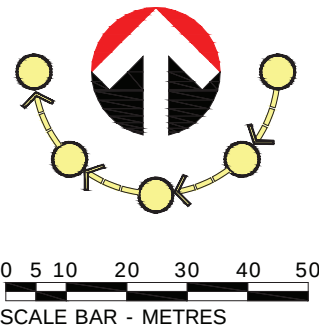




KEY

- SITE BOUNDARY; 15.78ha (39acres)
- MAIN ACCESS / VEHICLE ACCESS
- ACCESS IMPROVEMENT TO EXISTING HIGHWAY
- PUBLIC RIGHT OF WAY
- LINE OF WAT'S DYKE
- DEVELOPMENT BOUNDARY
- KEY SETTING - EXISTING LONG DISTANCE VIEWS TO HORIZON & SETTING OF WAT'S DYKE PERMANENTLY MAINTAINED
- STREETS
- URBAN DESIGN FOCAL POINTS
- GATEWAY NODE
- ACOUSTIC ATTENUATION
- INDICATIVE RESIDENTIAL FRONTAGE
- DEVELOPMENT AREA
MEDIUM LEVEL DENSITY; UPTO 30no. Units pha
2 - 2.5 STOREY HEIGHT
DEVELOPMENT AREA; 6.31ha
UPTO 189NO. DWELLINGS
- NO BUILD BUFFER ZONE FOR SCHEDULED ANCIENT MONUMENT
ENHANCEMENT / IMPROVEMENT OF WAT'S DYKE BY AGREEMENT WITH L.A
- MAINTAINED LAND (PERMANENT GREEN BARRIER)
- LANDSCAPING (PERMANENT GREEN BARRIER)
POS AREA; 2.6ha

TOTAL UPTO 189NO. DWELLINGS



NEW ROAD - RHOSROBIN, WREXHAM
INDICATIVE MASTERPLAN / DEVELOPMENT FRAMEWORK

C3429 - P01A
SCALE - 1:2000 @ A2

Cassidy+
Ashton

C+A

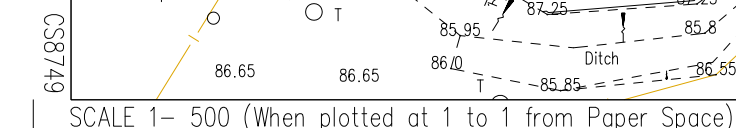
www.cassidyashton.co.uk

ARCHITECTURE BUILDING SURVEYING TOWN PLANNING

Preston Office: 7 East Cliff, Preston, Lancashire, PR1 3JE
Chester Office: Cassidy House, Station Road, Chester, CH1 3DW
T: 01772 258356
T: 01244 402900

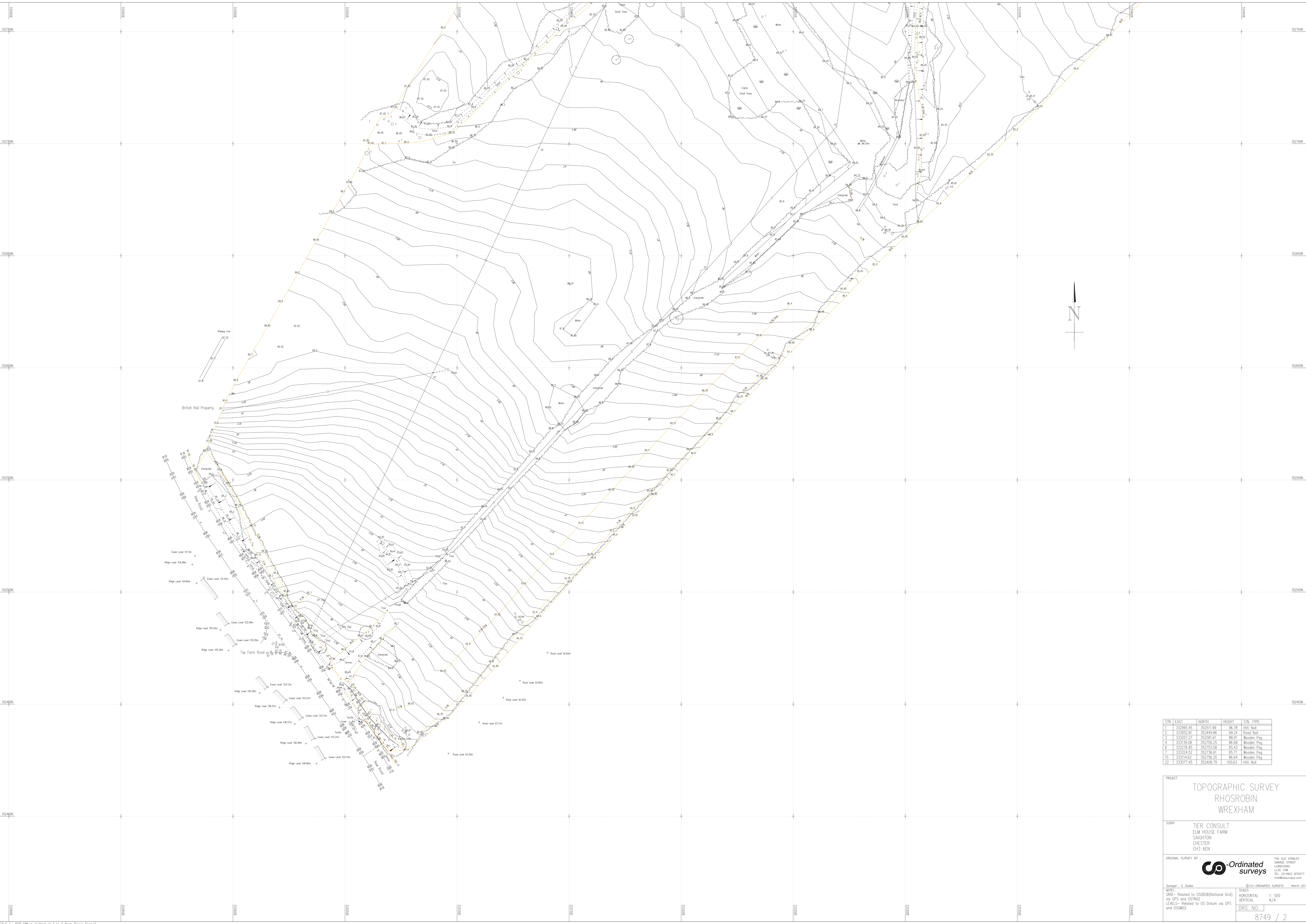
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APPENDIX D - TOPOGRAPHICAL SURVEY



PROJECT	TOPOGRAPHIC SURVEY RHOSROBIN WREXHAM	
CLIENT	TIER CONSULT ELM HOUSE FARM SAIGHTON CHESTER CH3 6EN	
ORIGINAL SURVEY BY :	 Ordinated surveys	THE OLD STABLES GARAGE STREET LUNDNOO LL15 1DN TEL: 01492 870277 info@ordinatedsurveys.co.uk

THE OLD STABLES
GARAGE STREET
LLANDUDNO
LL30 1DW
TEL. (01492) 870277
mol@uksurveys.com



STN	EAST	NORTH	HEIGHT	STN. TYPE
1	332995.45	352511.99	96.78	HM Nail
2	333002.81	352446.86	99.24	Road Nail
3	333207.27	352581.61	88.91	Wooden Peg
4	333130.08	352700.25	86.68	Wooden Peg
6	333276.85	352753.08	85.43	Wooden Peg
7	333324.52	352736.61	85.71	Wooden Peg
15	333114.62	352756.20	86.64	Wooden Peg
22	333077.45	352409.79	100.63	HM Nail

PROJECT

TOPOGRAPHIC SURVEY
RHOSROBIN
WREXHAM

CLIENT

TIER CONSULT
ELM HOUSE FARM
SAUGHTON
CHESTER
CH3 6EN

ORIGINAL SURVEY BY :

 **Ordinated
surveys**

THE OLD STABLES
CARPARK STREET
LANGLANDS
LL20 1UH
TEL: (01852) 870277
mail@ordinatedsurveys.com

Surveyor : G. Davies

NOTES
GRID- Related to OSGB36(National Grid)
via GPS and OSN02
LEVELS- Related to OS Datum via GPS
and OSBM02

SCALES
HORIZONTAL
VERTICAL

1: 500
N/A

DRG. NO.

8749 / 2

APPENDIX E - EXISTING GREENFIELD RUNOFF RATES



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Sheet no. 1		
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By	Checked	Reviewed

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HY 9.2

Project Land off New Road, Rhosrobin, Wrexham
Title Existing Surface Water Runoff

Hydrological Data:-

FSR Hydrology:-

Location =	Grid reference = SJ3449
M5-60 (mm) = 18	r = 0.32
Soil runoff = 0.15	SAAR (mm/yr) = 800
WRAP = 1	Area = England & Wales
Hydrological area = 9	Hydrological zone = 3

Soil classification for WRAP type 1

- i) Well drained permeable sandy or loam soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts;
- ii) Earthy peat soils drained by dykes and pumps;
- iii) Less permeable loamy over clayey soils on plateaux adjacent to very permeable soils in valleys.

Design data:-

Area = 0.0631 Km² - 6.31 Ha - 63100 m² % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban)} = Q_{BAR(rural)} (1 + URBAN)^{2NC} [1 + URBAN \{ (21/CIND) - 0.3 \}]$$

where:-

NC varies with the value of SAAR:-

for 500 < SAAR < 1100 mm then NC = 0.92 - 0.00024 SAAR

for 1100 < SAAR < 3000 mm then NC = 0.74 - 0.000082 SAAR

$$CIND = 102.4 SOIL + 0.28 (CWI - 125)$$

CWI = Catchment Wetness Index

CIND = 4.440 (see note below)

CWI = 86.000

NC = 0.728

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used

Reducing factor used for these calculations is 0.126

$$Q_{BAR(rural)} = 2.987 \text{ (l/s)}$$

$Q_{BAR(urban)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

$$\text{Mean Annual Peak Flow } Q_{BAR(urban)} = 2.99 \text{ l/s}$$

Values for $Q_{BAR(urban)}$

1 year	2 year	5 year	30 year	100 year	200 year	Units
0.003	0.003	0.004	0.005	0.007	0.007	cumecs
2.54	2.99	3.64	5.23	6.51	7.47	l/s
0.40	0.47	0.58	0.83	1.03	1.18	l/s/Ha
0.850	1.000	1.220	1.750	2.180	2.500	GC(T)

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7). Note that the 200 year growth curve was taken from W5-074/A.

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).

APPENDIX F - STORAGE VOLUMES



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Project	Land off New Road, Rhosrobin, Wrexham
Title	1 in 2 Year (+cc) Storage Volume

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 2

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 5.8mm/hr for a 6 hour storm

Storm duration = 6 hrs

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 25200 m²

Pervious area = 0 m²

Total area = 25200 m²

Equiv area = 18396 m² (Tot. area x % runoff).

Total runoff = 640.4 m³

Discharge rate = 5.000 l/s

Storage (m³) = 548.4 m³ (Sum of all balance quantities)

Total rainfall depth = 34.8 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	1.2	1.281	1.080	0.201	0.201
0.120	20.0	1.2	1.281	1.080	0.201	0.401
0.180	21.0	1.2	1.345	1.080	0.265	0.666
0.240	21.0	1.2	1.345	1.080	0.265	0.931
0.300	22.0	1.3	1.409	1.080	0.329	1.260
0.360	23.0	1.3	1.473	1.080	0.393	1.653
0.420	24.0	1.4	1.537	1.080	0.457	2.109
0.480	26.0	1.5	1.665	1.080	0.585	2.694
0.540	27.0	1.6	1.729	1.080	0.649	3.343
0.600	29.0	1.7	1.857	1.080	0.777	4.120
0.660	31.0	1.8	1.985	1.080	0.905	5.025
0.720	32.0	1.9	2.049	1.080	0.969	5.995
0.780	33.0	1.9	2.113	1.080	1.033	7.028
0.840	34.0	2.0	2.177	1.080	1.097	8.125
0.900	36.0	2.1	2.305	1.080	1.225	9.350
0.960	38.0	2.2	2.433	1.080	1.353	10.704
1.020	39.0	2.3	2.497	1.080	1.417	12.121
1.080	40.0	2.3	2.561	1.080	1.481	13.602
1.140	42.0	2.4	2.689	1.080	1.609	15.212
1.200	45.0	2.6	2.882	1.080	1.802	17.013
1.260	49.0	2.8	3.138	1.080	2.058	19.071
1.320	53.0	3.1	3.394	1.080	2.314	21.385
1.380	57.0	3.3	3.650	1.080	2.570	23.955
1.440	62.0	3.6	3.970	1.080	2.890	26.845
1.500	66.0	3.8	4.226	1.080	3.146	29.992
1.560	71.0	4.1	4.547	1.080	3.467	33.458
1.620	77.0	4.5	4.931	1.080	3.851	37.309
1.680	84.0	4.9	5.379	1.080	4.299	41.608
1.740	91.0	5.3	5.827	1.080	4.747	46.355
1.800	98.0	5.7	6.275	1.080	5.195	51.551
1.860	105.0	6.1	6.724	1.080	5.644	57.194
1.920	114.0	6.6	7.300	1.080	6.220	63.414
1.980	125.0	7.3	8.004	1.080	6.924	70.339
2.040	135.0	7.8	8.645	1.080	7.565	77.904
2.100	143.0	8.3	9.157	1.080	8.077	85.981
2.160	154.0	8.9	9.861	1.080	8.781	94.762
2.220	164.0	9.5	10.502	1.080	9.422	104.184
2.280	173.0	10.0	11.078	1.080	9.998	114.182
2.340	183.0	10.6	11.719	1.080	10.639	124.821
2.400	194.0	11.3	12.423	1.080	11.343	136.163



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Project **Land off New Road, Rhosrobin, Wrexham**
Title **1 in 2 Year (+cc) Storage Volume**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	11.8	13.063	1.080	11.983	148.147
2.520	212.0	12.3	13.576	1.080	12.496	160.642
2.580	219.0	12.7	14.024	1.080	12.944	173.586
2.640	226.0	13.1	14.472	1.080	13.392	186.978
2.700	233.0	13.5	14.920	1.080	13.840	200.818
2.760	239.0	13.9	15.304	1.080	14.224	215.043
2.820	244.0	14.2	15.625	1.080	14.545	229.588
2.880	248.0	14.4	15.881	1.080	14.801	244.388
2.940	249.0	14.4	15.945	1.080	14.865	259.253
3.000	250.0	14.5	16.009	1.080	14.929	274.182
3.060	250.0	14.5	16.009	1.080	14.929	289.111
3.120	249.0	14.4	15.945	1.080	14.865	303.976
3.180	248.0	14.4	15.881	1.080	14.801	318.777
3.240	244.0	14.2	15.625	1.080	14.545	333.321
3.300	239.0	13.9	15.304	1.080	14.224	347.546
3.360	233.0	13.5	14.920	1.080	13.840	361.386
3.420	226.0	13.1	14.472	1.080	13.392	374.778
3.480	219.0	12.7	14.024	1.080	12.944	387.722
3.540	212.0	12.3	13.576	1.080	12.496	400.217
3.600	204.0	11.8	13.063	1.080	11.983	412.201
3.660	194.0	11.3	12.423	1.080	11.343	423.544
3.720	183.0	10.6	11.719	1.080	10.639	434.182
3.780	173.0	10.0	11.078	1.080	9.998	444.180
3.840	164.0	9.5	10.502	1.080	9.422	453.602
3.900	154.0	8.9	9.861	1.080	8.781	462.383
3.960	143.0	8.3	9.157	1.080	8.077	470.461
4.020	135.0	7.8	8.645	1.080	7.565	478.025
4.080	125.0	7.3	8.004	1.080	6.924	484.950
4.140	114.0	6.6	7.300	1.080	6.220	491.170
4.200	105.0	6.1	6.724	1.080	5.644	496.814
4.260	98.0	5.7	6.275	1.080	5.195	502.009
4.320	91.0	5.3	5.827	1.080	4.747	506.756
4.380	84.0	4.9	5.379	1.080	4.299	511.055
4.440	77.0	4.5	4.931	1.080	3.851	514.906
4.500	71.0	4.1	4.547	1.080	3.467	518.372
4.560	66.0	3.8	4.226	1.080	3.146	521.519
4.620	62.0	3.6	3.970	1.080	2.890	524.409
4.680	57.0	3.3	3.650	1.080	2.570	526.979
4.740	53.0	3.1	3.394	1.080	2.314	529.293
4.800	49.0	2.8	3.138	1.080	2.058	531.351
4.860	45.0	2.6	2.882	1.080	1.802	533.152
4.920	42.0	2.4	2.689	1.080	1.609	534.762
4.980	40.0	2.3	2.561	1.080	1.481	536.243
5.040	39.0	2.3	2.497	1.080	1.417	537.661
5.100	38.0	2.2	2.433	1.080	1.353	539.014
5.160	36.0	2.1	2.305	1.080	1.225	540.239
5.220	34.0	2.0	2.177	1.080	1.097	541.336
5.280	33.0	1.9	2.113	1.080	1.033	542.370
5.340	32.0	1.9	2.049	1.080	0.969	543.339
5.400	31.0	1.8	1.985	1.080	0.905	544.244
5.460	29.0	1.7	1.857	1.080	0.777	545.021
5.520	27.0	1.6	1.729	1.080	0.649	545.670
5.580	26.0	1.5	1.665	1.080	0.585	546.255
5.640	24.0	1.4	1.537	1.080	0.457	546.712
5.700	23.0	1.3	1.473	1.080	0.393	547.104
5.760	22.0	1.3	1.409	1.080	0.329	547.433
5.820	21.0	1.2	1.345	1.080	0.265	547.698
5.880	21.0	1.2	1.345	1.080	0.265	547.963
5.940	20.0	1.2	1.281	1.080	0.201	548.163
6.000	20.0	1.2	1.281	1.080	0.201	548.364

Storage volume (m³) = 548.4 m³ (Sum of all balance quantities)



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Date

12/01/16

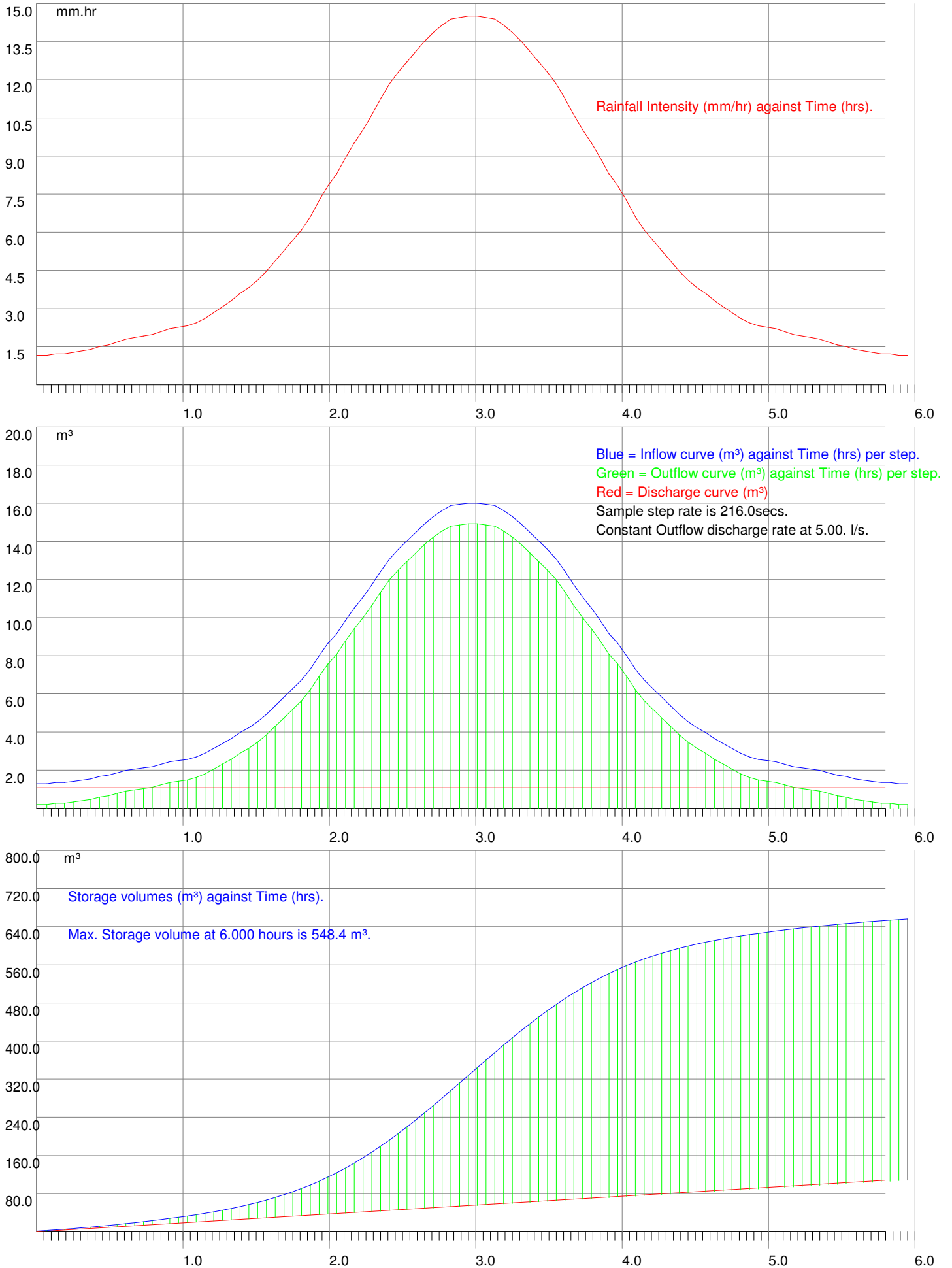
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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 2 Year (+cc) Storage Volume**





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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 2 Year (+cc) Storage Volume**

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.



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Job No.		
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Date 12/01/16		
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Project	Land off New Road, Rhosrobin, Wrexham
Title	1 in 30 Year (+cc) Storage Volume

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 30

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 10.4mm/hr for a 6 hour storm

Storm duration = 6 hrs

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 25200 m²

Total area = 25200 m²

Total runoff = 1149.2 m³

Storage (m³) = 1069.9 m³ (Sum of all balance quantities)

Total rainfall depth = 62.5 mm

Pervious area = 0 m²

Equiv area = 18396 m² (Tot. area x % runoff).

Discharge rate = 5.000 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	2.1	2.298	1.080	1.218	1.218
0.120	20.0	2.1	2.298	1.080	1.218	2.437
0.180	21.0	2.2	2.413	1.080	1.333	3.770
0.240	21.0	2.2	2.413	1.080	1.333	5.103
0.300	22.0	2.3	2.528	1.080	1.448	6.551
0.360	23.0	2.4	2.643	1.080	1.563	8.114
0.420	24.0	2.5	2.758	1.080	1.678	9.792
0.480	26.0	2.7	2.988	1.080	1.908	11.700
0.540	27.0	2.8	3.103	1.080	2.023	13.723
0.600	29.0	3.0	3.333	1.080	2.253	15.975
0.660	31.0	3.2	3.562	1.080	2.482	18.458
0.720	32.0	3.3	3.677	1.080	2.597	21.055
0.780	33.0	3.4	3.792	1.080	2.712	23.767
0.840	34.0	3.5	3.907	1.080	2.827	26.594
0.900	36.0	3.7	4.137	1.080	3.057	29.651
0.960	38.0	4.0	4.367	1.080	3.287	32.938
1.020	39.0	4.1	4.482	1.080	3.402	36.340
1.080	40.0	4.2	4.597	1.080	3.517	39.856
1.140	42.0	4.4	4.826	1.080	3.746	43.603
1.200	45.0	4.7	5.171	1.080	4.091	47.694
1.260	49.0	5.1	5.631	1.080	4.551	52.245
1.320	53.0	5.5	6.091	1.080	5.011	57.256
1.380	57.0	5.9	6.550	1.080	5.470	62.726
1.440	62.0	6.5	7.125	1.080	6.045	68.771
1.500	66.0	6.9	7.584	1.080	6.504	75.275
1.560	71.0	7.4	8.159	1.080	7.079	82.354
1.620	77.0	8.0	8.849	1.080	7.769	90.122
1.680	84.0	8.7	9.653	1.080	8.573	98.695
1.740	91.0	9.5	10.457	1.080	9.377	108.073
1.800	98.0	10.2	11.262	1.080	10.182	118.254
1.860	105.0	10.9	12.066	1.080	10.986	129.241
1.920	114.0	11.9	13.100	1.080	12.020	141.261
1.980	125.0	13.0	14.364	1.080	13.284	154.545
2.040	135.0	14.1	15.514	1.080	14.434	168.979
2.100	143.0	14.9	16.433	1.080	15.353	184.332
2.160	154.0	16.0	17.697	1.080	16.617	200.949
2.220	164.0	17.1	18.846	1.080	17.766	218.715
2.280	173.0	18.0	19.880	1.080	18.800	237.516
2.340	183.0	19.1	21.030	1.080	19.950	257.465
2.400	194.0	20.2	22.294	1.080	21.214	278.679



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Project **Land off New Road, Rhosrobin, Wrexham**
Title **1 in 30 Year (+cc) Storage Volume**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	21.2	23.443	1.080	22.363	301.042
2.520	212.0	22.1	24.362	1.080	23.282	324.324
2.580	219.0	22.8	25.167	1.080	24.087	348.410
2.640	226.0	23.5	25.971	1.080	24.891	373.301
2.700	233.0	24.3	26.775	1.080	25.695	398.997
2.760	239.0	24.9	27.465	1.080	26.385	425.381
2.820	244.0	25.4	28.039	1.080	26.959	452.341
2.880	248.0	25.8	28.499	1.080	27.419	479.760
2.940	249.0	25.9	28.614	1.080	27.534	507.294
3.000	250.0	26.0	28.729	1.080	27.649	534.943
3.060	250.0	26.0	28.729	1.080	27.649	562.592
3.120	249.0	25.9	28.614	1.080	27.534	590.126
3.180	248.0	25.8	28.499	1.080	27.419	617.545
3.240	244.0	25.4	28.039	1.080	26.959	644.504
3.300	239.0	24.9	27.465	1.080	26.385	670.889
3.360	233.0	24.3	26.775	1.080	25.695	696.584
3.420	226.0	23.5	25.971	1.080	24.891	721.475
3.480	219.0	22.8	25.167	1.080	24.087	745.562
3.540	212.0	22.1	24.362	1.080	23.282	768.844
3.600	204.0	21.2	23.443	1.080	22.363	791.207
3.660	194.0	20.2	22.294	1.080	21.214	812.420
3.720	183.0	19.1	21.030	1.080	19.950	832.370
3.780	173.0	18.0	19.880	1.080	18.800	851.170
3.840	164.0	17.1	18.846	1.080	17.766	868.937
3.900	154.0	16.0	17.697	1.080	16.617	885.554
3.960	143.0	14.9	16.433	1.080	15.353	900.907
4.020	135.0	14.1	15.514	1.080	14.434	915.340
4.080	125.0	13.0	14.364	1.080	13.284	928.625
4.140	114.0	11.9	13.100	1.080	12.020	940.645
4.200	105.0	10.9	12.066	1.080	10.986	951.631
4.260	98.0	10.2	11.262	1.080	10.182	961.813
4.320	91.0	9.5	10.457	1.080	9.377	971.190
4.380	84.0	8.7	9.653	1.080	8.573	979.763
4.440	77.0	8.0	8.849	1.080	7.769	987.532
4.500	71.0	7.4	8.159	1.080	7.079	994.611
4.560	66.0	6.9	7.584	1.080	6.504	1001.115
4.620	62.0	6.5	7.125	1.080	6.045	1007.160
4.680	57.0	5.9	6.550	1.080	5.470	1012.630
4.740	53.0	5.5	6.091	1.080	5.011	1017.641
4.800	49.0	5.1	5.631	1.080	4.551	1022.192
4.860	45.0	4.7	5.171	1.080	4.091	1026.283
4.920	42.0	4.4	4.826	1.080	3.746	1030.029
4.980	40.0	4.2	4.597	1.080	3.517	1033.546
5.040	39.0	4.1	4.482	1.080	3.402	1036.948
5.100	38.0	4.0	4.367	1.080	3.287	1040.234
5.160	36.0	3.7	4.137	1.080	3.057	1043.291
5.220	34.0	3.5	3.907	1.080	2.827	1046.119
5.280	33.0	3.4	3.792	1.080	2.712	1048.831
5.340	32.0	3.3	3.677	1.080	2.597	1051.428
5.400	31.0	3.2	3.562	1.080	2.482	1053.910
5.460	29.0	3.0	3.333	1.080	2.253	1056.163
5.520	27.0	2.8	3.103	1.080	2.023	1058.186
5.580	26.0	2.7	2.988	1.080	1.908	1060.094
5.640	24.0	2.5	2.758	1.080	1.678	1061.771
5.700	23.0	2.4	2.643	1.080	1.563	1063.335
5.760	22.0	2.3	2.528	1.080	1.448	1064.783
5.820	21.0	2.2	2.413	1.080	1.333	1066.116
5.880	21.0	2.2	2.413	1.080	1.333	1067.449
5.940	20.0	2.1	2.298	1.080	1.218	1068.667
6.000	20.0	2.1	2.298	1.080	1.218	1069.886

Storage volume (m³) = 1069.9 m³ (Sum of all balance quantities)



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3

Date

12/01/16

Project

Land off New Road, Rhosrobin, Wrexham

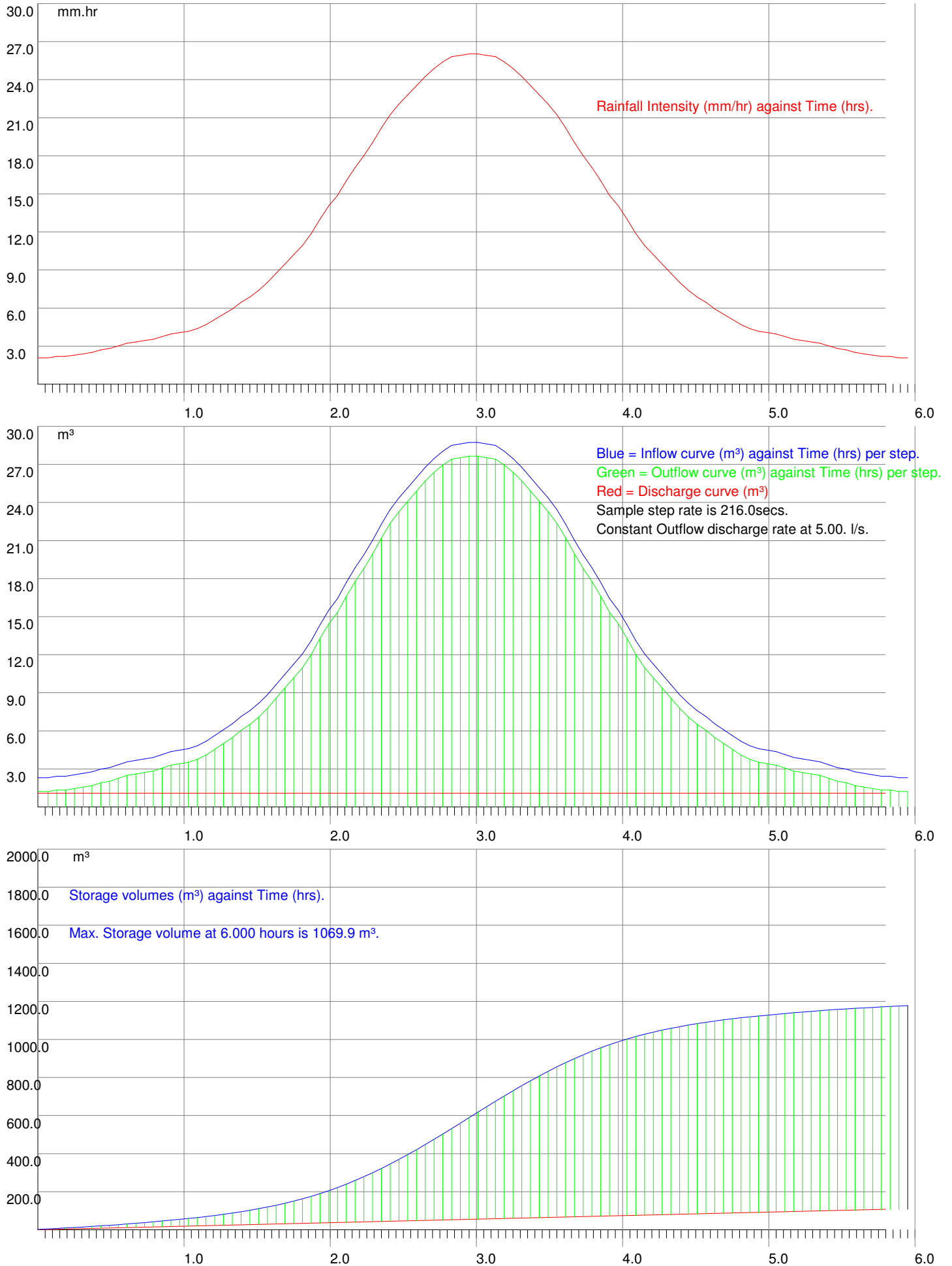
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1 in 30 Year (+cc) Storage Volume

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Project Land off New Road, Rhosrobin, Wrexham				By	Checked
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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.



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Project	Land off New Road, Rhosrobin, Wrexham
Title	1 in 100 Year (+cc) Storage Volume

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 100

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 13.5mm/hr for a 6 hour storm

Storm duration = 6 hrs

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 25200 m²

Total area = 25200 m²

Total runoff = 1490.3 m³

Storage (m³) = 1419.6 m³ (Sum of all balance quantities)

Total rainfall depth = 81.0 mm

Pervious area = 0 m²

Equiv area = 18396 m² (Tot. area x % runoff).

Discharge rate = 5.000 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	2.7	2.981	1.080	1.901	1.901
0.120	20.0	2.7	2.981	1.080	1.901	3.801
0.180	21.0	2.8	3.130	1.080	2.050	5.851
0.240	21.0	2.8	3.130	1.080	2.050	7.901
0.300	22.0	3.0	3.279	1.080	2.199	10.100
0.360	23.0	3.1	3.428	1.080	2.348	12.447
0.420	24.0	3.2	3.577	1.080	2.497	14.944
0.480	26.0	3.5	3.875	1.080	2.795	17.739
0.540	27.0	3.6	4.024	1.080	2.944	20.683
0.600	29.0	3.9	4.322	1.080	3.242	23.925
0.660	31.0	4.2	4.620	1.080	3.540	27.465
0.720	32.0	4.3	4.769	1.080	3.689	31.154
0.780	33.0	4.5	4.918	1.080	3.838	34.992
0.840	34.0	4.6	5.067	1.080	3.987	38.980
0.900	36.0	4.9	5.365	1.080	4.285	43.265
0.960	38.0	5.1	5.663	1.080	4.583	47.848
1.020	39.0	5.3	5.812	1.080	4.732	52.580
1.080	40.0	5.4	5.961	1.080	4.881	57.462
1.140	42.0	5.7	6.259	1.080	5.179	62.641
1.200	45.0	6.1	6.707	1.080	5.627	68.268
1.260	49.0	6.6	7.303	1.080	6.223	74.490
1.320	53.0	7.2	7.899	1.080	6.819	81.309
1.380	57.0	7.7	8.495	1.080	7.415	88.724
1.440	62.0	8.4	9.240	1.080	8.160	96.884
1.500	66.0	8.9	9.836	1.080	8.756	105.641
1.560	71.0	9.6	10.581	1.080	9.501	115.142
1.620	77.0	10.4	11.476	1.080	10.396	125.538
1.680	84.0	11.3	12.519	1.080	11.439	136.977
1.740	91.0	12.3	13.562	1.080	12.482	149.459
1.800	98.0	13.2	14.605	1.080	13.525	162.984
1.860	105.0	14.2	15.649	1.080	14.569	177.553
1.920	114.0	15.4	16.990	1.080	15.910	193.463
1.980	125.0	16.9	18.629	1.080	17.549	211.012
2.040	135.0	18.2	20.120	1.080	19.040	230.052
2.100	143.0	19.3	21.312	1.080	20.232	250.284
2.160	154.0	20.8	22.951	1.080	21.871	272.155
2.220	164.0	22.1	24.442	1.080	23.362	295.517
2.280	173.0	23.4	25.783	1.080	24.703	320.220
2.340	183.0	24.7	27.273	1.080	26.193	346.413
2.400	194.0	26.2	28.913	1.080	27.833	374.246



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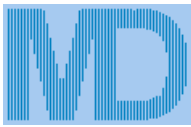
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Project	Land off New Road, Rhosrobin, Wrexham
Title	1 in 100 Year (+cc) Storage Volume

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	27.5	30.403	1.080	29.323	403.569
2.520	212.0	28.6	31.595	1.080	30.515	434.084
2.580	219.0	29.6	32.639	1.080	31.559	465.642
2.640	226.0	30.5	33.682	1.080	32.602	498.244
2.700	233.0	31.5	34.725	1.080	33.645	531.889
2.760	239.0	32.3	35.619	1.080	34.539	566.428
2.820	244.0	32.9	36.364	1.080	35.284	601.713
2.880	248.0	33.5	36.961	1.080	35.881	637.593
2.940	249.0	33.6	37.110	1.080	36.030	673.623
3.000	250.0	33.8	37.259	1.080	36.179	709.802
3.060	250.0	33.8	37.259	1.080	36.179	745.980
3.120	249.0	33.6	37.110	1.080	36.030	782.010
3.180	248.0	33.5	36.961	1.080	35.881	817.890
3.240	244.0	32.9	36.364	1.080	35.284	853.175
3.300	239.0	32.3	35.619	1.080	34.539	887.714
3.360	233.0	31.5	34.725	1.080	33.645	921.359
3.420	226.0	30.5	33.682	1.080	32.602	953.961
3.480	219.0	29.6	32.639	1.080	31.559	985.519
3.540	212.0	28.6	31.595	1.080	30.515	1016.035
3.600	204.0	27.5	30.403	1.080	29.323	1045.358
3.660	194.0	26.2	28.913	1.080	27.833	1073.190
3.720	183.0	24.7	27.273	1.080	26.193	1099.384
3.780	173.0	23.4	25.783	1.080	24.703	1124.087
3.840	164.0	22.1	24.442	1.080	23.362	1147.448
3.900	154.0	20.8	22.951	1.080	21.871	1169.320
3.960	143.0	19.3	21.312	1.080	20.232	1189.552
4.020	135.0	18.2	20.120	1.080	19.040	1208.591
4.080	125.0	16.9	18.629	1.080	17.549	1226.141
4.140	114.0	15.4	16.990	1.080	15.910	1242.051
4.200	105.0	14.2	15.649	1.080	14.569	1256.619
4.260	98.0	13.2	14.605	1.080	13.525	1270.145
4.320	91.0	12.3	13.562	1.080	12.482	1282.627
4.380	84.0	11.3	12.519	1.080	11.439	1294.066
4.440	77.0	10.4	11.476	1.080	10.396	1304.461
4.500	71.0	9.6	10.581	1.080	9.501	1313.963
4.560	66.0	8.9	9.836	1.080	8.756	1322.719
4.620	62.0	8.4	9.240	1.080	8.160	1330.879
4.680	57.0	7.7	8.495	1.080	7.415	1338.294
4.740	53.0	7.2	7.899	1.080	6.819	1345.113
4.800	49.0	6.6	7.303	1.080	6.223	1351.336
4.860	45.0	6.1	6.707	1.080	5.627	1356.962
4.920	42.0	5.7	6.259	1.080	5.179	1362.142
4.980	40.0	5.4	5.961	1.080	4.881	1367.023
5.040	39.0	5.3	5.812	1.080	4.732	1371.755
5.100	38.0	5.1	5.663	1.080	4.583	1376.339
5.160	36.0	4.9	5.365	1.080	4.285	1380.624
5.220	34.0	4.6	5.067	1.080	3.987	1384.611
5.280	33.0	4.5	4.918	1.080	3.838	1388.449
5.340	32.0	4.3	4.769	1.080	3.689	1392.138
5.400	31.0	4.2	4.620	1.080	3.540	1395.678
5.460	29.0	3.9	4.322	1.080	3.242	1398.920
5.520	27.0	3.6	4.024	1.080	2.944	1401.864
5.580	26.0	3.5	3.875	1.080	2.795	1404.659
5.640	24.0	3.2	3.577	1.080	2.497	1407.156
5.700	23.0	3.1	3.428	1.080	2.348	1409.504
5.760	22.0	3.0	3.279	1.080	2.199	1411.702
5.820	21.0	2.8	3.130	1.080	2.050	1413.752
5.880	21.0	2.8	3.130	1.080	2.050	1415.802
5.940	20.0	2.7	2.981	1.080	1.901	1417.702
6.000	20.0	2.7	2.981	1.080	1.901	1419.603

Storage volume (m³) = 1419.6 m³ (Sum of all balance quantities)



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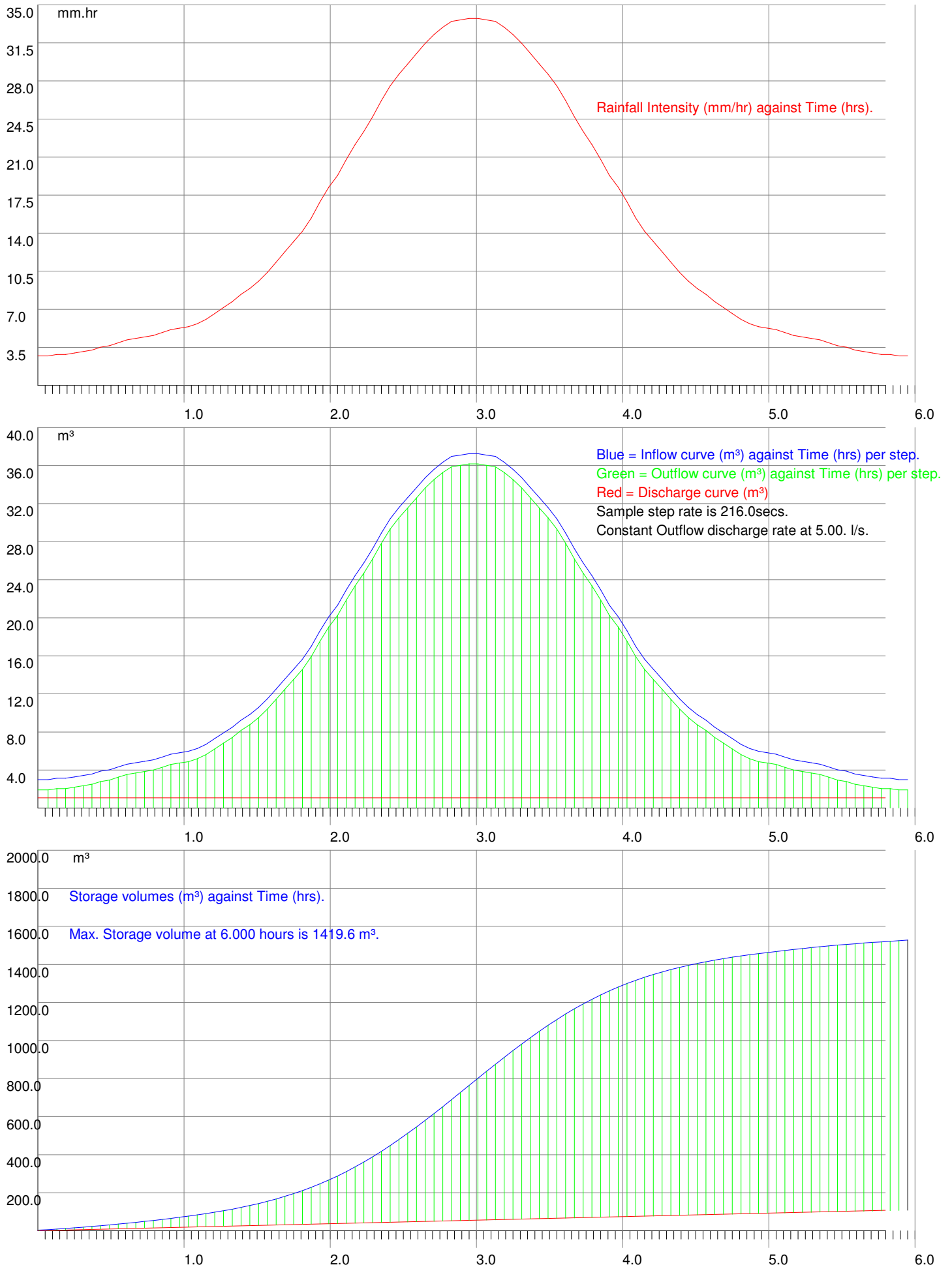
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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 100 Year (+cc) Storage Volume**





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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 100 Year (+cc) Storage Volume**

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.
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- 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.