Flood Risk Assessment

Proposed Residential Development
Land north of Hookhams Lane
Salph End
Bedford

Revision 0: August 2019
Report Reference: 248-FRA-01-0

Martin Andrews Consulting Limited | 8 Corn Kiln Close, Cogenhoe, NN7 1NX
T: 01604 340544 | E: info@mac-ltd.co.uk | W: mac-ltd.co.uk

Report Originator(s)

[redacted]

Revision Record

Revision	Date	Description	Written	Approved
0	29/08/19	Planning Issue	MJA	MJA

Contents

Appendices

1.0 Introduction

1.1 Instructions

1.1.1 This Flood Risk Assessment has been prepared for Manor Oak Homes.

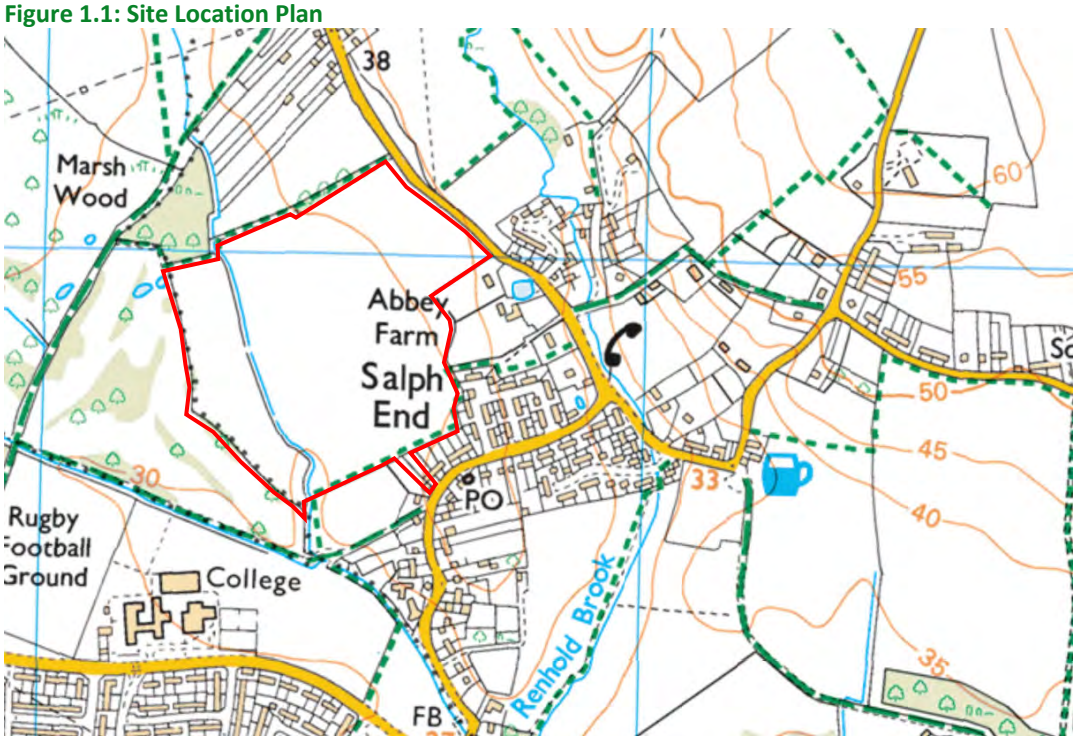
1.1.2 The report has been prepared to support the submission of an outline planning application.

1.1.3 The benefit of this report is to our instructing Client.

1.2 Site Location

1.2.1 The proposed residential development is located at land between Hookhams Lane and Ravensden Road, Salph End, as shown in Figure 1.1 below and enclosed in Appendix A. The approximate National Grid Reference for the site is E507519 N252820.

Figure 1.1: Site Location Plan



1.3 Current Use and Description

1.3.1 The site currently comprises agricultural land there has been no previous development on the site. The existing site is shown on the topographical survey enclosed in Appendix B.

1.3.2 A tributary of Renhold Brook runs through the site and forms the boundary between two of the site's fields.

1.3.3 There is a fall from north to south with both parcels either side of the watercourse falling towards the tributary.

1.4 Proposed Development

1.4.1 The proposed development will comprise up to 400 residential dwellings and a two-form entry primary school. The proposed development layout is shown on the plan enclosed in Appendix C.

1.4.2 The proposed development will provide a 9m maintenance strip adjacent to the watercourse as per the requirements of the Internal Drainage Board (IDB).

1.4.3 Inline with paragraph 26 of the Planning Practice Guidance for 'Flood risk and climate change' the lifetime of a residential development is considered to be at least 100 years whilst the school would have an expected lifetime of 50 years.

1.4.4 The 'Flood Risk Vulnerability Classification' of various development types is defined within Table 2 of the Planning Practice Guidance for Flood Risk and Costal Change (PPG). A residential development and school are both classified as More Vulnerable development. The relevant extract from Table 2 of the PPG is set out below.

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for **dwelling houses**, student halls of residence, drinking establishments, nightclubs and hotels.
- Non–residential uses for health services, nurseries and **educational establishments**.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

2.0 Site Specific Flood Risk

2.1 Risk of Fluvial / Tidal Flooding

2.1.1 The likelihood of fluvial and tidal flooding is defined on the Environment Agency's map 'Flood Map for Planning'. This flood map is published on the gov.uk website.

2.1.2 An extract of this flood map is provided below in Figure 2.1. The approximate site boundary is shown in red.

Figure 2.1: Fluvial / Tidal Flood Risk - gov.uk – 16/07/19

2.1.3 The Environment Agency's flood map shows that the proposed development site is located within Flood Zone 1 (Low Probability) and as such, the development is at a low (less than 1 in 1000 years) of flooding from rivers or the sea.

2.2 Risk of Surface Water Flooding

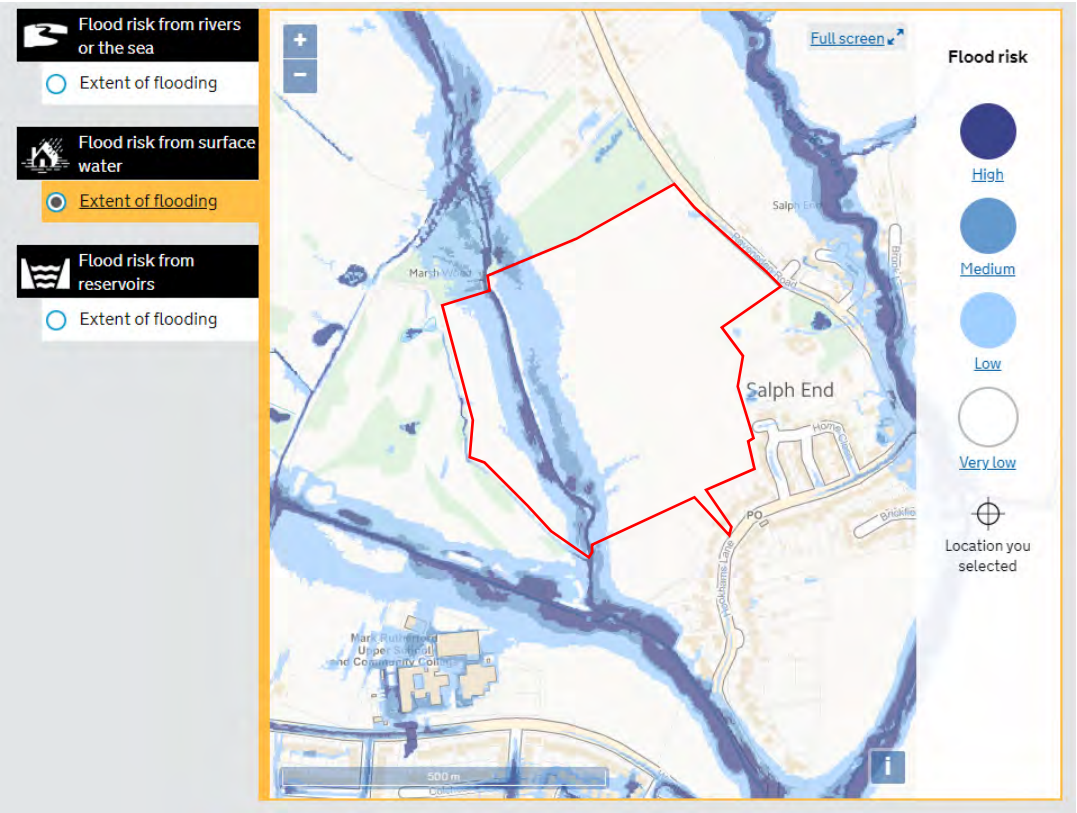
2.2.1 The likelihood of surface water flooding is defined on the Environment Agency's map 'Flood risk from surface water'. This flood map is published on the gov.uk website.

2.2.2 An extract of this flood map is provided below in Figure 2.2. The approximate site boundary is shown in red.

2.2.3 Regarding the accuracy of this map the EA state that:

"Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding. Because of this, we report the highest risk within 20m of a specific location, such as an individual property. This means reports for neighbouring properties may show different levels of risk."

Figure 2.2: Surface Water Flooding - gov.uk - 16/07/19

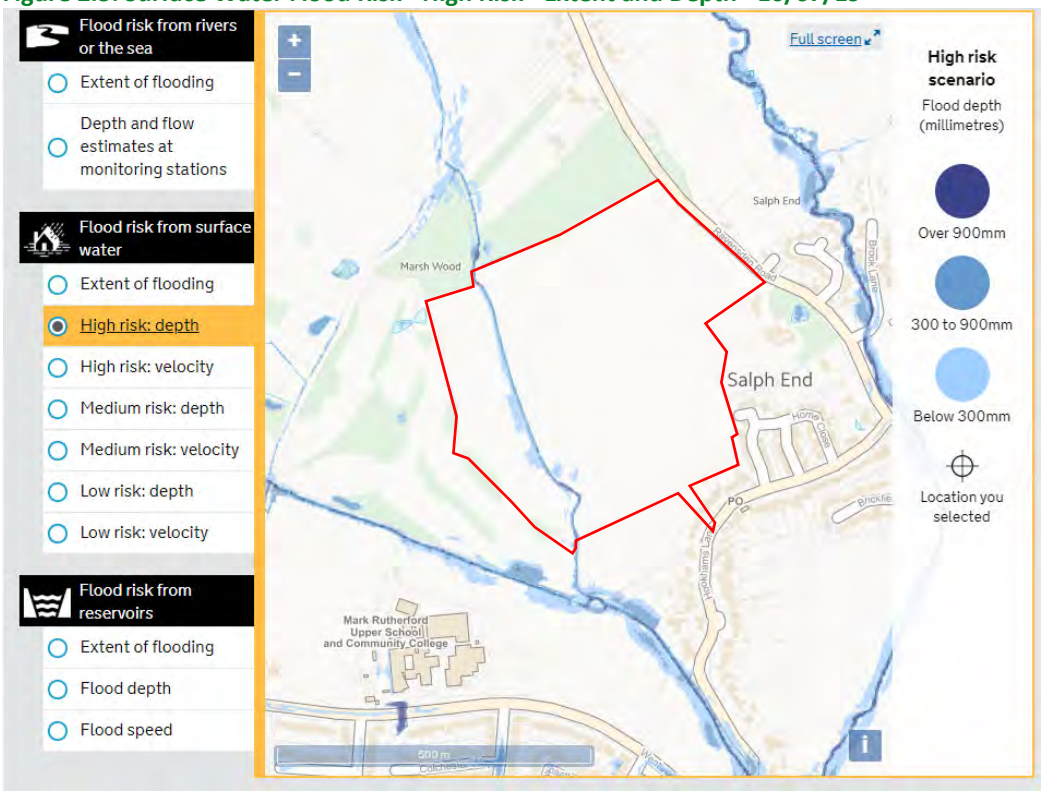


2.2.4 The site is located predominantly in an area of very low (less than 1 in 1000) risk of surface water flooding. Located towards the west and crossing the site north to south, an area of the site is shown to be at low (1 in 100 to 1 in 1000) risk, with small areas shown to be at medium (1 in 30 to 1 in 100) and high (greater than 1 in 30) risk of surface water flooding in a given year.

2.2.5 The areas of isolated surface water flooding are likely to be associated with low spots within the Lidar data used to create the map and would not occur post development of the site.

2.2.6 The extent and depth of flooding in the various return periods is shown in Figure 2.3, Figure 2.4 and Figure 2.5 below.

Figure 2.3: Surface Water Flood Risk - High Risk - Extent and Depth - 16/07/19



2.2.7

Figure 2.4: Surface Water Flood Risk - Medium Risk - Extent and Depth - 16/07/19

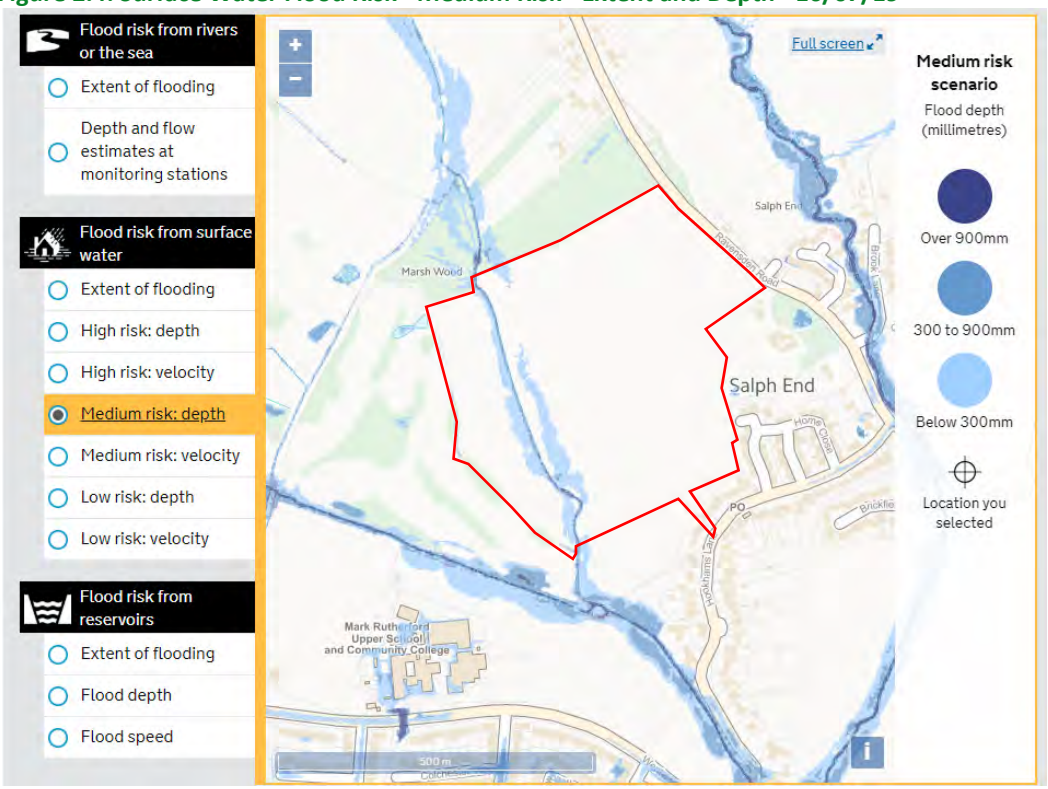
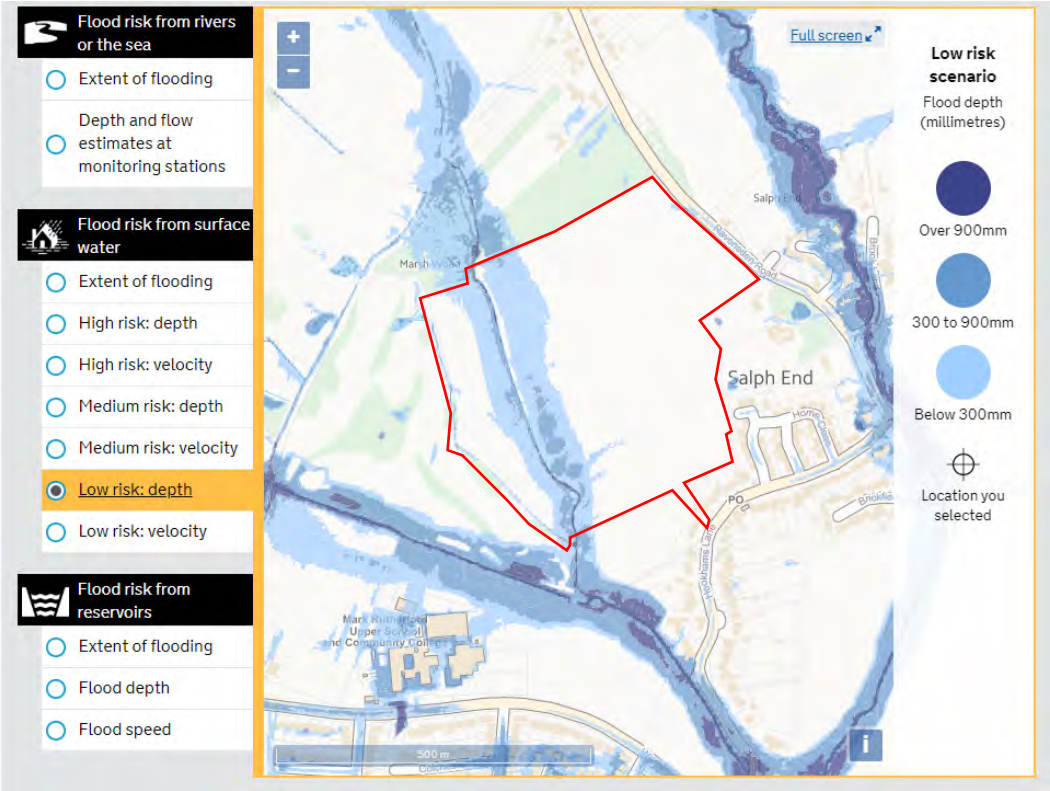


Figure 2.5: Surface Water Flood Risk - Low Risk - Extent and Depth - 16/07/19



2.2.8 The extent of high and medium risk surface water flooding is limited. The proposed development will avoid new development within the areas of high and medium risk flooding. The areas of high-risk flooding are predominately located within 9m of the watercourse and are therefore located within the maintenance strip required by the IDB.

2.2.9 The area of low risk surface water flooding is wider and has a chance of flooding of between 0.1% and 1%. The design standard for developments is to ensure that there is no risk of flooding for all events up to the 1% event. Hence, the area of low risk surface water flooding which has a less than 1% chance of flooding is appropriate for all of the proposed development types. However, the design of the development in areas of low risk surface water flooding will incorporate the following additional measures:

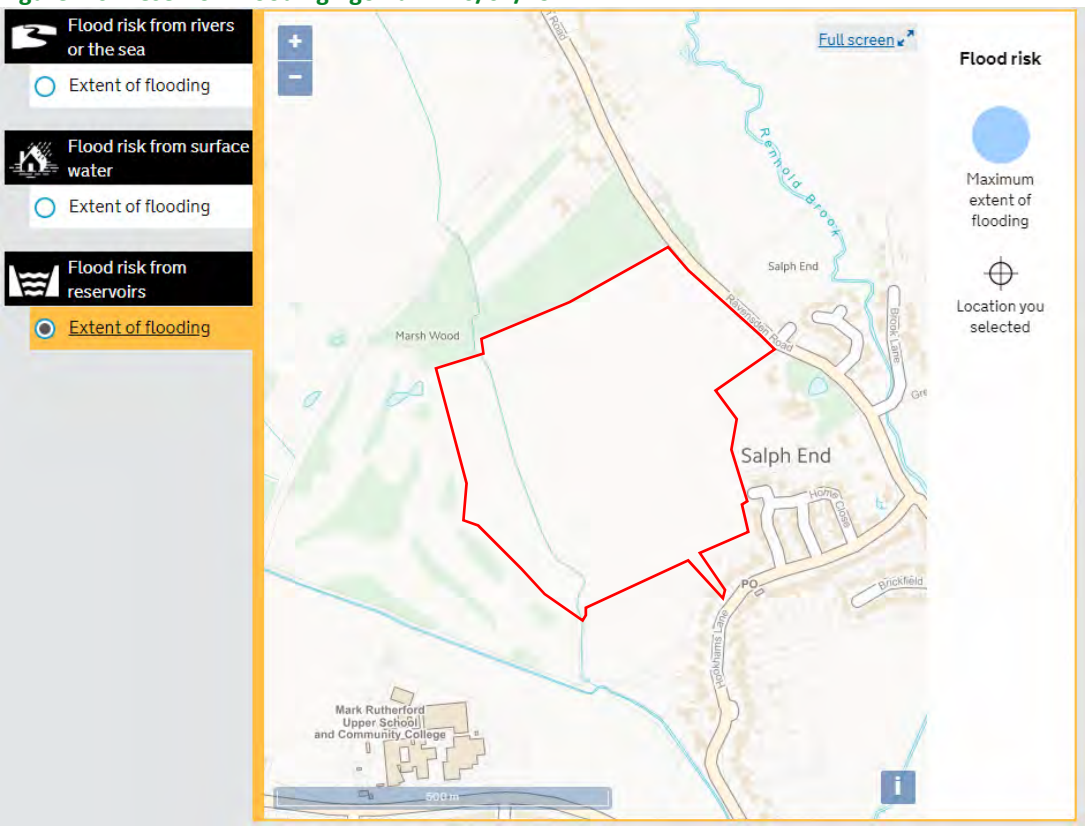
- Buildings will have a Finished Floor Level (FFL) raised 300mm above existing ground levels; and
- Layout will consider north to south flow of surface water during an extreme event.

2.3 Risk of Reservoirs, Canals and Other Artificial Sources Flooding

2.3.1 The likelihood of reservoir water flooding is defined on the Environment Agency's map 'Flood risk from reservoirs'. This flood map is published on the gov.uk website.

2.3.2 An extract of this flood map is provided below in Figure 2.6. The approximate site boundary is shown in red.

Figure 2.6: Reservoir Flooding - gov.uk – 16/07/19



2.3.3 The site is not at risk of reservoir flooding. We are not aware of any canals or other artificial sources which may cause flooding on the development site.

2.4 Risk of Ground Water Flooding

2.4.1 We do not have any records of ground water flooding within the vicinity of the site. We therefore consider the risk of ground water flooding to be low.

2.5 Risk of Sewer Flooding

2.5.1 We do not have any records of sewer flooding within the vicinity of the site. We therefore consider the risk of sewer flooding to be low.

2.6 Previous Flood Events

2.6.1 The Environment Agency's Historic Flood Map does not show any flooding within the boundary of the site. The Environment Agency's "Historic Flood Map is a GIS layer showing the maximum extent of all individual Recorded Flood Outlines from river, the sea and groundwater springs and shows areas of land that have previously been subject to flooding in England. Records began in 1946 when predecessor bodies to the Environment Agency started collecting detailed information about flooding incidents".

2.7 Summary of Flood Risk

2.7.1 With the exception of surface water, the proposed development is at a low risk of flooding from all sources and is located within Flood Zone 1.

2.7.2 The proposed development site has areas of high, medium and low surface water flooding. No development will be located in the high and medium surface water flood risk areas whilst development is appropriate within low risk surface water flooding areas. However, buildings in this area will have a raised FFL and the layout will be designed to accommodate the north to south overland flow routes during an extreme event with a less than 1% chance of occurring.

2.8 Flood Risk Vulnerability and Flood Zone 'Compatibility'

2.8.1 The suitability of different development types to be built and occupied within a particular Flood Zone is defined within Table 3 of the Planning Practice Guidance for 'Flood Risk and Coastal Change' to the National Planning Policy Framework. Table 3 is replicated below in Table 2.1 below. This table maps vulnerability classes against the flood zones to indicate where development is 'appropriate' and where it should not be permitted.

2.8.2 The proposed residential and school development is located within Flood Zone 1 and is classified as More Vulnerable development. Based on this categorisation of the development it is considered 'appropriate'.

Table 2.1: Flood risk vulnerability and flood zone 'compatibility'

Flood Zone	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	×	Exception Test required	✓	
Zone 3b *	Exception Test required *	×	×	×	×

✓ Development is appropriate
✗ Development should not be permitted.
† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.
" * " In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

3.0 Surface Water Management

3.1 Existing Drainage

3.1.1 The is currently undeveloped with no positive drainage.

3.2 Existing Discharge Rate

3.2.1 The existing discharge rate for the site per hectare has been calculate using the IH124 method. Full calculations are enclosed in Appendix F. Whilst the input parameters and results are summarised in Table 3.1 below. The estimated allowable discharge rate based on predicted impermeable area is shown for each catchment in the table below.

Table 3.1: Existing Runoff Rate Calculation Parameters and Results

Parameter		Value
Proposed Drained Area (ha)		1.000
SAAR (mm)		558
Soil Index / SPR		3 / 0.40
Region		5
Growth Factor 1 year		0.87
Growth Factor 30 year		2.55
Growth Factor 100 year		3.56
Results		Value
Q_{Bar} (l/s/ha)		2.6
Q1 (l/s/ha)		2.3
Q30 (l/s/ha)		6.7
Q100 (l/s/ha)		9.3
Catchment	Area (ha)	Q_{Bar} (l/s)
Residential	6.383	16.6
School	1.048	2.7

3.2.2 The allowable discharge rate for the site is the Q_{Bar} rate of 2.6 l/s/ha. Surface water from the site post development will be restricted to a discharge rate of 2.6 l/s/ha via a hydrobrake.

3.3 Proposed Method of Discharge

3.3.1 Paragraph 80 of the Planning Practice Guidance for 'Flood Risk and Coastal Change' defines the hierarchy of drainage options. Where reasonable practicable the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain, or another drainage system; and
4. to a combined sewer.

3.3.2 Each of these is considered separately below:

Into the ground

3.3.3 Inspection of the British Geological Society's maps show that there are limited superficial deposits across the site but where these are located they comprise Oadby Member or Alluvium – Clay. Below these the bedrock geology is thought to comprise Peterborough Member – mudstone.

3.3.4 Based on the above geology description we would anticipate that infiltration techniques across the site would be unviable. Infiltration testing will be undertaken at detailed design stage to confirm this assumption. Should infiltration be found to be viable the drainage strategy proposed for the development will be altered to take this into account.

To a Surface Water Body

3.3.5 A watercourse is located through the development site splitting the site into an eastern and western parcel for the purposes of drainage. This watercourse will be used as the outfall for surface water.

3.3.6 As a surface water body is viable the use of alternative drainage methods will not be considered further in this report.

3.4 Proposed Drainage Strategy

3.4.1 Surface water discharge from the proposed development will outfall to the watercourse located within the development site. The surface water discharge rate from the site will be restricted to greenfield equivalent runoff rates to ensure that the rate of surface water runoff from the site does not increase as a result of the proposed development.

3.4.2 The proposed drainage strategy for the residential areas will comprise a:

- A piped network;
- Hydrobrake flow control';
- Detention Basin – online; and
- Permeable paving to private drives – tanked.

3.4.3 For the school attenuation will be provided below ground within geocellular attenuation for safety reasons.

3.4.4 The proposed surface water drainage strategy is shown on the drawing enclosed in in Appendix D.

Design Parameters

3.4.5 Surface water drainage will be designed using the rainfall parameters from the Flood Estimation Handbook (FEH)

3.4.6 Climate change allowance are defined by the Environment Agency in their document 'Flood risk assessments: climate change allowances' first published in February 2016. Table 2 of this document shows anticipated changes in extreme rainfall intensity in small and urban catchments. The Environment Agency advise that flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact. Table 2 of the Environment Agency's guidance is replicated below in Table 3.2.

Table 3.2: Table 2 Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

3.4.7 To ensure a worst-case assessment is undertaken a 40% climate change allowance will be used throughout.

3.5 Attenuation Design

3.5.1 Surface water attenuation is required to store excess water during an extreme event whilst maintaining a greenfield discharge rate of. Surface water will be attenuated within detention basins. Full calculations are enclosed in Appendix G and H whilst design parameters are set out below.

Table 3.3: Attenuation Calculation Parameters and Results

Parameter	Value
Return Period (years)	100 + 40% Climate Change
Rainfall Parameters	FEH13
Eastern Catchment – Appendix G	
Drained Area (ha)	7.021, see Appendix E includes 10% urban creep
Discharge Rate (l/s)	16.6
Storage Requirement (m^3)	6050
School – Appendix H	
Drained Area (ha)	1.048
Discharge Rate (l/s)	2.7
Storage Requirement (m^3)	910

3.6 Maintenance Requirements

3.6.1 The drainage will be designed in line with Building Regulations, Sewers for Adoption and SUDS guidance to ensure compliance with best practice guidance thus minimising the maintenance requirements. A full maintenance plan for the site will be developed at detailed design stage.

3.6.2 The person / authority responsible for maintenance of the drainage will depend on ownership which will vary across the site as detailed design and adoption progresses the exact body responsible for adoption of the various surface water aspects will become clear. Typical responsibilities are set out below in Table 3.4.

Table 3.4: Surface Water Maintenance

Drainage	Maintainer
Drains	Home owner / school
Private Sewers	Home owner / management company / school
Household SUDS	Home owner
Communal SUDS - private	Management company / home owner.
Adopted SUDS	SUDS Body: Local Authority / water company / other SUDS adopting body.
Adopted sewers	Water company

4.0 Foul Water Management

4.1 Existing Drainage

4.1.1 The site is currently a field, therefore does not have any existing foul water infrastructure.

4.1.2 Existing adopted sewers within the vicinity of the site are shown on the asset plan enclosed in Appendix J.

4.2 Proposed Drainage Strategy

4.2.1 Foul water will discharge to Anglian Water's sewer located within Hookhams Lane.

4.3 Maintenance Requirements

4.3.1 The drainage will be designed in line with Building Regulations, Sewers for Adoption to ensure compliance with best practice guidance thus minimising the maintenance requirements. A full maintenance plan for the site will be developed at detailed design stage.

4.3.2 The person / authority responsible for maintenance of the drainage will depend on ownership which will vary across the site as detailed design and adoption progresses the exact body responsible for adoption of the various surface water aspects will become clear. Typical responsibilities are set out below in Table 4.1.

Table 4.1: Foul Water Maintenance

Drainage	Maintainer
Drains	Home owner / school
Private Sewers	Home owner / management company / school
Adopted sewers	Water company

5.0 Conclusions

5.1 Site location and proposed development

5.1.1 The proposed residential development is located at land between Hookhams Lane and Ravensden Road, Salph End

5.1.2 The proposed development will comprise up to 400 residential dwellings and a two-form entry primary school.

5.2 Flood Risk

5.2.1 With the exception of surface water, the proposed development is at a low risk of flooding from all sources and is located within Flood Zone 1.

5.2.2 The proposed development site has areas of high, medium and low surface water flooding. No development will be located in the high and medium surface water flood risk areas whilst development is appropriate within low risk surface water flooding areas. However, buildings in this area will have a raised FFL some 300mm above existing ground level and the layout will be designed to accommodate the north to south overland flow routes during an extreme event with a less than 1% chance of occurring.

5.2.3 The proposed development's vulnerability classification is compatible with the Flood Zone therefore the development is appropriate.

5.3 Surface Water Management

5.3.1 The key proposed surface water parameters are:

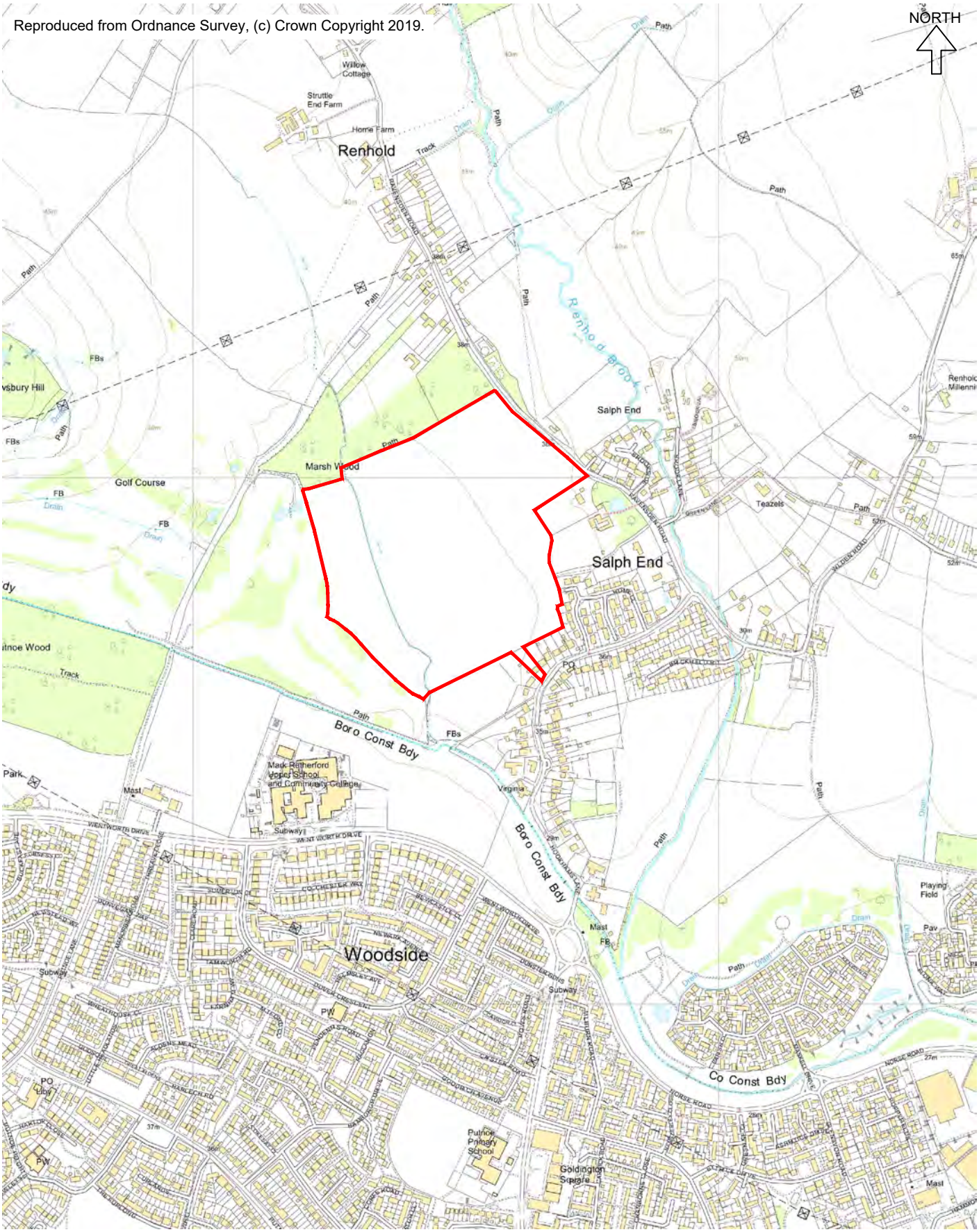
- Discharge rate: Greenfield equivalent – Residential catchment 16.6 l/s and School 2.7 l/s
- Outfall: watercourse
- Attenuation requirement: East catchment 6050 m^3, School 910 m^3
- SUDS features:
    - A piped network;
    - Hydrobrake flow control';
    - Detention Basin – online - residential;
    - Geocellular attenuation – online - school; and
    - Permeable paving to private drives – tanked.

5.4 Foul Water Management

5.4.1 Foul water will discharge to the adopted sewer located in Hookhams Lane.

Appendix A

Location Plan
MAC drawing no. 248-FRA01



Client: Manor Oak Homes	Project: Land North of Hookhams Lane Salph End		Date: 28/08/19
			Drw: MJA
Title: Location Plan			Chk: MJA
			Scale: 1:10,000
			Size: A4
Drawing No. 248-FRA01	Revision A	• Transport Assessments • Flood Risk Assessments • Highway Advice • Drainage Strategies	

T: 01604 340544 Northampton Office
E: info@mac-ltd.co.uk W: mac-ltd.co.uk
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Appendix B

Topographical Survey
MSurv drawing no. 1215/2272/1, 2 and 3

252850N
252800N
252750N
252700N
252650N
252600N
252550N
252500N
5072530E
5072630E
5072730E
5072830E
5072930E
5073030E
5073130E
5073230E
5073330E
5073430E
5073530E

Notes

Grid and levels have been aligned to O.S. National Grid OSGB36(15).

Suffix	Revision	Date	Initial

MSURV your surveying solution

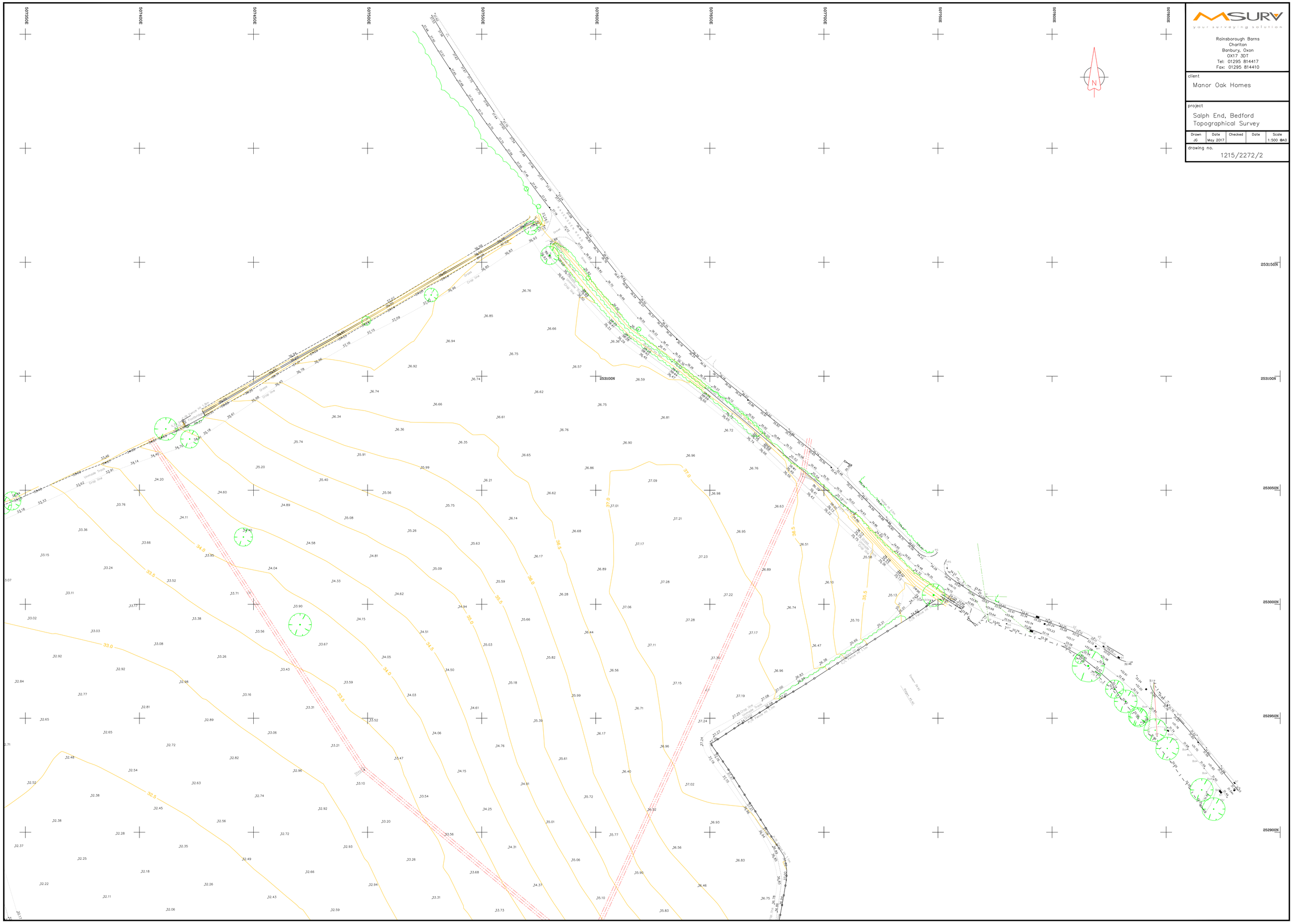
Rainsborough Barns
Charlton
Banbury, Oxon
OX17 3DT
Tel: 01295 814417
Fax: 01295 814410

client
Manor Oak Homes

project
Salph End, Bedford
Topographical Survey

Drawn	Date	Checked	Date	Scale
JG	May 2017			1:500 @A0

drawing no.
1215/2272/1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507850E
253150N
253100N
253050N
253000N
252950N
252900N
Rainsborough Barns
Charlton
Banbury, Oxon
OX17 3DT
Tel: 01295 814417
Fax: 01295 814410
client
Manor Oak Homes
project
Salph End, Bedford
Topographical Survey
Drawn JG
Date May 2017
Checked
Date
Scale 1:500 @A0
drawing no.
1215/2272/2

507250E
507300E
507350E
507400E

253250N
253200N
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253050N
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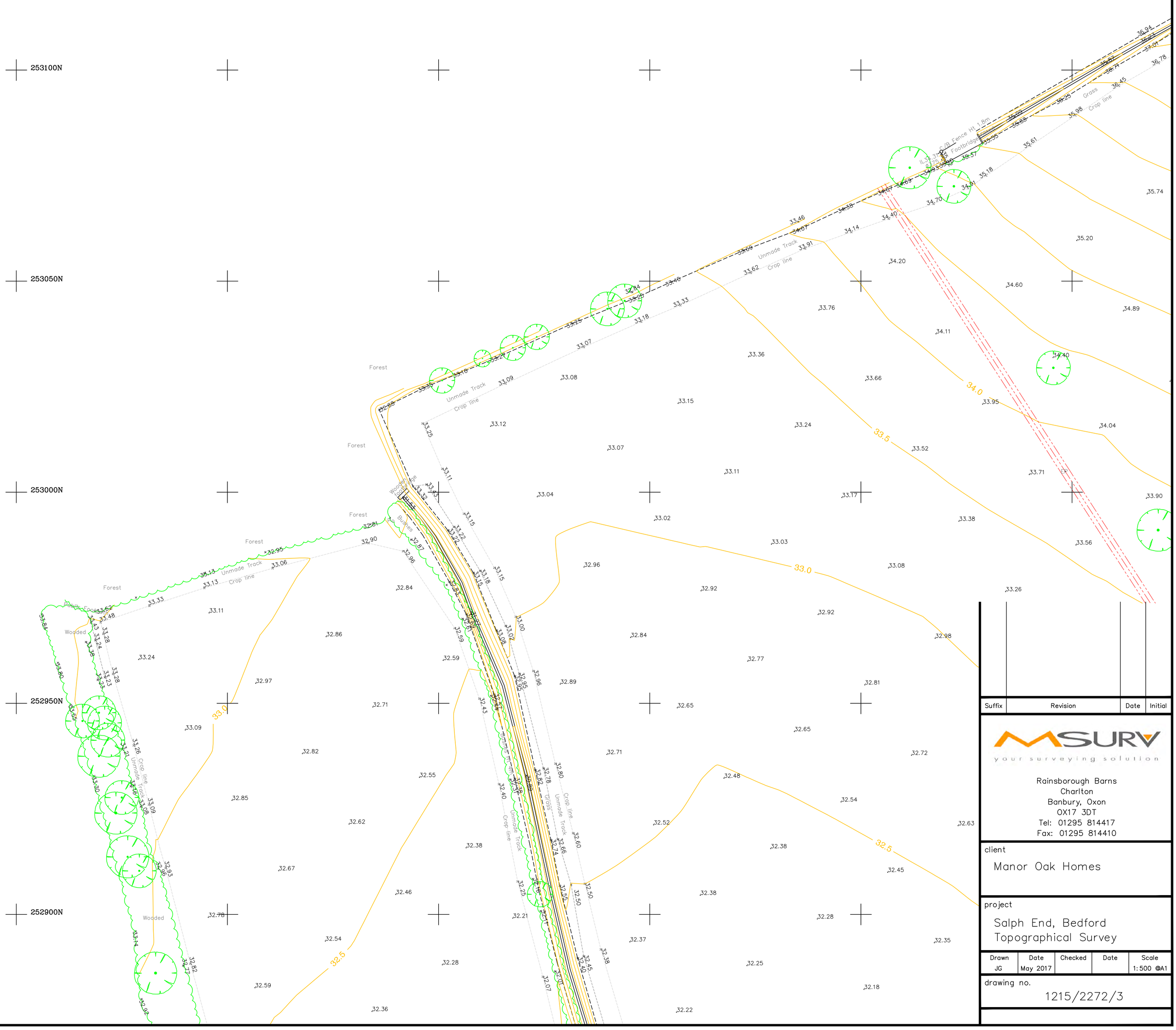
252950N
252900N

Notes

Grid and levels have been aligned to O.S. National Grid OSGB36(15).



Suffix	Revision	Date	Initial

MSURV your surveying solution

Rainsborough Barns
Charlton
Banbury, Oxon
OX17 3DT
Tel: 01295 814417
Fax: 01295 814410

client
Manor Oak Homes

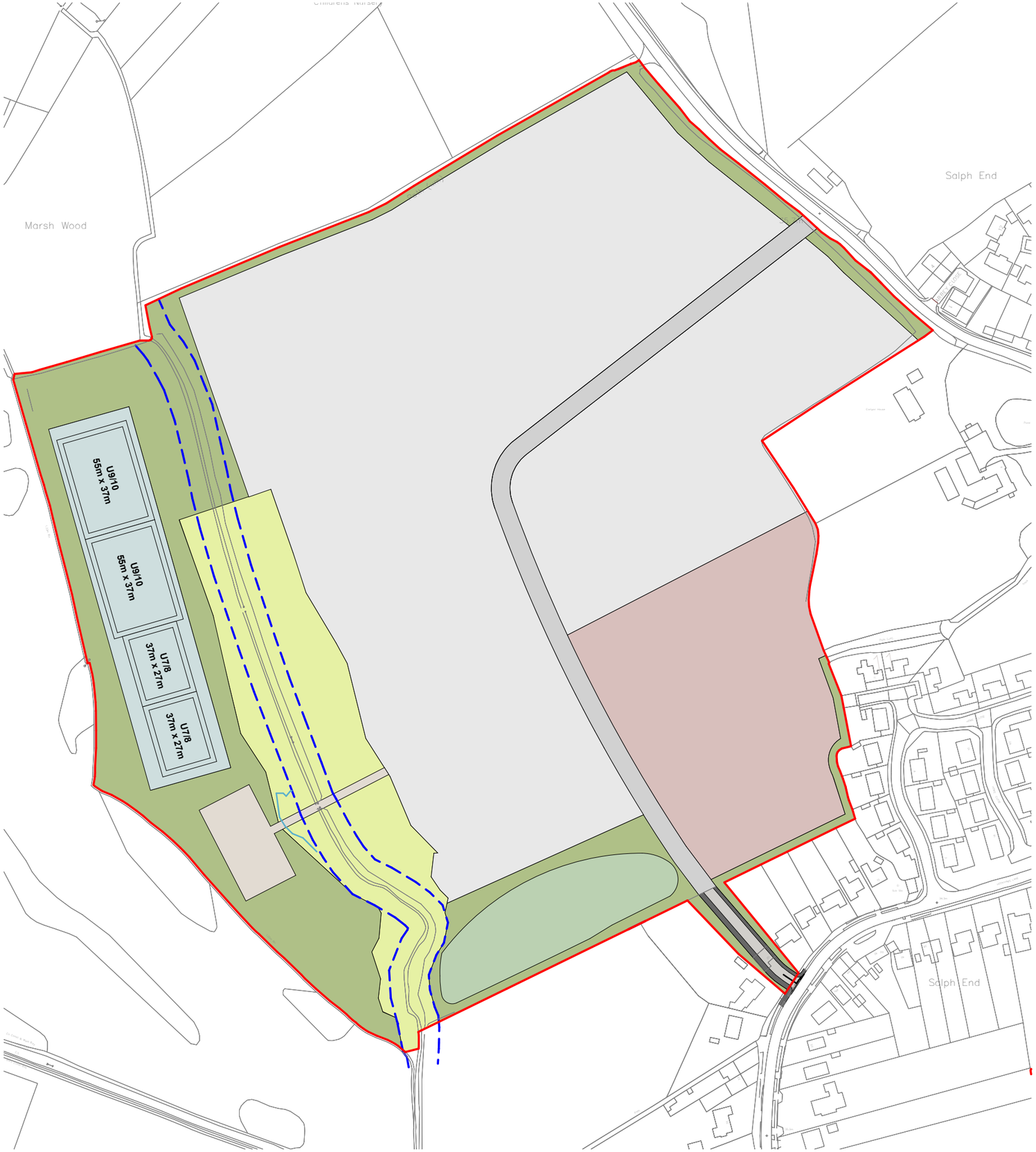
project
Salph End, Bedford
Topographical Survey

Drawn	Date	Checked	Date	Scale
JG	May 2017			1:500 @A1

drawing no.
1215/2272/3

Appendix C

Parameters Plan
RG+P drawing no. 40986 013C



Site area 19.57ha

Open Space 3.17ha

Developable area 10.75ha
Includes primary route

School area 2.1ha

Attenuation basins 0.59ha
Area excluded from open space calculation

Flood zone 1.88ha

Sports pitches 1.08ha

Primary route

Indicative vehicular access and parking for sports pitches.

Easement

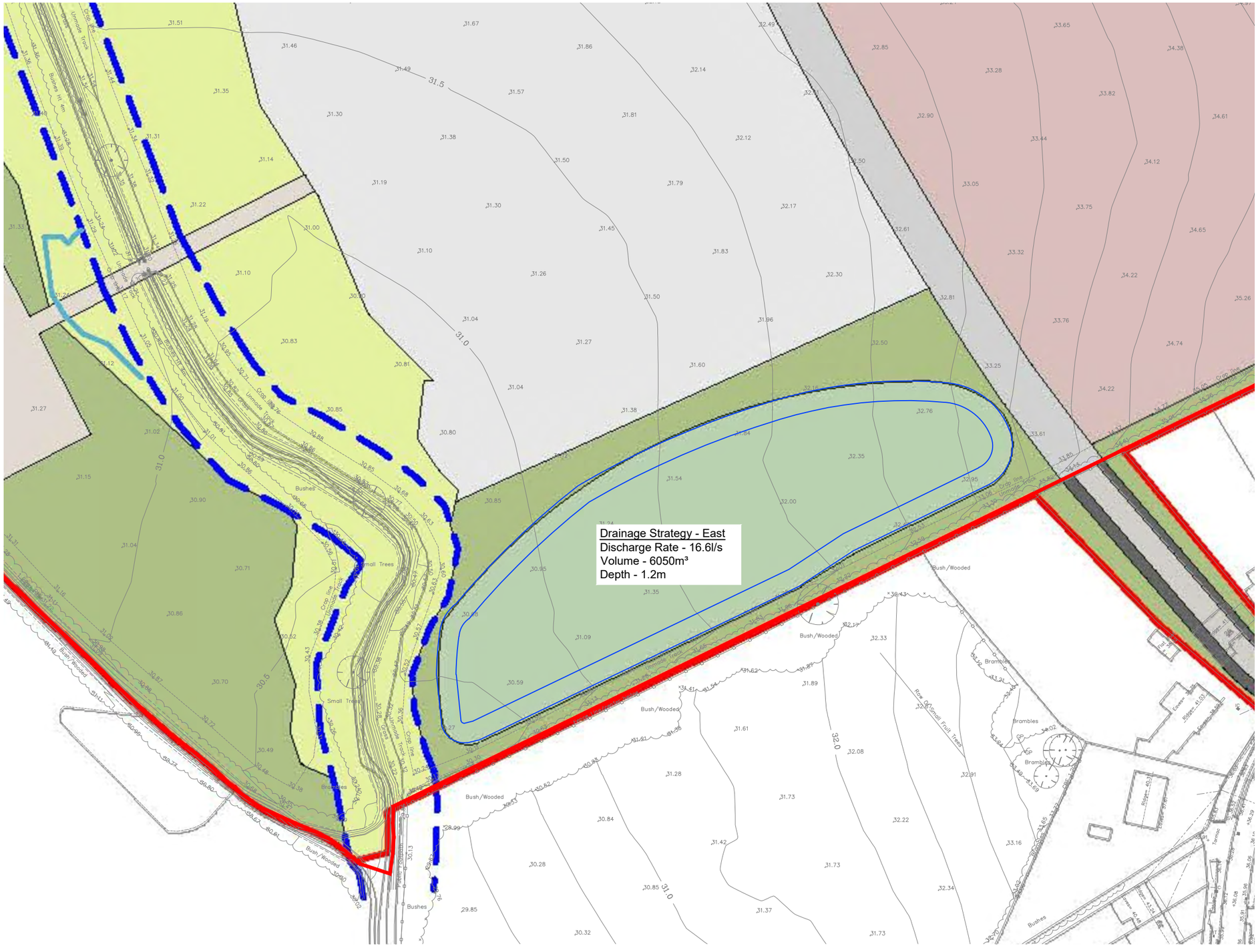
Revision:		Date:	
A	Plan updated with revised distribution of POS and relocation of site access.	12.08.19	HW/DW
B	Developable, open space and attenuation areas updated.	20.08.19	HW/DW
C	Attenuation basin amended. Site area added to key.	22.08.19	HW/DW

Architects · Project Managers · Quantity Surveyors
130 New Walk
Leicester, LE1 7JA
Tel: 0116 204 5800, Fax: 0116 204 5801
email: design@rg-p.co.uk, www.rg-p.co.uk

Project:	A development at Salph End, Bedford
Client:	Manor Oak Homes
Sheet title:	Parameters Plan
Ref:	40986 013C
Scale:	1:2500 @ A3
Date:	25.07.19
Drawn:	HW
Checked:	DW

Appendix D

Proposed Drainage Strategy
MAC drawing no. 248-FRA03



NORTH

Notes

1. Based on MSurv 'Topographical Survey' drawing number 1215/2272/1.
2. Based on RGP 'Parameters Plan' drawing number 40986 013 C
3. Based on Ordnance Survey mapping.

Key

- Site Boundary
- Proposed Surface Water Drainage
- Proposed Surface Water Attenuation - Residential

T: 01604 340544 Northampton Office
E: info@mac-ltd.co.uk W: mac-ltd.co.uk
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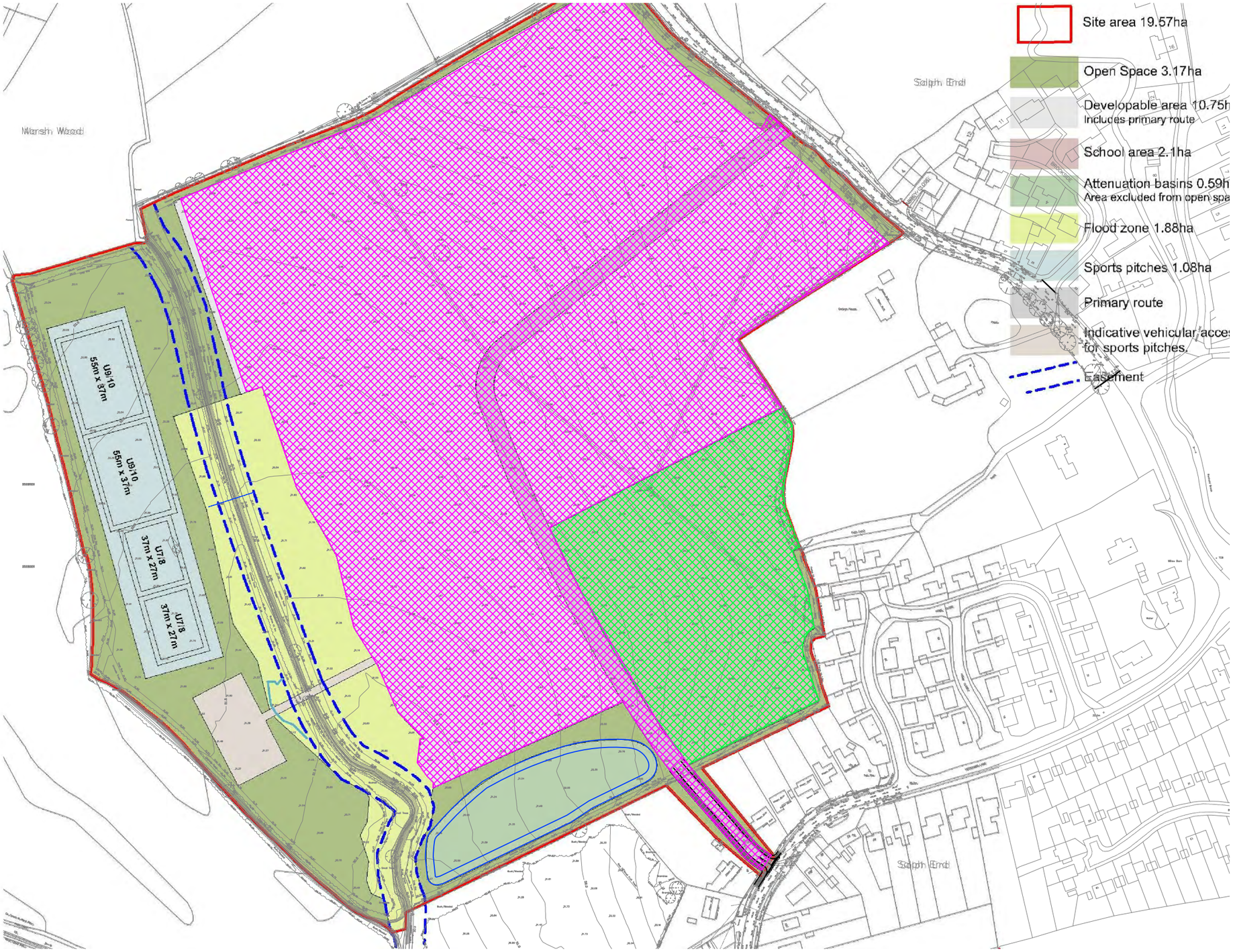
- Transport Assessments
- Flood Risk Assessments
- Highway Advice
- Access Design
- Drainage Strategies
- Vehicle tracking

Client: Manor Oak Homes		Project: Land North off Hookhams Lane, Salph End	
Title: Proposed Drainage Strategy			Date: 28/08/19
			Drw: MJA
			Chk: MJA
Drawing No: 248-FRA03	Revision: C		Scale: 1:2500
			Size: A3

Appendix E

Proposed Impermeable Area
MAC drawing no. 248-FRA02



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- Transport Assessments
- Flood Risk Assessments
- Highway Advice
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- Drainage Strategies
- Vehicle tracking

Client: Manor Oak Homes		Project: Land North off Hookhams Lane, Salph End	
Title: Proposed Impermeable Area			Date: 29/08/19
			Drw: MJA
			Chk: MJA
Drawing No: 248-FRA02	Revision: C		Scale: 1:2500
			Size: A3

Appendix F

Greenfield Runoff Calcs

Drainage Design Report

Flow+

v8.1

Network	Storm Network
Filename	C:\Users\Martin\OneDrive - Martin Andrews Consulting Ltd\Projects 200 - 299\248 - Salph End, Bedford\Design\FRA\Flow\248-Drainage Design-East.pfd
Username	[redacted]
Last analysed	22/07/2019 10:29:19
Report produced on	24/07/2019 09:07:44

Causeway Sales

Tel:	+44(0) 1628 552000
Fax:	+44(0) 1628 552001
Email:	marketing@causeway.com
Web:	www.causeway.com

Technical support web portal:

http://support.causeway.com

Rainfall Methodology	FEH-13
Return Period (years)	100
Additional Flow (%)	0
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

Site Makeup	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	1.000
SAAR (mm)	558
Soil Index	3
SPR	0.40
Region	1
Growth Factor 1 year	0.85
Growth Factor 30 years	1.95
Growth Factor 100 years	2.48
Betterment (%)	0
QBar	2.6
Q 1 year (l/s)	2.2
Q 30 year (l/s)	5.1
Q 100 year (l/s)	6.5

Appendix G

Drainage Design Calculations - Eastern

Drainage Design Report

Flow+

v8.1

Network	Storm Network
Filename	C:\Users\Martin\OneDrive - Martin Andrews Consulting Ltd\Projects 200 - 299\248 - Salph End, Bedford\Design\FRA\Flow\248-Drainage Design-East.pfd
Username	[redacted]
Last analysed	22/07/2019 10:29:19
Report produced on	24/07/2019 09:07:44

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Fax:	+44(0) 1628 552001
Email:	marketing@causeway.com
Web:	www.causeway.com

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Rainfall Methodology	FEH-13
Return Period (years)	100
Additional Flow (%)	0
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	1	5.936	5.00		100.000	Manhole		1200		100.000	100.000	2.000	

Rainfall Methodology	FEH-13		Return Period (years)	Climate Change (%)
Summer CV	0.750		100	40
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)				
1 year (l/s)	2.2			
30 year (l/s)	5.1			
100 year (l/s)	6.5			
Check Discharge Volume				
100 year 360 minute (m³)				

Site Makeup	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	1.000
SAAR (mm)	558
Soil Index	3
SPR	0.40
Region	1
Growth Factor 1 year	0.85
Growth Factor 30 years	1.95
Growth Factor 100 years	2.48
Betterment (%)	0
QBar	2.6
Q 1 year (l/s)	2.2
Q 30 year (l/s)	5.1
Q 100 year (l/s)	6.5

Hydro-Brake®													
Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
1	x	Online				98.000	1.000	14.0	(HE) Minimise upstream storage		CTL-SHE-0170-1400-1000-1400	0.225	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
1	0.00000	0.00000	2.0	1.00	98.000		0.000	5160.0	0.0
							1.000	5160.0	0.0
							1.001	0.0	0.0

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 99.99%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute winter	1	945	98.987	0.987	250.8	5154.1550	0.0000	OK	Hydro-Brake®		13.9				782.0

Appendix H

Drainage Design Calculations - Western

Appendix I

Drainage Design Calculations - School

Drainage Design Report

Flow+

v8.1

Network	Storm Network
Filename	C:\Users\Martin\OneDrive - Martin Andrews Consulting Ltd\Projects 200 - 299\248 - Salph End, Bedford\Design\FRA\Flow\248-Drainage Design-School.pfd
Username	[redacted]
Last analysed	22/07/2019 11:46:59
Report produced on	24/07/2019 09:08:48

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Tel:	+44(0) 1628 552000
Fax:	+44(0) 1628 552001
Email:	marketing@causeway.com
Web:	www.causeway.com

Technical support web portal:

http://support.causeway.com

Rainfall Methodology	FEH-13
Return Period (years)	100
Additional Flow (%)	0
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	1	1.069	5.00		100.000	Manhole		1200		100.000	100.000	2.000	

Rainfall Methodology	FEH-13		Return Period (years)	Climate Change (%)
Summer CV	0.750		100	40
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)				
1 year (l/s)	2.2			
30 year (l/s)	5.1			
100 year (l/s)	6.5			
Check Discharge Volume				
100 year 360 minute (m³)				

Site Makeup	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	1.000
SAAR (mm)	558
Soil Index	3
SPR	0.40
Region	1
Growth Factor 1 year	0.85
Growth Factor 30 years	1.95
Growth Factor 100 years	2.48
Betterment (%)	0
QBar	2.6
Q 1 year (l/s)	2.2
Q 30 year (l/s)	5.1
Q 100 year (l/s)	6.5

Hydro-Brake®													
Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
1	x	Online				98.000	1.000	2.8	(HE) Minimise upstream storage		CTL-SHE-0080-2800-1000-2800	0.100	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
1	0.00000	0.00000	2.0	1.00	98.000		0.000	910.0	0.0
							1.000	910.0	0.0
							1.001	0.0	0.0

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 99.99%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute winter	1	945	98.985	0.985	45.2	907.7075	0.0000	OK	Hydro-Brake®		2.8				165.7

Appendix J

Water Company Asset Plans

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Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main*
Private Sewer*
Decommissioned Sewer*
Outfall*
Inlet*
Manhole*
Sewage Treatment Works
Public Pumping Station
Decommissioned Pumping Station
*(Colour denotes effluent type)

[redacted]

248-Salph End

love every drop anglianwater

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
6501	F	-	-	-
6502	F	-	-	-
6503	F	-	-	-
6601	F	-	-	-
6602	F	-	-	-
7601	F	-	-	-
7602	F	-	-	-
7603	F	-	-	-
7702	F	-	-	-
7703	F	-	-	-
7704	F	-	-	-
8601	F	-	-	-
8602	F	-	-	-
8701	F	-	-	-
8702	F	-	-	-
9703	F	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert