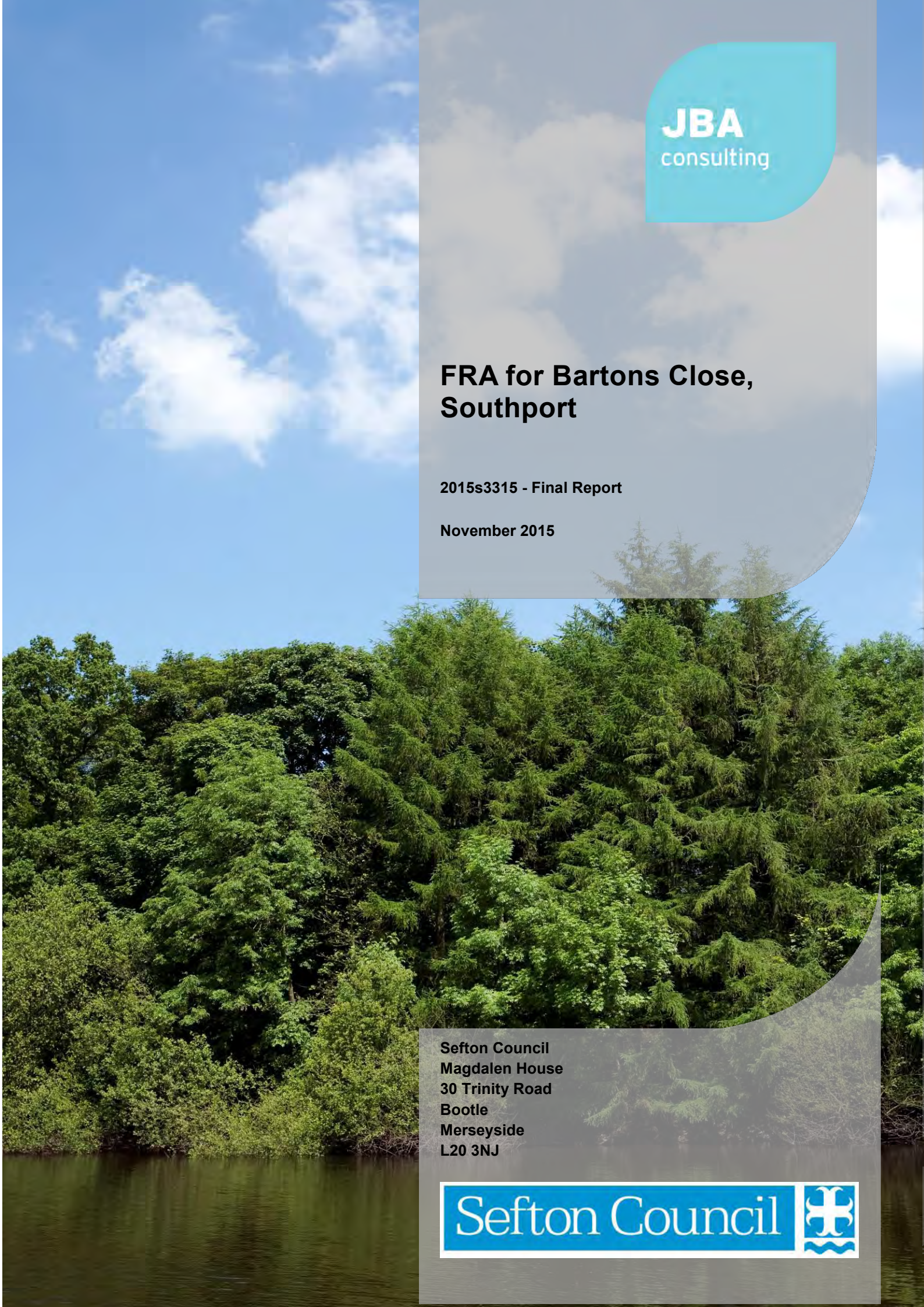

FRA for Bartons Close, Southport

2015s3315 - Final Report

November 2015

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
DRAFT Report / 09 November 2015		**Andrea O'Connor**
Final Report / 13 November 2015	Council comments considered	**Andrea O'Connor**
Final Report v3 / 23 November 2015	Environment Agency comments considered	**Andrea O'Connor**

Contract

This report describes work commissioned by Andrea O'Connor, on behalf of Sefton Council, by a letter dated 29 October 2015. Sefton Council's representative for the contract was Andrea O'Connor. Tim Diesner, Edward Blackburn and Mike Williamson of JBA Consulting carried out this work.

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Purpose

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Abbreviations

AEP	Annual Exceedance Probability
AStGWF	Areas Susceptible to Ground Water Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
CDA	Critical Drainage Area
EA	Environment Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
IH	Institute of Hydrology
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
uFMfSW	updated Flood Map for Surface Water
UU	United Utilities

Definitions

Flood Zones

The following table is a reproduction of Table 1 of the Planning Practice Guidance[1]. These refer to the probability of river and sea flooding (disregarding sea defences) as shown on the EA Flood Map for Planning (Rivers and Sea).

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

[1] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-1-flood-zones/

1 Introduction

1.1 Overview

This report has been prepared in response to a request from Sefton Council for a site Flood Risk Assessment (FRA) for land at Bartons Close, Southport, which is a proposed housing allocation in the draft Local Plan. Sefton Council's reference for this site is MN2.1.

The proposed allocation site covers an area of approximately 1 ha and part is located within Flood Zones 2 and 3. The site lies within the tidal floodplain and is at risk of flooding from the sea via Three Pools Waterway, which borders the site. Maintained flood defences are present along this reach of the watercourse.

For the proposed development to be considered appropriate in these Flood Zones, the Sequential Test must be passed in accordance with the National Planning Policy Framework. As part of the Exception Test a site specific FRA is required. Approximately 10% of the site area is in Flood Zone 3 because of tidal flooding.

1.2 Information provided

The following information, from Sefton Council's Strategic Flood Risk Assessment (SFRA) and Surface Water Management Plan (SWMP), has been provided:

- EA Flood Map for Planning
- EA Risk of Flooding from Rivers and Sea map
- EA Modelled Flood Levels
- EA updated Flood Map for Surface Water (uFMfSW)
- Areas Susceptible to Ground Water Flooding
- LiDAR
- SWMP Surface Water Flood Mapping

The following information has been provided by the Environment Agency (EA):

- 2014 Lancashire Tidal ABD Study - tidal flood mapping, including depths and hazards

1.3 Scope of FRA

The assessment of flood risk is based on flood and hazard mapping products provided by Sefton Council and the EA, and includes consideration of safe access and egress in times of flood. Owing to tight timescales for this study, direct consultation with the EA and United Utilities (UU) has not been possible.

It should be noted that no site investigation or contaminated land results are available at this initial stage. This assessment has therefore been prepared in order to quantify likely attenuation volumes required onsite to ensure that development of the proposed housing allocation site does not increase flood risk elsewhere. It should also be noted that this assessment does not include consideration of contamination issues, detailed drainage or the design of Sustainable Drainage Systems (SuDS).

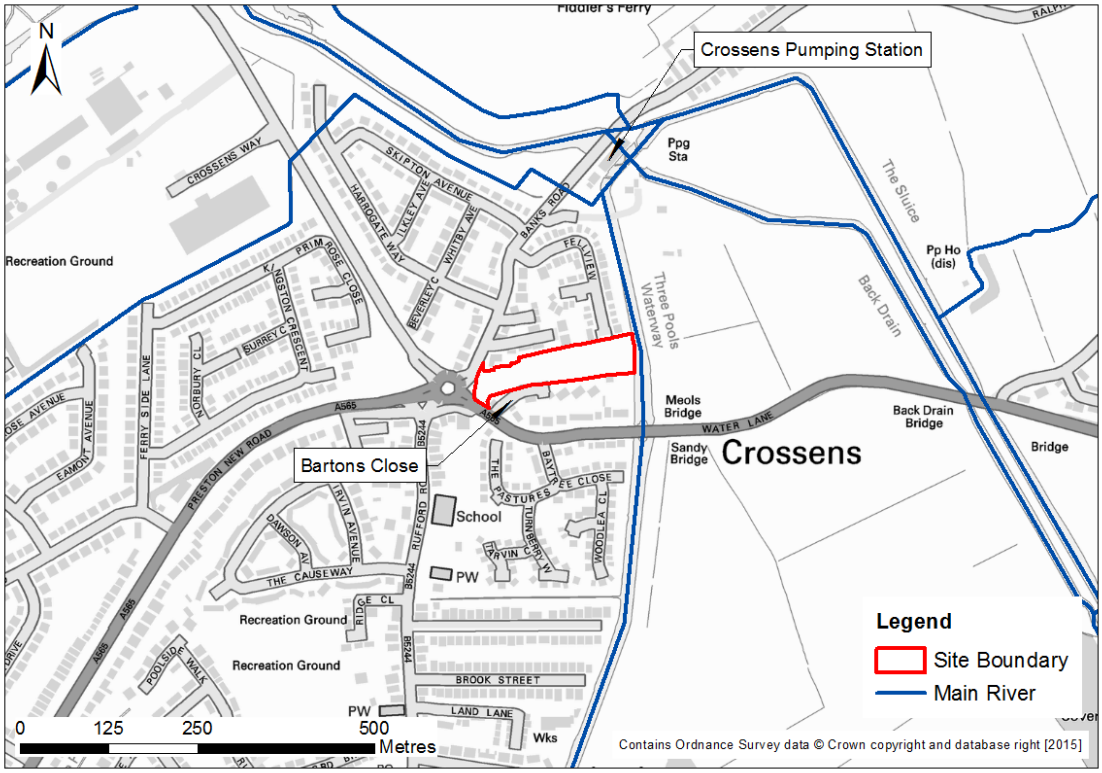
2 Development description and location

The proposed housing allocation is for approximately 36 dwellings on land at Bartons Close, Southport (Figure 2-1). Interrogation of OS mapping indicated that the allocation site covers an area of approximately 1.0 ha of Greenfield land. Access to the site could potentially be made from Barton Close or Fellview.

The site is bounded by housing except to the east. Three Pools Waterway (Main River) runs along the eastern boundary of the site, with raised defences forming the river banks along this reach. Three Pools Waterway is drained by Crossens Pumping Station, which outfalls to Crossens Marsh.

Inspection of filtered one metre resolution LiDAR indicates that the site slopes in an easterly direction toward Three Pools Waterway.

Figure 2-1: Site location



The proposed allocation is for approximately 36 dwellings. At this stage it is assumed that development of the site for housing will result in the introduction of impermeable areas covering 60% of the developable area. The area available for development is dependent on flood risk issues and is discussed in subsequent sections of this report.

In accordance with NPPF Planning Practice Guidance (PPG) Table 2[2], the flood risk vulnerability classification for this development is 'More Vulnerable'.

2.1 Flood History

The Sefton Strategic Flood Risk Assessment (SFRA) does not have any details of flood history at the allocation site. The allocation site is not covered by the EA Historic Flood Map.

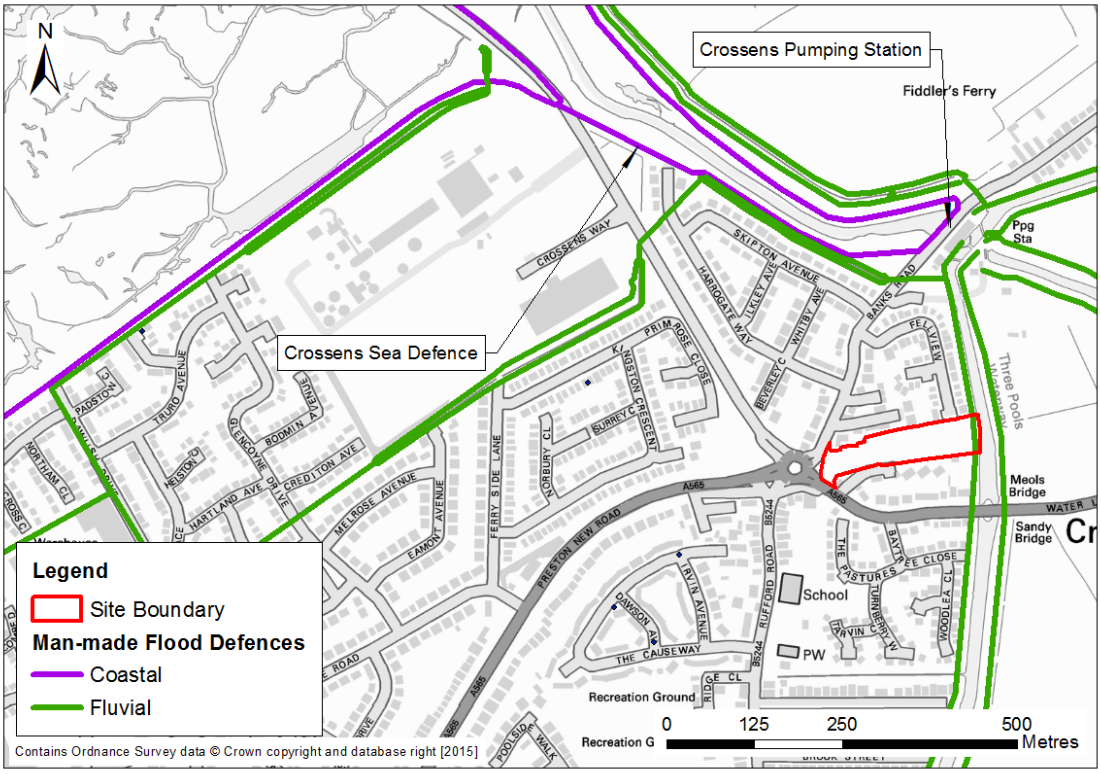
[2] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-2-flood-risk-vulnerability-classification/

2.2 Flood Defences

EA maintained fluvial flood defences border the eastern extent of the development site on Three Pools Waterway (Figure 2-2). Based on the data provided in the Sefton SFRA, these defences are provided in the form of maintained channels with a 1 in 50 year (2% AEP) design standard of protection.

Crossens Sea Defence borders the urban extent of Crossens, Southport. Based on the data provided in the Sefton SFRA, the majority of the Crossens Sea Defence shown in Figure 2-2 passing along the coastal front is maintained by the EA to provide a 1 in 150 year (0.66% AEP) Standard of Protection (SoP) of flooding from the sea. The section of Crossens Sea Defence nearest Crossens Pumping Station is shown to provide a 1 in 125 year (0.8% AEP) SoP of flooding from the sea.

Figure 2-2: Maintained flood defences in site vicinity

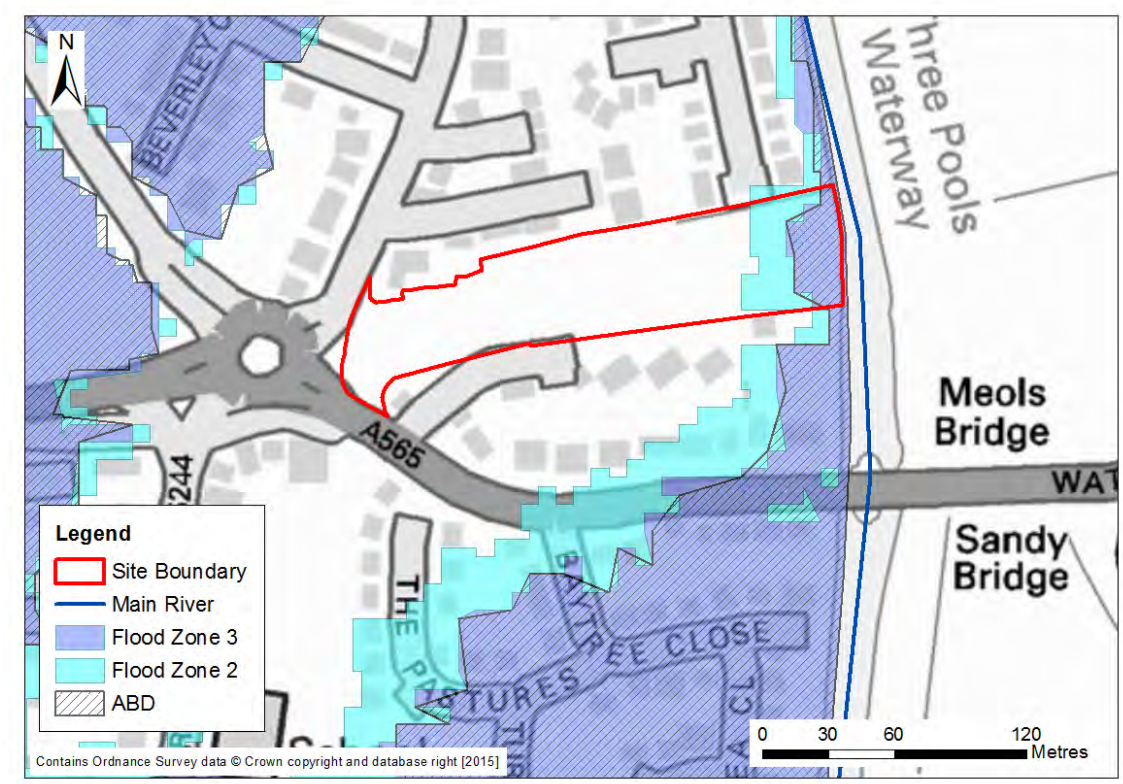


3 Tidal Flood Risk

The EA have provided flood data for use in this FRA from the 2014 Lancashire Tidal ABD Study undertaken by JBA Consulting, which was used to develop the flood zones in this area. The proposed allocation site is within EA Flood Zone 3 (Figure 3-1 below). The data provided by the EA confirms that the site is at risk of tidal flooding and is assessed as having a 1 in 200 or greater annual probability of flooding from the sea (> 0.5% AEP).

As shown in the figure below, the site is within the EA defined Areas Benefiting from Flood Defences (ABD).

Figure 3-1: EA Flood Mapping for Planning



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As identified in Section 2, the flood risk vulnerability classification for this development is 'More Vulnerable'. NPPF guidance (Table 3[3]) states that the Exception Test needs to be passed in order for 'More Vulnerable' development to be permitted in Flood Zone 3a. The Exception Test requires that the development both provides wider sustainability benefits to the community which outweighs the flood risk, and will be safe for its lifetime without increasing flood risk elsewhere and where possible reducing risk. This FRA will inform the second part of the Exception Test. The Council has addressed the first part of the Exception Test in its draft Local Plan and related documents.

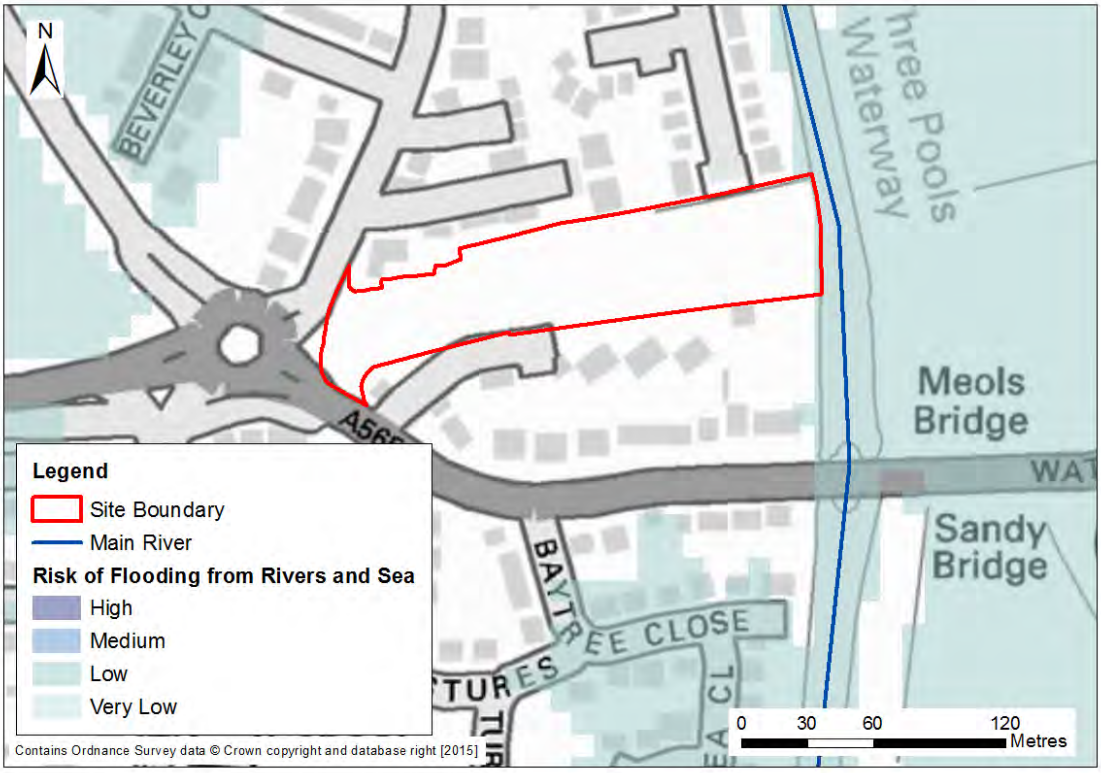
The Exception Test requires that development is steered away from areas at flood risk. Approximately 10% of the site, at the eastern boundary, is located within Flood Zone 3a, and this is also an area with surface water flood risk issues (see Section 4 below). The Environment Agency byelaws require an eight metre easement from the top of bank of the Main River which should remain undeveloped; this area falls partly within Flood Zone 3a.

Although 'More Vulnerable' development is permitted within Flood Zone 2, certain flood risk mitigation measures should be provided. Please refer to Section 6 for our recommendations for the management of flood risk on site.

[3] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-3-flood-risk-vulnerability-and-flood-zone-compatibility/

The modelled peak flood levels at the allocation site are 4.45 mAOD for Flood Zone 3 (the undefended 0.5% AEP tidal event) and 4.99 mAOD for Flood Zone 2 (the undefended 0.1% AEP tidal event). Typical depths are around 0.3 m in Flood Zone 3, but reach a maximum of over 2 m near the site's eastern boundary.

Figure 3-2: EA Flood Mapping (Defended)



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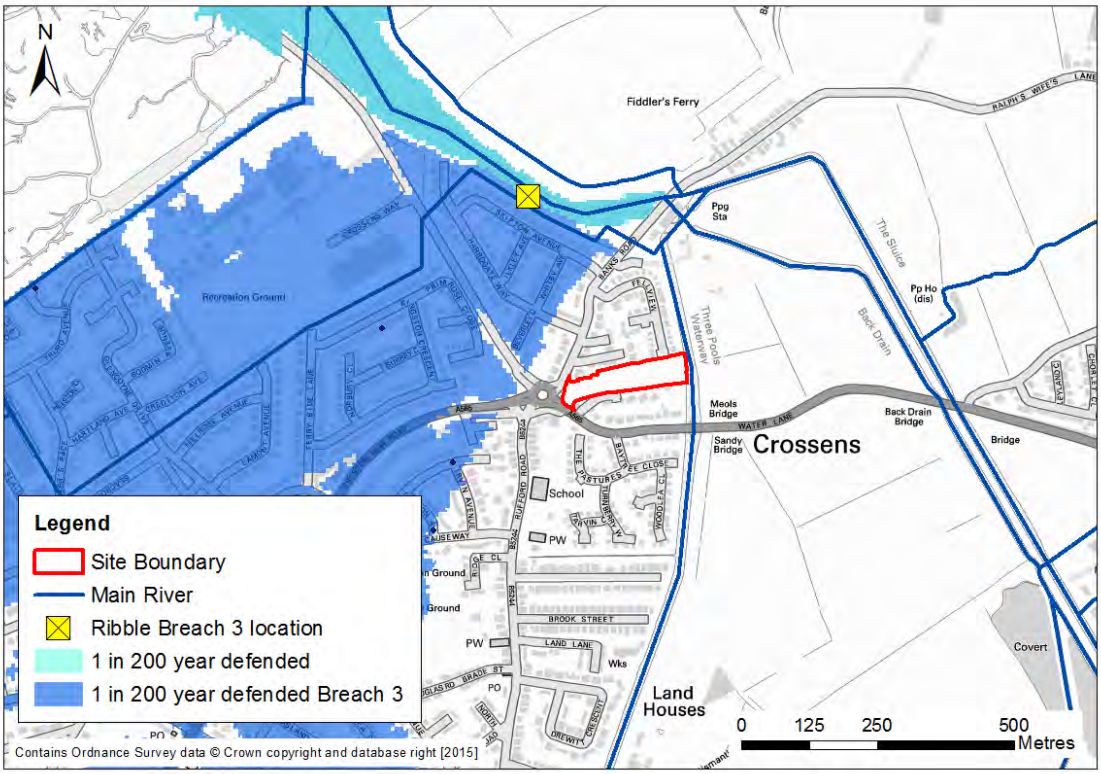
The EA Risk of Flooding from Rivers and Sea map is presented in Figure 3-2. Unlike the main EA flood map, this map presents the fluvial and tidal flood risk given the presence of flood defences. Given a scenario where there is full operation of Crossens Pumping Station and that the flood defences located in the Crossens area (Figure 2-2) do not fail, the development site is considered to be at a 'Very Low' risk of flooding, according to the EA Risk of Flooding from Rivers and the Sea map (defended). This means that the site has less than a 1 in 1000 year annual probability of flooding (< 0.1% AEP) of flooding from rivers or the sea, when flood defence infrastructure is taken into account.

However, this information has been provided for reference only. The EA Flood Map for Planning (Figure 3-1) should be used for planning purposes, as required by the NPPF and the PPG.

The allocation site is also within a designated EA Flood Warning Area (FWA). This relates to the eastern extent of the site; approximately to the extent of Flood Zone 2.

Figure 3-3: Coastal Defence Breach Extent



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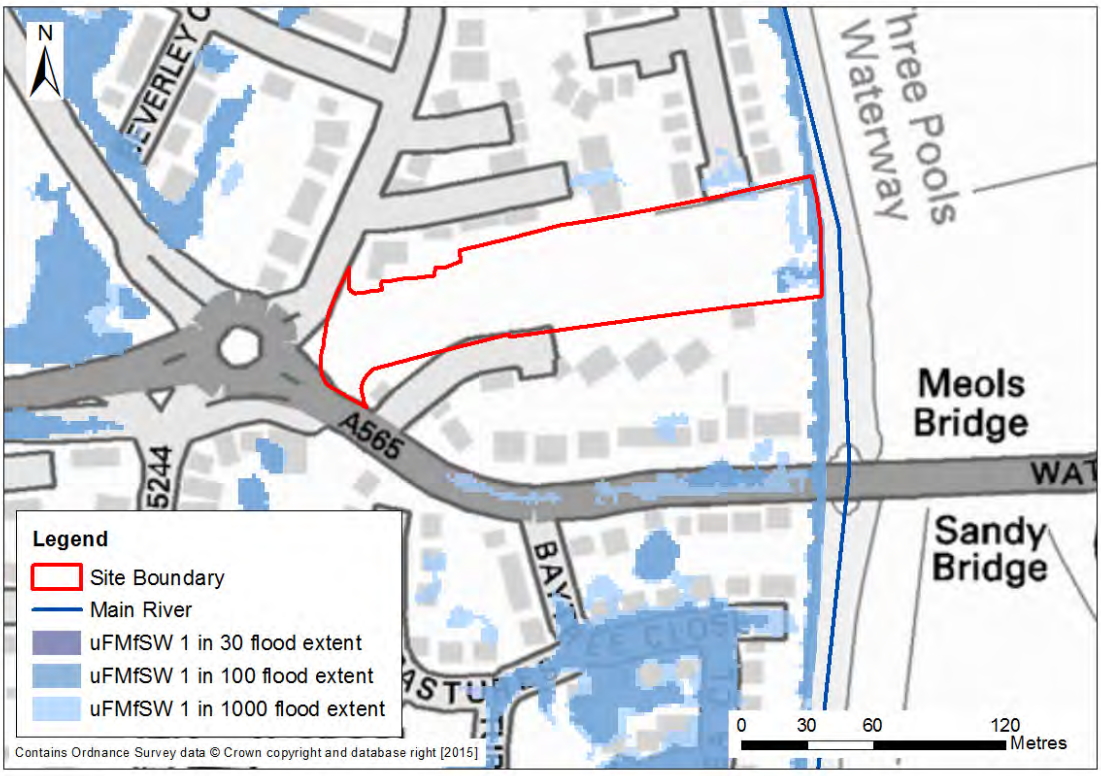
A breach report was commissioned by the EA as part of the 2014 Lancashire Tidal ABD Study. A total of nine breaches were simulated at different locations in the tidal defences protecting Lancashire. The breach locations were determined by the Environment Agency as areas of interest. The breach simulated nearest to the development site was in the Crossens Sea Defence, specifically at the rear of Skipton Avenue (see Figure 3-3). This breach was referred to as 'Ribble Breach 3'.

The hydraulic modelling results indicate that a breach in the sea defences at this location during a 1 in 200 year (0.5% AEP) tidal event would not result in flooding to the development site.

4 Surface Water Flood Risk

The updated Flood Map for Surface Water (uFMfSW) indicates that the housing site is at risk of flooding in a 1 in 100 year (1% AEP) storm event (Figure 4-1) in a relatively small area near the eastern boundary of the site. It should be noted that no uFMfSW flood depth data has been provided at this stage.

Figure 4-1: Updated Flood Map for Surface Water



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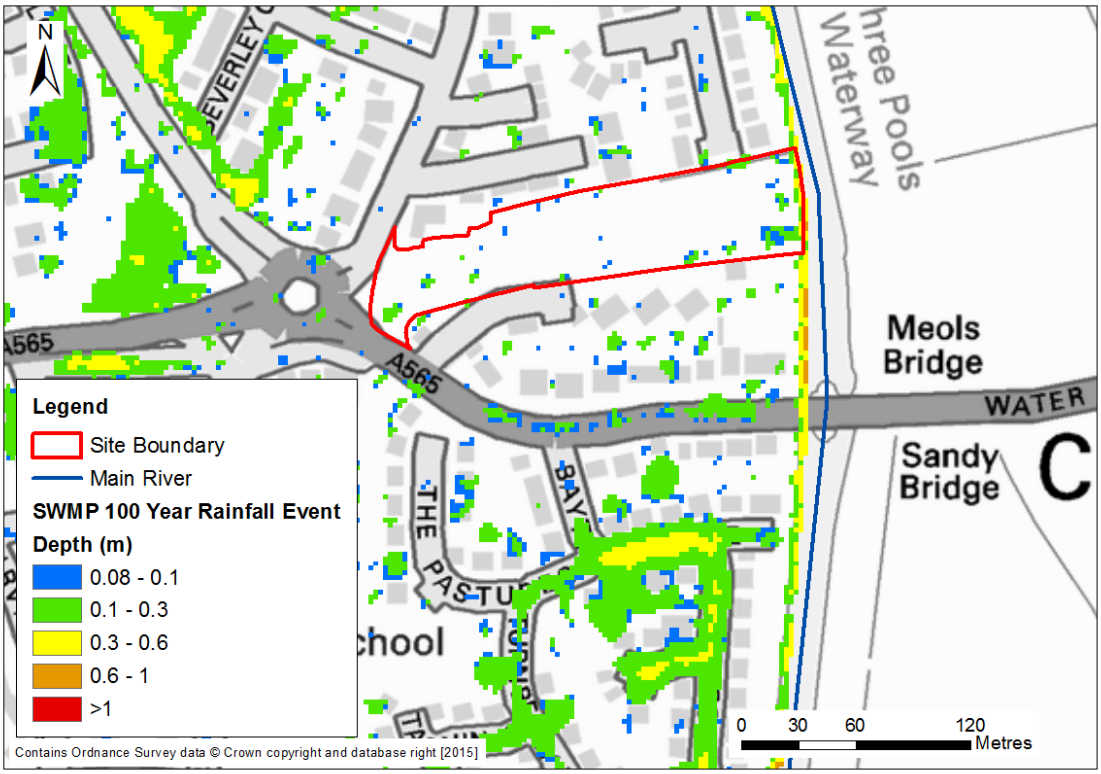
Based on uFMfSW flood mapping, approximately 3% of the site area (equivalent to 0.03 ha) is at some risk of surface water flooding. The total area at risk of surface water flooding is broken down as follows:

Table 4-1 Site area at risk of surface water flooding

Storm event	Site area	
	ha	%
1 in 30 year (3.33% AEP)	0.00	0
1 in 100 year (1% AEP)	0.03	3
1 in 1000 year (0.1% AEP)	0.03	3

SWMP mapping for the 1 in 100 year (1% AEP) storm event indicates a slightly larger flood extent at the eastern extent of the site compared to that given by the uFMfSW for the same design event (Figure 4-2 below). The SWMP mapping also shows small isolated areas of surface water flooding across the site. Areas of flooding with a total area less than 100 m^2 were removed from the uFMfSW; this post-processing of flood depth grids was not carried out on the SWMP maps. Flood depths towards the eastern boundary of the site are predicted up to 0.3 m. (Depths in the figure are shown in the 0.3 to 0.6 m depth band as a result of data processing, but are not shown in the SWMP Figure 1-3-01).

Figure 4-2 SWMP 100 year rainfall event



Although the allocation site is not within a locally-designated Critical Drainage Area (CDA), it is noted that the site is directly adjacent to a CDA which covers a large extent of the north of Southport. The CDA was designated in Sefton's SWMP 2011 and SFRA 2013.

5 Other Sources of Flood Risk

5.1 Fluvial

As discussed in Section 3, the EA Flood Map for Planning indicates that the site is not at risk of fluvial flooding. The allocation site is protected from fluvial flooding by EA maintained defences on Three Pools Waterway and Crossens Pumping station.

The 2014 Lancashire Tidal ABD Study assessed fluvial flood extents in the tidal floodplain as part of the study. This confirmed that there is no fluvial flood risk at the site.

5.2 Groundwater

Areas Susceptible to Ground Water Flooding (AStGWF) mapping indicates that the allocation site is located within an area considered to be susceptible to groundwater emergence. The relevant 1 km grid square covering the site suggests that between 25% and 50% of the grid square area could be susceptible to groundwater emergence from superficial deposits. It should be noted that the AStGWF dataset does not take account of the chance of flooding from groundwater rebound.

5.3 Reservoir

Reservoir inundation mapping from the SFRA indicates that the allocation site is not at risk from uncontrolled releases from reservoirs.

5.4 Canal

Canal risk mapping from the SFRA indicates that the allocation site is not at risk of flooding from canals.

6 Flood Risk Management measures

6.1 Tidal Risk

In accordance with the NPPF and PPG, the Exception Test should be applied to the future development of this site for residential dwellings, as discussed in Section 4.

The allocation site is protected from tidal flooding by the EA maintained Crossens Sea Defence and by Crossens Pumping Station. The EA has also modelled a breach scenario within the Crossens Sea Defence, close to the allocation site. This showed that the site would not be at risk of flooding given a breach at this location in the 1 in 200 year (0.5% AEP) tidal event.

It is recommended that the area within Flood Zone 3a should be kept free of residential development due to the risk of tidal flooding, as per the NPPF and PPG. This equates to approximately 10% of the site. As discussed in Section 3, the EA byelaws also require an easement of eight metres from the top of bank of the Main River which should remain undeveloped. The site area within Flood Zone 3a and the easement to the Main River cover a similar area and could be reserved for open space providing amenity benefit.

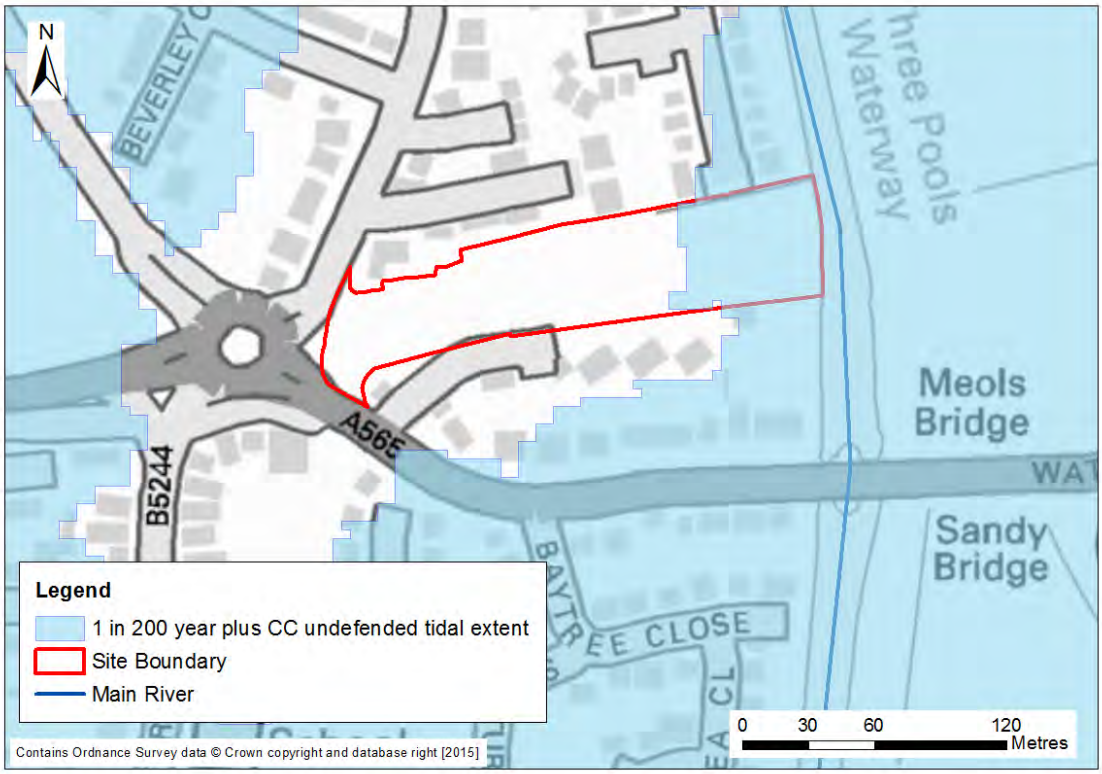
6.2 Finished Floor Levels

For all new development, the Sefton SFRA states that it is good practice and it is recommended to have Finished Floor Levels (FFLs) at least 0.3 m above the finished ground level. In addition to this general guidance, for 'More Vulnerable' development within Flood Zone 3a it is recommended that FFLs are at least 600 mm above the 1 in 200 year tidal event plus climate change flood level, taking account of the presence of flood defences and the residual risk of their failure.

Figure 6-1 below presents the undefended tidal flood extent for the 1 in 200 year event plus climate change (0.5% AEP plus climate change). The peak flood level on the site for this event is modelled as 5.6 m AOD. Including an allowance of 600 mm above this level would result in FFLs of 6.2 m AOD.

Future master planning and subsequent detailed design for the proposed housing development, with respect to surface water flood risk, should ensure the review of the depth outputs from the SWMP for the 1 in 100 annual probability event plus climate change, and use this information so that development proposals specify that floor levels should be at least 300 mm higher. Raised FFLs will also help to mitigate against any potential groundwater emergence at the allocation site.

Figure 6-1: 0.5% AEP plus climate change undefended tidal flood extent



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6.3 Safe Access and Egress

There are two main potential access and egress points; from Fellview to the north east and Bartons Close from the south. The Sefton SFRA recommends that safe access and egress should be provided for new developments. Safe access must be dry for this development type, meaning road levels should be set 600 mm above the undefended 1 in 200 year tidal event plus climate change flood level (i.e. 6.2 mAOD). Where this cannot be provided, safe refuge areas should be provided at the same elevation. Based upon the elevation of 6.2 mAOD, safe site access/egress should be possible via Bartons Close, which is not affected by tidal flooding. Based upon the available mapping, Bartons Close is also not considered to be at risk of surface water flooding.

Where development takes place within Flood Zone 3 or within the areas shown at surface water risk (see Section 4), it must be ensured that flood risk is not increased elsewhere. Roads built in these locations will need to be designed with sufficient drainage features to maintain existing flow routes. Compensatory storage may be required.

7 Surface Water Management

In accordance with PPG, this report assesses the volumes of surface water runoff likely to be generated by the proposed development. Proposals for surface water management are made to ensure any increased runoff does not cause flood risk elsewhere, in accordance with Sefton SFRA requirements for greenfield sites where development should restrict runoff to existing runoff rates and where possible volumes. Allowances have been made for the impact of climate change on increasing rainfall.

Based on the assumptions outlined in Section 2 the proposed housing development is likely to result in impermeable areas covering 60% of the developable area. Detailed ground investigation results were not available at the time of writing this FRA. Furthermore, indicative infiltration SuDS suitability mapping from the SFRA suggests that the allocation site is likely to have very low potential for infiltration SuDS based upon the underlying geology and the possibility of groundwater emergence at the site. We have therefore based our review on providing a fully compensated surface water management scheme on site to restrict surface water runoff from the development. A conventional piped surface water drainage system including a combination of storage tanks or oversized pipes is envisaged at this stage as a means of regulating surface water discharge to the sewer network.

7.1 Greenfield Runoff Rate

Greenfield runoff rates have been estimated for the allocation site in accordance with EA guidance Rainfall runoff management for developments using the drainage tools provided on the UK SuDS Tools Website[4]. The EA guidance indicates that two methods of calculating Greenfield runoff peak flow rates can be used, the Institute of Hydrology (IH) Report 124 method, or the Flood Estimation Handbook (FEH) statistical method. Further details of the strengths and weaknesses of these methods are available in the EA guidance. Runoff rates (l/s) for the allocation site estimated using both methods are provided in Table 7-1 below for comparison. A calculation record is provided in Appendix A.

Table 7-1: Estimated Greenfield runoff rates (l/s)

Method	IH124	FEH
QBAR*	2	3
1 in 1 year	5	5
1 in 30 years	5	5
1 in 100 years	5	5

*QBAR - Mean Annual Flood flow rate.

** Runoff rates limited to a minimum of 5 l/s

EA Report SC090031[5] regarding flood peak and hydrograph estimation in small catchments recommends that FEH methods should be used provided that the catchment is not highly permeable or heavily urbanised. Runoff rates are set at a minimum of 5 l/s where a lower value has been calculated; this is because it is not practical to control flows to a rate lower than this. As a result of this, in this instance both the IH124 and FEH method provide the same results.

Permissible discharge rates for the site will need to be agreed with the relevant authority at detailed design.

[4] http://geoservergisweb2.hrwallingford.co.uk/uksd/

[5] Environment Agency, 2012, Estimating flood peaks and hydrographs for small catchments. Project SC090031.

7.2 Surface Water Risks

Rainfall depths for the 30 year and 100 year rainfall events at the site were abstracted from the FEH CD-ROM. The rainfall depths were increased by an allowance of 30% to account for the effects of climate change (Table 7-2 below).

Table 7-2: Design rainfall depths

Duration (hours)	30-year rainfall (mm)	30-year rainfall plus 30% (mm)	100-year rainfall (mm)	100-year rainfall plus 30% (mm)
0.25	22.2	28.9	32.9	42.7
0.5	26.6	34.5	38.5	50.1
0.75	29.5	38.4	42.3	55.0
1	31.8	41.4	45.1	58.7
1.5	35.3	45.9	49.5	64.4
2	38.1	49.5	52.9	68.8
3	42.3	55.0	58.1	75.5
4	45.6	59.2	62.0	80.6
6	50.6	65.8	68.0	88.5
8	54.6	70.9	72.7	94.5
10	57.8	75.1	76.5	99.4
12	60.6	78.8	79.8	103.7
18	66.3	86.1	86.1	112.0
24	70.6	91.8	91.0	118.3
36	77.2	100.4	98.3	127.7
48	82.3	106.9	103.8	134.9

Likely attenuation volumes for the proposed development are provided in Table 7-3 below. These values are based on limiting discharge to 5 l/s in accordance with the Greenfield runoff rates estimated in Section 7.1.

Table 7-3: Estimated attenuation volumes (m^3)

Design event (including climate change)	Critical storm duration (hours)	Inflow volume (m^3)	Outflow volume (m^3)	Attenuation required (m^3)	Time to empty (assuming no infiltration) (hours)
1 in 30 year rainfall plus 30%	12	442	108	334	37
1 in 100 year rainfall plus 30%	12	581	108	473 (139 m^3 of exceedance storage)	52

The attenuation volumes estimated above assume a gravity outfall to the Main River (Three Pools Waterway) draining away from the site. The final point of discharge is to be determined at detailed design.

7.3 Outline Drainage Strategy

As stated above, detailed ground investigation results were not available at the time of writing this FRA. Furthermore, indicative SuDS suitability mapping from the SFRA suggests that the allocation site is likely to have very low potential for SuDS based upon the underlying geology and the possibility of groundwater emergence at the site. We have therefore based our review on providing a fully compensated surface water management scheme on site to restrict surface water runoff from the development. A conventional piped surface water drainage system including a combination of storage tanks or oversized pipes is envisaged at this stage as a means of regulating surface water discharge.

In accordance with Table 7-3 and in the absence of any infiltration drainage for impermeable areas, the total attenuation required for the proposed development for 1 in 30 year and 1 in 100 year design events including climate change are estimated to be 330 m^3 and 470 m^3 respectively.

Although SuDS options have not been investigated as part of this study due to the absence of ground investigations and percolations tests, based on the constrained dimensions of the site it seems unlikely that above ground features such as detention basins would offer a feasible solution. In addition to this, as groundwater depths could be shallow in this area, fully sealed systems are likely to be required.

The capacity of the piped drainage system connecting the developed area is likely to be designed to a 1 in 30 year standard, this means that storage would need to be provided to contain the exceedance volume for the 1 in 100 year climate change event. It is recommended that additional storage should be provided within the developed area to accommodate the estimated exceedance volume of 140 m^3 to limit offsite impacts. This could be achieved by landscaping and making best use of available green space to contain exceedance flows in swales. Use of raised kerbs could also provide some storage within internal road areas. These approaches can be used to allow certain areas of the site to flood to shallow depths when the capacity of the onsite drainage network is exceeded. Flood water will then be able to pond before gradually discharging back into the site drainage system.

Owing to the absence of ground investigations and percolation tests to date, a fully attenuated surface water system has been appraised at this outline planning stage. However, opportunities for SuDS should be fully investigated at detailed design stage.

Sewer maps have not been obtained at this stage. However, the nearest public sewers are likely to serve the existing housing on Bartons Close itself, or housing to the north on Fellview or Meadow Brow. It is assumed that site surface water will discharge to the existing Main River, Three Pools Waterway, which runs adjacent to the eastern extent of the site. Consent to discharge will need to be obtained from the relevant authority at detailed design.

8 Conclusion and Discussion

This report has been prepared for Sefton Council, who require a site FRA for a proposed housing allocation on land at Bartons Close, Southport.

The site is allocated for approximately 36 dwellings covering an area of approximately 1 ha. It has been assumed that development of the site would result in the introduction of impermeable areas covering 60% of the developable area.

The site lies within the tidal floodplain and is therefore considered to be at risk of flooding from the Sea. 10% of the site is located within tidal Flood Zone 3a and 30% of the site within tidal Flood Zone 2. When taking account of flood defence infrastructure including the Crossens Sea Defence and the Crossens Pumping Station, the site is considered to be fully defended from tidal flooding. Three Pools Waterway, a Main River, runs adjacent to the eastern boundary of the site though the site is not considered to be at risk from fluvial flooding. The site is within an EA Flood Warning Area, based on the tidal flood risk.

The uFMfSW indicates that a small area of the site, near its eastern extent, is at risk of surface water flooding from a 1 in 100 year (1% AEP) storm event. No surface water flood risk is predicted from a 1 in 30 year (3.33% AEP) storm event. SWMP mapping for the 1 in 100 year (1% AEP) storm event indicates a marginally larger flood extent to that given by the uFMfSW for the same design event. Flood depths of up to 0.3 m are predicted at the eastern extent of the allocation site, based on the information provided in the SWMP.

Attenuation requirements for the 1 in 30 year and 1 in 100 year surface water flooding design events including climate change are estimated to be 330 m^3 and 470 m^3 respectively, as shown in Table 7-3. Although SuDS options have not been investigated as part of this study, it seems unlikely that above ground features such as detention basins would be feasible given limited space available on site. In addition to this, as groundwater depths could be shallow in this area, fully sealed systems are likely to be required. The AStGWF dataset indicates that the site is located within an area considered to be susceptible to groundwater emergence.

Even if attenuation basins could provide sufficient storage for the 1 in 100 year climate change surface water runoff volume, the capacity of the piped drainage system connecting the developed area is likely to be designed to a 1 in 30 year standard. It is therefore recommended that additional storage should be provided within the developed area to accommodate the estimated exceedance volume of 139 m^3 (see Table 7-3) to limit offsite impacts. This could be achieved through sympathetic landscaping and making best use of available green space to contain exceedance flows in SuDS techniques such as swales. Implementation of raised kerbs could also provide some storage within internal road areas. These approaches can be used to allow certain areas of the site to flood to shallow depths when the capacity of the onsite drainage network is exceeded.

Owing to the absence of ground investigations and percolation tests to date, a fully attenuated surface water system has been appraised at this outline planning stage. However, opportunities for SuDS should be fully investigated at detailed design stage.

Focusing on the tidal risk associated with the site, due to the 10% area within Flood Zone 3a, the site must pass the second part of the Exception Test, which requires the site to be safe throughout its development lifetime without causing increased risk elsewhere off-site, as per the NPPF and the PPG. This FRA has assessed all available information including defence standards and a tidal defence breach modelling study carried out nearby. Based on this review of all available information, the recommendation of this FRA is that the area within Flood Zone 3a should not be developed and should be reserved for open space providing subsequent amenity benefit. The EA byelaws also require an eight metre easement from the top of bank of the Main River which should remain undeveloped and accessible and could be included within the amenity area: this 8 metre buffer covers a similar extent to the area in Flood Zone 3a.

Appendices

A Greenfield runoff estimation record

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Haywards Heath
Limerick
Newcastle upon Tyne
Newport
Saltaire
Skipton
Tadcaster
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