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

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI DISEMBER 2018

DCC6213 : HYDRAULICS AND HYDROLOGY

TARIKH : 21 APRIL 2019
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.

Bahagian A: Struktur (2 soalan)
Bahagian B: Struktur (4 soalan)

Dokumen sokongan yang disertakan : Manual MSMA, Formula, Borang Kadar Alir dan Kertas Graf

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

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.*

QUESTION 1

SOALAN 1

CLO1 C1

(a) Define the terms below:

Takrifkan istilah berikut:

i. Hydraulics

Hidraulik

ii. Hydrology

Hidrologi

iii. Fluid Mechanics

Mekanik Bendalir

[5 marks]

[*5 markah*]

CLO1 C2

(b) The discharge of water through a rectangular channel with the width of 6m, is $18m^3/s$ when the depth of water flow is 2m. Calculate the specific energy of the flowing water.

Kadaralir air yang melalui satu saluran segi empat tepat dengan lebar 6m, adalah $18m^3/s$ apabila kedalaman aliran air adalah 2m. Kirakan tenaga tentu air yang mengalir.

[5 marks]

[*5 markah*]

CLO1 C3

(c) Water is flowing in an open channel with a flow rate per unit width (q) of $10m^3/s/m$ and an upstream depth, of 1.25m. If the flow produces a hydraulic jump, calculate the:

Air mengalir dalam satu saluran terbuka dengan kadar aliran per unit lebar (q) 10m3/s/m dan kedalaman dihulu, 1.25m. Sekiranya aliran itu menghasilkan lompatan hidraulik, kira:

i. Depth after the jump, y_2
Kedalaman selepas lompatan, y_2

ii. Velocity after the jump, V_2
Halaju selepas lompatan, V_2

iii. Froude number after the jump, Fr_2
Nombor Froude selepas lompatan, Fr_2

iv. Energy loss, E_L
Kehilangan Tenaga, E_L

[15 marks]
[15 markah]

QUESTION 2

SOALAN 2

CLO2
C3

(a) Kundang Lake with an area of 55 km^2 had a water elevation of 110 m at the beginning of a certain month. In that month, the lake received an inflow of 6 m^3/s and outflow of 6.5 m^3/s. The lake also received a rainfall of 145 mm and the rate of evaporation was estimated to be 70 mm. Based on the information given, calculate:

Tasik Kundang dengan keluasan 55 km^2 mempunyai ketinggian air 110 m pada permulaan bulan tertentu. Pada bulan tersebut, tasik itu menerima aliran masuk sebanyak 6 m^3/s dan aliran keluar sebanyak 6.5 m^3/s. Tasik itu juga menerima hujan sebanyak 145 mm dan kadar penyejatan dianggarkan sebanyak 70 mm. Berdasarkan kepada informasi tersebut, kirakan:

i. Total inflow at the end of month.
Jumlah aliran masuk pada akhir bulan.

[5 marks]
[*5 markah*]

ii. Total outflow at the end of month.
Jumlah aliran keluar pada akhir bulan.

[3 marks]
[*3 markah*]

iii. Change in storage at the end of month.
Perubahan pada storan pada akhir bulan.

[2 marks]
[*2 markah*]

CLO2
C4

(b) Calculate the mean areal precipitation for the following data using the isohyetal method based on **TABLE A1**.
*Kirakan purata hujan untuk data berikut menggunakan kaedah isohyet berdasarkan kepada **JADUAL A1**.*

TABLE A1 / *JADUAL A1*

Isohyetal line, ***Garis isoyet* (cm)**	1 - 3	3 - 6	6 - 9	9 - 12	12 - 15
Area between isohyetal line, ***Luas antara Garis isoyet* (km²)**	85	175	120	128	92

[15 marks]
[*15 markah*]

SECTION B : 50 MARKS
BAHAGIAN B : 50 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

TABLE B1 / JADUAL B1

Discharge *Kadaralir,* Q (liter/sec)	0	100	200	300	350	400	500
Head *Turus,* H(m)	17	18	18	16	14	11.5	5
Efficiency *Kecekapan,* η (%)	0	30	61	82	85	80	47

A centrifugal pump is running at 720 rev/min produced the data as in **TABLE B1.** The pump was used to deliver water from its low tank to a high tank through 500 mm diameter pipe with a 2600 m total length of pipe. If the friction coefficient of pipe is 0.0025 and the head difference between the two tanks is 15m;
*Sebuah pam empar beroperasi dengan kelajuan 720 pusingan/min menghasilkan data seperti **JADUAL B1**. Pam ini telah digunakan untuk menyalurkan air dari sebuah tangki yang rendah kepada tangki yang tinggi menggunakan paip yang berdiameter 500 mm sepanjang 2600 m. Jika pekali geseran paip adalah 0.0025 dan perbezaan turus di antara dua tangki tersebut ialah 15 m;*

CLO1
C2

(a) Draw the pump characteristics graph
Lukiskan graf ciri-ciri pam

[13 marks]
[*13 markah*]

CLO1
C3

(b) Calculate the power output and pump efficiency at the operating point.
Kirakan kuasa yang terhasil dan kecekapan pam pada titik operasi.

[12 marks]
[*12 markah*]

QUESTION 2

SOALAN 2

CLO2
C3

(a)

i. List down **SIX (6)** important characteristics of hydrology on the rainfall measurement.

*Senaraikan **ENAM (6)** ciri-ciri penting hidrologi untuk sukat hujan.*

[6 marks]

[6 markah]

ii. **TABLE B2** below shows the rainfall data at 6 stations. Calculate the mean precipitation by using arithmetic average method.

***JADUAL B2** di bawah menunjukkan data hujan bagi 6 stesen. Kiraan purata hujan kawasan dengan menggunakan Kaedah Purata Aritmetik.*

TABLE B2 / *JADUAL B2*

Station No. ***No Stesen.***	1	2	3	4	5	6
Precipitation, ***Hujan (cm)***	13.8	17.5	7.9	14.8	15.0	10.5

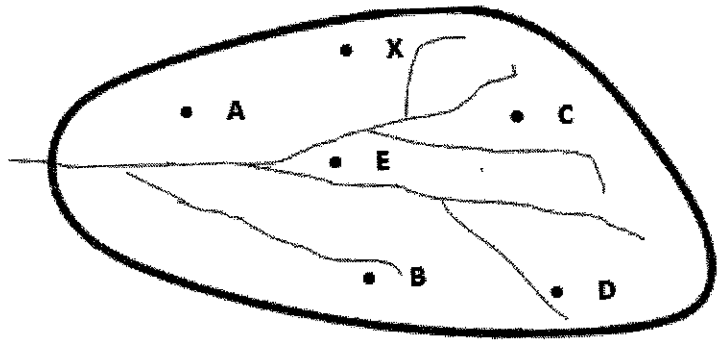
[7 marks]

[7 markah]

CLO2
C4

(b) The **PICTURE B1** shows the location of a few rain gauge and **TABLE B3** shows the monthly and annual rainfall for Setiawan catchment. Determine the missing amount of rainfall for gauge X using arithmetic average dan normal ratio method.

GAMBAR B1 *menujukkan kedudukan beberapa tolok hujan dan* ***JADUAL B3*** *menunjukkan data bulanan dan tahunan hujan untuk kawasan tadahan Setiawan. Dapatkan nilai data hujan bagi tolok X dengan menggunakan kaedah purata aritmetik dan nisbah normal.*



PICTURE B1 / *GAMBAR B1*

TABLE B3 / *JADUAL B3*

Station, ***Stesen***	**Monthly precipitation,** ***Hujan bulanan(mm)***	**Annual precipitation,** ***Hujan tahunan(mm)***
X	?	110.5
A	10.3	96.3
B	9.5	110.3
C	13.0	93.0
D	11.6	106.3
E	9.6	100.6

[12 marks]
[*12 markah*]

QUESTION 3
SOALAN 3

Based on the data from Sungai Kelang given in **TABLE B4.**
*Berdasarkan data dari Sungai Kelang yang diberikan dalam **JADUAL** **B4.***

CLO2
C3

a) By using Velocity Area Method, calculate the velocity for every section of a river
if the rating equation for current meter used is V= 0.05 + 0.9N.
Dengan menggunakan kaedah halaju luas, kirakan halaju pada setiap keratan sungai sekiranya persamaan meter arus yang digunakan adalah $V = 0.05 + 0.9N$.

[13 marks]
[*13 markah*]

CLO2
C4

b) Determine the discharge of the river.
Tentukan kadaralir sungai tersebut.

[12 marks]
[*12 markah*]

Distance From River Bank *Jarak Dari Tebing Sungai* (m)	Depth *Kedalaman* (m)	Depth Of Measurement *Pengukuran Kedalaman* (m)	Rotation *Putaran* (r)	Time *Masa* (s)
0.5	1.0	0.6d	15	50
1.5	4.0	0.2d	30	55
		0.8d	48	53
2.8	5.5	0.2d	40	46
		0.8d	60	54
3.5	6.5	0.2d	45	48
		0.8d	67	52
4.2	4.5	0.2d	33	54
		0.8d	51	50
5.5	2.5	0.2d	26	48
		0.8d	44	55
6.5	1	0.6d	20	47

TABLE B4 / JADUAL *B4*
(Note: Answer in Appendix 1)
(Nota: Jawab di Apendik 1)

CLO2
C3

QUESTION 4

SOALAN 4

a) Determine the peak flow of residential areas in Batu Pahat. The housing characteristics are as follows :

Tentukan aliran puncak kawasan perumahan di Batu Pahat. Ciri-ciri kawasan adalah seperti berikut:

Residential areas	= 15 Hectares
Kawasan kediaman	*= 15 Hektar*
Density residential	= Medium density
Kepadatan Kediaman	*= ketumpatan Sederhana*
Drainage types	= Minor Drainage
Jenis Saliran	*= Minor Saliran*
Length of overland flow	= 85 m
Panjang aliran atas permukaan	*= 85 m*
Length of flow channel	= 400 m
Panjang saliran aliran	*= 400 m*
Slope of the catchments area	= 1%
Kecerunan kawasan tadahan	*= 1%*

[13 marks]

[13 *markah*]

CLO2
C4

b) Calculate the peak flow rate that is generated from a minor drainage of medium density in a residential area of 8 hectares in Kuala Kangsar. Assume 50m of overland flow followed by 300m of flow in an open drain. The catchment area average slope is 2%. Assume the velocity = 1.0 m/s and minus system, design ARI for five (5) years.

Kirakan kadar aliran puncak yang dijana daripada saliran minor berkepadatan sederhana di kawasan kediaman seluas 8 hektar di Kuala Kangsar. Anggapkan 50m aliran darat diikuti dengan aliran 300m di longkang terbuka. Purata Kecerunan kawasan tadahan adalah 2%. Anggapkan halaju = 1.0 m/s sistem minus, rekabentuk ARI untuk lima (5) tahun.

[12 marks]
[12 *markah*]

SOALAN TAMAT

LIST OF FORMULA FOR

DCC6213: HYDRAULICS AND HYDROLOGY

OPEN CHANNEL FLOW	
$E = y + V^2/2g$	$E_{min} = \frac{3}{2} y_c$
$y_c = \left(\frac{q^2}{g}\right)^{1/3}$	$V_c = \sqrt{g y_c}$
$Q = [AR^{2/3}S^{1/2}] / n$	$q = \frac{Q}{b}$
$V = \frac{q}{y}$	$F_r = \frac{v}{\sqrt{gy}}$
$\frac{y_1}{y_2} = \frac{1}{2}\left(\sqrt{1 + 8{Fr_2}^2} - 1\right)$	$E_L = \frac{(y_2 - y_1)^3}{4 y_1 y_2}$
PUMPS	
$P_o = \rho g H Q$	$P_i = 2\pi N T$
$H_L = \frac{f L Q^2}{3 d^5}$	$H_m = H_s + H_L$
$\eta = \frac{H_1 + H_2}{\left(\frac{H_1}{\eta_1} + \frac{H_2}{\eta_2}\right)}$	$\eta = \frac{Q_1 + Q_2}{\left(\frac{Q_1}{\eta_1} + \frac{Q_2}{\eta_2}\right)}$
$\eta = \frac{P_o}{P_i} \times 100\%$	
WATER BALANCE EQUATION	
ΔS = Total Inflow - Total Outflow	

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

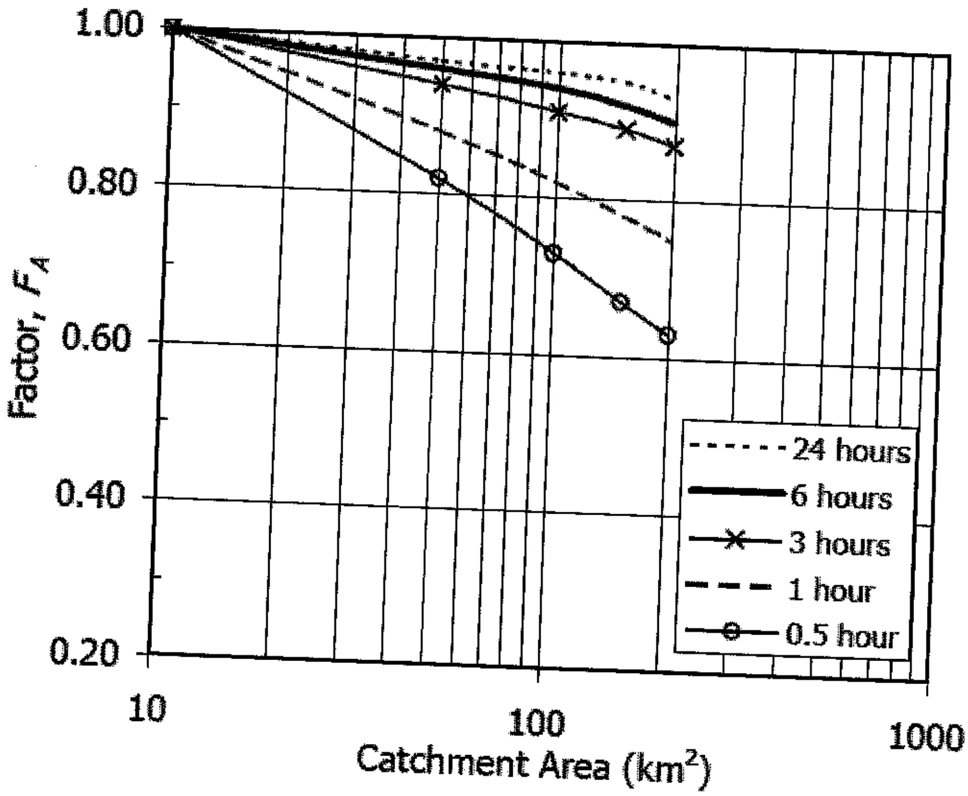


Figure 13.1 Graphical Areal Reduction Factors

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

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: $30 \leq t \leq 1000$ minutes

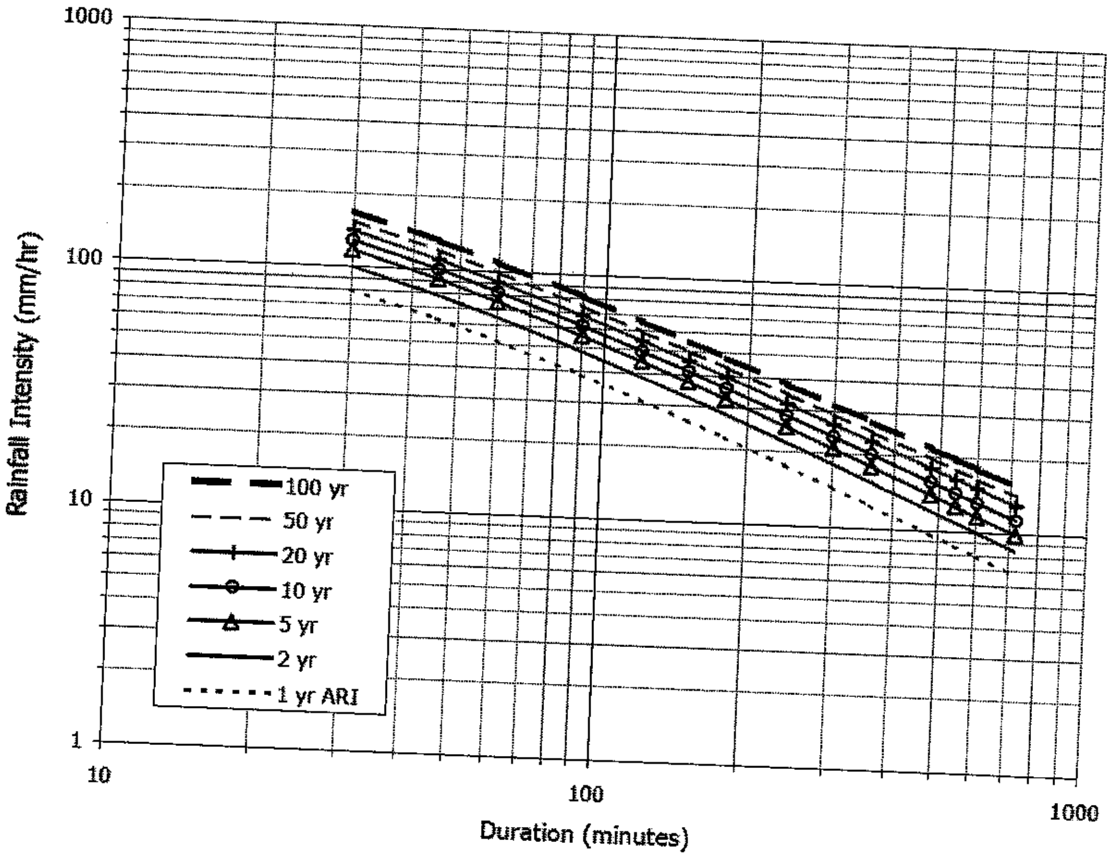


Figure 13.2 IDF Curves for Kuala Lumpur

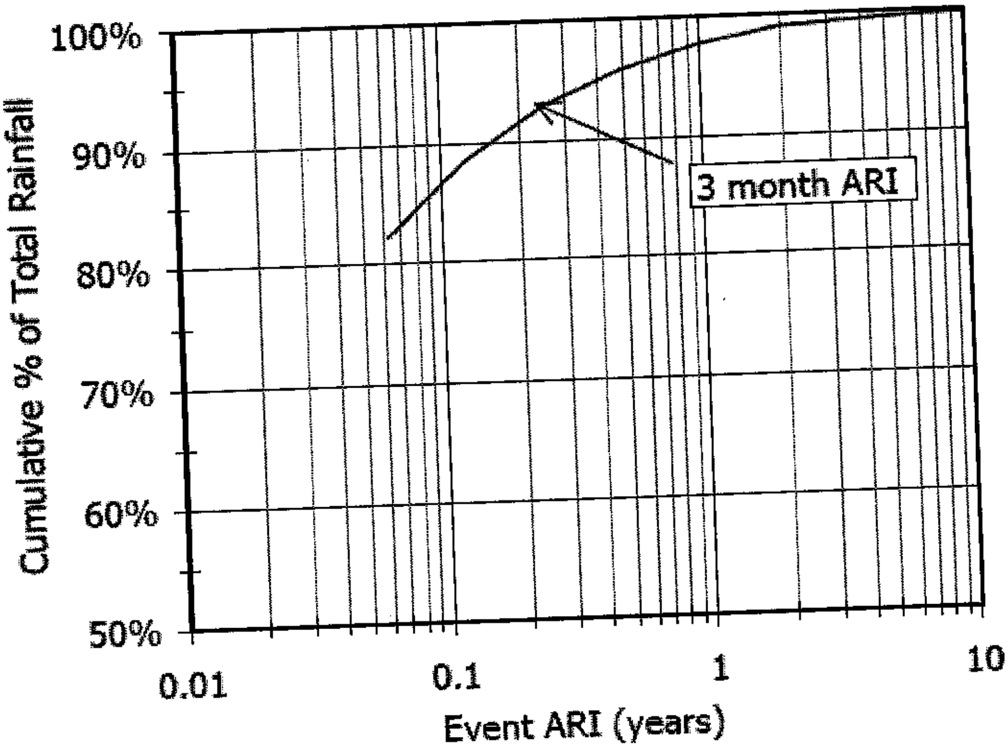
Table 13.3 Values of F_D for Equation 13.3

Duration (minutes)	$^{2}P_{24h}$ (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.



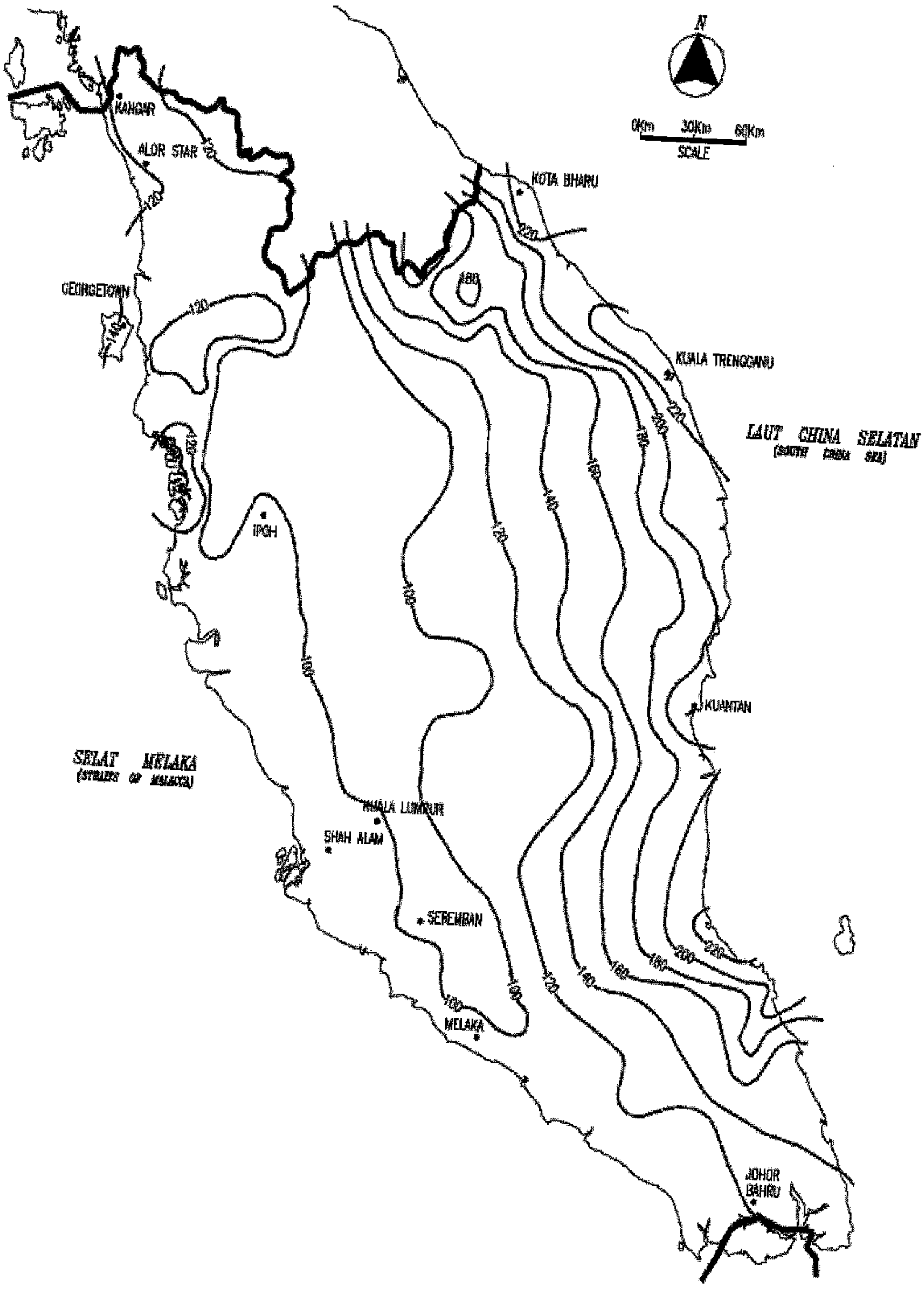
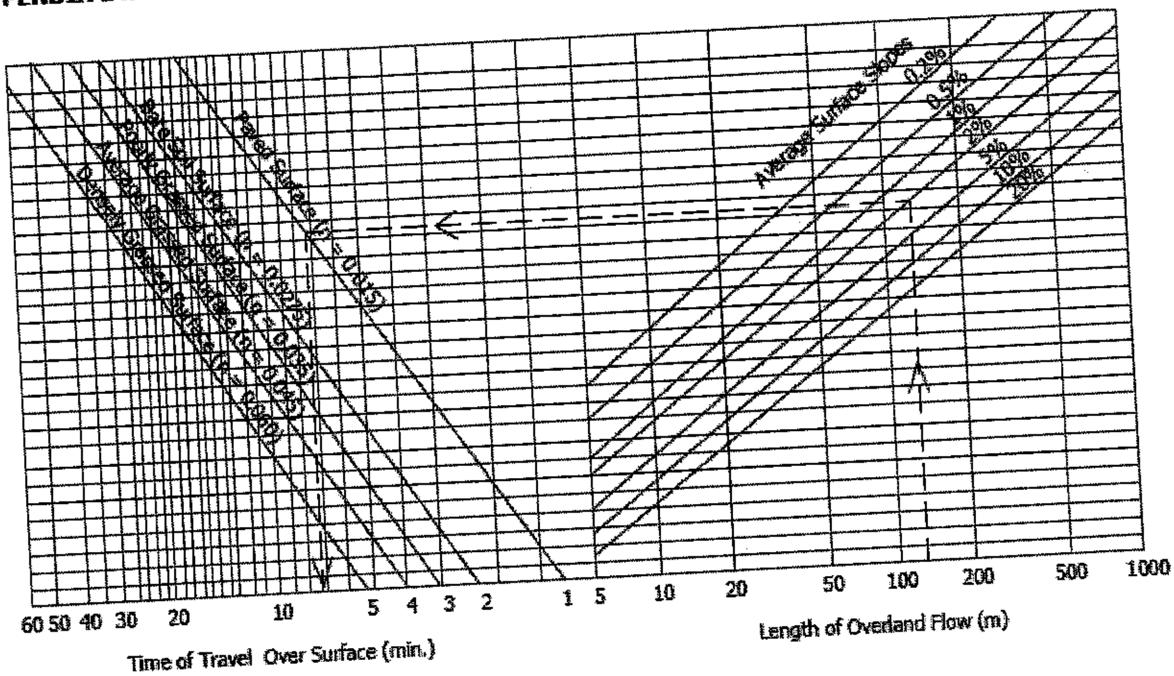
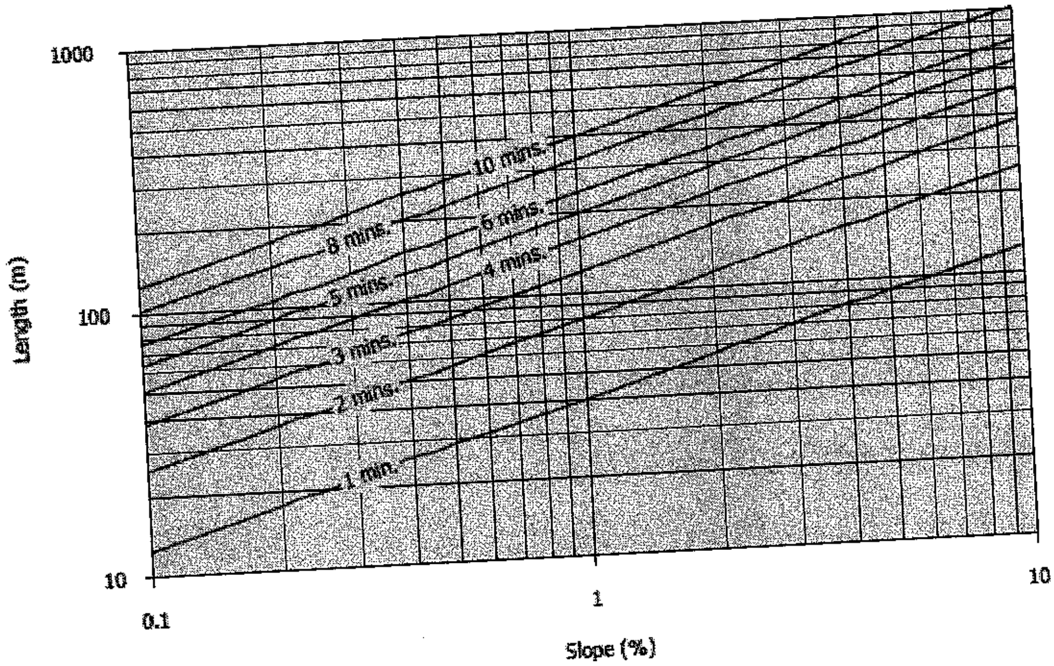


Figure 13.3 Values of ${}^{2}P_{24h}$ for use with Table 13.3
(source: HP 1, 1982)

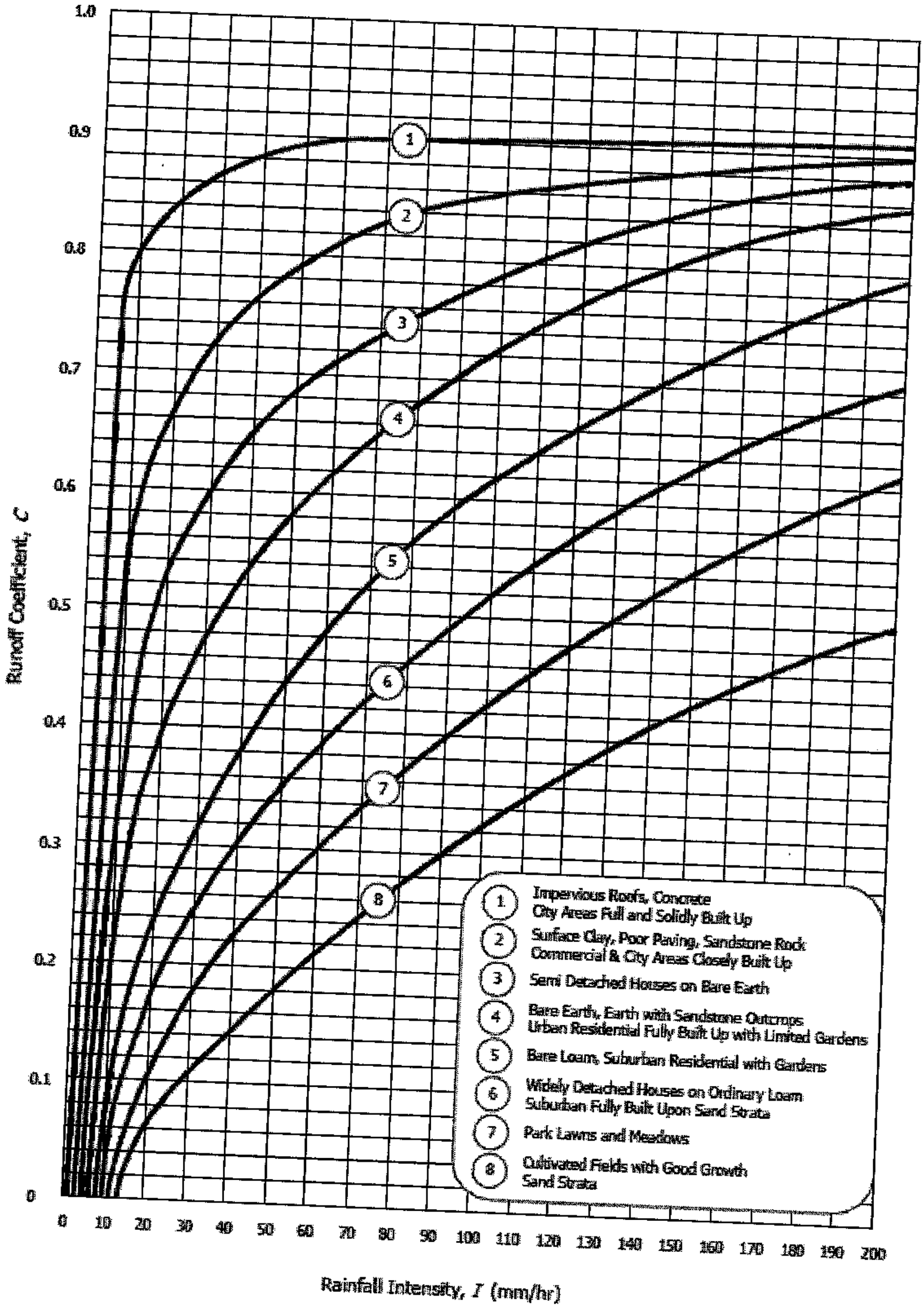
APPENDIX 14.A DESIGN CHARTS



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

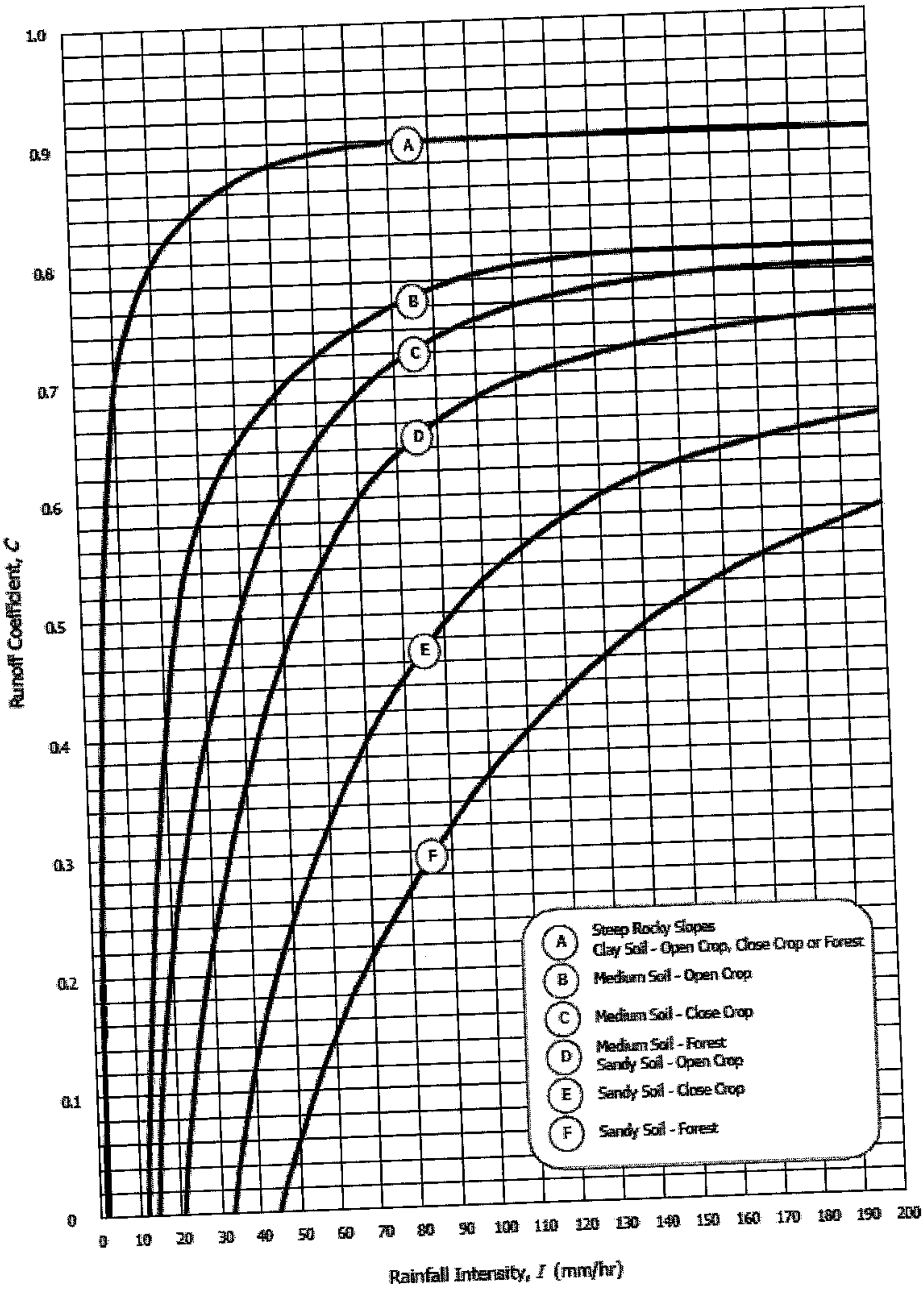


Design Chart 14.2 Kerb Gutter Flow Time



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	-0.6046	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 ≤ t ≤ 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 ($30 \leq t \leq 1000$ 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

Appendix 1

DISCHARGE FORM:

Distance From River Bank (m)	Water Depth (m)	Depth Of Measurement (m)	Time (s)	Rotation	Rotation per second	Velocity (meter per second)			Width (m)	Mean Water Depth (m)	Area (m^2)	Flowrate (m^3/s)
						At Point	Vertical Average	Horizontal Average				
Σ												