

CALCULATION SHEET



Client GOWER HOMES			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, THE SIDINGS, RAILWAY ROAD, WREXHAM	Job No 3916
By RW	Date 05.14	Chkd	Element SURFACE WATER DRAINAGE ANALYSIS HIGHWAY SOAKAWAY DESIGN:	Sheet No HSA1
DATA	CALCULATIONS			RESULTS
1.	<u>PURPOSE</u> The purpose of these calculations is to determine the size of the concrete ringed soakaways required to disperse the run-off from the adoptable carriageway to be constructed as part of the above development.			
2.	<u>SITE LAYOUT</u> The layout of the development site is shown on drawing N° 3916/02 and 03 (as revised) This drawing shows the proposed location of the soakaways and the impermeable areas draining to each facility.			
3.	<u>POROSITY TESTS</u> Porosity tests were carried out by Groundsolve Ltd in November 2013. The results of their investigations and percolation tests are included in their Geo-environmental Report issued December 2013 Ref:1432. The applicable results of these tests are summarised in Section 6 This geo-environmental report and investigation is limited to Phase 1 of the site with the exception of one trial pit TP7 excavated within Phase 2 of the development to the south.			
4.	<u>METHODOLOGY</u> Current best practice/design advice recommends that infiltration drainage systems should be designed to store the run-off from a 10% annual probability storm (1 in 10 year return period) and to half empty (by percolation) in a twenty-four hour period (CIRIA Report 156: Infiltration drainage - Manual of good practice). This latter requirement allows the system to cater for a succession of severe storm events However in order to achieve consistency between conventional drainage techniques (as set out in Sewers for Adoption), recent recommendations (CIRIA Report N° C609: Sustainable drainage systems - Hydraulic, structural and water quality advice) suggest that SUDS should be analysed for a 3.3% annual probability storm event (1 in 30 year return period) to ensure that internal flooding of properties and/or serious external flooding (SEF) does not occur. In addition, the Environment Agency, in pursuance of the requirements of TAN 15 (in Wales) and PPG25 (in England), recommends that greenfield run-off rates and volumes should be maintained after development for storm events up to a 1% annual probability (1 in 100 year return period). The additional water resulting from these severe storm events does not necessarily have to be stored within the SUDS, provided it can be contained by localised flooding of car parks and landscaped areas for short periods of time without adversely effecting residential or commercial property.			

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DATA		CALCULATIONS			RESULTS
4. <u>METHODOLOGY</u> (continued) These calculations therefore adopt the following methodology: 1. Rainfall intensities for different storm conditions are to be determined using the Wallingford Procedure 2. The infiltration device is to be sized to store the run-off from a 10% annual probability storm below the level of the incoming pipe(s) 3. The infiltration device is to be analysed to ensure that the run-off from a 3.3% annual probability storm is contained without the system flooding (ie that there is sufficient storage provided within the facility) 4. The system is to be further tested against 1% annual probability storm events to assess the volume of flooding and to confirm that it will not adversely effect residential or commercial property 5. <u>METHOD OF ANALYSIS</u> These calculations adopt the method of analysis for 3-D Infiltration Systems set out in CIRIA Report N° 156: Infiltration systems - Manual of good practice. For a vertically sided structure (ie a soakaway or infiltration trench) the maximum depth of water (h_{max}) can be calculated by solving the following equation $h_{max} = a (e^{(-bD)} - 1)$ where $a = (A_b / P) - (A_d / Pq)$ and $b = (Pq) / (nA_b)$ The time to half empty ($t_{1/2}$) can be determined from the following equation: $t_{1/2} = \frac{n A_b}{q P} \log_e \left\{ \frac{h_{max} + A_b / P}{h_{max} + A_b / P} \right\}$ The required inputs are: A_b area of base of infiltration device (m²) P perimeter of infiltration device (m) A_D area to be drained (m²) f infiltration rate from percolation tests (m/h) i, D intensity and duration of rainfall events with the required return period at the site location (m/h, h) n porosity of fill material (void volume/total volume) The results of these calculations are set out below					

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DATA		CALCULATIONS		RESULTS														
6.	<u>PERCOLATION TEST RESULTS</u> Porosity tests were carried out in October 2013 by GroundSolve Ltd to determine the infiltration rates within the underlying glacial sands and gravel's which are present at varying depths across the site. The location of the trial pits is shown on Figure 4 in their report. Below is a summary of the lowest infiltration rates derived from four trial pits where tests were undertaken including the existing Phase 1 soakaway. The results from the existing soakaway SA2 in Phase 2 have been ignored as the tests were abandoned due to heavy siltation. <table border="1"> <thead> <tr> <th>Trial Pit</th> <th>Measured Soil Infiltration Rate f (m/s)</th> </tr> </thead> <tbody> <tr> <td>TP 2 Test 1</td> <td>3.24E-06</td> </tr> <tr> <td>TP 4 Test 2</td> <td>1.34E-05</td> </tr> <tr> <td>TP 5 Test 2</td> <td>2.42E-04</td> </tr> <tr> <td>TP 7 Test 1</td> <td>6.44E-05</td> </tr> <tr> <td>Ex SA1 Test 1</td> <td>8.21E-05</td> </tr> <tr> <td>Average of all</td> <td>8.10E-05</td> </tr> </tbody> </table>			Trial Pit	Measured Soil Infiltration Rate f (m/s)	TP 2 Test 1	3.24E-06	TP 4 Test 2	1.34E-05	TP 5 Test 2	2.42E-04	TP 7 Test 1	6.44E-05	Ex SA1 Test 1	8.21E-05	Average of all	8.10E-05	
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7.	<u>DRAINED AREA</u> The following impermeable area drains to each individual soakaway <table border="1"> <thead> <tr> <th>Description</th> <th>Drained Area (m²)</th> </tr> </thead> <tbody> <tr> <td>SA1</td> <td>345.38</td> </tr> <tr> <td>SA2</td> <td>99.65</td> </tr> <tr> <td>SA3</td> <td>175.28</td> </tr> <tr> <td>SA4</td> <td>291.03</td> </tr> <tr> <td>SA5</td> <td>259.34</td> </tr> <tr> <td>Total</td> <td>1170.680</td> </tr> </tbody> </table>			Description	Drained Area (m ²)	SA1	345.38	SA2	99.65	SA3	175.28	SA4	291.03	SA5	259.34	Total	1170.680	
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DATA			CALCULATIONS						RESULTS		
7.			<u>RAINFALL DATA</u>								
Ratio (M5-60min/M5-2day)			r			32.7 %					
M5-2day Rainfall			M5-2day			55.04 mm					
M5-60min Rainfall			M5-60			18.00 mm					
M5-D Rainfall			M5-D			Z1(M5-60)					
MT-D Rainfall			MT D			Z2(M5-D)					
Rainfall Intensity			I			(MT-D)/D mm/hr					
D	Z1	M5	10 Year Return			30 Year Return			100 Year Return		
			Z2	M10	I	Z2	M30	I	Z2	M100	I
(min)		(mm)		(mm)	(mm/hr)		(mm)	(mm/hr)		(mm/hr)	(mm/hr)
5	0.35	6.28	1.2	7.54	90.45	1.44	9.05	108.54	1.82	11.43	137.18
10	0.50	8.98	1.21	10.87	65.20	1.48	13.29	79.75	1.89	16.97	101.85
15	0.61	10.94	1.22	13.35	53.40	1.50	16.41	65.66	1.93	21.12	84.48
20	0.67	11.97	1.23	14.72	44.16	1.50	17.95	53.86	1.94	23.22	69.66
25	0.72	12.99	1.23	15.98	38.36	1.51	19.62	47.09	1.96	25.47	61.13
30	0.78	14.02	1.24	17.39	34.77	1.52	21.31	42.62	1.97	27.62	55.24
45	0.89	16.01	1.24	19.85	26.47	1.53	24.49	32.66	2.00	32.02	42.69
60	1.00	18.00	1.24	22.32	22.32	1.54	27.72	27.72	2.01	36.18	36.18
90	1.12	20.09	1.24	24.91	16.60	1.54	30.93	20.62	2.03	40.77	27.18
120	1.23	22.17	1.24	27.50	13.75	1.54	34.15	17.07	2.02	44.79	22.40
240	1.53	27.61	1.23	33.96	8.49	1.52	41.97	10.49	1.99	54.94	13.74
360	1.74	31.23	1.22	38.10	6.35	1.51	47.15	7.86	1.96	61.20	10.20
600	2.05	36.86	1.2	44.23	4.42	1.48	54.55	5.46	1.92	70.77	7.08
1440	2.62	47.23	1.18	55.73	2.32	1.43	67.53	2.81	1.83	86.43	3.60

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DATA	CALCULATIONS			RESULTS
8.	<u>DESIGN DATA SA1</u>			
From porosity tests	Measured infiltration rate (average of TP2 and EX SA1)		f	5.83E-01 m/hr
CIRIA C697 Pg. 4-31	Factor of safety	(flooding road)	F _s	10.0
CIRIA C697 Pg. 4-31	Porosity	(clean stone)	n	0.45
From Plan	Area to be drained		A _D	345.38 m²
	Assume soakaway comprises 1.8m diameter ring in square excavation 300mm (minimum) larger than outside face of concrete ring.			
	Length, say	3.100 m	Diameter	1.800 m
	Width, say	3.100 m	Radius	0.900 m
CIRIA 156 Pgs. 54 & 92	Effective porosity (excavation filled with clean stone)		n'	0.596
9.	<u>SOAKAWAY DESIGN</u>			
By Calculation, q = f/F _s	Effective infiltration coefficient (measured infiltration rate/factor of safety)		q	0.058 m/hr
From Plan	Area to be drained		A _D	345.38 m ²
By Calculation, A _b = L * W	Base Area of soakaway		A _b	9.61 m ²
By Calculation, P = 2L + 2W	Perimeter of Soakaway		P	12.40 m
CIRIA 156 Pg. 57	Factor a = (A _b /P) - (iAD/Pq)		a	varies
CIRIA 156 Pg. 57	Factor b = (Pq/nA _b)		b	0.126

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DATA			CALCULATIONS						RESULTS				
9. SOAKAWAY DESIGN (continued)													
			Duration		10 Year Return			30 Year Return			100 Year Return		
					i	Factor	Max Depth	i	Factor	Max Depth	i	Factor	Max Depth
			min	hr	m/hr		m	m/hr		m	m/hr		m
			5	0.083	0.090	-42.4	0.444	0.109	-51.0	0.535	0.137	-64.7	0.678
			10	0.167	0.065	-30.4	0.633	0.080	-37.3	0.777	0.102	-47.9	0.997
			15	0.250	0.053	-24.7	0.769	0.066	-30.6	0.951	0.084	-39.6	1.230
			20	0.333	0.044	-20.3	0.838	0.054	-24.9	1.029	0.070	-32.5	1.340
			25	0.417	0.038	-17.5	0.900	0.047	-21.7	1.114	0.061	-28.4	1.457
			30	0.500	0.035	-15.8	0.969	0.043	-19.6	1.199	0.055	-25.6	1.568
			45	0.750	0.026	-11.9	1.073	0.033	-14.8	1.340	0.043	-19.6	1.773
			60	1.000	0.022	-9.9	1.173	0.028	-12.5	1.479	0.036	-16.5	1.958
			90	1.500	0.017	-7.2	1.235	0.021	-9.1	1.566	0.027	-12.2	2.107
			120	2.000	0.014	-5.8	1.293	0.017	-7.4	1.648	0.022	-9.9	2.215
			240	4.000	0.008	-3.3	1.301	0.010	-4.2	1.680	0.014	-5.8	2.295
360	6.000	0.006	-2.3	1.199	0.008	-3.0	1.582	0.010	-4.1	2.177			
600	10.000	0.004	-1.3	0.959	0.005	-1.8	1.313	0.007	-2.6	1.868			
1440	24.000	0.002	-0.3	0.318	0.003	-0.6	0.541	0.004	-0.9	0.899			
For 1 in 10 year return period storm From Table Maximum depth of water h_{max} 1.301 m By calculation Time for half emptying $t_{1/2}$ 3.66 hr For 1 in 30 year return period storm Depth of storage required additional to 1 in 10 year return period 0.379 m Total depth of storage to be provided. (Overall depth to suit actual level of sands and gravel's) 1.680 m													

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DATA	CALCULATIONS			RESULTS
9.	<u>SOAKAWAY DESIGN (continued)</u> For 1 in 100 year return period storm Potential flood volume (in excess of storage provided for 1 in 30 year storm conditions) 3.518 m³ Part of this volume will be stored within the soakaway and pipework as the overall depth of the soakaway is greater than required due to the depth at which the drainage strata is present. The base of the soakaway will be set relative to the depth of hmax below the top level of the sand and gravel drainage strata which is taken to be at a minimum depth of 1.5m below existing ground level from the geo-environmental report.			

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DATA		CALCULATIONS					RESULTS
10.		<u>SUMMARY</u>					
Soakaway	Cover Level (m)	Pipe Invert Level (m)	Depth hmax (m)	Depth h30 (m)	Vol 100 (m³)	Base Level (m)	Total (m)
SA1	50.165	48.700	1.301	3.660	3.518	46.819	3.346
SA2	50.165	49.000	0.779	1.132	0.880	47.371	2.794
SA3	50.025	48.950	1.289	5.568	1.930	46.631	3.394
SA4	50.110	49.040	1.448	7.770	3.394	46.552	3.558
SA5	50.055	48.655	1.385	6.988	3.010	46.535	3.520
11.		<u>Additional Storage Provided For More Severe Events & Climate Change</u> Additional storage for more severe events and increased rainfall due to climate change is provided within the soakaways above the 1 in 30 year event level up to the underside of cover slab and within the pipework up to the lowest gully cover level. Assuming the depth to underside of cover slab is 0.5m the additional volume in the soakaway is as follows:					
Soakaway	Gully Cover Level (m)	Underside Cover Slab Level (m)	1 in 30 Year Event Level (m)	Additional Storage Depth (m)	Additional Volume Provided (m³)		
SA1	49.900	49.665	48.799	0.866	4.956		
SA2	49.940	49.665	48.677	0.988	2.097		
SA3	49.940	49.525	48.566	0.959	2.974		
SA4	50.030	49.610	48.701	0.909	4.718		
SA5	49.860	49.555	48.605	0.950	4.368		