7. Flood Risk and Sustainable Drainage

7.1 Flood Risk

7.1.1 Strategic Flood Risk Assessments

The Environment Agency flood maps show a significant portion of the Borough to be at risk from tidal and/or fluvial flood sources, although these maps do not account for the presence of flood defences or other sources of flood risk such as sewers, groundwater or surface water. Strategic Flood Risk Assessments are prepared to provide a more accurate assessment of flood risk, usually through undertaking detailed modelling at a borough-wide scale. They take into consideration the effects of flood defences, all sources of flood risk and changes likely due to the effects of climate change.

A Strategic Flood Risk Assessment (SFRA) for the Borough of King's Lynn and West Norfolk was completed by Bullens Consultants in 2005, which was updated by Faber Maunsell in 2008. The updated SFRA applied more sophisticated 2D modelling methodologies and made use of recent LIDAR data, which provided more detailed information on local topography. Along with the Water Cycle Study, the SFRA report will form one of the Local Development Documents to be used as an evidence base for the Local Development Framework. To avoid repetition of this work, only a brief summary is presented in the following sections. The reader is referred to the SFRA for more detailed information.

7.1.2 Fluvial and Tidal Flood Risk

The Borough of King's Lynn and West Norfolk encompasses a wide variety of landforms, including: relatively narrow stream valleys in the chalk uplands; broader and relatively flat river valleys of the Nar and Wissey; extensive areas of fenland, and extensive coastline. Almost the whole of the Borough south of King's Lynn falls within the catchment of the River Great Ouse, one of the major rivers of Eastern England. North of King's Lynn, the small chalk streams drain either to the Wash or the North Sea. There are a number of historical records of major flooding events, both tidal and fluvial, which have occurred in the Borough, including the 1953 tidal flood disaster which claimed 81 lives in King's Lynn and West Norfolk.

The SFRA identified the following specific sources of flood risk;

Fluvial Flood Sources

- River Great Ouse (Ely Ouse)
- Cut-off Channel (upstream of Denver Sluice)
- Relief Channel (downstream of Denver Sluice)

- River Little Ouse
- River Wissey
- River Nar
- Old and New Bedford Rivers
- Middle Level Main Drain (including Well Creek)
- River Burn
- Heacham, Babingley and Gaywood Rivers

Tidal Flood Risk Sources

- Wash Banks
- Great Ouse Estuary (including the Tidal River downstream of Denver Sluice and the new Bedford River upstream of Denver)
- North Sea (North Norfolk Coast from Hunstanton to Burnham Overy)
- Nene Estuary (Wisbech to the Wash)

In addition, the SFRA identified a number of key mechanisms for flooding to occur:

- Overflowing of embanked high level watercourses;
- Breaching of embanked high level watercourses;
- Exceedance of pumped drainage capacity in areas with no natural drainage;
- Overflowing of relatively large, slow flowing rivers with extensive floodplains;
- Overflowing of smaller, fast flowing rivers with no extensive floodplains (normally in the headwaters);
- Overflowing of culverted watercourses in urban areas;
- Localised flooding due to overloading of the local surface water drainage system during storms;
- Localised flooding in urban areas due to flood locking;
- Tidal flooding as a result of overtopping of coastal flood defences;
- Tidal flooding as a result of breaching of coastal flood defences.

The SFRA assessed the flood risk in relation to 11 development zones across Kings Lynn, Downham Market and Hunstanton. These broadly correspond to the proposed development areas identified in the Core Strategy (Section 4). An assessment was made under current conditions and with an allowance for the effects of climate change. The findings are summarised briefly in Figure 7.1 and 7.2 and Table 7.1. More detailed information is contained within the SFRA.

Taking into consideration the presence of flood defences, five of the 11 development areas were identified as being wholly or largely within the Environment Agency's defined Flood Zone 1 or 2. One area is within Flood Zone 2 and 3, and the remaining five areas are wholly or largely within Flood Zone 3. It should be remembered however that these flood zones will change over time since climate change is predicted to substantially increase flood risk, particularly in relation to tidal flooding.

The SFRA identified that the predominantly tidal nature of flood risk in the northern part of the Borough and the likely future pattern of urban development in the area, means that flood risk in this part is not likely to be significantly increased by urban development. However, in the southern part of the Borough, where the Ely Ouse system is the principal flood source, large scale development in the Cam catchment could, if not strictly controlled, have a potentially significant impact on future flood risk.

Flooding and drainage issues therefore have the potential to significantly impact on the way in which development proceeds within the Borough, but there is an opportunity to reduce the existing risk of flooding through careful planning and risk management approaches.

7.1.3 Flood Risk from Other Sources

The 2008 SFRA focused on the tidal and fluvial flood risk, as these were identified as the principle sources in the Borough. However, development may still be at risk from other sources, such as groundwater and drainage infrastructure, that should be considered in the spatial planning process.

There is a potential for groundwater flooding in the Borough due to the nature of the Wash and the presence of the underlying Chalk geology. However, there have been no recorded incidences of groundwater flooding presumably as a result of a low water table being maintained through pumping undertaken by the Internal Drainage Boards. As such, this potential risk is not considered to constrain the spatial location of new development but should still be considered in the building design and planning controls. For example, a restriction on basement dwellings, building floor slabs should be built at least 300mm above ground to prevent any emerging groundwater from entering properties.

Flooding may occur as a result of overwhelmed or failed drainage infrastructure, resulting in a risk of inundation to properties. Anglian Water's records show that there have been a number of recorded instances of flooding as a result of blockages or pumping station failures (see maps in Appendix G). The number of incidents reveals that local improvements are needed in various parts of the sewer network but these will be addressed by AWS as part of their regular maintenance and AMP planning. Indeed the overall number of recorded incidents dropped from 323 in

2007 to only 52 in 2008, indicating that improvements are being carried out. Any new development would need to ensure there is sufficient capacity in the existing systems and should limit the discharge into drainage networks through the use of sustainable drainage systems (SuDS) wherever possible. This is discussed further in Section 7.3.

It should be pointed out that any increase in discharge rate or volume likely to result from an increase in the area of hard-standing associated with development should be assessed, ensuring that flood risk (of watercourses for example) is not increased. When impact is expected, mitigation will need to be agreed and implemented to the receiving system prior to any increase. Furthermore, volumes of discharge should not be used to improve quality of discharge, without the assessment of flood risk as detailed above.

7.1.4 Shoreline Management Plans

The Wash Shoreline Management Plan (SMP) is currently being prepared and expected for release in summer 2009 and the Norfolk Coast SMP is also currently being undertaken. Although some draft information was provided, the output of these studies was not available at the time of writing this report.

The SMPs will define the approach to managing the shoreline of the district, which is divided into distinct areas and over three time periods (referred to as Epochs). The approach will be based on one of the following four options:

- **No Active Intervention (NAI)**: no investment in coastal defences or operations;
- **Hold the Line (HtL)**: keep the existing defence line;
- **Advance the Line (AtL)**: building new defences on the seaward side of existing defences;
- **Managed Realignment (MR)**: allowing the shoreline to move back.

In the absence of the completed SMPs it has been assumed that all areas will adopt ‘Hold the Line’ and therefore the current flood risk will remain the same over the lifetime of the proposed development. This should be reviewed following the completion of the SMPs.

Table 7.1 Summary of findings of 2008 SFRA (the reader should refer to the SFRA and associated flood maps)

Development area	Summary of findings of the SFRA
South Lynn and Lynn South Expansion area	Potentially the area is at risk of flooding from the tidal Great Ouse, Flood Relief Channel and River Nar. The Nar represents the greatest risk of flooding but the extent is relatively small. North of the A47, South Lynn and the parcel of land between the River Nar and Hardwick Road are located in Flood Zone 1. The land surrounding Friars Fleet and the Friars Street School are located in Flood Zone 3 with the buildings to the south of Millfleet in Flood Zone 2. South of the A47 the more elevated western end of the study area is too high to be at risk from flooding from the Nar, and due to the height of the tidal defences the risk is Flood Zone 1. In the eastern part of the area, the risk is primarily fluvial in Flood Zone 2, apart from higher land adjacent to West Winch Road and the Trading Estate which is Flood Zone 1. Allowing for climate change fluvial risk Flood Zone 3 extends eastwards from the right bank of the River Nar to the south of the A47. The elevated land adjacent to West Winch Road and Trading Estate is still located in Flood Zone 1.
West Lynn	The primary flood risk comes from the tidal section of the Great Ouse. The whole of the area is in Flood Zone 1, though climate change raises the risk to Flood Zone 3 except the centre of West Lynn where the risk is Flood Zone 2.
Historic Core (Old Lynn)	The whole area is in Flood Zone 2 except for a large elevated area between Austin Street and St James Street which is Flood Zone 1. The resulting flooding however would be limited in duration and volume. Climate change would increase the risk to Flood Zone 3 in areas currently in Flood Zone 2, and to Flood Zone 2 in areas in Flood Zone 1, except in the Highgate area which would remain in Flood Zone 1.
North Lynn	The primary flood risk comes from the tidal section of the Great Ouse. The eastern half of the area is in flood risk Flood Zone 2 and the western half in Flood Zone 1. Climate change would bring the area into Flood Zone 3.
Gaywood	The primary flood risk comes from the Gaywood River/Bawsey Drain system. The low lying valley between Wootton Road and the Eastern bypass (A149) acts as a storage area which reduces flood risk to the urban zone to Flood Zone 2. Within the flood plain the risk is Flood Zone 3.
Hardwick	The flood risk maps were not available at the time of writing this report.
King's Lynn Eastern Expansion Area	The principal source of flood risk will be fluvial flooding from the Pierpoint/Middleton Stop Drains. The whole of the area to the north of the A47 roundabout is in Flood Zone 3 and the remaining parts in Flood Zone 1 due to the elevated nature of the land. This categorisation is unaffected by climate change.

Development area	Summary of findings of the SFRA
North and South Wootton	The primary flood risk comes from the tidal section of the Great Ouse. The whole of the area is in flood risk Flood Zone 1. Even allowing for the effects of climate change, Flood Zone 3 would extend only as far as the old railway line with a small area of Flood Zone 2 east of the line upstream of the North Wootton Drain culvert.
Downham Market West	The tidal Great Ouse and Flood Relief Channel represent the primary risks of flooding. However, the whole area is in flood risk Flood Zone 1. Climate change would increase the risk to Flood Zone 3 in a narrow wedge of land along the east bank of the Relief Channel. and Flood Zone 2 in an intermediate adjacent zone but most of the area remains in Flood Zone 1.
Downham Market South West	The majority of the area west of the railway but to the south of Bartons Farm falls within Flood Zone 2 and the remaining area in Flood Zone 1. Climate change would increase the risk in the area to the west of the railway to Flood Zone 3 with a small area to the east of the railway in Flood Zone 2. The remaining area remains in Flood Zone 1.
Hunstanton	The whole of the area is in Flood Zone 1 with a small area in Flood Zone 2. Climate change would increase the risk to Flood Zone 3 in most of the area with a small zone in Flood Zone 3.

Flood Zone 1: Annual probability of fluvial and/or tidal flooding is less than 1 in 1000 (<0.1%)

Flood Zone 2: Annual probability of fluvial flooding between 1 in 1000 and 1 in 100 (0.1% - 1%), tidal flooding between 1 in 1000 and 1 in 200 (0.1% - 0.5%)

Flood Zone 3a: Annual probability of fluvial flooding is greater than 1 in 100 (>1%), tidal flooding is greater than 1 in 200 (>0.5%)

Flood Zone 3b (Functional floodplain): Annual probability of fluvial and/or tidal flooding is greater than 1 in 20 (>5%)

7.2 Guiding principles of flood risk management in relation to housing development

The aim of PPS25, as enforced by the Environment Agency, is for managing flood risk through the planning system to avoid inappropriate development in flood risk areas. Spatial planning is recognised as being an important tool in facilitating this aim as it ensures development is located away from away from flood risk areas. PPS25 is based on a hierarchy of avoid, substitute, control and mitigate, as briefly described below.

Avoid

Description: Allocate development to areas of least flood risk and apportion development types vulnerable to the impact of flooding to areas of least risk.

Action: Locate development outside the floodplain, within Flood Zone 1.

Substitution

Description: Substitute development that is incompatible with the degree of flood risk with less vulnerable development types.

Action: Using the definitions of vulnerability and compatibility as provided in Table D.2 and D.3 of PPS25, development types would be allocated to compatible Flood Zones.

Control

Description: Implement flood risk management measures to reduce the impact of new development on flood frequency and use appropriate design.

Action: Developments would incorporate measures such as raising ground levels or building floors, making buildings flood resilient and/or resistant, ensuring safe dry access to ensure the risk from flooding is controlled to an acceptable level.

Mitigate

Description: Implement measures to manage the risk should the “control” solutions fail

Action: Implement measures (such as evacuation planning) to mitigate residual risks.

7.2.1 Spatial Planning Advice for King's Lynn and West Norfolk

Using the fluvial and tidal flood zones (including climate change) produced in the 2008 SFRA, the proposed development locations were mapped to determine the current risk of flooding to the area. Figure 7.1 depicts the developments in relation to current-day flood zones, whilst Figure 7.2 maps the proposed housing against flood zones which include an allowance for climate change. From these it can be seen that a large proportion of the development sites (91 out of the 118 in the climate change scenario) are located in Flood Zone 1and therefore meet the first aim of ***avoiding*** flood risk.

However, those sites shown on Figure 7.2 coloured either red (located in Flood Zone 3) or orange (located Flood Zone 2) are at risk of flooding. In accordance with the guiding principles of PPS25, land uses in these areas should be restricted only to compatible development types so as to ***substitute*** the flood risk. Table D.3 of PPS25 (shown below) details the appropriate development types for each flood zone. All are considered appropriate in Flood Zone 2, although 'Highly Vulnerable' (e.g. basement dwellings) land uses would require the Exception Test to be passed. In Flood Zone 3, 'Highly Vulnerable' land uses are not considered appropriate, and 'More Vulnerable' (e.g. residential) would require the Exception Test to be passed before development could proceed.

In following such an approach, the principles of PPS25 would be met and therefore objections from the Environment Agency (on the basis of flood risk) minimised.

In accordance with PPS25, those developments located in Flood Zone 2 or 3 (coloured red or orange), or any development on sites greater than 1 hectare, would need to undertake a site specific flood risk assessment prior to submitting a planning application. Table H.1 in Appendix H, highlights those developments for which this applies, based on the housing information provided, and provides an indication of the type of residential development which is considered appropriate.

7.2.2 Gaywood River Catchment Project

The Gaywood River flows through the north eastern side of King's Lynn and discharges to the tidal Great Ouse near Boal Quay through a tidal flap. This can result in tide locking and backing up of the river and potential flooding of the valley. To allow housing development in this area King's Lynn Internal Drainage Board has proposed the development of a flood storage area at Osier Marsh followed by a second phase to link the Gaywood River to the North Lynn Pump by the installation of new pumping infrastructure. This work is required before development in this area can go ahead.

Table D.2: Flood Risk Vulnerability Classification (taken from PPS25)

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.[19]
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste.[20] • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).

Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, **subject to a specific warning and evacuation plan**.

Table D.3[22]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Key:

✔ Development is appropriate

✗ Development should not be permitted

Figure 7.1 Flood risk maps from SFRA

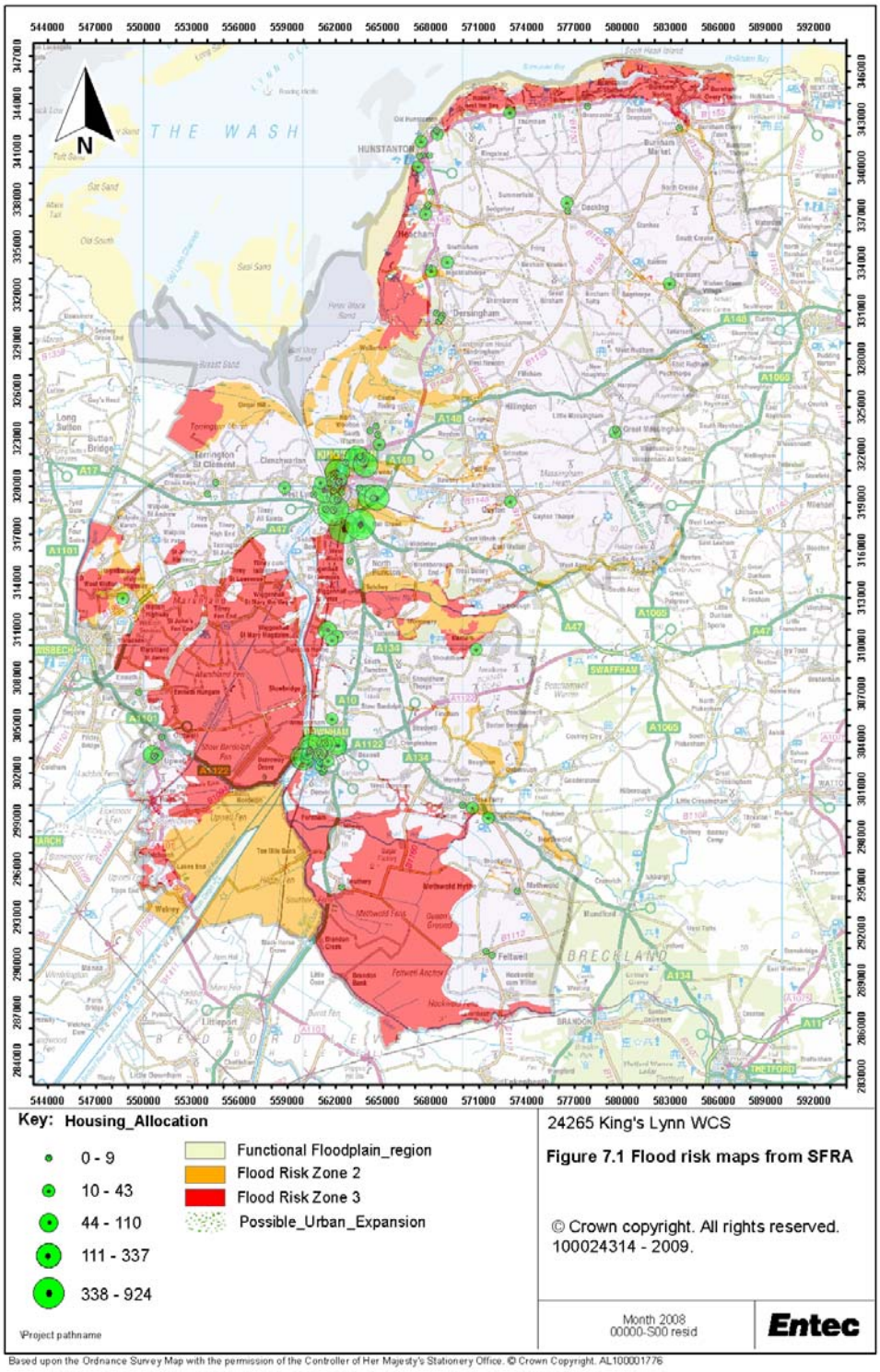
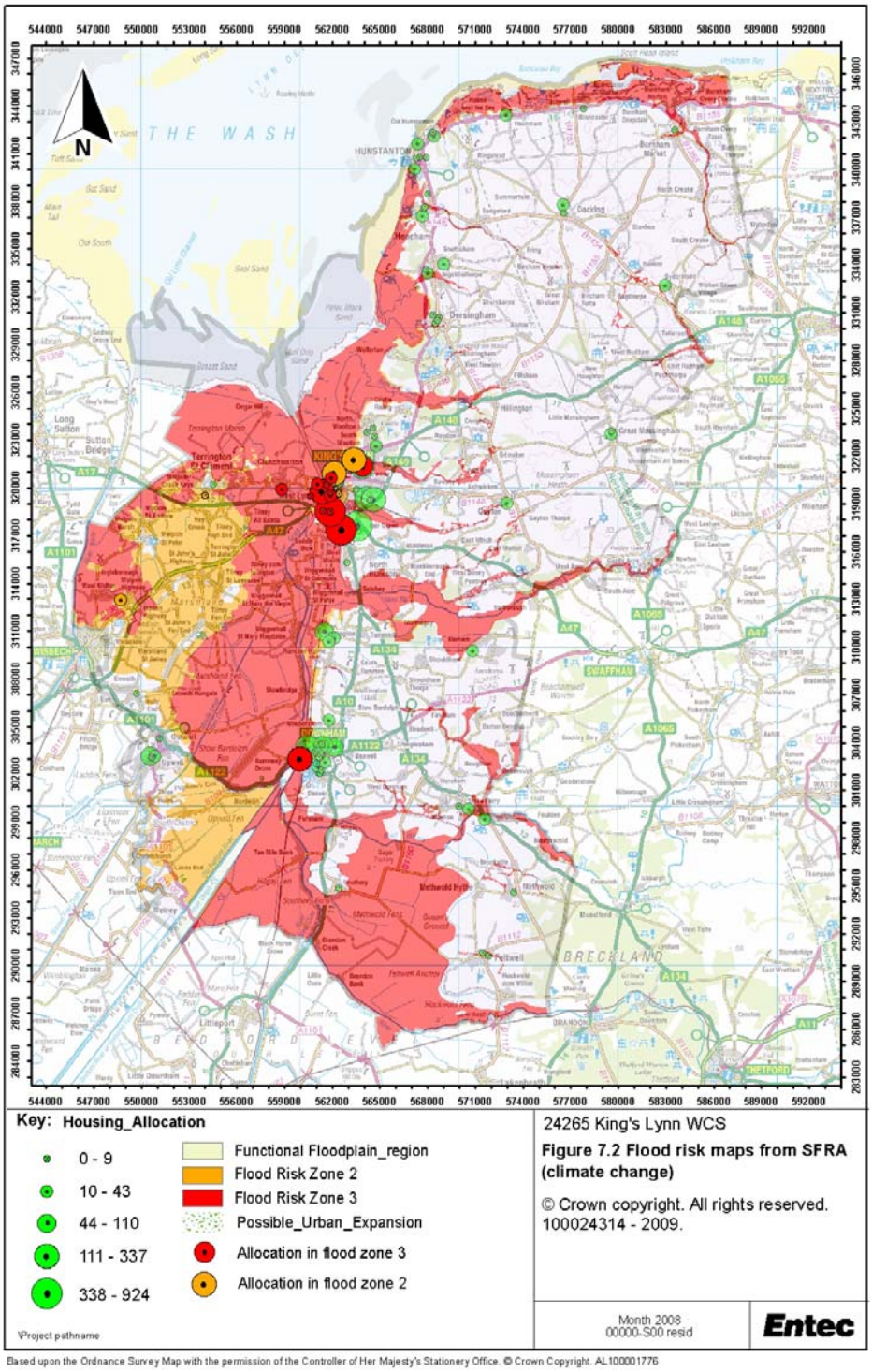


Figure 7.2 Flood risk maps from SFRA (climate change)



7.3 Sustainable Drainage

As described in PPS25, the effect of development is generally to reduce the permeability of at least part of the site due to increased areas of hardstanding. This in turn changes the site's response to rainfall and, without specific measures, the volume and rate of runoff are likely to increase. Inadequate surface water drainage arrangements in new development can increase the risk of flooding for the development and surrounding areas.

In order to minimise flooding resulting from heavy rainfall and drainage constraints, development plans must consider the runoff rates and volumes from potential development sites, as well as consulting the sewerage undertaker to determine existing capacity of the drainage network. PPS25 states that all developments or redevelopments greater than one hectare must provide a Flood Risk Assessment which considers surface water management for the development to prevent increased flood risk from surface drainage.

The Government's Water Strategies *Making Space for Water* (2005) and *Future Water* (2008) and the requirements of the Water Framework Directive require a more sustainable approach to managing surface water runoff than previously adopted. Appropriately designed, constructed and maintained SuDS are more sustainable than conventional drainage methods because they can mitigate many of the adverse effects of urban stormwater runoff on the environment. They achieve this through:

- reducing runoff rates;
- reducing the additional runoff volumes that tend to be increased as a result of urbanisation;
- encouraging natural groundwater recharge;
- reducing pollution concentrations in stormwater;
- reducing the volume of surface water runoff discharging to combined sewer systems;
- contributing to enhanced amenity and aesthetic value of developed areas;
- providing opportunities for habitat and biodiversity enhancement.

Within the Borough of King's Lynn and West Norfolk developments generally drain into conventional piped networks, either combined (foul and surface water) or surface water only (i.e. rainfall) although in some cases these discharge into Internal Drainage Board Drains and pumping is required to transfer the water to naturally draining rivers. Drainage infrastructure has the potential to cause flooding in areas when rainfall runoff exceeds the drainage capacity.

The type of land on which development is to be located dictates the amount of runoff that is permitted from development, and how it must be managed. Developments on brownfield, or developed sites, that have conventional drainage infrastructure, are permitted to discharge to the existing drainage system provided flows do not increase. It is likely that development will increase runoff and therefore the additional runoff would need to be

managed on site before being discharged into existing drains. However, the surface water runoff rate after development on greenfield, or undeveloped sites, must not be greater than the runoff rate from the undeveloped site.

The primary purpose of SuDS is to reduce flood risk and alleviate pressures on drainage systems. Where surface drainage is conveyed to combined drainage systems the use of SuDS and separate surface water systems also reduces pressures on wastewater treatment works. Furthermore, SuDS can be designed to form part of the green infrastructure network, providing additional ecological and amenity benefits.

7.3.1 The Benefit of Sustainable Drainage Systems

SuDS are designed to reduce the potential impact of new and existing development with respect to surface water drainage discharges by using more natural processes to convey surface water away from development. They do this by:

- Dealing with runoff close to where the rain falls;
- Managing potential pollution at its source now and in the future; and
- Protecting water resources from point pollution (such as accidental spills) and diffuse sources[5].

SuDS are often described in a 'management train', a series of progressively larger scale practices to manage runoff and control water quality. The management train is:

- Prevention: application at individual sites, e.g. use of rainwater harvesting;
- Source control: control of runoff at or very near to its source;
- Site control: management of water in a local area or site; and
- Regional control: management of runoff from a site or number of sites.

The philosophy of Water Framework Directive supports the use of SuDs as it:

- promotes sustainable water use based on a long-term protection of available water resources;
- Aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges; and
- Contributes to mitigating the effects of floods and droughts.

[5] CIRIA C69; *The SUDS Manual*; CIRIA 2007

Unlike conventional drainage, SuDS schemes often form part of public open space, with the potential to promote interaction between communities and their local environment, resulting in additional amenity benefits.

SuDS use two main processes to manage and control runoff from developed areas, as discussed below.

7.3.2 Infiltration SuDS

Many SuDS techniques are based on infiltration of surface water into the ground. In most cases any pollutant particles are absorbed and dissipated by vegetation. Infiltration SuDS are best suited to areas overlain by permeable soils, drift and geology.

Infiltration drainage techniques include permeable paving, soakaways, infiltration trenches, infiltration basins and swales. Areas underlain by Chalk and Glacial sand and gravel will generally be suitable for these techniques. Due to the variability of soils and geology however, site specific infiltration tests must be carried out to confirm the feasibility of infiltration drainage. In many cases, infiltration techniques provide capacity for holding back water whilst allowing infiltration to occur, and in this manner also offer storage or attenuation of rainfall runoff.

Where infiltration is into an aquifer the risk of contamination must be minimised, particularly where the groundwater is a source of public water supply. Additional measures, such as oil interceptors, may be required.

Source Protection Zones (SPZs) are used to protect groundwater resources from pollutants. In areas designated as SPZs, the location and type of discharges into the water environment are closely controlled. The level of control is most stringent close to the point of abstraction. Figure 5.4 shows the SPZs near King's Lynn and West Norfolk, and none of the proposed development sites lie within a SPZ.

7.3.3 Attenuation SuDS

Where infiltration SuDS are not feasible, either due to SPZs, soil-type or limited land availability, non-infiltration (or attenuation) techniques may be more appropriate. Green roofs, rainwater harvesting, wetlands and detention basins are examples of attenuation techniques, although the scope and impact of these can be far more limited without infiltration. These examples reduce the rate of surface water runoff by holding back peak flows, following the management train hierarchy.

Examples of a range of SuDS techniques are provided in Table 7.2 below.

Table 7.2 Examples of SuDS Techniques

SuDS technique	Description	Attenuation / Infiltration
Soakaways	Grassed trenches that store and dispose of water through infiltration	Infiltration
Permeable Paving	Paving that will permit rainwater to infiltrate into the soil or constructed layers beneath the surface	Both
Infiltration Basins	Depressions that store and dispose of water through infiltration when required during heavy rainfall events. During dry periods the basins remain dry	Both
Infiltration Trench	Vegetated strips of gently sloping ground that allow infiltration through the base and sides, as well as filtering out silt and pollutants.	Both
Filter Strips	Vegetated strips of gently sloping ground to drain water from impermeable surfaces and filter out pollutants, silt and suspended sediments.	Both
Swales	Shallow vegetated channels that conduct and/or retain water, and allow filtering of particulates through the vegetation. If unlined these features allow infiltration into the underlying ground.	Attenuation
Ponds	Permanently wet basins designed to store water and attenuate peak flows, with permanent bankside and emergent vegetation	Attenuation
Detention Basin	Dry basins designed to attenuate peak flows and store water for specific retention times	Attenuation
Wetlands	Shallow pond systems with aquatic vegetation that allow water to be stored and passed through vegetation for filtration of pollutants	Attenuation
Green Roofs	Vegetated roofs that reduce runoff volumes and rates	Attenuation

7.3.4 Local Drainage Assessment

As previously discussed, PPS25 requires all development greater than 1 ha, including redevelopment, to prepare a Surface Water Drainage Strategy (or Drainage Impact Assessment) that demonstrates sustainable management of surface water runoff in line with PPS25. This would be required of the major proposed development areas in King's Lynn, Downham Market and Hunstanton. Large sites that will potentially have a group of small housing development should also consider using integrated drainage systems.

The British Geological Survey (BGS) maps (see Figure 2.3) shows the Borough to have varying geology including Alluvium, Peat, Glacial Sand and Gravel, Glacial Till, Clay with Flints and River Terrace Deposits overlying Chalk including Red Chalk. The infiltration capacity will depend on the site specific characteristics, although generally only the areas underlain by Glacial Sand and Gravel will have a high permeability. With regard to the principal development areas:

1. King's Lynn is mainly located on estuarine alluvial deposits although on the western side of the town there are areas of glacial till, raised beach deposits and river terrace deposits.

2. Downham Market is mainly located on a mixture of clay, silt and sand

3. Hunstanton is located on the coast, on a mixture of rock types

In the areas dominated by alluvial estuarine deposits there is likely to be little scope for infiltration but there is greater scope in the western and northern parts of the Borough where the geology is more mixed. It is not appropriate at this stage to examine drainage in more detail as this requires detailed information and analysis of site specific surface permeability, rainfall runoff, and hydraulic capacity. It is recommended that such analyses are applied to specific potential development sites in a Phase 2 study.

Within the Outline Phase of the WCS it is not possible to include an analysis of the hydraulic capacity of the existing surface water systems in the absence of detailed information on the proposed developments. However, a more detailed assessment focused on the key areas identified for development should form part of the detailed Phase 2 study.

7.3.5 Adoption of SuDS

One of the biggest challenges in achieving the wider uptake of SuDs is the issue of eventual ownership of the systems and, in particular, who will maintain and repair them.

The ownership and maintenance of conventional piped drainage systems is clearly defined in Sewers for Adoption (Water Services Association, 1994). However, by their nature, many SUDS can be considered either drainage or landscape features, and there is no clear guidance on who is responsible for the operation and maintenance of such facilities.

S104 of the Water Industry Act allows for a statutory undertaker to adopt the works and vest them in the undertaker. In this case the undertaker needs to determine if the design meets operational and maintenance requirements, a standard set by Sewers for Adoption Current legislation therefore allows SuDs to be adopted only if they are legally sewers. SuDs combine amenity and environmental benefits with their drainage function, so often will not fully meet these requirements.

S106 of the Town and Country Planning Act 1990 allows a LPA to enter into a legally binding agreement of planning obligation with a land developer over a related issue. They often require developers to minimise the impact on the local community and to carry out tasks that will provide community benefits. Government thinking steers the implementation of SuDs through the planning process and advocates the grant of planning permission with or without a S106 as the vehicle for ensuring future maintenance and funding. The legislation equally provides the mechanism for this. The Town and Country Planning Act 1990 provides for financial payment to local authorities carrying out maintenance of SuDs systems. There is also provision for a local authority to carry out maintenance work themselves if there is a breach of maintenance agreement or if they are deemed to be landscape features.

Recommendation 20 of Sir Michael Pitt's Review of the Summer 2007 floods (final report published December 2008) was for the Government to resolve the issue of which organisations should be responsible for the ownership and maintenance of sustainable drainage systems. The Government responded in support of this recommendation and interim advice has been that it is intended that local authorities should be responsible for adopting and maintaining new build (and re-developed) SuDS on highways and in the local realm.

Where there is a requirement to implement SuDs, the local planning authority has two routes available to ensure that the SuDs are properly implemented and maintained. These are:

1. Through an agreement under S106
2. By a condition of planning permission

Where the development is larger or the SuDs scheme complex, the S106 approach would be used. The S106 route requires negotiations and legal preparatory work in advance of the development taking place, but offers more security as it may only be varied by agreement. It also allows for financial contributions in the form of a bond or a periodic payment.

There are alternative methods as to whether the maintenance agreement is included as part of the S106 agreement or is stand alone (discretion of the LPA). The choice is governed by the degree of control the LPA would like to have over the maintenance issues - greater control maintenance framework as part of S106.

It is essential that the ownership and responsibility for maintenance of every SuDS element is clear; the scope for dispute kept to a minimum; and durable, long-term accountable arrangements made, such as management companies. Where the surface water system is provided solely to serve any particular development, the construction and ongoing maintenance costs should be fully funded by the developer. S106 agreements may be appropriate to secure this.

Authorities may wish to consider entering into an agreement under S106 to ensure the developer carriers out the necessary works and that future maintenance commitments are met. They may also apply planning conditions which would require completion of the necessary works before the rest of the development can proceed.

7.3.6 Recommendations

A specific assessment of ground conditions is needed to determine the most appropriate SuDS for use at the new development. SuDS must be designed so that no flooding occurs at properties in the 1 in 100 year storm event (1% annual probability), including a 30% increase in rainfall to allow for the impacts of climate change. Priority should be given to SuDS over more traditional drainage systems, and if SuDS are not considered appropriate then justification must be given. Wherever possible, SuDS solutions should be integrated into the development so as to provide additional community and amenity benefits.

All new developments, including redevelopments, should aim to direct surface water runoff into infiltration schemes or nearby watercourses/ surface water systems that discharge to rivers directly. By using separate surface water sewers, the risk of urban flooding and exceedance of foul sewers will be avoided.

A decision to implement SuDS should consider a number of factors including:

- Permeability of the soils and drift;
- Proximity of groundwater abstractions to SPZs;
- Availability of land take;
- Surrounding land use;
- Site gradients;
- Ecology;
- Green infrastructure (considered in detail in Section 8);
- Economic viability; and,
- Safety issues and maintenance.

Where redevelopment takes place this provides a potential opportunity for renegotiation of limits to drainage rates into sewers; the Core Strategy could include a statement to this effect. The sewerage undertaker (AWS) will not necessarily permit drainage at existing rates for redeveloped sites, and this may be a particular issue in the King's Lynn area.

For developments in close proximity and limited land space, proposals to use offsite attenuation to serve more than one development should be considered. Developers should work together with the Environment Agency, sewerage undertakers and local planning authorities during the design of the surface water drainage for a particular site.

Adoption of SuDS can be a difficult process, as the sewerage undertakers can't always adopt them under current legislation. Failure to maintain SuDS to the required level could potentially lead to flooding issues. For local authorities to adopt, a funding mechanism is required usually through commuted sums from developers. A Maintenance Plan is usually required under section 106 of the Town and Country Planning Act 1990. It is recommended in the Phase 2 Water Cycle Study that further investigation is undertaken into procedures for SuDS adoption.

7.4 Internal Drainage Board Activities

The Internal Drainage Boards in the study area were consulted to identify potential constraints on development related to their surface water drainage operations. Feedback was received from King's Lynn Internal Drainage Board as follows:

The King's Lynn Internal Drainage Board is undertaking an ongoing study of the catchment served by the Pierpoint & Middleton Stop Drains, that flow to Pierpoint Pumping Station which is likely to include the employment expansion at Hardwick Industrial Estate and the two housing sites to the north-east. This study has established points/areas where there are existing drainage difficulties and is continuing to look at possible ways in which these could be improved. There may be certain issues with the discharge of surface water from these sites, but the Board is looking at ways this can hopefully be improved.

The possible employment expansion at North Lynn, adjacent to the River Ouse, and the housing site at approximate grid reference 563400,321200 both fall within the North Lynn Pumping Station catchment. Although the Board indicated that it is difficult to comment in detail at this stage given the lack of information about likely development areas and outfall positions and discharge rates, they do not believe there will be significant surface water disposal issues for these sites.

Of the other major potential housing sites within King's Lynn, the Board indicated that although the sites are believed to be adjacent to Board maintained drains it appears unlikely that they would result in significant increases to impermeable areas and direct discharges, and therefore they should not result in drainage problems.

The Board indicated that their comments are preliminary in nature and comments could not be made at present on many of the smaller sites. They indicated that they can provide further information to inform a more detailed assessment in the Detailed Phase once more details are available on the development sites.

7.5 Interaction with Neighbouring Council Areas

Fluvial flood risk may be affected by housing growth in upstream catchments in the River Wissey, Ely Ouse and Bedford Ouse catchments including the major growth areas of Cambridge and Milton Keynes if changes in land use and surface drainage change the shape of the flood hydrographs. Flood related issues in the upstream catchments have been considered in separate SFRA and WCS studies which will encourage development to have limited impact on downstream risk of flooding following the requirements to PPS25. Impacts from upstream should, therefore, be limited.

As King's Lynn is at the coastal boundary of the river system housing development and provision of waste water infrastructure does not impact on flood risk in neighbouring council areas.

7.6 Flood Risk and Drainage: Interim Conclusion

Q. Is Flood Risk and Drainage a Constraint to Growth in the Study Area?

The Phase 1 WCS has used the outcomes of the SFRA prepared for the Borough by Faber Maunsells in 2008. Using the flood zones (including an allowance for climate change) produced in this report, it has been determined that the majority of the development sites (91 out of the 118 sites) are located beyond the floodplain and are therefore not constrained by flood risk from the identified fluvial or tidal sources. However, 27 of the sites are at flood risk and further assessment will be required to manage this risk.

Surface drainage issues are unlikely to constrain housing growth as long as they are taken into account within the planning and design process. PPS25 requires all development greater than 1 ha to prepare a Surface Water Drainage Strategy (or Drainage Impact Assessment) that demonstrates sustainable management of surface water runoff in line with PPS25. This would be required of the major proposed development areas in King's Lynn, Downham Market and Hunstanton. Large sites that will potentially have a group of small housing development should also consider using integrated drainage systems. The type of land on which development is to be located dictates the amount of runoff that is permitted from development, and how it must be managed. Developments on brownfield, or developed sites, that have conventional drainage infrastructure, are permitted to discharge to the existing drainage system provided flows do not increase. It is likely that development will increase runoff and therefore the additional runoff would need to be managed on site before being discharged into existing drains. However, the surface water runoff rate after development on greenfield, or undeveloped sites, must not be greater than the runoff rate from the undeveloped site.

A high-level assessment of the geology in the Borough indicates there may be the potential for infiltration SuDS techniques to manage drainage. In other areas, attenuation options may still be a viable drainage solution and surface water drainage is not considered a constraint to growth in the Borough.