RESEARCH REPORT SERIES no. 51-2013

ENGLISH HERITAGE INLAND ESTATE
FLOOD RISK ASSESSMENT

Trevor Pearson

IMAGING AND
VISUALISATION

ENGLISH HERITAGE

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SUMMARY

The National Heritage Protection Plan (NHPP) Activity 2C1 addresses the threat natural agencies such as flooding and erosion pose to the historic environment, recognising that the risks may be increasing in severity due to climate change. Of particular concern is the potential impact these threats pose to the English Heritage estate at the core of which is the National Collection of 423 historical and archaeological sites, ranging in date from the Neolithic to the Cold War but which also includes important infrastructure such as offices and stores, car parks and access routes (English Heritage 2011a, 5). This project assesses the risk posed to English Heritage's inland estate from flooding and follows on from the internal project completed in 2011 investigating the risk to the coastal estate from erosion and flooding (Project 5982).

Using broadly the same approach as Project 5982, this study has identified 41 sites at high risk of flooding and 20 at medium risk from a total of 362 estates. The results of the assessment are summarised in tabular format followed by detailed assessments of the estates at high and medium risk. The report provides recommendations intended to inform future discussions between English Heritage, the Environment Agency and Local Authorities.

CONTRIBUTORS

The report was written and illustrated by Trevor Pearson. Peter Murphy, Paul Backhouse, Jen Heathcote and Neil Redfern commented on a draft of the text.

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The Project Design was put together in consultation with Dave Went, Marcus Jecock, Pete Herring and Neil Redfern. Duncan Munro, Modelling & Hydrology Officer with the Environment Agency discussed project proposals at an early stage and provided background information. Neil Redfern and Mark Douglas provided photographs of recent flood damage at Fountains Abbey and Prudhoe Castle respectively.

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Front Cover: Image from the project GIS showing flood map of Rievaulx Abbey
(Aerial photography licensed to English Heritage for PGA through Next Perspectives™)

(1) INTRODUCTION

(1.1) Overview

In 2010-11 an internal project under NHPP Activity 2C1 assessed the threat posed by erosion and flooding to 54 EH properties situated within the coastal zone (Project 5982) As defined by Natural England, the coastal zone is land lying within 'areas of marsh or mudflat or elsewhere a 200m band inland of mean high water' (Natural England 2007, 25). Compiled by Abby Hunt of the former EH Landscape Investigation team, this study took data on flood risk and coastal erosion from a variety of sources (primarily the Environment Agency) and assessed the risks posed to these sites using GIS (Geographical Information System) software (English Heritage 2011b, 11; English Heritage 2012a, 7; Hunt 2011). A further 26 sites situated in the coastal zone were not investigated as they are in urban areas and consequently benefit from enhanced protection from coastal erosion and flooding.

The current project complements the study of EH coastal sites by extending the assessment of flood risk to the inland estate, again mainly using data from the Environment Agency. At the same time and under the same NHPP Activity, English Heritage has commissioned research looking at the broader aspects of natural and environmental threats to the heritage through two projects: NHPP 2C1.*101 Assessment of Natural and Environmental Threats* and NHPP 2C1.201 *Characterisation of Heritage Assets Most at Risk from Natural and Environmental Threats*. The two projects are to be combined into one report (Project 6186) to be delivered by the firm W.S. Atkins during 2013.

The present project is intended to give a rapid overview of the exposure of the English Heritage inland estate to flooding. The analysis (Section 4) and detailed assessments (Section 5) are presented by English Heritage region. It is intended that this project will give English Heritage managers and curators the information to prioritise resources and develop response strategies for properties at risk of flooding, thereby complementing and extending the previous study of the coastal estate. As well as use in internal management of the English Heritage estate, it is hoped that the results will also feed into the flood management plans of national agencies and local authorities. The requirement for such an initiative is recognised in the English Heritage 'Strategy for Water and Wetland Heritage' (English Heritage 2012b – section 6.2) which calls for an improved understanding of the risk of flooding to the English Heritage estate as well as to the broader historic environment and to make sure the information is fed into the new generation of flood risk management plans.

(1.2) Climate Change

There is the common perception that in recent years in the UK flooding occurs more frequently and has a wider impact than it did a decade or more ago and that the main

reason is climate change, in particular change brought about by atmospheric pollution. The scientific evidence is still being debated and for the UK has been brought together in an initiative headed by the Met Office called the United Kingdom Climate Projections. Their report on 'Observed trends' published in 2008 and revised in 2009 indicates that

'*Annual mean precipitation over England and Wales has not changed significantly since records began in 1766. Seasonal rainfall is highly variable, but appears to have decreased in summer and increased in winter, although with little change in the latter over the last 50 years. All regions of the UK have experienced an increase in the contribution to winter rainfall from heavy precipitation events*' (Jenkins et al. 2009, 12).

Although the amount of rain has remained fairly constant, the study detected an increasing tendency toward the occurrence of heavy rainfall events (Jenkins et al. 2009, 15). Such a trend suggests we may be facing an increased risk of flash floods when local drainage systems fail to cope with a sudden rise in the quantity of rain water draining off the ground. However, the study emphasised that it is difficult to predict the effect global changes in weather patterns are going to have in the long term on a comparatively small area such as the UK.

English Heritage acknowledged the likely impact of climate change on the historic environment when it commissioned The Centre for Sustainable Heritage at University College London in 2002 to undertake a scoping study (Cassar 2005). Through a series of workshops and questionnaires, this study found that of the various likely manifestations of climate change and concerns about the risk of fluvial and coastal flooding ranked highly among those consulted. The need for direct repairs to buildings and the upgrading of drainage systems were identified as two of the consequences of facing up to a flood risk. The threat posed to both buildings and buried archaeology during the drying-out period after a flood was also highlighted along with the need to reassess and upgrade disaster recovery plans to take account of flood risk.

In 2004 English Heritage addressed the risk to historic properties posed by flooding in a guidance paper 'Flooding and Historic Buildings' which it revised in a second edition in 2010 (English Heritage 2010). This publication sets out in simple terms the main causes of flooding and offers guidance on how to prepare for a flood, how to cope during a flood event and how to deal with the aftermath from the perspective of owners of historic properties. Many of the recommendations are of direct relevance to the management of flood risk within the EH estate.

(1.3) The English Heritage Estate

The English Heritage Estate consists of 423 historic properties, ranging in date from the Neolithic to the Cold War collectively known as the 'Historic Collection' along with a range of associated infrastructure such as offices, stores, car parks, cafes and access routes. Data on the estate used in this study derives from the Corporate GIS dataset 'EH-Estate'

which holds details of over 900 individual parcels of land varying in legal status from land wholly owned by English Heritage to properties which are leased or access routes over which English Heritage has the right of passage. The varying legal status of the parcel or parcels of land making up each of the estates was not considered in this study.

As was mentioned above, excluded from the study are the 80 or so estates in the coastal zone assessed in the 2011 study including 26 coastal sites in urban areas not considered in that study. This leaves a total of 362 sites in the present study distributed as follows across the nine EH regions. This figure excludes 43 statues in the London Region which can be considered adequately protected because of their urban location.

1	East Midlands	24
2	East of England	44
3	London	12
4	North-east	37
5	North-west	38
6	South-east	49
7	South-west	91
8	West Midlands	33
9	Yorkshire	34

That flooding poses very real threats to the English Heritage estate has been demonstrated on several occasions in recent years as for example with the major inundation at Rievaulx Abbey in the summer of 2005. Indeed it could be argued that the sites in the National Collection are particularly exposed to flooding because of the historic relationship that the majority of these sites had with running water. Rivers and streams were not only used for drinking water but for defence, for communication, to provide power and to enhance landscape setting through both natural and engineered lakes and ponds. Consequently for historic reasons, many of the sites in the National Collection are close to water and as a result it could be argued that the estate is more exposed to flood risk than the built environment as a whole. There is no central record of the scale and extent of past flood events that impacted upon the English Heritage estate although there is plenty of anecdotal evidence and reports will exist in local newspapers.

(1.4) Managing Flood Risk

Government policy in relation to flood risk management has undergone a profound shift in the last decade or so, from one of defence to one of management and adaptation. This approach was articulated in the Government discussion paper, 'Making Space for Water' (Defra 2005), after which the policy for integrated Flood and Coastal Erosion Risk Management (FCERM) was developed. Milestones along the way include the Pitt Review (Cabinet Office 2008) looking at the lessons to be drawn from floods in 2007 and

'Understanding the risks, empowering communities, building resilience: the national flood and coastal erosion risk management strategy for England' (Defra/Environment Agency 2011). The National Trust followed the Pitt Review by undertaking its own study on water management issues confronting its estate including the risk posed by flooding (National Trust 2008, 12-15). This study found that around 120 National Trust properties are at risk of flooding and one of the main recommendations was to increase the capacity of open areas in the uplands to retain water at times of heavy rainfall as a means of protecting land downstream.

Government strategy to deal with flood risk is influenced by European legislation aimed at providing a consistent approach to the management of flood risk across Europe. European Union Directive 2007/60/EC on the assessment and management of flood risks (commonly known as The Floods Directive) came into force on 26 November 2007 (European Union 2007) and requires Member States

'to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk'.

The Directive goes on to state that

'*Its aim is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The Directive requires Member States to first carry out a preliminary assessment by 2011 to identify the river basins and associated coastal areas at risk of flooding. For such zones they would then need to draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015. The Directive applies to inland waters as well as all coastal waters across the whole territory of the EU*'.

The Directive passed into UK legislation on 10 December 2009 as 'The Flood Risk Regulations'. This legislation along with the Flood and Water Management Act of 2010 together provide clarity on the management of flood risk at the local level. The legislation made it clear that Lead Local Flood Authorities (LLFAs) manage the flood risk posed by surface runoff, groundwater and ordinary watercourses. The Environment Agency offer technical support to the LLFAs as well as managing the flood risk posed by major watercourses.

The approach adopted in the Regulations is based on a 6 year cycle of planning that includes the publication of Preliminary Flood Risk Assessments (PFRAs) by 22 December 2011; Hazard and risk maps by 22 December 2013; and Flood Risk Management Plans by 22 December 2015. The Environment Agency has a duty under the Flood Risk Regulations to review, collate and publish the reports, maps and plans produced by the LLFAs. It has published the PFRAs completed in 2011 on its website. The PFRAs and this project have comparable aims and approaches as they are both intended to give a high-

level overview of flood risk across an area from local flood sources using EA and local authority datasets.

(1.5) Project Scope

The project is a desk-based assessment of the exposure of the English Heritage inland estate to flooding with the secondary aim of highlighting those sites which appear to be most at risk. The assessment is based upon the interrogation of English Heritage and Environment Agency digital datasets within a project GIS using both map-based and database analytical functions. It is hoped that defining the threat flooding poses to the inland estate it will enable measures to be put in place to help protect those sites considered to be at most risk by working in partnership with local authorities and national agencies such as the Environment Agency.

It is outside the scope of the project to undertake research into past flood events beyond the information supplied as part of the GIS data by the Environment Agency. However, it is acknowledged that collecting more data on historic floods from sources such as newspaper accounts and local authority records would help to more closely define the nature of the risk and the level of threat at selected sites.

The study first describes the different causes of flooding and their possible impact on the English Heritage estate and is followed by a summary of the methods and sources used in the assessment. The risk and possible impact is set out in a gazetteer for each region followed by a more detailed description of the threat to individual sites deemed to be at high or moderate risk. As well as this report, the output of this study is the project Geographical Information System (GIS). This will be available for interrogation and consultation by internal stakeholders wishing to view the various datasets, and will be a useful tool for those preparing management plans for sites in the care of English Heritage. The structure of the GIS can also potentially be transferred to future projects looking at similar themes.

This report and its recommendations do not commit English Heritage to any course of action, but it envisaged that the results will be considered and discussed when formulating future management plans for the relevant properties and possibly to further projects within the National Heritage Protection Plan. It is hoped that some measures can be implemented as appropriate, if funding permits, in the medium to long term.

(2) FLOODING AND ITS IMPACT ON HERITAGE

(2.1) Types of Flooding and Causes

The likelihood of a flood occurring at any one location is due to the complex interplay of factors such as climate, geology, topography, soils and land-use and as a result the frequency and impact of flooding is still very difficult to predict with any degree of certainty. The main causes of flooding are listed below of which the first three are considered in this study.

(1) River (fluvial) flooding

This occurs when a watercourse cannot cope with the water draining into it from the surrounding land which can over top the banks and inundate extensive tracts of surrounding land called the floodplain. A river or stream in flood may also erode its banks more rapidly with the increase in the volume of water. The Environment Agency is charged with monitoring the water level of main rivers and streams and with issuing warnings when there is threat of flooding from this source. Most dangerous are flash floods which often result in a sudden build-up of water (one definition indicates less than six hours) and therefore pose the most risk to life as well as to property. A sudden flash flood inundated Rievaulx Abbey in the summer of 2005. Rivers are also prone to tidal flooding as they reach the sea when storm surges can push massive volumes of water miles inland back along the watercourse causing the river to overtop its bank.

(2) Surface water (pluvial) flooding

This occurs when heavy rainfall overwhelms the drainage capacity of the local area and water then flows over the surface. More specifically it is defined as rainfall-generated overland flow which has yet to enter a watercourse or sewer and is much more difficult to predict and pinpoint than river flooding. It occurs either where the infiltration capacity of the subsoil is exceeded by the amount of rainfall or where the ground is already saturated to the surface. The threat of surface water flooding is increased where the infiltration capacity of the ground has been reduced such as in hard surface areas (car parks, pavements etc.) found in towns and cities or where the land has been baked hard by the sun or frozen during cold weather. Poorly maintained drains can also increase the risk of flooding from surface water.

(3) Groundwater flooding

This occurs when extreme rainfall causes the water table to rise to the surface and areas are especially prone where the aquifer is shallow and underlain by impermeable rocks. It has also been shown that some urban centres are particularly prone to groundwater flooding where the amount of water being taken from the aquifer has declined in recent years following the loss of industry. This can mean there is over-capacity in the aquifer leading to groundwater breaking above ground, with cellars and basements most at risk.

(4) Sewer flooding

This occurs when sewers are overwhelmed by heavy rainfall or when they become blocked. The likelihood of flooding depends on the capacity of the local sewerage system. Land and property can be flooded with water contaminated with raw sewage and rivers can also become polluted by sewer overflows. As the likelihood of this type of flood occurring is down to local conditions such as how well the network is maintained, there is no realistic way to model the risk or anticipate the threat in a study such as this.

(5) Reservoir flooding

Some reservoirs hold large volumes of water above ground level, contained by walls, or dams. Although the safety record for reservoirs is excellent, it is still possible that a dam can fail resulting in a large volume of water being released very quickly. This is such an unlikely occurrence it is not considered in this study.

(2.2) Impact of floods on buildings and landscape

(1) Fluvial flooding

During a fluvial flood, the initial risk is from the physical force with which the flood water enters a particular area. The first manifestation might be increased erosion to the sides of a stream or river as the level of flow increases in response to a heavy rainfall event occurring within the catchment. As some catchments are very large it could take several days for the increased volume to move down the catchment. The erosion is caused not only by the force and speed of the water but by the abrasive effect of the sediment caught up in the flow. During a major flood event, this could include solid objects such as boulders and trees which are capable of causing great damage to the sides of a watercourse. Bridges crossing the river or stream are particularly vulnerable at this point due to the increased force of the water acting on piers and abutments and from the build-up of boulders, trees etc. against the structure brought downstream by the flood water. The destruction of several bridges of over the River Derwent at Workington in the floods of 2010 is an example of how vulnerable such structures can be.

Once a river or stream overtops its banks and starts to fill the floodplain then studies have shown that the force of the flow tends to dissipate reducing the risk of erosion of the bank sides. Also, the initial flow of water into the floodplain tends to move fairly gently with little destructive force however the risk of damage is exacerbated in a flash flood when a sudden surge of water over the floodplain could demolish structures and scour the land surface.

Water levels can continue to rise within the floodplain for hours or days after the initial flood event thus widening the area of the flood. Such rises tend to be gradual and therefore cause little direct physical damage as the boundary of the flooded zone extends across the landscape. Worse though is the impact of the flood on buildings and other structures as prolonged exposure will lead to water penetration of foundations and walls causing potential instability and long-term problems with damp. It will also damage

infrastructure such as wiring and plumbing, damage or destroy moveable objects and could spread water contaminated with sewage.

As flood waters recede they can leave behind extensive deposits of silt mixed with flood debris burying the land surface as well as the interiors of buildings. This flood debris can include sewage, farmyard effluent and agri-chemicals posing severe risks to health and creating difficult challenges to remove. Physical damage can occur to the ground surface through the creation of channels as water flows away leading to a short-lived but potentially quite extensive problem with surface erosion and possible landslips in steeply sloping areas.

(2.) Surface water flooding

Surface water flooding has many of the same consequences as fluvial flooding though the area affected is likely to be less extensive. As this type of flood is caused by the rapid accumulation of surface water, features such as erosion gullies and landslips may form unexpectedly during such an event potentially causing severe, if localised, damage to the landscape, especially on hill slopes. Erosion gullies begin as micro channels called rills up to 0.3m across and up to 0.3m in depth which can then develop into larger and more destructive gullies as the flood event continues, becoming semi-permanent features of the landscape. Minor gullies like this developed during the 2007 floods at Fountains Abbey. As surface water floods can occur with little warning, moveable items are potentially at greater risk than in a fluvial flood which usually develops over a longer period of time.

(3) Groundwater flooding

The emergence of groundwater on the surface would seem to pose broadly the same kind of threat as surface water flooding though there is a tendency for groundwater floods to last longer and they can appear in areas otherwise protected with defences from fluvial flooding. There is also the increased risk of flooding from groundwater where voids, such as basements, penetrate deeply into the water table. Groundwater and fluvial flooding often occur together as water forced above ground by an overloaded aquifer can put an additional strain on the river catchment during periods of heavy rain. The monitoring of borehole levels can be used to predict the likelihood of a groundwater flood occurring and the Environment Agency and their partners are developing a system to monitor the aquifer in chalk areas deemed to be most at risk from this category of flooding.

(2.3) Consequences for the English Heritage estate

(1) Loss of life

The greatest concern during any flood event is to the safety of individuals and the preservation of life. This means that flood warnings must be heeded and acted upon and therefore it is important that English Heritage estate managers have access to the flood warning services provided by the Environment Agency to information regarding the Agency's Flood Warning Areas (seen Section 3 below). The greatest threat to life comes from a flash flood as this can be difficult to predict but the impact could be sudden.

(2) Buildings and structures

The impact of flooding on historic buildings and structures is covered in the guidance paper issued by English Heritage 'Flooding and Historic Buildings' (English Heritage 2010). This document sets out the measures to be taken before, during and after a flood and though aimed widely at the owners of historic properties its recommendations are relevant to the English Heritage estate and are not repeated in detail here. The depth of the flood water is a critical factor in determining the damage to the property. Water that rises above floor level is the most damaging as it comes into contact with fittings and electrical wiring and can affect structural stability 'though it is rare for the structural integrity of a historic building to be compromised' (English Heritage 2010, 20). It can also cause damage to portable assets which in the case of English Heritage could include objects in on-site displays and stocks of food and gifts in its shops.

The 2010 document makes a distinction between the primary damage which occurs when water enters a property and secondary damage as the effects extend to parts of the building beyond the initial flood. Where flooding is due to seepage of groundwater then the effects can be long–lasting and difficult to resolve. For example a mosaic floor at Fishbourne Roman Palace is affected by bacterial and algal build-up because of flooding partially due to rising groundwater over the long-term (P. Murphy pers. comm).

(3) Open ground

Flooding could cause widespread damage to landscape features such as paths, lawns, planted borders which could prove costly to restore. Trees could be uprooted making full restoration of the landscape impossible in the short-term. It may also be necessary to re-establish property rights over the land after a flood since boundary features such as fences or walls can be uprooted and their precise alignments lost.

(4) Archaeology

Archaeological remains could be threatened with damage or destruction during a flood event, primarily form the increasing amount of erosion experienced along the banks of a stream or river channel. There is a wider risk if flood water enters an area with considerable erosive force or if it creates erosion features such as rills and gullies as it starts to drain away. Damage could occur both to both below ground remains and to earthwork features. Erosion gullies developed during the 2007 floods at Fountains Abbey some distance from the River Skell.

(5) Pollution

Flooding can cause the sewage system to fail bringing contaminated water to the surface and spreading it across the area affected by the flood. This poses a severe risk to health both during the flood and in its immediate aftermath as contaminated material is deposited on the land as flood water recedes. In rural areas there is the risk also of contamination from farmyard effluence and from the spreading of agri-chemicals by flood waters.

Erosion gullies at Fountains Abbey after the 2007 flood (Neil Redfern)

(6) Visitor experience

Depending on its severity a flood event could have a significant impact on the visitor experience. In the worst scenario the entire site may need to be closed for some months to allow the water levels to recede and for repairs to be undertaken.

(7) Access

Flooding can severe the access to a site and though the site itself may be under no direct threat it may be impossible to reach compromising both the day to day management of the site and the visitor experience.

(3) DATA SOURCES

In line with the earlier assessment of EH coastal properties, the methodology adopted involved the creation of a project GIS within which to undertake the analysis of flood risk using primarily digital data from English Heritage, the Ordnance Survey and the Environment Agency. The software used was ESRI ArcView v10.0

(3.1) English Heritage

English Heritage Estates boundary data has been captured by the GIS & Mapping Team at the NMR. Three classifications of EH Estates boundaries have been captured: a) Land - This is the land that is in the ownership or guardianship of English Heritage. b) Access - This is land that may or may not be in the ownership or guardianship of English Heritage but over which EH has rights and/or agreements for maintenance or access purposes. c) Occupation - Sites which are in the occupation of English Heritage. These are various office buildings, stores and warehouses.

The first task was to remove from the study those sites which formed part of the 2011 coastal assessment. That study investigated 80 sites from the English Heritage estate lying within the coastal zone and did a detailed study of 54 of these. The remaining 26 sites were left out of the 2011 study as they are well-protected by substantial defence schemes in urban areas backed by strong policies of protection.

(3.2) Ordnance Survey

For the detailed assessment of individual sites tiles of 1:10 000 digital maps from the Ordnance Survey were used as background supplemented on occasions by more detailed larger-scale mapping from MasterMap. The files are made available through the EH Corporate GIS on licence from the Ordnance Survey

(3.3) Environment Agency

Most of the data used to assess flood risk in this study has come from the Environment Agency under licence to the English Heritage Corporate GIS team. The Environment Agency has a wide range of data sets available related to flooding in England and Wales, of which the Floodzone data is viewable on their website as a public resource.

The main Environment Agency datasets used in the present study relate to the categories of flooding described above (1) river and stream (fluvial) flooding (2) surface (pluvial) flooding and (3) groundwater flooding along with ancillary data sets concerning flood mitigation, river and stream networks and historic flood extents. The following definitions are based on the Environment Agency's metadata accompanying each category of digital data.

(1) Fluvial Flooding

The risk of fluvial flooding is defined by the Environment Agency in three zones which relate to levels of risk with Flood Zone 3 being the highest. It assumes no flood protection since any barriers could be overtopped or fail in a severe flood event.

Flood Zone 3 defines the areas of land with a 100 to 1 (or greater) chance of flooding each year from rivers, or with a 200 to 1 chance (or greater) of flooding each year from the sea.

Flood Zone 2 defines the areas of land between Zone 3 and the extent of the flood from rivers with between a 1 in 100 and 1 in 1,000 chance of flooding in any year or between 1 in 200 and 1 in 1,000 risk of flooding from the sea. It includes those areas defined in Flood Zone 3. It replicates the extent of the floodplain.

Flood Zone 1 defines the areas with less than 1 in 1000 risk of flooding each year and therefore is the land at least risk.

Flood Zones 2 and 3 are categorised by the Environment Agency as fluvial, fluvial/tidal and tidal.

(2) Surface Water Flooding

The Environment Agency's surface water flood maps give an indication of the broad areas likely to be at risk of surface water flooding generated by rainwater and melting snow which is on the surface of the ground and has not yet entered a watercourse, drainage system or public sewer, i.e. areas where surface water would be expected to flow or pond. The resulting predictions are strongly influenced by topography picking out natural drainage channels, rivers, low areas in floodplains, and flow paths between buildings. The Environment Agency stress that the map gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for use at an individual property scale due to the methods used to derive the data.

The GIS data supplied by the EA models two rainfall events, one with a 1 in 30 and the other with a 1 in 200 chance of occurring in any year and the resulting map only provides a general indication of areas which may be more likely to suffer from surface water flooding in these rainfall probabilities.

For each rainfall probability, the map provides two layers of information which can be used individually to indicate:

- Surface Water Flooding (flooding greater than 0.1m deep);
- Deeper Surface Water Flooding' (flooding greater than 0.3m deep).

The 0.3m threshold is chosen as it represents a typical value for the onset of significant property damage when property flooding may start (above doorstep level) and because it

is at around this depth that moving through floodwater (driving or walking) may become more difficult; both of which may lead to road closures and evacuation.

(3) Groundwater Flooding

The area susceptible to groundwater flooding is a strategic scale map showing groundwater flood areas on a 1km square grid. Using data supplied by the British Geological Survey the map shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge. The susceptible areas are represented by one of four area categories (1.< 25%; 2.>= 25% <50% 3.>= 50% <75% 4.>= 75%) showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwater flooding occurring. In common with the majority of datasets showing areas which may experience groundwater emergence, this dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding. The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding.

(4) Rapid Response Catchments

The Environment Agency publishes a register of communities in Rapid Response Catchments based on extensive computer modelling of drainage networks, surface topography and rainfall events. Consequently, the data does not relate directly to the English Heritage estate and therefore was not used in this assessment. However identifying which estates are located in Rapid Response Catchments is an important objective for the future (see 6.4 below) as these areas can be prone to the most sudden and destructive types of flood, as seen for example at Boscastle in 2004, Cockermouth in 2009 and along the River Rye (including Rievaulx Abbey) in 2005.

(5) Historic Flood Outlines

Historic Flood Outlines contains the individual location, outline and approved attributes for records of historic flooding extracted from the National Flood and Coastal Defence Database (NFCDD). These records show flooding to the land and do not necessarily indicate that properties were flooded internally. It is also possible that the pattern of flooding in an area has changed or that an area would now flood under different circumstances. In addition, absence of a historic flood event for an area does not mean that the area has never flooded, only that the Environment Agency does not have any records.

(6) Detailed River Network

The Detailed River Network is captured from the water features theme of the Ordnance Survey MasterMap topography layer and built into a network using automated rules. Other input datasets and extensive local Environment Agency staff knowledge has been used to augment the core geometry to incorporate critical spatial detail and attribution, such as flow direction and path, not available from the Ordnance Survey mapping and to

verify the accuracy of the centreline itself. For the purposes of the present study this data set was used to identify minor watercourses.

(7) Major River Network

Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency, the Department of Environment, Food and Rural Affairs (in England) and the Welsh Assembly Government (in Wales). They can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. For the purposes of the present study this data set is interpreted as defining major watercourses.

(8) Flood Warning Areas

A Flood Warning Area is defined by the Environment Agency as a portion of the floodplain containing a community at risk of flooding, which is provided with an appropriate flood warning service. The primary concept of a Flood Warning Area is to form a recognised and named geographical community which can be an urban area, a significant suburb of a large city or a village or a hamlet. The purpose of Flood Warnings is to alert people of the danger to life and property.

(9) Flood defences

The Environment Agency provide mapping showing areas benefiting from the presence of defences in a 1 in 100 flood event and also those defences constructed during the recent past with a standard of protection equal to or better than 1 in 100.

(3.4) Topographic ground model

The broad topographic setting of sites was assessed against a Digital Ground Model derived from the Shuttle Radar Topography Mission and which is made freely available for research purposes by NASA/NGA/DLR/ASI as the originating agencies. The data was acquired from the CGIAR Consortium for Spatial Information (See Appendix 1). The cell size is close to 90m and covers the whole of the UK.

(3.5) Google Maps and Google Earth

The vertical aerial imagery from these two sources was consulted in order to answer specific questions about the nature of land-use and disposition of buildings not available from Ordnance Survey mapping.

(4) ANALYSIS OF FLOOD RISK ON THE EH ESTATE

(4.1) Assessing Risk

The initial step in assessing risk was to compare the polygons defining the English Heritage estate with the following Environment Agency data sets described above in the GIS to identify intersections:-

(1) Historic Flood outlines
(2) Flood Zone 2
(3) Flood Zone 3
(4) 1 in 30 Surface Water Flood
(5) intersected by a minor watercourse
(6) intersected by a major watercourse
(7) 75% groundwater flood
(8) 50% groundwater flood
(9) 25% groundwater flood

The '1 in 200 risk of surface water flooding' Environment Agency dataset was discounted from this stage of the assessment as indicating a much lower level of threat compared to the other datasets. Intersection with the Environment Agency Flood Zone 2 dataset is not considered apart from instances where an estate is in Flood Zone 2 but not in Flood Zone 3.

Where an English Heritage estate polygon intersected with one or more of the categories of flood risk area or with any element of the watercourse network then the data was assessed visually in the GIS. More weight was given to datasets (1), (3), and (4) as they indicate a higher level of flood risk compared to the Flood Zone 2 dataset (3). Consequently an estate within Flood Zone 2 was assessed at lower risk. Categories (5) and (6) give some indication of the exposure of the estate to erosion from watercourses that border or cross the estate which will be of heightened concern during a serious flood event. The groundwater flood risk datasets (7), (8) and (9) are not as precise as the other data sets as the risk is modelled on a coarse scale by kilometre square and therefore no weight was attached to these data sets in the analysis of risk although the data is listed in the summary tables for each region.

(4.2) Assessing Impact

The possible impact of flooding on each estate was assessed using OS mapping and Google earth imagery and checked against the following criteria:-

Access – the mapping indicates flooding across the access route or routes to the site which may become impassable

Modern Infrastructure – the mapping indicates where infrastructure such as occupied buildings, shops, stores and car parks are at risk from flooding. This also includes buildings forming part of the heritage asset such as windmills and watermills. Risk exists to all fixtures and fitting contained within the buildings.

Exposed footings – the mapping indicates that flooding may form in and around the exposed foundations of former structures. Fabric could be damaged by water penetration and from the force of the flood water.

Standing masonry – the mapping indicates flooding in and around the ruined remains of buildings standing above foundation level or other unroofed masonry structures. Fabric could be damaged by water penetration and from the force of the flood water.

Land surface – the mapping indicates flood water accumulating across open ground. These areas may become impassable until the water has drained away and there may be some impact on archaeological remains and earthworks from the passage of the flood water.

(4.3) Overall Assessment

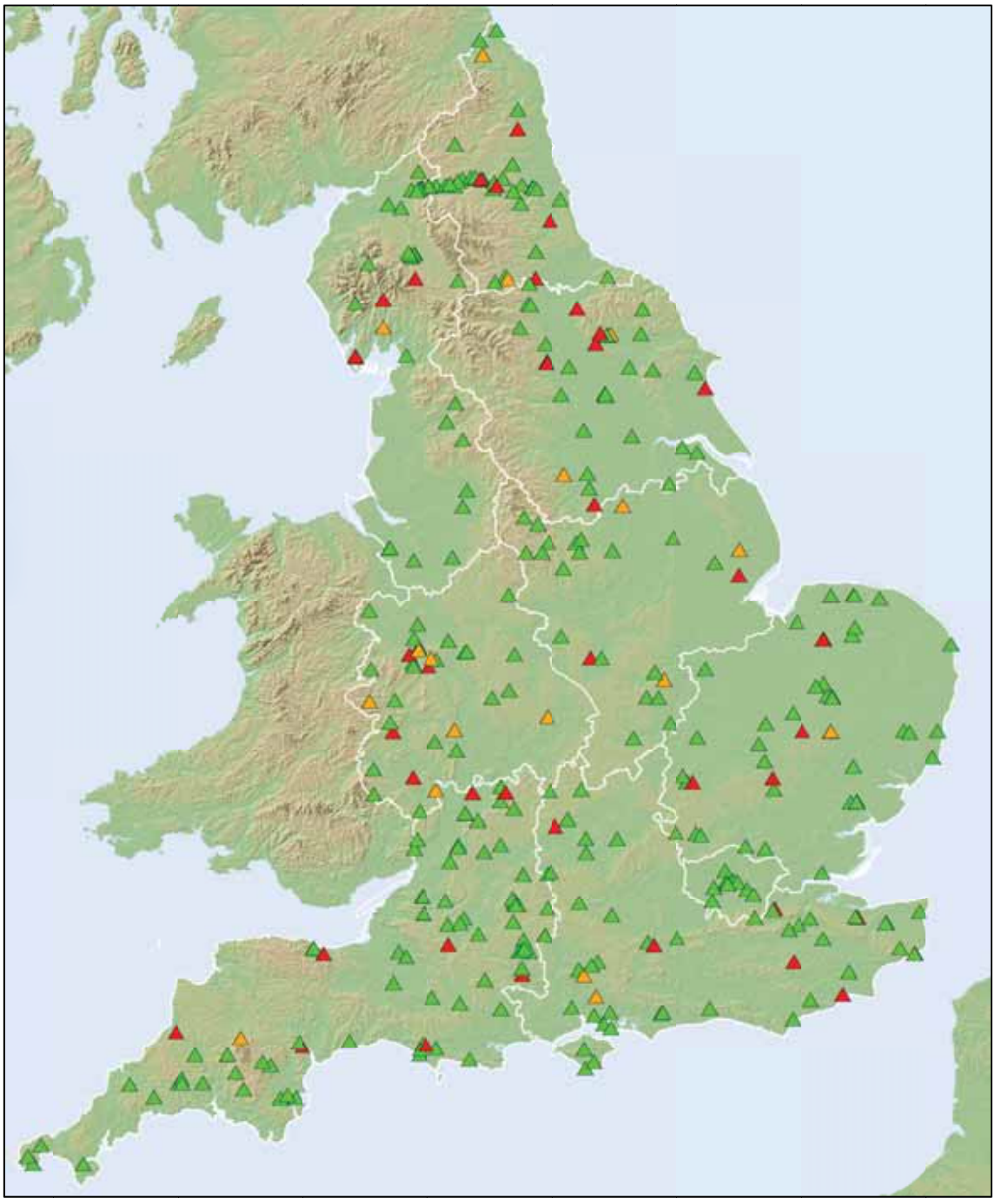
The overall assessment of flood risk for each estate was assessed by considering the range of risks indicated by the GIS analysis and their possible impacts. For each estate the overall risk is categorised as one of three levels:-

Low risk where there is no correspondence between the English Heritage estate data and any of the categories of flood risk data or with any element of the river network or where visual assessment indicates only minor risk or impact. It should be recognised, though, that this does not mean there is no risk of flooding as extraordinary local circumstances could create a flood at any location.

Medium risk where the visual assessment indicated there is threat from a single source or is limited in extent..

High risk where the visual assessment indicated the threat is from multiple causes and/or will impact upon a substantial part of the estate or certain key areas and buildings.

The results of the analysis for each region are summarised in a table. This records the intersections derived from the GIS analysis and presents the assessed level of risk (low risk = green; moderate risk = amber and high risk = red). The summary table gives a brief overview of the nature of the perceived threat to each estate. For the estates at moderate risk and high risk more detailed assessments follow on from the summary tables in Section 5. These detailed risk assessments include a map showing the extent and nature of the flood risk with a text entry summarising the nature and extent of each of the risk at that particular site.



Map of English Heritage Regions showing the distribution of estates at High Risk (red triangle); Medium Risk (orange triangle) and Low Risk (green triangle). Background mapping SRTM data courtesy of the CGIAR Consortium for Spatial Information.

Table 1. East Midlands Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
44 Derngate												Low	No tangible threat
Arbor Low Stone Circle			✔				✔					Low	Threat restricted to start of path from farm on north-west
Ashby de la Zouch Castle												Low	No tangible threat
Bolingbroke Castle			✔			25%	✔				✔	Medium	Threat mainly to east and south-east side of the estate
Bolsover Castle			✔								✔	Low	Threat to a single small area within the estate
Chichele College												Low	No tangible threat
Eleanor Cross, Geddington	1998		✔				✔	✔			✔	Low	Actual cross elevated above flood level on stepped plinth
Eyam Moor												Low	No tangible threat
Hardwick Old Hall						25%						Low	No tangible threat
Hob Hursts House												Low	No tangible threat
Jewry Wall						50%						Low	No tangible threat
Kirby Hall		3	✔		✔		✔		✔	✔	✔	Medium	Main threat to south and east margins of the estate
Kirby Muxloe Castle		3	✔				✔		✔	✔	✔	High	Almost the entire estate is under threat
Lincoln Medieval Bishops Palace												Low	No tangible threat
Lyddington Bede House												Low	No tangible threat
Mattersey Priory	1947 & 1977	3		✔			✔					Medium	Threat to access route and to east boundary of the estate
Nine Ladies Stone Circle												Low	No tangible threat
Peveril Castle						25%						Low	No tangible threat
Rufford Abbey												Low	No tangible threat
Rushton Triangular Lodge												Low	No tangible threat
Sibsey Trader Mill		3				50%	✔	✔			✔	High	A large part of the estate is under threat including the windmill
Sutton Scarsdale												Low	No tangible threat
Tattershall College						75%						Low	No tangible threat
Wingfield Manor												Low	No tangible threat

Table 2. East of England Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
24 Brooklands Avenue						25%						Low	No tangible threat
Audley End House	2001	3	✔	✔	✔	25%	✔			✔	✔	High	Extensive threat to the estate affecting a wide zone alongside the River Cam
Baconsthorpe Castle			✔				✔				✔	Low	Threat confined to margins of existing watercourses and moat
Beeston Store												Low	No tangible threat
Berkhamsted Castle			✔			50%					✔	Low	Threat restricted to castle ditches and isolated areas of the estate
Binham Priory			✔						✔	✔	✔	Low	Threat restricted to area of cloister
Binham Wayside Cross												Low	No tangible threat
Bury St Edmunds Abbey	1968	3	✔		✔	50%	✔		✔	✔	✔	Medium	Threat principally to Abbot's Bridge
Bury St Edmunds Tower						50%						Low	No tangible threat
Bushmead Priory												Low	No tangible threat
Caister Roman Site			✔						✔		✔	Low	Threat restricted to single area on south of the estate
Castle Acre Bailey Gate			✔							✔		Low	Threat restricted to small area on the exterior of the gate
Castle Acre Castle						50%						Low	No tangible threat
Castle Acre Priory		3	✔			25%			✔	✔	✔	High	Extensive threat along the south boundary of the estate
Castle Rising Castle			✔								✔	Low	Threat restricted to an isolated area of the castle interior adjacent to the east defences
Creake Abbey		3	✔	✔	✔	50%	✔					Low	Threat restricted to access route from the west
De Grey Mausoleum						75%						Low	No tangible threat
Denny Abbey						25%						Low	No tangible threat
Duxford Chapel						50%						Low	No tangible threat
Framlingham Castle		3	✔				✔				✔	Low	Threat restricted to path and strip of land on west margin of the estate
Grimes Graves			✔				✔				✔	Low	Threat confined to narrow strip in a valley bottom crossing estate from north-east to south-west
Hadleigh Castle												Low	No tangible threat
Hill Hall			✔			25%					✔	Low	Threat confined to existing water features
Houghton House												Low	No tangible threat
Isleham Priory						50%						Low	No tangible threat
Leiston Abbey			✔							✔	✔	Low	Threat confined to building range to south of cloister
Lexden and Bluebottle Grove			✔								✔	Low	Threat to extreme south-west corner of western parcel of the estate
Lindsey Chapel												Low	No tangible threat
Longthorpe Tower												Low	No tangible threat
Moulton Packhorse Bridge		3	✔		✔	25%	✔			✔		High	Threat to the entire monument
North Elmham Chapel			✔								✔	Low	Threat confined to ditch on extreme south-west corner of estate
Old Gorhambury House												Low	No tangible threat
Orford Castle		3	✔				✔				✔	Low	Threat confined to several earthwork depressions and track from Gedgrave Road
Priors Hall Barn			✔								✔	Low	Threat restricted to area of existing pond
Saxtead Green Postmill												Low	No tangible threat

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
St Albans Roman Wall			✔								✔	Low	Threat confined to several short sections of earthwork associated with the Roman defences
St Botolph's Priory						25%						Low	No tangible threat
St John's Abbey Gate						25%						Low	No tangible threat
Thetford Holy Sepulchre						50%						Low	No tangible threat
Thetford Priory			✔			50%			✔		✔	Low	Threat confined to margins of a drain on south and west of the estate and several small areas of the interior
Thetford Warren Lodge												Low	No tangible threat
Waltham Abbey Gatehouse	1947	3	✔		✔	25%	✔			✔	✔	Low	Threat restricted to west exterior of gatehouse and to Harold's Bridge from the Cornmill Stream
Weeting Castle						75%						Low	No tangible threat
Wrest Park		3	✔		✔	25%				✔	✔	High	Extensive areas threatened mainly across the south half of the estate

Table 3. London Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
1 Waterhouse Square						50%						Low	No tangible threat
55 Blandford Street						75%						Low	No tangible threat
Apsley House						50%						Low	No tangible threat
Chiswick House		3	✔			25%					✔	Low	Threat restricted to several small parts of the estate
Down House			✔								✔	Low	Threat resticted to several small areas within the estate
Eltham Palace			✔								✔	Low	Threat restricted to existing water features and sunken areas within the garden
Kenwood			✔								✔	Low	Threat restricted to margins of existing watercourses within the estate
Kingston Conduits						25%						Low	No tangible threat
London Wall						25%						Low	No tangible threat
Marble Arch						25%						Low	No tangible threat
Ranger's House												Low	No tangible threat
Wellington Arch						50%						Low	No tangible threat

Table 4. North-East Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Auckland Castle Deer House, Bishop Auckland						25%						Low	No tangible threat
Aydon Castle		3	✔	✔			✔				✔	High	Main flood risk is to a belt of ground running across the estate
Barnard Castle			✔				✔					Low	Surface water flood may impact on access from Market Place
Belsay Hall, Castle and Gardens			✔			50%	✔					Low	Surface water flood may impact on access
Benwell Roman Temple and Vallum												Low	No tangible threat
Berwick Barracks			✔			25%	✔			✔		Low	Threat restricted to west exterior of buildings facing on to the east end of The Parade
Black Carts Turret												Low	No tangible threat
Black Middens Bastle House		3	✔			50%	✔	✔				Low	Threat restricted to car park and start of access route
Bowes Castle												Low	No tangible threat
Brinkburn Priory	2008	3			✔	25%		✔		✔	✔	High	Major risk of flooding and erosion across the majority of the estate
Brunton Turret												Low	No tangible threat
Carrawburgh Temple of Mithras			✔			50%					✔	Low	Threat restricted to west boundary of the estate
Cawfields		2	✔				✔					Low	Threat restricted to access to the site from the west
Chesters Bridge Abutment		3	✔		✔		✔		✔	✔	✔	High	The entire estate is at risk of from flooding of the River North Tyne
Chesters Roman Fort		3	✔		✔				✔	✔	✔	High	Extensive area around the bath house at risk from flooding of the River North Tyne
Corbridge Roman Site			✔			50%			✔		✔	Low	Threat restricted to south-west corner of courtyard building (site XI)
Denton Hall Turret												Low	No tangible threat
Denton West												Low	No tangible threat
Derwentcote Steel Furnace	2008	3	✔			75%					✔	Low	Threat restricted to north boundary of the estate and to areas within associated with surface drains
Edlingham		3									✔	Low	Threat restricted to east boundary of the estate
Egglestone Abbey		3					✔	✔	✔	✔	✔	Medium	Threat to access and to the north-east corner of the estate
Etal Castle	2008	3			✔						✔	Medium	Threat to area adjacent to west boundary of the estate
Finchale Priory	1995	3			✔	25%	✔	✔	✔	✔	✔	High	Major flood risk extending across the entire estate
Gisborough Priory												Low	No tangible threat
Heddon-on-the-Wall												Low	No tangible threat
Housesteads Roman Fort			✔				✔					Low	Threat restricted to valley bottom section of the access from the south
Hylton Castle												Low	No tangible threat
Matfen Store			✔			25%		✔				Low	Threat restricted to north exterior of building and estimated at less than 0.3m depth
Norham Castle	2008	3	✔		✔						✔	Low	Threat restricted to north edge of estate bordering the River Tweed and to shallow valley on the east
Planetrees Roman Wall												Low	No tangible threat
Poltross Burn		3	✔	✔		25%	✔				✔	High	Risk to east third of the estate and to the access route
Portgate Stagshaw												Low	No tangible threat
Prudhoe Castle		2	✔			50%					✔	Low	Threat restricted to north boundary of the estate and to area adjacent to the pond within the estate
Sewingshields Roman Wall			✔			25%	✔				✔	Low	Threat restricted to extreme east end of the estate

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Vindolanda (Chesterholm) Fort		2	✔			**25%**	✔					**Low**	Threat restricted to start of the access on the north-east from the road
Walltown Crags												**Low**	No tangible threat
Winshield Crags Roman Wall												**Low**	No tangible threat

Table 5. North-West Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Ambleside	2009	3	✔		✔	50%	✔		✔		✔	High	Threat to the entire estate
Arthur's Round Table			✔			50%					✔	Low	Threat mainly restricted to ditches of henge monument and to small area on south-weast of the estate
Baguley Hall												Low	No tangible threat
Banks East Turret H.W												Low	No tangible threat
Banks Hill H.W			✔								✔	Low	Threat resticted to small section of ditch outside the course of the wall
Beeston Castle						25%						Low	No tangible threat
Bewcastle Cross						25%						Low	No tangible threat
Birdoswald Roman Fort		3	✔	✔	✔	25%					✔	Medium	Threat mainly to low-lying part of the estate adjacent to the River Irthing
Bow Bridge		3	✔		✔	25%	✔			✔		High	The entire bridge is at risk from a flood event
Brough Castle		3	✔		✔	25%					✔	Low	Threat resticted to area along the north boundary of the estate adjacent to Swindale Beck
Brougham Castle	2009	3									✔	Low	Threat restricted to west and north boundaries of the estate
Brougham Countess Pillar												Low	No tangible threat
Canada House												Low	No tangible threat
Carlisle Castle		2				75%		✔		✔	✔	Low	Flood Zone 3 is beyond the estate but the northern third is within Flood Zone 2
Castlerigg Stone Circle						25%						Low	No tangible threat
Chester Amphitheatre												Low	No tangible threat
Chester Castle						25%						Low	No tangible threat
Clifton Hall						50%						Low	No tangible threat
Furness Abbey		3	✔	✔	✔	25%		✔	✔	✔	✔	High	Extensive threat to the estate
Gisland Vicarage, Roman Wall						25%						Low	No tangible threat
Goodshaw Chapel												Low	No tangible threat
Hardknott Roman Fort			✔	✔		50%					✔	Low	Threat associated with short sections of streams within the estate
Hare Hill												Low	No tangible threat
Lanercost Priory			✔								✔	Low	Threat restricted to small area to north of gatehouse
Lea Hill Turret												Low	No tangible threat
Mayburgh Henge			✔			50%					✔	Low	Threat resticted to two areas within the henge adjacent to the bank
Milvain East & West		2	✔	✔		25%					✔	Medium	Threat restricted to central part of East Milvain estate
Penrith Castle												Low	No tangible threat
Pike Hill Signal Tower												Low	No tangible threat
Piper Sike Turret			✔								✔	Low	Threat resticted to Hadrian's Wall ditch on east boundary of the estate
Sandbach Crosses												Low	No tangible threat
Sawley Abbey			✔			25%			✔		✔	Low	Threat restricted to foundations on south-west of the cloister
Shap Abbey		3	✔		✔		✔	✔	✔	✔	✔	High	Threat to abbey remains and to access to the main part of the estate
Stott Park Bobbin Mill			✔	✔				✔			✔	Medium	Threat mainly associated with stream that crosses the estate
Walton Dovecote Bridge												Low	No tangible threat

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Warton Old Rectory												Low	No tangible threat
Weatheral Priory Gatehouse												Low	No tangible threat
Whalley Abbey Gatehouse		2				**75%**	✔			✔		Low	No serious threat though structure entirely within Flood Zone 2

Table 6. South-East Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Abingdon County Hall						50%						Low	No tangible threat
Appuldurcombe House			✔			50%					✔	Low	Threat restricted to several small areas within the estate
Battle Abbey		3	✔								✔	Low	Threat restricted to margins of streams within the estate
Bayham Abbey Ruins	1960	3	✔	✔			✔		✔	✔	✔	High	threat to substantial part of the estate including the access route
Bishops Waltham Palace		3	✔			25%					✔	Medium	Threat mainly restricted to sections of former moat
Boxgrove Priory			✔				✔					Low	Threat restricted to start of access from main road
Boxgrove Quarry			✔								✔	Low	Threat restricted to several small areas within the estate
Bramber Castle		3	✔			75%					✔	Low	threat restricted to section of east boundary of the estate and to several small areas of the interior
Camber Castle		3	✔			50%	✔			✔	✔	High	Threat to the entire estate
Canterbury Conduit House												Low	No tangible threat
Carisbrooke Castle			✔			25%					✔	Low	Threat restricted to one small area of the interior of the castle
Deddington Castle												Low	No tangible threat
Donnington Castle						50%						Low	No tangible threat
Dover Knights Templar Church												Low	No tangible threat
Dover Western Heights			✔							✔		Low	Threat confined to small areas at base of several of the bastions
Eastgate Court												Low	No tangible threat
Ebbsfleet, St Augustine's Cross												Low	No tangible threat
Eynsford Castle	1968	3	✔				✔		✔	✔	✔	High	Extensive threat to the estate
Farnham Castle						25%						Low	No tangible threat
Faversham Stone Chapel												Low	No tangible threat
Flowerdown Barrows						25%						Low	No tangible threat
Fort Brockhurst						75%						Low	No tangible threat
Horne's Place Chapel, Appeldore												Low	No tangible threat
Itchen Abbas Roman VIlla												Low	No tangible threat
Kit's Coty House and Little Kit's Coty House												Low	No tangible threat
Lullingstone Roman Villa	1968	2					✔				✔	Low	Threat to small section of east boundary of the estate
Medieval Merchant's House, Southampton						50%						Low	No tangible threat
Minster Lovell Hall and Dovecote	2007	3	✔		✔	50%			✔		✔	High	Threat is mainly to the south part of the estate
North Hinksey Conduit House						25%						Low	No tangible threat
North Leigh Roman Villa	1998	3									✔	Low	Threat restricted to east boundary of the estate
Northington, The Grange		3	✔	✔	✔		✔					Low	Threat restricted to access route
Old Soar Manor, Plaxtol												Low	No tangible threat
Ospringe, Maison Dieu		3	✔				✔	✔		✔		High	The entire estate comprising the historic building is at risk
Pevensey Castle		2	✔								✔	Low	Threat to a small area of the castle and section of the east boundary of the estate
Portsmouth, Landport Gate and King James's Gates												Low	No tangible threat
Rollright Stones												Low	No tangible threat

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Rycote Chapel												Low	No tangible threat
Silchester Roman City Walls and Ampitheatre			✔								✔	Low	Threat restricted to several small areas within the estate
Southwick Priory												Low	No tangible threat
St Augustine's Abbey, Canterbury												Low	No tangible threat
St Catherine's Oratory												Low	No tangible threat
St Leonard's Tower, West Malling												Low	No tangible threat
Sutton Valence Castle												Low	No tangible threat
Swingfield, St John's Commandery Chapel												Low	No tangible threat
Titchfield Abbey												Low	No tangible threat
Uffington White Horse, Castle and Dragon Hill												Low	No tangible threat
Waverley Abbey	1990	3	✔	✔	✔				✔	✔	✔	High	Extensive threat to the south half of the estate
Wayland's Smithy												Low	No tangible threat
Wolvesey Castle (Old Bishops Palace)		3	✔			**75%**			✔	✔		Medium	Threat confined to north-west of the estate

Table 7. South-West Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
29 Queen Square												Low	No tangible threat
5 Malborough Court		3					✔	✔				High	Building under threat of flood
Abbotsbury Abbey												Low	No tangible threat
Amesbury Raftyn Barrows												Low	No tangible threat
Avebury Museum						75%						Low	No tangible threat
Avebury Sanctuary						25%						Low	No tangible threat
Avebury Silbury Hill		3	✔			50%	✔				✔	Low	Threat mainly confined to the boundary around the base of Silbury Hill and to road access to car park
Avebury Stone Circle			✔			50%					✔	Low	Threat confined to ditch bottoms within the estate
Avebury West Kennet Avenue			✔			25%					✔	Low	Threat confined to boundary at north-west corner of the estate
Avebury West Kennet Long Barrow			✔	✔	✔	50%	✔					Low	Threat to access from road where it crosses the stream
Avebury Windmill Hill						25%						Low	No tangible threat
Belas Knap Long Barrow												Low	No tangible threat
Berry Pomeroy Castle												Low	No tangible threat
Blackbury Camp												Low	No tangible threat
Bowhill												Low	No tangible threat
Bradford-on-Avon Tithe Barn												Low	No tangible threat
Bratton Camp & White Horse			✔			25%					✔	Low	Threat restricted to one small area in ditch of the hillfort
Bristol Temple Church		2					✔			✔		Low	Moderate threat to the building
Carn Euny												Low	No tangible threat
Chisbury Chapel												Low	No tangible threat
Chysauster Ancient Village												Low	No tangible threat
Cirencester Roman Amphitheatre			✔			25%					✔	Low	Threat confined to one small area at the centre of the amphitheatre
Cleeve Abbey		3	✔	✔	✔		✔		✔	✔	✔	High	Extensive threat to the estate and abbey remains
Dunster Butter Cross												Low	No tangible threat
Dunster Gallox Bridge												Low	No tangible threat
Dunster Yarn Market						25%						Low	No tangible threat
Dupath Well												Low	No tangible threat
Durrington Walls						50%						Low	No tangible threat
Farleigh Hungerford	1925	3	✔								✔	Low	Threat restricted to north and east boundaries of the estate
Fiddleford Mill		3		✔			✔				✔	Low	Threat restricted to west boundary of the estate adjacent to the mill race and access from car park
Glastonbury Tribunal						50%						Low	No tangible threat
Gloucester Blackfriars						50%						Low	No tangible threat
Gloucester Greyfriars						50%						Low	No tangible threat
Grimspound			✔				✔				✔	Low	Threat restricted to north boundary of the estate
Hailes Abbey		3	✔	✔		50%			✔	✔	✔	High	Extensive threat to the abbey remains
Halliggye Fogou			✔	✔			✔					Low	Threat restricted to access from the road
Hatfield Earthworks						25%						Low	No tangible threat
Hound Tor DMV												Low	No tangible threat

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Hurlers, The												Low	No tangible threat
Isambard House						50%						Low	No tangible threat
King Doniert's Stone												Low	No tangible threat
Kingston Russell Stone Circle												Low	No tangible threat
Kingswood Abbey Gatehouse												Low	No tangible threat
Kirkham House, Paignton			✔			50%					✔	Low	Threat restricted to an area in front of the house
Knowlton Church & Earthworks												Low	No tangible threat
Launceston Castle												Low	No tangible threat
Ludgershall Castle			✔								✔	Low	Threat restricted to small areas at the south-west corner of the estate
Ludgershall Village Cross			✔									Low	Protected from surface flood on a brick plinth
Lulworth Castle						25%						Low	No tangible threat
Lydford Castle												Low	No tangible threat
Lydford Norman Fort												Low	No tangible threat
Lydford Town Banks												Low	No tangible threat
Maiden Castle			✔			75%						Low	Threat restricted to isolated sections of ditch
Meare Fish House												Low	No tangible threat
Merrivale Hut Circles			✔								✔	Low	Threat restricted to several small areas within the estate
Muchelney Abbey						75%						Low	No tangible threat
Netheravon Dovecote			✔			25%					✔	Low	Threat restricted to north and east exterior of the building
NMRC						50%						Low	No tangible threat
Notgrove Long Barrow												Low	No tangible threat
Nunney Castle	1968 1972	3	✔	✔			✔			✔	✔	High	Threat to the entire estate
Nympsfield Long Barrow			✔								✔	Low	Threat restricted to one small area within the estate
Odda's Chapel	1947 2000 2007	3				50%	✔			✔	✔	High	Threat to the entire estate
Offa's Dyke			✔								✔	Low	Threat restricted to one small area within the estate
Okehampton Castle		3	✔	✔	✔		✔				✔	Medium	Threat is extensive but unlikely to cause damage to the castle itself
Old Sarum Castle			✔			25%			✔		✔	Low	Threat restricted to small areas around the inner bank
Old Wardour Castle			✔									Low	Threat restricted to one small area on the south boundary of the estate
Penhallam		3	✔	✔			✔		✔		✔	High	Threat to exposed foundations of the manor house
Restormel Castle			✔			25%	✔			✔	✔	Low	Threat restricted to an area on the motte and to one section of the access track from Restormel Road
Rodmarton Long Barrow												Low	No tangible threat
Sherborne Old Castle						25%						Low	No tangible threat
Sir Bevil Grenville's Monument												Low	No tangible threat
St Breock Down Monolith												Low	No tangible threat
St Briavel's Castle			✔								✔	Low	Threat restricted to sections of outer ditch
St Catherine's Chapel						25%						Low	No tangible threat
St Mary's Church, Kempley		3	✔				✔				✔	Medium	Threat restricted to open areas away from the church
Stanton Drew Cove												Low	No tangible threat
Stanton Drew Stone Circle						25%						Low	No tangible threat

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
Stonehenge			✔								✔	Low	Threat restricted to extreme east point of the estate
Stonehenge Custodians Cottages												Low	No tangible threat
Stoney Littleton Chambered Tomb			✔	✔	✔		✔					Low	Threat restricted to access routes to the monument adjacent to Wellow Brook
Totnes Castle			✔			25%						Low	Threat restricted to one area within the bailey of the castle
Tregiffian Burial Chamber												Low	No tangible threat
Trethevy Quoit												Low	No tangible threat
Uley Long Barrow												Low	No tangible threat
Units in Toddington			✔									Low	Threat restricted to east side of northernmost unit
Upper Plym Valley		3	✔	✔		25%					✔	Low	Threat restricted to immediate area of several streams crossing the estate
Winterbourne Abbas Nine Stones		3	✔			25%	✔		✔		✔	High	Most of the stone circle is in the area under threat
Winterbourne Poor Lot Barrows			✔				✔					Low	Threat to access from the road
Witcombe Roman Villa			✔									Low	Threat to access from the road
Woodhenge			✔			50%					✔	Low	Threat to one area within the inner bank
Wyndham House		3				75%	✔	✔				High	Building under threat

Table 8. West Midlands Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
112 Colmore Row												Low	No tangible threat
26 Atcham						75%						Low	No tangible threat
30 Atcham						75%						Low	No tangible threat
31 Atcham						75%						Low	No tangible threat
Acton Burnell Castle						25%						Low	No tangible threat
Arthurs Stone												Low	No tangible threat
Boscobel House												Low	No tangible threat
Buildwas Abbey	2000 2004 1998	3	✔			50%			✔	✔	✔	Medium	Threat restricted mainly to west boundary of the estate extending to the west side of the claustral range
Cantlop Bridge		3	✔		✔	50%	✔	✔				High	Threat of damage to the structure
Clun Castle		3	✔	✔	✔	75%					✔	Medium	Threat to areas bordering the River Clun
Croxden Abbey												Low	No tangible threat
Edvin Loach Old Church												Low	No tangible threat
Goodrich Castle			✔								✔	Low	Threat restricted to outer ditch on the east side of the castle
Halesowen Abbey						25%						Low	No tangible threat
Haughmond Abbey												Low	No tangible threat
Iron Bridge	2000	3	✔	✔	✔					✔		Low	Threat resticted to reinforced base of arch on river banks
Kenilworth Castle		3	✔	✔	✔	25%					✔	Medium	Threat restricted to areas of the estate forming part of the former lake
Langley Chapel												Low	No tangible threat
Leigh Court Barn		3	✔			50%	✔				✔	Low	Threat to access along north boundary of the estate
Lilleshall Abbey						25%						Low	No tangible threat
Longtown Castle			✔								✔	Low	Threat restricted to one area within castle bailey
Mitchells Fold Stone Circle												Low	No tangible threat
Moreton Corbet Castle						25%						Low	No tangible threat
Mortimers Cross Mill	1947	3		✔		50%	✔	✔				High	Threat to mill building
Old Oswestry Hill Fort			✔			75%					✔	Low	Threat confined to short sections of hillfort ditch
Rotherwas Chapel	1960	3				75%	✔	✔		✔	✔	High	Threat to the entire estate
Stokesay Castle						50%						Low	No tangible threat
Wall Roman Site						50%						Low	No tangible threat
Wenlock Priory		3	✔				✔		✔	✔	✔	High	Threat to most of the estate
White Ladies Priory						50%						Low	No tangible threat
Wigmore Castle						75%						Low	No tangible threat
Witley Court		3	✔	✔		25%					✔	Medium	Threat largely restricted to margins of existing water features
Wroxeter Roman City	1998 2004	3	✔	✔	✔	50%					✔	Medium	Threat largely to the edges of the estate

Table 9. Yorkshire and The Humber Region

	THREAT						IMPACT						
	Recorded Flood	Flood Zone	Surface Water Flood	Minor Watercourse	Major Watercourse	Ground Water Flood	Access	Modern Infrastructure	Exposed Foootings	Standing masonry	Land surface	Assessment of Risk	
37 Tanner Row, York												Low	No tangible threat
Aldborough Roman Town												Low	No tangible threat
Beadlam Roman Villa	2000	3	✔				✔				✔	Medium	Threat mainly confined to south and west margins of estate
Brodsworth Hall						25%						Low	No tangible threat
Burton Agnes Manor House						25%						Low	No tangible threat
Byland Abbey		3	✔	✔		50%	✔	✔	✔	✔	✔	High	Extensive threat across the west and south of the estate
Clifford's Tower		2					✔					Low	Threat restricted to south-west margin of estate
Conisbrough Castle			✔								✔	Low	Threat restricted to sections of castle ditch
Easby Abbey	1995	3	✔			25%			✔	✔	✔	Low	Threat restricted to one area of building remains. Historic flood threatened west boundary of the estate.
Fountains Abbey		3	✔	✔			✔		✔	✔	✔	High	Extensive threat across the middle of the estate following the line of the valley bottom.
Gainsthorpe			✔								✔	Low	Threat restricted to part of a hollow way
Helmsley Castle	2005	3	✔	✔							✔	Low	Threat on south edge of the estate and surface water flood restricted to castle ditch on east side
Helmsley Warehouse 2												Low	No tangible threat
Howden Minster												Low	No tangible threat
Kirkham Priory												Low	No tangible threat
Marmion Tower		3									✔	Low	Threat restricted to south-west corner of the estate
Middleham Castle												Low	No tangible threat
Monk Bretton Priory	2007	3	✔			25%			✔		✔	Medium	Threat confined to large depression on east of the estate and to building remains along the south boundary
Mount Grace Priory			✔			50%	✔	✔	✔	✔	✔	High	Threat across the middle of the estate
Pickering Castle			✔								✔	Low	Threat restricted to north boundary of the estate
Piercebridge Roman Bridge		3	✔				✔		✔		✔	High	Threat extends across most of the estate
Richmond Castle	1995	3	✔	✔							✔	Low	Threat restricted to south boundary of the estate
Rievaulx Abbey	2005	3	✔			25%	✔	✔	✔	✔	✔	High	Extensive threat to west half of the estate
Roche Abbey	1950	3	✔		✔				✔	✔	✔	High	Extensive threat across the estate
Skipsea Castle	1982 2007	3	✔	✔		25%	✔				✔	High	Extensive threat across the east and central part of the estate
Spofforth Castle		3	✔			25%					✔	Low	Threat restricted to west edge of the estate
St Mary's Church, Studley Royal												Low	No tangible threat
St Peter's Church, Barton-on-Humber												Low	No tangible threat
Stanwick Camp												Low	No tangible threat
Steeton Hall Gatehouse		3	✔		✔		✔				✔	Low	Threat mainly to access from Whitecote Lane
Thornton Abbey			✔			75%					✔	Low	Threat confined to sections of ditch towards west edge of the estate
Wharram Percy		3	✔				✔				✔	Low	Threat mainly to access route across the valley bottom on the east of the estate
Wheeldale Roman Road		3	✔	✔							✔	Low	Threat confined to points where the Roman road crosses valleys at the north and south limits of the estate
York Warehouse	1947	3									✔	Low	Threat restricted to west boundary of the estate

(5) DETAILED RISK ASSESSMENTS

(5.1) Introduction

This section presents detailed assessments of estates considered to be at moderate or high risk. Each estate is treated individually on a region by region basis with the information presented in a standardised form. The estates at high and medium risk (red triangle and orange triangle respectively) are labelled on the regional maps which introduce each section.

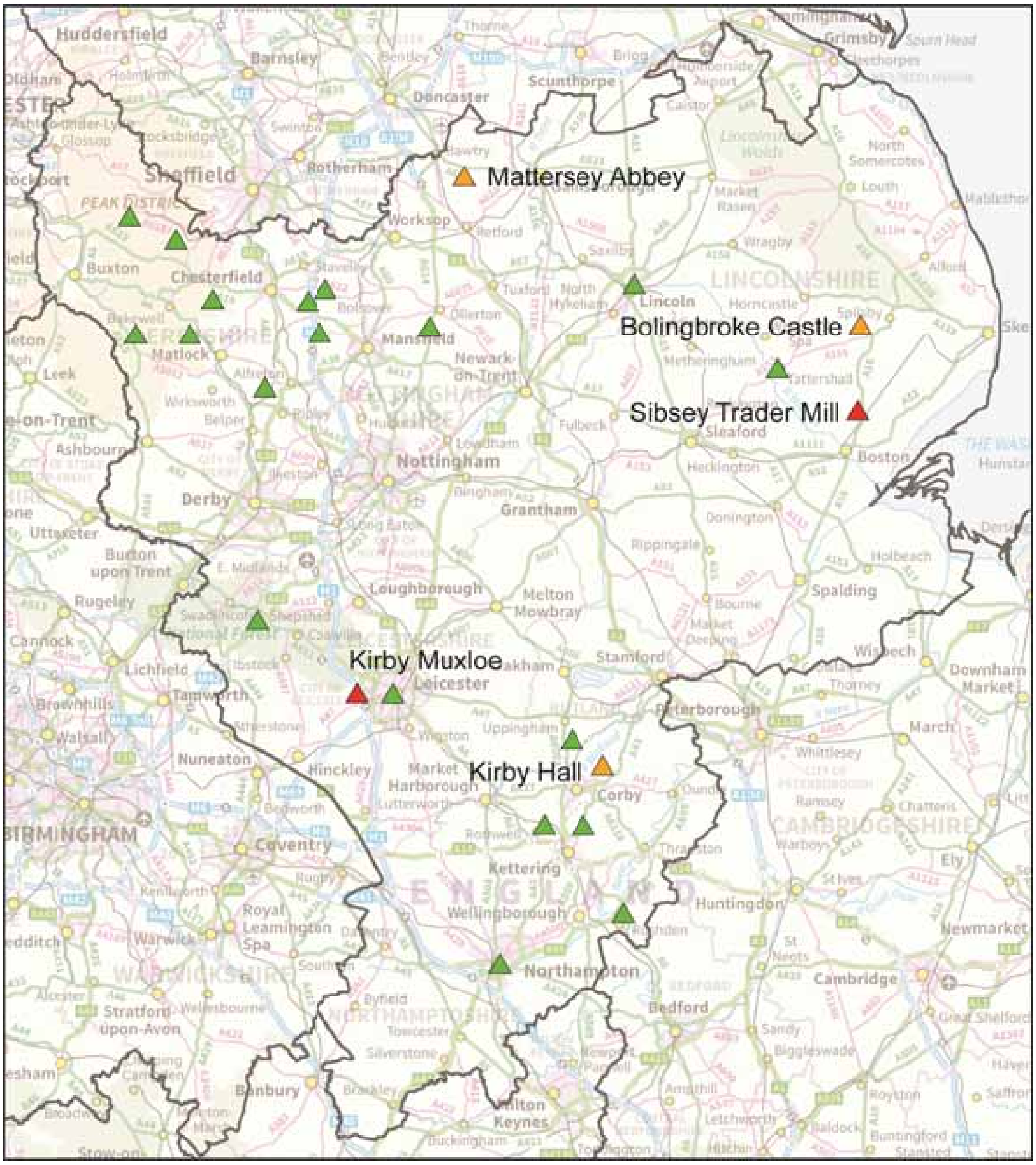
The introductory table gives basic information about the estate. Where there is more than one listed building or scheduled monument within the estate then in most cases the principal of these is listed. The Flood Watch Area (also referred to as a Flood Alert Area) is defined by the Environment Agency and is tied in to their Flood Warning Service. Any property within one of these areas is eligible to receive free flood alerts. The level of flood protection is based on an assessment of the proximity of flood defences as mapped by the Environment Agency which have been constructed in the last five years and with a standard of protection from fluvial flooding equal to or better than a 1 in 100 flood event.

The map shows the Environment Agency Flood Zone 3, Surface Water Flooding and Historic Flood Outline datasets along with the extent of each English Heritage estate. The background mapping is the Ordnance Survey 1:10 000 scale map. Unless otherwise stated the maps are reproduced at a scale of 1:5000. The Flood Zone 3 and Historic Flood Outlines are available for inspection also on the English Heritage Web GIS system where they can be viewed against Ordnance Survey mapping at a range of scales and periods.

The nature and extent of the flood risk is assessed from the mapping and takes into account additional information derived from inspection of vertical aerial photography from Google maps, from Google street view and from photographs and historic images traced on the internet.

Key to Assessment Maps

(5.2) East Midlands Region



Bolingbroke Castle, East Midlands

A castle founded in the thirteenth century

NGR	534925 364931	Listed Building	1309023
Scheduled Monument	1008318	Estate Number	M0083
Flood Watch Area	None listed	Flood Protection	None listed

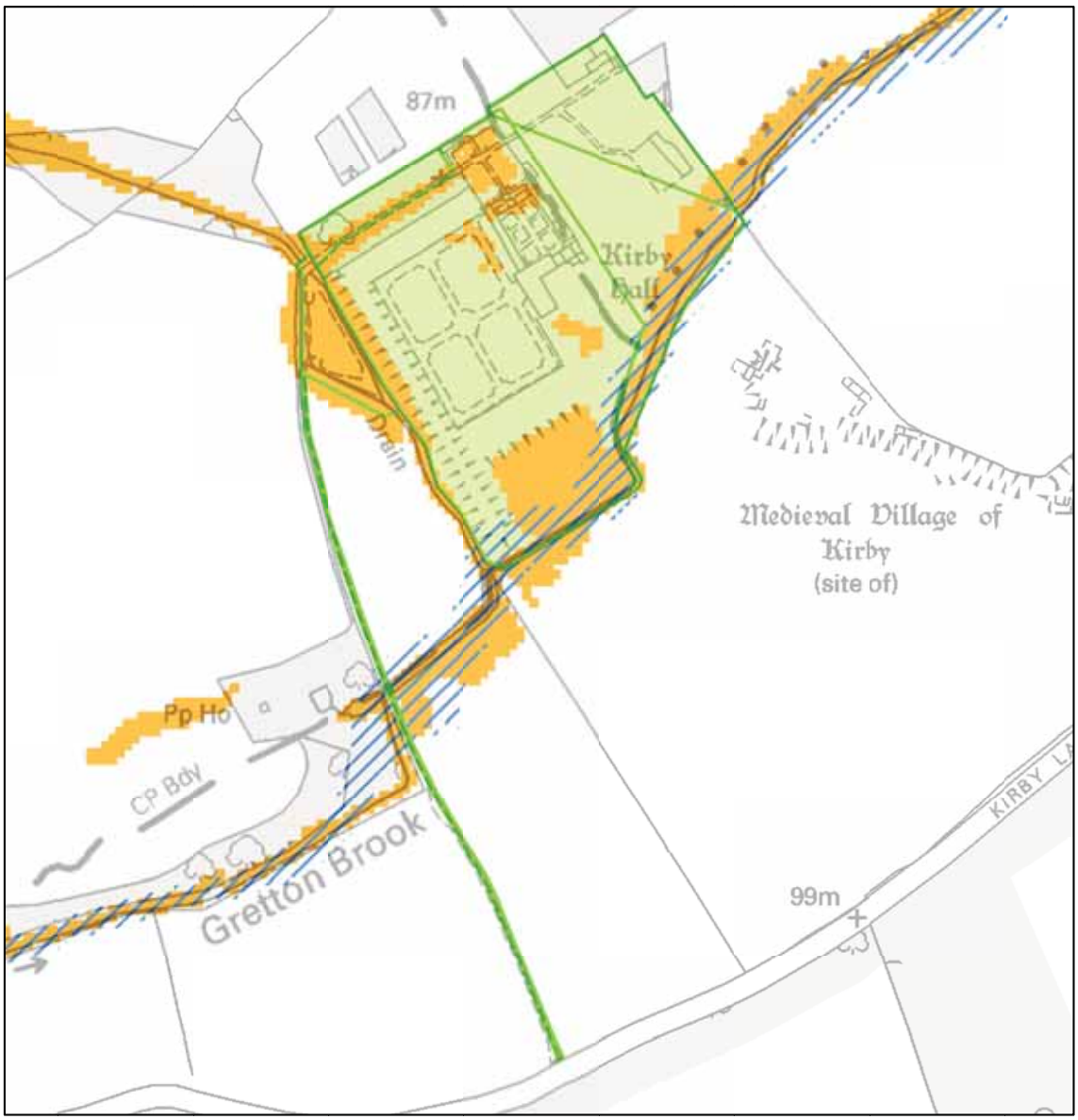
Nature and Extent of Flood Risk

(1) Surface Water Flooding – this poses a risk to the eastern third of the estate including a substantial part of the earthwork defences on the east and south-east of the castle bordering the watercourses that drain past the east and south of the site. The depth of the flood is predicted not to exceed 0.3m and therefore it is unlikely that a surface water flood will pose much threat to the earthwork remains.

Kirby Hall, East Midlands

An Elizabethan country house and gardens on an earlier village site

NGR	492570 292677	Listed Building	1374889 (Hall)
Scheduled Monument	1014421	Estate Number	M0356
Flood Watch Area	Harpers Brook and Willow Brook	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the main risk is to the south and east margin of the estate caused by overtopping of the Gretton Brook. This could also severe the route from the nearest road to the site.

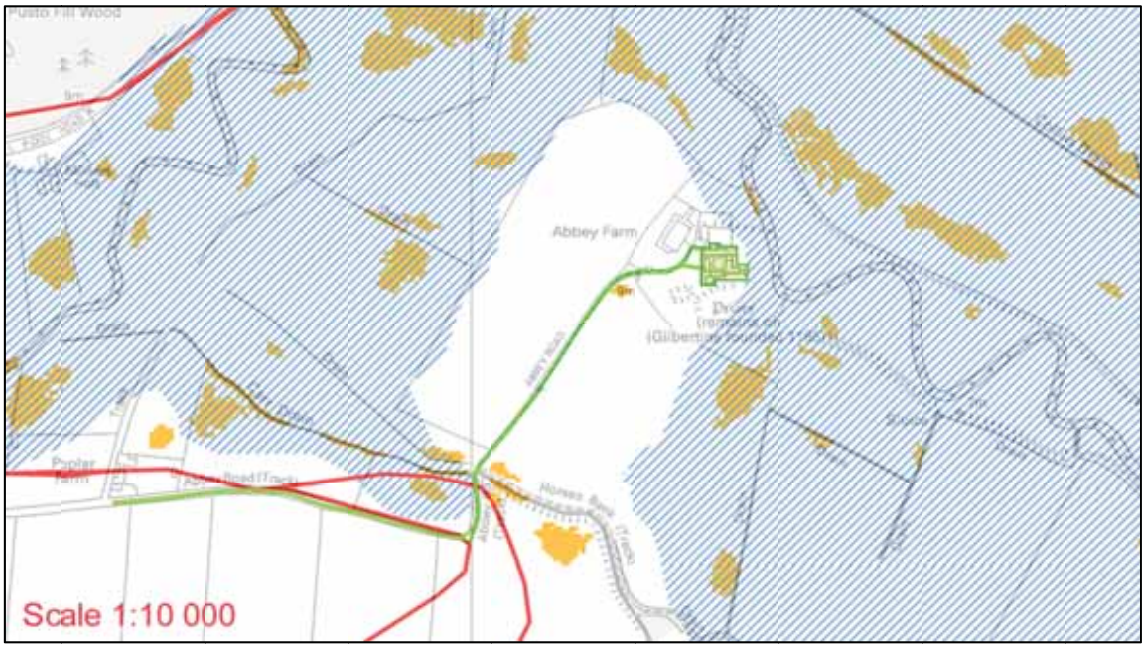
(2) Surface water flooding – this has the potential to affect several parts of the estate including parts of the garden area close to the main house. Such a flood event will also disrupt access to the site from the nearest road and could extend across almost the entire car park. However, it is unlikely to pose any long-term damage.

(3) The flooding of the Gretton Brook along the south and east margins of the estate could pose a threat to any archaeological remains in these area through erosion of the banks of the watercourse.

Mattersey Priory, East Midlands

A Gilbertine monastery founded in the late twelfth century

NGR	470315 389563	Listed Building	1239220 (Farmhouse)
Scheduled Monument	1012495	Estate Number	M0413
Flood Watch Area	River Idle in Nottinghamshire	Flood Protection	None listed



Nature and Extent of Flood Risk

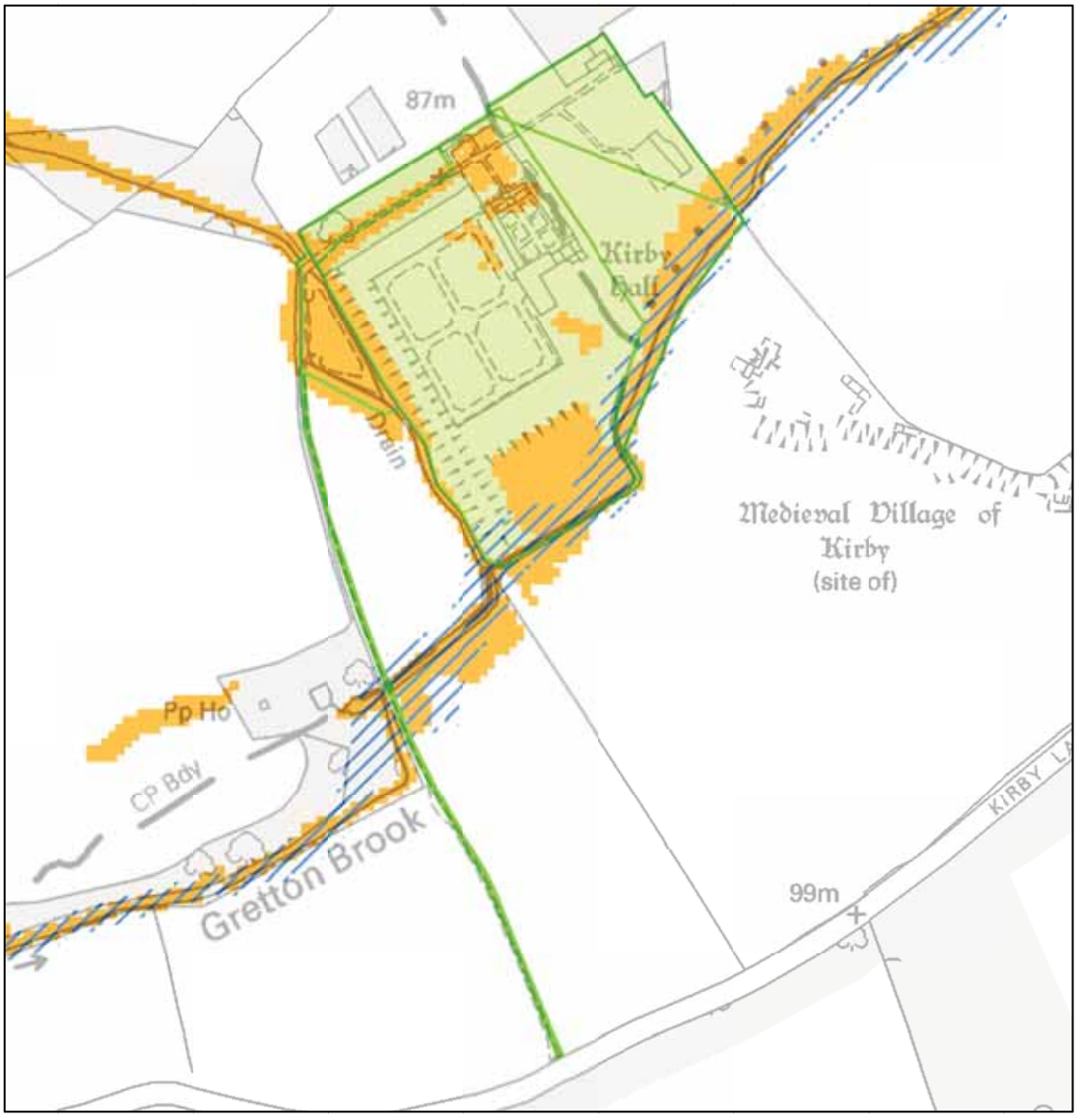
(1) Historic Flood – the Environment Agency records flood events in 1947 and 1977 and as mapped by them both these events appear to have covered the entire EH Estate. However this may not be correct as the priory sits on a gravel ridge which may have afforded a degree of protection to the main part of the estate during these two floods. The access route from Mattersey is likely to have been affected where it leaves the ridge.

(2) Flood Zone 3 – the predicted extent of this flood zone defines the extent of the ridge occupied by the priory and poses no risk to the estate apart from possibly impinging upon the access route from Mattersey where it crosses the Carr Drain.

Kirby Muxloe, East Midlands

A fortified mansion constructed in the late fifteenth century

NGR	452392 304604	Listed Building	1177213
Scheduled Monument	1013323	Estate Number	M0357
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the mansion was sited west of a small brook in order to create a watery setting which now leaves the east and middle of the estate exposed to flooding

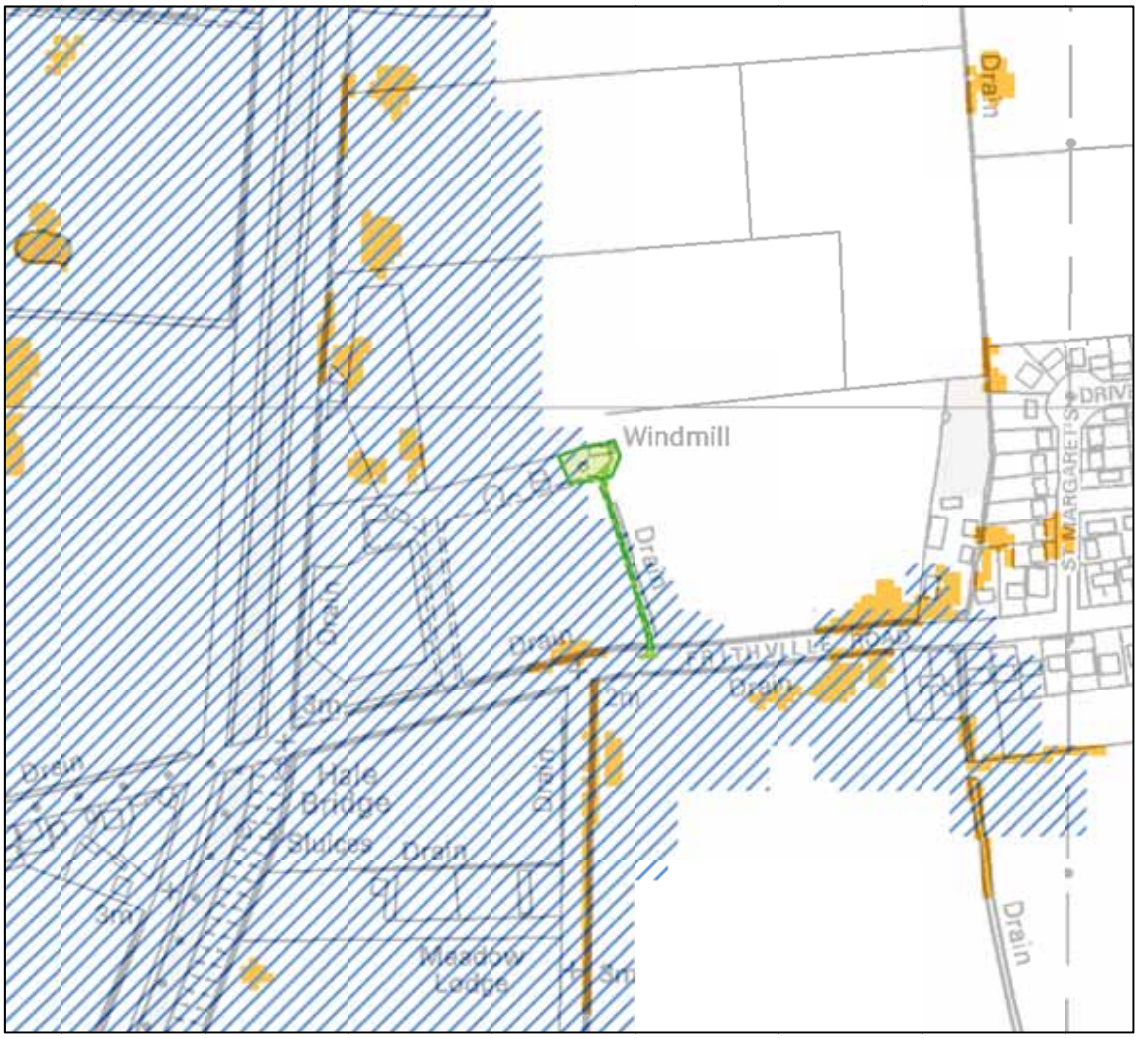
from the same watercourse. Such a flood may pose a risk to the standing remains of the fifteenth century brick gatehouse and other exposed foundations especially if there is a high force of water crossing the estate.

(2) Surface Water flooding –as mapped by the Environment Agency the extent of surface water flood is largely confined to the moat associated with the fifteenth century mansion and therefore is unlikely to pose any serious additional risk to the estate. In order to minimise the risk though, it is important that the modern engineering which controls the flow of water from the brook into the moat is properly maintained.

Sibsey Trader Mill, East Midlands

A windmill constructed in 1877

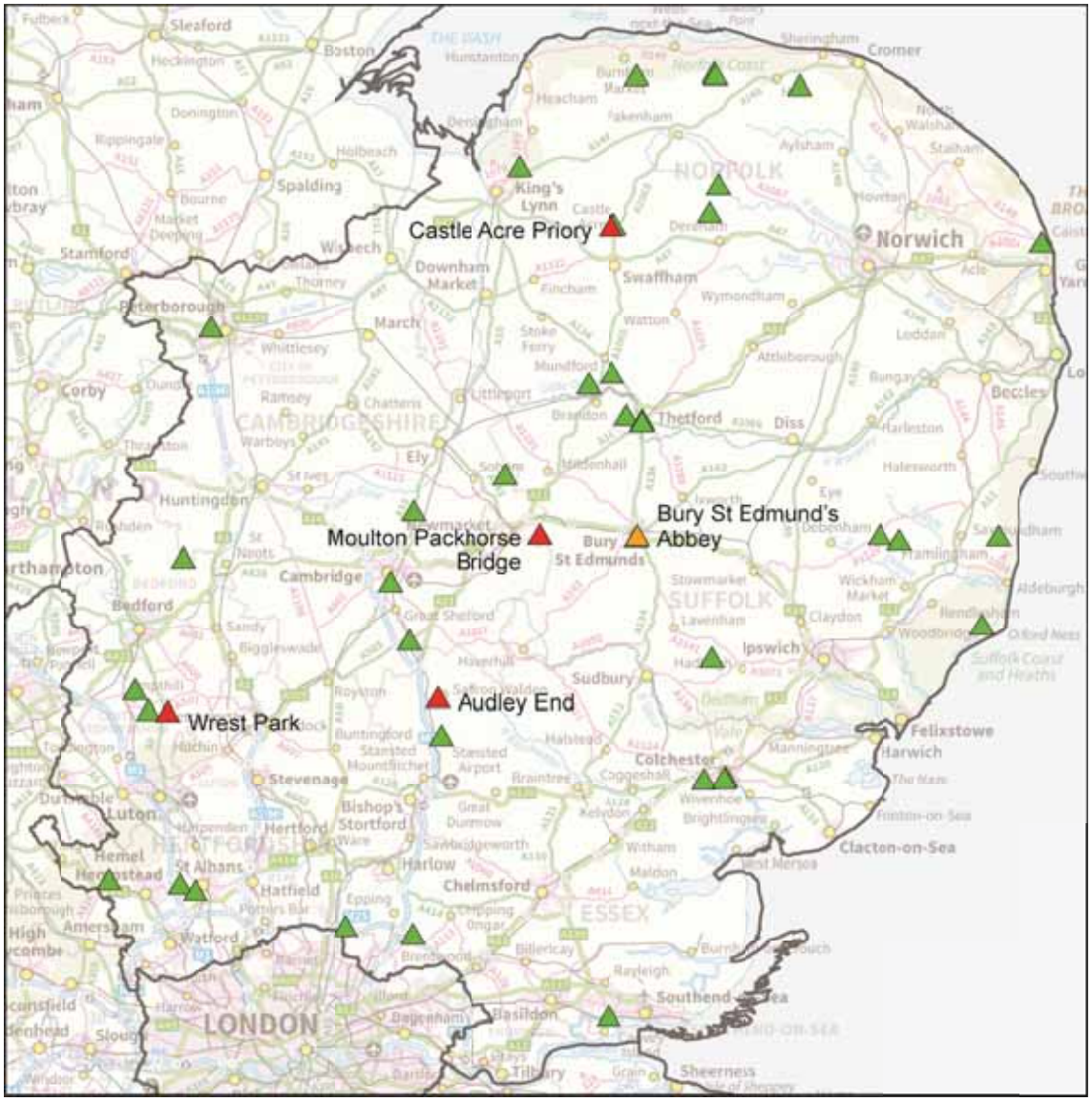
NGR	534494 350899	Listed Building	1063535
Scheduled Monument	1013828	Estate Number	M0561
Flood Watch Area	Far Extent of Tidal Flooding from the Wash and Tidal Estuaries	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 –the estate is on the east margin of an extensive area of tidal flooding. Virtually the entire estate including the mill itself and most of the access route from the main road is at risk.

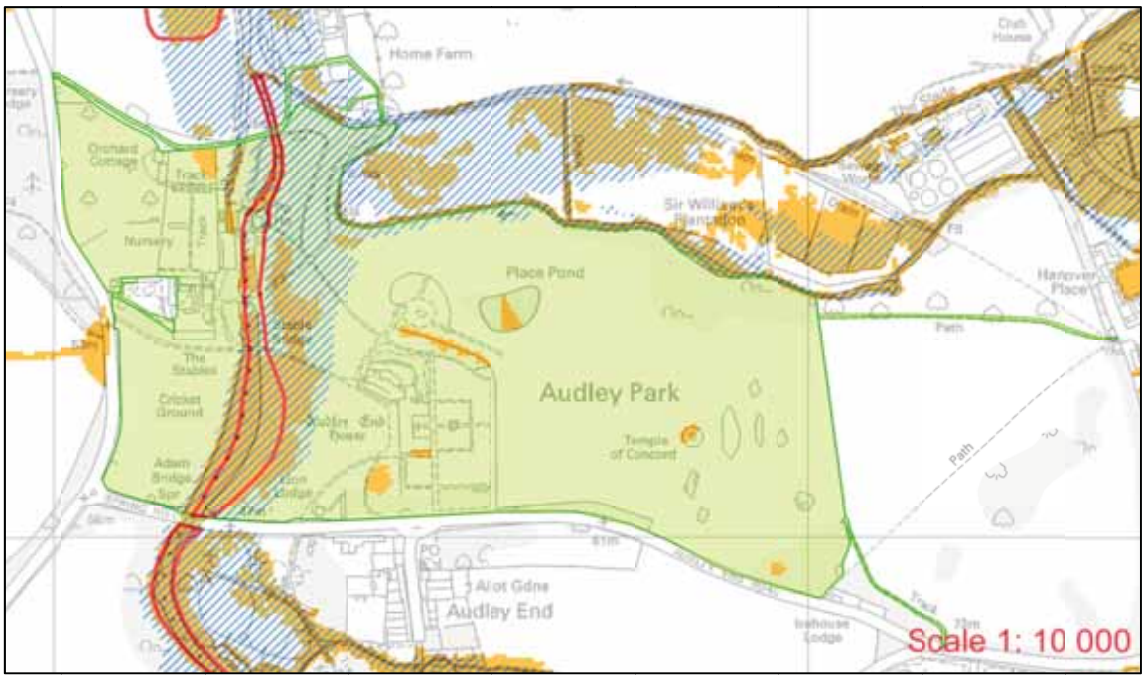
(5.3) East of England Region



Audley End House, East of England

House and gardens from the seventeenth century

NGR	552553 238211	Listed Building	1196114
Scheduled Monument	1002163	Estate Number	M0034
Flood Watch Area	River Cam and Tributaries	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic flood – the River Cam flowing from south to north across the estate is recorded as having flooded in October 2001. As mapped by the Environment Agency the flood covered a zone of mostly parkland landscape up to a maximum width of around 60m.

(2) Flood Zone 3 – such a flood event is predicted to extend up to 150m to the east of the River Cam with only marginal flooding to the west of the watercourse. Consequently the flood will impact mainly upon parkland landscape and should not affect the modern buildings to the west of the river.

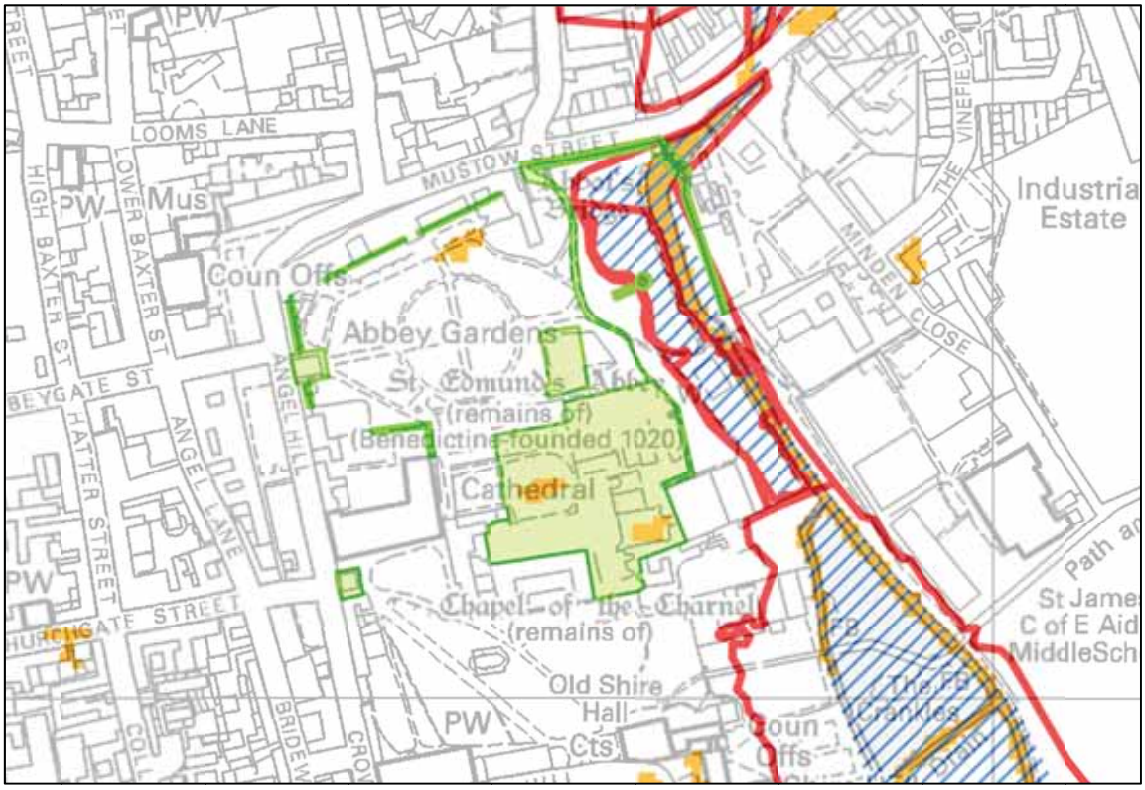
(3) Surface Water flood – the main area is again predicted to be adjacent to the River Cam though isolated patches are predicted in other parts of the estate including a stretch of ha-ha to the north of the main house and at the Temple of Concord.

(4) During the build-up to a flood event it is likely that increased water flow along the River Cam could lead to erosion of the banks. The river is an integral part of the designed parkland landscape and therefore there will be a duty to restore the banks to their previous state following a flood event.

Bury St Edmund's Abbey, East of England Region

A Benedictine Abbey founded in the early eleventh century

NGR	585727, 264145	Listed Building	1375552 (Abbots Bridge)
Scheduled Monument	1021450	Estate Number	M0103
Flood Watch Area	Rivers Lark and Kennett in Suffolk	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – the recorded extent of a flood in September 1968 indicates that the Abbot's Bridge at the north-east of the estate was affected along with the remains of a dovecote to the south of the bridge.

(2) Flood Zone 3 – the Abbot's Bridge is the only part of the estate within this flood zone although the dovecote is on the west edge of the predicted extent. Access to the bridge may be impeded during such an event.

(3) Surface water flood – the mapped extent indicates that such a flood event will be mainly confined to the immediate vicinity of the River Lark with several isolated areas at

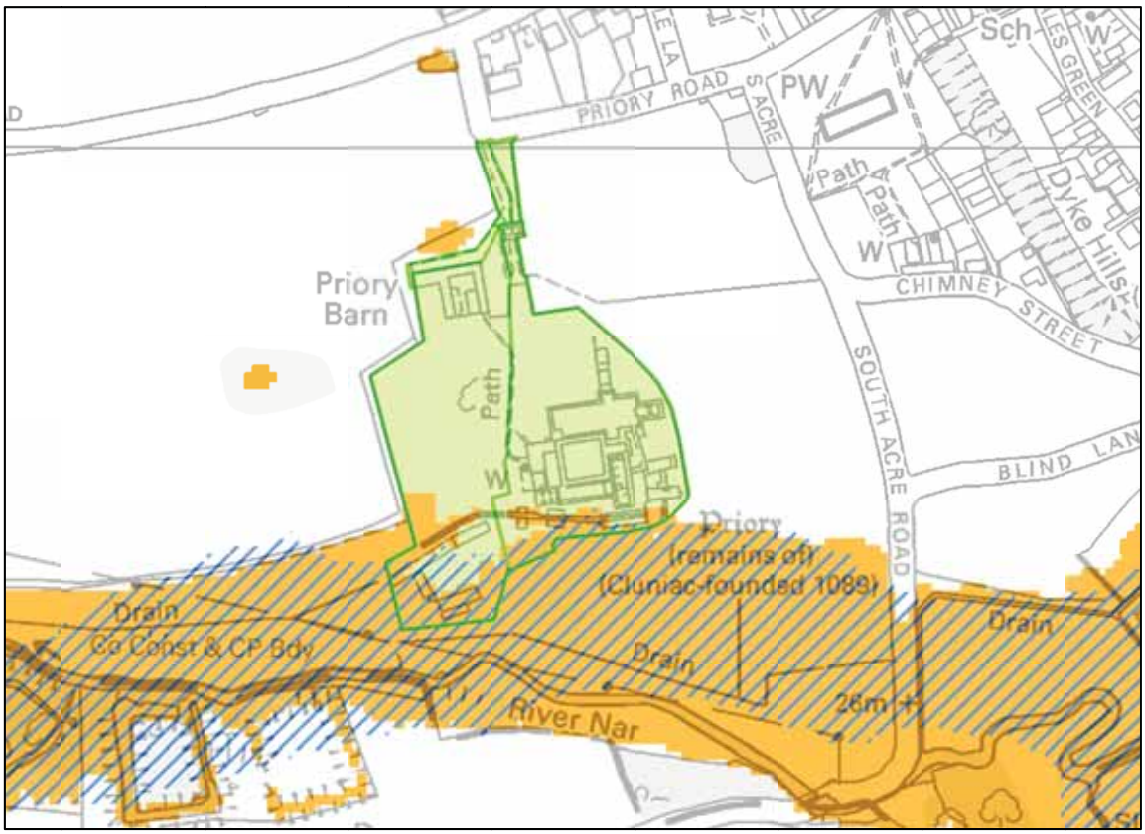
risk within the main part of the estate including within the area of the abbey church. This may pose some threat to the exposed remains in this area.

(4) During a major flood event there is some risk to the estate from increased erosion of the banks of the River Lark. In particular this may pose a threat to archaeological deposits along the west bank of the river associated with the medieval abbey and to the structural integrity of the Abbot's Bridge. The low arches of the bridge could act as a trap for material washed along the River Lark in a flood turning the bridge into a dam holding back the flood water.

Castle Acre Priory, East of England

A Cluniac priory founded in the late eleventh century

NGR	581433 314808	Listed Building	1342389
Scheduled Monument	1015870	Estate Number	M0135
Flood Watch Area	North West Norfolk Rivers	Flood Protection	None listed



Nature and Extent of Flood Risk

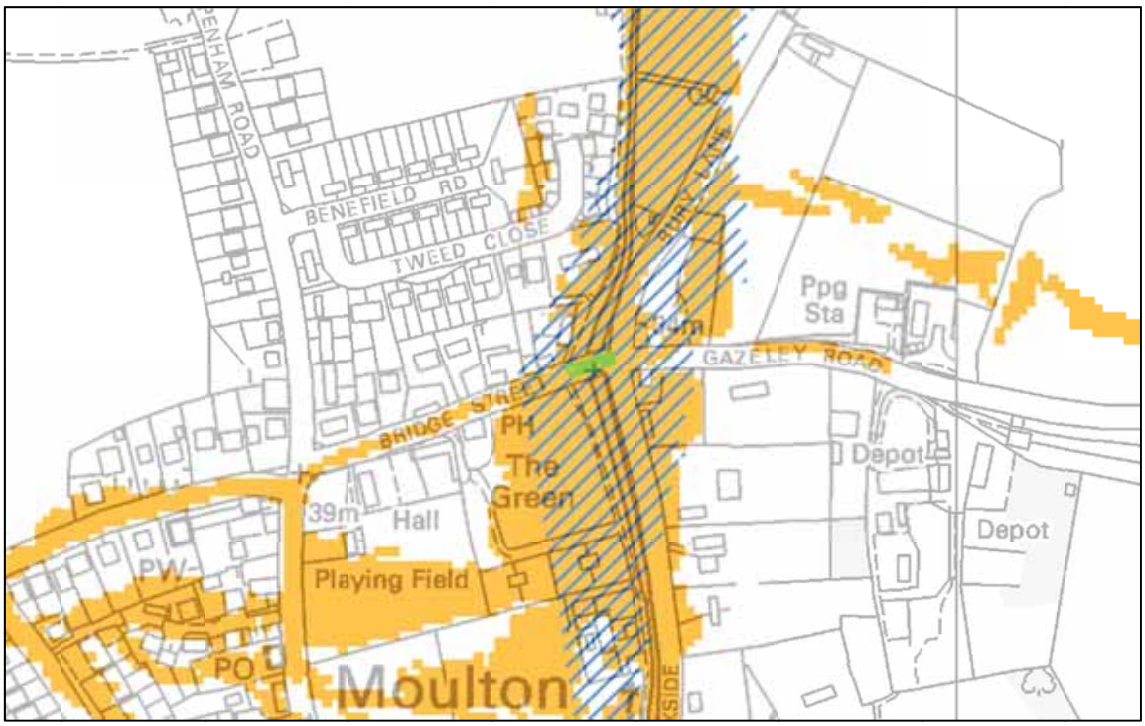
(1) Flood Zone 3- overtopping of the River Nar poses a risk to the southern edge of the estate potentially impacting on the exposed foundations of a range of medieval buildings sited in close proximity to the watercourse. The area affected may extend as far north as the southern edge of the claustral range.

(2) Surface water flood – the area predicted to be at risk along the southern edge of the estate is almost exactly the same as the estimated extent of Flood Zone 3 with the same threat to the exposed foundations of the medieval buildings nearest to the River Nar.

Moulton Packhorse Bridge, East of England

A packhorse bridge from the fifteenth century

NGR	569761 264533	Listed Building	1037678
Scheduled Monument	1003248	Estate Number	M0426
Flood Watch Area	Rivers Lark and Kennett in Suffolk	Flood Protection	None listed



Nature and Extent of Flood Risk

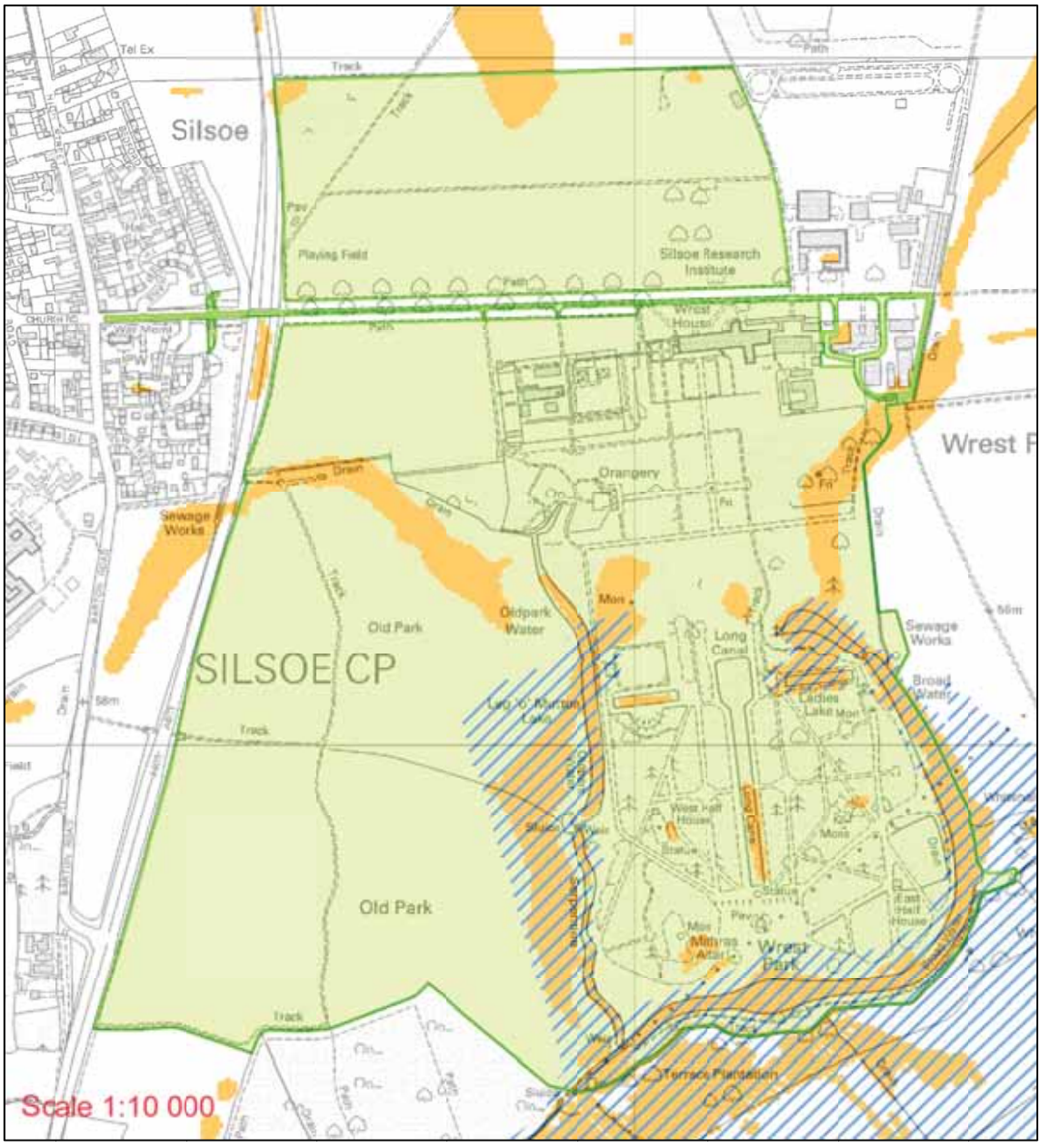
(1) Flood Zone 3 – the estate is the extent of the bridge which is wholly situated within Flood Zone 3 due to the risk posed by flooding of the River Kennett. The increase in the flow of water down the river during such a flood event could pose a considerable threat to the structural integrity of the bridge and therefore of the entire estate.

(2) Surface water flood – the estate is wholly situated within an area predicted to be at risk of surface water flooding and therefore the ingress of standing water into the fabric of the bridge could compromise its structural integrity.

Wrest Park, East of England

A nineteenth century house and gardens

NGR	509109 235589	Listed Building	1311484 (Main House)
Scheduled Monument	1005407	Estate Number	M0669
Flood Watch Area	None listed	Flood Protection	None listed



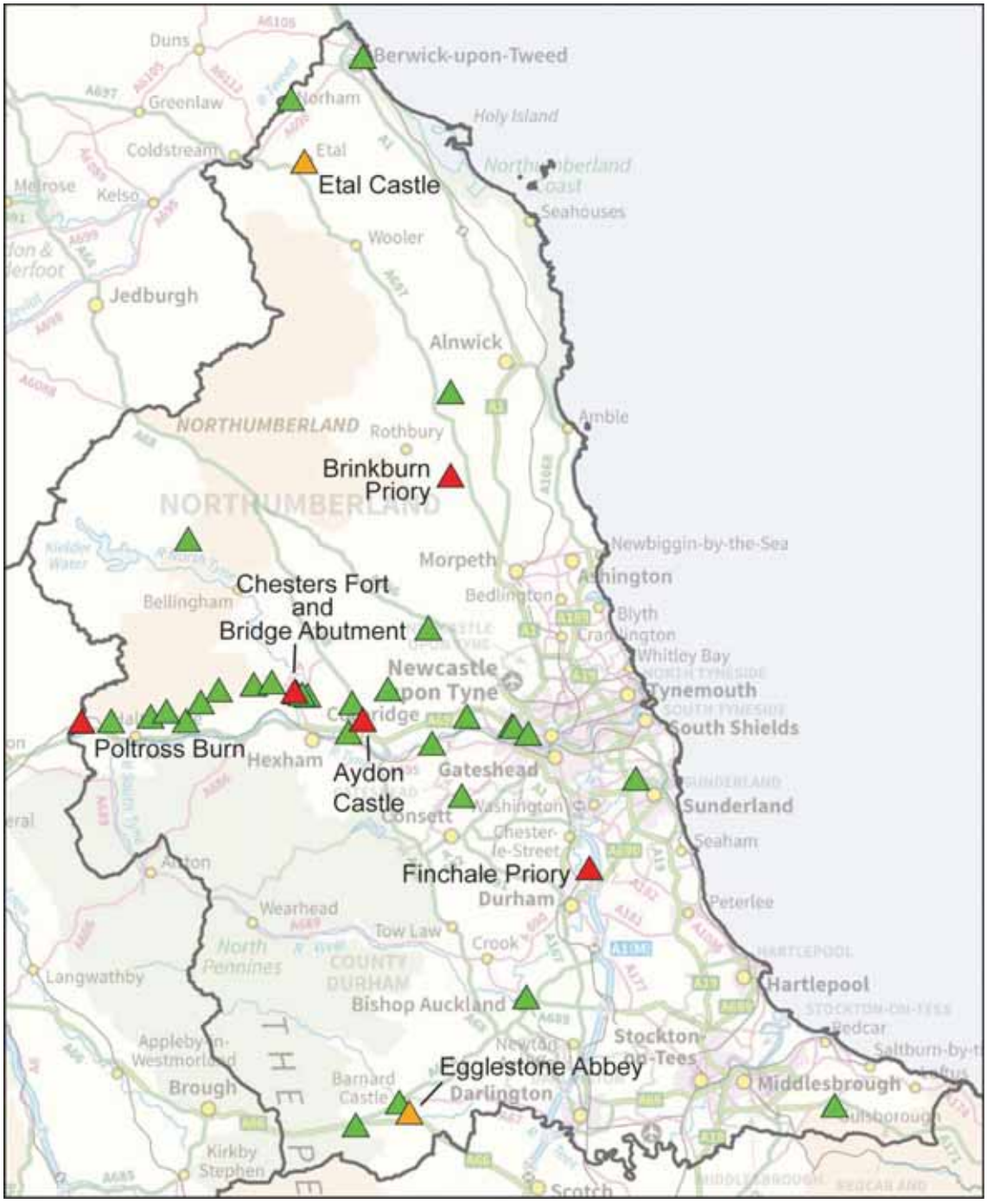
Nature and Extent of Flood Risk

(1) Flood Zone 3 – the main risk to the estate during such a flood event comes from overtopping of the bodies of water that border the east, south and west sides of the landscape garden though it is predicted that floodwaters will mostly spread across adjacent fields.

(2) Surface water flood – much of the area predicted to be at risk of surface water flooding is within and around the margins of existing water bodies. Smaller areas of surface water flooding elsewhere in the estate have a predicted depth of less than 0.3m and do not appear to pose any significant risk to either the house or landscape garden.

(5.4) London Region

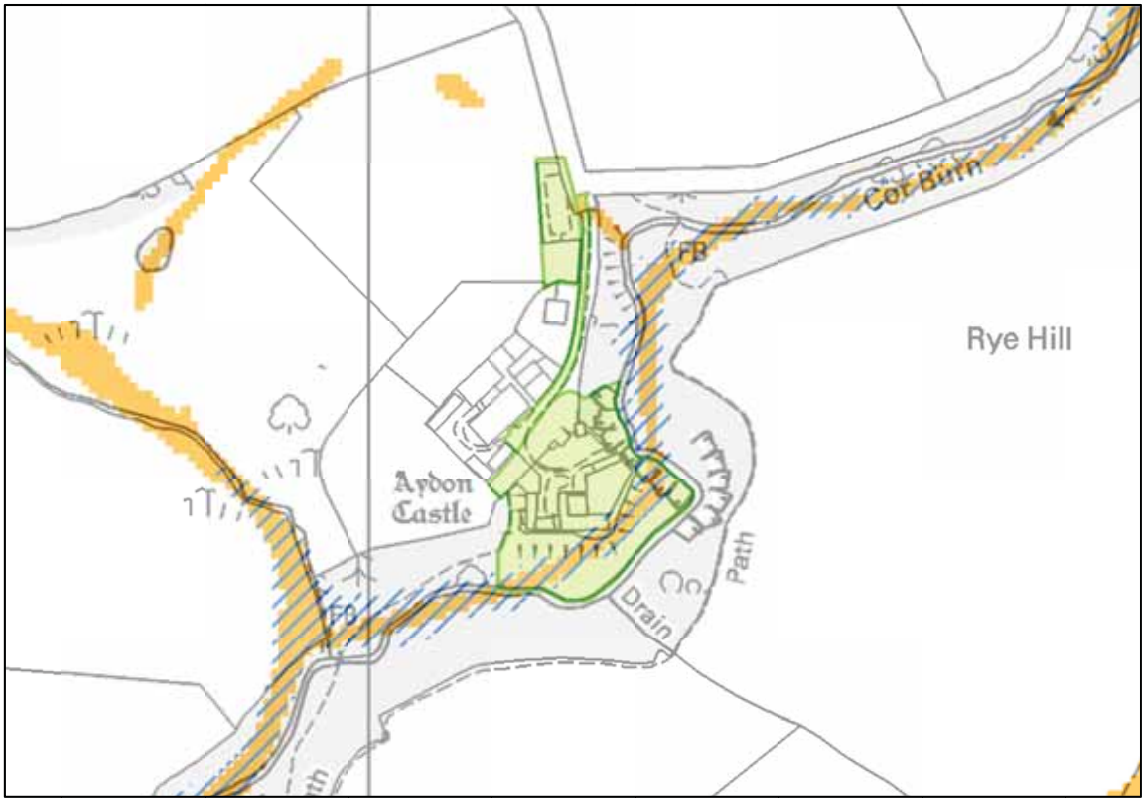
(5.5) North-East Region



Aydon Castle, North-East Region

A medieval fortified manor house

NGR	400138 566303	Listed Building	1303707 (Main building)
Scheduled Monument	1011645	Estate Number	N0041
Flood Watch Area	River Tyne	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the predicted flood risk to the estate is restricted to a belt running across the low ground between the south and east sides of the castle curtain wall and the Cor Burn. The mapped extent suggests flooding might encroach onto the wall itself but this seems unlikely given the elevation above the level of the stream.

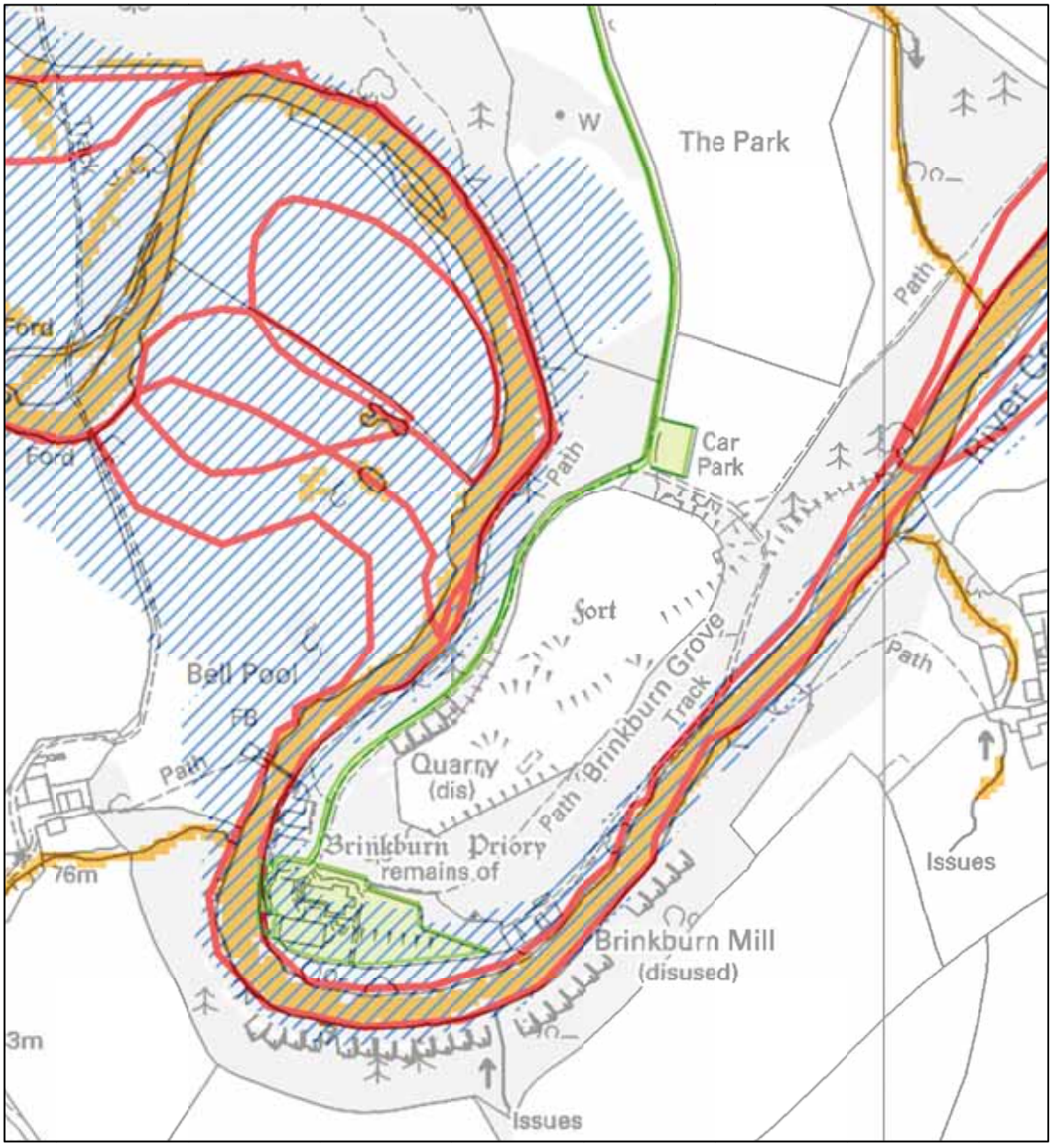
(2) Surface water flood – the area of the estate at risk is the same as the area within Flood Zone 3 apart from an additional risk that access to the estate from the north could be impaired by a narrow belt of surface water flooding.

(3) There is some risk of erosion to that part of the estate adjacent to the Cor Burn in the event of a serious flood event. Increase water flow could rapidly erode the banks of the watercourse leading to the loss of archaeological deposits associated with the castle.

Brinkburn Priory, North-East Region

An Augustinian Priory founded in the early twelfth century

NGR	411617 598306	Listed Building	1303969 (Priory Church)
Scheduled Monument	1007508	Estate Number	N0093
Flood Watch Area	Lower River Coquet	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Recorded Flood – the mapping by the Environment Agency of the extent of a flood when the River Coquet overtopped its banks on 6 September 2008 indicates that the flood waters impinged upon the west side of the estate. This is tangible evidence of the risk to the estate posed by the river during a flood event.

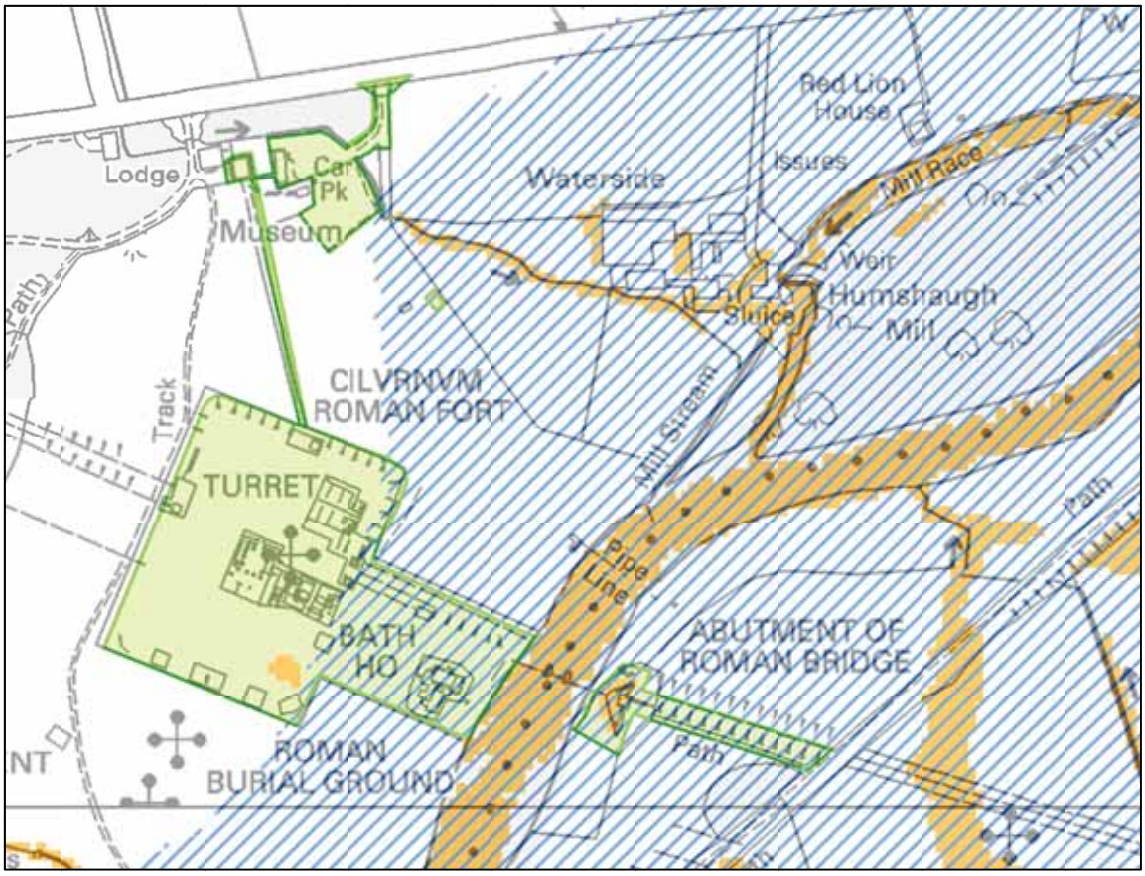
(2) Flood Zone 3 – the majority of the estate is at risk from such a flood event including the priory church and adjacent hall. These buildings could be at considerable risk of damage depending on the force of the water flow after the River Coquet has overtopped its banks.

(3) There is considerable risk to archaeological remains belonging to the priory from erosion by the River Coquet during a major flood event. The area under threat is likely to include remains belonging to the claustral range of the priory.

Chesters Roman Fort, North-East Region

A Roman fort on Hadrian's Wall

NGR	391206 570142	Listed Building	
Scheduled Monument	1010959	Estate Number	N0146
Flood Watch Area	River North Tyne	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – flooding poses a threat to that part of the estate nearest to the River North Tyne including the exposed remains of the Roman bath house which could be vulnerable to damage during a major flood event.

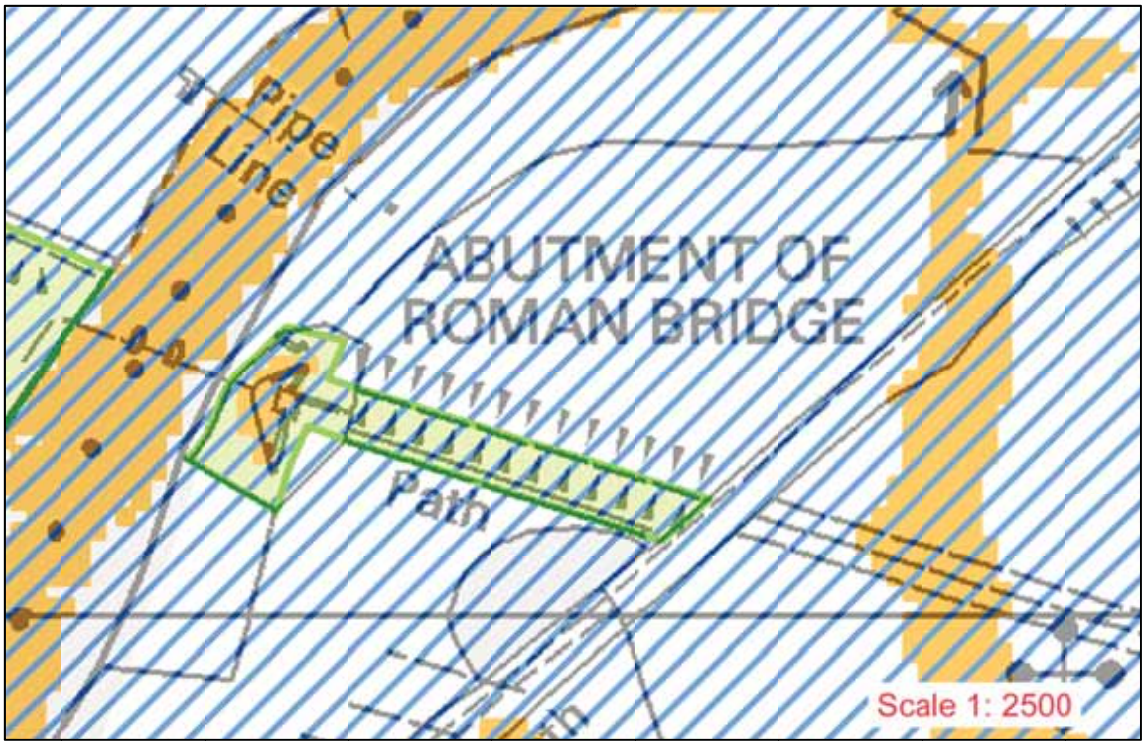
(2) Surface Water Flood –a small area of the fort interior appears to be at risk of surface water flooding but this is unlikely to cause any serious problems.

(3) A serious flood event affecting the River North Tyne could lead to some loss of archaeological remains on the east side of the estate bordering the river due to erosion of the banks.

Chesters Bridge Abutment, North-East Region

Remains of a Roman stone bridge

NGR	391470 570055	Listed Building	
Scheduled Monument	1018581	Estate Number	N0145
Flood Watch Area	River North Tyne	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the entire estate is at risk from such a flood event with the potential for extensive damage to the exposed remains of the bridge abutment and to the access to the site.

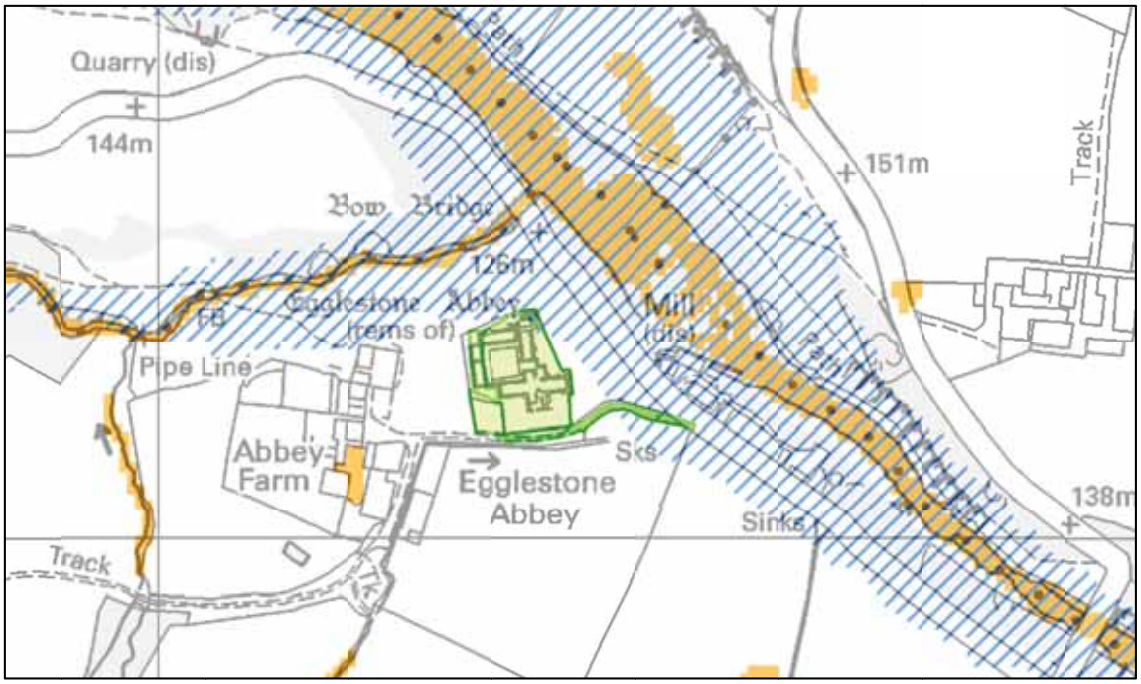
(2) Surface water flooding – the Environment Agency model indicates the possible risk of a small area of surface water flooding in and around the bridge abutment which could cause some damage to the exposed masonry.

(3) A serious flood event affecting the River North Tyne could lead to some loss of archaeological remains on the west side of the estate bordering the river due to erosion of the banks.

Egglestone Abbey, North-East Region

A Premonstratensian abbey founded in the late twelfth century

NGR	406237 515109	Listed Building	1322741
Scheduled Monument	1011642	Estate Number	N0216
Flood Watch Area	Upper River Tees	Flood Protection	None listed



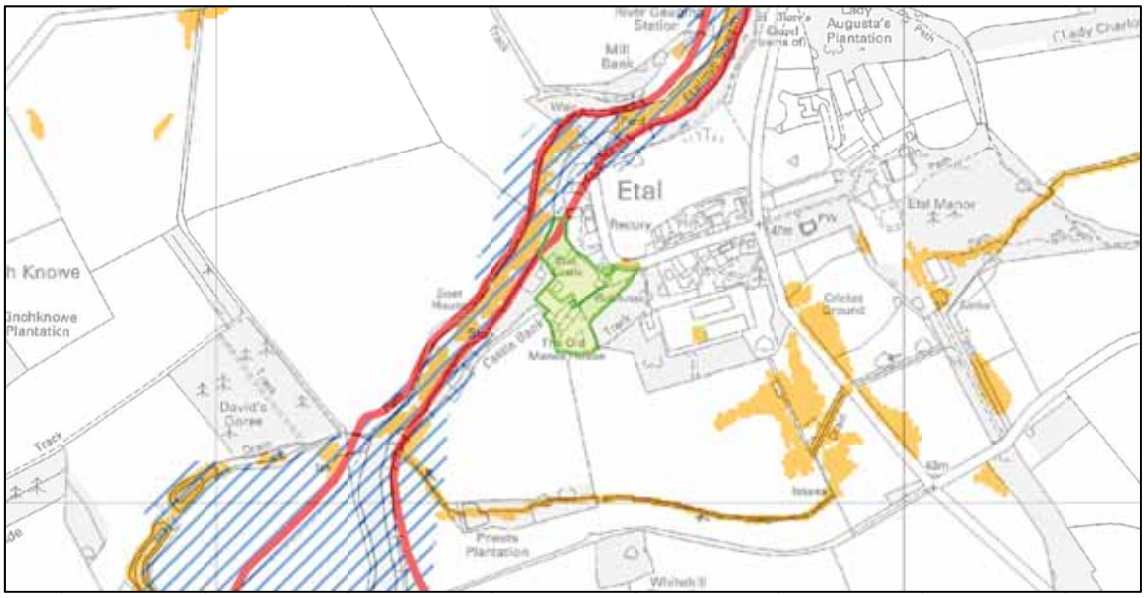
Nature and Extent of Flood Risk

(1) Flood Zone 3 – the estate is on the edge of a wide zone at risk of flooding from the River Tees. This could prevent access to the site along the track from the main road and possibly impinge on the north-east corner of the estate affecting the standing remains of part of the claustral range and a modern building in the same area.

Etal Castle, North-East Region

A castle founded in the fourteenth century

NGR	392525 639319	Listed Building	1042183 (Castle Tower)
Scheduled Monument	1011644	Estate Number	N0218
Flood Watch Area	River Till and Tributaries	Flood Protection	None listed



Nature and Extent of the Flood Risk

(1) Historic Flood – the River Till overtopped its banks on 6 September 2008. The Environment Agency mapped the extent of the flood as impinging on the north-west edge of the estate.

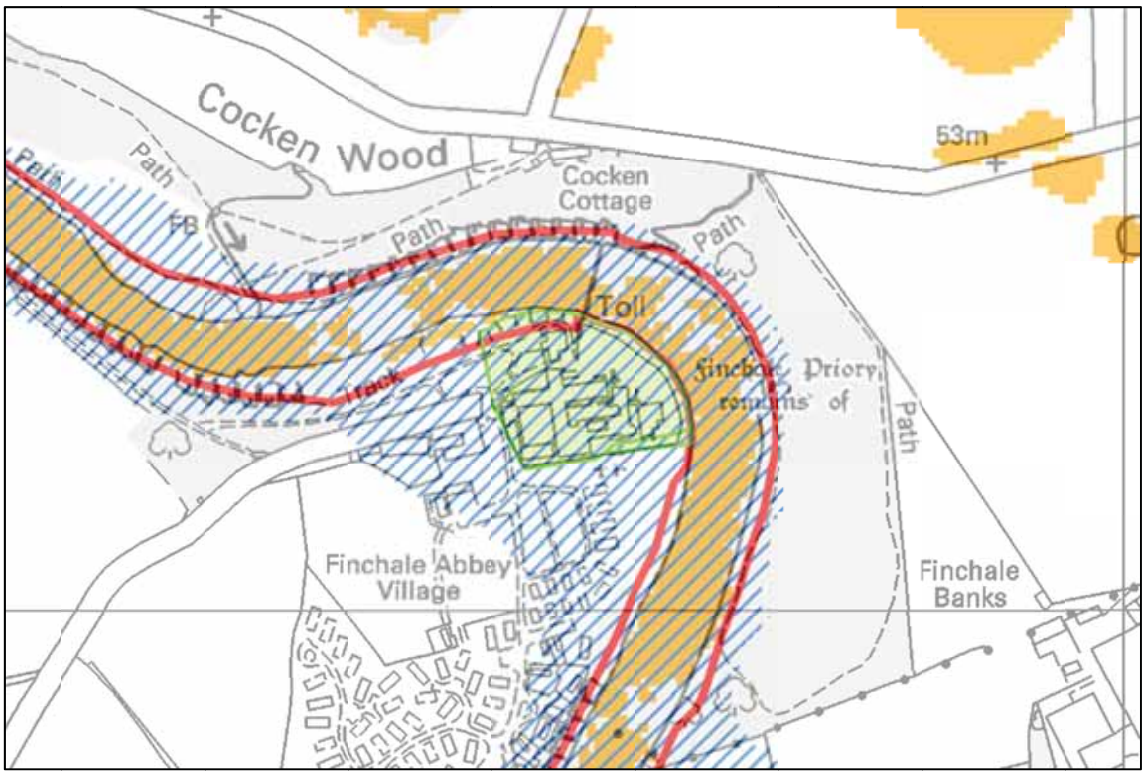
(2) Flood Zone 3 - there is a risk of flooding affecting the north-west edge of the estate but it is not predicted to extend more than a couple of metres so should not impact on the central area of the castle.

(3) There may be some risk of loss of archaeological evidence relating to the castle during a major flood event due to erosion of the south bank of the River Till where it borders the estate.

Finchale Priory, North-East Region

A Benedictine Priory founded in the late twelfth century

NGR	429638 547145	Listed Building	1159246
Scheduled Monument	1007561	Estate Number	N0239
Flood Watch Area	Lower River Wear	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – a flood caused by overtopping of the River Wear between 31 January and 1 February 1995 was mapped by the Environment Agency as extending across the north edge of the estate. None of the medieval buildings appears to have been affected.

(2) Flood Zone 3 – there is the possibility of the entire estate becoming subsumed by such a flood event which would have a major impact on the remains of the abbey and associated modern infrastructure. During such an event the estate would in all probability be totally inaccessible.

(3) During a major flood event there must be serious risk of the loss of archaeological evidence relating to the abbey due to erosion caused by increased water flow along the River Tees. The erosion risk extends for a distance of almost 200m along the east and north sides of the estate.

Poltross Burn, North-East Region

A Roman milecastle (no. 48) on Hadrian's Wall

NGR	363405 566173	Listed Building	
Scheduled Monument	1015923	Estate Number	N0496
Flood Watch Area	Rivers Esk and Irthing	Flood Protection	None listed

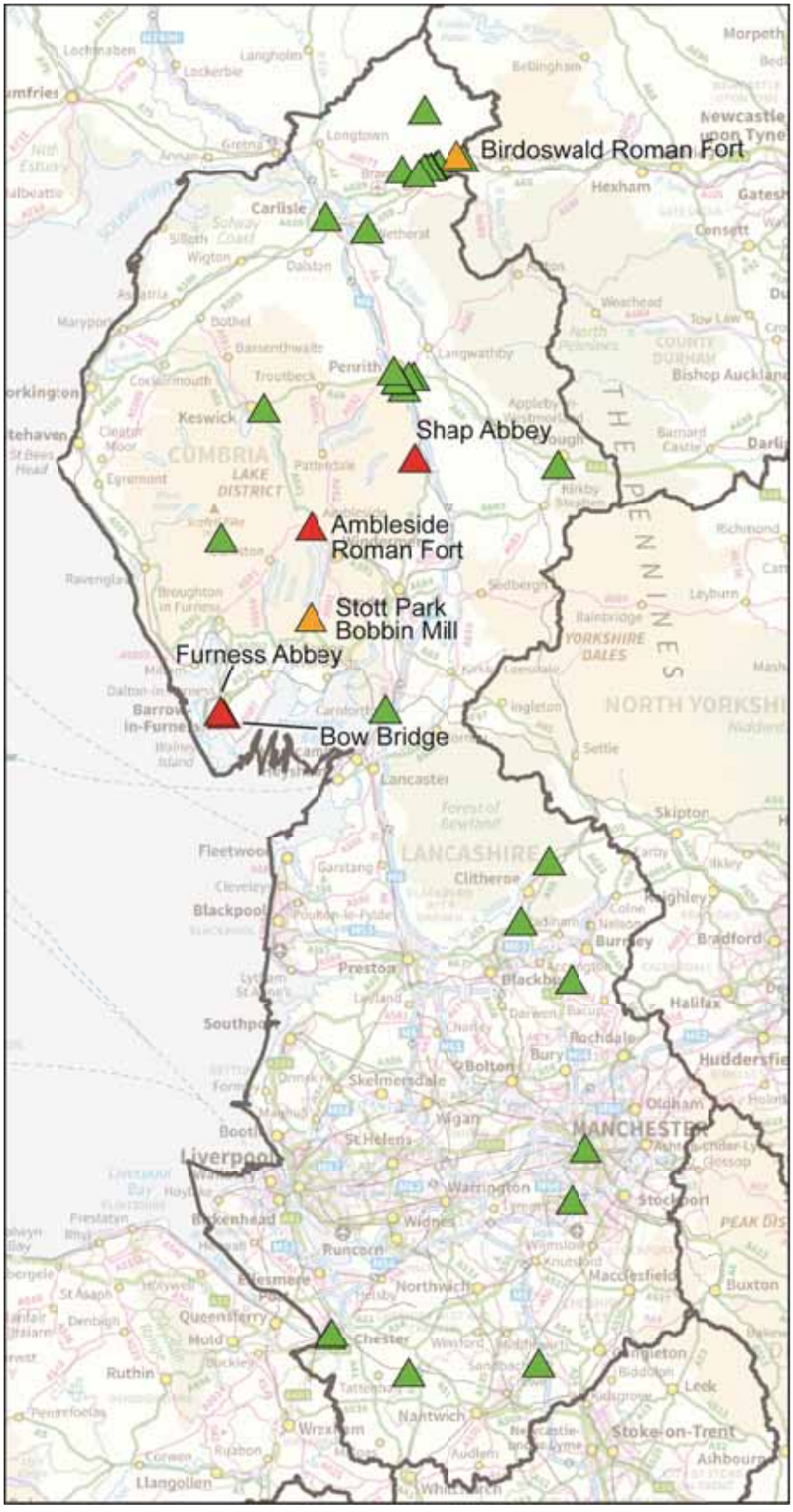
Nature and Extent of the Flood Risk

(1) Flood Zone 3 – such a flood event is predicted to extend across the eastern third of the estate in which case access to the site along the path will be severed. There is likely to be minimal impact on the remainder of the site as from the mapped a flood of this severity is unlikely to extend as far the remains of the milecastle.

(2) Surface water flood – this risk is restricted to the margins of the Poltross Burn and therefore unlikely to have severe consequences although it is possible that part of the path giving access to the estate will be covered and may be rendered impassable.

(3) Flooding of the Poltross Burn may lead to erosion of the west bank which marks the east boundary of the estate. Erosion during a severe flood event could lead to loss of archaeological remains in particular associated with the vallum to the south of Hadrian's Wall.

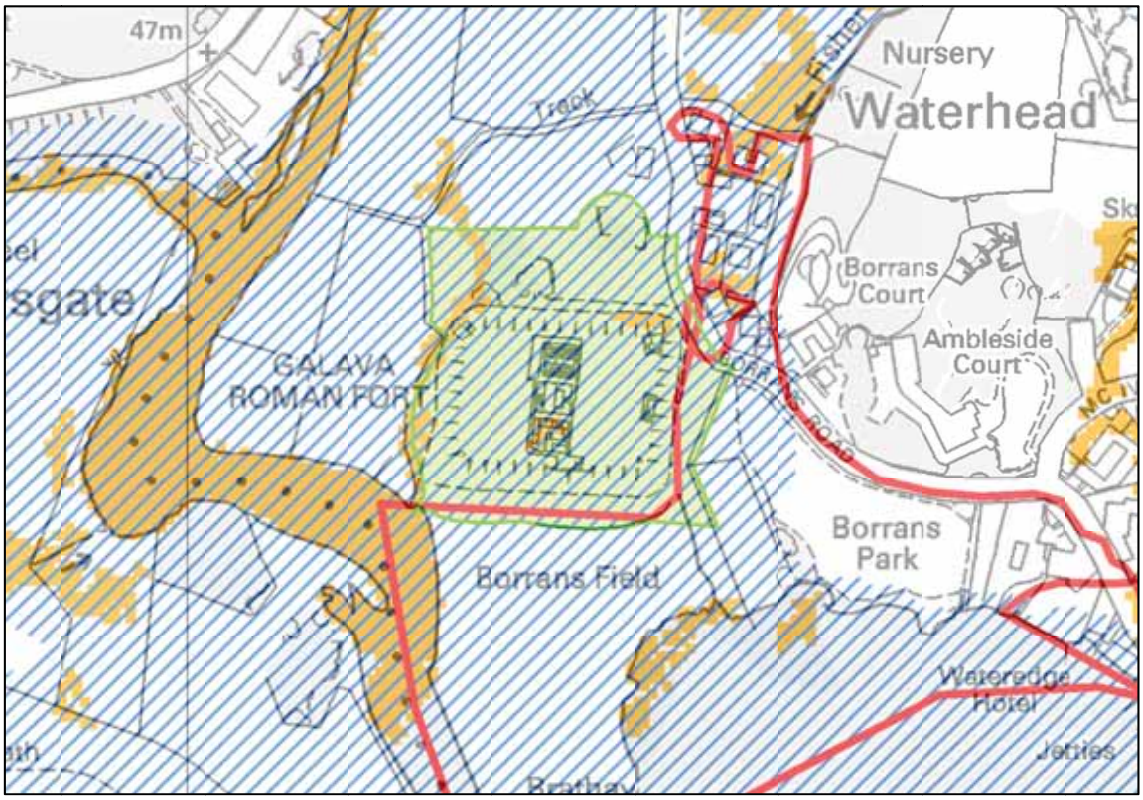
(5.6) North-West Region



Ambleside Roman Fort, North-West Region

A Roman fort established in the first century AD

NGR	337242 503441	Listed Building	1244785
Scheduled Monument	1009348	Estate Number	N0026
Flood Watch Area	Rivers Brathay, Rothey and Winster	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – as mapped by the Environment Agency the east and south edges of the estate were covered by flood waters between 19 and 22 November 2009. On the east the flood waters extended as far as the perimeter of the Roman fort.

(2) Flood Zone 3 – the entire estate is at risk during such a flood event with waters predicted to extend right across the low-lying ground between Lake Windermere and the River Rothay. This could cause extensive damage to the exposed remains of the Roman fort and to associated earthworks and will make the site impassable for a period.

(3) Surface water flooding – the risk is mainly restricted to a depression marking the former course of the river on the west of the estate. Elsewhere surface water flooding is

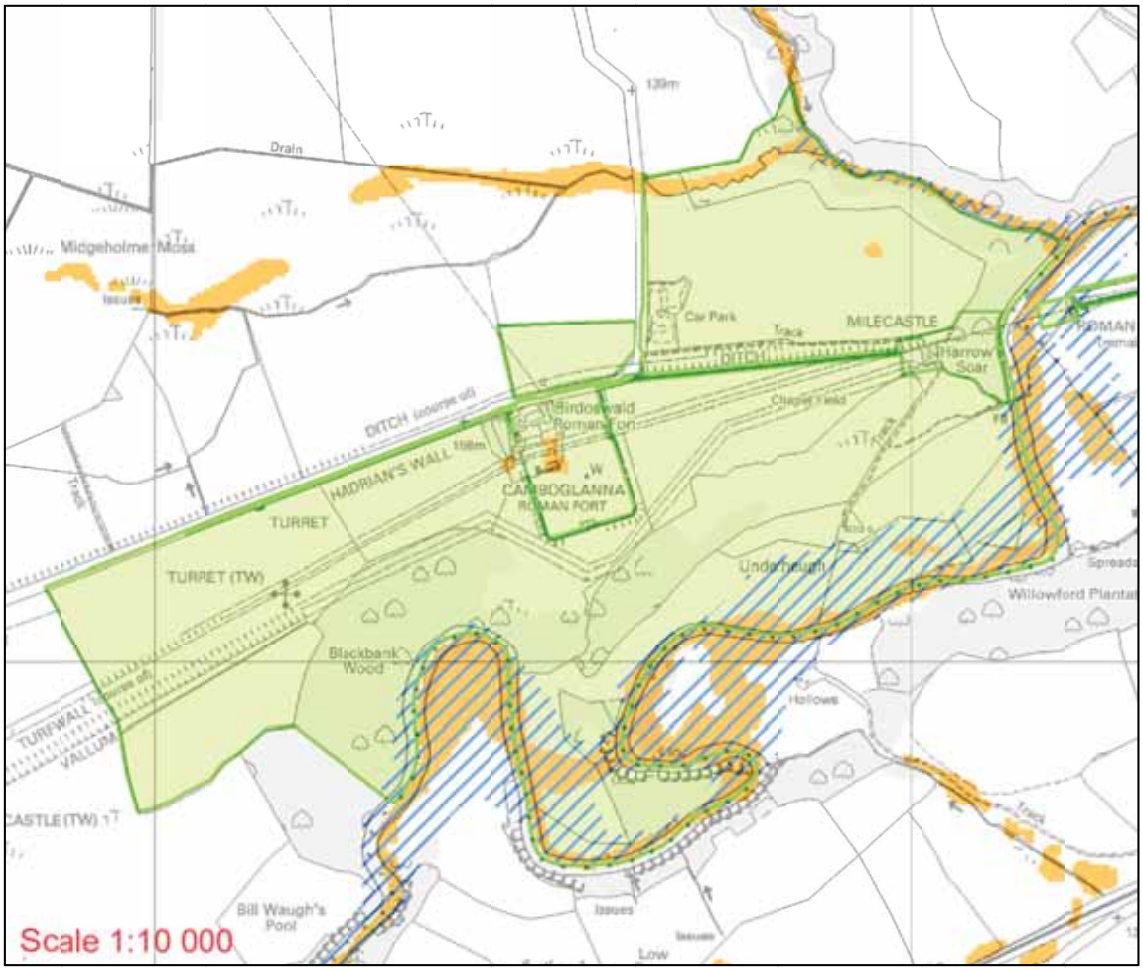
predicted in the ditch bottom on the north-east of the fort and among the exposed remains of the Commandant's House.

(4) During a major flood event it is possible that increased erosion by the River Rothay could cause damage to the south-west corner of the estate where they may well be archaeological deposits associated with the Roman fort.

Birdoswald Roman Fort, North-West Region

A Roman Fort on Hadrian's Wall

NGR	361561 566254	Listed Building	1249314 (Farmhouse)
Scheduled Monument	1010994	Estate Number	N0076
Flood Watch Area	River Esk and Irthing	Flood Protection	None listed



Nature and Extent of the Flood Risk

(1) Flood Zone 3 – the risk is to the low-lying land along the south margin of the estate situated between the escarpment and the River Irthing. Such a flood event is therefore likely to mainly affect the fields in this area and have minimal impact on the Roman fort and associated infrastructure.

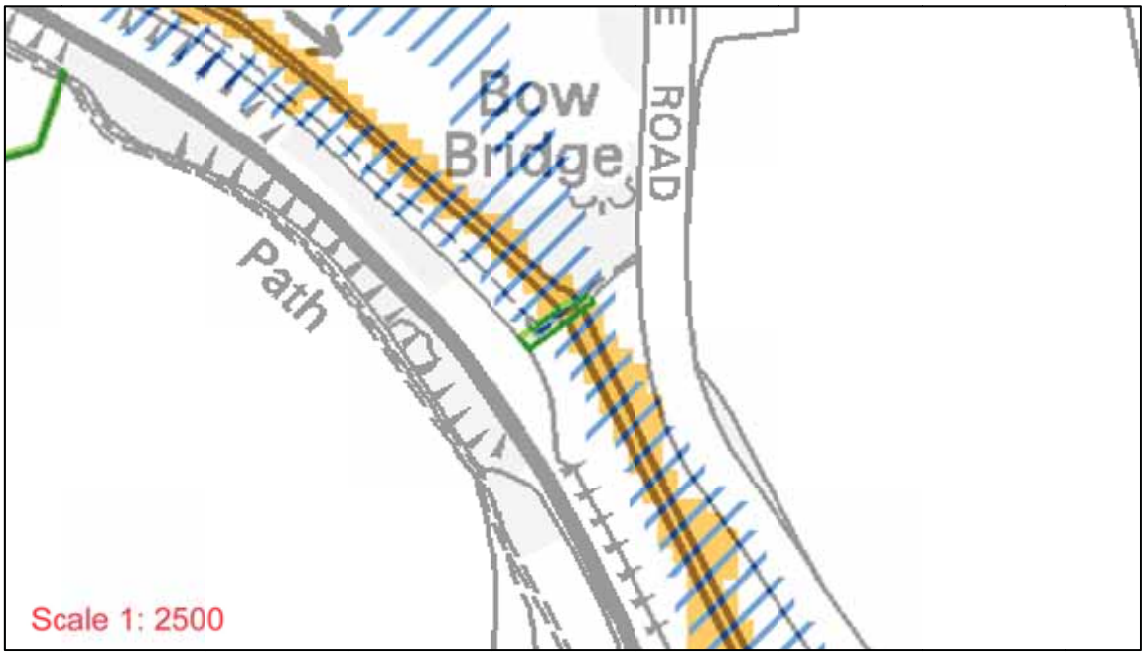
(2) Surface water flooding – the risk is restricted to the low-lying ground bordering the River Irthing.

(3) A flood event affecting the River Irthing is likely to lead to some erosion of the bank forming the south side of the estate. This is well away from the main area of known Roman activity above the escarpment and therefore its archaeological impact is likely to be negligible.

Bow Bridge, North-West Region

A stone bridge from the fifteenth century

NGR	322377 471479	Listed Building	
Scheduled Monument	1011245	Estate Number	N0086
Flood Watch Area	Rivers Duddon, Crake and Mill Beck	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the bridge and access to it are likely to be affected by a flood of this magnitude leading to possible structural damage to the bridge itself depending on the strength of the flood water.

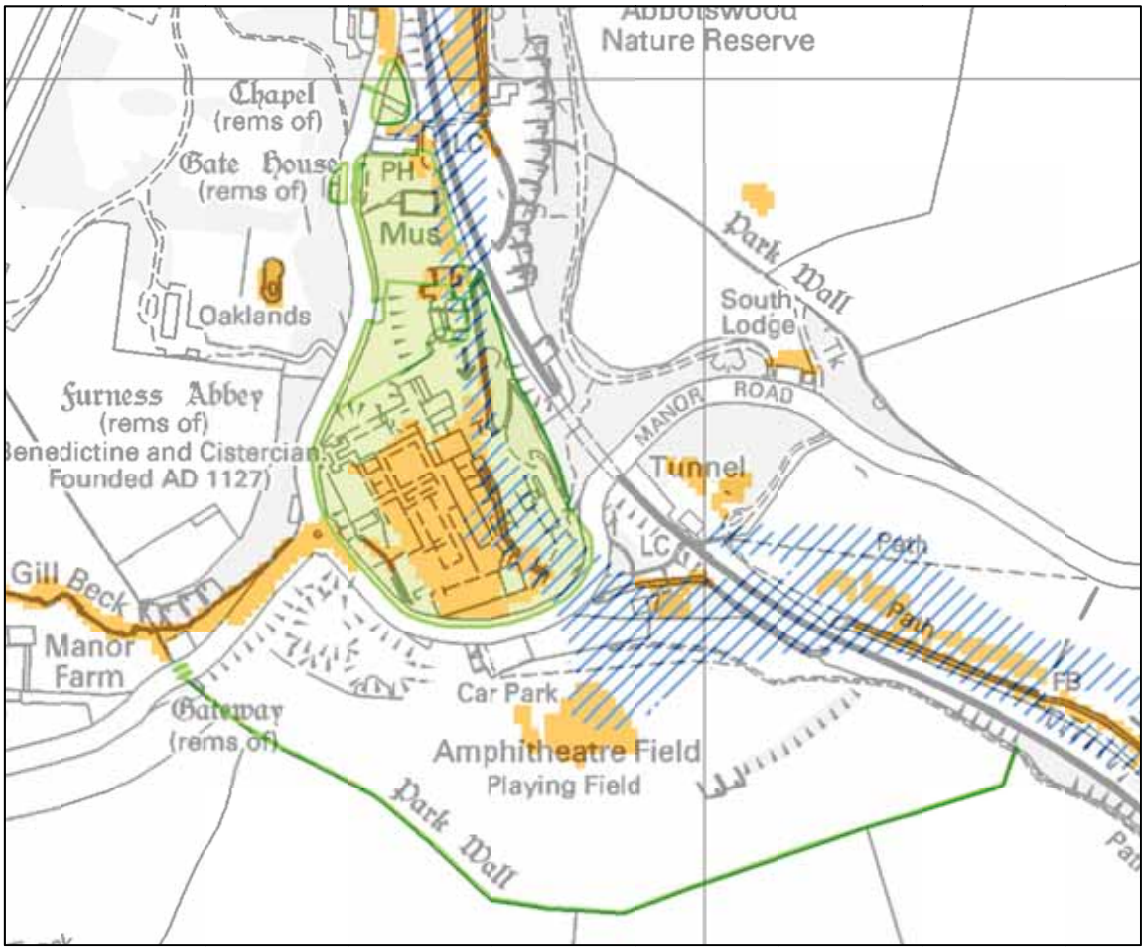
(2) Surface water flood – this is predicted to spread out along the margins of the Mill Beck and may make the bridge itself impassable

(3) There is a risk that during a flood event the force of the Mill Beck could damage the structure of the bridge especially as the narrow opening could turn the bridge into a dam by trapping material washed down from higher up the river.

Furness Abbey, North-West Region

A Savignac Monastery founded in the early twelfth century

NGR	321833 471773	Listed Building	1197906
Scheduled Monument	1010014	Estate Number	N0247
Flood Watch Area	Rivers Duddon, Crake and Mill Beck	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the main risk is to flooding along the margins of the Mill Beck which crosses the estate from north to south and presumably supplied the abbey with water in the medieval period. The flooding could extend as far as the east side of the claustral range where it could damage standing masonry and exposed foundations and could impinge upon the site museum.

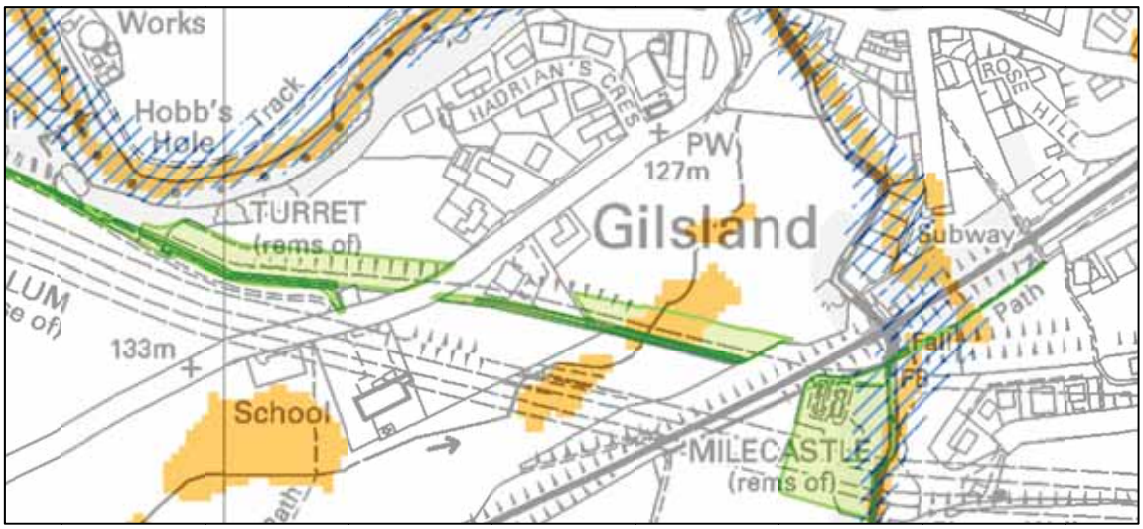
(2) Surface water flood – the risk is predicted to extend across the claustral range as far as the site of the abbey church with other pockets of flooding predicted elsewhere along the margins of the Mill Beck. The predicted depth is in excess of 0.3m posing a considerable risk to most of the standing remains of the abbey.

(3) A flood event that increased the flow along the Mill Beck and the smaller Dane Gill Beck (which enters the estate from the west) could lead to considerable erosion within the main body of the estate affecting the remains of the abbey buildings and associated archaeological deposits. Due to the hilly nature of the terrain, water flow could increase quite rapidly to become a destructive force during an exceptional period of heavy rain.

Milvain East and West, North-West Region

A section of Hadrian's Wall and Vallum

NGR	363150 566275	Listed Building	
Scheduled Monument	1015923	Estate Number	N0691
Flood Watch Area	Rivers Esk and Irthing	Flood Protection	None listed



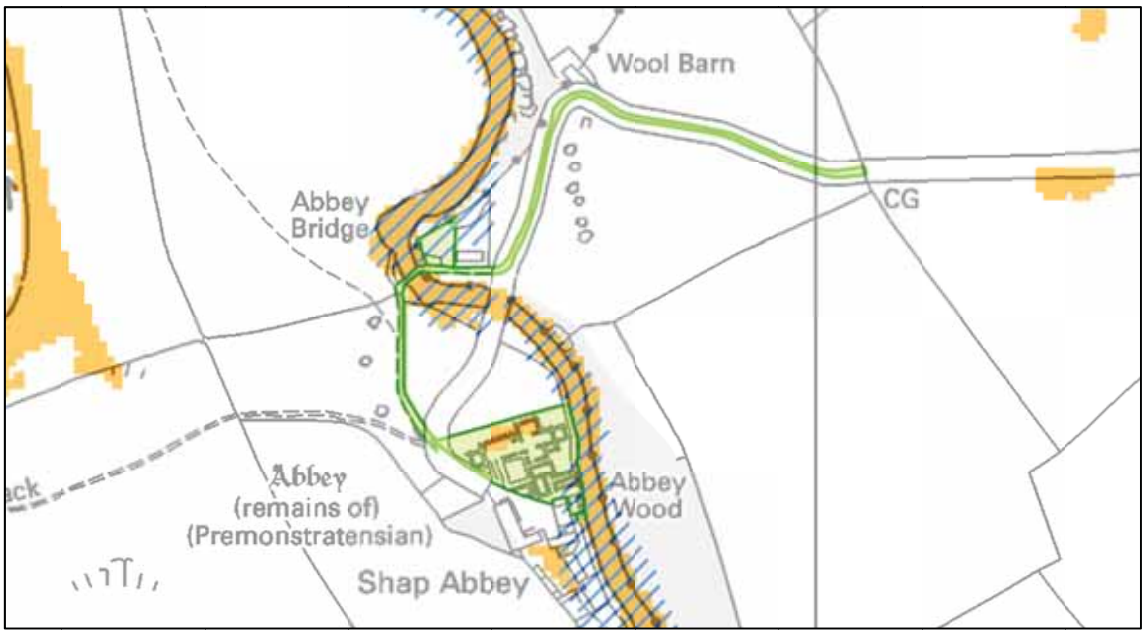
Nature and Extent of Flood Risk

(1) Surface water flood – this is predicted to occur in the low ground followed by the small stream that crosses the East Milvain estate. Such a flood event will put at risk the central section of the estate with the flooding predicted to exceed 0.3m depth over some of the area. Roughly this same area is predicted to fall within Flood Zone 2 (not shown on the map).

Shap Abbey, North-West Region

A Premonstratensian abbey founded in the late twelfth century

NGR	354807 515228	Listed Building	
Scheduled Monument	1011636	Estate Number	N0559
Flood Watch Area	Rivers Lowther and Eamont	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – flooding is confined to the margins of the River Lowther and the main impact of such a flood event will be on access to the site with waters predicted to cover the area of the car park and part of the route from there to the main part of the estate containing the abbey ruins. Flooding may also impinge upon the remains of claustral buildings nearest to the river.

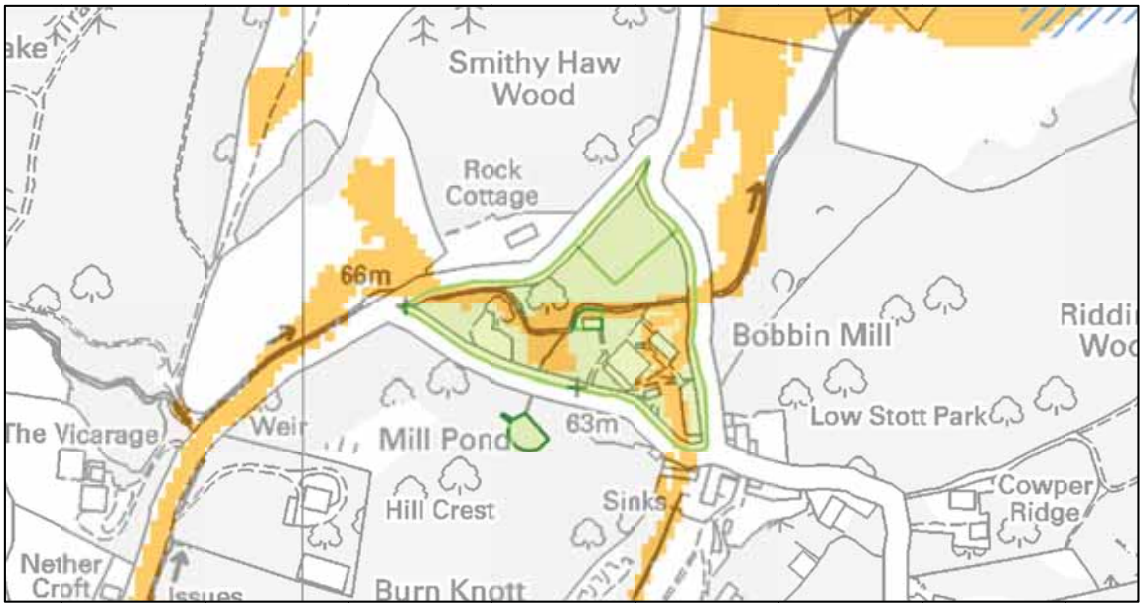
(2) Surface water flooding – predicted to occur along the margins of the river Lowther and therefore may impact on access to the site via Abbey Bridge and on the remains of claustral buildings nearest to the river. There is also the possibility of an area of surface water flooding around the north side of the nave of the abbey church which may cause some damage to the exposed masonry.

(3) Flooding of the River Lowther could result in erosion of the bank bordering the main part of the EH estate leading to the risk of destruction of archaeological deposits in this area close to the abbey church and claustral range.

Stott Park Bobbin Mill, North-West Region

A bobbin mill from the nineteenth century

NGR	337199 488228	Listed Building	
Scheduled Monument	1014936	Estate Number	N0576
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of the Flood Risk

(1) Surface water flood – there is an extensive risk predicted of surface water flooding either side of the stream that crosses the estate reaching a predicted depth in excess of 0.3m. The flooding may also extend around the immediate environs of the mill and the associated structures though this is estimated to reach a shallower depth.

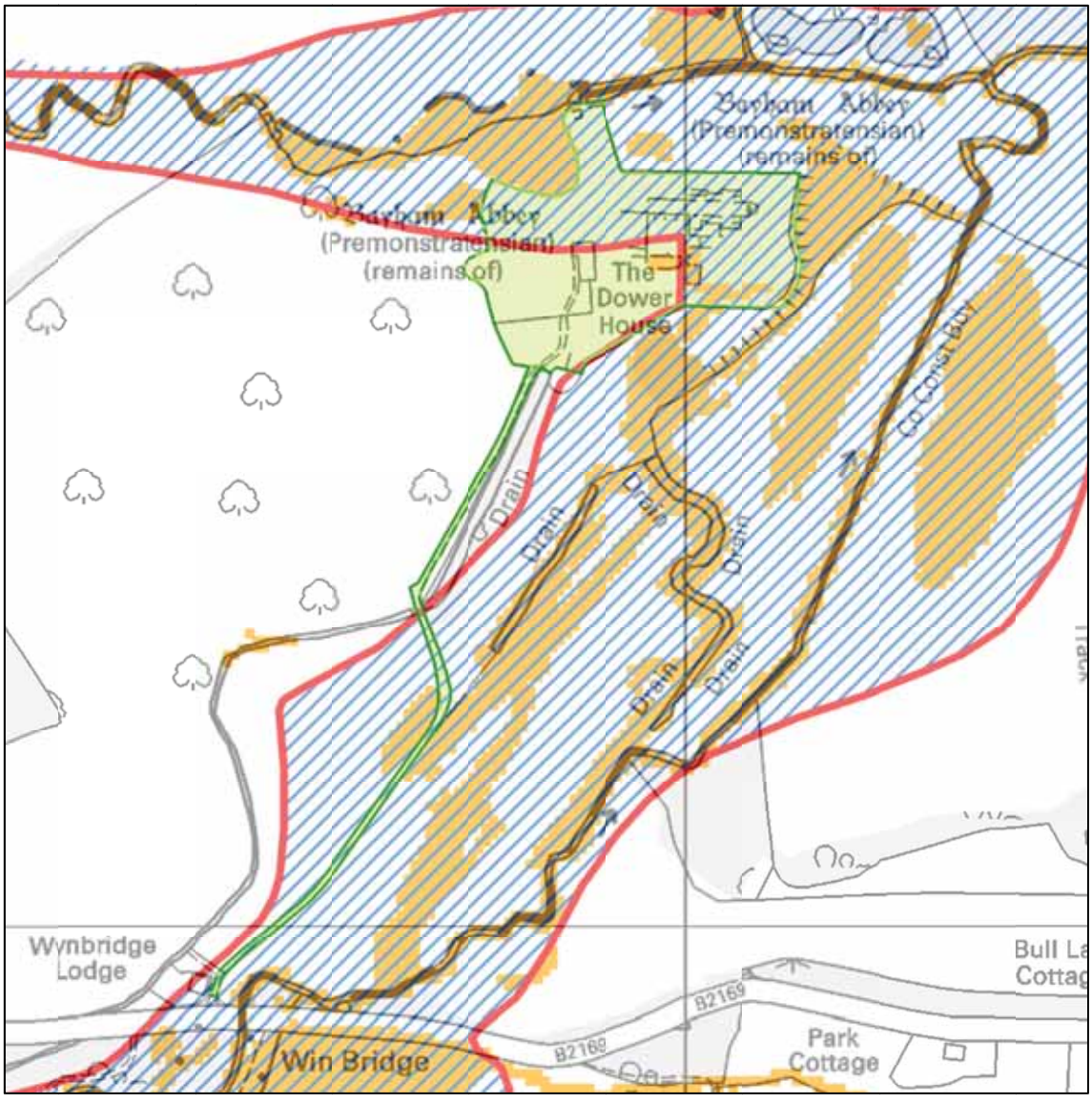
(2) The estate is vulnerable to erosion from the stream which crosses the site from west to east. The stream flows from higher ground to the west and could experience a rapid increase in erosive force during a period of exceptionally heavy rain.

(5.7) South-East Region

Bayham Abbey Ruins, South-East Region

A Premonstratensian Abbey founded in the early thirteenth century

NGR	564960 136741	Listed Building	1192095
Scheduled Monument	1012541	Estate Number	Listed as unknown
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – the mapped extent by the Environment Agency of a flood that occurred on 2-4 November 1960 indicates that a substantial part of the EH estate was

flooded including the exposed foundations of the abbey and the access route from the B2169.

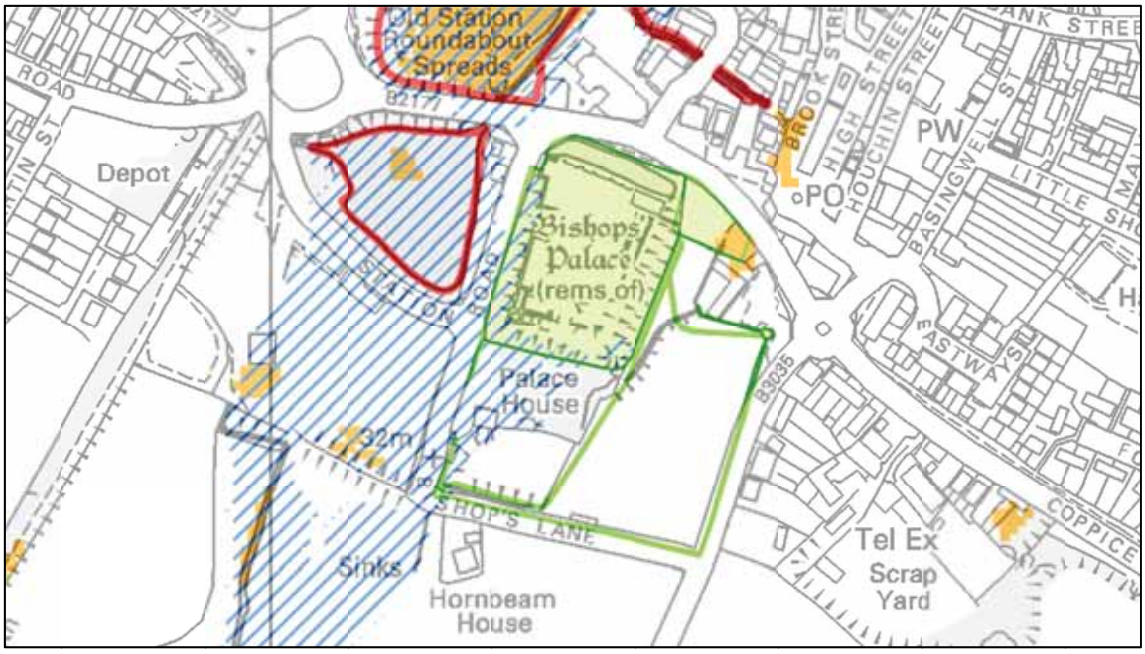
(2) Flood Zone 3 – a substantial part of the EH Estate including the access from the B2169 are at risk and such a flood event could damage the abbey remains and will make the site impassable.

(3) Surface water flood – the predicted extent are mainly associated with the drains flowing northwards into the River Teise to the north of the estate. Such an event could disrupt access to the main part of the estate from the B2169 in one area and also impinge upon exposed medieval foundations on the south side of the monastic cloister.

Bishops Waltham Palace, South-East Region

A residence of the Bishop of Winchester founded in the mid-twelfth century

NGR	45224 117355	Listed Building	1350584 (Stables)
Scheduled Monument	1016169	Estate Number	Listed as unknown
Flood Watch Area	River Hamble	Flood Protection	None listed



Nature and Extent of the Flood Risk

(1) Flood Zone 3 – the predicted extent of such a flood event is confined to the south and west boundary of the main part of the estate where a moat formally bordered the residential complex. It is not likely to have any major impact on the standing remains and associated earthworks.

(2) Surface water flood – the area predicted by the Environment Agency is confined to one area on the north-east corner of the main part of the estate and therefore will probably have little impact on the overall estate.

Camber Castle, South-East Region

A Tudor artillery fort

NGR	592173 118451	Listed Building	1234738
Scheduled Monument	1014632	Estate Number	Listed as unknown
Flood Watch Area	Coast from Fairlight to Dungeness including the Tidal River Rother	Flood Protection	Listed as benefitting from flood defences

Nature and Extent of Flood Risk

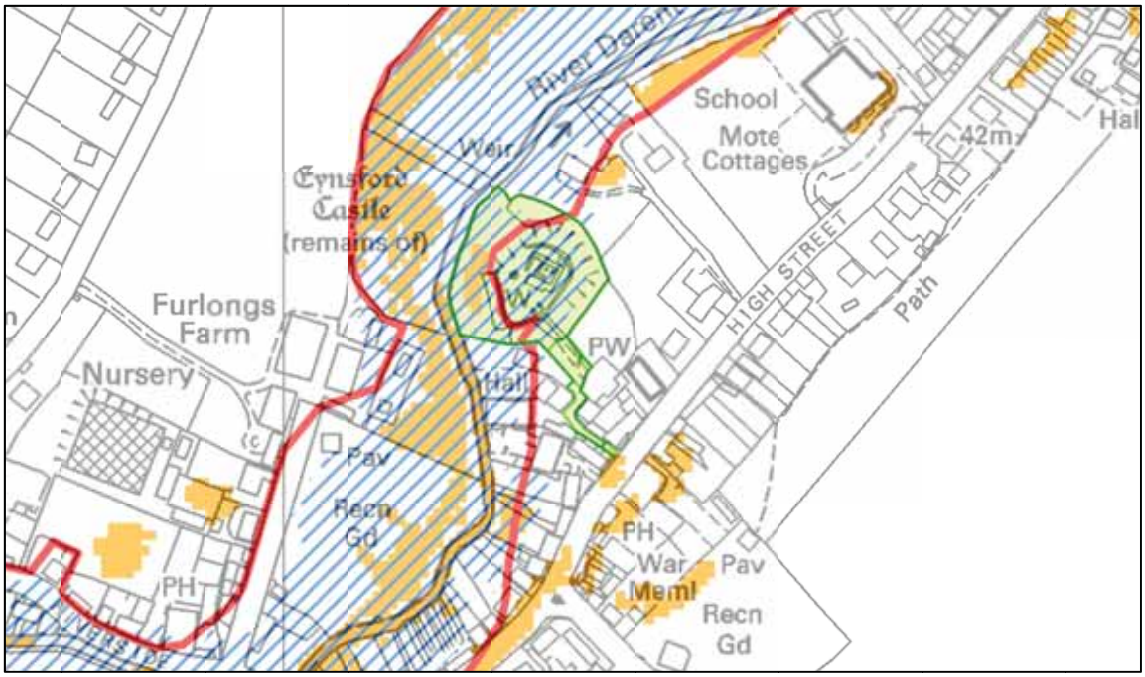
(1) Flood Zone 3 – the entire estate is at risk from such a flood event caused by tidal flooding. The estate will be rendered impassable and damage could occur to the standing remains of the artillery fort.

(2) Surface water flood – the predicted extent suggests the impact on the estate will be minimal with no risk to the standing remains.

Eynsford Castle, South-East Region

A castle founded in the late eleventh century

NGR	554165 165817	Listed Building	
Scheduled Monument	1007462	Estate Number	Listed as unknown
Flood Watch Area	River Darent Area	Flood Protection	None listed



Nature and Extent of the Flood Risk

(1) Historic Flood – the extent of the flood event of the 14 September 1968 as recorded by the Environment Agency indicates that the west half of the estate was covered by the flood water.

(2) Flood Zone 3 – the majority of the estate lies within this flood zone suggesting there is a major risk to the estate and in particular to the standing remains of the castle. Such a flood event would probably make the site impassable and could cause extensive damage.

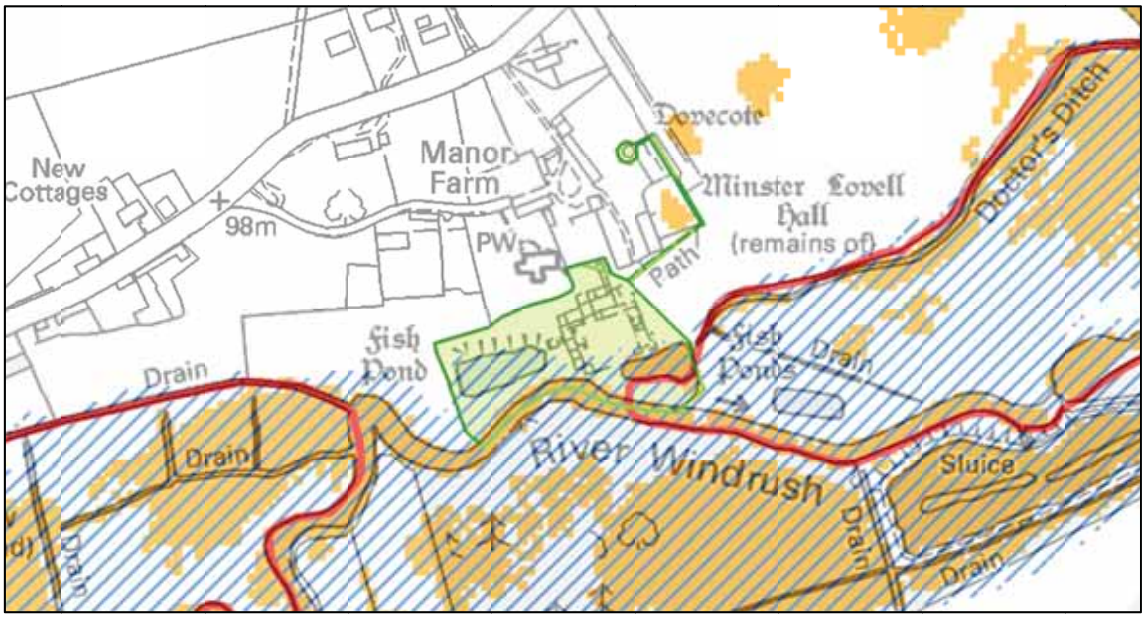
(3) Surface water flood – the predicted extent indicates the risk is to an area immediately to the west of the standing remains of the castle and perhaps also to the area where the access route leaves the main road.

(4) A risk exists during a major flood event that the west boundary of the estate bordering the River Darant will be at risk due to increased flow eroding the banks of the river. This could lead to the loss of archaeological remains associated with the castle.

Minster Lovell Hall and Dovecote, South-East Region

A manor house founded in the fifteenth century

NGR	432431 211321	Listed Building	1053431
Scheduled Monument	1015321	Estate Number	Listed as unknown
Flood Watch Area	River Windrush from Bourton to Newbridge	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – the extent of the flood of 19-29 July 2007 as mapped by the Environment Agency indicates that the south-east corner of the main part of the estate was affected by the flood water when the River Windrush overtopped its banks.

(2) Flood Zone 3 – the predicted extent indicates that the south half of the main part of the estate is likely to be at risk during such a flood event and which may cause some damage to the exposed foundations of buildings forming the medieval hall complex although the standing remains lie outside the predicted extent of the flood.

(3) Surface water flood – the Environment Agency prediction indicates a marginal risk to the south boundary of the main part of the estate bordering the River Windrush and around the margins of a pond within the estate.

(4) A major flood event could lead to the loss of archaeological deposits associated with the medieval hall due to increased erosion of the north bank of the River Windrush which forms the south boundary of the estate.

Ospringe, Maison Dieu, South-East Region

A hospital founded in the thirteenth century

NGR	600362 160853	Listed Building	1069431
Scheduled Monument	1011801	Estate Number	Listed as unknown
Flood Watch Area	None listed	Flood Protection	None listed

Nature and Extent of Flood Risk

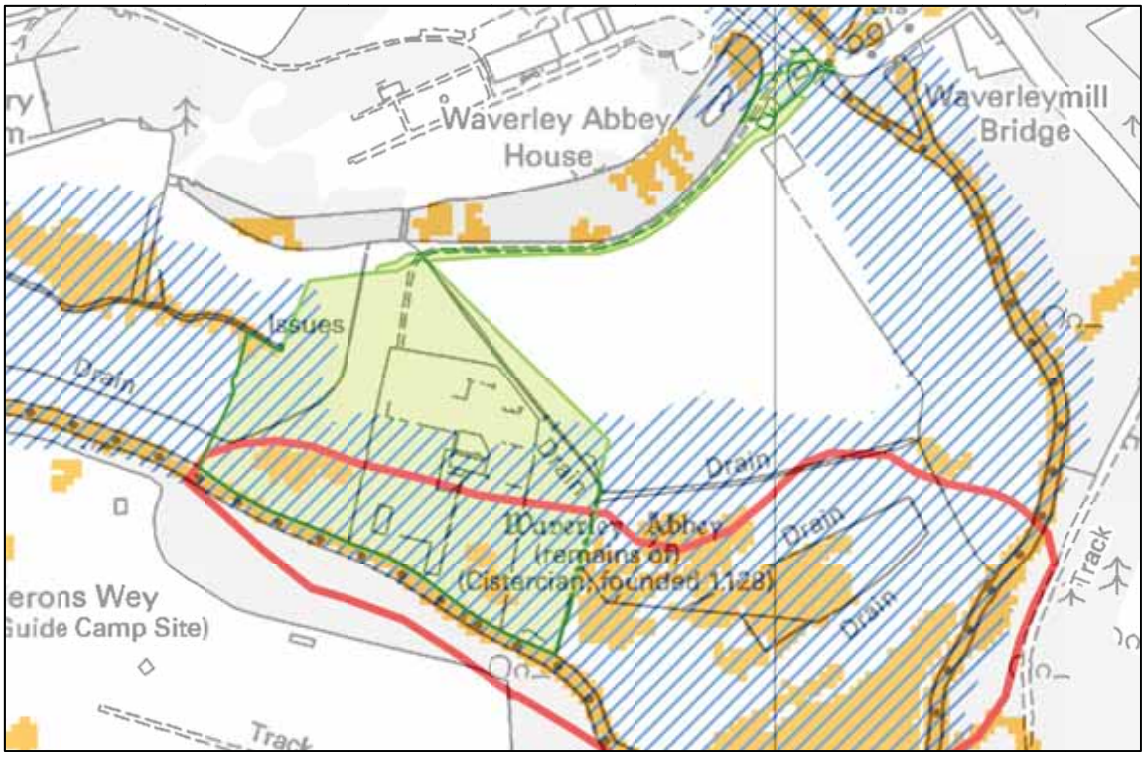
(1) Flood Zone 3 – the entire estate is at risk from such a flood event which could cause extensive damage to the historic building and its contents.

(2) Surface water flood – the predicted extent indicates that the risk is mainly to the roads adjacent to the estate and therefore may not have a direct impact on the historic building.

Waverley Abbey, South-East Region

A Cistercian abbey founded in the early twelfth century

NGR	486760 145302	Listed Building	
Scheduled Monument	1007814	Estate Number	Listed as unknown
Flood Watch Area	Upper River Wey	Flood Protection	None listed



Nature and Extent6 of Flood Risk

(1) Historic flood – as recorded by the Environment Agency, the flood of 6 February 1990 extended across the south half of the estate affecting some of the standing remains and exposed foundations of abbey buildings to the south of the church.

(2) Flood Zone 3 – the predicted extent of such a flood event indicates that around two-thirds of the estate is at risk. The area includes most of the remains of the claustral buildings and extends up to the south side of the site of the abbey church.

(3) Surface water flood – the predicted results of such a flood event are that two areas within the estate will be affected but these do not appear to put any of the visible remains of the abbey buildings at risk and therefore the impact is likely to be minimal.

(4) There is a risk that a flood event will increase the severity of erosion along the north bank of the River Wey where it forms the south boundary of the estate. This could lead to the loss of archaeological evidence connected with the abbey.

Wolvesey Castle (Old Bishops Palace), South-East Region

A residence of the Bishop of Winchester founded in the mid-twelfth century

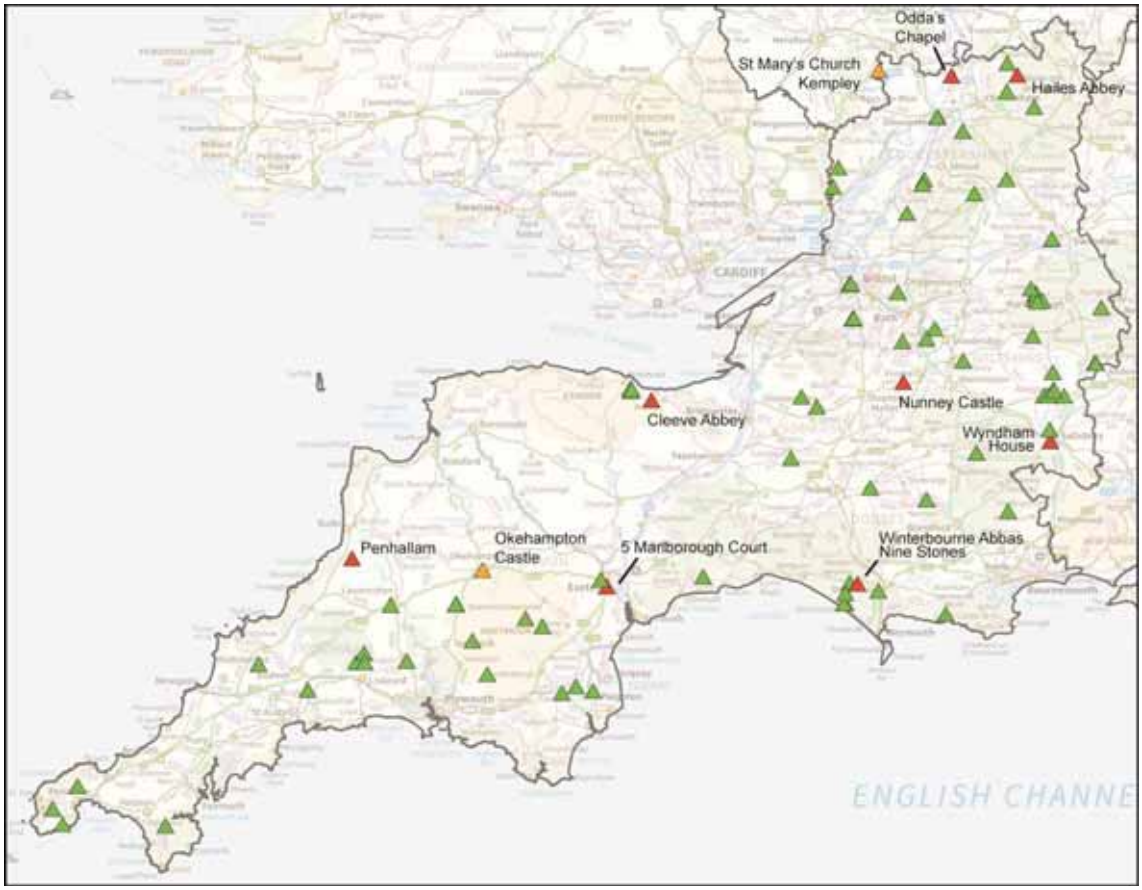
NGR	448444 129092	Listed Building	1095511
Scheduled Monument	1005535	Estate Number	Listed as unknown
Flood Watch Area	Middle Itchen	Flood Protection	None listed

Nature and Extent of Flood Risk

(1) Flood Zone 3 – risk appears to be confined to one area of the residence identified as the former latrine block and presumably connected with the drain that flows through this building. There may be some risk to exposed foundations and to standing masonry.

(2) Surface water flood – the predicted extent is confined to the area of the former latrine block. There may be some risk to exposed foundations and standing masonry.

(5.8) South-West Region



5 Marlborough Court, South-West Region

English Heritage Office Accommodation

NGR	292367 089673	Listed Building	
Scheduled Monument		Estate Number	Listed as unknown
Flood Watch Area	Lower Exe Area	Flood Protection	None listed

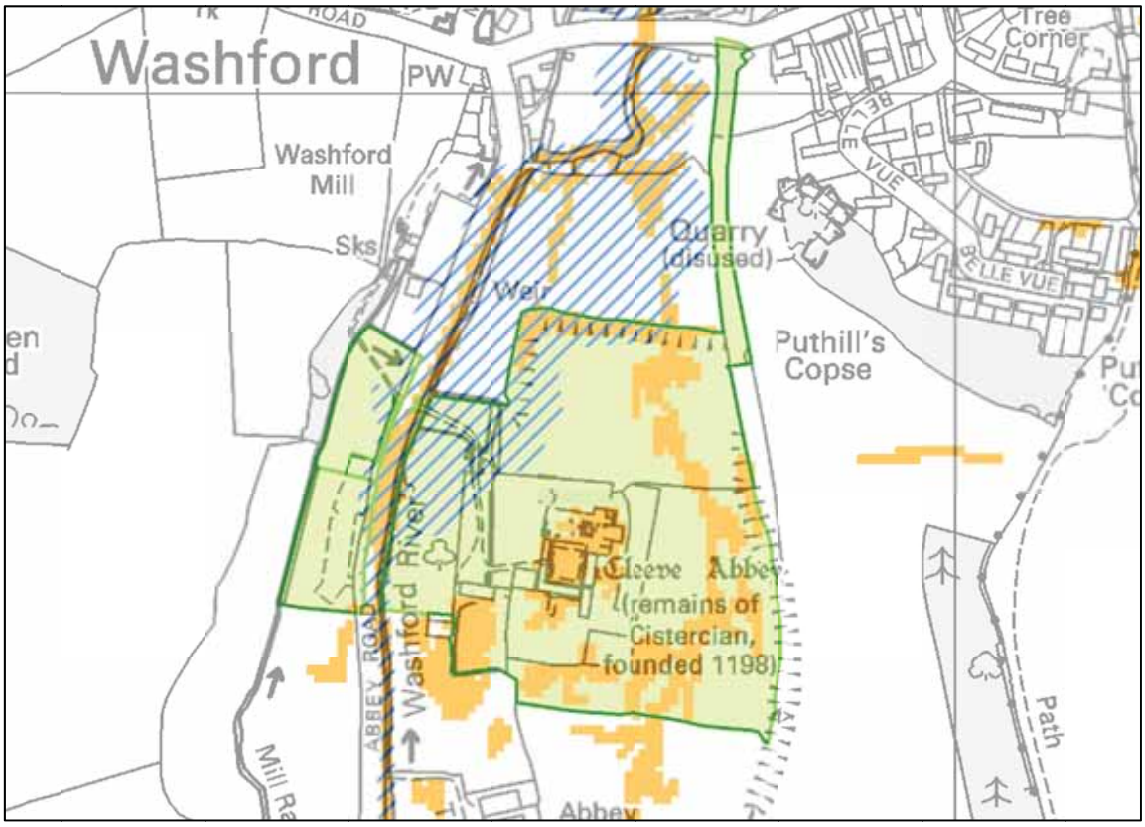
Nature and Extent of Flood Risk

(1) Flood Zone 3 – the building forming this estate is situated on the edge of the predicted flood zone and would become impassable during such an event with a strong risk of damage to the structure and its fixtures and fittings.

Cleeve Abbey, South-West Region

A Cistercian abbey founded in the late twelfth century

NGR	304757 140709	Listed Building	1057579
Scheduled Monument	1014824	Estate Number	W0153
Flood Watch Area	West Somerset Streams	Flood Protection	Flood defences along the stream crossing the estate



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the predicted extent along the course of the Washford River indicates that a significant part of the estate to the north-west of the abbey church is at risk.

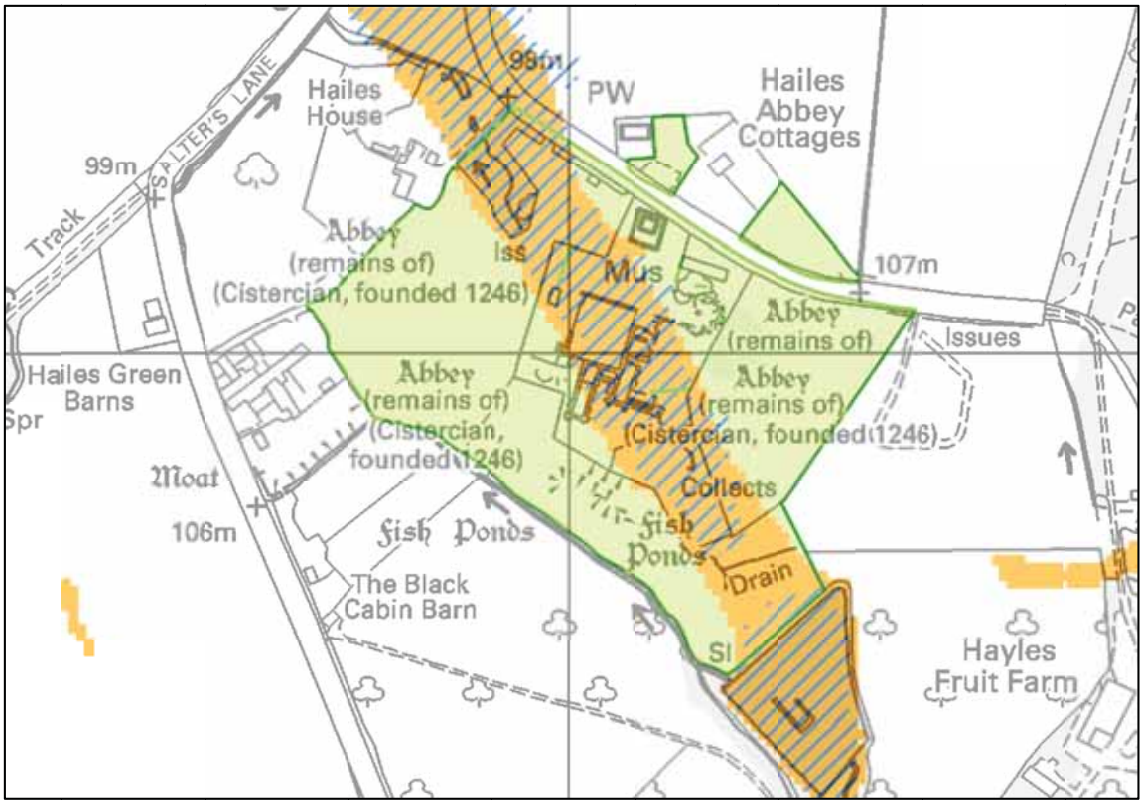
(2) Surface water flood – a significant part of the estate is predicted to be at risk from such a flood event and including the site of the abbey church and cloisters.

(3) The Washford River and the Mill Race to the west both pose a risk to the estate from increased erosion of the banks during a flood event. This could damage archaeological deposits associated with the abbey as well as possibly disrupting access to the site and the car park on the west side of Abbey Road.

Hailes Abbey, South-West Region

A Cistercian Abbey founded in the thirteenth century

NGR	405026 230002	Listed Building	1154262
Scheduled Monument	1018070	Estate Number	W0291
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the zone creates a wide belt across the middle of the estate and includes the site of the abbey church and claustral range. Such a flood event would undoubtedly cause damage to the exposed remains of the abbey.

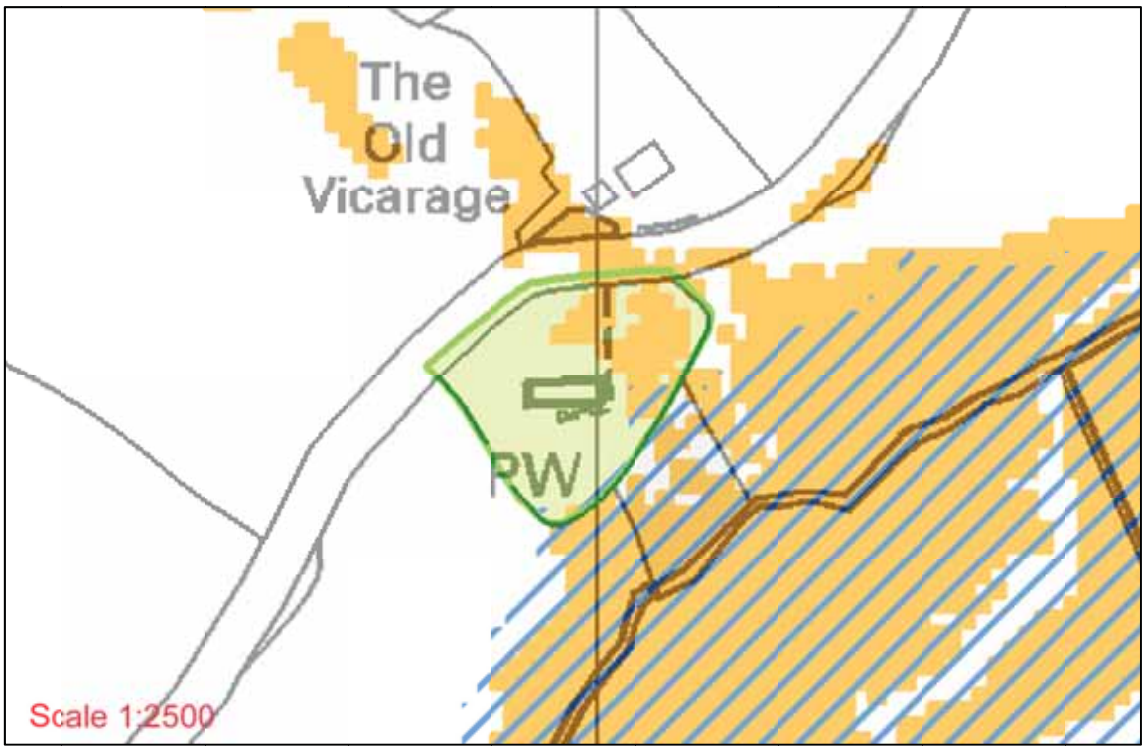
(2) Surface water flood – the area predicted to be at risk from surface water flooding almost exactly matches the extent of Flood Zone 3 putting at risk the site of the abbey church and claustral range.

(3) The abbey appears to be situated across the line of a natural water course which could conceivably reassert itself during a major flood event. Depending on the speed of water flow it is possible that flood water flowing across the estate could result in extensive damage to the exposed remains of the abbey.

St Mary's Church, Kempley, South-West Region

A church from the early twelfth century

NGR	366994 231266	Listed Building	1156244
Scheduled Monument		Estate Number	W0350
Flood Watch Area	Rivers in West Gloucestershire	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – there is a risk to a small part of the estate along the south-east boundary which may risk damaging the gravestones in this area.

(2) Surface water flood – the predicted extent is across the east half of the estate coming in close proximity to the church and possibly impeding access. There may be a risk of damage to the gravestones in this area.

Nunney Castle, South-West Region

A castle established in the fourteenth century

NGR	373672 145732	Listed Building	
Scheduled Monument	1014716	Estate Number	W0454
Flood Watch Area	Somerset Frome Area	Flood Protection	Non listed

Nature and Extent of Flood Risk

(1) Historic flood – the extent of the floods recorded by the Environment Agency on 11 June 1968 and 2 December 1972 include the south-east corner of the estate with the 1968 flood possibly extending up to the castle.

(2) Flood Zone 3 – the entire estate is predicted to be at risk from such a flood event. Damage could occur to the standing remains of the castle and impede access to the site.

(3) Surface water flood – the extent is predicted to be across the south part of the estate extending into the interior of the castle. There is a risk that the masonry of the castle will be affected by such a flood event and that access to the site will be impeded.

(4) During a flood event there is a risk that increased erosion of the banks of the Nunney Brook which forms the boundary of the estate on the south-east may threaten the loss of archaeological deposits associated with the castle and could even breach the barrier between the castle moat and the brook.

Odda's Chapel, South-West Region

A chapel dating from the mid eleventh century

NGR	386912 229853	Listed Building	1304997
Scheduled Monument	1018632	Estate Number	W0184
Flood Watch Area	River Severn in Gloucestershire	Flood Protection	Land immediately adjacent benefits from flood defences

Nature and Extent of Flood Risk

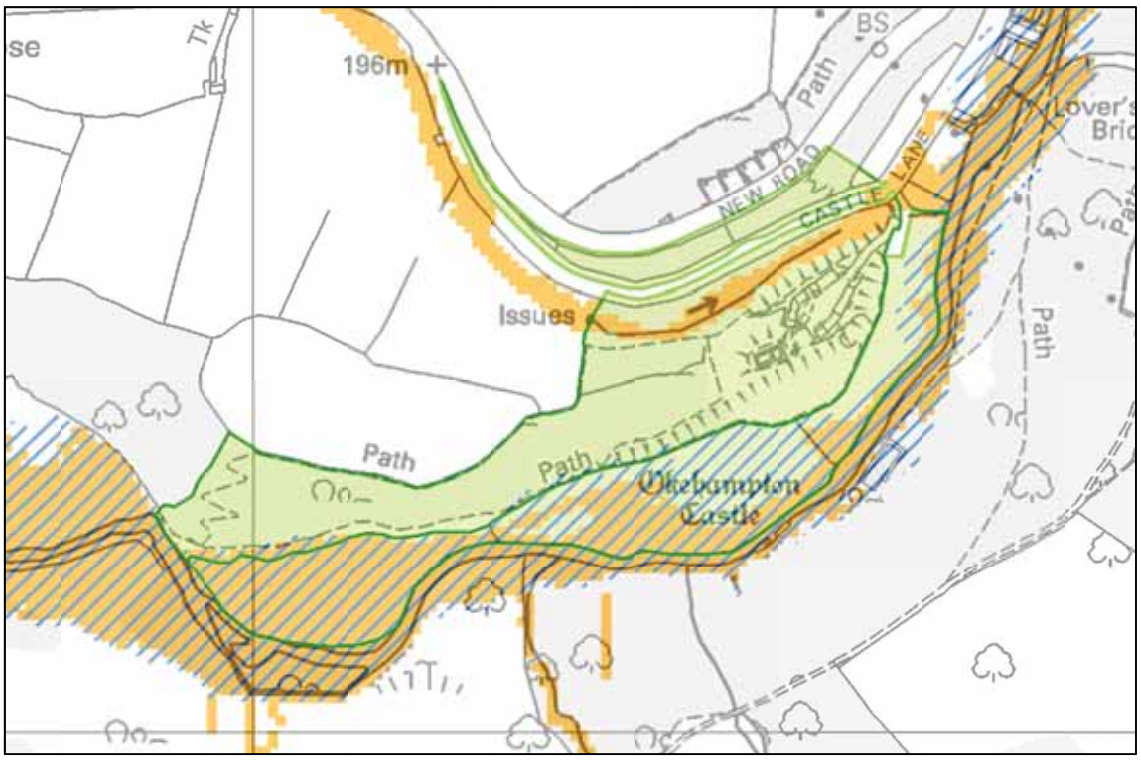
(1) Historic Flood – the estate has been the subject of a series of floods recorded by the Environment Agency in 1947, 2000 and 2007 suggesting that the chapel is fairly resilient to the ingress of flood water.

(2) Flood Zone 3 – the estate is wholly within this zone indicating the severity of the risk flooding poses to the chapel.

Okehampton Castle, South-West Region

A castle founded in the mid-late eleventh century

NGR	258250 094198	Listed Building	1165647
Scheduled Monument	1007812	Estate Number	W0466
Flood Watch Area	North Dartmoor Rivers	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – there is a risk to the south half of the estate comprising the low-lying ground nearest to the River West Okement but this poses no risk to the castle itself.

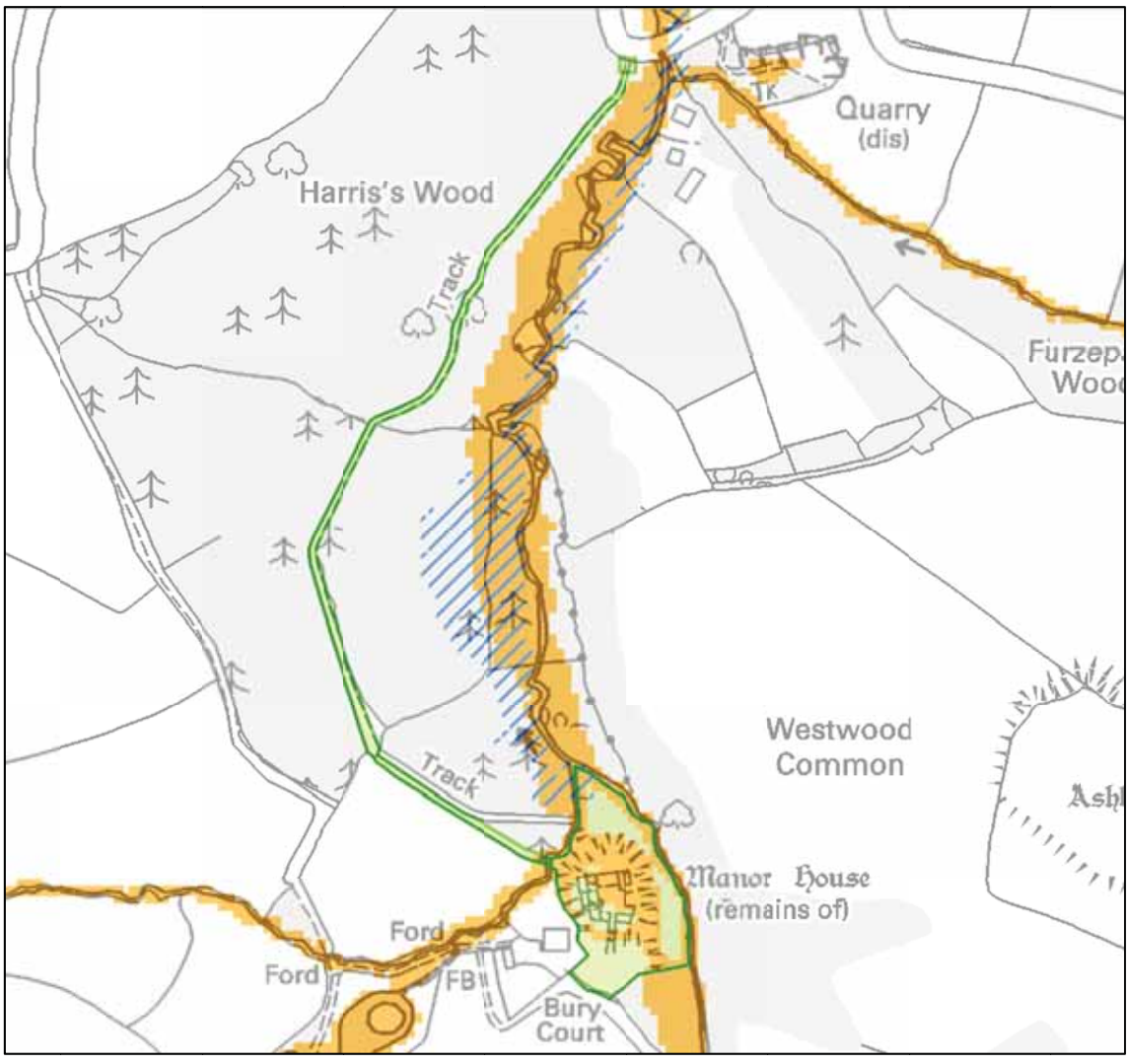
(2) Surface water flood – this is mainly predicted to affect the low-lying part of the estate next to the River West Okement and along the margins of a small stream further to the north but neither area indicates there is likely to be any significant threat to the castle area though access to the site from the main road to the north may be impeded.

(3) There is the possibility that increased water flow along the river West Okement and the watercourse to the north could lead to erosion of their respective banks posing some threat to archaeological deposits associated with the castle.

Penhallam, South-West Region

A moated manor house from the late twelfth century

NGR	222453 097406	Listed Building	
Scheduled Monument	1013669	Estate Number	W0102
Flood Watch Area	Upper River Tamar	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the predicted threat is to a small area at the northern tip of the main part of the estate and therefore poses little risk

(2) Surface water flooding – the Environment Agency prediction indicates the risk of surface water accumulating within the footprint of the manor house to depths in excess

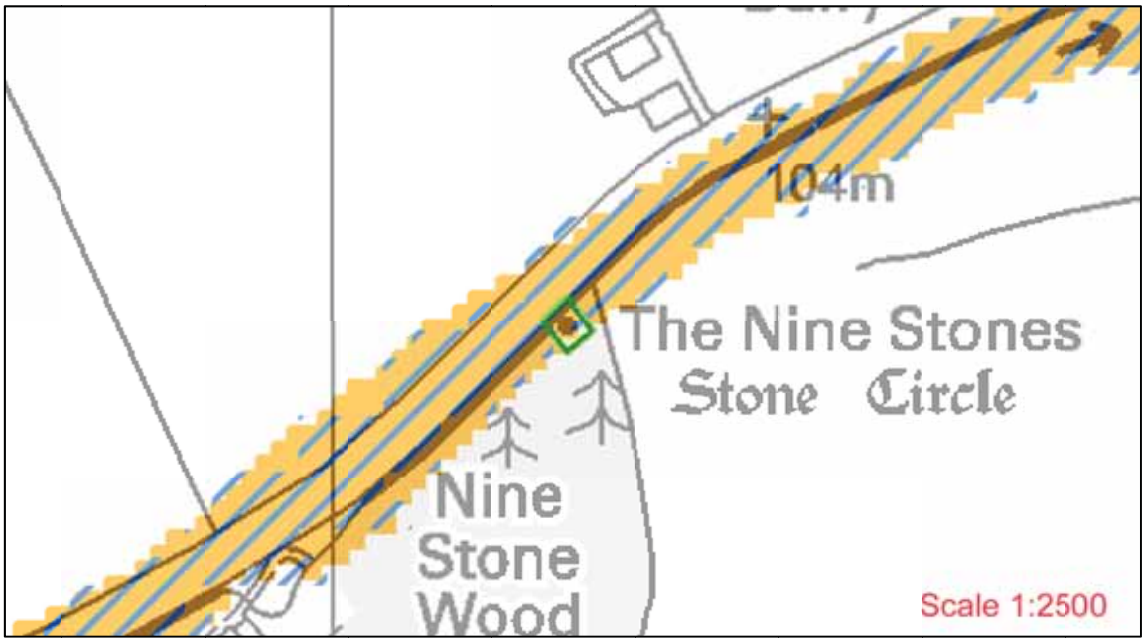
of 0.3m. There is therefore the possibility that such a flood event may damage the exposed foundations of the medieval manor house. Access to the site may also be impeded by flood water across the path leading from the road at the point where it enters the main part of the estate.

(3) During a severe flood event there is the possibility of increased erosion along the banks of the two tributaries of the River Neet which border the site on the east and west. This may lead to the damage or destruction of archaeological deposits associated with the manor house.

Winterbourne Abbas Nine Stones, South-West Region

A prehistoric stone circle

NGR	361078 090430	Listed Building	
Scheduled Monument	1011986	Estate Number	W0664
Flood Watch Area	Groundwater Flooding in the West Dorset Area	Flood Protection	None listed



Nature and Extent of Flood Risk

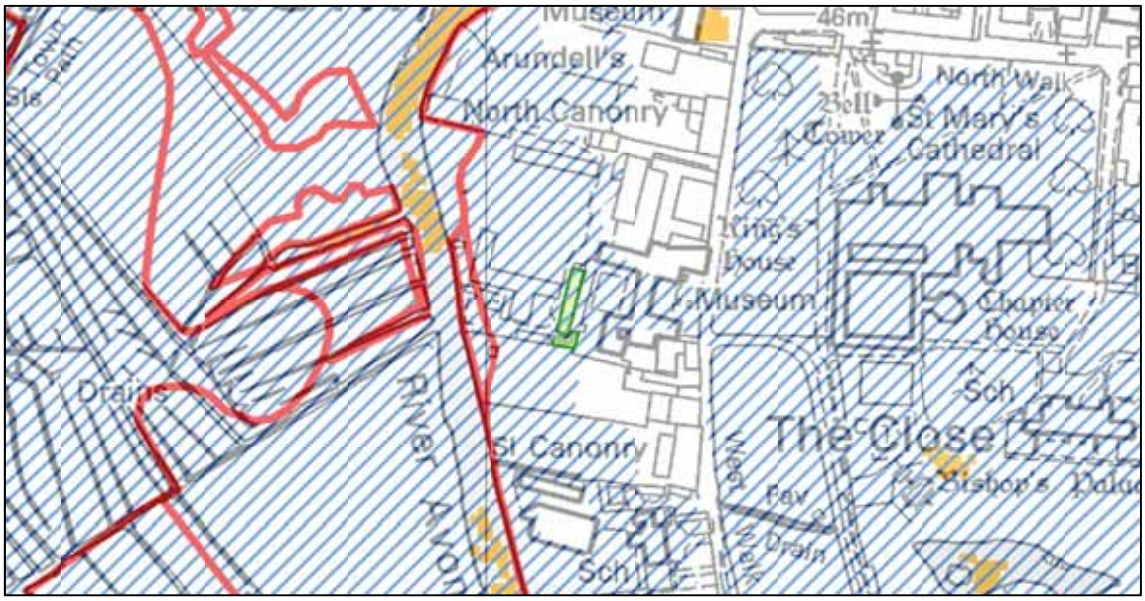
(1) Flood Zone 3 – almost the entire estate is in this flood zone indicating a severe risk to the monument. Access to the site will be impaired during such a flood event.

(2) Surface water flood – the extent is predicted to cover almost all of the estate to depths in excess of 0.3m therefore putting the monument at risk of some damage and impeding access to the site.

Wyndham House, South-West Region

English Heritage Office Accommodation

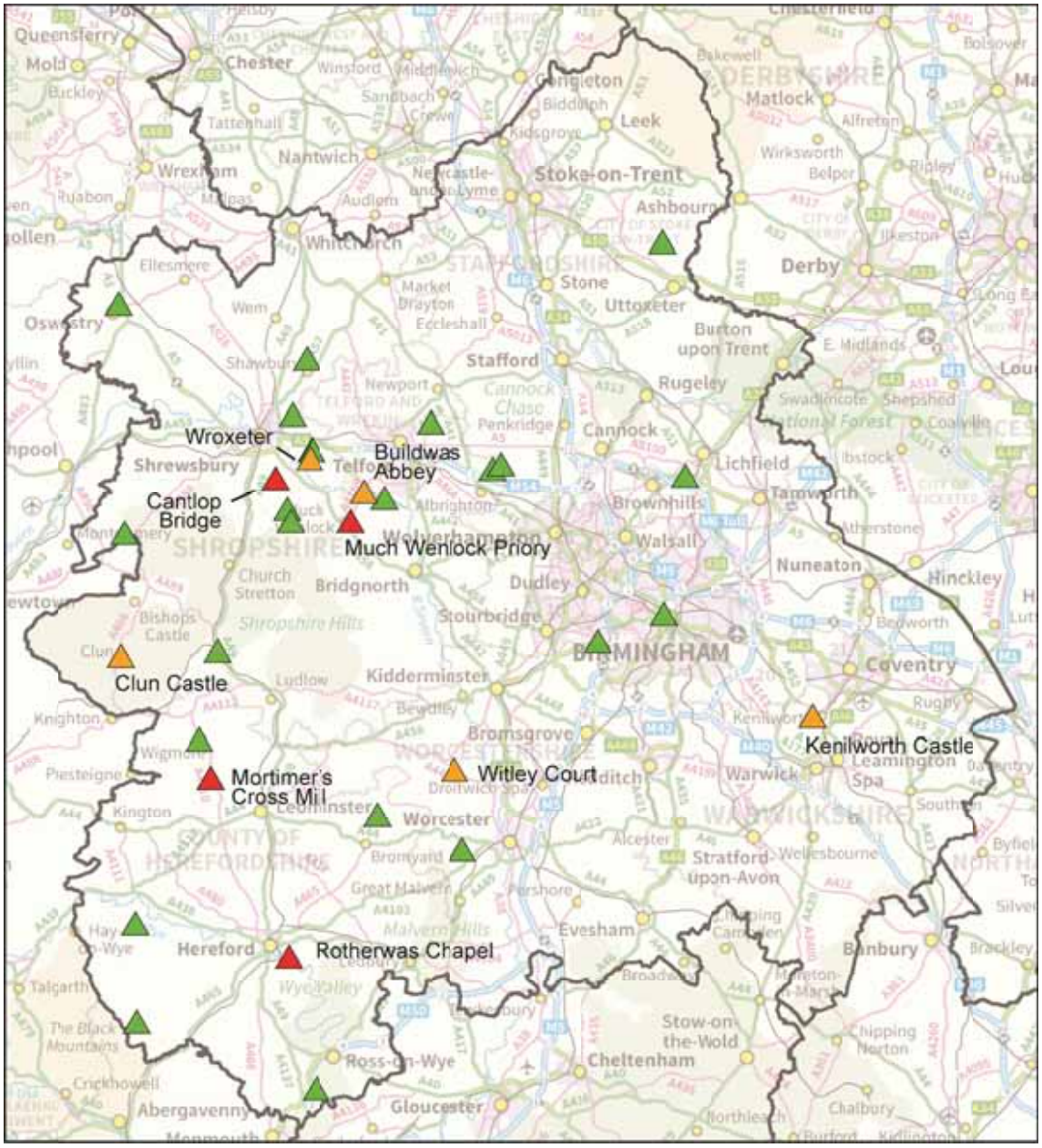
NGR	414056 129482	Listed Building	
Scheduled Monument		Estate Number	W0673
Flood Watch Area	(1) Ground Water Flooding in the Salisbury Plain Area (2) Middle Avon and Tributaries	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the entire office lies with the flood zone indicating it is at high risk from a flood event of this scale and that access would be impeded.

(5.9) West Midlands Region



Buildwas Abbey, West Midlands Region

Abbey founded by the Savignac Order in the early twelfth century

NGR	364350 304267	Listed Building	1175126 (part of claustral range)
Scheduled Monument	1015813	Estate Number	M00099
Flood Watch Area	River Severn in Shropshire	Flood Protection	None listed

Nature and Extent of Flood Risk

(1) Historic Flood – the Environment Agency mapping indicates that the west boundary of the estate has been affected by flood waters on 26 October 1998, in the autumn of 2000 and 3 – 7 February 2004. This appears to have extended as far eastwards as the remains of abbey buildings on the west side of the claustral range.

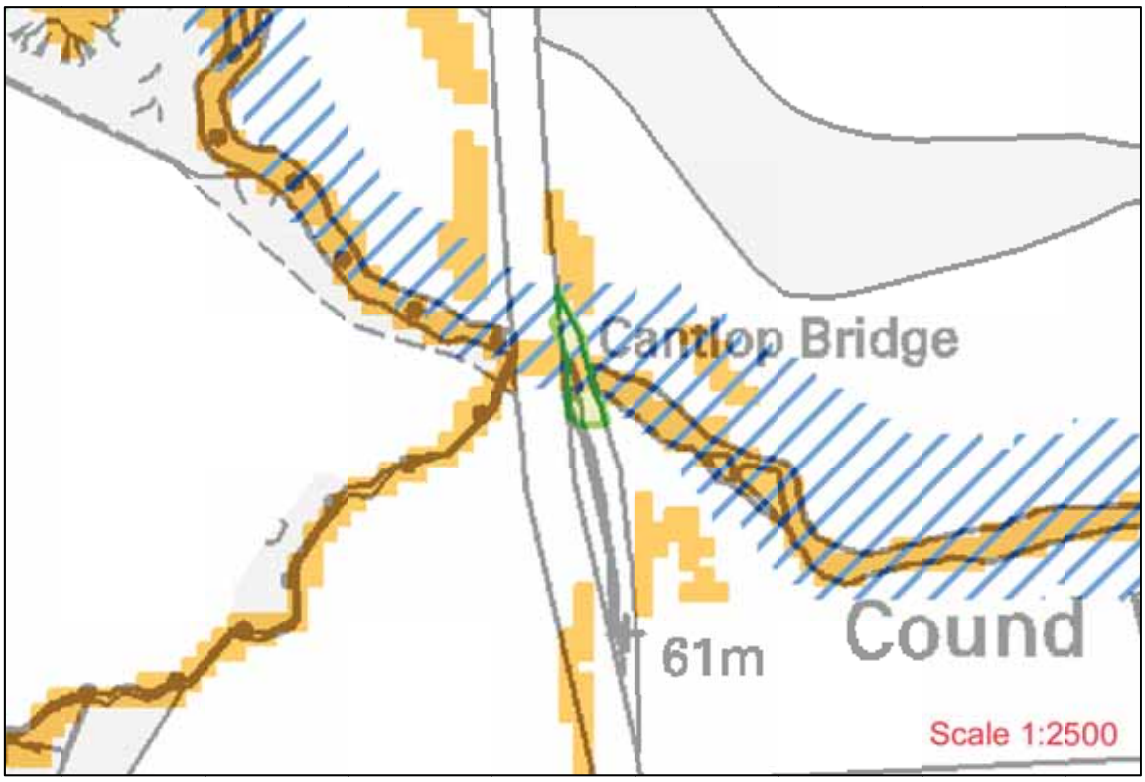
(2) Flood Zone 3 – this is predicted to include the west boundary of the estate extending as far as the west side of the claustral range covering much the same area as previous recorded floods and emphasising the risk to the exposed foundations of medieval buildings in this area.

(3) Surface water flood – the Environment Agency mapping indicates that this risk is confined to one area within the estate away from any exposed medieval remains.

Cantlop Bridge, South-West Region

A cast-iron bridge from the early nineteenth century

NGR	351738 306243	Listed Building	1366715
Scheduled Monument	1014885	Estate Number	M0128
Flood Watch Area	Rea Brook and Cound Brook	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the entire structure is within the flood zone indicating a possible risk to the structure with impeded access on to the bridge during such a flood event.

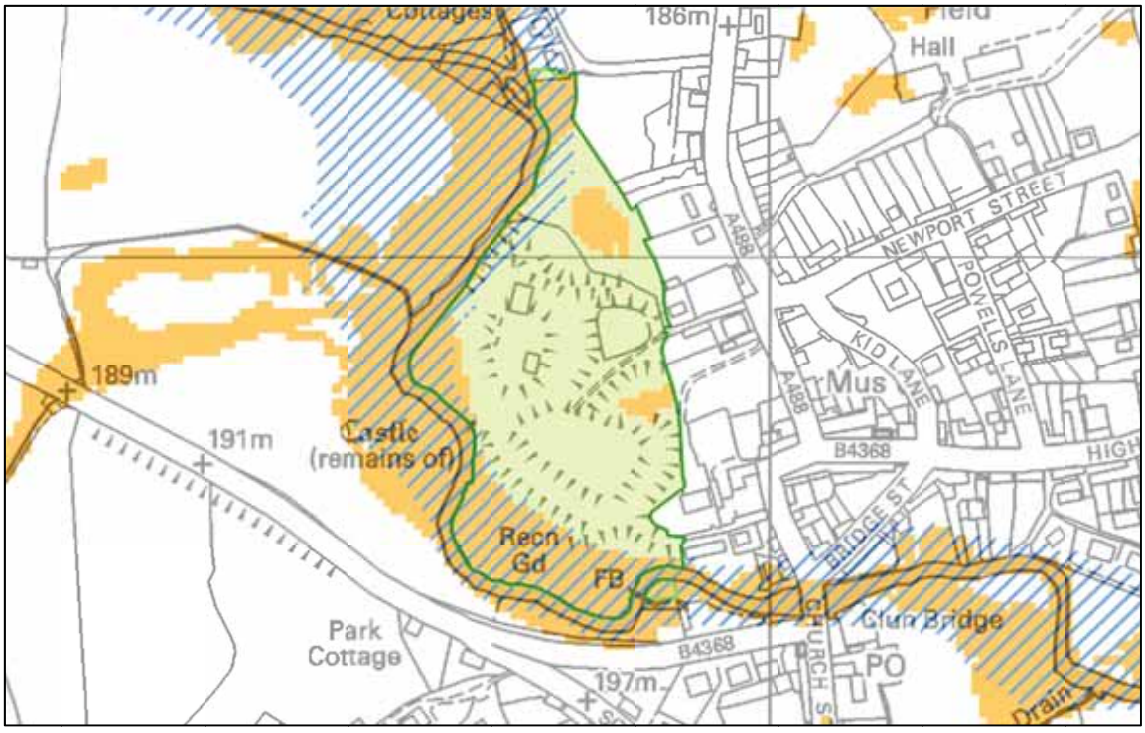
(2) Surface water flooding – the risk is confined to the margins of the Cound Brook and an area at the very north of the estate which could impede access from this direction.

(3) During a serious flood event it is possible that the banks of the Cound Brook in the vicinity of the bridge may erode more rapidly exposing the structure to damage. As it is a single span bridge this minimises the risk of it acting as a dam trapping material washed down from higher up the brook and so lessens the risk of flood water building up against the structure and causing damage.

Clun Castle, West Midlands Region

A motte and bailey castle from the late eleventh century

NGR	329865 280938	Listed Building	1295475
Scheduled Monument	1011021	Estate Number	M0168
Flood Watch Area	Upper Teme	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the risk is to the low-lying part of the estate bordering the River Clun and though the area is quite extensive it does not pose a significant threat to any of the earthworks or remains of the castle.

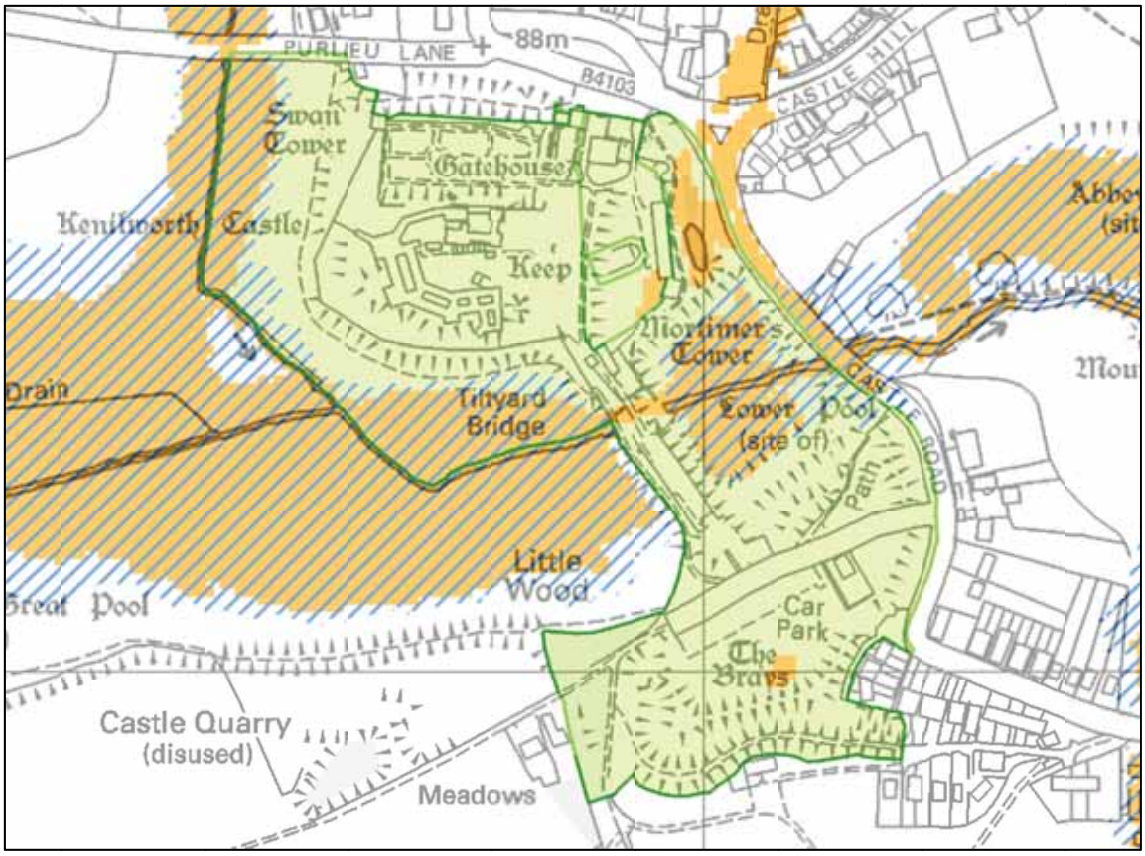
(2) Surface water flood – the part of the estate mapped by the Environment Agency as being at risk is largely the same as for Flood Zone 3 apart from two discrete areas toward the east boundary of the estate. These are probably depressions in the ground surface and may be earthworks connected with the medieval castle.

(3) The west and south sides of the estate are exposed to risk during a flood event from the potentially increased erosion of the banks of the River Clun which forms the boundary of the estate on these two sides. Erosion by the river could damage or destroy archaeological deposits in these areas associated with the medieval castle.

Kenilworth Castle, West Midlands Region

A castle established in the early twelfth century

NGR	427953 272228	Listed Building	1035327
Scheduled Monument	1014041	Estate Number	M0351
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – the area predicted to be at risk of such a flood event is the low-lying part of the estate which lies within the area of the ornamental lake belonging to the medieval castle. The ground is now open pasture and therefore there is little risk to the castle from flooding of this area.

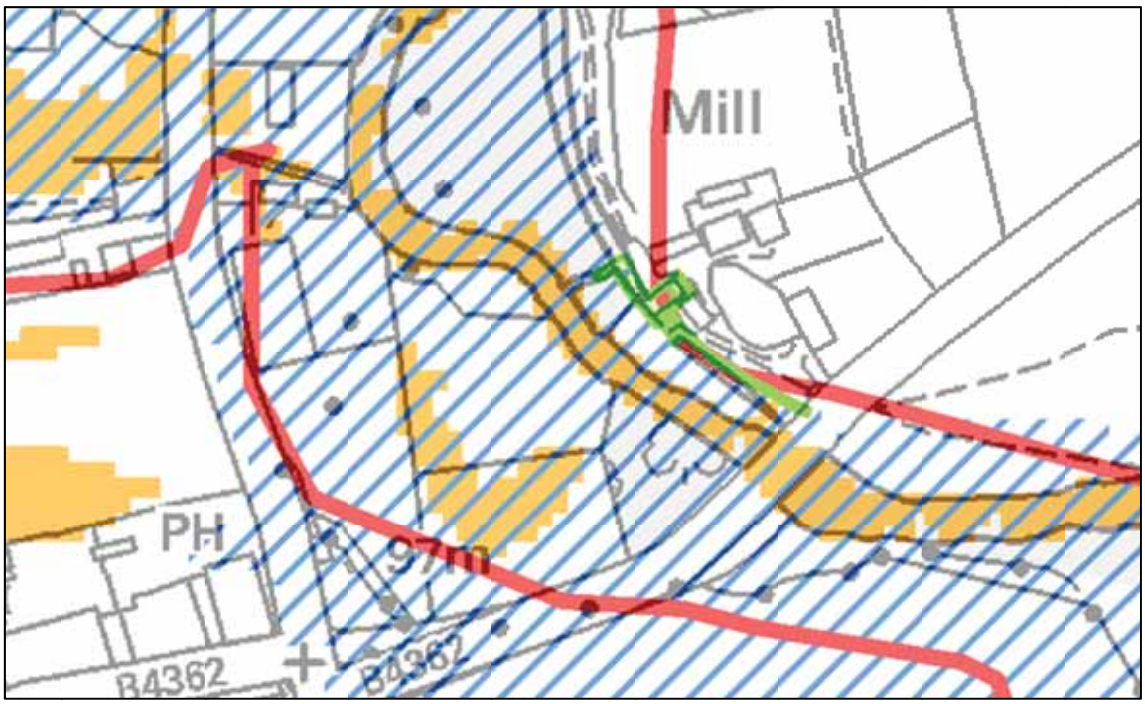
(2) Surface water flood – the areas predicted by the Environment Agency to be at risk are confined to areas of the former lake and to depressions formed by earthworks belonging to the medieval castle. There appears to be no substantial threat to the standing remains of the castle from such a flood event.

(3) There is a possible risk of increased erosion along the banks of the Finham Brook that cross the low-lying part of the estate during a flood event but it is unlikely that any significant damage will occur to the castle remains or to archaeological deposits associated with the castle.

Mortimers Cross Mill, West Midlands Region

A water mill from the mid eighteenth century

NGR	342614 263739	Listed Building	1082088
Scheduled Monument	1016252	Estate Number	M0425
Flood Watch Area	River Lugg north of Leominster	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – the estate is on the edge of the recorded extent of a flood in April 1947 when the River Lugg overtopped its banks

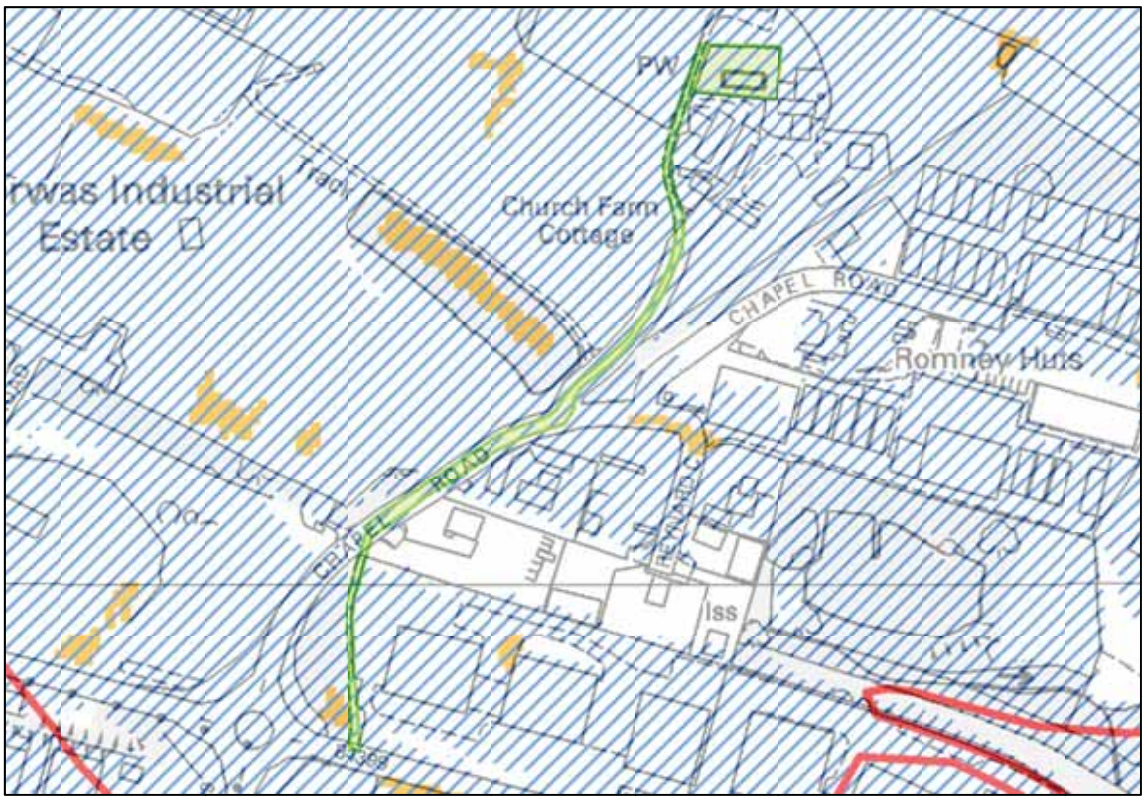
(2) Flood Zone 3 – the estate is on the east edge of the flood zone and therefore such a flood event could affect the mill structure and access to the site

(3) The mill race which powers the water mill could develop a potentially destructive force during a major flood event if the sluice fails where the water for mill race is taken from the River Lugg some 200m to the north. This could cause damage to the mill and the engineering of the mill wheel.

Rotherwas Chapel, West Midlands Region

A chapel from the fourteenth century

NGR	353616 238339	Listed Building	1180032
Scheduled Monument	1014880	Estate Number	M0527
Flood Watch Area	River Wye in Herefordshire	Flood Protection	None listed



Nature and Extent of Flood Risk

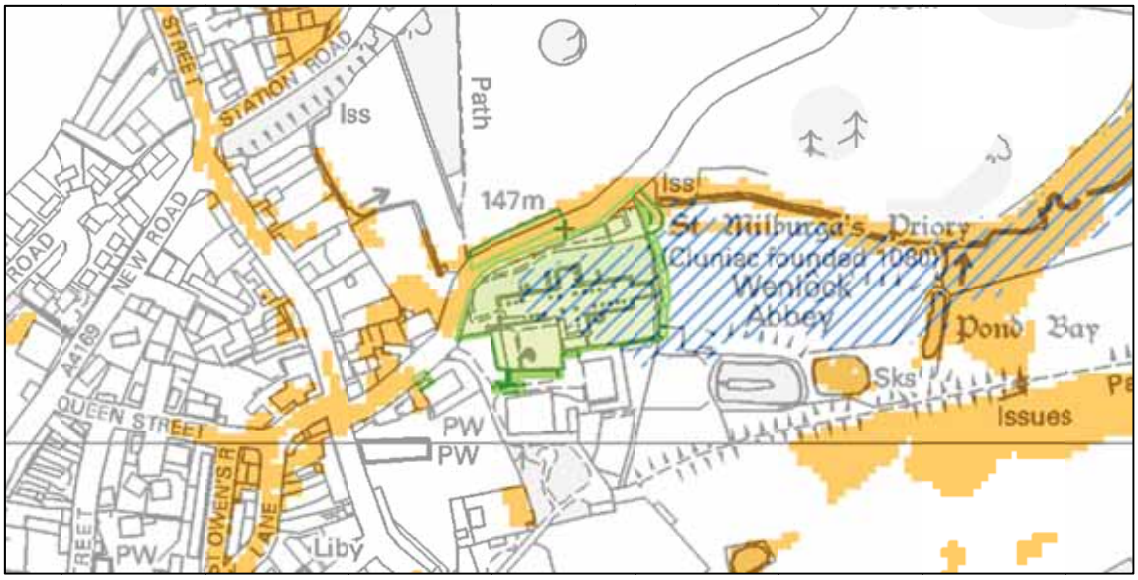
(1) Historic Flood – the estate is entirely within the mapped extent of a flood that occurred on 4 December 1960.

(2) Flood Zone 3 – the estate is wholly within the flood zone and therefore such an event could have a devastating impact on the chapel and churchyard. Access to the site will also become impassable.

Wenlock Priory, West Midlands Region

A Clunicac Priory founded in the late eleventh century

NGR	362486 300097	Listed Building	
Scheduled Monument	1004779	Estate Number	M0430
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

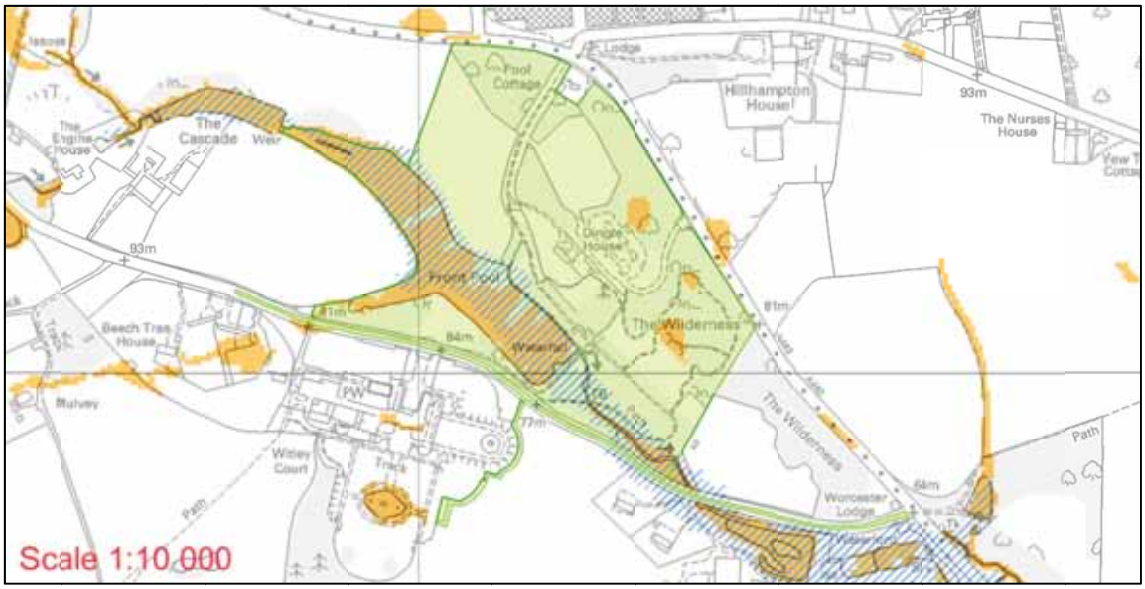
(1) Flood Zone 3 – a large part of the estate lies within the flood zone potentially putting at risk the standing remains of the priory church and its immediate surroundings. Access to the site from the road to the north could be made impassable.

(2) Surface water flood – the road bordering the north side of the estate is at risk and as mapped by the Environment Agency this flooding could impinge onto the margin of the estate. It is unlikely to have any significant impact apart from possibly impeding access to the site.

Witley Court, West Midlands Region

A country house from the early seventeenth century with medieval predecessor

NGR	377195 265144	Listed Building	
Scheduled Monument		Estate Number	M0666
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – this is predicted to extend some distance beyond the existing pool and the watercourse leading from it but will not impact more widely on the estate.

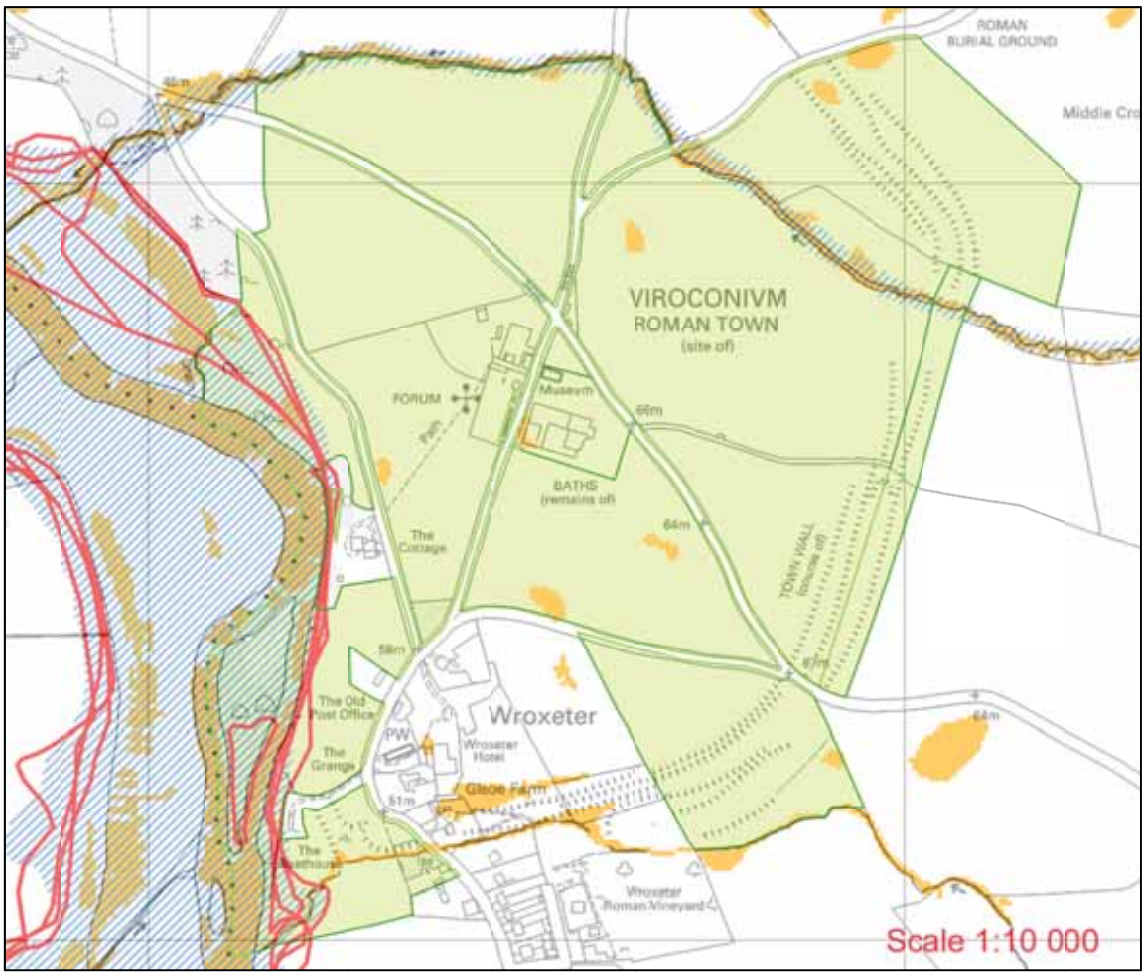
(2) Surface water flood – the margins of the pool may experience some surface water flooding and along the course of the stream leading from it but elsewhere in the estate the areas predicted to be at risk are small and unlikely to have any significant impact.

(3) There must be some risk of increased erosion along the banks of the watercourse leading from the pool if there is a large increase in the flow of water during a major flood event but any erosion is unlikely to have any significant or lasting impact on the landscape park.

Wroxter Roman Town, West Midlands Region

Remains of a Roman walled town

NGR	356545 308715	Listed Building	
Scheduled Monument	1003705	Estate Number	M0670
Flood Watch Area	River Severn in Shropshire	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – as mapped by the Environment Agency, flooding from the River Severn extended across the west boundary of the estate on 26-31 October 1998 and 3-7 February 2004. The eastern extent of the flood appears to have stopped at the base of a slope probably representing the former edge of the river.

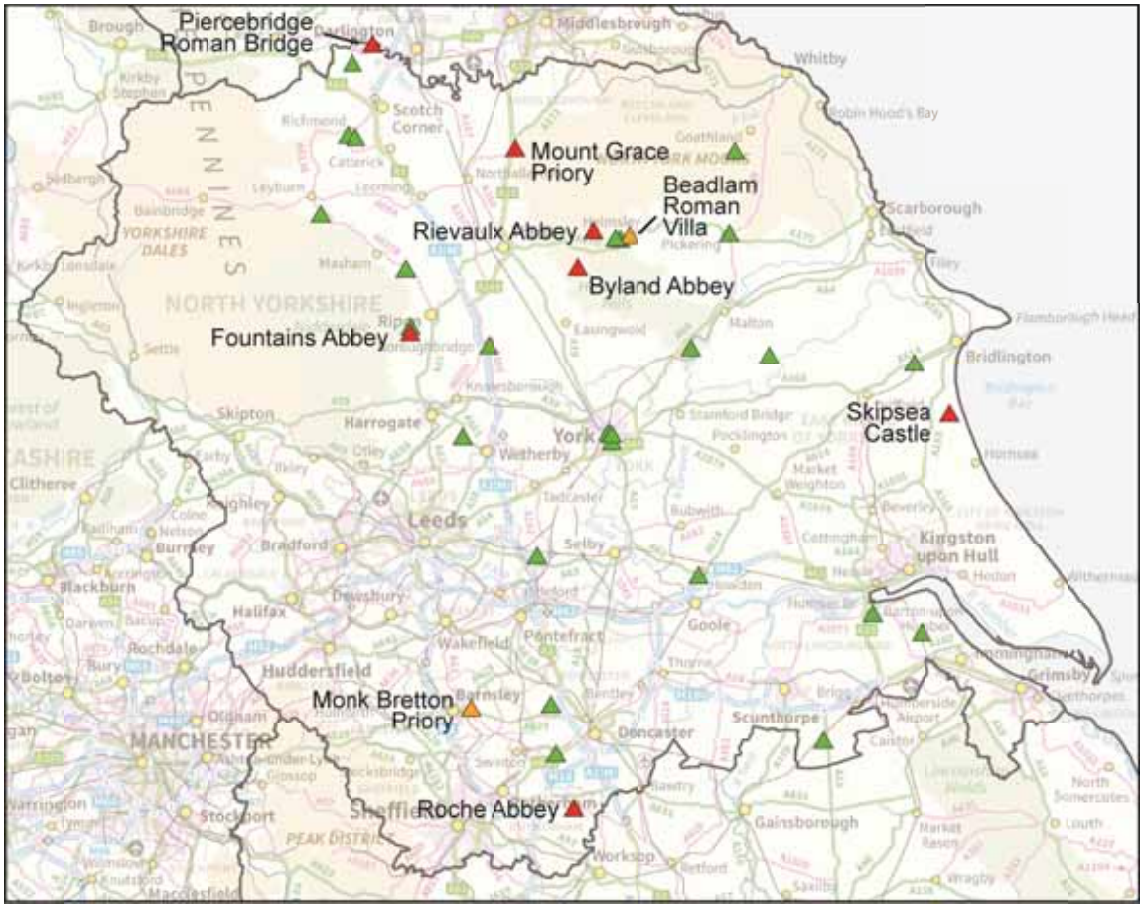
(2) Flood Zone 3 – the predicted extent indicates such a flood event will largely be confined to that part of the estate on the west between the River Severn and the slope

up to the main part of the site which probably represents the former edge of the river. It is probable that flooding of this area will not have any serious impact on the majority of the estate. There is also some risk of flooding along the line of the small brook that flows into the Severn across the north of the estate but this would not affect a very wide zone of land.

(3) Surface water flood – the Environment Agency map several small areas of flooding across the estate presumably related to hollows in the landscape which could either be natural or be part of the earthwork remains of the Roman town. Such a flood event is therefore unlikely to have a significant or lasting impact on the estate.

(4) There must be some risk to archaeological deposits associated with the Roman town adjacent to the east bank of the River Severn as they are likely to be under threat of destruction during a flood event from increased erosion of the river bank. There might also be some risk from increased erosion along the line of the small brooks that flow to the south and north of the estate.

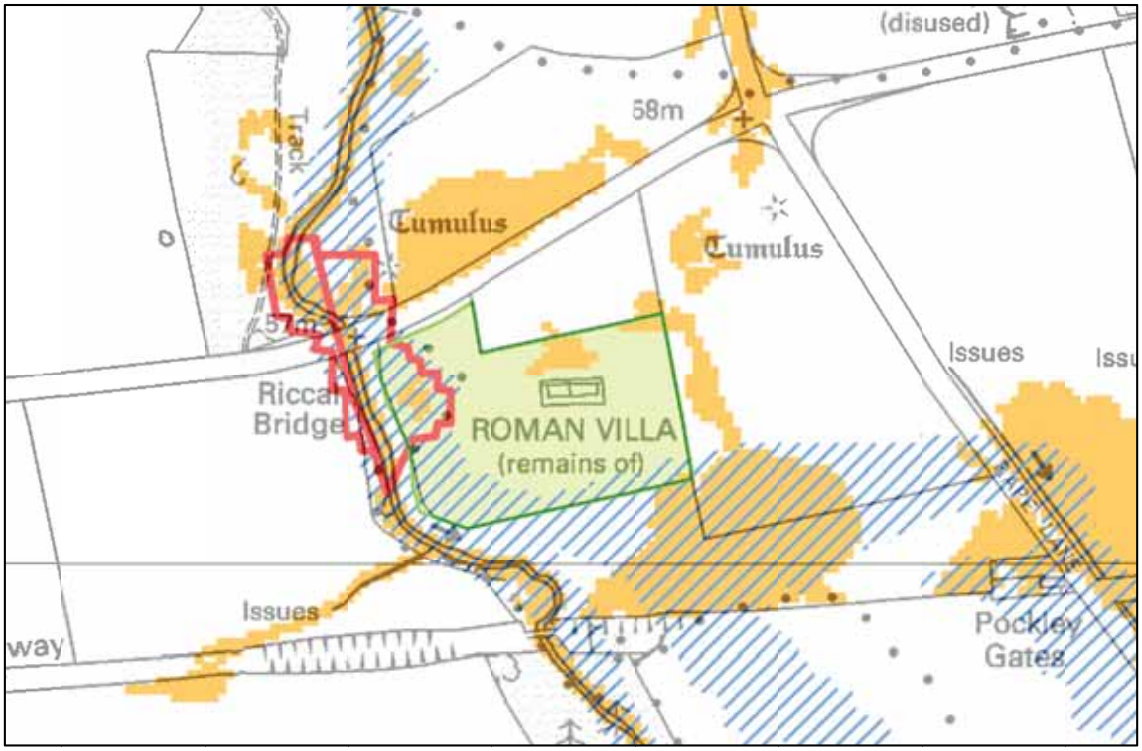
(5.10) Yorkshire and The Humber Region



Beadlam Roman Villa, Yorkshire and The Humber Region

A second century Roman villa

NGR	463389 484097	Listed Building	
Scheduled Monument	1011365	Estate Number	N0060
Flood Watch Area	River Rye Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – A flood occurred 30 October -15 November 2000 due to overtopping of the River Riccal. The maximum extent mapped by the Environment Agency covered north-west corner of estate and extended over the A170 to the north affecting access to the site along the A170.

(2) Flood Zone 3 – risk of flooding affecting predominately the west and south margins of the estate and access to the site along the A170

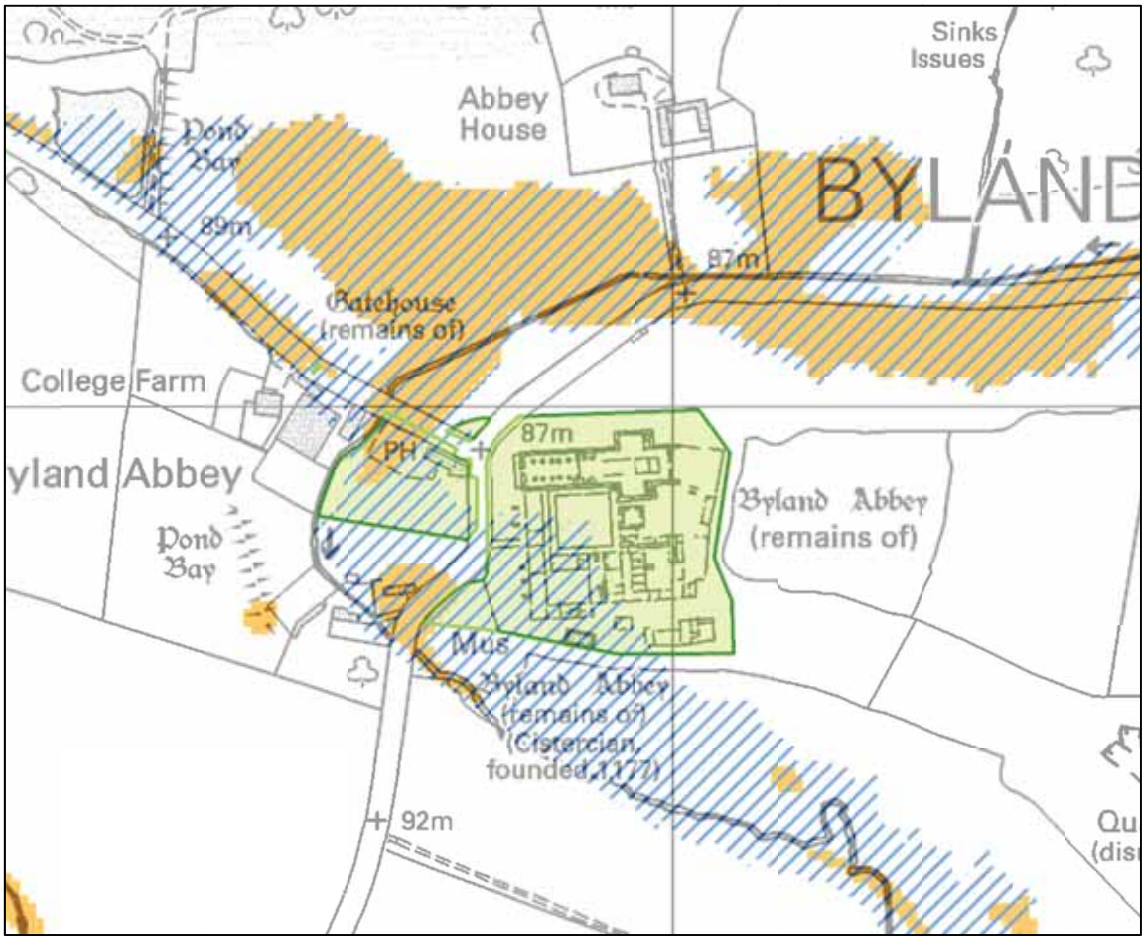
(3) Surface Water flooding - risk of some flooding in isolated areas within the estate and along the west margin

(4) Possible erosion threat to west margin of the estate from River Riccal at times of flood.

Byland Abbey, Yorkshire and The Humber Region

A twelfth century Cistercian Abbey

NGR	454962 478918	Listed Building	1315790
Scheduled Monument	1013403	Estate Number	N0107
Flood Watch Area	River Wiske Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 – risk to the west of the estate from overtopping of the stream flowing from the north-west from Cocker Dale.

(2) Surface water flooding – risk of significant accumulations of standing water across the fields immediately to the north of the estate and to the south-west which may extend across the roads and impede access to the estate. At its maximum extent such flooding

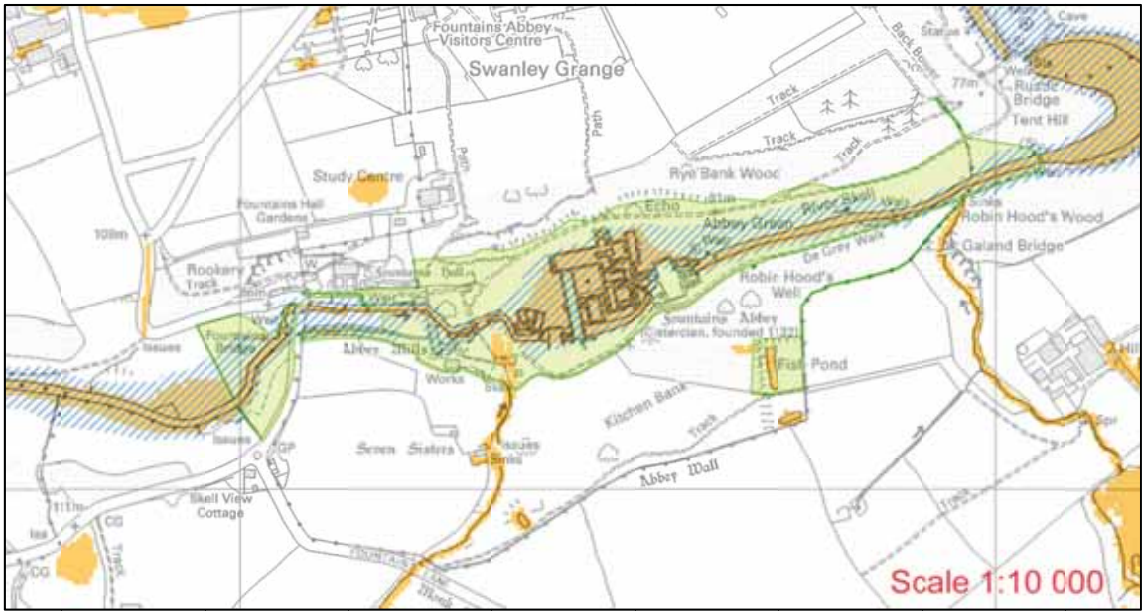
could extend as far as the standing remains of the medieval gatehouse which is situated on the road from the north-west.

(3) During a major flood there is the risk that the stream from Cocker Dale could experience increased erosion of its banks leading to some loss of archaeological remains in adjacent areas of the abbey.

Fountains Abbey, Yorkshire and The Humber Region

A twelfth century Cistercian Abbey in an eighteenth century parkland landscape

NGR	427390 468169	Listed Building	1149811
Scheduled Monument	1014395	Estate Number	N0689
Flood Watch Area	Lower River Ure Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Flood Zone 3 - risk to the valley floor from flooding of the River Skell affecting the entire standing remains of the abbey church and claustral buildings and extending east-west along the valley to the limits of the EH Estate and beyond.

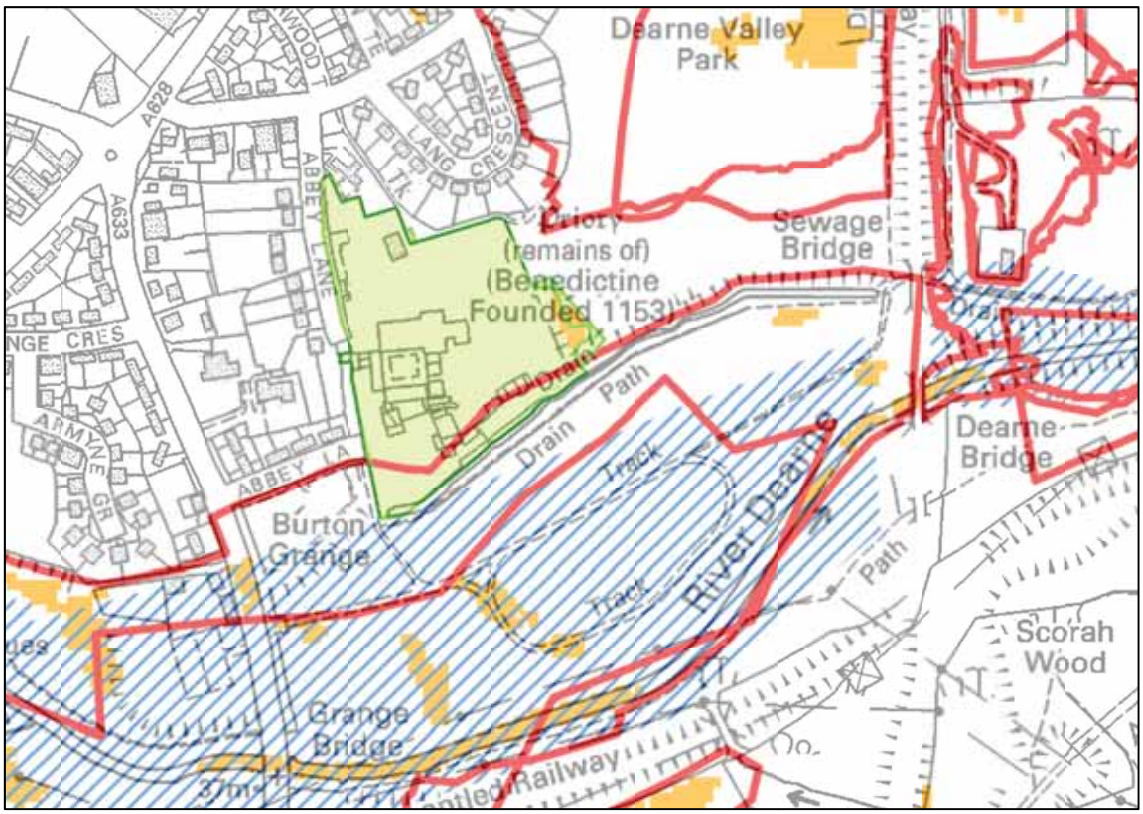
(2) Surface water flooding - this poses a risk to an extensive area at the centre of the estate encompassing the entire standing remains of the abbey and the claustral buildings. Across most of this area the Environment Agency assess that the flooding will be in excess of 0.3m in depth which could impact seriously on wall foundations and footings.

(3) There is a possible erosion threat during flooding along the length of the estate from the River Skell potentially putting at risk significant archaeological remains relating to the abbey and the later gardens. However the catchment area for the River Skell is not extensive and encompasses quite gently undulating terrain which could indicate that the velocity of the stream will not increase dramatically during a flood event moderating the erosion threat.

Monk Bretton Priory, Yorkshire and The Humber Region

A Cluniac Priory founded in the mid twelfth century

NGR	437346 406528	Listed Building	1151178
Scheduled Monument	1010057	Estate Number	N0423
Flood Watch Area	River Dearne Catchment Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

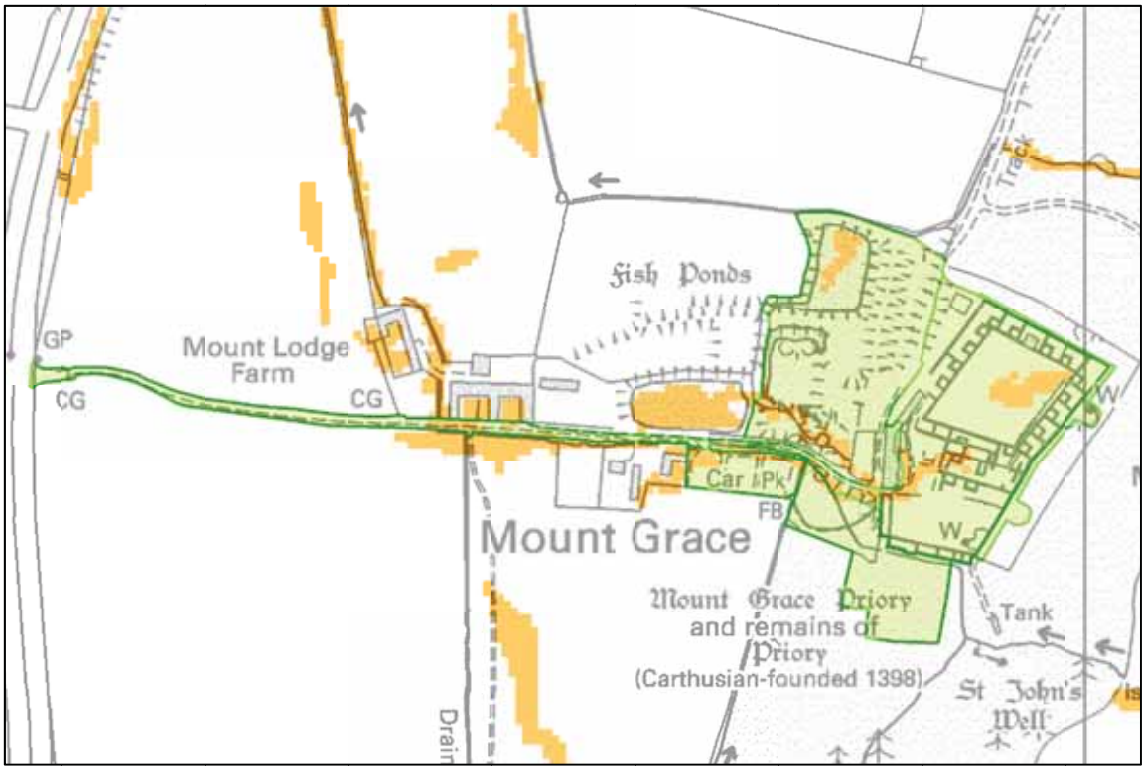
(1) Flood Zone 3 - The estate lies just to the north of the area at risk from flooding of the River Dearne although the flood of 25-26 June 2007 did extend along the southern edge of the estate. This approximately equates to the edge of the area assessed by the Environment Agency as Flood Zone 2.

(2) Surface water flooding - this is restricted to an area defined by an earthwork depression immediately to the east of the exposed foundations of the medieval priory.

Mount Grace Priory, Yorkshire and The Humber Region

A Carthusian Priory founded in the late fourteenth century

NGR	444815 498536	Listed Building	1315123
Scheduled Monument	1013019	Estate Number	N0428
Flood Watch Area	None listed	Flood Protection	None listed



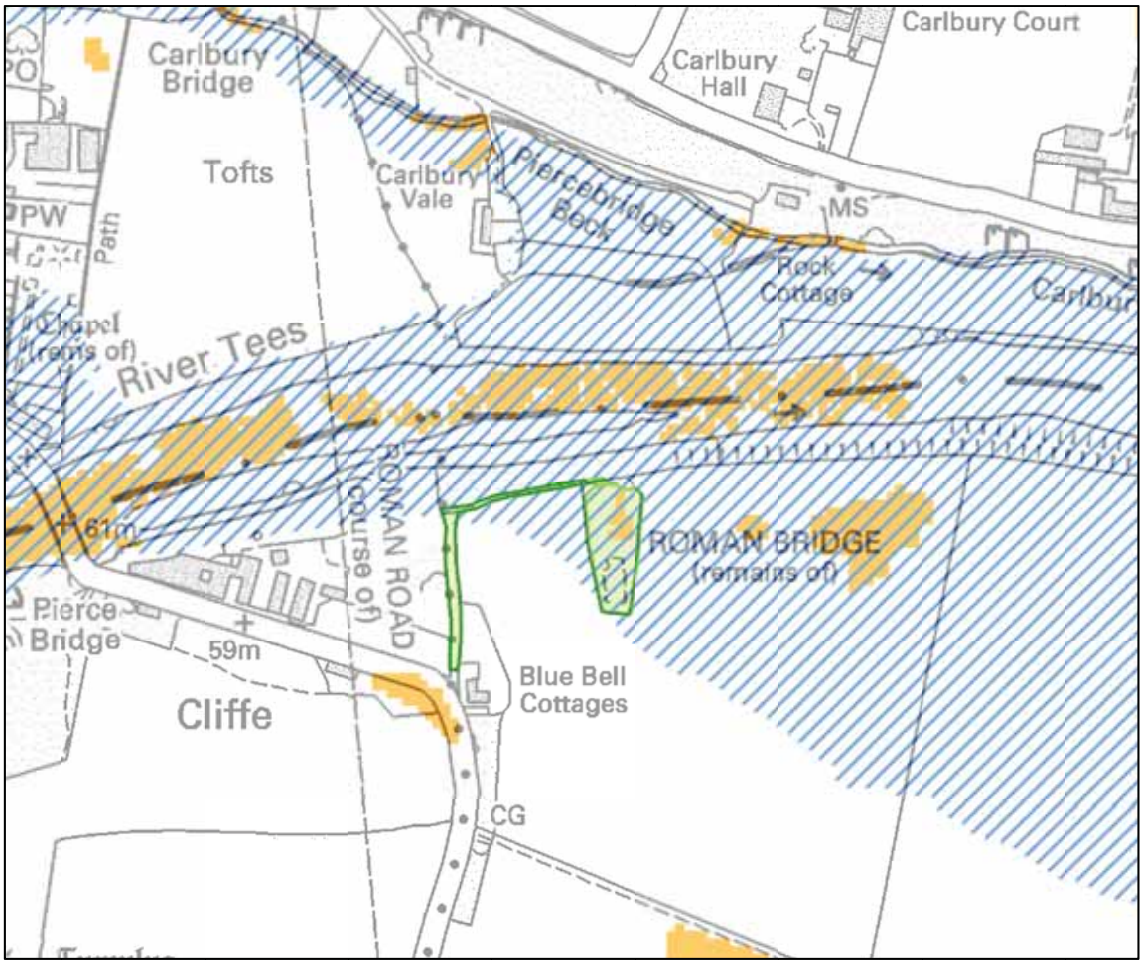
Nature and Extent of Flood Risk

(1) Surface water flooding – the risk to the estate appears most likely related to existing or former drains taking surface water across the site from the higher ground to the east. As mapped by the Environment Agency this flooding could pose a risk to some sections of exposed medieval foundations and may create erosion gullies if it flows with some force.

Piercebridge Roman Bridge, Yorkshire and The Humber Region

A Roman bridge probably constructed in the late second or early third century

NGR	42145 51550	Listed Building	
Scheduled Monument	1004062	Estate Number	N0490
Flood Watch Area	Upper River Tees Flood Watch Area	Flood Protection	A section of flood bank borders the north side of the estate dividing the estate from the River Tees



Nature and Extent of Flood Risk

(1) Flood Zone 3 - The majority of the estate including the strip of land encompassing the route to the site from the west are at risk from flooding from the River Tees. However

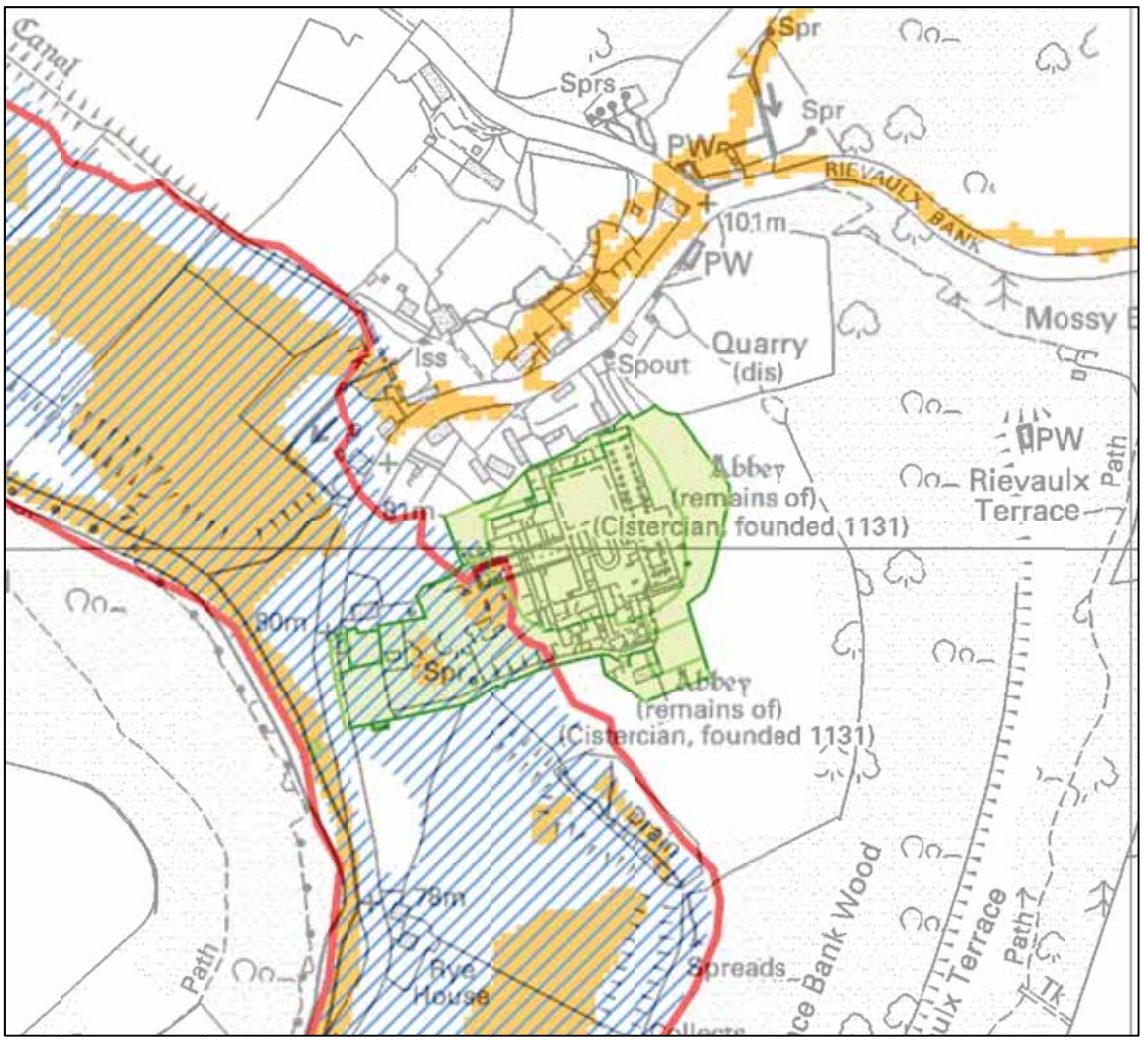
the estate is set some distance back from the river and therefore there is only minimal risk of erosion during a flood event involving the river.

(2) Surface water flooding - the mapped area is restricted to an area towards the east side of the estate adjacent to the east side of the exposed remains of the Roman causeway which may be affected by standing water should such a flood occur.

Rievaulx Abbey, Yorkshire and The Humber Region

A Cistercian Abbey founded in the mid twelfth century

NGR	45768 48501	Listed Building	1175724
Scheduled Monument	1012065	Estate Number	N0521
Flood Watch Area	Rive Rye Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood – the west half of the estate extending as far as the claustral buildings and encompassing the ticket office and gift shop were severely affected by flooding of the River Rye between 19 and 20 June 2005.

(2) Flood Zone 3 – the extent is approximately the same as the extent of the 2005 flood as mapped by the Environment Agency indicating a continued threat to the west half of the estate.

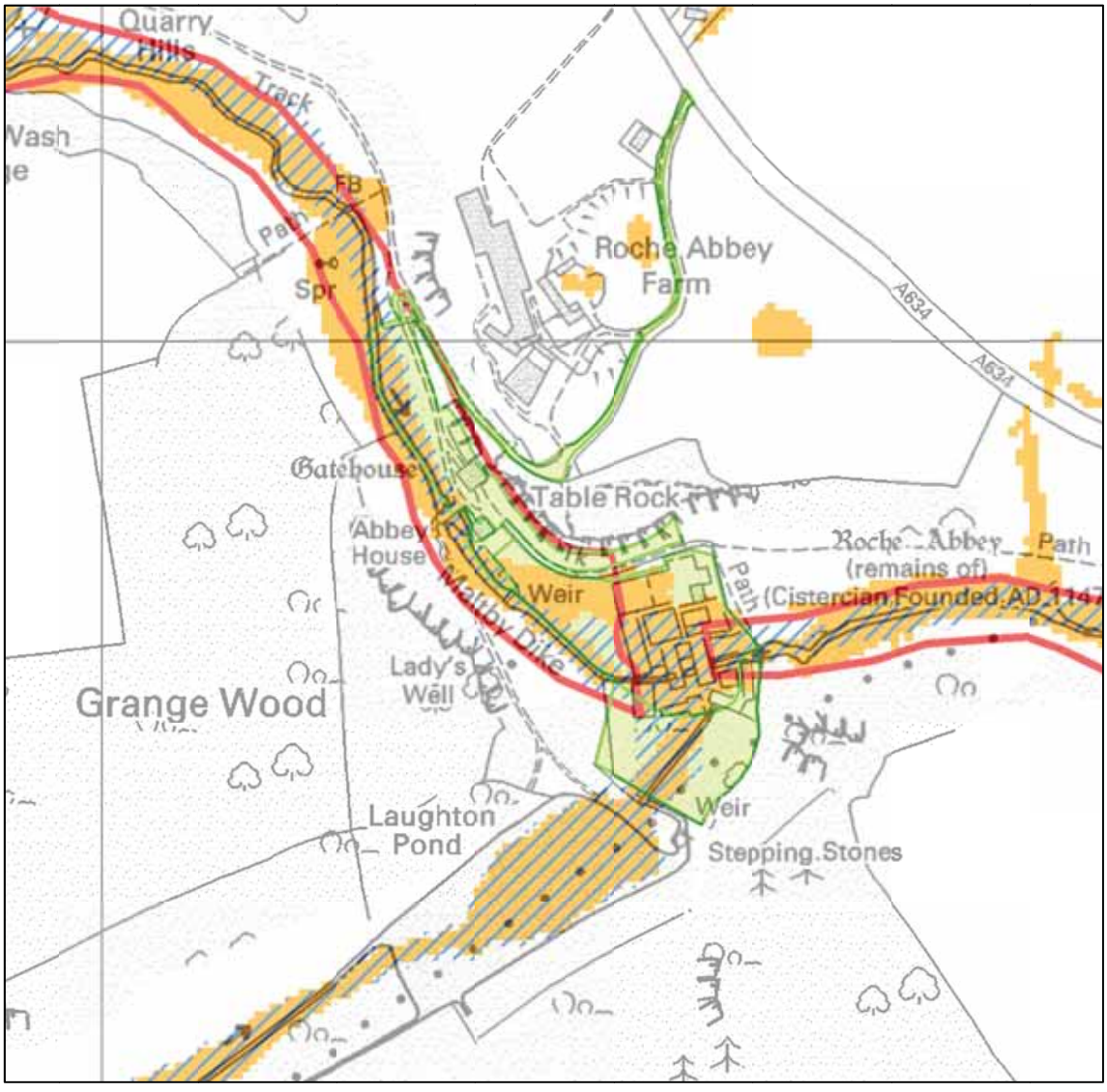
(3) Surface water flooding – there is risk to two areas within the estate, one impinging upon the area of the gift shop and ticket office and the other extending over the west end of the abbey refectory and other exposed medieval foundations to the south.

(4) The River Rye flows from an upland area with tributary streams flowing down often quite narrow and steep-sided valleys. As was shown in 2005, water levels within the river can build rapidly during a flood event and with some force. However, at the point where the river is opposite the estate it is in a wider valley and at a sufficient distance that erosion poses no direct threat to the estate itself though archaeological features within the wider landscape could be at risk.

Roche Abbey, Yorkshire and The Humber Region

A Cistercian abbey founded in the mid twelfth century

NGR	454393 389754	Listed Building	
Scheduled Monument	1019059	Estate Number	N0522
Flood Watch Area	None listed	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood - the extent of a flood event in 1950 mapped by the Environment Agency indicates that the flood waters impinged upon the west and east sides of the abbey ruins but did not extend across the remains.

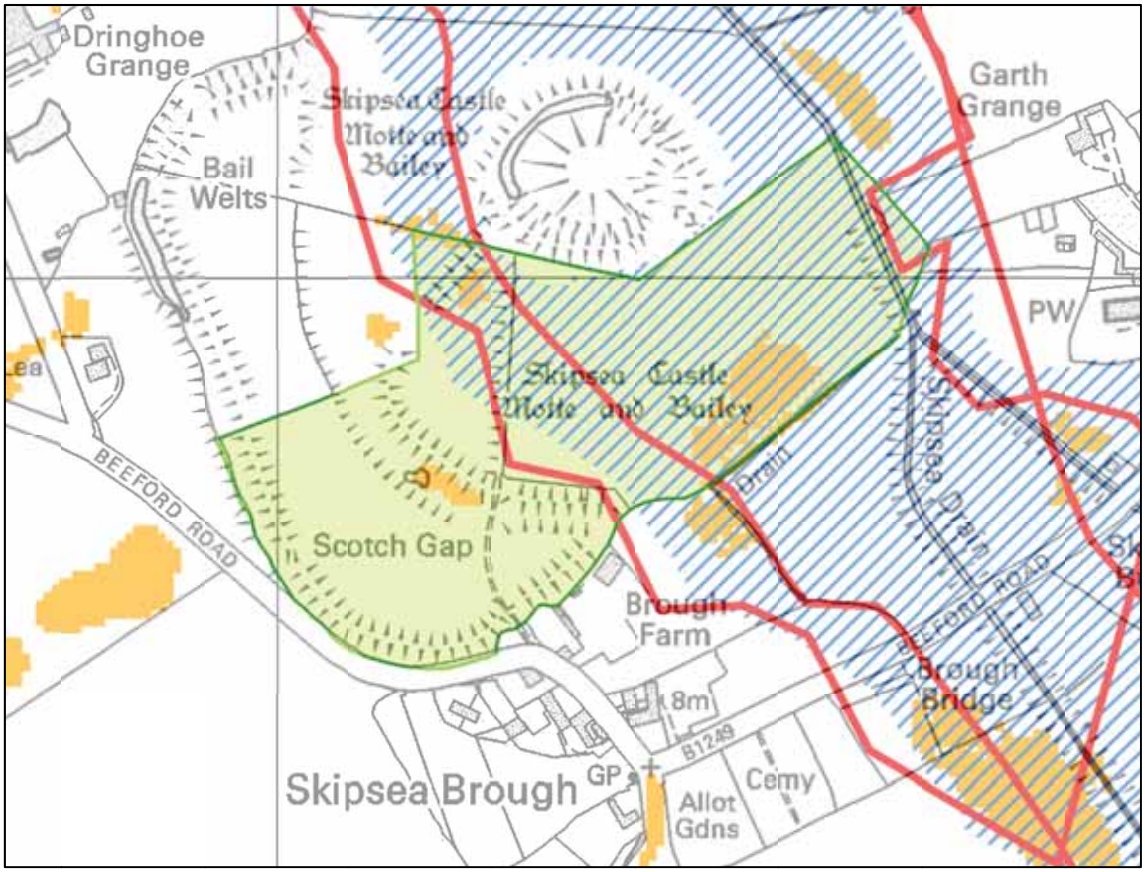
(2) Flood Zone 3 – risk of flooding from the Maltby Dike extends the length of the estate mainly threatening the west side but widening out in the area of the abbey ruins. (3) Surface water flooding – the majority of the estate is at risk including the entire area of the abbey church and associated claustral buildings. This flooding is assessed to be above 30cm in depth which poses a significant risk to the exposed foundations of medieval buildings.

(3) The risk of erosion posed by the Maltby Dike and the Hooton Dike is lessened because in these sections both watercourses flow along culverts, though the culverts themselves could be medieval in date and therefore at risk of damage during a flood event from the intensity of the water flow. Across the rest of the estate the sides of the Maltby Dike are less well protected and therefore erosion of the banks could be more of a risk, posing a threat in particular to archaeological remains connected with the abbey.

Skipsea Castle, Yorkshire and The Humber Region

An earthwork castle founded in the late eleventh century

NGR	51621 45507	Listed Building	
Scheduled Monument	1011212	Estate Number	N0563
Flood Watch Area	Holderness Area Flood Watch Area	Flood Protection	None listed



Nature and Extent of Flood Risk

(1) Historic Flood - the Environment Agency mapping indicates floods between 28 and 31 January 1982 and again between 25 and 26 June 2007 extended over the east half of the estate. On both occasions the west part of the estate escaped flooding.

(2) Flood Zone 3 – the risk is to the east half of the estate excluding the tall castle motte as has been demonstrated by the historic floods mentioned above and is due to tidal flooding.

(3) Surface water flooding - several discrete areas within the estate are at risk but would appear to pose a minimal risk to the archaeology contained within the estate as long as the water is left to drain away naturally and the areas are avoided until that occurs.

(4) The low-lying nature of the ground suggests that erosion from the Skipsea Drain is likely to be negligible as the drain will soon overtop during a flood event which in turn will dissipate the force of the water flow as it fills the surrounding landscape as during the 1982 and 2007 flood events.

(6) CONCLUSIONS AND RECOMMENDATIONS

(6.1) Overview of Risk

The result of the GIS analysis of the 362 EH inland estates has identified 41 estates at high risk of possible flooding and 20 estates at medium risk. The remaining 300 estates are assessed at low risk, either because the GIS analysis found no overlap with any of the datasets used to define a flood risk (187 estates) or because the nature and extent of the overlap indicate the risk is minimal (113 estates).

The results give an overview of the likely degree of threat flooding poses to the EH inland estate to set alongside the results of the previous assessment of coastal erosion and flooding. It is important to remember that low risk is not the same as no risk as local circumstances such as exceptionally heavy rain combined with blocked drains or sewers can cause a flood where none has been predicted from the GIS analysis. The GIS data used in the analysis is derived from computations that will not precisely reflect real world conditions while the analytical routines then applied to the data can lack precision. On the other hand, large parts of the English Heritage estate encompass buildings and landscapes of some antiquity which by their very survival demonstrate they have resilience to flooding.

(1) Historic Floods

The Environment Agency data on historic floods indicate that 29 English Heritage inland estates have experienced one flood event while six estates have had two or more. The earliest recorded by the Environment Agency is at Farleigh Hungerford in the South-West Region in 1925. The total is likely to be far greater than this figure indicates as some recent flood events do not appear in the Environment Agency data such as the damaging flood at Fountains Abbey in 2007.

(2) Fluvial Flooding

The 2007 flood at Fountains Abbey highlights the impact rapidly moving flood water can have on the ground surface exposing and destroying archaeological deposits and damaging upstanding masonry. Overall, erosion caused by fluvial flood water probably poses the greatest risk to the English Heritage estate either in circumstances as seen at Fountains Abbey from the erosive power of the running water after the River Skell overtopped its banks or where erosion increases along the banks of an existing watercourse undermining the foundations of adjacent structures and destroying archaeological deposits. The several bridges in the English Heritage estate are particularly exposed to fluvial flooding although as they are all centuries old they must have a degree of structural resilience. As a forthcoming assessment of historic bridges in the catchment of the River Aire will point out, there is very little direct intervention that can be done to protect a historic bridge without detracting from its character (Project 6189). Three sites at high risk are exposed to tidal flooding (Camber Castle, Skipsea Castle and Sibsey Trader Mill).

(3) Surface Flooding

The risk posed by surface water flooding where water tends to accumulate during heavy rain is less certain and in any case the Environment Agency urge caution in relying on their mapped extents. It is likely though that hard surfaces within the footprints of former buildings defined by exposed masonry foundations could tend to retain water after heavy rain. Environment Agency mapping has picked out two areas in particular, one within the medieval latrine block at Wolvesey Castle in the South-East region and the other within the nave at Shap Abbey in the North-West Region.

(6.2) Overview of Impact

(1) Access

The study has identified that access at just over 20% of the entire EH estate (73 sites in total) could become a problem during a severe flood event which in extreme circumstances could make it difficult to take emergency remedial measures to protect other parts of the estate.

(2) Modern Infrastructure

Severe flooding could have an impact on modern infrastructure at 20 estates of which two are offices (5 Marlborough Court in Exeter and Wyndham House in Salisbury) where measures need to be in place to protect important files and digital data off site. The on-site museum at Byland Abbey is wholly within Flood Zone 3 putting at risk the collections housed there and there is continuing risk of damage by flooding to modern infrastructure at Rievaulx Abbey following on from the destructive floods in 2005.

(3) Exposed Foundations/Standing Masonry

The assessment indicates that there may be some impact on historic building remains at just over 15% of the EH estate. It is likely that in most cases the ingress of water will be short-lived and therefore should have relatively minimal impact. The only exception will be instances where flood waters build up rapidly and overflow a site with great force resulting in the risk of physical damage to exposed masonry.

(4) Land Surface

The assessment indicates that just over a third of the English Heritage estate may experience some flooding of open ground during a severe case of surface water or fluvial flooding. The impact of such flooding on open ground is difficult to assess with any degree of certainty. At estates with ornamental gardens, planted borders, lakes and ponds the damage could be quite severe and expensive to put right but elsewhere little damage will occur if the flood builds up slowly and dissipates gently. Erosion will be a risk if the water builds up or drains away rapidly and with force when it could scour the surface or create erosion channels which might penetrate archaeological deposits. A phase of recording of exposed remains would then be required before repairs to the ground surface.

(6.3) Recommendations

The recommendations issued by English Heritage to owners of historic properties at risk of flooding apply equally to the English Heritage estate and are therefore not repeated here (English Heritage 2010). Also, many of the general recommendations contained in the 2011 assessment of the coastal estate apply to the inland estate (Hunt 2011, 53-5).

(1) The results of this assessment should be noted by the EH AMP teams to feed into estate management plans.

(2) The Emergency Planning team should take note of the results in order to consider contingency plans at the high and medium risk sites to deal with severe flood events.

(3) EH properties should register for the free Environment Agency flood warning service.

(4) Where river or stream erosion is threatening the loss of evidence at a property the risk will grow if a flood occurs therefore measures should be taken to minimise the impact by a prior programme of excavation and/or survey.

(5) Develop a system of reporting involving site managers to record and map the impact of flood events in order to further understanding of the risk to the estate, to highlight issues and to help develop mitigation strategies.

(6) Open a dialogue with the Environment Agency and relevant local authorities to make sure that their flood management plans take particular account of the risk to the National Collection posed by flooding. The 2C1 Activity Team could take responsibility for co-ordinating this approach. The initial target for action should be those properties assessed to be at high risk of flooding in particular the eleven sites listed below where flooding is likely to have the greatest impact.

Ambleside Roman Fort	Threat to the entire estate	North-West Region
Brinkburn Priory	Major risk of flooding and erosion across the majority of the estate	North-East Region
Camber Castle	Threat to the entire estate	South- East Region
Finchale Priory	Major flood risk extending across the entire estate	North-East Region
Fountains Abbey	Extensive threat across the middle of the estate following the line of the valley bottom.	Yorkshire and The Humber Region
Furness Abbey	Extensive threat to the estate	North-West Region
Kirby Muxloe Castle	Almost the entire estate is under threat	East Midlands Region

Nunney Castle	Threat to the entire estate	South-West Region
Rievaulx Abbey	Extensive threat to west half of the estate	Yorkshire and The Humber Region
Roche Abbey	Extensive threat across the estate	Yorkshire and The Humber Region
Wenlock Priory	Threat to most of the estate	West Midlands Region

(6.4) Future Work

The results of this assessment provide a broad overview of the exposure of the English Heritage inland estate to various types of flooding. Emerging from the recommendations outlined above are several possible areas for future work under Measure 2C1 of the National Heritage Protection Plan.

(1) The first objective should be to make teams with a role in managing the National Collection aware of the results of this report to set alongside the earlier study of the coastal estate. One way of delivering this message would be through a meeting between the relevant teams and members of the 2C1 Activity to present the results, to receive feedback and to discuss further initiatives such as the recommendation to report and map the impact of flood events.

(2) It is a key recommendation of this report that the Environment Agency and local authorities give due consideration to the importance of the National Collection when developing the next generation of flood management plans. The inclusion of a site in the National Collection recognises it is of unique importance to the country's story and therefore its protection should be given due weight in local and regional flood mitigation plans. The meeting discussed above could be a useful forum to consider how to raise the profile of the National Collection in these plans. A joint approach with the National Trust may have greater impact on organisations responsible for flood management plans.

(3) The estates assessed as being at high risk are clear targets for more detailed work, perhaps focussing on the eleven sites highlighted above where flooding is likely to have the greatest impact. The objective at these sites would be to develop greater precision in modelling the nature, extent and impact of a serious flood event achieved through a collaborative project with the Environment Agency and local authorities. The objective would be to model a wider range of flood scenarios than those used in the present study to understand flood risk more precisely at a local level and formulating measures to enhance protection. Such measures may include work within the estate but is also likely to require management of the wider drainage network along the lines of recent projects undertaken by the National Trust (National Trust 2008, 12-15). Records of historic floods at these sites may give useful information on the extent and impact of past events and evidence could be looked for on the ground. The recent landscape investigation of

Byland Abbey has reinterpreted a dam as a medieval flood defence (Jecock et al 2011, 82) and unrecognised examples of early flood defences may exist at other English Heritage properties.

(4) The Environment Agency could be approached to create a register of English Heritage estates situated within Rapid Response Catchments along the lines of the register they provide of communities in these areas. Heavy and prolonged rainfall in such catchments can lead to extremely dangerous and destructive floods and consequently a register of sites could extend the number of estates identified as being at high risk.

(5) The Environment Agency is continually improving and adding to its data sets. Consequently it is recommended to periodically revise this assessment and that of the coastal estate (Hunt 2011) in order to take account of advances in the range and accuracy of the flood and erosion risk mapping. In particular the nature and extent of the risk of groundwater flooding will become clearer in the future as the Environment Agency continues to research this area.

(6) The methodology used in this study and the earlier assessment of the coastal estate could be applied more widely to consider the flood risk to particular categories of heritage asset or across geographic zones or administrative regions. This study and the 2011 study of the coastal estate concentrated on a site by site assessment, but a regional or thematic study could aim to characterise risk and impact across a much greater number of sites taking into account the results of the forthcoming study by W.S Atkins looking at natural and environmental threats to the historic environment (Project 6186).

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APPENDIX 1: SOURCES OF DIGITAL DATA

Data Source	File Name	Supplier
English Heritage Regions	EH_regions.shp	English Heritage
English Heritage estates	Estates_data.shp	English Heritage
Detailed River Network	drn.shp	Environment Agency
Main Rivers	main_rivers_10k.shp	Environment Agency
Flood Alert Areas	flood_watch.shp	Environment Agency
Flood Map Areas Benefit	nat_areasbenefit_v201208.shp	Environment Agency
Flood Map Defences	nat_defences_v201208.shp	Environment Agency
Historic Flood Event Outlines (with dates)	Historic_Flood_Event_Outlines.shp	Environment Agency
Flood Zone 2	nat_floodzone2_v201208.shp	Environment Agency
Flood Zone 3	nat_flodzone3_v201208.shp	Environment Agency
Flood Map for Surface Water - 30 years (shallow)	Surface_Water_Flooding_30Years_v2	Environment Agency
Flood Map for Surface Water - 30 years (deep)	Deeper_Surface_Water_Flooding_30 Years_v2	Environment Agency
Areas susceptible to ground water flooding	astwgf.shp	Environment Agency
Rapid Response Catchments	RRC.shp	Environment Agency
OS 1:10,000 mapping	*[Various in 5km tiles]*	Ordnance Survey
UK Topography	UK_srtm	CGIAR Consortium for Spatial Information http://srtm.csi.cgiar.org/

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