

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 11 (after 2 years planting)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :
Area of catchment, A_c = 7.43 sq. km
Length of mainstream, L = 4.32 km
Percentage developed, = 30.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i \cdot \sqrt{s_i}$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i \cdot \sqrt{s_i})}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 2 years (HP # 1)

$$T_c = \left\{ \frac{1.286 \times L}{A^{0.223} \times S^{0.263}} \right\}$$

$$= \left\{ \frac{1.286 \times 4.32}{7.43^{0.223} \times 2.77777778^{0.263}} \right\}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5) = 40 \text{ mm}$
 $x(20, 0.5) = 70 \text{ mm}$
 $x(2, 3) = 80 \text{ mm}$
 $x(20, 3) = 140 \text{ mm}$

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with $T = 2$ years.

$x(T, 0.5) = 75.00 \text{ mm}$
 $x(T, 3) = 120.00 \text{ mm}$

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

With $T_c = 2.72 \text{ hours}$
and $T = 2 \text{ years}$.
 $x(2, 2.72) = 77.77 \text{ mm}$
 $x(20, 2.72) = 136.10 \text{ mm}$
 $x(T, 2.72) = 117.49 \text{ mm}$

8. Confidence limits

$$D = x(20) - x(2)$$

$$= 136.10312 - 77.77321$$

$$= 58.329907$$

$$0.43 D = 25.08186 \text{ mm}$$

$$9. \text{Max } x(T) = x(T) + 0.43 D$$

$$[T = 2] = 117.49486 + 25.08186$$

$$= 142.58 \text{ mm}$$

D. FLOOD ESTIMATION

1. From step C,

$$\text{Max } x_i(2) = 142.57672 \text{ mm}$$

$$\text{Therefore, } i(2) = x(100) = 142.57672$$

$$\begin{aligned}
 &= T_c = 52.51 \text{ mm/hr} \quad 2.7151996 \\
 2. \text{ From Figure 4 with,} & \text{Region} = 4 \\
 & T = 2 \text{ years.} \\
 & C_{10} = 0.38 \\
 & C_t / C_{10} = 0.712 \\
 \text{Therefore } C_t &= 0.27 \\
 3. \text{ Percentage developed} &= 30 \% \\
 \text{Land use factor, } F &= 1.05 \\
 \text{THEREFORE} \\
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 30.81 \text{ cu. m/s}
 \end{aligned}$$

E. DETERMINATION OF THE FLOOD WATER LEVEL AND VELOCITY

1. Plot cross-section of the river.
2. consider the recorded flood level as our first trial
3. Divide into sub-section
4. Stream slope at bridge site,

From the river survey plan :

Number of Part	= 4 Section			
Part	BedL1	BedL2	Length	Slope
1	6.880	6.544	60.000	0.006
2	6.544	6.067	25.000	0.019
3	6.067	6.037	25.000	0.001
4	6.037	5.604	20.000	0.022
5				
6				
7				
Average Slope, S _o	0.0118825			

5. Calculation of V_m and Q_c

$$V_i = R_i^{(2/3)} \times S_o^{(1/2)} / n_i$$

$$\text{TRY Flood Level} = 7.700 \text{ m} \quad \text{OK}$$

Sc.	Level	Chng.	Roughness	Area, A	Wetted	Hydraulic	Velocity	Q=V _i A _i
	(m)	(m)	n _i	Sq. ft	perimeter	Radius	(m/s)	(cu. m)
					(pi) (m)	R _i = A _i / P _i		
						(m)		
0	9.200	0.000	0.045					
1	7.000	4.000	0.045	-1.600	4.565	-0.350	#NUM	
2	6.741	18.000	0.045	11.613	14.002	0.829	2.138	24.832
3	5.857	23.100	0.045	7.145	5.176	1.380	3.003	21.458
4	5.792	27.000	0.045	7.314	3.901	1.875	3.684	26.944
5	5.272	33.600	0.045	14.309	6.620	2.161	4.049	57.941
6	6.344	38.000	0.045	8.325	4.529	1.838	3.635	30.261
7	6.659	42.500	0.045	5.393	4.511	1.196	2.729	14.717
8	7.000	50.500	0.045	6.964	8.007	0.870	2.207	15.370
9	9.200	54.000	0.045					
10								
			TOTAL	59.4634			TOTAL	191.52328

Type of bed material (Code) = 7 Rock

Therefore,

$$\begin{aligned}
 \text{Mean velocity, } V_m &= E(V_i A_i) / E(A_i) \\
 &= 191.523277 / 59.4634 \\
 &= 3.220859839
 \end{aligned}$$

$$\begin{aligned}
 \text{Discharge capacity, } Q_c &= V_m \times E(A_i) \\
 &= 191.523277 > 30.813 \text{ cu. m} \\
 &\quad \text{Therefore OK}
 \end{aligned}$$

CODE	BED
1	Clay
2	Sandy Clay
3	Very fine sand
4	Fine sand
5	Fine Gravel
6	Rocky soil
7	Rock
8	Grass-lined

$$\begin{aligned}
 &< 5.18 \text{ m/sec} \\
 &\quad \text{Therefore OK}
 \end{aligned}$$

11. 4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 7.43 sq. km
Length of mainstream L = 4.32 km
Percentage developed, = 30.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
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Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 5 years (HP # 1)

$$T_c = \frac{1.286 \times L}{\{A^{0.223} \times S^{0.263}\}}$$

$$= \frac{1.286 \times 4.32}{\{7.43^{0.223} \times 2.77777778^{0.263}\}}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 5 years.

$x(T, 0.5)$ = 98.94 mm
 $x(T, 3)$ = 176.59 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

11.4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

$$\begin{aligned}
 & \text{With } T_c = 2.7151996 \text{ hours} \\
 & \text{and } T = 5 \text{ years.} \\
 & x(2, 2.72) = 77.77 \text{ mm} \\
 & x(20, 2.72) = 136.10 \text{ mm} \\
 & x(T, 2.72) = 172.27 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 136.10312 - 77.77321 \\
 &= 58.329907 \\
 0.43 D &= 25.08 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 5 \right] &= x(T) + 0.43 D \\
 &= 172.26852 + 25.08186 \\
 &= 197.35 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(5) &= 197.35038 \text{ mm} \\
 \text{Therefore, } i(10) &= x(100) = 197.35038 \\
 &= \frac{T_c}{2.7151996} = 72.68 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region } &= 4 \\
 T &= 5 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 0.88 \\
 \text{Therefore } C_t &= 0.3344
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed } &= 30 \% \\
 \text{Land use factor, } F &= 1.05
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 52.71 \text{ cu. m/s}
 \end{aligned}$$

11. 4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 11 (after 2 years planting)
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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 7.43 sq. km
Length of main stream L = 4.32 km
Percentage developed, = 30.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 10 years (HP # 1)

$$T_c = \frac{1.286 \times L}{\{A^{0.223} \times S^{0.263}\}}$$

$$= \frac{1.286 \times 4.32}{\{7.43^{0.223} \times 2.77777778^{0.263}\}}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 10 years.

$x(T, 0.5)$ = 114.79 mm
 $x(T, 3)$ = 214.06 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

11.4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

$$\begin{aligned}
 & \text{With } T_c = 2.7151996 \text{ hours} \\
 & \text{and } T = 10 \text{ years.} \\
 & x(2, 2.72) = 77.77 \text{ mm} \\
 & x(20, 2.72) = 136.10 \text{ mm} \\
 & x(T, 2.72) = 208.53 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 136.10312 - 77.77321 \\
 &= 58.329907 \\
 0.43 D &= 25.08 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 10 \right] &= x(T) + 0.43 D \\
 &= 208.53344 + 25.08186 \\
 &= 233.62 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(10) &= 233.6153 \text{ mm} \\
 \text{Therefore, } i(10) &= \frac{x(100)}{T_c} = \frac{233.6153}{2.7151996} \\
 &= 86.04 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region } &= 4 \\
 T &= 10 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1 \\
 \text{Therefore } C_t &= 0.38
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed } &= 30 \% \\
 \text{Land use factor, } F &= 1.05
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 70.91 \text{ cu. m/s}
 \end{aligned}$$

11. 4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 11 (after 2 years planting)
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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 7.43 sq. km
Length of mainstream L = 4.32 km
Percentage developed, = 30.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 20 years (HP # 1)

$$T_c = \frac{1.286 \times L}{A^{0.223} \times S^{0.263}}$$

$$= \frac{1.286 \times 4.32}{7.43^{0.223} \times 2.77777778^{0.263}}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 20 years.

$x(T, 0.5)$ = 130.00 mm
 $x(T, 3)$ = 250.00 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

11.4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

$$\begin{aligned}
 &\text{With } T_c = 2.7151996 \text{ hours} \\
 &\text{and } T = 20 \text{ years.} \\
 &x(2, 2.72) = 77.77 \text{ mm} \\
 &x(20, 2.72) = 136.10 \text{ mm} \\
 &x(T, 2.72) = 243.32 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 136.10312 - 77.77321 \\
 &= 58.329907 \\
 0.43 D &= 25.08 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x(20) &= x(T) + 0.43 D \\
 [T = 20] &= 243.31963 + 25.08186 \\
 &= 268.40 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(20) &= 268.40149 \text{ mm} \\
 \text{Therefore, } i(20) &= \frac{x(100)}{T_c} = \frac{268.40149}{2.7151996} \\
 &= 98.85 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 20 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1.128 \\
 \text{Therefore } C_t &= 0.43
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 30 \% \\
 \text{Land use factor, } F &= 1.05
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 91.90 \text{ cu. m/s}
 \end{aligned}$$

11. 4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 11 (after 2 years planting)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 7.43 sq. km
Length of mainstream L = 4.32 km
Percentage developed, = 30 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 50 years (HP # 1)

$$T_c = \frac{1.286 \times L}{\{A^{0.223} \times S^{0.263}\}}$$

$$= \frac{1.286 \times 4.32}{\{7.43^{0.223} \times 2.77777778^{0.263}\}}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 50 years.

$x(T, 0.5)$ = 149.68 mm
 $x(T, 3)$ = 296.52 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

11.4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

$$\begin{aligned}
 &\text{With } T_c = 2.7151996 \text{ hours} \\
 &\text{and } T = 50 \text{ years.} \\
 &x(2, 2.72) = 77.77 \text{ mm} \\
 &x(20, 2.72) = 136.10 \text{ mm} \\
 &x(T, 2.72) = 288.35 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 136.10312 - 77.77321 \\
 &= 58.329907 \\
 0.43 D &= 25.08186 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 50 \right] &= x(T) + 0.43 D \\
 &= 288.34678 + 25.08186 \\
 &= 313.43 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(50) &= 313.42864 \text{ mm} \\
 \text{Therefore, } i(50) &= \frac{x(100)}{T_c} = \frac{313.42864}{2.7151996} \\
 &= 115.43 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 50 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1.296 \\
 \text{Therefore } C_t &= 0.49
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 30 \% \\
 \text{Land use factor, } F &= 1.05
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 123.30 \text{ cu. m/s}
 \end{aligned}$$

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 7.43 sq. km
Length of mainstream, L = 4.32 km
Percentage developed, = 30 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
4.32	120.00	2.78	7.20
4.32	120.00	2.78	7.20

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{7.20}{4.32}$$

$$= 2.78 \%$$

B. LOCATION OF SITE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 100 years (HP # 1)

$$2. T_c = \{ 1.286 \times L \} / \{ A^{0.223} \times S^{0.263} \}$$

$$= \{ 1.286 \times 4.32 \} / \{ 7.43^{0.223} \times 2.77777778^{0.263} \}$$

$$= 2.72 \text{ hours}$$

$$= 162.91 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 0.5)$ = 40 mm
 $x(20, 0.5)$ = 70 mm
 $x(2, 3)$ = 80 mm
 $x(20, 3)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 100 years.

$x(T, 0.5)$ = 164.43 mm
 $x(T, 3)$ = 331.38 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

11.4 HP5 catchment 11 Tabung Haji (Q after 2 years planting)

$$\begin{array}{rcl}
 \text{With } T_c = & 2.72 \text{ hours} \\
 \text{and } T = & 100 \text{ years.} \\
 x(2, 2.72) & = & 77.77 \text{ mm} \\
 x(20, 2.72) & = & 136.10 \text{ mm} \\
 x(T, 2.72) & = & 322.09 \text{ mm}
 \end{array}$$

8. Confidence limits

$$\begin{array}{rcl}
 D & = & x(20) - x(2) \\
 & = & 136.10312 - 77.77321 \\
 & = & 58.329907 \\
 0.43 D & = & 25.08 \text{ mm}
 \end{array}$$

$$\begin{array}{rcl}
 9. \text{ Max } x & (100) & = x(T) + 0.43 D \\
 [T = 100] & & = 322.0883 + 25.08186 \\
 & & = 347.17 \text{ mm}
 \end{array}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{array}{rcl}
 \text{Max } x & (100) & = 347.17 \text{ mm} \\
 \text{Therefore, } i(100) & = & \frac{x(100)}{T_c} = \frac{347.17016}{2.7151996} \\
 & = & 127.86 \text{ mm/hr}
 \end{array}$$

2. From Figure 4 with,

$$\begin{array}{rcl}
 \text{Region} & = & 4 \\
 T & = & 100 \text{ years.} \\
 C_{10} & = & 0.38 \\
 C_t / C_{10} & = & 1.46
 \end{array}$$

$$\text{Therefore } C_t = 0.5548$$

$$\begin{array}{rcl}
 3. \text{ Percentage developed} & = & 30 \% \\
 \text{Land use factor, } F & = & 1.05
 \end{array}$$

THEREFORE

$$\begin{array}{rcl}
 Q_{\max} & = & F \times 0.278 \times C_t \times i(T) \times A \\
 & = & 153.85 \text{ cu. m/s}
 \end{array}$$