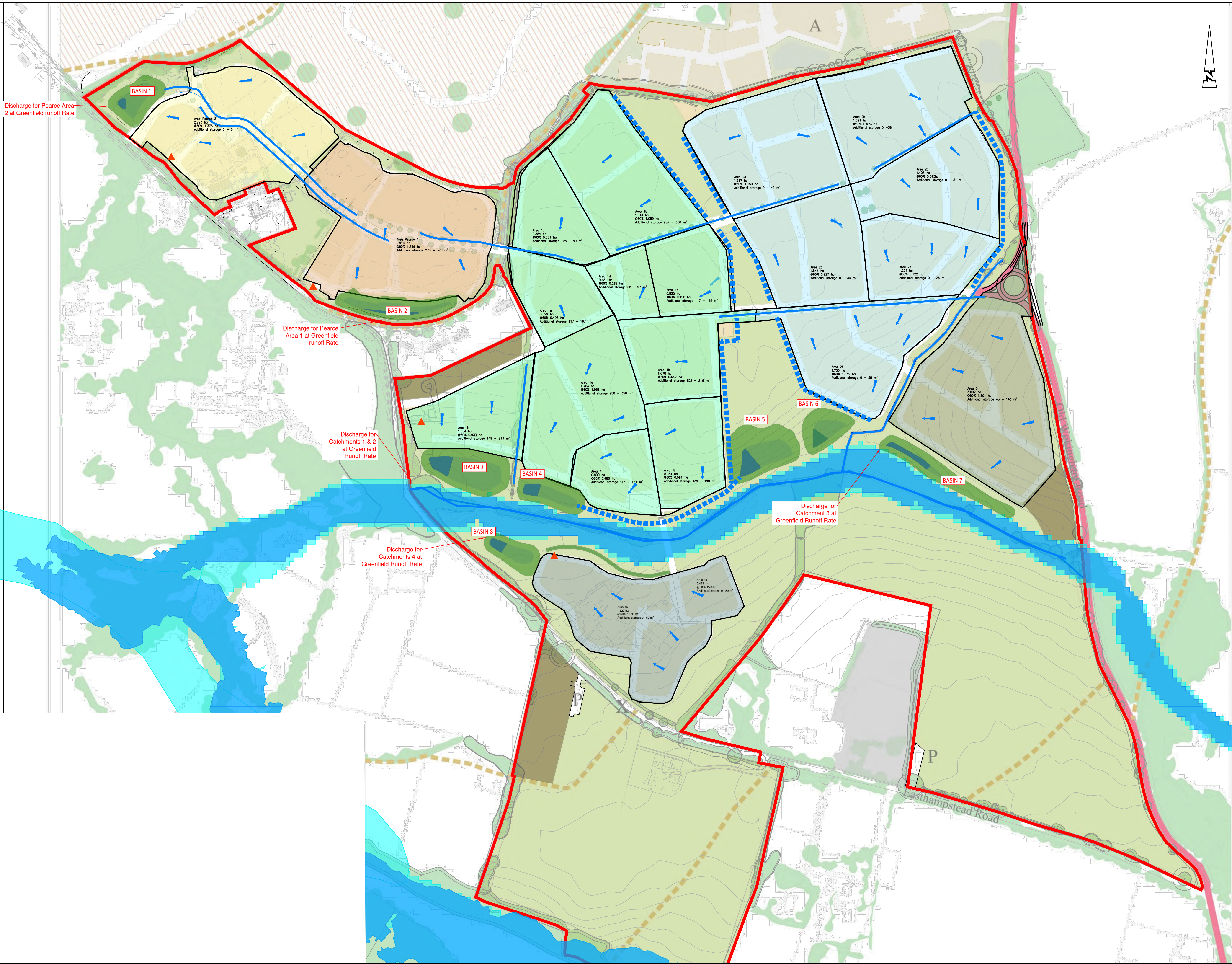




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- NOTES:
1. Do not scale.
 2. Refer to all other Project Drawings and supporting notes.
 3. All levels are in meters above Ordinance Datum.
 4. Surface Water Strategy is indicative and based on masterplanning information at the time of production.
 5. All Surface Water Calculations were Undertaken Using Causeway Flow Drainage Software and are subject to detailed design.
 6. All Outfalls have been visually determined during site walkover and are assumed viable to be utilized as surface water outfalls.

Return Period	Flow (l/s/ha)
0.5yr	3.87
1 in 2	5.29
1 in 50	8.91
1 in 100	12.36

Longterm Storage	rate	Volume
rate	2 l/s/ha	42.4 m ³ /ha

	Estimated storage required	Estimated storage required
	using 0.5yr flow	using 1 in 100 flow
Zone 1	680 m ³	680 m ³
Zone 2	500 m ³	500 m ³
Zone 3	1700 m ³	1700 m ³
Zone 4	100 m ³	100 m ³
Zone 5	100 m ³	100 m ³
Zone 6	100 m ³	100 m ³

Key:

- Application Boundary

Flood Zone 2

Flood Zone 3

Proposed Drainage

Attenuation Basin

Flow Arrow

Basin 1 Catchment

Basin 2 Catchment

Basin 3 & 4 Catchment

Basin 5 & 6 Catchment

Basin 7 Catchment

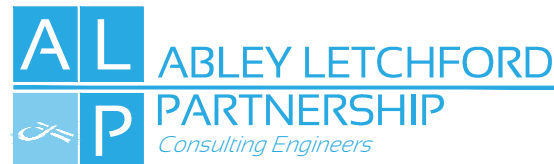
Basin 8 Catchment

Potential Foul Pump Station Location

2m wide Swale/Filter Drain

3m - 5m wide Swale/Filter Drain

P5	07/24	Layout updated to latest version	LC	JS
P4	07/24	Discharge Points added	LC	JS
P3	03/24	Basins 1 & 2 updated	LC	JS
P2	01/24	Swales/filter drain added showing basin connections.	LC	JS
P1	12/23	First Issue	LC	JS
Rev	Date	Description	Drawn	Checked



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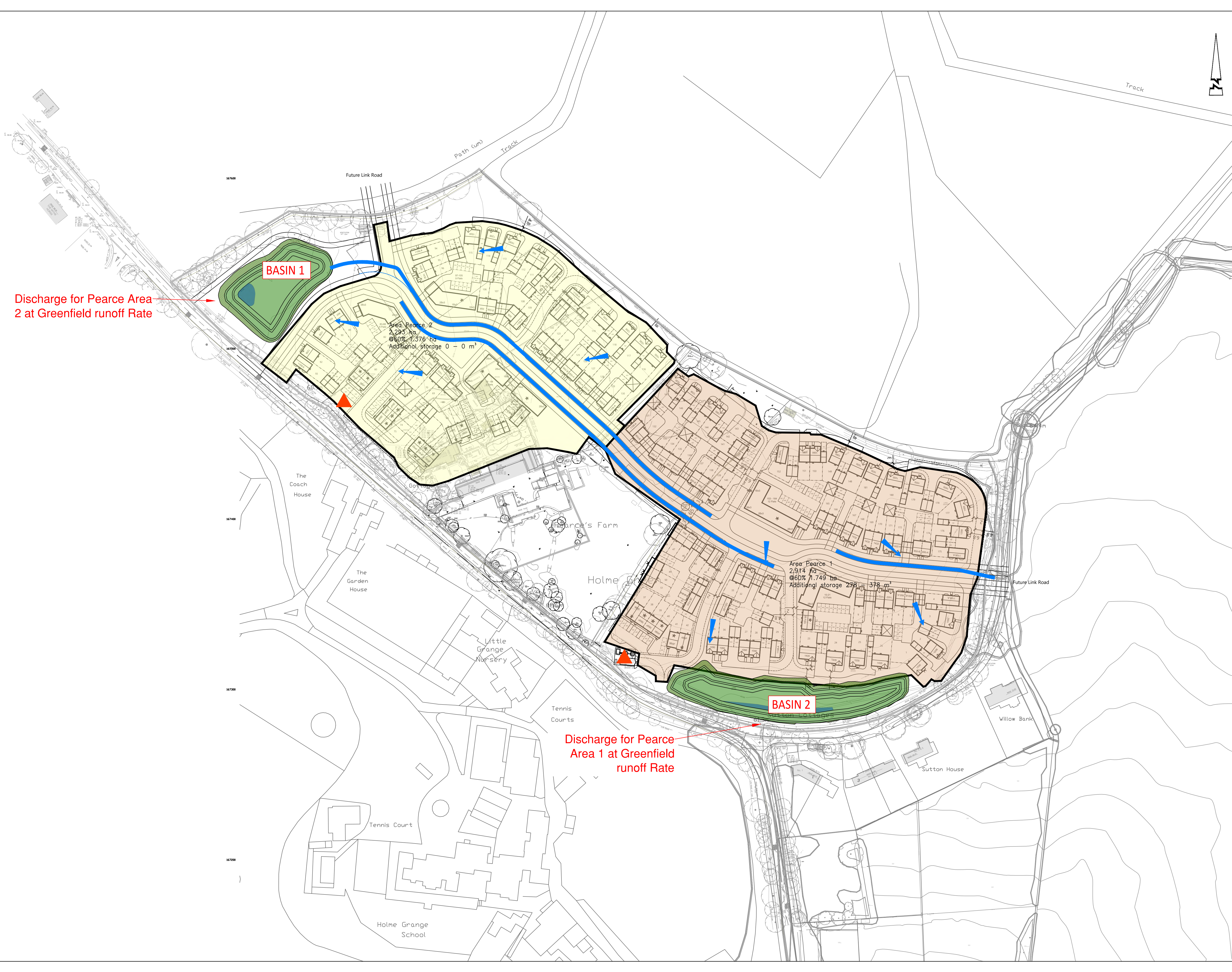
LIGHTWOOD STRATEGIC

Project
PRIORS FARM,
SOUTH WOKINGHAM SDL

Title
SITE WIDE DRAINAGE
CATCHMENT STRATEGY

Status
FOR INFORMATION

Scale	Date	Drawn	Checked
1:2000 @ A1	DEC 2023	LC	JS
Drawing No			Revision
A218-025			P5



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5. All Surface Water Calculations were Undertaken Using Causeway Flow Drainage Software and are subject to detailed design.
6. All Outfalls have been visually determined during site walkover and are assumed viable to be utilized as surface water outfalls.

Return Period	Flow (l/s/ha)
1 in 2	3.37
1 in 10	3.29
1 in 30	8.91
1 in 100	12.36

Longterm Storage	
rate	2 l/s/ha
Volume	62.4 m ³ /ha

Basin 1	Basin 2
Estimated storage required using 10 min storage	Estimated storage required using 10 min storage
1000 m ³	1000 m ³
1000 m ³	1000 m ³

- Key:
- Application Boundary
 - Proposed Drainage
 - Attenuation Basin
 - Flow Arrow
 - Basin 1 Catchment
 - Basin 2 Catchment
 - Potential Foul Pump Station Location
 - 2m wide Swale/Filter Drain

P3	07/24	EASTERN BOUNDARY SWALE REMOVED	LC	JS
P2	07/24	DISCHARGE POINTS ADDED	LC	JS
P1	12/23	FIRST ISSUE	LC	JS
Rev	Date	Description	Drawn	Checked

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Client

NICHOLAS KING HOMES

Project

**PRIORS FARM,
SOUTH WOKINGHAM SDL**

Title

**PEARCE FARM DRAINAGE
CATCHMENT STRATEGY**

Status

FOR INFORMATION

Scale	Date	Drawn	Checked
1:1000 @ A1	DEC 2023	LC	JS
Drawing No	Revision		
A218-026	P2		

Calculated by: Jonathan Shuttleworth

Site name: Priors Farm

Site location: Wokingham

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.

Site Details

Latitude: 51.39600° N

Longitude: 0.80342° W

Reference: 721263223

Date: Oct 02 2023 12:25

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 1

Methodology

Q_{MED} estimation method: Calculate from BFI and SAAR

BFI and SPR method: Specify BFI manually

HOST class: N/A

BFI / BFIHOST: 0.389

Q_{MED} (l/s):

Q_{BAR} / Q_{MED} factor: 1.14

Hydrological characteristics

	Default	Edited
SAAR (mm):	667	662
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Q_{BAR} (l/s):		3.87
1 in 1 year (l/s):		3.29
1 in 30 years (l/s):		8.91
1 in 100 year (l/s):		12.36
1 in 200 years (l/s):		14.49

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Long Term Storage (LTS) Volume Calculation



Project No.	A218
Project Title	Priors Farm, Wokingham
Client	Lightwood Strategic

Calcs by	JS
Checked	SL
Date	11/12/2023
Revision	A

LTS calculation method based on equation 24.10 from CIRIA C753 - The SuDS Manual

Where;	Vol_{xs}	Extra runoff volume from a development site compared to the greenfield equivalent during the 100 yr 6		
	RD	Rainfall Depth	74.67 mm	(for 100 year 6 hour storm)
	A	Site Area	1.67 ha	(Exc. Large undeveloped areas)
		Impermeable Catchment	1 ha	
	PIMP	Percentage Impermeable	60 %	
	α	Proportion Impermeable to Network	1	
	Cv	Impermeable Runoff Coefficient	0.84	(0.84 Modified Rational Method)
		Permeable Catchment	0.67 ha	
		Permeable Catchment to Network	0.00	
	β	Proportion Perm to Network	0.00	
	SPR	Soil Proportion Runoff	0.47	(Based on data provided by HR Wallingford)

$$Vol_{xs} = \frac{RD}{100} \times A \times \left(\frac{PIMP}{100} \right) \times \left(\frac{\alpha}{1} \times \frac{Cv}{0.84} \right) + \left(1 - \frac{PIMP}{100} \right) \times \left(\frac{\beta}{1} \times \frac{SPR}{0.47} \right) - \frac{SPR}{0.47}$$

Volume_{xs} = 42.40 m³/ha

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	2	Maximum Rainfall (mm/hr)	550.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	✓
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	8.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Per Ha LTS	1.000	100.000	1200	-60.353	378.274	1.500
Per Ha Storage QBar	1.000	100.000	1200	46.023	381.354	1.500

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	2 year (l/s)	3.3	100 year 360 minute (m ³)	328
Summer CV	1.000	Drain Down Time (mins)	240	30 year (l/s)	8.9		
Winter CV	1.000	Additional Storage (m ³ /ha)	0.0	100 year (l/s)	12.4		
Analysis Speed	Detailed	Check Discharge Rate(s)	✓	Check Discharge Volume	✓		

Storm Durations

60	180	360	600	960	2160	4320	7200	10080
120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	40	0	0	100	40	0	0
30	40	0	0				

Pre-development Discharge Rate

Site Makeup	Greenfield	Region	6	QMed	3.4
Greenfield Method	FEH	QBar/QMed conversion factor	1.136	QBar	3.9
Positively Drained Area (ha)	1.000	Growth Factor 2 year	0.88	Q 2 year (l/s)	3.4
SAAR (mm)	662	Growth Factor 30 year	2.30	Q 30 year (l/s)	8.9
Host	1	Growth Factor 100 year	3.19	Q 100 year (l/s)	12.4
BFIHost	0.389	Betterment (%)	0		

Pre-development Discharge Volume

Site Makeup	Greenfield	SPR	0.47	Storm Duration (mins)	360
Greenfield Method	FSR/FEH	CWI	99.556	Betterment (%)	0
Positively Drained Area (ha)	1.000	Return Period (years)	100	PR	0.457
Soil Index	1	Climate Change (%)	0	Runoff Volume (m³)	328

Node Per Ha Storage QBar Offline Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Loop to Node		Sump Available	✓
Invert Level (m)	98.500	Product Number	CTL-SHE-0094-3900-1000-3900
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	3.9	Min Node Diameter (mm)	1200

Node Per Ha LTS Offline Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Loop to Node		Sump Available	✓
Invert Level (m)	98.500	Product Number	CTL-SHE-0079-2000-0125-2000
Design Depth (m)	0.125	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node Per Ha LTS Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	98.900	Product Number	CTL-SHE-0096-4200-1100-4200
Design Depth (m)	1.100	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.2	Min Node Diameter (mm)	1200

Node Per Ha LTS Online Weir Control

Flap Valve	x	Invert Level (m)	99.400	Design Flow (l/s)	2.9	Discharge Coefficient	0.590
Replaces Downstream Link	✓	Design Depth (m)	0.100	Width (m)	0.050		

Node Per Ha Storage QBar Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	990.0	0.0	1.500	990.0	0.0

Node Per Ha LTS Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	890.0	0.0	1.500	890.0	0.0

Results for 2 year +40% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	Per Ha LTS	690	98.880	0.380	24.8	338.7560	0.0000	OK
600 minute winter	Per Ha Storage QBar	570	98.823	0.323	28.6	320.5976	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
720 minute winter	Per Ha LTS	Hydro-Brake®	0.0	0.0
720 minute winter	Per Ha LTS	Weir	0.0	0.0
720 minute winter	Per Ha LTS	Hydro-Brake®	3.3	136.0
600 minute winter	Per Ha Storage QBar	Hydro-Brake®	3.9	148.6

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	Per Ha LTS	464	99.286	0.786	73.6	700.7449	0.0000	OK

720 minute winter	Per Ha Storage QBar	705	99.277	0.777	51.8	770.3555	0.0000	OK
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Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
480 minute winter	Per Ha LTS	Hydro-Brake®	4.2	117.4
480 minute winter	Per Ha LTS	Weir	0.0	0.0
480 minute winter	Per Ha LTS	Hydro-Brake®	4.7	151.0
720 minute winter	Per Ha Storage QBar	Hydro-Brake®	3.9	169.4

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

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	Per Ha LTS	464	99.487	0.987	91.5	879.6086	0.0000	OK

720 minute winter	Per Ha Storage QBar	720	99.482	0.982	64.1	973.6196	0.0000	OK
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Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
480 minute winter	Per Ha LTS	Hydro-Brake®	4.2	118.3
480 minute winter	Per Ha LTS	Weir	2.4	20.4
480 minute winter	Per Ha LTS	Hydro-Brake®	5.2	168.6
720 minute winter	Per Ha Storage QBar	Hydro-Brake®	3.9	184.5

Area 1	Parcel	Total Area (ha)	Hardstanding (ha)	l/s/ha			
	1a	0.8843	0.53058	Flow Rates	Qbar	3.87	24.3944676 l/s
	1b	1.8142	1.08852		LTS	2	12.60696 l/s
	1c	0.8293	0.49758		1 in 2	3.4	21.431832 l/s
	1d	0.4806	0.28836		1 in 30	8.9	56.100972 l/s
	1e	0.8253	0.49518		1 in 100	12.4	78.163152 l/s
	1f	1.0543	0.63258		LTS vol	42.4	267.267552 m ³
	1g	1.7637	1.05822	Downstream Storage			
	1h	1.0703	0.64218				
	1i	0.7995	0.4797	Pond 3		2670 m ³	
	1j	0.9843	0.59058	Pond 4		1452 m ³	
	Total	10.5058	6.30348			4122 m ³	
Estimated Storage Required							
Using Long Term Storage			5610.0972 m ³				
Using Qbar			6240.4452 m ³				
Estimated Required Additional Storage							
Using Long Term Storage			1488.0972 m ³	or	236.075501 m ³ /ha		
Using Qbar			2118.4452 m ³	or	336.075501 m ³ /ha		
Additonal Storage							
Area 1	Parcel	Total Area (ha)	Hardstanding (ha)	using Qbar (m ³)	Using method LTS (m ³)		
	1a	0.8843	0.53058	125.2569394	178.3149394		
	1b	1.8142	1.08852	256.9729045	365.8249045		
	1c	0.8293	0.49758	117.4664479	167.2244479		
	1d	0.4806	0.28836	68.07473151	96.91073151		
	1e	0.8253	0.49518	116.8998667	166.4178667		
	1f	1.0543	0.63258	149.3366405	212.5946405		
	1g	1.7637	1.05822	249.8198168	355.6418168		
	1h	1.0703	0.64218	151.6029653	215.8209653		
	1i	0.7995	0.4797	113.2454179	161.2154179		
	1j	0.9843	0.59058	139.4214695	198.4794695		
	Total	10.5058	6.30348	1488.0972	2118.4452		

Area 2	Parcel	Total Area (ha)	Hardstanding (ha)	l/s/ha			
	2a	1.917	1.1502	Flow Rates	Qbar	3.87	21.9296646 l/s
	2b	1.6213	0.97278		LTS	2	11.33316 l/s
	2c	1.5443	0.92658		1 in 2	3.4	19.266372 l/s
	2d	1.405	0.843		1 in 30	8.9	50.432562 l/s
	2e	1.2041	0.72246		1 in 100	12.4	70.265592 l/s
	2f	1.7526	1.05156		LTS vol	42.4	240.262992 m ³
	Total	9.4443	5.66658				
Downstream Storage							
				Pond 5		3660 m ³	
				Pond 6		1743 m ³	
				Total		5403 m ³	
Estimated Storage Required							
	Using Long Term Storage		5043.2562 m ³				
	Using Qbar		5609.9142 m ³				
Estimated Required Additional Storage							
	Using Long Term Storage		0 m ³	or		0 m ³ /ha	
	Using Qbar		206.9142 m ³	or		36.5148291 m ³ /ha	
Additional Storage							
	Parcel	Total Area (ha)	Hardstanding (ha)	using Qbar (m ³)	Using method LTS (m ³)		
	2a	1.917	1.1502	0	41.99935637		
	2b	1.6213	0.97278	0	35.5208954		
	2c	1.5443	0.92658	0	33.8339103		
	2d	1.405	0.843	0	30.78200089		
	2e	1.2041	0.72246	0	26.3805034		
	2f	1.7526	1.05156	0	38.39753364		
	Total	9.4443	5.66658	0	206.9142		

Area 3	Parcel	Total Area (ha)	Hardstanding (ha)	l/s/ha			
	3	3.0017	1.80102	Flow Rates	Qbar	3.87	6.9699474 l/s
					LTS	2	3.60204 l/s
					1 in 2	3.4	6.123468 l/s
					1 in 30	8.9	16.029078 l/s
					1 in 100	12.4	22.332648 l/s
					LTS vol	42.4	76.363248 m ³
	Total	3.0017	1.80102				
				Downstream Storage			
				Pond 7		1525 m ³	
				Total		1525 m ³	
	Estimated Storage Required						
	Using Long Term Storage		1602.9078 m ³				
	Using Qbar		1783.0098 m ³				
	Estimated Required Additional Storage						
	Using Long Term Storage		77.9078 m ³	or	43.2575985 m ³ /ha		
	Using Qbar		258.0098 m ³	or	143.257598 m ³ /ha		

Area 4	Parcel	Total Area (ha)	Hardstanding (ha)	l/s/ha			
	4a	0.4635	0.2781	Flow Rates	Qbar	3.87	5.3194698 l/s
	4b	1.8274	1.09644		LTS	2	2.74908 l/s
					1 in 2	3.4	4.673436 l/s
					1 in 30	8.9	12.233406 l/s
					1 in 100	12.4	17.044296 l/s
					LTS vol	42.4	58.280496 m ³
	Total	2.2909	1.37454				
					Downstream Storage		
					Pond 8	1280 m ³	
				Total	1280 m ³		
Estimated Storage Required							
Using Long Term Storage			1223.3406 m ³				
Using Qbar			1360.7946 m ³				
Estimated Required Additional Storage							
Using Long Term Storage			0 m ³	or	0 m ³ /ha		
Using Qbar			80.7946 m ³	or	58.7793735 m ³ /ha		

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PEARCES FARM, WOKINGHAM

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

NICHOLAS KING HOMES PLC

01 JULY 2024



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Document Reference:	A218-R022A

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Appendices

- Appendix 1 - Plans
- Appendix 2 - EA Product 4 Data
- Appendix 3 - LLFA Developer Checklist
- Appendix 4 - Drainage Strategy



1.0 Introduction

Context

- 1.1. This Flood Risk Assessment (FRA) has been prepared by Abley Letchford Partnership Ltd (ALP), on behalf of Nicholas King Homes PLC to support an Outline planning application for up to 180 units with all matters reserved (except access to the Site) by Nicholas King Homes ("NKH Site") in South Wokingham.

Development Proposals

- 1.2. The proposals are for the provision for up to 180 residential dwellings as depicted on the Illustrative Masterplan within Appendix 1.

Requirement for a Flood Risk Assessment

- 1.3. The requirement for a FRA is set out in Section 14 of the revised National Planning Policy Framework (NPPF) as revised in December 2023.
- 1.4. The footnote accompanying Paragraph 172 states:
- 1.5. 'A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency (EA) as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.'
- 1.6. The Site is a greenfield site that comprises of farmland with established hedges and tree lined boundaries. The Site is approximately 7.5 hectares. As the Site area extends greater than 1 hectare, a site-specific flood risk assessment is required. To comply with the requirements of the NPPF, matters related to flood risk and drainage are addressed within this report.

Report Aim and Formation

- 1.7. The principal aims of this report are to demonstrate that the proposed development complies with national and local planning policy in respect to flood risk and to demonstrate that a suitable drainage strategy can be provided as part of the development.
- 1.8. This report will also summarise the impacts the development could have on flood risk to the surrounding area and outlines the mitigation strategies that will be implemented to minimise this risk.
- 1.9. The drainage design embraces the guiding principles of Sustainable Drainage Systems (SuDS) which are central to the design of the surface water drainage strategy for the proposed development.



Report Structure

- 1.10. This report addresses the requirements of revised NPPF and considers the following aspects:
- Section 2: Policy and Sources of Information – a review of policy relevant to the assessment and sources of information used to inform the assessment.
 - Section 3: Site Setting – a description of the site location, topography, geology, and hydrology.
 - Section 4: Overview of Flood Risk – a review of data for flooding from all sources to determine the baseline flood risk to the site and an assessment of the impacts of the development on flood risk.
 - Section 5: Sequential Test and Exception Test – a description of the proposed development and a classification of the vulnerability in the context of the Sequential Test and Exception Test.
 - Section 6: Flood Risk Mitigation – the mitigation measures implemented to manage the potential flood risk to the development.
 - Sections 7 and 8: Drainage Strategy – a summary of appropriate strategies to manage the surface water and foul water from the site in the post development scenario.
 - Section 9: Conclusion – a summary of the development proposals in the context of site vulnerability and the requirements of the NPPF.



2.0 Policy and Sources of Information

Introduction

- 2.1. This chapter provides a review of policy relevant to the assessment and the available information on all sources of flood risk.

National Planning Policy

- 2.2. National Planning Policy in relation to Flood Risk is set out in Section 14 of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) ID: 7 for Flood Risk and Coastal Change. Flood Risk is discussed in Paragraphs 165-175 of the NPPF.

- 2.3. Paragraphs 165-168 discuss the sequential approach. Paragraph 166 refers to a Strategic Flood Risk Assessment (SFRA) that would form the basis of applying the Sequential Test for local authorities to allocate development, whilst Paragraphs 168-169 relates to the Exception Test.

- 2.4. Paragraph 173 discusses the determination of planning applications stating:

‘When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood risk assessment. Development should only be allowed in areas at risk of flooding where, in light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
- c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- d) any residual risk can be safely managed; and*
- e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.’*

- 2.5. The proposed development comprising of approximately 200 dwellings would be classed as a Major development as it is providing more than 10 homes and the site is greater than 0.5 hectares. Paragraph 175 states:

‘Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- a) Take account of advice from the lead local flood authority;*
- b) Have appropriate proposed minimum operational standards;*



- c) *Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- d) *Where possible, provide multifunctional benefits.'*

Environment Agency

- 2.6. The Flood and Water Management Act (2010) provides the EA a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation, and remediation of flood damage for main rivers and coastal areas. The EA is a statutory consultee in relation to flood risk and planning dependent upon criteria.
- 2.7. The EA Standing Advice has been consulted and reviewed within this FRA.
- 2.8. The EA Flood Map for Planning, EA Long Term Flood Risk Mapping and the Catchment Data Explorer websites have been interrogated in respect to flood risk extents and sources.

Local Authorities

- 2.9. The Site lies within the administrative area of Wokingham Borough Council (WBC). WBC is the Local Planning Authority (LPA) and the Lead Local Flood Authority (LLFA).
- 2.10. Planning guidance published by WBC regarding the flood risk was referred to in order to assess the methodology best suited to suit the local area. The following key documents were reviewed:
 - WBC Core Strategy policy CP1 'Sustainable development' and CP3 'General Principles for Development' (adapted January 2010),
 - WBC Local Flood Risk Management Strategy (dated April 2015),
 - WBC Preliminary Flood Risk Assessment (PRFA) (dated June 2011) and PFRA addendum (dated 2017),
 - WBC Level 1 Strategic Flood Risk Assessment (SFRA) (dated May 2023 and published May 2024), and
 - WBC Level 2 SFRA (dated August 2023 and published May 2024).
- 2.11. WBC became the LLFA under the Flood and Water Management Act 2010. WBC provide guidance to assess, manage and inform flood risk.
- 2.12. As the LLFA, WBC's Flood and Water Management Team provide a Planning Application Drainage Checklist to assist developers seeking planning permission for new sites by setting criteria to be met as part of the design of the drainage strategy and a list of documentation to be presented in the associated Flood Risk Assessment. A completed Planning Application Drainage Checklist is included within Appendix 3.
- 2.13. WBC has permissive rights over any Ordinary Watercourses including land drainage ditches. If any work is required within the watercourse (improvements or crossings) then approval from the LLFA is required under the Flood and Water Management Act 1991.



Local Water Authority

- 2.14. South East Water (SEW) is responsible for the supply of clean water. Thames Water (TW) is responsible for the disposal of wastewater.
- 2.15. Information with regards to sewer and water main flooding is contained within the WBC Level 1 and Level 2 SFRA and has been reviewed as part of this FRA. All water companies have a statutory obligation to maintain a register of properties and areas which are at risk of flooding from the public sewerage system and is shown on the DG5 Flood Register.

Other Sources of Information

- 2.16. A desktop study of the site was carried out using the following websites to ascertain local features, hydrology and soil characteristics:
- DEFRA's Magic Map portal,
 - British Geological Survey (BGS) 'Geology of Britain' online viewer, and
 - Cranfield University 'Soilscapes' portal.
- 2.17. Guidance with respect to Sustainable Drainage Systems (SuDS) is contained within DEFRA document Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems March 2015, CIRIA C753 The SuDS Manual and within the NPPF Planning Practice Guidance (PPG) – 'Flood Risk and Coastal Change'.
- 2.18. Additional guidance on development and flood risk is contained within CIRIA C624 Development and Flood Risk – Guidance for the Construction Industry which identifies several key aims for a development to ensure it is sustainable in flood risk terms.

3.0 Site Setting

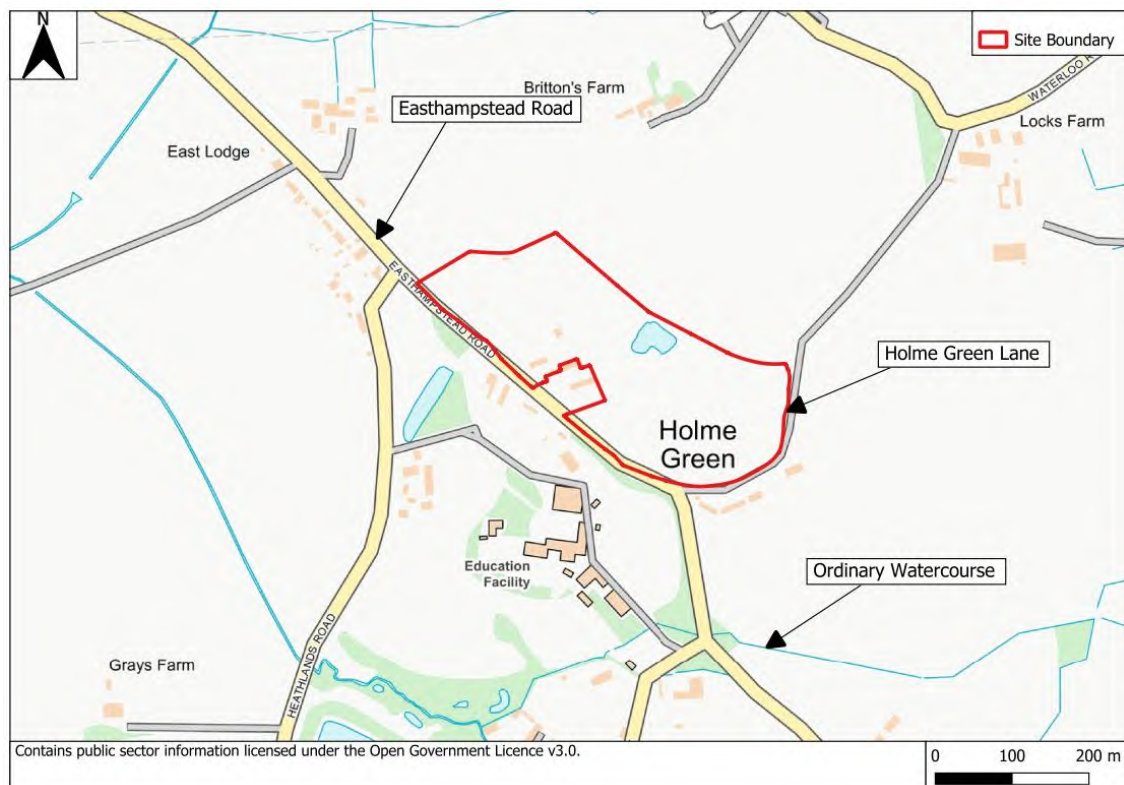
Introduction

- 3.1. This chapter provides a description of the site location, its topography, hydrological context, geology and hydrogeology.

Site Location

- 3.2. The NKH Site (the Site) is located approximately 3km to the east of Wokingham. The nearest postcode is RG40 3BQ. The Site centre grid reference is 482,842E, 167,458N. The Site location is shown in Figure 1.

Figure 1 – Site Location



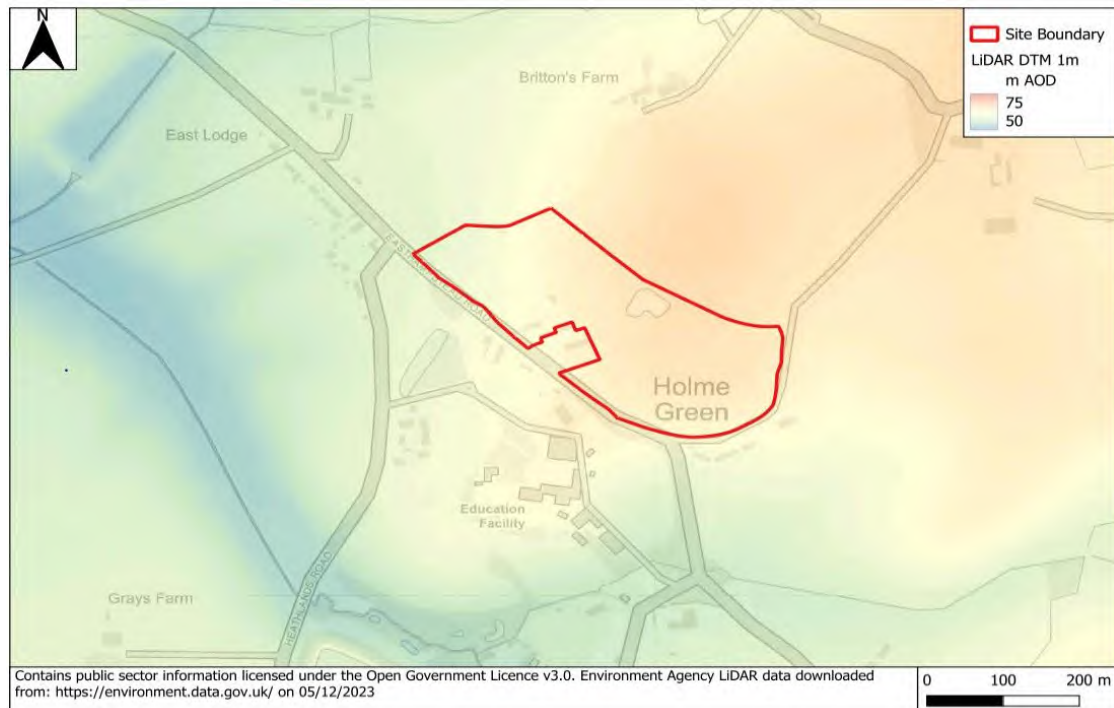
- 3.3. The Site is bounded to the south by Easthampstead Road. An education facility is also located to the south. To the north is Brittons Farm. To the west is Woods Farm and to the east is Meadows Farm. The Site comprises agricultural farmland and is boarded by trees and hedges.
- 3.4. The Site covers an area of approximately 7.5 hectares.

Topography

- 3.5. Ground levels across the Site are shown by LiDAR data in Figure 2.

- 3.6. The LiDAR data indicates that the ground levels across the site slope downwards from north-east to the south-west towards the Emm Brook. The ground levels across the site are between 66.3m AOD and 59.7m AOD.

Figure 2 – Site Topography



- 3.7. A topographical survey of the Site has been carried out by MK Surveys dated July 2021. A copy of the topographical survey is included in Appendix 1. In general, the detailed survey agrees with the LiDAR data. The ground elevations in the northeast of the Site are 65.2m AOD. The Site slopes downwards to the southwest to an elevation of 59.7m AOD.
- 3.8. Easthampstead Road to the south of the Site has an elevation of 59.6 m AOD. The ground elevations slope downwards towards the Emm Brook. This is consistent with the LiDAR elevations.

Watercourses and Ditches

- 3.9. A review of the Ordnance Survey (OS) mapping and a site walkover undertaken in February 2023 did not indicate any formal watercourses onsite. A pond is located adjacent to the Site's northern boundary.
- 3.10. The nearest watercourse is Emm Brook which is located approximately 250m to the south of the Site. The watercourse flows in an easterly direction before its confluence with the Emm Brook, which is designated a Main River by the EA.



- 3.11. A review of the topographic survey indicates that there is a drainage ditch along the north-west boundary of the Site. The drainage ditch is within the Site boundary. The drainage ditch flows in a southerly direction towards Easthampstead Road. There are drainage ditches to the north and south of Easthampstead Road to the south of the Site. The drainage ditch to the north of Easthampstead Road is located within the Site boundary. The north-western drainage ditch joins the northern Easthampstead Road drainage ditch to the south-west of the Site. There is drainage ditch along the eastern boundary of the Site, to the west of Holme Green Lane. The topographical survey and application boundary show the drainage ditch as partially within the Site boundary. The eastern drainage ditch flows in a southern direction where it connects to the drainage ditch to the north of Easthampstead Road in the south-east corner of the Site.

Surface and Foul Water Sewers

- 3.12. Sewer Asset Records obtained from Thames Water do not indicate the presence of any surface or foul water sewers within the site or within the road network immediately adjoining the Site. The nearest public asset is a foul sewer located adjacent to the Easthampstead Sewage Treatment Works on Old Wokingham Road to the south-east of the site.
- 3.13. A copy of Thames Waters Asset Record is included within Appendix 1.

Geology and Hydrogeology

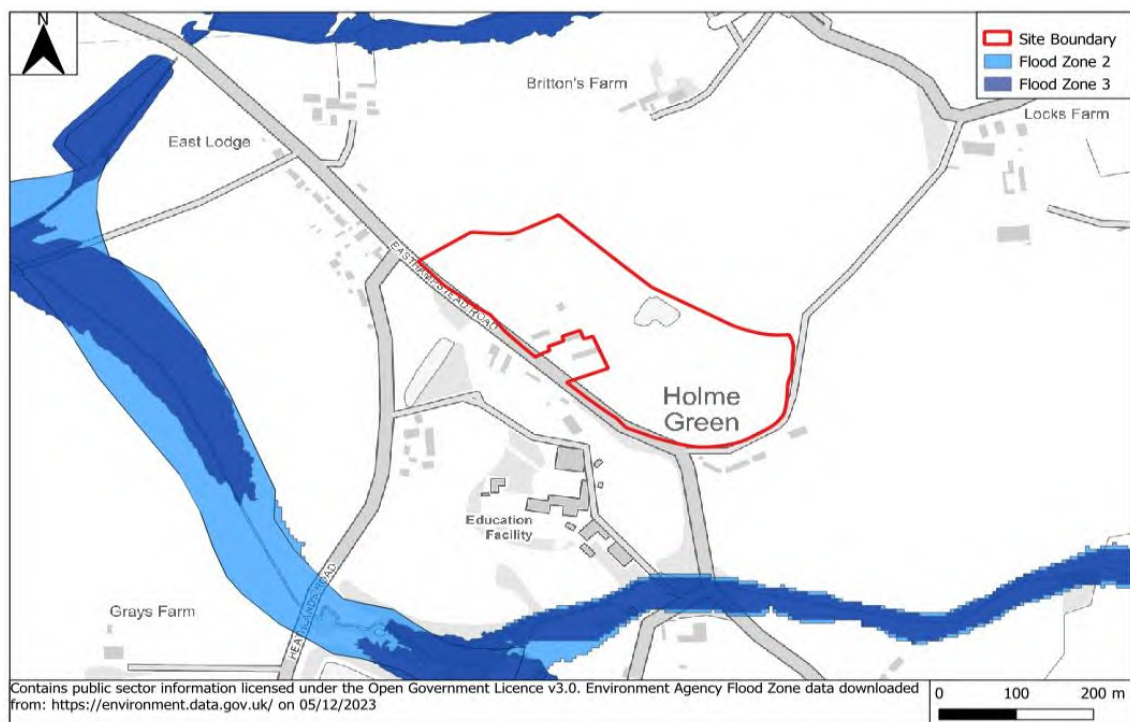
- 3.14. British Geological Survey (BGS) 'Geology of Britain' online viewer indicates that the geology underlying the Site is predominantly London Clay Formation. There are some superficial river terrace deposits of sand and gravel found across the Site.
- 3.15. The Cranfield University 'Soilscapes' online viewer indicates the Site overlies slowly permeable seasonally wet slightly acidic but base rich loamy and clayey soils.
- 3.16. The DEFRA Magic Map online viewer indicates the Site lies outside of any Groundwater Source Protection Zone (SPZ), Principal Aquifer designation or Groundwater Vulnerability Areas.

4.0 Overview of Flood Risk

EA Flood Zone Map

- 4.1. The EA Flood Map for Planning provides an initial indication of the extent of Flood Zones. In the NPPF, Flood Zones are defined as follows:
- Flood Zone 1 'Low Probability' – Land less than 1 in 1000 (0.1%) annual probability of river or sea flooding.
 - Flood Zone 2 'Medium Probability' – Land between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding, or between 1 in 200 (0.5%) and 1 in 1000 (0.1%) annual probability of sea flooding.
 - Flood Zone 3 'High Probability' – Land at 1 in 100 (1%) or greater annual probability of river flooding, or 1 in 200 (0.5%) or greater annual probability of sea flooding.
- 4.2. Figure 3 shows the EA Flood Zone mapping. It confirms that the entire Site is located within Flood Zone 1 'Low Probability' of fluvial flooding.

Figure 3 – EA Flood Zone Map

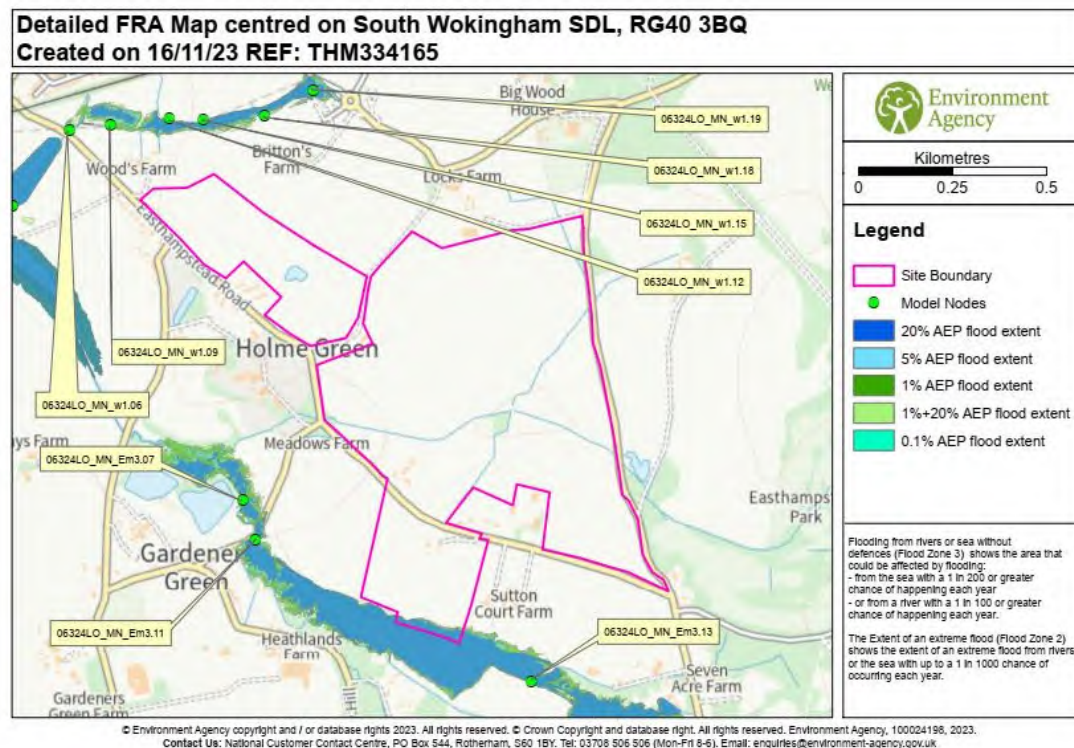


Flood Risk from Fluvial Sources

- 4.3. The Site is shown to be within Flood Zone 1 of the EA Flood Map for Planning. This indicates that the Site is not affected by fluvial flooding in the 1 in 1000 annual probability scenario. These maps are based on strategic modelling and do not take into consideration site specific information.

- 4.4. The EA has provided modelled flood levels and extents for the Site as part of their Product 4 'Detailed Flood Risk Assessment Map' dataset (EA reference: THM334165). The modelled data is from the EA River Loddon (Lower) model, dated 2009.
- 4.5. Figure 4 shows an extract from the EA Product 4 dataset.

Figure 4 - EA Product 4 Extract – Detailed FRA Map



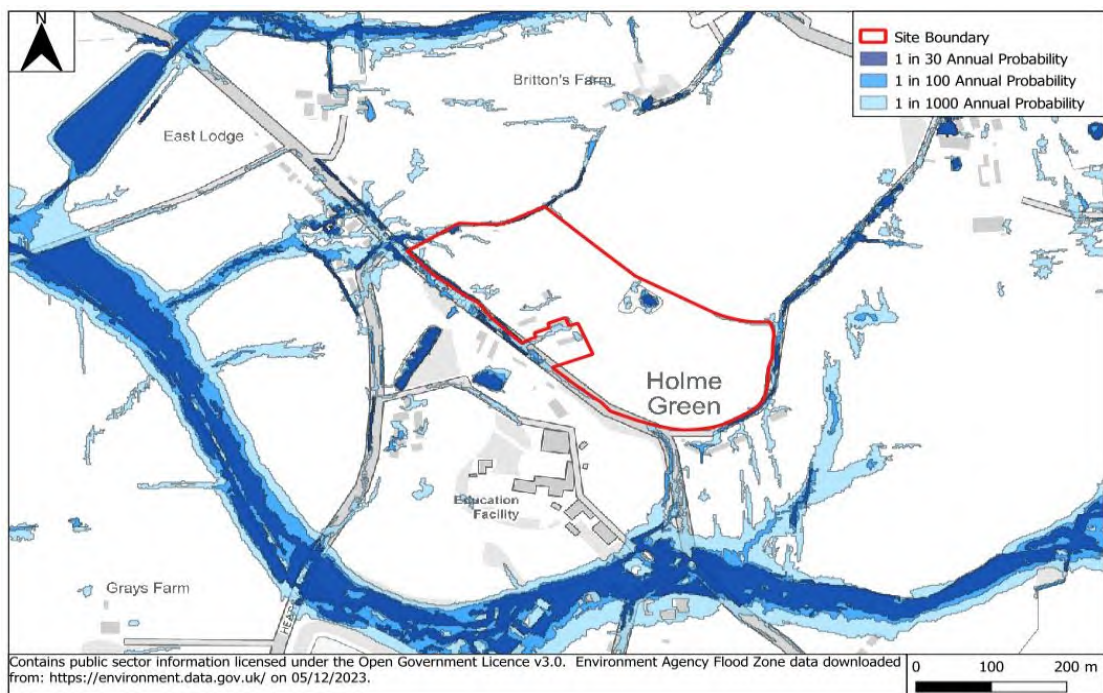
- 4.6. The mapping in Figure 4 confirms that the Site is located within Flood Zone 1.
- 4.7. The fluvial flood risk was assessed within the WBC Level 2 SFRA. The WBC Level 2 SFRA shows additional flooding to the north and north-west of the Site, that is not included within the EA Flood Map for Planning, nor Product 4 dataset. The additional flooding does not affect the Site and the WBC Level 2 SFRA mapping confirms that the Site is located with Flood Zone 1.
- 4.8. The WBC Level 2 SFRA states '*in the absence of detailed hydraulic modelling, Flood Zones 2 and 3a have been taken from the Environment Agency's Flood Map for Planning.*' As such the EA mapping has been taken as the best available data.

Flood Risk from Surface Water

- 4.9. The EA's Risk of Flooding from Surface Water (RoFSW) mapping indicates areas that could be susceptible to surface water flooding during extreme rainfall events. The EA surface water mapping defines rainfall events based on the following:
 - 1 in 30 (3.3%) annual probability 'High Risk'
 - 1 in 100 (1%) annual probability 'Medium Risk'

- 1 in 1000 (0.1%) annual probability 'Low Risk'
 - Lower than 1 in 1000 (0.1%) annual probability 'Very Low Risk'.
- 4.10. The NPPF PPG – 'Flood Risk and Coastal Change' includes the 1 in 100 annual probability of surface water flood (including climate change) within the definition of the design flood event to be used to inform a FRA.
- 4.11. Figure 5 shows the risk of surface water flooding.

Figure 5 – EA Flood Risk from Surface Water



- 4.12. The EA RoFSW mapping indicates that the majority of the Site is at a 'Very Low' (less than 0.1% annual probability) of surface water flooding. There is a flow route along the Site's north-western boundary. The flow route follows the location of the drainage ditch. This flows in a south-westerly direction towards Easthampstead Road.
- 4.13. There is flow route shown in the EA RoFSW mapping along Easthampstead Road to the south of the Site. The topographical survey indicates that there is drainage ditch to the north and south of Easthampstead Road. It is likely that the surface water flooding will be flow into these drainage ditches adjacent to Easthampstead Road.
- 4.14. The RoFSW mapping shows a flow route along the eastern boundary of the Site, along Holme Green Lane. There is a ditch to the west of the road. It is likely that surface water flooding from the road will flow into the drainage ditch. The ditch flows in a southerly direction towards Easthampstead Road. The ditch joins the ditch to the north of Easthampstead Road in the south-eastern corner of the Site.



- 4.15. There are a few isolated areas of surface water ponding with the Site boundary. One of the isolated areas is associated with the pond within the Site. This existing pond appears to be ornamental and as part of the Scheme this will be removed. The other isolated areas are associated with low lying areas. The areas corresponding to low lying areas are purely derived from within the Site. Therefore, these will be addressed within the surface water drainage strategy.
- 4.16. The EA surface water mapping is strategic scale which does not pick up any site-specific local information or below ground drainage infrastructure. The mapping therefore provides a guide to vulnerable areas based on the topography of the area and not a detailed assessment of surface water flooding for a specific site.
- 4.17. The WBC Level 1 and Level 2 SFRA use the EA RoFSW map to define areas at risk of surface water flooding.

Flood Risk from Groundwater

- 4.18. Groundwater flooding has the potential to occur after prolonged periods of unusually high rainfall. During such periods, more water than usual infiltrates through the ground, raising the water table above its normal depth below the surface. Where the water table is at a shallow depth in any case, the water table can reach the surface. This can cause groundwater to merge with rainfall and cause localised flooding.
- 4.19. The WBC Level 1 SFRA includes mapping of the areas susceptible to groundwater flooding and areas susceptible to groundwater flooding. The mapping for the Site is included within Appendix A, Page D3. The areas susceptible to groundwater flooding mapping indicates that the majority of the Site is located within a 1km² grid square of which <25% of the area is susceptible to groundwater flooding. The eastern part of the Site is located within a 1km² grid square where between 25% and 50% of the area is susceptible to groundwater flooding.
- 4.20. The WBC Level 1 SFRA includes mapping of the areas of groundwater emergence flooding which is shows the depth below the ground surface. The mapping for the Site is included within Appendix A, Page D3. The mapping does not include groundwater emergence flooding data for the Site.
- 4.21. In assessing the site allocation, the WBC Level 2 SFRA suggests that an appropriate assessment of the groundwater regime may be required. If necessary this can be completed at detailed design

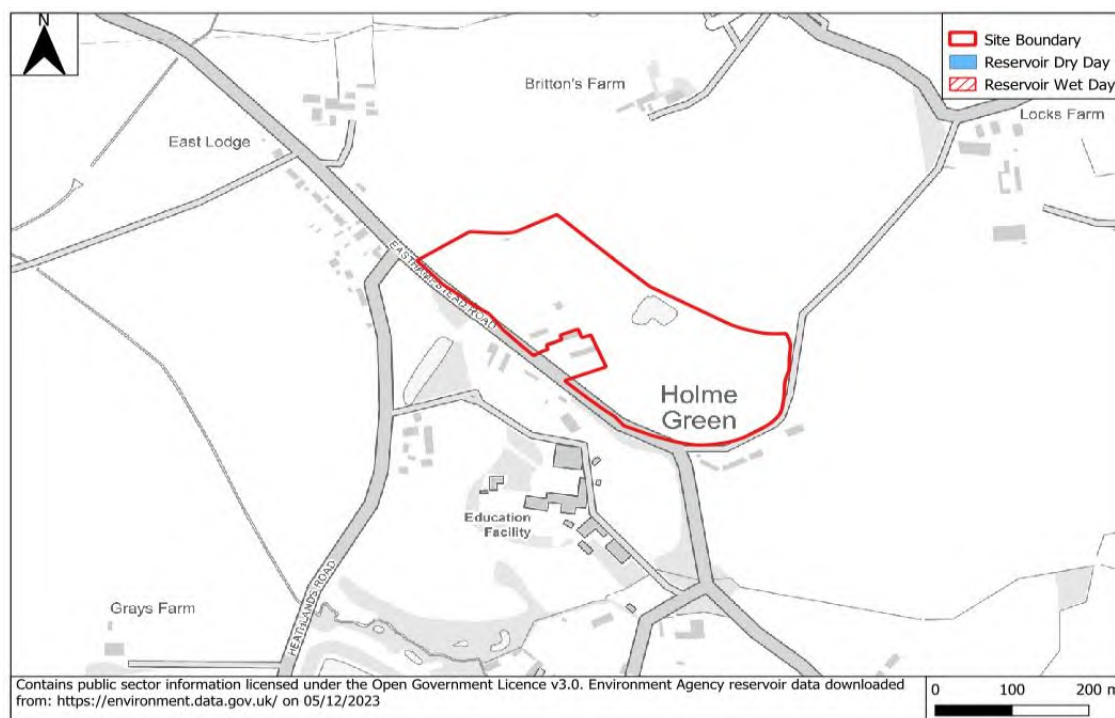
Flood Risk from Sewers

- 4.22. When exceeded, surcharged sewer networks can lead to flooding from backed up manholes and gully connections.
- 4.23. The TW Asset Location Plans (reference 2018_3887954) show that there are no sewers within the Site boundary. A copy of the Thames Water Asset Location Plans is provided in Appendix 1.
- 4.24. The WBC Level 2 SFRA states that the Site *'is in a postcode area (RG40 3) with no recorded historic sewer flooding incidents, according to available incident records from Thames Water (from January 2000 up to 1 May 2022).'*

Flood Risk from Reservoirs

4.25. Figure 6 shows the flood risk from reservoirs.

Figure 6 – EA Flood Risk from Reservoirs



4.26. The mapping indicates that the Site is not at risk of flooding in the event of a reservoir breach. The Site is therefore at low risk of flooding from reservoirs.

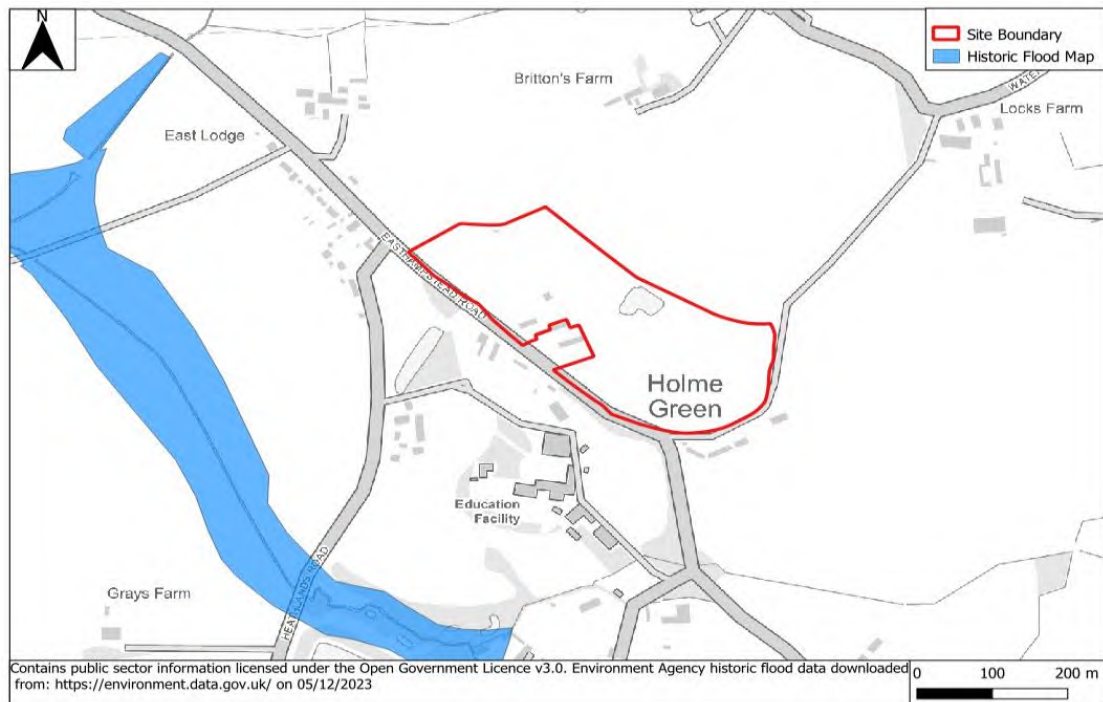
Flood Risk from Other Sources

4.27. The EA flood risk maps, WBC PFRA and WBC Level 1 and 2 SFRA indicate that the Site is not at risk of flooding from canals or other artificial sources.

Historic Flooding

4.28. Figure 7 shows the EA Historic Flood Map. The EA Historic Flood Map shows the maximum extent of recorded flood events.

Figure 7 - EA Historic Flooding



- 4.29. The Site is not shown to have been impacted by a historic flood event.
- 4.30. The EA historic flood outlines dataset indicates that land to the west and south of the Site was impacted by fluvial flooding from the Emm Brook in March 1947. Flooding occurred when the channel capacity was exceeded.

Flood Risk Summary

- 4.31. A summary of flooding from all sources is provided in Table 1.

Table 1 – Summary of Flood Risk

Source of Flooding	High	Medium	Low	Comments
Tidal			✓	The Site is inland and not influenced by tidal levels.
Fluvial			✓	The Site is located within Flood Zone 1 according to both the EA Flood Zone mapping and the EA detailed FRA mapping provided as part of their product 4. The WBC Level 1 and Level 2 SFRA's confirm that the Site is located within Flood Zone 1.
Pluvial			✓	The EA Risk of Flooding from Surface Water mapping indicates the majority of the Site is at a 'Very Low' risk of surface water flooding. There are flow routes along the Site's southern, western and eastern boundaries which has a 'Low', 'Medium' and 'High' risk of surface water flooding. The flow is likely to flow into the drainage ditches along these boundaries.
Groundwater			✓	The risk of groundwater flooding across the Site is considered to be low.
Sewers			✓	There are no sewers within the Site boundary.
Reservoirs, canals and other artificial sources			✓	EA and WBC Level 1 and Level 2 SFRA mapping do not indicate the Site to be at risk of flooding from reservoirs, canals or other artificial sources.

- 4.32. The Site is deemed to be at low risk of flooding once the surface water drainage strategy is implemented.
- 4.33. For the purpose of this FRA, the Site is not affected by fluvial flooding and no fluvial design event needs to be considered.
- 4.34. The pluvial design flood event should be taken as the pluvial 1 in 100 annual probability scenario with an allowance for climate change. The 2070 Upper End allowance of 40% has been used for the design of the surface water strategy. This is in line with the Loddon and Tributaries Management Catchment peak rainfall allowances.



5.0 Sequential Test and Exception Test

NPPF Sequential Test

- 5.1. NPPF states that Local Planning Authorities allocating land for development should apply the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- 5.2. The Site is entirely located within Flood Zone 1.
- 5.3. The majority of the Site is located within an area of 'Very Low' risk of surface water flooding. There are isolated areas of 'Low', 'Medium' and 'High' risk of surface water flooding.
- 5.4. The flood risk from other sources is low.
- 5.5. The proposed development is for a residential development and is therefore classed within the NPPF as 'More Vulnerable' development.
- 5.6. All of the Site is located within Flood Zone 1 and the majority of the Site is at a 'Very Low' risk of flooding from surface water. Therefore it is a sequentially preferable site.
- 5.7. In any case, the Site is allocated with the WBC Local Plan. As the Site is allocated within the WBC Local Plan, the Sequential Test is deemed to have been passed as part of this.

Exception Test

- 5.8. The Level 2 SFRA states that the South Wokingham Master Planning Area extension allocation needs to pass the Exception Test. However, for this part of the allocation, the entire Site is located within Flood Zone 1 and with generally low probability of surface water flooding. The vulnerability of the development is 'More Vulnerable'. Table 2 in the NPPF PPG sets out when the Exception Test is required. The Exception Test is not required.



6.0 Flood Mitigation Strategy

Sequential Approach

- 6.1. The NPPF encourages a 'sequential approach' in master planning for new development: locating the more vulnerable uses of the development in the areas of lowest flood risk from all sources.
- 6.2. A sequential approach has been applied to the layout of the development.

Ground Floor Levels

- 6.3. The requirements for setting ground floor levels for new developments are set out in BS8533:2017 'Assessing and Managing Flood Risk in New Developments – Code of Practice'. The WBC Level 1 SFRA and EA advise a finished floor level of at least 300mm above the 1 in 100 annual probabilities plus climate change allowance.
- 6.4. The Site is located outside of the fluvial flood extents, and therefore ground floor levels should be set a minimum of 150mm above the surrounding ground level to mitigate the residual flood risk from surface water runoff events. It is recommended that surrounding ground levels are appropriately contoured to direct surface water away from the development.

Floodplain Storage and Flow Routing

- 6.5. The development areas are located outside of the fluvial and surface water flood extents. There is therefore no impact on fluvial floodplain storage or flow routes as a result of the development.
- 6.6. The potential for isolated ponding from surface water flooding will be addressed through the implementation of the surface water drainage strategy.

Safe Access

- 6.7. The entire site is in Flood Zone 1. Safe access is therefore not an issue.

Residual Risk

- 6.8. The NPPF PPG – 'Flood Risk and Coastal Change' defined residual risk as coming from 'flood risk management infrastructure' and the 'residual risk to a development once any site-specific flood mitigation measures are taken into account'.
- 6.9. Residual risk to the Site includes a breach in the raised flood defences, the failure of a reservoir and a flood event greater than the designed standards.
- 6.10. The EA AIMS dataset, which contains information of flood defences, indicates that the Site does not benefit from raised flood defences. The EA mapping for reservoir breaches indicates that the Site is not located within an area at risk of flooding in the event of a reservoir. The Site is located outside of the 1 in 1000 annual probability flood extent.
- 6.11. The residual risk to the Site is therefore low.

WBC Requirements

- 6.12. As part of the WBC Level 2 SFRA there is a site specific guidance for the South Wokingham Master Planning Area extension allocation that sets out what is required for site design and making development safe. This has been used to inform this FRA. This guidance and how this FRA demonstrates this is set out below in Table 3.

Table 2 – WBC Level 2 SFRA Guidance

WBC Level 2 SFRA Guidance	Summary of Mitigation Measures
The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development, (Para 048 Flood Risk and Coastal Change PPG). This FRA has been written in accordance with WBC guidelines following data sourced from the WBC PFRA, WBC Level 1 and Level 2 SFRA, alongside using the EA Flood Risk Maps.	This FRA has been written in accordance with WBC guidance within the WBC Level 1 and Level 2 SFRA using flood risk datasets from the WBC Level 1 and Level 2 SFRA, alongside the EA flood risk mapping. Residential development will be located within Flood Zone 1, and in areas at a 'Very Low' risk of surface water flooding. Finished floor levels will be set a minimum 150mm above the finished ground level. The ground will be profiled away from the buildings to mitigate the residual risk from surface water flooding.
The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, so runoff magnitudes from the development are not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure runoff rates areas close as possible to pre-development greenfield rates	The surface water flow routes are located along the surface water ditches along the southern, western and eastern boundaries of the Site. Residential development will not be located in these areas. The localised are of surface water ponding will be accommodated within the surface water drainage strategy. The surface water drainage strategy has been designed to greenfield run off rates.
Arrangements for safe access and egress will need to be provided for the 1% AEP fluvial and rainfall events with an appropriate allowance for climate change, considering depth, velocity, and hazard. Design and access arrangements will need to incorporate measures, so development and occupants are safe.	The Site is located entirely within Flood Zone 1. Continuous safe access and egress is therefore available to the Site.
Provisions for safe access and egress should not impact on surface water flow routes or contribute to loss of floodplain storage. Consideration should be given to the siting of access points with respect to areas of surface water flood risk.	The majority of the Site is located within an area of Very Low surface water flood risk, including the access to the Site.
Flood resilience and resistance measures should be implemented where appropriate during the construction phase, e.g. raising of floor levels and use of boundary walls. These measures should be assessed to make sure that flooding is not increased elsewhere.	Finished floor levels will be set a minimum of 150mm above the finished ground level to mitigate the residual risk of surface water flooding.



7.0 Surface Water Drainage

Introduction

- 7.1. This chapter provides details on the surface drainage strategy and includes measures to drain the proposed development site.

Overall Strategy

- 7.2. The proposed drainage strategy has been designed to the requirements of the NPPF by providing a comprehensive drainage system which embraces the SuDS philosophy and key principals. The utilisation of Sustainable Drainage Systems (SuDS) not only provides the benefit of controlling waters at source and online treatment of collected surface water but also allows enhanced aesthetics through improved landscaping, biodiversity, and ecological opportunities.
- 7.3. These features offer a holistic treatment train and management system to the benefit of new residents, members of the wider community, downstream receptors and the environment.
- 7.4. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. Changes of land uses can have significant downstream impacts where existing drainage systems may not have sufficient capacity for any additional surface water flow.
- 7.5. A surface water management strategy is therefore required to manage and reduce the flood risk posed by the surface water runoff from the Site. The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates to the pre-development scenario, unless specific off-site arrangements are made and result in the same net effect.
- 7.6. Sustainable water management measures (SuDS) should be introduced to control the surface water runoff from the proposed development Site therefore, managing the flood risk to the Site and surrounding areas from the surface water runoff.
- 7.7. The Construction Industry Research and Information Association, CIRIA's C690 states the following:
- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing surfaces)
 - **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting)
 - **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one or several soakaways for the entire site)
 - **Regional Control** – management of runoff from several sites, typically in a detention basin or wetland.



- 7.8. The SuDS Manual 2015 (C753) provides best practice guidance on the planning, design, construction, operation and maintenance of SuDS. This document provides guidance to ensure that SuDS are planned and designed to maximise the opportunities and benefits of surface water management.
- 7.9. The four main categories of benefits that can be achieved by SuDS, referred to as the four pillars of SuDS design, are:
- **Water quantity** – control the quantity of runoff to support the management of flood risk, and maintain and protect the natural water cycle;
 - **Water quality** – manage the quality of the runoff to prevent pollution
 - **Amenity** – create and sustain better places for people
 - **Biodiversity** – create and sustain better places for nature.
- 7.10. Supplemental to CIRIA guidance, Document H of the Building Regulations 2015 sets out three possible options to discharge surface water runoff. Rainwater shall discharge to one of the following, listed in order of priority:
- An adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,
 - A watercourse; or where that is not reasonably practicable
 - A sewer.
- 7.11. As the underlying geology is not conducive to the use of infiltration type techniques (Ref: Para 3.19 above), the surface water drainage proposals will be designed to attenuate runoff with controlled discharge to the existing local watercourses i.e. the existing open field ditch on site which would be feasible point of discharge.
- 7.12. Implementation of SuDS will ensure that flood risk downstream is not increased due to the proposed development. These features will also provide positive improvements to the quality of surface water runoff.
- 7.13. The following SuDS components are deemed applicable to the site:
- Pervious surfacing systems – structural surfaces that allow water to penetrate into a granular layer thus providing storage and treatment, e.g. pervious paving.
 - Conveyance systems – components that convey flows to downstream storage systems, e.g. swales and filter drains.
 - Storage systems – components that control flow, and possibly volumes, by storing water and releasing it slowly, e.g. geocellular units, attenuation basins and wetlands.
 - Treatment systems – components that remove or facilitate the degradation of contaminants present in runoff, e.g. filter strips and proprietary treatment systems.

Pre and Post Development Areas/Rates

- 7.14. To quantify any potential increase in surface water runoff, the existing Greenfield/Pre-Development runoff rate from the site must be determined. The rates of runoff have been determined using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS. The recommended methodology for sites up to 50 hectares in area is the ICP SuDS method.
- 7.15. An assessment of existing surface water runoff has been undertaken, to determine the potential surface water options and attenuation requirements for the Site utilising the following parameters taken from the UK Centre for Ecology & Hydrology Flood Estimation Handbook Web Service:
- NGR: SU 83354 671164
 - BFIHOST: 0.395
 - BFIHOST19: 0.389
 - PROPWET: 0.29
 - SAAR6190: 662mm
 - Q_{BAR} / Q_{MED} Factor: 1.14
- 7.16. The calculated Greenfield run off discharge rates, based on a discharge rate per hectare of impermeable area, are as presented in Figure 8. The corresponding runoff outputs created with H R Wallingford Greenfield runoff rate estimation tool can be found within Appendix 4.

Table 3 – Pre-Development Runoff Rates/Volumes per Hectare

Annual Probability	Greenfield/Pre-Development Runoff Rate per hectare (l/s)	Greenfield/Pre-Development Volume 360 minute storm (m ³)
1 in 1 year event	3.3	106
QBar	3.9	-
1 in 30 year event	8.9	253
1 in 100 year event	12.4	328

- 7.17. Based on the Illustrative Masterplan, it has been conservatively estimated that the impermeable surfaces will be approximately 60% of the developable area. Depending upon how future Reserved Matters Site Layouts evolve, this percentage typically reduces slightly to around 50-55%.
- 7.18. The use of 60% therefore provides for a robust assessment which allows for fluctuations in residential density, and future urban creep of up to 10% on private curtilage areas, which typically results in approximately 5% of the total area, in accordance with The SuDS Manual (CIRIA 753).
- 7.19. In order to comply with best practice as stipulated in EA Report SC030219 'Rainfall Runoff Management for Developments', proposed discharge rates should be restricted to one of two methods for all storms up to and including the 1 in a 100 year storm event plus a 40% allowance for climate change.



1. Variable Greenfield discharge rates

- 7.20. This would require traditional on-site attenuation to hold back flows controlled by a complex control device, such as multiple vortex control devices. Discharge rates would be set so as not to exceed the pre-development 1in1, 1in30 and 1in100 year runoff rates set out in Figure 13 based upon the appropriate catchment area.
- 7.21. In addition to this onsite attenuation, consideration of Long Term Storage would also be necessary given the increase in discharge volume generated by the proposed development, over and above that pre-development. This storage would need to be release into the surrounding watercourses at a low rate of 2.0 l/s/ha. This would normally be controlled by a secondary attenuation area and supplemental control device.
- 7.22. The Long Term Storage (LTS) requirement calculations based upon CIRIA EQ 24.10, have been included in Appendix 4 with the calculated value being 42.4m³/ha.
- 7.23. The drainage simulation software Causeway Flow has been used to determine the combined 100 + 40% Climate Change Long Term and basic attenuation requirements per hectare of impermeable catchment. The output of this model can be seen within Appendix 4.

Table 4 – Variable Rate Discharge Attenuation Storage Volumes

Attenuation	Volume requirements (per hectare of impermeable catchment)
Attenuation Volume	857.6 m ³
Long Term Storage (Discharged at 2 l/s/ha)	42.4 m ³
Total Attenuation Required	890 m³

2. QBar Greenfield discharge rate

- 7.24. Alternatively, all discharge flows could be restricted to QBar. This would negate the requirement for Long Term Storage and again flows would be attenuated on Site and discharged utilising an onsite control device, such as a vortex control device. This normally requires a greater volume of attenuation.
- 7.25. For the purposes of this report and to provide a robust analysis, all attenuation requirements have been calculated utilising all discharge flows restricted to QBar, as this is normally the worst case scenario. Appendix 4 establishes the 'per hectare' calculation of QBar as being 3.9 litres/second.
- 7.26. The use of QBar gives a value for the average annual peak runoff rate, this provides a comprehensive SuDS scheme with the volume runoff being reduced for intense storms. However, either method described above is viable and will be investigated further during detailed design.
- 7.27. With the above in mind, and having assessed limiting the offsite discharge rate to QBar, the anticipated attenuation volumes for a 100 year storm with a 40% allowance for climate change are as follows:

Table 5 – Calculated Attenuation Volumes based upon QBar

Attenuation	Volume requirements (per hectare of impermeable catchment)
Total Attenuation Required	990 m³



- 7.28. It likely that at the detailed design a mixture of both strategies may be beneficial as complexities can lie within the use of the variable discharge rates especially when used at source but the reduction of the required storage volumes can have other benefits for the use of the development such as dedicated green space areas and play areas.

Surface Water Proposals

- 7.29. It is proposed to provide a network of trapped gullies, pipes and Sustainable Drainage (SuDS) features to collect the surface water runoff from impermeable areas such as roads, roofs and driveways. The traditional system will work in combination with such features as permeable paving, roadside swales and filter drains, within the residential parcels and Green Blue corridors, to filtrate, store and transport water to attenuation basins to provide attenuation storage and high-quality water benefits.
- 7.30. The final attenuation basins will drain, with a controlled discharge into the existing ordinary watercourses which run alongside the northern verge of Easthampstead Road and discharge eventually to the west and the Emm Brook.
- 7.31. Even though the end point attenuation basins located across the Site will provide the full storage requirements on their own to attenuate the flows at the proposed discharge rate, it will be necessary to provide storage features upstream of these basins to facilitate the function of the surface water drainage system and provide filtration at source. These features may come in the form of permeable paving, swales, filter drains, crate storage or even smaller attenuation basins to mimic the existing Greenfield conditions as well as enhance the Green Blue corridors through the Site.
- 7.32. Drawing A218-026, a copy of which is included within Appendix 4, provides a high level overview of the drainage proposals together with the estimated requirements for the required storage and SuDS features for the parcels within the various zones of the proposed development.
- 7.33. The banks of the SuDS basins will be designed in accordance with the SuDS Manual C753 in respect to having a maximum gradient of 1 in 4 and an appropriate freeboard above the maximum water level. This allows landscaping of both wetland and wildflower mixes to provide an appropriate landscape context in the vicinity of the features through the provision of an aquatic shelf.
- 7.34. Open SuDS features will be designed so as not to compromise the safety of residents, visitors and their property. Generally open boundaries are provided, and perimeter planting could be utilised to define the extents of the features.
- 7.35. Proposed discharge rates will be restricted to QBAR for all storm events up to and including the 1 in 100 year storm event plus 40% allowance for climate change. This would negate the requirement for Long Term Storage and flows would be attenuated on site and discharged utilising an on-site flow control device such as a Hydrobrake.
- 7.36. All conveyance systems will be designed to cater for the 1:30 year storm event, in accordance with industry standard, with all attenuation features designed to allow for the 1 in 100 year storm event plus 40% climate change allowance.



- 7.37. The proposals draw reference to the DEFRA document Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems March 2015, as well as CIRIA C753 The SuDS Manual.
- 7.38. Current uncontrolled pluvial runoff exhibited onsite during high rainfall events will be mitigated as a result of the Development. This will occur by virtue of the change in surface from greenfield to positively drained impermeable areas, which will serve to capture, attenuate and delay surface water runoff eastwards beyond Green Lane. This will be a benefit to downstream receptors.
- 7.39. This proposal identifies the principal components of the surface water strategy and is subject to further detailed localised investigations as part of the subsequent Reserved Matters applications. These assumptions are subject to evolution as the design develops and the individual parcels are further realised.
- 7.40. There is scope to utilise source control techniques (such as swales, granular strips and permeable paving) which will assist with the reduction of larger attenuation storage features. This should be embraced and investigated as the project progresses.
- 7.41. Subject to the provision of additional geotechnical information, the attenuation basins may require partial lining to protect against the ingress of natural groundwater. Such lining provides the ability to create localised, small permanent bodies of water which adds landscaping and biodiversity opportunities to the scheme.

Exceedance Flood Routing

- 7.42. Flows in excess of the above design storms, which may flood from the network for storms in excess of the 1 in 100 year storm plus 40% climate change, will be kept within the internal road network, until such time as they can be directed into adjacent landscaping areas or existing vegetation/woodland. This ensures that no onsite or offsite residential units are afforded an increased level of protection from flood waters until such time as the rain events become significant.
- 7.43. The attenuation basins along the eastern edge of the Development are designed to provide 300mm freeboard and therefore can accept additional flood water from manholes upstream.

Water Quality Improvements

- 7.44. CIRIA report C753 The SuDS Manual outlines the methodology for assessing water quality risks associated with new development. This is a simple index approach which provides a high level scoping analysis of the land usage and gives guidelines for appropriate treatment stages.
- 7.45. This process identifies features necessary to provide adequate substance removal in line with EA requirements. This is a three step process of Allocation, Mitigation and Review.
- 7.46. Surfaces generating runoff are 'graded' on their potential to contribute to various harmful pollutants and gives each surface a risk of pollution from each element. An extract of Table 26.2 within the SuDS Manual is set out overleaf.

Table 6 – Extract from Table 26.2 SuDS Manual

Land Use	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Other Roofs	Low	0.3	0.2-0.8	0.05
Low traffic residential roads and non-residential parking with infrequent change.	Low	0.5	0.4	0.4
Commercial yard, parking with frequent change, other roads,	Medium	0.7	0.6	0.7
Sites with heavy pollution	High	0.8	0.8	0.9

- 7.47. Historically, PPG3 documentation would recommend that pollutants were removed utilising oil separators, but since its superseding, more recent guidance has shifted to the use of SuDS features to remove pollutants; thereby providing significant improvements in treatment.
- 7.48. The use of non-mechanical features decreases the requirements for maintenance and increase natural biodiversity. That said, the SuDS Manual does not remove the possibility of utilising separators, so long as they are considered in partnership with a comprehensive overall SuDS regime.
- 7.49. Without adequate treatment, the pollutants would cause damage if they were to enter the watercourse or water table in large volumes. The use of SuDS features to slow down and degrade these pollutants is critical to the provision of an acceptable discharge.
- 7.50. The respective cleansing abilities of common SuDS features are given by corresponding mitigation indices within the SuDS Manual. An extract of Table 26.3 is set out below.

Table 7 – Extract from Table 26.3 SuDS Manual

Type of SuDS component	Total Suspended Solids	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable Paving	0.7	0.6	0.7
Detention Basin	0.5	0.5	0.6

Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8

- 7.51. The individual pollution indices are totalled, with the first SuDS component utilising its full value and subsequent downstream SuDS features acting with 50% efficiency. This provides a realistic strategy which mimics the reduced cleansing effectiveness as the concentration of a pollutant decreases along the SuDS train.
- 7.52. In line with EA guidance, before the design phase is concluded, the proposals are reviewed and analysed in order to identify potential shortcomings and to ensure that adequate volume of SuDS features are provided to mitigate the risk of pollution from each source.

SuDS Maintenance Strategy

- 7.53. For the water treatment effects of SuDS features to remain effective, a comprehensive maintenance strategy should be implemented.
- 7.54. During construction, maintenance of SuDS features should be undertaken by the Contractor. Upon completion, the assets should be passed over to the Management Company, statutory authority, or community group commissioned to maintain the features in perpetuity.
- 7.55. As part of the strategy, a regular maintenance regime will be created, which consists of several primary measures required to ensure the longevity of the system. These should be undertaken on a regular basis to ensure consistent performance. Typical maintenance activities consist of:
- Inspecting and reporting; relatively regular review of the condition identifying issues and providing resolutions. Periodic review from the maintenance contractor;
 - Litter and debris removal;
 - Grass trimming, overall cutting and localised strimming preventing blockages;
 - Weed and evasive plant control;
 - Shrub management;
 - Aquatic and shoreline vegetation management;
 - Sweeping pervious surfaces; and
 - Oil removal from proprietary systems.
- 7.56. A remedial maintenance schedule would be recommended as part of the handover of the SuDS features, remedial maintenance is required to provide repairs to the system and monitor long term damage ensuring the system remains consistently productive. the schedule could consist of;
- Structure rehabilitation and repair;
 - Infiltration surface rehabilitation;
 - Scarifying to remove "Thatch";



- Spiking or Tining the soil;
 - Air pressure treatment.
- 7.57. The maintenance schedule contents and timing will depend upon multiple factors including usage, contents of water utilising the system, location and biology. To this end, it is suggested that the schedule be finalised as part of detailed design; ensuring the most comprehensive maintenance schedule is incorporated for the phase in hand.
- 7.58. Community outreach can be undertaken as part of the development, which will raise awareness on the importance of SuDS to both flood risk and water quality in the local area. Imparting the new residents with knowledge on the risks associated with pollution to the surface water drainage system is key, as is the direct effect their actions may have on water quality and biodiversity in the area.

Adoption and Ownership

- 7.59. The drainage system is designed to the appropriate standards including the new Sewerage Sector Guidance (SSG), the Building Regulations and the requirement of the National Planning Policy Framework.
- 7.60. The intention of adoption and ownership of drainage and SuDS is as follows:
- Surface water sewers within development parcels to be offered for adoption to Thames Water under the Section 104 process of the Water Industry Act.
 - Surface water highway drains, gullies and leads within adopted roads to be maintained by the Highway Authority.
 - Above ground attenuation (i.e. swales and basins) to be maintained by a private maintenance company funded by residential properties or subject to agreement with the Local Authority.
 - SuDS features serving single properties, for example, permeable paved driveways to single dwellings, will be owned and maintained by the owner of that property.
- 7.61. Suitable adoption and maintenance regimes for SuDS should be submitted in support of the Reserved Matters application.



8.0 Foul Water Drainage

Introduction

- 8.1. This chapter provides details on the proposed foul water drainage strategy and measures to convey effluent.

Overall Strategy

- 8.2. Due to the topography of the Site and location of the existing foul sewer point of connection, wastewater from the Site will require pumping to the receiving public sewer.
- 8.3. There are currently no public sewers located within the adjacent roads bordering the Site, therefore construction of the infrastructure necessary to service the site will be required.
- 8.4. Discussions are currently ongoing with Thames Water as to the best possible location for the final connection for the foul water coming from the Site depending on capacity of the sewage treatment works and incoming pipework.
- 8.5. Two possibilities for the general direction of the ultimate foul discharge point currently exist. Option one is to pump flows North, through the adjacent Priors farm development, to the strategic pump station located on the SDL which pumps flows underneath the existing railway line eventually discharging to the Sewage Treatment plant to the North of Dalley Road in Wokingham. The alternative option is to pump flows South, eventually discharging to the Easthampstead Sewage Treatment works located to the East of Old Wokingham Road.
- 8.6. The topography of the site and the location and invert of the existing foul sewers in either direction will requires wastewater from the development to be pumped as it cannot drain by gravity.
- 8.7. Discussions are ongoing with Thames Water regarding the exact location(s) and specifications of possible pump stations that will be required to provide sufficient capacity to service the development.
- 8.8. Notwithstanding this, the delivery of the proposed on-site foul water sewers will be designed in collaboration with Thames Water as approving body in accordance with the new Sewerage Sector Guidance (SSG) and will be offered to Thames Water for adoption under S104 Agreement of the Water Industry Act. The connection to the existing public sewer system will be made via a S106 Agreement of the Water Industry Act with Thames Water as part of the overall adoption process.

Adoption and Ownership

- 8.9. The drainage system is designed to the appropriate standards including the new Sewerage Sector Guidance (SSG), the Building Regulations and British Standards.
- 8.10. Foul water sewers within development parcels and offsite to the point of connection are to be offered for adoption to Southern Water under the Section 104 process of the Water Industry Act.



9.0 Conclusion

Flood Risk

- 9.1. The EA Flood Risk mapping has been reviewed alongside the Wokingham Borough Council (WBC) Preliminary Flood Risk Assessment (PFRA) and WBC Level 1 and Level 2 Strategic Flood Risk Assessments (SFRA).
- 9.2. This Flood Risk Assessment (FRA) concludes that:
- The Site is located within Flood Zone 1 'Low Probability' (land at less than 1 in 1000 (0.1%) annual probability of river or sea flooding').
 - The majority of the Site is located in an area with a 'Very Low' (land lower than 1 in 1000 (0.1%) annual probability) risk of flooding from surface water. There are isolated areas of surface water ponding with a 'Low' 1 in 1000 (0.1%) annual probability, 'Medium' 1 in 100 (1%) annual probability and 'High' 1 in 30 (3.3%) annual probability risk of surface water flooding associated with the pond with the Site and low lying areas within the Site.
 - There are surface water flow routes along the southern, western and eastern boundaries of the Site. The flow most likely goes into the drainage ditches along these boundaries.
 - The WBC Level 1 SFRA susceptibility to groundwater flooding map indicates that the majority of the Site is located within a 1km grid square of which <25% is susceptible to groundwater flooding. The eastern part of the Site is located in a 1km grid square that is between 25 and 50% that is susceptible to groundwater flooding.
 - The TW asset location plans show that there are no sewers within the Site boundary. The Site is therefore at a low risk of flooding from sewers.
 - The EA reservoir mapping shows that the Site is located outside of the reservoir breach flood extents.
 - In summary the majority of the Site is at a low risk of flooding from all sources.

Sequential Test and Exception Test

- 9.3. The Site is located within Flood Zone 1.
- 9.4. The Site forms part of the South Wokingham Strategic Development Land which is allocated with the WBC Local Plan. The Sequential Test is deemed to have been carried out as part of this.
- 9.5. The Site is located in Flood Zone 1. The residential development is classed as 'More Vulnerable'. This use is considered in the NPPF PPG as acceptable without the need for the Exception Test to be carried out.



9.6. The Level 2 SFRA states that the South Wokingham Master Planning Area extension allocation needs to pass the Exception Test. However, for this part of the allocation, the entire Site is located within Flood Zone 1 and with generally low probability of surface water flooding. The vulnerability of the development is 'More Vulnerable'. Table 2 in the NPPF PPG sets out when the Exception Test is required. The Exception Test is not required.

9.7.

Mitigation Strategy

9.8. As the Site is located outside of the fluvial flood extent, ground floor levels should be set a minimum of 150mm above the surrounding ground level to mitigate the residual flood risk from surface water runoff events. It is recommended that surrounding ground levels are appropriately contoured to direct surface water away from houses.

9.9. The isolated areas of surface water ponding within the Site will be managed through the surface water drainage strategy.

9.10. The proposed surface water drainage strategy will manage the flood risk posed by uncontrolled surface water runoff from the site. Any increase in surface water run-off can be managed using SuDS source control techniques as well as attenuation features to provide storage in extreme storm events. This provides the minimum of two treatment storage stages which is in accordance with the recommendations of CIRIA C753. All surface water drainage systems will be designed to restrict drainage discharge rates to QBAR runoff rates and store the balance of water for all events up to and including the 1 in 100 year event including allowance for a 40% increase in rainfall intensities as a result of climate change and urban creep.

9.11. The WBC Level 2 SFRA has considered this Site (South Wokingham Master Planning Area extension) and sets out key criteria to be addressed as part of any development of the Site. These are summarised in Table 8.

Table 8 - WBC Level 2 SFRA Key Message

Key Message	This FRA Demonstrates That
Development is steered away from the south border of the Site as this affected by both fluvial flooding and surface water flooding.	The Site is located away from the south border of the wider allocated development site.
A carefully considered and integrated flood resilient and sustainable drainage design is put forward, with development to be steered away from the areas identified to be at risk from both fluvial and surface water flooding, particularly along the southern border and south east corner of the site.	The Site is located away from the south border of the wider allocated development site. Surface water flow routes are located along the southern, western and eastern boundaries of the Site, within the drainage ditches. Built development will be located away from these areas.
Safe access and egress can be demonstrated in the 1% AEP plus 40% climate change surface water event. This includes measures to reduce flood risk along these routes such as raising access, but not displacing flood water elsewhere. A detailed hydraulic model of Emm	The Site is located entirely in Flood Zone 1. Continuous safe access and egress is available.



Brook along the southern border of the site and the unnamed watercourse within the site may be required at FRA stage to accurately represent the risk from these watercourses.	
A site-specific FRA demonstrates that the site is not at an increased risk of flooding in the future and that development of the site does not increase the risk of surface water flooding on the site and to neighbouring properties.	This FRA has reviewed all sources of flooding and confirms that there will be no increase in offsite flood risk as a result of the Proposed Development.
If any flood mitigation measures implemented are tested to check they will not displace water elsewhere (for example if land is raised to permit development on one area, compensatory flood storage will be required in another.	This FRA has reviewed all sources of flooding and confirms that there will be no increase in offsite flood risk as a result of the Proposed Development.
The development reviews the suitability of the Emm Brook model to inform this site and carries out any further modelling work deemed necessary.	The Site is located within Flood Zone 1. It is not at risk of flooding from the Emm Brook, therefore detailed modelling work is not necessary.

Summary

- 9.12. This FRA demonstrates that the proposed development complies with national and local planning policy with respect to flood risk and drainage. The risk of flooding is adequately managed, and, with the implementation of a suitable surface water drainage strategy, the offsite flood risk is not increased.



Appendices



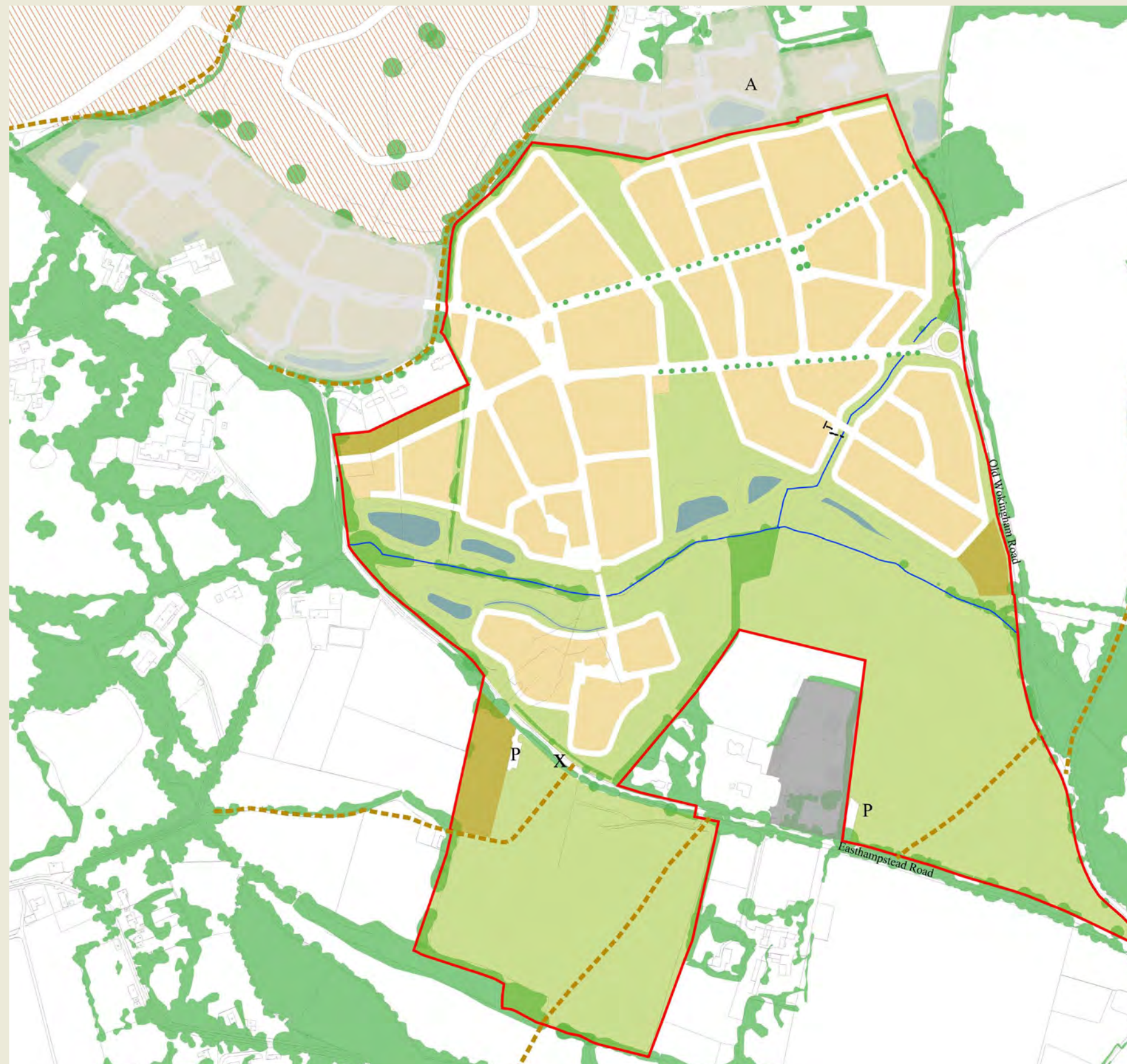
Appendix 1 - Plans

Illustrative Masterplan

Topographical Survey

Thames Water Sewer Asset Plan

MASTERPLAN AND URBAN BLOCK STRUCTURE



Key	
	Public Right of Way
	Urban Blocks
	SuDS
	Green Open Spaces
	Allotments
	Potential for Intensification of Commerical Use
	Indicative Trees
	Ordinary watercourses
	Application ref: 191068 (resolution to permit subject to S106)
A	Application 211033 (being determined)
P	SANG parking
x	Point closure

