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| Cotswold Transport Planning | | Page 0 |
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

| | |
|---|-------|
| FEH Rainfall Model | |
| Return Period (years) | 2 |
| FEH Rainfall Version | 2013 |
| Site Location GB 444817 163231 SU 44817 63231 | |
| Data Type | Point |
| Maximum Rainfall (mm/hr) | 50 |
| Maximum Time of Concentration (mins) | 30 |
| Foul Sewage (l/s/ha) | 0.000 |
| Volumetric Runoff Coeff. | 0.750 |
| PIMP (%) | 100 |
| Add Flow / Climate Change (%) | 0 |
| Minimum Backdrop Height (m) | 0.200 |
| Maximum Backdrop Height (m) | 1.500 |
| Min Design Depth for Optimisation (m) | 1.200 |
| Min Vel for Auto Design only (m/s) | 1.00 |
| Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits



Time Area Diagram for Surface Network 1

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|-------------|-----------|-------------|-----------|
| 0-4 | 0.335 | 4-8 | 0.230 |

Total Area Contributing (ha) = 0.565

Total Pipe Volume (m³) = 15.211




Network Design Table for Surface Network 1

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section | Type | Auto Design |
|-------|------------|----------|-------------|-------------|-------------|-----------------|--------|----------|----------|--------------|------|---|
| 1.000 | 19.780 | 0.132 | 150.0 | 0.433 | 5.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |  |
| 1.001 | 21.902 | 0.219 | 100.0 | 0.032 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |  |

Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | E I.Area (ha) | E Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|-------|--------------|-------------|-----------|---------------|-------------------|------------|----------------|-----------|-----------|------------|
| 1.000 | 50.00 | 5.22 | 93.702 | 0.433 | 0.0 | 0.0 | 0.0 | 1.48 | 163.1 | 58.6 |
| 1.001 | 50.00 | 5.40 | 93.489 | 0.465 | 0.0 | 0.0 | 0.0 | 2.03 | 323.3 | 63.0 |

Network Design Table for Surface Network 1

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|-------|------------|----------|-------------|-------------|-------------|-----------------|--------|----------|----------|--------------|---|
| 1.002 | 9.437 | 0.095 | 99.3 | 0.023 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit |  |
| 1.003 | 39.710 | 0.175 | 226.9 | 0.077 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit |  |
| 1.004 | 24.422 | 0.146 | 167.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit |  |

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) |
|-------|--------------|-------------|-----------|---------------|-------------------|------------|----------------|-----------|-----------|------------|
| 1.002 | 50.00 | 5.48 | 93.270 | 0.488 | 0.0 | 0.0 | 0.0 | 2.04 | 324.4 | 66.1 |
| 1.003 | 50.00 | 5.97 | 93.175 | 0.565 | 0.0 | 0.0 | 0.0 | 1.35 | 214.0 | 76.5 |
| 1.004 | 50.00 | 6.31 | 93.000 | 0.565 | 0.0 | 0.0 | 0.0 | 1.21 | 85.7 | 76.5 |

Simulation Criteria for Surface Network 1

| | | | |
|---------------------------------|-------|--|-------|
| Volumetric Runoff Coeff | 0.750 | Additional Flow - % of Total Flow | 0.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m ³ /ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coefficient | 0.800 |
| Hot Start Level (mm) | 0 | Flow per Person per Day (l/per/day) | 0.000 |
| Manhole Headloss Coeff (Global) | 0.500 | Run Time (mins) | 60 |
| Foul Sewage per hectare (l/s) | 0.000 | Output Interval (mins) | 1 |
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

Synthetic Rainfall Details

| | |
|-----------------------|---------------------------------|
| Rainfall Model | FEH |
| Return Period (years) | 2 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 444817 163231 SU 44817 63231 |
| Data Type | Point |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Storm Duration (mins) | 30 |

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S34, DS/PN: 1.004, Volume (m³): 8.1

Unit Reference MD-SHE-0094-4100-1100-4100
 Design Head (m) 1.100
 Design Flow (l/s) 4.1
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 94
 Invert Level (m) 93.000
 Minimum Outlet Pipe Diameter (mm) 150
 Suggested Manhole Diameter (mm) 1200

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---------------------------|----------|------------|---------------------------|----------|------------|
| Design Point (Calculated) | 1.100 | 4.1 | Kick-Flo® | 0.689 | 3.3 |
| Flush-Flo™ | 0.329 | 4.1 | Mean Flow over Head Range | - | 3.6 |

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 | 3.0 | 1.200 | 4.3 | 3.000 | 6.5 | 7.000 | 9.8 |
| 0.200 | 3.9 | 1.400 | 4.6 | 3.500 | 7.0 | 7.500 | 10.1 |
| 0.300 | 4.1 | 1.600 | 4.9 | 4.000 | 7.5 | 8.000 | 10.4 |
| 0.400 | 4.1 | 1.800 | 5.1 | 4.500 | 7.9 | 8.500 | 10.7 |
| 0.500 | 4.0 | 2.000 | 5.4 | 5.000 | 8.3 | 9.000 | 11.0 |
| 0.600 | 3.7 | 2.200 | 5.7 | 5.500 | 8.7 | 9.500 | 11.3 |
| 0.800 | 3.5 | 2.400 | 5.9 | 6.000 | 9.1 | | |
| 1.000 | 3.9 | 2.600 | 6.1 | 6.500 | 9.4 | | |

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Storage Structures for Surface Network 1

Tank or Pond Manhole: S34, DS/PN: 1.004

Invert Level (m) 93.100

| Depth (m) | Area (m ²) | Depth (m) | Area (m ²) | Depth (m) | Area (m ²) | Depth (m) | Area (m ²) |
|-----------|------------------------|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 0.000 | 295.2 | 0.401 | 404.2 | 0.801 | 522.2 | 1.201 | 649.3 |
| 0.101 | 321.6 | 0.501 | 432.8 | 0.901 | 553.2 | 1.300 | 682.2 |
| 0.201 | 348.6 | 0.601 | 462.1 | 1.001 | 584.6 | 1.301 | 0.0 |
| 0.301 | 376.1 | 0.701 | 491.9 | 1.101 | 616.7 | | |

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000


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

Synthetic Rainfall Details

Rainfall Model FEH
FEH Rainfall Version 2013
Site Location GB 444817 163231 SU 44817 63231
Data Type Point
Cv (Summer) 0.750
Cv (Winter) 0.840
Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status OFF
Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surge | First (Y) Flood | First (Z) Overflow | Water Level (m) |
|-------|------------|------------|---------------|----------------|-----------------|-----------------|--------------------|-----------------|
| 1.000 | S2 | 15 Winter | 2 | +0% | 30/15 Summer | | | 93.890 |
| 1.001 | S22 | 15 Winter | 2 | +0% | 100/15 Summer | | | 93.650 |
| 1.002 | S23 | 15 Winter | 2 | +0% | 100/15 Summer | | | 93.476 |
| 1.003 | S25 | 15 Winter | 2 | +0% | 100/15 Summer | | | 93.384 |
| 1.004 | S34 | 240 Winter | 2 | +0% | 2/240 Winter | | | 93.302 |


| PN | US/MH Name | Depth (m) | Surcharged Volume (m ³) | Flooded Flow / Cap. (l/s) | Half Drain Time (mins) | Pipe Flow (l/s) | Status | Level Exceeded |
|-------|------------|-----------|-------------------------------------|---------------------------|------------------------|-----------------|--------|----------------|
| 1.000 | S2 | -0.187 | 0.000 | 0.49 | | 67.0 | OK | |
| 1.001 | S22 | -0.289 | 0.000 | 0.27 | | 71.1 | OK | |
| 1.002 | S23 | -0.244 | 0.000 | 0.43 | | 74.9 | OK | |
| 1.003 | S25 | -0.241 | 0.000 | 0.44 | | 82.7 | OK | |

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Surface Network 1

| PN | US/MH Name | Surcharged | | Flow / Cap. | Overflow (1/s) | Half Drain Time (mins) | Pipe Flow (1/s) | Status | Level Exceeded |
|-------|---------------|--------------|-----------------------------|----------------|-------------------|------------------------------|-----------------------|------------|-------------------|
| | | Depth (m) | Volume (m ³) | | | | | | |
| 1.004 | S34 | 0.002 | 0.000 | 0.05 | | | 4.1 | SURCHARGED | |

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

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

Synthetic Rainfall Details


Rainfall Model FEH
FEH Rainfall Version 2013
Site Location GB 444817 163231 SU 44817 63231
Data Type Point
Cv (Summer) 0.750
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surge | First (Y) Flood | First (Z) Overflow | Water Level (m) |
|-------|------------|------------|---------------|----------------|-----------------|-----------------|--------------------|-----------------|
| 1.000 | S2 | 15 Winter | 30 | +0% | 30/15 Summer | | | 94.105 |
| 1.001 | S22 | 15 Winter | 30 | +0% | 100/15 Summer | | | 93.754 |
| 1.002 | S23 | 15 Winter | 30 | +0% | 100/15 Summer | | | 93.668 |
| 1.003 | S25 | 15 Winter | 30 | +0% | 100/15 Summer | | | 93.599 |
| 1.004 | S34 | 240 Winter | 30 | +0% | 2/240 Winter | | | 93.563 |


| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m ³) | Flow / Cap. (l/s) | Half Drain Time (mins) | Pipe Flow (l/s) | Status | Level Exceeded |
|-------|------------|----------------------|----------------------------------|-------------------|------------------------|-----------------|------------|----------------|
| 1.000 | S2 | 0.028 | 0.000 | 1.12 | | 153.6 | SURCHARGED | |
| 1.001 | S22 | -0.185 | 0.000 | 0.63 | | 166.5 | OK | |
| 1.002 | S23 | -0.052 | 0.000 | 0.97 | | 169.1 | OK | |
| 1.003 | S25 | -0.026 | 0.000 | 1.00 | | 189.9 | OK | |

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

| PN | US/MH Name | Surcharged | | Flooded | | Flow / Cap. | Overflow (1/s) | Half Drain Time (mins) | Pipe Flow (1/s) | Status | Level Exceeded |
|-------|---------------|--------------|-----------------------------|---------|----------|----------------|-------------------|------------------------------|-----------------------|------------|-------------------|
| | | Depth (m) | Volume (m ³) | Flow | Overflow | | | | | | |
| 1.004 | S34 | 0.263 | 0.000 | 0.05 | | | | | 4.1 | SURCHARGED | |

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria


| | | | |
|---------------------------------|-------|--|-------|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m ³ /ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coefficient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

Synthetic Rainfall Details

| | |
|------------------------------------|---|
| Rainfall Model | FEH |
| FEH Rainfall Version | 2013 |
| Site Location | GB 444817 163231 SU 44817 63231 |
| Data Type | Point |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Margin for Flood Risk Warning (mm) | 300.0 |
| Analysis Timestep | 2.5 Second Increment (Extended) |
| DTS Status | OFF |
| DVD Status | ON |
| Inertia Status | OFF |
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 240, 360, 480, 960, 1440 |
| Return Period(s) (years) | 2, 30, 100 |
| Climate Change (%) | 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|-------|------------|-------|---------------|----------------|-----------------|-----------------|--------------------|---------------|-----------------|
| 1.000 | S2 | 15 | Winter | +40% | 30/15 | Summer | | | 94.961 |
| 1.001 | S22 | 15 | Winter | +40% | 100/15 | Summer | | | 94.479 |
| 1.002 | S23 | 15 | Winter | +40% | 100/15 | Summer | | | 94.235 |
| 1.003 | S25 | 15 | Winter | +40% | 100/15 | Summer | | | 93.969 |
| 1.004 | S34 | 360 | Winter | +40% | 2/240 | Winter | | | 93.920 |

| PN | US/MH Name | Depth (m) | Surcharged Volume (m ³) | Flooded Volume (m ³) | Flow / Overflow Cap. (l/s) | Half Drain Time (mins) | Pipe Flow (l/s) | Status | Level Exceeded |
|-------|------------|-----------|-------------------------------------|----------------------------------|----------------------------|------------------------|-----------------|------------|----------------|
| 1.000 | S2 | 0.884 | 0.000 | 0.000 | 1.89 | | 258.6 | SURCHARGED | |
| 1.001 | S22 | 0.540 | 0.000 | 0.000 | 1.04 | | 274.8 | SURCHARGED | |
| 1.002 | S23 | 0.515 | 0.000 | 0.000 | 1.65 | | 286.8 | SURCHARGED | |
| 1.003 | S25 | 0.344 | 0.000 | 0.000 | 1.72 | | 326.8 | SURCHARGED | |

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

| PN | US/MH Name | Surcharged | | Flooded | | Flow / Cap. | Overflow (1/s) | Half Drain Time (mins) | Pipe Flow (1/s) | Status | Level Exceeded |
|-------|---------------|--------------|-----------------------------|---------|----------|----------------|-------------------|------------------------------|-----------------------|------------|-------------------|
| | | Depth (m) | Volume (m ³) | Flow | Overflow | | | | | | |
| 1.004 | S34 | 0.620 | 0.000 | 0.05 | | | | | 4.1 | SURCHARGED | |