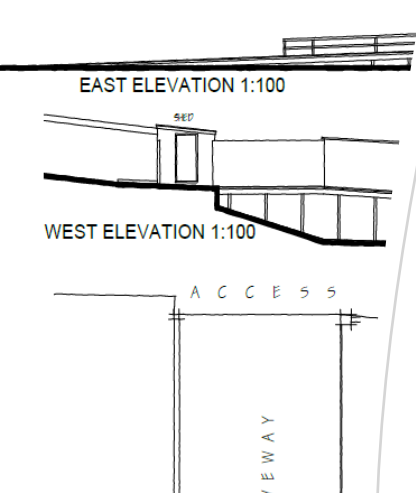
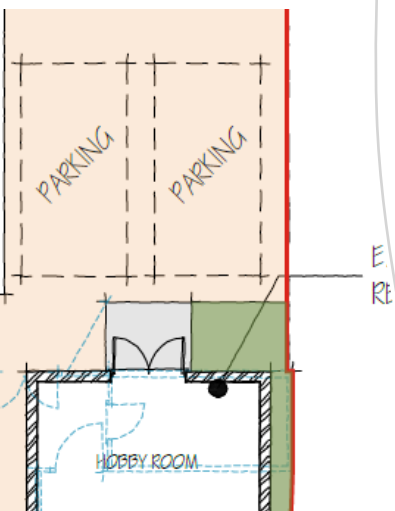




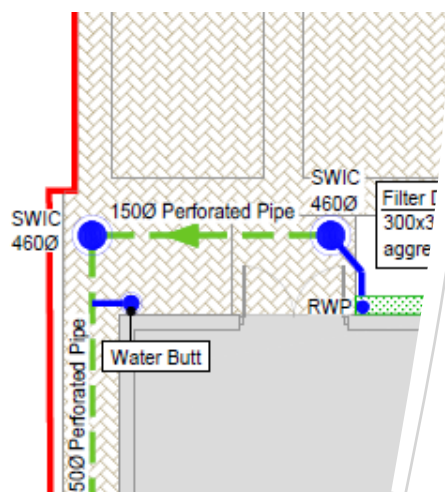
Earth Environmental
& Geotechnical



New Hobby Room Building at
Willowbend, The Warren
Caversham, RG4 7TH

Flood Risk Assessment and Surface
Water Management

September 2024
Revision A



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CONTENTS

1.	Introduction	1
2.	National Policy and Water Management Guidance	2
3.	Site Setting and Description	3
4.	Potential Sources of Existing Flooding	5
5.	Flood Risk Assessment – Sourced Data	6
6.	Probability of Flooding	9
7.	Flood Risk and Vulnerability	11
8.	The Sequential Test and Exception Test	14
9.	Surface Water Management Principles	15
10.	Surface Water Run-Off Destination	17
11.	SuDS Feasibility	18
12.	Development Greenfield Run-Off Rate and Volumes	21
13.	Drainage Network and Surface Water Management Calculation	23
14.	Maintenance Requirements	26
15.	Surface Water Exceedance Design	27
16.	Water Quality	28
17.	Development Management and Construction Phase	29
18.	Conclusion / Summary	30

APPENDICES

Appendix A	-	Existing Site Plans
Appendix B	-	Proposed Site Plans
Appendix C	-	British Geological Survey Data
Appendix D	-	Landmark EnviroCheck Flood Map Data
Appendix E	-	Greenfield Run-Off Calculations
Appendix F	-	Surface Water Management Layout
Appendix G	-	Surface Water Management Calculations

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1. Introduction

Earth Environmental and Geotechnical Ltd have prepared this flood risk assessment and surface water management report in support of an application for a new residential development at Willowbend, The Warren, Caversham (hereafter referred to as 'the Site').

The report provides evidence of the assessment of current flood risks to the development site and describes how the surface water run-off rate and volume from the post development site is proposed to be managed. National and local planning policy, regulations and relevant design guidance include:

- National Planning Policy Framework (NPPF), December 2023, Paragraphs 153-158 and 159-169;
- National Planning Practice Guidance (NPPG) ('Flood Risk and Coastal Change' section), released in March 2014 and updated in August 2022;
- National Standards for Sustainable Drainage Systems (SuDS) set out by the Department for Environment, Food & Rural Affairs (DEFRA) (2011);
- CIRIA (2010) Planning for SuDS – Making it Happen C687;
- CIRIA SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (DEFRA) (March 2015).

And local policies including:

- Reading Borough Council Strategic Flood Risk Assessment (March 2009);
- Reading Borough Council Local Flood Risk Management Strategy (October 2015);
- Reading Borough Local Plan (Adopted November 2019) – Policies CC3 and EN18.

Reading Borough Council, acting as Lead Local Flood Authority (LLFA), need to be satisfied that the design and drainage principles of the proposed development will: address the risk of flooding to the development site; will ensure that the drainage is maintained to prevent flooding; and in turn not to increase the risk of flooding to neighbouring land and property.

This flood risk assessment and surface water management report has therefore been prepared to identify and evaluate the various possible sources of flood risk to which the proposed site might be subjected to; to identify any mitigation, protection or compensation measures deemed necessary or feasible; and to manage the surface water so it is sustainable, and does not increase the probability of flooding within, or near the site.

2. National Policy and Water Management Guidance

2.1. National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG)

NPPF (December 2023) sets out the Government's national policy on development and flood risk, and seeks to provide clarity on what is required at regional and local levels, to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk.

NPPF 2023 Paragraphs 152 to 158 provide guidance for developments to take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk.

NPPF 2023 Paragraphs 159 to 169 provide guidance for planning and flood risk, where are plans should apply a sequential, risk-based approach to the location of development taking into account current and future impacts of climate change; to ensure that flood risk is not increased elsewhere due to the development; and to incorporate sustainable drainage systems.

NPPG, Paragraph 020 (Reference ID: 7-020-20220825), outlines that the objectives of this FRA are to establish whether a proposed development is likely to be affected by current or future flooding from any source; whether it will increase flood risk elsewhere; whether the measures proposed to deal with these effects and risks are appropriate; whether there is evidence for the local planning authority to apply (if necessary) the Sequential Test; and whether the development will be safe and pass the Exception Test, if applicable.

NPPG, Paragraph 055 (Reference ID:7-055-20220825) states that sustainable drainage systems (SuDS) are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, where they provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban run-off at source; and to combine water management with green space with benefits for amenity, recreation, and wildlife.

Further to this NPPG, Paragraph 056 (Reference ID:7-056-20220825) states that the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable which (in order) are into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain, or another drainage system; to a combined sewer.

2.2. Reading Borough Local Plan

Policy EN18: Flooding and Sustainable Drainage Systems, states:

'Development will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change. It will consider flooding from all sources, including fluvial, surface water, groundwater and sewer flooding. Where development in areas at risk of flooding is necessary, it will not reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding. Wherever possible, development should be designed to reduce flood risk, both on- and off-site.'

All major developments must incorporate sustainable drainage systems (SuDS) as appropriate and in line with the Government's Technical Standards. Smaller schemes are encouraged to incorporate SuDS, where possible. Runoff rates should aim to reflect greenfield conditions and, in any case, must be no greater than the existing conditions of the site. Schemes should ensure that the movement of water through vertical infiltration as well as horizontal run-off does not worsen contamination effects. Wherever possible, SuDS provision should maximise ecological benefits, link into the existing Green Network, incorporate tree planting and landscaping and avoid damage to existing significant trees, including through changes to the site hydrology. All new developments in areas of flood risk should give priority to SuDS'.

3. Site Setting and Description

3.1. Site Location

The Site is in a residential area of Caversham, is approximately 1.5 km south of Reading West station, and is bound by The Warren to the north; residential dwelling (Caversham Cottage and Warrenside) to the east and west, respectively, and the River Thames to the south.

The nearest postcode to the Site is RG4 7TQ, with the co-ordinates to the centre of the Site being – E:470190, N: 174960.

3.2. Existing Site

As detailed on the existing site plan in Appendix A, the Site, in a pre-development state, consists of a shed to the north, an outbuilding and boathouse to the south, and a covered walkway along the western boundary.

3.3. Topography

The Site has a relatively steep fall from The Warren along the northern boundary, to the River Thames along the southern boundary.

3.4. Proposed Development

The proposed plans are shown in Appendix B, which shows the Site, in a post development state, to consist of the demolition of the shed and covered walkway, and the erection of a detached hobby room building to the north. Parking areas will be formed between The Warren and the new hobby room building, with new steps leading from the new hobby room building to the existing ground along the western boundary.

As detailed in this report, the new hobby room building is to be built to the north of the Site where the levels are at their highest and above the fluvial flood extent from the River Thames.

3.5. Ground Conditions

The ground conditions can be determined by the British Geological Survey (BGS) website. As shown in Figure 1 the lower areas of the Site to have superficial deposits of Alluvium (clay, silt sand and gravel), with the higher area of the Site (area of new hobby room building) having no superficial deposits. This is over bedrock consisting of Seaford Chalk Formation (chalk).



Figure 1 – BGS Superficial Deposits

The BGS website also shows public borehole log data areas within a 250m radius of the Site, and within the same strata, which shows the ground to predominantly consist of clay to approximately 1.50m bgl, over a chalk strata. See Appendix C for borehole log details.

3.6. Waterbody / Rivers / Canals / Reservoirs

The nearest waterbody to the Site is the River Thames which flows along the southern boundary.

3.7. On-Site Drainage and Public Sewers

There are no known drainage networks within the Site, as the Site currently consists of a shed, outbuilding and boathouse only. There is also no evidence of any public sewer network within The Warren (road north of the Site).

3.8. Surface Water Management Areas

The Site area equates to approximately **670m² / 0.067 ha**.

The undeveloped areas south of the new hobby room building, and the existing outbuilding and boat house building are to remain as existing, and are therefore not included in the surface water management area.

The surface water management area includes the new hobby room building, driveway and pedestrian access areas (including steps) only, which equates to approximately 130m² / 0.013 ha.

The remaining undeveloped, outbuilding and boat house areas (equating to 540m² / 0.054 ha) will continue to discharge off the Site at the natural / current rates. Therefore, the surface water management area will be **0.013 ha**.

The surface water management area (not whole site area), in a pre-development state, consists of the shed equating to an area of 30m² only, and therefore the development area is deemed to be a '**Greenfield Site**'.

In terms of greenfield calculations, the surface water management area of the Site has an existing urban factor of **0.23** (30m² / 130m²).

4. Potential Sources of Existing Flooding

In accordance with the NPPF, flood risk must be assessed for all sources of flooding and development of the Site should be carried out in such a way as to mitigate any potential flood risk to both the Site and third parties and their property. This section identifies all possible sources of flooding.

4.1. Fluvial Flooding

Fluvial flooding results from watercourses / rivers surcharging and flooding the surrounding areas.

4.2. Coastal Flooding

Coastal flooding results from high tides from the sea.

4.3. Pluvial Flooding

'Pluvial' flooding is that which results from rainfall generated overland flow before the run-off enters any watercourse, drain or sewer. It is more often linked to high intensity rainfall events (typically in excess of 30mm per hour). However, it can also result from lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or has low permeability. This results in overland flow and ponding in depressions in the topography. In urban areas 'pluvial' flows are likely to follow the routes of highways and other surface connectivity to low spots where flooding can occur. In some cases, it can deviate from this route into adjacent developments via dropped kerbs (either for access to driveways or disability access).

4.4. Groundwater Flooding

Groundwater flooding is caused by the emergence of water from sub-surface permeable strata. Fluctuations in the groundwater table can cause flooding should the table rise above the existing ground level. Groundwater flooding events tend to have long durations, lasting days, or weeks.

4.5. Flooding from Drains and Sewers

Flooding from drains and sewers is caused when the capacity of the drains and sewers is exceeded, and will result in flooding from the manholes.

4.6. Canals, Reservoirs and Other Artificial Sources

Flood is from canals, reservoirs and artificial sources is caused when the capacity of the sources is exceeded, or if there is an infrastructure failure.

5. Flood Risk Assessment – Sourced Data

Data from the Environment Agency and information from other parties are to be studied to establish which sources of flooding are at the Site.

5.1. Environment Agency Flood Maps for Planning

The fluvial flood zone map (Risk of Flooding from Rivers and Sea) on the EA website (see Figure 2 below), identifies that the southern areas of the Site to be in Flood Zone 3 (high probability - land having a 1 in 100 or greater annual probability of river flooding), with the northern areas of the site, to which the new hobby room building is to be built, being in Flood Zone 1 (low probability - less than 1 in 1000 annual probability of river flooding in any year).



Figure 2 – EA Fluvial Flood Zone Map

The fluvial flood probability map on the EA website (see Figure 3 below) identifies that the southern areas of the Site to have a high probability of fluvial flooding, with the northern areas (new hobby room building area) having a better than very low probability of fluvial flooding.

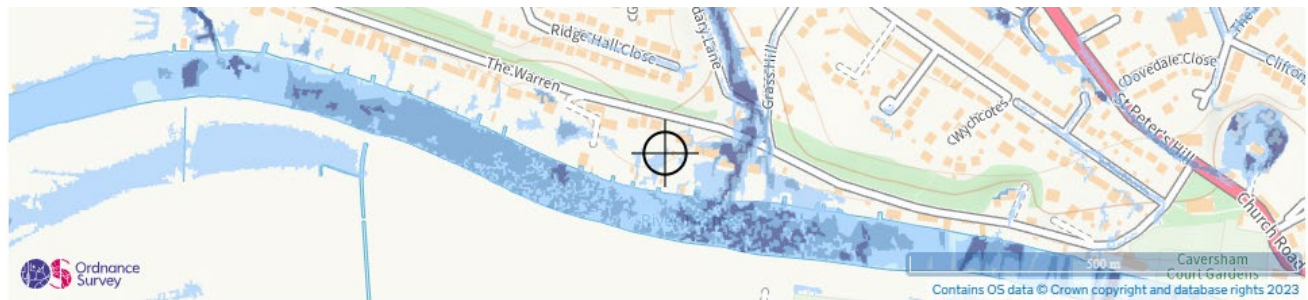


Extent of flooding from rivers or the sea

● High ● Medium ● Low ● Very low ⊕ Location you selected

Figure 3 – EA Fluvial Flood Probability Map

The pluvial flood map on the EA website (see Figure 4 below) identifies that there is a low probability pluvial flooding to the south of the Site, and very low risk of pluvial flooding for the northern areas of the Site.



Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

Figure 4 – EA Pluvial / Surface Water Flood Probability Map

The EA extent of flooding from reservoirs map (see Figure 5) identifies that all the Site is not in an area subjected to the maximum extent of flooding when the river is normal. The map does show that the southern areas of the site are in the extent of flooding when there is also flooding from rivers, with the northern area (new hobby room building area) being outside this area.



Maximum extent of flooding from reservoirs:

 when river levels are normal  when there is also flooding from rivers  Location you selected

Figure 5 – Extent of Reservoir Flood Map

5.2. Landmark Envirocheck Data Maps

Refer to Appendix D for Landmark Envirocheck flood map data. The data shown on the maps have been sourced from studies by JBA Consulting, the EA and NRW. The summary of each of the maps are as follows:

Flood Zone Map

The EA/NRW flood data map also identifies that the southern areas of the Site to be in Flood Zone 3 (high probability - land having a 1 in 100 or greater annual probability of river flooding), with the northern areas of the site, to which the new hobby room building is to be built, being in Flood Zone 1 (low probability - less than 1 in 1000 annual probability of river flooding in any year).

JBA Flood Maps (Fluvial, Pluvial and Coastal)

The Envirocheck (EA/NRW) 75-year return period flood map indicates that there is no pluvial or coastal flooding at the site, fluvial flooding to the south of the Site to depths over 1.0m, and no fluvial flooding to the northern areas of the Site (new hobby room building location).

The Envirocheck (EA/NRW) 100-year return period flood map indicates that there is no coastal flooding at the site, fluvial flooding to the south of the Site to depths over 1.0m, and no fluvial flooding to the northern areas of the Site (new hobby room building location).

The Envirocheck (EA/NRW) 200-year return period flood map indicates that there is no pluvial or coastal flooding at the site, fluvial flooding to the south of the Site to depths over 1.0m, and no fluvial flooding to the northern areas of the Site (new hobby room building location).

The Envirocheck (EA/NRW) 1000-year return period flood map indicates that there is no pluvial or coastal flooding at the site, fluvial flooding to the south of the Site to depths over 1.0m, and no fluvial flooding to the northern areas of the Site (new hobby room building location).

EA / NRW Flood Map (Surface Water / Pluvial Flooding)

The EA 30-year return period flood map indicates that there is no surface water / pluvial flooding in the Site.

The EA 100-year return period flood map indicates that there is no surface water / pluvial flooding in the Site.

The EA 1000-year return period flood map indicates that there are surface water / pluvial flood depths of up to 0.15m to the southern areas of the Site, and no surface water / pluvial flood depth to the northern areas of the Site.

Ground Water

The BGS flood data map indicates that there is potential for groundwater flooding to occur at the Site.

The ESI groundwater flood map indicates that there is a high risk of ground water flooding at the Site.

Canal Failure

The Envirocheck (JBA) canal failure map indicates that the Site is in the canal flood coverage, but is not in an area of flooding in the event of a canal failure.

Historic Flood Map

The Envirocheck historic flood map indicates that there is history of fluvial flooding (channel capacity exceedance) to the southern areas of the Site (same extents of Flood Zone 3), and no history of flooding from any source at the northern areas of the Site.

6. Probability of Flooding

The flood risk to the **Development Areas** of the Site to be assessed against the sourced data.

6.1. Fluvial Flooding - *Probability: High (Southern Areas) – Low (Northern Development Areas)*

The fluvial flood zone map on the EA website identifies that the southern areas of the Site to be in Flood Zone 3 with the northern areas of the site, to which the new hobby room building is to be built, being in Flood Zone 1.

The fluvial flood probability map on the EA website identifies that the southern areas of the Site to have a high probability of fluvial flooding, with the northern areas (new hobby room building area) having a better than very low probability of fluvial flooding.

The EA/NRW flood data map also identifies that the southern areas of the Site to be in Flood Zone 3 with the northern areas of the site, to which the new hobby room building is to be built, being in Flood Zone 1.

The Envirocheck (EA/NRW) 75-year to 1000-year return period flood map indicates that there is fluvial flooding to the south of the Site to depths over 1.0m, but no fluvial flooding to the northern areas of the Site (new hobby room building location).

Based on the flood map data, there is a high probability of fluvial flooding to the southern areas of the Site, and a low probability of flooding to the northern areas of the Site.

The new hobby room building / development areas of the Site will be **purposely built** within the northern Flood Zone 1 areas, and therefore it is deemed that there will be a low probability of fluvial flooding.

6.2. Pluvial Flooding - *Probability: Low*

The pluvial flood map on the EA website identifies that there is a low probability pluvial flooding to the south of the Site, and very low risk of pluvial flooding for the northern areas of the Site.

The EA 30-year and 100-year return period flood map indicates that there is no surface water / pluvial flooding in the Site.

The EA 1000-year return period flood map indicates that there are surface water / pluvial flood depths of up to 0.15m to the southern areas of the Site, and no surface water / pluvial flood depth to the northern areas of the Site.

The new hobby room building / development areas of the Site will be **purposely built** within the northern areas, and therefore it is deemed that there will be a low probability of pluvial flooding.

6.3. Ground Water Flooding - *Probability: Low*

The BGS flood data map indicates that there is potential for groundwater flooding to occur at the Site.

The ESI groundwater flood map indicates that there is a high risk of ground water flooding at the Site.

Due to the topography of the Site, groundwater flooding is likely to occur south of the development areas (lower levels) and therefore will not flow towards the new hobby room building.

BGS data also identifies a band of clay above the chalk strata at the site, which is known to have exceptionally low or no percolation value. Therefore, it is unlikely that ground water would penetrate the clay strata to the surface.

Based on the topography of the Site and the presence of clay, it is deemed that there will be a low probability of groundwater flooding.

6.4. Canals, Reservoirs and Other Artificial Sources - *Probability: Low*

The EA extent of flooding from reservoirs map identifies that all the Site is not in an area subjected to the maximum extent of flooding when the river is normal. The map does show that the southern areas of the is in the extent of flooding when the is also flooding from rivers, with the northern area (area of new hobby room building) being outside this area.

The Envirocheck (JBA) canal failure map indicates that the Site is in the canal flood coverage, but is not in an area of flooding in the event of a canal failure.

Reservoirs are well managed and maintained infrastructure assets that are designed not to fail, and if failure would occur flood water would be in the Flood Zone 3 extent of the Site only, and not in the Flood Zone 1 extent to the north.

The new hobby room building / development areas of the Site will be **purposely built** within the northern Flood Zone 1 area, and therefore it is deemed that there will be a low probability of flooding from artificial sources.

6.5. Flooding from Drains and Sewers - *Probability: Low*

There are no known drainage networks within the Site, as the Site currently consists of a shed, outbuilding and boathouse only. There is also no evidence of any public sewer network within The Warren (road north of the Site).

Therefore, as there are no known drains or sewers near the Site, the probability of flooding from this source is deemed to be low.

7. Flood Risk and Vulnerability

The NPPG Paragraphs 077 to 078 set out the flood risk for the Site by assessing the flood zones, flood risk vulnerability classification, and flood risk vulnerability and flood zone 'compatibility'.

7.1. Flood Zones

NPPG Paragraph 077, Table 1 indicates that the flood zones are:

Flood Zones	
Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
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)
Flood Zone 3b The Functional Flood Plain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

The assessed flood map data identifies the southern areas of the Site to be in Flood Zone 3a, and the northern areas to be in Flood Zone 1.

7.2. Flood Risk Vulnerability Classification

NPPG Paragraph 077, refers to NPPF Annex 3 where it states the flood risk vulnerability classifications as:

Flood Risk Vulnerability Classification
Essential Infrastructure Essential transport infrastructure (including mass evacuation routes) which should cross the area at risk; Essential utility infrastructure which must be in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; Wind turbines.
Highly Vulnerable Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding; Emergency dispersal points; Basement dwellings; Caravans, mobile homes and park homes intended for permanent residential use; Installations requiring hazardous substances consent.
More Vulnerable Hospitals; Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels; Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels; Non-residential uses for health services, nurseries and educational establishments; Landfill* and sites used for waste management facilities for hazardous waste; Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable Police, ambulance and fire stations which are not required to be operational during flooding; Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure; Land and buildings used for agriculture and forestry; Waste treatment (except landfill* and hazardous waste facilities); Minerals working and processing (except for sand and gravel working); Water treatment works which do not need to remain operational during times of flood.
Water Compatible Development Flood control infrastructure; Water transmission infrastructure and pumping stations; Sewage transmission infrastructure and pumping stations; Sand and gravel working; Docks, marinas and wharves; Navigation facilities; Ministry of Defence installations; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms; Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

The Site is deemed to be 'Less Vulnerable' as the new building will be used as a hobby room only

7.3. Flood Risk Vulnerability and Flood Zone ‘Compatibility’

NPPG Paragraph 078 Table 2, gives guidance on flood risk vulnerability compared with flood zone, to determine the compatibility.

Flood Risk Vulnerability and Flood Zone ‘Compatibility’					
Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a†	† Exception Test required	✗	Exception Test required	✓	✓
Zone 3b*	* Exception Test required	✗	✗	✗	✓*

“†” In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

“**” In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

The Site is classed as ‘Less Vulnerable’, with areas of the Site being Flood Zone 3 and 1. Table 2 of the NPPG states that Less Vulnerable development in Flood Zones 1 and 3 are both appropriate, with **no requirement for an exception test**.

8. The Sequential Test and Exception Test

Although the NPPG states that an exception test is not required due to the development being classed as 'Less Vulnerable', the exception test, as well as the sequential test principles are still being applied to ensure the development is safe for its lifetime.

8.1. Sequential and Exception Test Guidance

Paragraph 101 of the NPPG states that: *'The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding'*.

Paragraph 102 of the NPPG states that: *'If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be in zones with a lower probability of flooding, the Exception Test can be applied if appropriate'*.

8.2. Sequential and Exception Test Requirement for Development

To meet the sequential test for the Site, the new hobby room building, driveway and pedestrian access routes are to be built to the north of the Site, to steer them to an area with the lowest probability of flooding (area within Flood Zone 1), with the remaining southern areas of the Site remaining as existing (no change to levels or use).

Therefore, as the development areas are to the north of the Site only, **the sequential test has passed**, but to ensure the Site is safe for its lifetime, flood mitigation measures are to be implemented into the design, which include:

- The new new hobby room building having a suitable finished floor levels to prevent flooding;
- The development will not affect flood flows or displace any flood water to neighbouring land, and subsequently increasing the risk of flooding elsewhere;
- There will be safe access and egress to and from the new hobby room building.
- Surface water run-off management to ensure no increase in flooding elsewhere.

8.3. Finished Floor Levels

The new hobby room building is to be built to the north of the Site and above the extent of the fluvial and pluvial flooding. The finished floor level will be at least 300mm above the lowest ground level at the new hobby room building location, which will be more than **600mm above** the fluvial and pluvial flood extent.

8.4. Flood Flows and Flood Water Displacement

The new new hobby room building will be built to the north of the Site where no flooding or flood flows will occur, with the southern areas remaining as existing. Therefore, the new new hobby room building will **not displace any flood water and subsequently will not increase flood risk elsewhere**.

8.5. Safe Access and Egress

Safe access and egress can be made to and from the new hobby room building from the road to the north (The Warren) at all times, as the road and development areas are in Flood Zone 1 with no flooding from any other source.

8.6. Surface Water Management

Details of the surface water management are set out in Section 9 onward within this report.

9. Surface Water Management Principles

The surface water run-off from the development area is to be managed so they do not increase the risk of flooding to any areas within or near to the site. The principles will be as follows:

9.1. National Planning Policy Framework (NPPF)

Paragraph 165 of NPPF – July 2021 states that:

‘Developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- *take account of advice from the lead local flood authority;*
- *have appropriate proposed minimum operational standards;*
- *have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- *where possible, provide multifunctional benefits’.*

9.2. Surface Water Discharge Destination

Surface water run-off is to discharge to one or more of the following in the order of priority shown:

- Water to be retained for future use.
- Discharge into the ground (infiltration).
- Discharge to a surface water body.
- Discharge to a surface water sewer, highway drain or other drain.
- Discharge to combined sewer.

9.3. The Management Train

A concept fundamental to implementing a successful SuDS scheme is the management train. This is a sequence of SuDS components that serve to reduce run-off rates and volumes and reduce pollution. The hierarchy of techniques that are to be used for the surface water management of the development are:

- Prevention - Prevention of run-off by good site design and reduction of impermeable areas;
- Source Control - Dealing with water where and when it falls (e.g. infiltration techniques);
- Site Control - Management of water in the local area (e.g. swales, detention basins);
- Regional Control - Management of run-off from sites (e.g. balancing ponds, wetlands).

9.4. Peak Surface Water Flow

DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems states:

‘S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event’.

9.5. Volume Control

DEFRA Non-statutory technical standards for sustainable drainage systems states:

S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk'.

9.6. Flood Risk

DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems states:

S7 *The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30-year rainfall event.*

S8 *The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100-year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.*

S9 *The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100-year rainfall event are managed in exceedance routes that minimise the risks to people and property'.*

9.7. Pollution

The SuDS design for the development site will ensure that the quality of any receiving water body is not adversely affected and preferably enhanced in accordance with Ciria SuDS Manual C753, Chapter 4.

9.8. Designing for Exceedance

The development site design will be such that when SuDS features fail or are exceeded, exceedance flows do not cause flooding of properties on or off site. This will be achieved by designing suitable ground exceedance or flood pathways, and run-off will be completely contained within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 100-year event. The design of the site ensures that flows from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

10. Surface Water Run-Off Destination

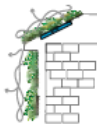
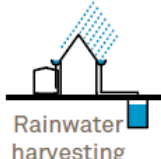
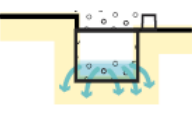
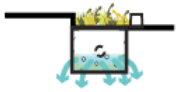
The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

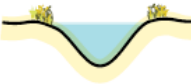
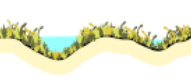
Run-Off Destination	Feasible	Description
Discharge to Ground	No	BGS data identifies the ground at the Site to consists of bands of clay to approximately 1.50m bgl over chalk strata. Chalk strata may have suitable percolation value for surface water infiltration. However, flood map data shows there to be a high risk of groundwater flooding at the Site. A soakaway at the Site will not adhere to the requirements of CIRIA 753 where the base of the soakaway is unlikely to be at least 1.0m above any groundwater. The external areas of the Site that are being developed and are not in Flood Zone 3 are relatively small (driveway only), and therefore the minimum distance of 5m from a soakaway and structure cannot be achieved, as required / stated in Approved Document H. Based on the above assessment, surface water discharge to ground is not a feasible destination.
Discharge to Surface Water Body	Yes	As the ground deemed to be unsuitable for infiltration, the only alternative is to discharge the surface water to the River Thames south of the Site. Due to the topography of the this is the surface water runoff from the Site in a pre-development state
Discharge to Surface Water Sewer	No	There are surface water sewers near the site. However, discharge destination is not required, as it is feasible to discharge to a waterbody.
Discharge to Highway Drain or Other	No	There are no known highway or other drains near to the development site, and this surface water discharge destination is not feasible.
Discharge to Combined Water Sewer	No	There are no known combined water sewers near to the development site, and this surface water discharge destination is not feasible.

11. SuDS Feasibility

To reduce the surface water run-off to the greenfield rate, SuDS methods are to be introduced to the post development design.

SuDS methods as per the Sustainable Drainage System (SuDS) hierarchy, and the Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015, that can be used are detailed below:

	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	 Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	 Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	 Open space	Dependant on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	 Open space	Minimum length 5 metres.
 Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below.	 Street/open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	 Street/open space	Typically surface area is 5-10% of drained area with storage below.

	Description	Setting	Required area
 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	 Street/open space	Account for width to allow safe maintenance typically 2-3 metres wide.
 Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	 Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	 Open space	Dependant on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	 Open space	Typically 5-15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	 Open space	Dependant on runoff volumes and soils.

The feasibility of the above SuDS methods for the post developed site are summarised in the table below:

SuDS Method	Feasible / Required	Description
Living Roofs	No	The residential building is to have a pitched roof, and therefore living roofs are not feasible.
Rainwater Harvesting	Yes	The cost of dual pipework for rainwater harvesting use within the new hobby room building is not financially viable for this development. However, a water butt can be installed at some rainwater pipes where the water can be collected and re-used for irrigation.
Soakaway	No	As stated in Section 10. BGS data identifies the ground at the Site to consist of bands of clay to approximately 1.50m bgl over chalk strata. Chalk strata may have suitable percolation value for surface water infiltration. However, flood map data shows there to be a high risk of groundwater flooding at the Site. A soakaway at the Site will not adhere to the requirements of CIRIA 753 where the base of the soakaway is unlikely to be at least 1.0m above any groundwater. The external areas of the Site that are being developed and are

		not in Flood Zone 3 are relatively small (driveway only), and therefore the minimum distance of 5m from a soakaway and structure cannot be achieved, as required / stated in Approved Document H. Based on the above assessment, the use of soakaways is not feasible.
Permeable Paving	Yes	There is potential to have permeable paving within the driveway and external pedestrian areas of the Site. Permeable paving system will not discharge the surface water to ground, but will convey the surface water to the main network via perforated pipes within the granular sub-base (formed of 20mm no fines aggregate). Permeable paving will also reduce the surface water run-off rate and act as a pollutant control.
Filter Strips	Yes	There can be a small filter strip / granular trench built along the southern edge of the new hobby room building and steps. The filter strip will be formed of a 300x300mm wide trench filled with 20mm no fines aggregate, wrapped in an impermeable membrane and to house a perforated pipe. The perforated pipe will convey the surface water to the main network. A filter drain will also reduce the surface water run-off rate and act as a pollutant control. Note that the filter drain will be built north of the Flood Zone 3 / flood area extents.
Hardscape Storage	No	Hardscape storage will not be required, as surface water run-off from all external areas (within surface water management area) will discharge to either permeable paving or filter drain system.
Bioretention Areas / Swales / Ponds	No	The undeveloped area to the south of the Site (only area for these SuDS methods) is in Flood Zone 3 and at a relatively steep gradient. Therefore, the use of bioretention areas, swales or ponds would be suitable as a SuDS method.
Underground Storage	Yes	The surface water run-off from the development site will be restricted to suitable rates to meet local authority requirements. Therefore, there will be a requirement to have underground storage for storm events up to 1 in 30-year; and to suitable sized so that the volume of water during the 1 in 100-year storm event is kept a minimum at surface level, where it can be contained on site. Note that the cellular units will be built north of the Flood Zone 3 / flood area extents.

12. Development Greenfield Run-Off Rate and Volumes

To minimise the surface water run-off from the new development areas of the site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rate and volume.

12.1. Greenfield Run-Off Rate

The Flood Estimation Handbook is often used for the calculation of the greenfield run-off rate, however, relevant documents state that to calculate the greenfield run-off rates on small catchments less than 25km², the IH 124 QBAR equation (and the equation for the instantaneous time to peak for the unit hydrograph approach) is to be used. The IH method is based on the Flood Studies Report (FSR) approach and is developed for use on catchments less than 25km². It yields the Mean Annual Maximum Flood (QBAR). This reference also recommends the use Ciria C753 Table 24.2 to generate Growth Factors. These are used to convert QBAR to different return periods for different regions in the UK.

The input variables to establish QBAR are:

Return Period (years)	Results based on a range of return periods and the specified RP;
Area	Catchment Area (ha) which is adjusted to km ² for use in the equation;
SAAR	Average annual rainfall in mm (1941-1970) from FSR figure II.3.1;
Soil	Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively;
Urban	Proportion of area urbanised expressed as a decimal;
Region Number	Region number of the catchment based on FSR Figure I.2.4.

QBAR(l/s)

The output variables to establish QBAR are calculated using the following formula (equation yields m³/s):

$$\text{QBAR} = 0.00108 \times \text{AREA}^{0.89} \times \text{SAAR}^{1.17} \times \text{SOIL}^{2.17}$$

The IH 124 Variables (taken from FSR) that are specific to this site are as follows:

Area	=	50.00 ha
SAAR	=	700
Soil	=	0.450
Urban Factor	=	0.23 (percentage of area already developed)
Region Number	=	6

Based on these variables, and the calculation results provided by the MicroDrainage computer software (Appendix E), the QBAR for a 50.00ha catchment area is:

$$\text{QBAR} = 123.7 \text{ l/s}$$

This figure is for the catchment area of 50.00 ha, and is to be reduced to reflect the surface water management area (0.013 ha) of the development site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

$$\text{QBAR} = \underline{\underline{0.04 \text{ l/s (2.79 l/s/ha)}}}$$

Ciria C753 Table 24.2 identifies the growth factors for each of the storm events, based on the known QBAR figure. The growth factors from the table vary depending on the site location. In this case hydrometric area (Region Number) is 6.

Based on the figures shown in the table, the growth factors, and the existing greenfield run-off rates for each of the storm events for the development areas of the site are as follows:

Storm Event	QBAR	Growth Factor (C753 Table 24.2)	Greenfield Run-off Rate
Q ₂	0.04 l/s	0.88	0.1 l/s
Q ₃₀	0.04 l/s	2.40	0.1 l/s
Q ₁₀₀	0.04 l/s	3.19	0.2 l/s

Note: Greenfield rates are rounded up to single decimal place to adhere to MicroDrainage calculations.

12.2. Greenfield Run-Off Volume

The greenfield run-off volume for the 100-year, 6-hour storm event has also been calculated in the MicroDrainage software using the data from the FEH 2013, with the results shown in Appendix E.

The FEH 2013 data and variables used to calculate the greenfield run-off volume at the Site location area as follows:

Site Location	=	GB 470190 174960 SU 70190 74960
Area	=	0.013 ha
SAAR	=	644
CWI	=	94.920
SPR Host	=	47.000
URBTEXT	=	0.23 (percentage of area already developed)

Based on these calculation results (Appendix E), the greenfield run-off volume for the surface water management area of the Site is:

Q ₁₀₀ (6-Hour)	=	3.78m ³ (290.77m ³ /ha)
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13. Drainage Network and Surface Water Management Calculation

13.1. Climate Change Allowance

The NPPF makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are taken from the Environment Agency guidance summarised in Figure 6 below.

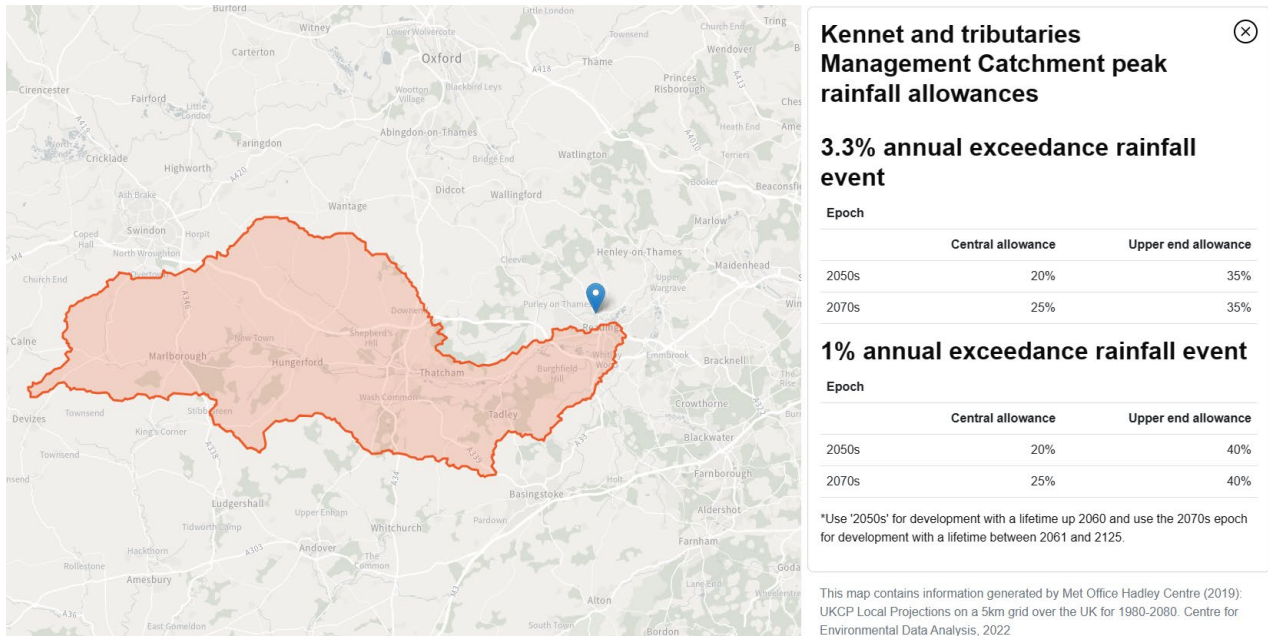


Figure 6 - Department for Environment Food & Rural Affairs – Climate Change Allowances

The lifetime of the new hobby room building is likely to be beyond 2061, and therefore the Epoch 2070's is to be used with Upper End Allowance. Therefore, the climate change allowance for the pre and post development surface water run-off will be: **30-Year Storm - 35% and 100-Year Storm - 40%.**

13.2. Surface Water Network Calculations

The calculations to determine the post development surface water run-off rates are based on the post development surface water run-off area of 0.013 ha, and the rainfall data given by the FEH.

13.3. Surface Water Management Details

As shown on the surface water management layout drawing in Appendix F, the proposed drainage network and SuDS features will consist of 150mm diameter pipes, 150mm perforated pipes, 460mm diameter inspection and silt trap chambers, a 500mm diameter flow control chamber containing an orifice, a water butt, permeable paving, a filter drain, and an attenuation structure in the form of cellular units.

The surface water run-off from the roof will discharge to the main drainage network via the water butts and filter drain systems, and the surface water run-off from the external areas will discharge to the main drainage network via the permeable paving and filter drain systems.

The surface water will be restricted by the orifice prior to discharge to the waterbody, where the restricted surface water will surcharge the drainage network and the attenuation tank, in the form of cellular units, and store the surface water during a storm event to prevent flooding.

13.4. Surface Water Run-Off Rate

For the surface water run-off from the Site, in a post-development state, to be at the greenfield run-off rate, they are to be restricted to 0.1 l/s for the 1 in 2-year storm event; 0.1 l/s for the 1 in 30-year storm event including 35% allowance, and 1.2 l/s for the 1 in 100-year storm event including 40% allowance.

For the surface water run-off volume to be a betterment of, or equivalent to, the greenfield volume (100-year, 6-hour storm event), the surface water discharge rates need to be a maximum of 0.2 l/s ($3.78\text{m}^3 \times 1000 / 60 \times 60 \times 6$).

For this development, to achieve the 1-year and 100-year greenfield rates, the size of the flow control opening (orifice opening) is 10mm.

As shown in the output calculation from the MicroDrainage computer software in Appendix G, if the orifice opening is set at 10mm, the maximum surface water run-off rates for each storm event will be as follows:

Storm	-	Rate	-	Critical Storm Event
Q ₂	-	0.1 l/s	-	360-minute winter storm duration
Q _{30 + CC}	-	0.2 l/s	-	240-minute winter storm duration
Q _{100 + CC}	-	0.2 l/s	-	240-minute winter storm duration

A summary of the post development surface water run-off rates compared to the greenfield rates are as follows:

Greenfield Rate to Post Development Rate

Storm	-	Greenfield	-	Post Dev	-	Difference
Q ₂	-	0.1 l/s	-	0.1 l/s	-	Equivalent
Q _{30 + CC}	-	0.1 l/s	-	0.2 l/s	-	Increase
Q _{100 + CC}	-	0.2 l/s	-	0.2 l/s	-	Equivalent

The calculations show that the surface water run-off rates are greater than the 30-year greenfield rate, but are equivalent to the 2-year and 100-year greenfield rate. Therefore, the rates still adhere to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems (S2).

13.5. Surface Water Run-Off Volume

The surface water run-off volumes for the post development site have also been calculated for 1 in 100-Year the 6-hour duration (Inc. 40% CC), within the MicroDrainage computer software in Appendix G, based on the peak discharge rate, where:

$$Q_{100 (6\text{-hour})} = 0.2 \text{ l/s} \times (60 \times 60 \times 6) = 4,320 \text{ litres} = 4.32\text{m}^3$$

A summary of the post development surface water run-off volume compared to the greenfield volume is as follows:

Greenfield Volume to Post Development Volume

Storm	-	Greenfield	-	Post Dev	-	Difference
Q ₁₀₀	-	3.78m ³	-	4.32m ³	-	Equivalent*

The surface water run-off volume for the 100-year, 6-hour storm event is equivalent to the greenfield volume, as the water butts will contain at least 500 litres of water. Therefore, the discharge volume is acceptable, as it meets the requirements of DEFRA National Non-statutory technical standards for sustainable drainage systems (S4-S6).

13.6. Surface Water Attenuation Calculations

As the surface water run-off from the development site is being restricted, there will be a requirement for below ground attenuation to prevent flooding.

Ciria SuDS Manual 2015, Paragraph 10.2.4 where it states that: *'Exceedance flows (i.e. flows more than those for which the system is designed) should be managed safely in above-ground space such that risks to people and property are acceptable'*.

The surface water attenuation for the development site will be within an attenuation tank in the form of cellular units. As detailed in the MicroDrainage calculations (Appendix G) and surface water management layout (Appendix F), the attenuation volume for this SuDS method is as follows:

Attenuation Tank (Cellular Units)

Tank Length	-	5.00m
Tank Width	-	2.00m
Tank Area	-	10.00m ²
Tank Depth	-	1.20m
Overall Tank Volume	-	12.00m ³
Tank Porosity	-	0.95
Attenuation Volume	-	11.40m³

The MicroDrainage calculations (Appendix G) show that with the cellular unit volume, no flooding will occur for all storms up to and including the 100-year + 40% storm event. Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems (S7-S9).

14. Maintenance Requirements

Details of the maintenance required, and the parties to carry out the maintenance of all drainage aspects, to ensure that the SuDS methods are working effectively, and subsequently reducing the risk of flooding on the Site, are set out below.

14.1. Drainage Responsibilities

The management and maintenance of the surface water drainage networks and SuDS features within the Site will be by contractors appointed by the owners of the new hobby room building.

A copy of the drainage design layout / details and a drainage maintenance / management document will be handed to the occupants on completion of the new hobby room building, where they will be made aware of the features within the Site, and responsibility to maintain the drainage features shown on said drawings and details.

14.2. Maintenance and Management Document on Completion

The document produced, and handed to the owners of the new hobby room building, will state the following:

'The owners & parties with responsibilities for the surface water drainage system on this development will comprise of the following stakeholders:

Hobby Room Building Owners

All of which is clearly defined on the surface water drainage plan.

As you are the owner of the hobby room building you have responsibilities for the maintenance of the surface water drainage system which fall within the extent of the title which you own.

Failure to maintain or removal of surface water drainage features may result in civil litigation with neighbouring owners if flooding occurs as a result.

Surface water drainage pipes, inspection chambers, water butts, permeable paving, filter drains, flow control chamber and cellular units within the title of your property are owned by you as the owner & as such responsibility for maintenance / repairs & replacement are yours.

'The operation and frequency of the maintenance and management set out in this report and as shown on the drainage layout are to be carried out as follows':

14.3. Drainage Network and Cellular Units

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from drainage network and cellular units (where may cause risk performance)	Monthly
Where rainfall into the cellular units from above, check surface for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from upstream surface water network by jetting.	Annually or as required

<i>Repair/check all inlets, outlets, and overflow pipes</i>	<i>As required</i>
<i>Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating</i>	<i>Annually and after large storms</i>

14.4. Permeable Paving, Filter Drains, Raingardens

Operation	Frequency
<i>Inspect and identify any areas that are not operating correctly, if required, take remedial actions</i>	<i>Monthly for 3 months, then six monthlies</i>
<i>Debris removal from on surface of permeable paving, filter drain, raingarden, or near system (where may cause risk performance)</i>	<i>Monthly</i>
<i>Rainfall infiltration into permeable paving, filter drain, raingarden is ensured working effectively.</i>	<i>As required, but at least twice a year</i>

14.5. Linked and Further Maintenance and Maintenance Activities

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance plan for the industrial estate. A log of all maintenance activities is to be kept and made available to the local planning authority (LPA) and / or the Lead Local Flood Authority (LLFA) on request.

15. Surface Water Exceedance Design

In the event of an extreme storm event (greater than 100-year + 40% climate change) flooding of the surface water management system could occur.

Surface water flow paths to follow existing and proposed ground topography, where water will flow towards the southern boundary and discharge directly to the River Thames. Surface water will not flow towards the proposed or existing buildings / properties near the site prior to discharge to the River Thames.

Therefore, an exceedance event will not increase the risk of flooding to any areas within or near the development site.

16. Water Quality

The level of water treatment (for external areas subject to pollutants) is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26 sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment.

Roof and External Area Pollutant Hazard

C753 Table 26.2 Pollution Hazard Level = Low

C753 Table 26.2 Pollution Hazard Index:

- Total Suspended Solid (TSS) = 0.3
- Metals = 0.2
- Hydrocarbons = 0.05

Pollution Hazard Index = **0.55**

Roof and External Area Pollutant Mitigation

Mitigation Measures:

- **Permeable Paving and Filter Drain**

Lowest Pollutant Mitigation Indices:

Total Suspended Solid (TSS) = 0.4

Metals = 0.4

Hydrocarbons = 0.5

SuDS Mitigation Indices = **1.30**

The mitigation indices are greater than the pollution hazard index, and therefore suitable water quality is achieved.

17. Development Management and Construction Phase

Any existing drainage networks within the development area are to be maintained during construction. The flow control chamber and cellular units are to be the first part of the drainage network to be built. This will ensure that the surface water discharge is suitably restricted without flooding.

17.1. Construction Environment Management Plan

Full details of the construction environment management plan (CEMP) has to be confirmed by the chosen contractor who have been appointed for the development. However, it will conform to the requirements of CIRIA 753 – The SuDS Manual – Chapter 31, and will include:

17.2. Construction Access

The main construction traffic will access the site from The Warren at the northern boundary. The set-up areas will be limited to avoid the attenuation tank, with protection measures (i.e. concrete slab) put over the installed attenuation tank to prevent damage during vehicle movements.

17.3. Sediments and Traps

Sediment basins and traps are to be installed before any major site earthworks take place, with further sediment traps and silt fences being installed as the earthworks progresses. This will keep sediment contained on site at appropriate locations.

17.4. Run-Off Control Measures

Run-off control measures are to be used in conjunction with sediment traps to divert water around planned earthworks areas to remove silts. Any surface water upstream of the site is to be diverted around the development areas, and to be discharged to the River Thames.

17.5. Main Surface Water Run-Off Systems

The flow control chamber and cellular units are to be built prior to any phase of construction of site. Surface water from each of the phased area is to discharge to the new drainage network, where the water is adequately restricted before discharging to the River Thames. Temporary inlet and outlet protection measures and appropriate silt traps are to be installed to prevent silt ingress into the main drainage network.

17.6. Clearing and Earthworks

Clearing and earthworks will only start when adequate erosion and sediment control measures are in place. Once the development areas are cleared, earthworks will follow immediately to ensure that the ground cover can be re-established quickly. Adjacent land to that being developed will be left undisturbed for as long as possible.

17.7. Surface Stabilisation Measures

Surface stabilisation measures will be applied to completed areas, channels ditches and other disturbed areas after the land is cleared and profiled. Permanent stabilisation measures will be installed as soon as possible after final profiling.

17.8. Construction of Permeable Surfacing

Construction of permeable paving is to be left to the later stages of construction. Unsuitable sediment is to be removed from surfacing prior to installation of sand binder layer and paving.

18. Conclusion / Summary

18.1. Existing Flood Probability

All potential sources of flooding to the development site have been assessed, and it is deemed that the probability of flooding from all existing sources at the development areas of the site are low.

18.2. SuDS Principles and Surface Water Discharge Destination

All feasible SuDS methods, and surface water discharge destination have been assessed, with the feasible SuDS methods being permeable paving, filter drains, water butts, cellular units, and a flow control, with the surface water destination being to waterbody.

18.3. Peak Flow Control

The surface water run-off rates are greater than the 30-year greenfield rate, but are equivalent to the 2-year and 100-year greenfield rate. Therefore, the rates still adhere to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems (S2).

18.4. Volume Control

The surface water run-off volume for the 100-year, 6-hour storm event is equivalent to the greenfield volume, as the water butts will contain at least 500 litres of water. Therefore, the discharge volume is acceptable, as it meets the requirements of DEFRA National Non-statutory technical standards for sustainable drainage systems (S4-S6).

18.5. Flood Risk within the Development

With the cellular unit volume, no flooding will occur for all storms up to and including the 100-year + 40% storm event. Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems (S7-S9).

18.6. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features within the Site will be by contractors appointed by the owners of the new hobby room building.

18.7. Surface Water Exceedance Design

Surface water flow paths to follow existing and proposed ground topography, where water will flow towards the southern boundary and discharge directly to the River Thames. Surface water will not flow towards the proposed or existing buildings / properties near the site prior to discharge to the River Thames. Therefore, an exceedance event will not increase the risk of flooding to any areas within or near the development site.

18.8. Water Quality

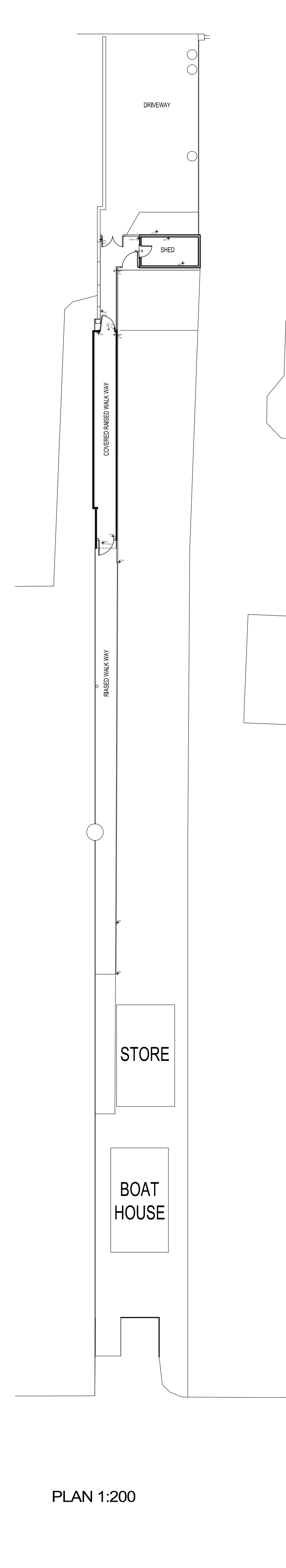
The level of water treatment is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26 sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment. The mitigation indices are greater than the pollution hazard index, and therefore suitable water quality is achieved.

18.9. Development Management and Construction Phase

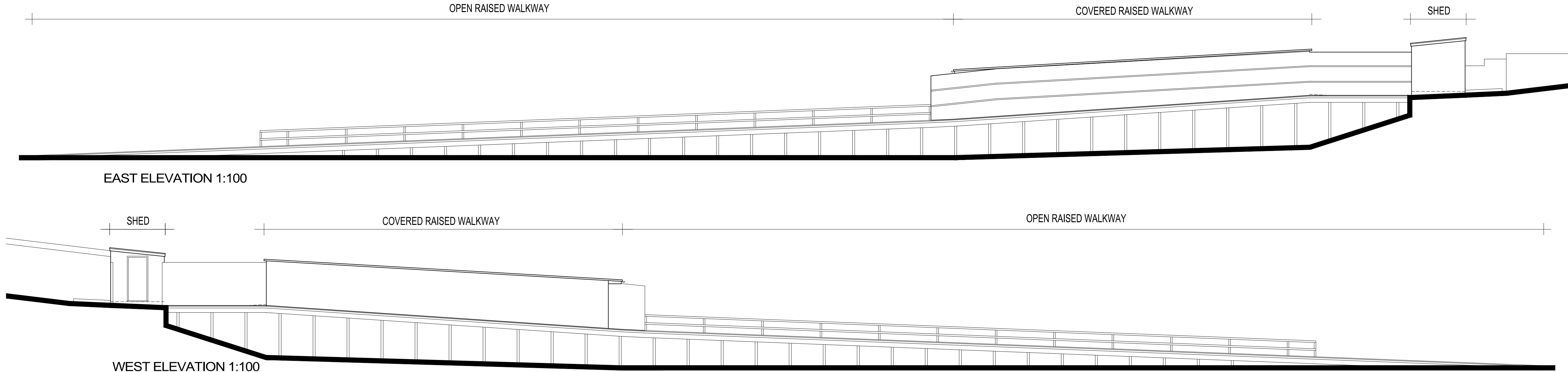
The flow control and attenuation tank are to be the first part of the drainage network to be built. This will ensure that the surface water discharge at a restricted rate during all phases of the build. Full details of the CEMP are to be confirmed by the chosen contractor, and will conform to CIRIA 753 – The SuDS Manual – Chapter 31.

Appendix A

Existing Site Plans

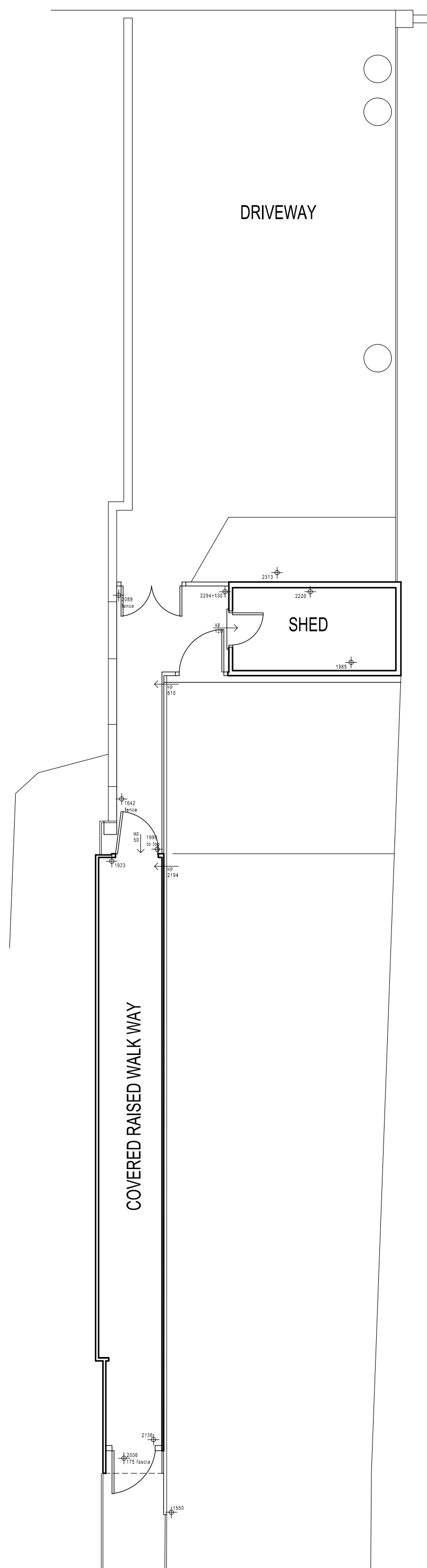


PLAN 1:200

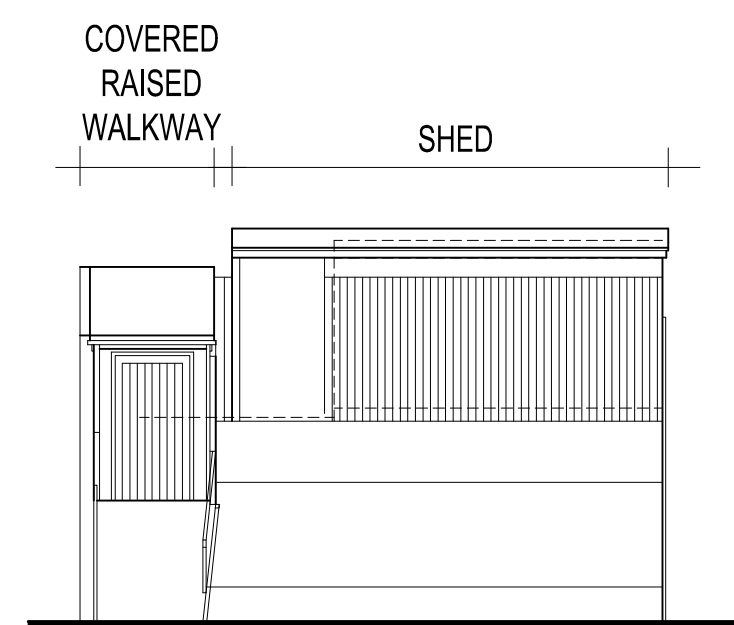


EAST ELEVATION 1:100

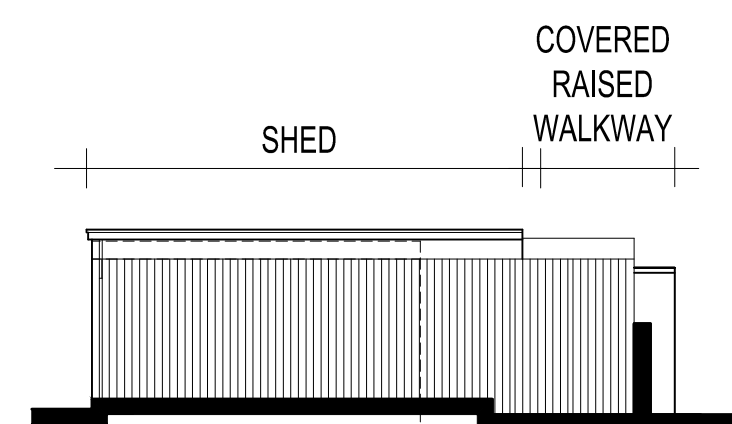
WEST ELEVATION 1:100



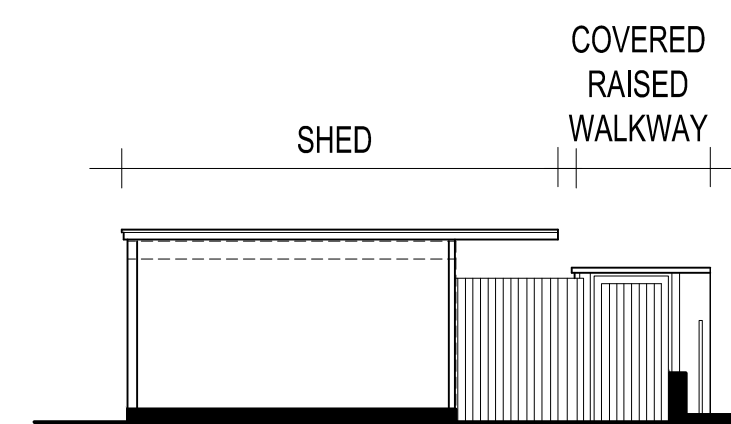
PLAN 1:100



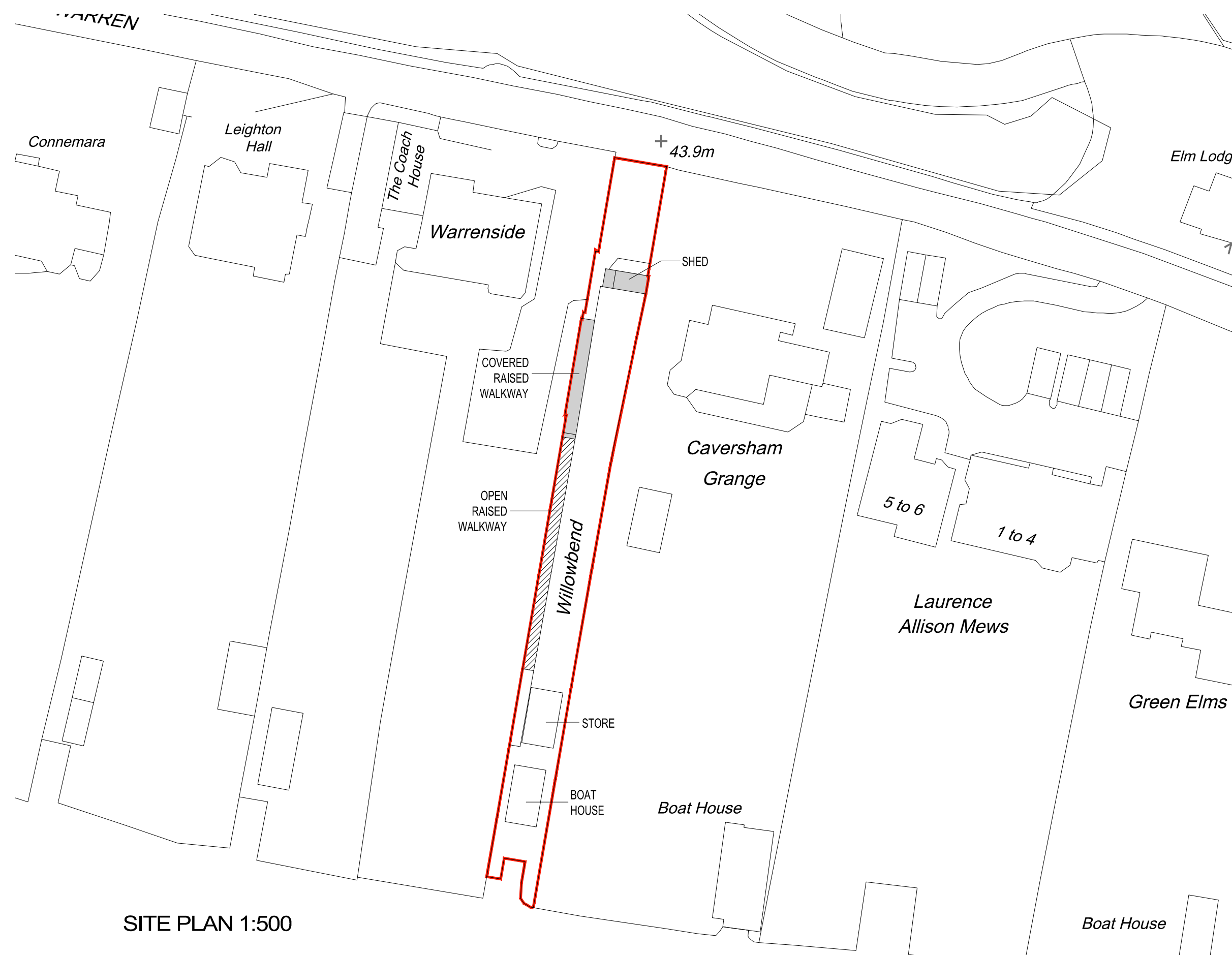
SOUTH ELEVATION 1:100



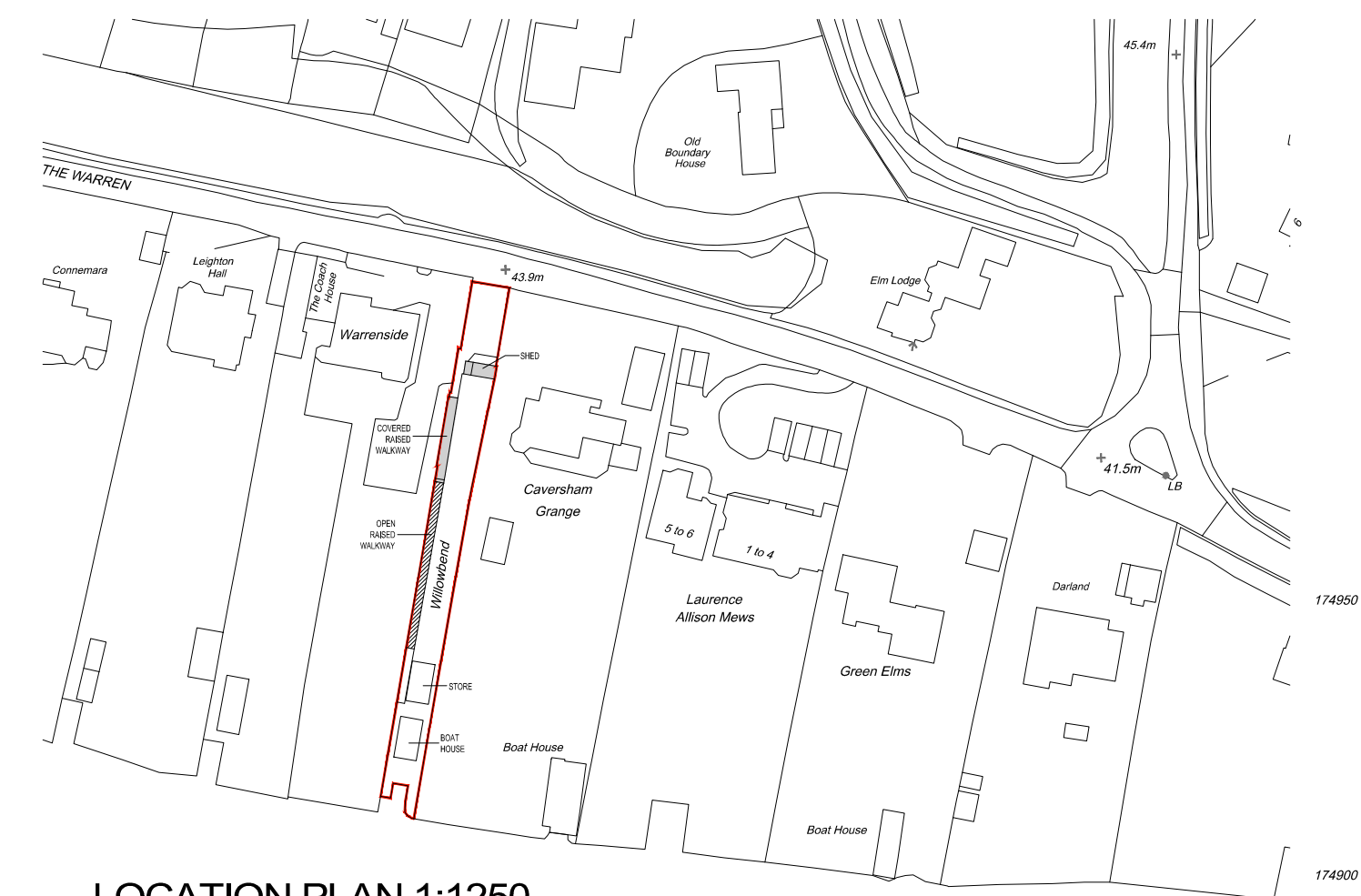
NORTH ELEVATION 1:100



NORTH SECTIONAL ELEVATION 1:100



SITE PLAN 1:500



LOCATION PLAN 1:1250

1:100 scale Bar
This Drawing has been produced for printing onto A1 size paper.
If printing on A3 please use the scale below for reference.

0m 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m

REV	COMMENTS	DATE

td Tony Day Architecture Ltd
Planning • Design • Architecture
www.tonydayarchitecture.co.uk info@tonydayarchitecture.co.uk

CLIENT Mr D Hamblin
PROJECT Willowbend, The Warren, Caversham

DRAWING EXISTING PLANS AND ELEVATIONS

SCALE 1:100/200/500/1250 DRAWN TB NO 3772/100 REV

DATE Feb 2022
Albany House
14 Shute End
Wokingham
RG40 1BJ
0118 380 5585

THIS DRAWING MUST NOT BE SCALED UNLESS ISSUED FOR PLANNING PURPOSES. ALL DIMENSIONS ARE TO BE VERIFIED PRIOR TO SETTING OUT, COMMENCING WORK, OR PRODUCTION OF FABRICATION DRAWINGS. REPORT ANY DISCREPANCIES TO THE SUPERVISING OFFICER IMMEDIATELY. ©

Appendix B

Proposed Site Plans

Appendix C

British Geological Survey Data

WR38: Borehole record form

Borehole record form



British
Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL



Environment
Agency

Water Resources Act 1991 (as amended by the Water Act 2003)

A Site details

Borehole drilled for [REDACTED]
Location 14B The Warren, Caversham, Reading, RG4 7TG
NGR (ten digits) SU 70447 74899 Please attach site plan
Ground level (if known) 45 metres Above Ordnance Datum
Drilling company H D Services Ltd. - Ref: 14308
Date drilling commenced 18/07/2023 (DD/MM/YYYY) Completed 24/07/2023 (DD/MM/YYYY)

B Construction details

Borehole datum (if not ground level) _____ metres (m). Please tick if this is above ☐ or below ☐ ground level.
(point from which all measurements of depth are taken, for example, flange, edge of chamber)

Borehole drilled diameter 250 mm from 0.0 to 7.5 m/depth
200 mm from 7.5 to 15.0 m/depth
_____ mm from _____ to _____ m/depth
_____ mm from _____ to _____ m/depth

Casing material _____ diameter _____ mm from _____ to _____ m/depth
and type (for example, if plain steel, plastic slotted). Please record permanent casing details, not temporary casing.

Casing material Plain PVC diameter 150 mm from 0.0 to 11.0 m/depth

Casing material Slotted PVC diameter 150 mm from 11.0 to 15.0 m/depth

Casing material _____ diameter _____ mm from _____ to _____ m/depth

Grouting details Pea-shingle surround with cement seal from 1 to 2-metres below ground level

Water struck at 1. 1.25 m (depth below datum - mbd) 2. _____ m (mbd)
3. _____ m (mbd) 4. _____ m (mbd)

C Test pumping summary (Please supply full details on form WR39)

Test pumping datum _____ m. Please tick if this is above ☐ or below ☐ ground level.
(if different from borehole datum)

Pump suction depth 13.0 mbd

Water level (start of test) 1.25 mbd

Water level (end of test) 1.27 mbd

Type of test (for example, bailer, step, constant rate)

Pumping rate 2.0 m³/hour ☐ or litres/second ☐. Please tick as appropriate.
for _____ days, 3 hours, _____ mins

Recovery to _____ mbd in _____ days, _____ hours, 2 mins
(from end of pumping)

Date(s) of measurements Pump started 16/08/2023 (DD/MM/YYYY)

Pump stopped 16/08/2023 (DD/MM/YYYY)

Please supply chemical analysis if available. If you have included this please tick this box ☐

WR38: Borehole record form

D Strata log

Geological classification (BGS only)	Description of strata	Thickness m	Depth (to base of strata) m
	Topsoil Grey clay Broken chalk END OF BOREHOLE	0.5 2.0 12.5	0.5 2.5 15.0
	(continue on separate page if necessary)		
	Other comments (for example, gas encountered, saline water intercepted)		

E Completing this form

How long did it take you to fill in this form? _____

For Official use only

Date received (DD/MM/YYYY)	File	Consent number	BGS reference number
_____	_____	_____	_____
Accession number	Wellmaster number	SOBI number	NGR
_____	_____	_____	_____
LIC NO	Purpose	EA reference number	
_____	_____	_____	
Copy number	Entered by		
_____	_____		



Easton
H.S.
Thames
N.R.A.

RECORD OF WELL

At Elm Lodge
The Warren
Caversham
Reading, Berkshire
County

SU77NW 72 7020-7510

For BGS use only Form No

N 42057

SU77/173

268

SU77NW

EXACT SITE

OF WELL

National Grid sheet and reference SU 7020 7510
For Mr. J. Andreassen
State whether owner, tenant, builder, contractor, contractor, etc. Owner
Address (if different from above)

POSSIBLE

AS

NECESSARY

Level of ground surface above sea level (OD) 50.00 m
If well top is not at ground level state how far above or below

SHAFT diameter 150 mm
HEADINGS (please attach details—dimensions and functions)
BORE diameter at top 150 mm
at bottom 150 mm

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.)
21.00 metres of 150mm diameter glass polypropylene lining tube installed

Water struck at depth of 7.00m below well top

Rest level of water 5.40m below well top. Station at

TEST

CONDITIONS

Yield test pumping at 1 l/s with
depression to 1.0m below well top. Recovery to test level in 1 hour
Capacity of pump 1 l/s

Date of measurements

SOURCE

CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT

Make and of type Mafac power

Capacity 1 l/s per hour. Station at

below well top. Amount pumped 1 l/s per day. Estimated

consumption 1 l/s per week

Well made by Smith & Webb (Drilling) Ltd. Date of sinking 26th March 1992

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

DATE OF

SURVEY

OVERLAY

INSTITUTE OF GEOLOGICAL SCIENCES
HYDROLOGY UNIT
EXTENSION ROAD
LONDON SW7 2DE

01223 316111

Domestic supply

26th Oct 92

James

Received from Smith & Webb
Drilling
Date 6.9.92
Observations well
Remarks
P.H. log
Site marked on
1:1 map
6" map (Grid Sheet)
Town symbol
Equipment
Pipes



For Institute use only

Geological
Classification

NATURE OF STRATA

If measurements start below ground surface, state how far.

Thickness

Depth

Feet

Inches

Meters

Feet

Inches

Meters

? Clay & Flints
[Plasma Green]
Upper Chalk

Brown clay

1.50

1.50

Brown clay, chalk and flint

1.50

3.00

Chalk and flints

27.00

25.00

12/1/93



ELM LODGE, THE WARREN CAVERSHAM

SU 77/173

Name Mr S. ANDREASSEN		License No.	Nat Grid Ref SU 7020 7510
Company		BGS Ref. No.	Status DOM
Ground Level	m OD	m OD	Anchor CHALK
Level of the Top	m OD	m OD	
First Water Level	5.30 m OD	m OD	Summary of Geological Section
Date	m OD	m OD	Thickness
Construction T8/00/BE/RO		Depth	
Length	0 -	Clay + flints	
25 M	150-200	0	21 M
		150	UPVC
State of the Pits		Type of Pump	
1st		1st	
2nd		2nd	
Well Driller			

Insufficient space has been allowed for further details, if any.

Depth	From	To	Thickness
25.0	25.00	23.00	2.00
23.0	23.00	21.00	2.00
21.0	21.00	19.00	2.00
19.0	19.00	17.00	2.00
17.0	17.00	15.00	2.00
15.0	15.00	13.00	2.00
13.0	13.00	11.00	2.00
11.0	11.00	9.00	2.00
9.0	9.00	7.00	2.00
7.0	7.00	5.00	2.00
5.0	5.00	3.00	2.00
3.0	3.00	1.00	2.00
1.0	1.00	0.00	1.00

Record depth

Chalk and flints

flints

Brown clay, chalk and

Brown clay

[illegible]



For Institute use only

GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

For measurements start below ground surface, state how far

THICKNESS

DEPTH

Feet

Inches

Metres

Feet

Inches

Metres

Brown clay

1.50

1.50

Brown clay, chalk and flints

1.50

1.00

Chalk and flints

22.00

23.00

SU 67 SE 25

174980

SU 67 SE 25

6993 74%

Coombe Bank, Reading West

Block 15

Water level 17.7 m (12.0 m)

Water Struck 17.3 m (12.0 m)

Gravel and sand (mostly fine) in 102 mm (4 in) sieve

Depth 1013

Overburden 1.7 m (5.6 ft)

Mineral 4.4 m (14.5 ft)

Bedrock 0.5 m (1.5 ft)

LOG

		Thickness m	ft	Depth m	ft
	Made ground	0.4	(1.3)	0.4	(1.3)
Alluvium	Clay - silty, light brown at top passing to greenish brown and blue at base	2.5	(8.5)	3.0	(10.0)
	Peat, dark brown	0.7	(2.5)	3.7	(12.0)
River terrace deposits (undifferentiated)	Gravel Gravel: fine to coarse sub- angular to rounded limestone and flint with well rounded chalk and ironstone and some quartz Sand: coarse, with medium and trace of fine cobble limestone and quartz	4.4	(14.5)	8.1	(26.5)
Upper Chalk	Chalk, with flint nodules	0.5+	(1.5+)	8.6	(28.0)

GRADING

	Mean for deposit			Bulk samples Depth below surface (m)	Percentages		
	%	mm	%		Fines	Sand	Gravel
Gravel	51	+16 -16+4	22 29	*3.4 - 4.7 *4.7 - 5.7 *5.7 - 6.7 *6.7 - 8.1	6 2 2 3	47 47 44 43	47 51 54 54
Sand	45	-4+1 +1+1/2 -1/2+1/16	27 15 2				
Fines	4	-1/16	4				

COMPOSITION

Depth below surface (m)	Percentages (in 4.75 to 9.5 mm fraction)				
	Flint	Quartz	Limestone	Chalk	Ironstone
3.4 - 4.7	9	3	65	3	10
4.7 - 5.7	No information				
5.7 - 6.7	52	4	28	9	7
6.7 - 8.1	50	6	30	8	6
MEAN	32	4	49	6	9

Appendix D

Landmark EnviroCheck Flood Maps

EA/NRW Flood Data Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

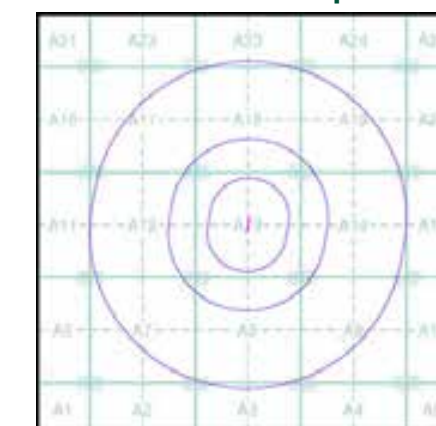
Flood Data

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Contours (height in metres)

- Standard Contour: 105, 100, 95
- Master Contour: 105, 100, 95
- Spot Height: 167.8
- MLW: Mean Low Water
- MHW: Mean High Water

EA/NRW Flood Data Map - Slice A

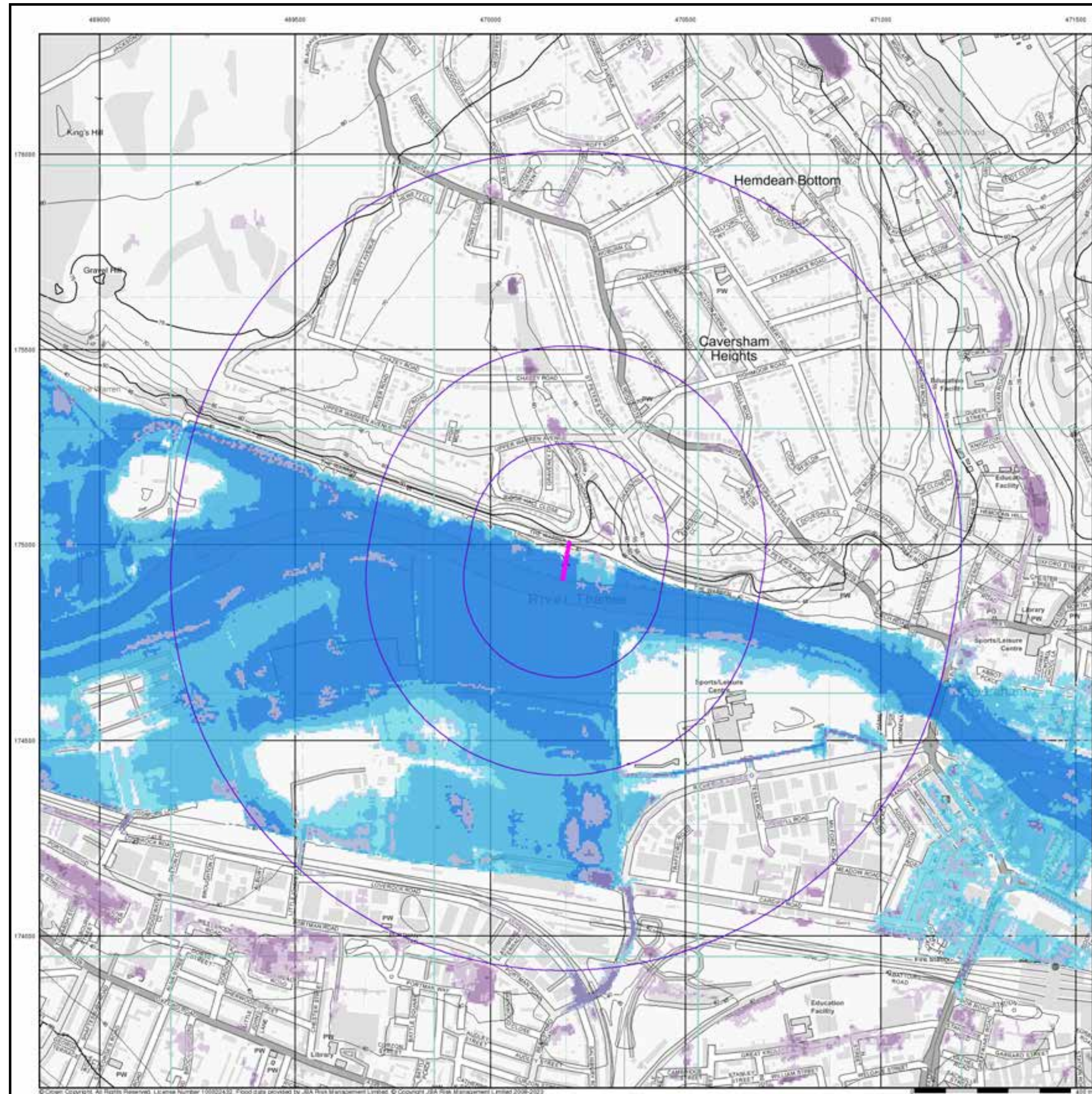


Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010



JBA 75 Year Return Flood Map (Undefended) (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

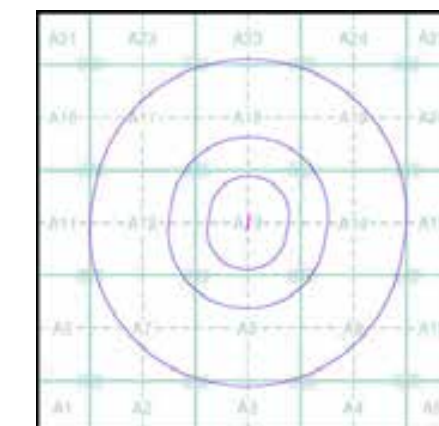
Modelled Flood Depth

Pluvial Depth	Fluvial Depth	Coastal Depth
0.1m	0.01m - 0.05m	0.01m - 0.05m
0.1m - 0.3m	0.05m - 0.1m	0.05m - 0.1m
0.3m - 1m	0.1m - 0.3m	0.1m - 0.3m
>1m	0.3m - 1m	0.3m - 1m
	>1m	>1m

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

JBA 75 Year Return Flood Map (Undefended) - Slice A



Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010

JBA 100 Year Return Flood Map (Un defended) (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

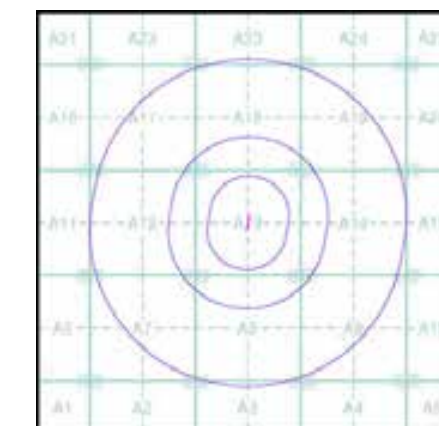
Modelled Flood Depth

Fluvial Depth	Coastal Depth
0.01m - 0.05m	0.01m - 0.05m
0.05m - 0.1m	0.05m - 0.1m
0.1m - 0.3m	0.1m - 0.3m
0.3m - 1m	0.3m - 1m
>1m	>1m

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- Mean Low Water
- Mean High Water

JBA 100 Year Return Flood Map (Un defended) - Slice A



Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010

JBA 200 Year Return Flood Map (Undefended) (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

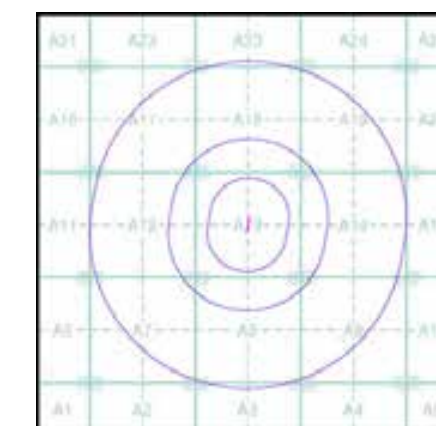
Modelled Flood Depth

Pluvial Depth	Fluvial Depth	Coastal Depth
0.1m	0.01m - 0.05m	0.01m - 0.05m
0.1m - 0.3m	0.05m - 0.1m	0.05m - 0.1m
0.3m - 1m	0.1m - 0.3m	0.1m - 0.3m
>1m	0.3m - 1m	0.3m - 1m
	>1m	>1m

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- MHW Mean Low Water
- MHW Mean High Water

JBA 200 Year Return Flood Map (Undefended) - Slice A

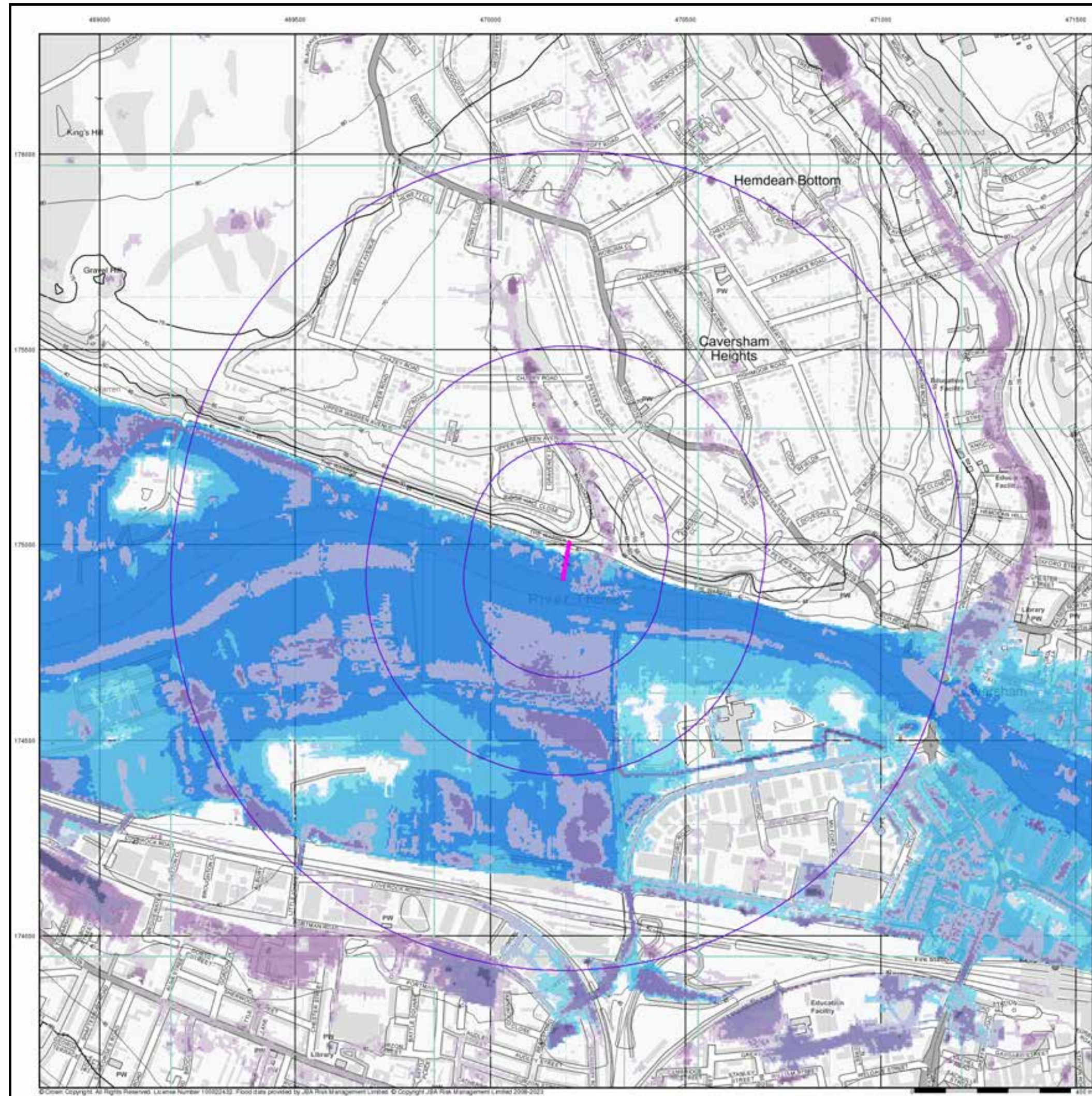


Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010



JBA 1000 Year Return Flood Map (Undefended) (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

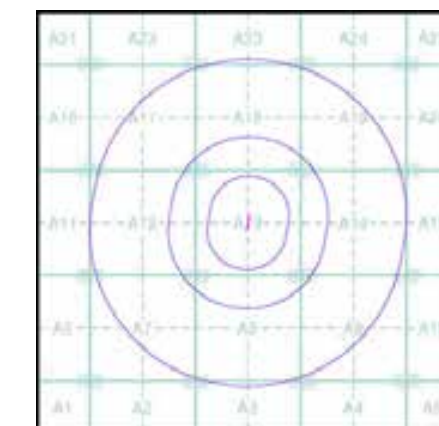
Modelled Flood Depth

Pluvial Depth	Fluvial Depth	Coastal Depth
0.1m	0.01m - 0.05m	0.01m - 0.05m
0.1m - 0.3m	0.05m - 0.1m	0.05m - 0.1m
0.3m - 1m	0.1m - 0.3m	0.1m - 0.3m
>1m	0.3m - 1m	0.3m - 1m
	>1m	>1m

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

JBA 1000 Year Return Flood Map (Undefended) - Slice A



Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010

EA/NRW Surface Water 30 Year Return Depth Map (1:10,000)

General
 Specified Site Specified Buffer(s) Bearing Reference Point

Surface Water Depth

0 - 0.15m
 0.15 - 0.30m
 0.30 - 0.60m
 0.60 - 0.90m
 0.90 - 1.20m
 > 1.20m

Contours (height in metres)

Standard Contour 105 100 95
 Master Contour 100 95
 Spot Height *167.8
 MLW Mean Low Water
 MHW Mean High Water

Suitability

See the suitability map below
 National to county
 County to town
 Town to street
 Street to parcels of land
 Property

EA/NRW Suitability Map - Slice A



Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010

EA/NRW Surface Water 100 Year Return Depth Map

General

Specified Site Specified Buffer(s) Bearing Reference Point

Surface Water Depth

0 - 0.15m
0.15 - 0.30m
0.30 - 0.60m
0.60 - 0.90m
0.90 - 1.20m
> 1.20m

Contours (height in metres)

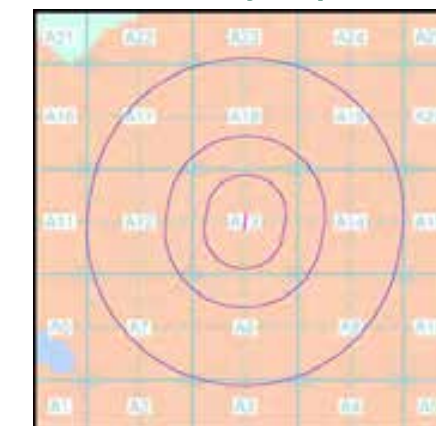
Standard Contour 105 100 95
Master Contour 100 95
Spot Height *167.8
MLW Mean Low Water
MHW Mean High Water

Suitability

See the suitability map below

National to county
County to town
Town to street
Street to parcels of land
Property

EA/NRW Suitability Map - Slice A



Order Details

Order Number: 314421426_1_1
Customer Ref: 967
National Grid Reference: 470190, 174960
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 1000

Site Details

Site at 470210, 175010

EA/NRW Surface Water 1000 Year Return Depth Map (1:10,000)

General
 Specified Site Specified Buffer(s) Bearing Reference Point

Surface Water Depth

0 - 0.15m
 0.15 - 0.30m
 0.30 - 0.60m
 0.60 - 0.90m
 0.90 - 1.20m
 > 1.20m

Contours (height in metres)

Standard Contour 105 100 95
 Master Contour 100 95
 Spot Height *167.8
 MLW Mean Low Water
 MHW Mean High Water

Suitability

See the suitability map below
 National to county
 County to town
 Town to street
 Street to parcels of land
 Property

EA/NRW Suitability Map - Slice A

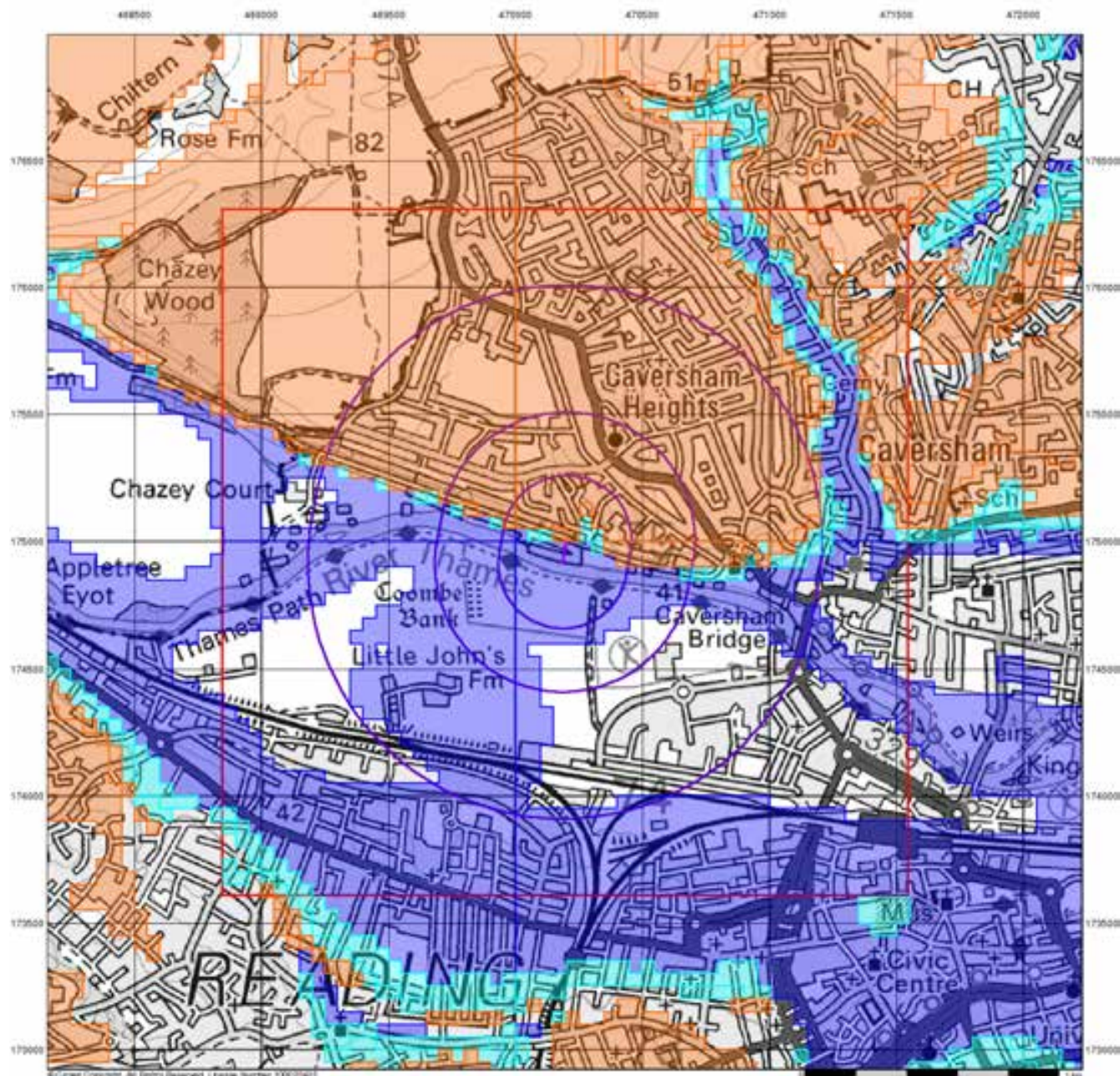


Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010



Envirocheck®

LANDMARK INFORMATION GROUP®

BGS Flood Data (1:50,000)

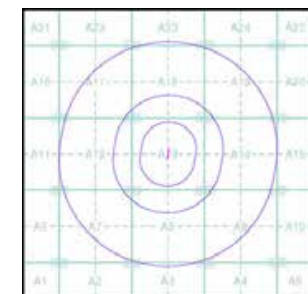
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

BGS Groundwater Flooding Susceptibility

- Potential for Groundwater Flooding to Occur at Surface
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Limited Potential for Groundwater Flooding to Occur

BGS Flood Data Map - Slice A



Order Details

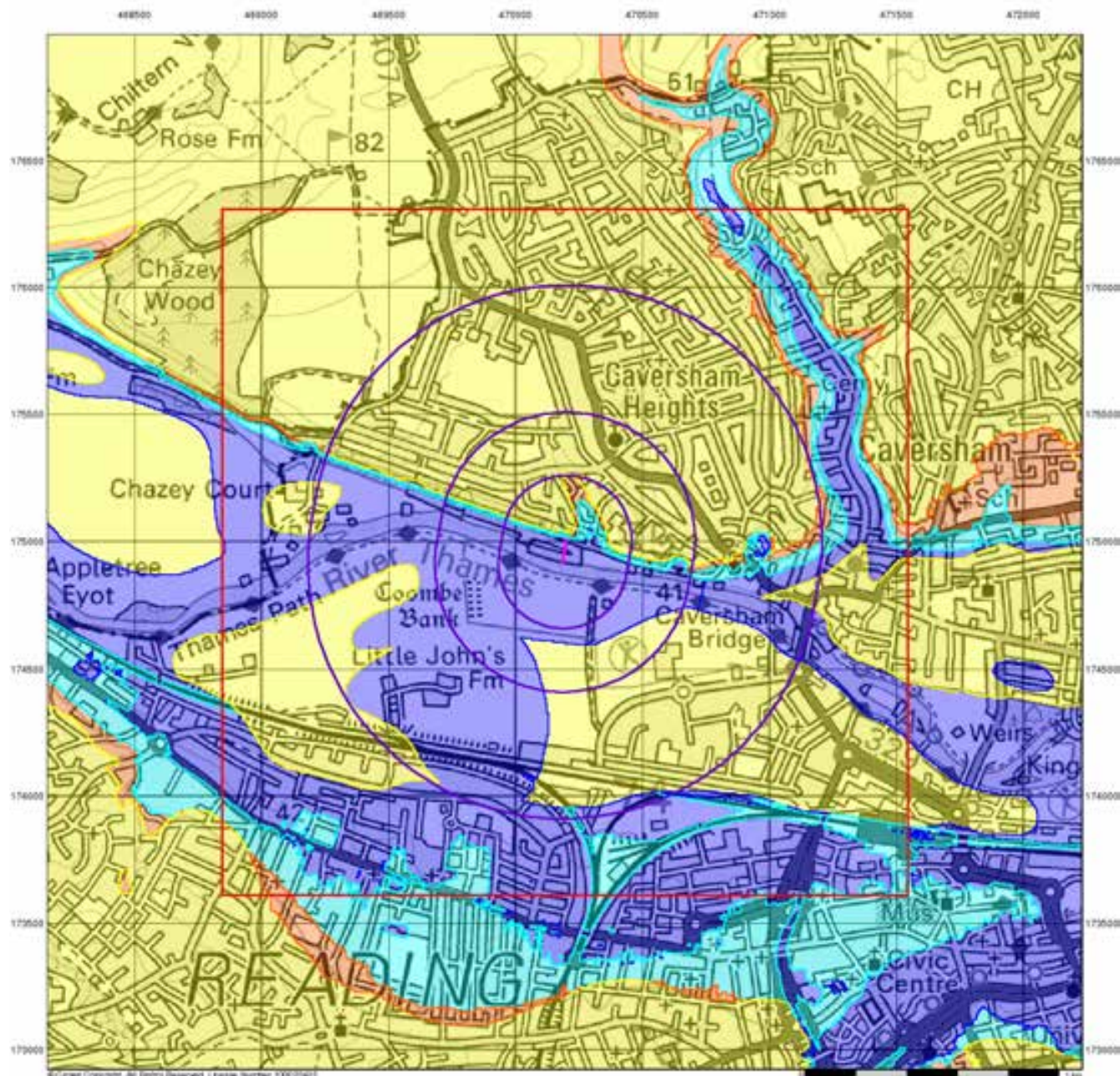
Order Number: 314421426_1_1
Customer Ref: 967
National Grid Reference: 470190, 174960
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 1000

Site Details

Site at 470210, 175010

Landmark®
LANDMARK INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck®

LANDMARK INFORMATION GROUP®

GeoSmart Information Groundwater Flood Map (1:50,000)

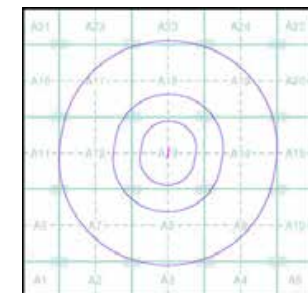
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice

GeoSmart Information Groundwater Flooding Risk

- High Risk
- Moderate Risk
- Low Risk
- Negligible Risk

GeoSmart Information Groundwater Flood Map - Slice A



Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010

Landmark
 INFORMATION GROUP

Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

JBA Canal Failure Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

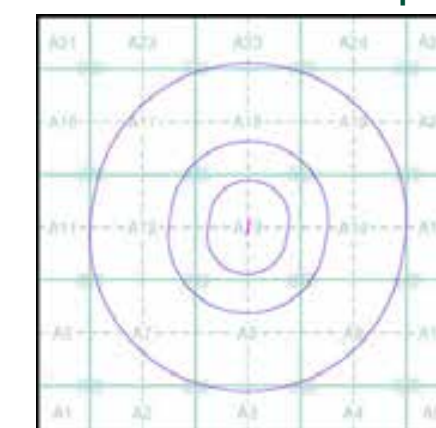
Flood Data

- Canal Failure
- Coverage

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

JBA Canal Failure Flood Map - Slice A

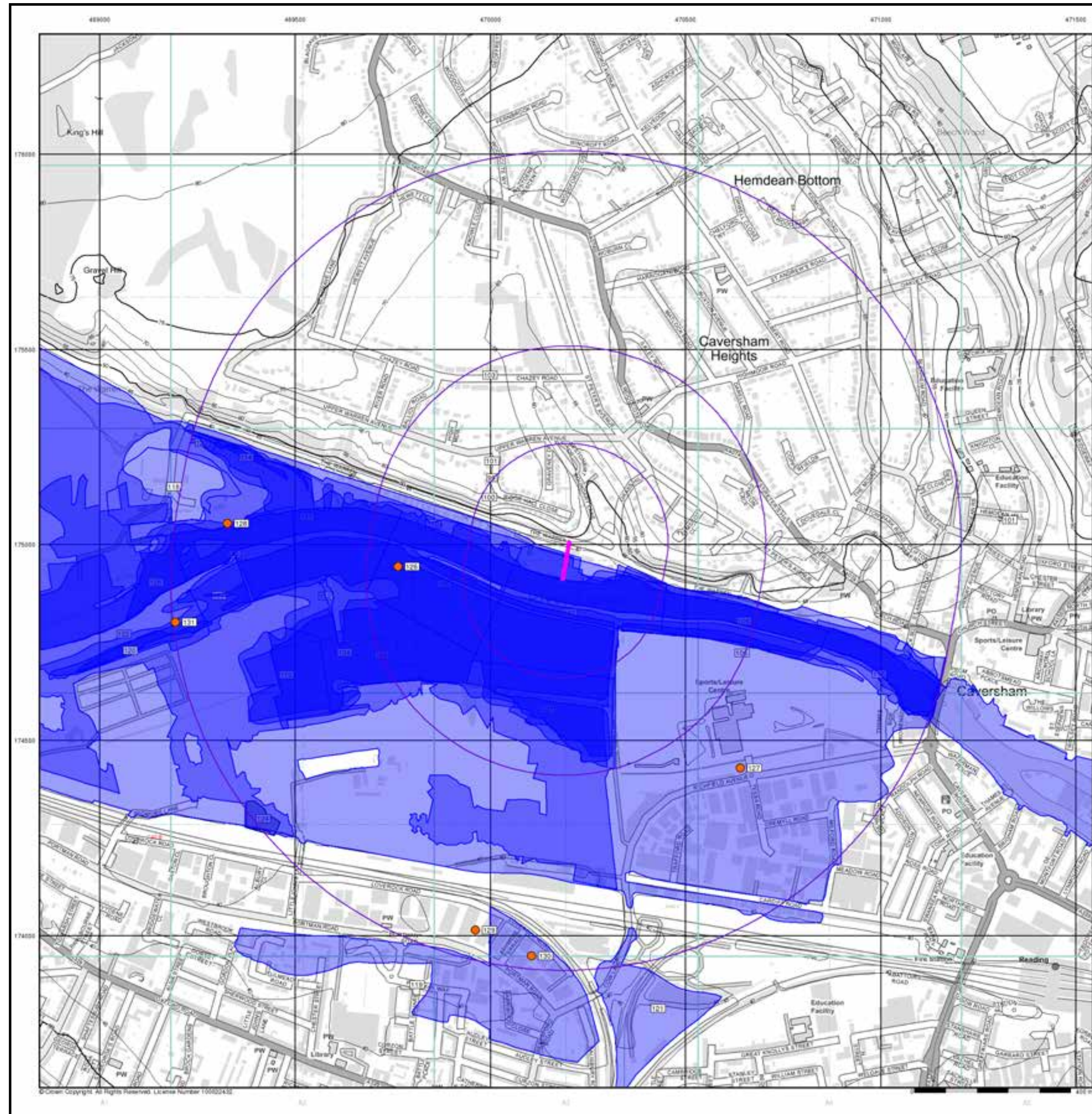


Order Details

Order Number: 314421426_1_1
 Customer Ref: 967
 National Grid Reference: 470190, 174960
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 470210, 175010



EA/NRW Historic Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

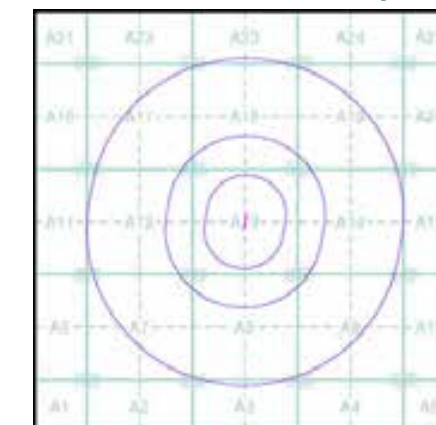
Historic Flood Events Data

- | | |
|--|---------------------------------------|
| Channel Capacity Exceeded (no raised defences) | Obstruction/Blockage - Culvert |
| Channel Capacity Exceeded /Surface Water | Obstruction/Blockage - Debris Screen |
| Groundwater/High Water Table | Operational Failure/Breach of Defence |
| Local Drainage/Surface Water | Other |
| Mechanical Failure | Overtopping of Defences |
| Obstruction/Blockage - Bridge | Surface Water |
| Obstruction/Blockage - Channel | Unknown |
| Historical Flood Liabilities | |

Contours (height in metres)

- Standard Contour 105 100 95
- Master Contour
- Spot Height *167.8
- MLW Mean Low Water
- MHW Mean High Water

EA/NRW Historic Flood Map - Slice A



Order Details

Order Number: 314421426_1_1
Customer Ref: 967
National Grid Reference: 470190, 174960
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 1000

Site Details

Site at 470210, 175010

Appendix E

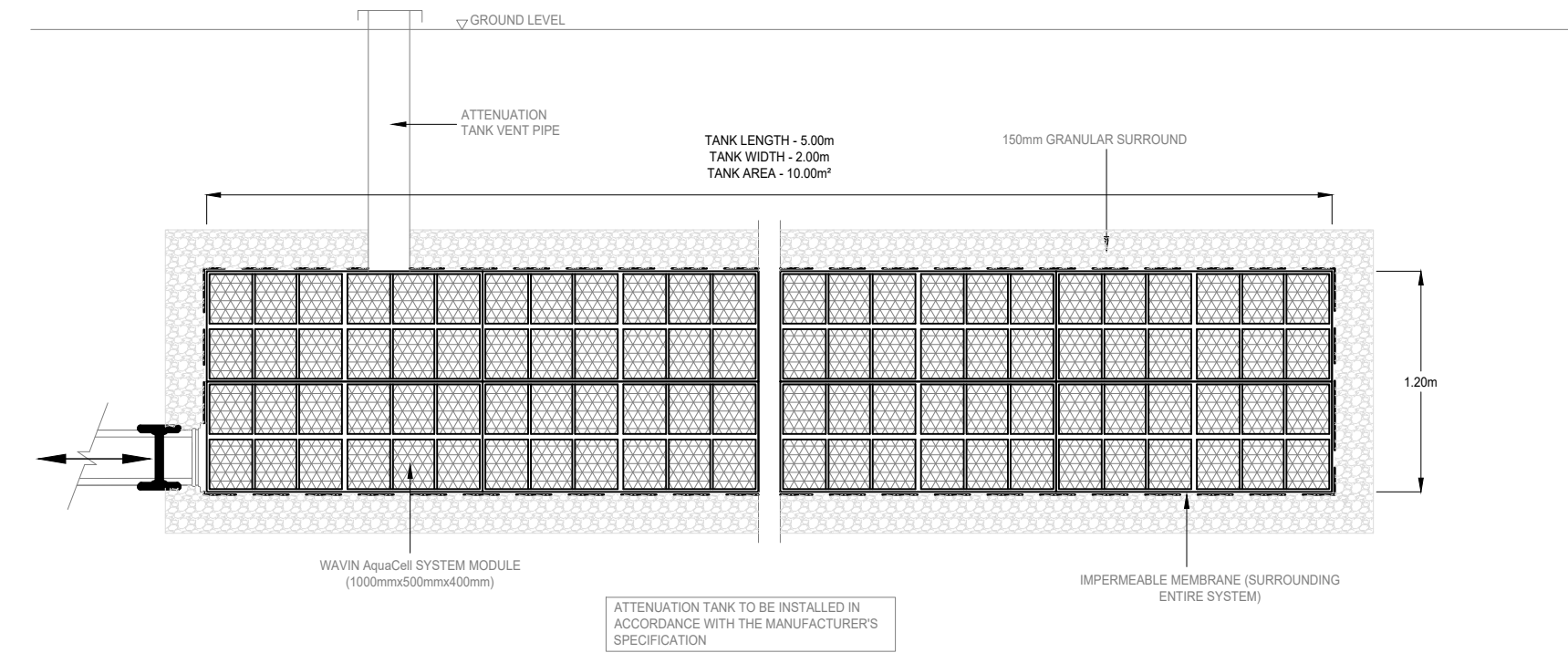
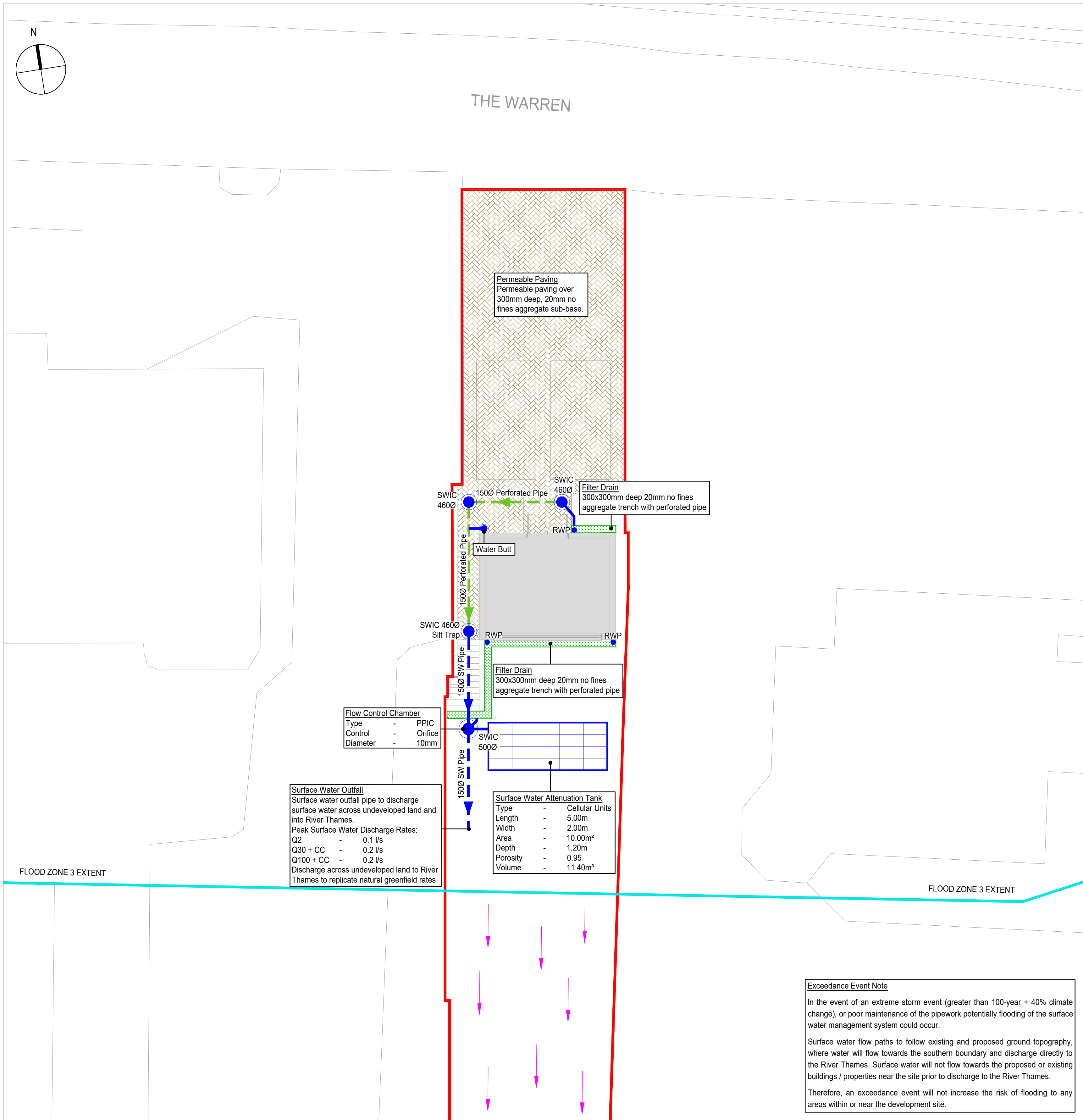
Greenfield Run-Off Calculations

Flo Consult UK Ltd		Page 1
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Willowbend Greenfield Run-Off Rate Calculations	
Date 10/09/2024	Designed by MDS	
File	Checked by MDS	
Innovyze	Source Control 2020.1.3	
IH 124 Mean Annual Flood Input Return Period (years)2 SAAR (mm)700Urban0.230 Area (ha)50.000Soil0.300Region NumberRegion6 Results1/s QBAR Rural91.1 QBAR Urban139.7 Q2 years128.9 Q1 year118.8 Q2 years128.9 Q5 years181.7 Q10 years223.3 Q20 years264.8 Q25 years278.5 Q30 years288.4 Q50 years317.5 Q100 years371.9 Q200 years423.1 Q250 years439.1 Q1000 years547.4		
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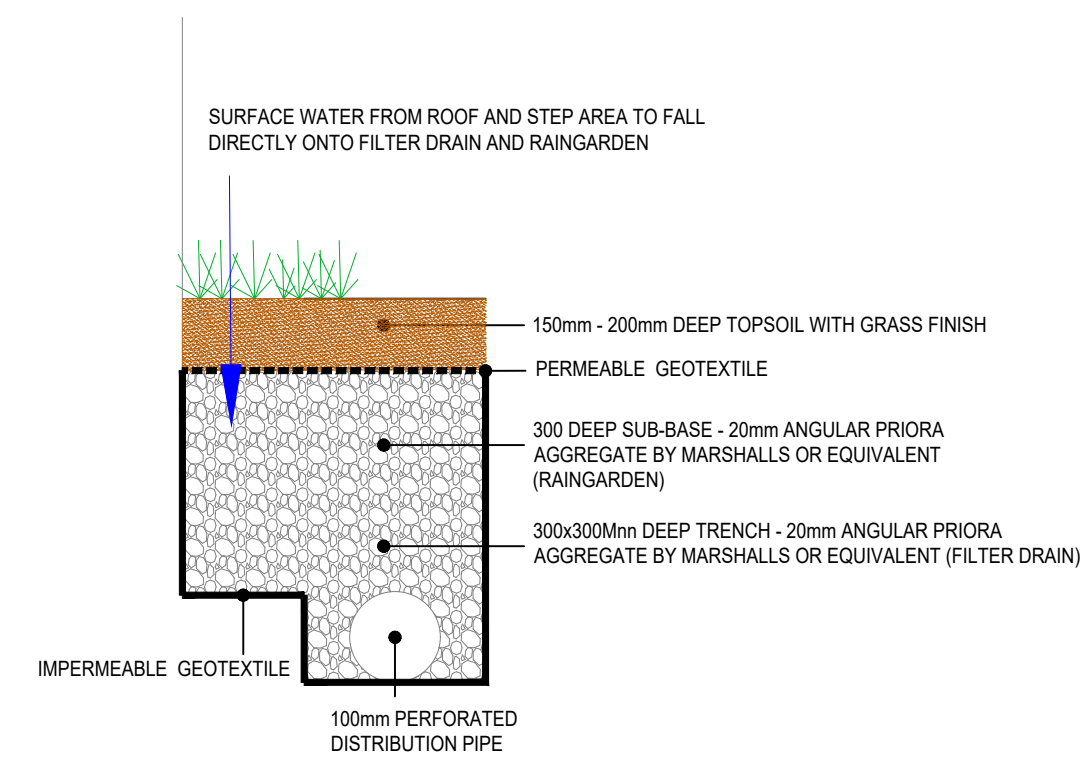
Flo Consult UK Ltd		Page 1																										
4 Market Square	Willowbend																											
Old Amersham	Greenfield Run-Off																											
Buckinghamshire, HP7 0DQ	Volume Calculations																											
Date 10/09/2024	Designed by MDS																											
File	Checked by MDS																											
Innovyze	Source Control 2020.1.3																											
<u>Greenfield Runoff Volume</u> FEH Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>FEH Rainfall Version</td> <td>2013</td> </tr> <tr> <td>Site Location</td> <td>GB 470190 174960 SU 70190 74960</td> </tr> <tr> <td>Data Type</td> <td>Point</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>0.013</td> </tr> <tr> <td>SAAR (mm)</td> <td>644</td> </tr> <tr> <td>CWI</td> <td>94.920</td> </tr> <tr> <td>SPR Host</td> <td>47.000</td> </tr> <tr> <td>URBEXT (USER)</td> <td>0.2300</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>47.13</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>3.781</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	FEH Rainfall Version	2013	Site Location	GB 470190 174960 SU 70190 74960	Data Type	Point	Areal Reduction Factor	1.00	Area (ha)	0.013	SAAR (mm)	644	CWI	94.920	SPR Host	47.000	URBEXT (USER)	0.2300	Percentage Runoff (%)	47.13	Greenfield Runoff Volume (m³)	3.781
Return Period (years)	100																											
Storm Duration (mins)	360																											
FEH Rainfall Version	2013																											
Site Location	GB 470190 174960 SU 70190 74960																											
Data Type	Point																											
Areal Reduction Factor	1.00																											
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CWI	94.920																											
SPR Host	47.000																											
URBEXT (USER)	0.2300																											
Percentage Runoff (%)	47.13																											
Greenfield Runoff Volume (m³)	3.781																											
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Appendix F

Surface Water Management Layout and Details



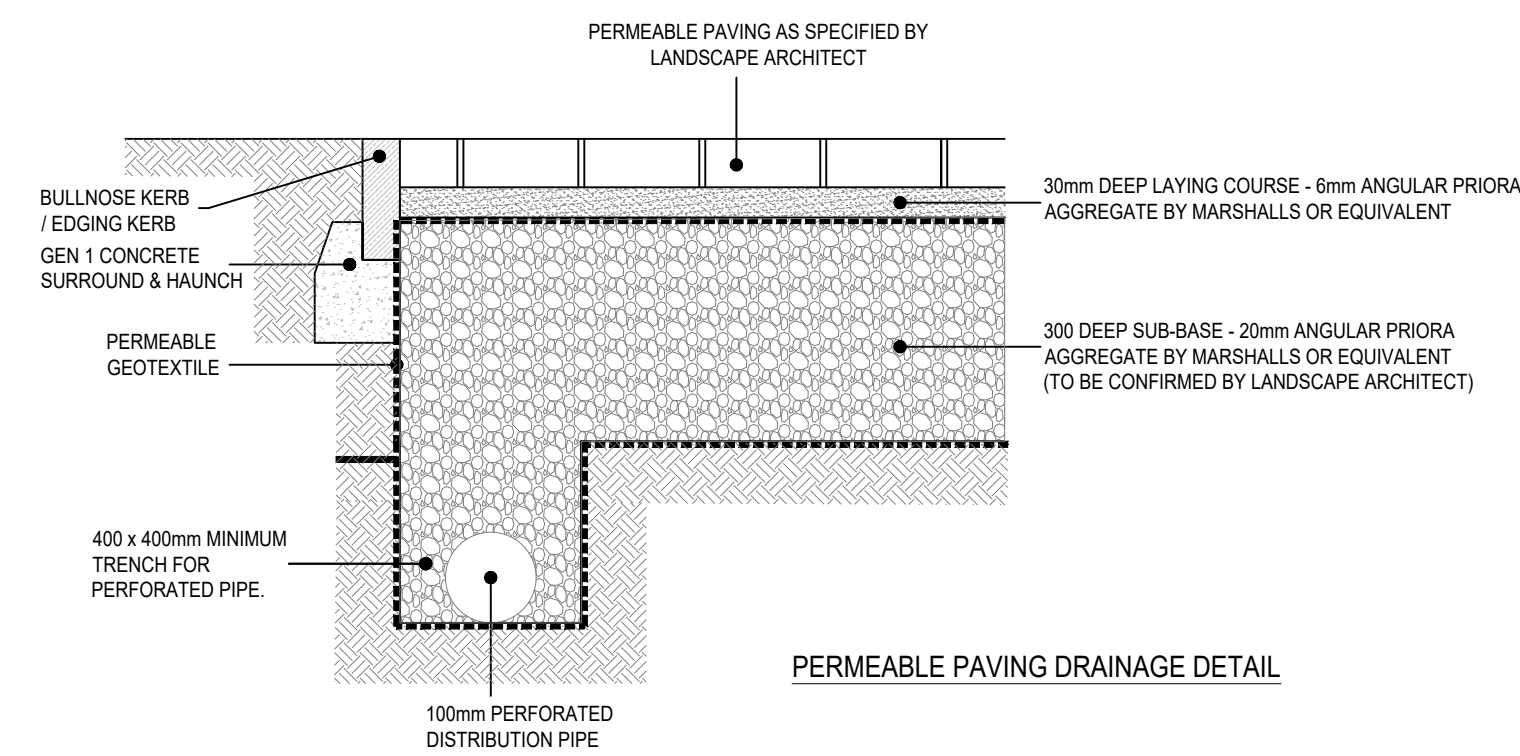
TYPICAL CELLULAR UNIT / TANK DETAIL



RAINGARDEN AND FILTER DRAIN DETAIL



FLOW CONTROL DETAIL



PERMEABLE PAVING DRAINAGE DETAIL

Drainage Key:

- Surface Water Pipes - Solid
- Proposed Perforated Pipe
- Permeable Paving
- Filter Drain / Raingarden
- Exceedance Flow Path
- Development Boundary

P2	ISSUED FOR APPROVAL	MDS	NC	10.09.24
P1	ISSUED FOR APPROVAL	MDS	NC	09.11.23
Rev	Description	Dwn	Chk	Date

Client

-

Project
NEW HOBBY ROOM BUILDING
AT WILLOWBEND
THE WARREN, CAVERSHAM

Drawing
SURFACE WATER MANAGEMENT
LAYOUT AND DETAILS

Scale	Date	Drawn by	Checked
1:100@A1	09.11.23	MDS	NC

Status

APPROVAL



Job No.	Drng. No.	Rev
967	DR-100	P2

Appendix G

Surface Water Management Calculations

Flo Consult UK Ltd						Page 1	
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ				Willowbend Surface Water Management Calculations			
Date 10/09/2024				Designed by MDS			
File Willowbend - SW Manageme...				Checked by MDS			
Innovyze				Source Control 2020.1.3			
<u>Summary of Results for 2 year Return Period</u>							
Half Drain Time : 199 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.382	0.082	0.0	0.1	0.1	0.8	O K
30 min Summer	8.403	0.103	0.0	0.1	0.1	1.0	O K
60 min Summer	8.421	0.121	0.0	0.1	0.1	1.2	O K
120 min Summer	8.450	0.150	0.0	0.1	0.1	1.4	O K
180 min Summer	8.462	0.162	0.0	0.1	0.1	1.5	O K
240 min Summer	8.468	0.168	0.0	0.1	0.1	1.6	O K
360 min Summer	8.471	0.171	0.0	0.1	0.1	1.6	O K
480 min Summer	8.468	0.168	0.0	0.1	0.1	1.6	O K
600 min Summer	8.464	0.164	0.0	0.1	0.1	1.6	O K
720 min Summer	8.459	0.159	0.0	0.1	0.1	1.5	O K
960 min Summer	8.449	0.149	0.0	0.1	0.1	1.4	O K
1440 min Summer	8.430	0.130	0.0	0.1	0.1	1.2	O K
2160 min Summer	8.409	0.109	0.0	0.1	0.1	1.0	O K
2880 min Summer	8.393	0.093	0.0	0.1	0.1	0.9	O K
4320 min Summer	8.372	0.072	0.0	0.1	0.1	0.7	O K
5760 min Summer	8.359	0.059	0.0	0.0	0.0	0.6	O K
7200 min Summer	8.351	0.051	0.0	0.0	0.0	0.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	34.391	0.0	0.8	28			
30 min Summer	21.993	0.0	1.1	41			
60 min Summer	13.604	0.0	1.3	66			
120 min Summer	9.180	0.0	1.8	122			
180 min Summer	7.149	0.0	2.1	156			
240 min Summer	5.913	0.0	2.3	188			
360 min Summer	4.429	0.0	2.6	256			
480 min Summer	3.579	0.0	2.8	324			
600 min Summer	3.025	0.0	2.9	394			
720 min Summer	2.633	0.0	3.1	462			
960 min Summer	2.113	0.0	3.3	598			
1440 min Summer	1.550	0.0	3.6	860			
2160 min Summer	1.137	0.0	4.0	1240			
2880 min Summer	0.917	0.0	4.3	1612			
4320 min Summer	0.688	0.0	4.8	2336			
5760 min Summer	0.568	0.0	5.3	3056			
7200 min Summer	0.494	0.0	5.8	3760			
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Flo Consult UK Ltd		Page 2
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Willowbend Surface Water Management Calculations	
Date 10/09/2024 File Willowbend - SW Manageme...	Designed by MDS Checked by MDS	
Innovyze	Source Control 2020.1.3	

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	8.345	0.045	0.0	0.0	0.0	0.4	O K
10080 min Summer	8.340	0.040	0.0	0.0	0.0	0.4	O K
15 min Winter	8.392	0.092	0.0	0.1	0.1	0.9	O K
30 min Winter	8.416	0.116	0.0	0.1	0.1	1.1	O K
60 min Winter	8.437	0.137	0.0	0.1	0.1	1.3	O K
120 min Winter	8.471	0.171	0.0	0.1	0.1	1.6	O K
180 min Winter	8.485	0.185	0.0	0.1	0.1	1.8	O K
240 min Winter	8.491	0.191	0.0	0.1	0.1	1.8	O K
360 min Winter	8.492	0.192	0.0	0.1	0.1	1.8	O K
480 min Winter	8.487	0.187	0.0	0.1	0.1	1.8	O K
600 min Winter	8.480	0.180	0.0	0.1	0.1	1.7	O K
720 min Winter	8.472	0.172	0.0	0.1	0.1	1.6	O K
960 min Winter	8.457	0.157	0.0	0.1	0.1	1.5	O K
1440 min Winter	8.430	0.130	0.0	0.1	0.1	1.2	O K
2160 min Winter	8.401	0.101	0.0	0.1	0.1	1.0	O K
2880 min Winter	8.381	0.081	0.0	0.1	0.1	0.8	O K
4320 min Winter	8.357	0.057	0.0	0.0	0.0	0.5	O K
5760 min Winter	8.344	0.044	0.0	0.0	0.0	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.444	0.0	6.2	4496
10080 min Summer	0.407	0.0	6.7	5240
15 min Winter	34.391	0.0	0.9	28
30 min Winter	21.993	0.0	1.2	41
60 min Winter	13.604	0.0	1.5	66
120 min Winter	9.180	0.0	2.0	120
180 min Winter	7.149	0.0	2.3	172
240 min Winter	5.913	0.0	2.6	198
360 min Winter	4.429	0.0	2.9	274
480 min Winter	3.579	0.0	3.1	350
600 min Winter	3.025	0.0	3.3	424
720 min Winter	2.633	0.0	3.4	498
960 min Winter	2.113	0.0	3.7	638
1440 min Winter	1.550	0.0	4.1	908
2160 min Winter	1.137	0.0	4.5	1296
2880 min Winter	0.917	0.0	4.8	1668
4320 min Winter	0.688	0.0	5.4	2384
5760 min Winter	0.568	0.0	6.0	3112

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Flo Consult UK Ltd		Page 4																								
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Willowbend Surface Water Management Calculations																									
Date 10/09/2024	Designed by MDS																									
File Willowbend - SW Manageme...	Checked by MDS																									
Innovyze	Source Control 2020.1.3																									
<u>Rainfall Details</u> Rainfall ModelFEH Return Period (years)2 FEH Rainfall Version2013 Site Location GB 470190 174960 SU 70190 74960 Data TypePoint Summer StormsYes Winter StormsYes Cv (Summer)0.750 Cv (Winter)0.840 Shortest Storm (mins)15 Longest Storm (mins)10080 Climate Change % +0 <u>Time Area Diagram</u> Total Area (ha) 0.013 <table><thead><tr><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th></tr><tr><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th></tr></thead><tbody><tr><td>0 4</td><td>0.004</td><td>4 8</td><td>0.003</td><td>8 12</td><td>0.003</td><td>12 16</td><td>0.003</td></tr></tbody></table>			Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	0 4	0.004	4 8	0.003	8 12	0.003	12 16	0.003
Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area																			
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)																			
0 4	0.004	4 8	0.003	8 12	0.003	12 16	0.003																			
©1982-2020 Innovyze																										

Flo Consult UK Ltd		Page 5
4 Market Square	Willowbend	
Old Amersham	Surface Water	
Buckinghamshire, HP7 0DQ	Management Calculations	
Date 10/09/2024	Designed by MDS	
File Willowbend - SW Manageme...	Checked by MDS	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 8.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	10.0	0.0	2.600	0.0	0.0
0.200	10.0	0.0	2.800	0.0	0.0
0.400	10.0	0.0	3.000	0.0	0.0
0.600	10.0	0.0	3.200	0.0	0.0
0.800	10.0	0.0	3.400	0.0	0.0
1.000	10.0	0.0	3.600	0.0	0.0
1.200	10.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Orifice Outflow Control

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 8.300

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4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Willowbend Surface Water Management Calculations																									
Date 10/09/2024	Designed by MDS																									
File Willowbend - SW Manageme...	Checked by MDS																									
Innovyze	Source Control 2020.1.3																									
Rainfall Details Rainfall ModelFEH Return Period (years)30 FEH Rainfall Version2013 Site Location GB 470190 174960 SU 70190 74960 Data TypePoint Summer StormsYes Winter StormsYes Cv (Summer)0.750 Cv (Winter)0.840 Shortest Storm (mins)15 Longest Storm (mins)10080 Climate Change % +35 Time Area Diagram Total Area (ha) 0.013 <table><thead><tr><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th></tr><tr><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th></tr></thead><tbody><tr><td>0 4</td><td>0.004</td><td>4 8</td><td>0.003</td><td>8 12</td><td>0.003</td><td>12 16</td><td>0.003</td></tr></tbody></table>			Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	0 4	0.004	4 8	0.003	8 12	0.003	12 16	0.003
Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area																			
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)																			
0 4	0.004	4 8	0.003	8 12	0.003	12 16	0.003																			
©1982-2020 Innovyze																										

Flo Consult UK Ltd		Page 5
4 Market Square	Willowbend	
Old Amersham	Surface Water	
Buckinghamshire, HP7 0DQ	Management Calculations	
Date 10/09/2024	Designed by MDS	
File Willowbend - SW Manageme...	Checked by MDS	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 8.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	10.0	0.0	2.600	0.0	0.0
0.200	10.0	0.0	2.800	0.0	0.0
0.400	10.0	0.0	3.000	0.0	0.0
0.600	10.0	0.0	3.200	0.0	0.0
0.800	10.0	0.0	3.400	0.0	0.0
1.000	10.0	0.0	3.600	0.0	0.0
1.200	10.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Orifice Outflow Control

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 8.300

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Flo Consult UK Ltd							Page 1
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ			Willowbend Surface Water Management Calculations				
Date 10/09/2024			Designed by MDS				
File Willowbend - SW Manageme...			Checked by MDS				
Innovyze			Source Control 2020.1.3				
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Half Drain Time : 396 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.646	0.346	0.0	0.1	0.1	3.3	O K
30 min Summer	8.750	0.450	0.0	0.1	0.1	4.3	O K
60 min Summer	8.849	0.549	0.0	0.2	0.2	5.2	O K
120 min Summer	8.911	0.611	0.0	0.2	0.2	5.8	O K
180 min Summer	8.941	0.641	0.0	0.2	0.2	6.1	O K
240 min Summer	8.953	0.653	0.0	0.2	0.2	6.2	O K
360 min Summer	8.947	0.647	0.0	0.2	0.2	6.2	O K
480 min Summer	8.936	0.636	0.0	0.2	0.2	6.0	O K
600 min Summer	8.923	0.623	0.0	0.2	0.2	5.9	O K
720 min Summer	8.907	0.607	0.0	0.2	0.2	5.8	O K
960 min Summer	8.875	0.575	0.0	0.2	0.2	5.5	O K
1440 min Summer	8.813	0.513	0.0	0.1	0.1	4.9	O K
2160 min Summer	8.734	0.434	0.0	0.1	0.1	4.1	O K
2880 min Summer	8.675	0.375	0.0	0.1	0.1	3.6	O K
4320 min Summer	8.596	0.296	0.0	0.1	0.1	2.8	O K
5760 min Summer	8.544	0.244	0.0	0.1	0.1	2.3	O K
7200 min Summer	8.508	0.208	0.0	0.1	0.1	2.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	140.367	0.0	3.4	29			
30 min Summer	92.261	0.0	4.5	43			
60 min Summer	57.737	0.0	5.6	72			
120 min Summer	33.764	0.0	6.6	126			
180 min Summer	24.845	0.0	7.3	184			
240 min Summer	19.923	0.0	7.8	240			
360 min Summer	14.401	0.0	8.4	304			
480 min Summer	11.384	0.0	8.9	366			
600 min Summer	9.464	0.0	9.2	432			
720 min Summer	8.126	0.0	9.5	500			
960 min Summer	6.373	0.0	9.9	636			
1440 min Summer	4.508	0.0	10.5	908			
2160 min Summer	3.175	0.0	11.1	1304			
2880 min Summer	2.484	0.0	11.6	1688			
4320 min Summer	1.784	0.0	12.5	2432			
5760 min Summer	1.427	0.0	13.3	3176			
7200 min Summer	1.209	0.0	14.1	3896			
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Flo Consult UK Ltd							Page 2
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ			Willowbend Surface Water Management Calculations				
Date 10/09/2024			Designed by MDS				
File Willowbend - SW Manageme...			Checked by MDS				
Innovyze			Source Control 2020.1.3				
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	8.482	0.182	0.0	0.1	0.1	1.7	O K
10080 min Summer	8.462	0.162	0.0	0.1	0.1	1.5	O K
15 min Winter	8.688	0.388	0.0	0.1	0.1	3.7	O K
30 min Winter	8.806	0.506	0.0	0.1	0.1	4.8	O K
60 min Winter	8.919	0.619	0.0	0.2	0.2	5.9	O K
120 min Winter	8.991	0.691	0.0	0.2	0.2	6.6	O K
180 min Winter	9.028	0.728	0.0	0.2	0.2	6.9	O K
240 min Winter	9.045	0.745	0.0	0.2	0.2	7.1	O K
360 min Winter	9.039	0.739	0.0	0.2	0.2	7.0	O K
480 min Winter	9.023	0.723	0.0	0.2	0.2	6.9	O K
600 min Winter	9.005	0.705	0.0	0.2	0.2	6.7	O K
720 min Winter	8.984	0.684	0.0	0.2	0.2	6.5	O K
960 min Winter	8.939	0.639	0.0	0.2	0.2	6.1	O K
1440 min Winter	8.852	0.552	0.0	0.2	0.2	5.2	O K
2160 min Winter	8.745	0.445	0.0	0.1	0.1	4.2	O K
2880 min Winter	8.666	0.366	0.0	0.1	0.1	3.5	O K
4320 min Winter	8.565	0.265	0.0	0.1	0.1	2.5	O K
5760 min Winter	8.503	0.203	0.0	0.1	0.1	1.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
8640 min Summer	1.063	0.0	14.9	4592			
10080 min Summer	0.960	0.0	15.7	5344			
15 min Winter	140.367	0.0	3.8	29			
30 min Winter	92.261	0.0	5.0	43			
60 min Winter	57.737	0.0	6.3	70			
120 min Winter	33.764	0.0	7.4	126			
180 min Winter	24.845	0.0	8.1	182			
240 min Winter	19.923	0.0	8.7	236			
360 min Winter	14.401	0.0	9.4	340			
480 min Winter	11.384	0.0	9.9	384			
600 min Winter	9.464	0.0	10.3	460			
720 min Winter	8.126	0.0	10.6	536			
960 min Winter	6.373	0.0	11.1	686			
1440 min Winter	4.508	0.0	11.8	978			
2160 min Winter	3.175	0.0	12.5	1388			
2880 min Winter	2.484	0.0	13.0	1788			
4320 min Winter	1.784	0.0	14.0	2548			
5760 min Winter	1.427	0.0	15.0	3280			
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Flo Consult UK Ltd		Page 4																																																
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Flo Consult UK Ltd		Page 5
4 Market Square	Willowbend	
Old Amersham	Surface Water	
Buckinghamshire, HP7 0DQ	Management Calculations	
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Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 8.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	10.0	0.0	2.600	0.0	0.0
0.200	10.0	0.0	2.800	0.0	0.0
0.400	10.0	0.0	3.000	0.0	0.0
0.600	10.0	0.0	3.200	0.0	0.0
0.800	10.0	0.0	3.400	0.0	0.0
1.000	10.0	0.0	3.600	0.0	0.0
1.200	10.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Orifice Outflow Control

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 8.300

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