



MasterDrain
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Muir Associates (UK) Limited

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Job No. 18-1022		
Sheet no. 1		
Date 01/08/18		
By	Checked	Reviewed

Project	Bridge Road North Wrexham
Title	Preliminary Attenuation Calculations 1 in 30 + 0% Climate Change

Data:-

Location = WREXHAM Grid reference = SJ3349
M5-60 (mm) = 18 r = 0.32
Soil index = 0.45 SAAR (mm/yr) = 800
Return period = 30 WRAP = 4
UCWI = 0.0 Climate change = 0%

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Pipeline storage = 0.0 m³ Available MH storage = 0.0 m³
Offline storage = 0.0 m³

Percentage runoff = 95.0% (manual setting)

Imperv. area = 7250 m² Pervious area = 0 m²
Total area = 7250 m² Equiv area = 6888 m² (Tot. area x % runoff).
Total runoff = 345.5 m³ Discharge rate = 5.000 l/s
Storage (m³) = 238.3 m³ (Sum of all balance quantities)
Total rainfall depth = 50.2 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.070	20.0	1.4	0.691	1.260	0.000	0.000
0.140	20.0	1.4	0.691	1.260	0.000	0.000
0.210	21.0	1.5	0.725	1.260	0.000	0.000
0.280	21.0	1.5	0.725	1.260	0.000	0.000
0.350	22.0	1.6	0.760	1.260	0.000	0.000
0.420	23.0	1.6	0.795	1.260	0.000	0.000
0.490	24.0	1.7	0.829	1.260	0.000	0.000
0.560	26.0	1.9	0.898	1.260	0.000	0.000
0.630	27.0	1.9	0.933	1.260	0.000	0.000
0.700	29.0	2.1	1.002	1.260	0.000	0.000
0.770	31.0	2.2	1.071	1.260	0.000	0.000
0.840	32.0	2.3	1.105	1.260	0.000	0.000
0.910	33.0	2.4	1.140	1.260	0.000	0.000
0.980	34.0	2.4	1.175	1.260	0.000	0.000
1.050	36.0	2.6	1.244	1.260	0.000	0.000
1.120	38.0	2.7	1.313	1.260	0.053	0.053
1.190	39.0	2.8	1.347	1.260	0.087	0.140
1.260	40.0	2.9	1.382	1.260	0.122	0.262
1.330	42.0	3.0	1.451	1.260	0.191	0.453
1.400	45.0	3.2	1.555	1.260	0.295	0.748
1.470	49.0	3.5	1.693	1.260	0.433	1.180
1.540	53.0	3.8	1.831	1.260	0.571	1.751
1.610	57.0	4.1	1.969	1.260	0.709	2.460
1.680	62.0	4.4	2.142	1.260	0.882	3.342
1.750	66.0	4.7	2.280	1.260	1.020	4.362
1.820	71.0	5.1	2.453	1.260	1.193	5.555
1.890	77.0	5.5	2.660	1.260	1.400	6.955
1.960	84.0	6.0	2.902	1.260	1.642	8.597
2.030	91.0	6.5	3.144	1.260	1.884	10.481
2.100	98.0	7.0	3.386	1.260	2.126	12.607
2.170	105.0	7.5	3.627	1.260	2.367	14.974
2.240	114.0	8.2	3.938	1.260	2.678	17.652
2.310	125.0	9.0	4.318	1.260	3.058	20.711
2.380	135.0	9.7	4.664	1.260	3.404	24.114
2.450	143.0	10.2	4.940	1.260	3.680	27.794
2.520	154.0	11.0	5.320	1.260	4.060	31.855
2.590	164.0	11.8	5.666	1.260	4.406	36.260
2.660	173.0	12.4	5.977	1.260	4.717	40.977
2.730	183.0	13.1	6.322	1.260	5.062	46.039
2.800	194.0	13.9	6.702	1.260	5.442	51.481



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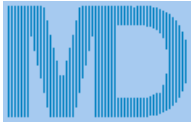
Project **Bridge Road North Wrexham**

Title **Preliminary Attenuation Calculations 1 in 30 + 0% Climate Change**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.870	204.0	14.6	7.048	1.260	5.788	57.268
2.940	212.0	15.2	7.324	1.260	6.064	63.332
3.010	219.0	15.7	7.566	1.260	6.306	69.638
3.080	226.0	16.2	7.808	1.260	6.548	76.186
3.150	233.0	16.7	8.049	1.260	6.789	82.975
3.220	239.0	17.1	8.257	1.260	6.997	89.972
3.290	244.0	17.5	8.429	1.260	7.169	97.141
3.360	248.0	17.8	8.568	1.260	7.308	104.449
3.430	249.0	17.8	8.602	1.260	7.342	111.791
3.500	250.0	17.9	8.637	1.260	7.377	119.167
3.570	250.0	17.9	8.637	1.260	7.377	126.544
3.640	249.0	17.8	8.602	1.260	7.342	133.886
3.710	248.0	17.8	8.568	1.260	7.308	141.194
3.780	244.0	17.5	8.429	1.260	7.169	148.363
3.850	239.0	17.1	8.257	1.260	6.997	155.360
3.920	233.0	16.7	8.049	1.260	6.789	162.149
3.990	226.0	16.2	7.808	1.260	6.548	168.696
4.060	219.0	15.7	7.566	1.260	6.306	175.002
4.130	212.0	15.2	7.324	1.260	6.064	181.066
4.200	204.0	14.6	7.048	1.260	5.788	186.854
4.270	194.0	13.9	6.702	1.260	5.442	192.296
4.340	183.0	13.1	6.322	1.260	5.062	197.358
4.410	173.0	12.4	5.977	1.260	4.717	202.074
4.480	164.0	11.8	5.666	1.260	4.406	206.480
4.550	154.0	11.0	5.320	1.260	4.060	210.540
4.620	143.0	10.2	4.940	1.260	3.680	214.220
4.690	135.0	9.7	4.664	1.260	3.404	217.624
4.760	125.0	9.0	4.318	1.260	3.058	220.682
4.830	114.0	8.2	3.938	1.260	2.678	223.361
4.900	105.0	7.5	3.627	1.260	2.367	225.728
4.970	98.0	7.0	3.386	1.260	2.126	227.854
5.040	91.0	6.5	3.144	1.260	1.884	229.737
5.110	84.0	6.0	2.902	1.260	1.642	231.379
5.180	77.0	5.5	2.660	1.260	1.400	232.779
5.250	71.0	5.1	2.453	1.260	1.193	233.972
5.320	66.0	4.7	2.280	1.260	1.020	234.992
5.390	62.0	4.4	2.142	1.260	0.882	235.874
5.460	57.0	4.1	1.969	1.260	0.709	236.583
5.530	53.0	3.8	1.831	1.260	0.571	237.154
5.600	49.0	3.5	1.693	1.260	0.433	237.587
5.670	45.0	3.2	1.555	1.260	0.295	237.882
5.740	42.0	3.0	1.451	1.260	0.191	238.073
5.810	40.0	2.9	1.382	1.260	0.122	238.194
5.880	39.0	2.8	1.347	1.260	0.087	238.282
5.950	38.0	2.7	1.313	1.260	0.053	238.335
6.020	36.0	2.6	1.244	1.260	0.000	238.318
6.090	34.0	2.4	1.175	1.260	0.000	238.233
6.160	33.0	2.4	1.140	1.260	0.000	238.113
6.230	32.0	2.3	1.105	1.260	0.000	237.958
6.300	31.0	2.2	1.071	1.260	0.000	237.769
6.370	29.0	2.1	1.002	1.260	0.000	237.511
6.440	27.0	1.9	0.933	1.260	0.000	237.184
6.510	26.0	1.9	0.898	1.260	0.000	236.822
6.580	24.0	1.7	0.829	1.260	0.000	236.391
6.650	23.0	1.6	0.795	1.260	0.000	235.926
6.720	22.0	1.6	0.760	1.260	0.000	235.426
6.790	21.0	1.5	0.725	1.260	0.000	234.891
6.860	21.0	1.5	0.725	1.260	0.000	234.357
6.930	20.0	1.4	0.691	1.260	0.000	233.788
7.000	20.0	1.4	0.691	1.260	0.000	233.219

Storage volume (m³) = 238.3 m³ (Sum of all balance quantities)



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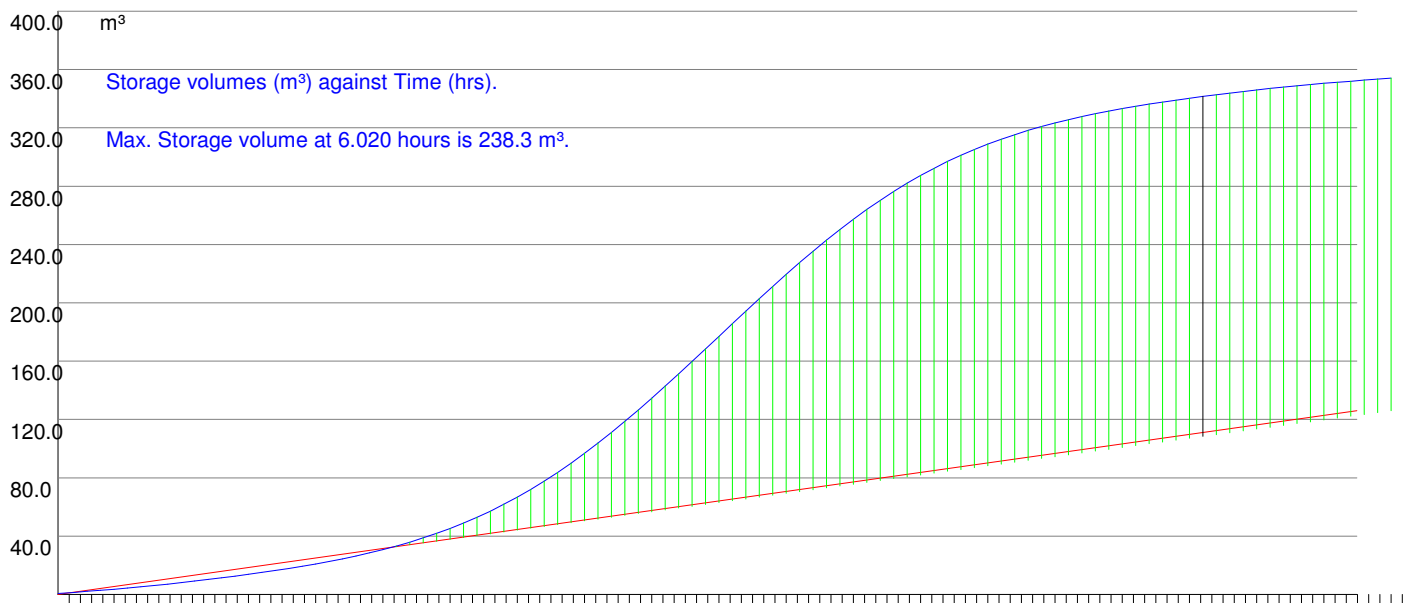
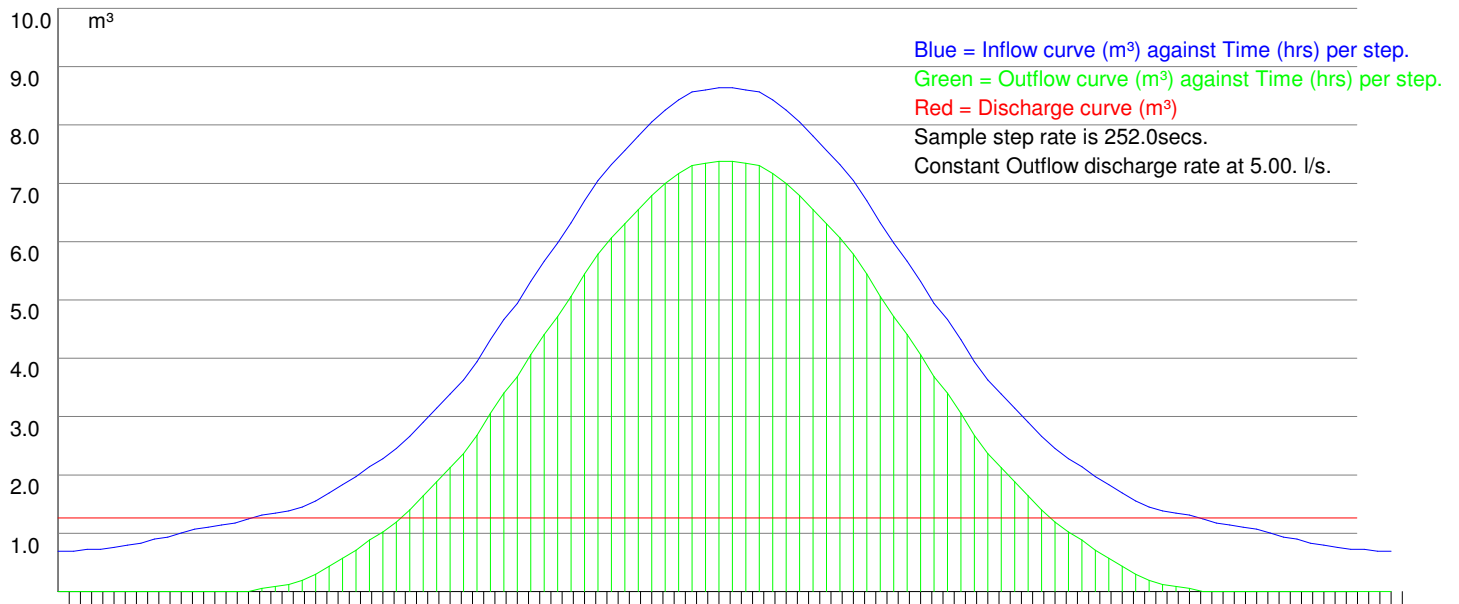
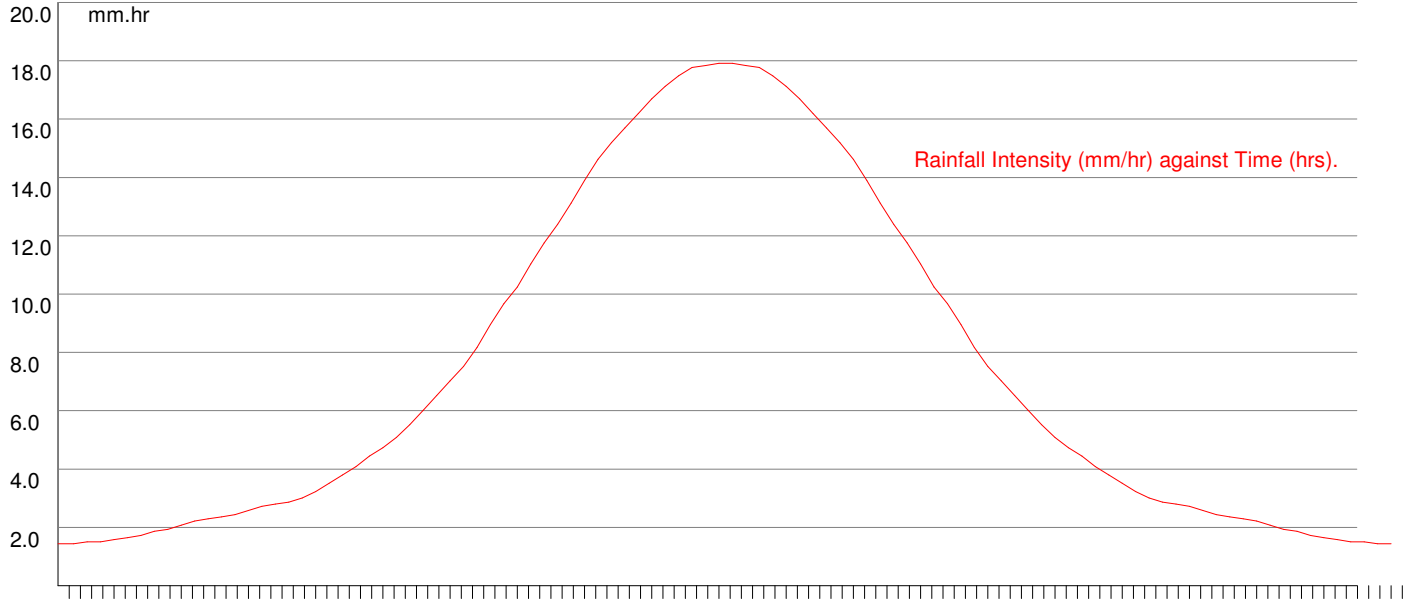
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Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	106.80	0.25	63.06	0.2	
0.5	141.44	0.50	42.62	0.3	
1	177.22	1.00	27.65	0.6	
2	210.23	2.00	17.44	1.2	
3	224.87	3.00	13.17	1.8	
4	232.18	4.00	10.73	2.4	
5	235.68	5.00	9.13	3.0	
6	237.56	6.00	8.01	3.6	
7	238.33	7.00	7.17	4.2	Peak found
8	238.26	----	6.51	4.8	
9	237.75	----	5.97	5.4	
10	236.64	----	5.53	6.0	
12	233.03	----	4.84	7.2	
15	225.41	----	4.12	9.0	
18	216.34	----	3.60	10.8	
20	209.75	----	3.33	12.0	
24	195.72	----	2.92	14.4	
30	173.82	----	2.47	18.0	
36	151.95	----	2.16	21.6	
42	130.00	----	1.93	25.2	
48	109.21	----	1.75	28.8	
54	89.22	----	1.60	32.4	
60	70.84	----	1.48	36.0	
66	53.87	----	1.38	39.6	
72	38.22	----	1.29	43.2	
84	13.21	----	1.15	50.4	
96	0.00	----	1.04	57.6	
120	0.00	----	0.88	72.0	
150	0.00	----	0.75	90.0	
175	0.00	----	0.66	105.0	
200	0.00	----	0.60	120.0	
250	0.00	----	0.51	150.0	
300	0.00	----	0.45	180.0	
375	0.00	----	0.38	225.0	
500	0.00	----	0.31	300.0	
750	0.00	----	0.23	450.0	
1000	0.00	----	0.19	600.0	
1250	0.00	----	0.16	750.0	
1500	0.00	----	0.14	900.0	
1570	0.00	----	0.13	942.0	
2000	0.00	----	0.11	1200.0	
2500	0.00	----	0.10	1500.0	
3000	0.00	----	0.08	1800.0	
3500	0.00	----	0.08	2100.0	
4000	0.00	----	0.07	2400.0	



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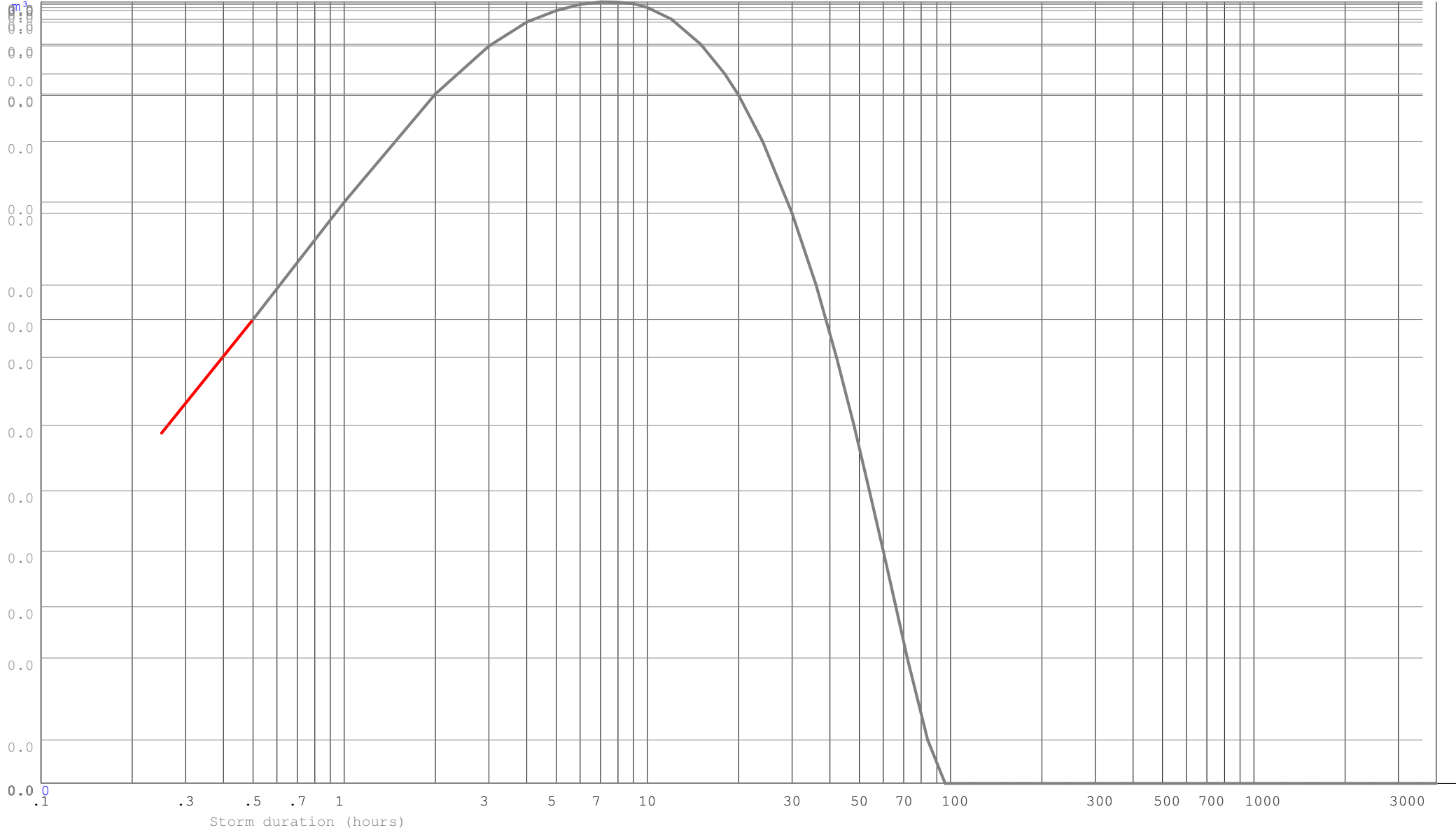
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Sequential storage volume at specific storm durations.





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Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.