

|                                                        |                      |                                                                                     |
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| JNM Engineering Limited                                |                      | Page 0                                                                              |
| 14-16 High Street<br>Ironbridge<br>Shropshire, TF8 7AD | Millbrook<br>Cradley |  |
| Date 22/09/2020                                        | Designed by JJM      |                                                                                     |
| File cradley.MDX                                       | Checked by           |                                                                                     |
| Innovyze                                               | Network 2017.1.2     |                                                                                     |

### STORM SEWER DESIGN by the Modified Rational Method

#### Design Criteria for CRADLEY.SWS

Pipe Sizes CRADLEY Manhole Sizes CRADLEY

FSR Rainfall Model - England and Wales

|                                      |        |                                       |       |
|--------------------------------------|--------|---------------------------------------|-------|
| Return Period (years)                | 100    | PIMP (%)                              | 100   |
| M5-60 (mm)                           | 19.000 | Add Flow / Climate Change (%)         | 40    |
| Ratio R                              | 0.390  | Minimum Backdrop Height (m)           | 0.200 |
| Maximum Rainfall (mm/hr)             | 50     | Maximum Backdrop Height (m)           | 0.000 |
| Maximum Time of Concentration (mins) | 30     | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha)                 | 0.000  | Min Vel for Auto Design only (m/s)    | 0.75  |
| Volumetric Runoff Coeff.             | 0.750  | Min Slope for Optimisation (1:X)      | 500   |

Designed with Level Soffits

#### Network Design Table for CRADLEY.SWS

| PN    | Length<br>(m) | Fall<br>(m) | Slope<br>(1:X) | I.Area<br>(ha) | T.E.<br>(mins) | Base<br>Flow (l/s) | k<br>(mm) | HYD<br>SECT | DIA<br>(mm) | Section Type |
|-------|---------------|-------------|----------------|----------------|----------------|--------------------|-----------|-------------|-------------|--------------|
| 1.000 | 13.732        | 0.475       | 28.9           | 0.021          | 5.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 1.001 | 11.755        | 0.241       | 48.8           | 0.000          | 0.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 1.002 | 16.109        | 0.156       | 103.3          | 0.000          | 0.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 2.000 | 8.938         | 0.894       | 10.0           | 0.017          | 5.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 1.003 | 42.000        | 0.065       | 646.2          | 0.065          | 0.00           | 0.0                | 0.600     | o           | 1200        | Pipe/Conduit |
| 3.000 | 19.437        | 0.972       | 20.0           | 0.034          | 5.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 3.001 | 4.287         | 0.214       | 20.0           | 0.000          | 0.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 4.000 | 9.570         | 0.479       | 20.0           | 0.017          | 5.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |

#### Network Results Table

| PN    | Rain<br>(mm/hr) | T.C.<br>(mins) | US/IL<br>(m) | Σ I.Area<br>(ha) | Σ Base<br>Flow (l/s) | Foul<br>(l/s) | Add Flow<br>(l/s) | Vel<br>(m/s) | Cap<br>(l/s) | Flow<br>(l/s) |
|-------|-----------------|----------------|--------------|------------------|----------------------|---------------|-------------------|--------------|--------------|---------------|
| 1.000 | 50.00           | 5.16           | 100.733      | 0.021            | 0.0                  | 0.0           | 1.1               | 1.44         | 11.3         | 4.0           |
| 1.001 | 50.00           | 5.34           | 100.258      | 0.021            | 0.0                  | 0.0           | 1.1               | 1.11         | 8.7          | 4.0           |
| 1.002 | 50.00           | 5.69           | 100.017      | 0.021            | 0.0                  | 0.0           | 1.1               | 0.76         | 5.9          | 4.0           |
| 2.000 | 50.00           | 5.06           | 100.755      | 0.017            | 0.0                  | 0.0           | 0.9               | 2.46         | 19.3         | 3.2           |
| 1.003 | 50.00           | 6.17           | 98.761       | 0.103            | 0.0                  | 0.0           | 5.6               | 1.46         | 1656.0       | 19.5          |
| 3.000 | 50.00           | 5.19           | 100.982      | 0.034            | 0.0                  | 0.0           | 1.8               | 1.73         | 13.6         | 6.4           |
| 3.001 | 50.00           | 5.23           | 100.010      | 0.034            | 0.0                  | 0.0           | 1.8               | 1.73         | 13.6         | 6.4           |
| 4.000 | 50.00           | 5.09           | 101.178      | 0.017            | 0.0                  | 0.0           | 0.9               | 1.74         | 13.6         | 3.2           |

|                                                        |                               |                                                                                     |
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| Innovyze                                               | Network 2017.1.2              |                                                                                     |

Network Design Table for CRADLEY.SWS

| PN    | Length<br>(m) | Fall<br>(m) | Slope<br>(1:X) | I.Area<br>(ha) | T.E.<br>(mins) | Base<br>Flow (l/s) | k<br>(mm) | HYD<br>SECT | DIA<br>(mm) | Section Type |
|-------|---------------|-------------|----------------|----------------|----------------|--------------------|-----------|-------------|-------------|--------------|
| 4.001 | 18.064        | 0.903       | 20.0           | 0.013          | 0.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |
| 1.004 | 10.155        | 0.034       | 298.7          | 0.000          | 0.00           | 0.0                | 0.600     | o           | 300         | Pipe/Conduit |
| 1.005 | 14.292        | 0.048       | 297.8          | 0.000          | 0.00           | 0.0                | 0.600     | o           | 300         | Pipe/Conduit |
| 1.006 | 4.118         | 0.014       | 294.1          | 0.000          | 0.00           | 0.0                | 0.600     | o           | 300         | Pipe/Conduit |

Network Results Table

| PN    | Rain<br>(mm/hr) | T.C.<br>(mins) | US/IL<br>(m) | Σ I.Area<br>(ha) | Σ Base<br>Flow (l/s) | Foul<br>(l/s) | Add Flow<br>(l/s) | Vel<br>(m/s) | Cap<br>(l/s) | Flow<br>(l/s) |
|-------|-----------------|----------------|--------------|------------------|----------------------|---------------|-------------------|--------------|--------------|---------------|
| 4.001 | 50.00           | 5.27           | 100.699      | 0.030            | 0.0                  | 0.0           | 1.6               | 1.73         | 13.6         | 5.7           |
| 1.004 | 50.00           | 6.36           | 98.696       | 0.167            | 0.0                  | 0.0           | 9.0               | 0.90         | 63.9         | 31.7          |
| 1.005 | 50.00           | 6.62           | 98.662       | 0.167            | 0.0                  | 0.0           | 9.0               | 0.91         | 64.0         | 31.7          |
| 1.006 | 50.00           | 6.69           | 98.614       | 0.167            | 0.0                  | 0.0           | 9.0               | 0.91         | 64.4         | 31.7          |

|                      |
|----------------------|
| Millbrook<br>Cradley |
|----------------------|



|                 |
|-----------------|
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Network 2017.1.2

## Manhole Schedules for CRADLEY.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) |
|---------|-----------|--------------|---------------|--------------------|-------|---------------------------|---------------|-------|---------------------------|---------------|---------------|
| 1       | 102.150   | 1.417        | Open Manhole  | 450                | 1.000 | 100.733                   | 100           |       |                           |               |               |
| 2       | 102.150   | 1.892        | Open Manhole  | 450                | 1.001 | 100.258                   | 100           | 1.000 | 100.258                   | 100           |               |
| 3       | 102.700   | 2.683        | Open Manhole  | 450                | 1.002 | 100.017                   | 100           | 1.001 | 100.017                   | 100           |               |
| 10      | 102.750   | 1.995        | Open Manhole  | 450                | 2.000 | 100.755                   | 100           |       |                           |               |               |
| 4       | 102.700   | 3.939        | Open Manhole  | 2700               | 1.003 | 98.761                    | 1200          | 1.002 | 99.861                    | 100           |               |
|         |           |              |               |                    |       |                           |               | 2.000 | 99.861                    | 100           |               |
| 11      | 102.100   | 1.118        | Open Manhole  | 450                | 3.000 | 100.982                   | 100           |       |                           |               |               |
| 12      | 101.300   | 1.290        | Open Manhole  | 450                | 3.001 | 100.010                   | 100           | 3.000 | 100.010                   | 100           |               |
| 14      | 103.300   | 2.122        | Open Manhole  | 450                | 4.000 | 101.178                   | 100           |       |                           |               |               |
| 13      | 103.000   | 2.301        | Open Manhole  | 450                | 4.001 | 100.699                   | 100           | 4.000 | 100.699                   | 100           |               |
| 6       | 101.500   | 2.804        | Open Manhole  | 2700               | 1.004 | 98.696                    | 300           | 1.003 | 98.696                    | 1200          |               |
|         |           |              |               |                    |       |                           |               | 3.001 | 99.796                    | 100           | 900           |
|         |           |              |               |                    |       |                           |               | 4.001 | 99.796                    | 100           | 900           |
| 7       | 101.000   | 2.338        | Open Manhole  | 450                | 1.005 | 98.662                    | 300           | 1.004 | 98.662                    | 300           |               |
| 8       | 99.750    | 1.136        | Open Manhole  | 450                | 1.006 | 98.614                    | 300           | 1.005 | 98.614                    | 300           |               |
| 9       | 99.500    | 0.900        | Open Manhole  | 0                  |       | OUTFALL                   |               | 1.006 | 98.600                    | 300           |               |

|                                                        |                               |                                                                                     |
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| Innovyze                                               | Network 2017.1.2              |                                                                                     |

PIPELINE SCHEDULES for CRADLEY.SWS

Upstream Manhole

| PN    | Hyd<br>Sect | Diam<br>(mm) | MH<br>Name | C.Level<br>(m) | I.Level<br>(m) | D.Depth<br>(m) | MH<br>Connection | MH DIAM., L*W<br>(mm) |
|-------|-------------|--------------|------------|----------------|----------------|----------------|------------------|-----------------------|
| 1.000 | o           | 100          | 1          | 102.150        | 100.733        | 1.317          | Open Manhole     | 450                   |
| 1.001 | o           | 100          | 2          | 102.150        | 100.258        | 1.792          | Open Manhole     | 450                   |
| 1.002 | o           | 100          | 3          | 102.700        | 100.017        | 2.583          | Open Manhole     | 450                   |
| 2.000 | o           | 100          | 10         | 102.750        | 100.755        | 1.895          | Open Manhole     | 450                   |
| 1.003 | o           | 1200         | 4          | 102.700        | 98.761         | 2.739          | Open Manhole     | 2700                  |
| 3.000 | o           | 100          | 11         | 102.100        | 100.982        | 1.018          | Open Manhole     | 450                   |
| 3.001 | o           | 100          | 12         | 101.300        | 100.010        | 1.190          | Open Manhole     | 450                   |
| 4.000 | o           | 100          | 14         | 103.300        | 101.178        | 2.022          | Open Manhole     | 450                   |
| 4.001 | o           | 100          | 13         | 103.000        | 100.699        | 2.201          | Open Manhole     | 450                   |
| 1.004 | o           | 300          | 6          | 101.500        | 98.696         | 2.504          | Open Manhole     | 2700                  |
| 1.005 | o           | 300          | 7          | 101.000        | 98.662         | 2.038          | Open Manhole     | 450                   |
| 1.006 | o           | 300          | 8          | 99.750         | 98.614         | 0.836          | Open Manhole     | 450                   |

Downstream Manhole

| PN    | Length<br>(m) | Slope<br>(1:X) | MH<br>Name | C.Level<br>(m) | I.Level<br>(m) | D.Depth<br>(m) | MH<br>Connection | MH DIAM., L*W<br>(mm) |
|-------|---------------|----------------|------------|----------------|----------------|----------------|------------------|-----------------------|
| 1.000 | 13.732        | 28.9           | 2          | 102.150        | 100.258        | 1.792          | Open Manhole     | 450                   |
| 1.001 | 11.755        | 48.8           | 3          | 102.700        | 100.017        | 2.583          | Open Manhole     | 450                   |
| 1.002 | 16.109        | 103.3          | 4          | 102.700        | 99.861         | 2.739          | Open Manhole     | 2700                  |
| 2.000 | 8.938         | 10.0           | 4          | 102.700        | 99.861         | 2.739          | Open Manhole     | 2700                  |
| 1.003 | 42.000        | 646.2          | 6          | 101.500        | 98.696         | 1.604          | Open Manhole     | 2700                  |
| 3.000 | 19.437        | 20.0           | 12         | 101.300        | 100.010        | 1.190          | Open Manhole     | 450                   |
| 3.001 | 4.287         | 20.0           | 6          | 101.500        | 99.796         | 1.604          | Open Manhole     | 2700                  |
| 4.000 | 9.570         | 20.0           | 13         | 103.000        | 100.699        | 2.201          | Open Manhole     | 450                   |
| 4.001 | 18.064        | 20.0           | 6          | 101.500        | 99.796         | 1.604          | Open Manhole     | 2700                  |
| 1.004 | 10.155        | 298.7          | 7          | 101.000        | 98.662         | 2.038          | Open Manhole     | 450                   |
| 1.005 | 14.292        | 297.8          | 8          | 99.750         | 98.614         | 0.836          | Open Manhole     | 450                   |
| 1.006 | 4.118         | 294.1          | 9          | 99.500         | 98.600         | 0.600          | Open Manhole     | 0                     |

|                                                        |                               |                                                                                     |
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| Innovyze Network 2017.1.2                              |                               |                                                                                     |

  

Free Flowing Outfall Details for CRADLEY.SWS

| Outfall<br>Pipe Number | Outfall<br>Name | C. Level<br>(m) | I. Level<br>(m) | Min<br>I. Level<br>(m) | D,L<br>(mm) | W<br>(mm) |
|------------------------|-----------------|-----------------|-----------------|------------------------|-------------|-----------|
| 1.006                  | 9               | 99.500          | 98.600          | 0.000                  | 0           | 0         |

Simulation Criteria for CRADLEY.SWS

|                                 |       |                                            |        |
|---------------------------------|-------|--------------------------------------------|--------|
| Volumetric Runoff Coeff         | 0.840 | Foul Sewage per hectare (l/s)              | 0.000  |
| Areal Reduction Factor          | 1.000 | Additional Flow - % of Total Flow          | 40.000 |
| Hot Start (mins)                | 0     | MADD Factor * 10m <sup>3</sup> /ha Storage | 2.000  |
| Hot Start Level (mm)            | 0     | Run Time (mins)                            | 60     |
| Manhole Headloss Coeff (Global) | 0.500 | Output Interval (mins)                     | 1      |

  

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

Synthetic Rainfall Details

|                       |                   |                       |        |
|-----------------------|-------------------|-----------------------|--------|
| Rainfall Model        | FSR               | Profile Type          | Winter |
| Return Period (years) | 100               | Cv (Summer)           | 0.750  |
| Region                | England and Wales | Cv (Winter)           | 0.840  |
| M5-60 (mm)            | 19.000            | Storm Duration (mins) | 15     |
| Ratio R               | 0.390             |                       |        |

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|                                                        |                               |                                                                                     |
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| Innovyze                                               | Network 2017.1.2              |                                                                                     |

Online Controls for CRADLEY.SWS

Hydro-Brake® Optimum Manhole: 6, DS/PN: 1.004, Volume (m³): 60.7

|                                   |                            |
|-----------------------------------|----------------------------|
| Unit Reference                    | MD-SHE-0074-3500-2300-3500 |
| Design Head (m)                   | 2.300                      |
| Design Flow (l/s)                 | 3.5                        |
| Flush-Flo™                        | Calculated                 |
| Objective                         | Minimise upstream storage  |
| Application                       | Surface                    |
| Sump Available                    | Yes                        |
| Diameter (mm)                     | 74                         |
| Invert Level (m)                  | 98.696                     |
| Minimum Outlet Pipe Diameter (mm) | 100                        |
| Suggested Manhole Diameter (mm)   | 1200                       |

| Control Points            | Head (m) | Flow (l/s) | Control Points            | Head (m) | Flow (l/s) |
|---------------------------|----------|------------|---------------------------|----------|------------|
| Design Point (Calculated) | 2.300    | 3.5        | Kick-Flo®                 | 0.656    | 2.0        |
| Flush-Flo™                | 0.323    | 2.4        | Mean Flow over Head Range | -        | 2.6        |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| 0.100     | 2.0        | 1.200     | 2.6        | 3.000     | 4.0        | 7.000     | 5.9        |
| 0.200     | 2.3        | 1.400     | 2.8        | 3.500     | 4.2        | 7.500     | 6.1        |
| 0.300     | 2.4        | 1.600     | 3.0        | 4.000     | 4.5        | 8.000     | 6.3        |
| 0.400     | 2.4        | 1.800     | 3.1        | 4.500     | 4.8        | 8.500     | 6.4        |
| 0.500     | 2.3        | 2.000     | 3.3        | 5.000     | 5.0        | 9.000     | 6.6        |
| 0.600     | 2.2        | 2.200     | 3.4        | 5.500     | 5.2        | 9.500     | 6.8        |
| 0.800     | 2.2        | 2.400     | 3.6        | 6.000     | 5.5        |           |            |
| 1.000     | 2.4        | 2.600     | 3.7        | 6.500     | 5.7        |           |            |

|                                                        |                      |                                                                                     |
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| File cradley.MDX                                       | Checked by           |                                                                                     |
| Innovyze                                               | Network 2017.1.2     |                                                                                     |

Summary of Results for 15 minute 100 year Winter (CRADLEY.SWS)

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

|       |            | Water     | Surcharged | Flooded     |             | Pipe           |                   |
|-------|------------|-----------|------------|-------------|-------------|----------------|-------------------|
| PN    | US/MH Name | Level (m) | Depth (m)  | Volume (m³) | Flow / Cap. | Overflow (l/s) | Flow (l/s) Status |
| 1.000 | 1          | 101.371   | 0.538      | 0.000       | 1.00        | 10.7           | SURCHARGED        |
| 1.001 | 2          | 100.889   | 0.531      | 0.000       | 1.29        | 10.5           | SURCHARGED        |
| 1.002 | 3          | 100.488   | 0.371      | 0.000       | 1.84        | 10.5           | SURCHARGED        |
| 2.000 | 10         | 100.809   | -0.046     | 0.000       | 0.56        | 9.9            | OK                |
| 1.003 | 4          | 99.642    | -0.319     | 0.000       | 0.04        | 47.7           | OK                |
| 3.000 | 11         | 101.954   | 0.872      | 0.000       | 1.28        | 16.8           | FLOOD RISK        |
| 3.001 | 12         | 100.331   | 0.221      | 0.000       | 1.44        | 16.8           | SURCHARGED        |
| 4.000 | 14         | 101.581   | 0.303      | 0.000       | 0.74        | 9.4            | SURCHARGED        |
| 4.001 | 13         | 101.332   | 0.533      | 0.000       | 1.25        | 16.4           | SURCHARGED        |
| 1.004 | 6          | 99.642    | 0.646      | 0.000       | 0.05        | 2.4            | SURCHARGED        |
| 1.005 | 7          | 98.703    | -0.259     | 0.000       | 0.05        | 2.4            | OK                |
| 1.006 | 8          | 98.657    | -0.257     | 0.000       | 0.05        | 2.4            | OK                |