Northstowe
Phase 1 Planning Application

Environmental Statement
Technical Appendix H: Flood Risk Assessment

February 2012

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Northstowe

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1 Introduction

1.1 BACKGROUND

1.1.1 WSP Property and Development (WSP) was commissioned by Gallagher to carry out a PPS25 Flood Risk Assessment (FRA) and foul and surface water drainage strategy to support an outline planning application for Phase 1 of the proposed new town of Northstowe. The FRA assesses issues of flooding affecting the site and covers the Environment Agency's published Flood Maps, anecdotal flooding information, and detailed hydraulic modelling work undertaken by both the Environment Agency and WSP. The report also summarises the results of previous work and recent discussions with the Environment Agency, the Swavesey Internal Drainage Board, the Old West Internal Drainage Board and South Cambridgeshire District Council

1.2 SITE PLANNING HISTORY AND CURRENT APPROACH

1.2.1 In 2007 a Planning Application for 9,500 residential units and associated infrastructure was submitted, hereafter referred to as the primary development site. This set of planning documents contained a Flood Risk assessment and a sustainable water management strategy for the entire town. The principles of the flood mitigation strategy and surface water drainage strategy were agreed with all the parties although there were a number of points of detail that the counsultees were looking for clarification.

1.2.2 The current planning strategy is to produce a site wide Development Framework Document (DFD) for the whole town and then an outline planning application for the Phase 1 Development located adjacent to the B1050.

1.2.3 The Development Framework covers the whole of Northstowe as defined in the Northstowe Area Action Plan (AAP). The Framework will be supported by a set of drainage principles agreed as part of the previous Planning Application and are summarised in Section 3. A plan showing the Development Framework area is shown in Appendix F.

1.2.4 This Flood Risk Assessment provides a more detailed assessment for the Phase 1 Development Planning Application area in terms of flood risk and drainage issues. The Phase 1 Development Application area is shown in Figure 1 in Appendix A.

1.3 CURRENT PLANNING APPLICATION – PHASE 1

1.3.1 Outline planning application for Phase 1 of Northstowe comprises:

- Up to 1,500 dwellings; a primary school;
- mixed-use local centre (including a community building, and provision for non-residential institutions, financial and professional services, shops, cafes and restaurants, drinking establishments, and hot food takeaways);
- leisure, community, residential institutions, cultural, health, and employment provision (business, general industry and storage & distribution) including a household recycling centre;
- formal and informal recreational space and landscaped areas;
- infrastructure works including site re-profiling and associated drainage works, foul and surface water pumping stations, two flood attenuation ponds on land east of Hattons Road; and
- associated works including the demolition of existing buildings and structures.

1.3.2 The land use schedule for Phase 1 is shown in Table 1.1 below.

Table 1.1: Land use schedule

Land Use	Area (ha)
Residential	42
Community / local centre	1.22
Employment & recycling centre	5
Primary school	3
Sports hub	6.17
Public open space / parks / play space	23
Allotments	1.57
Other land (including streets & water bodies)	40.04
Total	**122**

1.4 REPORT STRUCTURE

1.4.1 This report will take the form of a formal Flood Risk Assessment in accordance with the Environment Agency's FRA Guidance Note 3: Development in Flood Zones 3 and 2 (Excluding Minor Extensions) and Annexe E of PPS25. Refer to Appendix B.

1.4.2 The report outlines a preliminary surface water drainage strategy for the site, as this is a requirement of 'Planning Policy Statement Note 25: Development and Flood Risk' (PPS25) and Environment Agency guidance. This is because of the effects a new development can have on catchment-wide flooding if surface water run-off is not controlled adequately.

1.4.3 The report also outlines a foul drainage strategy for the disposal of sewage both within the site and from the eventual sewerage treatment works. This strategy has been included within this report because of the historical flooding issues downstream of Uttons Drove STW.

1.5 PHASE 1 AND ITS CONTEXT TO NORTHSTOWE

1.5.1 A Development Framework Document (DFD), including a Framework Master Plan has been prepared which refreshes the master plan for Northstowe and provides place making principles and guidance for individual phases of development. The DFD defines the rationale and structure for Northstowe's planning and delivery as a comprehensive development enabling Phase 1 to come forward as part of an integrated whole.

1.5.2 The spatial planning and urban design principles of the framework master plan are founded on the vision, development principles and policies of the Northstowe Area Action Plan (NAAP, July 2007). Given the passage of time since the NAAP was adopted, the DFD takes into account more recent and emerging changes in national and local planning policy and the impact of current and likely future economic events to ensure that the master plan is future proofed and remains relevant.

1.5.3 As a consequence, the master plan and development principles for Northstowe have been strengthened and brought up-to-date to ensure a viable scheme for creating a sustainable community. The new town is to be built to high standards of design and

layout within a framework of green infrastructure comprising formal and informal open space and wildlife habitat corridors.

2 Background

2.1 PREVIOUS PROPOSALS

2.1.1 In December 2007 a Planning Application was submitted for a new town of 9500 dwellings. Supporting this Planning Application was a Flood Risk Assessment which pulled together technical work undertaken in the previous years as part of the Drainage and Flooding Technical Group. This technical group includes representatives of the Environment Agency, South Cambridgeshire District Council, Swavesey IDB, Old West IDB, Anglian Water and the Developer Consortium.

2.1.2 The Technical Liaison Group developed, discussed and approved strategies for the site which informed:

- The local policies (discussed below)
- The Master plan for the town
- The Planning Application material

2.1.3 This required a number of technical work streams covering

- The proposed mitigation for Longstanton and Oakington
- Options for the management of surface water drainage
- The operation of the water park with the pumping stations, the flood bund and the telemetry systems.
- The disposal of treated sewage effluent from Uttons Drove STW.

2.1.4 These items are discussed in more detail in section 3 but this work has formed the framework for the Planning Application for phase 1.

2.2 NATIONAL POLICY BACKGROUND

2.2.1 The Government's sustainable development strategy makes it a requirement to assess appropriate forms of development for areas at risk of flooding. This is to avoid an unnecessary increase in the requirement for flood defences.

2.2.2 The Environment Agency's Flood Map shows that the overall Northstowe Development area is primarily located within Flood Zones 1 (low probability of flooding), with some areas falling within Flood Zone 3 (high probability of flooding). However, the Flood Zone 3 extent is an undefended scenario and as such, this 1 in 100 year flooding extent would only occur if the existing defences were not present. It is therefore considered as an existing residual risk of flooding in the 1 in 100 year event should the defences in this area fail.

2.2.3 The area shown as defended Flood Zone 3 is located to the south west of the site covering approximately 30% of the Phase 1 area.

2.2.4 Table D.2 in Annex D of PPS25 gives the flood risk vulnerability classification of development proposals of housing and a school as 'More Vulnerable'. Therefore according to PPS25 the proposals are appropriate for development within Flood Zone 1,2 and 3, subject to satisfying the Sequential Test.

2.2.5 A requirement of PPS25 is that developers making planning applications for sites that are potentially at risk of flooding should consult with the Environment Agency and, where appropriate, produce a Flood Risk Assessment for their proposals.

2.2.6 PPS25 states that sites situated in Flood Zone 1 are suitable for all forms of development including 'More Vulnerable' uses such as residential development.

2.3 SEQUENTIAL AND EXCEPTION TEST

2.3.1 The Sequential Test described in PPS25 gives preference to locating new development in Flood Zone 1. The site is predominantly located within Flood Zone 1. However; there is a residual risk of flooding in the 1 in 100 year event (Flood Zone 3) if local defences were to fail.

2.3.2 The location and principle of the Framework site has been tested as part of a Core Strategy and the Northstowe Area Action Plan AAP and therefore the site is deemed to have passed both the sequential and exception tests. This issue was addressed fully as part of the Northstowe Development Area Planning Application.

2.3.3 The distribution of land uses within the Phase 1 site has been developed following a sequential approach with more vulnerable development located away from sources of flood risk, and less vulnerable development such as the water park located in the higher flood risk areas.

2.4 DEVELOPMENT CONTROL POLICIES DEVELOPMENT PLAN DOCUMENT (DCP DPD)

2.4.1 The DCP DPD (adopted July 2007) includes a number of objectives and policies that have an impact on flood risk.

POLICY DP/1 Sustainable Development: "Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development, as appropriate to its location, scale and form." It should make efficient and effective use of land by giving priority to the use of brownfield sites and achieve adaptable, compact forms of development through the use of higher densities;

- Where practicable, minimise use of energy and resources;
- Incorporate water conservation measures;
- Minimise flood risk;
- Where practicable, use sustainable drainage systems (SUDS);
- Mitigate against the impacts of climate change on development through the location, form and design of buildings;
- Ensure no unacceptable adverse impact on land, air and water;
- Conserve and wherever possible enhance biodiversity of both wildlife and the natural environment.

2.4.2 POLICY NE/9 Water and Drainage Infrastructure: "Planning permission will not be granted where there is inadequate water supply, sewerage or land drainage systems (including water sources, water and sewage treatment works) available to meet the demands of the development unless there is an agreed phasing agreement between the developer and the relevant service provider to ensure the provision of the necessary infrastructure."

2.4.3 POLICY NE/11 Flood Risk: "In relation to flood risk, applications for planning permission will be judged against national policy (currently in PPS25)."

2.4.4 POLICY NE/12 Water Conservation: “Development must incorporate all practicable water conservation measures. All development proposals greater than 1,000 m^2 or 10 dwellings will be required to submit a Water Conservation Strategy prior to the commencement of the development to demonstrate how this is to be achieved.” A separate Water Conservation Report has been prepared and submitted as part of the Planning Application.

2.4.5 Paragraph 7.47 refers to SUDS and state “it is preferable to manage surface water runoff through the use of Sustainable Drainage Systems as they provide environmental, biodiversity and aesthetic benefits. SUDS may take the form of swales, lagoons, permeable paving, green roofs and sensitively re-engineered channels or reed beds, depending on the nature of the development and the area.”

2.4.6 The above policies have been revisited as part of this application through the Flood Risk Assessment process, and Water Strategy. The development minimises on-site flood risk, reduces flood risk to existing off-site conurbations, incorporates water conservation measures, SUDS, takes into account climate change and therefore complies with the above policies.

2.5 NORTHSTOWE AREA ACTION PLAN

2.5.1 Chapter D11 ‘An Integrated Water Strategy’ of the Northstowe Area Action Plan (NAAP), which was adopted in July 2007, sets out the requirements for the provision of strategic flood risk management, drainage and water supply infrastructure that should be considered as part of the Northstowe development proposals. The main objectives with regard to flood risk are:

- Ensure that the development will not be at risk of flooding either from itself or surrounding watercourses, for up to the 1 in 100 year event including the forecast effects of climate change.
- Not increase the flood risk to surrounding properties and communities, particularly Oakington and Longstanton, or downstream areas.
- Mitigate current flood risk affecting Oakington and Longstanton village.

2.5.2 The other objectives refer to maintaining the natural catchments; maintaining the Fen-edge character of the surrounding area; ensuring a net increase of biodiversity; appropriate surface and foul water systems; use of SUDS and water minimisation, conservation and recycling.

2.5.3 POLICY NS/21 for Land Drainage, Water Conservation, Foul Drainage and Sewage Disposal sets out the requirement for the use of SUDS and the release of surface water run-off into the surrounding water courses at Greenfield rates such that there is no risk of untreated sewage discharge or increased flood risk from treated waste water. All flood mitigation measures should make allowance for the forecast effects of climate change. If practicable, such measures will take the opportunity to mitigate the existing flood risk to Oakington and Longstanton by providing balancing ponds.

2.5.4 The above policies are addressed and complied with in this FRA and the Sustainable Water Management Strategy.

2.6 SOUTH CAMBRIDGESHIRE DISTRICT COUNCIL AND CAMBRIDGE CITY COUNCIL LEVEL 1 STRATEGIC FLOOD RISK ASSESSMENT (SEPTEMBER 2010)

2.6.1 The principal aim of the Strategic Flood Risk Assessment (SFRA) is to set out flood risk constraints to help inform the preparation of the Local Development Framework (LDF) documents. The objective is to provide a detailed and robust assessment of the extent and nature of the risk of flooding in the areas of South Cambridgeshire District Council which are likely to accommodate significant growth in the next plan period (to 2016).

2.6.2 The Northstowe Development area has been categorised into Flood Risk Zones in accordance with Planning Policy Statement 25: 'Development and Flood Risk' (PPS25).

2.6.3 The SFRA has assessed the flood risk associated with the watercourses either crossing or adjacent to the site. These are the Cottenham Lode, Long Lane Drain, Brookfield Farm Drain Rampton Road Drain, Station Road Drain, Reynolds Drove (1st Public Drain A-B, Rampton), and Barracks Drain. The SFRA confirms that the Northstowe Development Area lies in a defenced Flood Zone 1. Refer to SFRA drawings in Appendix K, these drawings show the current flood risk and the predicted flood risk by the year 2055.

2.6.4 Parts of the villages of Oakington and Longstanton flooded during the October 2001 event. The Oakington flooding came from Cottenham Lode, the 8th Public drain and Oakington Brook, while the flooding in Longstanton came from Longstanton Brook. Although the development of Northstowe would increase impermeable areas, run-off from the development will be controlled such that the development of Northstowe will benefit the catchment of the watercourses of Oakington, Longstanton and surrounding areas.

2.6.5 The SFRA provides the following guidelines:

- Wherever possible, finished floor levels should be situated a minimum of 300mm above the 1 in 100 year plus climate change flood level, determined as an outcome of the site based FRA. A minimum of 600mm above the 1 in 100 year flood level should be adopted if no specific climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard'.
- The location of Source Protection Zones in the study area should be taken into consideration when considering the application of SUDS.
- A flood defence scheme for Oakington, is still a long term aspiration of the Environment Agency, however the viability of any such scheme will be dependent on the development proposals for Northstowe.
- This area served by Uttons Drove STW has been identified as a growth area in the Local Development Framework and has seen new development in recent years such as at Cambourne, with more development expected in the medium to long term such as at Northstowe. The Uttons Drove sewage treatment works, which discharges into the Uttons Drove drain, was identified by Anglian Water as the treatment facility best suited for improvement in order to receive the increased effluent associated with any new development in this area.

3 Northstowe Framework and Supporting Flooding and Drainage Strategies

3.1 KEY PRINCIPLES SUPPORTING THE NORTHSTOWE DEVELOPMENT AREA

3.1.1 This report relates to the issues associated with the delivery of Phase 1 of Northstowe. The strategies associated with the delivery for Phase 1 are part of the wider strategies for the whole of Northstowe.

3.1.2 Proposals for the whole of Northstowe are defined in the development framework document. This document contains a number of overarching strategies and principles, the strategies relating to the flood risk and drainage are summarised below:

Flood Risk Mitigation to Oakington and Longstanton

3.1.3 Flood Storage is being proposed upstream of Longstanton Brook, to the south of the Northstowe Development Area. These ponds will mitigate the flood risk to Longstanton. Details of the scheme and the benefits provided are discussed in detail in Section 9.3 of this report.

3.1.4 Additional flood storage is being proposed upstream of Oakington on the Oakington Brook, as part of a later phase of development. These ponds will mitigate to flood risk to Oakington, details of the mitigation proposals will be submitted with the relevant phase

3.1.5 Flood mitigation will be provided to the catchments downstream of the site by the implementation of the water park and the proposed control mechanisms. Part of the waterpark will be constructed as part of the Phase 1 Application.

Flood Risk to the Phase 1 Development Area.

3.1.6 A small section of the site is shown as being at risk of flooding from the Beck Brook / Cottenham Lode. Work undertaken as part of the original approved application has found that this risk is minimal due to the presence of existing defences.

3.1.7 Development across this site will be sited sequentially that is placing the lower vulnerability land uses, the water park, in the higher risk area and placing more vulnerable residential development in lower risk areas.

3.1.8 The site proposals will place development buildings above the flood level associated with a 1 in 100 plus climate change (20%) events. The development is therefore located within Flood Zone 1 having a less than 1 in 1000 annual probability of river flooding in any year (<0.1%)

The Proposed Drainage Strategy

3.1.9 The Framework Plan can be split into two distinct areas

- The core site as set out in the NAAP
- The potential reserve land

3.1.10 The drainage strategy for the core site will all eventually drain to the water park and discharge to the Beck Brook and Cottenham Lode. This discharge will be pumped at a time when the Cottenham Lode is not in flood and therefore not increase the flood risk downstream. The Expansion land will drain towards the Swavesey Drain or will be managed at source.

3.1.11 The water park has two strategic attenuation areas connected by an open channel each attenuated area will contain a pumping station. These areas can be delivered in phases as the development grows.

3.1.12 Additional surface water attenuation will be provided adjacent to the old airfield road, these facilities will control the runoff from the development that would naturally drain through Oakington and then pump it back to the water park.

3.1.13 The development proposals include the creation of a large bund to form a reservoir on site. This bund ensures the run-off from the site can be managed to reduce the risk downstream but also to prevent the external flood risk affecting the site. A plan showing the principles of the strategy can be found in Appendix H.

Off-Site Telemetry

3.1.14 The flood flow and levels in the Beck Brook and Cottenham Lode will be monitored using a series of new gauging stations. These systems will be integrated into both the pump control systems on the site and the stakeholders monitoring systems to allow discharge from the site to have a wider benefit to the surrounding communities.

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4 Requirements of the Flood Risk Assessment

4.1 REPORT STRUCTURE

4.1.1 PPS25 – Development and Flood Risk, Annex E and Flood Risk Assessment Guidance Note 3: Development in Flood Zones 3 and 2 (Excluding Minor Extensions), sets out the requirements of a Flood Risk Assessment. Refer to Appendix B.

4.1.2 The guidance specifies that the report shall contain the following:

- Location Plan – see Appendix A and Section 5 of this report.
- Level Plan – see Appendix E and Section 6.
- Details of existing flood alleviation measures – see Section 9.
- Sources of Flooding – see Section 7.
- Flood Plan – see Section 8.
- Structures influencing Local Hydraulics – see Section 11.
- Flood Probabilities – see Section 12.
- Flood Progress – see Section 14.
- Sewer Hydraulics – see Section 10.
- Flood Volume Displaced – see Section 15.
- Impact of Displaced Water – see Section 16.
- Climate Change Impacts – see Section 17.
- Flood Defence Residual Risk Assessment – see Section 18.

4.1.3 The following paragraphs address each of the above points referring to the relevant paragraph in PPS25, Annex E, and FRA Guidance Note 3.

4.1.4 A preliminary sustainable drainage strategy (SUDS) is outlined in Section 10 of this report.

5 Site Location

5.1 SITE LOCATION

5.1.1 The Northstowe development area is located within South Cambridgeshire District, approximately 10km to the north west of Cambridge; the development area extends around the eastern side of the existing village of Longstanton and to the north of the village of Oakington. The Phase 1 Application area is located within the northern section of the overall site to the north east of Longstanton. The Cambridgeshire Guided Busway (CGB) forms the eastern boundary, with the B1050 and Longstanton Village forming the western boundary.

5.1.2 The Phase 1 Application boundary includes an area southwest of Longstanton which will accommodate the attenuation basins downstream of the site.

5.1.3 Refer to Location Plan Figure 1 in Appendix A.

5.2 SITE AREA

5.2.1 The site covers a total area of approximately 122ha (of which 25ha forms the attenuation basins at Hatton's Road away from the primary development site). Areas within the site boundary include a combination of existing grazing land with wooded scrub areas and a golf course.

5.2.2 The two parcels of land to the southwest of Longstanton are adjacent to Hatton's Road. The Longstanton Brook effectively flows through these areas.

5.3 WATERCOURSES

5.3.1 There are no significant watercourses within the residential area, a number of drainage ditches are present across the site which are the responsibility of their riparian owners, SCDC and the Old West Internal Drainage Board. These ditches flow from south west to north east across the Phase 1 area to the tributaries of the Cottenham Lode/Beck Brook, itself a tributary of the Old West River.

5.3.2 The areas surrounding the site, including the existing settlement of Longstanton, are drained to two main river catchments: Swavesey Drain/Longstanton Brook catchment and the Cottenham Lode catchment including the Beck Brook, Oakington Brook and their awarded watercourse catchments.

5.3.3 The site will naturally drain away from the existing villages and into the Cottenham Lode catchment, via both the Reynolds Drain/Reynolds Ditch and the Beck Brook through existing culverts under the CGB, maintaining the existing catchments where they do not drain through Longstanton and Willingham.

5.4 GROUND CONDITIONS AND HYDROGEOLOGY

5.4.1 The geology underlying the site is a mixture of River Terrace Deposits, Alluvium and Clay defined as Secondary Aquifer (River Terrace Deposits) and Unproductive Strata (Ampthill and Kimmeridge).

5.4.2 Groundwater levels were initially monitored for a twelve month period between June 2002 and June 2003. A second larger study was conducted from 2006 to 2007. The results show that the geology of the Northstowe development area creates perched groundwater tables and shallow aquifers. The groundwater level within the Phase 1 development area has a typical range of between 0.2m – 1.0m below ground level (bgl).

Refer to Appendix L for borehole location information and details of the maximum groundwater levels across the site shown on WSP Drawing 2951/SK/007 in Appendix L.

5.4.3 The geological strata that overlays the clay has relatively mixed properties and permeability which result in groundwater levels increasing in the winter and not being able to flow away freely. This groundwater drainage regime results in the groundwater levels increasing quickly in the winter and only dropping slowly in the summer. The Kimmeridge Clay layer underlying the site is almost impermeable.

5.4.4 Owing to the topography of the site and the cohesive soil the aquifer under this section is almost self-contained. The River Terrace aquifer across the western part of the site is part of a wider aquifer. There are no major excavations within this aquifer and that any filling of the development areas are designed to facilitate falls away from the existing village of Longstanton towards the water park. It is the intention that the development will utilise greenways to recreate the existing drains to channel water into the water park. This means that if the development has the impact of lowering the groundwater level within the site, the impact to the surrounding area should not be significant. Great care will be taken around the site boundaries to ensure there is no adverse impact. The design of the drainage strategy will ensure that the impact on existing ground and surface water abstractions, base flows within retained land drainage ditches and groundwater fed surface water features will be minimal.

6 Level Plan

6.1 SITE LEVELS

6.1.1 The overall topography of the site is of existing gently falling ground, with levels ranging from approximately 8.0mAOD to the west of the site, to approximately 5.5mAOD to the east towards the CGB route.

6.1.2 Topographical survey information undertaken in 2011 for the site can be found in WSP Drawing 1768/XS/01 in Appendix E.

6.1.3 The development will require existing ground levels to be raised, to provide suitable drainage falls and flood mitigation across Phase 1. Table 6.1 below sets out the volume of material required and the proposed source of fill. More earthworks details can be found in Appendix M, in Drawing 2951/D/03 in Appendix J and in Drawing 2951/D/02 in Appendix H.

Table 6.1: Earthworks cut and fill strategy

	Cut (m^3)	Fill (m^3)
Excavate Main Pond	104,000	
Excavate Minor Pond	6,000	
Excavate Greenway A	23,000	4,000
Construct Secondary Bund		10,000
Development North Of Greenway A	28,000	79,000
Western Half Of Development Between Greenways A & B		56,000
Greenway B	8,000	4,300
Excavate Material From Hatton's Road Attenuation Ponds	215,000	
Remaining Development Between Greenways A & B	18,800	186,500
Development South Of Greenway B		59,300
Total	402,800	399,100

6.2 HATTONS ROAD FLOOD MITIGATION FOR LONGSTANTON

6.2.1 The existing bed levels of the Longstanton Brook along the reach adjacent to Hatton's Road in the location of the proposed attenuation areas range between approximately 8.68mAOD (downstream) to 11.75mAOD (upstream).

6.2.2 The existing ground levels in this location are between approximately 10.2m to 11.8mAOD and 13.0m to 14.6mAOD for the downstream and upstream attenuation areas respectively.

7 Sources of Flooding

7.1 FLUVIAL FLOODING BACKGROUND

7.1.1 Despite several flooding occasions in the vicinity of the site over the last 40-50 years, the site is not known to have flooded in the past except to a shallow level at the lowest part of the site nearest Reynolds Drain.

7.1.2 The Phase 1 site currently drains through Longstanton and to the Reynolds Drains. A number of technical studies have been undertaken on the surrounding watercourse. The one most applicable to the Phase 1 site is the Cottenham Lode / Beck Brook model. This model indicates that the site is protected by flood defences, but if these defences were removed the site may flood.

7.1.3 The following paragraphs summarise flood risk in the wider Northstowe development area:

Longstanton

7.1.4 Longstanton is located to the west of Phase 1, situated on the edge of the fens. The village is affected by flooding, primarily as a result of insufficient capacity of the culverts through the urbanised area. Downstream of the site, both the Beck Brook and the Swavesey Drain will flow through flood embankments where they enter the flat fen land. The watercourses draining away from the site are currently at capacity.

7.1.5 The principal cause of flooding in Longstanton is the Longstanton Brook because culverts throughout the village are not large enough to pass the flood flows for extreme events over a 1 in 25 year event. This is the normal situation for the majority of watercourses in the country. The lack of capacity has been exacerbated historically by a lack of maintenance which may be a factor causing flooding.

Oakington

7.1.6 After the significant flooding that occurred in Oakington (to the south) and to a lesser extent in Longstanton during October 2001 the Environment Agency commissioned Halcrow Group Limited to undertake an assessment of the flood risk on the Cottenham Lode System. The study area for Halcrow's assessment included Oakington and Girton but did not include Longstanton, although this catchment has been assessed by WSP and more recently by Faber Maunsell. The findings of this study are summarised in the report entitled 'Cottenham Lode Flood Alleviation Scheme, Pre-feasibility Report' (Halcrow Group Limited, February 2003).

Swavesey Drain

7.1.7 The Webbs Hole Sluice is located in the Longstanton Brook/Swavesey Drain catchment. The key function of Webbs Hole Sluice is to discharge flows to the Great River Ouse as quickly as possible; however during high water level conditions in the Great River Ouse the sluice can become tide-locked. During these conditions the resulting flows can back up within the Swavesey Drain leading to potential flooding problems.

7.2 TIDAL FLOODING

7.2.1 The site is not at risk of tidal flooding.

7.3 GROUND WATER

7.3.1 Parts of the Phase 1 area adjacent to Longstanton have shallow groundwater levels during prolonged wet periods and during the winter months. Although there is no record of flooding from groundwater in the past, as part of the proposed works on site development, this area will be raised and this will have the benefit of providing protection against the impact of groundwater flood risk.

7.3.2 The groundwater levels have been recorded in two separate surveys. The more recent survey shows the groundwater levels in the terrace gravels fluctuate with prolonged periods of rain, changing seasonally. Maximum water levels have been recorded as less than 0.5m below ground level within the site. For details please refer to WSP Drawing No. 2951-SK-007 in Appendix L.

7.4 OVERLAND FLOWS

7.4.1 The site lies at the top of a natural catchment for the Beck Brook / Cottenham Lode watercourse and therefore flooding from overland flow does not pose a significant flood risk to the site.

8 Flood Plain

8.1 FLOOD PLAIN EXTENT

8.1.1 The Environment Agency has published information defining the flood risk for the area in the vicinity of Northstowe development area: the Flood Maps (of 2011) that are published on the Environment Agency website, these maps have been produced from a model audit study of WSP's Longstanton Brook modelling study undertaken by Faber Maunsell's and the results of a pre-feasibility flood alleviation study undertaken for Oakington and Girton which included the development of a hydraulic model for Beck Brook (Halcrow Group Limited, February 2003).

8.1.2 The current Flood Maps (2011) for the Beck Brook indicate that the site area is located within Flood Zone 1, with approximately one third of the area falling within Flood Zone 3 in an undefended scenario.

8.1.3 The CGB route runs between the Phase 1 area and the Beck Brook/Cottenham Lode. The crest level of the CGB route embankment is located above the predicted flood levels, and therefore flooding mechanism from the Beck Brook into the site are likely to be as a result of flood waters backing up and entering the primary development site via the culverts located along the eastern boundary, under the CGB route embankment. The predicted flooding in the primary development site and estimated 1 in 100 year floodplain are discussed further in Section 12.

8.1.4 It should be noted that site knowledge and anecdotal evidence suggest that this estimated 1 in 100 year floodplain is conservative and over-predicts flood levels and that the actual 1 in 100 year floodplain is not as extensive as that predicted. This is confirmed by anecdotal evidence from local farmers relating to the storm on 21 October 2001 (estimated by Halcrow's return period of up to 1 in 200 years to the south of the A14(T) but slightly less within Oakington and Longstanton), during which event flooding occurred in Oakington and Longstanton villages and yet flooding was very limited and minor within the primary development site.

8.1.5 The water park proposed as part of the wider Northstowe development provides an increased residual flood risk to Phase1. Whilst the risk is very low it is being mitigated by ensuring development platform levels are set above the higher flood level and the new bund is created.

8.2 HATTON'S ROAD ATTENUATION PONDS

8.2.1 The Hatton's Road attenuation ponds included in the Phase 1 area are crossed by the Longstanton Brook which has a small area of flood plain associated with it. This river and associated flood plain has been modelled and reviewed by the Environment Agency. The Longstanton model has been used as part of this assessment.

8.2.2 As Longstanton Brook flows through the village of Longstanton, the capacity of the brook is reduced by numerous culverts, crossing and poor maintenance. The Flood Plain expands in the village and a number of properties are at risk of flooding.

9 Flood Mitigation Measures

9.1 EXISTING FLOOD MITIGATION

9.1.1 The level of protection against flooding for the Phase 1 site and the wider surrounding areas was increased significantly when the Environment Agency (the former National Rivers Authority) undertook flood alleviation works on the Oakington Brook in 1985.

9.1.2 The 1985 flood alleviation works involved the clearance, widening and dredging of 6.34km of award drains and the widening of 8km of Main River. In addition the twin arch Rampton Road Bridge was replaced with a clear span deck.

9.1.3 Works were also undertaken in the Swavesey Drain area to form a separate high level carrier drainage system across the Swavesey IDB. The works involved the construction of a replacement outfall sluice with greater discharge capacity, channel improvement works to Swavesey Drain, Church End Drain and Uttons Drove Drain, and a short length of new cut to divert another high level carrier drain to the new system.

9.1.4 There is one culvert located downstream of the Phase 1 area connecting the Reynolds Drain/Reynolds Ditch to the Cottenham Lode as discussed in paragraph 3.2.9. This is a 1050mm pipe with flap valve to prevent flows from the Cottenham Lode entering the Reynolds Drain/Reynolds Ditch in times of high flow within the Cottenham Lode.

Surrounding Villages

9.1.5 Oakington Village to the south of the site is known to have flooding problems and flooded most recently in October 2001. In addition, an area of Longstanton Village also experienced some flooding in October 2001. These villages have no other known flood protection measures.

9.1.6 The Cottenham Lode is protected by flood bunds; these flood bunds protect the majority of land between the CGB route and the River Great Ouse and help to protect the villages of Rampton and Cottenham and the surrounding farm land.

9.1.7 Rampton is also drained by an Internal Drainage Board watercourse which is the responsibility of the Old West Internal Drainage Board and has no flood protection measures. Rampton experienced flooding in October 2001, partly due to a breach on the Cottenham Lode and the failure of a small balancing facility within the village.

9.1.8 The flood alleviation works carried out in 1985 by the Environment Agency (NRA) also increased the level of protection against flooding in the surrounding villages.

9.1.9 Anecdotal evidence suggests that the Cottenham Lode is at Capacity.

Secondary Flood Defences

9.1.10 The site area is located predominantly in Flood Zone 1 with a third of the site shown to lie within the theoretical undefended Flood Zone 3, and therefore reliant on existing flood defences. Refer to the Indicative Flood Zone Map in Appendix C.

9.1.11 The Beck Brook has flood banks along part of its length to east of the CGB route but these are not designed to a high standard. Overtopping has minimal impact on the site. The exact level of protection is unknown but is likely to be approximately 1 in 100 year event. For events that overtop the defences the flood water flows down either

side of the Lode and outfalls eventually to the Old West River. This is the flooding mechanism that was observed in the October 2001 flood.

9.1.12 The CGB route was constructed on a historical mineral railway embankment and acts as an informal secondary flood defence.

9.2 POST DEVELOPMENT ON-SITE FLOOD MITIGATION

9.2.1 The proposed strategy water park and future management of flows within the site for the benefit of the catchment requires the construction of a new flood bund between the water park and the CGB, the flood bund can be seen on WSP Drawing no. 2951/200/D-01 provided in Appendix H. This will isolate the site from any residual flood risk.

9.2.2 As the site is outside the defended 1 in 100 year plus climate change flood plain, the proposed development can only be affected by extreme flood events in excess of the 1 in 100 year plus climate change flood level or through failure of the local flood defences.

9.2.3 The South Cambridgeshire District Council and Cambridge City Council SFRA published in September 2010 states that safe dry access and egress should be provided for development within Flood Zones 2 and 3 up to the 1 in 100 year flood event taking into account climate change. In addition, finished floor levels will be situated a minimum of 300mm above the 1 in 100 year plus climate change flood level.. A minimum of 600mm above the 1 in 100 year flood level should be adopted if no specific climate change data is available. Refer to the extracts from the SFRA in Appendix K.

The site, including access and egress routes will be located above the 1 in 100 year plus climate change (20%) flood level. Therefore residents will remain safe with safe dry access and egress available at all times, in the event that the primary and secondary defences are breached during a 1 in 100 year plus climate change event. .

9.2.4 The on-site drainage strategy will hold run-off for the 1 in 100 year plus climate change (30%) without any discharge to the receiving watercourses. The surface water will then be pumped off-site at a rate and time which minimises the risk of flooding to areas downstream of the site. This will therefore reduce the risk to downstream properties.

9.2.5 Telemetry systems will be provided to allow the discharge rates from the on-site outfalls to be regulated in response to dry weather and storm conditions within the catchment, thereby ensuring that surface water runoff from the development does not exacerbate existing flood risks to downstream settlements and to enable riparian base flows to be maintained.

9.3 POST DEVELOPMENT HATTON'S RD FLOOD MITIGATION

9.3.1 The flooding mechanisms within Longstanton are primarily caused by a lack of hydraulic capacity within the culverted sections of the Longstanton Brook as it flows through Longstanton village and a lack of maintenance at Bar Hill ponds. As part of the site wide application for the Northstowe development mitigation works to reduce flood risk in the existing villages of Longstanton and Oakington were proposed. As part of the phase 1 proposals the flood mitigation for Longstanton will be delivered. The measures are discussed in more detail in the following paragraphs. Refer to WSP drawing nos. 2988/FLD/302 and 2951/D/03 in Appendix J.

9.3.2 To mitigate the flood risk to Longstanton, two attenuation areas (of approximately 4.0ha and 5.5ha which each provide a storage volume of approximately 47,000m^3 and 58,000m^3 respectively) are proposed. These areas are located between Bar Hill and Longstanton villages adjacent to the Longstanton Brook, south of the B1050 (Hatton's Road) and are included within the Phase 1 Application area. (Refer to Appendix A for location information and Appendix H WSP Drawing No. 2988/FLD/302 for details of the proposals).The Hatton's Road attenuation ponds are to have off-line connections to the Longstanton Brook, and have been designed to reduce peak flow in the brook. The scheme will utilise adjustable side inlet weirs to channel some of the existing flood flow into the Hatton's Road attenuation ponds, with culverts to allow the water to drain out once flood flows have passed, this means that normal flows will by-pass the attenuation areas but will divert flood flows in extreme events reducing flood flows through Longstanton. The brook will be locally diverted around these areas so they can to be integrated into the landscape whilst reducing the extent of earthworks required.

9.3.3 Hydraulic modelling of the proposed Longstanton Brook attenuation areas show that the existing peak flood flow of approximately 6.96m^3/s for the 1 in 100 year event upstream of the High Street (Node 198.2), is reduced significantly into two smaller peak flows of approximately 3.258m^3/s, representing the attenuation provided by both the proposed areas.

9.3.4 The benefit of these attenuation features will be to reduce the 1 in 100 year flow through Longstanton village to less than the existing 1 in 20 year event peak flows, therefore reducing both the frequency and severity of flood events. Refer to Table 9.1 below. Further details can be found in the Flood Modelling Report in Appendix N.

Table 9.1: Hydraulic Modelling Results for existing and post implementation of the flood mitigation proposals

Location Peak flow in m3/s	Baseline (pre-development)				Post-development			
	1 in 100 (+20%)	1 in 100	1 in 20	1 in 5	1 in 100 (+20%)	1 in 100	1 in 20	1 in 5
u/s of Ponds (node 2711.2)	6.596	5.542	3.694	2.353	6.600	5.542	3.694	2.358
d/s of Ponds (node 1653.8)	8.076	7.088	4.652	2.977	5.598	3.289	2.395	2.017
u/s of School Lane (node 920.9)	8.069	6.991	4.549	2.971	5.53	3.278	2.394	2.016
u/s of Hatton's Road (node 481.1)	8.056	6.947	4.548	2.963	5.463	3.259	2.393	2.016
u/s of High Street (east crossing) (node 258.6)	8.055	6.943	4.545	2.962	5.463	3.258	2.393	2.016
u/s of High Street (west crossing)	8.055	6.962	4.545	2.962	5.467	3.258	2.393	2.016

(node 198.2)								

10 Drainage Strategy for the Proposed Development

10.1 EXISTING DRAINAGE ARRANGEMENT

10.1.1 The Phase 1 development area is split into a number of existing drainage catchments, these primarily drain to the north east towards the CGB and then to the Reynolds Drain situated to the east of the site. The Reynolds Drain flows east discharging to the Cottenham Lode ditch approximately 1km east of the Phase 1 boundary. A small parcel of land to the north of the B1050 drains towards Willingham along the highway. Refer to Existing Catchment Plan Figure 3 in Appendix H.

10.1.2 There are no known existing public surface water sewers crossing the site.

10.1.3 The ditches on-site are either the responsibility of SCDC as they are award drains, the Old West IDB within the board area or the responsibility of the riparian owner.

10.2 DRAINAGE REQUIREMENTS

10.2.1 The proposed surface water strategy sets out a range of measures that will be incorporated within the scheme to ensure that the impacts on the existing surface water drainage system are minimised.

10.2.2 The key principle and constraint of the drainage strategy involves a zero discharge from the site when the nearby Beck Brook and Cottenham Lode are in flood (this may be up to 48hrs). This will be achieved by storing all on-site surface water runoff in proposed attenuation ponds within the development area. The water would then be pumped (at restricted rates) from the ponds once the flood conditions in the downstream watercourses had receded sufficiently. Due to offsite flooding mechanisms the run-off within the development will need to be stored for up to 1 – 2 days with a zero discharge during the 1 in 200 plus climate change event

10.2.3 The key features of the existing site and their impact on the development of the current master plan drainage strategy are set out below;

10.3 SURFACE WATER DRAINAGE STRATEGY

10.3.1 The planning applications for the main Northstowe development area include a water park along the eastern boundary of the site which comprises an interlinked system of attenuation ponds providing the main on-site flood mitigation. The water park has been designed to attenuate increased discharges of surface water run-off from the Framework development area. Due to the topography of the site and the location of the main off-site outfall, the Phase 1 area of the water park has been located within the low spot that runs parallel along the north eastern/eastern boundary of the site adjacent to the CGB route.

10.3.2 Existing drainage paths tend to converge towards the CGB route, which is also where the main off-site surface water outfalls will be located. Consequently this area is the logical location for surface water balancing ponds.

10.3.3 The proposed strategy for the Phase 1 site consists of one attenuation area containing two ponds which will be designed as permanent water features to provide a site level SUDS feature and to manage run-off quantity, quality and achieve biodiversity gain.

10.3.4 The surface water run off generated from the site will be conveyed to the ponds by gravity via a combination of a conventional piped systems and arterial greenways running west to east that discharge into the main flood attenuation ponds.

10.3.5 In order to regulate flows and maintain water quality of the run-off, the development will include a range of Source Control SUDS measures such as 'living roofs', lined porous paving in courtyards, etc.

10.3.6 The site is therefore providing the first phase of the Waterpark providing ecological and social benefits at the outset of the scheme as well as ensuring there is no increase in flood risk as a result of the scheme. Parts of the Phase 2 site will also drain to this part of the water park. The proposed drainage strategy is shown on WSP Drawing No. 2951/200/D01 Rev B provided in Appendix H.

10.3.7 A range of SUDS options will be used and considered at the next stage in the planning process and included into the design codes depending on the development type and location. The exact form of SUDS will depend on the specific local constraints associated with individual areas of the site.

10.3.8 The Phase 1 area of the water park will be designed to store the 1 in 200 year plus climate change (30%) storm event below ground, with additional capacity provided within the adjacent area of public open space to cater for extreme storms in excess of the design event. The Phase 1 pond area has been designed to contain all the run-off from the site assuming that the source control measures have no benefit. During flood conditions within the Beck Brook and Reynolds Drain it is intended that the pond will operate with a zero discharge rate, with all run-off stored on-site until flood conditions within the adjacent watercourses subside. It is anticipated that following recession of flooding within the receiving watercourses it will be possible to discharge using a variable discharge rate dependent on hydraulic capacity within the downstream catchment. There is substantial freeboard (over 1 metre) from the top flood water level during the 1 in 200 year event (including an allowance for climate change) and the proposed minimum finished floor levels of built development will be set at higher levels to the Waterpark area. This will provide a substantial amount of storage if a second storm occurred whilst the water park was draining down. The proposal for the water park will contain in the order of 300,000m^3 of storage up to a level of 7.0mAOD however; the exact volume required in this area and therefore its final capacity will be confirmed as part of the detailed design.

10.3.9 It is proposed to provide the Phase 1 section of the water park with a single outfall discharging to the Reynolds Drain which is the under the jurisdiction of the Old West IDB.

10.3.10 In order to provide a degree of flexibility in the outflow from the water park to cater for normal dry weather and storm conditions, it is proposed to regulate discharges from the water park outfall into the Reynolds Drain using a telemetry system linked to a number of sensors (outstations) to provide water level information within the downstream sections of the Cottenham Lode catchment including the confluence with the River Great Ouse.

10.3.11 The operating strategy will be based upon stage discharge curves for the respective locations along the watercourse that will be used to develop a logic rule on/off algorithm for the water park outfalls based on downstream locations sensitive to flooding. Once flood levels within the downstream catchment recede below a predetermined level, the telemetry system will trigger the operation of the pumped outfalls from the water park discharging into existing culverts under the CGB then into Beck Brook and/ or Reynolds Drain.

10.3.12 The proposed catchment areas are shown on the previously referred to drawing number 2951/200/D01. The total development site area as shown on the Phase 1 master plan has been measured as 97ha. However, impermeability factors will be applied to the respective land uses as follows:

- Residential areas 80% impermeable
- Local Centre/Town Centre 100% impermeable
- Employment areas 90% impermeable
- Schools 80% impermeable
- Roads and Footways 100% impermeable
- Green areas/Sports Hub 0% impermeable (for sewer design purposes)

10.3.13 The application of the above impermeability factors and land use allocations result in a total impermeable area of 49.459ha. The table below shows the predicted impermeable area for Phase 1.

Table 10.1: Assumed proposed site impermeability

Development Type	Total Area (ha)	Impermeable Area (ha)
Residential (80% Imp)	43.845	35.076
Community/Local Centre (100% Imp)	1.217	1.217
Employment & Recycling Centre (90% Imp)	5.014	4.512
School (80% Imp)	3.000	2.400
Public Open Space (10% Imp)	1.255	0.125
Allotments (10% Imp)	1.548	0.155
Roads & Footways (100% Imp)	5.974	5.974
Total	61.853	49.459

Sewer Design Criteria

10.3.14 The strategic spine sewers have been routed along the main distributor roads as indicated within the Phase 1 master plan. Lateral sewer runs that join the main spine collector sewers will be provided to serve individual development parcels and sub catchments.

10.3.15 The impermeable area served by each respective drainage network has been derived using the impermeability factors listed above. All surface water sewers will be sized using the FSR rainfall parameters in conjunction with the Modified Rational Method. The WinDes drainage design package has been used to analyse the proposed sewer networks.

10.3.16 On-site sewers will be designed in accordance with Building Regulations, Anglian Water or Sewers for Adoption 6th Edition (or such edition current at the time of detailed design) criteria. At the head of each sewer run an allowance of 1.3m depth of cover to pipe soffit has been assumed. Minimum pipe gradients used within the surface water sewer design are 1 in 500.

10.3.17 A 'round the houses' check will be undertaken as part of on-going design process to ensure that sufficient depth to the soffit of all the strategic sewers is provided to allow for incoming drainage from housing parcels. Typically, a 'round the houses' check involves the following:

- Assume 0.60m below ground level within plot contained within the drainage catchment
- Longest route from plot to spine sewer divided into thirds, the first 1/3 assumed to have a gradient of 1 in 60 and the remaining 2/3 to have a gradient of 1 in 200.

10.3.18 Sewers have been sized to ensure that no surface water flooding occurs for events up to and including the 1 in 30 year design storm event, as per the requirements of Sewers for Adoption The pipe diameters within the sewer networks will be designed to accommodate the 1 in 2 year storm event at full bore and avoid surface flooding for 1 in 30 year storm event.

Greenways

10.3.19 The greenways are basically open channels cut into the ground to convey surface water. Both Greenways A and B run in a north easterly direction to discharge into the smaller attenuation pond. (typical Cross sections details of the greenways can be found in Appendix H).

10.3.20 Greenway A has a trapezoidal shaped cross-section with a 4.0m wide base width, 1 in 1 side slopes 1.0m deep. From the top of this section the ground will be sloped at 1 in 5 to join existing ground levels in open space areas or proposed levels within the proposed development areas.

10.3.21 Greenway B has a trapezoidal shaped cross-section with a 4.0m wide base width, 1 in 1 side slopes 1.0m deep. On the northern side there is a 5.0m maintenance /access strip followed by another 1.0m high slope at 1 in 1. From the top of this section the ground will be sloped at no greater 1 in 5 to join existing ground levels in open space areas or proposed levels within the proposed development areas. On the southern side, side slopes will be at 1 in 5 to join existing ground levels.

10.3.22 Both greenways will have a longitudinal gradient of 1 in 750. This is to keep ground levels as low as possible at the top end of the channels in order to minimise ground raising.

Attenuation Ponds

10.3.23 The requirement for ground raising is dictated by the drainage strategy and the need to achieve gravity outfalls and facilitate effective cover to the drainage system. The design outfall levels to the respective attenuation features are one of the critical factors in establishing the requirement for land raisings. The assumed outfall invert levels to the attenuation ponds 4.0mAOD, which will be the permanent water level for each pond. Details of these basins can be found in WSP drawing no. 2951/D/02 in Appendix H.

10.3.24 The northern smaller pond has a base level of 3.0mAOD with side slopes of 1 in 4. This pond will be linked to the southern larger pond by underground pipes (size to be determined).

10.3.25 The larger pond has a base level of 2.1mAOD with side slopes of 1 in 4. The pond will be excavated to this depth to provide material for ground raising as part of the earthworks strategy. This will result in the permanent water having a depth of 1.9m.

Attenuation Requirements

10.3.26 Due to offsite flooding mechanisms, the run-off within the development will need to be stored for up to 1 to 2 days with a zero discharge during the 1 in 200 plus climate change event. This requires approximately 70,000m^3 of storage.

10.3.27 To accommodate this, the proposed ponds will overspill during the 1 in 200 plus climate event and flood the surrounding open space areas as shown on drawing number 2951/200/D01. Development platform levels on adjacent plots will be raised to prevent flooding of the built development areas. The water Park being proposed as part of Phase 1 has a capacity in the order of 300,000m^3 of storage up to a level of 7.0mAOD

10.4 FOUL DRAINAGE STRATEGY

10.4.1 It is proposed that the entire Northstowe development will utilise one terminal pumping station discharging effluent from the site. It is likely that at least one further local pumping station will be required to support Phase 1. The drainage strategy can be seen on WSP Drawing No. 2951/200/D01 in Appendix H.

10.4.2 The individual pumping stations will be designed in accordance with Anglian Water's requirements for storage at the detailed design stage and therefore will not pose a significant flood risk.

10.4.3 The on-site strategy utilises the topography and the layout to minimise the depth of sewers whilst at the same time minimising the number of pumping stations to reduce the long term operating cost for the water company.

10.5 OFF-SITE FOUL SEWAGE DISPOSAL STRATEGY

10.5.1 Anglian Water (AW) is the Sewerage Undertaker for the area. They are responsible for the existing and proposed surface and foul water sewerage systems as well as the sewage treatment facilities in the area.

10.5.2 AW's network in the villages of Longstanton and Oakington is at capacity and there are existing flooding problems from the foul drainage system in Longstanton. The existing foul flow from Longstanton is pumped to Over Sewage Treatment Works (STW).

10.5.3 As part of the process WSP has met with AW on several occasions and they have confirmed that they can service the site.

10.5.4 Uttons Drove STW is the proposed location for the foul sewage from the site. This STW will need to be updated as part of AW's Investment Plan. However AW has confirmed that they can provide capacity for the development though implementation of their upgrade plans.

10.5.5 The discharge of treated sewage from Uttons Drove STW is the subject of a number of technical studies and designs to ensure that any increase to the flow does not increase the flood risk to downstream properties.

10.5.6 A land drainage scheme has been proposed and agreed in principle with the Swavesey Internal Drainage Board, the Environment Agency, Anglian Water, South Cambridgeshire District Council, the developers at Cambourne and the joint promoters of Northstowe. An extra 950 dwellings has been agreed for Cambourne by increasing the density of the original outline application.

10.5.7 The proposed scheme is split into two sections:

1) Upgrade to the watercourses between Uttons Drove and Webb's Hole Sluice.
2) Installation of a pumping station at Webb's Hole Sluice to pump out the extra flows when the sluice is closed.

10.5.8 This scheme has the capacity to deliver the expansion at Cambourne (950 dwellings) and the whole of Northstowe (up to 10,000 dwellings in total including the strategic reserve area).

10.5.9 The scheme will be delivered in two stages:

- Stage 1. The upgrading works to the channel are likely to be undertaken in 2011-2013. These channel works have enough capacity for all the planned works at Cambourne and Northstowe.
- Stage 2. A pumping station capable of pumping 1 m^3/s will be installed, again capable of serving the whole development.

10.5.10 The proposed Stage 1 works have been modelled with a temporary pump that has been installed at Webb's Hole Sluice capable of pumping 40 l/s to accommodate the original Cambourne development. The modelling undertaken by the Environment Agency has demonstrated that the temporary scheme can accommodate the additional 950 dwellings at Cambourne plus 1500 dwellings.

10.5.11 AW has confirmed that they intend to use this additional capacity to serve Phase 1 of Northstowe.

10.5.12 The second stage of the scheme is expected to be triggered by the second Phase of Northstowe.

11 Hydraulic Structures

11.1 RESTRICTIONS TO FLOW

11.1.1 The existing outfalls under the CGB route are the only hydraulic structures that could produce a flood risk to the site area. As summarised in Section 10, surface water run-off will be stored within the attenuation ponds in the water park prior to discharging by pumping into the existing culverts under the CGB and then into Beck Brook and/or Reynolds Drain. Therefore it is not anticipated that these culverts would cause a flood risk even if they became blocked due to the significant capacity of the ponds.

11.2 HATTON'S RD ATTENUATION PONDS

11.2.1 There are numerous hydraulic structures that affect the watercourses which flow through Longstanton. Whilst these structures do not affect the Phase 1 area, they are considered as part of design parameters for the flood mitigation for Longstanton.

11.2.2 The Hatton's Rd attenuation ponds proposals for phase 1 of the Northstowe new town will help with the balancing of flows upstream of Longstanton to mitigate the existing flooding problems.

12 Flood Probabilities

12.1 VULNERABILITY OF USERS BOTH ON-SITE AND OFF-SITE

12.1.1 The Northstowe development proposals for the creation of a sustainable new town will result in the modification of the existing natural catchment behaviour within the overall development area. Whilst the site is currently part-developed, the scale of the development proposals will result in areas of greenfield being replaced by built development including impermeable roof areas, hard standing and highways that will lead to increased rates and volumes of run-off being generated from the site. The Phase 1 area is predominantly Greenfield.

12.1.2 The increased run-off generated from the Phase 1 area will be managed through a series of SUDS measures provided both at source and regional control level. However, the performance of these techniques is limited and cannot be guaranteed in perpetuity, and a failsafe measure for controlling run-off from the site in the form of a water park feature has been provided to store all run-off during storm conditions within the surrounding areas. The surface water strategy will ensure that no run-off generated by the development will be discharged off-site during periods of flood within the downstream catchment to ensure that the development does not exacerbate existing flood risks to downstream areas.

12.1.3 Given that a proportion of the site is shown to lie in the undefended 1 in 100 year floodplain the development proposals have been designed to ensure that all residential properties within the site will be located within Flood Zone 1 (annual probability of 1 in 1000 year), low risk of fluvial flooding), and therefore site users will be subject to minimal flood risks over the life time of the development.

12.1.4 The site is known to have fluctuations in groundwater levels which have been observed to rise in wet winters and slowly recede in spring/summer. This groundwater supports a number of existing ponds on and adjacent to the site and will need to be maintained. The site is looking to raise levels for drainage reasons but this will also result in reducing groundwater flood risk.

12.2 HATTON'S ROAD INFRASTRUCTURE AREA

12.2.1 The proposed Hatton's Road area has been taken into account in this FRA. In order to provide benefit to the existing residents of Longstanton that are prone to flooding the Hatton's Rd area contain a number of flood attenuation ponds designed to reduce peak flows through Longstanton village, thereby ensuring that the severity and extent of flooding currently experienced within this area is reduced (Refer to Section 9). These attenuation ponds have been tested for a storm event up to and including the 1 in 100 year event and an allowance for climate change. .

12.3 DISPOSAL OF TREATED EFFLUENT

12.3.1 The impact of increased flows in the Swavesey Drain Catchment from the Uttons Drove STW during extreme events will be mitigated so that the flood risk is not increased in the Swavesey area.

12.3.2 Anglian Water has confirmed that there is existing available capacity at their Uttons Drove Sewage Treatment Works for Phase 1.

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13 Cross Section and Finished Level

13.1 HISTORIC FLOOD LEVELS

Phase 1 Site

13.1.1 Flood modelling carried out for the Oakington / Girton Flood Study ('Cottenham Lode Flood Alleviation Scheme, Pre-feasibility Report' by Halcrow Group Limited, February 2003) has been calibrated against the October 2001 flood event outline in order to provide a reasonably accurate and verified model. Based on the predicted flood levels and the topographical survey for the site the flood envelope does encroach into the primary development site. However this was produced by extrapolating flood levels from the Beck Brook across the primary development site and therefore it is considered a theoretical flood envelope, as it ignores the presence of the CGB embankment and the restrictive nature of the culverts. Anecdotal evidence from local farmers indicates that flood levels are lower and therefore the theoretical flood envelope predicts a worst case scenario.

13.1.2 This flood envelope is not shown on the Strategic Flood Risk Assessment (SFRA) maps, as the SFRA considers this area to be defended from flooding beyond a 1 in 100 year flood. Refer to Appendix K for extracts of the South Cambs SFRA.

Hatton's Rd Attenuation pond Area

13.1.3 The existing modelled 1 in 100 year flood level immediately upstream of the location of the proposed flood attenuations areas are 13.29mAOD (WSP ISIS model node 2651.1) and 10.98mAOD (Node 1991.89) for upstream (southern) and downstream (downstream) areas respectively for locations of the model nodes see Drawing No. 2988/FLD/302 in Appendix J.

13.2 MODELLED FLOOD LEVELS

Phase 1 Site

13.2.1 The 1 in 100 year and 1 in 200 year flood levels for the Oakington Brook / Beck Brook in the area immediately to the east of the primary development site is given as 6.32m and 6.39mAOD respectively at model node CL8000 (grid ref 541577, 266933). To the north, where the revised flood envelope bulges, the 1 in 100 year level falls to 6.0mAOD. To the south of the primary development site at model node BB9600 the respective flood levels are given as 7.50m and 7.58mAOD, for locations of the model nodes see WSP drawing number 2988/FLD/303 in Appendix E.

The Hatton's Rd Attenuation Pond Area

13.2.2 Hydraulic modelling results indicate that the peak water levels for the proposed flood attenuation areas adjacent to the Longstanton Brook for the 1 in 100 year event are approximately 12.57mAOD and 10.31mAOD for the upstream and downstream areas respectively.

13.3 FLOOR LEVELS

13.3.1 The development platform levels will be set at least 300mm above both the on-site and off-site flood levels that relate to the 1 in 100 year event plus climate change to ensure that they are not liable to flooding and the levels proposed within Phase 1 need to reflect the wider levels.

14 Flood Progress

14.1 FLOOD PROGRESS

14.1.1 The site is not at flood risk at the moment and therefore the proposals will only help to manage the flooding mechanism in the vicinity of the site.

14.2 PROPOSED DEVELOPMENT

14.2.1 The development will include the construction of a bund along the inside edge of the CGB route which will eliminate the risk of any water flowing back into the site. Additionally the site development levels will be raised above this flood level.

14.2.2 The bund and the water park will be classified as a reservoir under the 1975 Reservoir Act. This reservoir will be designed to discharge the 1 in 10,000 year flood event over the spillway without flooding any of the onsite properties. The classification of the water park as a reservoir does require a statutory inspection and maintenance programme to be undertaken for the lifetime of the development..

15 Flood Volume Displaced

15.1 FLOOD COMPENSATION

15.1.1 The site is not at flood risk and will not displace any flood water. Additionally, the drainage strategy therefore provides a tangible benefit to the existing catchment, by the retention of flows on site for the 1 in 200 year event (plus climate change).

16 Impact of Displaced Water

16.1 IMPACT ON FLOOD PLAIN

16.1.1 The Phase 1 proposals do not result in loss of floodplain. Therefore, the site will not increase flooding to off-site areas during a 1 in 100 year plus climate change flood event.

17 Climate Change Impacts

17.1 CLIMATE CHANGE

17.1.1 PPS25, Annex B, requires new development to cater for a 30% increase in rainfall intensities up to the year 2115, and to allow for a 20% increase in flow with respect to fluvial flood risk.

17.1.2 The future development levels will be set significantly higher than the predicted 1 in 100 +20% floodplain associated with the Beck Brook/Cottenham Lode.

17.1.3 The proposed on-site attenuation has been designed to accommodate all the run-off from the development area from the 1 in 200 year event (plus climate change 30%) without discharging. The relative levels of the water park area have been designed so that if a storm occurred in excess of the 1 in 200 year event (plus climate change) the volume of water could be stored without discharge from the primary development site or placing the development at risk. Therefore, although during extreme events there may be overtopping of the attenuation ponds and flooding of the water park area there will be no flood risk to the developed areas / properties on site and significant benefit to downstream properties.

17.1.4 The Hatton's Rd attenuation pond areas along Longstanton Brook are designed to provide effective flood mitigation measures for Longstanton village within the land available for their construction. Simulations of the hydraulic model have also defined the benefit of the scheme when an allowance of 20% is added.

17.1.5 Therefore the effects of climate change have been taken into account as required by PPS25 and it has been shown that there is no significant increase in flood risk to the proposed development due to climate change.

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18 Residual Risk Assessment

18.1 CONSEQUENCES OF FAILURE OF INFRASTRUCTURE

18.1.1 Owing to the land raising and the provision of the bund along the edge of the water park the risk of a failure in terms of defences is minimal.

18.1.2 A residual risk for the proposed development is for flood events greater than the current design criteria, i.e. the 1 in 200 year return period flood event for the Beck Brook / Cottenham Lode and 1 in 30 year return period for sewers. This risk has been mitigated by setting the development platform levels well above the 1 in 200 year flood level and by providing significant flow balancing in the attenuation ponds and water park area. The attenuation ponds have been sized for the 1 in 100 year event plus climate change. The relative levels of the water park have been designed to retain run-off for rainfall events well in excess of the 100 year event plus climate change. The drainage strategy therefore provides a tangible benefit to the existing catchment. Due to the requirement to control discharge rates pumps are to be utilised at the attenuation ponds to ensure water can be controlled while the receiving watercourse (the Cottenham Lode) is under flood conditions. However should these pumps fail water will overflow within the pipe chambers and be discharged under gravity to the watercourse. Therefore failure of the pumps will not impact on the proposed residential development.

18.1.3 High groundwater levels have been recorded across the site in previous investigations. It is intended however that levels will be raised across the site to provide flood mitigation thus raising the site further above the groundwater table. The ponds are located within an area of high groundwater however the ponds will be lined to prevent infiltration of groundwater. Checks against flotation of the ponds will be undertaken as part of the detailed design stage.

18.1.4 There is a slight residual risk from blockage of one or more of the outfall structures underneath the CGB route; however it is not anticipated that these culverts would cause a flood risk even if there was a blockage due to the extent of attenuation provided on-site within the water park. The Reservoirs Act 1975 defines that all water bodies that are capable of holding more than 25,000 m^3 of water above natural ground level are classified as a reservoir and hence require a mandatory safety regime. The water park area is technically considered a reservoir and will require an overtopping mechanism for the 1 in 10,000 year event. The initial proposals have been developed in conjunction with a Reservoirs Panel Engineer. Further details regarding the safety regime will be provided during the detailed design.

18.1.5 The classification of the water park as a reservoir does require an inspection and maintenance programme for the future. An agreed programme by a Reservoirs Panel Engineer will be produced in accordance with legal requirements set out within the Reservoirs Act 1975. This programme is in line with what would be expected for a new town of this size.

18.1.6 A residual risk remains for the proposed development for rainfall events greater than the drainage design criteria for the proposed drainage system. The risks will be mitigated by creating overland flow routes within the built form. However, on-site sewers will be designed in accordance with Building Regulations, Anglian Water or Sewers for Adoption 6th Edition (or such editions current at the time of detailed desing) criteria, as appropriate; to take account of overland flood flow routes and to divert any excess floodwater around and away from proposed buildings.

18.1.7 The Reservoirs Act requires the consideration of the 1 in 10,000 year event to assess overtopping failure mechanisms associated with the water park.

18.1.8 There is a risk that the reservoir (bund) fails which will be addressed as part of the detailed design with the Reservoir Panel Engineer. However, it is very unlikely that a failure would result in loss of life.

18.2 FLOOD RESILIENCE

18.2.1 All built development will be located above the 1 in 100 year plus climate change flood levels.

18.2.2 Given the high groundwater levels present in the Phase 1 area, no basement construction will be permitted and the ponds present across the site will be lined to prevent the infiltration of groundwater.

18.3 FLOOD WARNING

18.3.1 The proposed drainage strategy includes telemetry stations to be located at strategic points downstream of the site. It is proposed to link the monitoring points for the stations with the Environment Agency's flood warning network thereby providing the opportunity to improve emergency planning within areas of existing development prone to flooding.

18.3.2 The flood warnings which are already in place will be augmented and enhanced by the proposed additional telemetry stations.

18.4 SAFE ACCESS AND EGRESS

Safe access to and from the site can be achieved in the event of flooding in the area via Hatton's Road and the New Longstanton bypass and then to the site via the B1050.

19 Conclusions and Recommendations

19.1 CONCLUSIONS

19.1.1 The Northstowe development area is a sustainable new town development of up to 10,000 units. The Application for which this Flood Risk Assessment has been prepared to support is for Phase 1 of the development which comprises up to 1,500 dwellings, associated infrastructure, and the construction of two offsite flood alleviation basins.

19.1.2 The primary development site was the subject of an outline planning application in December 2007. This report has been prepared using data from the previous Flood Risk Assessment which accompanied the previous submission for the primary development site.

19.1.3 The offsite flood alleviation measures provide significant betterment to the village of Longstanton by reducing peak flows during a 1 in 100 year event to that of a 1 in 20 year event.

19.1.4 A section of the Phase 1 site is shown to lie within the defended 1 in 100 year floodplain. However this floodplain is theoretical as it does not take into account a number of features which would restrict the flow of water onto the site. This includes the CGB route, and the primary flood defences.

19.1.5 Notwithstanding the above, it is also intended to construct a secondary defence bund on site, to restrict the flow of surface water off site, and to raise finished floor levels above the predicted flood level. Development across the site has also been sited sequentially placing low vulnerability land uses in the higher flood risk areas.

19.1.6 The application includes the construction of Phase 1 of the Waterpark with two attenuation basins being constructed to the southeast corner of the site. These attenuation basins have been designed to completely retain the 1 in 200 year + climate change storm event on site for up to 1 to 2 days with zero discharge off site.

19.1.7 Discharge from the site will be controlled using a telemetry and pumped system to ensure that flows are controlled while the receiving watercourse, the Cottenham Lode is under flood conditions. Should a storm event greater than the 1 in 200 year + 30% event occur the construction of the secondary bund will retain storm water on site to ensure there is no increased risk to the existing residential areas.

19.1.8 High groundwater levels have been recorded within the site, however the proposed development area is to be raised significantly, and this together with the impact of construction on the groundwater table will mean that the depth below the finished ground level will be increased. The attenuation basins will be lined with puddle clay to protect against the infiltration of groundwater.

19.1.9 In Summary, the proposed development is located in Flood Zones 1, and partially within Flood Zone 3 in a defended area. In the event of an over-topping or failure of the both the primary and secondary flood defences safe access and egress from the site will be available at all times. In addition, the implementation of the waterpark on site will ensure there is no adverse impact in terms of increased runoff rates from the site.

19.1.10 Therefore the proposals are robust in terms of flood risk and comply with PPS25