# The Sizewell C Project

SZC Co.'s Response to the Secretary of State's Request for Further Information dated 18 March 2022: Appendix 3 - The Drainage Strategy Part 7 of 12

Revision: 2.0

April 2022

# APPENDIX B: INFILTRATION BASIN LAYOUT SKETCH BASE LEVEL 10.5 MAOD


| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Levels | 14.395 | 14.323 | 14.324 | 13.077 | 11.826 | 11.100 | 10.500 | 10.500 | 10.908 | 11.700 | 12.658 | 13.908 | 14.193 | 14.051 | 13.923 |
| Pond Levels | | | | 13.078 | 11.828 | 10.578 | 10.500 | 10.500 | 10.500 | 10.500 | 11.701 | 12.951 | | | |
| Offset | -65.00 | -60.00 | -55.00 | -50.00 | -45.00 | -40.00 | -35.00 | -30.00 | -25.00 | -20.00 | -15.00 | -10.00 | -5.00 | 0.00 | 5.00 |

**Yoxford Roundabout**

| ***Location*** | ***Area (m²)*** | ***Min. Depth (m) [for storage volume calculation]*** |
|---|---|---|
| *Base of basin (10.500m AOD)* | 271 | 0 |
| *1st berm – internal (11.100m AOD)* | 522 | 0.6 |
| *1st berm – internal (11.101m AOD)* | 705 | 0.601 |
| *2nd berm – internal (11.700m AOD)* | 1030 | 1.2 |
| *2nd berm – internal (11.701m AOD)* | 1254 | 1.201 |
| *Basin footprint (without including the area of the 3rd berm next to the earth band)* | 2982 | 3 |

# APPENDIX C: HYDRAULIC MODELLING RESULTS FOR INFILTRATION BASIN BASE LEVEL 10.5 MAOD

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Network 1.SWS

Pipe Sizes Network 1 Manhole Sizes Network 1

FEH Rainfall Model

| | |
|---|---|
| Return Period (years) | 2 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 640286 267538 TM 40286 67538 |
| Data Type | Point |
| Maximum Rainfall (mm/hr) | 500 |
| 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 Network 1.SWS

| Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|---|---|---|---|---|---|
| 0-4 | 0.388 | 4-8 | 0.188 | 8-12 | 0.130 | 12-16 | 0.119 | 16-20 | 0.040 |

Total Area Contributing (ha) = 0.865

Total Pipe Volume (m³) = 129.423

### Network Design Table for Network 1.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | 40.080 | 0.200 | 200.4 | 0.042 | 15.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | |
| N1-2.000 | 37.927 | 0.474 | 80.0 | 0.043 | 15.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | |
| N1-1.001 | 9.833 | 0.098 | 100.3 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.002 | 25.404 | 0.254 | 100.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.003 | 53.084 | 0.531 | 100.0 | 0.013 | 0.00 | 0.0 | 0.600 | | o | 150 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | 32.89 | 16.05 | 12.127 | 0.042 | 0.0 | 0.0 | 0.0 | 0.63 | 1350.4 | 3.7 |
| N1-2.000 | 32.77 | 16.15 | 13.732 | 0.043 | 0.0 | 0.0 | 0.0 | 0.55 | 89.6 | 3.8 |
| N1-1.001 | 32.57 | 16.31 | 11.927 | 0.085 | 0.0 | 0.0 | 0.0 | 1.00 | 17.7 | 7.5 |
| N1-1.002 | 32.07 | 16.73 | 11.829 | 0.085 | 0.0 | 0.0 | 0.0 | 1.00 | 17.8 | 7.5 |
| N1-1.003 | 31.07 | 17.61 | 11.575 | 0.098 | 0.0 | 0.0 | 0.0 | 1.00 | 17.8 | 8.2 |

## Network Design Table for Network 1.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.004 | 22.158 | 0.222 | 99.8 | 0.012 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.005 | 20.412 | 0.204 | 100.1 | 0.183 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-3.000 | 100.097 | 1.251 | 80.0 | 0.076 | 15.00 | 0.0 | | 0.029 | →\|o\|→ | | Filter Drain | |
| N1-4.000 | 53.523 | 0.268 | 199.7 | 0.053 | 15.00 | 0.0 | | 0.029 | →\|o\|→ | | Filter Drain | |
| N1-3.001 | 31.584 | 0.211 | 149.7 | 0.026 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-3.002 | 27.428 | 0.183 | 149.9 | 0.145 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-3.003 | 11.460 | 0.076 | 150.8 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-3.004 | 13.058 | 0.087 | 150.1 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-5.000 | 29.057 | 0.171 | 169.9 | 0.068 | 15.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-5.001 | 40.512 | 0.238 | 170.2 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-6.000 | 16.186 | 0.162 | 99.9 | 0.204 | 15.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-1.006 | 3.000 | 0.015 | 200.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 375 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.004 | 30.67 | 17.98 | 11.044 | 0.110 | 0.0 | 0.0 | 0.0 | 1.01 | 17.8 | 9.1 |
| N1-1.005 | 30.39 | 18.24 | 10.822 | 0.293 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 24.1 |
| N1-3.000 | 30.62 | 18.02 | 13.732 | 0.076 | 0.0 | 0.0 | 0.0 | 0.55 | 89.6 | 6.3 |
| N1-4.000 | 31.47 | 17.25 | 11.800 | 0.053 | 0.0 | 0.0 | 0.0 | 0.40 | 88.1 | 4.5 |
| N1-3.001 | 30.10 | 18.52 | 11.532 | 0.155 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 12.6 |
| N1-3.002 | 29.67 | 18.95 | 11.321 | 0.300 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 24.1 |
| N1-3.003 | 29.49 | 19.13 | 11.138 | 0.300 | 0.0 | 0.0 | 0.0 | 1.06 | 42.2 | 24.1 |
| N1-3.004 | 29.29 | 19.33 | 11.063 | 0.300 | 0.0 | 0.0 | 0.0 | 1.06 | 42.3 | 24.1 |
| N1-5.000 | 33.60 | 15.48 | 10.981 | 0.068 | 0.0 | 0.0 | 0.0 | 1.00 | 39.8 | 6.2 |
| N1-5.001 | 32.76 | 16.16 | 10.810 | 0.068 | 0.0 | 0.0 | 0.0 | 1.00 | 39.7 | 6.2 |
| N1-6.000 | 33.96 | 15.21 | 11.000 | 0.204 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 18.8 |
| N1-1.006 | 29.25 | 19.37 | 10.500 | 0.865 | 0.0 | 0.0 | 0.0 | 1.28 | 141.1 | 68.5 |

## Manhole Schedules for Network 1.SWS

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | PN | Pipe Out Invert Level (m) | Diameter (mm) | PN | Pipes In Invert Level (m) | Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-1 | 13.127 | 1.000 | Open Manhole | 1050 | N1-1.000 | 12.127 | | | | | |
| N1-6-1 | 14.732 | 1.000 | Open Manhole | 1050 | N1-2.000 | 13.732 | | | | | |
| N1-2 | 14.306 | 2.379 | Open Manhole | 1050 | N1-1.001 | 11.927 | 150 | N1-1.000 | 11.927 | | |
| | | | | | | | | N1-2.000 | 13.258 | | 2181 |
| N1-3 | 14.839 | 3.010 | Open Manhole | 1050 | N1-1.002 | 11.829 | 150 | N1-1.001 | 11.829 | 150 | |
| N1-4 | 15.205 | 3.630 | Open Manhole | 1050 | N1-1.003 | 11.575 | 150 | N1-1.002 | 11.575 | 150 | |
| N1-5 | 14.735 | 3.691 | Open Manhole | 1050 | N1-1.004 | 11.044 | 150 | N1-1.003 | 11.044 | 150 | |
| N1-90 | 14.735 | 3.913 | Open Manhole | 1050 | N1-1.005 | 10.822 | 225 | N1-1.004 | 10.822 | 150 | |
| N1-6-2 | 14.732 | 1.000 | Open Manhole | 1050 | N1-3.000 | 13.732 | | | | | |
| N1-10 | 12.800 | 1.000 | Open Manhole | 1050 | N1-4.000 | 11.800 | | | | | |
| N1-7 | 13.653 | 2.121 | Open Manhole | 1050 | N1-3.001 | 11.532 | 225 | N1-3.000 | 12.481 | | 1724 |
| | | | | | | | | N1-4.000 | 11.532 | | |
| N1-8 | 13.685 | 2.364 | Open Manhole | 1050 | N1-3.002 | 11.321 | 225 | N1-3.001 | 11.321 | 225 | |
| N1-9 | 14.150 | 3.012 | Open Manhole | 1050 | N1-3.003 | 11.138 | 225 | N1-3.002 | 11.138 | 225 | |
| N1-91 | 14.150 | 3.088 | Open Manhole | 1050 | N1-3.004 | 11.063 | 225 | N1-3.003 | 11.062 | 225 | |
| N1-11 | 12.578 | 1.597 | Open Manhole | 1050 | N1-5.000 | 10.981 | 225 | | | | |
| N1-92 | 12.578 | 1.768 | Open Manhole | 1050 | N1-5.001 | 10.810 | 225 | N1-5.000 | 10.810 | 225 | |
| N1-93 | 14.000 | 3.000 | Open Manhole | 1050 | N1-6.000 | 11.000 | 225 | | | | |
| N1-94 | 14.000 | 3.500 | Open Manhole | 1050 | N1-1.006 | 10.500 | 375 | N1-1.005 | 10.618 | 225 | |
| | | | | | | | | N1-3.004 | 10.976 | 225 | 326 |
| | | | | | | | | N1-5.001 | 10.572 | 225 | |
| | | | | | | | | N1-6.000 | 10.838 | 225 | 188 |
| N1- | 14.276 | 3.791 | Open Manhole | 0 | | OUTFALL | | N1-1.006 | 10.485 | 375 | |

| MH Name | Manhole Easting (m) | Manhole Northing (m) | Intersection Easting (m) | Intersection Northing (m) | Manhole Access | Layout (North) |
|---|---|---|---|---|---|---|
| N1-1 | 640080.114 | 268632.015 | 640080.114 | 268632.015 | Required | |
| N1-6-1 | 640017.030 | 268676.907 | 640017.030 | 268676.907 | Required | |
| N1-2 | 640045.278 | 268651.709 | 640045.278 | 268651.709 | Required | |
| N1-3 | 640038.961 | 268644.175 | 640038.961 | 268644.175 | Required | |
| N1-4 | 640019.415 | 268660.403 | 640019.415 | 268660.403 | Required | |
| N1-5 | 639984.209 | 268700.133 | 639984.209 | 268700.133 | Required | |
| N1-90 | 639962.988 | 268706.510 | 639962.988 | 268706.510 | Required | |

## Manhole Schedules for Network 1.SWS

| MH Name | Manhole Easting (m) | Manhole Northing (m) | Intersection Easting (m) | Intersection Northing (m) | Manhole Access | Layout (North) |
|---|---|---|---|---|---|---|
| N1-6-2 | 640016.329 | 268677.689 | 640016.329 | 268677.689 | Required | |
| N1-10 | 639954.638 | 268810.122 | 639954.638 | 268810.122 | Required | |
| N1-7 | 639973.951 | 268764.964 | 639973.951 | 268764.964 | Required | |
| N1-8 | 639942.374 | 268764.316 | 639942.374 | 268764.316 | Required | |
| N1-9 | 639942.936 | 268736.894 | 639942.936 | 268736.894 | Required | |
| N1-91 | 639943.171 | 268725.436 | 639943.171 | 268725.436 | Required | |
| N1-11 | 639874.518 | 268718.064 | 639874.518 | 268718.064 | Required | |
| N1-92 | 639902.929 | 268711.968 | 639902.929 | 268711.968 | Required | |
| N1-93 | 639938.156 | 268697.080 | 639938.156 | 268697.080 | Required | |
| N1-94 | 639943.439 | 268712.380 | 639943.439 | 268712.380 | Required | |
| N1- | 639940.565 | 268713.243 | | | No Entry | |

## Area Summary for Network 1.SWS

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.042 | 0.042 | 0.042 |
| 2.000 | - | - | 100 | 0.043 | 0.043 | 0.043 |
| 1.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.003 | - | - | 100 | 0.013 | 0.013 | 0.013 |
| 1.004 | - | - | 100 | 0.012 | 0.012 | 0.012 |
| 1.005 | - | - | 100 | 0.183 | 0.183 | 0.183 |
| 3.000 | - | - | 100 | 0.076 | 0.076 | 0.076 |
| 4.000 | - | - | 100 | 0.053 | 0.053 | 0.053 |
| 3.001 | - | - | 100 | 0.026 | 0.026 | 0.026 |
| 3.002 | - | - | 100 | 0.145 | 0.145 | 0.145 |
| 3.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 5.000 | - | - | 100 | 0.068 | 0.068 | 0.068 |
| 5.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 6.000 | - | - | 100 | 0.204 | 0.204 | 0.204 |
| 1.006 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 0.865 | 0.865 | 0.865 |

## Free Flowing Outfall Details for Network 1.SWS

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| N1-1.006 | N1- | 14.276 | 10.485 | 0.000 | 0 | 0 |

## Storage Structures for Network 1.SWS

### Filter Drain Pipe: N1-1.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 40.1 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.225 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 200.4 |
| Invert Level (m) | 12.127 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 7.0 | Cap Infiltration Depth (m) | 0.000 |

### Filter Drain Pipe: N1-2.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 37.9 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 80.0 |
| Invert Level (m) | 13.732 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.5 | Cap Infiltration Depth (m) | 0.000 |

### Filter Drain Pipe: N1-3.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 100.1 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 80.0 |
| Invert Level (m) | 13.732 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.5 | Cap Infiltration Depth (m) | 0.000 |

### Filter Drain Pipe: N1-4.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 53.5 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 199.7 |
| Invert Level (m) | 11.800 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.7 | Cap Infiltration Depth (m) | 0.000 |

### Infiltration Basin Manhole: N1-94, DS/PN: N1-1.006

| | | | |
|---|---|---|---|
| Invert Level (m) | 10.500 | Safety Factor | 5.0 |
| Infiltration Coefficient Base (m/hr) | 0.00000 | Porosity | 1.00 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | | |

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|
| 0.000 | 271.0 | 0.601 | 705.0 | 1.201 | 1254.0 |
| 0.600 | 522.0 | 1.200 | 1030.0 | 3.000 | 2982.0 |

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

### 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 Coeffecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 5 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 30 Winter | 2 | +0% | | | | | 12.144 | -0.983 |
| N1-2.000 | N1-6-1 | 30 Winter | 2 | +0% | | | | | 13.787 | -0.945 |
| N1-1.001 | N1-2 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 11.992 | -0.085 |
| N1-1.002 | N1-3 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 11.891 | -0.088 |
| N1-1.003 | N1-4 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 11.638 | -0.087 |
| N1-1.004 | N1-5 | 30 Winter | 2 | +0% | 30/15 Summer | | | | 11.110 | -0.084 |
| N1-1.005 | N1-90 | 5760 Winter | 2 | +0% | 2/720 Winter | | | | 11.095 | 0.048 |
| N1-3.000 | N1-6-2 | 30 Winter | 2 | +0% | | | | | 13.809 | -0.923 |
| N1-4.000 | N1-10 | 30 Winter | 2 | +0% | | | | | 11.872 | -0.928 |
| N1-3.001 | N1-7 | 30 Winter | 2 | +0% | 30/15 Summer | | | | 11.612 | -0.145 |
| N1-3.002 | N1-8 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.444 | -0.102 |
| N1-3.003 | N1-9 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.267 | -0.096 |
| N1-3.004 | N1-91 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.191 | -0.097 |
| N1-5.000 | N1-11 | 5760 Winter | 2 | +0% | 30/240 Winter | | | | 11.094 | -0.112 |
| N1-5.001 | N1-92 | 5760 Winter | 2 | +0% | 2/600 Winter | | | | 11.094 | 0.059 |
| N1-6.000 | N1-93 | 5760 Winter | 2 | +0% | 30/360 Winter | | | | 11.095 | -0.130 |
| N1-1.006 | N1-94 | 5760 Winter | 2 | +0% | 2/120 Winter | | | | 11.094 | 0.219 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 0.000 | 0.00 | | 3.2 | OK | |
| N1-2.000 | N1-6-1 | 0.000 | 0.04 | | 3.4 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.39 | | 6.1 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.36 | | 6.1 | OK | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.003 | N1-4 | 0.000 | 0.37 | | 6.4 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.40 | | 6.8 | OK | |
| N1-1.005 | N1-90 | 0.000 | 0.02 | | 0.9 | SURCHARGED | |
| N1-3.000 | N1-6-2 | 0.000 | 0.07 | | 5.9 | OK | |
| N1-4.000 | N1-10 | 0.000 | 0.05 | | 4.1 | OK | |
| N1-3.001 | N1-7 | 0.000 | 0.27 | | 10.9 | OK | |
| N1-3.002 | N1-8 | 0.000 | 0.57 | | 22.4 | OK | |
| N1-3.003 | N1-9 | 0.000 | 0.62 | | 22.3 | OK | |
| N1-3.004 | N1-91 | 0.000 | 0.61 | | 22.4 | OK | |
| N1-5.000 | N1-11 | 0.000 | 0.01 | | 0.2 | OK | |
| N1-5.001 | N1-92 | 0.000 | 0.01 | | 0.2 | SURCHARGED | |
| N1-6.000 | N1-93 | 0.000 | 0.01 | | 0.7 | OK | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

## 5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 1.SWS

### 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 Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 5 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 30 Winter | 5 | +0% | | | | | 12.149 | -0.978 |
| N1-2.000 | N1-6-1 | 30 Winter | 5 | +0% | | | | | 13.798 | -0.934 |
| N1-1.001 | N1-2 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.004 | -0.073 |
| N1-1.002 | N1-3 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 11.903 | -0.076 |
| N1-1.003 | N1-4 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 11.651 | -0.074 |
| N1-1.004 | N1-5 | 2160 Winter | 5 | +0% | 30/15 Summer | | | | 11.137 | -0.057 |
| N1-1.005 | N1-90 | 2160 Winter | 5 | +0% | 2/720 Winter | | | | 11.136 | 0.089 |
| N1-3.000 | N1-6-2 | 30 Winter | 5 | +0% | | | | | 13.826 | -0.906 |
| N1-4.000 | N1-10 | 30 Winter | 5 | +0% | | | | | 11.887 | -0.913 |
| N1-3.001 | N1-7 | 30 Winter | 5 | +0% | 30/15 Summer | | | | 11.627 | -0.130 |
| N1-3.002 | N1-8 | 30 Winter | 5 | +0% | 30/15 Summer | | | | 11.472 | -0.074 |
| N1-3.003 | N1-9 | 30 Winter | 5 | +0% | 30/15 Summer | | | | 11.298 | -0.065 |
| N1-3.004 | N1-91 | 30 Winter | 5 | +0% | 30/15 Summer | | | | 11.221 | -0.067 |
| N1-5.000 | N1-11 | 2160 Winter | 5 | +0% | 30/240 Winter | | | | 11.135 | -0.071 |
| N1-5.001 | N1-92 | 2160 Winter | 5 | +0% | 2/600 Winter | | | | 11.135 | 0.100 |
| N1-6.000 | N1-93 | 2160 Winter | 5 | +0% | 30/360 Winter | | | | 11.135 | -0.090 |
| N1-1.006 | N1-94 | 2160 Winter | 5 | +0% | 2/120 Winter | | | | 11.135 | 0.260 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 0.000 | 0.00 | | 4.3 | OK | |
| N1-2.000 | N1-6-1 | 0.000 | 0.05 | | 4.6 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.53 | | 8.3 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.49 | | 8.3 | OK | |

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 1.SWS

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.003 | N1-4 | 0.000 | 0.50 | | 8.7 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.05 | | 0.9 | OK | |
| N1-1.005 | N1-90 | 0.000 | 0.05 | | 2.3 | SURCHARGED | |
| N1-3.000 | N1-6-2 | 0.000 | 0.09 | | 8.1 | OK | |
| N1-4.000 | N1-10 | 0.000 | 0.06 | | 5.7 | OK | |
| N1-3.001 | N1-7 | 0.000 | 0.37 | | 14.9 | OK | |
| N1-3.002 | N1-8 | 0.000 | 0.78 | | 30.6 | OK | |
| N1-3.003 | N1-9 | 0.000 | 0.85 | | 30.6 | OK | |
| N1-3.004 | N1-91 | 0.000 | 0.83 | | 30.5 | OK | |
| N1-5.000 | N1-11 | 0.000 | 0.02 | | 0.6 | OK | |
| N1-5.001 | N1-92 | 0.000 | 0.01 | | 0.5 | SURCHARGED | |
| N1-6.000 | N1-93 | 0.000 | 0.04 | | 1.7 | OK | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

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

### 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 Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 5 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 30 Winter | 30 | +0% | | | | | 12.159 | -0.968 |
| N1-2.000 | N1-6-1 | 30 Winter | 30 | +0% | | | | | 13.822 | -0.910 |
| N1-1.001 | N1-2 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 12.035 | -0.042 |
| N1-1.002 | N1-3 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 11.932 | -0.047 |
| N1-1.003 | N1-4 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 11.679 | -0.046 |
| N1-1.004 | N1-5 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.380 | 0.186 |
| N1-1.005 | N1-90 | 1440 Winter | 30 | +0% | 2/720 Winter | | | | 11.343 | 0.296 |
| N1-3.000 | N1-6-2 | 30 Winter | 30 | +0% | | | | | 13.877 | -0.855 |
| N1-4.000 | N1-10 | 30 Winter | 30 | +0% | | | | | 11.927 | -0.873 |
| N1-3.001 | N1-7 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.827 | 0.070 |
| N1-3.002 | N1-8 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.814 | 0.268 |
| N1-3.003 | N1-9 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.505 | 0.142 |
| N1-3.004 | N1-91 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.357 | 0.069 |
| N1-5.000 | N1-11 | 1440 Winter | 30 | +0% | 30/240 Winter | | | | 11.342 | 0.136 |
| N1-5.001 | N1-92 | 1440 Winter | 30 | +0% | 2/600 Winter | | | | 11.341 | 0.306 |
| N1-6.000 | N1-93 | 1440 Winter | 30 | +0% | 30/360 Winter | | | | 11.342 | 0.117 |
| N1-1.006 | N1-94 | 1440 Winter | 30 | +0% | 2/120 Winter | | | | 11.341 | 0.466 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 0.000 | 0.01 | | 6.8 | OK | |
| N1-2.000 | N1-6-1 | 0.000 | 0.09 | | 7.8 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.87 | | 13.7 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.81 | | 13.7 | OK | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.003 | N1-4 | 0.000 | 0.82 | | 14.3 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.86 | | 14.5 | SURCHARGED | |
| N1-1.005 | N1-90 | 0.000 | 0.11 | | 5.1 | SURCHARGED | |
| N1-3.000 | N1-6-2 | 0.000 | 0.15 | | 13.7 | OK | |
| N1-4.000 | N1-10 | 0.000 | 0.14 | | 11.9 | OK | |
| N1-3.001 | N1-7 | 0.000 | 0.63 | | 24.9 | SURCHARGED | |
| N1-3.002 | N1-8 | 0.000 | 1.28 | | 50.3 | SURCHARGED | |
| N1-3.003 | N1-9 | 0.000 | 1.39 | | 49.9 | SURCHARGED | |
| N1-3.004 | N1-91 | 0.000 | 1.37 | | 50.2 | SURCHARGED | |
| N1-5.000 | N1-11 | 0.000 | 0.03 | | 1.2 | SURCHARGED | |
| N1-5.001 | N1-92 | 0.000 | 0.03 | | 1.2 | SURCHARGED | |
| N1-6.000 | N1-93 | 0.000 | 0.08 | | 3.7 | SURCHARGED | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

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

### 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 Coeffecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 5 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 30 Winter | 100 | +40% | | | | | 12.190 | -0.937 |
| N1-2.000 | N1-6-1 | 30 Winter | 100 | +40% | | | | | 13.880 | -0.852 |
| N1-1.001 | N1-2 | 30 Winter | 100 | +40% | 100/15 Summer | | | | 12.186 | 0.109 |
| N1-1.002 | N1-3 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 12.149 | 0.170 |
| N1-1.003 | N1-4 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 12.270 | 0.545 |
| N1-1.004 | N1-5 | 15 Winter | 100 | +40% | 30/15 Summer | | | | 12.275 | 1.081 |
| N1-1.005 | N1-90 | 15 Winter | 100 | +40% | 2/720 Winter | | | | 12.238 | 1.191 |
| N1-3.000 | N1-6-2 | 30 Winter | 100 | +40% | | | | | 13.992 | -0.740 |
| N1-4.000 | N1-10 | 30 Winter | 100 | +40% | | | | | 12.553 | -0.247 |
| N1-3.001 | N1-7 | 30 Winter | 100 | +40% | 30/15 Summer | | | | 12.529 | 0.772 |
| N1-3.002 | N1-8 | 15 Winter | 100 | +40% | 30/15 Summer | | | | 12.501 | 0.955 |
| N1-3.003 | N1-9 | 15 Winter | 100 | +40% | 30/15 Summer | | | | 11.846 | 0.483 |
| N1-3.004 | N1-91 | 1440 Winter | 100 | +40% | 30/15 Summer | | | | 11.782 | 0.494 |
| N1-5.000 | N1-11 | 1440 Winter | 100 | +40% | 30/240 Winter | | | | 11.782 | 0.576 |
| N1-5.001 | N1-92 | 1440 Winter | 100 | +40% | 2/600 Winter | | | | 11.781 | 0.746 |
| N1-6.000 | N1-93 | 1440 Winter | 100 | +40% | 30/360 Winter | | | | 11.782 | 0.557 |
| N1-1.006 | N1-94 | 1440 Winter | 100 | +40% | 2/120 Winter | | | | 11.780 | 0.905 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-1 | 0.000 | 0.01 | | 8.8 | OK | |
| N1-2.000 | N1-6-1 | 0.000 | 0.16 | | 14.3 | OK | |
| N1-1.001 | N1-2 | 0.000 | 1.01 | | 15.9 | SURCHARGED | |
| N1-1.002 | N1-3 | 0.000 | 1.03 | | 17.4 | SURCHARGED | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.003 | N1-4 | 0.000 | 1.00 | | 17.3 | SURCHARGED | |
| N1-1.004 | N1-5 | 0.000 | 1.19 | | 20.0 | SURCHARGED | |
| N1-1.005 | N1-90 | 0.000 | 2.55 | | 120.0 | SURCHARGED | |
| N1-3.000 | N1-6-2 | 0.000 | 0.28 | | 25.0 | OK | |
| N1-4.000 | N1-10 | 0.000 | 0.26 | | 23.0 | FLOOD RISK | |
| N1-3.001 | N1-7 | 0.000 | 1.22 | | 48.6 | SURCHARGED | |
| N1-3.002 | N1-8 | 0.000 | 1.84 | | 72.2 | SURCHARGED | |
| N1-3.003 | N1-9 | 0.000 | 2.02 | | 72.6 | SURCHARGED | |
| N1-3.004 | N1-91 | 0.000 | 0.28 | | 10.3 | SURCHARGED | |
| N1-5.000 | N1-11 | 0.000 | 0.07 | | 2.4 | SURCHARGED | |
| N1-5.001 | N1-92 | 0.000 | 0.06 | | 2.4 | SURCHARGED | |
| N1-6.000 | N1-93 | 0.000 | 0.16 | | 7.4 | SURCHARGED | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Network 2.SWS

Pipe Sizes Network 1 Manhole Sizes Network 1

FEH Rainfall Model

| | |
|---|---|
| Return Period (years) | 2 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 640286 267538 TM 40286 67538 |
| Data Type | Point |
| Maximum Rainfall (mm/hr) | 500 |
| 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) | 0.000 |
| Maximum Backdrop Height (m) | 0.000 |
| 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 Network 2.SWS

| Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|---|---|---|---|---|---|
| 0-4 | 0.063 | 4-8 | 0.026 | 8-12 | 0.007 | 12-16 | 0.007 | 16-20 | 0.001 |

Total Area Contributing (ha) = 0.104

Total Pipe Volume (m³) = 14.392

### Network Design Table for Network 2.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | 14.997 | 0.405 | 37.0 | 0.026 | 15.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | 🔒 |
| N2-1.001 | 15.001 | 0.484 | 31.0 | 0.020 | 0.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | 🔒 |
| N2-1.002 | 20.265 | 0.699 | 29.0 | 0.023 | 0.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | 🔒 |
| N2-1.003 | 21.005 | 0.568 | 37.0 | 0.035 | 0.00 | 0.0 | | 0.029 | →\|○\|→ | | Filter Drain | 🔒 |
| N2-1.004 | 4.900 | 0.049 | 100.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | 🔓 |
| N2-1.005 | 9.360 | 0.019 | 500.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | 33.86 | 15.29 | 11.800 | 0.026 | 0.0 | 0.0 | 0.0 | 0.87 | 167.4 | 2.4 |
| N2-1.001 | 33.52 | 15.55 | 11.395 | 0.046 | 0.0 | 0.0 | 0.0 | 0.95 | 184.5 | 4.2 |
| N2-1.002 | 33.09 | 15.89 | 10.911 | 0.069 | 0.0 | 0.0 | 0.0 | 0.98 | 191.2 | 6.2 |
| N2-1.003 | 32.59 | 16.29 | 10.212 | 0.104 | 0.0 | 0.0 | 0.0 | 0.87 | 170.2 | 9.2 |
| N2-1.004 | 32.52 | 16.36 | 9.644 | 0.104 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 9.2 |
| N2-1.005 | 32.19 | 16.63 | 9.595 | 0.104 | 0.0 | 0.0 | 0.0 | 0.58 | 23.0 | 9.2 |

Manhole Schedules for Network 2.SWS

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | PN (Pipe Out) | Pipe Out Invert Level (m) | Pipe Out Diameter (mm) | PN (Pipes In) | Pipes In Invert Level (m) | Pipes In Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N2-1 | 12.800 | 1.000 | Open Manhole | 1050 | N2-1.000 | 11.800 | | | | | |
| N2-2 | 12.403 | 1.008 | Open Manhole | 1050 | N2-1.001 | 11.395 | | N2-1.000 | 11.395 | | |
| N2-3 | 11.921 | 1.010 | Open Manhole | 1050 | N2-1.002 | 10.911 | | N2-1.001 | 10.911 | | |
| N2-4 | 11.227 | 1.015 | Open Manhole | 1050 | N2-1.003 | 10.212 | | N2-1.002 | 10.212 | | |
| N2-5 | 10.700 | 1.056 | Open Manhole | 1050 | N2-1.004 | 9.644 | 225 | N2-1.003 | 9.644 | | |
| N2-6 | 10.700 | 1.105 | Open Manhole | 1050 | N2-1.005 | 9.595 | 225 | N2-1.004 | 9.595 | 225 | |
| N2- | 10.700 | 1.123 | Open Manhole | 0 | | OUTFALL | | N2-1.005 | 9.577 | 225 | |

| MH Name | Manhole Easting (m) | Manhole Northing (m) | Intersection Easting (m) | Intersection Northing (m) | Manhole Access | Layout (North) |
|---|---|---|---|---|---|---|
| N2-1 | 639956.641 | 268810.644 | 639956.641 | 268810.644 | Required | |
| N2-2 | 639956.495 | 268825.005 | 639956.495 | 268825.005 | Required | |
| N2-3 | 639959.332 | 268839.735 | 639959.332 | 268839.735 | Required | |
| N2-4 | 639963.520 | 268859.456 | 639963.520 | 268859.456 | Required | |
| N2-5 | 639969.147 | 268879.367 | 639969.147 | 268879.367 | Required | |
| N2-6 | 639974.011 | 268878.784 | 639974.011 | 268878.784 | Required | |
| N2- | 639972.843 | 268869.498 | | | No Entry | |

## Area Summary for Network 2.SWS

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.026 | 0.026 | 0.026 |
| 1.001 | - | - | 100 | 0.020 | 0.020 | 0.020 |
| 1.002 | - | - | 100 | 0.023 | 0.023 | 0.023 |
| 1.003 | - | - | 100 | 0.035 | 0.035 | 0.035 |
| 1.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 0.104 | 0.104 | 0.104 |

## Free Flowing Outfall Details for Network 2.SWS

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| N2-1.005 | N2- | 10.700 | 9.577 | 0.000 | 0 | 0 |

## Simulation Criteria for Network 2.SWS

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.750 | Additional Flow - % of Total Flow | 0.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 9 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Summer |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.400 | Storm Duration (mins) | 30 |
| Ratio R | 0.406 | | |

Online Controls for Network 2.SWS

Weir Manhole: N2-6, DS/PN: N2-1.005, Volume ($m^3$): 1.1

Discharge Coef 0.544 Width (m) 0.500 Invert Level (m) 10.500

## Storage Structures for Network 2.SWS

### Filter Drain Pipe: N2-1.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 15.0 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 3.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 37.0 |
| Invert Level (m) | 11.800 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.6 | Cap Infiltration Depth (m) | 0.000 |

### Lined Soakaway Manhole: N2-2, DS/PN: N2-1.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.06984 | Ring Diameter (m) | 1.05 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pit Multiplier | 1.5 |
| Safety Factor | 3.0 | Number Required | 1 |
| Porosity | 0.30 | Cap Volume Depth (m) | 1.000 |
| Invert Level (m) | 10.395 | Cap Infiltration Depth (m) | 0.000 |

### Filter Drain Pipe: N2-1.001

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 15.0 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 3.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 31.0 |
| Invert Level (m) | 11.395 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.6 | Cap Infiltration Depth (m) | 0.000 |

### Lined Soakaway Manhole: N2-3, DS/PN: N2-1.002

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.06984 | Ring Diameter (m) | 1.05 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pit Multiplier | 1.5 |
| Safety Factor | 3.0 | Number Required | 1 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 9.911 | Cap Infiltration Depth (m) | 1.000 |

### Filter Drain Pipe: N2-1.002

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 20.3 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 3.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 29.0 |
| Invert Level (m) | 10.911 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.6 | Cap Infiltration Depth (m) | 0.000 |

### Lined Soakaway Manhole: N2-4, DS/PN: N2-1.003

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.06984 | Ring Diameter (m) | 1.05 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pit Multiplier | 1.5 |
| Safety Factor | 3.0 | Number Required | 1 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 9.212 | Cap Infiltration Depth (m) | 1.000 |

## Filter Drain Pipe: N2-1.003

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 21.0 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 3.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 37.0 |
| Invert Level (m) | 10.212 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.6 | Cap Infiltration Depth (m) | 0.000 |

## Lined Soakaway Manhole: N2-5, DS/PN: N2-1.004

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.06984 | Ring Diameter (m) | 1.05 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pit Multiplier | 1.5 |
| Safety Factor | 3.0 | Number Required | 1 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 8.644 | Cap Infiltration Depth (m) | 1.000 |

## Lined Soakaway Manhole: N2-6, DS/PN: N2-1.005

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.06984 | Ring Diameter (m) | 2.70 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pit Multiplier | 1.5 |
| Safety Factor | 3.0 | Number Required | 3 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 8.500 | Cap Infiltration Depth (m) | 0.000 |

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

### 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 Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 9 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 30 Winter | 2 | +0% | | | | | 11.831 | -0.969 |
| N2-1.001 | N2-2 | 30 Winter | 2 | +0% | | | 2/15 Summer | | 11.435 | -0.968 |
| N2-1.002 | N2-3 | 120 Summer | 2 | +0% | | | 2/15 Winter | | 10.953 | -0.968 |
| N2-1.003 | N2-4 | 120 Summer | 2 | +0% | | | 2/30 Summer | | 10.268 | -0.959 |
| N2-1.004 | N2-5 | 120 Winter | 2 | +0% | 100/15 Summer | | 2/30 Summer | | 9.702 | -0.168 |
| N2-1.005 | N2-6 | 480 Winter | 2 | +0% | 100/120 Summer | | | | 8.777 | -1.043 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 0.000 | 0.01 | | 2.1 | OK | |
| N2-1.001 | N2-2 | 0.000 | 0.02 | | 3.1 | OK | |
| N2-1.002 | N2-3 | 0.000 | 0.02 | | 4.0 | OK | |
| N2-1.003 | N2-4 | 0.000 | 0.03 | | 5.6 | OK | |
| N2-1.004 | N2-5 | 0.000 | 0.14 | | 4.4 | OK | |
| N2-1.005 | N2-6 | 0.000 | 0.00 | | 0.0 | OK | |

## 5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 2.SWS

### 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 Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 9 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 30 Winter | 5 | +0% | | | | | 11.837 | -0.963 |
| N2-1.001 | N2-2 | 30 Winter | 5 | +0% | | | 2/15 Summer | | 11.448 | -0.955 |
| N2-1.002 | N2-3 | 30 Winter | 5 | +0% | | | 2/15 Winter | | 10.969 | -0.952 |
| N2-1.003 | N2-4 | 30 Winter | 5 | +0% | | | 2/30 Summer | | 10.287 | -0.940 |
| N2-1.004 | N2-5 | 60 Winter | 5 | +0% | 100/15 Summer | | 2/30 Summer | | 9.723 | -0.147 |
| N2-1.005 | N2-6 | 480 Winter | 5 | +0% | 100/120 Summer | | | | 8.942 | -0.879 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 0.000 | 0.02 | | 2.8 | OK | |
| N2-1.001 | N2-2 | 0.000 | 0.03 | | 5.1 | OK | |
| N2-1.002 | N2-3 | 0.000 | 0.04 | | 6.9 | OK | |
| N2-1.003 | N2-4 | 0.000 | 0.06 | | 9.5 | OK | |
| N2-1.004 | N2-5 | 0.000 | 0.25 | | 7.8 | OK | |
| N2-1.005 | N2-6 | 0.000 | 0.00 | | 0.0 | OK | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 2.SWS

### 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 Coeffiecient | 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 9 Number of Real Time Controls 0

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | 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 | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 30 Winter | 30 | +0% | | | | | 11.850 | -0.950 |
| N2-1.001 | N2-2 | 15 Winter | 30 | +0% | | | 2/15 Summer | | 11.476 | -0.927 |
| N2-1.002 | N2-3 | 15 Winter | 30 | +0% | | | 2/15 Winter | | 11.020 | -0.901 |
| N2-1.003 | N2-4 | 30 Summer | 30 | +0% | | | 2/30 Summer | | 10.366 | -0.861 |
| N2-1.004 | N2-5 | 30 Summer | 30 | +0% | 100/15 Summer | | 2/30 Summer | | 9.795 | -0.074 |
| N2-1.005 | N2-6 | 600 Winter | 30 | +0% | 100/120 Summer | | | | 9.455 | -0.365 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 0.000 | 0.03 | | 4.8 | OK | |
| N2-1.001 | N2-2 | 0.000 | 0.05 | | 9.7 | OK | |
| N2-1.002 | N2-3 | 0.000 | 0.08 | | 14.4 | OK | |
| N2-1.003 | N2-4 | 0.000 | 0.13 | | 21.6 | OK | |
| N2-1.004 | N2-5 | 0.000 | 0.70 | | 21.9 | OK | |
| N2-1.005 | N2-6 | 0.000 | 0.00 | | 0.0 | OK | |

## 100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 2.SWS

### 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 Coeffiecient | 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 Offline Controls | 0 | Number of Time/Area Diagrams | 0 |
| Number of Online Controls | 1 | Number of Storage Structures | 9 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FEH | Data Type | Point |
| FEH Rainfall Version | 2013 | Cv (Summer) | 0.750 |
| Site Location | GB 640286 267538 TM 40286 67538 | Cv (Winter) | 0.840 |

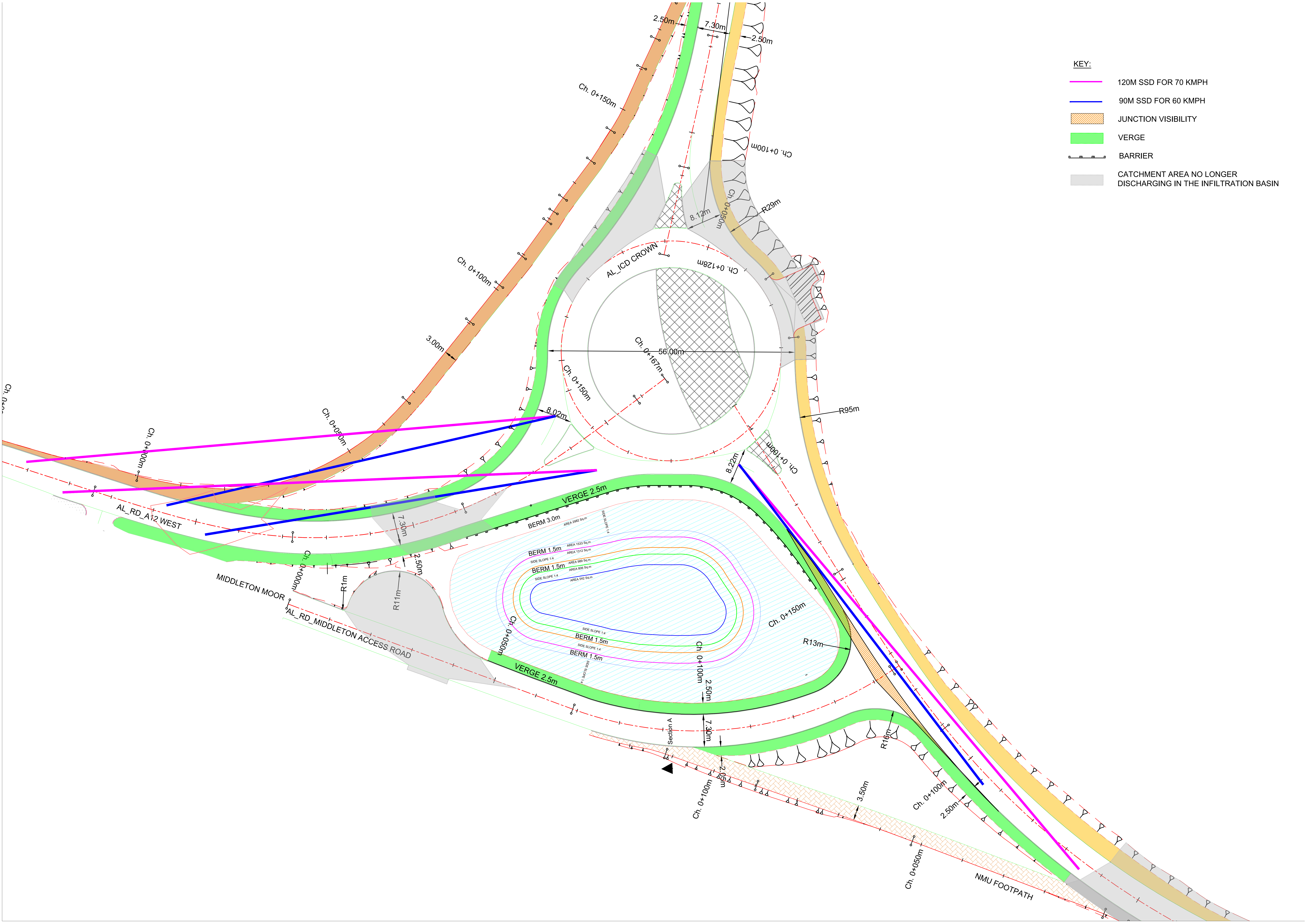
| | |
|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 |
| Analysis Timestep | 2.5 Second Increment (Extended) |
| DTS Status | OFF |
| DVD Status | ON |
| Inertia Status | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760 |
| Return Period(s) (years) | 2, 5, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 30 Winter | 100 | +40% | | | | | 11.870 | -0.930 |
| N2-1.001 | N2-2 | 15 Summer | 100 | +40% | | | 2/15 Summer | | 11.511 | -0.892 |
| N2-1.002 | N2-3 | 15 Summer | 100 | +40% | | | 2/15 Winter | | 11.094 | -0.827 |
| N2-1.003 | N2-4 | 720 Winter | 100 | +40% | | | 2/30 Summer | | 10.539 | -0.688 |
| N2-1.004 | N2-5 | 720 Winter | 100 | +40% | 100/15 Summer | | 2/30 Summer | | 10.535 | 0.666 |
| N2-1.005 | N2-6 | 720 Winter | 100 | +40% | 100/120 Summer | | | | 10.533 | 0.713 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N2-1.000 | N2-1 | 0.000 | 0.05 | | 8.7 | OK | |
| N2-1.001 | N2-2 | 0.000 | 0.10 | | 18.5 | OK | |
| N2-1.002 | N2-3 | 0.000 | 0.17 | | 32.6 | OK | |
| N2-1.003 | N2-4 | 0.000 | 0.04 | | 6.3 | OK | |
| N2-1.004 | N2-5 | 0.000 | 0.20 | | 6.1 | FLOOD RISK | |
| N2-1.005 | N2-6 | 0.000 | 0.11 | | 1.7 | FLOOD RISK | |

# APPENDIX D: INFILTRATION BASIN LAYOUT SKETCH BASE LEVEL 11.25 MAOD



KEY:
120M SSD FOR 70 KMPH
90M SSD FOR 60 KMPH
JUNCTION VISIBILITY
VERGE
BARRIER
CATCHMENT AREA NO LONGER DISCHARGING IN THE INFILTRATION BASIN
AL_ICD CROWN
56.00m
AL_RD_A12 WEST
MIDDLETON MOOR
AL_RD_MIDDLETON ACCESS ROAD
NMU FOOTPATH
VERGE 2.5m
BERM 3.0m
BERM 1.5m
Section A
R95m
R29m
R13m
R16m
R11m
R1m
8.02m
8.12m
8.22m
7.30m
2.50m
3.00m
3.50m
2.05m
Ch. 0+150m
Ch. 0+100m
Ch. 0+050m
Ch. 0+000m
Ch. 0+128m
Ch. 0+167m

# APPENDIX E: HYDRAULIC MODELLING RESULTS FOR INFILTRATION BASIN BASE LEVEL 11.25 MAOD

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Network 1.SWS

Pipe Sizes Network 1 Manhole Sizes Network 1

FEH Rainfall Model

| | |
|---|---|
| Return Period (years) | 2 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 640286 267538 TM 40286 67538 |
| Data Type | Point |
| Maximum Rainfall (mm/hr) | 500 |
| 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 Network 1.SWS

| Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|---|---|---|---|---|---|
| 0-4 | 0.362 | 4-8 | 0.138 | 8-12 | 0.090 | 12-16 | 0.079 | 16-20 | 0.022 |

Total Area Contributing (ha) = 0.690

Total Pipe Volume (m³) = 34.647

### Network Design Table for Network 1.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | 37.927 | 0.474 | 80.0 | 0.043 | 15.00 | 0.0 | | 0.029 | →\|o\|→ | | Filter Drain | |
| N1-1.001 | 9.833 | 0.098 | 100.3 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.002 | 25.404 | 0.254 | 100.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.003 | 53.084 | 0.531 | 100.0 | 0.013 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.004 | 22.158 | 0.222 | 99.8 | 0.012 | 0.00 | 0.0 | 0.600 | | o | 150 | Pipe/Conduit | |
| N1-1.005 | 20.412 | 0.491 | 41.6 | 0.159 | 0.00 | 0.0 | 0.600 | | o | 225 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | 32.82 | 16.11 | 13.482 | 0.043 | 0.0 | 0.0 | 0.0 | 0.57 | 114.3 | 3.8 |
| N1-1.001 | 32.62 | 16.27 | 12.846 | 0.043 | 0.0 | 0.0 | 0.0 | 1.00 | 17.7 | 3.8 |
| N1-1.002 | 32.12 | 16.69 | 12.748 | 0.043 | 0.0 | 0.0 | 0.0 | 1.00 | 17.8 | 3.8 |
| N1-1.003 | 31.11 | 17.57 | 12.494 | 0.056 | 0.0 | 0.0 | 0.0 | 1.00 | 17.8 | 4.7 |
| N1-1.004 | 30.71 | 17.94 | 11.963 | 0.068 | 0.0 | 0.0 | 0.0 | 1.01 | 17.8 | 5.7 |
| N1-1.005 | 30.53 | 18.11 | 11.741 | 0.227 | 0.0 | 0.0 | 0.0 | 2.03 | 80.9 | 18.8 |

## Network Design Table for Network 1.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-2.000 | 100.097 | 1.251 | 80.0 | 0.076 | 15.00 | 0.0 | | 0.029 | →\|o\|→ | | Filter Drain | |
| N1-2.001 | 31.584 | 0.316 | 100.0 | 0.025 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-2.002 | 27.428 | 0.274 | 100.0 | 0.145 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-2.003 | 11.460 | 0.115 | 100.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-2.004 | 13.058 | 0.087 | 150.1 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-3.000 | 16.186 | 0.162 | 100.0 | 0.217 | 15.00 | 0.0 | 0.600 | | o | 225 | Pipe/Conduit | |
| N1-1.006 | 3.000 | 0.015 | 200.0 | 0.000 | 0.00 | 0.0 | 0.600 | | o | 375 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-2.000 | 30.73 | 17.92 | 13.482 | 0.076 | 0.0 | 0.0 | 0.0 | 0.57 | 114.3 | 6.3 |
| N1-2.001 | 30.31 | 18.32 | 12.206 | 0.101 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 8.3 |
| N1-2.002 | 29.95 | 18.67 | 11.890 | 0.246 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 20.0 |
| N1-2.003 | 29.80 | 18.82 | 11.616 | 0.246 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 20.0 |
| N1-2.004 | 29.60 | 19.02 | 11.501 | 0.246 | 0.0 | 0.0 | 0.0 | 1.06 | 42.3 | 20.0 |
| N1-3.000 | 33.96 | 15.21 | 12.000 | 0.217 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 20.0 |
| N1-1.006 | 29.56 | 19.06 | 11.250 | 0.690 | 0.0 | 0.0 | 0.0 | 1.28 | 141.1 | 55.2 |

## Manhole Schedules for Network 1.SWS

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | PN | Pipe Out Invert Level (m) | Pipe Out Diameter (mm) | PN | Pipes In Invert Level (m) | Pipes In Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N1-6-1 | 14.732 | 1.250 | Open Manhole | 1050 | N1-1.000 | 13.482 | | | | | |
| N1-2 | 14.306 | 1.460 | Open Manhole | 1050 | N1-1.001 | 12.846 | 150 | N1-1.000 | 13.008 | | 1262 |
| N1-3 | 14.839 | 2.091 | Open Manhole | 1050 | N1-1.002 | 12.748 | 150 | N1-1.001 | 12.748 | 150 | |
| N1-4 | 15.205 | 2.711 | Open Manhole | 1050 | N1-1.003 | 12.494 | 150 | N1-1.002 | 12.494 | 150 | |
| N1-5 | 14.735 | 2.772 | Open Manhole | 1050 | N1-1.004 | 11.963 | 150 | N1-1.003 | 11.963 | 150 | |
| N1-90 | 14.735 | 2.994 | Open Manhole | 1050 | N1-1.005 | 11.741 | 225 | N1-1.004 | 11.741 | 150 | |
| N1-6-2 | 14.732 | 1.250 | Open Manhole | 1050 | N1-2.000 | 13.482 | | | | | |
| N1-7 | 13.653 | 1.447 | Open Manhole | 1050 | N1-2.001 | 12.206 | 225 | N1-2.000 | 12.231 | | 1050 |
| N1-8 | 13.685 | 1.795 | Open Manhole | 1050 | N1-2.002 | 11.890 | 225 | N1-2.001 | 11.890 | 225 | |
| N1-9 | 14.150 | 2.534 | Open Manhole | 1050 | N1-2.003 | 11.616 | 225 | N1-2.002 | 11.616 | 225 | |
| N1-91 | 14.150 | 2.649 | Open Manhole | 1050 | N1-2.004 | 11.501 | 225 | N1-2.003 | 11.501 | 225 | |
| N1-93 | 14.000 | 2.000 | Open Manhole | 1050 | N1-3.000 | 12.000 | 225 | | | | |
| N1-94 | 14.000 | 2.750 | Open Manhole | 1050 | N1-1.006 | 11.250 | 375 | N1-1.005 | 11.250 | 225 | |
| | | | | | | | | N1-2.004 | 11.414 | 225 | 14 |
| | | | | | | | | N1-3.000 | 11.838 | 225 | 438 |
| N1- | 14.276 | 3.041 | Open Manhole | 0 | | OUTFALL | | N1-1.006 | 11.235 | 375 | |

| MH Name | Manhole Easting (m) | Manhole Northing (m) | Intersection Easting (m) | Intersection Northing (m) | Manhole Access | Layout (North) |
|---|---|---|---|---|---|---|
| N1-6-1 | 640017.030 | 268676.907 | 640017.030 | 268676.907 | Required | |
| N1-2 | 640045.278 | 268651.709 | 640045.278 | 268651.709 | Required | |
| N1-3 | 640038.961 | 268644.175 | 640038.961 | 268644.175 | Required | |
| N1-4 | 640019.415 | 268660.403 | 640019.415 | 268660.403 | Required | |
| N1-5 | 639984.209 | 268700.133 | 639984.209 | 268700.133 | Required | |
| N1-90 | 639962.988 | 268706.510 | 639962.988 | 268706.510 | Required | |
| N1-6-2 | 640016.329 | 268677.689 | 640016.329 | 268677.689 | Required | |
| N1-7 | 639973.951 | 268764.964 | 639973.951 | 268764.964 | Required | |
| N1-8 | 639942.374 | 268764.316 | 639942.374 | 268764.316 | Required | |

Manhole Schedules for Network 1.SWS

| MH Name | Manhole Easting (m) | Manhole Northing (m) | Intersection Easting (m) | Intersection Northing (m) | Manhole Access | Layout (North) |
|---|---|---|---|---|---|---|
| N1-9 | 639942.936 | 268736.894 | 639942.936 | 268736.894 | Required |  |
| N1-91 | 639943.171 | 268725.436 | 639943.171 | 268725.436 | Required |  |
| N1-93 | 639938.156 | 268697.080 | 639938.156 | 268697.080 | Required |  |
| N1-94 | 639943.439 | 268712.380 | 639943.439 | 268712.380 | Required |  |
| N1- | 639940.565 | 268713.243 | | | No Entry |  |

## Area Summary for Network 1.SWS

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.043 | 0.043 | 0.043 |
| 1.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.003 | - | - | 100 | 0.013 | 0.013 | 0.013 |
| 1.004 | - | - | 100 | 0.012 | 0.012 | 0.012 |
| 1.005 | - | - | 100 | 0.159 | 0.159 | 0.159 |
| 2.000 | - | - | 100 | 0.076 | 0.076 | 0.076 |
| 2.001 | - | - | 100 | 0.025 | 0.025 | 0.025 |
| 2.002 | - | - | 100 | 0.145 | 0.145 | 0.145 |
| 2.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 2.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.000 | - | - | 100 | 0.217 | 0.217 | 0.217 |
| 1.006 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 0.690 | 0.690 | 0.690 |

## Free Flowing Outfall Details for Network 1.SWS

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| N1-1.006 | N1- | 14.276 | 11.235 | 0.000 | 0 | 0 |

## Storage Structures for Network 1.SWS

### Filter Drain Pipe: N1-1.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 37.9 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 80.0 |
| Invert Level (m) | 13.482 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.5 | Cap Infiltration Depth (m) | 0.000 |

### Filter Drain Pipe: N1-2.000

| | | | |
|---|---|---|---|
| Manning's N | 0.029 | Trench Length (m) | 100.1 |
| Infiltration Coefficient Base (m/hr) | 0.06984 | Pipe Diameter (m) | 0.150 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | Pipe Depth above Invert (m) | 0.000 |
| Safety Factor | 5.0 | Number of Pipes | 1 |
| Porosity | 0.30 | Slope (1:X) | 80.0 |
| Invert Level (m) | 13.482 | Cap Volume Depth (m) | 0.000 |
| Trench Width (m) | 0.5 | Cap Infiltration Depth (m) | 0.000 |

### Infiltration Basin Manhole: N1-94, DS/PN: N1-1.006

| | | | |
|---|---|---|---|
| Invert Level (m) | 11.250 | Safety Factor | 5.0 |
| Infiltration Coefficient Base (m/hr) | 0.00000 | Porosity | 1.00 |
| Infiltration Coefficient Side (m/hr) | 0.06984 | | |

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|
| 0.000 | 542.0 | 0.601 | 989.0 | 1.201 | 1533.0 |
| 0.600 | 806.0 | 1.200 | 1312.0 | 2.750 | 3000.0 |

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

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 Coeffiecient 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 640286 267538 TM 40286 67538 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760
Return Period(s) (years) 2, 5, 30, 100
Climate Change (%) 0, 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 30 Winter | 2 | +0% | | | | | 13.537 | -1.195 |
| N1-1.001 | N1-2 | 30 Winter | 2 | +0% | 100/15 Winter | | | | 12.893 | -0.103 |
| N1-1.002 | N1-3 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 12.794 | -0.104 |
| N1-1.003 | N1-4 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 12.544 | -0.100 |
| N1-1.004 | N1-5 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 12.019 | -0.094 |
| N1-1.005 | N1-90 | 15 Winter | 2 | +0% | 100/15 Summer | | | | 11.830 | -0.136 |
| N1-2.000 | N1-6-2 | 30 Winter | 2 | +0% | | | | | 13.559 | -1.173 |
| N1-2.001 | N1-7 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 12.262 | -0.169 |
| N1-2.002 | N1-8 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.998 | -0.117 |
| N1-2.003 | N1-9 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.729 | -0.112 |
| N1-2.004 | N1-91 | 15 Winter | 2 | +0% | 30/15 Summer | | | | 11.628 | -0.098 |
| N1-3.000 | N1-93 | 30 Winter | 2 | +0% | 100/15 Summer | | | | 12.096 | -0.129 |
| N1-1.006 | N1-94 | 5760 Winter | 2 | +0% | 5/1440 Winter | | | | 11.600 | -0.025 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 0.000 | 0.03 | | 3.4 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.22 | | 3.4 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.20 | | 3.4 | OK | |
| N1-1.003 | N1-4 | 0.000 | 0.24 | | 4.1 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.30 | | 5.1 | OK | |
| N1-1.005 | N1-90 | 0.000 | 0.33 | | 24.1 | OK | |
| N1-2.000 | N1-6-2 | 0.000 | 0.05 | | 5.9 | OK | |
| N1-2.001 | N1-7 | 0.000 | 0.14 | | 6.7 | OK | |
| N1-2.002 | N1-8 | 0.000 | 0.46 | | 22.3 | OK | |
| N1-2.003 | N1-9 | 0.000 | 0.51 | | 22.3 | OK | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-2.004 | N1-91 | 0.000 | 0.61 | | 22.2 | OK | |
| N1-3.000 | N1-93 | 0.000 | 0.38 | | 17.6 | OK | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | OK | |

## 5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 1.SWS

### 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 Coeffiecient 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 3 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 640286 267538 TM 40286 67538 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760
Return Period(s) (years) 2, 5, 30, 100
Climate Change (%) 0, 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 30 Winter | 5 | +0% | | | | | 13.548 | -1.184 |
| N1-1.001 | N1-2 | 30 Winter | 5 | +0% | 100/15 Winter | | | | 12.901 | -0.095 |
| N1-1.002 | N1-3 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.801 | -0.097 |
| N1-1.003 | N1-4 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.553 | -0.091 |
| N1-1.004 | N1-5 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.030 | -0.083 |
| N1-1.005 | N1-90 | 15 Winter | 5 | +0% | 100/15 Summer | | | | 11.847 | -0.119 |
| N1-2.000 | N1-6-2 | 30 Winter | 5 | +0% | | | | | 13.575 | -1.157 |
| N1-2.001 | N1-7 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.272 | -0.159 |
| N1-2.002 | N1-8 | 15 Winter | 5 | +0% | 30/15 Summer | | | | 12.020 | -0.095 |
| N1-2.003 | N1-9 | 15 Winter | 5 | +0% | 30/15 Summer | | | | 11.752 | -0.089 |
| N1-2.004 | N1-91 | 15 Winter | 5 | +0% | 30/15 Summer | | | | 11.657 | -0.069 |
| N1-3.000 | N1-93 | 30 Winter | 5 | +0% | 100/15 Summer | | | | 12.115 | -0.110 |
| N1-1.006 | N1-94 | 5760 Winter | 5 | +0% | 5/1440 Winter | | | | 11.655 | 0.030 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 0.000 | 0.04 | | 4.6 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.29 | | 4.6 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.27 | | 4.6 | OK | |
| N1-1.003 | N1-4 | 0.000 | 0.33 | | 5.7 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.41 | | 6.9 | OK | |
| N1-1.005 | N1-90 | 0.000 | 0.44 | | 32.6 | OK | |
| N1-2.000 | N1-6-2 | 0.000 | 0.07 | | 8.1 | OK | |
| N1-2.001 | N1-7 | 0.000 | 0.19 | | 9.2 | OK | |
| N1-2.002 | N1-8 | 0.000 | 0.62 | | 30.0 | OK | |
| N1-2.003 | N1-9 | 0.000 | 0.68 | | 30.0 | OK | |

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Network 1.SWS

| PN | US/MH Name | Flooded Volume ($m^3$) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-2.004 | N1-91 | 0.000 | 0.81 | | 29.7 | OK | |
| N1-3.000 | N1-93 | 0.000 | 0.52 | | 23.8 | OK | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

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

### 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 Coeffiecient 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 3 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 640286 267538 TM 40286 67538 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760
Return Period(s) (years) 2, 5, 30, 100
Climate Change (%) 0, 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 30 Winter | 30 | +0% | | | | | 13.572 | -1.160 |
| N1-1.001 | N1-2 | 30 Winter | 30 | +0% | 100/15 Winter | | | | 12.921 | -0.075 |
| N1-1.002 | N1-3 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 12.819 | -0.079 |
| N1-1.003 | N1-4 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 12.572 | -0.072 |
| N1-1.004 | N1-5 | 15 Winter | 30 | +0% | 100/15 Summer | | | | 12.055 | -0.058 |
| N1-1.005 | N1-90 | 15 Winter | 30 | +0% | 100/15 Summer | | | | 11.913 | -0.053 |
| N1-2.000 | N1-6-2 | 30 Winter | 30 | +0% | | | | | 13.620 | -1.112 |
| N1-2.001 | N1-7 | 15 Winter | 30 | +0% | 100/15 Summer | | | | 12.319 | -0.112 |
| N1-2.002 | N1-8 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 12.297 | 0.182 |
| N1-2.003 | N1-9 | 15 Winter | 30 | +0% | 30/15 Summer | | | | 11.970 | 0.129 |
| N1-2.004 | N1-91 | 2880 Winter | 30 | +0% | 30/15 Summer | | | | 11.829 | 0.103 |
| N1-3.000 | N1-93 | 30 Winter | 30 | +0% | 100/15 Summer | | | | 12.162 | -0.063 |
| N1-1.006 | N1-94 | 2160 Winter | 30 | +0% | 5/1440 Winter | | | | 11.828 | 0.203 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 0.000 | 0.07 | | 7.8 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.50 | | 7.8 | OK | |
| N1-1.002 | N1-3 | 0.000 | 0.46 | | 7.8 | OK | |
| N1-1.003 | N1-4 | 0.000 | 0.53 | | 9.1 | OK | |
| N1-1.004 | N1-5 | 0.000 | 0.66 | | 11.1 | OK | |
| N1-1.005 | N1-90 | 0.000 | 0.93 | | 67.9 | OK | |
| N1-2.000 | N1-6-2 | 0.000 | 0.12 | | 13.7 | OK | |
| N1-2.001 | N1-7 | 0.000 | 0.27 | | 13.2 | OK | |
| N1-2.002 | N1-8 | 0.000 | 1.11 | | 53.6 | SURCHARGED | |
| N1-2.003 | N1-9 | 0.000 | 1.18 | | 52.3 | SURCHARGED | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-2.004 | N1-91 | 0.000 | 0.07 | | 2.4 | SURCHARGED | |
| N1-3.000 | N1-93 | 0.000 | 0.87 | | 39.9 | OK | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

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

### 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 Coeffiecient 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 3 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 0.750
Site Location GB 640286 267538 TM 40286 67538 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760
Return Period(s) (years) 2, 5, 30, 100
Climate Change (%) 0, 0, 0, 40

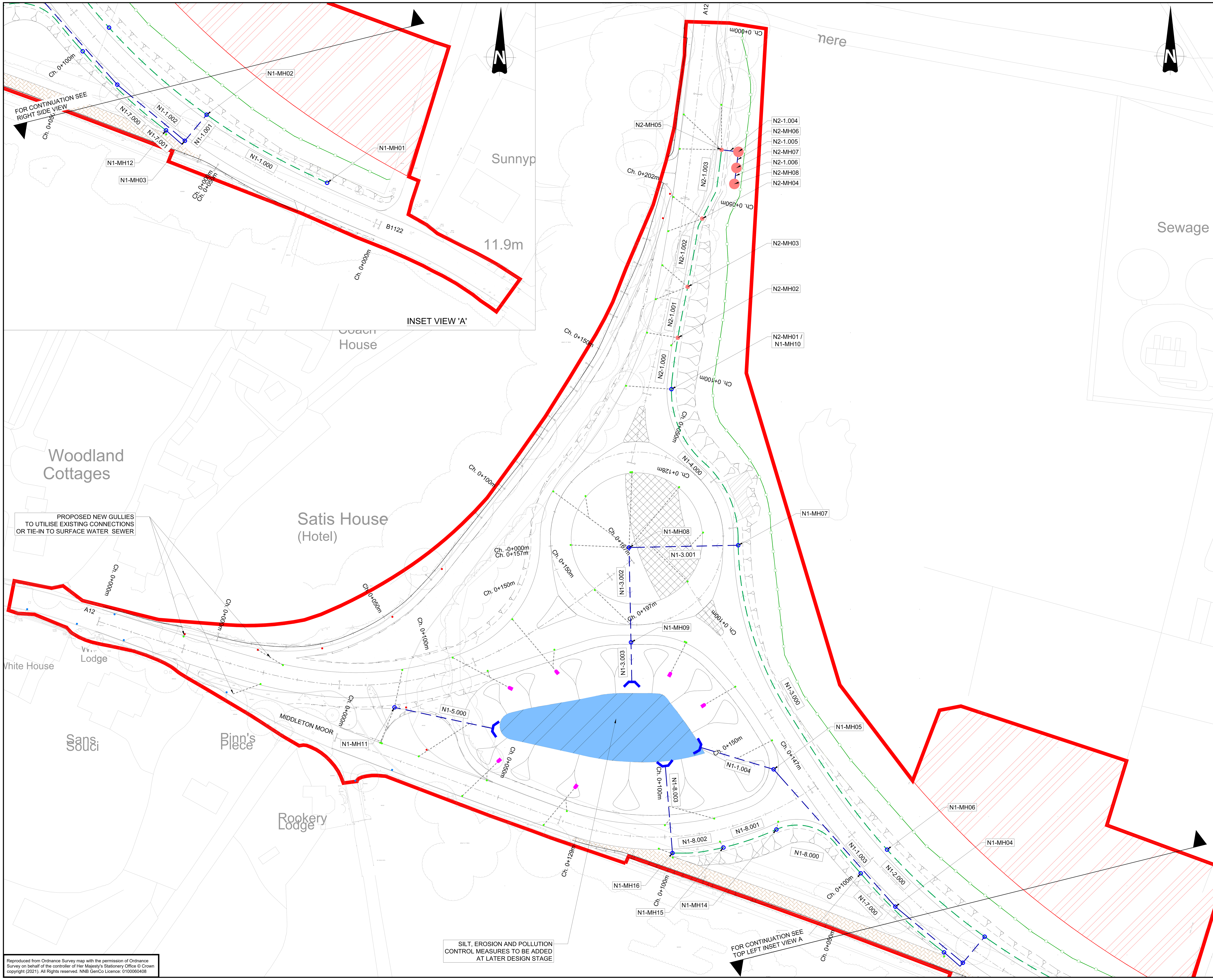
| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 30 Winter | 100 | +40% | | | | | 13.624 | -1.108 |
| N1-1.001 | N1-2 | 15 Winter | 100 | +40% | 100/15 Winter | | | | 13.068 | 0.072 |
| N1-1.002 | N1-3 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 13.017 | 0.119 |
| N1-1.003 | N1-4 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 12.943 | 0.299 |
| N1-1.004 | N1-5 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 12.752 | 0.639 |
| N1-1.005 | N1-90 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 12.622 | 0.656 |
| N1-2.000 | N1-6-2 | 30 Winter | 100 | +40% | | | | | 13.740 | -0.992 |
| N1-2.001 | N1-7 | 15 Winter | 100 | +40% | 100/15 Summer | | | | 13.145 | 0.714 |
| N1-2.002 | N1-8 | 15 Winter | 100 | +40% | 30/15 Summer | | | | 13.139 | 1.023 |
| N1-2.003 | N1-9 | 15 Winter | 100 | +40% | 30/15 Summer | | | | 12.392 | 0.552 |
| N1-2.004 | N1-91 | 1440 Winter | 100 | +40% | 30/15 Summer | | | | 12.166 | 0.440 |
| N1-3.000 | N1-93 | 30 Winter | 100 | +40% | 100/15 Summer | | | | 12.451 | 0.226 |
| N1-1.006 | N1-94 | 1440 Winter | 100 | +40% | 5/1440 Winter | | | | 12.164 | 0.539 |

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-1.000 | N1-6-1 | 0.000 | 0.13 | | 14.3 | OK | |
| N1-1.001 | N1-2 | 0.000 | 0.89 | | 14.0 | SURCHARGED | |
| N1-1.002 | N1-3 | 0.000 | 0.88 | | 14.9 | SURCHARGED | |
| N1-1.003 | N1-4 | 0.000 | 1.00 | | 17.4 | SURCHARGED | |
| N1-1.004 | N1-5 | 0.000 | 1.40 | | 23.5 | SURCHARGED | |
| N1-1.005 | N1-90 | 0.000 | 1.49 | | 109.3 | SURCHARGED | |
| N1-2.000 | N1-6-2 | 0.000 | 0.27 | | 30.5 | OK | |
| N1-2.001 | N1-7 | 0.000 | 0.78 | | 38.0 | SURCHARGED | |
| N1-2.002 | N1-8 | 0.000 | 1.63 | | 78.9 | SURCHARGED | |
| N1-2.003 | N1-9 | 0.000 | 1.78 | | 78.5 | SURCHARGED | |

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

| PN | US/MH Name | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|
| N1-2.004 | N1-91 | 0.000 | 0.24 | | 8.6 | SURCHARGED | |
| N1-3.000 | N1-93 | 0.000 | 1.57 | | 72.3 | SURCHARGED | |
| N1-1.006 | N1-94 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |

# APPENDIX F: DRAINAGE NETWORK LAYOUT WITH HYDRAULIC MODEL LABELS




NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE SURVEY DATUM UNLESS STATED OTHERWISE.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH WITH ALL RELEVANT ENGINEERS DRAWING AND SPECIFICATION.
4. THE WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH DESIGN MANUAL FOR ROADS AND BRIDGES, MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS,CIRIA C753 THE SUDS MANUAL AND SUFFOLK COUNTY COUNCIL SPECIFIC STANDARD DETAILS AND SPECIFICATIONS AS APPROPRIATE.
5. POSITION OF PROPOSED HIGHWAY GULLIES IS APPROXIMATE AND TO BE FIXED AT DETAILED DESIGN STAGE.
6. CONDITION OF RETAINED GULLIES TO BE ASSESSED BY CONTRACTOR, CLEANED AND REPLACED IF IN POOR CONDITION. DISCARDED GULLY CONNECTIONS FROM FILLED OR REMOVED GULLIES ARE TO BE INSPECTED AND PLUGGED WITH GROUT.
7. ALL MANHOLES SHALL BE CATCHPIT MANHOLES.
8. POLLUTION CONTROL MEASURES TO BE ADDED AT DETAILED DESIGN STAGE FOLLOWING RECOMMENDATIONS OF HEWRAT ASSESSMENT.
9. DRAINAGE PIPE AND MANHOLE REFERENCE RELATE TO THOSE CONTAINED IN THE HYDRAULIC MODEL.

KEY:

- PROPOSED FILTER DRAINS
- PROPOSED CARRIER DRAINS
- PROPOSED GULLY CONNECTION
- PROPOSED GULLY
- EXISTING GULLY TO BE RETAINED
- EXISTING GULLY TO BE DISCARDED
- PROPOSED CATCHPIT
- PROPOSED SOAKAWAY PIT
- PROPOSED HEADWALL
- PROPOSED FLOW SPREADER ACO OR SIMILAR APPROVED
- PROPOSED INFILTRATION BASIN LOCATION AND EXTENT
- PROPOSED FENCE
- RED LINE BOUNDARY
- PROPOSED OVERRUNABLE ISLAND FOR AIL VEHICLES
- YOXFORD TEMPORARY CONTRACTOR COMPOUND AREA
- PROPOSED POLICE WAITING BAY

| Rev. | Date | Description | App'd | Auth'd |
|---|---|---|---|---|
| P02 | 04/06/21 | Final Issue | TA | --- |
| P01 | 11/01/21 | First Revision | TA | --- |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Client

Project Title
AD3 MAJOR ROAD SCHEMES
AD0330 YOXFORD JUNCTION

Drawing Title
PRELIMINARY DESIGN
DRAINAGE HIGHWAYS
NETWORK LAYOUT

| Scale @ A1 | Date | Drawn | Check | Approved | Authorised |
|---|---|---|---|---|---|
| 1:500 | 11/01/21 | ZC | DL | TA | --- |

| Suitability | Status | Stage |
|---|---|---|
| S4 | Suitable for Stage Approval | 3 |

| Drawing Number | Revision |
|---|---|
| SZC-AD0330-WSP-YOXHDG-ZZ0000-DRW-HCD-305001 | P02 |



WSP Project Number: 70071215

# APPENDIX G: POLLUTION ASSESSMENT RESULTS(HEWRAT)

# TECHNICAL NOTE 16

| | | | |
|---|---|---|---|
| **DATE:** | 21 July 2021 | **CONFIDENTIALITY:** | Confidential |
| **SUBJECT:** | Sizewell C - Associated Development Major Highway Schemes – Yoxford Roundabout | | |
| **PROJECT:** | 70071215 | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

# YOXFORD ROUNDABOUT – POLLUTION ASSESSMENT REPORT

## 1 INTRODUCTION

1.1. WSP has been commissioned by Sizewell Co. (SZC) to validate and develop the design of the Yoxford Roundabout (YR) that was submitted to the Planning Inspectorate as part of a Development Consent Order (DCO) application to build and operate a new nuclear power station to the north of Sizewell B. The YR shall be designed to Suffolk County Council's (SCC) adoptable standards.

1.1. The YR forms one of the Associated Developments (AD) which are required to mitigate traffic impacts arising from the Main Development Site construction activities. The YR consists of a new three arm roundabout , which includes the realignment of the existing A12 and B1122 Middleton Road, and the removal of the existing A12 and B1122 ghost island junction.

1.2. YR and its associated arms will require provision of highway drainage infrastructure to effectively remove highway runoff for disposal. Highway runoff will collect contaminants from the road surface which can cause pollution to the receiving water body whether it be watercourse or aquafer. The extent of pollution and whether it is low so as to be acceptable depends on the discharge rate and volume. It also depends on the drainage infrastructure (treatment train) provided which can remove some contaminants, the receiving water body and discharge dilution rate.

1.3. In addition to general lower level pollution in the highway runoff produced by rainfall, there is a risk that pollution may occur as a result of road traffic accident or other incident resulting in spillage onto the highway.

1.4. Prior to the DCO submission, pollution risk was discussed in workshops attended by SCC and the Environment Agency (EA). They both confirmed that an assessment of pollution risk is required. Since the YR is a highway and is designed in accordance with the requirements of Design Manual for Roads and Bridges (DMRB), it was agreed that the Highways England Water Risk Assessment Tool (HEWRAT) would be used as a basis for assessment. The HEWRAT assessment methodology is set out in DMRB LA113.

1.5. This Technical Note (TN) 16 Pollution Assessment Report sets outs the results of the HEWRAT assessment. The calculations and results are contained in Appendix A.

## 2 PURPOSE

2.1 This TN provides details of an assessment of pollution risk to water bodies as a result of construction and use of the YR and its associated arms due to

- Contaminates which are contained in highway runoff generated by rainfall
- Accidental spillage of contaminates on the highway

# TECHNICAL NOTE 16

| | | | |
|---|---|---|---|
| **DATE:** | 21 July 2021 | **CONFIDENTIALITY:** | Confidential |
| **SUBJECT:** | Sizewell C - Associated Development Major Highway Schemes – Yoxford Roundabout | | |
| **PROJECT:** | 70071215 | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

2.2 The assessment methodology is described in the results report shown in Appendix A, The methodology includes for an assessment of the effectiveness of the treatment train infrastructure provided, which has the effect of reducing the pollution load on the receiving water body. In this case the Preliminary Design treatment infrastructure consists of shallow vegetated channels, filter drains, one large infiltration basin and soakaway manholes.

# 3 SCOPE OF WORK

3.1 The assessment includes the YR and its associated east, north and south west arms. The assessment was undertaken during the Preliminary Design stage but before its completion and results became available in January 2021. As such the results are based on the drainage design strategy being developed at December 2020.

3.2 For YR the design was based on the assumption of infiltration to ground via filter drains, the infiltration basin and soakaway manholes. Highway runoff from the eastern and part of the northern arm would be discharged from the road either over the edge into a shallow vegetated channel with underlying filter drain or via gullies into collector drains. For the roundabout and south west arm highway runoff would discharge via gullies and carrier drains. All runoff would discharge into the infiltration basin located immediately south of the roundabout.

Highway runoff for the majority of the northern arm would be discharged via the shallow vegetated channel and filter drains or gullies into a carrier drain which would outfall to soakaway manholes located at the back of layby close to the River Yox bridge.

3.3 The vegetated channels filter out some of the silt and adsorb some of the pollutants. The infiltration basin collects remaining silt and its vegetation adsorbs more of the pollutants.

# 4 CONCLUSIONS

4.1 Following completion of the HEWRAT assessment it can be confirmed that the treatment train arrangements contained in the Preliminary Design would not be sufficient since they would create a medium risk of pollution to the underlying aquafer. This is because the groundwater level is assessed as being approximately 4 -5 metres below ground level. The potential transit time for runoff infiltration passing through the bed of the basin to it reaching the groundwater through the unsaturated zone is not sufficient to allow for an acceptable level of removal of pollutants.

4.2 The HEWRAT assessment report confirms that by providing additional treatment train measures it should be possible to reduce the risk of pollution to the underlying aquafer to low risk. The main recommendation is for the infiltration basin be lined with lower permeability material to allow draining water to have increased retention time within the unsaturated zone. Maximising the use of vegetation to filter and absorb pollutants is also recommended.

# TECHNICAL NOTE 16

| | | | |
|---|---|---|---|
| **DATE:** | 21 July 2021 | **CONFIDENTIALITY:** | Confidential |
| **SUBJECT:** | Sizewell C - Associated Development Major Highway Schemes – Yoxford Roundabout | | |
| **PROJECT:** | 70071215 | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

4.4 The addition of an impermeable lining to the base of the infiltration basin is technically achievable. It would also support the provision of vegetation such as reed beds which will improve the take up and removal of pollutants. However, it would reduce the effective area through which the runoff can infiltrate to ground by removing the base area. Hydraulic modelling of this change has been undertaken and it is confirmed that there will still be sufficient storage volume within the basin and no increased risk of flooding elsewhere.

4.5 In the case of the northern arm soakaway manhole outfall, it is not technically possible to add measures to allow draining water to have increased retention time within the unsaturated zone. This situation has been discussed with SCC in advance of formally sharing this report. It is agreed in principle that instead of the northern arm runoff being removed by infiltration, it can be discharged to the adjacent River Yox. It is noted from site inspection that this section of road does currently discharge indirectly to the River Yox.

4.6 The HEWRAT assessment results have been reported to SCC and this report will be shared for formal comment.

4.7 SCC has indicated that they may wish to see additional treatment trains added to further mitigate of pollution risk. If such additional treatment is required, this will be included as part of Detailed Design.

## 5 NEXT STEPS

5.1 As noted, the HEWRAT assessment was undertaken for the design as proposed in December 2020.

5.2 Following on from completion and acceptance of the HEWRAT assessment, the drainage arrangements for the northern arm will be changed at Detailed Design from infiltration to ground to a discharge to the River Yox. Requirements for any attenuation of flow rate and additional treatment train measures will be obtained from SCC and the Environment Agency. These will be included for implementation as part of Detailed Design.

5.3 Detailed Design for the infiltration basin will incorporate appropriate recommendations contained in the SCC SuDS palette and take account of any specific SCC treatment train requirements.

5.6 The proposed changes to the northern arm and the lining of the base of the infiltration basin have not been subject to HAWRAT assessment. It will be necessary to undertake a HAWRAT assessment to confirm that they will also pass as low risk such that discharge to watercourse or the northern arm and infiltration to ground through the infiltration basin is acceptable. The assessment should be undertaken in advance of or at the commencement of Detailed Design

# TECHNICAL NOTE 16

| | | | |
|---|---|---|---|
| **DATE:** | 21 July 2021 | **CONFIDENTIALITY:** | Confidential |
| **SUBJECT:** | Sizewell C - Associated Development Major Highway Schemes – Yoxford Roundabout | | |
| **PROJECT:** | 70071215 | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

# APPENDIX A

## DRAINAGE NETWORK WATER QUALITY ASSESSMENT

# TECHNICAL NOTE 16 Appendix A

| | | | |
|---|---|---|---|
| **DATE:** | 25 January 2021 | **CONFIDENTIALITY:** | Internal |
| **SUBJECT:** | Drainage Network Water Quality Assessment | | |
| **PROJECT:** | Yoxford Roundabout Improvement | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

## INTRODUCTION

WSP have been commissioned to complete the detailed drainage design for the Yoxford Roundabout Improvement. A water quality assessment has been carried out to determine if the proposed drainage design provides suitable treatment of highway runoff before it is discharged to ground. This technical note summarises the results of the assessment and recommends further mitigation to be included in the drainage design to ensure that there is a low risk of impact to groundwater quality.

## DATA SOURCES

The following data was used for the assessments:

- Impermeable and permeable highway catchment areas drainage to each outfall or infiltration basin
- Annual Average Traffic Flow (AADT) and Percentage HGVs for Sizewell Link Road and associated roads. Provided from the most recent traffic model for the scheme
- Rainfall depth informed by the maps in the HEWRAT user guide
- Ground Investigation data for the site
- Defra's magic mapping
- Historical borehole records (Geology of Great Britain Viewer)

## ASSESSMENT METHODOLOGY

The simple assessment methodology set out in DMRB LA113 was used to assess impact of the proposed drainage design on water quality of the underlying groundwater body.

An assessment of impacts from routine runoff to groundwater quality (Appendix C of LA113) was completed for the proposed infiltration basin to the south of the roundabout.

An assessment of spillage risk for the infiltration basin was completed (Appendix D of LA113).

## ASSESSMENT RESULTS

### Groundwater Quality (Method C)

The assessment results are presented in Table 1 below. The impact to the underlying groundwater via the infiltration basin is determined to be of 'medium risk'. This risk level is mainly attributed to the shallow groundwater expected at the proposed infiltration basin; historic borehole logs (TM46NW27 located approximately 0.20 km east of the infiltration basin) and the elevation of the Minsmere River indicate groundwater is likely to be observed between 4 and 5 mbgl. Several other reasons why the medium risk is justified include: low concentration of organic matter, highly permeable bedrock and the Crag Group designation as a Principal Aquifer. In addition to the above, there is a risk that contaminated water (if not mitigated) could impact the water quality of the abstraction borehole located 0.25 km west of the site which is noted to be used for both farming and domestic purposes.

# TECHNICAL NOTE 16 Appendix A

| | | | |
|---|---|---|---|
| **DATE:** | 25 January 2021 | **CONFIDENTIALITY:** | Internal |
| **SUBJECT:** | Drainage Network Water Quality Assessment | | |
| **PROJECT:** | Yoxford Roundabout Improvement | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

To mitigate the effects outlined above more pre-treatment of the scheme runoff is required before it gets to the water table. Ideally the basin would be lined but if this is not possible measures need to be put in place to prevent any accidental spillages essentially going straight into the aquifer, in the form of passive treatment. This could include (but not be limited to) the infiltration basin be lined with lower permeability material to allow draining water to have increased retention time within the unsaturated zone. In addition, the swales upstream of the basin should incorporate vegetation which removes a significant proportion of pollutants before water is discharged into the infiltration basin.

## Spillage Risk (Method D)

The spillage risk is less than 0.5% which is acceptable and satisfies the standards set out in LA113. The input parameters used and results are presented in Table 2.

*Table 1 - Input parameters and results for the assessment of impact to groundwater quality for Yoxford Roundabout.*

| | Parameter | Y01 | | |
|---|---|---|---|---|
| | | Value | Risk Score | Score |
| Source | Traffic flow | 13000 | 1 | 10 |
| | Rainfall depth | 550mm | 1 | 10 |
| | Drainage area ratio | 17.7 | 1 | 10 |
| Pathway | Infiltration method | Region | 2 | 30 |
| | Unsaturated zone | <4.5m bgl | 3 | 60 |
| | Flow type | Intergranular | 1 | 20 |
| | Unsaturated zone clay content | 11.9% | 2 | 10 |
| | Organic carbon | 0.2% | 3 | 15 |
| | Unsaturated zone soil pH | 6.8 | 2 | 10 |
| | **TOTAL** | | | **175 Medium risk** |

# TECHNICAL NOTE 16 Appendix A

| | | | |
|---|---|---|---|
| **DATE:** | 25 January 2021 | **CONFIDENTIALITY:** | Internal |
| **SUBJECT:** | Drainage Network Water Quality Assessment | | |
| **PROJECT:** | Yoxford Roundabout Improvement | **AUTHOR:** | [redacted] |
| **CHECKED:** | [redacted] | **APPROVED:** | [redacted] |

*Table 2 - Input parameters and results of assessment of spillage risk at Yoxford Roundabout.*

| Road label | Length (km) | Road type | Junction type | AADT | %HGV | PSPL[1] | PPOL[2] | PINC[3] | RRF[4] | Mitigated PINC |
|---|---|---|---|---|---|---|---|---|---|---|
| Ya | 0.151 | Rural Trunk Road | Roundabout | 15815 | 5 | 0.013% | 0.6 | 0.008% | 0.48 | 0.004% |
| Yb | 0.1 | Rural Trunk Road | Roundabout | 15520 | 5 | 0.009% | 0.6 | 0.005% | 0.48 | 0.003% |
| Yc | 0.036 | Rural Trunk Road | No Junction | 15520 | 5 | 0.000% | 0.6 | 0.000% | 0.48 | 0.000% |
| Yd | 0.1 | Rural Trunk Road | Roundabout | 15815 | 5 | 0.009% | 0.6 | 0.005% | 0.48 | 0.003% |
| Ye | 0.026 | Rural Trunk Road | No Junction | 15815 | 5 | 0.000% | 0.6 | 0.000% | 0.48 | 0.000% |
| Yf | 0.1 | Rural Trunk Road | Roundabout | 3878 | 3 | 0.001% | 0.6 | 0.001% | 0.48 | 0.000% |
| Yg | 0.067 | Rural Trunk Road | Side Road | 3878 | 3 | 0.000% | 0.6 | 0.000% | 0.48 | 0.000% |
| Yh | 0.024 | Rural Trunk Road | No Junction | 3878 | 3 | 0.000% | 0.6 | 0.000% | 0.48 | 0.000% |
| **TOTAL** | | | | | | | | | | **0.010%** |

[1] PSPL = annual probability of a spillage with the potential to cause a serious pollution incident
[2] PPOL = the probability, given a spillage, that a serious pollution incident will result. The location was considered to be rural with a response time to site of <1 hour.
[3] PINC = the probability of a spillage with an associated risk of a serious pollution incident occurring
[4] RRF = risk reduction factor. Implementation of swales and an infiltration basin provide a RRF of 0.48 according to the values provided in Table 8.6.4N3 of CG501. Infiltration basin has half the efficiency stated in CG501 as it is part of a linear treatment train.

# APPENDIX H: RECORD OF SCC COMMENTS AND SZC ACTIONS

| SCC Comments at Rev02 | |
|---|---|
| The general principles of surface water drainage for the road schemes (Two Village Bypass, Sizewell Link Road and Yoxford Roundabout) and agreed between SZC Co and SCC. | . |
| the details required to confirm that the drainage strategies are deliverable within the Order Limits, whilst complying with national and local policy, best practice and guidance (in order to be eligible for adoption by SCC Highways) have not been provided to SCC. Design assumptions, such as maximum water depths, maximum basin depths, side slope gradients, factors of safety and maintenance requirements has not been provided to SCC to confirm agreement, any forthcoming design which does comply with SCC requirements will not be accepted. We are therefore unable to confirm that the proposed drainage strategies deliver suitable and sufficient mitigation. | Full set of drainage drawings issued at preliminary design show all drainage infrastructure located within red line boundary<br>Details of attenuation basin parameters are provided in Appendix B and in text<br>Also provided MicroDrainage calculations shown in previously issued Hydraulic Modelling Report |
| Final results of infiltration testing, used for design, have not been provided. | Provided in Appendix A |
| Results of pollution assessments have not been provided. | Provided in Appendix G |
| It has not been demonstrated that positive outfalls (where required) are located within the Order Limits. | One outfall is now required for the A12 roundabout northern arm discharging to the river Yox as agreed with SCC and EA on 12/01/22<br>The river Yox forms the red line boundary. |

| | |
|---|---|
| SCC Comments at Rev03 dated 18/02/2022 | |
| Only potential criticism is the lack of corresponding plan for the calculations. Always difficult to interpret calcs without a plan! That being said, we wouldn't expect Network calcs at this stage usually, so you've gone a step further than needed there, which is appreciated. | Network Plan with Network Calculation Labels provided in Appendix F |

# ANNEX 2A.11: TWO VILLAGE BYPASS PRELIMINARY DRAINAGE DESIGN NOTE

## CONTENTS



## TABLES

**None provided.**

## PLATES

## FIGURES

**None provided.**

## APPENDICES

# 1 INTRODUCTION

1.1.1 NNB Generation Company (SZC) Limited (SZC Co.) submitted an application for a Development Consent Order (DCO) to the Planning Inspectorate under the Planning Act 2008 for the Sizewell C Project (referred to as the 'Application') in May 2020. The Application was accepted for examination in June 2020.

1.1.2 SZC Co. has undertaken work to validate and develop the design of the Two Village Bypass that was originally submitted as part of the DCO application. This document forms one of a series of design validation and evolution documents being provided to the Examining Authority in support of the **Outline Drainage Strategy** [REP2-033].

1.1.3 The two village bypass forms one of the Associated Developments (AD) which are required to mitigate traffic impacts arising from the main development site. The two village bypass consists of a new 2.4 km long single carriageway road bypassing the villages of Stratford St Andrew and Farnham. The new bypass will connect to the existing A12 via at grade roundabouts at both the western and eastern ends of the scheme. The roundabout at the western end ties in with the existing A12 Main Road and the roundabout at the eastern end ties in with Friday Street.

1.1.4 It will be designed to DMRB standards (**Ref.2.**) and Suffolk County Council's (SCC) adoptable standards (**Ref. 1.**). SCC adoptable standards take precedence.

1.1.5 The two village bypass will generate highway surface water runoff which will require to be removed, treated as necessary and disposed by infiltration to ground.

1.1.6 The two village bypass will cross the River Alde, its associated flood plain and two minor watercourses which need to be accommodated.

# 2 PURPOSE

2.1.1 The **Outline Drainage Strategy** [REP2-033] identified at concept level the proposed drainage approach required for:

- The effective removal of runoff from the proposed two village bypass highway and its disposal
- The crossing of the River Alde and its associated floodplain and watercourses along the line of the two village bypass

2.1.2 This strategy was developed in consultation with drainage regulators and local authorities, including SCC and the Environment Agency (EA). A number of workshops were held and the observations/requirements of drainage regulators were incorporated in the strategy.

2.1.3 The proposed drainage infrastructure was described in the concept drainage design submitted as part of the DCO application. This concept design was based on data and information available at that time. The design was supported by the submission of the **Two Village Bypass Flood Risk Assessment** (FRA) [APP-119].

2.1.4 Following the provision of new data, and subsequent to the DCO submission, SZC Co. has developed the concept level design to preliminary design stage.

2.1.5 The purpose of this technical note is to provide details of how the concept design has been modified in response to the new data, such that it continues to provide for the effective and satisfactory drainage of the two village bypass, without unacceptable adverse impact on the water environment, both in terms of flood risk and pollution.

2.1.6 The content of this technical note summarises the design details and approach already shared in a series of design review meetings held with key stakeholders, including the EA and SCC.

2.1.7 This technical note was updated at revision 03 to include for new data that has become available, provide additional information and responses to points raised by SCC following their review during the DCO Examination Stage.

2.1.8 This technical note is updated at revision 04 to address comments raised by SCC following their review of revision 03. These are shown in Appendix G

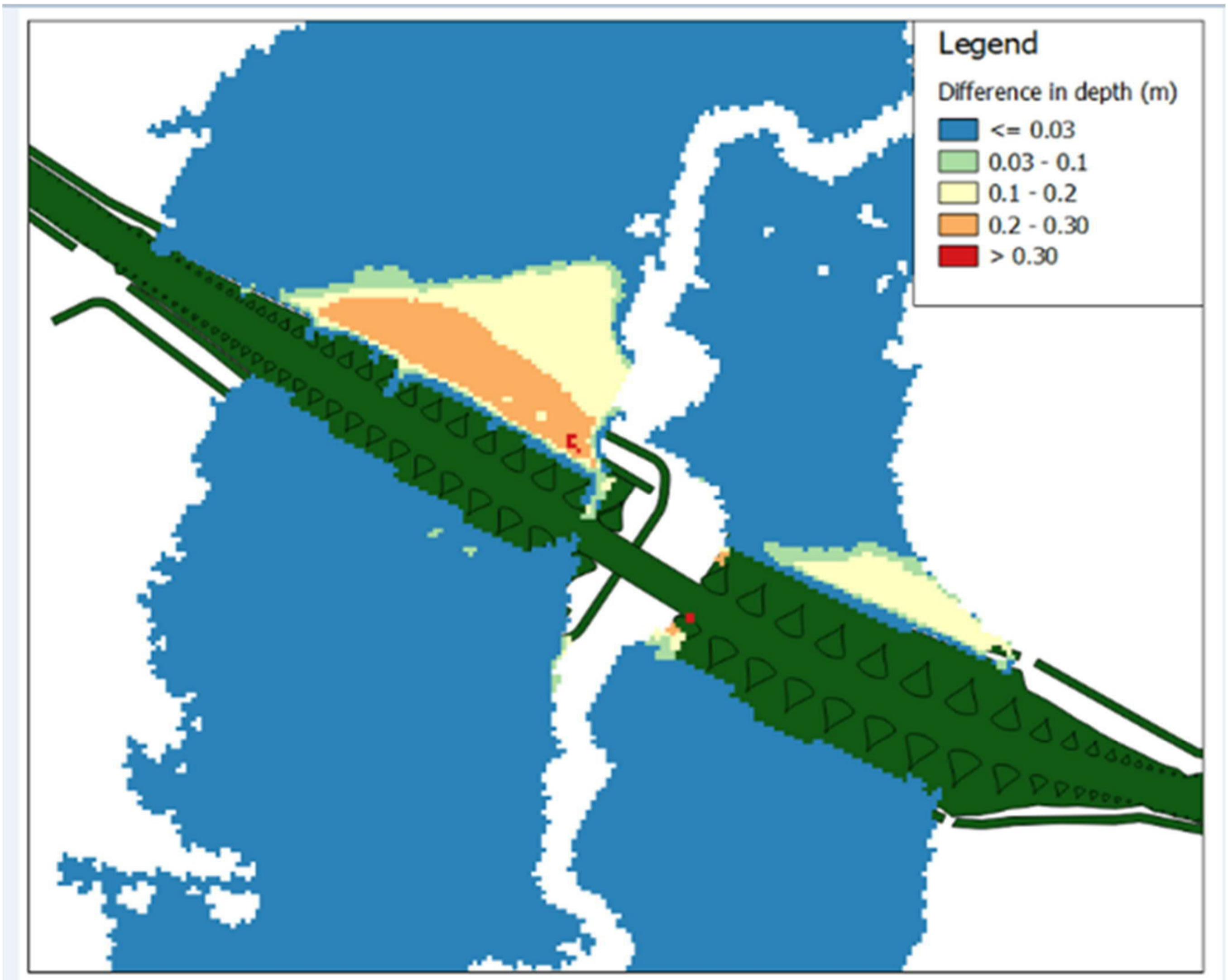
2.1.9 It is intended that this updated drainage strategy and resultant drainage infrastructure will remain in accordance with the with the **Outline Drainage Strategy** [REP2-033] submitted to the Examining Authority. It is further intended that following consultation with the Lead Local Flood Authority, it will be submitted to and approved by East Suffolk Council.

# 3 DESCRIPTION OF DCO DRAINAGE CONCEPT DESIGN

3.1.1 The concept design proposal for the road crossing of the River Alde, its floodplain, and two adjacent local watercourses is with an embankment, wide bridge and flood relief culverts. The proposals were tested by hydraulic modelling undertaken as part of the **Two Village Bypass FRA** [APP-119]. This enabled the arrangements to be modified to optimise hydraulic performance and mitigate any increase in flood risk due to the construction of the two village bypass.

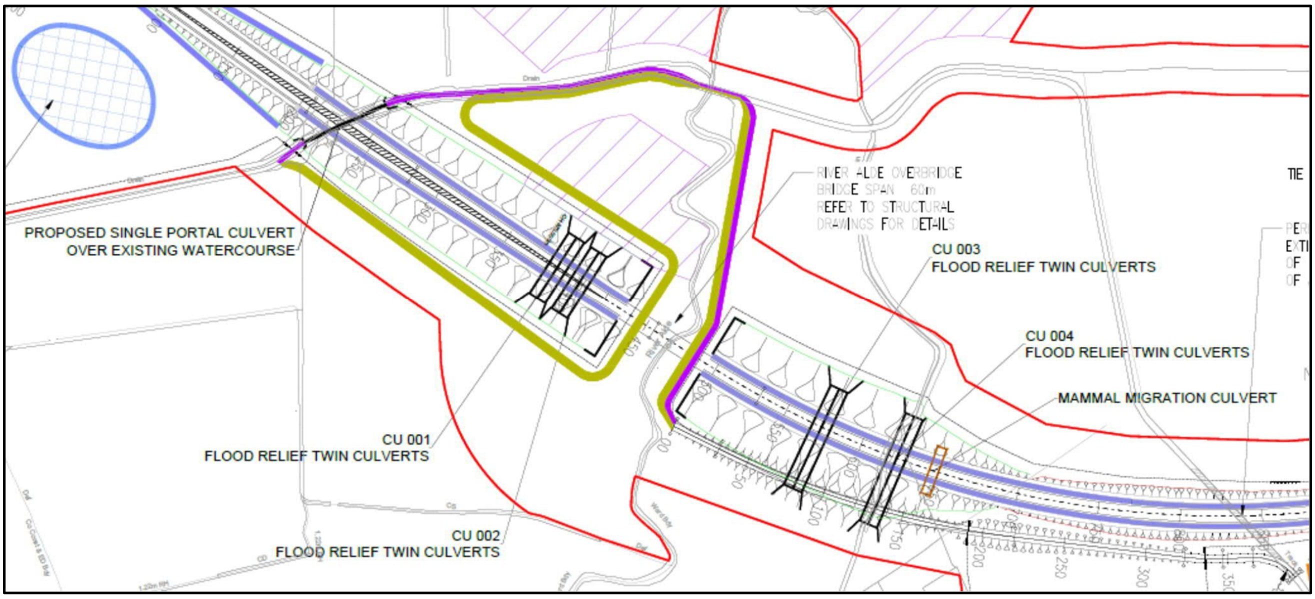
3.1.2 The final layout hydraulic modelling results predicted a limited increase in flood levels at the bridge of approximately 14 mm due to a 1 in 100 year rainfall event plus 35% climate change. Higher increases of up to 320 mm were predicted immediately upstream of the embankment but over a limited area and for a limited period. The results are shown in **Plate 1**.

**Plate 1: River Alde crossing - predicted increase in flood depth for proposed bridge and embankment**




3.1.3 The proposed final layout submitted for DCO is shown in **Plate 2**.

**Plate 2: River Alde crossing - ridge and flood relief culvert locations**




3.1.4 The concept drainage design provided for traditional drainage at the A12 roundabouts located at either end of the bypass with a combination of highway gullies and combined kerb drains (CKDs) collecting runoff and discharging via carrier drains to infiltration basins where runoff would infiltrate to ground.

3.1.5 The required size of infiltration basins required for the roundabout runoff could not, at that time, be accurately determined without validated infiltration rates. As a result, the basins were shown schematically and sufficient space within the red line boundary was provided.

3.1.6 Elsewhere on the main line of two village bypass and Hill Farm Lane side road, drainage would be by "over the edge" with runoff flowing from the carriageway to be collected in the adjacent swales. The swales were proposed to be 1 m wide, 0.5 m deep and have side slopes of 1 in 3. The location and extent of swales are shown indicatively on the DCO drawings.

3.1.7 Given the lack of validated infiltration rates the design included for the potential need for filter trenches in the base of the swale

3.1.8 In addition, as back up to the swale/filter drain arrangement, a further allowance was made for an infiltration basin located immediately east of the proposed embankment crossing of the River Alde floodplain. This basin has the twin purpose of collecting runoff not removed by the swale/filter drains but also prevents runoff flowing onto the embankment.

3.1.9 During liaison, SCC confirmed that removal of highway runoff from the River Alde embankment via infiltration within the floodplain would not be acceptable.

3.1.10 The DCO proposed the section of road between the eastern end of the embankment and the River Alde bridge would be drained either by underground drainage or drainage channel towards the bridge and then outfall with discharge into the river. Both the EA and SCC did not want highway runoff discharging directly to the river therefore in response to their concerns it was proposed that the highway on the embankment would therefore be drained either by underground drainage or a drainage channel, over the bridge, and discharge to the west and into the infiltration basin adjacent to the A12 roundabout.

3.1.11 A pipe would be provided within the bridge structure to pass forward the runoff to the west of the bridge.

3.1.12 The section of road between the River Alde bridge and the western end of the embankment would be drained either by underground drainage or drainage channel to the west and then discharge into the infiltration basin adjacent the A12 roundabout.

# 4 ADDITIONAL INPUT DATA

4.1.1 The preliminary drainage design has been developed based on the concept design but modified to take account of data which has become available since DCO submission.

4.1.2 The new data which informs the design is listed below:

- Drone topographic survey of the two village bypass route
- Topographic survey of watercourses within and adjacent to red line boundary
- Aerial view from drone flyover
- Ground investigation and infiltration testing
- Ground penetrating radar (GPR) survey
- Additional traditional topographic survey of critical locations
- Site visit and inspection of the full length of the two village bypass route on 12 January 2021 and 4 August 2021

- Highways England Water Risk Assessment Tool (HEWRAT) (**Ref. 3**)

4.1.3 The January 2021 site visit was undertaken jointly with SCC.

4.1.4 The design development has also evolved through the design review meetings held with SCC and the EA. Comments and requirements confirmed by SCC and the EA have been recorded in minutes of the review meetings and taken into account.

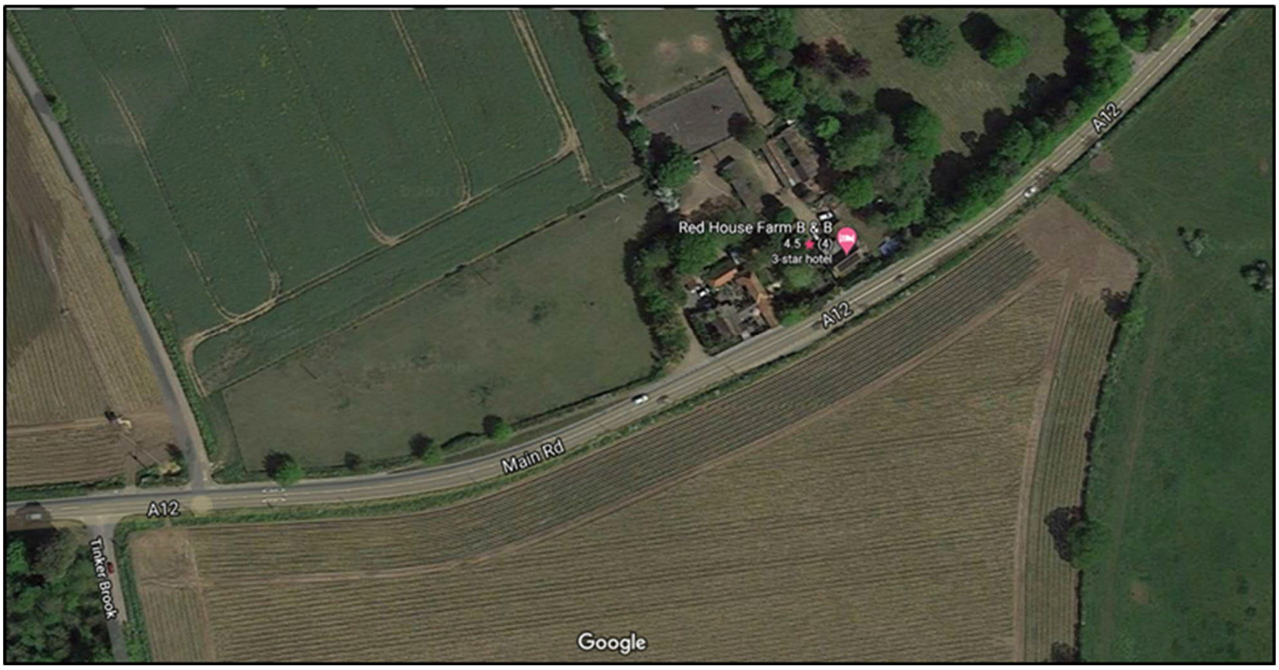
4.1.5 The final draft preliminary design will be submitted to SCC as the intended adopting Highway Authority, to SCC as Lead Local Flood Authority and the EA. Any final comments can be addressed in the preliminary design drawings and reports, prior to issue as final design.

# 5 EXISTING HIGHWAY DRAINAGE ARRANGEMENTS

5.1.1 Following the site visit and review of survey data, details of existing highway drainage arrangements have been determined and are described below. The existing arrangements have been taken into account as part of preliminary design.

5.1.2 The existing section of the A12 south of Stratford St Andrew which will be modified with the construction of the two village bypass western roundabout and shown in **Plate 3** does have some limited formal surface drainage outlets in the form of 5 gullies and 4 kerb gullies.

**Plate 3: Existing A12 at the location of two village bypass western roundabout**

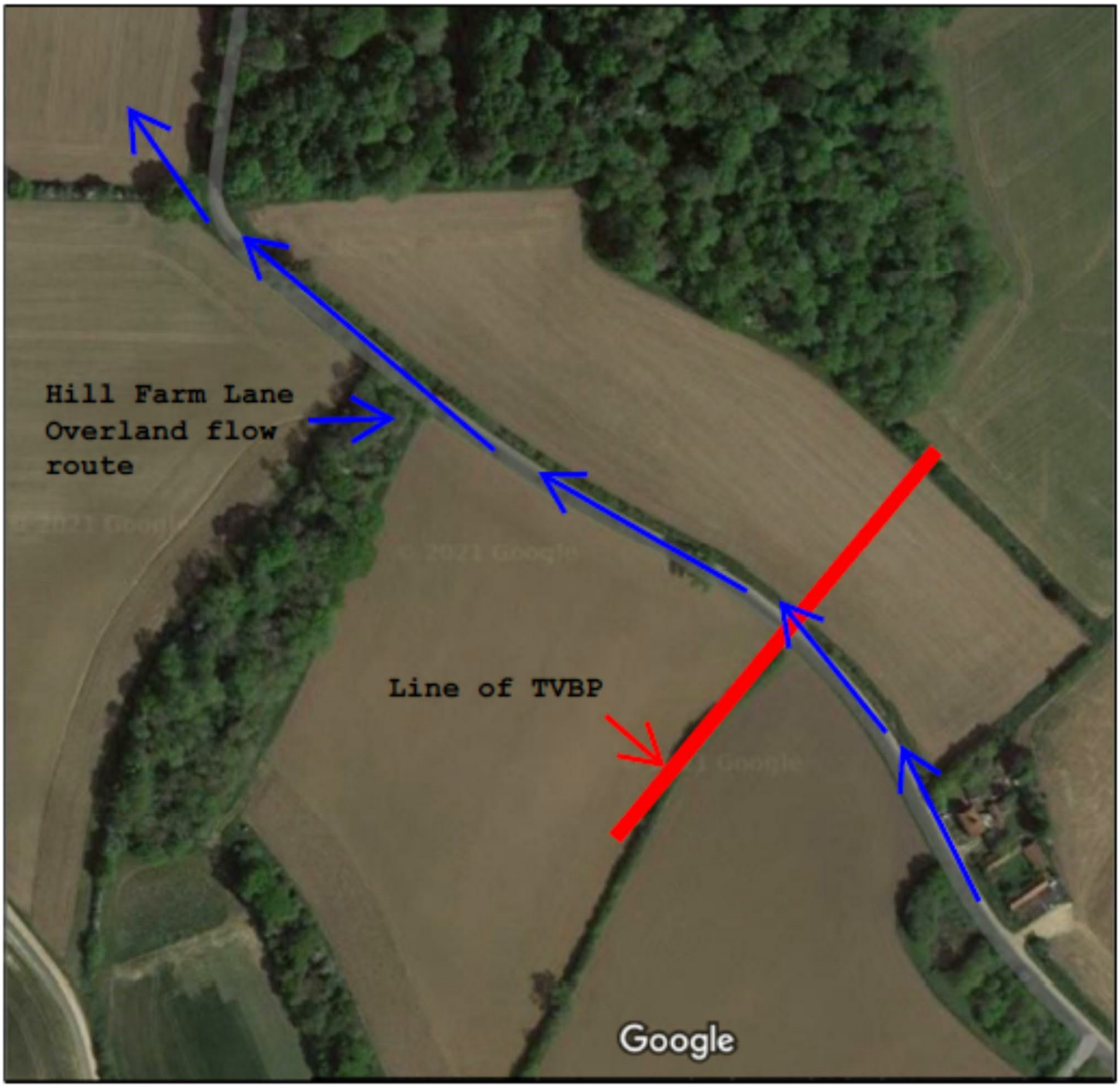



5.1.3 For part of the southbound carriageway where there is no kerb, runoff is over the edge and onto the verge.

5.1.4 During the GPR utility survey the gullies and kerb gullies were inspected and all found to be silted up to an extent which prevented survey to establish the outfall routes. No surface water manholes were identified. As a result, it is assumed that all of the gullies and kerb gullies discharge to soakaway.

5.1.5 Further to the east the proposed two village bypass route cuts across the line of Hill Farm Lane and connectivity is retained through the provision of offset staggered T junctions. The current layout of Hill Farm Lane is shown in **Plate 4**.

**Plate 4: Hill Farm Lane showing line of two village bypass and overland flow path**




5.1.6 From survey data it can be seen that there is steep fall in level along Hill Farm Lane from Pond Barn Cottages, south of the line of two village bypass, to the north. This fall was noted during the site visit. No surface drainage outlets or formal infrastructure exists. As shown in **Plate 5** there are high banks on either side of the road. These contain runoff within the road and this flows downhill to a bend in the road where it runs off into a field to the northwest.

**Plate 5: Hill Farm Lane showing high banks**


5.1.7 The existing section of the A12 to the east of Farnham will be modified with the construction of the two village bypass eastern roundabout is shown in **Plate 6**. It does have a formal drainage network which has been identified and recorded as part of the GPR utility survey. The GRP survey traced the line of some highway drains but no outfall has been identified.

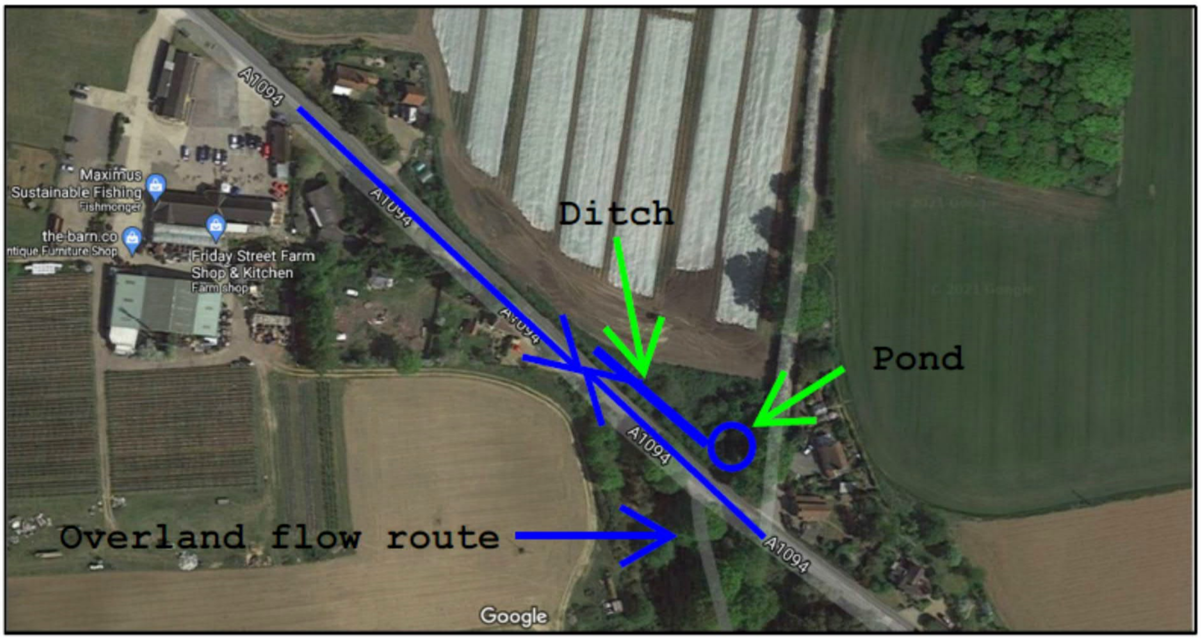
**Plate 6: Existing A12 and A1094 junction at the location of two village bypass eastern roundabout**


5.1.8 During the GPR utility survey a large number of gullies and kerb gullies were inspected and all found to be silted up to an extent which prevented survey to establish their outfall routes.

5.1.9 The junction of A12 and A1094 forms a local low point. The eastbound carriageway is lower than the westbound carriageway. The westbound carriageway has a crossfall to the centre reserve. Any runoff that does not get removed via gullies and kerb gullies flows through the gap created by the junction turning lanes and ultimately reaches the eastbound carriageway channel line.

5.1.10 The A1094 from its junction with the A12 crest point, has a steep fall to the southeast to a low point. Surface water overland flow passes from the crest point to the local low point where it is removed by a highway grip and discharges into an existing ditch. The ditch runs southeast behind the highway boundary hedge and terminates in an existing pond as shown in **Plate 7**.

**Plate 7: Existing A12 and A1094 junction at the location of two village bypass eastern roundabout**




# 6 GROUND INVESTIGATION AND INFILTRATION TESTING RESULTS

6.1.1 Ground investigation and infiltration testing has been undertaken for the two village bypass scheme. Infiltration testing was undertaken in accordance with BRE365 and the trial pit data results were shared with SCC in October 2020. Following review by SCC, it was agreed that infiltration is viable for the two village bypass.

6.1.2 Formal calculations for infiltration rates were not available A plan showing location of the infiltration test together with test results and log describing the strata are shown in **Appendix A**.

# 7 POLLUTION ASSESSMENT POLLUTION MITIGATION MEASURES ASSESSMENT

7.1.1 As agreed with SCC and the EA prior to DCO submission, the environmental impact of discharging highway runoff is to be assessed using the Highways England Water Risk Assessment Tool (HEWRAT) (**Ref. 3**)

7.1.2 The assessment results confirm that a SuDS management train with the combination of swales, filter drains and infiltration basins, for the two village bypass discharges are low risk and therefore acceptable. SCC has indicated that they will wish to review the management train at detailed design stage and may wish to see provision of additional treatment stages.

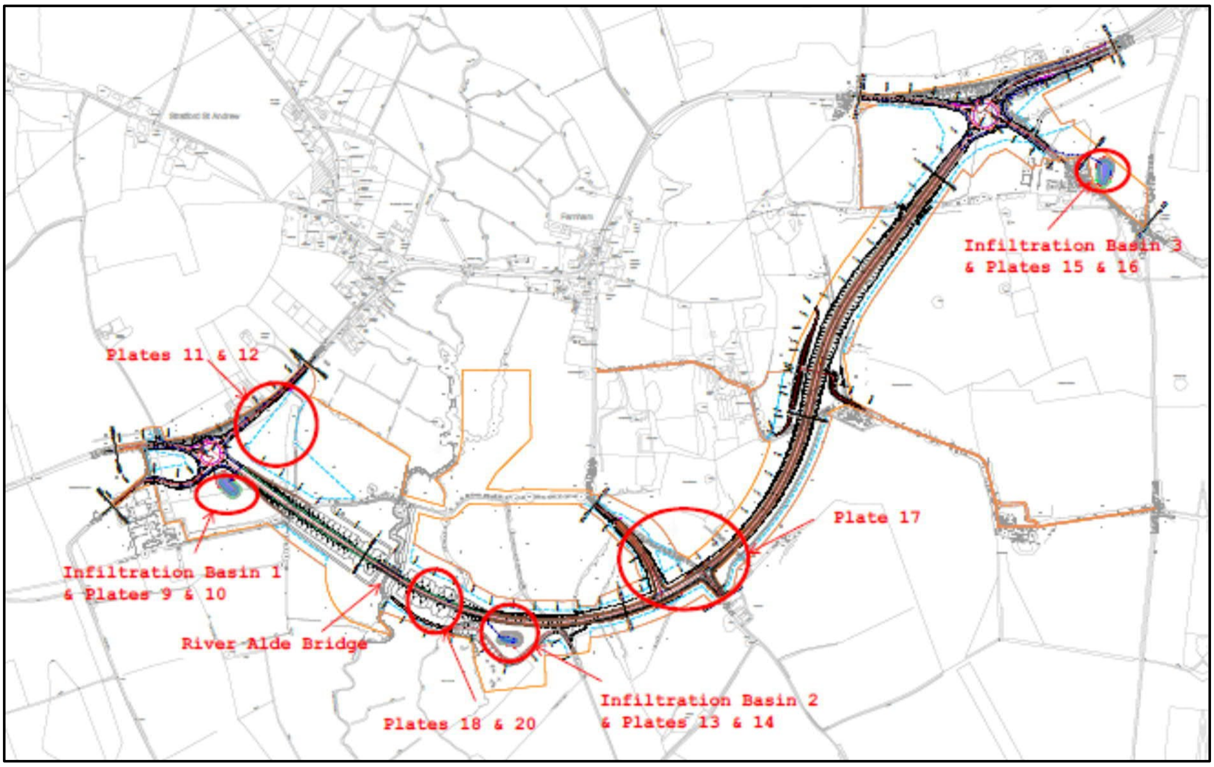
7.1.3 The report containing the HEWRAT assessment is shown in **Appendix B**

# 8 PRELIMINARY DRAINAGE DESIGN – HIGHWAY DRAINAGE

8.1.1 The results of geotechnical investigation infiltration testing undertaken at the proposed location of the three infiltration basins and at locations along the line of two village bypass demonstrate that it is possible to remove highway runoff by infiltration to ground. The infiltration rate data has been shared with SCC who have agreed that infiltration is achievable. Accordingly, the concept design proposal that highway runoff is removed and disposed by infiltration to ground remains broadly unchanged.

8.1.2 A large-scale plan showing the route of the two village bypass is shown in **Plate 8.** The specific locations shown in subsequent Plates are identified for convenience.

**Plate 8: Two village bypass location, route and features**



8.1.3 The 3 proposed infiltration basins were shown schematically in the DCO drawings. As part of preliminary design, the highway drainage network has been developed using hydraulic modelling. This has enabled the required size of the basins to be determined and space has been allocated.

8.1.4 Taking into account highway safety issues, the swale dimensions stated in 3.1.6 have been modified. When located in cutting or at level grade the depth of swale is reduced to 200 mm and the side slopes slackened to 1 in 5. This enables the requirement for the provision of vehicle restraint systems (VRS) to be avoided.

8.1.5 The location and performance of the A12 West Roundabout infiltration basin 1 is shown in **Plate 9** and the current dimensions hydraulic performance is shown in **Plate 10**.

**Plate 9: A12 west roundabout with infiltration basin 1**

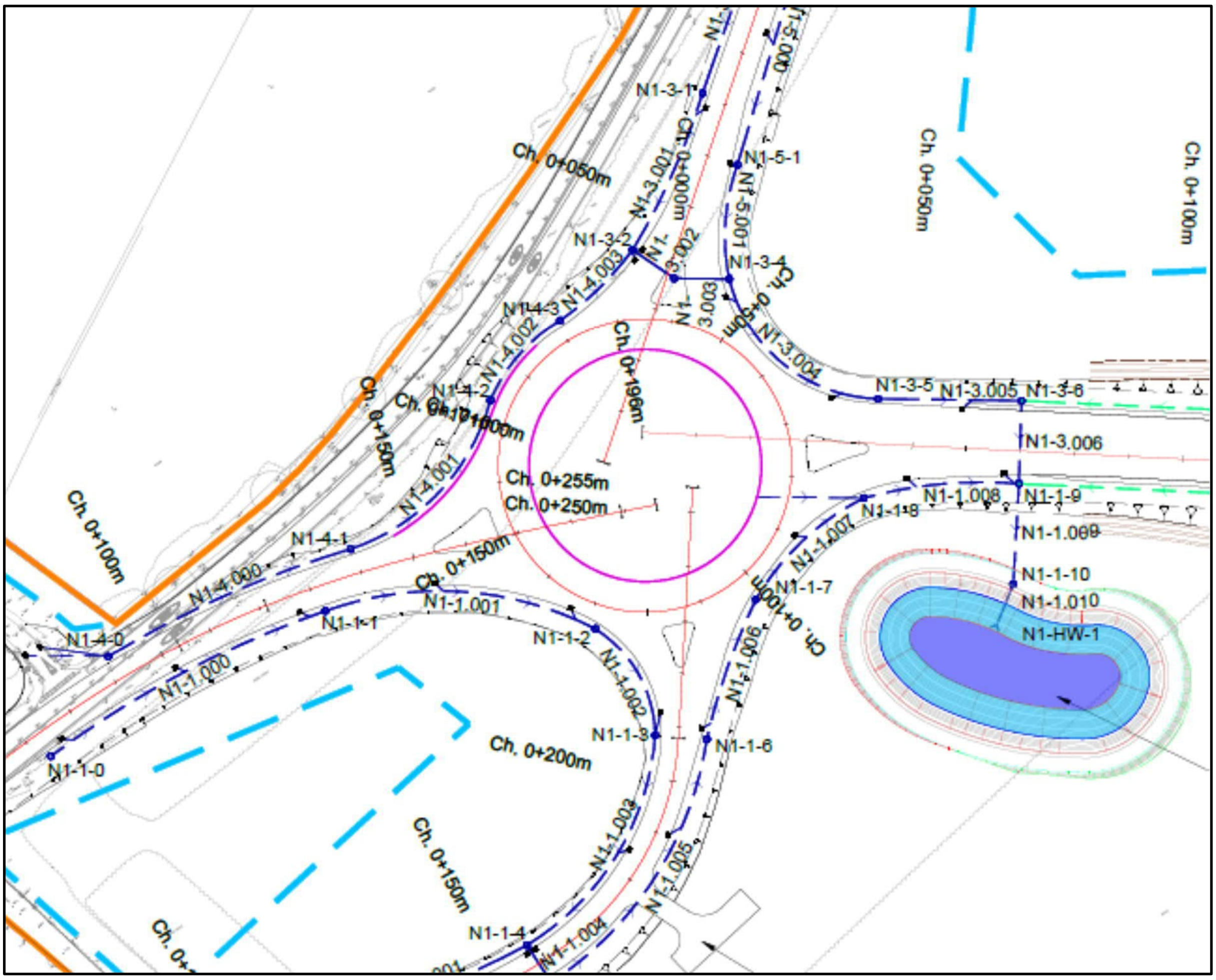


**Plate 10: Two village bypass infiltration basin 1 approximate size and hydraulic performance**

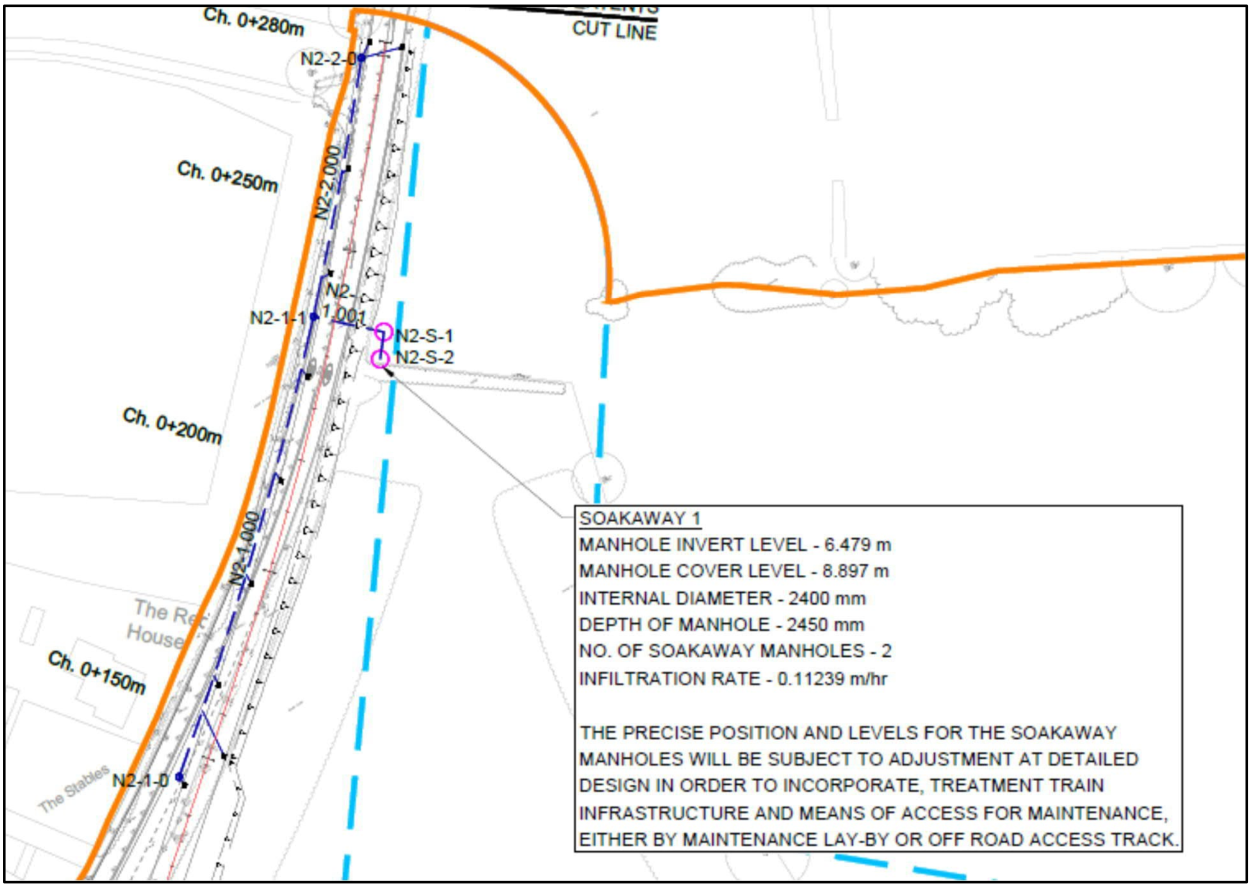
INFILTRATION BASIN 1 PRELIMINARY DESIGN
BASIN INVERT LEVEL - 7.130 m
TOP OF BASIN LEVEL - 9.119 m
STORAGE VOLUME - 1527 $m^3$
STORAGE DEPTH - 1.989 m
FREEBOARD - 300 mm
INFILTRATION RATE - 0.11239 m/hr
PREDICTED MAXIMUM WATER LEVEL IN 1 YEAR RETURN PERIOD - 7.391 m AOD
PREDICTED MAXIMUM WATER LEVEL IN 5 YEAR RETURN PERIOD - 7.576 m AOD
PREDICTED MAXIMUM WATER LEVEL IN 100 YEAR +40 % CC RETURN PERIOD - 8.326 m AOD

THE PRECISE POSITION, SHAPE AND LEVELS FOR THE BASIN WILL BE SUBJECT TO ADJUSTMENT AT DETAILED DESIGN IN ORDER TO INCORPORATE, TREATMENT TRAIN INFRASTRUCTURE, POTENTIAL ECOLOGICAL ENHANCEMENT AND OPTIMISE EARTHWORKS.

8.1.6 In addition to the majority of the A12 Roundabout, the infiltration basin will also provide an outfall for highway runoff from the two village bypass embankment crossing of the River Alde floodplain.

8.1.7 As a result of receiving detailed topographic levels and development of highway gradients, it has become apparent that it is not practical to drain the full length of the roundabout northern arm, back to the infiltration basin as it would require the basin to be approximately 4 m deep and with potential interaction with groundwater. Accordingly, whilst the first 150 m of the northern arm does drain back to the infiltration basin, the remaining 130 m where the proposed road alignment ties into the existing A12 drains to the north and would discharge into proposed soakaway manholes which enable infiltration. The northern roundabout tie-in drainage arrangement, based on assumed performance using the same infiltration rate as infiltration basin 1, is shown in **Plate 11**.

**Plate 11: A12 west roundabout northern arm with soakaway manhole location**




8.1.8 Given its proximity to the infiltration basin and the fact that the existing highway appears to drain via local kerb drains or over the edge, infiltrating runoff to ground, it was reasonable to assume that the soakaways would work. The hydraulic modelling of the catchment used the infiltration rates applicable to the infiltration basin. However, it was agreed with SCC and as a reasonable precaution, that infiltration testing at the soakaway manhole location should be undertaken prior to commencing detailed design.

8.1.9 Field log sheets for infiltration testing have been received in May 2021. They indicate that infiltration rates are not sufficient at the proposed soakaway manhole location for the western roundabout northern arm. In consequence the layout contained in the preliminary design will not be acceptable. Further site investigation and consideration of alternative outfall arrangements will be required either in advance of or at the start of detailed design stage.

8.1.10 Potential options have been identified which provide for an outfall arrangement located entirely within the permanent land take areas. These include:

i. possible connection to the proposed infiltration basin with increased depth;

ii. moving the soakaway closer to the roundabout; or

iii. an outfall route along the line of the two village bypass embankment discharging into the local watercourse.

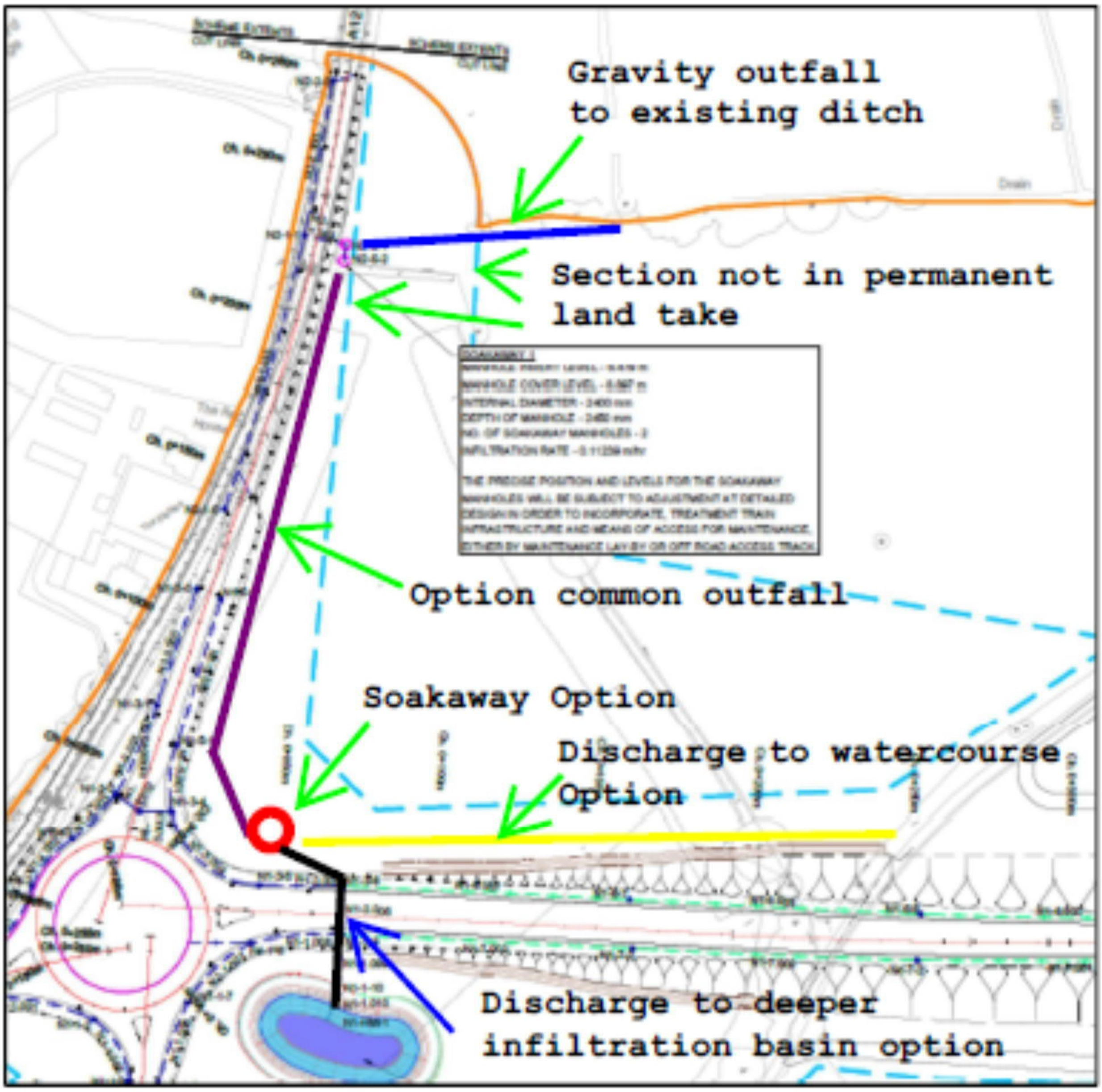
8.1.11 A further alternative option would be to

iv. discharge into a local ditch located within 100 m of the soakaway manhole.

8.1.12 The route would be located entirely within the red line boundary. However, it crosses land that is not retained and which will be transferred back to the landowner. SCC has confirmed that as a general position they do not require outfall highway drains to be located in land under their ownership. If this option was pursued, SCC would require a legal agreement in the form of an easement or wayleave providing a right to have the drain located in the land (not within their ownership) and a right of access for maintenance

8.1.13 The potential options are shown in **Plate 12**.

**Plate 12: A12 west roundabout northern arm showing soakaway alternative options**



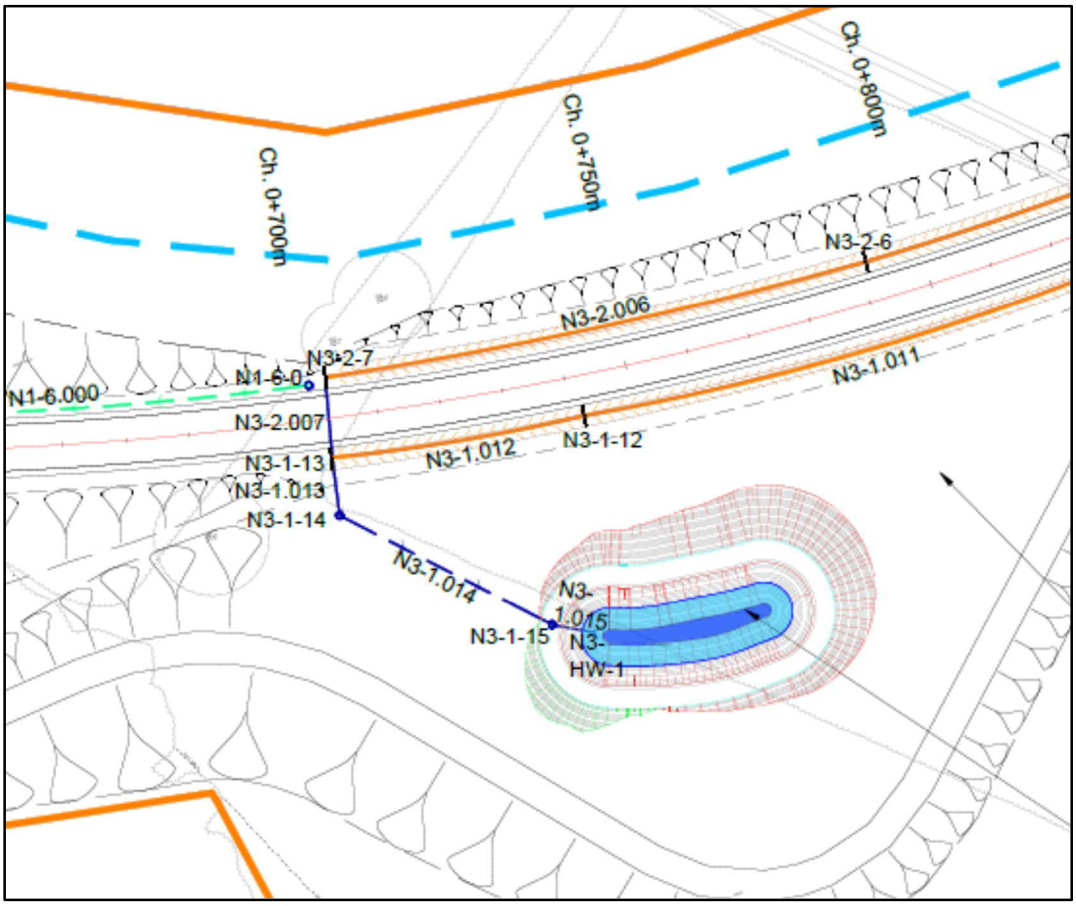

8.1.14 Infiltration basin 2, east of the River Alde, remains in the same area indicated at DCO. It receives runoff from the two village bypass swales to the east. All runoff flowing along the swales and associated filter drains which does not infiltrate to ground is intercepted and diverted to the basin. This prevents the runoff overrunning onto the River Alde embankment.

8.1.15 Hydraulic modelling has been undertaken to determine the required location, size, depth and volume of the infiltration basin. Details are provided in the first issue of the preliminary design drawings. Subsequent to issue it has been necessary to move the position of the basin to coordinate with the revised position and levels of the accommodation access track. The revised location of the infiltration basin will be shown either on an updated preliminary design drawing or in first revision of detailed design.

8.1.16 The DCO schematic location of infiltration basin 2 is shown in **Plate 13** and the current dimensions hydraulic performance is shown in **Plate 14**. The movement of the basin will nominally change the data in **Plate 14,** but it is included to demonstrate the technical feasibility of the design.

## Plate 13: Two village bypass infiltration basin 2 location

## Plate 1: Two village bypass accommodation track and flood relief culverts east of the River Alde – revised arrangement



### Plate 14: Two village bypass infiltration basin 2 approximate size and hydraulic performance

INFILTRATION BASIN 2 PRELIMINARY DESIGN
BASIN INVERT LEVEL - 12.124 m
TOP OF BASIN LEVEL - 13.810 m
STORAGE VOLUME - 611 $m^3$
STORAGE DEPTH - 1.686 m
FREEBOARD - 300 mm
INFILTRATION RATE - 0.82005 m/hr
PREDICTED MAXIMUM WATER LEVEL IN 1 YEAR RETURN PERIOD - 12.267 m AOD
PREDICTED MAXIMUM WATER LEVEL IN 5 YEAR RETURN PERIOD - 12.287 m AOD
PREDICTED MAXIMUM WATER LEVEL IN 100 YEAR +40 % CC RETURN PERIOD - 12.771 m AOD

THE PRECISE POSITION, SHAPE AND LEVELS FOR THE BASIN WILL BE SUBJECT TO ADJUSTMENT AT DETAILED DESIGN IN ORDER TO INCORPORATE, TREATMENT TRAIN INFRASTRUCTURE, POTENTIAL ECOLOGICAL ENHANCEMENT AND OPTIMISE EARTHWORKS.

8.1.17 The location and performance of the A12 East Roundabout infiltration basin 3 is shown in **Plate 15**. and the current dimensions hydraulic performance is shown in **Plate 16.**

### Plate 15: A12 east roundabout infiltration basin 3 location

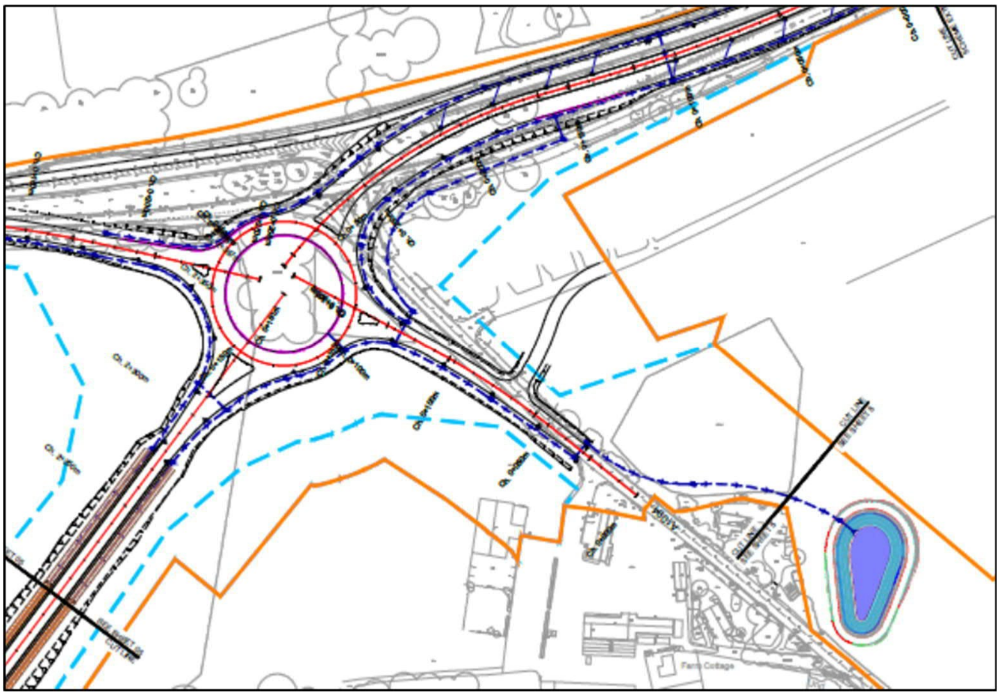


**Plate 16: Two village bypass infiltration basin 3 approximate size and hydraulic performance**

INFILTRATION BASIN 3 PRELIMINARY DESIGN

BASIN INVERT LEVEL - 9.914 m

TOP OF BASIN LEVEL - 11.700 m

STORAGE VOLUME - 1512 $m^3$

STORAGE DEPTH - 1.786 m

FREEBOARD - 300 mm

INFILTRATION RATE - 0.12611 m/hr

PREDICTED MAXIMUM WATER LEVEL IN 1 YEAR RETURN PERIOD - 10.511 m AOD

PREDICTED MAXIMUM WATER LEVEL IN 5 YEAR RETURN PERIOD - 10.631 m AOD

PREDICTED MAXIMUM WATER LEVEL IN 100 YEAR +40 % CC RETURN PERIOD - 11.269 m AOD

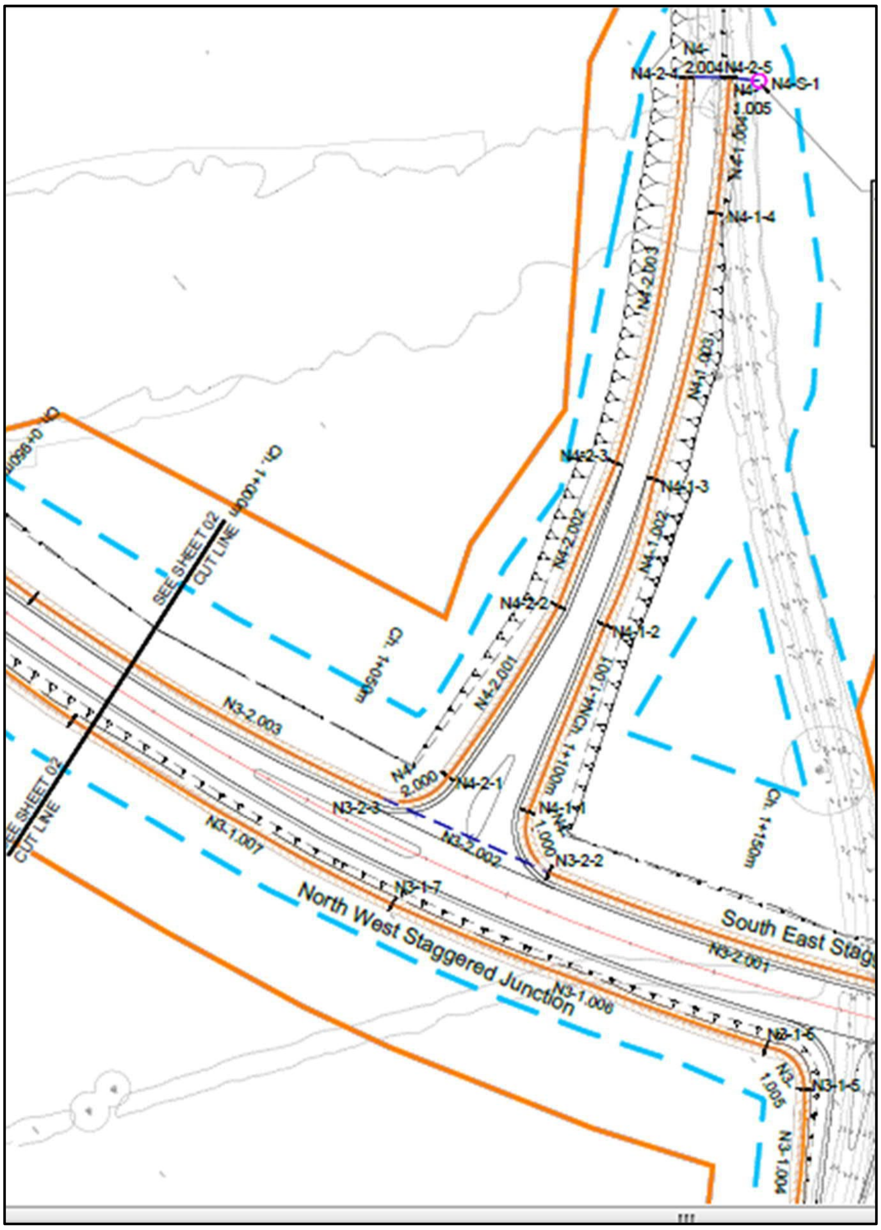
THE PRECISE POSITION, SHAPE AND LEVELS FOR THE BASIN WILL BE SUBJECT TO ADJUSTMENT AT DETAILED DESIGN IN ORDER TO INCORPORATE, TREATMENT TRAIN INFRASTRUCTURE, POTENTIAL ECOLOGICAL ENHANCEMENT AND OPTIMISE EARTHWORKS.

8.1.18 The infiltration basin receives all the runoff from the A12 East Roundabout and its arms. It also receives some runoff from the northern part of the two village bypass that has not fully infiltrated via the swales and filter drains.

8.1.19 The infiltration basin remains located in the same field adjacent to the A1094 but has been moved further north. This change has been made following the discovery of the ditch and pond described in section 5.1.10 and shown in **Plate 7**. If the infiltration were to be located in proximity to the pond the efficiency of infiltration could be reduced because the additional infiltration could cause local rising of groundwater.

8.1.20 As described in section 5.1.5, and shown in **Plate 17**, Hill Farm Lane is severed by the proposed two village bypass route with a proposed staggered junction arrangement being provided for connectivity.

**Plate 17: Two village bypass Hill Farm Lane junction with soakaway manhole location**




8.1.21 The DCO Drainage Strategy assumed that runoff from Hill Farm Lane would discharge to swales and filter drains allowing infiltration to ground.

8.1.22 The section of Hill Farm Lane to the south, which is at a higher level than two village bypass, has swale/filter drains which discharge into those proposed alongside the two village bypass, and for which Infiltration testing achieves satisfactory results.

8.1.23 The section of Hill Farm Lane to the north is at a lower level that two village bypass. A borehole excavated next to this side road found cohesive material which typically has poor infiltration rates and therefore would suggest that infiltration would not be viable. Based on available data it was considered that granular material would be found at a deeper depth below the cohesive material at a depth of around 5 m.

8.1.24 Discussions have taken place with SCC. Since it is agreed that there are no watercourses to which discharge can be made, it has been agreed that subject to detail, in principle a deep borehole soakaway could be permitted, providing evidence of the underlying granular material at reasonable depth is proven.

8.1.25 Results of a borehole excavation have been received in May 2021 and confirm the presence of the granular material at depth of 3.2 m bgl, adjacent to Hill Farm Lane. Infiltration testing results demonstrate that flow passes through into the permeable strata and that hence infiltration will be suitable. As agreed with SCC, when construction takes place, excavation will be made down into the granular material and an infiltration test to an appropriate standard (e.g. BRE Digest Soakaway design: DG 365 – 2016 (Ref. 3)) will be undertaken. The required size of soakaway manholes will be determined by the results.

# 9 REVISED DRAINAGE DESIGN STRATEGY – RIVER ALDE CROSSING

9.1.1 The position of the embankment with its flood relief culverts and the 60 m wide bridge remain as shown in the DCO drawings and as hydraulically modelled, with only minor changes which do not change hydraulic performance as reported in the **Two Village Bypass FRA**.

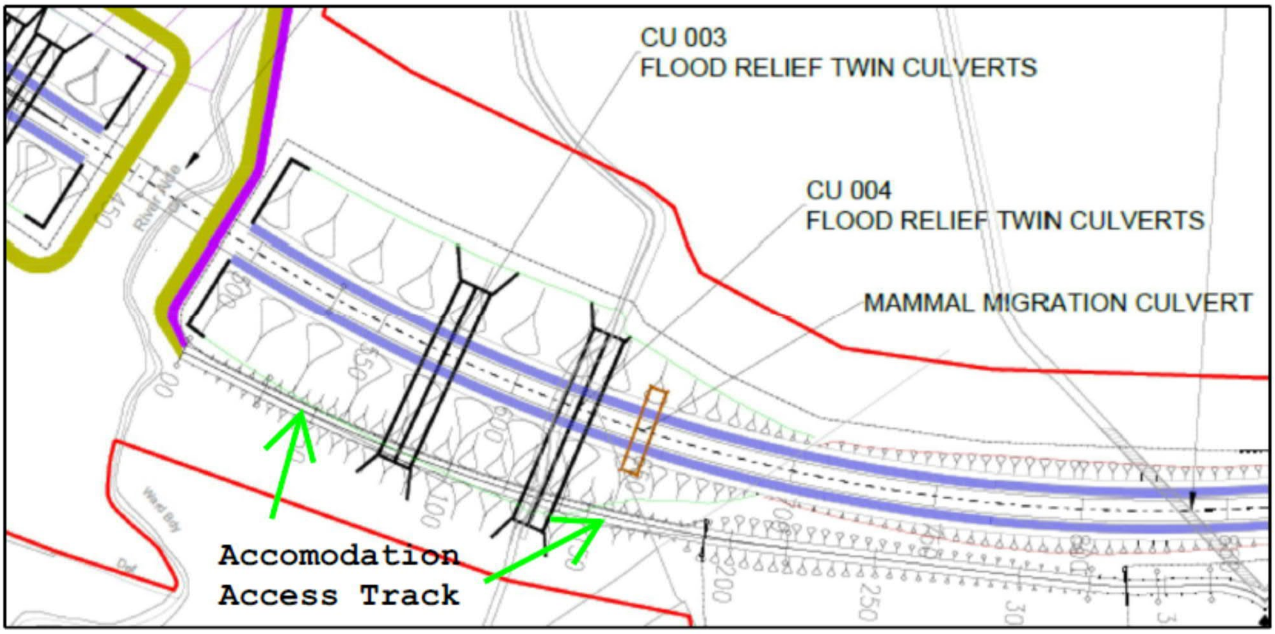
9.1.2 Following review of the topographic survey the central piers of the bridge have been moved to create greater distance from the proven position of the River Alde and its banks. The central span is increased to a width of 30 m and the side spans reduced to 15 m. The change is made to reduce the risk of scour should the river move its position and to provide a better width between top of bank and pier for maintenance. The reduction in side span widths does not adversely impact on the access track which is provided.

9.1.3 It is confirmed that this modification of piers does not cause any change to the hydraulic modelling results.

9.1.4 The change to the bridge pier positions has been notified to and discussed with SCC and the EA in design review meetings and no objection was raised.

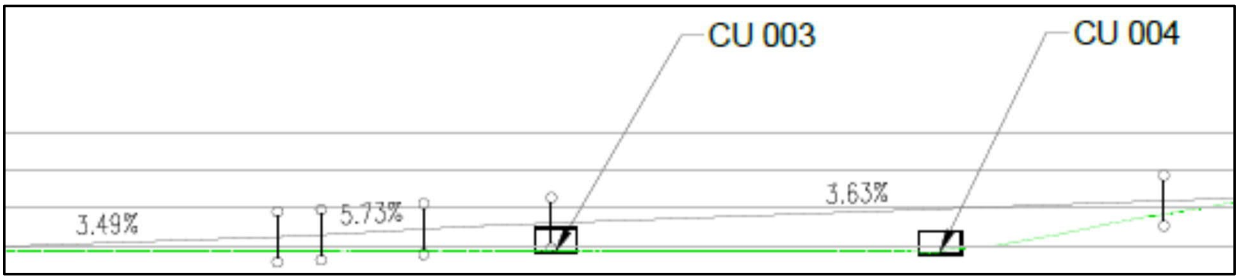
9.1.5 An accommodation access track is shown on the DCO drawing extract in **Plate 18**. This passes under the bridge on the east side of the River Alde and then follows in parallel alongside the downstream side of the proposed embankment and over the flood relief culverts as shown in **Plate 19**.

**Plate 18: Two village bypass accommodation track east of the River Alde at DCO Submission**




9.1.6 The culvert lengths were reviewed to meet an EA request to achieve a maximum length of 50m. The flood relief culverts CU003 and CU004 have a length of 65 m, and the flood relief culverts to the west have a length of 40m.

**Plate 19: two village bypass accommodation track east of the River Alde – long section**

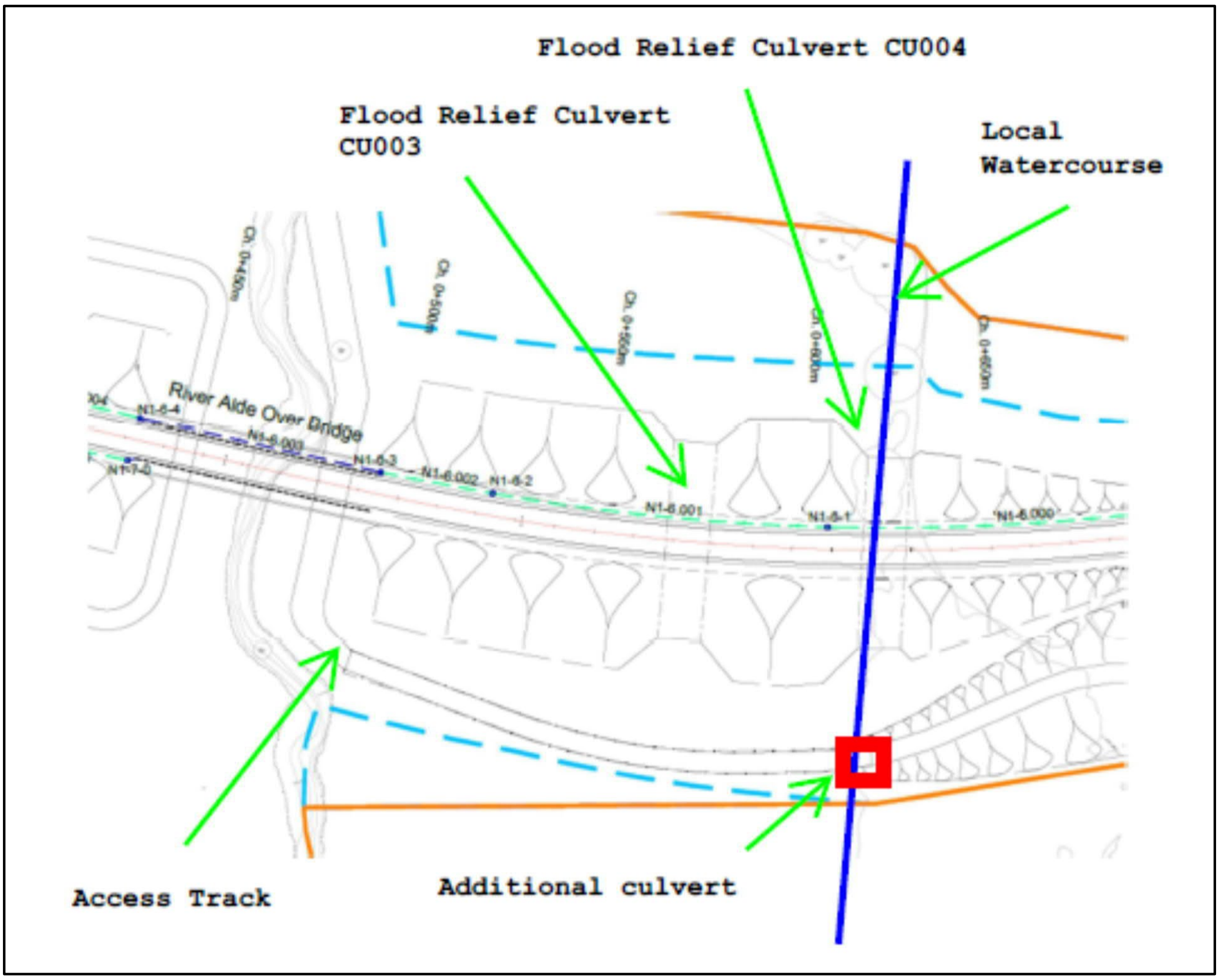



9.1.7 In order to reduce the length of culverts CU003 and CU004, it has been proposed that the accommodation track be laid at existing ground levels in front of the toe of the embankment but with a steeper section to the east to achieve the higher tie-in levels at Hill Farm Road.

9.1.8 A residual impact of the accommodation track amendment is that, for the watercourse which passes through flood relief culvert CU004, there is a requirement for a new downstream culvert where the proposed track crosses.

9.1.9 The accommodation track amendment and associated alterations has been notified to and discussed with SCC and the EA in Design Review Meetings and no objection in principle was raised. The shortening for the length of the flood relief culverts albeit with the new downstream culvert crossing is the preferred solution. The revised arrangement is shown in **Plate 20.** Accordingly, SZC Co. has submitted a design amendment into consultation.

**Plate 20: Two village bypass accommodation track and flood relief culverts east of the River Alde – revised arrangement**



9.1.10 As part of structural design, the form of the flood relief culverts has been considered. Whilst the cross-sectional dimensions of the culverts remain unchanged, it has been decided that portal culvert structures will be proposed. The advantage of this is that the portal culvert better allows for the watercourse to pass through culvert CU004.

9.1.11 The same portal form of culvert is proposed for the watercourse and track which passes under the embankment to the west of the River Alde at chainage 210 m. This culvert is located just clear of the River Alde floodplain extent also provides a mammal crossing point beneath the embankment.

9.1.12 The DCO design included for the provision of a dedicated mammal crossing culvert to the east of culvert CU004 at chainage 650 m but this is some distance clear of the flood plain. As discussed with the EA it is acceptable to delete this culvert and replace it with a mammal ledge in culvert CU004 to better follow the flood plain extent and existing watercourse route. The mammal ledge is to be installed above the 1 in 100 year plus 40% climate change flood level.

9.1.13 During the joint site inspection with SCC which took place on 12 January 2021 it was confirmed that swales at the toe of embankment within the River Alde flood plain would not serve useful purpose as they will be regularly flooded.

9.1.14 The EA confirmed that the predicted limited increase in flood levels adjacent to the upstream side of the embankment is acceptable subject to agreement with the landowner.

9.1.15 SZC Co. has reached agreement with the landowner in a form that satisfies the EA. Accordingly, the provision of flood compensation areas (within the concept design) is deleted from the preliminary design.

9.1.16 During liaison SCC confirmed that there must be no infiltration directly adjacent the carriageway for highway runoff where drainage is located on top of the road embankment as SCC were concerned of erosion within the embankment layers. It was suggested to SCC that the section highway on the embankment could drain to either a linear channel drain or surface V channel and be removed by an underground drain discharging to the infiltration basin to the west and adjacent to the A12 roundabout. SCC stated that a linear channel drain would not be acceptable due to maintenance concerns. For the preliminary design the indicative proposed swales are replaced by options of either: surface V channel and gully; or kerb and gully infrastructure. The drainage options have been discussed with SCC in design review meetings and the preliminary design currently proposes the use of concrete surface V channels and gullies. However, following recent review and consideration of integration with landscaping, SZC Co. is exploring a design alternative which provides for a vegetated surface with filtration layer and impermeable membrane below to ensure no infiltration to ground and this will be reviewed at the next design stage. Any proposed alternative would be discussed with and approved by SCC.

# 10 DEVELOPMENT OF HIGHWAY DRAINAGE AT DETAILED DESIGN

10.1.1 Both SCC and the EA have reviewed the preliminary drainage design both during design review meetings and subsequently in advance of Examination. Their comments have been considered and discussed in joint meetings. As a result of these discussions the preliminary drainage design will be subject to modification at detailed design stage, such it will address the comments and be acceptable to SCC and the EA. Details of the agreed modifications and design development are described in this section.

10.1.2 Since full geotechnical interpretation reports were not available at commencement of preliminary design, infiltration rates used in hydraulic modelling were calculated from the site log sheets. At a later stage it was noticed that there is a discrepancy between the values contained in the geotechnical interpretation report and those calculated for use in design.

10.1.3 The geotechnical interpretation report results shown in **Appendix A** have lower values. The reason for the discrepancy has been confirmed as being a correction factor which allows for the trial pit being filled with gravel to ensure stability which modifies the volume of water. Since the geotechnical interpretive report values appear to be more accurate and also give lower more conservative rates, as agreed by email to SCC dated 1 October 2021, the lower values will be used in hydraulic modelling at detailed design stage.

10.1.4 The preliminary drainage design was developed and validated by hydraulic modelling. The hydraulic modelling software uses rainfall data known as FSR and FEH. Either rainfall data can be used and depending on geographic location may give very similar or varying results for drainage network performance. The two village bypass hydraulic model at preliminary design stage used FSR data. SCC have confirmed that they believe that the use of FEH gives more conservative results in this area. The hydraulic model has been rerun using FEH and the results are shown in **Appendix C.**

10.1.5 The use of lower infiltration rates and FEH rainfall results in a reduced hydraulic performance for the networks. Since it is intended to adjust and optimise the drainage at detailed design stage, any predicted noncompliance with hydraulic performance will be resolved at that stage. It is considered that the hydraulic model results demonstrate that, as adjusted, the drainage will meet adoptable standards.

10.1.6 Since the hydraulic performance of networks 1, 3 and 5 is dependent on the three infiltration basins, details of the predicted hydraulic performance of the basins have been extracted from the results shown in **Appendix C** and is shown in **Appendix D.**

10.1.7 The results predict the maximum depth of water in basins 1 and 3 exceed the value of 1m due to a 1 in 100 year return period rainfall event plus 40% climate change. This performance requirement was confirmed by SCC on 1 October 2021. However as shown in **Appendix D,** there is available additional space within the red line boundary to increase the size of these basins.

10.1.8 Following the undertaking of infiltration testing at the Network 2 proposed soakaway as noted in 8.1.9 -8.1.13, it was confirmed that infiltration is not viable and options for an alternative outfall were identified. Following the site visit on 4 August 2021 and a review of topographic survey data, it is confirmed that a gravity outfall to a local watercourse located within the red line boundary will be progressed at detailed design.

10.1.9 As noted in 8.1.25 it is intended to modify the proposed soakaway to a deep borehole soakaway. Since deep boreholes can have an adverse impact of polluting the underlying aquifer SCC required that the EA also agree to the deep borehole. The proposals were discussed jointly with SCC and the EA on 12 January 2022 and the EA has confirmed no objection. The EA indicated that the depth of the deep borehole should be minimised.

# 11 SIZING OF INFILTRATION BASINS 1, 2 AND 3

11.1.1 SCC have reviewed the hydraulic modelling results shown in Appendix C and the infiltration basin sizes and performance shown in Appendix D. Concerns have been raised regarding some elements of modelling and in particular the assumptions regarding infiltration at locations in the networks upstream of the basins. SCC consider that this creates a risk that the basins will not be of adequate size and hence SCC will not support the current strategy.

11.1.2 This issue was discussed by Derek Lord and Matt Williams on 24 February 2022. SCC confirmed that they would like to see the size of the basins determined for the Network 1, 3 and 5 catchments using source control and the Fugro infiltration data. If it can be demonstrated that the basin sizes determined by source control will fit within the red line boundary then SCC could support the strategy.

11.1.3 Calculations of basin size have been undertaken. They assume the Network 1, 3 and 5 catchment extents as currently designed and the preliminary design bed level for the basins. The results are shown in **Appendix E.** Sketches showing the basin bed and surface footprints are also shown in **Appendix E** to demonstrate that sufficient space is available.

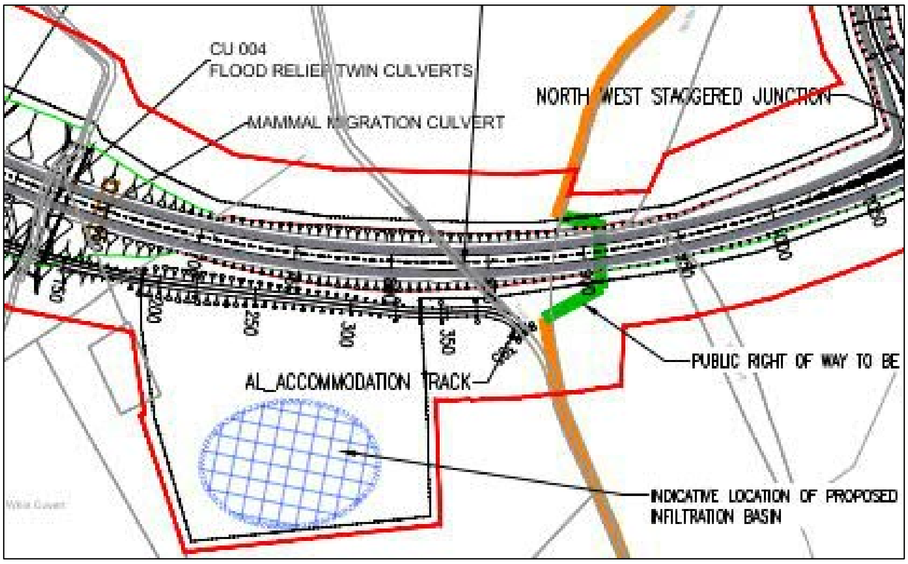
11.1.4 In a general response SCC have advised that they wouldn't expect detailed network hydraulic calculations at this stage of development drainage review. On this basis it is agreed that further updating of the Network hydraulic models at this stage is not required. However, as the hydraulic modelling is developed at detailed design, SCCs comments will be taken into account.

11.1.5 It is anticipated that at this stage the size of basins will revert towards that shown in **Appendix F.**

# 12 INFILTRATION BASIN 2 LOCATION

12.1.1 The location of Infiltration Basin 2 was set as part of the DCO submission as shown in **Plate 21**.

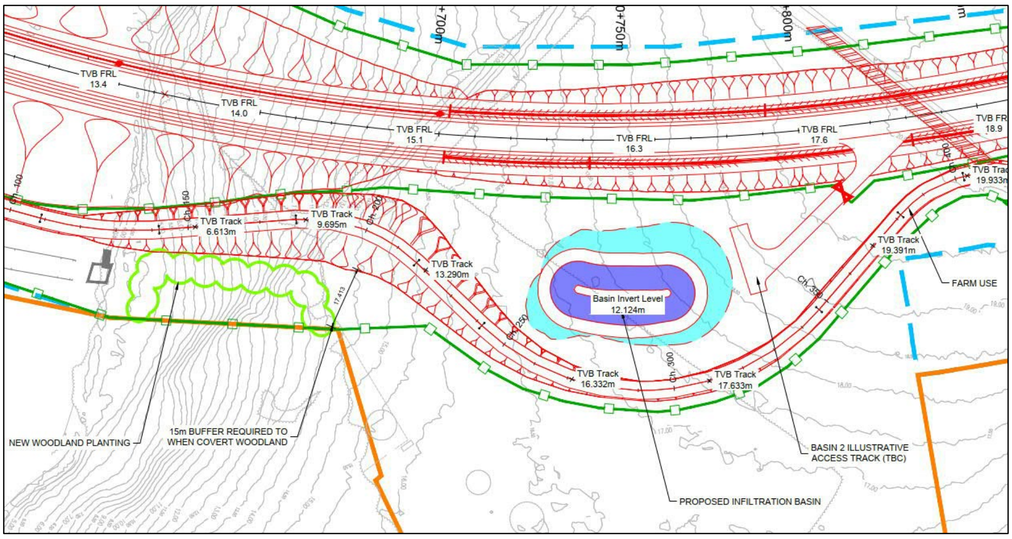
**Plate 21: Infiltration Basin 2 and accommodation track, DCO proposed arrangement**



12.1.2 SCC will required access to the basin for inspection and maintenance and noted that the basin is separated from the bypass by the accommodation track. During preliminary design review meetings SCC confirmed that they wanted basin 2 to be located closer to the bypass and with no crossing of the accommodation track.

12.1.3 Accordingly, an alternative arrangement has been developed and is shown in **Plate 22.**

**Plate 22: Infiltration Basin 2 and accommodation track, potential alternative to DCO proposed arrangement**




12.1.4 Whilst this layout is compliant with technical requirements, following review, it is not compliant with the DCO landscaping masterplan. There are concerns that the revised position of the accommodation access track will conflict with the protection zoned required for new woodland planting and being in cutting could adversely impact the existing Whin Covert. As a result, this layout cannot currently be confirmed.

12.1.5 The issue has been discussed at a joint meeting between SCC and SZC on 20 January 2022. The agreed conclusion is that the final layout option will be agreed as part of detailed design. SZC will assess in more detail the environmental and ecological impacts of the option shown in **Plate 22**. If these impacts can be mitigated to an acceptable level, then this option will be progressed.

12.1.6 SCC have confirmed that if it can be demonstrated that mitigation is not reasonably achievable then the original DCO layout with basin 2 separated from the bypass by the accommodation track will be accepted.

# 13 VALIDATION OF OUTLINE DRAINAGE STRATEGY

13.1.1 In accordance with the drainage hierarchy, the **Outline Drainage Strategy** [REP2-033] proposed the primary use of infiltration, with additional use of attenuation techniques (e.g. basins and swales) to manage water quality and to further promote infiltration. The **Outline Drainage Strategy** is validated by the completed preliminary design.

13.1.2 The approach in the **Outline Drainage Strategy** [REP2-033] is validated by the completed preliminary design, which has demonstrated that infiltration is viable except for the drainage of the A12 roundabout northern arm where discharge of water to a local watercourse is confirmed.

13.1.3 The preliminary design documents will be made available for review and acceptance by SCC and the EA with respect to acceptance of the road modification by SCC and for required regulatory consents.

# 14 SUMMARY AND CONCLUSION

14.1.1 The purpose of this technical note is to provide details of how the concept design has needed to evolve and develop as a result of provision of new information. The proposed developments have been discussed with SCC and the EA in liaison and through design review meetings.

14.1.2 The highway drainage has been designed in accordance with Design Manual for Roads and Bridges **(Ref.2)**, the CIRIA SUDs Manual C753 (**Ref. 5**) and to comply with stated requirements of SCC contained in their SUDs Local Design Guide Appendix A (**Ref. 6**).

14.1.3 At this preliminary design stage, it is considered that the design provides for the effective removal, treatment and disposal of highway runoff without adversely increasing flood risk to or from watercourses, impacting on third parties. The flood risk performance of the highway is as specified in DMRB and SCC guidance.

# REFERENCES

1. Design Guide, Suffolk County Council, 2000, https://www.suffolk.gov.uk/planning-waste-and-environment/planning-and-development-advice/suffolk-design-guide-for-residential-areas/

2. Design Manual for Roads and Bridges and Manual of Contract Documents for Highway Works Series 500 Highways England 2000, [redacted]

3. Highways Agency et al. (2009). Volume 11, Section 3, Part 10: Road Drainage and the Water Environment, LA 113 [redacted]

4. BRE Digest Soakaway design: DG 365 – 2016, BRE, 2016 [redacted]

5. The SUDs Manual (C753), CIRIA, 2015, ISBN 978-0-86017-760-9.

6. Sustainable Drainage Systems (SuDS) a Local Design Guide Appendix A to the Suffolk Flood Risk Management Strategy, Suffolk County Council, May 2018 [redacted]