3.2	25.6	98.8	31.2	37.1	77.0	35.1	25.4	45.5	0.0	846
Net Irrigation Requirement	35	50	0	6	44	2	0	0	12	19	24	47	25	19	43	23	0	12	8	0	7	17	0	46	440
Irrigation Efficiency	0.85		0.85		0.85		0.85		0.85		0.85		0.85		0.85		0.85		0.85		0.85			0.85	
Conveyance Efficiency																									
Application Efficiency																									
Gross Irrigation Requirement (mm)	42	59	0	8	51	2	0	0	15	22	28	56	30	22	50	27	0	14	9	0	8	20	0	54	518
Horticulture																									
Crop coefficient (Kc)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	Average Kc 0.8
Crop Evapotranspiration (ETcrop)	44.4	47.4	48.0	41.6	46.8	49.9	46.8	46.8	45.6	48.6	44.4	44.4	44.4	47.4	43.2	46.1	40.8	40.8	42.0	44.8	39.6	39.6	40.8	43.5	1067.7
Effective Rainfall	11.0	0.0	48.5	34.2	6.0	51.0	105.0	47.5	31.2	28.6	21.7	0.0	21.7	31.0	3.3	26.4	95.0	30.0	35.1	72.9	31.5	22.8	40.6	0.0	795
Net Irrigation Requirement	33	47	0	7	41	0	0	0	14	20	23	44	23	16	40	20	0	11	7	0	8	17	0	44	416
Irrigation Efficiency	0.75		0.75		0.75		0.75		0.75		0.75		0.75		0.75		0.75		0.75		0.75			0.75	
Conveyance Efficiency																									
Application Efficiency																									
Gross Irrigation Requirement (mm)	45	63	0	10	54	0	0	0	19	27	30	59	30	22	53	26	0	14	9	0	11	22	0	58	554

Table 3.3.2 Water Balance Calculation on Mentangor Reservoir

		Jan(1)	Jan(2)	Feb(1)	Feb(2)	Mar(1)	Mar(2)	Apr(1)	Apr(2)	May(1)	May(2)	June(1)	June(2)	July(1)	July(2)	Aug(1)	Aug(2)	Sept(1)	Sept(2)	Oct(1)	Oct(2)	Nov(1)	Nov(2)	Dec(1)	Dec(2)
1	1960	230.0	217.5	191.3	164.7	129.4	126.4	125.9	114.8	86.7	69.4	45.3	105.1	156.5	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
2	1961	230.0	210.6	197.0	186.9	167.3	161.0	200.5	230.0	230.0	230.0	230.0	230.0	230.0	223.0	230.0	218.0	192.1	186.7	152.9	131.3	108.5	100.8	94.4	90.0
3	1962	61.5	31.5				11.2	164.2	230.0	230.0	230.0	230.0	230.0	196.1	171.9	175.3	223.6	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
4	1963	196.8	173.7	136.5	114.2	79.6	62.1	32.0		23.2	46.4	85.0	74.8	58.0	28.8	8.3			0.8	107.8	163.1	222.5	230.0	230.0	230.0
5	1964	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	214.9	215.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
6	1965	230.0	230.0	230.0	203.6	172.9	172.8	200.3	216.0	199.0	176.5	161.3	134.8	133.5	111.5	90.6	57.1	40.2	12.5	2.2	1.2	5.9	122.7	230.0	230.0
7	1966	230.0	225.8	203.4	191.2	164.7	164.5	177.9	230.0	230.0	230.0	218.3	207.0	208.7	220.2	217.1	204.4	193.9	198.4	230.0	230.0	230.0	230.0	230.0	230.0
8	1967	230.0	230.0	230.0	230.0	230.0	223.7	215.5	214.5	194.5	230.0	230.0	230.0	224.8	199.6	197.9	176.4	202.4	230.0	230.0	230.0	230.0	230.0	230.0	230.0
9	1968	230.0	211.2	176.6	144.6	144.2	146.5	138.5	155.4	218.0	230.0	230.0	208.0	190.9	189.5	172.6	171.0	207.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
10	1969	230.0	230.0	228.9	200.4	187.0	187.4	230.0	230.0	230.0	230.0	230.0	230.0	216.4	216.0	202.4	182.8	155.4	154.9	155.9	230.0	230.0	230.0	230.0	230.0
11	1970	230.0	230.0	209.0	178.5	166.8	166.3	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	210.7	210.8	228.2	230.0	225.3	230.0	230.0	230.0	230.0
12	1971	230.0	230.0	230.0	230.0	204.4	230.0	226.8	197.5	183.7	185.7	180.1	230.0	230.0	230.0	228.3	230.0	230.0	230.0	220.4	230.0	230.0	230.0	230.0	230.0
13	1972	230.0	227.3	230.0	230.0	230.0	230.0	230.0	219.0	184.8	153.7	119.7	112.8	77.2	75.8	159.1	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
14	1973	221.5	211.3	171.5	171.9	157.4	119.7	119.3	230.0	230.0	230.0	208.6	189.5	153.2	117.2	115.9	93.3	92.3	69.4	52.8	52.0	51.5	25.0	20.0	
15	1974										125.8	146.8	144.9	114.6	114.0	92.7	118.5	121.6	230.0	230.0	221.2	204.5	230.0	230.0	230.0
16	1975	230.0	230.0	230.0	212.1	212.8	205.5	227.8	230.0	230.0	229.1	230.0	222.3	200.1	197.5	192.4	216.9	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
17	1976	230.0	202.0	162.3	127.1	126.4	101.3	100.4	83.8	89.1	77.6	52.7	45.6	24.9	32.8	30.4	71.0	130.8	195.2	230.0	230.0	230.0	230.0	230.0	230.0
18	1977	204.5	165.3	168.9	156.1	137.4	96.6	76.0	55.4	87.2	83.4	78.6	67.3	69.4	109.1	125.0	134.5	109.6	116.4	142.0	116.4	146.4	184.8	182.6	184.7
19	1978	182.1	142.5	121.1	111.9	81.5	48.9	69.4	209.1	230.0	230.0	230.0	228.1	230.0	217.0	218.9	230.0	230.0	228.2	210.0	214.2	230.0	230.0	230.0	230.0
20	1979	230.0	201.0	195.1	174.9	173.0	187.0	230.0	230.0	230.0	230.0	230.0	209.2	179.9	207.8	222.5	201.5	186.7	167.0	155.8	140.4	129.5	230.0	230.0	230.0
21	1980	226.6	212.6	178.5	179.4	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	217.1	219.9	230.0	230.0	210.1	205.4	213.5	220.5	230.0	230.0	230.0	230.0
22	1981	211.1	173.4	172.2	166.1	132.6	130.6	181.7	230.0	230.0	230.0	220.1	184.9	165.3	150.4	117.5	99.5	100.5	199.4	227.2	230.0	230.0	230.0	230.0	224.6
23	1982	218.6	181.5	143.8	127.0	125.8	124.8	230.0	230.0	230.0	230.0	230.0	212.7	212.9	223.7	230.0	230.0	230.0	230.0	207.4	230.0	230.0	230.0	230.0	230.0
24	1983	230.0	215.1	178.8	153.4	113.6	75.9	52.7	37.6	14.5				3.1	23.4	61.5	43.9	40.4	44.5	102.5	146.4	230.0	230.0	230.0	230.0
25	1984	207.0	201.7	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	223.1	211.1	209.2	190.5	178.0	221.9	230.0	230.0	230.0
26	1985	230.0	230.0	230.0	202.4	194.9	201.4	229.5	223.6	223.0	229.5	230.0	198.8	173.1	170.1	158.3	152.2	125.6	124.6	220.1	230.0	230.0	230.0	230.0	230.0
27	1986	229.5	230.0	230.0	225.8	230.0	230.0	230.0	230.0	230.0	230.0	228.8	220.4	201.2	199.7	166.1	150.7	149.6	194.9	230.0	230.0	230.0	230.0	230.0	199.7
28	1987	199.1	179.9	139.2	106.4	85.0	79.7	79.1	78.7	99.1	111.0	207.6	230.0	230.0	206.0	220.8	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
29	1988	208.2	207.3	208.5	204.5	212.9	227.3	230.0	230.0	230.0	230.0	230.0	230.0	230.0	206.0	205.7	204.4	230.0	230.0	230.0	230.0	230.0	230.0	230.0	221.6
30	1989	225.0	187.6	149.9	149.2	230.0	230.0	230.0	230.0	221.8	207.3	175.4	174.2	159.6	131.4	162.0	217.9	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
31	1990	229.2	230.0	212.3	188.0	183.8	172.7	158.8	138.5	136.6	107.2	87.7	49.8	12.9						38.6	93.9	99.1	104.1	230.0	

Table 3.3.3 Unite Price Analysis (MA-16)

Description	Unit	Tender Price	Tender Year	Infration Rate (%)	Up-dated Price (RM)	Adopted Price (RM)	Remarks Data sources
1 Dam							
Land Clearing of Dam Axis	ha	1,000.0	1992	1.084	1,084.0		Sg.Melaka Flood Alleviation Project
		900.0	1991	1.131	1,017.9	1,051.0	JPS Price List 1993 Average price
Stripping	m3	2.0	1992	1.084	2.2		Sg.Melaka Flood Alleviation Project
Excavation	m3	8.0	1992	1.084	8.7		Sg.Melaka Flood Alleviation Project
	m3	13.1	1993	1.035	13.6	11.1	JPS Schedule of Rate 1993
Embankment	m3	28.7	1991	1.131	32.5		Sg.Melaka Flood Alleviation Project
Embankment for road	m3	34.0	1991	1.131	38.5	35.5	JPS Price List 1993
Stone Covering	m3	40.0	1991	1.131	45.2	45.0	JPS Price List 1993 Average price
Horizontal Filter Drain	m3	30.0	1991	1.131	33.9	34.0	JPS Price List 1993 Average price
Toe Drain	m3	30.0	1991	1.131	33.9	34.0	JPS Price List 1993 Average price
Turfing	m2	2.0	1992	1.084	2.2		Sg.Melaka Flood Alleviation Project
		2.8	1991	1.131	3.1	2.6	JPS Price List 1993 Average price
Culvert Spillway & Operation Bridge							
Stripping	m3	2.0	1992	1.084	2.2		Sg.Melaka Flood Alleviation Project
		2.0	1993	1.035	2.1	2.1	JPS Schedule of Rate 1993
Excavation for canal &structures	m3	13.1	1993	1.035	13.6		JPS Schedule of Rate 1993
		8.0	1992	1.084	8.7	11.1	Sg.Melaka Flood Alleviation Project
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Embankment	m3	10.4	1990	1.166	12.1		Pipe line project Tannga Batu 1990
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Reinforced Concrete incl. form	m3	380.0	1992	1.084	411.9		Sg.Melaka Flood Alleviation Project
		470.0	1991	1.131	531.6		JPS Price List 1993
		490.0	1993	1.035	507.2	519.4	JPS Schedule of Rate 1993
Foundation Concrete	m3	80.0	1991	1.131	90.5	90.0	JPS Price List 1993
Plain Concrete incl. form	m3	250.0	1992	1.084	271.0		Sg.Melaka Flood Alleviation Project
	m3	240.0	1991	1.131	271.4	271.2	JPS Price List 1993
Concrete Pile dia. 200	m	90.0	1991	1.131	101.8	102.0	JPS Price List 1993
Gabion	m3	90.0	1991	1.131	101.8	101.8	JPS Price List 1993 Average price)
Riprap	m2	25.0	1992	1.084	27.1	27.1	Sg.Melaka Flood Alleviation Project
Steel gate 1.5 x 2.0 m	set	2,850.0	1991	1.131	3,223.4	3,223.4	JPS Price List 1993
Other steel accessary(hand rail)	m	90.0	1991	1.131	101.8	102.0	JPS Price List 1993
Emergency Spillway							
Excavation	m3	8.0	1992	1.084	8.7		Sg.Melaka Flood Alleviation Project

		13.1	1993	1.035	13.6	11.1	JPS Schedule of Rate 1993
Plain Concrete	m3	250.0	1992	1.084	271.0		Sg.Melaka Flood Alleviation Project
		240.0	1991	1.131	271.4	271.2	JPS Price List 1993
Gabion	m3	90.0	1991	1.131	101.8	101.8	JPS Price List 1993 Average price)
Riprap	m2	25.0	1992	1.084	27.1	27.1	Sg.Melaka Flood Alleviation Project
Access Road							
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Embankment	m3	10.4	1990	1.166	12.1		Pipe line project Tannga Batu 1990
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Laterite pavement	m3	28.6	1992	1.084	31.0	31.0	Sg.Melaka Flood Alleviation Project
Pump Station							
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Stripping	m3	2.0	1992	1.084	2.2	2.2	Sg.Melaka Flood Alleviation Project
Embankment	m3	10.4	1990	1.166	12.1		Pipe line project Tannga Batu 1990
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Reinforced Concrete incl. form	m3	380.0	1992	1.084	411.9		Sg.Melaka Flood Alleviation Project
		470.0	1991	1.131	531.6		JPS Price List 1993
		490.0	1993	1.035	507.2	519.4	JPS Schedule of Rate 1993
Foundation Concrete	m3	80.0	1991	1.131	90.5	90.0	JPS Price List 1993
Trash screen	m2	444.4	1991	1.131	502.7	502.7	JPS Price List 1993
Pumps							
Type 2.5 kw H 20 m	nos.	10,000.0	1994	1	10,000.0	11,000.0 *	Supplyer's price
Type 4.0 kw H 30 m	nos.	12,450.0	1994	1	12,450.0	13,695.0 *	Supplyer's price
Type 7.0 kw H 50 m	nos.	15,200.0	1994	1	15,200.0	16,720.0 *	Supplyer's price
Pipe line							
Excavation for pipe	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Excavation for anchor block	m3	15.0	1994	1	15.0	15.0	Bkt Bakul-Melaka Pindah Pipe line Pro.
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Sand bed	m3	20.0	1992	1.084	21.7	21.7	Sg.Melaka Flood Alleviation Project
Reinforced Concrete of anchor	m3	387.6	1990	1.166	451.9		Bkt Asu reservoir-Petronas Pipe line
		444.0	1991	1.131	502.2	477.0	JPS Price List 1993
PVC Pipe							
dia. less than 75 mm	m	17.0	1992	1.084	18.4	18.8	Sg.Melaka Flood Alleviation Project
dia. 100 mm	m	17.0	1991	1.131	19.2	26.9	JPS Price List 1993
dia. 150 mm	m	22.5	1991	1.131	25.4	35.6	JPS Price List 1993
dia. 225 mm	m	28.0	1991	1.131	31.7	44.2	JPS Price List 1993

Sluice Valve	nos.	30.0	1990	1.166	35.0	35.0	Bkt Asu reservoir-Petronas Pipe line
Flange & valve	nos.						
Farm Pond							
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Embankment	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Stripping	m3	2.0	1992	1.084	2.2	2.2	Sg.Melaka Flood Alleviation Project
Reinforced Concrete	m3	436.0	1991	1.131	493.1		JPS Price List 1993
		464.0	1993	1.035	480.2	486.7	JPS Schedule of Rate 1993
Plain Concrete	m3	250.0	1992	1.084	271.0		Sg.Melaka Flood Alleviation Project
		240.0	1991	1.131	271.4	271.2	JPS Price List 1993
Sand bed	m3	20.0	1992	1.084	21.7	21.7	Sg.Melaka Flood Alleviation Project
Canal & Related Structures							
Reinforced Concrete	m3	453.0	1991	1.131	512.3		JPS Price List 1993
		495.0	1993	1.035	512.3	512.3	JPS Schedule of Rate 1993
Plain Concrete	m3	250.0	1992	1.084	271.0		Sg.Melaka Flood Alleviation Project
		240.0	1991	1.131	271.4	271.2	JPS Price List 1993
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Embankment	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Gate							
On-farm development							
Drip irrigation facilities	ha	4,300.0	1994	1	4,300.0	4,300.0 *	Supplyer's price

Table 3.3.4 Estimate of Construction Cost (MA-16)

	Work Item	Unit	Quantity	Unit Price(RM)	Amount(RM)
1	Dam and Reservoirs				
	Land crearing	ha	3	1,051.0	2,838
	Excavation	m3	24,233	11.1	268,986
	Embankment	m3	54,934	35.5	1,950,157
	Stone Covering	m3	3,600	45.0	162,000
	Horizontal Drain Filter & Toe di	m3	2,050	34.0	69,700
	Trufing	m2	2,200	2.6	5,720
	subtotal				2,459,401
2	Culvert Spillway & Operation Bridge				
	Stripping	m3		2.1	
	Excavation	m3	1,180	11.1	13,098
	Backfill	m3	330	17.0	5,610
	Embankment	m3	70	17.0	1,190
	Reinforced concrete	m3	490	519.4	254,506
	Foundation concrete	m3	112	90.0	10,080
	Concrete Pile dia. 200	m	66	102.0	6,732
	Gabion	m3	100	101.8	10,180
	Steel slide gate 1.5m x 2.0 m	nos.	2	3,223.0	6,446
	Other steel accessary(hand ra	m	121	102.0	12,342
	subtotal				320,184
3	Emergency Spillway				
	Excavation	m3	8,861	11.1	98,352
	Plain concrete	m3	40	271.2	10,848
	Gabion	m3	200	101.2	20,240
	subtotal				129,440
4	Access Road				
	Excavation	m3	60	9.6	576
	Embankment	m3	40	17.0	680
	Literite pavement	m3	900	31.0	27,900
	subtotal				29,156
5	Pump Station				
	Excavation	m3	1,902	9.6	18,255
	Stripping	m3	28	2.2	61
	Embankment	m3	220	17.0	3,740
	Backfill	m3	477	17.0	8,101
	Reinforced concrete	m3	136	519.4	70,446
	Foundation concrete	m3	19	90.0	1,696
	Trash screen	m2	55	502.7	27,498
	Submersible pump				
	2.5 kw H 20 m	nos.	2	11,000.0	22,000
	4.0 kw H 30 m	nos.	4	13,695.0	54,780
	7.0 kw H 50 m	nos.	2	16,720.0	33,440
	Pump House	m2	0	1,000.0	0
	subtotal				240,016
6	Pipe line				
	Excavation for pipe line	m3	580	9.6	5,568
	Excavation for anchor block	m3	4	15.0	60
	Backfill	m3	360	17.0	6,120
	Sand bed	m3	170	21.7	3,689
	Plain concrete	m3	3	477.0	1,431
	PVC pipe				
	dia. less than 75 mm	m	8,350	18.8	156,980
	dia. 150 mm	m	470	26.9	12,643
	Sluice valve	nos.	35	35.0	1,225
	subtotal				187,716

7	Farm Pond				
	Excavation	m3	350	9.6	3,360
	Embankment	m3	45	17.0	765
	Stripping	m3	12	2.2	26
	Reinforeced Concrete	m3	35	486.7	17,035
	Plain Concrete	m3	13	271.2	3,526
	Sand bed	m3	11	21.7	239
	subtotal				24,950
8	On-farm irrigation facilities				
	(drip & Sprinkler facilities)				
	FELCRA area				
	Durian	ha	44	4,300.0	190,404
	MIADP area	ha	25	4,300.0	107,500
	subtotal				297,904
9	Rain shelter				
	FELCRA area	nos.	0	0.0	0
	MIADP area	nos.	0	0.0	0
	subtotal				0
	SUBTOTAL				3,688,767
	Land acquisition cost	ha	0		0
7	Physical Contingency (15 % of Subtotal)				553,315
8	Engineering Cost (10 % of Subtotal)				368,877
9	Administration cost (5 % of Subtotal)				184,438
	TOTAL				4,795,397

Fig.3.3.1 Reservoir Storage Volume Curve

MENTANGOR DAM (MA.16)

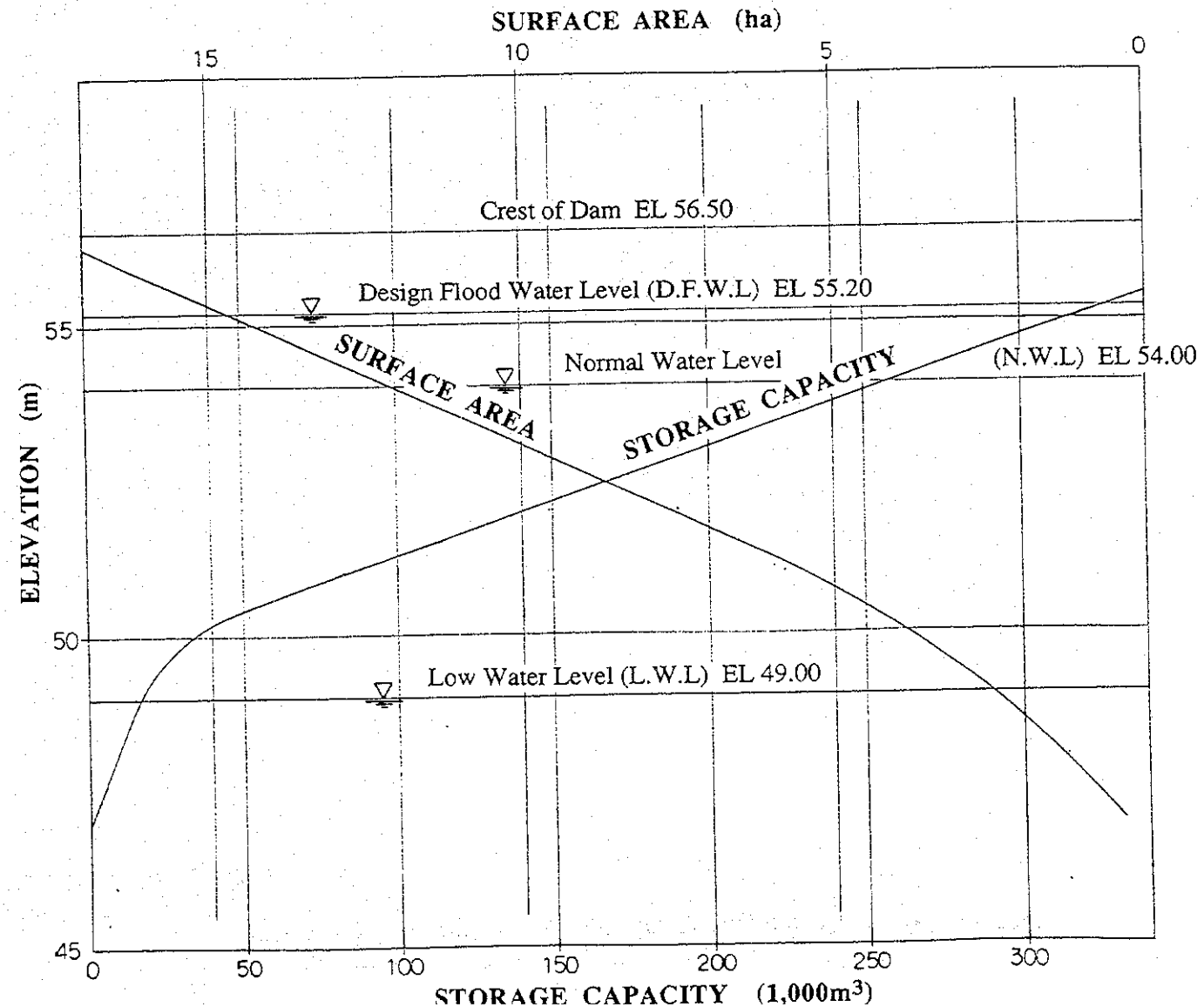


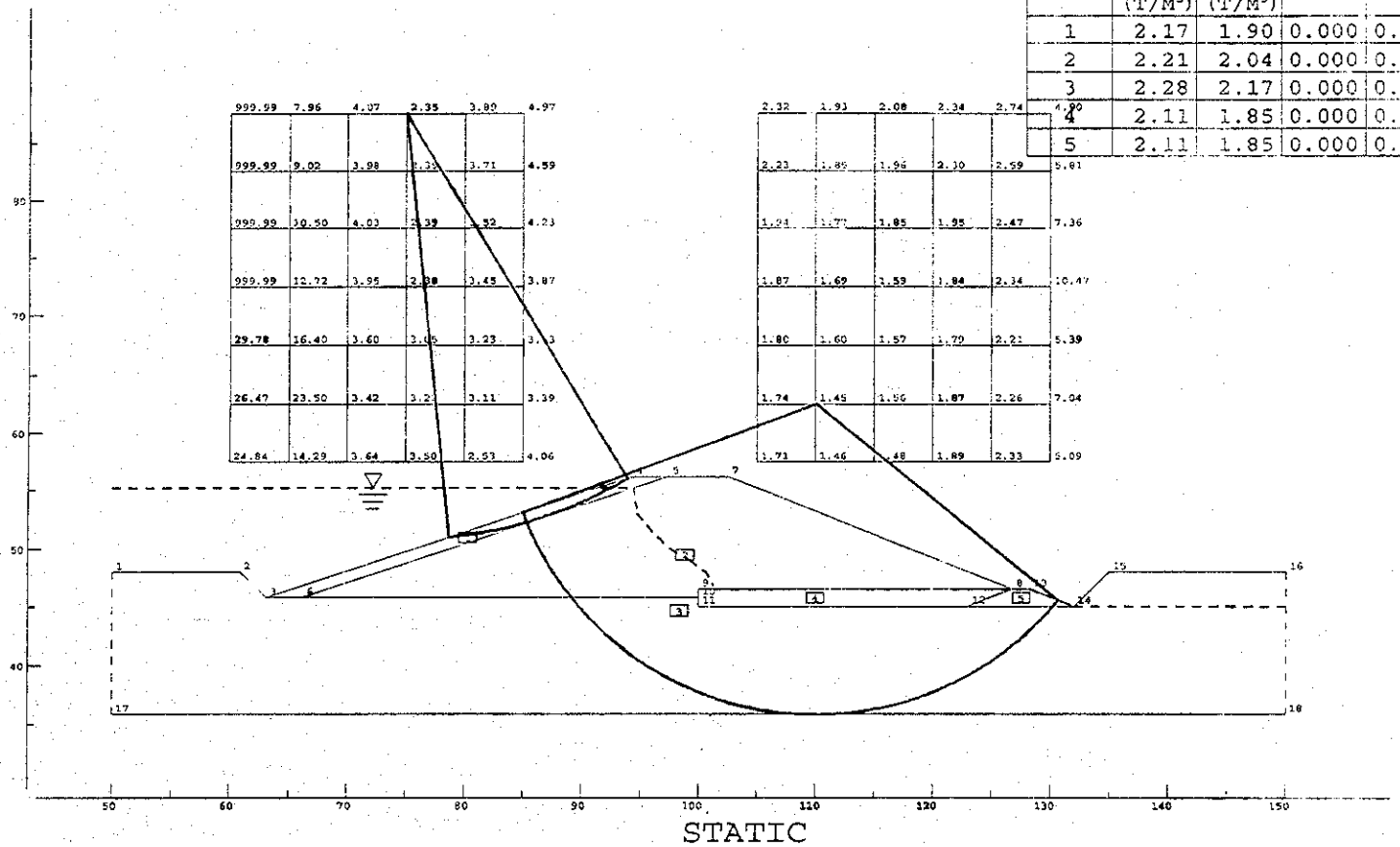
Fig. 3.3.2 Stability Analysis of Mentangor Dam (Full Storage)

MENTANGOR DAM (FULL)

SCALE 1 / 600

$F_{S\,MIN}$	=	1.45
X	=	110.00 (M)
Y	=	62.50 (M)
R	=	26.70 (M)
M_R	=	7921.26 (T*M)
Mo	=	5443.93 (T*M)

LAYER	W_S (T/M^3)	W_W (T/M^3)	K_H	Kv	C (T/M^2)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.21	2.04	0.000	0.000	1.0	33.0
3	2.28	2.17	0.000	0.000	6.0	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.000	0.0	35.0



STATIC

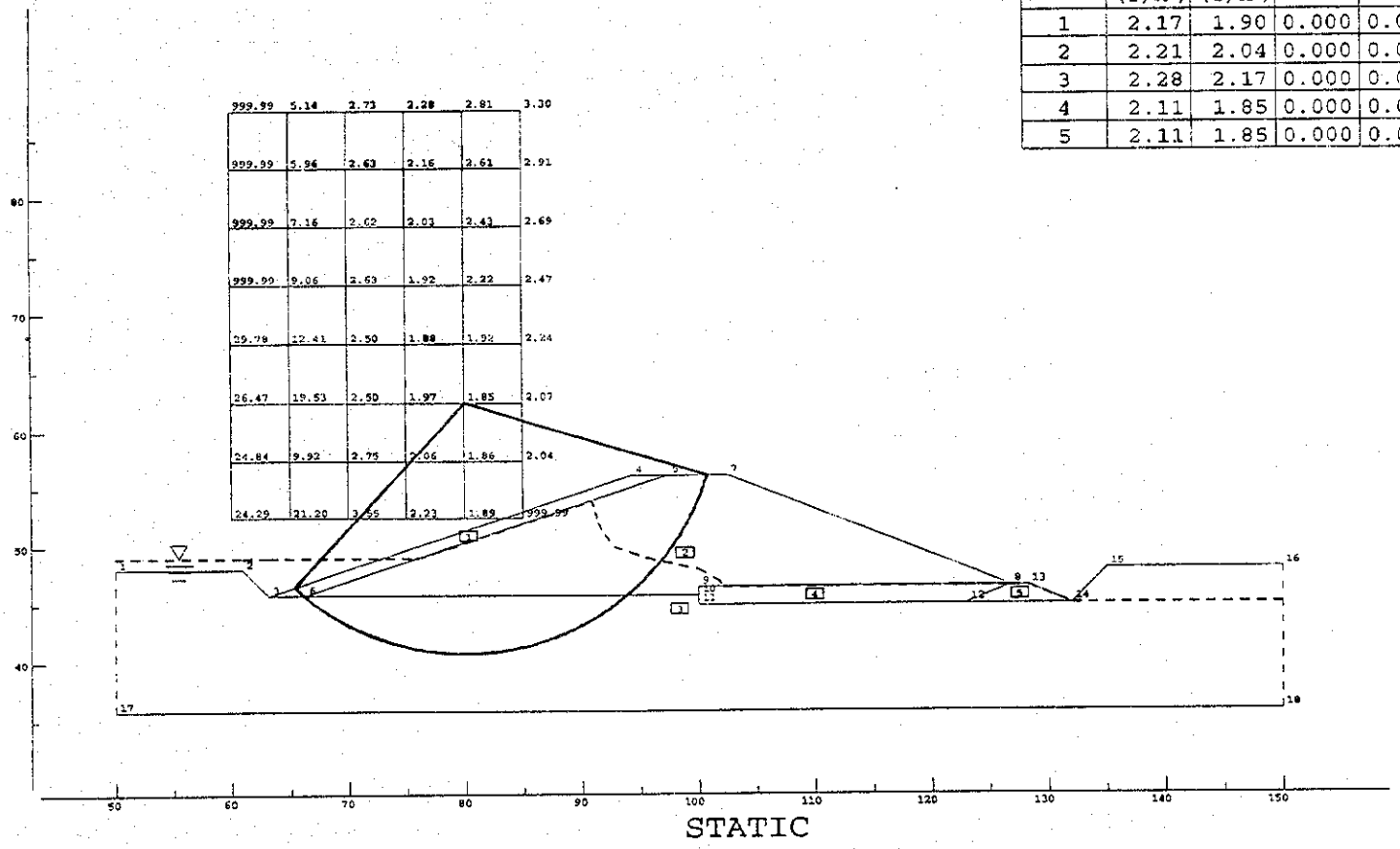
Fig. 3.3.3 Stability Analysis of Mentangor Dam (Draw Down)

MENTANGOR DAM (DRAW DOWN)

SCALE 1 / 600

Fs MIN	=	1.85
X	=	80.00 (M)
Y	=	62.50 (M)
R	=	21.70 (M)
MR	=	4969.23 (T*M)
Mo	=	2675.80 (T*M)

LAYER	Ws (T/M³)	Ww (T/M³)	KH	Kv	C (T/M²)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.21	2.04	0.000	0.000	1.0	33.0
3	2.28	2.17	0.000	0.000	6.0	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.000	0.0	35.0



STATIC

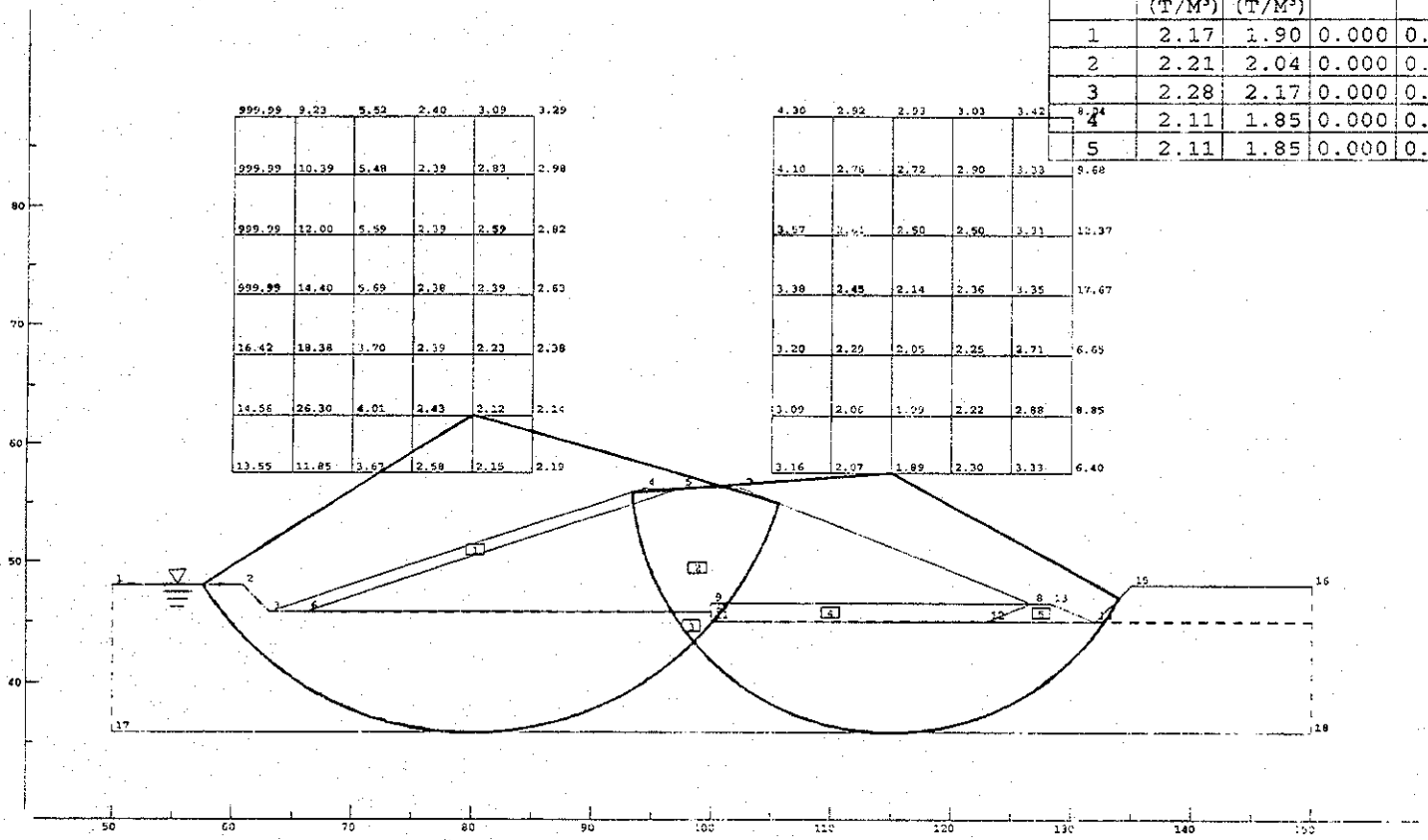
Fig. 3.3.4 Stability Analysis of Mentangor Dam (No Storage)

MENTANGOR DAM (EMPTY)

SCALE 1 / 600

Fs MIN	=	1.89
X	=	115.00 (M)
Y	=	57.50 (M)
R	=	21.70 (M)
MR	=	7194.31 (T*M)
Mo	=	3803.28 (T*M)

LAYER	Ws (T/M³)	Ww (T/M³)	KH	Kv	C (T/M²)	ANGLE (DEG)
1	2.17	1.90	0.000	0.000	0.0	38.4
2	2.21	2.04	0.000	0.000	5.4	28.0
3	2.28	2.17	0.000	0.000	6.0	0.0
4	2.11	1.85	0.000	0.000	0.0	35.0
5	2.11	1.85	0.000	0.000	0.0	35.0



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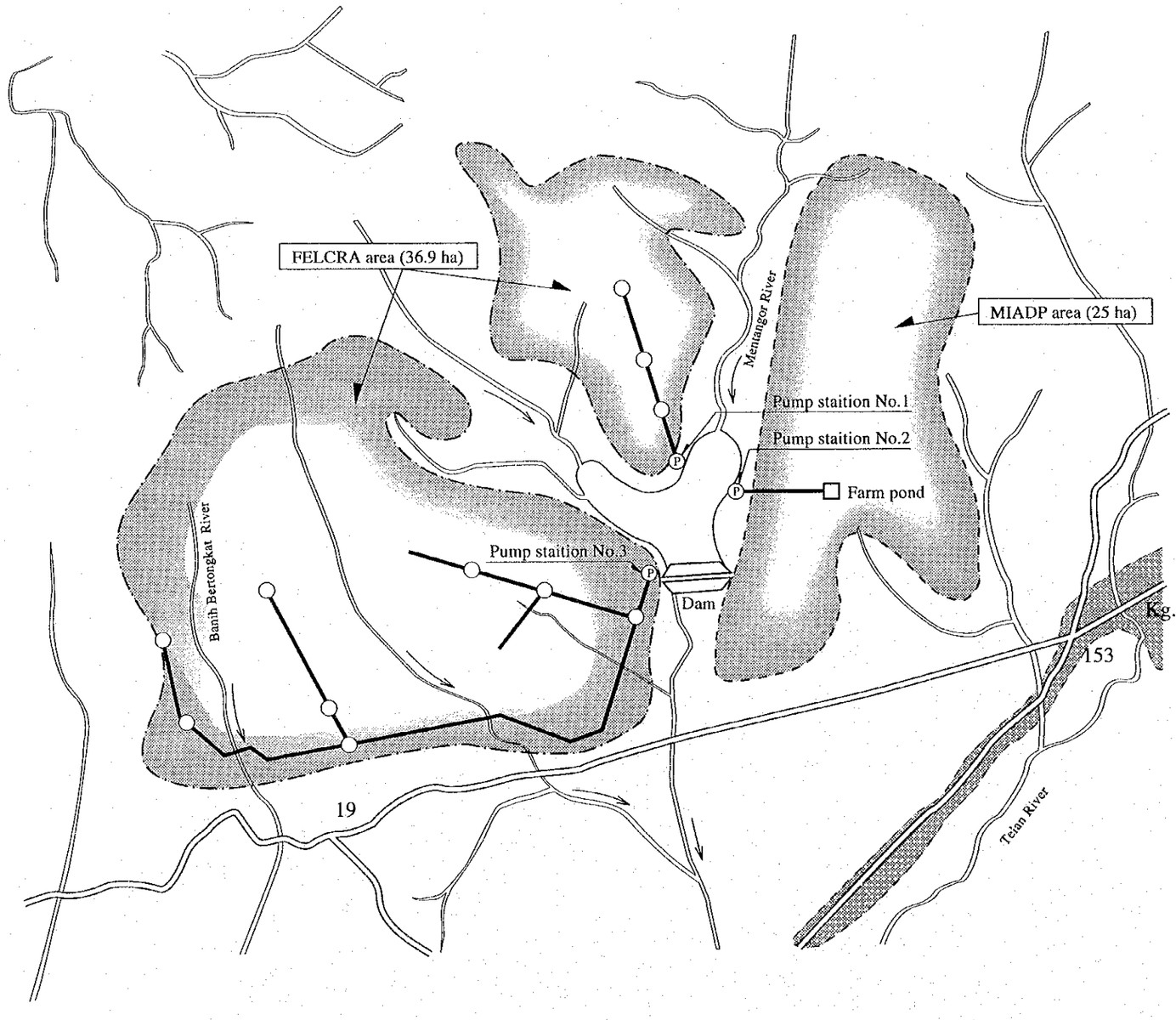
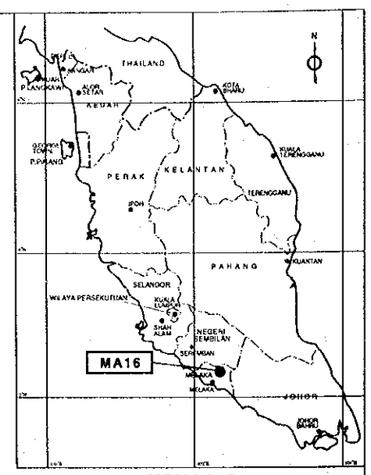




KEY MAP

N

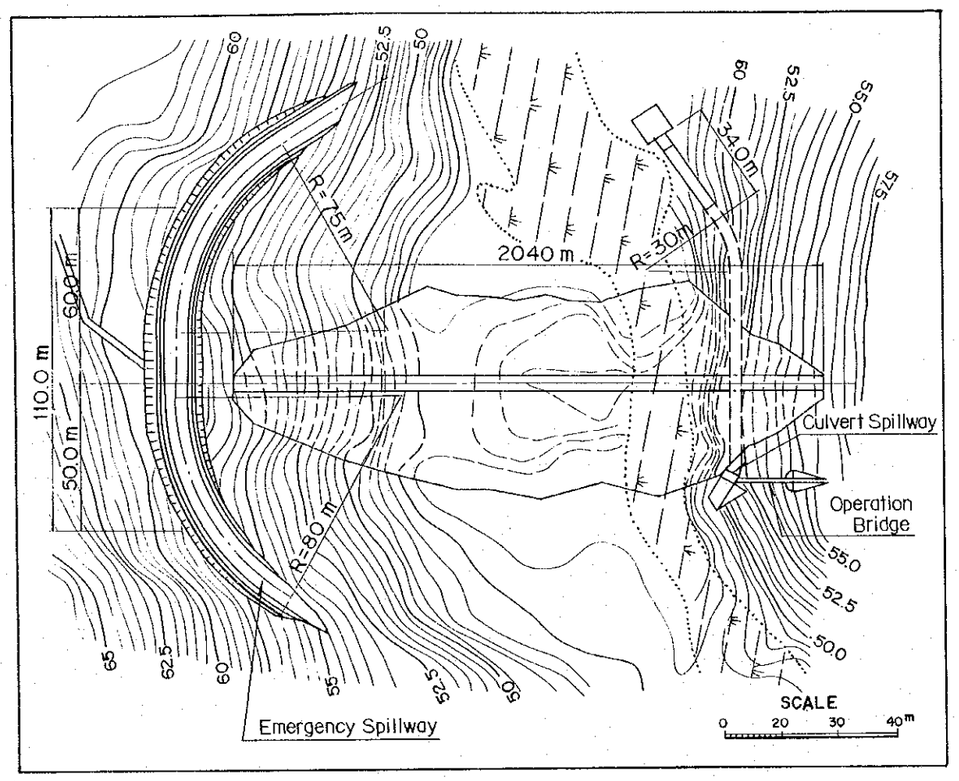
LEGEND

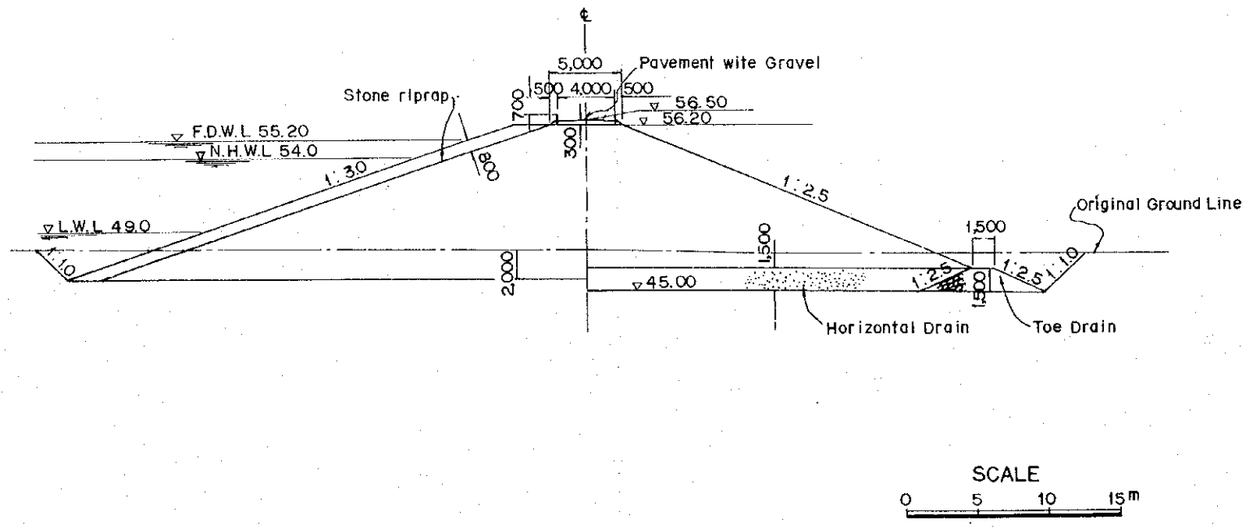
Ⓟ	Pump staition
▬▬	Pipe line
□	Farm pond
○	Valves for pipe lines
⬭	Village area
—·—·—	Boundary of Irrigation area (FELCRA)
- - - -	Boundary of Irrigation area (MIADP)

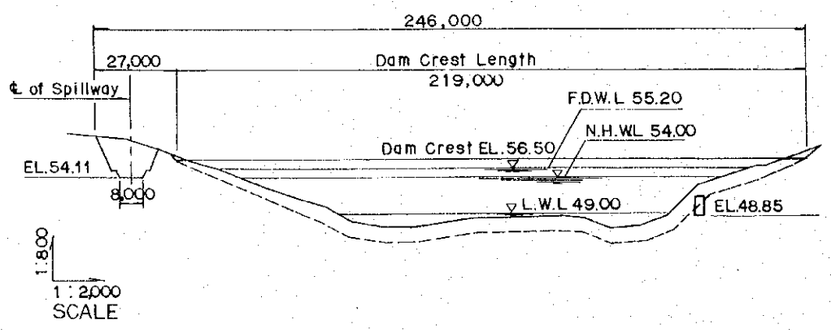
SCALE

0 500m 1km

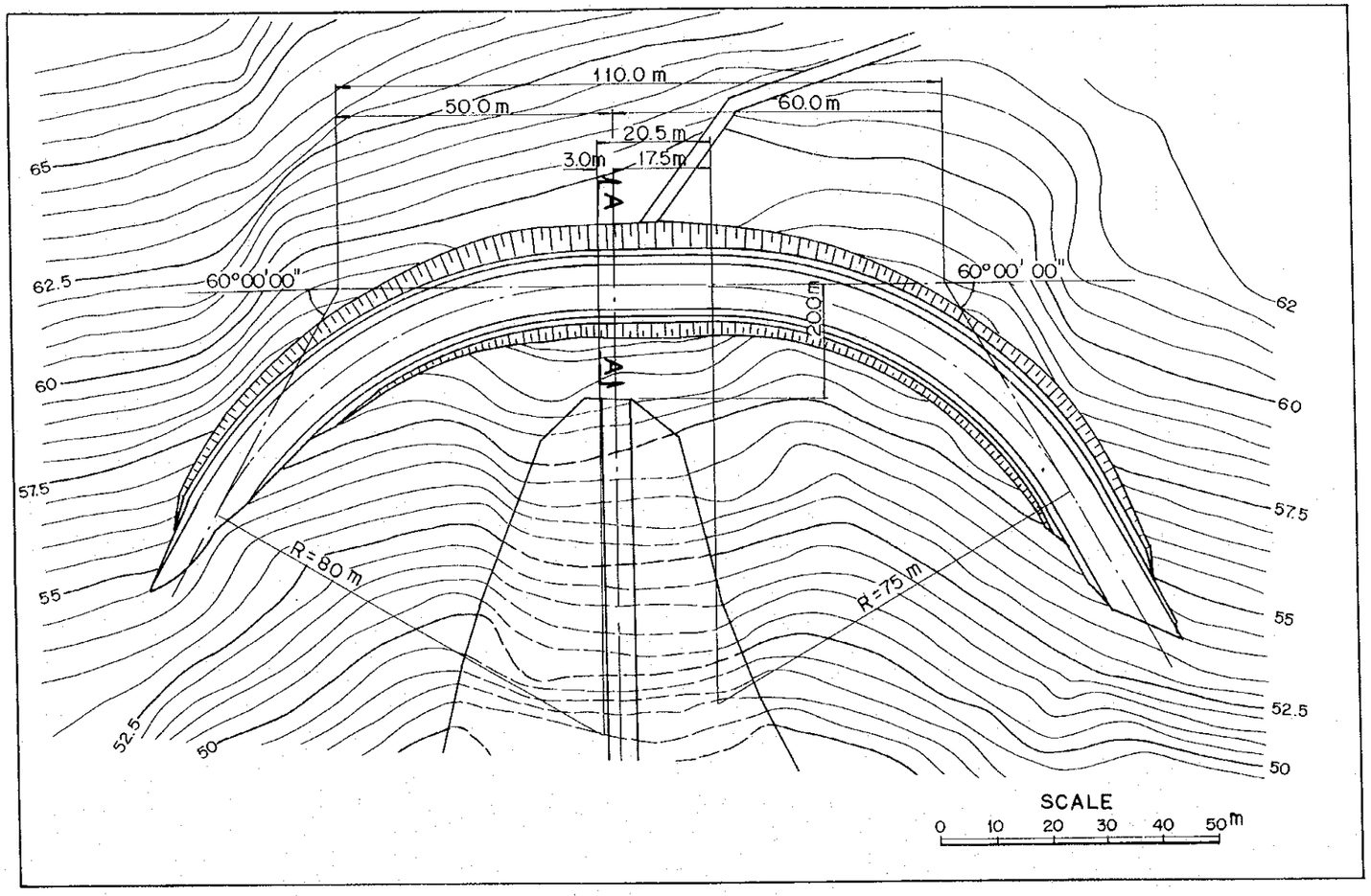
DWG3001 General Layout of Bukit Sadanan Project

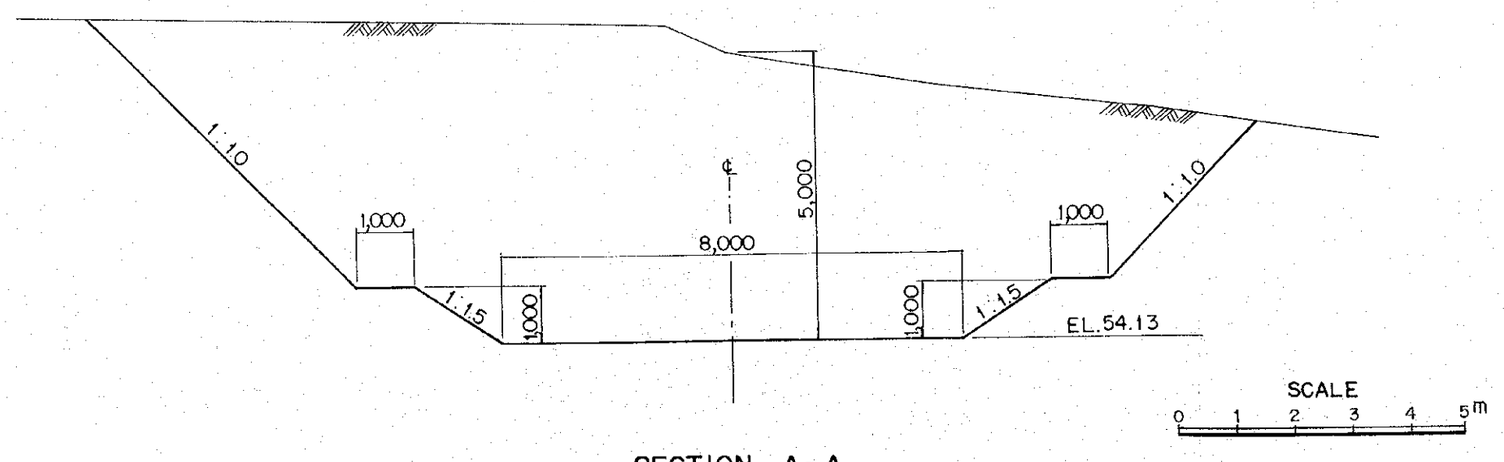






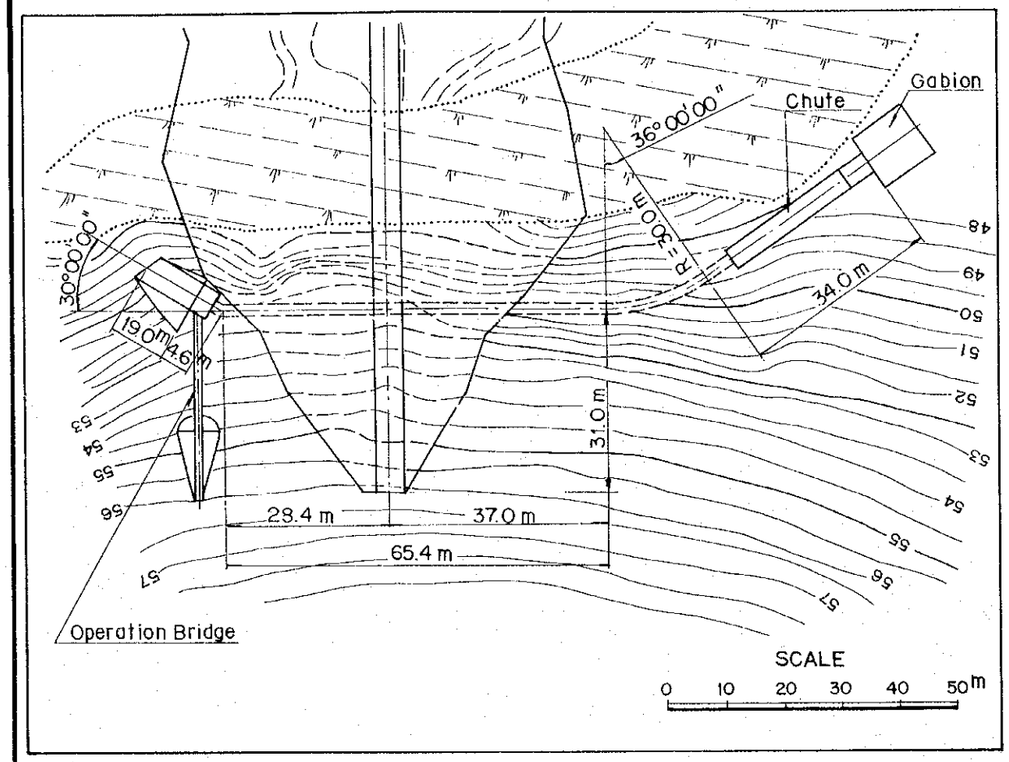
DWG3002 General Plan & Typical Section of Mentangor Dam
Bukit Sedanan Project (MA.16)

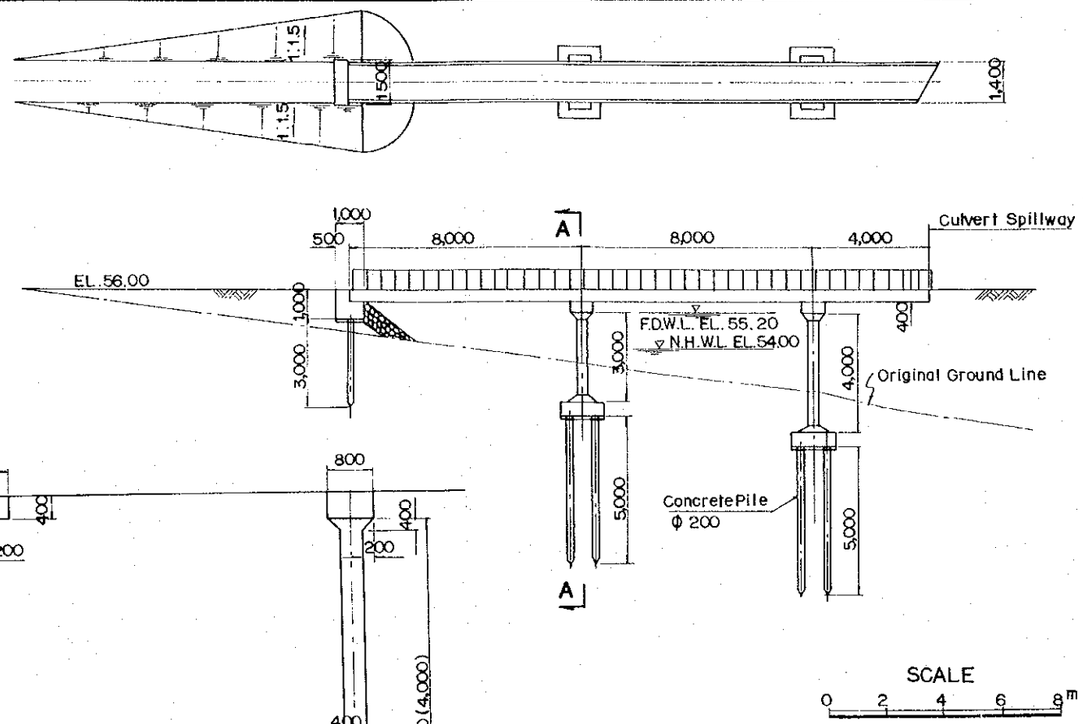


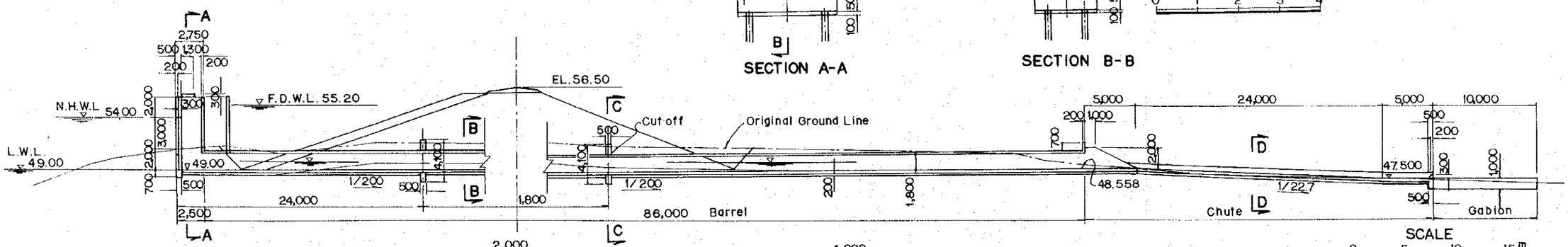


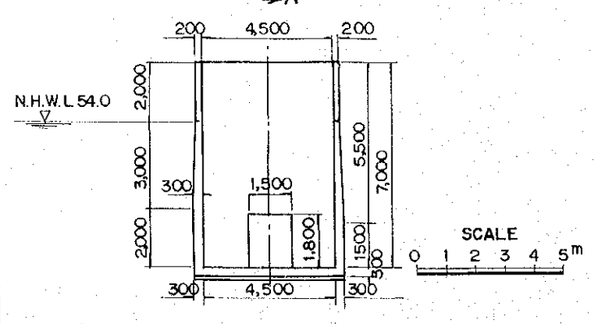
SECTION A-A

DWG3003 Plan & Typical Cross Section of Emergency Spillway
Bukit Sedanan Project (MA.16)

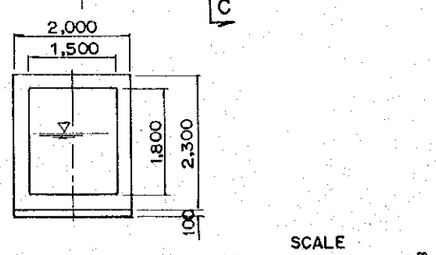




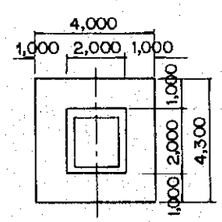




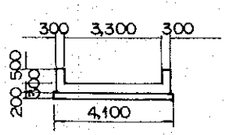
SECTION A-A



SECTION B-B



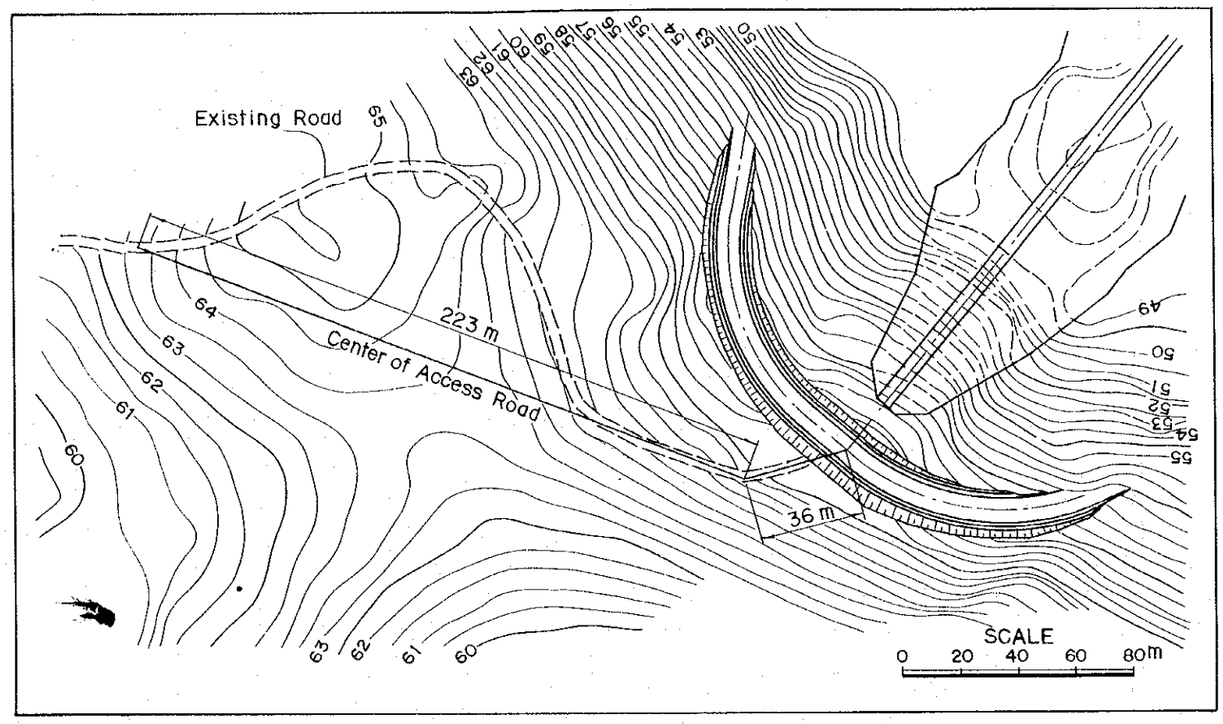
CUT OFF
(SECTION C-C)

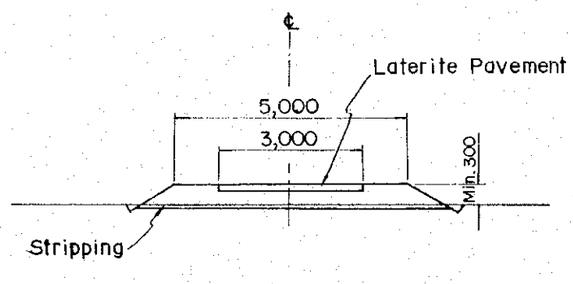


SECTION D-D

SCALE
0 1 2 3 4 5 m

DWG.3004 General Plan & Sections of Culvert Spillway
Bukit Sedanan Project (MA 16)

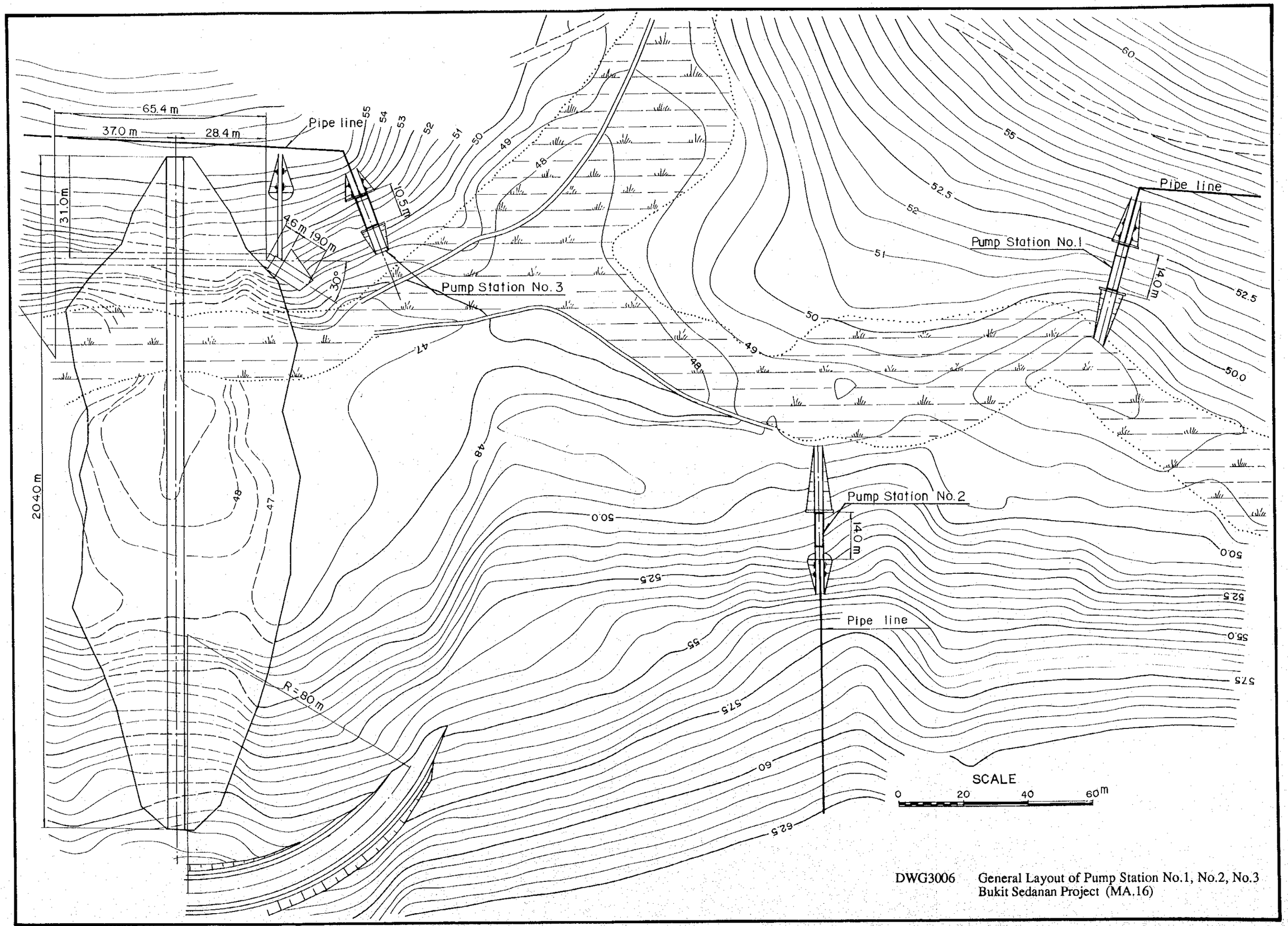




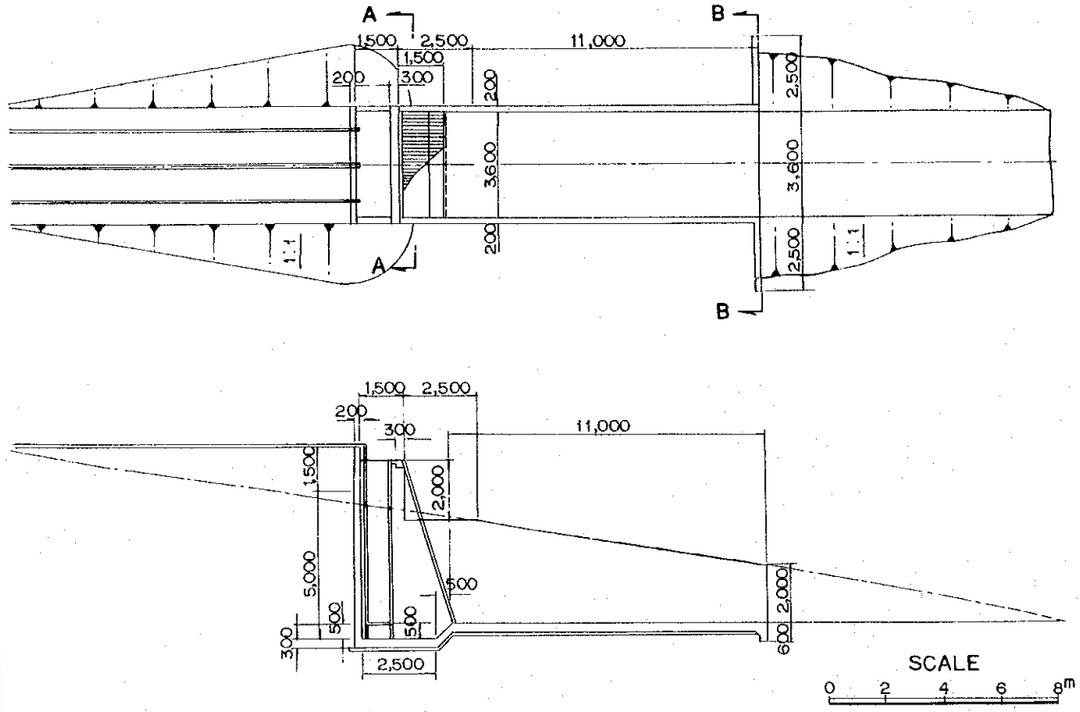
TYPICAL CROSS SECTION

SCALE
0 1 2 3 4 5m

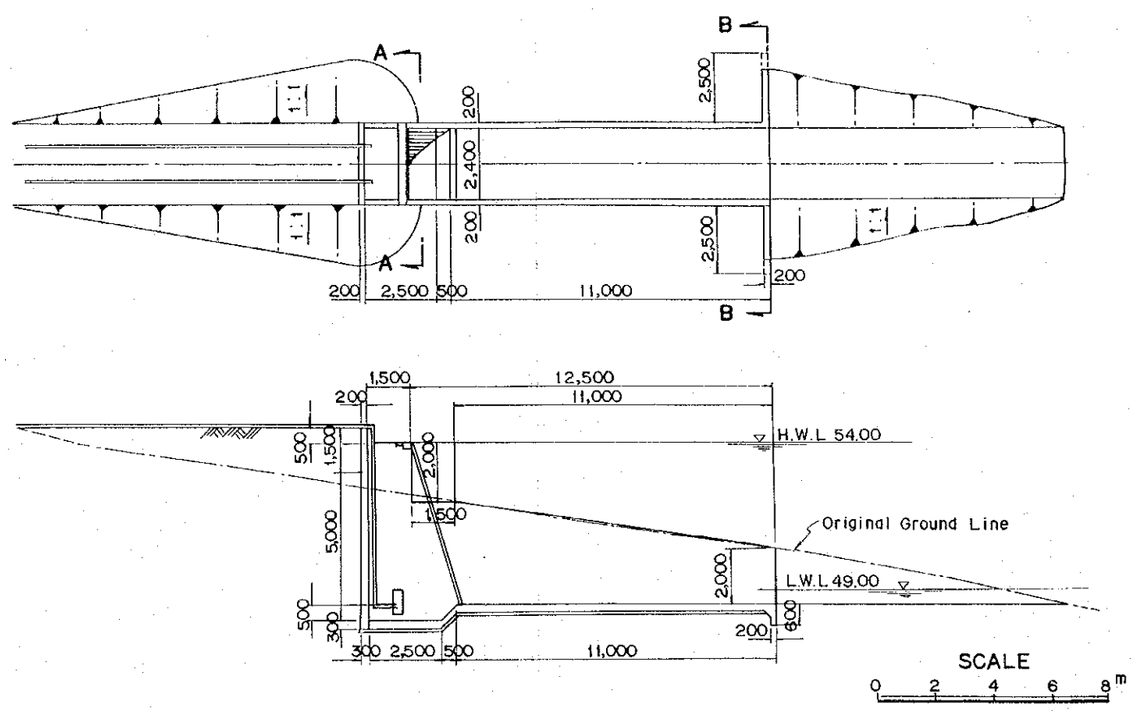
DWG3005 General Layout & Section of Access Road
Bukit Sedanan Project (MA.16)



DWG3006 General Layout of Pump Station No.1, No.2, No.3
Bukit Sedanan Project (MA.16)



PUMP STATION NO.1



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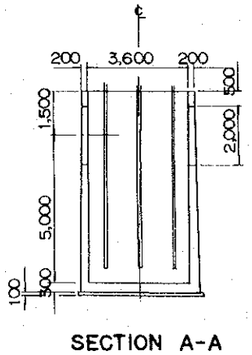
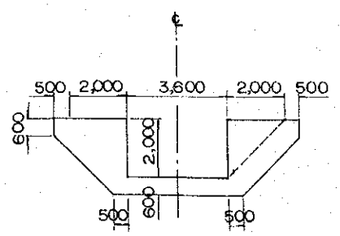
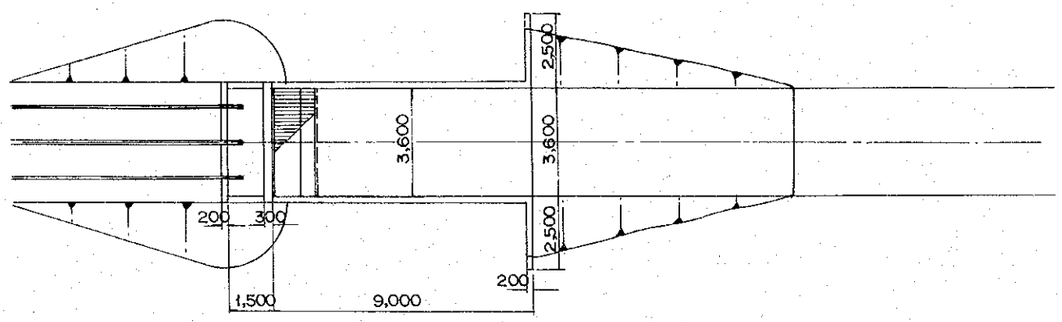
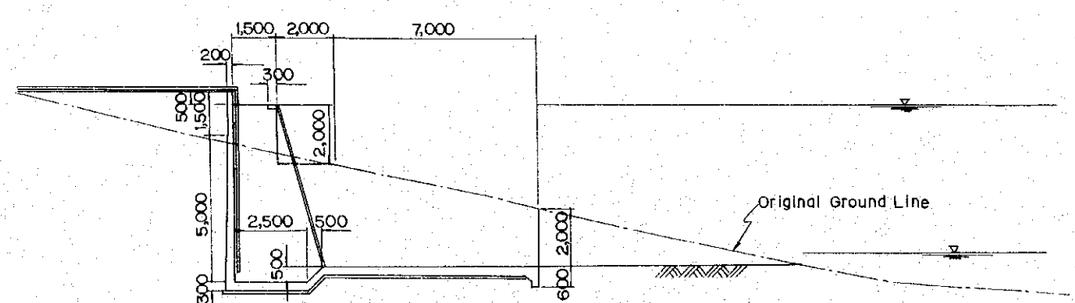


SECTION A-A

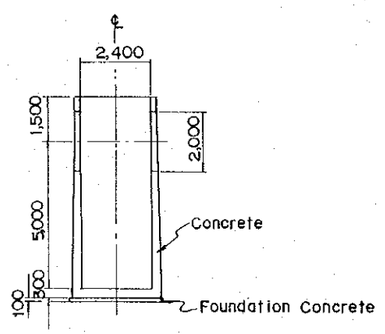


SECTION B-B

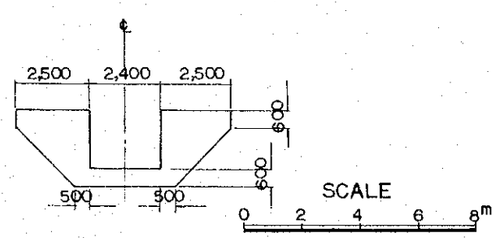




PUMP STATION NO. 3



SECTION A-A



SECTION B-B

DWG3007 Plan & Sections of Pump Station
Bukit Sedanan Project (MA.16)