VI. CONCLUSIONS AND RECOMMENDATIONS

(1) There are five types of small reservoirs; the most common types are the low dam constructed on a small river (Type A) and the pond excavated in a depression or abandoned paddy fields (Type B).

Small reservoirs are used not only for irrigation but also for aquaculture, agro-tourism, and domestic and industrial water supply.

Small reservoirs are characterized by low construction cost, simple design, quick yielding of benefits, easy operation and maintenance, and cause minor environmental problems.

(2) The current feasibility study on five small reservoir pilot projects has reached a conclusion that all the projects are economically feasible in terms of their economic internal rate of return. (See Table 6.1)

Two projects in Langkawi have rather low EIRRs, because their main crop is paddy. The Kedawang area has been designated as a paddy area by the Langkawi Structure Plan.
The two projects in Perlis have extremely high EIRRs, which are attributable to the high return of tobacco cultivation and the sunk cost of the link canal from the Timah Tasoh dam.

(3) All the five pilot projects would require more labour input as the production is expanded. The labour shortage is one of the constraints for the economic development of Malaysia. If the pilot projects should experience insufficient family labour, the labour shortage would be alleviated by group farming and/or hired labour.

(4) According to the preliminary environmental assessment, it was found that all the five pilot projects were within the environmental dimensions prescribed by the Environmental Quality Act 1974 and therefore no environmental impact assessment (EIA) was necessary. Most of small reservoir projects would require no EIA in this regard.

A water quality survey revealed that there will be no water quality problem related to the five pilot projects.

(5) In conclusion, all the five pilot projects are feasible from technical, economic and environmental points of view.

It is recommended that the Government would consider to implement the pilot projects during the Seventh Malaysia Plan (7MP) period.

(6) The small reservoir development project would generally be very feasible and viable as the present feasibility studies have clarified.

The small reservoir development project would be useful to achieve the production targets of the National Agricultural Policy (1992-2010) particularly for the production of high value commodities such as vegetables, fruit, flowers, and fish.

It is recommended that the Government would substantially start the small reservoir development project in parallel with the implementation of the pilot projects taking into account the limited time period up to the year 2010.

(7) It is recommended that the Government would establish a project implementation system for the small reservoir development covering all phases of project implementation, including the identification, planning, design, construction, and operation and maintenance.

It is recommended that first of all the Government would take action to disseminate the basic concepts of small reservoir development to the private sector concerned, including the farmers' organizations, through government agencies at the Federal and State levels.

It is recommended that the Government would establish an inter-departmental coordinating committee for the small reservoir development.

(8) Based on the experience in this study, guidelines for the small reservoir development with regards identification, planning, design, and O/M have been prepared. It is recommended that the Government would apply the guidelines for the implementation of small reservoir development projects.

These guidelines are a product of the present feasibility study which dealt with only identification and planning of five pilot projects and was carried out in a short time period (20 months). Therefore, it is recommended that the Government would improve and amend the guidelines in the future when more experience is accumulated not only in identification and planning but also in designing and O/M.

(9) It is recommended that the Government would keep a register of all small reservoirs owned by government agencies and the private sector, carry out periodic inspection, and advise owners on dam safety, water resources management, and environmental preservation.

It is also recommended that the Government would monitor small reservoir projects during the O/M stage, in order to confirm that project benefits are realized as envisaged in the plan.

Tables

Table 2.1.1 CONTRIBUTION OF THE MAIN SECTORS TO GDP AND SHARE OF EMPLOYMENT

	1970 (actual)	1990 (actual)	2000 (target)
1. Share to GDP	(%)	(%)	(%)
Agriculture and Forestr	29.0	18.7	13.4
Mining	13.7	9.7	5.7
Manufacturing	13.9	27.0	37.2
Construction	3.8	3.5	3.5
Services	36.2	42.3	45.4
2. Share to Employment			
Agriculture and Forestr	53.5	27.8	20.0
Mining	2.6	0.6	0.5
Manufacturing	8.7	19.5	23.9
Construction	2.7	6.4	7.4
Services	32.5	45.7	48.2

Source : The Second Outline Perspective Plan 1990 - 2000

Table 2.1.2 GDP GROWTH RATE

	Achieved OPP1	Target OPP2
	(%)	(%)
Agriculture & Forestry	4.4	3.5
Mining	4.9	1.5
Manufacturing	10.3	10.5
Construction	6.4	7.0
Services	7.3	7.4
Total	6.7	7.0

Source : The Second Outline Perspective Plan 1990 - 2000

Table 2.2.1 LAND USE IN MALAYSIA, 1990

Land Use			Area ('ooo ha)	Ratio (%)
Land Suitable for Agriculture				
	Peninsular Malaysia	Total	6,320	19.3
		Cultivated	4,025	12.3
		Balance	2,295	7.0
	Sabah	Total	2,148	6.5
		Cultivated	860	2.6
		Balance	1,288	3.9
	Sarawak	Total	1,700	5.2
		Cultivated	557	1.7
		Balance	1,144	3.5
	Sub-total		10,168	31.0
Forest Area:				
	Permanent Area		12,700	38.7
	National Park		1,500	4.6
	State Forest Land		6,100	18.6
	Sub-total		20,300	61.9
Settlement Area			1,200	3.7
Others			1,132	3.5
Total Malaysia			32,800	100.0

Table 2.2.2 AGRICULTURAL LAND USE unit : ha

Crop	1985	1990	1995	Average annual growth rate (%) 5MP Target	5MP Achieved	6MP Target
Rubber	1,956,000	1,833,000	1,750,000	-0.5	-1.5	-0.7
Oil Palm	1,482,000	1,984,000	2,166,000	3.7	6.0	1.8
Cocoa	304,000	420,000	452,000	5.9	6.7	1.5
Paddy	656,000	650,000	646,000	n.a.	0.4	-0.6
Coconut	334,000	331,000	328,000	n.a.	-0.2	-0,2
Pepper	5,000	9,000	10,000	n.a.	12.4	1.3
Pineapple	10,000	9,000	12,000	n.a.	-2.1	5.9
Vegetables	15,000	15,000	19,000	n.a.	0.2	5.7
Fruits	119,000	162,000	246,000	n.a.	6.4	8.7
Tobacco	16,000	10,000	13,000	n.a.	-8.9	5.0
Others	69,000	65,000	74,000	n.a.	-1.2	2.7

Source : Sixth Malaysia Plan 1991-1995

Table 2.2.3 PRODUCTION OF AGRICULTURAL COMMODITIES unit : 'ooo tonnes

Crop	1985	1990	1995	Average annual growth rate (%) 5MP Target	5MP Achieved	6MP Target
Rubber	1,470	1,292	1,300	0.8	-2.6	0.1
Crude palm oil	4,133	6,095	7,600	6.7	8.1	4.5
Cocoa	108	255	339	11.5	19.4	5.3
Paddy	1,953	1,590	1,671	n.a.	-4.0	1.0
Coconut*	1,826	1,557	1,572	-	-3.1	0.2
Pepper	19	29	36	5.6	8.7	4.4
Pineapple	153	173	248	n.a.	2.6	7.5
Vegetables**	184	224	256	-	4.0	2.8
Fruits**	852	1,165	1,584	-	6.4	6.3
Tobacco	9	10	13	-	1.6	5.0
Fisheries						
Marine	575	830	984	n.a.	7.6	3.5
Aquaculture	51	75	113	n.a.	7.9	8.4
Livestock						
Beef	17	18	21	n.a.	1.9	3.2
Mutton	1	1	1	n.a.	1.9	7.8
Poultry	251	368	560	n.a.	7.9	8.8
Eggs*	3,395	4,718	5,645	n.a.	6.8	3.7
Pork	164	211	287	n.a.	5.1	6.3
Milk***	24	34	68	n.a.	7.4	14.8

Source : Sixth Malaysia Plan

* : in million units; ** : refers to Peninsular Malaysia; *** : in million liyres

Table 2.2.4 AGRICULTURE VALUE-ADDED (RM MILLION)
in constant 1978 prices

					Growth Rate (%)				
	1990	1995	2000	2010	1991-1995	1996-2000	1991-2000	2001-2010	1991-2010
Oil Palm	5,246	6,563	7,340	9,074	4.5	2.3	3.4	2.1	2.8
Fish	1,480	2,002	2,485	4,335	6.2	4.4	5.3	5.7	5.5
Rubber	2,001	2,123	2,371	2,632	1.2	2.2	1.7	1.1	1.4
Livestock	744	984	1,220	2,386	5.7	4.4	5.1	6.9	6.0
Vegetables	380	715	927	1,838	13.5	5.3	9.3	7.1	8.2
Cocoa	1,191	1,326	1,446	1,688	2.2	1.8	2.0	1.6	1.8
Sawlogs	2,521	1,783	1,352	1,107	-6.7	-5.4	-6.0	-2.0	-4.0
Rice	607	597	588	641	-0.3	-0.3	-0.3	0.9	0.3
Fruits	181	251	325	618	6.7	5.3	6.0	6.6	6.3
Pepper	89	110	143	169	4.4	5.2	4.8	1.7	3.2
Others	370	1,120	2,658	2,800	24.8	18.9	21.8	0.5	10.6
Total	14,828	17,575	20,855	27,288	3.5	3.5	3.5	2.7	3.1

Source : NAP 1992-2010 (based on MOA's calculation on 1991)

Table 2.2.5 PER CAPITA FOOD CONSUMPTION 1990-2010 (kg/year/person)

Food Items	1990	1995	2000	2010	Growth Rate (%)				
					1991-199	1996-200	1991-200	2001-201	1991-201
Rice	87	80	75	65	-1.66	-1.28	-1.47	-1.42	-1.45
Vegetables	43	50	53	77	3.06	1.17	2.11	3.81	2.96
Eggs (numbers)	246	293	314	482	3.56	1.39	2.47	4.38	3.42
Meat : Beef	3	3.71	4.03	6.78	4.34	1.67	3.00	5.34	4.16
Mutton	0.3	0.37	0.4	0.68	4.28	1.57	2.92	5.45	4.18
Poultry	22	28	30	51	4.94	1.39	3.15	5.45	4.29
Pork	24	25	25	26	0.82	0	0.41	0.39	0.40
Fruits	40	47	49	72	3.28	0.84	2.05	3.92	2.98
Milk (litres)	34	40	43	65	3.30	1.46	2.38	4.22	3.29

Table 2.2.6 PRODUCTION AND SELF-SUFFICIENCY LEVELS OF SELECTED COMMODITIES (ton)

Food Items	1990		1995		2000		2010		Growth Rate of Output (%)				
	SSL %	Output	SSL %	Output	SSL %	Output	SSL %	Output	1991-199	1996-200	1991-200	2001-201	1991-201
Rice	73	1,138,000	62	1,120,000	65	1,102,000	65	1,200,000	-0.32	-0.32	-0.32	0.86	0.27
Vegetables	73	566,469	105	1,066,420	115	1,382,697	125	2,739,179	13.49	5.33	9.33	7.08	8.20
Eggs (numbers	109	4,829,000	115	6,834,674	120	8,518,327	125	17,083,841	7.19	4.50	5.84	7.21	6.52
Meat : Beef	30	15,000	28	21,375	30	27,750	14	27,750	7.34	5.36	6.35	0	3.12
Mutton	10	550	30	2,250	43	3,950	21	3,950	32.54	11.91	21.79	0	10.36
Poultry	115	464,182	124	700,000	139	950,000	139	2,000,000	8.56	6.30	7.42	7.73	7.58
Pork	117	168,285	76	126,214	45	84,143	2	5,000	-5.59	-7.79	-6.70	-24.00	-16.12
Fruits	99	716,366	105	992,019	115	1,286,230	120	2,446,151	6.73	5.33	6.03	6.64	6.33
Milk (litres)	4.3	26,024	5	40,763	5	48,349	10	183,533	9.39	3.47	6.39	14.27	10.26

Source : NAP 1992-2010 (based on MOA's calculation in 1991)

Table 2.2.7 AREA UNDER VEGETABLES 1986-1990 (Crop hectares equivalent)

		1986	1987	1988	1989	1990
Peninsular Malaysia						
	Leafy vegetable	4,586	5,632	6,556	8,688	8,781
	Fruit vegetable	7,039	6,282	9,498	14,533	17,100
	Root vegetables	347	221	418	592	792
	Spice vegetable	2,248	1,927	2,664	4,733	4,221
	Other vegetable	142	138	148	121	49
	Sub-total	14,362	14,200	19,284	28,667	30,943
Sabah		2,445	2,506	2,792	3,350	n.a.
Total		16,807	16,706	22,076	32,017	30,943

Source : Ministry of Agriculture Note : No figures are available for Sarawak.

Table 2.2.8 PRODUCTION OF VEGETABLES 1986-1990 (tonnes)

		1986	1987	1988	1989	1990
Peninsular Malaysia						
	Leafy vegetable	70,642	92,500	109,403	140,087	148,162
	Fruit vegetable	134,335	119,253	181,490	279,077	327,933
	Root vegetables	9,335	6,320	11,750	16,727	22,230
	Spice vegetable	38,759	32,730	42,547	79,122	71,140
	Other vegetable	1,420	1,380	1,480	1,205	490
	Sub-total	254,491	252,183	346,670	516,218	569,955
Sabah		36,675	37,590	41,880	50,025	n.a.
Total		291,166	289,773	388,550	566,243	569,955

Source : Ministry of Agriculture Note : No figures are available for Sarawak.

Table 2.2.9 VALUE OF VEGETABLES PRODUCED 1985-1989 (RM million)

	1985	1986	1987	1988	1989
Peninsular Malaysia					
Leafy Vegetables	60.5	48.6	62.5	74.7	95.1
Fruit Vegetables	58.1	72.1	77	121.5	184.3
Root Vegetables	3.2	1.5	1.3	2.6	4.5
Spice Vegetables	73.2	64.1	61.7	92.2	156.2
Other Vegetables-		4.1	5.6	11.7	7.7
Sub-total	195	190.4	208.1	302.7	447.8
Sabah	31	27.3	31	37	43.1
Total	226	217.7	239.1	339.7	490.9

Source : Ministry of Agriculture Note : No figures are available for Sarawak.

Table 2.2.10 IMPORT AND EXPORT VOLUME AND VALUE OF VEGETABLES 1985-1989 (tonnes and RM'000)

	1985	1986	1987	1988	1989	1990
Import Volume	233,209	232,908	226,909	281,455	313,016	304,282
Export Volume	92,756	100,216	116,142	119,713	136,196	240,064
Net Import Volume	140,453	132,692	110,767	161,742	176,820	164,218
Import Value	171,074	183,480	174,187	226,343	242,572	247,870
Export Value	28,378	31,479	38,957	58,846	61,963	67,933
Net Import Value	142,696	152,001	135,230	167,497	180,609	179,937

Source : Ministry of Agriculture

Table 2.2.11 ESTIMATED VEGETABLE AREA TO BE DEVELOPED BY SMALL RESERVOIRS

year	(1) Production (tons)	(2) Average yield (t/ha)	(3) Area in crop hectare (ha)	(4) Vegetable Farm area (ha)	(5) Vegetable area in P. Malaysia (ha)	(6) Area to be irrigated (ha)	(7) Area to depend on small reservoirs (ha)
1990	569,955	18.4	30,943	12,377	12,377	11,758	
1995	1,066,420	19.3	55,255	22,102	19,892	18,897	3,570
2000	1,382,697	20.3	68,113	27,245	24,521	23,295	2,199
2010	2,739,179	22.4	122,285	48,914	44,023	41,822	9,264

Note :
(1) value for 1990 is the actual production in P. Malaysia and others are targets of NAP 1992-2010 for the entire country.
(2) value for 1990 is the actual unit yield averaging all kinds of vegetable in P. Malaysia and others are estimated unit yields for respective years which are increased at an annual rate of 1%.
(3) value for 1990 is the actual vegetable area (crop hectares) and others are calculated by (1)/(2).
(4) indicates the area under vegetable cultivation obtained assuming the yearly crop intensity of 250 % and multiplying 0.4 to the crop hectares.
(5) the value for 1990 is the actual area in P. Malaysia and others are obtained by multiplying 0.9 to (4).
(6) obtained by multiplying 0.95 to (5) assuming that leafy vegetables, fruit vegetables and spice vegetables require irrigation.
(7) obtained by assuming that 50 % of incremental irrigation area will depend its water source on small reservoirs and remaining 50 % on other water sources like wells, rivers and irrigation canals.

Table2.2.12 PROJECTED NATIONAL AREA OF FRUIT 1985-2000 (ha)

	1985	1988	1990	1995	2000
P. Malaysia	119,024	147,500	162,085	246,019	262,780
Sabah	8,553	11,400	13,010	19,902	30,457
Sarawak	10,981	14,500	16,800	25,316	38,549
Total	138,558	173,400	191,895	291,237	331,786

Source : Ministry of Agriculture

Table 2.2.13 CHANGES IN AREA UNDER EIGHT MAJOR FRUITS IN P. MALAYSIA

	1985	1989	% change
Durian	31,000	56,700	+82
Jackfruit	1,900	2,400	+26
Papaya	600	2,600	+333
Starfruit	100	900	+800
Watermelon	2,000	4,800	+140
Duku/langsat	5,200	7,700	+48
Mango	8,900	7,900	-11
Rambutan	21,000	24,500	+17

Source : Ministry of Agriculture

Table 2.2.14 CHANGES IN FRUITS AREA BY STATE 1985-1990 (ha)

State	1985	1990	Increase
Perlis	350	1,590	1,240
Kedah	8,981	13,541	4,560
Penang	2,385	4,860	2,475
Perak	11,788	21,830	10,042
Selangor	6,455	10,979	4,524
N. Sembilan	6,595	7,977	1,382
Malacca	2,385	4,046	1,661
Johor	26,786	37,051	10,265
Pahang	12,630	13,382	752
Terengganu	9,402	14,774	5,372
Kelantan	10,665	12,200	1,535
Sabah	13,472	18,337	4,865
Sarawak	26,308	31,334	5,026
Total	138,202	191,901	53,699

Table 2.2.16 EXPORTS OF FRESH FRUITS 1985-1989

year	Quantity (tonnes)	Value (RM million)
1985	116795	70.1
1986	112894	64.4
1987	141728	87
1988	221271	84.5
1989	378756	117.1

Table 2.2.15 PRODUCTION OF THE 15 MOST POPULAR FRUITS IN P. MALAYSIA 1985-1989

Fruit	1985	1989	% change
Durian	204,532	299,346	+46
Rambutan	61,867	59,345	-4
Mango	30,928	25,147	-19
Cempedak	49,402	80,863	+64
Jackfruit	15,946	22,504	+41
Citrus	3,157	9,558	+203
Duku/langsat	48,087	71,636	+49
Ciku	16,298	15,900	-2
Starfruit	387	7,953	+1956
Mangosteen	23,794	32,891	+38
Papaya	3,812	12,423	+226
Pineapple	157,240	129,144	-18
Banana	191,846	200,148	+4
Watermelon	45,221	81,766	+81
Guava	0	54,111	
Total	852,517	1,102,735	+29

Source : Ministry of Agriculture

Table 2.2.17 ORCHARD AREA TO BE DEVELOPED BY SMALL RESERVOIR IN PENINSULAR MALAYSIA

Year	(1) Target Production (ton)	(2) National Area (ha)	(3) Area in P. Malaysia (ha)	(4) Increase in Area (ha)	(5) Area to beDeveloped by Small Reservoir (ha)
1990	716,336	191,895	162,085	-	
1995	992,019	291,237	246,019	83,934	41,967
2000	1,286,230	331,786	262,780	16,761	8,381
2010	2,446,151	*630,451	*499,317	236,537	118,269

Note : (1) Production of fruits targeted by NPA 1992-2010.
(2) data of MOA
(3) ditto
(4) increase in area from the preceding target year.
(5) 50% of the increased area is deemed to be developed by small reservoirs.
* estimated by Study Team

Table 2.2.18 AREA AND PRODUCTION OF PADDY AND RICE 1975-92

	Area ('000 ha)		Production ('000 tons)	
year	Planted	Harvested	Padi	Rice
1975	766.0	750.4	1,996	1,288
1980	716.9	697.5	2,045	1,318
1985	656.4	649.3	1,953	1,258
1986	711.0	703.0	1,745	1,149
1987	704.0	684.2	1,697	1,096
1988	665.8	647.1	1,783	1,152
1989	646.2	628.0	1,714	1,104
1990	650.4	632.1	1,725	1,114
1991p	661.2	642.6	1,847	1,201
1992e	666.9	648.2	1,867	1,214

Source : Ministry of Agriculture p = provisional, e = estimate

Table 2.2.19 YIELD OF PADI

	(kg/ha)	
year	Main season	Off season
1980	3,038	3,260
1985	3,392	3,291
1986	3,425	3,293
1987	3,472	2,734
1988	3,330	2,933
1989	3,286	3,264
1990	3,293	3,204
1991p	3,500	2,830
1992e	3,230	n.a.

Table 2.2.20 IMPORTS OF RICE

(tons)	(tons)
year	imports
1980	167,592
1985	428,412
1986	199,593
1987	193,784
1988	283,880
1989	367,471
1990	329,711
1991p	430,448
1992e	462,000

Table 2.3.1 MEAN MONTHLY RAINFALL BY RIVER BASIN

unit : mm

Basin	Period	Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	1983-1992	19	47	111	138	177	129	180	182	257	247	169	76	1733
2	1983-1992	12	51	102	212	288	225	359	316	459	409	218	35	2686
3a	1983-1992	18	35	102	172	221	138	270	294	327	258	168	64	2066
3b	1983-1992	18	39	105	162	207	135	243	260	306	255	169	67	1966
3c	1983-1992	18	53	121	187	237	141	263	289	332	289	202	73	2203
3d	1983-1992	18	52	121	186	236	141	263	289	331	287	201	72	2198
4	1983-1992	51	116	175	253	273	156	214	232	324	351	283	121	2549
5a	1983-1992	18	89	161	217	270	147	248	278	340	350	269	91	2478
5b	1983-1992	18	99	172	226	279	149	244	275	342	368	288	97	2557
5c	1983-1992	18	99	172	226	279	149	244	275	342	368	288	97	2557
5d	1983-1992	95	138	180	289	266	166	174	176	299	329	276	153	2540
6	1983-1992	95	138	180	289	266	166	174	176	300	329	276	153	2540
7	1983-1992	58	63	138	221	262	189	256	240	385	365	236	96	2508
8	1983-1992	97	128	167	255	235	148	156	157	272	294	252	144	2305
9	1983-1992	130	102	143	148	123	81	81	85	155	152	181	149	1530
10a	1983-1992	79	123	153	186	242	132	184	190	278	273	280	227	2348
10b	1983-1992	84	143	150	153	207	104	129	138	206	190	188	127	1820
10c	1983-1992	169	210	240	280	244	151	175	160	243	260	296	235	2663
10d	1983-1992	180	211	249	298	253	162	175	160	247	276	329	256	2794
11	1983-1992	147	144	198	239	219	130	115	145	207	232	290	226	2292
12	1983-1992	169	115	141	158	149	74	116	139	180	187	184	221	1833
13	1983-1992	143	123	155	183	179	88	119	141	200	206	206	207	1950
14	1983-1992	169	115	141	158	149	74	116	139	180	187	184	221	1833
15	1983-1992	113	132	205	201	210	86	173	157	263	265	298	214	2317
16	1983-1992	89	97	162	166	216	106	167	142	256	244	263	168	2075
17	1983-1992	83	86	142	153	198	99	150	121	218	205	229	138	1822
18	1983-1992	72	102	164	186	191	90	142	114	183	178	230	128	1779
19	1983-1992	72	102	164	186	191	90	142	114	183	178	230	128	1779
20	1983-1992	78	104	176	236	193	146	153	152	205	186	233	142	2003
21a	1983-1992	122	108	184	141	197	84	129	128	187	163	218	197	1856
21b	1983-1992	152	78	221	173	170	96	125	120	160	172	249	244	1962
22	1983-1992	174	108	240	192	176	102	131	122	168	186	263	231	2094
23	1983-1992	186	115	195	194	207	124	138	123	182	149	186	252	2051
24	1983-1992	233	107	197	205	233	146	153	154	221	178	225	340	2392
25	1983-1992	300	100	196	206	250	167	169	189	259	210	295	474	2815
26	1983-1992	349	110	135	119	146	119	151	159	187	157	409	656	2698
27	1983-1992	244	72	192	152	149	117	133	130	168	161	303	431	2254
28	1983-1992	222	99	172	133	150	86	115	120	148	154	273	386	2058
29	1983-1992	307	112	198	154	121	122	123	114	174	199	472	577	2675
30a	1983-1992	152	115	162	187	224	165	174	155	261	283	306	284	2467
30b	1977-1986	92	90	131	213	228	153	178	140	201	256	238	337	2258
30c	1983-1992	119	119	173	188	205	95	123	138	225	227	240	196	2048
30d	1983-1992	102	99	162	139	196	116	149	118	200	192	221	196	1888
30e	1983-1992	129	102	172	149	192	87	115	124	184	171	214	212	1852
30f	1977-1986	104	91	144	197	203	118	138	99	171	225	209	171	1868
30g	1983-1992	262	106	197	143	119	113	105	108	172	220	499	566	2610
31	1983-1992	180	76	151	106	130	105	100	115	168	151	298	420	1999
32	1983-1992	153	73	125	98	128	105	101	123	190	167	421	487	2172
33	1983-1992	120	69	93	89	124	105	102	134	218	188	573	569	2385
34	1983-1992	120	69	93	89	124	105	102	134	218	188	573	569	2385
35	1983-1992	114	57	108	89	109	109	93	131	206	202	655	534	2408
36a	1977-1986	64	78	96	112	142	115	133	148	193	237	463	471	2252
36b	1983-1992	110	50	117	89	99	111	88	130	199	211	706	512	2421
37	1983-1992	110	50	117	89	99	111	88	130	199	211	706	512	2421
38	1983-1992	155	71	102	135	169	141	212	178	300	271	425	599	2757
39	1983-1992	97	51	98	82	169	177	200	213	271	235	486	608	2687
40a	1977-1986	78	85	108	165	233	158	184	180	256	295	294	333	2368
40b	1983-1992	119	100	139	158	243	156	164	171	287	274	308	309	2429
40c	1983-1992	155	71	102	135	169	141	212	178	300	271	425	599	2757
40d	1983-1992	97	51	98	82	169	177	200	213	271	235	486	608	2687
41	1983-1992	97	51	98	82	169	177	200	213	271	235	486	608	2687

Note : River basin 41 basins with 27 sub-basins which originate from "National Water Resources Study, Malaysia (JICA 1982)"

Table 2.3.2 80% RELIABLE MONTHLY RAINFALL BY RIVER BASIN

unit : mm

Basin	Period	Month												A	B	A/B
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Rainfa	%
1	1983-1992	14.6	12.2	8.9	17.4	37.4	33.1	26.8	48.0	81.6	119.4	131.9	54.7	586.1	1733.4	34%
2	1983-1992	18.5	19.4	24.5	33.8	64.7	105.4	192.5	202.9	271.6	322.1	192.7	56.4	1504.5	2686.3	56%
3a	1983-1992	12.9	11.2	13.9	20.7	44.4	45.0	72.8	135.6	162.8	174.6	116.8	53.2	863.8	2065.9	42%
3b	1983-1992	11.0	9.3	10.3	13.0	31.0	35.1	59.1	107.0	137.2	158.2	117.1	46.9	735.2	1966.1	37%
3c	1983-1992	14.9	12.3	14.9	20.3	51.1	47.9	72.6	125.3	166.4	193.1	148.1	69.3	936.2	2203.3	42%
3d	1983-1992	14.9	12.2	14.8	20.2	50.6	47.6	72.4	125.6	166.1	192.3	147.1	68.9	932.8	2198.4	42%
4	1983-1992	30.8	28.2	37.5	70.5	109.1	88.7	63.4	71.6	143.5	216.0	231.7	103.6	1194.7	2549.5	47%
5a	1983-1992	19.4	16.1	23.5	44.0	82.1	82.6	73.1	104.8	173.1	235.7	214.3	101.7	1170.5	2478.2	47%
5b	1983-1992	24.8	22.7	34.8	56.8	93.7	91.6	79.8	103.3	170.8	241.5	232.4	116.4	1268.5	2556.7	50%
5c	1983-1992	24.8	22.7	34.8	56.8	93.7	91.6	79.8	103.3	170.8	241.5	232.4	116.4	1268.5	2556.7	50%
5d	1983-1992	56.2	56.5	43.5	101.0	127.5	102.8	59.9	60.3	120.1	187.2	227.9	93.3	1236.1	2539.9	49%
6	1983-1992	56.2	56.5	43.5	101.0	127.5	102.8	59.9	60.3	120.1	187.2	227.9	93.3	1236.1	2539.9	49%
7	1983-1992	31.2	18.9	28.9	64.0	94.6	83.9	108.1	108.4	182.4	250.4	195.6	96.2	1262.6	2491.7	51%
8	1983-1992	46.5	46.7	31.1	79.3	97.9	76.7	41.2	39.2	96.5	156.4	197.2	76.8	985.3	2304.9	43%
9	1983-1992	37.8	37.4	32.6	35.6	17.7	13.4	11.1	7.4	36.2	28.8	43.8	49.9	351.8	1530.0	23%
10a	1983-1992	51.9	36.1	40.4	60.2	112.1	78.5	62.8	70.9	138.1	176.8	189.2	199.1	1216.1	2359.5	52%
10b	1983-1992	21.7	26.8	20.8	35.9	63.6	40.1	18.0	21.9	61.6	68.5	98.9	66.1	543.8	1818.4	30%
10c	1983-1992	99.3	88.0	91.6	120.5	141.9	98.9	79.6	73.2	105.9	108.0	151.2	130.9	1288.9	2654.0	49%
10d	1983-1992	114.0	99.3	104.4	150.2	164.7	114.8	87.5	84.0	114.0	120.4	176.5	150.9	1480.7	2794.3	53%
11	1983-1992	77.3	68.0	83.6	101.9	103.2	69.2	50.9	51.2	60.0	75.5	134.7	137.0	1012.5	2292.0	44%
12	1983-1992	84.9	46.4	47.0	55.4	39.1	40.1	30.5	39.7	57.4	53.5	76.7	99.7	670.3	1833.1	37%
13	1983-1992	69.0	46.5	48.2	60.2	58.0	50.2	29.4	34.0	60.5	62.1	94.2	111.9	724.3	1950.3	37%
14	1983-1992	84.9	46.4	47.0	55.4	39.1	40.1	30.5	39.7	57.4	53.5	76.7	99.7	670.3	1833.1	37%
15	1983-1992	58.1	49.5	76.4	98.6	100.9	68.8	53.5	46.0	66.8	141.3	203.4	162.0	1125.4	2319.8	49%
16	1983-1992	34.1	17.4	25.3	48.1	76.9	62.3	31.8	22.2	75.1	142.9	169.6	128.3	834.1	2089.6	40%
17	1983-1992	24.3	15.6	15.4	39.1	60.4	51.9	37.3	34.6	58.5	90.6	128.0	82.7	638.5	1822.2	35%
18	1983-1992	24.3	18.4	21.6	61.2	78.1	49.8	43.6	44.9	39.2	72.1	126.9	78.1	658.3	1776.9	37%
19	1983-1992	27.7	26.5	54.4	62.3	83.5	77.3	57.0	63.7	63.7	82.7	118.0	81.5	798.3	1999.9	40%
20	1983-1992	27.7	26.5	54.4	62.3	83.5	77.3	57.0	63.7	63.7	82.7	118.0	81.5	798.3	1999.9	40%
21a	1983-1992	57.2	34.0	49.0	31.4	49.5	34.3	20.6	28.3	36.2	57.7	103.5	111.0	612.5	1851.4	33%
21b	1983-1992	82.7	21.5	73.3	37.5	56.3	24.8	19.1	22.7	24.6	56.1	117.4	161.5	697.6	1965.0	35%
22	1983-1992	96.0	44.4	86.0	59.6	75.3	35.1	28.2	32.5	34.5	73.3	141.8	149.4	856.0	2099.3	41%
23	1983-1992	114.6	59.6	57.8	53.5	97.4	53.0	35.2	36.7	46.5	51.7	94.7	143.7	844.3	2051.3	41%
24	1983-1992	171.7	68.6	63.9	66.7	114.9	61.6	51.7	53.0	86.5	85.8	124.7	226.7	1175.8	2391.8	49%
25	1983-1992	254.4	88.2	65.1	69.9	109.4	66.4	68.2	67.2	118.4	117.3	163.6	350.8	1539.0	2815.5	55%
26	1983-1992	349.7	121.2	60.3	24.0	35.3	31.2	26.3	43.2	54.5	60.1	186.5	534.4	1526.9	2698.1	57%
27	1983-1992	201.3	44.7	62.2	32.7	38.8	26.8	23.1	33.0	38.4	57.9	140.4	320.7	1019.9	2259.9	45%
28	1983-1992	174.1	78.0	68.9	40.2	33.2	13.5	12.9	27.2	24.0	42.0	109.5	291.5	914.8	2057.9	44%
29	1983-1992	274.7	110.9	109.2	59.0	33.2	23.3	30.7	25.3	41.4	57.2	241.8	524.0	1530.6	2675.4	57%
30a	1983-1992	96.6	49.2	51.5	50.5	99.0	87.2	68.6	58.9	101.9	177.1	197.9	225.5	1263.7	2467.1	51%
30b	1977-1986	61.9	26.4	42.5	62.5	113.8	78.8	50.4	55.4	74.7	126.2	146.3	155.6	994.5	2123.6	47%
30c	1983-1992	54.2	43.7	51.0	56.8	89.2	50.3	18.5	23.3	55.2	120.4	145.5	121.1	829.2	2069.4	40%
30d	1983-1992	45.9	28.5	41.9	36.9	50.3	47.0	38.8	19.6	57.4	86.5	128.2	108.8	689.8	1921.0	36%
30e	1983-1992	68.5	41.8	48.0	26.6	48.2	30.4	15.5	25.4	35.3	63.9	104.2	134.2	641.9	1845.3	35%
30f	1977-1986	47.7	29.1	35.7	55.7	94.2	43.7	23.3	24.8	36.5	85.9	104.7	109.8	690.8	1876.1	37%
30g	1983-1992	222.9	92.7	109.6	53.9	31.2	27.3	23.7	20.5	29.6	66.2	268.2	550.5	1496.4	2610.4	57%
31	1983-1992	119.2	48.1	73.3	22.5	23.7	28.6	16.1	26.0	22.7	42.8	125.0	348.1	896.0	1998.5	45%
32	1983-1992	120.9	42.5	60.1	21.0	18.8	20.0	18.5	18.2	29.4	50.2	197.2	465.0	1061.7	2172.4	49%
33	1983-1992	130.7	46.3	41.1	20.0	18.6	17.3	18.8	21.0	31.4	52.7	280.9	592.1	1271.0	2385.0	53%
34	1983-1992	130.7	46.3	41.1	20.0	18.6	17.3	18.8	21.0	31.4	52.7	280.9	592.1	1271.0	2385.0	53%
35	1983-1992	113.0	31.1	41.9	24.0	16.7	15.9	16.1	16.7	18.7	34.7	334.2	596.2	1259.2	2407.6	52%
36a	1977-1986	85.2	21.4	37.9	16.3	14.4	14.0	20.9	22.1	21.8	53.7	225.2	529.1	1061.9	2269.9	47%
36b	1983-1992	110.7	24.6	43.7	32.9	17.7	16.9	16.6	18.2	19.5	41.3	360.0	599.8	1301.9	2421.5	54%
37	1983-1992	110.7	24.6	43.7	32.9	17.7	16.9	16.6	18.2	19.5	41.3	360.0	599.8	1301.9	2421.5	54%
38	1983-1992	175.5	50.1	48.7	33.6	42.8	40.3	53.3	55.5	107.1	153.5	227.6	529.5	1517.4	2759.0	55%
39	1983-1992	162.5	39.0	54.0	27.3	34.6	38.2	51.7	79.9	114.3	129.5	257.3	556.1	1544.4	2696.3	57%
40a	1977-1986	78.3	34.2	47.5	35.0	78.2	59.2	46.8	62.9	119.1	171.8	202.1	310.9	1246.1	2371.4	53%
40b	1983-1992	99.2	38.8	54.1	36.6	81.0	73.7	51.2	60.0	136.1	183.6	197.9	275.2	1287.4	2411.2	53%
40c	1983-1992	183.8	56.6	56.1	39.2	49.9	43.4	72.7	72.7	140.3	170.7	248.9	558.6	1692.9	2759.0	61%
40d	1983-1992	162.5	39.0	54.0	27.3	34.6	38.2	51.7	79.9	114.3	129.5	257.3	556.1	1544.4	2696.3	57%
41	1983-1992	162.5	39.0	54.0	27.3	34.6	38.2	51.7	79.9	114.3	129.5	257.3	556.1	1544.4	2696.3	57%

Note : River basin : 41 basins with 27 sub-basins which originate from "National Water Resources Study, Malaysia (JICA 1982)"

Table 2.3.3 MEAN DAILY EVAPORATION IN PRINCIPAL METEOROLOGICAL STAITIONS

Station	Period	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Senao	1974-1989	3.5	3.9	3.6	3.5	3.3	3.3	3.1	3.2	3.1	3.2	2.9	3.0	3.3
Kluang	1974-1989	3.4	3.9	3.7	3.3	3.0	2.9	2.8	2.9	2.9	3.0	2.8	2.9	3.1
Mersing	1974-1989	4.2	4.7	4.6	4.1	3.8	3.6	3.5	3.7	3.8	3.6	3.2	3.5	3.9
Alor Setar	1974-1989	5.3	5.8	5.5	4.9	3.9	3.5	3.6	3.6	3.5	3.5	3.3	4.3	4.2
Kota Bharu	1968-1989	4.4	4.9	5.3	5.5	5.0	4.5	4.7	4.5	4.5	4.2	3.6	3.6	4.5
Kuala Krai	Dec.1984-1989	2.8	4.0	4.1	4.5	4.0	4.0	4.1	3.8	3.8	3.4	2.7	2.4	3.6
Malacca	1968-1989	5.1	5.5	5.1	4.5	4.2	4.1	3.9	4.0	4.2	4.2	3.9	4.3	4.4
Batu Embun	Jun.1982-1989	2.5	3.4	3.7	3.9	3.5	3.2	3.3	3.3	3.4	3.1	2.9	2.1	3.2
Kajiklim Tanah Rata	1973-1987	2.3	2.5	2.6	2.3	2.2	2.4	2.4	2.4	2.1	2.0	1.8	1.9	2.2
Cameron Highlands	Apr.1983-1989	1.9	2.3	2.3	2.1	1.9	2.2	2.1	1.9	1.7	1.7	1.6	1.7	1.9
Kuantan	1974-1989	3.2	3.7	4.2	4.0	4.1	3.9	4.0	4.1	4.1	3.8	2.9	2.9	3.7
Muadzam Shah	Aug.1983-1989	3.5	4.1	3.5	3.7	3.5	3.5	3.5	3.7	3.4	3.6	2.9	2.9	3.5
Temerloh	1979-1989	3.1	3.8	3.9	3.7	3.5	3.4	3.4	3.5	3.4	3.3	2.9	2.7	3.4
Bayan Lepas	1974-1989	5.0	5.0	4.7	4.3	3.8	3.8	3.8	3.7	3.5	3.5	3.6	4.4	4.1
Ipoh	1974-1989	4.1	4.4	4.5	4.5	4.0	4.1	4.0	4.0	3.7	3.9	3.5	3.8	4.0
Sitawan	1974-1989	3.4	3.9	4.0	4.0	3.8	3.6	3.8	3.5	3.7	3.5	3.2	3.3	3.6
Chuping	1979-1989	4.8	5.4	5.0	4.3	3.6	3.1	3.2	3.2	3.1	2.8	2.7	3.5	3.7
Subang	1968-1989	4.3	5.0	5.1	4.8	4.6	4.4	4.4	4.5	4.4	4.4	4.0	3.8	4.5
Petaling Jaya	1971-1989	3.4	3.9	3.9	3.8	3.6	3.4	3.4	3.5	3.3	3.3	3.1	3.0	3.5
Kuala Terengganu Airport	1985-1989	4.4	5.2	5.2	5.3	4.8	4.6	4.6	4.4	4.5	3.9	3.7	4.1	4.5
Kajiklim Kuala Terengganu	1974-1989	3.7	4.1	4.6	4.6	4.3	4.0	4.0	4.0	3.8	3.5	3.0	3.2	3.9
Kota Kinabalu	1971-1989	4.5	4.7	5.2	5.5	5.3	5.1	5.1	5.0	4.9	4.8	4.6	4.6	4.9
KUdat	Oct.1981+1989	3.7	4.2	5.0	5.3	5.0	4.6	4.4	4.6	4.3	4.0	3.5	3.5	4.3
Sandakan	1972-1989	4.2	4.8	5.4	5.5	5.1	4.8	4.6	4.8	4.4	4.3	4.0	3.8	4.6
Tawau	Jul.1979-1989	3.6	3.9	4.3	4.3	4.3	3.7	3.9	4.3	4.2	4.1	3.9	3.6	4.0
Labuan	1972-1989	4.4	4.8	5.4	5.3	4.8	4.4	4.3	4.8	4.7	4.4	4.4	4.4	4.7
Bintulu	1968-1989	3.5	4.0	4.3	4.4	4.3	4.4	4.2	4.3	4.2	4.0	3.8	3.7	4.1
Kuching	1968-1989	3.1	3.4	3.7	3.9	4.1	4.1	4.1	4.1	3.9	3.9	3.5	3.3	3.7
Miri	1968-1989	3.6	4.2	4.5	4.7	4.5	4.5	4.5	4.7	4.7	4.4	4.1	3.8	4.3
Sibu	1968-1989	3.1	3.4	3.7	3.7	3.8	3.9	3.8	3.8	3.9	3.8	3.5	3.3	3.6
Sri Aman	1983-1989	2.8	3.1	3.4	3.3	3.2	3.5	3.2	3.4	3.4	3.5	3.3	3.0	3.3

Table 2.3.4 EVAPOTRANSPIRATION CROP COEFFICIENTS (K_c). (DOORENBOS AND KASSAM, 1979)

CROP	Crop Development Stage					Total Growing Period
	Initial	Crop Development	Mid-Season	Late Season	At Harvest	
Banana						
tropical	0.40-0.50	0.70-0.85	1.00-1.10	0.90-1.00	0.75-0.85	0.70-0.80
Bean						
green	0.30-0.40	0.65-0.75	0.95-1.05	0.90-0.95	0.85-0.95	0.85-0.90
dry	0.30-0.40	0.70-0.80	1.05-1.20	0.65-0.75	0.25-0.30	0.70-0.80
Cabbage	0.40-0.50	0.70-0.80	0.95-1.10	0.90-1.00	0.80-0.95	0.70-0.80
Grape	0.35-0.55	0.60-0.80	0.70-0.90	0.60-0.80	0.55-0.70	0.55-0.75
Groundnut	0.40-0.50	0.70-0.80	0.95-1.10	0.75-0.85	0.55-0.60	0.75-0.80
Maize						
sweet	0.30-0.50	0.70-0.90	1.05-1.20	1.05-1.20	0.95-1.10	0.80-0.95
grain	0.30-0.50*	0.70-0.85*	1.05-1.20*	1.05-1.20*	0.55-0.60*	0.75-0.90*
Onion						
green	0.40-0.60	0.60-0.75	0.95-1.05	0.95-1.05	0.95-1.05	0.65-0.80
Pea,fresh	0.40-0.50	0.70-0.85	1.05-1.20	1.00-1.15	0.95-1.10	0.80-0.95
Pepper, fresh	0.30-0.40	0.60-0.75	0.95-1.10	0.85-1.00	0.80-0.90	0.70-0.80
Potato	0.40-0.50	0.70-0.80	1.05-1.20	0.85-0.95	0.70-0.75	0.75-0.90
Rice	1.10-1.15	1.10-1.50	1.10-1.30	0.95-1.05	0.95-1.05	1.05-1.20
Sorghum	0.30-0.40	0.70-0.75	1.00-1.15	0.75-0.80	0.50-0.55	0.75-0.85
Soybean	0.30-0.40	0.70-0.80	1.00-1.15	0.70-0.80	0.40-0.50	0.75-0.90
Sugarcane	0.40-0.50	0.70-1.00	1.00-1.30	0.75-0.80	0.50-0.60	0.85-1.05
Tobacco	0.30-0.40	0.70-0.80	1.00-1.20	0.90-1.00	0.75-0.85	0.85-0.95
Tomato	0.40-0.50	0.70-0.80	1.05-1.25	0.80-0.95	0.60-0.65	0.75-0.90
Watermelon	0.40-0.50	0.70-0.80	0.95-1.05	0.80-0.90	0.65-0.75	0.75-0.85
Citrus						
clean weeding						0.65-0.75
no weed control						0.85-0.90

First Figure :Under high humidity (RHmin>70%) and low wind (U<5m/sec).
Second Figure :Under low humidity (RHmin<20%) and strong wind (U>5m/sec).

Table 2.5.1 INDICATIVE CAPITAL COST OF IRRIGATION SET-UPS

Crop	Capital cost (RM/ha)
Sprinkler System	
Oil palm (nursery)	8,750
Durian	8,750
Star fruit	8,750
Banana	8,750
Papaya	8,750
Chilli	8,750
Watermelon	8,750
Leaf vegetables	8,750
Micro-irrigation	
Oil palm (nursery)	12,500
Durian	3,250
Star fruit	5,000
Banana	6,250
Papaya	5,000
Chilli	5,250
Watermelon	5,250
Flower (chrysanthemum)	6,250

Source : Industry
Note : Based on a system for 10 ha.

Table5.2.1 EXTENT OF GEOLOGICAL INVESTIGATION & SOILMECHANICAL TEST

No.	Name of Project	Site	Hole	Place	Elevation	Depth	DIA	SPT	BPT	SMT	Remarks
1	KH 4 Kawasan Pad	Upstream Lembu	KH-1	Left B.	11.681 m	5.0 m	100 mm	3 nos	1 nos	1 sp	
	and	Lembu	KH-2	Left B.	4.686 m	10.0 m	do	8 nos	1 nos		
						(5.0 m)		(3 nos)			
	KH 5 Kedawang	Ketapang	KH-3	Left B.	17.639 m	10.0 m	do	4 nos	2 nos		
								(7 nos)			
			KH-4	Right B.	15.586 m	7.0 m	do	3 nos	1 nos		
						(10.0 m)		(7 nos)	(2 nos)		
2	TR 44 Pasir Nerin	-	TR-1	Right B.		10.0 m	do	8 nos	2 nos	1 sp	
								(7 nos)			
			TR-2	Left B.		9.0 m	do	5 nos	1 nos		
						(10.0 m)		(7 nos)	(2 nos)		
3	MA 16 Felcra	-	MA-1	Right B.		10.0 m	do	7 nos	2 nos	1 sp	
	BK. Sedanan					(5.0 m)		(3 nos)	(1 nos)		
			(MA-2	Left B.)		(5.0 m)		(3 nos)	(1 nos)		
4	NS 1 Stesen Mard	-	NS-1	Right B.		10.0 m	do	7 nos	1 nos	1 sp	one additional hole for sampling & k-test (NS-1A, d=10 m)
									(2 nos)		
	Jelebu		NS-2	Left B.		10.0 m	do	7 nos	2 nos		
5	KN 16 Bendang Pmt	-	KN-1	Right B.		12.0 m	do	8 nos	2 nos	1 sp	
	Sungkai					(6.0 m)		(4 nos)	(2 nos)		
			(KN-2	Left B.)		(6.0 m)		(4 nos)	(2 nos)		
6	PP 3 Tok Bedu	-	PP-1	-		16.0 m	do	13 nos	2 nos		
						(5.0 m)		(3 nos)	(1 nos)		
	Irrigation		(PP-2)	-		(5.0 m)		(3 nos)	(1 nos)		
	Total		11 hols			109.0 m		73 nos	17 nos	5 sp	
			(14 hols)			(102.0 m)		(68 nos	22 nos)		

NOTE:
1) Columns of Hole & Depth, parentheses means original plan
2) DIA:Borehole Diameter, SPT:Standard Penetration Test, BPT:Borehole Permeability Test, SMT:Soil Mechanical Test Sample
3) No.1 to No.3 Project for JICA, No.4 to No.6 for DID

Table 5.2.2 RESULTS OF SOIL MECHANICAL TESTS FOR DAM MATERIAL

No.	Project	Sample	B.Densi	S.Gravity	N.Water	G.size					Att.Limits		Compaction		Perm.Test	Tri.UU		Tri.CU		Soil Type
						cl	si	ss	gr	PL	LL	PI	Max.D.D	Opt.M.C	$x10^{-7}$	c	pi	c	pi	
			(Mg/m^3)		(%)	(%)							(Mg/m^3)	(%)	(m/s)	(kPa)	(deg)	(kPa)	(deg)	
1	KH 4/KH 5	KH	(2.03)	2.62	11	13	15	49	23	36	56	20	1.77	17	0.115	55	24	15	38	SM
2	TR 44	TR	(1.98)	2.60	17	46	11	32	11	37	63	26	1.68	20	0.467	50	31	0	33	MH
3	MA 16	MA	(2.02)	2.64	24	47	8	44	1	36	73	37	1.70	20	0.152	140	43	10	33	MH
4	NS 1	NS	(2.10)	2.61	12	20	45	35	0	18	31	13	1.93	12.5	1.600	75	22	0	41	CL
5	KN 16	KN(O)	(2.02)	2.61	9	-	4	50	46	-	NP	-	2.01	7.5	3.540	-	-	0	50	SP
6	KN 16	KN(N)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.2.3 INTERIM NATIONAL WATER QUALITY STANDARDS (INWQS) FOR MALAYSIA

No.	Parameters		Interim National Water Quality Standard				
			Crass I	Crass IIA	Class IIB	Class III	**Class IV**
1	pH		6.5-8.5	6.5-9.0	6.5-9.0	5-9	**5-9**
2	Temperature	(°C)	-	-	-	-	**-**
3	EC	(mS/cm)	1	1	-	-	**6**
4	Salinity	(%)					
5	Turbidity	(NTU)	5	50	50	-	**-**
6	Dissolved Oxygen	(mg/l)	7	5-7	5-7	3-5	**3**
7	COD	(mg/l)	10	25	25	50	**100**
8	Color	(TUC)	15	150	150	-	**-**
9	BOD	(mg/l)	1	3	3	6	**12**
10	Amminiacal Nitrogen	(mg/l)	0.1	0.3	0.3	0.9	**2.7**
11	Nitrate Nitrogen	(mg/l)	-	7	-	0.028	**5**
12	Total Solids	(mg/l)	525	1050	50	150	**4300**
13	Dissolved Solids	(mg/l)	500	1000	-	-	**4000**
14	Suspended Solids	(mg/l)	25	50	50	150	**300**
15	Alkalinity	(mg/l)	-	-	-		
16	Hardness		-	100	-		
17	Calcium	(mg/l)	-	-	-		
18	Magnesium	(mg/l)	-	-	-		
19	Potassium	(mg/l)	-	-	-		
20	Sodium	(mg/l)	-	-	-		
21	Chloride	(mg/l)	200	-	-		**79**
22	Fluoride	(mg/l)	-	1	-		**1**
23	Phosphate	(mg/l)	-	0.1	-	0.1	**-**
24	Sulphate	(mg/l)	-	200	-	-	**-**
25	Iron	(mg/l)	-	0.3	-	1	**1/5****
26	Silica	(mg/l)	-	50	-	-	**-**

Class I: Conservation of natural environment water
supply I-Practically no treatment necessary
Fishery I-Very sensitive species

Class IIA: Water supply II-conventional treatment required,
Fishery II-Sensitive aquatic species

Class IIB: Water supply III-Extensive treatment required,
Fishery III-Common and tolerant species

Class IV: Irrigation

** Iron: 1-For leaves, and 5-for others

Table 5.3.1 IRRIGATION WATER REQUIREMENTS TO RELY ON THE TIMAH TASOH DAM FOR TABACCO CULTIVATION OF SIMPANG GETY AND TASIK MURATY SCHEMES

Simpang Geti : 40 ha ; Tasik Murati : 100 ha

Item	Unit	Jan	Feb	Mar	Apr	May	Total
Evaporation at Chuping	mm/day	4.8	5.4	5.0	4.0	3.6	
Crop Factor (Kc)		0.4	0.8	1.1	1.0	0.8	
Evapotranspiration	mm/month	60	121	171	120	89	501
Effective Rainfall	mm/month		7	23	34	88	152
Net Irrig. Requirements	mm/month	0 **	114	148	86	1	349
Irrigation Efficiency			0.5	0.5	0.5	0.5	
Gross Irrig Requirements	mm/month		228	296	172	2	698
Gross Irrig. Requirements for 140 ha ***	'000 m3		319	414	241	3	977

Note ** : January is the nursery period requiring no irrigation because of residual moisture.
Note ***: 10 ha in Simpang Geti Scheme is excluded because it is irrigated by existing 8 ponds.

Table 5.3.2 COST AND BENEFIT STREAM (SIMPANG GETHI)

PR1&4

		BENEFIT	COST		B-C:RM
		Tobacco	Canal	O&M	in 1994
Simpang Gethi	ha	40	Drainage		price
1995	1	0	261,003	0	-261,003
1996	2	81,280		1,305	79,975
1997	3	81,280		1,305	79,975
1998	4	81,280		1,305	79,975
1999	5	81,280		1,305	79,975
2000	6	81,280		1,305	79,975
2001	7	81,280		1,305	79,975
2002	8	81,280		1,305	79,975
2003	9	81,280		1,305	79,975
2004	10	81,280		1,305	79,975
2005	11	81,280		1,305	79,975
2006	12	81,280		1,305	79,975
2007	13	81,280		1,305	79,975
2008	14	81,280		1,305	79,975
2009	15	81,280		1,305	79,975
2010	16	81,280		1,305	79,975
2011	17	81,280		1,305	79,975
2012	18	81,280		1,305	79,975
2013	19	81,280		1,305	79,975
2014	20	81,280		1,305	79,975
2015	21	81,280		1,305	79,975
2016	22	81,280		1,305	79,975
2017	23	81,280		1,305	79,975
2018	24	81,280		1,305	79,975
2019	25	81,280		1,305	79,975
2020	26	81,280		1,305	79,975
2021	27	81,280		1,305	79,975
2022	28	81,280		1,305	79,975
2023	29	81,280		1,305	79,975
2024	30	81,280		1,305	79,975
				EIRR=	30.63%

Table 5.3.3 COST AND BENEFIT STREAM (TASEK MELATI)

PR1&4

		BENEFIT	COST		B-C:RM
		Tobacco	Canal	O&M	in 1994
Tasek Melati	ha	40	Drainage		price
1995	1	0	400,864	0	-400,864
1996	2	203,200		2,004	201,196
1997	3	203,200		2,004	201,196
1998	4	203,200		2,004	201,196
1999	5	203,200		2,004	201,196
2000	6	203,200		2,004	201,196
2001	7	203,200		2,004	201,196
2002	8	203,200		2,004	201,196
2003	9	203,200		2,004	201,196
2004	10	203,200		2,004	201,196
2005	11	203,200		2,004	201,196
2006	12	203,200		2,004	201,196
2007	13	203,200		2,004	201,196
2008	14	203,200		2,004	201,196
2009	15	203,200		2,004	201,196
2010	16	203,200		2,004	201,196
2011	17	203,200		2,004	201,196
2012	18	203,200		2,004	201,196
2013	19	203,200		2,004	201,196
2014	20	203,200		2,004	201,196
2015	21	203,200		2,004	201,196
2016	22	203,200		2,004	201,196
2017	23	203,200		2,004	201,196
2018	24	203,200		2,004	201,196
2019	25	203,200		2,004	201,196
2020	26	203,200		2,004	201,196
2021	27	203,200		2,004	201,196
2022	28	203,200		2,004	201,196
2023	29	203,200		2,004	201,196
2024	30	203,200		2,004	201,196
				EIRR=	50.19%

Table 5.3.4 WATER QUALITY AT SIMPANG GETI AND TASEK MELATI, PERLIS

No.	Parameters		Simpang Geti				Tasik Melati				INWQS for Irrigation
			PR-L1		PR-L2		PR-L3		PR-L4		
			S1	S2	S1	S2	S1	S2	S1	S2	
	On Site Parameters										
1	pH		8.45	8.30	8.13	7.37	7.38	7.77	7.65	7.84	5-9
2	Temperature	(°C)	30.4	30.9	29.8	29.8	29.3	29.4	29.7	29.7	-
3	EC	(mS/cm)	0.250	0.274	0.195	0.194	0.400	0.461	0.290	0.485	6
4	Salinity	(%)	0.01	0.01	0	0	0.01	0.02	0.01	0.02	
5	Turbidity	(NTU)	4	5	45	49	56	36	8	7	-
6	Dissolved Oxygen	(mg/l)	5.9	5.2	6.2	4.5	3.2	3.8	3.5	4.4	3
7	COD	(mg/l)	15	15	10	20	45	20	20	20	100
	Laboratory Parameters										
8	Color	(Hazen Units)	10	10	40	>70	50	20	60	15	-
9	BOD	(mg/l)	<1	1	4	6	2	1	1	1	12
10	Amminiacal Nitrogen	(mg/l)	0.06	0.47	0.17	0.10	0.06	0.73	0.17	0.78	2.7
11	Nitrate Nitrogen	(mg/l)	0.20	0.10	0.20	0.30	0.05	0.15	0.05	0.10	5
12	Total Solids	(mg/l)	180	200	170	170	290	335	245	315	4300
13	Dissolved Solids	(mg/l)	155	190	95	135	240	315	190	310	4000
14	Suspended Solids	(mg/l)	25	10	75	35	50	20	55	5	300
15	Alkalinity	(mg/l)	-	91	68	68	220	225	100	225	-
16	Hardness		101	107	71	70	224	250	200	240	-
17	Calcium	(mg/l)	23.0	20.0	16.0	16.0	11.0	3.0	7.0	5.0	-
18	Magnesium	(mg/l)	11.0	14.0	8.0	7.0	48.0	59.0	44.0	55.0	-
19	Potassium	(mg/l)	6.0	5.6	5.0	4.2	2.8	1.8	3.3	2.1	-
20	Sodium	(mg/l)	12.0	11.2	5.0	10.4	8.0	7.2	9.0	7.2	-
21	Chloride	(mg/l)	24.0	26.0	22.0	21.0	13.0	13.0	12.0	15.0	79
22	Fluoride	(mg/l)	0.4	0.3	0.2	0.5	0.3	0.2	0.3	0.2	1
23	Phosphate	(mg/l)	<0.1	<0.05	<0.1	0.1	<0.1	0.1	<0.1	<0.05	-
24	Sulphate	(mg/l)	3.0	6.0	<1.0	2.0	<1.0	1.0	4.0	2.0	-
25	Iron	(mg/l)	<0.1	<0.1	0.1	0.3	<0.1	<0.1	<0.1	<0.1	1/5**
26	Silica	(mg/l)	10.0	6.0	8.0	8.0	10.0	6.0	14.0	6.0	-

Sampling Locations

PR-L1: Simpang Geti (Pond 1)
PR-L2: Simpang Geti (Pond 2)
PR-L3: Tasek Melati (upstream)
PR-L4: Tasik Melati (Downstream)
S1: Sample 1 (July 6,1994)
S2: Sample 2 (July 28,1994)

Table 5.3.5 WATER QUALITY AT SG.NGLONG HEADWORKS, SG.RUPOH, SG.JERNEH, TIMAH TASOH DAM AND PAYA HEADWORKS, PERLIS

No.	Parameters		PR-L1		PR-L6		PR-L7	PR-L8	PR-L9	INWQS for Irrigation
			S1	S2	S1	S2				
	On Site Parameters									
1	pH		7.43	7.58	7.44	7.47	8.25	7.51	7.36	**5-9**
2	Temperature	(°C)	28.7	28.6	29.5	29.1	29.6	28.0	29.4	-
3	EC	(mS/cm)	0.400	0.462	0.280	0.376	0.218	0.582	0.339	**6**
4	Salinity	(%)	0.01	0.01	0.01	0.01	0.00	0.02	0.01	
5	Turbidity	(NTU)	12	8	13	19	11	3	9	-
6	Dissolved Oxygen	(mg/l)	3.4	5.4	4.6	3.2	5.7	4.2	3.4	**3**
7	COD	(mg/l)	20	15	20	15	10	10	10	**100**
	Laboratory Parameters									
8	Color	(HAZEN UNITS)	50	20	50	20	30	10	15	-
9	BOD	(mg/l)	2	1	2	1	1	<1	1	**12**
10	Amminiacal Nitrogen	(mg/l)	0.14	0.13	0.04	0.13	0.17	0.08	0.13	**2.7**
11	Nitrate Nitrogen	(mg/l)	0.04	0.35	0.05	0.15	0.15	0.45	0.15	**5**
12	Total Solids	(mg/l)	270	325	205	255	170	310	250	**4300**
13	Dissolved Solids	(mg/l)	225	300	120	240	155	295	240	**4000**
14	Suspended Solids	(mg/l)	45	25	85	15	15	15	10	**300**
15	Alkalinity	(mg/l)	207	209	66	164	92	273	149	-
16	Hardness		214	237	133	175	97	190	156	-
17	Calcium	(mg/l)	14.0	11.0	30.0	22.0	23.0	2.0	20.0	-
18	Magnesium	(mg/l)	44.0	51.0	14.0	29.0	10.0	45.0	26.0	-
19	Potassium	(mg/l)	4.0	4.2	4.0	4.3	3.2	0.8	5.1	-
20	Sodium	(mg/l)	6.0	8.4	8.0	10.0	6.0	5.0	10.0	-
21	Chloride	(mg/l)	13.0	16.0	16.0	25.0	12.0	10.0	19.0	**79**
22	Fluoride	(mg/l)	0.4	0.2	0.4	0.3	0.3	<0.1	0.3	**1**
23	Phosphate	(mg/l)	<0.1	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	-
24	Sulphate	(mg/l)	1.0	2.0	<1.0	2.0	2.0	1.0	3.0	-
25	Iron	(mg/l)	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	**1/5****
26	Silica	(mg/l)	18.0	8.0	7.0	8.0	6.0	8.0	8.0	-

Sampling Locations

PR-L5: Nglong Headworks
PR-L6: Sg.Rupoh
PR-L7: Timah Tasoh Dam
PR-L8: Sg.JJerneh
PR-L9: Paya Headworks
S1: Sample 1 (July 6,1994)
S2: Sample 2 (July 28,1994)

Table 5.4.1 COST AND BENEFIT STREAM (LEMBU)

		BENEFIT		COST			B-C KH-IRR
		Paddy	Hortus	Fish	Construciton	O&M	unit:RM
Lembu	ha	100	10	2			in 1994 price
1995	1	0	0		5,903,770	0	-5,903,770
1996	2	168,600	460,000	460,000		29,519	645,081
1997	3	168,600	460,000	460,000		29,519	645,081
1998	4	168,600	460,000	460,000		29,519	645,081
1999	5	168,600	460,000	460,000		29,519	645,081
2000	6	168,600	460,000	460,000		29,519	645,081
2001	7	168,600	460,000	460,000		29,519	645,081
2002	8	168,600	460,000	460,000		29,519	645,081
2003	9	168,600	460,000	460,000		29,519	645,081
2004	10	168,600	460,000	460,000		29,519	645,081
2005	11	168,600	460,000	460,000		29,519	645,081
2006	12	168,600	460,000	460,000		29,519	645,081
2007	13	168,600	460,000	460,000		29,519	645,081
2008	14	168,600	460,000	460,000		29,519	645,081
2009	15	168,600	460,000	460,000		29,519	645,081
2010	16	168,600	460,000	460,000	166,750	29,519	645,081
2011	17	168,600	460,000	460,000		29,519	645,081
2012	18	168,600	460,000	460,000		29,519	645,081
2013	19	168,600	460,000	460,000		29,519	645,081
2014	20	168,600	460,000	460,000		29,519	645,081
2015	21	168,600	460,000	460,000		29,519	645,081
2016	22	168,600	460,000	460,000		29,519	645,081
2017	23	168,600	460,000	460,000		29,519	645,081
2018	24	168,600	460,000	460,000		29,519	645,081
2019	25	168,600	460,000	460,000		29,519	645,081
2020	26	168,600	460,000	460,000		29,519	645,081
2021	27	168,600	460,000	460,000		29,519	645,081
2022	28	168,600	460,000	460,000		29,519	645,081
2023	29	168,600	460,000	460,000		29,519	645,081
2024	30	168,600	460,000	460,000		29,519	645,081
						EIRR=	10.21%

Table 5.4.2 COST AND BENEFIT STREAM (KETAPANG)

		BENEFIT		COST			B-C KH-IRR
		Paddy	Hortus	Reservoir,	Equipment	O&M	unit:RM
Ketapang	ha	60	10	canal, drain			in 1994 price
1995	1	0	0	4,319,482	212,691	0	-4,532,173
1996	2	101,160	460,000			22,661	538,499
1997	3	101,160	460,000			22,661	538,499
1998	4	101,160	460,000			22,661	538,499
1999	5	101,160	460,000			22,661	538,499
2000	6	101,160	460,000			22,661	538,499
2001	7	101,160	460,000			22,661	538,499
2002	8	101,160	460,000			22,661	538,499
2003	9	101,160	460,000			22,661	538,499
2004	10	101,160	460,000			22,661	538,499
2005	11	101,160	460,000			22,661	538,499
2006	12	101,160	460,000			22,661	538,499
2007	13	101,160	460,000			22,661	538,499
2008	14	101,160	460,000			22,661	538,499
2009	15	101,160	460,000			22,661	538,499
2010	16	101,160	460,000		320,620	22,661	217,879
2011	17	101,160	460,000			22,661	538,499
2012	18	101,160	460,000			22,661	538,499
2013	19	101,160	460,000			22,661	538,499
2014	20	101,160	460,000			22,661	538,499
2015	21	101,160	460,000			22,661	538,499
2016	22	101,160	460,000			22,661	538,499
2017	23	101,160	460,000			22,661	538,499
2018	24	101,160	460,000			22,661	538,499
2019	25	101,160	460,000			22,661	538,499
2020	26	101,160	460,000			22,661	538,499
2021	27	101,160	460,000			22,661	538,499
2022	28	101,160	460,000			22,661	538,499
2023	29	101,160	460,000			22,661	538,499
2024	30	101,160	460,000			22,661	538,499
						EIRR=	11.17%

Table 5.4.3 WATER QUALITY AT KAWASAN PADI LANGKAWI, KEDAH

No.	Parameters		Langkawi, Kedah						INWQS for Irrigation
			KH-L1		KH-L2		KH-L3		
			S1	S2	S1	S2	S1	S2	
	On Site Parameters								
1	pH		5.65	5.50	7.27	6.65	6.49	6.67	**5-9**
2	Temperature	(°C)	26.8	26.4	33.7	28.8	27.7	27.0	-
3	EC	(mS/cm)	0.055	0.070	0.065	0.109	0.070	0.077	**6**
4	Salinity	(%)	0	0	0	0	0	0	
5	Turbidity	(NTU)	5	7	17	37	4	2	-
6	Dissolved Oxygen	(mg/l)	5.7	4.5	6.2	4.6	6	5.3	**3**
7	COD	(mg/l)	4	5	5	15	2	5	**100**
	Laboratory Parameters								
8	Color	(TUC)	20	10	70	70	15	5	-
9	BOD	(mg/l)	<1	<1	<1	<1	<1	<1	**12**
10	Amminiacal Nitrogen	(mg/l)	0.12	0.02	0.04	0.10	0.02	0.02	**2.7**
11	Nitrate Nitrogen	(mg/l)	0.10	0.05	0.10	0.05	0.10	0.05	**5**
12	Total Solids	(mg/l)	55	65	75	160	70	90	**4300**
13	Dissolved Solids	(mg/l)	40	50	55	75	45	55	**4000**
14	Suspended Solids	(mg/l)	15	15	20	85	25	35	**300**
15	Alkalinity	(mg/l)	19	18	23	32	11	25	-
16	Hardness		10	11	16	29	16	15	-
17	Calcium	(mg/l)	1.0	3.0	3.0	6.0	2.0	2.0	-
18	Magnesium	(mg/l)	2.0	1.0	2.0	3.0	3.0	2.0	-
19	Potassium	(mg/l)	2.5	7.7	3.0	10.0	3.0	9.0	-
20	Sodium	(mg/l)	6.0	7.2	6.0	9.6	8.0	9.6	-
21	Chloride	(mg/l)	6.0	9.0	8.0	24.0	8.0	10.0	**79**
22	Fluoride	(mg/l)	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	**1**
23	Phosphate	(mg/l)	<0.1	0.2	<0.1	0.2	0.1	0.1	-
24	Sulphate	(mg/l)	1.0	1.0	<1	3.0	2.0	1.0	-
25	Iron	(mg/l)	0.1	0.1	0.2	2.4	0.1	0.1	**1/5****
26	Silica	(mg/l)	14.0	10.0	11.0	8.0	4.0	10.0	-

Sampling Locations

KH-L1: Sg.Jenali
KH-L2: Sg.Bukit Lembu
KH-L3: Sg.Ketapang
S1: Sample 1 (July 3,1994)
S2: Sample 2 (July 30,1994)

Table 5.4.4 MAJOR POLICIES RELATED TO THE STUDY IN TOURISM AND ENVIRONMENT UNDER LANGKAWI STRUCTURE PLAN (1990-2005)

No.	Policy
1	Tourism activities shall be the basis for the overall economic growth.
2	An attractive and conductive environment for tourism shall be created in line with Langkawi's function as an international tourist destination.
3	Agriculture areas, especially paddy field, shall be preserved as a tourist attraction.
4	Development of accommodation facilities for tourism such as hotels, chalets and other types are encouraged in areas which have been identified for tourism development, and in the major settlement areas.
5	Development of chalets shall be undertaken in a planned and systematic manner.
6	More tourist attractions shall be identified, developed and provided with related facilities.
7	Paddy areas shall be preserved as an attractive landscape and tourist attraction.
8	Existing tourism recreational activities shall be improved and new recreational facilities shall be identified and developed.
9	Promotional activities shall be carried out in a concerted manner based on the theme of Langkawi's uniqueness and outstanding natural beauty.
10	Modern technology and assistance shall be provided to increase productivity in the agriculture sector.
11	Crop yields shall be increased through diversification and the identification of more hardy and suitable crops.
12	Protective and recreation forests reserve shall be preserved and only development related to tourism recreation will be permitted.
13	Sufficient and suitable recreational facilities, to meet the demand of both the local population as well as the tourists shall be provided.
14	Stringent and effective control of sources of water pollution shall be imposed.
15	Only non-polluting types of industry shall be permitted for development.
16	Appropriate methods of natural resource utilization shall be adopted in order to avoid environment from being polluted.
17	The quality of the environment at major attraction areas shall be conserved an upgraded.
18	Landscape planning is to be an integral part of landuse planning.
19	Selection of suitable trees and plants shall be undertaken to characterize the environment of Langkawi.

Table 5.5.1 COST AND BENEFIT STREAM (FELCRA+MIADP:BUKIT SEDANAN)

MA.16

FELCRA + MIADP		BENEFIT Durian 37	Orchid 2	Hortus 25	COST Dam+Equipment	O&M	B-C unit:RM in 1994 price
1995	1	-313,723	-250,000	0	4,795,397	0	-5,359,120
1996	2	-57,128	290,000	750,000		8,667	974,005
1997	3	-68,561	290,000	750,000		8,667	962,572
1998	4	-78,773	290,000	750,000		8,667	952,360
1999	5	-107,596	290,000	750,000		8,667	923,537
2000	6	-98,346	290,000	750,000		8,667	932,787
2001	7	-14,504	290,000	750,000		8,667	1,016,629
2002	8	106,042	290,000	750,000		8,667	1,137,175
2003	9	244,496	290,000	750,000		8,667	1,275,629
2004	10	360,676	290,000	750,000		8,667	1,391,809
2005	11	508,380	290,000	750,000	148,000	8,667	1,391,513
2006	12	595,293	290,000	750,000		8,667	1,626,426
2007	13	682,243	290,000	750,000		8,667	1,713,376
2008	14	769,156	290,000	750,000		8,667	1,800,289
2009	15	754,911	290,000	750,000		8,667	1,786,044
2010	16	769,156	40,000	750,000	719,293	8,667	830,997
2011	17	769,159	290,000	750,000		8,667	1,800,289
2012	18	769,156	290,000	750,000		8,667	1,800,289
2013	19	769,156	290,000	750,000		8,667	1,800,289
2014	20	754,911	290,000	750,000		8,667	1,786,044
2015	21	769,156	290,000	750,000	148,000	8,667	1,652,289
2016	22	769,156	290,000	750,000		8,667	1,800,289
2017	23	769,156	290,000	750,000		8,667	1,800,289
2018	24	769,156	290,000	750,000		8,667	1,800,289
2019	25	769,156	290,000	750,000		8,667	1,800,289
2020	26	769,156	290,000	750,000		8,667	1,800,289
2021	27	769,156	290,000	750,000		8,667	1,800,289
2022	28	769,156	290,000	750,000		8,667	1,800,289
2023	29	769,156	290,000	750,000		8,667	1,800,289
2024	30	769,156	290,000	750,000		8,667	1,800,289
						EIRR=	20.80%

Table 5.5.2 WATER QUALITY AT BUKIT SEDANAN, MELAKA

No.	Parameters		Bukit Sedanan, Melaka							INWQS for Irrigation
			MA-L1		MA-L2		MA-L3		MA-04	
			S1	S2	S1	S2	S1	S2		
	On Site Parameters									
1	pH		6.35	6.59	5.85	5.90	5.95	6.01	5.82	**5-9**
2	Temperature	(°C)	30.5	31.5	27.0	30.4	26.3	25.5	26.1	-
3	EC	(mS/cm)	0.029	0.030	0.033	0.035	0.037	0.025	0.023	**6**
4	Salinity	(%)	0	0	0	0	0	0	0	
5	Turbidity	(NTU)	7	12	8	11	12	9	14	-
6	Dissolved Oxygen	(mg/l)	6.4	6.8	6.5	5.2	6.6	5.9	4.1	**3**
7	COD	(mg/l)	8	10	10	8	10	10	20	**100**
	Laboratory Parameters									
8	Color	(HAZEN UNITS)	20	-	80	-	10	-	-	-
9	BOD	(mg/l)	1.0	1.0	0.7	0.7	0.8	0.6	0.9	**12**
10	Amminiacal Nitrogen	(mg/l)	<0.02	0.09	<0.02	0.12	<0.02	0.08	0.15	**2.7**
11	Nitrate Nitrogen	(mg/l)	<0.02	<0.02	<0.02	<0.02	0.05	0.10	<0.02	**5**
12	Total Solids	(mg/l)	35	33	47	45	48	46	58	**4300**
13	Dissolved Solids	(mg/l)	25	25	34	34	33	35	52	**4000**
14	Suspended Solids	(mg/l)	10	8	13	11	15	11	6	**300**
15	Alkalinity	(mg/l)	9.1	5.0	14.8	10.1	12.5	13.1	6.1	-
16	Hardness		9.0	10.0	10.0	11.0	13.0	12.0	10.0	-
17	Calcium	(mg/l)	2.8	2.4	3.2	3.6	3.6	3.2	2.8	-
18	Magnesium	(mg/l)	0.5	1.0	0.5	0.5	1.0	1.0	0.7	-
19	Potassium	(mg/l)	1.8	1.7	1.5	1.9	2.1	2.1	2.5	-
20	Sodium	(mg/l)	2.6	1.9	3.1	2.4	4.1	3.1	3.0	-
21	Chloride	(mg/l)	5.0	5.0	5.0	4.0	5.0	5.0	6.0	**79**
22	Fluoride	(mg/l)	0.07	0.08	0.07	0.08	0.07	0.08	0.08	**1**
23	Phosphate	(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
24	Sulphate	(mg/l)	0.5	0.6	0.4	0.3	0.2	0.3	1.0	-
25	Iron	(mg/l)	1.0	0.7	4.9	2.8	4.2	4.0	0.7	**1/5****
26	Silica	(mg/l)	8.0	8.0	12.0	12.0	12.0	12.0	16.0	-

Sampling Locations

MA-L1 Existing pond
MA-L2 Pond near durian farm
MA-L3 Sg.Mentangor tributary
MA-L4 Sg.Mentangor Tributary (At the forestry area)
S1: Sample 1 (June 14,1994)
S2: Sample 2 (July 18,1994)

Table 5.6.1 COST AND BENEFIT STREAM (KELOMPOK KANGAR MARLIMAU)

JR-10

		BENEFIT		COST			B-C
		Durian 1	Durian 2	Pond,Canal	Equipment	O&M	unit:RM
	ha	24	13	& Road			in 1994 price
1995	1	100,298	-105,988	751,048	598,922	0	-1,355,660
1996	2	146,593	-19,300			6,750	120,543
1997	3	212,910	-23,163			6,750	182,998
1998	4	240,617	-26,613			6,750	207,254
1999	5	268,347	-36,350			6,750	225,247
2000	6	310,694	-33,225			6,750	270,719
2001	7	301,646	-4,900			6,750	289,996
2002	8	310,694	35,825			6,750	339,769
2003	9	310,694	82,600			6,750	386,544
2004	10	310,694	121,850			6,750	425,794
2005	11	310,694	171,750			6,750	475,694
2006	12	310,694	201,113			6,750	496,009
2007	13	310,694	230,488			6,750	534,431
2008	14	310,694	259,850			6,750	563,794
2009	15	310,694	255,038			6,750	558,981
2010	16	310,694	259,850		531,555	6,750	32,239
2011	17	310,694	259,850			6,750	563,794
2012	18	310,694	259,850			6,750	563,794
2013	19	310,694	259,850			6,750	563,794
2014	20	310,694	255,038			6,750	558,981
2015	21	310,694	259,850			6,750	563,794
2016	22	310,694	259,850			6,750	563,794
2017	23	310,694	259,850			6,750	563,794
2018	24	310,694	259,850			6,750	563,794
2019	25	310,694	259,850			6,750	563,794
2020	26	310,694	259,850			6,750	563,794
2021	27	310,694	259,850			6,750	563,794
2022	28	310,694	259,850			6,750	563,794
2023	29	310,694	259,850			6,750	563,794
2024	30	310,694	259,850			6,750	563,794
						EIRR=	20.48%

*1:Durian 1= betterment:with-without
Durian 2= new planting
*2:Replacement costs include pumps, gates and screens on top of the equipment costs.
*3:O&M costs= Construction costs*0.005

Table 5.6.2 WATER QUALITY AT THE KELOMPOK KANGKAR MERLIMAU, JOHOR

No.	Parameters		Kangkar, Johor				INWQS for Irrigation
			JR-L1		JR-L2		
			S1	S2	S1	S2	
	On Site Parameters						
1	pH		5.96	5.35	5.62	5.23	**5-9**
2	Temperature	(°C)	25.4	25.7	27.6	28.7	-
3	EC	(mS/cm)	0.024	0.017	0.034	0.029	**6**
4	Salinity	(%)	0	0	0	0	
5	Turbidity	(NTU)	20	6	70	4	-
6	Dissolved Oxygen	(mg/l)	6.8	6.0	5.5	5.3	**3**
7	COD	(mg/l)	6	5	7	3	**100**
	Laboratory Parameters						
8	Color	(TUC)	40	-	100	-	-
9	BOD	(mg/l)	0.8	0.6	0.6	0.7	**12**
10	Amminiacal Nitrogen	(mg/l)	<0.02	<0.02	0.11	0.18	**2.7**
11	Nitrate Nitrogen	(mg/l)	0.22	0.24	0.25	0.36	**5**
12	Total Solids	(mg/l)	58	28	102	32	**4300**
13	Dissolved Solids	(mg/l)	29	26	35	28	**4000**
14	Suspended Solids	(mg/l)	29	2	67	4	**300**
15	Alkalinity	(mg/l)	2.3	<0.1	2.3	<0.1	-
16	Hardness		6.0	12.0	13.0	9.0	-
17	Calcium	(mg/l)	1.6	3.2	4.0	2.0	-
18	Magnesium	(mg/l)	0.5	1.0	0.7	1.0	-
19	Potassium	(mg/l)	1.8	0.6	1.9	0.8	-
20	Sodium	(mg/l)	1.2	1.0	2.1	1.6	-
21	Chloride	(mg/l)	5.0	5.0	7.0	6.0	**79**
22	Fluoride	(mg/l)	0.05	0.08	0.07	0.07	**1**
23	Phosphate	(mg/l)	<0.1	<0.1	0.1	<0.1	-
24	Sulphate	(mg/l)	0.6	1.9	3.8	1.0	-
25	Iron	(mg/l)	1.3	0.3	3.4	0.2	**1/5****
26	Silica	(mg/l)	8.0	12.0	12.0	16.0	-

Sampling Locations

JR-L1 Existing pond used for irrigation

JR-L1 Pt.Kangkar Limau

S1: Sample 1 (July 23,1994)

S2: Sample 2 (July 20,1994)

Table 5.7.1 COST AND BENEFIT STREAM
(PASIR NERING, TRENGGANU)

TR-44

		BENEFIT	COST			B-C:RM
		Rossele	Canal,Road	Equipment	O&M	in 1994
	ha	42	Pump House			price
1995	1	149,940	454,523	410,132	0	-714,715
1996	2	149,940			4,323	145,617
1997	3	149,940			4,323	145,617
1998	4	149,940			4,323	145,617
1999	5	149,940			4,323	145,617
2000	6	149,940			4,323	145,617
2001	7	149,940			4,323	145,617
2002	8	149,940			4,323	145,617
2003	9	149,940			4,323	145,617
2004	10	149,940			4,323	145,617
2005	11	149,940			4,323	145,617
2006	12	149,940			4,323	145,617
2007	13	149,940			4,323	145,617
2008	14	149,940			4,323	145,617
2009	15	149,940			4,323	145,617
2010	16	149,940		145,900	4,323	-283
2011	17	149,940			4,323	145,617
2012	18	149,940			4,323	145,617
2013	19	149,940			4,323	145,617
2014	20	149,940			4,323	145,617
2015	21	149,940			4,323	145,617
2016	22	149,940			4,323	145,617
2017	23	149,940			4,323	145,617
2018	24	149,940			4,323	145,617
2019	25	149,940			4,323	145,617
2020	26	149,940			4,323	145,617
2021	27	149,940			4,323	145,617
2022	28	149,940			4,323	145,617
2023	29	149,940			4,323	145,617
2024	30	149,940			4,323	145,617
					EIRR=	20.01%

*1:presumption is given in the adjacent table on roselle cultivation

*2:Replacement costs include gates and screens on top of the equipment costs

*3:O&M costs = Construction costs*0.005

Table 5.7.2 WATER QUALITY AT PASIR NERING, TRENGGANU

No.	Parameters		Pasir Nering, Trengganu						INWQS for Irrigation
			TR-L1		TR-L2		TR-L3		
			S1	S2	S1	S2	S1	S2	
	On Site Parameters								
1	pH		5.63	5.75	5.49	5.53	6.01	6.30	5-9
2	Temperature	(°C)	25.4	25.4	27.6	25.3	24.8	25.9	-
3	EC	(mS/cm)	0.098	0.019	0.013	0.013	0.023	0.020	6
4	Salinity	(%)	0	0	0	0	0	0	
5	Turbidity	(NTU)	14	41	12	8	7	14	-
6	Dissolved Oxygen	(mg/l)	5.6	4.8	4.1	3.7	6.1	5.2	3
7	COD	(mg/l)	4	15	15	15	10	15	100
	Laboratory Parameters								
8	Color	(HAZEN UNITS)	85	125	100	70	40	40	-
9	BOD	(mg/l)	<0.5	0.5	1.4	0.6	1.0	<0.5	12
10	Amminiacal Nitrogen	(mg/l)	0.19	0.19	0.49	0.49	0.36	0.36	2.7
11	Nitrate Nitrogen	(mg/l)	0.31	0.11	<0.02	<0.02	0.06	0.21	5
12	Total Solids	(mg/l)	54	115	68	70	84	75	4300
13	Dissolved Solids	(mg/l)	34	71	44	57	70	44	4000
14	Suspended Solids	(mg/l)	20	44	24	13	14	31	300
15	Alkalinity	(mg/l)	5.0	4.0	4.0	4.0	8.0	9.0	-
16	Hardness		7.0	10.0	8.0	7.0	7.0	8.0	-
17	Calcium	(mg/l)	1.2	1.2	0.8	2.0	2.0	2.0	-
18	Magnesium	(mg/l)	1.0	1.7	1.5	0.5	0.5	0.7	-
19	Potassium	(mg/l)	3.5	1.0	0.7	0.3	1.0	0.9	-
20	Sodium	(mg/l)	16.0	4.9	2.7	4.5	3.5	5.0	-
21	Chloride	(mg/l)	9.0	9.0	8.0	10.0	7.0	9.0	79
22	Fluoride	(mg/l)	-	-	-	-	-	-	1
23	Phosphate	(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
24	Sulphate	(mg/l)	<0.1	<0.1	<0.1	3.0	2.9	<0.1	-
25	Iron	(mg/l)	0.9	0.9	0.7	0.7	0.4	0.4	1/5**
26	Silica	(mg/l)	4.0	8.0	5.0	7.0	5.0	7.0	-

Sampling Locations

TR-L1 Sg.Perching
TR-L2 Sg.Udang
TR-L3 Sg.Por
S1: Sample 1 (June 27,1994)
S2: Sample 2 (August 3,1994)

Table 6.1 **SUMMARY OF FEASIBILITY STUDY OF FIVE PILOT PROJECTS**

State	Project	Code	Cropping Pattern	Small Reservoir	Main Project Works	Project Costs (RM)	Unit Cost (RM/ha)	EIRR (%)
Perlis	**Simpang Geti**	(PR1)	(present) Dry season : 10 ha of tobacco (proposed) Dry season : 50 ha of tobacco	Existing (Type B)	Drain : 1.6 km Farm road : 1.6 km	261,000	5,200	31
	Tasek Melati	(PR4)	(present) Dry season : fallow (proposed) Dry season : 100 ha of tobacco	Existing (Type B)	Drain : 1.6 km Farm road : 1.6 km	401,000	4,000	50
Kedah	**Kedawang** (Lembu reservoir)	(KH4/KH5)	(present) Wet season : 100 ha of paddy Dry season : fallow (proposed) Wet season : 100 ha of paddy Year round : 10 ha of horticulture	Lembu Pond (Type B) Capacity : 130,000 m3 Pond area : 7.8 ha	Irrig. canal : 9.5 km Drain : 5.5 km	10,617,000	96,500	10
	Kedawang (Ketapang dam)	(KH4/KH5)	(present) Wet season : 60 ha of paddy Dry season : fallow (proposed) Wet season : 60 ha of paddy Year round : 10 ha of horticulture	Ketapang Dam (Type A) Capacity : 160,000 m3 Dam height : 14.8 m Dam length : 164 m	Irrig. canal : 1.6 km Drain : 2.8 km	5,222,000	74,600	11
Melaka	**Bukit Sedanan**	(MA16)	(present) FELCRA Scheme : fallow MIADP area : to be reclaimed (proposed) FELCRA Scheme : 37 ha of durian; 2 ha of orchid MIADP area : 25 ha of horticulture	Mentagor Dam (Type A) Capacity : 250,000 Dam height : 11.5 m Dam length : 236 m	Pump station : 3 nos. Pipeline : 3.8 km Drip system : 62 ha	4,795,000	74,900	21
Johor	**Kelompok Kangkar Merlimau**	(JR10)	(present) Perennial : 37 ha of durian (proposed) Perennial : 37 ha of durian	Pond (Type B) Capacity : 100 m3	Pump station : 3 nos. Pipeline : 1.8 km	1,242,000	34,500	20
Terengganu	**Pasir Nering**	(TR44)	(present) Year round : 2 ha of roselle (proposed) Year round : 42 ha of roselle	Pond (Type B) Capacity : 100 m3	Pump station : 1 no. Pipeline : 3.3 km	865,000	20,600	20

Figures

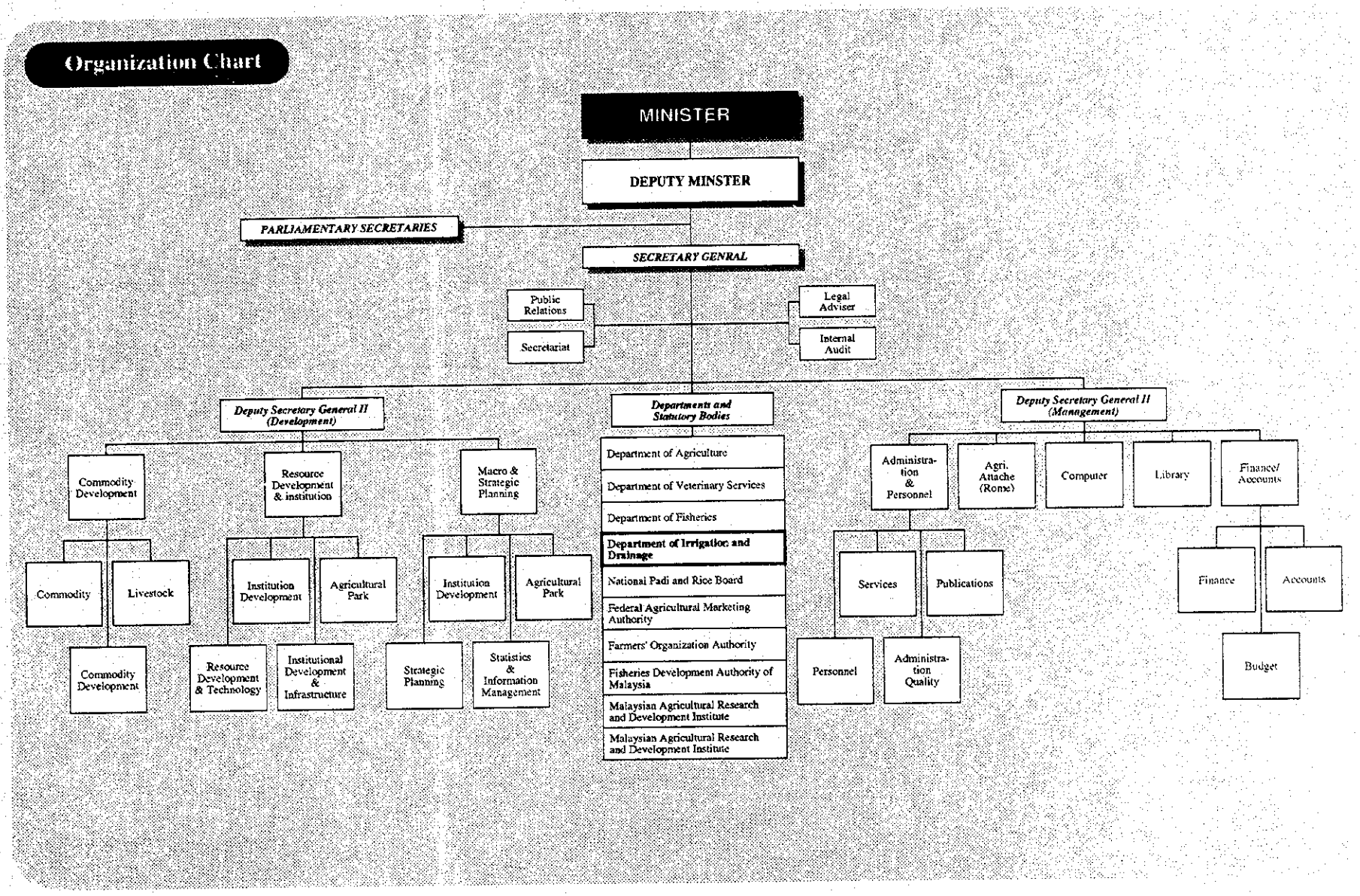


Fig. 1.4.1 Ministry of Agriculture

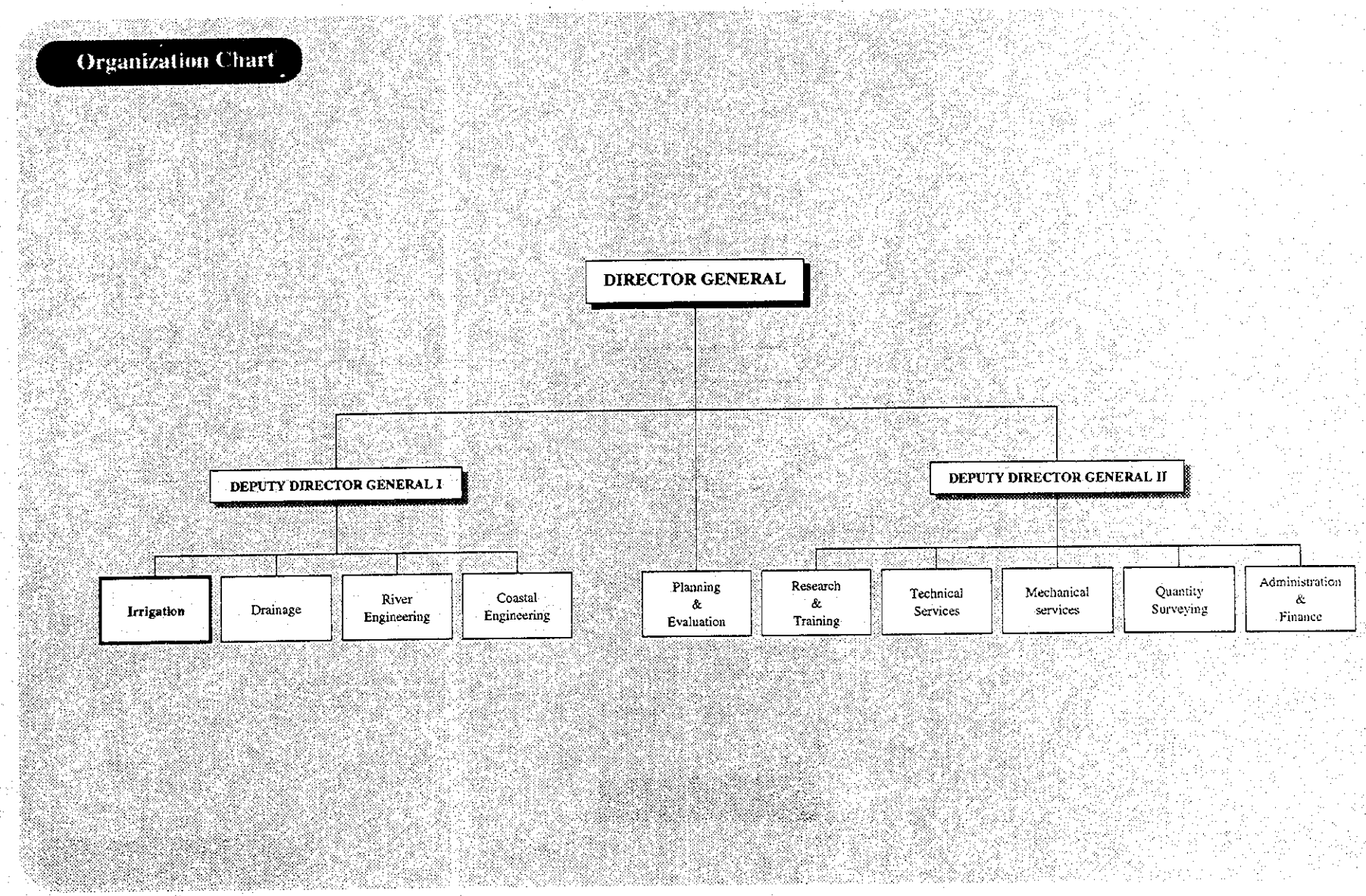


Fig. 1.4.2 Department of irrigation and Drainage

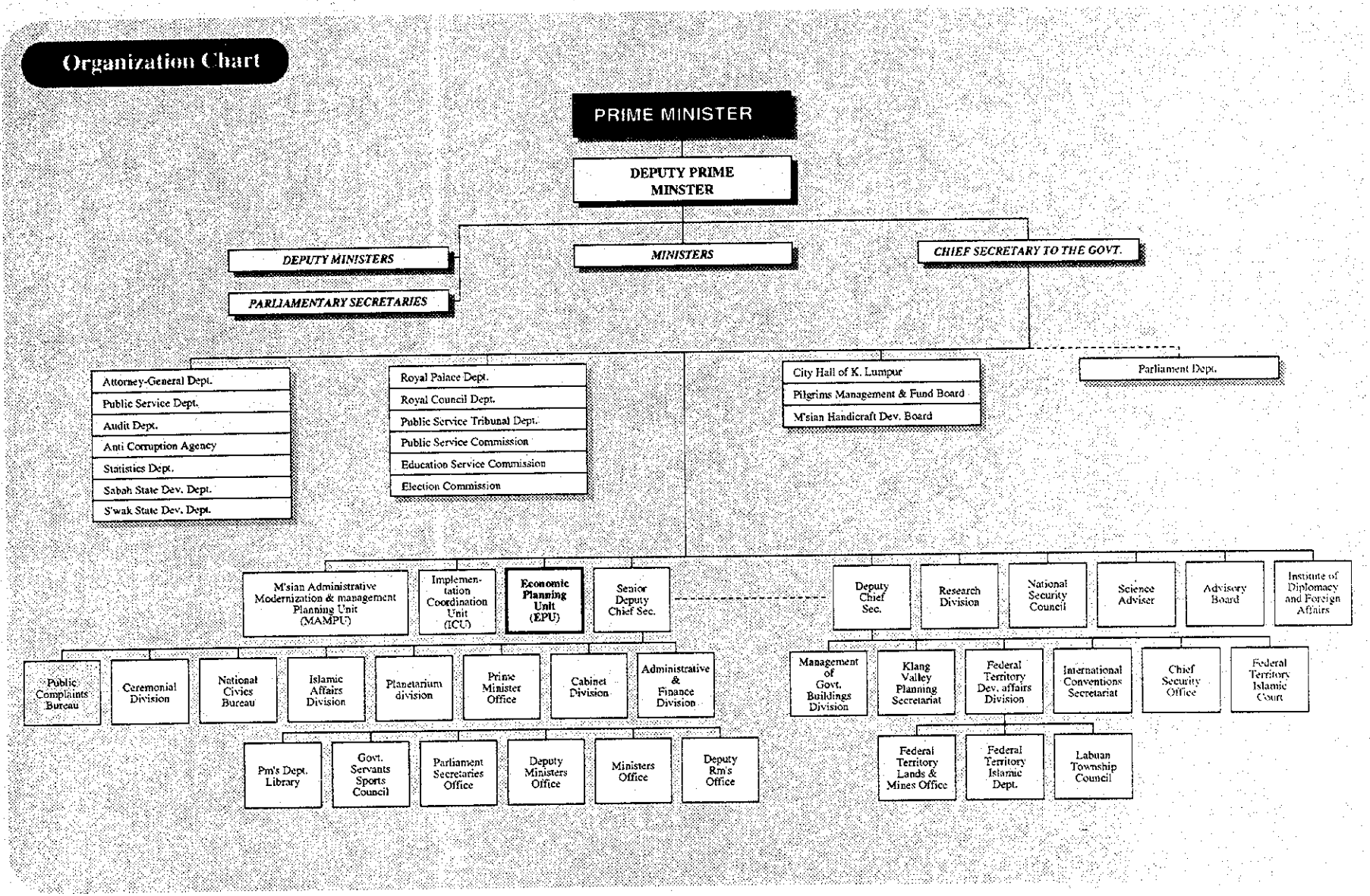
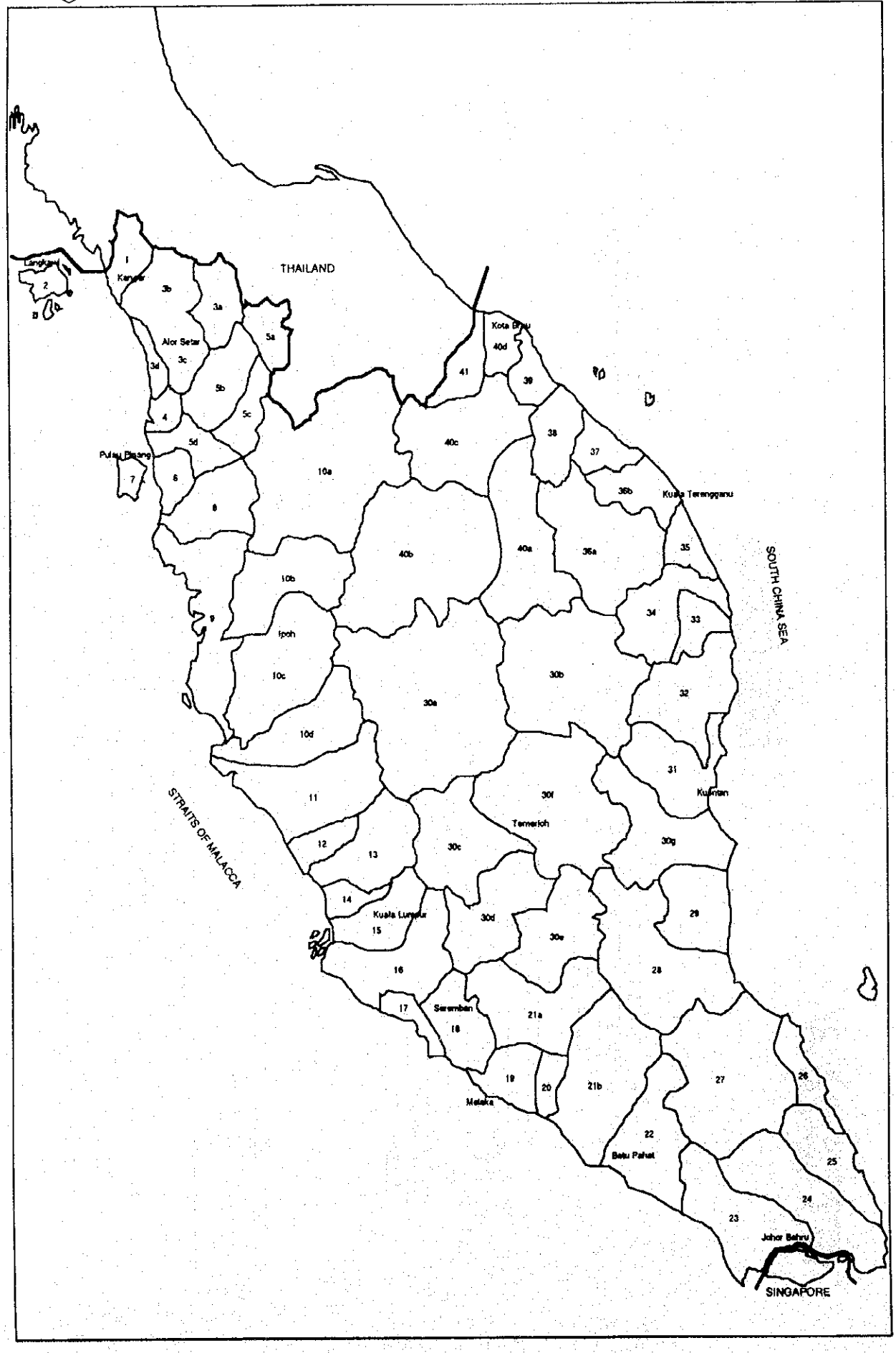
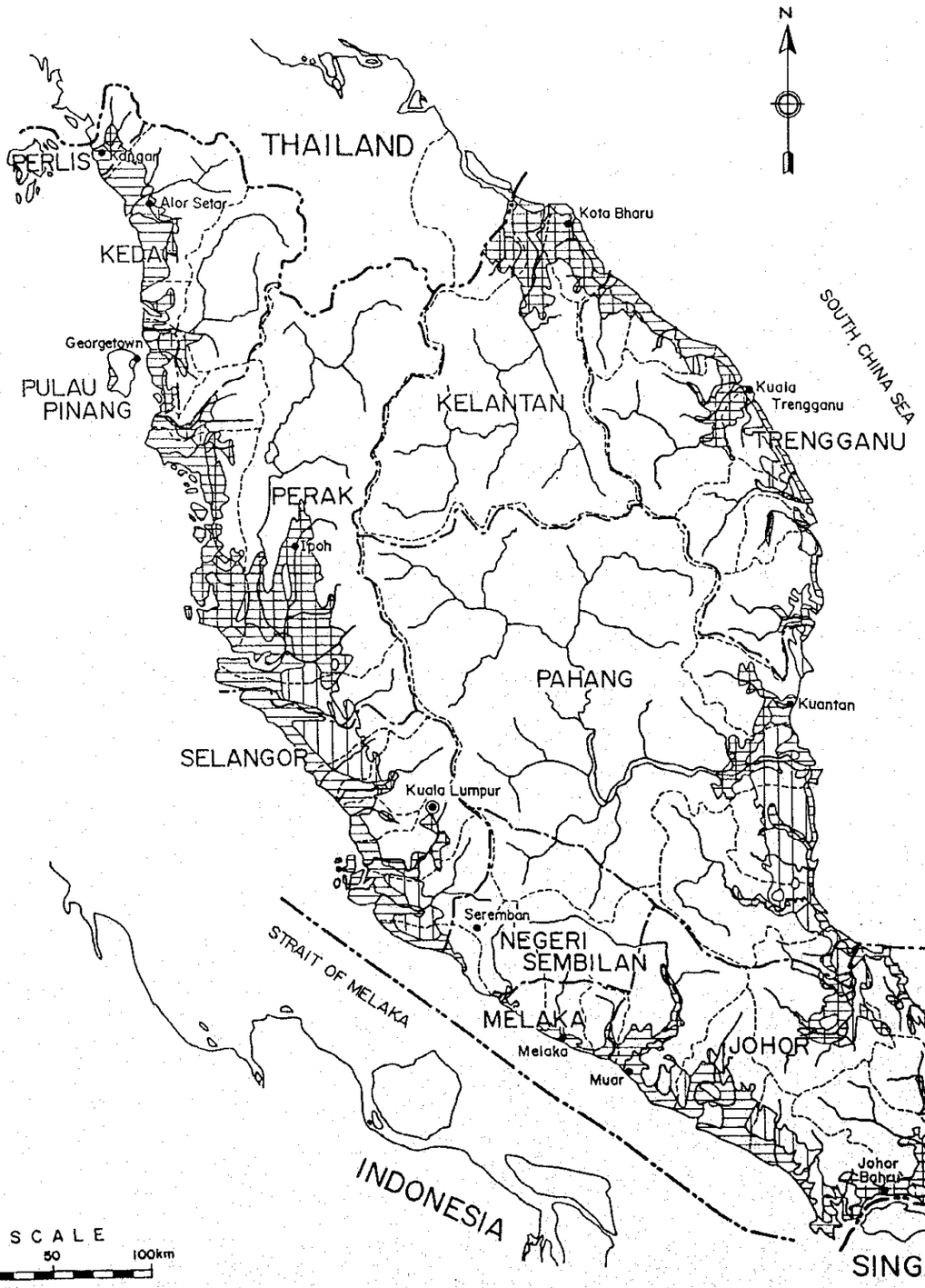
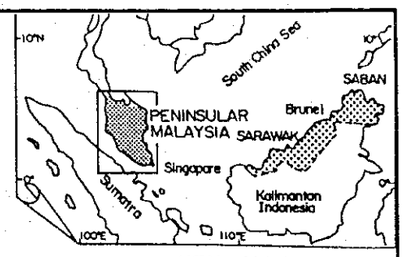


Fig. 1.4.3 Prime Minister's Department

Fig. 2.3.1 Basins for Hydrological Evaluation







KEY MAP

LEGEND

- National Boundary
- State Boundary
- Watershed Boundary
- Rivers
- Capital
- City and Town

Simpang Formation	Continental, fluviatile sediments made up gravel, sand, clay and silt of Pleistocene age. The bulk of the placer tin is derived from this unit which overlies bedrock.
Kempandang Formation	Pleistocene marine sediments made up of clay with shells and sand.
Gula Formation	Holocene grey to greenish-grey marine to estuarine clay and subordinate sand covering the coastal areas of peninsular. Included in this unit are the beach ridges, mangrove, and the riverine nipah deposits.
Beruas Formation	Fluviatile-estuarine-lacustrine deposits, made up of clay, sandy clay, sandy gravel, silt and peat of Holocene age. This unit overlies the Simpang Formation, filling channels, depressions as well as overlying bedrock at several places.

Fig. 2.4.1 Quaternary Geological Map of Peninsular Malaysia

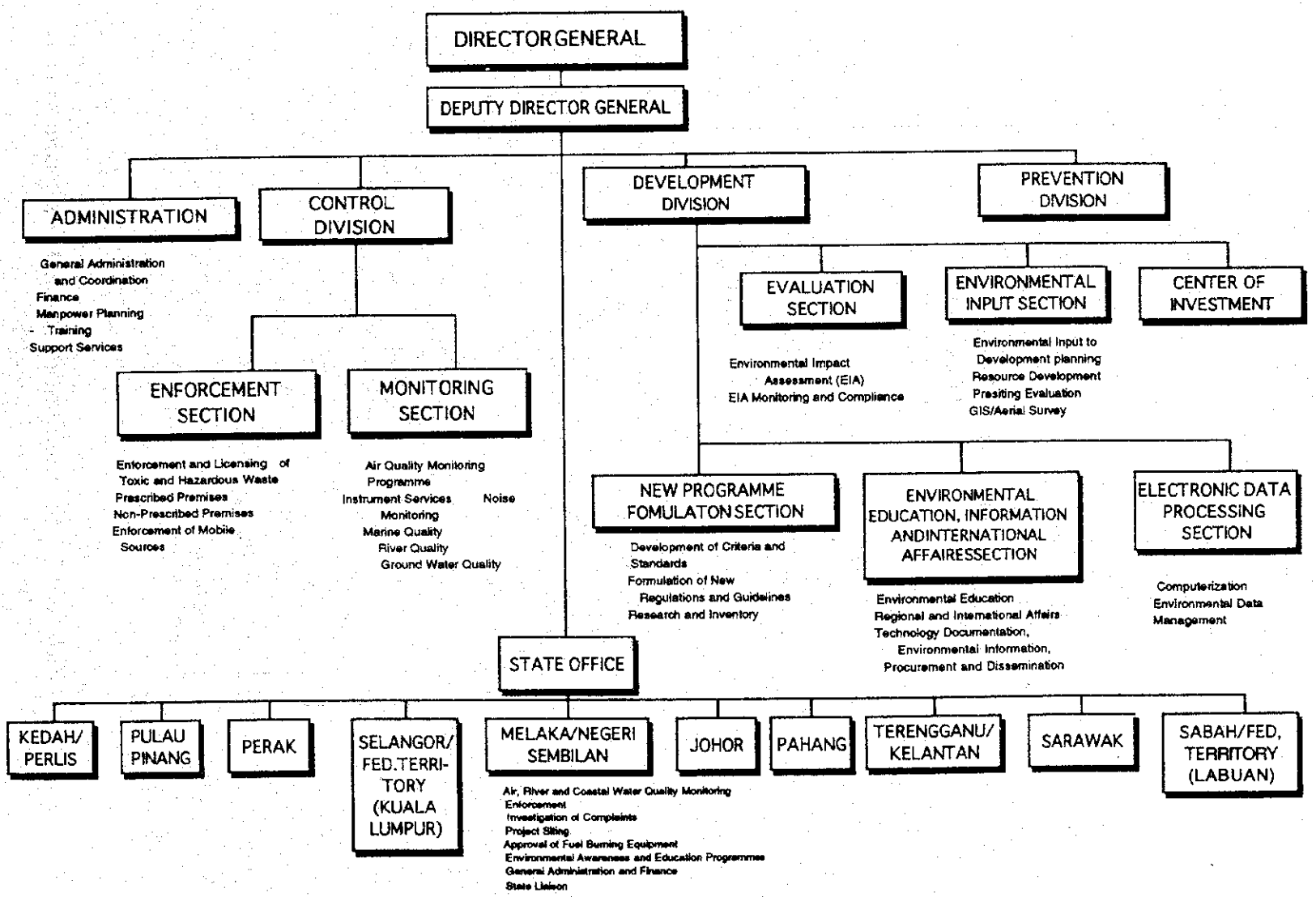


Fig. 2.6.1 Organizational Chart of Department of Environment

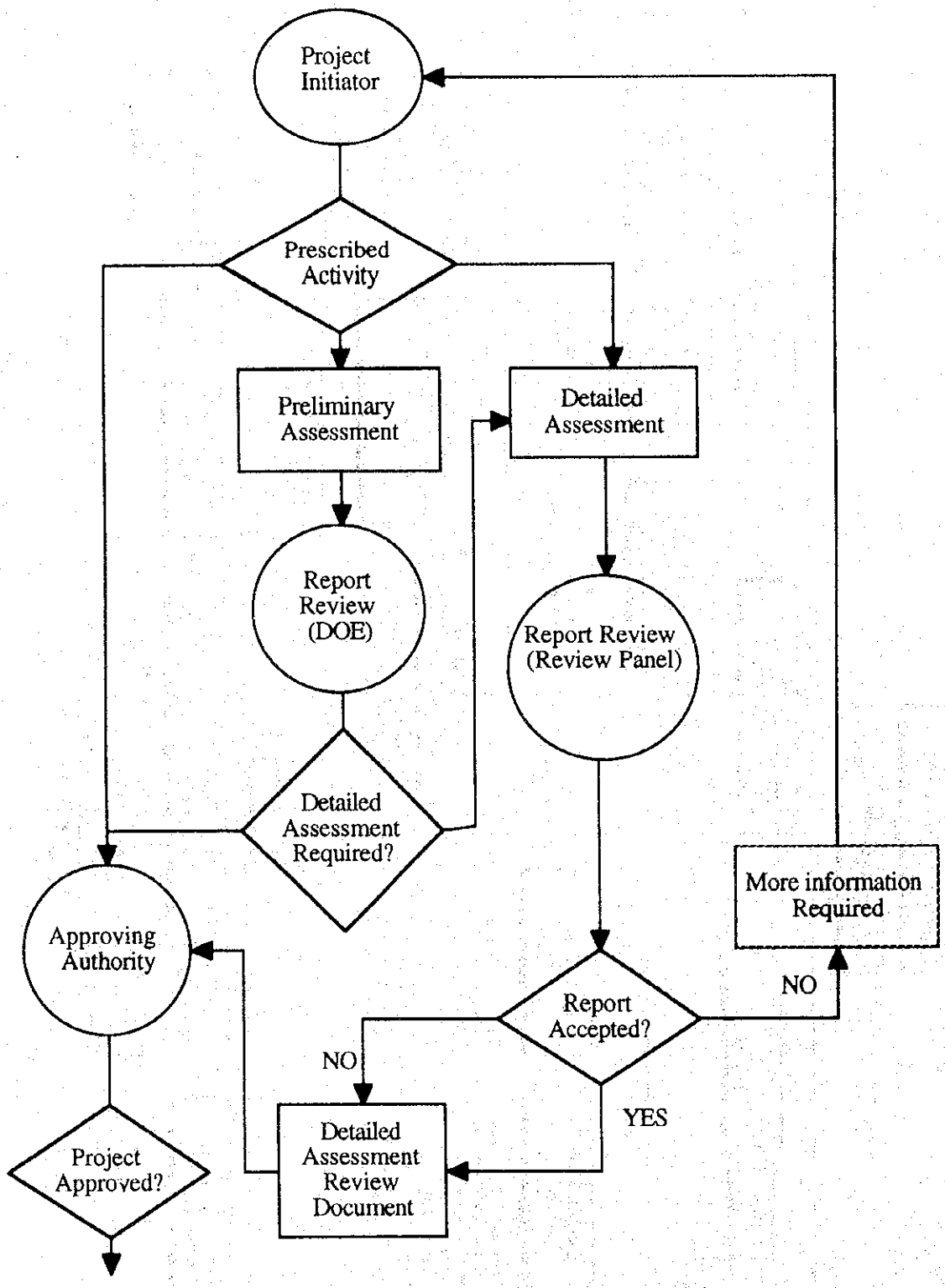


Fig. 2.6.2 **Outline of Environmental Impact Assessment Procedure in Malaysia**

Fig.3.2.1 Conceptual Diagram of Small Reservoir Development

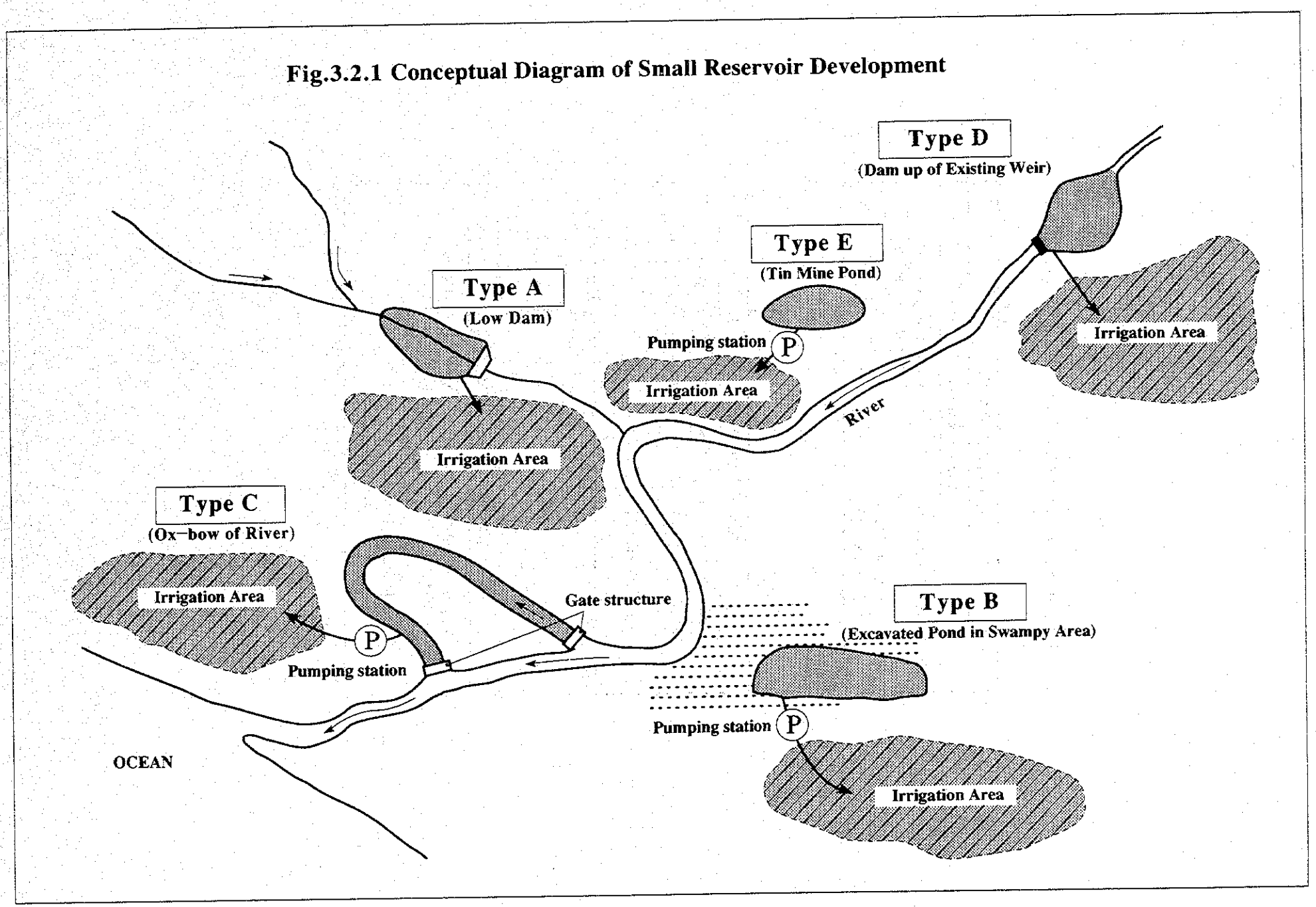


Fig. 3.4.1 Implementation Model for "Integrated Mini-Project"

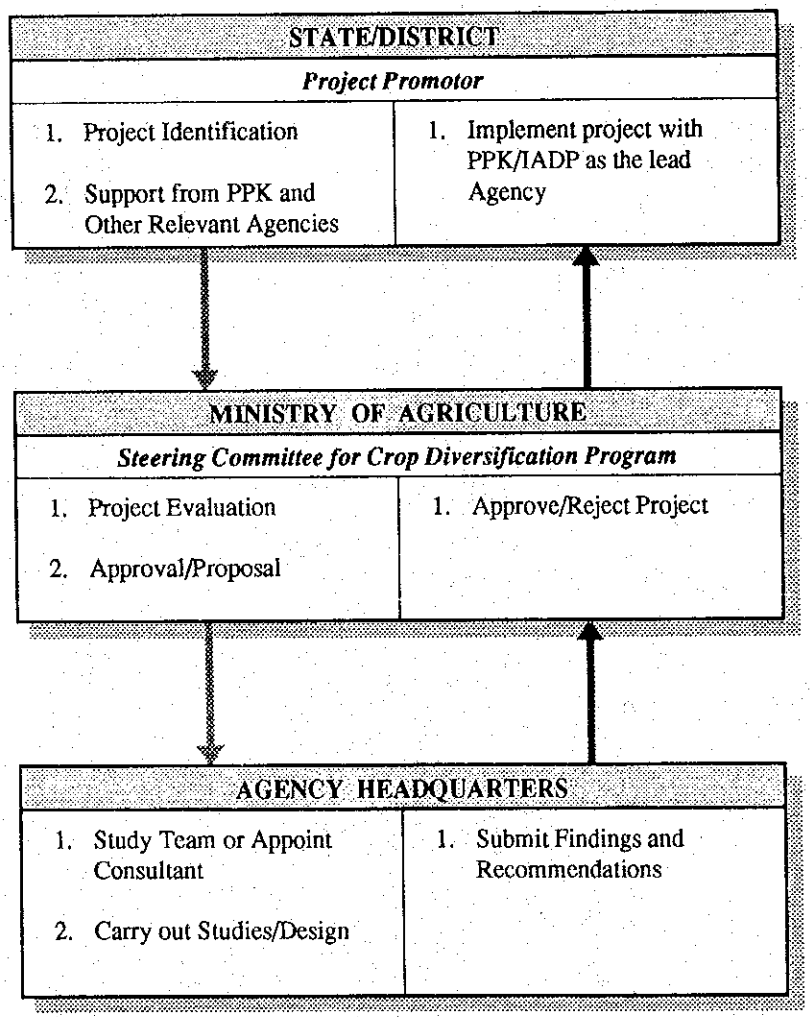


Fig. 3.5.1 REGISTRATION FORM FOR SMALL RESERVOIR

Code No.	
Basin No.	
Name of River	

1	Owner	
2	Office Address	
3	Contact Person	
4	Telephone No.	
5	Fax. No.	
6	Location of Reservoir	
	- Mukim	
	- District	
	- State	
	- Description of direction to site	
7	Type of Reservoir	
	- Low Dam	
	- Pond	
	- Oxbow of River	
	- Upstream Weir	
	- Tin Mine Pond or Lake	
8	Height of Dam (m)	
9	Length of Dam (m)	
10	Surface Area (ha)	
11	Storage Volume (cu. m)	
12	Normal Water Level (El. m)	
13	Year Constructed	
14	Sketch of layout and cross section	

Fig. 5.2.1 Mean Monthly Rainfall in/around the Project Area

unit : mm

		Jan	Feb	Mar	Apr	May	Jun	Nul	Aug	Sep	Oct	Nov	Dec	Ann
PERLIS	*1	41.9	38.7	109.0	151.7	180.5	141.7	167.0	175.5	266.5	237.9	206.4	100.4	1817.2
KEDAH	*2	26.4	35.3	90.5	202.0	293.7	260.9	298.2	316.6	404.0	394.5	218.2	48.9	2589.2
MELAKA	*3	97.1	90.3	163.3	189.2	156.7	104.0	119.3	121.2	153.9	182.3	212.2	139.8	1729.3
JOHOR	*4	155.9	137.9	219.8	259.4	177.3	151.2	174.8	171.3	202.4	234.7	270.4	191.6	2346.8
TERENGGANU	*5	287.8	152.9	140.3	144.2	199.1	166.9	186.6	195.4	263.8	293.9	429.6	597.6	3058.1

Remarks:
*1 Based on the records of Bukit Temiang (DID 6502010), average of 1967 to 1990
*2 Based on the records of Ulu Melaka (DID 6397112), average of 1953 to 1990
*3 Based on the records of Bukit Senggeh (DID 2324032), average of 1953 to 1990
*4 Based on the records of Parit Sulong (DID 1929064), average of 1951 to 1990
*5 Based on the records of Paya Kemat (DID 5029036), average of 1956 to 1990

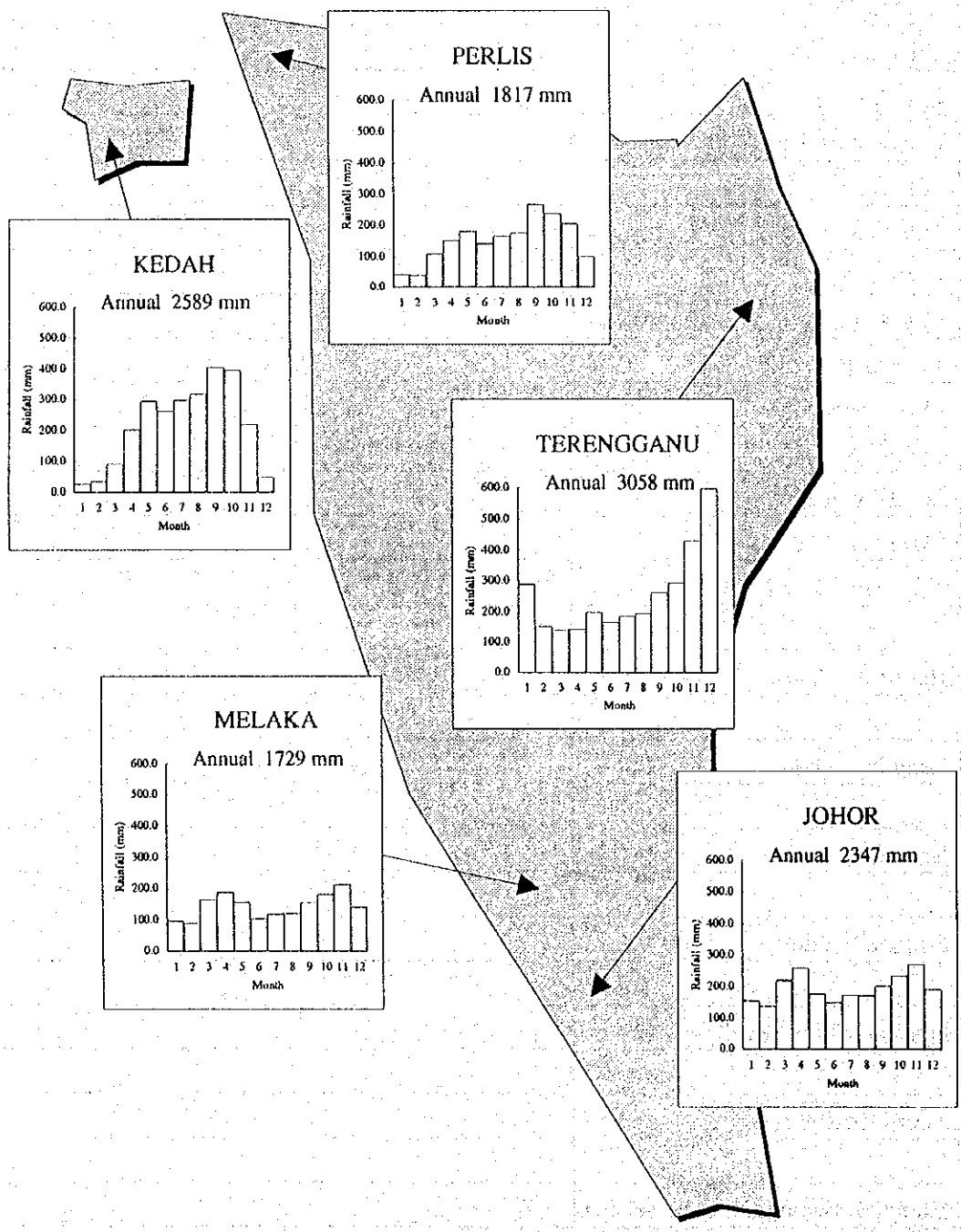
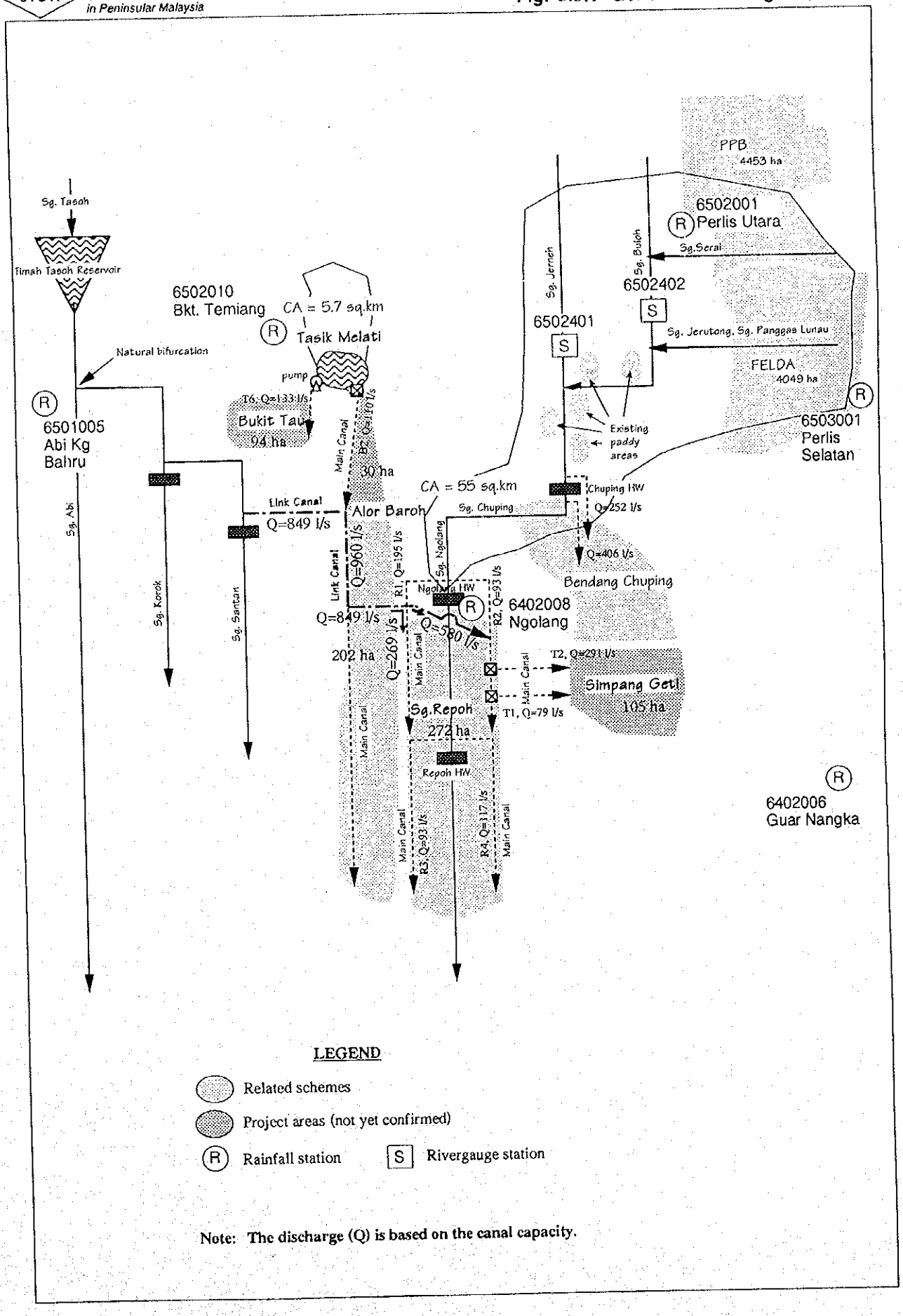


Fig. 5.3.1 General Flow Diagram, Perlis



Note: The discharge (Q) is based on the canal capacity.

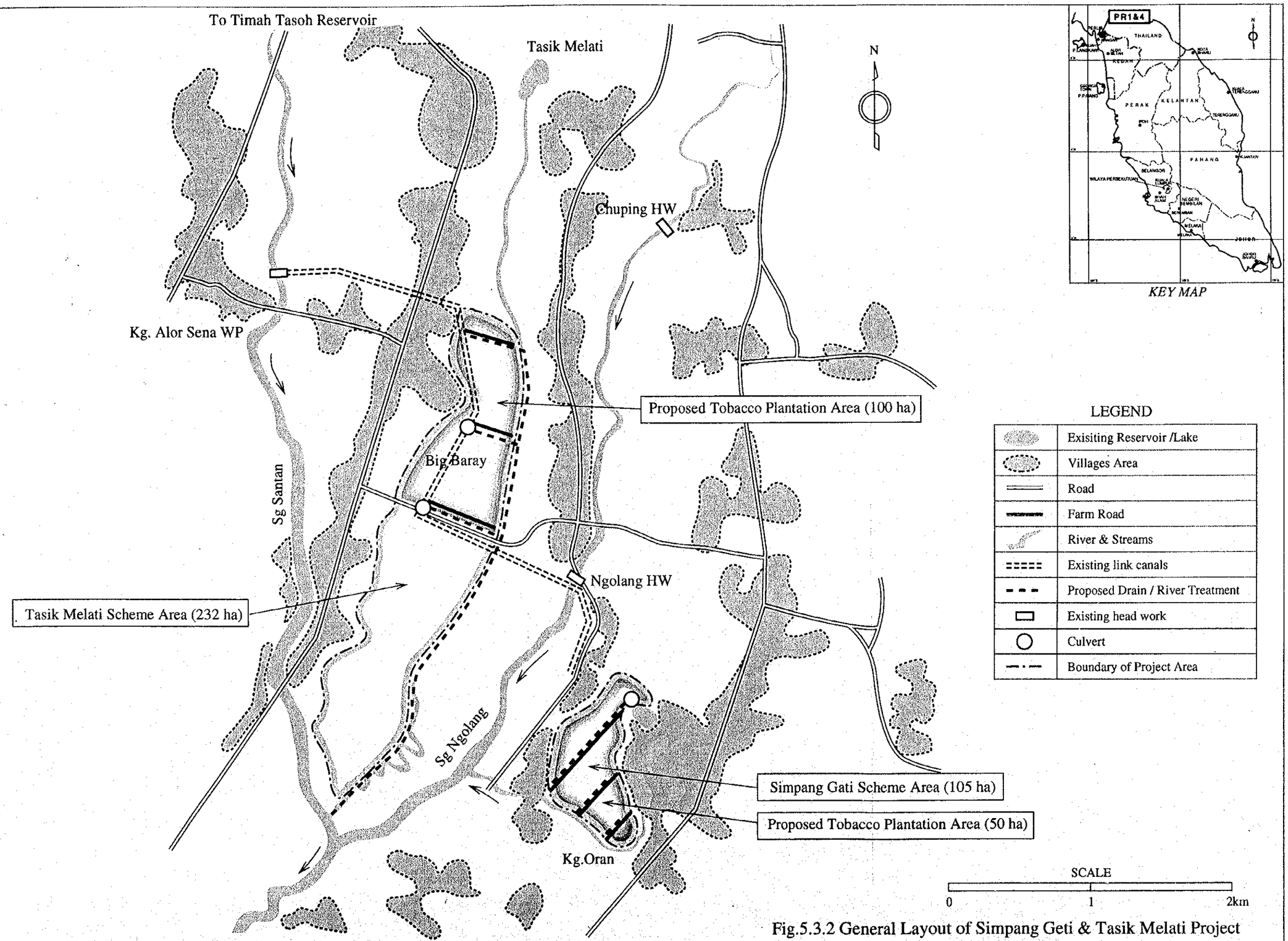


Fig.5.3.2 General Layout of Simpang Geti & Tasik Melati Project

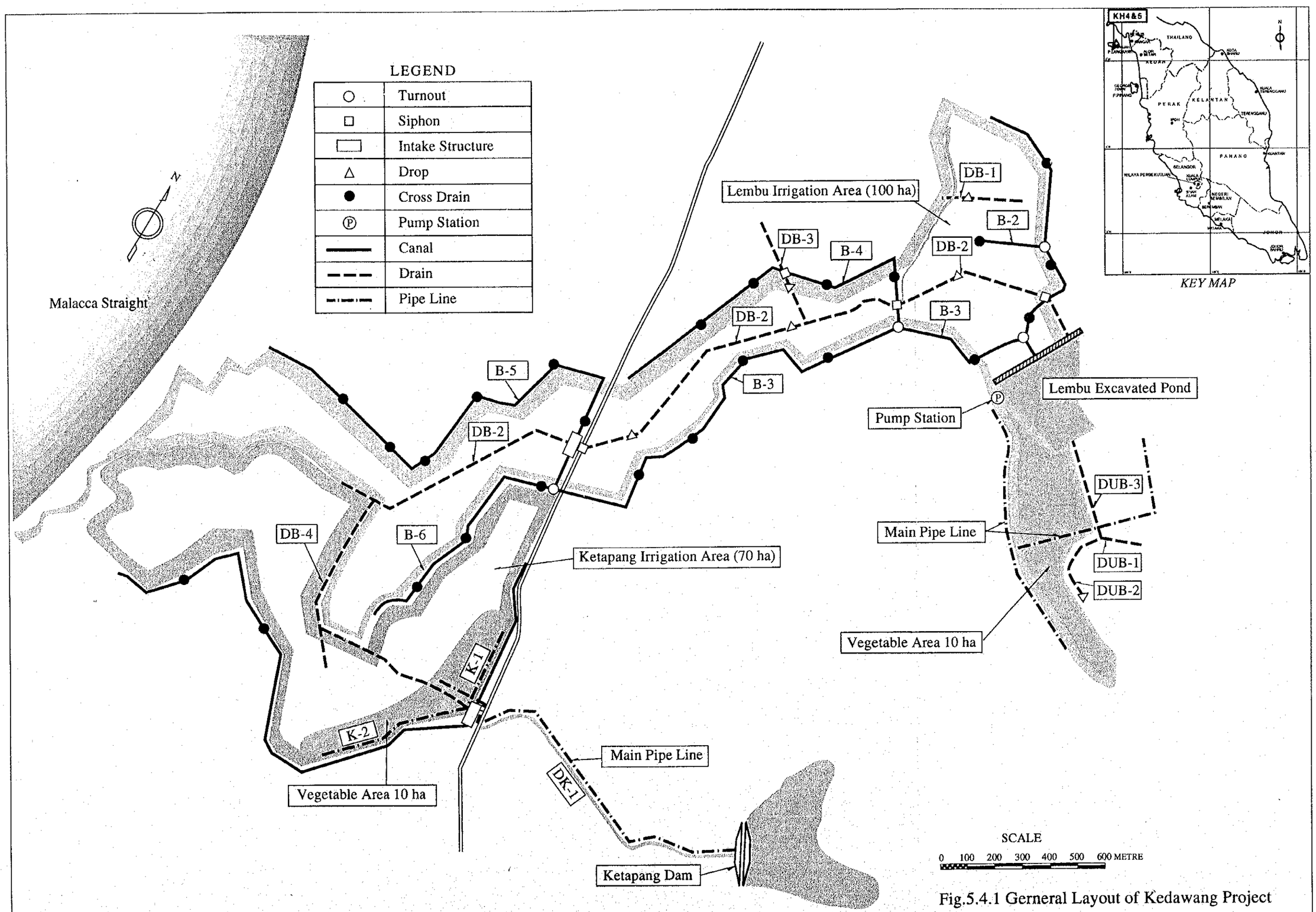
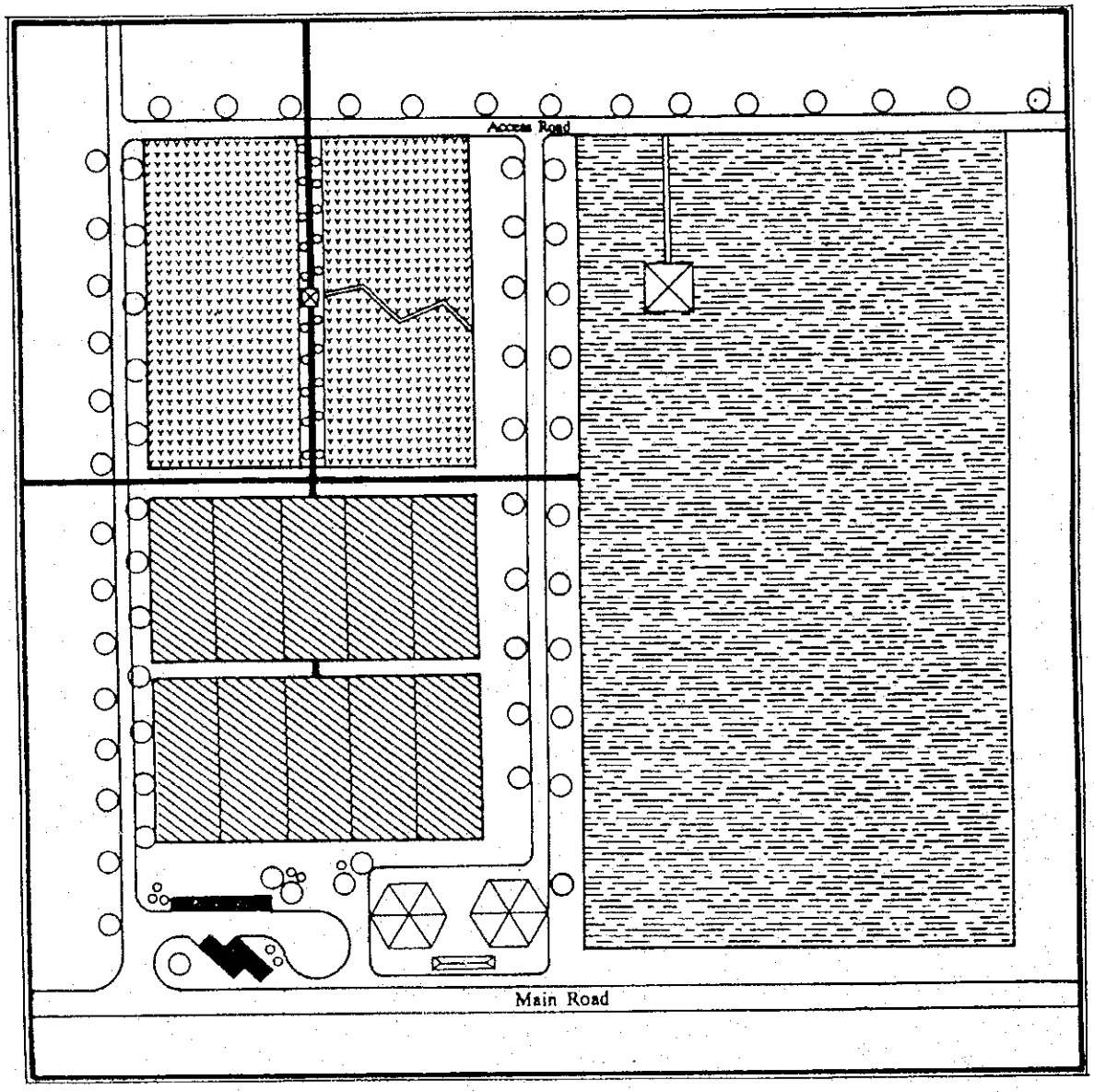


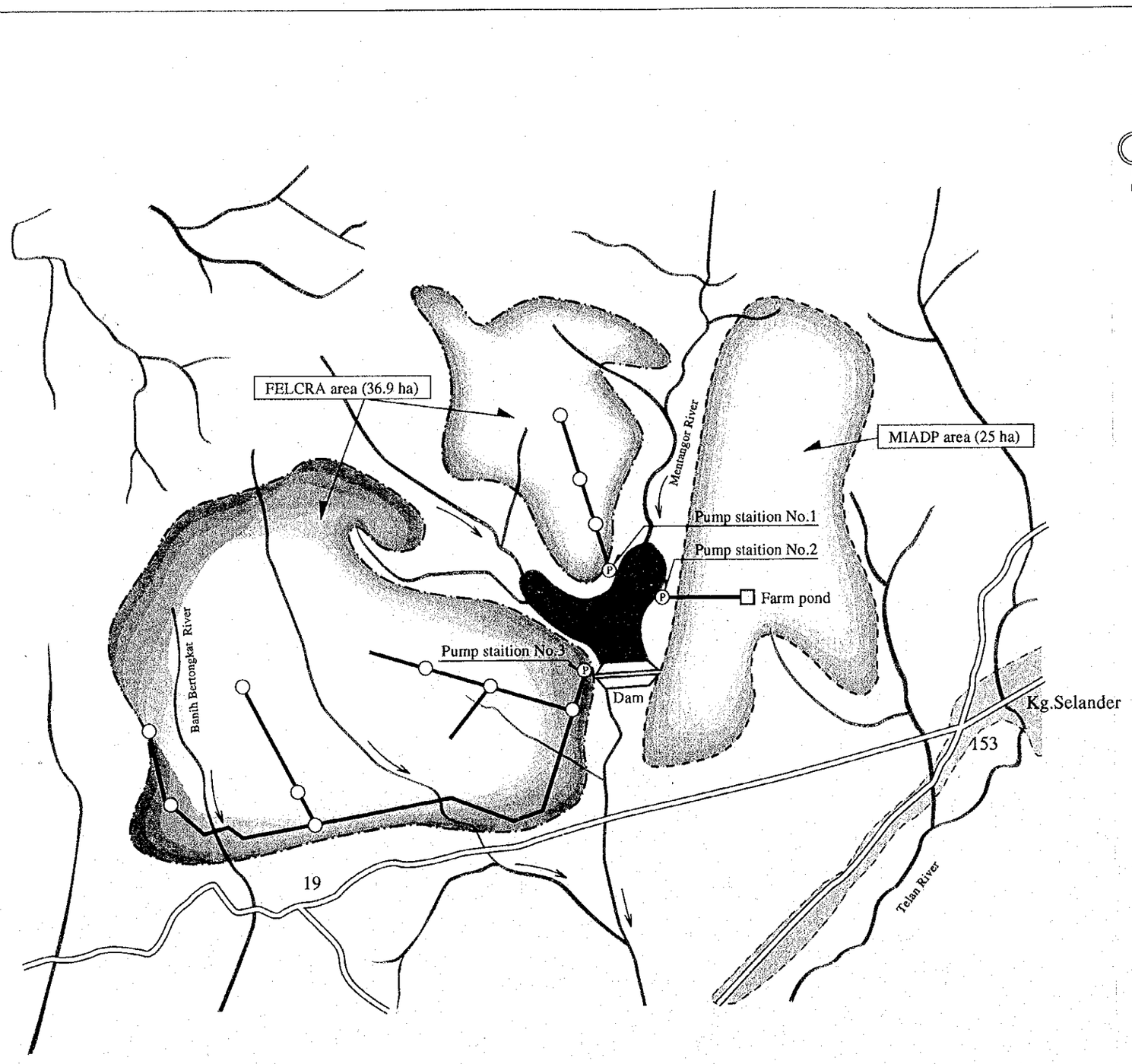
Fig.5.4.1 Gerneral Layout of Kedawang Project

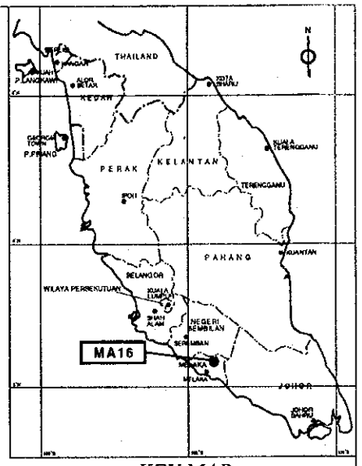


LEGEND

- Paddy Field
- Sunshine Shelter
- Resting Facilities
- Parking Area
- Restaurants
- Small Reservoir
- Wooden Pathway
- Open Channel
- Trees
- Toilets

Fig. 5.4.2 A Schematic View of Agrotourism Facilities





KEY MAP

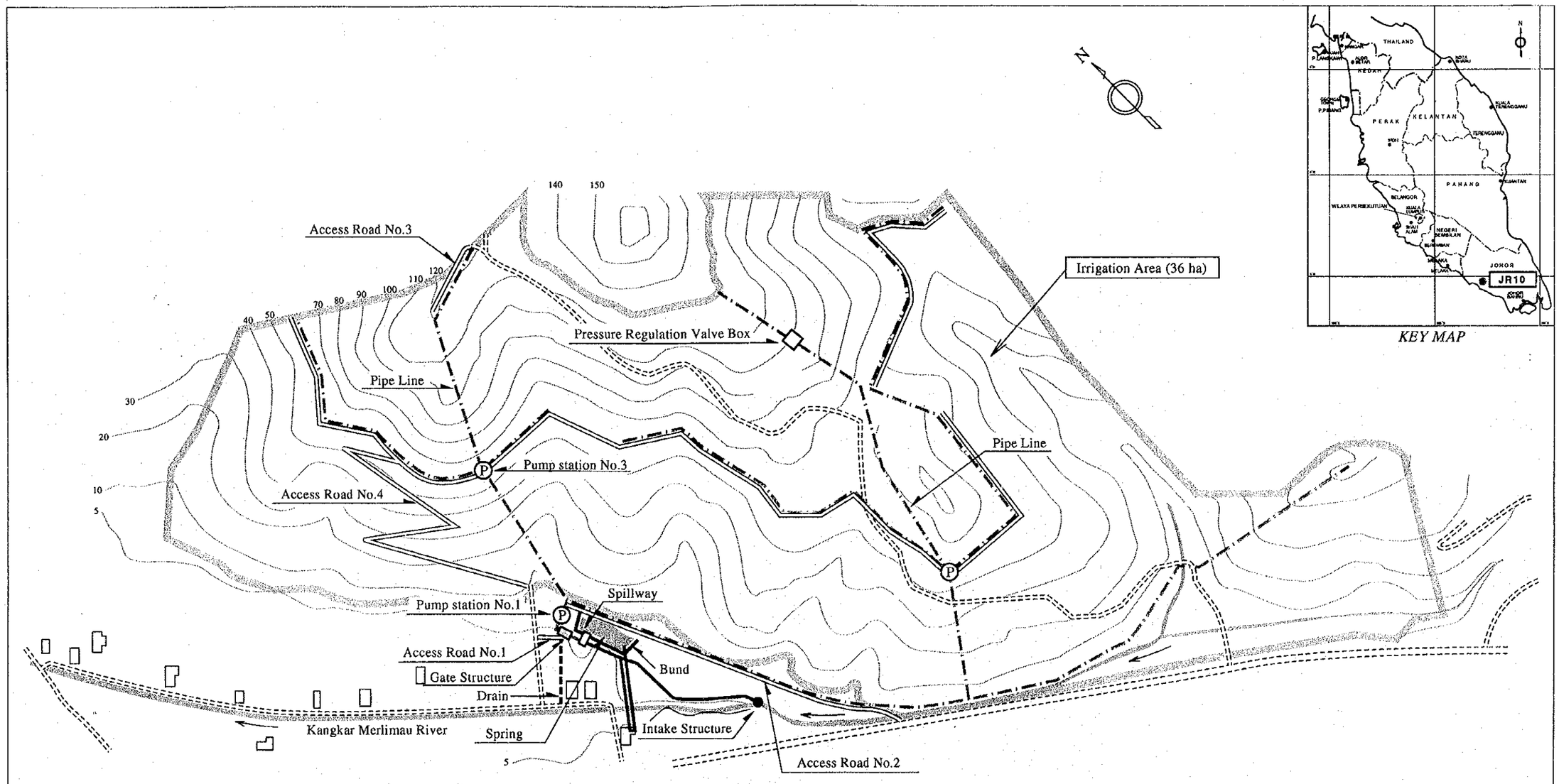
LEGEND

Ⓟ	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

Fig.5.5.1 General Layout of Bukit Sadanan Project



KEY MAP

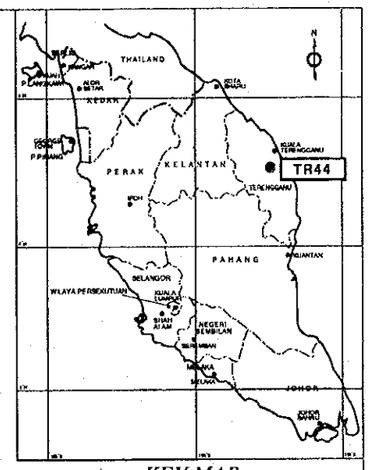
LEGEND

	Existing Roads
	Access & Farm Roads
	Pipe line
	Irrigation Canals
	Drains
	Villager's houses

SCALE

0 100 200m

Fig.5.6.1 General Layout of Kelompok Kangkar Merlimau Project



KEY MAP

N

Irrigation Area (26.7 ha)

Peching River

Spil bank

Short cut of River
l=130m

Pump station

Udang River

Rehabilitation of
Existing Access Road
l = 1,300m

Por River

Irrigation Area (15.3 ha)

LEGEND

○	Culvent
▭	Pump station
═══	Farm / Access Road
━━━	Pipe line
= = = =	Existing Roads
—·—·—	Boundary of Project Area

SCALE

0 100 200m

Fig.5.7.1 General Layout of Pasir Nering Project

Annex

S / W

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY

ON

SMALL RESERVOIR DEVELOPMENT

IN

PENINSULAR MALAYSIA

AGREED UPON BETWEEN

THE ECONOMIC PLANNING UNIT

OF

THE PRIME MINISTER'S DEPARTMENT

ON BEHALF OF THE GOVERNMENT OF MALAYSIA

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

KUALA LUMPUR, 16 FEBRUARY 1993

Kassim bin Sarbani
Director, Agriculture Section
The Economic Planning Unit
The Prime Minister's Department
on behalf of the Government of Malaysia

Terushi Egashira
Leader
Preparatory Study Team
The Japan International
Cooperation Agency

I. INTRODUCTION

In response to the request by the Government of Malaysia, the Government of Japan has decided to conduct the Feasibility Study on Small Reservoir Development in Peninsular Malaysia (hereinafter referred to as the Study) in accordance with the relevent laws and regulations in force in Japan. Accordingly, the Japan International Cooperation Agency (hereinafter referred to as JICA), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Malaysia.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are as follows:

A. To identify and evaluate existing and potential small reservoir development in Peninsular Malaysia.

B. To select pilot small reservoir irrigation projects and undertake feasibility studies.

C. To establish guidelines for the planning, design, operation and maintenance of small reservoirs for irrigation.

III. OUTLINE OF THE STUDY

A. Study Area

The Study shall cover agricultural areas in Peninsular Malaysia.

B. Scope of the Study

The Study shall comprise the following two phases:

Phase I

1. Review existing development policies, strategies and projects relevent to the Study.

2. Collect and review the existing data and information on small reservoir development practices.

3. Prepare criteria (taking into account factors such as erosion, siltation, hydrology, topography, geology, engineering, socio-economy and environment) for identifying potential sites for small reservoir development.

4. Identify potential sites for small reservoir development in accordance with the above criteria for various purposes in the Study area.

5. Collect and compile data and information on potential service areas of the small reservoirs.

6. Compile and evaluate the results of the above identification and classify the potential small reservoir schemes into several categories.

7. Establish an information system on small reservoirs.

8. Select sites where the pilot small reservoir irrigation projects can be formulated.

Phase II

1. Collect additional data and information relevant to the formulation of the pilot small reservoir irrigation projects.

2. Formulate the pilot small reservoir irrigation projects, including agricultural development, water resources development, irrigation and drainage, and supporting services plans.

3. Design the pilot projects facilities and prepare the operation and maintenance manuals.

4. Analyze the expected results of the pilot projects (financial profitability, economic impact, social changes and environmental effects).

5. Prepare guidelines for the small reservoir irrigation development including planning, design, operation and maintenance.

IV. Study Schedule

The tentative schedule of the Study is as attached (see Annex).

V. REPORTS

JICA shall submit the following reports in English to the Government of Malaysia.

A. Inception Report

Thirty (30) copies at the commencement of the Study.

B. Progress Report I

Thirty (30) copies in the middle of Phase I.

C. Interim Report

Thirty (30) copies at the end of Phase I.

D. Draft Final Report

Thirty (30) copies at the end of Phase II.
The Government of Malaysia shall submit the comments on the Draft Final Report to JICA within one (1) month.

E. Final Report

Hundred (100) copies within two months after the receipt of the comments from the Government of Malaysia on the Draft Final Report.

F. Guidelines for Small Reservoir Irrigation Development

Hundred (100) copies to be submitted at the same time as the Final Report.

VI. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures :

1. To dispatch, at its own expense, a Study Team(s) to Malaysia; and

2. To provide technical training of the Malaysian counterpart personnel in the course of the Study.

VII. UNDERTAKING OF THE GOVERNMENT OF MALAYSIA

A. To facilitate smooth conduct of the Study, the Government shall take necessary measures :

1. To inform the members of the Study Team any existing risk in the Study area and to take any measures deemed necessary to secure the safety of the Study Team;

2. To ensure the necessary entry permits for the Study Team to conduct field surveys in Malaysia and exempt them from consular fees;

3. To exempt the members of the Study Team from taxes and duties, as normally accorded under the provision of Malaysian General Circular No. 1 of 1979, on equipment, machinery and other materials brought into and out of Malaysia for the conduct of the Study;

4. To exempt the non-Malaysian members of the Study Team from Malaysian income tax on their official emoluments in respects of their period of assignment in Malaysia in connection with the conduct of the Study while retaining the right to take such emoluments into account for the purpose of assessing the amount to be applied to income from other sources;

5. To provide necessary facilities to the Study Team for the remittance as well as the utilization of funds introduced into Malaysia from Japan in connection with the implementation of the Study;

6. To secure permission for entry into private properties or restricted areas for the implementation of the Study;

7. To make arrangements for the Study Team to take back to Japan the data, maps and other materials connected with the Study, subject to the approval of the Government of Malaysia, in order to prepare the reports;

8. To provide the Study Team with medical services when needed, the expenses of which shall be chargeable to the members of the Study Team; and

9. To secure clearance for the use of communication facilities including transceivers.

B. The Government of Malaysia shall indemnify any member of the Study Team in respect of damages arising from any legal action against him in relation of any act performed or omissions made in undertaking the Study except when the both Government agree that such a member is guilty of gross negligence of wilful misconduct.

C. The Department of Irrigation and Drainage (hereinafter referred to as DID) shall act as a counterpart agency of the Study Team and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the Study.

D. DID shall, at its own expense, provide the Study Team with the following in cooperation with other organizations concerned :

1. available data, information and materials including aerial photographs and topographic maps related to the Study,

2. counterpart personnel,

3. suitable office space with clerical services and necessary equipment in DID headquarters and the Study area,

4. vehicles with drivers and other supporting services necessary for the implementation of the Study, and

5. credential or identification cards.

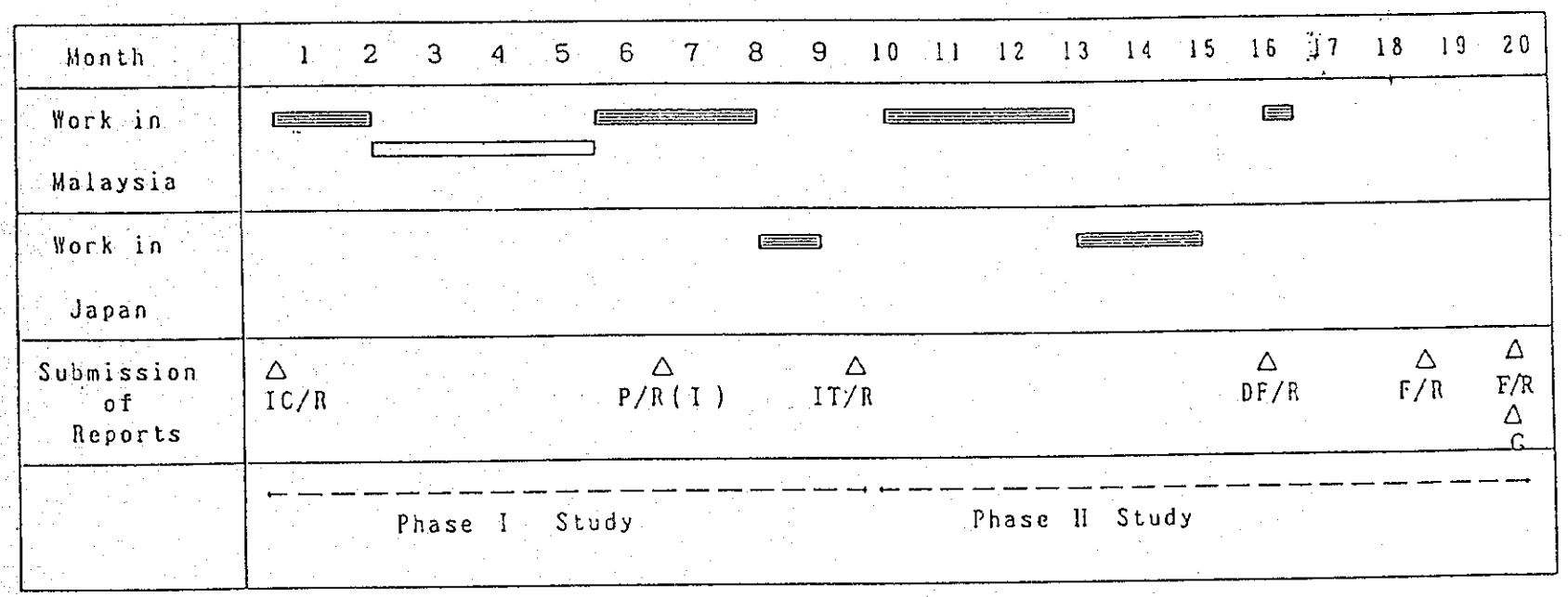
E. DID shall assist in conducting surveys assigned/requested by the Study Team in the course of the Study.

VIII. CONSULTATION

JICA, DID, Ministry of Agriculture and the Economic Planning Unit shall consult with each other in respect of any matter that may arise from or in connection with the Study.

(Annex 1)

TENTATIVE WORK SCHEDULE



(Note)

IC/R : Inception Report
IT/R : Interim Report
DF/R : Draft Final Report
P/R (I) : Progress Report (I)
F/R : Final Report
G : Technical Guidelines

work carried out by the Japanese Study team
work carried out by Malaysian side