## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | Add Flow / Climate Change (%) | 0 |
| M5-60 (mm) | 18.000 | Minimum Backdrop Height (m) | 0.200 |
| Ratio R | 0.354 | Maximum Backdrop Height (m) | 1.500 |
| Maximum Rainfall (mm/hr) | 100 | Min Design Depth for Optimisation (m) | 1.200 |
| Maximum Time of Concentration (mins) | 30 | Min Vel for Auto Design only (m/s) | 1.00 |
| Foul Sewage (l/s/ha) | 0.000 | Min Slope for Optimisation (1:X) | 500 |
| Volumetric Runoff Coeff. | 0.750 | | |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.092 | 4-8 | 0.079 |

Total Area Contributing (ha) = 0.171

Total Pipe Volume (m³) = 33.322

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 29.000 | 3.000 | 9.7 | 0.016 | 4.00 | 0.0 | 0.600 | o | 225 |
| 1.001 | 22.000 | 2.000 | 11.0 | 0.018 | 0.00 | 0.0 | 0.600 | o | 225 |
| 1.002 | 15.000 | 1.450 | 10.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 |
| 1.003 | 31.000 | 3.000 | 10.3 | 0.022 | 0.00 | 0.0 | 0.600 | o | 225 |
| 1.004 | 27.500 | 0.900 | 30.6 | 0.055 | 0.00 | 0.0 | 0.600 | o | 225 |
| 1.005 | 18.500 | 0.125 | 148.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 |
| 1.006 | 7.500 | 0.050 | 150.0 | 0.060 | 0.00 | 0.0 | 0.600 | o | 225 |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 64.03 | 4.11 | 97.475 | 0.016 | 0.0 | 0.0 | 0.0 | 4.23 | 168.3 | 2.8 |
| 1.001 | 63.50 | 4.21 | 94.475 | 0.034 | 0.0 | 0.0 | 0.0 | 3.97 | 157.8 | 5.8 |
| 1.002 | 63.16 | 4.27 | 92.475 | 0.034 | 0.0 | 0.0 | 0.0 | 4.09 | 162.7 | 5.8 |
| 1.003 | 62.47 | 4.39 | 91.025 | 0.056 | 0.0 | 0.0 | 0.0 | 4.09 | 162.8 | 9.5 |
| 1.004 | 61.44 | 4.59 | 88.025 | 0.111 | 0.0 | 0.0 | 0.0 | 2.38 | 94.5 | 18.5 |
| 1.005 | 59.99 | 4.87 | 87.125 | 0.111 | 0.0 | 0.0 | 0.0 | 1.07 | 42.6 | 18.5 |
| 1.006 | 59.42 | 4.99 | 87.000 | 0.171 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 27.5 |

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## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 1.007 | 44.000 | 0.100 | 440.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 600 |
| 2.000 | 44.000 | 0.100 | 440.0 | 0.000 | 4.00 | 0.0 | 0.600 | o | 600 |
| 2.001 | 2.500 | 0.006 | 416.7 | 0.000 | 0.00 | 0.0 | 0.600 | o | 600 |
| 1.008 | 44.000 | 0.275 | 160.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.007 | 56.53 | 5.63 | 86.575 | 0.171 | 0.0 | 0.0 | 0.0 | 1.15 | 326.4 | 27.5 |
| 2.000 | 61.19 | 4.64 | 86.581 | 0.000 | 0.0 | 0.0 | 0.0 | 1.15 | 326.4 | 0.0 |
| 2.001 | 61.01 | 4.67 | 86.481 | 0.000 | 0.0 | 0.0 | 0.0 | 1.19 | 335.5 | 0.0 |
| 1.008 | 53.67 | 6.34 | 86.475 | 0.171 | 0.0 | 0.0 | 0.0 | 1.03 | 41.0 | 27.5 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.008 | | 86.800 | 86.200 | 0.000 | 0 | 0 |

## Simulation Criteria for Storm

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.840 | Foul Sewage per hectare (l/s) | 0.000 |
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 0.000 |
| Hot Start Level (mm) | 0 | Run Time (mins) | 120 |
| Manhole Headloss Coeff (Global) | 0.500 | Output Interval (mins) | 2 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 0 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | | |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Winter |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 18.000 | Storm Duration (mins) | 60 |
| Ratio R | 0.354 | | |

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## Online Controls for Storm

### Hydro-Brake Optimum® Manhole: 11, DS/PN: 1.008, Volume (m³): 14.2

| | |
|---|---|
| Unit Reference | MD-SHE-0105-5000-1000-5000 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 5.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 105 |
| Invert Level (m) | 86.475 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 5.0 |
| Flush-Flo™ | 0.295 | 4.9 |
| Kick-Flo® | 0.636 | 4.0 |
| Mean Flow over Head Range | - | 4.3 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.6 | 1.200 | 5.4 | 3.000 | 8.3 | 7.000 | 12.4 |
| 0.200 | 4.8 | 1.400 | 5.8 | 3.500 | 8.9 | 7.500 | 12.8 |
| 0.300 | 4.9 | 1.600 | 6.2 | 4.000 | 9.5 | 8.000 | 13.2 |
| 0.400 | 4.9 | 1.800 | 6.5 | 4.500 | 10.1 | 8.500 | 13.6 |
| 0.500 | 4.7 | 2.000 | 6.9 | 5.000 | 10.6 | 9.000 | 14.0 |
| 0.600 | 4.3 | 2.200 | 7.2 | 5.500 | 11.1 | 9.500 | 14.4 |
| 0.800 | 4.5 | 2.400 | 7.5 | 6.000 | 11.5 | | |
| 1.000 | 5.0 | 2.600 | 7.8 | 6.500 | 12.0 | | |

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