

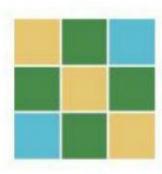
Aqua Construction

High Street, Saul

Flood Risk Assessment

December 2020





DOCUMENT REGISTER

CLIENT:	AQUA CONSTRUCTION	
PROJECT:	HIGH STREET, SAUL	
PROJECT CODE:	CTP-20-614	

REPORT TITLE:	FLOOD RISK ASSESSMENT
PREPARED BY:	
CHECKED BY:	

REPORT STATUS:	04
REVISION:	FOR PLANNING

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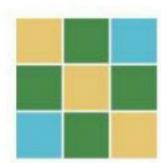
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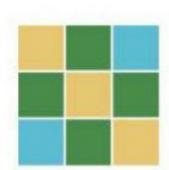
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1 Introduction

Background

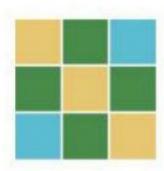
- 1.1 Cotswold Transport Planning (CTP) were appointed by Aqua Construction (the Applicant) to undertake a Flood Risk Assessment (FRA) to support a full planning application for a proposed residential development at High Street, Saul.
- 1.2 This assessment considers the risks of flooding to the site including tidal, fluvial, surface, groundwater, sewer and artificial sources and recommends mitigation measures where appropriate. The FRA also includes a drainage strategy.
- 1.3 This report supersedes that produced for application reference S.20/1732/FUL. This assessment accounts for the details requested by the Environment Agency in their consultation response to the previous application (their reference SV/2020/110731/01).

National & Local Policies

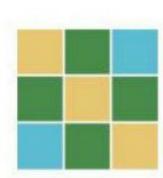
- 1.4 The National Planning Policy Framework (NPPF)¹ sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. Planning Practice Guidance (PPG) is also available online².
- 1.5 The PPG sets out the vulnerability to flooding of different land uses. It encourages development to be located in areas of lower flood risk where possible and stresses the importance of preventing increases in flood risk off site to the wider catchment area.
- 1.6 New applications will require a surface water drainage scheme submitted to accompany all planning applications and will be required to demonstrate the use of SuDS within the design and should be in line with the requirements as set out within PPG.
- 1.7 The NPPF states that a site-specific Flood Risk Assessment will be required for proposals:
 - i) that are greater than 1 hectare in area within Flood Zone 1;
 - ii) for all proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
 - iii) in an area within Flood Zone 1 which has critical drainage problems; and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

https://www.gov.uk/government/publications/national-planning-policy-framework--2

² https://www.gov.uk/guidance/flood-risk-and-coastal-change



- iv) in an area within Flood Zone 1 identified in a Strategic Flood Risk Assessment as being at increased flood risk in the future.
- v) in an area in Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.
- 1.8 This FRA aims to provide sufficient flood risk information to satisfy the requirements of the NPPF, PPG and regional/local government plans and policies.
- 1.9 This assessment considers the risks of all types of flooding to the site including tidal, fluvial, surface, groundwater, sewer and artificial sources and provides mitigation measures to ensure that the flood risk to the site is minimised and that flood risk off-site is not increased.
- 1.10 This FRA has been based on the following sources of information:
 - NPPF.
 - NPPF-PPG.
 - Site Layout Plan
 - OS Explorer Series mapping
 - Site Topographical Survey
 - DEFRA Magic mapping
 - British Geological Survey (BGS) mapping
 - Environment Agency flooding information and mapping
 - Severn Trent Water sewer records
 - Gloucestershire County Council drainage guidance
 - Gloucestershire County Council Local Flood Risk Management Strategy (LFRMS)
 - Stroud District Council Strategic Flood Risk Assessment (SFRA) Level 1, 2008
 - Stroud District Council Strategic Flood Risk Assessment (SFRA) Level 2, 2014



2 Existing Site and Hydrology Characteristics

Site Location and Composition

- 2.1 The site is located on the western side of High Street (B4071) within the south of the village of Saul, Gloucestershire, post code GL2 7LW at grid reference coordinates, X (easting): 374810 Y (northing): 209224.
- 2.2 High Street forms the eastern boundary of the site, from where it is accessed, with residential property to the north and open agricultural land to the west and south (horse paddocks).
- 2.3 The majority of the site is grassed. An area of gravel/bare earth surfacing is situated within the north and east of the site along with a concrete base. A minor watercourse/ditch is located within the south east of the site along the eastern boundary. A brick wall is present along the eastern boundary between the ditch and pavement on High Street.
- 2.4 The application site area is approximately 0.1ha.
- 2.5 The site location is shown in **Appendix A** and outlined in red on **Figure 2.1**.

Topography

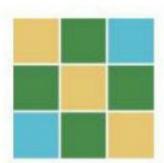
- 2.6 The existing topographical survey shows ground levels generally fall in a south eastern direction. The highest levels on site are circa 7.93 metres above ordnance datum (mAOD) towards the western boundary of the site with a low of 7.06mAOD in the south eastern corner adjacent to the ditch.
- 2.7 A copy of the existing topographical survey can be found in **Appendix B**.

Ground Conditions

- 2.8 Geological data held by the British Geological Survey (BGS) and as displayed on the Geology of Britain Viewer³ shows that the bedrock geology underlying the entire site and wider surrounding area is Blue Lias Formation and Charmouth Mudstone Formation with sand and gravel river terrace superficial deposits.
- 2.9 Soilscapes Mapping⁴ shows that the soil underlying the site is classified as lime rich loamy and clayey slowly permeable soils with impeded drainage.

³ http://mapapps.bgs.ac.uk/geologyofbritain/home.html

⁴ http://www.landis.org.uk/soilscapes/



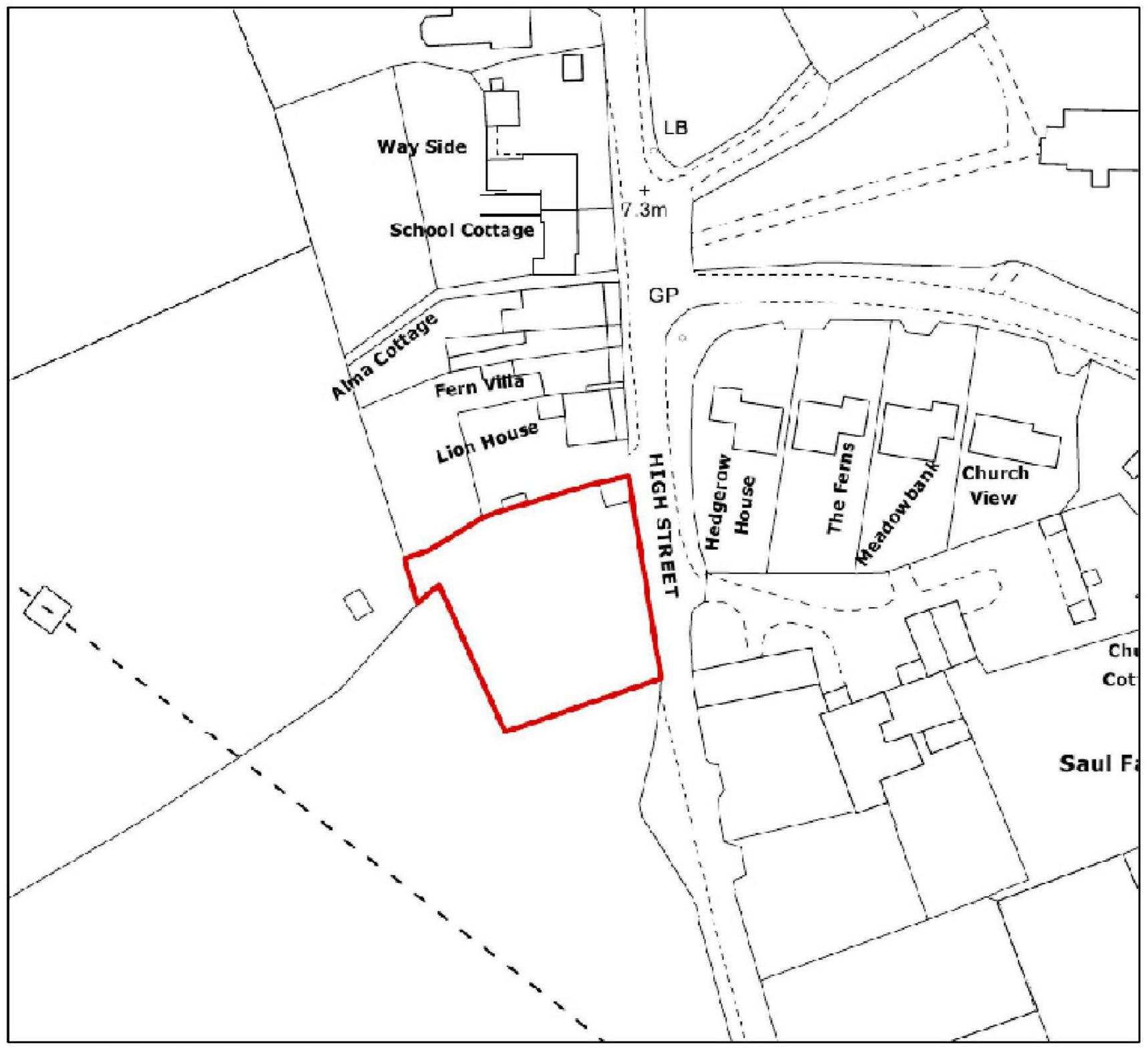


Figure 2.1: Site Location

Existing Drainage and Hydrology

- 2.10 A section of minor watercourse is located along the eastern boundary of the site as shown on the topographical survey. Flows are directed south within a 750mm diameter culvert prior to returning to open channel within the south east of the site, which continues as open channel within the paddock's development to the south (see **Figure 2.2**).
- 2.11 The ditch was observed with a relatively high water level but with no discernible flow as part of conducting a visit to the site and surrounding area on 11th December 2020.

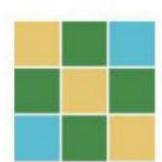




Figure 2.2: Looking North at Ditch along Site Eastern Boundary

- 2.12 The River Frome (see **Figure 2.3**) is located 606m to the north east of the site with its flows directed north towards its confluence with the River Severn at Upper Framilode just under a mile north west of the site.
- 2.13 The River Severn is located 0.8 miles to the south west and north of the site.
- 2.14 The Gloucester and Sharpness Canal is located 560m adjacent to the south of the site.
- 2.15 Severn Trent Water records indicate there is a foul sewer located within High Street adjacent to the site. Records are included in **Appendix C**.

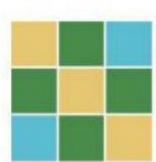
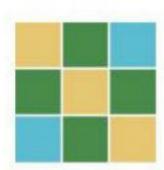




Figure 2.3: Nearby Main Rivers



3 Proposed Development

Site Proposals

- 3.1 The proposed development, drawings details of which provided in **Appendix D**, shows the development proposals as follows:
- 3.2 Plot 1 Detached four bedroom residential property totalling 168m² (excluding garage) with associated car parking and garden amenity space.
- 3.3 Plot 2 Detached four bedroom house totalling 130m² (excluding garage) with private car parking and garden space.



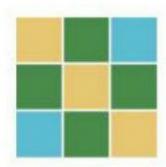
4 Development Vulnerability and Flood Zone Classification

National Planning Policy Framework (NPPF)

- 4.1 Local Planning Authorities, (LPA) have a statutory obligation to consult the Environment Agency, (EA) on all applications in flood risk zones. The EA will consider the effects of flood risk in accordance with the NPPF.
- 4.2 NPPF requires that, as part of the planning process:
 - A 'site specific' Flood Risk Assessment will be undertaken for any site that has a flood risk potential.
 - Flood risk potential is minimised by applying a 'sequential approach' to locating 'vulnerable' land uses.
 - Sustainable drainage systems are used for surface water disposal where practical.
 - Flood risk is managed through the use of flood resilient and resistant techniques.
 - Residual risk is identified and safely managed.
- 4.3 Table 1 of NPPF, categorises flood zones into:
 - Zone 1- Low probability (< 1 in 1000 years)
 - Zone 2- Medium probability (1 in 1000 1 in 100 years)
 - Zone 3a- High probability (> 1 in 100 years)
 - Zone 3b- The functional floodplain (>1 in 20 years)
- 4.4 The site is located within Flood Zone 3 as shown on the Environment Agency Flood Map for Planning⁵ and **Figure 5.1**. This is the area shown to be at high risk of river/tidal flooding associated with the River Frome and River Severn.
- 4.5 The proposed development is considered to be 'more vulnerable' in terms of its land use type flood risk vulnerability as shown in Table 2 of the PPG⁶.
- 4.6 The NPPF sets out a matrix indicating the flood risk vulnerability types of development that are acceptable in different flood zones based upon the Flood Map for Planning as shown in **Table 4.1**.

⁵ https://flood-map-for-planning.service.gov.uk/

⁶ https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables



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

Table 4.1: Land Use Vulnerability & Flood Zone Compatibility

Sequential and Exception Test

4.7 The site is located in Flood Zone 3, development in these areas is considered acceptable, subject to the Sequential Test and Exception Test being passed.



5 Site Specific Flooding

National Planning Policy Framework (NPPF)

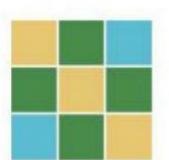
- 5.1 In accordance with the National Planning Policy Framework, this Flood Risk Assessment considers all sources of flooding including:
 - i) Fluvial flooding from rivers and streams;
 - ii) Tidal flooding from the sea;
 - iii) Pluvial flooding overland surface water flow and exceedance;
 - iv) Groundwater flooding from elevated groundwater levels or springs;
 - v) Flooding from sewers exceedance flows from existing sewer systems; and
 - vi) Artificial sources reservoirs, canals etc.

Fluvial Flooding

- 5.2 Flooding from watercourses occurs when flows exceed the capacity of the channel, or where a restrictive structure is encountered, which leads to water overtopping the banks into the floodplain. This process can be exacerbated when debris is mobilised by high flows and accumulates at structures.
- 5.3 The Environment Agency Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, since these can be breached, overtopped and may not be in existence for the lifetime of a development.
- 5.4 The site and wider surrounding area are located wholly within Flood Zone 3 as shown on the Environment Agency Flood Map for Planning⁷ and on **Figure 5.1** and indicated to be at high risk of flooding. The site is shown to be located within an area that benefits from flood defences.

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⁷ https://flood-map-for-planning.service.gov.uk/confirm-location?easting=374830&northing=209294&placeOrPostcode=saul



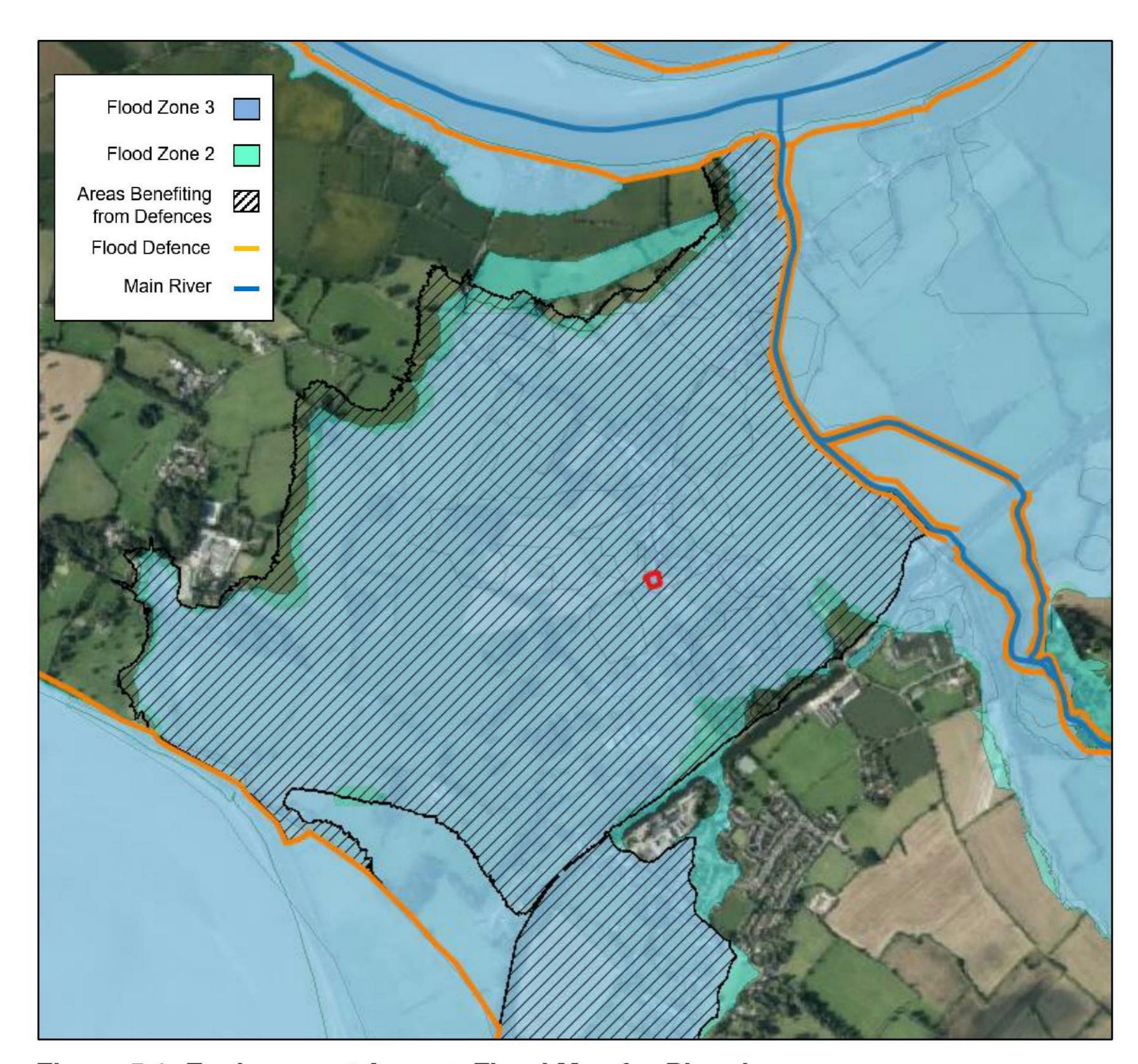


Figure 5.1: Environment Agency Flood Map for Planning

- 5.5 A minor watercourse is shown to be present crossing the site, flowing south, predominantly within a 750mm diameter culvert, prior to returning to open section for a short reach within the site and continuing in open channel on land to the south of the site parallel to the carriageway on High Street.
- 5.6 It is understood this watercourse serves as highway drainage for High Street. Flows are understood to be directed along Church Lane to the north east of the site, in a short section of open channel (see **Figure 5.2**) prior to entering a culvert east of the road junction between Church Lane and High Street. Flows are believed to be directed in a north east to south west direction crossing High Street before returning to open channel within the site.

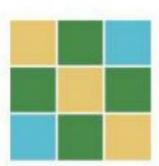
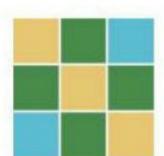




Figure 5.2: Looking East at Open Channel on Church Lane

- 5.7 No specific records of localised flooding in relation to the watercourse crossing the site have been obtained via desk based research. In view of the large, culverted nature of the watercourse and its primary purpose as a highway drainage ditch, the risk of flooding from this watercourse is considered to be **low**.
- 5.8 The Environment Agency were contacted for their records and data relating to flooding that could be used for the purposes of a site specific assessment. The details provided are included within **Appendix E**. The EA provided flood model outlines for their River Frome and River Severn models.
- 5.9 Historic records of flooding identify that the site was flooded during July 1968 from the River Severn.



5.10 The River Frome flood model extents provided are displayed on **Figure 5.2**. The site is shown to sit well outside the area at high risk of river flooding shown in mid blue (100yr event) due to the presence of the flood defences (high ground/embankments) but within the area at medium risk of flooding in a 1 in 1000 year event (light blue) ignoring the presence of the defences. Extents mapping for the defended 1000yr event were not supplied.

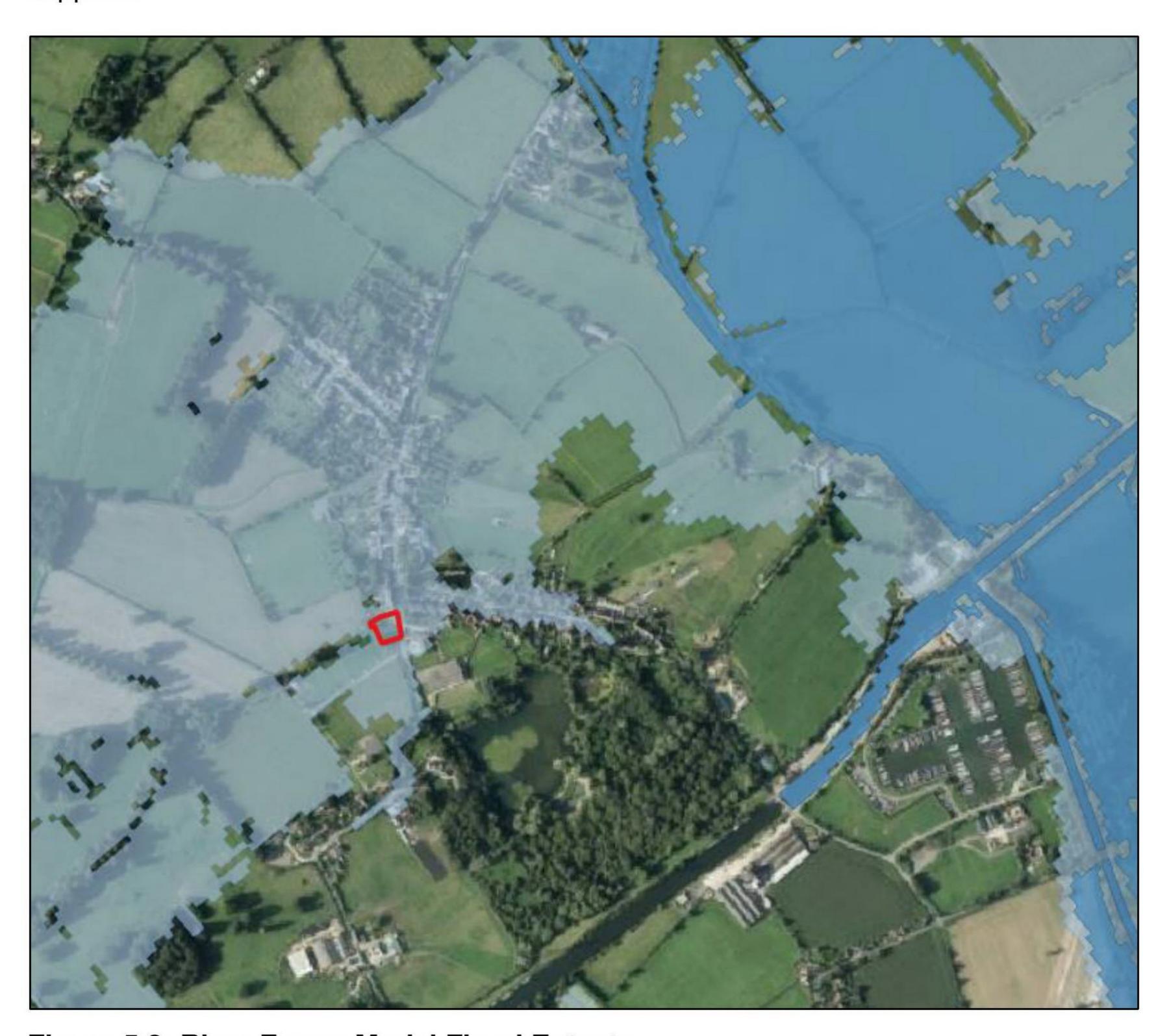
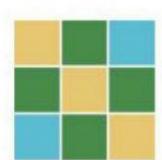


Figure 5.2: River Frome Model Flood Extents

5.11 Flood model depth grid data provided applicable to the site area has enabled maximum depths that could be encountered to be understood in defended and undefended situations. On review of this information, the maximum depth flooding that could be encountered from a 1000yr event is circa 450mm in the undefended scenario. Where the two proposed houses are to be positioned, potential flood depths are less, approximately 300mm.

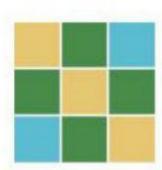


5.12 The depth grid data for the defended scenarios identifies that the site is protected from flooding from events up to the 1000yr event as shown by the dark pink area made up of the depth grid points in **Figure 5.3**. Review of flood defence data applicable to the River Frome along its reach from Saul Junction Bridge (upstream of the site) to the Moor Street Bridge (downstream of the site) identifies a design crest level of 9.38mAOD. The 1000 year return period undefended flood level applicable from node reference 01119.1 (parallel to the site within the river channel) is 9.08mAOD.



Figure 5.3: River Frome Model 1000yr Event Depth Grid Data

5.13 In view of the above assessment and the information supplied by the Environment Agency, the site is effectively protected from fluvial flooding from the River Frome from high and medium risk flood events. So, the risk of flooding to the proposed development is residual.

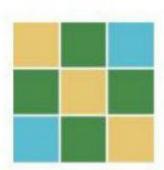


River Frome Climate Change

- 5.14 The Environment Agency now require that the latest climate change allowances be applied to 100 year return period, high risk flood levels in accordance with revised guidance published in 2016⁸.
- 5.15 In accordance with local area EA guidance, (see **Appendix E**) the development proposed is classed as minor development, so the use of the nominal allowances provided, or interpolated flood levels are applicable as opposed to re-running the flood models available.
- 5.16 Due to the nature of the proposed development being of a 'more vulnerable' classification within land shown to lie within Flood Zone 3; it is appropriate to consider the 'higher central' climate change allowance (35%) as a conservative estimate of potential climate change in relation to fluvial flooding.
- 5.17 The applicable identified design flood level, 100 year plus 35% allowance for climate change, could be interpolated as follows utilising the provided 100yr+20% event to represent the flood event that accounts for previous climate change allowances and applying to model node applicable (ref 01119.1):
 - 100yr+20%CC (9.08mAOD) 100yr (9.07mAOD) = 0.01m
 - 0.01 m/20% = 0.0005 m per 1% increase
 - 0.0005m x 35%CC = 0.0175m (increase due to 35% climate change allowance)
 - 100yr (9.07mAOD) + 0.0175m = 9.09mAOD
- 5.18 The interpolated method flood level derived using the calculation above identifies a 0.01m increase in flood levels accounting for a 35% climate change allowance. The flood level of 9.09mAOD determined would not result in a material increase to fluvial flood risk at the site due to the defences present providing protection to a height of 9.38mAOD.
- 5.19 Part of the reason why the previous application was objected to by the Environment Agency related to the manner in which climate change flood levels had been interpolated. The way in which this was undertaken was described as incorrect, but no details were provided to explain why this was the case.
- 5.20 In acknowledgement of the above, through following local EA guidance the pre-defined increase in flood levels (300mm) can be applied through identifying the River Frome to be a tributary watercourse of the River Severn. This would mean the 100 year plus

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⁸ https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances



climate change flood level applicable is 9.37mAOD. As the crest level of flood defences present along the River Frome applicable to the site is 9.38mAOD then the previous application conclusions are considered to remain applicable because the site would just remain protected from a local guidance, conservative 100 year plus climate change event.

River Frome Defence Breach Scenario

- 5.21 A further request from the Environment Agency on consultation related to the previous application was to provide defence breach assessment details and how the site could be affected by flooding in such an extreme, residual risk situation.
- 5.22 For the River Frome it was advised that the undefended model results would be sufficient for this process. The 100yr event is applicable for such an assessment. Extents are shown below in grey based on the flood depth grid point data on **Figure 5.4**.

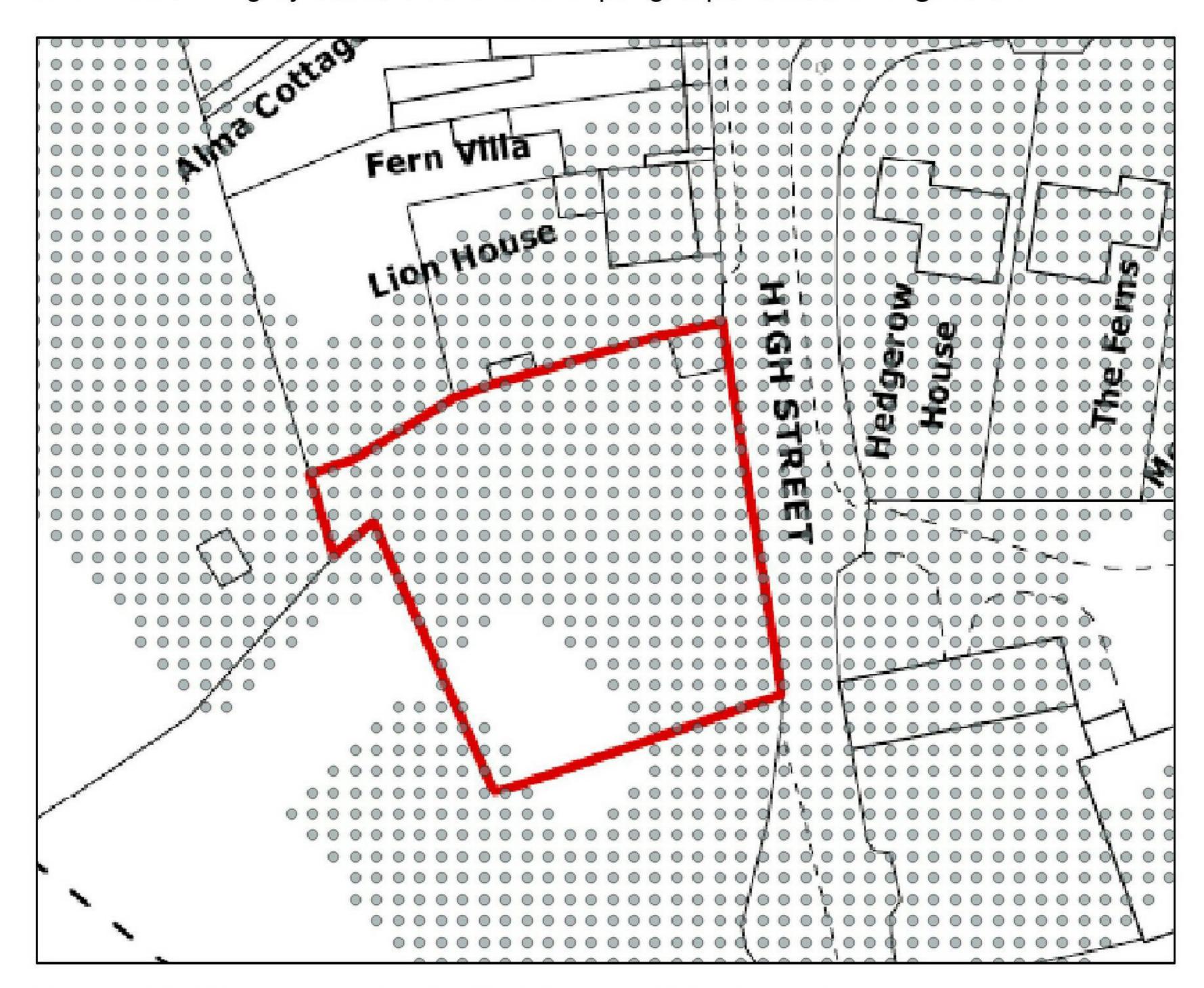
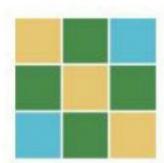


Figure 5.4: River Frome Model Undefended 100yr Event Extents



- 5.23 Reviewing this information and comparing the undefended flood data to ground levels on the site identifies the majority of site, (with the exception of the south west corner) the High Street outside the site and the majority of Saul would be at high risk of flooding in such an extreme eventuality.
- 5.24 Maximum depths of potential flooding near the site entrance are shown to be 420mm. Where the two new properties are to be constructed the depth is circa 320mm. The maximum high risk flood level identified to be on site is 7.80mAOD.
- 5.25 So, to summarise, the actual risk of fluvial flooding to the proposed development has been identified as **low** and residual up to an including flood events with a 1000 year return period from the River Frome for the present day situation. This is due to the standard of protection afforded by flood defences. On this basis there will be no actual loss of floodplain storage capacity as a result of the proposal that could increase flood risk elsewhere.
- 5.26 In acknowledgement of the future effects of climate change, the site is identified to remain protected from flooding from the River Frome, based on local office EA assessment guidance. In an unlikely breach situation, the site could be flooded to a maximum height of 7.80mAOD.

Tidal Flooding

- 5.27 Inundation of low lying coastal areas by the sea may be caused by seasonal high tides, storm surges and storm driven wave action. Tidal flooding is most commonly a result of a combination of two or more of these mechanisms, which can result in the overtopping or breaching of sea defences. River systems may also be subject to tidal influences.
- 5.28 In their consultation response to the previous planning application for the site the EA advised that tidal flooding is the primary risk to the site from the River Severn.
- 5.29 The EA provided flood model extents from their River Severn flood model for reference.
 Figure 5.5 displays the extent (outlined in blue) in relation to the site (undefended). This identifies the site is at high risk of tidal flooding from the River Severn in a 1 in 200 year event in an undefended scenario.

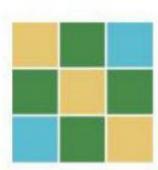
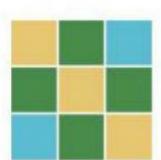




Figure 5.5: River Severn Model Tidal 200yr Event Extents (Undefended)

- 5.30 Tidal flood levels applicable to the site are 10.6mAOD and 10.43mAOD (nodes SEV24 and 83) for the 200 year event (high risk) based upon the 2007 produced model data. Flood levels from the 2020 model re-run version for the year 2020 are 10.54mAOD and 10.40mAOD for nodes SEV24 and 83.
- 5.31 Flood defence data obtained in relation to the defences along the banks of the River Severn, applicable to the model nodes related to the site and the area identified to benefit from defences, details design defence crest levels associated with the corresponding model nodes as 10.7mAOD (SEV24) and 10.6mAOD (83).



5.32 The defences applicable to node SEV24 include the Upper Framilode Wall and the Upper Framilode Lock Defence. **Figure 5.6** shows the defence wall present opposite St Peters Church (at grid coordinates location: 3750029, 210468).



Figure 5.6: Looking West along Upper Framilode Wall Defence

5.33 The defences applicable to model node 83 include the embankment present (Hock Ditch to Hock Cliff asset) south of the village of Fretherne as shown on **Figure 5.7**. At the time of the site visit on 11th December 2020, improvement works were being undertaken to the embankment.

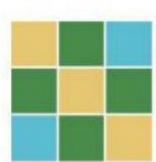


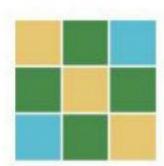


Figure 5.7: Looking East at Defence Embankment

- 5.34 Review of the applicable tidal flood levels against the defence crest levels confirms the site is protected from high risk tidal flood events, as suggested by the EA Flood Map for Planning.
- 5.35 In flood events in excess of this return period, the flood levels increase to 10.63mAOD and 10.59AOD respectively for nodes SEV24 and 83 when accounting for the 1000 year return period scenario provided (2007 model data). Again, the defences would appear to be high enough to protect the site from such a flooding scenario and a such the risk of tidal flooding is considered to be residual.

River Severn Climate Change

- 5.36 Since submission of the previous application and FRA, the EA released updated flood model data related to the River Severn, which accounts for the latest allowances for climate change (see **Appendix D**). Applicable flood levels are provided for the years 2040, 2070 and 2125.
- 5.37 Modern residential development is considered to be built with a 100 year design lifetime. On this basis the 2125 flood levels are appropriate to consider, which are 10.86mAOD and 11.05mAOD (higher central allowance) for nodes SEV24 and 83. Comparison of



these flood levels to the current defence crest design heights identify they would be overtopped.

River Severn Defence Breach & Overtopping Scenario

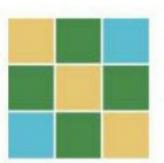
- 5.38 To undertake a breach and/or overtopping assessment related to the River Severn, the guidance set out in the DEFRA report ref FD2321/TR2 (2006)9 should be followed as advised by the EA.
- 5.39 A simple desktop assessment was commissioned by the applicant and is discussed as follows to satisfy the requirements of this particular assessment requirement given the scale and nature of the proposal.

Overtopping

- 5.40 A simple overtopping assessment and identifying danger to people has been undertaken through reference to lookup table 12.1 within the DEFRA guidance document (see **Figure 5.8**). This involves assessment of the hazard posed by an overtopping situation through cross referencing the distance of the site from the flood defences in question and the head above crest level applicable (difference between flood level and defence height).
- 5.41 The simple approach was undertaken based on applying the 200 year 2125 climate change event flood levels which could overtop the defences in relation to defence design crest levels.
- 5.42 The hazard classifications are based on four categories listed as follows:
 - Danger for All includes emergency services
 - Danger for Most includes the general public
 - Danger for Some includes children, the elderly and infirm
 - Danger for None no risk to human health

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⁹ http://randd.defra.gov.uk/Document.aspx?Document=FD2321_3437_TRP.pdf



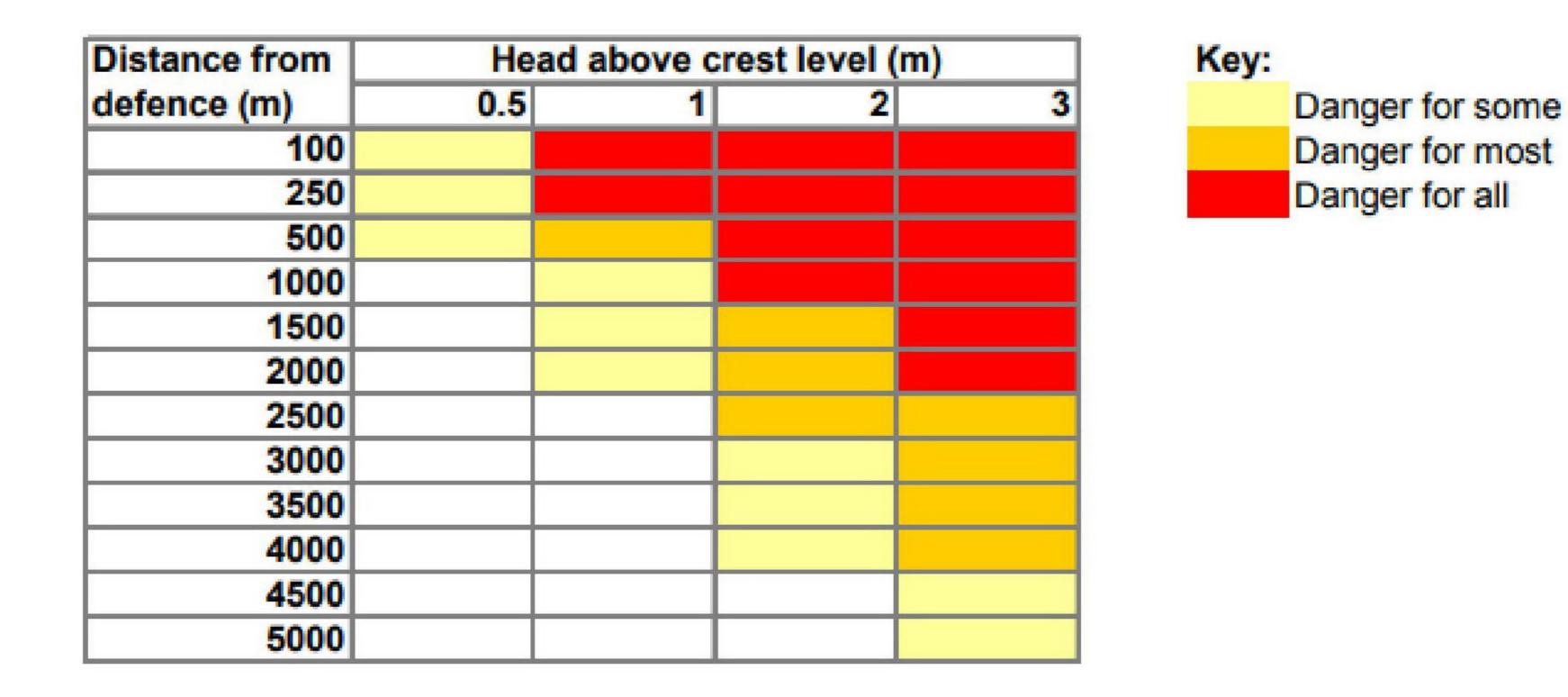


Figure 5.8: Overtopping Assessment Table

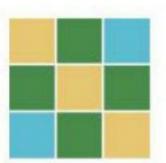
5.43 **Table 5.1** below summaries the results of this exercise and identifies that there is no hazard posed to human health from a defence overtopping situation. It should be noted that this approach assumes a flat floodplain.

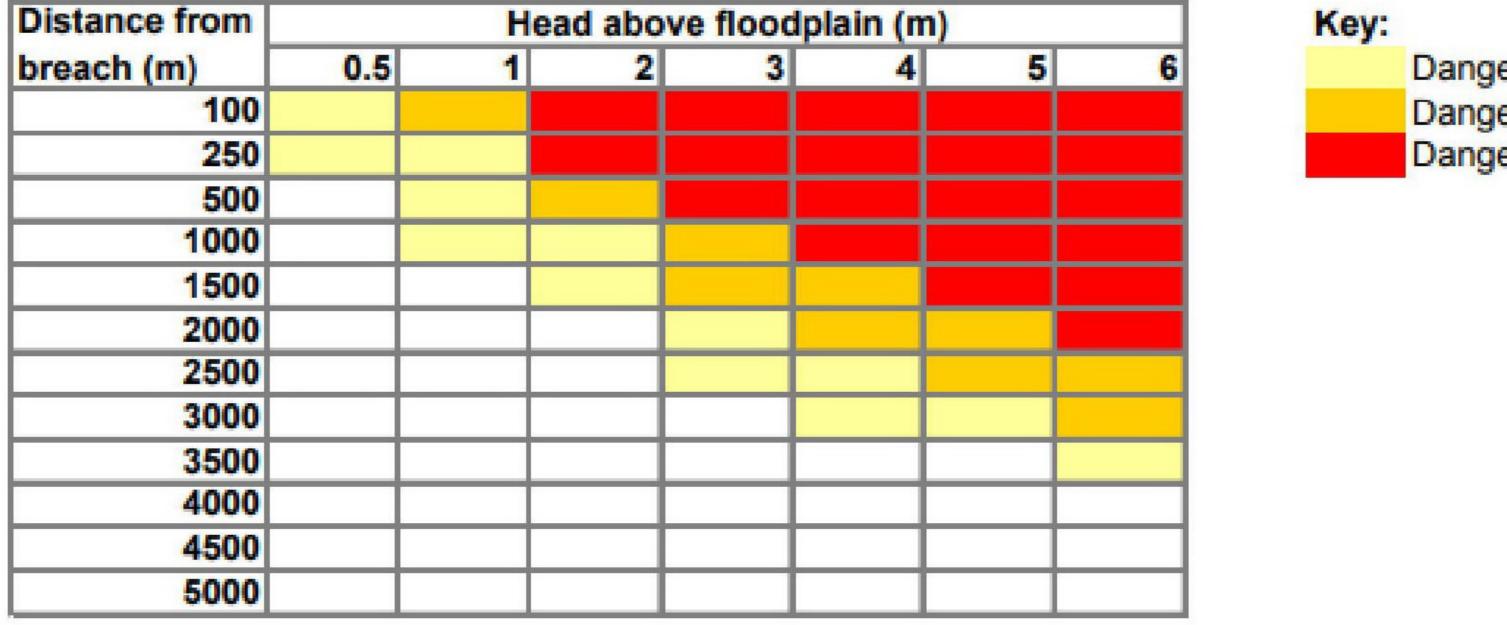
EA Model Node	Node Location Coordinates	Distance to Site	Head Above Defence Crest	Hazard
SEV24	375007, 210485	1,237m	0.16m	Danger for None
83	373295, 208841	1,569m	0.45m	Danger for None

Table 5.1: Defence Overtopping Assessment Results

Breach Scenario

- 5.44 For the simple defence breach assessment, the lowest ground levels on the site are referred to in addition to the distance of the defences from the site and the applicable flood levels.
- 5.45 **Table 5.2** displays the results of the breach assessment is relation to the development site through reference to lookup table 12.1 within the DEFRA guidance (see **Figure 5.9**).
- 5.46 The hazard is calculated through subtracting the applicable flood level from the ground level height to determine the 'head' of water and cross referencing against the distance of the defences from the site.





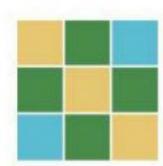
Danger for some Danger for most Danger for all

Figure 5.9: Breach Assessment Table

EA Model Node	Location	Distance to Site (m)	Ground Level (mAOD) (A)	200yr 2025 Flood Level (mAOD) (B)	Head Above Ground Levels (m) (B-A)	Hazard
SEV24	375007, 210485	1,237	7.06	10.86	3.8	Danger for Most
83	373295, 208841	1,569	7.06	11.05	3.99	Danger for Most

Table 5.2: Defence Breach Assessment Results

- 5.47 The results of the exercise identify a significant hazard would be posed to future occupants of the site due to the maximum head of floodwaters that could be encountered.
- 5.48 In summary, this assessment has identified actual tidal flood risk to the site is **low** and residual in the present day based on the protection afforded by defences up to a 1000 year return period.
- 5.49 The tidal Severn defences could be overtopped in the year 2125 as a result of climate change should there be no improvement to the existing defences applicable. However, there is considered to be no danger posed to the development from such a situation given the distance of the site from the flood defences.
- 5.50 In a breach of the Severn defences, which would be an extreme eventuality, a danger for most would be present and a head of floodwaters in excess of 3m depth could occur.



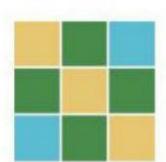
- 5.51 It is understood that there is a current policy within the Severn Estuary Strategy for Fretherne, Epney and Saul whereby the defences are to be raised and integrity maintained in response to the threat of climate change. It is understood works are/have taken place to the defences in Epney where they are being raised by 600mm, as advised by the applicant on this basis.
- 5.52 Given the catastrophic nature of a Severn defences breach flood event occurring and the impact it could have to Saul and the wider surrounding area as well as the site; it is understandable why such a policy/strategy is in place to improve and maintain the standard and integrity of the defences to prevent a reduction of protection to existing communities and settlements.

Pluvial Flooding

- 5.53 Pluvial flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes.
- 5.54 Risk of flooding from surface water mapping has been prepared¹⁰, this shows the potential flooding which could occur when rainwater does not drain away through the normal drainage systems or soak into the ground but lies on or flows over the ground instead.
- 5.55 The Surface Water (Pluvial) Flood map provided by the Environment Agency (**Figure 5.10**) indicates that the site is partially at high risk of pluvial flooding. The majority is identified to be at very low risk.

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¹⁰ https://flood-warning-information.service.gov.uk/long-term-flood-risk/map



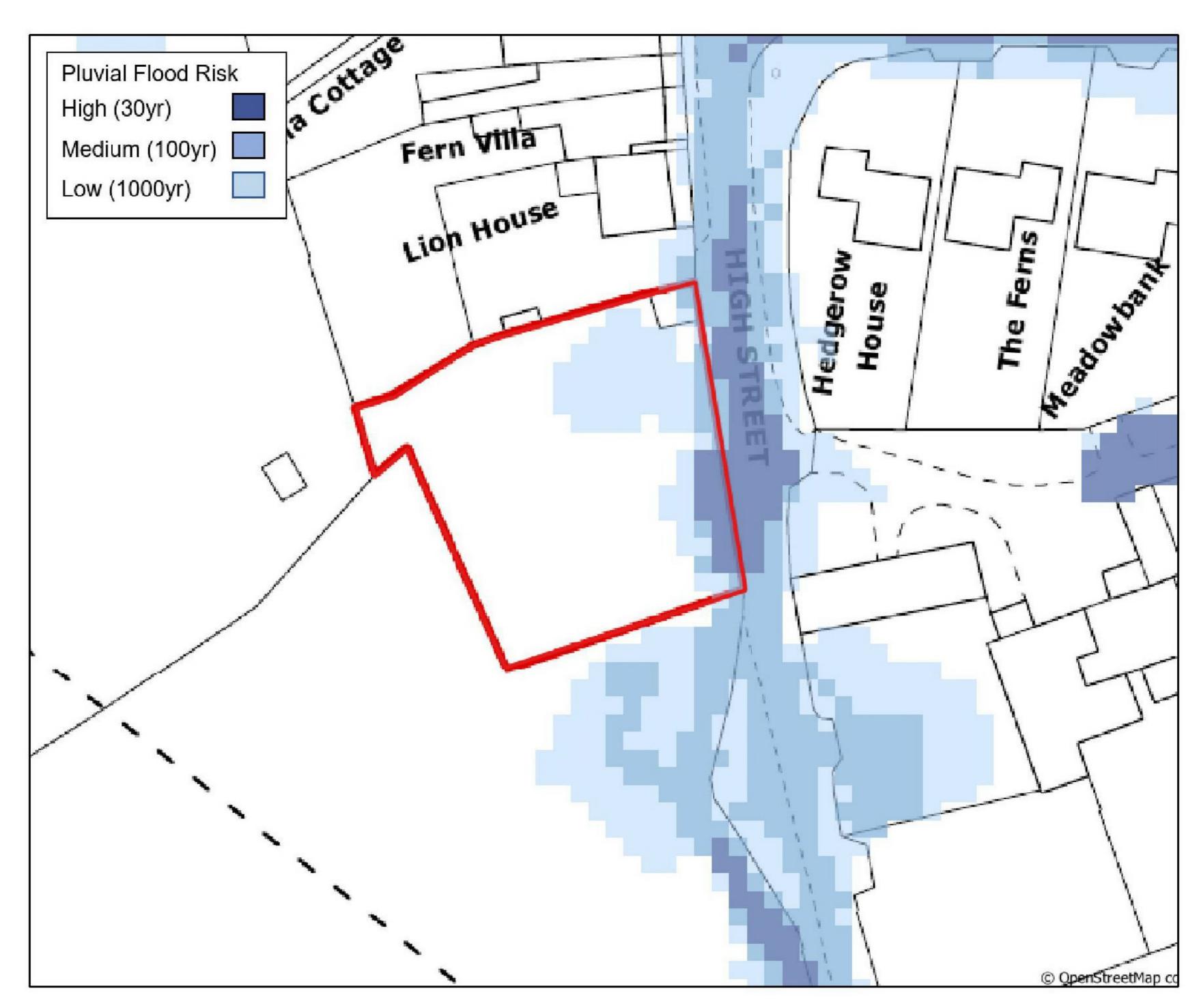
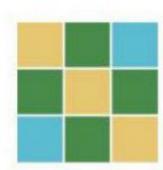


Figure 5.10: Pluvial Flood risk Map

- 5.56 The north west of the site is identified to be at low risk (1 in 1,000 year annual chance of flooding) in the vicinity of the site access point. Depths of flooding are predicted as less than 300mm for the area considered to be at risk.
- 5.57 High Street adjacent to the site and within/along the site eastern boundary associated with the ditch present and lowest ground levels is considered to be partially at high risk of pluvial flooding to a depth less than 300mm.
- 5.58 It should be noted the pluvial maps do not fully consider the surrounding underground drainage systems and therefore any flooding entering the site from existing roads will likely be intercepted by road gullies and discharged into the local drainage network instead of flow through the site.
- 5.59 The development is considered to be partially at **high** risk of flooding from surface water based upon the EA mapping.



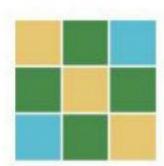
Groundwater Flooding

- 5.60 Groundwater flooding occurs when the water table rises above ground elevations. It is most likely to happen in low lying areas underlain by permeable geology. This may be regional scale chalk or sandstone aquifers, or localised deposits of sands and gravels underlain by less permeable strata such as that in a river valley.
- 5.61 Mapping available from the Department for Environment, Food & Rural Affairs (DEFRA) Magic Mapping Service¹¹ shows that the site is located in a Secondary Undifferentiated aquifer. This designation has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
- 5.62 Geological data held by the BGS shows that the bedrock geology underlying the site is Mudstone. Superficial deposits are indicated as Sand and Gravel. Consequently, it is considered any risk to the site from groundwater would occur in the superficial deposits.
- 5.63 High level mapping included with GCC-LRFMS mapping indicates that there is a medium susceptibility of groundwater flooding.
- 5.64 In the absence of any other evidence to the contrary, the risk of groundwater flooding is considered to be **medium**.

Flooding from Sewers

- 5.65 Sewer flooding can occur when the capacity of the infrastructure is exceeded by excessive flows, or as a result of a reduction in capacity due to collapse or blockage, or if the downstream system becomes surcharged. This can lead to the sewers flooding onto the surrounding ground via manholes and gullies, which can generate overland flows.
- 5.66 Severn Trent Water records indicate there is a 150mm diameter foul sewer located within High Street to the east of the site directing flows north past the site, (see **Appendix C**).
- 5.67 Details within the SFRA identify that Stroud district is at medium-low risk of sewer flooding and that the greatest risk areas are within postcode areas that do not include Saul, however there are records of flooding within the GL2 7 postcode area, which the site is located within.

¹¹ https://magic.defra.gov.uk/MagicMap.aspx



5.68 The risk of sewer flooding to the site is therefore considered to be **medium**.

Flooding from Artificial Sources

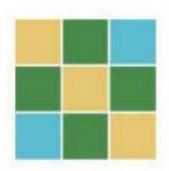
Reservoirs

- 5.69 Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.
- 5.70 To help identify this risk, reservoir failure flood risk mapping has been prepared¹², this shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The map displays a worst case scenario and is only intended as a guide.
- 5.71 Mapping data from the EA long term flood risk mapping indicate that the site and wider area is not at risk of flooding from reservoirs.
- 5.72 The development is considered to be at **negligible** risk of flooding from reservoirs.

Canals

- 5.73 The site is located north of the Gloucester and Sharpness Canal. The canal is a waterbody maintained by the Canal and River Trust (CRT) and they are generally responsible for maintaining water levels within this canal system using reservoirs, feeders and boreholes and manages water levels by transferring it within the canal system.
- 5.74 Water in a canal is typically maintained at predetermined levels by control weirs. When rainfall or other water enters the canal, the water level rises and flows out over the weir. If the level continues rising it will reach the level of the storm weirs. The control weirs and storm weirs are normally designed to take the water that legally enters the canal under normal conditions. However, it is possible for unexpected water to enter the canal or for the weirs to become obstructed. In such instances the increased water levels could result in water overtopping the towpath and flowing onto the surrounding land.
- 5.75 Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.
- 5.76 Where required overflows into adjacent rivers such as the River Frome are available, and this process ensures for the most part that canal flooding does not pose a risk.

¹² https://flood-warning-information.service.gov.uk/long-term-flood-risk/map



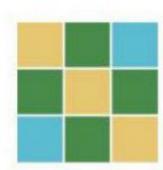
- 5.77 As detailed within the SFRA, there is one recorded incident of breach/overtopping associated with this canal. This occurred in June 1990 at Parkend (SO 7746 1055) circa 2 miles north east of the site as a result of culvert collapse at Saul Junction.
- 5.78 The development is considered to be at **low** risk of flooding from the canal.

Flood Risk Summary

5.79 The conclusion of the assessment is summarised in **Table 5.3** as follows:

Source of Potential Flooding	Flood Risk	
Tidal	Low	
Fluvial (River)	Low	
Pluvial	High	
Groundwater	Medium	
Sewers	Medium	
Artificial	Low	

Table 5.3: Flood Risk Summary



6 Flood Mitigation Measures

6.1 It is important to demonstrate that future users will not be at risk from flood hazards during the lifetime of the development, as well as ensuring that flood risk is not increased elsewhere.

Finished Floor Levels (FFLs)

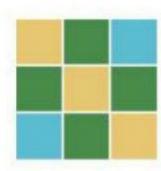
- 6.2 In accordance with Environment Agency guidance, finished floor levels (FFLs) should (where possible) be set a minimum of 600mm above the 100 year+35% climate change allowance flood levels for the site. In relation to the River Frome this would imply an FFL of 9.97mAOD and for the River Severn a FFL of 11.65mAOD.
- 6.3 In this instance, given the height of flood levels predicted from both the River Frome and River Severn based on in channel flood levels, at a considerable distance from the site it is not realistic to set FFLs near or above 10mAOD as this would involve significant raising of existing ground levels.
- 6.4 It is recommended that FFLs be set a minimum of 400mm above the proposed ground levels in the vicinity of the proposed two dwellings at a height of 8mAOD to provide protection against flooding from surface water runoff and the residual risk of fluvial flooding. This is in consideration of the extreme, undefended 1000 year return period River Frome flood depth data provided specific to the site and simple River Frome defence breach scenario data which identified a flood level of 7.8mAOD is applicable.

Ground Levels

- 6.5 Ground levels should be profiled to remove hollows/depressions within the site topography and the area of potential risk of pluvial flooding.
- 6.6 Ground levels should be finished so that overland runoff is encouraged to flow away from the proposed new buildings and be directed to the nearest on site drainage system runoff collection point.

Floodplain Compensation

6.7 As identified in the previous section, the development will not result in any actual loss of floodplain storage capacity for either the River Frome or the River Severn. This is due to the protection afforded by flood defences and the primary tidal flood risk nature of the River Severn.



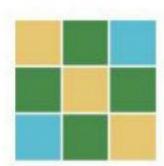
Access and Egress

- 6.8 Access and egress from the site will be via High Street. The site access point and the wider surrounding area is wholly located within defended floodplain so on this basis safe access would be readily achievable to leave Saul and travel south to Frampton on Severn and access land outside the floodplain.
- 6.9 Further onward travel in a south easterly direction on roads outside the floodplain could be undertaken to ultimately reach the M5 motorway.
- 6.10 Surface water flood mapping shows there to be areas of risk along High Street adjacent to the site. Potential depths of flooding are less than 300mm and considered to be shallow. It is expected that this flow route is dealt with by the drainage infrastructure present serving the highway, and therefore access and egress is not considered to be a significant risk.

Flood Warning and Evacuation Plan

- 6.11 The reality is the site is protected from fluvial and tidal flooding from maintained defences. A strategy is in place to ensure such defences remain to required standards in the future to provide the design protection required. However, it is acknowledged that in the unlikely and residual event of a defence breach scenario, floodwaters could reach depths posing a significant hazard to future occupants of the properties as identified in the simple approach breach assessment.
- 6.12 It is therefore recommended that future occupants of the proposed residential dwellings sign up to the available Environment Agency flood warning service for Saul¹³. This is to be aware of and receive warnings of predicted flooding in order to act appropriately and make plans to evacuate to areas of lower risk as required.
- 6.13 It is recommended that a flood plan be prepared by future occupants. This should include the actions to be taken before, during and after a flood. Further details for preparing a flood plan can be found at: https://www.gov.uk/prepare-for-flooding/future-flooding.
- 6.14 The site is located a significant distance away from the River Frome and River Severn in order to act before defence breach floodwaters reached the site. The site should be evacuated if either a flood warning indicates that this is appropriate action, or if advised to do so by the Environment Agency, Lead Local Flood Authority, or a Category 1 responder.

¹³ https://www.fws.environment-agency.gov.uk/app/olr/viewmap?tald=c4d121090ab71fc5190b3e3f3fc89a26



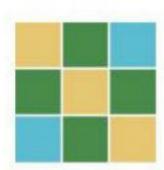
6.15 In the unlikely event of a defence breach and significant depth floodwaters reaching the site prior to occupants leaving, safe refuge could be sought on the first floor of the respective properties prior to rescue by the emergency services when safe and available to do so.

Resilience

- 6.16 As well as production of a flood warning plan, it is recommended that consideration be given to the use of flood resilient building materials in view of the risk posed by a defence breach flooding situation in accordance with Environment Agency standing advice and Communities and Local Government document Improving the Flood Performance of New Buildings.
- 6.17 Resilience measures are either an integral part of the building or features inside the building. Flood resilient buildings are designed to reduce the impact of flood water entering the building to restrict permanent damage, ensure structural integrity is maintained and to assist with drying and cleaning following flooding.

Groundwater

6.18 The potential for shallow groundwater should also be considered during the construction phase of the development, particularly during the excavations. It is recommended that groundwater levels are monitored during the construction phase, and where groundwater is encountered appropriate dewatering should be employed.

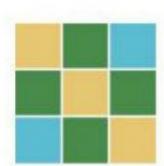


7 Proposed Drainage Strategy

- 7.1 Consideration of flood issues is not confined to the floodplain. This is recognised in the NPPF and associated guidance. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in a catchment, particularly flooding downstream; and replacing permeable vegetated areas with low permeability roofs, roads and other paved areas will increase the speed, volume and peak flow of surface water runoff.
- 7.2 A surface water management strategy for the development is proposed to manage and reduce the flood risk posed by surface water runoff from the site. The surface water drainage arrangements for any development site should be such that the volume and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same net effect.
- 7.3 An assessment of the surface water runoff rates was undertaken to determine the surface water options and attenuation requirements for the site and is discussed below.

Existing Drainage

- 7.4 The current site totalling approximately 0.1ha in area, is a predominantly greenfield, undeveloped plot of land, considered to drain via natural infiltration at existing greenfield rates of runoff.
- 7.5 The existing greenfield runoff rates have been calculated using the Micro Drainage Source Control tool and the Interim Code of Practice (ICP) SuDs method. The resulting calculations are included within **Appendix F**.
- 7.6 The QBAR (annual average) runoff rate is determined to be 0.2l/s for the area of the application site, (approximately 1200m2 0.12ha).
- 7.7 This level of flow restriction is not considered to be feasible. The BBA Agrément Certificate for Hydro International's S-Range Hydro-Brake Optimum Flow Controls states a minimum design flow rate of 0.7l/s with a minimum design head value of 0.4m.
- 7.8 For the proposed development, a design flow rate of 0.7l/s shall therefore be used, with a design head value of 1.0m. Flows shall be restricted through use of a vortex flow control, and upstream storage provided by an underground geocellular crate system and within the sub-base material below permeable parking areas.



7.9 The storage shall be sized to attenuate the design 1 in 100 year storm, with a 40% increase to account for the effects of climate change

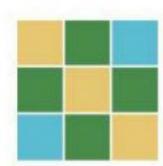
Surface Water Management

- 7.10 Sustainable drainage system measures (SuDS) should be used to control the surface water runoff from the proposed development site, thereby managing the flood risk to the site and surrounding areas from surface water runoff. These measures will also improve the quality of water discharged from the site.
- 7.11 The SuDS hierarchy demands that surface water run off should be disposed of as high up the following list as practically possible:
 - Into the ground (infiltration) and re-use, or then;
 - To a surface water body, or then;
 - To a surface water sewer, highway drain or another drainage system, or then;
 - To a combined sewer.
- 7.12 Due to the presence of Mudstone geology, it is assumed for the purposes of this assessment that the use of soakaway drainage for the proposed development is not feasible. This is because the drain down rates likely to be encountered during intrusive site investigations are expected to be poor and unsuitable to meet development drainage design requirements in accordance with BRE Digest 365 methodology standards.
- 7.13 On the above basis it is proposed to discharge flows of runoff generated to the section of open watercourse located within the south east of the site.
- 7.14 Infiltration testing should be carried out prior to further design development to investigate whether the use of permeable paving or mass infiltration is feasible.

Proposed Drainage

- 7.15 The introduction of hardstanding associated with the proposed development will introduce an impermeable area of which will increase the amount of runoff generated and could increase flood risk elsewhere unless managed to Lead Local Flood Authority (LLFA) drainage requirements¹⁴, which in this case is Gloucestershire County Council.
- 7.16 It is proposed to introduce a new gravity stormwater system with attenuation and a controlled discharge for up to a 1 in 100 year event plus 40% climate change allowance, which will reduce risk of flooding downstream.

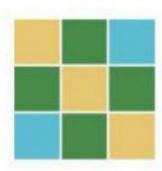
¹⁴https://www.gloucestershire.gov.uk/media/6846/gloucestershire_suds_design_and_maintenance_guide_dec_2015-compressed-63334.pdf



- 7.17 As detailed in paragraph 7.6, the QBAR (annual average) runoff rate is determined to be 0.2l/s for the area of the application site. This level of flow restriction is not considered to be feasible. For example, the BBA Agrément Certificate for Hydro International's S-Range Hydro-Brake Optimum Flow Controls states a minimum design flow rate of 0.7l/s with a minimum design head value of 0.4m.
- 7.18 For the proposed development, a design flow rate of 0.7l/s shall therefore be used, with a design head value of 1.0m.
- 7.19 Surface water shall be collected through a traditional gravity drainage system. Areas of hardstanding shall be drained with highway gullies and grated surface water channels with appropriate loading classes for the proposed traffic, while the buildings shall be drained with traditional roof gutters and downpipes. All surface water drainage shall be conveyed via gravity and discharged to the ditch via the vortex flow control device, with excess flows stored in the offline geocellular storage system and in the sub-base below permeable paving areas.
- 7.20 Micro Drainage Source Control Calculations have been undertaken for the 1 in 100 year storm event with 40% climate change to assess storage requirements. Results indicate a minimum 34.3m³ of storage is required for stormwater runoff. This model uses a hydrobrake control discharging at a max rate of 0.7 l/s.
- 7.21 The storage can be accommodated within the geocellular crate system and the sub-base below the permeable parking areas.
- 7.22 A drainage strategy layout has been produced and is included in **Appendix G** with supporting calculations.

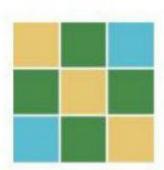
Water Quality

- 7.23 It is acknowledged that SuDS can be incorporated into the stormwater strategy to provide water quality measures.
- 7.24 It is proposed that parking areas may be constructed from permeable paving. Infiltration rates are considered likely to be low, however a full or partial infiltration system may be viable for these areas. This will help to reduce the volume entering the system.



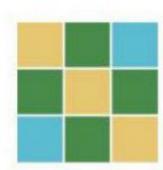
Maintenance Regime

- 7.25 Maintenance of SuDS features are essential to ensure that the surface water drainage system operates effectively and that flooding of the site and surrounding areas is prevented.
- 7.26 The responsibility of maintaining the private surface water and foul water drainage components would lie with the landowner of the site, who may delegate responsibility to an appointed external private management company.
- 7.27 For all drainage aspects a full maintenance regime should be carried out to ensure that drainage systems remain operational in accordance with manufacturer's guidelines and drainage features maintenance requirements as set out in the SuDS Manual (C753) see Table 7.1 overleaf.



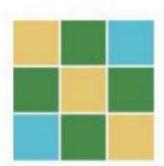
Drainage Component	Required Action	Typical Frequency		
Component	Stabilise adjacent areas	As required		
	Remove weeds	As required		
Pipework,	Clear any poor performing structures.	As required		
manholes, flow control chambers, catch pits	Inspect all structures for poor operation	Three monthly, 48 hours after large storms in first six months		
and silt traps	Monitor inspection chambers. Inspect silt accumulation rates and determine silt clearance frequencies	Annually		
	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually.		
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly		
Attenuation Tank	Inspect inlets, outlets, banksides, structures, Repair/rehabilitate inlets, outlet, overflows and vents	As Required		
	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually		
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required.		
	Brushing and vacuuming	Once a year or as required		
	Stabilise and mow contributing and adjacent areas	As required		
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements		
	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required		
Permeable Paving	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace jointing material	As required		
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required.		
	Inspect for evidence of poor operation and/or weed growth	3 monthly, 48 hours after large storms in first 6 months		
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually		
	Monitor inspection chambers	Annually		

Table 7.1: Initial Operation and Maintenance Plan



8 Summary and Conclusion

- 8.1 Cotswold Transport Planning were appointed by Aqua Construction to produce a Flood Risk Assessment (FRA) for a proposed residential development at High Street, Saul.
- 8.2 This assessment has considered the risks of all types of flooding to the site including tidal, fluvial, surface, groundwater, sewer and artificial sources and provides mitigation measures to ensure that the flood risk to the site is minimised and that flood risk off-site is not increased.
- 8.3 The site is classified as being located within defended Flood Zone 3, as displayed on the Environment Agency Flood Map for Planning and at high risk of flooding.
- 8.4 The proposed development is categorised as more vulnerable, which is acceptable to consider in Flood Zone 3 locations in line with the NPPF provided flood risk is not increased elsewhere.
- 8.5 Review of flood data received from the Environment Agency and available flood defence crest level information in relation to the topography of the development site has identified the site is at residual risk of flooding and protected from fluvial and tidal flooding from the River Frome and River Severn.
- 8.6 Over the lifetime of the development, unless flood defences are raised on the River Severn, floodwaters could overtop them through the effect of climate change. However, such an eventuality is not considered to pose a hazard to the site. This is based on a simple approach overtopping assessment conducted in view of the distance of the site away from the defences and the head of floodwaters that could be encountered.
- 8.7 In the unlikely scenario that the flood defences along the River Severn and/or the River Frome are breached, whereby the Environment Agency do not continue to maintain the defence integrity; the site could be at significant risk of flooding from the River Severn, as would the rest of Saul and the surrounding area. In acknowledgement of this, it is recommended that future occupants sign up to receive Environment Agency flood warnings as part of preparing a flood evacuation plan. Refuge could be sought within the properties proposed on the first floor if evacuation were not possible or did not occur for whatever reason.
- 8.8 The site is not considered to be at a significant risk of flooding from surface water, sewer, reservoir and groundwater sources.



- 8.9 It is recommended that finished floor levels are set at a minimum of 8mAOD to provide protection against generated surface water runoff and the extreme residual risk of river flooding from the River Frome.
- 8.10 Access and egress from the site will be via High Street. The site access point and the wider surrounding area is wholly located within defended floodplain so on this basis safe access would be readily achievable to leave Saul and travel south to Frampton on Severn and access land outside the floodplain.
- 8.11 A drainage strategy has been produced in accordance with LLFA guidance and sets out how the increase in impermeable catchment is managed to prevent an increase in flood risk elsewhere with discharge of surface water runoff.
- 8.12 This FRA demonstrates that the proposed development could be operated in view of identified flood risk and would not measurably increase flood risk elsewhere in accordance with the requirements of national policy and guidance.


Appendix A

Site Location Plan



Appendix B

Topographical Survey

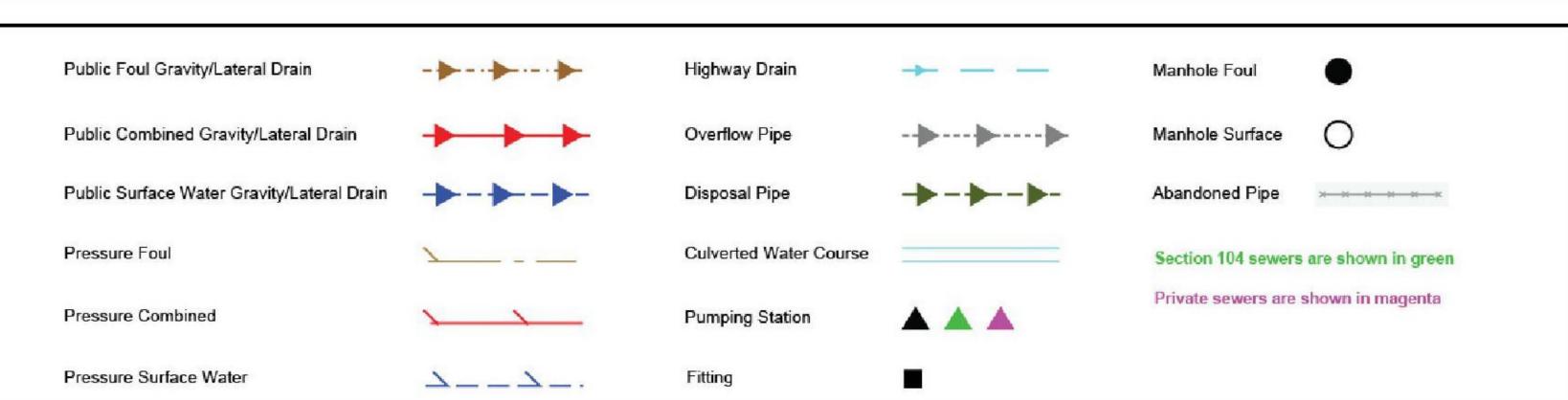


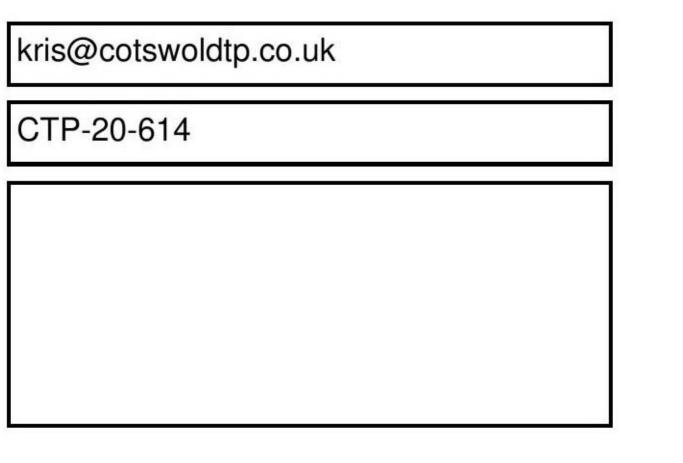
Appendix C

Severn Trent Water Sewer Records



Do not scale off this Map. This plan and any information supplied with it is furnished as a general guide, is only valid at the date of issue and no warranty as to its correctness is given or implied. In particular this plan and any information shown on it must not be relied upon in the event of any development or works (including but not limited to excavations) in the vicinity of SEVERN TRENT WATER assets or for the purposes of determining the suitability of a point of connection to the sewerage or distribution systems. On 1 October 2011 most private sewers and private lateral drains in Severn Trent Water's sewerage area, which were connected to a public sewer as at 1 July 2011, Transferred to the ownership of Severn Trent Water and became public sewers and public lateral drains. A further transfer takes place on 1 October 2012. Private pumping stations, which form part of these sewers or lateral drains, will transfer to ownership of Severn Trent Water on or before 1 October 2016. Severn Trent Water does not ossess complete records of these assets. These assets may not be displayed on the map. Reproduction by permission of Ordnance Survey on behalf of HMSO. © Crown Copyright and database right 2004. All rights reserved. Ordnance Survey licence number: 100031673. Document users other than SEVERN TRENT WATER business users are advised that this document is provided for reference purpose only and is subject to copyright, therefore, no further copies should be made from it.









GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on:

0800 783 4444 (24 hours)

- a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991 (a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.
- b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.
- c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.
- d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.
- e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).
- f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

- 1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
- 2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
- 3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
- 4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
- 5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW Apparatus to be surveyed prior to the works commencing.
- 6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
- 7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
- 8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
- 9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
- 10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
- 11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
- 12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
- 13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,

14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

- 15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
- 16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
- 17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
- 18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
- 19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0203	F	7.26	5.63	1.63
8102	F	7.38	4.02	3.36
8201	F	7.13	4.97	2.16
8202	F		3.75	3.56
8203	F		3.43	3.94
8301	F	2.13 10 10	2.91	4.28
9201	F	7.18	5.29	1.89

lanhole l	Reference	Liquid T	уре	Cover Le	vel Inv	ert Level	Depth to In	ver

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix D

Proposed Development Drawings



www.quattrodesign.co.uk

This drawing is the copyright of Quattro Design Architects Ltd and should not be reproduced in whole or in part without written permission. Only figured dimensions to be used for construction. Check all dimensions on site. Any discrepancies are to be reported to the Architect as soon as possible.

REVISIONS REV: DATE - DRAWN - CHECKED: NOTES

-: 24.07.20 - HD - HP:

Site plan finalised for planning submission.

A: 31.07.20 - HD - HP: Boundary wall label updated.

B: 18.08.20 - HD: Wall along rear boundary of Plot 1 updated to 1.8m

C: 19.08.20 - HD: Parking Updated for Plot 1.

DRAWING TITLE

Proposed Site Plan

PROJECT

Land to south of Lion House, High Street Saul

CLIENT

DATE

Aqua Construction

SCALE

July 2020

DRAWING NO.

REV

ignarchitects

1:100@A1

5904/P/21

Matthews Warehouse, High Orchard Street Gloucester Quays, GL2 5QY T: (01452) 424234

Appendix E

Environment Agency Flood Risk Data



Product 4 (Detailed Flood Risk Data) for High street,

Saul, GL2 7LW

Reference number: 190732 (Re-issue of 174521)

Date of issue: 12 November 2020

Model Information

The following information and attached maps contain a summary of the modelled information relevant to the area of interest. The information provided is based on the best available data as of the date of issue.

Model Name	Release Date
River Severn	2007
Tidal Severn Climate Change Re-run	2020
River Frome	2008

Flood Map for Planning (Rivers and Sea)

The Flood Map for Planning (Rivers and Sea) indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring in any year for fluvial (river) flooding (Flood Zone 3). It also shows the extent of the Extreme Flood Outlines (Flood Zone 2) which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater. The Flood Zones refer to the land at risk of flooding and **do not** refer to individual properties. It is possible for properties to be built at a level above the floodplain but still fall within the risk area.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water, sewers, road drainage, etc.

To find out which flood zone a location is in please use: https://flood-map-for-planning.service.gov.uk/

Definition of flood zones

- **Zone 1** The area is within the lowest probability of flooding from rivers and the sea, where the chance of flooding in any one year is less than 0.1% (i.e. a 1000 to 1 chance).
- **Zone 2** The area which falls between the extent of a flood with an annual probability of 0.1% (i.e. a 1000 to 1 chance) fluvial and tidal, or greatest recorded historic flood, whichever is greater, and the extent of a flood with an annual probability of 1% (i.e. a 100 to 1 chance) fluvial / 0.5% (i.e. a 200 to 1 chance) tidal. (Land shown in light blue on the Flood Map).



• **Zone 3** - The chance of flooding in any one year is greater than or equal to 1% (i.e. a 100 to 1 chance) for river flooding and greater than or equal to 0.5% (i.e. a 200 to 1 chance) for coastal and tidal flooding.

Note: The Flood Zones shown on the Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Reference should therefore also be made to the Strategic Flood Risk Assessment when considering location and potential future flood risks to developments and land uses.

Areas Benefitting From Defences

Where possible we show the areas that benefit from the flood defences, in the event of flooding:

- from rivers with a 1% (1 in 100) chance in any given year, or;
- from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would flood. Please note that we do not show all areas that benefit from flood defences.

The associated Dataset is available here: https://data.gov.uk/dataset/flood-map-for-planning-rivers-and-sea-areas-benefiting-from-defences



Node Data / Modelled Levels

The attached map will show a selection of 1D model node points near to your site, the fluvial levels for these node points on the River Frome are shown below.

Fluvial Flood Levels (m AOD)

The modelled levels are given in m AOD (N), m AOD indicates metres Above Ordnance Datum (Newlyn).

The information is taken from the model referenced above and does not include the updated climate change figures.

				Annual Exc	ceedance Pro	bability - Ma	aximum Wat	er Levels (m	AOD) (defe	nded unless r	marked *UD)	
Node Label	Easting	Northing	20% (1 in 5)	10% (1 in 10)	4% (1 in 25)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) *UD	1% (1 in 100) inc. 20% increase in inflow	0.1% (1 in 1000)	0.1% (1 in 1000) *UD
01363LW.1	375649	209354	9.75	9.78	9.79	9.79	9.79	9.79	-	9.80	9.81	-
01363Ru.1	375663	209363	8.81	8.86	8.89	8.91	8.91	8.92	8.20	8.93	8.93	8.25
01363.1	375628	209380	8.87	8.94	8.98	9.03	9.02	9.04	8.15	9.07	9.06	8.19
01119.1	375473	209501	8.88	8.94	9.01	9.04	9.05	9.07	7.96	9.08	9.08	8.03
00812.1	375312	209615	8.77	8.83	8.87	8.88	8.88	8.90	7.87	8.90	8.90	7.93
00740.1	375207	209757	8.77	8.82	8.86	8.87	8.88	8.89	7.84	8.89	8.89	7.91
00740.2	375161	209907	8.75	8.81	8.86	8.87	8.88	8.91	7.84	8.89	8.89	7.91
01486.1	375843	209521	8.80	8.85	8.88	8.89	8.90	8.92	8.39	8.93	8.93	8.53
01295.1	375672	209608	8.84	9.12	8.99	9.00	9.00	9.03	7.95	9.03	9.04	8.08
01098.1	375495	209688	8.82	8.90	8.94	8.96	8.96	8.98	7.90	8.98	8.98	8.00



A second node point map will show a selection of model node points near to your site for the River Severn, the tidal & fluvial levels for these node points are shown below.

Tidal Flood Levels (m AOD)

The modelled levels are given in m AOD (N), m AOD indicates metres Above Ordnance Datum (Newlyn).

The information is taken from the model referenced above and may not include the updated climate change figures.

			Annual Exceedance Probability - Maximum Water Levels (m AOD) (defended)						d)			
Node Label	Easting	Northing	20% Fluvial, 1.33% Tidal	20% Fluvial, 1% Tidal	20% Fluvial, 0.5% Tidal	20% Fluvial, 0.5% inc. 20% increase in inflows	20% Fluvial, 0.1% Tidal	1.33% Fluvial, 50% Tidal	1% Fluvial, 50% Tidal	1% Fluvial, 50% Tidal inc. 20% increase in inflows	0.5% Fluvial, 50% Tidal	0.1% Fluvial, 50% Tidal
SEV22	375899	210916	10.50	10.52	10.56	10.61	10.57	10.38	10.39	10.53	10.41	10.48
SEV23	375509	210719	10.56	10.58	10.61	10.68	10.65	10.41	10.41	10.57	10.43	10.51
SEV24	375020	210588	10.55	10.57	10.60	10.67	10.63	10.39	10.39	10.57	10.41	10.51
SEV25	374568	210533	10.63	10.65	10.67	10.77	10.73	10.41	10.42	10.60	10.43	10.52
SEV26	374082	210692	10.69	10.71	10.74	10.84	10.80	10.44	10.45	10.62	10.47	10.52
SEV51	372217	209168	10.27	10.31	10.39	10.66	10.53	9.84	9.84	10.21	9.85	9.92
SEV52	372674	209017	10.31	10.34	10.42	10.70	10.57	9.89	9.89	10.21	9.89	9.91
83	373280	208807	10.32	10.35	10.43	10.71	10.59	9.91	9.91	10.20	9.91	9.92
82	373280	208807	10.32	10.35	10.43	10.71	10.59	9.91	9.91	10.20	9.91	9.92
81	373922	207775	10.30	10.34	10.42	10.69	10.57	9.89	9.89	10.18	9.90	9.90



Climate Change Scenarios – Maximum Water Levels (m AOD) (defended)

Node Label	Easting	Northing	Fluvial 2020 HC	Tidal 2020 HC	Fluvial 2020 UE	Tidal 2020 UE	Fluvial 2040 HC	Tidal 2040 HC	Fluvial 2040 UE	Tidal 2040 UE
SEV22	375899	210916	10.30	10.47	10.31	10.48	10.31	10.50	10.37	10.51
SEV23	375509	210719	10.30	10.54	10.33	10.55	10.33	10.57	10.40	10.58
SEV24	375020	210588	10.30	10.54	10.33	10.54	10.33	10.57	10.40	10.58
SEV25	374568	210533	10.31	10.61	10.33	10.62	10.33	10.65	10.39	10.66
SEV26	374082	210692	10.32	10.67	10.33	10.68	10.33	10.72	10.37	10.73
SEV51	372217	209168	9.79	10.36	9.81	10.47	9.83	10.50	9.83	10.64
SEV52	372674	209017	9.78	10.39	9.79	10.41	9.79	10.49	9.81	10.53
83	373280	208807	9.76	10.40	9.77	10.42	9.77	10.50	9.79	10.54
82	373280	208807	9.76	10.40	9.76	10.42	9.76	10.50	9.77	10.53
81	373922	207775	9.75	10.39	9.75	10.41	9.75	10.48	9.75	10.52



			Climate Change Scenarios – Maximum Water Levels (m AOD) (defended)							
Node Label	Easting	Northing	Fluvial 2070 HC	Tidal 2070 HC	Fluvial 2070 UE	Tidal 2070 UE	Fluvial 2125 HC	Tidal 2125 HC	Fluvial 2125 UE	Tidal 2125 UE
SEV22	375899	210916	10.35	10.57	10.48	10.60	10.35	10.79	10.48	11.01
SEV23	375509	210719	10.38	10.63	10.50	10.67	10.38	10.86	10.50	11.04
SEV24	375020	210588	10.38	10.62	10.49	10.65	10.38	10.86	10.49	11.01
SEV25	374568	210533	10.37	10.71	10.48	10.74	10.37	10.92	10.48	11.10
SEV26	374082	210692	10.36	10.78	10.45	10.82	10.36	10.98	10.45	11.17
SEV51	372217	209168	9.83	10.64	9.87	10.73	9.83	11.02	9.87	11.30
SEV52	372674	209017	9.80	10.67	9.84	10.75	9.80	11.04	9.84	11.32
83	373280	208807	9.78	10.68	9.81	10.76	9.78	11.05	9.81	11.33
82	373280	208807	9.76	10.68	9.79	10.76	9.77	11.05	9.79	11.33
81	373922	207775	9.75	10.66	9.77	10.75	9.75	11.04	9.77	11.32

Note;

All Climate Change levels detailed above represent respective high risk events in each instance (i.e. a 1% or 1 in 100 year for fluvial, 0.5% or 1 in 200 year for tidal).

HC = Higher Central

UE = Upper End



Modelled Flood Extents

Available modelled flood outlines produced as part of the detailed modelling have been provided to you in GIS format. These show modelled flood extents. Climate change will increase flood risk due to overtopping of defences.

Please note; There are currently no available GIS layers for the respective Climate Change scenarios.

River Severn: https://ea.sharefile.com/d-s38674e346cc471f8
River Frome: https://ea.sharefile.com/d-sf42106f43964852b

Climate Change

The 'Flood Risk Assessments: Climate Change Allowances' are published on gov.uk. This is in replacement of previous climate change allowances for planning applications. The data provided in this product does not include the new allowances. You will need to consider this data and factor in the new allowances to demonstrate the development will be safe from flooding. The climate change factors are now more complex and a single uplift percentage across England cannot be justified.

The Environment Agency will incorporate the new allowances into future modelling studies. For now it remains the applicant's responsibility to demonstrate through their proposal and flood risk assessments that new developments will be safe in flood risk terms for its lifetime.

Recorded Flood Outlines

Please find tabulated information below for records of historic flood events.

Flood Event Date	Source of Flooding	Cause of Flooding
July 1968	Main River	Channel capacity exceeded (no raised defences)
January 1994	Main River	Channel capacity exceeded (no raised defences)
November 2000	Main River	Channel capacity exceeded (no raised defences)

The corresponding recorded flood outline/s can be accessed here: https://data.gov.uk/dataset/recorded-flood-outlines1

The Recorded Flood Outlines take into account the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages. Any flood extents shown do not necessarily indicate that properties were flooded internally. It is also possible that the pattern of flooding in this area has changed and that this area would now flood or not flood under different circumstances.



Please note that our records are not comprehensive and that the map is an indicative outline of areas which have previously flooded, not all properties within this area will have flooded. It is possible that other flooding may have occurred that we do not have records for.

You may also wish to contact your Local Authority or Internal Drainage Board (where relevant), to see if they have other relevant local flood information.

Defence Data

Flood defences do not completely remove the chance of flooding. They can be overtopped by water levels which exceed the capacity of the defences.

If flood defences are located in your area, you can access this data here: https://data.gov.uk/dataset/spatial-flood-defences-including-standardised-attributes

Supporting Information

Surface Water

Managing the risk of flooding from surface water is the responsibility of Lead Local Flood Authorities. The 'risk of flooding from surface water' map has been produced by the Environment Agency on behalf of government, using Lead Local Flood Authority surface water information.

You may wish to contact your Local Authority who may be able to provide information on surface water.

It is not possible to say for certain what the flood risk is but we use the best information available to provide an indication so that people can make informed choices about living with or managing the risks. The information we supply does not provide an indicator of flood risk at an individual site level. Further information can be found on the Agency's website:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

Additional Details

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments:

https://www.gov.uk/planning-applications-assessing-flood-risk

https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Flood Risk and Coastal Change Environment

Climate Change allowances for planning (SHWG area)

March 2016 (Sept 2020 update)

The National Planning Practice Guidance refers to Environment Agency guidance on considering climate change in planning decisions which is available online: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

This has been updated and replaces the September 2013 guidance.

It should be used to help planners, developers and advisors implement the National Planning Policy Framework (NPPF)'s policies and practice guidance on flood risk. It will help inform Flood Risk Assessments (FRA's) for planning applications, local plans, neighbourhood plans and other projects.

Fluvial flooding - peak river flows

Table 1 of the guidance advises that an allowance should be added to 'peak river flows' to account for 'climate change' which should be specific to a river basin district catchment.

In Shropshire, Herefordshire, Worcestershire and Gloucestershire area, we would refer you to the relevant extract from Table 1 below. This outlines the 'peak river flows' within the 'Severn River Basin District', and specifies the range of percentage allowances to reflect individual development's lifetime and vulnerability. For example, residential would be 100 years (so 2070-2115).

Table 1 Extract

Severn Peak River Flows: Total potential change anticipated	2015-39	2040-2069 (less vulnerable)	2070-2115 (more vulnerable)
Upper end	25%	40%	70%
Higher central	15%	25%	35%
Central	10%	20%	25%

Sea Level rise allowances

Table 3 of the guidance (extract below) indicates that net sea level risk is as follows (updated from the 2013 version).

Area of England	Allowance	2000 to 2035	2036 to 2065	2066 to 2095	2096 to 2125	Cumulative rise
		(mm)	(mm)	(mm)	(mm)	2000 to 2125
						(metres)
South West	Higher central	5.8 (203)	8.8 (264)	11.7 (351)	13.1 (393)	1.21
South West	Upper end	7 (245)	11.4 (342)	16 (480)	18.4 (552)	1.62

Note - For sites utilising the Severn tidal model the above allowances should be considered and applied. As of August 2020, specific updated flood level data is now available for the 2096 to 2125 epoch based upon the Environment Agency's

Tidal Severn model within the West Midlands area and will be provided where relevant as part of our Request For Information service; contact

Enquiries Westmids@environment-agency.gov.uk

Flood Risk Assessment considerations:

The design flood (1% flood level fluvial, or 0.5% tidal, plus climate change allowance) should be used to inform the sequential test, including appropriate location of built development; consideration of flood risk impacts, mitigation/enhancement and ensure 'safe' development.

Vulnerability classification

- Development classed as 'Essential Infrastructure' (as defined within Table 2 Flood Risk Vulnerability Classification, Paragraph: 066 Reference ID: 7-066-20140306 of the NPPG) should be designed to the 'upper end' climate change allowance (70%).
- For highly vulnerable or more vulnerable development e.g. housing, the FRA should use the 'higher central' climate change allowance (35%), as a minimum, to inform built in resilience; but aim to incorporate managed adaptive approaches/measures for the 'upper end' allowance (70%) where feasible.
- For water compatible or less vulnerable development e.g. commercial, the FRA should use the 'central' climate change allowance (20%), as a minimum, to inform built in resilience; but aim to incorporate managed adaptive approaches/measures for the 'higher central' allowance (25%) where feasible.

Modelling approach

– Major Development:

For 'major' development (as defined within The Town and Country Planning Development Management Procedure (England) Order 2015)*, see definition note below, we would expect a detailed FRA to provide an appropriate assessment (hydraulic model) of the 1% with relevant climate change ranges.

There are two options:

Scenario 1 - Produce a model and incorporate relevant climate change allowances in Table 1.

Scenario 2 - Re-run an existing model and incorporate relevant climate change allowances in Table 1.

– Non Major Development:

For 'non major' development, we would advise that a model is produced or existing model is re-run, similar to the above approach (Scenario 1 and 2). This would give a greater degree of certainty on the design flood extent to inform a safe development.

However, for 'non major' development only, in the absence of modelled climate change information it may be reasonable to utilise an alternative approach. To assist applicants and Local Planning Authorities we have provided some 'nominal' climate change allowances within the 'Table of nominal allowances' below. These should be considered as appropriate within any FRA. There are three additional options:

Scenario 3 - Where previous modelled data (for a variety of return periods) is available, you could interpolate your own climate change figure (see note iv below).

Scenario 4 - Where the 1% level is available from an existing model add on the relevant 'nominal climate change allowance' provided in the 'Table of nominal allowances' below.

Scenario 5 - Establish the 1% level, for example using topographical levels (including LiDAR) and assessment of watercourse flow and nature and then add on the relevant 'nominal climate change allowances' provided in the 'Table of nominal allowances' below.

*Note: For definitions of 'major' development see 'Interpretation 2.—(1)', on page 5, at: www.legislation.gov.uk/uksi/2015/595/pdfs/uksi/20150595 en.pdf

Table of Nominal Allowances

Watercourse	20% - 25%	35% - 40%	70%	
Upper Severn				
River Wye	600mm	850mm	1500mm	
River Teme				
River Avon	400mm	600mm	1000mm	
Lower Severn	400mm	600mm	1000mm	
Tributaries and 'ordinary				
watercourses'	200mm	300mm	500mm	

Notes to above:-

(i) Watercourse definition:

The "Upper Severn"/"Lower Severn" boundary is taken as Lincomb Weir, Worcestershire (national grid reference SO8196869458).

An 'Ordinary Watercourse' is a watercourse that does not form part of a main river. Main Rivers are indicated on our Flood Map. You can also check the classification of the watercourse with the LLFA, some of which have produced Drainage and Flooding Interactive Maps.

- (ii) Where a site is near the confluence of two, or more, watercourses, the FRA should use the larger river climate change allowances.
- (iii) We may hold more precise information for some of the "tributaries". We would recommend that you seek this information from us via a 'pre-planning enquiry/data request', to the email address below.
- (iv) We would also recommend that you contact us for our modelled '20%' allowances and associated flow data. This is available for some rivers. This data may help inform a more detailed climate change analysis (where necessary), including any interpolation of levels or flow to create a 'stage discharge rating' in order to estimate the required percentage; or be of assistance to inform 'less vulnerable' or 'water compatible' development proposals.

IMPORTANT NOTE

Please note the nominal climate change allowances are provided as a pragmatic approach, for consideration, in the absence of a modelled flood level and the applicant undertaking a detailed model of the watercourse. Use of nominal climate change allowances are not provided/ recommended as a preference to detailed modelling and historical data.

The Local Planning Authority may hold data within their Strategic Flood Risk Assessment (SFRA), or any future updates, which may help inform the above.

FREEBOARD NOTE

It is advised that Finished Floor Levels should be set no lower than '600mm' above the 1% river flood level plus climate change. Flood proofing techniques might be considered where floor levels cannot be raised (where appropriate). This 600mm freeboard takes into account any uncertainties in modelling/flood levels and wave action (or storm surge effects).

customer service line 03708 506 506

incident hotline 0800 80 70 60

floodine 0845 988 1188

Surface Water

Table 2 of the guidance also indicates the relevant increases that surface water FRA should consider for an increase in peak rainfall intensity.

The following table is for 'peak rainfall intensity' allowance in small and urban catchments. Please note that surface water (peak rainfall intensity) climate change allowances should be discussed with the Lead Local Flood Authority (LLFA).

Peak Rainfall Intensity - Applies across all of England	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2069	Total potential change anticipated for 2070-2115
Upper end	101/2010-2039	20%	40%
Central	5%	10%	20%

Note to above:-

For river catchments around or over 5 square kilometres, the peak river flow allowances are appropriate.

Produced by: WestMidsPlanning@environment-agency.gov.uk

West Midlands Area -

Shropshire, Herefordshire, Worcestershire and Gloucestershire Sustainable Places Team.

Appendix F

MicroDrainage Calculations

Cotswold Transport Planning	Page 1	
CTP House, Knapp Road	HIGH STREET, SAUL	
Cheltenham	ATTENUATION VOLUME	
Gloucestershire, GL50 3QQ	UP TO 1 IN 100 YR + 40% CC	Micro
Date 14/08/2020 16:25	Designed by DM	Drainage
File	Checked by NT	namaye
Innovyze	Source Control 2020.1	X7

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 550 minutes.

Storm		Max	Max	Max	Max	Max	Max	Status	
Event		t	Level	Depth	Infiltration	Control	Σ Outflow	Volume	
			(m)	(m)	(1/s)	(1/s)	(1/s)	(m³)	
15	min	Summer	0.256	0.256	0.0	0.5	0.5	13.4	O K
30	min	Summer	0.341	0.341	0.0	0.5	0.5	17.8	O K
60	min	Summer	0.428	0.428	0.0	0.5	0.5	22.3	O K
120	min	Summer	0.508	0.508	0.0	0.5	0.5	26.5	O K
180	min	Summer	0.544	0.544	0.0	0.5	0.5	28.4	O K
240	min	Summer	0.561	0.561	0.0	0.5	0.5	29.3	O K
360	min	Summer	0.570	0.570	0.0	0.5	0.5	29.8	O K
480	min	Summer	0.566	0.566	0.0	0.5	0.5	29.6	O K
600	min	Summer	0.559	0.559	0.0	0.5	0.5	29.2	O K
720	min	Summer	0.552	0.552	0.0	0.5	0.5	28.8	O K
960	min	Summer	0.534	0.534	0.0	0.5	0.5	27.9	O K
1440	min	Summer	0.497	0.497	0.0	0.5	0.5	26.0	O K
2160	min	Summer	0.442	0.442	0.0	0.5	0.5	23.1	O K
2880	min	Summer	0.388	0.388	0.0	0.5	0.5	20.3	O K
4320	min	Summer	0.270	0.270	0.0	0.5	0.5	14.1	O K
5760	min	Summer	0.188	0.188	0.0	0.5	0.5	9.8	O K
7200	min	Summer	0.133	0.133	0.0	0.5	0.5	7.0	O K
8640	min	Summer	0.099	0.099	0.0	0.5	0.5	5.2	O K
0080	min	Summer	0.078	0.078	0.0	0.5	0.5	4.1	O K
15	min	Winter	0.288	0.288	0.0	0.5	0.5	15.0	O K

	Stor	m	Rain	Flooded	Discharge	Time-Peak
Event			(mm/hr)	Volume	Volume	(mins)
				(m ³)	(m³)	
15	min	Summer	122.474	0.0	13.7	19
30	min	Summer	82.355	0.0	18.4	33
60	min	Summer	52.892	0.0	23.7	64
120	min	Summer	32.827	0.0	29.5	122
180	min	Summer	24.479	0.0	33.0	182
240	min	Summer	19.741	0.0	35.5	242
360	min	Summer	14.507	0.0	39.1	360
480	min	Summer	11.659	0.0	41.9	430
600	min	Summer	9.833	0.0	44.2	490
720	min	Summer	8.551	0.0	46.1	556
960	min	Summer	6.853	0.0	49.2	684
1440	min	Summer	5.007	0.0	53.9	966
2160	min	Summer	3.650	0.0	59.1	1384
2880	min	Summer	2.913	0.0	62.9	1788
4320	min	Summer	2.116	0.0	68.5	2512
5760	min	Summer	1.684	0.0	72.7	3224
7200	min	Summer	1.410	0.0	76.1	3888
8640	min	Summer	1.220	0.0	79.0	4504
10080	min	Summer	1.080	0.0	81.6	5240
15	min	Winter	122.474	0.0	15.3	19

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Cotswold Transport Planning	Page 2	
CTP House, Knapp Road	HIGH STREET, SAUL	
Cheltenham	ATTENUATION VOLUME	
Gloucestershire, GL50 3QQ	UP TO 1 IN 100 YR + 40% CC	Micro
Date 14/08/2020 16:25	Designed by DM	Drainage
File	Checked by NT	Diali laye
Innovyze	Source Control 2020.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event			Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m³)	Status
			, ,						
30	min	Winter	0.383	0.383	0.0	0.5	0.5	20.0	O K
60	min	Winter	0.482	0.482	0.0	0.5	0.5	25.2	O K
120	min	Winter	0.574	0.574	0.0	0.5	0.5	30.0	O K
180	min	Winter	0.618	0.618	0.0	0.6	0.6	32.3	O K
240	min N	Winter	0.640	0.640	0.0	0.6	0.6	33.4	O K
360	min I	Winter	0.656	0.656	0.0	0.6	0.6	34.3	OK
480	min N	Winter	0.656	0.656	0.0	0.6	0.6	34.3	O K
600	min N	Winter	0.647	0.647	0.0	0.6	0.6	33.8	O K
720	min N	Winter	0.636	0.636	0.0	0.6	0.6	33.2	O K
960	min N	Winter	0.614	0.614	0.0	0.6	0.6	32.1	O K
1440	min N	Winter	0.561	0.561	0.0	0.5	0.5	29.3	O K
2160	min N	Winter	0.478	0.478	0.0	0.5	0.5	25.0	O K
2880	min N	Winter	0.396	0.396	0.0	0.5	0.5	20.7	O K
4320	min N	Winter	0.219	0.219	0.0	0.5	0.5	11.5	O K
5760	min	Winter	0.121	0.121	0.0	0.5	0.5	6.3	O K
7200	min N	Winter	0.075	0.075	0.0	0.5	0.5	3.9	O K
8640	min	Winter	0.058	0.058	0.0	0.4	0.4	3.0	O K
10080	min	Winter	0.050	0.050	0.0	0.4	0.4	2.6	O K

Storm			m	Rain	Flooded	Discharge	Time-Peak
Event			t	(mm/hr)	Volume	Volume	(mins)
					(m ³)	(m³)	
	30	min	Winter	82.355	0.0	20.6	33
	60	min	Winter	52.892	0.0	26.6	62
	120	min	Winter	32.827	0.0	33.0	120
	180	min	Winter	24.479	0.0	36.9	178
	240	min	Winter	19.741	0.0	39.7	236
	360	min	Winter	14.507	0.0	43.8	348
	480	min	Winter	11.659	0.0	46.9	456
	600	min	Winter	9.833	0.0	49.5	554
	720	min	Winter	8.551	0.0	51.6	578
	960	min	Winter	6.853	0.0	55.1	732
	1440	min	Winter	5.007	0.0	60.4	1040
	2160	min	Winter	3.650	0.0	66.2	1492
	2880	min	Winter	2.913	0.0	70.4	1932
	4320	min	Winter	2.116	0.0	76.7	2636
	5760	min	Winter	1.684	0.0	81.5	3232
	7200	min	Winter	1.410	0.0	85.3	3824
	8640	min	Winter	1.220	0.0	88.5	4416
	10080	min	Winter	1.080	0.0	91.4	5144

Cotswold Transport Planning	Page 3	
CTP House, Knapp Road	HIGH STREET, SAUL	
Cheltenham	ATTENUATION VOLUME	
Gloucestershire, GL50 3QQ	UP TO 1 IN 100 YR + 40% CC	Micro
Date 14/08/2020 16:25	Designed by DM	Drainage
File	Checked by NT	Diali lade
Innovyze	Source Control 2020.1	1.

Rainfall Details

Return Period (years) 100 Cv (Summer) 0.750
Region England and Wales Cv (Winter) 0.840
M5-60 (mm) 18.700 Shortest Storm (mins) 15
Ratio R 0.350 Longest Storm (mins) 10080
Summer Storms Yes Climate Change % +40

Time Area Diagram

Total Area (ha) 0.060

Time (mins) Area From: To: (ha)

0 4 0.060

Cotswold Transport Planning		Page 4
CTP House, Knapp Road	HIGH STREET, SAUL	
Cheltenham	ATTENUATION VOLUME	
Gloucestershire, GL50 3QQ	UP TO 1 IN 100 YR + 40% CC	Micro
Date 14/08/2020 16:25	Designed by DM	Drainage
File	Checked by NT	Dialilade
Innovyze	Source Control 2020.1	

Model Details

Storage is Online Cover Level (m) 1.000

Cellular Storage Structure

Invert Level (m) 0.000 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 55.0 55.0 0.661 0.0 77.4 0.660 55.0 77.4

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0039-7000-1000-7000 Design Head (m) 1.000 0.7 Design Flow (1/s) Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 39 Invert Level (m) 0.000 Minimum Outlet Pipe Diameter (mm) 75 1200 Suggested Manhole Diameter (mm)

Control Points Head (m) Flow (1/s) Design Point (Calculated) 1.000 0.7 Flush-Flo $^{\mathbb{T}M}$ 0.172 0.5 Kick-Flo $^{\mathbb{R}}$ 0.345 0.4 Mean Flow over Head Range - 0.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m) Fl	ow (1/s)	Depth (m) Flow	(1/s)	Depth (m) Flow	(1/s)	Depth (m)	Flow (1/s)
0.100	0.5	1.200	0.8	3.000	1.1	7.000	1.7
0.200	0.5	1.400	0.8	3.500	1.2	7.500	1.7
0.300	0.5	1.600	0.9	4.000	1.3	8.000	1.8
0.400	0.5	1.800	0.9	4.500	1.4	8.500	1.8
0.500	0.5	2.000	1.0	5.000	1.4	9.000	1.9
0.600	0.6	2.200	1.0	5.500	1.5	9.500	1.9
0.800	0.6	2.400	1.0	6.000	1.6		
1.000	0.7	2.600	1.1	6.500	1.6		

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Appendix G

Surface Water Drainage Strategy

