

Land East of Spitfire Road

Calne

Wiltshire



Flood Risk Assessment

&

Drainage Strategy



**Unit 9 Westway Garage
Marksbury
BATH, BA2 9HN
t: 01761 479950**

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Author: Mark Headford

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1. INTRODUCTION

- 1.1.** This Flood Risk Assessment (FRA) and Drainage Strategy has been prepared by Phoenix Design Partnership Limited on behalf of Robert Hitchins Limited and their successors in title to the land to support an outline planning application.
- 1.2.** The outline planning application is for residential development for up to 20 dwellings, associated works including infrastructure, ancillary facilities and landscaping. Construction of a new vehicular access off Spitfire Road.

See Illustrative Masterplan enclosed within Appendix A.

- 1.3.** This site specific Flood Risk Assessment (FRA) has been produced in accordance with the National Planning Policy Framework document, Section 14 'Meeting the challenge of climate change, flooding and coastal change' and Planning Practice Guidance document 'Flood Risk and Coastal Change' Framework together with Environment Agency FRA Guidance Notes.
- 1.4.** The FRA demonstrates that the site is suitable for development without flood risk and without causing an increase in flood risk to others, including allowances for climate change. It also demonstrates how SuDS will be used to manage surface water from the development, and to ensure that water quality is not adversely affected.
- 1.5.** The application site is located immediately south of land that has recently obtained planning permission following an appeal, reference APP/Y3940/W/24/3351528, for a residential development for up to 90 dwellings (planning reference PL/2022/07893) and a Local Centre comprising a day nursery and convenience store with associated parking (planning reference PL/2023/10421).

2. POLICY & GUIDANCE

The following is a list of policy and guidance which has been referred and adhered to:-

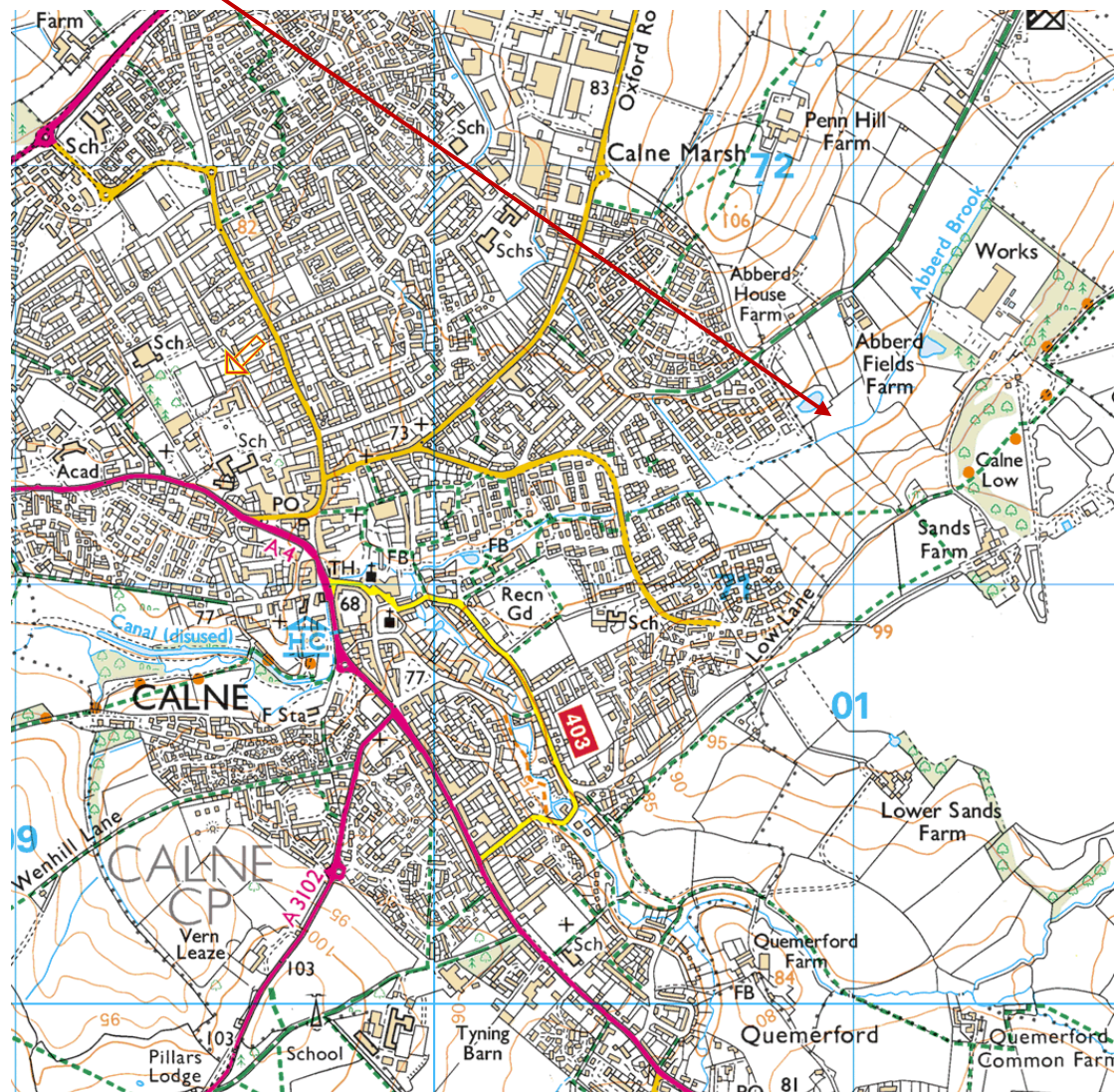
- National Planning Policy Framework (NPPF): December 2024 – Section 14 ‘Meeting the challenge of climate change flooding and coastal change’
- Planning Practice Guidance: February 2024 – ‘Flood risk and coastal change’
- Flood & Water Management Act (FWMA): 2021
- Wiltshire Council Drainage and Betterment Strategy: 2024
- North Wiltshire Strategic Flood Risk Assessment
- Wiltshire Council Strategic Flood Risk Assessments
- Ciria C753 ‘The SuDS Manual’
- Ciria C635 ‘Designing for Exceedance’
- SSG Appendix C - Design and Construction guidance: Version 2.3 November 2023
- Environment Agency, Defra & DCLG guidance
- Building Regulations Part H 2015 ‘Drainage & Waste Disposal’
- BS 8582:2013 Code of practice for surface water management for development sites
- Non Statutory Technical Standards For Sustainable Drainage Systems 2015
- Environment Agency Flood Risk Assessments: Climate Change Allowances: Updated May 2022

3. EXISTING SITE DETAILS

3.1. Site Location & Description

Item	Brief Description
Site address	Land off Spitfire Road, Calne, Wiltshire, SN11 8GA
Council Area	Wiltshire Council
Ordnance Survey Grid Reference	400972 , 171409

Site Location



The application site located off Spitfire Road, Calne, Wiltshire approximately 1km to the east of Calne Town Centre. The site comprises agricultural/greenfield land and covers approximately 1.9 hectares (ha).

The site is bound to the North by land that has recently obtained planning permission for a residential development (up to 90 dwellings) and a Local Centre comprising a day nursery and convenience store with associated parking.

There is also an existing attenuation pond located immediately north of the site which currently provides attenuation to the surface water run-off from the residential developments located to the west of Sandpit Lane planning reference 08/2438/OUT and part of the residential development to the south of Abberd lane and immediately west of Spitfire road, planning reference 13/2833/OUT.

The site is bound to the west by Spitfire road and to the east by a shallow ditch (low depression) that runs down the entire eastern boundary with open fields beyond.

Abberd Brook runs along the entire southern boundary of the site.

3.2. Topography

A topographical survey of the site was undertaken by Ruxton Surveys. The survey shows that the site generally falls from northeast to southwest. The site has an approximate elevation of 73.5mAOD in the northeast and 71.25mAOD in the southwest with an average gradient of 1 in 100.

The site survey and existing hydrology is shown on drawing No. 647-P-011 "Site Survey & Hydrology" enclosed within Appendix B.

3.3. Hydrogeology

3.3.1. The 'Winter Rain Acceptance Potential' (WRAP) map

This WRAP map below shows the site to be located entirely within soil class 4.

Soil class 4 is described as being:-

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

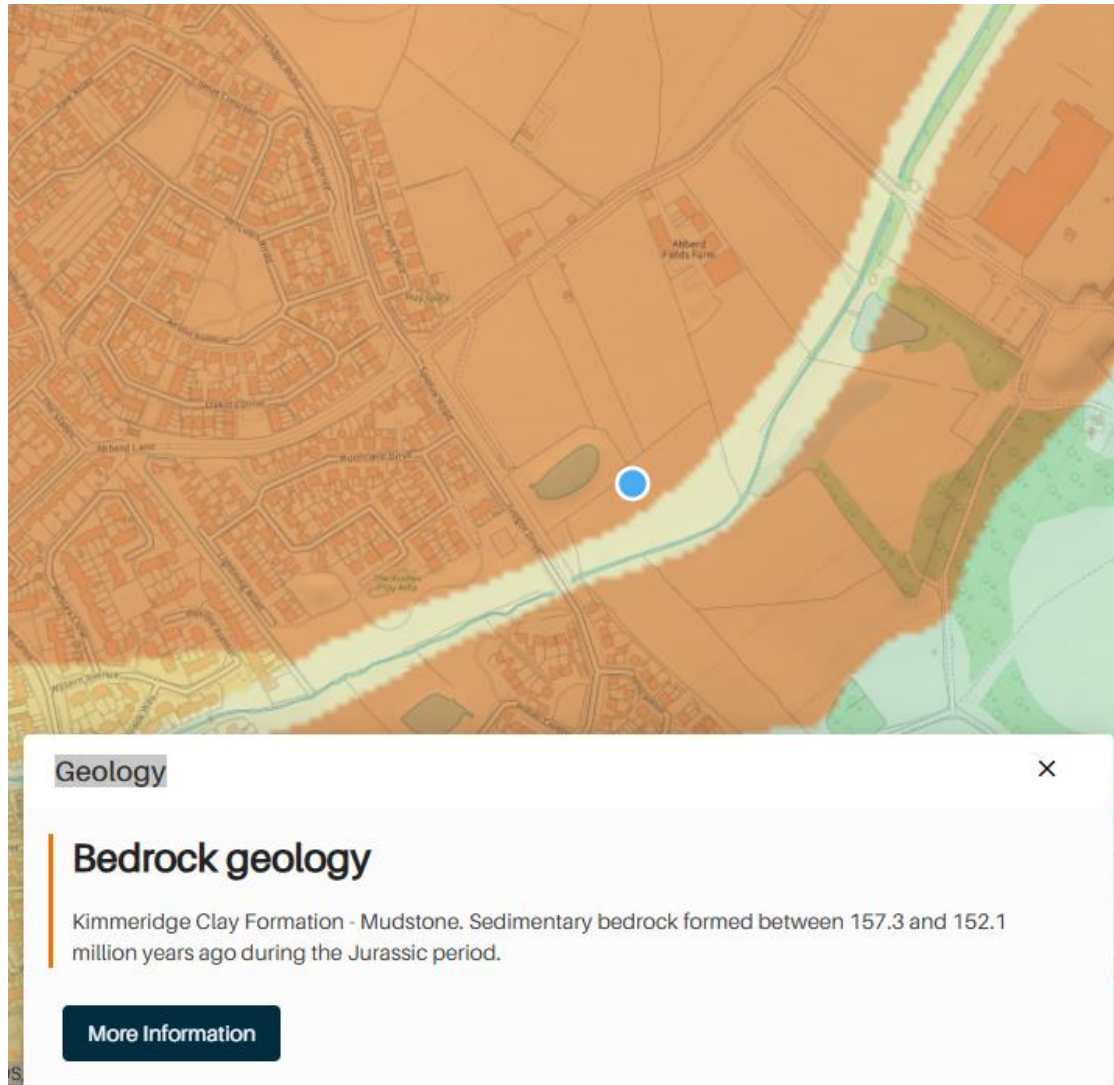
These ground conditions are unlikely to support the use of SuDS in the form of infiltration drainage. Refer to ground investigation within section 3.5.



The distribution and movement of groundwater within the soil and rock for application site has been discussed within Section 3.3.3.

3.3.2. The British Geological Survey (BGS)

The 1:50,000 geological map indicates the site to be entirely underlain by the Kimmeridge Clay Formation (undifferentiated) - Mudstone. These ground conditions are unlikely to support the use of SuDS in the form of infiltration drainage.



A detailed investigation and assessment of the ground conditions are included in section 3.5 of this report.

The distribution and movement of groundwater within the soil and rock for application site has been discussed within Section 3.3.3.

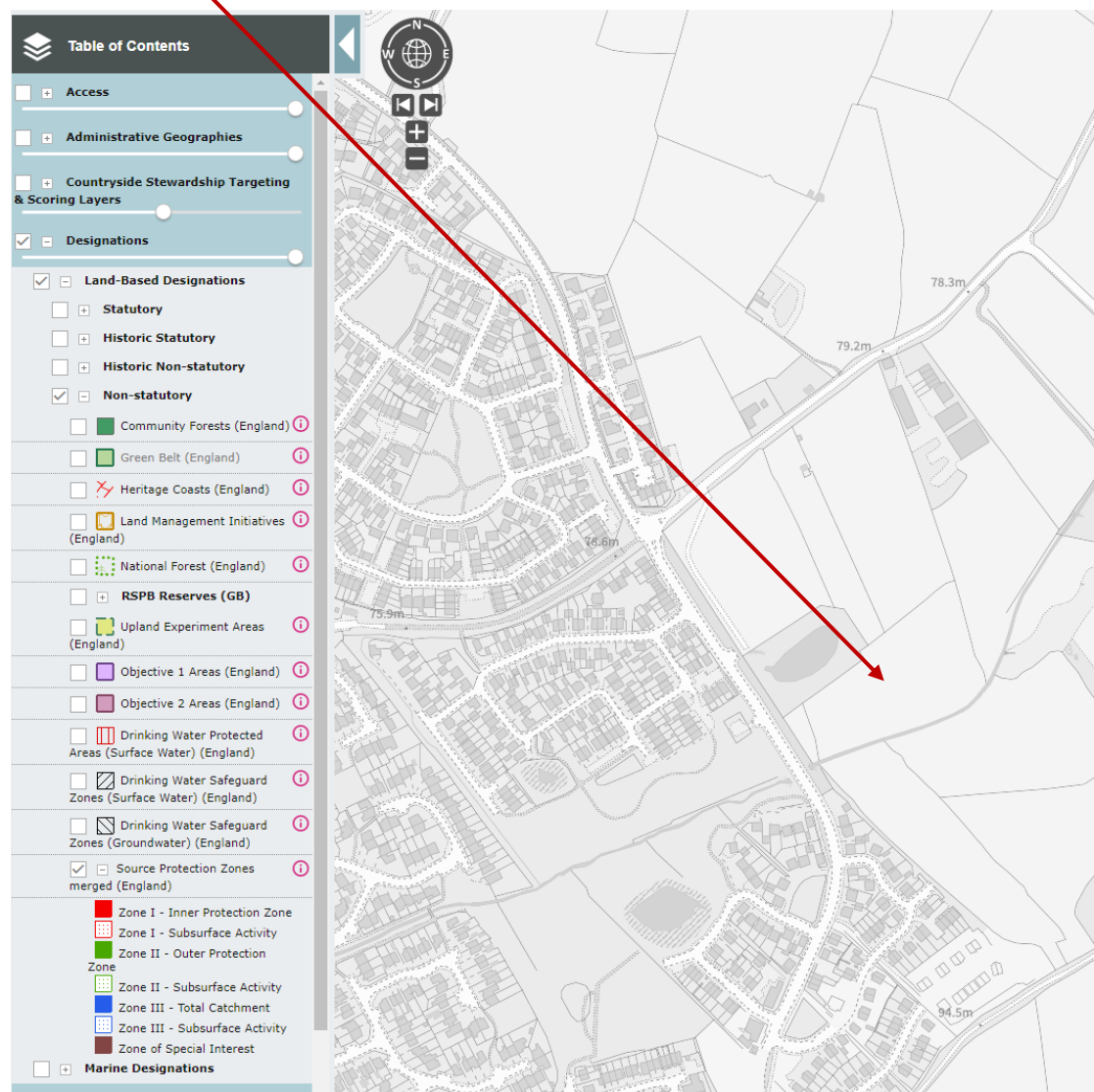
3.3.3. Environment Agency Hydrogeology Information

Groundwater provides a third of our drinking water in England, and it also maintains the flow in many of our rivers. In some areas of Southern England, groundwater supplies up to 80% of the drinking water that you get through your taps. It is crucial that we look after these sources and ensure that your water is completely safe to drink.

Groundwater Source Protection Zone Map

The Source Protection map below confirms that the site is not located within a Groundwater Source Protection Zones (SPZ).

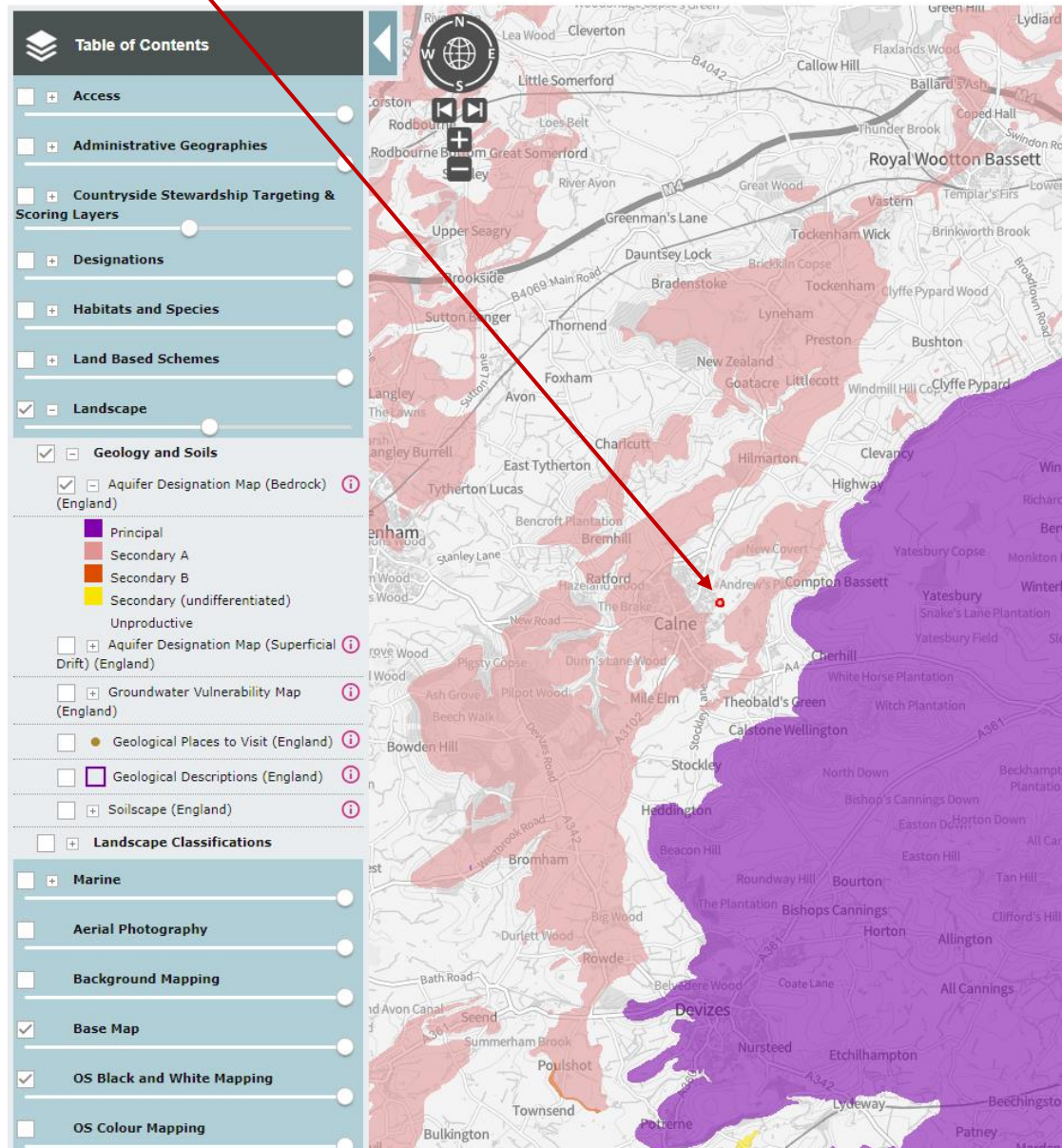
Site Location



Aquifer Designation

The Environment Agency website classifies the bedrock as Unproductive. These are rocks layers or drift deposits with low permeability that have negligible significance for water supply or baseflow to rivers, lakes and wetlands.

Site Location



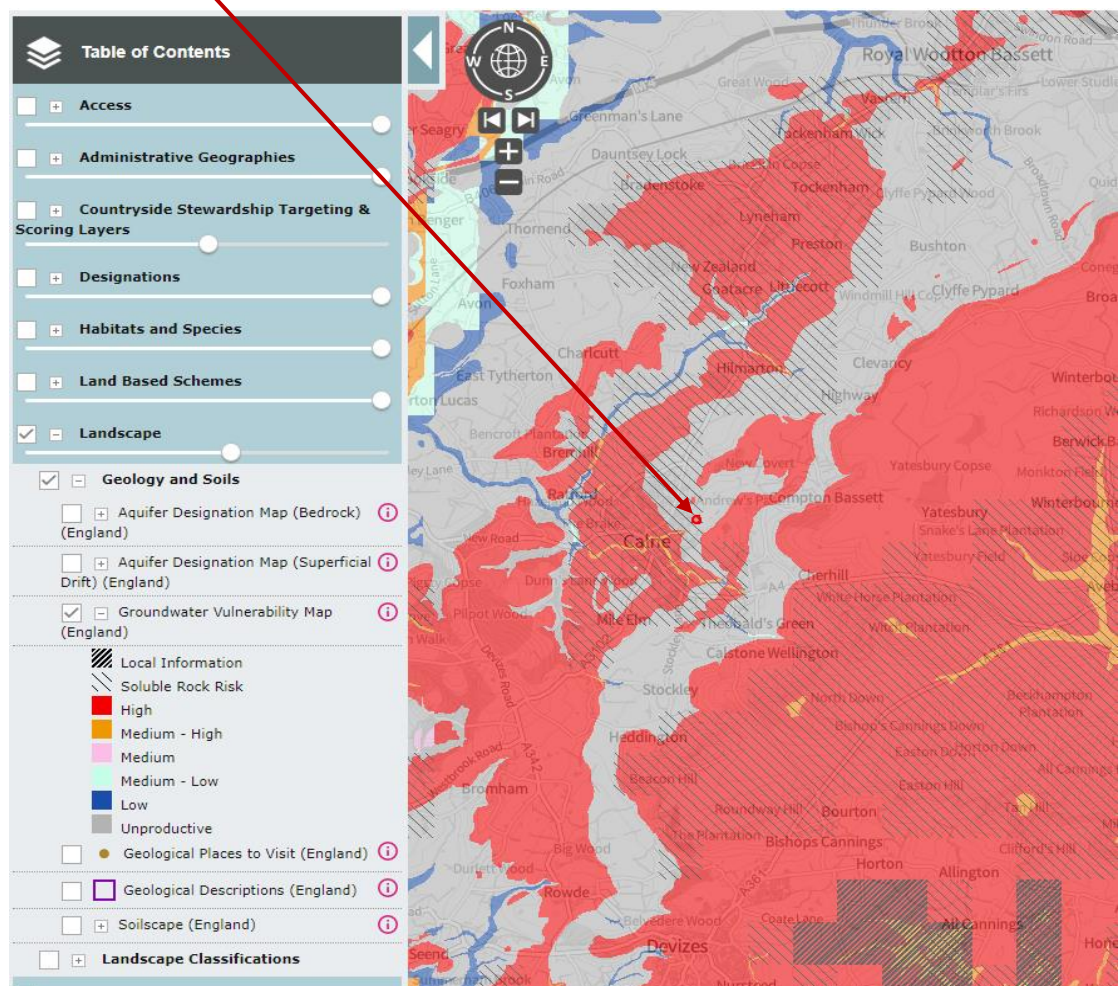
Ground Vulnerability Zone Map

The Environment Agency groundwater vulnerability map shows the vulnerability of groundwater to a pollutant discharged at ground level based on hydrology, geology, hydrogeology and soil properties within a single square kilometre. The potential impact of groundwater pollution is considered using the aquifer designation status which provides an indication of the scale and importance of groundwater for potable water supply and/or in supporting baseflow to rivers, lakes and wetlands.

The map has five risk categories (High, Medium-High, Medium, Medium-Low and Low) based on the likelihood of a pollutant reaching the groundwater (i.e. vulnerability) and the impact this would have on the type of aquifer present and the potential impact.

The ground water vulnerability map below shows that the application site to be located entirely within unproductive area.

Site Location



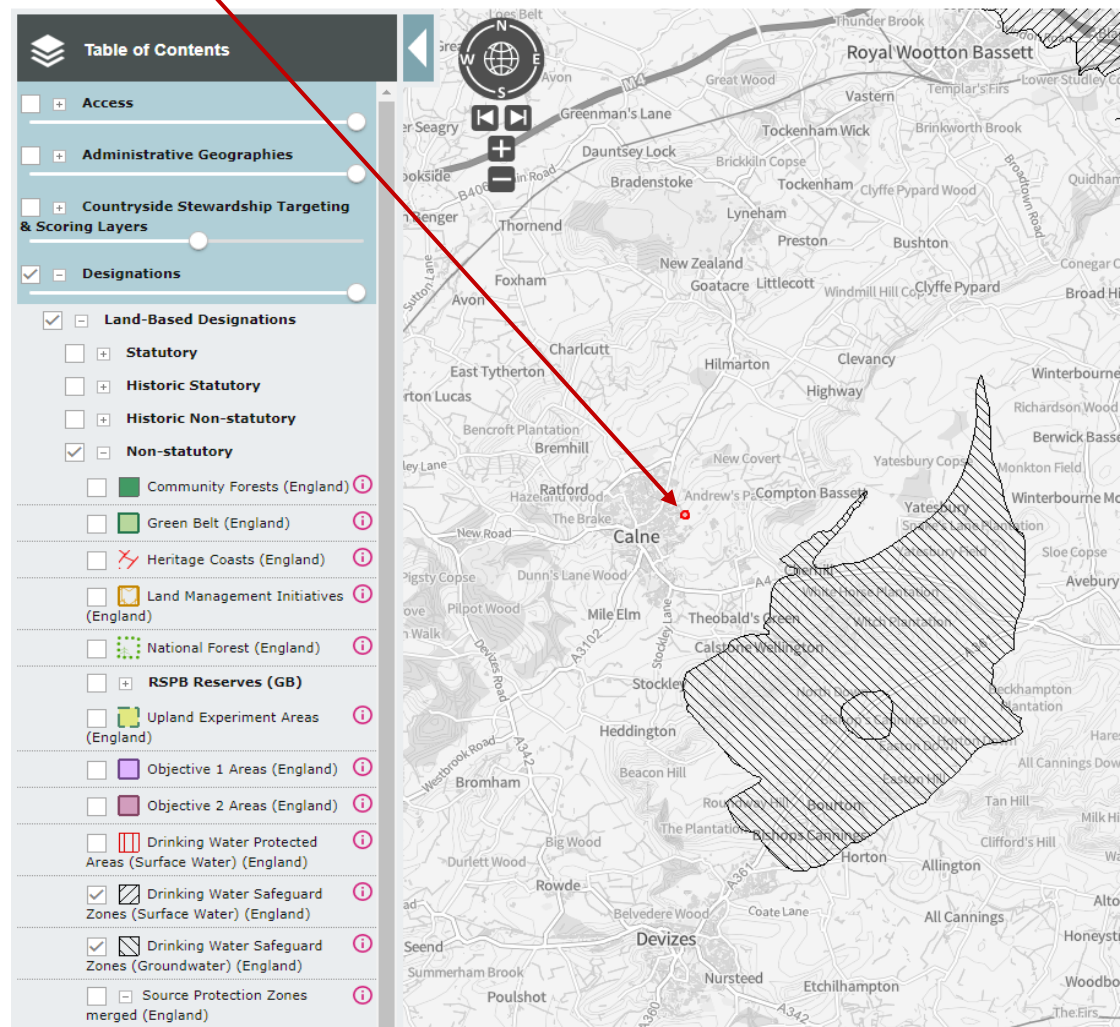
Unproductive: Activities in areas of unproductive strata do not represent a risk to groundwater resources and therefore are not assigned a vulnerability, although water run-off from these areas may represent a risk to surface water and to groundwater if this component provides run-recharge to aquifers (i.e. infiltration via solution features).

Drinking Water Safeguard Zones Map

Drinking Water Protected Areas (Surface Water) are, within the Water Framework Directive, where raw water is abstracted from rivers and reservoirs. Raw water needs to be protected to ensure that it is not polluted which could lead to additional purification treatment. To do this water companies and the Environment Agency identify raw water sources that are 'at risk' of deterioration which would result in the need for additional treatment. These zones are areas where the land use is causing pollution of the raw water.

The site is not located within a drinking water safeguard zone.

Site Location



There are no records of licenced surface water abstractions within 500m of the site.

There is one recorded licenced ground water abstractions approximately 250m to the east of the site, where Henly Bros are permitted to abstract ground water from a single well point for general farming and domestic purposes.

Based upon the above information the site is considered to be within an area of low sensitivity in terms of Hydrogeology and groundwater resources.

The proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual' and will ensure that water quality is not adversely affected.

3.4. Hydrology

The nearest main river to the application site is westerly flowing Abberd Brook which marks the sites entire southern boundary.

There is a shallow ditch (low depression) that runs down the entire eastern boundary which will collect any potential overland surface water run-off from land to the east and direct it to Abberd Brook.

There is an existing pond (attenuation pond) which serves the existing residential development off Sandpit road and Spitfire road.

The existing hydrology is shown on drawing No. 647-P-011 “Site Survey & Hydrology” contained within Appendix B.

Water Framework Directive River Basin Management Plans (WFD)

There are 7 river basin districts in England. Each river basin district has a river basin management plan. These plans set out the environmental objectives and a summary programmes of measures to achieve those objectives.

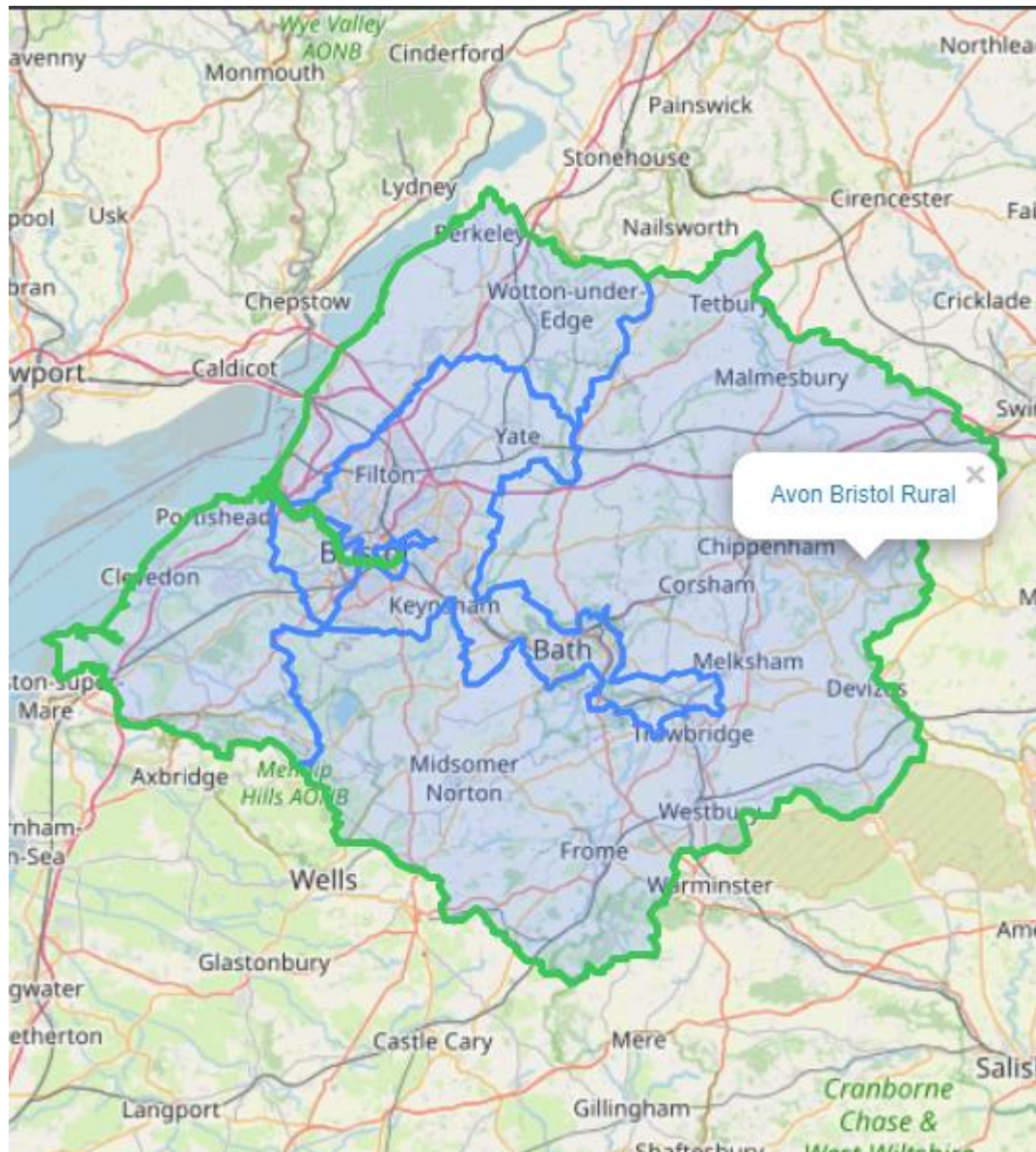
The application site is located in River Severn Basin District shown below:-



The River Severn Basin District is split into 11 Management Catchment Areas. The application site is located in the Avon Bristol and Somerset North Streams Management Catchment Area as shown below:-



The Avon Bristol and Somerset North Streams Management Catchment Area is then split into 4 operational catchment areas. The application site is located in the Avon Bristol Rural Operational Catchment Area as shown below:-

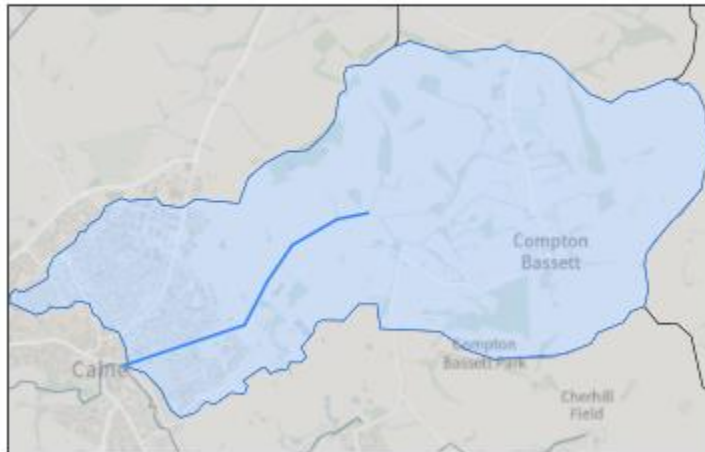


There are 76 water bodies within the Avon Bristol Rural Operational Catchment Area.
The application site will drain into Abbert Brook which outfalls into the River Marden

Abberd Brook Water Body

Abberd Bk - source to conf R Marden Water Body

Moderate ecological status



Get Abberd Bk - source to conf R Marden data

[Download water body \(Shapefile\)](#)
[Download water body \(GeoJSON\)](#)
[Download classifications \(CSV\)](#)
[Download site classifications \(CSV\)](#)
[Download investigations \(CSV\)](#)
[Download challenges \(CSV\)](#)
[Download objectives \(CSV\)](#)
[Download protected areas \(CSV\)](#)

Related links

[Plan maps on ArcGIS online](#)
[Flood risk management plans](#)

The EA information below currently shows that the Abberd Brook has an overall classification of Moderate for Ecological status in 2019.

Classifications

Classification Item	2019
Ecological	Moderate
Biological quality elements	Moderate
Invertebrates	Moderate
Macrophytes and Phytobenthos Combined	Moderate
Macrophytes Sub Element	Moderate

The reasons why the Daniels Brook Water Body is not currently achieving good status is shown below:-

Reasons for not achieving good status by business sector

The issues preventing waters reaching good status and the sectors identified as contributing to them. The numbers in the table are individual counts of the reasons for not achieving good status with a confidence status of 'confirmed' and 'probable', where the latest classification is less than good status. There may be more than one reason in a single water body. Note, table does not include reasons for deterioration.

Significant water management issue	Physical modifications	Pollution from waste water	Pollution from towns, cities and transport	Changes to the natural flow and level of water	Invasive non-native species	Pollution from rural areas	Pollution from abandoned mines
Agriculture and rural land management	0	0	0	0	0	4	0
Industry	0	0	2	0	0	0	0
Mining and quarrying	0	0	0	0	0	0	0
Navigation	0	0	0	0	0	0	0
Urban and transport	0	0	2	0	0	0	0
Water Industry	0	0	0	0	0	0	0
Local & central government	0	0	0	0	0	0	0
Domestic general public	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0
Waste treatment and disposal	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0
No sector responsible	0	0	0	0	0	0	0
Sector under investigation	0	0	0	0	0	0	0
Total	0	0	4	0	0	4	0

The Abberd Brook Water Body is not predicted to achieve good ecological status by 2027 for the reasons shown below:

Classification Item	Status	Year	Reasons
Ecological	Moderate	2015	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits

Based upon the above information the site is considered to be within an area of moderate to low sensitivity in terms of Hydrology.

The proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual' and will ensure that the WFD objectives are not adversely affected.

3.5. Ground Investigation

An intrusive ground investigation was undertaken in July 2022 by Wilson Associates Consulting Engineering Geologists & Geo-Environmental Engineers.

The intrusive investigation was carried using a windowless sampling, small diameter boreholes. A total of 12 number boreholes were drilled to depths of up to 3m (BH17 – BH28). The borehole locations are shown on drawing no. 5019/1 contained within Appendix G.

The intrusive investigation has shown the natural ground conditions to commensurate with geological mapping with all Boreholes finding undisturbed clay representing the recorded Kimmeridge Clay Formation, overlain by a veneer of topsoil.

Summary of strata encountered:

Stratum	Base Depth (m)	Notes
TOPSOIL: probable soft, dark brown, organic, slightly gravelly, slightly sandy, mostly plastic (locally desiccated) CLAY with frequent roots from overlying grass. Gravel is sub-angular to sub-rounded fine to medium siltstone, limestone, charcoal and brick	0.10 – 0.40	Encountered in all boreholes
MADE GROUND: probable stiff to very stiff, orangish-brown and grey, slightly sandy, slightly gravelly CLAY. With frequent roots. Gravel is fine brick and charcoal	0.40 – 1.30	Encountered in all boreholes except BH8 & BH10
CLAY: initially firm, orangish-brown and mottled bluish grey CLAY. Becoming extremely soft below 1.2m depth (ALLUVIUM)	2.10	Encountered in BH8 only
SAND: very loose, dark grey, silty, clayey, fine SAND. Becoming loose below 3.0m depth (ALLUVIUM)	>3.00	Encountered in BH8 only to terminal depth
CLAY: soft to firm, bluish grey and brown, plastic CLAY, locally with pockets of crystalline gypsum deposits (KIMMERIDGE CLAY FORMATION))	>3.00m	Encountered to terminal depth in all boreholes except BH8
Perched/Groundwater	BH1-14 – dry	

All boreholes remained dry and stable during the works with no water seepages or ground water evident.

Groundwater Water Levels/ Monitoring

Five boreholes were installed with monitoring wells and water level monitoring gas been undertaken on four separate occasions. The results are presented in Table 1.

Table 1 – Ground Water Monitoring

BH No.	Depth to standing water (m,begl)				
	27 July 2022	8 September 2022	30 September 2022	13 October 2022	28 October 2022
BH1	2.86	2.54	2.31		
BH5	2.92	2.74	2.61		
BH8	2.82	1.82	1.93		
BH10	2.88	2.83	2.73		
BH14			2.91	2.69	0.72

The ground investigation consultants have confirmed that infiltration will not be feasible for this site due to the clayey soils beneath the site. This is further supported by previous experience and past results from ground investigations undertaken on adjacent sites both sides of Abberd Brook. The Ground investigations report has therefore recommended that alternative drainage options be considered such as an attenuation pond.

The relevant sections of the ground investigation report are enclosed within Appendix G for reference.

3.6. Existing Greenfield Run-off Rates

The greenfield run-off rate for the site has been calculated using Micro-Drainage ICP SuDS method assuming:-

SAAR (Standard Average Annual Rainfall) = 800mm (from Wallingford Map)
SOIL (soil Index) = 0.45 (Obtained from Ground Investigation results)
Region = 8 (FSR Region)

The Micro Drainage calculations are contained with within Appendix D with results summarised for a 1ha site are:-

Q1	(1 year existing green-field run-off)	=	4.0 l/s
Q30	(30 year existing green-field run-off)	=	9.8 l/s
Q100	(100 year existing green-field run-off)	=	12.4 l/s
Qbar	(mean annual green-field run-off, 2.3 years)	=	5.1 l/s

Please Note: In accordance with Wilshire Council Drainage and Betterment Strategy, post development discharge rates will have 30% betterment over pre-development discharges for all storms events between the 1 in 1 year and 1 in 100year storm return periods.

3.7. Existing Greenfield Run-off Volume

Ciria C753 & the EA/DEFRA guide 'Preliminary Rainfall Runoff Management for Developments' recommend that the basis for considering the run-off volume is the difference pre- and post-development for the 100 year 6 hour event.

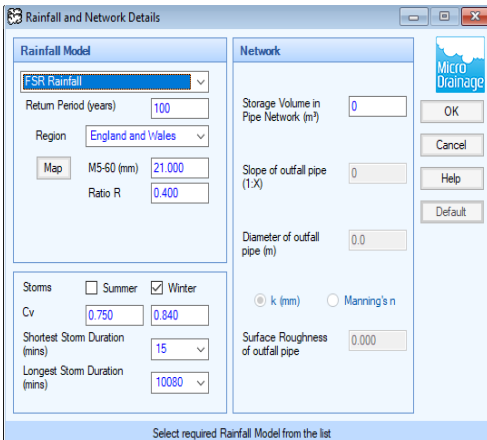
Ciria C753 (Section 24.10)

Green-field Run-off Volume = $10 \times RD \times A \times (SPR \text{ or } PR)$

RD: 100 year 6 hour rainfall (6 hours @ 10.862mm/hr, from Micro Drainage) = 59.17mm (see Micro Drainage images below and included within Appendix H)

A: Site Area (Ha) = 0.631 ha

SPR: Soil Type Standard Percentage Run-off = 0.45



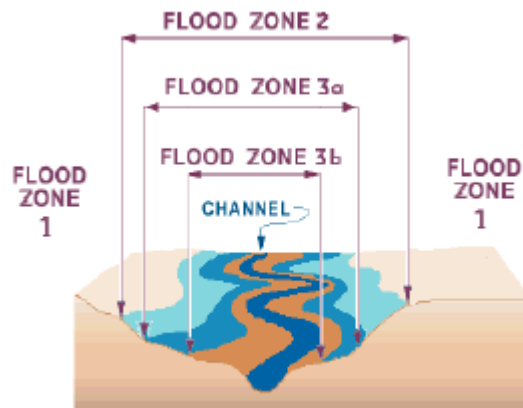
Storm Event	Rain (mm/hr)
15 min Winter	104.095
30 min Winter	68.264
60 min Winter	42.578
120 min Winter	25.605
180 min Winter	18.739
240 min Winter	14.936
360 min Winter	10.862
480 min Winter	8.652
600 min Winter	7.247

Existing 100 Year Green-field Run-off Volume: $10 \times 59.17 \times 0.631 \times 0.45 = 168\text{m}^3$

4. FLOOD RISK ASSESSMENT

4.1. Flood Zones

Table 1 of the NPPF Technical Guidance defines different flood zones according to the probability of river and sea flooding, ignoring the presence of any defences (although areas benefiting from formal defences are identified).



Flood Zone 1 - Low Probability

This zone comprises 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 - Medium Probability

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Flood Zone 3a - High Probability

This zone comprises land assessed as having between a 1 in 100 or greater annual probability of river flooding (>1%) or 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Flood Zone 3b - The Functional Floodplain

This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, including conveyance routes).

It should be noted that flooding from surface water, groundwater, sewers and impounded water bodies can occur in any flood zone, even in Flood Zone 1.

Flood risk from all potential sources (sea, fluvial, pluvial, sewers, groundwater, and artificial) has been assessed and discussed in detail within Section 4.2.

4.2. Flooding Hazards to the Application Site

4.2.1. Fluvial & Tidal Flooding

The nearest main river to the application site is Abberd Brook which forms the southern boundary of the site. Abberd Brook outfalls into the River Marden located approximately 3.5Km to the west of the site.

The Environment Agency March 2025 flood map for planning below identifies the majority of the application site to be located entirely within Flood Zone 1 (low probability of flooding having a less than 1 in 1,000 annual probability of fluvial flooding).

The land immediately adjacent to Abberd Brook lies within Flood Zones 2 & 3 associated with flooding from this River.

This area will not be developed and will form part of the public open space. All habitable built development will be located within Flood Zone 1 in accordance with the NPPF sequential approach.

Please note:

Due to new rainfall data being released in March 2025, new hydraulic modelling of the Abberd Brook and culvert has been carried out to accurately identify the surface water flood risk from this river as part of this FRA. Therefore, the flood levels / flood extents obtained from the new 2025 hydraulic modelling will be used, refer section 4.3 of this report for further details.

Get a boundary report

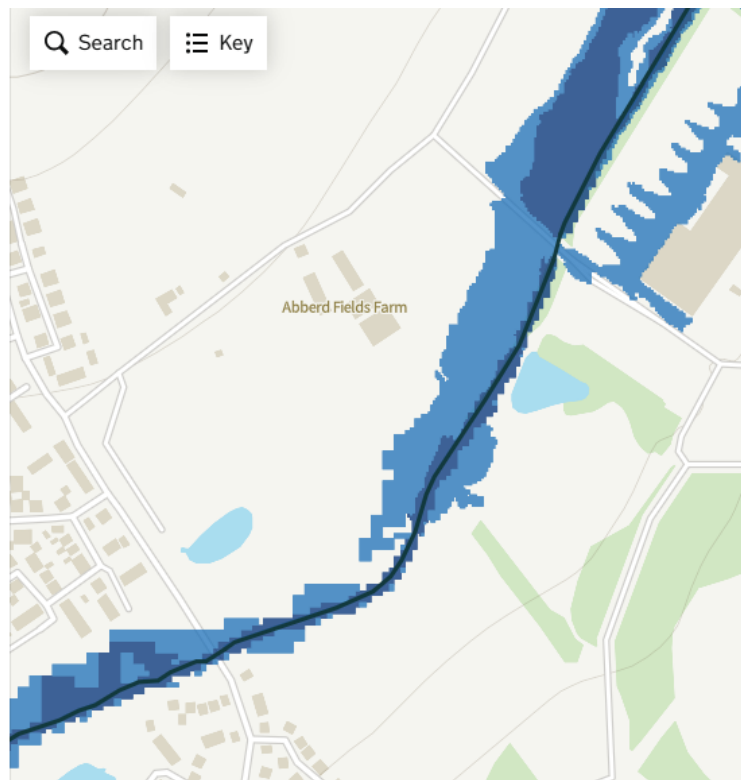
☐ Add

Datasets

- ☒ Flood zones 2 and 3
- ☐ River and sea with defences
- ☐ River and sea without defences
- ☐ Surface water
- ☐ None

Map features

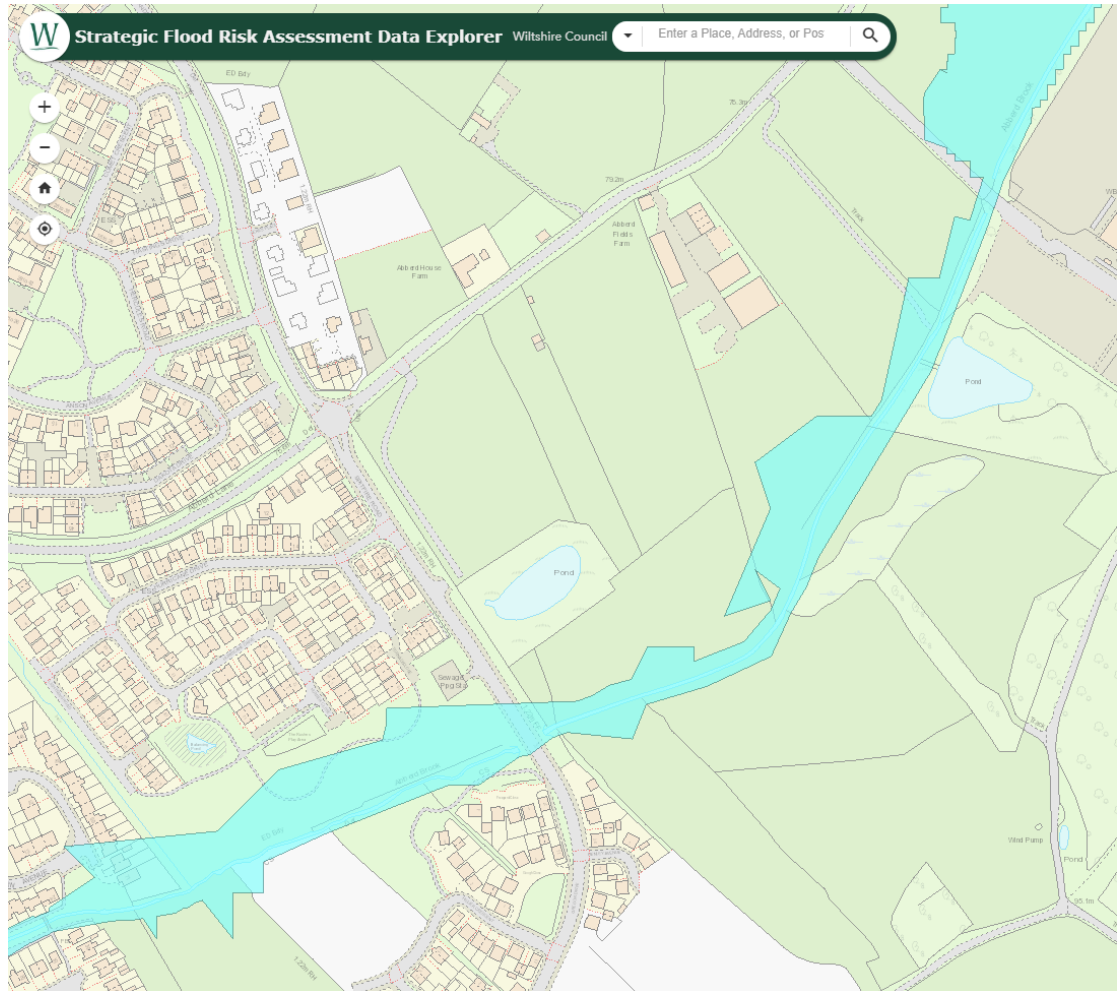
- ☐ Water storage
- ☐ Flood defence
- ☒ Main Rivers



Environment Agency Flood Map for Planning – March 2025– Scale 1:2500

4.2.2. Wiltshire County Council Flood Mapping

The below Wiltshire Council Online Flood Mapping commensurate with the Environment Agency flood mapping showing that the majority of the application site being located entirely within Flood Zone 1, with the land immediately adjacent to Abberd Brook being within Flood Zones 2 & 3.



Wiltshire Council online Flood Mapping

4.2.3. Flood Risk from Land (Surface Water Overland Flow)

Intense periods of rainfall over a short duration can often lead to overland flow as rainwater is unable to infiltrate into the ground or enter drainage systems. It is made worse when soils are saturated so that they cannot accept any more water. Surface water run-off is currently collected by on site ditches and watercourses.

The EA surface water flood map below has been generated by simulating rainfall events over the site to determine where surface flows and collects based on Lidar survey information. The rainfall events chosen for modelling were the 1 in 30, 1 in 100 and 1 in 1000 year storm return periods. These events were modelled for the 1 hour, 3 hour and 6 hour storm durations.

High – Land that has a chance of flooding of greater than 1 in 30 (3.3%) in every year

Medium - Land that has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%) in every year

Low – Land that has a chance of flooding of between 1 in 1,000 (0.1%) and 1 in 100 (1%) in every year

Very Low – Land that has a chance of flooding of less than 1 in 1,000 (0.1%) in every year

Get a boundary report

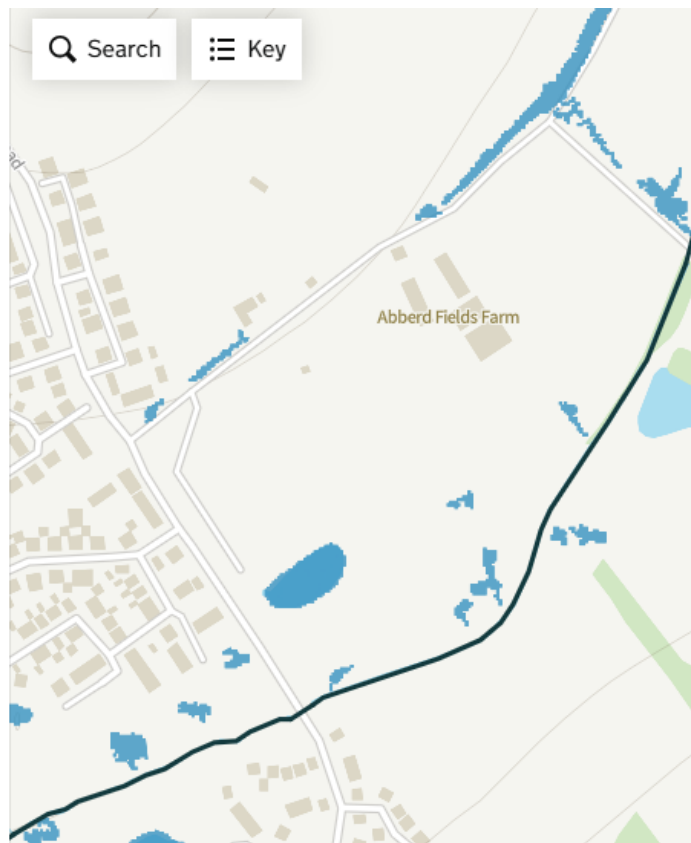
☐ Add

Datasets

- ☐ Flood zones 2 and 3
- ☐ River and sea with defences
- ☐ River and sea without defences
- ☒ Surface water
- ☐ None

Annual likelihood of flooding

- ☒ 1 in 30
- ☐ 1 in 100
- ☐ 1 in 1000



Environment Agency Flood Risk from Surface Water – 1 in 30 Year Annual Likelihood of Flooding

Get a boundary report

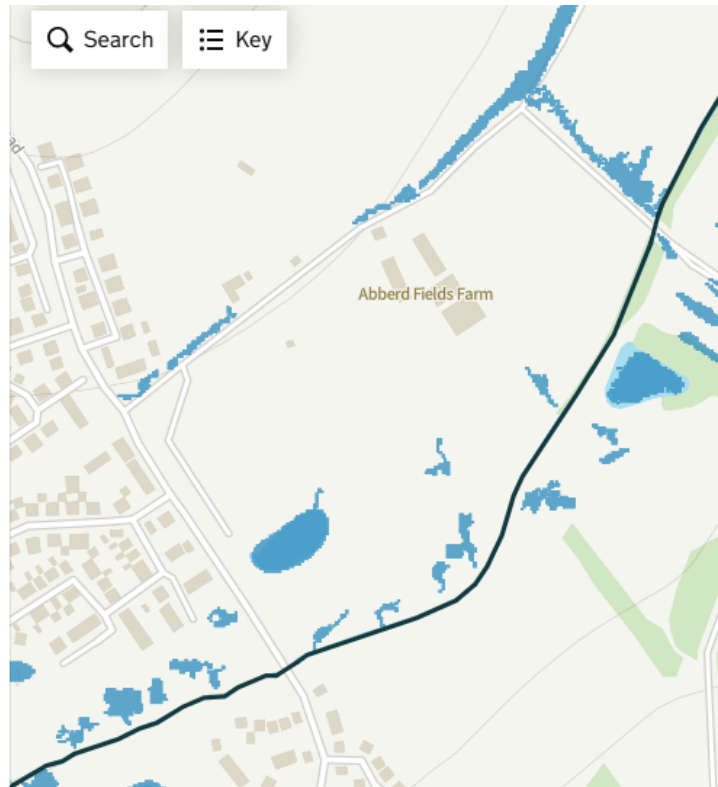
☐ Add

Datasets

- ☐ Flood zones 2 and 3
- ☐ River and sea with defences
- ☐ River and sea without defences
- ☒ Surface water
- ☐ None

Annual likelihood of flooding

- ☐ 1 in 30
- ☒ 1 in 100
- ☐ 1 in 1000



Environment Agency Flood Risk from Surface Water – 1 in 100 Year Annual Likelihood of Flooding

Get a boundary report

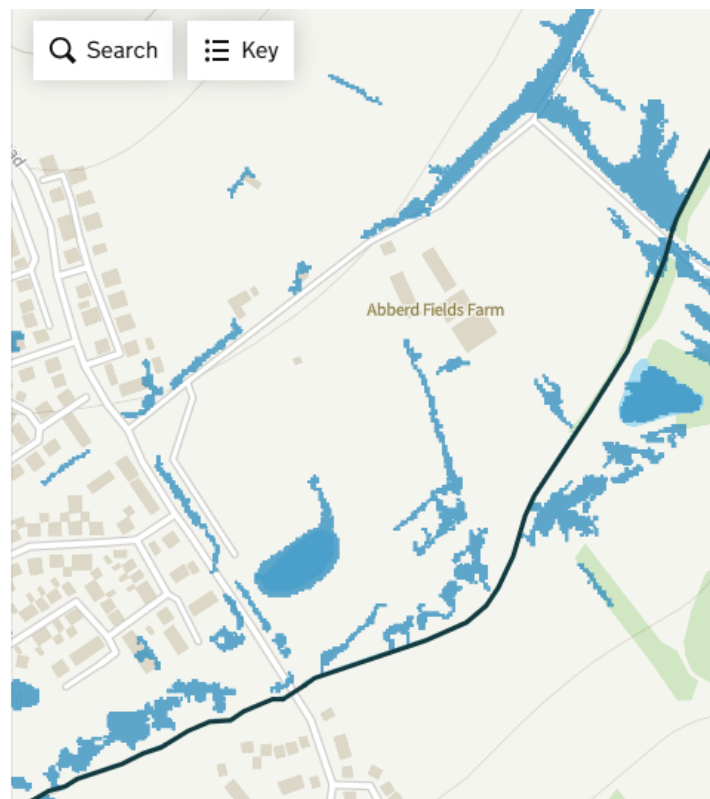
☐ Add

Datasets

- ☐ Flood zones 2 and 3
- ☐ River and sea with defences
- ☐ River and sea without defences
- ☒ Surface water
- ☐ None

Annual likelihood of flooding

- ☐ 1 in 30
- ☐ 1 in 100
- ☒ 1 in 1000



Environment Agency Flood Risk from Surface Water – 1 in 100 Year Annual Likelihood of Flooding

The surface water mapping shows that the parts of the site is located in low, medium and high surface water flood risk. However, as mentioned, the surface water flood mapping is based on lidar data, which is not always entirely accurate. The topographical survey of the site shows that there are no low points within this application site. The ground falls towards Abberd Brook at a constant average gradient of 1 in 100. Therefore, the surface water flood mapping in this instance is considered to be inaccurate and misleading.

Surface water run-off from the proposed development impermeable areas will be collected and managed through the use of Sustainable Drainage System. Therefore as the site is developed, any potential surface water flood risk will effectively be mitigated against as greenfield areas will become hard paved areas which will be drained to the proposed surface water drainage system.

Based on the topographical survey of the site and the proposed SuDS, the overall risk from surface water flooding is considered to be negligible.

4.2.4. Groundwater Flooding

Groundwater flooding occurs when the sub-surface water levels in the ground rise above surface elevations, which is most likely to occur in low lying areas underlain by permeable rocks (aquifers).

According to Wiltshire Council SFRA there are areas of Wiltshire where ground water levels can be high, and in some locations, there may be a risk of groundwater emergence during extremely wet winters. This occurred in 2013/14 when groundwater levels rose to their highest recorded level causing flooding at multiple locations in the south of Wiltshire. The risk of groundwater flooding is dependent on local conditions at any given time. Groundwater levels rise during wet winter months and fall again in the summer when effective rainfall is low, and extractions are higher. In very wet winters, rising groundwater levels may lead to the flooding of normally dry land, as well as reactivating flow in streams that only flow for part of the year. This is particularly true for some of the upper reaches in the Hampshire Avon catchment where there are ephemeral chalk streams.

The underlying soils for the site are clays which are impermeable and do not allow the free passage of groundwater and therefore the risk of flooding from ground water is considered negligible for this site.

Ground water monitoring undertaken as part of the ground investigation identified that the highest ground water level recorded for this application site was 1.93m below ground level.

The Environment Agency online live flood map, extract below, identifies that flooding from groundwater is unlikely in this area.

Groundwater

Flooding from groundwater is unlikely in this area.

However, in the unlikely event that the ground water table rises above existing ground levels, the proposed development will be designed to ensure flood routes are provided which will convey and channel groundwater away from site and towards the existing watercourses, mimicking the existing drainage regime for the site.

4.2.5. Flooding from Sewers

Sewer flooding occurs when sewers are overwhelmed by heavy rainfall or when they become blocked. The likelihood of flooding depends on the capacity of the local sewerage system.

There is an existing 375mm diameter outfall pipe from the existing attenuation pond to the north which is routed through the application site and discharges into Abberd Brook.

There is an existing 1050mm diameter surface water sewer located to the north of application site which outfalls into an existing attenuation pond. This sewer serves upstream residential developments located of Sandpit road and west of Spitfire road.

Any potential flooding from these sewers would either drain directly into the existing pond or naturally follow the ground contours and flow way from the application site towards Abberd Brook.

There is no foul sewer within the application site. The nearest foul sewer being located to the west within Spitfire Road. Any flooding from this sewers would be contained within the highway and flow towards Abberd Brook away from the application site.

The risk of flooding from sewers is therefore considered to be very low.

The surface water run-off from the proposed development will be collected and managed through the use of Sustainable Drainage Syetem. This system will be designed to cater for the 1 in 100 year plus 45% climate change without flooding occuring. In the unlikely event that a sewer becomes blocked or fails, or the capacity exceeded the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties.

The risk of flooding from existing and proposed future sewers is therefore considered to be negligible.

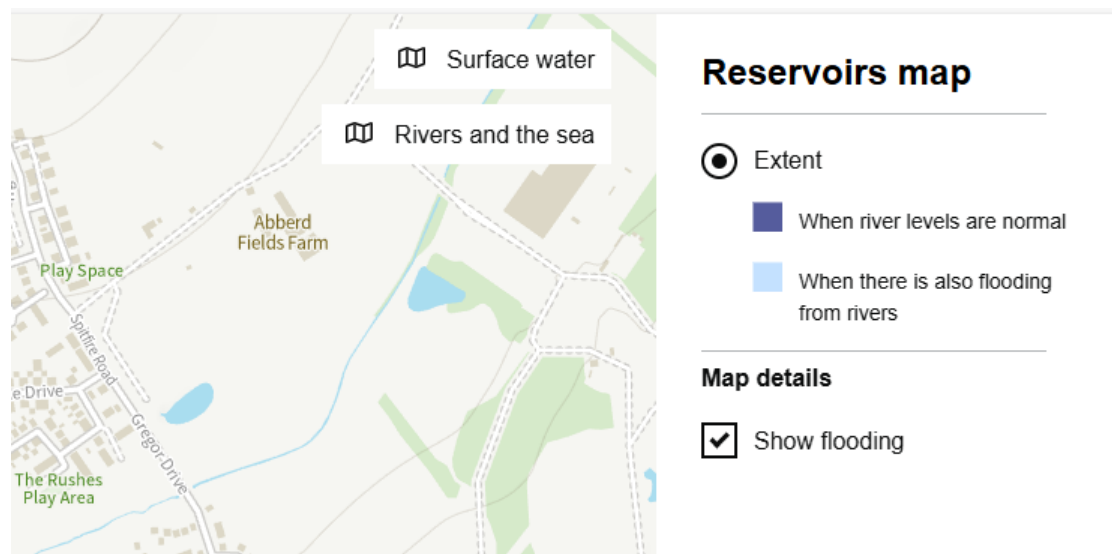
4.2.6. Artificial Sources

Artificial sources of flooding include reservoirs, dams, canals and lakes upstream of the site.

Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensure that reservoirs are inspected regularly and essential safety work is carried out.

The EA online mapping below shows the site is not affected by potential flooding from reservoirs. There are no other artificial sources that that could result in flood risk.

There is an existing attenuation pond on site, however, any flooding from this source (due to a blockage occurring) would naturally follow the ground slope and flow away from the site towards Abberd Brook.

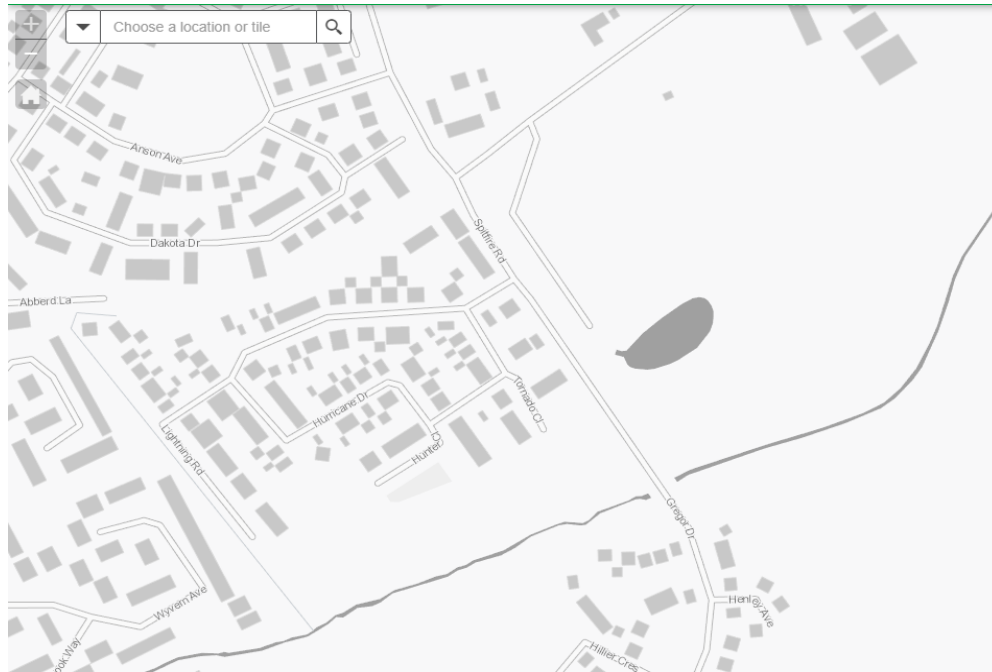


Environment Agency Flood Risk from Reservoirs - Extent of Flooding

4.2.7. Flood Warning & Flood Alert Areas

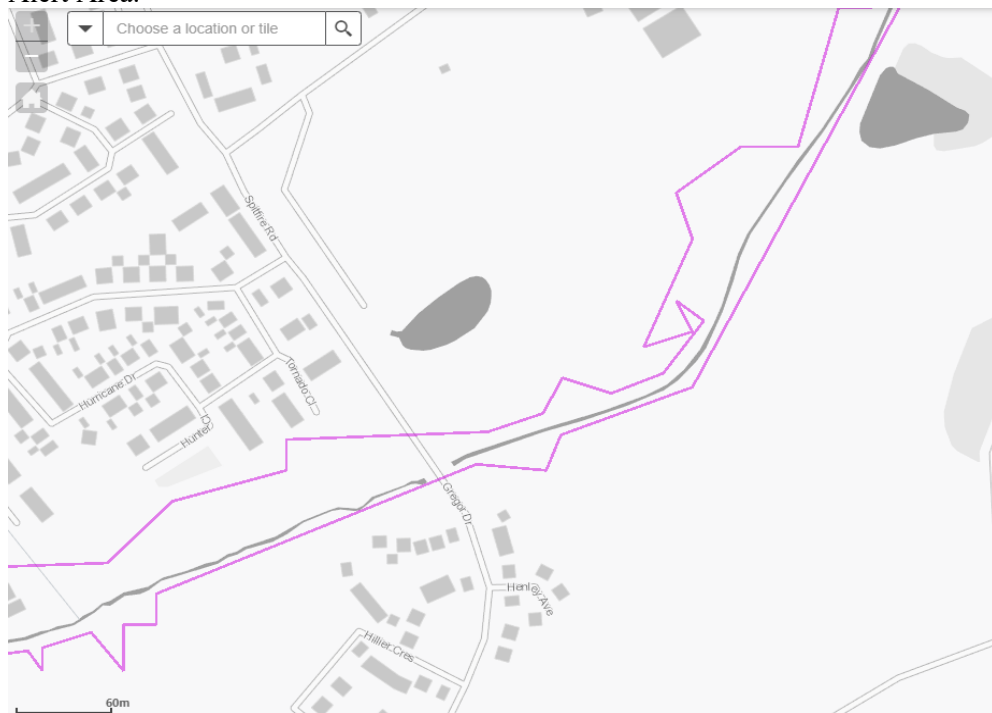
The SFRA map below shows details of Flood Warning and Flood Alert Areas. The Environment Agency issues flood alerts to homes and business in these areas when flooding is possible.

The map below shows that the application site is not located within a flood warning area.



Environment Agency Flood Warning Area Map

The map below shows that part of the application site is not located within a flood Alert Area.



Environment Agency Flood Alert Area Map

4.2.8. Historic Flooding

Recent years have seen a number of large scale flood events throughout the UK including Easter and October 1998, autumn 2000, February 2002, February 2004 and summer of 2007.

The EA historic flood map below shows that there has been no recorded incidence of flooding for the application site.



Environment Agency Historic Flood Map

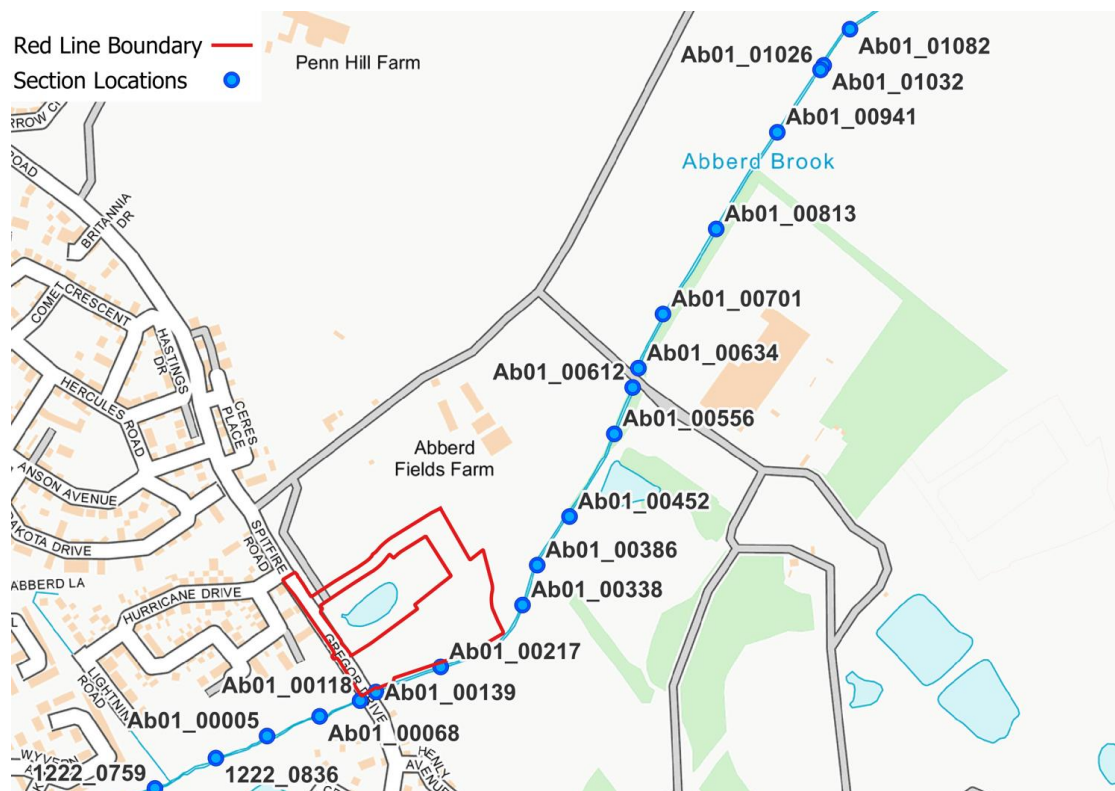
4.3. 2025 Abberd Brook Hydraulic Modelling

Due to new rainfall data and flood maps being released in March 2025, new hydraulic modelling of the Abberd Brook and culvert has been carried out to accurately identify the surface water flood risk from Abberd Brook as part of this FRA.

The below is a brief summary of the 2025 hydraulic modelling undertaken for the site. For full details please refer to the dedicated hydraulic modelling report included within Appendix I.

Chris Whitlow Associates was appointed by Phoenix Design Partnership (PDP) to carry out hydraulic modelling of the existing river (Abberd Brook) and culverts to accurately identify the surface water flood risk for existing base line conditions.

A topographical survey was undertaken of the site including upstream and downstream areas to accurately model the profile of the Abberd Brook, adjacent land and existing culverts. A number of cross sections were generated which are represented by the nodes points shown below.



The baseline hydraulic model was run for a number of storm return periods, these include:-

- 1 in 30 (3.3%)
- 1 in 100 (1%)
- 1 in 100 + 26% climate change allowance (1% + CC)
- 1 in 1,000 (0.1%)

The flood levels for each node point is shown in below:-

Label	1 in 30	1 in 100	1 in 100 plus 26% CC	1 in 1000
Ab01_01082	77.29	77.38	77.42	77.47
Ab01_01032	77.30	77.40	77.46	77.55
Ab01_01026	76.44	76.64	76.80	77.07
Ab01_00941	76.21	76.33	76.40	76.54
Ab01_00813	75.38	75.55	75.87	76.09
Ab01_00701	74.74	75.08	75.74	76.00
Ab01_00634	74.67	75.03	75.72	75.99
Ab01_00612	73.80	73.96	74.09	74.23
Ab01_00556	73.34	73.50	73.62	73.88
Ab01_00452	73.20	73.34	73.46	73.71
Ab01_00386	73.09	73.25	73.38	73.64
Ab01_00338	72.74	72.91	73.01	73.23
Ab01_00217	71.80	71.98	72.09	72.28
Ab01_00139	71.73	71.89	71.96	72.14
Ab01_00118	71.65	71.77	71.80	71.86
Ab01_00068	71.34	71.45	71.53	71.64
Ab01_00005	70.93	71.03	71.11	71.19
1222_0836	70.63	70.76	70.87	71.08
1222_0759	70.28	70.44	70.61	70.91

The baseline model results for the 1 in 1,000 year flood extents has been shown on drawing No. 647-P-010 – SuDS Strategy enclosed within Appendix E, this being similar but slightly more extensive than the 1 in 100 + 26% climate change allowance flood extents (not shown).

To provide additional flood resilience to the proposed residential development now and in the future, and provide safe access and egress to the development, the flood outline for the 1 in 1000yr storm event has been offset by a minimum 0.5m and the ground raised by 600mm above the 1 in 1000yr flood level. This level will be the minimum level for roads.

For example using node point ab01-00338 just upstream of the site (in the east) which has a 1:1000yr flood level of 73.23, ground levels adjacent to this node and cross section have been raised to 73.85mAOD (620mm above the 1:1000yr flood level). This process has been repeated from east to west maintaining a minimum of 600mm above the 1:1000yr flood level.

Finished floor levels (FFL) for houses will be set a minimum of 150mm above road level and therefore the minimum FFL will be at least 750mm above the 1:1000yr flood level.

Therefore, all habitable development and attenuation ponds will be located outside 1 in 1,000 year modelled flood extents to ensure all houses and SuDS features are located entirely within Flood Zone 1.

4.4. Flood Risk Vulnerability Classification & Flood Zone Compatibility

The proposed development, classified in accordance with Annex 3 of the Planning Practice Guidance 'Flood Risk Vulnerability Classification', is 'More Vulnerable' (residential).

More Vulnerable – Building used for dwelling houses

Water Compatible – Amenity Open Space

Flood Risk Vulnerability and Flood Zone 'Compatibility' Table

Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test	✓	✓
	Zone 3a	Exception Test	✓	✗	Exception Test	✓
	Zone 3b	Exception Test	✓	✗	✗	✓

Key:

✓ Development is appropriate

✗ Development should not be permitted

All habitable development and attenuation pond will be located outside of the 1 in 100 year + CC and the 1 in 1,000 year modelled flood extents to ensure all houses and SuDS features are located entirely within Flood Zone 1.

In accordance with the Flood Risk Vulnerability and Flood Zone 'Compatibility' table all types of development are compatible with Flood Zone 1.

Areas of application site that fall into Flood Zones 2 and 3 will be public open space.

4.5. Sequential Test

Paragraph 172 of the NPPF states that:

All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

- a) applying the sequential test and then, if necessary, the exception test as set out below;*
- b) safeguarding land from development that is required, or likely to be required, for current or future flood management;*
- c) using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and*
- d) where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.*

Paragraph 173 of the NPPF states that:

'A sequential risk-based approach should also be taken to individual applications in areas known to be at risk now or in future from any form of flooding, by following the steps set out below.'

Paragraph 174 of the NPPF states that:

'Within this context the aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test.'

Paragraph 175 of the NPPF states that:

'The sequential test should be used in areas known to be at risk now or in the future from any form of flooding, except in situations where a site-specific flood risk assessment demonstrates that no built development within the site boundary, including access or escape routes, land raising or other potentially vulnerable elements, would be located on an area that would be at risk of flooding from any source, now and in the future (having regard to potential changes in flood risk).'

Hydraulic modelling of the existing river (Abberd Brook) and culverts has been carried out to accurately identify the existing surface water flood risk. The flood levels / flood extents obtained from the modelling have and will be used to inform the development, refer section 4.3 of this report for further details.

In accordance with the NPPF sequential approach any land that lies within flood 2 / 3 (as modelled) will not be developed and will form part of the public open space. All habitable built development will be located within Flood Zone 1 in accordance with the NPPF sequential approach.

4.6. Exception Test

Paragraph 177 of the NPPF states that:

‘Having applied the sequential test, if it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3.’

Paragraph 178 of the NPPF states that:

The application of the exception test should be informed by a strategic or site specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. For the exception test to be passed it should be demonstrated that:-

- the development provides wider sustainability benefits to the community that outweigh flood risk, and*
- the development will be safe for its lifetime taking into account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

Paragraph 179 of the NPPF states that:

‘Both elements of the exception test should be satisfied for development to be allocated or permitted.’

The proposed development will assist in meeting the housing shortfall in the Wiltshire Council area, offering an attractive and sustainable location for new residents. The development is well located in terms of sustainability, with good foot / cycle connections to existing infrastructure including schools, supermarkets and open space. In addition the application site is also extremely well located in terms of pending permitted facilities, which include a day nursery and convenience store which have planning consent to be constructed almost immediately northwest of the proposed site. These facilities also have the potential to offer employment opportunities for future residents. It’s important to note that the proposed built development is all located within Flood Zone 1. Whilst it is acknowledged that the application area includes areas beyond Flood Zone 1, no habitable development is proposed in these areas. The proposals will there help assist in delivering the central governments housing targets without compromising flood risk.

Hydraulic modelling of the existing river (Abberd Brook) has been carried out to accurately identify the surface water flood risk and inform the proposed development masterplan, refer section 4.3 of this report for further details.

The FRA demonstrates that the proposed development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and how it will reduce overall flood risk.

Therefore, the details and information provided within this FRA addresses the second part of the exception test and confirms that the Exception Test has been passed and the proposed development is appropriate, in flood risk terms.

4.7. Probability of Flood Risk

The EA and SFRA flood mapping have identified the site to be predominantly located within Flood Zone 1 (low probability of flooding having a less than 1 in 1,000 annual probability of fluvial flooding). The land immediately adjacent to Abberd Brook lies within Flood Zones 2 & 3 associated with flooding from this river. This area will not be developed and will form part of the public open space. All habitable built development will be located within Flood Zone 1 in accordance with the NPPF sequential approach.

Hydraulic modelling of the Abberd Brook and culvert has been carried out to accurately identify the surface water flood risk from this river. Therefore, the flood levels / flood extents obtained from the Hydraulic modelling will be used, refer section 4.3 of this report for further details.

To provide additional flood resilience to the proposed residential development now and in the future, and provide safe access and egress to the development, the flood outline for the 1 in 1000yr storm event has been offset by a minimum of 0.5m and the ground raised by a minimum 600mm above the 1 in 1000yr flood level. This level will be the minimum level for roads.

The indicative Finished floor levels (FFL) for houses are shown between 74.50mAOD and 73.00mAOD which equates to 1.27m and 1m above the relevant adjacent 1:1000yr flood level.

Therefore, all habitable development and attenuation ponds will be located outside 1 in 1,000 year modelled flood extents to ensure all houses and SuDS features are located entirely within Flood Zone 1.

The surface water run-off from the proposed development will be collected and managed using Sustainable Drainage Systems. This SuDS will be designed to cater for the 1 in 100 year plus 45% climate change without flooding occurring. In the unlikely event that a sewer becomes blocked the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties.

All flood hazards appropriate for this site have been evaluated within section 4.2. It has been concluded that the application site is not at risk of flooding from any of the hazards identified and therefore the probability and consequences of flooding from all sources is considered to be negligible and the risk of flooding low.

5. DEVELOPMENT PROPOSALS

5.1. Development

The outline planning application is for residential development for up to 20 dwellings, associated works including infrastructure, ancillary facilities and landscaping.
Construction of a new vehicular access off Spitfire Road.

See Illustrative Masterplan enclosed within Appendix A.

5.2. Foul Drainage Strategy

The proposed foul drainage strategy is shown on drawing number 647-P-010 – “SuDS Strategy” enclosed within Appendix E.

The nearest public foul sewer to the application site is a 375mm diameter pipe located in Spitfire road immediately to the east of the site. This sewer drains to an existing adjacent foul pumping station. This sewer and pumping station is owned and maintained by Wessex Water.

The whole of the application site has therefore been designed to drain by gravity and connect to the existing 375mm diameter foul sewer in Spitfire road. This connection point including calculated flows will need to be agreed with Wessex Water.

Section 106 of the Water Industry Act 1991 (as amended) secures the right for a developer to connect to a public sewer. Any upgrades works required to public sewers, pumping stations and Water Treatment Works to cater for the future development will be provided by Wessex Water and included within their Asset Management Plan (AMP), once the proposed development is granted planning permission.

All private foul drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the foul sewers for adoption under a Section 104 Agreement in accordance with Design and Construction Guidance for foul and surface water Code for adoption agreements "the Code". All details will be subject to technical approval at the detailed design stage as part of the S104 process. The S104 may be with Wessex Water or a suitably accredited NAV operator.

The future management and maintenance of the foul drainage system is discussed in detail within section 8 of this report.

5.3. Surface Water Drainage Strategy

5.3.1. Sustainable Drainage System (SuDS)

SuDS will be used to manage surface water run-off from the proposed development. The SuDS will be designed to ensure that the existing run-off regime is maintained as closely as possible and that there is no increase in flood risk as a result of the development of the site.

The SuDS design for the site is based on providing a SuDS management train (also referred to as SuDS treatment train). This approach facilitates in replicating as close as possible the existing natural drainage catchment, by reducing flow and enhancing water quality characteristics of the runoff in stages.

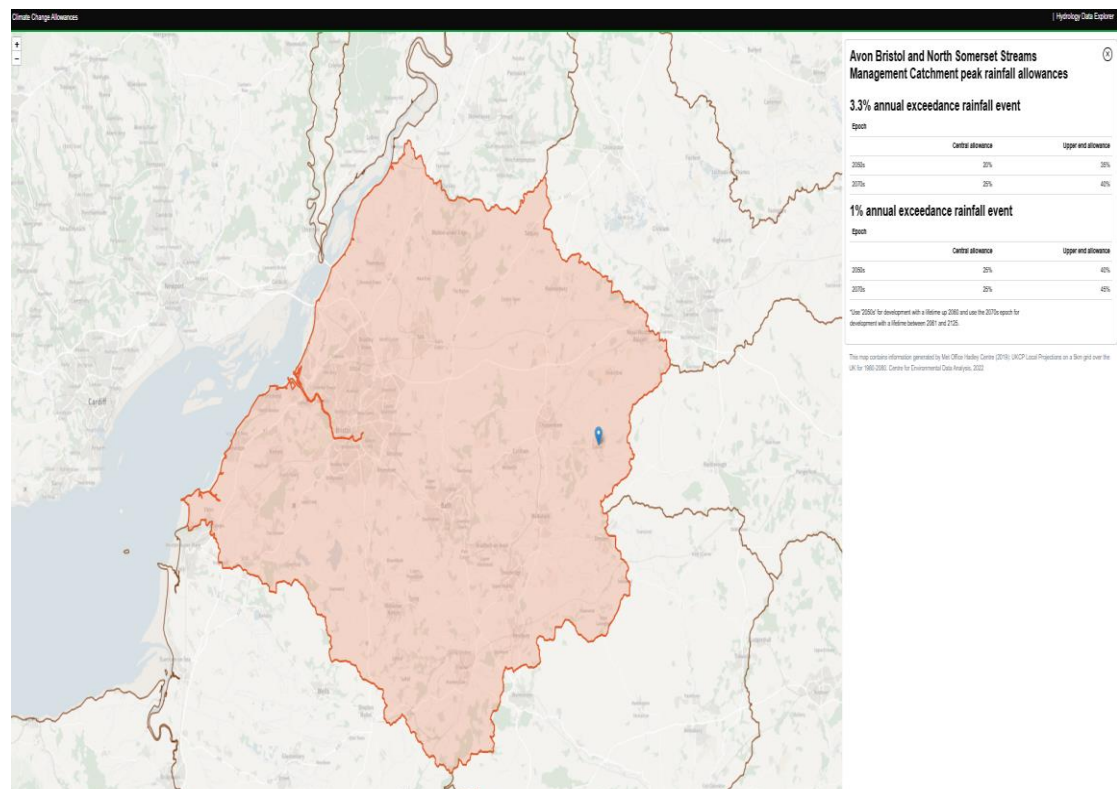
The ground investigation consultants have confirmed that infiltration will not be feasible for this site due to the clayey soils beneath the site. This is further supported by previous experience and past results from ground investigations undertaken on adjacent sites both sides of Abberd Brook. The Ground investigations report has therefore recommended that alternative drainage options be considered such as an attenuation pond.

Therefore, SuDS in the form of attenuation pond will be used and lined where necessary (impermeable membrane provided) to prevent ground water entering the surface water drainage system.

Refer to section 6 “SuDS Details” for a full description and additional information on all SuDS provided for this application site.

5.3.2. Climate Change

The application site lies within the Avon Bristol and North Somerset Streams Management Catchment. In accordance with the current Environment Agency guidance ‘Flood risk assessments: climate change allowances’ the SuDS will be designed with 45% upper end climate change allowances for the predicted increase in rainfall intensity over the lifetime of the residential development (100 year design life between 2061 - 2125)



5.3.3. Development Run-off Volume

Guidance recommends that the run-off volume for the 100 year 6 hour event is used to compare existing and proposed volumes. The existing greenfield run-off volume from the development area has been calculated in section 3.7 to be 3989m³. The developed run-off has been calculated using formulae from Ciria C753 as shown below.

Developed Run-off Volume:

$$10.RD.A[((PIMP/100)\alpha 0.8) + ((1-(PIMP/100))\beta SPR)] \text{ (From Paragraph 24.4)}$$

RD = Rainfall Depth (mm)

A = Catchment Area

α = Proportion of impermeable draining to system at 80% (0.8) run-off (roofs, parking, roads, etc). Can be increased to 100 % for more conservative assessment (will depend on materials, drainage...).

β = Proportion of pervious areas draining to system, 0-1.0 (gardens, open space, etc).

RD: 100 year 6 hour rainfall (6 hours @ 10.184mm/hr, from Micro Drainage) = 61.10mm

A: Development Site Area (excluding POS) = 0.631 ha

PIMP: 60% (0.631/0.3678)

SPR: Soil Type Standard Percentage Run-off (Soil Type 4 WRAP Map) = 0.45

Existing 100 Year 6 Hour Volume = 168m³

Developed 100 Year + 40% 6 Hour Volume = **380 m³**

The full set of calculations can be seen in Appendix H along with extracts from Micro Drainage showing results.

The calculations show that there is an increase in the volume of runoff from the development. As the underlying soils are impermeable and are not suitable for infiltration it will be necessary to follow alternative guidance to mitigate for the increase in run-off volume resulting from the development.

To mitigate for the additional run-off volume EA/Defra and Ciria guidance together with BS8582 recommend that Extended Attenuation Storage is provided and that run-off is restricted to the Mean Annual Flood Flow (Q_{bar}) green-field rate for all events up to the 1:100 year with an allowance for climate change.

However, in order to meet Wiltshire Council Drainage and Betterment Strategy, the post development discharge rates will have 30% betterment over pre-development discharges for all storms events between the 1 in 1 year and 1 in 100 year storm return periods, refer to section 5.3.6 for further details.

5.3.4. Surface Water Parameters

A surface water drainage strategy has been developed that incorporates a Sustainable Drainage System and is shown on drawing number 647-P-010 “SuDS Strategy” enclosed within Appendix E. The strategy is intended to provide guidance to inform the detailed design. The detailed design should be based on the principles established in this FRA and SuDS Strategy.

The surface water drainage and SuDS will be designed in accordance with the following:

- Building Regulations Part H: Drainage & Waste Disposal
- Sewers for Adoption and the requirements of Thames Water
- Ciria C753: The SuDS Manual.
- BS8582: Code of Practice for Surface Water Management for Development Sites
- Non Statutory Technical Standards For Sustainable Drainage Systems

The hierarchy for the disposal of surface water (Part H of Building regulations) is that rainwater shall discharge to one of the following, listed in order of priority:

- a) an adequate soakaway, or some other adequate infiltration system; or, where that is not reasonably practicable,
- b) a watercourse; or, where that is not reasonably practicable,
- c) a sewer.

5.3.5. Surface Water Outfall

British Geological Survey mapping indicates the site to be entirely underlain by the Kimmeridge Clay Formation (undifferentiated) - Mudstone. These ground conditions are unlikely to support the use of SuDS in the form of infiltration drainage.

The ground investigation consultants have confirmed that infiltration will not be feasible for this site due to the clayey soils beneath the site. This is further supported by previous experience and past results from ground investigations undertaken on adjacent sites both sides of Abberd Brook. The Ground investigations report has therefore recommended that alternative drainage options be considered such as an attenuation pond.

Therefore, in accordance with the hierarchy for surface water disposal, the surface water run-off from the development will be discharged to Abberd Brook (main river) located on the southern boundary of the site via an attenuation pond mimicking the natural drainage pattern for the site as shown on drawing No. 647-P-010 “SuDS Strategy” enclosed within Appendix E.

5.3.6. Proposed Strategy

The proposed drainage strategy is shown on drawing No. 647-P-010 “SuDS Strategy” enclosed within Appendix E.

The surface water run-off from the site has been designed to drain to an attenuation pond via a combination of surface water piped network, swale and permeable paving with filter drains.

A conveyance ditch / outfall channel has been designed to collect and discharged the surface water from the attenuation pond to Abberd Brook.

Development Area = 0.631 Hectares (excluding POS).
Impermeable Area = 0.631 x 60% (estimated) = 0.3786 ha.
Urban Creep Allowance (10% of Imp Area) = 0.0378 ha
Total Impermeable Area = 0.416 ha

Greenfield run-off rate based on development area = $Q_{bar} (5.1 \text{ l/s}) \times 0.631 = 3.2 \text{ l/s}$

However, in order to meet Wilshire Council Drainage and Betterment Strategy, the post development discharge rates will need to have 30% betterment over pre-development discharges for all storms events between the 1 in 1 year and 1 in 100 year storm return periods.

To meet this criteria the surface water discharge rate has been set to 2.5 l/s for all storm return periods from the 1 in year up to and including the 1 in 100 year + 45% CC.

Coefficient of run-off (CV Value) - Wilshire Council Drainage and Betterment Strategy requires the CV value to be set to 1.

The attenuation pond has been designed as online pond to provide storage and treatment to the surface water run-off from the proposed development prior to discharging into Abberd Brook to the south of the site, replicating existing greenfield conditions.

To mitigate for the additional surface water run-off volume resulting from the proposed development, as stated within section 5.3.3, the EA/Defra and Ciria guidance together with BS8582 recommends that Extended Attenuation Storage is provided and that run-off is restricted to the existing Mean Annual Flood Flow (Q_{bar} , 1:2.3 event) green-field rate for all events up to the 1:100 year storm return period with allowance for climate change. This approach ensures that sufficient run-off is retained on site for extreme events to protect the receiving water course in times of flooding. However, an additional 30% betterment benefit has been provided on top of this criteria in order to meet Wilshire Council Drainage and Betterment Strategy.

In order to restrict the surface water flows a suitable flow control device (e.g. Hydro-brake vortex control) will be used and all flows attenuated within the pond.

The civil engineering industry Micro-drainage has been used to design the proposed surface water drainage network, attenuation ponds and at source SuDS features. The results of the modelling are contained within Appendix F and summarised below.

Attenuation Pond

(Top of Pond = 72.65mAOD, Base Level = 71.15mAOD, 1.5m deep)

Event	Discharge (l/s)	Water Level (mAOD)	Attenuation Depth (m)	Attenuation Volume (m3)	Freeboard (m)
1:1	2.0	71.413	0.263	77	1.237
1:30	2.0	71.726	0.576	188	0.924
1:100	2.0	71.877	0.727	250	0.773
1:100+45%	2.3	72.164	1.014	326	0.396

The total discharge from the site is less than the 30% greenfield run-off betterment rate of 2.5 l/s for all storm return periods, based on worst case rainfall duration and therefore offering even further betterment post development. A minimum 300mm of freeboard has been provided in accordance with Ciria guidance.

All private surface water drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the surface water sewers for adoption under a Section 104 Agreement in accordance with Design and Construction Guidance for foul and surface water Code for adoption agreements "the Code". All details will be subject to technical approval at the detailed design stage as part of the S104 process. The S104 may be with Wessex Water or a suitably accredited NAV operator.

Approval for any works to Abberd Brook for the future proposed outfall to this main river will need to be obtained from the Environment Agency via a Flood Defence consent application.

5.4. Overland Flows / Flood Exceedance Routing

Flood routes have been provided for exceedance events or for local failure of the drainage system and will ensure that flood flows are directed safely through the development to the downstream attenuation features or into existing watercourses.

The existing onsite and offsite overland flow routes are shown on drawing No.647-P-011 Site Survey & Hydrology" contained within Appendix B. The post development flood exceedance routing is shown on drawing No. 647-P-010 "SuDS Strategy" enclosed within Appendix E.

The surface water drainage system has been designed to cater for the 1 in 100 year plus 45% climate change without flooding occurring. In the unlikely event that a sewer becomes blocked, or fails or the capacity exceeded the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties. Drawing No. 647-010 "SuDS Strategy" contained within Appendix E shows indicative Strategic flood

routes and how any flood water will be directed towards proposed SuDS features or public open space. A suitably worded condition can be used to secure this surface water construction stage management if necessary.

It is important to note that the proposed flood routes would only come in to use in extreme and exceptionally rare storm events.

6. SuDS Details

6.1. Attenuation Pond Design

Attenuation Pond Layout

The attenuation pond layout and location is shown on drawing number 647-P-010 “SuDS Strategy” enclosed within Appendix E.

An example of an attenuation pond designed by Phoenix Design Partnership is shown in the photograph below. The attenuation pond for this application site will be similar



Attenuation Pond Design

The pond has been designed to provide storage and treatment to the surface water run-off from the proposed development.

To provide treatment to the surface water run-off from the development and remove pollutants prior to discharge to the downstream receiving waters, the pond will have a 0.7m deep permanent pool of water. The combination of the permanent pool and the use of at source SuDS means that the proposed water quality treatment is in accordance with the recommendations in C753 ‘The SuDS Manual’; refer to Section 7 for further details.

Pond Edge Geometry

The pond has been designed with bank slope of 1 in 3 for safety and maintenance purposes in accordance with Ciria C753 “The SuDS Manual”. The pond will have a 2m wide shallow zone with 1:13 slope (aquatic bench) along the edge of the permanent pool to support wetland planting which will act as a biological filter and safety margin. The pond will provide ecology, amenity and biodiversity benefits and will add to the aesthetics of the open space.

Landscaping

The landscaping and aquatic planting for the pond will be designed by the Landscape Architect to provide a diversity of plant species to enhance visual interest and provide a variety of wildlife habitats.

Pond Access

Vehicle access to the pond will be via the new development roads. A 3m wide grassed maintenance strip will be provided around the perimeter of the pond to allow routine maintenance activities and inspections to be carried out.

Health and Safety

Fencing would isolate the pond and reduce its amenity benefit. Barrier planting and landscaping will therefore be used to discourage public access to the open areas of water.

Safety signage and information boards can be provided around the perimeter to improve awareness, discourage unauthorised access and to inform the public of the potential danger, and the purpose and benefits of the pond.

Fencing or guarding will be provided around any structures such as headwalls where there is a vertical drop of 600mm or more.

6.2. Bioretention Systems

Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce run-off rates and volumes, and treat pollution through the use of engineered soils and vegetation. They are particularly effective in delivering interception and can be an attractive landscape feature and also provide habitat and biodiversity. The below picture shows a rain garden taking surface water run-off from an adjacent highway.

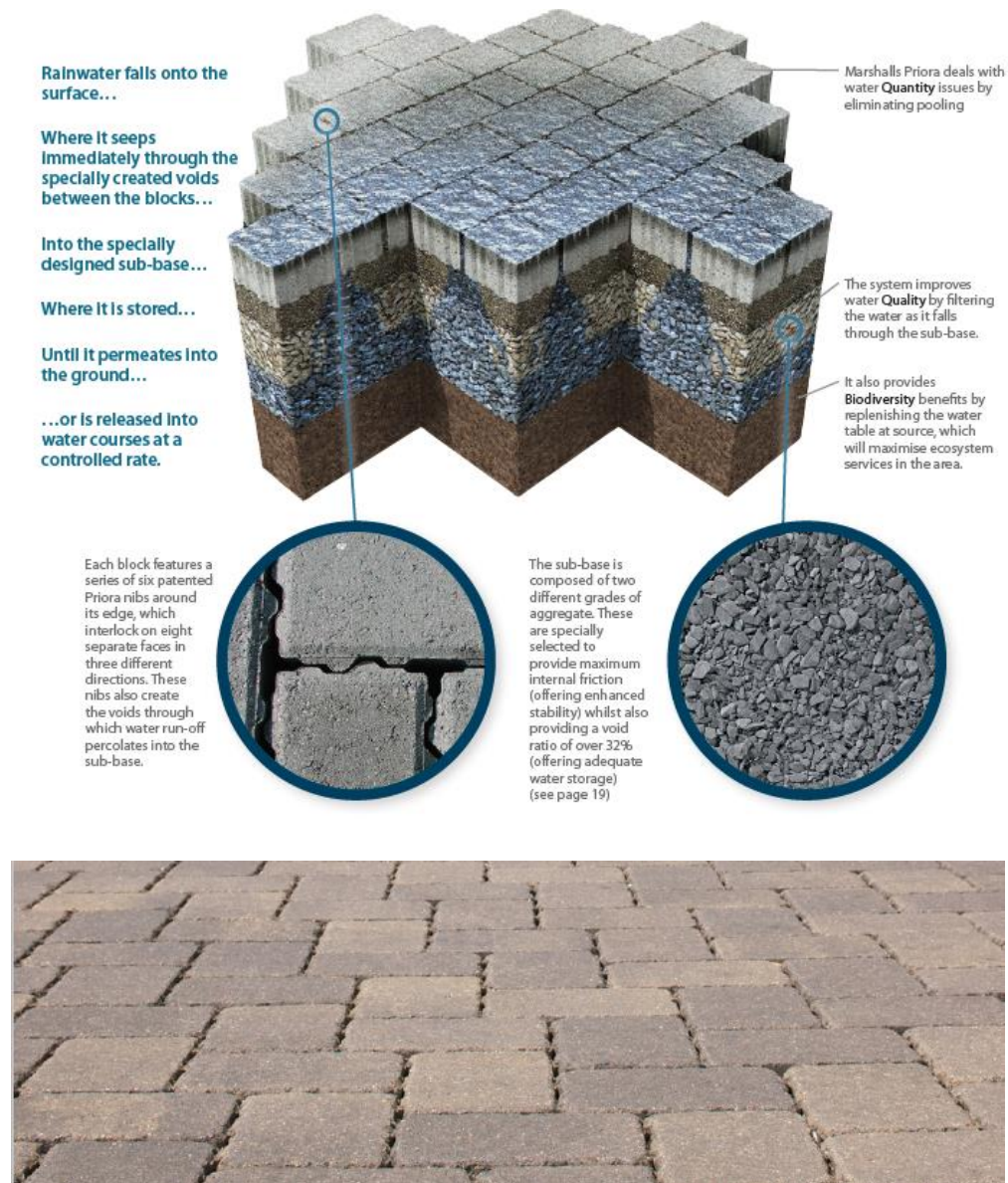


Swales / Rain Gardens have been incorporated with the SuDS for the site and has been designed to take direct run-off from the highway.

6.3. Pervious Pavements

Pervious pavements provide a pavement suitable for pedestrian and/or vehicle traffic, whilst allowing rainwater to infiltrate through the surface and into the underlying structural layer. The water is temporarily stored beneath the overlying surface before either infiltrating into the ground, or controlled discharge downstream. Permeable block paving and porous asphalt concrete are typical examples of pervious paving.

The picture below shown typical construction detail for permeable block paving:-



Permeable paving is a very efficient SuDS feature for managing surface water run-off close to its source by intercepting run-off, reducing the volume and frequency of run-off, and providing a treatment medium. Any pollutants will be filtered through the gravel/stone construction and provide treatment for the surface water, using the natural process of sedimentation, filtration, adsorption and biological degradation.

One of the highest risks of pollution within residential/commercial developments is from vehicles, particularly stationary ones. The use of permeable paving for parking areas is therefore very effective in dealing with any localised incidents and removing pollutants at source. Therefore, large parking areas, courtyards and private driveways will be constructed using pervious paving.

The photograph below shows an example of oil leaking from a parked car which is collected by the adjacent road gully. In this instance, this road gully outfalls directly into a main river (River Avon). This is the type of pollution permeable paving is very efficient in dealing with at source, ensuring that the water quality within the downstream watercourse is not affected and the water framework objectives are not compromised.



6.4. Swales

These are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water run-off. When incorporated into the site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths or car parks and can replace conventional pipework as a means of conveying run-off and the use of adjacent filter strips can also remove the need for kerbs and gullies.

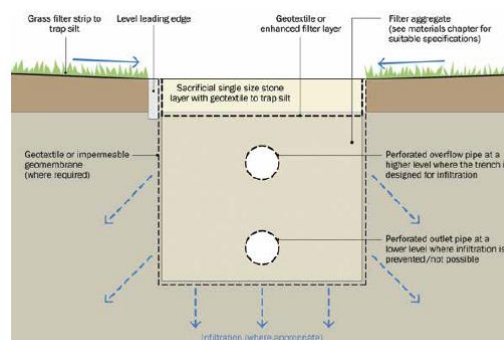
An example of an swale designed by Phoenix design Partnership is shown in the photograph below. The swales for this application site will be similar.



Swales have been incorporated with the SuDS for the site and has been designed to take direct run-off from the highway and maintain greenfield run-off.

6.5. Filter Drains

Filter drains are shallow trenches filled with stone/gravel with a perforated pipe near the base of the stone. Filter drains create temporary sub-surface storage for attenuation, conveyance and filtration of surface water run-off, depending of soil conditions. This SuDS component can help reduce pollutants levels in run-off by filtering out fine sediments, metals, hydrocarbons and other pollutants. They also encourage absorption and biodegradation processes.



Filter Drains have been provided under all permeable paving areas.

6.6. Conveyance Ditch / Channel

Similar to swales, but much deeper flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water run-off. When incorporated into the site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths or car parks and can replace conventional pipework as a means of conveying run-off.

An example of an a recently constructed conveyance ditch / channel (not yet fully established due to recent construction) designed by Phoenix design Partnership is shown in the photograph below.



A conveyance ditch has been designed to collect the restricted surface water discharge from the pond and outfall into Abberd Brook.

7. Water Quality

The Water Framework Directive objective is to achieve good status for all watercourses by 2027. SuDS will be used to ensure that the proposed development will not result in deterioration in the status of the watercourses or compromise the WFD objectives.

The proposed development will include roads, hard standings, roofs and landscaped areas. Run-off from roofs is unlikely to contain significant pollution. Run-off from roads and hard standings will pick up fuel, oil, heavy metals, rubbish and other pollutants. Run-off from landscaped areas could include pesticides and fertilisers.

Higher concentration of pollutants occurs in the early stages of a storm event known as the 'first flush' and is due to higher initial rainfall intensities, greater erosion potential and to greater solids and pollutants that have built up on urban surfaces during preceding dry weather. To remove pollution guidance recommends that the run-off from small frequent events and the initial run-off (first flush) from larger and rarer events is captured and treated using SuDS.

The main techniques used to remove pollutants are filtration and detention. Improvements to water quality can be achieved by filtering the run-off (particularly for small frequent events) using a variety of media such as gravels (permeable paving and filter trenches), grass/vegetation (swales, basins). Storing run-off with controlled discharges allows sedimentation to take place which also contributes to water quality improvements.

The following SuDS techniques will be used within the proposed development to help remove pollution:

Trapped Gullies (Access Roads, Drives and Parking Areas) – Sedimentation.

Attenuation Pond – Filtration through aquatic planting & sedimentation.

Swales – Filtration & sedimentation.

Filter Drains: (Roofs, Drives & Parking Areas) – Filtration.

Ditches: Conveyance, Filtration & sedimentation.

Permeable Paving - sedimentation, filtration, adsorption and biological degradation.

During construction there is also an increased risk of pollution particularly from silt and sediment. Temporary pre-treatment might be needed prior to discharge to the main drainage system. Areas of permeable or porous construction will also need to be protected from silt during construction. There is also an increased risk in run-off during the construction phase due to topsoil strip. The contractor will comply with current guidance and good construction practice to ensure that the risk of pollution is managed, details will be agreed with the appropriate approving body. Where required additional measures such as silt screens/fences, silt removal devices such as 'Siltbuster' settlement units can be used to provide further protection. The applicant would welcome a construction stage water management plan condition to ensure that run off and pollution measures are agreed with the LLFA and Land Drainage Officers in advance of a site start.

Prior to completion and handover of the SuDS features to the management body or purchaser excess silt resulting from construction will be removed and any remedial works required carried out to ensure that the features will operate effectively.

Ciria C753, Chapter 26 provides guidance on Water Quality Management: Design Methods. The SuDS pollution mitigation index should equal or exceed the pollution hazard index. Tables 26.2 and 26.3 below provide details of the indices.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

Type of SuDS component	Mitigation indices ¹		
	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4 ²	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond ⁴	0.7 ²	0.7	0.5
Wetland	0.8 ²	0.8	0.8
Proprietary treatment systems ^{3,4}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

The table below summarizes the Indices for the proposed development.

Pollution Hazard Indices for the Site

Land Use	Total Suspended Solids	Metals	Hydrocarbons
Pollution Index (Residential Roofs)	0.2	0.2	0.05
Pollution Index (Driveways, Residential Roads)	0.5	0.4	0.4

SuDS Mitigation Indices Provided

Type of SuDS Component	Total Suspended Solids	Metals	Hydrocarbons
Filter Drains	0.4	0.4	0.4
Pervious Pavement	0.7	0.6	0.7
Bio Retention System	0.8	0.8	0.8
Attenuation Pond (Permanent pool)	0.7	0.7	0.5
Swale	0.5	0.6	0.6

All surface water run-off from the site will pass through an attenuation pond and therefore this SuDS component alone provides adequate pollution mitigation for the whole of the site. Additional SuDS components have be incorporated with the SuDS Strategy for the site to provide a treatment train approach to water treatment in accordance with Ciria C753 guidance.

8. MANAGEMENT & MAINTENANCE

8.1. General

The table below lists the proposed drainage and anticipated Maintenance / Management responsibilities.

Drainage Feature	Management and Maintenance Responsibility
Sewers (Foul & Surface Water).	Wessex Water or other approved Water/Sewerage Undertaker.
Attenuation Pond, Inlet & Outlet Headwalls, Flow Controls, outfall channel and outfall to the watercourse.	Wessex Water or other approved Water/Sewerage Undertaker, other Public Body, or a Private Management Company with appropriate experience.
Highway Drains and Gullies	Wiltshire Council Highways.
Drainage for buildings, drives, parking areas, landscaping, etc. in private ownership	The owners where in sole ownership will be responsible for private drainage etc etc. For any communal features, this will be maintained by a Private Management Company

The exact maintenance regime will be confirmed although it is likely it will be similar to that recommended by the SUDS manual.

TABLE 32.1 Typical key SuDS components operation and maintenance activities (for full specifications, see Chapters 11–23)

Operation and maintenance activity	SuDS component											
	Pond	Wetland	Detention basin	Infiltration basin	Soakaway	Infiltration trench	Filter drain	Modular storage	Pervious pavement	Swale/bioretention/trees	Filter strip	Green roofs
Regular maintenance												
Inspection	■	■	■	■	■	■	■	■	■	■	■	■
Litter and debris removal	■	■	■	■	□	■	■	□	■	■	■	□
Grass cutting	■	■	■	■	□	■	■	□	□	■	■	
Weed and invasive plant control	□	□	□	□		□	□		□		□	■
Shrub management (including pruning)	□	□	□	□					□	□	□	
Shoreline vegetation management	■	■	□									
Aquatic vegetation management	■	■	□									
Occasional maintenance												
Sediment management ¹	■	■	■	■	■	■	■	■	■	■	■	■
Vegetation replacement	□	□	□	□						□	□	■
Vacuum sweeping and brushing									■			
Remedial maintenance												
Structure rehabilitation /repair	□	□	□	□	□	□	□	□	□	□	□	□
Infiltration surface reconditioning				□	□	□	□		□	□	□	

Key

■ will be required

□ may be required

8.2. Attenuation Pond

TABLE 23.1 Operation and maintenance requirements for ponds and wetlands

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (during growing season)
	Cut the meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices, eg penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1 m above water level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay.	Every 1–5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays.	Every 5 years, or as required
Occasional maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, eg every 25–50 years
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair / rehabilitate inlets, outlets and overflows.	As required

8.3. Bioretention Systems

TABLE 18.3 Operation and maintenance requirements for bioretention systems		
Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

8.4. Pervious Pavements

TABLE 20.15 Operation and maintenance requirements for pervious pavements		
Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

8.5. Swales & Conveyance Ditch / Channel

TABLE 17.1 Operation and maintenance requirements for swales

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeded	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

8.6. Filter Drains

TABLE 16.1 Operation and maintenance requirements for filter drains

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

8.7. Management & Maintenance Plan

A Management and Maintenance Plan will be produced for agreement with the LPA identifying ownership and maintenance responsibilities for the drainage system to ensure that it will be maintained and will operate effectively for the lifetime of the development.

9. CONCLUSIONS

- 9.1.** This site specific FRA has been produced in accordance with the requirements of the National Planning Policy Framework document, Planning Practice Guidance, and Environment Agency advice notes, and demonstrates that the proposed development will be safe from flood risk and that it will not increase flood risk elsewhere.
- 9.2.** According to the Environment Agency 2025 flood map for planning included in section 4.2.1, the majority of the application site to be located entirely within Flood Zone 1 (low probability of flooding having a less than 1 in 1,000 annual probability of fluvial flooding).

The land immediately adjacent to Abberd Brook lies within Flood Zones 2 & 3 associated with flooding from this River.

This area will not be developed and will form part of the public open space. All habitable built development will be located within Flood Zone 1 in accordance with the NPPF sequential approach.

The EA flood mapping has now been superseded by hydraulic modelling of Abberd Brook, refer to paragraph 9.4 below.

- 9.3.** The North Wiltshire and Wiltshire Council Strategic Flood Risk Assessments have assessed the risk of flooding from Fluvial (rivers), Tidal (sea), groundwater, surface water, sewers and impounded water bodies (reservoirs and canals). The extent of flooding has been reproduced on flood maps for the Council study area. A review of the SFRA maps and report for the proposed development site area has been carried out and commensurate to that shown on Environment Agency flood mapping.

The SFRA flood mapping has now been superseded by hydraulic modelling of Abberd Brook, refer to paragraph 9.4 below.

- 9.4.** Due to new rainfall data and flood maps being released in March 2025, new hydraulic modelling of the Abberd Brook and culvert has been carried out to accurately identify the surface water flood risk from this river as part of this FRA. Therefore, the flood levels / flood extents obtained from the 2025 hydraulic modelling will be used, refer section 4.3 of this report for further details. The modelled flood outline is shown on the drawing No. 647-P-010 –SuDS Strategy contained within Appendix E.

To provide additional flood resilience to the proposed residential development now and in the future, and provide safe access and egress to the development, the flood outline for the 1 in 1000yr storm event has been offset by a minimum of 0.5m and the ground raised by 600mm above the 1 in 1000yr flood level. This level will be the minimum level for roads. Finished floor levels (FFL) for houses will be set a minimum of 150mm above road level and therefore the minimum FFL will be at least 750mm above the 1:1000yr flood level. Indicative Finished floor levels (FFL) for houses are shown on drawing No. 647-P-010 –SuDS Strategy. The FFL vary between 74.50mAOD and 73.00mAOD which equates to 1.27m and 1m above the relevant adjacent 1:1000yr flood level.

- 9.5.** Flood risk from all other sources (pluvial, sewers, groundwater, and artificial) has been assessed and it has been demonstrated that the proposed development will not be at risk from flooding from these sources.

- 9.6.** A surface water drainage strategy has been developed that incorporates a Sustainable Drainage System (SuDS) and is shown on drawing No. 647-P-010 – SuDS Strategy contained within Appendix E. The proposed SuDS will ensure that flood risk resulting from pluvial events (rainfall) will be managed on-site and that flood risk will not be increased elsewhere as a result of the development. The restricted surface water flows from the attenuation pond will discharge into Abberd Brook, replicating the existing natural drainage pattern for the site.
- 9.7.** To mitigate for the additional surface water run-off volume resulting from the proposed development the EA/Defra and Ciria guidance together with BS8582 recommends that extended attenuation Storage is provided and that surface water run-off is restricted to the existing Mean Annual Flood Flow (Qbar, 1:2.3 event) green-field rate for all events up to the 1:100 with allowance for climate change. This approach ensures that sufficient run-off is retained on site for extreme events to protect the receiving water course in times of flooding. However, in order to meet Wilshire Council Drainage and Betterment Strategy, the post development discharge rates will need to have 30% betterment over pre-development discharges for all storms events between the 1 in 1 year and 1 in 100 year storm return periods. To meet this criteria the surface water discharge rate has been set to 2.5 l/s for all storm return periods from the 1 in year up to and including the 1 in 100 year + 45% CC.
- The coefficient of run-off (CV Value) has also been set to 1 in accordance with Wilshire Council Drainage and Betterment Strategy.
- 9.8.** A 45% allowance in accordance with Environment Agency guidance for climate change has been included in the SuDS design to take in to account the predicted increase in rainfall intensity over the 100 year design life of the development.
- 9.9.** Micro-drainage has been used for the design of the proposed SuDS. The results of the modelling are contained within Appendix F and summarised in section 5.3.6. The results show that surface water run-off from the proposed development will be less than the 30% betterment over pre-development discharges for all storms events between the 1 in 1 year and 1 in 100 year + 45%CC storm return periods.
- 9.10.** The proposed SuDS will provide treatment to the surface water run-off from the development and follows the SuDS treatment train approach with all areas receiving significantly greater treatment than the recommended level in accordance with guidance provided in Ciria C753, 'The SuDS Manual'. The proposals will ensure that there is no adverse effect on the downstream watercourses.
- 9.11.** The proposed foul drainage strategy is shown on drawing number 647-P-010 – "SuDS Strategy" enclosed within Appendix E.

The nearest public foul sewer to the application site is a 375mm diameter pipe located in Spitfire road immediately to the east of the site. This sewer drains to an existing adjacent foul pumping station. This sewer and pumping station is owned and maintained by Wessex Water.

The whole of the application site has therefore been designed to drain by gravity and connect to the existing 375mm diameter foul sewer in Spitfire road. This connection point including calculated flows will need to be agreed with Wessex Water.

Section 106 of the Water Industry Act 1991 (as amended) secures the right for a developer to connect to a public sewer. Any upgrades works required to public sewers, pumping stations and Water Treatment Works to cater for the future development will be provided by Wessex Water and included within their Asset Management Plan (AMP), once the proposed development is granted planning permission.

- 9.12.** Flood routes have been provided for exceedance events or for local failure of the drainage system and will ensure that flood flows are directed safely through the development to the downstream attenuation features or Public Open Space Areas.
- 9.13.** The proposed Sustainable Drainage System for the development will be managed and maintained to ensure that it will operate effectively for its lifetime and has been discussed in detail within section 8 of this report.
- 9.14.** The Flood Risk Assessment and Drainage Strategy demonstrates that the proposed development meets with all the national and regional policy requirements, and satisfies all the criteria of the Wiltshire Council, LLFA & Environment Agency.
- 9.15.** The Flood Risk Assessment concludes that the site can be safely developed without flood risk and without increasing flood risk elsewhere through the use of an appropriately designed Sustainable Drainage System.

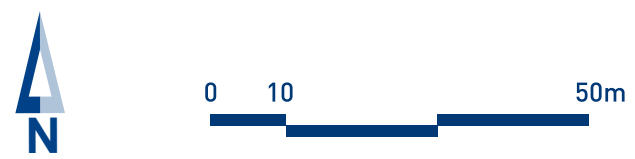
Appendix A

Drawing:

381.UD.01 - Illustrative Masterplan



- KEY**
- SITE ACCESS
 - DWELLINGS
 - EXISTING VEGETATION
 - PROPOSED STREET TREE
 - PROPOSED AMENITY TREE
 - PRIVATE DRIVEWAY
 - INDICATIVE SUDS
 - INFORMAL FOOTPATH
 - INTERNAL ROAD
 - PLAY AREA



Site Name: LAND EAST OF SPITFIRE ROAD		Drawing Number: 381.UD.01		Revision: G	 Robert Hitchins The Complete Development Solution The Manor, Boddington, Cheltenham, Gloucestershire, GL51 0TJ Tel: 01242 680694 www.robert-hitchins.co.uk
Drawing Title: ILLUSTRATIVE MASTERPLAN		Drawn By: LD	Checked By: GRJ	Date: 19/06/25	

Appendix B

Drawing:

647-P-011- Site Survey & Hydrology



- LEGEND**
- EXISTING WATERCOURSE & DIRECTION OF FLOW
 - DIRECTION OF GROUND SLOPE & OVERLAND FLOOD ROUTES
 - EXISTING ATTENUATION POND
 - EXISTING SURFACE WATER SEWER
 - EXISTING FOUL SEWER
 - EXISTING SURFACE WATER CULVERTS
 - EXISTING CONTOURS
 - APPLICATION BOUNDARY

Revisions

Project:	Land East of Spitfire Road Calne, Wiltshire		
Client:	Robert Hitchens		
Drawing:	Site Survey & Hydrology	Date:	19/02/2025
Scale:	1:500 @ A0	Drawn by:	MJH
Drawing No:	647-P-011	Rev:	

PHOENIX DESIGN
Partnership Ltd.
Unit 5, Wilmsey Garage,
Newbury, South, RG2 2PH
Tel: 01753 479262
email: enquiries@phoenixdesign.co.uk
www.phoenixdesign.co.uk

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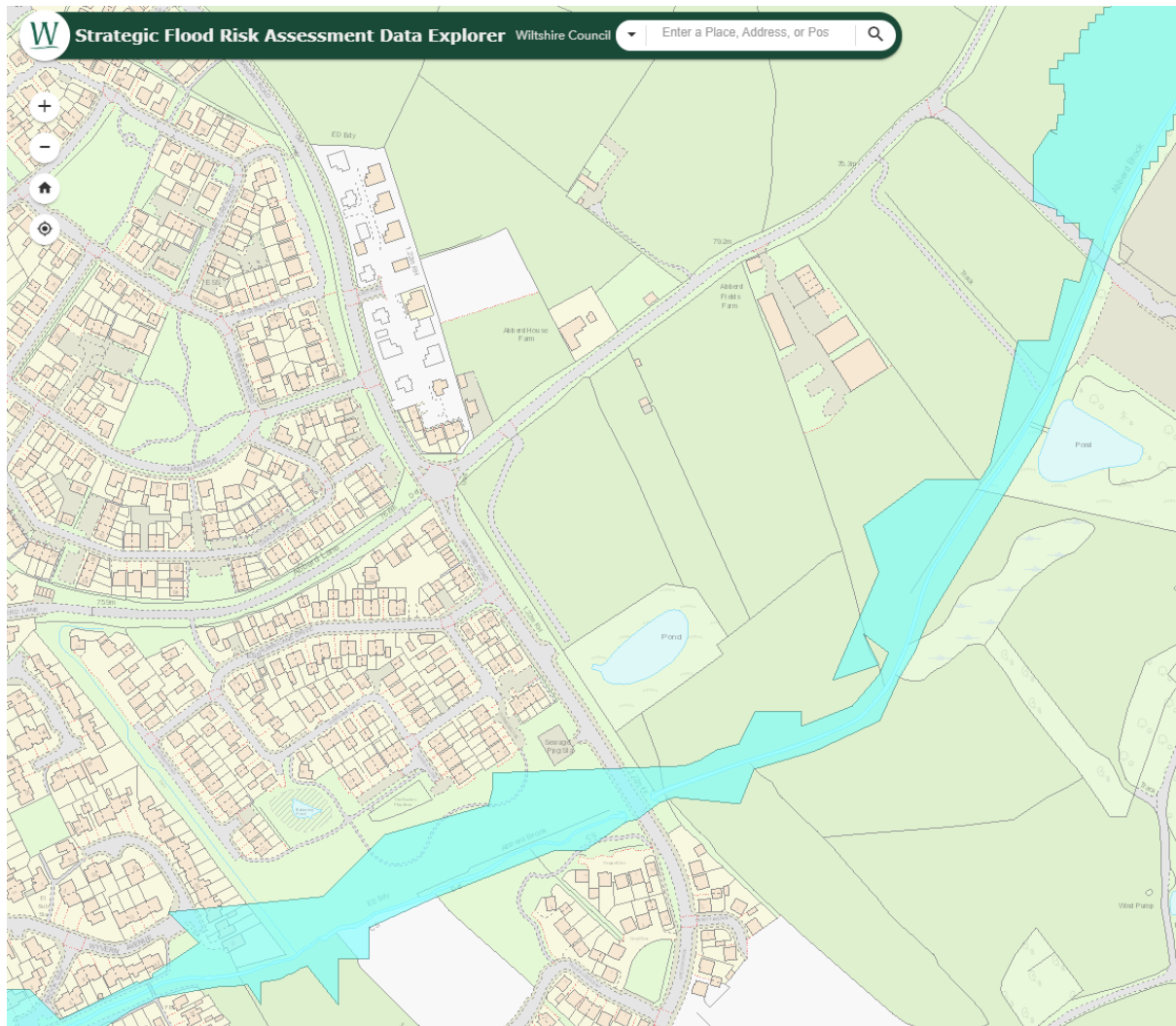
Dwg Status: **PLANNING**

Appendix C

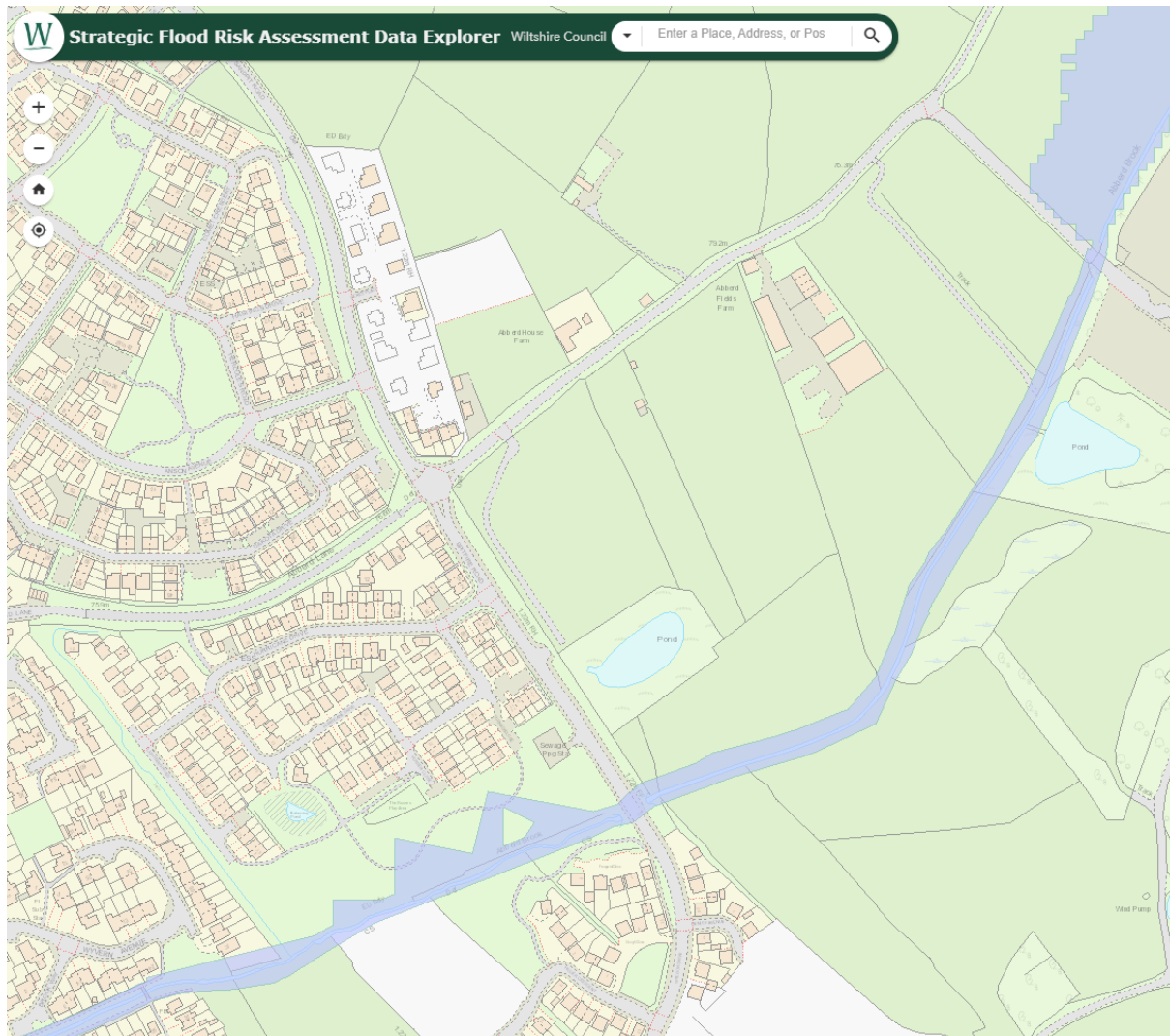
SFRA Mapping

Wiltshire SFRA Flood Mapping

Flood Zone 2 Extents



Flood Zone 3 Extents



Appendix D

Greenfield Runoff Calculations

Phoenix Design Partnership Ltd		Page 1
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN	Existing Greenfield Run-off Calne Phase 6A	
Date 24/02/2025 14:37	Designed by Mark	
File	Checked by	
Innovyze		Source Control 2020.1.3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	SAAR (mm)	800	Urban	0.000
Area (ha)	1.000	Soil	0.450	Region Number	Region 8

Results 1/s

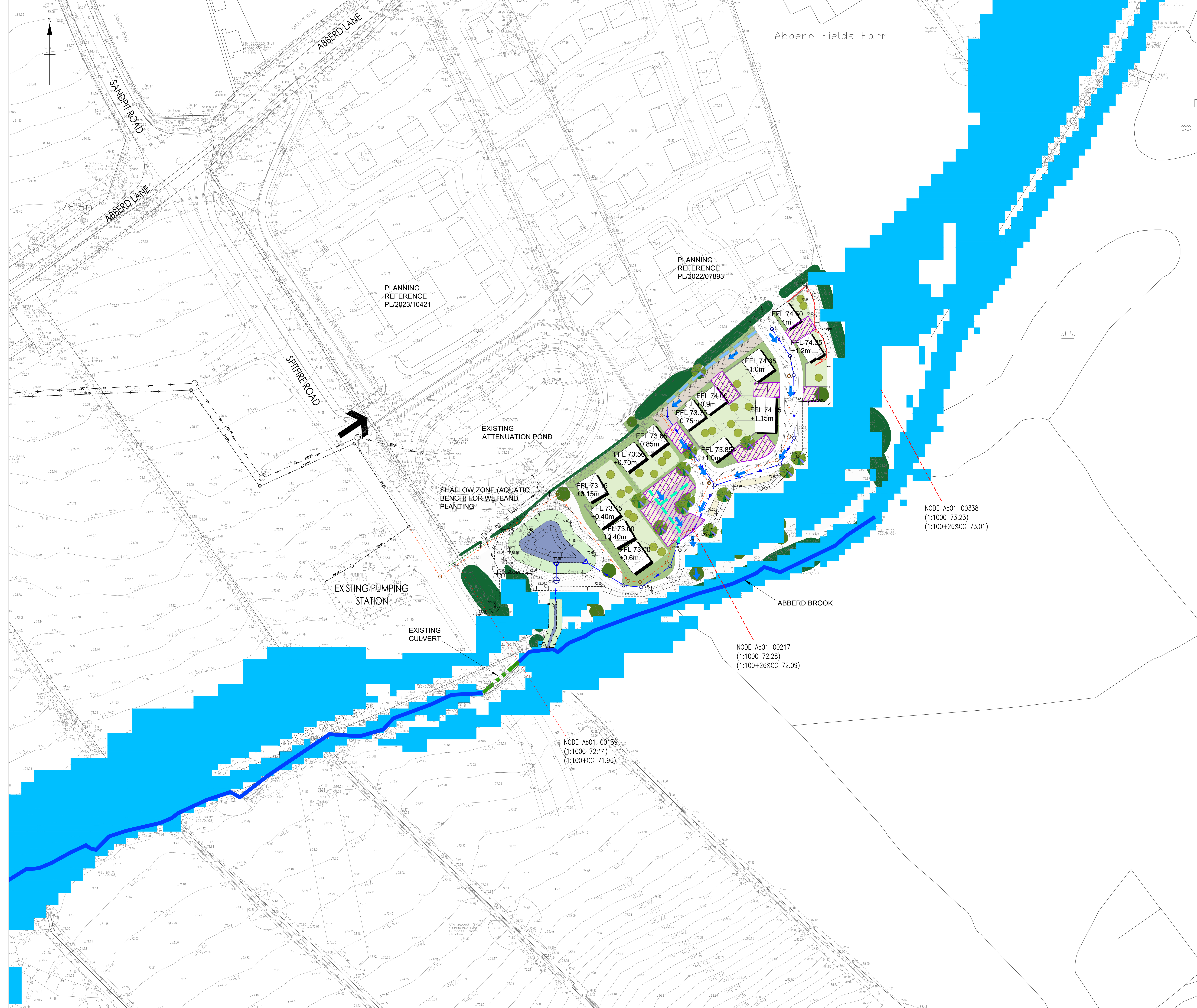
QBAR Rural	5.1
QBAR Urban	5.1
Q100 years	12.4
Q1 year	4.0
Q30 years	9.8
Q100 years	12.4

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Appendix E

Drawing:

647-P-010 – SuDS Strategy



- LEGEND**
- EXISTING WATERCOURSE (ABBERD BROOK)
 - MODELLED 1:1000 YEAR FLOOD LEVEL EXTENTS
 - EXISTING SURFACE WATER SEWER
 - EXISTING FOUL SEWER
 - EXISTING CULVERT
 - INDICATIVE SURFACE WATER SEWER
 - INDICATIVE FOUL SEWER
 - INDICATIVE SWALE
 - PROPOSED PERMEABLE PAVING
 - INDICATIVE FILTER DRAIN
 - ON-SITE FLOOD EXCEEDANCE ROUTE
 - PROPOSED ATTENUATION POND
 - CONVEYANCE DITCH / OUTFALL CHANNEL
 - FFL 73.700 +150mm INDICATIVE FINISHED FLOOR LEVEL AND HEIGHT ABOVE EXISTING GROUND LEVEL
 - INDICATIVE RETAINING WALL AND HEIGHT

PLANNING REFERENCE PL/2022/07893

PLANNING REFERENCE PL/2023/10421

EXISTING ATTENUATION POND

SHALLOW ZONE (AQUATIC BENCH) FOR WETLAND PLANTING

EXISTING PUMPING STATION

EXISTING CULVERT

ABBERD BROOK

NODE Ab01_00338
(1:1000 73.23)
(1:100+26%CC 73.01)

NODE Ab01_00217
(1:1000 72.28)
(1:100+26%CC 72.09)

NODE Ab01_00139
(1:1000 72.14)
(1:100+CC 71.96)

Revisions

Project:	Calne Phase 6A
Client:	Spitfire Road, Calne, Wiltshire

Drawing: SuDS Strategy

Scale: 1:500 @ A0 Date: 19/10/2025 Drawn by: MJH

Drawing No: 647-P-010 Rev:

PHOENIX DESIGN
Partnership Ltd.
Unit 9, Westway Garage,
Mansbury, Bath, BA2 9RN
Tel: 01225 070900
Email: enquiries@phoenixdesign.co.uk
www.phoenixdesign.co.uk

Team House, Lanes Road,
Cirencester, Gloucestershire, GL7 1JH
Tel: 01295 444771

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Dwg Status: PLANNING

Appendix F

Micro-Drainage Simulations

Phoenix Design Partnership Ltd		Page 1
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN	Calne Attenuation Pond MD Simulations	
Date 23/06/2025 13:03	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze		Source Control 2020.1.3

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.416

Time (mins)	Area
From:	To: (ha)
0	4 0.416

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Phoenix Design Partnership Ltd		Page 2
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN	Calne Attenuation Pond MD Simulations	
Date 23/06/2025 13:03	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 72.650

Tank or Pond Structure

Invert Level (m) 71.150

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	268.0	1.500	640.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-CHE-0069-2500-1200-2500
Design Head (m)	1.200
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	No
Diameter (mm)	69
Invert Level (m)	71.150
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.5	Kick-Flo®	0.238	1.2
Flush-Flo™	0.167	2.0	Mean Flow over Head Range	-	1.8

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)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.5	3.000	3.9	7.000	5.9
0.200	1.5	1.400	2.7	3.500	4.2	7.500	6.1
0.300	1.3	1.600	2.9	4.000	4.5	8.000	6.3
0.400	1.5	1.800	3.1	4.500	4.8	8.500	6.5
0.500	1.6	2.000	3.2	5.000	5.0	9.000	6.7
0.600	1.8	2.200	3.4	5.500	5.3	9.500	6.9
0.800	2.1	2.400	3.5	6.000	5.5		
1.000	2.3	2.600	3.7	6.500	5.7		

Phoenix Design Partnership Ltd					Page 1
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 12:58		Designed by MJH			
File Attenuation Pond.SRCX		Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+45%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	71.639	0.489	2.0	155.7	O K
30 min Summer	71.762	0.612	2.0	203.3	O K
60 min Summer	71.878	0.728	2.0	251.3	O K
120 min Summer	71.982	0.832	2.1	297.4	O K
180 min Summer	72.035	0.885	2.2	321.5	O K
240 min Summer	72.066	0.916	2.2	336.5	O K
360 min Summer	72.108	0.958	2.2	356.7	O K
480 min Summer	72.132	0.982	2.3	368.4	O K
600 min Summer	72.146	0.996	2.3	375.2	O K
720 min Summer	72.153	1.003	2.3	378.9	O K
960 min Summer	72.156	1.006	2.3	380.3	O K
1440 min Summer	72.139	0.989	2.3	371.8	O K
2160 min Summer	72.109	0.959	2.2	356.9	O K
2880 min Summer	72.078	0.928	2.2	342.2	O K
4320 min Summer	72.020	0.870	2.1	314.7	O K
5760 min Summer	71.966	0.816	2.1	289.9	O K
7200 min Summer	71.914	0.764	2.0	267.0	O K
8640 min Summer	71.866	0.716	2.0	246.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	150.938	0.0	124.5	19	
30 min Summer	98.983	0.0	129.7	34	
60 min Summer	61.738	0.0	249.6	64	
120 min Summer	37.127	0.0	282.7	124	
180 min Summer	27.171	0.0	286.1	184	
240 min Summer	21.657	0.0	292.8	242	
360 min Summer	15.750	0.0	306.1	362	
480 min Summer	12.545	0.0	314.4	482	
600 min Summer	10.508	0.0	319.8	602	
720 min Summer	9.088	0.0	323.4	722	
960 min Summer	7.221	0.0	327.1	960	
1440 min Summer	5.214	0.0	326.0	1282	
2160 min Summer	3.758	0.0	556.5	1640	
2880 min Summer	2.976	0.0	572.4	2020	
4320 min Summer	2.139	0.0	545.0	2856	
5760 min Summer	1.691	0.0	674.5	3688	
7200 min Summer	1.408	0.0	701.9	4472	
8640 min Summer	1.212	0.0	724.7	5280	
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Phoenix Design Partnership Ltd				Page 2	
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 12:58		Designed by MJH			
File Attenuation Pond.SRCX		Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+45%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	71.819	0.669	2.0	226.5	O K
15 min Winter	71.639	0.489	2.0	155.7	O K
30 min Winter	71.762	0.612	2.0	203.3	O K
60 min Winter	71.878	0.728	2.0	251.4	O K
120 min Winter	71.983	0.833	2.1	297.8	O K
180 min Winter	72.036	0.886	2.2	322.0	O K
240 min Winter	72.068	0.918	2.2	337.3	O K
360 min Winter	72.111	0.961	2.2	357.8	O K
480 min Winter	72.135	0.985	2.3	369.8	O K
600 min Winter	72.150	1.000	2.3	377.2	O K
720 min Winter	72.158	1.008	2.3	381.4	O K
960 min Winter	72.164	1.014	2.3	384.1	O K
1440 min Winter	72.150	1.000	2.3	377.1	O K
2160 min Winter	72.113	0.963	2.3	359.1	O K
2880 min Winter	72.077	0.927	2.2	341.4	O K
4320 min Winter	71.999	0.849	2.1	305.0	O K
5760 min Winter	71.923	0.773	2.0	271.0	O K
7200 min Winter	71.851	0.701	2.0	240.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
10080 min Summer	1.068	0.0	744.0	6056	
15 min Winter	150.938	0.0	124.5	19	
30 min Winter	98.983	0.0	129.7	34	
60 min Winter	61.738	0.0	249.6	64	
120 min Winter	37.127	0.0	282.6	122	
180 min Winter	27.171	0.0	285.9	180	
240 min Winter	21.657	0.0	292.6	240	
360 min Winter	15.750	0.0	305.8	356	
480 min Winter	12.545	0.0	313.9	472	
600 min Winter	10.508	0.0	319.3	588	
720 min Winter	9.088	0.0	322.7	702	
960 min Winter	7.221	0.0	326.1	926	
1440 min Winter	5.214	0.0	324.4	1356	
2160 min Winter	3.758	0.0	556.3	1688	
2880 min Winter	2.976	0.0	571.3	2160	
4320 min Winter	2.139	0.0	545.1	3068	
5760 min Winter	1.691	0.0	674.5	3928	
7200 min Winter	1.408	0.0	701.9	4824	
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Phoenix Design Partnership Ltd		Page 3
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN	Calne Attenuation Pond MD Simulations	
Date 23/06/2025 12:58	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze	Source Control 2020.1.3	

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Winter	71.783	0.633	2.0	211.6	O K
10080 min Winter	71.718	0.568	2.0	185.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Winter	1.212	0.0	724.7	5624
10080 min Winter	1.068	0.0	744.1	6456

Phoenix Design Partnership Ltd				Page 1	
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 13:01 File Attenuation Pond.SRCX		Designed by MJH Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	71.503	0.353	2.0	107.2	O K
30 min Summer	71.595	0.445	2.0	139.8	O K
60 min Summer	71.683	0.533	2.0	172.4	O K
120 min Summer	71.762	0.612	2.0	203.1	O K
180 min Summer	71.800	0.650	2.0	218.7	O K
240 min Summer	71.823	0.673	2.0	228.0	O K
360 min Summer	71.851	0.701	2.0	239.7	O K
480 min Summer	71.865	0.715	2.0	245.5	O K
600 min Summer	71.871	0.721	2.0	248.1	O K
720 min Summer	71.872	0.722	2.0	248.6	O K
960 min Summer	71.865	0.715	2.0	245.8	O K
1440 min Summer	71.846	0.696	2.0	237.8	O K
2160 min Summer	71.816	0.666	2.0	225.3	O K
2880 min Summer	71.786	0.636	2.0	213.1	O K
4320 min Summer	71.730	0.580	2.0	190.4	O K
5760 min Summer	71.677	0.527	2.0	169.9	O K
7200 min Summer	71.627	0.477	2.0	151.3	O K
8640 min Summer	71.580	0.430	2.0	134.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	104.095	0.0	101.5	19	
30 min Summer	68.264	0.0	122.3	34	
60 min Summer	42.578	0.0	174.4	64	
120 min Summer	25.605	0.0	209.0	124	
180 min Summer	18.739	0.0	228.5	182	
240 min Summer	14.936	0.0	241.6	242	
360 min Summer	10.862	0.0	259.2	362	
480 min Summer	8.652	0.0	267.1	482	
600 min Summer	7.247	0.0	268.5	602	
720 min Summer	6.267	0.0	266.0	720	
960 min Summer	4.980	0.0	264.8	932	
1440 min Summer	3.596	0.0	266.2	1142	
2160 min Summer	2.592	0.0	386.2	1536	
2880 min Summer	2.053	0.0	407.2	1956	
4320 min Summer	1.475	0.0	433.3	2768	
5760 min Summer	1.166	0.0	465.1	3584	
7200 min Summer	0.971	0.0	484.0	4400	
8640 min Summer	0.836	0.0	499.7	5192	
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Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations																																																																																																																					
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<table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Control (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>10080 min Summer</td><td>71.536</td><td>0.386</td><td>2.0</td><td>118.8</td><td>O K</td></tr><tr><td>15 min Winter</td><td>71.503</td><td>0.353</td><td>2.0</td><td>107.1</td><td>O K</td></tr><tr><td>30 min Winter</td><td>71.595</td><td>0.445</td><td>2.0</td><td>139.8</td><td>O K</td></tr><tr><td>60 min Winter</td><td>71.683</td><td>0.533</td><td>2.0</td><td>172.4</td><td>O K</td></tr><tr><td>120 min Winter</td><td>71.762</td><td>0.612</td><td>2.0</td><td>203.4</td><td>O K</td></tr><tr><td>180 min Winter</td><td>71.801</td><td>0.651</td><td>2.0</td><td>219.1</td><td>O K</td></tr><tr><td>240 min Winter</td><td>71.824</td><td>0.674</td><td>2.0</td><td>228.6</td><td>O K</td></tr><tr><td>360 min Winter</td><td>71.853</td><td>0.703</td><td>2.0</td><td>240.6</td><td>O K</td></tr><tr><td>480 min Winter</td><td>71.868</td><td>0.718</td><td>2.0</td><td>246.9</td><td>O K</td></tr><tr><td>600 min Winter</td><td>71.875</td><td>0.725</td><td>2.0</td><td>249.9</td><td>O K</td></tr><tr><td>720 min Winter</td><td>71.877</td><td>0.727</td><td>2.0</td><td>250.9</td><td>O K</td></tr><tr><td>960 min Winter</td><td>71.873</td><td>0.723</td><td>2.0</td><td>249.1</td><td>O K</td></tr><tr><td>1440 min Winter</td><td>71.849</td><td>0.699</td><td>2.0</td><td>239.0</td><td>O K</td></tr><tr><td>2160 min Winter</td><td>71.813</td><td>0.663</td><td>2.0</td><td>224.1</td><td>O K</td></tr><tr><td>2880 min Winter</td><td>71.774</td><td>0.624</td><td>2.0</td><td>208.0</td><td>O K</td></tr><tr><td>4320 min Winter</td><td>71.694</td><td>0.544</td><td>2.0</td><td>176.7</td><td>O K</td></tr><tr><td>5760 min Winter</td><td>71.618</td><td>0.468</td><td>2.0</td><td>147.9</td><td>O K</td></tr><tr><td>7200 min Winter</td><td>71.542</td><td>0.392</td><td>2.0</td><td>120.6</td><td>O K</td></tr></table>						Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status	10080 min Summer	71.536	0.386	2.0	118.8	O K	15 min Winter	71.503	0.353	2.0	107.1	O K	30 min Winter	71.595	0.445	2.0	139.8	O K	60 min Winter	71.683	0.533	2.0	172.4	O K	120 min Winter	71.762	0.612	2.0	203.4	O K	180 min Winter	71.801	0.651	2.0	219.1	O K	240 min Winter	71.824	0.674	2.0	228.6	O K	360 min Winter	71.853	0.703	2.0	240.6	O K	480 min Winter	71.868	0.718	2.0	246.9	O K	600 min Winter	71.875	0.725	2.0	249.9	O K	720 min Winter	71.877	0.727	2.0	250.9	O K	960 min Winter	71.873	0.723	2.0	249.1	O K	1440 min Winter	71.849	0.699	2.0	239.0	O K	2160 min Winter	71.813	0.663	2.0	224.1	O K	2880 min Winter	71.774	0.624	2.0	208.0	O K	4320 min Winter	71.694	0.544	2.0	176.7	O K	5760 min Winter	71.618	0.468	2.0	147.9	O K	7200 min Winter	71.542	0.392	2.0	120.6	O K
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5760 min Winter	71.618	0.468	2.0	147.9	O K																																																																																																																		
7200 min Winter	71.542	0.392	2.0	120.6	O K																																																																																																																		
<table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>10080 min Summer</td><td>0.736</td><td>0.0</td><td>512.8</td><td>6048</td></tr><tr><td>15 min Winter</td><td>104.095</td><td>0.0</td><td>101.5</td><td>19</td></tr><tr><td>30 min Winter</td><td>68.264</td><td>0.0</td><td>122.3</td><td>33</td></tr><tr><td>60 min Winter</td><td>42.578</td><td>0.0</td><td>174.4</td><td>64</td></tr><tr><td>120 min Winter</td><td>25.605</td><td>0.0</td><td>209.0</td><td>122</td></tr><tr><td>180 min Winter</td><td>18.739</td><td>0.0</td><td>228.5</td><td>180</td></tr><tr><td>240 min Winter</td><td>14.936</td><td>0.0</td><td>241.6</td><td>238</td></tr><tr><td>360 min Winter</td><td>10.862</td><td>0.0</td><td>259.1</td><td>356</td></tr><tr><td>480 min Winter</td><td>8.652</td><td>0.0</td><td>266.8</td><td>470</td></tr><tr><td>600 min Winter</td><td>7.247</td><td>0.0</td><td>267.9</td><td>584</td></tr><tr><td>720 min Winter</td><td>6.267</td><td>0.0</td><td>265.1</td><td>698</td></tr><tr><td>960 min Winter</td><td>4.980</td><td>0.0</td><td>264.2</td><td>914</td></tr><tr><td>1440 min Winter</td><td>3.596</td><td>0.0</td><td>265.5</td><td>1170</td></tr><tr><td>2160 min Winter</td><td>2.592</td><td>0.0</td><td>386.2</td><td>1624</td></tr><tr><td>2880 min Winter</td><td>2.053</td><td>0.0</td><td>407.2</td><td>2076</td></tr><tr><td>4320 min Winter</td><td>1.475</td><td>0.0</td><td>434.0</td><td>2984</td></tr><tr><td>5760 min Winter</td><td>1.166</td><td>0.0</td><td>465.1</td><td>3864</td></tr><tr><td>7200 min Winter</td><td>0.971</td><td>0.0</td><td>484.0</td><td>4688</td></tr></table>						Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	10080 min Summer	0.736	0.0	512.8	6048	15 min Winter	104.095	0.0	101.5	19	30 min Winter	68.264	0.0	122.3	33	60 min Winter	42.578	0.0	174.4	64	120 min Winter	25.605	0.0	209.0	122	180 min Winter	18.739	0.0	228.5	180	240 min Winter	14.936	0.0	241.6	238	360 min Winter	10.862	0.0	259.1	356	480 min Winter	8.652	0.0	266.8	470	600 min Winter	7.247	0.0	267.9	584	720 min Winter	6.267	0.0	265.1	698	960 min Winter	4.980	0.0	264.2	914	1440 min Winter	3.596	0.0	265.5	1170	2160 min Winter	2.592	0.0	386.2	1624	2880 min Winter	2.053	0.0	407.2	2076	4320 min Winter	1.475	0.0	434.0	2984	5760 min Winter	1.166	0.0	465.1	3864	7200 min Winter	0.971	0.0	484.0	4688																			
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Date 23/06/2025 13:01	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze	Source Control 2020.1.3	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Winter	71.451	0.301	2.0	89.9	O K
10080 min Winter	71.305	0.155	2.0	44.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Winter	0.836	0.0	499.8	5624
10080 min Winter	0.736	0.0	513.0	5456

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Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 13:02 File Attenuation Pond.SRCX		Designed by MJH Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 30 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	71.428	0.278	2.0	82.2	O K
30 min Summer	71.500	0.350	2.0	106.3	O K
60 min Summer	71.570	0.420	2.0	130.5	O K
120 min Summer	71.633	0.483	2.0	153.5	O K
180 min Summer	71.665	0.515	2.0	165.5	O K
240 min Summer	71.684	0.534	2.0	172.8	O K
360 min Summer	71.707	0.557	2.0	181.6	O K
480 min Summer	71.718	0.568	2.0	185.7	O K
600 min Summer	71.722	0.572	2.0	187.2	O K
720 min Summer	71.721	0.571	2.0	187.1	O K
960 min Summer	71.715	0.565	2.0	184.7	O K
1440 min Summer	71.700	0.550	2.0	178.9	O K
2160 min Summer	71.675	0.525	2.0	169.3	O K
2880 min Summer	71.649	0.499	2.0	159.3	O K
4320 min Summer	71.598	0.448	2.0	140.6	O K
5760 min Summer	71.549	0.399	2.0	123.3	O K
7200 min Summer	71.504	0.354	2.0	107.5	O K
8640 min Summer	71.457	0.307	2.0	92.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	80.063	0.0	79.2	19	
30 min Summer	52.084	0.0	101.5	34	
60 min Summer	32.372	0.0	132.7	64	
120 min Summer	19.508	0.0	159.8	124	
180 min Summer	14.344	0.0	176.1	182	
240 min Summer	11.487	0.0	187.8	242	
360 min Summer	8.400	0.0	205.5	362	
480 min Summer	6.719	0.0	218.3	482	
600 min Summer	5.647	0.0	228.2	600	
720 min Summer	4.897	0.0	235.8	720	
960 min Summer	3.910	0.0	244.5	838	
1440 min Summer	2.843	0.0	236.4	1084	
2160 min Summer	2.065	0.0	307.8	1492	
2880 min Summer	1.645	0.0	326.7	1904	
4320 min Summer	1.192	0.0	353.6	2728	
5760 min Summer	0.949	0.0	378.3	3568	
7200 min Summer	0.794	0.0	395.7	4392	
8640 min Summer	0.686	0.0	410.3	5184	
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Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 13:02 File Attenuation Pond.SRCX		Designed by MJH Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 30 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	71.385	0.235	2.0	68.6	O K
15 min Winter	71.428	0.278	2.0	82.2	O K
30 min Winter	71.500	0.350	2.0	106.3	O K
60 min Winter	71.570	0.420	2.0	130.5	O K
120 min Winter	71.633	0.483	2.0	153.7	O K
180 min Winter	71.666	0.516	2.0	165.8	O K
240 min Winter	71.685	0.535	2.0	173.2	O K
360 min Winter	71.709	0.559	2.0	182.2	O K
480 min Winter	71.720	0.570	2.0	186.7	O K
600 min Winter	71.725	0.575	2.0	188.6	O K
720 min Winter	71.726	0.576	2.0	188.8	O K
960 min Winter	71.720	0.570	2.0	186.5	O K
1440 min Winter	71.700	0.550	2.0	178.8	O K
2160 min Winter	71.666	0.516	2.0	165.9	O K
2880 min Winter	71.629	0.479	2.0	151.9	O K
4320 min Winter	71.552	0.402	2.0	124.2	O K
5760 min Winter	71.470	0.320	2.0	96.1	O K
7200 min Winter	71.316	0.166	2.0	47.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
10080 min Summer	0.607	0.0	422.5	6048	
15 min Winter	80.063	0.0	79.2	19	
30 min Winter	52.084	0.0	101.5	33	
60 min Winter	32.372	0.0	132.7	62	
120 min Winter	19.508	0.0	159.8	122	
180 min Winter	14.344	0.0	176.1	180	
240 min Winter	11.487	0.0	187.8	238	
360 min Winter	8.400	0.0	205.4	354	
480 min Winter	6.719	0.0	218.3	468	
600 min Winter	5.647	0.0	228.2	582	
720 min Winter	4.897	0.0	235.7	692	
960 min Winter	3.910	0.0	244.3	904	
1440 min Winter	2.843	0.0	236.4	1126	
2160 min Winter	2.065	0.0	307.9	1596	
2880 min Winter	1.645	0.0	326.7	2048	
4320 min Winter	1.192	0.0	353.9	2940	
5760 min Winter	0.949	0.0	378.3	3856	
7200 min Winter	0.794	0.0	395.7	4040	
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Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN	Calne Attenuation Pond MD Simulations	
Date 23/06/2025 13:02	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze	Source Control 2020.1.3	

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Winter	71.287	0.137	1.9	38.4	O K
10080 min Winter	71.268	0.118	1.7	33.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Winter	0.686	0.0	410.3	4672
10080 min Winter	0.607	0.0	422.7	5352

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Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Calne Attenuation Pond MD Simulations			
Date 23/06/2025 13:03 File Attenuation Pond.SRCX		Designed by MJH Checked by			
Innovyze		Source Control 2020.1.3			
Summary of Results for 1 year Return Period					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	71.268	0.118	1.7	33.0	O K
30 min Summer	71.300	0.150	1.9	42.3	O K
60 min Summer	71.332	0.182	2.0	52.0	O K
120 min Summer	71.366	0.216	2.0	62.6	O K
180 min Summer	71.386	0.236	2.0	68.9	O K
240 min Summer	71.398	0.248	2.0	72.7	O K
360 min Summer	71.409	0.259	2.0	76.2	O K
480 min Summer	71.412	0.262	2.0	77.2	O K
600 min Summer	71.413	0.263	2.0	77.4	O K
720 min Summer	71.412	0.262	2.0	77.3	O K
960 min Summer	71.409	0.259	2.0	76.3	O K
1440 min Summer	71.397	0.247	2.0	72.4	O K
2160 min Summer	71.365	0.215	2.0	62.1	O K
2880 min Summer	71.327	0.177	2.0	50.5	O K
4320 min Summer	71.294	0.144	1.9	40.7	O K
5760 min Summer	71.274	0.124	1.7	34.7	O K
7200 min Summer	71.259	0.109	1.6	30.3	O K
8640 min Summer	71.247	0.097	1.5	27.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	32.607	0.0	31.5	18	
30 min Summer	21.335	0.0	41.8	33	
60 min Summer	13.524	0.0	55.1	62	
120 min Summer	8.401	0.0	68.6	122	
180 min Summer	6.328	0.0	77.6	182	
240 min Summer	5.165	0.0	84.5	242	
360 min Summer	3.846	0.0	94.4	360	
480 min Summer	3.119	0.0	102.1	470	
600 min Summer	2.651	0.0	108.4	522	
720 min Summer	2.321	0.0	113.9	586	
960 min Summer	1.882	0.0	123.1	714	
1440 min Summer	1.401	0.0	137.1	984	
2160 min Summer	1.043	0.0	155.4	1384	
2880 min Summer	0.845	0.0	167.8	1672	
4320 min Summer	0.629	0.0	186.7	2376	
5760 min Summer	0.510	0.0	203.3	3112	
7200 min Summer	0.434	0.0	216.0	3816	
8640 min Summer	0.380	0.0	226.9	4504	
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Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 1 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	71.239	0.089	1.4	24.5	O K
15 min Winter	71.268	0.118	1.7	33.0	O K
30 min Winter	71.300	0.150	1.9	42.4	O K
60 min Winter	71.332	0.182	2.0	52.0	O K
120 min Winter	71.366	0.216	2.0	62.4	O K
180 min Winter	71.385	0.235	2.0	68.5	O K
240 min Winter	71.397	0.247	2.0	72.2	O K
360 min Winter	71.407	0.257	2.0	75.5	O K
480 min Winter	71.410	0.260	2.0	76.4	O K
600 min Winter	71.409	0.259	2.0	76.1	O K
720 min Winter	71.405	0.255	2.0	75.0	O K
960 min Winter	71.398	0.248	2.0	72.5	O K
1440 min Winter	71.367	0.217	2.0	63.0	O K
2160 min Winter	71.316	0.166	2.0	47.1	O K
2880 min Winter	71.291	0.141	1.9	39.7	O K
4320 min Winter	71.259	0.109	1.6	30.5	O K
5760 min Winter	71.240	0.090	1.4	24.9	O K
7200 min Winter	71.227	0.077	1.2	21.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
10080 min Summer	0.340	0.0	236.2	5248	
15 min Winter	32.607	0.0	31.5	18	
30 min Winter	21.335	0.0	41.8	32	
60 min Winter	13.524	0.0	55.1	62	
120 min Winter	8.401	0.0	68.6	120	
180 min Winter	6.328	0.0	77.6	178	
240 min Winter	5.165	0.0	84.5	236	
360 min Winter	3.846	0.0	94.4	350	
480 min Winter	3.119	0.0	102.1	460	
600 min Winter	2.651	0.0	108.5	564	
720 min Winter	2.321	0.0	113.9	654	
960 min Winter	1.882	0.0	123.1	744	
1440 min Winter	1.401	0.0	137.4	1040	
2160 min Winter	1.043	0.0	155.4	1340	
2880 min Winter	0.845	0.0	167.8	1700	
4320 min Winter	0.629	0.0	186.7	2424	
5760 min Winter	0.510	0.0	203.3	3168	
7200 min Winter	0.434	0.0	216.0	3824	
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Date 23/06/2025 13:03	Designed by MJH	
File Attenuation Pond.SRCX	Checked by	
Innovyze	Source Control 2020.1.3	

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Winter	71.219	0.069	1.1	18.8	O K
10080 min Winter	71.212	0.062	1.0	17.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Winter	0.380	0.0	226.9	4576
10080 min Winter	0.340	0.0	236.3	5248

Appendix G

Ground Investigation Extracts

EXISTING DEVELOPMENT LAYOUT SHOWING SITE BOUNDARY AND INVESTIGATION LOCATIONS

Job No.

5019

Drawing No.

5019/1

Scale:

NTS

Date:

11/08/22



BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH16	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 80.00	Co-Ordinates (c.) E 400,911 N 171,603		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thickness)	DESCRIPTION		
0.20	ES					0.20	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
0.75	D					(0.50)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete.		
1.00-1.45	SPT C					0.70	CLAY: firm bluish grey and brown CLAY with pockets of gypsum (up to 10mm)		
1.45		N9						KC	
2.00-2.45	SPT C					(2.30)			
2.25	D								
2.45		N13							
3.00-3.45	SPT C					3.00	Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100%		
3.45		N16					Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: 50mm ID HDPE plain pipe: 0.00-1.00m. ID HDPE slotted pipe with washed gravel response zone: 1.00-3.00m. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	3									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH17	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 80.00	Co-Ordinates (c.) E 400,955 N 171,636		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
0.40 0.50	ES D					0.10 (0.50) 0.60	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
1.00 1.00-1.45 1.45	D SPT C	N9				(1.40) 2.00	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete. CLAY: firm bluish grey and brown CLAY with pockets of gypsum (up to 10mm)	KC	
2.00-2.45 2.45	SPT C	N15					Core Recovery; 0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100% Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH18	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 77.00	Co-Ordinates (c.) E 400,983 N 171,567		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
0.15	ES					0.10 (0.50) 0.60	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
1.00-1.45	SPT C					(1.40)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete. CLAY: firm bluish grey and brown CLAY with pockets of gypsum (up to 10mm)	KC	
1.45		N10							
1.50	D								
2.00	D					2.00			
2.00-2.45	SPT C						Core Recovery; 0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100%		
2.45		N19					Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

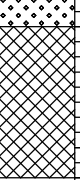
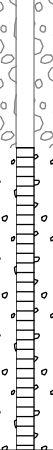
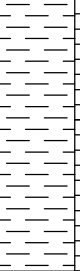
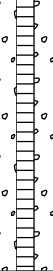
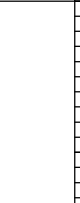
Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH19	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 77.00	Co-Ordinates (c.) E 400,951 N 171,550		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30	ES	N11				0.15	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
1.00	D					(0.65)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete.		
1.00-1.45	SPT C					0.80	CLAY: firm, bluish grey and brown CLAY with pockets of gypsum (up to 10mm)		
1.45	D					(1.20)			
1.50						2.00			
2.00-2.45	SPT C	N15					Core Recovery; 0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100%		
2.45							Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH20	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 76.00	Co-Ordinates (c.) E 400,996 N 171,514		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thickness)	DESCRIPTION		
0.25	ES					0.20	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert	KC	
1.00-1.45	SPT C					(1.00)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete.		
1.45		N9				1.20	CLAY: firm, bluish grey and brown CLAY with pockets of gypsum (up to 10mm) and yellow dissolution features throughout		
2.00	D					(1.80)		KC	
2.00-2.45	SPT C								
2.45		N12							
3.00	D					3.00	Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100%		
3.00-3.45	SPT C						Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		
3.45		N13							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	3									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

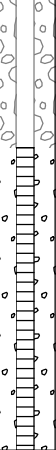
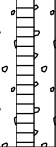
Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH21	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 76.00	Co-Ordinates (c.) E 400,948 N 171,475		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thickness)	DESCRIPTION		
0.50	ES					0.30	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
1.00-1.45	SPT C					(0.70)	MADE GROUND: very stiff, dark brown and mottled grey CLAY with abundant pockets of fine sand (mix of colours)		
1.45		N7				1.00	CLAY: firm dark bluish grey CLAY		
2.00-2.45	SPT C					(2.00)		KC	
2.45		N8							
2.50	D								
3.00	D					3.00			
3.00-3.45	SPT C						Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100%		
3.45		N9							
3.90		N15					Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	3									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

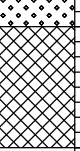
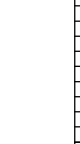
Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH22	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 75.00	Co-Ordinates (c.) E 400,998 N 171,455		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
0.35	ES					0.15	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert	AL	
1.00-1.45	SPT C					(1.95)	CLAY: firm to locally stiff, orangish brown, mottled bluish grey CLAY		
1.45		N0					1.20 - 2.00 - extremely soft		
2.00	D					2.10	SAND: extremely soft dark grey, silty, clayey fine SAND	AL	
2.00-2.45	SPT C					(0.90)			
2.45		N0							
3.00	D					3.00	Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100%		
3.00-3.45	SPT C						Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: 50mm ID HDPE plain pipe: 0.00-1.00m. ID HDPE slotted pipe with washed gravel response zone: 1.00-3.00m. No groundwater encountered		
3.45		N7							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	3									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected AL = Alluvium
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH23	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 75.00	Co-Ordinates (c.) E 400,999 N 171,420		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thickness)	DESCRIPTION		
0.20	ES	N5				0.20	TOPSOIL: comprising dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert	KC	
	D					(0.80)	MADE GROUND: very stiff, dark brown and mottled grey CLAY with abundant pockets of fine sand (mix of colours)		
1.00						1.00	CLAY: soft dark bluish grey CLAY		
1.45	SPT C	N5				(1.00)			
1.45	D								
1.50		N10				2.00	2.00 - becoming firm		
2.45	SPT C						Core Recovery;		
2.45							0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100%		
							Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH24	
Job No 5019	Date 21-07-22	Ground Level (c.m,AOD) 75.00	Co-Ordinates (c.) E 400,965 N 171,422		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30	ES	N7				0.20	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert	KC	
0.50	D					(0.80)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete.		
1.00-1.45	SPT C					1.00	CLAY: soft to firm, bluish grey and brown CLAY with pockets of gypsum (up to 10mm)		
1.45						(1.00)			
2.00-2.45	SPT C	N11				2.00	2.00 - becoming firm		
2.45							Core Recovery;		
2.50	D						0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100%		
Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered									

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH25	
Job No 5019	Date 22-07-22	Ground Level (c.m,AOD) 74.00	Co-Ordinates (c.) E 400,946 N 171,390		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION		
1.00-1.45	SPT C	N7				0.20	TOPSOIL: probable soft slightly sandy, slightly gravelly, desiccated CLAY with frequent roots. Gravel is sub-angular to sub-rounded, fine to coarse brick, chert and limestone	KC	
1.45						(0.80)	CLAY: firm to stiff brown and orangish brown plastic CLAY with pockets (upto 15mm) of fine to medium sand		
2.00-2.45	SPT C	N10				1.00	CLAY: soft to firm, dark grey plastic CLAY with rare pockets of gypsum (upto 15mm)	KC	
2.25	D					(2.00)	2.00 - becoming firm		
2.45						3.00	Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100%	KC	
3.00-3.45	SPT C	N13					Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: 50mm ID HDPE plain pipe: 0.00-1.00m. ID HDPE slotted pipe with washed gravel response zone: 1.00-3.00m. No groundwater encountered		
3.45									

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
22/07/2022	101	3									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH27	
Job No 5019	Date 22-07-22	Ground Level (c.m,AOD) 77.00	Co-Ordinates (c.) E 400,911 N 171,522		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thickness)	DESCRIPTION		
0.50	D					(0.40) 0.40	TOPSOIL: probable stiff, brown, slightly gravelly, desiccated CLAY. Gravel is sub-angular to sub-rounded fine to medium concrete, rubble, brick, chert and limestone		
1.45 1.45	SPT C	N7				(0.60) 1.00	MADE GROUND: firm locally stiff, brown plastic CLAY with rare pockets (15mm) of fine orange sand		
2.45 2.45	SPT C	N11				(2.00)	CLAY: soft to firm, dark grey plastic CLAY with rare gypsum dusting 2.00 - becoming firm	KC	
3.45 3.45	SPT C	N16				3.00	Core Recovery: 0.00 - 1.00m: hand-dug starter pit 1.00 - 3.00m: 100% Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-3.00m. Upon completion: 50mm ID HDPE plain pipe: 0.00-1.00m. ID HDPE slotted pipe with washed gravel response zone: 1.00-3.00m. No groundwater encountered		

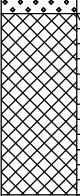
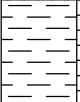
Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
22/07/2022	101	3									
All dimensions in metres Scale 1:50						Client RHL		Method/ Plant Used Window Sampling (Archway Competitor)		Logged By CD	

Borehole position scanned using Cable Avoidance Tool (CAT); no services detected

KC = Kimmeridge Clay

BOREHOLE LOG

Project Phase 6, Land off Spitfire Way, Calne SN11 8GA				BOREHOLE No BH28	
Job No 5019	Date 22-07-22	Ground Level (c.m,AOD) 80.00	Co-Ordinates (c.) E 400,882 N 171,581		
Contractor Cook Ground Investigation Limited				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick- ness)	DESCRIPTION		
0.40	ES	N8				0.10	TOPSOIL: probable soft, dark brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to medium rubble, charcoal, rare brick and chert		
1.00-1.45	D SPT C					(1.20)	MADE GROUND: very stiff, orangish brown and grey, slightly sandy, slightly gravelly CLAY with frequent rootlets. Gravel is fine brick and concrete.		
1.45						1.30			
2.00-2.45	D SPT C	N14				(0.70)	CLAY: soft to firm, bluish grey and brown CLAY with pockets of gypsum (up to 10mm)	KC	
2.45						2.00			
							2.00 - becoming firm		
							Core Recovery; 0.00 - 1.00m: hand-dug starter pit 1.00 - 2.00m: 100%		
							Hand dug inspection pit: 0.00-1.00m. Continuous disturbed sampling using 101mm sample barrels: 1.00-2.00m. Upon completion: borehole backfilled with arisings. No groundwater encountered		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
22/07/2022	101	2									Borehole position scanned using Cable Avoidance Tool (CAT); no services detected KC = Kimmeridge Clay
All dimensions in metres Scale 1:50			Client RHL			Method/ Plant Used Window Sampling (Archway Competitor)			Logged By CD		

Appendix H

Micro-drainage Rainfall and Development run-off volume Calculations

Phoenix Design Partnership Ltd					Page 1																																																																																																																																																																																																																												
Unit 9 Westway Business Centre Marksbury Bath, BA2 9HN		Land of Spitfire Road Rainfall Calculation																																																																																																																																																																																																																															
Date 16/08/2022 13:25 File Rainfall Calculation for FRA....		Designed by MJH Checked by																																																																																																																																																																																																																															
Causeway		Source Control 2020.1.3																																																																																																																																																																																																																															
<u>Summary of Results for 100 year Return Period</u> <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Control (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>30 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>60 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>120 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>180 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>240 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>360 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>480 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>600 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>720 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>960 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>1440 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>2160 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>2880 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>4320 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>5760 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>7200 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>8640 min Winter</td><td>17.150</td><td>0.000</td><td>0.0</td><td>0.0</td><td>O K</td></tr><tr><td>10080 min 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Developed Run-off Volume.

Ciria C697 (Box 4.11)

$$\text{Developed Run-off Volume} = 10.RD.A [((PIMP/100)^{\alpha 0.8}) + ((1-(PIMP/100))^{\beta SPR})]$$

RD = Rainfall depth for 100 year 6 hour event (mm).

PIMP = Percentage impermeable area.

A = Total Catchment Area (ha)

SPR = Standard percentage run-off for soil type (as fraction)

α = Proportion of impermeable draining to system at 80% (0.8) run-off (roofs, parking, roads, etc).

Can be increased to 100 % for more conservative assessment (will depend on materials, drainage...).

β = Proportion of pervious areas draining to system, 0-1.0 (gardens, open space, etc).

Total Area	0.631 Ha
Impereable Area	0.3786 Ha
PIMP	60%
SPR (Soil Type 4)	0.45
α (100% run-off from impermeable surfaces)	1
β (100% run-off from gardens to drainage system)	1

	mm/hrs	mm
RD 100 20% year 6 hour rainfall (6 hours from Micro Drainage)	0	0
RD 100 40% year 6 hour rainfall (6 hours from Micro Drainage)	10.862	65.172

	Total Vol
	m ³
	0
Development runoff Volume 100 year 6hr	271
Development runoff Volume 100 40% year 6hr	380

Extras From Micro Drainage

Rainfall and Network Details

Rainfall Model		Network	
FSR Rainfall		Storage Volume in Pipe Network (m³)	
Return Period (years)	100	0	
Region	England and Wales	Slope of outfall pipe (1:X)	
Map	M5-60 (mm) 18.000	0	
	Ratio R 0.365	Diameter of outfall pipe (m)	
		0.0	
Storms ☐ Summer ☒ Winter		☒ k (mm) ☐ Manning's n	
Cv	0.750 0.840	Surface Roughness of outfall pipe	
Shortest Storm Duration (mins)	15	0.000	
Longest Storm Duration (mins)	10080		

Select required Rainfall Model from the list

Appendix I

2025 Abberd Brook Hydraulic Modelling Report

CALNE PHASE 6A, ABBERD BROOK

HYDRAULIC MODELLING REPORT

DRAFT

Environmental Consultancy | www.chriswassocs.com

Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

Registered in England & Wales No 15113786 | VAT Number 448376884

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1. Introduction

Chris Whitlow & Associates Ltd. were instructed by Phoenix Design Partnership to undertake a hydraulic modelling study for the Phase 6A development site to the north of Abberd Brook in Calne, Wiltshire. The purpose of this exercise is to inform accurate flood risk mapping local to the proposed residential development site.

The approximate location of the Phase 6A development is shown in Figure 1 together with the latest (May 2025) Environment Agency Flood Zones.

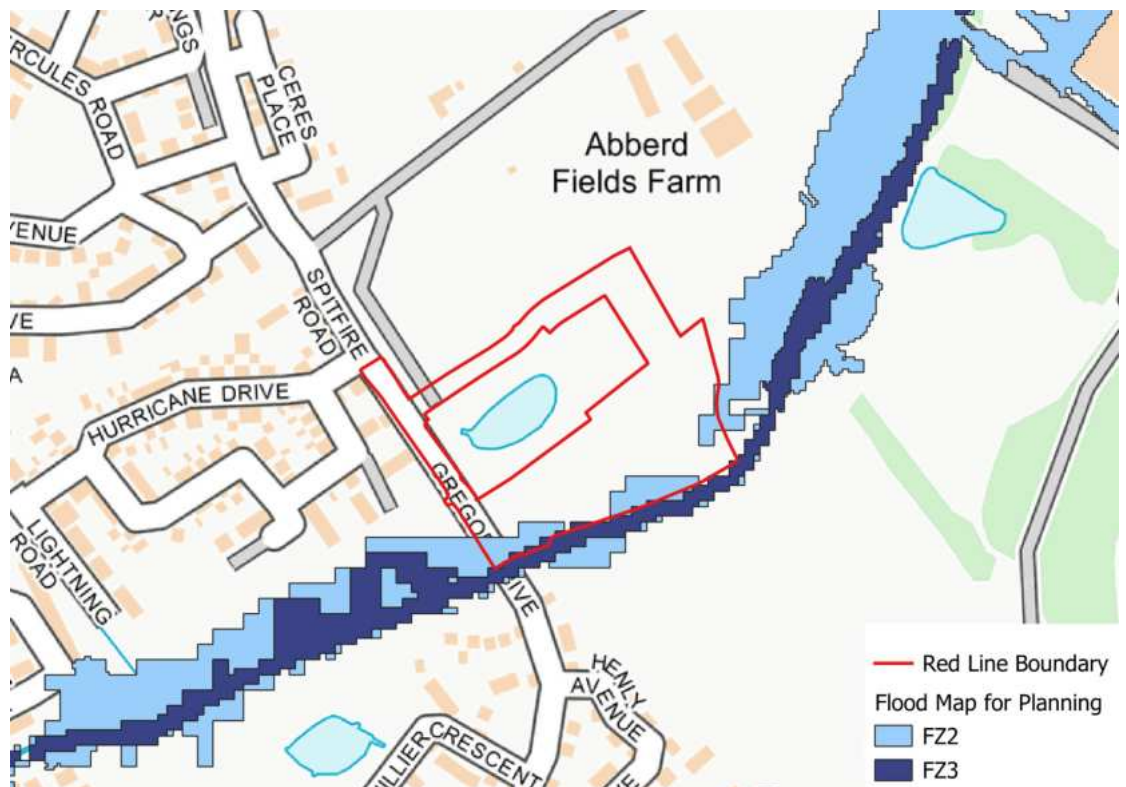


Figure 1 Location of Site 6A and current EA Flood Zones

An indicative masterplan for the proposed residential development for Site 6A is shown below in Figure 2. This was developed by Phoenix Design Partnership.



Figure 2: Supplied Illustrative Masterplan for Site 6A to the north of Abberd Brook

The areas proposed for residential development are shown in Figure 2 together with the existing pond and a proposed new SUDS pond.

It is noted that this site layout was subject to revision depending on the results from the current detailed modelling exercise.

1.1 Existing Surface Water Flood Mapping

As well as fluvial flood mapping, the Environment Agency publishes another map which indicates the risk of flooding from surface water. The surface water flood mapping (as updated in February 2025) local to the proposed development is presented in Figures 3, 4 and 5 for 30 year, 100 year and 1000 year events respectively.

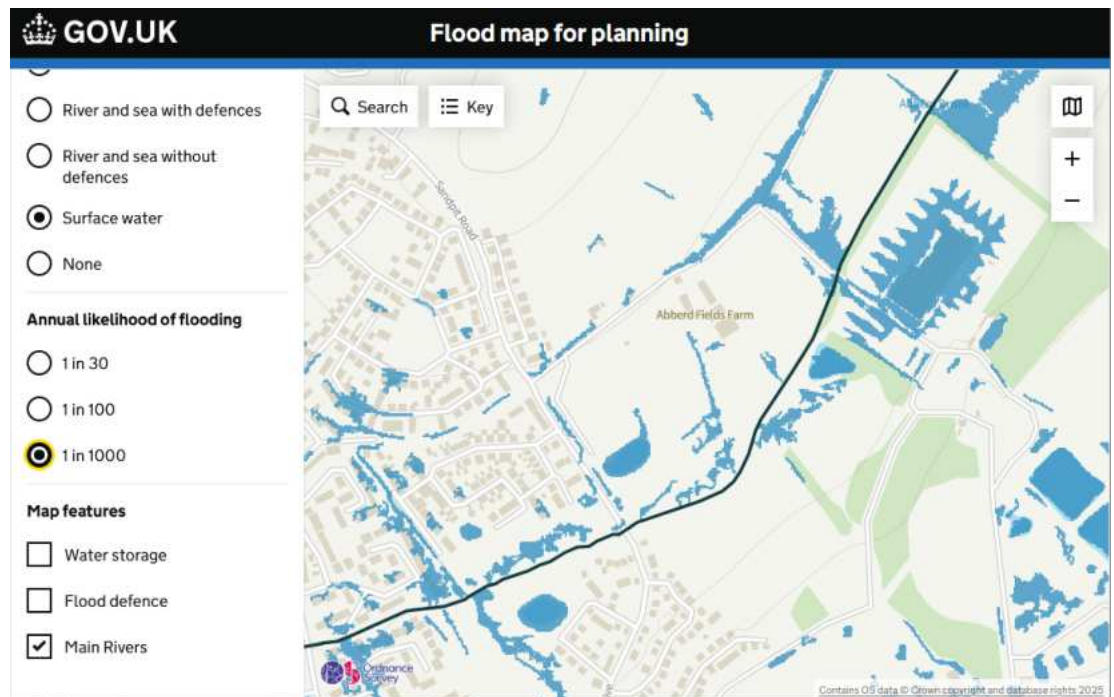


Figure 3: Environment Agency Surface Water Flood Map for 1 in 1000 year Return Period (0.1%AEP) Storm Event

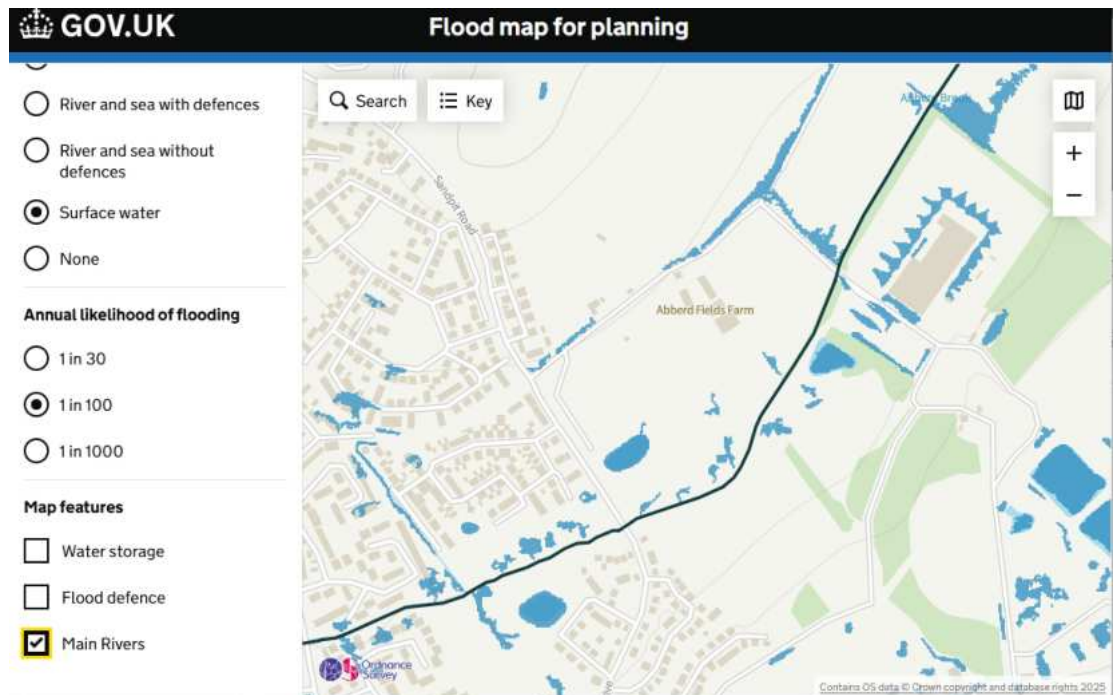


Figure 4: Environment Agency Surface Water Flood Map for 1 in 100 year Return Period (1%AEP) Storm Event

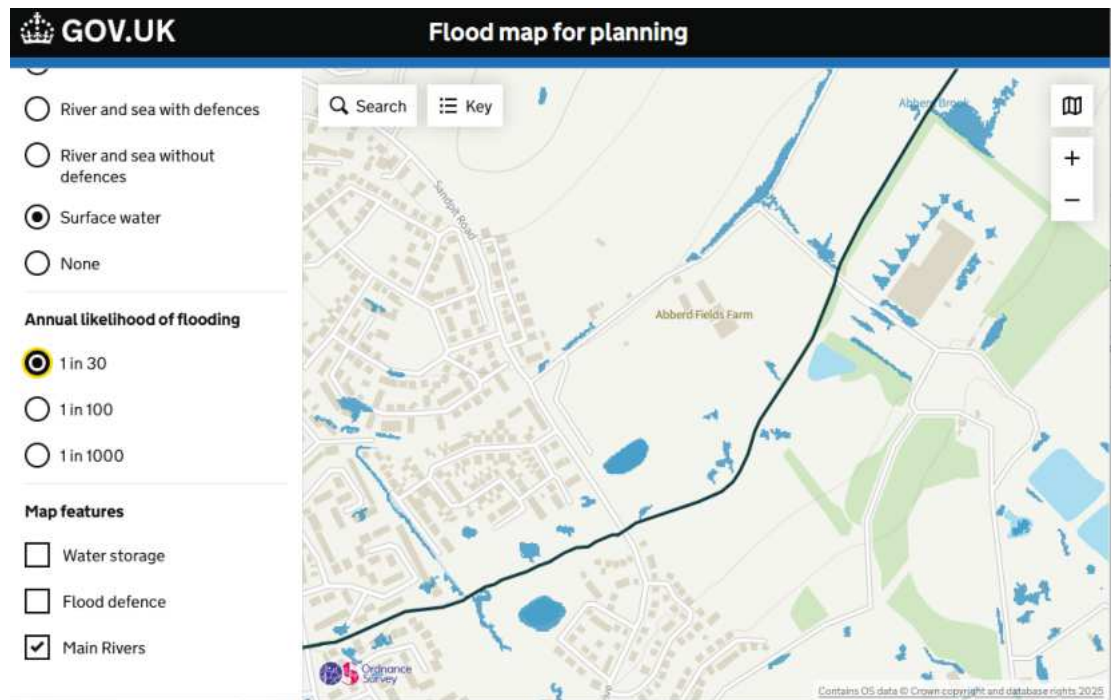


Figure 5: Environment Agency Surface Water Flood Map for the 1 in 30 year Return Period (3.33%AEP) Storm Event

Apart from the filling of the existing pond on the proposed development site, figures 3, 4 and 5 show isolated areas of ponding at low depth which appear to be associated with historical field drainage. They are not of concern for planning purposes in comparison with the fluvial flood zone mapping.

1.2 Existing Fluvial Flood Zone Mapping

As noted above, Figure 1 shows the existing fluvial flood zone mapping for the Abberd Brook. This was prepared by Edenvale Young Associates in 2017 and the project was managed by the author of the current document.

The 2017 model comprised of a 1D/2D Flood Modeller/TUFLOW model where the one dimensional component used the Flood Modeller software for the channel model and TUFLOW for the two dimensional component, used for the out of bank floodplain areas. This is a very large model which covers both Chippenham and Calne and a reach of the Bristol Avon between Kellaways and Melksham.



A version of this model, amended by Atkins in 2019, was provided by the Environment Agency for use on the current modelling exercise.

In the location to the south of the Phase 6A development, the Abberd Brook is classified as a Main River and maintenance responsibility lies with the Environment Agency.

Environmental Consultancy | www.chriswassocs.com

Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

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2. New Survey Data

New survey of the Abberd Brook local to the proposed Phase 6A development was commissioned and undertaken by Infomap Survey and Mapping in March 2025.

Figure 6 shows the locations of the new surveyed open channel cross sections which comprise infill surveys within the extent of the 2017 EA model as well as additional sections and structures on the Abberd Brook upstream of this model.

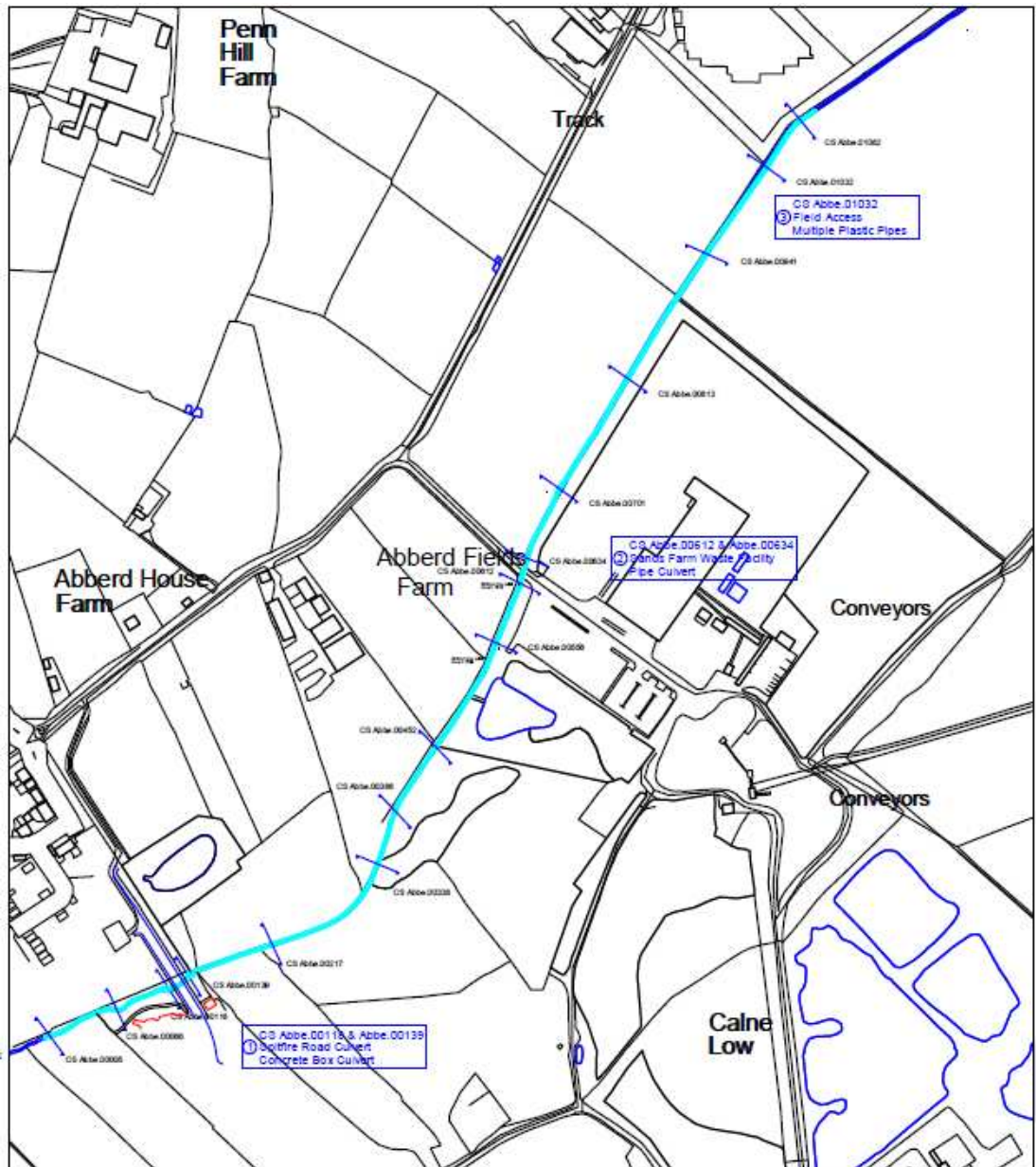


Figure 6: Locations of new cross section and structure survey

Figure 6 shows that three structures were surveyed, together with sixteen cross sections.

This data should be compared with the model node locations supplied by the Environment Agency with their supplied Product 4 data. These are presented below in Figure 7.



Figure 7: 2017 Model Node Locations Supplied by Environment Agency

It should be noted that not all of the model nodes in Figure 7 correspond to actual surveyed cross sections. Those whose final character is “i” are locations where data has been interpolated from the upstream and downstream surveyed cross sections.

3. Hydrology

A hydrological assessment has been undertaken, according the latest Environment Agency Flood Estimation Guidance, to establish updated peak flows at the upstream boundary of the model which corresponds to the furthest upstream surveyed cross section.

rainfall intensities at key return periods and storm durations.

3.1 Catchment Delineation

The delineation of the catchment was undertaken using data from the Flood Estimation Handbook (FEH Web Service¹).

The FEH catchment was chosen as that draining to Prince Charles Drive and is shown below on Figure 8.

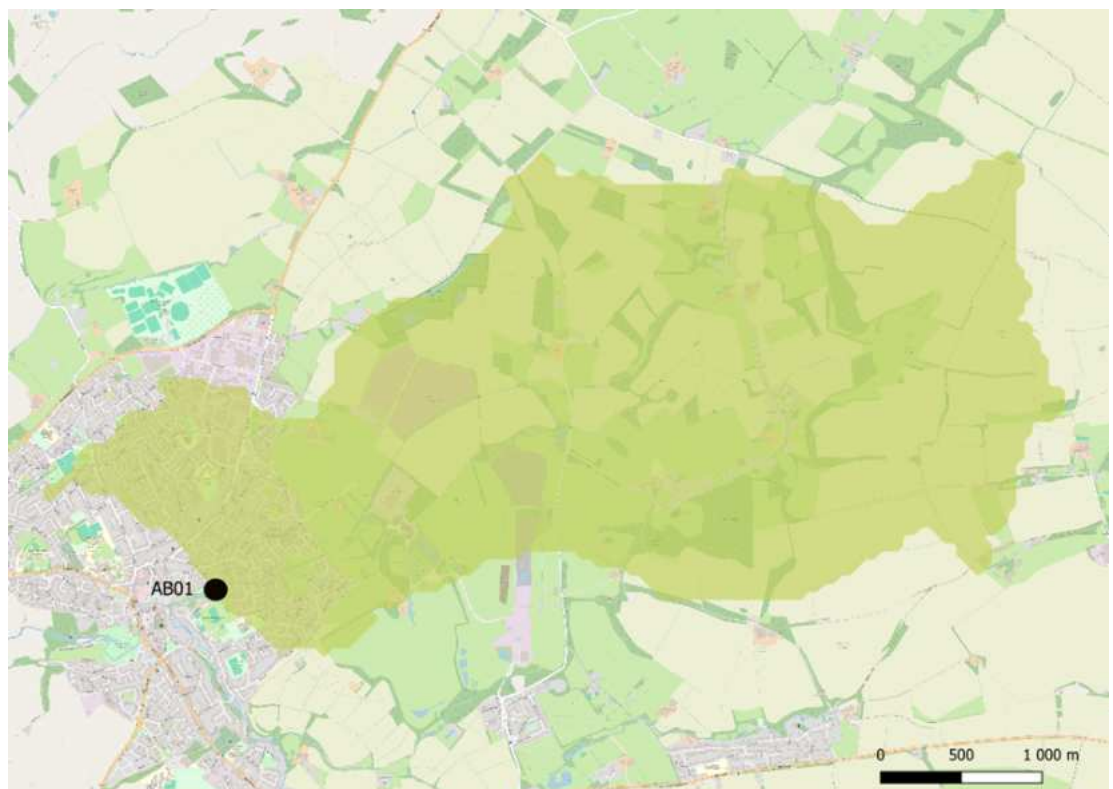


Figure 8: Abberd Brook Catchment draining to Prince Charles Drive

1 <https://fehweb.ceh.ac.uk/GB/map>

The area of this catchment was supplied by the FEH Webservice and is 10.2km².

A small urbanised right bank tributary joins the Abberd Brook just downstream of Prince Charles Drive and the associated catchment is shown on Figure 9.



Figure 9: Small right bank catchment draining to Abberd Brook downstream of Prince Charles Drive

The area of this small right bank FEH catchment is 0.91km².

After inspection, no amendments were made to the FEH catchment extents.

3.2 Catchment Descriptors

The key FEH catchment descriptors are shown in Table 1.

Table 1: Key FEH catchment descriptors

	Area (km ²)	PROPWET	DPLBAR (km)	BFIHOST19	FARL	SAAR	Urbext2025	FPEXT
AB01	11.1	0.34	3.75	0.61	0.999	720	0.045	0.0736

BFIHOST19 is consistent with available information from geology and soil maps. These indicate a predominance of loamy and clayey soils over a sedimentary bedrock formation.

The FARL parameter was checked against Ordnance Survey mapping and found to be consistent with that. The FARL parameter is a measure of the influence of reservoirs or lakes in the catchment and a value of 0.999 shows that there is negligible influence on peak flows from this source.

The SAAR parameter is the standard annual average rainfall (mm), a measure of catchment wetness associated with the geographical location.

The URBEXT2025 parameter is a measure of the urban extent in the catchment in 2025. The default value for a rural catchment is 0.03 so the 0.045 value for the Abberd Brook catchment draining to Prince Charles Drive is classified as relatively urbanised.

A review of the catchment descriptors determined they did not require amendment.

3.3 Climate Change

The Environment Agency guidance is clear that climate change should be accounted for in the assessment of flood risk for planning applications.

The site is located within the Bristol Avon and North Somerset Streams Management Catchment for peak rainfall climate change allowances.

In line with the Environment Agency guidance "Flood risk assessments: climate change allowances" (updated in May 2022), for a Flood Risk Assessment, the upper end allowance for the 2070's epoch should be assessed and for development with a lifetime beyond 2100 and the central allowance for the 2070s epoch should be assessed for development with a lifetime between 2061 and 2100. The allowance should be applied to both the 1% (100 year) and 3.3% (30 year) annual exceedance probability (AEP) events.

Bristol Avon and North Somerset Streams Management Catchment:

- The central allowance for the 2070s epoch is a 26% peak flow uplift for the 1% annual exceedance probability event.

The peak flow uplift was applied by adjusting the design peak flow by the appropriate allowance for use with a rainfall-runoff method (ReFH2 used for this study).

3.4 Design Flow Estimation

Both the Revitalised Rainfall Runoff model (ReFH2) and the FEH Statistical Method were used to derive peak flows. Both of these methods are industry standard and Environment Agency approved methods used to estimate peak flows.

The peak flow derivation for the FEH Statistical Method is described in Appendix A: FEH Calculation Record

Table 2: Statistical Method Peak flow values for different (present day) design events

Design Event Return Period/%AEP	Peak Flow (m ³ /s)
1 in 5 year (20%AEP)	2.87
1 in 10 year (10%AEP)	3.54
1 in 20 year (5%AEP)	4.29
1 in 50 year (2%AEP)	4.78
1 in 100 year (1%AEP)	6.52
1 in 200 year (1%AEP)	7.75
1 in 1000 year (0.1%AEP)	11.54

RefH2 peak flows were based on catchment descriptors obtained from the FEH catchment. These are presented in Table 3.

Table 3: Summary of RefH2 model parameters

Site code	Method	Tp (hours) rural	Cmax (mm)	BL (hours)	Area modelled as urban (km ²)	TP urban scaling factor	IF	IRF	DS
AB01	CD	4.22	543.57	50.2	0.8	0.75	0.4	0.7	0.5

The ReFH2 method also generates design flow hydrographs.

Flow hydrographs have been generated for the 3.3% (30 year return period), 1% (100 year return period), 1% (100 year return period) + climate change, and 0.1% (1000 year return period) annual event probability (AEP) flood events.

The recommended storm duration for the Abberd Brook catchment was 7.5 hours for a Winter storm event and this was adopted. The catchment type was “Rural” and the latest rainfall Depth Duration Frequency (DDF) model was selected (FEH22)

The estimated peak design flows for different design return periods for the Prince Charles Drive catchment are presented in Table 2.

Table 4: RefH2 Peak flow values for different (present day) design events

Design Event Return Period/%AEP	Peak Flow (m ³ /s)
1 in 5 year (20%AEP)	1.96
1 in 10 year (10%AEP)	2.350
1 in 20 year (5%AEP)	2.78
1 in 50 year (2%AEP)	3.46
1 in 100 year (1%AEP)	4.1
1 in 200 year (1%AEP)	4.9
1 in 1000 year (0.1%AEP)	7.25

It can be seen from Tables 2 and 4 that the higher peak flows are generated from the Statistical Method. The choice of a conservative approach in selecting final design peak flow estimates is deemed appropriate according to Environment Agency guidance due to uncertainties in estimating peak flows in small ungauged catchments. Consequently the Statistical Method peak flows were adopted for use in the new hydraulic model.

Hydrographs estimated at AB01 were scaled by the ratio of catchment areas to derive:

- one upstream inflow on the Abberd Brook at the confluence with the tributary in Figure 8 (catchment area 10.238 km²);
- one upstream inflow for the small right bank tributary in Figure 9 (catchment area 0.910km²) at its confluence with the Abberd Brook;
- one lateral distributed inflow for the intervening area between the confluence of the Abberd Brook with the tributary in Figure 9 and AB01 (intervening area 0.243 km²).

3.5 Peak Flow Comparison with Previous Work

The peak flows calculated for the present study were compared with those calculated for the Abberd Brook for the Chippenham and Calne 2017 model.

The new modelled peak flows and the 2017 model peak flows are shown in Table 5.

Table 5: Comparison of peak flows from the new model and the 2017 model

Design event return period/%AEP	New Peak Flow	Peak flow from 2017 model (m ³ /s)
30 (3.33%AEP)	4.78	4.52
100 (1%AEP)	6.52	5.73
100 (1%AEP) + 26% Climate Change	8.21	7.22
1000 (0.1%AEP)	11.54	9.63

It should be noted that the peak flows for the 1 in 100 year return period (1%AEP) from the current model and the 2017 Chippenham and Calne model differ by 0.79m³/s (13.8%). For the 1 in 1000 year return period (0.1%AEP), the peak flows from the current assessment and the 2017 model differ by 1.91m³/s (19.8%). Although a “model to model” comparison, this is regarded as useful and shows that the new calculations generate higher peak flows.

4. New Model Development

A linked 1D-2D modelling approach was adopted using Flood Modeller-TUFLOW (version 7.3 of Flood Modeller and version 2025.1.0 of TUFLOW).

4.1 Terrain Data

Environment Agency Light Detection and Ranging (LiDAR) data was available for the catchment. This is in the format of a Digital Terrain Model (DTM) at 1m resolution. Environment Agency National LiDAR Programme LiDAR data, published in 2022 was used in the new model build as opposed to the 2019 data used in the updated 2017 model supplied by the Environment Agency.

4.2 Truncation of 2017 EA Chippenham and Calne Model

As noted above, the supplied 2017 model domain included the Bristol Avon from Kellaways to Melksham as well as the River Marden catchment including Calne. This is a very large model comprising 2634 Flood Modeller nodes and there was no need to work with this entire catchment model to update the modelling of the Abberd Brook.

To accommodate this, the supplied Chippenham and Calne model was truncated at Stanley Gauging Station on the River Marden and a “Marden Only” model was created which includes all of the urban areas of Calne.

Importantly this enabled an increase in the model resolution by reducing the two dimensional (TUFLOW) grid size from 10m to 5m.

Choice of Stanley gauging station as the downstream boundary for this model ensures that there will be no impact of downstream boundary conditions on peak flood levels on the Abberd Brook as may be the case if a much smaller model was developed.

This approach also ensures consistency with historic EA modelling and mapping information for Calne.

4.1 One Dimensional (Flood Modeller) Component

The Flood Modeller 1D domain was updated using the truncated Marden Only model by incorporating the new surveyed cross section data and structures into the existing data for the Abberd Brook. In this way, a new, blended model was created for this watercourse which extended upstream by approximately 1km when compared to the 2017 model.

A 1 second timestep has been utilised for the one dimensional (Flood Modeller) model which is appropriate. Changes made to default 1D parameters are maintained as in the supplied EA model. It was attempted to return them to default parameters but the model experienced instabilities in the areas around Hazeland Mill and upstream of the A4 at Quemerford.

Manning roughness values were applied as informed by survey photos. Chow (1959) was utilised as a method by which to assign values. A Manning roughness value between 0.035 and 0.045 has been used for in-channel conditions and a Manning roughness value between 0.050 and 0.070 has been used for the channel banks. The Manning roughness values on the River Marden remain unchanged from the supplied calibrated model.

Figure 9 shows an example of a typical channel at node label AB01_00612.



Figure 10: Example of a typical channel (AB01_00612)

Figure 10 shows an example of relatively dense vegetation present on the banks of the watercourse in some locations.



Figure 11: Example of a channel with relatively dense brush on the banks (AB01_00634)

As noted in Section 2, a total of sixteen new surveyed cross sections were used to build the new model, together with three additional hydraulic structures. The two upstream structures appear to be farm access culverts.

4.3 Two Dimensional (TUFLOW) Component

All parameters were retained as default and a timestep of 2 seconds was chosen for the two dimensional (TUFLOW) model component.

A 5m resolution grid was adopted for the TUFLOW domain, reduced from the 10m in the supplied model to provide a greater resolution for a site specific study.

Publicly available Environment Agency 1m resolution LiDAR Composite DTM (2022) data was used as the basis for the 2D floodplain areas.

Two dimensional Manning roughness values were applied as informed by OS MasterMap and aerial photography. Chow (1959) was utilised as a method by which to assign values. Buildings were modelled with a higher roughness approach.

The linked 1D-2D hydraulic model domain is presented in Figure 11.

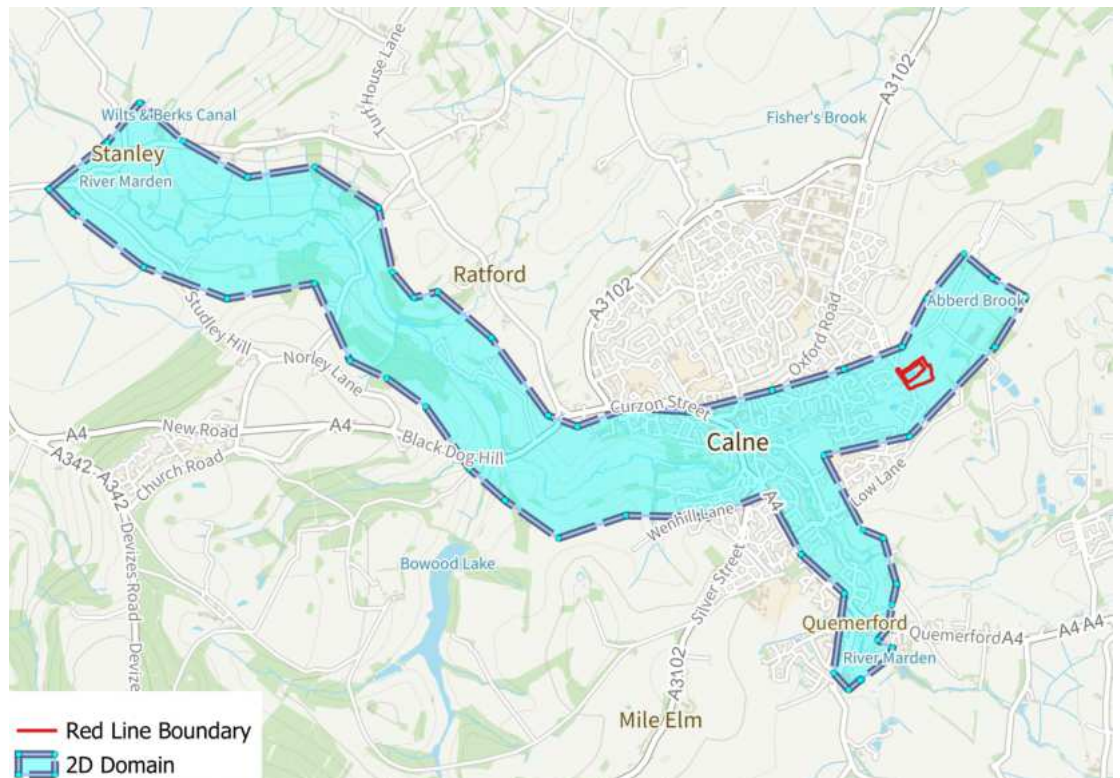


Figure 12: Updated 1D/2D Flood Modeller/TUFLOW model domain

4.4 Boundary Conditions

The 1D (Flood Modeller) domain for the channel was linked to the 2D (TUFLOW) domain representing the floodplain via a '2d_bc' layer with type 'HX' links.

The location of the HX lines were digitised to follow the bank levels as far as possible.

Likewise channel bank and floodplain levels were verified against the survey data where possible. A good linking between the 1D and 2D domain was established.

At the downstream extent of the new modelling, the previous 2017 EA modelling has been used via the development of new “Marden-only” model as far downstream as Stanley gauging station where a QH boundary has been applied which corresponds to the latest Environment Agency stage discharge rating relationship, as derived during the development of the Environment Agency’s Chippenham and Calne model. HQ boundaries based on the floodplain slope have been applied to the 2D domain to enable floodplain flows to exit the model at this location. The downstream boundary is approximately 7.75km downstream of the confluence of the Abberd Brook with the River Marden. This guarantees that there will be no impact from the boundary on peak flood levels on the Abberd Brook.

4.5 Design Events

The updated Abberd Brook/Marden-only model was simulated for the following key design flood events:

- 3.3% AEP
- 1% AEP
- 1% AEP + 26% allowance for climate change
- 0.1% AEP

5. Model Results

Peak flood extents have been simulated using the new model for the 1 in 30 year return period (1%AEP) and presented in Figure 12. The extent of this outline would correspond to Environment Agency Flood Zone 3b.

For all the flood mapping in this section, the base mapping is from OS Open Data

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and the Flood Map for Planning Outlines are from the DEFRA Data Services Platform

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Figure 13: Peak flood extent map and EA flood zone 3b extent for 1 in 30 year return period (3.33%AEP) flood event.

Similarly peak depths have been simulated for the 1 in 100 year return period (1%AEP) and presented in Figure 13. The extent of this outline would correspond to Environment Agency Flood Zone 3.

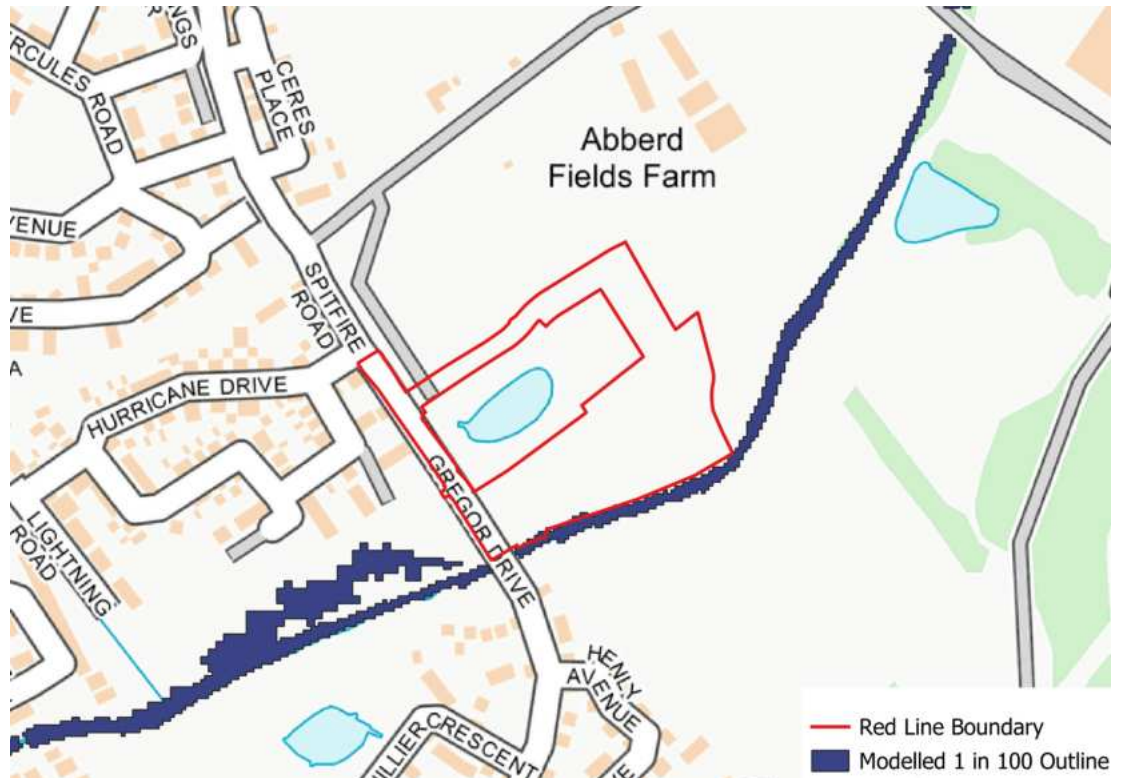


Figure 14: Peak flood extent map and EA flood zone 3 extent for 1 in 100 year return period (1%AEP) flood event.

Similarly peak extents have been simulated for the 1 in 1000 year return period (0.1%AEP) and presented in Figure 14. The extent of this outline would correspond to Environment Agency Flood Zone 2.

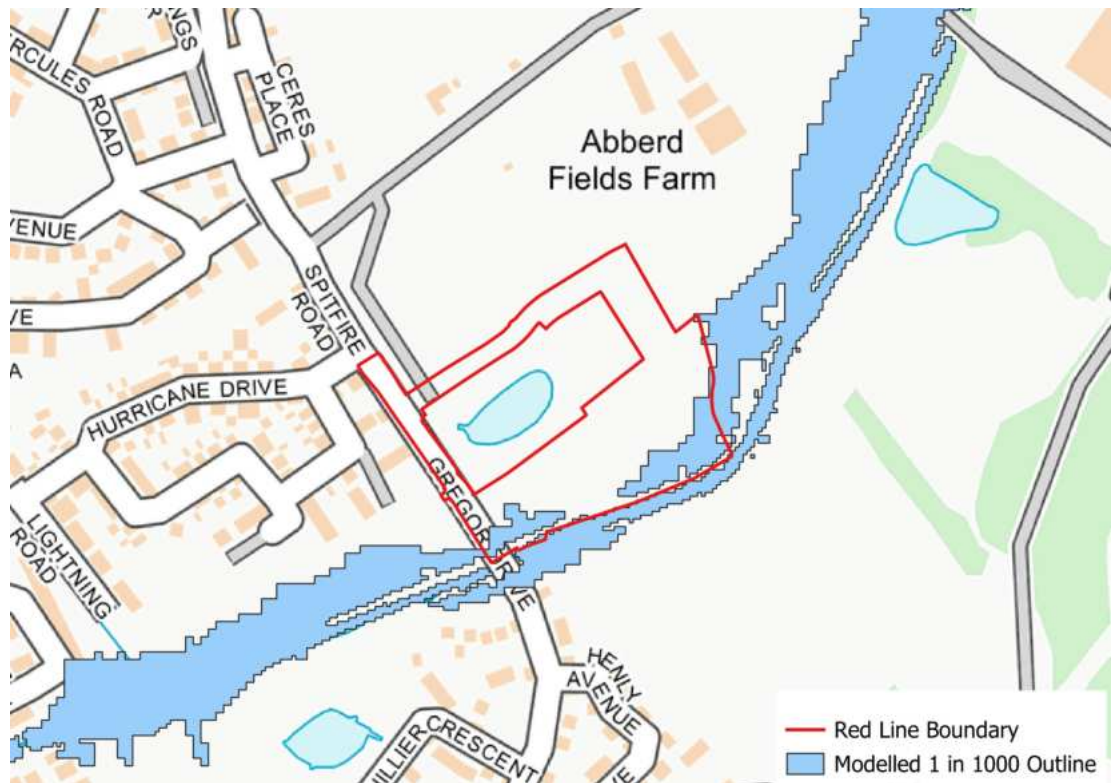


Figure 15: Peak flood extent map and EA Flood Zone 2 extent for 1 in 1000 year return period (0.1%AEP) flood event

Figure 16 shows a peak flood depth map, also for the 1 in 1000 year return period (0.1%AEP).

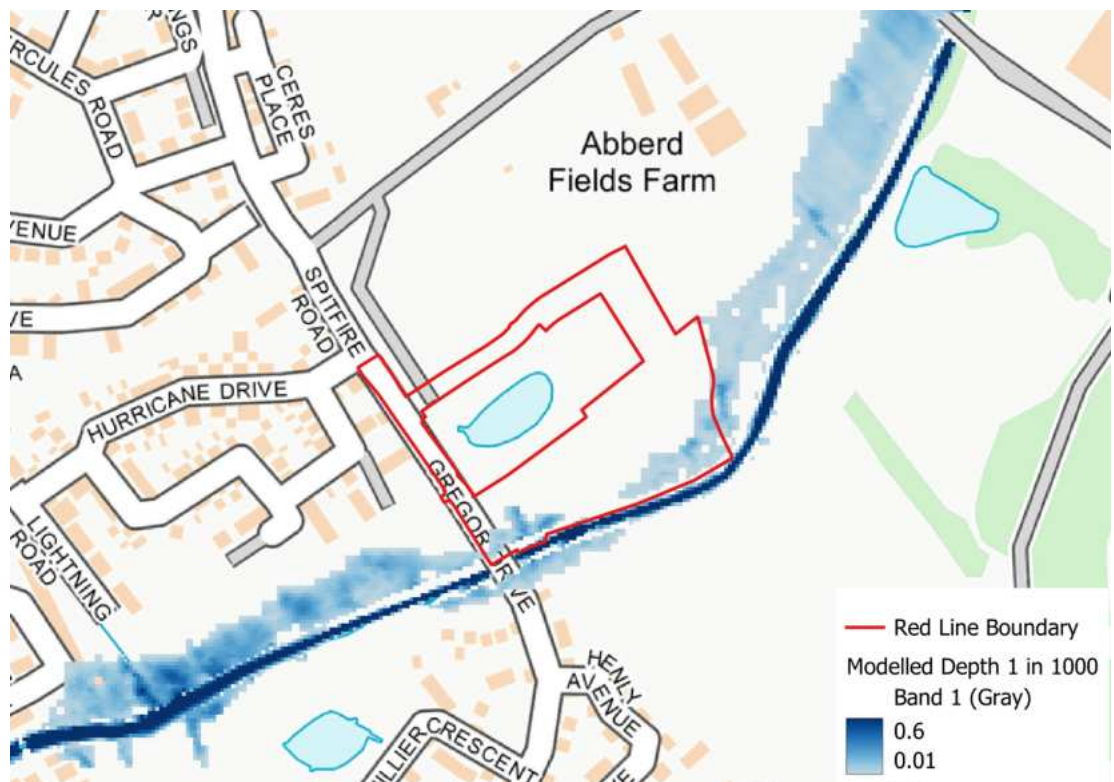


Figure 16: Peak flood depth map for 1 in 1000 year return period (0.1%AEP) flood event.

Figures 14 and 15 show flooding on the proposed development site for the 1 in 1000 year return period (0.1%AEP) flood event but Figure 15 indicates that flood depths, averaging approximately 100mm, are relatively low.

A comparison of the new modelled Flood Zone 2 extent and the current EA Flood Zone 2 extent is presented in Figure 16.

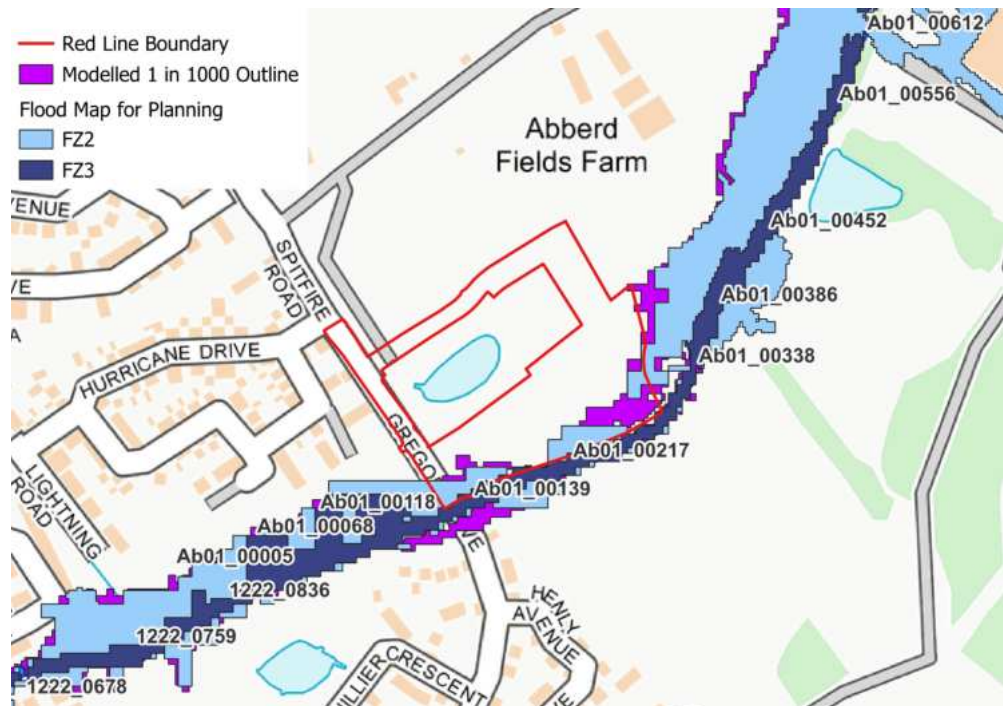


Figure 17: Comparison of new modelled EA Flood Zone 2 extents with current EA Flood Zone extents

Figure 16 shows a slightly greater flood zone 2 extent both on the proposed development site and for both upstream and downstream locations. This is likely to be as a result of use of greater peak flood flows for the current modelling.

Figure 16 also shows a flood zone 2 extent which is very similar to the existing Environment Agency flood zone mapping which should provide some confidence in the latest model results.

Figure 17 shows the modelled flood extent for the 1 in 100 year return period (1%AEP) including the appropriate (higher central) allowance for climate change.

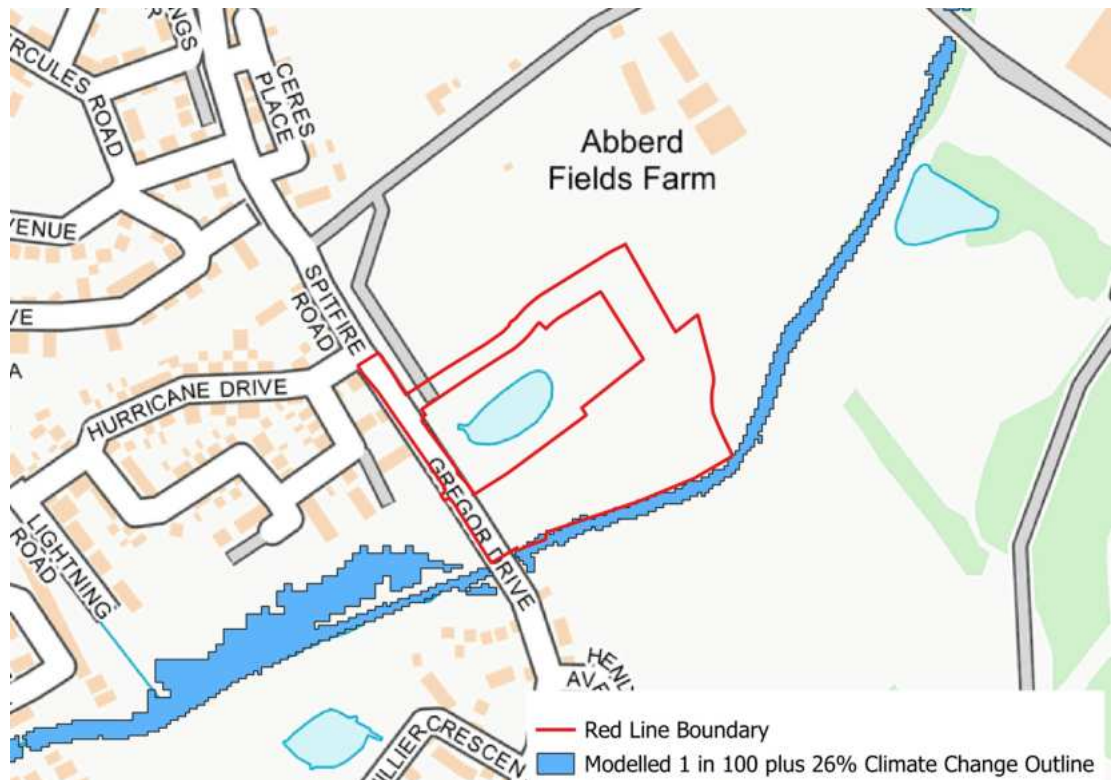


Figure 18: Peak flood extent map for the 1 in 100 year return period (1%AEP) flood event with an allowance for Climate Change.

Figure 17 shows that the new modelled outline for the 1 in 100 year return period (1%AEP) including an appropriate higher central allowance for climate change does not affect the proposed development site.

The peak flood extents for model nodes adjacent to the proposed development site are shown in Table 6.

Table 6: Peak Flood Levels for Model Nodes adjacent to Proposed Development Site

Node Label	1 in 30 year return period (3.33%AEP) Peak Flood Level (mAOD)	1 in 100 year return period (1%AEP) Peak Flood Level (mAOD)	1 in 100 year return period (1%AEP) plus 26% Climate Change Peak Flood Level (mAOD)	1 in 1000 year return period (0.1%AEP) Peak Flood Level (mAOD)
Ab01_01082	77.29	77.38	77.42	77.47
Ab01_01032	77.30	77.40	77.46	77.55
Ab01_01026	76.44	76.64	76.80	77.07
Ab01_00941	76.21	76.33	76.40	76.54
Ab01_00813	75.38	75.55	75.87	76.09
Ab01_00701	74.74	75.08	75.74	76.00
Ab01_00634	74.67	75.03	75.72	75.99
Ab01_00612	73.80	73.96	74.09	74.23
Ab01_00556	73.34	73.50	73.62	73.88
Ab01_00452	73.20	73.34	73.46	73.71
Ab01_00386	73.09	73.25	73.38	73.64
Ab01_00338	72.74	72.91	73.01	73.23
Ab01_00217	71.80	71.98	72.09	72.28
Ab01_00139	71.73	71.89	71.96	72.14
Ab01_00118	71.65	71.77	71.80	71.86
Ab01_00068	71.34	71.45	71.53	71.64
Ab01_00005	70.93	71.03	71.11	71.19
1222_0836	70.63	70.76	70.87	71.08
1222_0759	70.28	70.44	70.61	70.91

The model node locations used for Table 6 are shown in Figure 18.

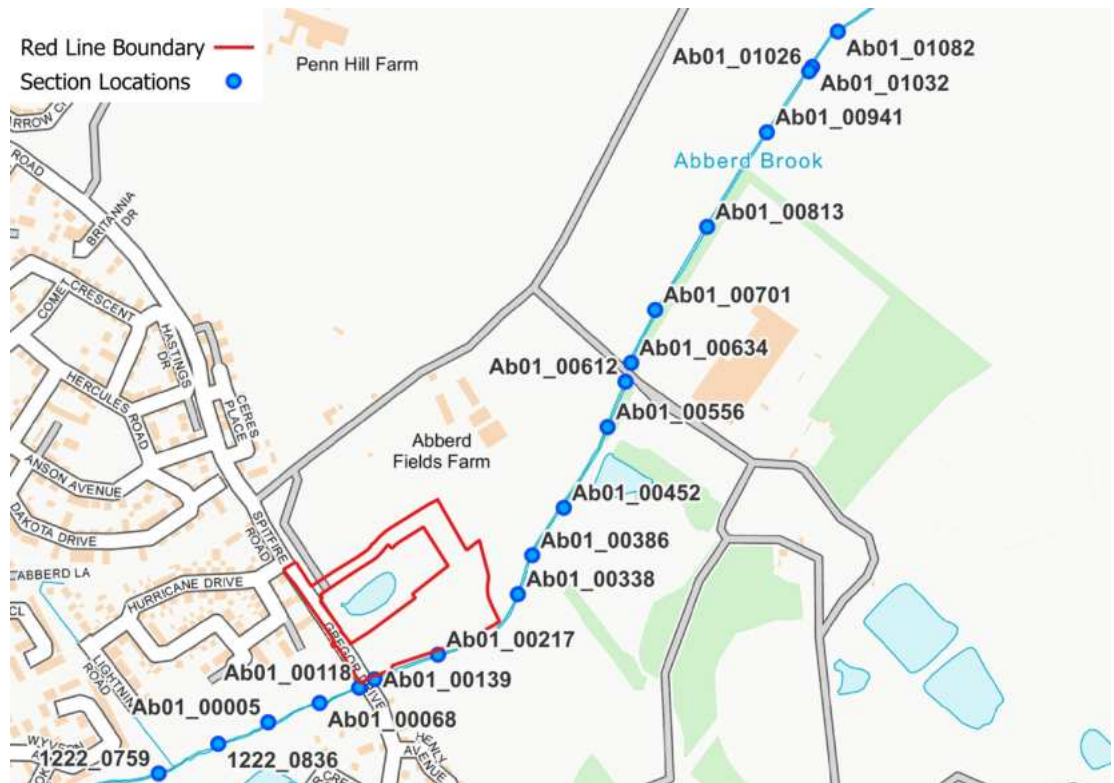


Figure 19: Node Locations in the New Model

6. Model Sensitivity Analysis

The Environment Agency specify that a set of sensitivity tests should be applied to any hydraulic model developed to inform a flood risk assessment report. These should relate to parameters which assess the uncertainty of key model components such as inflows, hydraulic roughness and downstream boundary representation.

All the sensitivity testing in this section has been applied to the updated model for the design event, namely the 1%AEP event plus a 26% allowance for climate change. In the following sections this baseline event for the sensitivity testing will be referred to as the Design Event.

Hydraulic Roughness

The sensitivity of the model to hydraulic roughness has been tested. The model has been simulated with $\pm 20\%$ change to Manning roughness values. The 1D roughness was altered for all river units using the global edit feature in Flood Modeller. The 2D roughness was varied through the multiplication of roughness values in the TUFLOW materials files.

In the “plus 20%” hydraulic roughness scenario the peak level at Node AB01_00217 adjacent to the site increases from 72.086mAOD to 72.196mAOD an increase of 110mm. In the “minus 20%” hydraulic roughness scenario the peak level at Node AB01_00217 adjacent to the site reduces from 72.086mAOD to 71.999mAOD a decrease of 87mm. As shown in Figure 20 the nature of the channel at this location in relation to the peak flood level means these changes within the 1D channel have limited impact on the flood extent in the 2D domain near the site.

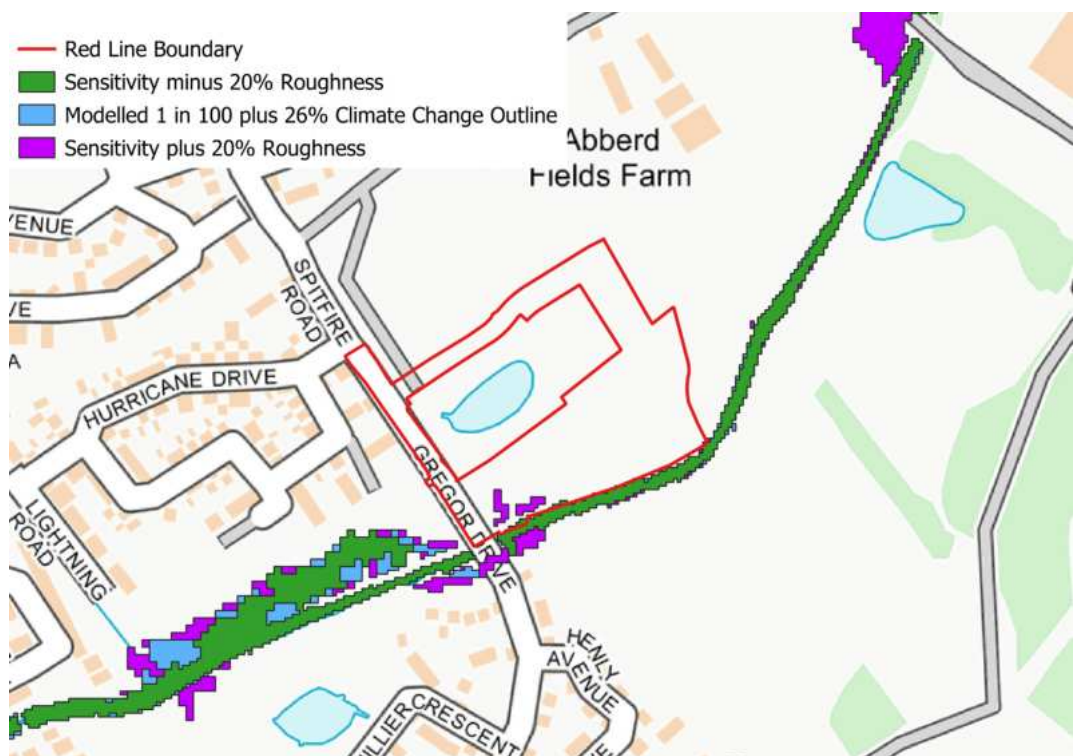


Figure 20: Increased Manning Roughness Sensitivity Results

Flow

To vary flow in the model, all Abberd Brook model inflows were scaled with the use of a multiplication factor. Inflows on the River Marden which forms the downstream boundary to the Abberd Brook were maintained at their baseline values. The multiplication factor was applied to each boundary unit. The model inflows were increased and decreased by 20% for the Design Event.

As would be expected the water levels in the 1D channel increase with additional flow and decrease with a reduction in flow. Levels in the 1D channel at node AB01_00217 adjacent to the site are increased by 123mm and decreased by 105mm in the respective scenarios. The impact within the 2D domain can be observed in Figure 21. When flows are increased by 20% the flood outline becomes more similar to the 0.1% AEP modelled outline, there are no significant changes in flood mechanism observed.

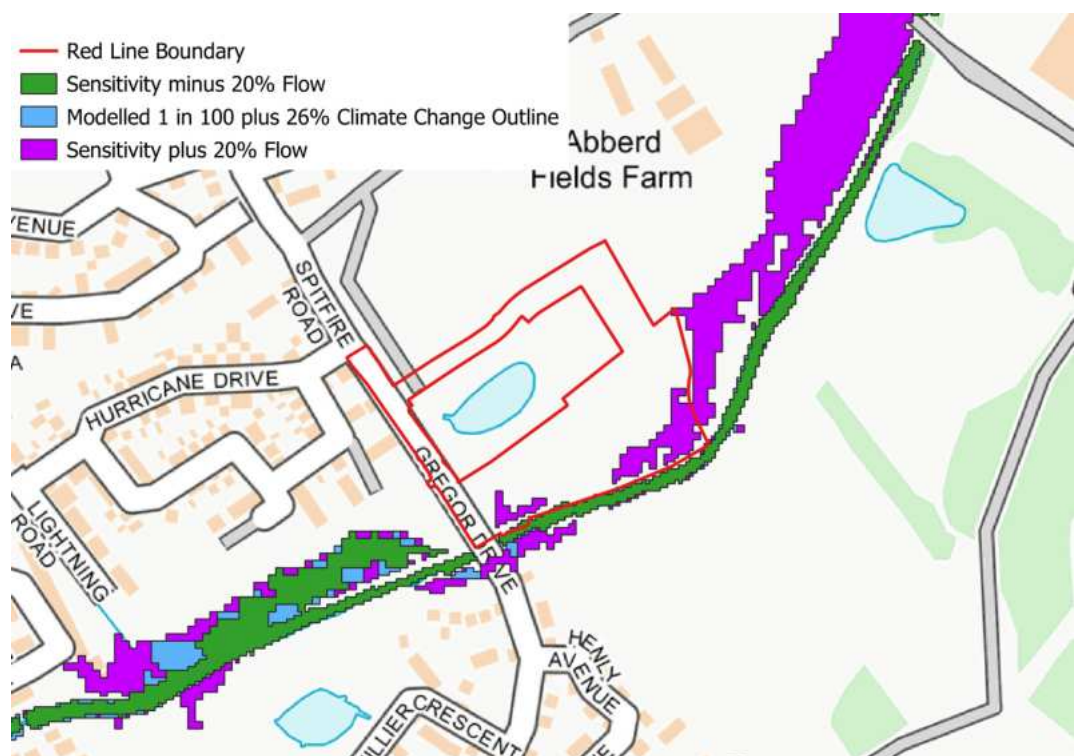


Figure 21: Flow Sensitivity Results

Downstream Boundary

In the updated model the downstream boundary location is at Stanley Gauge and the boundary is set to the rating curve for the Stanley gauge. This location is approximately 7.75km downstream of the confluence of the Abberd Brook with the Marden. Since this location is remote from both the Abberd Brook and the site no sensitivity testing in relation to the downstream boundary has been undertaken.

Blockage

Immediately downstream of the site the Abberd Brook is culverted under Gregor Drive, shown in Figure 22. As shown in Figure 23, the structure is a recent box culvert with wing walls at the entrance. There is plenty of vegetation within and on the banks of the channel upstream of this location and therefore it is considered important to determine the potential impact of a blockage at this structure to the site.

The culvert has been blocked by 20% and 50%, which have been modelled by multiplying the culvert width at the entrance by factors of 0.8 and 0.5 respectively.

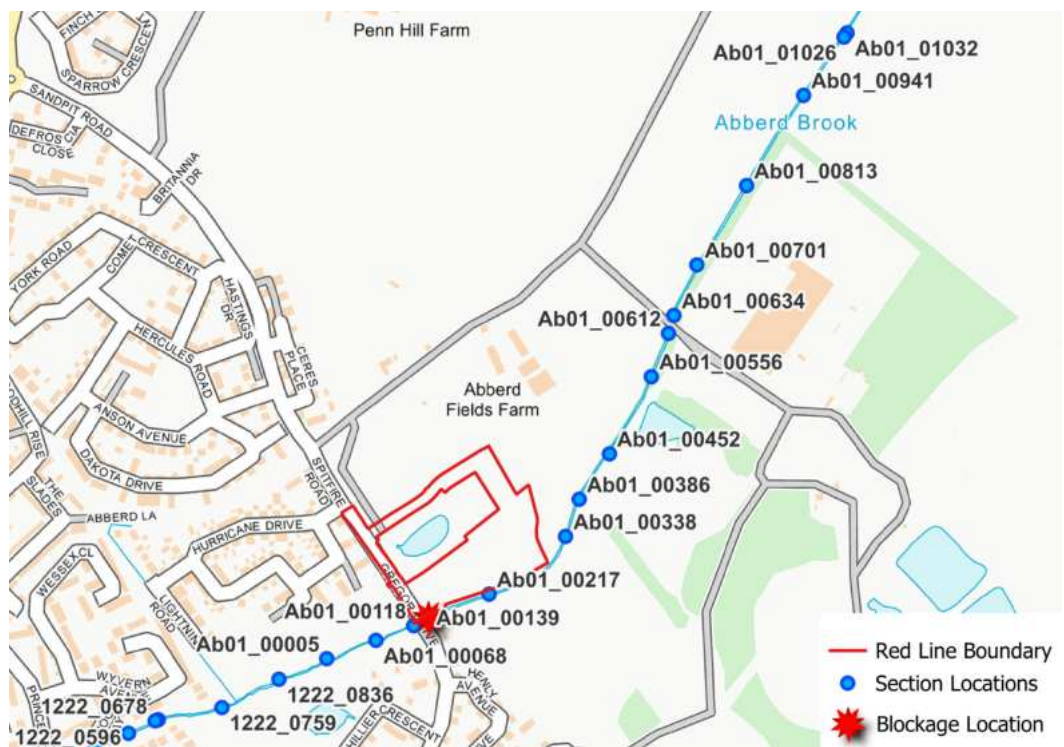


Figure 22: Blockage Location



Figure 23: Gregor Drive Culvert Entrance

In the 20% blockage scenario the peak level at Node AB01_00217 adjacent to the site increases from 72.086mAOD to 72.112mAOD an increase of 26mm, as shown in Figure 24 this has limited impact on the flood extent in the 2D domain. In the 50% blockage scenario the peak level at Node AB01_00217 adjacent to the site increases from 72.086mAOD to 72.224mAOD an increase of 138mm, there is a greater impact on the flood extent in the 2D domain shown in Figure 24 but this is confined to the portion of the site adjacent to Gregor Drive and within the 0.1% AEP outline and where no residential development is proposed.



*Chris Whitlow
& Associates*

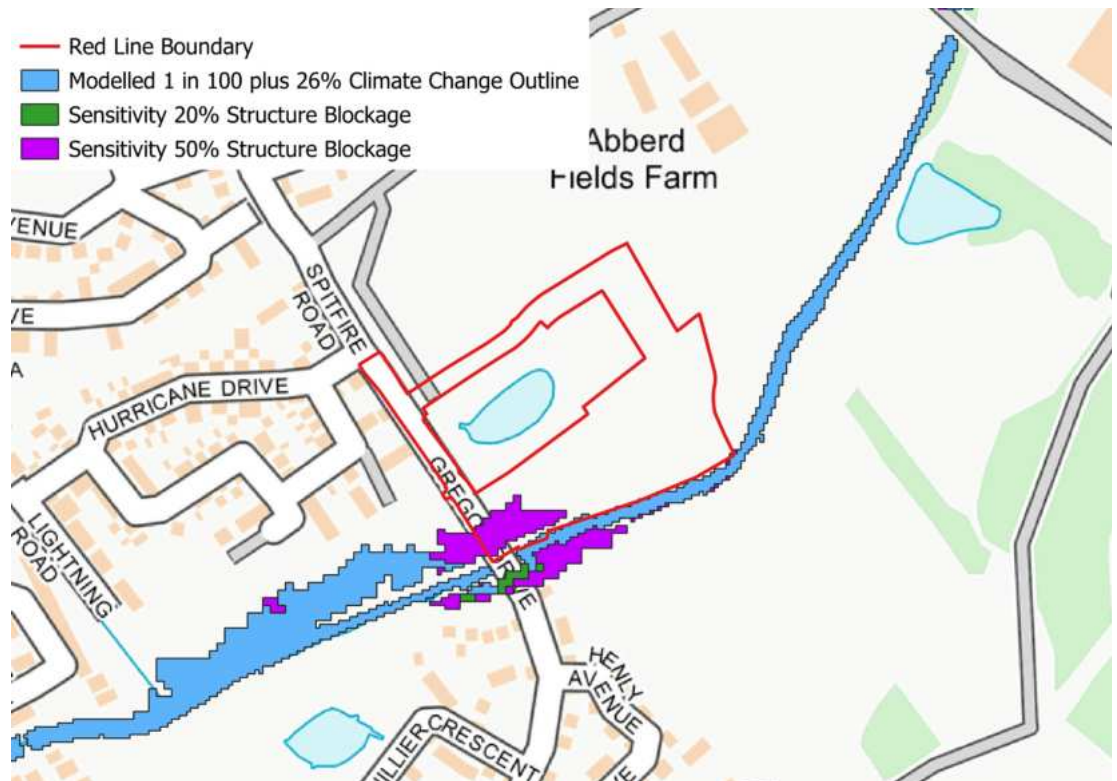


Figure 24: Blockage Sensitivity Results

Environmental Consultancy | www.chriswassocs.com

Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

Registered in England & Wales No 15113786 | VAT Number 448376884

7. Model Calibration, Stability & Limitations

7.1 Calibration

No additional information was available to calibrate the new model and Manning roughness values have been matched with those in the existing EA 2017 model. This model was calibrated to historical flood extents and photographs including those available for Calne.

Apart from out of bank flooding due to culvert blockage, no out of bank flooding was reported by the landowner.

While not a formal calibration, it is noted that the flood zone mapping model for the 1 in 1000 year return period (0.1%AEP) flood event from the new model are very similar to the Environment Agency's existing flood zone mapping.

7.2 Stability

The model simulations completed satisfactorily with limited 1D non-convergence (see Figure 25). The non convergence observed is appears to consistently be associated with the change of mode of a structure on the Marden upstream of the Abberd Brook confluence and has negligible impact on flows or levels within the Abberd Brook.



Chris Whitlow
Associates

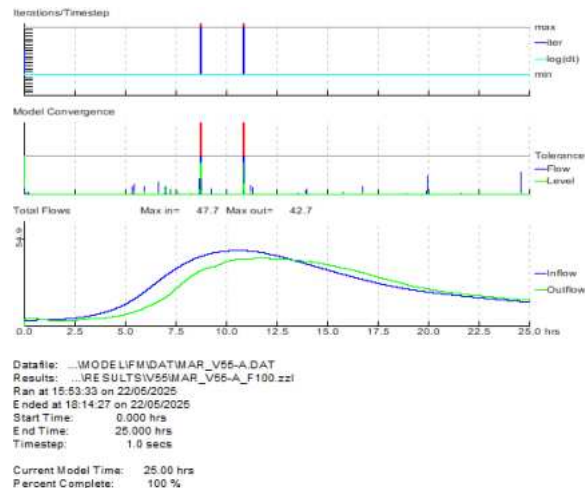


Figure 25: 1D Convergence Plot

The 1D results show that the mass balance error for all AEPs is less than 1% (within the specified tolerance). Mass balance errors of less than 1% indicate a stable model with no areas of concern. The values observed above are acceptable considering the overall performance of the model.

The cumulative mass error reports output from the TUFLOW 2D model have been checked for all simulated events. Figure 26 shows that for most of the 1% AEP flood event the cumulative mass error is well within this tolerance range. The spike of the mass error at the beginning of the simulation is expected and relate to when the water flows from 1D to 2D and does not affect the peak values and results.

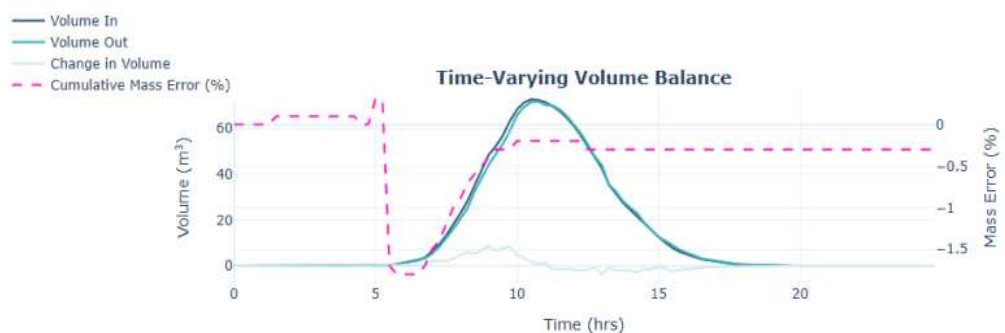


Figure 26: 1% AEP Cumulative Mass Error

Consequently the updated model is considered both healthy and stable.

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Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

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7.3 Limitations

The model 2D resolution is 5 metres, which might artificially lower or raise modelled elevations for observed topography at a higher resolution.

The sensitivity testing has shown that the model is slightly sensitive to changes in model inflow and blockage and slightly sensitive to roughness, as would be expected.

The modelling exercise has made best use of the available data at the time of model construction and simulations. There is one EA gauge in the Abberd Brook catchment, located immediately upstream of the Prince Charles Drive culvert which suggests it's purpose is to monitor the impact of blockage at this location rather than to calculate flows. No rating for the gauge is available. The gauge has only been operational for two complete hydrological years and no out of bank flood events have occurred during this period.

The baseline model results are consistent with the lack of out of bank flooding that has been reported. It produces very similar results to the existing EA flood zone mapping.



Environmental Consultancy | www.chriswassocs.com

Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

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8. Conclusions

An updated hydraulic model has been developed for the River Marden catchment by truncation of the existing Chippenham and Calne model, developed by Edenvale Young Associates for the Environment Agency in 2017.

This model has been improved for the Abberd Brook watercourse by inclusion of 16 new surveyed cross sections and three new structures.

The new model has double the grid resolution of the existing Chippenham and Calne model which has been achieved by reduction of the model grid size from 10m to 5m.

Additionally the new Marden-only model includes the latest Environment Agency LiDAR data, flown in 2022.

The new model has also benefitted from further hydrological analysis, developed in accordance with the latest EA hydrological guidance.

Mapping results from the new model are fully consistent with flood zones calculated from the supplied 2017 EA model.

The new model results indicate slightly greater but very similar extents when compared with the existing EA Flood Zone 2 mapping for the proposed development site as well as upstream and downstream reaches on the Abberd Brook.

It is a 1D/2D Flood Modeller/TUFLOW model which accords with Environment Agency best practice for hydraulic modelling.

The model results agree well with both the lack of reports of recent flooding in the catchment.

9. Recommendations

The results from the new model could be used to update the current (May 2025) Environment Agency fluvial mapping for the Abberd Brook catchment as they include additional cross section and survey data as well as being of finer grid resolution and using the latest (202?) Environment Agency LiDAR data.



Appendix A: Survey Drawings

Environmental Consultancy | www.chriswassocs.com

Chris Whitlow & Associates Limited, 29 Oakwood Road, Henleaze, Bristol, BS9 4NP

T: +44 (0) 7976 365017 | E: chris@chriswassocs.com

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