# Surface Water
# Drainage Design Report

## for the

## Proposed Agricultural Building
## on land off
## Station Road,
## Epworth
## North Lincolnshire

**Prepared for**

**Mr J Knaggs**

**Issue 01**

**October 2025**


***George Shuttleworth Ltd***

***Consulting Engineers***

*1 Fulmar Court*
*Fulmar Rd,*
*Lincoln LN6 3NE*
*Tel: 07940 927285*
*gsl_engineers@outlook.com*

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| | | |
|---|---|---|
| Issue | : | 01 |
| Author | : | G Shuttleworth BSc C Eng. MICE. |
| Date | : | 21st October 2025 |

## 1.0 INTRODUCTION

1.1 A planning application has been submitted for a mono pitch agricultural building on land off Station Road, Epworth. The Planning Reference is PA/2025/915.

1.2 In a consultation response the Lead Local Flood Authority requested further details and calculations on the proposed surface water drainage system submitted on Drawing PL002 High level Drainage Design.

1.3 The Developer has appointed George Shuttleworth Ltd (GSL) to provide further details and calculations to support the submitted design.

1.4 This report contains information on the design of the proposed surface water drainage system to allow discharge of the planning condition.

## 2.0 SUSTAINABLE DRAINAGE SYSTEMS

2.1 Sustainable Drainage Systems (SuDS) have been considered for this development.

2.2 Following the preferred hierarchy of drainage stated in Part H of the Building Regulations and The Suds Manual the following disposal routes were considered

a) Disposal via Infiltration

b) Disposal to a Watercourse

c) Disposal to Surface Water Sewer

2.3 No site-specific site investigation information is available for the site but a Desktop Geotechnical Study was undertaken.

***Desktop Geotechnical Study***

2.4 From the HR Wallingford Greenfield run-off Calculation Tool available on their web-site the tool identifies the site as having Soil Type 2 on the Winter Rainfall Acceptance Potential (WRAP) Map. Soil Type 2 has relatively good drainage characteristics and is normally suitable for infiltration drainage systems. A copy of the Greenfield Run-off Calculation Sheet is provided in Appendix 1.

2.5 However, the presence of the drainage ditches immediately to the west of the site indicate that vertical drainage may be restricted. In addition groundwater levels are likely to be within 1.0m of any SuDS features employed.

2.6 There are no borehole scans in the vicinity of the site available on the BGS web-site.

2.7 It is understood that the area may be overlain with a layer of glacial wind blown sand which is known to have variable drainage characteristics.

2.8 Given, the presence of the drainage ditches and the uncertainty of the ground conditions it is proposed that infiltrations systems alone are not used on this site and a discharge/ overflow to Ingham Drain is installed.

2.9 This will allow the maximum volume possible to be discharged by infiltration but have the security of overflowing to Ingham Drain should ground conditions be unfavourable at certain times of the year. Such a system will also have the benefit of slowing the discharge from the roofs down towards existing greenfield rates.

## 3.0 PROPOSED SURFACE WATER DRAINAGE SYSTEM

3.1 The proposed surface water drainage system involves collecting the roofwater, passing it through four rainwater harvesting vessels and discharging the overflow to Ingham Dyke via an infiltration/attenuation swale.

3.2 Details of the proposed system are shown on Drawing 858-001, contained in Appendix 1.

### *Piped Drainage System and Levels*

3.3 The peak flow from 150m2 of roof is 4.8 l/s which can be accommodated in a 100mm pipe laid at 1 in 100.

3.4 No accurate levels have been provided so assumed levels have been used in the design. The actual levels will need checking prior to commencing construction and adjusted as necessary. The individual levels shown on the drawing should maintain the same relativity to the others.

3.5 The distance from the attenuation swale Ingham Dyke is around 45m. The proposed attenuation swale is 450m deep at the outlet so the outlet to Ingham Dyke needs to be 450mm lower.

3.6 We are unaware of the peak water level in Ingham Dyke so it is recommended that a non return valve is fitted in the outlet chamber.

### *Discharge Control System*

3.7 The 1 in 1 year greenfield run-off for the site is only 1.2 l/s/hectare. For the connected area of 150m2 this equates to a controlled run-off of 0.02 l/s. An orifice to control flow to this level at 0.3m head would be as small as 5mm. This is impractical as it would be blocked by the smallest leaf.

3.8 To provide a practical means of discharge control it is proposed that a small 1.0m length of half perforated pipe, surrounded in pea gravel is installed in the base of the attenuation swale.

3.9 With flow restricted by the perforations and pea gravel preventing blockages flow would be restricted to no more than 2.5 l/s which is as low as can practically be achieved.

### *Attenuation Required*

3.10 Although the rainwater harvesting system is unlikely to be 100% full for all rainfall events, conservatively, it has been ignored in calculating the attenuation volume required.

3.11 Restricting the discharge to an average of 1.8 l/s a Rainfall Run-Off Analysis was undertaken for a range of storms up to the 1440 minute 1 in 100 year plus climate change event.

3.12 The critical storm, requiring the greatest attenuation volume was assessed as the 15 minute 1 in 100 plus 40% climate change event, with the attenuation volume required calculated at 3.6m3. A spreadsheet is presented in Appendix 1.

3.13 As the maximum attenuation was calculated using average rainfall intensities and an average discharge figure further simulations were undertaken for the critical 75% Winter and 50% Summer 6 hours storms using the varying rain profiles and actual head/discharge curves.

3.14 For the 15 minute 1 in 100 year plus Climate Change 75% Winter Storm the attenuation swale shown on Drawing 858-001, which provides a volume of 13.3m3 brimful, would fill to a depth of 215mm at the outlet end.

3.15 For the 15 minute 1 in 100 year plus Climate Event 50% Summer Storm the attenuation swale would also fill to a depth of 215mm at the outlet end but would have a different fill profile

3.16 The simulation calculations are presented in Appendix 1.

### *Water Quality and Suds Treatment*

3.17 The run-off entering the surface water drainage system will come from either the building roofs.

3.18 Commercial roofs have a low pollution hazard level and discharge via the attenuation swale should provide an adequate level of treatment..

### *Exceedance flows*

3.19 It the unlikely event of the capacity of the system being exceeded then the attenuation swale would overflow and excess floodwaters would flow overland to Ingham Dyke.

### *Future Management & Maintenance*

3.20 The surface water drainage system will remain in private ownership who shall be responsible for ongoing maintenance.

3.21 The system will require little maintenance. Except for grass cutting and litter picking in the attenuation swale.

3.22 Should the top layer of pea gravel become blocked so flow is restricted excessively then the top layer of pea gravel can be removed and replaced.

## 4.0 APPENDIX 1 SUPPORTING INFORMATION

a) HR Wallingford Greenfield Run-off Calculation

b) Simplified Run-off Analysis to determine Critical Storm

c) Simulation for 75% Winter and 50% Summer Critical Storms

d) Drawing 858-001 – Proposed SW Drainage Design

# Greenfield runoff rate estimation tool

www.uksuds.com | Greenfield runoff rate estimation tool (https://www.uksuds.com/)

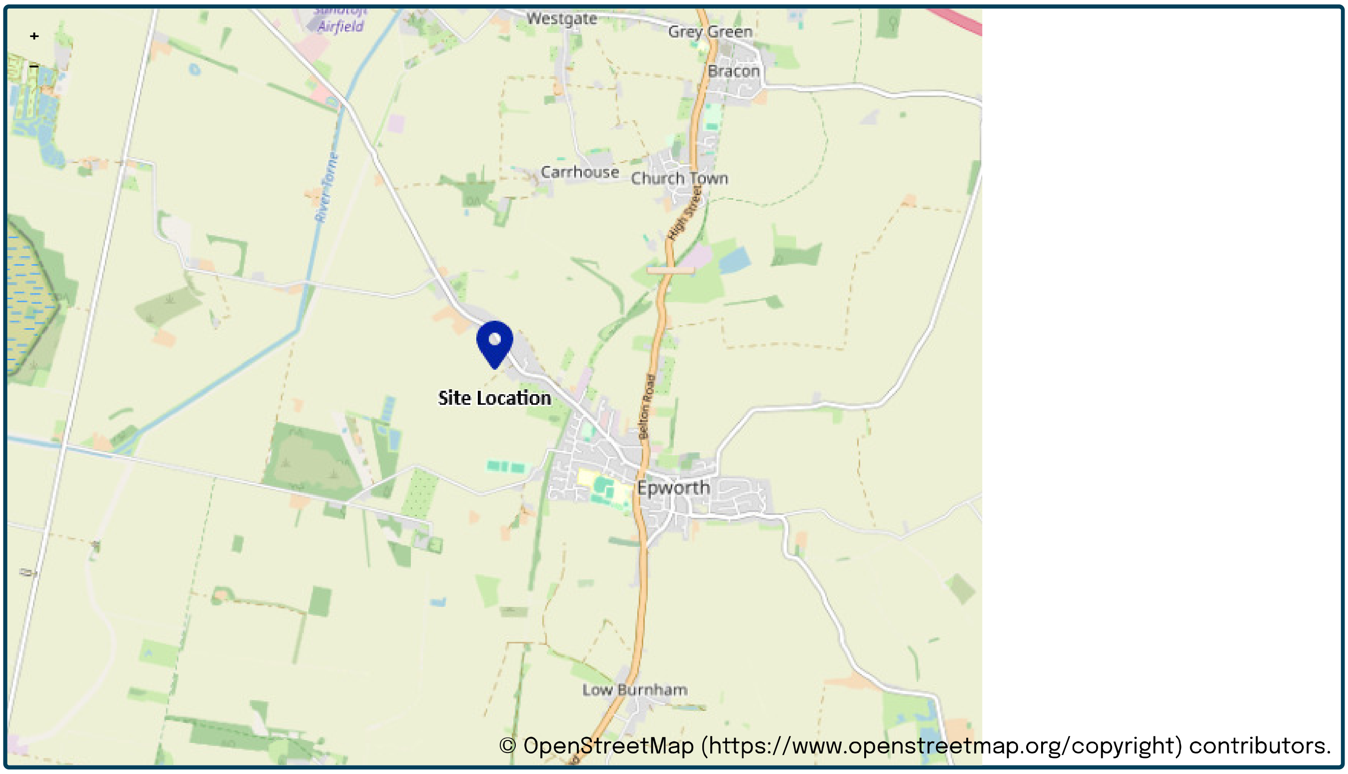
This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

## Project details

| | |
|---|---|
| Date | 20/10/2025 |
| Calculated by | |
| Reference | |
| Model version | 2.2.1 |

## Location

| | |
|---|---|
| Site name | |
| Site location | |




| | |
|---|---|
| Site easting (British National Grid) | 476909 |
| Site northing (British National Grid) | 404509 |

## Site details

| | |
|---|---|
| Total site area (ha) | 1.0 ha |

## Greenfield runoff

### Method

| | |
|---|---|
| Method | IH124 |

### IH124

| | My value | | Map value |
|---|---|---|---|
| SAAR (mm) | 580 mm | | 580 |
| How should SPR be derived? | WRAP soil type | | |
| WRAP soil type | 2 | | 2 |
| SPR | 0.3 | | |
| QBar (IH124) (l/s) | 1.5 l/s | | |

### Growth curve factors

| | My value | | Map value |
|---|---|---|---|
| Hydrological region | 4 | | 4 |
| 1 year growth factor | 0.83 | | |
| 2 year growth factor | 0.89 | | |
| 10 year growth factor | 1.49 | | |
| 30 year growth factor | 2 | | |
| 100 year growth factor | 2.57 | | |
| 200 year growth factor | 3.04 | | |

## Results

| | | |
|---|---|---|
| Method | IH124 | |
| Flow rate 1 year (l/s) | 1.2 | l/s |
| Flow rate 2 year (l/s) | 1.3 | l/s |
| Flow rate 10 years (l/s) | 2.2 | l/s |
| Flow rate 30 years (l/s) | 2.9 | l/s |
| Flow rate 100 years (l/s) | 3.8 | l/s |
| Flow rate 200 years (l/s) | 4.4 | l/s |

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent 'zero' figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

### Disclaimer

**ATTENUATION & DISCHARGE TO WATERCOURSE**

**Calculation of Rain Profiles**

| | |
|---|---|
| M5-60 | 20 |
| r | 0.4 |

| D (mins) | 15 | 30 | 60 | 120 | 240 | 360 | 720 | 1440 |
|---|---|---|---|---|---|---|---|---|
| Z1 | 0.64 | 0.81 | 1 | 1.21 | 1.4 | 1.62 | 1.8 | 2.2 |
| M5-D | 12.8 | 16.2 | 20.0 | 24.2 | 28.0 | 32.4 | 36.0 | 44.0 |
| Z2(100) | 1.94 | 1.99 | 2.03 | 2.02 | 2.01 | 1.95 | 1.92 | 1.86 |
| Z2(30) | 1.50 | 1.52 | 1.53 | 1.54 | 1.53 | 1.51 | 1.49 | 1.45 |
| Z2(2) | 0.80 | 0.80 | 0.81 | 0.82 | 0.83 | 0.83 | 0.84 | 0.85 |
| Z2(1) | 0.62 | 0.62 | 0.64 | 0.65 | 0.67 | 0.68 | 0.69 | 0.71 |
| MT-D(100) | 24.83 | 32.24 | 40.60 | 48.88 | 56.28 | 63.18 | 69.12 | 81.84 |
| MT-D(30) | 19.20 | 24.62 | 30.60 | 37.15 | 42.84 | 48.92 | 53.64 | 63.80 |
| MT-D(2) | 10.24 | 12.96 | 16.20 | 19.84 | 23.24 | 26.89 | 30.24 | 37.40 |
| MT-D(1) | 7.87 | 10.04 | 12.70 | 15.73 | 18.76 | 22.03 | 24.84 | 31.24 |
| I(100) | 99.33 | 64.48 | 40.60 | 24.44 | 14.07 | 10.53 | 5.76 | 3.41 |
| I(30) | 76.80 | 49.25 | 30.60 | 18.57 | 10.71 | 8.15 | 4.47 | 2.66 |
| I(2) | 40.96 | 25.92 | 16.20 | 9.92 | 5.81 | 4.48 | 2.52 | 1.56 |
| I(1) | 31.49 | 20.09 | 12.70 | 7.87 | 4.69 | 3.67 | 2.07 | 1.30 |

**Calculation of Flows and Volumes**

Contributing Impermeable Area = 150 m2
Climate Change of 40%
Flows (l/s) = 2.78 x I x A(ha) x Global warming

| Storm | 15 | 30 | 60 | 120 | 240 | 360 | 720 | 1440 |
|---|---|---|---|---|---|---|---|---|
| 1 in 100 yr | 5.80 | 3.76 | 2.37 | 1.43 | 0.82 | 0.61 | 0.34 | 0.20 |
| 1 in 30 yr | 4.48 | 2.88 | 1.79 | 1.08 | 0.63 | 0.48 | 0.26 | 0.16 |
| 2 in 30 yr | 2.39 | 1.51 | 0.95 | 0.58 | 0.34 | 0.26 | 0.15 | 0.09 |
| 1 in 1 yr | 1.84 | 1.17 | 0.74 | 0.46 | 0.27 | 0.21 | 0.12 | 0.08 |

Volume (m3) = Cv x A(ha) x I x D/60 Cv= 1.00

| Storm | 15 | 30 | 60 | 120 | 240 | 360 | 720 | 1440 |
|---|---|---|---|---|---|---|---|---|
| 1 in 100 yr | 5.21 | 6.77 | 8.53 | 10.27 | 11.82 | 13.27 | 14.52 | 17.19 |
| 1 in 30 yr | 4.03 | 5.17 | 6.43 | 7.80 | 9.00 | 10.27 | 11.26 | 13.40 |
| 1 in 2 yr | 2.15 | 2.72 | 3.40 | 4.17 | 4.88 | 5.65 | 6.35 | 7.85 |
| 1 in 1 yr | 1.65 | 2.11 | 2.67 | 3.30 | 3.94 | 4.63 | 5.22 | 6.56 |

**Initial Estimate of Balancing Volume Required**

For Peak Discharge of 2.00 l/s Av Discharge Factor= 0.9 Av Qout = **1.80** l/s

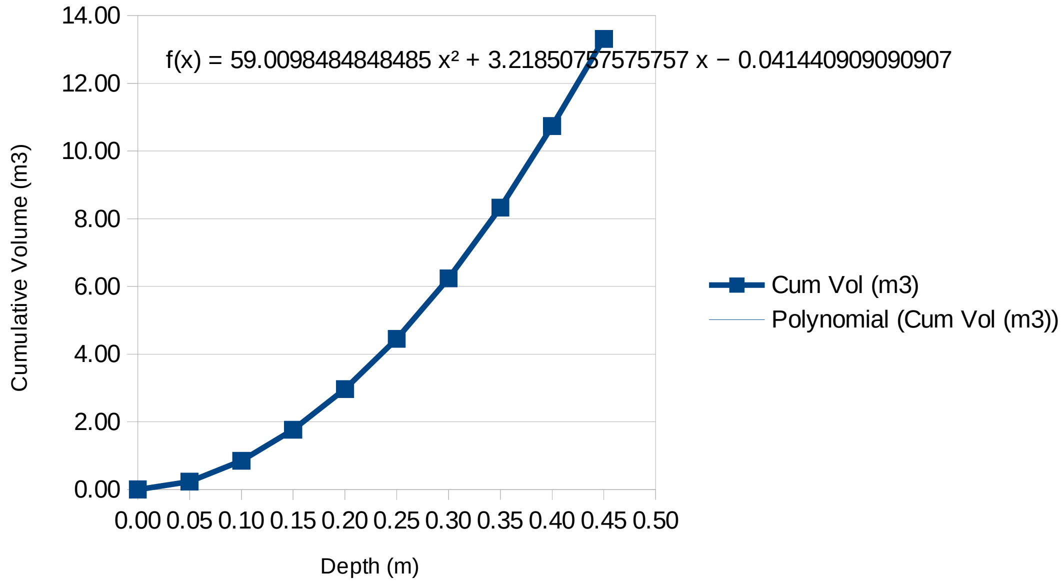
| Storm | 15 | 30 | 60 | 120 | 240 | 360 | 720 | 1440 |
|---|---|---|---|---|---|---|---|---|
| 1 in 100 yr | 3.59 | 3.53 | 2.05 | 0 | 0 | 0 | 0 | 0 |
| 1 in 30 yr | 2.41 | 1.93 | 0.00 | 0 | 0 | 0 | 0 | 0 |
| 1 in 2 yr | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 in 1 yr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Storage required for Critical Storm = **3.6** m3

**SIMULATION MODEL OF ATTENUATION SWALE**

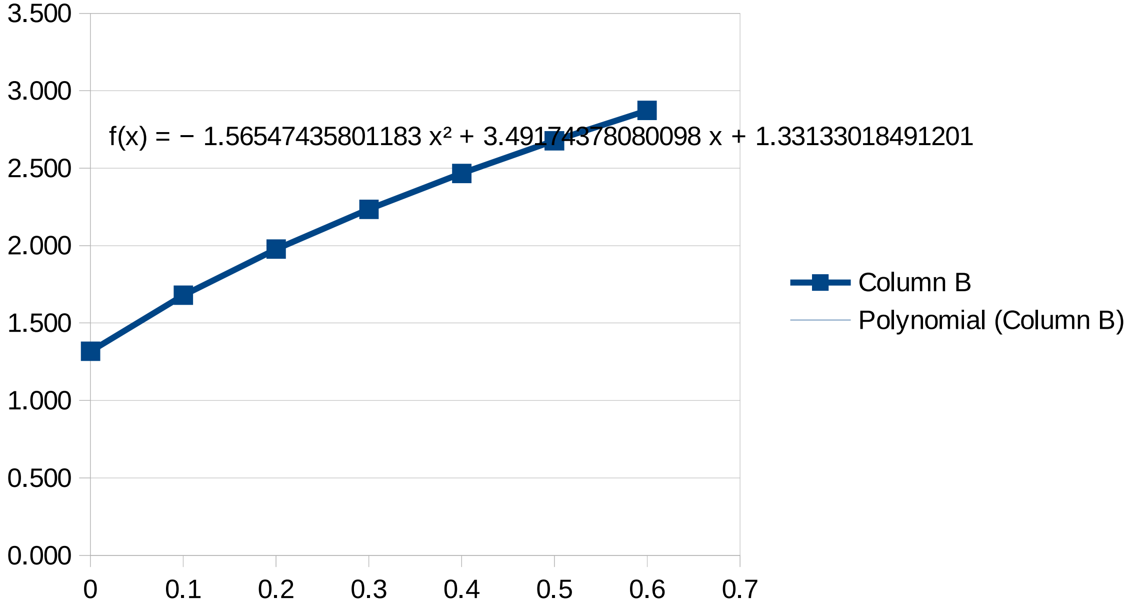
**Open Infiltration Basin**
Areas measured from CAD Drawing

| Depth (m) at Outlet End | Area (m2) | Volume in Slice (m3) | Cum Vol (m3) |
|---|---|---|---|
| 0.00 | 0.00 | | 0.00 |
| 0.05 | 4.03 | 0.23 | 0.2 |
| 0.10 | 9.21 | 0.62 | 0.8 |
| 0.15 | 15.56 | 0.92 | 1.8 |
| 0.20 | 21.10 | 1.20 | 3.0 |
| 0.25 | 26.80 | 1.49 | 4.5 |
| 0.30 | 32.70 | 1.78 | 6.2 |
| 0.35 | 38.70 | 2.09 | 8.3 |
| 0.40 | 45.00 | 2.41 | 10.7 |
| 0.45 | 51.40 | 2.57 | 13.3 |



**Discharge Through Length of Perforated Pipe Surrounded in Gravel**

| | | |
|---|---|---|
| Length of Pipe | 1 | m |
| Pipe dia | 100 | mm |
| Full or Half Perforated | 0.5 | |
| Min Slot Area | 1200 | mm2/m |
| Slot Width | 2 | mm |
| Slot Length | 12 | mm |
| Slot Spacing | 100 | mm |
| No per Circumference | 5 | mr |
| Pipe Backfill above Pipe | 100 | mm |
| Head to C/l | 200 | mm |
| Average Head to Slot | 160 | mm |
| Flow through an Orifice | | |
| k= | 0.62 | |
| Flow into slot on C/l | | |
| $Q=kA(2gh)^{0.5}$ | 0.000026 | m3/s |
| | 0.026 | l/s |
| Flow per circumference | 0.13 | |
| Flow per m | 1.3 | l/s |




| **Head Above Gravel** | **Discharge (l/s)** |
|---|---|
| 0 | 1.318 |
| 0.1 | 1.680 |
| 0.2 | 1.977 |
| 0.3 | 2.235 |
| 0.4 | 2.466 |
| 0.5 | 2.677 |
| 0.6 | 2.873 |

**RAIN PROFILE 15 MINUTE 1 IN 100 YR 75% WINTER**

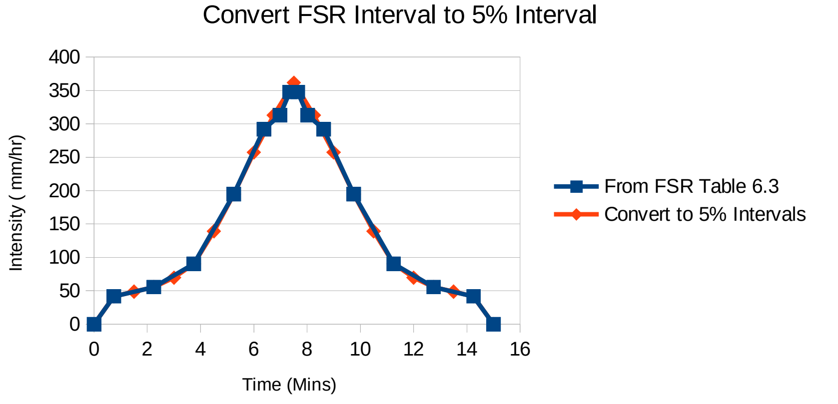
| | | |
|---|---|---|
| Critical Storm Duration | 15 | min |
| 1 in 100 average Intensity | 99.33 | mm/hr |
| Cv | 1.00 | |
| Climate Change | 1.40 | |
| Connected Area | 150 | |

**From FSR Table 6.3**

| % Duration of Storm | Proportion of I | Mins from Centre | Time from Start Mins | Intensity mm/hr | Volume | Cumulative Volume |
|---|---|---|---|---|---|---|
| 0 | | 7.5 | 0 | 0 | 0 | 0 |
| 5 | 0.3 | 6.75 | 0.75 | 41.72 | 0 | 0 |
| 15 | 0.4 | 5.25 | 2.25 | 55.62 | 0 | 0 |
| 25 | 0.65 | 3.75 | 3.75 | 90.39 | 0 | 0 |
| 35 | 1.4 | 2.25 | 5.25 | 194.69 | 1 | 1 |
| 42.5 | 2.1 | 1.125 | 6.375 | 292.03 | 1 | 2 |
| 46.5 | 2.25 | 0.525 | 6.975 | 312.89 | 0 | 2 |
| 49 | 2.5 | 0.15 | 7.35 | 347.66 | 0 | 2 |
| 51 | 2.5 | -0.15 | 7.65 | 347.66 | 0 | 3 |
| 53.5 | 2.25 | -0.525 | 8.025 | 312.89 | 0 | 3 |
| 57.5 | 2.1 | -1.125 | 8.625 | 292.03 | 0 | 4 |
| 65 | 1.4 | -2.25 | 9.75 | 194.69 | 1 | 4 |
| 75 | 0.65 | -3.75 | 11.25 | 90.39 | 1 | 5 |
| 85 | 0.4 | -5.25 | 12.75 | 55.62 | 0 | 5 |
| 95 | 0.3 | -6.75 | 14.25 | 41.72 | 0 | 5 |
| 100 | | -7.5 | 15 | 0.00 | 0 | 5 |

**Convert to 5% Intervals**

| % | Time Mins | Proportion of I | Intensity (mm/hr) |
|---|---|---|---|
| 0 | 0.0 | 0 | 0 |
| 5 | 0.8 | 0.3 | 41.72 |
| 10 | 1.5 | 0.35 | 48.67 |
| 15 | 2.3 | 0.4 | 55.62 |
| 20 | 3.0 | 0.5 | 69.53 |
| 25 | 3.8 | 0.65 | 90.39 |
| 30 | 4.5 | 1 | 139.06 |
| 35 | 5.3 | 1.4 | 194.69 |
| 40 | 6.0 | 1.85 | 257.26 |
| 45 | 6.8 | 2.25 | 312.89 |
| 50 | 7.5 | 2.6 | 361.56 |
| 55 | 8.3 | 2.25 | 312.89 |
| 60 | 9.0 | 1.85 | 257.26 |
| 65 | 9.8 | 1.4 | 194.69 |
| 70 | 10.5 | 1 | 139.06 |
| 75 | 11.3 | 0.65 | 90.39 |
| 80 | 12.0 | 0.5 | 69.53 |
| 85 | 12.8 | 0.4 | 55.62 |
| 90 | 13.5 | 0.35 | 48.67 |
| 95 | 14.3 | 0.3 | 41.72 |
| 100 | 15.0 | 0 | 0.00 |



**RAIN PROFILE 15 Min 1 IN 100 YR 50% SUMMER**

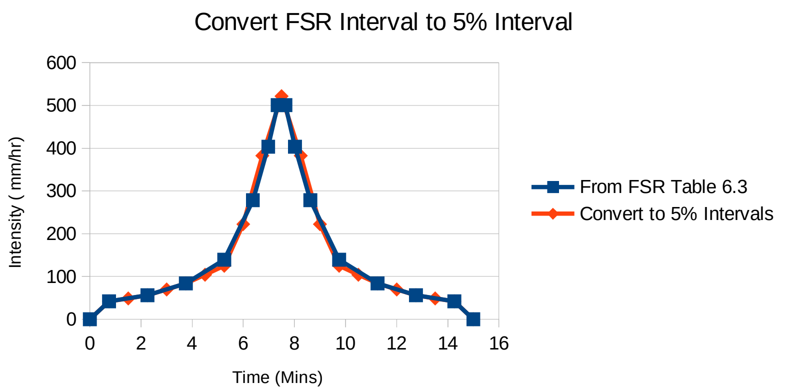
| | | |
|---|---|---|
| Critical Storm Duration | 15 | min |
| 1 in 100 average Intensity | 99.33 | mm/hr |
| Cv | 1.00 | |
| Climate Change | 1.40 | |
| Connected Area | 150 | |

**From FSR Table 6.3**

| % Duration of Storm | Proportion of I | Mins from Centre | Time from Start Mins | Intensity mm/hr | Volume | Cumulative Volume |
|---|---|---|---|---|---|---|
| 0 | | 7.5 | 0 | 0 | 0 | 0 |
| 5 | 0.30 | 6.75 | 0.75 | 41.72 | 0 | 0 |
| 15 | 0.40 | 5.25 | 2.25 | 55.62 | 0 | 0 |
| 25 | 0.60 | 3.75 | 3.75 | 83.44 | 0 | 0 |
| 35 | 1.00 | 2.25 | 5.25 | 139.06 | 0 | 1 |
| 42.5 | 2.00 | 1.125 | 6.375 | 278.12 | 1 | 1 |
| 46.5 | 2.90 | 0.525 | 6.975 | 403.28 | 1 | 2 |
| 49 | 3.60 | 0.15 | 7.35 | 500.62 | 0 | 2 |
| 51 | 3.60 | -0.15 | 7.65 | 500.62 | 0 | 3 |
| 53.5 | 2.90 | -0.525 | 8.025 | 403.28 | 0 | 3 |
| 57.5 | 2.00 | -1.125 | 8.625 | 278.12 | 1 | 4 |
| 65 | 1.00 | -2.25 | 9.75 | 139.06 | 1 | 4 |
| 75 | 0.60 | -3.75 | 11.25 | 83.44 | 0 | 5 |
| 85 | 0.40 | -5.25 | 12.75 | 55.62 | 0 | 5 |
| 95 | 0.30 | -6.75 | 14.25 | 41.72 | 0 | 5 |
| 100 | | -7.5 | 15 | 0.00 | 0 | 5 |

**Convert to 5% Intervals**

| % | Time Mins | Proportion of I | Intensity (mm/hr) |
|---|---|---|---|
| 0 | 0.0 | 0 | 0 |
| 5 | 0.8 | 0.3 | 41.72 |
| 10 | 1.5 | 0.35 | 48.67 |
| 15 | 2.3 | 0.4 | 55.62 |
| 20 | 3.0 | 0.5 | 69.53 |
| 25 | 3.8 | 0.6 | 83.44 |
| 30 | 4.5 | 0.75 | 104.30 |
| 35 | 5.3 | 0.9 | 125.16 |
| 40 | 6.0 | 1.6 | 222.50 |
| 45 | 6.8 | 2.75 | 382.42 |
| 50 | 7.5 | 3.75 | 521.48 |
| 55 | 8.3 | 2.75 | 382.42 |
| 60 | 9.0 | 1.6 | 222.50 |
| 65 | 9.8 | 0.9 | 125.16 |
| 70 | 10.5 | 0.75 | 104.30 |
| 75 | 11.3 | 0.6 | 83.44 |
| 80 | 12.0 | 0.5 | 69.53 |
| 85 | 12.8 | 0.4 | 55.62 |
| 90 | 13.5 | 0.35 | 48.67 |
| 95 | 14.3 | 0.3 | 41.72 |
| 100 | 15.0 | 0 | 0.00 |



**ATTENUATION FOR CRITICAL STORM DURATION OF 15.0 min**
**75% Winter Storm**

Connected Area 150 m2 Design Storage 13.3 m3

**Open Storage**
From Storage Sheet
Storage= 59 x2 + 3.218 x -0.04

**Discharge Control**
From Discharge Control Sheet
Outflow= -1.565 x2 3.492 x 1.33

**Instructions** Adjust head at DCV at each interval to give checksum=0 or close to 0

| Time | Rainfall | | | | DCV | Storage | | Discharge Control | | | | Check Sum | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rainfall | Av Rainfall mm/hr | Vol In m3 | Cum In m3 | Head h (mm) | Depth in Basin (m) | Vol m3 | Out-flow l/s | Av Flow Out l/s | Vol Out m3 | Cum Out m3 | Inflow - Storage - Out = 0 | % Design Storage |
| 0.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000 | 0.000 | 0.0 | 1.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 0.8 | 41.7 | 20.86 | 0.04 | 0.04 | 0.151 | 0.001 | 0.0 | 1.82 | 1.58 | 0.07 | 0.07 | 0.00 | 0 |
| 1.5 | 48.7 | 45.20 | 0.08 | 0.12 | 0.153 | 0.003 | 0.0 | 1.83 | 1.82 | 0.08 | 0.15 | 0.00 | 0 |
| 2.3 | 55.6 | 52.15 | 0.10 | 0.22 | 0.158 | 0.008 | 0.0 | 1.84 | 1.84 | 0.08 | 0.24 | 0.00 | 0 |
| 3.0 | 69.5 | 62.58 | 0.12 | 0.34 | 0.164 | 0.014 | 0.0 | 1.86 | 1.85 | 0.08 | 0.32 | 0.00 | 0 |
| 3.8 | 90.4 | 79.96 | 0.15 | 0.49 | 0.177 | 0.027 | 0.1 | 1.90 | 1.88 | 0.08 | 0.40 | 0.00 | 1 |
| 4.5 | 139.1 | 114.73 | 0.22 | 0.70 | 0.194 | 0.044 | 0.2 | 1.95 | 1.92 | 0.09 | 0.49 | 0.00 | 2 |
| 5.3 | 194.7 | 166.87 | 0.31 | 1.02 | 0.217 | 0.067 | 0.4 | 2.01 | 1.98 | 0.09 | 0.58 | 0.00 | 3 |
| 6.0 | 257.3 | 225.98 | 0.42 | 1.44 | 0.243 | 0.093 | 0.8 | 2.09 | 2.05 | 0.09 | 0.67 | 0.00 | 6 |
| 6.8 | 312.9 | 285.08 | 0.53 | 1.98 | 0.270 | 0.120 | 1.2 | 2.16 | 2.12 | 0.10 | 0.77 | 0.01 | 9 |
| 7.5 | 361.6 | 337.23 | 0.63 | 2.61 | 0.298 | 0.148 | 1.7 | 2.23 | 2.20 | 0.10 | 0.87 | 0.01 | 13 |
| 8.3 | 312.9 | 337.23 | 0.63 | 3.24 | 0.323 | 0.173 | 2.3 | 2.29 | 2.26 | 0.10 | 0.97 | -0.01 | 17 |
| 9.0 | 257.3 | 285.08 | 0.53 | 3.77 | 0.340 | 0.190 | 2.7 | 2.34 | 2.32 | 0.10 | 1.07 | 0.00 | 20 |
| 9.8 | 194.7 | 225.98 | 0.42 | 4.20 | 0.352 | 0.202 | 3.0 | 2.37 | 2.35 | 0.11 | 1.18 | 0.00 | 23 |
| 10.5 | 139.1 | 166.87 | 0.31 | 4.51 | 0.360 | 0.210 | 3.2 | 2.38 | 2.37 | 0.11 | 1.28 | -0.01 | 24 |
| 11.3 | 90.4 | 114.73 | 0.22 | 4.73 | 0.363 | 0.213 | 3.3 | 2.39 | 2.39 | 0.11 | 1.39 | 0.01 | 25 |
| 12.0 | 69.5 | 79.96 | 0.15 | 4.88 | 0.365 | 0.215 | 3.4 | 2.40 | 2.39 | 0.11 | 1.50 | 0.00 | 25 |
| 12.8 | 55.6 | 62.58 | 0.12 | 4.99 | 0.365 | 0.215 | 3.4 | 2.40 | 2.40 | 0.11 | 1.61 | 0.01 | 25 |
| 13.5 | 48.7 | 52.15 | 0.10 | 5.09 | 0.365 | 0.215 | 3.4 | 2.40 | 2.40 | 0.11 | 1.72 | 0.00 | 25 |
| 14.3 | 41.7 | 45.20 | 0.08 | 5.18 | 0.364 | 0.214 | 3.4 | 2.39 | 2.39 | 0.11 | 1.82 | 0.00 | 25 |
| 15.0 | 0.0 | 20.86 | 0.04 | 5.21 | 0.362 | 0.212 | 3.3 | 2.39 | 2.39 | 0.11 | 1.93 | -0.01 | 25 |

**ATTENUATION FOR CRITICAL STORM DURATION OF 15.0 min**
**50% Summer Storm**
Connected Area 150 m2 Max Storage 13.3 m3

**Open Storage**
From Storage Sheet
Storage= 59 x2 + 3.218 x -0.04

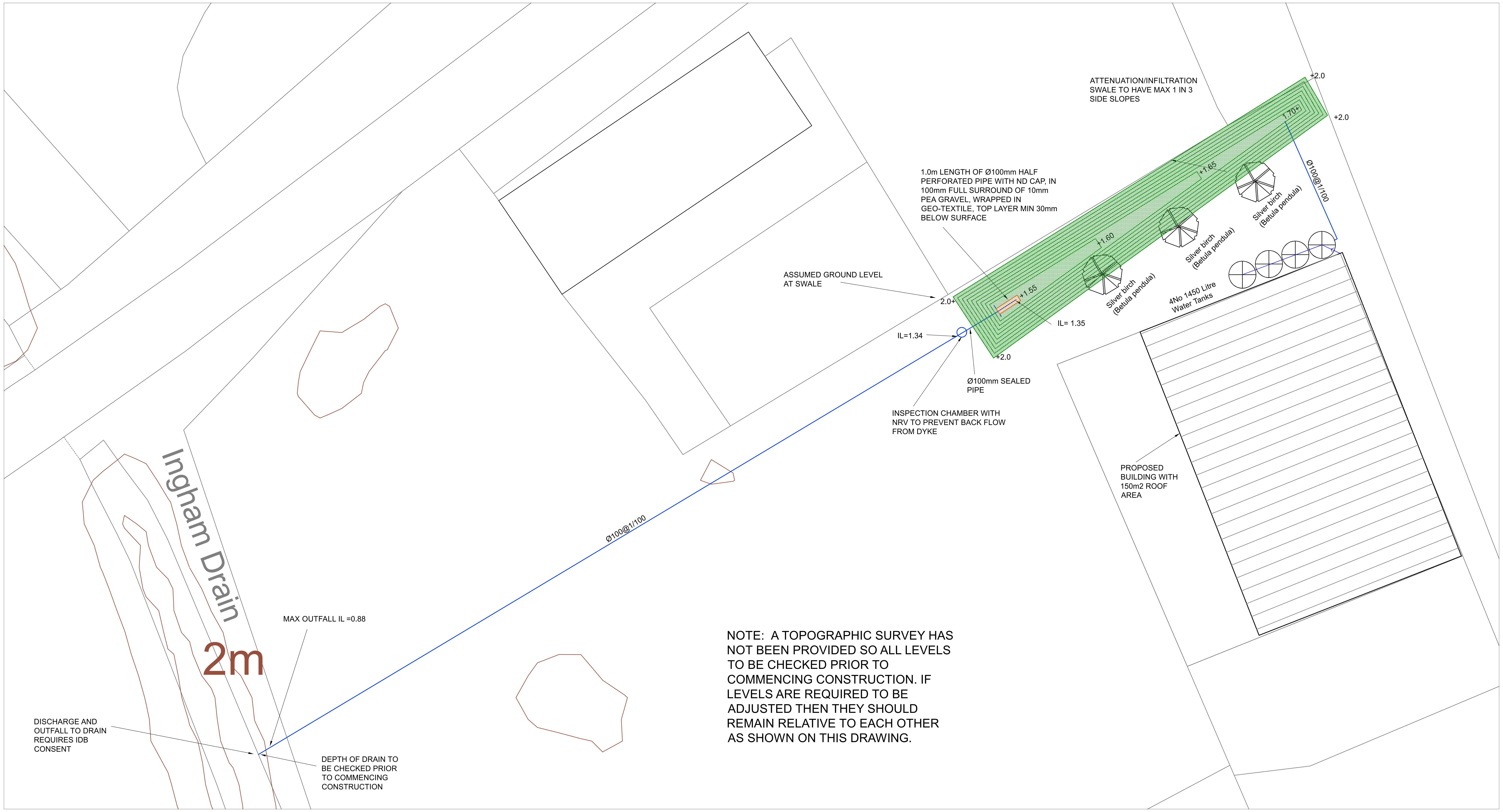
**Discharge Control**
From Discharge Control Sheet
Outflow= -1.565 x2 3.492 x 1.33

**Instructions** Adjust head at DCV at each interval to give checksum=0 or close to 0

| Time | Rainfall | | | | DCV | Storage | | Discharge Control | | | | Check Sum | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rainfall | Av Rainfall mm/hr | Vol In m3 | Cum In m3 | Head h (mm) | Depth in Basin (m) | Vol m3 | Out-flow l/s | Av Flow Out l/s | Vol Out m3 | Cum Out m3 | Inflow - Storage - Out = 0 | % Dsign Storage |
| 0.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000 | 0.000 | 0.0 | 1.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 0.8 | 41.7 | 20.86 | 0.04 | 0.04 | 0.151 | 0.001 | 0.0 | 1.82 | 1.58 | 0.07 | 0.07 | 0.00 | 0 |
| 1.5 | 48.7 | 45.20 | 0.08 | 0.12 | 0.153 | 0.003 | 0.0 | 1.83 | 1.82 | 0.08 | 0.15 | 0.00 | 0 |
| 2.3 | 55.6 | 52.15 | 0.10 | 0.22 | 0.158 | 0.008 | 0.0 | 1.84 | 1.84 | 0.08 | 0.24 | 0.00 | 0 |
| 3.0 | 69.5 | 62.58 | 0.12 | 0.34 | 0.164 | 0.014 | 0.0 | 1.86 | 1.85 | 0.08 | 0.32 | 0.00 | 0 |
| 3.8 | 83.4 | 76.48 | 0.14 | 0.48 | 0.177 | 0.027 | 0.1 | 1.90 | 1.88 | 0.08 | 0.40 | -0.01 | 1 |
| 4.5 | 104.3 | 93.87 | 0.18 | 0.66 | 0.190 | 0.040 | 0.2 | 1.94 | 1.92 | 0.09 | 0.49 | -0.01 | 1 |
| 5.3 | 125.2 | 114.73 | 0.22 | 0.87 | 0.203 | 0.053 | 0.3 | 1.97 | 1.96 | 0.09 | 0.58 | 0.00 | 2 |
| 6.0 | 222.5 | 173.83 | 0.33 | 1.20 | 0.224 | 0.074 | 0.5 | 2.03 | 2.00 | 0.09 | 0.67 | 0.01 | 4 |
| 6.8 | 382.4 | 302.46 | 0.57 | 1.77 | 0.259 | 0.109 | 1.0 | 2.13 | 2.08 | 0.09 | 0.76 | -0.01 | 8 |
| 7.5 | 521.5 | 451.95 | 0.85 | 2.61 | 0.299 | 0.149 | 1.7 | 2.23 | 2.18 | 0.10 | 0.86 | 0.00 | 13 |
| 8.3 | 382.4 | 451.95 | 0.85 | 3.46 | 0.332 | 0.182 | 2.5 | 2.32 | 2.28 | 0.10 | 0.96 | 0.00 | 19 |
| 9.0 | 222.5 | 302.46 | 0.57 | 4.03 | 0.350 | 0.200 | 3.0 | 2.36 | 2.34 | 0.11 | 1.07 | 0.00 | 22 |
| 9.8 | 125.2 | 173.83 | 0.33 | 4.35 | 0.358 | 0.208 | 3.2 | 2.38 | 2.37 | 0.11 | 1.17 | 0.00 | 24 |
| 10.5 | 104.3 | 114.73 | 0.22 | 4.57 | 0.362 | 0.212 | 3.3 | 2.39 | 2.38 | 0.11 | 1.28 | -0.01 | 25 |
| 11.3 | 83.4 | 93.87 | 0.18 | 4.75 | 0.364 | 0.214 | 3.4 | 2.39 | 2.39 | 0.11 | 1.39 | 0.01 | 25 |
| 12.0 | 69.5 | 76.48 | 0.14 | 4.89 | 0.365 | 0.215 | 3.4 | 2.40 | 2.39 | 0.11 | 1.50 | 0.01 | 25 |
| 12.8 | 55.6 | 62.58 | 0.12 | 5.01 | 0.366 | 0.216 | 3.4 | 2.40 | 2.40 | 0.11 | 1.60 | -0.01 | 26 |
| 13.5 | 48.7 | 52.15 | 0.10 | 5.10 | 0.365 | 0.215 | 3.4 | 2.40 | 2.40 | 0.11 | 1.71 | 0.01 | 25 |
| 14.3 | 41.7 | 45.20 | 0.08 | 5.19 | 0.365 | 0.215 | 3.4 | 2.40 | 2.40 | 0.11 | 1.82 | -0.01 | 25 |
| 15.0 | 0.0 | 20.86 | 0.04 | 5.23 | 0.362 | 0.212 | 3.3 | 2.39 | 2.39 | 0.11 | 1.93 | 0.01 | 25 |

OUTLINE DESIGN NOTES

1. THE DETAILS SHOWN ON THIS DRAWING ARE TO DEMONSTRATE A WORKABLE DRAINAGE STRATEGY. FURTHER CHECKS ON LEVELS ARE REQUIRED TO DEVELOP THIS DESIGN FOR CONSTRUCTION PURPOSES.
2. THE INVERT LEVEL OF INGHAM DYKE SHOULD BE CHECKED PRIOR TO FINALISING LEVELS.
3. ALL PIPEWORK AND ASSOCIATED STRUCTURES TO BE INSTALLED IN ACCORDANCE WITH bUILDING REGULATIONS PART H




NOTE: A TOPOGRAPHIC SURVEY HAS NOT BEEN PROVIDED SO ALL LEVELS TO BE CHECKED PRIOR TO COMMENCING CONSTRUCTION. IF LEVELS ARE REQUIRED TO BE ADJUSTED THEN THEY SHOULD REMAIN RELATIVE TO EACH OTHER AS SHOWN ON THIS DRAWING.

THIS DRAWING HAS BEEN PRODUCED TO BE READ AT A1 SIZE. IF VIEWING A PDF, ZOOM TO 100% FOR BEST VIEW.

NOTES

1. DO NOT SCALE FROM THIS DRAWING



| REV | DESCRIPTION | AP | DATE |
| --- | --- | --- | --- |


*George Shuttleworth Ltd*
*Consulting Engineers*
*www.georgeshuttleworthltd.co.uk*
*gsl_engineers@outlook.com*
*1 Fulmar Court, Fulmar Rd, Lincoln, LN6 3NE*
*Tel 07940 927285*




CLIENT: MR J KNAGGS

PROJECT: LAND OFF STATION ROAD EPWORTH, NORTH LINCS

DRAWING TITLE: OUTLINE OF PROPOSED SURFACE WATER DESIGN

| SCALE | APPROVED BY | DATE |
| --- | --- | --- |
| 1:100 | GS | OCT 25 |

| DRG SIZE | DRAWING NO. | REV. |
| --- | --- | --- |
| A1 | 858-001 | |