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Flood Risk and SuDS Assessment for the Proposed Development at East Hill, North Dane Way, Medway

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1 Background and Scope of Appraisal

The objectives of the Flood Risk Assessment (FRA) are therefore to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source
- whether the development will increase flood risk elsewhere within the floodplain
- whether the measures proposed to address these effects and risks are appropriate
- whether the site will pass the second element of the Exception Test (where applicable).

Herrington Consulting has been commissioned by **F.D. Attwood & Partners** to prepare a Flood Risk Assessment (FRA) for the proposed development at **East Hill, North Dane Way, Medway, Kent, ME5 8JY**.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (2019) and the National Planning Practice Guidance Suite (March 2014) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs. In addition, reference has also been made to Local Planning Policy.

To ensure that due account is taken of industry best practice, this FRA has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

2 Development Description and Planning Context

2.1 Site Location and Existing Use

The site is located at OS coordinates 577498, 165192 off North Dane Way in Chatham, Kent and covers an area of approximately 49.47 hectares. The existing greenfield site comprises a number farmland plots, used for agricultural purposes. There is an existing road (Shawstead Road) and various public footpaths which cross the site. The site is bordered to the west and north by the residential area of Luton and an existing landfill site is located to the east. The location of the site in relation to the surrounding area is shown in Figure 2.1.

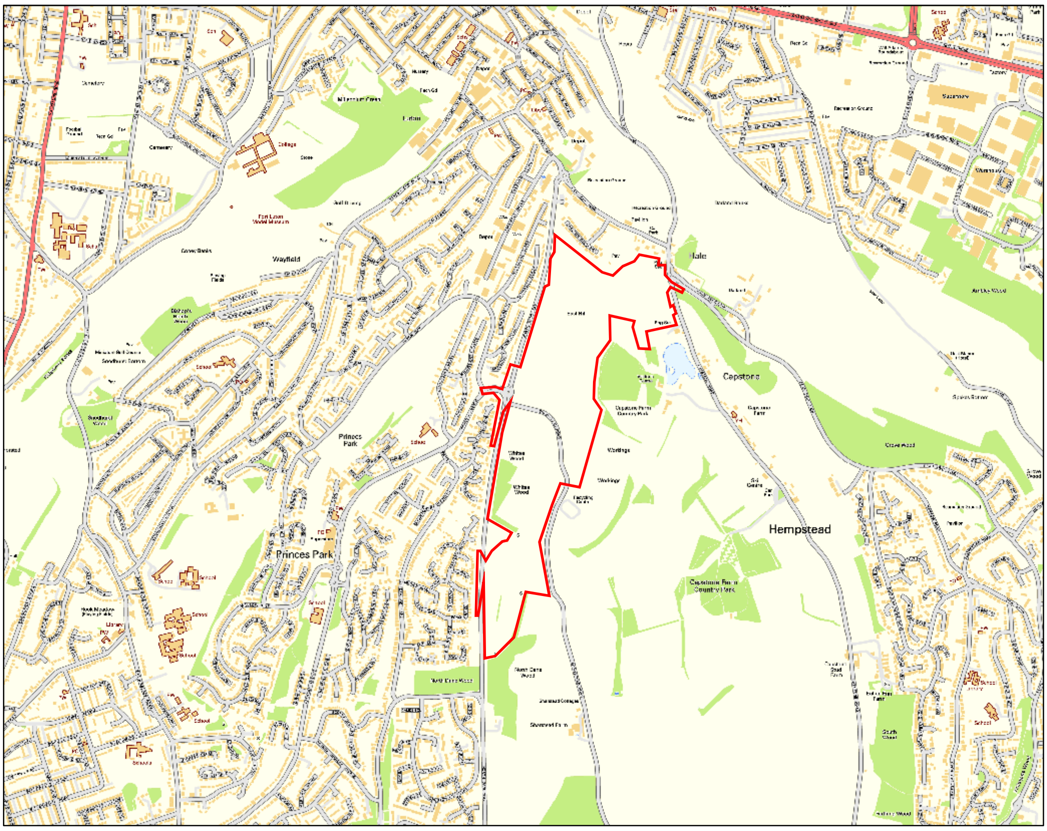


Figure 2.1 – Location map (Contains Ordnance Survey data © Crown copyright and database right 2019).

The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

2.2 Proposed Development

The development proposals comprise up to 800 residential dwellings, a primary school, 4 local shops, a doctor's surgery, open space and road access.

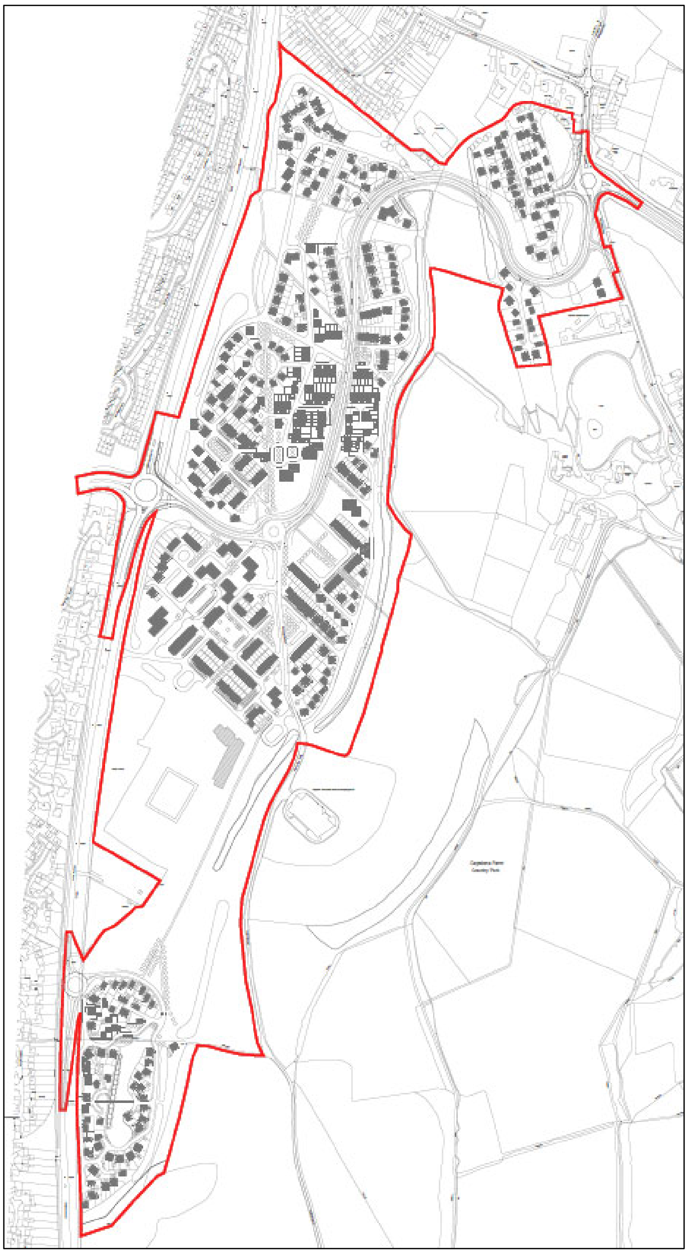


Figure 2.2 – Proposed Masterplan.

Drawings of the proposed scheme are included in Appendix A.1 of this report.

3 Definition of Flood Hazard

3.1 Site Specific Information

In addition to the high level flood risk information shown in the Environment Agency (EA) flood zone maps, additional data from detailed studies, topographic site surveys and other information sources is referenced. This section summarises the additional information collected as part of this FRA.

Site specific flood level data provided by the EA – The EA has been consulted as part of the development of this FRA and confirm that they do not have modelled flood level data for the site.

Information contained within the SFRA – The Medway Council SFRA (2006) contains detailed mapping showing the extent of flooding from a wide range of sources. This document has been referenced as part of this site-specific FRA, alongside the information contained within the emerging Medway SFRA (2019).

Information provided by Southern Water – Southern Water has provided the results of an asset location search for the site. Their response is included in Appendix A.3.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From this it can be seen that the level of the site varies between 34.43m and 105.97m Above Ordnance Datum Newlyn (AODN). Ground levels gradually fall from south to north, and from west to east.

Geology – Reference to the British Geological Survey map shows that the underlying solid geology in the location of the subject site is Lewes Nodular Chalk Formation to the north and Seaford Chalk Formation to the south. Overlying this are superficial deposits of Head (clay, silt, sand and gravel) to the north and Clay with Flints Formation (clay, silt, sand and gravel) to the south.

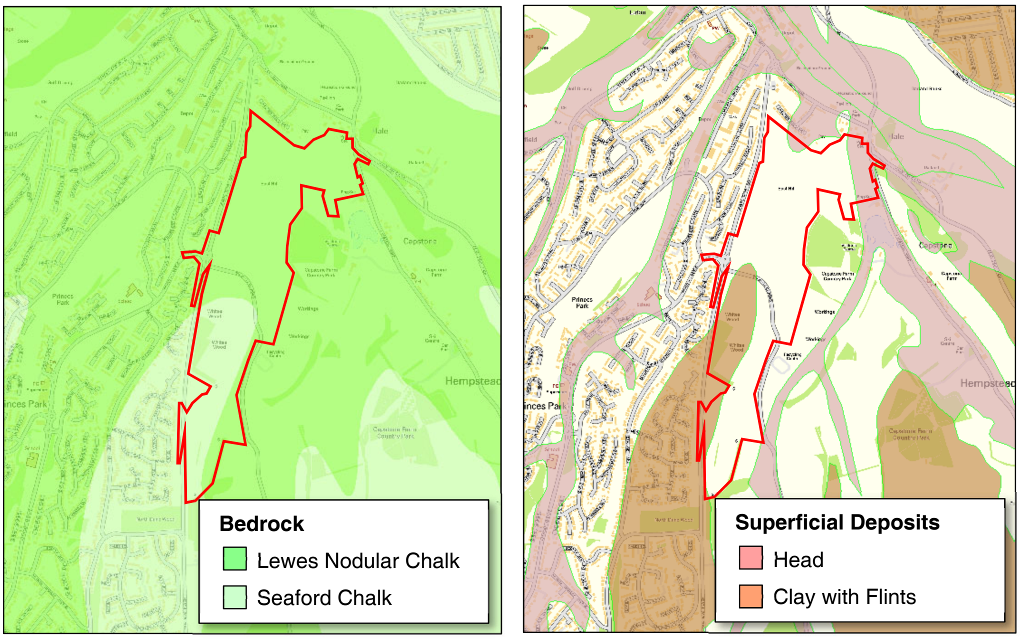


Figure 3.1 – Geology map showing the superficial deposits on the site. (© British Geological Survey, Mapping contains Ordnance Survey Data © Crown copyright and database right 2019)

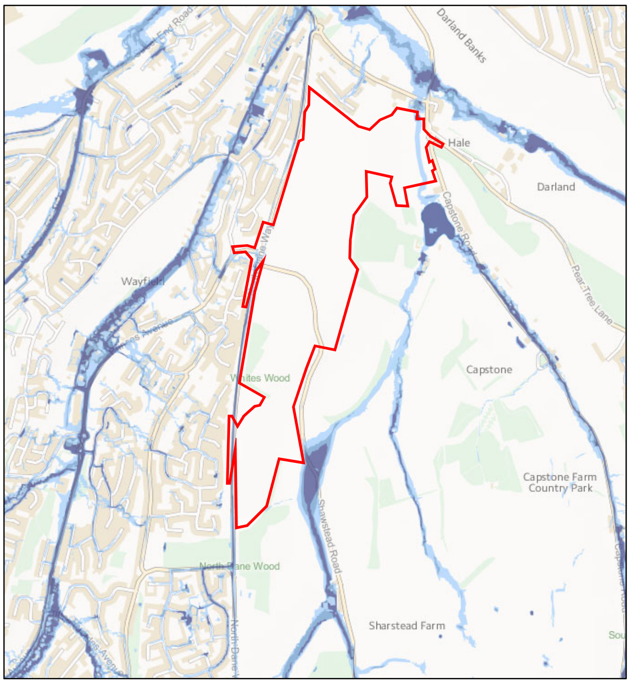
Historic flooding – Correspondence with the EA has confirmed that there are no historic records of flooding from a main river or the sea. In addition, information contained within the Medway Council SFRA shows that there are no records of flooding from any other sources in the past at the site.

3.2 Potential Sources of Flooding

The main sources of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this particular development are discussed below. Table 3.1 at the end of this section summarises the risks associated with each of the sources of flooding.

Flooding from Land (overland flow and surface water runoff) – Overland flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This flooding mechanism can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

Figure 3.2 below is an extract of the Environment Agency's 'Flood Risk from Surface Water' map which can be interrogated to identify whether the site is located in an area at risk of surface water flooding.



Probability of flooding

- High – Extent of flooding from surface water that has a 3.3% (1 in 30) or greater chance of happening each year.
- Medium - Extent of flooding from surface water that has between a 3.3% (1 in 30) and 1% (1 in 100) chance of happening each year.
- Low - Extent of flooding from surface water that has between a 1% (1 in 100) and 0.1% (1 in 1000) chance of happening each year.
- Location of development site

Figure 3.2 – Surface water flooding map showing the location of the development site (© Environment Agency)

From the Figure above, it can be seen that the development site is partially located (some 1.2% of the overall site area) in an area identified as being at 'low' risk of flooding from surface water. Consequently, the risk of flooding to the site from this source is appraised in more detail in Section 5 of this report.

Flooding from Rivers and the Sea – The site is partially located within Flood Zone 3 as shown by the EA's 'Flood Maps for Planning' (Figure 3.3 below).

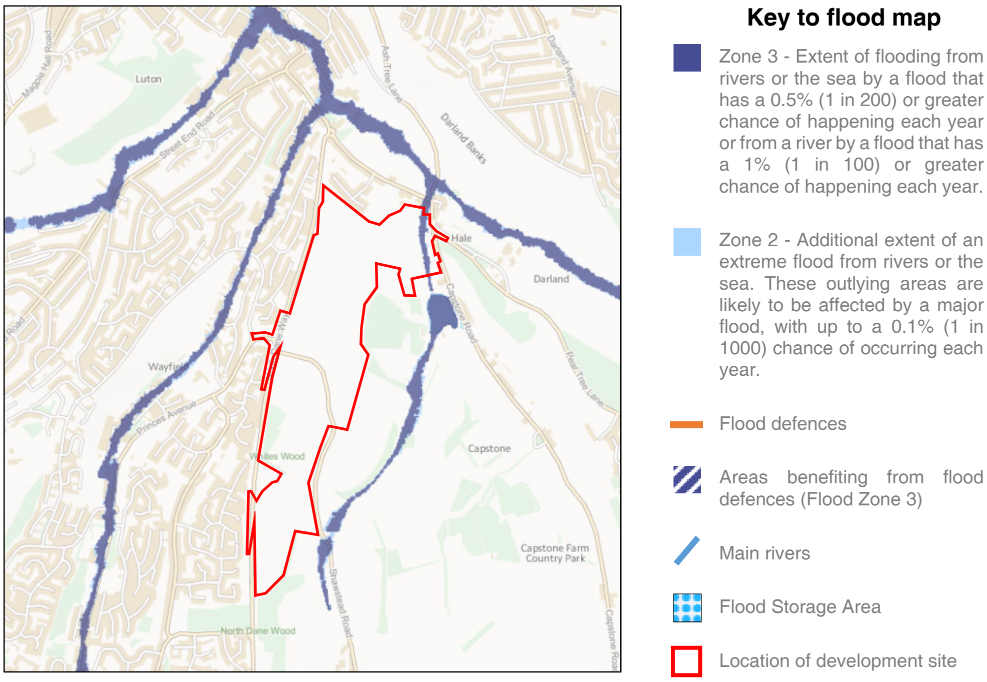


Figure 3.3 – Flood zone map showing the location of the development site (© Environment Agency)

Inspection of OS mapping of the site and the surrounding area shows that there are no main rivers within close proximity to the site and furthermore, the site itself is located a significant distance from the sea. The Flood Zone mapping is therefore attributed to the overland flow path identified in the section above, which will be appraised further in Section 5.

Flooding from Ordinary or Man-made Watercourses – Natural watercourses that have not been enmained and man-made drainage systems such as irrigation drains, sewers or ditches could potentially cause flooding.

Inspection of OS mapping of the site and surrounding area reveals that there are no non-main rivers or artificial watercourses within close proximity to the site and therefore, the risk of flooding from this source is considered to be *low*.

Flooding from Groundwater – Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in ‘bournes’ (streams that only flow for part of the year).

Groundwater flooding is most likely to occur in low lying areas underlain by permeable rock (aquifers). The underlying geology in this area is Seaford Chalk Formation and Lewes Nodular Chalk Formation. A review of mapping provided as part of the Defra Groundwater Flood Scoping Study (May 2004) shows that no groundwater flooding events were recorded near the site during the very wet periods of 2000/01 or 2002/03. The mapping also identifies that the site itself is not located within an area where groundwater emergence is predicted.

Furthermore, reference to the results of site-specific ground investigations (completed by others) identifies that no groundwater was encountered within the 20m deep boreholes carried out at the site. Therefore, taking the above into consideration, the risk of flooding to the site from groundwater is concluded to be low.

Flooding from Sewers – In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater known as "combined sewers". Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or is of inadequate capacity; this will continue until the water drains away.

Asset location data provided by Southern Water shows that there is a foul sewer which runs across the small parcel of land located to the northeast. In the unlikely event that water was to exit this sewer (i.e. as a result of a blockage), land levels suggest that water would flow towards the east and continue to follow the natural depression to the north.

Further interrogation of the asset location data shows that there are no other sewers on site. The closest sewer is a surface water sewer located to the west of the site, along North Dane Way, and this sewer flows away from the site to the northwest, following the gradient of the highway. The absence of combined sewers significantly reduces the risk of the network surcharging and this is supported by the historic records within the SFRA, which indicate that there have been no recorded incidents of sewer flooding in this location previously. Consequently, there is a low risk of flooding to the site from sewers.

Flooding from Reservoirs, Canals and other Artificial Sources – Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including; mining, quarrying, sand and gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example; reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the OS mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the EA's 'Flood Risk from Reservoirs' website shows that the site is not within an area considered to be at risk of flooding from reservoirs. Therefore, the risk of flooding from this source is considered to be *low.*

A summary of the overall risk of flooding from each source is provided in Table 3.1 below.

Source of flooding	Initial level of risk	Appraisal method applied at the initial flood risk assessment stage

Rivers and Sea/Estuaries	Low	OS mapping and Environment Agency flood zone map
Ordinary and man-made watercourses	Low	OS mapping and aerial height data
Overland flow	Appraised further in Section 5	Environment Agency 'Flood Risk from Surface Water' flood maps and Environment Agency flood zone map
Groundwater	Low	BGS site-specific geological data, BGS Borehole survey records and historic records contained within the SFRA
Sewers	Low	Southern Water asset location data and historic sewer records contained within the SFRA
Artificial sources	Low	OS mapping and Environment Agency 'Flood Risk from Reservoirs' flood map

Table 3.1 – Summary of flood sources and risks.

3.3 Existing Flood Risk Management Measures

There are no formal flood defence structures that provide protection to the development site.

4 Climate Change

When the impact of climate change is considered it is generally accepted that the standard of protection provided by current defences will reduce with time. The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the recent UK flooding could be expected.

These effects will tend to increase the size of flood zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development. For commercial development, a 60 year design life is typically assumed. The development that is the subject of this FRA is classified as mixed and consequently, a conservative approach has been adopted and a lifetime of 100 years has been assumed.

4.1 Potential Changes in Climate

Peak Rainfall Intensity

The recommended allowances for increases in peak rainfall intensity are applicable nationally. There is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 4.1 below.

Allowance Category (applicable nationwide)	Total potential change anticipated for each epoch		
	2015 to 2039	**2040 to 2069**	**2070 to 2115**
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 4.1 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline)

For a residential development a design life of 100 years is assumed and therefore an increase of 20% in peak rainfall intensity has been applied to the calculations in the surface water management strategy (refer to Section 8).

All of the above recommended allowances for climate change should be used as a guideline and can be superseded if local evidence supports the use of other data or allowances. Additionally, in the instance where flood mitigation measures are not considered necessary at present, but will be required in the future to account for changes in the climate, a "managed adaptive approach" can be adopted. This approach allows appropriate mitigation measures to be incorporated into the development in the future to combat the impacts of climate change.

5 Probability and Consequence of Flooding

From the analysis in Section 3 of this report it has been identified that the site could be subject to flooding from surface water. When appraising the risk of flooding to new development it is necessary to assess the impact of the 'design flood event'. The design flood event is taken as the 1 in 100 year (1% AEP) event for pluvial flooding, including an appropriate allowance for climate change (refer to Section 4.1). There is no modelled flood level information which includes an allowance for climate change and therefore, further analysis has been undertaken to quantify the risk of flooding to the site.

Inspection of aerial height data for the site and the surrounding area shows that the north-eastern parcel of land is partially located within a natural valley and land levels fall from south to north, towards lower-lying land. During an extreme rainfall event, any water which does not infiltrate into the ground will flow overland, following the natural contours of the site, resulting in flooding in the lower part of the site (as indicated in Figure 3.1).

To quantify the runoff from the catchment, rainfall data has been obtained from Flood Estimation Handbook (FEH) online and the design rainfall depth has been extracted using the FEH Depth-Duration-Frequency model (DDF). This shows design rainfall depths for a range of storm durations and return periods. However, the rainfall depths calculated do not include an allowance for climate change as outlined in Section 4.1 and as such, the rainfall depth for the 1 in 100 year return period event has been multiplied by a factor 1.2, to represent a 20% increase in peak rainfall intensity for climate change (i.e. termed the 'design rainfall event').

Table 5.1 below shows the rainfall depths for a number of return periods and for the 6-hour storm duration, including the design rainfall event.

Return Period (AEP %)	Total rainfall depth (mm)
1 in 100 year (1% AEP)	69.5
1 in 100 year (1% AEP) +20%cc	**83.4**
1 in 100 year (1% AEP) +40%cc	97.3
1 in 1000 year (0.1% AEP)	122.2

Table 5.1 – Total rainfall depth derived from the FEH DDF model for a 6hrs storm duration.

At this stage in the application process, detailed pluvial flood modelling has not been undertaken, however, in order to predict the approximate extent of flooding under the design event the results of the EA's surface water flooding maps have been interrogated.

Inspection of the EA's 'Risk of Flooding from Surface Water' maps shows that under the 1 in 100 year rainfall event, only a small area to the northeast of the development site would be affected by flooding. The vast majority of the development site is shown to remain dry as shown in Figure 5.1.

Figure 5.1 – Extract from the Environment Agency 'Risk of Flooding from Surface Water' Maps showing indicative flood depths for the 1 in 100 year extreme rainfall event (© Environment Agency).

The EA do not provide any surface water mapping which includes an allowance for climate change, however, mapping is available for the 1 in 1000 year rainfall event. From Table 5.1 above, it is evident that the total rainfall depth for the 1 in 1000 year rainfall event is over 46% higher than the total rainfall depth predicted for the design flood event (i.e. 1 in 100 year rainfall event plus 20% climate change) and therefore, although the 1 in 1000 year rainfall event can be referenced, it should be recognised that the results will represent a significant over-estimate of the design event (i.e. the 1 in 100 year rainfall event including an allowance for 20% climate change). Nevertheless, in the absence of any more site specific data, this worst case scenario has been referenced and Figure 5.2 below shows an extract of the modelled depth of surface water flooding for the 1 in 1000 year rainfall event.

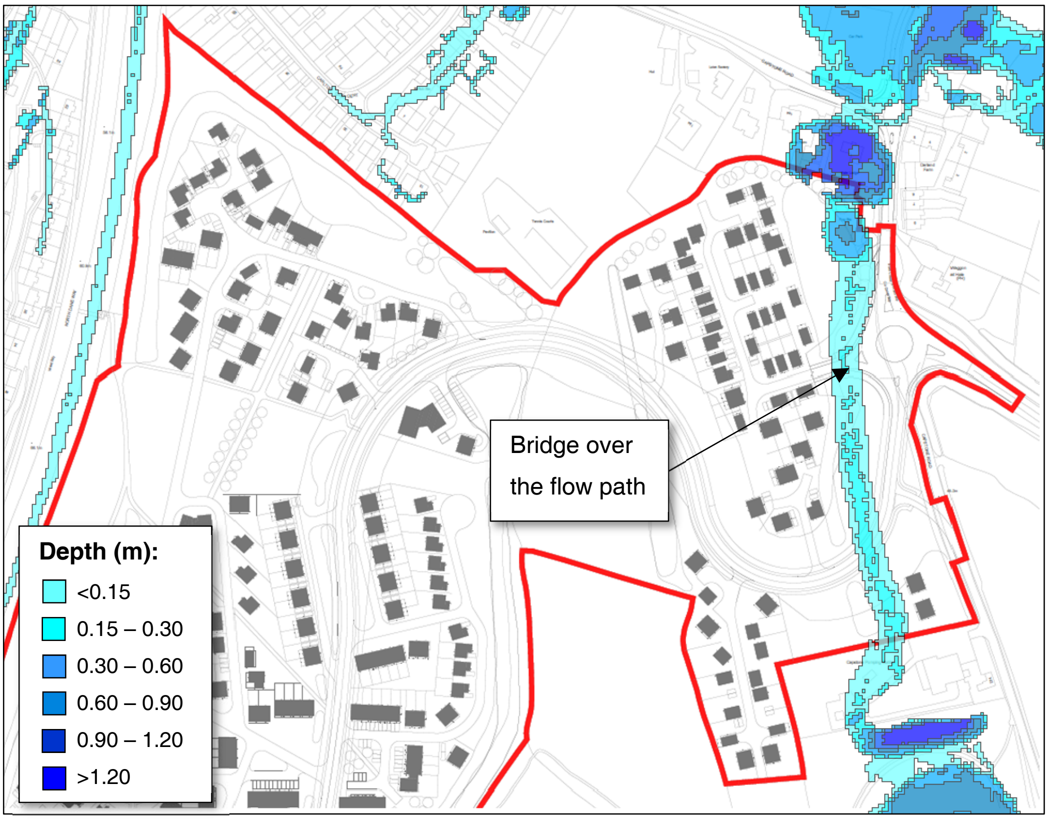


Figure 5.2 – Extract from the Environment Agency 'Risk of Flooding from Surface Water' Maps showing indicative flood depths for the 1 in 1000 year extreme rainfall event (© Environment Agency).

From the figure above, it is evident that all of the proposed buildings are located outside the predicted flood extents for the worst-case scenario and consequently, it is concluded that the buildings would remain dry under the design event conditions. It is only the access road to the south that is shown to be affected by flooding, with flood depths predicted to be less than 300mm.

5.1 Residual Risk of Flooding

Further to the above, the NPPF requires the residual risk of flooding to the development to be considered. Based on the EA's guidance on climate change allowances, the impact of an 'upper end' climate change allowance should be considered as this represents an event which exceeds the design flood event (refer to Section 4.1).

Reference to Table 5.1 shows that when a 40% increase in peak rainfall intensity (i.e. 'upper end') is taken into account, the predicted rainfall depth under this scenario would still be significantly lower than the rainfall depth predicted under 1 in 1000 year extreme rainfall event. Consequently, the analysis above clearly demonstrates that the proposed dwellings would continue to remain unaffected under this residual risk scenario.

6 Offsite Impacts and Other Considerations

6.1 Displacement of Floodwater

The construction of a new building within the floodplain has the potential to displace flood water and to increase the risk elsewhere by raising flood levels. A compensatory flood storage scheme can be used to mitigate this impact, ensuring the volume of water displaced is minimised.

The analysis demonstrates that the proposed development is located outside of the 1 in 100 year floodplain and consequently, the development will not displace floodwater. Compensatory floodplain storage is therefore not considered necessary in this instance.

6.2 Public Safety and Access

The NPPF states that safe access and escape should be available to/from new developments located within areas at risk of flooding. The Practice Guide goes on to state that access routes should enable occupants to safely access and exit their dwellings during design flood conditions and that vehicular access should be available to allow the emergency services to safely reach the development.

It has been demonstrated that the proposed buildings are located outside of the predicted design flood extents and consequently, safe access and escape from the dwellings can be achieved. It is only the access road to the south of the area of interest which is shown to be affected by minor flooding, with flood depths predicted to be less than 0.3m. Consequently, alternative routes should be considered during times of flooding and given the size of the proposed development, it is evident that access is still achievable from the road to the west, which leads onto the larger estate. Similarly safe access/egress is available across the bridge which leads to the east of the site.

6.3 Proximity to Watercourse

Under the Water Resources Act 1991 and Land Drainage Byelaws, any proposals for development in close proximity to a 'main river' would need to take into account the EA's requirement for an 8m buffer zone between the river bank and any permanent construction such as buildings or car parking etc. This buffer zone increases to 16m for tidal waterbodies and sea defence infrastructure.

The development site is located more than 2.9km from the River Medway and as such, will not compromise any of the EA's maintenance or access requirements.

6.4 Impact on Fluvial Morphology and Impedance of Flood Flows

In terms of the way in which the development would interact and modify flood flows, its location and size with respect to the flood risk area and the flow path has to be considered. The proposed buildings have, however, been shown to be located entirely outside of the predicted flood extents. In addition, the lower-lying land to the east will be designed as a green corridor to ensure that the overland flow path is not impeded and will continue to flow freely. Therefore, the proposals are unlikely to impede or change flood flow regimes.

7 Flood Mitigation Measures

The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded.
- to ensure continued operation and safety during flood events
- to ensure that the flood risk downstream of the site is not increased by increased runoff
- to ensure that the development does not have an adverse impact on flood risk elsewhere

The following section of this report examines ways in which the risk of flooding at the development site can be mitigated.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e. Sequential Approach)	✓	Refer to Section 7.1
Raising floor levels	✓	Refer to Section 7.2
Land raising	x	Not required
Compensatory floodplain storage	x	Not required
Flood resistance & resilience	✓	Refer to Section 7.3
Alterations/ improvements to channels and hydraulic structures	x	Not required
Flood defences	x	Not required
Flood warning	✓	Refer to Section 7.4
Surface water management	✓	Refer to Section 8

Table 7.1 – Appropriateness of mitigation measures.

7.1 Application of the Sequential Approach at a Local Scale

The sequential approach to flood risk management can also be adopted on a site-based scale and this can often be the most effective form of mitigation. For example, on a large scheme this would mean locating the more vulnerable dwellings on the higher parts of the site and placing parking, recreational land or commercial buildings in the lower lying and higher risk areas.

The scheme layout takes advantage of the higher ground as much as other site constraints allow and in addition, all of the proposed buildings have been located outside the areas identified as being at risk of flooding.

7.2 Raising Floor Levels

The proposed dwellings have been shown to be located outside of the predicted flood extents and not to be at significant risk from other sources of flooding. Consequently, floor raising is not considered to be a necessary form of mitigation at this site.

Notwithstanding this, it is recommended that as a precautionary measure the finished floor levels of the building are raised a minimum of 150mm above the ground level, to help prevent the ingress of floodwater into properties caused as a result of any localised surface water flooding, (for example, as a result of a failure/blockage of the local drainage system).

7.3 Flood Resistance and Resilience

During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood Resistance or 'dry proofing', where flood water is prevented from entering the building. For example using flood barriers across doorways and airbricks, or raising floor levels. These measures are considered appropriate for 'more vulnerable' development where recovery from internal flooding is not considered to be practical.

Flood Resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

It has been shown that the risk of flooding to the proposed development is very low and therefore, in this instance the use of flood resilience or flood resistance measures is not considered to be strictly necessary. Instead it is recommended that the above measures are considered for inclusion within the development as a precautionary measure only.

Details of flood resilience and flood resistance construction techniques can be found in the document 'Improving the Flood Performance of New Buildings; Flood Resilient Construction', which can be downloaded from the Communities and Local Government website.

7.4 Flood Warning

The site is located within an area which is not currently covered by any flood warnings issued by the EA. However, during times of heightened flood alert it is likely that regular updates on local and regional flooding will be broadcast via a number of media (e.g. radio/television/online). Therefore, occupants of the site are encouraged to keep updated by watching local TV stations or listening to local radio for flood warning updates.

Monitoring of the Met Office "Weather Warnings" may also provide an indication of when flooding might be expected (http://www.metoffice.gov.uk/weather/uk/uk_forecast_warnings.html).

8 Surface Water Management Strategy

8.1 Background and Policy

The general requirement for all new development is to ensure that the runoff from the development is managed sustainably and that the drainage solution does not increase the risk of flooding at the site, or within the surrounding area. For undeveloped greenfield sites, the impact of the proposed development will therefore require mitigation to ensure that the runoff from the site replicates the natural drainage characteristics of the pre-developed site.

The Flood and Water Management Act 2010 National Standards (Schedule 3 – paragraph 5) for design, construction, maintenance and operation of Sustainable Drainage Systems (SuDS), came into effect from 6 April 2015, and provide additional detail and requirements not initially covered by the NPPF and are Non-statutory Technical Standards for SuDS (NTSS).

The NTSS specify criteria to ensure sustainable drainage is included within developments of 10 dwellings or more; or equivalent non-residential, or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010). It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is classified as 'major' development and therefore, the NTSS will apply. Reference to the NTSS has therefore been made throughout the following sections of this report to ensure the principles of sustainable drainage are considered.

In addition to the NTSS, Chatham is located within the Medway area and therefore, Medway Council is the Lead Local Flood Authority (LLFA). The site is also subject to local requirements set out within the Medway Strategic Flood Risk Assessment (SFRA), specifically requiring Sustainable Drainage Systems (SuDS) to be incorporated into all local development.

8.2 Surface Water Management Overview

The main characteristics of the site that have the potential to influence surface water drainage are summarised in Table 8.1 below.

Site Characteristic	Value
Total area of site	49.47 ha
Current site condition	Greenfield site
Estimated impermeable area from proposed development	~18.5 ha
Greenfield runoff rates (based on the FEH methodology)	QBar = 25.5 l/s Q30 = 58.6 l/s Q100 = 81.3 l/s
Current surface water discharge method	Infiltration (informally)
EA Groundwater Source Protection Zone (SPZ)	SPZ1 and SPZ2
Is there a watercourse within close proximity to site?	No

Table 8.1 – Site characteristics affecting rainfall runoff.

The proposed development will increase the percentage of impermeable area within the boundaries of the site and consequently, this will increase the rate and volume of surface water runoff discharged from the site. It will therefore be necessary to provide mitigation measures to ensure the rate of runoff discharged from the site is not increased as a result of the proposed development.

Furthermore, the proposed development is located within SPZ1 (inner) and SPZ2 (outer), which require additional restrictions to ensure that the groundwater table is not adversely impacted by future development. Figure 8.1 below shows the site in relation to the surrounding Source Protection Zones outlined by the EA. (SPZ1 and SPZ2 are defined at a 50 and 400 day travel time from any point below the water table to the source).

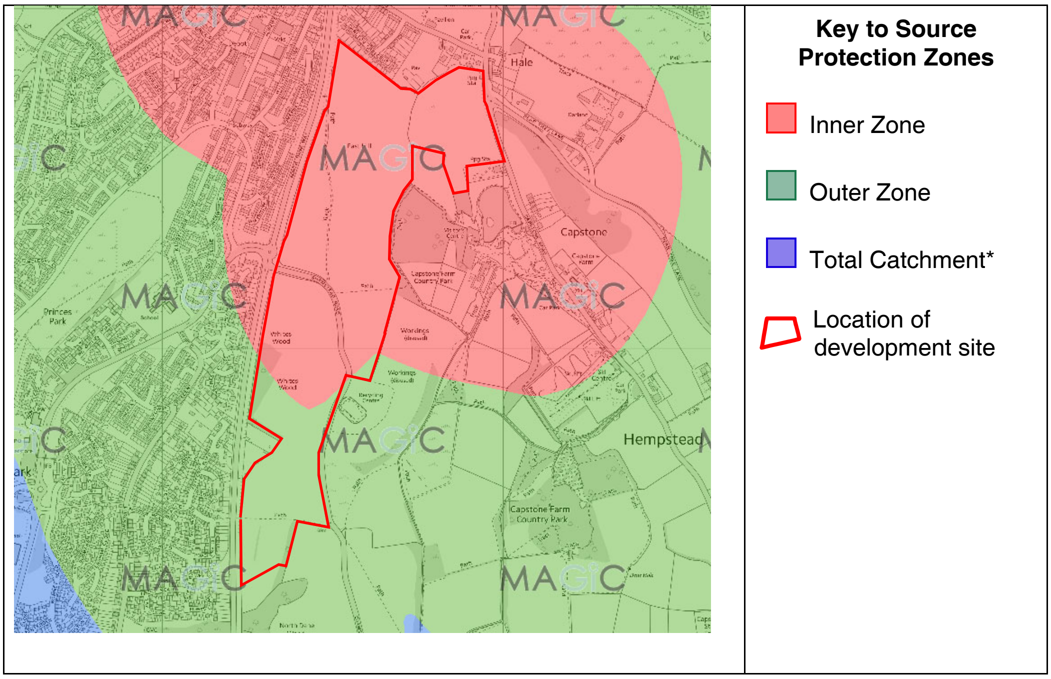


Figure 8.1 – Groundwater map showing the Environment Agency's Source Protection Zones taken from MAGIC Map provided by DEFRA (Contains Ordnance Survey data © Crown copyright and database right 2019).

Therefore, where any infiltration SuDS are proposed it will be necessary to provide appropriate mitigation to treat and convey surface water runoff.

8.3 Existing Drainage

The existing site is undeveloped and used for agricultural purposes. There are no formal land drains across the site and as such, rainfall landing on the site is assumed to infiltrate into the ground. Any surface water runoff from the site is assumed to follow the existing topography and overflow to the surrounding area and into the roads.

Southern Water has provided sewer mapping for the site and surrounding area and an extract from the mapping is shown in Figure 8.2 below. A full asset plan is included with the Appendices.

Figure 8.2 – Southern Water Asset Plan Extract.

From Figure 8.2, it can be seen that there are no sewers on site, with the exception to the north-east between Capstone Road and Capstone Pumping Station, which contains a foul sewer. At this stage it is assumed that there are no existing connection points.

8.4 Opportunities to Discharge Surface Water Runoff

Part H of the Building Regulations summarises a hierarchy of options for discharging surface water runoff from developments. The preferred option is to **infiltrate** water into the ground, as this deals with the water at source and serves to replenish groundwater. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse**. Only if neither of these options are possible, the water should be conducted into the **public sewer** system.

The following opportunities for managing the surface water runoff discharged from the development site are listed in order of preference:

Water re-use - Water re-use systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and hardstanding area to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems can be considered for inclusion within the scheme, an alternative solution for attenuating storm water will still be required.

Infiltration – Reference to the British Geological Survey map shows that the underlying solid geology in the location of the subject site is Lewes Nodular Chalk Formation to the north and Seaford Chalk Formation to the south. Overlying this are superficial deposits of Head (clay, silt, sand and gravel) to the north, and Clay with Flints Formation (clay, silt, sand and gravel) to the south. Aerial photography and a site walkover both confirm that patches of chalk can be seen on the surface at ground level.

Preliminary infiltration testing has been undertaken across the site and this information confirms that both shallow and deep soakage is available. Providing that the risks associated with the SPZ can be mitigated, it is considered that infiltration is a viable method for draining the site.

Discharge to Watercourses – There are no watercourses within close proximity to the site in which to permit a direct connection and consequently, there is no opportunity to discharge surface water to an existing watercourse.

Discharge to Public Sewer System – as an alternative preferred solution is available, it is considered that a connection to the public sewer will not be required.

Notwithstanding this, should infiltration methods prove to be unviable, the next appropriate solution would be to discharge to the surface water sewer located along North Dane Way. It will be necessary to consult with Southern Water to see if a connection could be achieved at this location, and to ensure there is sufficient capacity within the existing drainage network.

8.5 Environment Agency Source Protection Zones

As indicated in Section 8.2, the site is located within SPZ1 and SPZ2. It is important to ensure that the proposed development does not impact on the existing SPZ's and therefore it will be necessary to ensure mitigation measures are specified within the proposed Surface Water Management Strategy.

The Environment Agency and the Lead Local Flood Authority have both been consulted during the preparation of the Surface Water Management Strategy, with specific reference to two points; the methods of infiltrating surface water runoff at this location, and the proximity to the existing historic landfill site located on Capstone Road. In order to reduce the impact of the development site, a number of SuDS will need to be incorporated within the proposed development and a water quality management train is to be introduced. This has been assessed further within later sections of this report.

One constraint flagged by the consultees is in relation to the existing ground water level on site. Site Investigations (undertaken by others) have demonstrated that the ground water level was not found within 20m of the existing ground level, with exception to the lowest point on the site (north eastern area), where groundwater was located at 15m below the existing ground level (~21.1m AODN).

8.6 Other Constraints

There are a number of potential constraints that should be considered as part of the drainage strategy. The key constraints that are relevant to this development are listed below:

- Due to the steep topography of the site, it will be necessary to incorporate check dams within the sub-base of any permeable paving, or swales.

- Infiltration SuDS intended to drain highway or parking areas will usually require additional safeguards, such as seal-trapped gullies or oil/grit separators.

- If additional surface water runoff is to be discharged into the public sewer system, or if a new connection is required, it will be necessary to gain consent for this connection from the sewerage undertaker (Southern Water).

- There is a responsibility to protect groundwater resources, in accordance with the EA's "Groundwater Protection: Principles and Practice Guidance" (GP3). The use of pollution control measures including oil interception systems and sediment traps should be considered as part of the detailed drainage design for the site.

- Infiltration testing has been undertaken at the site and the results confirm soakage rates vary between 0.01m/hr – 0.28m/hr. The strategy has been developed based on the soakage tests within the site investigation report. The permeable paving systems specified have, however, been designed based on the lowest infiltration rate of 0.01m/hr. These rates should be confirmed through further infiltration testing at full planning submission stage.

8.7 Proposed Surface Water Management Strategy (SWMS)

The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with calculations that have been undertaken to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF can be met at the planning stage.

Due to the large scale of the site and the existing site topography, the development has been sub-divided into discrete drainage catchments for the purpose of the SWMS. The extent of each of these catchments can be seen in Figure 8.3 below.

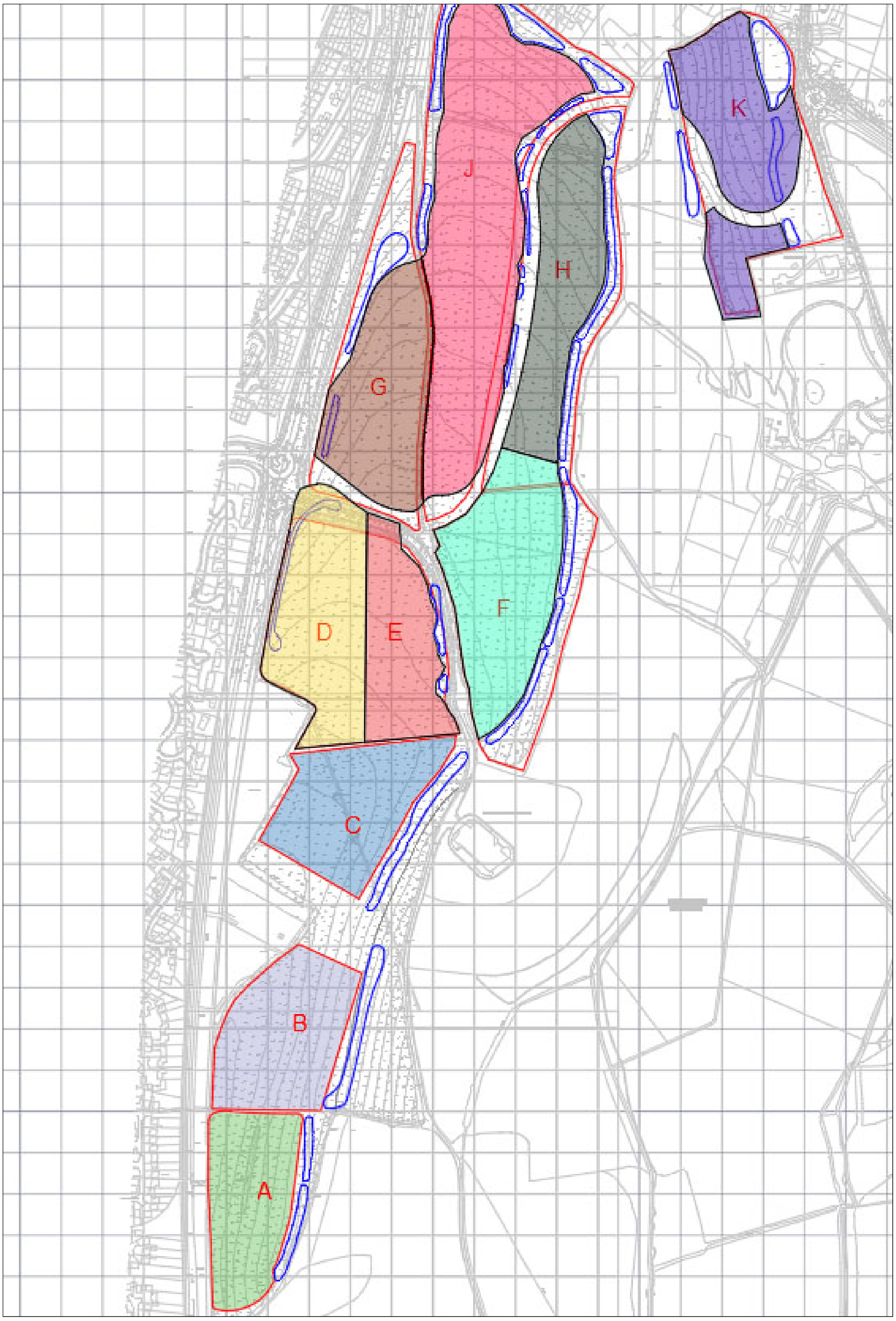


Figure 8.3 – Development Drainage Catchments.

The following strategy should be read in conjunction with the Indicative Drainage Layout Plan located within the Appendices.

Water Butts

To reduce the developments reliance on potable water supplies for external use there is the potential to incorporate water butts within the garden areas. Typical sizes and dimensions of water butts are outlined below.

Typical house water butt options	Dimensions of a typical house water butt	Volume of storage provided (litres)
Type 1 (wall mounted – Small)	1.22m high x 0.46m x 0.23m	100
Type 2 (Standard house water butt)	0.9m high x 0.68m diameter	210
Type 3 (Large house water butt)	1.26m high x 1.24m x 0.8m	510
Type 4 (Column tank – Very large)	2.23m high x 1.28m diameter	2000

Table 8.2 – Estimated storage capacity of available water butts.

In this case the demand for potable water from each of the gardens is likely to be relatively small and as a result, standard house water butts (typical 200 - 210 litre units) are likely to be the most appropriate size for inclusion within the scheme.

It is recognised that each of the water butts will need to overflow into the main drainage system for the site, to ensure that in the event the water butt is full prior to the onset of the design rainfall event, water can be discharged away from the properties without increasing the risk of flooding.

Highway Runoff – Permeable Surfacing

Surface water runoff from the hardstanding areas across the site, in addition to overflow from the water butts, will be directed via a series of underground pipes into a layer of open graded subbase material, located beneath the permeable surfacing. The base of the permeable surfacing system can be underlain with a permeable geotextile liner to maximise the volume of water discharged to the ground via infiltration.

Where the site is sloping, a series of check dams located within the sub-base layer will be required to maximise the storage available. A summary of the Micro Drainage analysis for permeable surfacing is shown in Table 8.3 below.

Parameter	Value (1:100yr+30%cc event)
SuDS	Permeable surfacing
Infiltration	0.01m/hr
Sub-base depth	500 mm
Critical storm duration	1,440 minutes
Half drain time	1,376 minutes

Table 8.3 – Summary of permeable surfacing SuDS.

From Table 8.3 it is evident that, with the inclusion of permeable surfacing, there is potential to accommodate all the surface water runoff from highway areas up to, and including, the design rainfall event.

Property (roof) runoff – Bioretention Swales and Rain Gardens
Surface water runoff from the roofs of properties will be transported via underground pipelines to bioretention swales, located at the low-lying areas of each catchment. Bioretention swales are designed to be wide landscaped features, which will be used to attenuate and infiltrate storm water. In order to enhance the storage volumes during peak rainfall periods, the total landscaped depressions will be between 500-1000mm in depth, and where the ground is sloping, will consist of a series of cascading pools. The swale systems will contain shrubs and vegetation to maximise filtration and promote biodiversity.

At this early stage in the development process, the storage volumes from each catchment have been calculated using point data extracted from the Flood Estimation Handbook (2013). The design parameters for the bioretention swales are summarised within Table 8.4 below.

Parameter			**Value (1:100yr+30%cc event)**		
SuDS method			Bioretention Swales		
Bioretention Swale Reference and (depth)	**Infiltration rate (m/hr)**	**Estimated impermeable area draining to system**	**Total retention storage volume required**	**Overflow**	**Critical storm duration (minutes)**
A (600mm)	0.28	1.041ha	561 m^3	No	480
B (800mm)	0.01	0.925ha	1,197 m^3	No	2880
C (900mm)	0.27	3.218ha	1,873 m^3	No	480
D (600mm)	0.27	2.425ha	1,275 m^3	Yes (A)	600
E (500mm)	0.28	0.441ha	196 m^3	No	120
F (1000mm)	0.01	2.029ha	1,372 m^3	Yes (D)	720
G (500mm)	0.17	1.33ha	714 m^3	No	360
H (900mm)	0.27	0.14ha	56 m^3	No	60

Table 8.4 – Summary of the Micro Drainage Results for the bioretention swales.

Table 8.4 above demonstrates that the surface water runoff from the roofs of the properties can be managed safely and sustainably, creating significant improvements with respect to biodiversity and in places, helping to reduce greenfield runoff rates. Where infiltration rates are exceptionally low, an overflow system has been designed so that the swale systems are cascaded to areas where the infiltration rate is higher.

Water Quality

Table 26.2 of the CIRIA C753 SuDS Manual defines residential roads and car parking to have a 'medium risk' of pollution and residential roofs to have a 'very low' risk of pollution, particularly when discharging to ground water. This site is located within an Environment Agency Source Protection Zone and therefore, the simple index approach has been undertaken to assess the water quality management for the site.

The pollution hazard indices for the proposed highways have been summarised in Table 8.5 below. This has been compared with the mitigation index for proposed SuDS at this site.

Parameter	Total suspended solids (TSS)	Metals	Hydro-Carbons
Pollution Hazard Index	0.7	0.6	0.7
Permeable Paving mitigation Index	0.7	0.6	0.7

Table 8.5 – CIRIA C753 simple index approach to water quality management for highways.

With reference to Table 8.5, the simple index approach to water quality management has been applied for the permeable surfacing system at this site, and providing that the depth of sub-base is greater than 300mm, the proposed SuDS system is equal to or greater that the pollution hazard index, and is therefore considered acceptable.

The pollution hazard indices for the proposed residential roofs have been summarised in Table 8.6 below. This has been compared with the mitigation index for proposed SuDS at this site.

Parameter	Total suspended solids (TSS)	Metals	Hydro-Carbons
Pollution Hazard Index	0.2	0.2	0.05
Swale mitigation Index	0.5	0.6	0.6

Table 8.6 – CIRIA C753 simple index approach to water quality management for residential roofs

With reference to Table 8.6, the simple index approach to water quality management has been applied to the swale system at this site, and this demonstrates a significant betterment in the treatment of surface water runoff from the proposed development, and is therefore considered to be acceptable.

8.8 Management and Maintenance

For any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime.

The key requirements of any management regime are routine inspection and maintenance, when the development is taken forward to the detailed design stage an 'owner's manual' will need to be prepared. This should include:

- A description of the drainage scheme,
- A location plan showing all of the SuDS features and equipment such as flow control devices etc.

- Maintenance requirements for each element, including any manufacturer specific requirements
- An explanation of the consequences of not carrying out the specified maintenance
- Details of who will be responsible for the ongoing maintenance of the drainage system.

The typical maintenance requirements for the various SuDS measures incorporated into the proposed scheme are outlined within the maintenance schedules which have been included within the appendices.

For developments such as this that rely to some extent on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development.

For a site of this size with communal SuDS, it is recommended that the management company responsible for maintaining the rest of the site is also tasked with maintaining the associated SuDS and drainage features.

8.9 Sensitivity Testing and Residual Risk

When considering residual risk it is necessary to consider the impact of a flood event that exceeds the design event, or the implications if the proposed drainage system becomes blocked. Notwithstanding this, it is recognised that the drainage proposals will incorporate a significant volume of additional storage for storm water, which is not currently provided for on the existing site. As a result, when compared to the existing site it is evident that the volume of water discharged from the site during an extreme rainfall event is likely to be reduced, thus minimising the potential impact of flooding to the surrounding area.

The proposed drainage system has been designed for an extreme rainfall event with a return period of 1 in 100 years, including a 30% increase in peak rainfall intensity (to account for the impacts of climate change). Nonetheless, based on the EA's most contemporary climate change guidance an Upper End climate change allowance of 40% has been used to test the proposed drainage system to reflect further increases in peak rainfall intensity.

Calculations have been undertaken to assess the performance of the drainage system under the design rainfall event, including a 40% increase in peak rainfall intensity due to climate change. These calculations can be found within Appendix A.4.

The calculations for the permeable surfacing and swale system show that the proposed drainage systems are not susceptible to increases in peak rainfall intensity and as such, the system does not flood. This is due to the storage features having additional (spare) capacity.

Inspection of the topography across the site suggests that if the permeable surfacing was to block, or become overwhelmed following an extreme rainfall event, water could exit the system and flow towards the lower areas of the catchment. Where this is not possible, local ponding may occur. It is recommended that kerbs are installed on the road network to contain any flood water resulting from a blockage, or as the result of an exceedance event.

It should be recognised that the drainage proposals will incorporate a significant volume of additional storage for storm water, which is not currently provided for on the existing site. As a result, when compared to the existing site, it is evident that the volume of water discharged from the site during an extreme rainfall event is likely to be reduced, thus minimising the potential impact of flooding

8.10 Foul Water Management Strategy

Southern Water has been consulted to determine the impact of the development on the surrounding sewers, and a Feasibility Study has been undertaken (see Appendix A.7).

The Feasibility Study identifies that there is sufficient capacity within the public sewer to accommodate foul water from the development, by utilising the proposed connection into the manholes located at TQ77658802, TW77657902 or TQ77665101. It should be recognised that in order drain foul water from some parts of the site, it will be necessary to provide a pumping station. This should be considered in more detail at the next stage of the development process.

With regard to allowing surface water runoff from the eastern part of the development to e discharged into the sewer, the study has found that there is sufficient spare capacity to drain the eastern part of the development providing flows are restricted to 3l/s.

Consequently, it is evident that a connection from the proposed development to a public sewer will be available if required, although it is acknowledged that the construction of a proposed pipeline and pumping station may be necessary.

9 The Sequential and Exception Test

9.1 The Sequential Test

The National Planning Policy Framework (NPPF) requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the Environment Agency's flood zone maps. These maps and the associated information are intended for guidance, and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country.

The NPPF requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the EA's flood zone maps. Reference to Figure 3.1 identifies that the majority of the development site is located within Flood Zone 1 and therefore, will meet the requirements of the Sequential Test. It is only the most north-eastern part of the site which is located partially within Flood Zone 2 and 3 and as such, the Sequential Approach should be considered.

The NPPF states that the Local Planning Authority should apply the sequential approach as part of the identification of land for development in areas at risk from flooding. When applying the test, it is also necessary to ensure that the subject site is compared only to those sites that are available for development and are similar in size. In this case, this site-specific appraisal demonstrates that the proposed development is located outside the extents of flooding under the design flood event (i.e. an event with a 1 in 100 year return period, including an appropriate allowance for climate change). The proposed development is also shown to be unaffected by flooding under an event with a 1 in 1000 year return period. These findings support the EA's flood zone mapping which show the area of proposed development to be located within Flood Zone 1 as shown in the figure below.

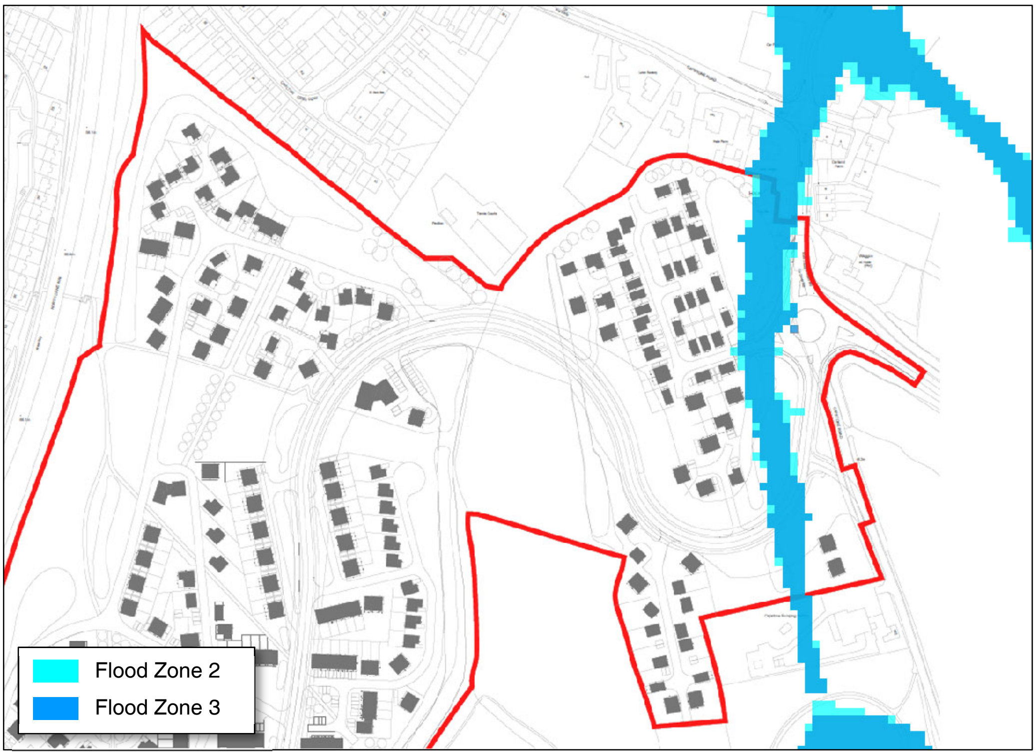


Figure 9.1 – Flood zone map showing the location of the development site (© Environment Agency).

In addition, the development site has been identified as a preferred development site in three of the four growth scenarios set out in the emerging Medway Local Plan, which allocates sites for development following a review of comparative site constraints and sustainability criteria.#

The second level of appraisal is through the application of the more detailed and refined flood risk information contained within Strategic Flood Risk Assessments (SFRA). Such a document has been prepared for the Medway Council and this has been referenced as part of this site-specific FRA.

The most detailed stage at which the sequential approach can be applied is at a site-based level. This typically comprises locating more vulnerable buildings on the higher parts of the site, whilst siting less vulnerable elements (such as car parking) on the lower lying area on site. Inspection of the proposed scheme drawings, with reference to the site-specific topographic survey, identifies that this approach has also been applied.

9.2 The Exception Test

According to the NPPF, if it is not possible, consistent with wider sustainability objectives, for the development to be located in areas at lower risk, the Exception Test may have to be applied. The application of the Exception Test will depend on the type and nature of the development, in line with the Flood Risk vulnerability classification set out in the NPPG. This has been summarised in Table 9.1 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations	✓	✓	e	e
High vulnerability – Emergency services, basement dwellings, caravans and mobile homes intended for permanent residential use	✓	e	×	×
More vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education	✓	✓	e	×
Less vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants	✓	✓	✓	×
Water compatible development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓
Key : ✓ Development is appropriate × Development should not be permitted e Exception Test required		Shaded cell represents the classification of this development		

Table 9.1 – Flood risk vulnerability and flood zone compatibility.

From Table 9.1 above it can be seen that although the proposed development is located within Flood Zone 1 and 2, part of the site is shown to be located within Flood Zone 3. Therefore, the development falls into a classification that requires the Exception Test to be applied. For the Exception Test to be passed it should be demonstrated that:

- *the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*
- *the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

Both elements of the test will have to be passed for development to be allocated or permitted. Demonstrating that the development provides wider sustainability benefits to the community that outweigh flood risk is outside the scope of this report.

Nevertheless, the analysis undertaken within this report has demonstrated that the proposed buildings are located outside the extents of flooding for both the design and exceedance event, and there will be safe access/egress to/from the development available. Furthermore, it has been demonstrated that, as a result of the proposed surface water management strategy, the development will not increase the risk of flooding offsite.

It is therefore concluded that the requirements of the second criteria of the Exception Test can be met.

10 Conclusions

The key aims and objectives for a development that is to be sustainable in terms of flood risk are summarised in the following bullet points:

- the development should not be at a significant risk of flooding, and should not be susceptible to damage due to flooding.
- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, is threatened
- normal operation of the development should not be susceptible to disruption as a result of flooding and safe access to and from the development should be possible during flood events
- the development should not increase flood risk elsewhere
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences by the EA
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk; the responsibility for any operation and maintenance required should be clearly defined
- the development should not lead to degradation of the environment
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change

In determining whether the proposals for development at North Dane Way, Medway are sustainable in terms of flood risk and are compliant with the NPPF and its Planning Practice Guidance, all of the above have been taken into consideration as part of this FRA.

Whilst part of the site is located within Flood Zones 2 and 3, the proposed buildings are located entirely within Flood Zone 1. In addition, the development site has been lghqwlilhg#iru#ghyhorsphqw#lq#d#qxpehu#ri#Phgzd|*v#hphujlqj#jurzwk#rswlrqv#wkdw#lv#dzdlwlqj#wkh#rxwfrph#ri#d#KLI#ixqglqj#elg#ehiruh#ixuwkhu#sxeolf#frqvxowdwlrq/ and therefore, the Sequential Test is considered to be passed. Notwithstanding this, the development proposals are classified as 'more vulnerable' use and the site is partially situated in Flood Zones 2 and 3. Consequently, there is still the requirement to apply the Exception Test to determine whether suitable and appropriate mitigation measures can be incorporated into the design of the scheme to ensure that is it sustainable in terms of flood risk.

Consequently, the risk of flooding has been appraised across a wide range of sources and it has been demonstrated that the majority of the site is at low risk of flooding. It is only the lower part of the development site which could be subject to flooding from surface water, however, the analysis shows that the proposed dwellings are located outside of any areas at risk of flooding, and will remain dry under the design flood conditions.

Furthermore, this FRA has demonstrated that the development will not increase flood risk elsewhere and by incorporating SuDS features within the design of the surface water drainage system, it will be possible to limit the impact with respect to surface water runoff.

The preferred solution for draining surface water from the site has been identified and it is proposed to use permeable surfacing and bioretention swales to convey, store and treat surface water runoff before infiltrating water into the ground. The proposal reduces the rate of runoff from the development when compared to the existing greenfield runoff rates, and therefore the proposals meet the requirements set out in the NTSS and the Medway SFRA.

In addition to demonstrating that a sustainable solution is available for managing surface water runoff, a foul water drainage strategy has also been developed to confirm that foul effluent from the proposed development can be discharged offsite. The preferred solution for draining foul effluent from the site will be to utilise a connection to the public sewer system and Southern Water has confirmed that there is sufficient capacity within the current network to accommodate the proposed development.

In conclusion, following the recommendations of this report, the occupants of the development will be safe and the development will not increase the risk of flooding elsewhere. Consequently, it has been demonstrated that the development will meet the requirements of the NPPF.

11 Recommendations

The findings of this report conclude that the development will not increase the risk of flooding at the site, or elsewhere. There are, however, a number of mitigation measures and recommendations that could further reduce the risk to the development and other areas within the floodplain.

- All proposed dwellings should include a 150mm threshold where practicable.
- The flood resilience measures outlined in Section 7.3 of this report are to be incorporated into the design of the building where possible.
- The surface water management strategy for the development will need to be developed to a detailed design stage and this will need to take into account the constraints set out in Section 8.6.
- It will be necessary to undertake further site-specific investigations at the detailed design stage in order to quantify the available infiltration in relation to the proposed development.
- The use of appropriate SuDS as discussed in Section 8 should be considered for incorporation into the scheme design. For this development the use of rainfall harvesting and porous paving for all hardstanding surfaces is recommended.

With the above mitigation measures incorporated into the design of the development, the proposals will meet the requirements of the NPPF and its Planning Practice Guidance and will therefore be acceptable and sustainable in terms of flood risk.

12 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Environment Agency Response

Appendix A.3 – Southern Water Asset Location Data

Appendix A.4 – Surface Water Management Calculations

Appendix A.5 – Indicative Drainage Layout

Appendix A.6 – Maintenance Schedules

Appendix A.7 – Southern Water Feasibility Study