SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI JUN 2019

DCC6213 : HYDRAULICS AND HYDROLOGY

TARIKH : 03 NOVEMBER 2019
MASA : 2.30PETANG-4.30PETANG (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.
Bahagian A : Struktur (2 soalan)
Bahagian B : Struktur (4 soalan)

Dokumen sokongan yang disertakan : Kertas Graf, Formula, Manual Saliran Mesra Alam, Borang Kadar Alir

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A : 50 MARKS
BAHAGIAN A : 50 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** structured questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan berstruktur. Jawab **SEMUA** soalan.*

CLO1
C1

QUESTION 1
SOALAN 1

(a) Define the terms Hydraulic and Hydrology.

Takrifkan istilah bagi Hidraulik dan Hidrologi.

[5 marks]
[*5 markah*]

CLO1
C2

(b) A rectangular channel with the width of 9.14m flows water at the rate of $7.64m^3/s$. The water flows at the depth of 914mm. Calculate the specific energy.

Satu saluran segiempat mempunyai lebar 9.14m mengalirkan air pada kadar $7.64m^3/s$. Kedalaman aliran adalah 914mm. Kira tenaga tentu.

[5 marks]
[*5 markah*]

CLO1
C3

(c)

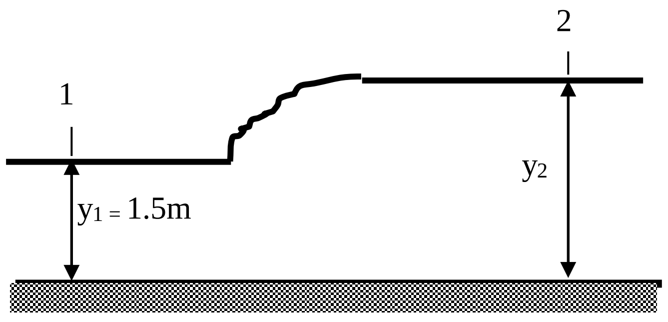


Figure A1 / *Rajah A1*

Water flows in a wide channel at the rate of $15m^3/s$. The upstream water depth is 1.5m. If hydraulic jump occurs, calculate:

Air mengalir dalam satu saluran lebar pada kadar $15m^3/s$. Kedalaman air di hulu ialah 1.5m. Jika lompatan hidraulik berlaku, kira:

i. Downstream depth
Kedalaman di bahagian hilir

[6 marks]
[*6 markah*]

ii. Velocity at downstream
Halaju di hilir

[3 marks]
[*3 markah*]

iii. Froude number at downstream
Nombor Froude di hilir

[3 marks]
[*3 markah*]

iv. Energy lost due to hydraulic jump
Kehilangan tenaga akibat lompatan

[3 marks]
[*3 markah*]

QUESTION 2
SOALAN 2

A pump is used to pump water as high as 14m. The pipe used is 400mm in diameter and its total length is 2500m. Friction coefficient of the pipe is 0.0025 and the pump works at the speed of 700 r.p.m. The characteristic of the pump is as follows:

Satu pam digunakan untuk mengepam air pada ketinggian 14m. Paip yang digunakan mempunyai diameter 400mm dan panjang 2500m. Pekali geseran paip ialah 0.0025 dan pam beroperasi pada kelajuan 700 r.p.m. Ciri-ciri pam adalah seperti berikut:

Table A2 / *Jadual A2*

Flowrate, Q (l/s) *Kadaralir, Q (l/s)*	*0*	*100*	*200*	*300*	*350*	*400*	*500*
Head, H (m) *Turus Tekanan, H (m)*	*15*	*17*	*18*	*16*	*14*	*11*	*5*
Efficiency, η (%) *Kecekapan, η (%)*	*0*	*30*	*60*	*81*	*83*	*80*	*45*

CLO1 C2

(a) Interpret pump characteristic and system characteristic in a graph.
Tafsirkan ciri-ciri pam dan ciri-ciri sistem dalam bentuk graf.

[13 marks]
[*13 markah*]

CLO1 C3

(b) Calculate the input and output power at that operational point.
Kirakan kuasa masukan dan keluaran kuasa pada titik operasi tersebut.

[12 marks]
[*12 markah*]

SECTION B : 100 MARKS

BAHAGIAN B : 100 MARKAH

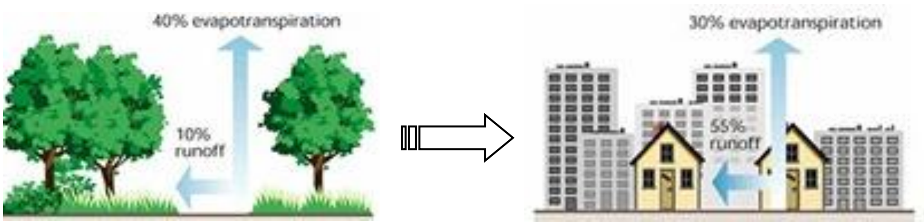
INSTRUCTION:
This section consists of **FOUR (4)** structured questions. Answer **TWO (2)** questions only.

ARAHAN:
Bahagian ini mengandungi ***EMPAT (4)*** *soalan berstruktur. Jawab* ***DUA (2)*** *soalan sahaja.*

QUESTION 1
SOALAN 1

CLO2 C2 (a) Based on the illustration in **Figure B1**, identify the effect of soil use towards the hydrological cycle.

Berdasarkan kepada ilustrasi dalam ***Rajah B1****, kenalpasti kesan penggunaan tanah terhadap kitaran hidrologi.*



Before construction After construction

Figure B1 / ***Rajah B1***

[5 marks]
[*5 markah*]

CLO2 C3 (b) Rainfall with intensity of 150mm/hr fell on catchment area of 300ha for 8 hours. Measured runoff during this period was 780 x $10^3 m^3$. Calculate the amount of water lost from this 8 hours rainfall. (1ha = 10 000m^2)

Keamatan hujan sebanyak 150mm/hr yang turun ke atas satu kawasan tadahan yang luasnya 300 ha selama 8 jam. Air larian yang diukur sepanjang tempoh ini *direkodkan sebanyak* 780 x $10^3 m^3$. *Kirakan jumlah kehilangan air bagi tempoh hujan 8 jam ini. (1ha = 10 000m^2)*

[10 marks]
[*10 markah*]

CLO2 C4

(c) Estimate the evapotranspiration loses for the area in cm/yr if the drainage area given is 2.59 x $10^{10}m^2$, the mean annual runoff is $19.82m^3/s$ and the average annual rainfall is 20cm.

Anggarkan kehilangan sejat-transpirasi bagi kawasan ini dalam unit cm/yr jika luas kawasan aliran diberi adalah 2.59 x $10^{10}m^2$, purata kadaralir tahunan sebanyak $19.82m^3/s$ dan purata kedalaman hujan tahunan ialah 20cm.

[10 marks]
[*10 markah*]

QUESTION 2
SOALAN 2

CLO2 C2

(a) Identify **FIVE** (5) rainfall characteristics.

*Kenalpasti **LIMA** (5) ciri-ciri hujan.*

[5 marks]
[*5 markah*]

CLO2 C3

(b) Calculate the mean areal precipitation for the following data in **Table B2(b)** using the Polygon Thiessen Method.

*Kira hujan purata bagi data yang diberi dalam **Jadual B2(b**) menggunakan Kaedah Polygon Thiessen.*

Table B2(b) / *Jadual B2(b)*

Station No.	Precipitation (mm)	Area of Polygon Thiessen (km^2)
1	35	18
2	32	20
3	28	24
4	46	17

[10 marks]
[*10 markah*]

CLO2
C4

(c) **Table B2(c)** shows the X station rainfall and average annual rainfall of 8 stations nearby. Analyze the consistency of annual rainfall at the X station with the corrective action of inconsistency using Double Mass Curve Method.
Jadual B2(c) *menunjukkan data hujan stesen X dan purata hujan tahunan bagi 8 stesen berhampiran. Analisis kekonsistenan bagi data hujan tahunan stesen X dengan melakukan pembetulan terhadap data yang tidak konsisten menggunakan Kaedah Lengkung Jisim Kembar.*

Table B2(c) / ***Jadual B2(c)***

Year	**Rainfall at X Station (cm)**	**Average Rainfall of 8 Station (cm)**
2013	30	55
2014	27	50
2015	26	28
2016	28	19
2017	55	37
2018	58	57

[10 marks]
[*10 markah*]

QUESTION 3
SOALAN 3

CLO2 C2

(a) Identify **FIVE (5)** types of method to measure stream flow.

Kenalpasti ***LIMA (5)*** *jenis kaedah untuk mengukur aliran sungai.*

[5 marks]
[5 markah]

Table B3 / ***Jadual B3***

Distance from river bank (m) ***Jarak dari tebing (m)***	**Vertical depth (m)** ***Kedalaman pugak (m)***	**Current Meter Reading**					
		0.6D		**0.2D**		**0.8D**	
		Rotation	**Time (s)**	**Rotation**	**Time (s)**	**Rotation**	**Time (s)**
1.0	0.2	9	50				
2.0	0.36	14	50				
4.0	0.82	25	50				
6.0	1.30			34	50	31	50
8.0	1.44			39	50	33	50
10.0	1.32			32	50	29	50
12.0	0.84	22	50				
14.0	0.58	16	50				
16.0	0.30	12	50				

Table B3 shows the current meter gauging data for Sungai Ketereh, by using the Mean Section Method.

Jadual B3 *menunjukkan bacaan data bagi Sungai Ketereh, dengan menggunakan Kaedah Purata Seksyen.*

CLO2 C3

(b) Calculate the velocity if V = 0.5N + 0.04.

Kirakan halaju jika V = 0.5N + 0.04.

[10 marks]
[10 markah]

CLO2 C4

(c) Estimate the discharge of the river.

Anggarkan kadar alir bagi sungai tersebut.

[10 marks]
[10 markah]

QUESTION 4
SOALAN 4

Below is the information of a medium density residential area in Kota Bharu.
Di bawah merupakan maklumat bagi kawasan kediaman kepadatan sederhana di Kota Bharu.

Residential area	= 10hectares
Keluasan kawasan perumahan	*= 10hektar*
Drainage type	= minor drainage
Jenis saliran	*= saliran minor*
Length of overland flow	= 80m
Panjang saliran atas tanah	*= 80m*
Length of the drain	= 400m
Panjang saluran	*= 400m*
Slope averange	= 0.5%
Peratus kecerunan	*= 0.5%*

CLO2
C2

(a) Identify the value of coefficients for Intensity Duration Frequency (IDF) Polynomial Equation if Recurrence Interval (ARI) is 5 years.
Kenalpasti nilai-nilai pekali bagi Persamaan Polimonial IDF sekiranya nilai ARI ialah 5 tahun.

[5 marks]
[*5 markah*]

CLO2
C3

(b) Calculate the Intensity Duration Frequency (IDF) for the area.
Kirakan keamatan IDF bagi kawasan tersebut.

[10 marks]
[*10 markah*]

CLO2
C4

(c) Estimate the peak flow for the area.
Anggarkan aliran puncak bagi kawasan tersebut.

[10 marks]
[*10 markah*]

SOALAN TAMAT

URBAN STORMWATER MANAGEMENT MANUAL FOR MALAYSIA

MANUAL SALIRAN MESRA ALAM (MASMA)

Table 4.1 Design Storm ARIs for Urban Stormwater Systems

Type of Development (See Note 1)	Average Recurrence Interval (ARI) of Design Storm (year)		
	Quantity		Quality
	Minor System	Major System (see Note 2 and 3)	
Open Space, Parks and Agricultural Land in urban areas	1	up to 100	3 month ARI (for all types of development)
Residential:			
• Low density	2	up to 100	
• Medium density	5	up to 100	
• High density	10	up to 100	
Commercial, Business and Industrial – Other than CBD	5	up to 100	
Commercial, Business, Industrial in Central Business District (CBD) areas of Large Cities	10	up to 100	

Notes:

(1) If a development falls under two categories then the higher of the applicable storm ARIs from the Table shall be adopted.

(2) The required size of trunk drains within the major drainage system, varies. According to current practices the trunk drains are provided for the areas larger than 40 ha. Proceeding downstream in the drainage system, a point may be reached where it becomes necessary to increase the size of the trunk drain in order to limit the magnitude of "gap flows" as described in Section 4.6.2.

(3) Ideally, the selection of design storm ARI should also be on the basis of economic efficiency. In practice, however, economic efficiency is typically replaced by the concept of the level of protection. In the case where the design storm for higher ARI would be impractical, then the selection of appropriate ARI should be adjusted to optimise the ratio cost to benefit or social factors. Consequently lower ARI should be adopted for the major system, with consultation and approval from Local Authority. However, the consequences of the higher ARI shall be investigated and made known. Even though the stormwater system for the existing developed condition shall be designed for a lower ARI storm, the land should be reserved for higher ARI, so that the system can be upgraded when the area is built up in the future.

(4) Habitable floor levels of buildings shall be above the 100 year ARI flood level.

(4) In calculating the discharge from the design storm, allowance shall be made for any reduction in discharge due to quantity control (detention or retention) measures installed as described in Section 4.5.

Table 13.1 Values of Areal Reduction Factors (F_A)

Catchment Area (km^2)	Storm Duration (hours)				
	0.5	1	3	6	24
0	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00
50	0.82	0.88	0.94	0.96	0.97
100	0.73	0.82	0.91	0.94	0.96
150	0.67	0.78	0.89	0.92	0.95
200	0.63	0.75	0.87	0.90	0.93

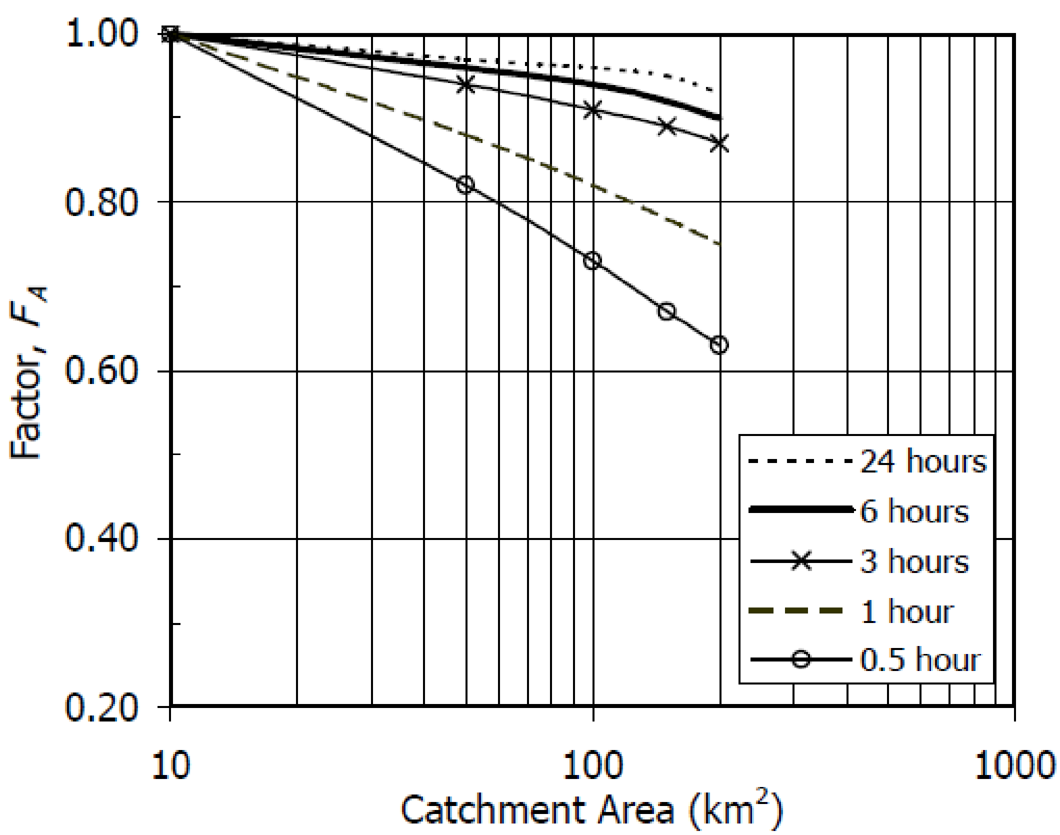


Figure 13.1 Graphical Areal Reduction Factors

$$ln({}^{R}I_{t}) = a + b\,ln(t) + c(ln(t))^{2} + d(ln(t))^{3} \qquad (13.2)$$

where,

${}^{R}I_{t}$ = the average rainfall intensity (mm/hr) for ARI and duration t

R = average return interval (years)

t = duration (minutes)

a to d are fitting constants dependent on ARI.

$$P_{d} = P_{30} - F_{D}(P_{60} - P_{30}) \qquad (13.3)$$

where P_{30}, P_{60} are the 30-minute and 60-minute duration rainfall depths respectively, obtained from the published design curves. F_{D} is the adjustment factor for storm duration

Table 13.2 Coefficients of the Fitted IDF Equation for Kuala Lumpur

ARI (years)	a	b	c	d
2	5.3255	0.1806	-0.1322	0.0047
5	5.1086	0.5037	-0.2155	0.0112
10	4.9696	0.6796	-0.2584	0.0147
20	4.9781	0.7533	-0.2796	0.0166
50	4.8047	0.9399	-0.3218	0.0197
100	5.0064	0.8709	-0.307	0.0186

(data period 1953 – 1983); Validity: $30 \le t \le 1000$ minutes

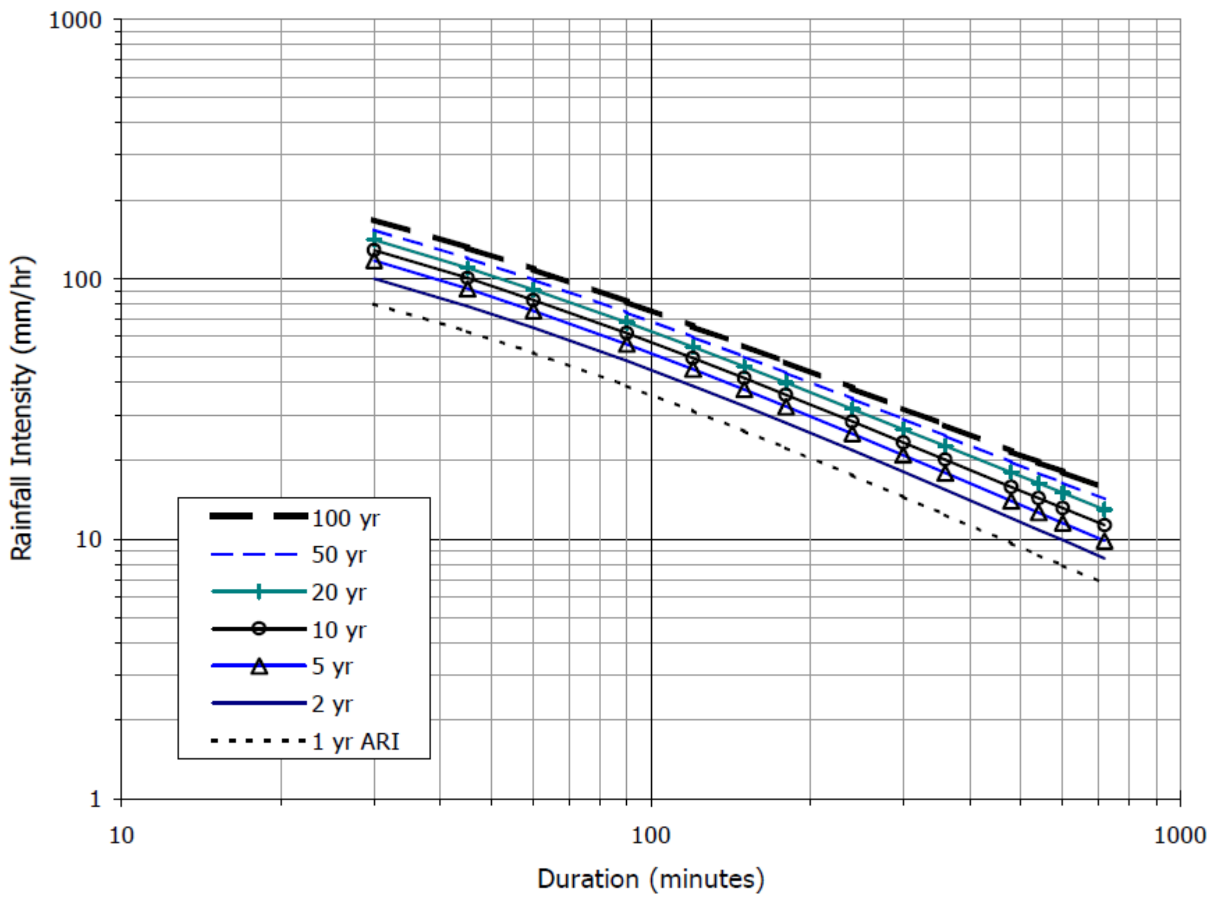


Figure 13.2 IDF Curves for Kuala Lumpur

Table 13.3 Values of F_D for Equation 13.3

Duration (minutes)	$^2P_{24h}$ (mm)				
	West Coast				East Coast
	≤ 100	120	150	≥ 180	All
5	2.08	1.85	1.62	1.40	1.39
10	1.28	1.13	0.99	0.86	1.03
15	0.80	0.72	0.62	0.54	0.74
20	0.47	0.42	0.36	0.32	0.48
30	0.00	0.00	0.00	0.00	0.00

Table 13.4 Standard Durations for Urban Stormwater Drainage

Standard Duration (minutes)	Number of Time Intervals	Time Interval (minutes)
10	2	5
15	3	5
30	6	5
60	12	5
120	8	15
180	6	30
360	6	60

Note that minutes are used in this Table, for consistency with the units in Equation 13.2.

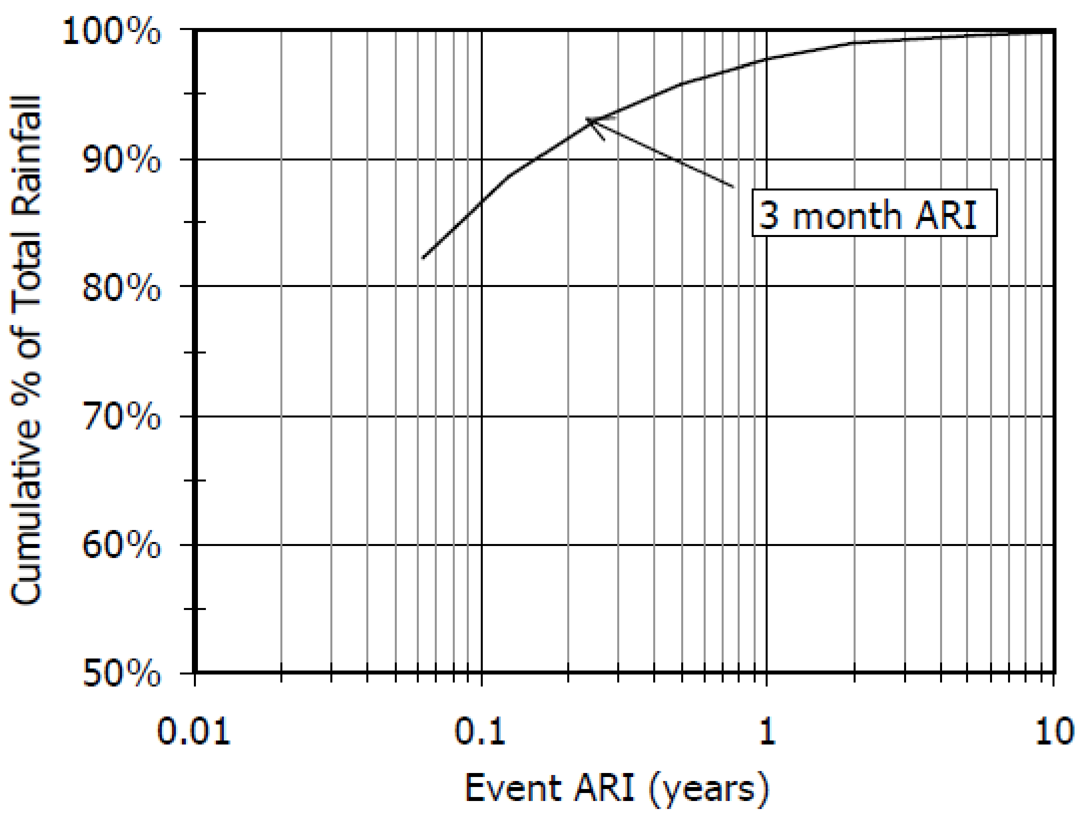
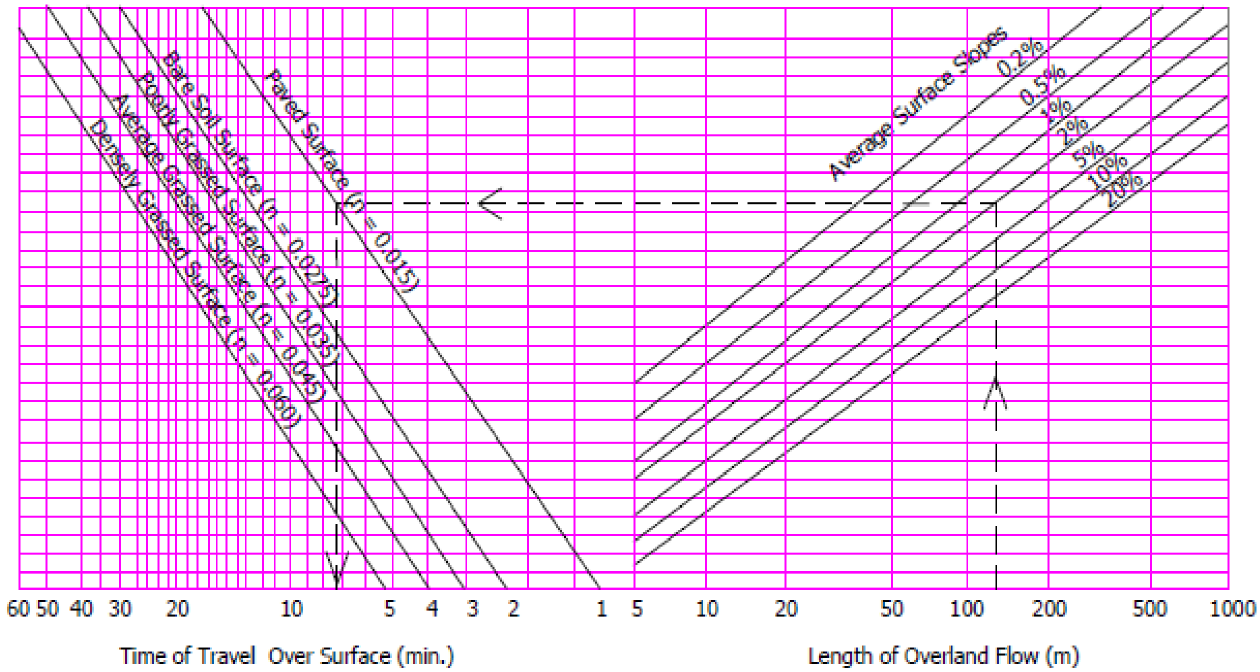
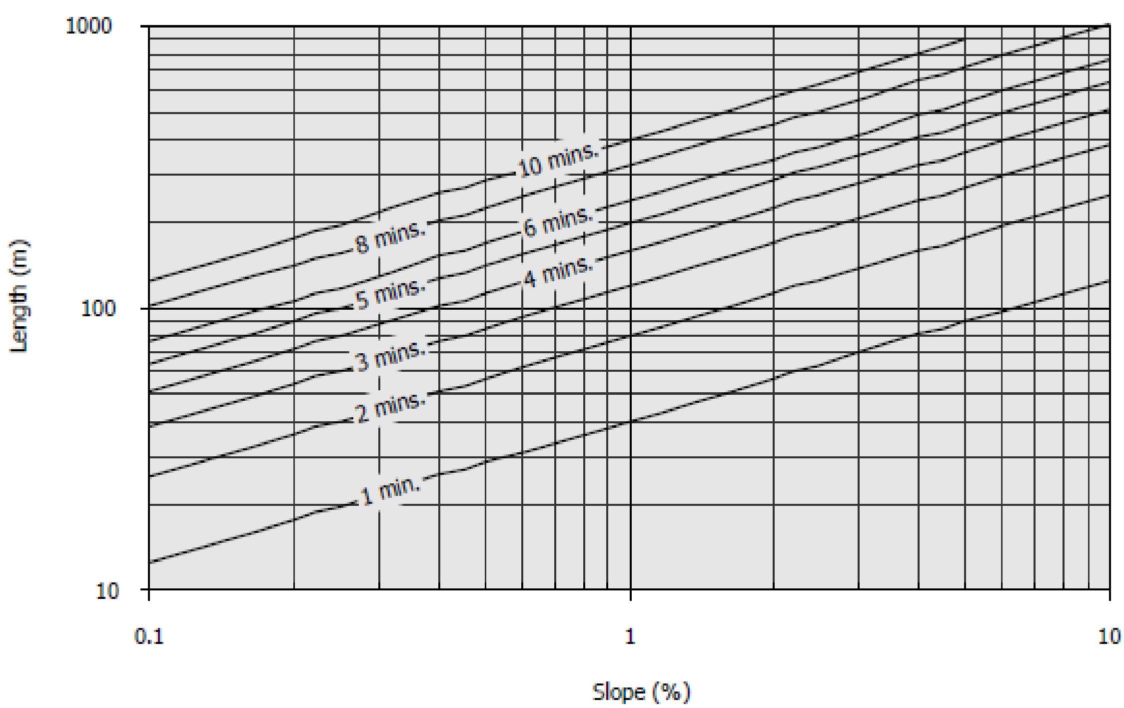


Figure 13.3 Values of $^{2}P_{24h}$ for use with Table 13.3
(source: HP 1, 1982)

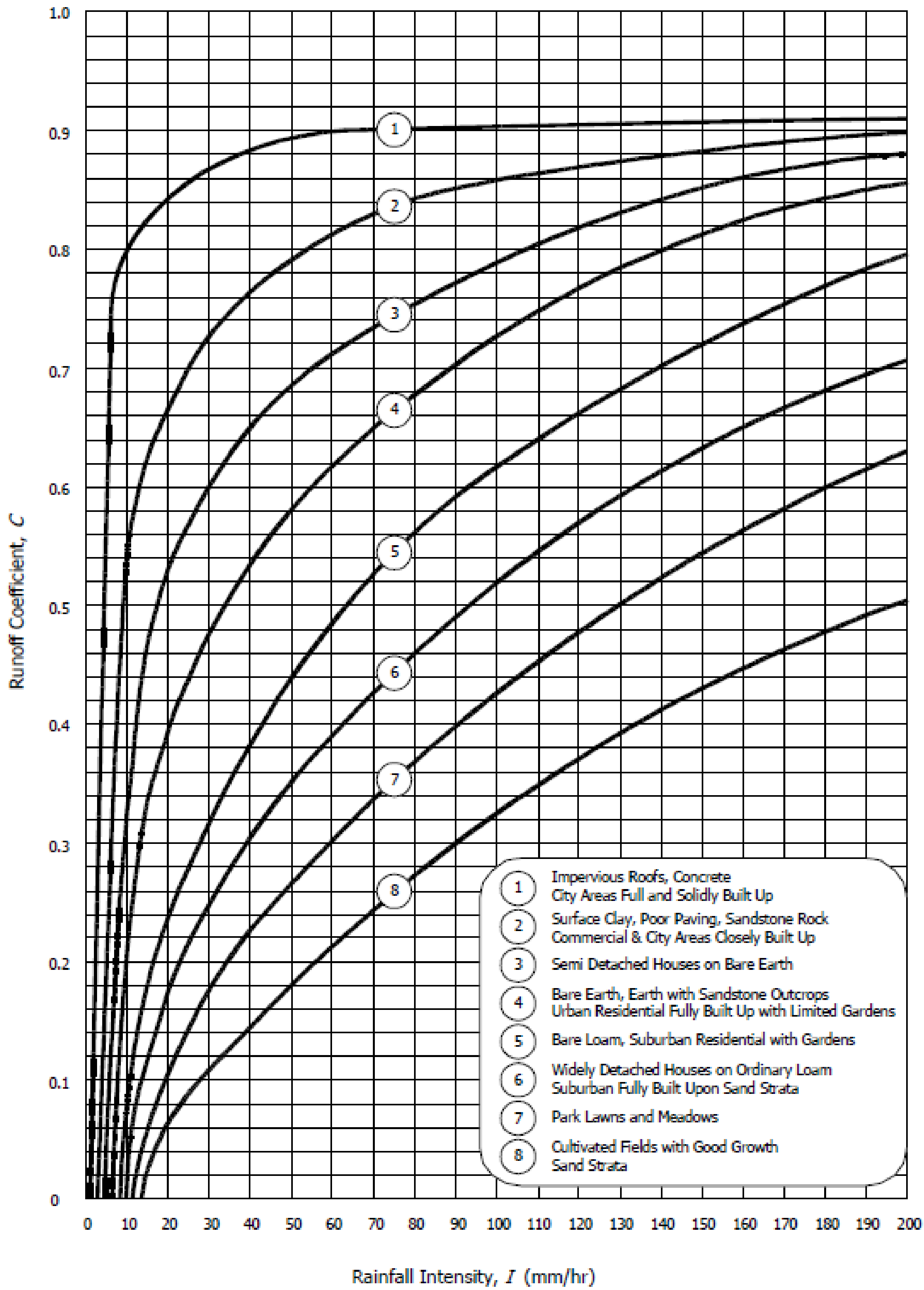
APPENDIX 14.A DESIGN CHARTS



Design Chart 14.1 Nomograph for Estimating Overland Sheet Flow Times (Source: AR&R, 1977)
(Overland Sheet Flow Times - Shallow Sheet Flow Only)

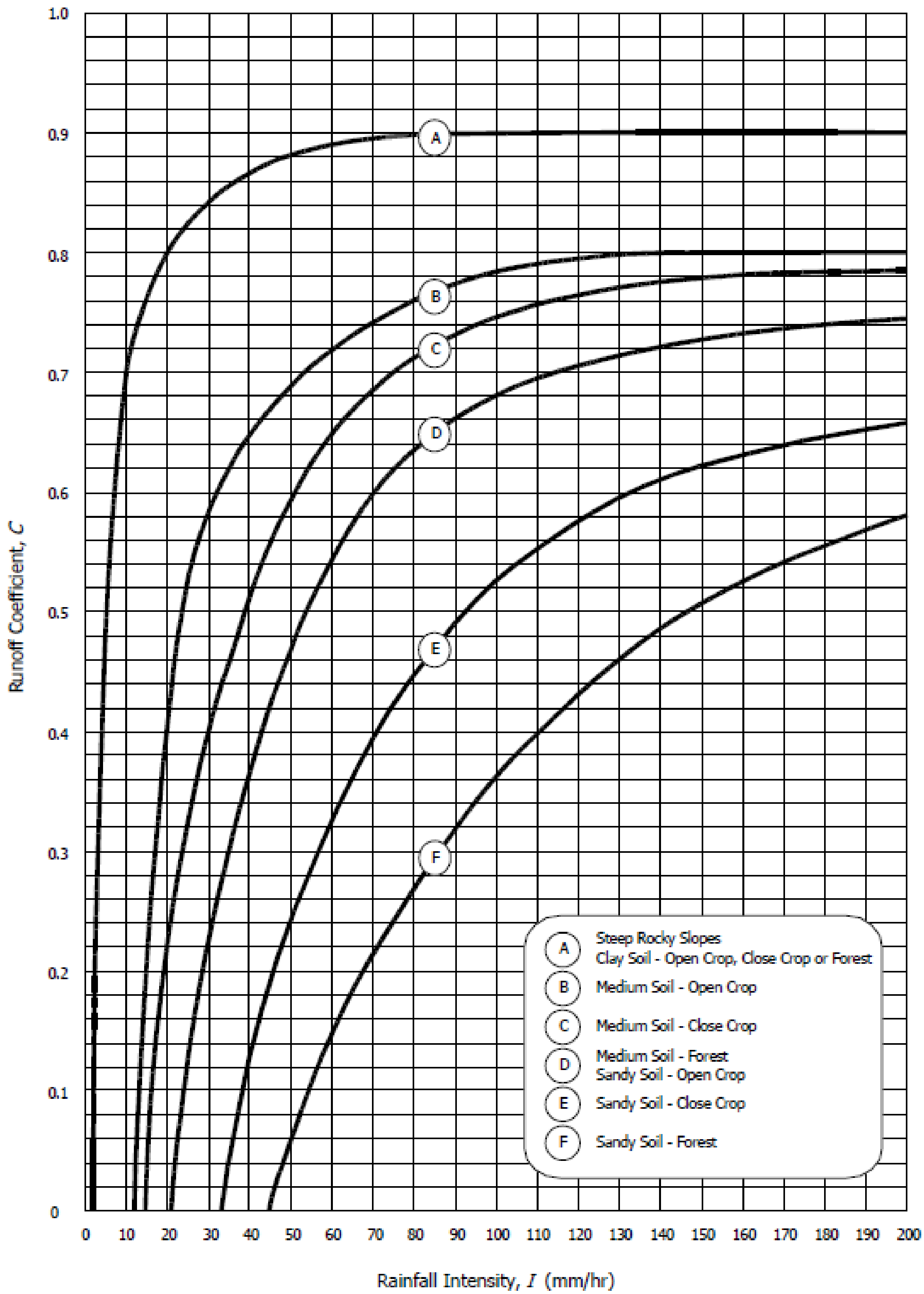


Design Chart 14.2 Kerb Gutter Flow Time



Design Chart 14.3 Runoff Coefficients for Urban Catchments
Source: AR&R, 1977

Note: For $I > 200$ mm/hr, interpolate linearly to $C = 0.9$ at $I = 400$ mm/hr



Design Chart 14.4 Runoff Coefficients for Rural Catchments

Source: AR&R, 1977

Note: For $I > 200$ mm/hr, interpolate linearly to $C = 0.9$ at $I = 400$ mm/hr

APPENDIX 13.A FITTED COEFFICIENTS FOR IDF CURVES FOR 35 URBAN CENTRES

Table 13.A1 Coefficients for the IDF Equations for the Different Major Cities and Towns in Malaysia (30 ≤ t ≤ 1000 min)

State	Location	Data Period	ARI (year)	Coefficients of the IDF Polynomial Equations			
				a	b	c	d
Perlis	Kangar	1960-1983	2	4.6800	0.4719	-0.1915	0.0093
			5	5.7949	-0.1944	-0.0413	-0.0008
			10	6.5896	-0.6048	0.0445	-0.0064
			20	6.8710	-0.6670	0.0478	-0.0059
			50	7.1137	-0.7419	0.0621	-0.0067
			100	6.5715	-0.2462	-0.0518	0.0016
Kedah	Alor Setar	1951-1983	2	5.6790	-0.0276	-0.0993	0.0033
			5	4.9709	0.5460	-0.2176	0.0113
			10	5.6422	0.1575	-0.1329	0.0056
			20	5.8203	0.1093	-0.1248	0.0053
			50	5.7420	0.2273	-0.1481	0.0068
			100	6.3202	-0.0778	-0.0849	0.0026
Pulau Pinang	Penang	1951-1990	2	4.5140	0.6729	-0.2311	0.0118
			5	3.9599	1.1284	-0.3240	0.0180
			10	3.7277	1.4393	-0.4023	0.0241
			20	3.3255	1.7689	-0.4703	0.0286
			50	2.8429	2.1456	-0.5469	0.0335
			100	2.7512	2.2417	-0.5610	0.0341
Perak	Ipoh	1951-1990	2	5.2244	0.3853	-0.1970	0.0100
			5	5.0007	0.6149	-0.2406	0.0127
			10	5.0707	0.6515	-0.2522	0.0138
			20	5.1150	0.6895	-0.2631	0.0147
			50	4.9627	0.8489	-0.2966	0.0169
			100	5.1068	0.8168	-0.2905	0.0165
Perak	Bagan Serai	1960-1983	2	4.1689	0.8160	-0.2726	0.0149
			5	4.7867	0.4919	-0.1993	0.0099
			10	5.2760	0.2436	-0.1436	0.0059
			20	5.6661	0.0329	-0.0944	0.0024
			50	5.3431	0.3538	-0.1686	0.0078
			100	5.3299	0.4357	-0.1857	0.0089
Perak	Teluk Intan	1960-1983	2	5.6134	-0.1209	-0.0651	0.00004
			5	6.1025	-0.2240	-0.0484	-0.0008
			10	6.3160	-0.2756	-0.0390	-0.0012
			20	6.3504	-0.2498	-0.0377	-0.0016
			50	6.7638	-0.4595	0.0094	-0.0050
			100	6.7375	-0.3572	-0.0070	-0.0043
Perak	Kuala Kangsar	1960-1983	2	4.2114	0.9483	-0.3154	0.0179
			5	4.7986	0.5803	-0.2202	0.0107
			10	5.3916	0.2993	-0.1640	0.0071
			20	5.7854	0.1175	-0.1244	0.0044
			50	6.5736	-0.2903	-0.0482	0.00002
			100	6.0681	0.1478	-0.1435	0.0065
Perak	Setiawan	1951-1990	2	5.0790	0.3724	-0.1796	0.0081
			5	5.2320	0.3330	-0.1635	0.0068
			10	5.5868	0.0964	-0.1014	0.0021
			20	5.5294	0.2189	-0.1349	0.0051
			50	5.2993	0.4270	-0.1780	0.0082
			100	5.5575	0.3005	-0.1465	0.0058
Selangor	Kuala Kubu Bahru	1970-1990	2	4.2095	0.5056	-0.1551	0.0044
			5	5.1943	-0.0350	-0.0392	-0.0034
			10	5.5074	-0.1637	-0.0116	-0.0053
			20	5.6772	-0.1562	-0.0229	-0.0040
			50	6.0934	-0.3710	0.0239	-0.0073
			100	6.3094	-0.4087	0.0229	-0.0068

(Continued)

Table 13.A1 Coefficients for the IDF Equations for the Different Major Cities and Towns in Malaysia (30 ≤ t ≤ 1000 min)

State	Location	Data Period	ARI (year)	Coefficients of the IDF Polynomial Equations			
				a	b	c	d
Federal Territory	Kuala Lumpur	1953-1983	2	5.3255	0.1806	-0.1322	0.0047
			5	5.1086	0.5037	-0.2155	0.0112
			10	4.9696	0.6796	-0.2584	0.0147
			20	4.9781	0.7533	-0.2796	0.0166
			50	4.8047	0.9399	-0.3218	0.0197
			100	5.0064	0.8709	-0.3070	0.0186
Malacca	Malacca	1951-1990	2	3.7091	1.1622	-0.3289	0.0176
			5	4.3987	0.7725	-0.2381	0.0112
			10	4.9930	0.4661	-0.1740	0.0069
			20	5.0856	0.5048	-0.1875	0.0082
			50	4.8506	0.7398	-0.2388	0.0117
			100	5.3796	0.4628	-0.1826	0.0081
Negeri Sembilan	Seremban	1970-1990	2	5.2565	0.0719	-0.1306	0.0065
			5	5.4663	0.0586	-0.1269	0.0062
			10	6.1240	-0.2191	-0.0820	0.0039
			20	6.3733	-0.2451	-0.0888	0.0051
			50	6.9932	-0.5087	-0.0479	0.0031
			100	7.0782	-0.4277	-0.0731	0.0051
Negeri Sembilan	Kuala Pilah	1970-1990	2	3.9982	0.9722	-0.3215	0.0185
			5	3.7967	1.2904	-0.4012	0.0247
			10	4.5287	0.8474	-0.3008	0.0175
			20	4.9287	0.6897	-0.2753	0.0163
			50	4.7768	0.8716	-0.3158	0.0191
			100	4.6588	1.0163	-0.3471	0.0213
Johor	Kluang	1976-1990	2	4.5860	0.7083	-0.2761	0.0170
			5	5.0571	0.4815	-0.2220	0.0133
			10	5.2665	0.4284	-0.2131	0.0129
			20	5.4813	0.3471	-0.1945	0.0116
			50	5.8808	0.1412	-0.1498	0.0086
			100	6.3369	-0.0789	-0.1066	0.0059
Johor	Mersing	1951-1990	2	5.1028	0.2883	-0.1627	0.0095
			5	5.7048	-0.0635	-0.0771	0.0036
			10	5.8489	-0.0890	-0.0705	0.0032
			20	4.8420	0.7395	-0.2579	0.0165
			50	6.2257	-0.1499	-0.0631	0.0032
			100	6.7796	-0.4104	-0.0160	0.0005
Johor	Batu Pahat	1960-1983	2	4.5023	0.6159	-0.2289	0.0119
			5	4.9886	0.3883	-0.1769	0.0085
			10	5.2470	0.2916	-0.1575	0.0074
			20	5.7407	0.0204	-0.0979	0.0032
			50	6.2276	-0.2278	-0.0474	0.00002
			100	6.5443	-0.3840	-0.0135	-0.0022
Johor	Johor Bahru	1960-1983	2	3.8645	1.1150	-0.3272	0.0182
			5	4.3251	1.0147	-0.3308	0.0205
			10	4.4896	0.9971	-0.3279	0.0205
			20	4.7656	0.8922	-0.3060	0.0192
			50	4.5463	1.1612	-0.3758	0.0249
			100	5.0532	0.8998	-0.3222	0.0215
Johor	Segamat	1970-1983	2	3.0293	1.4428	-0.3924	0.0232
			5	4.2804	0.9393	-0.3161	0.0200
			10	6.2961	-0.1466	-0.1145	0.0080
			20	7.3616	-0.6982	-0.0131	0.0021
			50	7.4417	-0.6247	-0.0364	0.0041
			100	8.1159	-0.9379	0.0176	0.0013

(Continued)

Table 13.A1 Coefficients for the IDF Equations for the Different Major Cities and Towns in Malaysia ($30 \leq t \leq 1000$ min)

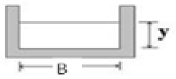
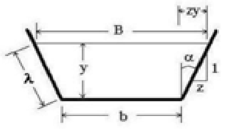
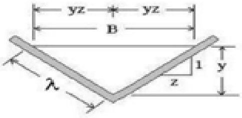
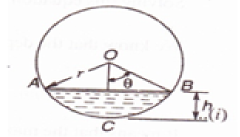
State	Location	Data Period	ARI (year)	Coefficients of the IDF Polynomial Equations			
				a	b	c	d
Pahang	Raub	1966-1983	2	4.3716	0.3725	-0.1274	0.0026
			5	4.5461	0.4017	-0.1348	0.0036
			10	5.4226	-0.1521	-0.0063	-0.0056
			20	5.2525	0.0125	-0.0371	-0.0035
			50	4.8654	0.3420	-0.1058	0.0012
			100	5.1818	0.2173	-0.0834	0.0001
Pahang	Cameron Highland	1951-1990	2	4.9396	0.2645	-0.1638	0.0082
			5	4.6471	0.4968	-0.2002	0.0099
			10	4.3258	0.7684	-0.2549	0.0134
			20	4.8178	0.5093	-0.2022	0.0100
			50	5.3234	0.2213	-0.1402	0.0059
			100	5.0166	0.4675	-0.1887	0.0089
Pahang	Kuantan	1951-1990	2	5.1899	0.2562	-0.1612	0.0096
			5	4.7566	0.6589	-0.2529	0.0167
			10	4.3754	0.9634	-0.3068	0.0198
			20	4.8517	0.7649	-0.2697	0.0176
			50	5.0350	0.7267	-0.2589	0.0167
			100	5.2158	0.6752	-0.2450	0.0155
Pahang	Temerloh	1970-1983	2	4.6023	0.4622	-0.1729	0.0066
			5	5.3044	0.0115	-0.0590	-0.0019
			10	4.5881	0.5465	-0.1646	0.0049
			20	4.4378	0.7118	-0.1960	0.0068
			50	4.4823	0.8403	-0.2288	0.0095
			100	4.5261	0.7210	-0.1988	0.0071
Terengganu	Kuala Dungun	1971-1983	2	5.2577	0.0572	-0.1091	0.0057
			5	5.5077	-0.0310	-0.0899	0.0050
			10	5.4881	0.0698	-0.1169	0.0074
			20	5.6842	-0.0393	-0.0862	0.0051
			50	5.5773	0.1111	-0.1231	0.0081
			100	6.1013	-0.1960	-0.0557	0.0035
Terengganu	Kuala Terengganu	1951-1983	2	4.6684	0.3966	-0.1700	0.0096
			5	4.4916	0.6583	-0.2292	0.0143
			10	5.2985	0.2024	-0.1380	0.0089
			20	5.8299	-0.0935	-0.0739	0.0046
			50	6.1694	-0.2513	-0.0382	0.0021
			100	6.1524	-0.1630	-0.0575	0.0035
Kelantan	Kota Bharu	1951-1990	2	5.4683	0.0499	-0.1171	0.0070
			5	5.7507	-0.0132	-0.1117	0.0078
			10	5.2497	0.4280	-0.2033	0.0139
			20	5.4724	0.3591	-0.1810	0.0119
			50	5.3578	0.5094	-0.2056	0.0131
			100	5.0646	0.7917	-0.2583	0.0161
Kelantan	Gua Musang	1971-1990	2	4.6132	0.6009	-0.2250	0.0114
			5	3.8834	1.2174	-0.3624	0.0213
			10	4.6080	0.8347	-0.2848	0.0161
			20	4.7584	0.7946	-0.2749	0.0154
			50	4.6406	0.9382	-0.3059	0.0176
			100	4.6734	0.9782	-0.3152	0.0183

(Continued)

Table 13.A1 Coefficients for the IDF Equations for the Different Major Cities and Towns in Malaysia (30 ≤ t ≤ 1000 min)

State	Location	Data Period	ARI (year)	Coefficients of the IDF Polynomial Equations			
				a	b	c	d
Sabah	Kota Kinabalu	1957-1980	2	5.1968	0.0414	-0.0712	-0.0002
			5	5.6093	-0.1034	-0.0359	-0.0027
			10	5.9468	-0.2595	-0.0012	-0.0050
			20	5.2150	0.3033	-0.1164	0.0026
			50	5.1922	0.3652	-0.1224	0.0027
Sabah	Sandakan	1957-1980	2	3.7427	1.2253	-0.3396	0.0191
			5	4.9246	0.5151	-0.1886	0.0095
			10	5.2728	0.3693	-0.1624	0.0083
			20	4.9397	0.6675	-0.2292	0.0133
			50	5.0022	0.6587	-0.2195	0.0123
Sabah	Tawau	1966-1978	2	4.1091	0.6758	-0.2122	0.0093
			5	3.1066	1.7041	-0.4717	0.0298
			10	4.1419	1.1244	-0.3517	0.0220
			20	4.4639	1.0439	-0.3427	0.0220
Sabah	Kuamut	1969-1980	2	4.1878	0.9320	-0.3115	0.0183
			5	3.7522	1.3976	-0.4086	0.0249
			10	4.1594	1.2539	-0.3837	0.0236
			20	3.8422	1.5659	-0.4505	0.0282
			50	5.6274	0.3053	-0.1644	0.0079
			100	6.3202	-0.0778	-0.0849	0.0026
Sarawak	Simanggang	1963-1980	2	4.3333	0.7773	-0.2644	0.0144
			5	4.9834	0.4624	-0.1985	0.0100
			10	5.6753	0.0623	-0.1097	0.0038
			20	5.9006	-0.0189	-0.0922	0.0027
Sarawak	Sibu	1962-1980	2	3.0879	1.6430	-0.4472	0.0262
			5	3.4519	1.4161	-0.3754	0.0200
			10	3.6423	1.3388	-0.3509	0.0177
			20	3.3170	1.5906	-0.3955	0.0202
Sarawak	Bintulu	1953-1980	2	5.2707	0.1314	-0.0976	0.0025
			5	5.5722	0.0563	-0.0919	0.0031
			10	6.1060	-0.2520	-0.0253	-0.0012
			20	6.0081	-0.1173	-0.0574	0.0014
			50	6.2652	-0.2584	-0.0244	-0.0008
Sarawak	Kapit	1964-1974	2	3.2235	1.2714	-0.3268	0.0164
			5	4.5416	0.2745	-0.0700	-0.0032
			10	4.5184	0.2886	-0.0600	-0.0045
			20	5.0785	-0.0820	0.0296	-0.0110
Sarawak	Kuching	1951-1980	2	5.1719	0.1558	-0.1093	0.0043
			5	4.8825	0.3871	-0.1455	0.0068
			10	5.1635	0.2268	-0.1039	0.0039
			20	5.2479	0.2107	-0.0968	0.0035
			50	5.2780	0.2240	-0.0932	0.0031
Sarawak	Miri	1953-1980	2	4.9302	0.2564	-0.1240	0.0038
			5	5.8216	-0.2152	-0.0276	-0.0021
			10	6.1841	-0.3856	0.0114	-0.0048
			20	6.1591	-0.3188	0.0021	-0.0044
			50	6.3582	-0.3823	0.0170	-0.0054

LIST OF FORMULA

CROSS SECTION	AREA, A	WET PERIMETER, P	WIDTH
 Rectangular Channel	By	$B + 2y$	B
 Trapezoidal Cross Section	$\frac{1}{2}y(B+b)$	$b + 2y\sqrt{1+z^2}$	$b + 2zy$
 Triangular Channel	$\frac{1}{2}By$ y^2z	$2y\sqrt{1+z^2}$	$2zy$
	$r^2\theta - \frac{r^2 sin2\theta}{2}$	$2\theta r$	$(sin\frac{1}{2}\theta)d$
	θ in radian		

1. $Q = A\frac{1}{N}m^{2/3}\sqrt{S_o}$

2. $E = y + \frac{v^2}{2g}$

3. $\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{1+8Fr_1^2} - 1\right)$

4. $y_c = \sqrt[3]{\frac{q^2}{g}}$

5. $y_c = \frac{2}{3}E_{min}$

6. $F_r = \frac{v}{\sqrt{gy}}$

7. $E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$

8. $P_L = \rho g Q E_L$

9. $P_o = \rho g Q H$

10. $\eta = \frac{Po}{Pi}$

11. $h_L = \frac{flQ^2}{3d^5}$

12. $\eta = \frac{\sum_i H_i}{\sum_i \left(H_i/\eta_i\right)}$

13. $\eta = \frac{\sum_i Q_i}{\sum_i \left(Q_i/\eta_i\right)}$

14. $\Sigma\, Inflows - \Sigma\, Outflows = \Delta Storages$

15. $P - R - ET = \Delta S$

DISCHARGE FORM:

Distance from left water edge (m)	Vertical depth (m)	Stream depth (m)	Time (s)	Revolution	Revolution per second	**Velocity (m/s) at**			Segment width (m)	Average vertical depth (m)	Segment area (m^2)	**Discharge (m^3/s)**
						Stream depth	**Average vertical depth**	**Average cross section**				