

|                                                                |                                                |                                                                                     |
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| BIC110 - The MedBIC<br>Alan Cherry Drive<br>Chelmsford CM1 1SQ | The Grove<br>(Latest Site Plan)<br>CO22/289/07 |  |
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| XP Solutions                                                   | Network 2018.1                                 |                                                                                     |

### STORM SEWER DESIGN by the Modified Rational Method

#### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

|                                      |        |                                       |       |
|--------------------------------------|--------|---------------------------------------|-------|
| Return Period (years)                | 2      | PIMP (%)                              | 100   |
| M5-60 (mm)                           | 20.000 | Add Flow / Climate Change (%)         | 0     |
| Ratio R                              | 0.405  | Minimum Backdrop Height (m)           | 0.200 |
| Maximum Rainfall (mm/hr)             | 50     | Maximum Backdrop Height (m)           | 1.500 |
| 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)    | 1.00  |
| Volumetric Runoff Coeff.             | 0.750  | Min Slope for Optimisation (1:X)      | 500   |

Designed with Level Soffits

#### Network Design Table for Storm

« - Indicates pipe capacity < flow

| 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 | Auto<br>Design                                                                        |
|-------|---------------|-------------|----------------|----------------|----------------|--------------------|-----------|-------------|-------------|--------------|---------------------------------------------------------------------------------------|
| 1.000 | 8.000         | 0.055       | 145.5          | 0.041          | 5.00           | 0.0                | 0.600     | o           | 150         | Pipe/Conduit |  |
| 2.000 | 8.500         | 0.105       | 81.0           | 0.014          | 5.00           | 0.0                | 0.600     | o           | 100         | Pipe/Conduit |  |
| 1.001 | 18.770        | 0.035       | 536.3          | 0.030          | 0.00           | 0.0                | 0.600     | o           | 225         | Pipe/Conduit |  |
| 1.002 | 8.000         | 0.035       | 228.6          | 0.025          | 0.00           | 0.0                | 0.600     | o           | 225         | Pipe/Conduit |  |
| 1.003 | 45.000        | 0.225       | 200.0          | 0.005          | 0.00           | 0.0                | 0.600     | o           | 225         | Pipe/Conduit |  |
| 1.004 | 9.600         | 0.050       | 192.0          | 0.035          | 0.00           | 0.0                | 0.600     | o           | 225         | Pipe/Conduit |  |
| 1.005 | 10.250        | 0.070       | 146.4          | 0.000          | 0.00           | 0.0                | 0.600     | o           | 150         | 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           | 198.250      | 0.041            | 0.0                  | 0.0           | 0.0               | 0.83         | 14.7         | 5.6           |
| 2.000 | 50.00           | 5.17           | 198.350      | 0.014            | 0.0                  | 0.0           | 0.0               | 0.86         | 6.7          | 1.9           |
| 1.001 | 50.00           | 5.73           | 198.120      | 0.085            | 0.0                  | 0.0           | 0.0               | 0.56         | 22.2         | 11.5          |
| 1.002 | 50.00           | 5.88           | 198.085      | 0.110            | 0.0                  | 0.0           | 0.0               | 0.86         | 34.2         | 14.9          |
| 1.003 | 50.00           | 6.70           | 198.050      | 0.115            | 0.0                  | 0.0           | 0.0               | 0.92         | 36.6         | 15.6          |
| 1.004 | 50.00           | 6.87           | 197.825      | 0.150            | 0.0                  | 0.0           | 0.0               | 0.94         | 37.4         | 20.3          |
| 1.005 | 50.00           | 7.07           | 197.850      | 0.150            | 0.0                  | 0.0           | 0.0               | 0.83         | 14.6«        | 20.3          |

|                                                                |                                                |                                                                                     |
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| XP Solutions                                                   | Network 2018.1                                 |                                                                                     |

#### Simulation Criteria for Storm

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

#### Synthetic Rainfall Details

|                       |                   |                       |        |
|-----------------------|-------------------|-----------------------|--------|
| Rainfall Model        | FSR               | Profile Type          | Summer |
| Return Period (years) | 2                 | Cv (Summer)           | 0.750  |
| Region                | England and Wales | Cv (Winter)           | 0.840  |
| M5-60 (mm)            | 20.000            | Storm Duration (mins) | 30     |
| Ratio R               | 0.405             |                       |        |

|                                                                |                                                |                                                                                     |
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Online Controls for Storm

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.005, Volume (m³): 2.4

|                                   |                            |
|-----------------------------------|----------------------------|
| Unit Reference                    | MD-SHE-0063-2000-1320-2000 |
| Design Head (m)                   | 1.320                      |
| Design Flow (l/s)                 | 2.0                        |
| Flush-Flo™                        | Calculated                 |
| Objective                         | Minimise upstream storage  |
| Application                       | Surface                    |
| Sump Available                    | Yes                        |
| Diameter (mm)                     | 63                         |
| Invert Level (m)                  | 197.850                    |
| Minimum Outlet Pipe Diameter (mm) | 75                         |
| Suggested Manhole Diameter (mm)   | 1200                       |

| Control Points            | Head (m) | Flow (l/s) |
|---------------------------|----------|------------|
| Design Point (Calculated) | 1.320    | 2.0        |
| Flush-Flo™                | 0.277    | 1.7        |
| Kick-Flo®                 | 0.560    | 1.4        |
| Mean Flow over Head Range | -        | 1.6        |

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     | 1.4        | 1.200     | 1.9        | 3.000     | 2.9        | 7.000     | 4.3        |
| 0.200     | 1.6        | 1.400     | 2.0        | 3.500     | 3.1        | 7.500     | 4.5        |
| 0.300     | 1.7        | 1.600     | 2.2        | 4.000     | 3.3        | 8.000     | 4.6        |
| 0.400     | 1.6        | 1.800     | 2.3        | 4.500     | 3.5        | 8.500     | 4.7        |
| 0.500     | 1.5        | 2.000     | 2.4        | 5.000     | 3.7        | 9.000     | 4.9        |
| 0.600     | 1.4        | 2.200     | 2.5        | 5.500     | 3.9        | 9.500     | 5.0        |
| 0.800     | 1.6        | 2.400     | 2.6        | 6.000     | 4.0        |           |            |
| 1.000     | 1.8        | 2.600     | 2.7        | 6.500     | 4.2        |           |            |

|                                                                |                                                |                                                                                     |
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Storage Structures for Storm

Cellular Storage Manhole: 3, DS/PN: 1.001

Invert Level (m) 198.195 Safety Factor 2.0  
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95  
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m <sup>2</sup> ) | Inf. Area (m <sup>2</sup> ) | Depth (m) | Area (m <sup>2</sup> ) | Inf. Area (m <sup>2</sup> ) |
|-----------|------------------------|-----------------------------|-----------|------------------------|-----------------------------|
| 0.000     | 159.8                  | 159.8                       | 0.500     | 0.0                    | 183.4                       |
| 0.400     | 159.8                  | 183.4                       |           |                        |                             |

|                                                                |                                                |                                                                                     |
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)  
for Storm

Simulation Criteria

Areal Reduction Factor 1.000      Additional Flow - % of Total Flow 0.000  
 Hot Start (mins) 0      MADD Factor \* 10m<sup>3</sup>/ha Storage 2.000  
 Hot Start Level (mm) 0      Inlet Coefficient 0.800  
 Manhole Headloss Coeff (Global) 0.500      Flow per Person per Day (l/per/day) 0.000  
 Foul Sewage per hectare (l/s) 0.000

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

Synthetic Rainfall Details

Rainfall Model FSR      Ratio R 0.407  
 Region England and Wales Cv (Summer) 0.750  
 M5-60 (mm) 19.900 Cv (Winter) 0.840

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

Profile(s) Summer and Winter  
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440  
 Return Period(s) (years) 1, 30, 100  
 Climate Change (%) 0, 0, 40

| US/MH |             | Return<br>Period | Climate<br>Change | First (X)<br>Surcharge | First (Y)<br>Flood | First (Z)<br>Overflow | Overflow<br>Act. | Water<br>Level |
|-------|-------------|------------------|-------------------|------------------------|--------------------|-----------------------|------------------|----------------|
| PN    | Name        |                  |                   |                        |                    |                       |                  | (m)            |
| 1.000 | 1 15 Winter | 1                | +0%               | 30/15 Winter           |                    |                       |                  | 198.321        |
| 2.000 | 2 15 Winter | 1                | +0%               | 100/15 Summer          |                    |                       |                  | 198.389        |
| 1.001 | 3 60 Winter | 1                | +0%               | 30/60 Summer           |                    |                       |                  | 198.239        |
| 1.002 | 4 30 Winter | 1                | +0%               | 30/15 Summer           |                    |                       |                  | 198.271        |
| 1.003 | 5 30 Winter | 1                | +0%               | 1/30 Winter            |                    |                       |                  | 198.278        |
| 1.004 | 6 30 Winter | 1                | +0%               | 1/15 Summer            |                    |                       |                  | 198.283        |
| 1.005 | 7 30 Winter | 1                | +0%               | 1/15 Summer            |                    |                       |                  | 198.281        |

| US/MH |      | Surcharged Flooded |                             | Pipe           |                   | Status     | Level<br>Exceeded |
|-------|------|--------------------|-----------------------------|----------------|-------------------|------------|-------------------|
| PN    | Name | Depth<br>(m)       | Volume<br>(m <sup>3</sup> ) | Flow /<br>Cap. | Overflow<br>(l/s) |            |                   |
| 1.000 | 1    | -0.079             | 0.000                       | 0.44           | 5.7               | OK         |                   |
| 2.000 | 2    | -0.061             | 0.000                       | 0.31           | 1.9               | OK         |                   |
| 1.001 | 3    | -0.106             | 0.000                       | 0.24           | 4.1               | OK         |                   |
| 1.002 | 4    | -0.039             | 0.000                       | 0.23           | 6.2               | OK         |                   |
| 1.003 | 5    | 0.003              | 0.000                       | 0.17           | 6.0               | SURCHARGED |                   |
| 1.004 | 6    | 0.233              | 0.000                       | 0.09           | 2.8               | SURCHARGED |                   |

|                                                                |                                                |                                                                                     |
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)  
for Storm

|       |               | Surcharged   |                             | Flooded        |                   |               | Pipe       |                   |  |
|-------|---------------|--------------|-----------------------------|----------------|-------------------|---------------|------------|-------------------|--|
| PN    | US/MH<br>Name | Depth<br>(m) | Volume<br>(m <sup>3</sup> ) | Flow /<br>Cap. | Overflow<br>(l/s) | Flow<br>(l/s) | Status     | Level<br>Exceeded |  |
| 1.005 | 7             | 0.281        | 0.000                       | 0.13           |                   | 1.7           | SURCHARGED |                   |  |

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BIC110 - The MedBIC

Alan Cherry Drive

Chelmsford CM1 1SQ

The Grove

(Latest Site Plan)

CO22/289/07

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Micro Drainage

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

for Storm

Simulation Criteria

Areal Reduction Factor 1.000

Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0

MADD Factor \* 10m³/ha Storage 2.000

Hot Start Level (mm) 0

Inlet Coefficient 0.800

Manhole Headloss Coeff (Global) 0.500

Flow per Person per Day (l/per/day) 0.000

Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0

Number of Storage Structures 1

Number of Online Controls 1

Number of Time/Area Diagrams 0

Number of Offline Controls 0

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR

Ratio R 0.407

Region England and Wales Cv (Summer) 0.750

M5-60 (mm) 19.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0

Analysis Timestep 2.5 Second Increment (Extended)

DTS Status OFF

DVD Status ON

Inertia Status OFF

Profile(s) Summer and Winter

Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440

Return Period(s) (years) 1, 30, 100

Climate Change (%) 0, 0, 40

| PN    | US/MH Name | Storm      | Return Period | Climate Change | First (X) Surge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|-------|------------|------------|---------------|----------------|-----------------|-----------------|--------------------|---------------|-----------------|
| 1.000 | 1          | 15 Winter  | 30            | +0%            | 30/15 Winter    |                 |                    |               | 198.406         |
| 2.000 | 2          | 15 Winter  | 30            | +0%            | 100/15 Summer   |                 |                    |               | 198.417         |
| 1.001 | 3          | 120 Winter | 30            | +0%            | 30/60 Summer    |                 |                    |               | 198.393         |
| 1.002 | 4          | 15 Winter  | 30            | +0%            | 30/15 Summer    |                 |                    |               | 198.436         |
| 1.003 | 5          | 15 Winter  | 30            | +0%            | 1/30 Winter     |                 |                    |               | 198.488         |
| 1.004 | 6          | 15 Winter  | 30            | +0%            | 1/15 Summer     |                 |                    |               | 198.594         |
| 1.005 | 7          | 15 Winter  | 30            | +0%            | 1/15 Summer     |                 |                    |               | 198.593         |

| Surcharged Flooded |            |           |             |             | Pipe           |                 |            |                |
|--------------------|------------|-----------|-------------|-------------|----------------|-----------------|------------|----------------|
| PN                 | US/MH Name | Depth (m) | Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status     | Level Exceeded |
| 1.000              | 1          | 0.006     | 0.000       | 1.07        |                | 13.7            | SURCHARGED |                |
| 2.000              | 2          | -0.033    | 0.000       | 0.77        |                | 4.7             | OK         |                |
| 1.001              | 3          | 0.048     | 0.000       | 0.16        |                | 2.7             | SURCHARGED |                |
| 1.002              | 4          | 0.126     | 0.000       | 0.31        |                | 8.6             | SURCHARGED |                |
| 1.003              | 5          | 0.213     | 0.000       | 0.23        |                | 7.9             | SURCHARGED |                |
| 1.004              | 6          | 0.544     | 0.000       | 0.20        |                | 6.3             | SURCHARGED |                |

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

| PN    | US/MH<br>Name | Surcharged Flooded |                             | Flow / Overflow |       | Pipe<br>Flow | Status     | Level    |
|-------|---------------|--------------------|-----------------------------|-----------------|-------|--------------|------------|----------|
|       |               | Depth<br>(m)       | Volume<br>(m <sup>3</sup> ) | Cap.            | (l/s) | (l/s)        |            | Exceeded |
| 1.005 | 7             | 0.593              | 0.000                       | 0.13            |       | 1.7          | SURCHARGED |          |

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

Simulation Criteria

Areal Reduction Factor 1.000      Additional Flow - % of Total Flow 0.000  
 Hot Start (mins)                      0                      MADD Factor \* 10m<sup>3</sup>/ha Storage 2.000  
 Hot Start Level (mm)                      0                      Inlet Coefficient 0.800  
 Manhole Headloss Coeff (Global) 0.500      Flow per Person per Day (l/per/day) 0.000  
 Foul Sewage per hectare (l/s) 0.000

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

Synthetic Rainfall Details

Rainfall Model                      FSR                      Ratio R 0.407  
 Region England and Wales Cv (Summer) 0.750  
 M5-60 (mm)                      19.900 Cv (Winter) 0.840

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

Profile(s)                      Summer and Winter  
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440  
 Return Period(s) (years)                      1, 30, 100  
 Climate Change (%)                      0, 0, 40

| US/MH |      | Return Climate |        | First (X) |               | First (Y) |          | First (Z) |  | Overflow | Water Level |
|-------|------|----------------|--------|-----------|---------------|-----------|----------|-----------|--|----------|-------------|
| PN    | Name | Storm          | Period | Change    | Surcharge     | Flood     | Overflow | Act.      |  |          | (m)         |
| 1.000 | 1    | 240 Winter     | 100    | +40%      | 30/15 Winter  |           |          |           |  |          | 198.968     |
| 2.000 | 2    | 240 Winter     | 100    | +40%      | 100/15 Summer |           |          |           |  |          | 198.967     |
| 1.001 | 3    | 240 Winter     | 100    | +40%      | 30/60 Summer  |           |          |           |  |          | 198.966     |
| 1.002 | 4    | 240 Winter     | 100    | +40%      | 30/15 Summer  |           |          |           |  |          | 198.964     |
| 1.003 | 5    | 240 Winter     | 100    | +40%      | 1/30 Winter   |           |          |           |  |          | 198.962     |
| 1.004 | 6    | 240 Winter     | 100    | +40%      | 1/15 Summer   |           |          |           |  |          | 198.958     |
| 1.005 | 7    | 240 Winter     | 100    | +40%      | 1/15 Summer   |           |          |           |  |          | 198.956     |

| US/MH |      | Surcharged Flooded |                          | Pipe        |                | Pipe       |            | Level    |  |
|-------|------|--------------------|--------------------------|-------------|----------------|------------|------------|----------|--|
| PN    | Name | Depth (m)          | Volume (m <sup>3</sup> ) | Flow / Cap. | Overflow (l/s) | Flow (l/s) | Status     | Exceeded |  |
| 1.000 | 1    | 0.568              | 0.000                    | 0.36        |                | 4.6        | SURCHARGED |          |  |
| 2.000 | 2    | 0.517              | 0.000                    | 0.25        |                | 1.5        | FLOOD RISK |          |  |
| 1.001 | 3    | 0.621              | 0.000                    | 0.10        |                | 1.8        | FLOOD RISK |          |  |
| 1.002 | 4    | 0.654              | 0.000                    | 0.08        |                | 2.3        | FLOOD RISK |          |  |
| 1.003 | 5    | 0.687              | 0.000                    | 0.07        |                | 2.3        | FLOOD RISK |          |  |
| 1.004 | 6    | 0.908              | 0.000                    | 0.06        |                | 1.9        | SURCHARGED |          |  |

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

|       |               | Surcharged   |                             | Flooded        |                   |               | Pipe       |       |          |
|-------|---------------|--------------|-----------------------------|----------------|-------------------|---------------|------------|-------|----------|
| PN    | US/MH<br>Name | Depth<br>(m) | Volume<br>(m <sup>3</sup> ) | Flow /<br>Cap. | Overflow<br>(l/s) | Flow<br>(l/s) | Status     | Level | Exceeded |
| 1.005 | 7             | 0.956        | 0.000                       | 0.14           |                   | 1.8           | SURCHARGED |       |          |