

**Scheme : Cae Mor Farm, Llwynmawr, Llangollen**

**Subject : Soakaway Design**

Waterco Consultants have been instructed to undertake soakaway design in support of a proposed Egg Laying Unit at Cae Mor Farm, Llwynmawr, Llangollen. A Location Plan and a Proposed Site Plan are enclosed. This document details the required dimensions for a soakaway (or soakaways) to accommodate surface water runoff from the roof area and access road (including turning circle).

An infiltration test has been carried out by the client. The trial pit was located north of the proposed building. The trial pit was set at a depth of 1.2m with dimensions of 300mm wide x 300mm long x 300mm deep. The pit was filled with water (300mm deep) and the test was repeated three times to represent soil moisture conditions typical to those when a soakaway becomes operative. The test results are shown below:

Table 1 – Percolation Rates

| Test | Time for water to drain (seconds) |
|------|-----------------------------------|
| 1    | 85                                |
| 2    | 155                               |
| 3    | 180                               |

The result of the third infiltration test will be used to calculate the infiltration rate and inform design. This provides a conservative approach to the design. The Percolation Value (Vp) for the third test is 0.6milimetres per second (mm/s).

The Infiltration Rate, calculated in accordance with Building Regulations Part H, is calculated below:

Infiltration Rate =  $10^{-3} / (3 \times Vp)$

Infiltration Rate =  $10^{-3} / 1.8$

Infiltration Rate =  **$5.56 \times 10^{-4}$**  metres / second (m/s)

**File Ref: w1952-170815-Soakaway Design**

01824 702220

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Waterco Ltd. Company No. 3577754

Eden Court, Lôn Parcwr Business Park, Ruthin, Denbighshire, LL15 1NJ

The client has indicated a preference for storm crate style soakaways. A summary of the required soakaway dimensions for a storm crate style soakaway is provided in Table 2 below. The soakaways have been sized to accommodate a 1 in 100 year storm including a 30% addition for climate change. The dimensions have been rounded up to suit standard storm crate dimensions (1m x 0.5m x 0.4m).

Table 2 – Dimensions for storm crate style soakaways – 95% void

| Soakaway    | Area (m <sup>2</sup> ) | Length (m) | Width (m) | Depth (m) | Design Volume (m <sup>3</sup> ) |
|-------------|------------------------|------------|-----------|-----------|---------------------------------|
| Combined    | 2,355                  | 8.5        | 6         | 1.6       | 77.52m <sup>3</sup>             |
| Building    | 1,425                  | 7          | 4         | 1.6       | 42.56m <sup>3</sup>             |
| Access Road | 930                    | 5          | 3.5       | 1.6       | 26.6m <sup>3</sup>              |

In accordance with Part H of the Building Regulations and BRE365, soakaways should be located at least 5m away from building foundations.

We trust this completes your current requirements for this site however if you have any questions please don't hesitate to contact me.

Yours sincerely,

Johanne Williams

[johanne.williams@waterco.co.uk](mailto:johanne.williams@waterco.co.uk)

#### Enclosed documents

- Proposed Development Plan
- Trial Pit Location Plan
- Soakaway Calculation Sheets

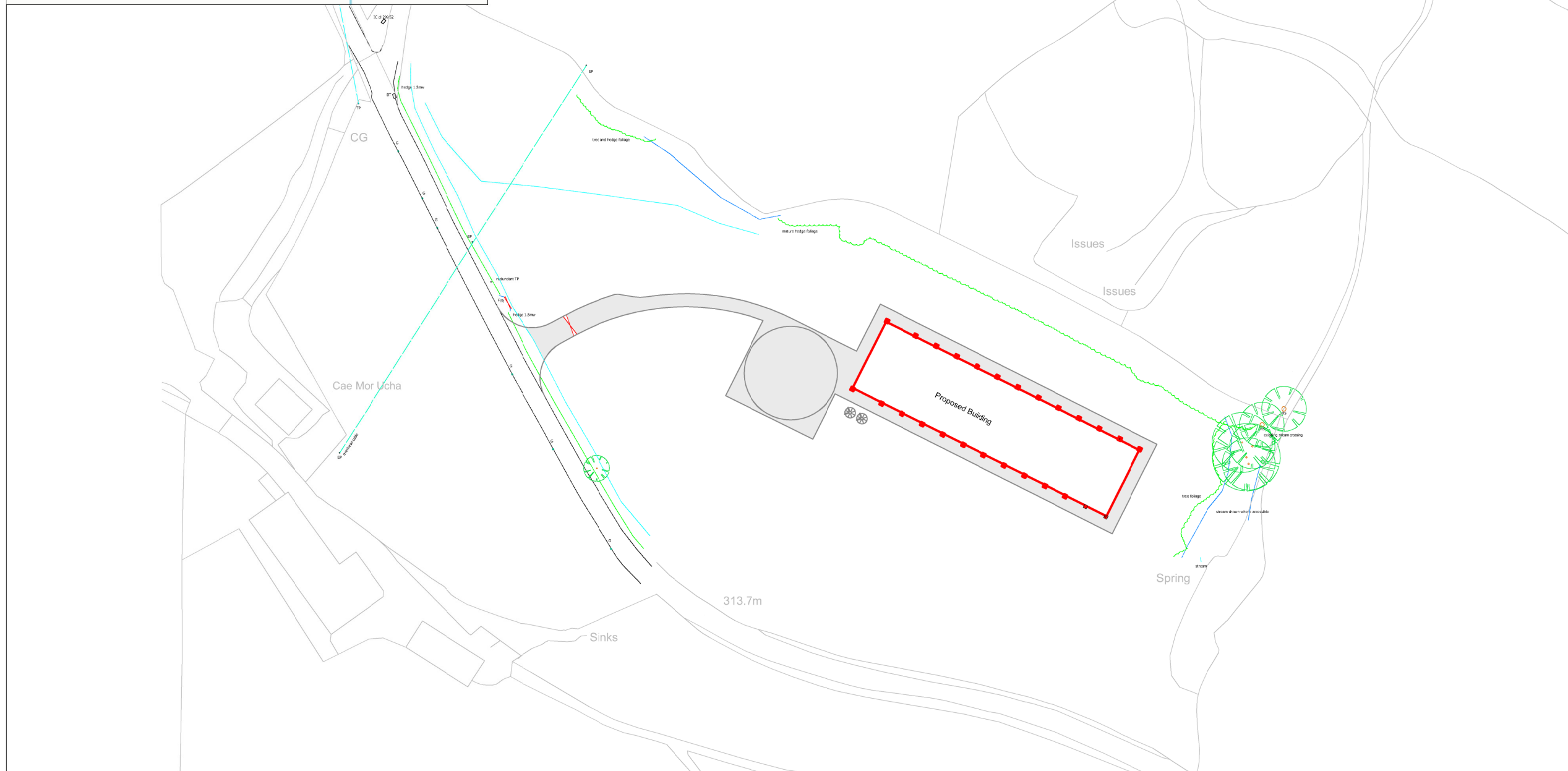
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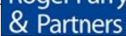
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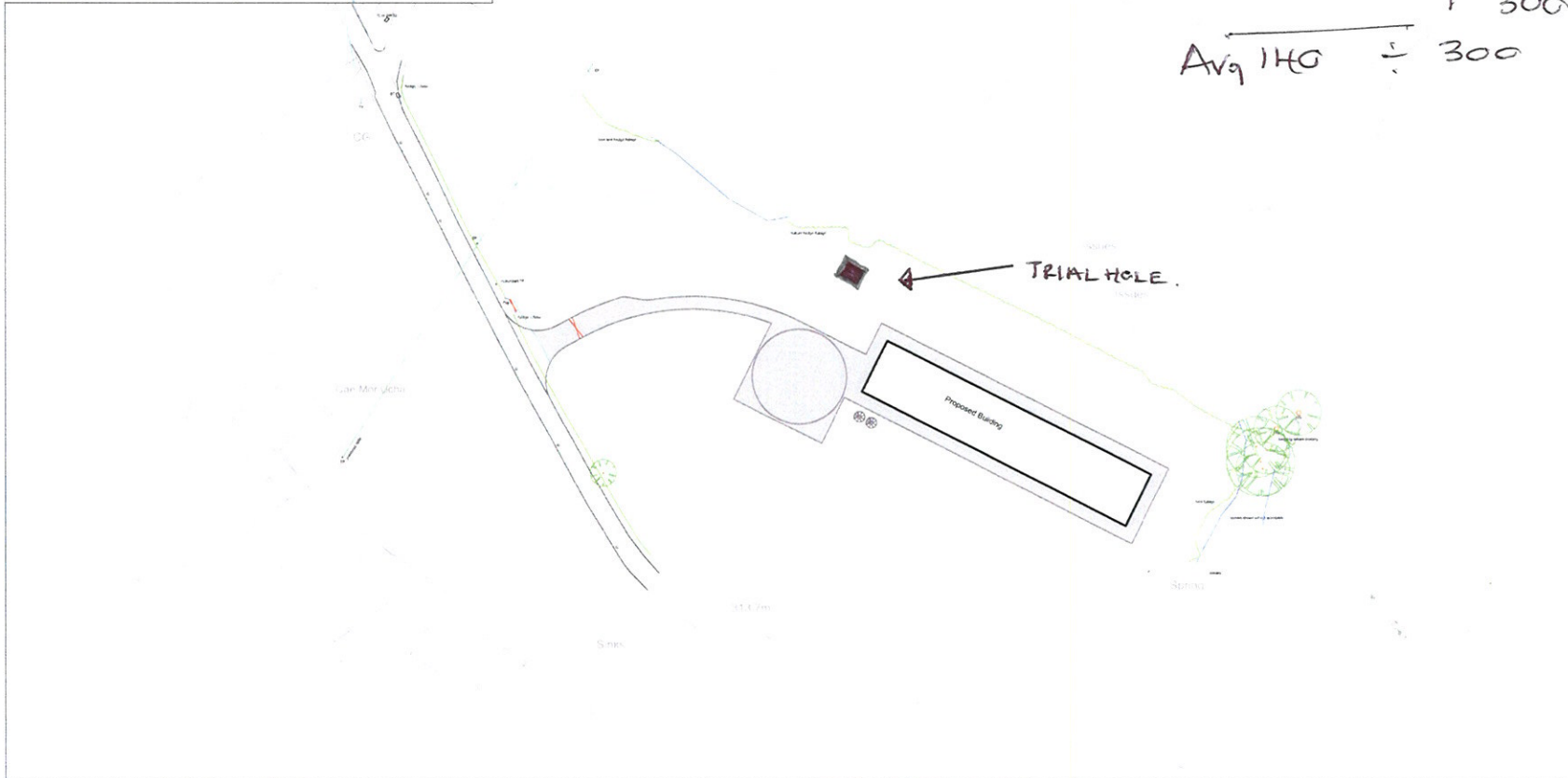
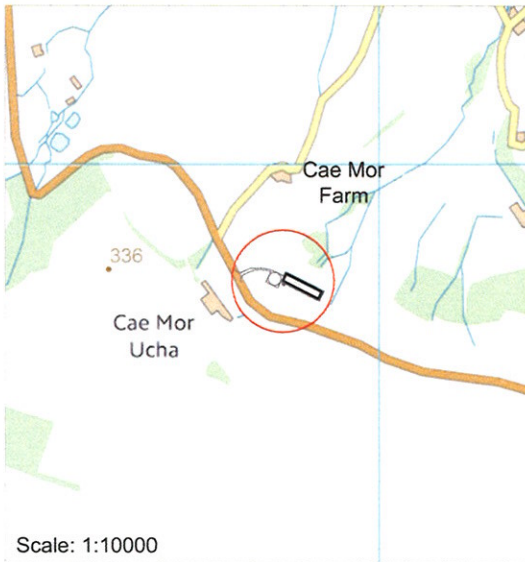
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|-----|-------------|------|-------|--------|
| Rev | Description | Date | Dr by | App by |
|     | Original by |      |       |        |



|                                                                                       |                                                     |
|---------------------------------------------------------------------------------------|-----------------------------------------------------|
|  |                                                     |
| Residential - Agricultural - Commercial                                               |                                                     |
| Job                                                                                   | 16000 Free Range Egg Laying Unit                    |
| Title                                                                                 | Location Plan                                       |
| Location                                                                              | Cae Mor Farm<br>Llwynmawr<br>Llangollen<br>LL20 7BE |
| Client                                                                                | E & J Morris                                        |
| Scales                                                                                | 1:1250 @ A3                                         |
| Drawing No.                                                                           | RJC-MZ-1845-01A                                     |
| Drawn by                                                                              | MZ                                                  |
| Date                                                                                  | 2-07-2015                                           |

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A list of members of the LLP is available at the above address.



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|-------------|---------------------------------------------------|
| Job         | 16000 Frgg La                                     |
| Title       | Location Pl                                       |
| Location    | Cae Mor Fa<br>Llwynmawr<br>Llangollen<br>LL20 7BE |
| Client      | E & J Morris                                      |
| Scales      | 1:1250 @ A                                        |
| Drawing No. | RJC-MZ-18                                         |
| Drawn by    | MZ -2015                                          |

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|                                                                                  |                                                 |              |          |
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|  | Eden Court, Lon Parcwr,<br>Ruthin, 01824 702220 | Calculations | w1952    |
| Client :                                                                         | Roger Parry & Partners LLP                      | Page 1 of 3  |          |
| Scheme :                                                                         | Cae Mor Farm, Llwynmawr                         | Prefix       | Rev.     |
| Section :                                                                        | Soakaway Design - Storm Crate                   | SD           | A        |
| Prepared By:                                                                     | Johanne Williams                                | Date:        | 10-08-17 |
| Checked By:                                                                      | Jordan Jones                                    | Date:        | 10-08-17 |
| Approved By:                                                                     | Aled Williams                                   | Date:        | 14-08-17 |

### **Determination of soakaway storage requirement and proposed dimensions**

#### **Development description and estimate of Impervious areas**

Proposed free range egg laying unit.

Total impervious area (including building, access road and turning circle) = 2,355m<sup>2</sup>

#### **Design Procedure from BRE Digest 365 with alternative return period 100yr**

The design method for sizing a soakaway is based upon the equation of volumes:

$$S = I - O$$

Where: S = Required storage in the soakaway to balance inflow and outflow.  
I = Inflow from Impermeable Areas drained to soakaway.  
O = Outflow Infiltrating into the soil.

#### **I = Total inflow Volume**

I = Inflow to soakaway from on-site impervious areas  
= Impervious Area, A x Total Rainfall (100yr Return Period)

#### **O = Outflow Volume = as50 x f x D x 60**

as50 = Internal Surface Area of soakaway to 50% effective depth (m<sup>2</sup>)  
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)  
D = Storm Duration (mins)

#### **f = Soil Infiltration Rate**

300mm x 300mm x 300mm trial pit

Test 1 - 85 seconds

Test 2 - 155 seconds

**Test 3 - 180 seconds**

Percolation Value (VP) taken from Test 3 - 0.6mm per second

Infiltration Rate (based on Test 3) = 5.56 x 10<sup>-4</sup> m/s

|           |                               |             |      |
|-----------|-------------------------------|-------------|------|
| Client :  | Roger Parry & Partners LLP    | Page 2 of 3 |      |
| Scheme :  | Cae Mor Farm, Llwynmawr       | Prefix      | Rev. |
| Section : | Soakaway Design - Storm Crate | SD          | A    |

### Rainfall Parameters

|                                     |        |                                               |
|-------------------------------------|--------|-----------------------------------------------|
| Storm return frequency - 1 in (yrs) | 100.00 | (Alternative to std 10yr as BRE Digest 365)   |
| M5-60 min rainfall (mm)             | 20.00  | (BRE Digest 365: 20mm to be taken for all UK) |
| Climate change allowance (%)        | 30     |                                               |
| Adjusted M5-60min rain (mm)         | 26     | (calculated)                                  |
| Ratio (M5-60 / M5-2day) - r         | 0.30   | (From Map on Page 3)                          |

### Drainage Area

|                                     |         |
|-------------------------------------|---------|
| Total impervious area <b>A</b> (m2) | 2355.00 |
|-------------------------------------|---------|

### Soakaway Details

|                        |                                     |       |                              |
|------------------------|-------------------------------------|-------|------------------------------|
| (Rectangular soakaway) | Length <b>L</b> (m) =               | 8.50  |                              |
|                        | Width <b>W</b> (m) =                | 6.00  |                              |
|                        | Effective Depth <b>d</b> (m) =      | 1.60  |                              |
|                        | Design Area (m²), <b>as50</b> (m2)= | 23.20 | Area of sidesto 50% depth    |
|                        | Percentage Voids <b>P</b> (%) =     | 95    | Typical 95% for storm crates |
|                        | Design Volume <b>V</b> (m3) =       | 77.52 | (P/100xLxWxd)                |

### Soil Infiltration

|                                    |          |                                |
|------------------------------------|----------|--------------------------------|
| Infiltration Rate <b>f</b> (m/s) = | 5.56E-04 | From infiltration test results |
|------------------------------------|----------|--------------------------------|

### Calculations in table below

Total rainfall **R** = M5-60 \* Z1\* Z2 (calculated page 3)

Inflow Volume, **I** = A x R (100% run-off)

Outflow Volume **O** = as50 \* f \* D \* 60

Storage Volume **S** = I - O

| Storm duration (D)                                 |       | R                | I       | O        | S             |
|----------------------------------------------------|-------|------------------|---------|----------|---------------|
| (Minutes)                                          | (Hrs) | (M100-D)<br>(mm) | m³      | m³       | m³            |
| 15                                                 | 0.25  | 30.57            | 71.988  | 11.609   | 60.379        |
| 30                                                 | 0.50  | 40.64            | 95.705  | 23.219   | 72.486        |
| <b>Crit D</b> 60                                   | 1.00  | 52.05            | 122.582 | 46.437   | 76.145        |
| 120                                                | 2.00  | 63.38            | 149.248 | 92.874   | 56.374        |
| 240                                                | 4.00  | 76.98            | 181.294 | 185.748  | 0.000         |
| 360                                                | 6.00  | 86.02            | 202.568 | 278.623  | 0.000         |
| 600                                                | 10.00 | 99.16            | 233.529 | 464.371  | 0.000         |
| 1440                                               | 24.00 | 121.78           | 286.799 | 1114.491 | 0.000         |
| Design Storage Requirement = Maximum Volume (m³) = |       |                  |         |          | <b>76.145</b> |

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

### Time of Emptying of Soakaway (Taken from BRE Digest 365)

The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

**ts50** = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = \frac{76.145 \times 0.5}{23.20 \times 0.000556 \times 3600} = 0.83 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

### Summary of acceptable dimensions:

|                   |        |
|-------------------|--------|
| Length =          | 8.50 m |
| Width =           | 6.00 m |
| Effective Depth = | 1.60 m |

Client : Roger Parry &amp; Partners LLP

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### Values of Factor Z1 ( From BRE 365 - Table 1 )

| Ratio | Rainfall Duration (mins) |       |       |       |       |       |       |       |
|-------|--------------------------|-------|-------|-------|-------|-------|-------|-------|
| r     | 15                       | 30    | 60    | 120   | 240   | 360   | 600   | 1440  |
| 0.12  | 0.450                    | 0.670 | 1.000 | 1.480 | 2.170 | 2.750 | 3.700 | 6.000 |
| 0.15  | 0.480                    | 0.690 | 1.000 | 1.420 | 2.020 | 2.460 | 3.230 | 4.900 |
| 0.18  | 0.510                    | 0.710 | 1.000 | 1.360 | 1.860 | 2.250 | 2.860 | 4.300 |
| 0.20  | 0.530                    | 0.723 | 1.000 | 1.340 | 1.800 | 2.163 | 2.700 | 3.833 |
| 0.21  | 0.540                    | 0.730 | 1.000 | 1.330 | 1.770 | 2.120 | 2.620 | 3.600 |
| 0.24  | 0.560                    | 0.750 | 1.000 | 1.300 | 1.710 | 2.000 | 2.400 | 3.350 |
| 0.25  | 0.567                    | 0.753 | 1.000 | 1.290 | 1.687 | 1.960 | 2.347 | 3.267 |
| 0.27  | 0.580                    | 0.760 | 1.000 | 1.270 | 1.640 | 1.880 | 2.240 | 3.100 |
| 0.30  | 0.590                    | 0.770 | 1.000 | 1.250 | 1.570 | 1.780 | 2.120 | 2.840 |
| 0.33  | 0.610                    | 0.780 | 1.000 | 1.230 | 1.530 | 1.730 | 2.040 | 2.600 |
| 0.35  | 0.617                    | 0.787 | 1.000 | 1.223 | 1.497 | 1.690 | 1.947 | 2.480 |
| 0.36  | 0.620                    | 0.790 | 1.000 | 1.220 | 1.480 | 1.670 | 1.900 | 2.420 |
| 0.39  | 0.630                    | 0.800 | 1.000 | 1.210 | 1.460 | 1.620 | 1.820 | 2.280 |
| 0.40  | 0.633                    | 0.803 | 1.000 | 1.207 | 1.447 | 1.603 | 1.793 | 2.240 |
| 0.42  | 0.640                    | 0.810 | 1.000 | 1.200 | 1.420 | 1.570 | 1.740 | 2.160 |
| 0.45  | 0.650                    | 0.820 | 1.000 | 1.190 | 1.380 | 1.510 | 1.680 | 2.030 |

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### Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values \*\*

M5-60 rain (mm) 26.00 (Taken from Page 1)

Ratio M5-60/M5-2day 0.30 (Taken from Page 1)

| Duration (mins) | Duration (hrs) | Factor Z1 | R (M5-D) (mm) | Z2 Values - M100 |           |         | Prorata Z2 | R (M100-D) (mm) |
|-----------------|----------------|-----------|---------------|------------------|-----------|---------|------------|-----------------|
|                 |                |           |               | Z2 low           | Diff (mm) | Z2 high |            |                 |
| 2               | 15.0           | 0.25      | 15.340        | 1.99             | 5.00      | 2.03    | 1.993      | 30.568          |
| 3               | 30.0           | 0.50      | 20.020        | 2.03             | 5.00      | 2.01    | 2.030      | 40.639          |
| 4               | 60.0           | 1.00      | 26.000        | 2.01             | 5.00      | 1.97    | 2.002      | 52.052          |
| 5               | 120.0          | 2.00      | 32.500        | 1.97             | 10.00     | 1.89    | 1.950      | 63.375          |
| 6               | 240.0          | 4.00      | 40.820        | 1.89             | 10.00     | 1.84    | 1.886      | 76.982          |
| 7               | 360.0          | 6.00      | 46.280        | 1.89             | 10.00     | 1.84    | 1.859      | 86.016          |
| 8               | 600.0          | 10.00     | 55.120        | 1.84             | 25.00     | 1.64    | 1.799      | 99.163          |
| 9               | 1440.0         | 24.00     | 73.840        | 1.84             | 25.00     | 1.64    | 1.649      | 121.783         |

### Z2 Factors - England & Wales ( from Wallingford Procedure )

| M5 Rain (mm) | Diff (mm) | M100  |
|--------------|-----------|-------|
| 0            | 5         | 1.790 |
| 5            | 5         | 1.790 |
| 10           | 5         | 1.910 |
| 15           | 5         | 1.990 |
| 20           | 5         | 2.030 |
| 25           | 5         | 2.010 |
| 30           | 10        | 1.970 |
| 40           | 10        | 1.890 |
| 50           | 25        | 1.840 |
| 75           | 25        | 1.640 |
| 100          | 50        | 1.540 |
| 150          | 50        | 1.450 |
| 200          | 50        | 1.400 |

Site Location

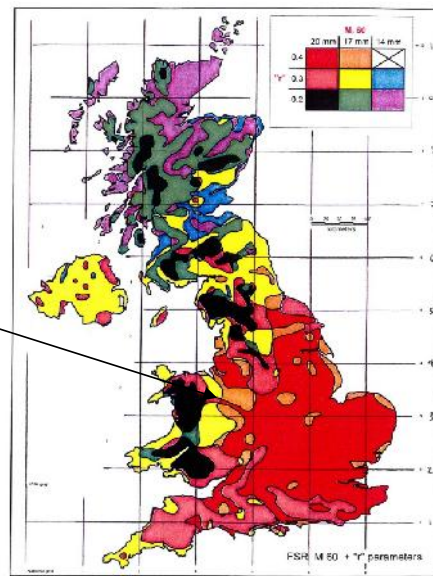


Figure 2 Hydrological rainfall zones of UK

|                                                                                  |                                                 |              |          |
|----------------------------------------------------------------------------------|-------------------------------------------------|--------------|----------|
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| Client :                                                                         | Roger Parry & Partners LLP                      | Page 1 of 3  |          |
| Scheme :                                                                         | Cae Mor Farm, Llwynmawr                         | Prefix       | Rev.     |
| Section :                                                                        | Soakaway Design - Storm Crate - Access          | SD           | A        |
| Prepared By:                                                                     | Johanne Williams                                | Date:        | 10-08-17 |
| Checked By:                                                                      | Jordan Jones                                    | Date:        | 10-08-17 |
| Approved By:                                                                     | Aled Williams                                   | Date:        | 10-08-17 |

### **Determination of soakaway storage requirement and proposed dimensions**

#### **Development description and estimate of Impervious areas**

Proposed free range egg laying unit.

Total impervious area (access road and turning circle) = 930m<sup>2</sup>

#### **Design Procedure from BRE Digest 365 with alternative return period 100yr**

The design method for sizing a soakaway is based upon the equation of volumes:

$$S = I - O$$

Where: S = Required storage in the soakaway to balance inflow and outflow.  
I = Inflow from Impermeable Areas drained to soakaway.  
O = Outflow Infiltrating into the soil.

#### **I = Total inflow Volume**

I = Inflow to soakaway from on-site impervious areas  
= Impervious Area, A x Total Rainfall (100yr Return Period)

#### **O = Outflow Volume = as50 x f x D x 60**

as50 = Internal Surface Area of soakaway to 50% effective depth (m<sup>2</sup>)  
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)  
D = Storm Duration (mins)

#### **f = Soil Infiltration Rate**

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds

Test 2 - 155 seconds

**Test 3 - 180 seconds**

Percolation Value (VP) taken from Test 3 - 0.6mm per second

Infiltration Rate (based on Test 3) = 5.56 x 10<sup>-4</sup> m/s

|           |                                        |             |      |
|-----------|----------------------------------------|-------------|------|
| Client :  | Roger Parry & Partners LLP             | Page 2 of 3 |      |
| Scheme :  | Cae Mor Farm, Llwynmawr                | Prefix      | Rev. |
| Section : | Soakaway Design - Storm Crate - Access | SD          | A    |

### Rainfall Parameters

|                                     |        |                                               |
|-------------------------------------|--------|-----------------------------------------------|
| Storm return frequency - 1 in (yrs) | 100.00 | (Alternative to std 10yr as BRE Digest 365)   |
| M5-60 min rainfall (mm)             | 20.00  | (BRE Digest 365: 20mm to be taken for all UK) |
| Climate change allowance (%)        | 30     |                                               |
| Adjusted M5-60min rain (mm)         | 26     | (calculated)                                  |
| Ratio (M5-60 / M5-2day) - r         | 0.30   | (From Map on Page 3)                          |

### Drainage Area

|                                     |        |
|-------------------------------------|--------|
| Total impervious area <b>A</b> (m2) | 930.00 |
|-------------------------------------|--------|

### Soakaway Details

|                        |                                     |       |                              |
|------------------------|-------------------------------------|-------|------------------------------|
| (Rectangular soakaway) | Length <b>L</b> (m) =               | 5.00  |                              |
|                        | Width <b>W</b> (m) =                | 3.50  |                              |
|                        | Effective Depth <b>d</b> (m) =      | 1.60  |                              |
|                        | Design Area (m²), <b>as50</b> (m2)= | 13.60 | Area of sidesto 50% depth    |
|                        | Percentage Voids <b>P</b> (%) =     | 95    | Typical 95% for storm crates |
|                        | Design Volume <b>V</b> (m3) =       | 26.60 | (P/100xLxWxd)                |

### Soil Infiltration

|                                    |          |                                |
|------------------------------------|----------|--------------------------------|
| Infiltration Rate <b>f</b> (m/s) = | 5.56E-04 | From infiltration test results |
|------------------------------------|----------|--------------------------------|

### Calculations in table below

Total rainfall **R** = M5-60 \* Z1\* Z2 (calculated page 3)

Inflow Volume, **I** = A x R (100% run-off)

Outflow Volume **O** = as50 \* f \* D \* 60

Storage Volume **S** = I - O

| Storm duration (D)                                 |           |       | R                | I       | O       | S      |
|----------------------------------------------------|-----------|-------|------------------|---------|---------|--------|
|                                                    | (Minutes) | (Hrs) | (M100-D)<br>(mm) | m³      | m³      | m³     |
| Crit D                                             | 15        | 0.25  | 30.57            | 28.429  | 6.805   | 21.623 |
|                                                    | 30        | 0.50  | 40.64            | 37.794  | 13.611  | 24.183 |
| Crit D                                             | 60        | 1.00  | 52.05            | 48.408  | 27.222  | 21.187 |
|                                                    | 120       | 2.00  | 63.38            | 58.939  | 54.444  | 4.495  |
|                                                    | 240       | 4.00  | 76.98            | 71.594  | 108.887 | 0.000  |
|                                                    | 360       | 6.00  | 86.02            | 79.995  | 163.331 | 0.000  |
|                                                    | 600       | 10.00 | 99.16            | 92.222  | 272.218 | 0.000  |
|                                                    | 1440      | 24.00 | 121.78           | 113.258 | 653.322 | 0.000  |
| Design Storage Requirement = Maximum Volume (m³) = |           |       |                  |         |         | 24.183 |

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

### Time of Emptying of Soakaway (Taken from BRE Digest 365)

The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

**ts50** = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.49 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

### Summary of acceptable dimensions:

|                   |        |
|-------------------|--------|
| Length =          | 5.00 m |
| Width =           | 3.50 m |
| Effective Depth = | 1.60 m |

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### Values of Factor Z1 ( From BRE 365 - Table 1 )

| Ratio | Rainfall Duration (mins) |       |       |       |       |       |       |       |
|-------|--------------------------|-------|-------|-------|-------|-------|-------|-------|
| r     | 15                       | 30    | 60    | 120   | 240   | 360   | 600   | 1440  |
| 0.12  | 0.450                    | 0.670 | 1.000 | 1.480 | 2.170 | 2.750 | 3.700 | 6.000 |
| 0.15  | 0.480                    | 0.690 | 1.000 | 1.420 | 2.020 | 2.460 | 3.230 | 4.900 |
| 0.18  | 0.510                    | 0.710 | 1.000 | 1.360 | 1.860 | 2.250 | 2.860 | 4.300 |
| 0.20  | 0.530                    | 0.723 | 1.000 | 1.340 | 1.800 | 2.163 | 2.700 | 3.833 |
| 0.21  | 0.540                    | 0.730 | 1.000 | 1.330 | 1.770 | 2.120 | 2.620 | 3.600 |
| 0.24  | 0.560                    | 0.750 | 1.000 | 1.300 | 1.710 | 2.000 | 2.400 | 3.350 |
| 0.25  | 0.567                    | 0.753 | 1.000 | 1.290 | 1.687 | 1.960 | 2.347 | 3.267 |
| 0.27  | 0.580                    | 0.760 | 1.000 | 1.270 | 1.640 | 1.880 | 2.240 | 3.100 |
| 0.30  | 0.590                    | 0.770 | 1.000 | 1.250 | 1.570 | 1.780 | 2.120 | 2.840 |
| 0.33  | 0.610                    | 0.780 | 1.000 | 1.230 | 1.530 | 1.730 | 2.040 | 2.600 |
| 0.35  | 0.617                    | 0.787 | 1.000 | 1.223 | 1.497 | 1.690 | 1.947 | 2.480 |
| 0.36  | 0.620                    | 0.790 | 1.000 | 1.220 | 1.480 | 1.670 | 1.900 | 2.420 |
| 0.39  | 0.630                    | 0.800 | 1.000 | 1.210 | 1.460 | 1.620 | 1.820 | 2.280 |
| 0.40  | 0.633                    | 0.803 | 1.000 | 1.207 | 1.447 | 1.603 | 1.793 | 2.240 |
| 0.42  | 0.640                    | 0.810 | 1.000 | 1.200 | 1.420 | 1.570 | 1.740 | 2.160 |
| 0.45  | 0.650                    | 0.820 | 1.000 | 1.190 | 1.380 | 1.510 | 1.680 | 2.030 |

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### Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values \*\*

M5-60 rain (mm) 26.00 (Taken from Page 1)

Ratio M5-60/M5-2day 0.30 (Taken from Page 1)

| Duration (mins) | Duration (hrs) | Factor Z1 | R (M5-D) (mm) | Z2 Values - M100 |           |         | Prorata Z2 | R (M100-D) (mm) |
|-----------------|----------------|-----------|---------------|------------------|-----------|---------|------------|-----------------|
|                 |                |           |               | Z2 low           | Diff (mm) | Z2 high |            |                 |
| 2               | 15.0           | 0.25      | 15.340        | 1.99             | 5.00      | 2.03    | 1.993      | 30.568          |
| 3               | 30.0           | 0.50      | 20.020        | 2.03             | 5.00      | 2.01    | 2.030      | 40.639          |
| 4               | 60.0           | 1.00      | 26.000        | 2.01             | 5.00      | 1.97    | 2.002      | 52.052          |
| 5               | 120.0          | 2.00      | 32.500        | 1.97             | 10.00     | 1.89    | 1.950      | 63.375          |
| 6               | 240.0          | 4.00      | 40.820        | 1.89             | 10.00     | 1.84    | 1.886      | 76.982          |
| 7               | 360.0          | 6.00      | 46.280        | 1.89             | 10.00     | 1.84    | 1.859      | 86.016          |
| 8               | 600.0          | 10.00     | 55.120        | 1.84             | 25.00     | 1.64    | 1.799      | 99.163          |
| 9               | 1440.0         | 24.00     | 73.840        | 1.84             | 25.00     | 1.64    | 1.649      | 121.783         |

### Z2 Factors - England & Wales ( from Wallingford Procedure )

| M5 Rain (mm) | Diff (mm) | M100  |
|--------------|-----------|-------|
| 0            | 5         | 1.790 |
| 5            | 5         | 1.790 |
| 10           | 5         | 1.910 |
| 15           | 5         | 1.990 |
| 20           | 5         | 2.030 |
| 25           | 5         | 2.010 |
| 30           | 10        | 1.970 |
| 40           | 10        | 1.890 |
| 50           | 25        | 1.840 |
| 75           | 25        | 1.640 |
| 100          | 50        | 1.540 |
| 150          | 50        | 1.450 |
| 200          | 50        | 1.400 |

Site Location

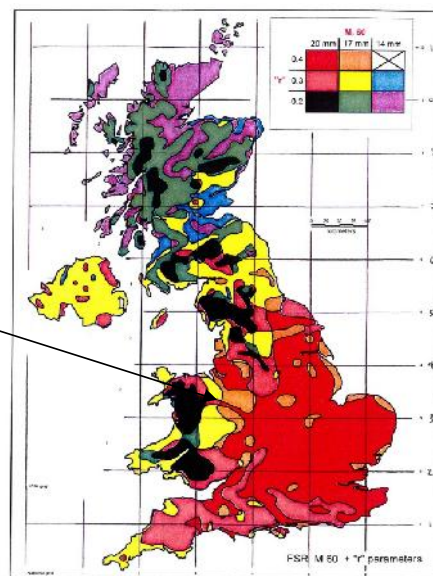


Figure 2 Hydrological rainfall zones of UK

|                                                                                  |                                                 |              |          |
|----------------------------------------------------------------------------------|-------------------------------------------------|--------------|----------|
|  | Eden Court, Lon Parcwr,<br>Ruthin, 01824 702220 | Calculations | w1952    |
| Client :                                                                         | Roger Parry & Partners LLP                      | Page 1 of 3  |          |
| Scheme :                                                                         | Cae Mor Farm, Llwynmawr                         | Prefix       | Rev.     |
| Section :                                                                        | Soakaway Design - Storm Crate - Building        | SD           | A        |
| Prepared By:                                                                     | Johanne Williams                                | Date:        | 10-08-17 |
| Checked By:                                                                      | Jordan Jones                                    | Date:        | 10-08-17 |
| Approved By:                                                                     | Aled Williams                                   | Date:        | 10-08-17 |

### **Determination of soakaway storage requirement and proposed dimensions**

#### **Development description and estimate of Impervious areas**

Proposed free range egg laying unit.

Total impervious area (building only) = 1,425m<sup>2</sup>

#### **Design Procedure from BRE Digest 365 with alternative return period 100yr**

The design method for sizing a soakaway is based upon the equation of volumes:

$$S = I - O$$

Where: S = Required storage in the soakaway to balance inflow and outflow.  
I = Inflow from Impermeable Areas drained to soakaway.  
O = Outflow Infiltrating into the soil.

#### **I = Total inflow Volume**

I = Inflow to soakaway from on-site impervious areas  
= Impervious Area, A x Total Rainfall (100yr Return Period)

#### **O = Outflow Volume = as50 x f x D x 60**

as50 = Internal Surface Area of soakaway to 50% effective depth (m<sup>2</sup>)  
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)  
D = Storm Duration (mins)

#### **f = Soil Infiltration Rate**

300mm x 300mm x 300mm trial pit

Test 1 - 85 seconds

Test 2 - 155 seconds

**Test 3 - 180 seconds**

Percolation Value (VP) taken from Test 3 - 0.6mm per second

Infiltration Rate (based on Test 3) = 5.56 x 10<sup>-4</sup> m/s

|           |                                          |             |      |
|-----------|------------------------------------------|-------------|------|
| Client :  | Roger Parry & Partners LLP               | Page 2 of 3 |      |
| Scheme :  | Cae Mor Farm, Llwynmawr                  | Prefix      | Rev. |
| Section : | Soakaway Design - Storm Crate - Building | SD          | A    |

### Rainfall Parameters

|                                     |        |                                               |
|-------------------------------------|--------|-----------------------------------------------|
| Storm return frequency - 1 in (yrs) | 100.00 | (Alternative to std 10yr as BRE Digest 365)   |
| M5-60 min rainfall (mm)             | 20.00  | (BRE Digest 365: 20mm to be taken for all UK) |
| Climate change allowance (%)        | 30     |                                               |
| Adjusted M5-60min rain (mm)         | 26     | (calculated)                                  |
| Ratio (M5-60 / M5-2day) - r         | 0.30   | (From Map on Page 3)                          |

### Drainage Area

|                                     |         |
|-------------------------------------|---------|
| Total impervious area <b>A</b> (m2) | 1425.00 |
|-------------------------------------|---------|

### Soakaway Details

|                        |                                     |       |                              |
|------------------------|-------------------------------------|-------|------------------------------|
| (Rectangular soakaway) | Length <b>L</b> (m) =               | 7.00  |                              |
|                        | Width <b>W</b> (m) =                | 4.00  |                              |
|                        | Effective Depth <b>d</b> (m) =      | 1.60  |                              |
|                        | Design Area (m²), <b>as50</b> (m2)= | 17.60 | Area of sidesto 50% depth    |
|                        | Percentage Voids <b>P</b> (%) =     | 95    | Typical 95% for storm crates |
|                        | Design Volume <b>V</b> (m3) =       | 42.56 | (P/100xLxWxd)                |

### Soil Infiltration

|                                    |          |                                |
|------------------------------------|----------|--------------------------------|
| Infiltration Rate <b>f</b> (m/s) = | 5.56E-04 | From infiltration test results |
|------------------------------------|----------|--------------------------------|

### Calculations in table below

Total rainfall **R** = M5-60 \* Z1\* Z2 (calculated page 3)

Inflow Volume, **I** = A x R (100% run-off)

Outflow Volume **O** = as50 \* f \* D \* 60

Storage Volume **S** = I - O

| Storm duration (D) |       | R                | I       | O       | S      |
|--------------------|-------|------------------|---------|---------|--------|
| (Minutes)          | (Hrs) | (M100-D)<br>(mm) | m³      | m³      | m³     |
| Crit D 15          | 0.25  | 30.57            | 43.560  | 8.807   | 34.753 |
| Crit D 30          | 0.50  | 40.64            | 57.911  | 17.614  | 40.296 |
| 60                 | 1.00  | 52.05            | 74.174  | 35.228  | 38.946 |
| 120                | 2.00  | 63.38            | 90.309  | 70.456  | 19.853 |
| 240                | 4.00  | 76.98            | 109.700 | 140.913 | 0.000  |
| 360                | 6.00  | 86.02            | 122.573 | 211.369 | 0.000  |
| 600                | 10.00 | 99.16            | 141.307 | 352.282 | 0.000  |
| 1440               | 24.00 | 121.78           | 173.541 | 845.476 | 0.000  |

Design Storage Requirement = Maximum Volume (m³) = 40.296

Proposed Soakaway Dimension Check = OK, but check Time of Emptying

### Time of Emptying of Soakaway (Taken from BRE Digest 365)

The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

**ts50** = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.60 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

### Summary of acceptable dimensions:

|                   |        |
|-------------------|--------|
| Length =          | 7.00 m |
| Width =           | 4.00 m |
| Effective Depth = | 1.60 m |

Client : Roger Parry &amp; Partners LLP

Page 3 of 3

Scheme : Cae Mor Farm, Llwynmawr

Prefix

Rev.

Section : Soakaway Design - Storm Crate - Building

SD

A

### Values of Factor Z1 ( From BRE 365 - Table 1 )

| Ratio | Rainfall Duration (mins) |       |       |       |       |       |       |       |
|-------|--------------------------|-------|-------|-------|-------|-------|-------|-------|
| r     | 15                       | 30    | 60    | 120   | 240   | 360   | 600   | 1440  |
| 0.12  | 0.450                    | 0.670 | 1.000 | 1.480 | 2.170 | 2.750 | 3.700 | 6.000 |
| 0.15  | 0.480                    | 0.690 | 1.000 | 1.420 | 2.020 | 2.460 | 3.230 | 4.900 |
| 0.18  | 0.510                    | 0.710 | 1.000 | 1.360 | 1.860 | 2.250 | 2.860 | 4.300 |
| 0.20  | 0.530                    | 0.723 | 1.000 | 1.340 | 1.800 | 2.163 | 2.700 | 3.833 |
| 0.21  | 0.540                    | 0.730 | 1.000 | 1.330 | 1.770 | 2.120 | 2.620 | 3.600 |
| 0.24  | 0.560                    | 0.750 | 1.000 | 1.300 | 1.710 | 2.000 | 2.400 | 3.350 |
| 0.25  | 0.567                    | 0.753 | 1.000 | 1.290 | 1.687 | 1.960 | 2.347 | 3.267 |
| 0.27  | 0.580                    | 0.760 | 1.000 | 1.270 | 1.640 | 1.880 | 2.240 | 3.100 |
| 0.30  | 0.590                    | 0.770 | 1.000 | 1.250 | 1.570 | 1.780 | 2.120 | 2.840 |
| 0.33  | 0.610                    | 0.780 | 1.000 | 1.230 | 1.530 | 1.730 | 2.040 | 2.600 |
| 0.35  | 0.617                    | 0.787 | 1.000 | 1.223 | 1.497 | 1.690 | 1.947 | 2.480 |
| 0.36  | 0.620                    | 0.790 | 1.000 | 1.220 | 1.480 | 1.670 | 1.900 | 2.420 |
| 0.39  | 0.630                    | 0.800 | 1.000 | 1.210 | 1.460 | 1.620 | 1.820 | 2.280 |
| 0.40  | 0.633                    | 0.803 | 1.000 | 1.207 | 1.447 | 1.603 | 1.793 | 2.240 |
| 0.42  | 0.640                    | 0.810 | 1.000 | 1.200 | 1.420 | 1.570 | 1.740 | 2.160 |
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### Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values \*\*

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|-----------------|----------------|-----------|---------------|------------------|-----------|---------|------------|-----------------|
|                 |                |           |               | Z2 low           | Diff (mm) | Z2 high |            |                 |
| 2               | 15.0           | 0.25      | 15.340        | 1.99             | 5.00      | 2.03    | 1.993      | 30.568          |
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| 5               | 120.0          | 2.00      | 32.500        | 1.97             | 10.00     | 1.89    | 1.950      | 63.375          |
| 6               | 240.0          | 4.00      | 40.820        | 1.89             | 10.00     | 1.84    | 1.886      | 76.982          |
| 7               | 360.0          | 6.00      | 46.280        | 1.89             | 10.00     | 1.84    | 1.859      | 86.016          |
| 8               | 600.0          | 10.00     | 55.120        | 1.84             | 25.00     | 1.64    | 1.799      | 99.163          |
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### Z2 Factors - England & Wales ( from Wallingford Procedure )

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| 5            | 5         | 1.790 |
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| 20           | 5         | 2.030 |
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| 30           | 10        | 1.970 |
| 40           | 10        | 1.890 |
| 50           | 25        | 1.840 |
| 75           | 25        | 1.640 |
| 100          | 50        | 1.540 |
| 150          | 50        | 1.450 |
| 200          | 50        | 1.400 |

Site Location

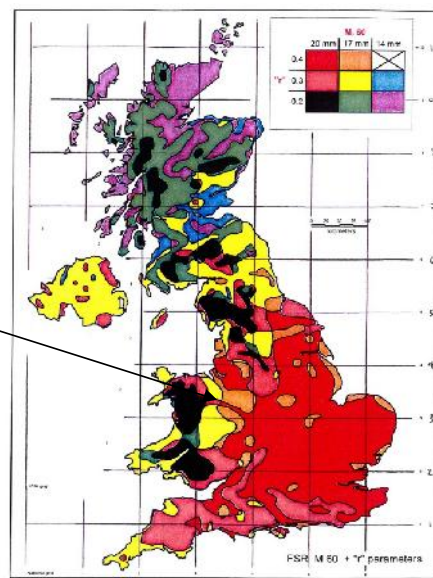


Figure 2 Hydrological rainfall zones of UK