

KNOWLE PARK CRANLEIGH **FLOOD RISK ASSESSMENT**

KNOWLE PARK INITIATIVE

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This Flood Risk Assessment was commissioned by Knowle Park Initiative in June 2014 to investigate the risks and assess the consequences of flooding of the proposed development at West Cranleigh Nurseries and Knowle Park, in Cranleigh, Surrey.

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GLOSSARY

AOD	Above Ordnance Datum
BGS	British Geological Survey
CDA	Critical Drainage Area
DEFRA	Department for Environment Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
LDF	Local Development Framework
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
ReFH	Revitalised FSR/FEH Rainfall-Runoff method
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Urban Drainage Systems
SWMP	Surface Water Management Plan

EXECUTIVE SUMMARY

The site is located to the west of Cranleigh in Surrey and is currently West Cranleigh Nurseries and surrounding greenfield land. The proposed development site is separated into three areas: Area A, Area B and Area C. Proposals involve the demolition of the existing nursery buildings within the West Cranleigh Nursery (Area C). 265 residential developments are to be constructed on Area B and Area C combined. Area A is to be retained as public open space and is to be enhanced into amenity space and parkland.

The closest river to the site is the Littlemead Brook which flows in a westerly direction along the northern boundary of Area C to its confluence with Cranleigh Waters (an Environment Agency designated main river), which flows in a northerly direction along the far western site boundary. The Wey and Arun Canal is located beyond Cranleigh Water to the west of the site and is currently undergoing plans for restoration.

The Environment Agency online flood zone map indicates that the site is located partially within Flood Zone 2 and 3, with the remainder located in Flood Zone 1. The site is greater than one hectare in area and a full flood risk assessment, including surface water drainage strategy, has therefore been prepared to accompany the planning application.

Although part of the site is shown to be partially located within Flood Zone 3 of the Littlemead Brook, a sequential approach has been adopted for the site layout and the all proposed residential developments will be entirely located within Flood Zone 1, therefore the Sequential Test does not apply. The risk of flooding to the development from all other sources has been assessed as low.

Based on the modelled flood water levels provided by the Environment Agency, all of the buildings would remain dry during the 1% AEP event (including climate change). Finished floor levels within the residential developments will be set at least 300mm above modelled 1% annual exceedence probability flood water levels including an allowance for climate change. The residential development area is located outside of Flood Zone 3 and, as a result, the proposed development will not result in a loss of floodplain storage and compensation is therefore not required.

Safe, dry access to the site would be achieved via normal access routes to Alfold Road during even the 0.1% extreme flood event. Access to the village of Little Mead is shown to be available during the design 1% AEP plus climate change flood event.

The surface-water drainage system as proposed above will prevent an increase in runoff for the 100 year plus climate change event from the existing greenfield runoff rate of 250.1l/s. Surface water will be collected and attenuated using the existing surface water storage ponds, including two new extension ditches, and also through the provision of permeable paving with a granular sub-base. The proposed drainage system is sustainable in nature, providing amenity and biodiversity enhancements whilst improving the quality of the discharged runoff. Outfalls will be provided to the ponds and the extension ditches, with three new outfalls proposed to the Littlemead Brook. There will be the provision for drainage exceedance and overland flow routes in building design.

There will be no significant consequences of flooding in the 1% AEP event, including an allowance for climate change and no adverse effects for any neighbouring property.

1 INTRODUCTION

General Information

- 1.1 The site is located to the west of Cranleigh in Surrey and is currently formed of a horticultural nursery and agricultural land.
- 1.2 The site comprises of land located mostly within Flood Zone 1, with part of the site located within Flood Zone 2 and a small area within Flood Zone 3, according to the Environment Agency's Flood Zone map. In addition, the site is greater than one hectare in area, and a full flood risk assessment including a surface water drainage strategy has therefore been prepared to accompany a planning application for the site.
- 1.3 There are two watercourses which potentially impact upon the site; Cranleigh Waters and the Littlemead Brook, and will be considered within this assessment. Cranleigh Waters forms the western boundary of the site, whilst the Littlemead Brook passes along the northern edge.
- 1.4 The site lies partially within Flood Zone 3 and therefore has an annual exceedence probability (AEP) of flooding from rivers and the sea of greater than 1%. The site is also greater than one hectare and a flood risk assessment is therefore required to support the planning application in accordance with the National Planning Policy Framework (NPPF)¹ and the associated Planning Practice Guidance². A significant emphasis of the assessment is the management of surface water on the site.

Scope of Study

- 1.5 The main objectives of this study are to:
 - assess the risk and implications of flooding on the site from all possible flood sources, including the future risk as a result of projected climate change over the lifetime of the development;
 - assess the impact of the proposed development on flood risk elsewhere, with particular consideration of surface water management on the site;
 - provide a flood risk assessment of the site, compliant with the guidelines set out in the NPPF and the associated Flood Risk and Coastal Change section of the Planning Practice Guidance, to accompany any application for planning permission; and
 - provide advice on the site layout and design that will ensure safe operation of the site in an extreme flood or rainfall event, and avoid causing an unacceptable impact on the risk of flooding elsewhere in the catchment.

1 Communities and Local Government, National Planning Policy Framework, March 2012

2 Communities and Local Government, Planning Practice Guidance: Flood Risk and Coastal Change, March 2014

2 SITE DESCRIPTION

Location

- 2.1 The site is located to the west of Cranleigh in Surrey and is approximately 41.22 ha. in size. The site comprises of land on both sides of Alford Road, with West Cranleigh Nurseries on the west side and Knowle Park on the east. The site also has an existing access point from Knowle Lane to the East.
- 2.2 The site is bounded on the western edge by Cranleigh Waters, flowing northwards, which is major tributary of the River Wey. The Littlemead Brook traverses the northern edge of the site running from East to West, beneath Knowle Lane, through the Knowle Park site, north of Knowle Wood and along the northern edge of West Cranleigh Nurseries before joining Cranleigh Waters.
- 2.3 The location of the site relative to surrounding water and geographical features is presented in Figure 1.

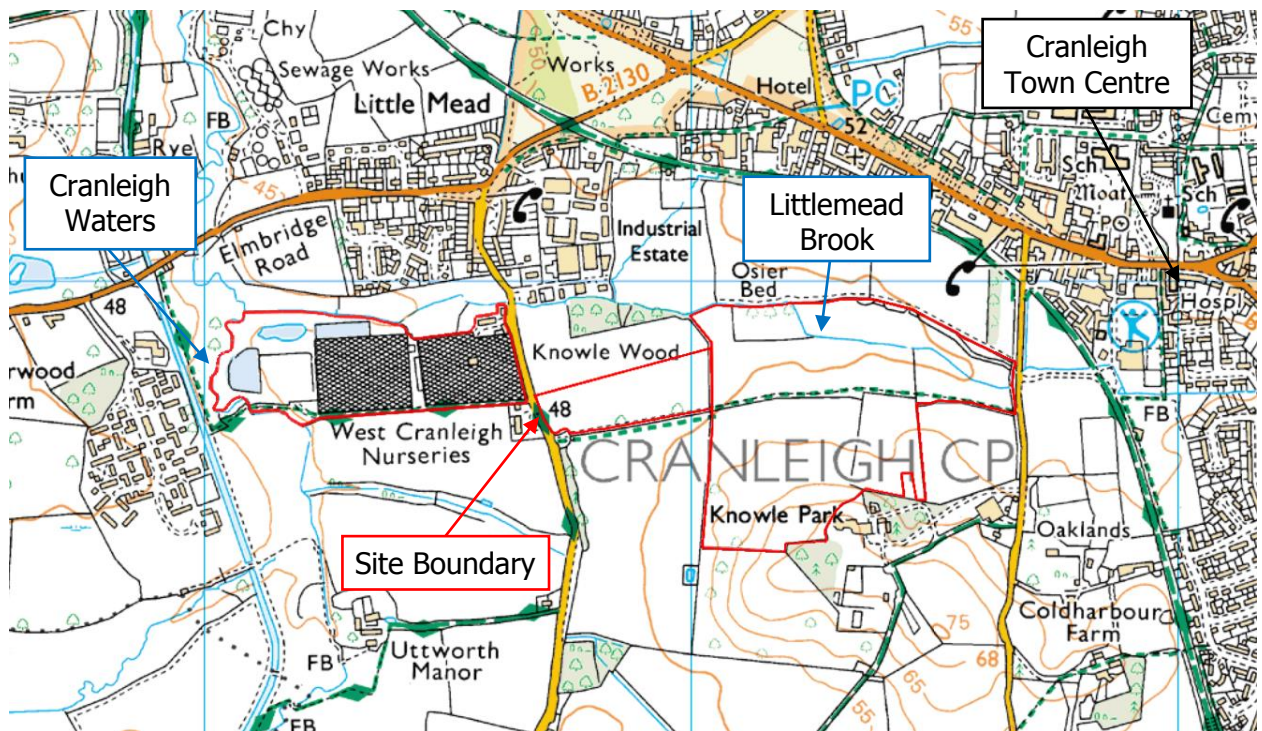


Figure 1 – Location of proposed development site

Existing Development

- 2.4 The development site is formed of two existing site areas; West Cranleigh Nurseries and Knowle Park. They will be redeveloped as a single site.
- 2.5 West Cranleigh Nurseries is an existing horticultural nursery site, occupied by glasshouses, three storage reservoirs and various other buildings related to the operation of the nursery. All buildings will be demolished as a result of the proposed

development. The Knowle Park site comprises cultivated arable fields with a small area of woodland known as the Osier Beds.

Topographic Survey

- 2.6 A topographic survey of the site was undertaken by ABM Surveys in June 2014, and is referenced to Ordnance Datum (AOD) and Ordnance Survey National Grid. The survey has been included as Drawing 1 across two sheets. The surveyed area covers West Cranleigh Nurseries (Sheet 1 of 2) and Knowle Park West, south of Knowle Wood (Sheet 2 of 2).
- 2.7 Ground levels generally fall towards the north-west corner of the site, towards the confluence of Cranleigh Waters and the Littlemead Brook where levels are approximately 44.9m AOD. The West Cranleigh Nurseries site steps up from the Littlemead Brook (approximately 45.2m AOD), to ground levels at the glasshouses of approximately 46.3m in the north-west corner, rising to approximately 48.0m AOD at the south-east away from the watercourse.
- 2.8 Levels fall to the north along Alfold Road towards the Littlemead Brook, from approximately 48.2m at the southern end, to 46.2m at the northern end close to Alford Road Bridge. Levels on Knowle Park West rise from Alford Road up towards approximately 50.5m AOD at the south-east corner of the site. Average levels across the centre of the site are approximately 48.5 to 49.0m AOD.
- 2.9 The topographic survey identified a number of manholes and road gulleys along Alford Road and within the central portion of the West Cranleigh Nurseries site associated with the surface water drainage infrastructure. Three storage ponds were confirmed, along with surface water drainage ditches around the western perimeter of the glasshouses and along the eastern side of Alford Road.

Site Visit

- 2.10 Site visits were undertaken on the 13th June 2014 and the 26th August 2014 to review the current development at the West Cranleigh Nurseries, the existing surface water drainage provision, the existing water storage ponds and the proximity of the site to the Littlemead Brook and Cranleigh Waters. A selection of photographs from the site visits are provided in Appendix D.

Proposed Development

- 2.11 The proposed development has been divided into three areas (Area A, B and C), providing development of housing, community facilities and open space. An overview of the proposed development layout is presented in Figure 2, and detailed development plans are included in Appendix A. The areas will be developed as follows:
 - Area A (Knowle Park) is 27.29 Ha in size and is intended as dedicated public parkland, with recreational facilities, visitor parking and sites for open air events. The site will be open along the watercourse and have allocated nature trails and wildlife areas.

- Area B (Knowle Park West) is 2.73 Ha and is proposed as an area of low density housing in a parkland setting.
- Area C (West Cranleigh Nurseries) will be redeveloped as housing development (11.2 Ha) in place of the redundant glasshouses on the site. Two of the existing storage reservoirs will be retained for community recreational and environmental uses with green spaces integrating the watercourse, footpaths and key points within the development.

2.12 The drainage infrastructure on the site will incorporate sustainable drainage components in accordance with the recommendations stated in the Flood Risk and Coastal Change section of the Planning Practice Guidance.

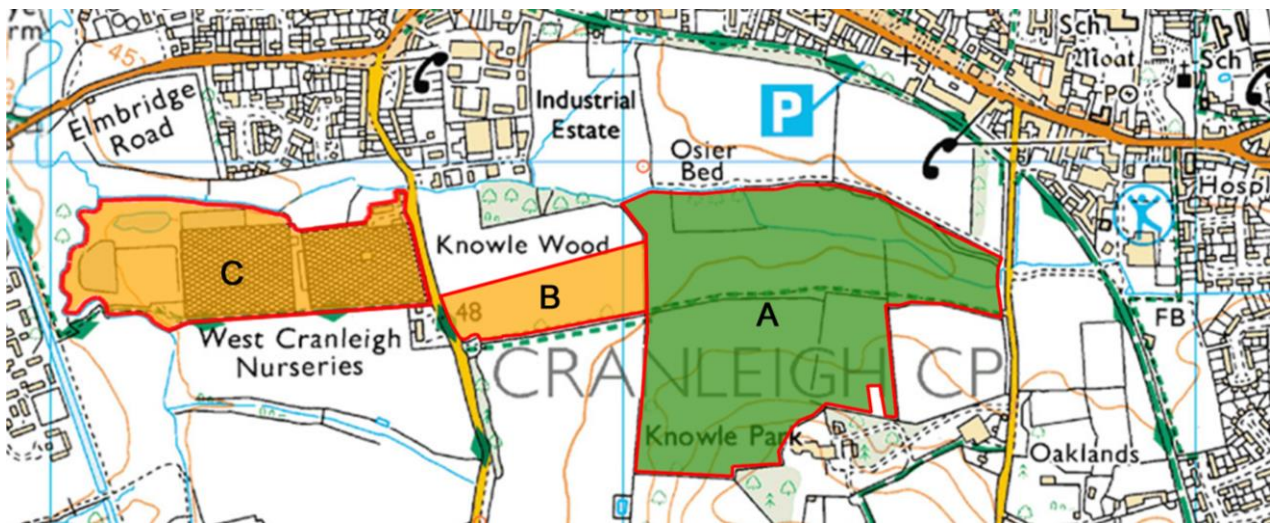


Figure 2 – Overview of proposed development main areas

3 PLANNING POLICY AND GUIDANCE

National Planning Policy Framework

- 3.1 The NPPF was released in March 2012 and sets out the Governments' planning policies for England and how these are expected to be applied. The NPPF states that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."

- 3.2 In addition to the NPPF, online Planning Practice Guidance was released in March 2014 to clarify planning aspects of flood risk management. The Planning Practice Guidance supersedes the Technical Guidance to the NPPF and clarifies which development types are considered appropriate within each flood zone.
- 3.3 The proposed development can be described as predominantly residential development or "dwelling houses" which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be 'More Vulnerable'. This represents an increase in vulnerability as a result of the development since the previous land use at the site is considered 'Less Vulnerable' since it consists (partially) of "Land and buildings used for agriculture".
- 3.4 Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that 'More Vulnerable' development is compatible within Flood Zone 1 and Flood Zone 2. For 'More Vulnerable' development located in Flood Zone 3a, the Exception Test will be required.

Local Planning Policy

- 3.5 Waverley District Council has no active policies relating to flood risk at present, since the new Core Policy is currently being developed and reviewed. The existing Local Plan was adopted by the borough in 2002 and the saved policies are still the key strategic planning documents for Waverley Borough. In 2007, a number of policies within this plan ceased to have effect, including Policy D12 Runoff and Flooding.
- 3.6 As such, the existing Core Policy has no specific guidance of flood risk and therefore planning objectives divert to the NPPF and associated Planning Practice Guidance. Information from the Surrey County Council Preliminary Flood Risk Assessment³ (PFRA) and Waverley District Council Strategic Flood Risk Assessment⁴ (SFRA) has been used to inform this assessment.

Surrey County Council Preliminary Flood Risk Assessment

- 3.7 A PFRA was completed by Surrey County Council in 2011 as part of their responsibility as a Lead Local Flood Authority (LLFA). The PFRA process aims to provide a high-level

³ Surrey County Council, June 2011, Preliminary Flood Risk Assessment

⁴ Capita Symonds, June 2010, Waverley District Council Strategic Flood Risk Assessment

overview of flood risk from all local flood sources, including surface water, groundwater, main rivers and ordinary watercourses, and canals.

- 3.8 The PFRA considers incidences of historical flooding within Surrey, from all sources, and assess the future flood risk from fluvial, groundwater and surface water sources.
- 3.9 Figure 4.1 of the PFRA shows Point Data for Historic Floods, and includes a cluster of historic flood events located in and around Cranleigh.

Waverley Strategic Flood Risk Assessment

- 3.10 The Waverley SFRA⁵ was undertaken by Capita Symonds in June 2010, on behalf of Waverley Borough Council. This assessment considers flood risk in borough and the outputs of the SFRA have been taken into consideration when undertaking this assessment.
- 3.11 The SFRA highlights that Cranleigh is at “medium to high risk” of flooding from both fluvial (rivers) and land (surface water) sources. There is also a significant risk of flooding from sewers. Table 4.1 of the SFRA report flooding in Cranleigh in 2000, as a result of flooding of the Littlemead Brook. Several critical infrastructure sites are located within Flood Zone 3, including Cranleigh police station and sewage treatment works. All sources of risk are mapped at a broad scale, and will be referenced and utilised within this report.
- 3.12 The rural River Wey catchment, including Cranleigh, is covered by the Thames Catchment Flood Management Plan (CFMP). This confirms that in undeveloped areas the Environment Agency will reduce maintenance and allow increased flooding of the floodplain, focussing their efforts on ensuring that rivers are flowing through towns in order to reduce risk.
- 3.13 The SFRA states that Sustainable Drainage Systems (SuDS) should be considered for all new developments, with due consideration of the SuDS management train. “All probable SuDS options should be explored as part of site investigation”, and the report emphasises the importance of allocation of land within the design to accommodate SuDS requests.

Sequential Test

- 3.14 Parts of the site are shown to be located within Flood Zones 2 and 3. A sequential approach has been adopted to ensure that all residential properties will be constructed within Flood Zone 1. The Sequential Test is therefore considered to have been passed since no additional developments will be placed in an area at risk of flooding. There is subsequently no requirement to apply the Exception Test to the proposed development.

Climate Change

- 3.15 The projected impacts of climate change are likely to cause long term variations in the probability and risk of flooding. Risk of flooding from groundwater is likely to be

⁵ Capita Symonds (June 2010) Waverley Strategic Flood Risk Assessment

reduced, but risks from other sources are likely to increase. This will affect the site in terms of the likelihood of flooding from rivers and sewers. The impact of climate change is considered in more detail in relevant sections of this report, and has been accounted for in the site design.

4 POTENTIAL FLOODING ON SITE

Historic Information

- 4.1 The Environment Agency has provided records of a historical incident of flooding from Cranleigh Waters in 1968. The flood event (6th September 1968) occurred as a result of the channel capacity being exceeded and flooding is shown to encroach upon the western end of the West Cranleigh Nurseries site. The Waverley SFRA historical flood map (Figure 4.1), which includes historical flooding from all sources, records the same fluvial flood outline. There are no other recorded incidents of pluvial, sewer, or groundwater flooding close to the site.
- 4.2 The Environment Agency information states that floodplain extents are an indication of the geographical extent of a historical flood, and do not provide information regarding flooding to individual properties.

Flood Sources

Flooding from Rivers (Fluvial Flooding)

- 4.3 The site lies within an area of land bounded by Cranleigh Waters on the western edge and the Littlemead Brook along the northern boundary. The Littlemead Brook flows east to west across the site, towards the confluence with Cranleigh Waters. The two watercourses join and flow northwards, to the River Wey. Figure 3 shows the Environment Agency online Flood Zone map for the area surrounding the site.

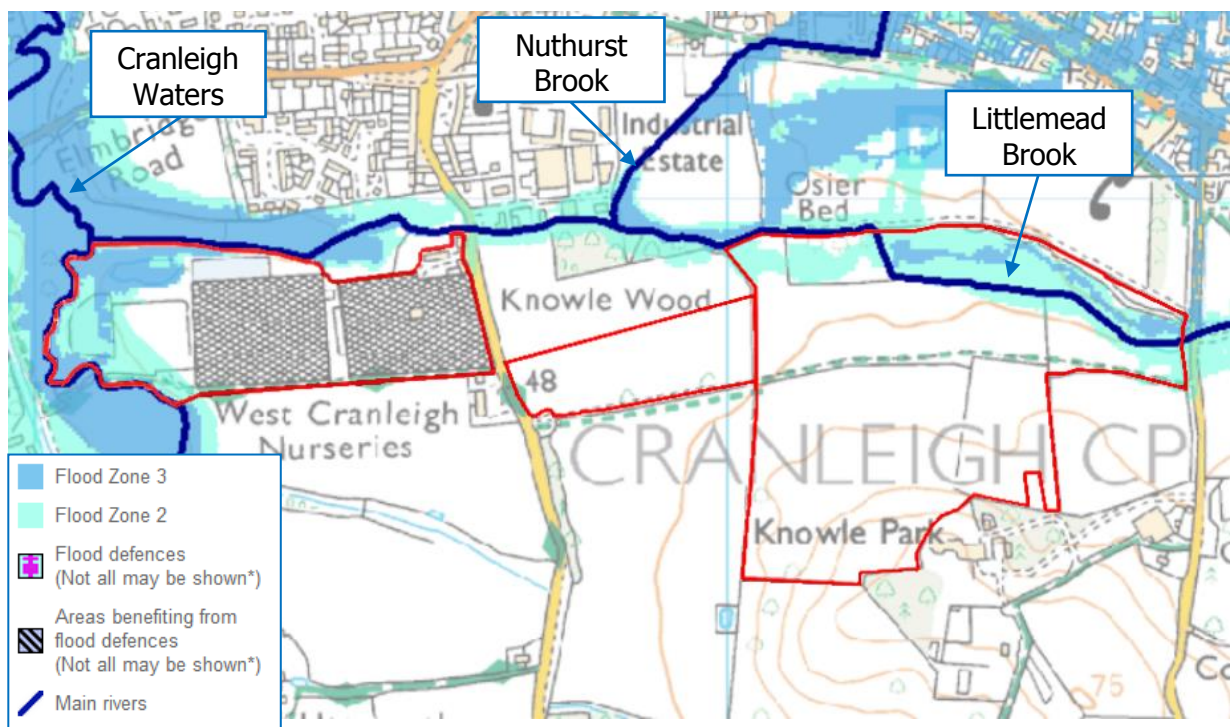


Figure 3 – Environment Agency Flood Zone Map

- 4.4 The floodplain indicated in dark blue is the area that may be affected by the 1% AEP fluvial flooding event, neglecting the influence of any flood defences in the area. This is categorised by the Environment Agency as Flood Zone 3. The light blue colour shows the additional extent of an extreme flood (0.1% probability in any year), and is categorised as Flood Zone 2.
- 4.5 Figure 3 shows the site to lie largely within Flood Zone 1, with Flood Zone 2 along the northern and western edges of the site and a small amount of Flood Zone 3 in the north-west corner of the West Cranleigh Nurseries site adjacent to the watercourses. A detailed flood zone map for the site as provided by the Environment Agency is included in Appendix B. The impact of fluvial flood risk is discussed further in Chapter 5 of this report.

Flooding from the Sea (Tidal Flooding)

- 4.6 The site is located approximately 37km directly north of the sea at Littlehampton, West Sussex and the lowest level on site is in the order of 45m AOD. The site is therefore not considered to be at risk of tidal flooding.

Flooding from the Land (Pluvial Flooding)

- 4.7 Surface water (or pluvial) flooding results from flood water flowing overland in times of intense rainfall before reaching watercourses or drainage systems. Surface water flooding is generally associated with topographic depressions and natural valleys.
- 4.8 A surface water flood map has been provided by the Environment Agency, which includes the most up-to-date surface water modelling available. The Likelihood of Surface Water Flooding map included as Figure 5.1 within the Waverley SFRA has therefore been superseded by the new information. An extract of the Environment Agency surface water flood map for the site is shown in Figure 4.

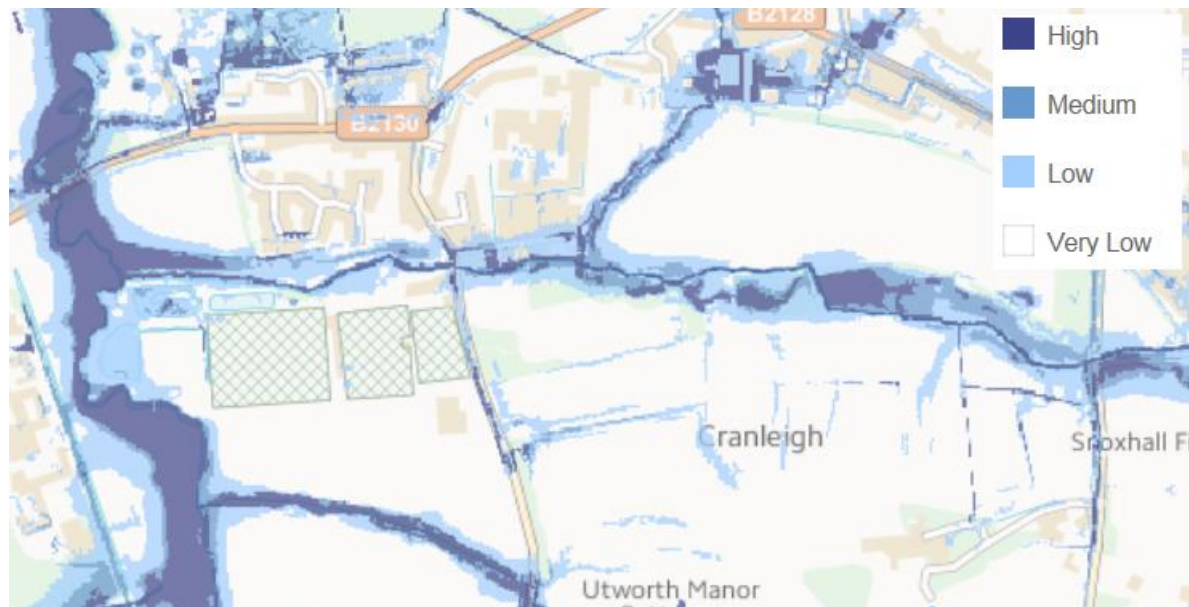


Figure 4 – Environment Agency Online Surface Water Flood Map

- 4.9 The surface water flood mapping indicates that the area at risk is largely similar to the extent of the Flood Zone Maps, due to the low-lying nature of the land associated with

floodplains. Surface water flooding will preferentially flow overland before collecting in valleys and topographical low spots, and hence frequently appears to mimic patterns of fluvial risk. However, surface water modelling also indicates the location of other drainage paths, field drains and dry valleys.

- 4.10 Surface water maps illustrate a notable overland flow path from Alford Road east towards Cranleigh Waters. This is south of the site and joins the river upstream of West Cranleigh Nurseries and therefore this surface water flow path causes no additional risk of flooding to the site.
- 4.11 There are several areas considered to be at 'Low Risk' of surface water flooding on the Knowle Park site. These appear to typically lie along field boundaries, indicating the presence of drainage ditches. Natural overland flow routes into the Littlemead Brook are also highlighted on the eastern side of the site. In addition, a small drainage ditch is highlighted around the edge of the most westerly of the existing greenhouses on the West Cranleigh Nurseries site. 'Low Risk' is considered to be a likelihood of flooding from surface water "less than 1 in 100 (1%) but greater than or equal to 1 in 1000 (0.1%) chance in any given year". The Environment Agency's surface water depth map indicates a flood depth less than 300mm deep for these areas.
- 4.12 There is a small area considered to be at 'Medium Risk' close to Alford Road, and 'High Risk' along the road itself; where medium risk is between 1 in 100 and 1 in 30 (3.3%) chance, and high risk greater than (or equal to) a 1 in 30 chance in any given year. Alford Road appears to provide a preferential route for surface water to flow north towards the Littlemead Brook, and therefore small amounts of flooding may collect in the road during an extreme rainfall event.
- 4.13 Development on the site will be designed to avoid areas at risk of fluvial flooding, and hence will avoid the area shown to be at high risk of surface water flooding by default. Redevelopment of the site will involve ground works and there may be changes to natural overland flow routes shown to be at 'Low Risk' of surface water flooding. However, surface water runoff routes will be implemented by design on the site and finished floor levels of houses on site will be raised above surrounding ground levels. Typically, proposed threshold levels will be raised approximately 150mm above external levels, in accordance with CIRIA Guidance⁶, to provide protection from any surface water ponding on site in extreme rainfall events which exceed the design storm criteria. As a result, the risk of flooding from overland flow is therefore considered to be low.

Flooding from Groundwater

- 4.14 The underlying geology at the site, as observed by the British Geological Survey (BGS) online 1:50,000 mapping, consists of Weald Clay Formation overlain by River Terrace Deposits.
- 4.15 The bedrock geology, Weald Clay Formation, is largely mudstone beneath the site, which is characterised by low permeability. Some sandstone lenses are found within the Weald Clay Formation, and the BGS mapping indicates these to be present beneath the Knowle Park site. These sandstone lenses can contain quantities of groundwater.

⁶ CIRIA, Designing for exceedance in urban drainage – good practice (C635)

- 4.16 The superficial geology consists of River Terrace Deposits (Bramley Wey) which is indicated to lie beneath a large portion of the western side of the site (West Cranleigh Nurseries in particular), and Alluvium along the river corridor. These superficial deposits consist of sands and gravels, which have potential to contain shallow groundwater due to interaction with the watercourses.
- 4.17 A ground investigation on the site, undertaken by Card Geotechnics Limited in August 2014⁷, has confirmed this general geological succession of River Terrace Deposits over Weald Clay. Six boreholes were included in the ground investigation, three locations on the existing West Cranleigh Nurseries and three on the Knowle Park site. These boreholes suggest that River Terrace deposits are seen, at varying thicknesses, across the entirety of the site. The Weald Clay is described as “slightly sandy clay” in places, and included sands are fine to coarse.
- 4.18 The site is shown on the Environment Agency’s online mapping to lie partially within a superficial Source Protection Zone. The Environment Agency classifies the River Terrace deposits as being “Secondary A” aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic level and in some cases forming an important source of base flow to rivers. Whilst the majority of the site is shown to lie on unproductive bedrock strata, the sandstone lenses beneath the Knowle Park site are shown to be “Secondary A” bedrock aquifer. Overall, “Secondary A” aquifer deposits (both superficial and bedrock) underlie the majority of the site and this is reflected on the Environment Agency’s groundwater vulnerability maps, shown in Figure 5.

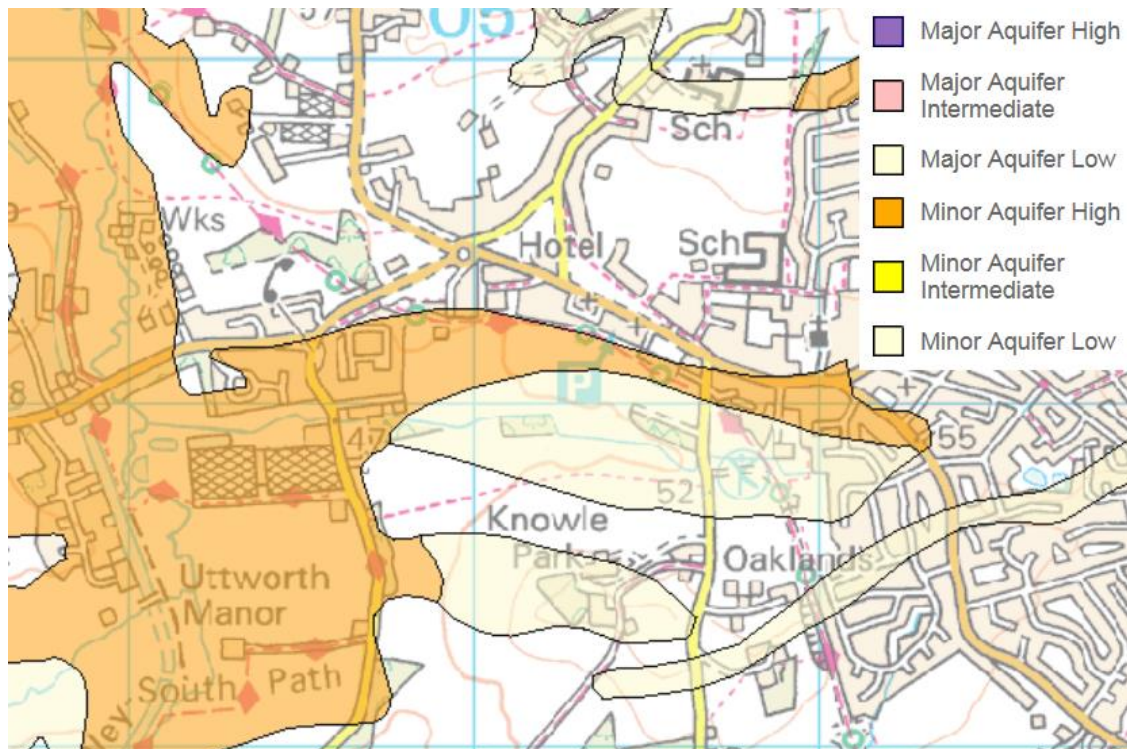


Figure 5 – Environment Agency Online Groundwater Vulnerability Map

⁷ Card Geotechnics Limited (CGL), August 2014, Knowle Park Initiative, Cranleigh, Review of ground conditions and groundwater levels.

- 4.19 Groundwater strikes were recorded during drilling in five of the six boreholes, the exception being WS5 where it is noted that the Weald Clay Formation was encountered at the shallowest depth, at 1.14m below ground level (BGL). Groundwater was first encountered at levels between 1.7m and 3.0m BGL, within the River Terrace Deposits.
- 4.20 Groundwater monitoring wells were installed in four of the boreholes, and groundwater levels were recorded on 5th August 2014. Groundwater levels ranged between 1.11m BGL to 2.10m BGL within the River Terrace sands and gravels, with shallower levels seen towards the north of the site, closer to the Littlemead Brook. This indicates a general south to north trend, with shallow groundwater flowing towards the watercourse. It can therefore be assumed that the River Terrace Deposits are in hydraulic connectivity with watercourses in the area and thus groundwater levels are similar to observed base-flow river levels.
- 4.21 Groundwater within the River Terrace Gravels will be well-drained and flowing in the direction of the watercourse. Under these conditions, and given the raised nature of the site above the 0.1% AEP flood level, it is unlikely that groundwater would cause flooding.

Flooding from Sewers

- 4.22 The Thames Water sewer asset location plan shows that there are separate foul and surface-water sewer networks in this area, however there are no public sewers shown on the existing West Cranleigh Nursery or Knowle Park site. The existing nursery site is drained by a private drainage from the roof of the greenhouses, partly to surface water storage ponds located on the site and partly discharging directly into the Littlemead Brook. There are no public sewers shown in Alfold Road south of the crossing with Littlemead Brook.
- 4.23 The site is not currently considered to be at significant risk of sewer flooding. The proposed drainage system will be designed to ensure that no internal flooding occurs for rainfall events up to and including the critical duration 1% AEP event with an appropriate allowance for climate change. The outline surface water drainage strategy is discussed in more detail in Chapter 6.

Flooding from Artificial Water Bodies

- 4.24 The nearest artificial water body to the site is the Wey & Arun Canal, which lies a 50m to the west of the West Cranleigh Nurseries site. Presently the Wey & Arun Canal is not continuous adjacent to the site and is currently undergoing restoration by the Wey & Arun Canal Trust. The canal does not presently interact with the adjacent watercourse, Cranleigh Waters.
- 4.25 Canals can pose a risk of flooding as the result of a breach of the defences, where the canal is raised above surrounding ground levels. Based on available LiDAR information for the site and surrounding area, canal levels in this vicinity are lower than the site. Furthermore, the canal is situated on the western side of Cranleigh Waters. In the unlikely event of a breach of the canal water would flow within the natural floodplain of Cranleigh Waters. Figure 7.1 (Artificial Sources) of the Waverley SFRA confirms that the extent of flooding as a result of the canal breach would be contained to the left bank (west side) of Cranleigh Waters. Therefore, the site is not considered to be at risk as a result of a breach of the Wey & Arun Canal.

- 4.26 The Environment Agency online mapping also shows an area at risk of flooding from reservoir failure associated with Vachery Pond. Vachery Pond is privately owned and located on the Vachery Estate, discharging to the Thornhurst Brook, a tributary of the Cobbler's Brook which is in turn a tributary of Cranleigh Water.
- 4.27 In the event of a reservoir failure from Vachery Pond, water released would follow the natural floodplain of Cranleigh Waters. The extent of flooding as presented in Environment Agency mapping is shown in Figure 6.

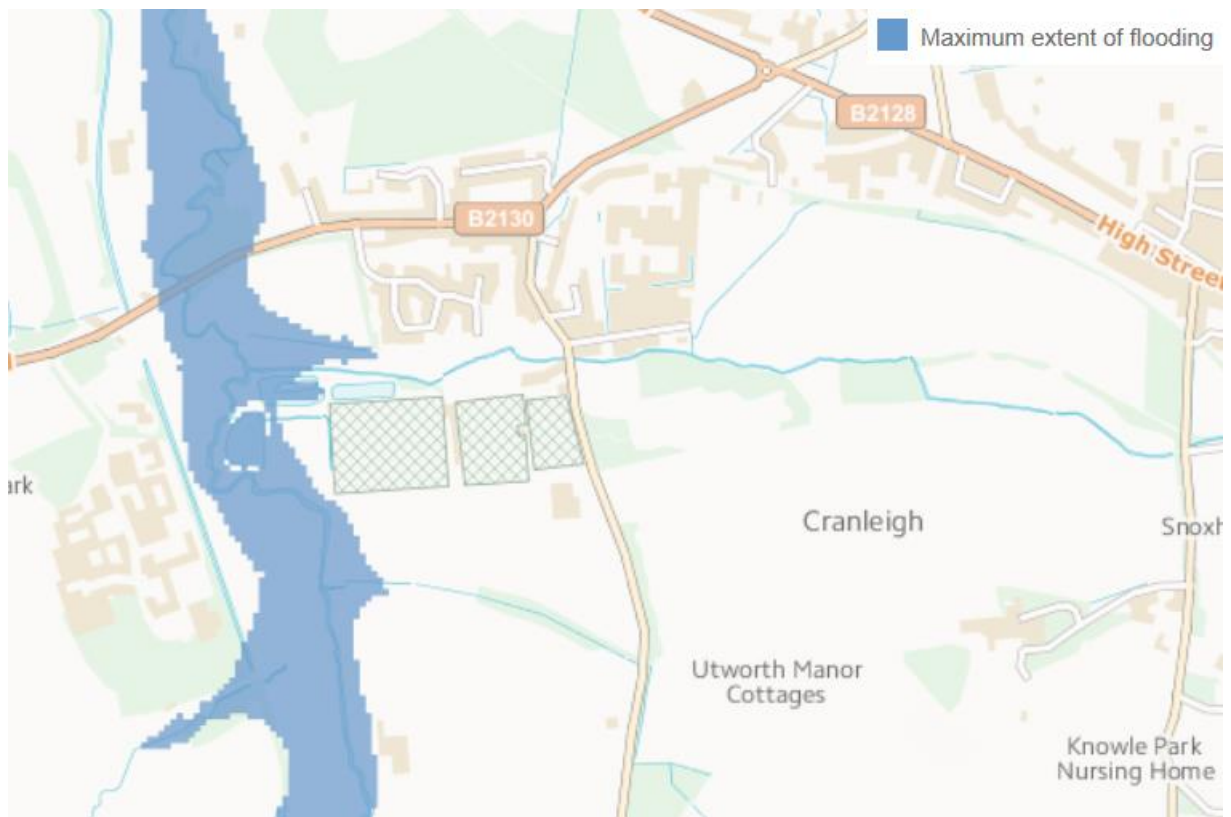


Figure 6 – Environment Agency Online Reservoir Flooding Map

- 4.28 Detailed water levels associated with flooding as a result of reservoir flooding are not provided by the Environment Agency, however the extent of flooding in this unlikely scenario is shown to encroach upon the western side of the site, over an area similar to that of the modelled fluvial and pluvial flooding. Since development will be located outside of the area at risk for fluvial flooding reasons, the residual risk of flooding as a result of a reservoir failure is therefore low.
- 4.29 There are no other artificial water bodies that would constitute a source of flood risk to the site.

5 ASSESSMENT OF FLUVIAL FLOOD RISK

Modelled Flood Water levels

5.1 The Environment Agency has provided modelled flood water levels from the Lower Wey modelling, undertaken in 2009, and this includes levels for Cranleigh Waters and the Littlemead Brook. For the purposes of this study these are assumed to be correct. Detailed modelling outlines for the watercourses for a range of return periods are provided in Appendix B. A detailed hydrological study to the Cranleigh Waters and Littlemead Brook catchments and bespoke hydraulic analysis of the watercourses through the site has therefore not been carried out as part of this investigation.

Cranleigh Waters

5.2 Modelled flood water levels in Cranleigh Waters for a range of return periods for all model node locations relevant to the site are shown in Table 1. The locations of the 1D nodes are shown in Appendix B.

Table 1 – Modelled 1D flood water levels in Cranleigh Waters appropriate to this site

Node	1% AEP Level (m AOD)	1% AEP + 20% Level (m AOD)	0.1% AEP Level (m AOD)
CW0422	45.52	45.66	45.94
CW0422D	45.51	45.66	45.93
CW0315	45.48	45.62	45.89
CW0315D	45.48	45.62	45.89
CW0215	45.23	45.39	45.70
CW0015	44.97	45.12	45.44
LMS0000	45.48	45.48	45.89

5.3 The site is located at the confluence of Cranleigh Waters and the Littlemead Brook. Flooding on site may be as a result of either watercourse independently, or both watercourses together.

Littlemead Brook

5.4 The Littlemead Brook was modelled as part of the Lower Wey model in 2009, however 1D in-channel node data are not available for this tributary. Instead 2D floodplain nodes in the Environment Agency hydraulic model representing the Littlemead Brook, have been provided for the purposes of this assessment.

5.5 Modelled water levels within the Littlemead Brook floodplain for a range of return periods are included within Table 2. The locations of the 2D nodes are shown in Appendix B, with the 1D Cranleigh Waters nodes above. "Floodplain 1" and "Floodplain 3" are located on the existing West Cranleigh Nurseries site (Zone C of proposed development, designated for housing), and "Floodplain 5" is upstream of Alfold Road at Knowle Wood. "Floodplain 8" and "Floodplain 9" are within Zone A of the proposed development, which will be developed as a community park.

Table 2 – Modelled 2D flood water levels in Littlemead Brook adjacent to the site

Node	2% AEP Level (m AOD)	1% AEP Level (m AOD)	1% AEP + 20% Level (m AOD)	0.1% AEP Level (m AOD)
Floodplain 1	45.34	45.48	45.48	45.89
Floodplain 3	-	45.53	45.56	45.95
Floodplain 5	-	-	47.48	47.74
Floodplain 8	-	-	49.42	50.02
Floodplain 9	-	50.87	50.87	50.99

Flooding on Site

- 5.6 The lowest ground levels on the site are approximately 44.9m AOD, in the north-west corner of West Cranleigh Nurseries, close the confluence of the Littlemead Brook and Cranleigh Waters. This area is a pond. Based on modelled 1D (LMS0000) and 2D ("Floodplain 1") flood levels, this portion of the site would be expected to flood in the 2% AEP event. In the 1% AEP plus climate change event, this corner of the site could be flooded up to 600mm deep.
- 5.7 Based on modelled floodplain output provided by the Environment Agency (Appendix B) the 1% AEP outline from the Littlemead Brook encroaches to the south slightly, flooding an area close to the existing fish pond at the western end of the site.
- 5.8 The western end of the site would be at risk of flooding during a 0.1% AEP event, flooding to a level of approximately 45.9m AOD from both Cranleigh Waters and the Littlemead Brook. In this event both of the existing ponds would be submerged. In the same area, flooding up to and including the 1% AEP plus climate change flood event would not result in flooding of the ponds, but instead it would be contained close to the channel of Cranleigh Waters. East of the ponds, ground levels are slightly elevated and consequently the existing glasshouses are not shown to be at risk of flooding.
- 5.9 Flooding from the Littlemead Brook is shown to encroach upon the northern edge of the site during the 1% AEP event ("Floodplain 3"). The lowest ground levels in the area are approximately 45.2m AOD, and therefore flooding would be approximately 300mm deep on this area of the site. Levels rise away from the watercourse, and the existing glasshouses (at approximately 46.8m AOD) are significantly above any of the modelled flood levels for the Littlemead Brook.
- 5.10 Upstream of Alfold Road, the Littlemead Brook rises to approximately 47.48m AOD at Knowle Wood during a 1% AEP plus climate change flood event ("Floodplain 5"). With ground levels in this area at 48.2m AOD and higher the Knowle Park West site is, in all places, more than 700mm above this event. The Knowle Park West site is not at risk of flooding from any event from the Littlemead Brook, up to and including the 0.1% AEP event.
- 5.11 On the eastern end of the site, the Littlemead Brook floods on the northern side of the watercourse during a 1% AEP flood event, downstream of Knowle Lane on the Knowle Park site ("Floodplain 9"). This area is a well-established natural floodplain, on both sides of the watercourse along the northern boundary of the site.

Structures which may Influence Local Hydraulics

5.12 Both the Littlemead Brook and Cranleigh Waters have man-made bridge structures crossing the river channel. These structures are accounted for in the Environment Agency's hydraulic model of Cranleigh Waters and the Littlemead Brook, and their influence is reflected in the modelled flood water levels.

Flood Defences

5.13 There are no formal flood defences in the vicinity of the site.

Flood Risk to the Proposed Development

5.14 Due to the extensive size of the whole site, and complex nature of flood mechanisms from both watercourses, the risk of flooding varies across the site. With reference to Figure 2, flood risk on areas A, B and C are discussed below. The Sequential Approach has been applied in the design layout of the site, providing water-compatible land uses (such as parkland) in areas which are more prone to flooding, and keeping more vulnerable land uses (such as housing) in areas which are not at significant risk of flooding.

Area A – Knowle Park

5.15 Area A (Knowle Park) will be developed as landscaped community parkland.

5.16 This portion of the site includes both sides of the Littlemead Brook watercourse immediately west of Knowle Lane. The area includes the natural floodplain of Littlemead Brook and consequently there is a risk of flooding on some parts of this site.

5.17 All of Area A will be open parkland with recreation areas for residents. Based on Table 2 of the NPPF, "amenity open space" is considered to be "water-compatible" development. As a result, it is considered that this is an acceptable land use within an area which is partially at risk of flooding.

Area B – Knowle Park West

5.18 Area B (Knowle Park West) is located within the centre of the overall site boundary. It is accessed from Alfold Road and is approximately 100m south of the Littlemead Brook at its closest point. This area is proposed as a development of low-density housing within a parkland setting.

5.19 The Knowle Park West part of the site is a minimum of 700mm above the modelled 1% AEP flood event, including a 20% allowance for climate change. It is shown to be in Flood Zone 1 and the proposed residential development on this portion of the site is will not be at risk of fluvial flooding from any event in the Littlemead Brook, up to and including the 0.1% AEP.

Area C – West Cranleigh Nurseries

5.20 Area C (West Cranleigh Nurseries) lies at the western end of the whole site boundary and will be redeveloped as a housing development. Two of the three existing storage reservoirs, adjacent to Cranleigh Waters, will be retained.

5.21 Figure 7 shows the Environment Agency modelled flood water levels projected onto LiDAR information at the site. The area in light blue identifies the 0.1% AEP flood water level, with the mid-blue identifying the 1% AEP plus climate change level and the dark blue identifying the 1% AEP level. All proposed dwellings have been located outside the modelled 0.1% AEP flood event, and are thereby outside the modelled 1% AEP extent including a 20% allowance for climate change.

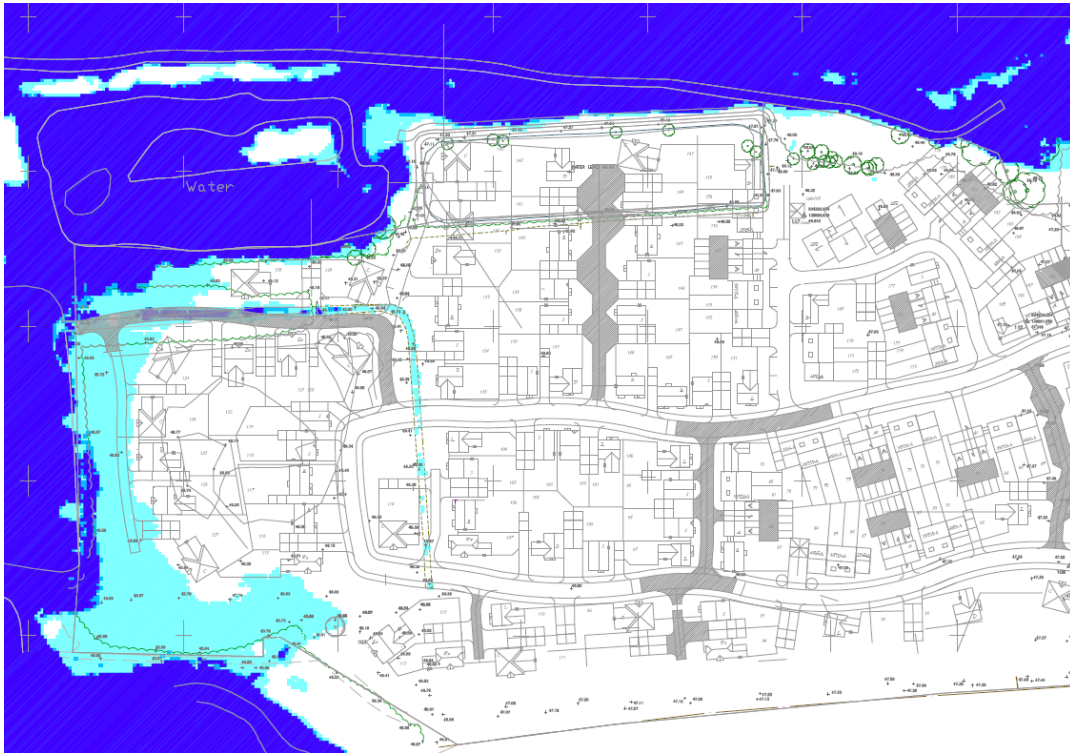


Figure 7 - Interpolated Flood Extents

5.22 At the western edge of the site, although in close proximity to the modelled flood zones, a topographic survey of the site confirms that proposed properties will be located above the modelled flood water level. The lowest existing ground level at the north-east corner of the proposed housing development is approximately 45.92m AOD. Therefore, houses proposed within this area of the site are a minimum of 440mm above the modelled 1% AEP plus climate change floodwater level (based on level of 45.48m AOD at "Floodplain 1"). This area of the site is also just outside of the area considered to be at risk of flooding during the extreme flood event (Flood Zone 2 or 0.1% AEP flood extent).

5.23 Towards the northern boundary, the proposed development includes a cluster of 8 properties located close to the Littlemead Brook where the watercourse meanders to the south. The lowest ground levels at the north-west end of this development block are 46.26m AOD. The nearest modelled floodplain node to this portion of the development is "Floodplain 3" slightly upstream, where the modelled 1% AEP plus climate change level is 45.56m AOD. The proposed properties are therefore a minimum of 700mm above required flood water level, and are also safely outside of the extreme 0.1% AEP flood extent.

5.24 Threshold levels of all proposed properties are more than 300mm above the modelled 1% AEP plus climate change flood levels.

5.25 By comparison of modelled floodplain levels with existing ground levels from a topographic survey of the site, it is clear that all proposed residential properties on the West Cranleigh Nurseries site will be located outside of the extent of the extreme flood plain and are therefore considered to be within Flood Zone 1.

Dry Access

5.26 Based on the modelled flood water levels provided by the Environment Agency, all developed areas of the site would remain dry during the 1% AEP plus climate change event from either the Littlemead Brook or Cranleigh Waters. Safe, dry access for all pedestrians and vehicles would be available from the site via normal routes onto Alfold Road.

5.27 Information provided by the Environment Agency shows that the bridge crossing of the Littlemead Brook by Alfold Road to the north of the proposed development is expected to remain dry during the design flood event (1% AEP plus climate change). Residents within the development are therefore expected to be able to cross the Littlemead Brook towards the village of Little Mead.

5.28 To the south of the development, Alfold Road crosses a further tributary of Cranleigh Waters that is expected to be flooded during the 1% AEP event. Residents should therefore not attempt to leave the development to the south during a flood event in the Littlemead Brook or Cranleigh Waters.

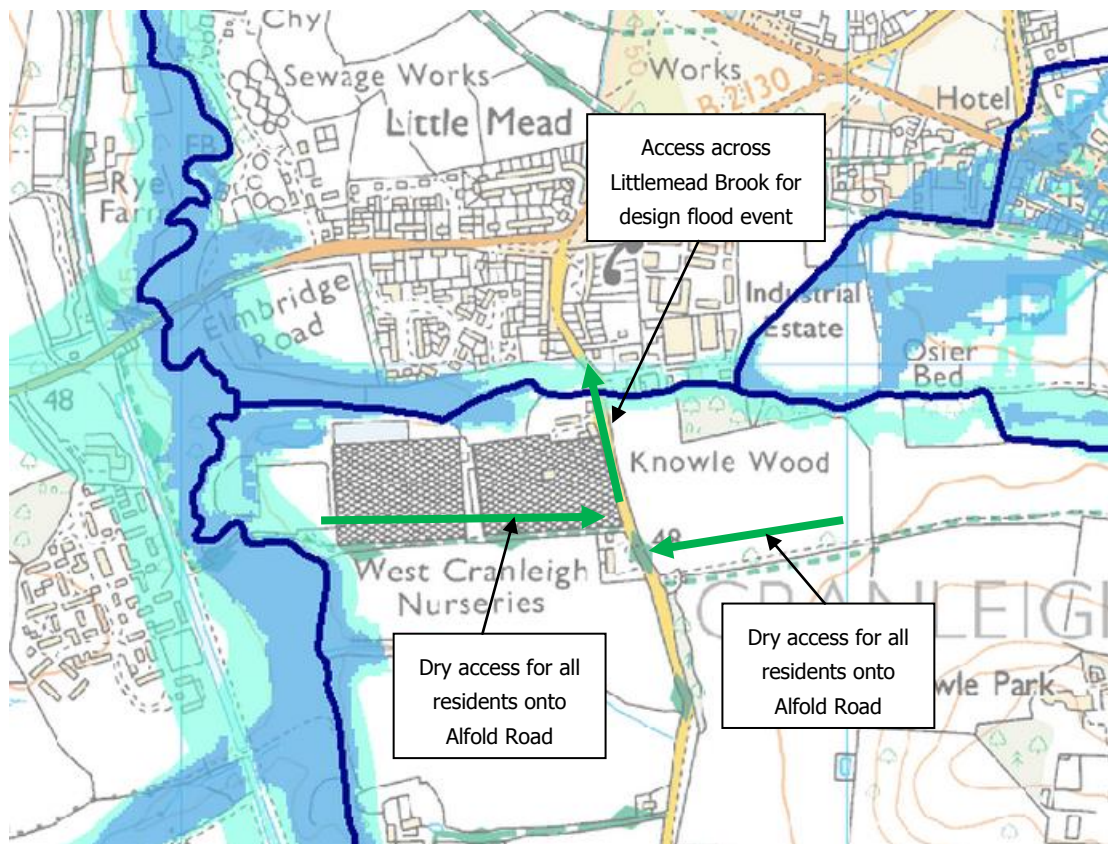


Figure 8 - Safe Access Routes

5.29 Although outside of the area at risk flooding during the design 1% AEP plus climate change event and the extreme 0.1% AEP event, the driveways and access road to the front of the buildings at the western extremity of Area C is located within an area at risk of flooding. A rear access track will be provided will access available from these properties in the event of flooding within Cranleigh Waters. The track provides access to the highway within the development that is not at risk of flooding.

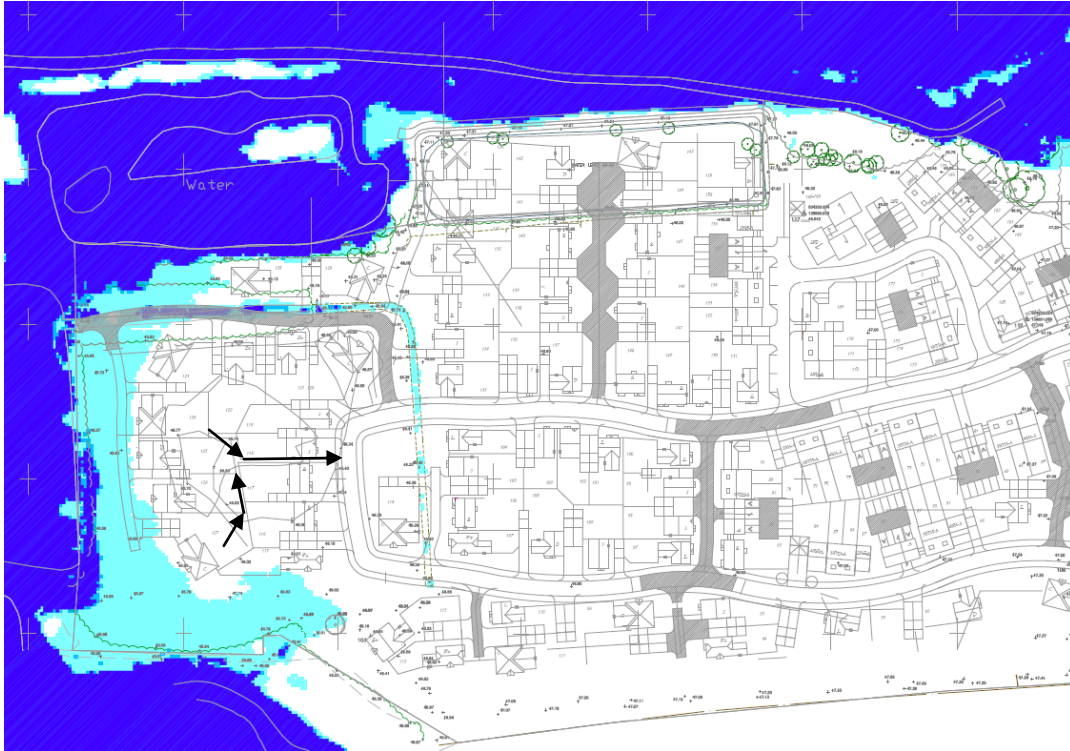


Figure 9 – Indicative Access Route to Properties at Western Extent of Area C

5.30 During a more extreme event (i.e. 0.1% AEP) the bridge over the Littlemead Brook to the north of the development is predicted to be flooded to a depth of up to approximately 400mm. Although this AEP is more extreme than is required to be designed for, residents should be aware that crossing the bridge over the Littlemead Brook could be dangerous should flood water be present on the road surface.

Floodplain Storage and Compensation

5.31 Based on the modelled flood water levels provided by the Environment Agency, the residential development area is located outside of Flood Zone 3 and would remain dry during the 1% AEP plus climate change event in either the Littlemead Brook or Cranleigh Waters. As a result, the proposed development will not result in a loss of floodplain storage and compensation is not required.

5.32 Ground levels for the parkland area are yet to be finalised, but will be broadly unchanged from existing levels within the floodplain.

Consequences of Flooding on Site

- 5.33 By virtue of the modelled flood water levels, site layout, high ground levels away from the watercourse and raised floor levels, all developed areas of the site is expected to remain safe during the 1% AEP event including the effects of climate change. The economic consequences of flooding on site are therefore expected to be minimal.

Flood Warning Service

- 5.34 The western edge of the site, close to Cranleigh Waters, falls into an area that benefits from the Environment Agency's free flood warning service. The full Environment Agency flood warning service comprises of four staged warning codes, each indicating the severity of flooding and the level of danger. These are Flood Alert, Flood Warning and Severe Flood Warning and All Clear,. The flood status of an area is updated at 15 minute intervals on the internet and is also available by telephone on a 24 hour Floodline.
- 5.35 There are two flood warning areas relevant to the site; "Cranleigh Waters near Cranleigh and Shamley Green including Elmbridge Village, Surrey" and, "Littlemead Brook at Cranleigh including Littlemead, Surrey". Occupants of the proposed development should subscribe to Floodline by calling 0345 988 1188 or 0845 988 1188, selecting option 1 and entering Quickdial number **172701**. Subscribers to the flood warning service receive automatic notification of a change in flood status for the area by telephone, text message, email, pager or facsimile.

6 SURFACE WATER MANAGEMENT

Existing Site Drainage

- 6.1 The site boundary encloses a total area of approximately 41.2ha. and currently comprises a horticultural nursery and undeveloped land. The total area of impermeable surfaces on the West Cranleigh Nurseries site (Area C) occupies approximately 64,800m². There are areas of open water on the nursery site associated with the water storage ponds.
- 6.2 Area C is currently the only part of the proposed development site to have a formal surface water drainage system. Surface water is currently collected from the roofs of the greenhouses and surrounding areas of hardstanding and is discharged into the water storage ponds in the west of the site via pipes and informal open ditches (as identified in Figure 7 in Section 5 of this report to the west of the site). The water within the ponds is used for irrigation within the nursery, and also has an outfall into the local watercourse network. There is currently no formal drainage provision for Areas A or B since these are formed of previously undeveloped land.
- 6.3 The land at Area A is due to become open parkland that is to be used as public amenity space. There will be no development on the site that will adversely alter the runoff characteristics of this land. The site runoff rates for the pre- and post-development scenarios have therefore been calculated using Areas B and C only.
- 6.4 Although parts of the site are currently developed, the West Cranleigh Nurseries stores surface water runoff in ponds for re-use as irrigation. It is therefore assumed that a greenfield runoff rate is an appropriate representation of the existing scenario. Greenfield runoff rates for the site (excluding climate change) have been calculated using both the Institute of Hydrology Report 124 methodology and the Flood Estimation Handbook (FEH) methodology. Detailed calculation sheets are provided in Appendix C.
- 6.5 The resulting runoff using the IoH 124 method was calculated as 242.03l/s for the 1% AEP event - assuming a SOIL index of 0.47 and a Standard Average Annual Rainfall (SAAR) of 776mm - and 174.5l/s for the 3.33% AEP event.
- 6.6 Using the FEH method the resulting runoff was calculated as 250.31l/s for the 1% AEP event - assuming a Base Flow Index of 0.41 and a Standard Average Annual Rainfall (SAAR) of 776mm - and 180.48l/s for the 3.33% AEP event.
- 6.7 The greenfield rates of runoff calculated using these methodologies are comparable in magnitude. The Environment Agency recommend the use of the FEH methodology for site under 50ha. in area and therefore the greenfield runoff rate of the development for the 1% AEP event is considered to be 250.31l/s.

Proposed Surface Water Drainage System

- 6.8 An outline surface water drainage system has been designed for Areas B and C. A drawing showing the surface water drainage system in Area B is provided in

Appendix A. A drawing showing the surface water drainage system in Area C is provided in Appendix A.

- 6.9 Surface water will be collected throughout the development and conveyed via a network of adopted surface water sewers. Throughout the development there are proposed to be areas of permeable paving that will have a granular sub-base that will be used for surface water attenuation. The underlying geology is not favourable to infiltration techniques and these areas of permeable paving will be connected to the surface water drainage network via lateral drains.
- 6.10 There will be a number of outfalls across the proposed development area. Starting in the west of Area C, there will be two connections to the existing surface water storage ponds at the western extent of the site. A drainage channel will be constructed to extend the southern pond to the south-west. This will be in hydraulic connectivity to the pond and will have a further three drainage connections from the surface water drainage network. There will be a connection from Area C directly into the Littlemead Brook from the centre of Area C to the north, the invert of which has been set above the modelled 20% AEP flood water level as provided by the Environment Agency.
- 6.11 There will be a further connection to the Littlemead Brook at its crossing with Alfold Road. A surface water sewer will convey flows to this outfall from the eastern parts of Area C and also from the western parts of Area B. From the eastern side of Area B there will be a connection to a storage pond within Area A that will have an outfall to the Littlemead Brook.
- 6.12 The outline drainage system has been designed (where applicable) to adoptable standards assuming a minimum cover of 1.2m from the soffit of the pipe where the pipe lies beneath an adoptable road, and a minimum gradient of 1:150 has been assumed. The detailed drainage design will be undertaken in the next stage of the design of the development following the approval of outline planning permission.
- 6.13 Thames Water has been contacted in the form of a pre-application enquiry to determine the principles of the surface water drainage design, which will be incorporated in the next phase.

Proposed Surface Water Attenuation

- 6.14 There will be a change in the runoff coefficient for the site following development. Although the impermeable area within Area C is likely to reduce as a result of development (since the existing greenhouses make up a large proportion of this site), the amount of impermeable surface within Area B will increase since this is currently undeveloped. It is expected that the intensity of development will result in a global runoff coefficient for the site of approximately 0.66.
- 6.15 Following development, it is considered to be more appropriate to calculate design rainfall intensities using the Wallingford Procedure⁸ and calculating resulting runoff using the Modified Rational Method.
- 6.16 A 1% AEP, 38.4 minute storm (M5-60 of 20mm and an 'R' value of 0.30) was applied to arrive at a rainfall intensity of 50mm/h. The runoff rate was then calculated and

⁸ HR Wallingford (2000) The Wallingford Procedure for Europe – Best Practice Guide to urban drainage modelling (CD)

found to be 1,272l/s. The runoff rate for the 3.33% AEP event was calculated to be 974l/s.

- 6.17 In order to attenuate runoff to an existing greenfield runoff rate of 250.1l/s, an attenuation volume of 3,847.1m³ has been calculated as being required based on the critical storm duration of 60 minutes. This is to ensure that rate of runoff for the 1% AEP rainfall event including an allowance for climate change does not increase beyond the existing 1% AEP runoff rate.
- 6.18 The proposed surface water drainage system will utilise the capacity in the existing surface water storage ponds, as well as providing attenuation across the site in the form of areas of permeable paving with a granular sub-base. The total area of permeable paving will be approximately 3,050m². A granular sub-base 300mm in depth with a void ratio of 0.33 will be used, thereby providing a surface water attenuation storage depth of 100mm. The total volume of storage available for within the areas of permeable paving is therefore 305m³.
- 6.19 The total surface area of the two existing ponds in the west of Area C is approximately 8950m². The proposed drainage system will utilise a freeboard of 300mm from the current water level in the ponds as additional storage. The total volume available from the existing ponds is therefore 2,685m³.
- 6.20 Two linear features will be excavated on the site to provide additional surface water attenuation. The combined base surface area of these ditches will be approximately 2,890m². As with the existing ponds, these features will utilise a freeboard of 300mm for surface water attenuation. The total storage available from these two features is 867m³.
- 6.21 The combined surface water attenuation storage that is to be provided on the site is 3857m³, which is in excess of the calculated volume required to attenuate the proposed development site to existing greenfield runoff rates. Flow control devices will be used to ensure that the rate of runoff leaving the site and entering nearby watercourses does not exceed the existing rate.
- 6.22 The detailed design of the surface water drainage system will be undertaken in consultation with Thames Water as the Statutory Undertaker and also with the Environment Agency to arrange discharge consents.

Sustainable Drainage Principles

- 6.23 The aim of SuDS is to emulate natural processes with the result that watercourses and storage areas receive the hydrological profiles under which they evolved, and that water quality in local ecosystems is protected or improved. The best practice guide states that a sustainable drainage system will⁹:

⁹ CIRIA C523 – Sustainable Urban Drainage Systems – Best Practice Manual

- reduce the impact of additional urbanisation on the frequency and size of floods;
- protect or enhance river and groundwater quality;
- be sympathetic to the needs of the local environment and community; and
- encourage natural groundwater recharge

6.24 Table 3 represents the preferred SUDS hierarchy as specified by the Environment Agency. The scope for use of infiltration devices is limited for this site, despite permeable ground conditions, due to the shallow groundwater levels. As a result, surface-based drainage solutions were chosen for the proposed development.

6.25 The proposed surface water drainage strategy will utilise the existing storage provision formed of established surface water storage ponds. These will be extended to provide additional attenuation storage. The use of attenuation ponds will improve the amenity and biodiversity of the development site.

6.26 Permeable paving will be used alongside a granular sub-base to provide additional areas of surface water attenuation. The use of a granular medium through which collected surface water will flow, will introduce a treatment process that will help to improve the quality of the discharged surface water.

Table 3 – Environment Agency SUDS hierarchy

<i>Most Sustainable</i>	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
	Tanked systems - over-sized pipes/tanks - storms cells	✓		
	<i>Least Sustainable</i>			

7 SUMMARY OF FLOOD RISK ASSESSMENT

7.1 Table 4 illustrates the points which should be addressed for all development sites greater than 1 hectare in size, as defined in FRA Guidance Note 1 (March 2007).

Table 4 – Summary of Flood Risk Assessment based on the guidelines set out in the NPPF

Requirement	Assessment
1. Development description and location	
1a. Location plan of the site at an appropriate scale.	Figure 1 shows the location of the site, geographical features and the nearby watercourses.
1b. Vulnerability classifications of the proposed types of development as provided in the NPPF and Planning Practice Guidance.	The proposed development comprises of residential development, and therefore is classified as 'More Vulnerable'.
1c. Land use allocations for the site in the local plan, including whether an SFRA has been used as a guide for the Sequential Test in developing the Local Development Documents.	The local area is covered by the Waverley Borough Council Strategic Flood Risk Assessment, which will inform land use allocations in the development.
1d. Evidence that the Exception Test has been satisfied with reference to pages 2 and 3 of the technical guidance document to the NPPF.	As the developed areas of the site are located in Flood Zone 1, the Exception Test is not required.
2. Definition of the flood hazard	
2a. Identification of potential sources of flooding which may affect the site.	The site lies between Cranleigh Waters and the Littlemead Brook and is potentially at risk from fluvial flooding. Due to its size, the surface water runoff volumes from the site are high, and must be managed to avoid creating a risk to the site and/or increasing flood risk elsewhere. All other potential sources of flooding are considered low or negligible.

Requirement	Assessment
<p>2b. An appraisal of each hazard, the mechanisms that could lead to a flood occurring and the pathways that flood water would take to, and across, the site. Details of any historical flood events which may have affected the site.</p>	<p>The Environment Agency records suggest that the western end of the site flooded in the September 1968 event.</p> <p>Modelled fluvial information suggests that although areas of the site immediately adjacent to the watercourses are expected to flood, the remainder of the site is located in Flood Zone 1, above the area at risk.</p> <p>Detailed drainage design will ensure that the probability of flooding from surface water will be less than 1% (including an allowance for climate change) as specified in the NPPF.</p>
<p>2c. A description of existing surface water infrastructure on the site.</p>	<p>Surface water currently discharges to the watercourse, with on-site attenuation in the form of large ponds.</p>
3. Probability	
<p>3a. The Flood Zone the site lies in, as per Table 1 of the technical guidance document to the NPPF.</p>	<p>The site lies partially in Flood Zone 2 and 3, with the large majority in Flood Zone 1.</p>
<p>3b. Consideration of a Strategic Flood Risk Assessment covering the site.</p>	<p>The site is covered by the Waverley SFRA. Information in the SFRA is largely superseded by more up to date information available from the Environment Agency and uses for the purposes of this assessment.</p>
<p>3c. Probability of the site flooding taking into account the contents of the SFRA and the site-specific flood risk assessment, including a description of any existing flood defences or alleviation measures, structures which may influence local hydraulics, and details of modelling carried out to define the degree of flood risk.</p>	<p>The probability of flooding is less than 1% in any year over the lifetime of the development.</p>
<p>3d. Existing rates and volumes of runoff generated by the site for a range of annual probability events where appropriate.</p>	<p>The current runoff characteristics of the site were determined using the Flood Estimation Handbook method to obtain an estimate of the current and proposed rates of runoff. The 1% AEP, 15 minute rainfall event results in existing rate of 250.1l/s.</p>

Requirement	Assessment
4. Climate change	
4a. Assessment of climate change and its impact on probabilities of flooding. The assessment should ensure that the development meets an acceptable standard of flood defence for the design life of the development as per the NPPF.	The Environment Agency have provided flood water levels in Cranleigh Waters and the Littlemead Brook for a range of return periods and including climate change.
5. Detailed development proposals	
5a. Details of the proposed development, reference to relevant drawings, and including the assessment of vulnerability classification in Table 2 of the technical guidance document to the NPPF.	Proposals involve the construction of two area of housing development, considered to be "More Vulnerable" in terms of the NPPF. A third area will be utilised as open parkland, and is considered "Water-Compatible".
5b. Demonstration of how land-uses most sensitive to flood damage have been placed within the site that are at least risk of flooding.	The developed areas of the site are not expected to flood in the 1% AEP fluvial event, including an allowance for climate change.
6. Flood risk management measures	
6a. Description of proposed flood defences, alleviation or protection measures, including surface water attenuation facilities and SUDS, as well as access and egress arrangements.	No flood defences are proposed as ground levels on the developed area of the site are above modelled flood water levels. Surface water runoff will be attenuated using sustainable drainage systems, specifically swales and permeable paving. Safe and dry access will be achieved via normal access routes in the 1% AEP event, including an allowance for climate change.
7. Off-site impacts	
7a. An assessment of the impact on third-party land, including mitigation measures, floodplain compensation, details of post development modelling, and an assessment of the impact on geomorphology of local watercourses.	<p>The developed areas of the site are not expected to flood in a 1% AEP event including climate change and the development is not expected to impede flood flows or displace floodwater.</p> <p>There will be no significant impact on the fluvial morphology of the local watercourses as a result of the proposed development. There will be no adverse impacts on third-party landowners as a result of the proposed development.</p>

Requirement	Assessment
<p>7b. Evidence that the drainage of the site will not result in an increase in the peak rate or volumes of runoff generated by the site.</p>	<p>Surface water runoff rates for the proposed site were calculated using the Modified Rational Method, with design rainfall events estimated using the Wallingford Procedure, as recommended by the Environment Agency. Analysis of the resultant runoff hydrographs was used to determine the amount of storage required to limit runoff to existing greenfield rates, as presented in detail in Chapter 6 of this report.</p> <p>Sufficient storage will be provided to ensure that runoff rates will be restricted to existing greenfield rates for rainfall events up to and including the 1% AEP plus climate change event.</p>
Requirement	Assessment
8. Residual risks	
<p>8a. Flood-related residual risks on the developed site, including potential event exceedence for on-site drainage systems, or site-specific flood protection measures to be implemented on site.</p>	<p>Residual risks of flooding are extremely low. Exceedence of on-site drainage systems will result in shallow flooding of external areas for a short time, but internal areas will remain dry.</p>
<p>8b. Management of risks over the lifetime of the development, including flood warning and evacuation procedures, and an assessment of the potential economic, social and environmental consequences of a flood event occurring.</p>	<p>The environmental, social and economic consequences resulting from the proposed development during flood events will be negligible, since the developed areas of the site are not expected to flood, and surface water will be managed such that discharge rates will not increase following development.</p>

8 CONCLUSIONS AND RECOMMENDATIONS

- 8.1 The site is located to the west of Cranleigh in Surrey and is currently West Cranleigh Nurseries and surrounding greenfield land. The proposed development site is separated into three areas: Area A, Area B and Area C. Proposals involve the demolition of the existing nursery buildings within the West Cranleigh Nursery (Area C). 265 residential developments are to be constructed on Area B and Area C combined. Area A is to be retained as public open space and is to be enhanced into amenity space and parkland.
- 8.2 The closest river to the site is the Littlemead Brook which flows in a westerly direction along the northern boundary of Area C to its confluence with Cranleigh Waters (an Environment Agency designated main river), which flows in a northerly direction along the far western site boundary. The Wey and Arun Canal is located beyond Cranleigh Water to the west of the site and is currently undergoing plans for restoration.
- 8.3 The Environment Agency online flood zone map indicates that the site is located partially within Flood Zone 2 and 3, with the remainder located in Flood Zone 1. The site is greater than one hectare in area and a full flood risk assessment, including surface water drainage strategy, has therefore been prepared to accompany the planning application.
- 8.4 Although part of the site is shown to be partially located within Flood Zone 3 of the Littlemead Brook, a sequential approach has been adopted for the site layout and the all proposed residential developments will be entirely located outside of Flood Zone 3, therefore the Sequential Test does not apply. The risk of flooding to the development from all other sources has been assessed as low.
- 8.5 Based on the modelled flood water levels provided by the Environment Agency, all of the buildings would remain dry during the 1% AEP event (including climate change). Finished floor levels within the residential developments will be set at least 300mm above modelled 1% annual exceedence probability flood water levels including an allowance for climate change. The residential development area is located outside of Flood Zone 3 and, as a result, the proposed development will not result in a loss of floodplain storage and compensation is therefore not required.
- 8.6 Safe, dry access to the site would be achieved via normal access routes to Alfold Road during even the 0.1% extreme flood event. Access to the village of Little Mead is shown to be available during the design 1% AEP plus climate change flood event.
- 8.7 The surface-water drainage system as proposed above will prevent an increase in runoff for the 100 year plus climate change event from the existing greenfield runoff rate of 250.1l/s. Surface water will be collected and attenuated using the existing surface water storage ponds, including two new extension ditches, and also through the provision of permeable paving with a granular sub-base. The proposed drainage system is sustainable in nature, providing amenity and biodiversity enhancements whilst improving the quality of the discharged runoff. Outfalls will be provided to the ponds and the extension ditches, with three new outfalls proposed to the Littlemead Brook. There will be the provision for drainage exceedance and overland flow routes in building design.

- 8.8 There will be no significant consequences of flooding in the 1% AEP event, including an allowance for climate change and no adverse effects for any neighbouring property.