Table 3-1 Probable Point Rainfall Intensities

Kepala Batas, Alor Star

(Unit : mm/hour)

Return Period	Rainfall Duration									
	15 min	30 min	45 min	1 hr	2 hr	3 hr	4 hr	5 hr	6 hr	12 hr
2	132.8	98.4	78.4	64.0	37.8	26.7	21.0	17.3	14.7	8.1
3	144.8	105.8	85.6	70.6	41.7	29.8	23.4	19.4	16.5	9.0
5	158.0	114.0	93.7	77.9	46.2	33.2	26.0	21.6	18.6	10.1
8	169.6	121.0	100.7	84.2	50.0	36.2	28.3	23.6	20.3	11.0
10	174.8	124.4	103.9	87.1	51.8	37.5	29.4	24.5	21.1	11.5
20	190.8	134.4	113.6	96.0	57.2	41.6	32.5	27.2	23.5	12.8
25	196.0	137.4	116.7	98.8	58.8	42.9	33.5	28.1	24.3	13.2
30	200.0	140.0	119.2	101.0	60.2	44.0	34.4	28.8	24.9	13.5
50	211.6	147.2	126.3	107.4	64.1	47.0	36.7	30.7	26.6	14.4
100	227.2	156.8	135.7	115.9	69.3	51.0	39.8	33.4	29.0	15.7
200	242.4	166.4	145.1	124.5	74.4	55.0	42.8	36.0	31.3	16.9

Bayan Lepas, Penang

(Unit : mm/hour)

Return Period	Rainfall Duration									
	15 min	30 min	45 min	1 hr	2 hr	3 hr	4 hr	5 hr	6 hr	12 hr
2	129.2	102.6	84.5	71.7	44.0	31.0	24.6	20.2	17.3	9.4
3	140.4	110.0	91.5	78.7	49.0	34.6	27.3	22.3	19.1	10.6
5	152.4	118.4	99.2	86.6	54.6	38.6	30.3	24.6	21.1	12.0
8	163.2	125.4	105.9	93.3	59.4	42.1	32.8	26.6	22.8	13.1
10	168.0	128.6	109.1	96.4	61.6	43.7	34.0	27.6	23.6	13.6
20	182.8	138.6	118.4	105.9	68.3	48.5	37.5	30.4	25.9	15.3
25	187.6	141.8	121.3	108.9	70.5	50.1	38.7	31.3	26.7	15.8
30	191.6	144.4	123.7	111.3	72.3	51.3	39.5	32.0	27.3	16.2
50	202.0	151.6	130.5	118.1	77.1	54.8	42.1	34.0	29.0	17.3
100	216.4	161.2	139.6	127.3	83.6	59.5	45.6	36.7	31.3	18.9
200	230.8	170.8	148.7	136.5	90.2	64.2	49.0	39.4	33.6	20.4

Lapangan Terbang, Melaka

(Unit : mm/hour)

Return Period	Rainfall Duration									
	15 min	30 min	45 min	1 hr	2 hr	3 hr	4 hr	5 hr	6 hr	12 hr
2	128.4	100.0	80.1	66.8	40.7	29.1	22.9	18.8	15.9	8.5
3	140.0	109.8	88.4	74.9	46.3	33.7	26.8	21.9	18.5	9.9
5	153.2	120.6	97.6	83.9	52.5	38.8	31.1	25.4	21.5	11.4
8	164.8	130.0	105.5	91.7	58.0	43.1	34.8	28.4	24.0	12.8
10	170.0	134.2	109.1	95.3	60.5	45.2	36.5	29.8	25.2	13.4
20	186.0	147.4	120.1	106.2	67.9	51.3	41.7	34.0	28.7	15.3
25	190.8	151.6	123.6	109.6	70.3	53.3	43.3	35.4	29.9	15.9
30	195.2	155.0	126.5	112.4	72.3	54.8	44.7	36.5	30.8	16.3
50	206.4	164.4	134.4	120.3	77.8	59.3	48.4	39.5	33.3	17.7
100	222.0	177.0	145.2	130.8	85.1	65.2	53.4	43.6	36.8	19.5
200	237.6	189.8	155.9	141.3	92.3	71.2	58.4	47.6	40.2	21.3

Table 3-2 Parameters for Land Use Categories Applied to Flood Simulation Model

Land Use Item	Parameters of Quasi Liner Storage Type Model		Concentration Time "Tc" (min./km^2)		Peak Discharge (m3/s/km^2)	
	Coefficient "C" of Basin Characteristics Applied to Kadoya's Formula	Runoff Coefficient "F"	Return Period of 1/5 year	Return Period of 1/100 year	Return Period of 1/5 year	Return Period of 1/00 year
Residential Area	120	0.85	0.4	0.3	33	49
Commercial Area	90	0.90	0.3	0.2	38	55
Industrial Area	120	0.80	0.4	0.3	31	46
Institutional Area	120	0.80	0.4	0.3	31	46
Recreation Area	200	0.30	1.0	0.8	9	15
Nature Areas	290	0.35	1.8	1.4	6	12
Paddy	1,000	0.90	5.9	4.5	8	16
Dry Crop	210	0.45	1.0	0.8	12	20
Road	60	0.95	0.3	0.2	40	58

Table 3-3(1/2) Features of River Channels Applied to Flood Runoff Simulation Model (for Sungai Petani)

River		Channel No.	Channel Length (m)	Average Channel Width (m)	Average Channel Bed Gradient	Manning's Roughness Coefficient "n"	Parameters of Storage Function Model		Channel Travelling Time (hour)
							K	P	
Lalang	Main Stream	CLA- 1	1,750.0	6	1/ 300	0.035	nil	nil	0.23
		CLA- 2	2,328.0	6	1/ 700	0.035	nil	nil	0.31
		CLA- 3	1,362.0	16	1/ 850	0.035	1.2	0.6	0.18
		CLA- 4	1,549.0	40	1/ 850	0.035	1.9	0.6	0.20
	Line A	CLA- 5	3,526.5	5	1/ 230	0.015	nil	nil	0.47
	Bakap	CLA- 6	1,204.5	14	1/ 300	0.035	0.7	0.6	0.16
		CLA- 7	2,840.5	7	1/ 1300	0.015	nil	nil	0.38
Tukang	Main Stream	CTU- 1	1,800.0	12	1/ 800	0.015	nil	nil	0.24
		CTU- 2	300.0	4	1/ 1000	0.035	nil	nil	0.04
		CTU- 3	1,800.0	25	1/ 5000	0.035	3.1	0.6	0.24
Layar Besar	Main Stream	CLB- 1	2,000.0	4	1/ 500	0.015	nil	nil	0.26
		CLB- 2	1,800.0	16	1/ 800	0.035	1.5	0.6	0.24
Che Bima	Main Stream	CCB- 1	1,330.0	4	1/ 1000	0.015	nil	nil	0.18
		CCB- 2	1,170.0	8	1/ 1000	0.015	nil	nil	0.15
Sg. Petani	Main Stream	CPE- 1	500.0	6	1/ 700	0.035	nil	nil	0.07
		CPE- 2	400.0	6	1/ 700	0.035	nil	nil	0.05
		CPE- 3	1,004.0	9	1/ 700	0.035	0.6	0.6	0.13
		CPE- 4	803.0	14	1/ 3500	0.035	1.0	0.6	0.11
		CPE- 5	1,000.0	12	1/ 3500	0.035	1.2	0.6	0.13
		CPE- 6	400.0	17	1/ 7500	0.035	0.7	0.6	0.05
		CPE- 7	1,082.0	24	1/ 7500	0.035	2.1	0.6	0.14
		CPE- 8	788.0	45	1/ 7500	0.035	2.0	0.6	0.10
		CPE- 9	730.0	69	1/ 7500	0.035	2.1	0.6	0.10
		CPE- 10	4,193.0	79	1/ 7500	0.035	13.0	0.6	0.55
	Pasir Kechil	CPE- 11	849.2	5	1/ 270	0.035	nil	nil	0.11
	Line A1	CPE- 12	1,300.0	12	1/ 710	0.035	0.9	0.6	0.17
		CPE- 13	900.0	2	1/ 610	0.035	nil	nil	0.12
	Line A	CPE- 14	800.0	3	1/ 220	0.035	nil	nil	0.11
	Line G	CPE- 15	1,400.0	6	1/ 270	0.035	nil	nil	0.19
	Air Mendideh	CPE- 16	1,079.0	6	1/ 380	0.035	nil	nil	0.14
		CPE- 17	1,121.0	11	1/ 740	0.035	0.8	0.6	0.15
	Gelegpr	CPE- 18	1,950.0	11	1/ 1250	0.035	1.6	0.6	0.26
Pasir	Main Stream	CPA- 1	1,400.0	9	1/ 1250	0.035	nil	nil	0.19
		CPA- 2	2,800.0	13	1/ 2000	0.035	2.8	0.6	0.37
		CPA- 3	700.0	9	1/ 770	0.035	0.5	0.6	0.09
		CPA- 4	1,600.0	7	1/ 770	0.035	1.0	0.6	0.21
		CPA- 5	1,100.0	12	1/ 770	0.035	0.8	0.6	0.15
		CPA- 6	2,354.0	36	1/ 2000	0.035	3.6	0.6	0.31

Table 3-3(2/2) Features of River Channels Applied to Flood Runoff Simulation Model (for Melaka)

River		Channel No.	Channel Length (m)	Average Channel Width (m)	Average Channel Bed Gradient	Manning's Roughness Coefficient "n"	Parameters of Storage Function Model		Channel Travelling Time (hour)
							K	P	
Lereh	Main Stream	CLE- 1	3,000.0	18	1/ 3,750	0.035	4.2	0.6	0.40
	Udang	CLE- 2	2,700.0	7	1/ 300	0.020	0.9	0.6	0.36
		CLE- 3	4,300.0	7	1/ 870	0.035	2.7	0.6	0.57
	S. Gajah	CLE- 4	1,800.0	10	1/ 1,000	0.035	1.3	0.6	0.24
Marim	Main Stream	CMA- 1	2,194.5	58	1/ 12,200	0.020	5.0	0.6	0.29
	Ayer Salak	CMA- 2	1,200.0	46	1/ 500	0.020	1.0	0.6	0.16
		CMA- 3	1,800.0	28	1/ 600	0.020	1.2	0.6	0.24
		CMA- 4	1,800.0	23	1/ 2,000	0.020	1.6	0.6	0.24
	Bertam Ulu	CMA- 5	600.0	8	1/ 240	0.350	nil	nil	0.08
	Ayer Hitam	CMA- 6	650.0	20	1/ 240	0.020	0.3	0.6	0.09
		CMA- 7	900.0	20	1/ 700	0.020	0.6	0.6	0.12
		CMA- 8	1,600.0	20	1/ 700	0.020	1.0	0.6	0.21
		CMA- 9	1,500.0	20	1/ 3,800	0.020	1.6	0.6	0.20
Melaka	Main Stream (1)*1	CME- 1	915.2	100	1/ 2,000	0.020	1.5	0.6	0.12
	Main Stream (2)*2	CME- 2	2,200.0	26	1/ 3,000	0.020	2.4	0.6	0.29
		CME- 3*3	1,800.0	26	1/ 3,000	0.035	2.7	0.6	0.24
		CME- 4	1,200.0	26	1/ 6,000	0.035	2.2	0.6	0.16
		CME- 5	1,000.0	28	1/ 7,000	0.035	2.0	0.6	0.13
		CME- 6	2,200.0	28	1/ 10,000	0.035	4.9	0.6	0.29
		CME- 7	800.0	26	1/ 10,000	0.035	1.7	0.6	0.11
		CME- 8	1,600.0	38	1/ 10,000	0.035	4.0	0.6	0.21
		CME- 9	800.0	32	1/ 10,000	0.035	1.9	0.6	0.11
		CME- 10	2,000.0	40	1/ 10,000	0.035	5.2	0.6	0.26
Cheng	Main Stream	CCH- 1	2,000.0	33	1/ 4,000	0.035	3.6	0.6	0.26
	S. Bangsal	CCH- 2	2,200.0	5	1/ 1,000	0.035	nil	nil	0.29
	Paya Rumput	CCH- 3	1,400.0	6	1/ 530	0.035	nil	nil	0.19
	Arang	CCH- 4	2,400.0	5	1/ 1,000	0.035	nil	nil	0.32
	Jeram	CCH- 5	2,400.0	18	1/ 1,300	0.020	1.7	0.6	0.32
	Jenuang	CCH- 6	1,800.0	6	1/ 1,000	0.035	nil	nil	0.24
Putat	Air Kero	CPU- 1	1,400.0	10	1/ 300	0.035	nil	nil	0.19
	Main Stream	CPU- 2	875.0	8	1/ 200	0.035	nil	nil	0.12
		CPU- 3	1,425.0	13	1/ 900	0.035	1.1	0.6	0.19
		CPU- 4	2,400.0	16	1/ 2,500	0.035	2.8	0.6	0.32
		CPU- 5	1,800.0	25	1/ 2,000	0.035	2.4	0.6	0.24

Note: *1 Upstream from diversion point up to confluence with Cheng river
*2 Downstream from diversion point
*3 The channel meets with Putat river

Table 3-4(1/2) Present and Future Basin Run-off Discharge (sg.Petani)

River	Sub-basin No.	Catchment Area (km2)	5-year return period		100-year return period	
			Present	Future	Present	Future
Lalang	LA- 1	2.29	25	53	39	78
	LA- 2	2.53	28	67	43	97
	LA- 3	3.47	35	108	55	156
	LA- 4	2.73	29	69	46	101
	LA- 5	1.14	14	35	21	50
	LA- 6	2.88	34	94	52	135
	LA- 7	1.18	5	7	6	11
	LA- 8	2.39	46	46	68	68
	LA- 9	3.17	66	104	97	150
	LA- 10	1.80	35	60	52	86
	LA- 11	0.95	14	25	20	36
Tukang	TU- 1	1.35	11	13	16	18
	TU- 2	1.45	24	46	35	67
	TU- 3	0.49	5	17	9	25
	TU- 4	0.18	4	7	5	9
	TU- 5	2.09	61	61	89	89
	TU- 6	0.89	23	29	34	41
	TU- 7	1.48	26	50	39	71
Layar Besar	LB- 1	0.66	20	22	29	32
	LB- 2	1.32	37	41	53	59
	LB- 3	0.94	27	31	38	45
	LB- 4	0.85	10	30	15	42
Che Bima	CB- 1	1.25	17	41	27	59
	CB- 2	1.19	12	39	20	56
	CB- 3	0.83	14	28	21	40
S. Petani	PE- 1	1.60	27	51	41	73
	PE- 2	0.28	9	10	12	14
	PE- 3	1.43	37	45	53	64
	PE- 4	1.41	42	44	60	64
	PE- 5	0.41	6	14	10	21
	PE- 6	0.96	22	32	32	47
	PE- 7	1.32	20	39	31	56
	PE- 8	0.78	22	27	32	39
	PE- 9	0.48	6	16	10	23
	PE- 10	0.82	17	27	25	39
	PE- 11	0.62	19	21	27	30
	PE- 12	1.55	15	24	22	34
	PE- 13	0.76	16	26	24	37
	PE- 14	1.13	12	15	17	21
	PE- 15	0.32	12	12	17	16
	PE- 16	0.90	29	31	42	44
	PE- 17	0.55	14	19	20	27
	PE- 18	0.46	13	16	19	22
	PE- 19	1.98	13	15	19	21
	PE- 20	1.21	17	30	26	43
	PE- 21	0.21	8	8	11	11
	PE- 22	0.43	11	15	16	21
	PE- 23	0.71	25	25	36	36
	PE- 24	1.18	37	39	53	56
	PE- 25	1.14	28	38	41	55
	PE- 26	1.08	34	38	49	55
	PE- 27	0.45	16	16	22	23
	PE- 28	1.46	41	42	59	60
	PE- 29	1.30	42	42	60	61
	PE- 30	0.91	30	30	43	43
	PE- 31	0.39	13	14	19	20
	PE- 32	2.70	79	84	116	122
	PE- 33	1.95	45	60	66	87
	PE- 34	4.84	81	124	121	181
Pasir	PA- 1	0.76	17	25	25	35
	PA- 2	3.61	65	107	98	156
	PA- 3	1.36	34	46	50	66
	PA- 4	2.40	68	78	98	112
	PA- 5	1.05	9	9	12	12
	PA- 6	1.44	32	32	46	46
	PA- 7	3.91	61	107	92	157
	PA- 8	2.27	24	50	37	73
	PA- 9	1.76	51	56	74	82
	PA- 10	4.88	44	130	69	189

Table 3-4(2/2) Present and Future Basin Run-off Discharge (Melaka)

River		Sub-basin No.	Catchment Area (km2)	5-year return period		100-year return period	
				Present	Future	Present	Future
Leleh	Udang	UD- 1	3.85	45	106	72	162
		UD- 2	7.34	94	160	154	249
		UD- 3	4.02	102	103	157	159
	S. Gajah	GA- 1	5.83	38	129	73	203
		GA- 2	1.34	12	13	22	24
		GA- 3	1.02	17	23	27	35
		GA- 4	0.67	10	10	17	17
	Leleh	LE- 1	10.75	85	202	152	325
Malim	Ayer Salak	AS- 1	8.48	91	210	155	328
		AS- 2	3.37	33	80	56	122
		AS- 3	3.15	27	72	49	112
		AS- 4	1.68	20	45	34	68
	Ayer Hitam	AH- 1	9.53	58	240	111	377
		AH- 2	2.62	31	71	52	108
		AH- 3	1.50	15	35	27	54
		AH- 4	1.04	18	27	28	42
		AH- 5	2.24	28	68	47	103
		AH- 6	2.10	18	21	33	37
	Malim	MA- 1	4.64	65	132	107	201
		MA- 2	2.26	28	59	48	90
		MA- 3	2.76	26	51	46	82
		MA- 4	4.16	63	126	102	190
		MA- 5	2.40	31	53	52	82
Melaka (1)*1	Melaka	UM- 1	4.97	64	121	107	188
		UM- 2	3.61	65	98	103	149
		UM- 3	0.42	10	16	14	23
Melaka (2)*2	Melaka	ME- 1	0.80	14	25	21	37
		ME- 2	3.89	61	67	97	107
		ME- 3	2.25	20	28	30	42
		ME- 4	0.86	44	64	69	96
		ME- 5	2.36	54	69	83	104
		ME- 6	2.40	53	68	83	103
		ME- 7	0.45	14	15	21	22
		ME- 8	1.83	38	56	60	84
		ME- 9	2.25	36	68	59	103
		ME- 10	1.43	34	45	52	66
		ME- 11	0.52	13	17	19	25
		ME- 12	0.33	9	11	13	16
		ME- 13	0.51	13	17	20	25
		ME- 14	0.43	14	15	21	22
		ME- 15	0.86	27	29	40	43
		ME- 16	1.00	24	30	36	44
		ME- 17	1.10	29	35	43	52
Cheng	S. Bangsal	SB- 1	1.29	20	42	32	62
		SB- 2	1.40	15	42	27	63
	Arang	AR- 1	2.89	23	33	44	58
		AR- 2	2.16	20	66	35	100
		AR- 3	1.78	26	53	43	79
	Jenuang	JN- 1	6.85	37	49	76	93
		JN- 2	2.80	21	44	40	72
		JN- 3	12.81	69	135	138	232
		JN- 4	2.63	22	76	41	116
	Cheng	CH- 1	2.29	26	61	43	93
Putat	Putat	PU- 1	2.31	19	21	33	35
		PU- 2	0.68	8	12	13	18
		PU- 3	0.91	24	26	36	39
		PU- 4	2.03	21	21	34	34
		PU- 5	1.00	17	17	27	27
		PU- 6	3.36	83	95	128	143
		PU- 7	3.66	66	80	103	124
		PU- 8	5.60	93	125	148	194
		PU- 9	3.56	57	99	89	151
Minor Basin		CD- 1	0.97	26	33	39	48
		CD- 2	0.44	14	16	20	23
		CD- 3	2.14	43	69	68	103
		CD- 4	3.71	54	111	89	168
		CD- 5	0.87	17	29	27	43
		CD- 6	0.56	13	19	19	28
		CD- 7	2.45	24	49	43	78
		CD- 8	0.77	21	24	32	36
		CD- 9	0.66	21	21	31	30

Note : *1 Upstream from Diversion point
*2 Downstream from Diversion point

Table 3-5(1/2) Present and Future Channel Flow Discharge (Sg.Petani)

River		Channnel No.	5- year Return Period		100- year Return Period	
			Present	Future	Present	Future
Lalang	Main Stream	CLA-1	44	100	70	149
		CLA-2	66	164	101	245
		CLA-3	199	393	304	592
		CLA-4	193	372	296	556
	Line A	CLA-5	55	138	85	203
	Bakap	CLA-6	50	51	72	74
		CLA-7	92	131	137	191
Tukang	Main Stream	CTU-1	32	56	47	80
		CTU-2	39	75	58	107
		CTU-3	67	91	105	139
Laya Besar	Main Stream	CLB-1	49	54	72	79
		CLB-2	61	69	92	106
Che Bima	Main Stream	CCB-1	26	67	42	98
		CCB-2	33	78	53	115
Petani	Main Stream	CPE-1	135	192	201	286
		CPE-2	154	222	233	330
		CPE-3	167	238	251	352
		CPE-4	168	238	255	354
		CPE-5	170	236	256	350
		CPE-6	185	249	282	373
		CPE-7	183	245	279	367
		CPE-8	199	259	311	400
		CPE-9	220	277	348	433
		CPE-10	196	239	325	390
	Pasil Kechil	CPE-11	31	51	46	74
	Line A1	CPE-12	61	68	91	102
		CPE-13	67	82	101	122
	Line A	CPE-14	38	58	57	85
	Line G	CPE-15	28	42	40	59
	Air Mendidih	CPE-16	55	67	81	98
		CPE-17	68	79	103	119
	Gelugor	CPE-18	58	58	86	88
Pasir	Main Stream	CPA-1	77	123	115	181
		CPA-2	103	133	159	206
		CPA-3	120	145	185	225
		CPA-4	138	196	211	303
		CPA-5	149	202	233	313
		CPA-6	165	231	262	367

Table 3-5(2/2) Present and Future Channel Flow Discharge (Melaka)

River		Channnel No.	5- year Return Period		100- year Return Period	
			Present	Future	Present	Future
Lereh	Main Stream	CLE-1	172	299	334	540
	Udang	CLE-2	112	204	191	331
		CLE-3	134	164	227	281
	S.Gajah	CLE-4	47	119	93	195
Marim	Main Stream	CMA-1	261	538	507	969
	Ayer Salak	CMA-2	91	210	155	328
		CMA-3	97	222	174	352
		CMA-4	116	235	210	402
	Bertam ULU	CMA-5	58	240	111	377
	Ayer Hytam	CMA-6	76	247	143	399
		CMA-7	81	248	153	402
		CMA-8	83	245	158	389
		CMA-9	92	252	174	405
Melaka	Main Stream(1)*	CME-1	221	408	425	720
	Main Stream(2)*	CME-2	14	25	21	37
		CME-3	82	108	141	180
		CME-4	210	280	380	503
		CME-5	208	279	382	498
		CME-6	208	264	387	481
		CME-7	211	262	393	478
		CME-8	211	262	393	478
		CME-9	206	253	384	466
		CME-10	200	245	377	456
Cheng	Main Stream	CCH-1	184	333	368	581
	S.Bangsal	CCH-2	27	66	47	101
	Paya Rumput	CCH-3	37	90	69	144
	Arang	CCH-4	48	102	90	168
	Jeram	CCH-5	50	69	102	128
	Jenuang	CCH-6	121	217	245	375
Putat	Ayer Keroh	CPU-1	22	27	39	44
	Main Stream	CPU-2	71	76	117	124
		CPU-3	171	192	294	329
		CPU-4	171	192	294	329
		CPU-5	163	193	283	346

Note : *1 Upstream from Diversion point
*2 Downstream from Diversion point

Table 3-6 Structure Features of Flood Regulation Facilities

Description	Unit	Storage in House Lot	Storage in Public Space	Flood Detention Pond	
(1) Unit Lot Space	(m^2)	200	20,000	4,000	
(2) Catchment Area/Unit					
(2-1) Area	(m^2)	100*[1]	20,000	100000*[3]	
(2-2) Land Use		Roof in Residential Area	Institutional Area	Projected Built-up Area	
(3) Design Flood Level					
(3-1) Return Period	(year)	5	5	5	100
(3-2) Max. Rainfall Intensity	(mm/hr)	85	85	85	132
(3-3) Rainfall Volume	(m^3/km^2)	137	137	137	237
(3-4) Runoff Volume	(m^3/km^2)	130	109	123	213
(3-5) Runoff Coefficient		0.95	0.80	0.90	0.90
(3-6) Peak Inflow Discharge	($m^3/s/km^2$)	44	31	38	55
(3-7) Peak Outflow Discharge	($m^3/s/km^2$)	29	5	6	12
(4) Storage Capacity/Unit					
(4-1) Area	(m^2)	2	4,000*[2]	4,000*[4]	
(4-2) Height (h1) *[5]	(m)	1	0.3	3.2	
(4-3) Volume	(m^3)	2	1,200	12,800	
(5) Outlet (lower)					
(5-1) Width of Outlet Hole	(m)	0.04	0.20	0.32	
(5-2) Height of Outlet Hole	(m)	0.03	0.05	0.50	
(5-2) Position of Outlet (h2) *[5]	(m)	0	- 0.30	- 0.50	
(6) Outlet (upper)					
(6-1) Width of Outlet Hole	(m)			0.50	
(6-2) Height of Outlet Hole	(m)			0.50	
(6-3) Position of Outlet (h2) *[5]	(m)			2.00	
(7) Duration of Water Impounded	(min.)	40	380	510 (for 5-year) 670 (for 100-year)	

* 1: Only rainfall in rooftop is collected by water tank. The rooftop is assumed to cover 50% of house lot.
* 2: Percentage of available open space for storage area to total public compound is assumed to be 20%.
*3: The regulation pond for land development of 10ha is examined.
*4: The land development area is assumed to contain 40% of open space, out of which 10% could be used as the area for flood detention pond.
*5: h1, h2 and h3 are as below:

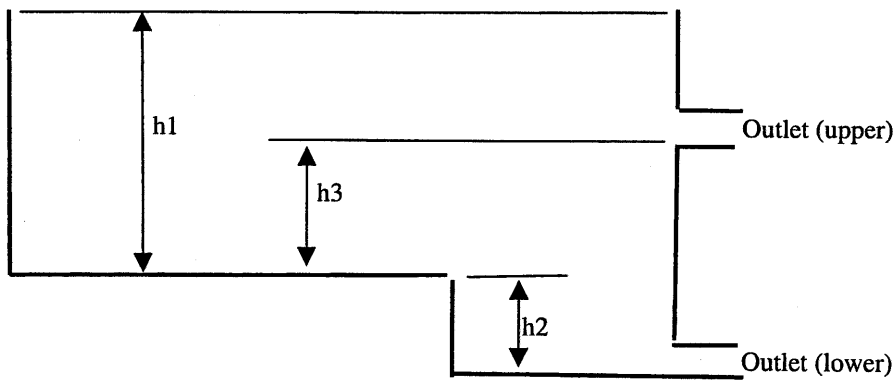

Table 3-7 Tidal Level at Tanjung Dawai

Sungai Petani

Item	Standard Port	Secondary Port	
	Kedah Pier, Pulau Pinang	Tanjung Dawai	
	lat : 05 25 long: 100 21	lat : 05 40 long: 100 21	
	Tidal Level	Height Difference from Standard Port	Tidal Level
Mean High Water Spring	1.18	0.1	1.28
Mean High Water Neaps	0.38	0.1	0.48
Mean Sea Level	0.18		
Mean Low Water Neaps	-0.12	0	-0.12
Mean Low Water Springs	-0.82	0	-0.82

Source: Tide Tables, 1999 by Royal Malaysian Navy

Note: Tidal levels in the Tide Tables are presented on the basis of Chart Datum and conveted herein to Land Datum with referring that the Chart Datum is 1.42m below Land Datum.

Melaka

Item	Standard Port	Secondary Port	
	Tanjung Keling	Kuala Melaka	
	lat : 02 13 long: 102 10	lat : 02 11 long: 102 15	
	Tidal Level*1	Height Difference from Standard Port*2	Tidal Level
Mean High Water Spring	0.94	-0.3	0.64
Mean High Water Neaps	0.35	-0.3	0.05
Mean Sea Level	Not Reported		
Mean Low Water Neaps	Not Reported		
Mean Low Water Springs	Not Reported		

Source: *1: Tide Table, 1999 by Department of Survey and Mapping, Malaysia
*2: Tide Table, 1999 by Royal Malaysian Navy

Note: Tidal levels in the Tide Tables are presented on the basis of Chart Datum and conveted herein to Land Datum with referring that the Chart Datum is 1.19m below Land Datum.

Table 4-1 Flood Control Effects of Existing Dentention Pond

Sub-basin Code	Key Drainage System	Catchment Area of Sub-basin (km^2)	Total Catchment Area of Ponds (km^2)	Coverage of Pond Catchment (%)	5-yr Flood under Present Conditions				Remarks (Functioning Pond)
					Peak Discharge without Pond [Q1] (m^3/s)	Peak Discharge with Pond [Q2] (m^3/s)	Controlled Discharge [Q1-Q2] (m^3/s)	Flood Control Effect [(Q1-Q2)/Q1] (%)	
Sg. Lalang Basin									
LA-7	Internal Drain	1.18	1.18	100.0	37	5	32	86.5	Kaw. Industri LPK
River-mouth	Sg. Lalang	24.53	1.18	4.8	209	199	10	4.8	1 Pond
Sg. Tukang Basin									
TU-1	Internal Drain	1.35	1.12	83.0	43	11	32	74.4	Taman Ria
River-mouth	Sg. Tukang	7.93	1.12	14.1	81	67	14	17.3	1 Pond
Sg. Petani Basin									
PE-12	Line C	1.55	0.95	61.3	40	15	25	62.5	Taman Ria Jaya
PE-14	Line D	1.13	0.77	68.1	35	12	23	65.7	Taman Ria Jaya
PE-19	Line G	1.98	1.50	75.8	40	13	27	67.5	Taman Keladi
PE-20	Line G	1.21	0.38	31.4	28	17	11	39.3	Taman Sri Wang
PE-28	Sg. Gelugor	1.46	0.16	11.0	45	41	4	8.9	Taman Sri Wang
River-mouth	Sg. Petani	37.72	3.76	10.0	259	220	39	15.1	5 Ponds in Total
Sg. Pasir Basin									
PA-5	Trunk Drain	1.05	0.92	87.6	35	9	26	74.3	Taman Sejati Indah
PA-6	Small Drains	1.44	0.50	34.7	45	32	13	28.9	Taman Kempas
PA-8	Small Drains	2.27	0.52	22.9	38	24	14	36.8	3 Ponds in Taman Semarak
River-mouth	Sg. Pasir	23.44	1.94	8.3	194	165	29	14.9	5 Ponds in Total

Table 4-2 Proposed Agencies Related to Drainage Policy and Programme

Policy/Programme	Agency
Drainage Policy	National River Council, DID, Ministry of Housing and Local Government (Local Govt. Dept.), State Water Management Authority, State DID, State Planning Committee
Drainage Development Programme	Economic Planning Unit, Treasury, National River Council, DID, Ministry of Housing and Local Government (Local Govt. Dept.)
Regulation / Guidelines	National Council for Local Government, DID, Ministry of Housing and Local Government (Local Govt. Depart.), SA, DOE, State Water Management Authority
Drainage Master Plan	DID, Local Authority
Research and Development	National Hydraulic Research Institute, Malaysia, University, DID, Ministry of Housing and Local Government (Local Govt. Dept.)
Public Awareness and Education	DID, Local Authority
Emergency Response Management for Urban Floods	Local Authority, District Office

Table 4-3 Functional Responsibility for Drainage Facility

Drainage and Basic Facility	Catchment Area	Planning	Design	Construction	Maintenance
Basin Wide Drainage Facility					
1) River Channel Improvement	> 4km^2	DID	DID	DID	DID
2) Flood Retardation Basin	> 4km^2	DID	DID	DID	DID
3) Weirs/Gates	> 4km^2	DID	DID	DID	DID
4) Trunk Drain (connected to flood mitigation	< 4km^2	DID	DID	DID	DID
5) Community Retention Facilitie (incorporated with multipurpose use/recreation facilities)	-	DID	DID	DID	LA
Sub-basin Drainage Facility					
6) Infrastructure Drain / Secondary Drain	< 4km^2	D/LA	D/LA	D/LA	D/LA
7) Roadside drain (State/Federal Roads)	-	JKR	JKR	JKR	JKR
8) Roadside drain (Municipal roads)	-	D	D	D	LA
9) Perimeter / Tertiary Drain	< 2km^2	D	D	D	LA
10) Flood Detention Ponds	-	D	D	D	LA
11) Other on site detention facilities	-	D	D	D	LA
12) Rehabilitation of existing detention ponds	-	LA	LA	LA	LA
13) Construction of Storage facility in open space	-	LA	LA	LA	LA
14) Storage tanks in new development	-	D	D	D	LO
15) Storage tanks in existing built-up area	-	LO	LO	LO	LO

Notes: D : Developer
LO : Landowner
LA : Local Authority
JKR : Public Work Department

Table 4-4 Proposed Sources of Funding and Cost Recovery Measures

Work Item	Source of Funding	Cost Recovery Measures
Formulation of Drainage Policy and Programme		
1. Drainage Master Plan	Federal/State Govt./Local Authority/International Grants	
2. Non-Structural / Measures / Public Education / Public awareness	Local Authority Fund/DID	
3. Research and Development	Research Grants (MOSTE), International Grants	
4. Emergency Response Management	Local Authority Funds	
Basin Wide Drainage Facility		
1. River Channel Improvement	Federal/State Grant	Drainage Contribution
2. Flood Retardation Basin	- do -	(National Land Code)
3. Weirs / Gate	- do -	
4. Trunk Drains (related to flood mitigation)	- do -	
5. Community Detention Pond	- do -	
Sub-Basin Drainage Facility		
1. Infrastructure Drain / Secondary Drain	Developer/Local Authority Funding	Drainage Improvement Charge s51 (SDBA)
2. Perimeter / Tertiary Drain	Developer	-
3. Flood Detention Ponds	Developer	-
4. Roadside Drain (Fed/State Roads)	Road Development Fund	State Road Grant
5. Other Municipal road side drains	- do -	- do -
6. Other on site detention facilities	Developer	Drainage Rate (LGA)
7. Rehabilitation of Existing detention ponds	Local Authority Fund	- do -
8. Construction of storage facilities in open space	- do -	Drainage Rate (LGA)
9. Storage tanks in new development	Developer	-
10. Storage tank in house	Land Owner	Subsidy

Table 4-5 Enabling Law and Enforcement Agency for Illegal Activities on Urban Drainage

Violation/Offenses/Enforcement	Enabling Law	Enforcement Agency
Overall custodian role on all waterways	Street Drainage Building Act, Local Government Act, Town and Country Planning Act	Local Authority
Land use violation	National Land Code, Town and Country Planning Act	Land Administrator, Local Planning Authority
Litter and unauthorized garbage disposal	Local Government Act	Local Authority
Erosion of Hillland	Land Conservation Act 1960	District Land Administrator
Control of Earthworks	Earthwork By-laws, Erosion and Sediment Control Plan	Local Authority DOE
Diversion and abstraction of water and damage to river banks	Waters Act, State Water Management Authority Enactment	District Office, State Water Management Authority
Sand Mining operation	National Land Code, State Water Management Authority Enactment	Director of Land and Mines, Inspector of Mines, State Water Management Authority
Discharge of waste water	Environmental Quality Act, State Water Management Authority Enactment	DOE, State Water Management Authority, Local Authority
Unlicensed blockage and diversion	Street Drainage Building Act, WA, State Water Management Authority Enactment	Local Authority
Indiscriminate Development in Catchment Area	State Water Management Authority Enactment, National Forestry Act	State Water Management Authority, Forestry Department
Enforcement of river and drain reserve	National Land Code, State Water Management Authority Enactment	DID, State Water Management Authority, Director of Land and Mines
Enforcement of Detention Pond Facilities in Residential Development	Town and Country Planning Act	Local Authority
Enforcement of Community Detention Pond Facilities	Town and Country Panning Act	Local Authority

Table 4-6 Maintenance Items of Flood Detention Pond

Case	Descriptios of Maintenance Managements				Maintenance Time
	Inspection Place			Inspection Point	
Normal Condition	Inspection	Outlet Facility	Outlet Tower	Condition of structure	Rainy season : 2 times/month Dry seson : 1 time/3 months
			Orifice	Clogging of screen, sedimentation	
			Conduit Pipe	Leakage of water	
			Spillway	Condition of structure, revetment, obstacle and damage	
			Others		
		Pond	Slope	Slope failure, crack, leakage, spring, damage, subsidence, collecting drain, clogging of box, turffing and weeding	
			Crest	Damage, settlement, subsidence, condition of crest drainage, damage of pavement	
			Sedimentation Basin	Sedimentation, condition of drainage, rubbish, weeding, obstacle for releasing water	
			Others		
		Periphery of Facility/Downstream	Periphery of Facility	Change of ground, influence against safety of facility	
			Cut Slope	Slope failure, crack, leakage, spring, turffing	
			Downstream of Spillway	Increment of dangerous condition	
			Downstream Channel	Condition of structure, obstacle	
			Others		
		Observation Facilities and others	Observation Facility	Conditions of water level gauge and structure	
			Air Supply Pipe	Damage, clogging	
			Guard Fence	Damage, collapse	
			Sign Board	Damage, collapse	
			Others		
		Materials and Equipment	Materials	Quantity and quality, condition of custody	
			Equipment	Quantity and quality, condition of custody	
			Others		
	Removal of Sedimetation				
	Weeding and Clearing				Flooding time
At Flooding	Inspection same as the above				In case of forecasting flooding
	Patrol	Inspectio Point		Reasons	Flooding time
		Does water level reach High Water Level?		Due to overflow from spillway sever influence to downstream can be expected.	
		Does water level surge or draw down rapidly?		It might be caused by clogging of orifice/screen or crack of embankment. Sudden fluctuation of water level might suggest some possibility to produce slope/embankment failure.	
		Does quantity of releasing water decrease?		Clogging of orifice/screen can be considered as main cause.	
		Does seepage or slope failure occur at embankment ?			
After Flooding	Inspection same as the above				After flooding

Table 5.1 Basic Unit Costs/Prices Applied for Cost Estimate in Sungai Petani and Melaka

Item	Unit	Applied Cost (RM) May 1999	Remarks
1.Civil Engineering Construction			
Excavation (common, by mechanical equipment)	m3	3.0	
Excavation (foundation, by hand)	m3	13.5	
Excavation (foundation, by mechanical equipment)	m3	8.0	
Embankment (earthfill)	m3	21.0	
Steel Round bar	ton	1,200.0	
Steel Screen	ton	2,400.0	
Sluice Gate	ton	7,000.0	
Revetment/wall (Stone-Pitching, t=250mm)	m2	65.0	
Revetment/wall (One brickwall, t=250mm)	m2	60.0	
Revetment/wall (CHBl, t=190mm)	m2	52.0	
Mass. Concrete	m3	180.0	
R.C. Concrete	m3	250.0	
Concret Pavement (t=120mm)	m2	30.0	
PC pile (150mm x 150mm)	m	30.0	
PC pile (200mm x 200mm)	m	33.0	
Pipe Culvert (600mm)	m	120.0	
Pipe Culvert (900mm)	m	190.0	
Road Work (130mm thick crusher run w/ 50mm pavement)	m2	6.0	
Close Turfing	m2	4.0	
Roadside Drain (300mm x 300mm)	m	12.5	
PVC Rainwater Downpipe (100mm) w/ fixture	m	24.0	
PVC Half Round (150mm) Rainwater Gutter w/ fixture	m	35.0	
FRP Water Tank (2000l) w/ fixture	no.	800.0	
Chain Link Fencing (1.8m high)	m	45.0	
2. Land Prices			
Residential Area	m2	100.0	Land Acquisition : for drainage channel areas
Agricultural Land (rubber)	m2	6.2	for detention pond areas
3. Labour Wages			
Foreman	day	80.0	
Equipment Operator	day	55.0	
Stonemason	day	48.0	
Common Labour	day	33.0	