

Project Name:		Cytec Adhesive Capacity Expansion			
Location:		Wrexham, Wales, UK			
Title:		Preliminary Stormwater Storage Estimate			
Prepared by:	M Canete	Date:	03-Mar-15	Rev:	A

I. This calculation estimates the excess volume of stormwater runoff created by new development covered by this project. This document is for conceptual stage purpose only and shall not be used for construction purposes. This calculation shall be verified during detailed design stage.

II. The conditions stipulated in the document BREEAM New Construction (Non-Domestic Building) Technical Manual SD5073-2.0:2011 as stated below are to be satisfied by this project.

Under Chapter Pol 03 Surface water runoff

- **Clause 7:** Where drainage measures are specified to ensure that the peak rate of run-off from the site to the watercourses (natural or municipal) is no greater for the developed site than it was for the pre-development site. This should comply at the 1 year and 100 year return period events.
- **Clause 8:** Calculations include an allowance for climate change; this should be made in accordance with current best practice planning guidance.
- **Clause 9:** Where flooding of property will not occur in the event of local drainage system failure (caused either by extreme rainfall or a lack of maintenance) AND
- **Clause 10:** The post development run-off volume, over the development lifetime, is no greater than it would have been prior to the assessed site's development.
- **Clause 12:** Justification from the Appropriate Consultant indicating why the above criteria cannot be achieved i.e. where infiltration or other SuDS techniques are not technically viable options.
- **Clause 13:** The post development peak rate of run-off is reduced to a limiting discharge. The limiting discharge is defined as the following and the option with the highest flow rate must be achieved;
The mean annual flow rate Q_{bar} OR
- **Clause 14:** For either option above calculations must include an allowance for climate change; this should be made in accordance with current best practice planning guidance.

III. **Calculating peak rate of run-off**

Greenfield sites of less than 50 ha (see page 2)

The calculation of greenfield run-off rates is in accordance with IH Report 124, Flood estimation for small catchments (Marshall and Bayliss, 1994). The pro-rata method on the size of catchment detailed in Table 4.2 in The SuDS Manual, CIRIA C697 (2007) is used in this calculation.

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IV. Catchment Areas
(See Attachment A)

Pre-development

Surface	Area	
	m2	ha
Impermeable Area	0	0.00
Permeable Area	16514	1.65
Total	16514.00	1.65

Post Development

Surface	Area	
	m2	ha
Impermeable Area	8055	0.81
Permeable Area	8459	0.85
Total	16514.00	1.65

V. GREENFIELD RUNOFF METHOD
(value to be divided by 50)

Qbar = **0.00108 x (0.01 x AREA)^{0.89} x SAAR^{1.17} x SPR^{2.1} in m³/s**

Where:

AREA area in ha

SAAR standard average annual rainfall for the period of 1940 to 1971 in mm

SPR standard percentage runoff coefficient for the SOIL category

Qbar Mean Annual Flood Flow rate in m3/sec

SPR = 0.45 (For Wrexham, equivalent value extracted from Microdrainage, see attachment B)

Annual rainfall = 796 mm (Annual average bet. 1940 - 1971)
(For Wrexham, equivalent value extracted from Microdrainage, see attachment B)

Greenfield Runoff Rates

Qbar (50) = 0.2553 m3/s 255.30 l/s (based on 50 Hectares)

Qbar = 0.0051 m3/s/ha 5.106 l/s/ha (per hectare)

VI. Allowable Peak Flow Rate per Ha (Using Hydrologic Region 9 Growth Curves)
(See Attachment 2A & 2B for growth curve factors)

	Return Period	Growth curve factor	Peak Flow Rate, l/s/ha
<i>Qbar</i>	1 Yr	0.88	4.49
	2 Yr	0.93	4.75
	30 Yr	1.78	9.09
	100 Yr	2.18	11.13
	100+CC Yr	2.83	14.45

Existing Qbar (for 1.65 Ha) 0.0084 m3/s or 8.43 l/s

Estimated Allowable Site Discharge Rate per return period

(Pre-development area of = 1.65 ha

Q_{1yr} = 7.41 l/s

Q_{2yr} = 7.84 l/s

Q_{30yr} = 15.01 l/s

Q_{100yr} = 18.38 l/s

Q_{100+ CCyr} = 23.86 l/s

VII. Peak Flow Growth Curve

Site Location: **Wrexham, Wales**

Hydrologic Region: **9**

Return Period	Approximate Growth Curve Factors (see Figure A1.2)
1 year	0.88
2 year	0.93
10 year	1.42
30 year	1.78
100 year	2.18
100 year + CC(30%)	2.83



Figure A1.1 Hydrological regions of UK

Table 4.3 UK growth curve factors

Region	Hydrometric Area	Return period						
		2	5	10	25	50	100	500
NW	1	0.90	1.20	1.45	1.81	2.12	2.48	3.25
	2	0.91	1.11	1.42	1.81	2.17	2.63	3.45
	3	0.94	1.25	1.45	1.70	1.90	2.08	2.73
	9	0.93	1.21	1.42	1.71	1.94	2.18	2.86
	10	0.93	1.19	1.38	1.64	1.85	2.08	2.73
SE	4	0.89	1.23	1.49	1.87	2.20	2.57	3.62
	5	0.89	1.29	1.65	2.25	2.83	3.56	5.02
	6/7	0.88	1.28	1.62	2.14	2.62	3.19	4.49
	8	0.88	1.23	1.49	1.84	2.12	2.42	3.41
Ireland		0.95	1.20	1.37	1.60	1.77	1.96	2.40

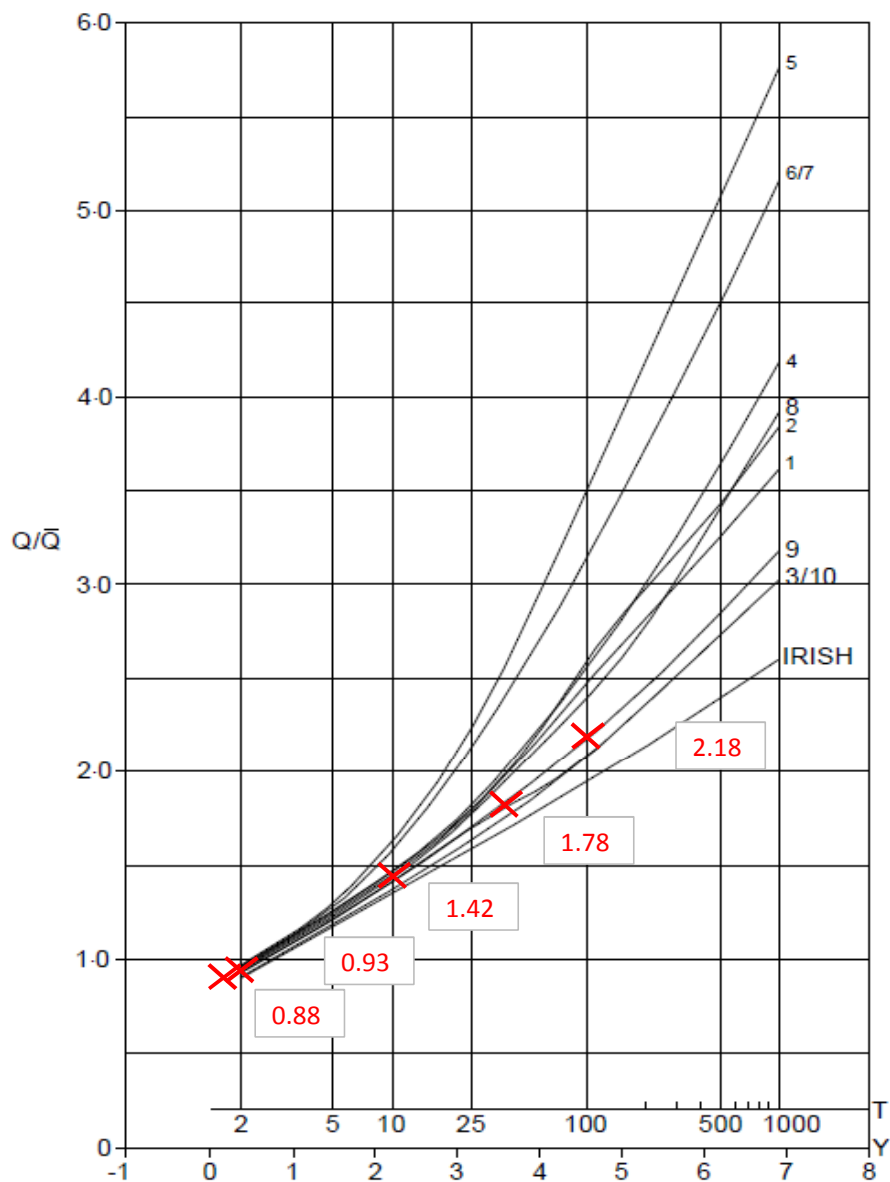


Figure A1.2 Peak flow growth curves of UK (from FSSR 14)

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VIII. Rainfall Depths
(Wrexham)

M100 - 6hr	61	mm
M5 - 60	18	mm
'r' Ratio (M5-60 / M5- 2 day)	0.325	

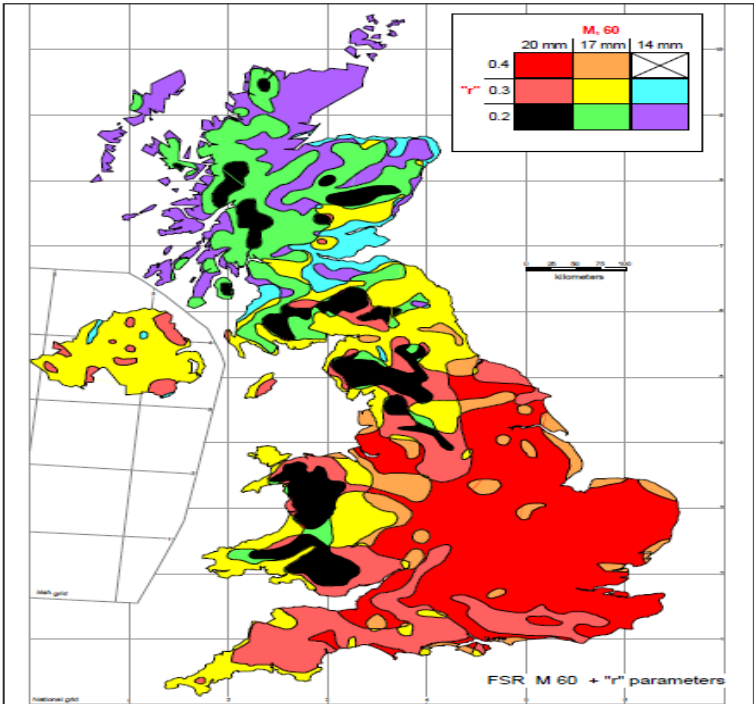


Figure A2.1 5 year 60 minute rainfall depth parameters of UK

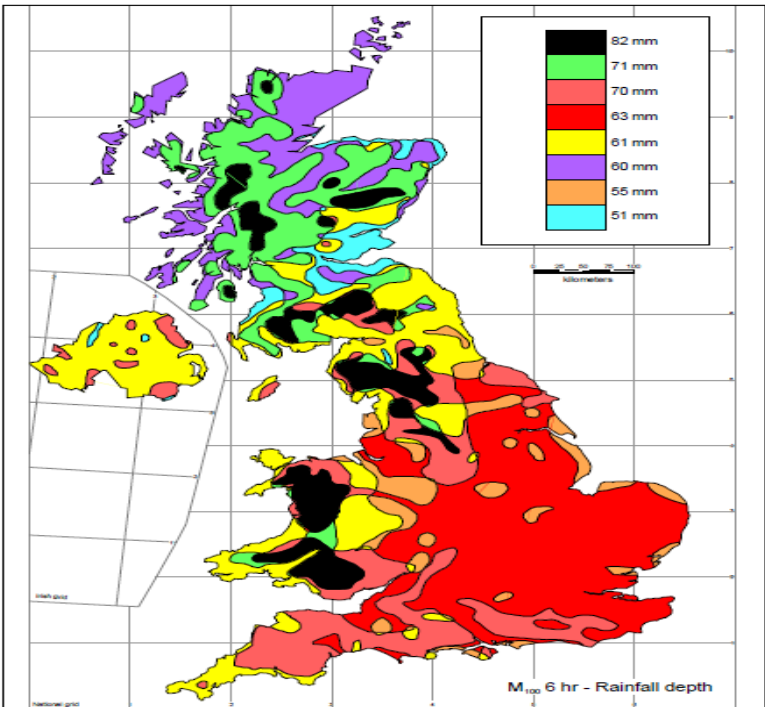


Figure A3.1 100 year 6 hour rainfall depths of UK

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IX. Peak flow rate of Impervious area by Modified Rational Formula

Q =

2.78 Cv * Cr * I * A/1000

(SI)

(in m3/s)

where

Cr

Routing coefficient =

1.3

(for urban area)

Cv

Runoff coefficient

0.9

(assumed - to be confirmed during detailed stage)

I

rainfall intensity, mm/hr

A

area, ha

Post Development Areas

Surface	Area	
	m2	ha
Impermeable Area	8055	0.806
Permeable Area	8459	0.846
Total	16514.0	1.65

Rainfall Intensities and Depths

Return Period / Duration	Rainfall Depth, mm					Rainfall Intensity, mm/hr				
	1	2	30	100	100+CC	1	2	30	100	100+CC
5	3.9	5.0	9.1	11.3	14.7	46.9	59.7	109.6	135.3	175.9
10	5.5	7.1	13.7	17.2	22.3	32.9	42.7	82.1	103.1	134.1
15	6.7	8.7	16.7	21.0	27.3	26.8	34.7	66.8	83.9	109.1
30	8.7	11.2	21.8	27.9	36.3	17.4	22.5	43.5	55.9	72.6
60	11.5	14.6	28.4	36.5	47.5	11.5	14.6	28.4	36.5	47.5
120	14.6	18.2	35.0	44.5	57.9	7.3	9.1	17.5	22.3	28.9
240	18.7	22.9	42.7	54.3	70.5	4.7	5.7	10.7	13.6	17.6
360	21.2	25.8	48.3	61.3	79.7	3.5	4.3	8.0	10.2	13.3
600	25.7	30.8	55.1	69.4	90.2	2.6	3.1	5.5	6.9	9.0
1440	33.7	39.8	67.9	86.1	111.9	1.4	1.7	2.8	3.6	4.7

Peak Flow Runoff Rate and Runoff volume

Return Period / Duration	Peak Flow Rate, (m3/s)					Volume of Runoff, m3				
	1	2	30	100	100+CC	1	2	30	100	100+CC
5	0.123	0.156	0.287	0.355	0.461	36.8	46.9	86.1	106.3	138.2
10	0.086	0.112	0.215	0.270	0.351	51.7	67.0	128.9	162.0	210.6
15	0.070	0.091	0.175	0.220	0.286	63.1	81.7	157.3	197.6	256.9
30	0.046	0.059	0.114	0.146	0.190	82.0	105.9	205.1	263.3	342.3
60	0.030	0.038	0.075	0.096	0.124	108.6	137.4	268.0	344.4	447.7
120	0.019	0.024	0.046	0.058	0.076	137.7	171.1	329.7	419.4	545.2
240	0.012	0.015	0.028	0.036	0.046	176.5	215.4	402.3	511.3	664.7
360	0.009	0.011	0.021	0.027	0.035	199.6	243.6	454.9	578.1	751.6
600	0.007	0.008	0.014	0.018	0.024	242.2	290.7	519.1	654.1	850.3
1440	0.004	0.004	0.007	0.009	0.012	317.6	374.9	639.5	811.5	1055.0

Notes:

1. Rainfall intensity and depth derived using Wallingford procedure (see paragraph XII)

2. Peak flow rate of impervious area determined using modified rational method

3. Volume of runoff of impervious area is determined using rational formula

X. Post- Development Flow Rate of Pervious area

Flow Rate = Pervious Area x Greenfield runoff rate per hectare per return period
(see Greenfield Runoff Rate per hectare from paragraph V)

Total Pervious Area = 0.850 ha

Pervious Area Flow Rates per return period

Qbar @ 1yr =	= 0.85 x4.49	3.82 L/s	0.0038	m3/s
Qbar @ 2yr =	= 0.85 x4.75	4.04 L/s	0.0040	m3/s
Qbar @ 30yr =	= 0.85 x9.09	7.73 L/s	0.0077	m3/s
Qbar @ 100yr =	= 0.85 x11.13	9.46 L/s	0.0095	m3/s
Qbar @ 100+ CCyr =	= 0.85 x14.45	12.28 L/s	0.0123	m3/s

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XI. Calculation of Post Development Peak Runoffs and Volumes and Required Storage

(Note:

Return Period: **1 Year**

Storm Duration	Existing Discharge runoff rate (1.65 Ha - permeable)		Existing Discharge runoff volume	Post development Discharge runoff rate				Post development Discharge runoff volume			Excess Runoff Volume due to new development
				Impervious	Pervious Greenfield	Total		Impervious	Pervious Greenfield	Total	
(a)	(b)	(c)	(d) = (a) x (b)	(e)	(f)	(g) = (e) x (f)	(h)	(i) = (a) x (e) / 60	(k) = (a) x (f) / 60	(l) = (j) + (k)	(m) = (l) - (d)
minutes	m3/s	L/s	m3	m3/s	m3/s	m3/s	L/s	m3	m3	m3	m3
5	0.0074	7.4	2.2	0.123	0.0038	0.127	127	36.8	1.1	38.0	35.8
10	0.0074	7.4	4.4	0.086	0.0038	0.090	90	51.8	2.3	54.1	49.6
15	0.0074	7.4	6.7	0.070	0.0038	0.074	74	63.2	3.4	66.6	59.9
30	0.0074	7.4	13.3	0.046	0.0038	0.049	49	82.1	6.9	89.0	75.6
60	0.0074	7.4	26.7	0.030	0.0038	0.034	34	108.7	13.7	122.4	95.7
120	0.0074	7.4	53.4	0.019	0.0038	0.023	23	137.8	27.5	165.3	111.9
240	0.0074	7.4	106.7	0.012	0.0038	0.016	16	176.6	55.0	231.6	124.9
360	0.0074	7.4	160.1	0.009	0.0038	0.013	13	199.7	82.4	282.2	122.1
600	0.0074	7.4	266.8	0.007	0.0038	0.011	11	242.4	137.4	379.8	113.1
1440	0.0074	7.4	640.2	0.004	0.0038	0.007	7	317.8	329.7	647.6	7.3

Peak Excess Runoff Volume: **124.9**

Return Period: **2 Year**

Storm Duration	Existing Discharge runoff rate (1.65 Ha - permeable)		Existing Discharge runoff volume	Post development runoff rate				Post development runoff volume			Excess Runoff Volume due to new development
				Impervious	Pervious Greenfield	Total		Impervious	Pervious Greenfield	Total	
(a)	(b)	(c)	(d) = (a) x (b)	(e)	(f)	(g) = (e) x (f)	(h)	(i) = (a) x (e) / 60	(k) = (a) x (f) / 60	(l) = (j) + (k)	(m) = (l) - (d)
minutes	m3/s	L/s	m3	m3/s	m3/s	m3/s	L/s	m3	m3	m3	m3
5	0.0078	7.8	2.4	0.156	0.0040	0.161	161	46.9	1.2	48.2	45.8
10	0.0078	7.8	4.7	0.112	0.0040	0.116	116	67.1	2.4	69.5	64.8
15	0.0078	7.8	7.1	0.091	0.0040	0.095	95	81.8	3.6	85.4	78.4
30	0.0078	7.8	14.1	0.059	0.0040	0.063	63	105.9	7.3	113.2	99.1
60	0.0078	7.8	28.2	0.038	0.0040	0.042	42	137.5	14.5	152.1	123.8
120	0.0078	7.8	56.4	0.024	0.0040	0.028	28	171.2	29.1	200.3	143.9
240	0.0078	7.8	112.9	0.015	0.0040	0.019	19	215.6	58.1	273.7	160.8
360	0.0078	7.8	169.3	0.011	0.0040	0.015	15	243.8	87.2	331.0	161.6
600	0.0078	7.8	282.2	0.008	0.0040	0.012	12	290.9	145.4	436.3	154.0
1440	0.0078	7.8	677.4	0.004	0.0040	0.008	8	375.2	348.8	724.0	46.7

Peak Excess Runoff Volume: **161.6**

Return Period: **30 Year**

Storm Duration	Existing Discharge runoff rate (1.65 Ha - permeable)		Existing Discharge runoff volume	Post development runoff rate				Post development runoff volume			Excess Runoff Volume due to new development
				Impervious	Pervious Greenfield	Total		Impervious	Pervious Greenfield	Total	
(a)	(b)	(c)	(d) = (a) x (b)	(e)	(f)	(g) = (e) x (f)	(h)	(i) = (a) x (e) / 60	(k) = (a) x (f) / 60	(l) = (j) + (k)	(m) = (l) - (d)
minutes	m3/s	L/s	m3	m3/s	m3/s	m3/s	L/s	m3	m3	m3	m3
5	0.0150	15.0	4.5	0.287	0.0077	0.295	295	86.2	2.3	88.5	84.0
10	0.0150	15.0	9.0	0.215	0.0077	0.223	223	129.0	4.6	133.7	124.7
15	0.0150	15.0	13.5	0.175	0.0077	0.183	183	157.4	7.0	164.4	150.9
30	0.0150	15.0	27.0	0.114	0.0077	0.122	122	205.3	13.9	219.2	192.1
60	0.0150	15.0	54.0	0.075	0.0077	0.082	82	268.2	27.8	296.1	242.0
120	0.0150	15.0	108.1	0.046	0.0077	0.054	54	329.9	55.6	385.6	277.5
240	0.0150	15.0	216.1	0.028	0.0077	0.036	36	402.6	111.3	513.9	297.7
360	0.0150	15.0	324.2	0.021	0.0077	0.029	29	455.2	166.9	622.1	297.9
600	0.0150	15.0	540.4	0.014	0.0077	0.022	22	519.5	278.2	797.7	257.3
1440	0.0150	15.0	1296.9	0.007	0.0077	0.015	15	640.0	667.6	1307.6	10.8

Peak Excess Runoff Volume: **297.9**

100 Year

Storm Duration	Existing Discharge runoff rate (1.65 Ha - permeable)		Existing Discharge runoff volume	Post development runoff rate				Post development runoff volume			Excess Runoff Volume due to new development
				Impervious	Pervious Greenfield	Total		Impervious	Pervious Greenfield	Total	
(a)	(b)	(c)	(d) = (a) x (b)	(e)	(f)	(g) = (e) x (f)	(h)	(j) = (a) x (e) / 60	(k) = (a) x (f) / 60	(l) = (j) + (k)	(m) = (l) - (d)
minutes	m3/s	L/s	m3	m3/s	m3/s	m3/s	L/s	m3	m3	m3	m3
5	0.0184	18.4	5.5	0.355	0.0095	0.364	364	106.4	2.8	109.2	103.7
10	0.0184	18.4	11.0	0.270	0.0095	0.280	280	162.1	5.7	167.8	156.8
15	0.0184	18.4	16.5	0.220	0.0095	0.229	229	197.8	8.5	206.3	189.8
30	0.0184	18.4	33.1	0.146	0.0095	0.156	156	263.5	17.0	280.6	247.5
60	0.0184	18.4	66.2	0.096	0.0095	0.105	105	344.6	34.1	378.7	312.5
120	0.0184	18.4	132.3	0.058	0.0095	0.068	68	419.7	68.1	487.8	355.5
240	0.0184	18.4	264.7	0.036	0.0095	0.045	45	511.7	136.2	647.9	383.3
360	0.0184	18.4	397.0	0.027	0.0095	0.036	36	578.6	204.3	783.0	385.9
600	0.0184	18.4	661.7	0.018	0.0095	0.028	28	654.6	340.6	995.2	333.5
1440	0.0184	18.4	1588.0	0.009	0.0095	0.019	19	812.2	817.4	1629.6	41.6

385.9

100 Year + Climate change

Storm Duration	Existing Discharge runoff rate (1.65 Ha - permeable)		Existing Discharge runoff volume	Post development runoff rate				Post development runoff volume			Excess Runoff Volume due to new development
				Impervious	Pervious Greenfield	Total		Impervious	Pervious Greenfield	Total	
(a)	(b)	(c)	(d) = (a) x (b)	(e)	(f)	(g) = (e) x (f)	(h)	(j) = (a) x (e) / 60	(k) = (a) x (f) / 60	(l) = (j) + (k)	(m) = (l) - (d)
minutes	m3/s	L/s	m3	m3/s	m3/s	m3/s	L/s	m3	m3	m3	m3
5	0.0239	23.9	7.2	0.461	0.0123	0.473	473	138.3	3.7	142.0	134.8
10	0.0239	23.9	14.3	0.351	0.0123	0.364	364	210.8	7.4	218.1	203.8
15	0.0239	23.9	21.5	0.286	0.0123	0.298	298	257.1	11.1	268.2	246.7
30	0.0239	23.9	42.9	0.190	0.0123	0.203	203	342.6	22.1	364.7	321.7
60	0.0239	23.9	85.9	0.124	0.0123	0.137	137	448.0	44.2	492.3	406.4
120	0.0239	23.9	171.8	0.076	0.0123	0.088	88	545.7	88.4	634.1	462.3
240	0.0239	23.9	343.6	0.046	0.0123	0.058	58	665.2	176.9	842.1	498.5
360	0.0239	23.9	515.4	0.035	0.0123	0.047	47	752.2	265.3	1017.5	502.1
600	0.0239	23.9	859.0	0.024	0.0123	0.036	36	851.0	442.2	1293.1	434.2
1440	0.0239	23.9	2061.5	0.012	0.0123	0.025	25	1055.9	1061.2	2117.1	55.6

502.1

Summary:

502.00 m3

Therefore to satisfy Clause 10 of Pol 03 under BREAAm, the excess volume shall be not leave the site during the storm. This excess volume shall be dispersed by slow ground infiltration or, if this not possible, shall be stored within site (attenuation storage) and will be slowly released after the storm event.

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XII. RAINFALL INTENSITIES AND DURATION FOR WREXHAM BASED ON WALLINGFORD PROCEDURE
(Rainfall derivation based Wrexham values for 'r'=0.325 and M5-60=18mm)

Table 1

Storm Duration	Z1 for 'r' value	M5 - D min	Average Intensity
	= 0.325	5 Year Rainfall	
		mm	mm/hr
5	0.35	6.3	75.6
10	0.50	9.0	54.0
15	0.61	11.0	43.9
30	0.78	14.0	28.1
60	1.00	18.0	18.0
120	1.23	22.1	11.1
240	1.53	27.5	6.9
360	1.73	31.1	5.2
600	2.04	36.7	3.7
1440	2.60	46.8	2.0

Table 2

1-Year Return Period

Table 3

2-Year Return Period

Table 4

5-Year Return Period

Storm Duration	M1 - D min	M1 - D min	Ave. Intensity	Storm Duration	M2 - D min	M2 - D min	Ave. Intensity	Storm Duration	M5 - D min	M5 - D min	Ave. Intensity
	Z2 value	1 Year Rainfall			Z2 value	2 Year Rainfall			Z2 value	5 Year Rainfall	
	mm	mm/hr			mm	mm/hr			mm	mm/hr	
5	0.62	3.9	46.9	5	0.79	5.0	59.7	5	1.02	6.4	77.1
10	0.61	5.5	32.9	10	0.79	7.1	42.7	10	1.03	9.3	55.6
15	0.61	6.7	26.8	15	0.79	8.7	34.7	15	1.03	11.3	45.2
30	0.62	8.7	17.4	30	0.80	11.2	22.5	30	1.03	14.5	28.9
60	0.64	11.5	11.5	60	0.81	14.6	14.6	60	1.03	18.5	18.5
120	0.66	14.6	7.3	120	0.82	18.2	9.1	120	1.03	22.8	11.4
240	0.68	18.7	4.7	240	0.83	22.9	5.7	240	1.03	28.4	7.1
360	0.68	21.2	3.5	360	0.83	25.8	4.3	360	1.03	32.1	5.3
600	0.7	25.7	2.6	600	0.84	30.8	3.1	600	1.02	37.5	3.7
1440	0.72	33.7	1.4	1440	0.85	39.8	1.7	1440	1.02	47.7	2.0

Table 5

10-Year Return Period

Table 6

30-Year Return Period

Table 7

100-Year Return Period

Storm Duration	M10 - D min	M10 - D min	Ave. Intensity	Storm Duration	M30 - D min	M30 - D min	Ave. Intensity	Storm Duration	M100 - D min	M100 - D min	Ave. Intensity
	Z2 value	10 Year Rainfall			Z2 value	30 Year Rainfall			Z2 value	100 Year Rainfall	
	mm	mm/hr			mm	mm/hr			mm	mm/hr	
5	1.19	7.5	90.0	5	1.45	9.1	109.6	5	1.79	11.3	135.3
10	1.22	11.0	65.9	10	1.52	13.7	82.1	10	1.91	17.2	103.1
15	1.22	13.4	53.6	15	1.52	16.7	66.8	15	1.91	21.0	83.9
30	1.24	17.4	34.8	30	1.55	21.8	43.5	30	1.99	27.9	55.9
60	1.24	22.3	22.3	60	1.58	28.4	28.4	60	2.03	36.5	36.5
120	1.24	27.5	13.7	120	1.58	34.98	17.5	120	2.01	44.5	22.3
240	1.23	33.9	8.5	240	1.55	42.7	10.7	240	1.97	54.3	13.6
360	1.22	38.0	6.3	360	1.55	48.3	8.0	360	1.97	61.3	10.2
600	1.2	44.1	4.4	600	1.5	55.1	5.5	600	1.89	69.4	6.9
1440	1.18	55.2	2.3	1440	1.45	67.9	2.8	1440	1.84	86.1	3.6

Notes:

- The rainfall depth are derived using Wallingford Procedure - Design and Analysis of Urban Storm Drainage.
- The value of M5-60 (18mm) and the "r" = 0.325 (which is the ratio of 60 minute to 2 day rainfall for a 5 year return period storm) is based on FSR Rainfall Map of UK (see attachment 1x)
- Rainfall depth values of different duration from table 1 is calculated as D = M5-60min rainfall x Z1 or 18mm x Z1 value.
- Values of Z1 and Z2 are as shown in table 8 & 9.
- Derivation of rainfall depth for different return period is as shown for example below:
Rainfall depth for 2 hour rainfall of 30 year return storm -
M30-2 hour storm = M5-2 hour rainfall depth x Z2 factor for depth 22.1mm in Table 9
M30-2 hour storm = 22.14 x 1.58 = 35 mm

Table 8
Z1 Factor for England and Wales

‘r’	Rainfall duration D									
	Minutes					Hours				
	5	10	15	30	1	2	4	6	10	24
0.12	0.22	0.34	0.45	0.67	1.00	1.48	2.17	2.75	3.70	6.00
0.15	0.25	0.38	0.48	0.69	1.00	1.42	2.02	2.46	3.23	4.90
0.18	0.27	0.41	0.51	0.71	1.00	1.36	1.86	2.25	2.86	4.30
0.21	0.29	0.43	0.54	0.73	1.00	1.33	1.77	2.12	2.62	3.60
0.24	0.31	0.36	0.56	0.75	1.00	1.30	1.71	2.00	2.40	3.35
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.90	2.42
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03

Table 9

Z2 Factors for England & Wales from table 6.2 - Wallingford Procedure

M5 Rain (mm)	Diff (mm)	M1	M30	M100
		1	30	100
5.00	5	0.62	1.45	1.79
10.00	5	0.61	1.52	1.91
15.00	5	0.62	1.55	1.99
20.00	5	0.64	1.58	2.03
25.00	5	0.66	1.57	2.01
30.00	10	0.68	1.55	1.97
40.00	10	0.70	1.50	1.89
50.00	25	0.72	1.45	1.84
75.00	25	0.76	1.36	1.64
100.00	50	0.78	1.32	1.54
150.00	50	0.78	1.26	1.45
200.00		0.78	1.24	1.40

N.B. M30 Factors interpolated graphically.

M5-D min rainfall value	M5	M10	M20	M50	M100
5	1.02	1.19	1.36	1.56	1.79
10	1.03	1.22	1.41	1.65	1.91
15	1.03	1.24	1.44	1.70	1.99
20	1.02	1.24	1.45	1.73	2.03
25	1.02	1.24	1.44	1.72	2.01
30	1.02	1.22	1.42	1.70	1.97
40	1.02	1.19	1.38	1.64	1.89
50	1.02	1.17	1.34	1.58	1.81
75	1.02	1.14	1.28	1.47	1.64
100	1.02	1.13	1.25	1.40	1.54
150	1.02	1.12	1.21	1.33	1.45
200	1.01	1.11	1.19	1.30	1.40

ATTACHMENT B

Fluor Limited		Page 1																								
Fluor Centre 140 Pinehurst Road Farnborough Hants GU14 7BF	Cytec Adhesive Capacity Expansion Wrexham, Wales, UK																									
Date 24 Feb 15 File CYTEC SUDS DESIGN.SRCX	Designed by MC Checked by JH																									
XP Solutions																										
Source Control 2014.1																										
<u>ICP SUDS Mean Annual Flood</u> Input <table><tr><td>Return Period (years)</td><td>100</td><td>Soil</td><td>0.450</td></tr><tr><td>Area (ha)</td><td>1.000</td><td>Urban</td><td>0.000</td></tr><tr><td>SAAR (mm)</td><td>796</td><td>Region Number</td><td>Region 9</td></tr></table> Results l/s <table><tr><td>QBAR Rural</td><td>5.1</td></tr><tr><td>QBAR Urban</td><td>5.1</td></tr><tr><td>Q100 years</td><td>11.1</td></tr><tr><td>Q1 year</td><td>4.5</td></tr><tr><td>Q30 years</td><td>9.0</td></tr><tr><td>Q100 years</td><td>11.1</td></tr></table>			Return Period (years)	100	Soil	0.450	Area (ha)	1.000	Urban	0.000	SAAR (mm)	796	Region Number	Region 9	QBAR Rural	5.1	QBAR Urban	5.1	Q100 years	11.1	Q1 year	4.5	Q30 years	9.0	Q100 years	11.1
Return Period (years)	100	Soil	0.450																							
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