

# CALCULATION SHEET



|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                                                                          |                          |
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| Client<br><b>GOWER HOMES LTD</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>    |
| By<br><b>RW</b>                  | Date<br><b>08.16</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN:</b>           | Sheet No<br><b>HSA/1</b> |
| DATA                             | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                                                                          | RESULTS                  |
| 1.                               | <b><u>PURPOSE</u></b><br><br>The purpose of these calculations is to determine the size of the geocellular soakaways required to disperse the run-off from the shared private access roads, parking areas and roofs which are to be constructed as part of the above development. Separate Soakaways are to be constructed to disperse run-off from the adoptable access road.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                                                                                          |                          |
| 2.                               | <b><u>SITE LAYOUT</u></b><br><br>The layout of the development site and associated drainage layout is shown on drawing N° 5009/ 100 Drainage General Arrangement (as revised)<br><br>This drawing shows the proposed location of the concrete ringed soakaways within the highway including the impermeable area draining to these facilities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                                                                                          |                          |
| 3.                               | <b><u>POROSITY TESTS</u></b><br><br>Porosity tests were carried out by Groundsolve Ltd in March 2016. The results of their investigations and percolation tests are included in their report dated 16 <sup>th</sup> March 2016 Ref: 1754/BPW/LetRepSA/erw.<br><br>The applicable results of these tests are summarised in Section 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |                                                                                          |                          |
| 4.                               | <b><u>METHODOLOGY</u></b><br><br>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<br><br>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 <b>not</b> occur.<br><br>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).<br><br>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. |                   |                                                                                          |                          |

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.

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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

|        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
|--------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|--------|----------|-------|-------------------------------------|-------------------|-----|----------------------------------|-----|-------|--------------------|-------------------|-----|------------------------------------------|-------|--------|------------------------------------------------------------------------------------------------|----------|-----|------------------------------------------------------|--|--|
| Client | (1 in 100 year return period).                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Job Title                                                                                                                                                                                                                                                                                            | PROPOSED RESIDENTIAL DEVELOPMENT, PACKSADDLE BANK, PENTRE BYCHAN | Job No | 5009     |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| By     | RW                                                                                             | Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 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 affecting residential or commercial property. |                                                                  |        | Sheet No | HSA/2 |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| DATA   |                                                                                                | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                      |                                                                  |        | RESULTS  |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| 4.     |                                                                                                | <p><b>METHODOLOGY</b> (continued)</p> <p>These calculations therefore adopt the following methodology:</p> <ol style="list-style-type: none"><li>1. Rainfall intensities for different storm conditions are to be determined using the Wallingford Procedure</li><li>2. The infiltration device is to be sized to store the run-off from a 10% annual probability storm <b>below</b> the level of the incoming pipe(s)</li><li>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)</li><li>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</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| 5.     |                                                                                                | <p><b>METHOD OF ANALYSIS</b></p> <p>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.</p> <p>For a vertically sided structure (ie a soakaway or infiltration trench) the maximum depth of water (<math>h_{max}</math>) can be calculated by solving the following equation</p> $h_{max} = a(e^{(-bD)} - 1)$ <p>where <math>a = (A_b / P) - (A_{di} / Pq)</math> and <math>b = (Pq) / (nA_b)</math></p> <p>The time to half empty (<math>t_{1/2}</math>) can be determined from the following equation:</p> $t_{1/2} = \frac{nA_b}{qP} \text{Log}_e \left\{ \frac{h_{max} + A_b / P}{h_{max} + A_b / P} \right\}$ <p>The required inputs are:</p> <table><tr><td><math>A_b</math></td><td>area of base of infiltration device</td><td>(m<sup>2</sup>)</td></tr><tr><td><math>P</math></td><td>perimeter of infiltration device</td><td>(m)</td></tr><tr><td><math>A_D</math></td><td>area to be drained</td><td>(m<sup>2</sup>)</td></tr><tr><td><math>f</math></td><td>infiltration rate from percolation tests</td><td>(m/h)</td></tr><tr><td><math>i, D</math></td><td>intensity and duration of rainfall events with the required return period at the site location</td><td>(m/h, h)</td></tr><tr><td><math>n</math></td><td>porosity of fill material (void volume/total volume)</td><td></td></tr></table> <p>The results of these calculations are set out below</p> |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          | $A_b$ | area of base of infiltration device | (m <sup>2</sup> ) | $P$ | perimeter of infiltration device | (m) | $A_D$ | area to be drained | (m <sup>2</sup> ) | $f$ | 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) |  |  |
| $A_b$  | area of base of infiltration device                                                            | (m <sup>2</sup> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| $P$    | perimeter of infiltration device                                                               | (m)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| $A_D$  | area to be drained                                                                             | (m <sup>2</sup> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |
| $f$    | 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)                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                      |                                                                  |        |          |       |                                     |                   |     |                                  |     |       |                    |                   |     |                                          |       |        |                                                                                                |          |     |                                                      |  |  |

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| Client<br><b>GOWER HOMES LTD</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>    |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------------------------------|--|-----|-----------|------------|-----------|--|--|--|
| By<br><b>RW</b>                     | Date<br><b>08.16</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>GEOCELLULAR SOAKAWAY DESIGN:</b>       | Sheet No<br><b>HSA/3</b> |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| DATA                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | CALCULATIONS      |                                                                                          | RESULTS                  |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| 6.                                  | <p><b><u>PERCOLATION TEST RESULTS</u></b></p> <p>Porosity tests were carried out in March 2016 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 1 of their report.</p> <p>Below is a summary of the <u>lowest</u> infiltration rates derived from the trial pits where tests were undertaken.</p> <table border="1"> <thead> <tr> <th>Trial Pit</th> <th>Measured Soil Infiltration Rate<br/>f (m/s)</th> </tr> </thead> <tbody> <tr> <td>TP 1 Test 3</td> <td>2.862E-05</td> </tr> <tr> <td>TP 2 Test 2</td> <td>2.312E-06</td> </tr> <tr> <td>TP 3 Test 3</td> <td>1.476E-04</td> </tr> <tr> <td>TP 4 Test 3</td> <td>8.784E-05</td> </tr> <tr> <td>TP 5 Test 2</td> <td>2.053E-05</td> </tr> <tr> <td>TP 8 Test 3</td> <td>1.776E-05</td> </tr> <tr> <td colspan="2"><b>Applicable Infiltration Rate</b></td> </tr> <tr> <td>SA1</td> <td>1.476E-04</td> </tr> <tr> <td>SA2 to SA4</td> <td>2.458E-05</td> </tr> <tr> <td></td> <td></td> </tr> </tbody> </table> <p>TP3<br/>Median of all</p> |                   |                                                                                          | Trial Pit                | Measured Soil Infiltration Rate<br>f (m/s) | TP 1 Test 3 | 2.862E-05 | TP 2 Test 2 | 2.312E-06 | TP 3 Test 3 | 1.476E-04 | TP 4 Test 3 | 8.784E-05 | TP 5 Test 2 | 2.053E-05 | TP 8 Test 3 | 1.776E-05 | <b>Applicable Infiltration Rate</b> |  | SA1 | 1.476E-04 | SA2 to SA4 | 2.458E-05 |  |  |  |
| Trial Pit                           | Measured Soil Infiltration Rate<br>f (m/s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 1 Test 3                         | 2.862E-05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 2 Test 2                         | 2.312E-06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 3 Test 3                         | 1.476E-04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 4 Test 3                         | 8.784E-05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 5 Test 2                         | 2.053E-05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| TP 8 Test 3                         | 1.776E-05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| <b>Applicable Infiltration Rate</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA1                                 | 1.476E-04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA2 to SA4                          | 2.458E-05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| 7.                                  | <p><b><u>DRAINED AREA: Roofs &amp; Parking</u></b></p> <p>The following impermeable area drains to each individual soakaway</p> <table border="1"> <thead> <tr> <th>Description</th> <th>Drained Area (m<sup>2</sup>)</th> </tr> </thead> <tbody> <tr> <td>SA1</td> <td>232.80</td> </tr> <tr> <td>SA2</td> <td>169.20</td> </tr> <tr> <td>SA3</td> <td>196.80</td> </tr> <tr> <td>SA4</td> <td>157.60</td> </tr> </tbody> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                                                                                          | Description              | Drained Area (m <sup>2</sup> )             | SA1         | 232.80    | SA2         | 169.20    | SA3         | 196.80    | SA4         | 157.60    |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| Description                         | Drained Area (m <sup>2</sup> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA1                                 | 232.80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA2                                 | 169.20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA3                                 | 196.80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |
| SA4                                 | 157.60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |                                                                                          |                          |                                            |             |           |             |           |             |           |             |           |             |           |             |           |                                     |  |     |           |            |           |  |  |  |

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|----------------------------------|----------------------|-------------------|------------------------------------------------------------------------------------------|-------|---------|----------------|-------|---------|--------------------------|---------|---------|
| By<br><b>RW</b>                  | Date<br><b>05.16</b> | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN:</b>           |       |         |                |       |         | Sheet No<br><b>HSA/4</b> |         |         |
| DATA                             |                      |                   | CALCULATIONS                                                                             |       |         |                |       |         | RESULTS                  |         |         |
| 7.                               |                      |                   | <b><u>RAINFALL DATA</u></b>                                                              |       |         |                |       |         |                          |         |         |
| Ratio (M5-60min/M5-2day)         |                      |                   | r                                                                                        |       |         |                |       |         | 31 %                     |         |         |
| M5-2day Rainfall                 |                      |                   | M5-2day                                                                                  |       |         |                |       |         | 58.06 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          |         |         |
| (min)                            |                      | (mm)              | Z2                                                                                       | M10   | I       | Z2             | M30   | I       | Z2                       | M100    | I       |
|                                  |                      |                   |                                                                                          | (mm)  | (mm/hr) |                | (mm)  | (mm/hr) |                          | (mm/hr) | (mm/hr) |
| 5                                | 0.34                 | 6.18              | 1.2                                                                                      | 7.42  | 88.99   | 1.44           | 8.90  | 106.78  | 1.82                     | 11.25   | 134.96  |
| 10                               | 0.49                 | 8.88              | 1.21                                                                                     | 10.74 | 64.46   | 1.48           | 13.14 | 78.85   | 1.88                     | 16.69   | 100.16  |
| 15                               | 0.60                 | 10.74             | 1.22                                                                                     | 13.10 | 52.41   | 1.50           | 16.11 | 64.43   | 1.92                     | 20.62   | 82.48   |
| 20                               | 0.66                 | 11.80             | 1.23                                                                                     | 14.51 | 43.54   | 1.50           | 17.70 | 53.10   | 1.94                     | 22.89   | 68.67   |
| 25                               | 0.71                 | 12.86             | 1.23                                                                                     | 15.82 | 37.96   | 1.51           | 19.42 | 46.60   | 1.96                     | 25.20   | 60.49   |
| 30                               | 0.77                 | 13.92             | 1.24                                                                                     | 17.26 | 34.52   | 1.52           | 21.16 | 42.31   | 1.97                     | 27.42   | 54.84   |
| 45                               | 0.89                 | 15.96             | 1.24                                                                                     | 19.79 | 26.39   | 1.53           | 24.42 | 32.56   | 2.00                     | 31.92   | 42.56   |
| 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                 | 20.19             | 1.24                                                                                     | 25.03 | 16.69   | 1.54           | 31.09 | 20.73   | 2.03                     | 40.98   | 27.32   |
| 120                              | 1.24                 | 22.38             | 1.24                                                                                     | 27.75 | 13.87   | 1.54           | 34.46 | 17.23   | 2.02                     | 45.20   | 22.60   |
| 240                              | 1.56                 | 28.02             | 1.23                                                                                     | 34.46 | 8.62    | 1.52           | 42.59 | 10.65   | 1.99                     | 55.76   | 13.94   |
| 360                              | 1.76                 | 31.74             | 1.21                                                                                     | 38.40 | 6.40    | 1.51           | 47.92 | 7.99    | 1.96                     | 62.21   | 10.37   |
| 600                              | 2.09                 | 37.68             | 1.2                                                                                      | 45.21 | 4.52    | 1.48           | 55.76 | 5.58    | 1.91                     | 71.96   | 7.20    |
| 1440                             | 2.76                 | 49.68             | 1.17                                                                                     | 58.12 | 2.42    | 1.42           | 70.54 | 2.94    | 1.81                     | 89.91   | 3.75    |
|                                  |                      |                   |                                                                                          |       |         |                |       |         |                          |         |         |

# CALCULATION SHEET



|                                                                                                                              |                                                                                  |                   |                                                                                          |                              |
|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|------------------------------|
| Client<br><b>GOWER HOMES LTD</b>                                                                                             |                                                                                  |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>        |
| By<br><b>RW</b>                                                                                                              | Date<br><b>05.16</b>                                                             | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA1</b>       | Sheet No<br><b>HSA/5</b>     |
| DATA                                                                                                                         |                                                                                  | CALCULATIONS      |                                                                                          | RESULTS                      |
|                                                                                                                              |                                                                                  |                   |                                                                                          |                              |
| <b>8.</b>                                                                                                                    | <b><u>DESIGN DATA SA1</u></b>                                                    |                   |                                                                                          |                              |
| From porosity tests                                                                                                          | Measured infiltration rate                                                       |                   | f                                                                                        | 5.314E-01 m/hr               |
| CIRIA C697 Pg. 4-31                                                                                                          | Factor of safety                                                                 | (flooding road)   | Fs                                                                                       | <b>10.0</b>                  |
| CIRIA C697 Pg. 4-31                                                                                                          | Porosity                                                                         | (clean stone)     | n                                                                                        | 0.45                         |
| From Plan                                                                                                                    | Area to be drained                                                               |                   | A <sub>D</sub>                                                                           | <b>232.80</b> m <sup>2</sup> |
| Assume soakaway comprises 1.8m diameter ring in square excavation 300mm (minimum) larger than outside face of concrete ring. |                                                                                  |                   |                                                                                          |                              |
| Length, say                                                                                                                  |                                                                                  | <b>2.650</b> m    | Diameter                                                                                 | <b>1.800</b> m               |
| Width, say                                                                                                                   |                                                                                  | <b>2.650</b> m    | Radius                                                                                   | 0.900 m                      |
| CIRIA 156 Pgs. 54 & 92                                                                                                       | Effective porosity (excavation filled with clean stone)                          |                   | n'                                                                                       | 0.649                        |
| <b>9.</b>                                                                                                                    | <b><u>SOAKAWAY DESIGN</u></b>                                                    |                   |                                                                                          |                              |
| By Calculation, q = f/Fs                                                                                                     | Effective infiltration coefficient (measured infiltration rate/factor of safety) |                   | q                                                                                        | 0.0531 m/hr                  |
| From Plan                                                                                                                    | Area to be drained                                                               |                   | A <sub>D</sub>                                                                           | 232.80 m <sup>2</sup>        |
| By Calculation, A <sub>b</sub> = L * W                                                                                       | Base Area of soakaway                                                            |                   | A <sub>b</sub>                                                                           | 7.02 m <sup>2</sup>          |
| By Calculation, P = 2L + 2W                                                                                                  | Perimeter of Soakaway                                                            |                   | P                                                                                        | 10.60 m                      |
| CIRIA 156 Pg. 57                                                                                                             | Factor a = (Ab/P) - (iAD/Pq)                                                     |                   | a                                                                                        | varies                       |
| CIRIA 156 Pg. 57                                                                                                             | Factor b = (Pq/nAb)                                                              |                   | b                                                                                        | 0.124                        |

# CALCULATION SHEET



|                                                                    |                                                                                                   |                                             |                                                                                          |             |                   |                |                |                   |                 |                          |                   |  |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------|-------------|-------------------|----------------|----------------|-------------------|-----------------|--------------------------|-------------------|--|
| Client<br><b>GOWER HOMES LTD</b>                                   |                                                                                                   |                                             | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> |             |                   |                |                |                   |                 | Job No<br><b>5009</b>    |                   |  |
| By<br><b>RW</b>                                                    | Date<br><b>05.16</b>                                                                              | Chkd<br><b>RW</b>                           | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA1</b>       |             |                   |                |                |                   |                 | Sheet No<br><b>HSA/6</b> |                   |  |
| DATA                                                               |                                                                                                   | CALCULATIONS                                |                                                                                          |             |                   |                |                |                   |                 | RESULTS                  |                   |  |
| 9.                                                                 | <b><u>SOAKAWAY DESIGN (continued)</u></b>                                                         |                                             |                                                                                          |             |                   |                |                |                   |                 |                          |                   |  |
|                                                                    | Duration                                                                                          |                                             | 10 Year Return                                                                           |             |                   | 30 Year Return |                |                   | 100 Year Return |                          |                   |  |
|                                                                    |                                                                                                   |                                             | i                                                                                        | Factor<br>a | Max<br>Depth<br>m | i              | Factor<br>a    | Max<br>Depth<br>m | i               | Factor<br>a              | Max<br>Depth<br>m |  |
|                                                                    | min                                                                                               | hr                                          | m/hr                                                                                     |             |                   | m/hr           |                |                   | m/hr            |                          |                   |  |
|                                                                    | 5                                                                                                 | 0.083                                       | 0.089                                                                                    | -36.1       | 0.370             | 0.107          | -43.5          | 0.445             | 0.135           | -55.1                    | 0.564             |  |
|                                                                    | 10                                                                                                | 0.167                                       | 0.064                                                                                    | -26.0       | 0.529             | 0.079          | -31.9          | 0.651             | 0.100           | -40.7                    | 0.830             |  |
|                                                                    | 15                                                                                                | 0.250                                       | 0.052                                                                                    | -21.0       | 0.639             | 0.064          | -26.0          | 0.790             | 0.082           | -33.4                    | 1.016             |  |
|                                                                    | 20                                                                                                | 0.333                                       | 0.044                                                                                    | -17.3       | 0.699             | 0.053          | -21.3          | 0.859             | 0.069           | -27.7                    | 1.118             |  |
|                                                                    | 25                                                                                                | 0.417                                       | 0.038                                                                                    | -15.0       | 0.754             | 0.047          | -18.6          | 0.933             | 0.060           | -24.3                    | 1.221             |  |
|                                                                    | 30                                                                                                | 0.500                                       | 0.035                                                                                    | -13.6       | 0.815             | 0.042          | -16.8          | 1.008             | 0.055           | -22.0                    | 1.318             |  |
|                                                                    | 45                                                                                                | 0.750                                       | 0.026                                                                                    | -10.2       | 0.906             | 0.033          | -12.8          | 1.132             | 0.043           | -16.9                    | 1.498             |  |
|                                                                    | 60                                                                                                | 1.000                                       | 0.022                                                                                    | -8.6        | 0.995             | 0.028          | -10.8          | 1.254             | 0.036           | -14.3                    | 1.661             |  |
|                                                                    | 90                                                                                                | 1.500                                       | 0.017                                                                                    | -6.2        | 1.055             | 0.021          | -7.9           | 1.337             | 0.027           | -10.6                    | 1.798             |  |
|                                                                    | 120                                                                                               | 2.000                                       | 0.014                                                                                    | -5.1        | 1.110             | 0.017          | -6.5           | 1.414             | 0.023           | -8.7                     | 1.900             |  |
|                                                                    | 240                                                                                               | 4.000                                       | 0.009                                                                                    | -2.9        | 1.130             | 0.011          | -3.7           | 1.457             | 0.014           | -5.1                     | 1.988             |  |
|                                                                    | 360                                                                                               | 6.000                                       | 0.006                                                                                    | -2.0        | 1.038             | 0.008          | -2.6           | 1.381             | 0.010           | -3.6                     | 1.896             |  |
|                                                                    | 600                                                                                               | 10.000                                      | 0.005                                                                                    | -1.2        | 0.856             | 0.006          | -1.6           | 1.165             | 0.007           | -2.3                     | 1.640             |  |
|                                                                    | 1440                                                                                              | 24.000                                      | 0.002                                                                                    | -0.3        | 0.321             | 0.003          | -0.6           | 0.524             | 0.004           | -0.9                     | 0.840             |  |
|                                                                    | From Table                                                                                        | <b>For 1 in 10 year return period storm</b> |                                                                                          |             |                   |                |                |                   |                 |                          |                   |  |
|                                                                    |                                                                                                   | Maximum depth of water                      |                                                                                          |             |                   |                | $h_{max}$      |                   | <b>1.130 m</b>  |                          |                   |  |
| Time for half emptying                                             |                                                                                                   |                                             |                                                                                          |             | $t_{1/2}$         |                | <b>2.88 hr</b> |                   |                 |                          |                   |  |
| <b>For 1 in 30 year return period storm</b>                        |                                                                                                   |                                             |                                                                                          |             |                   |                |                |                   |                 |                          |                   |  |
| Depth of storage required additional to 1 in 10 year return period |                                                                                                   |                                             |                                                                                          |             | <b>0.327 m</b>    |                |                |                   |                 |                          |                   |  |
| By calculation                                                     | Total depth of storage to be provided. (Overall depth to suit cover level, base level and strata) |                                             |                                                                                          |             |                   | <b>1.457 m</b> |                |                   |                 |                          |                   |  |
| <24 hrs OK                                                         |                                                                                                   |                                             |                                                                                          |             |                   |                |                |                   |                 |                          |                   |  |

# CALCULATION SHEET



|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                                                                          |                          |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|--------------------------|
| Client<br><b>GOWER HOMES LTD</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>    |
| By<br><b>RW</b>                  | Date<br><b>05.16</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA1</b>       | Sheet No<br><b>HSA/7</b> |
| DATA                             | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                                                                                          | RESULTS                  |
| 9.                               | <p><b><u>SOAKAWAY DESIGN (continued)</u></b></p> <p><b>For 1 in 100 year return period storm</b></p> <p>Potential flood volume (in excess of storage provided for 1 in 30 year storm conditions) <b>2.419 m<sup>3</sup></b></p> <p>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 to invert of the incoming pipework and lowest gully cover level.</p> <p>The base of the soakaway will be a minimum of the depth of 'hmax' below the invert level of the lowest connecting pipe. From the geo-environmental report the adjacent trial pit TP3 extended to 1.9m below ground level.</p> <p>Additional testing will be required at the location of the soakaway to confirm that the infiltration rate used is appropriate.</p> |                   |                                                                                          |                          |

# CALCULATION SHEET



|                                                                                                                              |                                                                                  |                   |                                                                                          |                              |
|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|------------------------------|
| Client<br><b>GOWER HOMES LTD</b>                                                                                             |                                                                                  |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>        |
| By<br><b>RW</b>                                                                                                              | Date<br><b>05.16</b>                                                             | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA2</b>       | Sheet No<br><b>HSA/8</b>     |
| DATA                                                                                                                         |                                                                                  | CALCULATIONS      |                                                                                          | RESULTS                      |
| <b>8. <u>DESIGN DATA SA2</u></b>                                                                                             |                                                                                  |                   |                                                                                          |                              |
| From porosity tests                                                                                                          | Measured infiltration rate                                                       |                   | f                                                                                        | 8.847E-02 m/hr               |
| CIRIA C697 Pg. 4-31                                                                                                          | Factor of safety                                                                 | (flooding road)   | Fs                                                                                       | <b>10.0</b>                  |
| CIRIA C697 Pg. 4-31                                                                                                          | Porosity                                                                         | (clean stone)     | n                                                                                        | 0.45                         |
| From Plan                                                                                                                    | Area to be drained                                                               |                   | A <sub>D</sub>                                                                           | <b>196.80</b> m <sup>2</sup> |
| Assume soakaway comprises 1.8m diameter ring in square excavation 300mm (minimum) larger than outside face of concrete ring. |                                                                                  |                   |                                                                                          |                              |
| Length, say                                                                                                                  |                                                                                  | <b>3.000</b> m    | Diameter                                                                                 | <b>1.800</b> m               |
| Width, say                                                                                                                   |                                                                                  | <b>3.000</b> m    | Radius                                                                                   | 0.900 m                      |
| CIRIA 156 Pgs. 54 & 92                                                                                                       | Effective porosity (excavation filled with clean stone)                          |                   | n'                                                                                       | 0.606                        |
| <b>9. <u>SOAKAWAY DESIGN</u></b>                                                                                             |                                                                                  |                   |                                                                                          |                              |
| By Calculation, q = f/Fs                                                                                                     | Effective infiltration coefficient (measured infiltration rate/factor of safety) |                   | q                                                                                        | 0.009 m/hr                   |
| From Plan                                                                                                                    | Area to be drained                                                               |                   | A <sub>D</sub>                                                                           | 196.80 m <sup>2</sup>        |
| By Calculation, A <sub>b</sub> = L * W                                                                                       | Base Area of soakaway                                                            |                   | A <sub>b</sub>                                                                           | 9.00 m <sup>2</sup>          |
| By Calculation, P = 2L + 2W                                                                                                  | Perimeter of Soakaway                                                            |                   | P                                                                                        | 12.00 m                      |
| CIRIA 156 Pg. 57                                                                                                             | Factor a = (A <sub>b</sub> /P) - (iA <sub>D</sub> /Pq)                           |                   | a                                                                                        | varies                       |
| CIRIA 156 Pg. 57                                                                                                             | Factor b = (Pq/nA <sub>b</sub> )                                                 |                   | b                                                                                        | 0.020                        |

# CALCULATION SHEET



|                                                                    |                                                                                                   |                                             |                                                                                          |             |                |                |                 |              |                 |                          |              |  |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------|-------------|----------------|----------------|-----------------|--------------|-----------------|--------------------------|--------------|--|
| Client<br><b>GOWER HOMES LTD</b>                                   |                                                                                                   |                                             | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> |             |                |                |                 |              |                 | Job No<br><b>5009</b>    |              |  |
| By<br><b>RW</b>                                                    | Date<br><b>05.16</b>                                                                              | Chkd<br><b>RW</b>                           | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA2</b>       |             |                |                |                 |              |                 | Sheet No<br><b>HSA/9</b> |              |  |
| DATA                                                               |                                                                                                   | CALCULATIONS                                |                                                                                          |             |                |                |                 |              |                 | RESULTS                  |              |  |
| 9.                                                                 | <b><u>SOAKAWAY DESIGN (continued)</u></b>                                                         |                                             |                                                                                          |             |                |                |                 |              |                 |                          |              |  |
|                                                                    | Duration                                                                                          |                                             | 10 Year Return                                                                           |             |                | 30 Year Return |                 |              | 100 Year Return |                          |              |  |
|                                                                    |                                                                                                   |                                             | i                                                                                        | Factor<br>a | Max<br>Depth   | i              | Factor<br>a     | Max<br>Depth | i               | Factor<br>a              | Max<br>Depth |  |
|                                                                    | min                                                                                               | hr                                          | m/hr                                                                                     |             | m              | m/hr           |                 | m            | m/hr            |                          | m            |  |
|                                                                    | 5                                                                                                 | 0.083                                       | 0.089                                                                                    | -161.4      | 0.266          | 0.107          | -193.8          | 0.320        | 0.135           | -245.2                   | 0.405        |  |
|                                                                    | 10                                                                                                | 0.167                                       | 0.064                                                                                    | -116.7      | 0.385          | 0.079          | -142.9          | 0.471        | 0.100           | -181.8                   | 0.599        |  |
|                                                                    | 15                                                                                                | 0.250                                       | 0.052                                                                                    | -94.7       | 0.468          | 0.064          | -116.7          | 0.577        | 0.082           | -149.5                   | 0.739        |  |
|                                                                    | 20                                                                                                | 0.333                                       | 0.044                                                                                    | -78.6       | 0.517          | 0.053          | -96.0           | 0.632        | 0.069           | -124.4                   | 0.819        |  |
|                                                                    | 25                                                                                                | 0.417                                       | 0.038                                                                                    | -68.4       | 0.563          | 0.047          | -84.2           | 0.692        | 0.060           | -109.5                   | 0.900        |  |
|                                                                    | 30                                                                                                | 0.500                                       | 0.035                                                                                    | -62.2       | 0.613          | 0.042          | -76.4           | 0.753        | 0.055           | -99.2                    | 0.978        |  |
|                                                                    | 45                                                                                                | 0.750                                       | 0.026                                                                                    | -47.3       | 0.698          | 0.033          | -58.6           | 0.864        | 0.043           | -76.8                    | 1.133        |  |
|                                                                    | 60                                                                                                | 1.000                                       | 0.022                                                                                    | -39.9       | 0.783          | 0.028          | -49.8           | 0.976        | 0.036           | -65.2                    | 1.279        |  |
|                                                                    | 90                                                                                                | 1.500                                       | 0.017                                                                                    | -29.7       | 0.869          | 0.021          | -37.0           | 1.084        | 0.027           | -49.0                    | 1.436        |  |
|                                                                    | 120                                                                                               | 2.000                                       | 0.014                                                                                    | -24.5       | 0.953          | 0.017          | -30.6           | 1.191        | 0.023           | -40.4                    | 1.571        |  |
|                                                                    | 240                                                                                               | 4.000                                       | 0.009                                                                                    | -14.9       | 1.139          | 0.011          | -18.7           | 1.421        | 0.014           | -24.6                    | 1.879        |  |
|                                                                    | 360                                                                                               | 6.000                                       | 0.006                                                                                    | -10.9       | 1.223          | 0.008          | -13.8           | 1.548        | 0.010           | -18.1                    | 2.034        |  |
|                                                                    | 600                                                                                               | 10.000                                      | 0.005                                                                                    | -7.5        | 1.346          | 0.006          | -9.4            | 1.692        | 0.007           | -12.4                    | 2.223        |  |
|                                                                    | 1440                                                                                              | 24.000                                      | 0.002                                                                                    | -3.7        | 1.386          | 0.003          | -4.6            | 1.743        | 0.004           | -6.1                     | 2.300        |  |
|                                                                    | From Table                                                                                        | <b>For 1 in 10 year return period storm</b> |                                                                                          |             |                |                |                 |              |                 |                          |              |  |
|                                                                    |                                                                                                   | Maximum depth of water                      |                                                                                          |             |                |                | $h_{max}$       |              | <b>1.386 m</b>  |                          |              |  |
| Time for half emptying                                             |                                                                                                   |                                             |                                                                                          |             | $t_{1/2}$      |                | <b>24.19 hr</b> |              |                 |                          |              |  |
| <b>For 1 in 30 year return period storm</b>                        |                                                                                                   |                                             |                                                                                          |             |                |                |                 |              |                 |                          |              |  |
| Depth of storage required additional to 1 in 10 year return period |                                                                                                   |                                             |                                                                                          |             | <b>0.357 m</b> |                |                 |              |                 |                          |              |  |
| By calculation                                                     | Total depth of storage to be provided. (Overall depth to suit cover level, base level and strata) |                                             |                                                                                          |             |                | <b>1.743 m</b> |                 |              |                 |                          |              |  |
|                                                                    | <24 hrs OK                                                                                        |                                             |                                                                                          |             |                |                |                 |              |                 |                          |              |  |

# CALCULATION SHEET



|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                                                                          |                           |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|---------------------------|
| Client<br><b>GOWER HOMES LTD</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> | Job No<br><b>5009</b>     |
| By<br><b>RW</b>                  | Date<br><b>05.16</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Chkd<br><b>RW</b> | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN: SA2</b>       | Sheet No<br><b>HSA/10</b> |
| DATA                             | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                                                                                          | RESULTS                   |
| 9.                               | <p><b><u>SOAKAWAY DESIGN (continued)</u></b></p> <p><b>For 1 in 100 year return period storm</b></p> <p>Potential flood volume (in excess of storage provided for 1 in 30 year storm conditions) <b>3.034 m<sup>3</sup></b></p> <p>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 to invert of the incoming pipework and lowest gully cover level.</p> <p>The base of the soakaway will be a minimum of the depth of 'hmax' below the invert level of the lowest connecting pipe. From the geo-environmental report the adjacent trial pit TP3 extended to 1.9m below ground level.</p> <p>Additional testing will be required at the location of the soakaway to confirm that the infiltration rate used is appropriate.</p> |                   |                                                                                          |                           |

# CALCULATION SHEET



|                                  |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                          |                                     |                                                   |                       |                           |  |
|----------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------|-----------------------|---------------------------|--|
| Client<br><b>GOWER HOMES LTD</b> |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Job Title<br><b>PROPOSED RESIDENTIAL DEVELOPMENT,<br/>PACKSADDLE BANK, PENTRE BYCHAN</b> |                                     |                                                   |                       | Job No<br><b>5009</b>     |  |
| By<br><b>RW</b>                  | Date<br><b>08.16</b>         | Chkd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Element<br><b>SURFACE WATER DRAINAGE ANALYSIS<br/>HIGHWAY SOAKAWAY DESIGN:</b>           |                                     |                                                   |                       | Sheet No<br><b>HSA/11</b> |  |
| DATA                             |                              | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                          |                                     |                                                   |                       | RESULTS                   |  |
| 10.                              |                              | <u><b>SUMMARY</b></u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                          |                                     |                                                   |                       |                           |  |
| <b>Soakaway</b>                  | <b>Cover Level (m)</b>       | <b>Pipe Invert Level (m)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Depth hmax (m)</b>                                                                    | <b>Depth h30 (m)</b>                | <b>Vol 100 (m<sup>3</sup>)</b>                    | <b>Base Level (m)</b> | <b>Total (m)</b>          |  |
| SA1                              | 120.350                      | 119.010                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.130                                                                                    | 0.327                               | 2.419                                             | 117.580               | 2.770                     |  |
| SA2                              | 118.275                      | 117.150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.386                                                                                    | 0.357                               | 3.034                                             | 115.464               | 2.811                     |  |
| SA3                              | 116.205                      | 115.145                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.386                                                                                    | 0.357                               | 3.034                                             | 113.459               | 2.746                     |  |
| SA4                              | 114.660                      | 113.540                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.386                                                                                    | 0.357                               | 3.034                                             | 111.854               | 2.806                     |  |
|                                  |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                          |                                     |                                                   |                       |                           |  |
| 11.                              |                              | <p>Design depth / level is hmax below invert of incoming gully pipe</p> <p>Base level is underside of 300mm thick foundation. 300mm below design depth</p> <p><u><b>Additional Storage Provided For More Severe Events &amp; Climate Change</b></u></p> <p>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.</p> <p>Assuming the depth from clver level to underside of cover slab is 0.5m (150mm cover, 150mm brickwork, 175mm cover slab) the additional volume in the soakaway is as follows:</p> |                                                                                          |                                     |                                                   |                       |                           |  |
| <b>Soakaway</b>                  | <b>Gully Cover Level (m)</b> | <b>Underside Cover Slab Level (m)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>1 in 30 Year Event Level (m)</b>                                                      | <b>Additional Storage Depth (m)</b> | <b>Additional Volume Provided (m<sup>3</sup>)</b> |                       |                           |  |
| SA1                              | 119.830                      | 119.850                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 119.337                                                                                  | 0.513                               | 2.338                                             |                       |                           |  |
| SA2                              | 117.965                      | 117.775                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 117.507                                                                                  | 0.268                               | 1.461                                             |                       |                           |  |
| SA3                              | 115.945                      | 115.705                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 115.502                                                                                  | 0.203                               | 1.107                                             |                       |                           |  |
| SA4                              | 114.340                      | 114.160                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 113.897                                                                                  | 0.263                               | 1.434                                             |                       |                           |  |
|                                  |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                          |                                     |                                                   |                       |                           |  |