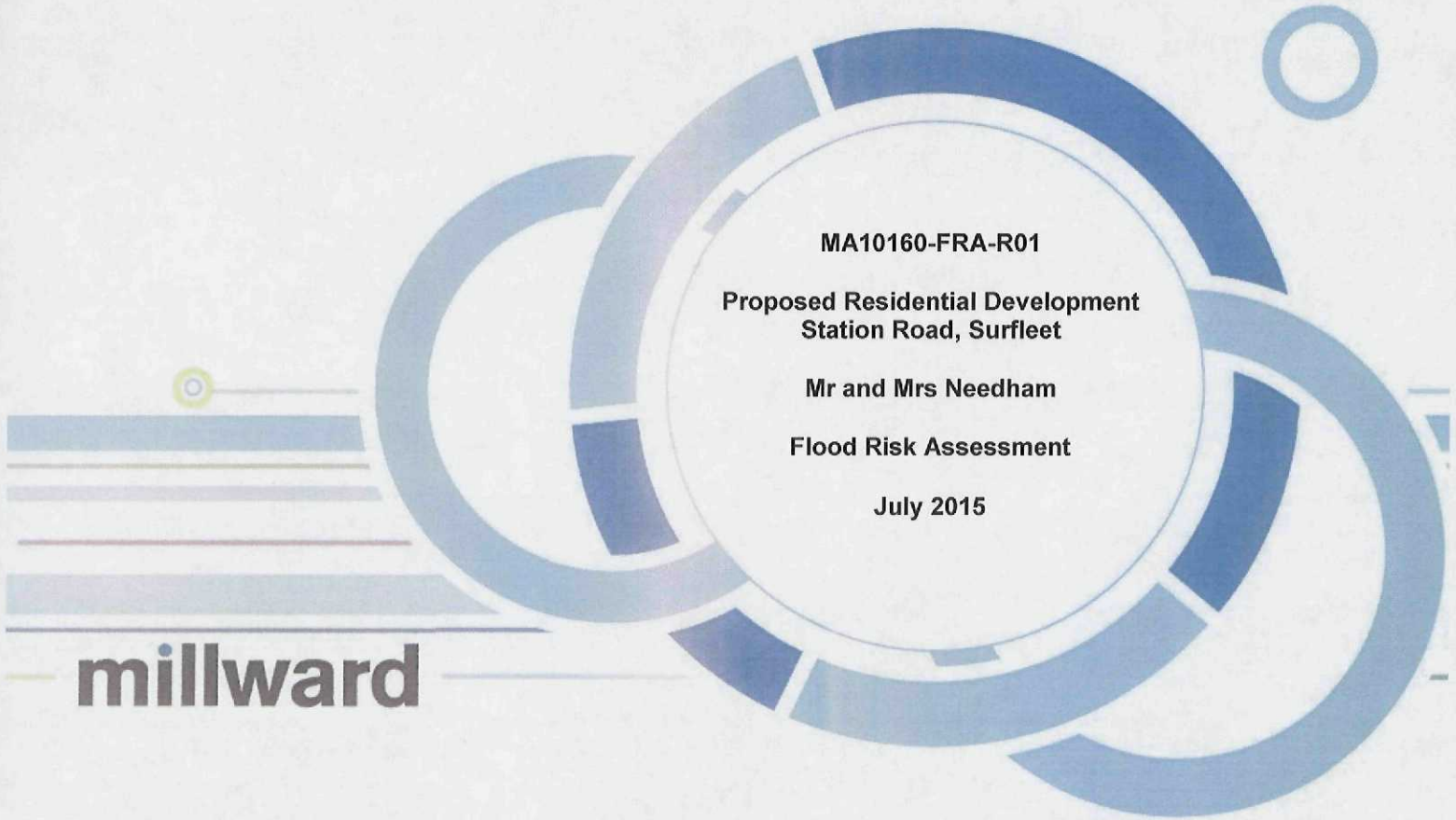




**MA10160-FRA-R01**

**Proposed Residential Development  
Station Road, Surfleet**

**Mr and Mrs Needham**

**Flood Risk Assessment**

**July 2015**

**millward**

- Civil & Structural Engineering
- Environmental & Geotechnical
- Flood Risk & Drainage
- Highways & Infrastructure
- Structural Inspections
- Transportation

## REVISION

| Reference       | Revision                   | Author | Date        |
|-----------------|----------------------------|--------|-------------|
| MA10160-FRA-R01 | Initial Issue for planning | JMcK   | August 2015 |

## CONTENTS

|    |                                      |    |
|----|--------------------------------------|----|
| 1. | INTRODUCTION .....                   | 4  |
| 2  | THE SITE.....                        | 5  |
| 3  | CONSULTATIONS .....                  | 6  |
| 4  | SEQUENTIAL AND EXCEPTION TESTS ..... | 7  |
| 5  | PROPOSED DEVELOPMENT .....           | 8  |
| 6  | FLOOD RISK .....                     | 9  |
| 7  | MITIGATION MEASURES .....            | 12 |
| 8  | CONCLUSIONS.....                     | 14 |



## **APPENDICIES**

### **Appendix A – Drawings**

Site Location Plan: MA10160/SK01

Proposed Drainage Strategy: MA10160/200

Proposed Site Layout

### **Appendix B – Consultations**

Anglian Water Sewer Map

### **Appendix C – WinDES Calculation Results**

ICP SUDS Greenfield Run Off Calculation

Proposed Peak Foul Flows

Source Control Surface water drainage – permeable paving calculations



## **1. INTRODUCTION**

- 1.1 Millward have been appointed to undertake a Flood Risk Assessment (FRA) for a proposed residential development on land adjacent to Station Road, Surfleet, PE11 4BW.
- 1.2 This FRA is undertaken in accordance with the National Planning Policy Framework and associated Technical Guidance Document March 2012 (NPPF).
- 1.3 This FRA discusses and provides both a qualitative assessment and quantitative assessment for the residential development in terms of flood risk, future flood risk over the anticipated lifetime of the development and reference to the sequential and exception test using a precautionary and risk based approach.



## **2 THE SITE**

- 2.1 This proposed residential development is located to the north side of Station Road on Brownfield Land in Surfleet, totalling 0.284 Hectares (2,835m<sup>2</sup>) in area. The site is located within the urban extents of Surfleet approximately 5miles north of the centre of Spalding. The site location is shown on drawing MA10160/SK01 contained within Appendix A.
- 2.2 Vehicular access to the development will be via Station Road as per the architects drawing contained within Appendix A.
- 2.3 The site was previously developed as a nursery with the site area for development technically arable land for growing of plants. Whilst part of a previous development there has not been any physical development on the land such as impermeable areas of buildings. Therefore for the purpose of analysis for surface water run-off, the site is classed as Greenfield.
- 2.4 There is no evidence that the site is or has been formally drained into the existing adopted sewer system on Station Road and with the topography of the land falling away circa 1m to the north away from Station Road and the River Glen surface water connectivity to the River or the road is unlikely.
- 2.5 It is concluded that the land will currently drain via natural percolation into the sub soils and surface water run off would be north towards the other areas of the nursery and glasshouses.
- 2.6 Site levels within the development area vary from circa 7m AOD to the frontage of the site (Southern boundary) to circa 6m AOD to the rear of the site (Northern boundary), giving an average gradient across the site of circa 1:50 (2%).
- 2.7 The site is currently 100% permeable and therefore the site surface water run-off has been calculated by the ICP SUDS method, which confirms a Greenfield run-off rate of 0.4 l/s for the 1 in 1 year event. The WinDES results are contained within Appendix C.

### **3 CONSULTATIONS**

#### **3.1 Environment Agency (EA)**

- 3.1.1 The EA national flood risk maps available on their web site have been interrogated firstly to define in terms of planning what flood zone the site is contained within.
- 3.1.2 The development site is contained wholly within Flood Zone 1 which in accordance with Table 1 of the NPPF Technical Guidance document, is defined as Low Probability having less than a 1 in 1000 chance (<0.1%) of flooding from rivers or the sea in any one year.
- 3.1.3 Therefore further EA consultation has not taken place for this development as the development is in the lowest flood zone in terms of planning.
- 3.1.4 The Environment Agency standing advice note for sites within Flood Zone 1 greater than 1 hectare in size requires a flood risk assessment to be undertaken which should concentrate on dealing with the proposed surface water run-off from the site and how the run-off is dealt with and controlled. Whilst this site is less than 1 hectare the assessment of this site remains in line with this standing advice.

#### **3.2 Anglian Water (AW)**

- 3.2.1 As part of this assessment AW sewer plans have been obtained to determine the location of sewers in the vicinity of the site which is shown in Appendix B.
- 3.2.2 To the north of the site there is a 150mm diameter foul sewer and rising main which from the records MH7501, 7502, and 6501 are 1.69m to 2.18m depth.
- 3.2.3 There are no surface water sewers in the vicinity of the site whatsoever.
- 3.2.4 The foul connection to the existing adopted sewer are subject to a S106 application which would be undertaken as part of the detailed design of the drainage for the development.



## **5 PROPOSED DEVELOPMENT**

- 5.1 The proposed development proposals consist of 5no detached dwellings in total with associated driveways and garages (off road) and garden areas to the rear of the proposed dwellings. The site is accessed by a central cul-de-sac access road with a turning head at the western end for service vehicles. The proposed plan layout of the development is shown on the sketch layout contained within in Appendix A.
- 5.2 The impermeable areas of the proposed site are 45% (0.129Ha) as shown on drawing MA10160/200 contained in Appendix A which is an increase in impermeable area on the site, which therefore will require mitigation measures in terms of surface water drainage to reduce the surface water run off to equivalent Greenfield rates.
- 5.3 The proposals will also look into provision of permeable paving solutions to the driveways and potentially soakaways for roof drainage subject to on site percolation testing of the soil strata. Therefore on site testing would be required before detailed design of any drainage system to determine if soakaways are potentially viable at this site. However this is unlikely due to ground conditions and therefore the drainage strategy for this site assumes infiltration is not feasible.
- 5.4 Foul drainage would connect into the existing Anglian Water sewer network to the northern boundary of the site with anticipated peak foul flows of less than 1 l/s (Circa 0.2 l/s peak for all the plots) into the existing sewer. These connections would of course be subject to approval from Anglian water as part of the planning and detailed design process.

## 6 FLOOD RISK

### 6.1 Flooding From Watercourses

- 6.1.1 The development area is shown within Flood Zone 1 (Less than a 1 in 1000 (0.1%) chance of flooding in any one year – Low Probability in line with the NPPF) from watercourses.
- 6.1.2 The closest area of flood zone 3 is located to the north in the nursery area to the north of the site which is reasonably close to the site.
- 6.1.3 The South Holland SFRA (2010 update) provides district wide assessment of the flood risk including flood defence breach scenarios which have been assessed.
- 6.1.4 The SFRA shows the site is not at risk of flooding in the present day scenario
- 6.1.5 The risk of flooding to the development area from fluvial sources is considered to be **LOW** probability as the site is situated in the lowest flood zone from this source when assessing the site against the information available.

### 6.2 Flooding From Land / Adjacent Development

- 6.2.1 The main risk of flooding to this site is from the impermeable surfaces within the adjacent residential area to the east and west of the site, along with the Station Road carriageway which due to failure of the existing adopted drainage systems or intense rainfall saturating the soil resulting in run off over land instead of infiltration or interception by drainage infrastructure.
- 6.2.2 Any overland flow from adjacent development site is likely to be shallow and there are no low points within the site which would create a localised depression in the ground which would be at risk of ponding / pooling water from this source.

6.2.3 Any flooding from this source would be sheet flooding, shallow in depth. Flood flow routes from the existing properties would not be towards the development site. Station Road flood flow routes would potentially be towards the site but volumes of water from this source would be low.

6.2.4 Overall the risk of flooding from this source is considered to be **LOW**.

### **6.3 Flooding From Infrastructure Failure**

6.3.1 The site is not within an area deemed to be at risk of flooding from reservoirs (according to the data on the EA website).

6.3.2 As the site is outside the limits of any deemed flood extents from a reservoir failure, the risk of flooding to the site is considered **LOW**.

### **6.4 Flooding From Groundwater**

6.4.1 There are no confirmed records of groundwater flooding in the vicinity of the site in the SFRA.

6.4.2 The site is underlain by Oxford Clay and therefore the chances of groundwater being an issue is remote as these soils are predominantly impermeable which would stop any rise in groundwater reaching the surface.

6.4.3 Overall the risk of flooding from this source is considered to be **LOW**. As there should not be any dwellings in localised low points within the site it is not considered further assessment is required to assess flooding from this source.

### **6.5 Flooding From Sewers**

6.5.1 There are existing adopted foul sewers to the north of the development site which are 150mm diameter and connect to an existing pumping station to the north west of the site.



- 6.5.2 If any of these sewers were to flood, the water flow routes would be away from the development flowing in a northerly direction. The pump station is also lower than the site and if this was to fail flood flow routes of any foul water would be away from the site also
- 6.5.3 Overall taking into account the proximity of the sewers and topography of the area, the risk of flooding from this source is considered to be **LOW**.

## **6.6 Flooding From Climate Change**

- 6.6.1 The NPPF Technical Guidance Document confirms in Table 5 that peak rainfall intensity is estimated to increase up to 30% over the lifetime of this development (100 years) and peak river flows by 20%. Tidal aspects extreme wave heights could increase between 5% and 10%. Sea level rises in this area over the lifetime of the development would be anticipated to be circa 1.2m (to year 2115).
- 6.6.2 The South Holland SFRA assesses the risk of flooding from Tidal and Fluvial events at year 2115. The plans show that the actual flood depth could be between 0 and 0.5m in depth for this general area. The site is located towards the outer extents of the limits of flooding and therefore levels in the region of 250mm should be expected which is mid-range for the area identified.
- 6.6.3 The SFRA plans show that the existing Station Road is at the limits of anticipated flooding.
- 6.6.4 The proposed site drainage will however be designed not to flood with an allowance of 30% for climate change in line with the NPPF technical guidance document.
- 6.6.5 Overall the risk of flooding from the effects of climate change is considered to be **MEDIUM**.

## 7 MITIGATION MEASURES

### 7.1 Essential Mitigation Measures

- 7.1.1 The assessment of flood risk in Section 6 of this assessment confirms a **LOW** risk of flooding from all sources of flooding except for the potential implications of climate change which is considered a **MEDIUM** risk primarily from tidal sources.
- 7.1.2 The finished floor levels of the properties should be set no lower than the existing Station Road or a minimum of 300mm above existing levels whichever is the higher. This will ensure that the floor levels of the dwellings are above any anticipated flood levels expected to occur over the lifetime of the development.
- 7.1.3 Surface water drainage for the site should be designed to accommodate the 1 in 100 year event storm scenarios including a 30% allowance for climate change.

### 7.2 Recommended Mitigation Measures

- 7.2.1 All dwellings should have concrete ground floors with damp proof membranes as they are regarded as the most flood resilient floor types with effective connections between the dpc and dpm. The dpm should be between the surface screed and the concrete slab as this enables the concrete floor to dry out quickly and would also protect against any rising groundwater (unlikely) should flood risk from this source increase over the lifetime of the development.
- 7.2.2 Permeable paving to private driveways and parking areas should be utilised even if infiltration SUDS are not viable as permeable paving can be designed into a sealed system before outfall into the drainage ditch to the north of the site. This would form part of a SUDS treatment train in line with CIRIA C697.
- 7.2.3 Further investigations will be required as part of the detailed design of the drainage outfall which may require off site mitigation works to this existing drainage ditch to ensure free flow of the ditch.

- 7.2.4 Where external gradients are flat or towards the dwelling entrances, provision of linear drainage should be provided to all access points.



## 8 CONCLUSIONS

- 8.1 This Flood Risk Assessment serves to review, assess and quantify (where applicable) the sources, or any potential flooding, the pathways of this flooding and potential receptors within the vicinity of the site.
- 8.2 The assessment of flood risk undertaken for this development confirms that the risk of flooding is **LOW** from all sources of flooding except for tidal sources with climate change applied which is **MEDIUM**.
- 8.3 The site is not at risk of flooding from any source present day and is situated within Flood Zone 1. Therefore safe access and egress to the properties is available if required.
- 8.4 The mitigation measures will provide further protection to the development and reduce any residual risk (however low) as far as practicable. It is recommended that compliance with the recommendations of this FRA are conditioned as part of any planning permission.
- 8.5 This assessment concludes that the site is suitable for development for residential use without unacceptable risk of flooding from all sources to the site itself and elsewhere for the lifetime of the development.

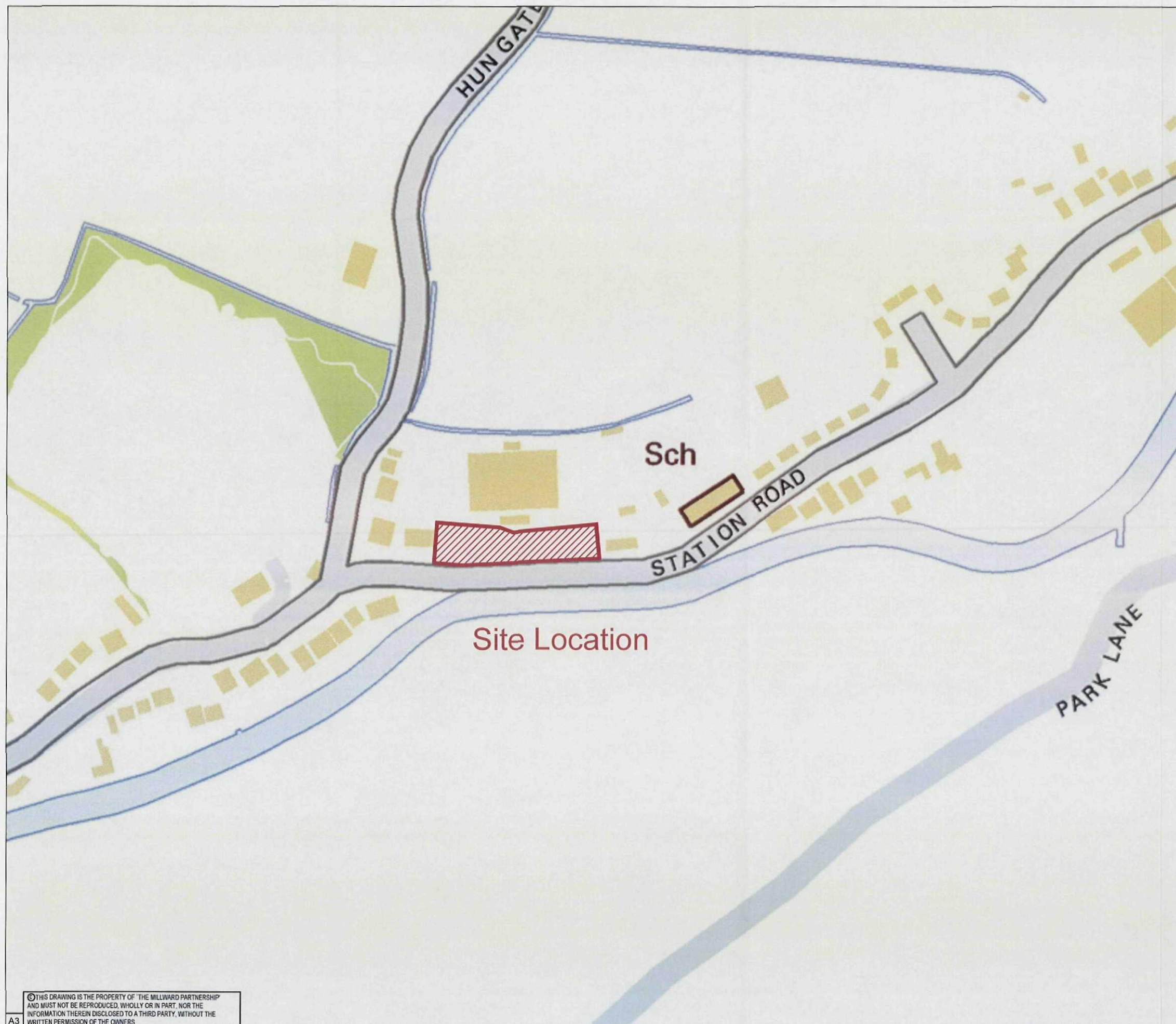
## ***Appendix A – Drawings***

***Site Location Plan: MA10160/SK01***

***Proposed Drainage Strategy: MA10160/200***

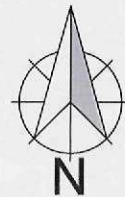
***Proposed Site Layout***





| ASSOCIATED DRAWINGS                                                                                                                                                         |            |    |                |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----|----------------|------|
| No.                                                                                                                                                                         | TITLE      |    |                |      |
|                                                                                                                                                                             |            |    |                |      |
| NOTES                                                                                                                                                                       |            |    |                |      |
|                                                                                                                                                                             |            |    |                |      |
| REV                                                                                                                                                                         | DATE       | BY | DETAILS        | CHKD |
|                                                                                                                                                                             |            |    |                |      |
| AMENDMENTS                                                                                                                                                                  |            |    |                |      |
| CLIENT                                                                                                                                                                      |            |    |                |      |
| LarkfleetHomes                                                                                                                                                              |            |    |                |      |
| PROJECT                                                                                                                                                                     |            |    |                |      |
| Land off Station Road<br>Surfleet                                                                                                                                           |            |    |                |      |
| TITLE                                                                                                                                                                       |            |    |                |      |
| SITE LOCATION PLAN                                                                                                                                                          |            |    |                |      |
| DRAWING No.                                                                                                                                                                 |            |    | DRAWING STATUS |      |
| MA10160 / SK01                                                                                                                                                              |            |    |                |      |
|                                                                                                                                                                             |            |    |                |      |
| SCALE                                                                                                                                                                       | DRAWN      |    | ENGINEER       |      |
| NTS                                                                                                                                                                         | J Harrison |    | J McKellar     |      |
| DATE                                                                                                                                                                        | CHECKED    |    | APPROVED BY    |      |
| June 2015                                                                                                                                                                   | J McKellar |    | J McKellar     |      |
|   |            |    |                |      |
| t: 0115 941 4560<br>no.1 malin hill, nottingham ng1 1jq<br>e: info@millward.co.uk w: www.millward.co.uk                                                                     |            |    |                |      |

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150mmØ PIPE DISCHARGING  
TO EXISTING DITCH TO  
NORTHERN BOUNDARY OF  
NURSERY AT 0.4 l/s.

HYDROBRAKE MANHOLE  
DESIGN HEAD 0.6m  
DESIGN FLOW 0.4 l/s  
31mm ORIFICE.

S106 CONNECTION INTO  
MH6502 FOR PLOTS 1 & 2

CATCHPIT MANHOLE TO  
CATCH SILTS

S106 CONNECTION INTO  
MH6501 FOR PLOT 3

S106 CONNECTION INTO  
MH7502 FOR PLOTS 4 & 5

EXISTING ACCESS  
TO NURSERY

STATION ROAD

RIVER GLEN

EXISTING GLASSHOUSES.

N° 72.

#### ASSOCIATED DRAWINGS

| No. | TITLE |
|-----|-------|
|     |       |

#### NOTES

#### KEY

 PRIVATE PERMEABLE PAVING  
(654m<sup>2</sup>)

 DWELLING / GARAGE ROOF  
AREAS (635m<sup>2</sup>)

NB: ROOF AREAS DRAIN INTO  
PERMEABLE PAVING

| REV | DATE | BY | DETAILS | CHK'D |
|-----|------|----|---------|-------|
|-----|------|----|---------|-------|

#### AMENDMENTS

CLIENT

MR & MRS NEEDHAM

PROJECT

PROPOSED RESIDENTIAL  
DEVELOPMENT  
STATION ROAD, SURFLEET

TITLE

PROPOSED DRAINAGE  
STRATEGY

DRAWING No:

MA10160 / 200

DRAWING STATUS

PLANNING

SCALE  
1:500 @ A3

DRAWN  
ATF

ENGINEER  
JMCK

DATE  
06.08.15

CHECKED  
JMCK

APPROVED BY  
JMCK

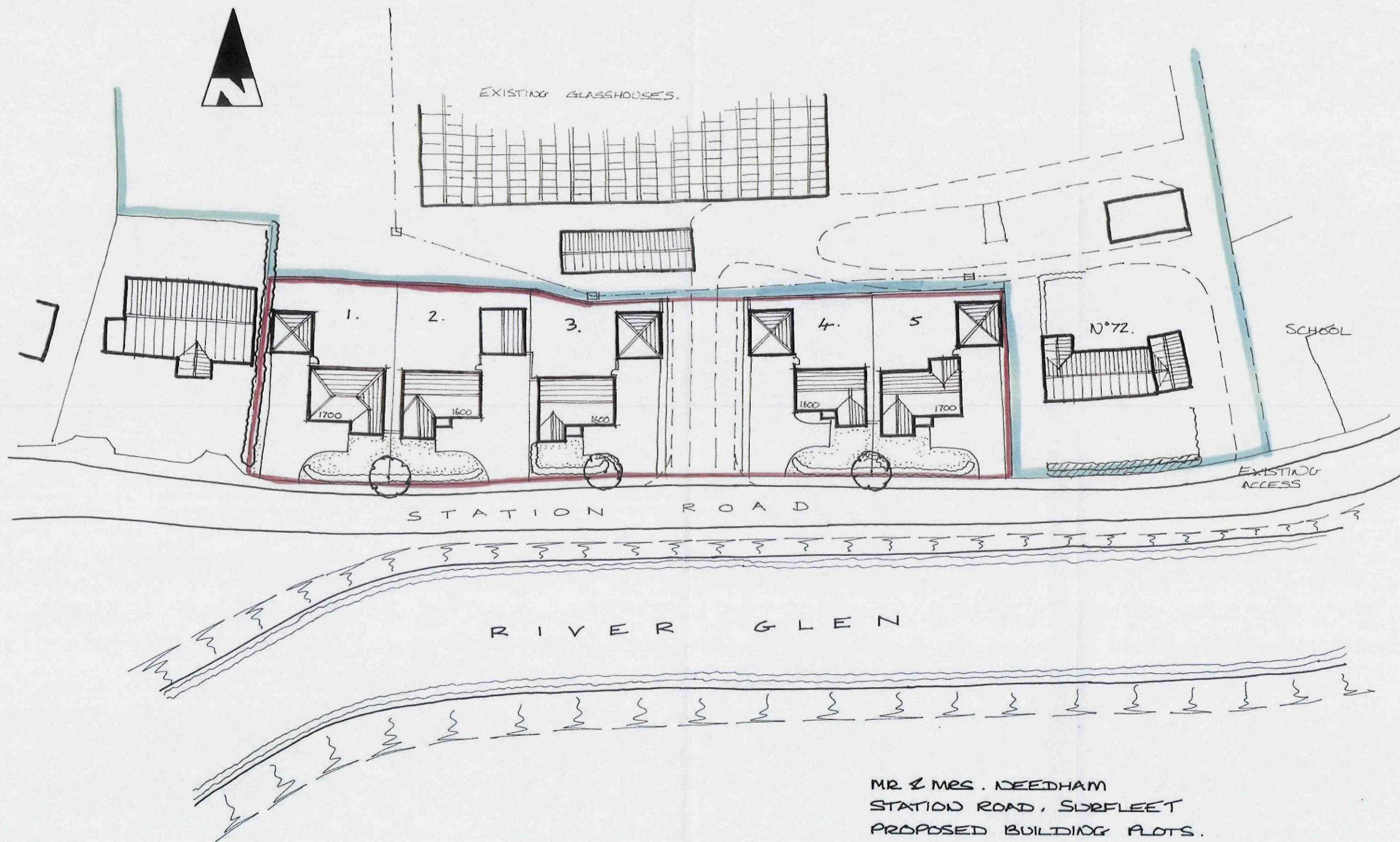
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A3

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MR & MRS. DEEDHAM  
 STATION ROAD, SURFLEET  
 PROPOSED BUILDING PLOTS.  
SKETCH LAYOUT - 5 NO PLOTS  
 1:500 @ A3 . NOV 2014

## ***Appendix B – Consultations***

### ***Anglian Water Sewer Map***





(c) Crown copyright and database rights 2015 Ordnance Survey 100022432

Date: 30/07/15

Scale: 1:1000

Map Centre: 525680,328528

Data updated: 15/06/15

Our Ref: 151177 - 1

Wastewater Plan A3

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2015 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

|                                |     |                                |   |
|--------------------------------|-----|--------------------------------|---|
| Foul Sewer                     | --- | Outfall                        | ☞ |
| Surface Sewer                  | --- | (Colour denotes effluent type) |   |
| Combined Sewer                 | --- | Inlet                          | ☞ |
| Final Effluent                 | --- | (Colour denotes effluent type) |   |
| Rising Main                    | --- | Manhole                        | ● |
| (Colour denotes effluent type) |     | (Colour denotes effluent type) |   |
| Private Sewer                  | --- | Sewage Treatment Works         | ☐ |
| (Colour denotes effluent type) |     | Pumping Station                | ⬢ |
| Decommissioned Sewer           | --- |                                |   |
| (Colour denotes effluent type) |     |                                |   |

|                      |
|----------------------|
| jason@millward.co.uk |
| MA10160              |
|                      |





## ***Appendix C – WinDES Calculation Results***

### ***ICP SUDS Greenfield Run Off Calculation***

#### ***Proposed Peak Foul Flows***

#### ***Source Control Surface water drainage – permeable paving calculations***



2nd Floor

Station Road Surfleet

3-7 Middle Pavement

ICP SUDS

Nottingham NG1 7DX

Greenfield Run Off

Date July 2015

Designed By JMcK

File

Checked By

Micro Drainage

Source Control W.12.4

ICP SUDS Mean Annual Flood

## Input

|                       |       |               |          |
|-----------------------|-------|---------------|----------|
| Return Period (years) | 1     | Soil          | 0.300    |
| Area (ha)             | 0.284 | Urban         | 0.000    |
| SAAR (mm)             | 567   | Region Number | Region 5 |

## Results 1/s

|            |     |
|------------|-----|
| QBAR Rural | 0.4 |
| QBAR Urban | 0.4 |

Q1 year 0.4

Q1 year 0.4

Q30 years 1.0

Q100 years 1.4

|                              |                       |                                                                                     |
|------------------------------|-----------------------|-------------------------------------------------------------------------------------|
| The Millward Partnership Ltd |                       | Page 1                                                                              |
| 2nd Floor                    | Station Road Surfleet |  |
| 3-7 Middle Pavement          | Foul Drainage Flows   |                                                                                     |
| Nottingham NG1 7DX           |                       |                                                                                     |
| Date July 2015               | Designed By JMCK      |                                                                                     |
| File MA10160 Foul Flow...    | Checked By            |                                                                                     |
| Micro Drainage               | Network W.12.4        |                                                                                     |

# FOUL SEWERAGE DESIGN

## Design Criteria for Foul - Main

Pipe Sizes STANDARD Manhole Sizes STANDARD

|                             |        |                                       |       |
|-----------------------------|--------|---------------------------------------|-------|
| Industrial Flow (l/s/ha)    | 0.00   | Add Flow / Climate Change (%)         | 0     |
| Industrial Peak Flow Factor | 0.00   | Minimum Backdrop Height (m)           | 0.200 |
| Flow Per Person (l/per/day) | 222.00 | Maximum Backdrop Height (m)           | 1.500 |
| Persons per House           | 3.00   | Min Design Depth for Optimisation (m) | 1.200 |
| Domestic (l/s/ha)           | 0.00   | Min Vel for Auto Design only (m/s)    | 0.75  |
| Domestic Peak Flow Factor   | 6.00   | Min Slope for Optimisation (1:X)      | 500   |

Designed with Level Soffits

## Network Design Table for Foul - Main

| PN    | Length<br>(m) | Fall<br>(m) | Slope<br>(1:X) | Area<br>(ha) | Houses | DWF<br>(l/s) | k<br>(mm) | HYD<br>SECT | DIA<br>(mm) |
|-------|---------------|-------------|----------------|--------------|--------|--------------|-----------|-------------|-------------|
| 1.000 | 10.000        | 0.067       | 150.0          | 0.000        | 5      | 0.0          | 1.500     | o           | 150         |

## Network Results Table

| PN    | US/IL<br>(m) | Σ Area<br>(ha) | Σ DWF<br>(l/s) | Σ Hse | Add Flow<br>(l/s) | P.Dep<br>(mm) | P.Vel<br>(m/s) | Vel<br>(m/s) | Cap<br>(l/s) | Flow<br>(l/s) |
|-------|--------------|----------------|----------------|-------|-------------------|---------------|----------------|--------------|--------------|---------------|
| 1.000 | 4.500        | 0.000          | 0.0            | 5     | 0.0               | 14            | 0.27           | 0.71         | 12.6         | 0.2           |

2nd Floor  
 3-7 Middle Pavement  
 Nottingham NG1 7DX  
 Date July 2015  
 File MA10160 Permeable...  
 Micro Drainage

Station Road Surfleet  
 Permeable Pavement  
 Prelim Strategy  
 Designed By JMCK  
 Checked By  
 Source Control W.12.4



Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 2003 minutes.

| Storm<br>Event  | Max<br>Level<br>(m) | Max<br>Depth<br>(m) | Max<br>Infiltration<br>(l/s) | Max<br>Control<br>(l/s) | Max<br>E Outflow<br>(l/s) | Max<br>Volume<br>(m³) | Status |
|-----------------|---------------------|---------------------|------------------------------|-------------------------|---------------------------|-----------------------|--------|
| 15 min Summer   | 6.381               | 0.181               | 0.0                          | 0.3                     | 0.3                       | 25.9                  | O K    |
| 30 min Summer   | 6.437               | 0.237               | 0.0                          | 0.3                     | 0.3                       | 34.8                  | O K    |
| 60 min Summer   | 6.494               | 0.294               | 0.0                          | 0.3                     | 0.3                       | 44.0                  | O K    |
| 120 min Summer  | 6.552               | 0.352               | 0.0                          | 0.3                     | 0.3                       | 53.1                  | O K    |
| 180 min Summer  | 6.584               | 0.384               | 0.0                          | 0.3                     | 0.3                       | 58.2                  | O K    |
| 240 min Summer  | 6.604               | 0.404               | 0.0                          | 0.3                     | 0.3                       | 61.5                  | O K    |
| 360 min Summer  | 6.629               | 0.429               | 0.0                          | 0.4                     | 0.4                       | 65.5                  | O K    |
| 480 min Summer  | 6.646               | 0.446               | 0.0                          | 0.4                     | 0.4                       | 68.1                  | O K    |
| 600 min Summer  | 6.656               | 0.456               | 0.0                          | 0.4                     | 0.4                       | 69.7                  | O K    |
| 720 min Summer  | 6.663               | 0.463               | 0.0                          | 0.4                     | 0.4                       | 70.8                  | O K    |
| 960 min Summer  | 6.669               | 0.469               | 0.0                          | 0.4                     | 0.4                       | 71.8                  | O K    |
| 1440 min Summer | 6.665               | 0.465               | 0.0                          | 0.4                     | 0.4                       | 71.2                  | O K    |
| 2160 min Summer | 6.652               | 0.452               | 0.0                          | 0.4                     | 0.4                       | 69.1                  | O K    |
| 2880 min Summer | 6.638               | 0.438               | 0.0                          | 0.4                     | 0.4                       | 66.9                  | O K    |
| 4320 min Summer | 6.609               | 0.409               | 0.0                          | 0.4                     | 0.4                       | 62.3                  | O K    |
| 5760 min Summer | 6.582               | 0.382               | 0.0                          | 0.3                     | 0.3                       | 58.0                  | O K    |
| 7200 min Summer | 6.558               | 0.358               | 0.0                          | 0.3                     | 0.3                       | 54.1                  | O K    |
| 8640 min Summer | 6.535               | 0.335               | 0.0                          | 0.3                     | 0.3                       | 50.4                  | O K    |

| Storm<br>Event  | Rain<br>(mm/hr) | Time-Peak<br>(mins) |
|-----------------|-----------------|---------------------|
| 15 min Summer   | 121.269         | 27                  |
| 30 min Summer   | 79.695          | 42                  |
| 60 min Summer   | 49.937          | 72                  |
| 120 min Summer  | 30.267          | 130                 |
| 180 min Summer  | 22.297          | 190                 |
| 240 min Summer  | 17.851          | 250                 |
| 360 min Summer  | 12.957          | 368                 |
| 480 min Summer  | 10.330          | 486                 |
| 600 min Summer  | 8.659           | 606                 |
| 720 min Summer  | 7.492           | 724                 |
| 960 min Summer  | 5.959           | 962                 |
| 1440 min Summer | 4.309           | 1376                |
| 2160 min Summer | 3.110           | 1712                |
| 2880 min Summer | 2.466           | 2084                |
| 4320 min Summer | 1.775           | 2904                |
| 5760 min Summer | 1.405           | 3752                |
| 7200 min Summer | 1.171           | 4552                |
| 8640 min Summer | 1.008           | 5368                |

2nd Floor  
 3-7 Middle Pavement  
 Nottingham NG1 7DX  
 Date July 2015  
 File MA10160 Permeable...  
 Micro Drainage

Station Road Surfleet  
 Permeable Pavement  
 Prelim Strategy  
 Designed By JMcK  
 Checked By  
 Source Control W.12.4



Summary of Results for 100 year Return Period (+30%)

| Storm Event      | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max $\Sigma$ Outflow (l/s) | Max Volume (m <sup>3</sup> ) | Status     |
|------------------|---------------|---------------|------------------------|-------------------|----------------------------|------------------------------|------------|
| 10080 min Summer | 6.513         | 0.313         | 0.0                    | 0.3               | 0.3                        | 47.0                         | O K        |
| 15 min Winter    | 6.402         | 0.202         | 0.0                    | 0.3               | 0.3                        | 29.4                         | O K        |
| 30 min Winter    | 6.465         | 0.265         | 0.0                    | 0.3               | 0.3                        | 39.4                         | O K        |
| 60 min Winter    | 6.530         | 0.330         | 0.0                    | 0.3               | 0.3                        | 49.7                         | O K        |
| 120 min Winter   | 6.595         | 0.395         | 0.0                    | 0.3               | 0.3                        | 60.0                         | O K        |
| 180 min Winter   | 6.631         | 0.431         | 0.0                    | 0.4               | 0.4                        | 65.8                         | O K        |
| 240 min Winter   | 6.655         | 0.455         | 0.0                    | 0.4               | 0.4                        | 69.6                         | O K        |
| 360 min Winter   | 6.684         | 0.484         | 0.0                    | 0.4               | 0.4                        | 74.2                         | O K        |
| 480 min Winter   | 6.704         | 0.504         | 0.0                    | 0.4               | 0.4                        | 77.3                         | Flood Risk |
| 600 min Winter   | 6.717         | 0.517         | 0.0                    | 0.4               | 0.4                        | 79.4                         | Flood Risk |
| 720 min Winter   | 6.725         | 0.525         | 0.0                    | 0.4               | 0.4                        | 80.8                         | Flood Risk |
| 960 min Winter   | 6.735         | 0.535         | 0.0                    | 0.4               | 0.4                        | 82.3                         | Flood Risk |
| 1440 min Winter  | 6.736         | 0.536         | 0.0                    | 0.4               | 0.4                        | 82.5                         | Flood Risk |
| 2160 min Winter  | 6.719         | 0.519         | 0.0                    | 0.4               | 0.4                        | 79.8                         | Flood Risk |
| 2880 min Winter  | 6.703         | 0.503         | 0.0                    | 0.4               | 0.4                        | 77.2                         | Flood Risk |
| 4320 min Winter  | 6.665         | 0.465         | 0.0                    | 0.4               | 0.4                        | 71.2                         | O K        |
| 5760 min Winter  | 6.627         | 0.427         | 0.0                    | 0.4               | 0.4                        | 65.1                         | O K        |
| 7200 min Winter  | 6.591         | 0.391         | 0.0                    | 0.3               | 0.3                        | 59.5                         | O K        |
| 8640 min Winter  | 6.559         | 0.359         | 0.0                    | 0.3               | 0.3                        | 54.2                         | O K        |

| Storm Event      | Rain (mm/hr) | Time-Peak (mins) |
|------------------|--------------|------------------|
| 10080 min Summer | 0.889        | 6160             |
| 15 min Winter    | 121.269      | 27               |
| 30 min Winter    | 79.695       | 41               |
| 60 min Winter    | 49.937       | 70               |
| 120 min Winter   | 30.267       | 128              |
| 180 min Winter   | 22.297       | 186              |
| 240 min Winter   | 17.851       | 244              |
| 360 min Winter   | 12.957       | 362              |
| 480 min Winter   | 10.330       | 478              |
| 600 min Winter   | 8.659        | 594              |
| 720 min Winter   | 7.492        | 710              |
| 960 min Winter   | 5.959        | 938              |
| 1440 min Winter  | 4.309        | 1378             |
| 2160 min Winter  | 3.110        | 1800             |
| 2880 min Winter  | 2.466        | 2220             |
| 4320 min Winter  | 1.775        | 3156             |
| 5760 min Winter  | 1.405        | 4040             |
| 7200 min Winter  | 1.171        | 4912             |
| 8640 min Winter  | 1.008        | 5792             |

2nd Floor

Station Road Surfleet

3-7 Middle Pavement

Permeable Pavement

Nottingham NG1 7DX

Prelim Strategy

Date July 2015

Designed By JMcK

File MA10160 Permeable...

Checked By



Micro Drainage

Source Control W.12.4

Summary of Results for 100 year Return Period (+30%)

| Storm<br>Event   | Max<br>Level<br>(m) | Max<br>Depth<br>(m) | Max<br>Infiltration<br>(l/s) | Max<br>Control<br>(l/s) | Max<br>E Outflow<br>(l/s) | Max<br>Volume<br>(m <sup>3</sup> ) | Status |
|------------------|---------------------|---------------------|------------------------------|-------------------------|---------------------------|------------------------------------|--------|
| 10080 min Winter | 6.528               | 0.328               | 0.0                          | 0.3                     | 0.3                       | 49.4                               | O K    |

| Storm<br>Event   | Rain<br>(mm/hr) | Time-Peak<br>(mins) |
|------------------|-----------------|---------------------|
| 10080 min Winter | 0.889           | 6656                |

|                           |                       |
|---------------------------|-----------------------|
| 2nd Floor                 | Station Road Surfleet |
| 3-7 Middle Pavement       | Permeable Pavement    |
| Nottingham NG1 7DX        | Prelim Strategy       |
| Date July 2015            | Designed By JMCK      |
| File MA10160 Permeable... | Checked By            |
| Micro Drainage            | Source Control W.12.4 |



### Model Details

Storage is Online Cover Level (m) 7.000

### Porous Car Park Structure

|                                      |         |                         |       |
|--------------------------------------|---------|-------------------------|-------|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m)               | 29.8  |
| Membrane Percolation (mm/hr)         | 1000    | Length (m)              | 17.8  |
| Max Percolation (l/s)                | 147.3   | Slope (1:X)             | 500.0 |
| Safety Factor                        | 1.0     | Depression Storage (mm) | 5     |
| Porosity                             | 0.30    | Evaporation (mm/day)    | 3     |
| Invert Level (m)                     | 6.200   | Cap Volume Depth (m)    | 0.600 |

### Hydro-Brake® Outflow Control

|                               |       |                  |       |
|-------------------------------|-------|------------------|-------|
| Design Head (m)               | 0.600 | Diameter (mm)    | 31    |
| Design Flow (l/s)             | 0.4   | Invert Level (m) | 6.200 |
| Hydro-Brake® Type Md6 SW Only |       |                  |       |

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| 0.100     | 0.2        | 1.200     | 0.6        | 3.000     | 0.9        | 7.000     | 1.5        |
| 0.200     | 0.3        | 1.400     | 0.6        | 3.500     | 1.0        | 7.500     | 1.5        |
| 0.300     | 0.3        | 1.600     | 0.7        | 4.000     | 1.1        | 8.000     | 1.6        |
| 0.400     | 0.3        | 1.800     | 0.7        | 4.500     | 1.2        | 8.500     | 1.6        |
| 0.500     | 0.4        | 2.000     | 0.8        | 5.000     | 1.2        | 9.000     | 1.6        |
| 0.600     | 0.4        | 2.200     | 0.8        | 5.500     | 1.3        | 9.500     | 1.7        |
| 0.800     | 0.5        | 2.400     | 0.8        | 6.000     | 1.3        |           |            |
| 1.000     | 0.5        | 2.600     | 0.9        | 6.500     | 1.4        |           |            |