Forge Engineering Design Solutions

FLOOD RISK ASSESSMENT
FRA 1

Barn Conversion
Cotefield Farm
Bodicote

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Introduction

Policy 103 of the National Planning Policy Framework (NPPF) requires that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (FRA), compliant with the technical guidance to the NPPF, "Planning Practice Guidance Flood Risk and Costal Change" (PPG FRCC), following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems

Forge Engineering Design Solutions Ltd was commissioned by the applicant, Mr R Bratt, to carry out a site-specific FRA to support a planning application to Cherwell District Council (CDC) for the proposed conversion of an existing barn to a residential dwelling at Bodicote, Banbury in compliance with the NPPF.

Site Location, Main Rivers, Watercourses and Flood Zones

The site is located just off Church Street, to the South of Bodicote village, and to the west of Oxford Road A4260. The site can be located by Grid Coordinates 446080mE, 237190mN, and covers an area of approximately 740m^2 (0.0740 hectares).

The site is bound by agricultural land to the north, south, east and west. See site Location Maps in Appendix 1.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 170m south and 2380m east of the site, respectively. Other surface water features within the vicinity of the site are the Oxford Canal approximately 2700m east of the site and a reservoir approximately 290m south east of the site.

The Environment Agency's (EA) Indicative Flood Zone Map indicates that the site is located in Flood Zone 2 which is land assessed as having a Medium risk of fluvial flooding from Main Rivers. See Environment Agency's Indicative Flood Zone Maps in Appendix 1.

Therefore, this FRA has been carried out in accordance with the EA's FRA Guidance Note - More Vulnerable development up to 1ha in size in Flood Zone 2.

The FRA should address the following issues:

- Surface water runoff should not increase flood risk to the development or third parties. This should be done by using a Sustainable Drainage Systems (SuDS) to attenuate to at least pre-development runoff rates and volumes or where possible achieving betterment in the surface water runoff regime.

- An allowance for climate change needs to be incorporated, which means adding an extra amount to peak rainfall (20% for commercial development, 30% for residential).

- The residual risk of flooding needs to be addressed should any drainage features fail or if they are subjected to an extreme flood event. Overland flow routes should not put people and property at unacceptable risk. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

The EA operates a risk based approach to planning consultations. As the site lies in Flood Zone 2 and is less than 1ha the EA does not always make a bespoke response to development proposals of a minor nature.

However, to assist the Local Planning Authority reviewing the FRA, the EA recommend that their FRA pro-forma is completed, which will act as a summary of the development proposals, flood risks and flood mitigation measures. The LPA should review the FRA with the pro-forma. To assist the LPA the pro-forma has been completed and included in Appendix 1 of this FRA.

Existing Development

The existing development consists of an agricultural barn with an impermeable building footprint of 370m^2 (0.037 ha) and permeable soft and hard landscaping area of 370m^2 (0.037 ha), The site covers a total area of 740m^2. Consequently, 50% of the existing site is impermeable and 50% is permeable. See Existing Site Plan in Appendix 2.

Proposed Development

The proposed development includes the conversion of the existing agricultural barn into a single residential dwelling. See Proposed Site Plan in Appendix 2.

The proposed development has an impermeable building footprint of 370m^2 (0.037 ha) and a proposed permeable soft and hard landscaping area of 370m^2 (0.037 ha), The site covers a total area of 740m^2. Consequently, 50% of the proposed site is impermeable and 50% is permeable.

Topographical Survey

Ground levels at the site, to Ordnance Datum, are shown on the topographical survey included in Appendix 3.

The site is located on the side of a valley base. The site levels range from 95.640m Above Ordnance Datum (AOD) at the northern boundary of the site down to 95.130m AOD along the southern boundary of the site. The average site level is approximately 95.385m AOD.

Existing Site Drainage

As well as infiltrating into the ground at its source, surface water at the site flows across the site, in a north to south direction towards the Sor Brook at the base of the valley, at the Greenfield run-off rate. Roof water from the existing barn currently discharges via the existing surface water drainage system into the public sewer, to the east of the site, shown on the Thames Water Plans. Thames Water Asset Location Plans are included in Appendix 4.

Geology, Hydrogeology and Permeability

The British Geological Survey (BGS) Maps indicate that the site is not underlain by any superficial drift geology. The site is directly underlain by the Lower Jurassic Lias Group bedrock geology, which consists of varying quantities of Mudstone, Siltstone, Limestone and Sandstone. BGS maps are included in Appendix 1.

Trial pits were excavated in the adjacent agricultural fields to confirm the geology and conduct a Building Research Establishment (BRE) 365 Infiltration Test. The average infiltration rate was calculated to be 3.15×10^{-6}m/s, which is a moderate infiltration rate. See infiltration test result in Appendix 5.

The trial pits identified a geology of approximately 0.20m to 0.30m of topsoil, underlain by a weathered Marlstone, to depths between 0.300m and 2.250m, which contains iron-rich limestone and is orange brown in colour. Towards the base of the deeper trial pits the Marlstone started to become a bluish colour as it became un-weathered Marlstone.

Groundwater was not encountered within the 0.600m deep trial pits.

The Environment Agency's aquifer maps identify that the site is located over a Secondary A Aquifer. These aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers. This Secondary A Aquifer would be located within the Marlstone bedrock.

Strategic Flood Risk Assessment

West Oxfordshire District Council (WODC) and Cherwell District Council (CDC) carried out a joint Level 1 Strategic Flood Risk Assessment (SFRA) for their districts, and published the final report in April 2009.

The aim of WODC and CDC's SFRA is to assess and map the different levels and types of flood risk in the study area for the land use planning process.

The objectives of the SFRA were:

• To provide an assessment of the impact of all potential sources of flooding in accordance with PPS25 using the information available, including an assessment of any future impacts associated with climate change;

• To enable planning policies to be identified to minimise and manage local flooding issues;

• To provide information required to apply the Sequential Test for identification of land suitable for development in line with the principles of PPS25;

• To provide baseline data to inform the Sustainability Appraisal (SA) of the Development Plan Documents (DPDs) with regard to catchment-wide flooding issues which affect the Study Area;

• To provide sufficient information to allow the Councils to assess flood risk for specific development proposal sites to include minerals and waste sites, thereby setting out the requirements for site specific Flood Risk Assessments (FRAs);

• To enable the Councils to use the SFRA as a basis for decision making at the planning application stage;

• To provide recommendations of suitable mitigation measures including the objectives of Sustainable Drainage Systems (SuDS);

• Where necessary, provide technical assessments to demonstrate that development located in flood risk areas are appropriate and in line with the requirements of the exception test;

• Present sufficient information to inform the Councils of the acceptability of flood risk in relation to emergency planning capability.

Please note that Planning Policy Statement 25 (PPS25) has been superseded by the National Planning Policy Framework (NPPF) and the technical guidance to the NPPF, PPG RFCC.

The SFRA states that new development or intensification of existing development will not be permitted within areas at risk from flooding which is likely to:

- Impede the flow of flood water;
- Result in the net loss of floodplain storage;
- Increase the risk of flooding elsewhere.

The proposed development has been designed to comply with the above planning and flood risk mitigation requirements.

Surface Water Management Strategy

SuDS

The implementation of a surface water management strategy for new developments can ensure that there is no increase of flood risk as a result of the proposed development by avoiding the creation of, reducing and delaying the discharge of rainfall run-off to watercourses and public sewers using SuDS techniques.

The use of the SuDS management train and infiltration techniques also allows for the management of potential pollution to controlled waters, through sedimentation and infiltration. SuDS ensure that surface water run-off cannot discharge directly into controlled waters such as groundwater and watercourses, and consequently reduces the risk of pollution.

The existing site's Greenfield surface water run-off rate can be maintained through the utilisation of SuDS. SuDS aim to mimic the natural drainage processes whilst also removing pollutants from urban run-off at the source before entering a watercourse. There are a wide range of SuDS infiltration techniques. These include, but are not limited to;

- Soakaways (Recharge groundwater/aquifer)
- Filter strips adjacent to roads (Re-charge groundwater/aquifer)
- Swales around the site and adjacent to roads (Re-charge groundwater/aquifer and biodiversity)
- Pervious paving of road and car parks (Re-charge groundwater/aquifer)

There are other forms of SuDS that do not use infiltration, which can assist in the reduction of the post-development surface water run-off. Examples of these are;

- Rainwater harvesting tanks and rainwater harvesting butts (water conservation)
- Above ground attenuation ponds and detention basins (amenity and biodiversity areas)
- Below ground geo-cellular attenuation tanks
- Green Roof (attenuation)

SuDS, can be used to mitigate flooding or pollution. They also provide environmental benefits. Some of the environmental benefits are listed below:

- The hydraulic benefits, including peak flow rate reductions, storm run-off volume reductions, and enhancements to river base flow and aquifer recharge.
- The pollutant loading reductions achieved by the system, and associated benefits to in-stream ecology, human health, and human value perceptions.
- The amenity and recreational benefit enjoyed by those who live close to the SUDS scheme.
- The additional value of properties adjacent or within view of the SUDS scheme.
- The ecological value of the SUDS schemes themselves.

One or more of the above SuDS techniques should be utilized in the surface water management strategy to minimise the surface water run-off from the site and the impacts of the development on the surrounding area.

The SuDS Management Train as set out in the SuDS Manual (CIRIA C697), which provides best practice guidance on the planning, design, construction and maintenance of SuDS, should be utilized in the SuDS design to mimic natural catchment processes as closely as possible. It uses SuDS drainage techniques in series to incrementally reduce pollution, flow rates and volumes.

The hierarchy of techniques that should be considered in developing the management train are as follows:

1. **Prevention** – the use of good site design and site housekeeping measures to prevent run-off and pollution (e.g. sweeping to remove surface dust and detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. **Source control** – control of run-off at or very near its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).
3. **Site control** – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).
4. **Regional control** – management of run-off from a site or several sites, typically in a balancing pond or wetland.

Wherever possible, storm water should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas (end of pipe solutions).

The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at source should always be considered before site or regional controls.

Climate Change

Paragraph 100 of the NPPF requires Climate Change to be considered with regards to flood risk and recommends the national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights that should be applied to new developments:

<table>
<tr><th>Parameter</th><th>1990-2025</th><th>2025-2055</th><th>2055-2085</th><th>2085-2115</th></tr>
<tr><td>Peak Rainfall intensity</td><td>+5%</td><td>+10%</td><td>+20%</td><td>+30%</td></tr>
<tr><td>Peak River Flow</td><td>+10%</td><td colspan="3">+20%</td></tr>
<tr><td>Offshore wind speed</td><td colspan="2">+5%</td><td colspan="2">+10%</td></tr>
<tr><td>Extreme wave height</td><td colspan="2">+5%</td><td colspan="2">+10%</td></tr>
</table>

Climate change is expected to increase the risk of fluvial flooding due to a 20% increase in river flows, and surface water run-off is expected to increase due to a 30% increase in rainfall intensities.

Developments should not increase flood risk at the site or the surrounding area and, where possible, they should aim to reduce existing flood risk by incorporating SuDS to reduce the surface water run-off rate of the site.

The surface water management strategy should ensure that the new surface water drainage system at the site is capable of attenuating the 1 in 100 year storm event including a 30% allowance for climate change, while limiting the surface water discharge rate from the site to the site's existing run-off rate or where possible the Greenfield run-off rate.

Existing and Proposed Developments' Surface Water Run-off without SuDS

The development site covers an area of approximately 740m^2 (0.074ha), and is located near the base of a valley.

The proposed development does not result in an increase in the current impermeable area; however the site is located in a Flood Risk Zone 2 area. Mitigating SuDS techniques should be employed to reduce the flood risk at the site and surrounding areas.

The existing site has permeable areas totalling 370m^2 (0.037ha) and 370m^2 (0.037ha) of impermeable building area. See the Existing site plan in Appendix 2.

The proposed development was predicted to include permeable areas totalling 370m^2 (0.037ha) and an impermeable area of approximately 370m^2 (0.037ha). See the Proposed site plan in Appendix 2.

Therefore, without mitigating SuDS, there would be no increase in the impermeable areas at the site , which equates to 50% of the total site area, and no increase in the resultant surface water run-off.

Consequently, there would be no increase in flood risk to the site or the surrounding areas.

However, the development proposals should incorporate SuDS to provide betterment and to mitigate the potential impacts of Climate Change.

Institute of Hydrology (IOH) Surface Water Run-Off Calculations

Greenfield run-off rates are calculated to determine the theoretical rate of discharge from the Greenfield site to surrounding areas and receiving watercourses in the vicinity.

The calculation of peak rates of run-off from Greenfield areas is related to catchment size.

As stated in The SuDS Manual, the existing site's estimated Greenfield run-off rate was calculated using the Institute of Hydrology's Report No. 124 methodology for sites with an area between 0 ha and 50 ha:

$QBAR_{rural} = 0.00108\ AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$ (IHR 124 equation 7.1)

Where,

0.00108 is a conversion factor for the units used
AREA is the site catchment area in km^2
SAAR is the Standard Average Annual Rainfall
SOIL is the soil index classification.

The run-off rate is calculated for a 50 ha ($0.5km^2$) catchment using the site's catchment details, and then interpolated using the site's total area to calculate the site's Greenfield run-off rate.

Using a SAAR of 654mm and SOIL of 0.400, the estimated existing site's Greenfield surface water run-off rate peak flow is:

$QBar_{rural} = 0.00108 \times 0.50^{0.89} \times 654^{1.17} \times 0.400^{2.17} = 0.1571$ cumecs / 50 ha

which equates to $QBar_{Rrural}$ = 157.1 l/s/ 50 ha

which equates to $QBar_{Greenfield}$ = 3.142 l/s/ha

and for a site area of 0.074 ha = 0.23 l/s

For the site's catchment area of 0.074ha and specified storm events, the site's estimated Greenfield run-off rates and volumes are calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Estimated Site's Run-off Rate Peak Flows (l/s)	Estimated Site's Run-off Peak Volume (m^3)
$QBAR_{Greenfield}$	-	0.23	4.97
1 in 1 year	0.85	0.20	4.32
1 in 30 year	2.27	0.52	5.40
1 in 100 year	3.19	0.73	15.77
1 in 100 year + 30% CC	4.15	0.95	20.52

The IOH 124 method requires that Brownfield run-off rates are calculated using the Greenfield Run-off rates and an adjustment for urbanisation, to allow for the Brownfield impermeable areas, which is demonstrated below for the proposed development site;

The ratio of $QBar_{Brownfield}$ to $QBar_{Greenfield}$ is:

$(1+URBAN)^{2NC}[1+URBAN((21/CIND)-0.3)]$

Where,

NC is the Rainfall continentality factor which is a function of SAAR
CIND is the catchment index = 102.4 SOIL+0.28(CWI-125)
CWI is the Catchment Wetness Index which is a function of SAAR from FSR Report
URBAN is the fraction of the catchment that is impermeable

NC = 0.92-(0.00024 x 654) = 0.76
CWI = 92.1
CIND = (102.4 x 0.400) + 0.28(92.1-125) = 31.7
URBAN = 0.50

The ratio of $QBar_{Brownfield}$ to $QBar_{Greenfield}$ $= (1+0.50)^{1.52}[1+0.50((21/31.7)-0.3)]$
$= 2.19$

For the site's catchment area of 0.074 ha and specified storm events, the site's existing and proposed Brownfield run-off rates and volumes (without mitigating SuDS) are calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Proposed Site's Run-off Rate Peak Flows(l/s)	Proposed Site's Run-off Peak Volume (m^3)
$QBAR_{Proposed}$	-	0.50	10.80
1 in 1 year	0.85	0.43	9.29
1 in 30 year	2.27	1.14	24.62
1 in 100 year	3.19	1.60	34.56
1 in 100 year + 30% CC	4.15	2.08	44.93

As the existing and proposed surface water run-off would be the same, there would also be no increase in flood risk. Accordingly, the development proposals could mitigate Climate Change by implementing SuDS to provide betterment.

Proposed Surface Water Management Strategy

The proposed surface water management strategy (SWMS) aims to not increase, and where practicable reduce the rate of run-off from the site as a result of the proposed development, in accordance with sustainable drainage principles and the published WODC and CDC SFRA.

BRE 365 Infiltration Tests were carried out at agricultural land adjacent to the site to enable the design of the preliminary SuDS and to confirm its feasibility. The test results are included in Appendix 5. The average permeability rate was 3.15×10^{-6}m/s (0.011 m/hr), which is a moderate infiltration rate.

Firstly, in accordance with the SuDS Management Train as set out in The SuDS Manual (CIRIA C697), it is proposed to mitigate any increase in surface water run-off created by implementing "Prevention" in the SuDS design.

Accordingly, it is proposed to include areas such as porous paving, gravel paths and maximise soft landscaped areas to minimise any increase in post development impermeable areas and their surface water run-off.

Therefore, there is no proposed increase in impermeable areas at the site and both hard and soft landscaping are proposed to be permeable.

Secondly, it is proposed to implement "Source Control" infiltration techniques such as soakaways and porous paving to manage surface water run-off from roofs and roads at their source.

The Flood and Water Management Act 2010, Sewers for Adoption and The SuDS Manual require that, as a minimum, the SuDS should be designed to manage and attenuate the 1 in 30 year storm event so that there is no flooding of the site.

However, new developments should also mitigate Climate Change, so SuDS should be designed for exceedence and, be designed to manage and attenuate the 100 year storm event including a 30% allowance for Climate Change.

Surface Water run-off can be attenuated above ground as long as there is no flooding to buildings. Infiltration basins are proposed to be implemented to attenuate and infiltrate surface water above ground, where required.

The new dwelling's impermeable area is approximately 370m^2 (0.037 ha).

Using Windes MicroDrainage, an impermeable area of 0.037 ha, the 100 year plus 30% Climate Change storm event and an average permeability rate of $3.15x10^{-6}$m/s (0.01134 m/hr), the new dwellings soakaway size to mitigate the impermeable roof area needs to have a net storage capacity of approximately 22.65m^3.

Therefore, cellular soakaways could be used which have 95% voids or greater. A typical cellular soakaway, with zero discharge, would have dimensions of approximately 8.0m x 7.5m x 0.4m deep, which has a net attenuation volume of 22.80m^3, which is greater than the required 22.65m^3. See MicroDrainage calculations in Appendix 5.

Alternatively, the private court yard could be constructed of either gravel or porous paving, to suit the budget of the development, to enable impermeable areas and resultant surface water run-off to be kept to a minimum. Roof water could also be discharged to a porous driveway to reduce the size of the soakaway or as an alternative to surface drainage.

Using Windes MicroDrainage, an impermeable area of 0.037 ha, the 100 year plus 30% Climate Change storm event and an average permeability rate of $3.15x10^{-6}$m/s (0.01134 m/hr), the new dwellings porous paved size to mitigate the impermeable roof area needs to have a net storage capacity of approximately 17.3m^3. Using a sub-base depth of 0.250m, this equates to a plan area of approximately 230m^2.

The proposed development has a porous hardstanding area of approximately 245m^2, which is greater than the required of 230m^2. See MicroDrainage calculations in Appendix 5.

The above SuDS are sized to mitigate the 100 year storm including a 30% allowance for climate change with zero outflow.

Consequently, 50% of the site would not have a Greenfield run-off rate and the site's post development run-off rate could be reduced to approximately 0.115 l/s, which is 50% of the existing site's Greenfield run-off rate of 0.23 l/s.

As 50% of the existing site would currently discharge surface water at the Brownfield run-off, reducing the run-off rate to below the existing site's Greenfield run-off rate, and mitigating Climate Change would provide betterment as less water would be discharged to the existing drainage ditches and the Sor Brook.

Consequently, the proposed SuDS could provide a reduction in flood risk at and down river of the site.

See proposed porous hardstanding SuDS SWMS Plan in Appendix 2.

The proposed SuDS surface water management strategy ensures that:

- there is no increase in run-off as a result of the proposed development,
- there is no increased flood risk as a result of the proposed development,
- there is a decrease in the site's overall run-off rate and volume,
- the site's run-off rate is reduced to less than the Greenfield run-off rate,
- betterment can be provided with regards to flood risk.

Assessment of Flood Risk from All Potential Sources

Flooding of a site can occur from several sources, including, watercourses such as Main Rivers, Ordinary Watercourses and streams, tidal seas and estuaries, groundwater, sewers, surface water run-off and failure of water infrastructure. The risk of flooding to the site from each source has been assessed in turn.

Main Rivers

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 170m south and 2280m east of the site, respectively.

The SFRA states that, the River Cherwell rises at Charwelton in Northamptonshire. Its general course is flowing from north to south through the centre of the District passing through Banbury, Upper Heyford, and Kidlington before flowing to Oxford where the Cherwell meets the River Thames. The river drains a total catchment area of 906 km^2 with a mean annual rainfall of 682mm.

Tributaries that flow to the River Cherwell include the Hanwell Brook, the Sor Brook, the Bloxham Brook and the River Swere all flowing from the West and the River Ray flowing from the East. The confluence of the River Cherwell with the River Thames is located about 5km beyond the Cherwell District southern boundary.

Land use across the catchment is predominately rural (less than 2% of the catchment is classified as 'urban') and includes the two main urban centres of Banbury and Bicester.

The EA's Indicative Flood Zone Map indicates that the site is located in Flood Zone 2, which has a Medium to Low risk of fluvial flooding from Main Rivers.

That is land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year. See EA's Indicative Flood Zone Maps in Appendix 1.

The Sequential Test looks at the Flood Risk Vulnerability and Flood Zone Compatibility of a development.

Table 3 of the PPG FRCC, identifies the development types that are appropriate in each flood zone, subject to the requirements of the EA National Standing Advice and the Application of the Sequential Test.

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	√	√	√	√	√
Flood Zone 2	√	√	Exception Test	√	√
Flood Zone 3a	Exception Test	√	X	Exception Test	√
Flood Zone 3b Functional FZ	Exception Test	√	X	X	X

Key:
√ Development is appropriate
X Development should not be permitted

The Sequential and Exception Tests do not need to be applied to minor developments and changes of use developments.

However, the residential development is classified as More Vulnerable development in accordance with Table 2: Flood Risk Classification of PPG FRCC. Therefore, based on Table 3 of the PPG FRCC the developments classifications and land use are appropriate for the flood zone at the site.

The SFRA does not have any records of the site flooding due to Main Rivers. The EA were consulted but they do not have modelled flood levels for the site, only modelled flood mapping using LiDAR data is available, which can be inaccurate do to the clearing out process that removed trees and vegetation to give a bare earth model.

Consequently, the flood levels have been estimated using the flood maps and the ordnance survey ground contours where the flood zones follow the ground contours and are connected to the main river.

It should be noted that the southern floodplain on the EA's indicative flood zone map appears to follow the contours of the ground, as would be expected. However, the floodplain to the north of the main river does not follow the ground contours and is disconnected from the river in some areas.

This suggests that the bare earth ground level data is incorrect in this area.

Therefore, based on the southern floodplain it is appears that the flood zone 2 water level would exceed a height of 95.000m AOD. If this conservative level is applied to the northern floodplain, it is anticipated that the whole of the proposed development site is actually located in Flood Zone 1, as it has an average ground level of 95.385m AOD. See Topographical Survey, Ground Contour and EA Indicative Flood Map Drawing in Appendix 3.

Due to the distance and change in ground levels between the site and the main rivers it is unlikely that the site is at risk of flooding from Main Rivers.

The site is perceived to have a Low risk of fluvial flooding from Main Rivers.

Ordinary Watercourses and Streams

There are no known ordinary watercourses or streams in the immediate vicinity of the site. The SFRA does not have any records of flooding from watercourses or streams.

Therefore, the site is perceived to have a Low risk of fluvial flooding from ordinary watercourses and streams.

Coastal or Estuarine

The site is not located near the coastline or an estuary. Consequently, the site is at low risk of tidal flooding.

Groundwater

The SFRA states that, the underlying superficial geology of the area is predominantly clay, particularly in the north. This results in flashy runoff and rapid responses of fluvial systems to rainfall events. In the locality of Bicester there are outcrops of shale which are more permeable.

There are locations within the District that are affected by high water tables and are susceptible to seasonal spring fed activity such as Mollington. This may result in standing water on low lying ground that is unable to reach a ditch or watercourse and is unable to percolate through the ground due to seasonally high water perched groundwater levels.

However, the site is not known to be affected by high ground water tables and, as demonstrated by the permeability tests, surface water is able to percolate through the ground. The proposed layout of the site takes into consideration the findings of the SFRA and proposes swales and infiltration basins along the valley floor. The SFRA does not have records of the site flooding due to groundwater.

There are no other known records of the site being flooded due to groundwater. This indicates that the risk of groundwater flooding at the site is low.

Sewers and highway drains

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The SFRA indicates that the site is in a low incident area with regards to sewer flooding. All developments are required to assess the residual capacity of the surface water system proposed to discharge to. The system should have sufficient residual capacity so as not to surcharge up to the 1 in 30 year event

There are no other known records of the site being flooded, due to surcharging of sewers. This indicates that the risk of flooding at the site due to surcharging of local sewers is Low.

Any new drainage on site should be constructed to comply with the current Building Regulations Approved Document H and Sewers for Adoption, to ensure that sewer surcharging is mitigated.

Surface water and Overland Flow

The SFRA states that, during periods of prolonged rainfall events and sudden intense downpours, overland flow from adjacent higher ground may ‘pond’ in low-lying areas of land without draining into watercourses, surface water drainage systems or the ground.

The WODC SFRA has records of other areas experiencing surface water flooding, it does not have any records of the proposed development site experiencing surface water flooding.

The surface water management strategy, based on permeability tests, has demonstrated that by utilising SuDS it is feasible to mitigate surface water run-off as a result of the proposed development.

The proposed SuDS can provide betterment by reducing the post-development’s surface water run-off rate to below the existing Greenfield run-off rate, and consequently reduce flood risk to the site and the surrounding areas.

There are no other known records of the property being flooded due to surface water. This indicates that the risk of flooding at the site due to surface water flooding is low.

Water Infrastructure failure

The WODC SFRA has identified that flooding may result from the failure of engineering installations such as flood defence, land drainage pumps, sluice gates and floodgates.

Hard defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Such deterioration is often difficult to detect, so that failure when it occurs is often sudden and unexpected. Failure is more likely when the structure is under maximum stress, such as extreme fluvial events when pressures on the structure are at its most extreme.

The Oxford Canal is located approximately 2,700m east of the site, and to the east of the M40. A small reservoir is located approximately 290m south west of the site.

Therefore, the risk of flooding from water infrastructure failure is believed to be Low.

Main River Bylaw Distance

In accordance with the Land Drainage Act 1976, The Water Resources Act 1991 and the Environment Act 1995 a Flood Defence Consent must be separately obtained from the EA for any work in, over, under or within the Bylaw distance of a Main River.

This is to ensure that the work activities do not cause or make existing flood risk worse, interfere with the EA's work, and do not adversely affect the local environment, fisheries or wildlife.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 170m south west and 2380m east of the site, respectively.

Therefore, the proposed development works would not require a Flood Defence Consent grated by the EA.

Conclusions and Recommendations

Policy 103 of the National Planning Policy Framework (NPPF) requires that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (FRA), compliant with the technical guidance to the NPPF (PPG FRCC), following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

The site is located to the west of Oxford Road, the A4260, and can be located by Grid Coordinates 446080mE, 237190mN. The site covers an area of approximately 0.0740 hectares.

The site is bound by agricultural land to the north, east, south and west.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 170m south and 2380 m east of the site, respectively.

The Environment Agency's (EA) Indicative Flood Zone Map indicates that the site is located in Flood Zone 2, which has a medium risk of fluvial flooding from Main Rivers. Therefore, in accordance with the NPPF and based on Table 3 of the PPG FRCC the development's classifications and land use are appropriate for the flood zone at the site.

However, based on ground level and contour data it is anticipated that the site is actually located in Flood Zone 1 with a Low risk of fluvial flooding.

The SFRA does not have records of the site flooding due to groundwater. This indicates that the risk of groundwater flooding at the site is low.

The SFRA does not have records of the site flooding due to surface water. This indicates that the risk of surface water flooding at the site is low.

The SFRA does not have records of the site flooding due to sewers. This indicates that the risk of sewer flooding at the site is low.

The risk of flooding from water infrastructure failure is anticipated to be low.

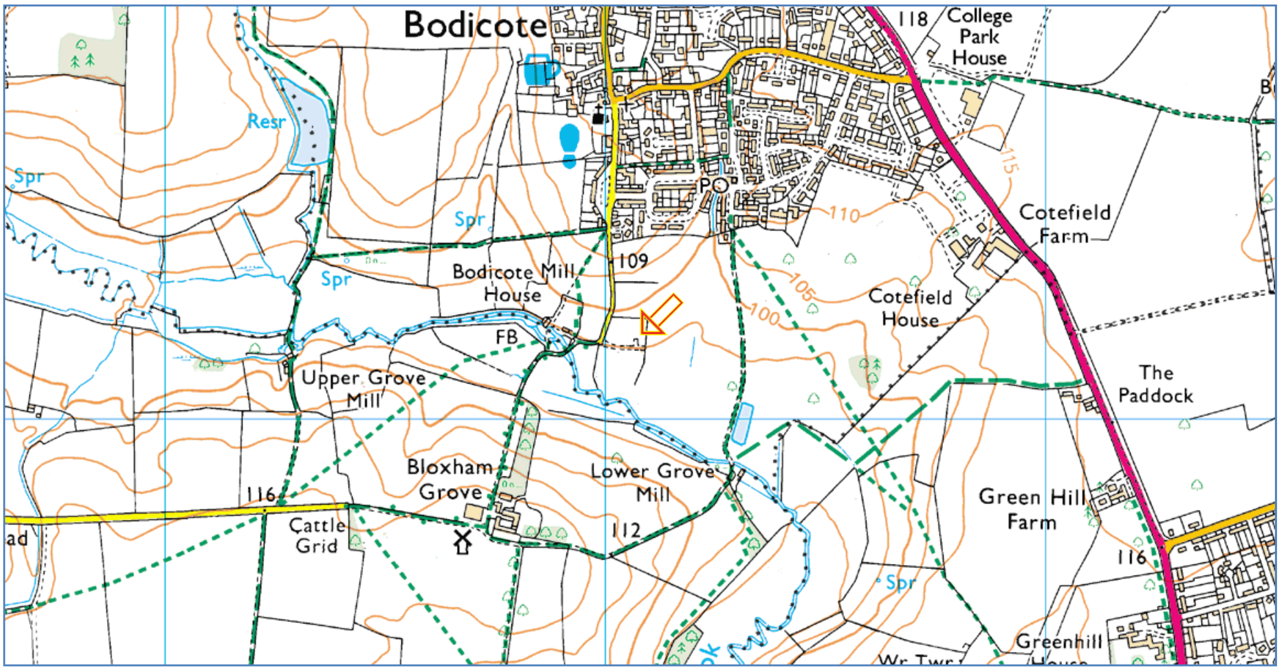
This site-specific FRA has identified that the development proposals, which incorporates a SuDS surface water management strategy, ensures that:

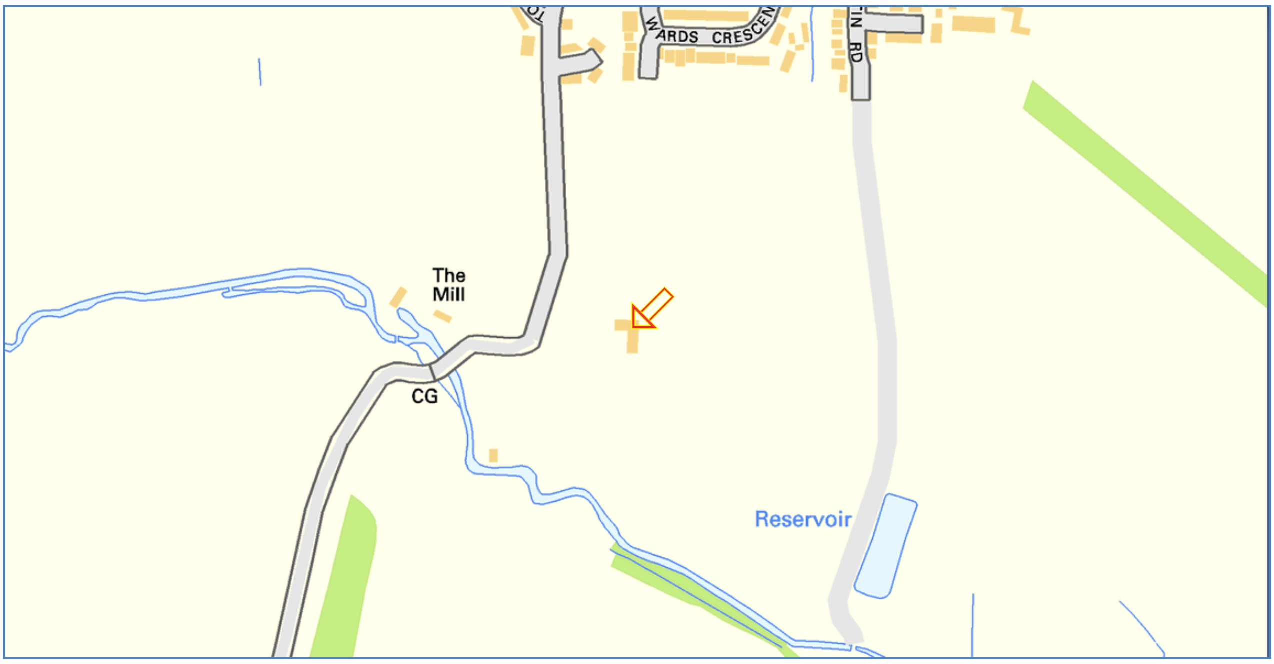
- there is no increase in run-off as a result of the proposed development,
- there is no increased flood risk as a result of the proposed development,
- there is a decrease in the overall site's run-off rate and volume,
- the site's run-off rate is reduced to less than the Greenfield run-off rate,
- betterment can be provided with regards to reduction in flood risk,
- the development proposals comply with the EA's requirements,
- the development proposals comply with the NPPF and the PPG FRCC.

Based on the findings of this site specific FRA, the proposed SuDS SWMS is feasible and consequently the development proposals are considered acceptable.

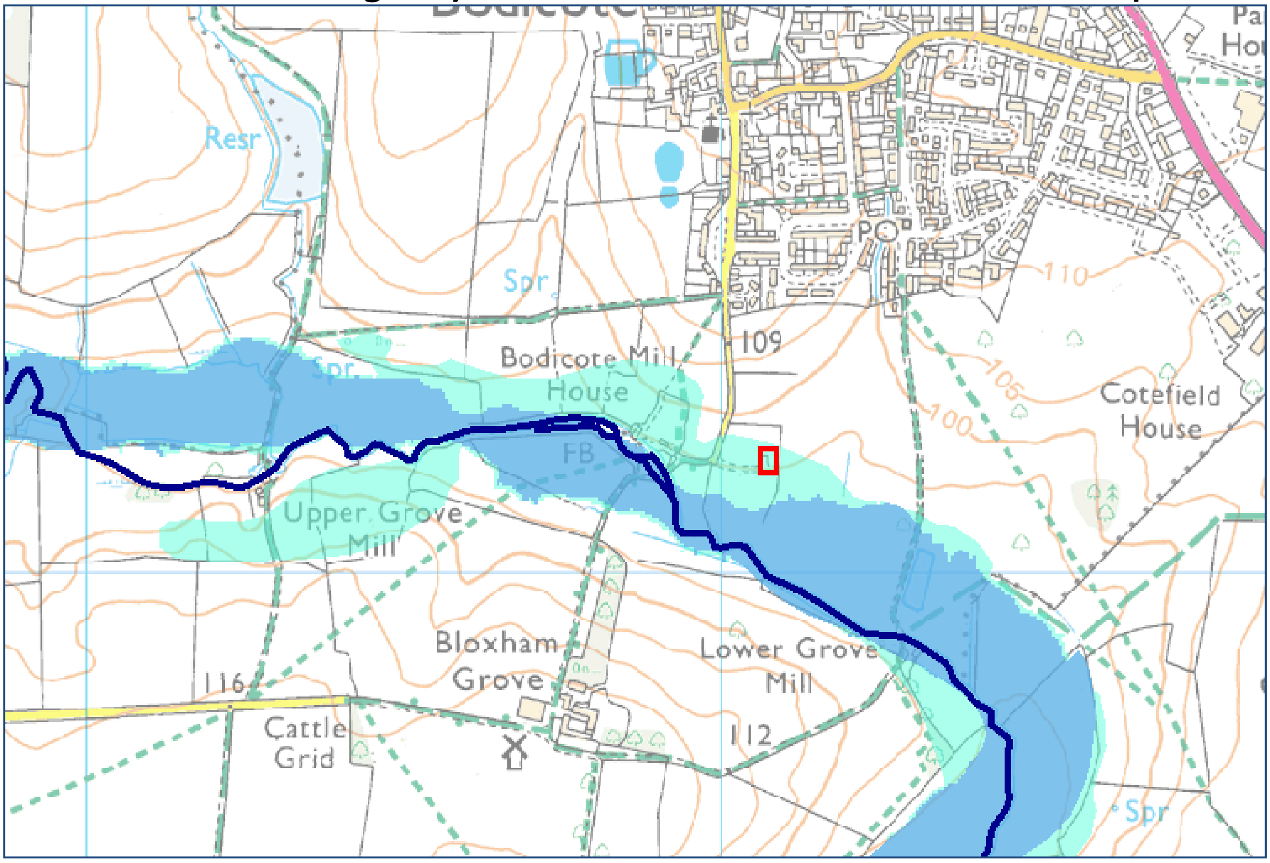
APPENDIX 1

Site Location Maps
Barn Conversion, Bodicote, Banbury, Oxfordshire, OX15 4DR
Grid Reference 446080mE, 237190mN





Environment Agency Indicative Main River Flood Zone Maps



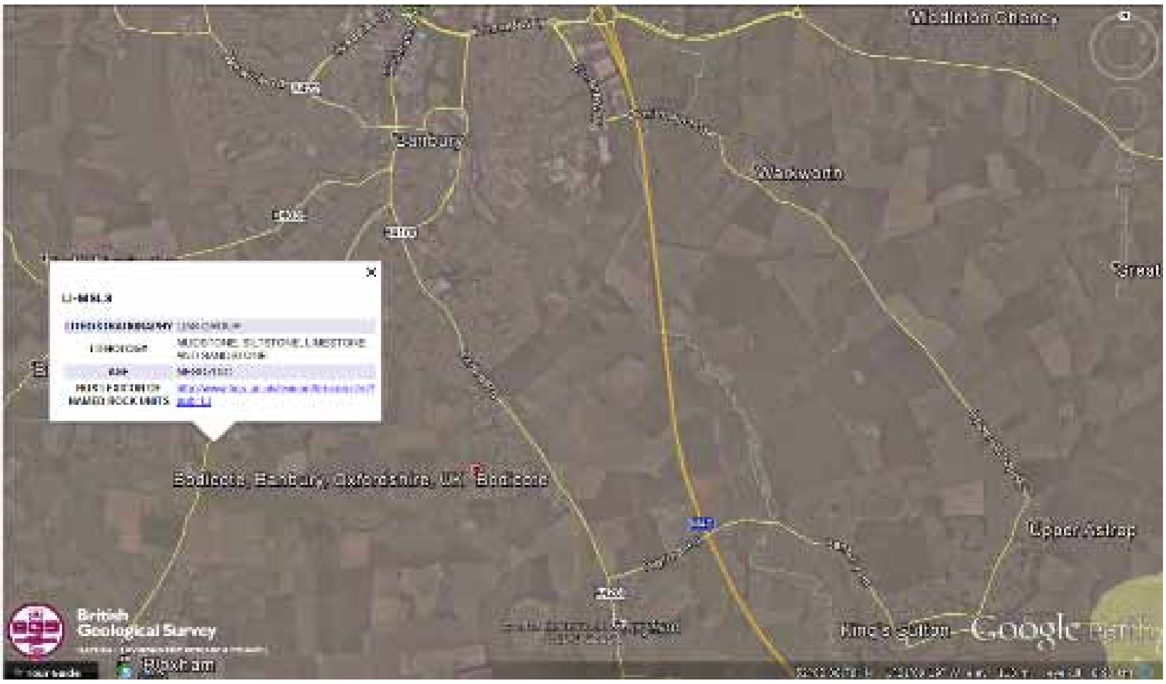
Key:

- Flood Zone 3 – Medium to High Risk
- Flood Zone 2 – Low to Medium Risk
- Flood Zone 1 – None to Low
- Flood Defence Protected Area
- Flood Defence
- Main River
- Site Location

British Geological Survey Maps

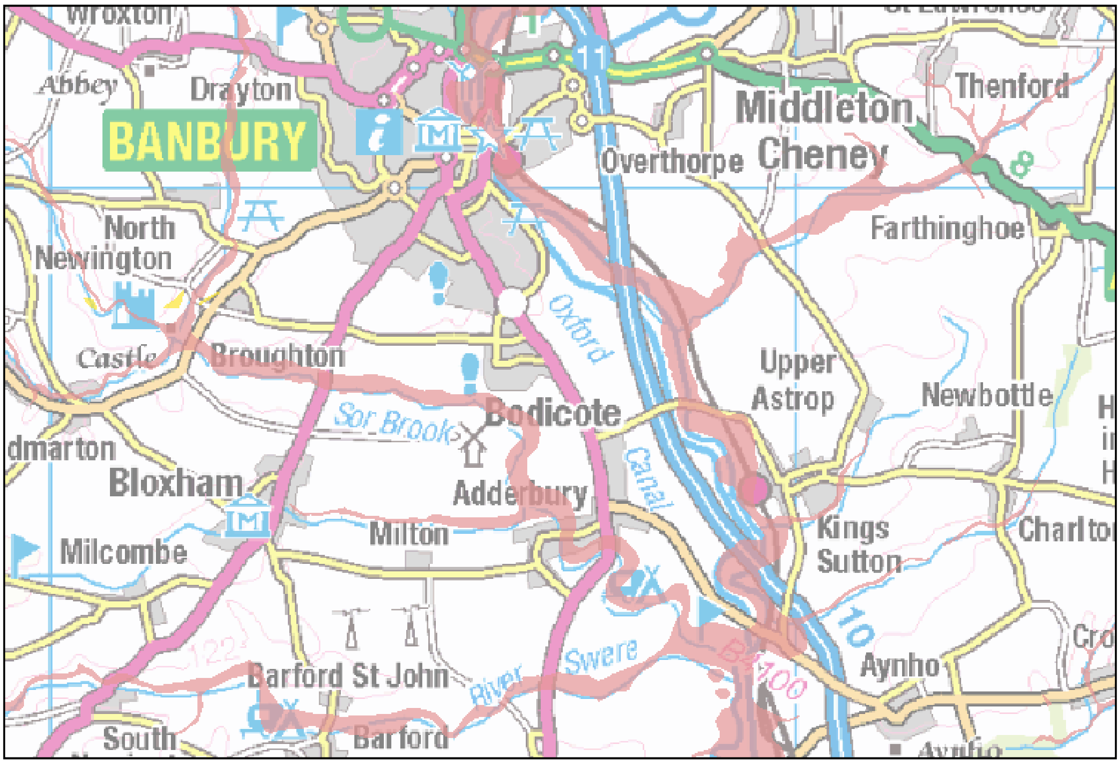
Superficial Drift Geology – NONE

Bedrock Geology – Lias Group – Varying quantities of Mudstone, Siltstone, Limestone and Sandstone

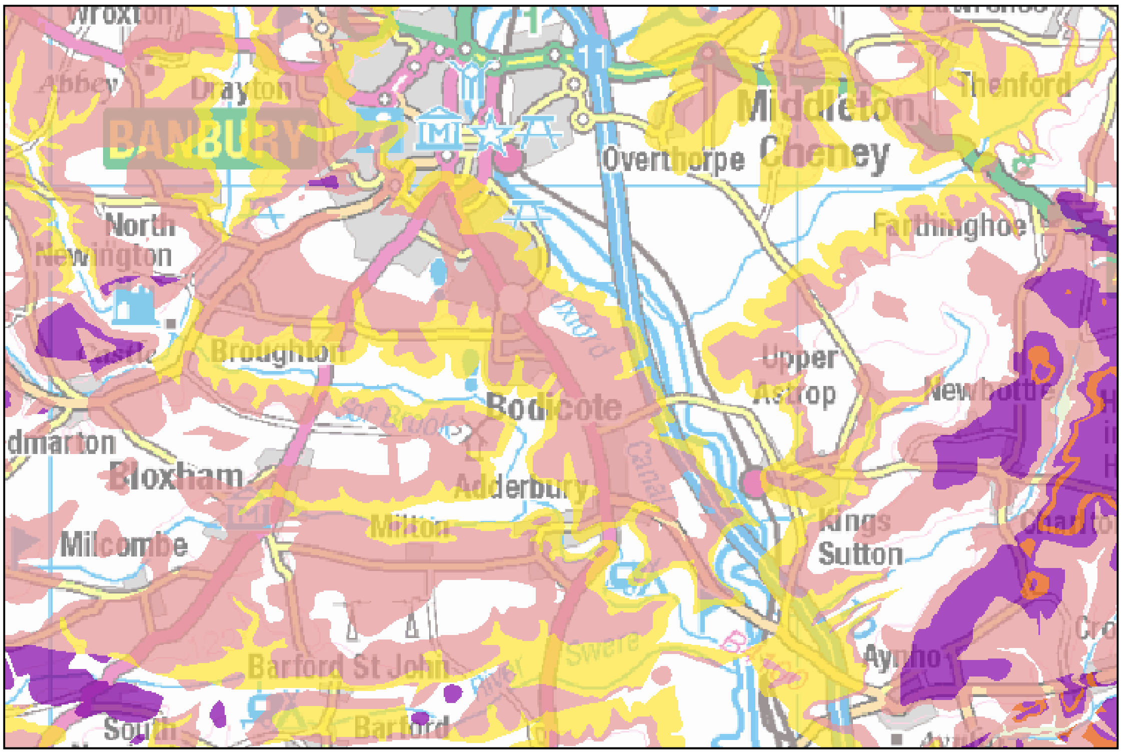


Environment Agency Aquifer Maps

Superficial Drift Geology – NONE



Bedrock Geology – Secondary A Aquifer – Minor Aquifer



More Vulnerable development up to 1ha in size (excludes non-residential extension with a footprint of less than 250sq. metres or a domestic extension) in Flood Zone 2

Applications for planning permission should be accompanied by a completed form. An electronic version can be submitted by 'printing' it to a PDF writer.

The guidance on this sheet concerning Flood Risk Assessment requirements should also be applied to applications for Change Of Use within this category. Note - the Sequential Test does not apply to Change of Use applications. This advice is not applicable to development proposals for landfill/waste facilities & holiday/short-let caravans in this Flood Zone.

Sequential Test requirements

The Sequential Test is applied by the Local Planning Authority (LPA) to planning applications within this category. Details of the sequential test are set out in paragraph 101 of the NPPF.

FRA requirements

Planning applications must be accompanied by a Flood Risk Assessment (FRA). We recommend the FRA meets the requirements set out in the table below. All flood management measures will need to be supported by plans and drawings that form part of the FRA. The requirement for a FRA is set out in the NPPF in paragraphs 103 and 104 and footnote 20.

We recommend that Table 1.0 is completed by the applicant as part of the FRA submission. The standing advice help pages[1] provide guidance to help the applicant through this process. Plans may need to be amended and/or application withdrawn if the detail provided in the table does not meet the requirements as set out.

The following sections are to be completed by the applicant and checked by the LPA:

Site address & development description:	Barn Conversion Church Street Bodicote Oxfordshire OX15 4DR
Print Name:	D Prichard
Signature:	D Prichard
Date:	19.05.15

Continued...

[1]The help pages are available to see on the Environment Agency website www.environment-agency.gov.uk on the flood risk standing advice pages.

Table 1.0

More vulnerable development up to 1ha in size (excludes Non-residential extension with a footprint of less than 250 sq. metres or a domestic extension) in Flood Zone 2 (Does not apply to sites used for holiday or short-let caravans and camping, or landfill and waste management sites. For these proposals please refer to FRA Guidance note 3).

Flood risk to building/occupants. **Information to be provided by the applicant as part of the Flood Risk Assessment**	**Applicant to provide level information in the boxes below**	**Criteria to be used by LPA in assessing the Flood Risk Assessment**
Flood level for the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) in any year (including an allowance for climate change) in relation to Ordnance Datum[2] [1] (Newlyn)	<95.000m	In order to deliver safe development, we strongly advise the following - Ground floor levels to be set at a minimum of whichever is the higher of: • 300mm above the general ground level of the site OR • 600mm above the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) in any year (including an allowance for climate change). • Basement rooms to have unimpeded access internally to an upper level. **LPA's role:** Ensure that the level information has been provided and the standards set out above have been met.
Average ground level of the site in relation to Ordnance Datum (Newlyn)	95.385m	
Finished floor level of lowest habitable room in relation to Ordnance Datum (Newlyn)	~95.600m	
1 in 1000 annual probability (0.1%) in any year flood level including an allowance for climate change where this information is available.	<95.000m	In order to deliver safe development, we strongly advise the following - For single storey buildings or ground floor subdivisions with no access to higher floors, users of the development have access to a refuge set above the 1 in 1000 annual probability (0.1%) in any year flood level including an allowance for climate change. **LPA's role:** Ensure that the provision of a safe refuge for **single storey** buildings complies with the above information. To achieve these standards floor levels should be raised. Note: For buildings with more than one storey in this category upper floors can be considered safe refuge

Continued…

[2] Ordnance Datum or the abbreviation 'OD' is the mean level of the sea at Newlyn in Cornwall from which heights above sea level are taken. The contour lines on Ordnance Survey maps measure heights above OD for example, though these are not accurate enough for a flood risk assessment.

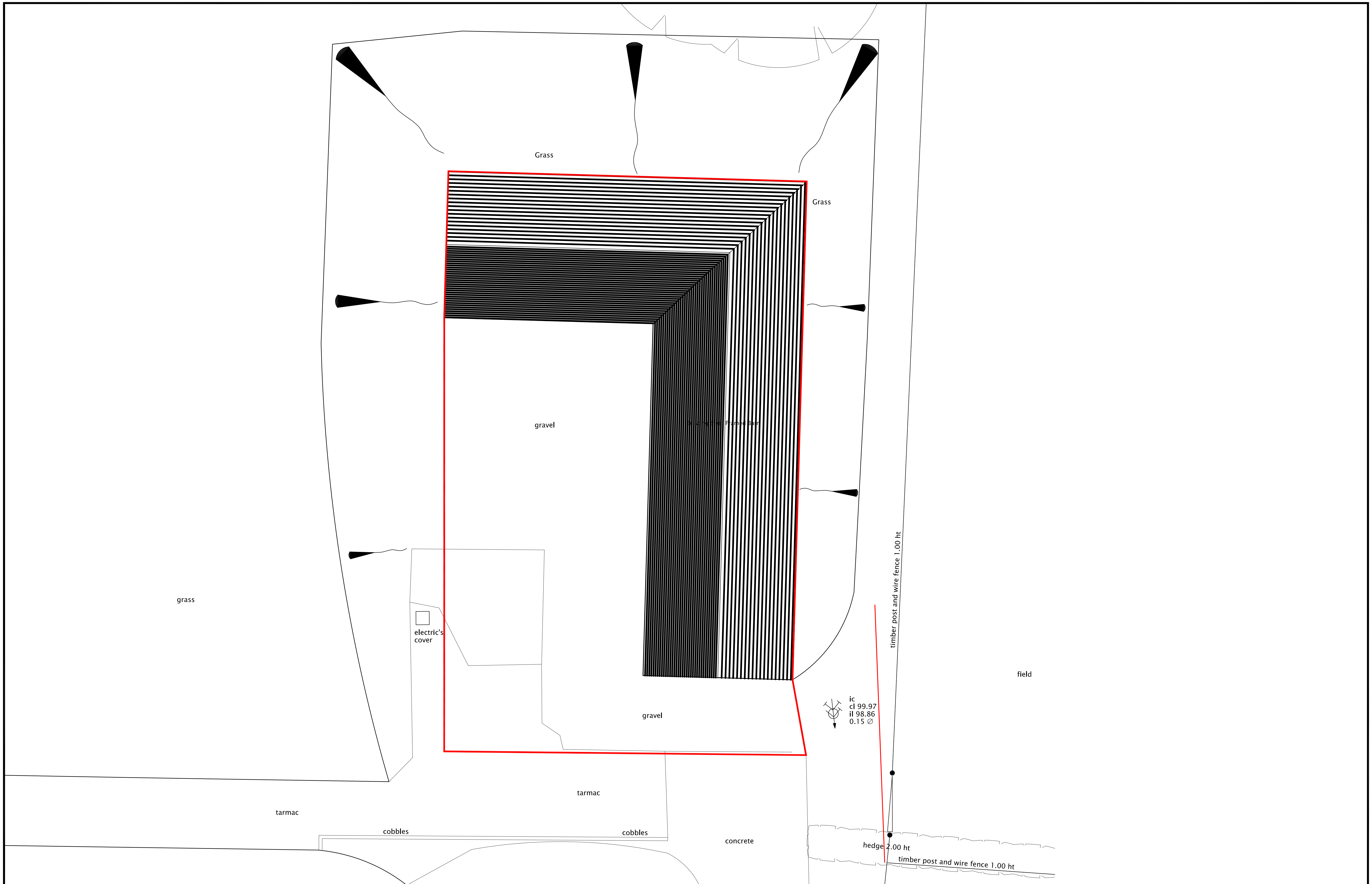
Table 1.0 (Continued)

Applicant is to provide confirmation that the requirements below have been met	Applicant to indicate compliance in the box below. Enter 'yes' or 'no'	LPA should satisfy themselves with regard to the comments below.
Management of surface water Applicant is to indicate that surface water will be managed in accordance with the following standards: • Specific requirements for managing surface water set out in an adopted Strategic Flood Risk Assessment and/or Surface Water Management Plan produced by the Local Planning Authority. • Surface water run-off will be controlled to ensure no flooding of property and no increase in surface water run-off from the site to a watercourse or receiving water body compared to the existing pre-application run-off rate in a 1 in 100 year storm event (1% chance in any one year) plus an appropriate allowance for climate change (Flood risk Practice Guide paragraphs 5.51 and 5.54) • Meets the requirements of Approved Document Part H of Building Regulations 2000.	YES	**LPA's role:** Look for assurance from the applicant that surface water will be managed in accordance with the requirements opposite. Seek assurance if not already provided. Cross check the planning application with the Local Plan . Consultation with the local authority Building Control department is recommended. Paragraph 103 of NPPF states that LPAs should in determining planning applications give priority to the use of SuDS. **Note**: Strategic options for surface water management should be used wherever available. Options such as this would be identified as part of the SFRA for inclusion within in the Local Plan. Building regulation requirements alone are not appropriate for areas with critical drainage problems.
Flood resilience and resistance Applicant is to indicate that flood resilience/ resistance and emergency escape measures/ procedures have been incorporated where possible. This applies to any part of the building (e. g. basements), that are situated below the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) level in any year (including an allowance for climate change).	YES	**LPA's role:** Look for assurance from the applicant that resilience/resistance and evacuation procedures have been addressed in accordance with the requirements opposite. Seek assurance if not already provided. Cross check the planning application with the Local Plan. Consultation with the local authority Building Control (flood resilience/ resistance) and Emergency Planning (evacuation) department is recommended.
Other sources of flooding (not rivers or the sea) Applicant is to indicate that the SFRA has been referred to and that the recommendations regarding other sources of flooding have been incorporated into the application. If no SFRA is available and flood risk from other sources is present, guidance should be sought from the organisations listed in the help pages under the heading `other sources of flooding'.	YES	**LPA's role:** Look for assurance from the applicant that the SFRA has been referred to (where available) and that mitigation for flooding from other sources has been provided where necessary.

Note on flood level information: Flood Level information should be obtained by the applicant first from the SFRA, or if not available, from the Environment Agency. Where the applicant is unable to obtain the information from either of these sources the LPA should consult the Environment Agency for an individual consultation response.

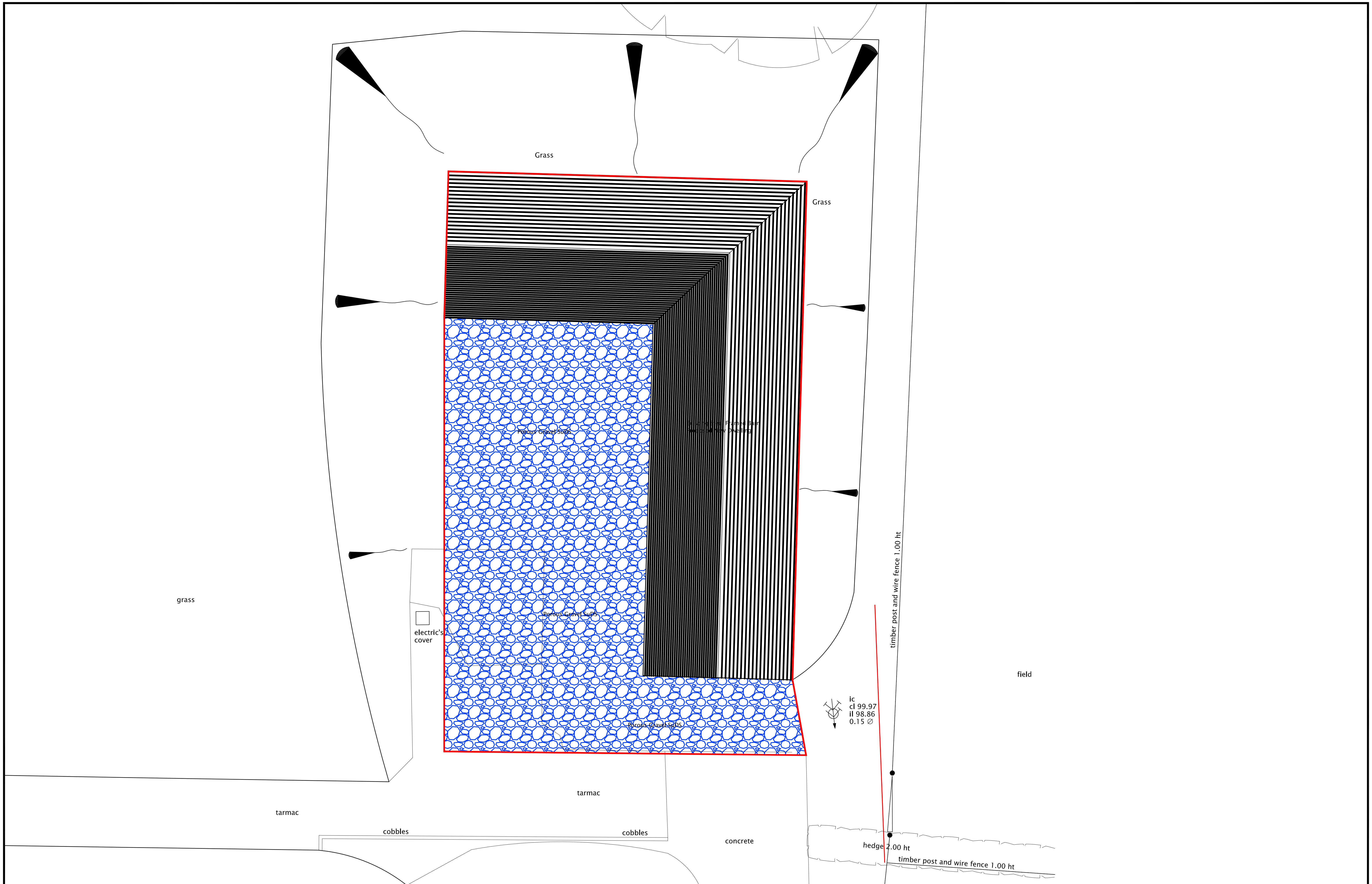
End of comment

APPENDIX 2



Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Barn Conversion, Bodicote, OX15 4DR	Existing Site Plan	DKP	WHA	A1
	Project Ref: FEDS-215012		Date: 19.05.15	Scale: 1:100	
			Dwg.no: 215012-001	Rev: A	

Forge Engineering Design Solutions
Forge House
30 Digging Lane
Fyfield, Abingdon
Oxfordshire, OX13 5LY
tel: 01865 362 780
info@f-eds.co.uk
www.f-eds.co.uk



Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Barn Conversion, Bodicote, OX15 4DR	Proposed Site Plan including SuDS	DKP	WHA	A1
	Project Ref: FEDS-215012		Date: 19.05.15	Scale: 1:100	
			Dwg.no: 215012-002	Rev: A	

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APPENDIX 3

Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Barn Conversion, Bodicote, OX15 4DR	Topographical Survey	DKP	WHA	A1
	Project Ref: FEDS-215012		Date: 19.05.15	Scale: 1:100	
			Dwg.no: 215012-003	Rev: A	

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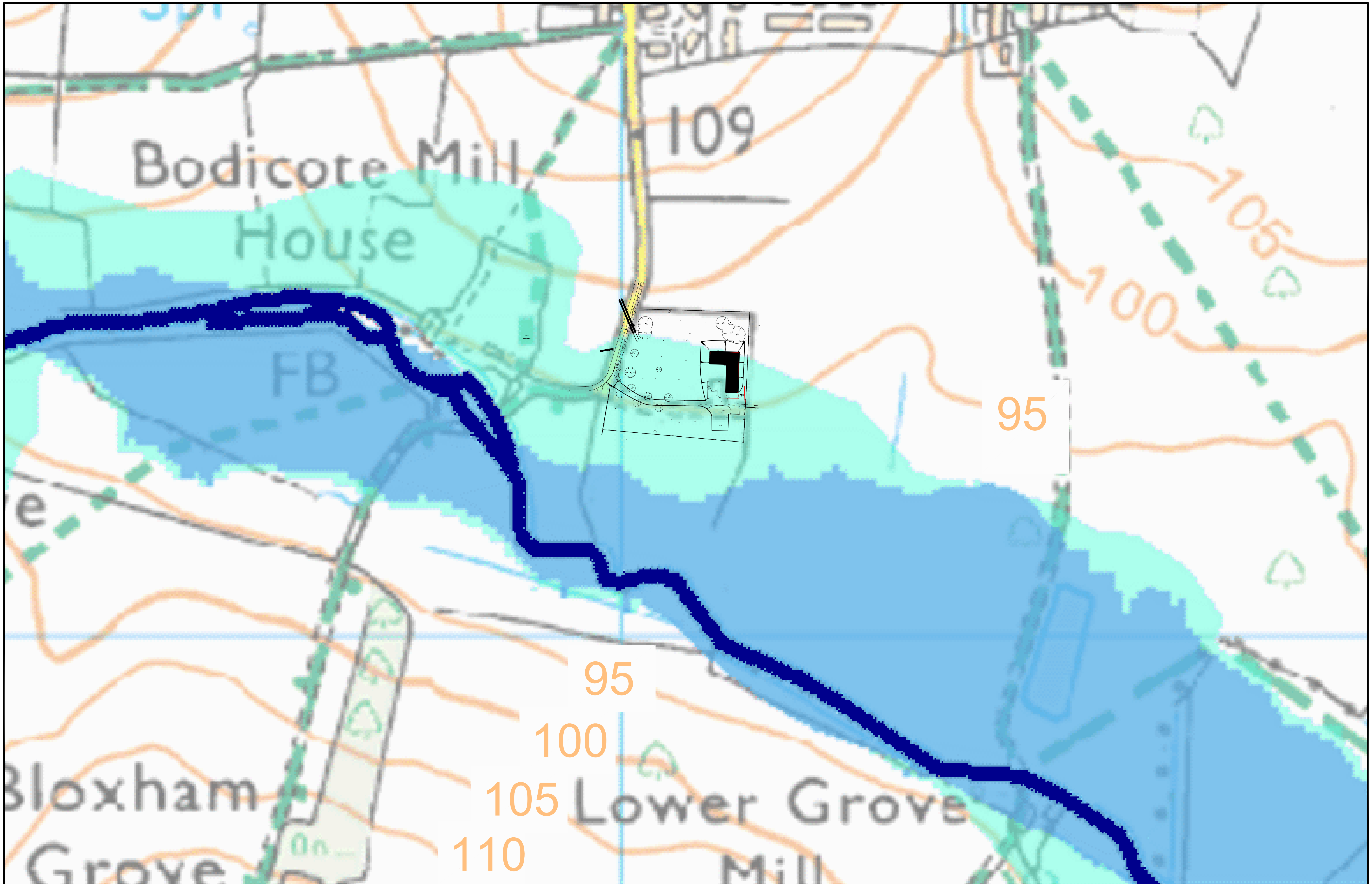

Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Barn Conversion, Bodicote, OX15 4DR	Topographical Survey, Ordnance Survey Ground Contours and Environment Agency Indicative Flood Map	DKP	WHA	A1
	Project Ref: FEDS-215012		Date: 19.05.15	Scale: 1:100	
			Dwg.no: 215012-004	Rev: A	

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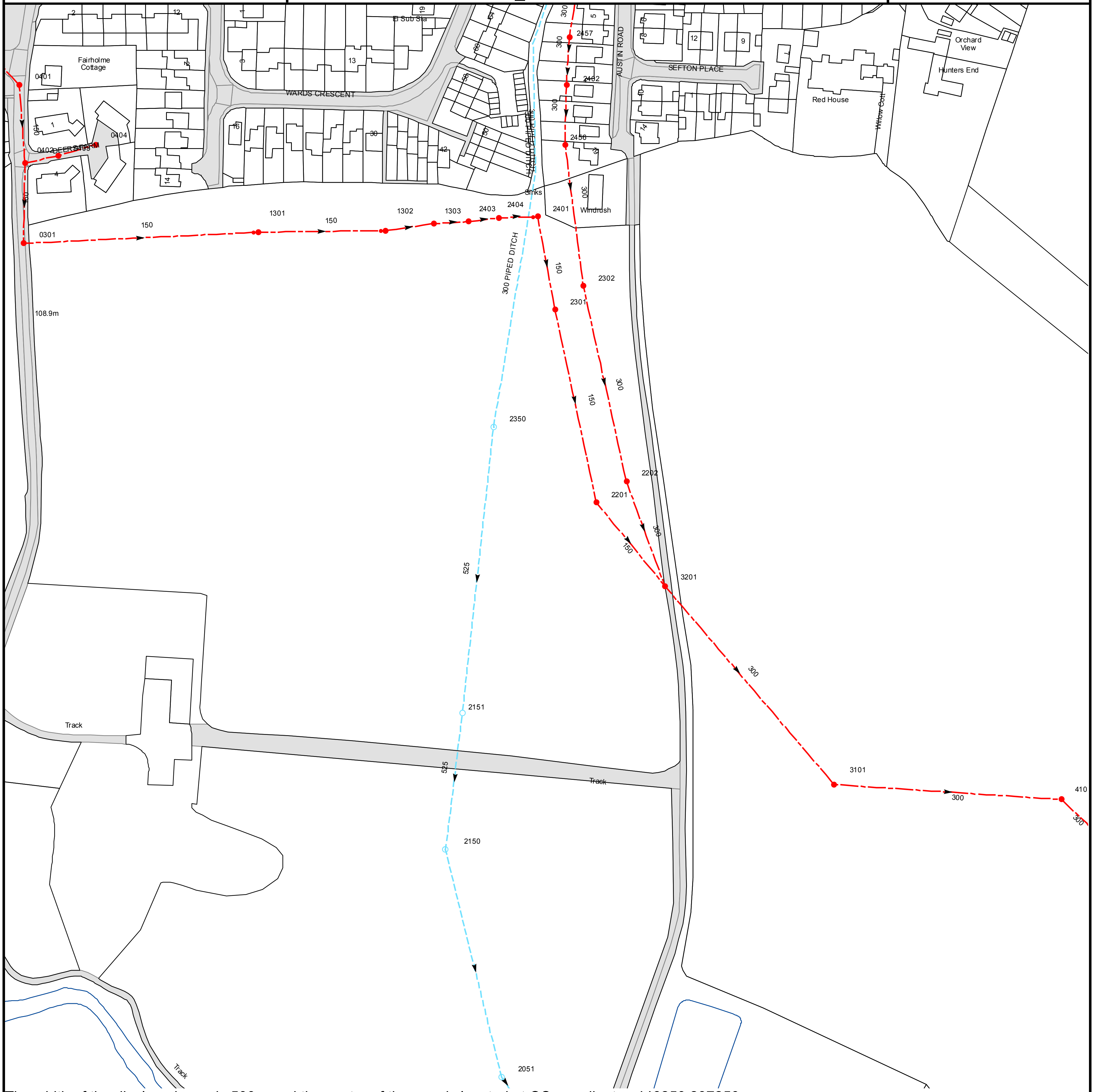
APPENDIX 4

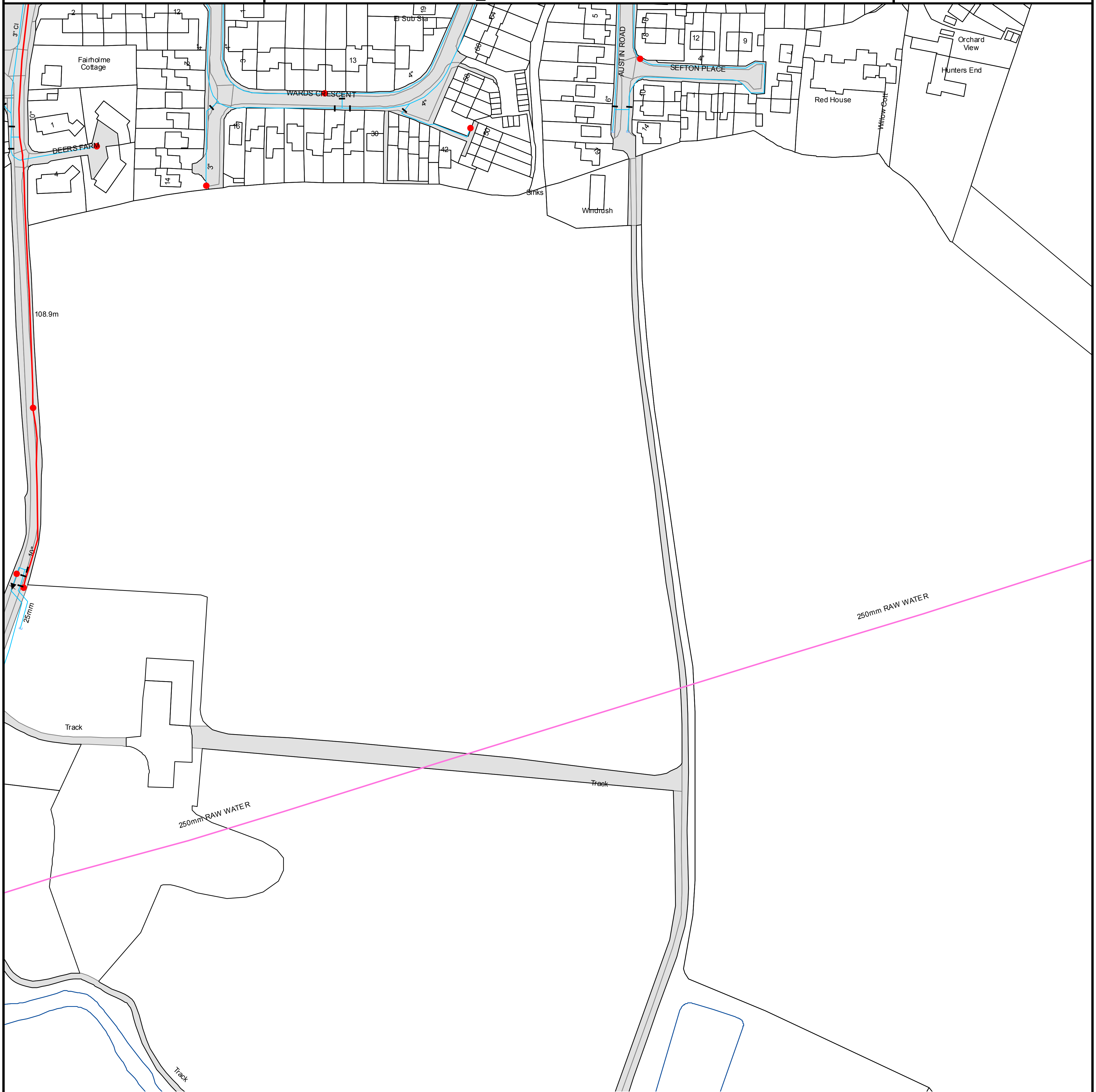
Asset Location Search Sewer Map - ALS/ALS Standard/2013_2459550	SP4637SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446250,237250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Water Map - ALS/ALS Standard/2013_2459550	SP4637SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446250,237250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

APPENDIX 5

Forge Engineering Design Solutions

Trial Pit
Dimensions

Length	1.700	m
Width	0.600	m
Depth	1.000	m
Inlet Depth	0.500	m
Effective Depth	0.500	m

Soil Infiltration Rate = $\frac{Vp_{75-25}}{ap_{50} \times tp_{75-25}}$

Vp_{75-25}	the effective storage volume of water in the trial pit between 75% and 25% effective depth		0.360 m^3		
ap_{50}	the internal surface area of the trial pit up to 50% effective depth and including the base		2.170 m^2		
tp_{75-25}	the time for the water level to fall from 75% and 25% effective depth	876.7 minutes	52600 seconds	(average)
f	Soil Infiltration Rate		3.15E-06 m/s	(average)

TP 1

Time	Water level	Water Depth	
0	0.100	0.900	
30	0.140	0.860	
95	0.220	0.780	
130	0.250	0.750	25%
165	0.290	0.710	
210	0.350	0.650	
250	0.380	0.620	
320	0.450	0.550	
355	0.490	0.510	
380	0.510	0.490	
400	0.530	0.470	
430	0.560	0.440	
460	0.590	0.410	
490	0.620	0.380	
420	0.650	0.350	
550	0.680	0.320	
580	0.710	0.290	
610	0.740	0.260	75%
640	0.770	0.230	
670	0.800	0.200	
700	0.830	0.170	
730	0.860	0.140	
760	0.890	0.110	

tp75-25 490 minutes 29400 seconds
f1 5.64E-06 m/s

TP 2

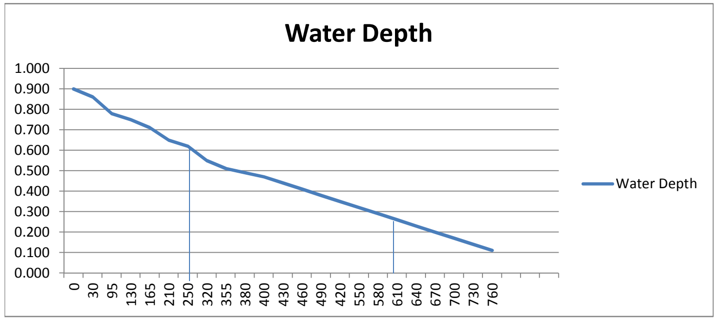
Time	Water level	Water Depth	
0	0.120	0.880	
40	0.150	0.850	
80	0.160	0.840	
120	0.160	0.840	
150	0.170	0.830	
210	0.190	0.810	
260	0.200	0.800	
285	0.205	0.795	
320	0.215	0.785	
350	0.225	0.775	
370	0.230	0.770	
490	0.265	0.735	25%
610	0.300	0.700	
730	0.340	0.660	
850	0.375	0.625	
970	0.410	0.590	
1090	0.445	0.555	
1210	0.480	0.520	
1330	0.520	0.480	
1450	0.555	0.445	
1570	0.590	0.410	
1690	0.625	0.375	
1810	0.660	0.340	
1930	0.700	0.300	
2050	0.735	0.265	
2170	0.770	0.230	75%

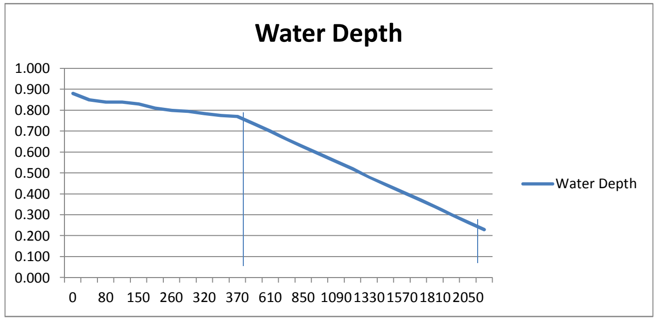
tp75-25 1740 minutes 104400 seconds
f2 1.59E-06 m/s

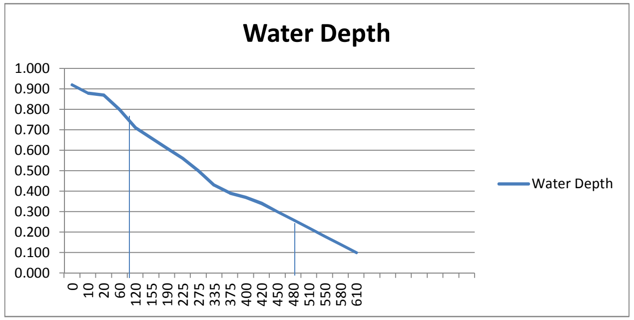
TP 3

Time	Water level	Water Depth	
0	0.080	0.920	
10	0.120	0.880	
20	0.130	0.870	
60	0.200	0.800	
120	0.290	0.710	25%
155	0.340	0.660	
190	0.390	0.610	
225	0.440	0.560	
275	0.500	0.500	
335	0.570	0.430	
375	0.610	0.390	
400	0.630	0.370	
420	0.660	0.340	
450	0.700	0.300	
480	0.740	0.260	75%
510	0.780	0.220	
550	0.820	0.180	
580	0.860	0.140	
610	0.900	0.100	

tp75-25 400 minutes 24000 seconds
f3 6.91E-06 m/s







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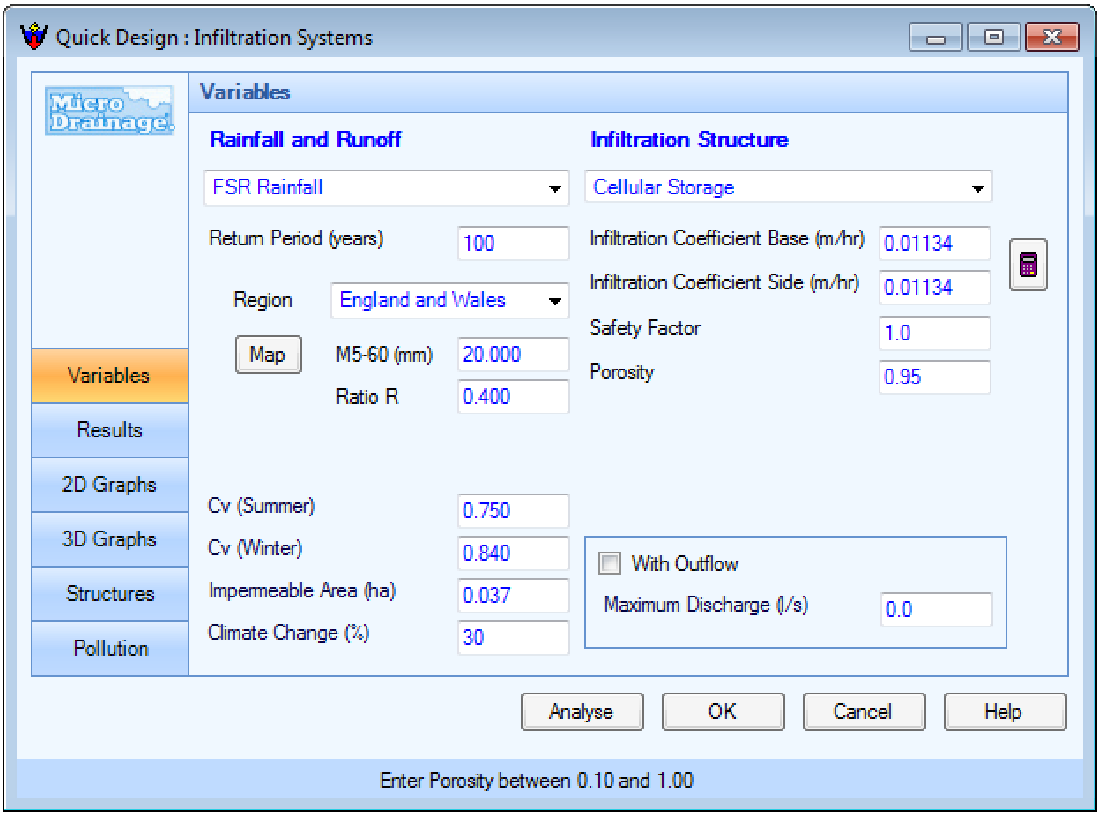
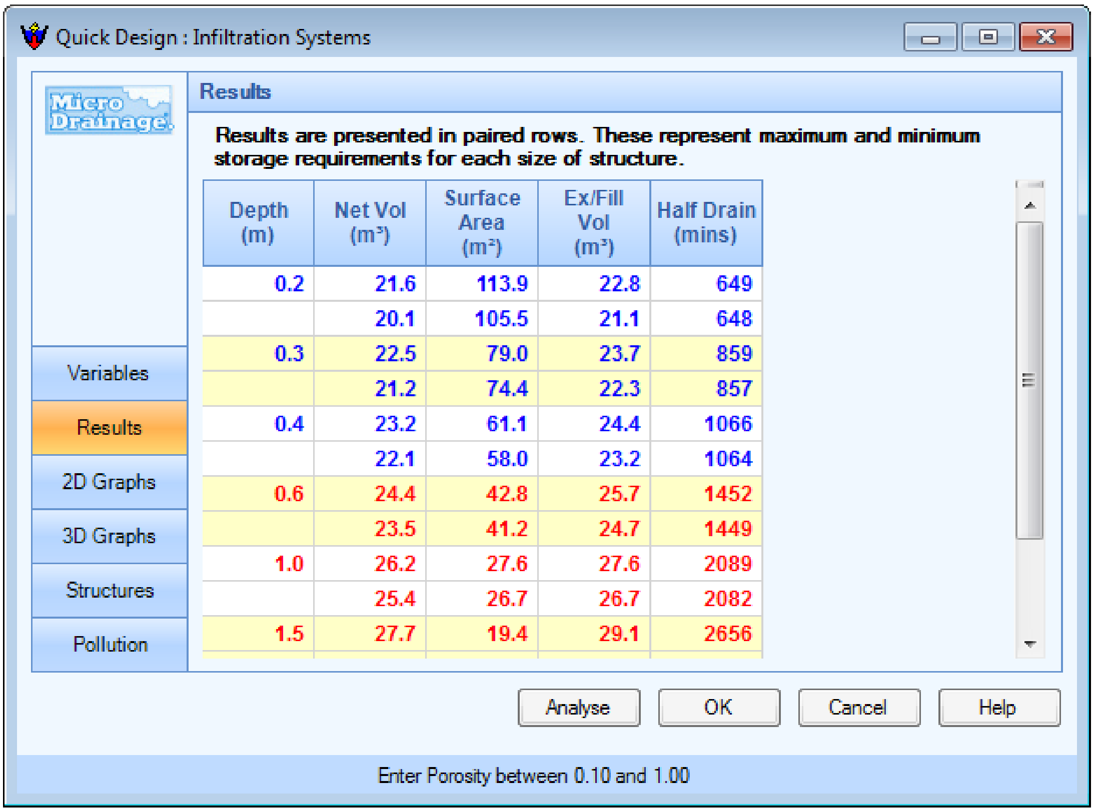
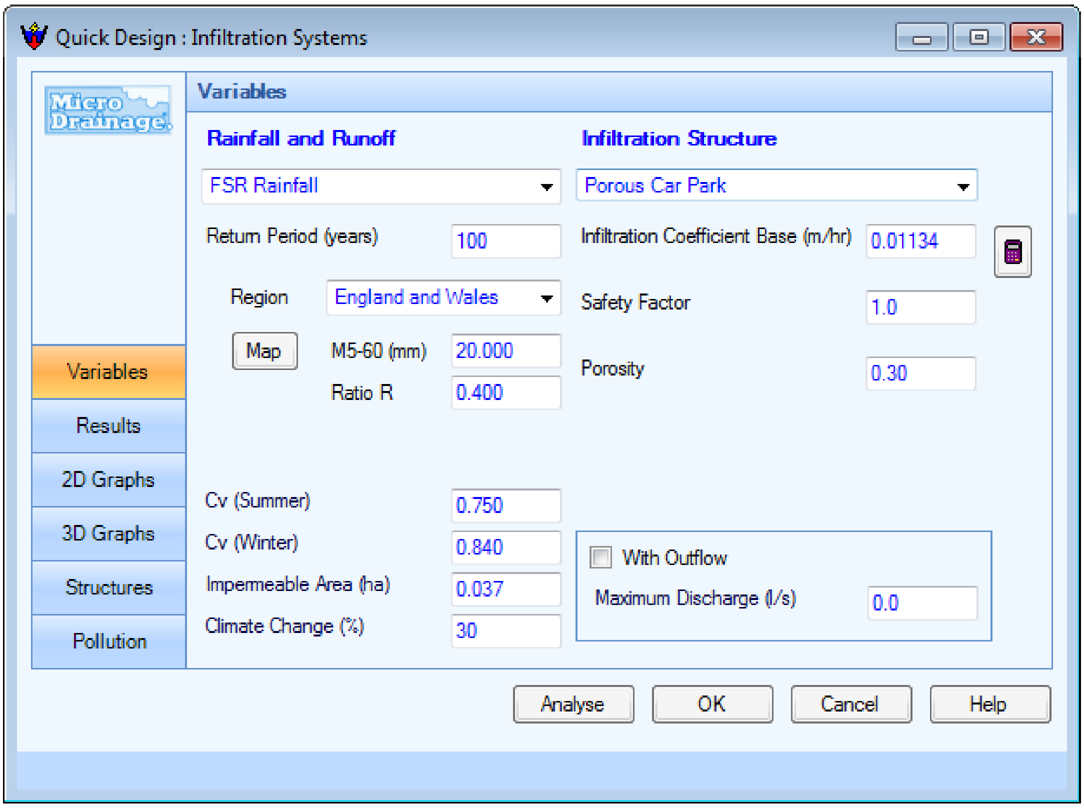
Company Registration No. 871378 9

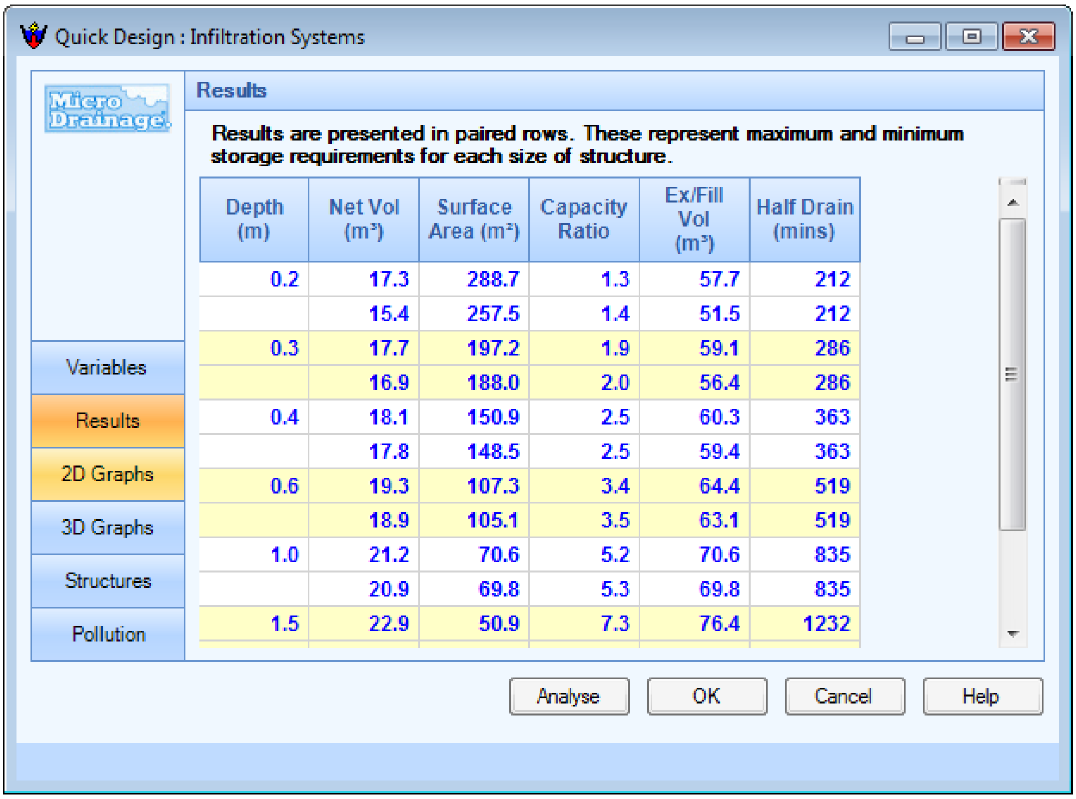
Option 1 – House Soakaway





Option 2 – Porous Paving





Depth (m)	Net Vol (m³)	Surface Area (m²)	Capacity Ratio	Ex/Fill Vol (m³)	Half Drain (mins)
0.2	17.3	288.7	1.3	57.7	212
	15.4	257.5	1.4	51.5	212
0.3	17.7	197.2	1.9	59.1	286
	16.9	188.0	2.0	56.4	286
0.4	18.1	150.9	2.5	60.3	363
	17.8	148.5	2.5	59.4	363
0.6	19.3	107.3	3.4	64.4	519
	18.9	105.1	3.5	63.1	519
1.0	21.2	70.6	5.2	70.6	835
	20.9	69.8	5.3	69.8	835
1.5	22.9	50.9	7.3	76.4	1232