Sefton Metropolitan Borough Council Strategic Flood Risk Assessment

Volume 1 – Guidance

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Executive Summary

Capita Symonds has been commissioned to update a Strategic Flood Risk Assessment (SFRA) on behalf of Sefton Metropolitan Borough Council (Sefton MBC) in order to inform its Local Plan, and the development management process (including the content of site-specific Flood Risk Assessments prepared by developers). The commission builds on and updates the findings of the Level 1 SFRA (2009) using a wide range of information on flood risk that has been published since the publication of that document. This updated SFRA has been produced in line with guidance within the National Planning Policy Framework (NPPF) (March 2012) and the supporting Technical Guidance to the National Planning Policy Framework (March 2012), hereafter referred to as 'the Technical Guidance'.

The principal purpose of an SFRA is to refine the information available on the probability of flooding, taking into account other sources of flooding and the currently understood impacts of climate change into account. This SFRA presents additional information on the probability and consequences of flooding and, where the information is available, this SFRA takes the presence of flood defences into account and the effect that they have on river and tidal flooding by presenting information on the depth, velocity and time of inundation of flooding. In line with the NPPF, this SFRA takes a proportionate approach to this additional information, drawing mainly on existing evidence and studies (including those carried out by partners such as the Environment Agency).

The fundamental concepts that underpin an SFRA are incorporated into the NPPF and the Technical Guidance. The NPPF requires development to be directed away from areas at highest risk of flooding, but, where development is necessary, making it safe without increasing flood risk elsewhere. In their Local Plans, local authorities should apply a risk-based, sequential approach to the location of development through the application of a Sequential Test and, where applicable, an Exception Test, and taking account of climate change. This document facilitates the application of both the Sequential and the Exception Test at the potential sites being considered for allocation within the emerging Local Plan.

The underlying objective of the risk-based, sequential allocation of land is to reduce the exposure of new development to flooding and to reduce reliance on built flood defences. Within areas at risk from flooding, it is expected that development proposals will not increase flood risk and ideally, contribute to a reduction in the overall magnitude of the flood risk. SFRAs are therefore essential in enabling a strategic and proactive approach to be applied to flood risk management.

The SFRA also contributes to applying the sequential approach by providing information on the distribution of risk, which will also help to understand whether sites are developable and what flood risk management measures may be required to facilitate their development.

The SFRA also forms an important part of the evidence to inform the development of Local Plan policies for managing flood risk. It will also help define the requirements of site-specific flood risk assessments (site-specific FRAs) prepared by developers, and inform the development management process. Recommendations are therefore made within the SFRA on potential planning policies and the approach to development management, based on the evidence collated throughout the development of the SFRA.

The SFRA is a live document that should be updated as new information and guidance becomes available. Its outcomes and conclusions may not be valid in the event of future changes to legislation, government policy or guidance on flood risk, or if the data on flood risk is updated or changes as a result of future flood risk management measures.

It is the responsibility of the user to ensure that they are using the best available information.

The principal source of flood risk across the borough of Sefton, based on the spatial extent of all flood risk datasets, is surface water flooding. However, parts of Sefton are also at risk from fluvial and tidal sources, from groundwater flooding and from failure of canal and reservoir infrastructure,

Surface water flooding affects significant areas of Sefton and, as a result of the low-lying topography of the borough, there are areas in which the extent of flooding is large and the number of properties affected is significant. This is compounded in some locations by the influence on flooding by infrastructure such railway lines, roads and the Leeds and Liverpool Canal.

Sewer flooding is also considered to be a significant issue across the borough that is closely linked with surface water flooding. It is generally caused by sewer systems that have insufficient capacity to cope with severe rainfall events.

Fluvial (river) flood risk is notable in a number of areas, from both main rivers and ordinary watercourses. Based on the risk to people and property, areas around Formby, Thornton, parts of Maghull and the northern fringes of Aintree are the principal areas of river flood risk within Sefton. More rural areas at risk of fluvial flooding include areas to the east of Southport and Formby, around the River Alt from north of Ince Blundell (including North End) through to the western fringes of Maghull and north of Netherton and Aintree; and to the north and east of Maghull. A number of these river flood risk areas, particularly in Formby, Thornton and Maghull, heavily influence flood risk from other sources, such as surface water, hence the records of flooding in these areas may also be from those sources or a mixture of both. Climate change will increase the risk in all locations, and from many sources.

Tidal flooding – a risk mostly in northern Southport, between Formby and Hightown and along a narrow coastal strip – is largely managed by the existing defences, which are

generally in fair condition. There is potential for climate change to increase this risk of tidal flooding in the future. There is a potential risk of groundwater related flooding based on the nature of the drift and solid geology and from the areas of shallow or potentially shallow groundwater levels. However, the direct risk of flooding to people and property is considered relatively low. Groundwater is however expected to constrain drainage, influence surface water flood risk and in places influence fluvial flooding, such as the River Alt.

There are raised sections of the Leeds and Liverpool canal across southern Sefton which pose a potential risk to properties on the downstream (lower) side, in the event of failure of raised embankments and where culverts pass beneath the canal itself. There have been historical incidents. However, the risk is considered to be relatively low due to the ongoing management of the canal.

Similarly, there are areas within Sefton that are at risk from the failure of reservoirs. The reservoirs are all located outside of the borough and modelling indicates that the consequences of failure within Sefton are relatively minor, affecting properties in areas that are already at risk of fluvial flooding, such as Dover's Brook.

A number of locations appear to be at risk from a number of different sources and these 'hotspots' should be noted. Based on historical records, the Environment Agency's flood zone map, fluvial flood risk modelling, surface water and sewer flood risk modelling and consideration of the influences and effects of groundwater, canal flooding and reservoir flooding there are hotspots of flooding at the following locations:

- Along Whinney Brook, particularly at Hall Lane and at Fouracres (Maghull);
- Associated with Dover's Brook and ordinary watercourses in the vicinity of Sefton Lane (Western Maghull); and
- Eight Acre Lane Brook and along Hawksworth Drive (Formby).

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1.1 What is a Strategic Flood Risk Assessment?

1.1.1 The principal purpose of a Strategic Flood Risk Assessment (SFRA) is to refine the information available on the probability of flooding, taking into account other sources of flooding and the currently understood impacts of climate change into account, so that it can be used within the development planning and decision making process and to support the Sustainability Appraisal of the Local Plan.

1.1.2 In accordance with the National Planning Policy Framework (2012) (NPPF) an SFRA forms the basis for applying the Sequential Test and, where available and necessary, the SFRA presents additional information on the probability and consequences of flooding, for example by taking the presence of flood defences into account and the effect that they have on river and tidal flooding, and presenting information on the depth, velocity and time of inundation of flooding, so that it can be understood whether a site is safe from flooding, does not increase flood risk elsewhere and whether it may provide a benefit to flood risk. An SFRA can also provide information on potential flood risk management measures that may be required at a site to ensure that it meets these requirements.

1.1.3 In line with the NPPF, this SFRA takes a proportionate approach providing this additional information, drawing mainly on existing evidence and studies (including those carried out by partners such as the Environment Agency). As a result, it should be noted that this SFRA utilises the 1 in 25 annual probability modelled flood extent (taking into account the presence of defences) to define the functional floodplain within Sefton. This has been adopted in preference to the 1 in 20 annual probability flood extent referred to in the Technical Guidance to the NPPF because this is a dataset that is available from *all* modelling within the Sefton study area. The fact that it is marginally more conservative is also considered beneficial. Similarly, information presented on the consequences of failure of tidal flood defences is only available for the Crossens area of Southport.

1.1.4 An SFRA enables local authorities and those responsible for development decisions to demonstrate that they have applied a risk-based, sequential approach in preparing development plans and consideration of flooding at all levels of the planning process through the application of a Sequential Test and, where applicable, an Exception Test. SFRAs achieve this by presenting an assessment of risk from all sources before focussing on the potential development sites that are considered to be at risk from flooding. SFRAs also contribute towards a strategic and proactive approach being applied to flood risk

management across the whole of the Sefton MBC area.

1.2 Background

1.2.1 In June 2009 Sefton MBC jointly published its Level 1 Strategic Flood Risk Assessment (SFRA)[1] with Knowsley Metropolitan Borough Council (KMBC) to inform their respective Local Plans. The Level 1 SFRA provided the information required to apply the Sequential Approach and Sequential Test and was produced in line with the now superseded Planning Policy Statement 25 – *Development and Flood Risk* (PPS25) (DCLG, 2006)[2].

1.2.2 PPS25 was revoked[3] and replaced in March 2012 by the National Planning Policy Framework (NPPF)[4], which sets out the need for a SFRA that supports a Local Plan and which provides the evidence base for planning and development policies to manage flood risk within that plan. The NPPF sets out the requirement for the SFRA to be the basis of applying the Sequential Test and for taking a risk-based, sequential approach to the location of development in order to avoid flood risk to people and property.

1.2.3 The NPPF is supported by Technical Guidance to the National Planning Policy Framework[5] (the Technical Guidance), which was also published in March 2012. The Technical Guidance provides supporting information on the application of the Sequential Test and Exception Test and provides further guidance on what should be presented within a SFRA as well as the need for a site-specific flood risk assessment (FRA). The Technical Guidance also presents the recommended allowances that should be considered to take into account the effect of climate change on sea level rise, river flows, rainfall intensity and wind speed and wave height.

1.2.4 In August 2012, Capita Symonds was commissioned by Sefton MBC to update the SFRA on its behalf, which is a direct response to the changing framework of flood risk management since the publication of the Level 1 SFRA published in 2009. As well as the aforementioned changes in national planning policy in relation to flood risk, there have been numerous changes in legislation such as

[1] Knowsley Council and Sefton Council Level 1 SFRA (Atkins, June 2009).
[2] Planning Policy Statement 25: Development and Flood Risk, March 2010, http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25.pdf .
[3] It should be noted that the Planning Policy Statement 25: Development and Flood Risk Practice Guide has not formally been revoked and therefore the guidance provided within it is still largely relevant and applicable.
[4] National Planning Policy Framework, March 2012, http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf
[5] Technical Guidance to the National Planning Policy Framework, March 2012, http://www.communities.gov.uk/documents/planningandbuilding/pdf/2115548.pdf

the publication of the Flood Risk Regulations 2009[6], which enacts the EU Floods Directive[7] in the England and Wales, and the Flood and Water Management Act 2010, which places new responsibilities on Lead Local Flood Authorities (including Sefton MBC).

1.2.5 In addition to these changes, there is a significant volume of new information on flood risk that has become available since 2009 that should be included within a SFRA for consideration during the planning process. The Environment Agency revised its flood zones in 2011 following detailed studies on the Lower Alt, Maghull and in the Crossens catchment. The Environment Agency also published its Areas Susceptible to Surface Water Flooding (AStSWF) dataset, which provided an indication of areas at risk of surface water flooding from a storm event with a 1 in 200 year probability. This was quickly followed by its Flood map for Surface Water (FMfSW) dataset, which is similar but which considers different storm durations and return periods (once in 30 annual probability as well as 1 in 200 year probability). The Environment Agency has also published its Areas Susceptible to Groundwater Flooding (AStGWF) dataset, which provides a coarse indication of groundwater flood risk.

1.2.6 To add to the Environment Agency's own data, along with an expanding database of flooding records and United Utilities' expanding database of sewer flooding records, Sefton also undertook its own Surface Water Management Plan[8] (SWMP) in 2009/2010 in which surface water flood risk was modelled in priority areas using a combination of predicted sewer flooding with an annual probability of 1 in 5 year and 1 in 30 year plus flooding from a combination of sewer flooding and extreme rainfall with a 1 in 100 year probability of occurring. The SWMP also considered the effect of climate change on surface water flooding.

1.2.7 Sefton MBC is also in the process of developing its Local Plan. In May 2011, Sefton MBC published a Core Strategy Options document that set out three alternative options for the future of Sefton, each based on a different future housing provision. With the publication of the NPPF[4], these three options are being carried forward in the preparation of the Preferred Option and further stages of the Local Plan. This SFRA will therefore provide some of the supporting information for the Preferred Option, by assessing the overall risk of flooding within Sefton from all sources and also by assessing each of the potential development sites in more detail. More information about the Local Plan

[6] The Flood Risk Regulations 2009, http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf
[7] Directive 2007/60/EC on the assessment and management of flood risks, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF
[8] Surface Water Management Plan Final Report (Sefton MBC, August 2011), http://www.sefton.gov.uk/pdf/Sefton_SWMP_Final.pdf

and potential development sites is provided in paragraphs 2.4.5 to 2.4.8.

1.2.8 This document is Volume 1 – Guidance of the SFRA. It outlines the existing sources and risk of flooding within the study area and provides a summary of the background and methodology adopted for assessing flood risks at the strategic scale. It also provides a user-guide element, describing how the document should be used by various functions within the council and by developers, seeking guidance on preparing site-specific flood risk assessments. Volume 1 should be read in conjunction with Volume 2 – Mapping, which provides supporting mapping of the available flood risk information for the whole borough as well as further information on the risk of flooding at each of the potential allocation sites.

1.2.9 The remainder of this document has been broken into the following chapters:

- Chapter 2: Legislative and Planning Context – A summary of the key national legislative and planning controls and guidance as well as other relevant local flood risk management planning documents and technical guidance documents;
- Chapter 3: Sefton Study Area – A summary of the Sefton study area, including topography, geology and land use;
- Chapter 4: Flooding in Sefton – a summary of the flood risk in the Borough from all sources including an outline of the data that is available, and any limitations with the data;
- Chapter 5: How to use the SFRA in Local Planning – Explains how Sefton Metropolitan Borough Council should use the SFRA to support its strategic land use planning function, including an explanation of the application of the Sequential and Exception Tests;
- Chapter 6: How to use the SFRA in Development Management – this chapter identifies the role of the SFRA in identifying the need for an FRA and the level of detail required within an FRA when one is required;
- Chapter 7: Policy Recommendations – this chapter presents policy recommendations that have been developed on the basis of current national planning policy, Environment Agency recommendations and on the strategic assessment of flood risk across the borough presented in Chapter 2;
- Chapter 8: SFRA Maintenance and Management – this chapter provides advice on how to keep the SFRAs technical and policy information up to date; and
- Chapter 9: References

2 Legislative and Planning Context

2.1 Legislation

Flood Risk Regulations, 2009

2.1.1 The Flood Risk Regulations 2009 came into force on the 10th December 2009 and transpose the European Union (EU) Floods Directive (Directive 2007/60/EC on the assessment and management of flood risks) into domestic law in England and Wales and implement its provisions.

2.1.2 The Regulations define a Lead Local Flood Authority (LLFA) to be a unitary or county authority for the area, so that Sefton Metropolitan Borough Council is the Lead Local Flood Authority for Sefton. The Regulations also place duties on the Environment Agency and LLFAs to prepare a number of documents across an ongoing 6-year cycle. These documents include:

- Preliminary Flood Risk Assessments (PFRAs) – deadline 22nd June 2011, consisting of preliminary assessment maps and preliminary assessment reports (PARs);
- Flood hazard and flood risk maps – deadline 22nd June 2013; and
- Flood Risk Management Plans – deadline 22nd June 2015

2.1.3 As part of the requirement to prepare PFRAs, the Flood Risk Regulations 2009 place a duty on the Environment Agency to identify 'Flood Risk Areas' within each river basin district that are at significant flood risk from the sea, main rivers and reservoirs, which is available on the Environment Agency's website in the form of its flood maps and its reservoir inundation maps.

2.1.4 The Regulations also place a duty on LLFAs to determine in the production of its PFRA whether there is a significant risk in its area from other sources, i.e. ordinary watercourses, surface water, groundwater and artificial sources such as canals, and to identify where these 'flood risk areas' are located.

2.1.5 Sefton has prepared a PFRA. Flood Hazard and Flood Risk Maps are not yet available for the borough of Sefton, however, they principally relate to the 'flood risk areas' identified within the PFRA, as do the Flood Risk Management Plans required by June 2015.

Flood and Water Management Act, 2010

2.1.6 The Flood and Water Management Act 2010 places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues.

2.1.7 The Act set out the requirements and targets that LLFAs and other flood risk management authorities need to meet with regards to local flood risk management, including:

- The need for LLFAs playing an active role leading flood risk management;
- The requirement for LLFAs to develop Local Flood Risk Management Strategies (LFRMS);
- Cooperation between relevant authorities with regard to flood risk and coastal erosion functions, including the sharing of information,
- The responsibility of LLFAs to investigate flooding incidents within its area to the extent that it considers necessary;
- The duty of LLFAs to maintain a register of structures or features which may affect flood risk within its area, including information on ownership and maintenance responsibility and the current state of repair; and
- The Act enables the EA and local authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent;

2.1.8 The Flood and Water Management Act also clarifies three key areas that influence development:

- Sustainable drainage (SuDS) - the Act makes provision for a national standard to be prepared on SuDS. Developers will be required to obtain local authority approval for the SuDS in accordance with the standards, likely with conditions. When they are designed and constructed robustly, local authorities will be required to adopt and maintain the approved SuDS.
- Permitted flooding of third party land - the EA and local authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

2.1.9 The Act reinforces the need to manage flooding holistically and in a sustainable

manner and it grew from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007 floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt's Review of the summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

Planning legislation, including Town and Country Planning Act 1990 (as amended) and Planning and Compulsory Purchase Act 2004

2.1.10 Local planning authorities such as Sefton Council must prepared development plans and manage development in their areas. Local Plans must be prepared with the objective of contributing to the achievement of sustainable development. Development management decisions must be taken in accordance with the development plan unless material considerations indicate otherwise.

2.2 National Planning Policy

National Planning Policy Framework, 2012

2.2.1 The National Planning Policy Framework[4] (NPPF) was issued in March 2012 and outlines the national development policy including with respect to flood risk. This replaced with immediate effect national policy including Planning Policy Statement 25 – *Development and Flood Risk*[2].

2.2.2 The NPPF requires Local Plans to be supported by a Strategic Flood Risk Assessment (SFRA) and to develop policies to manage flood risk from all sources. The advice of the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs), as well as from within a local authority's own internal drainage and emergency planning functions should be sought when developing a Strategic Flood Risk Assessment. Sefton is the LLFA. There are currently no IDBs for any parts of Sefton. In developing policies, Local Plans should apply a sequential, risk-based approach to the location of development in order to avoid flood risk to people and property, to manage any residual risk, and to take account of the impacts of climate change.

2.2.3 In general, these requirements will be met by:

- Applying the Sequential Test and where appropriate and necessary the

Exception Test;

- Safeguarding land from development that is required for current and future flood risk management;
- Using opportunities offered by new development to reduce the causes and impacts of flooding; and
- Seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations where climate change is expected to increase flood risk to existing development.

2.2.4 Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The SFRA will be the basis for applying the Sequential Test and a sequential approach should be used in areas known to be at risk from any form of flooding.

2.2.5 Following application of the Sequential Test, if it is not possible for the development to be located in zones with a lower probability of flooding, the Exception Test should be applied. It should only be applied if appropriate to the type of development and flood zone and if consistent with wider sustainability objectives.

2.2.6 For the Exception Test to be passed it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA. It must also be demonstrated within a site-specific FRA that the development will be safe for its lifetime without increasing flood risk elsewhere, and where possible reducing flood risk.

2.2.7 When determining planning applications, Local Planning Authorities should ensure that flood risk is not increased elsewhere and should only consider development in areas at risk from flooding where it can be demonstrated that a sequential approach has been taken, that the development is appropriately flood resilient, that residual risks can be managed and that priority is given to the use of sustainable drainage systems.

Technical Guidance to the National Planning Policy Framework, 2012

2.2.8 The Technical Guidance to the National Planning Policy Framework[5] provides additional guidance to Local Planning Authorities to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework on development in areas at risk of flooding. The guidance retains key

elements of the now superseded PPS 25.

2.2.9 The document provides supporting information on:

- The definition of Flood Zones;
- Flood risk vulnerability of different land uses;
- The application of the sequential approach and Sequential and Exception Tests;
- Flood risk assessment at the strategic and site level; and
- Climate change and managing residual risks.

2.2.10 The Technical Guidance clarifies that the SFRA should also:

- refine information on the probability of flooding by taking into account information on other sources of flooding and the effect of climate change;
- support the Local Plan;
- be prepared in consultation with the Environment Agency, a Local Planning Authorities' own emergency planning and drainage functions and any internal drainage boards
- inform appropriate flood risk management policies and the sustainability appraisal of the development plan documents; and
- form the basis of applying the Sequential and Exception Test in the development allocation and development control process.

2.3 Regional Planning Policy

North West Regional Spatial Strategy, 2009

2.3.1 The North West's Regional Spatial Strategy[9] (RSS), the North West of England Plan, was published in 2009 and is the development plan document that sets out regional spatial strategies and policies within which sub-regional and local planning policy should be developed. Supporting the RSS is the Regional Flood Risk Appraisal (RFRA), which is discussed in Section 2.5.

2.3.2 The Government expressed its intention to revoke Regional Spatial Strategies in 2010 and legislated to do so. However, following a ruling by the European Court of Justice with respect to the environmental consequences of revocation, the

[9] North West of England Plan – Regional Spatial Strategy to 2021 (4NW, 2009)

Government is updating its reports and consulting further.

2.3.3 Until revoked, Policy DP2 of the RSS (Promote Sustainable Communities) indicates that flood risk is one of a number of safety and security issues to consider, and Policy DP9 (Reduce Emissions and Adapt to Climate Change) identifies increased storminess and flood risk as one of the consequences of climate change that will need adaptation measures to be applied.

2.3.4 The RSS identifies that flood risk should be one of the factors considered when considering coastal development.

2.3.5 Policy EM5 (Integrated Water Management) indicates that plans and strategies should have regard to River Basin Management Plans (RBMPs), Water Company Asset Management Plans (AMPs), Catchment Flood Management Plans (CFMPs) and the Regional Flood Risk Appraisal (RFRA). Local planning authorities and developers should protect the quantity and quality of surface water, groundwater and coastal waters and manage flood risk. This can be achieved by working with the United Utilities and the Environment Agency when phasing and locating new development, by producing a strategic flood risk assessment, guided by the RFRA, by requiring new development to meet the requirements of the sequential test and exception test, by designing appropriate mitigation measures, incorporating SuDS and raising people's awareness.

2.4 Local Planning Policy

Sefton Unitary Development Plan, 2006

2.4.1 Sefton's Unitary Development Plan (UDP)[10] was adopted in June 2006 and it set out the strategies and policies within which development within the borough would take place until approximately 2021, however, in June 2009 under the transitional arrangements for moving towards the Local Development Framework (LDF), the Secretary of State saved all but four of the policies within the plan. The following policies were saved and will remain in place until such a time as new policies within the Local Plan are adopted.

2.4.2 Policy EP1 (Managing Environmental Risk) states that:

- Development proposals should demonstrate that environmental risks have been evaluated and appropriate measures have been taken to minimise the risks of harm or damage to people property and the natural environment,

[10] Sefton Unitary Development Plan (Sefton MBC, 2006), http://www.sefton.gov.uk/default.aspx?page=5861

from;

- Pollution of land, surface water, ground water and the air;
- Previously contaminated land;
- Hazardous substances;
- Noise, vibration and light nuisance; and
- Flooding.

2.4.3 Policy EP8 (Flood risk) states that:

- Where development is like to be at risk of flooding or increase the risk of flooding elsewhere, a flood risk assessment shall be submitted as part of the planning application;
- Development which would be at unacceptable risk of flooding or would be likely to increase the risk of flooding elsewhere will not be permitted unless the proposal contains adequate flood protection or mitigation measures;
- Development will not be permitted if it increases the need for additional engineering or other works to prevent flooding. Exceptions may be made where the developer pays for the capital and maintenance costs of the necessary works; and
- Planning conditions or legal agreement will be used to ensure that development is not at risk of flooding or likely to cause flooding elsewhere.

2.4.4 Planning Policy DQ5 (Sustainable Drainage Systems) states that:

- Proposal for new residential, commercial, industrial or leisure development will not be permitted unless a Sustainable Drainage System is incorporated into the overall design;
- Exceptions may be made where it can be demonstrated that:
  - The Sustainable Drainage System would be likely to cause either significant land or water pollution;
  - The site's ground conditions would preclude the use of a Sustainable Drainage System;
  - The size of the site precludes the use of a Sustainable Drainage System; or
  - The proposed Sustainable Drainage System could cause damage to adjacent buildings or sites.

- Where appropriate planning conditions or legal agreements will be used to ensure that Sustainable Drainage Systems are provided and maintained.

Sefton Local Plan

2.4.5 Sefton MBC consulted on the Core Strategy Options [11] (including the draft Green Belt Study and draft Green Space Study) in summer 2011. The Options focussed on housing and employment land supply, with the three main Options being:

- Option 1 'urban containment': Development only within the existing urban areas, although this would meet less than 60% of identified housing needs;
- Option 2: 'Meeting identified needs': Development in the urban area, with some development in the Green Belt ; and
- Option 3 'Stabilising Sefton's Population': Development in the urban area, with more development (than Option 2) in the Green Belt.

2.4.6 The supply of housing sites within the urban area is based on the information in the Strategic Housing Land Availability Assessment (SHLAA). Employment sites within the urban area are set out in the Employment Land and Premises Study, and sites for other development are based largely on the Unitary Development Plan allocations.

2.4.7 The draft Green Belt Study[12] identified potential development sites in the Green Belt, if Option 2 or 3 were to become the Preferred Option. It also ruled out other sites in the Green Belt for a range of reasons, including sites at greatest risk of river or tidal flooding, internationally and nationally important nature sites, and sites which were within 'essential gaps' in the Green Belt.

2.4.8 Sefton is now preparing a Local Plan, which will carry forward this earlier work on the Core Strategy. While the Council has not yet approved a Local Plan Preferred Option or hence clarified whether Green Belt release will form part of this Preferred Option, it is anticipated that this will be approved in mid 2013, with consultation on the Preferred Option being carried out in summer 2013.

2.4.9 If the Preferred Option were to require development sites to be released from the Green Belt, the choice of sites would be based on the larger pool of sites identified as potential development sites in the draft Green Belt Study and in consultation responses. For this reason these sites are subject to the sequential

[11] Sefton Local Plan , http://www.sefton.gov.uk/localplan
[12] See http://www.sefton.gov.uk/greenbeltstudy

test in this Strategic Flood Risk Assessment.

2.5 Other Strategies, Plans, Assessments and Guidance documents

2.5.1 The SFRA will be an important tool for Sefton MBC when making land use decisions and in the formulation of development and planning policies. The SFRA is also linked to a number of relevant strategy documents and new development should take into account best-practice guidance from a number of sources. The following sections first deal with other national strategies, plans assessments and guidance documents, then sub-regional documents, then with local, Sefton-specific documents.

UK Climate Impact Programme (UKCIP09), 2009

2.5.2 In June 2009 the UK Climate Impact Programme released new guidance with respect to climate change predictions. The predictions have moved from a deterministic approach (i.e. one range of outcomes) to a probabilistic approach (i.e. a range of possible outcomes based on a range of climate change scenarios).

2.5.3 The results indicate that based on a central estimate of likely outcomes (i.e. 50 percentile), increases in rainfall are expected to remain similar to those predicted by UKCP02 (i.e. those used in this FRA). A high estimate of likely outcomes (i.e. 95th percentile) could result in significantly more intense rainfall than at present.

2.5.4 The Environment Agency has recently released its advice to Flood and Coastal Risk Management Authorities on Adapting to Climate Change, which replaces advice in Defra's Supplementary Advice to Operating Authorities in October 2006 and it is specifically intended to be applied to projects seeking Government Flood Defence Grant in Aid (FDGiA) that are started new from August 2011 or which will be submitted from January 2012. **This does not therefore apply to development planning decisions or flood risk assessments, which should continue to utilise the guidance in the Technical Guidance to the National Planning Policy Framework.**

2.5.5 The Environment Agency's guidance recommends that assessments are made on a 'change factor' that quantifies the potential change (in mm or %) to the baseline. Upper, Lower and H^{++} values are also provided to enable a range of

estimates to be assessed over then lifetime of a scheme. The H^{++} scenario is an estimate of the change beyond the likely range but within the physical plausibility and it is useful for contingency planning.

2.5.6 With respect to the North West, the following are advised:

Table 2-1: Changes to River Flood Flows compared to a 1961 to 1990 baseline – North West England

Scenario	Total potential change anticipated for the 2020s	Total potential change anticipated for the 2050s	Total potential change anticipated for the 2080s
Upper end estimate	25%	35%	65%
Change factor	15%	20%	30%
Lower end estimate	5%	10%	10%
H^{++} estimate	40%	60%	105%

2.5.7 With respect to rainfall intensity and extreme rainfall the table below applies to daily total rainfall data. It is pointed out that the effect on sub-daily intervals is unknown; however, a similar effect must be seen on average, though peak intensities may be higher than shown. These should be applied to return periods less frequent than the 1 in 5 annual probability storm event. For events more frequent then this the guidance within UKCP09 should be used.

Table 2-2: Changes to daily total rainfall – All England

Scenario	Total potential change anticipated for 2020s	Total potential change anticipated for 2050s	Total potential change anticipated for 2080s
Upper end estimate	10%	20%	40%
Change factor	5%	10%	20%
Lower end estimate	0	5%	10%

CIRIA C697 The SUDS Manual, 2007

2.5.8 This guidance provides best practice on planning, design, construction, operation and maintenance of Sustainable Drainage Systems (SUDS) to facilitate their effective implementation within developments.

2.5.9 The guidance supersedes previous general guidance on SUDS and addresses

landscaping, biodiversity issues, public perception and community integration as well as water quality treatment and sustainable flood risk management. The output is based on results contained in the Environment Agency R&D Report SCO20114/2.

2.5.10 The SUDS Manual aims to provide comprehensive advice on the implementation of sustainable drainage techniques in the UK. It provides guidance on:

- Initial planning;
- Design through to construction;
- The management of SUDS in the context of the current regulatory framework; and
- Advice on landscaping, waste management, cost, and community engagement.

CIRIA C635 Designing for Exceedence in Urban Drainage: Good Practice, 2006

2.5.11 The good practice guide aims to provide best practice advice to designers and managers of urban sewerage and drainage systems to reduce the issues arising from exceedence in urban drainage systems. The guide also provides council on risk assessment procedures and planning that can reduce the impact of exceedence events to those at risk.

2.5.12 The guide has been used to provide direction on the design of urban drainage systems capable of coping with extreme events and within an assessment of the likelihood and impact of exceedence.

WRc, Sewers for Adoption 7th Edition, 2012

2.5.13 This document is the definitive guide for those planning, designing and constructing sewers and pumping stations for subsequent adoption by water companies in England and Wales under Section 104 of the Water Industry Act.

2.5.14 This guidance provides best practice on planning, design, construction, operation and maintenance of SUDS to facilitate their effective implementation within developments. The 7th Edition extends the guidance to cover small types of sewers and lateral drains that were not previously covered and which have been brought under the management of sewer companies through the Flood and

Water Management Act 2010.

CLG Improving the Flood Performance of New Buildings: Flood Resilient Construction, 2007

2.5.15 This government document published by Communities and Local Government[13] provides developers and designers with guidance on improving the flood resilience of new properties in low or residual flood risk areas. It covers the use of suitable materials and construction details and supports the general hierarchy of building and site design:

- Flood avoidance – design and construction to avoid a site being flooded;
- Flood resistance – design and construction to prevent flood water entering the building or fabric;
- Flood resilience – design and construction to reduce any permanent damage and to facilitate drying and cleaning post-flood; and
- Flood repairable – design and construction such that damaged elements can easily be repaired or replaced.

2.5.16 Where it is not possible to avoid construction in areas at flood risk the guidance advocates a 'water exclusion strategy' when water depths are less than 0.3m by using low permeability materials and construction methods to prevent ingress of water.

2.5.17 Where depths are between 0.3m and 0.6m then measures should be used to attempt to keep water out in full or in part through the use of low permeability materials and construction methods, flood resilient materials and designs and by providing access to all spaces to permit drying and cleaning.

2.5.18 Where depths are in excess of 0.6m then a 'water entry strategy' is recommended. The building should adopt low permeability materials and construction measures in case water depths remain low but should also design for the passage of water through the building, design for the building to drain water away and to facilitate drying and cleaning.

Defra Draft National Standards for SuDS, 2011

[13] Improving the Flood Performance of New Buildings: Flood Resilient Construction (CLG, 2007), http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

2.5.19 The draft National Standards for Sustainable Drainage Systems (SuDS) in England were developed to be used in order to manage surface runoff in accordance with Schedule 3 of the Flood and Water Management Act 2010. The key objectives are to manage the flow rate and volume of surface runoff to reduce the risk of flooding and water pollution. SuDS also reduce pressure on the sewerage network and can improve biodiversity and local amenity.

2.5.20 The National Standards set out what to design and construct in order obtain approval from the SuDS Approving Body (SAB) and what is required for operating and maintaining SuDS which the SAB adopts. Sefton Metropolitan Borough Council would be the SAB for Sefton. Drainage for approval by the SAB must be designed to comply with the [draft] National Standards, which have two parts:

- Principles that:
  i. Must be taken into account for the design of SuDS; and
  ii. Set the criteria for governing the judgement of SABs on the functionality of drainage they adopt; and
  iii. Exempt development from complying with certain aspects of the standards on the grounds of disproportionate cost.
- Standards with design, construction and maintenance requirements for SuDS, based on run-off destination, peak flow rates and volumes, water quality and function.

The [draft] National Standards also state that in addition, the Local Planning Authority may set local requirements for planning permission that have the effect of more stringent requirements than these National Standards.

2.5.21 Consultation on the draft National Standards for Sustainable Drainage Systems (SuDS) took place between December 2011 and March 2012. However, Defra has not yet set a date for final implementation of the National Standards or SAB process.

North West England and North Wales Shoreline Management Plan, 2011

2.5.22 In February 2011 Halcrow Group Ltd completed an update and revision of the original Shoreline Management Plan (SMP) for the area, which has now been

approved. The SMP2[14] provides a large-scale assessment of the risk associated with coastal erosion and flooding for the North West of England and North Wales. The SMP2 is intended to inform wider strategic planning policy for Local Planning Authorities.

2.5.23 Within the SMP the coastline is divided into five separate sub-cells (11a-e). Each sub-cell has been assessed individually for the risk associated with coastal erosion and flooding. Furthermore, each sub-cell has assigned its own preferred policy in the short term (present to 2025), medium term (2025 to 2055) and long term (2055 to 2105). The preferred policy is selected on the basis of the potential environmental impacts the proposed action is likely to have, positive and negative, considering a number of factors including its impact on biodiversity, flora and fauna, water quality, flood risk etc.

2.5.24 The preferred policy will suggest one of four courses of action for a given section of the shoreline. The four policies are:

- Hold the Line – To maintain or change the current standard of protection. This policy includes work both behind and in front of the existing defences in order to maintain the current coastal defence system;
- Advance the line – Involves Building new defences on the seaward side of the existing defences. This policy is restricted to policy units in which significant land reclamation is considered;
- Managed Realignment – Allowing the shoreline to move backwards or forwards through reducing erosion or building new defences on the landward side of existing defences; and
- No active intervention – no investment into coastal defences.

2.5.25 The Sefton area is represented within four specific areas of sub-cells 11a and 11b. These areas are listed and summarised below:

- 11a-7: The Mersey Estuary – For the majority of the shoreline the preferred policy is to hold the line in the short to long term. In the medium to long term it is proposed that there be some managed realignment along the north and south bank of the upper Mersey estuary. For the majority of the estuary there is continued flood protection to properties along the shoreline. Where managed realignment is to take place, some isolated properties may be at increased risk. However, these fall outside of the Sefton area;
- 11a-8: Seaforth to the River Alt – In the long term the preferred policy is to

[14] North West England and North Wales Shoreline Management Plan SMP2 (North West England and North Wales Coastal Group, 2011), http://mycoastline.org/index.php/shoreline-management/smp2

hold the line and manage erosion risk to properties as and when required. There is also the proposal to allow, as far as possible, natural processes to continue with managed realignment policies preferred from the MEPAS pumping station to Hightown. The proposal to implement managed realignment along this section of the shoreline does increase the flood risk to the Lancashire golf course and could result in partial or complete loss of the course. The policies to hold the line in other areas of the shoreline provide protection from flooding to Crosby and Hightown;

- 11a-9: Formby Dunes – The long term preferred policy is to allow the natural evolution of the shoreline. This will allow an increase in the intertidal habitat with obvious ecological benefits. However, in the long term many areas are likely to experience an increased risk of flooding. Most notably the tourism assets in Ainsdale, Sefton coastal path and the car park on Victoria road are at increased long term risk. Furthermore there is an additional risk posed to a small number of isolated properties along the frontage on Albert road. However, in managing the natural roll back of the dune system a certain level of natural protection can be delivered in the short to medium term; and
- 11b-1: Ribble Estuary – The preferred policy is to continue to manage the flood risk to towns by maintaining the naturally functioning systems. In addition the maintenance of the existing defences will ensure the protection of key infrastructure, industry and property. However, it is also proposed that opportunities to implement managed realignment should be investigated. In the longer term the flood risk to property within this area is likely to increase and a balance between reducing flood risk to communities and allowing for the provision of natural habitats is highlighted as a key concern.

Regional Flood Risk Appraisal, 2008

2.5.26 The Regional Flood Risk Appraisal for the North West Regional Spatial Strategy[15] was produced by 4NW in 2008 and gives a regional overview of flooding from all sources. Given the Governments intention to revoke Regional Spatial Strategies at an early date, which the RFRA supported as an evidence base, it is unlikely that the RFRA will be updated.

2.5.27 Whilst the regional nature of the RFRA enabled cross-district sources and receptors of flooding to be identified and considered in spatial planning, this

[15] North West RSS Regional Flood Risk Appraisal, October 2008, http://www.4nw.org.uk/downloads/documents/oct_08/nwra_1225456013_Final_Regional_Flood_Risk_Appr.pdf

information is also largely presented within Catchment Flood Risk Management Plans (CFMPS) and whilst the focus of these is largely fluvial flooding they do cover other sources of flooding where appropriate.

2.5.28 There are areas within Sefton, typically within the floodplain of the River Alt and those areas along the boundary of the borough with West Lancashire, that are at risk from sources of flooding outside of the borough and there are a few areas in which Sefton contributes to flood risk in adjacent boroughs. Despite this, it is not considered cost-effective to update the relevant sections of the RFRA but instead the focus should be on ensuring that the Local Flood Risk Management Strategy incorporates the latest information on all sources of flooding within the Borough, that the SFRA is kept up to date with the latest information on all sources of flooding, and that mechanisms exist for cross-boundary consideration of flood risk issues where development and planning decisions may affect receptors outside of the borough in which the decision is being made.

Alt Crossens Catchment Flood Management Plan, 2009

2.5.29 The Alt Crossens Catchment Flood Management Plan (CFMP)[16] gives an overview of flood risk in the Alt Crossens catchment and sets out the Environment Agency's plan for sustainable flood risk management over the next 50 to 100 years.

2.5.30 The CFMP highlights that within the Sefton area there exists a number of different sources of flood risk. The CFMP states that river flooding has not been a significant issue in recent years however, a large number of culverted watercourses represent a potentially significant source of flooding due to blockage or failure. The CMFP also suggest that surface water flooding is a source of localised flooding and that a number of surface water drainage systems are prone to blocking within the catchment. Sewer flooding has been recorded in Maghull and Southport although the CFMP finds that work is needed to better understand this source of flooding. (The Sefton Surface Water Management Plan contributes to this). Finally the CFMP notes the canal running through Maghull as a potential source of flood risk.

2.5.31 Within the CFMP the Alt Crossens catchment is divided into eight policy units relating to Flood Risk Management. Within these eight policy units there are seven areas that fall within the Sefton MBC area. These are the Middle Urban Alt, Altcar and Ince, Formby, Southport Liverpool, Martin Mere and Banks Marsh.

[16] Alt Crossens CFMP, Environment Agency, December 2009.

2.5.32 The Middle Urban Alt policy unit falls under policy option 3 as an area of low to moderate flood risk where, generally, flood risk is being managed effectively. The Altcar and Ince and Martin Mere policy units fall under policy option 6 as areas of low to moderate flood risk where further action is required to store water/manage run-off in locations that provide overall flood risk reductions or environmental benefits. The Formby, Southport and Liverpool policy units all fall under policy option 4 as areas of low, moderate or high flood risk where flood risk is currently being managed effectively but where there is need to take further action to keep pace with climate change.

Mersey Estuary Catchment Flood Management Plan, 2009

2.5.33 The Mersey Estuary CFMP[17] gives an overview of flood risk in the Lower Mersey and the Mersey Estuary and sets out the Environment Agency's plan for sustainable flood risk management over the next 50 to 100 years. The CFMP highlights that flood risk is generally low within the Mersey Estuary North asset systems area, the majority of which is in Liverpool, relative to areas such as Warrington. There are approximately 1,321 properties at risk in a 1 in 100 annual probability flood event along with 10 vulnerable receptors[18] and 2 community facilities. There is no transport infrastructure affected. It is estimated that the number of properties at risk would rise due to the effects of climate change and development.

2.5.34 The Policy Unit for this area is known as the Liverpool Policy Unit falling under policy 4 as an area of low, moderate or high flood risk where flood risk is currently being managed effectively but where there is need to take further action to keep pace with climate change.

Lower Alt with Crossens Pumped Drainage: Draft Flood Risk Management Strategy, 2011

2.5.35 The Environment Agency has prepared a consultation draft Flood Risk Management Strategy for the Lower Alt with Crossens Pumped Drainage catchments[19,20]. Sefton Council sits on the advisory group in relation to the

[17] Mersey Estuary CFMP, Environment Agency, December 2009.
[18] Vulnerable receptors are types of property or land use that are particularly vulnerable to flooding. The consequences of flooding to vulnerable receptors may have wider effects on human health, the economy or the environment.
[19] Environment Agency (2011) Lower Alt with Crossens Draft Flood Risk Management Strategic Plan: Consultation Document

Strategy.

2.5.36 The principal areas covered by the strategy are:

- The Crossens pumped catchment, which includes Southport and land to the south and east of Southport;
- The lower area of the River Alt catchment, which includes parts of Maghull, Lydiate and Aintree and those areas downstream, such as Hightown, Formby, Ince Blundell, Lunt, Sefton village and Little Altcar, the edges of Crosby and Thornton

2.5.37 In summary, the Environment Agency manages water levels and assets within much of this area and a large proportion of its activity and expenditure is on the land drainage and management of flood risk within these largely rural areas.

2.5.38 It is acknowledged that because the area is low lying it relies on pumped rather than gravity drainage, and that much of the agricultural land that is protected may be sensitive to how water levels are managed.

2.5.39 In general the Environment Agency consider that the current management of the Lower Alt and Crossens catchments cannot be sustained, and as such they are seeking comments on alternative approaches from 2015; including:

- A reduction in capacity or closing down of some of the pumping stations, including a potential reduced capacity at Altmouth and Crossens Pumping Stations, together with;
- An increased use of the natural floodplain in rural areas as washlands for flood storage and flood risk (including urban flood risk) management, for example in Lunt Meadows.

2.5.40 The implications of these on rural land drainage and flood risk within Sefton may be potentially significant and may result in more frequent, and potentially more severe, flooding in the rural areas of the Lower Alt and Crossens. However, this is not expected to impact properties significantly.

2.5.41 It is not anticipated that urban flood risk will increase, although in the future it may be managed in a different way. .

2.5.42 The Environment Agency has confirmed that it intends to continue to manage tidal defences.

[20] Sefton Council (2011) Report to Planning Committee Cabinet member – Environment Overview and Scrutiny Committee (Regeneration and Environmental Services) 19th October

Sefton Local Flood Risk Management Strategy

2.5.43 The Flood and Water Management Act 2010[21] (FWMA) requires each Lead Local Flood Authority (LLFA) to produce a Local Flood Risk Management Strategy (LFRMS), which must be consistent with the national strategy produced by the Environment Agency. The LFRMS should make an assessment of the flood risk and plans and actions for managing the risk. It should include local organisations with responsibility for flood risk in the area and partnership arrangements.

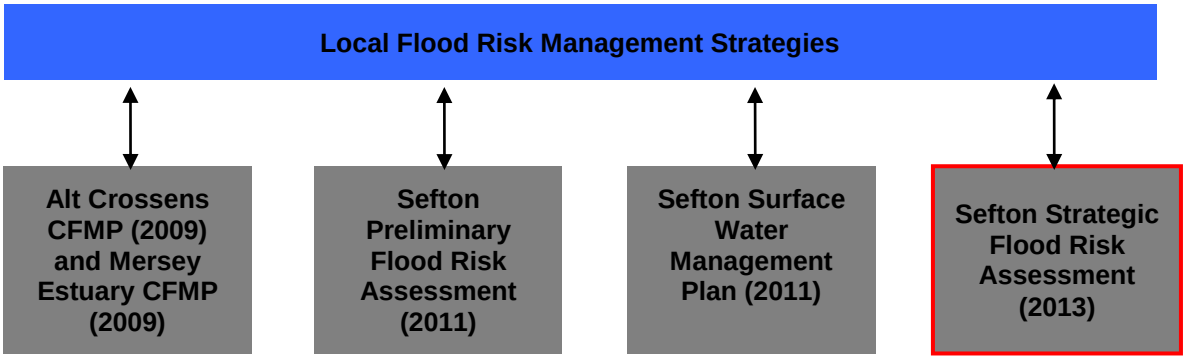


Figure 2-1: The Sefton Strategic Flood Risk Assessment in context with other strategic flood risk plans

2.5.44 The Catchment Flood Management Plans (CFMP), Preliminary Flood Risk Assessment (PFRA), Surface Water Management Plan (SWMP) and this updated SFRA with its supporting risk maps will contribute towards the evidence base to support the development of a Local Flood Risk Management (LFRM) strategy for Sefton.

2.5.45 It is understood that Sefton's LFRMS is currently under development.

Sefton Preliminary Flood Risk Assessment, 2011

2.5.46 Preliminary Flood Risk Assessments (PFRAs) are a principal requirement of the Flood Risk Regulations 2009, which implement the requirements of the European Floods Directive (2007/60/EC). The PFRA gives an overview of all current and future local sources of flood risk, i.e. surface water, groundwater, ordinary watercourses and artificial sources. It does not cover flooding from main rivers, the sea or large reservoirs, which remain the overall responsibility of the Environment Agency. LLFAs must review these PFRAs every 6 years.

[21] Flood and Water Management Act, April 2010, http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

2.5.47 Sefton MBC, as the Lead Local Flood Authority (LLFA), prepared a Preliminary Flood Risk Assessment in May 2011[22]. The PFRA provides a summary of historic floods that are considered or known to have had significant harmful consequences. In Sefton, significant local consequences were defined as an event that impacted 20 people or approximately 8 houses. The PFRA provides details of 13 events in the last 20 years that are said to have had locally significant harmful consequences. The main source of flooding in 11 of these 13 is highlighted as surface water. In the remaining two events one is highlighted to have been caused by a combination of surface water and ordinary watercourse flooding and the second was caused by the collapse of a culvert beneath the Leeds and Liverpool Canal.

2.5.48 Future flood risk was also considered in relation to numerous sources of information provided by the Environment Agency. These Sources included: Areas Susceptible to Surface Water Flooding (AStSWF), EA Flood map for Surface Water (FMfSW), Areas Susceptible to Groundwater Flooding (AStGWF) and EA Flood Zone Maps. Along with a number of other Merseyside local authorities, Sefton MBC adopted the AStSWF dataset to define future flood risk combined with the historical flooding records. In total it was identified that 131,400 buildings in Sefton are at risk during a 1 in 200 annual probability event of which roughly 91, 980 are residential properties and 38,420 are non-residential properties (assuming that approximately 70% of these buildings are residential, which is the typical proportion within Sefton). In assessing the future flood risk to Sefton it was concluded that no local information was available to provide evidence on future groundwater flood risk across Sefton. Furthermore information relating to the future flood risk from Canals and Sewers was unavailable.

Sefton Surface Water Management Plan, 2011

2.5.49 The Sefton Surface Water Management Plan[8] outlines the preferred surface water management strategy for the Sefton area. In addition it establishes a long term action plan to manage surface water. The SWMP has a number of objectives outlined within the report, however, the pertinent objectives relative to this level 2 Strategic Flood Risk Assessment are:

- To determine and map current and potential surface water flood risk areas across the Sefton MBC area, irrespective of source;
- To determine the consequences of surface water flooding on people,

[22] Sefton PFRA (Sefton MBC, May 2011), http://www.sefton.gov.uk/pdf/TS_FCERM_Sefton_PFRA.pdf

property, infrastructure and the environment, now and in the future;

- To identify an effective, affordable and achievable strategy with sustainable and cost-beneficial measures to mitigate surface water flood risk, which achieve multiple benefits where possible, and which make the most of opportunities for economic, social and environment enhancement; and
- To inform and advise spatial planning so that new development is directed away from area at greatest risk of actual and potential surface water and other flooding so that appropriate surface water mitigation measures are prompted.

2.5.50 The SWMP provides a summary of the key risks within the Sefton area. Within the report it concludes that the principal risk within the area arises from surface water and sewer flooding. It suggests that some areas are also at risk from fluvial and tidal flooding, however, the presence of defences and a pumped drainage system largely mitigates these risks. The SWMP also suggests that areas in which groundwater is shallow or may merge, typically associated with the River Alt as well as areas from Bootle to Southport, create an additional source of flood risk.

3 Sefton Study Area

3.1 Location and overview

3.1.1 The study area for this SFRA is defined by the administrative boundary of Sefton Metropolitan Borough Council which is presented in Figure 3-1, overleaf, and in Figure 1 in Volume 2.

3.1.2 Sefton Metropolitan District is situated to the north of Liverpool City Region, extending along the coastline between Bootle Docks on the edge of the Mersey Estuary, to Southport on the south bank of the Ribble Estuary. To the north and east lies the District of West Lancashire, to the south east lies the Metropolitan Borough of Knowsley, to the South the District of Liverpool and there is a very small border with the Wirral where the two districts overlap in the Mersey Estuary.

3.1.3 The district covers approximately 154.6km^2 and contains the urban centres of Bootle, Crosby, Formby, Southport and Maghull along with the other urban areas of Ainsdale, Hightown, Little Altcar, Thornton, Litherland, Netherton, Aintree, Melling and Lydiate and smaller villages such as Lunt, Sefton Village and Ince Blundell. The main built up areas cover about half of Sefton, and are where almost all of Sefton's residents live.

3.1.4 The M57 and M58 pass through the south of the area near Maghull and Thornton. Other significant infrastructure includes the A59, A565 and A570; and a new road between the M57/ M58 and Thornton, giving easier access between north Sefton and the motorway network, is due to be built in the new few years. There are also passenger railway lines from Liverpool to Southport, Liverpool to Ormskirk and Southport to Manchester, and other freight based rail lines in the south of Sefton. Sefton shares close economic, social, cultural and transport links with the rest of the Liverpool City Region, and also has important links to Preston and West Lancashire – many Sefton residents work elsewhere in the City Region, Preston or West Lancashire.

3.1.5 Within the administrative boundary of Sefton there is a diverse mixture of urban areas with industrial, commercial, leisure and other development, coupled with rural green belt, villages, agricultural land and the internationally important nature sites along the Sefton Coast. The Leeds and Liverpool Canal runs through urban and rural area of south Sefton; including Maghull, Lydiate, Aintree, Netherton and Bootle, and the rural areas between them.

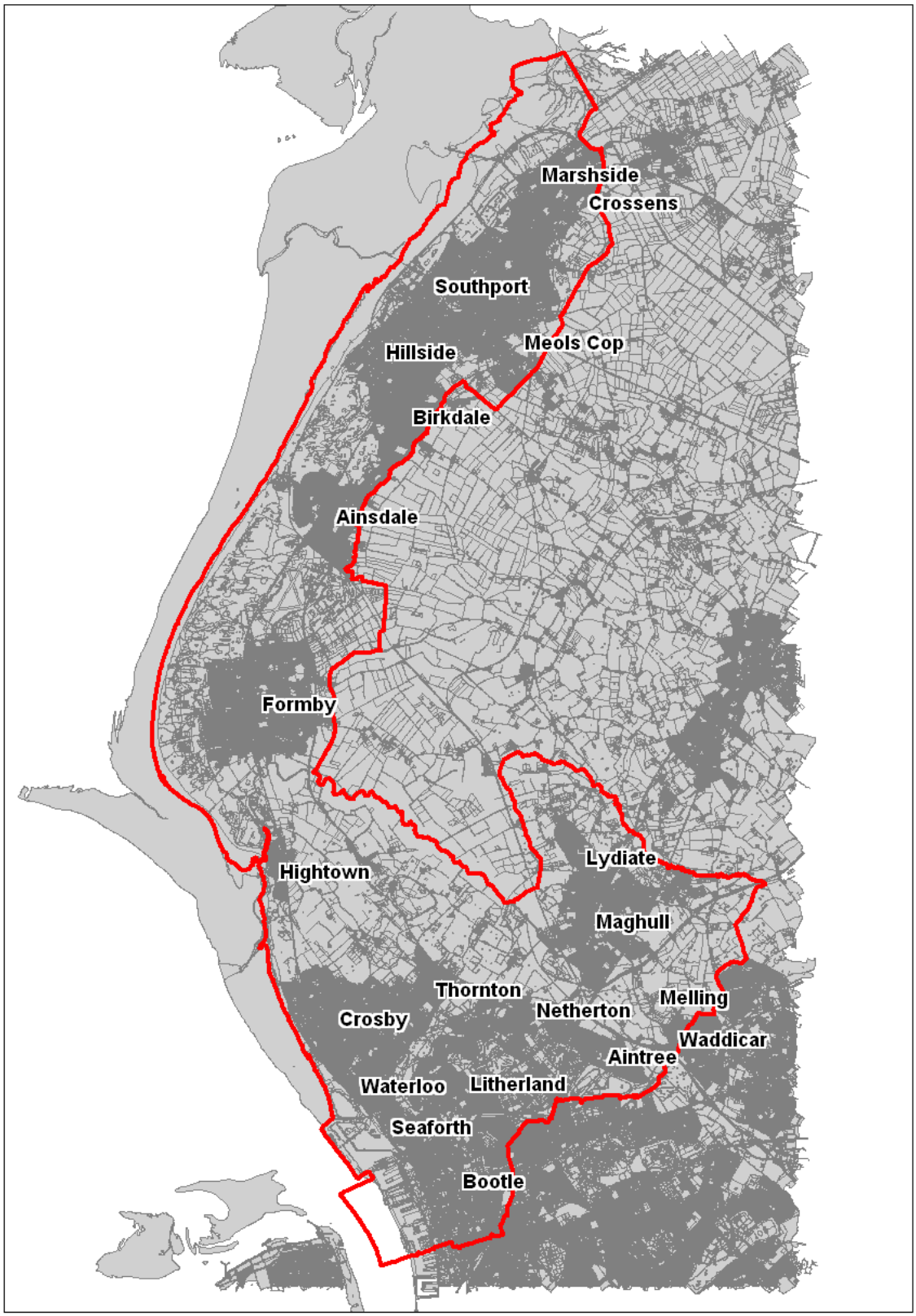


Figure 3-1: Sefton SFRA study area

3.1.6 Sefton has a number of famous features that help make it distinctive, including the 'classic resort' of Southport, the outstanding natural coast, the home of the Grand National at Aintree, England's 'golf coast' which includes Royal Birkdale, and Antony Gurley's Iron Men on Crosby Beach. Sefton is home to most of the Port of Liverpool and the Freeport, and has extensive commuter travel into Liverpool from the key urban areas of Bootle, Crosby, Formby, Southport and Maghull.

3.2 Geology

3.2.1 The solid geology of Sefton consists predominantly of mudstone of the Sidmouth Formation and sandstone of the Ormskirk Formation, Sherwood Group and Wilmslow Formation and Helsby Formation. There is a small area of Chester Pebble Beds Formation in the south.

3.2.2 Sefton is largely coastal, and as a result the overlying deposits along the coastal boundary consist predominantly of blown sand. Towards the north of Southport there are tidal flats deposits, whilst inland there is alluvium associated with the River Alt and some small areas of peat. On higher ground the deposits consist largely of sand with areas of till and there are occasional areas with no drift deposits.

3.2.3 Along the shoreline the sand drift can be expected to exhibit a high level of infiltration, though it should be noted that shallow groundwater is recorded in many of these areas that may affect infiltration locally. Further inland, due to the nature of the soils and the low lying topography groundwater levels are likely to high and as a result infiltration is likely to be reduced. Sand on higher ground is likely to be favourable to infiltration, however, the low infiltration rates of the till may preclude infiltration in areas.

3.2.4 The Alt Crossens CFMP[16] indicates that there are parts of the borough in which groundwater emergence may take place and which may have been influenced by the cessation of pumping from former mines. The lower Alt catchment is identified as one of the areas at risk. This conclusion is supported by the Lower Mersey and North Merseyside Groundwater Resources Study[23], which indicates that there is a significant proportion of base flow in the River Alt that comes from the Permo-Triassic Sandstone.

3.2.5 The consequence of rising groundwater may not necessarily impact the location at which it emerges, unless there are low lying areas in which ground water levels

[23] ESI (2009) Lower Mersey and North Merseyside Groundwater Resources Study: Final Report

could remain above the ground surface for long periods of time. Higher groundwater levels may instead contribute to an increased probability and duration of flooding in those areas affected by other sources of flooding, such as surface water or sewer flooding.

3.3 Topography

3.3.1 Topography of the Sefton is typically flat and low lying, however, this generalisation hides a complexity that heavily influences the nature and distribution of flooding within the study area.

3.3.2 High ground in the form of a low lying ridge up to an elevation of 20m AOD runs along the coast from the western edge of Formby to the southern edge of Southport. To the south and east of the borough there is also high ground up to 35m AOD, upon which Lydiate, parts of Maghull, Litherland and part of Bootle are situated.

3.3.3 Low lying ground is typically located along the eastern boundary of Sefton, from west of Maghull northwards to the tip of Southport at Fiddler's Ferry. Splitting the higher areas of Maghull and Litherland is the River Alt, which runs north westwards between these two settlements, then along the boundary of Sefton until it turns south westwards, south east of Formby, to discharge to the sea north of Hightown.

3.3.4 The coastal ridge between Formby and Southport results in most watercourses within this area flowing inland away from the coast. Those north of Ainsdale typically drain eastwards to the boundary of Sefton MBC and then turn northwards, flowing via Fine Jane's Brook, Boundary Brook and Three Pools Waterway towards Crossens, where it discharges to the sea via Crossens pumping station at Banks. Those watercourses south of Ainsdale generally discharge southwards via Downholland Brook to the River Alt, which discharges into the sea via Altmouth pumping station.

3.3.5 Crosby, western parts of Litherland and Bootle generally lie on ground that slopes in a west and south westward direction towards the coastline and docks. Crosby and Litherland are split by the path of Rimrose Brook and also by the Leeds and Liverpool Canal, which zigzags across Sefton from north of Lydiate, passing through Maghull, Waddicar, Aintree, Litherland and Bootle on its way southwards to Liverpool City centre.

3.3.6 Figure 3-2, overleaf, presents the topography of Sefton collated from LiDAR data and Figure 2 in Volume 2 presents the topography in more detail.

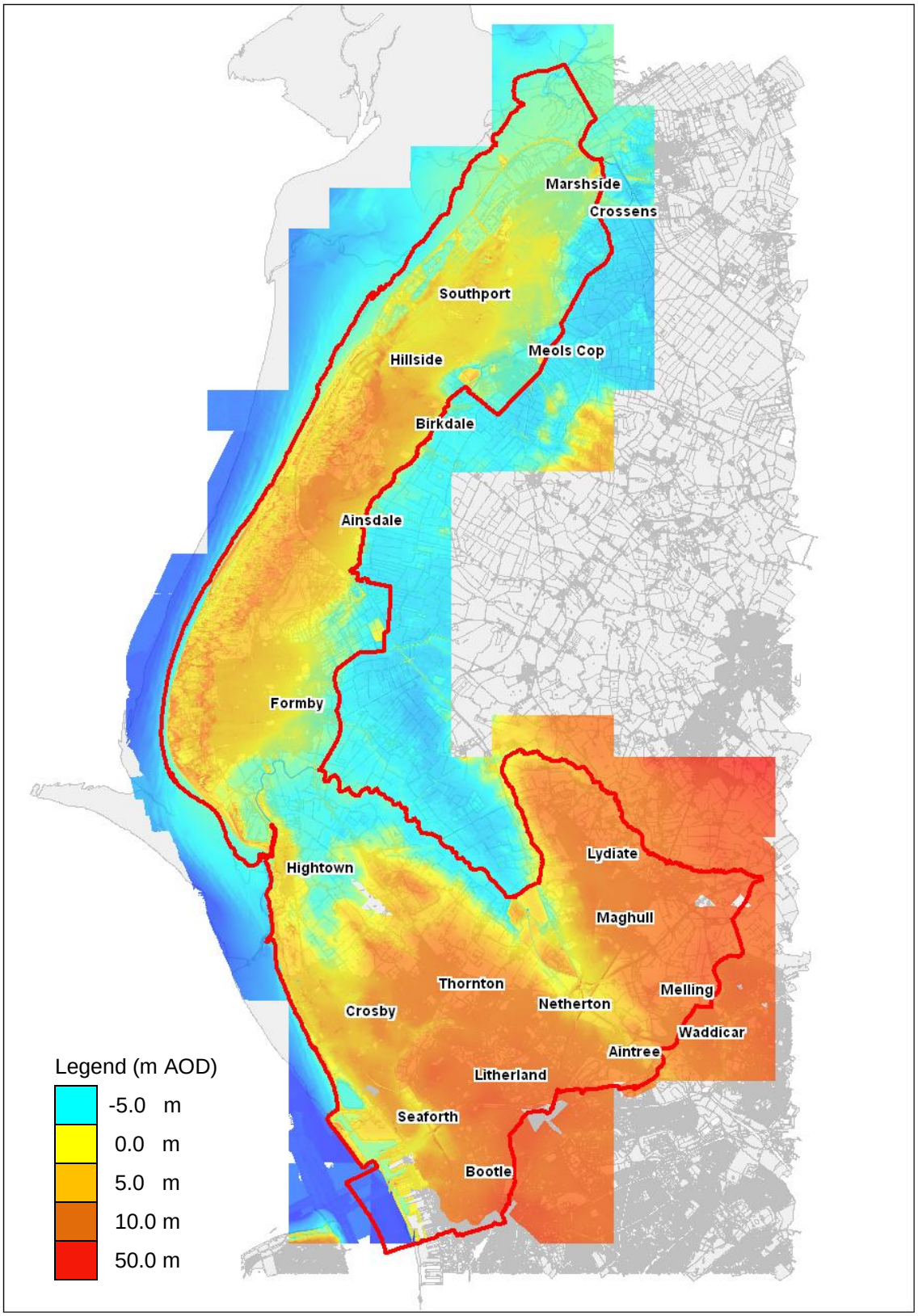


Figure 3-2: Sefton topography (based on available LiDAR coverage)

3.4 General land use

3.4.1 The northern half of Sefton, from Formby to Southport, is quite narrow and has a mix of urban areas, Formby, Ainsdale and Southport, bordered by coastal dunes to the west and arable and grazing fields to the east. The area immediately south and east of Formby is typically rural, dominated by arable fields until the edge of the urban areas of Crosby, Netherton and Maghull. There is some woodland between Ince Blundell and Crosby, however, woodland cover in Sefton is not extensive. Lydiate in the north east is also bordered by arable fields.

3.4.2 Significant infrastructure within Sefton includes the following key transport routes:

- M57, M58
- A59, A5036 (T), A565, A5203; and
- Merseyrail Northern Line:
  - Liverpool to Southport has stations at Bootle Oriel Road, Bootle New Strand, Seaforth and Litherland, Waterloo, Blundellsands and Crosby, Hall Road Station, Hightown, Formby, Freshfield, Ainsdale, Hillside, Birkdale and Southport.
  - Merseyrail Northern Line: Liverpool to Ormskirk has stations at Aintree, Old Roan and Maghull on the way to Ormskirk;
- Manchester to Southport Line and Meols Cop Station; and
- Freight lines.

3.4.3 Other significant infrastructure includes:

- Southport and Formby District General Hospital and Ashworth Hospital;
- 56 GPs Surgeries and 13 Health Centres;
- 8 Police Stations, 4 Fire Stations and 5 Ambulance Stations;
- 106 Schools, 39 Pre-schools, 46 Nurseries and 19 Children's Centres; and
- 86 Residential Homes and 47 Nursing Homes.

3.4.4 There are also the following environmental designations:

- The Ribble and Alt Estuaries Ramsar Site and Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI);
- Proposed Mersey Narrows & North Wirral Foreshore Ramsar site and potential SPA and SSSI;
- Sefton Coast Special Area of Conservation and SSSI;

- Ribble Estuary SSSI;
- Hesketh Golf Links SSSI;
- Five historical parks and gardens;
- 25 conservation areas;
- 15 Scheduled Ancient Monuments (SAMs); and
- 560 Listed Buildings.

3.4.5 In addition, there are 41 Local Wildlife Sites (known locally as Sites of Local Biological Interest, or SLBIs) or Sites of Geological or Geomorphological Interest, and a significant number of sites which are habitats of principal importance (Priority Habitats). Together, the internationally, nationally and locally important wildlife sites, the priority habitats and other features such as waterways and transport corridors make up Sefton's part of the Liverpool City Region Ecological Framework.

3.5 Interactions with neighbouring Boroughs / District Councils

3.5.1 The nature of the catchments of the River Alt and the drains that discharge at Crossens means that there are potential interactions with adjacent boroughs that could influence surface water flooding. Like Sefton, as unitary authorities, Liverpool and Knowsley are Lead Local Flood Authorities for their areas. Lancashire County Council is the Lead Local Flood Authority for West Lancashire.

3.5.2 Areas of Sefton, particularly those north of Formby, drain to the watercourses that run along the eastern boundary of Sefton, which it shares with West Lancashire. Although the boundary is sparsely developed on the West Lancashire side, the floodplain is relatively extensive and therefore actions taken within Sefton could influence surface water related flooding in this area.

3.5.3 The River Alt has its source in Knowsley and drains a catchment that includes areas of Liverpool, Sefton, West Lancashire and a small part of St. Helens District. Flood levels within the River Alt are known to influence flooding in places like Formby and so actions taken to manage flood risk, either within the Alt or within its catchment, could therefore influence flooding for better or worse in some parts of Sefton.

3.5.4 In addition, the Leeds and Liverpool Canal enters Sefton from West Lancashire to the north east of Lydiate District before passing out of Sefton in Bootle into Liverpool City Centre. The canal has previously breached in Maghull in 1994. It

should be noted that between Stanley Lock (Liverpool) and Dean Locks and Appley Locks (north west of Wigan) there are no locks to limit the available volume of floodwater in the event of a similar breach.

3.6 Population

3.6.1 The population of Sefton Borough stands at 273,800 residing in 117,900 households[24]. Between 2001 and 2011 the population of Sefton decreased by 3.2%. Latest population growth projections from the Office For National Statistics (2010) indicate that population is set to increase in the Borough by 5.3% over the next 25 years to 288,200 from the Census 2011 baseline.

[24] Office for National Statistics Census 2011.

4 Flooding in Sefton

4.1 Introduction

4.1.1 Six key sources of flooding are considered in this SFRA:

- Flooding from main rivers and ordinary watercourses (fluvial flooding);
- Flooding from the sea (tidal flooding)
- Flooding from groundwater;
- Flooding from surface water;
- Flooding from sewers; and
- Flooding from artificial sources (canals, reservoirs).

4.1.2 The study area and the key hydrological features that are considered within this study, such as main rivers, ordinary watercourses and large water bodies, are presented in Figure 1 in Volume 2.

4.1.3 The following sections present the risk of flooding from each source, identifying where possible the influence on that flood risk that any defence and other infrastructure may have and that climate change and new development may have. The sections identify if there are areas where further assessment may be required when considering risk to existing or new development.

4.1.4 Details of the data collected in this assessment, limitations with that data, the priority given to different types of data etc in making the above assessments and when undertaking the assessment of potential allocation sites is presented in Volume 3.

4.2 Fluvial Flood Risk

Fluvial flood risk - sources

4.2.1 Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (the floodplain). The main reasons for water levels rising in rivers are:

- Intense or prolonged rainfall causing runoff rates and flows to increase in rivers, which then exceeds the capacity of the channel. This can be exacerbated by wet conditions leading up to the prolonged rainfall and where there are significant contributions of groundwater;

- Constrictions in the river channel that reduce the capacity of the channel and causing flood water to backup and spill into the floodplain, i.e. culverts, bridges, pipe-crossings etc;
- Blockage of structures or the river channel causing flood water to backup and spill into the floodplain; and
- High water levels and/or locked flood gates preventing discharge at the outlet of a tributary into a river.

4.2.2 The consequence of river flooding depends on how hazardous the flood waters are and the nature of the receptor[18]. Vulnerability varies by land use, for example a Care Home or a children's nursery is considered to be highly vulnerable to flooding, dwelling houses are considered to be more vulnerable, whilst a commercial property would be considered to be less vulnerable. Further information on vulnerability classifications can be found within the Technical Guidance to the National Planning Policy Framework[5].

4.2.3 The hazard posed by floodwater is proportional to the depth of flooding, the velocity of flow, the speed of onset of flooding and duration. Flood hazard can therefore vary greatly throughout catchments and even across floodplain areas. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure as a result of deep and/or fast flowing water whilst lower hazard flooding can be less of a risk to life, by reason of being shallower or with low velocity. It can, however, disrupt communities, require significant post-flood cleanup and can cause costly and possibly structural damage to property.

Main Rivers

4.2.4 Main rivers are a statutory type of watercourse in England and Wales, and in England all main rivers are so defined by Defra. They are usually larger streams and rivers, but may also include some smaller watercourses. A main river can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only. A main river is defined as a watercourse marked as such on a Defra main river map. In Sefton this includes a significant number of drainage ditches.

4.2.5 Sefton contains a large number of main rivers (See Figure 2 in Volume 2). These are principally within two larger catchments; the River Alt catchment and the Crossens catchment. Those areas within Sefton that are outside either of these two catchments will drain towards the coast and are referred to as 'coastal catchments' within the remainder of this document.

4.2.6 The River Alt, the most significant of these main rivers, has its source in the adjacent borough of Knowsley, and enters Sefton between Aintree and Waddicar, draining areas south of Ainsdale. In total the River Alt drains a catchment of approximately 235km^2, approximately two-thirds of which lies outside of Sefton. It receives runoff from Huyton and Kirkby in Knowsley and some areas of Liverpool via Fazakerley Brook; as well as from Maghull, Lydiate and areas such as Aintree, Netherton and Thornton within Sefton itself. The River Alt is largely a pumped watercourse, with some natural gravity drainage, and it discharges into the sea via Altmouth Pumping Station.

4.2.7 Downholland Brook, which is a major tributary of the River Alt, drains from the north, along the boundary of Sefton and West Lancashire. Downholland Brook largely receives runoff from West Lancashire. However, it is also the receiving watercourse for runoff from areas such as Formby and parts of Ainsdale, and as such it contributes to fluvial flood risk within Formby. A tributary of Downholland Brook, Sudell Brook, runs along the boundary of Sefton and West Lancashire to the north of Lydiate and Maghull.

4.2.8 The Crossens catchment is the second significant catchment and it consists of a large number of watercourses that drain the eastern boundary of Sefton, from Ainsdale northwards to Southport. The catchment is approximately 120km^2, the majority of which is within West Lancashire District. It is a largely rural catchment, though it does receive runoff from places such as Ormskirk and eastern Southport. It is a pumped catchment, draining via the Crossens Pumping Station.

Ordinary Watercourses

4.2.9 There are a large number of smaller watercourses within Sefton which are classified as ordinary watercourses (See Figure 2 in Volume 2). All watercourses that are not designated as main rivers are termed and considered to be classified as Ordinary Watercourses. In Sefton this includes a number of drainage ditches. The regulation of activities on ordinary watercourses is the responsibility of Lead Local Flood Authorities (in Sefton this is Sefton MBC, Knowsley, Liverpool and Lancashire County Council are Lead Local Flood Authorities (the latter for West Lancashire), or where they exist Internal Drainage Boards (IDBs).

4.2.10 In the Southport area, a large number of ordinary watercourses exist to the north of Marshside drain beneath tidal defences. There are also a large number of field drainage ditches, which are also ordinary watercourses, associated with Captains Watercourse and the Three Pools Waterway (both main rivers) along the eastern boundary of the borough.

4.2.11 The Pool watercourse drains northwards from the western edge of Southport Golf Course. The watercourse flows into Serpentine Lake in the Botanic Gardens from where it flows, largely in culverts, through the Crossens area of Southport into Three Pools Waterway. The Pool receives very little runoff from nearby surface water sewers, as most runoff in this area discharges to combined sewers or to Three Pools Waterway.

4.2.12 On the coast there are a number of ordinary watercourses, again drainage ditches, which are associated with the coastal road, Royal Birkdale Golf Links, the dunes between Hillside and Ainsdale and Ainsdale Sand Dunes National Nature Reserve.

4.2.13 In the Formby area, south of this, there is a network of drains (ordinary watercourses) associated with the Wham's Dyke, Eight Acre Lane and Acre Lane Brook main rivers to the north of Formby. Within Formby itself, Dobb's Gutter is a notable ordinary watercourse, not least because of the localised flooding that occurs when there is heavy rainfall and also when there are high water levels in Downholland Brook and the River Alt. Dobb's Gutter is heavily culverted, has low gradients and significant capacity issues which contribute to the localised flooding, and despite regular maintained by Sefton MBC the watercourse causes frequent problems.

4.2.14 Dobb's Gutter and a number of other ordinary watercourses within Formby are remnants of a network of watercourses that have since become incorporated into a surface water sewer network. The Formby area is therefore a complex mix of surface water sewers managed by United Utilities, open and culverted ordinary watercourses that receive runoff from these surface water sewers, which are largely the responsibility of the Lead Local Flood Authority but in some cases riparian owners (including the Council), and main rivers on the northern, eastern and southern edge of the town that are the responsibility of riparian owners and the Environment Agency.

4.2.15 South of Formby, to the east of Hightown and within the low lying areas between Thornton and the River Alt there are a large number of field drains (also ordinary watercourses) that feed a number of main rivers, such as Ince Blundell, Northend Watercourse and Farmoss Pool. These main rivers all ultimately drain into the River Alt.

4.2.16 In the Maghull area, there are also ordinary watercourses to the north that drain to Sudell Brook, a main river that drains along the boundary of Sefton to the north. The headwaters of Maghull Brook and Rigby Brook are largely piped ordinary watercourses that become main rivers downstream of the Leeds and Liverpool Canal. There are also a network of ordinary watercourses that feed the

main rivers of Whinney Brook and Melling Brook.

4.2.17 Another notable series of ordinary watercourses exists in the vicinity of Claremont Avenue and Gainsborough Avenue, Maghull. These are located between residential properties and are therefore the responsibility of riparian owners, however, it is known that there are capacity and maintenance issues that cause problems here. These all drain to the Upland Drain main river.

4.2.18 Finally, in the Bootle and Crosby area, there remain open sections of Rimrose Brook, which is an ordinary watercourse that, historically, flowed through Rimrose Valley Country Park and through Seaforth into the docks area. This watercourse has largely disappeared downstream of the Country Park and most of the headwaters are drained via the combined sewer system, which runs alongside the historical path through the Country Park to the Sandon WwTW. Areas between Seaforth Road and Riverside Close, both along the original path of the Brook, were flooded in July 2010.

4.2.19 Sefton MBC has identified a number of critical ordinary watercourses within its Flood and Water Management Act Asset Register, which includes the following:

- Cross Green / Ditchfield
- Deansgate Lane
- Dobb's Gutter / Long Lane
- Drain to Dobb's
- Freshfield Road
- Grange Road
- Larkhill Lane
- Lytles Close
- Moss Side
- Rosemary Lane
- Whitehouse Lane

4.2.20 All of the above watercourses are in Formby.

Fluvial Flood Risk - Historic Records

4.2.21 A number of sources of data have been reviewed for information on historic fluvial flood events, including those provided by the Environment Agency and Sefton

MBC and from data available on its HiFlows website[25], the Alt Crossens CFMP[16] and the Mersey Estuary CFMP[17], Sefton's PFRA[22] and Sefton's Level 1 SFRA.

4.2.22 The Environment Agency provided a historical fluvial flood extent dataset that shows flooding in 8 locations in the south of Sefton. Table 4-1 below presents a summary of this information, and it is also presented in Figure 18 of Volume 2.

Table 4-1: Environment Agency historical fluvial flooding records

Date	Duration	Source	Cause/Consequences
12/11/1969	1 day	Whinney Brook	Inadequate, non-consented culverts through various garden areas in Brook Rd, causing problems in the Brook Rd area, but specifically , and on this date, flooding to 1 property and/or to agricultural land upstream of the Liverpool to Kirkby Railway
18/11/1970	1 day	Whinney Brook	Inadequate, non-consented culverts through various garden areas in Brook Rd, causing problems in the Brook Rd area, but specifically , and on this date, flooding to 1 property and/or to agricultural land upstream of the Liverpool to Kirkby Railway
22/10/1994	1 day	Whinney Brook	Inadequate, non-consented culverts through various garden areas in Brook Rd, causing problems in the Brook Rd area, but specifically , and on this date, flooding to 1 property and/or to agricultural land upstream of the Liverpool to Kirkby Railway
21/01/1995	1 day	Whinney Brook	Inadequate, non-consented culverts through various garden areas in Brook Rd, causing problems in the Brook Rd area, but specifically , and on this date, flooding to 1 property and/or to agricultural land upstream of the Liverpool to Kirkby Railway
10/08/2004	1 day	Dover's Brook	Dovers Brook, Sefton Meadows. Flooding to 2 properties. Sandbags taken to site and assistance given to householders.
20/07/2010	1 day	Dover's Brook	Dovers Brook channel capacity exceeded, water flowed along Sefton Lane and the access road for the Waste Transfer Station following the road gully. The water was then directed down a drain. 1 property affected.
20/07/2010	10 days	River Alt breach at Lunt Meadows	River Alt breached and flooded Lunt Meadows, the event outline has been derived from a topographic contour based upon the recorded flood level of 3.66m.
06/02/2011	1 day	Maghull at Hall Lane	Culvert at Alscot Close blocked causing flooding along Hall Lane. Manholes surcharging at points indicated on Hall Lane (approximate locations).

4.2.23 In addition to the above, Sefton MBC has confirmed flooding in Water Street, Thornton, from an ordinary watercourse on 9th July 2010 and again on 9th July 2012 and 13th August 2012. The latter date also affected a property on Essex Road, Ainsdale. Main River flooding was confirmed by Sefton MBC on 25th September from Eight Acre Lane Brook, Formby and in Fouracres, Maghull from

[25] HiFlows UK, www.environment-agency.gov.uk/hiflows

Dover's Brook. A search of the internet revealed photographs of the flooding north of Formby, in the vicinity of the bypass[26], and recent flooding whose source is not clear but which is likely to have been a combination of flooding associated with Dover's Brook, Maghull and surface water flooding.

4.2.24 Images of the flooding from Eight Acre Lane Brook were taken looking up Sixteen Acre Lane, which borders the main river of Acre Lane Brook and Eight Acre Lane Brook, on 25th September 2012. It is clear that parts of Hawksworth Drive, Formby, flooded but it is not clear what the source of this flooding is, i.e. main river or surface water. It is likely a combination of the two.

4.2.25 The flooding from Dover's Brook was reported by a local Councillor on 25th September 2012 and it affected a number of properties[27]. Reports by Merseyside Fire Service[28] support the onset of flooding in this area on 24th September 2012 and there are also records of Bridges Lane, near Sefton Village, having been shut due to flooding[29].

4.2.26 Flow and level data is available from the Environment Agency's HiFlows-UK website for the Alt at Kirkby flow and stage monitoring gauge (Gauge Ref: 69032). This is located at NGR 339180, 398340 on the boundary of Sefton and Knowsley and is operated by the Environment Agency.

4.2.27 A review of the annual maximum series, which identifies the highest flow within each water year (1st October to 30th September), indicates that the highest recorded flow at the gauge was approximately $31m^3s^{-1}$ recorded on 10th August 2004, which correlates with the event identified in Table 4-1 on Dover's Brook.

4.2.28 Prior to this the highest recorded flow had been of $26m^3s^{-1}$ on 10th August 1971, followed by two events of nearly $25m^3s^{-1}$ in successive water years, on 30th October 2000 and 9th September 2002. None of these correlate with historic flood outlines and it is not known whether these events caused localised flooding anywhere that was not reported at the time.

4.2.29 A review of the Chronology of British Hydrological Events website, managed by the University of Dundee, and an internet search were also carried out for other historical fluvial flooding information. No results were found on the Chronology of British Hydrological Events.

[26] http://www.formbyfirst.org.uk/2012/09/some-views-of-flooded-formby.html
[27] http://tonyrobertson.mycouncillor.org.uk/2012/09/25/flooding-maghull/
[28] http://www.merseyside.police.uk/news/latest-news/2012/09/25/flooding-across-merseyside.aspx
[29] http://tonyrobertson.mycouncillor.org.uk/2012/09/25/flooding-sefton-parish/

Fluvial Flood Risk - Flood Zones

4.2.30 Current national planning policy defines three distinct flood zones, 1, 2 and 3, with further sub-classification of Flood Zone 3 into Flood Zone 3a and Flood Zone 3b. Table 4-2, below, provides detail of how each flood zone is defined. It is important to note that Flood Zones do not consider the presence of flood defences or other flood risk management infrastructure and they do not account for climate change. They also do not typically apply to watercourses with a catchment area less than 3km^2 and as such do not include many ordinary watercourses.

Table 4-2: Fluvial flood zones defined in Table 1, NPPF

Flood Zone	Definition
Flood Zone 1. Low probability	Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year
Flood Zone 2. Medium probability	Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding
Flood Zone 3a. High probability	Land assessed as having a 1 in 100 or greater annual probability of river flooding
Flood Zone 3b. Functional floodplain	Land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 or greater in any year or is designed to flood in an extreme (1 in 1000 annual probability) flood.

4.2.31 Flood Zones are updated on a quarterly basis by the Environment Agency, though this will only result in a change to Flood Zones within Sefton when new data is available, for example from detailed hydraulic modelling studies or when existing flood zones have been challenged by a developer or a Local Authority. In light of this, it is recommended that Sefton MBC regularly discuss potential changes to the Flood Zones within its area and ensure that the most up-to-date datasets are available.

4.2.32 This assessment uses the latest Environment Agency Flood Zones, which explicitly identify Flood Zones 2 and 3 and therefore, by omission, also identify those areas that lie within Flood Zone 1. Figure 3 in Volume 2 presents the extent of the Environment Agency's Fluvial Flood Zones 2 and 3 throughout the study area.

4.2.33 However, it is understood that the Environment Agency is aware of an issue with the currently defined extent of Flood Zone 2 in the Maghull area, associated with the River Alt. Discussions with the Environment Agency indicate that the issue relates to areas that are shown to be within Flood Zone 2 but which could not be

at risk of flooding. The extent of Flood Zone 2 is therefore overly conservative in this area. The Environment Agency has indicated that the Flood Map will not be updated until 2013.

Flood Zone 3

4.2.34 Within the Crossens catchment, from Ainsdale to Southport, the only area affected by fluvial Flood Zone 3 is an area around and between Captains Watercourse and Three Pools Waterway; it affects areas of rural land but no properties.

4.2.35 Within the Downholland Brook catchment there are small areas at risk of inundation north and east of Formby along Eight Acre Lane and in areas bordering Wham's Dyke until it meets Downholland Brook. This affects properties and businesses along Eight Acre Lane and Southport Old Road. There are also flooded areas associated with Formby Moss Brook, Fine Jane's and Boundary Brook (Woodvale) that only affect rural land. South east of Formby, flooding is shown to affect land south of Altcar Road that is associated with Boundary Brook (Formby).

4.2.36 Along the River Alt there is an area of flooding associated with Melling Brook and Brooklea that borders the eastern edge of the Liverpool-Ormskirk railway line and connects the two watercourses (east of Maghull, north of Aintree). It would appear from the flood extent that flow from Melling Brook is unable to pass beneath the railway line and that it then connects with and contributes to flooding from Brooklea.

4.2.37 There is also flooding that appears to be affected by this railway line on Whinney Brook and again there is some flow down gradient from the culvert beneath the railway line. Flooding is also shown downstream, affecting Foxhouse Lane and Eastway in Maghull, then further downstream affecting properties on Damfield Lane and on Hall Lane/Alscot Close within Maghull. The Damfield Lane area appears to be caused by constriction at the Leeds and Liverpool Canal, whilst it is noted that Hall Lane/Alscot Close is an area that has previously been flooded according to the Environment Agency (Table 4-1).

4.2.38 Downstream of the confluence of Whinney Brook and Dover's Brook there is a large area of flooding shown around western Maghull and including the eastern side of the line of the disused railway which now forms part of the Cheshire Lines Path / Trans Pennine Trail. The flooding extends from Whinney Brook northwards across Sefton Lane, and incorporating Upland Drain until Maghull Brook in the north. This area affects Sefton Industrial Estate and numerous properties on Hathaway, Meadway, Lincoln Green, Old Racecourse Road, Sefton

Drive and the western ends of Gainsborough Lane, Rosslyn Avenue and Claremont Avenue, Maghull.

4.2.39 There is flooding associated with the left bank of the River Alt downstream of its confluence with Dover's Brook, again associated with areas of previous flooding (Table 4-1). Downstream of this, relatively large areas of rural land associated with Ince Blundell pumped watercourse, which is adjacent and flows parallel to the River Alt until North End, Ince Blundell, is affected. Finally, there are small areas bordering the Alt just upstream of the Altmouth Pumping Station, around Hightown that are shown to be affected by fluvial Flood Zone 3.

4.2.40 Sudell Brook, along the boundary of Sefton to the north of Lydiate and Maghull, has a well defined and relatively confined floodplain that within Sefton impacts mainly agricultural land. There are exceptions, however, and properties are impacted by Jackson's Bridge, near the Leeds and Liverpool Canal, and by the junction of the A59 Northway and Liverpool Road (B5407), Lydiate. There are also buildings within the Ashworth Hospital (North) complex that are shown to lie within Flood Zone 3, as are works buildings north of Powderworks Lane and a section of the M58.

Flood Zone 3b 'The Functional Floodplain' and Flood Zone 3a

4.2.41 The National Planning Policy Framework and Technical Guide divides Flood Zone 3 into two – Flood Zone 3a, areas with a high probability of flooding (presented in Figure 3 of Volume 2), and Flood Zone 3b, the functional flood plain – the land where water *has* to flow or be stored in times of flood. The range of potentially suitable land uses and development differs between Flood Zone 3a and Flood Zone 3b, with the restrictions being less for Flood Zone 3a. In principle, Flood Zone 3b is only suitable for water compatible development (such as public green space, or flood control infrastructure), and essential infrastructure (such as transport infrastructure) if the sequential and exceptions tests have been passed.

4.2.42 The land that would flood in a 1 in 20 annual probability event or which is designed to flood in a 1 in 1000 annual probability event is typically associated with Flood Zone 3b (Table 1 of the Technical Guidance to the NPPF). However, this is noted in the Technical Guidance as only the starting point for consideration of what defines the function floodplain. As noted in Section 1.1.3, this SFRA adopts the 1 in 25 annual probability flood extent on the basis that this dataset is available from *all* detailed modelling outputs. It also has the benefit of being slightly more conservative in the absence of a full dataset presenting the extent of the 1 in 20 annual probability event.

4.2.43 Within the Crossens catchment, there are no areas identified to be at risk from a

1 in 25 annual probability event (See Figure 8 in Volume 2)

4.2.44 Within the Lower Alt there are five areas shown to be at risk from a 1 in 25 annual probability event. Two of these are located in fields at North End, to the north west of Ince Blundell, that are associated with the Ince Blundell watercourse and which in the case of the larger area abuts Scaffold Lane (See Figure 8 in Volume 2). No properties are affected. To the east of Formby, there is a large area affected to the south of Formby Business Park that is associated with Boundary Brook (Formby) although again only farmland is affected. North of this along Wham's Dyke there is flooding around Formby Moss that affects farmland whilst further north, again on Wham's Dyke where it crosses underneath Eight Acre Lane, there is flooding of farmland but also of properties.

4.2.45 Within the area covered by the Maghull modelling there are a number of areas shown to be at risk from a 1 in 25 annual probability event. These principally lie along the path of Whinney Brook, Melling Brook and Brooklea (See Figure 8 in Volume 2). The flooding on Whinney Brook is largely affected by the presence of the Liverpool-Ormskirk railway line to the east of Maghull that results in flooding of fields to its east. This creates a flow path down gradient in a southerly direction along the railway line that affects Maghull Station car park.

4.2.46 Downstream of the railway line a number of properties alongside Whinney Brook are affected. There is also further flooding on Whinney Brook where the watercourse passes beneath the Leeds and Liverpool Canal, though no properties are affected. There is again flooding around Alscot Close, Maghull where Whinney Brook passes beneath Hall Lane.

4.2.47 On Melling Brook the Liverpool-Ormskirk railway has a similar effect in that a flow path is forced southwards along the eastern edge of the railway line. In this case the flow crosses the M58 and joins up with Brooklea at the point at which Brooklea meets the River Alt (See Figure 8 in Volume 2). No properties are affected.

Flood Zone 2

4.2.48 Fluvial Flood Zone 2 results in flood risk in larger areas around Captains Watercourse, Southport, and also affects more areas of Three Pools Waterway within the Crossens catchment. Properties around Colchester Road, Wollaton Drive and Glaisdale Drive, Kew, are also now affected.

4.2.49 North and north west of Formby around Eight Acre Lane and Wham's Dyke and by Boundary Brook (Woodvale) the extent of flooding is greater. To the east of Formby there is now flooding north of Moss Side, which receives runoff from Dobb's Gutter and much of Formby, and there is more extensive flooding

between Bull Cop and Downholland Brook and the extent of flooding around Boundary Brook (Formby) is larger in this event.

4.2.50 In this event the extent of flooding along the River Alt is significantly larger. Areas of Aintree are affected to the south of the M57, encompassing significant areas to the south of the River Alt associated with Moor Hey Brook as far as Netherton Brook. North of the River Alt, the floodplain of Brooklea merges with the lower floodplain of Melling Brook, Whinney Brook and continues across Sefton Lane until meeting with Upland Drain Maghull Brook. Significant numbers of properties would be affected by flooding in this part of the flood plain.

4.2.51 Downstream of the confluence of the River Alt and Maghull Brook, significant additional areas of the left bank are flooded. Downstream of Hunts Brook, only areas around North End, Ince Blundell are significantly more affected by Flood Zone 2 than they were by Flood Zone 3.

4.2.52 The extent of Flood Zone 2 along Sudell Brook is only slightly larger than that of Flood Zone 3 with impacts to a small number of additional properties.

4.2.53 Sudell Brook, along the boundary of Sefton to the north of Lydiate and Maghull, has a well defined and relatively confined floodplain that within Sefton impacts mainly agricultural land. There are exceptions, however, and properties are impacted by Jackson's Bridge, near the Leeds and Liverpool Canal, and by the junction of the A59 Northway and Liverpool Road (B5407). East of Maghull, there are also buildings within the Ashworth Hospital (North) complex that are shown to lie within Flood Zone 3, as are works buildings north of Powderworks Lane and a section of the M58.

Fluvial Flood Risk - Risk with Defences

4.2.54 As the Environment Agency's Flood Zone Map (and hence Flood Zones 2 and 3) – shown for Sefton in Figure 3 in Volume 2 - does not take into account the presence of defences or climate change, more detailed data has been collated, principally from the Environment Agency, that can provide additional information on risk.

4.2.55 When referring to Flood Zones, which do not take into account defences, the classification presented in Table 4-2 is used. Understanding the risk with defences (which may be termed actual flood risk) is also important; that is, taking into account the presence of defences, and assuming that they are of good condition and remain operational during a flood event. A probability is used to describe the frequency with which a flood event might occur, taking into account

defences.

4.2.56 The probability of flooding is described in this SFRA using the term Annual Probability. This is sometimes known as the 'annual probability' of flooding, for example a flood event described as a 1 in 100 annual probability has a 1% chance of occurring in any given year. This could alternatively be described as a 1 in 100 year return period flood event, i.e. a storm that has a 1 in 100 or 1% chance of happening in any given year.

4.2.57 The risk with defences of fluvial flooding within Sefton has been assessed using available hydraulic model data for a 1 in 25 annual probability flood event, a 1 in 100 annual probability flood event, a 1 in 100 annual probability event plus a 20% allowance for climate change event and a 1 in 1000 annual probability event. As indicated elsewhere, the 1 in 25 annual probability event has been used, rather than the 1 in 20 annual probability event, to represent the functional floodplain, which also ensures that all of the available modelling could be directly compared, as all model outputs provided a 1 in 20 annual probability flood extent. The extent of the fluvial flood risk with defences is shown in Figure 6 in Volume 2. The extent of defences is shown in Figure 11a and 11b in Volume 2.

4.2.58 All of the above probabilities, and the resulting flood extents shown in Figure 6 in Volume 2, assume that all the formal and de facto defences are in place, and that they are fully maintained and operational[30]. The following table sets out what additional hydraulic modelling information is available and indicates what data was used within the assessment.

Table 4-3: Available fluvial hydraulic models within Sefton

Model Name	Completion Date	Model Type	Hydrology	Description	Comments
River Alt Section 105 Study[31]	01/01/2000	1D Hydro-dynamic	Calibrated FSR	R. Alt, Dovers Brook, Whinney Brook, Downholland Brook, Fazakerley Brook, Croxteth Brook, Knowsley Brook - Originally modelled in 1997.	Not provided by the EA because of the age of the study and given that FSR hydrology is now superseded.

[30] The assumption that formal and de facto defences are in place and fully functional is inherent in the assumption as it is difficult to attribute a probability of failure to a defence and incorporation of multiple failure scenarios would be excessive. Instead, the residual risk and consequences of failure of flood defences is typically considered so that this can be incorporated into the design of new developments. Residual risks, when considered within this assessment, are those that remain after consideration of the presence of flood defences and flood risk management measures. Residual risks might therefore include a 1 in 1000 annual probability flood event where the defences are only built to a design standard of a 1 in 100 annual probability flood event. Residual risk might also include consider the consequences of a 1 in 100 annual probability flood event combined with the failure of a flood defence.

Model Name	Completion Date	Model Type	Hydrology	Description	Comments
Crossens Modelling Project	01/03/2007	1D Hydro-dynamic, ISIS	Calibrated FEH	ASM modelling study of the Crossens catchment. Project considers the response of the Catchment, which is entirely dependent upon pumped drainage, to high and low flow events. The Q1000 undefended outline was produced in December 2010.	The undefended levels classed as pumps offline, but defences still in place.
The Alt Strategy Model 2010	04/10/2010	1D/2D Hydro dynamic, ISIS-TUFLOW	Calibrated FEH	Extends from River Alt upstream of Kirkby gauging station to Altmouth and includes Downholland Brook to Ainsdale.	Only partially calibrated because new pumping station at Altmouth has been included in the model.
Maghull SFRM Study 2010	20/12/2010	1D/2D Hydro dynamic, ISIS-TUFLOW	Calibrated FEH	1D-2D ISIS-TuFLOW Def_Undef model of Whinney, Melling, Old Alt and Dovers Brooks.	Built for Flood Risk Mapping purposes and to compliment the Alt Strategy model to complete picture of fluvial risk in Maghull. Culvert Blockage Assessment conducted.

4.2.59 It will be noted from Table 4-3 that the Section 105[31] model data for the River Alt was not provided or used within the assessment. The hydrology used within this model is now 12 years old and has been superseded a number of times and it is possible that there are areas where the river and structures along it have changed. Fluvial flood risk with defences within Sefton is therefore predominantly based on the Crossens model, the Lower Alt Strategy Model and the Maghull Model, and more information about these is set out in the following sections.

4.2.60 Figure 6 in Volume 2 presents the extent of flooding simulated by the Environment Agency's fluvial hydraulic modelling within the study area, shown in Table 4-3 above, and discussed in more detail below. It should be noted that all scenarios discussed below (Sections 4.2.61 to 4.2.111) are based on the outputs of 'with defences' hydraulic modelling scenarios.

[31] Section 105 refers to the appropriate section of the Water Resources Act 1991 which requires the Environment Agency to from time to time to survey matters relation to its flood defence function. This included areas where flood defence problems were likely but also included floodplains, washlands and other land liable to flood.

Crossens Modelling

Flood Extents

4.2.61 Within the Crossens catchment, there are no areas identified to be at risk from a 1 in 25 annual probability event (See Figure 6 in Volume 2). However, large areas of land (greater than 50ha) in the vicinity of Captains Watercourse are shown to be at risk in a 1 in 100 annual probability flood event.

4.2.62 The effect of climate change is to increase the extent of flooding in this area, to one that is not significantly different from the with defences 1 in 1000 annual probability flood extent which is only marginally larger and which has no notable additional impacts.

Flood Depths and Velocities

4.2.63 There is no information available on the depth of flooding seen within the Crossens catchment when the presence of defences is taken into account, as the model used to simulate flood levels is 1D only. There are therefore no 2D depth grids or velocity grids to review. However, comparison of topographical levels to the extent of flooding suggests that the maximum depth of flooding may be between 0.5 and 1.0m in places.

Time to Peak and Time of Inundation

4.2.64 The Crossens model utilises flow estimated from a Probability Distributed Model (PDM). The PDM hydrology indicates that a peak flow is generated between approximately 67 hours and 73 hours into the simulation, which is reflected by peak water levels at around 85 hours from the start of simulation. It is noted in the model results files that when water levels start to rise they do so consistently taking approximately 24 hours to reach peak water levels that are around 1.0m higher. There is therefore likely to be sufficient lead in time from rainfall to a flood event for hazards to people to be minimised, though once overtopping of the banks takes place inundation is likely to take place relatively rapidly and levels could remain high for more than 24 hours.

Influences on Flood Risk

4.2.65 There are a large number of structures in the Crossens catchment and along Three Pools Waterway and Captains Waterway that may have an influence on flood risk. The most important structure is obviously Crossens Pumping Station itself, which is the main means by which flooding in the catchment is managed.

4.2.66 The current operating regime of the Crossens catchment means that, when

operating as intended, there is generally little risk from river or tidal flooding, though it is understood to be sensitive in a few locations to large flood events, including parts of Southport.

4.2.67 Based on the extent of flood risk seen in the Environment Agency's fluvial Flood Zone Map, which is understood to be based on an undefended scenario that considers failure of the pumping station but defences remaining in place, the failure of the Crossens Pumping Station does not seem to result in a significantly greater risk to areas within Sefton, though areas of West Lancashire would be significantly impacted.

4.2.68 In addition to the pumping station there are also a number of weed screens, access bridges for roads and farm tracks, railway bridges and service pipes that cross the Crossens watercourses along the boundary of Sefton. Blockage of these may have localised effects to agricultural land, however, the consequences are not expected to significant increase risk to people and property.

Lower Alt Strategy Modelling

Flood Extents

4.2.69 Within the Lower Alt there are five areas shown to be at risk from a 1 in 25 annual probability event (See Figure 6 in Volume 2). Two of these are located in fields at North End, to the north west of Ince Blundell. To the east of Formby, there is a large area affected to the south of Formby Business Park that is associated with Boundary Brook (Formby). North of this, along the Wham's Dyke, there is flooding around Formby Moss. All areas only affect farmland except Wham's Dyke, which affects properties as well.

4.2.70 Flooding in a 1 in 100 annual probability flood event in the North End area, Ince Blundell, is more extensive and has a greater depth and there is an additional area of farmland to the north east of Ince Blundell that also becomes flooded. Notably to the east of Formby the 1 in 100 annual probability event increases the area of flooding to affect businesses in the Formby Business Park, where approximately a dozen properties are affected. Flooding associated with Wham's Dyke impacts a greater area in Formby Moss and to the north of Eight Acre lane and the extent of flooding around properties in this area is also larger. Figure 6 in Volume 2 presents the extent of this flooding. The areas shown to be at risk in the 1 in 100 annual probability event are generally significantly smaller than those shown by the fluvial only Flood Zone 3 in the Flood Zone Map (See Figure 3 in Volume 2). The exception is in the vicinity of Formby where the detailed modelled flood extent is larger (See Figure 6 in Volume 2)

4.2.71 The effect of climate change on flood risk in the 1 in 100 annual probability event

within the Lower Alt catchment is significant. Along the path of the River Alt in the south of the borough, there is a risk of flooding at the confluence of Brooklea and the River Alt (east of Maghull, north of Aintree). Flood water appears to be held back by the Liverpool-Ormskirk railway line, though no properties area affected. Just downstream, land between the two slip roads to the M58 from the junction of Dunnings Bridge Road and the M57 is also at risk of flooding .The extent of flooding predicted here by the Environment Agency's models is not different to that in the Environment Agency's Flood Zone 3.

4.2.72 Further downstream, west of Maghull, farmland at the confluence of Moor Hey Brook and the River Alt is also at risk of inundation, and beyond this there is a small pocket of inundation risk at an outfall downstream of Sefton Meadows and downstream of the confluence of the River Alt, St. Helen's Brook and Dover's Brook. Just downstream of Showrick's Bridge, which is just downstream of the confluence of the River Alt with Maghull Brook, in the Lunt Washland area there is a significant area of farmland inundated on the left bank of the River Alt which continues beyond this along the Ince Blundell watercourses.

4.2.73 Climate change effects in the Downholland Brook catchment on the 1 in 100 annual probability event are also notable, with flooding in farmland alongside Downholland Brook where it is crossed by Lunt Lane, Lunt. Flooding in Formby Business Park from Boundary Brook (Formby) is more significant, affecting more properties and inundating larger areas of Formby Moss to the north. Flooding from Wham's Dyke is seen to extend down to Moss Side, where it inundates properties and the flooding of farmland and properties to the north of Eight Acre Lane, Formby is more extensive.

4.2.74 The modelled 1 in 1000 annual probability flood extent significantly increases the area at flood risk within both the Lower Alt catchment and the Downholland Brook catchment. Along the Lower Alt, the extent of flooding upstream of the Liverpool–Ormskirk railway line at the confluence of the River Alt and Brooklea is almost 1km wide at its greatest and it inundates parts of both the M57 and the M58 to the east of the railway line. It is not, however, as extensive as is shown in fluvial only Flood Zone 2 (See Figure 3 in Volume 2). Downstream of the railway line the flood extent is almost as wide and it impacts the Dunnings Bridge Road and the M57 junction as well as a Superstore and associated buildings, including electricity sub-stations. Again, this is not as extensive as shown in the fluvial only Flood Zone Map.

4.2.75 Downstream of the junction between the River Alt and Brooklea the flood extent narrows a little, though it is remains wide and covers areas north of Netherton between the River Alt and Moor Hey Brook and extensive areas on the left bank of Moor Hey Brook, including some farm buildings, until as far as Netherton Brook

(See Figure 6 in Volume 2). This is as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2.

4.2.76 On Dover's Brook, Maghull there is flooding downstream of Sefton Lane, affecting a Garden Centre, properties and areas around a waste transfer site. Flooding to the north of here inundates a large number of properties on Sefton Drive. This flood extent then runs northwards along the eastern edge of the disused railway which now forms part of the Cheshire Lines Path / Trans Pennine Trail, until just before Maghull Brook. This is not as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2.

4.2.77 On the left bank of the River Alt, south west of Maghull, the extent of flooding of farmland is significantly larger in the modelled 1 in 1000 annual probability flood event. This area of flooding extends from the confluence of the River Alt and Maghull Brook beyond Hunts Brook and then in a number of places along the Ince Blundell watercourses until North End, Ince Blundell, where flooding is again significantly more extensive. Flooding is also seen to the west of this area, associated with Lighthouse Brook and also North End Watercourse. Again, only farmland is affected in this area. The detailed modelling extents are not as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2.

4.2.78 Flooding in farmland is again significantly larger in the 1 in 1000 annual probability event alongside Downholland Brook where it is crossed by Lunt Lane, and to the north of Formby Business Park. However, flooding in Formby Business Park from Boundary Brook (Formby) is not much changed from the 1 in 100 annual probability event with an allowance for climate change. Flooding from Wham's Dyke inundates more properties along Moss Side, Formby and the flooding of farmland and properties to the north of Eight Acre Lane is again more extensive. The flooding shown here in Figure 6 of Volume 2 is as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2.

Flood Depths and Velocities

4.2.79 Depth grids are available from the Lower Alt Strategy model for the Formby area only, covering Downholland Brook and Wham's Dyke. In the 1 in 100 annual probability flood event with an allowance for climate change, depths reach a maximum of approximately 1.0m to the south of Formby Business Park and along the edge of Downholland Brook. Within the business park itself, depths on roads are typically less than 0.25m, however, along Stephenson Way they increase to around 0.5m deep. To the north of the business park depths are in places up to 0.8m deep, however, the majority are less than 0.5m.

4.2.80 Along Wham's Dyke, the depths of flooding along the watercourse by Moss Side

are typically less than 0.25m, though in the channel the water is deeper. Within Formby Moss the depths reach up to 0.9m and the properties south of Eight Acre Lane are affected by flood waters that are less than 0.25m deep.

4.2.81 Velocity grids are also available from the Lower Alt Strategy model for Downholland Brook. In the 1 in 100 annual probability flood event with an allowance for climate change, velocities reach a maximum of approximately 0.7m/s to the south of Formby Business Park but generally in this area velocities are low. Along Wham's Dyke, the velocities associated with the flooding are typically less than 0.20m/s, though in isolated places within the channel there are higher velocities of up to 1.0m/s. The properties south of Eight Acre Lane are affected by velocities that are less than 0.25m/s, as are the fields to the north.

4.2.82 Flood depths are presented from the Lower Alt Strategy model in Figure 9 of Volume 2 and flood velocities are presented in Figure 10 of Volume 2.

Time to Peak and Time of Inundation

4.2.83 The Lower Alt Strategy model utilises hydrology estimates derived from ReFH model inflow boundaries that have been scaled to match FEH Statistical flow estimates at key locations. There are 21 flow nodes in total and sensitivity testing indicates that a 24-hour duration storm is critical across the catchment.

4.2.84 Analysis of the modelling results indicates that peak water levels are achieved between 16.75 hours and 24.6 hours into the simulation of this critical storm duration for a 1 in 100 annual probability flood event with an allowance for climate change. The time at which flooding commences in this event varies by location. Along the Lower Alt in the vicinity of Maghull, the time of inundation is between 10 and 15 hours, and the peak is reached around 18 to 19 hours into the simulation. Along the pumped Ince Blundell watercourses, the time of inundation as after 17 to 18 hours and peak is reached around 20 hours - however, because of the pumped nature water levels can remain relatively high for a day or more. Inundation in the flooded areas of the Downholland Brook catchment takes place between 9 and 14 hours into the simulation, and typically peaks around 24 hours, with the exception of Wham Dyke, which is a small tributary catchment to the north of Formby, which peaks at around 17 hours.

Influences on Flood Risk

4.2.85 There are a large number of structures in the Lower Alt catchment that have a significant influence on flood risk. The most important structure is Altmouth Pumping Station itself, which is the main means by which flooding in the catchment is managed. However, there are also the Altcar Pumping Station, Ince

Blundell Pumping Station and Hey Cop Pumping Stations; although with the exception of Ince Blundell Pumping Station these principally manage water levels, and therefore flood risk, within West Lancashire District.

4.2.86 Major channel conveyance limitations are understood to mean that only two pumps are operated at any one time, but in general they appear to limit the flood risk from the watercourse to predominantly farmland, with the exception of areas in and around Formby and Maghull. While failure of the pumps could result in additional impacts within the borough, however, review of the fluvial only Flood Zone Map (Figure 3 in Volume 2) indicates that the additional consequences would largely be limited to farmland and those areas surrounding these areas that are already at risk in extreme events.

4.2.87 In addition to the pumping station there are also a number of weed screens, access bridges for roads and farm tracks, railway bridges and service pipes that cross the Lower Alt watercourses. Blockage of these may have localised effects to agricultural land, however, the consequences are not expected to significant increase risk to people and property.

Maghull Modelling

Flood Extents

4.2.88 Within the area covered by the Maghull modelling there are a number of areas shown to be at risk from a 1 in 25 annual probability event. These principally lie along the path of Whinney Brook, Melling Brook and Brooklea (See Figure 6 in Volume 2). The Whinney Brook flood area appears to be affected by the presence of the Liverpool-Ormskirk railway line to the east of Maghull that results in flooding of fields to its east. There is flow from here in a southerly direction along the railway line that affects Maghull Station car park.

4.2.89 Downstream of the railway line a number of properties alongside Whinney Brook are also affected. There is also flooding where the watercourse passes beneath the Leeds and Liverpool Canal, though no properties are affected. There is flooding around Alscot Close, Maghull where Whinney Brook passes beneath Hall Lane.

4.2.90 On Melling Brook the Liverpool-Ormskirk railway has a similar effect in that a flow path is forced southwards along the eastern edge of the railway line. In this case the flow crosses the M58 and joins up with Brooklea at its confluence with the River Alt (See Figure 6 in Volume 2). No properties are affected.

4.2.91 In a 1 in 100 annual probability flood event there is a greater extent of flooding upstream of the railway line on both Whinney Brook and Melling Brook (See

Figure 6 in Volume 2). Near Maghull Station the flood extent is larger both in the car park and on the eastern side of the Liverpool-Ormskirk railway line, though it does not impact any properties. Downstream of the railway line, Whinney Brook impacts more properties between Eastway and Foxhouse Lane with the area of risk of flooding crossing Eastway and affecting properties to the west. Properties are impacted upstream of the Leeds and Liverpool Canal, at Hall Lane a few more properties would be affected, as would two properties along Northway. The flooding shown for the 1 in 100 annual probability event along Whinney Brook in Figure 6 of Volume 2 is as extensive as shown in the fluvial Flood Zone 3 in Figure 3 of Volume 2.

4.2.92 As well as these flood risk areas, the Maghull modelling also shows impacts to properties and businesses downstream of Sefton Lane on the right bank of Dover's Brook and towards Upland Drain. These areas were also shown to be affected by the Lower Alt Strategy modelling, however not as extensively. No properties on Sefton Drive itself are affected in this 1 in 100 annual probability flood event. The flooding shown for the 1 in 100 annual probability event in this area in Figure 6 of Volume 2 is significantly less extensive as is shown in the fluvial Flood Zone 3 in Figure 3 of Volume 2.

4.2.93 The effect of climate change on flood risk in the 1 in 100 annual probability event, as elsewhere in Sefton, would be significant. Whilst there is little change in the upper reach of Whinney Brook, the overland flow that runs southwards along the railway line would now extend beyond Melling Lane as far as Willow Hey, impacting numerous properties to the north of the Leeds and Liverpool Canal (See Figure 6 in Volume 2).

4.2.94 Downstream of the railway line the extent of flooding from Whinney Brook would extend as far as Brook Lane and beyond Colburn Close, impacting more properties. Upstream of the canal the extent of flooding is significantly larger affecting properties and also parts of the Maricourt Catholic High School site. At Hall Lane the extent of flooding is greater, affecting more properties along Hall Lane but also adjacent to Northway. Flooding could continue down Northway for some way and would cause problems with traffic flow along this road. To the west of Maghull, flooding would affect properties along the west of Sefton Drive and farmland northwards to Upland Drain.

4.2.95 The modelled 1 in 100 annual probability flood extent significantly increases the area at flood risk. The extent of flooding in the upper reaches of Whinney Brook, and around the confluence of Brooklea and the River Alt, is wider but remains largely affecting only farmland, as does the extent along the River Alt itself between the Liverpool-Ormskirk railway line and Netherton Brook with a few exceptions where properties are affected.

4.2.96 In the modelled 1 in 1000 annual probability flood extent, in eastern Maghull, more properties are affected by flooding from Whinney Brook downstream of the Liverpool-Ormskirk railway line. In the Willow Hey area the extent of flooding would be wider and flooding deeper with additional impacts to properties along and around Melling Road. The Maricourt Catholic High School site is affected more severely in this event and there are more properties affected at Hall Lane and along both sides of Northway. The flooding shown along Whinney Brook in Figure 6 of Volume 2 is as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2. However, in the vicinity of Brooklea the Flood Zone Map shows a larger extent at risk.

4.2.97 The largest increase in the consequences of flooding in this 1 in 1000 annual probability flood event is in the areas bordering Dover's Brook, in western and central Maghull. Flooding is seen again at Sefton Lane. However, it would now extend northwards all the way to Maghull Brook, and southwards to Whinney Brook. All properties on Sefton Drive are affected, as are additional properties in Sefton Business Park and properties along and bordering the Old Racecourse Road. Areas along Bridges Lane are also affected. The flooding shown in this area in Figure 6 of Volume 2 is not as extensive as shown in the fluvial Flood Zone Map in Figure 3 of Volume 2,

Flood Depths and Velocities

4.2.98 Depth grids are available from the Maghull model. In the 1 in 100 annual probability flood event with an allowance for climate change, depths reach a maximum of 1.0m adjacent to Whinney Brook upstream (east) of the Liverpool-Ormskirk railway line. Downstream of the railway line the depths immediately adjacent to the watercourse remain high, at over 1m, but beyond they quickly drop to around 0.1m to 0.2m deep. Southwards, depths along the railway line are around 0.35m, which deepens in the station car park. In the vicinity of Melling Lane depths are less than 0.1m, but they increase with proximity to the Leeds and Liverpool Canal at Willow Hey, where they reach up to 0.9m.

4.2.99 Depths of flooding in the 1 in 100 annual probability with an allowance for climate change flood event are significant where Whinney Brook passes beneath the Leeds and Liverpool Canal. Here depths would reach up to 1.8m, and are in excess of 1.0m for much of the area. Downstream in the Hall Lane area and along Northway depths are typically less than 0.2m, however, they are deeper in places.

4.2.100 In Maghull at Sefton Lane, the flow from Dover's Brook would result in depths of flooding that reach over 1.3m in a relatively large area. Because of the disused railway embankment, which now forms part of the Cheshire Lines Path / Trans

Pennine Trail, the flood water north of Sefton Drive would reach up to 1.0m, whilst along the edge of Sefton Drive itself it would generally remain below 0.5m, but could be higher in places.

4.2.101 Velocity grids are also available from the Maghull model for Whinney Brook. In the 1 in 100 annual probability flood event with an allowance for climate change, velocities associated with Whinney Brook upstream (east) of the Liverpool-Ormskirk railway line are generally less than 0.1m/s, however, there are places where it is higher, up to a maximum of approximately 0.8m/s. Flow velocities downstream (west) of the railway line are largely similar,. Southwards along the railway line to Maghull Station flow is typically less than 0.2m/s slowing down to less than 0.1m/a where water spreads out..

4.2.102 Despite deep water on the upstream (north eastside of the Leeds and Liverpool Canal) velocities associated with the flooding here are relatively low at less than 0.3m. Downstream, in Hall Lane, velocities are generally less than 0.3m in the floodplain but are higher closer to the watercourse.

4.2.103 In the Sefton Lane area of western Maghull, the velocity of flood water leaving Dover's Brook reaches a maximum of almost 1.6m/s. Away from this flow path, however, velocities are typically less than 0.3m/s. Flow through this area north-eastwards follows a route with velocities of around 0.2m/s with high spots of 0.3m/s.

4.2.104 Flood depths are presented from the Maghull model in Figure 9 of Volume 2 and flood velocities are presented in Figure 10 of Volume 2.

Time to Peak and Time of Inundation

4.2.105 The Maghull model utilises hydrology estimates derived from ReFH model inflow boundaries that have been scaled to match FEH Statistical flow estimates at key locations. There are 15 flow nodes in total, and sensitivity testing indicates that a 7.75-hour duration storm is critical within Maghull. This is less than the critical catchment storm used for the Lower Alt Catchment modelling, and is justified on the basis that the focus of the Maghull modelling is Maghull rather than the catchment as a whole. The Maghull modelling generally produces more conservative outlines.

4.2.106 Analysis of the modelling results indicates that peak water levels are achieved between 9.4 hours and 16.6 hours into the simulation of this critical storm duration for a 1 in 100 annual probability flood event with an allowance for climate change. The time at which flooded commences in this event varies by location. Along the Whinney Brook the time of inundation is between 5 and 10 hours from the start of the storm event, with the critical factor being the capacity of the

numerous culverts along this watercourse. Where flow arrives overland from Whinney Brook, for example in the Melling Lane and Willow Hey area, the time taken will be slightly longer than this, as flow has to travel further overland.

4.2.107 On Melling Brook the peak stage is reached after 9.4 hours, but inundation of surrounding areas and the start of the overland flow path to Brooklea takes place around 5 hours into the event, again because of culvert capacity. On Dover's Brook the peak water level is reach after 10.8 hours, however, because of low lying land inundation may take place after only 6 hours into the event.

Influences on Flood Risk

4.2.108 Flood risk in Maghull from Whinney Brook, Melling Brook and Brooklea is influenced by a number of key culverts beneath roads and railway lines but also by a number of small culverts and access bridges that have been constructed over the years without consent, prior to the watercourse being designated as a main river. There is a risk of blockage at these structures, and an increased risk of flooding.

4.2.109 As well as these larger structures there are numerous footbridges, farm access bridges, pipe crossings and screens that cross the watercourses. In addition, Dover's Brook shows some sensitivity to pumping at Altmouth pumping station, though not as much as areas lower down the catchment.

4.2.110 Blockage analysis has been undertaken by the Environment Agency for a number of structures, and the results for a 1 in 100 annual probability flood event have been reviewed here. In general, blockage results in an increased risk in this event to properties between Brook Lane and Whinney Brook, as well as to properties south of Maghull Station, in the vicinity of Melling Lane and Willow Hey.

4.2.111 Elsewhere, blockages in the Hall Lane area result in significant flow down Northway that would cause extensive inundation between Dover Road and Melling Brook. There is also flow to the west of Hall Lane that inundates areas between Northway and Fouracres, also affecting areas to the north of Whinney Brook that run along the southern edge of Maghull High School and then northwards affecting properties on Hathaway, Meadway and Lincoln Green.

4.3 Tidal Flooding

4.3.1 Tidal flooding occurs when water levels along the coast exceed the level of coastal land or coastal flood defences.

4.3.2 Tides are controlled by the gravitational pull of the moon and sun, by the rotation of the earth and by the bathymetry of the coast. High astronomical tides occur approximately twice per month when the gravitational pull is at its highest and are at their highest three to four times per year when the moon is at its closest in its cycle.

4.3.3 Astronomical tides can be influenced by storms in which the low pressure results in higher than normal water levels referred to as a storm or tidal surge. When a storm surge coincides with a high astronomical tide the result can be water levels that are significantly higher than usual mean high waters.

4.3.4 Tidal flooding can also be caused within rivers or estuaries by 'tide locking', which is where a high tide prevents a river or estuary from discharging into the sea, causing 'backing up' and resulting in flooding.

Source of flooding risk and overview of defences

4.3.5 The whole coastline of Sefton is exposed to high astronomical tides and storm surges. However, not all of the coastline presents a potential source of tidal flooding, largely due to the presence of man-made and natural defences. These defences are shown on Figures 11a and 11b in Volume 2.

4.3.6 A short stretch of the Banks Sea Embankment, which is an earth embankment, runs from Crossens Pumping Station along the boundary of Sefton and West Lancashire, before continuing into West Lancashire. Southwards, high ground along the south side of Crossens Pool then connects into a sea defence consisting of defence embankments and a wall that runs along the length of Marine Drive to the Weld Road roundabout. The Sefton Coastal Defence Strategy[32] indicates that these defences are liable to settlement. Within this wall is a second, earlier, defence line, which pre-dates the construction of Marine Drive (the Coast Road) and above defences. This consists of secondary earth embankments, which are maintained from Crossens to Southport Golf Course.

4.3.7 Between Weld Road roundabout, Birkdale and the mouth of the River Alt at Hightown there is a continuous ridge of sand dunes that forms a natural sea defence. These dunes are between 7 and 20m high in places and are generally not maintained.

4.3.8 Up the Alt, to the Altmouth Pumping Station, there are man-made defences consisting of embankments, and these which river embankments continue for some distance on the eastern, inland side of the Pumping Station. Along the

[32] Sefton Council (2000) Coastal Defence Issues and Strategy

coast to the south of the River Alt there are dunes that are considered to form natural sea defences, which then connect with a wall, classed as coastal protection, at Blundellsands Sailing Club, Hightown.

4.3.9 Between Hightown and Hall Road, Crosby, first dunes and then a cliff offer coastal protection for the land, including the West Lancashire Golf Club. A groyne protects the beaches from erosion, whilst to the south of this are coastal protection embankments and then a wall (and promenade) to the former Coast guard station at Hall Road. This wall continues to run southwards along the coast, past Crosby beach to end at the northern boundary of the Port of Liverpool, where the Marine Lake adjoins Seaforth Nature Reserve (which is within the Port area). The Port of Liverpool docks continue southward to Sefton's boundary with Liverpool.

4.3.10 The Coastal Defence Strategy indicates that all defences north of Mariners Road, Crosby, to Hightown are at risk of breach or erosion, which may then result in a higher risk of breach. In Southport, north of Weld Road and Marine Drive there is also a risk. The Port of Liverpool docks, which are not considered a risk in light of comments in the Sefton Coastal Defence Strategy, which states that:

The coastline consists of rock armour river walls that provide immediate protection to the Brocklebank to Gladstone and Royal Seaforth Docks. The defences are owned and maintained by [formerly, the Mersey Docks and Harbour Company; now, by Peel Ports]. The river bed shoreline is only exposed at water - its condition is stable. The river walls are massive and the risk of breach or flooding is considered very low.

Tidal Flood Risk - Historic Records

4.3.11 Historic flood records for the Sefton coastline are limited, however, the Coastlines website[33], which is the website of the Sefton Coast Partnership[34], mention the following anecdotal information and records of tidal flooding and inundation since the 1600s.

Date	Comment
1600's	Villages of Meanedale, Argameols and Ravemmeols lost to the sea
December 1720	'Great losses sustained in Lancashire by the violent overflowing of the sea' as a result of storm tides flooding 6,600 acres of land, destroying 157 houses and damaging a further 200. Damage to Pilling Moss and Marton Moss on the Fylde Coast and the West Lancashire Moss between Sefton and Tarleton. Sea banks at Ince Blundell were

[33] http://www.seftoncoast.org.uk/articles/02winter_tidalflooding.html

[34] Sefton Coast Partnership is a partnership between a number of interested parties including Sefton Council officers and Councilors, regulators, charities, conservation groups and leisure organisations.

Date	Comment
	breached, the River Alt floodgates were broken and more than 100 acres of farmland were damaged by sea water. A bridge at Crosby was also damaged.
January 1839	Sea walls broken down in Southport
December 1852	Sea walls broken down in Southport
January 1959	Sea walls broken down in Southport
October 1883	Promenade and Cheshire Lines Railway damaged.
December 1883	Damage to Hesketh Bank (West Lancashire)
November 1866	Damage to Hesketh Bank (West Lancashire) resulting in flooding of village and farmland
11th/12th November 1977	110 houses flooded along Harrogate Way in Crossens due to tide level approximately 1.5m (5ft) higher than predicted level. Water had overtopped a lower lying portion of seawall dating from the 1890's. Sand dunes elsewhere in Sefton also eroded by approximately 20m with damage to promenades, coastal parks and sea walls

Tidal Flood Risk - Flood Zones

4.3.12 The table below provides detail of how tidal flood zones are defined. It is important to note that neither river nor tidal Flood Zones consider the presence of flood defences or other flood risk management infrastructure, and that they do not account for climate change.

Table 4-4: Tidal flood zones defined in Table 1, NPPF

Flood Zone	Definition
Flood Zone 1. Low probability	Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year
Flood Zone 2. Medium probability	Land assessed as having between a 1 in 200 and 1 in 1000 annual probability of sea flooding
Flood Zone 3a. High probability	Land assessed as having a 1 in 200 or greater annual probability of flooding from the sea in any year.
Flood Zone 3b. Functional floodplain	Land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 annual probability or greater in any year or is designed to flood in an extreme (1 in 1000 annual probability) flood.

4.3.13 This assessment uses the latest Environment Agency Flood Zones, which explicitly identify Flood Zones 2 and 3 and therefore, by omission, also identify those areas that lie within Flood Zone 1. The tidal Flood Zone 3b is not currently

of particular relevance within Sefton, as the existing tidal flood defences currently provide a sufficient standard of protection to ensure that there are no areas of tidal flood zone 3b inland from the defence line and consequently there is no flood extent shown within Figure 7 in Volume 2 for this event and Figure 8, which presents the extent of Flood Zone 3, only presents that available from fluvial modelling. Flood Zone 3b may, however, become an issue if the standard of protection is not maintained when taking into account the effects of climate change, particularly within the Southport area and inland from Altmouth. Consequently, the tidal Flood Zone 3b is considered further in the sections below.

4.3.14 Figure 4 in Volume 2 presents the extent of the Environment Agency's Tidal Flood Zones 2 and 3 throughout the study area.

Tidal Flood Risk - Flood Zone 3

4.3.15 The Environment Agency's tidal Flood Zone 3 is extensive in the north of Sefton in the Southport area. This largely reflects the fact that the Flood Zones do not take account of the presence of defences. Tidal inundation is seen covering all of the Marshside Area, extending as far as Three Pools Waterway and affecting areas in the vicinity of Captains Watercourse by virtue of flow paths along The Pool. A significant number of existing properties in this area are therefore shown to be at risk.

4.3.16 Inundation of Marine Lake is noted, however, south of this no inundation beyond existing defence lines is noted. South of Weld Road roundabout there is no inundation beyond the immediate extent of the beach and dunes until Altmouth, Hightown.

4.3.17 At Altmouth, the tidal flood zones, which assume no defences, are shown to inundate significant areas inland, including areas as far north as Ravens Meols Brook and Hogshill Lane in the south of Formby, plus areas between the Ince Blundell pumped watercourses and the River Alt. No flooding, however, is seen upstream of North End, Ince Blundell.

Flood Zone 3b 'The Functional Floodplain' and Flood Zone 3a

4.3.18 Sections 4.2.41 and 4.2.42 define Flood Zone 3a and Flood Zone 3b and identify what development is appropriate within these flood zones.

4.3.19 As indicated in 4.3.13, above, the current extent of the tidal Flood Zone 3b within Sefton is not currently of much relevance, as all tidal flood defences provide a level of protection that is equal in almost all areas to the current 1 in 200 annual probability flood level, as indicated by the extent of flooding shown in Figure 7 of Volume 2.

4.3.20 Where Flood Zone 3b becomes of more relevance is when the effect of climate change on flood levels is taken into account. Using the levels presented in Table 4-6 with an allowance for climate change of 0.95m to the year 2115, it is estimated that the 1 in 25 annual probability tidal flood level will increase to between 6.57m AOD and 6.72m AOD along the Sefton coastline. In all cases this is higher than the current 1 in 200 annual probability flood level and whilst this is not expected to effect the extent of flooding inland from tidal defences, in the Southport area there would certainly be more encroachment of tidal flood levels into the dunes alongside Hillside, which is likely to increase the opportunity for erosion and breach of natural defences.

4.3.21 There are no existing model outputs or mapped flood extents to present the extent of the tidal Flood Zone 3b, or for that matter the extent of the tidal Flood Zone 3a with an allowance for climate change and it is therefore recommended that where a site lies within the currently defined tidal Flood Zone 2 that the identification of the consequences of climate change on these flood extents is investigated within a site-specific Flood Risk Assessment.

Tidal Flood Risk - Flood Zone 2

4.3.22 The tidal Flood Zone 2 indicates an increase in the area of flooding within Southport by approximately 10 to 15% compared to Flood Zone 3, with a larger area between the coast and the Crossens catchment watercourses inundated. A small area south of Marine Lake is also noted to be inundated in this event.

4.3.23 No additional flooding is seen until Altmouth, Hightown, where Flood Zone 2 inundates areas to the west of the River Alt in the vicinity of Altcar Rifle Ranges and the area of flooding around the Ince Blundell pumped watercourses is more extensive.

Tidal Flood Risk with Defences

4.3.24 As the Environment Agency's Flood Zone Map does not take into account the presence of defences or climate change, more detailed information has been collated from data provided by the Environment Agency, which can provide additional information. Available tidal hydraulic models are identified in Table 4-5 and the extent of simulated flooding is shown in Figure 7 in Volume 2.

4.3.25 The tidal flood risk with defences within Sefton has been assessed using this available hydraulic model data for a 1 in 200 annual probability event, and further checks have been made against extreme sea level information for a range of flood events including the 1 in 25 annual probability event, a 1 in 200 annual

probability event plus an allowance for sea level rise to 2115 as a result of climate change, and a 1 in 1000 annual probability event.

4.3.26 The 1 in 25 annual probability event has been used over the 1 in 20 annual probability event principally to maintain consistency with the SFRA assessment of Flood Zone 3b for fluvial flood risk and available outputs of fluvial hydraulic models. All of the above probabilities and the resulting flood extent shown in Figure 7 in Volume 2 assume that all the formal and de facto defences are in place, and that they are fully maintained and operational[30]. The following table sets out what additional hydraulic modelling information is available and indicates what data was used within the assessment.

4.3.27 Modelling of tidal flood risk was undertaken in 2008 as part of a study to define both areas benefitting from flood defences (ABDs) and extreme sea levels along the North West coast. Extreme sea levels were estimated for the year 2007 using a combination of data from a hindcast tide-surge model, and TUFLOW models that simulated the effect that tidal forcing had on water levels upstream in a number of tidal rivers and estuaries. Climate change has been added by using the latest (unchanged since 2007) climate change predictions.

Table 4-5: Available tidal hydraulic models within Sefton

Model Name	Completion Date	Model Type	Hydrology	Description	Comments
Tidal ABD SFRM Study	31/08/2008	Tidal - other	Other	Study to recalculate extreme sea levels and re-model Flood Zone 2 and 3 along the coastline and estuaries of Central Area, North West Region. NEIS and TUFLOW models used	Tidal Water Levels
Extreme Sea Level 2008	31/08/2008	Tidal - Dixon & Tawn	Other	SFRM; Joint Probability Analysis of results from North Eastern Irish Sea (NEIS) Model. Still water levels provided only.	Levels available for a number of locations along the coast.

Tidal Areas Benefitting from Defences (ABD) Study

Flood Extents (with defences)

4.3.28 Flood extents from the Tidal Areas Benefitting from Defences (ABD) study are

presented in Figure 7 of Volume 2. This figure only presents the 'with defences' 1 in 200 annual probability flood extent, as this is the only with defences scenario that was simulated. These results are understood to include the effect of 1 in 1 year wave action. The outputs indicate that there is no overtopping of the sea defences in Southport north of Weld Road.

4.3.29 South of Weld Road, Birkdale there are small areas of inundation beyond the dune defence line, however, these do not typically extent more than 50m, and most probably reflect the variable nature of the dunes. A larger, but still insignificant area of inundation is seen to the north of Royal Birkdale Golf Course that extends approximately 80m inland from the dunes defence line.

4.3.30 South of this there are no areas of inundation beyond 50m from the defence line until at Altmouth, Hightown where a car park on the west side of the River Alt, seaward of the pumping station, is shown to be inundated. Immediately south of Altmouth, the tidal inundation in the 1 in 200 annual probability event reaches 150m inland from coastal protection measures to the west of Hightown. In this event the sea is only 30m from properties in Hightown, however, high ground levels are show in topographical data to suggest that higher levels would not extend further inland. South of this the extent of tidal flooding follows the line of coastal protection until the southern extent of the model just north of Crosby.

4.3.31 As the modelling only relates to the 1 in 200 annual probability flood extent with defences, the following table identifies the 1 in 25 annual probability, the 1 in 200 annual probability, the 1 in 200 annual probability plus an appropriate allowance for sea level rise to 2115 and the 1 in 1000 annual probability extreme sea levels.

Table 4-6: Predicted Extreme Sea Levels (Extreme Sea Level Study, 2008)

Annual Probability Event	Average Return Period (years)	Extreme Sea Level (m AOD)								Comment
		Marshside	Southport Seafront	Coastal Road	Ainsdale on Sea	Formby	Hightown	North Crosby	South Crosby	
1 in 25	25	-	5.77	5.72	5.69	5.63	5.70	5.72	5.71	Not expected to be significantly different to the event below.
1 in 200	200	6.12	6.11	6.04	6.03	5.95	6.02	6.07	6.04	Very little inundation simulated in this event

Annual Probability Event	Average Return Period (years)	Extreme Sea Level (m AOD)								Comment
		Marshside	Southport Seafront	Coastal Road	Ainsdale on Sea	Formby	Hightown	North Crosby	South Crosby	
1 in 200 + climate change sea level rise to 2115	200 + climate change sea level rise to 2115	7.07	7.06	6.99	6.97	6.89	6.97	7.01	6.99	Comparison of topography against a maximum level of 7.07m AOD and against current NFCDD, suggests that there will be areas susceptible to flooding, particularly in Southport, at Altmouth and inland from there.
1 in 1000	1000	6.31	6.38	6.29	6.29	6.19	6.27	6.33	6.30	Comparison of topography against a maximum level of 6.38m AOD, suggest that there will be areas susceptible to flooding, particularly in Southport, but also at Altmouth and inland from there by virtue of wave overtopping,

Flood Depths and Velocities (with defences)

4.3.32 No model information is available on the depth or velocity associated with flood waters in these areas of tidal inundation. However topographical data, when compared against tidal extents, suggests that the maximum depth would be seen to the west of Hightown, where depths could reach up to 1.5m above surrounding ground levels.

Time to Peak and Time of Inundation (with defences)

4.3.33 No information is available for the time of inundation from tidal inundation. However, because of the limited areas at risk in the 1 in 200 annual probability event it is likely that inundation would be relatively rapid once it commences.

Wave heights (with defences)

4.3.34 It is understood that the Tidal ABD study included an allowance for 1 in 1 annual probability extreme wave heights, which were provided by the Environment Agency. Wave heights for the 1 in 1 annual probability event for the Sefton Coastline are presented in Table 4-7.

Table 4-7: Predicted Extreme Wave Heights (Extreme Sea Level Study, 2008)

Parameter	Extreme Sea Level (m AOD)								Comment
	Marshside Sands	Southport Seafront	Coastal Road	Ainsdale a	Formby	Hightown	North Crosby	South Crosby	
1 in 1 annual probability extreme wave height (m)	0.5	0.9	0.8	2.8	-	-	1.9	2.3	Addition of these wave heights could considerably increase flood risk in places along the coast.
Wave bearing (°)	300	300	300	300	-	-	270	270	

Residual Risk and effects of possible failure of the defences

4.3.35 The Tidal Areas Benefitting from Defences study included assessment of the risk from breach of the tidal defences at 9 locations across the North West. One of these locations was in Crossens in the earth sea embankment bordering Crossens Pool, next to Skipton Avenue. A 50m wide breach was simulated in the embankment and the results indicate that a failure in this location would result in significant flooding of properties in north Crossens.

4.3.36 The resulting flood extent from this breach was developed over a period of three high tides and around 36 hours. The first high tide inundated areas in the immediate vicinity that were generally to the north of Kingstone Crescent, south of the Wastewater Treatment Works and contained within the sports fields west of Ferryside Lane. The second, larger high tide then inundates the remainder of the area with flooding no further east or south than Banks Road, Preston New Road or Fylde Road. In the south west flooding crossed Millar's Pace but did not extend past the Marshside Health Club and Swims'cool'.

4.3.37 Figure 4-1, overleaf, presents the extent of flooding reached in the first high tide (purple hatch) and the extent then reached in the second tide (blue hatch). The arrows indicate the general direction of inundation, the red identifies the location of coastal protection assets and the black identifies the extent of sea defence assets. It should be noted that these areas are within the Environment Agency's Flood Zone 3 – no additional areas would be flooded according to this breach model.

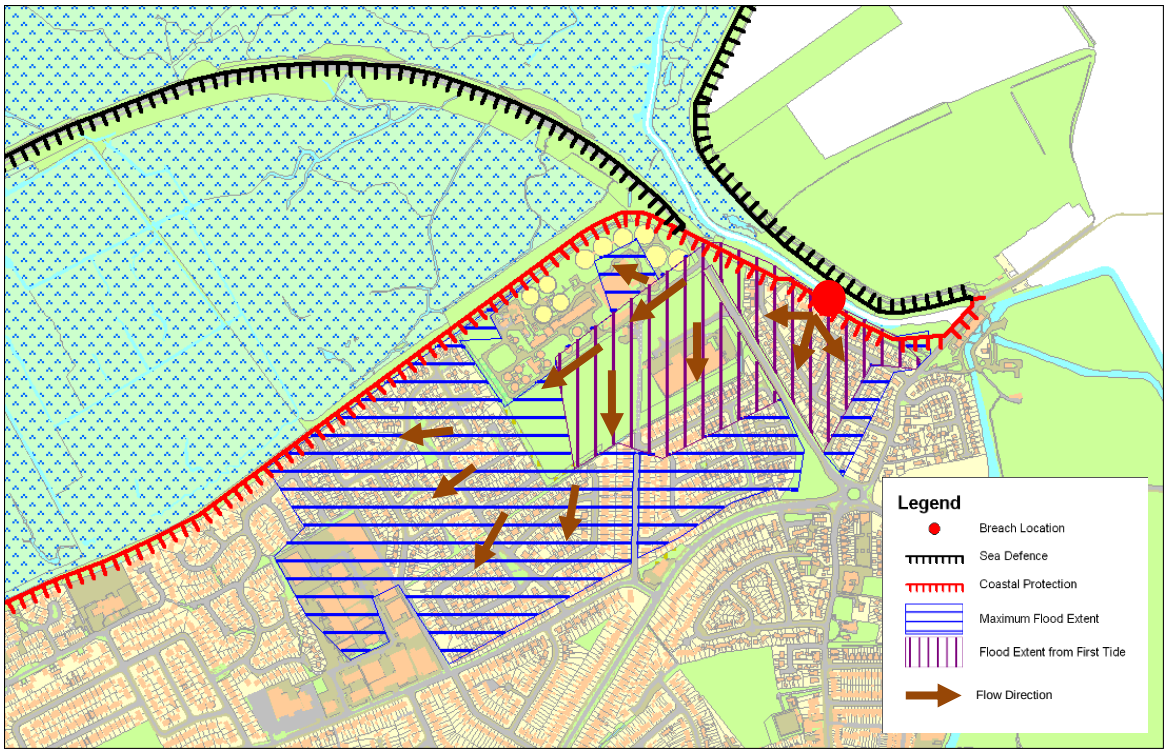


Figure 4-1: Potential breach extent and flow directions in Crossens.

Defences and Other Influences on Tidal Flood Risk

4.3.38 The principal influence on tidal flooding is the performance of flood defences which stop high astronomical tides and storm surges from impacting areas inland from the coast. As indicated in Table 4-6, the effects of climate change on extreme sea levels may result in areas currently protected from flooding from the sea becoming at risk from tidal flooding. In Southport, and in the south of the Borough, inland from Altmouth, the consequences may be particularly widespread and severe.

4.3.39 The effect of high tides on the discharge of rivers, and drainage, within Sefton should also be acknowledged. These would not influence the consequences of flooding from tidal sources. However, tidal sources may have a significant effect on flood risk from these sources as extreme sea levels increase with climate change. With the continued operation of the Altmouth and Crossens Pumping Stations the principal influence in Sefton would be on the watercourses and land drainage draining by gravity to the sea – these would become tide locked (unable to drain into the sea) more frequently and severely. Most notably this would affect watercourses and sewers in parts of Birkdale, Ainsdale, Hightown and indirectly in Formby via the River Alt and Downholland Brook.

4.3.40 The consequence of failure of tidal flood defences also needs to be considered.

The Tidal Areas Benefitting from Defences Study report indicates that over 900 properties in Southport lie in the 1 in 200 annual probability breach flood zone when considering a breach in the defences by Crossens Pool. The Study indicates that a breach here would allow flood water to flow into Skipton Avenue/Harrogate Way, and would then overtop the raised Marine Drive embankment. This would result in significant consequences to Crossens. The model also indicates that Preston New Road to the south of the flooded area, which is slightly raised, will contain flow and prevent it from flooding further properties to the south.

4.3.41 No detailed mapping was provided of this breach assessment, however, the extent of flooding during the first high tide event following failure and the subsequent maximum flood extent are shown in Figure 4-1. Figure 7 in Volume 2 shows the simulated tidal flood extent assuming all defences are present and fully operational and therefore it does not include the areas at risk from failure.

4.4 Flood Defences, Structures, Assets and Flood Warning

4.4.1 Within Sefton, and in adjacent areas that may affect land within Sefton, there are in the region of 261km of assets identified within the Environment Agency's National Flood and Coastal Defence Database (NFCDD), which contains information on a wide range of assets, including the following types:

- coastal protection (man-made);
- coastal protection (natural);
- culverted channel;
- maintained channel;
- natural channel;
- raised defence (man-made);
- sea defence (man-made); and
- sea defence (natural)

4.4.2 Of these 261km of assets, the Environment Agency is responsible for approximately 72%, Sefton MBC is responsible for approximately 16% and the remainder are the responsibility of private individuals or organisations.

4.4.3 Table 4-8 summarises the type of assets being managed by each type of maintainer, and the percentage of those assets that meet different condition criteria as indicated in the NFCDD.

Table 4-8: Summary of Flood Defence Maintainer, Asset Type and Condition within Sefton

Maintainer	Asset type	Total asset length (m)	Asset Condition			
			2 (Good)	3 (Fair)	4 (Poor)	9 (Unknown or Uncertain
Environment Agency	Coastal Protection (Man-Made)	1,534	0.0%	100.0%	0.0%	0.0%
	Culverted Channel	529	0.0%	55.2%	28.1%	16.7%
	Maintained Channel	155,617	0.0%	71.6%	13.4%	15.0%
	Natural Channel	7,642	0.0%	100.0%	0.0%	0.0%
	Raised Defence (Man-Made)	18,593	0.0%	99.1%	0.0%	0.9%
	Sea Defence (Man-Made)	3,520	0.0%	100.0%	0.0%	0.0%
	TOTAL	**187,434**	**0.0%**	**76.2%**	**11.2%**	**12.6%**
Local Authority	Coastal Protection (Man-Made)	8,553	0.0%	89.3%	0.0%	10.7%
	Coastal Protection (Natural)	1,213	0.0%	0.0%	0.0%	100.0%
	Culverted Channel	3,025	0.0%	100.0%	0.0%	0.0%
	Natural Channel	7,947	0.0%	0.0%	100.0%	0.0%
	Sea Defence (Man-Made)	11,084	15.6%	84.4%	0.0%	0.0%
	Sea Defence (Natural)	8,996	0.0%	100.0%	0.0%	0.0%
	TOTAL	**40,817**	**4.2%**	**71.1%**	**19.5%**	**5.2%**
Private	Coastal Protection (Man-Made)	233	0.0%	100.0%	0.0%	0.0%
	Culverted Channel	4,563	0.0%	98.3%	1.3%	0.4%
	Maintained Channel	15,528	0.0%	35.5%	0.0%	64.5%
	Natural Channel	2,333	0.0%	0.0%	0.0%	100.0%
	Raised Defence (Man-Made)	1,100	0.0%	100.0%	0.0%	0.0%
	Sea Defence (Natural)	8,440	0.0%	78.7%	21.3%	0.0%
	TOTAL	**32,197**	**0.0%**	**55.8%**	**5.8%**	**38.4%**
Total		**260,448**	**0.7%**	**72.9%**	**11.8%**	**14.7%**

4.4.4 With respect to flood defence assets, notable points from the NFCDD dataset and the above table are that:

- A total of just under 12% of all assets are considered to be in poor condition, however, nearly 15% of the assets have a condition which is either unknown or with which the current assessment of condition is uncertain;
- Coastal defences make up approximately 17% of all assets by length, with the remainder consisting of watercourses (83%). Approximately 3% of all assets by length are culverted watercourses;
- Of the coastal assets, approximately 4% by length are in Good condition, 87% are Fair, 4.1% are Poor and the remainder (4.9%) are of unknown / uncertain condition;
- Of the fluvial assets, none are in Good condition, however, 70% by length are in Fair condition, 13.4% are Poor and the remainder (16.6%) are of unknown / uncertain condition; and
- Of the culverted watercourses, approximately 96.1% of the assets by length are in Fair condition, 2.6% are in Poor condition and 1.3% has an unknown / uncertain condition.

4.4.5 In general, the above suggests that the current condition of maintained assets is generally good, particularly the sea defences. However there are exceptions, particularly the fact that approximately 54km (31% of the total asset length) of maintained channel assets managed by the Environment Agency, Sefton MBC and private individuals or organisations are considered to be in a poor or unknown condition[35]. These are typically related to less significant watercourses, such as Captains Watercourse (Southport), Boundary Brook (Woodvale), in the Formby area Formby Moss and Acre Lane Brook, and in the Ince Blundell area Ince Blundell pumped watercourses and the upper reaches of Hunt's Brook. More notably however, they include the River Alt upstream (east) of the A59 and sections of Wham's Dyke in Formby.

4.4.6 The location, condition and maintenance responsibility of man-made flood defences are presented in Figure 11a of Volume 2, whilst the location, condition and maintenance responsibility of natural flood defences are presented in Figure 11b of Volume 2.

Flood Defences

Raised Defences

[35] This excludes some of the maintained watercourses like Dobb's Gutter in Formby, which is not contained within the NFCDD dataset. It is known that Sefton MBC undertakes regular maintenance of this watercourse.

4.4.7 The NFCDD dataset identifies 57 sections of man-made raised flood defence alongside watercourses. The majority of these are located on the River Alt or on Downholland Brook, however, there are some lengths of defences on Eight Acre Lane Brook north of Formby, on Upland Drain and at the confluence of Whinney Brook and Dover's Brook in Maghull. The majority of the raised fluvial defences are in Fair condition and maintained by the Environment Agency.

4.4.8 The standard of protection (SoP) provided by these defences is predominantly equivalent to a 1 in 50 annual probability flood event. Of the 19.7km of raised defences, approximately 84% has a SoP equivalent to the 1 in 50 annual probability, whilst 4% of the raised defences have a SoP equivalent to a 1 in 25 annual probability flood event. The remaining defences have a SoP equivalent to a 1 in 100 annual probability flood event.

Sea and Coastal Defences

4.4.9 The NFCDD dataset identifies 18 sections of man-made sea defence and 15 sections of man-made coastal protection. Sea defences are the principal line of defence in the Southport area, a secondary line of defence in a short reach to the north west of Altmouth (Hightown), and the principal line of defence from Blundellsands to the Port of Liverpool. Coastal protection extends north of Blundellsands towards Altmouth, and makes up the secondary line of defence in Southport. The majority of the raised defences are in Fair condition and approximately 75% by length are maintained by Sefton MBC with the remainder largely maintained by the Environment Agency with the exception of a small privately maintained section.

4.4.10 The standard of protection (SoP) provided by these defences varies. Approximately 58% of man-made coastal protection assets have a SoP equivalent to a 1 in 150 annual probability flood event. Of the remainder, 1% has a SoP equivalent to the 1 in 125 annual probability flood event and 1% has a SoP equivalent to the 1 in 20 annual probability flood event. The remaining 40% does not have an identified SoP.

4.4.11 Approximately 68% of man-made coastal protection assets have a SoP equivalent to a 1 in 20 annual probability flood event. Of the remainder, 18% has a SoP equivalent to the 1 in 75 annual probability flood event and 6% has a SoP equivalent to the 1 in 200 annual probability flood event. The remaining 8% does not have an identified SoP.

Culverted Watercourses

4.4.12 The NFCDD dataset identifies a total of 154 sections, totalling 8.2km, of culverted watercourse within Sefton and these are located on 42 different watercourses.

4.4.13 The watercourse with the greatest length of culverting is Marshside Drain in Southport followed by Crossens Marsh Drain. Melling Brook to the east of Maghull, Farmoss Pool to the south of Hightown and Whinney Brook are also watercourses with relatively large culverted sections, as are Boundary Brook (Formby) and Bull Cop in Formby.

4.4.14 More than half of the culverted watercourses by length are maintained by private individuals or organisations, with nearly 40% managed by Sefton MBC. The Environment Agency manages 6.5% of the assets. As indicated above, the majority are in Fair condition.

4.4.15 There are a number of culverted watercourses that are not identified within the NFCDD dataset, including a number in Formby, for example Dobb's Gutter, which are identified by Sefton MBC as critical ordinary watercourses (COWs). The list of critical ordinary watercourses is presented in Section 4.2. In addition to these, United Utilities' asset database includes assets identified as private sewers that in some cases are culverted watercourses. Examples include:

- Lengths of The Pool in Southport, downstream of Serpentine Lake;
- Dobb's Gutter, Formby ;
- Surface water sewers draining to Bull Cop, Formby;
- Sewers in Ditchfield, Formby ;
- Surface water sewers draining to Hogshill Lane, Formby;
- Sewers draining through Thornton to Hunt's Brook;
- Sewers draining from Aintree into the River Alt;
- Sewers draining to Melling Brook;
- Sewers draining Claremont Road and other roads to Dover's Brook and Upland Drain (Maghull); and
- Sewers draining to Maghull Brook and Rigby Brook.

4.4.16 The condition of these watercourses is generally unknown as they are not included in the NFCDD, and United Utilities consider them to be third party assets. In many cases, such as Dobb's Gutter and the watercourse through Thornton, they are managed by Sefton MBC.

Structures

4.4.17 The NFCDD also contains information on structures within and affecting watercourses and the coast. There are 14 types of structure contained in the NFCDD within Sefton, which are indicated in Table 4-9.

Table 4-9: Summary of Structures within Sefton

Type	Number of structures
Access Bridge	165
Beach Structure - Slipway	11
Flapped Outfall	6
Gauging Station	1
Lock Gate	2
Manhole	39
Outfall	209[36]
Penstock	5
Pump House	7
Screen	23
Pipe Crossing	27
Spillway	1
Structure - Control Gate	3
Weir	5

Sefton MBC Asset Register

4.4.18 Sefton MBC has collated its Flood and Water Management Act (2010) Asset Register, which consists of:

- Critical Ordinary Watercourse assets;
- Environment Agency Main River Amendments (affecting Eight Acre Lane, Bull Cop and Hogshill Lane;
- Highway Drain Pipe assets;
- Highway Drain Manhole assets;
- Sewers that provide no highway drainage function;

[36] This includes the outfall, headwall and inlet in many cases.

- Coastal Defence Assets;
- Sefton MBC Pumping Stations and their condition;
- United Utilities combined sewer manholes; and
- United Utilities surface water sewer manholes.

Flood Warning Areas

4.4.19 The Environment Agency operates a free flood warning service called Flood Warnings Direct, which will send messages to those signed up within a Flood Warning Area when flooding is expected and may affect a property. In some locations, residents will have been signed up automatically.

4.4.20 The Flood Warning Areas (FWAs) cover those areas that are at risk from tidal, and in some cases fluvial, flooding in the Southport area. Most areas within the currently defined Flood Zone 2 (See Figures 3 and 4 in Volume 2) are within the FWA, however, there are some areas outside in which there are no receptors other than farmland.

4.4.21 Elsewhere within Sefton, FWAs cover land that is inland from Altmouth Pumping Station as far north as Ravens Meols Brook and Hoggs Hill Lane and eastwards towards, but not covering Ince Blundell. There are no areas further upstream on the River Alt or its tributaries that are covered by a FWA.

4.4.22 On the coast, the Coast Guard station lies within a FWA, as is a small area by the Swimming Baths in Brighton Le Sands, between Blundellsands and Waterloo.

4.4.23 Figure 22 in Volume 2 presents the existing FWAs in Sefton.

4.5 Surface Water and Sewer Flooding

4.5.1 Flooding from land can be caused by rainfall being unable to infiltrate into the natural ground or unable to enter watercourses, due to blockage, or if flows within the drainage system are already at or above design capacity. This can then result in (temporary) localised ponding and flooding. The natural topography and location of buildings/structures can influence the direction and depth of water flowing off impermeable and permeable surfaces.

4.5.2 High intensity storms (often with a short duration) are sometimes unable to percolate into the ground, or be drained by formal drainage systems when the capacity of these collection systems is not sufficient to convey runoff to

underground pipe systems (which might themselves be surcharged). The pathway for surface water flooding can include blockage and overflows of the drainage system and failure of sluice outfalls and pump systems.

4.5.3 Flooding can also result when the design capacity of sewers, typically combined foul and surface water, is exceeded and surcharge water into the nearby environment. Because of the links to rainfall, some aspects of surface water flooding are sometimes referred to as pluvial flooding.

4.5.4 There are numerous datasets available to identify the extent of surface water flooding within Sefton. In 2009 the Environment Agency published its Areas Susceptible to Surface Water Flooding (AStSWF) map, which shows those areas with a Low, Intermediate or High Susceptibility to flooding from a 1 in 200 annual probability storm event.

4.5.5 Towards the end of 2010 the Environment Agency released a second dataset, the Flood Map for Surface Water (FMfSW), which presented surface water flooding from 1 in 30 and 1 in 200 annual probability storm events. These outputs considered a different critical storm duration and took into account losses from different types of land use.

4.5.6 During this time, Sefton MBC was developing its own Surface Water Management Plan (SWMP)[8] which included modelling of sewer flooding volumes from a 1 in 5 annual probability and 1 in 30 annual probability storm. Additional flooding was also simulated for the 1 in 100 annual probability storm event and with a 30% increase in rainfall intensity to allow for the effects of climate change.

4.5.7 Figures 12, 15 and 16 in Volume 2 show these various surface water flood risk areas. Appendix C presents more discussion of the available surface water data, its limitations, and the modelling that was undertaken as part of the SWMP. The following sections, below, outline the outputs of the SWMP for those areas which were included in the Intermediate Stage modelling. For those areas outside of the SWMP modelled areas, the Areas Susceptible to Surface Water Flooding dataset is discussed. As indicated in Section 2.5.48 the AStSWF dataset is preferred to the FMfSW dataset, on the grounds that it is considered a better representation of historical flooding within the borough, and that it may be the more appropriate representation in areas with a flatter topography like Sefton.

Sefton Surface Water Management Plan, 2011

4.5.8 The Surface Water Management Plan considers flood risk from two sources, sewer flooding and pluvial flooding.

4.5.9 Flooding from combined and surface water sewers is assessed by modelling the location and extent of flooding using the outputs from United Utilities' own sewer

network models for storms with a 1 in 5 annual probability and a 1 in 30 annual probability of occurring. There is an inherent assumption in this approach that all rainfall will enter the sewers. However, the outputs effectively show the expected flooding in these events that would be the result of hydraulic inadequacy within the system.

4.5.10 Pluvial flood risk, i.e. that from heavy rain itself that typically does not then enter the sewer system, is simulated in the SWMP by a storm event with a 1 in 100 annual probability of occurring in any given year, and from an event with a 1 in 100 annual probability of occurring in any given year plus a 30% increase in rainfall intensity to allow for the currently understood impacts of climate change. In addition, as there would remain a risk from sewer flooding, these events also include the simulated flooding from the sewers with a 1 in 30 annual probability of occurring.

4.5.11 The outputs of the SWMP models are maps of flood depth, velocity and hazard. The flood extents are limited to those where the depth of flooding exceeds 80mm[37]. Figure 12 in Volume 2 presents the simulated flood extents from the four modelled scenarios of the SWMP.

4.5.12 The SWMP and subsequent analysis identified the number of properties and vulnerable receptors to be at risk from surface water flood events within Sefton and these are presented in Table 4-10, below. As can be seen there are approximately 2,600 homes, businesses and infrastructure that could be impacted in a 1 in 30 annual probability event and this rises significantly to 37,900 for the 1 in 100 annual probability event.

Table 4-10: Summary of key impacts across all return periods

Receptor	1 in 5 annual probability	1 in 30 annual probability	1 in 100 annual probability	1 in 100 annual probability plus climate change
Homes, businesses and infrastructure (132,400)	716	2,591	37,880	58,299
Fire stations (4)	0	0	1	2
Police stations (8)	0	0	3	3
Hospitals (2)	0	0	1	1
GPs Surgeries (56)	0	1	10	15

[37] The SWMP adopted 80mm as the minimum flood depth to represent on maps and figures as a conservative means of representing those areas that flood through the collection of rainfall, overland flow and sewer flooding. Adoption of a lower value would have identified those areas that receive rainfall and would not have allowed the differentiation of flooded areas from those that just get wet.

Receptor	1 in 5 annual probability	1 in 30 annual probability	1 in 100 annual probability	1 in 100 annual probability plus climate change
Health Centres (13)	0	0	3	6
Nursing Homes and Residential Homes (133)	0	0	32	37
Children's Centres, Nurseries and Pre-school Play Groups (103)	0	3	23	27
Schools (NRD point records) (106)	0	1	25	37
Schools (Boundary) (106)	15	32	104	104
Schools (Buildings) (311)	0	7	201	218

4.5.13 The SWMP also identified that in the region of 43% of the sewer network was below the current design standard associated with new build properties and that approximately 22% of the network has a capacity that is less than that required for a 1 in 5 annual probability storm event.

SWMP Flood extents

4.5.14 Modelling of the flooding expected from a storm with a 1 in 5 annual probability of occurring in any given year results in relatively limited impacts with isolated properties flooded along with minor roads and some traffic sensitive routes.

4.5.15 In most areas the mechanism of flooding is therefore shallow flow from manholes and the collection of this flood water into lower lying areas. This is particularly common between Southport and Formby, in Hightown and to the north of Crosby. Elsewhere, the greater relief in Bootle and Maghull results in areas where the ponding is more extensive, though the mechanisms remain the same. This is shown in Figure 12 in Volume 2.

4.5.16 As the severity of storm event increases to 1 in 30 annual probability, the volume and intensity of rainfall is such that the volume of flooding from manholes increases, in addition to the number of manholes from which flooding occurs. The result of this is typically greater depths of flooding in those areas that flood during the 1in 5 annual probability event, along with new areas of ponding in areas that previously did not.

4.5.17 Again, the mechanism between Southport and the north of Crosby is predominantly collection of water in low lying areas; whilst in Thornton, Bootle, Netherton, Litherland, Aintree, Maghull and Lydiate, the mechanism becomes

increasingly one of ponding, and flooding along what was historically a watercourse or a drain that fed a watercourse. Examples include areas around Water Lane in Thornton, which eventually discharges to Hunt's Brook, flooding in Princess Way in Seaforth along the path of the former Rimrose Brook, and flooding along Menai Road and Province Road (Bootle), which follow the course of a southern tributary of Rimrose Brook and Maghull Brook. This is shown in Figure 12 in Volume 2.

4.5.18 These trends of water collecting, ponding and flooding along historical watercourses or drains continue as the severity of storm events increase and the annual probability of flooding decreases to 1 in 100. Sewer flooding and rainfall collecting in depressions create extensive areas of ponded floodwater between Southport and north Crosby. These areas inevitably highlight underlying topographical features, particularly in Southport. However, in areas such as Formby it is a reflection of the flatness of the area, coupled with the presence of the Formby Bypass to the east, which acts as a restriction to flow that causes flood water to collect and cause extensive flooding of property along its western edge.

4.5.19 In these extreme events, flooding is identified along pathways that would have fed Rimrose Brook, the River Alt, Whinney Brook and Maghull Brook. The extent of flooding along these pathways is significantly influenced by existing or historical infrastructure in these areas, such as railway lines, the canal and road layouts. This is shown in Figure 12 in Volume 2.

4.5.20 The SWMP modelling outputs for the 1 in 100 annual probability plus climate change event shows that there are extensive areas in Sefton which flood but where flood water is less than 0.3m deep, and there are many areas that are shown to have flood depths between 0.3m and 0.6m. Those areas that are affected by flooding of greater depths, e.g. above 0.6m, are however typically limited to areas along watercourses, in low lying shallow basins, or where flow is prevented from following its normal pathway but existing infrastructure. Examples include:

- Along The Pool in Southport;
- In the vicinity of Norwood Primary School and Holy Family Catholic Primary School, Southport;
- The western end of Lord Street, Southport;
- Preston Road, Southport and along the pathway of former railway lines, such as between Beresford Drive and Silverthorne Drive;
- Properties in a large area to the north of Regent Road and east of Lulworth

Road, affecting Weld Road, Saxon Road, Birkdale;

- The Garden Centre by Bentham's Way, Kew;
- Properties and land to the north of Moss Side alongside Wham's Dyke and Downholland Brook, Formby;
- Properties west of the Formby Bypass near to Formby Business Park;
- Fields north of Hall Road East, Crosby, associated with Farm Moss Pool;
- Fields north of Back Lane in Little Crosby;
- Properties around Water Lane in Thornton;
- Properties between Cambridge Road and College Road North, and affecting Cambridge Drive, and properties between Ince Avenue and Victoria Road in Crosby;
- Bowling greens to the south of College Road, Crosby;
- Areas along Rimrose Brook, particularly near Rimrose Valley Road in Crosby and in Seaforth and Litherland;
- Numerous locations on the upstream side of the Leeds and Liverpool Canal (mostly in Maghull);
- Along Brooklea, Melling Brook, Whinney Brook, Maghull Brook and the River Alt in the Maghull area; and
- Bordering the disused railway line which now forms part of the Cheshire Lines Path / Trans Pennine Trail, running parallel to the River Alt, west of Maghull.

4.5.21 As expected, the highest velocities are typically seen running along the path of watercourses, along the path of roads that become flow paths, and in some cases along railway lines and along embankments. In the majority of these flow paths there are sections where the velocity of flow is up to 1.0m/s, however, few locations reach velocities higher than 1.5m/s. Away from watercourses, the exceptions are:

- Along Menai Road (Bootle), the path of a historical watercourse;
- Along Aintree Road and Earl Road (Bootle);
- Along Church Road and Sefton Road, Seaforth.

Time of Inundation

4.5.22 The SWMP modelling simulated a 1.1hour pluvial event and simulated the flow of flood water from manholes over a period of 1.5 hours. Model simulation times were 5 hours. The time and rate of inundation shown in the SWMP outputs is therefore relatively rapid. Historical flooding records would suggest that it takes between 12 and 24 hours for flood water to reside.

SWMP Local Flood Risk Zones

4.5.23 Local Flood Risk Zones were defined within the Sefton SWMP as:

"discrete areas of flooding that do not exceed the national criteria[38] for a Flood Risk Area but which still affect houses, business or infrastructure."

4.5.24 In practice the LFRZs were defined as the actual extent of predicted flooding in a single location and, they were determined directly from the surface water modelling outputs as those discrete areas of flooding that are greater than 80mm deep and which have a surface area greater than $5m^2$ [39].

4.5.25 LFRZs therefore represent both the principal pathways and receptors of surface water flooding and facilitate the targeting of measures and options to manage flood risk.

4.5.26 Related LFRZs have been grouped together within Critical Drainage Areas, however, they can be left in isolation and policies could be focussed on individual LFRZs. They should be primarily be used as a planning policy tool for end users of the SWMP but post-SWMP assessment has also used them to prioritise actions from the SWMP and for influencing the proposed programme of work to be delivered by United Utilities within AMP6.

4.5.27 LFRZs have been defined for all modelled return periods and the following presents a summary of the number and potential consequences from each event.

Table 4-11: Local Flood Risk Zones and identified consequences within Sefton

SWMP Scenario	No. of Locally Significant Flood Risk Zones	Local Significance defined by impacts to		
		Homes	Shops / Businesses	Critical Infrastructure
1 in 5 annual probability	83	61	24	6
1 in 30 annual probability	81	47	29	14
1 in 100 annual probability	839	286	283	352

[38] National criteria require at least 200 people to be impacted for an event to meet thresholds for flooding to be considered an issue and at least 30,000 for the area to be identified as a Flood Risk Area.

[39] This is consistent with the Environment Agency's Strategic Flood Risk Mapping specification, which requires the removal of polygons that are less than $5m^2$.

SWMP Scenario	No. of Locally Significant Flood Risk Zones	Local Significance defined by impacts to		
		Homes	Shops / Businesses	Critical Infrastructure
1 in 100 annual probability plus climate change	1,043	486	348	383

SWMP Critical Drainage Areas

4.5.28 The Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006 introduces the concept of Critical Drainage Areas (CDAs) as:

"an area within Flood Zone 1 which has critical drainage problems and which has been notified… [to]…the local planning authority by the Environment Agency"

4.5.29 As part of the Sefton Surface Water Management Plan (SWMP) the definition of a CDA was specifically defined as follows:

"a discrete geographical area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones (LFRZ) during severe weather thereby affecting people, property and local infrastructure".

4.5.30 In effect, land within a Critical Drainage Area (CDAs) either contributes to flooding at a critical location or acts as a pathway for the water that contributes to that flooding. To give the definition more of a practical application within the SWMP and the SFRA, Critical Drainage Areas were defined by identifying the catchment areas that contribute to flooding in Local Flood Risk Zones that could result in locally significant surface water flooding i.e. those in which more than 8 properties or 20 people may be impacted.

4.5.31 Because the area with a Critical Drainage Area contributes to flooding that is considered to have locally significant consequences, any measures taken to manage flood risk – and especially surface water flood risk - within a CDA, such as to promote infiltration based SuDS or reduce surface water runoff to greenfield rates, would contribute towards a reduction in flood risk at that critical location. **Within the CDAs of Sefton it is recommended that the threshold for requiring a flood risk assessment based on area, which is currently 1ha in the NPPF and Technical Guidance, be reduced to at least 0.5ha.** This will ensure that those sites that have the potential to increase flood risk within these CDAs will be assessed in more detail and it will minimise the cumulative impact on flood risk from smaller developments. It will also increase the opportunities to identify where sites could benefit flood risk elsewhere within the borough.

4.5.32 The Sefton SWMP defined 22 Critical Drainage Areas within its study area. Figure 14 in Volume 2 of shows their location. Appendix B of this SFRA document provides a summary of each CDA, outlining the location, size receiving watercourses, flood risk influences and a summary of the key Local Flood Risk Zones. Note the summary is not an exhaustive list and the reader is referred to the full CDA summary sheets in the Sefton SWMP.

Areas Susceptible to Surface Water Flooding (AStSWF)

4.5.33 The AStSWF dataset shows areas where surface water would be expected to flow or pond. One rainfall event, a 1 in 200 annual probability storm was modelled and mapped. Three outputs were provided:

- Less Susceptible - flooding greater between 0.1m and 0.3m deep.
- Medium Susceptibility - flooding between 0.3m and 1.0m deep.
- More Susceptible - flooding greater than 1.0m deep.

4.5.34 The 0.1m threshold for Less Susceptible was chosen to remove modelling 'noise' that may suggest flooding where there was really none. The 0.3m threshold was chosen as it represents a typical value for the onset of significant property damages when property flooding may start (above doorstep level) and because it is at around this depth that moving through floodwater (driving or walking) may become more difficult. Both of these may lead users to consider the need to close roads or evacuate areas.

4.5.35 Within Sefton, where there are areas that lie outside of the SWMP modelling, the AStSWF dataset has been used to assess the risk from surface water flooding. The following presents a brief discussion of those areas:

- Ainsdale-on-Sea Holiday Centre and Ainsdale Discovery Centre – potential flooding within the centre of the holiday centre the majority of which is of medium susceptibility with a small area of More Susceptible. Areas immediately east of the Discovery Centre are shown to have a Medium Susceptibility.
- Woodvale Airfield and areas around Formby Hall – The airfield is shown to have a medium susceptibility but only parts of the runways themselves are affected. Parts of Formby bypass here are shown to have a Medium Susceptibility and around Formby Hall there are isolated but relatively large areas that are generally of Medium Susceptibility but in places More Susceptible. There are some isolated properties affected, such as the Club House of the Golf Course and some along North Moss Lane.
- South west of Formby – Large areas of Less Susceptible lane is shown to

affect properties along Beechwood Drive, Elm Drive, Pine Wood Avenue, Jubilee Road, Funchal Avenue, Bartonheys Road and Elseworth Close, along with various surrounding roads. There are also some areas of Medium Susceptibility in these areas. Numerous properties shown to be affected.

- Altcar Training Camp and Rifle Range – Isolated properties affected by area shown to be predominantly Less Susceptible but in places it is of Medium Susceptibility.
- Ince Blundell – there are isolated patches of Less and Medium Susceptibility land and isolated properties affected. Large areas of North End are affected to the north with predominantly Medium but also More Susceptible Land, though this does not affect any properties. Some properties at Ince Blundell Hall are shown to be at risk.
- Little Crosby – Some properties are shown to be affected by areas of surface water flooding. The majority are within areas of Less Susceptible land but there are some that are within land that has a Medium Susceptibility.
- South west Bootle – Areas around the docks are shown to be within both Less and Medium Susceptible land, as are roads leading towards these areas. The only areas of More Susceptible land are on the upgradient (generally, the landward) side of railway embankments running across the area.
- Areas bordering Simonswood Brook (north of Waddicar) – Land bordering the watercourse is shown to be susceptible to surface water flooding with a large area to the south east of Ash Holt farm being at risk.
- Ashworth Hospital and M58 – Areas of the M58 are shown to be at risk and a large area and numerous properties within the Ashworth Hospital site is on land with a Medium Susceptibility to flooding. Those buildings near to Sudell Brook are shown to be More Susceptible.
- Sudell Brook – Alongside Sudell Brook (north of Lydiate and Maghull) there are numerous areas of land with Less and Medium Susceptibility to flooding and only isolated areas that are More Susceptible. Isolated properties are shown to be at risk and within pockets of susceptible land to the west.

4.5.36 Figure 15 in Volume 2 presents the Areas Susceptible to Surface Water Flooding dataset for Sefton.

Surface Water and Sewer Flooding - Historic Records

4.5.37 Sefton's Preliminary Flood Risk Assessment (PFRA) presents a list of historical flood events which had locally significant consequences. Those which were identified as events caused by surface water flooding are presented in Table 4-12, overleaf. The list presented in Table 4-12 was developed from a full list of flood events that is presented in Appendix A.1 of Sefton MBC's PFRA. The criterion for inclusion in the full list requires that a flood event was caused by local sources (i.e. not Main River or the sea) and that it affected two or more properties. The full list was developed from datasets held by Sefton MBC to July 2010, and provided by United Utilities in February 2011.

4.5.38 The criteria for determining the local significance of consequences was left to each Lead Local Flood Authority, though it was recommended that some measure of equivalent risk was applied. The Merseyside group of authorities have determined that flood events that resulted in impacts to 20 people should be considered as having had locally significant harmful consequences. The threshold of 20 people was chosen as it is an order of magnitude less than was required to identify a 1km^2 grid cell as being a 'place where flood risk is an issue' in the national assessment of indicative Flood Risk Areas that was undertaken by the Environment Agency.

4.5.39 Guidance presented in *Selecting and reviewing Flood Risk Areas for local sources of flooding*[40] indicates that there are on average 2.34 people per property. Consequently, any flood event that results in 8 or more properties impacted is equivalent to 20 people and therefore considered to be locally significant.

[40] Defra (2010) Selecting and reviewing Flood Risk Areas for local sources of flooding: Guidance to Lead Local Flood Authorities – Flood Risk Regulations 2009

Table 4-12: Past flood events from local sources with significant local consequences.

Date	Main source of flooding	Description	Data Source
19/07/2010 to 22/07/2010	Surface Water	A total of 77 surface water flooding incidents affected properties in Aintree, Birkdale, Bootle, Brighton-le-Sands, Crosby, Formby, Litherland, Maghull, Melling, Netherton, Seaforth, Sefton, Southport, Thornton and Waterloo. Impacts in Maghull were locally significant in isolation.	Sefton MBC
06/10/2009 to 08/10/2009	Surface Water	9 records of flooding in Maghull and Southport	UU (WIRS)
21/01/2008	Surface water / ordinary watercourse	An intense storm system produced surface water flooding across Sefton. There were 98 records of flooding in Ainsdale, Aintree, Blundellsands, Bootle, Crosby, Crossens, Formby, Lunt, Lydiate, Maghull, Melling, Netherton, Southport and Thornton. Impacts in Formby, Maghull and Southport were locally significant in isolation.	Sefton MBC
20/07/2007 to 22/07/2007	Surface water	Flooding incidents reported across Sefton (75 in total). Some internal flooding of properties. Incidents concentrated in Crosby, Sefton & Maghull	Sefton MBC
30/11/2004	Surface Water	55 records of flooding in Ainsdale, Aintree, Birkdale, Bootle, Formby, Litherland, Maghull, Melling, Seaforth and Southport. Impacts in Maghull and Southport were locally significant in isolation.	Sefton MBC
01/08/2004	Surface Water	10 residential properties were recorded having suffered internal and external flooding in Southport.	Sefton MBC
30/04/2001	Surface water / ordinary watercourse	Records of 5 properties flooding are held by Sefton MBC, though it is understood that nearer 25 properties were impacted.	Sefton MBC
12/04/2001	Surface Water	59 residential properties were recorded having suffered internal and external flooding at Claremont Avenue area in Maghull and 10 residential properties were recorded having suffered internal and external flooding at Hawksworth Drive area in Formby.	Sefton MBC
24/11/1996 to 25/11/1996	Surface Water	11 records of flooding in Litherland, Maghull and Southport	UU (SIRS)
31/07/1994 to 03/08/1994	Surface Water	8 records of flooding in Southport and Waterloo	UU (SIRS)
24/01/1994 to 27/01/1994	Surface Water	9 records of flooding in Bootle, Crosby, Formby, Litherland and Waterloo	UU (SIRS)
13/12/1993 to 15/12/1993	Surface Water	8 records of flooding in Aintree, Formby, Lydiate, Maghull and Southport	UU (SIRS)

4.5.40 Since the above list was collated there have been a number of significant events within Sefton that have resulted in localised surface water flooding within Sefton. Sefton MBC has provided the following additional information since the publication of the SWMP.

Table 4-13: Recent surface water flooding records

Date	Location	Consequence	Source of Information
7th February 2011	Moss Lane	2 properties flooded	Sefton MBC
24th September 2012	Highbank, Maghull	2 properties flooded	Sefton MBC
24th September 2012	Moss Lane, Maghull	1 property flooded	Sefton MBC
25th September 2012	Kenyons, Maghull	1 property flooded	Sefton MBC
25th September 2012	Southport Road, Lydiate	1 property flooded	Sefton MBC

4.5.41 In addition to the above, an internet search revealed the following records:

- Flash flooding took place in Ainsdale on 5th September 2008[41];
- Flooding is noted at Savon Hook, Formby[42]. It is assumed that this was from 24th/25th September 2012;
- Flooding in Southport[43] also mentions flooding at Switch Island at end of M57 with flooded fields on 24th September 2012; and
- Southport Botanic Gardens Lake was flooded on the 24th/25th September 2012 and remained flooded until at least 6th October 2012[44].

4.5.42 Past flooding can often be from an unknown source, because records are insufficient to identify where the water came from, or it can be a result of interactions between different sources some of which may not have been identified.

4.5.43 There is some evidence that past floods, particularly in Formby, have been related to high water levels within Main Rivers, particularly the River Alt and its tributaries, and there is some evidence that past floods have related to ordinary watercourses, for example Dobb's Gutter in Formby.

4.5.44 There is little direct evidence that any of the local flooding sources are related to groundwater, though this is likely to be due to a lack of information rather than a

[41] http://www.southportvisiter.co.uk/videos-pics/southport-videos/2008/09/05/ainsdale-flash-floods-101022-21682087/
[42] http://formby.n0tice.com/report/9056/extensive-floods-on-site-of-proposed-housing-development-in-the-greenbelt
[43] http://www.southport.gb.com/southport/news_list/Heavy_Rain_Brings_Flooding_To_Parts_Of_Southport-51684153.htm
[44] http://www.otsnews.co.uk/southports-botanic-gardens-lake-remains-flooded/

lack of connection between the two, as groundwater is known to influence baseflows in the River Alt, and groundwater monitoring networks suggest groundwater at shallow depths (<1m) in parts Formby[45]. Therefore it is likely to be an influence. Groundwater is also understood to have an influence in flooding on Maghull.

4.5.45 Figure 16 in Volume 2 presents the historical flood records of United Utilities as a thematically mapped grid that is a darker blue where there are more records and a lighter blue where there are fewer records. No grid implies no flooding records in that location. In addition, the records of flooding from Sefton MBC are also presented.

Sewer Flooding

4.5.46 United Utilities has provided data of its sewer assets, as well as its records of incidents within its sewer system.

4.5.47 The urban areas of Sefton are well served by United Utilities sewers. Formby, Aintree, Maghull, parts of Ainsdale and small parts of Southport are served by separate surface water and foul water sewers, whilst the majority of the remaining areas are served by combined sewer systems.

4.5.48 There are a number of sources of data with respect to sewer flooding. United Utilities maintain an incident reporting system of flooding events associated with its assets. Prior to April 2008 this was referred to as the Sewer Incident Recording System (SIRS), though following changes to the data that was recorded this became the Wastewater Incident Recording System (WIRS). Records are kept of the location of flooding, and the causes and effects, including whether there is internal or external flooding, basement flooding etc.

4.5.49 A review of the older SIRS data for Sefton, which covers the period from 1990 to 2008, indicates that there were 372 records of surface water flooding of which only 24 related to flooding of property internally or externally. Of these, none were due to hydraulic inadequacy of the system but were instead due to causes such as blockage or collapse.

4.5.50 Within the more recent WIRS datasets between April 2008 and August 2012, there are 125 records of surface water flooding of which 32 relate to property flooding. Eight of the records are due to hydraulic inadequacy and this is the cause of flooding in five of the incidents affecting properties. Other causes again include blockage, collapse pumping station failure and equipment failure.

[45] IMCORE Project (2010) Sefton Coast – Hydrological Monitoring Progress Report October 2010

4.5.51 United Utilities also maintains a register of properties that are known to be at risk from sewer flooding, known as the DG5 Register. The DG5 register contains properties that are considered to be at risk, based on previous internal or external flooding from various causes, from hydraulic inadequacy, and which occurs with an annual probability of one in 20 year. It does not contain properties that have not yet flooded, i.e. it is not a predictive database of properties that might flood, nor is it a record of past sewer flooding.

4.5.52 The DG5 register for Sefton indicates the following:

- There are 309 properties within the 'DG5 External' register of properties that have experienced external flooding;
- Within the DG5 External dataset there are:
  - 137 properties at risk of flooding once in 20 years;
  - 77 properties at risk of flooding once in 10 years; and
  - 95 properties at risk of flooding twice in 20 years.
- There are 186 properties within the 'DG5 Internal' register of properties that have experienced internal flooding;
- Within the DG5 External dataset there are:
  - 70 properties at risk of flooding once in 20 years;
  - 74 properties at risk of flooding once in 10 years; and
  - 42 properties at risk of flooding twice in 20 years.
- The DG5 external properties are distributed across most of the urban areas of Sefton. However, the DG5 internal properties are largely concentrated in Southport and in the Seaforth area. Few properties in Formby or Maghull are included in the DG5 internal dataset.

4.5.53 As the DG5 register is not a predictive register the breakdown into the bands above (once in 20 years, once in 10 years etc) is not an indicator of real risk.

4.5.54 As part of the SWMP, United Utilities provided outputs from its sewer models within the study area. These outputs provide information on the location and volume or predicted surcharging across United Utilities models within the Borough. The volume shown to flood from a manhole represents the largest predicted surcharging volume from a range of storm durations, which makes direct comparison impossible.

4.5.55 The sewer modelling results show predicted surcharging of sewer manholes across all areas of Sefton which are served by United Utilities sewers. With

respect to certain rainfall events, flooding would be expected to occur as frequently as once every year from only isolated manholes across all areas of Sefton, with the exception of Formby. In Formby, flooding in this event would be more extensive, particularly in the vicinity of Dobb's Gutter and Bull Cop, and the Hawksworth Drive area. Elsewhere, the main location of larger flooding volumes appears to be at the lower end of Rimrose Valley and the along former path of Rimrose Brook, in Seaforth.

4.5.56 In general, the modelling indicates a sewer system that in places would not provide the design capacity associated with a new build system, which is an understandable issue affecting older sewerage systems. As rainfall events become more extreme, for example due to climate change, the number and density of manhole surcharging across urban areas increases, which is likely to lead to localised and in some cases severe consequences.

4.5.57 It is anticipated that climate change, which is currently predicted to result in wetter winters and to increase storm intensity, will increase the extent of these areas of flooding and perhaps result in a risk of flooding in areas that are not currently shown to be at risk. Further development also has the potential to increase pressure on the system unless surface water is effectively managed to result in no detriment and if possible to provide betterment.

4.6 Groundwater Flooding

4.6.1 Groundwater flooding occurs when water levels in the ground rise above the ground surface. It is most likely to occur in low-lying areas underlain by permeable drift and rocks.

4.6.2 Where groundwater flooding occurs, it may have a number of different aspects. In low lying depressions groundwater can be above the ground surface and cause ponding that can last for long periods of time. Elsewhere it may result in watercourses flowing where there are normally none, and in other areas it may cause waterlogging of ground. It is difficult to predict how groundwater flooding will affect an area. However, groundwater will typically emerge and flow to low points, where it will pond or into these 'new' watercourses. Consequently, existing surface water flooding datasets may in some locations be a suitable proxy for the areas that might be affected within those areas at risk of groundwater flooding.

4.6.3 At the time of its publication Sefton MBC's Preliminary Flood Risk Appraisal (PFRA) Preliminary Assessment Report (PAR) indicated that there is no direct evidence of groundwater contributing to flood risk within the borough, and no

records available from any source to identify groundwater as a primary or secondary cause. Since then, 2012 was recorded as the United Kingdom's second wettest year on record and England's wettest year. Within Sefton, an exceptionally high water table developed in the vicinity of Ainsdale and Birkdale as a result of rainfall over the latter six months of the year. This resulted in the closure of parts of the Coastal Road between Weld Road and Shore Road that affected the Royal Birkdale Golf Club and some properties in the winter of 2012/2013. Pumping had little effect and drainage channels were checked and confirmed not to be contributing to the flooding. Elsewhere fields and other golf courses noted flooding that may also have been influenced by groundwater levels.

4.6.4 The Environment Agency's national dataset, Areas Susceptible to Groundwater Flooding (AStGWF), was used to inform the assessment of future flood risk from groundwater within the PFRA. This dataset illustrates that groundwater flood risk across Sefton mainly arises from the permeable superficial (drift) deposits along the coast (Formby, Ainsdale and Southport), where large areas of the Borough (>75%) are potentially susceptible to groundwater flooding.

4.6.5 The AStGWF data matches relatively well the outputs of Groundwater Susceptibility mapping that is available from the British Geological Survey. These maps show the northern half of Sefton, generally north of Crosby, as being susceptible to groundwater flooding. There is also an area within the Alt floodplain in the vicinity of Maghull and in isolated patches associated with the Rimrose Brook valley.

4.6.6 The Alt Crossens Catchment Flood Management Plan (CFMP) indicates that there are some parts of the borough in which groundwater emergence may have been influenced by the cessation of pumping from former mines (which themselves are outside Sefton). The lower Alt catchment is identified as one of the areas at risk. This conclusion is supported by the Lower Mersey and North Merseyside Groundwater Resources study[23], which indicates that there was a significant proportion of baseflow in the River Alt that came from the Permo-Triassic Sandstone.

4.6.7 The Level 1 SFRA presented DEFRA's Groundwater Emergence Map (GEM), which identifies areas where, in exceptionally wet winters, groundwater may be expected to rise to be close to or at the ground surface. This dataset is presented in Figure 17 of Volume 2 and it indicates that that the lower lying areas of the Alt floodplain, extending from the boundary of Knowsley to North End near Ince Blundell, could be affected by potentially shallow groundwater. Other areas affected include areas to the north east of Seaforth Docks, areas in the upper reaches of the Rimrose Valley Country Park, areas north of Farmoss Pool,

sections of coastline and areas to the east of Fine Jane's Brook and Captains Watercourse.

4.6.8 There is therefore some overlap between the AStGWF, BGS Groundwater Susceptibility datasets and DEFRA's GEM in Sefton but there are also areas where there is a clear difference and most notably the Groundwater Emergence Zones are far less extensive than those areas identified in the Susceptible to Groundwater Flooding dataset. The GEM dataset appears to reflect the findings of the Mersey and North Merseyside Water Resources study more closely that it does the other datasets, which gives some confidence with respect to its use to assess the source of groundwater flooding in addition to the BGS dataset.

4.6.9 With respect to new development, the consequences of groundwater near the surface or emerging at the surface may not necessarily directly impact the development itself. New development should have threshold and ground floor levels above the surrounding ground surface which would typically be sufficient to prevent internal flooding, particularly where the groundwater is only near the surface or where it emerges but flows or remains at very shallow depths.

4.6.10 Direct impacts are more likely, however, where new development is constructed in a lower lying depression within a site and where the lowest elevation within that depression is below the highest possible groundwater level. Should groundwater rise in these areas then there is a higher chance that it will rise above the threshold or ground floor level, causing internal flooding or at the very least a frequent nuisance during the wetter months. **For this reason, in areas of groundwater emergence or where the susceptibility to groundwater flooding is Moderate to Very High it is recommended that consideration be given to the layout of the development relative to the topography, that groundwater levels are identified and that where possible new development avoid low lying depressions within a site.**

4.6.11 Elsewhere, shallow or emerging groundwater is likely to increase the probability and duration of flooding in areas affected by flowing and ponding water; as identified in the surface water management plan (SWMP) outputs and, where these are not available, within the Areas Susceptible to Surface Water Flooding (AStSWF) datasets. As a result, in areas at risk of groundwater emergence and areas susceptible to groundwater flooding the risk of flooding from other sources of flooding, such as surface water, may be exacerbated by groundwater and or made more frequent. **As such it is recommended that development within these areas be avoided and that any such flow paths or area of ponding be protected from inappropriate development.**

4.6.12 In addition to the direct effects of groundwater on flooding and other sources of

flooding, groundwater influences the available options for drainage within a site and it may constrain the opportunities for including basements into the design of a new building.

4.6.13 Shallow groundwater levels will constrain the opportunities for infiltration based SuDS. The SuDS Manual[46] indicates that there should be at least a 1m level difference between the base of an infiltration-based SuDS system and the highest groundwater level expected at a site. Consequently, shallow groundwater can prevent the use of infiltration-based SuDS and force more conventional drainage systems and higher volumes of storage to be provided to meet relevant drainage design requirements.

4.6.14 It is known from local groundwater studies[45] that the groundwater level in parts of Formby and between Formby and Ainsdale is shallower than 1m below ground level. **Groundwater levels are not explicitly included in the Suitability for SuDS map in Figure 21, therefore it is recommended that groundwater depths be investigated as early as possible to feed into the planning application process, the sustainable drainage design process and in the preparation of any site-specific Flood Risk Assessment.**

4.6.15 The risk of groundwater ingress into new basements can be designed out by application of appropriate engineering methods that utilise waterproofing or tanking of the basement, sumps and drainage systems direct groundwater to the pump, however, such measures can be costly. British Standard (BS8102:2009), Code of practice for protection of below ground structures against water from the ground, gives recommendations and provides guidance on methods of dealing with and preventing the entry of water into structures below the ground.

4.6.16 Further advice on what to do if you are at risk of groundwater flooding is provided by the Environment Agency[47].

4.6.17 Local groundwater monitoring data exists in 19 locations within the borough, however, the information held covers different groundwater units and the frequency of sampling differs across the monitoring locations. There is some correlation with periods of very wet weather, for example the winter of 2000/2001 is recorded as being very high, particularly at Birkdale Sand Hills monitoring well, which is close to the Coastal Road where a high water table flooding affected properties in the winter of 2012/2013. Further detailed analysis is required to identify whether groundwater levels have historically contributed to surface water flooding and it is recommended that this be undertaken to inform future flood risk management.

[46] CIRIA, 2007, The SuDS Manual Report C697
[47] Environment Agency, 2011, Flooding from Groundwater, http://www.groundwateruk.org/downloads/EAGWFlooding.pdf

4.6.18 As a result of the above, groundwater flooding is considered to be both a source of flooding in some locations and an influence on other sources of flooding, such as surface water flooding or fluvial flooding within Sefton.

4.7 Flooding from Artificial Sources

Leeds and Liverpool Canal

4.7.1 The Leeds and Liverpool Canal flows through the Borough for approximately 21.1km. It enters Sefton at Jackson's Bridge, which lies to the north east of Lydiate. It then runs around to the west of Lydiate and south-eastwards through Maghull into Melling and Waddicar, before crossing the River Alt and running north westwards through Aintree and Netherton and then around the edge of Litherland to head back south eastwards into Bootle and then into Liverpool just past Princess Street.

4.7.2 The canal is raised in a number of locations along its length, which presents a potential risk of flooding should the condition of the embankments become increasingly poor. Table 4-14, presents the location of raised canal sections within Sefton and identifies the receiving watercourse in the event of a failure of the embankment.

Table 4-14: Raised canal sections and receiving watercourses

Location	Receiving Watercourses
Jackson's Bridge, north of Lydiate	Sudell Brook
Lydiate	Altcar Lane Brook Rigby Brook Maghull Brook River Alt
Maghull	Upland Drain Maghull Brook Dover Brook Whinney Brook River Alt
Melling	Melling Brook Old Alt Brook Brooklea River Alt
Waddicar	Brooklea Melling Watercourse River Alt

Location	Receiving Watercourses
Aintree	Moor Hey Tributary River Alt
Netherton	Moor Hey Tributary Netherton Brook River Alt
Litherland	Rimrose Brook Overland to Seaforth
Bootle	Overland to Seaforth Overland to Docks

4.7.3 There are also risks from the canal where a watercourse is culverted beneath it. The following watercourses / structures pass beneath the canal, mainly in the Maghull area, and therefore pose a potential risk:

- Sudell Brook, culverted;
- Rigby Brook, culverted;
- Maghull Brook, culverted;
- Whinney Brook, culverted;
- Melling Brook, culverted;
- Brooklea, unknown;
- Melling Watercourse, unknown;
- River Alt, Bridge;

4.7.4 There may also be a number of smaller drains that pass beneath the canal but which are likely to pose a much lower risk than the above watercourses.

4.7.5 There was a failure of the canal in October 1994, when the roof of a culvert carrying Maghull Brook beneath the canal collapsed. The flow from the canal into the culvert caused further collapse of the culvert and the canal eventually breached into the watercourse, causing extensive flooding upstream and downstream of the failure. The extent of this flooding is identified in Figure 18 of Volume 2.

4.7.6 Because the canal infrastructure is managed by the Canal and River Trust the risk of failure should be relatively low. However, the canal infrastructure is aging and the length of assets that require management are significant. Given the area of Sefton at risk from this source, and the potential consequences in the event of failure, the overall risk of flooding from this source is considered to be moderate.

This should be acknowledged when assessing risks to a site and, where appropriate, this risk may need to be assessed in more detail and addressed by measures proposed to manage flood risk. As a residual risk, however, the risk of flooding from the canal should not be used to determine whether development should take place on a site or not.

Reservoirs

4.7.7 There are no reservoirs within the Borough of Sefton. However, areas in the south of Borough are affected by flooding from reservoirs located outside of the Borough.

4.7.8 The Environment Agency is the enforcement authority for the Reservoir Act 1975[48] in England and Wales. The Environment Agency ensures that reservoirs are regularly inspected and essential safety work is carried out. Sefton MBC is responsible for co-ordinating emergency plans for reservoir flooding and ensuring that communities are well prepared.

4.7.9 The Reservoirs Act 1975 is in the process of being updated by the Flood and Water Management Act 2010. The Flood and Water Management Act reflects a more risk-based approach to reservoir regulation through:

- Reducing Capacity at which a reservoir will be regulated from 25,000m^3 to 10,000m^3;
- Ensuring that only those reservoirs assessed as high risk are subject to regulation;
- Ensuring that all undertakers with reservoirs over 10,000m^3 register their reservoirs with the Environment Agency;
- Inspecting engineers must provide a report on their inspection within 6 months;
- All undertakers must prepare a reservoir flood plan; and
- All incidents at reservoirs must be reported.

4.7.10 Reservoir owners will in due course be required to prepare on-site emergency plans. On-site emergency plans detail how reservoir owners or those responsible for the operation of a reservoir will respond to a potential or real reservoir failure. It is good practice for all reservoirs to have on-site plans and all reservoir owners are recommended to prepare one.

[48] Reservoirs Act, 1975.

4.7.11 In 2009 the Environment Agency produced a series of reservoir inundation flood maps. Only large reservoirs that hold over 25,000 cubic meters of water were assessed. Maps of the maximum flood extent are available on the Environment Agency's website and have been provided by the Environment Agency for use within this SFRA to determine the potential risk to key development sites. Figure 19 of Volume 2 presents the extent of reservoir inundation within Sefton.

4.7.12 White Man's Dam is located within Knowsley Park and is owned and maintained by the Earl of Derby's Estate (NGR 344965 394135). Figure 19 indicates that a breach at the southern tip of the reservoir is shown to flood areas between the reservoir and Stockbridge Village in Knowsley The flood waters are conveyed north by Croxteth Brook towards the River Alt and from there into Sefton. Flooding is seen from the boundary of Sefton as far as Maghull Brook and between the River Alt and Lydiate Moss Ditch. Flooding would impact areas along the edge of Aintree, the Garden Centre at Sefton Meadows in Maghull, and properties on Sefton Drive Maghull. Elsewhere, and mainly in the Maghull area, there would be extensive flooding of the floodplain of the River Alt, Brooklea, Old Alt Brook and between Dover's Brook and Upland Drain. St. Helens Brook would also flood in places.

4.7.13 Prescot No.4 reservoir lies within the adjacent borough of Knowsley at NGR 346920 393950. It is owned and maintained by United Utilities Water plc. Although located outside of the Borough, should a breach occur on the south western side of the reservoirs, then flood waters could be conveyed south westwards towards Huyton and the headwaters of the River Alt. Flows are then conveyed north westwards, taking the path of the River Alt and Croxteth Brook into the Sefton. The consequences of this failure are largely confined to Knowsley, though there is a small area upstream of the Leeds and Liverpool Canal Aqueduct over the River Alt that lies within Sefton which would be affected.

4.7.14 The probability of reservoir failure is low, and has not caused a loss of life in the UK since 1925. The active management and regular maintenance of reservoirs and associated structures mean that there is a low to very low probability of failure. Flooding may be rapid and without warning if it were to occur. However given that there are relatively few properties within Sefton that would be affected, and a small number of traffic sensitive routes, this assessment concludes that the overall risk of flooding from this source is low.

4.7.15 The Merseyside Community Risk Register, published by the Merseyside Resilience Forum, presents a medium risk rating for reservoir flooding. The assessment presented within Community Risk Register is based on the Multi-Agency Flood Plan that was led by the Environment Agency. At the Merseyside scale, the risk posed by a number of large reservoirs to locations within Knowsley

and St. Helens is considered appropriate. However, when considering Sefton in isolation the assessment presented above is considered to be more valid.

4.7.16 In light of the above, the risk of reservoir flooding should be considered as a residual risk to new and existing development in Sefton. This should be acknowledged when assessing risks to a site and, where appropriate, this risk may need to be addressed by measures proposed to manage flood risk. As a residual risk, however, it should not be used to determine whether development should take place on a site or not.

4.7.17 As discussed in Section 7 this document is a living document and therefore Sefton MBC should update this section of the SFRA to reflect future updates to guidance within the Reservoir Act. This is anticipated to be updated in October 2012.

4.8 Summary of Flood Risk

4.8.1 The principal source of flood risk within the borough of Sefton, based on the spatial extent of all flood risk datasets, is surface water flooding, and this is a risk across Sefton. However, there is a risk from all sources of flooding somewhere within Sefton.

4.8.2 Fluvial (river) flood risk is notable in a number of areas, from both main rivers and ordinary watercourses. Based on the risk to people and property, areas around Formby, Thornton, parts of Maghull and north of Netherton and Aintree; and to the north and east of Maghull. A number of these fluvial flood risk areas, particularly in Formby, Thornton and Maghull, heavily influence flood risk from other sources, such as surface water, hence the records of flooding in these areas may also be from those sources or a mixture of both. Climate change will increase the risk in all locations, and from many sources.

4.8.3 Tidal flooding – a risk mostly in northern Southport, between Formby and Hightown and along a narrow coastal strip - is largely managed by the existing defences, which are generally in fair condition. There is potential for climate change to increase this risk of tidal flooding in the future.

4.8.4 Surface water flooding affects significant areas of Sefton, and as a result of the low-lying topography of the borough there are areas in which the extent of flooding is large, and the number of properties affected is significant. This is compounded by the influence on flooding by transport infrastructure such as existing and disused railway lines, roads and the Leeds and Liverpool Canal. The SWMP identified that approximately 38,000 properties could be at risk in the

event of a 1 in 100 annual probability storm event with an allowance for climate change. This includes impacts to fire and police stations, a hospital, GP surgeries, health centres, nursing homes, children's centres and nurseries, most school grounds and a significant number of school buildings.

4.8.5 Sewer flooding is considered to be a significant issue across the borough, predominantly as a result of sewer systems that generally have insufficient capacity to cope with severe rainfall events.

4.8.6 There is a potential risk of groundwater related flooding based on the nature of the drift and solid geology and from the areas of shallow or potentially shallow groundwater levels. However, the direct risk of flooding to people and property is considered relatively low. Groundwater is considered however to pose a potentially significant constraint to drainage, surface water flood risk and in place to fluvial flooding, such as the River Alt.

4.8.7 There are raised sections of the Leeds and Liverpool canal across southern Sefton which pose a potential risk to properties on the downstream (lower) side, in the event of failure of raised embankments and where culverts pass beneath the canal itself. There have been historical incidents. However, the risk is considered relatively low due to the ongoing management of the canal.

4.8.8 Similarly, there are areas within Sefton that are at risk from the failure of reservoirs. The reservoirs are all located outside of the borough and modelling indicates that the consequences of failure within Sefton are relatively minor, affecting properties in areas that are already at risk of fluvial flooding, such as Dover's Brook.

4.8.9 A number of locations appear to be at risk from a number of different sources and these 'hotspots' should be noted. Based on historical records, the Environment Agency's flood zone map, detailed fluvial flood risk modelling, surface water and sewer flood risk modelling and consideration of the influences and effects of groundwater, canal flooding and reservoir flooding there are hotspots of flooding at the following locations:

- Along Whinney Brook, particularly at Hall Lane and at Fouracres (Maghull);
- Associated with Dover's Brook and ordinary watercourses in the vicinity of Sefton Lane (Western Maghull); and
- Eight Acre Lane Brook and along Hawksworth Drive (Formby).

5 How to use the SFRA in Local Planning

5.1 Introduction

5.1.1 National guidance on development and flood risk is presented in the National Planning Policy Framework and supporting Technical Guidance (March 2012) (NPPF).

5.1.2 The NPPF requires that the allocation of sites take account of the nature and spatial distribution of flood risk, as well as the degree of vulnerability of different types of development. This should be achieved at all stages of the development planning process, including the allocation of sites in the Local Plan and when assessing windfall planning applications. The NPPF advocates a sequential, risk-based approach to the allocation of sites and to development within sites.

5.1.3 The evidence presented in this SFRA is intended to inform Local Plan policies and allocation of development sites, and to provide an appropriate level of detail so it can be considered sound evidence, and robust with respect to flood risk. It will also inform the preparation of any Neighbourhood Plans within Sefton, and any development briefs or similar documents which are associated with the Local Plan process. The term 'Local Plan' in this chapter should be taken to include, where appropriate, both Neighbourhood Plans and any development briefs or similar documents which are associated with the Local Plan process. The evidence presented in this SFRA is also intended to inform developers when they prepare site-specific flood risk assessments. .

5.1.4 In summary, the SFRA provides the evidence to:

- Direct development away from area at greatest risk of flooding, and manage residual risk, taking into account the impacts of climate change – applying the risk-based, Sequential Test approach to choice of sites in the local plan and to many windfall sites, and where necessary applying the Exception Test;
- Inform the Sustainability Appraisal of the Local Plan;
- Make sure that any development is safe, does not increase flood risk (from any source) elsewhere, and if possible reduces flood risk overall; and
- Inform the preparation and content of site-specific flood risk assessments for development sites, and help identify when site-specific flood risk assessments or flood risk management statements are required.

This chapter focuses on all four of these bullet points, in relation to Local

Planning. The next chapter, Chapter 6, focuses on the last two bullet points, in relation to development management – the fourth bullet is relevant to both Local Planning and development management.

5.1.5 The NPPF makes clear that the main basis for directing development away from areas at greatest risk of flooding is through the application of the Sequential Test, and Exception Test where necessary. More information about these is set out below.

5.2 Sequential Test

5.2.1 The aim of the Sequential Test, set out in the NPPF, is to steer new development to the areas with lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The NPPF makes clear that Environment Agency's river and tidal Flood Zones are the starting point for assessing the probability of flooding in the Sequential Test approach. These are set out in Table 1 of the NPPF Technical Guidance, which is recreated in Table 4-2 of this SFRA. Table 1 of the Technical Guidance also sets out the types (uses) of development which are appropriate in each Flood Zone.

5.2.2 However, the NPPF also makes clear that SFRAs should refine information on the probability of flooding, taking into account other sources of flooding and the impacts of climate change. It also makes clear, that where they are in place, SFRAs provide the basis for applying the Sequential Test and the Exception Test.

5.2.3 This SFRA incorporates information on the Environment Agency's river and tidal Flood Zones, and presents (including in the figures in Volume 2) more refined information on flood risk by taking into account the presence of flood defences and other flood risk management infrastructure, by presenting information on depth and velocity and by presenting information on other sources of flooding and climate change.

5.2.4 It is recognised that flood risk information must be considered alongside other local planning issues, including through the sustainability appraisal process. These other issues include for example housing and employment needs, the natural environment and other planning policy considerations and constraints. This other information is relevant with respect to defining whether alternative locations are 'reasonable', sustainable and available in sufficient quantities. Thus potential sites to be allocated for development are 'tested' on the basis of their

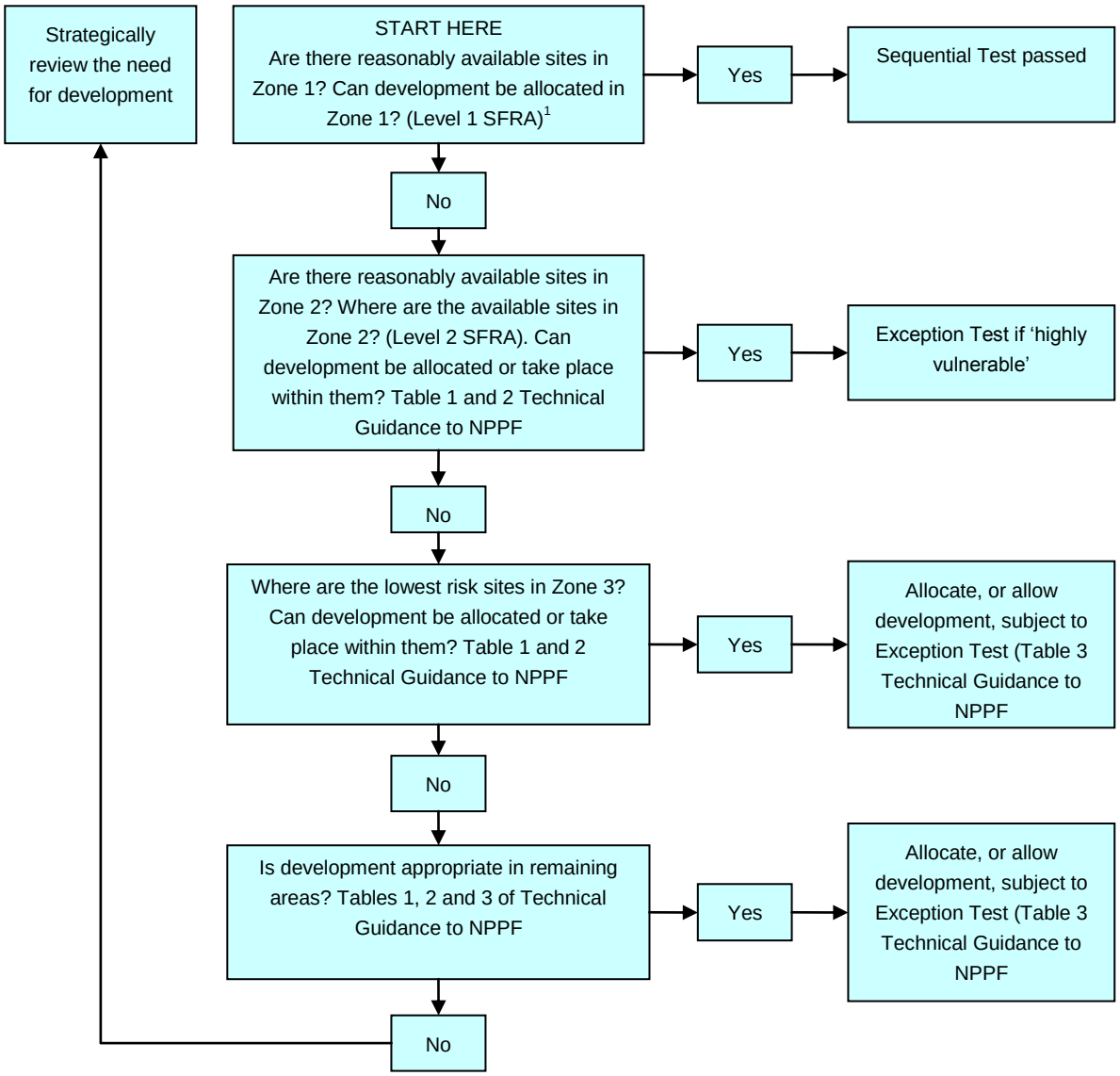
flood risk attributes, and the outcome used to inform decisions that are also informed by other issues.

5.2.5 To perform the Sequential Test Sefton MBC first needs to be aware of what sites are reasonably available[49] within the Borough. It is necessary to define 'reasonably available' and be able to provide evidence that there are not locations outside of those considered with a lower probability of flooding that could be considered to be 'reasonably available'. This links both to the definitions of deliverable and developable housing sites set out in the NPPF and to other local planning issues and requirements. When applying the Sequential Test it will be important for Sefton MBC to demonstrate that a transparent process has been formulated and followed; that this process has sought to steer new development to areas with the lowest probability of flooding, where possible; and that full consideration has been given to reasonably available alternatives on land with a lower probability of flooding, consistent with other policy requirements.

5.2.6 Figure 5-1 contains a flow chart for use by Sefton MBC in the application of the Sequential Test. It is a tool to help the decision-maker locate a proposed development in lower flood risk categories. The table that follows, Table 5-1, contains additional notes which direct the user to the particular chapters of technical information or mapping within this SFRA and which should be used in each stage of the process.

5.2.7 The flood risk information required to address the four stages in the application of the Sequential Test noted above is provided in the flood maps in Volume 2 of this SFRA. Specific guidance for Sefton MBC on the use of these flood maps in the application of the Sequential Test is provided in Table 5-1.

[49] Reasonably available is considered to mean those sites that can meet the functional requirements of the type of development proposed are located in an appropriate location, could be available for the developer to use for the proposed purpose, and which can be reasonably developed for that purpose.



Note 1. Other sources of flooding need to be considered in Flood Zone 1

Note 2. Adapted from the PP25 25 Practice Guide (June 2008) to be applicable to the NPPF.

Figure 5-1: Application of the Sequential Test

Table 5-1: How to Apply the Sequential Test

Stage in Sequential Test	Guidance	Associated figure in SFRA (Volume 2)
1. Are there reasonably available sites in Zone 1? Can development be allocated in Zone 1?	Sefton MBC should use Flood Zone maps to identify areas of the Borough within Zone 1 and consider whether there are appropriate locations for the allocation of development sites, or which are reasonably available for development, in Zone 1 areas. Sefton MBC should use more detailed information within this SFRA to understand the extent and distribution of flood risk within Flood Zone 1. Within Zone 1, areas at risk from other sources of flooding should be avoided where possible.	Figure 3 – EA fluvial Flood Zones Figure 4 – EA Tidal Flood Zones
2. Where are the available sites in Zone 2? Should development be allocated within them?	Sefton MBC should initially use Flood Zone maps to identify areas of Borough within Zone 2, and consider whether these are appropriate locations for the allocation of development sites, or which are reasonably available for development. Sefton MBC should use more detailed information within this SFRA to understand the extent and distribution of flood risk within Flood Zone 2. Within Zone 2, development in areas at risk from other sources of flooding should be avoided where possible.	Figure 3 – EA fluvial Flood Zones Figure 4 – EA Tidal Flood Zones
3. Where are the lowest risk available sites in Zone 3? Should development be allocated within them?	Sefton MBC should use more detailed information within this SFRA to understand the extent and distribution of risk within Flood Zone 3. The Flood Zones do not take account of existing control structures and defences. Maps are presented in this SFRA which show the actual risk of fluvial flooding from watercourses when existing defences are in place. Within Zone 3, areas at risk from other sources of flooding should be avoided where possible. Sefton MBC should also consider the potential impacts of climate change, as discussed in Chapter 4, on different sources of flooding.	Figure 6 – Fluvial Flood Risk with Defences (including climate change) Figure 7 – Tidal Flood Risk with Defences (including climate change) Figure 8 – Flood Zone 3b Figure 9 – Fluvial Flood Depth with Defences (1 in 100 annual probability event plus climate change) Figure 10 – Fluvial Flood Velocity with Defences (1 in 100 annual probability event plus climate change) Figure 12 – SWMP outputs (including climate change for areas where modelling is available) Figure 15 – Areas Susceptible to Surface Water Flooding

Stage in Sequential Test	Guidance	Associated figure in SFRA (Volume 2)
4. Is development appropriate within the resulting areas?	In considering the appropriateness of development in remaining areas, Sefton MBC should consider the vulnerability of the proposed development and Tables 2 and 3 of the Technical Guidance to the NPPF. Although information on flood hazard from river flooding is not available within this SFRA, maps showing maximum depth and velocity maps are included. Sefton MBC should also consider the potential impacts of climate change, as discussed in Chapter 4, on different sources of flooding.	Figure 9 – Fluvial Flood Depth with Defences (1 in 100 annual probability event plus climate change) Figure 10 – Fluvial Flood Velocity with Defences (1 in 100 annual probability event plus climate change)

5.2.8 It should be noted when applying the process outlined above that the Environment Agency's Flood Map does not take into account small watercourses with a catchment area of less than 3km^2. As such the Flood Zone Map will not provide flood extents for many Ordinary Watercourses; that is, rivers, streams, ditches, drains, cuts, sluices, sewers (other than public sewers) and passages through which water flows that do not form part of a main river. Furthermore, the detailed hydraulic models available for watercourses within the Borough also exclude Ordinary Watercourses within the study area.

5.2.9 A review of the Flood Zone Map against the location of Ordinary Watercourses indicates that none of the Ordinary Watercourses identified in paragraphs 4.2.9 to 4.2.20 have an associated Flood Zone with the exception of the upper extent of Whinney Brook. This may imply that there is no flood risk associated with the watercourse, but it may also reflect the small size of the watercourse and lack of information.

5.2.10 However, the Surface Water Management Plan and Areas Susceptible to Surface Water Flooding (AStSWF) map shown in presented in Figure 15 in Volume 2 can be a useful source of information to understand the potential flood risk associated with an Ordinary Watercourse. It must be understood that these data sets are not a detailed assessment of fluvial flood zones, and should therefore only be considered an indication of where ordinary watercourses may pose a risk of flooding. **It is recommended that where new development is proposed near to Ordinary Watercourses that a Flood Risk Assessment be undertaken in support of that development and that this includes an assessment and if necessary measures to manage the risk to and from these watercourses.**

5.2.11 The process illustrated in Table 5-1 refers to the potential impacts of climate change on the level of flood risk shown. The potential impacts of climate change

on different sources of flooding is discussed throughout Section 4 of this report and presented in Figures 6 and 7 in relation to fluvial and tidal flood risk and in Figure 12 in relation to surface water and sewer flooding for those areas in which detailed modelling of the consequences of climate change impacts are available. These figures should be referred to when considering where the areas of lowest risk within a site are located. **Where development takes place outside of these areas it is recommended that developers should be required to provide further information on the consequences of climate change on the flood risk to their developments and on flood risk elsewhere as a result of their development.**

5.2.12 **The effects of climate change on other sources of flood risk within Sefton is less well understood and it is recommended that it should also be the responsibility of the developer to show that the effects of climate change can be managed over the lifetime of the development.**

The protocols adopted for applying the Sequential Test should be agreed with the Environment Agency, as it Environment Agency, as it is important that decision makers engage key stakeholders early in the decision stakeholders early in the decision making process. It is also important to consider uncertainty of information consider uncertainty of information when making land use planning decisions and to document all decisions to document all decisions made throughout the process. An example process for applying the Sequential applying the Sequential Test is presented in [1] Flood Zone 1 for fluvial and tidal flooding and with low risk of flooding from other sources

[2] [3] Flood Zone 2 for fluvial and tidal flooding with a medium risk of flooding from other sources
[4] As defined by the Sequential Test
[5] Development to be safe and to not increase flood risk elsewhere. Required to pass the Exception Test, where applicable
Including to susceptibility to future climate change and residual flood risk.

5.2.13 Figure 5-2.

5.3 Exception Test

5.3.1 The Exception Test provides a method of managing flood risk while still allowing necessary development. Where application of the Sequential Test shows that there are insufficient reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding, the NPPF and Table 2 of its Technical Guidance set out the circumstances and types of development for which an Exception Test can be carried out, in effect to see if development is acceptable in flood risk terms in areas at greater risk of flooding. They also set out the circumstances where an Exception Test, and therefore a particular type of development, is not appropriate.

5.3.2 The NPPF makes clear that where they are in place, SFRAs provide a basis for applying the Sequential Test and the Exception Test. There are two parts to

Exceptions Test, and both of these must be passed for the potential development site to be allocated or permitted:

- 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; and
- a site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

5.3.3 Figure 5-1 highlights the stages in the Sequential Test at which the Exception Test may need to be applied. Figure 5-3 presents the process that should be followed by Sefton MBC in its application of the Exception Test under the NPPF.

5.3.4 The first part of the Exception Test refers to the wider sustainability benefits of the development. These may be considered through the sustainability appraisal process for the site allocation process or, for unallocated sites by considering similar sustainability issues.

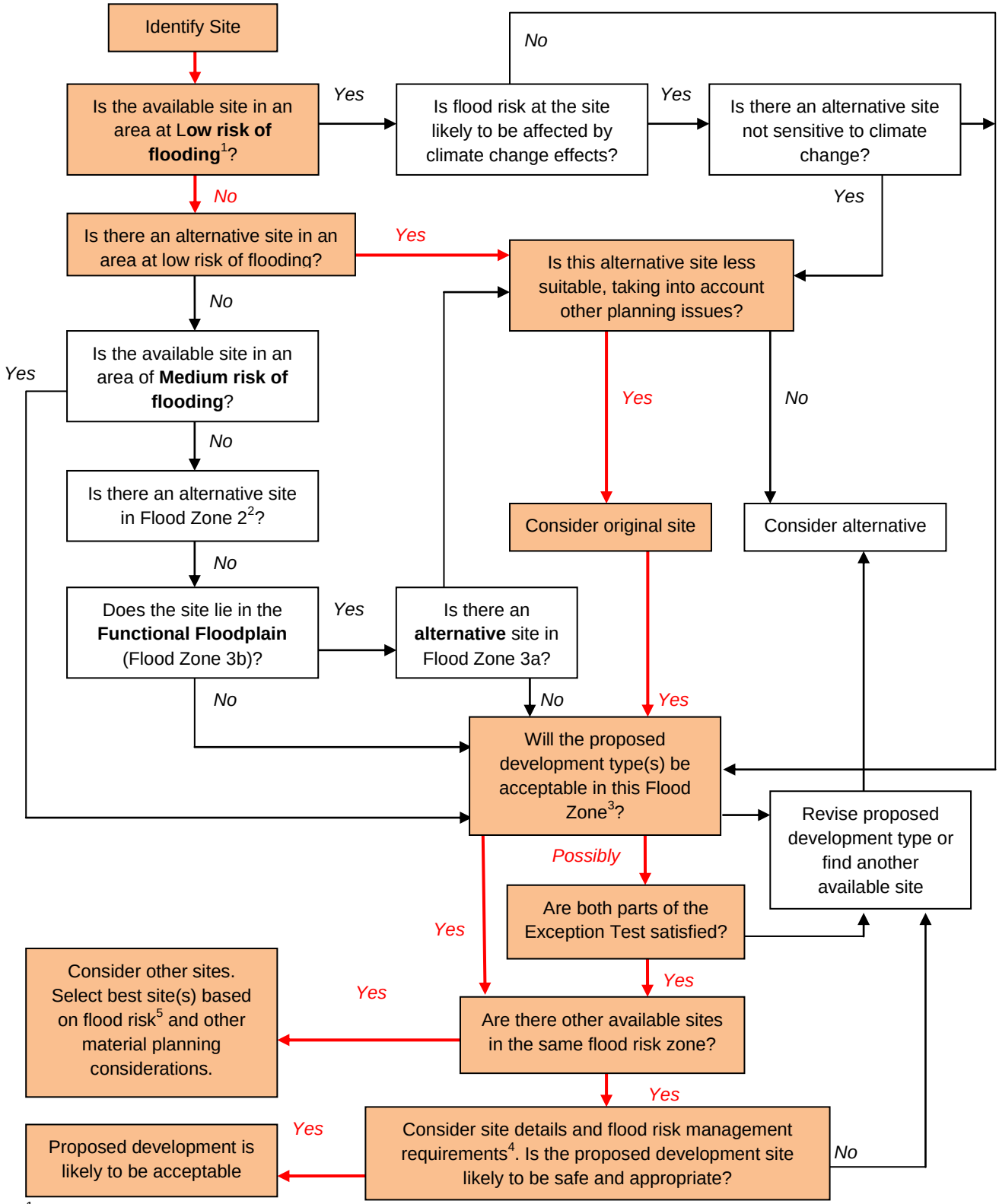
5.3.5 The second part of the Exception Test relates to the safety of the development and the need to not increase flood risk elsewhere. There are no fixed criteria for what constitutes 'safe' development, as it will depend upon factors such as the nature and detailed design and layout of the development, the source and mechanism of flood risk and the vulnerability of the land use or users.

5.3.6 However, appropriate application of the flood risk management hierarchy of 'Avoid – Substitute – Control – Mitigate' will increase the safety of a development. Table 5-2 outlines the data that should be used when considering the above aspects and when determining the safety of a development over its projected lifetime. Information is also provided in paragraph 6.37 in Chapter 6. Also, where possible, the following should be considered for new development that is within the floodplain and justification should be provided where this cannot be achieved:

- Development ground floor levels and access should be dry, particularly for More or Highly Vulnerable uses; and
- The Flood Hazard should be less than Significant (Dangerous for Most People), as defined within DEFRA/EA FD2321/TR1 Report *Flood Risks to People*[50]. This implies a Hazard rating of less than 1.25, which correlates to fast flowing shallow water and/or slow flowing deep water.

[50] Defra/EA, 2006, Flood Risk to People, Phase 2, FD2321/TR1, The Flood Risk to People Methodology

5.3.7 It is important that Sefton MBC records the assumptions and decisions made with regard to both the Sequential and Exception Tests.



[1] Flood Zone 1 for fluvial and tidal flooding and with low risk of flooding from other sources
[2] Flood Zone 2 for fluvial and tidal flooding with a medium risk of flooding from other sources

[3] As defined by the Sequential Test
[4] Development to be safe and to not increase flood risk elsewhere. Required to pass the Exception Test, where applicable
[5] Including to susceptibility to future climate change and residual flood risk.

Figure 5-2: The process of allocating a site using the Sequential Test

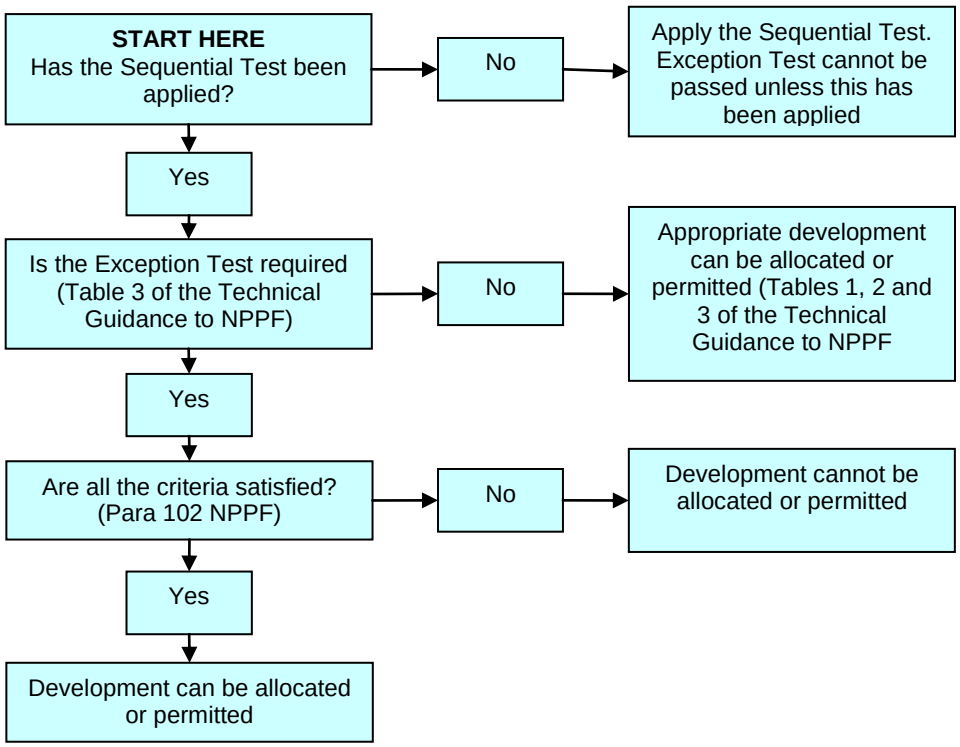


Figure 5-3: Application of the Exception Test

Table 5-2: Information and guidance on assessing whether a site is 'safe'

Source of flood risk	Key Information	Guidance	Information within the SFRA
Fluvial flooding	Are there areas of the site with a risk of flooding taking into account the presence of defences? What is the probability of flooding within the site?	Avoid if possible, otherwise ensure the vulnerability of the development matches the probability of flooding of the flood zone in which the development would be appropriate.	Figure 6 – Fluvial Flood Risk with Defences Figure 7 – Tidal Flood Risk with Defences
	What is the depth of flooding?	Seek to ensure that the internal ground floor level is at least 600mm above the 1 in 100 annual probability flood level plus an allowance for climate change, particularly for More Vulnerable development within Flood Zone 3a. Ensure access and egress routes are dry where possible.	Figure 9 – Fluvial Flood Depth with Defences (1 in 100 annual probability event plus climate change)

Source of flood risk	Key Information	Guidance	Information within the SFRA
	What is the velocity of flooding?	Where possible, seek to ensure that the velocity of flood water is sufficiently low to result in a hazard rating that is no greater than 'Danger to Some', as defined by DEFRA/EA FD2321.	Figure 10 – Fluvial Flood Velocity with Defences (1 in 100 annual probability event plus climate change)
	Is the site covered by Environment Agency Flood Warning Areas?	Ensure that the development has a Flood Warning / Evacuation Plan and that it is signed up to the Environment Agency's Automated Flood Warning Service	Figure 22 – Flood Warning Areas
Fluvial flooding from Ordinary Watercourses	Is there an Ordinary Watercourse within or adjacent to the site? Is the Ordinary Watercourse shown to flood within the SWMP outputs or within the Areas Susceptible to Surface Water Flooding datasets?	If yes to both then ensure that the FRA and that mitigation measures considers Ordinary Watercourses particularly those that may not be covered by the Environment Agency's Flood Zone Maps.	Figure 1 – Sefton Overview Figure 11 – SWMP outputs Figure 15 – Areas Susceptible to Surface Water Flooding
Tidal Flooding	Are there areas of the site with a risk of flooding when taking into account defences? Is there a risk of failure of the tidal defences or overtopping?	Avoid if possible, otherwise ensure the vulnerability of the development matches the probability of flooding of the flood zone in which the development would be appropriate.	Figure 7 – Tidal Flood Risk with Defences
	What is the depth of flooding?	Seek to ensure that the internal ground floor level is at least 600mm above the 1 in 100 annual probability flood level plus an allowance for climate change, particularly for More Vulnerable development within Flood Zone 3a. Ensure access and egress routes are dry where possible or that safe refuge is available.	
	What is the velocity of flooding?	Where possible, seek to ensure that the velocity of flood water is sufficiently low to result in a hazard rating that is no greater than 'Danger to Some', as defined by DEFRA/EA FD2321.	

Source of flood risk	Key Information	Guidance	Information within the SFRA
	Is the site covered by Environment Agency Flood Warning Areas?	Where the site lies within a Flood Warning Area, ensure that the development has a Flood Warning/Evacuation Plan and that it is signed up to the Environment Agency's Automated Flood Warning Service	Figure 22 – Flood Warning Areas
Surface Water Flooding	Is the site at risk from surface water flooding as shown in the SWMP outputs or AStSWF dataset? What is the probability of flooding?	Avoid areas at risk with a 1 in 30 annual probability of flooding if possible, otherwise ensure the vulnerability of the development matches the probability of flooding of the equivalent flood zone in which the development would be appropriate.	Figure 12 – SWMP outputs Figure 15 – Areas Susceptible to Surface Water Flooding
	What is the depth of flooding?	Seek to ensure where possible that the internal ground floor level is above the 1 in 100 annual probability flood level plus an allowance for climate change, particularly for More Vulnerable development. Ensure that flood resistant and flood resilient design is incorporated into the development, as appropriate to the depth of flooding expected in residual flood risk events Ensure access and egress routes are dry where possible or that safe refuge is available.	Figure 12 – SWMP outputs Figure 15 – Areas Susceptible to Surface Water Flooding
	What is the velocity of flooding?	Where possible, seek to ensure that the velocity of flood water is sufficiently low to result in a hazard rating that is no greater than 'Danger to Some', as defined by DEFRA/EA FD2321.	
Groundwater Flooding	Is the site at risk from or might be influenced by groundwater flooding?	Ensure that the FRA considers the risk from groundwater and considers the influence of groundwater on flood risk from other sources. Ensure that the drainage design and the potential use of SuDS takes into account the depth to groundwater as well as the potential for groundwater emergence.	Figure 17 – Groundwater Flood Risk

Source of flood risk	Key Information	Guidance	Information within the SFRA
Flooding from Canals	Is the site at risk from canal flooding?	Ensure that the FRA includes consultation with the Canals and Rivers Trust and Sefton MBC's emergency planners. Where More Vulnerable development is proposed that the consequences of canal failure on flood risk at the site have been identified and taken into account in flood risk management measures.	Figure 20 – Canal Flood Risk
Flooding from reservoirs	Is the site at risk from reservoir flooding?	Ensure that the FRA includes consultation with the Environment Agency, the appropriate reservoir owner/operator and Sefton MBC's emergency planners. Where More Vulnerable development is proposed that the consequences of reservoir failure on flood risk at the site has been identified and taken into account in flood risk management measures.	Figure 19 – Reservoir Flood Risk

5.4 Local Plan development site allocations and assessment of potential development sites in Sefton

5.4.1 Site assessments are due to be carried out for the current list of potential development sites identified at this stage of the preparation of the Sefton Local Plan. More information about these potential sites is set out in section 2.4 (Sefton Local Plan) above.

5.4.2 The SFRA, sequential test, and these site assessments should inform Sefton MBC's decisions on the allocation of development sites in the Local Plan.

5.4.3 It should also inform, where applicable, for example for larger sites, decisions about the site design and layout.

5.5 Flood risk management policies in the Local Plan

5.5.1 The SFRA provides evidence to inform Sefton MBC's preparation of Local Plan policies to manage flood risk from all sources, in line with the National Planning Policy Framework.

5.5.2 Chapter 2 of this document draws together national, regional and local strategies,

policies and other guidance relevant to management of flood risk, including sustainable surface water drainage. Chapter 4 of this document and the figures in Volume 2 provide information on flood risk from all sources in Sefton. It is clear that flood risk is an important local planning issue for Sefton.

5.5.3 The SFRA, and notably chapters 2 and 4 of this document and the figures in Volume 2 should inform the content, focus and priorities for Sefton's Local Plan policies for managing flood risk from all sources. These are primarily land-use and development policies.

5.5.4 Sefton MBC should also work with the Environment Agency and land owners, in relation to the Community Infrastructure Levy (CIL), to assess the condition of those defences that have an unknown or uncertain condition assessment, and investigate whether it is appropriate for improvements to be funded through CIL.

5.5.5 In its role as Lead Local Flood Authority, the Council will set out wider flood risk management policies or strategies, for example in the forthcoming Local Flood Risk Strategy, and to some extent the Surface Water Management Plan. These may involve specific schemes to manage flood risk in particular areas, such as the use of land for flood storage or retro-fitting flood resilience and flood resistance measures to existing properties. Both in its policies and on the Proposals Map, the Local Plan may identify such areas and protect them from harmful development.

Management of surface water run-off

5.5.6 As set out in the Sefton Surface Water Management Plan (SWMP) and chapter 4 of this SFRA document (above), the SWMP identifies Local Flood Risk Zones (LFRZs), which are grouped together into Critical Drainage Areas. Surface water flood risk is the main source of flood risk within them. More info about each Critical Drainage Area is set out in Appendix B of this SFRA document. The location of the Critical Drainage Areas in Sefton is shown in Figure 14 of Volume 2. It can be seen that the majority of Sefton's existing urban area falls within these Critical Drainage Areas.

5.5.7 As set out in the Sefton Surface Water Management Plan (SWMP), and chapter 4 of this SFRA document (above), surface water flood risk has been identified as the main source of flood risk affecting Sefton. The extent of the Critical Drainage Areas helps to illustrate this.

5.5.8 **It is recommended that Sefton's Local Plan should include and give priority to specific policies to manage surface water flood risk, in addition to other**

sources of flood risk. For greenfield sites, development should restrict runoff to existing runoff rates and where possible volumes. For brownfield sites a minimum reduction in total site runoff of 20% should be provided.

5.5.9 These values are in line with the recommendations presented in Section 4.2 of the Sefton Surface Water Management Plan[8] and based on evidence presented in Section 4.5 of this report. They are also in line with targets that are typically sought by United Utilities. All new development and redevelopment, particularly within Critical Drainage Areas should encourage the reduction of surface water runoff rates and surface water runoff volumes below the existing rates and volumes across to ensure a neutral if not beneficial impact on existing properties that are at risk from surface water flooding when considering the consequences of climate change and permitted development on rainfall and surface water runoff.

5.5.10 **It is also recommended that in the light of this, all site–specific Flood Risk Assessments should refer to surface water run-off and set out the measures that will be taken, including use of sustainable surface water drainage systems (SuDS) to manage surface water run-off.**

5.5.11 Measures taken to manage flood risk, and especially surface water flood risk, within a Critical Drainage Area, such as to promote infiltration based SuDS or reduce surface water runoff rates below the pre-existing rates, or to greenfield rates would therefore contribute towards a reduction in flood risk at that critical location. **Within the CDAs of Sefton it is recommended that the threshold for requiring a flood risk assessment based on area, which is currently 1ha in the NPPF and Technical Guidance, be reduced to at least 0.5ha.**

This will ensure that those sites that have the potential to increase flood risk within these CDAs will be assessed in more detail and it will minimise the cumulative impact on flood risk from smaller developments. It will also increase the opportunities to identify where sites could benefit flood risk elsewhere within the borough.

Sustainable Drainage Systems (SuDS

5.5.12 The use of Sustainable Drainage Systems (SuDS) is recommended within the NPPF and the Technical Guidance as a means by which drainage from new development can mimic as closely as possible natural drainage patterns and the natural runoff rates and volumes from undeveloped sites. The concept is supported by the hierarchy for drainage of surface water runoff from a site in the

current Buildings Regulations. It is also supported by the proposed, but as yet un-implemented, National Standards for SuDS and SuDS Approval Body (SAB) process, linked to Schedule 3 of the Flood and Water Management Act 2010. More information about this is set out in chapter 2 of this SFRA document, above.

5.5.13 By maximising infiltration and minimising runoff discharged to watercourses and sewers or through overland flow from the site, SuDS effectively seek to prevent runoff from a site from contributing to flood risk elsewhere in frequent storm events, and to minimise the contribution to flood risk in more extreme storm events. Use of SuDS should also reduce flood risk within the development site, and ensure that any buildings or critical features are safe. For these reasons the sustainable surface water management and SuDS are recommended in Sefton.

5.5.14 While many sites are suitable for above ground, natural sustainable drainage systems, others may not be. The indicative suitability of land within Sefton for sustainable surface water drainage systems has been considered at a strategic level within this SFRA, using drift geology and solid geology data obtained via the Environment Agency. In effect, a matrix approach has been applied whereby the general permeability of the drift geology and of the underlying solid geology has been assessed to identify the overall indicative suitability. For example, where potentially permeable drift overlies potentially permeable solid geology then the land was classified as potentially having a Very High suitability for SuDS. The following table presents a summary of the approach. A plan showing this strategic suitability of sites in Sefton for SuDS is shown in Figure 21 in Volume 2.

5.5.15 It should be noted that the above approach does not explicitly account for groundwater levels within Sefton, though the results of the assessment were adjusted using the Groundwater Emergence Map (GEM) for Sefton, so that land with the potential for groundwater to emerge at surface was placed in the Very Low suitability classification.

5.5.16 It is recommended in The SuDS Manual[46] that SuDS be designed to operate during periods of extreme groundwater levels (up to a 1 in 100 annual probability groundwater level) and also recommends that the infiltration surface is at least 1m above the groundwater surface. The GEM outputs show those areas where groundwater may reach within 2m of the ground surface, therefore areas outside of the GEM may have a reasonable minimum infiltration surface depth of 1m which should be suitable for most shallow types of infiltration.

5.5.17 It is known from local groundwater studies45 that the groundwater level in parts of Formby and between Formby and Ainsdale is shallower than 1m below ground level. Figure 21 presents the indicative suitability for SuDS based on the underlying drift and solid geology, however, groundwater levels are not explicitly

included in this measure. **It is recommended that groundwater depths be investigated as early as possible to feed into the planning application process, the sustainable drainage design process and in the preparation of any site-specific Flood Risk Assessment.**

Helping make development safe - Flood Resilience and Resistance

5.5.18 The Sefton Surface Water Management Plan (SWMP) indicated that, given the nature of flooding mechanisms in much of the Sefton area, there are many areas of existing development that would benefit from the installation of measures that increase the resilience of a property from surface water flooding. These quicken the time of recovery and reduce the damage done in the event of a flood and therefore reduce the cost of the consequences of flooding. Table E-2 of the Sefton SWMP indicates these areas. Significant parts of Sefton's existing urban areas would benefit from flood resilience measures where flood depths are predicted to be less than 0.3m.

5.5.19 These issues are more appropriately addressed in the forthcoming Local Flood Risk Management Strategy or other similar documents, and the role of the Local Plan is likely to be limited.

5.5.20 Examples of flood resilience measures include waterproof plaster on the walls, solid concrete floors rather than wooden floors, and electric circuitry raised above the flood level. Examples of flood resistance measures include air brick covers, flood gates for doorways and windows and no–return valves for drainage pipes. More details are available from guidance documents published by Communities and Local Government[13], Defra[51] and the Association of British Insurers[52].

5.5.21 Guidance from CLG indicates that a water exclusion strategy using flood resistance measures is appropriate for existing developments where predicted water depths are below 0.3m. Where predicted depths are between 0.3m and 0.6m, both flood resistance and resilience measures should be used, as part of a water exclusion strategy when shallow but a water entry strategy when deeper. Where predicted depths are greater than 0.6m a water entry strategy is appropriate.

5.5.22 For all new development, it is good practice and it is recommended to have finished floor levels at least 0.3m above the finished ground level, and this is relevant to the Local Plan. In addition to this general guidance, developers

[51] DEFRA (2007) Flood Resistance and Resilience Solutions: an R&D scoping study
[52] ABI, Flood Resilient Homes: What homeowners can do to reduce flood damage

should review the depth outputs from the SWMP for the 1 in 100 annual probability event, and use this information so that their development proposals specify floor levels that are at least 300mm higher.

5.5.23 **It is recommended that Sefton MBC consider the need for policies relating to flood resistance and flood resistance design in new development to address residual risks. Flood resistance and resilience measures should only be used as a flood risk management measure to address the residual risk of flooding**.

Other Flood Risk Management

5.5.24 Sefton MBC should continue to work with the Environment Agency to make sure that the Local Plan has regard to the likely outcomes of the Environment Agency's Lower Alt with Crossens Draft Flood Risk Management Strategy[19]. More information about this is set out in Chapter 2 of this SFRA document.

5.6 Consultation

5.6.1 In preparing local plans, local planning authorities such as Sefton MBC have a legal duty to co-operate with other local authorities (usually neighbouring authorities and those within the same sub-region) and a number of public bodies, including the Environment Agency. The bodies affected by the duty to co-operate are set out in Part 2 of the Town & Country Planning (Local Planning) (England) Regulations 2012. Private sector utility providers are not covered by the duty. However it is their interests and those of Councils to be involved in the planning process.

5.6.2 The National Planning Policy Framework also sets out requirements for consultation, co-operation and joint working with these partners, in addition to the wider public consultation and engagement requirements for the Local Plan preparation process. Local planning authorities should consult neighbouring authorities on larger than local issues, strategic priorities that cross local authority boundaries, and other cross boundary issues, and it is possible that in some cases these might include flood risk issues. Local Planning Authorities should take advice from the Environment Agency, Lead Local Flood Authorities and any other relevant flood risk management bodies when preparing local plan policies for flood risk. The process should be informed by the SFRA.

5.6.3 The Environment Agency has been involved in the preparation of this SFRA, and

has provided much of the information which underpins it. It is understood that the Environment Agency has been consulted on the draft SFRA. It is also understood that Sefton Council's planning officers have consulted extensively with the Council's flood and coastal erosion risk management officers during the preparation of this SFRA. The Environment Agency and United Utilities have been consulted at earlier stages of the preparation of the Local Plan, and will continue to be consulted in the future.

Cross-boundary Issues

5.6.4 There are potential cross-boundary flood risk issues in or affecting parts of Sefton, with West Lancashire, Liverpool and Knowsley. In line with the National Planning Policy Framework, planning policies for flood risk management in Sefton and these neighbouring authorities should aim to avoid adverse effects elsewhere. In line with the duty to co-operate, Sefton as local planning authority is encouraged to work with adjoining districts to help achieve this..

5.6.5 There are potential cross boundary issues in the Waddicar area. The upper half of the catchment that drains to the Brooklea watercourse lies within the Metropolitan Borough of Knowsley. South of this there are also areas that border Simonswood Brook, which is also in Knowsley.

5.6.6 Similar cross-boundary issues may exist within small parts of Aintree, and in Bootle in relation to Liverpool City.

5.6.7 Finally, Sudell Brook runs along the boundary of Sefton borough, to the north of Maghull and the majority of the catchment lies within West Lancashire District. West Lancashire is also the source of some of the tributaries of River Alt and of the Crossens catchment.

6 How to use the SFRA in Development Management

6.1 Introduction

6.1.1 The Strategic Flood Risk Assessment has a specific role in relation to the development management process, in relation to planning applications and other planning-related consents. The SFRA helps set the context within which all planning applications should be considered.

6.1.2 In summary, the SFRA provides the evidence to:

- Direct development away from area at greatest risk of flooding, and manage residual risk, taking into account the impacts of climate change – applying the risk-based, Sequential Test approach to choice of sites in the local plan and to many windfall sites, and where necessary applying the Exception Test;
- Inform the Sustainability Appraisal of the Local Plan ;
- Make sure that any development is safe, does not increase flood risk (from any source) elsewhere, and if possible reduces flood risk overall; and
- Inform the preparation and content of site-specific flood risk assessments for development sites, and help identify when site-specific flood risk assessments or flood risk management statements are required.

6.1.3 This chapter focuses on the last two bullet points, in relation to development management. The previous chapter, Chapter 5, focuses on the first four bullet points, in relation to Local Planning – the fourth bullet is relevant to both development management and Local Planning.

6.1.4 This chapter first looks at the role of the SFRA in informing site-specific Flood Risk Assessments, and provides additional information for developers .It then provides additional information for Sefton Council to help it in the processes of determining planning applications and when providing pre-application advice.

6.2 Site-specific Flood Risk Assessments (site-specific FRAs)

6.2.1 The National Planning Policy Framework (NPPF) states that site-specific Flood Risk Assessments are required to accompany planning applications for sites within Flood Zones 2 or 3; or where the site lies within Flood Zone 1 and is greater than 1 hectare in area, or is in an area in Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment

Agency). **Paragraph 5.5.11 above recommends that within the Critical Drainage Areas of Sefton the threshold for requiring a flood risk assessment based on area, which is currently 1ha in the NPPF and Technical Guidance, be reduced to at least 0.5ha.** These Critical Drainage Areas are identified in the Surface Water Management Plan, and discussed in Chapter 4 and Appendix B of this SFRA document and are shown in Figure 14 of Volume of the SFRA.

6.2.2 The NPPF states that site-specific Flood Risk Assessments (site-specific FRAs) should be carried out to the appropriate degree, at all levels of the planning process and to inform the application of the sequential approach. They should assess the risks of all forms of flooding to and from development, taking climate change into account.

6.2.3 It is the responsibility of developers to consider the flood risk to a site, as early as possible. Developers should refer to the SFRA at the start of the pre-application stage, or if this is not carried out, at the earliest stage in the preparation of development proposals and a planning application. The preparation of this SFRA on behalf of Sefton MBC does not remove the need for site-specific FRAs to be undertaken at the planning application stage. Instead, this SFRA provides advice on the scope of the additional information likely to be required within the site-specific FRA.

6.2.4 A site-specific FRA will need to demonstrate that flood risk to the development can be managed now and over the lifetime of the development for all sources of flooding. It should show that the development is safe. A site-specific FRA should demonstrate also that the development does not increase the risk of flooding from all sources elsewhere and that the proposals are compliant with local planning policy. Where possible the development should aim to reduce flood risk overall, and the site-specific FRA should demonstrate this where it is the case.

Consultation during the preparation of the site–specific FRA

6.2.5 Developers should liaise with Sefton MBC to agree on who should be consulted. **It is recommended that in all cases developers should liaise with Sefton Council's planning officers, flood and coastal erosion risk management officers and those providing drainage advice on behalf of the Council; the Environment Agency, United Utilities, and, where canal flood risk is a potential issue, the Canal and Waterways Trust. If any future internal drainage boards are set up within the borough of Sefton, they should also**

be consulted if the site falls within or it's likely to affect the area covered by the Internal Drainage Board. Once the SuDS and SABs provisions of the Flood and Water Management Act come into effect (see chapter 2 of this SFRA document, above) it may be appropriate for a developer to consult these bodies when preparing the sustainable drainage application.

6.2.6 It is the developer's responsibility to provide sufficient detail to demonstrate compliance with Local Plan policies, the National Planning Policy Framework and it's supporting Technical Guidance, including the need to have regard to other material considerations such as other national, regional or local guidance (see for example the documents listed in Chapter 2). It is therefore particularly important that the developer conducts pre-application discussions with Sefton MBC, the Environment Agency, United Utilities and the Canal and River Trust, where appropriate, to avoid lengthy consultation following submission, or potential planning objections.

6.2.7 The scope of any site-specific FRA should also be agreed with Sefton MBC. This will be informed by the outputs from the SFRA and in consultation with the Environment Agency where necessary. Where the Sequential and Exceptions tests need to be applied within the site-specific FRA, pre-application discussions between Sefton MBC, the Environment Agency and other relevant stakeholders should be used to scope out the availability of other sites. Pre-application consultation should also scope out what evidence will be required to show that other sites have been considered.

6.2.8 Following the implementation of the Flood and Water Management Act 2010, Local Authorities are now responsible for the management of flood risk from local sources. They are therefore responsible for, and should be consulted about, all sources of flooding other than from main rivers, the sea and large reservoirs. These remain the responsibility of the Environment Agency. The Environment Agency and United Utilities may also hold information on local sources of flooding, as may the Canals and Rivers Trust.

6.2.9 Developers may want to consult with insurers to discuss the suitability of flood risk management measures and how this affects the overall insurability.

Consultation with the Environment Agency

6.2.10 Due to the large number of consultations and the variety of planning applications received by the Environment Agency, it has developed a consultation matrix which identifies when the Agency should be consulted, and what level of information needs to accompany the site-specific FRA if one is required. Sefton MBC supports this process, by identifying the extent of flood risk from different

sources within the Borough and, with respect to fluvial flood risk, the extent, depth, velocity and hazard associated with flooding from modelled watercourses within this SFRA.

6.2.11 The Environment Agency consultation matrix is part of the Environment Agency's Flood Risk Standing Advice (FRSA)[53], which is provided to developers and local planning authorities (LPAs) for more straightforward planning applications and is available on its website. The FRSA also allows LPAs to identify those higher risk development situations where consultation with the Agency is essential.

Consultation with United Utilities

6.2.12 The Sefton area and the urban areas within it are extensively serviced by surface water, foul and combined sewers. Unless new development is to be located in an area in which soakaways can manage all surface water runoff or is directly adjacent to a watercourse, it is likely that development runoff will discharge to the local sewer network. However, the Sefton Surface Water Management Plan indicates that this has limited capacity.

6.2.13 Developers should therefore consult with United Utilities as early as possible in the formulation of development proposals, in order to determine the capacity of the local drainage network to accept surface water runoff, as well as the potential connection points.

6.2.14 United Utilities' general position is that development in any area may have difficulty in connecting to the public sewerage system. Its starting point for all developments is that surface water should not be connected to the public sewerage system unless it can be proved that this is the most sustainable option. Supporting this position, Part H of the Building Regulations presents a preferred hierarchy for the management of surface water runoff with discharge to soakaway preferred, followed by discharge to watercourse and then to sewer.

6.2.15 The Flood and Water Management Act 2010[21] is set to remove the automatic right to connect to public surface water sewers in the future. This may require developers to provide more justification than is currently required in order to connect to the United Utilities sewer network. For example, it may in future be necessary to provide evidence that surface water runoff cannot be appropriately managed within the site through the use of soakaways or direct discharge to surface water in order to gain approval for connection to the public surface water sewer.

6.2.16 The Flood and Water Management Act 2010 is also set to establish SuDS

Approval Bodies (SABs) within county, county borough or unitary local authorities (as set out in section 2.5 above). The SAB will have the responsibility for approving, adopting and maintaining drainage plans and schemes that meet National Standards for sustainable drainage, or other locally agreed, more rigourous standards. Drainage schemes will need to be approved before construction, and this process is therefore likely to run in parallel with the planning approval process. The SAB elements of the FMWA have not yet been enacted; however, it will require developers to ensure drainage is designed to National Standards for SuDS or other locally agreed standards, and to consult with Sefton MBC as SAB when designing drainage systems.

Consultation with the Canal and River Trust

6.2.17 In Sefton the Leeds and Liverpool Canal runs through most of the southern areas of the borough. The canal is owned and managed by the Canal and River Trust, formerly British Waterways, with whom consultation in relation to any development adjacent to its assets must be undertaken.

6.2.18 The *Code of Practice for Works Affecting British Waterways* (August 2007)[54], gives guidance and procedures to Developers, Local Authorities, Statutory Undertakers and their consultants when undertaking work that may affect the waterways. The Canal and River Trust has also published *Waterways and Development Plans*[55], which is intended to influence emerging local plans where there is an interaction with the waterways.

6.2.19 The Canal and River Trust can advise of flood risk from a canal to a particular property. They can also provide guidance on the need to conduct more detailed analysis of the potential flood risk, at site level, from failure of Canal and River Trust assets. This includes the need for and details of breach modelling. It should be noted that because of the managed nature of the waterway network and the unlikely and unpredictable nature of flooding from the waterway, flooding from the canal should be considered a residual risk. It should therefore be considered a potential source of flooding that should be considered within the flood risk management and design of the site rather than a source of flooding that should determine whether development takes place.

Cross-boundary issues

6.2.20 Where a development site is close to the Borough boundary, or is likely to affect areas outside Sefton borough, the developer may need to consult the adjoining

Code of Practice for Waterways, British Waterways, April 2010.
2003.

local authority (for example, it's planning and flood risk management officers).

The Sequential and Exception Tests

6.2.21 The site-specific FRA should apply and include the Sequential Test, and, where appropriate the Exception Test - set out in the National Planning Policy Framework (NPPF) and referred to in chapter 5 of this document – unless the proposed development is located on a site that has been allocated for that type of development in a Local Plan, where the Local Plan has been sequentially tested and is supported by a SFRA. Also, applications for minor development (as defined in the NPPF) and changes of use are not subject to the Sequential or Exceptions Test.

6.2.22 Where development is proposed outside of the allocated areas in the Local Plan, and within flood risk areas set out in the SFRA, applicants are responsible for demonstrating that the proposed application satisfies the outcome of the Sequential Test, and if necessary the Exception Test. The evidence required for the Sequential and Exception Tests to be applied is likely to include:

- Information on the levels of flood risk on the site;
- Information on the availability of 'reasonably available[49]' sites in areas of lower flood risk;
- Information on the vulnerability classification of the development;
- Information on the wider sustainability benefits of the site (if the Exception Test is to be applied);
- Information to show that the development is safe.

6.2.23 In all cases a developer should apply the sequential approach to any flood risk within the site itself and demonstrate compliance with the NPPF when determining the location of appropriate land uses within the site. The aim of the sequential approach is to minimise flood risk by considering the probability of flooding in conjunction with the vulnerability of receptors[18].

6.2.24 **It is recommended that Sefton MBC prepare further guidance for developers regarding the application of the Sequential and Exceptions Tests in site-specific Flood Risk Assessments**.

6.2.25 A site-specific FRA will need to demonstrate that flood risk to the development can be managed now and over the lifetime of the development for all sources of flooding. It also should not increase the risk of flooding elsewhere and

demonstrate that the proposals are compliant with local planning policy.

Scope of the site-specific FRAs

6.2.26 This SFRA can be used to provide guidance on the scope required within a site-specific Flood Risk Assessment. This includes identifying the likely flood risk constraints within potential development sites.

6.2.27 Using information presented within this SFRA and supporting maps, together with the Council's flooding records database, it is possible to identify whether there are records of flooding at a site and from what source that flooding took place. It is possible to identify where available hydraulic models exist and therefore whether the site is at risk of flooding from fluvial and/or tidal sources taking into account the presence of defences, as well as the impact of climate change and the location of the functional floodplain. The potential risk and influence of groundwater, surface water and any residual risk from canal flooding or reservoir flooding can also be identified. The information available from United Utilities can be used to identify potential sewer flooding constraints.

6.2.28 Taking account of the potential sources of flooding, the scope of a site-specific FRA should include the following key points, directed by the policy guidance and recommendations included in Chapters 2, 5 and 6 and 7 of this SFRA document. It should also ensure that it meets the Assess, Avoid, Substitute, Control, and Mitigate provisions set out in paragraph 6.3.7.

A description of the development and the planning context

- What is the development proposed and where will it be located?
- What are the proposed developments Vulnerability Classifications (see Table 2 of the Technical Guidance to the NPPF)?
- Is the proposed site consistent with the policies within the National Planning Policy, Local Plan, and any other national, sub-regional or local guidance (see for example the documents listed in Chapter 2), and has the Sequential Test or Exception Test been applied in the selection of the proposed site for the development type proposed? If not, the Sequential Test, and if appropriate, the Exceptions Test, should be carried out,

Definition of flood hazard

- What sources of flooding could affect the proposed development site?

- For each source, describe the pathway and receptor of the flooding. Refer to historic records where available.
- What is the extent of flooding, including depth, velocity and hazard where available (see DEFRA/EA (2006) *Flood Risks to People*. FD2321/TR1[50]), on the proposed development site?
- What does the SWMP indicate?
- Where sites lie outside of the areas covered in detail by the SWMP, what does the Areas Susceptible to Surface Water Flooding Map indicate?
- Is the site within an area at risk from groundwater, canal, or reservoir flooding? Does groundwater affect the type of sustainable surface water management system used?
- What are the existing surface water drainage arrangements for the site? In all cases, in line with the recommendation in paragraph 5.5.7 above, the site-specific FRA should consider surface water flood risk and show, both how and that, the development scheme will incorporate the principles of sustainable management of surface water. How best can surface water be managed sustainably on the site?

Probability of flooding

- Which flood zone is the proposed development site within?
- What is shown within Volume 2 of the SFRA with respect to the different sources of flood risk at the proposed development site?
- What are the existing site surface water runoff rates and volumes and how do they compare to the proposed rates and volumes of run-off generated by the proposed development and to national and local guidance on appropriate rates and volumes of run-off?
- What is the permeability of the ground at the proposed location of SuDS and what are the groundwater levels at the proposed site?

Impacts of climate change on flood risk

- How is the flood risk at the proposed development site likely to be affected by climate change?

Detailed description of development proposals

- Details of the development layout, referring to relevant drawings.

- Where appropriate, demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding.

How will flood risk be controlled or mitigated?

What design, layout or other measures will be taken to control development? For example, flood resistance or flood resilience measures such as raising floor levels, modification of ground levels.

Flood risk management measures including the application of Sustainable Drainage Systems (SuDS)

- How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?
- How will the developer maintain flood defences (for sites adjacent to defences/watercourses)? The riparian owner is required to survey, renew and maintain the flood defences.
- In all cases, in line with the recommendation in paragraph 5.5.7 above, the site-specific FRA should consider surface water flood risk and show, both how and that, the development scheme will incorporate the principles of sustainable management of surface water. How best can surface water be managed sustainably on the site? What opportunities are there for the utilisation of SuDS in managing surface water, have they been optimised?

Impacts of the development off site

- How will the proposed development ensure it does not increase flood risk from all sources elsewhere?

Assessment of residual risk

- What forms of flood risk management are proposed for the site, for example, flood warning and evacuation?
- What flood related risks will remain after implementing flood risk management measures?
- A breach analysis may be required for developments close to a defended watercourse or the Leeds and Liverpool Canal. The parameters of the breach analysis should be agreed with the Environment Agency or Canal and River Trust where relevant.
- How, and by whom, will these risks be managed over the lifetime of the

development?

6.3 Guidance for Sefton Metropolitan Borough Council

6.3.1 This SFRA is a tool that should be used to ensure that flood risk is taken into account within local planning and development management decisions in Sefton. It can also be used to facilitate Sefton's flood risk management and land drainage functions and to ensure that flood risk is incorporated into its emergency planning.

6.3.2 Site assessments are due to be carried out for the current list of potential development sites identified at this stage of the preparation of the Sefton Local Plan (further explanation is set out in section 2.4). This site assessment information should inform any site-specific FRAs for these sites.

6.3.3 The following sections outline how Sefton MBC should use the SFRA:

- to define the scope of site-specific FRAs for new development;
- to review site-specific FRAs that are submitted in support of planning applications;
- to define additional requirements within Critical Drainage Areas;
- to help support the implementation of Sustainable Drainage Systems (SuDS);
- to help review the options for flood risk management within the Borough;
- to help understand the opportunities for implementing new or retrofit flood resilience and resistance measures within the Borough;
- to minimise the implications of cross-boundary flooding issues: and
- in relation to other flood risk and flood risk management issues.

Assessing Flood Risk Assessments

6.3.4 Once a planning application, together with an appropriate site-specific FRA, is submitted by the developer, it should be assessed to ensure that flood risk from all sources has been considered and that appropriate flood risk management measures are included to manage the risk over the lifetime of the development.

6.3.5 It is recommended that a precautionary approach be undertaken when making

land-use planning decisions regarding flood risk. This is partly due to the considerable uncertainty surrounding flooding mechanisms and how flooding may respond to climate change. It is also due to the potentially devastating consequences of flooding to the people and property affected.

6.3.6 Site-specific FRAs should be reviewed to determine how the key principles of Assess, Avoid, Substitute, Control and Manage have been used to manage flood risk for new development in Sefton. Flood risk is a combination of the probability of flooding and the consequences of flooding. Hence 'managing flood risk' involves managing the probability of flooding, the consequences of flooding or both. Modern flood risk management involves identifying how the source, pathway or receptors[18] can be managed to reduce flood risk.

6.3.7 In Sefton, those responsible for assessing applications and in particular site-specific FRAs should ensure that the hierarchical approach to flood risk management has been adopted through:

i. **Assess**: An appropriate site-specific FRA should accompany the planning application, which identifies the flood risk from all appropriate sources over the lifetime of the development, taking into account the presence of flood defences, residual risks associated with extreme events, asset failure or blockage and opportunities for providing flood risk benefits within Sefton ;

ii. **Avoid**: At the site level, an appropriate Sequential Test (and Exception Test where necessary) accompanies the planning application to show that the developer has considered locating the development within reasonably available[49] sites at a lower risk from flooding. In addition the sequential approach at the site level should show that, where possible, high flood risk areas have not been developed;

iii. **Substitute**: the sequential approach has been applied within the development site, demonstrating that the most vulnerable elements have been located in the lowest probability flooding areas or, for example, less vulnerable/non-habitable uses are located on the ground floor of properties that have a residual risk of flooding;

iv. **Control**: measures are proposed that will control and manage the flood risk to the development that will ensure that it is safe from flooding but which also does not increase the flood risk elsewhere. The following broad measures are often employed to ‘control’ flood risk.

- Raising floor levels – managing both 'actual' and 'residual' flood risk and providing 'safe refuge' above flood levels. This is particularly relevant for areas in Sefton that are at risk from fluvial flooding during the 1 in 100 annual probability or 1 in 1000 annual probability event even when defences are considered.
- Opening up culverts – within Sefton there are a few watercourses, particularly Ordinary Watercourses, with culverted reaches. Where there are opportunities to open up the culverts and set back development from the resulting open watercourse, this should be encouraged. Setting back riverside defences and designing green, floodable storage spaces and routes for water can create a safe, attractive and well-connected development for both people and wildlife. This would also achieve betterment in connection with the Water Framework Directive (WFD).
- Modification of ground levels – this approach can be used to reduce the depth of flooding during 'extreme' flood events. This approach, however, will need to be considered early in the design process as it can affect the overall layout and design, and impact upon neighbouring sites. Raising ground levels in areas at risk of fluvial flooding will generally not be suitable, unless it can be demonstrated that effective compensatory flood storage can be provided to prevent an increase in flood risk elsewhere;
- Construction of new, or enhancing existing, floodwalls or embankments – either in relation to specific developments, where these improvements are necessary for the development to proceed; or more generally through the Community Infrastructure Levy (CIL) process;
- Sustainable Drainage Systems – where space is available and ground conditions are favourable, opportunities should be sought to maximise management of runoff via soakaway to reduce volumes and rates of water discharged to watercourses and sewers. Within developments SuDS such as swales, balancing ponds and wetlands should be promoted. Green roofs should also be promoted, especially in urban areas and on appropriate types of buildings.

v. **Mitigate**: in accordance with the Sequential Approach, flood resilience and resistance measures in new buildings should only be used as a means to manage relatively low hazard or 'residual' flooding risk. Where development is exceptionally necessary (i.e. it passes the

Exception Test), the ability to use flood resilience and resistance measures to manage flood risk should not be used as justification for new development.

6.3.8 Current Building Regulations do not currently allow for the specific use of flood resilience and resistance measures, however, future proposed revisions may include additional guidance. Until this time, where developers are proposing the use of resilience and resistance measures to manage flood risk the following guidance should be consulted:

- Improving the Flood Performance of New Buildings: Flood Resilient Construction, CLG, June 2007
- Flood Resistance and Resilience Solutions: an R&D scoping study, DEFRA, May 2007
- Flood Resilient Homes: What homeowners can do to reduce flood damage, ABI

6.3.9 The hierarchal approach to managing flood risk should take account of climate change and should include an appropriate freeboard[56] to allow for uncertainty, this is typically between 300mm and 600mm. Works to main rivers will need consent from the Environment Agency under the Water Resources Act 1991 and Land Drainage Act 1991 respectively. From 6 April 2012 Lead Local Flood Authorities (County Councils and Unitary Authorities) were given responsibility for Land Drainage Consents on Ordinary Watercourses.

6.3.10 Sefton MBC should consult with the Environment Agency, and where appropriate United Utilities and neighbouring authorities, regarding site-specific FRAs received.

[56] The height of the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action).

7 Policy Guidance and Recommendations

7.1 Introduction

7.1.1 This chapter of the SFRA summarises the recommendations with regards to the development of flood risk policy by Sefton Metropolitan Borough Council. It includes consideration of flood risk management techniques, as well as providing guidance on sustainable drainage requirements. These recommendations are based on the findings of this SFRA, and current national policy and guidance.

7.1.2 The list of recommendations is not exhaustive and it is therefore recommended that Sefton MBC additionally refer to key flood risk management documents and spatial planning documents to inform the development of its policies. The documents to be considered include the following:

- The National Planning Policy Framework[4] and its supporting Technical Guidance[5];
- Making Space for Water[57];
- The North West Regional Spatial Strategy[9];
- The North West Regional Flood Risk Appraisal[15];
- Sefton Council PFRA[22];
- Alt Crossens Catchment Flood Management Plan[16]; and
- Mersey Estuary Catchment Flood Management Plan[17].

7.1.3 These recommendations have been taken into consideration when assessing the sites being considered for allocation.

7.1.4 There are areas at risk from all sources of flooding within Sefton and whilst the key flood risk within Sefton is considered to be from surface water and sewer flooding, based on the extent of flooding and potential consequences, there are also areas with a frequent risk of fluvial flooding, areas in which groundwater will contribute to these risks and areas with residual risks of tidal inundation, canal flooding and reservoir flooding.

7.1.5 The probability of flooding from surface water can be reduced on new developments by reducing the flow and volume of runoff from the site. Runoff should be controlled as close to the source as possible through the use of SuDS and the layout of sites should be designed so that areas at greatest risk of

[57] Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England, March 2005

surface water flooding are avoided and that flow paths are maintained with no loss of storage on site.

7.1.6 Sefton Metropolitan Borough Council must consider how to respond to the risk outlined above. The risk of surface water flooding is significant, the probability (chance) of occurrence is quite high as seen in recent flood events but the consequences of the event are typically quite low or at least localised. The risk is heavily influenced by the urban nature of the settlements within Sefton and there may be only a limited opportunity in the short term to mitigate the probability or consequences of flooding.

7.1.7 As part of this SFRA, recommendations for development management and Local Planning policy have been identified and they are presented in Table 7-1, overleaf.

Table 7-1: Policy Recommendations for the Local Plan and Development Management

ID	Recommendation	Aspect	Local Plan (including allocations and policy)	Development Management
1	The Sequential Test, and where necessary the Exceptions test, should be applied to all new developments, in line with national planning policy.	Sequential Test	✓	✓
2	Sefton MBC should seek to apply the principle of directing development away from areas at greatest risk of flooding, when allocating developments sites. This should be through use of the sequential test, and where necessary the exceptions test, where there are no other reasonably available alternatives on land with a lower probability of flooding, consistent with other planning policy issues and requirements. This applies principally to land within Flood Zone 2 and 3. Sefton MBC should consider whether to apply the same principle to areas in Flood Zone 1 which are identified as having a high risk of surface water flooding.	Sequential Test	✓	
3	Where development is located within Flood Zone 2 or 3 it should be supported by a robust Sequential Test, and where necessary an Exceptions Test.	Sequential Test	✓	✓
4	Where development is proposed within Flood Zone 2 or 3, Sefton MBC should consider whether there are sites that currently lie in areas of lower flood risk that consist of lower vulnerability development that could feasibly be relocated to Flood Zone 2 or 3 to facilitate the new development being located within that lower risk flood zone, consistent with other planning policy issues and requirements.	Sequential Test	✓	
5	Sefton MBC should consider whether there are opportunities to relocate areas of public open space within Flood Zone 1 into Flood Zone 2 or 3 in order to make more land available for new development within Flood Zone 1, consistent with other planning policy issues and requirements.	Sequential Test	✓	
6	In preparing site-specific Flood Risk Assessments, developers should, in line with the National Planning Policy Framework, provide further information on the consequences of climate change on the flood risk to their developments.	Climate Change	✓	✓
7	Breach analysis may be required for new developments with a residual risk of flooding from breach or failure of flood defences or infrastructure. Breach analysis should be carried out in accordance with best-practice guidance and be used to inform flood risk management measures.	Climate Change		✓
8	Where development is proposed bordering defended watercourses and associated tributaries the design of new development should seek opportunities to set defences back from the watercourse in accordance with the principles of 'Making Space for Water' and other national planning guidance.	Climate Change	✓	✓
9	The risk of flooding from local sources, i.e. ordinary watercourses, surface water, groundwater, canals and reservoirs, must be fully considered within a site-specific Flood Risk Assessments and avoided or mitigated to an appropriate level within development sites. Potential flow paths or areas of ponding should be protected from inappropriate development.	Local Sources of Flood Risk		
10	Critical Drainage Areas identify the catchments that contribute to areas of locally significant flood risk, and should therefore be used as areas within which specific policy may be applied to reduce surface water flood risk, through reducing surface water runoff rates and volumes, by appropriate means.	Surface Water	✓	
11	Groundwater depths should be investigated as early as possible when planning new development, designing drainage (especially SuDS) and assessing the risk of flooding. Information on groundwater level and infiltration rates at the location of proposed infiltration should be provided within a site-specific Flood Risk Assessment.	Groundwater		✓
12	In areas of groundwater emergence or where the susceptibility to groundwater flooding is Moderate to Very High it is recommended that consideration be given within a site-specific Flood Risk Assessment to the layout of the development relative to the topography so that where possible new built or hard-surfaced development avoids potential flow paths and low-lying depressions within a site that might result from groundwater emergence or flooding.	Groundwater		✓
13	The Local Planning and Development Management teams should consult with those leading on flood prevention within Sefton MBC on all proposed development sites that require a site-specific Flood Risk Assessment. Appropriate consultation should take place with the emergency planning team.	Consultation	✓	
14	Sefton MBC should consult adjacent districts where development may affect flood risk outside of the borough. It should seek reciprocal arrangements with adjacent boroughs where development may affect areas along the boundary of Sefton.	Consultation	✓	

ID	Recommendation	Aspect	Local Plan (including allocations and policy)	Development Management
15	Developers should consult with Sefton Council's planning officers, flood and coastal erosion risk management officers and those providing drainage advice on behalf of the Council, the Environment Agency, United Utilities, and, where canal flood risk is a potential issue, the Canal and Waterways Trust. If any future internal drainage boards are set up within the borough of Sefton, they should also be consulted if the site falls within or it's likely to affect the area covered by the Internal Drainage Board. Once the SuDS and SABs provisions of the Flood and Water Management Act come into effect (see chapter 2 of this SFRA document) it may be appropriate for a developer to consult these bodies when preparing the sustainable drainage application.	Consultation		✓
16	All site-specific Flood Risk Assessments and sustainable drainage applications should include an assessment of surface water management, and should consider how surface water from a site will change as a result of the development and how surface water runoff will be managed in a sustainable manner. Surface water management strategies for new developments should demonstrate how the preferred approach has been reached.	Site-specific Flood Risk Assessment		✓
17	Development layouts should consider the effect of exceedence of the drainage system during the 1 in 100 year storm event with an allowance for climate change, and should seek to ensure that no runoff can leave the site via overland flow paths by provision of appropriate storage within the drainage system or on the surface.	Sustainable Drainage Systems	✓	✓
18	Site-specific Flood Risk Assessments should consider the residual risks of flooding from all sources, looking at events that are more extreme than the standard of protection provided by defences (where there are any) or in the event of the failure of flood risk management infrastructure under normal 'design' conditions.	Site-specific Flood Risk Assessment		✓
19	Site-specific Flood Risk Assessments should be required for all sites that are within Flood Zones, 2, 3a or 3b, all sites that are larger than 1 hectare in Flood Zone 1, and all sites within a Critical Drainage Area (CDA) that are larger than 0.5 hectares. All site-specific Flood Risk Assessments should include an assessment of surface water management, and should consider how surface water from a site will change as a result of the development and how surface water runoff will be managed in a sustainable manner. Surface water management strategies for new developments should demonstrate how the preferred approach has been reached.	Site-specific Flood Risk Assessment		✓
20	Site-specific Flood Risk Assessments must be fully compliant with the local plan policies, the National Planning Policy Framework and its supporting Technical Guidance, and have regard to other material considerations such as other national, regional or local guidance.	Site-specific Flood Risk Assessment		✓
21	There should be no increase in flood risk elsewhere as a result of development. Site-specific Flood Risk Assessments should demonstrate that the development proposals would not increase flood risk from any sources elsewhere (identifying and managing any potential risks).	Site-specific Flood Risk Assessment		✓
22	New development should aim to reduce the overall risk of flooding. Site-specific Flood Risk Assessments should set out whether and how the development proposals would positively contribute to a reduction in the risk of flooding overall.	Site-specific Flood Risk Assessment		✓
23	Site-specific Flood Risk Assessments should include details of site levels to Ordnance Datum.	Site-specific Flood Risk Assessment		✓
24	Site-specific Flood Risk Assessments should identify the vulnerability of the development over its lifetime. Opportunities to reduce the vulnerability classification of a site that is currently at flood risk through redevelopment of the site should be identified.	Flood Risk Assessment		✓
25	Where opportunities to improve the standard of protection or condition of existing defences are available, and which will provide protection to wider areas without increasing risk elsewhere, this should be considered as part of development proposals;	Flood Risk Management	✓	✓
26	Ground floor and basement access levels of all 'More Vulnerable' development should be 600mm above the 1 in 100 annual probability fluvial flood level or the 1 in 200 annual probability tidal flood level with an allowance for climate change, taking into account the presence of defences and the residual risks of failure of those defences.	Flood Risk Management	✓	✓
27	Ground floor and basement access levels of all More Vulnerable development to be at least 300mm above the 1 in 100 annual probability surface water flood level with an allowance for climate change.	Flood Risk Management	✓	✓
28	Safe access and egress should be provided where possible for proposed developments. Safe access is considered to be 'dry' for More Vulnerable or Highly Vulnerable development unless under exceptional circumstances.	Flood Risk Management	✓	✓

ID	Recommendation	Aspect	Local Plan (including allocations and policy)	Development Management
29	Safe refuge should be provided in areas of residual tidal flood risk where dry access cannot be maintained. Safe can be considered to include suitable refuge at least 600mm above the residual flood level in the event of failure of the tidal defences. Buildings should be designed to withstand the water pressures and consequences of flooding.	Flood Risk Management	✓	✓
30	Developers should ensure that leases and owners of new developments within areas that have a flood risk are made aware of the existing flood risks so that appropriate flood warning and emergency planning can be undertaken.	Flood Risk Management	✓	✓
31	Essential Infrastructure should be designed to remain operational in times of flood.	Flood Risk Management	✓	✓
32	Where developments may be at a residual risk of flooding, the use of flood resistance and resilience measures may be appropriate to manage that residual risk. Resistance and resilience measures alone are not appropriate forms of flood risk management for sites with anything other than a residual risk of flooding from any source.	Flood Risk Management		✓
33	Where development takes place within the floodplain, principal flow paths should be maintained by avoiding built development within areas of the highest velocity and depth.	Flood Risk Management		✓
34	The Functional Floodplain should be safeguarded from new development other than water–compatible uses and essential infrastructure that has to be located within it. Appropriate opportunities should be taken to achieve environmental enhancement, including removing or reducing obstructions.	Flood Risk Management	✓	
35	Compensatory storage should be required where development that reduces flood storage takes place within fluvial/tidal Flood Zone 3 and within areas at risk from surface water flooding. Developments should explore opportunities to reduce the footprint of existing buildings within the floodplain.	Flood Risk Management	✓	✓
36	In line with Land Drainage Act 1991 (Environment Agency) byelaws, development proposals should make sure that an 8m wide undeveloped buffer strip should be provided from the top of bank of main rivers or from the landward toe of flood defences, and a 16m wide undeveloped buffer strip should be provided alongside tidal flood defences to allow for maintenance access.	Flood Risk Management		✓
376	In line with the principles of the Water Framework Directive and the Environment Agency's policy on Culverts, Sefton MBC should adopt a presumption against the further culverting of watercourses and should seek appropriate opportunities to deculvert existing culverted watercourses, with consideration of flood risk and ground conditions and other planning policy issues and requirements.	Flood Risk Management	✓	✓
38	Sefton MBC should require new Greenfield development to restrict runoff rates and volumes to those of the pre-developed site, and should require new Brownfield development to reduce existing runoff rates by 20%. Volumes for a 1 in 100 year 6 hour storm event should be no greater than from the pre-development site in the same event. Where these requirements cannot be met then sufficient information should be provided to satisfactorily demonstrate why this is the case.	Sustainable Drainage Systems	✓	✓
39	As part of sustainable management of surface water all major development proposals should take opportunities to incorporate Green Roofs where they are appropriate. Reference should be made to the Green Roof Code when considering the design of green roofs.	Sustainable Drainage Systems	✓	✓
40	Development should take into account the likely implications of the Environment Agency's Lower Alt and Crossens Draft Flood Risk Management Strategy	Other		✓
441	Sefton MBC should consider the scope for flood risk management infrastructure provision or improvements within the Community Infrastructure Levy (CIL) or the wider planning process.	Other	✓	
41	Contributions towards the continued maintenance and/or the improvement of existing flood defences may be sought from new riverside development or development protected by tidal flood defences.	Other		✓
42	Sefton MBC should work with the Environment Agency and other relevant partners to identify how and where flood defence contributions should be used, taking into account relevant Catchment Flood Management Plans (CFMPs), Strategies and the Local Flood Risk Management Strategy.	Other	✓	

8 SFRA Maintenance and Management

8.1 Introduction

8.1.1 This chapter provides an introduction to the maintenance and management procedures that are required to ensure the SFRA remains up-to-date and continues to make use of the best available information. Implementing a maintenance and management procedure for the SFRA will assist Sefton MBC to regularly review the technical data available and to commission technical updates where necessary.

8.2 Data Collection

8.2.1 The data sets used in the Sefton MBC SFRA were supplied by:

- The Environment Agency;
- Sefton Metropolitan Borough Council;
- United Utilities;

8.2.2 Table 8-1 details the key data sets received from various organisations in order to develop the Sefton MBC SFRA from July to October 2012. The SFRA is a living document and as such the contents of this table should be updated when the SFRA is revised and new data is incorporated. A record should be kept so that is possible to attribute the data used to inform flood risk at any moment in time throughout the plan period.

Table 8-1: Data Register

Data	Description	Source	Date Provided
OS Mapping, Mastermap	GIS layer identifying open space, water, roads and urban areas	Sefton MBC	August 2012
Sefton Metropolitan Allocated sites	Potential Development Sites	Sefton MBC	July 2012
Sefton Level 1 SFRA	Sefton Level 1 SFRA	Sefton MBC	June 2009
Flood Zone Map (FZ2, FZ3, ABD, Flood Storage Areas, Defences)	Fluvial flood zones and associated data (v201208)	Environment Agency	Provided 14th August 2012

Data	Description	Source	Date Provided
Areas Susceptible to Surface Water Flooding (AStSWF) (Less, Intermediate, More Susceptible)	GIS Layer of Broad Scale modelling of areas potentially at risk of surface water flooding	Environment Agency	April 2009
Flood Map for Surface Water (FMfSW) (30yr, 30yr-deep, 200yr, 200yr-deep layers)	Updated GIS layers of Broad Scale modelling of areas potentially at risk of surface water flooding	Environment Agency	Provided 14th August 2012
Sefton Preliminary Flood Risk Assessment	An overview of all local sources of flood risk. Boroughs must review these PFRAs every 6 years.	Sefton Metropolitan Borough Council	May 2011
Reservoir Inundation Mapping	Potential reservoir breach extents	Environment Agency	November 2009
Sewer and water flooding records (DG5 Internal, DG5 External, Manholes, Sewers, Water Incident Records)	GIS layers of UU assets and historic sewer and water flooding records (WIRS)	United Utilities	16th August 2012
LiDAR	Digital topographical data for the catchment with a horizontal resolution of 2m and a vertical accuracy of +/- 0.15m	Environment Agency	August 2010
		Bluesky International Ltd	22nd December 2010
Flood Event Outlines	Historic Flood Map (v201208)	Environment Agency	Provided 20th August 2012
Flood Warning Areas	Flood Warning Areas (v201208)	Environment Agency	Provided 20th August 2012
Bedrock Geology	Solid geology	Environment Agency	Provided 14th August 2012
Superficial Geology	Drift geology	Environment Agency	Provided 14th August 2012
National Receptors Database (NRD)	Receptors vulnerable to flooding dataset	Environment Agency	Provided 14th August 2012
Areas Susceptible to Groundwater Flooding (AStGWF)	Grid-based coarse risk assessment of potential groundwater flooding	Environment Agency	Provided 14th August 2012
Sefton FWMA Asset Register (Nodes, Links and Polygons)	Point, linear and area assets related to flood risk management within Sefton	Sefton Metropolitan Borough Council	Provided 20th August 2012

Data	Description	Source	Date Provided
Extreme Sea Levels	Outputs of an extreme sea level study, providing a range of still water levels and extreme wave heights along the coast	Environment Agency	Provided 22nd August 2012
Lower Alt and Crossens Hydraulic Modelling (Crossens deliverables -Oct, 2010, Lower Alt deliverables - August 2010, Crossens FZ Update – March 2012)	Hydraulic model and flood risk mapping outputs	Environment Agency	Provided 14th August 2012
Maghull Hydraulic Modelling (Maghull Deliverables – November 2010)	Hydraulic model and flood risk mapping outputs	Environment Agency	Provided 14th August 2012
Tidal ABD study (A and B models – March 2008)	Hydraulic model and flood risk mapping outputs	Environment Agency	Provided 14th August 2012
National Flood and Coastal Defence Database (NFCDD) (Defences and Structures layers)	GIS layer showing locations of Flood Defences including condition assessment and Standard of Protection(v201208)	Environment Agency	Provided 14th August 2012
Sefton Flooding Records	Council Flooding Records Database	Sefton Metropolitan Borough Council	October 2012

8.2.3 It is recommended that key contacts within the organisations in Table 8-1 are maintained to facilitate the updating of the SFRA and any future iterations following new studies.

8.2.4 It is understood that the there are already regular quarterly updates from the Environment Agency if the Flood Zones change and there are regular meetings between Local Planning and the Environment Agency's Planning Liaison Officer from the Sustainable Places Team, however, the Local Planning function within does not have regular direct contact with United Utilities regarding its assets.

8.3 Data Processing

8.3.1 The following processing was undertaken during the development of the SFRA:

- The attributes of available data have been investigated and where appropriate the datasets have been sub-sampled to identify specific information with respect to flood risk within Sefton.

8.3.2 No other data manipulation has been undertaken and no additional modelling was undertaken.

8.4 Data Ownership

8.4.1 The datasets obtained for use in the SFRA have come from a number of sources, under licence agreement. These datasets cannot be passed to external parties without permission from the owner and that those who require the data should ensure that they possess the appropriate copyrights and access.

8.4.2 Sefton MBC should be aware of the IPR they possess so that they only issue data that is contractually appropriate. Datasets produced during the SFRA are owned by Sefton MBC and can be passed to external parties at their discretion. The key datasets are summarised in Table 7-2.

Table 8-2: Key Datasets

Data	Ownership	Licence Required	Contact
LiDAR	Environment Agency	Yes	Environment Agency (Geomatics Group)
	Bluesky	No, fee required for purchase	
Flood Zones and ABDs	Environment Agency	Yes	Environment Agency
Flood Defences			
Hydraulic Models and Outputs			
Reservoir Inundation Mapping			
Areas Susceptible to Surface Water Flooding (AStSWF)			
Historic Flood Map			
NFCDD			
Historic flooding records	Sefton MBC	No, but may be confidential	Sefton MBC
OS Mapping	Ordnance Survey	Yes	
PFRA reports and Maps	Sefton MBC	No	
SWMP reports and Maps	Sefton MBC	No	
SFRA reports and Maps	Sefton MBC	No	
Emergency Flood Plans	Sefton MBC and Merseyside Resilience Forum	No	
Sewer Asset and Flood Risk	United Utilities	Yes, may also be	United Utilities

Data	Ownership	Licence Required	Contact
		confidential	

8.4.3 It is recommended that information on all sources of flooding continues to be collected by Sefton MBC periodically and in consultation with the data provider. The suggested frequency is at least on an annual basis depending on the availability of resources.

8.4.4 When more detailed or updated hydraulic modelling becomes available from the Environment Agency and other sources this information should be incorporated into the SFRA dataset. More detailed information should also be collated from FRAs carried out by developers at the local site scale. Information from site level FRAs will be submitted to the Council and the Environment Agency as part of the planning process and this information should be logged as it may be useful in informing the LFRMS and future iterations of the SFRA.

8.5 SFRA data management system

8.5.1 The data management strategy developed for the SFRA is designed to account for the likelihood that external parties will seek to make use of the information within the SFRA in preparing flood risk assessments and assessing the flood risk constraints at potential development sites. The SFRA is also a “live” document, and as such it is necessary to ensure at regular intervals in the future that the information within it remains valid.

8.5.2 To ensure that the SFRA remains ‘live’ it is important to nominate a Management Group with responsibility for monitoring, managing and maintaining the SFRA, as shown in Figure 8-1, overleaf. It is recommended that the monitoring of the SFRA is linked to the Borough’s Local Plan Monitoring Report. By following this process of information dissemination and review, the management team can ensure a consistent and up to date supply of strategic flood risk information to all levels of the planning process.

8.6 Monitoring the SFRA

8.6.1 It is in the interest of Sefton MBC that the SFRA remains current and up to date. Table 8-3 contains a list of datasets that are updated regularly along with the frequency of updates. Updating the SFRA would typically involve obtaining the

latest map overlays for example rather than extensive new or updated modelling.

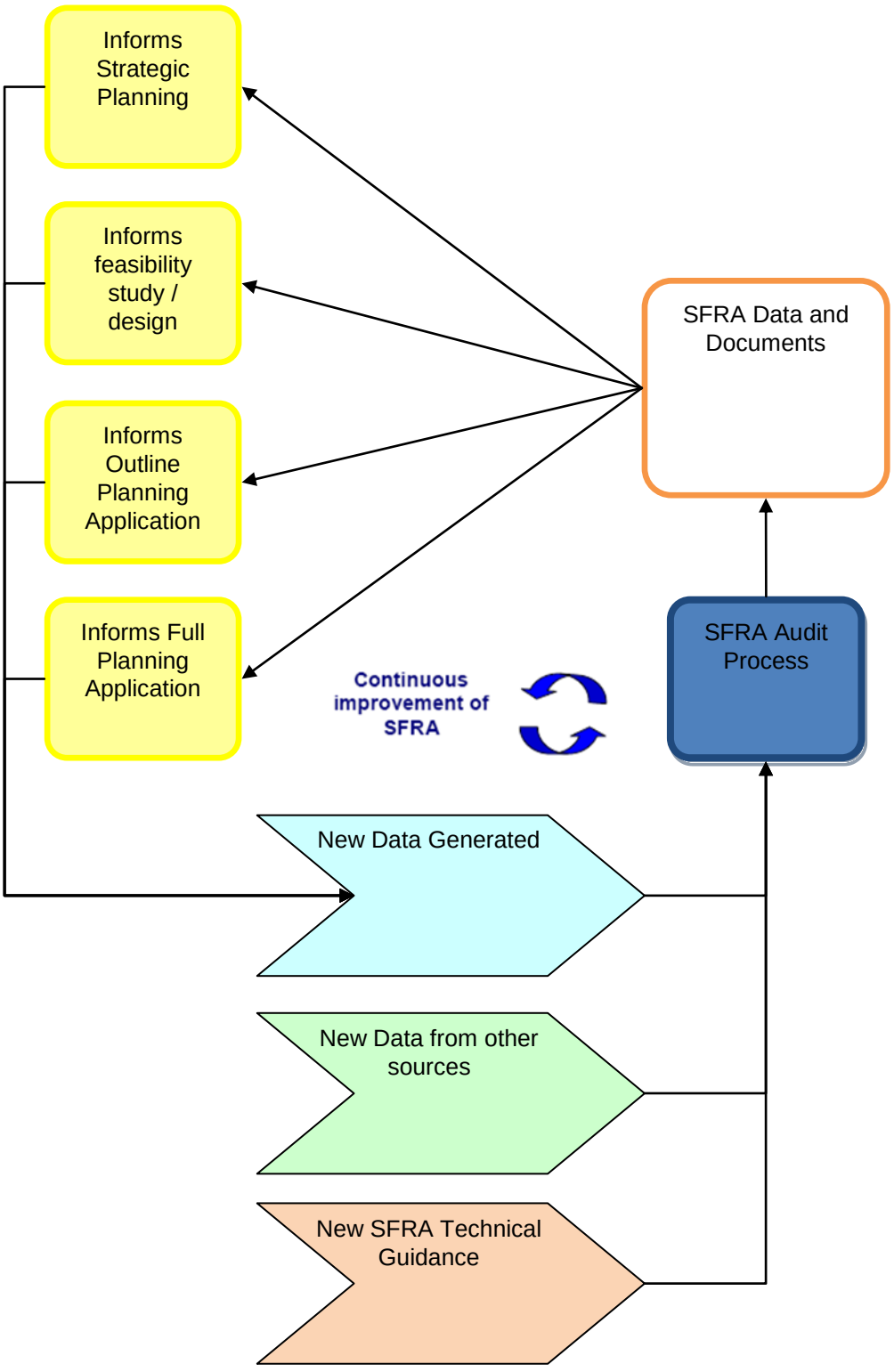


Figure 8-1: Conceptual SFRA management process

Table 8-3: Frequency of dataset renewal

Datasets	Owner	Frequency of update
Flood Zones	Environment Agency	Quarterly
Catchment Flood Management Plans	Environment Agency	Every five years
National Flood & Coastal Defence Database (NFCDD)	Environment Agency	Ongoing
Historic flood records (Historic Flood Map, Historic Flood Records, WIRS)	Environment Agency, United Utilities, Sefton MBC	Ongoing
Surface Water Flood Maps	Environment Agency	When national modelling is updated

9 References

4NW (2008) North West RSS Regional Flood Risk Appraisal

4NW (2008) North West RSS

ABI, Flood Resilient Homes: What homeowners can do to reduce flood damage.

Allitt, M & Tewkesbury, A (2009) Investigations into Urban Creep at 5 Cities

British Waterways (2010) Hydraulic Design of Canal Works

British Waterways (2010) Code of Practice for Waterways

British Waterways (2003) Waterways and Development Plans

British Standard Institute (2009) Code of practice for protection of below ground structures against water from the ground (BS8102:2009)

Chronology of British Hydrological Events. http://www.trp.dundee.ac.uk/cbhe/welcome.htm

CIRIA (2004) 'Development and Flood Risk – Guidance for the Construction Industry' Report C624

CIRIA (2006) Designing for Exceedence in Urban Drainage - Good Practice. Report C635

CIRIA (2007) The SuDS Manual. Report C697

Civil Contingencies Act, 2004

Communities and Local Government (2007) Improving the Flood Performance of New Buildings: Flood resilient construction

Communities and Local Government (2012) National Planning Policy Framework

Communities and Local Government (2012) Technical Guidance to National Planning Policy Framework

DEFRA (2007) Flood Resistance and Resilience Solutions: an R&D scoping study

DEFRA (2010) Selecting and reviewing Flood Risk Areas for local sources of flooding: Guidance to Lead Local Flood Authorities – Flood Risk Regulations 2009

DEFRA (2006) 'FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts'

DEFRA/Environment Agency (2005) FD2320 Flood Risk Assessment for New Development

DEFRA/Environment Agency (2006) FD2321/TR1 Report Flood Risks to People

Draft Flood and Water Management Bill, 2009

EC Floods Directive (2007/60/EC)

Environment Agency (2008) Alt Crossens Catchment Flood Management Plan

Environment Agency (2011) Flooding from Groundwater, http://www.groundwateruk.org/downloads/EAGWFlooding.pdf

Environment Agency (2008) Mersey Estuary Catchment Flood Management Plan

Environment Agency (2009) North West River Basin Management Plan

Environment Agency (2011) National Flood and Coastal Erosion Risk Management Strategy for England

Environment Agency (2011) Lower Alt with Crossens Draft Flood Risk Management Strategic Plan: Consultation Document

Environment Agency Flood Risk Matrix. http://www.environment-agency.gov.uk/research/planning/93498.aspx

Environment Agency Flood Risk Standing Advice. http://www.environment-agency.gov.uk/research/planning/82584.aspx/

Environment Agency's website. www.environment-agency.gov.uk/homeandleisure/default.aspx

ESI (2009) Lower Mersey and North Merseyside Groundwater Resources Study: Final Report

EU Water Framework Directive (2000/60/EC)

Flood and Water Management Act, 2010.

Flood Risk Regulations, 2009

Future water: the Government's water strategy for England, 2008

G. B. Wright, S. Arthur, G. Bowles, N. Bastien & D. Unwin. (2011). Urban creep in Scotland: stakeholder perceptions, quantification and cost implications of permeable solutions. *Water and Environment Journal,* Chartered Institute of Water and Environmental Management

Green Roof Centre (2011) The Green Roof Code

HiFlows UK. www.environment-agency.gov.uk/hiflows

http://formby.notice.com

http://tonyrobertson.mycouncillor.org.uk

IMCORE Project (2010) Sefton Coast – Hydrological Monitoring Progress Report October 2010

Knowsley Council and Sefton Council (2009) *Strategic Flood Risk Assessment*, Atkins Limited

Land Drainage Act, 1991

Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England, 2005

Merseyside Resilience Forum (2008) Multi-Agency Response Plan for Flooding in Merseyside

North West England and North Wales Coastal Group (2011) North West England and North Wales Shoreline Management Plan SMP2

Office for National Statistics (2011) Regional Profiles – Population and Migration – North West

Part H Building Regulations, 2000

Planning Policy Statement 25: Development and Flood Risk – Practice Guide, 2009

Planning Policy Statement 25: Development and Flood Risk, 2010

Reservoirs Act, 1975

Sefton Council (2000) Coastal Defence Issues and Strategy

Sefton Council (2001) Sefton Socio-Economic Data

Sefton Council (2006) Unitary Development Plan

Sefton Council (2011) Preliminary Flood Risk Assessment for Knowsley

Sefton Council (2011) Report to Planning Committee Cabinet member – Environment Overview and Scrutiny Committee (Regeneration and Environmental Services) 19th October

Sefton Council (2011) Sefton Local Development Framework Core Strategy Options Paper

Sefton Council (2011) Surface Water Management Plan Final Report

The Government's Response to Sir Michael Pitt's Review of the Summer 2007 Floods, 2008

Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006

Water Industry Act, 1991.

www.formbyfirst.org.uk

www.merseyside.police.gov.uk

www.otsnews.co.uk

www.seftoncoast.org.uk

www.southport.gb.com

www.southportvisiter.co.uk

Appendix A Glossary

Term	Definition
AEP	Annual exceedence of probability. The annual chance of experiencing a flood with the corresponding flood magnitude, i.e. a 1 in 100 annual probability event flood is a flood with a flow magnitude that has a 1 in 100 annual probability of occurring in each and every year
ABD	Areas benefitting from defences. Those areas that are protected against flooding by flood defences with a standard of protection (SoP) equivalent to a 1 in 100 annual probability flood event.
ABI	Association of British Insurers
Areas Susceptible to Surface Water Flooding (AStSWF)	National scale surface water flood modelling published in 2009. Three bandings are indicated, showing Less to More Susceptible.
Areas Susceptible to Groundwater Flooding (AStGWF)	A strategic scale map showing groundwater flood areas on a 1km square grid. Shows the proportion of each grid square where geological and hydrogeological conditions show that groundwater might emerge.
Breach or failure hazard	Hazards attributed to flooding caused by a breach or failure of flood defences or other infrastructure which is acting as a flood defence.
Building Regulations	Building Regulations promote standards that apply to most aspects of a buildings construction, energy efficiency and the covers drainage and waste disposal
BRE	Building Research Establishment
BW	Canal and River Trust. BW ceased to exist on 2nd July 2012 and it has now been replaced by the Canal and River Trust.
CDA	Critical Drainage Area. Defined within the Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006 as “an area within Flood Zone 1 which has critical drainage problems and which has been notified… [to]…the local planning authority by the Environment Agency”. In the context of this SFRA, the concept of a CDA applies to an area that contributes towards an area with surface water flooding issues.
CFMP	Catchment Flood Management Plan: A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIL	See Community Infrastructure Levy, below.
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act 2004	The Civil Contingencies Act 2004, the bulk of which was enacted in 2005, imposed duties on local bodies to assess the risk of an emergency occurring and to maintain plans for the purposes of responding to emergencies. Emergency includes acts that would have engaged previous civil defence legislation, terrorism and events which threaten serious damage to human welfare or to the environment.
CLG	Communities and Local Government: The Government department responsible for the National Planning Policy Framework (NPPF)[4] and the Technical Guidance to the National Planning Policy Framework[5]

Term	Definition
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Community Infrastructure Levy (CIL)	Under the Planning Act 2008 and subsequent Community Infrastructure Levy Regulations (2010 and amendments 2011) local planning authorities to choose to levy a charge on new development in their area. The money can be used to support development by funding infrastructure that the council, local community and neighbourhoods want. This is known as the Community Infrastructure Levy (CIL). The amount of CIL, and types of development to which is applies, is set by each local planning authority, following consultation and examination by an independent Planning Inspector.
Consequence	Impact that the flood event would cause if it occurred
DEFRA / Defra	Department for Environment, Food and Rural Affairs: The Government department responsible for environmental protection, agriculture, food production and food standards as well as fisheries and rural communities.
Developable Area	The area or proportion of the site that is developable for a specific type of development/vulnerability class without application of the exception test. The areas defined in this SFRA are as follows: • Very High Risk Areas – Water Compatible / Essential Infrastructure only • High Risk Areas – Less Vulnerable development • Moderate Risk Areas – More Vulnerable development • Low Risk Areas – All types of development
DG5 Register	A water-company held register of properties that have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years. Taken from the Director General of Ofwat's Report on Issue Number 5, hence DG5.
Drift Geology	The name for all material of glacial origin found anywhere on land or at sea. Typically refers to deposits of Quaternary age (up to 2.6M years).
EA	Environment Agency: A non-departmental Agency reporting to DEFRA charged with protecting or enhancing the Environment and managing flood risk and pollution in England.
Exception Test	The Exception Test should be applied following the application of the Sequential Test. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, is on developable land, the development is safe and will not increase flood risk elsewhere.
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist.
Flood Map for Surface Water (FMfSW)	National scale surface water flood modelling published in 2009. Two bandings are provided, 'Surface Water Flooding' and 'Deeper Surface Water Flooding', which indicate surface water flooding greater than 0.1m and greater than 0.3m respectively. There are outputs available for events with a 1 in 30 and 1 in 200 annual probability of occurring in any given year.
Flood risk	Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred.

Term	Definition
Flood Risk Vulnerability	Classifications presented within the Technical Guidance to the National Planning Policy Framework, which indicates the vulnerability of a specific land-use to flood risk.
FRA	Flood Risk Assessment
Flood risk management	Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response.
FRSA	Flood Risk Standing Advice. The Environment Agency's website providing development and flood risk advice for Local Planning Authorities, applicants and agents.
Flood Zones	This refers to the Flood Zones in accordance with Table 1 of the Technical Guidance to the National Planning Policy Framework[4]. For the purpose of the SFRA, where the 'actual risk' is referred to this reflects the vulnerability of land to flooding taking into account the presence of flood defences.
FZM	Flood Zone Map. The term used to refer to the Environment Agency's maps that present the currently defined Flood Zones.
Floods and Water Management Act (FWMA)[21]	An Act of Parliament which forms part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods. The Act takes forward some of the proposals in three previous strategy documents published by the UK Government – Future Water[58], Making Space for Water[57] and the UK Government's response to the Sir Michael Pitt's Review of the Summer 2007 floods[59]. The Act also takes forward parts of the draft Flood and Water Management Bill[60] and takes into account pre-legislative scrutiny of the draft Bill by the Environment, Food and Rural Affairs Committee. The Act was passed in 2010 and is currently being enacted.
Fluvial	Relating to a watercourse (rivers or streams)
FRR	Flood Risk Regulations 2009[6]: Transposition of the EU Floods Directive[7] into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Freeboard	The height of the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action).
Groundwater	Groundwater is the term used to describe the water stored underground in areas of permeable rocks, known as aquifers. Consistently high levels of groundwater can lead to groundwater flooding.
GEM	The Groundwater Emergence Maps (GEMs) identify those parts of England where, in exceptionally wet winters, groundwater levels could be expected to be at or close to the ground surface. Where possible these maps have been calibrated on observations made in the winter of 2000-01. Where no flooding was reported, or information was not made available, the maps indicated estimated areas based on anticipated groundwater levels using relevant aquifer properties or river baseflow indexes.

[58] Future water: the Government's water strategy for England, February 2008
[59] The Government's Response to Sir Michael Pitt's Review of the Summer 2007 Floods, December 2008
[60] Draft Flood and Water Management Bill, April 2009

Term	Definition
Groundwater Rebound	Groundwater rebound is the term given to local or regional groundwater levels that rise back to natural levels as a result of the cessation of activities that had artificially lowered the groundwater level, such as groundwater pumping associated with mining or abstraction of water for use in industrial processes. Because groundwater levels have often been artificially controlled for long periods of time there is risk to vulnerable sub-surface infrastructure built in the intervening time period.
HEC-RAS	Hydraulic modelling software (River Analysis System) developed by the United States Army Hydraulic Engineering Corps (HEC) to simulate the hydraulics of waterways in 1D
ISIS	Hydraulic modelling software developed by Halcrow to simulate the hydraulics of waterways in 1D and 2D.
JFLOW	Hydraulic modelling software developed by JBA to simulate the hydraulics of waterways in 2D.
LFRMS	Local Flood Risk Management Strategy. Under the Flood & Water Management Act 2010[21], a Lead Local Flood Authority (LLFA) must produce a strategy for managing local flood risk from surface run off, ordinary water courses and ground water.
LLFA	Lead Local Flood Authority: Local Authority responsible for taking the lead on local flood risk management (i.e. from local sources of flooding (see below)). The duties of LLFAs are set out in the Floods and Water Management Act[21].
LiDAR	Light Detection and Ranging, a technique to measure ground and building levels remotely from the air, LiDAR data is used to develop DTMs and DEMs (see definitions above).
LDD	Local Development Documents: Documents describing a Local Planning Authority's strategy for development and use of land within their area of authority. These include Local Plans, Supplementary Planning documents, and Neighbourhood Plans
Local Plan	The plan for the future development of the local area drawn up by the local planning authority in consultation with the community.
Local Sources of Flooding	The flood risk posed from ordinary watercourses, surface water, groundwater, canals and small reservoirs. Any source of flooding other than main rivers, the sea and large reservoirs.
LPA	Local Planning Authority
Main River	Main rivers are a statutory type of watercourse in England and Wales, and in England all main rivers are so defined by Defra. They are usually larger streams and rivers, but may also include some smaller watercourses. A main river can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only. A main river is defined as a watercourse marked as such on a Defra main river map.
NFCDD	National Flood and Coastal Defence Database. The data held in NFCDD consists of mapping data showing the areas at risk of flooding and data about the defences themselves (their type, location and condition) and the areas that benefit from those defences.
NGR	National Grid Reference

Term	Definition
MAFP	Multi-Agency Flood Plan. An emergency plan focussed specifically on the complex issues associated with flooding that can be prepared by a Local Resilience Forum and/or a Local Planning Authority.
NPPF	National Planning Policy Framework (March 2012)[4]: the document and its supporting Technical Guidance[5] that sets out the Government's planning policies for England and how these are expected to be applied, providing a framework within which local and neighbourhood plans can be produced to reflect local needs and priorities.
Ordinary Watercourse	All watercourses that are not designated as main rivers are ordinary watercourses. These are the responsibility of Lead Local Flood Authorities or, where they exist, Internal Drainage Boards are termed Ordinary Watercourses.
PAR	Preliminary Appraisal Report. The reporting element of the Preliminary Flood Risk Assessment (PFRA) process
PFRA	Preliminary Flood Risk Assessment: A statutory requirement of the Flood Risk Regulations[6], which implement the requirements of the European Floods Directive[7]. The Floods Directive required PFRAs to be published by 22 December 2011.
Policy Unit	A defined area in which the Environment Agency's CFMP policies are applied. Sefton falls within the Liverpool Policy Unit of the Mersey Estuary CFMP and falls within the Southport, Formby, Altcar and Ince, Middle Urban Alt and Liverpool Policy Units of the Alt Crossens CFMP.
PPS25	Planning Policy Statement 25: *Development and Flood Risk* (December 2006)[2]. Now replaced by the National Planning Policy Framework (March 2012)
Probability of Consequence	The probability of a flood event being met or exceeded in any one year. For example, an annual probability of 1 in 100 corresponds to a 1 per cent or 100:1 chance of an event occurring in any one year.
Receptor	A property, business or land-use that is at risk from flooding.
Residual risk	Flood risks resulting from an event more severe than for which particular flood defences have been designed to provide protection.
RFRA	The North West Regional Spatial Strategy Regional Flood Risk Appraisal[15] developed by 4NW to support the RSS.
Risk with defences	Actual risk is the term given to the flood risk posed from fluvial or tidal sources when taking into account the presence of defences. Where there are no defences then the Actual flood extent is unlikely to differ from the risk presented in the Environment Agency's Flood Zone Maps, however, where defences exist and have been taken into account in detailed modelling then the extents will show the effect that those defences have on flood risk. It should be noted that the Actual risk presented assumes that the flood defences remain effective and fully operational during a flood event and no allowance is made for failure of the defences through breach. If a flood event overtops the defence then the extent reflects the volume of water that overtops the defence and makes no allowance for scour or erosion of the defence under such conditions. Actual risk covers scenarios with an annual probability of occurring equal to 1 in 20, 1 in 100 and 1 in 100 plus an allowance for climate change.
RPB	Regional Planning Body

Term	Definition
RBMP	River Basin Management Plan. A strategic document that sets out measures to protect and improve the water environment. They have been developed in consultation with organisations and individuals and they identify the main issues for the water environment and the actions that are needed to deal with them.
RSS	Regional Spatial Strategy: The Regional Planning Document that provides a broad development strategy for the region for a fifteen to twenty year period. In the North West the RSS is referred to as the North West of England Plan – Regional Spatial Strategy to 2021[9]. The Government has expressed its intent to revoke Regional Spatial Strategies.
S105 modelling or s105 mapping	Section 105 refers to the appropriate section of the Water Resources Act 1991 which requires the Environment Agency to from time to time to survey matters relation to its flood defence function. This included areas where flood defence problems were likely but also included floodplains, washlands and other land liable to flood.
SAB	SuDS Approval Body. A body that will be set up when the provisions of Schedule 3 of the Flood and Water Management Act come into force, i.e. the National Standards for Sustainable Drainage that will be responsible for approving, adopting and maintaining drainage plans and SuDS schemes that meet the National Standards for sustainable drainage systems serving two or more properties. Sefton MBC will be the SAB for Sefton.
Sefton MBC	Sefton Metropolitan Borough Council
Sequential risk-based assessment	Priority in allocating or permitting sites for development, in descending order to the Flood Zones set out in Table 1 of the Technical Guidance to the National Planning Policy Framework[5], including the sub divisions in Zone 3. Those responsible for land development plans or deciding applications for development would be expected to demonstrate that there are no reasonable options available in a lower- risk category.
Sequential Test	Test to determine if there are other reasonable available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
Sewer flooding	Sewer flooding occurs when surface water or foul sewage escapes from the sewerage system due to either hydraulic inadequacy or other causes (blockage, collapse or equipment failure).
SIRS	Sewer Incident Reporting System. A now superseded database of historical incidents associated with United Utilities sewer network. Replaced in 2008 by the Wastewater incident Reporting System (WIRS)
Solid Geology	The bedrock geology underlying soil or drift geology.
SFRA	Strategic Flood Risk Assessment
Sefton MBC	Sefton Metropolitan Borough Council
SoP	Standard of Protection. The actual or design standard of protection afforded by a flood defence, whether formal or informal.
SuDS	Sustainable Drainage Systems
Surface water	Any body of water that is not groundwater (for example rivers, estuaries, ponds etc) as well as temporary waters resulting from flooding, run-off etc.
SWMP	Surface Water Management Plan

Term	Definition
TUFLOW	Hydraulic modelling software developed by WBM to simulate the hydraulics of waterways in 2D.
WFD	The Water Framework Directive (2000/60/EC)[61] came into force in 2000. It was transposed into UK law in 2003 and it establishes a strategic framework for the management of the water environment with the aim of enhancing aquatic ecosystems, promoting the sustainable use of water and reducing water pollution.
Windfall Sites	Sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan
WIRS	Wastewater Incident Reporting System. A database of incidents associated with United Utilities sewer network. Replaced the Sewer incident Reporting System (SIRS) in 2008.

[61] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

Appendix B Summary of Critical Drainage Areas

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
1	0.44	Alt	Rigby's Brook	LFRZ shown in the north of the CDA Ponding is observed east of Sandy Lane and between Moss Lane and Weld Blundell Avenue Ponding is also observed on the upside of the Leeds Liverpool Canal in the Silverstone Grove /Pilling Lane area
2	2.39	Alt	Maghull Brook	LFRZ are shown across the CDA area including:- East of Kenyons Lane The playing fields of Northway Primary School An extensive LFRZ is defined between Oakhill Road and Wynstay Road across to an area of deep flooding centred on Hickson Avenue Upstream of Leeds & Liverpool Canal in the Highbanks area
3	1.19	Alt	Upland Drain	In the north a LFRZ is defined between The Round Meade, across West Meade, Airegate and the Thorns to Green Lane. A second one identified from Manor House Close, running westwards across Green Lane and down Hynchley Green In the south there is an extensive LFRZ covering all of the Old Racecourse Road and many businesses in the Sefton Lane Industrial Estate
4	2.76	Alt	Whinny Brook	The pathway of the Whinny Brook forms a clear LFRZ which extends from the headwaters to its confluence with the Dover's Brook LFRZs defined between Broadoak Road and Farmdale Drive affecting properties between Station Road and the canal
5	1.38	Alt	Melling Brook	Single LFRZ that's located between the Leeds and Liverpool Canal and Willow Hey. The deepest areas of the LFRZ are in the undeveloped areas

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
6	0.04	Alt	Melling Brook	Single LFRZ is defined containing the source, pathway and receptor of flooding in the settlement of Melling Flow comes from a small rise in the south west and then flows north-westwards along Tithebarn Lane to pond and impact 7 properties at the junction of Tithebarn lane and School Lane.
7	0.53	Alt	Brooklea	Numerous LFRZ are identified, including around the junction of Waddicar Lane and Liddell Avenue, across Station Road, Chestnut Walk, Baytree Grove, Dapple Heath Avenue and around Satinwood Crescent and Cypress Close
8	1.60	Alt	River Alt, Moor Hey Tributary, Netherton Brook	Numerous LFRZ are identified including properties around Taunton Drive, between Aintree Parish Playing fields and Oriel Drive/ Close. To the north west a LFRZ impacts properties between Mostyn Avenue, Stoneyhurst Avenue, Altway, Keble Drive and Oriel Drive. A single LFRZ is seen in the smaller of the two Netherton areas, which primarily affect properties at the eastern end of Apollo Way. To the west in the second Netherton area flooding of properties is predicted within Parkway, Windsor Close and York Close.
9	1.98	Alt	Leeds and Liverpool Canal, Moor Hey Tributary, Netherton Brook	Key LFRZs include properties flooded on Lingfield Close and between Parker Close and Hudswell Close In the Netherton area there are LFRZs containing is extensive flooding of properties along Howard Florey Avenue, St. Oswalds Way, Eden Vale, Westminster Avenue and Peterborough Drive. To the south, a LFRZ identifies impacts around The Marian Way and, to the west of the canal, flooding between Fleetwoods Lane and St. Augustine‟s Way results in a number of properties being impacted.

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
10	15.18	Mersey Estuary	Rimrose Brook, Docks	Largest CDA within Sefton, it covers the majority of the natural catchment Rimrose Brook. Within this CDA, there are a large number of smaller LFRZs associated with ponding of water in shallow depressions; however, the key LFRZs are associated with overland flow paths from historical watercourses and topographical features that would once have fed Rimrose Brook. Refer to Sefton SWMP for discussion of predicted flood risk areas
11	0.78	Alt	Hunts Brook	Within this CDA there are three principal LFRZs. These are located within Runnels Lane, where impacts to property are shown, and also along Stannyfield Drive, which appears to act as a flow path towards Water Street. The main LFRZ, however, is along Halifax Crescent and across Water Street and Hartdale Road to Quarry Road. Significant numbers of properties are simulated to flood to significant and depths.
12	0.60	Alt	Farmoss Pool	Within this CDA there are many small LFRZs, however, the principal areas are an area of ponding to the south of the catchment between Cranfield Road, Moorfield Road and Rosemoor Drive. Other key areas follow the path of the combined sewer from Edgemoor Drive and cover flooding between this road and Meribel Close and Beech Park.

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
13	3.86	Alt	Farmoss Pool	Within this CDA there are several smaller LFRZs, the principal LFRZs are associated with large areas of ponding. First is west of college Road, between Rossetts Park Football Club in the north and Crosby Road in the south. This affects in the region of 394 properties. The second extends from Alexandra Park to St. Michaels Road, impacting properties in Cambridge Road, Cambridge Drive, Ince Avenue, Victoria Avenue, Cambridge Avenue and Victoria Road West. In the north of the CDA, there are flow paths that follow the path of historical watercourses.
14	2.17	Mersey Estuary	Coast	Within this CDA there are many small LFRZs associated with flow and ponding in roads, however, the principal LFRZ is associated with Warrenhouse Road, Sudbury Road, Endsleigh Road, Holden Road and Westward View. There is also flooding along Pinehurst Avenue. In the small northern catchment there is a principal LFRZ covering Bronte Close, Channel Reach, Almacs Close and Seathwaite Close. A LFRZ covers areas along Warrenhouse Road, Endsleigh Road and Sudbury Road and there is flooding to Mason Street to the south.
15	0.18	Alt	River Alt	Within this CDA there are many small LFRZs associated with ponding in roads and shallow depressions, however, the principal LFRZs in this area are associated with low lying areas on either side of. There is also a low lying area affecting property and a police station to the west of.
16	1.95	Alt	Hogshill Lane	Within this CDA there are a number of LFRZs. In the north west there are LFRZs affecting properties along Larkhill Lane and Wicks Lane, at the junction of Harrington lane and Wicks Lane, between Greenloons Drive and Greenloons Walk, either side of St. Luke‟s Drive and Bushby‟s Park and between Kirklake Road and Queens Road. Elsewhere, a LFRZ corresponds with the records of historical flooding in Park Road, Hogshill Lane, Osborne Road and within the WwTW.

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
17	8.13	Alt	Wham Dyke, Acre Lane Brook, Eight Acre Lane, Moss Side, Bull Cop, Boundary Brook, Downholland Brook	In the south of the CDA, there is an extensive LFRZ that affects numerous properties between Phillips Close/Tyrers Close and the Formby Bypass to the east. To the north, properties bordering Dobb‟s Gutter are affected from Freshfield Road eastwards to Moss Lane, covering Halsall Lane, Davenham Road, Church Road, Watchyard Lane and Freshfield Primary School Properties to the east of Formby Bypass are also affected, including those along Southport Old Road such as Golf View, Fernlea, Rose Farm, parts of Warren Farm, the Golf Centre in the Formby Moss area and further south properties within Formby Business Park
18	2.86	Alt	Sandy Brook	Within this CDA there are LFRZs defined in the south between Liverpool Road and Cornwall Way and between Rose Crescent and Sandy Brook North west of Meadow Lane there are numerous LFRZs that affect property in the region of Gleneagles Drive, Windermere Crescent, Woodside Avenue and further north west still, a LFRZ that affects Westminster Drive and in particular Merefield School. There is extensive flooding shown alongside the Merseyrail line to Southport
19	0.19	Ribble Estuary	Coast	Within this CDA there are shown to be LFRZs that typically relate to ponding in and around depressions and roads, specifically those off Westminster Drive such as Grafton Drive, Daresbury Avenue, Arden Close, Bareford Close and Stratford Close
20	2.18	Crossens	Fine Jane's Brook	Within this CDA there are numerous small LFRZs that affect isolated properties, however the key LFRZs are located in Central Avenue and Ryder Crescent in the south, both of which coincide with records of flooding
21	12.39	Crossens	Fine Jane's Brook, Captains Watercourse, Three Pools Waterway, Crossens Marsh Drain, Marshside Drain	Within this CDA there are numerous small LFRZs that affect isolated properties; however there are also a large number of significant LFRZs that affect numerous properties. There is extensive discussion in the Sefton SWMP on the potential areas affected by flooding

Critical Drainage Area	Area Km^2	Catchment	Receiving Watercourse / Water Body	Summary of key LFRZ and flooding mechanisms
22	4.69	Ribble Estuary	Coast	Contains those areas of Southport that naturally drain towards the coast, incorporating Southport Town Centre from just south of Hesketh Park to Birkdale as far as Hillside Station The LFRZs within this CDA therefore tend to define areas in which the topography is low lying and the mechanisms of flooding are ponding related There is extensive discussion in the Sefton SWMP on the potential areas affected by flooding

Appendix C Assessment Data Hierarchy

Data Hierarchy

The following sets out the method undertaken to assess the risk from each source, the data hierarchy to be used and any specific limitations, if any, of the data/method.

Fluvial Flooding

Fluvial Flooding (Main Rivers, Ordinary Watercourses greater than 3km^2)					
Scenario		**Flood Zone 2**	**Flood Zone 3 / 3a**	**Impact of climate change**	**Flood Zone 3b**
Without defences		EA Fluvial Flood Zones	EA Fluvial Flood Zones	N/A	N/A
With defences	**Detailed modelling available**	1 in 1000 annual probability	1 in 100 annual probability	1 in 100 annual probability event +CC	1 in 25 annual probability[62]
	No detailed modelling available	EA Fluvial Flood Zones	EA Fluvial Flood Zones	N/A	N/A

Comment
Where detailed modelling is available in 2D it should be able to provide depth and velocity as a minimum, with the speed of onset at each site (where there is an impact) identified manually from model results. The frequency of flooding is determined by the return period of the events that impact the site.

Fluvial Flooding (Ordinary Watercourses smaller than 3km^2)					
Scenario		**Flood Zone 2**	**Flood Zone 3 / 3a**	**Impact of climate change**	**Flood Zone 3b**
Without defences		EA Fluvial Flood Zones	EA Fluvial Flood Zones SWMP 1 in 100 annual probability AStSWF (Intermediate)	SWMP 1 in 100 annual probability event +CC	N/A
With defences	**Detailed modelling available**	N/A	N/A	N/A	N/A

[62] Only the Maghull Modelling (2010) contains results for the 5% AEP event. All detailed models however contain results for the 4% AEP event. The principal of using the 4% AEP outline to define the Functional Floodplain (Flood Zone 3b) was discussed with Sefton and briefly with the EA and it was deemed acceptable to use the more conservative 4% AEP outline.

Fluvial Flooding (Ordinary Watercourses smaller than 3km^2)					
	No detailed modelling available	EA Fluvial Flood Zones	EA Fluvial Flood Zones SWMP 1 in 100 annual probability AStSWF (Intermediate)	SWMP 1 in 100 annual probability event +CC	N/A

Comment
Ordinary watercourses are not well covered by existing datasets. They are either not modelled in detail, not large enough to be included in the EA's Flood Zone Maps or the return periods assessed by other national datasets (AStSWF/FMfSW) are not consistent with those considered within the planning framework (i.e. 1 in 20, 1 in 100 and 1 in 1000 annual probability events).

The EA's Flood Zones are the starting point. In locations outside of the EA's Flood Zone the outputs of the SWMP (1 in 100 annual probability) and then the Intermediate Susceptibility outline of the AStSWF dataset should be used to define the risk[63].

It should be noted that the SWMP outlines and AStSWF outlines are ***NOT*** Flood Zone 3a but that they may be ***INDICATIVE*** of the extent of flood zone 3 in those locations.

Tidal Flooding

Tidal Flooding				
Scenario	**Flood Zone 2**	**Flood Zone 3 / 3a**	**Impact of climate change**	**Flood Zone 3b**
Without defences	EA Tidal Flood Zones	EA Tidal Flood Zones	N/A	N/A
With defences	Tidal ABD Study 1 in 1000 annual probability	Tidal ABD Study 1 in 200 annual probability	Tidal ABD Study 1 in 200 annual probability + CC	Tidal ABD Study – extrapolated from report

[63] The SWMP noted that the Intermediate Susceptibility extent was most consistent with the outputs of the SWMP, hence the recommendation to use the Intermediate Susceptibility extent.

Surface Water Flooding

Surface Water				
Scenario	**1 in 100 annual probability event +CC**	**1 in 100 annual probability**	**1 in 30 annual probability**	**1 in 5 annual probability**
Without defences	SWMP 1 in 100 annual probability event +CC AStSWF (Less)	SWMP 1 in 100 annual probability AStSWF (Intermediate)	SWMP 1 in 30 annual probability	SWMP 1 in 5 annual probability

Comment
As outlined in the SWMP report, the two more frequent events that were simulated are based solely on the flooding volumes that were simulated to surcharge from manholes by United Utilities own sewer models. There is an inherent assumption therefore that the where there is no flooding simulated that the sewer system can cope the amount of water during this rainfall event and that the water can enter into the sewer.
Where SWMP modelling is available it can provide depth and velocity, with the speed of onset at each site (where there is an impact) identified manually from model results. The frequency of flooding is determined by the return period of the events that impact the site.

Sewer Flooding

Sewer Water		
Scenario	**1 in 30 annual probability**	**1 in 5 annual probability**
Without defences	SWMP 1 in 20 annual probability	SWMP 1 in 5 annual probability

Comment
In locations outside of the SWMP model areas there are no sewer flooding extents available from other datasets. Historical flood records should be used to qualitatively assess the history and therefore potential future risk of flooding from this source.

Groundwater Flooding

Groundwater Water	
Scenario	**Dataset**
Without defences	GEM Groundwater Flooding Susceptibility (BGS) AStGWF (EA) / AStSWF

Comment
No assessment of depth, velocity, speed of onset is possible.
There can be no probability associated with groundwater flooding.

Unless there are low lying areas that could be flooded and which would stay flooded, groundwater emergence is likely to cause overland flow similar to the effect of heavy rainfall. The topographical data that we hold will therefore be used in conjunction with surface water datasets to assess the anticipated consequences of groundwater emergence/flooding.
No quantitative assessment of the impact of climate change can be undertaken.

Reservoir Flooding

Reservoirs	
Scenario	**Dataset**
Without defences	EA Reservoir Inundation Mapping

Comment
The data only considers large, high-risk reservoirs and does not include smaller reservoirs.
No assessment of depth, velocity, speed of onset is possible.
No quantitative assessment of the impact of climate change can be undertaken, though a qualitative assessment will be made.

Canal Flooding

Canal	
Scenario	**Dataset**
Without defences	Canal source-pathway-receptor assessment

Comment
No assessment of depth, velocity, speed of onset is possible.
No quantitative assessment of the impact of climate change can be undertaken.

Residual Flood Risks

Residual Risks	
Scenario	**Assessment**
Failure of fluvial flood defences	Review of the NFCDD dataset, Areas Benefitting from Defences, Potential Allocation sites indicates that there are areas that are at a potential risk from breach of defences within the Maghull area; however no potential allocation sites are at risk from events up to and including the 1 in 100 annual probability event plus an allowance for climate change. Breach analysis has therefore not been undertaken at this stage.
Failure of tidal flood defences	Not included in the scope at this stage. The results of breach modelling in the Crossens area are discussed and identified from the Tidal ABD study.

Comment
There can be no probability associated with this type flooding, as this relates to both the interaction between fluvial return period and the condition/maintenance etc of the defences.

No quantitative assessment of the impact of climate change can be undertaken.

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