PROJECT: BLUE HOUSE

PROJECT NO. 21032

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DRAINAGE CALCULATIONS

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INTRODUCTION

Blue house is a new build eco-house located near Hereford. It is built using Timber, Glulam and Finn Joist I-beams. The following calculations are for the soakaway design for the surface water from impermeable areas and drainage field for a Klargester Biodigester

Calculations make reference to the following design codes

BRE Digest 365 Soakaway design

BS6297 Code of Practice for design and installation of drainage fields

Frame calculations are performed with Tekla Tedds

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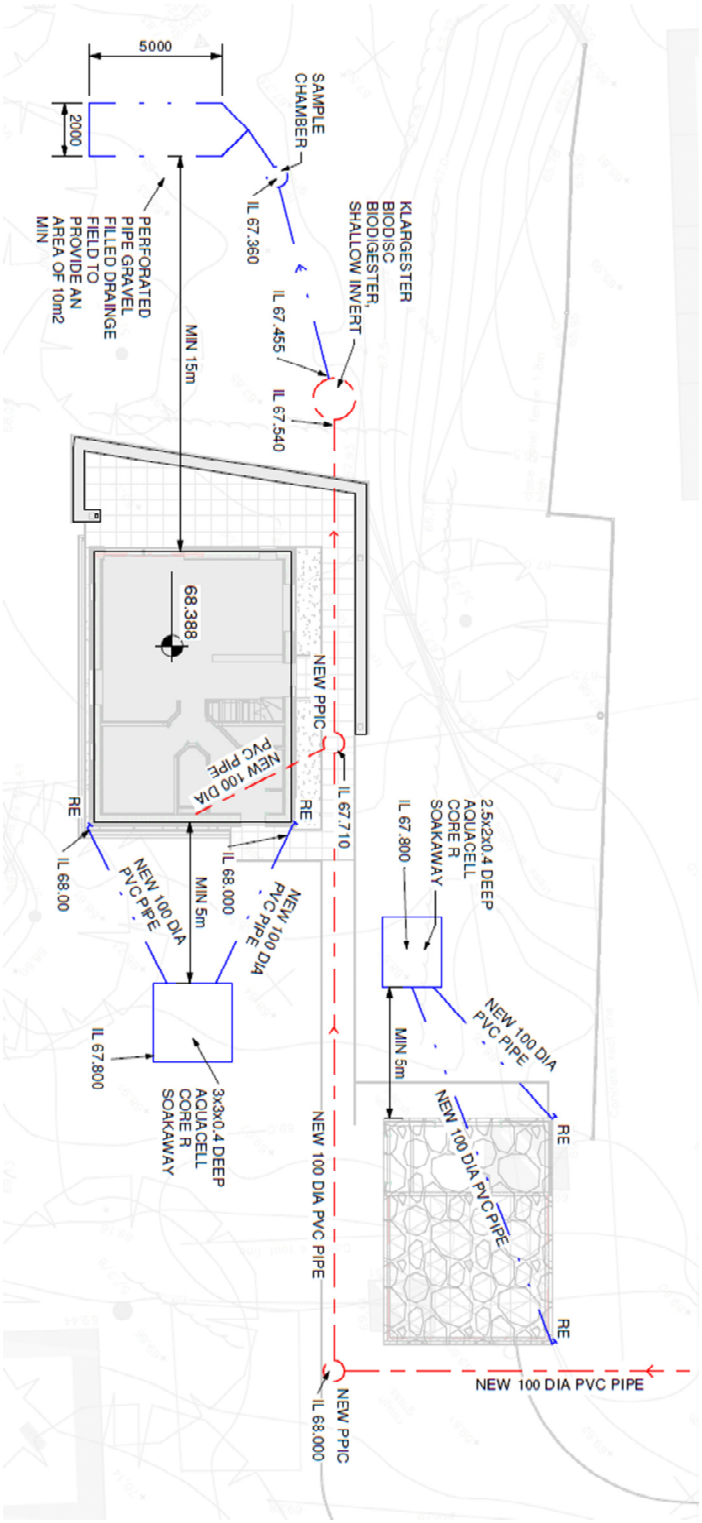
UNDERGROUND DRAINAGE LAYOUT



Site Plan

DRAINAGE DESIGN

Soakaway test results

Soakaway invert 1.1m BGL and depth of soakaway 0.4m. Select drainage time for appropriate depth from test results

$D_{BGL,75\%} = 1.1 - 0.75 \times 0.4 = 0.8\text{m}$

$D_{BGL,25\%} = 1.1 - 0.25 \times 0.4 = 1\text{m}$

1000 long x 300 wide test trench

Test 1		**Test 2**		**Test 3**	
0 mins	25cm	0 mins	13cm	0 mins	14cm
12 mins	56cm	5 mins	37 cm	5 mins	38cm
		10 mins	53cm	10 mins	49cm
		15 mins	61 cm	15 mins	54 cm
		20 mins	68cm	20 mins	59 cm
		25 mins	70 cm	25 mins	63 cm
		30 mins	75 cm	30 mins	66 cm
1.5 hours	84cm	1 hr	91 cm	1 hr	80cm
		1.5 hours	95 cm	1.5 hours	84cm
2.5 hours	91cm	2 hours	99 cm	2 hours	91cm
		2.5 hours	-	2.5 hours	92.5
3.5 hours	98cm	3.0 hours	105 cm	3.0 hours	94.5
		3.5 hours	-	3.5 hours	97cm
		4.0	109 cm		
6.0 hours	106cm	5.0	111cm		

Soakaway Design 1

Soakaway drains roof to house

Soakaway design

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.04

Design rainfall intensity

Location of catchment area; Leeds

Impermeable area drained to the system; A = **92.0** m^2

Return period; Period = **10** yr

Ratio 60 min to 2 day rainfall of 5 yr return period; r = **0.360**

5-year return period rainfall of 60 minutes duration; M5_60min = **19.0** mm

Increase of rainfall intensity due to global warming; $p_{climate}$ = **0** %

Soakaway / infiltration trench details

Soakaway type; Rectangular

Minimum depth of pit (below incoming invert); d = **394** mm

Width of pit; w = **3000** mm

Length of pit; l = **3000** mm

Percentage free volume; V_{free} = **95** %

Soil infiltration rate (BRE digest 365)

Length of trial pit; l_{trial} = **1000** mm

Width of trial pit; b_{trial} = **300** mm

Depth of trial pit (below invert); d_{trial} = **400** mm

Free volume (if fill used); V_{trial} = **100** %;

75% depth of pit; d_{75} = (d_{trial} ´ 0.75) = **300.00** mm

50% depth of pit; d_{50} = (d_{trial} ´ 0.50) = **200.00** mm

25% depth of pit; d_{25} = (d_{trial} ´ 0.25) = **100.00** mm

Test 1 - time to fall from 75% depth to 25% depth; T1 = **120** min

Test 2 - time to fall from 75% depth to 25% depth; T2 = **90** min

Test 3 - time to fall from 75% depth to 25% depth; T3 = **150** min

Longest time to fall from 75% depth to 25% depth; t_{lg} = max(T1, T2, T3) = **150** min

Storage volume from 75% to 25% depth; $V_{p75\_25} = (l_{trial} \times b_{trial} \times (d_{75} - d_{25})) \times V_{trial}$ = **0.06** m^3

Internal surface area to 50% depth; $a_{p50} = ((l_{trial} \times b_{trial}) + (l_{trial} + b_{trial}) \times 2 \times d_{50})$ = **0.82** m^2

Surface area of soakaway to 50% storage depth; $A_{s50} = 2 \times (l_{trial} + b_{trial}) \times d_{trial} / 2$ = **0.520** m^2

Soil infiltration rate; $f = V_{p75\_25} / (a_{p50} \times t_{lg})$ = **8.13 × 10^{-6}** m/s

Wetted area of pit 50% full; $a_{s50} = l \times d + w \times d$ = **2363194** mm^2

Table equations

Inflow (cl.3.3.1); I = M10 × A

Outflow (cl.3.3.2); $O = a_{s50} \times f \times D$

Storage (cl.3.3.3); S = I - O

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	10 year rainfall, M10 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
5;	0.36;	6.8;	1.20;	8.2;	0.76;	0.01;	0.75
10;	0.51;	9.7;	1.22;	11.8;	1.09;	0.01;	1.07
15;	0.62;	11.8;	1.23;	14.5;	1.33;	0.02;	1.31
30;	0.79;	15.0;	1.24;	18.6;	1.71;	0.03;	1.68
60;	1.00;	19.0;	1.24;	23.6;	2.17;	0.07;	2.10
120;	1.22;	23.2;	1.24;	28.7;	2.64;	0.14;	2.51
240;	1.48;	28.1;	1.23;	34.5;	3.18;	0.28;	2.90
360;	1.67;	31.7;	1.21;	38.5;	3.55;	0.42;	3.13
600;	1.90;	36.1;	1.20;	43.4;	3.99;	0.69;	3.30

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	10 year rainfall, M10 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
1440;	2.42;	46.0;	1.18;	54.2;	4.98;	1.66;	3.32

Required storage volume; S_{req} = **3.32** m^3

Soakaway storage volume; S_{act} = l ´ d ´ w ´ V_{free} = **3.37** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume; $t_{s50} = S_{req}$ ´ 0.5 / (a_{s50} ´ f); = 24hr

PASS - Soakaway discharge time less than or equal to 24 hours

Therefore use 3 x 3 x 0.4 deep aquacell soakaway base level 1.1m BGL

Soakaway Design 2

Soakaway design

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.04

Design rainfall intensity

Location of catchment area; Leeds

Impermeable area drained to the system; A = **55.0** m^2

Return period; Period = **10** yr

Ratio 60 min to 2 day rainfall of 5 yr return period; r = **0.360**

5-year return period rainfall of 60 minutes duration; M5_60min = **19.0** mm

Increase of rainfall intensity due to global warming; $p_{climate}$ = **0** %

Soakaway / infiltration trench details

Soakaway type; Rectangular

Minimum depth of pit (below incoming invert); d = **393** mm

Width of pit; w = **2500** mm

Length of pit; l = **2000** mm

Percentage free volume; V_{free} = **95** %

Soil infiltration rate (BRE digest 365)

Length of trial pit; l_{trial} = **1000** mm

Width of trial pit; b_{trial} = **300** mm

Depth of trial pit (below invert); d_{trial} = **400** mm

Free volume (if fill used); V_{trial} = **100** %;

75% depth of pit; d_{75} = (d_{trial} ´ 0.75) = **300.00** mm

50% depth of pit; d_{50} = (d_{trial} ´ 0.50) = **200.00** mm

25% depth of pit; d_{25} = (d_{trial} ´ 0.25) = **100.00** mm

Test 1 - time to fall from 75% depth to 25% depth; T1 = **120** min

Test 2 - time to fall from 75% depth to 25% depth; T2 = **90** min

Test 3 - time to fall from 75% depth to 25% depth; T3 = **150** min

Longest time to fall from 75% depth to 25% depth; t_{lg} = max(T1, T2, T3) = **150** min

Storage volume from 75% to 25% depth; $V_{p75\_25} = (l_{trial} \times b_{trial} \times (d_{75} - d_{25})) \times V_{trial}$ = **0.06** m^3

Internal surface area to 50% depth; $a_{p50} = ((l_{trial} \times b_{trial}) + (l_{trial} + b_{trial}) \times 2 \times d_{50})$ = **0.82** m^2

Surface area of soakaway to 50% storage depth; $A_{s50} = 2 \times (l_{trial} + b_{trial}) \times d_{trial} / 2$ = **0.520** m^2

Soil infiltration rate; $f = V_{p75\_25} / (a_{p50} \times t_{lg})$ = **8.13×10^{-6}** m/s

Wetted area of pit 50% full; $a_{s50} = l \times d + w \times d$ = **1769698** mm^2

Table equations

Inflow (cl.3.3.1); $I = M10 \times A$

Outflow (cl.3.3.2); $O = a_{s50} \times f \times D$

Storage (cl.3.3.3); $S = I - O$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	10 year rainfall, M10 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
5;	0.36;	6.8;	1.20;	8.2;	0.45;	0.00;	0.45
10;	0.51;	9.7;	1.22;	11.8;	0.65;	0.01;	0.64
15;	0.62;	11.8;	1.23;	14.5;	0.80;	0.01;	0.78
30;	0.79;	15.0;	1.24;	18.6;	1.02;	0.03;	1.00
60;	1.00;	19.0;	1.24;	23.6;	1.30;	0.05;	1.24
120;	1.22;	23.2;	1.24;	28.7;	1.58;	0.10;	1.48
240;	1.48;	28.1;	1.23;	34.5;	1.90;	0.21;	1.69
360;	1.67;	31.7;	1.21;	38.5;	2.12;	0.31;	1.81
600;	1.90;	36.1;	1.20;	43.4;	2.39;	0.52;	1.87
1440;	2.42;	46.0;	1.18;	54.2;	2.98;	1.24;	1.74

Required storage volume; S_{req} = **1.87** m^3

Soakaway storage volume; S_{act} = l ´ d ´ w ´ V_{free} = **1.87** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume; t_{s50} = S_{req} ´ 0.5 / (a_{s50} ´ f); = 18hr 3min 6s

PASS - Soakaway discharge time less than or equal to 24 hours

Therefore use 2.5 x 2 x 0.4 deep aquacell soakaway base level 1.1m BGL

Drainage Field Design

Blue House test 300x300x300 deep hole, 07.07.21		Test 1: (S)	Test 2: (S)	Test 3: (S)
	From top to 75% full	468	688	923
	From 75% to 25% full	1586	1802	2046

Average time taken to drain from 75% to 25%

$$T_{av} = \frac{1586 + 1802 + 2046}{3} = 1811(s)$$

$$V_p = \frac{T_{av}}{150} = \frac{1811}{150} = 12.1\ (s/mm)$$

Area of drainge field based on p=4 occupants

$$A = p \times V_p \times 0.2 = 4 \times 12.1 \times 0.2 = 9.7(m^2)$$

Therefore use min 2m wide x 5m long perforated pipe drainage field