4. Flooding and Drainage

4.1 Background

The relevance of flood risk and drainage to planning in the borough of King's Lynn and West Norfolk has been considered in previous studies including:

- Bullen Consultants (2003) Level 1 Strategic Flood Risk Assessment;
- Faber Maunsell (2008) Revised Level 1 Strategic Flood Risk Assessment;
- Entec (2010) Level 1 Strategic Flood Risk Assessment Addendum;
- Entec (2009) Outline Water Cycle Study.

This report aims not to repeat assessments already carried out, but to reinforce the findings and draw out aspects of flood risk relevant to the Water Cycle Study. The SFRA reports should be referred to for more detail of borough-wide flood risks.

4.2 Flood Risk and Development

4.2.1 Overview

The Strategic Flood Risk Assessment reports, as well as the Environment Agency mapping, identify the areas of the borough that are at risk of flooding from rivers and the sea. The Environment Agency's maps identify the extent of Flood Zone 2 (0.1 % annual probability of occurrence) and Flood Zone 3 (1 % annual probability for fluvial and 0.5% annual probability for tidal), with the remaining area being classed as Flood Zone 1. Mapping presented within the SFRA updates the EA Flood Zones and is used throughout this report to identify level of flood risk across the Borough. The EA and the Council have prepared a protocol stating that the SFRA climate change flood zones should be used to apply the Sequential Test to new development. The protocol can be found on the Council's website at this address: http://www.west-norfolk.gov.uk/pdf/Strategic%20Flood%20Risk%20Assessment%20KingsLynn%20Protocol.pdf.

According to the sequential test process described in *Planning Policy Statement 25: Development and Flood Risk* (PPS25), allocation sites in Flood Zone 1 should be considered for development first. If there is not sufficient capacity available in Flood Zone 1, then development in Flood Zones 2 and 3 can be considered. However this should take account of the land use and flood zone 'compatibility' defined in PPS25. PPS25 specifies appropriate land uses in each flood zone, based on the 'vulnerability' of the land uses. The vulnerability classifications and flood zone compatibilities from PPS25 are reproduced in Appendix B. Residential development is classed as 'more vulnerable', and is permitted in Flood Zones 1 and 2 under PPS25. Residential development can only be located in Flood Zone 3 if the Exception Test (see Appendix B) can be passed. The Exception Test has the following components:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission' stage the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

- The development should be on developable previously developed land or if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land;

- A Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The Addendum to the Level 1 SFRA (Entec, 2010) reviewed the policy recommendations for sustainable development in the Borough, and determined that although potentially at a high risk of flooding, the redevelopment of the urban area of King's Lynn is considered necessary to deliver the wider sustainability objectives benefiting the local community and therefore could be considered to outweigh the risk of flooding. Proposed developments that are 'more vulnerable' and located within Flood Zone 3 in the town of King's Lynn will need to demonstrate that the development contributes to the regeneration objectives of the town in order to meet Part A of the Exception Test.

Flood risks from other sources (i.e. from groundwater, surface water run-off and sewers) are discussed briefly in the Phase 1 Water Cycle Study report. Groundwater flooding is possible but is not considered to constrain spatial development. Basement dwellings should take account of potential groundwater flooding. Surface water drainage in the study area is controlled by either surface water drains/ watercourses or combined sewers. Furthermore King's Lynn contains numerous CSOs that discharge via tide locked gates into the River Great Ouse. Anglian Water has reported a number of sewer flooding incidents reflecting some capacity issues in the network and surface water flooding is identified as an issue in the Level 1 SFRA. These are discussed in more detail in Section 4.3 and Section 4.4.

4.2.2 Mitigation Requirements for Fluvial and Tidal Flood Risks

To satisfy Part C of the Exception Test, a Flood Risk Assessment will be required to be prepared with any development application within Flood Zone 3. To ensure that development located in Flood Zone 3 or areas of rapid inundation[4] will be safe without increasing flood risk elsewhere and where possible reduce flood risk overall, recommendations have been made in the Level 1 SFRA Addendum for flood mitigation in this zone (with a focus on King's Lynn town). These recommendations are presented in Table 4.1. Figure 4.1 illustrates the recommended land use types across the borough, and can also be used to highlight where the recommendations of Table 4.1 must be applied in order for development to be permitted.

[4] As defined in the Level 1 SFRA (Faber Maunsell, 2008). Includes areas at risk of flooding with depth greater than 0.25 m and velocity greater than 0.5 m/s.

Table 4.1 Policy Suggestions for Development in King's Lynn Town within Flood Zone 3 (Including Flood Zone 3a with an Allowance for the Potential Impacts of Climate Change)

Recommendations	
1.	The development must pass the requirements of the PPS25 Sequential Test and where necessary the Exception Test (as indicated by Table D.3 of PPS25). To pass part (a) of the Exception Test the application must demonstrate that the development meets the sustainability and regeneration objectives of King's Lynn town, as set out in Chapter 4 of the Level 2 SFRA;
2	Development in all areas of Flood Zone 3 should be for the replacement and redevelopment of existing buildings with no increase in building footprint, unless it can be reasonably demonstrated that the design reduces flood risk through physical measures:
3	Development should include SuDS to reduce surface water runoff where possible;
4	Finished ground floor levels should be raised with at least 300 mm freeboard above the 1% Annual Probability plus climate change predicted flood level[5];
5	The developer should identify safe escape and access routes in the event of a flood to an area wholly outside the floodplain; and
6	Developments should sign up to the Environment Agency's Floodline Warnings Direct Service.

It is recommended that in line with the Floods and Water Management Act a Local Flood Risk Management Strategy is prepared, to further identify mitigation measures, funding streams for developments to be flood resistant and resilient, flood evacuation procedures and mechanisms to communicate the strategy to the local community.

4.2.3 Site-Specific Considerations of Fluvial and Tidal Flood Risks

The Phase 1 WCS (Entec, 2009) identified 27 potential housing sites located in either Flood Zones 2 or 3 (associated with either tidal or fluvial flooding). Figure 4.2 shows the locations of these sites in relation to the flood zones (including an allowance for climate change) in more detail. Based on the mapping in Figure 4.2, and the vulnerability classifications of PPS25, the land uses appropriate to each of the 27 proposed development sites are presented in Table 4.2. Table 4.2 and Figure 4.2 also show where the Exception Test would need to be passed in order for residential development to be permitted.

[5] As advised by the Environment Agency at the time of planning application

Table 4.2 Appropriate Land Uses for Development Sites with a Risk of Flooding

Site no.	Name	Grid Reference	Flood Zone*	Maximum Recommended Vulnerability of Land Use	Residential Development Appropriate?
1	King's Lynn	561678 32021	T3	More vulnerable (with E/T**)	Only with exception test
2	King's Lynn	562228 31903	T3+Hazard	More vulnerable (with E/T)	Only with exception test
3	King's Lynn	561923 31852	T3+Hazard	More vulnerable (with E/T)	Only with exception test
4	King's Lynn	561464 31859	T3+Hazard	More vulnerable (with E/T)	Only with exception test
5	King's Lynn	561904 31952	T3	More vulnerable (with E/T)	Only with exception test
6	King's Lynn	561929 31972	T3	More vulnerable (with E/T)	Only with exception test
7	King's Lynn	560686 31950	T3	More vulnerable (with E/T)	Only with exception test
8	King's Lynn	561124 32027	T3	More vulnerable (with E/T)	Only with exception test
9	King's Lynn	561380 31979	T3	More vulnerable (with E/T)	Only with exception test
10	King's Lynn	561969 32061	T3	More vulnerable (with E/T)	Only with exception test
11	Downham Mkt	560000 30300	T3+Hazard	More vulnerable (with E/T)	Only with exception test
12	Downham Mkt	560611 30304	T3+Hazard	More vulnerable (with E/T)	Only with exception test
13	Villages S -	558862 31992	T3+Hazard	More vulnerable (with E/T)	Only with exception test
14	King's Lynn	563411 32177	T2	Highly vulnerable (with E/T)	Y
15	King's Lynn	561911 32073	T2	Highly vulnerable (with E/T)	Y
16	King's Lynn	562152 32092	T2	Highly vulnerable (with E/T)	Y
17	King's Lynn	562060 31923	T2	Highly vulnerable (with E/T)	Y
18	King's Lynn	562434 31961	T2	Highly vulnerable (with E/T)	Y
19	King's Lynn	561882 31933	T2	Highly vulnerable (with E/T)	Y
20	King's Lynn	562150 31917	T2	Highly vulnerable (with E/T)	Y
21	King's Lynn	561931 32042	T2	Highly vulnerable (with E/T)	Y
22	King's Lynn	561886 32040	T2	Highly vulnerable (with E/T)	Y
23	Downham Mkt	560266 30295	T2	Highly vulnerable (with E/T)	Y
24	Terrington S	554026 31954	T2	Highly vulnerable (with E/T)	Y
25	Villages S -	548700 31300	T2	Highly vulnerable (with E/T)	Y
26	King's Lynn	563193 32133	F3	More vulnerable (with E/T)	Only with exception test
27	King's Lynn		F3	More vulnerable (with E/T)	Only with exception test

* T3= tidal flood zone 3; T2 = tidal flood zone 2; F3 = fluvial flood zone 3
** E/T = Exception Test

4.3 Surface Water Management

4.3.1 Overview

The Level 1 SFRA (Faber Maunsell, 2008) and Phase 1 WCS (Entec, 2009) identified surface water flooding incidents as being an issue in King's Lynn, particularly in the past five years. Within the Borough, 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 (see Section 4.3.3). A further complexity in King's Lynn exists in the presence of locked outfalls through the tidal flood defences into the Great Ouse.

The Phase 1 WCS reviewed information provided by Anglian Water on potential capacity issues in the drainage and sewer network. The information provided indicated that a number of flooding incidents have been reported in King's Lynn, Hunstanton and Downham Market, with the majority of the recorded incidents occurring in King's Lynn. The records show that almost all incidents were a result of blockages, highlighting the importance of maintenance in drainage infrastructure management. Anglian Water is addressing these incidents as part of their maintenance and Asset Management Planning programme. Any new developments need to ensure that there is sufficient capacity in the existing systems, and must limit the discharge into drainage networks through the use of sustainable drainage systems (SuDS).

The Level 1 Strategic Flood Risk Assessment (Bullens, 2005 and Faber Maunsell, 2008) identified surface water as one of the key mechanisms of flooding in the study area, via:

- Exceedance of pumped drainage capacity in areas with no natural drainage;
- 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.

The proposed development in King's Lynn as part of its Growth Point status provides a unique opportunity to review the existing drainage arrangements and to plan and deliver more sustainable solutions to managing surface water in the settlement. It is recommended that all new developments are served by separate surface water and foul water drainage systems to alleviate capacity issues in the sewer network. The redevelopment of brownfield sites must separate any combined drainage systems into surface water and foul water drainage. Section 4.2.6 discusses the capacity of Internal Drainage Board drains that might be used to discharge surface water run-off from new and redeveloped sites in the study area, and highlights areas where constraints in the drainage network exist.

A Surface Water Management Plan (SWMP) should be prepared in order to build on the work done in the first phases of the SFRA and WCS and to provide the vehicle for local organisations to develop a shared understanding of local surface water flood risk in line with Anglian Water's planned improvements. This will include setting out priorities for action, maintenance needs and links to the LDF and emerging plans.

The SWMP can be used to coordinate and strategically plan the drainage provision where piecemeal actions would be inefficient and do not support consistent ownership and maintenance regimes for SuDS (see further discussions in Section 4.4). Furthermore, through new development, there are opportunities to reduce existing surface water flood risk.

The Floods and Water Management Act (2010) sets out a duty for lead local flood authorities to establish and maintain a register of assets that will have a significant impact on flood risk. The Flood Risk Regulations (2009) require that flood risk and flood hazard maps in areas of significant risk are produced. A SWMP would also contribute to these tasks, by contributing to development of an asset register capturing information on the relevant assets, their ownership and condition, and through mapping surface water flood risk and associated flood hazard.

4.3.2 Surface Water Management Plan

Defra's guidance on preparing SWMPs shows the process to comprise of four stages: Preparation; Risk Assessment; Options; Implementation and Review. Based on the issues local to King's Lynn and the recent republication of the SWMP guidance, the work envisaged for the four SWMP stages is outlined in Box 4.1.

Box 4.1 Proposals for King's Lynn Surface Water Management Plan

Preparation

This stage should involve a number of project meetings to establish a partnership, identify stakeholders and scope the objectives of the SWMP.

Establish Partnership and Engagement Plan. Continuation of the WCS Steering Group (Borough Council, Environment Agency and Anglian Water) with additional bodies steering the project, for example the County Council and the King's Lynn Internal Drainage Board. Preparation of a stakeholder engagement plan to define:

- Each partner's role and responsibility,
- Data management procedures,
- Identification of additional stakeholders, and
- The level of engagement and communication methods.

Data Collation and Review. Collation and review of data held from the SFRA and WCS projects, updated information from Anglian Water, the Borough Council, the Environment Agency and the IDB and identification of data gaps.

Scope SWMP. Partner group to establish aims, objectives and timetable of the study based on realistic project milestones and aligned with other development and investment plans. Identify and confirm the level of assessment to be completed for the settlement. It is anticipated that a Detailed Assessment should be prepared for the town, in line with the SWMP guidance (see Table 4.3 below).

Box 4.1 (continued) Proposals for King's Lynn Surface Water Management Plan

Risk Assessment

It is envisaged that the Preparation Stage will identify the need for a Detailed Assessment of flood risks form surface water. Once confirmed this Risk Assessment stage should select the preferred modelling approach to deliver the detailed assessment:

Select modelling approach in agreement with all Partners on the steering group. It is recommended that a "drainage model" approach is considered for the King's Lynn SWMP, although it is recognised that choosing the modelling approach is an iterative process and will be confirmed during the development of the SWMP.

Quantify current and future flood risk. The modelling should be used to:

- Understand current annualised damages from surface water flooding;
- Understand how damages may change due to urban creep/climate change/urbanisation;
- Understand where new development can contribute to reducing existing surface flood risk;
- Test mitigation measures;
- Understand the impacts of surface water runoff on existing water quality.

Map flood risk. Outputs from the modelling to be mapped to inform the understanding of risk and flood hazard, understand the surface water flow pathways and to inform the spatial planning process.

Communicate flood risk to the identified stakeholders, including the local community.

Identify responsibility for maintenance of surface water drainage features.

Options

Using the outputs from preceding stages, options to reduce surface water flood risk in the short, medium and long term should be identified. The outcomes of this stage will be to agree on the preferred options for managing surface water.

Identify and Assess Options. This stage involves identification and assessment of options, based on a multi criteria analysis to ensure economic, social and environmental benefits are balanced to deliver sustainable solutions for storm water management. Section 4.2 has identified that infiltration SuDS would be suitable in King's Lynn and should be considered during this stage of the SWMP.

Develop and Test Options. Calculate annual average damages for current and future scenarios, and take account of carbon footprint of each option.

Implementation and Review

This final stage will inform the action plan for managing surface water flood risk, and should inform a Local Flood Risk Management Strategy. This is required to be prepared by the lead local flood authority to develop, maintain (which includes updating and reviewing), apply, and monitor the application of, a strategy for local flood risk in their area, as set out in the Floods and Water Management Act (April 2010).

Action Plan to be developed covering:

- Capital and maintenance actions and programmes of work for each partner/stakeholder;
- Advice and information to local authorities planners;
- Advice and information to local resilience forums and emergency planners;
- A communication strategy to disseminate the findings of the plan to all stakeholders;
- A programme of work or follow up actions, and;
- A reference to when the plan will be reviewed and updated.

Implement and Review Action Plan. The SWMP will require sign off from all partners to ensure the plan is in line with the original objectives set out in the first Preparation stage. The plan should include set review periods.

Table 4.3 Suggested Level of SWMP Assessment for King's Lynn, based on Defra Guidance

Level of Assessment	Appropriate Scale	Outputs	When this Approach would be Adopted
DETAILED To understand the detailed causes and impacts of flooding and design solutions	Small town (e.g. King's Lynn)	Detailed assessment of the causes and consequences of flooding, which can be used to understand the flooding and test mitigation measures (this is achieved through modelling of surface and sub-surface drainage systems)	Where the locations at higher risk of surface water flooding are already known (e.g. through recent flood incidents or level 2 SFRA) OR Where an intermediate assessment identifies the need for the detailed assessment

4.3.3 Internal Drainage Board Infrastructure

The Internal Drainage Boards operating within the Borough of King's Lynn (Downham Group, Middle Level Commissioners, Water Management Alliance) were consulted to identify drainage issues related to housing growth (meeting held on the 16 July 2009). Key issues for maintenance of the IDB system in relation to growth are identified in this section.

Downham Market (Downham Group of IDBs)

The Downham Group of IDBs operate the surface drainage system around Downham Market. The system is gravity drained and discharges to the Flood Relief Channel.

To the north of town in the vicinity of Fairfield Road, the system drains beneath the King's Lynn railway line through a pipe with limited capacity (see Figure 4.1). As a result engineering would be required to increase the capacity if additional flows result from housing development in this area. Attenuation of discharge from the proposed development is therefore considered essential. Engineering work to increase flow under the railway line would require consent from Network Rail which has proved difficult in the past and may therefore delay the development work. IDB discharges to the Flood Relief Channel are consented by the Environment Agency so increased discharges also would require modification to the consent. A similar pipe beneath the railway line to the south of the town and further north have similar capacity issues.

Hunstanton (WMA)

The Water Management Alliance operates the internal drainage system around Hunstanton which drains discharge directly to the sea by gravity. There are no major drainage issues in the area. Area 2a is preferred because it is in closer proximity to existing IDB drains.

Wisbech (Middle Level Commissioners)

The Middle Level Commissioners operate the internal drainage system around Wisbech. There is a major scheme planned to upgrade drainage to the west of the town (£10-12M) involving the replacement of pumping stations and channel improvements. This takes into account planned development in the area.

Area 2 is preferred to Area 1 as the latter is not well connected to the drainage system. Additional work to develop connections and upgrade drains is a time consuming process particularly where drains cross major roads such as the A47.

King's Lynn (WMA and the Downham Group)

The Water Management Alliance operates the internal drainage system in the central area and north of King's Lynn and the Downham Group operates the system on the southern outskirts of the town and to the south.

WMA Managed Area

In Scenario Area 3 improvements to the channel may be required to take drainage water to North Lynn pumping station. Improving connection between private drains and the IDB system may also be required. Sufficient capacity is available at this pump to receive additional flows.

Some of the system links in to Victorian culverts in the town some of which are thought to be in poor condition although ownership of these drains is in some cases uncertain.

Development of a connector drain along the line of the old railway is being considered to take the pressure off the Horsey drain.

Additional storage is planned in the Gaywood Valley to attenuate flows. The land was purchased 3-4 years ago and a £0.5M bid has been approved for development of the area.

For Scenario Area 2 some attenuation of flows may be required. The capacity of Black Drain also needs to be assessed in more detail including the siphon under the Gaywood River.

The channel leading to Pierpoint Pumping station is at capacity and there is little scope for improvement because of the building around the channel. There is a pinchpoint where the Middleton Drain and Pierpoint drains meet. Development in the catchment south of the town centre may therefore be constrained if it leads to increased runoff. This includes work to increase the size of the Queen Elizabeth Way and commercial development in the area. Attenuation of flows would therefore be required to accommodate development in this area.

The NORA development work may also affect flooding in this area.

Downham Group Managed Area

To the south of King's Lynn the original course of the Nar to the Ouse has been infilled. The Puny drain takes flows from the south of King's Lynn to the Flood Relief Channel via the Puny Pumping Station that takes water across the railway line. This pumping station has not been designed to take additional flows from urban areas (Areas 4 and 5). Attenuation would therefore need to be incorporated into the development plans. Soakaways are not an option as the land is impermeable. To upgrade the system improvements to the channel and pumping station and channel would be required (with an estimated cost of £10M). Developer contributions might therefore be considered to prevent delays to the developments.

Attenuation would need to be incorporated into development plans of major investment required to take additional flows from the south.

Figure 4.1 Drainage Issues in Downham Market

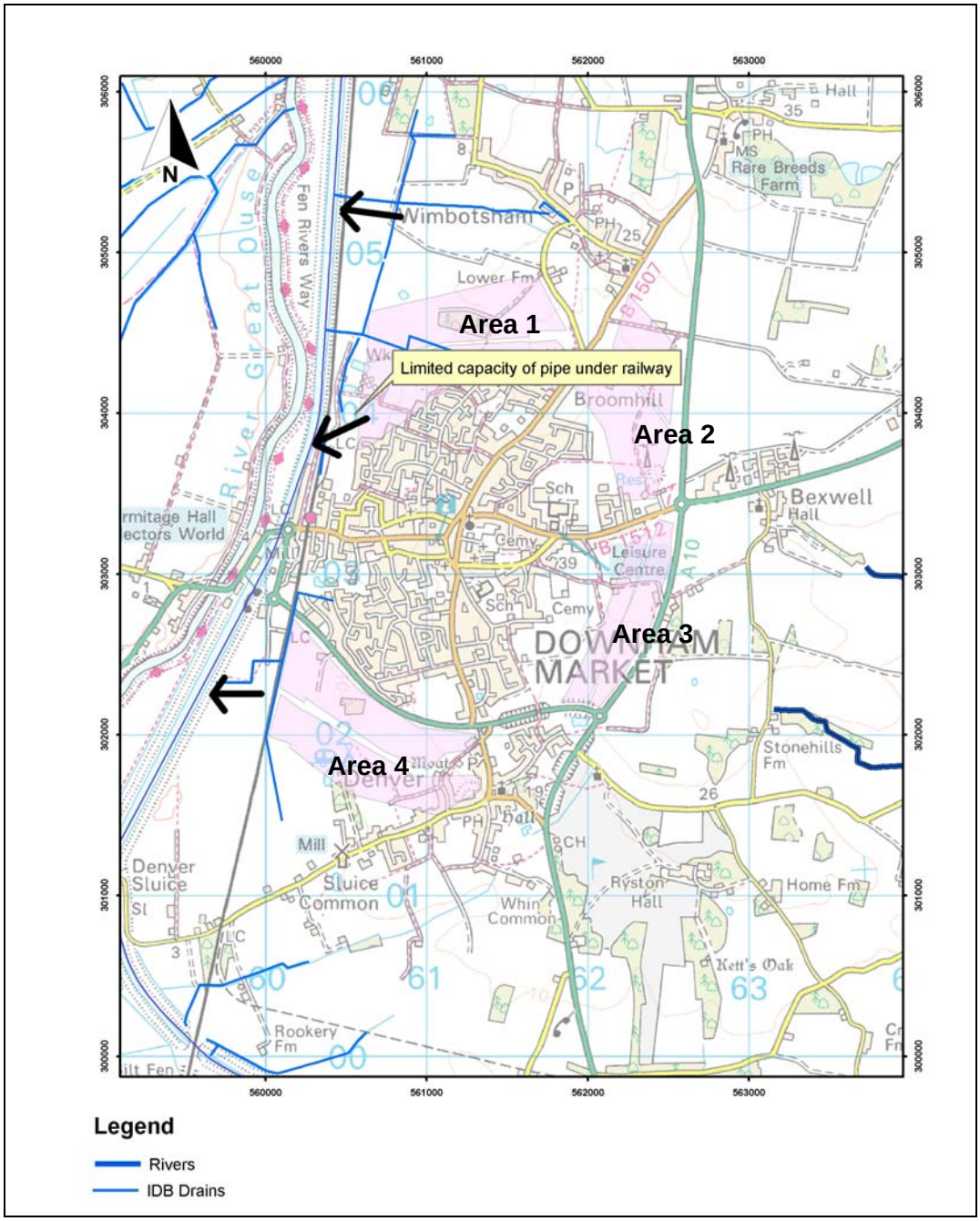
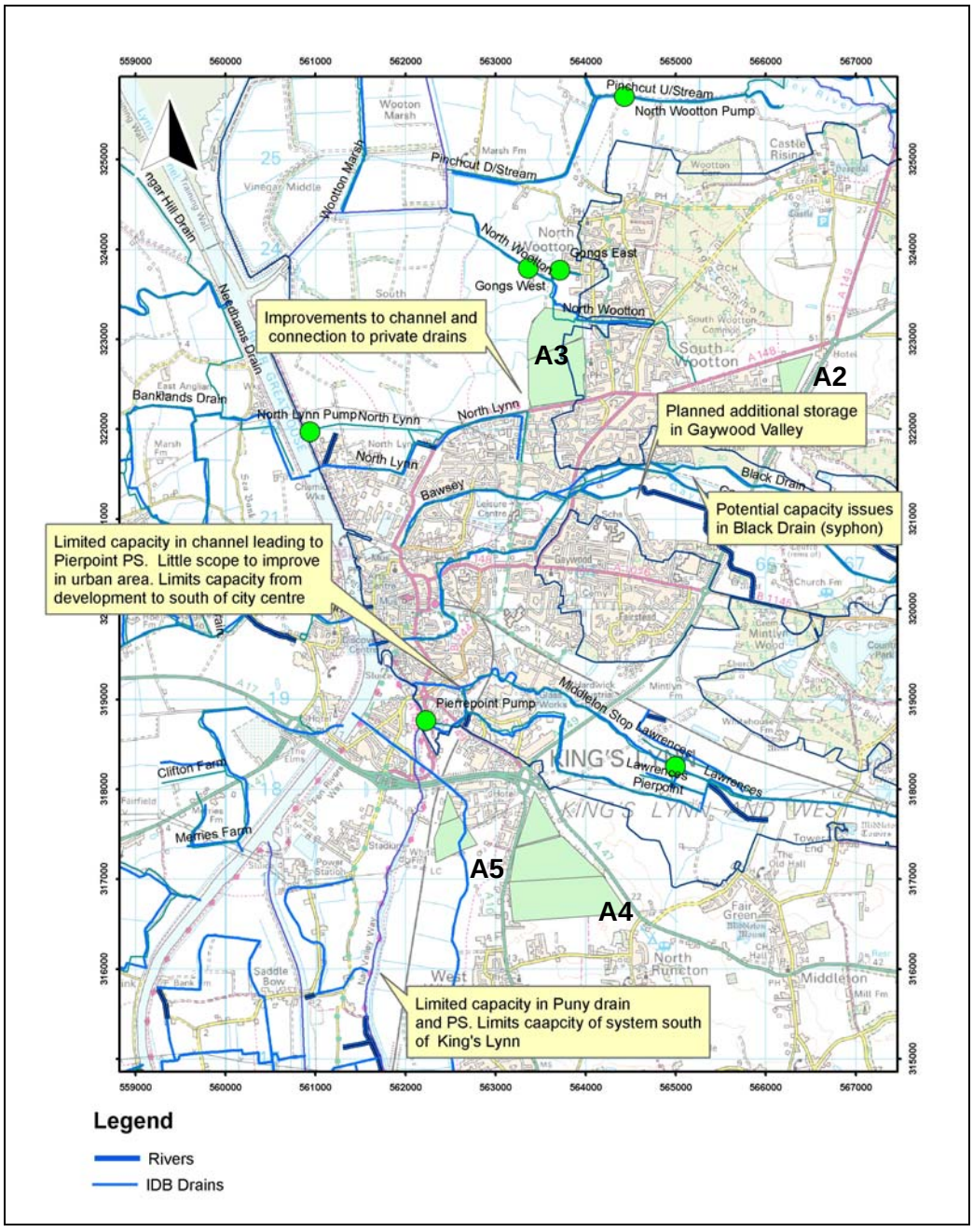


Figure 4.2 Drainage Issues in King's Lynn



4.3.4 IDB Infrastructure Requirements

The key infrastructure requirements identified by the IDBs in relation to growth are listed in Table 4.4.

Table 4.4 Key IDB Infrastructure Requirements

Area	Growth Scenario	Required Infrastructure
Downham Market	1	Increase in capacity of culvert beneath railway to increase discharge to Flood Relief Channel
Downham Market	4	Increase in capacity of culvert beneath railway to increase discharge to Flood Relief Channel
King's Lynn	A4, A5	Increase to channel and pumping station in Puny Drain

These capacity improvements will be required ahead of development in the areas listed, in order to facilitate the separation of surface water drainage from foul/ combined sewers. Attenuation of surface water as part of the drainage and SuDS strategy for developments in Downham Market and King's Lynn will be particularly important; to prevent any increased run-off entering IDB drains and exacerbating existing capacity issues.

4.4 Sustainable Drainage

4.4.1 Identification of SuDS Potential

An assessment of the Sustainable Drainage (SuDS) potential for each site has been carried out, and is presented in Appendix C. The assessment identifies areas where infiltration SuDS may be appropriate, based on the geology. Where BGS mapping indicates that the underlying geology will be permeable, such as Chalk, then SuDS techniques utilizing infiltration should be used in the first instance as they aid in groundwater recharge and will reduce the attenuation requirements by disposing of flows directly into the ground rather than discharging to a surface water sewer or watercourse. The following points should be noted when using infiltration based SuDS:

- Infiltration SuDS should not be used in areas where there is contaminated land due to the risk of pollution to groundwater;
- Care should be taken to ensure that pollutants are removed before entering the infiltration systems otherwise there is a risk that contaminants could enter groundwater;
- Onsite testing should be undertaken at detailed design stage as per the requirements of BRE digest 365, Soakaway design. This will confirm the onsite infiltration rates, which will inform the design of the attenuation storage;
- Infiltration techniques are generally not suitable for areas within source protection zones. However, none of the growth areas in the borough are within source protection areas, and as such there should be no hindrance posed by this.

The SuDS assessment concluded that infiltration based SuDS techniques may not be suitable Wisbech or the majority of King's Lynn, since the underlying geology is noted as containing clay and will hinder drainage. It is advised that infiltration testing should be undertaken for any sites in these areas at detailed design stage to confirm whether local conditions do make them suitable for infiltration based SuDS techniques, which would still be preferable to attenuation-based SuDS features if possible. Appendix C includes a summary of different SuDS

techniques that may be suitable across the borough, and provides further detail of which types are appropriate in each growth area.

4.4.2 SuDS Adoption

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. Without a formal maintenance and adoption regime there is a risk that SuDS can increase the risk of flooding by becoming eroded or outlets becoming blocked. This can also increase the risk that environmental quality standards are not met, if SuDS are poorly maintained, as they may not operate correctly and allow pollutants to enter the watercourse that they are draining to.

The issue of adoption has been a limiting issue affecting the uptake of SuDS in the past. Recommendation 20 of The Pitt Review (The Cabinet Office, 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.

Further clarity has now been provided by the Flood and Water Management Act 2010, which includes Schedule 3: Sustainable Drainage. The Act requires developers to include sustainable drainage, where practicable, in new developments, and for them to be built to standards which reduce flood damage and improve water quality. Procedures for the approval of SuDS by the relevant body are set out. The Act also amends Section 106 of the Water Industry Act 1991, by making the right to connect surface water run-off to public sewers conditional on meeting the new standards. It gives responsibility for approving sustainable drainage systems in new development, and adopting and maintaining them where they affect more than one property, to a SuDS Approving Body (SAB), generally the Lead Local Flood Authorities. The SAB will be a statutory consultee on the planning process to approve drainage systems in new developments and redevelopments, before construction can commence.

This is a strong step forward in promoting the uptake of SuDS. To ensure that SuDS are constructed to a suitable standard by developers, a financial bond is proposed prior to works commencing on a site. On satisfactory completion of the SuDS the bond will be returned. This is similar to current arrangements for adopted surface water sewers and highways. It is envisaged that these measures will simplify the process in promoting the adoption of SuDS features.

As discussed in Section 4.3.2, the adoption of SuDS can be further addressed through a SWMP, which will encourage partnership working and clarify roles.

4.4.3 Linking SuDS and Wider Green Infrastructure

While the type of SuDS that will be appropriate varies both between and within developments, those types that also provide multiple benefits such as biodiversity and recreation should be promoted. These types of SuDS can provide a tie-in to Green Infrastructure. For example, ponds and wetlands used in SuDS can clearly contribute as areas of new habitat, while green attenuation areas can be designed to provide recreational space in parks outside times of flooding. The Phase 1 WCS report outlined how different types of SuDS could be designed

sympathetically to ensure the greatest benefit for habitats and green infrastructure. The development of SuDS should take in to account the surrounding environment to ensure that it is in keeping with the habitat and landscape.

The King's Lynn Green Infrastructure study (Entec, 2009) identifies a number of priority areas where improvements could be made to Green Infrastructure (GI). Those which are most likely to be relevant to SuDS development include the creation of high quality urban landscape within King's Lynn town centre, and creating GI for the proposed urban extensions in King's Lynn and Hunstanton. However combined approaches to designing SuDS within the GI framework should also be considered more widely across the borough.

The GI study proposes a number of policies with clear tie-ins to SuDS, and other policies that are also relevant to SuDS, including:

- Where opportunities arise for GI development, provision should be designed and enhanced to accommodate a variety of complementary functions;
- To encourage the development of green roofs, and other innovative solutions, upon new and existing buildings;
- Further opportunities to support the enhancement of ground maintenance services and private landowners should be considered in relation to greenspaces. Site management plans should be created which state how maintenance will be achieved, by whom, and how this will be funded in the future. These bespoke management plans for individual sites should also identify opportunities for volunteers' involvement in maintenance activities. Exploring methods by which to ring fence planning contributions towards maintenance in order to support a more focused neighbourhood approach to the upkeep of GI will also be key to ensuring such activities can be delivered;
- Encourage the use of greenspace with new development as a means of managing flooding risk, both through slowing surface runoff and in providing flood attenuation zones. Incorporate SuDS, including reedbeds and other natural filtration systems, as a mechanism for managing floods while creating new habitats and green corridors.

These GI policies should be used to inform good practice in the placing, design and management of SuDS and should also be considered as a method for climate change adaptation/ mitigation and for improving water quality in line with WFD legislation.

4.4.4 SuDS Strategy

In order to implement the requirements of PPS25 and the Flood and Water Management Act 2010, it is recommended that a SuDS policy should be adopted for King's Lynn. This should encourage the use of SuDS and provide guidance as to their standards and design. A suggested SuDS policy is presented in Box 4.2.

Box 4.2 Draft SuDS Policy
All development should include appropriate sustainable drainage systems (SuDS) for the disposal of surface water, in order to avoid any increase in flood risk or adverse impact on water quality.
For brownfield developments, SuDS features shall be required so as to achieve a reduction from the existing runoff rate but must at least result in no net additional increase in runoff rates.
SuDS features should normally be provided on-site. If this cannot be achieved, then more strategic forms of SuDS may be appropriate. In such circumstances, developers will need to contribute toward the costs of provision via Section 106 Agreements or the strategic tariff. In all cases, applicants will need to demonstrate that acceptable management arrangements are funded and in place so that these areas are well maintained in future.
SuDS should be sensitively designed and located to promote improved bio-diversity, an enhanced landscape and good quality spaces that improve public amenities in the area.

4.5 Climate Change Predictions

In 2009, the UKCP09 climate change scenarios were released[6], which replace UKCIP02 as the most recent climate predictions for the UK. The climate predictions include consideration of temperature, rainfall and sea level rise, amongst other variables. The predicted changes in rainfall and sea level rise are directly relevant for understanding how flood risk may change in King's Lynn district in the future.

Recommended climate change allowances with regards to flood risk were presented in PPS25, and are now used as standard in assessments of flood risk. The PPS25 climate change allowances were based on UKCIP02 scenarios (Defra 2002). The UKCP09 predictions and PPS25 allowances have been compared, to ensure that sufficient allowance is being made for climate change in assessments of flood risk in the borough, based on the most recent predictions. A summary of relevant PPS25 recommended allowances is presented in Table 4.5.

Table 4.5 Recommended Allowances for Climate Change from PPS25

	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%	+20%	+20%
Sea level rise (East of England)	4.0 mm/yr	8.5 mm/yr	12.0 mm/yr	15.0 mm/yr
Extreme wave height	+5%	+5%	+10%	+10%

Summarised from Tables B1 and B2 of PPS25

[6] All data are freely available from http://ukclimateprojections.defra.gov.uk

Table 4.6 Changes in Maximum Annual 1 Day on Land Rainfall Intensity: UKCP09 Medium Emissions Scenario

Location	Observed	2080s Prediction (mm)	2080s Prediction (% of Observed)
Coltishall (closest location reported)	35mm	38mm (32 – 46mm)*	+9% (-8% to 31%)*

Summarised from UKCP09 "Weather Generator Report"
* Values in brackets represent the 10 and 90 percentile probability outcomes

Table 4.7 Relative Increases in Sea Level from 1990 at King's Lynn

Probability	Medium Emissions Scenario	High Emissions Scenario
50 percentile (i.e. the median prediction)	0.37 m to 2080, 0.48 m to 2100	0.44m to 2080, 0.57m to 2100
95 percentile (i.e. a worse-case prediction)	0.56 m to 2080, 0.74 m to 2100	0.68 m to 2080, 0.90m to 2100

UKCP09 outputs for cell 20443 at King's Lynn, downloaded from http://ukclimateprojections-ui.defra.gov.uk

Tidal Flood Risk

Table 4.8 shows that sea level rise projections from UKCP09 in the vicinity of King's Lynn by the 2080s are similar to the allowance required by PPS25 (0.68m compared to 0.70 m). This suggests that the PPS25 allowance may be adequate, pending future Defra guidance and amendments to the policy. UKCP09 does not produce wettest day rainfall projections for marine regions so it is not possible currently to make a comparison with the PPS25 allowance.

It should be noted that PPS25 was reissued in April 2010 with some changes, but that no changes were made to the climate change allowances as a result of UKCP09. On a strategic scale therefore the PPS25 allowances should continue to be used, although site-specific studies should be recommended to make use of UKCP09.

Table 4.8 Comparison of PPS25 and UKCP09 Marine Climate Change Allowances for 2080s

Variable	PPS25 Allowance	UKCP09 95%ile High Emissions[a]
Sea level rise (m from 1990)[b]	0.70m[c]	0.68m[b]
Rainfall intensity (% increase in intensity)	+ 30%	-

[a] Precautionary approach representing a worse-case outcome of the high emissions scenario, to provide consistency with the precautionary approach of PPS25
[b] PPS25 prediction for East of England, UKCP prediction for King's Lynn, cell 20443
[c] Converted from the mm/yr values presented in PPS25

Fluvial and Pluvial Flood Risks

The climate change allowances in PPS25 are based on the worst case scenarios from UKCIP02, which predicted that by 2085 there could be a 30% increase in rainfall intensity. When compared to the rainfall intensity predictions in Table 4.6, this shows that UKCP09 is also predicting up to around a 30% increase in rainfall

intensity by the 2080s. The PPS25 allowances for climate change in the assessment of surface water flood risk are therefore considered still to be applicable.

UKCP09 itself does not include assessments of river flows, and the translation of the UKCP09 scenarios in to river flows has not yet been completed. Therefore for the time being, and since the rainfall intensity predictions have remained similar, it is reasonable to assume that the PPS25 allowances are still valid.

Within King's Lynn, much of the existing drainage and CSOs are discharged to the Tidal Great Ouse through tide locked outfalls. Predicted sea level rise projections have the potential to increase the frequency at which the tidal outfalls are locked, which would restrict discharges of rainfall run-off during that time, whilst predicted increases in rainfall indicate that during the winter months, increased rainfall run-off might be anticipated. The combination of these potential climate change impacts could therefore result in increased surface water flood risk. Future planning of the sewerage and drainage infrastructure should take this issue into account. The separation of existing combined systems into separate surface water and foul drainage, together with the preparation of a SWMP and Local Flood Risk Management Strategy, are essential starting points in considering this issue for King's Lynn.

4.6 Summary and Conclusions

4.6.1 Fluvial and Tidal Flood Risk and Development

The Addendum to the Level 1 Strategic Flood Risk Assessment for King's Lynn completed by Entec in April 2010 and modified in October 2010 determined that redevelopment of the urban area of King's Lynn is considered necessary to deliver wider sustainability benefits to the community which could be considered to outweigh risks to flooding. Residential developments proposed in Flood Zone 3 will need to demonstrate that the development contributes to the regeneration objectives of the town in order to meet Part A of the Exception Test of PPS25.

Detailed Flood Risk Assessments will be required for all applications within Flood Zone 3 and these will need to show that the development will be safe without increasing flood risk elsewhere, and where possible reduce flood risk overall. Policy recommendations have been made for all development in Zone 3 in King's Lynn Town to help ensure this requirement is met.

It is recommended that in line with the Floods and Water Management Act a Local Flood Risk Management Strategy is prepared, to further identify mitigation measures, funding streams for developments to be flood resistant and resilient, flood evacuation procedures and mechanisms to communicate the strategy to the local community.

27 development sites were identified as located within Flood Zones 2 or 3. Those in Flood Zone 3 (15 sites) will require the Exception Test of PPS25 to be passed in order for residential development to be permitted.

4.6.2 Surface Water Management

A number of recent historic flooding incidents have been reported in King's Lynn, Hunstanton and Downham Market, and almost all were a result of blockages, highlighting the importance of maintenance in drainage

infrastructure management. The Level 1 Strategic Flood Risk Assessment (Bullens, 2005 and Faber Maunsell, 2008) identified surface water as one of the key mechanisms of flooding in the study area.

New developments need to ensure that there is sufficient capacity in the existing surface water drainage systems, and must limit the discharge into drainage networks through the use of sustainable drainage systems (SuDS).

All new developments must be served by separate surface water and foul water drainage systems. The redevelopment of brownfield sites must separate any combined drainage systems into surface water and foul water drainage. It is recommended that this requirement is included as a local planning policy.

It is recommended that a Surface Water Management Plan (SWMP) is prepared in order to build on the work done in the SFRA and WCS and to provide the vehicle for local organisations to develop a shared understanding of local surface water flood risk in line with Anglian Water's planned improvements. The status of King's Lynn as a Growth Point could provide a unique opportunity to review the existing drainage arrangements and to plan and deliver strategic and sustainable solutions to managing surface water in the settlement. The SWMP would satisfy new requirements under the Floods and Water Management Act and the Flood Risk Regulations to establish a register of assets that will impact on flood risk, and to produce flood risk and flood hazard maps.

A structure for developing the Surface Water management Plan for King's Lynn has been presented.

4.6.3 Internal Drainage Board Infrastructure

Limited hydraulic capacity in the Internal Drainage Board drainage system is a significant issue in Downham Market and the southern part of King's Lynn. In some cases options to improve the system are not available or will require significant investment. This favours growth options away from the southern part of King's Lynn. In Downham Market all of the spatial options have similar hydraulic capacity issues and it is therefore critical that development is carried out in a way that does not increase surface water drainage into the IDB system (i.e. with a focus on SuDS). Attenuation of run-off will be critical in areas where the capacity of IDB drains has been identified as a constraint, for example in Downham Market and parts of King's Lynn.

4.6.4 Sustainable Drainage

An assessment of the potential to incorporate infiltration Sustainable Urban Drainage (SuDS) for each development site was carried out. The clay dominated geology in the Wisbech area and the majority of King's Lynn which means that potential for these techniques may be limited in these areas; infiltration tests will be required at each site to confirm this.

The Flood and Water Management Act adds clarity to the requirements for developers to include sustainable drainage where practicable, to meet standards which reduce flood damage and improve water quality. The right to connect to the public sewer is now conditional on meeting those standards.

A Surface Water Management Plan will help to provide a strategic plan for SuDS across the study area, which will encourage partnership working and clarify roles.

A Draft SuDS Policy to be adopted by the Council is presented (Section 4.4.4).

4.6.5 Climate Change

The assessment showed that for the King's Lynn study area climate change projections from the recent UKCP09 work indicated similar increases in rainfall intensities by the 2080s to the allowances required by PPS25 in flood risk assessment. Projections for sea level rise were also similar, suggesting that the PPS25 allowances may still be valid, and the re issue of PPS25 in April 2010 did not incorporate changes to the climate change allowances.