

Modified Rational Method

Area of study / catchment:	Acre	Ha
	160.18	64.82

$Q = C_s CIA / 360$

14.5.1 Rational Formula (USMM)

- Q = peak discharge (m³/s)
- C_s = storage coefficient (dimensionless) - pekali simpanan
- C = runoff coefficient (dimensionless) - pekali alirairan C = (A1C1 + A2C2 + ... + AnCn) / A
- i = uniform rate of rainfall intensity (mm/hr) for a duration equal to time of concentration
- A = drainage area (hectare)

note: the formula is in imperial unit

For metric calculation, $Q = C_s C i (mm/hr) A (ha) / 360$

td = distance of drain/rate of flow
 $C_s = 2tc / (2tc + td)$
 $C = \text{Sum}(C_n A_n) / \text{Sum}(A_n)$

$$t_o = \frac{1.48(L^{0.75} - C_s D)}{4.75}$$

t_o = overland flow time
 for travel distance < 1000 ft (300m)

avg rainfall intensity: $\ln(i) = a + b \ln(t) + c(\ln(t))^2 + d(\ln(t))^3$
 if duration t = 30, $\ln(t) = 4.8943$, so, $i = 133.53$ mm/hr

eq.13.2 USMM, DID - manual saliran mesra alam malaysia
 eq 13.2

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extracted from table 13.A1, USMM for Johor Bahru

ARI (year)	coef a	b	c	d
2	3.9845	1.1150	-0.3272	0.0182
5	4.3251	1.0147	-0.3308	0.0208
10	4.4898	0.9971	-0.3279	0.0208
20	4.7856	0.8922	-0.2980	0.0192
50	4.5483	1.1012	-0.3758	0.0249
100	5.0532	0.8998	-0.3222	0.0215

pre
1000

Limitation:

Catchment is assumed as the development area. This calculation is to indicate the difference of peak discharge (Q_{peak}) of the surface runoff before and after development. Actual Q_{peak} should be analysed according to the entire river catchment, to be carried out by the Drainage Engineer prior to Site Drainage Design

Development	A (acre)	A (ha)	C _n	C _n *A _n
Residential	68.20	27.60	0.75	20.70
Commercial	28.33	11.46	0.90	10.32
Recreation / Open space	20.98	8.49	0.90	2.55
Community Facilities	3.00	1.21	0.85	1.03
Utilities	22.87	9.26	0.90	8.33
Roads & Parking	16.90	6.80	0.95	6.46
Jumlah	160.18	64.82	0.78	49.39

C_n 0.78

ASSUMPTION:

pre development	post development
Drain distance 1000 m	Drain distance 1100 m
43% flow velocity 1.5 m/s	flow velocity 0.6 m/s
18% to, D 1000 m	to, D 1100 m
13% to, S 7.5 %	to, S 4 %
2%	
14%	
10%	
100%	

	C	td (min)	to (min)	tc (min)	C _s
Pre Dev.	0.2	11	39	29	0.84
Post Dev.	0.85	28	50	78	0.85

PRE DEVELOPMENT

ARI (year)	C	A (ha)	I (mm/hr)	C _s	Q(m ³ /s)
2	0.20	64.82	99.87	0.84	3.02
5	0.20	64.82	113.36	0.84	3.58
10	0.20	64.82	135.89	0.84	4.11
20	0.20	64.82	153.44	0.84	4.64
50	0.20	64.82	171.75	0.84	5.20
100	0.20	64.82	190.69	0.84	5.77

ARI (year)	Pre development		Post Development	
	ln(i)	I (mm/hr)	ln(i)	I (mm/hr)
2	4.6039	99.87	4.0200	55.70
5	4.7738	118.36	4.1655	64.42
10	4.9119	135.89	4.3083	74.31
20	5.0333	153.44	4.4354	84.39
50	5.1460	171.75	4.5346	93.19
100	5.2507	190.69	4.6238	103.42

calculated rainfall intensity, i is based on 30 minutes duration

POST DEVELOPMENT

ARI (year)	C	A (ha)	I (mm/hr)	C _s	Q(m ³ /s)
2	0.85	64.82	55.70	0.85	7.23
5	0.85	64.82	64.42	0.85	8.36
10	0.85	64.82	74.31	0.85	9.65
20	0.85	64.82	84.39	0.85	10.96
50	0.85	64.82	93.19	0.85	12.10
100	0.85	64.82	103.42	0.85	13.43

Difference (m ³ /s)	%
4.21	58.19
4.78	57.16
5.53	57.36
6.31	57.60
6.90	57.03
7.65	57.01