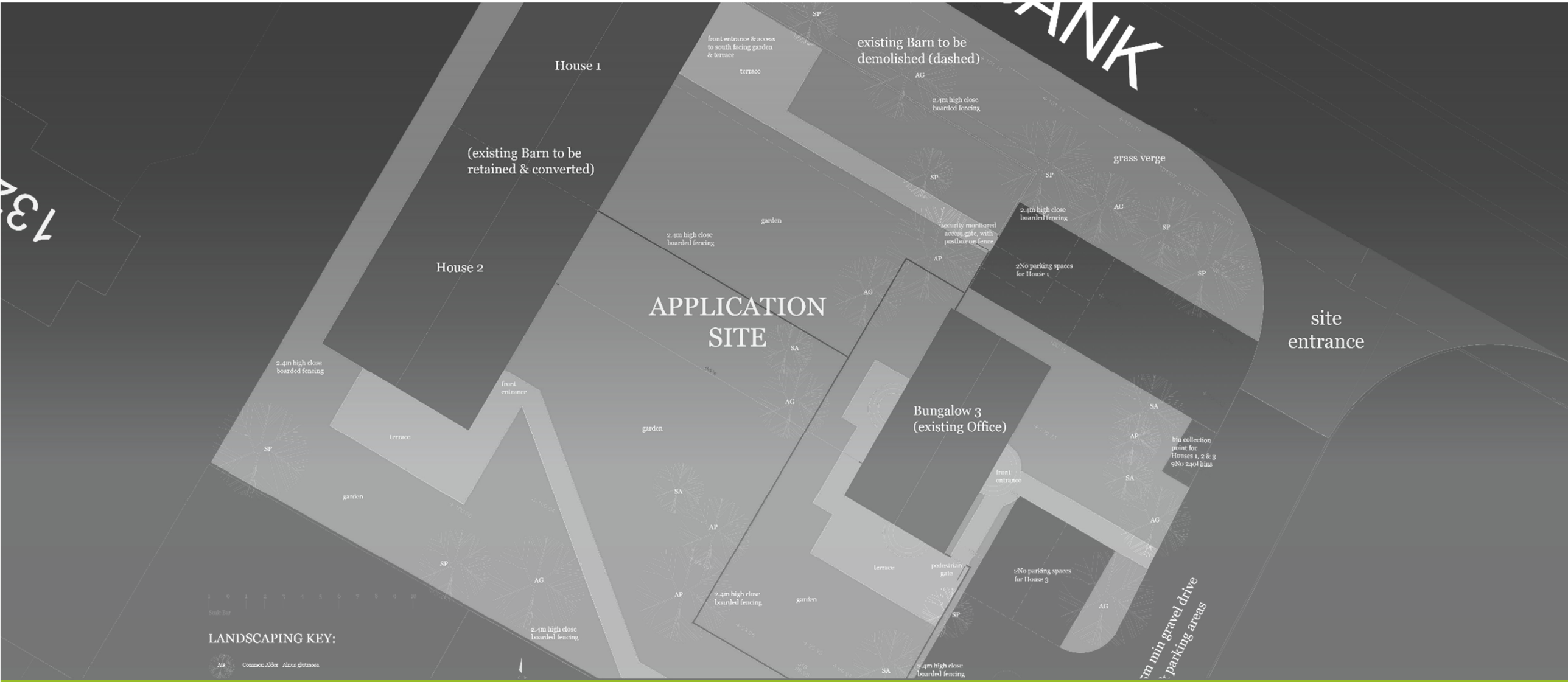

FLOOD RISK ASSESSMENT (FRA) & SUSTAINABLE DRAINAGE SYSTEMS (SuDS) FOR PLANNING- MARCH 2022

132 COCK BANK

132 COCK BANK
WHITTLESEA, PETERBOROUGH
PE7 2HN
UK

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132 COCK BANK WHITTLESEA, PETERBOROUGH PE7 2HN, UK
FLOOD RISK ASSESSMENT
SUSTAINABLE URBAN DRAINAGE SYSTEMS REPORT

ECO STUDIO Ltd - Registered in England No. 07610136
ECOstudio XV LTD is registered with BRE Global no BREC400198
and QUIDOS: QUID201107

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ARCHITECT:	FENLAND ARCHITECTURAL DESIGN
PROJECT TITLE:	132 COCK BANK
REPORT:	FLOOD RISK ASSESSMENT AND SUSTAINABLE URBAN DRAINAGE SYSTEMS REPORT
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4	29TH March 2022	**SCHEME UPDATE**

CONTENTS

1. INTRODUCTION

4

1. INTRODUCTION

INTRODUCTION

This report was commissioned by Fenland Architectural Design, on behalf of Mr Dempsey to provide a site specific to Flood Risk Assessment (FRA), including Sustainable Drainage Systems (SuDS) strategies to support the planning application for the proposed development located at 32 Cock Bank Whittlesea, Peterborough PE7 2HN, UK

ECOstudio XV Ltd, has prepared this FRA and SUDs report in line with the following guidance:

- National Planning Policy Framework (NPPF).
- Environment Agency Guidelines for Flood Risk Assessments for Planning.
- Flood Risk Assessment in Flood Zone 3.
- Fenland District Council
- Cambridgeshire County Council and Fenland District Council.

Government policy with respect to development in flood risk areas is contained within, the National Planning Policy Framework (NPPF) and its Technical Guidance, which was issued on March of 2012, replacing Planning Policy 25 (PPS25).

The Local Planning Authority will make the final decision regarding any planning application. The Environmental Agency has the lead role in providing advice on flood issues at a strategic level and in a relation to planning applications, and is a statutory consultee to the planning process.

The proposed development site lies within Zone 3a of the Environment Agency Flood Map, being the zone with risk of 1 in 100 years (1% AEP) or greater for river flooding and 1 in a 200 annual probability (0.5% AEP) or greater for tidal/coastal flooding

A Flood Risk Assessment (FRA) should be produced to determine the risks of flooding at a development site or the likely impact on neighbouring sites or receiving watercourses from increased site runoff or drainage. As such a FRA is an essential element in the overall assessment of the economic viability of the development as well as its acceptability in planning terms.

To minimize the impact of the proposed development and potential increase in surface water run off, ECOstudio LTD has prepared a Sustainable Urban Drainage System (SUDs) strategy and report. Using the SuDS listed below there would be **25.49** m3 of storage. This would achieve the requirements of more than 100% reduction in existing run off +35% climate change which is 21.34 m3.

Resilient measures in the extreme case of ground floor flooding have been included in the report. Particular attention should be taken to a water resistant wall base 850mm high from ground floor finished floor elevation. This would protect the proposed development in an extreme case of flooding. **PLEASE NOTE THAT THE ENVIRONMENT AGENCY STATED THEY DO NOT HAVE SPECIFIC FLOOD LEVELS FOR THIS SITE, therefore ECOstudio XV Ltd has taken flood levels from the nearest point, which is Mid Ouse (East of Bedfor to Roxton).**

There are several types of flooding that are taken into account when making the assessment. These are explained below.

- **River Flooding**: River flooding occurs when rivers and streams are unable to carry away floodwaters within their usual drainage channels. River flooding can cause widespread and extensive damage because of the sheer volume of water.

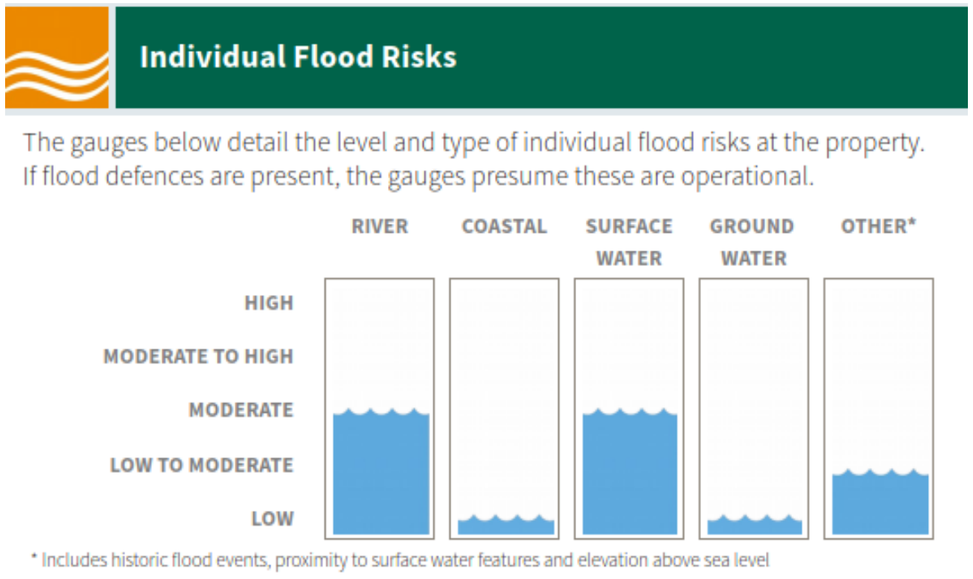
- **Coastal Flooding**: Coastal flooding results from a combination of high tides, low lying land and sometimes stormy conditions. Coastal flooding can cause widespread and extensive damage because of the sheer volume of water.

- **Surface Water Flooding**: Surface water flooding is common during prolonged or exceptionally heavy downpours, when rainwater does not drain away into the normal drainage systems or soak away into the ground.

- **Ground Water Flooding**: Groundwater flooding generally occurs during long and intense rainfall when underground water levels rise above surface level. Groundwater flooding may last for weeks or several months.

- **Other Flooding**: We analyze any historic flood events records, the proximity of the property to surface water features and the elevation of the property above sea level to enhance our overall analysis of the property.

FIGURE 01 – FLOOD RISKS BY LANDMARK FOR THIS SITE.



2. SITE LOCATION
EXISTING CONDITIONS

2. SITE LOCATION- EXISTING CONDITIONS

SITE LOCATION

The site of proposed development is located at 132 Cock Bank Whittlesea, Peterborough PE7 2HN, UK. The site coordinates are Latitude 52.5306 N and Longitude -0.03817 W. The site location is shown in red colour in the maps below.

FIGURE 2- SITE LOCATION PLAN IN RED MASK – RED OUTLINE BALANCE OF LANDHOLDING

FIGURE 3- SITE LOCATION MAP

FIGURE 4- SITE LOCATION IN RED MASK – AERIAL VIEW- RED OUTLINE BALANCE OF LANDHOLDING

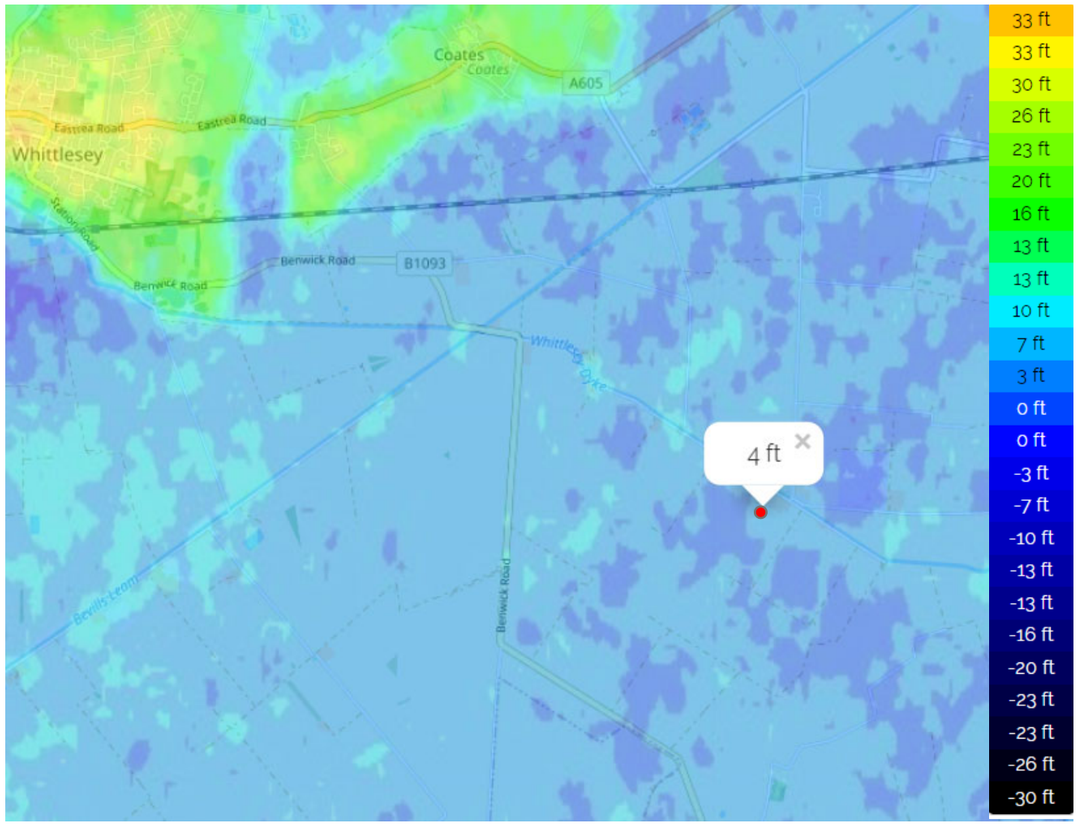
2. SITE LOCATION- EXISTING CONDITIONS

TOPOGRAPHY

The map below provides an idea of the topography and contour where the proposed development is located.

The site located at 132 Cock Bank, Peterborough, PE7 2HN at an elevation of approximately 4 ft above Ordnance Survey; the access to the site is from is Cock Bank.

FIGURE 5 –ELEVATION MAP- THE SITE LOCATION IS SHOWN IN RED DOT.



Site shown in red

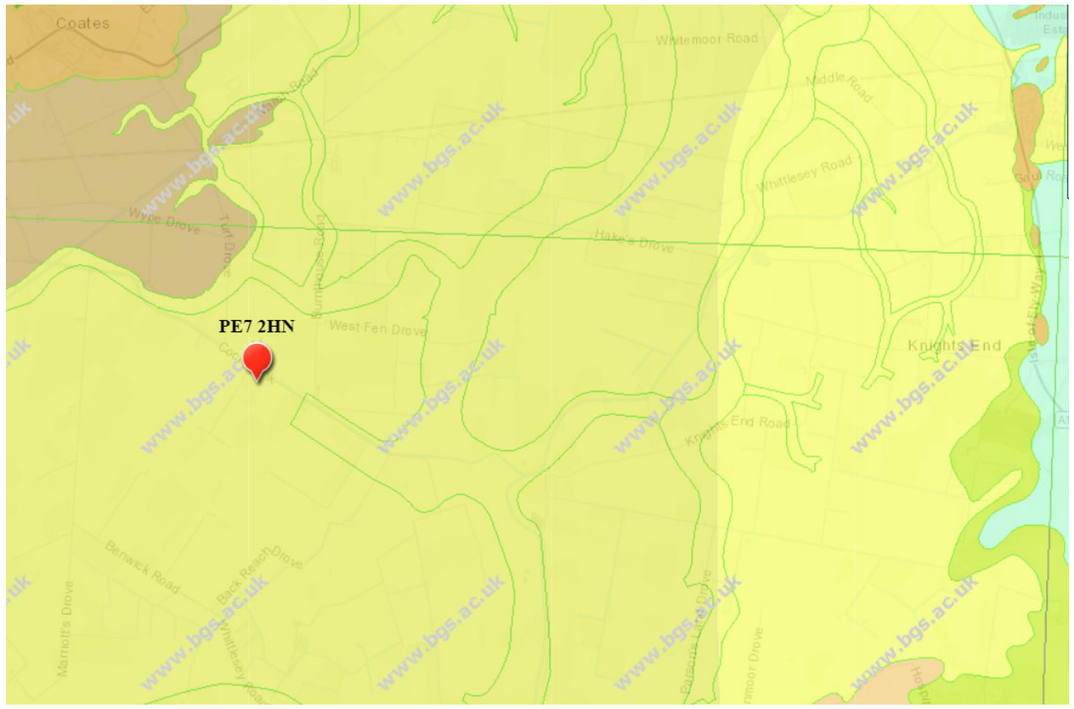
GEOLOGY

The site is located in the Tidal Flat Deposits with superficial deposits of clay and silt. Local environment previously dominated by shorelines.

The bedrock geology is Oxford Clay Formation - Mudstone. Sedimentary Bedrock are shallow-marine in origin. They are detrital, ranging from coarse- to fine-grained (locally with some carbonate content) forming interbedded sequences.

The surface layer normally a consolidated soft silty clay, with layers of peat, sand and a basal gravel. A stronger, desiccated surface zone is sometimes present.

FIGURE 6 –GEOLOGY MAP. BRITISH GEOLOGICAL SURVEY
THE SITE LOCATION IS SHOWN IN RED COLOUR IN THE MAP BELOW.



LEGEND

Tidal Flat Deposits - Clay and silt

2. SITE LOCATION- EXISTING CONDITIONS

3.1. SITE LOCATION AND EXISTING & PROPOSED CONDITIONS

SITE LOCATION

The site of proposed development is located at 132 Cock Bank Whittlesea, Peterborough PE7 2HN, UK. The site coordinates are Latitude 52.5306 N and Longitude -0.03817 W.

SITE PLAN AS EXISTING

- The total site area as existing is 1,903.74 m2
- Roof impermeable area 493.92 m2
- Permeable area 1229.91 m2
- Garden 179.91 m2

The total impermeable area as existing is 493.92 m2
The total permeable area as existing is 1409.82 m2

Figures 7no to 8no show the plans for the development as existing and proposed.

FIGURE 7 –GROUND FLOOR SITE PLAN AS EXISTING

KEY TO SITE PLAN

Garden / Green Area
179.91 m2

Impermeable Area
(Roof) 493.92 m2

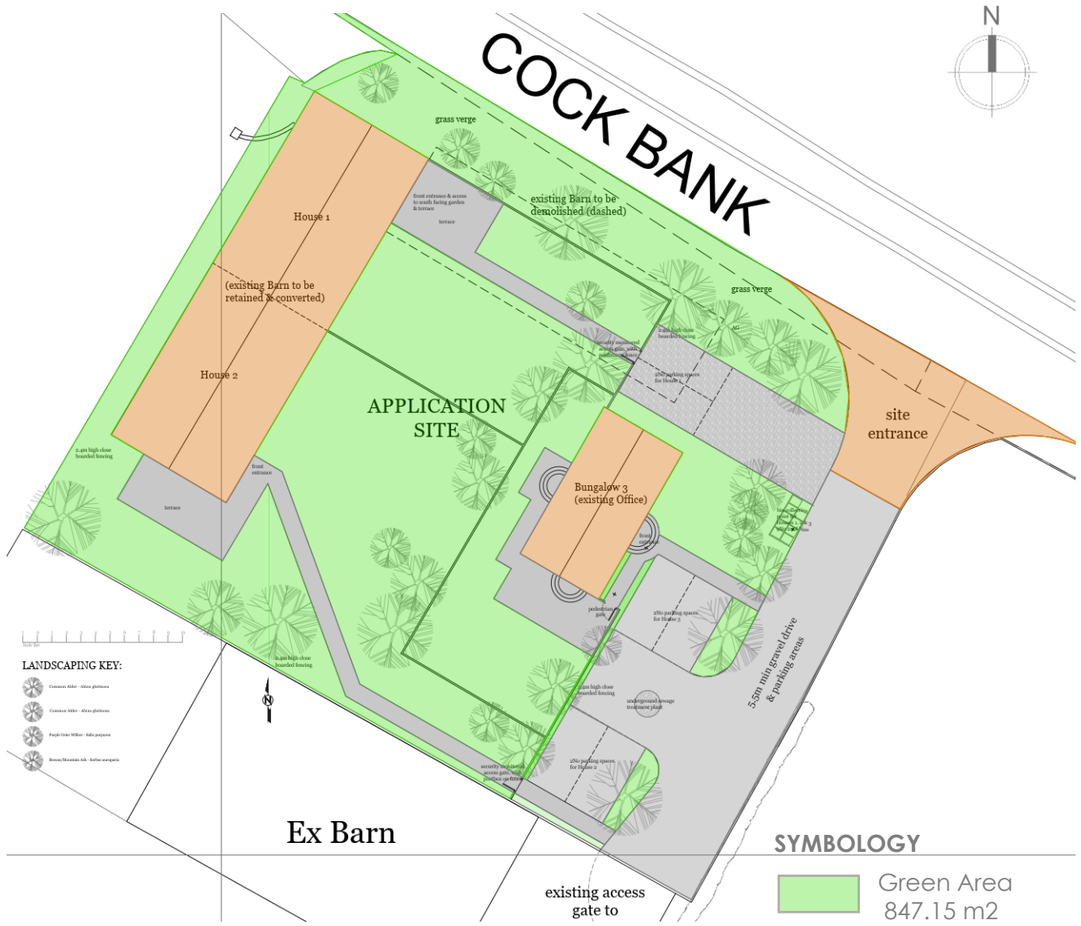
Permeable Paving Areas
1409.82 m2

3. PROPOSED CONDITIONS

10

3. PROPOSED DEVELOPMENT

FIGURE 8 – ROOF SITE PLAN AS PROPOSED



SITE PLAN AS PROPOSED

The proposed development consists of the creation of 3 x dwellings: Conversion of existing barn to 2 x dwellings (2 x 2-storey 3-bed), erect 1 dwelling (1 x 1-storey 1-bed), 2.4m high boundary fence, the formation of a new access, involving and the demolition of an existing barn and office at Buildings South East of 132 Cock Bank Turves Cambridgeshire.

The proposed development consists of the following:

- Roof impermeable area 424.47 m2
- Permeable 565.37 m2
- Green area 847.15 m2

The total impermeable area as proposed is 424.47 m2
The total permeable area as proposed is 1,479.27 m2

3. PROPOSED DEVELOPMENT

3.2 DEVELOPMENT PLANNING BACKGROUND AND STRATEGIC FLOOD RISK ASSESSMENT

Following enquiries, the Environment Agency has confirmed that the site is located within Flood Zone 3 (an area with a high probability of flooding that benefits from flood defences.). Shown as 'blue' on the Flood Map. A detailed flood risk assessment is necessary to rule out possible risks from other sources.

Flood Zone	Definition
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map)

3.3 EXISTING FLOOD DEFENCES

The area benefits from flood defences maintained by the Environmental Agency. Land and property in this flood zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

3.4 HISTORIC RECORDS

Data provided by the Environment Agency indicates that the property is not in or within 250 metres of an area that has flooded in the past. This includes all types of flooding.

1.06 **Historic Flooding** — PASS

Data provided by the Environment Agency indicates that the property is not in or within 250 metres of an area that has flooded in the past. This includes all types of flooding, including Groundwater. However, we would always recommend asking the vendor to confirm whether or not they are aware of any previous flooding at the property.

Please see the previous sections for the Flood Risk as of the date of this report.

3.5 VULNERABILITY CLASSIFICATION

According to Table 1 from PPS 25, the proposed development is classified as being "More Vulnerable". This type of development is allowable in this Flood Zone, subject to the sequential and exception test being passed.

TABLE 1. FLOOD RISK VULNERABILITY CLASSIFICATION

	• Hospitals, residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
More Vulnerable	• Buildings used for dwellings, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping.
	• Non–residential uses for health services, nurseries and education. • Landfill and waste management facilities for hazardous waste.

FIGURE 09 – FLOOD ZONES OVERVIEW BY ENVIRONMENT AGENCY

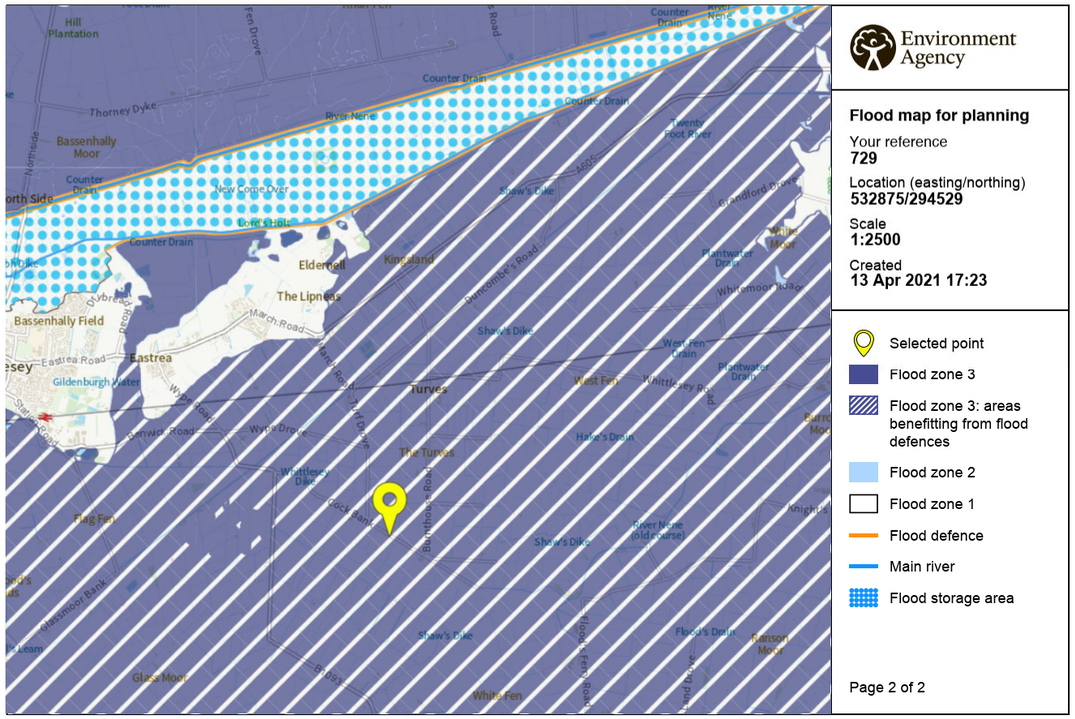


Table 2.2 Flood Risk Vulnerability and Flood Zone Compatibility

Vulnerability classification		Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception test	✔	✔
	Zone 3a	Exception test	✔	x	Exception test	✔
	Zone 3b	Exception test	✔	x	x	x

Key: ✔ Development is appropriate x Development should not be permitted (Source: PPS25 Table D3)

4. FLOOD RISK ASSESSMENT

4.1 EXISTING INFORMATION ON FLOOD RISK

4.1.1 FLOODING FROM RIVERS OR THE SEA

Streams and Rivers: Flooding that can take place from flows that are not contained within the channel due to high levels of rainfall in the catchment.

Coastal or Estuarine: Flooding that can occur from the sea due to a particularly high tide or surge, or combination of both.

Flood map of the Environment Agency shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding the cannot completely remove that risk as they may be over topped or beached during flood event.

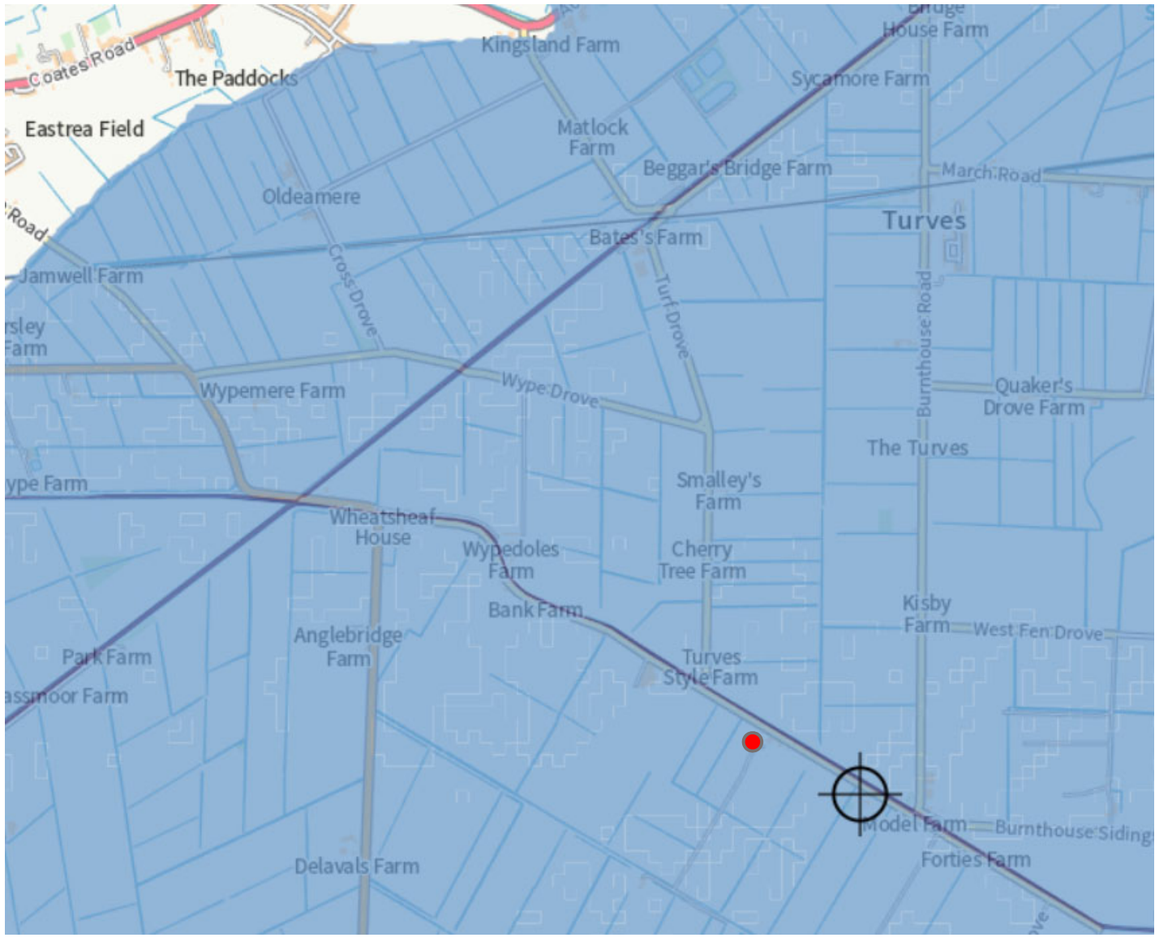
The flood map indicates a Medium Risk, which means that each year this area has a chance of flooding from rivers or the sea to be less than 1 in 30 (3.3%) but greater than 1 in 100 (1%) in any given year.

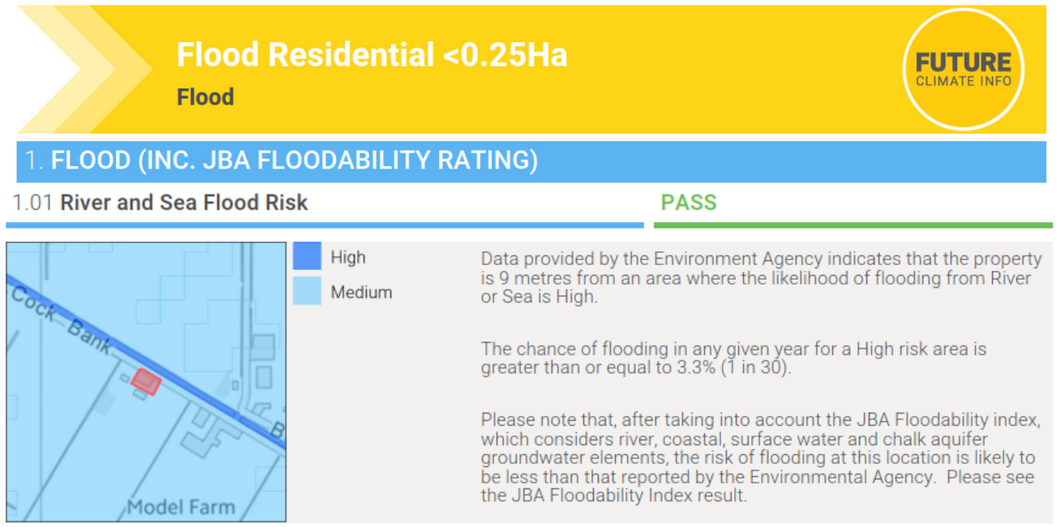
The flood map shows that this property is not within the current "extreme flood outline".

Data provided by the Environment Agency indicates that the property is 9 metres from an area where the likelihood of flooding from River or Sea is High.

The chance of flooding in any given year for a High risk area is greater than or equal to 3.3% (1 in 30)

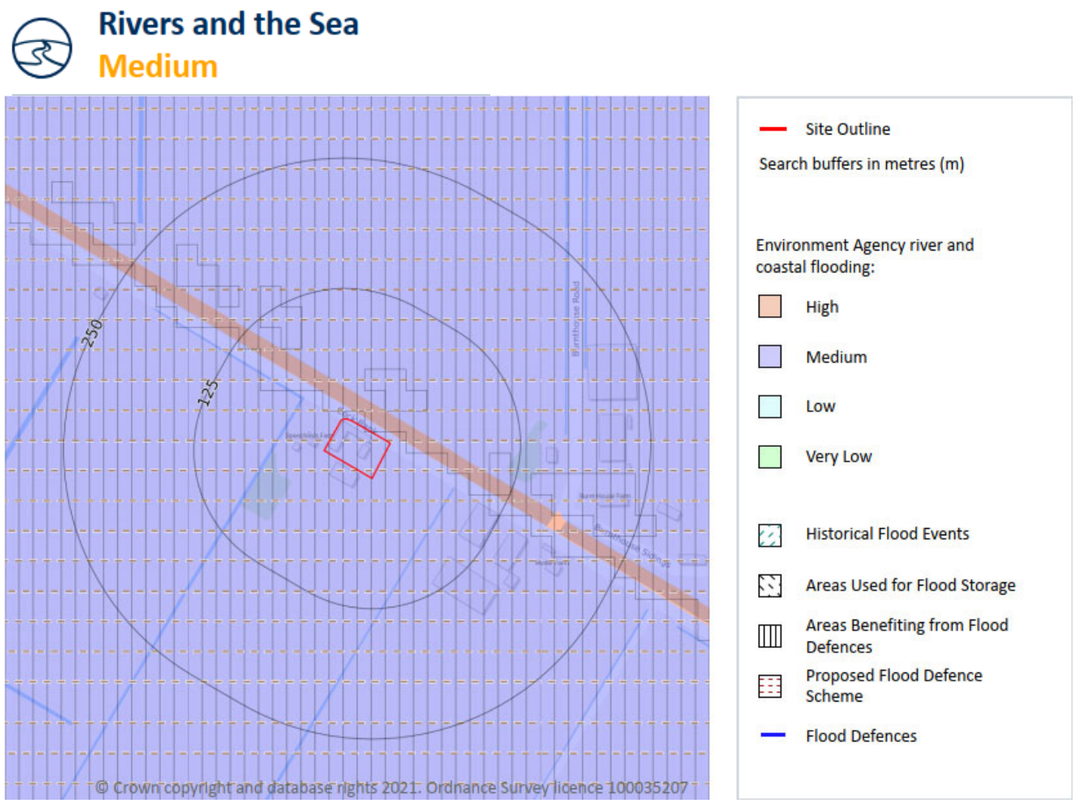
FIGURE 10 – FLOOD RISK FROM RIVERS OR SEA BY ENVIRONMENT AGENCY





4.1 EXISTING INFORMATION ON FLOOD RISK

FIGURE 11 – FLOOD RISK FROM RIVERS OR SEA BY GROUNDSURE FLOOD



Data provided Groundsure Flood indicates that the property has a Medium chance of flooding in any given year, according to Risk of Flooding from Rivers and Sea (RoFRaS).

FLOOD DEFENCES

Areas benefiting from flood defences. The property is located in an area benefiting from flood defences. These areas would flood if the defence were not present, but may not do so as it is. This means the area has major flood defences that may protect properties from flooding during a 1% river (fluvial) or 0.5% coastal flood event. We recommend discussing all flood defence in place as part of your discussions with insurance providers.

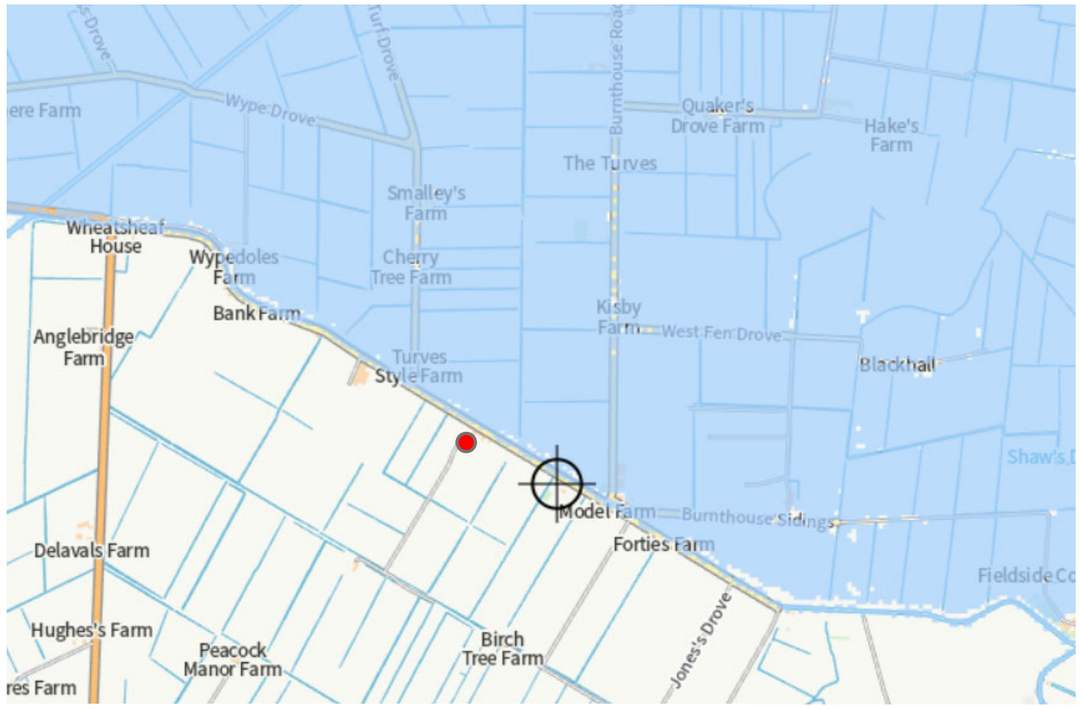
Data provided by Landmark confirms the existence of flood defences.

Flood Defences

Are there existing river/coastal flood defences that have been identified and taken into account in our overall risk assessment?	**Yes**

4.1 EXISTING INFORMATION ON FLOOD RISK

FIGURE 12 – FLOOD RISK FROM RESERVOIRS BY ENVIRONMENT AGENCY



Extent of flooding from reservoirs

Maximum extent of flooding Location you selected

1.04 **Surface Water Features** — PASS

Water Features

The Ordnance Survey Map indicates that the nearest body of surface water (such as a stream, river, canal, reservoir, lake or pond) is located 9 metres from the property boundary.

4.1.2 FLOOD RISK FROM RESERVOIRS OR CANALS

Reservoir flooding is extremely unlikely to happen. The shading on the map (if present) would show the area that could be flooded if a large reservoir were to fail and release the water it holds.

A large reservoir is one that holds over 25,000 cubic meters of water, equivalent to approximately 10 Olympic sized swimming pods.

The flood map indicates a Medium risk. Medium risk means that each year this area has a chance of flooding of between 1% and 3.3%.

The Ordnance Survey Map indicates that the nearest body of surface water (such as a stream, river, **canal**, reservoir, lake or pond) is **located 9 metres from the property boundary**.

Data provided by the Environment Agency indicates that the property is not located within 25 metres of a Flood Storage Area (land designed and operated to store flood water).See below an extract from their report for further details.

The property is NOT located in the potential path which water would follow if a reservoir dam or embankment was to fail.

Flood Residential <0.25Ha

Flood

FUTURE CLIMATE INFO

1. FLOOD (INC. JBA FLOODABILITY RATING)

1.07 **Flood Storage** — PASS

Data provided by the Environment Agency indicates that the property is not located within 25 metres of a Flood Storage Area (land designed and operated to store flood water).

1.08 **Dam Break** — PASS

Data provided by JBA identifies areas of England and Wales that are most likely to suffer damage to property following the sudden and catastrophic failure of a large reservoir embankment or dam. This is a worst case scenario, it's unlikely that any actual flood would be this large. The flooding is predicted using advanced modelling techniques to ascertain if a property or site is potentially at risk in such an event, although not all dams were modelled.

This property is not located in an area modelled by JBA as being in the potential path of water if a reservoir dam or embankment was to fail.

4.1 EXISTING INFORMATION ON FLOOD RISK

4.1.3 FLOOD RISK FROM SURFACE WATER

Surface water: Is the net rainfall falling on a surface (on or off the site) which acts as runoff which has not infiltrated into the ground or entered into a drainage system. Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground but lies on or flows over the ground instead.

Overland flow occurs following heavy or prolonged rainfall where intense rainfall is unable to soak into the ground or enter drainage systems due to blockages or capacity issues. It can also be because of sewers surcharging due to blockages rather than extreme rainfall events.

Unless it is channeled elsewhere, the run-off travels overland, following the gradient of the land. Ponding occurs as the overland flow reaches low lying areas in the local topography.

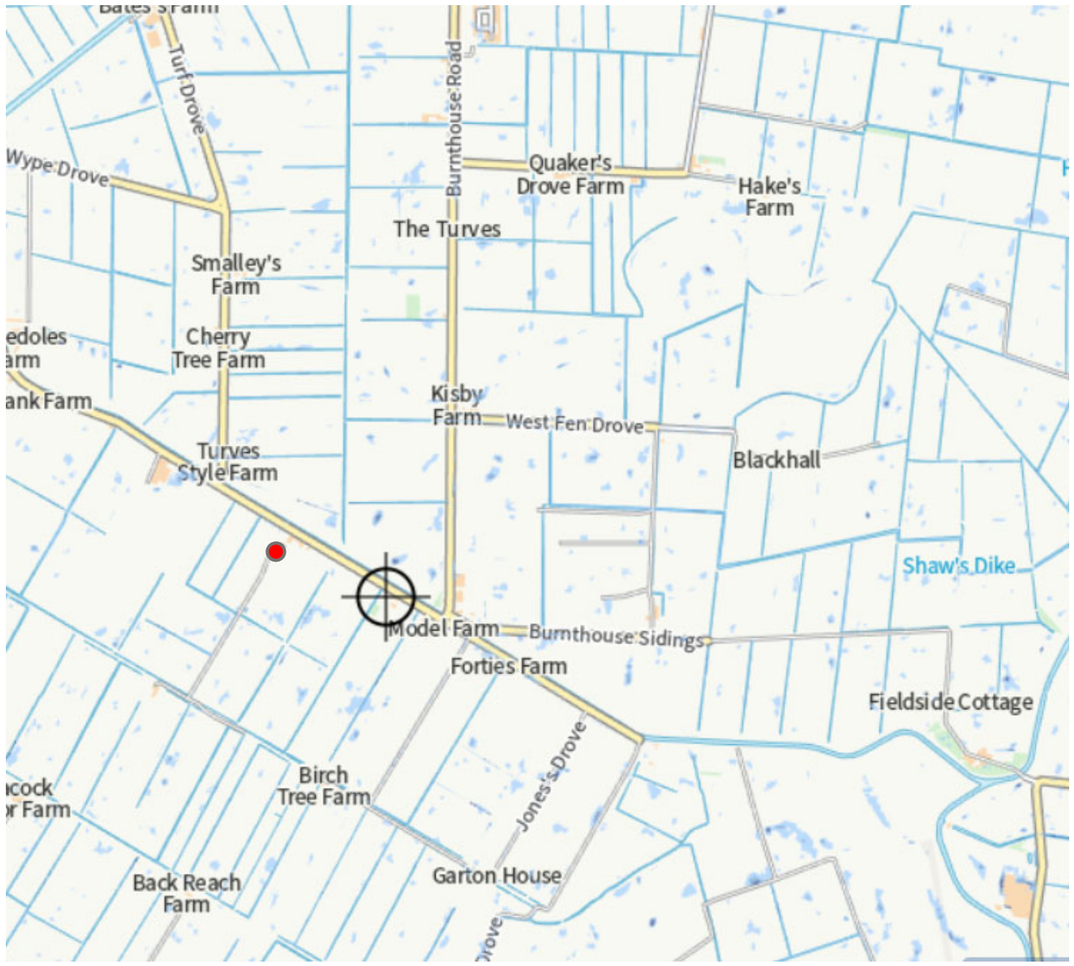
These flood events tend to have a short duration and depend on a number of factors such as geology, topography, rainfall, saturation, extent of urbanisation and vegetation.

The risk of flooding surface water map shows the spatial distribution of the closest flooded areas.

According to the data provided by the Environment Agency (Figure 13), the Flood risk from surface water is Very low risk, this means that each year this area has a chance of flooding of between 0.1% and 1%.

Data provided by JBA Risk Management Ltd (JBA) indicates that there is a negligible risk of Surface Water flooding within 5 metres of the property.

FIGURE 13 –FLOOD RISK FROM SURFACE WATER BY ENVIRONMENT AGENCY



Flood Residential <0.25Ha

Flood

FUTURE CLIMATE INFO

1. FLOOD (INC. JBA FLOODABILITY RATING)

1.02 **Surface Water Flood Risk** PASS

Surface water flooding occurs when heavy rainfall overwhelms the drainage capacity of an area. In these instances, the rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

Data provided by JBA Risk Management Ltd (JBA) indicates that there is a negligible risk of Surface Water flooding within 5 metres of the property.

4.1 EXISTING INFORMATION ON FLOOD RISK

4.1.4 FLOOD RISK FROM SEWERS, HIGHWAY DRAINS OR OTHER ARTIFICIAL SOURCES

Sewers and highway drains: Combined, foul or surface water sewers and highway drains that are temporarily over-loaded due to excessive rainfall or due to blockage.

Infrastructure failure: Canals, reservoirs, industrial processes, burst water mains, blocked sewers or failed pumping stations.

HISTORIC RECORDS

Anglian Water Services Limited has confirmed that the 132 Cock Bank, Peterborough PE7 2HN site has no incidents on record of flooding due to overloaded public sewers.

COMMERCIALDW
DRAINAGE AND WATER ENQUIRY

GEODESYS 20 YEARS OF EXCELLENCE

Order Reference:G2633590-3
Produced on:06 May 2021

GEODESYS
Land and property information

Question 2.8 Is any building which is or forms part of the property at risk of internal flooding due to overloaded public sewers?

Answer	The property is not recorded as being at risk of internal flooding due to overloaded public sewers. On 1 October 2011 private sewers, disposal mains and lateral drains were transferred into public ownership. It is therefore possible that a property may be at risk of internal flooding due to an overloaded public sewer which Anglian Water may not be aware of. For further information it is recommended that enquiries are made of the vendor as to any previous flooding occurances.
Informative	A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (eg. Flat gradient, small diameter). Flooding as a result of temporary problems such as blockage, siltation, collapses, and equipment or operational failures are excluded. "Internal flooding" from public sewers is defined as flooding which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes. "At Risk" properties are those that the water company has included in its Register of properties at risk of sewer flooding. These are defined as properties that have suffered flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company's reporting procedure. Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the Flood Risk register. Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the company. Public sewers are defined as those for which the company holds statutory responsibility under the Water Industry Act 1991. It should be noted that flooding can occur from private sewers and drains which are not the responsibility of Anglian Water Services Limited. This report excluded flooding from private sewers and drains and Anglian Water Services Limited makes no comment upon this matter. For reporting purposes buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.

FIGURE 14 –Asset Location Search Sewer Map

Site shown in red

4.1 EXISTING INFORMATION ON FLOOD RISK

4.1.5 FLOOD RISK FROM GROUNDWATER

Groundwater flooding occurs as a result of water rising from the underlying aquifer from water flowing from springs. This tends to occur after long periods of high-quality rainfall, and the areas at most risk are often low-lying where the water table is most likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers, if it is increasingly associated with more localized floodplain sands and gravels.

Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding.

It is also important to consider the impact of groundwater level conditions on other types of flooding e.g. fluvial, pluvial and sewer. High groundwater level conditions may not lead to widespread groundwater flooding. However, they have the potential to exacerbate the risk of pluvial and fluvial flooding by reducing rainfall infiltration capacity, and to increase the risk of sewer flooding through sewer / groundwater interactions.

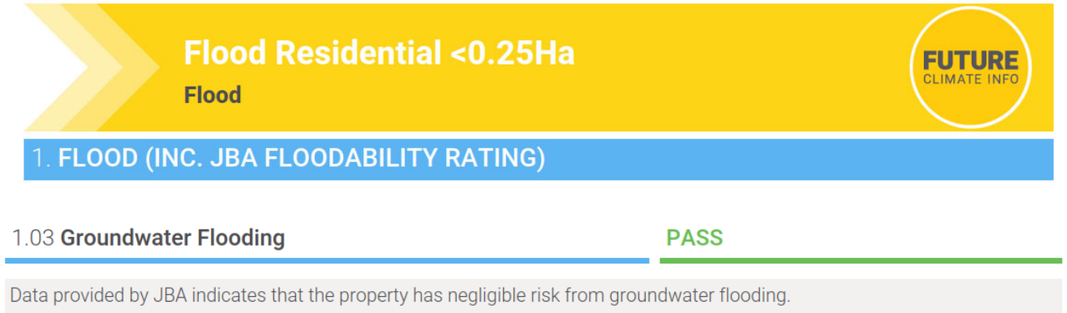
The Fenland District Council Strategic Flood Risk Assessment indicates no records of historical groundwater flooding in this area have been found.

> "The Oxford Clay Formation, West Walton & Ampthill Clay Formations and the West Walton are aquicludes and do not permit groundwater flow.
>
> The sand and gravel drift deposits are likely to behave as aquifers, containing perched groundwater tables where they overlie aquitards or aquicludes. The role of the head deposits is uncertain and is likely to be variable, although they probably allow some groundwater flow. The peat, tidal flats and till are expected to behave as aquitards i.e. relative to the aquifer units, they do not permit significant groundwater flow.

The Environment Agency Catchment Flood Management Plans (CFMP) present the status of flooding and can often provide locations that have experienced past flooding. Neither, the River Nene or Great Ouse CFMP indicate groundwater flooding problems within the Fenland DC area.

Based on the above, the site for the proposed development lies within zone with low probability of flooding for groundwater.

Data provided by JBA indicates that the property has negligible risk from groundwater flooding.



4.1 EXISTING INFORMATION ON FLOOD RISK

4.1.6 ASSESSMENT OF CLIMATE CHANGE IMPACT ON FLUVIAL FLOODING

Table A below indicates the level of technical assessment of climate change impacts on fluvial flooding appropriate for new developments depending on their scale and location. Table A defines three possible approaches to account for flood risk impacts due to climate change, in new development proposals:

According to table A the approached to follow is BASIC: Developer can add an allowance to the 'design flood' (i.e. 1% annual probability) peak levels to account for potential climate change impacts.

Table A – Indicative guide to assessment approach

VULNERABILITY CLASSIFICATION	FLOOD ZONE	DEVELOPMENT TYPE		
		MINOR	SMALL-MAJOR	LARGE-MAJOR
ESSENTIAL INFRASTRUCTURE	Zone 2	Detailed		
	Zone 3a	Detailed		
	Zone 3b	Detailed		
HIGHLY VULNERABLE	Zone 2	Intermediate/ Basic	Intermediate/ Basic	Detailed
	Zone 3a	Not appropriate development		
	Zone 3b	Not appropriate development		
MORE VULNERABLE	Zone 2	Basic	Basic	Intermediate/ Basic
	Zone 3a	Intermediate/ Basic	Detailed	Detailed
	Zone 3b	Not appropriate development		
LESS VULNERABLE	Zone 2	Basic	Basic	Intermediate/ Basic
	Zone 3a	Basic	Basic	Detailed
	Zone 3b	Not appropriate development		
WATER COMPATIBLE	Zone 2	None		
	Zone 3a	Intermediate/ Basic		
	Zone 3b	Detailed		

NOTES:

- Minor: 1-9 dwellings/ less than 0.5 ha | Office / light industrial under 1ha | General industrial under 1 ha | Retail under 1 ha | Gypsy/traveller site between 0 and 9 pitches

Where the Environment Agency and the applicant and their consultant has agreed that a "basic" level of assessment is appropriate the figures in Table B below can be used as a precautionary allowance for potential climate change impacts on peak 'design' (i.e. 1% annual probability)

Table B – Local precautionary allowances for potential climate change impacts

Cambridgeshire and Bedfordshire

Watercourse / Model	Central	Higher Central	Upper End
Alconbury Brook	600mm	700mm	900mm
River Kym			
Lower Ouse (Model Extent)	700mm	800mm	1100mm
Mid Ouse (Cold Brayfield to Bromham – between SP9156852223 and TL0132950919)	700mm	800mm	1100mm
Mid Ouse (East of Bedford to Roxton – between TL0791848903 and TL1618854543)	700mm	850mm	1200mm

For highly vulnerable or more vulnerable developments in flood zone 2, the 'central' climate change allowance is our minimum benchmark for flood risk mitigation, and in flood zone 3 the 'higher central' climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the higher central (in flood zone 2) and the upper end allowance (in flood zone 3)

Table 1 peak river flow allowances by river basin district (use 1961 to 1990 baseline)				
River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

4.1 EXISTING INFORMATION ON FLOOD RISK

The SFRA identifies the level of residual risk behind the flood defences. It also estimates the speed of flooding from a number of possible breach locations.

Residual risks associated with the project have been reduced to the minimum by all the proposed measures.

The predicted flood depth at 1200mm including climate change on the site would be approximately 850mm above ground floor finished floor elevation. This is based on Table B provided by The Environment Agency pictured in this page. **PLEASE NOTE THAT THE ENVIRONMENT AGENCY STATED THEY DO NOT HAVE SPECIFIC FLOOD LEVELS FOR THIS SITE, therefore ECOstudio XV Ltd has taken flood levels from the nearest point, which is Mid Ouse (East of Bedfor to Roxton)**

Care should be taken when entering or exiting the property by residents and appropriate signage warning the residents should be displayed, warning of the possible hazard of slipping and flood water.

Some of the strategies include:
- Flood resilient gates,
- Entrance doors
- Flood resilient construction
- Electrics running from above on the ground floor.

These will be incorporated to the proposed development, during detail design.

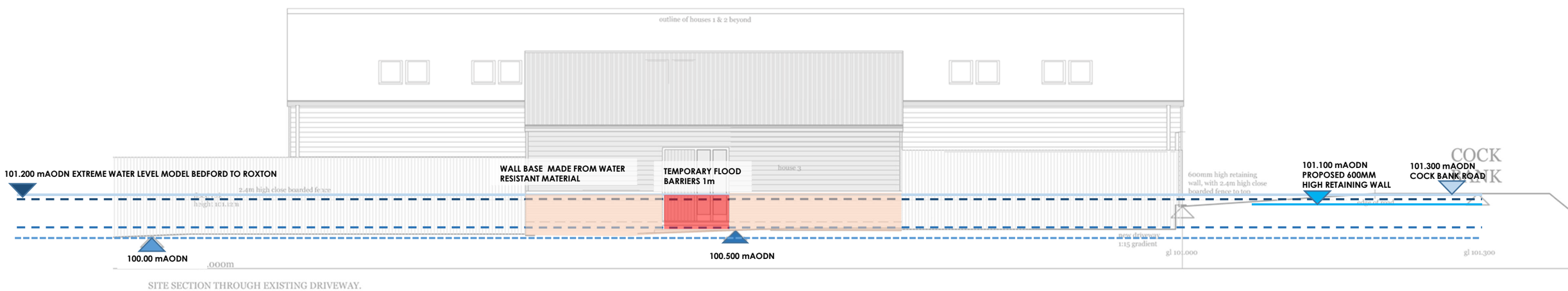
See Figure below for further details which shows the flood levels based on Table B – Local precautionary allowances for potential climate change impacts.

Table B – Local precautionary allowances for potential climate change impacts

Cambridgeshire and Bedfordshire

Watercourse / Model	Central	Higher Central	Upper End
Alconbury Brook	600mm	700mm	900mm
River Kym			
Lower Ouse (Model Extent)	700mm	800mm	1100mm
Mid Ouse (Cold Brayfield to Bromham – between SP9156852223 and TL0132950919)	700mm	800mm	1100mm
Mid Ouse (East of Bedford to Roxton – between TL0791848903 and TL1618854543)	700mm	850mm	1200mm

SECTION SHOWING FLOOD LEVELS IN RELATION TO THE BUILDING AS PROPOSED



4.1 EXISTING INFORMATION ON FLOOD RISK

SEQUENTIAL TEST

The sequential test has been applied following the risk based approach as detailed in PPS 25.

As shown in Figure 15, to pass the sequential test, parts A and B of the Exception Test need to be satisfied.

There are no other allocation sites in the same Flood Risk Zone, site details and flood risk management requirements are being considered. As the proposed development is likely to be safe and appropriate, the proposed development is acceptable.

EXCEPTION TEST

The EA Flood Map shows that the development site is situated within Flood Zone 3a –areas with a 1% (or 0.5% in tidal areas) chance of flooding in any given year.
For the Exception Test to be passed, the following requirements must be met:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
b) The development should be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable, previously developed land; and
c) A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

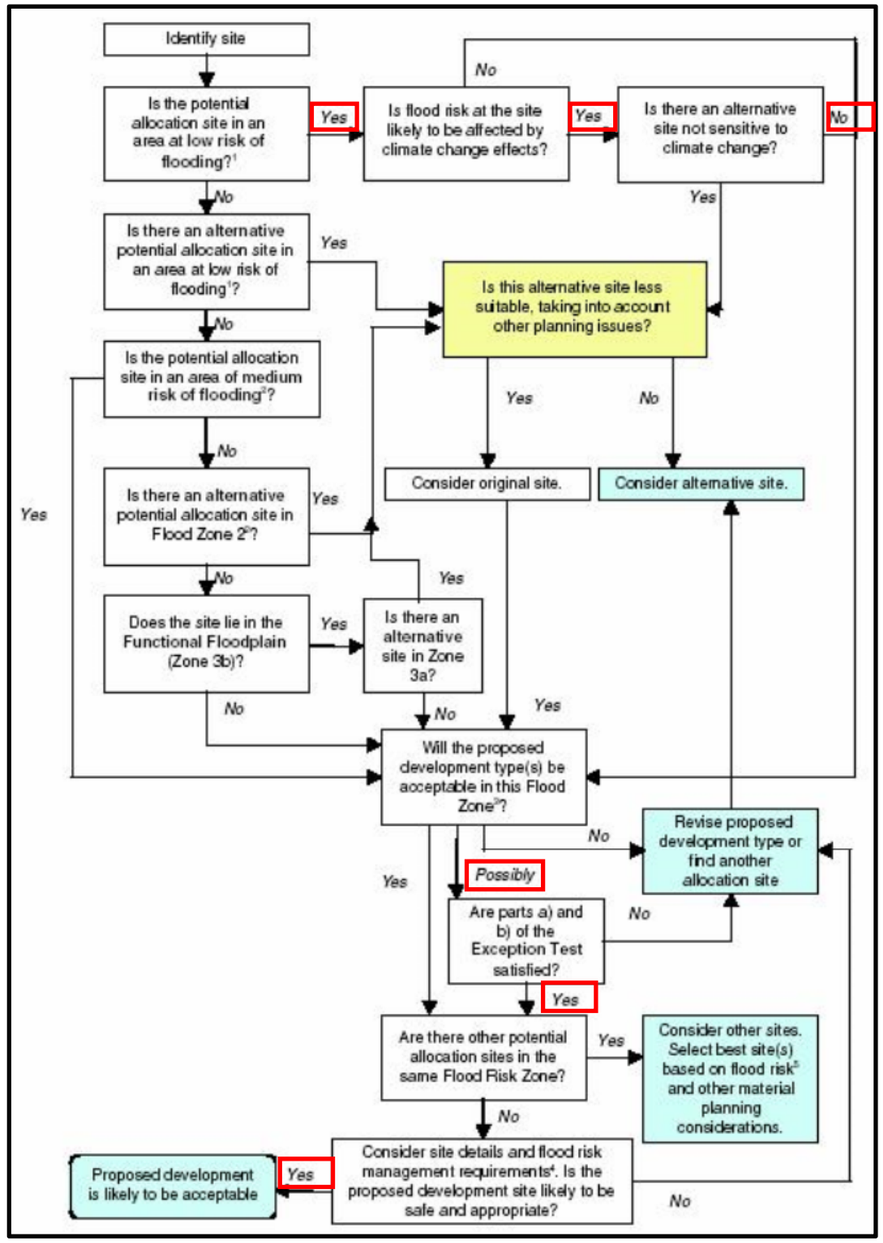
Both elements of the test will have to be passed for development to be allocated or permitted.

a) The wider sustainability benefits of implementing the proposed development include:
    - Building located in an already developed site, reducing the pressure to develop on greenfield sites.
    - Reduction of current surface water run-off
    - Implementing resilient measures to refurbished ground floor school to minimize the risk of flooding.
b) The development is on developable previously developed land, and finally
c) As detailed in this Flood Risk Assessment the site is safe for its lifetime, and reduces flood risk elsewhere by reducing the surface water runoff of the site.

In conclusion, the provided information confirms that the Exception Test has been passed and the proposed development extension is appropriate.

Safety of the development has been considered with respect to the possible consequences of a breach in the defences, with the potential impacts of climate change. Although the probability of the barrier's being breached is very low, various mitigation and resilience measures have been proposed in order to ensure no loss of life occurs, and there is no irreparable damage to the property.

FIGURE 15 –SEQUENTIAL TEST ITS PRACTICAL APPLICATION



4.1 EXISTING INFORMATION ON FLOOD RISK

JBA FLOOD RATING- PASS
The JBA Floodability Rating at this location is **CLEAR. CLEAR** indicates that the likelihood of flooding is **VERY LOW.**

LANDMARK Overall Flood Risk- PASSED MODERATE

Data provided by Landmark indicates that although the property is in an area that is at some risk of flooding, considering the frequency and/or severity of the risk, we are able to issue a **'PASSED'.**

Considerations mean that the client or owner should verify that their Building Insurance Policy covers Flood Damage, as the terms of any mortgage (if required) may require all risks to be covered. An insurance is also recommended to protect the client, tenant or owner assets given the location of the property in a Critical Drainage area. Please refer to the extract of JBA Floodability Rating pictured below for further details.

Flood Residential <0.25Ha
Flood
FUTURE CLIMATE INFO

1. FLOOD (INC. JBA FLOODABILITY RATING)

1.05 **JBA Floodability Rating** — PASS

The JBA Floodability Rating at this location is Clear. Clear indicates that the likelihood of flooding is Very Low.

JBA Floodability data is derived from their high resolution UK flood hazard maps which are used by most insurers when assessing flood risk. Where a higher rating is indicated further investigation into flood risk is usually advisable. For locations

Overall Flood Risk — PASSED MODERATE
CLICK TO VIEW ONLINE VIEWER

Although the property is in an area that is at some risk of flooding, considering the frequency and/or severity of the risk, we are able to issue a 'Passed'. However, it would be prudent for the home buyer to consider the recommendations detailed on page 1 and visit the online viewer to explore the risks further.

5 . SUSTAINABLE DRAINAGE SYSTEMS (SuDS) GOOD AND BEST PRACTICES

5. SUSTAINABLE DRAINAGE SYSTEMS GOOD AND BEST PRACTICES

Some of the SuDS good and best practices include the following:

A Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. *Store rainwater for later use*
2. *Use infiltration techniques, such as porous surfaces in non-clay areas*
3. *Attenuate rainwater in ponds or open water features for gradual release*
4. *Attenuate rainwater by storing in tanks or sealed water features for gradual release*
5. *Discharge rainwater direct to a watercourse*
6. *Discharge rainwater to a surface water sewer/drain*
7. *Discharge rainwater to the combined sewer.*

Drainage should be designed and implemented including water use efficiency and quality, biodiversity, amenity and recreation.

In the meantime, the now well established sustainable drainage hierarchy will lead to a steady reduction in the overall amount of rainfall being discharged to the drainage system. The sustainable drainage hierarchy is intended to ensure that all practical and reasonable measures are taken to manage surface water higher up the hierarchy (1 being the highest) and that the amount of surface water managed at the bottom of the hierarchy, is minimised.

There will be increased surface water flood risk due to Climate Change, with the likelihood of more intense storms. The Flood and Water Management Act 2010 gives all councils in England and Wales clearer responsibilities related to surface water flood risk.

Implementation mechanisms including the national Sustainable Drainage Systems Standards are emerging. Moreover, the Drain London Forum brings together the key agencies involved in managing drainage systems. As the RFRA illustrates, it has also made significant progress in the understanding of surface water flood risk.

6. NATIONAL SUDS STANDARDS

6. NATIONAL SUDS STANDARDS

The National Planning Policy Framework (NPPF)

Sustainable drainage and the planning process in England

In March 2012 Government published the National Planning Policy Framework (NPPF). The framework acts as guidance for LPAs and decision-takers in making decisions about planning applications. Section 14 of this document contains key information on how flood risk and sustainable drainage systems (SuDS) should be considered as part of new development.

Local Plans

The NPPF stresses that Local Plans should considerer climate change, covering factors like changes to flood risk, coastal areas and water supply. A local planning authority may develop local planning policies that facilitate:

- The protection of watercourse corridors within a green network and their use in place making.
- Avoidance of new culverting and effort to open existing culverted watercourses.
- Requiring sustainable drainage systems (SuDS) in new developments.

Local Plans should be supported by Strategic Flood Risk Assessments (SFRAs) which are carried out by local planning authorities. The SFRA should be used to improve knowledge of flooding and inform the sustainability appraisal of local development documents. It is also a requirement of the NPPF that site-specific flood risk assessments (FRAs) are undertaken and submitted together with a planning application. (A site-specific FRA may also be required even when the site is not in a flood risk area.

The Cambridgeshire Flood & Water Supplementary Planning Document (SPD) has been prepared by Cambridgeshire County Council (as the LLFA) in conjunction with the other Cambridgeshire Local Planning Authorities (LPAs) to provide guidance on the approach that should be taken to design new developments to manage and mitigate flood risk and include sustainable drainage systems (SuDS).

Source: Susdrain, SuDS and planning. Local Plans.
http://www.susdrain.org/delivering-suds/using-suds/delivery/planning.html

Surface Water Drainage Guidance for Developers. Cambridgeshire County Council
https://www.cambridgeshire.gov.uk/asset-library/imported-assets/SWGFD%20FINAL%20-%20November%202019.pdf

SuDS principles

Sustainable drainage is a departure from the traditional approach to draining sites. There are some key principles that influence the planning and design process enabling SuDS to mimic natural drainage by:

- storing runoff and releasing it slowly (attenuation).
- harvesting and using the rain close to where it falls.
- allowing water to soak into the ground (infiltration).
- slowly transporting (conveying) water on the surface.
- filtering out pollutants.
- allowing sediments to settle out by controlling the flow of the water.

Source: Susdrain, SuDS principles.
http://www.susdrain.org/delivering-suds/using-suds/suds-principles/suds-principals.html

7. SUSTAINABLE URBAN DRAINAGE SYSTEMS STRATEGY

7. SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) STRATEGY

SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS)

Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

Reducing the rate of surface water discharge from urban sites is one of the most effective ways of reducing and managing flood risk.

Traditional piped surface water systems work by removing surface water as quickly as possible, however this can cause various adverse impacts:

• Increased downstream flooding, and sudden rises in flow rates and water levels in local water courses.

• Reduction in groundwater levels and dry weather flows in watercourses.

• Reduce amenity and adversely affect biodiversity due to the surface water run-off containing contaminants such as oil, organic matter and toxic materials.

SUDS are defined as a sequence of management principles and control structures designed to drain surface water in a more sustainable fashion than conventional piped drainage techniques. SUDS should utilise the natural landscape of an area which as well as slowing down the rate of runoff provides several environmental, ecological and social benefits.

These include:

• Protection and enhancement of water quality – as well as providing on-site attenuation, SUDS treat the water, resulting in an improved quality of water leaving the site. This is achieved when the water passes through fine soils and the roots of specially selected plants, pollutants washed off the hard landscaping by rainfall will be safely removed before the water reaches the natural receiving water course.

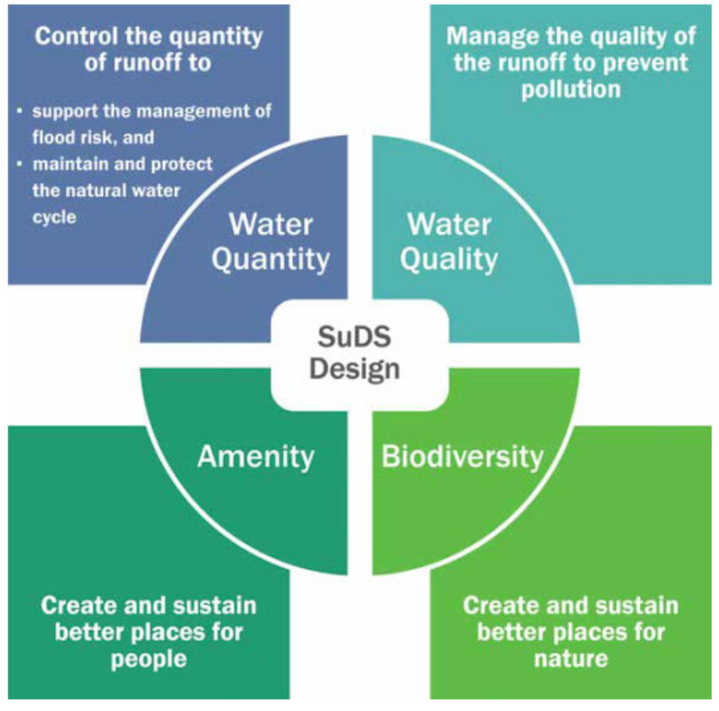
• A sympathetic approach to the environmental setting by providing opportunities to create habitats for flora and fauna in urban watercourses and open spaces.

• Meeting the amenity and social needs of the local community and residents in the creation of attractive green spaces.

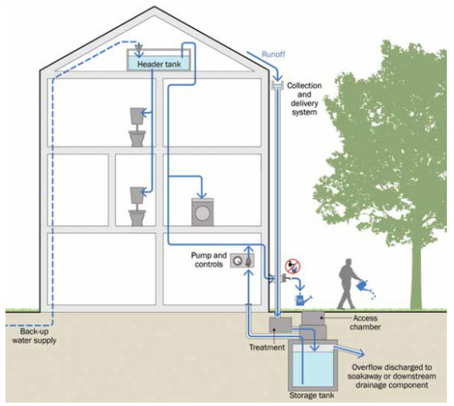
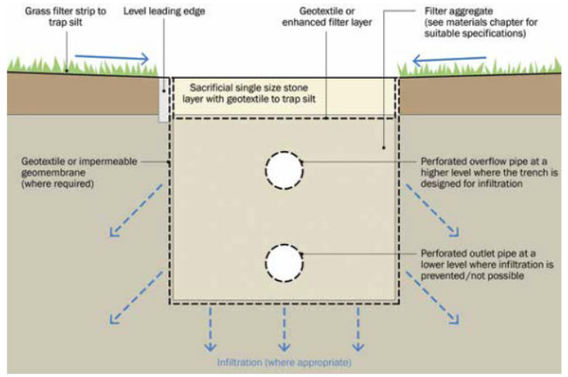
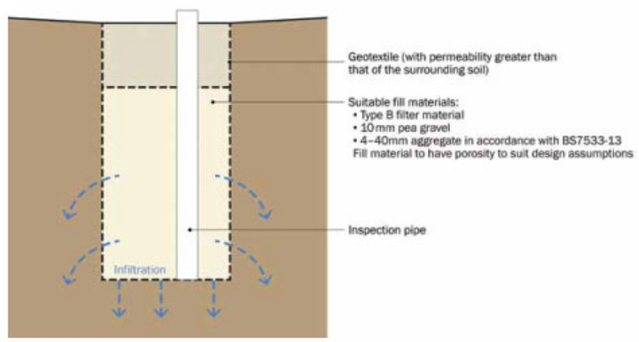
The various types of SUDS which can include:

- Permeable Paving (Infiltration).
- Soakaways (Infiltration).
- Swales and Basins.
- Green roofs and rainwater re-use.
- Infiltration trenches and filter drain.
- Ponds and Wetlands.
- Geocellular Systems.
- Storm storage tanks.
- French drains
- Bioretention systems (rain gardens)

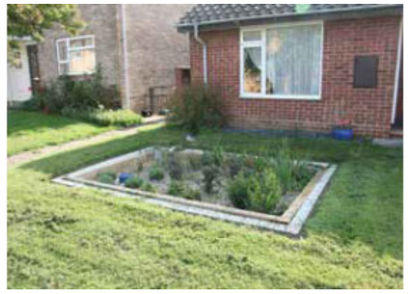
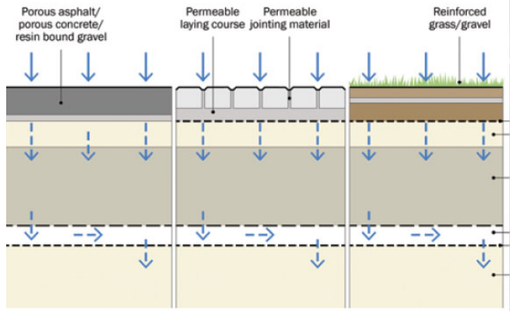
Preferably a combination of these techniques should be used as part of the surface water management train, and it is important for all stakeholders, to work together at the planning stage in order to determine a feasible solution.



7. SUSTAINABLE DRAINAGE SYSTEMS (SuDS) STRATEGY

COMPONENT TYPE	DESCRIPTION	FIGURE	FEASIBLE FOR THE PROPOSED DEVELOPMENT?
RAINWATER HARVESTING (RWH) Performance Peak flow reduction: High (depends on design) Volume reduction: High (depends on design) Water quality treatment: Poor Amenity potential: Poor Ecology potential: Poor	Rainwater harvesting (RWH) is the collection of rainwater runoff for use. Runoff can be collected from roofs and other impermeable areas, stored, treated (where required) and then used as a supply of water for domestic, commercial, industrial and/or institutional properties. RWH systems have a number of key benefits: ▪ They can meet some of the building's water demand, delivering sustainability and climate resilience benefits. ▪ They can help reduce the volume of runoff from a site. ▪ They can help reduce the volume of attenuation storage required on the site. The collected water can generally be used for a range of non-potable purposes, such as flushing toilets, washing machines (which may require adaptation) and for external uses such as car washing and irrigation.	 Figure 11.4 A conceptual pumped rainwater harvesting system	✓
FILTER DRAINS – FRENCH DRAINS Performance Peak flow reduction: Medium Volume reduction: Low Water quality treatment: High Amenity potential: Low Ecology potential: Low	Filter drains are shallow trenches filled with stone/gravel that create temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. The stone may be contained in a simple trench lined with a geotextile, geomembrane or other impermeable liner, or within a more structural facility such as a concrete trough. Filter drains should ideally receive lateral inflow from an adjacent impermeable surface that is pre-treated using a vegetated filter strip or equivalent.	 Figure 16.2 Filter drain schematic 	✓
INFILTRATION SYSTEMS Performance Peak flow reduction: Medium Volume reduction: High Water quality treatment: High Amenity potential: Low Ecology potential: Low	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The rate at which water can be infiltrated depends on the infiltration capacity (permeability) of the surrounding soils. These include soakaways, infiltration trenches, infiltration blankets and infiltration basins.	 Figure 13.3 Infiltration trench	✓

7. SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) STRATEGY

COMPONENT TYPE	DESCRIPTION	FIGURE	FEASIBLE FOR THE PROPOSED DEVELOPMENT?
BIORETENTION SYSTEMS / RAIN GARDENS Performance Peak flow reduction: Medium Volume reduction: Medium (High with infiltration) Water quality treatment: Good Amenity potential: Good Ecology potential: Medium	Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes, and treat pollution through the use of engineered soils and vegetation. They are particularly effective in delivering Interception and can also provide: ▪ attractive landscape features that are self-irrigating and fertilising ▪ habitat and biodiversity ▪ cooling of the local microclimate due to evapotranspiration. They are a very flexible surface water management component that can be integrated into a wide variety of development landscapes using different shapes, materials, planting and dimensions.	 	✓
PERVIOUS PAVEMENTS Performance Peak flow reduction: Good Volume reduction: Good Water quality treatment: Good Amenity potential: Poor Ecology potential: Poor	Pervious surfaces can be either porous or permeable. The important distinction between the two is: Porous surfacing is a surface that infiltrates water across the entire surface. Permeable surfacing is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration through the pattern of voids. Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers. The water can be temporarily stored before infiltration to the ground, reused, or discharged to a watercourse or other drainage system.	 Figure 20.13 Pervious pavement system types: Type B – partial infiltration 	✓

8. SUSTAINABLE DRAINAGE SYSTEMS CALCULATIONS

8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

SUSTAINABLE URBAN DRAINAGE SYSTEMS CALCULATIONS

These requirements include London Plan Policy 5.13 Drainage hierarchy contained within National SuDS Standards.

Sustainable Drainage Strategies Calculations include:

- Information about the design storm period and intensity
- Method employed to delay (attenuate) and control the rate of surface water discharged from the site as close to greenfield runoff rates as reasonably practicable, and
- The measures taken to prevent pollution of the receiving groundwater and / or surface waters.

CALCULATIONS

The design storm period and intensity used for the calculation was 100-year storm event, 6no hours duration with an intensity of 170mm/hr.

TABLE 02- YEAR STORM

ONE HUNDRED YEAR STORM EVENT						
D min	M5-60 mm	Z1	M5-D mm (2x3)	Z2	M100-D mm (4x5)	I mm/hr. (6+1 (hrs.))
5	20	0.37	7.4	1.96	14.5	170.05

EXISTING RUN OFF RATES

The existing impermeable area it is made from:

- 1903.74 m2 – 1409.82 m2 (garden and permeable areas) = 493.90 m2 from existing roofs and concrete paving.

Therefore, for a peak run off rate for 1no year return period storm, the existing flow rate is 7.82 l /sec. For a peak run off rate in a 100-year storm return period, the existing flow rate is 23.34 l/sec.

Peak Run off rate for 1 year return period

Q=	2.78	x1x56.96xArea	**7.82 l/sec**

Peak Run off rate for a 100 year return period

Q=	2.78	x1x170xArea	**23.34 l/sec**

PRE- DEVELOPMENT RUN OFF M100-60 **18.39 m3**

PROPOSED RUN OFF RATE

The proposed impermeable area is 424.47 m2 which corresponds to the proposed roof and the impermeable paving. The rest is made from 913.9 m2 of green areas and 565.37 m2 of permeable paving.

Therefore, for a peak run off rate for 1no year return period storm, the proposed flow rate is 6.72 l/ sec with a 35% increase for climate change, that equals 9.07 l/sec.

For a peak run off rate in a 100-year storm return period, the proposed flow rate is 20.06 l/sec, with a 35% increase for climate change is 27.08 l/ sec.

FORMULA

Q= 2.78 C i A	C	1.0 100% IMPERMEABLE
	i	Peak run off rate mm/hr
	A	Impermeable Area (Ha)

Peak Run off rate for 1 year return period

Q=	2.78	x1x56.96xArea	**6.72**	**l/sec**
		+35% climate change	**9.07**	**l/sec**

Peak Run off rate for a 100 year return period

Q=	2.78	x1x170xArea	**20.06**	**l/sec**
		+35% climate change	**27.08**	**l/sec**

8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

PRE-DEVELOPMENT ATTENUATION CALCULATIONS IN M3

The pre-development run off (M100-60) is 24.83 m3 for a 100-year event, 6no hour storm duration.

PRE- DEVELOPMENT RUN OFF M100-60 **18.39 m3**

TO CALCULATE RUN OFF VOLUME
100 YEAR EVENT - 6 HOUR DURATION

PREDEVELOPMENT IMPERMEABLE AREA = 493.92 **m2**
POSTDEVELOPMENT IMPERMEABLE AREA = 424.47 **m2**

M5-60 = 20 mm r= 0.4 (from map)

a) PRE DEVELOPMENT

D/R 50 mm (M5-2 DAY)
Z1 = 0.38 DEPTH= 0.38X50 = 19 mm
Z2= 1.96 (1:100) DEPTH= 1.96X19= **37.24 mm**
AREA REDUCTION FACTOR (ARF)=1

VOLUME = AREA X (DEPTH/1000)
PRE- DEVELOPMENT RUN OFF M100-60 **18.39 m3** **24.83 m3**

POST-DEVELOPMENT ATTENUATION CALCULATIONS IN M3

The post development run off, including a 35% climate change volume, result in a required capacity of 21.34 m3 as shown below.

POST- DEVELOPMENT RUN OFF M100-60 **21.34 m3**
(INCLUDING 35% CLIMATE CHANGE FACTOR)

100% REDUCTION IN EXISTING RUN OFF +35% CLIMATE CHANGE 100% **21.34 m3**

The Cambridgeshire County Council requires at least 50% reduction in existing run off +35% climate change of 10.67 m3.

SUDS CAPACITY

There are 2no systems to minimize rainwater runoff. These include

- 3no rainwater and storm storage tanks, and
- 120.75 m2 of rain garden of 600mm with a french drain.

This would provide 100% attenuation, including 35% climate change factor for a storm with a 100 year return period.

SUDS

STORM STORAGE TANKS	3.75	m3
2 x 1,500 (House 1 and 2) and 1 x 750 (House 3)		
RAINWATER TANK FOR REUSE IN IRRIGATION, WCS, WASHING MACHINES AND DISHWASHERS	3.75	m3
2 x 1,500 (House 1 and 2) and 1 x 750 (House 3)		
RAIN GARDES WITH FRENCH DRAIN	21.74	m3
120.7m2 x 0.6m deep x 50% capacity		
TOTAL SUDS (EXCLUDING RAINWATER)	**25.49**	m3
TOTAL SUDS WITH RAINWATER	29.24	m3

8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

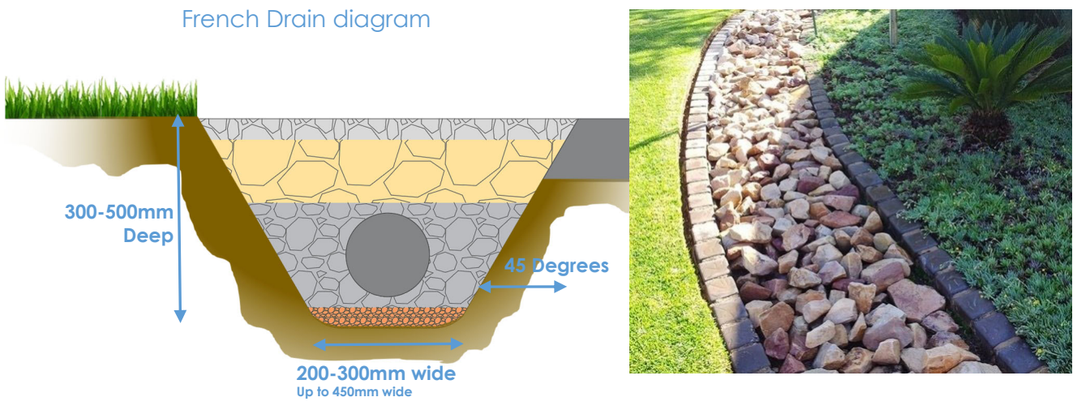
METHODS EMPLOYED TO DELAY (ATTENUATE) AND CONTROL THE RATE OF SURFACE WATER DISCHARGED FROM THE SITE AS CLOSE AS POSSIBLE TO GREENFIELD RUNOFF RATES

- The proposed development will have a total of 6no rainwater pipes, 3no manholes, 3no combined rainwater and storm storage tanks, permeable paving and 120.7m2 of rain gardens with a french drain. See Figures 27 to 30 for further information.
- Rainwater pipes from House 01 and 02 will feed two 3,000 litres water tank with 1,500 litres for rainwater storage and 1,500 litres for storm water extra capacity per house.
- Rainwater pipes from House 03 will feed a 1,500 litres water tank with 750 litres for rainwater storage and 750 litres for storm water extra capacity per house.
- A filtration system as part of the pump system in the rainwater tank filter will provide water for re-use in WCs, irrigation, cleaning and washing machines.
- If the rainwater section of the tank is full, excess rainwater would stored in the same storm water tank. In case the storm water tank section is full, its overflow would direct surface water to a rain garden and a french drain.
- The tank will have sump pumps with battery backup with enough capacity to empty the tank in a range of 5no to 6 hrs.
- The storm water tank is intended to remain empty, except during periods of rainfall and for a short time thereafter.

The combination of the above methods would delay (attenuate) and control the rate of surface water discharged from the site, reducing the current discharge rates more than 100% during a peak run off rate for a 100 year return period.

The SUDs and water calculations presented in this report will need to be continuously updated through the detailed design and construction stages to reflect any changes in the project performance.

FIGURE 16 –DRAIN



8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

FIGURE 17–RAINWATER GARDEN DIAGRAMS

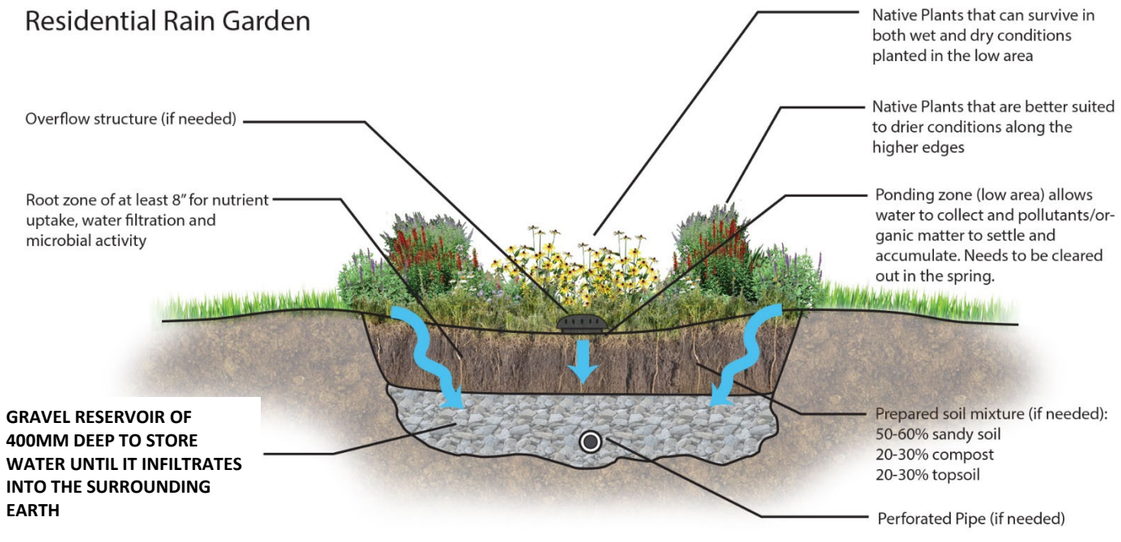
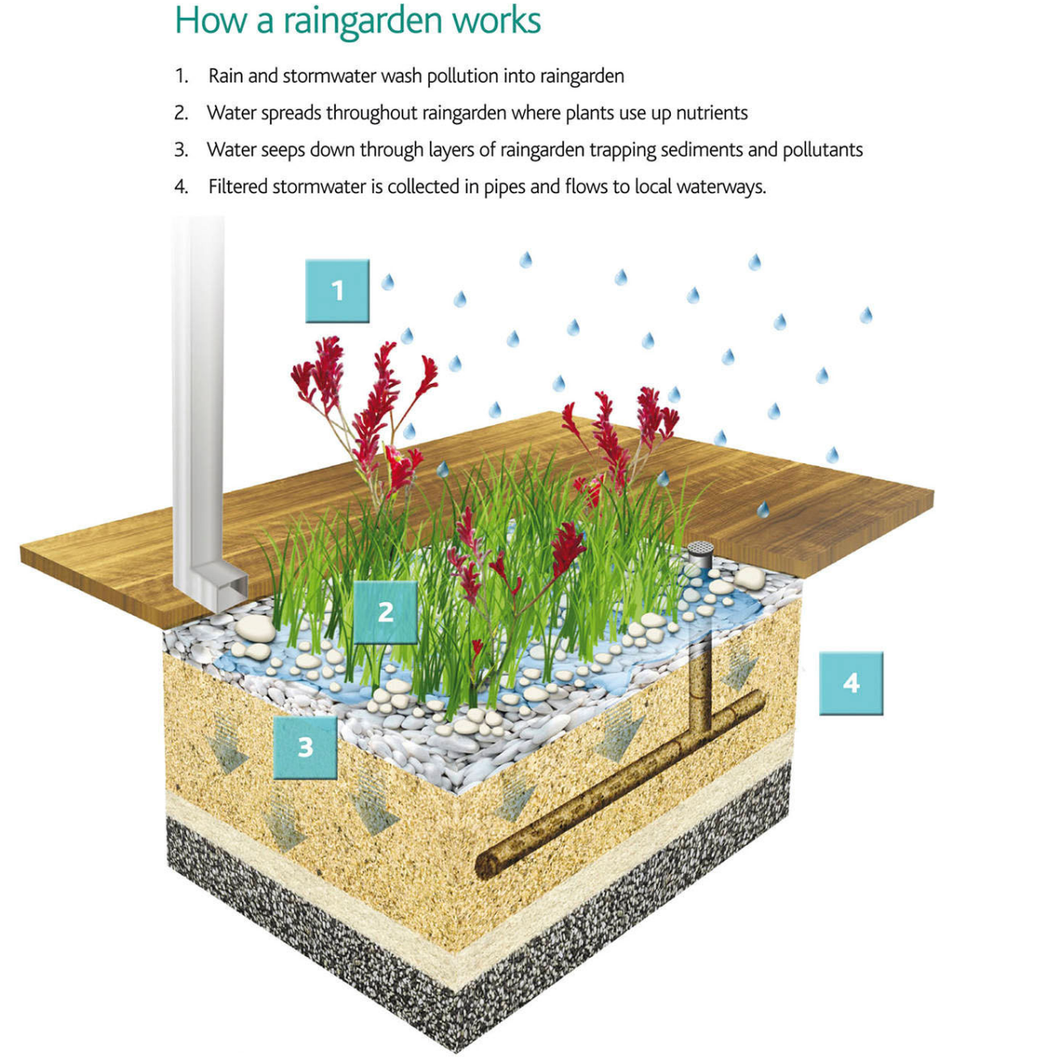


FIGURE 03–RAINWATER GARDEN DIMENSIONS

Raingarden		
Maximum water holding capacity (MWHC)	30%	
Area	120.75	m2
Depth of Freeboard	0.1	m
Depth of sub-base	0.5	m
Depth of storage	0.6	m
Volume	72.45	m3
Maximum water holding capacity (MWHC)	21.74	m3



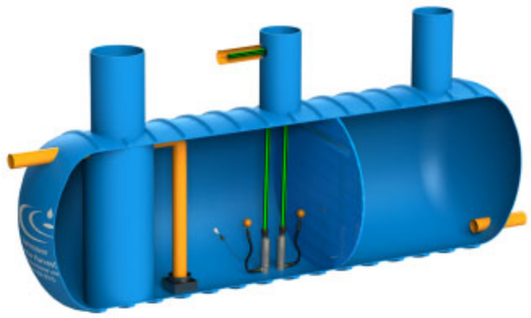
A raingarden is a specially prepared garden designed to receive and filter rain run-off from roofs or hard surfaces such as driveways or paving. A raingarden can be done even in a planter box or directly into the landscape, it just needs to be positioned to collect water from a diverted downpipe or rainwater tank overflow

8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

FIGURE 18 – STORMSAVER RAINWATER HARVESTING (1,500 L) AND ATTENUATION TANK (1,500 L)

Stormsaver Rainwater Harvesting and Attenuation Tank

Contact us on 0844 8840015 www.stormsaver.com



Rainwater Harvesting and Attenuation Tank
Product Data Sheet

Product Description

The Stormsaver Rainwater Harvesting and Attenuation tank enables users to both attenuate, and harvest rainwater, for use in the building. This is a great advantage as with this system, rainwater is managed on a wholly inclusive level. Only when the level of water on site is exponential, does the system begin to attenuate and divert stormwater safely to drain at a controlled flow rate, as specified by the client.

The tank is a single piece, pre-fabricated system, delivered to site for simple and rapid installation.

All tanks as standard come complete with:
- 600mm diameter x 1m high access shaft
- Pedestrian duty lockable cover
- Vortex Filter
- 1 x inlet, 1 x overflow and 2 x 100mm service ducts
- Flow controls, can be supplied separately and should be fitted to the overflow.

The flow rate will be determined by the site requirements.

Tanks come in a range of sizes starting from 1500L (up to) 300,000L, in a single vessel.

Multiple tanks, can also be joined together using interconnecting pipework to create larger volumes if required.

All tanks are manufactured in accordance with BS4994 under ISO9001 Design and Build approved conditions.

This option enables water to be separated with an internal weir. Harvested rainwater is filtered through the vortex filter. Surface water is contained in a separate section.

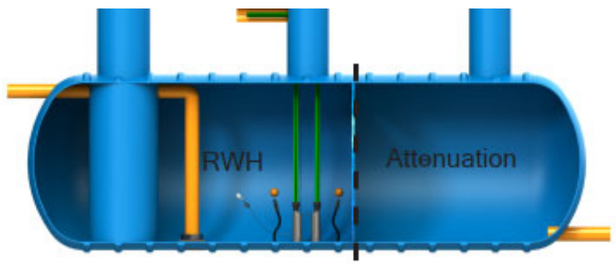
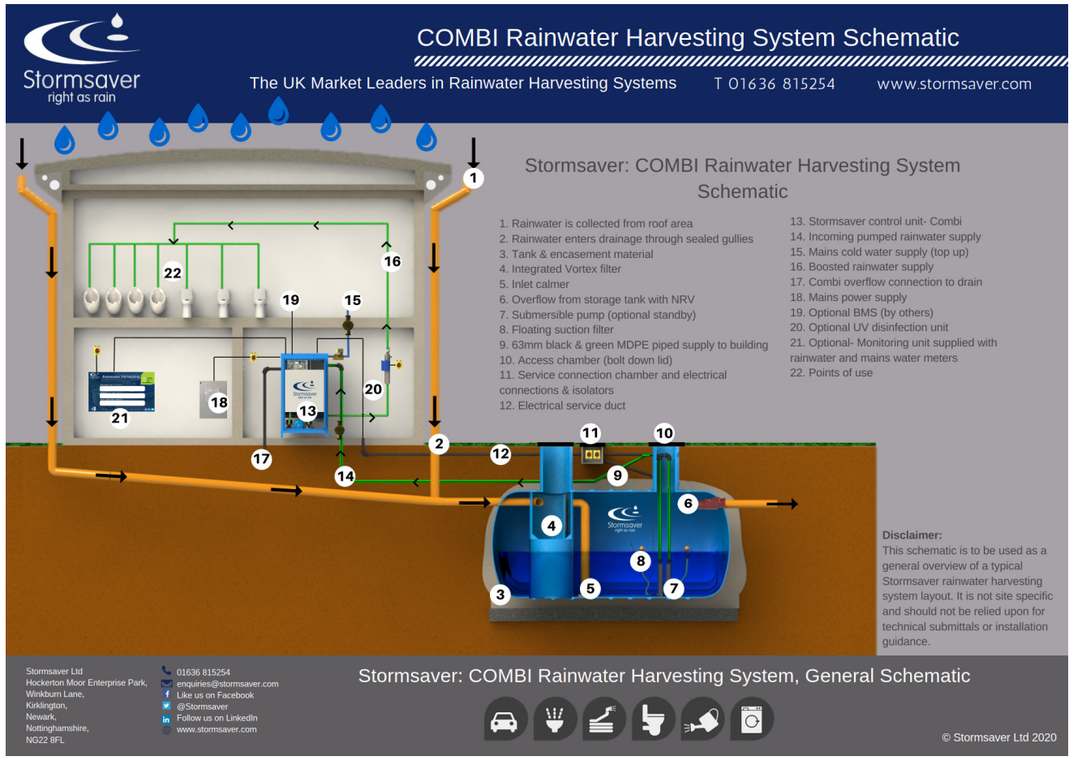


FIGURE 19– GENERAL SCHEMATIC, COMBI RAINWATER HARVESTING



8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

FIGURE 20 – PERVIOUS PAVING- PARTIAL INFILTRATION

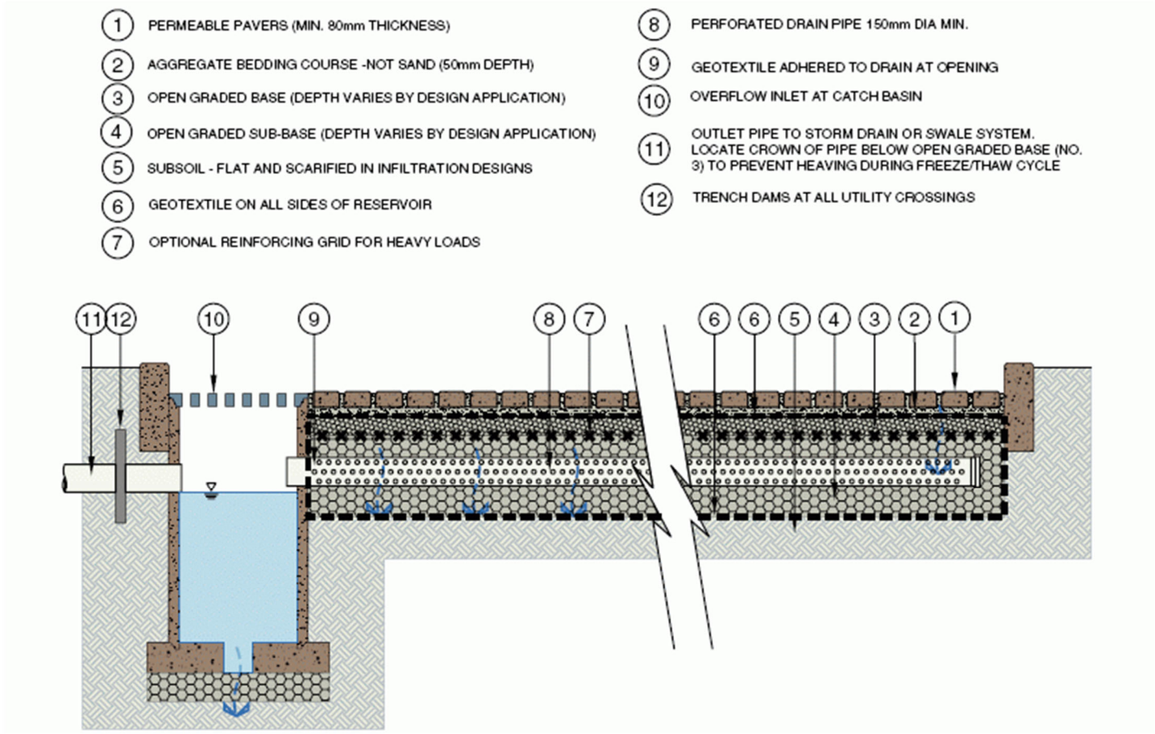
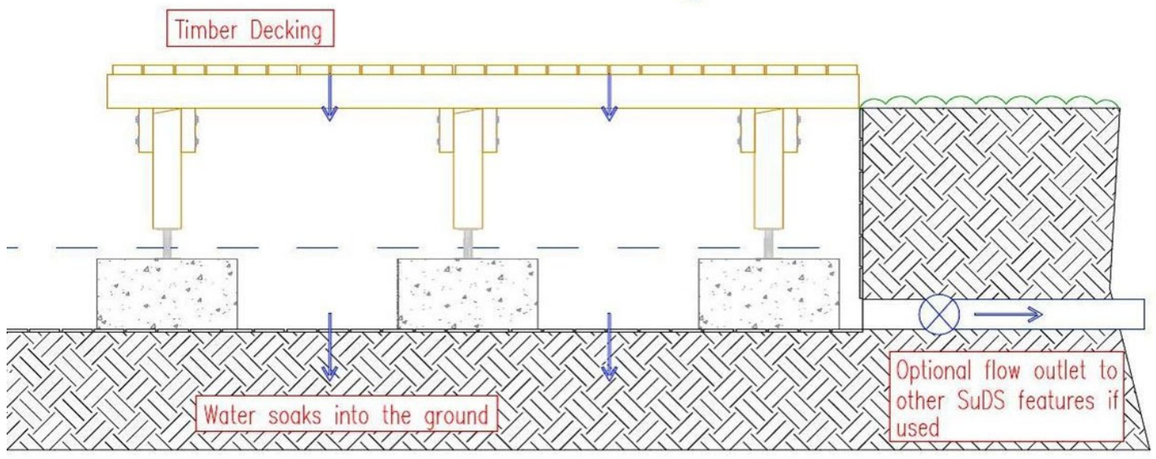


FIGURE 21 – EXAMPLE OF A TIMBER DECKING SCHEME



MANHOLE RINGS

Made from strong, dense concrete, FP McCann's manholes are capable of withstanding infiltration and attack from corrosive environments. Complementary products such as cover slabs are also available.

FEATURES:

- Strength and durability
- Manufactured to BS EN 1917:2002
- Reinforced
- Standard and wide wall systems available

BENEFITS:

- High resistance to infiltration and leaking
- Able to meet all design requirements
- Reduced construction time compared to cast in-situ

APPLICATIONS:

- Storm water manholes
- Sewer manholes
- Pipeline junctions
- Pipeline direction changes

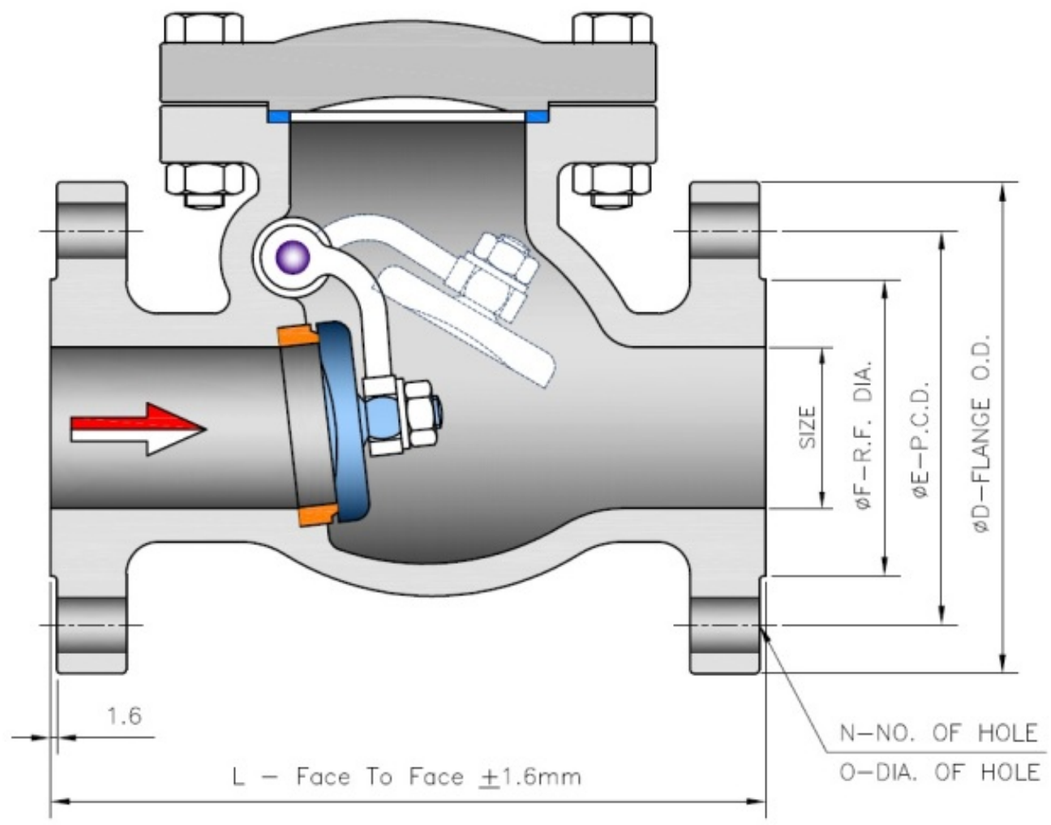
FIGURE 22 – MANHOLE RINGS

8. SUSTAINABLE DRAINAGE SYSTEMS (SUDS) CALCULATIONS

RESILIENT MEASURES IN CASE OF GROUND FLOOR FLOODING

- Flood information will be provided to all tenants and occupants, including EA Emergency Flood line.
- SUDs have been incorporated to the proposed development to reduce surface water run off with more than 100% reduction.
- All ground floor walls must be water resistant such as concrete, masonry, brick, stone, or equivalent up to the extreme flood level of 101.200 mAODN. This is 850mm high above finished ground floor elevation. In addition, they must have a waterproofing membrane at this same height.
- Electricity consumer unit and mains connection point feeds to be redirected and go down the building from the ceiling.
- Non return valves to be used in drainage design to prevent back up of flow (Figure 23)
- Adequate sealing of joints between the internal walls required to prevent any penetration of water (Figure 25).
- Installing Pedestrian Flood Doors. (Figure 24).
- Installing Temporary Flood barriers for windows and doors (Figure 26)
- Water resistant paint to be used for all internal walls on the refurbished ground floor.
- Reinforce ground floor external walls to resist an extreme flood.

FIGURE 23 –NO RETURN VALVE



8. SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) CALCULATIONS

FIGURE 24 –PEDESTRIAN FLOOD DOORS

FIGURE 25–SEALING JOINT DIAGRAM

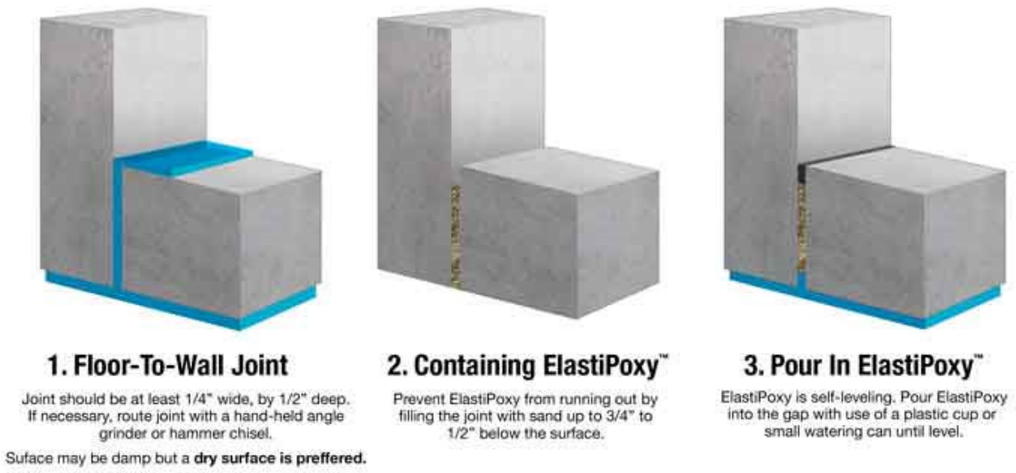
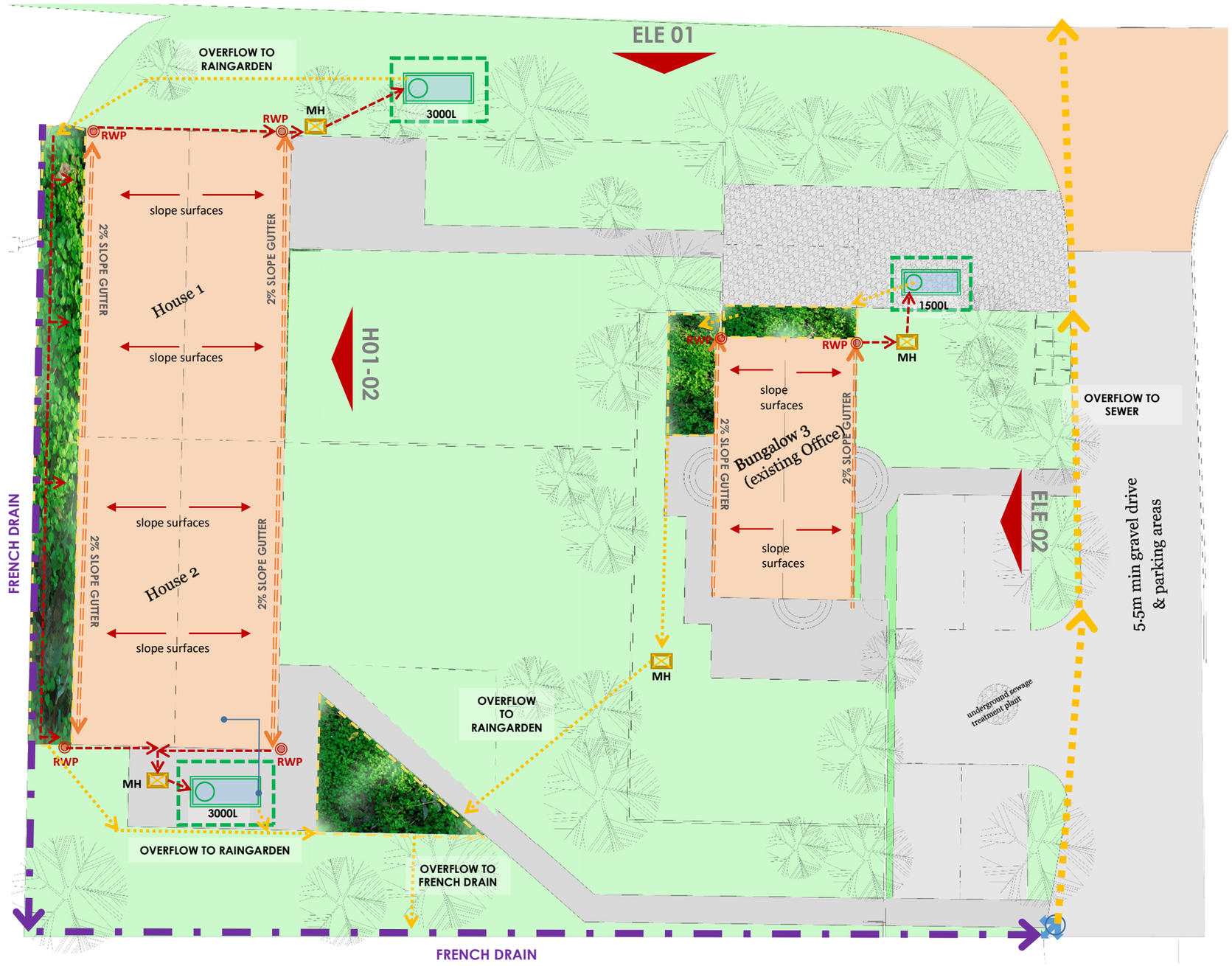


FIGURE 26 –TEMPORARY FLOOD BARRIERS FOR DOORS AND WINDOWS

8. SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) CALCULATIONS

FIGURE 27- SUDS DIAGRAM- SITE PLAN



SYMBOLOGY

- Garden / Green Area 913.9 m2
- Impermeable Areas (Roofs and driveway) 424.47 m2
- Permeable Paving 565.37 m2
- MANHOLE
- RWP RAINWATER PIPES
- FRENCH DRAIN
- OVERFLOW
- SLOPE GUTTER
- INSPECTION CHAMBER
- RAIN GARDEN

FIGURE 28- SUDS DIAGRAM SIDE ELEVATION – 01

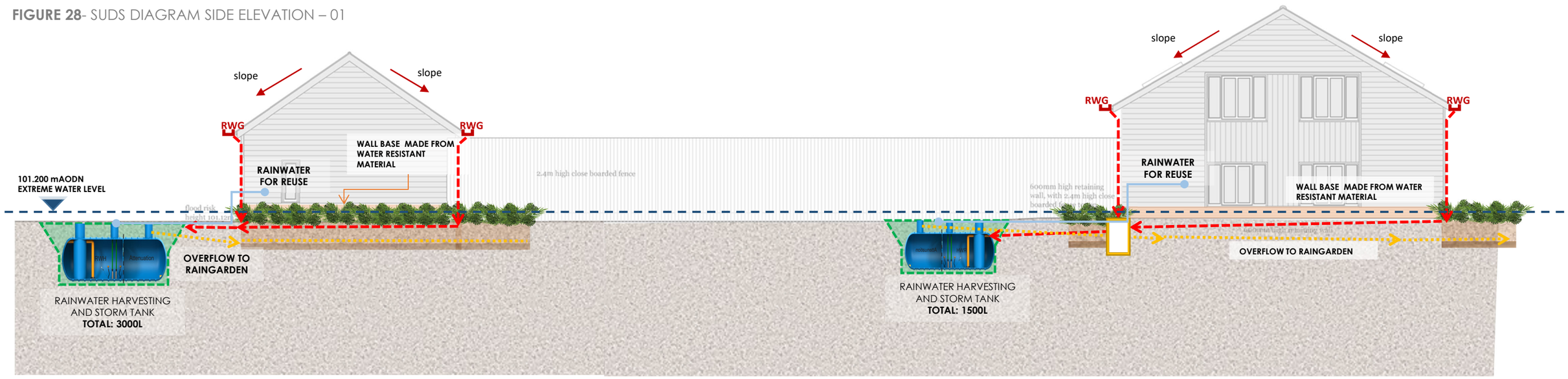


FIGURE 29- SUDS DIAGRAM SIDE ELEVATION – 02

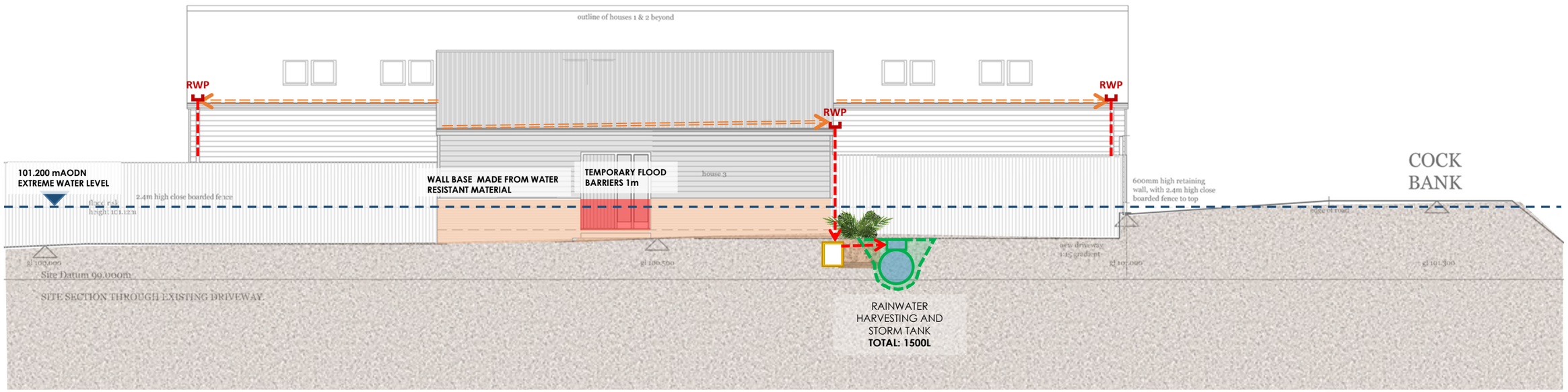
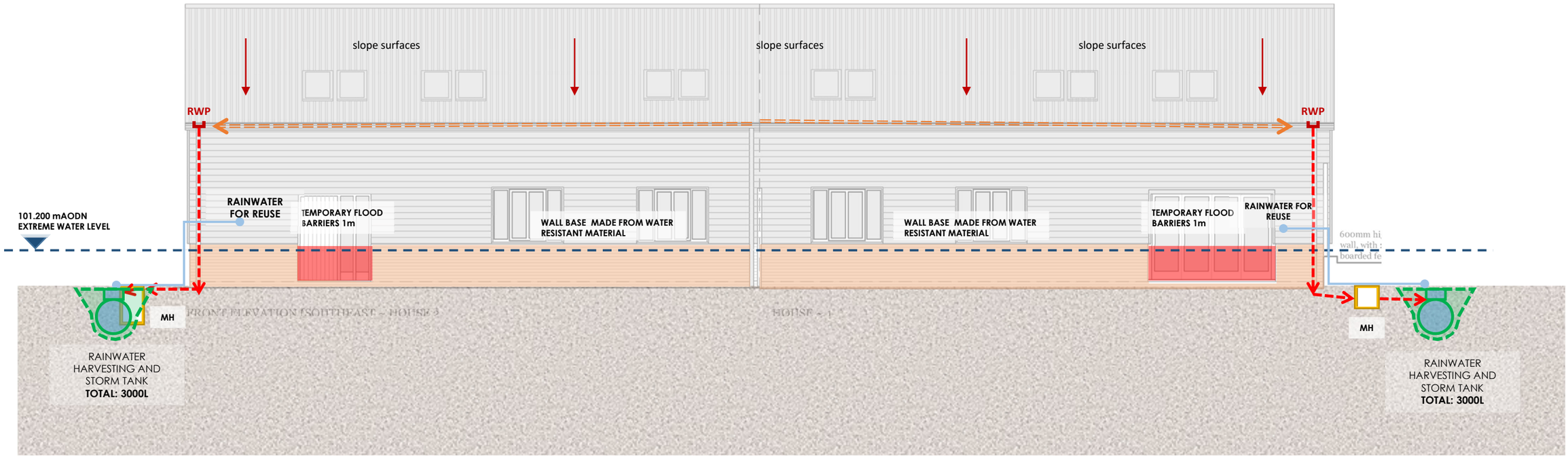


FIGURE 30- SUDS DIAGRAM FRONT ELEVATION – H01-02



9 . SUSTAINABLE DRAINAGE SYSTEMS MAINTENANCE

9. SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) MAINTENANCE

RAINWATER GARDENS

Once established, a vegetable or native species raingarden is low maintenance, however, a few simple tips can help the raingarden function well.

- Inspect your raingarden regularly - it is likely to need occasional watering in the summer months, during hot and dry periods. If the plants appear to be wilted or if the vegetable garden mix layer is very dry to touch, water the raingarden with a watering can, garden hose, or a spray/drip irrigation system. The vegetable raingarden is unlikely to require additional water in the winter months.
- Do not water your vegetable raingarden excessively and avoid watering immediately before or after rainfall. This will allow the system to function more effectively as a vegetable raingarden.
- The use of fertilisers and pesticides should be avoided. If necessary, apply small amounts and ensure that the overflow has been set up accordingly and to avoid polluting storm water, see pipe infrastructure
- Mulch such as pea straw will help retain moisture in your raingarden and prevent weeds from growing. However, some weeding may be necessary until plants have matured.
- Bird netting can be fitted to your vegetable raingarden to deter pests.
- Harvest and replace plants as necessary.
- The level of the vegetable garden mix needs to remain constant. If the level of the soil surface drops significantly below the height of the overflow, plants might become submerged following heavy rainfall affecting growth. Top up the vegetable garden mix layer as necessary.
- Ensure that the overflow pipe does not become blocked and remove any sediment or build up from the downpipe.

Source: Richards, Paul & Water, Melbourne. (2013). Building a raingarden: Vegetable raingarden (Melbourne Water).

RAINWATER HARVESTING

Any property with an RWH system installed should be provided with appropriate information as to what equipment has been installed, its purpose, its operation and maintenance requirements, the actions needed to address any potential failure and the expected performance of the system. Information on the options for external maintenance support should also be provided.

The maintenance responsibility for an RWH system is usually with the owner of the property, but any communal systems require the participating community to be informed of the system, as detailed, but also be provided with information of who the organisation is that is maintaining the system and any financial commitments and any legally binding maintenance agreement.

TABLE 11.6 Operation and maintenance requirements for RWH systems

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdrawal devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

PERVIOUS PAVEMENTS

Regular inspection and maintenance is important for the effective operation of pervious pavements. Maintenance responsibility for a pervious pavement and its surrounding area should be placed with an appropriate responsible organisation. Before handing over the pavement to the client, it should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the pavement should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

Table 20.15 of the CIRIA SuDS Manual provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

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 glyphospate 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

10. SUMMARY AND CONCLUSION

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The proposed development site lies within Zone 3a of the Environment Agency Flood Map, being the zone with risk of 1 in 100 years (1% AEP) or greater for river flooding and 1 in a 200 annual probability (0.5% AEP) or greater for tidal/coastal flooding

The area benefits from flood defences maintained by the Environmental Agency. Land and property in this flood zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

The proposed development is in Flood Zone 3a and is deemed to be 'appropriate' development subject to the Sequential and Exception Tests.

Application of both the Sequential Test and the Exception Test has shown that the site is appropriate for the proposed development. Due to the mitigation measures outlined in this report, the development is safe and has no adverse impact elsewhere.

- **FLOODING FROM RIVERS OR THE SEA**

Data provided by the Environment Agency indicates that the property is 9 metres from an area where the likelihood of flooding from River or Sea is High.

- **FLOOD RISK FROM RESERVOIRS OR CANALS**

Data provided by the Environment Agency indicates that the property is not located within 25 metres of a Flood Storage Area (land designed and operated to store flood water).See below an extract from their report for further details.

- **FLOOD RISK FROM GROUNDWATER**

Data provided by JBA indicates that the property has negligible risk from groundwater flooding.

- **HISTORIC RECORDS**

Anglian Water Services Limited has confirmed that the 132 Cock Bank, Peterborough PE7 2HN site has no incidents on record of flooding due to overloaded public sewers.

- **FLOOD RISK FROM SURFACE WATER**

Data provided by JBA Risk Management Ltd (JBA) indicates that there is a negligible risk of Surface Water flooding within 5 metres of the property.

To minimize the impact of the proposed development and potential increase in surface water run off, ECOstudio LTD has prepared a Sustainable Urban Drainage System (SUDs) strategy and report. Using the SuDS listed below there would be **25.49** m3 of storage. This would achieve the requirements of more than 100% reduction in existing run off +35% climate change which is 21.34 m3.

Resilient measures in the extreme case of ground floor flooding have been included in the report. Particular attention should be taken to a water resistant wall base 850mm high from ground floor finished floor elevation. This would protect the proposed development in an extreme case of flooding. **PLEASE NOTE THAT THE ENVIRONMENT AGENCY STATED THEY DO NOT HAVE SPECIFIC FLOOD LEVELS FOR THIS SITE, therefore ECOstudio XV Ltd has taken flood levels from the nearest point, which is Mid Ouse (East of Bedfor to Roxton).**

METHODS EMPLOYED TO DELAY (ATTENUATE) AND CONTROL THE RATE OF SURFACE WATER DISCHARGED FROM THE SITE AS CLOSE AS POSSIBLE TO GREENFIELD RUNOFF RATES

- The proposed development will have a total of 6no rainwater pipes, 3no manholes, 3no combined rainwater and storm storage tanks, permeable paving and 120.7m2 of rain gardens with a french drain. See Figures 27 to 30 for further information.
- Rainwater pipes from House 01 and 02 will feed two 3,000 litres water tank with 1,500 litres for rainwater storage and 1,500 litres for storm water extra capacity per house.
- Rainwater pipes from House 03 will feed a 1,500 litres water tank with 750 litres for rainwater storage and 750 litres for storm water extra capacity per house.
- A filtration system as part of the pump system in the rainwater tank filter will provide water for re-use in WCs, irrigation, cleaning and washing machines.
- If the rainwater section of the tank is full, excess rainwater would stored in the same storm water tank. In case the storm water tank section is full, its overflow would direct surface water to a rain garden and a french drain.
- The tank will have sump pumps with battery backup with enough capacity to empty the tank in a range of 5no to 6 hrs.
- The storm water tank is intended to remain empty, except during periods of rainfall and for a short time thereafter.

The combination of the above methods would delay (attenuate) and control the rate of surface water discharged from the site, reducing the current discharge rates more than 100% during a peak run off rate for a 100 year return period.

The SUDs and water calculations presented in this report will need to be continuously updated through the detailed design and construction stages to reflect any changes in the project performance.

11. APPENDIX A
SUDS CALCULATIONS

11. APENDIX A SUDS CALCULATIONS - SITE AS EXISTING

PRE- DEVELOPMENT SURFACE WATER DRAINAGE

SITE DETAILS

DESCRIPTION OF THE SITE AS EXISTING

STRATEGY

TOTAL SITE AREA	=	1903.74m2
ROOF IMPERMEABLE AREA EXISTING BUILDINGS	=	493.92m2
PERMEABLE AREAS	=	1229.91m2
GARDEN (PERMEABLE)		179.91m2
TOTAL IMPERMEABLE	**=**	493.92**m2**
TOTAL PERMEABLE	**=**	**1409.82m2**
		0.049392ha

FORMULA
Q= 2.78 C i A

C 1.0 100% IMPERMEABLE

i Peak run off rate mm/hr

A Impermeable Area (Ha)

Peak Run off rate for 1 year return period

Q= 2.78 x1x56.96xArea **7.82l/sec**

Peak Run off rate for a 100 year return period

Q= 2.78 x1x170xArea **23.34l/sec**

PRE- DEVELOPMENT RUN OFF M100-60 **18.39m3**

TO CALCULATE RUN OFF VOLUME
100 YEAR EVENT - 6 HOUR DURATION

PREDEVELOPMENT IMPERMEABLE AREA = 493.92**m2**
POSTDEVELOPMENT IMPERMEABLE AREA = 424.47**m2**

M5-60 = 20mm r=0.4 (from map)

a) PRE DEVELOPMENT

D/R 50 mm (M5-2 DAY)
Z1 = 0.38 DEPTH= 0.38X50 = 19 mm
Z2= 1.96 (1:100) DEPTH= 1.96X19= **37.24 mm**
AREA REDUCTION FACTOR (ARF)=1

		WITH 35% CLIMATE CHANGE
VOLUME = AREA X (DEPTH/1000)		
PRE- DEVELOPMENT RUN OFF M100-60	**18.39 m3**	**24.83 m3**

b) POST DEVELOPMENT

=SURFACE AREA X (DEPTH /1000)	**15.8 m3**
35% CLIMATE CHANGE	5.5 m3
TOTAL	**21.3 m3**

DIFFERENCE FOR ZERO INCREASE IN RUN OFF LEVELS	**2.9 m3**

STORM STORAGE FOR WITH NO DISCHARGE 21.3 m3

11. APENDIX A SUDS CALCULATIONS - SITE AS PROPOSED

POST- DEVELOPMENT SURFACE WATER DRAINAGE

SITE DETAILS

DESCRIPTION OF THE SITE AS PROPOSED STRATEGY			
TOTAL SITE AREA	=	1903.74	m2
IMPERMEABLE AREA	=	424.47	m2
GARDEN	=	913.9	m2
PERMEABLE AREA PARKING AND CIRCULATON		565.37	m2
TOTAL IMPERMEABLE AREA	=	**424.47**	**m2**
TOTAL PERMEABLE AREAS		**1479.27**	**m2**
		0.042447	**ha**

FORMULA
Q= 2.78 C i A

C — 1.0 100% IMPERMEABLE

i — Peak run off rate mm/hr

A — Impermeable Area (Ha)

Peak Run off rate for 1 year return period

Q=	2.78	x1x56.96xArea	**6.72 l/sec**
		+35% climate change	**9.07 l/sec**

Peak Run off rate for a 100 year return period

Q=	2.78	x1x170xArea	**20.06 l/sec**
		+35% climate change	**27.08 l/sec**

POST- DEVELOPMENT RUN OFF M100-60 **21.34 m3**
(INCLUDING 35% CLIMATE CHANGE FACTOR)

100% REDUCTION IN EXISTING RUN OFF +35% CLIMATE CHANGE	100%	**21.34 m3**

SUDS	ATTENUATION VOLUME	
STORM STORAGE TANKS	3.75	m3
2 x 1,500 (House 1 and 2) and 1 x 750 (House 3)		
RAINWATER TANK FOR REUSE IN IRRIGATION, WCS, WASHING MACHINES AND DISHWASHERS	3.75	m3
2 x 1,500 (House 1 and 2) and 1 x 750 (House 3)		
RAIN GARDES WITH FRENCH DRAIN	21.74	m3
120.7m2 x 0.6m deep x 50% capacity		
TOTAL SUDS (EXCLUDING RAINWATER)	**25.49**	m3
TOTAL SUDS WITH RAINWATER	29.24	m3

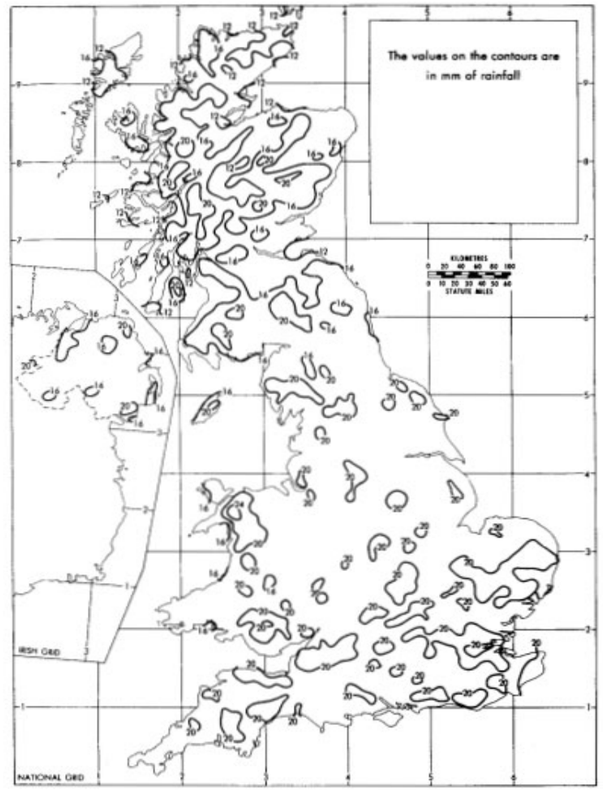

Fig. 5.3 Rainfall depths of 5 year return period and 60 minutes duration: M5–60 min (reproduced from 'The Wallingford Procedure' with permission of HR Wallingford Ltd)

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