Bourne Homes Ltd

Streamside (Land at Harpers Road)

Flood Risk Assessment and Drainage Strategy

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Purpose

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The conclusions and recommendations contained herein are limited by the availability of background information and the planned use for the Site.

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CDM

The revised Construction (Design and Management) Regulations 2015 (CDM Regulations) came into force on April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the designer's responsibilities under clause 9 (1) is to ensure that the client organisation, in this instance Bourne Homes Ltd, is made aware of their duties under the CDM Regulations.

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Appendices

1 Executive Summary

1.1.1 PJA has been commissioned by Bourne Homes Ltd to prepare a Flood Risk Assessment (FRA) and Drainage Strategy to support a planning application for a new residential-led development of twenty-two residential dwellings with associated green open space and infrastructure at *Streamside (Land at Harpers Road)*.

Table 1-1 - Executive Summary Table

Overview	
Site Location	The Site is located east of Aldershot and west of Guildford, Surrey. OS Co-ordinates: 490422 , 150821
Development Proposal	A residential led development of twenty-two residential dwellings.
Environment Agency Flood Zone(s)	Flood Zone 1
Vulnerability Classifications(s)	More Vulnerable
Fluvial Flood Risk	Medium, but reduced to low with mitigation
Tidal Flood Risk	Very Low
Surface Water Flood Risk	Low
Groundwater Flood Risk	Low
Sewer Flood Risk	Very Low
Artificial Flood Risk	Very Low
Surface Water Drainage	Surface water is proposed to be attenuated via soakaways (plot and highways) with surface water discharging via infiltration.

2 Introduction

2.1 Terms of Reference

2.1.1 PJA were commissioned by Bourne Homes Ltd. to prepare a Flood Risk Assessment (FRA) and Drainage Strategy for a proposed residential development at *Streamside (Land at Harpers Road) (*herein referred to as 'the Site').

2.2 Scope of works

Flood Risk Assessment

2.2.1 This FRA provides information on the nature of identified potential flood risk at the Site and follows government guidance with regard to development and flood risk largely in line with the National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance (PPG).

Drainage Strategy

2.2.2 The surface water drainage strategy aims to sustainably manage surface water from the Site and has been developed largely in accordance with current sustainable development best practices and the specific requirements of Surrey County Council as the Lead Local Flood Authority (LLFA).

2.3 Information Sources

2.3.1 This report comprises a review of readily available public information and other relevant information obtained from the following sources:

- Environment Agency (EA);
- British Geological Survey (BGS);
- Cranfield Soil and Agrifood Institute Soilscapes;
- DEFRA Magic Mapping; and
- Surrey County Council.

3 Site Details

3.1 Site Description

3.1.1 The proposed development Site, which is the focus of this FRA, is mostly greenfield (undeveloped) with the exception of an existing residential dwelling located in the centre of the east of the Site.

3.1.2 The Site is bound to the east by Harper's Road beyond which is greenfield land and existing residential development. The remainder of the Site is bound by existing greenfield land, with some further residential properties to the south.

3.1.3 The Site's OS co-ordinates are 490422 , 150821.

3.1.4 A Site location plan is available in Figure 3-1.

Figure 3-1: Site Location Plan

Table 3-1 - Summary of Site

Site Address	Land adjoining Streamside, Harpers Road, Ash, Guildford, GU12 6DB
Existing Land use	Residential dwellings with associated infrastructure and green open space.
Proposed Development Type	Residential
Site Area	1.26ha
OS Co-ordinates	490422 , 150821.
County	Surrey
Local Planning Authority	Guildford Borough Council
Lead Local Flood Authority	Surrey County Council
Local Water Authority	Thames Water

3.2 Site Planning History

3.2.1 The Site has previously sought outline planning permission (under planning ref. 17/P/02616) for twenty four dwellings considering access, layout and scale.

3.2.2 The previously accepted Flood Risk Assessment and Surface Water Drainage Strategy (Paul Timmins CEng MICE PMP, December 2017) and supporting Technical Note ASP_STR01_RP02 (Paul Timmins CEng MICE PMP, December 2017) were uploaded to Guildford Borough Council planning portal in support of the planning application. These supporting documents were reviewed by Surrey County Council Lead Local Flood Authority, who found the flood risk and drainage strategy supporting the Site acceptable subject to conditions.

3.2.3 The supporting Technical Note is available in Appendix C.

3.3 Site Topography

3.3.1 The Site is predominantly greenfield (undeveloped) in nature and comprises existing open space and vegetation. An existing residential dwelling is located in the centre of the Site. From a review of the Site-specific topographic survey, undertaken by P Stubbington Land Surveys Ltd (March 2017), the Site's topography generally falls towards the stream which bisects the centre of the Site and flows from east to west. The Site falls from a level of 81.87mAOD at the northern boundary of the Site and 76.41mAOD along the southern boundary of the Site to a level of 75.01mAOD at the stream in the centre of the Site. However, the natural floodplain of the stream is to the north of the watercourse (right-bank) where levels are lower as shown in the LiDAR data shown in Figure 3-2.

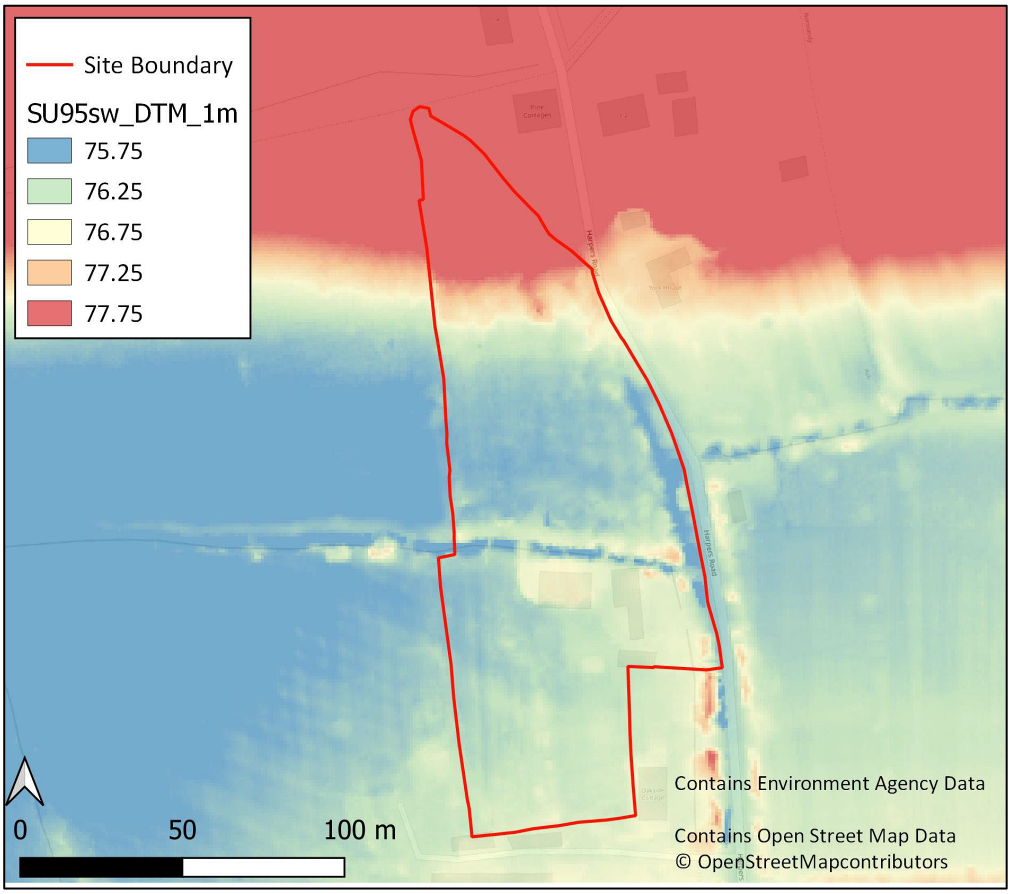


Figure 3-2: LiDAR elevation data

3.4 Ground Conditions

BGS Mapping

3.4.1 The British geological Survey (BGS) Geology of Britain viewer[1] was consulted to identify the local geological conditions. This identified that the Site is potentially underlain by sand of the Bagshot Formation. No overlying superficial deposits are identified.

Cranfield Soilscape Viewer

3.4.2 The Cranfield University Soilscape viewer[2] describes the soils as "*Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils*".

Hydrogeology

3.4.3 From a review of the publicly available DEFRA Magic Mapping[3], Aquifer Designation Map (Bedrock) the Site is underlain by a Secondary A Aquifer, that is defined as "*comprising permeable layers that can support local water supplies, and may form an important source of base flow to rivers*".

3.4.4 It is identified that the Site is not underlain by a Source Protection Zone.

Site-Specific Ground Investigation

3.4.5 A Ground Investigation Report has been undertaken for the proposed development Site by *Ground & Water (July 2015)* which identifies four windowless sample trial pits were dug at four locations across the Site. The supporting trial pit logs indicate the underlying ground conditions detailed in Table 3-1.

3.4.6 The Ground Investigation Report is available in Appendix J.

[1]British Geological Survey. Geology of Britain Viewer. https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html
[2]Cranfield Soil and Agrifood Institute. Soilscape Viewer. http://www.landis.org.uk/soilscapes/
[3] DEFRA Magic Map https://magic.defra.gov.uk/MagicMap.aspx

Table 3-1 - Ground Conditions Trial Pit Information

Trial Pit			
WS1 (mBGL)	**WS2 (mBGL)**	**WS3 (mBGL)**	**WS4 (mBGL)**
TOPSOIL: 0.0M - 0.2m	TOPSOIL: 0.0m – 0.75m	MADE GROUND: 0.0m – 0.45m	TOPSOIL: 0.0M - 0.045m
MADE GROUND: 0.2 – 0.5m	HEAD DEPOSITS (SAND): 0.75m – 1.0m	HEAD DEPOSITS (SAND): 0.45 – 0.7m	HEAD DEPSOITS (SAND) 0.45 – 0.65m
HEAD DEPOSITS (SAND AND GRAVEL): 0.55m – 0.80m	BAGSHOT FORMATION (SAND) 1.0m – 4.0m	HEAD DEPOSITS (CLAY): 0.7 – 1.1m	HEAD DEPOSITS (CLAY) 0.65m – 1.2 m
BAGSHOT FORMATION (SANDY CLAY) 0.8m – 1.6m		BAGSHOT FORMATION (SAND): 1.1m – 2.15m	BAGSHOT FORMATION (SAND) 1.2m – 1.35m
BAGSHOT FORMATION: (SAND): 1.6m – 4.45m		BAGSHOT FORMATION (CLAY): 2.15m – 2.8m	BAGSHOT FORMATION (CLAY) 1.35m – 1.75m
		BAGSHOT FORMATION (SAND): 2.8m – 4.5m	BAGSHOT FORMATION (SAND) 1.75m – 4.45m

3.4.7 No groundwater was encountered in WS1, whilst seepage was encountered at 3-4m below ground level (BGL) in WS2 and 3 and at 2-3mBGL in WS4.

3.4.8 Infiltration testing was undertaken in two locations on the Site (WS1 at 4mBGL and WS3 at 3mBGL) as part of the ground investigation and the results are shown in Table 3-2.

Table 3-2 – Infiltration Test Results (Ground Investigation Report)

Trial Hole	Depth (mBGL)	Initial Water Level (mBGL)	Final Water Level (mBGL)	Time Taken (mins)	Infiltration Rate (m/s)
WS1	4	Ground Level	0.5mBGL	60	3.33×10^{-6}
WS3	3	Ground Level	0.8mBGL	64	5.73×10^{-6}

3.4.9 In additional to the infiltration testing described above, further infiltration testing was undertaken for five test holes across the Site, as outlined in the previous approved Flood Risk Assessment and supporting Technical Note (available in Appendix C). An extract of the infiltration test location plan from the Paul Timmins Technical Note is shown in Figure 3-3.

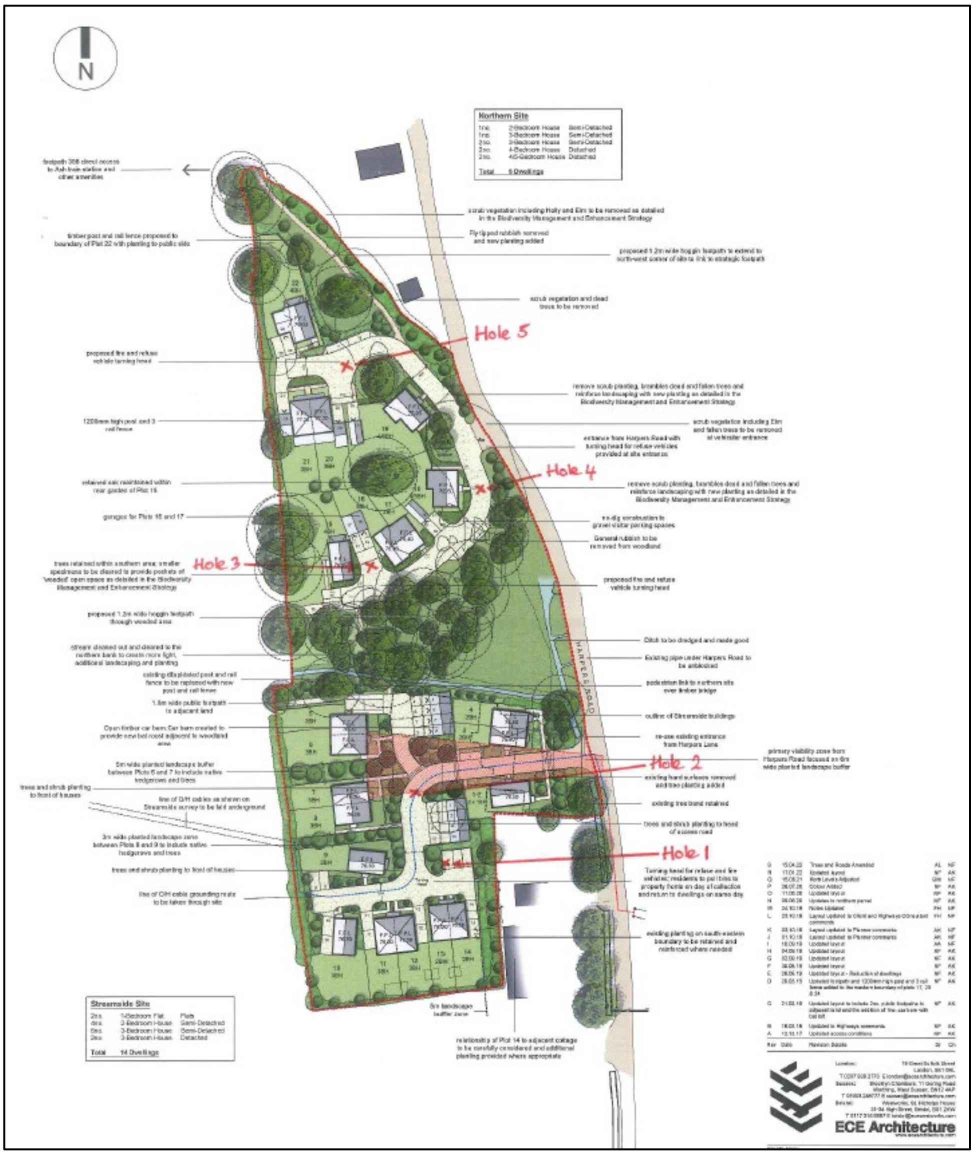


Figure 3-3: Infiltration Test Location Plan Extract

3.4.10 The infiltration test results, contained in Table 3-3, identify similar infiltration test results to those identified within the Ground Investigation Report.

Table 3-3 Infiltration Test Results (Supporting Technical Note)

Trial Hole	Depth (m)	Infiltration Rate (m/s)	Infiltration Rate (m/hr)
Hole 1	2.0	2.4×10^{-6}	0.01044
Hole 2	1.4	4.4×10^{-6}	0.01584
Hole 3	2.0	2.2×10^{-6}	0.00792
	1.5	2.9×10^{-5}	0.1044
Hole 5	2.0	7.8×10^{-6}	0.02808

3.5 Existing Drainage Assets

3.5.1 The existing Site is currently greenfield with an existing residential property. Rainwater downpipes from the existing residential dwelling are identified, however, it is not clear where surface water from the Site discharges to. It is understood that foul drainage from the existing property is treated before being discharged via infiltration.

3.5.2 Thames Water asset mapping, included in Appendix B, identifies that there are no Thames Water sewers within the Site boundary. The nearest mapped foul sewer is located approximately 150m north of the Site in Harper's Road. It is understood that there may be further Thames water sewers along Harper's Road which are not included within their asset mapping.

3.6 Site Proposals

3.6.1 The proposal is for twenty-four residential dwellings with associated infrastructure and open space.

3.6.2 The Proposed Site Plan Rev S, ECE Architects (April 2022) is available in Appendix A and an extract is contained in Figure 3-4.

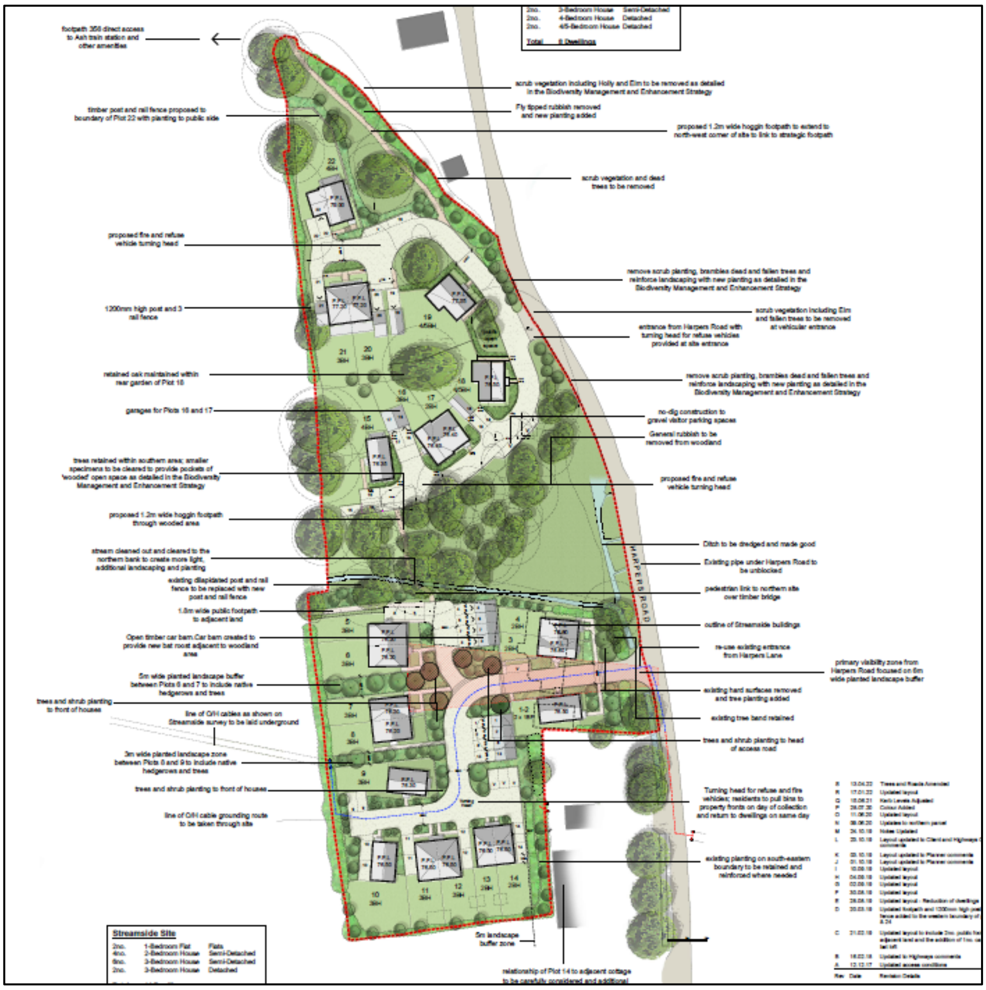


Figure 3-4: Proposed Site Plan Extract

4 Planning Context

4.1 National Planning Policy Framework

4.1.1 The revised National Planning Policy Framework (NPPF) was published by the Ministry of Housing, Communities and Local Government in July 2018 and was updated in 2021. The NPPF's Planning Practice Guidance (PPG) supports the Framework and is an online resource that is frequently updated.

4.1.2 The primary policy requirement is to identify the Flood Zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

4.1.3 Further to this, paragraph 169 of the NPPF sets out that major development should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

1 take account of advice from the lead local flood authority;

2 have appropriate proposed minimum operational standards;

3 have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

4 where possible, provide multifunctional benefits.

4.2 Local Policy

Local Plan

4.2.1 The Guildford Borough Local Plan was adopted in April 2019. Policy P4 relates to Flooding, Flood Risk and Groundwater Protection Zones. This states:

"Development in areas at medium or high risk of flooding, as identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment, including the 'developed' flood zone 3b (functional floodplain), will be permitted provided that:
a) the vulnerability of the proposed use is appropriate for the level of flood risk on the site
b) the proposal passes the sequential and exception test (where required) as outlined in the NPPF and Government guidance
c) a site–specific flood risk assessment demonstrates that the development, including the access and egress, will be safe for its lifetime, taking into account climate change, without increasing flooding elsewhere, and where possible, will reduce flood risk overall
d) the scheme incorporates flood protection, flood resilience and resistance measures appropriate to the character and biodiversity of the area and the specific requirements of the site
e) when relevant, appropriate flood warning and evacuation plans are in place and approved and

f) site drainage systems are appropriately designed, taking account of storm events and flood risk of up to 1 in 100 year chance with an appropriate allowance for climate change".

4.2.2 It also notes that SuDS should be provided to manage surface water drainage unless it is demonstrated that they are not appropriate.

4.2.3 As such, an updated Site-specific Flood Risk Assessment and surface water drainage strategy are described within this Report which demonstrates that the Site is within Flood Zone 1 of the Flood Map for Planning, that SuDS will be provided and that the development, including the access and egress, will be safe for its lifetime, taking into account climate change, without increasing flooding elsewhere.

Level 1 and 2 Strategic Flood Risk Assessment

4.2.4 The Guildford Borough Level 1 Strategic Flood Risk Assessment (SFRA)produced by CAPITA was published in January 2016.

4.2.5 This identifies Harper's Road as a key area at risk from surface water flooding in accordance with the Updated Flood Map for Surface Water. Groundwater Flood Risk Mapping, available in Appendix D of the Level 1 SFRA identifies the north of the Site as having '*Limited potential for groundwater flooding to occur*' and the south of the Site as having '*Potential for groundwater flooding of property situated below ground level*'.

4.2.6 Appendix F of the Level 1 SFRA also notes that there have been 37 reported incidents of sewer flooding across the GU12 postcode area although the specific location of these incidents are not disclosed.

4.2.7 This Site is not identified in the Level 2 SFRA. As such, this site-specific FRA will review flood risk from all sources.

Surrey Local Flood Risk Management Strategy

4.2.8 The Surrey Local Flood Risk Management Strategy sets out the following eight objectives to manage flood risk within the County:

1. Information
2. Maintenance
3. Risk Management Authority Responsibility
4. Landowner Responsibility
5. Resilience
6. Planning
7. Investment
8. Investigation

4.2.9 By enhancing how information is shared, improving maintenance of assets, better definition of the risk management authorities responsibilities, making private owners better aware of their responsibilities, improved community resilience, reduce the risk through the planning process, capital works programmes and investigation and recommendations into flooding incidents, the County aims to reduce flooding and enhance flood resilience across the County.

4.2.10 Flood risk to the Site will be reviewed through this Site-specific FRA.

4.3 Consultation

Surrey Council Lead Local Flood Authority

4.3.1 Surrey County Council were consulted and provided links to their standard information and guidance online. They did not provide any historic flood records for the Site or surrounding area.

Environment Agency

4.3.2 The Environment Agency confirmed that they hold no flood risk data for this Site.

4.3.3 All correspondence is available in Appendix I.

4.4 Flood Risk Policy and Development

4.4.1 The Environment Agency, through the publicly available Flood Map for Planning, categorises potential fluvial flood risk into Flood Zones, assuming no flood defences, which provides the basis for the assessment of flood risk and development suitability under the NPPF.

4.4.2 The proposed development Site is identified in the publicly available Flood Map for Planning as located wholly within Flood Zone 1, demonstrating that the fluvial flood risk is considered to have <0.1% Annual Exceedance Probability (AEP).

4.4.3 An extract of the Flood Map for Planning is contained in Figure 4-1.

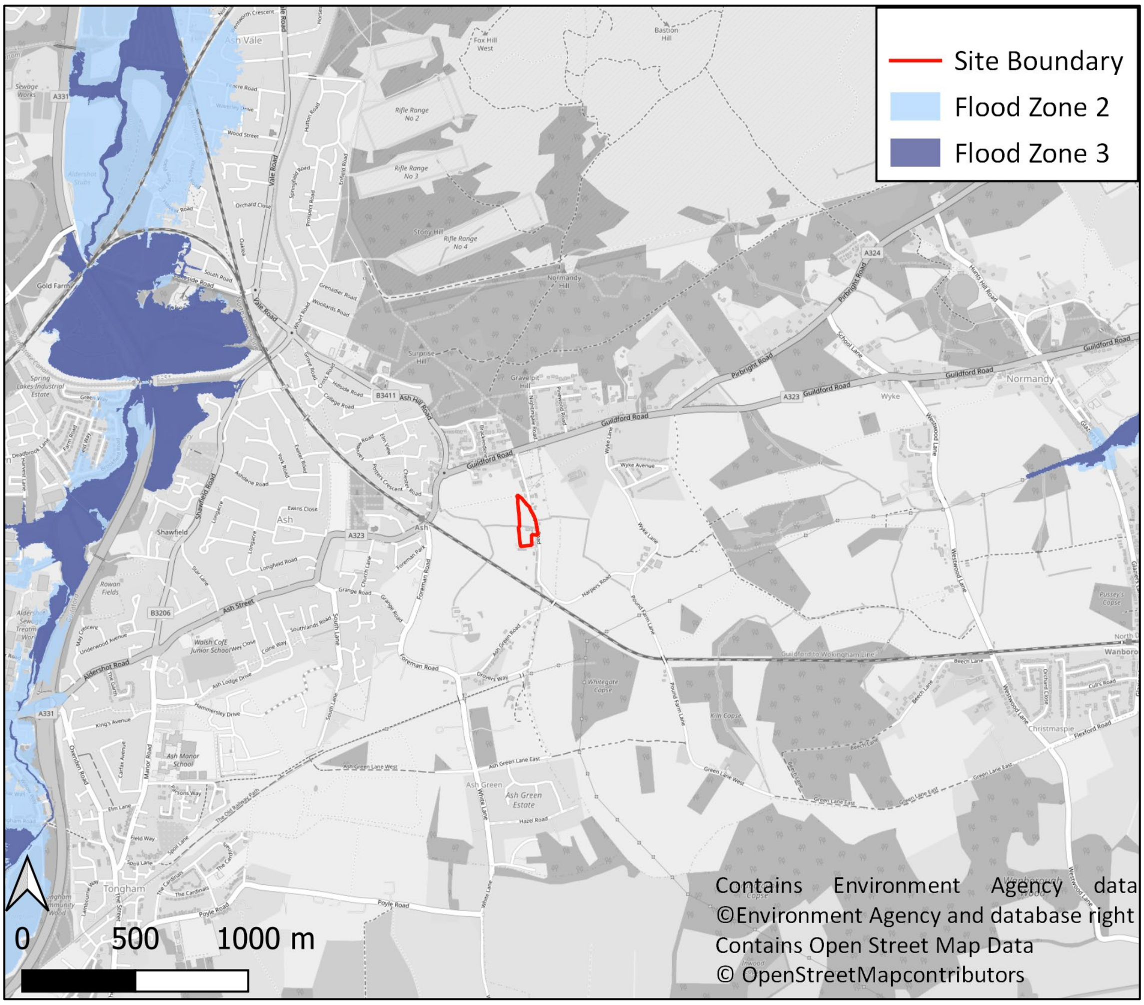


Figure 4-1 - Flood Map for Planning Extract

Vulnerability Classification

4.4.4 Table 2 of the NPPF, reprinted in Table 4-1, summaries the flood risk vulnerability classification for different types of development. The proposed residential development at the Site is classified as More Vulnerable development. An extract of NPPF Table 2 is provided Table 4-2.

Table 4-1: Vulnerability Classification (Table 2 NPPF Extract)

Class	Description
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.
Source: Table 2, NPPF Planning Practice Guidance, Reference ID: 7-066-20140306	

Sequential and Exception Test Requirements

4.4.5 In accordance with NPPF Table 3, more vulnerable and less vulnerable development is appropriate within Flood Zone 1 as shown in Table 5-3. Given this, the proposed development meets the requirements of the Sequential Test and there is no requirement to apply the Exception Test.

Table 4-2: Vulnerability and Flood Zone criteria (NPPF)

	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required †	X	Exception Test required	✓	✓
Zone 3b	Exception Test required*	X	X	X	✓*

5 Assessment of Flood Risk

5.1.1 The flood risk to and from the Site has been assessed based on a review of publicly available information (e.g. Environment Agency flood data). A summary of the flood risk at the Site is provided in Table 5-1 and discussed in more detail in the chapters below.

Table 5-1: Potential Sources of Flood Risk

Source of Flooding	On Site Presence
Fluvial	✓ *(Section 5.5)*
Tidal	×
Surface Water	✓ *(Section 5.5)*
Reservoirs	×
Groundwater	×
Sewers	×

5.2 Historic Flooding

5.2.1 The Environment Agency Recorded Flood Outlines Mapping does not identify any recorded flood extents within the Site.

5.2.2 Whilst the Guildford Borough Level 1 SFRA identifies Harper's Lane to be at risk of surface water flooding in accordance with the national surface water flood risk mapping, it does not identify any historic flood records for the Site.

5.3 Fluvial

5.3.1 The Flood Map for Planning included in Section 4.4 demonstrates that the Site is not at risk of flooding from any Environment Agency Main Rivers, however, the Site appears to be at risk from fluvial flooding from the unnamed stream which flows from east to west through the centre of the Site.

5.3.2 This is an Ordinary Watercourse and is the responsibility of Surrey Council as the Lead Local Flood Authority to consider.

5.3.3 This watercourse has been assessed within a 1D-2D hydraulic detailed model by AECOM to support the planning submission for Ash Road Bridge 19/P/01460, whose modelling was then extended upstream and refined by Ambiental in 2020.

5.3.4 The Ambiental 1D-2D TUFLOW model from 2020 has been reviewed by PJA and refined further to appropriately represent the topography from the 2017 topographic survey. The topographic survey has been digitised and applied within the 2D domain of the model as it was felt that LiDAR data incorrectly represented the Site levels due to vegetation cover.

5.3.5 On 19th February 2016, the Environment Agency released updated guidance on climate change allowances[4] to support the NPPF, which was later revised for peak river flows in 2021.

5.3.6 The Site is located within the *Loddon and tributaries Management Catchment* and the proposal is for More Vulnerable development as described in Section 4.4. Therefore, the Central climate change allowance of 14% has been used within the modelling to assess the current (baseline) flood risk.

5.3.7 The model was then updated to represent the latest climate change allowance detailed within the 2021 guidance by the Environment Agency.

5.3.8 Following these updates, the model was simulated for the 1 in 20 year, 1 in 100 year, 1 in 100 year plus climate change (14%) and 1 in 1000 year events to determine the current (baseline) flood risk.

5.3.9 Figure 5-2 to 5-4 demonstrates the maximum depths from the baseline model simulations. The 1 in 20 year event is contained within the channel of the unnamed ordinary watercourse adjacent to the proposed Site. Larger events result in shallow flooding across parts of the northern proposed Site due to the water entering Harper's Road from upstream and the flow being unable to re-join the channel immediately downstream of the road.

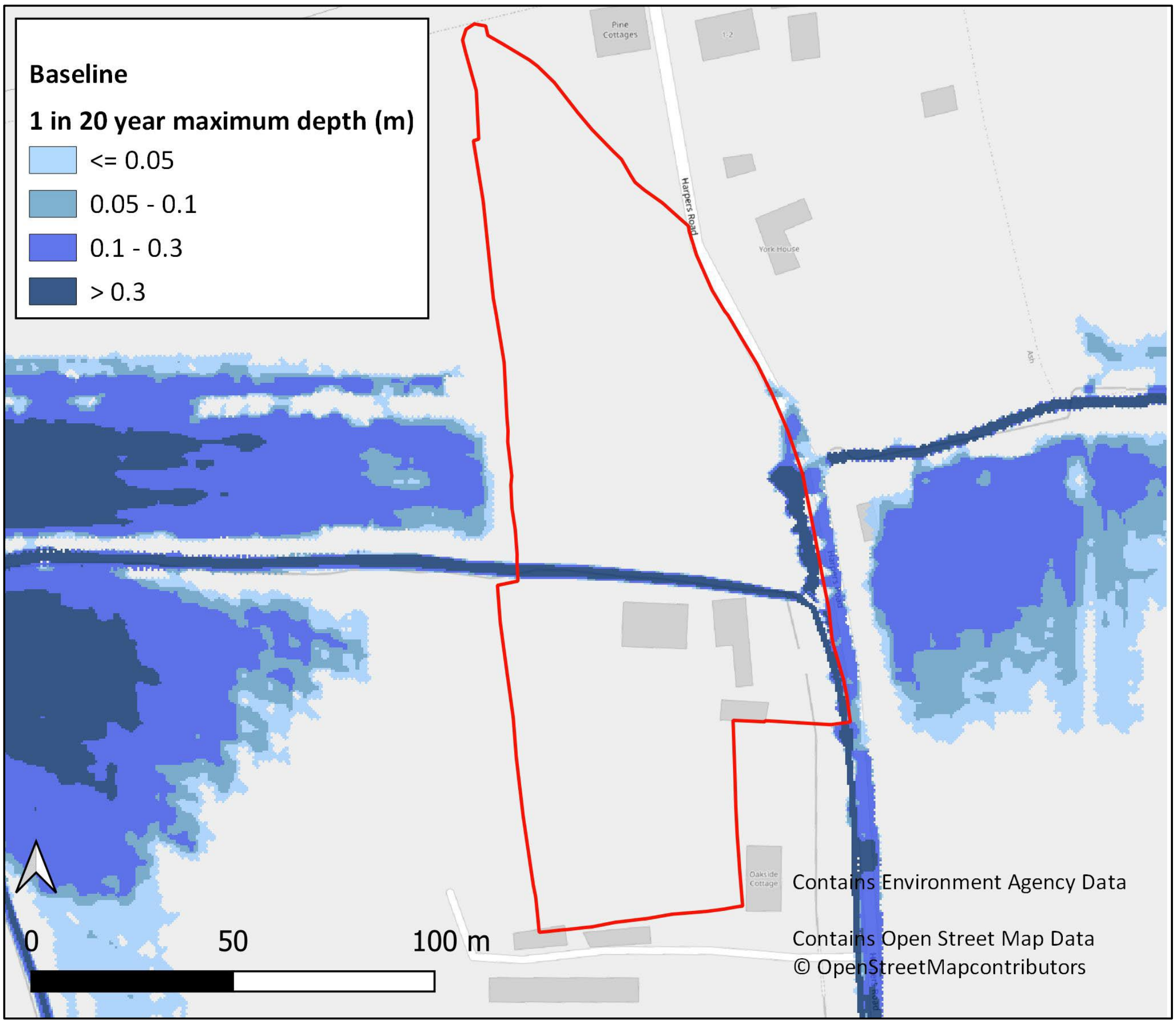


Figure 5-1: Baseline 1 in 20 year Maximum Depths

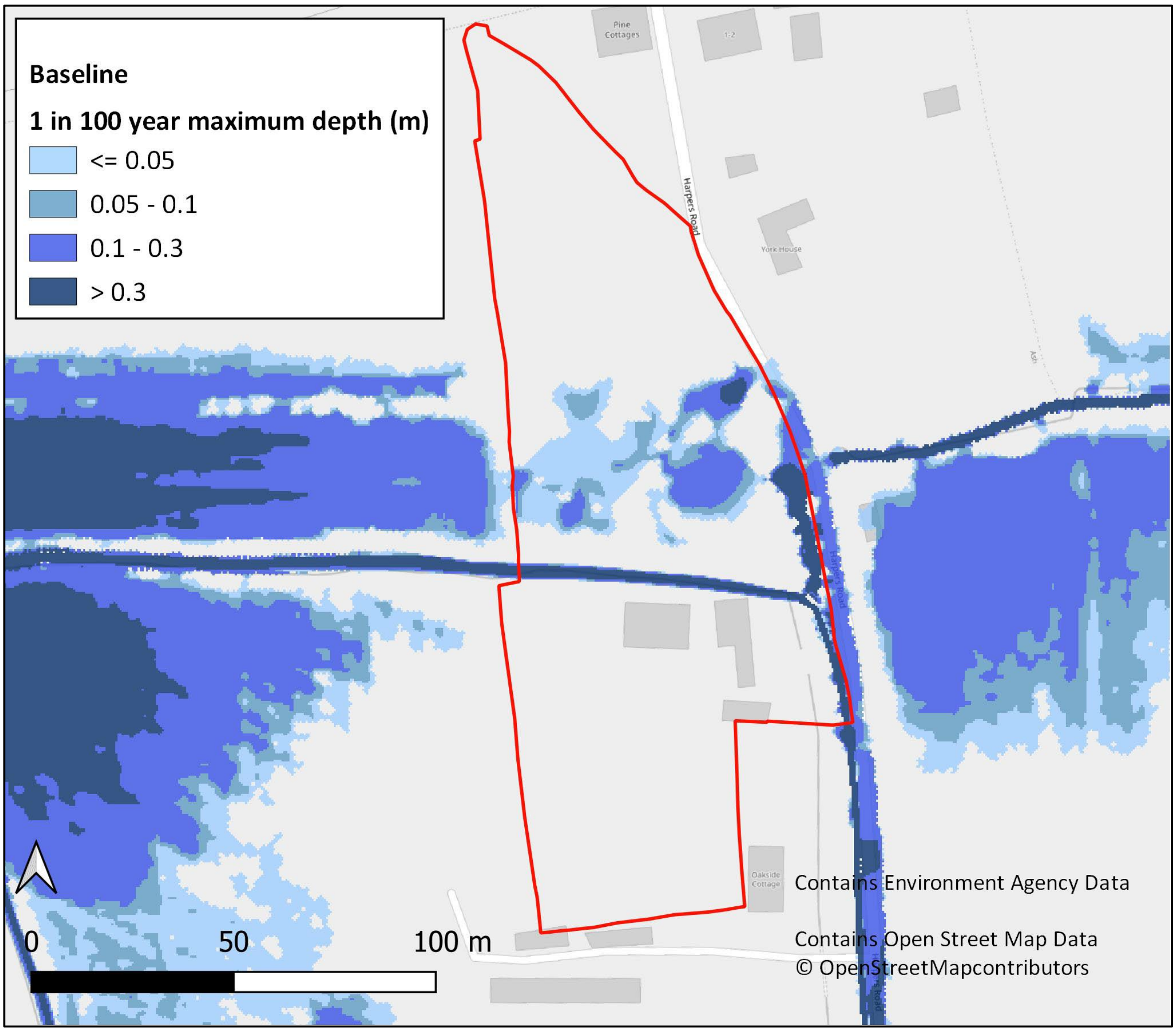


Figure 5-2: Baseline 1 in 100 year Maximum Depths

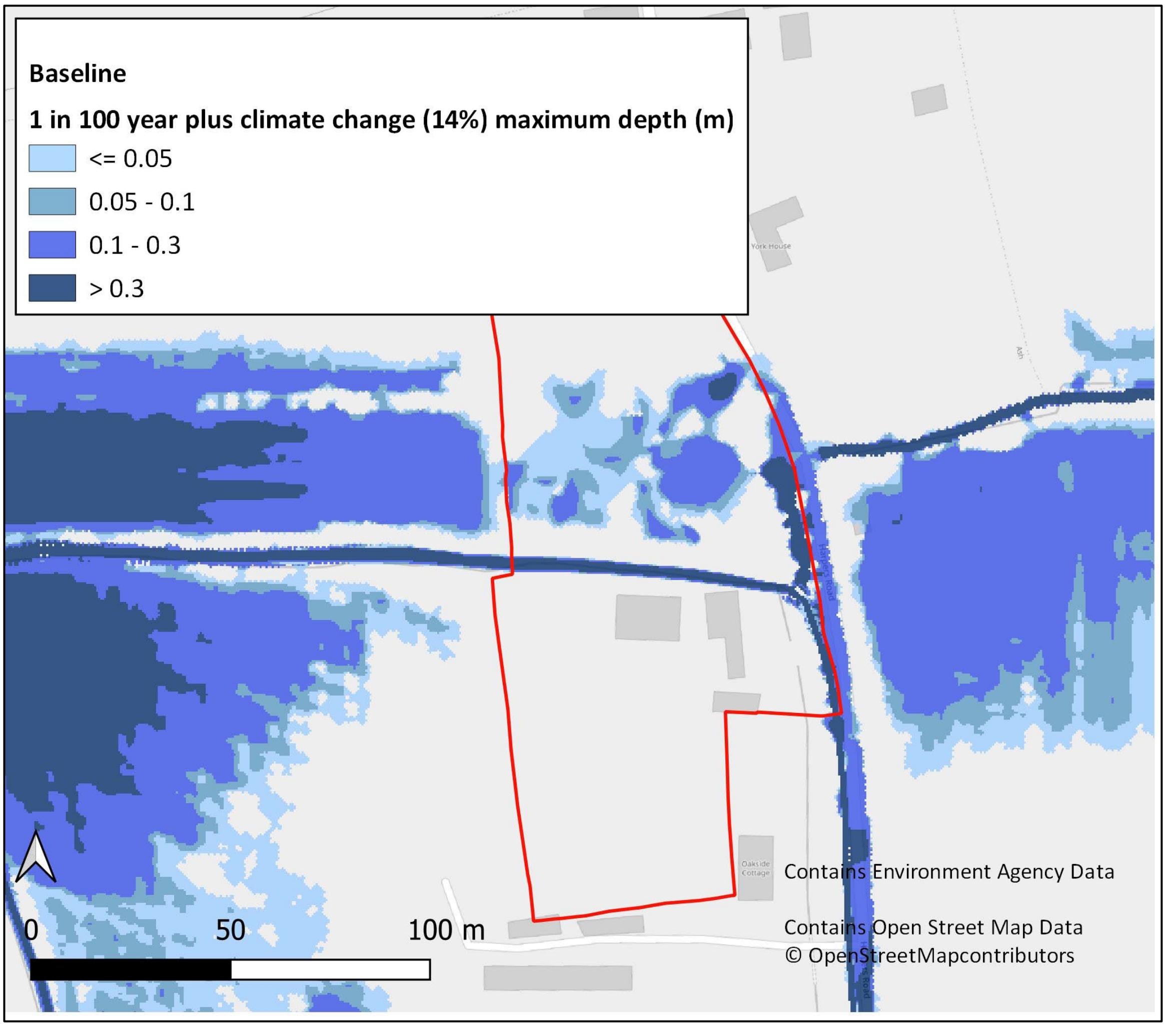


Figure 5-3: Baseline 1 in 100 year plus Climate Change (14%) Maximum Depth

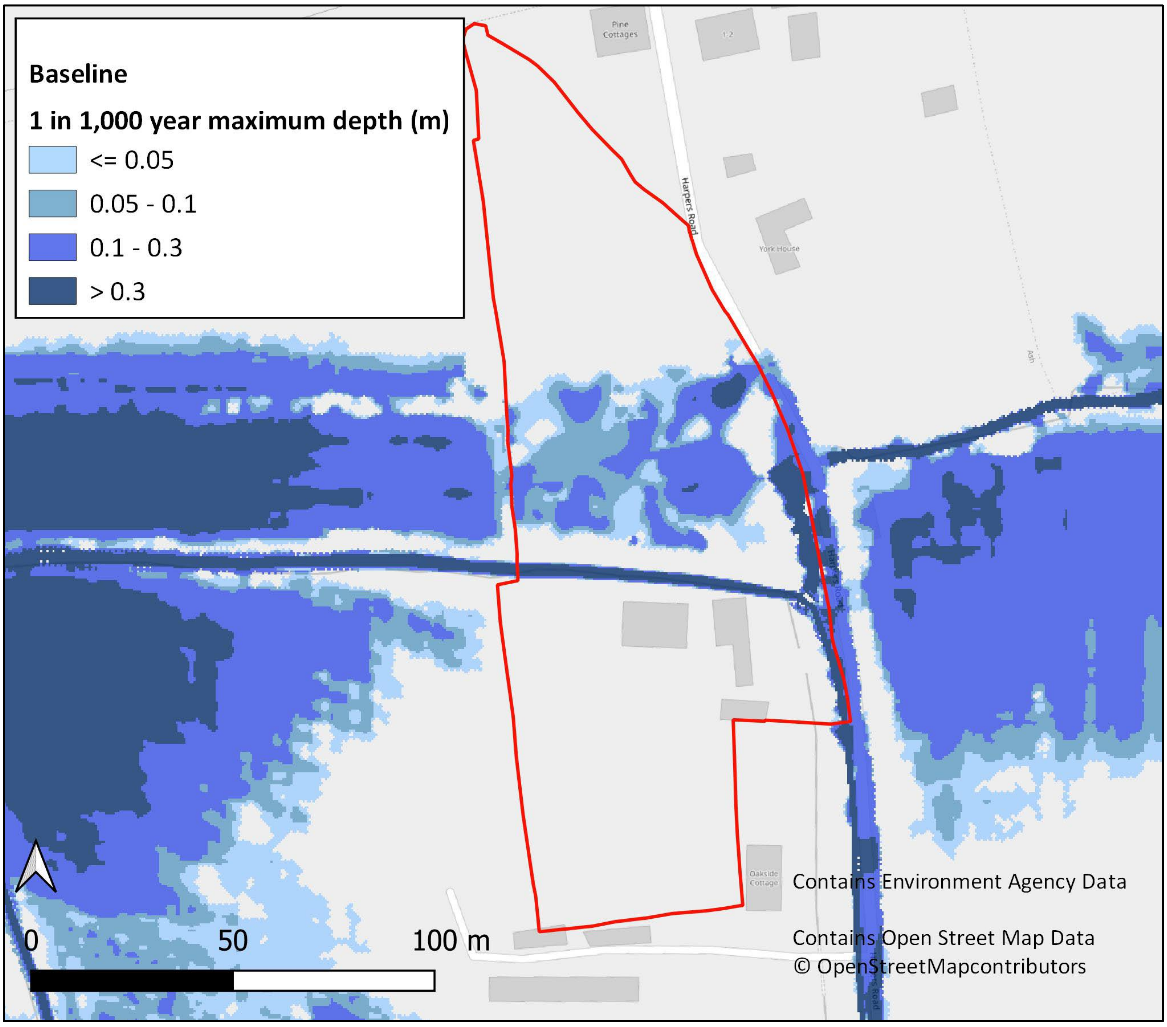


Figure 5-4: Baseline 1 in 1,000 year Maximum Depth

5.3.10 The proposed development layout requires much of the trees within the Site to be retained and therefore there is little opportunity to lower levels adjacent to the channel to allow for a more direct flow route for the water within the Site to re-join the channel.

5.3.11 The baseline model was therefore updated to represent the proposed levels required to ensure that the development would be safe for its lifetime with regards to fluvial risk from the unnamed watercourse.

5.3.12 Figure 5-5 to 5-8 demonstrates the modelled maximum depths during the proposed modelled scenarios.

5.3.13 The maximum levels adjacent to the proposed road during the 1 in 100 year plus climate change (14%) event are 75.82-76.05m AOD. The road levels will be raised above this maximum level to ensure that the road is flood-free for all events up to the 1 in 100 year event plus climate change

(14%) to allow for safe access and egress. If flooding on the road does occur this will be shallow and would be unlikely to pose a risk to life.

5.3.14 The finished floor levels of the proposed properties will be >300mm above the 1 in 100 year plus climate change maximum water levels which are denoted in Figure 5-9.

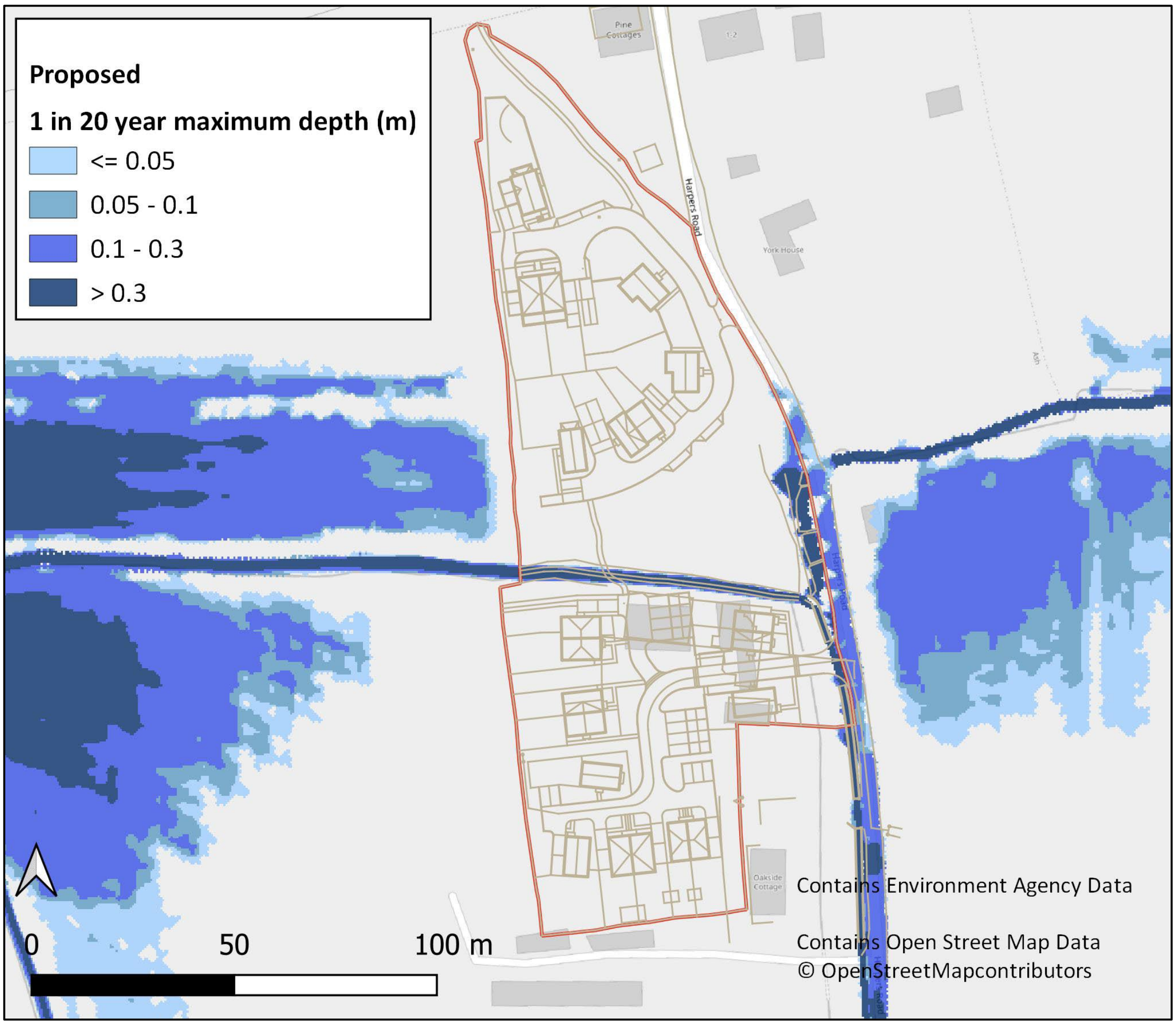


Figure 5-5: Proposed 1 in 20 Year Maximum Depth and Water Levels

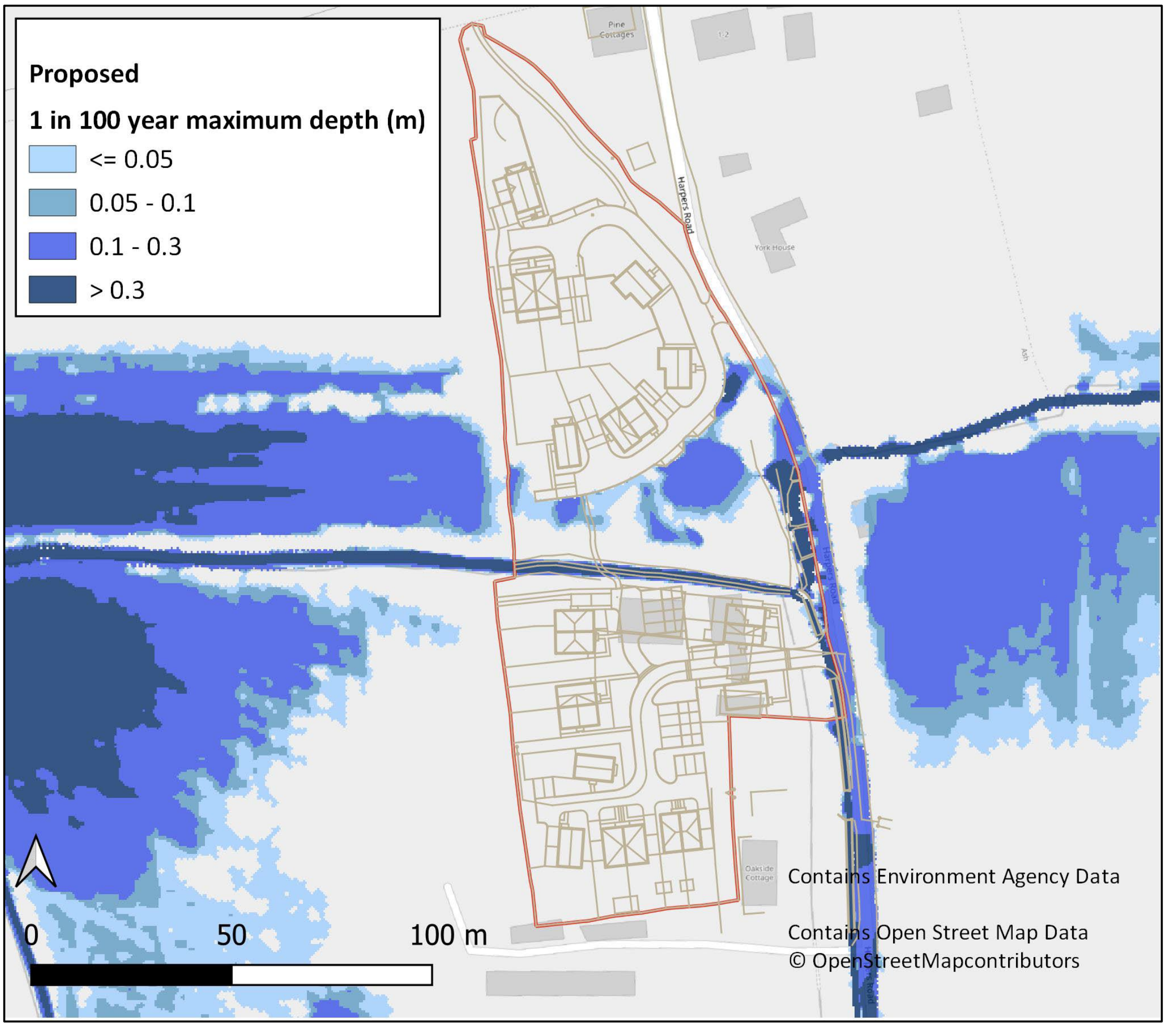


Figure 5-6: Proposed 1 in 100 Year Maximum Depth and Water Levels

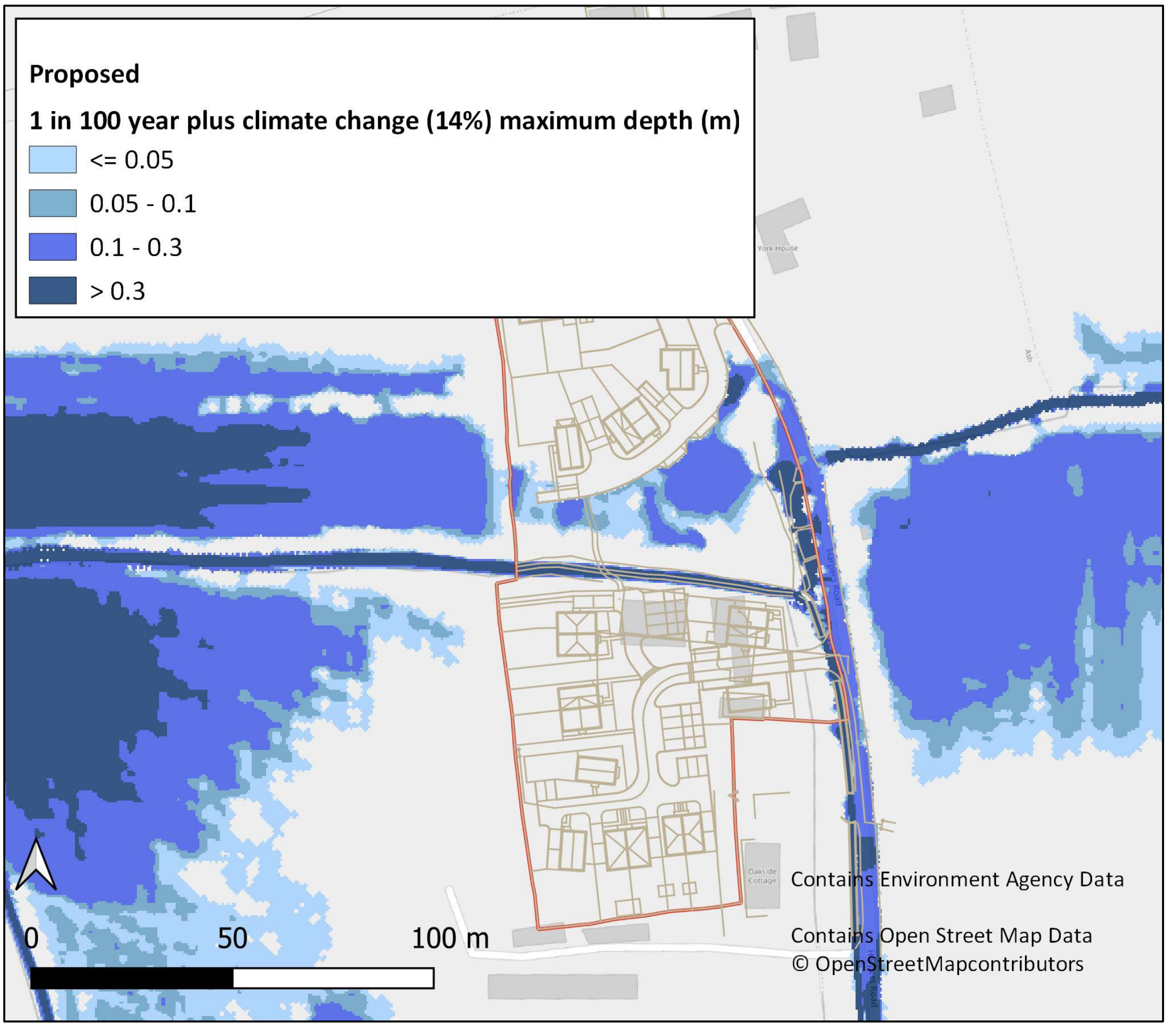


Figure 5-7: Proposed 1 in 100 Year Plus Climate Change Maximum Depth and Water Levels

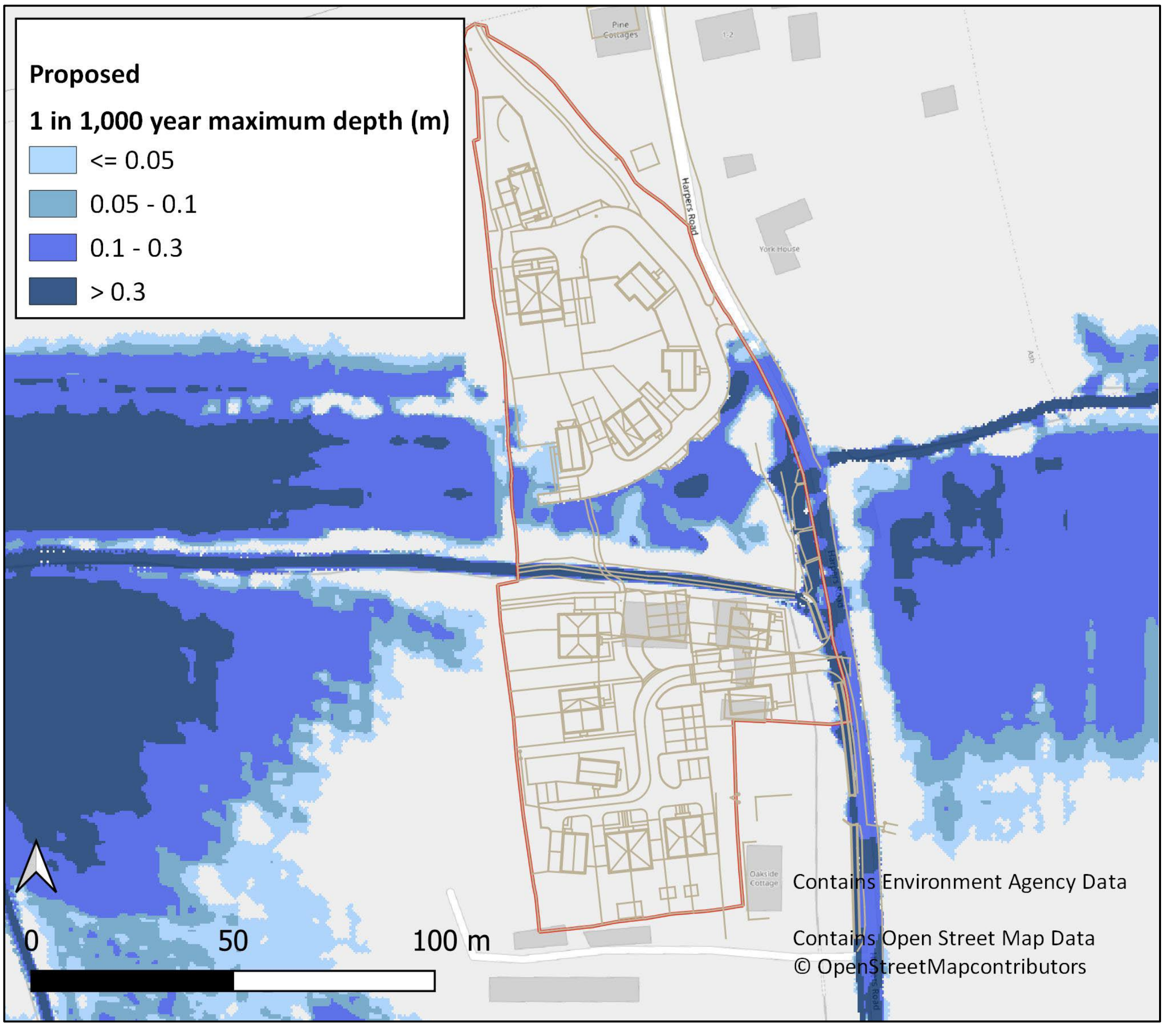


Figure 5-8: Proposed 1 in 1,000 Maximum Depth and Water Levels

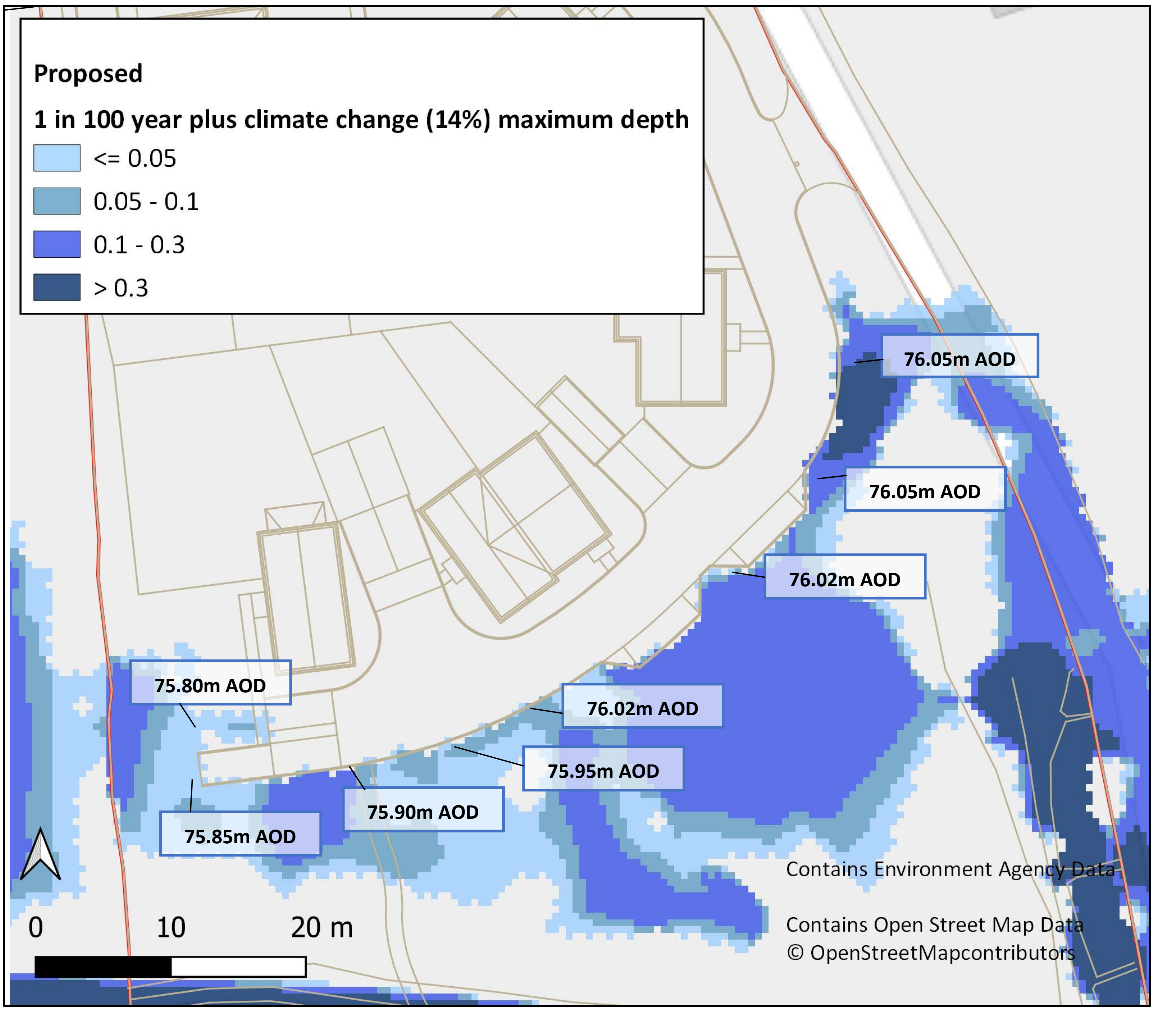


Figure 5-9: Maximum water levels during the proposed 1 in 100 year plus climate change (14%) event

5.3.15 Figure 5-10 and Figure 5-11 demonstrates that the proposed development and specifically the proposed levels on the road will not have any adverse impacts to third party flood risk during the 1 in 100 year and 1 in 100 year plus climate change modelled design events.

5.3.16 There are no changes to the flood extent or flow mechanisms during the 1 in 20 year event as the flow is contained within the channel and does not encroach into the proposed development. During the 1 in 100 year and 1 in 100 year plus climate change (14%) event the only increases in flood depth as a result of the proposed development are within the Site boundary to the south of the proposed road.

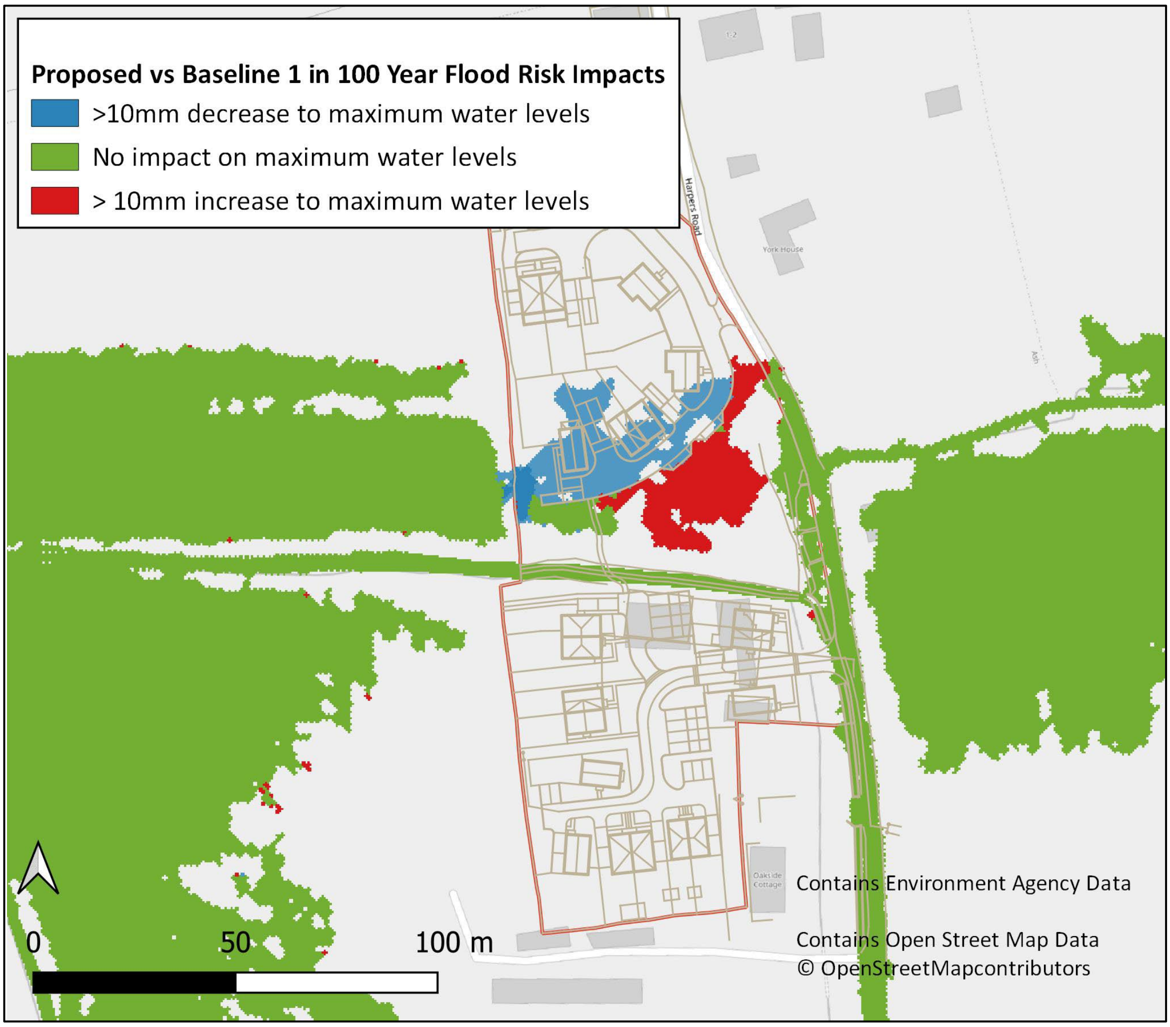


Figure 5-10: Impacts of the Proposed Development on Maximum Water Levels During the 1 in 100 year Event

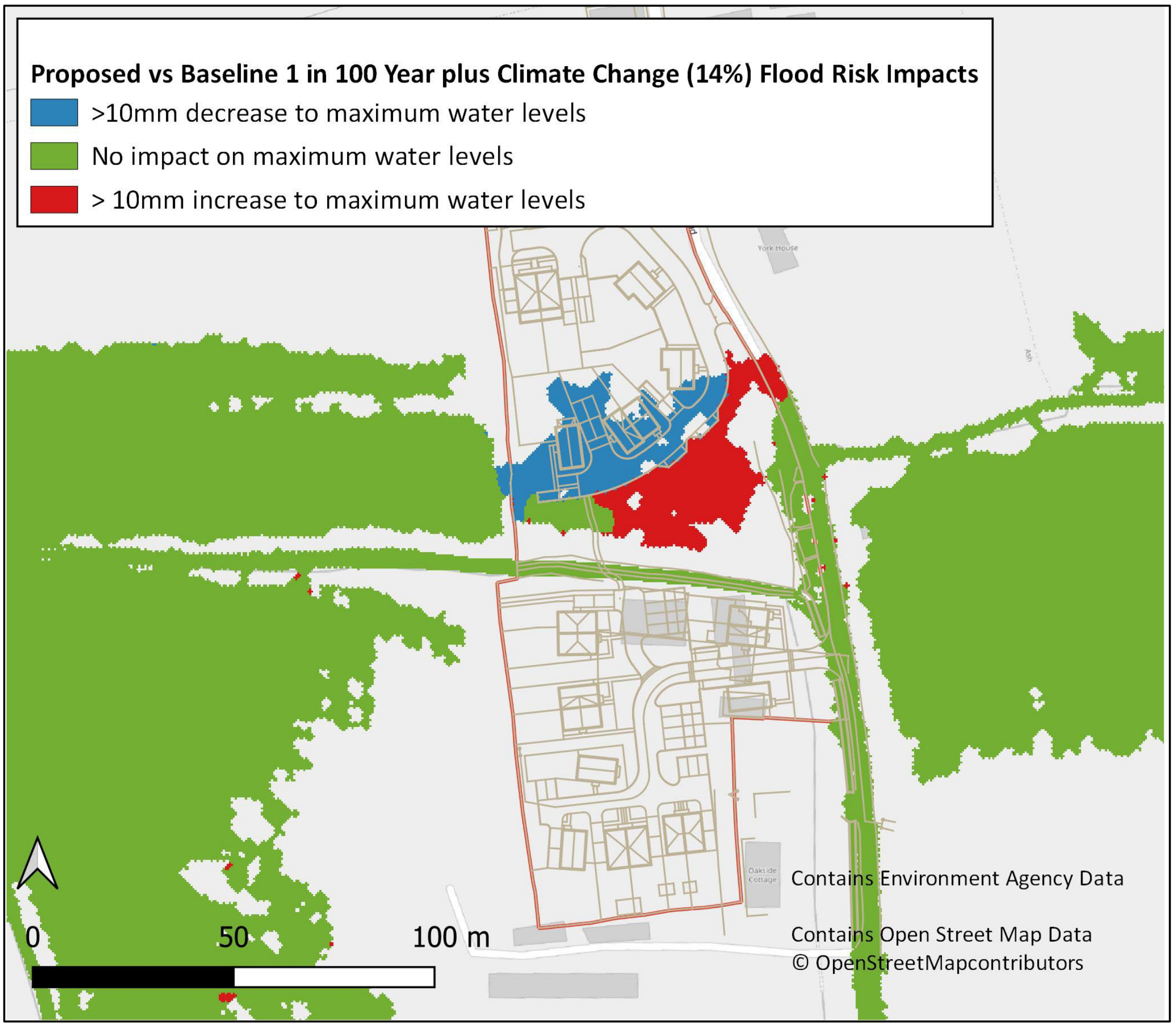


Figure 5-11: Impacts of the Proposed Development on Maximum Water Levels During the 1 in 100 year Plus Climate Change (14%) Event

5.3.17 Given the proposed mitigation at the Site, flood risk from fluvial sources is considered to be medium but can be reduced to **low** with the proposed road levels and finished floor levels incorporated without resulting in an adverse impact to third party flood risk.

5.4 Tidal

5.4.1 Given the in land location of the Site, flood risk from this source is considered very **low**.

5.5 Surface Water

Publicly Available Mapping

5.5.1 The Long-Term Flood Risk Information, Flood Risk from Surface Water Map is provided in Figure 5-12. The mapping identifies the north of the Site to be at very low risk from surface water flooding whilst a mapped surface water flow route through the southern extent of the Site is shown associated with the ordinary watercourse. This flow route comprises low, medium and high risk areas of surface water flooding and is a duplicate of the fluvial flood risk assessed in more detail within Section 5.3 of this FRA.

5.5.2 It should be also noted that the extent shown in Figure 5-12 is unrealistic as the area at the greatest risk of flooding is on the left bank to the south of the watercourses which is at a higher elevation than the right bank to the north of the watercourse as discussed in section 3.3 at.

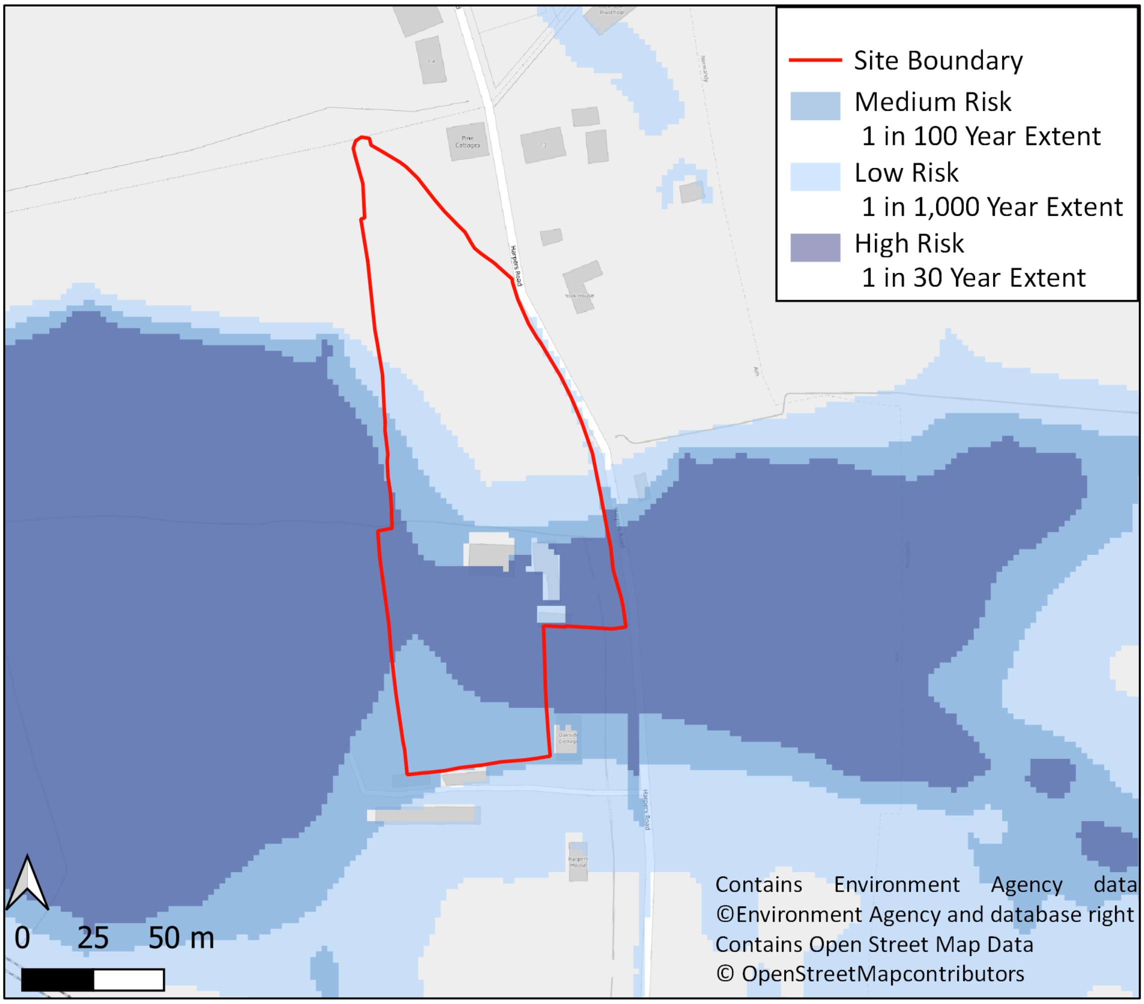


Figure 5-12: Long-Term Flood Risk, Surface Water Flood Risk Mapping Extract

5.5.3 Based on this mapping, the Guildford Borough Council Level 1 SFRA identifies Harpers Road to be at risk from surface water.

5.5.4 The production of the surface water mapping has been undertaken at a national scale to provide the first publicly available generation of surface water flood risk mapping and therefore the hydraulic modelling described in Section 5.3 provides a more accurate assessment of the flood risk indicated on the Flood Risk from Surface Water Mapping.

5.5.5 A surface water drainage strategy, detailed in Section 6, has been prepared to ensure that measures will be implemented to ensure there is negligible increase in surface water flood risk on- and off-Site and to ensure that exceedance flows will be directed away for property.

5.5.6 The Surface flood risk for the Site is therefore considered to be **Low**

5.6 Groundwater

5.6.1 Groundwater flooding is typically caused by high groundwater levels. It occurs where excess water emerges at the ground surface via springs or within manmade structures such as basements. The risk of groundwater flooding depends on the nature of the geological strata underlying the Site, as well as on the local topography.

5.6.2 Groundwater Flood Risk Mapping, available in Appendix D of the Guildford Borough Council Level 1 SFRA identifies the north of the Site as having 'Limited potential for groundwater flooding to occur' and the south of the Site as having 'Potential for groundwater flooding of property situated below ground level'.

5.6.3 A Ground Investigation Report has been undertaken for the proposed development Site by Ground & Water (July 2015) identifies four windowless sample trial pits were dug at four locations across the Site. This report is contained in Appendix J. No groundwater was encountered in WS1, whilst seepage was encountered at 3-4mBGL in WS2 and 3 and at 2-3mBGL in WS4.

5.6.4 Given this, flood risk from groundwater may be considered to be **low**.

5.7 Sewer Flood Risk

5.7.1 As set out in Section 3.5, there are no public sewers identified on Thames Water asset mapping serving the Site.

5.7.2 37 incidents of flooding across the GU12 post code area were identified within the Guildford Borough Council Level 1 SFRA however, due to the sensitive nature of this dataset, no exact locations of these incidents is available.

5.7.3 Thames Water should actively maintain its sewer network to minimise flood risk from this source.

5.7.4 Given there are no public sewers identified within the Site boundary, the Site may be considered to be at **low** risk of sewer flooding.

5.8 Reservoir Failure

5.8.1 The publicly available Long-Term Flood Risk, Information, Flood Risk from Reservoirs Mapping identifies that the Site lies outside the maximum extent of flooding from reservoirs.

5.8.2 Given this, flood risk from reservoirs may be considered to be **very low**.

5.9 Canal

5.9.1 Flooding from canals is a much less common occurrence than fluvial flooding due to the managed nature of water levels within the artificial waterways.

5.9.2 There are no canals within the vicinity of the Site.

5.9.3 Given this, flood risk from canals may be considered to be **very low**.

6 Surface Water Drainage Strategy

6.1.1 A Surface Water Drainage Strategy outlining the means of surface water management and disposal from the proposed development Site has been produced largely in line with the latest guidance as follows:

- CIRIA C753 "The SuDS Manual", November 2015;
- CIRIA document C522 Sustainable Drainage Systems – design manual for England and Wales;
- CIRIA document C635 Designing for exceedance in urban drainage;
- Rainfall Runoff Management for Developments – SC030219 (Environment Agency, 2013);
- Environment Agency's pollution prevention guidelines (PPGs);
- Sewerage Sector Guidance – Design & Construction Guidance v2 (Water UK, March 2020); and
- Surrey County Council Sustainable Drainage System Interim Guidance.

6.1.2 The proposed Surface Water Drainage Strategy aims to sustainably manage surface water runoff without increasing flood risk to on- or off-Site, nor adversely impacting on water quality through the use of Sustainable Drainage Systems (SuDS).

6.1.3 SuDS aim to mimic the natural processes of surface water drainage by allowing water to flow along natural flow routes ensuring that runoff rates and volumes during storm events are not increased above the Greenfield values. SuDS also aim to provide water treatment, biodiversity and amenity benefits within Blue and Green corridors.

6.1.4 There are typically three design storm events which should be considered when designing the SuDS system and managing flows and volumes:

- 1 in 1 year storm event, on sloping Sites without basements, where surcharging above soffits of any surface water drainage pipework is not permitted.
- 1 in 30 year storm event, where surface water flooding of the site does not occur at this frequency.
- 1 in 100 year storm event with allowances for future climate change, where runoff from the site should be controlled to the greenfield rate using SuDS attenuation features to manage flows and volumes within the extents of the development Site.

6.1.5 Further to this, dedicated overland flow routes should be identified through the development to convey any exceedance flows in rainfall events greater than the 1 in 100-year plus climate change event or in the event of system failure.

6.2 Existing Surface Water Drainage Features

6.2.1 The existing Site is currently greenfield with an existing residential property. Rainwater downpipes from the existing residential dwelling are identified however, it is not clear where surface water or foul water from the Site discharges to.

6.2.2 Thames Water asset mapping, included in Appendix B, identifies that there are no Thames Water sewer within the Site boundary. The nearest foul sewer is located approximately 150m north of the Site in Harpers Road.

6.2.3 Undeveloped areas of the Site will discharge overland flows to the central stream which bisects the Site.

6.3 Discharge Hierarchy

6.3.1 In accordance with SuDS guidance, surface water should be sustainably managed and designed in accordance with the discharge hierarchy; collect for re-use; infiltrate to ground; discharge to watercourse; discharge to surface water sewer, highway drain or another drainage system; and lastly discharge to a combined sewer.

Table 6-1 – Drainage Hierarchy

Discharge Location	Suitability	Comments
Collect for Re-Use	✓ / ×	Water butts and rainwater harvesting systems can collect rainwater for non-potable uses e.g. within gardens and other non-potable uses. The potential to incorporate rainwater harvesting and re-use measures may be assessed during the detailed design stage.
Infiltration	✓	Based on the Site-specific infiltration testing, as outlined in Section 3.4, soakaways may be utilised to manage surface water flows from the Site.
Watercourse	✓ / ×	An existing ordinary watercourse bisects the Site, should infiltration be found to be unsuitable at a later date, attenuated flows could discharge to the watercourse.
Surface Water Sewer	×	There are no public surface water sewers within the vicinity of the Site.
Combined Sewer	×	There are no public combined sewers within the vicinity of the Site.

6.3.2 In accordance with the above search sequence, it is proposed to utilise infiltration to manage surface water flows from the Site however, should the need arise, surface water could discharge at an attenuated rate to the adjacent watercourse which bisects the Site.

6.4 Climate Change Impact

6.4.1 In line with the climate change allowances recommended by the Environment Agency in their February 2016 guidance, updated May 2022, the impact of climate change on the peak rainfall intensities in urban drainage designs should be assessed by Management Catchment and increased accordingly.

6.4.2 The peak rainfall intensity allowances for the Loddon and tributaries Management Catchment has therefore been reviewed, as detailed for the 1% annual exceedance rainfall event in Table 6-2.

Table 6-2 – Peak Rainfall Allowances for the Loddon and tributaries Management Catchment

	Central Allowances	Upper End Allowances
2050s	20%	40%
2070s	25%	40%

6.4.3 The proposed development and associated surface water drainage scheme has been designed to sustainably manage the run-off from the critical 1 in 100 year storm event with a 40% allowance for climate change.

6.4.4 Consideration to the potential impact of climate change has been given in the proposed development, in particular with regard to locating built development outside of the maximum flood extents in climate change scenarios and exceedance flow routing.

6.5 Proposed Surface Water Drainage Strategy

6.5.1 The proposed Surface Water Drainage Strategy is shown on the Indicative Surface Water Drainage Strategy drawing (Ref. 06153-WR-A-0101), included in Appendix D.

6.5.2 In accordance with the drainage hierarchy, site-specific infiltration testing has been undertaken which indicates that the Site is suitable for an infiltration-led drainage strategy. As such, the drainage strategy is proposing a on-plot-soakaways to manage the surface water generated from the proposed dwellings and highway soakaways to manage the surface water generated from the proposed highways. The strategy incorporates SuDS components to control discharge from the Site in soakaways, provide attenuation storage on-Site and provide treatment to run-off.

6.5.1 Proposed bioretention features and landscaping have been proposed to be utilised in areas of proposed landscaping to enhance water quality and improve the Biodiversity Net Gain (BNG) scoring of the development.

6.5.2 Soakaways are proposed to be located >5m from any proposed buildings, in accordance with Building Regulations Document H. Further to this, the soakaways also have to be located outside of the existing tree root protection zones of retained trees on Site as far as reasonably practicable.

6.5.3 Infiltration rates utilised within the Causeway Flow Calculations have been based on the infiltration test results at the nearest location as outlined in Surface Water Drainage Infiltration Catchment Plan. Plots have been grouped based on the nearest infiltration test results and assumed 50% impermeable based on the largest plot size in that group. An extract of the plan, identifying which plot utilises which infiltration test result is available in Appendix E.

6.5.4 The required storage volume for the attenuation of the 1 in 100 year event plus 40% climate change event has been calculated for each plot and highway area, assuming the plots are 50% impermeable and the highway is 100% impermeable based on the current masterplan. As part of the detailed design the assumed proportion of impermeable area within each plot will be confirmed and the storage requirement can be refined based on the actual proportion of impermeable surfacing plus 10% for urban creep.

6.5.5 The estimated contributing areas and proposed soakaways are shown together with their required capacity on the Indicative Surface Water Drainage Strategy drawing in Appendix D. A summary table for the proposed attenuation for catchments shown in Appendix E is provided in Table 6-3 which also identifies the impermeable area which has been assumed each development parcel.

6.5.6 The surface water drainage system has been sized in Causeway Flow to convey the run-off from the critical 1 in 100 year (+40% climate change allowance) storm event without flooding. Refer to Appendix G for the Causeway Flow outputs.

Table 6-3: SuDS Summary

Assumed Catchment	Proposed Developable (per plot) [ha]	Proposed Impermeable Area [ha]	Proposed Attenuation Volume Required 1 in 100 Year + 40% CC [m^3]	Proposed Infiltration Rate (m/hr)
Hole 1 – Plots 10-14	0.030	0.018	15.3	2.4×10^{-6}
Hole 1 – Highway	0.030	0.030	25.2	4.4×10^{-6}
Hole 2 – Plots 1-9	0.027	0.016	12.4	2.2×10^{-6}
Hole 2 – Highway Area 1	0.010	0.010	8.0	2.9×10^{-5}
Hole 2 – Highway Area 2	0.020	0.020	15.8	7.8×10^{-6}
Hole 2 – Highway Area 3	0.030	0.030	23.4	2.4×10^{-6}
Hole 3 – Plots 15-17	0.032	0.019	12.4	4.4×10^{-6}
Hole 3 – Highway	0.033	0.033	29.4	2.2×10^{-6}
Hole 4 – Plot 18	0.028	0.017	9.2	2.9×10^{-5}
Hole 4 – Highway	0.033	0.033	17.5	7.8×10^{-6}
Hole 5 – Plots 19-22	0.032	0.019	13.9	2.4×10^{-6}
Hole 5 - Highway	0.022	0.022	15.4	4.4×10^{-6}

6.5.7 The proposed Surface Water Drainage Strategy implements SuDS in the form of geocellular soakaways and bioretention areas or rain gardens with appropriate communal areas.

6.5.8 Water butts may be available for all households to provide an opportunity for water re-use. However, as the attenuation capacity for the water butts cannot be guaranteed during a rainfall event, these have not been accounted for within drainage strategy attenuation calculations.

6.5.9 The drainage strategy is based upon the site masterplanning details at the time of production. Changes to the site development profile, impermeable areas across the site or other such aspects of the scheme will result in the need to revise the calculations.

6.6 Development Creep

6.6.1 Over the lifetime of a development, it is possible that the overall impermeable area within the Site could increase by as much as 10% through the house buyers undertaking activities such as property extensions and introducing paved gardens.

6.6.2 Table 6-4 identifies the potential increase in impermeable area as a result of urban creep over the lifetime of the development for the proposed residential plots. As the proposed highway catchments have already assumed to be 100% impermeable, a development creep assessment has not been undertaken on these catchments.

Table 6-4 - Development Creep Assessment

Catchment	Impermeable Area (ha)	10% Creep (ha)	Total Impermeable Area
Hole 1 – Plots	0.018	0.0018	0.0198
Hole 2 – Plots	0.030	0.0030	0.0330
Hole 3 – Plots	0.016	0.0016	0.0176
Hole 4 – Plots	0.010	0.0010	0.0110
Hole 5 - Plots	0.020	0.0020	0.0220

6.6.3 Calculations demonstrating the performance of the network with the additional impermeable area are available in Appendix H.

6.6.4 As part of the detailed design the assumed proportion of impermeable area within each plot will be confirmed and the storage requirement can be refined based on the actual proportion of impermeable surfacing plus 10% for urban creep.

6.7 Water Quality

Principles of Water Quality Assessment

6.7.1 The general principles to mitigate against adverse impacts on water quality in the receiving water environment is described in the CIRIA C753 "The SuDS Manual" (2015). This document recommends the following steps to determine the required water quality management for discharges to surface waters and groundwaters based on the risk posed:

1. Interception: Prevent runoff and associated pollutants from the Site to receiving surface waters for the majority of small rainfall events (e.g. <5mm rainfall events);
2. Determine the pollution hazard level associated with the given type of development;
3. Select a risk assessment approach based on receiving water environment and the pollution hazard level; and
4. Undertake a detailed risk assessment for each outfall or discharge point taking into account the pollution hazard level, the status of the receiving water environment and effectiveness of the proposed SuDS techniques.

6.7.2 The extent of the treatment required will depend on the water quality status of receiving watercourses, land use, the level of pollution prevention in the catchment and for groundwater, the natural protection afforded by underlying soil layers. The pollution hazard level of the development type should be identified.

6.7.3 Residential roofs are noted as having a 'very low' pollution hazard level and require removal of gross solids and sediments only. Residential car parks, access roads, driveways and non-residential car parking with infrequent change (e.g. schools) are shown to present a 'low' pollution hazard level.

6.7.4 Low pollution hazard levels require application of a 'simple index approach' for water quality risk assessment for discharges to surface and ground waters.

Existing Water Quality of the Proposed Receiving Watercourses

6.7.5 The Site falls within the Environment Agency's Thames River Basin which covers over 16,200km^2. It encompasses all of Greater London and extends from north Oxfordshire southwards to Surrey and from Gloucester in the west to the Thames Estuary and parts of Kent in the east[5].

6.7.6 The Thames River Basin has been divided into twenty management catchments where the Site falls into the *Loddon and Trib* Management Catchment and into the *Loddon* Operation Catchment.

6.7.7 From review of available mapping, the Site contributes to the waterbody *Blackwater (Aldershot to Cove Brook confluence at Hawley)*[6].

[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718342/Thames_RBD_Part_1_river_basin_management_plan.pdf

[6] https://environment.data.gov.uk/catchment-planning/WaterBody/GB106039017180

6.7.8 This is identified as a not designated artificial or heavily modified waterbody. The 2019 Cycle identifies it has a 'Moderate' ecological status and a 'Fail' chemical status.

6.7.9 Reasons for not achieving good status include:

- Unknown Perfluorooctane sulphonate (PFOS) - investigation pending
- Transport drainage
- Contaminated land
- Trade / industry discharge
- Sewage discharge (continuous)
- Polybrominated diphenyl ethers (PBDE) – no sectors responsible
- Urbanisation – transport and urban development
- Invasive non-native species - North American Signal Crayfish

6.7.10 As such the Environment Agency will be seeking improvements to the water quality of the local watercourse system to achieve a status of Good by 2027.

6.7.11 The principles of the SuDS Management Train should be incorporated into the proposed surface water drainage schemes for new development, to reduce the risk of further pollutants entering watercourses via run-off from roofs and paved areas.

6.7.12 SuDS components can reduce pollution in run-off through filtering out pollutants or reducing flow rates to encourage deposition of any contaminants. Suitable components could include:

- permeable paving;
- filter drains;
- swales;
- attenuation basins;
- wetlands; and
- proprietary treatment systems.

6.7.13 To protect biodiversity and amenity assets, polluted surface water run-off should not be discharged directly into permanent ponds but treated through an appropriate treatment train. Where possible, interception storage should be included as part of the treatment train to manage pollutants at source. Later stages of treatment in the train should incrementally reduce the level of pollution in run-off before discharge to the receiving water body.

6.8 Contamination and Water Quality

6.8.1 The proposed development will utilise a SuDS Management Trains across each network to ensure treatment of run-off and removal of pollutants prior to discharge.

6.8.2 This is likely to include a mixture of components across the Site, specified according to the opportunities/constraints presented by:

- the likely pollution hazard of the run-off;
- the available surface space; and
- the proposed ground levels/falls across areas of hardstanding.

6.8.3 Treatment components within each SuDS Management Train may include:

- permeable pavement (for car parking areas);
- channel drains;
- catchpits;
- trapped gullies;
- attenuation basins incorporating pre-treatment (such as a sediment forebay) and low flow channels;
- bioretention areas in greenspace around the Site;
- swales and linear wetlands;
- filter drains bordering paved areas such as roads and yards; and
- proprietary treatment systems (such as downstream defenders).

6.8.4 The arrangement and composition of each management train will be confirmed at the detailed design stage.

6.8.5 The proposed uses at the Site will comprise residential roofs and individual driveways. Roofs are classified as a 'very low' pollution risk and individual driveways are classed as a 'low' pollution risk level in Table 26.2 of CIRIA C753 The SuDS Manual. 'Low' hazard pollution levels require application of a 'simple index approach' for water quality risk assessment for discharge to surface and groundwaters. The "pollution hazard indices" for a low pollution hazard Site are given in Table 6-5 below.

Table 6-5 - Pollution Hazard Indices for a Low Pollution Hazard Site

Total Suspended Solids (TSS)	Metals	Hydrocarbons
0.5	0.4	0.4

6.8.6 The surface water drainage system should provide a sufficient level of water quality treatment to prevent pollution of the receiving waterbodies. During the water treatment design event (5mm rainfall across the entire Site) no runoff should leave the Site.

6.8.7 Indicative SuDS mitigation indices for soakaways are not detailed within the CIRIA C753 The SuDS Manual but in is understood that soakaways would provide the same level of treatment through the substrate as permeable paving.

6.8.8 Table 6-6 provides the Indicative SuDS mitigation indices for the proposed SuDS features for the Site. It demonstrates that the mitigation index for the proposed soakaways and Bioretention Systems are greater than the "*pollution hazard index*" for each pollutant type. Therefore, the strategy is deemed to comply with the water quality requirements of the SuDS standards.

Table 6-6 - Indicative SuDS Mitigation Indices

SuDS component	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Bioretention System	0.8	0.8	0.8
Soakaway, assuming similar water quality function as permeable paving	0.7	0.6	0.7

6.8.9 Should it be required, proprietary treatment systems could also be implemented to supplement the proposed geocellular soakaway crates that manage the surface water drainage from the Site.

6.9 Designing for Exceedance

6.9.1 During a rainfall event with a return period well in excess of that for which the surface water drainage system was designed (in this case a 1 in 100 year plus 40% climate change allowance), or in the event of a blockage, the capacity of the surface water drainage system may be exceeded, resulting in localised flooding in the areas affected. This is considered to be a residual risk.

6.9.2 However, the layout and landscaping of the proposed development will be developed to ensure that exceedance flood flow paths are routed away from vulnerable development and toward landscaped areas, areas of open attenuation or surrounding green infrastructure.

6.9.3 In line with Building Regulations the finished floor levels of the properties will be set at least 150mm above the surrounding ground levels to prevent surface water ingress through doorways. Location of buildings in ground depressions will be avoided to prevent water ponding around dwellings.

6.9.4 Minor modifications to topography, the profile of the access road, footpath or kerb and strategically placed green infrastructure will be developed to ensure that exceedance flood flows are managed and there is little or no risk of property flooding or unacceptable ponding within the highway.

7 Adoption & Management

7.1 Surface Water Drainage System

7.1.1 Responsibility for the maintenance of the main surface water drainage networks and SuDS features may be offered to Thames Water for adoption under S104 of the Water Industry Act 1991. To meet the requirements for adoption, the proposed infrastructure must be designed and constructed according to Sewerage Sector Guidance – Design & Construction Guidance v2 (Water UK, March 2020).

7.1.2 Alternatively, it is common for SuDS features in communal areas to be operated and maintained by a third-party private maintenance company. Should this be necessary, a third-party management company would be established to maintain the features in perpetuity and an adoption agreement between the final Site developer and Maintenance Company would be largely based upon the CIRIA ICoP MA2 SuDS Maintenance Framework Agreement.

7.1.3 The maintenance of the soakaways serving individual properties and the new private road will be the responsibility of the private householder.

7.1.4 Drainage serving the entrance to the private road may be offered for adoption by the Local Highway Authority and may become highway drains, adopted as part of Section 38 agreements (Highways Act 1980).

7.1.5 A typical maintenance schedule for the proposed SuDS are available in the Tables below.

Table 7-1 – Soakaway Indicative Maintenance Schedule

Frequency	Action
Monthly	• Inspect and identify and areas that are not operating correctly. If required, take remedial action (for three months following installation)
Six Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period)
Annually	• Remove sediment from any pre-treatment structures
As Required	• De-silt as required
Following All Significant Storm Events	• Inspect and carry out essential recovery works to return feature to full working order

Table 7-2 - Rain Garden/Bioretention System Indicative Maintenance Schedule

FRQUENCY	ACTION
Monthly	• Litter and debris removal • Mulching (where required) • Inspect / check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required.
Six Monthly	• Remove nuisance and invasive vegetation
Annually	• Pruning and trimming trees • Inspect and document presence of wildlife • Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where required
As Required	• Repair erosion or other damage by re-mulching or re-seeding • Re-seed areas of poor vegetation growth. Alter plant types to better suit requirements, if required. • Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface (typically every 60 month period) • Remove build-up of sediment, reinstate design levels (typically every 60 month period) • Remove and dispose of oils or petrol residues using safe standard practices
Following All Significant Storm Events	• Inspect and carry out essential recovery works to return feature to full working order

7.1.6 The proposed maintenance regimes for the drainage assets should be largely in accordance with The SuDS Manual (CIRIA C753) and other best practice guidelines and in accordance with manufacturer's recommendations. This will ensure the design performance, structural integrity and where applicable- appearance of each feature is maintained throughout its lifetime.

7.1.7 Further details will be provided on the maintenance requirements of the proposed SuDS components across the development as the detailed design is developed. The details of the party responsible for maintenance of each feature will be confirmed prior to occupation of the proposed development.

8 Conclusion & Recommendations

8.1 Conclusion

8.1.1 PJA has been commissioned by Bourne Homes Ltd. to prepare a Flood Risk Assessment and Drainage Strategy for the proposed residential development at '*Streamside (Land at Harpers Road)*'.

8.1.2 This Flood Risk Assessment has been undertaken in accordance with current national and local food risk policy requirements. This report assesses the existing and future flood risk at the Site, including an assessment of the potential effects of the proposed development on flood risk on- and off-Site.

8.1.3 The assessment concludes that the Site is currently considered at medium risk of fluvial flooding. However, the changes to the ground levels as part of the proposed development will reduce fluvial flood risk at the Site to low.

8.1.4 The assessment concludes that the Site is at either very low or low risk of flooding from the other sources assessed (tidal, reservoirs, canals, surface water, groundwater and sewers).

8.1.5 A Surface Water Drainage Strategy has been prepared to demonstrate that a sustainable drainage solution can be provided for the proposed development. The Surface Water Drainage Strategy has been designed largely in accordance with current sustainable development best practice and meets the requirements of Surrey County Council (as the LLFA).

8.1.6 The proposed surface water drainage systems aims to mimic the hydrological regime of the existing Site by utilising infiltrating discharge from each proposed surface water catchment. Attenuation storage will be provided in the form of plot soakaway and highway soakaways, with additional water quality treatment, biodiversity and amenity provided through the implementation of rain gardens / bioretention features. Water butts may be used to store water for re-use within feasible locations but these have not been included within attenuation calculations as the capacity availability cannot be guaranteed.

8.1.7 SuDS Management Trains will provide suitable treatment of run-off by removing pollutants prior to discharge.

8.1.8 Safe access and egress will be available to and from the Site for events up to and including the 1 in 100 year plus climate change (40%) rainfall events.

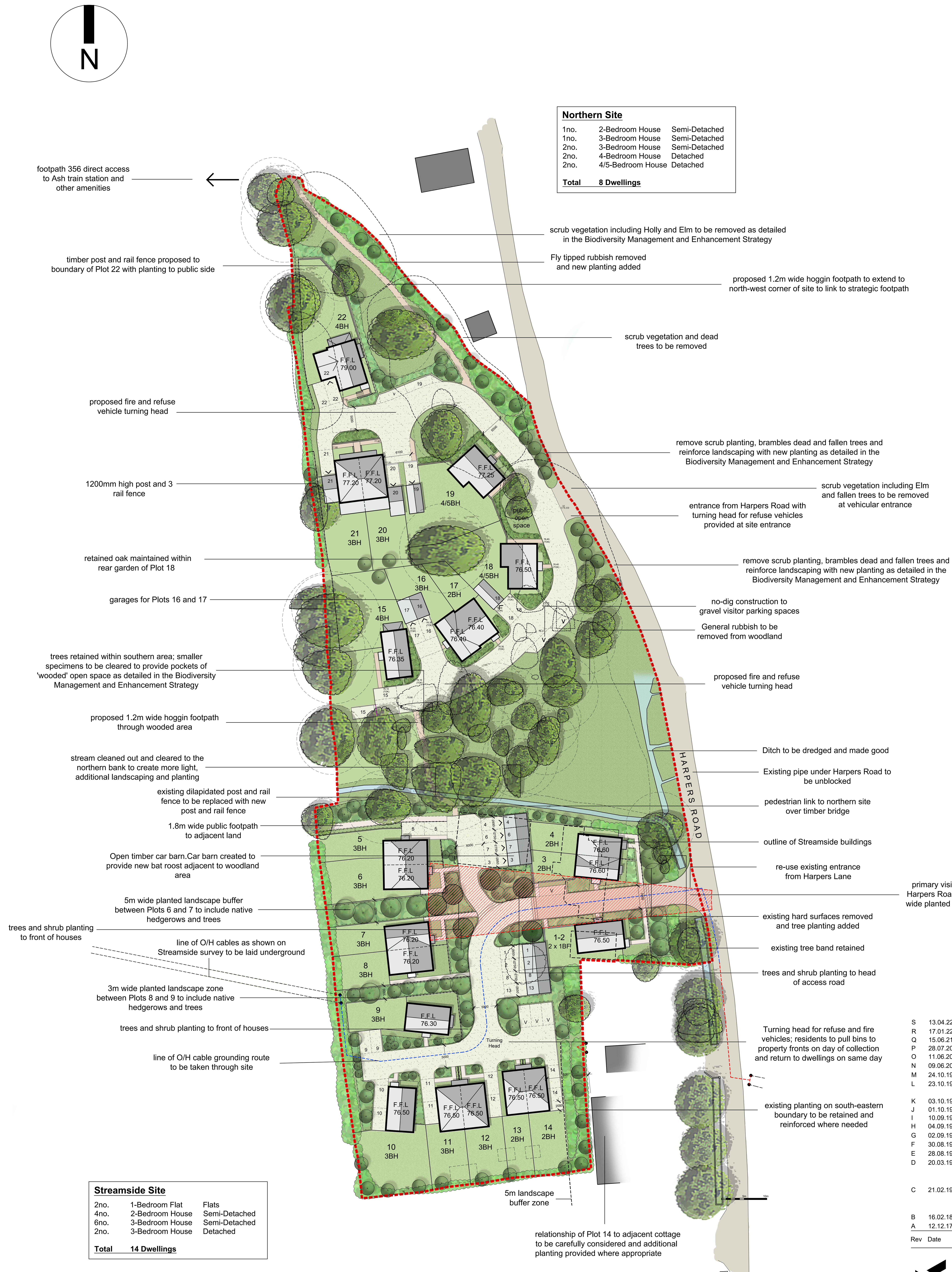
8.1.9 The responsibility for the operation and maintenance of each SuDS feature will be confirmed prior to the commencement of construction. The SuDS used on Site should be maintained in accordance with manufacturer's recommendations and current best practice and guidelines to ensure routine operation.

8.1.10 This report demonstrates that the proposed development may be undertaken in a sustainable manner without increasing the flood risk either at the Site or to any third-party land in line with NPPF requirements.

Appendix A Proposed Masterplan

CDM 2015 Health & Safety Information

This information relates only to 'Significant Hazards' identified on this drawing and is to be read in conjunction with the Designer's Risk Assessment Register.



Northern Site

1no.	2-Bedroom House	Semi-Detached
1no.	3-Bedroom House	Semi-Detached
2no.	3-Bedroom House	Semi-Detached
2no.	4-Bedroom House	Detached
2no.	4/5-Bedroom House	Detached
Total	**8 Dwellings**	

Streamside Site

2no.	1-Bedroom Flat	Flats
4no.	2-Bedroom House	Semi-Detached
6no.	3-Bedroom House	Semi-Detached
2no.	3-Bedroom House	Detached
Total	**14 Dwellings**	

Rev	Date	Revision Details	Dr	Ch
S	13.04.22	Trees and Roads Amended	AL	NF
R	17.01.22	Updated layout	NF	AK
Q	15.06.21	Kerb Levels Adjusted	BW	NF
P	28.07.20	Colour Added	NF	AK
O	11.06.20	Updated layout	NF	AK
N	09.06.20	Updates to northern parcel	NF	AK
M	24.10.19	Notes Updated	FH	NF
L	23.10.19	Layout updated to Client and Highways COnsultant comments	FH	NF
K	03.10.19	Layout updated to Planner comments	AK	NF
J	01.10.19	Layout updated to Planner comments	AK	NF
I	10.09.19	Updated layout	AA	NF
H	04.09.19	Updated layout	NF	AK
G	02.09.19	Updated layout	NF	AK
F	30.08.19	Updated layout	NF	AK
E	28.08.19	Updated layout - Reduction of dwellings	NF	AK
D	20.03.19	Updated footpath and 1200mm high post and 3 rail fence added to the western boundary of plots 17, 23 & 24	NF	AK
C	21.02.19	Updated layout to include 2no. public footpaths to adjacent land and the addition of 1no. car barn with bat loft	NF	AK
B	16.02.18	Updated to Highways comments	NF	AK
A	12.12.17	Updated access conditions	NF	AK

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Client's Name
Bourne Homes

Job Title
Steamside and Land Adjacent,
Harpers Road, Ash

Drawing Title
Proposed Site Plan

Scale
1:500 @ A1 / 1:1000 @ A3

metres 10 20 30 40 50

Drawn	Checked	Date
NF	AK	08.12.17

Job No	Drawing No	Rev
6502	001	S

Status
APPROVAL

CAD Plot date: 13/04/2022 - 15:52:07 6502 ash site layout planning - revised layout al.dwg

Appendix B Thames Water Asset Mapping

Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

DWS/DWS Standard/2015_2994289

Foul Drainage

0 25 50 100 150 200 Meters

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified before any works are undertaken. Crown copyright Reserved

Scale:	1:4037	**Comments:**
Width:	800m	
Printed By:	nmuniyas	
Print Date:	16/03/2015	
Map Centre:	490450,150784	
Grid Reference:	SU9050NW	

Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

DWS/DWS Standard/2015_2994289

0 15 30 60 90 120
Meters

Scale:	1:2524	**Comments:**
Width:	500m	
Printed By:	nmuniyas	
Print Date:	16/03/2015	
Map Centre:	490450,150784	
Grid Reference:	SU9050NW	

Appendix C Previously Approved Technical Approval (17/P/02616)

Project: Land adjoining Streamside, Harper's Road, Ash
Application ref: 17/P/02616
Report ref: ASP_STR01_RP02 dated December 2017
Supplementary information to support the Flood Risk Assessment

This addendum has been prepared by Paul Timmins CEng MICE in response to a request for further information from Stephen Haggett (Surrey County Council Flood Risk & Sustainable Drainage Officer) as communicated in his letter dated 27th February 2018.

His letter requested:

- Percolation test sheets from the Ground investigation to demonstrate the testing complies with BRE 365 and ground water monitoring for the site;
- An alternative drainage strategy to discharge to the stream

A location plan of BRE365 tests carried out on the site are appended to this document and accompanied by the calculations used to derive the infiltration rates.

These provide back-up to the infiltration rates stated within Table 3.2 of the report (see below).

Trial Hole/Depth (m)	Infiltration Rate (m/s)
Hole 1 / **2.0m***	2.4×10^{-6}
Hole 2 / 1.4m	4.4×10^{-6}
Hole 3 / **2.0m***	2.2×10^{-6}
Hole 4 / 1.5m	2.9×10^{-5}
Hole 5 / **2.0m***	7.8×10^{-6}

Table 3.2: BRE365 test results (taken from FRA)

* Due to a typographical error in the report the depths of the trial holes were misquoted in the FRA. The correct values are shown in the data sheets appended to this document. These values are used in all further analysis.

It has been reported that seepage of groundwater was not encountered within any of the trial holes undertaken for the BRE365 testing. Additionally, the ground investigation included within the FRA demonstrates that two of the four window sample location recorded groundwater (with a minimum depth of 2.15m below ground level). We are confident that infiltrating structures are appropriate for the site, however, no data is available which can definitively demonstrate that the groundwater levels are 1.0m or more below the base of the proposed infiltration structures.

An alternative solution is therefore proposed, which may be implemented if the groundwater is found to be at a level which prevents the use of infiltrating structures.

The alternative strategy will allow all runoff to be discharged to the stream passing through the site controlled at the pre-development greenfield runoff rate. For ease of calculation the discharge rate is to be limited to the value of QBAR for all storm events up to the 1 in 100 year plus climate change storm event.

As the depth of construction of permeable parking bays (traffic category 3) is expected to be 335mm, the trial hole information provided in this document demonstrates that the groundwater table is greater than 1m below the base of the permeable parking bays.

The table below uses the information from the impermeable areas calculation in Appendix K1 to calculate the total impermeable areas from each sub-catchment. These areas could be reduced still further by allowing part of the impermeable road area to drain to the permeable parking zones, however a conservative approach shall be taken which assumes that no additional runoff shall discharge into the parking bays.

Area	Unit / Zone	Roof area (m^2)	Roof Area inc. 10% for urban creep (m^2)	Road Area (m^2)	Permeable paving (m^2)	Total impermeable area (m^2)
South	**Unit 1**	38	42			42
	Unit 2	38	42			42
	Unit 3	51	57			57
	Unit 4	50	55			55
	Road 1			209	0	209
	Unit 5	57	63			63
	Unit 6	54	60			60
	Unit 7	51	57			57
	Unit 8	48	53			53
	Unit 9	48	53			53
	Unit 10	52	58			58
	Road 2			432	160	272
	Road 3			285	150	135
	Road 4			238	100	138
	Unit 11	85	94			94
	Unit 12	52	58			58
	Unit 13	57	63			63
	Unit 14	56	62			62
	Unit 15	57	63			63
	Unit 16	56	62			62
	Unit 17	98	108			108
	Total					**1804**
North	**Unit 18**	68	75			75
	Unit 19	71	79			79
	Unit 20	99	109			109
	Road 5			448	100	348
	Road 6			227	0	227
	Unit 21	99	109			109
	Unit 22	83	92			92
	Unit 23	81	90			90
	Road 7			389	87	302
	Unit 24	102	113			113
	Total		1717	2228	597	**1544**

The table shows that by including a 10% allowance for urban creep and deducting the area of permeable parking bays, that 1,804sqm of impermeable area drains from the South sub-catchment and 1,731 sqm drains from the North sub-catchment.

Table 4.1 in the main report states that the greenfield runoff rate for a QBAR event is 3.56 l/s. Apportioning this to the North and the South sub-catchments (0.7h and 0.5ha in area respectively), provides a target limiting discharge for each half of the site, i.e 2.1 l/s for the North and 1.5 l/s for the South.

In order to control flooding events an attenuation storage structure for each portion of the site has been sized to prevent flooding to the 1 in 100 year plus 20% climate change event. The output of these model runs are provided in Appendix 4.

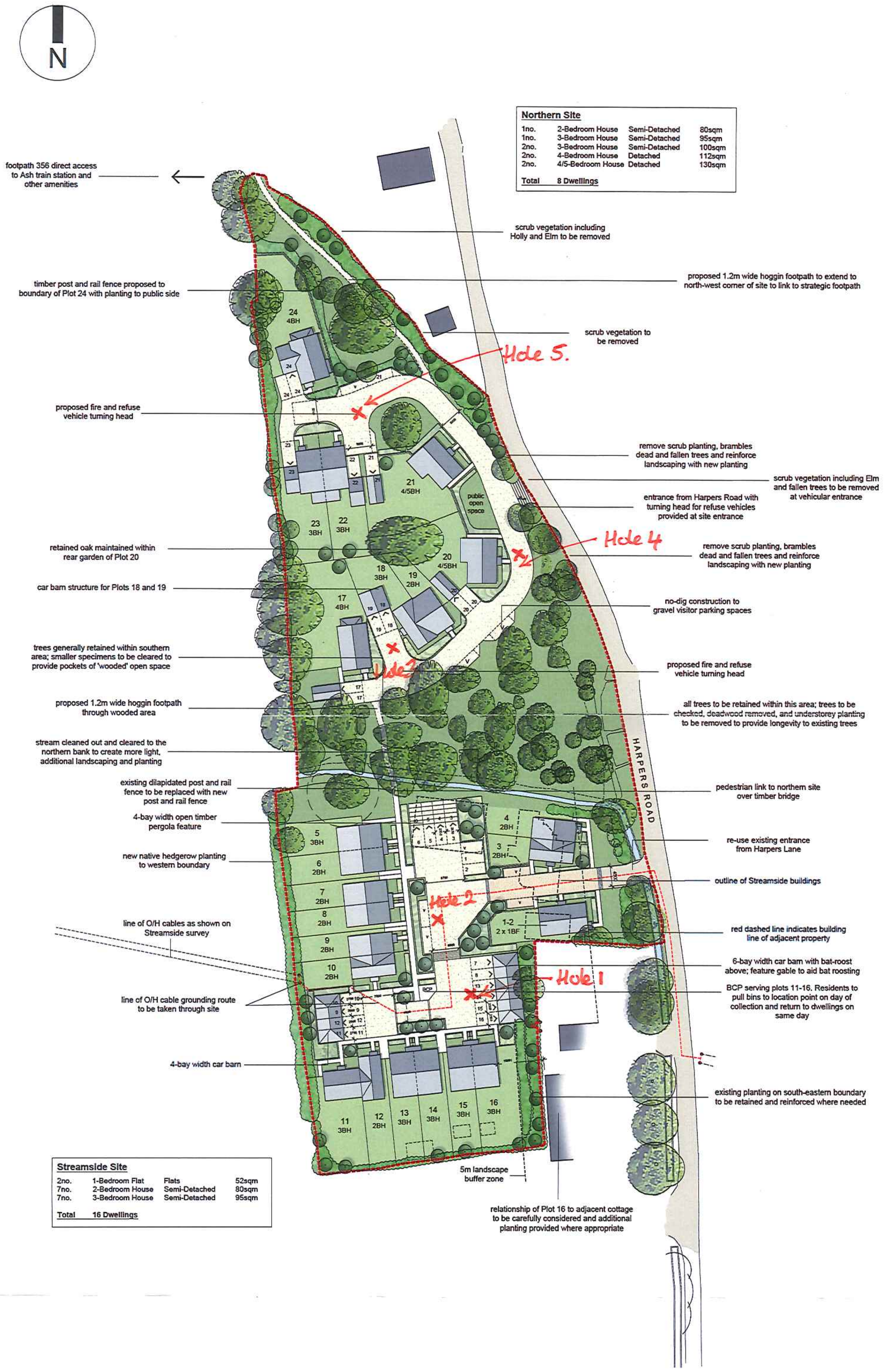
In the north portion of the site, an orifice plate to limiting flows to 2.1l/s and an attenuation structure of 12mx8mx0.8m (77m3) will prevent flooding during the 1 in 100 year (plus climate change) return period event.

In the south portion of the site, an orifice plate to limiting flows to 1.5l/s and an attenuation structure of 12mx12mx0.8m (115m3) will prevent flooding during the 1 in 100 year (plus climate change) return period event..

Appendix 1 – Location Plan of BRE365 tests

CDM 2015 Health & Safety Information

This information relates only to 'Significant Hazards' identified on this drawing and is to be read in conjunction with the Designer's Risk Assessment Register.



Project: Harpers Lane, Ash
Title: Locations of BRE365 permeability tests
Date: November 2017

Appendix 2 – BRE 365 tests results and calculations

SOAKAWAY, INFILTRATION RATE CALCULATION

Hole 1 - Streamside
Courtyard to Front of Plots 15 and 16

Excavate hole 2.1m long x 0.45m wide x 1.8m below finish ground level

Cover Level of soakaway 800mm below ground level

Invert Level of soakaway 1,800mm below ground level

Total effective depth 1,000mm

Effective storage volume Vp75-25

2.1 x 0.45 x (1.55 – 1.05) = 0.4725m^3

Internal surface area to 50% of effective depth and base area a550

2.1 x 0.5 x 2	2.100
0.45 x 0.5 x 2	0.450
2.1 x 0.45	0.945
	3.495m^2

Time for the outflow tp75-25

1,752-828 = 924 minutes (29 hours 12 minutes – 13 hours 48 minutes)

Soil infiltration rate

$$f = \frac{0.4725}{3.495 \times 924 \times 60} = 0.000002438$$

Infiltration rate= 2.4 x 10^{-6} m/second

SOAKAWAY, INFILTRATION RATE CALCULATION

Hole 2 – Streamside
Courtyard to Front of Plots 8 and 9

Excavate hole 2.0m long x 0.9m wide x 1.4m below finish ground level

Cover Level of soakaway 600mm below ground level

Invert Level of soakaway 1,400mm below ground level

Total effective depth 800mm

Effective storage volume Vp75-25

2.0 x 0.9 x (1.200 – 800) = 0.72m^3

Internal surface area to 50% of effective depth and base area a550

2.0 x 0.4 x 2	1.60
0.9 x 0.4 x 2	0.72
2.0 x 0.9	1.80
	4.12m^2

Time for the outflow tp75-25

765 - 90 = 655 minutes (12 hours 45 minutes – 1 hour 30 minutes)

Soil infiltration rate

$$f = \frac{0.72}{4.12 \times 655 \times 60} = 0.000004446$$

Infiltration rate= 4.4 x 10^{-6} m/second

SOAKAWAY, INFILTRATION RATE CALCULATION

Hole 3 – Harpers Road
Adjacent to Plot 17 and 18

Excavate hole 2.3m long x 0.4m wide x 1.6m below finish ground level of 104.100

Cover Level of soakaway 800mm below ground level

Invert Level of soakaway 1,600mm below ground level

Total effective depth 800mm

Effective storage volume Vp75-25

2.0 x 0.45 x (1.4 – 1.0) = 0.36m^3

Internal surface area to 50% of effective depth and base area a550

2.0 x 0.4 x 2	1.60
0.45 x 0.4 x 2	0.36
2.0 x 0.45	0.90
	2.86m^2

Time for the outflow tp75-25

2,052 - 1104 = 948 minutes (34 hours 12 minutes – 18 hours 24 minutes)

Soil infiltration rate

$$f = \frac{0.36}{2.86 \times 948 \times 60} = 0.000002212$$

Infiltration rate= 2.2 x 10^{-6} m/second

SOAKAWAY, INFILTRATION RATE CALCULATION

Hole 4 – Harpers Road
To Front of Plot 20

Excavate hole 2.1m long x 0.95m wide x 1.5m below finish ground level

Cover Level of soakaway 600mm below ground level

Invert Level of soakaway 1,500mm below ground level

Total effective depth 900mm

Effective storage volume Vp75-25

2.1 x 0.95 x (1.275 – 0.825) = 0.89775m^3

Internal surface area to 50% of effective depth and base area a550

2.1 x 0.45 x 2	1.890
0.95 x 0.45 x 2	0.855
2.1 x 0.95	1.995
	4.740m^2

Time for the outflow tp75-25

177 - 69 = 108 minutes (2 hours 57 minutes – 1 hour 9 minutes)

Soil infiltration rate

$$f = \frac{0.89775}{4.74 \times 108 \times 60} = 0.000029228$$

Infiltration rate= 2.9 x 10^{-5} m/second

SOAKAWAY, INFILTRATION RATE CALCULATION

Hole 5 – Harpers Road
To Front of Plots 20 and 21

Excavate hole 2.1m long x 0.5m wide x 1.8m below finish ground level

Cover Level of soakaway 800mm below ground level

Invert Level of soakaway 1,800mm below ground level

Total effective depth 1,000mm

Effective storage volume Vp75-25

2.1 x 0.45 x (1.55 – 1.05) = 0.4725m^3

Internal surface area to 50% of effective depth and base area a550

2.1 x 0.5 x 2	2.100
0.45 x 0.5 x 2	0.450
2.1 x 0.45	0.945
	3.495m^2

Time for the outflow tp75-25

510 - 225 = 285 minutes (8 hours 30 minutes – 3 hours 45 minutes)

Soil infiltration rate

$$f = \frac{0.4725}{3.495 \times 288 \times 60} = 0.0000078237$$

Infiltration rate= 7.8 x 10^{-6} m/second

Appendix 3 – Modelling for alternative strategy

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 360 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	75.258	0.358	0.0	1.3	1.3	32.6	O K
30 min Summer	75.364	0.464	0.0	1.5	1.5	42.4	O K
60 min Summer	75.465	0.565	0.0	1.7	1.7	51.6	O K
120 min Summer	75.547	0.647	0.0	1.8	1.8	59.0	O K
180 min Summer	75.576	0.676	0.0	1.8	1.8	61.7	O K
240 min Summer	75.582	0.682	0.0	1.9	1.9	62.2	O K
360 min Summer	75.580	0.680	0.0	1.9	1.9	62.0	O K
480 min Summer	75.574	0.674	0.0	1.8	1.8	61.5	O K
600 min Summer	75.565	0.665	0.0	1.8	1.8	60.6	O K
720 min Summer	75.553	0.653	0.0	1.8	1.8	59.6	O K
960 min Summer	75.526	0.626	0.0	1.8	1.8	57.1	O K
1440 min Summer	75.471	0.571	0.0	1.7	1.7	52.0	O K
2160 min Summer	75.396	0.496	0.0	1.6	1.6	45.2	O K
2880 min Summer	75.335	0.435	0.0	1.5	1.5	39.7	O K
4320 min Summer	75.244	0.344	0.0	1.3	1.3	31.3	O K
5760 min Summer	75.179	0.279	0.0	1.2	1.2	25.5	O K
7200 min Summer	75.132	0.232	0.0	1.1	1.1	21.2	O K
8640 min Summer	75.097	0.197	0.0	1.0	1.0	18.0	O K
10080 min Summer	75.069	0.169	0.0	0.9	0.9	15.4	O K
15 min Winter	75.302	0.402	0.0	1.4	1.4	36.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	117.768	0.0	33.5	29
30 min Summer	77.329	0.0	44.0	43
60 min Summer	48.361	0.0	55.6	70
120 min Summer	29.214	0.0	67.3	126
180 min Summer	21.461	0.0	74.1	184
240 min Summer	17.139	0.0	78.9	240
360 min Summer	12.448	0.0	86.0	294
480 min Summer	9.920	0.0	91.4	356
600 min Summer	8.312	0.0	95.7	424
720 min Summer	7.191	0.0	99.3	494
960 min Summer	5.716	0.0	105.3	630
1440 min Summer	4.131	0.0	114.0	904
2160 min Summer	2.980	0.0	123.8	1300
2880 min Summer	2.361	0.0	130.7	1680
4320 min Summer	1.699	0.0	141.0	2428
5760 min Summer	1.343	0.0	148.9	3168
7200 min Summer	1.119	0.0	155.0	3888
8640 min Summer	0.964	0.0	160.1	4592
10080 min Summer	0.849	0.0	164.5	5344
15 min Winter	117.768	0.0	37.5	29

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	75.422	0.522	0.0	1.6	1.6	47.6	O K
60 min Winter	75.537	0.637	0.0	1.8	1.8	58.1	O K
120 min Winter	75.632	0.732	0.0	1.9	1.9	66.8	O K
180 min Winter	75.668	0.768	0.0	2.0	2.0	70.0	O K
240 min Winter	75.679	0.779	0.0	2.0	2.0	71.0	O K
360 min Winter	75.672	0.772	0.0	2.0	2.0	70.4	O K
480 min Winter	75.663	0.763	0.0	2.0	2.0	69.6	O K
600 min Winter	75.649	0.749	0.0	1.9	1.9	68.3	O K
720 min Winter	75.631	0.731	0.0	1.9	1.9	66.7	O K
960 min Winter	75.591	0.691	0.0	1.9	1.9	63.0	O K
1440 min Winter	75.510	0.610	0.0	1.8	1.8	55.6	O K
2160 min Winter	75.404	0.504	0.0	1.6	1.6	46.0	O K
2880 min Winter	75.322	0.422	0.0	1.4	1.4	38.5	O K
4320 min Winter	75.205	0.305	0.0	1.2	1.2	27.8	O K
5760 min Winter	75.131	0.231	0.0	1.1	1.1	21.0	O K
7200 min Winter	75.081	0.181	0.0	0.9	0.9	16.5	O K
8640 min Winter	75.046	0.146	0.0	0.8	0.8	13.3	O K
10080 min Winter	75.021	0.121	0.0	0.7	0.7	11.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	77.329	0.0	49.3	43
60 min Winter	48.361	0.0	62.3	70
120 min Winter	29.214	0.0	75.3	126
180 min Winter	21.461	0.0	83.0	182
240 min Winter	17.139	0.0	88.4	236
360 min Winter	12.448	0.0	96.3	330
480 min Winter	9.920	0.0	102.3	378
600 min Winter	8.312	0.0	107.2	454
720 min Winter	7.191	0.0	111.3	532
960 min Winter	5.716	0.0	117.9	682
1440 min Winter	4.131	0.0	127.7	968
2160 min Winter	2.980	0.0	138.6	1380
2880 min Winter	2.361	0.0	146.5	1768
4320 min Winter	1.699	0.0	157.9	2516
5760 min Winter	1.343	0.0	166.7	3240
7200 min Winter	1.119	0.0	173.6	3968
8640 min Winter	0.964	0.0	179.4	4672
10080 min Winter	0.849	0.0	184.3	5352

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.154

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.038	4	8	0.038	8	12	0.039	12	16	0.039

Model Details

Storage is Online Cover Level (m) 76.200

Cellular Storage Structure

Invert Level (m) 74.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	96.0	96.0	0.900	0.0	128.0
0.800	96.0	128.0			

Orifice Outflow Control

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 74.900

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 809 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	74.988	0.288	0.0	0.5	0.5	39.5	O K
30 min Summer	75.076	0.376	0.0	0.8	0.8	51.4	O K
60 min Summer	75.164	0.464	0.0	0.9	0.9	63.5	O K
120 min Summer	75.248	0.548	0.0	1.1	1.1	75.0	O K
180 min Summer	75.290	0.590	0.0	1.2	1.2	80.8	O K
240 min Summer	75.315	0.615	0.0	1.2	1.2	84.1	O K
360 min Summer	75.341	0.641	0.0	1.2	1.2	87.7	O K
480 min Summer	75.352	0.652	0.0	1.2	1.2	89.2	O K
600 min Summer	75.358	0.658	0.0	1.3	1.3	90.0	O K
720 min Summer	75.362	0.662	0.0	1.3	1.3	90.6	O K
960 min Summer	75.367	0.667	0.0	1.3	1.3	91.3	O K
1440 min Summer	75.368	0.668	0.0	1.3	1.3	91.3	O K
2160 min Summer	75.353	0.653	0.0	1.2	1.2	89.3	O K
2880 min Summer	75.331	0.631	0.0	1.2	1.2	86.3	O K
4320 min Summer	75.281	0.581	0.0	1.1	1.1	79.5	O K
5760 min Summer	75.235	0.535	0.0	1.1	1.1	73.2	O K
7200 min Summer	75.195	0.495	0.0	1.0	1.0	67.7	O K
8640 min Summer	75.161	0.461	0.0	0.9	0.9	63.0	O K
10080 min Summer	75.132	0.432	0.0	0.9	0.9	59.1	O K
15 min Winter	75.023	0.323	0.0	0.6	0.6	44.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	117.768	0.0	11.5	30
30 min Summer	77.329	0.0	23.6	45
60 min Summer	48.361	0.0	37.4	74
120 min Summer	29.214	0.0	50.9	132
180 min Summer	21.461	0.0	58.9	190
240 min Summer	17.139	0.0	64.5	248
360 min Summer	12.448	0.0	72.7	364
480 min Summer	9.920	0.0	78.9	474
600 min Summer	8.312	0.0	83.9	520
720 min Summer	7.191	0.0	88.0	578
960 min Summer	5.716	0.0	94.8	702
1440 min Summer	4.131	0.0	104.3	972
2160 min Summer	2.980	0.0	117.1	1376
2880 min Summer	2.361	0.0	125.2	1772
4320 min Summer	1.699	0.0	136.9	2556
5760 min Summer	1.343	0.0	146.5	3296
7200 min Summer	1.119	0.0	153.7	4040
8640 min Summer	0.964	0.0	159.6	4760
10080 min Summer	0.849	0.0	164.6	5464
15 min Winter	117.768	0.0	16.1	30

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	75.121	0.421	0.0	0.9	0.9	57.5	O K
60 min Winter	75.220	0.520	0.0	1.0	1.0	71.1	O K
120 min Winter	75.315	0.615	0.0	1.2	1.2	84.1	O K
180 min Winter	75.363	0.663	0.0	1.3	1.3	90.7	O K
240 min Winter	75.392	0.692	0.0	1.3	1.3	94.6	O K
360 min Winter	75.422	0.722	0.0	1.3	1.3	98.8	O K
480 min Winter	75.437	0.737	0.0	1.4	1.4	100.8	O K
600 min Winter	75.441	0.741	0.0	1.4	1.4	101.4	O K
720 min Winter	75.441	0.741	0.0	1.4	1.4	101.4	O K
960 min Winter	75.443	0.743	0.0	1.4	1.4	101.6	O K
1440 min Winter	75.430	0.730	0.0	1.3	1.3	99.9	O K
2160 min Winter	75.395	0.695	0.0	1.3	1.3	95.0	O K
2880 min Winter	75.354	0.654	0.0	1.2	1.2	89.5	O K
4320 min Winter	75.278	0.578	0.0	1.1	1.1	79.0	O K
5760 min Winter	75.214	0.514	0.0	1.0	1.0	70.3	O K
7200 min Winter	75.162	0.462	0.0	0.9	0.9	63.3	O K
8640 min Winter	75.122	0.422	0.0	0.9	0.9	57.7	O K
10080 min Winter	75.090	0.390	0.0	0.8	0.8	53.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	77.329	0.0	29.7	44
60 min Winter	48.361	0.0	45.2	72
120 min Winter	29.214	0.0	60.3	128
180 min Winter	21.461	0.0	69.2	186
240 min Winter	17.139	0.0	75.5	242
360 min Winter	12.448	0.0	84.7	356
480 min Winter	9.920	0.0	91.6	466
600 min Winter	8.312	0.0	97.2	568
720 min Winter	7.191	0.0	101.9	604
960 min Winter	5.716	0.0	109.4	742
1440 min Winter	4.131	0.0	119.6	1046
2160 min Winter	2.980	0.0	134.4	1484
2880 min Winter	2.361	0.0	143.5	1908
4320 min Winter	1.699	0.0	156.7	2696
5760 min Winter	1.343	0.0	167.4	3464
7200 min Winter	1.119	0.0	175.5	4192
8640 min Winter	0.964	0.0	182.1	4936
10080 min Winter	0.849	0.0	187.7	5656

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.180

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.045	4	8	0.045	8	12	0.045	12	16	0.045

Model Details

Storage is Online Cover Level (m) 76.000

Cellular Storage Structure

Invert Level (m) 74.700 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	144.0	144.0	0.900	0.0	182.4
0.800	144.0	182.4			

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 74.900

Appendix D Existing Drainage Features Plan

NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

Notes

1. This Drawing is not to be reproduced in any part or form without the consent of PJA Civil Engineering Ltd. All copyright reserved.
2. No assessment of earthworks has been undertaken at this stage.
3. No consideration of existing constraints including utilities, arboricultural or ecological have been considered at this time.
4. Drawing should be read in conjunction with all other relevant scheme drawings.
5. Drawing Includes:
   - 5.1. Site Layout, ECE Architecture (March 2022).
   - 5.2. Topographic Survey, P Stubbington Land Surveys Ltd (July 2017).
   - 5.3. OS Mapping provided by Bourn Homes, March 2022.

Key

- Site Boundary
- Existing Ditch
- Existing Overland Flow Route

REV	DATE	REVISION NOTE	BY
P1	24/03/2022	DRAFT FOR COMMENT	PR

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CLIENT

Bourne Homes Ltd

PROJECT

Stream Side
Land at
Harpers Lane

DRAWING TITLE

Existing Drainage
Features Plan

DRAWING ISSUE STATUS

INFORMATION

PJA JOB No.	SUB-CODE	DRAWING NO.	REVISION
06153 -	A -	0100 -	P1

Revision Letter : P - Prelim / A - Approval / T - Tender / C - Construction

BIM DRAWING REFERENCE

SCALE	DRAWN	REVIEWED	DATE
A1@500	PR	AE	MAR 22

Appendix E Surface Water Drainage Strategy Drawings