SULIT

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

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI JUN 2018

DCC6213 : HYDRAULICS AND HYDROLOGY

TARIKH : 28 OKTOBER 2018
MASA : 8.30PAGI – 10.30PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** 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)

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.*

QUESTION 1
SOALAN 1

CLO1 C1

(a) Define the terms below:
Takrifkan istilah berikut:

i. Hydraulic
Hidraulik

ii. Hydrology
Hidrologi

iii. Fluid Mechanic
Mekanik Bendalir

[5 marks]
[*5 markah*]

CLO1 C2

(b) State **TWO (2)** types of open channels and identify **THREE (3)** examples for each type.
*Nyatakan **DUA (2)** jenis saluran terbuka dan kenalpasti **TIGA (3)** contoh untuk setiap jenis.*

[5 marks]
[*5 markah*]

CLO1
C3

(c) A rectangular channel with a width of 6m discharges water at a flow rate of 8.5 m^3/s. If the Manning of coefficient value for this channel is 0.025, calculate:
Satu saluran berbentuk segi empat dengan lebar 6 m mengalirkan air pada kadar alir 8.5 m^3/s. Jika nilai pekali Manning bagi saliran ini adalah 0.025, kirakan:

i. Critical of depth, y_c
Kedalaman kritikal, y_c

ii. Critical velocity, v_c
Halaju kritikal, v_c

iii. Critical slope, S_c
Kecerunan kritikal, S_c

iv. Value of minimum specific energy, E_{min}
Nilai tenaga tentu minima, E_{min}

[15 marks]
[15 markah]

QUESTION 2

SOALAN 2

CLO2 C3

(a) The water storage in a river at a particular time is 20 x 10^3 m^3. At that time, the recorded inflow and outflow are 10 m^3/s and 15 m^3/s respectively. One hour later, the inflow and outflow were recorded as 15 m^3/s and 16 m^3/s respectively. Calculate the change of storage and the new storage of water in the river.

Jumlah takungan air di dalam sebuah sungai pada suatu masa tertentu adalah 20 x 10^3 m^3. Pada ketika itu, nilai kadar alir masuk dan kadar alir keluar yang direkodkan masing-masing ialah 10 m^3/s dan 15 m^3/s. Satu jam kemudian, nilai kadar alir masuk dan kadar alir keluar yang direkodkan masing-masing ialah 15 m^3/s dan 16 m^3/s. Kirakan perubahan pada jumlah takungan dan jumlah takungan air yang baharu di dalam sungai tersebut.

[10 marks]

[*10 markah*]

CLO2 C4

(b) **TABLE A1** shows the rainfall data and the area bounded for each station at a catchment area. Determine the average rainfall for the catchment area by using Polygon Thiessen Method and Arithmetic Method.

JADUAL A1 *menunjukkan data hujan dan luas yang dilindungi bagi setiap stesen untuk satu kawasan tadahan. Tentukan purata hujan bagi kawasan tadahan itu dengan menggunakan Kaedah Poligon Thiessen dan Kaedah Aritmetik.*

TABLE A1 / *JADUAL A1*

Station *Stesen*	Precipitation (mm) *Curahan (mm)*	Polygon Area (m^2) Luas Poligon (m^2)
A	45.0	40.7
B	45.5	61.5
C	52.5	69.5
D	27.0	50.5
E	36.5	55.3

[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 shows the features of a centrifugal pump at a constant speed. This pump is connected with a 71m transmission pipe and a 4m suction pipe to deliver water 10m high over the pump. The pump itself is 4m above the water source. Both pipes are 0.25 m in diameter and friction coefficient is 0.008.

JADUAL B1 *menunjukkan ciri-ciri suatu pam empar pada kelajuan malar. Pam ini disambungkan dengan paip hantaran 71 m panjang dan paip sedutan 4 m untuk menghantar air setinggi 10 m di atas pam. Kedudukan pam itu sendiri ialah setinggi 4 m dari sumber air. Kedua-dua paip itu berdiameter 0.25 m dan nilai pekali geseran ialah 0.008.*

TABLE B1 / *JADUAL B1*

Head, H (m) *Turus, H (m)*	22.5	22.2	21.6	19.5	14.1	0
Discharge, Q x 10^{-2} (m^3/s) *Kadar alir, Q x 10^{-2} (m^3/s)*	0	7.5	15.0	22.5	30.0	37.5
Efficiency, η (%) *Kecekapan η (%)*	0	74	86	84	70	46

CLO1 C2

(a) Determine the pump characteristics by plotting the graph.
Tentukan ciri-ciri pam tersebut dengan memplotkan graf.

[13 marks]
[*13 markah*]

CLO1 C3

(b) From the graph plotted, determine the discharge, head, effiency and the power input of pump at its operational point.
Daripada graf yang telah diplotkan, tentukan kadaralir, turus, kecekapan dan kuasa masukan pada titik pengoperasian pam.

[12 marks]
[*12 markah*]

QUESTION 2
SOALAN 2

CLO2 C3

(a) Isohyets for a rain storm in a catchment area is shown in **TABLE B2(a)**. By using the Isohyetal Method, calculate the average rainfall for the area.
Isohyets bagi satu ribut hujan di sebuah kawasan tadahan ditunjukkan dalam ***JADUAL B2(a)****. Dengan menggunakan Kaedah Isohyets, kirakan purata hujan bagi kawasan tersebut.*

TABLE B2(a) / *JADUAL B2(a)*

Isohyets (cm) *Isohyets (cm)*	Area (km^2) *Luas (km^2)*
12.0	40
12.0 - 10.0	130
10.0 - 8.0	70
8.0 - 6.0	180
6.0 - 4.0	30
4.0 - 2.0	20
2.0 - 0.0	40

[13 marks]
[*13 markah*]

CLO2
C4

(b) Calculate the mean precipitation for the following data as shown in **TABLE B2(b)** by using these methods:

*Kirakan purata hujan bagi data yang diberikan dalam **JADUAL B2(b)** dengan menggunakan kaedah berikut:*

i. Arithmetic Average
Purata Aritmetik

ii. Polygon Thiessen
Poligon Thiessen

TABLE B2(b) / *JADUAL B2(b)*

Station *Stesen*	Area (km^2) *Luas (km^2)*	Precipitation (mm) *Curahan (mm)*
1	70	90
2	30	100
3	75	105
4	40	130
5	75	150
6	90	160
7	45	150
8	40	120
9	85	90

[12 marks]
[*12 markah*]

QUESTION 3
SOALAN 3

TABLE B3 shows the data reading for Sungai Klang. By using the Velocity-Area Method:
***JADUAL B3** menunjukkan bacaan data bagi Sungai Klang. Dengan menggunakan Kaedah Halaju-Luas:*

TABLE B3 / JADUAL B3

Distance from river bank (m) *Jarak dari tebing (m)*	Vertical depth (m) *Kedalaman pugak (m)*	Immersion of current meter depth *Kedalaman meter arus*	Rotation *Putaran*	Time (s) *Masa (s)*
2	1	0.6D	10	40
4	2.2	0.2D	36	48
		0.8D	20	50
6	4	0.2D	40	57
		0.8D	30	53
8	8	0.2D	46	59
		0.8D	33	57
10	4.2	0.2D	33	51
		0.8D	29	49
12	2.5	0.2D	34	52
		0.8D	29	53
14	1.2	0.2D	16	48

CLO2
C3

(a) Calculate the velocity if $V = 0.5N + 0.04$.
Kirakan halaju jika $V = 0.5N + 0.04$.

[13 marks]
[*13 markah*]

CLO2
C4

(b) Estimate the discharge of the river.
Anggarkan kadar alir bagi sungai tersebut.

[12 marks]
[*12 markah*]

(Note: Answer in Appendix 1)
(*Nota: Jawab di Apendik 1*)

QUESTION 4

SOALAN 4

CLO2
C3

(a) Calculate the peak discharge for a housing area in Kuala Kangsar. Use the parameters below as an assumption to measure the peak discharge.
Kirakan kadar alir puncak bagi kawasan perumahan di Kuala Kangsar. Gunakan parameter di bawah sebagai andaian untuk mengukur kadar alir puncak.

Housing area	= 8 hectares
Luas kawasan	*= 8 hektar*
Residential type	= Medium density
Jenis perumahan	*= Sederhana padat*
Types of drainage	= Minor
Jenis saliran	*= Minor*
Slope average	= 2 %
Kecerunan purata	*= 2 %*
Length of overland flow	= 50 m
Panjang aliran atas permukaan	*= 50 m*
Length of channel	= 300 m
Panjang saliran	*= 300 m*

[13 marks]
[*13 markah*]

CLO2
C4

(b) Estimate the rainfall intensity for the duration of 15 minutes in Kuching. Given the Average Recurrence Interval (ARI) is 5 years.
Anggarkan keamatan hujan bagi tempoh 15 minit di Kuching. Diberi ARI ialah 5 tahun.

[12 marks]
[*12 markah*]

SOALAN TAMAT

LIST OF FORMULA FOR

DCC6213: HYDRAULICS AND HYDROLOGY

OPEN CHANNEL FLOW	
$E = y + V^2/2g$	$E_{min} = \frac{3}{2} y_c$
$y_c = \left(\frac{q^2}{g}\right)^{1/3}$	$V_c = \sqrt{g y_c}$
$Q = [AR^{2/3}S^{1/2}] / n$	$q = \frac{Q}{b}$
$V = \frac{q}{y}$	$F_r = \frac{v}{\sqrt{gy}}$
$\frac{y_1}{y_2} = \frac{1}{2}\left(\sqrt{1 + 8Fr_2^{\,2}} - 1\right)$	$E\iota = \frac{(y_2 - y_1)^3}{4 y_1 y_2}$
PUMPS	
$P_o = \rho g H Q$	$P_i = 2\pi N T$
$H_L = \frac{fLQ^2}{3d^5}$	$H_m = H_s + H_L$
$\eta = \frac{H_1 + H_2}{\left(\frac{H_1}{\eta_1} + \frac{H_2}{\eta_2}\right)}$	$\eta = \frac{Q_1 + Q_2}{\left(\frac{Q_1}{\eta_1} + \frac{Q_2}{\eta_2}\right)}$
$\eta = \frac{P_o}{P_i} \times 100\%$	
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 (km²)	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

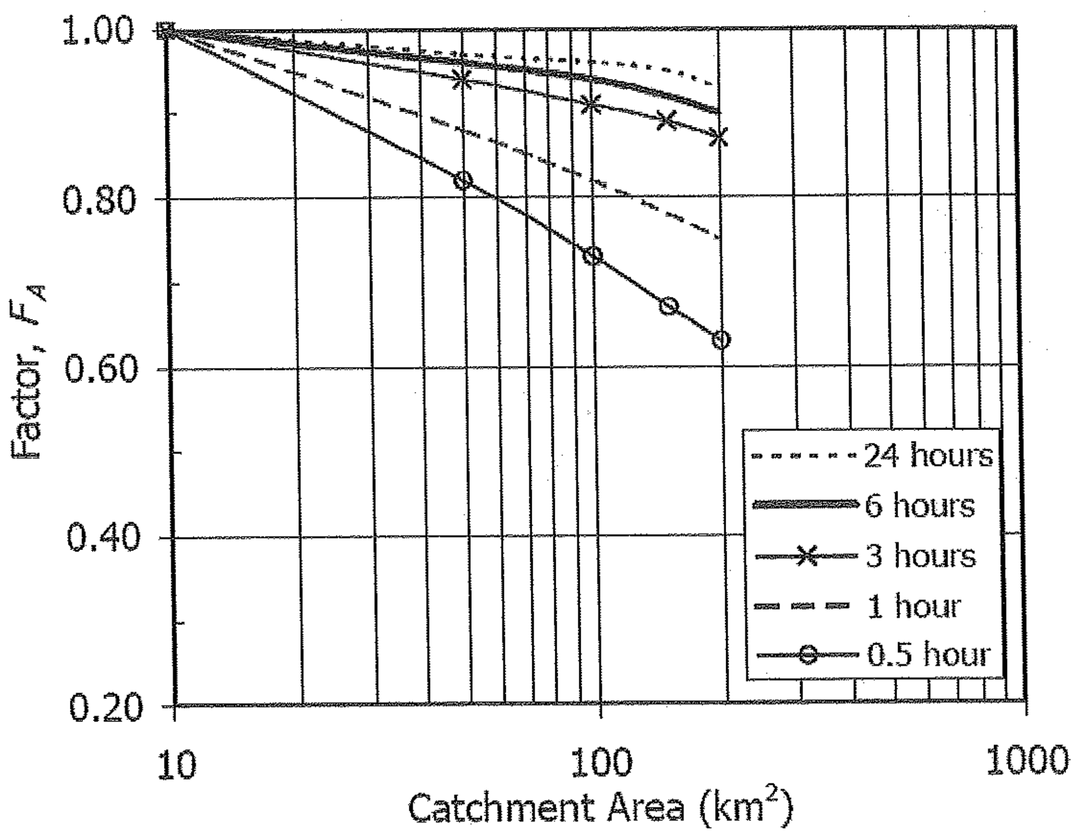


Figure 13.1 Graphical Areal Reduction Factors

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

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

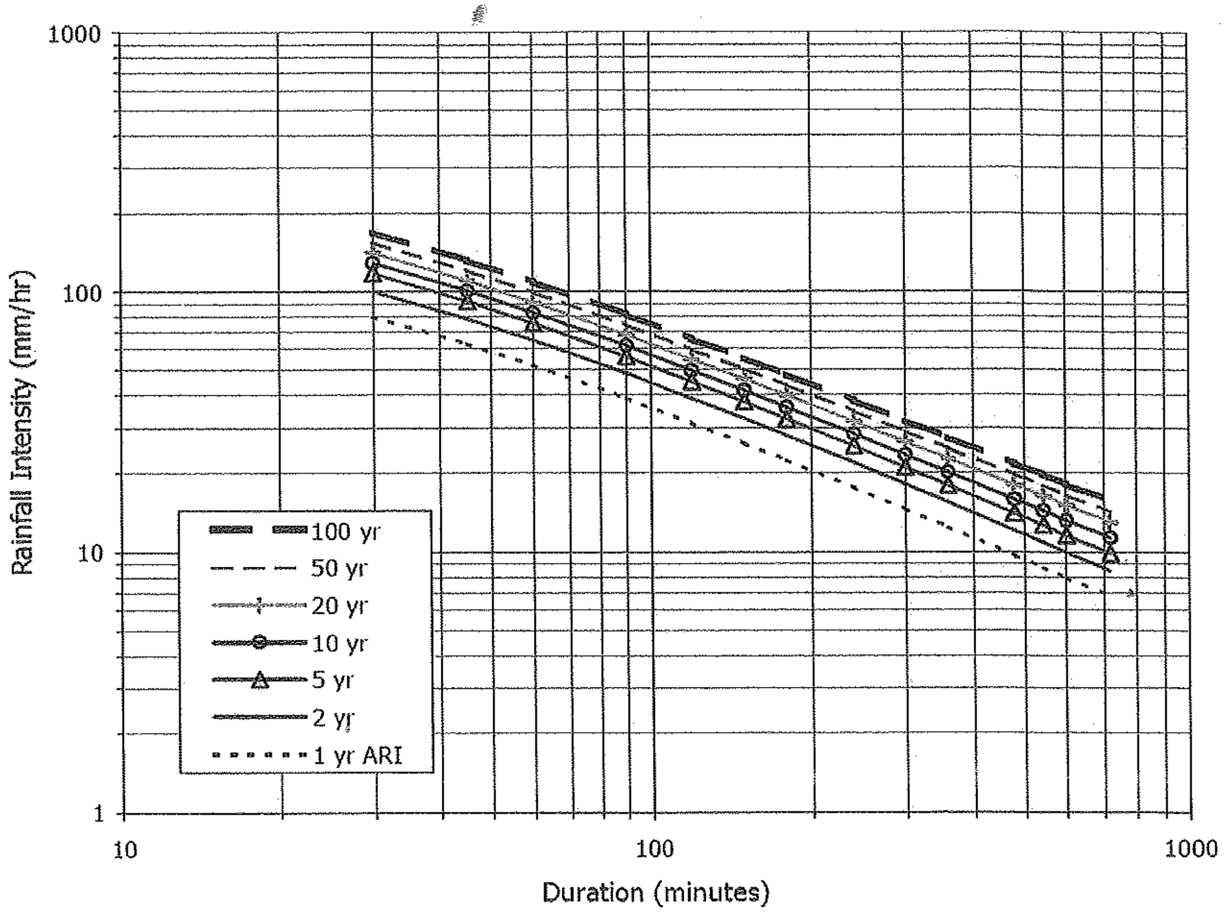


Figure 13.2 IDF Curves for Kuala Lumpur

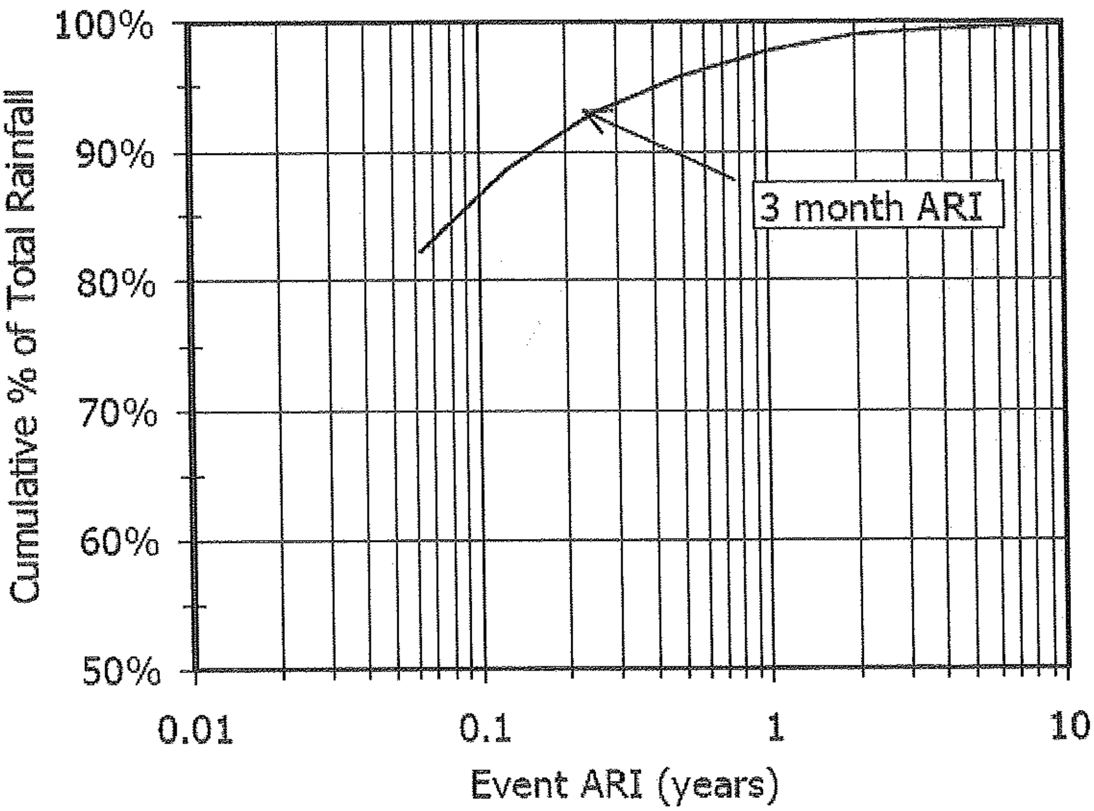
Table 13.3 Values of F_D for Equation 13.3

Duration	${}^2P_{24h}$ (mm)				
	West Coast				East Coast
(minutes)	≤ 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.



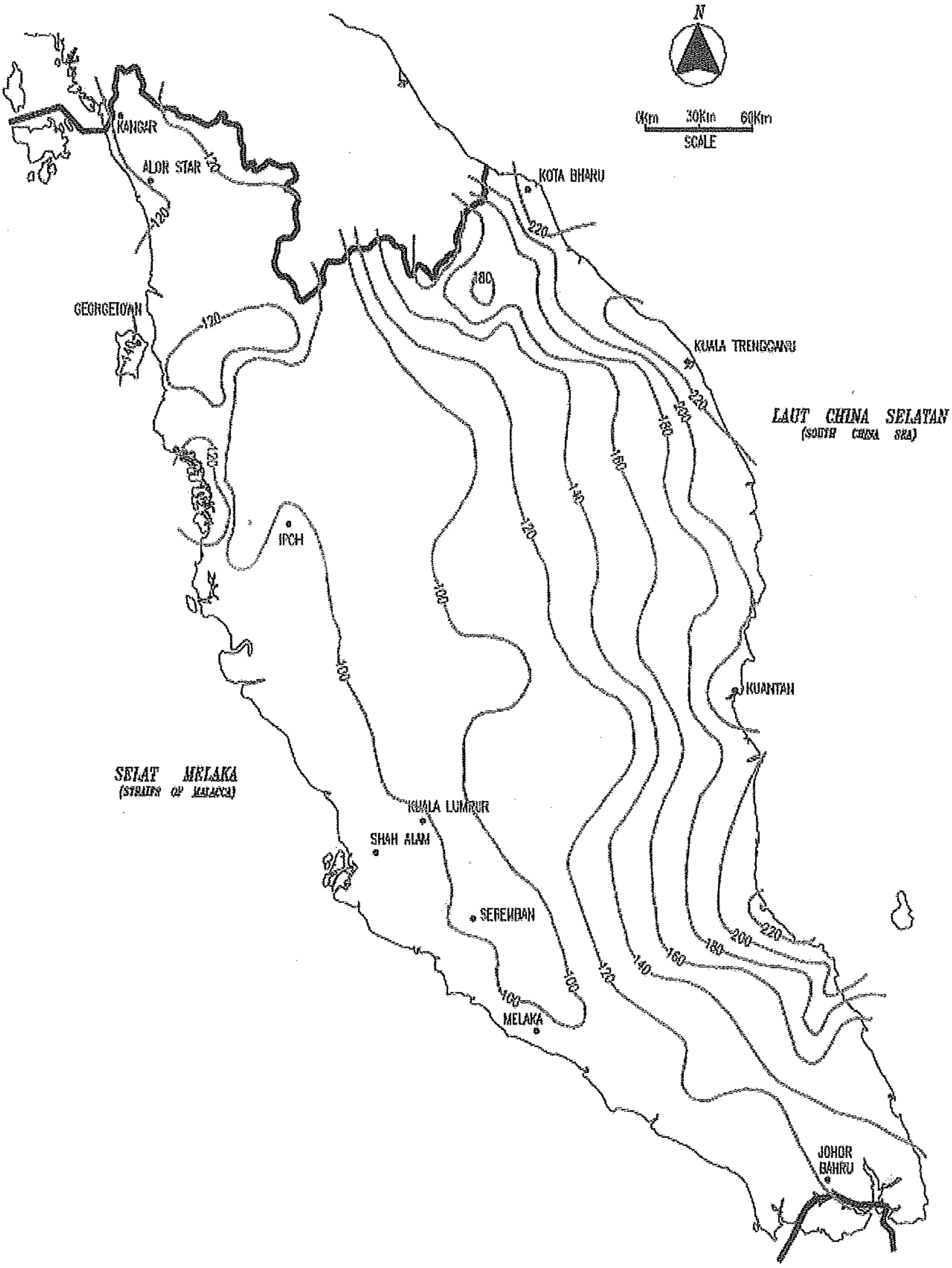
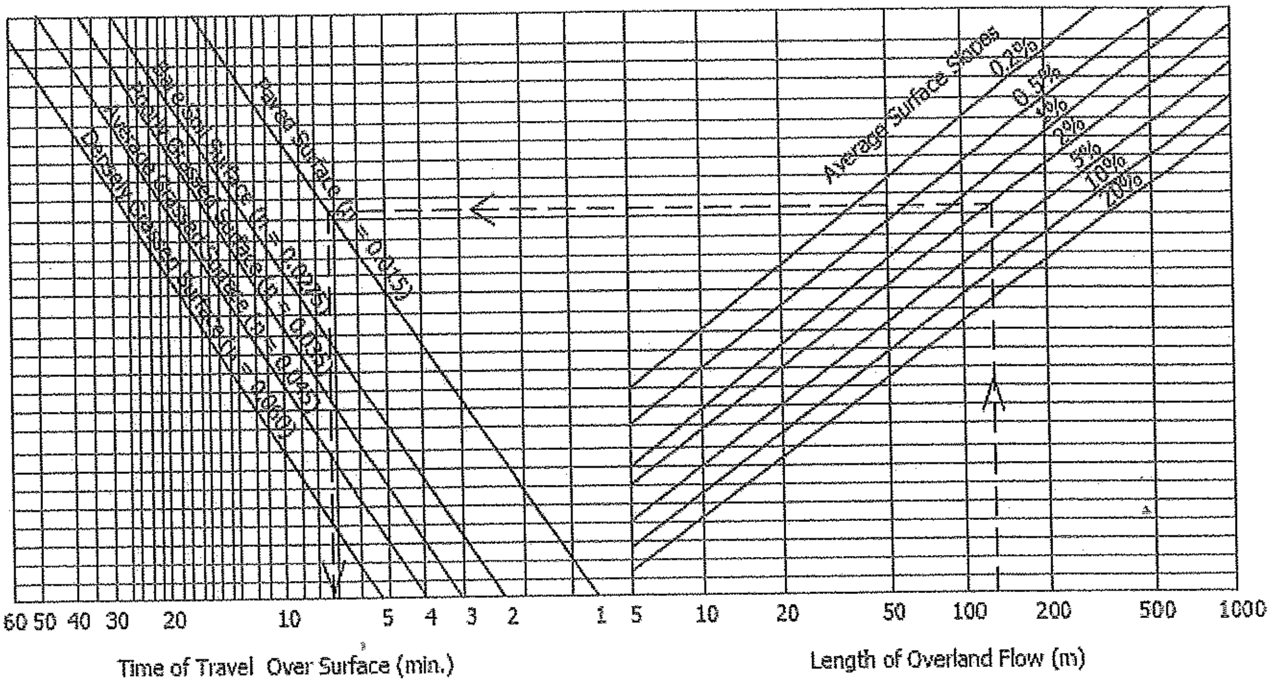
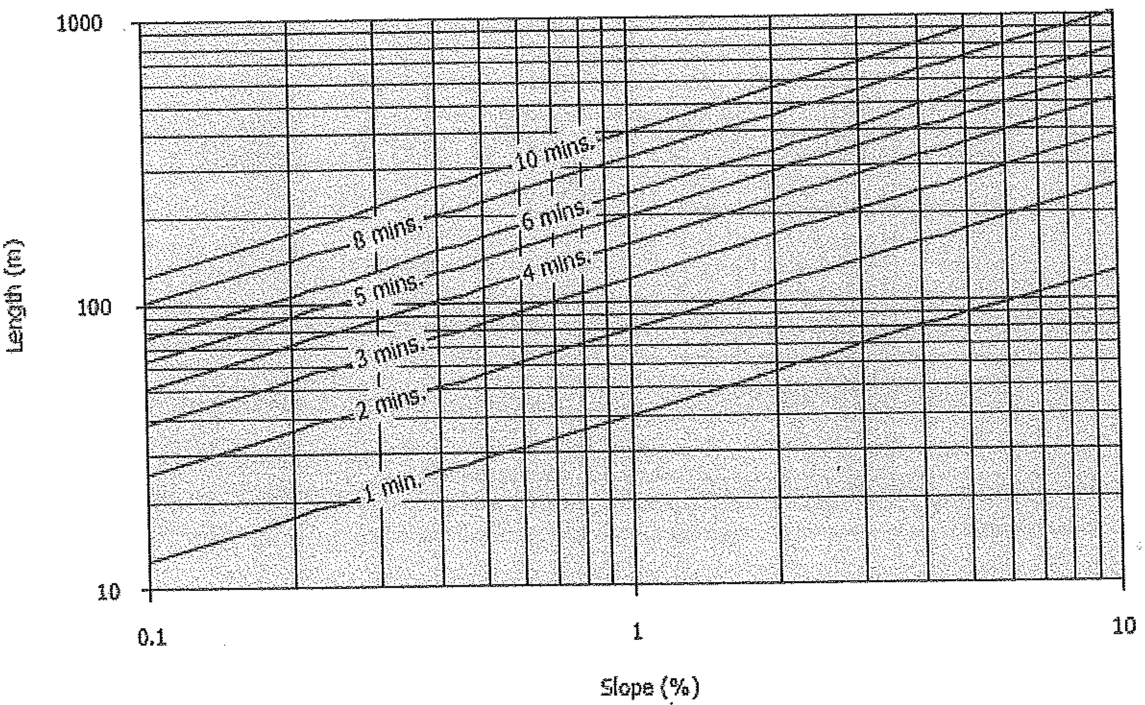


Figure 13.3 Values of ${}^{2}P_{24h}$ for use with Table 13.3
(source: HP 1, 1982)

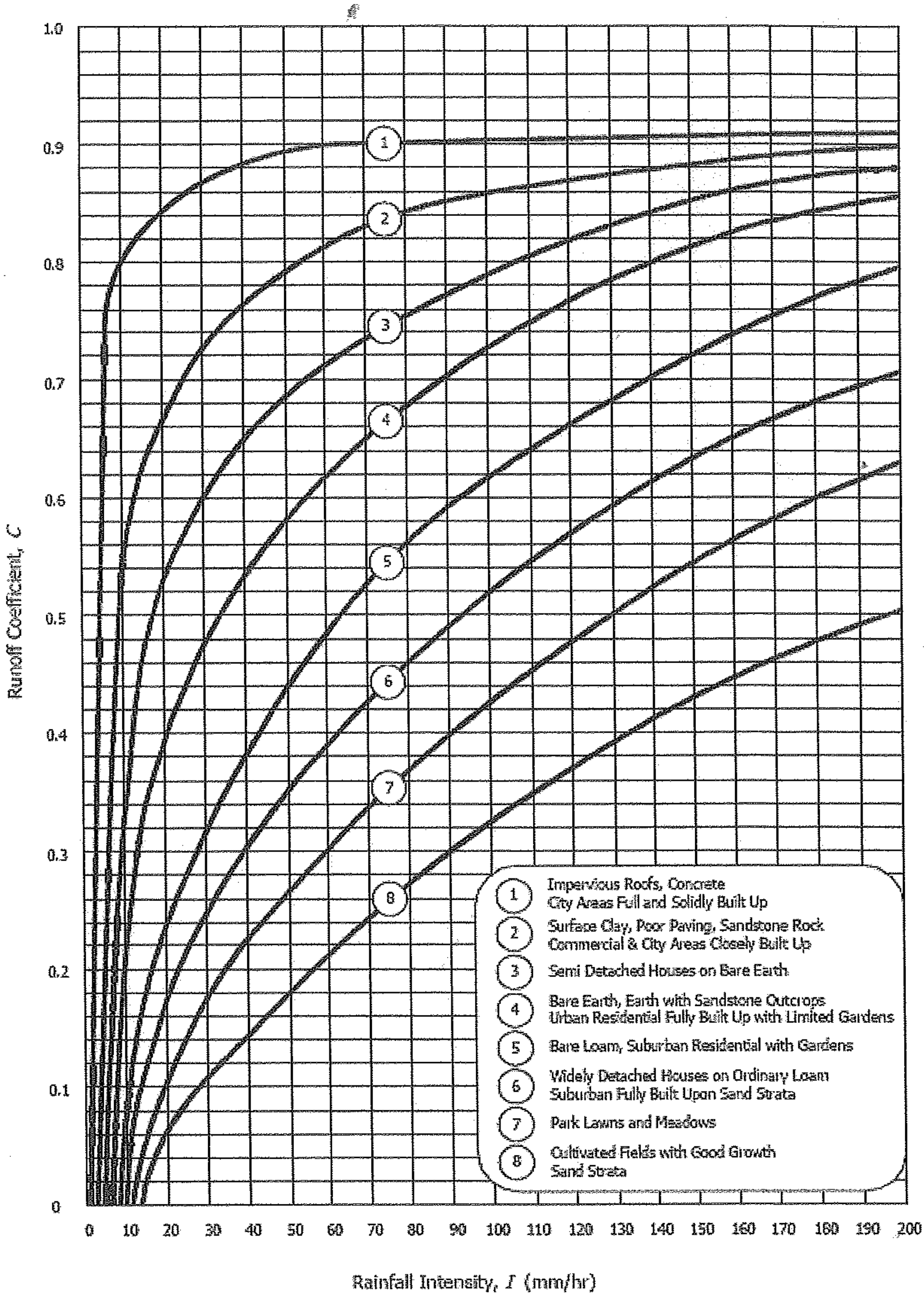
APPENDIX 14.A DESIGN CHARTS



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

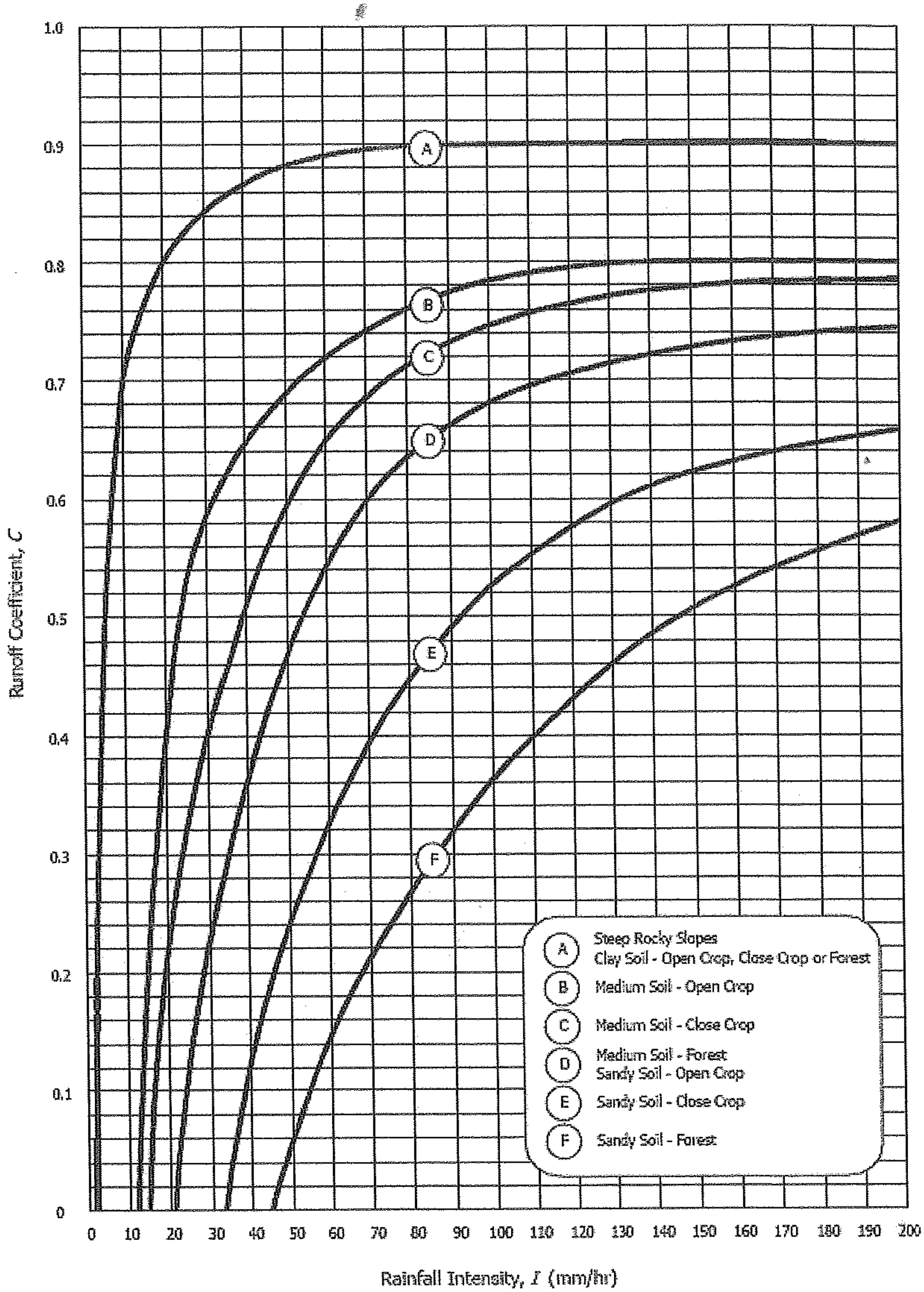


Design Chart 14.2 Kerb Gutter Flow Time



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 ($30 \le t \le 1000$ 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 ($30 \leq t \leq 1000$ 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)	Vertical depth (m)	Immersion of current meter depth	Number of rotation	Time (s)	Number of rotation per time (rev/s)	Velocity at point (m/s)	Mean velocity in vertical (m/s)	Mean velocity in section (m/s)	Width of section (m)	Mean depth (m)	Area of section (m^2)	Discharge (m^3/s)