



#### General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

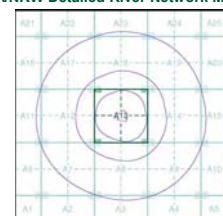
#### Detailed River Network Data

- Primary River
- Secondary River
- Tertiary River
- Canal
- Canal Tunnel
- Undefined River
- Lake/Reservoir
- Off-line Drainage Feature
- Extended Culvert (greater than 50m)
- Underground River (inferred)
- Underground River (local knowledge)
- Downstream of High Water Mark
- Downstream of Seaward Extension
- Not assigned River feature

#### Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- Mean Low Water
- Mean High Water

#### EA/NRW Detailed River Network Map - Slice A



#### Order Details

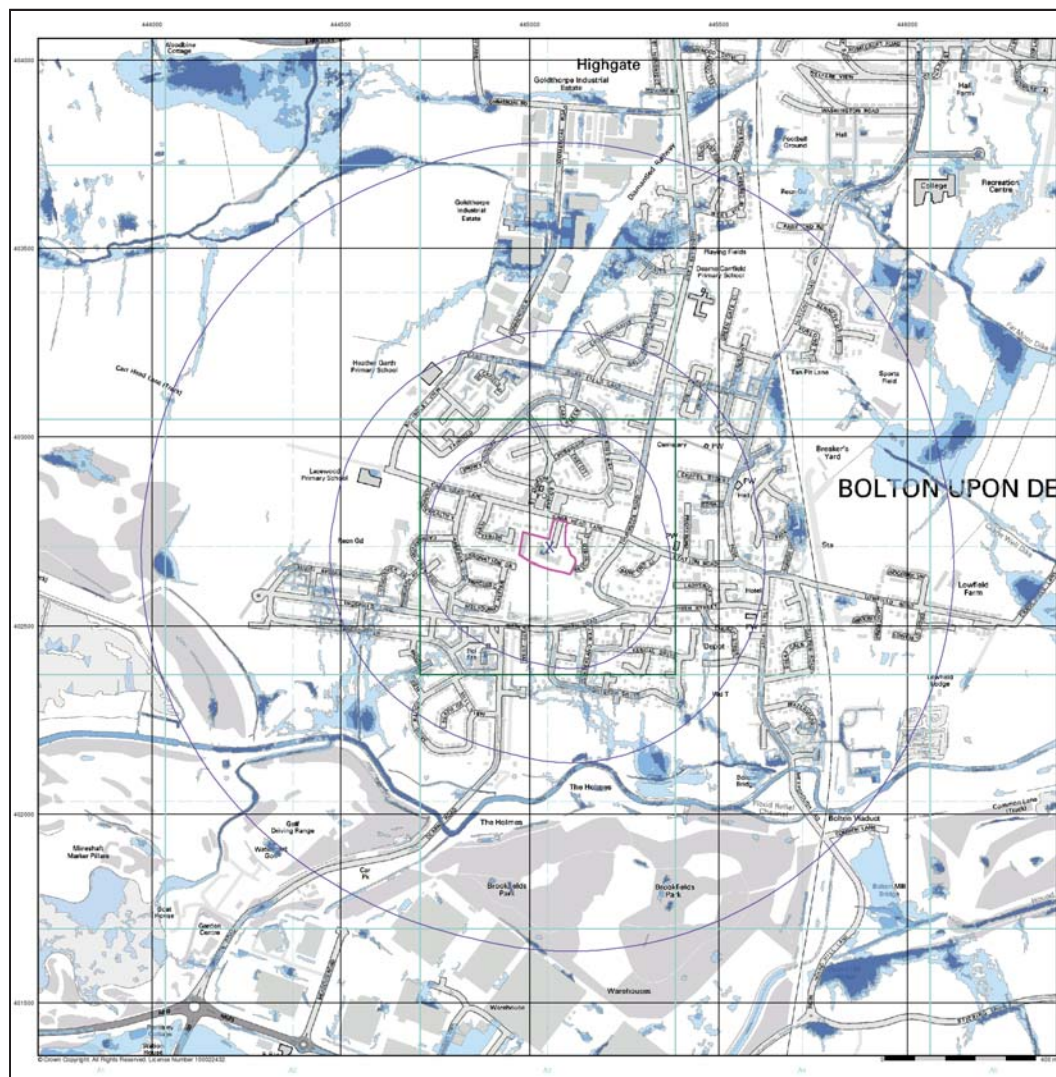
Order Number: 89063416.1.1  
 Customer Ref: LKC 16 1223  
 National Grid Reference: 445050, 402710  
 Slice: A  
 Site Area (Ha): 1.23  
 Search Buffer (m): 1000

#### Site Details

Carr Head Lane, Bolton-upon-Deane, Rotherham, S63 8DA



Tel: 0844 844 9952  
 Fax: 0844 844 9951  
 Web: www.environmentalcheck.co.uk



#### General

- Specified Site
- Specified Buffer(1)
- X Bearing Reference Point

#### Risk of Flooding from Surface Water

- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

#### Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

#### EA/NRW Suitability Map - Slice A



#### Order Details

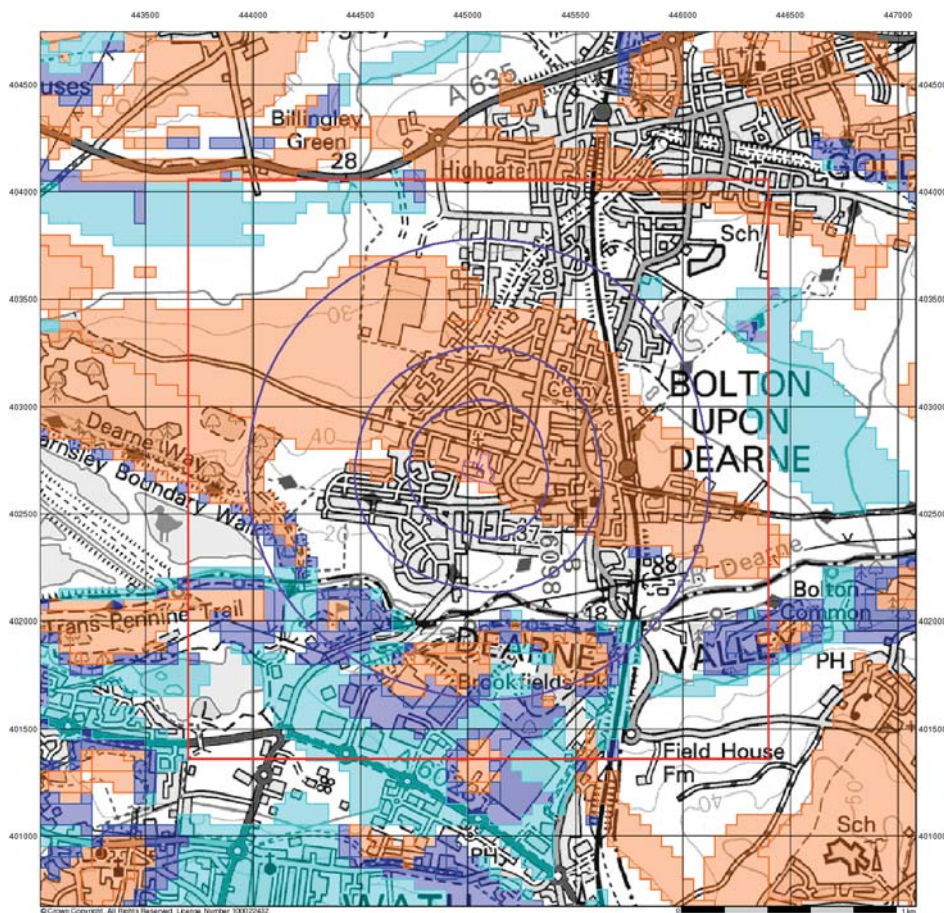
Order Number: 89063416\_1\_1  
 Customer Ref: LKC 16 1223  
 National Grid Reference: 445050, 402710  
 Slice: A  
 Site Area (Ha): 1.23  
 Search Buffer (m): 1000

#### Site Details

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# BGS Flood GFS Data

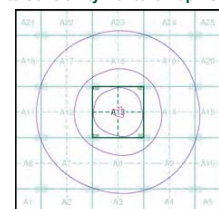
## General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Site

## Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

## Site Sensitivity Context Map - Slice A



## Order Details

Order Number: 89063416\_1\_1  
 Customer Ref: LKC 16 1223  
 National Grid Reference: 445050, 402710  
 Slice: A  
 Site Area (Ha): 1.23  
 Search Buffer (m): 1000

## Site Details

Carr Head Lane, Bolton-upon-Dearne, Rotherham, S63 8DA



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 Fax: 0844 844 9951  
 Web: www.emmrocheck.co.uk

## **APPENDIX D**

### **CONSULTEE CORRESPONDENCE**



## Mark Jones

---

**From:** Mark Jones  
**Sent:** 15 June 2016 17:48  
**To:** 'roads@barnsley.gov.uk'  
**Subject:** Flood Risk Assessment - south of Carr Head Lane, Bolton-upon-Deane, Barnsley, Yorkshire.  
**Attachments:** Site boundary A.pdf

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of a site located on Land south of Carr Head Lane, Bolton-upon-Deane, Nr. Barnsley. The site is in a central position in the village. Nearest Postcode S63 8DA.

Centred at approximate National Grid Reference 445060E, 402705N. The area of interest appears to be within Flood Zone 1

The site is currently used as a nursing home and grounds.

To complete the FRA we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.
- Any restrictions on discharging to sewers, if infiltration and discharge to watercourses proves impractical.



If you have any queries please get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

We will also contact Yorkshire Water, and Barnsley Metropolitan Borough Council as well for their information and requirements

Any advice or recommendations you may have regarding the potential discharges from the development of this site? The site slopes down to the watercourse from Saves Lane.

We will be in contact with all other relevant risk management authorities to get a more complete understanding of the issues in the area.

Regards

Mark Jones



**Mark Jones**

**Associate**

0161 763 7200 – 0780 076 8584 [www.thelkgroup.com](http://www.thelkgroup.com)

Manchester | Liverpool | Glasgow

## Mark Jones

---

**From:** Mark Jones  
**Sent:** 15 June 2016 17:44  
**To:** Technical\_Sewerage@yorkshirewater.co.uk  
**Subject:** Flood Risk Assessment - south of Carr Head Lane, Bolton-upon-Deane, Barnsley, Yorkshire.  
**Attachments:** Site boundary A.PDF; 3699-6\_717065\_WW\_Form\_PrePlanning\_Sewerage\_Enquiry\_Interactive (2).pdf; 12,387 - 201C Proposed Site Plan Woodlands.pdf; 2014-0497 A1 version Bolton Hall gf Stat Approvals\_250414 Model (1).pdf; 14\_0497 Extension-15.pdf

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of a site located on Land south of Carr Head Lane, Bolton-upon-Deane, Nr. Barnsley. The site is in a central position in the village. Nearest Postcode S63 8DA.

Centred at approximate National Grid Reference 445060E, 402705N. The area of interest appears to be within Flood Zone 1

The site is currently used as a nursing home and grounds.

To complete the FRA we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.
- Any restrictions on discharging to sewers, if infiltration and discharge to watercourses proves impractical.
- Your records indicate a surface water sewer to the north on Carr Head Lane, but the current buildings discharge surface water and foul to a drain that appears to fall to the south east from the south of the existing building.



If you have any queries please get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

We will also contact Yorkshire Water, and Barnsley Metropolitan Borough Council as well for their information and requirements

Any advice or recommendations you may have regarding the potential discharges from the development of this site? The site slopes down to the watercourse from Saves Lane.

We will be in contact with all other relevant risk management authorities to get a more complete understanding of the issues in the area.

Regards

Mark Jones



**Mark Jones**  
**Associate**  
0161 763 7200 – 0780 076 8584 [www.thelkgroup.com](http://www.thelkgroup.com)  
Manchester | Liverpool | Glasgow

## Build-Over Guidelines

Please be aware that since the 1st of October 2011 there are public sewers in existence that are not shown on the public sewer map. The actual position of all public sewers should be verified on site by the developer.

| Assessment questions for applying the criteria set out in Part H4 of the Building Regulations (2010)                                                                                                      | IF YES TO ANY YW OBJECT           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Is the proposed building footprint understood to be within 3 metres of a public sewer that is greater than 225mm diameter and or greater than 3m in depth?                                                | <b>NO</b><br>(If YES see 1 below) |
| Is the proposed building footprint understood to be over a public sewer access point?<br>(A public sewer access point is a manhole, inspection chamber, gully or rodding point that is on a public sewer) | <b>NO</b><br>(If YES see 2 below) |
| Is the proposed building footprint understood to be over more than 8 metres of a public sewer?                                                                                                            | <b>NO</b><br>(If YES see 3 below) |
| Are the proposed building foundations exerting additional loading upon a public sewer?                                                                                                                    | <b>NO</b><br>(If YES see 4 below) |

1. If public sewers greater than 225mm diameter and or greater than 3m in depth exist on site, no building should be permitted within at least 3 meters of them. Should this be the case, the applicant has the option to revise the building proposal or request a formal public sewer diversion agreement from Yorkshire Water.
2. Public sewers should remain accessible for rodding and jetting from access points, but these should not be within the proposed building footprint. If there are existing public sewer access points within the proposed building footprint the applicant has the option to move the building proposal or remove/relocate the access points. For such minor public sewer alterations, **Form "H4S185"** should be completed and returned with a plan showing the pipes and access points to be relocated or removed.
3. If a public sewer is in good condition, is 225mm in diameter or less and is less than 3 metres in depth, it may be built over to a maximum length of 8 metres.
4. If a public sewer is in good condition, is 225mm in diameter or less and is less than 3 metres in depth, it may be built over if the applicant ensures that it is not unduly loaded upon by the building foundations. The foundations should be taken below the public sewer or, where this is not possible, designed to pose no additional loading detriment to the sewer.

Yorkshire Water require notice to be provided by the applicant of any proposed new direct connections to a public sewer. S106 Sewer connection forms and guidance notes are available to download from our website at [www.yorkshirewater.com](http://www.yorkshirewater.com). Applications are not required for connections to private drains.

## Property Identifier



## Sewer Legend

|  |                               |  |                             |
|--|-------------------------------|--|-----------------------------|
|  | Combined Sewer                |  | s24 Combined Sewer          |
|  | Surface Water Sewer           |  | s24 Surface Water Sewer     |
|  | Foul Sewer                    |  | s24 Foul Sewer              |
|  | Section 104 Sewer             |  | Rising Main                 |
|  | Pumping Station               |  | Abandoned Sewer             |
|  | Public Sewage Treatment Works |  | Syphon Sewer & Vacuum Sewer |

## Water Legend

|  |                         |
|--|-------------------------|
|  | Water Main 4" and below |
|  | Water Main 4" and above |
|  | Raw Water Main          |
|  | Private Water Main      |
|  | Fire Hydrant            |
|  | Pumping Station         |



Public Clean Water Network

20/11/2014 16:42:20

OS Grid Coordinates: 445003 : 402564

Map Name : SE4502NW

mullockl



Public Waste Water Network

20/11/2014 16:42:26

OS Grid Coordinates: 445002 : 402576

Map Name : SE4502NW

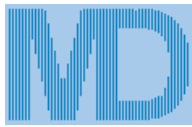
mullockl



## **APPENDIX E**

## **CALCULATIONS**





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## The LK Group

www.thelkgroup.com

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Kay Street,  
Bury. BL9 6BU  
Tel: 0161 763 7200  
email: info@thelkgroup.com

|                               |         |          |
|-------------------------------|---------|----------|
| Job No.<br><b>FRA 16 1050</b> |         |          |
| Sheet no.<br><b>1</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                             |                 |         |          |
|-------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Greenfield Runoff - IOH</b>                   | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>IoH 124 Runoff calcs for Bolton Upon Dearne</b> |                 |         |          |

### Hydrological Data:-

#### FSR Hydrology:-

|                               |                        |
|-------------------------------|------------------------|
| Location = Bolton Upon Dearne | Grid reference = SE412 |
| M5-60 (mm) = 18.5             | r = 0.36               |
| Soil runoff = 0.40            | SAAR (mm/yr) = 695     |
| WRAP = 3                      | Area = England & Wales |
| Hydrological area = 3         | Hydrological zone = 8  |

Soil classification for WRAP type 3

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

### Design data:-

Area = 0.0123 Km<sup>2</sup> - 1.23 Ha - 12300 m<sup>2</sup>

### Calculation method:-

Runoff is calculated from:-

$$Q_{\text{BAR(rural)}} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km<sup>2</sup>  
 SAAR = Standard Average Annual Rainfall (mm/yr)  
 SOIL = Soil value derived from Winter Rainfall Acceptance Potential  
 $Q_{\text{BAR(rural)}}$  = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$  is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

### Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used  
 Reducing factor used for these calculations is 0.025

Mean Annual Peak Flow  $Q_{\text{BAR(rural)}}$  = 4.15 l/s



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|                                               |  |                                                                                                           |  |             |          |
|-----------------------------------------------|--|-----------------------------------------------------------------------------------------------------------|--|-------------|----------|
| <b>The LK Group</b><br><br>www.thelkgroup.com |  | Bury Business Centre,<br>Kay Street,<br>Bury, BL9 6BU<br>Tel: 0161 763 7200<br>email: info@thelkgroup.com |  | Job No.     |          |
|                                               |  |                                                                                                           |  | FRA 16 1050 |          |
|                                               |  |                                                                                                           |  | Sheet no.   |          |
| Project                                       |  | Greenfield Runoff - IOH                                                                                   |  | Date        |          |
| Title                                         |  | IoH 124 Runoff calcs for Bolton Upon Dearne                                                               |  | By          | Checked  |
|                                               |  |                                                                                                           |  | MC          | Reviewed |

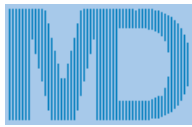
#### Values for $Q_{BAR(rural)}$

| Ret. per. | m <sup>3</sup> /s | l/s   | l/s/ha | Ret. per. | m <sup>3</sup> /s | l/s    | l/s/ha |
|-----------|-------------------|-------|--------|-----------|-------------------|--------|--------|
| 1yr       | 0.004             | 3.527 | 2.868  | 100yr     | 0.009             | 8.715  | 7.085  |
| 2yr       | 0.004             | 3.901 | 3.171  | 100yr+20% | 0.010             | 10.458 | 8.502  |
| 5yr       | 0.005             | 5.021 | 4.082  | 100yr+30% | 0.011             | 11.329 | 9.211  |
| 10yr      | 0.006             | 6.017 | 4.892  | 200yr     | 0.010             | 9.960  | 8.097  |
| 30yr      | 0.007             | 6.972 | 5.668  | 500yr     | 0.011             | 11.329 | 9.211  |
| 50yr      | 0.008             | 7.885 | 6.410  | 1000yr    | 0.013             | 12.616 | 10.257 |

#### Growth factors -

| 1yr  | 2yr  | 5yr  | 10yr | 30yr | 50yr | 100yr | 200yr | 500yr | 1000yr |
|------|------|------|------|------|------|-------|-------|-------|--------|
| 0.85 | 0.94 | 1.21 | 1.45 | 1.68 | 1.90 | 2.10  | 2.40  | 2.73  | 3.04   |

The above is based on the Institute of Hydrology Report 124  
to which you are referred for further details (see Sect 7).  
Note that the 200 and above year growth curves were taken from W5-074.



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| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

Project **Greenfield Runoff - ADAS - 1 in 1 year**

Title **ADAS runoff calculations for Bolton Upon Dearne**

### Data:-

#### Hydrology:-

|               |                      |                |                     |
|---------------|----------------------|----------------|---------------------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412             |
| M5-60 (mm)    | = 18.5               | SAAR (mm/yr)   | = 695               |
| r             | = 0.36               | Soil           | = 0.40              |
| Return period | = 1                  | Area           | = England and Wales |

Soil classification for WRAP type 3

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

### Site values used in design:-

|                  |           |                  |         |
|------------------|-----------|------------------|---------|
| Catchment area   | = 1.23 Ha | Catchment length | = 125 m |
| Catchment height | = 2.00 m  |                  |         |

### Calculations :-

Formula used:  $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is  $ToC = 6.09 \times L_c^{0.39}$

$L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$

$M_f = 4.938 \times S_m^2$  (Soil modification value( $S_m$ ) = fractional value of the WRAP)

$F_a$  = dimensionless annual rainfall factor ( $F_a = \{0.00127 \times SAAR\} - 0.321$ )

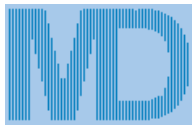
$A$  = Catchment Area (Ha)

### Results :-

|                              |               |
|------------------------------|---------------|
| Characteristic length $L_c$  | = 0.781       |
| Catchment $ToC$              | = 5.53 hrs    |
| Soil modification factor     | = 0.790       |
| Catchment Intensity at $ToC$ | = 3.84 mm/hr  |
| Flow off site                | = 5.83 l/s    |
| Catchment flow               | = 4.74 l/s/Ha |

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)  
For further information, you are directed to the above document.

**N.B.** The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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| Job No.<br><b>FRA 16 1050</b> |         |          |
| Sheet no.<br><b>1</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                                 |                 |         |          |
|-----------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Greenfield Runoff - ADAS - 1 in 30 year</b>       | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>ADAS runoff calculations for Bolton Upon Dearne</b> |                 |         |          |

### Data:-

#### Hydrology:-

|               |                      |                |                     |
|---------------|----------------------|----------------|---------------------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412             |
| M5-60 (mm)    | = 18.5               | SAAR (mm/yr)   | = 695               |
| r             | = 0.36               | Soil           | = 0.40              |
| Return period | = 30                 | Area           | = England and Wales |

Soil classification for WRAP type 3

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

### Site values used in design:-

|                  |           |                  |         |
|------------------|-----------|------------------|---------|
| Catchment area   | = 1.23 Ha | Catchment length | = 125 m |
| Catchment height | = 2.00 m  |                  |         |

### Calculations :-

Formula used:  $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is  $ToC = 6.09 \times L_c^{0.39}$   
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$   
 $M_f = 4.938 \times S_m^2$  (Soil modification value( $S_m$ ) = fractional value of the WRAP)  
 $F_a$  = dimensionless annual rainfall factor ( $F_a = \{0.00127 \times SAAR\} - 0.321$ )  
 $A$  = Catchment Area (Ha)

### Results :-

|                              |                |
|------------------------------|----------------|
| Characteristic length $L_c$  | = 0.781        |
| Catchment $ToC$              | = 5.53 hrs     |
| Soil modification factor     | = 0.790        |
| Catchment Intensity at $ToC$ | = 8.31 mm/hr   |
| Flow off site                | = 12.61 l/s    |
| Catchment flow               | = 10.25 l/s/Ha |

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)  
 For further information, you are directed to the above document.

**N.B.** The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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## The LK Group

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Job No.

**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Greenfield Runoff - ADAS - 1 in 100 year**

Title

**ADAS runoff calculations for Bolton Upon Dearne**

By

**MC**

Checked

Reviewed

### Data:-

#### Hydrology:-

|               |                      |                |                     |
|---------------|----------------------|----------------|---------------------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412             |
| M5-60 (mm)    | = 18.5               | SAAR (mm/yr)   | = 695               |
| r             | = 0.36               | Soil           | = 0.40              |
| Return period | = 100                | Area           | = England and Wales |

Soil classification for WRAP type 3

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

### Site values used in design:-

|                  |           |                  |         |
|------------------|-----------|------------------|---------|
| Catchment area   | = 1.23 Ha | Catchment length | = 125 m |
| Catchment height | = 2.00 m  |                  |         |

### Calculations :-

Formula used:  $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is  $ToC = 6.09 \times L_c^{0.39}$

$L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$

$M_f = 4.938 \times S_m^2$  (Soil modification value( $S_m$ ) = fractional value of the WRAP)

$F_a$  = dimensionless annual rainfall factor ( $F_a = \{0.00127 \times SAAR\} - 0.321$ )

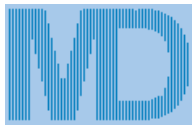
$A$  = Catchment Area (Ha)

### Results :-

|                              |                |
|------------------------------|----------------|
| Characteristic length $L_c$  | = 0.781        |
| Catchment $ToC$              | = 5.53 hrs     |
| Soil modification factor     | = 0.790        |
| Catchment Intensity at $ToC$ | = 10.80 mm/hr  |
| Flow off site                | = 16.39 l/s    |
| Catchment flow               | = 13.33 l/s/Ha |

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)  
For further information, you are directed to the above document.

**N.B.** The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



MasterDrain  
SW

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|                               |         |          |
|-------------------------------|---------|----------|
| Job No.<br><b>FRA 16 1050</b> |         |          |
| Sheet no.<br><b>0</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                                |                 |         |          |
|----------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Peak Flow - loH - 1 in 30</b>                    | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>Peak flow storage calcs for Bolton Upon Dearne</b> |                 |         |          |

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 30                 | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 6.970 l/s            | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 0                              |

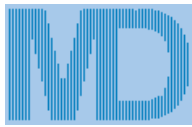
### Calculated data:-

|                  |                      |                           |                        |
|------------------|----------------------|---------------------------|------------------------|
| Time to max      | = 122.0 mins         | Calculated storage volume | = 126.9 m <sup>3</sup> |
| Rainfall at max  | = 17.35 mm/hr        | Discharge rate per Ha     | = 5.67 l/s/Ha          |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>   |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                        |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len   | Ovoid      | Len   | Box culvert | Len   |
|------|---------|------|-------|------------|-------|-------------|-------|
| 100  | 16163.0 | 1125 | 127.7 | 400 x 600  | 705.1 | 500 x 500   | 507.7 |
| 150  | 7183.5  | 1200 | 112.2 | 600 x 900  | 307.0 | 500 x 750   | 338.5 |
| 225  | 3192.7  | 1275 | 99.4  | 800 x 1200 | 172.7 | 500 x 1000  | 253.8 |
| 300  | 1795.9  | 1350 | 88.7  |            |       | 750 x 1000  | 169.2 |
| 375  | 1149.4  | 1425 | 79.6  |            |       | 750 x 1200  | 141.0 |
| 450  | 798.2   | 1500 | 71.8  |            |       | 750 x 1500  | 112.8 |
| 525  | 586.4   | 1575 | 65.2  |            |       | 1000 x 1000 | 126.9 |
| 600  | 449.0   | 1650 | 59.4  |            |       | 1000 x 1200 | 105.8 |
| 675  | 354.7   | 1725 | 54.3  |            |       | 1000 x 1500 | 84.6  |
| 750  | 287.3   | 1800 | 49.9  |            |       | 1000 x 1800 | 70.5  |
| 825  | 237.5   | 1875 | 46.0  |            |       | 1000 x 2000 | 63.5  |
| 900  | 199.5   | 1950 | 42.5  |            |       | 1500 x 1500 | 56.4  |
| 975  | 170.0   | 2025 | 39.4  |            |       | 1500 x 1800 | 47.0  |
| 1050 | 146.6   | 2100 | 36.7  |            |       | 1500 x 2000 | 42.3  |



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Data:-

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Job No.

**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Peak Flow - loH - 1 in 30**

Title

**Peak flow storage calcs for Bolton Upon Dearne**

By

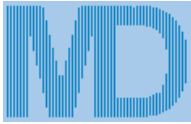
**MC**

Checked

Reviewed

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 83.0          | 70.118         | 4.182           | 65.936          |
| 20             | 57.0          | 96.357         | 8.364           | 87.993          |
| 30             | 45.0          | 112.914        | 12.546          | 100.368         |
| 40             | 37.0          | 125.234        | 16.728          | 108.506         |
| 50             | 32.0          | 135.134        | 20.910          | 114.224         |
| 60             | 28.0          | 143.456        | 25.092          | 118.364         |
| 70             | 26.0          | 150.662        | 29.274          | 121.388         |
| 80             | 23.0          | 157.031        | 33.456          | 123.575         |
| 90             | 22.0          | 162.748        | 37.638          | 125.110         |
| 100            | 20.0          | 167.940        | 41.820          | 126.120         |
| 110            | 19.0          | 172.701        | 46.002          | 126.699         |
| 120            | 18.0          | 177.099        | 50.184          | 126.915         |
| 130            | 17.0          | 181.188        | 54.366          | 126.822         |
| 140            | 16.0          | 185.010        | 58.548          | 126.462         |
| 150            | 15.0          | 188.598        | 62.730          | 125.868         |
| 160            | 14.0          | 191.980        | 66.912          | 125.068         |
| 170            | 14.0          | 195.178        | 71.094          | 124.084         |
| 180            | 13.0          | 198.213        | 75.276          | 122.937         |
| 190            | 13.0          | 201.098        | 79.458          | 121.640         |
| 200            | 12.0          | 203.850        | 83.640          | 120.210         |
| 210            | 12.0          | 206.478        | 87.822          | 118.656         |
| 220            | 11.0          | 208.995        | 92.004          | 116.991         |
| 230            | 11.0          | 211.408        | 96.186          | 115.222         |
| 240            | 11.0          | 213.725        | 100.368         | 113.357         |
| 250            | 10.0          | 215.954        | 104.550         | 111.404         |
| 260            | 10.0          | 218.101        | 108.732         | 109.369         |
| 270            | 10.0          | 220.171        | 112.914         | 107.257         |
| 280            | 9.0           | 222.170        | 117.096         | 105.074         |
| 290            | 9.0           | 224.102        | 121.278         | 102.824         |
| 300            | 9.0           | 225.970        | 125.460         | 100.510         |
| 310            | 9.0           | 227.780        | 129.642         | 98.138          |
| 320            | 9.0           | 229.615        | 133.824         | 95.791          |
| 330            | 8.0           | 231.411        | 138.006         | 93.405          |
| 340            | 8.0           | 233.165        | 142.188         | 90.977          |
| 350            | 8.0           | 234.877        | 146.370         | 88.507          |
| 360            | 8.0           | 236.551        | 150.552         | 85.999          |
| 370            | 8.0           | 238.189        | 154.734         | 83.455          |
| 380            | 8.0           | 239.791        | 158.916         | 80.875          |
| 390            | 7.0           | 241.360        | 163.098         | 78.262          |
| 400            | 7.0           | 242.897        | 167.280         | 75.617          |
| 410            | 7.0           | 244.404        | 171.462         | 72.942          |
| 420            | 7.0           | 245.882        | 175.644         | 70.238          |
| 430            | 7.0           | 247.332        | 179.826         | 67.506          |
| 440            | 7.0           | 248.755        | 184.008         | 64.747          |
| 450            | 7.0           | 250.153        | 188.190         | 61.963          |
| 460            | 7.0           | 251.526        | 192.372         | 59.154          |
| 470            | 6.0           | 252.876        | 196.554         | 56.322          |
| 480            | 6.0           | 254.203        | 200.736         | 53.467          |
| 490            | 6.0           | 255.508        | 204.918         | 50.590          |
| 500            | 6.0           | 256.792        | 209.100         | 47.692          |
| 510            | 6.0           | 258.056        | 213.282         | 44.774          |
| 520            | 6.0           | 259.300        | 217.464         | 41.836          |
| 530            | 6.0           | 260.526        | 221.646         | 38.880          |
| 540            | 6.0           | 261.733        | 225.828         | 35.905          |
| 550            | 6.0           | 262.922        | 230.010         | 32.912          |
| 560            | 6.0           | 264.095        | 234.192         | 29.903          |
| 570            | 6.0           | 265.250        | 238.374         | 26.876          |
| 580            | 5.0           | 266.390        | 242.556         | 23.834          |
| 590            | 5.0           | 267.514        | 246.738         | 20.776          |
| 600            | 5.0           | 268.624        | 250.920         | 17.704          |

Storage volume (m<sup>3</sup>) = 126.9 m<sup>3</sup>



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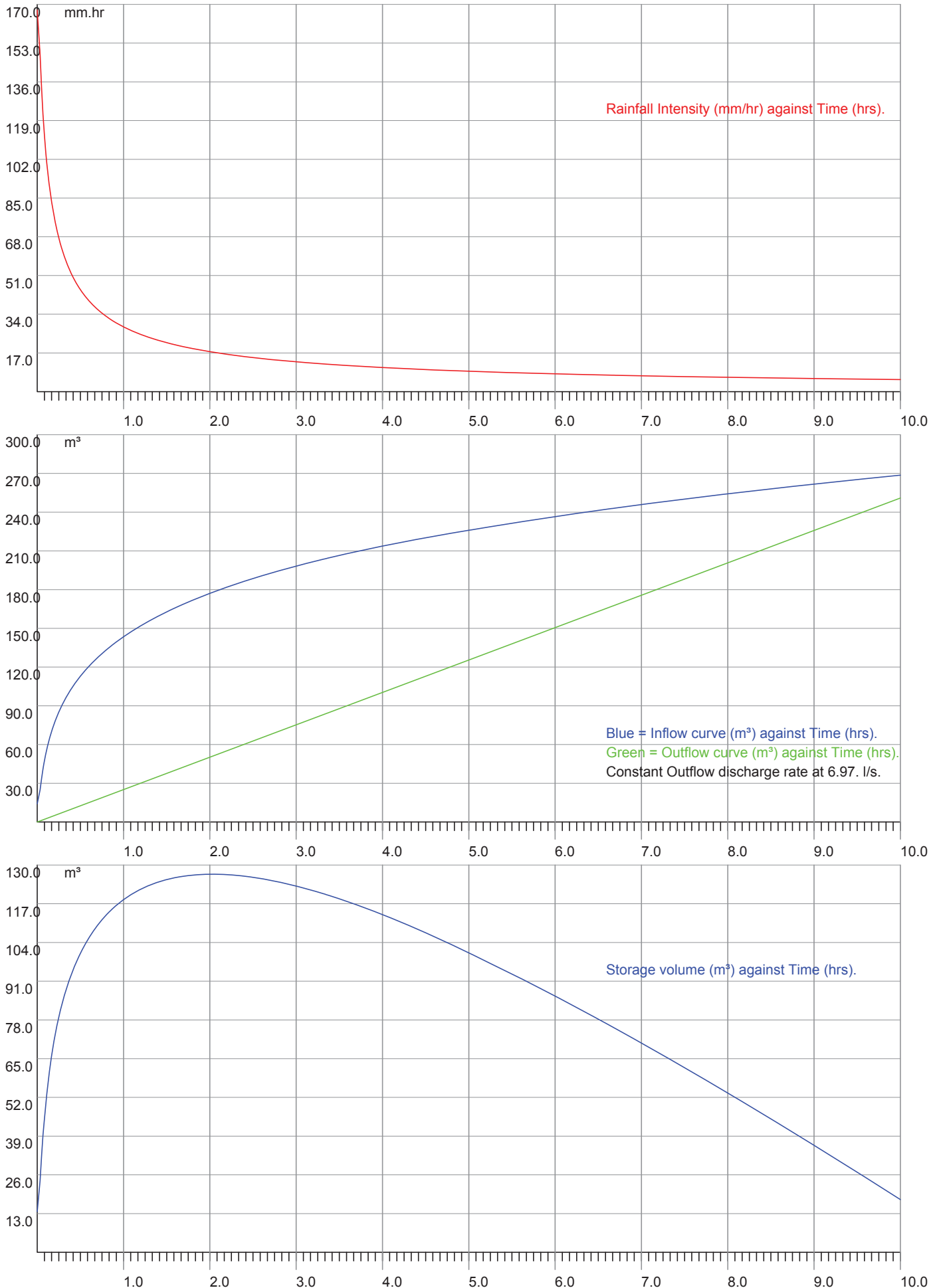
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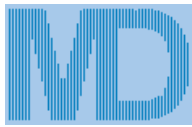
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email: info@thelkgroup.com

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| Sheet no. | <b>2</b>           |         |          |
| Date      | <b>08/07/16</b>    |         |          |
| By        | <b>MC</b>          | Checked | Reviewed |

Project **Peak Flow - loH - 1 in 30**

Title **Peak flow storage calcs for Bolton Upon Dearne**





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| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

Project **Peak Flow - ADAS - 1 in 30**

Title **Peak flow storage calcs for Bolton Upon Dearne**

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 30                 | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 12.610 l/s           | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 0                              |

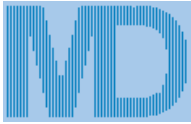
### Calculated data:-

|                  |                      |                           |                       |
|------------------|----------------------|---------------------------|-----------------------|
| Time to max      | = 61.0 mins          | Calculated storage volume | = 98.1 m <sup>3</sup> |
| Rainfall at max  | = 28.13 mm/hr        | Discharge rate per Ha     | = 10.25 l/s/Ha        |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>  |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                       |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len  | Ovoid      | Len   | Box culvert | Len   |
|------|---------|------|------|------------|-------|-------------|-------|
| 100  | 12488.9 | 1125 | 98.7 | 400 x 600  | 544.8 | 500 x 500   | 392.3 |
| 150  | 5550.6  | 1200 | 86.7 | 600 x 900  | 237.2 | 500 x 750   | 261.5 |
| 225  | 2466.9  | 1275 | 76.8 | 800 x 1200 | 133.4 | 500 x 1000  | 196.1 |
| 300  | 1387.7  | 1350 | 68.5 |            |       | 750 x 1000  | 130.8 |
| 375  | 888.1   | 1425 | 61.5 |            |       | 750 x 1200  | 109.0 |
| 450  | 616.7   | 1500 | 55.5 |            |       | 750 x 1500  | 87.2  |
| 525  | 453.1   | 1575 | 50.3 |            |       | 1000 x 1000 | 98.1  |
| 600  | 346.9   | 1650 | 45.9 |            |       | 1000 x 1200 | 81.7  |
| 675  | 274.1   | 1725 | 42.0 |            |       | 1000 x 1500 | 65.4  |
| 750  | 222.0   | 1800 | 38.5 |            |       | 1000 x 1800 | 54.5  |
| 825  | 183.5   | 1875 | 35.5 |            |       | 1000 x 2000 | 49.0  |
| 900  | 154.2   | 1950 | 32.8 |            |       | 1500 x 1500 | 43.6  |
| 975  | 131.4   | 2025 | 30.5 |            |       | 1500 x 1800 | 36.3  |
| 1050 | 113.3   | 2100 | 28.3 |            |       | 1500 x 2000 | 32.7  |



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Data:-

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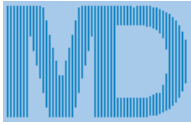
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| Job No.   | FRA 16 1050 |         |          |
| Sheet no. | 1           |         |          |
| Date      | 08/07/16    |         |          |
| By        | MC          | Checked | Reviewed |

|         |                                                |
|---------|------------------------------------------------|
| Project | Peak Flow - ADAS - 1 in 30                     |
| Title   | Peak flow storage calcs for Bolton Upon Dearne |

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 83.0          | 70.118         | 7.566           | 62.552          |
| 20             | 57.0          | 96.357         | 15.132          | 81.225          |
| 30             | 45.0          | 112.914        | 22.698          | 90.216          |
| 40             | 37.0          | 125.234        | 30.264          | 94.970          |
| 50             | 32.0          | 135.134        | 37.830          | 97.304          |
| 60             | 28.0          | 143.456        | 45.396          | 98.060          |
| 70             | 26.0          | 150.662        | 52.962          | 97.700          |
| 80             | 23.0          | 157.031        | 60.528          | 96.503          |
| 90             | 22.0          | 162.748        | 68.094          | 94.654          |
| 100            | 20.0          | 167.940        | 75.660          | 92.280          |
| 110            | 19.0          | 172.701        | 83.226          | 89.475          |
| 120            | 18.0          | 177.099        | 90.792          | 86.307          |
| 130            | 17.0          | 181.188        | 98.358          | 82.830          |
| 140            | 16.0          | 185.010        | 105.924         | 79.086          |
| 150            | 15.0          | 188.598        | 113.490         | 75.108          |
| 160            | 14.0          | 191.980        | 121.056         | 70.924          |
| 170            | 14.0          | 195.178        | 128.622         | 66.556          |
| 180            | 13.0          | 198.213        | 136.188         | 62.025          |
| 190            | 13.0          | 201.098        | 143.754         | 57.344          |
| 200            | 12.0          | 203.850        | 151.320         | 52.530          |
| 210            | 12.0          | 206.478        | 158.886         | 47.592          |
| 220            | 11.0          | 208.995        | 166.452         | 42.543          |
| 230            | 11.0          | 211.408        | 174.018         | 37.390          |
| 240            | 11.0          | 213.725        | 181.584         | 32.141          |
| 250            | 10.0          | 215.954        | 189.150         | 26.804          |
| 260            | 10.0          | 218.101        | 196.716         | 21.385          |
| 270            | 10.0          | 220.171        | 204.282         | 15.889          |
| 280            | 9.0           | 222.170        | 211.848         | 10.322          |
| 290            | 9.0           | 224.102        | 219.414         | 4.688           |
| 300            | 9.0           | 225.970        | 226.980         | 0.000           |
| 310            | 9.0           | 227.780        | 234.546         | 0.000           |
| 320            | 9.0           | 229.615        | 242.112         | 0.000           |
| 330            | 8.0           | 231.411        | 249.678         | 0.000           |
| 340            | 8.0           | 233.165        | 257.244         | 0.000           |
| 350            | 8.0           | 234.877        | 264.810         | 0.000           |
| 360            | 8.0           | 236.551        | 272.376         | 0.000           |
| 370            | 8.0           | 238.189        | 279.942         | 0.000           |
| 380            | 8.0           | 239.791        | 287.508         | 0.000           |
| 390            | 7.0           | 241.360        | 295.074         | 0.000           |
| 400            | 7.0           | 242.897        | 302.640         | 0.000           |
| 410            | 7.0           | 244.404        | 310.206         | 0.000           |
| 420            | 7.0           | 245.882        | 317.772         | 0.000           |
| 430            | 7.0           | 247.332        | 325.338         | 0.000           |
| 440            | 7.0           | 248.755        | 332.904         | 0.000           |
| 450            | 7.0           | 250.153        | 340.470         | 0.000           |
| 460            | 7.0           | 251.526        | 348.036         | 0.000           |
| 470            | 6.0           | 252.876        | 355.602         | 0.000           |
| 480            | 6.0           | 254.203        | 363.168         | 0.000           |
| 490            | 6.0           | 255.508        | 370.734         | 0.000           |
| 500            | 6.0           | 256.792        | 378.300         | 0.000           |
| 510            | 6.0           | 258.056        | 385.866         | 0.000           |
| 520            | 6.0           | 259.300        | 393.432         | 0.000           |
| 530            | 6.0           | 260.526        | 400.998         | 0.000           |
| 540            | 6.0           | 261.733        | 408.564         | 0.000           |
| 550            | 6.0           | 262.922        | 416.130         | 0.000           |
| 560            | 6.0           | 264.095        | 423.696         | 0.000           |
| 570            | 6.0           | 265.250        | 431.262         | 0.000           |
| 580            | 5.0           | 266.390        | 438.828         | 0.000           |
| 590            | 5.0           | 267.514        | 446.394         | 0.000           |
| 600            | 5.0           | 268.624        | 453.960         | 0.000           |

Storage volume (m³) = 98.1 m³



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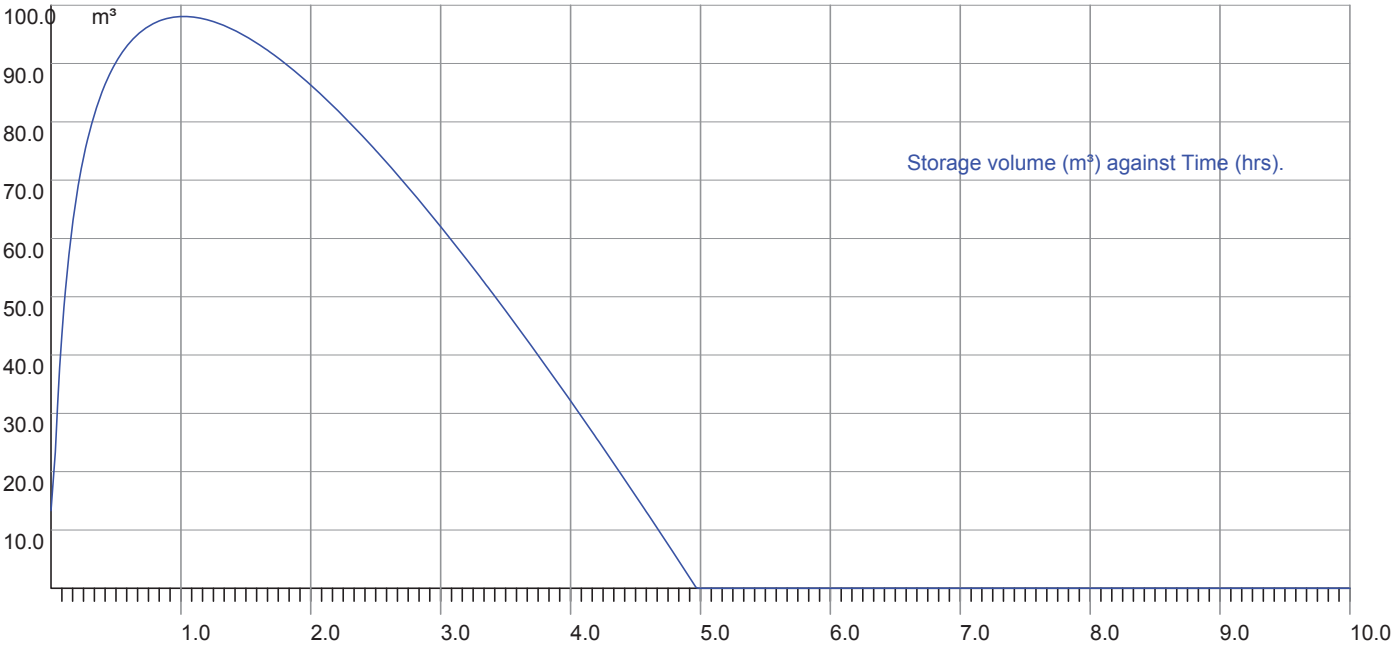
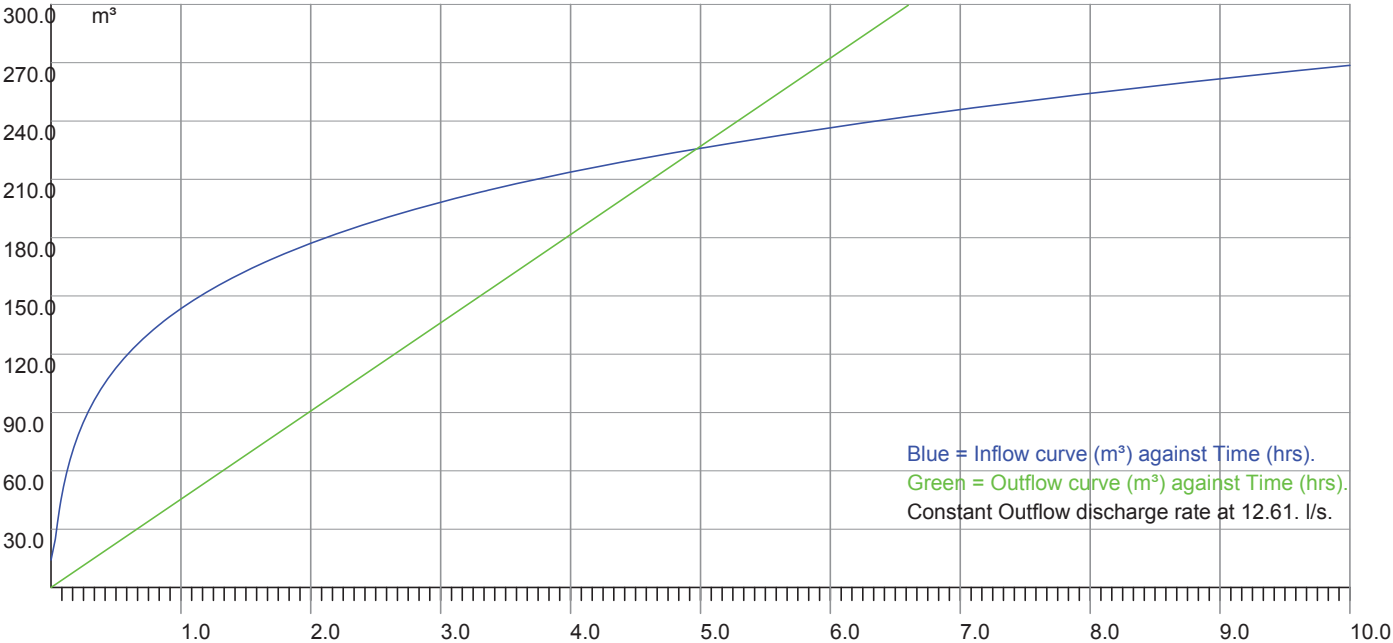
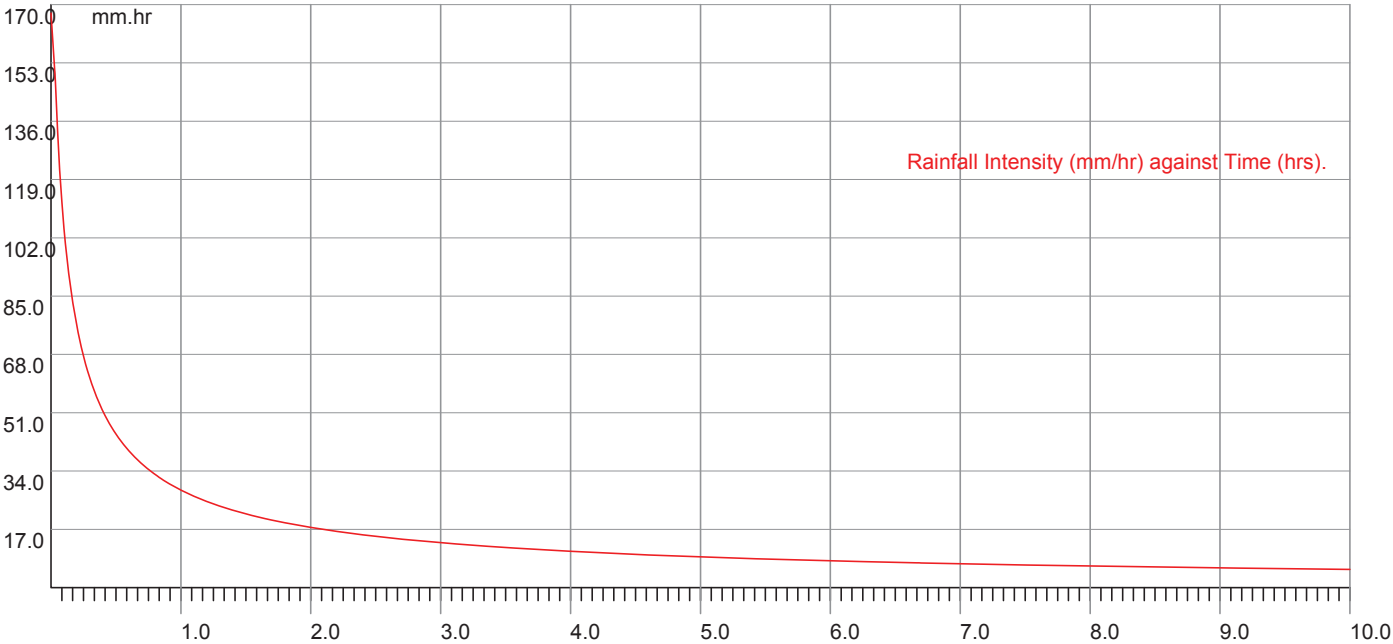
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| Sheet no.<br><b>2</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                                |                 |         |          |
|----------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Peak Flow - ADAS - 1 in 30</b>                   | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>Peak flow storage calcs for Bolton Upon Dearne</b> |                 |         |          |





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| Sheet no.<br><b>0</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|         |                                                        |
|---------|--------------------------------------------------------|
| Project | <b>Peak Flow - loH - 1 in 100 + 20% climate change</b> |
| Title   | <b>Peak flow storage calcs for Bolton Upon Dearne</b>  |

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 100                | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 6.970 l/s            | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 20                             |

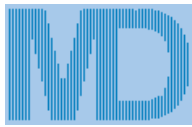
### Calculated data:-

|                  |                      |                           |                        |
|------------------|----------------------|---------------------------|------------------------|
| Time to max      | = 194.0 mins         | Calculated storage volume | = 237.0 m <sup>3</sup> |
| Rainfall at max  | = 19.51 mm/hr        | Discharge rate per Ha     | = 5.67 l/s/Ha          |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>   |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                        |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len   | Ovoid      | Len    | Box culvert | Len   |
|------|---------|------|-------|------------|--------|-------------|-------|
| 100  | 30187.5 | 1125 | 238.5 | 400 x 600  | 1316.9 | 500 x 500   | 948.2 |
| 150  | 13416.7 | 1200 | 209.6 | 600 x 900  | 573.4  | 500 x 750   | 632.1 |
| 225  | 5963.0  | 1275 | 185.7 | 800 x 1200 | 322.5  | 500 x 1000  | 474.1 |
| 300  | 3354.2  | 1350 | 165.6 |            |        | 750 x 1000  | 316.1 |
| 375  | 2146.7  | 1425 | 148.7 |            |        | 750 x 1200  | 263.4 |
| 450  | 1490.7  | 1500 | 134.2 |            |        | 750 x 1500  | 210.7 |
| 525  | 1095.2  | 1575 | 121.7 |            |        | 1000 x 1000 | 237.0 |
| 600  | 838.5   | 1650 | 110.9 |            |        | 1000 x 1200 | 197.5 |
| 675  | 662.6   | 1725 | 101.4 |            |        | 1000 x 1500 | 158.0 |
| 750  | 536.7   | 1800 | 93.2  |            |        | 1000 x 1800 | 131.7 |
| 825  | 443.5   | 1875 | 85.9  |            |        | 1000 x 2000 | 118.5 |
| 900  | 372.7   | 1950 | 79.4  |            |        | 1500 x 1500 | 105.4 |
| 975  | 317.6   | 2025 | 73.6  |            |        | 1500 x 1800 | 87.8  |
| 1050 | 273.8   | 2100 | 68.5  |            |        | 1500 x 2000 | 79.0  |



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Data:-

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Job No.

**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Peak Flow - loH - 1 in 100 + 20% climate change**

Title

**Peak flow storage calcs for Bolton Upon Dearne**

By

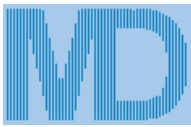
**MC**

Checked

Reviewed

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 128.0         | 107.860        | 4.182           | 103.678         |
| 20             | 89.0          | 150.095        | 8.364           | 141.731         |
| 30             | 70.0          | 176.824        | 12.546          | 164.278         |
| 40             | 59.0          | 196.721        | 16.728          | 179.993         |
| 50             | 51.0          | 212.684        | 20.910          | 191.774         |
| 60             | 45.0          | 226.065        | 25.092          | 200.973         |
| 70             | 40.0          | 237.611        | 29.274          | 208.337         |
| 80             | 37.0          | 247.778        | 33.456          | 214.322         |
| 90             | 34.0          | 256.868        | 37.638          | 219.230         |
| 100            | 32.0          | 265.088        | 41.820          | 223.268         |
| 110            | 29.0          | 272.592        | 46.002          | 226.590         |
| 120            | 28.0          | 279.493        | 50.184          | 229.309         |
| 130            | 26.0          | 285.880        | 54.366          | 231.514         |
| 140            | 25.0          | 291.822        | 58.548          | 233.274         |
| 150            | 24.0          | 297.373        | 62.730          | 234.643         |
| 160            | 23.0          | 302.581        | 66.912          | 235.669         |
| 170            | 22.0          | 307.483        | 71.094          | 236.389         |
| 180            | 21.0          | 312.111        | 75.276          | 236.835         |
| 190            | 20.0          | 316.490        | 79.458          | 237.032         |
| 200            | 19.0          | 320.645        | 83.640          | 237.005         |
| 210            | 18.0          | 324.595        | 87.822          | 236.773         |
| 220            | 18.0          | 328.357        | 92.004          | 236.353         |
| 230            | 17.0          | 331.946        | 96.186          | 235.760         |
| 240            | 17.0          | 335.376        | 100.368         | 235.008         |
| 250            | 16.0          | 338.659        | 104.550         | 234.109         |
| 260            | 16.0          | 341.804        | 108.732         | 233.072         |
| 270            | 15.0          | 344.821        | 112.914         | 231.907         |
| 280            | 15.0          | 347.719        | 117.096         | 230.623         |
| 290            | 14.0          | 350.504        | 121.278         | 229.226         |
| 300            | 14.0          | 353.185        | 125.460         | 227.725         |
| 310            | 14.0          | 355.767        | 129.642         | 226.125         |
| 320            | 13.0          | 358.464        | 133.824         | 224.640         |
| 330            | 13.0          | 361.109        | 138.006         | 223.103         |
| 340            | 13.0          | 363.689        | 142.188         | 221.501         |
| 350            | 12.0          | 366.206        | 146.370         | 219.836         |
| 360            | 12.0          | 368.664        | 150.552         | 218.112         |
| 370            | 12.0          | 371.066        | 154.734         | 216.332         |
| 380            | 12.0          | 373.415        | 158.916         | 214.499         |
| 390            | 11.0          | 375.714        | 163.098         | 212.616         |
| 400            | 11.0          | 377.964        | 167.280         | 210.684         |
| 410            | 11.0          | 380.167        | 171.462         | 208.705         |
| 420            | 11.0          | 382.327        | 175.644         | 206.683         |
| 430            | 11.0          | 384.444        | 179.826         | 204.618         |
| 440            | 10.0          | 386.521        | 184.008         | 202.513         |
| 450            | 10.0          | 388.560        | 188.190         | 200.370         |
| 460            | 10.0          | 390.560        | 192.372         | 198.188         |
| 470            | 10.0          | 392.526        | 196.554         | 195.972         |
| 480            | 10.0          | 394.457        | 200.736         | 193.721         |
| 490            | 10.0          | 396.354        | 204.918         | 191.436         |
| 500            | 9.0           | 398.220        | 209.100         | 189.120         |
| 510            | 9.0           | 400.056        | 213.282         | 186.774         |
| 520            | 9.0           | 401.861        | 217.464         | 184.397         |
| 530            | 9.0           | 403.638        | 221.646         | 181.992         |
| 540            | 9.0           | 405.388        | 225.828         | 179.560         |
| 550            | 9.0           | 407.111        | 230.010         | 177.101         |
| 560            | 9.0           | 408.808        | 234.192         | 174.616         |
| 570            | 9.0           | 410.480        | 238.374         | 172.106         |
| 580            | 8.0           | 412.128        | 242.556         | 169.572         |
| 590            | 8.0           | 413.752        | 246.738         | 167.014         |
| 600            | 8.0           | 415.354        | 250.920         | 164.434         |

Storage volume (m<sup>3</sup>) = 237.0 m<sup>3</sup>



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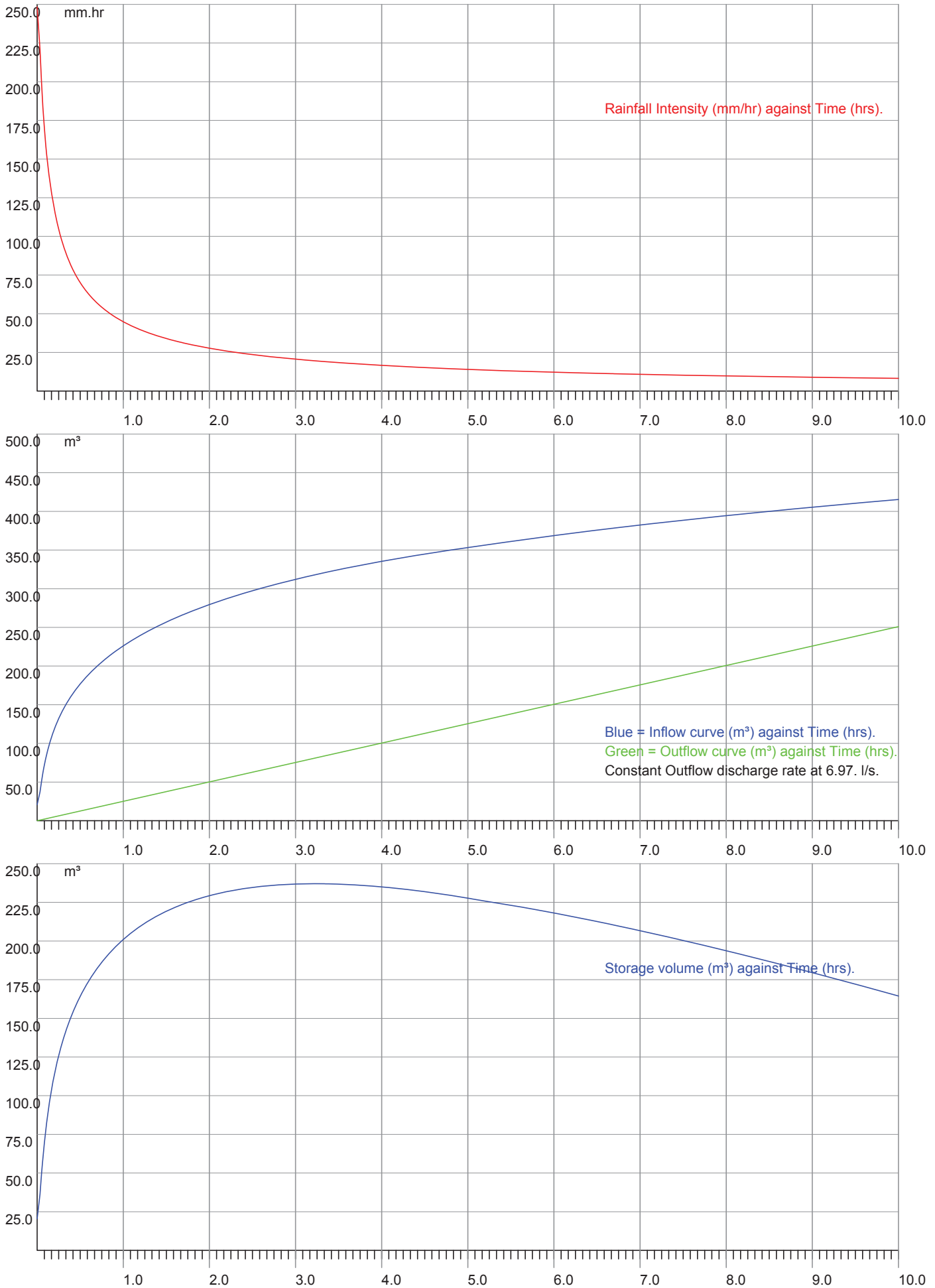
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| Job No.<br><b>FRA 16 1050</b> |         |          |
| Sheet no.<br><b>2</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

Project **Peak Flow - loH - 1 in 100 + 20% climate change**

Title **Peak flow storage calcs for Bolton Upon Dearne**





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| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|         |                                                        |
|---------|--------------------------------------------------------|
| Project | <b>Peak Flow - loH - 1 in 100 + 40% climate change</b> |
| Title   | <b>Peak flow storage calcs for Bolton Upon Dearne</b>  |

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 100                | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 8.720 l/s            | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 40                             |

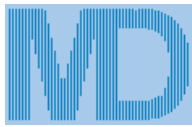
### Calculated data:-

|                  |                      |                           |                        |
|------------------|----------------------|---------------------------|------------------------|
| Time to max      | = 181.0 mins         | Calculated storage volume | = 270.0 m <sup>3</sup> |
| Rainfall at max  | = 23.97 mm/hr        | Discharge rate per Ha     | = 7.09 l/s/Ha          |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>   |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                        |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len   | Ovoid      | Len    | Box culvert | Len    |
|------|---------|------|-------|------------|--------|-------------|--------|
| 100  | 34378.0 | 1125 | 271.6 | 400 x 600  | 1499.7 | 500 x 500   | 1079.8 |
| 150  | 15279.1 | 1200 | 238.7 | 600 x 900  | 653.0  | 500 x 750   | 719.9  |
| 225  | 6790.7  | 1275 | 211.5 | 800 x 1200 | 367.3  | 500 x 1000  | 539.9  |
| 300  | 3819.8  | 1350 | 188.6 |            |        | 750 x 1000  | 359.9  |
| 375  | 2444.7  | 1425 | 169.3 |            |        | 750 x 1200  | 299.9  |
| 450  | 1697.7  | 1500 | 152.8 |            |        | 750 x 1500  | 240.0  |
| 525  | 1247.3  | 1575 | 138.6 |            |        | 1000 x 1000 | 270.0  |
| 600  | 954.9   | 1650 | 126.3 |            |        | 1000 x 1200 | 225.0  |
| 675  | 754.5   | 1725 | 115.5 |            |        | 1000 x 1500 | 180.0  |
| 750  | 611.2   | 1800 | 106.1 |            |        | 1000 x 1800 | 150.0  |
| 825  | 505.1   | 1875 | 97.8  |            |        | 1000 x 2000 | 135.0  |
| 900  | 424.4   | 1950 | 90.4  |            |        | 1500 x 1500 | 120.0  |
| 975  | 361.6   | 2025 | 83.8  |            |        | 1500 x 1800 | 100.0  |
| 1050 | 311.8   | 2100 | 78.0  |            |        | 1500 x 2000 | 90.0   |



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Data:-

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Job No.

**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Peak Flow - loH - 1 in 100 + 40% climate change**

Title

**Peak flow storage calcs for Bolton Upon Dearne**

By

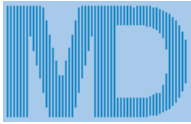
**MC**

Checked

Reviewed

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 150.0         | 125.837        | 5.232           | 120.605         |
| 20             | 104.0         | 175.111        | 10.464          | 164.647         |
| 30             | 82.0          | 206.295        | 15.696          | 190.599         |
| 40             | 68.0          | 229.508        | 20.928          | 208.580         |
| 50             | 59.0          | 248.131        | 26.160          | 221.971         |
| 60             | 52.0          | 263.742        | 31.392          | 232.350         |
| 70             | 47.0          | 277.213        | 36.624          | 240.589         |
| 80             | 43.0          | 289.075        | 41.856          | 247.219         |
| 90             | 40.0          | 299.679        | 47.088          | 252.591         |
| 100            | 37.0          | 309.270        | 52.320          | 256.949         |
| 110            | 34.0          | 318.024        | 57.552          | 260.472         |
| 120            | 32.0          | 326.076        | 62.784          | 263.292         |
| 130            | 31.0          | 333.527        | 68.016          | 265.511         |
| 140            | 29.0          | 340.458        | 73.248          | 267.210         |
| 150            | 28.0          | 346.936        | 78.480          | 268.456         |
| 160            | 26.0          | 353.012        | 83.712          | 269.300         |
| 170            | 25.0          | 358.731        | 88.944          | 269.787         |
| 180            | 24.0          | 364.129        | 94.176          | 269.953         |
| 190            | 23.0          | 369.239        | 99.408          | 269.831         |
| 200            | 22.0          | 374.086        | 104.640         | 269.446         |
| 210            | 21.0          | 378.694        | 109.872         | 268.822         |
| 220            | 21.0          | 383.083        | 115.104         | 267.979         |
| 230            | 20.0          | 387.271        | 120.336         | 266.935         |
| 240            | 19.0          | 391.272        | 125.568         | 265.704         |
| 250            | 19.0          | 395.102        | 130.800         | 264.302         |
| 260            | 18.0          | 398.771        | 136.032         | 262.739         |
| 270            | 18.0          | 402.291        | 141.264         | 261.027         |
| 280            | 17.0          | 405.672        | 146.496         | 259.176         |
| 290            | 17.0          | 408.922        | 151.728         | 257.194         |
| 300            | 16.0          | 412.049        | 156.960         | 255.089         |
| 310            | 16.0          | 415.062        | 162.192         | 252.870         |
| 320            | 16.0          | 418.208        | 167.424         | 250.784         |
| 330            | 15.0          | 421.294        | 172.656         | 248.638         |
| 340            | 15.0          | 424.304        | 177.888         | 246.416         |
| 350            | 15.0          | 427.240        | 183.120         | 244.120         |
| 360            | 14.0          | 430.108        | 188.352         | 241.756         |
| 370            | 14.0          | 432.911        | 193.584         | 239.327         |
| 380            | 14.0          | 435.651        | 198.816         | 236.835         |
| 390            | 13.0          | 438.333        | 204.048         | 234.285         |
| 400            | 13.0          | 440.958        | 209.280         | 231.678         |
| 410            | 13.0          | 443.529        | 214.512         | 229.017         |
| 420            | 13.0          | 446.048        | 219.744         | 226.304         |
| 430            | 12.0          | 448.518        | 224.976         | 223.542         |
| 440            | 12.0          | 450.942        | 230.208         | 220.734         |
| 450            | 12.0          | 453.319        | 235.440         | 217.879         |
| 460            | 12.0          | 455.654        | 240.672         | 214.982         |
| 470            | 12.0          | 457.947        | 245.904         | 212.043         |
| 480            | 11.0          | 460.199        | 251.136         | 209.063         |
| 490            | 11.0          | 462.413        | 256.368         | 206.045         |
| 500            | 11.0          | 464.590        | 261.600         | 202.990         |
| 510            | 11.0          | 466.731        | 266.832         | 199.899         |
| 520            | 11.0          | 468.838        | 272.064         | 196.774         |
| 530            | 11.0          | 470.911        | 277.296         | 193.615         |
| 540            | 10.0          | 472.952        | 282.528         | 190.424         |
| 550            | 10.0          | 474.962        | 287.760         | 187.202         |
| 560            | 10.0          | 476.942        | 292.992         | 183.950         |
| 570            | 10.0          | 478.893        | 298.224         | 180.669         |
| 580            | 10.0          | 480.816        | 303.456         | 177.360         |
| 590            | 10.0          | 482.711        | 308.688         | 174.023         |
| 600            | 10.0          | 484.580        | 313.920         | 170.660         |

Storage volume (m<sup>3</sup>) = 270.0 m<sup>3</sup>



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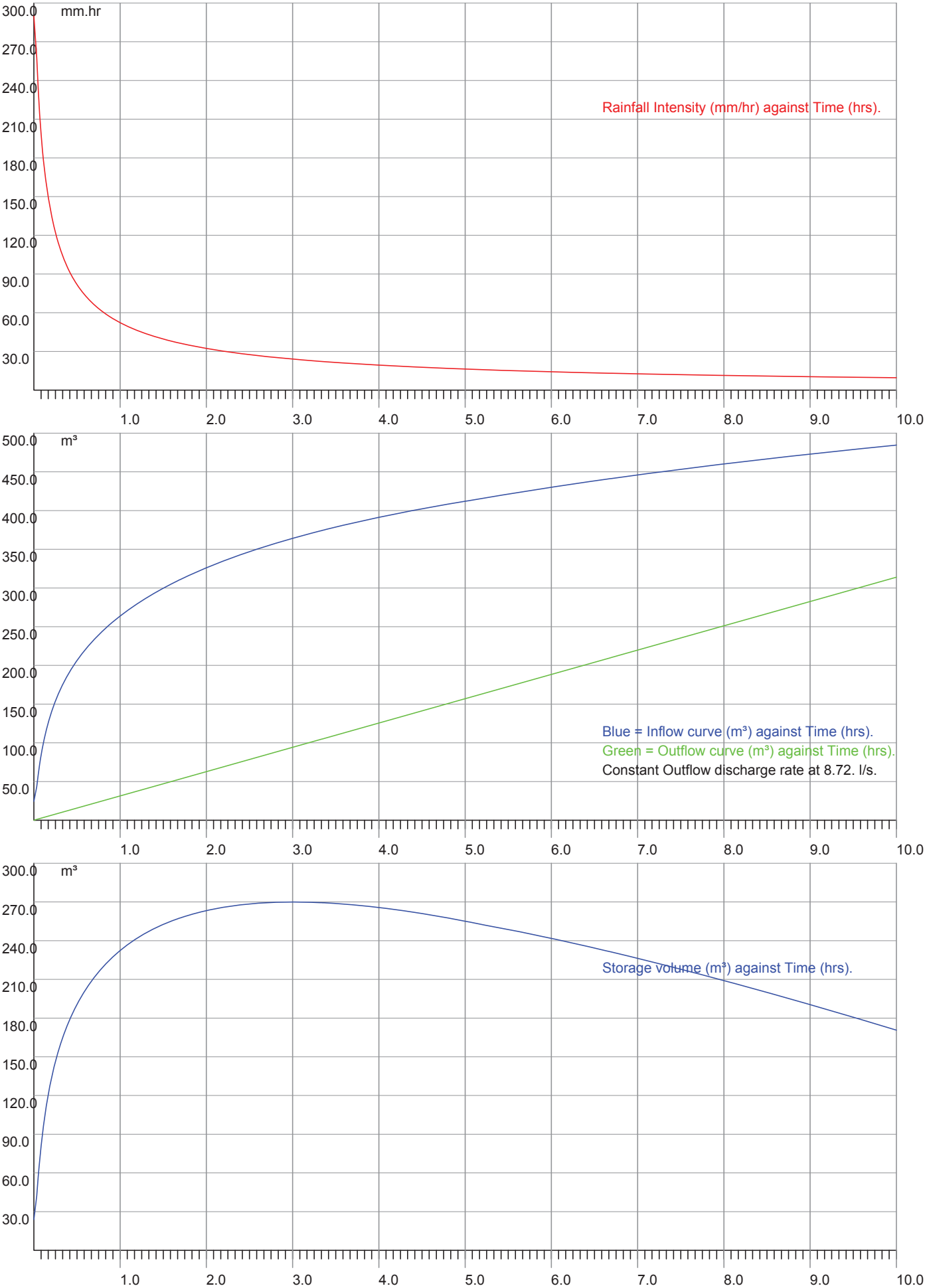
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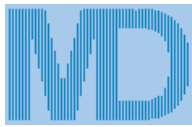
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email: info@thelkgroup.com

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| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

Project **Peak Flow - loH - 1 in 100 + 40% climate change**

Title **Peak flow storage calcs for Bolton Upon Dearne**





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| Sheet no.<br><b>0</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                                    |                 |         |          |
|--------------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Peak Flow - ADAS - 1 in 100 + 20% climate change</b> | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>Peak flow storage calcs for Bolton Upon Dearne</b>     |                 |         |          |

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 100                | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 16.390 l/s           | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 20                             |

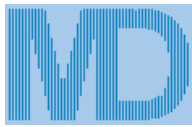
### Calculated data:-

|                  |                      |                           |                        |
|------------------|----------------------|---------------------------|------------------------|
| Time to max      | = 78.0 mins          | Calculated storage volume | = 169.1 m <sup>3</sup> |
| Rainfall at max  | = 37.50 mm/hr        | Discharge rate per Ha     | = 13.33 l/s/Ha         |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>   |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                        |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len   | Ovoid      | Len   | Box culvert | Len   |
|------|---------|------|-------|------------|-------|-------------|-------|
| 100  | 21538.9 | 1125 | 170.2 | 400 x 600  | 939.6 | 500 x 500   | 676.5 |
| 150  | 9572.8  | 1200 | 149.6 | 600 x 900  | 409.1 | 500 x 750   | 451.0 |
| 225  | 4254.6  | 1275 | 132.5 | 800 x 1200 | 230.1 | 500 x 1000  | 338.3 |
| 300  | 2393.2  | 1350 | 118.2 |            |       | 750 x 1000  | 225.5 |
| 375  | 1531.7  | 1425 | 106.1 |            |       | 750 x 1200  | 187.9 |
| 450  | 1063.6  | 1500 | 95.7  |            |       | 750 x 1500  | 150.3 |
| 525  | 781.5   | 1575 | 86.8  |            |       | 1000 x 1000 | 169.1 |
| 600  | 598.3   | 1650 | 79.1  |            |       | 1000 x 1200 | 140.9 |
| 675  | 472.7   | 1725 | 72.4  |            |       | 1000 x 1500 | 112.8 |
| 750  | 382.9   | 1800 | 66.5  |            |       | 1000 x 1800 | 94.0  |
| 825  | 316.5   | 1875 | 61.3  |            |       | 1000 x 2000 | 84.6  |
| 900  | 265.9   | 1950 | 56.6  |            |       | 1500 x 1500 | 75.2  |
| 975  | 226.6   | 2025 | 52.5  |            |       | 1500 x 1800 | 62.6  |
| 1050 | 195.4   | 2100 | 48.8  |            |       | 1500 x 2000 | 56.4  |



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Job No.

**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Peak Flow - ADAS - 1 in 100 + 20% climate change**

Title

**Peak flow storage calcs for Bolton Upon Dearne**

By

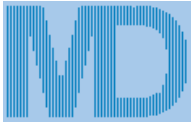
**MC**

Checked

Reviewed

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 128.0         | 107.860        | 9.834           | 98.026          |
| 20             | 89.0          | 150.095        | 19.668          | 130.427         |
| 30             | 70.0          | 176.824        | 29.502          | 147.322         |
| 40             | 59.0          | 196.721        | 39.336          | 157.385         |
| 50             | 51.0          | 212.684        | 49.170          | 163.514         |
| 60             | 45.0          | 226.065        | 59.004          | 167.061         |
| 70             | 40.0          | 237.611        | 68.838          | 168.773         |
| 80             | 37.0          | 247.778        | 78.672          | 169.106         |
| 90             | 34.0          | 256.868        | 88.506          | 168.362         |
| 100            | 32.0          | 265.088        | 98.340          | 166.748         |
| 110            | 29.0          | 272.592        | 108.174         | 164.418         |
| 120            | 28.0          | 279.493        | 118.008         | 161.485         |
| 130            | 26.0          | 285.880        | 127.842         | 158.038         |
| 140            | 25.0          | 291.822        | 137.676         | 154.146         |
| 150            | 24.0          | 297.373        | 147.510         | 149.863         |
| 160            | 23.0          | 302.581        | 157.344         | 145.237         |
| 170            | 22.0          | 307.483        | 167.178         | 140.305         |
| 180            | 21.0          | 312.111        | 177.012         | 135.099         |
| 190            | 20.0          | 316.490        | 186.846         | 129.644         |
| 200            | 19.0          | 320.645        | 196.680         | 123.965         |
| 210            | 18.0          | 324.595        | 206.514         | 118.081         |
| 220            | 18.0          | 328.357        | 216.348         | 112.009         |
| 230            | 17.0          | 331.946        | 226.182         | 105.764         |
| 240            | 17.0          | 335.376        | 236.016         | 99.360          |
| 250            | 16.0          | 338.659        | 245.850         | 92.809          |
| 260            | 16.0          | 341.804        | 255.684         | 86.120          |
| 270            | 15.0          | 344.821        | 265.518         | 79.303          |
| 280            | 15.0          | 347.719        | 275.352         | 72.367          |
| 290            | 14.0          | 350.504        | 285.186         | 65.318          |
| 300            | 14.0          | 353.185        | 295.020         | 58.165          |
| 310            | 14.0          | 355.767        | 304.854         | 50.913          |
| 320            | 13.0          | 358.464        | 314.688         | 43.776          |
| 330            | 13.0          | 361.109        | 324.522         | 36.587          |
| 340            | 13.0          | 363.689        | 334.356         | 29.333          |
| 350            | 12.0          | 366.206        | 344.190         | 22.016          |
| 360            | 12.0          | 368.664        | 354.024         | 14.640          |
| 370            | 12.0          | 371.066        | 363.858         | 7.208           |
| 380            | 12.0          | 373.415        | 373.692         | 0.000           |
| 390            | 11.0          | 375.714        | 383.526         | 0.000           |
| 400            | 11.0          | 377.964        | 393.360         | 0.000           |
| 410            | 11.0          | 380.167        | 403.194         | 0.000           |
| 420            | 11.0          | 382.327        | 413.028         | 0.000           |
| 430            | 11.0          | 384.444        | 422.862         | 0.000           |
| 440            | 10.0          | 386.521        | 432.696         | 0.000           |
| 450            | 10.0          | 388.560        | 442.530         | 0.000           |
| 460            | 10.0          | 390.560        | 452.364         | 0.000           |
| 470            | 10.0          | 392.526        | 462.198         | 0.000           |
| 480            | 10.0          | 394.457        | 472.032         | 0.000           |
| 490            | 10.0          | 396.354        | 481.866         | 0.000           |
| 500            | 9.0           | 398.220        | 491.700         | 0.000           |
| 510            | 9.0           | 400.056        | 501.534         | 0.000           |
| 520            | 9.0           | 401.861        | 511.368         | 0.000           |
| 530            | 9.0           | 403.638        | 521.202         | 0.000           |
| 540            | 9.0           | 405.388        | 531.036         | 0.000           |
| 550            | 9.0           | 407.111        | 540.870         | 0.000           |
| 560            | 9.0           | 408.808        | 550.704         | 0.000           |
| 570            | 9.0           | 410.480        | 560.538         | 0.000           |
| 580            | 8.0           | 412.128        | 570.372         | 0.000           |
| 590            | 8.0           | 413.752        | 580.206         | 0.000           |
| 600            | 8.0           | 415.354        | 590.040         | 0.000           |

Storage volume (m<sup>3</sup>) = 169.1 m<sup>3</sup>



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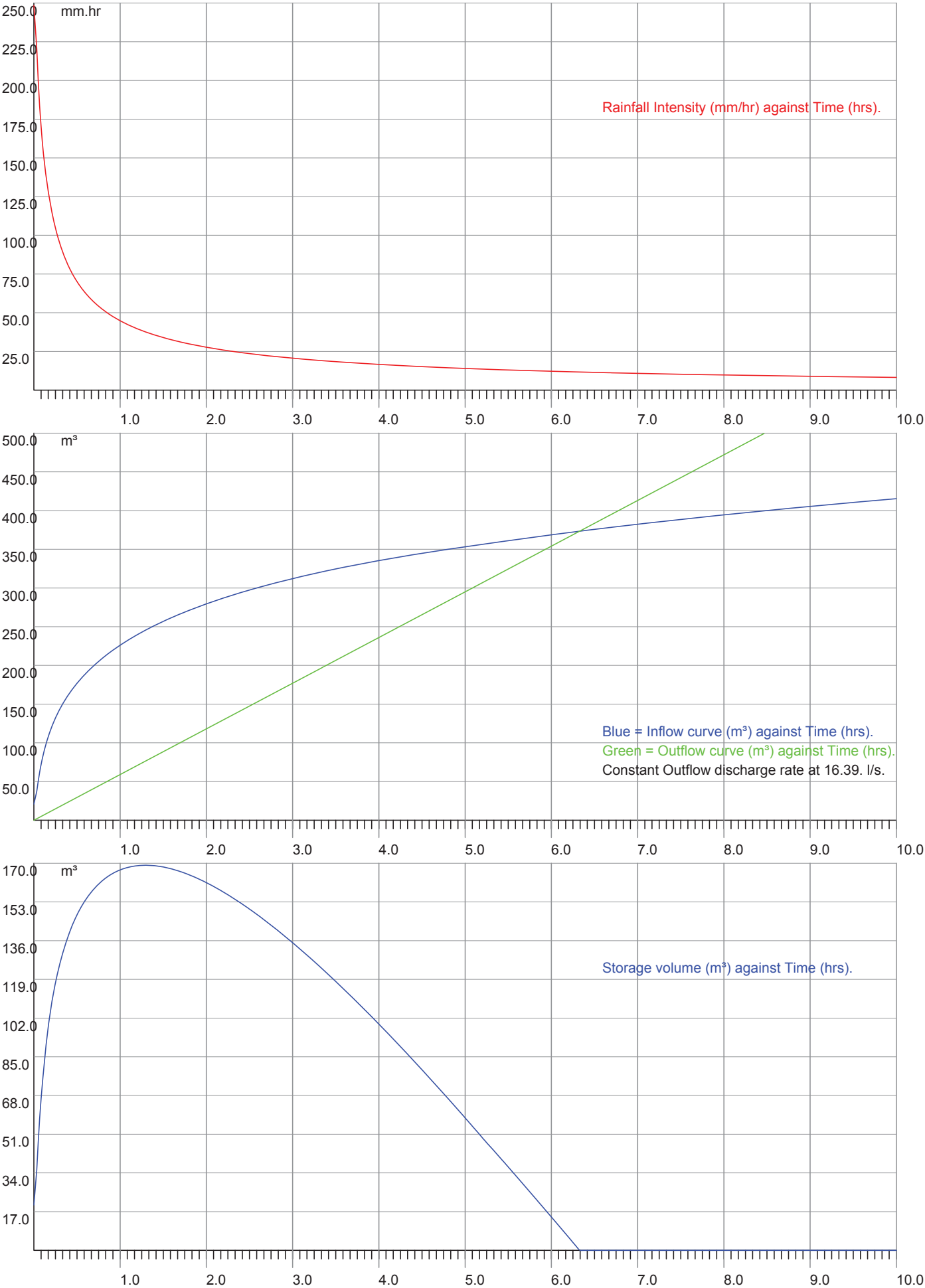
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| Sheet no. | 2           |         |          |
| Date      | 08/07/16    |         |          |
| By        | MC          | Checked | Reviewed |

Project **Peak Flow - ADAS - 1 in 100 + 20% climate change**  
Title **Peak flow storage calcs for Bolton Upon Dearne**





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| Sheet no.<br><b>0</b>         |         |          |
| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

|                                                                    |                 |         |          |
|--------------------------------------------------------------------|-----------------|---------|----------|
| Project<br><b>Peak Flow - ADAS - 1 in 100 + 40% climate change</b> | By<br><b>MC</b> | Checked | Reviewed |
| Title<br><b>Peak flow storage calcs for Bolton Upon Dearne</b>     |                 |         |          |

### Data:-

#### FSR Hydrology:-

|               |                      |                |         |
|---------------|----------------------|----------------|---------|
| Location      | = Bolton Upon Dearne | Grid reference | = SE412 |
| M5-60 (mm)    | = 18.5               | r              | = 0.36  |
| Soil index    | = 0.40               | SAAR (mm/yr)   | = 695   |
| Return period | = 100                | WRAP           | = 3     |
| UCWI          | = 72.1               |                |         |

- i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England;
- ii) Permeable soils with shallow ground water in low-lying areas;
- iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions.

Runoff factor (RF) = 41.0, calculated from:-

$$\text{Runoff factor} = (0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$$

where

PIMP = Impervious Area\*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

### Design data:-

|                    |                        |                        |                                  |
|--------------------|------------------------|------------------------|----------------------------------|
| Imperv. area       | = 6800 m <sup>2</sup>  | Pervious area          | = 5500 m <sup>2</sup>            |
| Total area (TA)    | = 12300 m <sup>2</sup> | Equiv area             | = 5043 m <sup>2</sup> (TA x RF). |
| Discharge to drain | = 16.390 l/s           | Areal reduction factor | = 1.000                          |
| Additional flow    | = 0.00 l/s             | Climate change factor  | = 40                             |

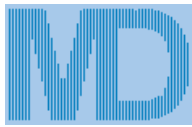
### Calculated data:-

|                  |                      |                           |                        |
|------------------|----------------------|---------------------------|------------------------|
| Time to max      | = 92.0 mins          | Calculated storage volume | = 211.2 m <sup>3</sup> |
| Rainfall at max  | = 39.01 mm/hr        | Discharge rate per Ha     | = 13.33 l/s/Ha         |
| Pipeline storage | = 0.0 m <sup>3</sup> | Available MH storage      | = 0.0 m <sup>3</sup>   |
| Offline storage  | = 0.0 m <sup>3</sup> |                           |                        |

### Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

| Diam | Len     | Diam | Len   | Ovoid      | Len    | Box culvert | Len   |
|------|---------|------|-------|------------|--------|-------------|-------|
| 100  | 26895.7 | 1125 | 212.5 | 400 x 600  | 1173.3 | 500 x 500   | 844.8 |
| 150  | 11953.7 | 1200 | 186.8 | 600 x 900  | 510.9  | 500 x 750   | 563.2 |
| 225  | 5312.7  | 1275 | 165.4 | 800 x 1200 | 287.3  | 500 x 1000  | 422.4 |
| 300  | 2988.4  | 1350 | 147.6 |            |        | 750 x 1000  | 281.6 |
| 375  | 1912.6  | 1425 | 132.5 |            |        | 750 x 1200  | 234.7 |
| 450  | 1328.2  | 1500 | 119.5 |            |        | 750 x 1500  | 187.7 |
| 525  | 975.8   | 1575 | 108.4 |            |        | 1000 x 1000 | 211.2 |
| 600  | 747.1   | 1650 | 98.8  |            |        | 1000 x 1200 | 176.0 |
| 675  | 590.3   | 1725 | 90.4  |            |        | 1000 x 1500 | 140.8 |
| 750  | 478.1   | 1800 | 83.0  |            |        | 1000 x 1800 | 117.3 |
| 825  | 395.2   | 1875 | 76.5  |            |        | 1000 x 2000 | 105.6 |
| 900  | 332.0   | 1950 | 70.7  |            |        | 1500 x 1500 | 93.9  |
| 975  | 282.9   | 2025 | 65.6  |            |        | 1500 x 1800 | 78.2  |
| 1050 | 244.0   | 2100 | 61.0  |            |        | 1500 x 2000 | 70.4  |



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**FRA 16 1050**

Sheet no.

**1**

Date

**08/07/16**

Project

**Peak Flow - ADAS - 1 in 100 + 40% climate change**

Title

**Peak flow storage calcs for Bolton Upon Dearne**

By

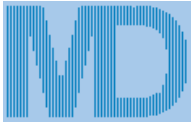
**MC**

Checked

Reviewed

| Time<br>(mins) | Rain<br>mm/hr | Inflow<br>(m3) | Outflow<br>(m3) | Balance<br>(m3) |
|----------------|---------------|----------------|-----------------|-----------------|
| 10             | 150.0         | 125.837        | 9.834           | 116.003         |
| 20             | 104.0         | 175.111        | 19.668          | 155.443         |
| 30             | 82.0          | 206.295        | 29.502          | 176.793         |
| 40             | 68.0          | 229.508        | 39.336          | 190.172         |
| 50             | 59.0          | 248.131        | 49.170          | 198.961         |
| 60             | 52.0          | 263.742        | 59.004          | 204.738         |
| 70             | 47.0          | 277.213        | 68.838          | 208.375         |
| 80             | 43.0          | 289.075        | 78.672          | 210.403         |
| 90             | 40.0          | 299.679        | 88.506          | 211.173         |
| 100            | 37.0          | 309.270        | 98.340          | 210.930         |
| 110            | 34.0          | 318.024        | 108.174         | 209.850         |
| 120            | 32.0          | 326.076        | 118.008         | 208.068         |
| 130            | 31.0          | 333.527        | 127.842         | 205.685         |
| 140            | 29.0          | 340.458        | 137.676         | 202.782         |
| 150            | 28.0          | 346.936        | 147.510         | 199.426         |
| 160            | 26.0          | 353.012        | 157.344         | 195.668         |
| 170            | 25.0          | 358.731        | 167.178         | 191.553         |
| 180            | 24.0          | 364.129        | 177.012         | 187.117         |
| 190            | 23.0          | 369.239        | 186.846         | 182.393         |
| 200            | 22.0          | 374.086        | 196.680         | 177.406         |
| 210            | 21.0          | 378.694        | 206.514         | 172.180         |
| 220            | 21.0          | 383.083        | 216.348         | 166.735         |
| 230            | 20.0          | 387.271        | 226.182         | 161.089         |
| 240            | 19.0          | 391.272        | 236.016         | 155.256         |
| 250            | 19.0          | 395.102        | 245.850         | 149.252         |
| 260            | 18.0          | 398.771        | 255.684         | 143.087         |
| 270            | 18.0          | 402.291        | 265.518         | 136.773         |
| 280            | 17.0          | 405.672        | 275.352         | 130.320         |
| 290            | 17.0          | 408.922        | 285.186         | 123.736         |
| 300            | 16.0          | 412.049        | 295.020         | 117.029         |
| 310            | 16.0          | 415.062        | 304.854         | 110.208         |
| 320            | 16.0          | 418.208        | 314.688         | 103.520         |
| 330            | 15.0          | 421.294        | 324.522         | 96.772          |
| 340            | 15.0          | 424.304        | 334.356         | 89.948          |
| 350            | 15.0          | 427.240        | 344.190         | 83.050          |
| 360            | 14.0          | 430.108        | 354.024         | 76.084          |
| 370            | 14.0          | 432.911        | 363.858         | 69.053          |
| 380            | 14.0          | 435.651        | 373.692         | 61.959          |
| 390            | 13.0          | 438.333        | 383.526         | 54.807          |
| 400            | 13.0          | 440.958        | 393.360         | 47.598          |
| 410            | 13.0          | 443.529        | 403.194         | 40.335          |
| 420            | 13.0          | 446.048        | 413.028         | 33.020          |
| 430            | 12.0          | 448.518        | 422.862         | 25.656          |
| 440            | 12.0          | 450.942        | 432.696         | 18.246          |
| 450            | 12.0          | 453.319        | 442.530         | 10.789          |
| 460            | 12.0          | 455.654        | 452.364         | 3.290           |
| 470            | 12.0          | 457.947        | 462.198         | 0.000           |
| 480            | 11.0          | 460.199        | 472.032         | 0.000           |
| 490            | 11.0          | 462.413        | 481.866         | 0.000           |
| 500            | 11.0          | 464.590        | 491.700         | 0.000           |
| 510            | 11.0          | 466.731        | 501.534         | 0.000           |
| 520            | 11.0          | 468.838        | 511.368         | 0.000           |
| 530            | 11.0          | 470.911        | 521.202         | 0.000           |
| 540            | 10.0          | 472.952        | 531.036         | 0.000           |
| 550            | 10.0          | 474.962        | 540.870         | 0.000           |
| 560            | 10.0          | 476.942        | 550.704         | 0.000           |
| 570            | 10.0          | 478.893        | 560.538         | 0.000           |
| 580            | 10.0          | 480.816        | 570.372         | 0.000           |
| 590            | 10.0          | 482.711        | 580.206         | 0.000           |
| 600            | 10.0          | 484.580        | 590.040         | 0.000           |

Storage volume (m<sup>3</sup>) = 211.2 m<sup>3</sup>



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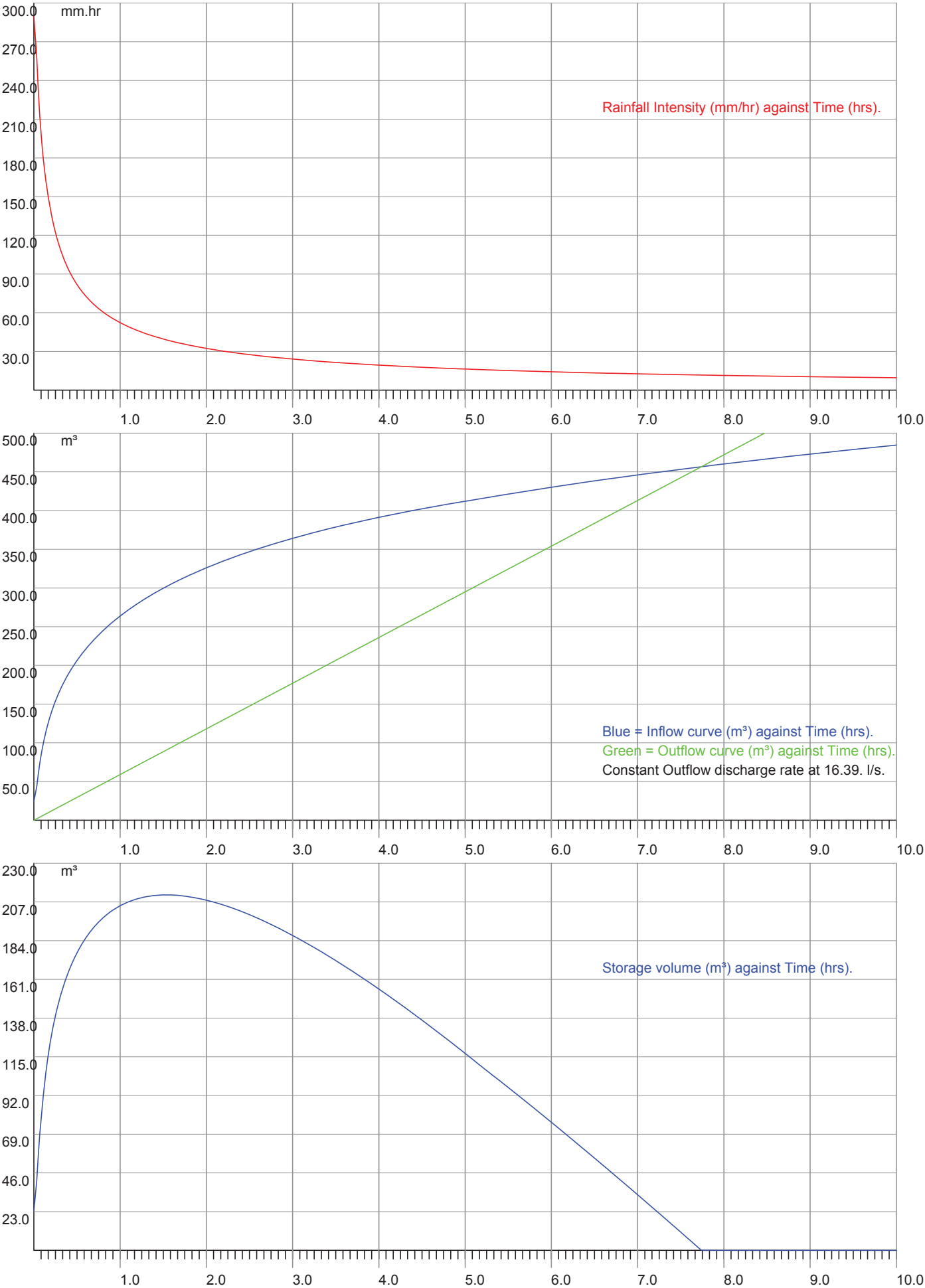
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Project **Peak Flow - ADAS - 1 in 100 + 40% climate change**  
Title **Peak flow storage calcs for Bolton Upon Dearne**





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| Date<br><b>08/07/16</b>       |         |          |
| By<br><b>MC</b>               | Checked | Reviewed |

Project **Peak Flow - ADAS - 1 in 100 + 40% climate change**

Title **Peak flow storage calcs for Bolton Upon Dearne**

### Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

### Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

\*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

### Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

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