ATTENUATION DESIGN

Attenuation design in accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 1.0.04

Pre post runoff method

Site characteristics

Location	Other
Hydrological region	2
Soil type (Wallingford Procedure W.R.A.P map)	4
Standard percentage runoff	SPR = **0.47**
Average annual rainfall	SAAR = **800** mm
5 year return period rainfall of 60 minute duration	M5_60min = **15.0** mm
Ratio 60-minute to 2 day rainfalls of 5 year return	r = **0.25**
Rainfall intensity increase due to global warming	$p_{climate}$ = **30**%
Routing coefficient	c_r = **1.30**
Volumetric runoff coefficient	c_v = **1.30**

Catchment details

Subcatchment	Name	Area (ha)	PIMP (%)	Impermeable. area (ha)
1;	Site with impermeable roof;	0.04;	26.0	0.01;
	Total	0.04;	26.0	0.01;

Greenfield runoff rates

Catchment area	AREA = **50.00** hectare
Greenfield runoff rate (50 hectare site)	$\bar{Q}_{rural} = 0.00108 m^3/s \times (AREA/1km^2)^{0.89} \times (SAAR/1mm)^{1.17} \times SPR^{2.17}$ = **282.2** l / s
Greenfield runoff rate	$\bar{Q} = \bar{Q}_{rural} / AREA \times A$ = **0.2** l / s
Greenfield runoff rate per unit area	$\bar{Q}_A = \bar{Q} / A$ = **5.6** l / s / hectare

Estimated site discharges

FSR growth rate (100 year)	FSR_{100yr} = **2.63**
Discharge (100 year)	$Q_{100yr} = \bar{Q} \times FSR_{100yr}$ = **0.6** l/s
FSR growth rate (200 year)	FSR_{200yr} = **2.97**
Discharge (200 year)	$Q_{200yr} = \bar{Q} \times FSR_{200yr}$ = **0.6** l/s

Table equations

Peak flow	$Q_{post\_imp} = c_r \times I_{max} \times A_{imp}$
Runoff volume	$V_{post\_imp} = Q_{post\_imp} \times D / c_r$
Post development runoff	$\bar{Q}_{post} = Q_{post\_imp} + Q_{post\_open}$
Permitted discharge	$O_{exist} = Q \times D$
Post development runoff volume	$I_{post} = Q_{post\_open} \times D + V_{post\_imp}$
Storage volume required	$S_{post} = I_{post} - O_{exist}$

Required storage for period of 100 year

Discharge per hectare	$Q_{100yr\_area} = Q_{100yr} / A$ = **14.8** l/s/hectare
Greenfield runoff rate post development	$Q_{100yr\_post\_open} = Q_{100yr\_area} \times A_{imp}$ = **0.1** l/s

Duration (min)	100 year rainfall (mm)	Rainfall intensity (mm/hr)	Peak flow (m^3/s)	Runoff volume (m^3)	Post dev. runoff (m^3/s)	Permit dischrge (m^3)	Post dev. runoff vol (m^3)	Storage vol. reqd (m^3)
5	11.6	139.7	0.01	1.2	0.01	0.17	1.21	1.04
10	17.7	106.5	0.00	1.8	0.00	0.34	1.87	1.53
15	21.8	87.2	0.00	2.2	0.00	0.52	2.32	1.81
30	29.1	58.2	0.00	2.9	0.00	1.03	3.19	2.15
60	37.7	37.7	0.00	3.8	0.00	2.06	4.32	2.26
120	47.5	23.8	0.00	4.8	0.00	4.13	5.84	1.72
240	60.1	15.0	0.00	6.0	0.00	8.25	8.18	-0.08
360	68.2	11.4	0.00	6.8	0.00	12.38	10.06	-2.31
600	79.7	8.0	0.00	8.0	0.00	20.63	13.36	-7.27
1440	106.1	4.4	0.00	10.6	0.00	49.51	23.52	-25.99

Attenuation storage required

Vol. increase due to head-discharge relationship p_{hydro} = **1.25**

Maximum attenuation storage required $V_{req\_max} = V_{max\_100yr} \times p_{hydro}$ = **2.8** m^3

Required storage for period of 200 year (rainfall based on extrapolated values of Z2)

Discharge per hectare $Q_{200yr\_area} = Q_{200yr} / A$ = **16.8** l/s/hectare

Greenfield runoff rate post development $Q_{200yr\_post\_open} = Q_{200yr\_area} \times A_{imp}$ = **0.2** l/s

Note that the Z2 values, used to calculate the following rainfall depths, have been extrapolated from the 50 year and 100 year Z2 values due to the limitations of the Wallingford Procedure.

Duration (min)	200 year rainfall (mm)	Rainfall intensity (mm/hr)	Peak flow (m^3/s)	Runoff volume (m^3)	Post dev. runoff (m^3/s)	Permit dischrge (m^3)	Post dev. runoff vol (m^3)	Storage vol. reqd (m^3)
5	14.7	176.7	0.01	1.5	0.01	0.19	1.53	1.33
10	22.7	136.3	0.00	2.3	0.01	0.39	2.38	1.99
15	28.0	111.9	0.00	2.8	0.00	0.58	2.96	2.38
30	37.3	74.6	0.00	3.7	0.00	1.16	4.05	2.88
60	48.3	48.3	0.00	4.8	0.00	2.33	5.45	3.12
120	60.1	30.0	0.00	6.0	0.00	4.66	7.24	2.58
240	75.3	18.8	0.00	7.6	0.00	9.32	9.98	0.66
360	84.7	14.1	0.00	8.5	0.00	13.98	12.13	-1.85
600	98.4	9.8	0.00	9.9	0.00	23.29	15.93	-7.37
1440	129.5	5.4	0.00	13.0	0.00	55.91	27.53	-28.38

Attenuation storage required

Vol. increase due to head-discharge relationship p_{hydro} = **1.25**

Maximum attenuation storage required $V_{req\_max} = V_{max\_200yr} \times p_{hydro}$ = **3.9** m^3

Interception storage

Interception rainfall depth d_{int} = **5** mm

Volume of interception storage required $V_{int\_req} = 0.8 \times A_{imp} \times d_{int}$ = **0.40** m^3

Tekla Tedds Turnbull Kyle Ltd 10 Oliver Place Hawick	Project 1 Douglas Crescnt, Bonnyrigg				Job no. 5804	
	Calcs for Surface Water Attenuation				Start page no./Revision 3	
	Calcs by AN	Calcs date 08/04/2024	Checked by DK	Checked date 08/04/2024	Approved by	Approved date