CHAPTER 8: WATER ENVIRONMENT

Chapter Alterations

A8.1 This chapter of the ES Addendum updates the ES with respect to the following:

1. Updated references to National Planning Policy Framework (NPPF).
2. Incorporation of further detail regarding updates to sewer design and construction guidance for systems proposed for adoption.
3. Updates to the development proposals.
4. Amendments of Appendix 8.1 (Flood Risk Assessment) to incorporate Points 1, 2 and 3 as well as information regarding further information requested by the Environment Agency and Lead Local Flood Authority.

A8.2 All amendments are highlighted in bold and underlined.

8.1 INTRODUCTION

8.1.1 This chapter of the ES Report has been produced by PBA, now part of Stantec (PBA). PBA has a designated Water Management team with many years of experience in, amongst other areas, the assessment of flood risk, hydrology and hydraulic modelling, flood management, the Water Framework Directive, surface water drainage and river engineering. PBA's Water Management team includes experienced staff who have relevant academic and professional qualifications, who are competent experts in the context of the EIA Regulations and for our contributions to the Environmental Statement. The authors are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) and/or the Institution of Civil Engineers (ICE).

8.1.2 The Water Environment Chapter of the ES will consider the impact of the Proposed Development on flood risk and surface water resources in the surrounding area. Consideration is given to temporary effects during the construction phase as well as the effects during the operation of the Proposed Development. The need for site specific mitigation measures is also identified and described. The nature of any residual effects that remain after mitigation is also discussed.

8.1.3 The potential impacts on the water environment resulting from the Proposed Development relate to four main events:

1. Erosion/sediment transport;

2. Chemical/pollution events;

3. Alteration/interruption of surface water flows; and

4. Alteration/interruption of groundwater flows.

8.2 ASSESSMENT CRITERIA & METHODOLOGY

Previous Assessment

8.2.1 No other hydrology or flood risk assessments are known to have been undertaken for the Project Site. However, some work was carried out (by others) to support a planning application for the site to the west known as Park Farm Thornbury (see Chapter 5).

Scoping Opinion

8.2.2 Within the Scoping Opinion, SGC confirmed that principles contained in the Applicants' Scoping Report were appropriate. They also provided the following advice:

"A Flood Risk Assessment (FRA) will need to be submitted as part of the planning application or ES for this site. The strategy for the FRA should be to use a sequential approach for locating development and follow the National Planning Policy Framework guidelines. To that effect, we would recommend that dwellings are located solely in Flood Zone 1. Flood Zone 2 can be used for dwellings, however, the use of this flood zone would be preferable to be used for "less vulnerable" uses such as shops. Flood Zone 3, especially 3b, should only be used for "water compatible" uses only. If it is planned to locate houses close to Flood Zone 3, then a river model would need to be undertaken for the watercourse, to help assess the risk to the development and determine finished floor levels and floodplain compensation."

8.2.3 An FRA has been prepared as part of the overall application documents (Technical Appendix 8.1).

8.2.4 The EA also provided comments with respect to the Water Framework Directive:

"From the information presented there does not appear to be any intention to realign or modify the channel form of the Pickedmoor Brook and Chapter 8 (Water Environment) therefore considers the impact on this channel in terms of hydrology and water quality only. However, there may be a risk that as the project develops plans may be put forward to modify the channel form itself - either for the purposes of flood risk mitigation or optimising the development potential of the site for example. Accordingly, the EIA should reflect this potential and include an assessment of channel morphology as well as ecological status.

While the EU Water Framework Directive is referred to in Chapter 8 as relevant legislation, it is important that the EIA is clear that it needs to meet the specific needs of a WFD compliance assessment. This can be done within the EIA and Environment Statement but it must address the impacts on all relevant WFD Quality Elements (including Hydromorphology) in all impacted water bodies and conclude with a 'statement of compliance' that considers the residual impacts at the water body scale on the water body objectives - following all appropriate mitigation."

8.2.5 Likely effects which may influence Water Framework Directive elements have been assessed within this chapter, and a Water Framework Directive compliance statement is included in Section 8.10.

8.2.6 As the application, does not propose to realign of modify the watercourse, no assessment on the ecological or channel morphology has been undertaken. It would not be appropriate to assess modifications to the watercourse that have not been applied for. In the unlikely event that modifications would be required the details of these, and impacts, would be assessed as part of a future application.

8.2.7 If required, a more detailed Water Framework Directive assessment would be undertaken as part of the application process for any outfalls required for the surface water drainage.

8.2.8 Lastly, the EA provided the following comments with respect to Environmental Management:

"A scheme for prevention of pollution during the construction phase should be included. The scheme should include details of the following:

1. Site security.

2. Fuel oil storage, bunding, delivery and use.

3. How both minor and major spillage will be dealt with.

4. Containment of silt/soil contaminated run-off.

5. Disposal of contaminated drainage, including water pumped from excavations.

6. Site induction for workforce highlighting pollution prevention and awareness.

Invitation for tenders for sub-contracted works must include a requirement for details of how the above will be implemented.

Measures should be taken to prevent the runoff of any contaminated drainage during the construction phase.

There shall be no discharge of foul or contaminated drainage from the site into either groundwater or any surface waters, whether direct to watercourses, ponds or lakes, or via soakaways/ditches."

8.2.9 Construction stage mitigation is addressed in Section 8.7.

Legislative Context

8.2.10 The assessment is underpinned by the following legislation:

Water Framework Directive

8.2.11 The Water Framework Directive (WFD) (Commission of the European Communities, 2000) (ref 13.2) establishes a framework for a European-wide approach to action in the field of water policy. Its aim is to ensure all inland and near shore watercourses and water bodies (including groundwater) are of 'Good' status or better, in terms of ecology and also chemical, biological and physical parameters, by the year 2027. Therefore, any activities or developments that could cause detriment to a nearby water resource, or prevent the future ability of a water resource to reach its potential status, must be mitigated so as to reduce the potential for harm and allow the aims of the WFD to be realised.

8.2.12 A water body is assessed for ecological status and chemical status as part of the WFD. The methodology for determining status has been set out by the UK Technical Advisory Group (UKTAG) on the WFD. The EA is responsible for monitoring and ensuring targets are met. Water bodies are classified as being 'High', 'Good', 'Moderate', 'Poor' or 'Bad'. The latest available status and targets for watercourses in England are available through the EA Catchment Data Explorer website.

8.2.13 Ecological status is based on biological quality which includes invertebrates, fish and macrophytes: physiochemical quality which includes temperature, dissolved oxygen, salinity, pH and nutrients and hydromorphological quality which assesses the range of available habitats.

8.2.14 Chemical status is assessed on the presence and concentration of priority substances for which standards have been established. A full list is in the UKTAG advice for classification. UKTAG has also proposed water quality, ecology and water abstraction and river flow standards to be adopted to ensure that water bodies in the UK (including groundwater) meet the required standard.

Flood and Water Management Act 2010.

8.2.15 The Flood and Water Management Act gives the EA a strategic overview role for flood risk, and gives the Lead Local Flood Authority (LLFA) responsibility for preparing and putting in place

strategies for managing flood risk from ground water, surface water and ordinary watercourses in their areas. Under the Flood and Water Management Act the LLFA role is carried out by county councils and unitary authorities. SGC is the LLFA in this area

Planning Policy and Guidance

8.2.16 This chapter has been prepared taking cognisance of the following planning policy and guidance.

National Planning Policy

National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG)

8.2.17 The NPPF and the accompanying PPG sets out the Government's policy on development and flood risk. The NPPF aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. In exceptional circumstances where new development is necessary in flood risk areas, the policy also aims to ensure it is safe, without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

8.2.18 The NPPF states that a FRA must be undertaken for all developments in Flood Zones 2 or 3, or for all sites greater than 1 hectare in area.

8.2.19 A FRA is required to assess the significance of any flooding to the Application Proposals and to assess the flood risk to third parties arising from the Application Proposals.

8.2.20 The NPPF advocates the use of the risk-based flood risk sequential test to steer new development to areas at lowest probability of flooding. It also matches the flood risk vulnerability of a development proposal to appropriate Flood Zones. For example, more sensitive developments like hospitals would not be permitted in areas at high risk of flooding, although leisure and tourism developments may be allowed.

8.2.21 The PPG defines the Flood Zones as:

"Flood Zone 1 – Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)

Flood Zone 2 – Land assessed as having between 1 in 1000 (0.1%) and 1 in 100 (1%) annual probability of river or sea flooding in any year

Flood Zone 3 – Land assessed as having a greater than 1 in 100 annual probability of river or sea flooding in any year (>1%)."

8.2.22 NPPF requires that development planning considers the projected impacts of climate change over the lifetime of the development, with reference to guidance published by the EA[1]. This guidance includes recommended allowances for peak river flow by river basin district, peak rainfall intensity, sea level rise and offshore wind speed, and extreme wave height. For the individual river basin districts, the climate change allowance for peak river flows range from 10% to 70%, while peak rainfall intensity allowance ranges from 5% to 40%.

8.2.23 The NPPF also requires the implementation of Sustainable Drainage Systems (SuDS) for the management of surface water run-off in developments, unless demonstrated to be inappropriate.

Local Planning Policy

South Gloucestershire Council Adopted Core Strategy

8.2.24 Objectives relating to flood risk and the site are as follows:

"Policy CS1 – High quality design

Development will only be permitted where the highest possible standards of design and site planning are achieved.

Development proposals will be required to demonstrate that:

- *Take account of the South Gloucestershire Strategic Flood Risk Assessments and provide, where appropriate, measures to manage flood risk and prepare surface water management plans."*

"Policy CS9 – Managing the environment and heritage

The natural and historic environment is finite and irreplaceable resource. In order to protect and manage South Gloucestershire's environment and its resources in a sustainable way, new development will be expected to:

- *Be located away from areas of flood risk.*
- *Reduce and manage the impact of flood risk through location, layout, design, choice of materials and the use of Sustainable Drainage Systems (SuDS)."*

[1] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

"Policy CS32 – Thornbury

Development plan documents and development proposals will take account of the vision and partnership priorities for Thornbury, and will:

- *Demonstrate through the preparation of appropriate Flood Risk Assessments, surface water management plans and drainage strategies, how flood risk will be managed."*

South Gloucestershire Policies, Site and Places Plan (2017)

8.2.25 The Policies, Site and Places Plan for South Gloucestershire was adopted in November 2017. The policies relevant to this document reflect the Core Strategy objective. Policy PSP20 Flood Risk, Surface Water and Watercourse Management sets out the council's policies derived to meet the Core Strategy objective of 'Understanding and reducing susceptibility to flood risk'. This policy is reproduced below.

"1. Flood Risk and Surface Water Management

All development proposal(s) should follow the sequential approach to flood risk, for all potential flood risk sources.

Development proposal(s) will be expected to:

i) reduce surface water discharge from the site, wherever practicable and feasible on:

a) previously developed land, by reducing post development runoff rates for events up to and including the 1 in 100 year return period, with an allowance for climate change, to that of a greenfield condition. Where it can be demonstrated that this is not practical or feasible, a 30% betterment to the existing condition will be required;

b) greenfield sites, by restricting discharge to a watercourse or surface water sewer to the estimated mean Greenfield runoff rate (QBAR) by means of a controlled outflow. The drainage system should be designed so that flooding does not occur on any part of the development for the 3.33% (1 in 30 year) rainfall event other than in those areas/systems designated to store or convey water. Flooding within the development site should not occur in any part of a building or utility plant susceptible to water during a 1% (1 in 100 year) event, with an allowance for climate change; and;

ii) incorporate Sustainable Drainage Systems (SuDS) to reduce surface water runoff and minimise the flood risk, supported by an appropriate surface water drainage strategy; and

iii) ensure that surface water drainage proposals are designed to not increase off-site flood risk; and

iv) wherever practicable achieve the top tier of the following Surface Water Discharge Hierarchy, providing justification where lower tiers are considered appropriate:

1. infiltration

2. surface water body (watercourse/ditch) (non-infiltration)

3. surface water sewer (non-infiltration)

4. combined sewer (non-infiltration)

2. Land Drainage and Water Quality

Development proposals will be acceptable where:

i) watercourses, ponds and lakes are retained, protected and enhanced as natural landforms, floodplains and wildlife habitats; and

ii) It is designed and located to protect the existing floodplain and enable suitable access for maintenance; and

iii) practicable the water environment is left in its natural state, and designed to avoid engineering activities which would cause harm to the water environment; and

iv) prevention and mitigation measures are sensitively designed to minimise the risk of pollution to the water environment.

3. Operation and Maintenance

Applicants must provide evidence of appropriate arrangements for future ownership, operation and maintenance of new and existing surface water drainage features, including SuDS, for the lifetime of the development proposal(s).”

South Gloucestershire Council Preliminary Flood Risk Assessment (2011)

8.2.26 The SGC Preliminary Flood Risk Assessment (PFRA) is a high-level screening exercise to gather and assess information on past (historic) and future (potential) floods. It identifies areas of significant local flood risk within the PFRA study area (where there are locally significant harmful consequences). The Project Site is not specifically identified in the PFRA as an area at risk of flooding.

South Gloucestershire Council Strategic Flood Risk Assessment (2009 and 2011)

8.2.27 SGC have produced Level 1 and Level 2 Flood Risk Assessments. Level 1 Report is primarily a desk-based study that allows a broad scale assessment of flood risk, which provides details of historic flooding incidents, areas at risk and areas which may become at risk from flooding in the future. It also identifies details of existing flood defences intended to reduce flood risk.

8.2.28 The Level 1 SFRA (2009) states that:

“The Lower Severn Internal Drainage Board (LSIDB) has suggested that without careful consideration of the potential impacts of surface water, urban extension of Thornbury is likely to have a detrimental impact upon flood risk downstream within the LSIDB area of responsibility. From discussions with the LSIDB, it is understood that the recipient watercourses of surface water from Thornbury experience flows at or near to capacity following rainfall. The LSIDB has suggested that whilst developers can limit the rate of surface water runoff, there is often no limit upon the duration of the controlled discharge and cumulative effect can result in an increase in flood risk.

Several watercourses flow through Thornbury, which all discharge into the rhine network near Oldbury on Severn.

There have been capacity issues associated with both the public surface water sewer network and a large culverted watercourse through residential development east of the town centre. It is understood that Wessex Water undertook the installation of a surface water relief sewer within the Knapp Road/Gillingstool area 2-3 years ago to alleviate internal flooding to a number of properties. The relief sewer diverts flow away from the aforementioned properties but this scheme may have increased flood risk downstream due to surcharging of the connecting culverted watercourse.

The LSIDB have expressed the concern that increased development within Thornbury could detrimentally impact flows in the Pickedmoor Lane Rhine and the downstream rhine system.

Strategically placed surface water attenuation infrastructure, as part of any development proposals directly upstream of the known sewer capacity issues and culverted watercourse, could help to control and reduce the rural flow component to provided betterment."

8.2.29 The Level 2 (2011) SFRA states that:

"The main risk addressed in the Level 2 SFRA is the potential increased flows from proposed development will have on land downstream of Thornbury, particularly with respect to the impact on the network of rhines.

The network of rhines is a complex system of drains of ditches serving to convey flows away from agricultural land in the Lower Severn Internal Drainage Board. The rhine network area is at risk from tidal flooding from the Severn Estuary and is prone to tide-locking."

8.2.30 With regards to the Pickedmoor Brook it further states:

"Two models have been prepared to classify the present level of flood risk. One is a developer model to support proposed development at Park Farm, the other was produced as part of this study to establish Flood Zones for the remaining length of watercourse."

The 'developer model' was created to support the planning application for the now consented Park Farm development to the east of the Project Site. The report further states:

"South Gloucestershire Council commissioned some additional modelling of the Pickedmoor Brook using JBA's JFLOW+ modelling software. Pickedmoor Brook had no previous modelled Flood Zones/outlines for its length. These outlines have been used to supplement areas outside the outlines from the Park Farm, Thornbury model. It should be noted that when viewing the outlines from JFlow+ that culverts and bridges have not been taken into account. For the development site at Thornbury, outlines were generated using the Park Farm 1D-2D linked ISIS

model. No defences were identified for the Pickedmoor Brook; therefore a defended model outline was not produced."

South Gloucestershire Council Local Flood Risk Management Strategy (2015)

8.2.31 The SGC Local Flood Risk Management Strategy (2015) sets out a series of objectives to ensure the successful delivery of the strategy across the authority. These are:

"Objective 1: Prioritise and implement improvements to local flood infrastructure to reduce the likelihood of flooding causing harm to the communities, businesses and environment of South Gloucestershire.

Objective 2: Increase public awareness of the level of flood risk affecting communities and businesses and how they can better protect themselves and their property.

Objective 3: Actively work with other Lead Local Flood Authorities and Risk Management Authorities to co-ordinate management and reduce flood risk across South Gloucestershire.

Objective 4: Contribute to wider social, economic, environmental and cultural benefits by encouraging sustainable multi-benefit solutions and maximising use of resources.

Objective 5: Improve our understanding of drainage assets, flood risk and how climate change will influence future flood risk.

Objective 6: Ensure future development considers all known flood risks and climate change projections for South Gloucestershire."

Emerging Planning Policy

South Gloucestershire Local Plan (2018 – 2036)

8.2.32 A new Local Plan is currently being prepared, which will eventually replace current planning policy documents, including the Adopted Core Strategy and the Policies, Site and Places Plan. Once adopted, the new Local Plan will form the basis for development planning going forward.

8.2.33 No specific proposed polices have yet been outlined, but a Local Plan Consultation Document was published in February 2018, setting out the proposed strategy for developing the Local Plan and seeking views to inform it. With respect to 'Environment, Climate Change and Flood Risk' the Consultation Document sets out a key priority for the new Local Plan to address issues relating to long-term resilience of new development through design and location.

8.2.34 With respect to the water environment, as a minimum, it would be expected that polices with similar objectives to those set out in the current Core Strategy will be brought forward in the new Local Plan.

Guidance/ Best Practice

Non-statutory technical standards for sustainable drainage systems (DEFRA, March 2015)

8.2.35 This document sets out non-statutory technical standards for sustainable drainage systems including peak flow and volume control parameters. They should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

The SuDS Manual (CIRIA 753)

8.2.36 This guidance covers the planning, design, construction and maintenance of Sustainable Drainage Systems (SuDS) to assist with their effective implementation within both new and existing developments. It looks at how to maximise the amenity and biodiversity benefits, and deliver the key objectives of managing flood risk and water quality.

8.2.37 There are four main categories of benefits that can be achieved by SuDS: water quantity, water quality, amenity and biodiversity. These are referred to as the four pillars of SuDS design.

8.2.38 SuDS deliver high quality drainage while supporting urban areas to cope better with severe rainfall both now and in the future. SuDS also help to counteract some of the impacts on our water cycle caused by increased urbanisation, such as reduced infiltration which in turn can result in diminished groundwater supplies.

Designing for exceedance in urban drainage (CIRIA, 2006)

8.2.39 'Designing for exceedance in urban drainage' provides good practice guidance on the design and management of urban sewerage and drainage systems to reduce the impacts from drainage exceedance.

Sewers for Adoption 7th Edition (WRc plc, 2012)

8.2.40 Sewers for Adoption 7th Edition provides guidance on the design, construction and maintenance of drains and sewers outside buildings which are to be adopted by a relevant public authority.

Design and Construction Guidance (also referred to as Sewers for Adoption 8th edition)

8.2.41 On 25 October 2019, Ofwat approved the revised adoption documentation submitted by Water UK. The documentation includes the "Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England ("the Code")" which wholly replaces previous editions of Sewers for Adoption. For the first time, specific SuDS components are included as adoptable elements of a drainage

system. The new sewerage adoption arrangements will come into effect on 1 April 2020 and will supersede the use of previous editions of Sewers for Adoption.

Building Regulations Part H (2015)

8.2.42 Building Regulations Part H covers drainage and waste disposal including foul water drainage, waste water treatment systems, rainwater drainage, building over sewers and separate systems of drainage.

BS EN 752:2008 – Drain and Sewer Systems Outside Buildings

8.2.43 BS EN 752:2008 provides a framework for the design, construction, rehabilitation, maintenance and operation of drain and sewer systems outside buildings.

West of England Sustainable Drainage Guide (March 2015, Section 1)

8.2.44 The West of England Sustainable Drainage Guide is structured around the non-statutory Technical Standards for Sustainable Drainage Systems in conjunction with the NPPF and the PPG. Section 1 provides an overview for the sub-regional approach whilst Section 2 sets out the authority-specific technical requirements. South Gloucestershire Council have a local variation that any development on greenfield land should restrict any surface water discharge from site to the QBAR (1 in 2.3 year) rate.

Baseline Data Collection

8.2.45 Baseline data on water resources and flood risk in the vicinity of the Proposed Development has been collated with reference to the following sources:

- EA – Flood Map for Planning, Risk of Flooding from Surface Water maps, Groundwater Mapping and Risk of Flooding from Reservoirs map;
- South Gloucestershire Planning Policy Documents;
- British Geological Survey – Geology of Britain Mapping;
- Cranfield Soil and Agrifood Institute Soilscapes (by Cranfield University) – Soil types of Britain Mapping;
- SGC – Preliminary Flood Risk Assessment (2011);
- SGC – Strategic Flood Risk Assessment (Level 1 and Level 2 – 2009 and 2011);
- SGC – Local Flood Risk Management Strategy (2015);

- EA Catchment Data Explorer data;
- Combined Phase 1 and Phase 2 Ground Condition Assessment (PBA, 2018);
- Flooding in Oldbury on Severn 9th March 2016 Report (Oldbury on Severn Parish Council);
- SGC - Oldbury-on-Severn Flood Report (May 2017);
- SGC - Flood Resilience Project – Oldbury-on-Severn (July 2018).

Assessment Methodology

8.2.46 The Technical Guidance of the NPPF requires assessment of all potential sources of flood risk with respect to new development. This has been carried out and reported in a separate Flood Risk Assessment (FRA) which is presented as an appendix to this ES (Technical Appendix 8.1). The FRA assesses the risk of flooding from the following sources:

- Fluvial Sources (river flooding);
- Tidal Sources (flooding from the sea);
- Groundwater Sources;
- Canals and Artificial Sources (including reservoirs);
- Pluvial Sources (flooding resulting from overland flows); and,
- Risk from increases in surface water discharge.

8.2.47 In accordance with the requirements of NPPF, the FRA includes consideration of the projected impacts of climate change on flood risk, and sets out appropriate flood risk mitigation principles, including an appropriate strategy for the management of surface water runoff from the Proposed Development.

8.2.48 Assessment of flood risk has been informed primarily by information set out in the 'Baseline Data Collection' section and information obtained from consultees.

<u>Assessment of Sensitive Receptors and Significance</u>

8.2.49 The significance of effects will be assessed by considering the sensitivity of receptors (i.e. their importance and ability to tolerate and recover from change) and the likely magnitude of the effect (i.e. its spatial extent and duration).

Sensitivity of Receptors

8.2.50 The sensitivity of the receptor with regards to water resources and flood risk refers to its considered value e.g. as a water dependent ecological habitat, a source of drinking water, a recreational resource, a watercourse with a significant ecological status or a watercourse with a significant history of flooding, see Table 8.1 for flood risk and drainage specific definitions.

Table 8.1: Sensitivity of Receptors

Sensitivity of Receptor	Description
High	• High environmental importance; international or national value including: - Ramsar Sites - Special Areas of Conservation (SAC); - Special Protection Areas (SPAs); - Sites of Special Scientific Interest (SSSIs); - WFD high/good 'ecological status' • Public water supplies and principal aquifers; • Nationally important fisheries containing protected species such as Freshwater Pearl Mussel; • Areas with a high risk of flooding; • Highly productive aquifer with high aquifer vulnerability.
Medium	• Medium environmental importance (e.g. WFD moderate 'ecological status') or important in the context of the region or district e.g. catchment scale issues, main river within a catchment, locally important aquifers or watercourses; • Private water supplies; • Groundwater that supports highly dependent groundwater dependent terrestrial ecosystems (GWDTE); • Areas with a moderate risk of flooding, with existing flooding being confined to areas immediately adjacent to watercourses; • Regionally important/moderately productive aquifers and drinking water protected areas; • Moderate groundwater/aquifer vulnerability; • Regionally important fisheries.
Low	• Low environmental importance (e.g. WFD poor/bad 'ecological status') or important within watersheds to which the site may drain; within the site and immediate vicinity e.g. non-aquifer and minor watercourses / waterbodies;

	• Low productivity / secondary aquifers with low groundwater vulnerability; • Private water supplies located within the vicinity of a mains water supply or private water supplies used for agricultural purposes and not for drinking water purposes; • Degraded fisheries or receptor not important for fisheries; • Low risk of flooding; • Receptor not used for water supplies (public or PWS); • Groundwater that supports moderately dependent groundwater dependent terrestrial ecosystems (GWDTE).
Negligible	• The sensitivity of the water resource is considered minimal.

Magnitude of Change

8.2.51 Determination of the magnitude of change to the receptors as a result of the Proposed Development has been undertaken based upon the criteria at Table 8.2. It should be noted that the magnitude of impact can be either beneficial or detrimental.

Table 8.2 Magnitude Criteria

Receptor	Magnitude			
	High	**Medium**	**Low**	**Negligible**
Fluvial flood risk and flow regime	Measurable change in riverine flows which is likely to alter WFD status or result in increase in flood risk for watercourses or water bodies directly monitored under the WFD. Permanent change to geomorphology over a large scale including large changes in erosion and deposition regimes.	Measureable change in riverine flows resulting in a change in dilution capacity or change in flood risk for smaller watercourses or water bodies, not directly monitored under the WFD. Permanent change in geomorphology over a limited area including some changes in erosion and deposition regimes.	Detectable change in river flows but no measurable change in dilution capacity or flood risk. Temporary change in geomorphology over a limited area including slight changes in bed morphology, sedimentation patterns and erosion rates.	No measureable change in riverine flow regime or geomorphology.

Surface Water Runoff Regime	Long term irreversible change in overall volume of runoff from the whole site and changes to flow paths and rates resulting in increase in flood risk and erosion potential.	Temporary change in overall volume of runoff from the whole site and changes to flow paths and rates resulting in increase in flood risk and erosion potential.	Short term change in volume of runoff and changes to flow paths and rates in localised areas of the site resulting in increase in flood risk and erosion potential to localised areas only.	No measureable change in site runoff regime.
Surface water quality	Measureable change in water quality status with respect to EQS[1] for more than one month; long term irreversible impact on aquatic ecosystems.	Measureable change in water quality status with respect to EQS for less than one month; temporary impact on aquatic ecosystems in the medium term.	Measurable deterioration in water quality but no change with respect to EQS. No significant impact on aquatic ecosystems.	No measureable deterioration in surface water quality.
Ground-water flow regime and quality	Irreversible or permanent change to recharge or groundwater flow regime resulting in long term decline of abstraction volumes; total loss of supply to or deterioration of quality of groundwater dependent habitats or groundwater base flow to a watercourse such that it impacts on WFD criteria or standards. Permanent or long term change in groundwater quality with respect to EQS for more than one month.	Measureable change to recharge or groundwater flow regime resulting in medium term decline of abstraction volumes or partial loss of supply to or deterioration of quality of groundwater dependent habitats or groundwater base flow to a watercourse but with no impact on WFD standards. Temporary change in groundwater quality, changing site quality with respect to EQS for less than one month.	Short term reversible change to recharge or groundwater flow regime resulting in short term change of abstraction volumes or small loss of groundwater dependent habitats. Measurable but temporary change in groundwater quality, but not changing status with respect to EQS.	No measureable change in recharge or groundwater flow regime or groundwater quality.

Determination of Significance

8.2.52 Finally, the magnitude of effects is compared to the sensitivity of the receptor to determine if the effect is significant and requires mitigation. The matrix for this assessment is presented in Table 8.3. Action will be required for any adverse effect which is not classified as Neutral.

[1] Environmental Quality Standards, UK Environmental Standards and Conditions (phase 1), UK Technical Advisory Group, 2008

Table 8.3 Effect Significance Matrix

		Magnitude of Impact			
		High	Medium	Low	Negligible
Sensitivity of Receptor	High	Substantial	Major	Moderate	Neutral
	Medium	Major/ Moderate	Moderate	Moderate/ Minor	Neutral
	Low	Moderate/ Minor	Minor	Minor/ Neutral	Neutral
	Negligible	Neutral	Neutral	Neutral	Neutral

8.2.53 The significance criteria specific to hydrology and flood risk are set out in Table 8.4.

Table 8.4 Definition of Significance

Significance	Definition
Substantial	These effects represent key factors in the decision-making process. They are generally, but not exclusively associated with sites and features of national importance and resources/features which are unique and which, if lost, cannot be replaced or relocated.
Major	These effects are likely to be important considerations at a regional or district scale but, if adverse, are potential concerns to the project, depending upon the relative importance attached to the issue during the decision making process.
Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.
Minor	These effects may be raised as local issues but are unlikely to be of importance in the decision making process. Nevertheless, they are of relevance in the detailed design of the project.
Neutral	Effects which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

8.2.54 For the purpose of this assessment anything rated as 'Moderate' or greater is considered to be significant and anything

8.2.55 As required by the EIA Regulations, the likely significant effects of the Proposed Development are described as:

- Adverse or beneficial
- Direct or indirect
- Temporary or permanent
- Reversible or irreversible

- Cumulative

8.2.56 Adverse effects are undesirable and result from negative impacts. Beneficial effects are desirable and result from positive impacts.

8.2.57 Each effect will have a source originating from the development, a pathway and a receptor. Effects which operate in this direct way are regarded as direct effects. Effects on other receptors via subsequent pathways are regarded as indirect effects.

Geographical Scope

8.2.58 The geographical scope of the assessment undertaken within this chapter is limited to within the Project Site boundary and areas immediately downstream that lie within the floodplain of the Pickedmoor Brook down to its confluence with the Oldbury Naite Rhyne in Oldbury on Severn.

Temporal Scope

8.2.59 The temporal scope of the assessment will cover the construction phase and the operational phase. When assessing flood risk, the effects of climate change on water flows for the 1 in 100 years will be considered. The Proposed Development will need to be designed to be flood free in the 1 in 100 year fluvial flood, and 1 in 200 year tidal flood when accounting for climate change.

Assumptions & Limitations

8.2.60 There are no 'industry standard' significance criteria for the consideration of water, hydrology and flood risk effects. The evaluation of effects is always subject to particular location-specific characteristics which need to be taken into account. A qualitative approach, based upon available knowledge, experience and professional judgement, is therefore employed to determine effect significance, and the assessment and evaluation of impact will not always correlate exactly with the cells in an assessment matrix. Cumulative effects have been taken into account through prediction and evaluation of effects at a catchment-wide level.

8.2.61 The FRA and ES chapter are reliant on publicly available data and additional data provided by consultees; it is assumed that this information is correct and complete.

8.2.62 The assessment has been undertaken in support of an outline planning application, therefore the level of detail relating to the proposed development is limited; the assessment of flood risk and preparation of the surface water management strategy has been undertaken against the detail available at this stage. The surface water management strategy will be refined as development proposals are brought forward in further detail at future stages.

8.2.63 The assessment has been undertaken on the assumption that the "Park Farm" development, adjacent to the east of the site, will be delivered in accordance with the consented scheme.

8.3 CONSULTATION

8.3.1 Consultation with statutory and non-statutory consultees has been undertaken to identify and collate data in respect of the baseline water environment, define the scope of investigation/technical work required to inform the FRA and ES chapter, agree assessment methodologies and the design principles to be applied to ensure compliance with the relevant policy, legislation and guidance.

8.3.2 The EA has been consulted with respect to flood risk; The LLFA and Lower Severn Internal Drainage Board (IDB) have been consulted with respect to flood risk and surface water management. Their responses are contained within the FRA which provides technical evidence in support of this ES Chapter (Technical Appendix 8.1).

8.4 BASELINE ENVIRONMENT

Hydrological Setting

8.4.1 The majority of the Project Site is currently under agricultural use. There are a number of open fields which are divided by hedgerows and trees. Adjacent to the western part of the Project Site there is a stand of ancient woodland. The Project Site is relatively flat and generally falls in a westerly direction.

8.4.2 The Pickedmoor Brook flows from east to west along the southern boundary of the Project Site. The Pickedmoor Brook is a small ordinary watercourse which flows into low-lying coastal land managed by the Lower Severn IDB. There is also a network of minor drainage ditches some of which flow through woodland and join the Pickedmoor Brook. There are two ponds in wooded areas within the Project Site boundary, which were recorded as being *"heavily shaded, shallow and muddy with no associated aquatic vegetation" Ecological Deliverability Report, Land at North-west Thornbury* (EAD Ecology, 2017).

8.4.3 The Pickedmoor Brook discharges to the Severn Estuary approximately 2.5km downstream of the site.

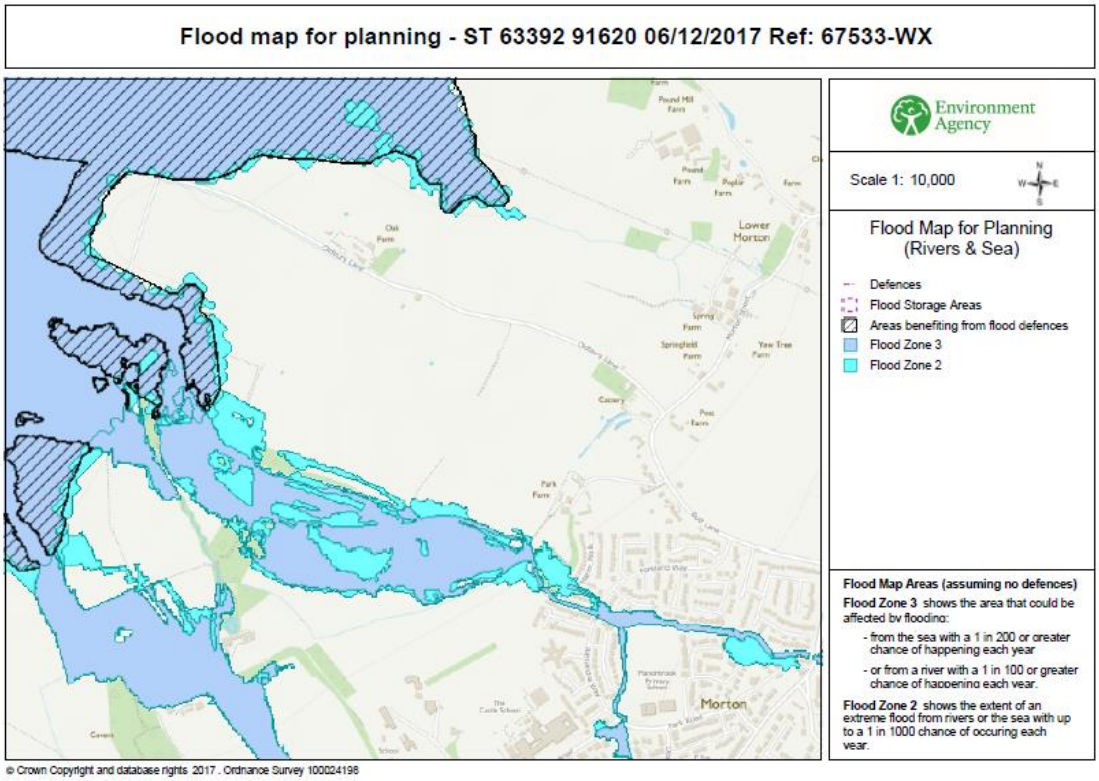
Fluvial and Tidal Flood Risk

8.4.4 The EA Flood Map for Planning confirms the majority of the Project Site lies in Flood Zone 1 'Low probability', defined as a less than 1 in 1,000 annual probability of fluvial and/or tidal flooding. The southern part of the Project Site is affected by Flood Zones 2 'Medium probability' (defined as between 1 in 1,000 and 1 in 100 annual probability of fluvial flooding) and Flood Zone 3 'High probability' (defined as a greater than 1 in 100 annual probability of fluvial flooding).

These outlines reflect a risk of fluvial flooding associated with Pickedmoor Brook and a risk of tidal flooding in the far west of the Project Site.

8.4.5 An extract of the EA Flood Map for Planning, as provided by the EA, is included in Figure 8.1 below.

Figure 8.1: Extract from EA Flood Map for Planning



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8.4.6 On the above basis the sensitivity of local watercourses and tributaries with respect to fluvial and tidal flood risk is considered to be **High** in accordance with Table 8.1.

Fluvial Flood Risk

8.4.7 The SFRA states that the Flood Zones are derived from a developer model which was prepared to support the planning application for the now committed development at Park Farm and from JFlow+ modelling carried out as part of the SFRA. The SFRA figures suggest the local flood outlines are significantly smaller than the Flood Zones as presented on the Flood Map for Planning.

8.4.8 Regarding the hydraulic modelling outputs produced in support of the adjacent “Park Farm” development, the flood extents agree closely with the Flood Map for Planning but do show a marginal reduction in flood extents of the Flood Zones on the Project Site. The EA have not

provided flood levels for the Project Site but did advise that the Flood Zones should be used for the purpose of assessing flood risk to the development.

8.4.9 It is not clear what information has been used to define the Flood Zones as it does not agree with the Park Farm developer model or the JFlow+ model commission as part of the SFRA. The EA advises that they do not hold any 1D model levels which suggests that the fluvial component of the Flood Zone definition is based on the National Generalised Model (JFlow). This methodology does not explicitly represent the channel capacity which generally leads to an overestimation of flooding.

Projected Climate Change Impacts (Future Baseline)

8.4.10 Guidance on the projected increase in river flows as a result of climate change is provided on the GOV.UK website. As detailed within the FRA, the implications of a 25% increase on the 1 in 100 year river flows should be considered with respect to the Proposed Development.

8.4.11 The Flood Zones within the Project Site boundary are very wide (in the order of 200m) and the channel catchment is relatively small (approximately 10km^2 at the downstream extent of the site). The SFRA shows predicted flood depths during the 1 in 100 year plus 20% climate change event for the Park Farm site (reproduced in the FRA) which extends to cover some of the Project Site. Within the floodplain simulated flood depths are for the most part less than 100mm and significant areas are less than 10mm. Although this plan doesn't extend to cover all of the Project Site, the channel geometry and floodplain between the two sites do not change significantly so it is reasonable to assume that flood depths within the floodplain on the Project Site would be comparable.

8.4.12 As the floodplain is very wide and flood depths are very shallow, any incremental increase in level represents a significant increase in flow. i.e. flood levels in the future 100 year fluvial event would not be expected to be significantly greater than those which currently define the Flood Zone 2 and 3 extents.

<u>Tidal Flood Risk</u>

8.4.13 Although the predominant source of flood risk is fluvial flooding, there is also a risk of tidal flooding at the western edge of the Project Site. Information provided by the EA defines the far western part of the site as being at risk of tidal flooding, but benefitting from the protection of existing defences. Although these defences are not defined, it is presumed that they are the defences on the banks of the Severn Estuary along with associated infrastructure to prevent the ingress of tidal waters into the Oldbury Naite Rhine and watercourses that drain to them.

8.4.14 For the purpose of undertaking a robust assessment of flood risk, taking into account the potential for breach of flood defences, the protection afforded by the defences is discounted

from tidal flood level information which has been provided by the EA. This information suggests that tidal flooding in the west of the Project Site would be expected up to a level of 9.44mAOD in the 1 in 200 year annual probability tidal event, and up to 9.86mAOD in the 1 in 1000 year annual probability tidal event.

Projected Climate Change Impacts (Future Baseline)

8.4.15 Guidance on the projected increase in sea level (both as a result of climate change and slow land movement) is provided on the GOV.UK website. Calculation set out in the FRA demonstrates that local sea level rise between 2012 and 2118 is projected to be 1.113m. On this basis, the 1 in 200 year plus climate change tidal flood level would be 10.532mAOD in 2118.

Surface Water Flooding

8.4.16 The EA's Risk of Flooding from Surface Water map delineates surface water flood risk into four categories as follows:

- *'Very Low' - less than 1 in 1000 annual probability*
- *'Low' – between 1 in 1000 and 1 in 100 annual probability*
- *'Medium' – between 1 in 100 and 1 in 30 annual probability*
- *'High' – greater than 1 in 30 annual probability*

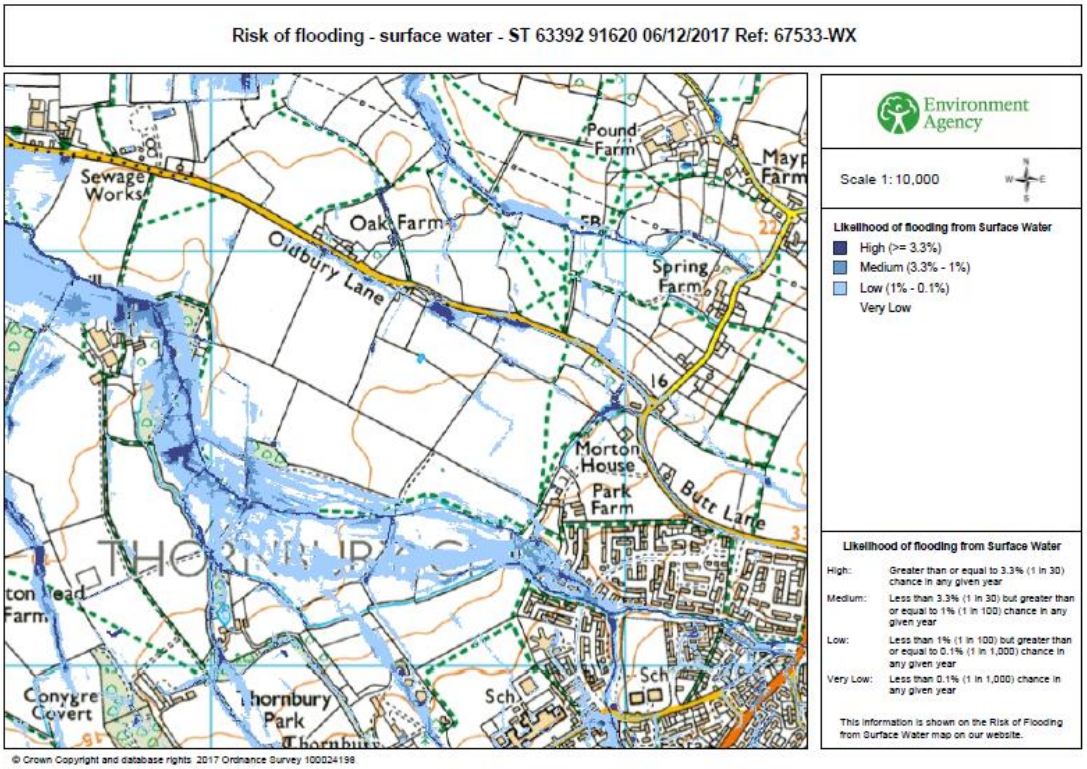
8.4.17 An extract of the EA Risk of Flooding from Surface Water map, as provided by the EA, is included in Figure 8.2 below.

8.4.18 The mapping indicates that the majority of the site is at 'Very Low' risk of flooding. The majority of the areas defined as being within Flood Zone 2 and Flood Zone 3 are shown to be at risk of 'Low' risk of surface water flooding, with some isolated areas being defined as being at risk of surface water flooding.

8.4.19 Outside the floodplain of the Pickedmoor Brook, there are areas at or beyond the Project Site boundary to the north shown as being at risk of surface water flooding. Some isolated low spots (generally field ditches or existing ponds) are shown as being at 'High' risk.

Some sections of Oldbury Lane and Butt Lane are shown as being a 'Medium' risk of flooding but predicted depths are below 300mm. These areas are assumed to be the parts of the ground model which have been lowered by 125mm to define the road flow paths (see the FRA for further detail). In reality, these roads are slightly higher than the surrounding land and generally served by drainage ditches on one or both sides (which are not fully represented in the modelling work) so flooding that would hinder access is considered

Figure 8.2: Extract from EA Risk of Flooding from Surface Water map



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8.4.20 to be extremely unlikely. There is no record of surface water flooding in these areas.

8.4.21 On the above basis the sensitivity of local environment with respect to pluvial flood risk is considered to be **Medium** in accordance with Table 8.1.

Surface Water Drainage

8.4.22 The majority of the Project Site is undeveloped agricultural land. Based on the Project Site's hydrological and geological context, it is assumed that it drains primarily by overland flow following the local topography towards the nearest drainage ditch or watercourse. The possible presence of some piped land drainage systems cannot be ruled out.

Surface Water Quality

8.4.23 The EA's Catchment Data Explorer website identifies the Project Site to lie within the 'Oldbury Naite Rhine' catchment which forms part of the Severn catchment. Although the watercourses within and adjacent to the site are not specifically WFD classified, the overall catchment water body classification for the 2016 cycle is Poor with the objective of achieving Good by 2027. The ecological status for the 2016 cycle is also Poor with the objective to achieve Good by 2027, and the chemical status is Good with the aim to remain so.

8.4.24 The watercourse is covered by the following Directives; Conservation of Wild Birds (Special Protection Area (SPA)), Habitats and Species Directive (Special Area of Protection (SAC)) and Nitrates Directive.

8.4.25 On the above basis the sensitivity of local surface water bodies is considered to be **High** in accordance with Table 8.1.

Groundwater Flood Risk

8.4.26 Ground investigation works determined that groundwater levels across the Project Site are relatively high but are unlikely to reach the ground surface and, in the event that they do, would not be expected to accumulate to any significant depth on Project Site due to site topography.

Groundwater Quality

8.4.27 The Project Site overlies a Principal Aquifer which is designated as high vulnerability in the south (broadly coinciding with the areas of Flood Zone 2 and 3) and low vulnerability in the north.

8.4.28 On the above basis the sensitivity of the groundwater is considered to be **High** in accordance with Table 8.1.

Sewer Flooding

8.4.29 There is no record of sewer flooding. A foul water sewer main bisects the Project Site in a north-westerly direction.

8.4.30 Wessex Water has advised that there are currently some issues within the wider network causing surcharging in some locations within Thornbury village but there is no reference to flooding. Wessex Water are currently undertaking network improvements to resolve these issues.

Flooding from Artificial Sources

8.4.31 Artificial sources of flooding include reservoirs, canals, lakes and ponds. No such features have been identified that could present a flood risk to the Project Site.

Historic Flooding

8.4.32 The EA has provided plans showing the outline of three historic flooding events in the vicinity of the Project Site. None of these are recorded to have flooded the Project Site itself. The data provided by the EA is provided within Appendix B of the FRA (Technical Appendix 8.1) and extracts are provided in Figures 8.3 - 8.5 below.

Figure 8.3: EA historic Flood Extents 1

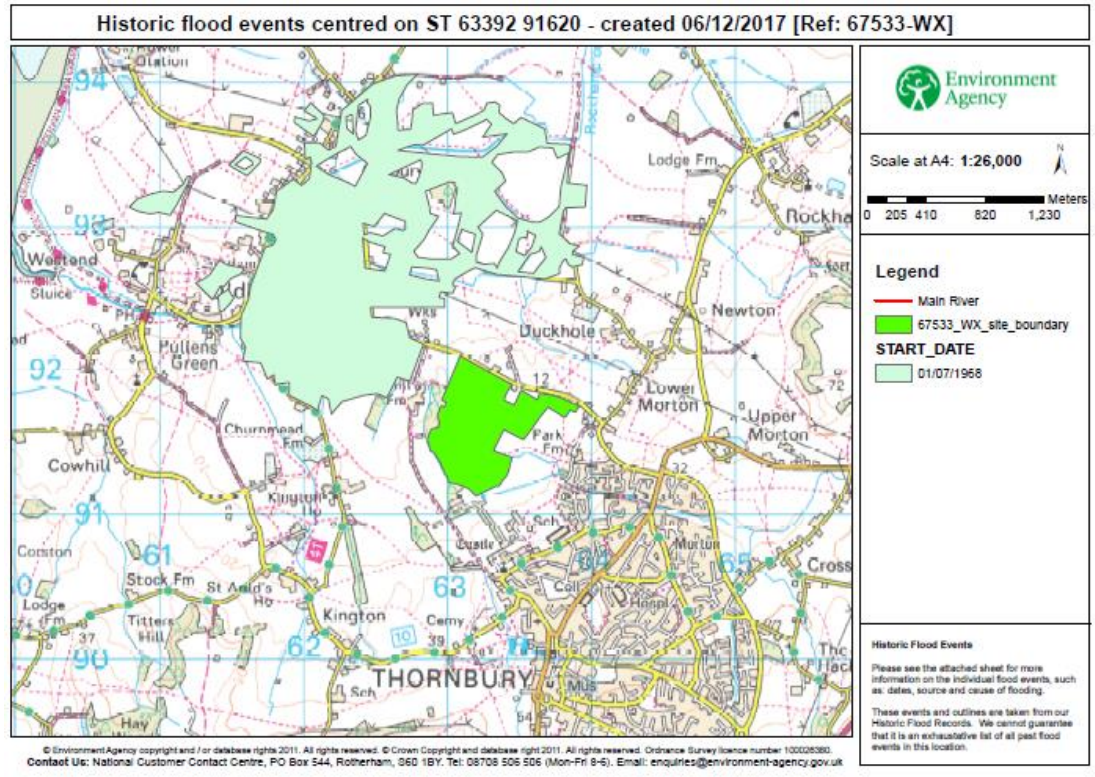

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Figure 8.4: EA historic Flood Extents 2

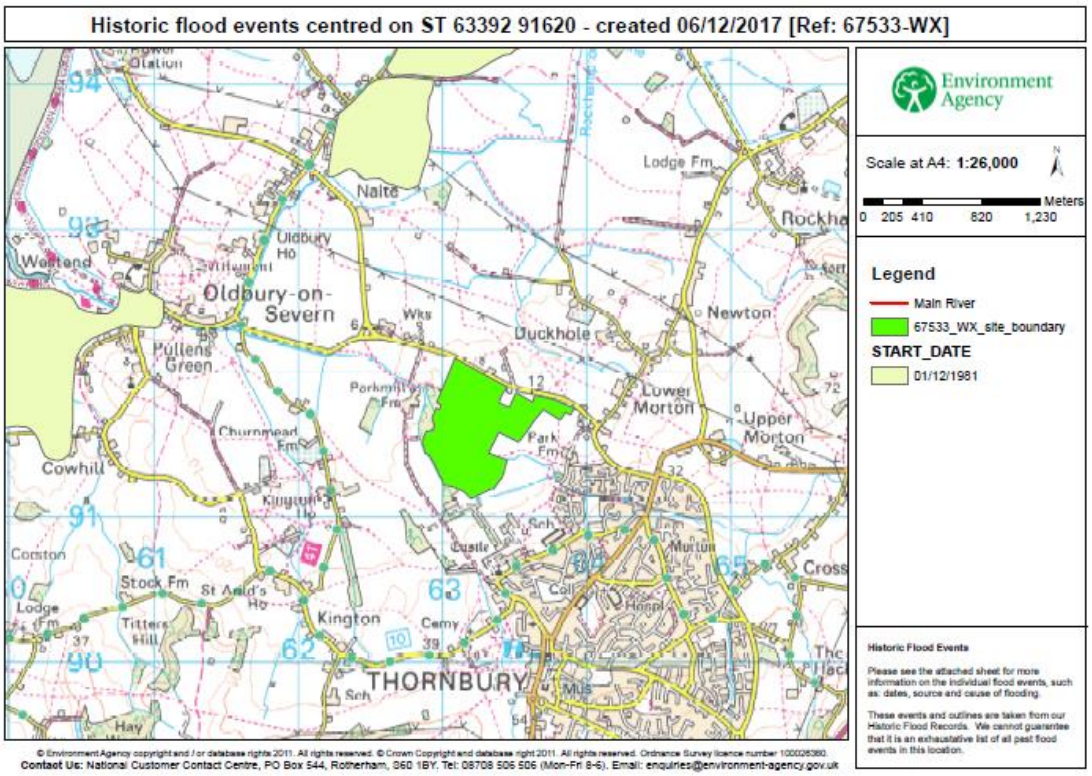

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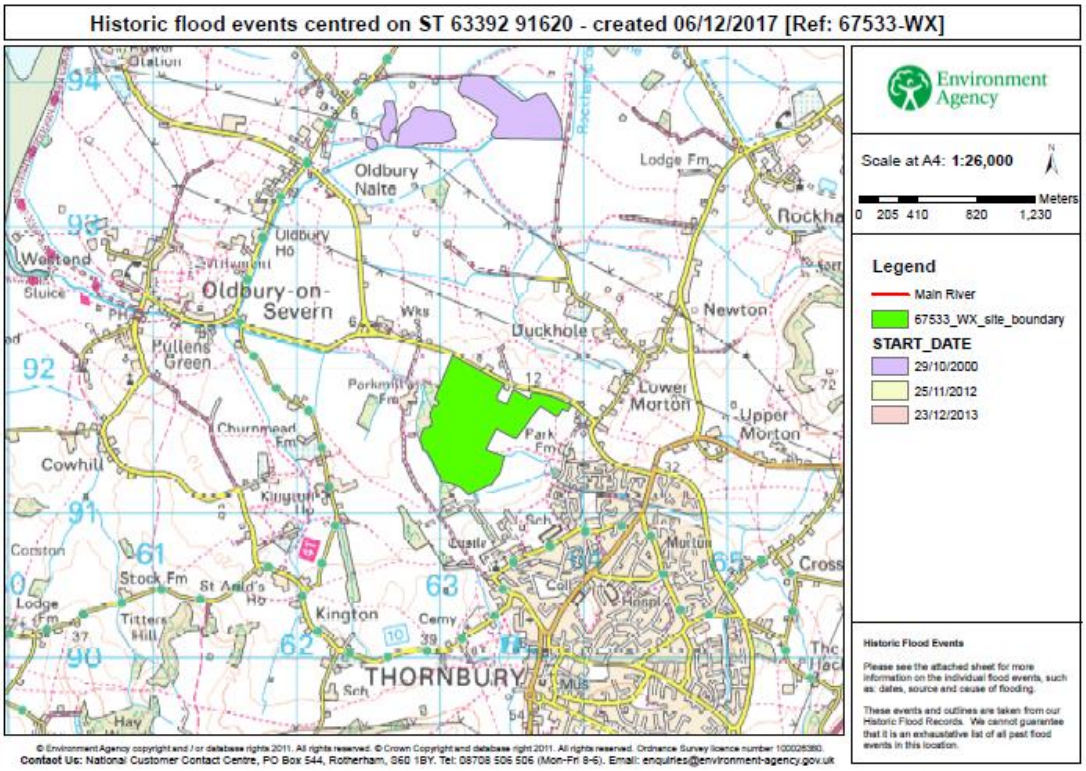
Figure 8.5: EA historic Flood Extents 3



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8.4.33 Flooding also occurred locally on 9th March 2016, with reports by Oldbury-on-Severn Parish Council and SGC (May 2017) noting that the flooding was caused by high river flows at Oldbury-on-Severn coinciding with high tidal levels (which restricted discharge) and failure of some flood defence infrastructure (notably flap valves at outfall locations). No records of flooding on the Project Site or within Thornbury itself during this event have been identified.

8.4.34 In 2017 SGC successfully applied for government funding *"to make major improvements to drainage systems at nine sites in South Gloucestershire".* One of these sites is referred to as *"Church Road & Chapel Road & Camp Road"* in Oldbury-on-Severn and another is *"Oldbury Lane"* in Thornbury. The proposed works at *"Church Road & Chapel Road & Camp Road"* in Oldbury-on-Severn are aligned with those recommended in the May 2017 Flood Report, and it is understood that it is intended for these works to commence in early 2019.

8.5 INHERENT DESIGN MITIGATION

8.5.1 The mitigation of the potential impacts of the development of the Project Site will principally be based on requirements set out in national planning policy and associated guidance. As summarised below, a number of 'embedded' mitigation measures have been defined by the FRA to mitigate flood risk and surface water impacts in the Occupation phase of development.

Fluvial and Tidal Flood Risk

8.5.2 In accordance with the NPPF, all flood vulnerable development will be located within Flood Zone 1. This is effective inherent mitigation against fluvial and tidal flooding.

Surface Water Management

8.5.3 The proposals include a surface water management strategy to control outflows to receiving systems and manage surface water sustainably within the Project Site. The proposed surface water management strategy is detailed in the FRA report but the key aspects of the strategy can be summarised as follows:

- Infiltration is not feasible on the Project Site due to elevated groundwater levels. Consequently, it is proposed that surface water is discharged to an on-site field drain which itself discharges to the Pickedmoor Brook.

- In accordance with local policy, discharge will be limited to the greenfield QBAR runoff rate, which has been calculated to be 2.9 l/s/ha for the 1 in 100 year storm event. Using a hydro-brake to restrict discharge from a 0.9m deep basin, MicroDrainage calculates that 900.1m^3/ha of attenuation will be required.

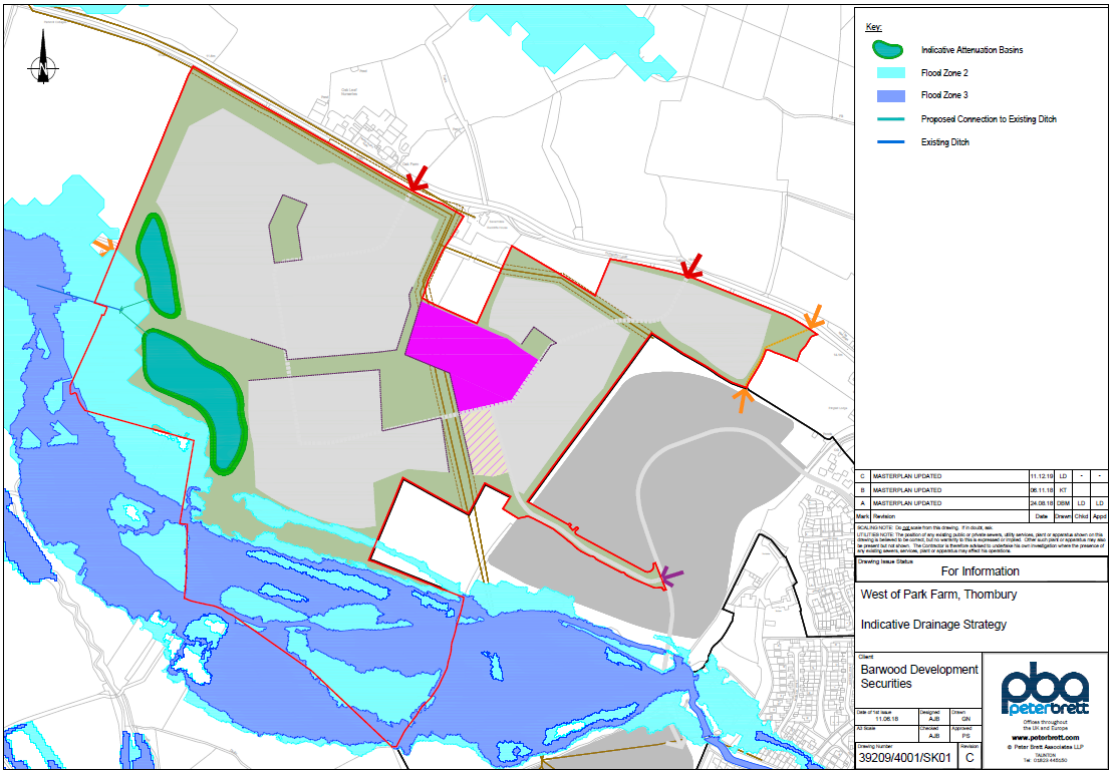
- Attenuation will be provided in an open attenuation basin which will attenuate surface water runoff for all events up to the 1 in 100 year storm event plus an additional 40% allowance for climate change.

- The strategy will provide a reduction in runoff rates when compared with calculated greenfield rates. Furthermore, for rainfall events over 6 hours in duration there will be no increase in runoff volume for 48 hours from the start of the rainfall event.

- The strategy includes key SuDS elements in the form of strategic attenuation basins, and is conducive to provision of a wider integrated SuDS strategy, making use of further SuDS methods throughout the development to manage water quality and quantity. The SuDS strategy will be defined as development proposals are brought forward in greater detail at future stages.

8.5.4 <u>The outline surface water management strategy is illustrated in PBA drawing 39209/4001/SK01 Revision C which is included in Appendix C of the FRA report (Technical Appendix 8.1). An extract of this drawing is also included in Figure 8.6 below for reference.</u>

Figure 8.6: Indicative Drainage Strategy



8.6 POTENTIAL ENVIRONMENTAL IMPACTS & EFFECTS

8.6.1 The impacts described in this section can have a range of magnitudes, this assessment uses a conservative approach in assessing the significance of the impact by considering the highest magnitude value where there is a range. The proposed mitigation is therefore based on the worst-case scenario and will provide mitigation for lesser impacts.

8.6.2 It is anticipated that any construction effects are temporary and any operational effects are permanent unless otherwise stated.

Construction Impacts and Effects

8.6.3 The potential construction impacts and effects would primarily be associated with the change in the hydrological response of the Project Site to rainfall events and impacts on water quality, runoff rates and runoff volumes.

8.6.4 During construction top soil will be stripped and ground will be compacted reducing the ability of the ground to absorb moisture and its ability to infiltrate down into the subsoil below, thereby increasing the rate of runoff from these areas.

Flood Risk

8.6.5 It is proposed that the all built development is located within Flood Zone 1, which is considered to be at a low risk of flooding from rivers and the sea. As part of the Proposed Development there will be construction of some footpaths with associated watercourse crossings. Therefore, the effect of construction on flood risk could have a potential **temporary moderate adverse impact**.

Surface Water Runoff Rates and Volumes

8.6.6 All construction sites have the potential to increase surface water runoff rates and volumes, alter drainage patterns and affect local and catchment wide flood risk. Key potential increases in surface water flood risk from construction activities include:

- Alteration to the rate and route of surface water runoff in temporary drains while the operational surface water drainage system is being constructed;
- Stripping of soil or the import of fill affecting surface water runoff potential and drainage patterns through the compaction and smearing of soils; and /or
- Alteration to the surface water runoff regime through reprofiling of the ground surface and by the introduction of temporary drainage channels.

8.6.7 Therefore, there is a **temporary moderate/minor adverse impact** on the surface water runoff from the Project Site during the construction phase.

Surface Water Runoff Quality

8.6.8 Construction sites can lead to an increase in the mobilisation of sediments in surface water runoff from the development areas. This is due to the removal of vegetation, the creation of open soil surfaces, ground disturbance and the stockpiling of soil and other construction materials, and the erosion caused by movement of heavy plant and other traffic on temporary access roads or unprotected surfaces.

8.6.9 Polluted water can be generated and enter watercourses through concrete washout or batching operation or accidental spillage of hydrocarbons or other chemicals.

8.6.10 Without the inclusion of mitigation measures during the construction phase there is a **temporary major adverse impact** on the quality of surface water runoff with the potential to impact upon on the Pickedmoor Brook.

Groundwater Quality

8.6.11 Construction may involve the delivery, use and storage of hydrocarbons and other chemicals, associated with the construction plant. Accidental spillages of hydrocarbons or other chemicals

in any areas of the Project Site could lead to pollution via contaminated groundwater and therefore there is considered to be **temporary major adverse effect**.

Occupation Impacts and Effects

Flood Risk

8.6.12 As set out in Section 8.5, inherent mitigation measures have been 'designed-in' to the development to mitigate flood risk to an appropriate level. It is proposed that all built development is located within Flood Zone 1, which is considered to be at a low risk of flooding from rivers and the sea.

8.6.13 In addition, finished floor levels will be set to 11.0mAOD or 600mm above the ground level at the edge of Flood Zone 2 adjacent to the development parcel, whichever is highest, to robustly mitigate against the potential impact of climate change. There is risk of fluvial flooding from watercourses in the event of blockage or in the event of flows exceeding the design event, but the inherent freeboard will reduce the risk from these potential impacts. This element of the proposals will therefore have a **negligible impact** on flood risk.

8.6.14 As discussed in Section 8.4, fluvial flood levels in the future (including the projected impacts of climate change) would not be expected to be significantly greater than the 1 in 1000 year flood level (which define Flood Zone 2). As all built development is to be located in Flood Zone 1, it is not expected that there will be any significant loss of flood plain storage in the future as a result of raising ground levels in the current Flood Zone 1. This element of the proposals will therefore have a **negligible impact** on flood risk

8.6.15 The replacement of the existing crossing over the Pickedmoor Brook in the southeastern part of the site to current standards will reduce the chance of blockage and therefore have a **low positive impact**.

8.6.16 Footpaths within the floodplain will have a **negligible impact** on flood risk providing no significant change to ground levels.

8.6.17 The overall flood risk effects during the operation phase of the Proposed Development are therefore considered to be **Neutral**.

Surface Water Runoff Rates and Volumes

8.6.18 As set out in Section 8.5, inherent mitigation measures have been 'designed-in' to the development to manage the rate of surface water runoff by restricting all site runoff to the greenfield QBAR runoff rate. This will have a **low positive impact** on downstream flood risk by reducing flow rates within the Pickedmoor Brook.

8.6.19 The increase in runoff volume caused by the development will have a **negligible adverse impact** on downstream flood risk. Although flooding has occurred further downstream at Oldbury-on-Severn the area of impermeable surfaces at the development represents less than 0.5% of the catchment draining to this point. Furthermore, the water falling on the site will be attenuated and should not coincide with the peak flows from other parts of the catchment.

8.6.20 However, there remains a risk to the Proposed Development in the event that drainage systems become blocked. Without mitigation this has the potential to have a **low adverse impact** effect.

8.6.21 The overall effects on surface water drainage during the operation phase of the Proposed Development are therefore considered to be **Moderate/Minor** without further mitigation.

Surface Water Quality

8.6.22 The increase in impermeable area and in traffic will lead to an increase in the risk of contamination of surface runoff due to accidental spillage of contaminants and from flushing of pollutants from impermeable surfaces. Contaminated surface runoff could enter and pollute the nearby watercourses via overland flow.

8.6.23 The quality of surface water runoff generated by residential development is generally reasonable as much of it will arise from falling on roofs of buildings and the hardstanding areas. The greatest risk lies with the possibility of hydrocarbon spillages from the movement and parking of vehicles and from residents disposing of chemicals into the drainage system.

8.6.24 Therefore, without the inclusion of mitigation measures there could be a **high adverse impact** at the occupation stage.

8.6.25 However, the inherent mitigation measures discussed previously in Section 8.5 will provide a level of surface water quality treatment through a number of processes. Vegetated basins can help retain runoff from small events, helping to reduce the contaminant load via volumetric control. For larger events, treatment can also be provided primarily by the gravitational settling of particulate pollutants, as well as some filtration through the vegetation on the basin base and underlying soils. Some biodegradation and photolytic breakdown of hydrocarbons will occur during the drying process between events.

8.6.26 Considering the inherent mitigation measures proposed, there may still be a **medium adverse impact** at the occupation stage.

8.6.27 Therefore, effects on surface water quality in Pickedmoor Brook during the operation phase of the Proposed Development, without further mitigation, are considered to be **Major** without further mitigation.

8.6.28 Although the Pickedmoor Brook discharges to the Severn Estuary, this is approximately 2.5km downstream, and as such the dilution effect will ensure that any pollutants from the Proposed Development will have a **negligible impact** on the Severn Estuary.

Groundwater Quality

8.6.29 There is potential for spillage or disposal of chemicals on landscaped area to impact on groundwater especially in the southern portion of the Project Site. However, this is considered to be unlikely to occur. Additionally, the Proposed Development will provide more impermeable surfaces thus reducing potential areas for infiltration. Therefore, the effect of the Proposed Development on the groundwater quality is considered to be a **negligible impact**.

8.6.30 The effect on groundwater quality during the operation phase of the Proposed Development are therefore considered to be **Neutral**.

8.7 ADDITIONAL MITIGATION, COMPENSATION & ENHANCEMENT MEASURES

Construction

8.7.1 During construction, the use of best practice construction techniques (such as CIRIA publication C753 the SuDS Manual and the C698 Site Handbook for the Construction of SuDS) and the implementation of a Construction Environmental Management Plan (CEMP) will be adopted to manage the construction process, minimise the risk of a pollution incident, silt-laden runoff, or blockage of channels during the construction works, and thus mitigating the potential for adverse effects upon the water environment.

8.7.2 The CEMP will be secured via a suitably worded planning condition and include method statements for the construction works and will provide details of the materials (type and quantity) to be taken to and from the Project Site. The CEMP will also provide a pollution control and contingency plan. Although the CEMP will aim to protect surface water quality, it will also benefit other water resource aspects together with associated areas of the environment.

8.7.3 The following specific measures for the protection of surface water quality during the construction activities will be included within the CEMP:

- Management of construction works so as to comply with the necessary surface water quality standards;
- Surface water runoff from the Site will be managed through a temporary and / or permanent drainage infrastructure, including measures for removing suspended solids and potential contaminants;

- Plant machinery and vehicles will be maintained in good condition with washing and dust suppression measures used to prevent the migration of pollutants; (particularly in relation to works using concrete and in areas where dust and mud can build up);

- Working areas with risk of spillage will be carefully sited and protected (e.g. bunds) so as to minimise the risk of hazardous substances affecting surface water quality – this may include vehicle maintenance and storage areas for hazardous materials;

- The movement of plant machinery and vehicles and the storage of materials during the construction works will be limited near to surface water features;

- Excavation activities will be carefully monitored and coordinated with forecasted dry periods, where possible, with excavation works covered during periods of heavy rain to minimise the entry and collection of rainwater and the transport of pollutants; and

- The movement of plant and machinery over bare soil areas will be limited so as to avoid soil compaction and smearing, with suitable preparatory works included where this cannot be avoided so as to minimise effects on the surface water runoff regime.

8.7.4 The requirement for Land Drainage Consent (in accordance with the Land Drainage Act 1991) with respect to significant works affecting Ordinary Watercourses, and associated approval of method statements, would also be expected to control/mitigate impacts upon flood risk during construction.

8.7.5 A phased approach to development will be undertaken on the Project Site, and future detailed reserved matter approvals will secure the delivery of attenuation facilities in advance of the construction of each phase of the development. The surface water drainage facilities will limit surface water ponding within the construction site and ensure that the risk of localised flooding is not increased.

8.7.6 Additional mitigation measures for reducing effects will include an emergency activity plan for enabling a timely and efficient clean-up operation, including consideration for the use of shut off valves, such as at the discharge points from the surface water drainage strategy. Temporary stilling basins can be used to allow silt to gravitate out of the runoff before off-site discharge. Temporary bunding can form temporary attenuation areas which can prevent a rise in flood risk.

Operation

Flood Risk

8.7.7 To robustly mitigate against potential future fluvial flooding it is recommended that finished floor levels be set to be at least 600mm above the ground level at the edge of Flood Zone 2.

8.7.8 To mitigate against the potential future risk of tidal flooding in the west of the Project Site, it is recommended that finished floor levels are set at a minimum of 11.0mAOD.

8.7.9 As Riparian Owner of the Ordinary Watercourses within the site, regular inspection and maintenance of the watercourses within the site, including any crossings, should also be incorporated in site management plans to further mitigate the residual risk of fluvial flooding from watercourses within the site in the event of blockage or in the event of flows exceeding the design event.

Surface Water Runoff Rates and Volumes

8.7.10 To mitigate the remaining risk of flooding due to surcharging of drainage systems due to blockage, ongoing management and maintenance of the proposed surface water management systems and existing local drainage assets will be undertaken, and exceedance flow routes will be analysed in the detailed design and implemented within the levels strategy.

8.7.11 Exceedance flows will be managed on-site by appropriate site level design to direct flows away from buildings and to areas designated for storage, such as the detention basins, car parking or formal landscaping where temporarily shallow flooding may occur. The specific means of managing exceedance flows will be defined as development proposals are brought forward in greater detail at future stages.

Surface Water Quality

8.7.12 The impacts on water quality will be inherently managed by utilising types of SuDS which mimic natural runoff treatment processes, thus ensuring a high quality water discharge from the Project Site. The following types of SuDS features are proposed as part of the surface water management strategy at this stage:

- Attenuation basins; and
- Flow control devices.

8.7.13 Upstream of the attenuation areas, there are a wide range of source control SuDS techniques that can be utilised to further manage the rate and quality of surface water leaving the Project Site. Permeable paving will be used where possible to treat surface water runoff as it filters through the pavement sub layers. In addition, bioretention areas and filter strips can be used to facilitate vegetative filtering and promote settlement of particulate pollutants and infiltration.

8.7.14 Ongoing management and maintenance of the proposed surface water management systems must be undertaken to maintain appropriate treatment of surface water runoff.

8.8 RESIDUAL ENVIRONMENTAL IMPACTS & EFFECTS

8.8.1 Following implementation of the proposed additional mitigation measures, there will be residual impacts and effects. The following paragraphs assess the impact on the baseline condition following the implementation of additional and inherent mitigation during construction and operation.

Construction Impacts and Effects

Flood Risk

8.8.2 Based on the additional mitigation measures set out in Section 8.7, the residual effects on flood risk during the construction phase of the Proposed Development are considered to be **Neutral**.

Surface Water Runoff Rates and Volumes

8.8.3 Based on the additional mitigation measures set out in Section 8.7, the residual effects on surface water runoff rates and volumes during the construction phase of the Proposed Development are considered to be **Neutral**.

Surface Water Quality

8.8.4 Based on the additional mitigation measures set out in Section 8.7, the residual effects on surface water quality during the construction phase of the Proposed Development are considered to be **Neutral**.

Groundwater Quality

8.8.5 Based on the additional mitigation measures set out in Section 8.7, the residual effects on groundwater quality during the construction phase of the Proposed Development are considered to be **Neutral**.

Operation Impacts and Effects

Flood Risk

8.8.6 Based on the proposed inherent mitigation measures set out in Section 8.5 and the additional management measures set out in Section 8.7, the residual flood risk effects during the operation phase of the Proposed Development are considered to be **Neutral**.

Surface Water Runoff Rates and Volumes

8.8.7 Based on the proposed inherent mitigation measures set out in Section 8.5 and the additional management measures set out in Section 8.7, the residual effects on surface water runoff rates

and volumes during the operation phase of the Proposed Development are considered to be **Neutral**.

Surface Water Quality

8.8.8 Based on the proposed inherent mitigation measures set out in Section 8.5 and the additional management measures set out in Section 8.7, the residual effects on surface water quality during the operation phase of the Proposed Development are considered to be **Neutral**.

Groundwater Quality

8.8.9 The effect of the operation of the Proposed Development on groundwater quality was found to be **Neutral,** therefore no residual impacts have been identified.

8.9 CUMULATIVE EFFECTS

8.9.1 Major local committed developments that have the potential to lead to likely significant cumulative effects close to the Project Site are set out in Chapter 5 and have been analysed as part of this assessment.

Flood Risk

8.9.2 As detailed above, the Proposed Development is expected to have a Neutral impact upon flood risk.

8.9.3 In accordance with national and local planning policy, the committed developments considered under the cumulative assessment will have incorporated measures such that there is no increase in flood risk off-site as a result of any development proposals.

8.9.4 As such, the cumulative effect of the Proposed Development and the committed schemes is considered to be **Neutral**.

Surface Water Runoff Rates and Volumes

8.9.5 As detailed above, the surface water management proposals for the Proposed Development are expected to have a Neutral impact.

8.9.6 In accordance with national and local planning policy, the committed developments considered under the cumulative assessment would be expected to include measures to limit the rate and volume of surface water runoff to no greater than pre-development values.

8.9.7 Therefore, the cumulative effect of the Proposed Development and the committed schemes is considered to be **Neutral**.

Surface Water Quality

8.9.8 As detailed above, the surface water management proposals for the Proposed Development is expected to have a Neutral impact on surface water quality.

8.9.9 As with the Proposed Development, surface water drainage systems for the committed schemes will be installed utilising SuDS and to the standards set out in the SuDS Manual and the West of England SuDS Developers Guide. This will manage the quality of discharge to the receiving water body / sewer.

8.9.10 Therefore, the cumulative effect of the Proposed Development and the committed schemes is considered to be **Neutral**.

Groundwater Quality

8.9.11 As detailed above, the Proposed Development is expected to have a Neutral impact on groundwater quality.

8.9.12 The committed developments considered under the cumulative assessment will include measures to mitigate any potential significant risk to groundwater quality to acceptable levels. Therefore, groundwater quality at these other sites is unlikely to be affected by the Proposed Development.

8.9.13 Therefore, the cumulative effect of the Proposed Development and the committed schemes is considered to be **Neutral**.

8.10 ASSESSMENT SUMMARY

8.10.1 This chapter summarises the likely significant effects of the Proposed Development in terms of water resources and flood risk, in particular water quality, groundwater quality, surface water drainage and flood risk.

8.10.2 The Proposed Development has been designed using the sequential approach to locating built development only within Flood Zone 1. Additional flood mitigation, in the form of raised finished floor levels (to the greater of 600mm above the local 1 in 1000 year level or 11 mAOD) will mitigate uncertainty in flood level information and the projected impacts of climate change (in accordance with current EA guidance on applicable allowances in development planning).

8.10.3 Of the environmental effects assessed for the Proposed Development, surface water quality and surface water drainage impacts are the most likely detrimental effects to the environment if no surface water attenuation and/or treatment is provided. However, a sustainable surface water management strategy - including attenuation of discharge to pre-development greenfield rates up to the 1 in 100 year annual probability event plus 40% allowance for climate change,

and the provision of surface water storage to accommodate the 1 in 100 year plus 40% climate change allowance event - has been outlined as part of the proposals and reflected in the EIA Parameter Plans, as required by NPPF.

8.10.4 Additional mitigation measures in the form of a comprehensive SuDS treatment train will be provided, allowing sedimentation to occur leading to an improvement in water quality entering the downstream river systems.

8.10.5 During construction, the use of best practice construction techniques and the implementation of a CEMP will be adopted to manage the construction process, minimise the risk of a pollution incident, silt-laden runoff, or blockage of channels during the construction works, and thus mitigating the potential for adverse effects upon the water environment.

8.10.6 The chapter has also considered potential cumulative impacts as a result of other committed development. As all proposed development is be expected to apply similar safeguards to mitigate potential impacts to the water environment, it is concluded that no significant cumulative impacts would be expected.

8.10.7 As required by NPPF, the projected impacts of climate change have been considered as an integral part of the assessment set out in this chapter. With reference to the allowances set out in current guidance provided by the EA, the proposed flood risk mitigation measures and surface water management proposals take into account the projected impacts of climate change over the expected lifetime of the development.

8.10.8 **Water Framework Directive Compliance:** The assessment has demonstrated that, through the provision of appropriate inherent and additional mitigation measures, there are no expected adverse impacts on water quality in the receiving waterbodies. It is anticipated that physical works affecting the Pickedmoor Brook and its tributaries will be limited to the construction of surface water drainage outfalls and watercourse crossings, potential development works adjacent to watercourses, or physical changes to the more minor drainage ditches within the Project Site. However, it is noted that significant works affecting Ordinary Watercourses would be subject to Land Drainage Consent being granted by the LLFA, and details of the proposed works (including permanent and temporary works) will be formally agreed through this process. On the above basis, it is concluded that the Proposed Development is unlikely to lead to a degradation in the chemical or ecological status of the receiving waterbody, or present a barrier to the waterbody achieving its future target status.

Table 8.5: Water Environment Assessment Summary

Environmental Effect	Sensitivity of Receptor	Nature of Impact	Impact Magnitude	Significance	Additional Mitigation	Residual Impact Magnitude	Residual Significance of Effect	Confidence Level
Construction Effects								
Increase in flood risk as a result of construction activities	High	Temporary Indirect	Low	Moderate Adverse	Implementation of best practice construction techniques and CEMP. Obtain Land Drainage Consent where required.	Negligible	Neutral	High
Increase in flood risk as a result of increased surface water runoff rates and volumes as a result of construction activities	Medium	Temporary Indirect	Low	Moderate/Minor Adverse	Implementation of best practice construction techniques and CEMP.	Negligible	Neutral	High
Degradation of surface water quality due to pollutants as a result of construction activities	High	Temporary Indirect	Medium	Major Adverse	Implementation of best practice construction techniques and CEMP.	Negligible	Neutral	High
Degradation of groundwater quality due to pollutants as a result of construction activities	High	Temporary Indirect	Medium	Major Adverse	Implementation of best practice construction techniques and CEMP.	Negligible	Neutral	High

Operation Effects								
Increase in flood risk to development and/or due to development.	High	Permanent Indirect	Negligible	Neutral	Built development to be located in Flood Zone 1. Finished floor levels to be set above expected flood levels.	Negligible		
Increase in flood risk as a result of increased surface water runoff rates and volumes	Medium	Permanent Indirect	Low	Moderate/Minor Adverse	Implementation of management and maintenance regime.	Negligible	Neutral	High
Degradation of surface water quality due to urban pollutants	High	Permanent Indirect	Medium	Major Adverse	Surface water management strategy to incorporate appropriate SuDS to provide treatment of surface water prior to discharge. Implementation of management and maintenance regime.	Negligible	Neutral	High
Degradation of groundwater quality due to urban pollutants	High	Permanent Direct	Negligible	Neutral	-	Negligible	Neutral	High

Cumulative Effects				
Effect	**Description**	**Mitigation**	**Significance**	**Confidence Level**
Increase in flood risk on or off site	Increased flood risk on or off site as a result of committed sites not adequately managing flood risk on site is possible. However, it has been assumed that the committed developments would be expected to include measures such that there is no increase in flood risk off-site as a result of any development.	N/A	Neutral	Medium
Increase in surface water runoff rates and volumes	Increased volume and rate of surface water discharge from the cumulative committed sites is possible. However, it has been assumed that the surface water drainage systems to be installed as part of each proposed development will limit the rate and volume of surface water runoff to pre-development values as is required by planning policies, SuDS Manual and the West of England SuDS Developer Guide.	N/A	Neutral	Medium
Increase in pollutants to surface water	Degradation in surface water quality from the cumulative impact of committed sites not adequately managing surface water pollutants on site is possible. However, it has been assumed that surface water drainage systems for the committed developments will be installed utilising SuDS and to the standards set out in the SuDS Manual and the West of England SuDS Developers Guide. This will ensure a high quality discharge to receiving water bodies.	N/A	Neutral	Medium
Increase in pollutants to groundwater	Degradation in groundwater quality from the cumulative impact of committed sites not adequately managing potential pollutants on site is possible. However, it has been assumed that the committed developments would be expected to be required measures to mitigate any potential significant risk to groundwater quality to acceptable levels.	N/A	Neutral	Medium
Climate Change				
Effect	**Description**	**Mitigation**	**Significance**	**Confidence Level**
Increased river flows– Increase in flood risk	Current climate change projections would result in an increase in river flows, therefore an increase in fluvial flood risk in the future.	Sequential approach to building location and raised finished floor levels.	Neutral	Medium
Sea level rise – Increase in flood risk	Current climate change projections would result in an increase in sea level, therefore an increase in tidal flood risk in the future.	Sequential approach to building location and raised finished floor levels.	Neutral	Medium
Increased rainfall intensity – increase in surface water runoff rate and volume	Current climate change projections would result in rainfall intensity, therefore an increase in volume of surface water to be managed within development.	Surface water management strategy defined with reference to applicable climate change events.	Neutral	Medium

Table 8.6: Mitigation Implementation

Mitigation Measure	Implementing Agent(s)	Legal Instrument	Compliance Target	Implementation Timescale
Construction Environmental Management Plan (CEMP)	Developer	Planning condition	Submission to planning officer	Pre-commencement
Land Drainage Consent	Developer	Land Drainage Act 1991	Submission to LLFA	Pre-commencement / During construction
Surface water management system and SuDS	Developer	Planning condition	Submission to planning officer and adoption by relevant body	During construction
Raising floor levels to reduce flood risk to properties	Developer	Reserved Matter Application	Submission to planning officer	Pre-commencement