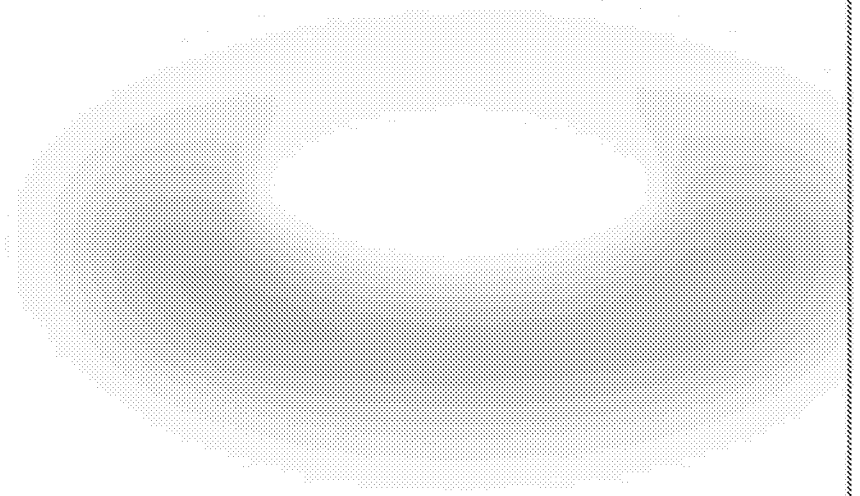




ambiental®

predicting · preventing · protecting

Project: 46A to 47 Pier Road, Phase 1 Flood Risk Assessment (FRA)
Prepared for: Dowsett Mayhew Planning Partnership Ltd
Reference: FRA 3152
Date: July, 2017
Version: Final v1.0



Document Issue Record

Project: 46A to 47 Pier Road, Phase 1 Flood Risk Assessment

Prepared for: Dowsett Mayhew Planning Partnership Ltd.

Reference: FRA 3152

Site Location: 46A to 47 Pier Road, Littlehampton, West Sussex, BN17 5LW.

Proposed Development: It is understood that the development is for the demolition of the existing structure on site and construction of a new structure to provide commercial on the ground floor and 8 residential units above.

Consultant		Date	Signature
Author	Jose Tenedor	21/04/2017	
Document Check	Thea Powell	19/07/2017	
Authorisation	Daniel Cook	02/08/2017	
Amended	Daniel Cook	06/11/2017	

Please Note:

This report has been prepared for the exclusive use of the commissioning party and may not be reproduced without prior written permission from AMBIENTAL Technical Solutions Limited. All work has been carried out within the terms of the brief using all reasonable skill, care and diligence. No liability is accepted by AMBIENTAL for the accuracy of data or opinions provided by others in the preparation of this report, or for any use of this report other than for the purpose for which it was produced.

Contents

Document Issue Record	1
Please Note:	1
Contact Us:	1
1. Summary	3
2. Development Description and Site Area	6
Proposed Development and Location	6
Vulnerability classification	7
Geology	7
3. Sequential Test/Exception Test	8
4. Site Flood Hazards	9
Sources of Flooding	9
Mechanisms and History of Flooding	9
Tidal	10
Surface Water (Pluvial)	12
Groundwater	14
Sewer	15
Surface Water Drainage Strategy	15
Records of Historical Flooding	16
5. Probability of Flooding	17
Climate Change on Site	18
6. Residual Risks	19
Overtopping	19
Defence Breach	20
7. Flood Risk Management Measures	21
Safe Access/Egress	22
8. Off Site Impacts	24
Impact to Flood Risk Elsewhere	24
Generation of Runoff	24
9. Conclusion	25
Appendix A – Development Plans	27
Appendix B – Environment Agency Flood Data	31
Appendix C – Arun District Council SFRA Data	41
Appendix D – Information Relating To JFLOW	47
JFLOW and flood outlines (Source: EA)	47
Limitations	48

1. Summary

- 1.1 Ambiantal Technical Solutions Limited has been appointed by Dowsett Mayhew Planning Partnership Ltd to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed development at 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW.
- 1.2 The proposed development is for the demolition of the existing structure on site and construction of a new structure to provide a commercial space on the ground floor and 8 residential units above, providing a mixed use scheme.
- 1.3 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the proposed development is located within Flood Zone 3 (high risk). Due to the proposed mixed use scheme, the proposed development is considered to be a “Less Vulnerable” and “More Vulnerable” development for the commercial and residential use respectively, under the NPPF.
- 1.4 Communication has been sought with the EA, who have confirmed that a residential finished floor level of 5.23mAOD is acceptable. Furthermore the EA have stipulated that despite there being defences in the area, the undefended flood levels should be used for analysis.
- 1.5 Ground levels across site vary between approximately 2.64mAOD and 1.96mAOD (Source: LiDAR, 2m resolution). Comparison of the site levels with modelled flood levels confirms the site partially resides within the extreme tidal flood extent for the undefended present day 1:200 year event (3.73mAOD) and the 1:1000 year flood event (4.05mAOD). Possible maximum flood depth, based on the minimum topographic level on site (1.96mAOD), for the undefended present day 1:200 year and 1:1000 year flood events has been shown to be 1.77m and 2.09m, respectively.
- 1.6 Comparison between the 1:200 year flood level for 2115 (4.93mAOD) and the minimum topographic levels at the location of the proposed built footprints (1.96mAOD) indicate a maximum potential flood depth of 2.97m for the 1:200 year (2115) scenario.
- 1.7 The EA have provided information regarding the flood defences in the area. **The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall has a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.**
- 1.8 As such and given that:
 - a) The proposed development is for the demolition of the existing structure and the construction of a mixed use scheme to provide commercial uses on the ground floor and residential above;
 - b) All sleeping accommodation to be located on the first floor level (5.23mAOD) and above;
 - c) The site lies within an area of tidal flood risk and therefore is not required to provide flood compensatory storage;
 - d) Given the nature of tidal flooding, prior evacuation can be sought;

- e) In terms of flood vulnerability betterment can be achieved through the implementation of formal flood warnings/alerts and prior evacuation, an area of safe refuge can be provided via internal stairwells to the upper floors;

following the guidelines contained within the NPPF, the proposed development is considered **to be suitable** assuming appropriate mitigation (including adequate warning procedures) can be maintained for the temporary lifetime of the development.

ambiental

Development Description	Existing	Proposed
Development Type:	Depot	Mixed use scheme with commercial uses on the ground floor and residential apartments above
(Number of Bedrooms):	N/A ¹	N/A ¹
EA Vulnerability Classification:	Less Vulnerable	Less and More Vulnerable
Ground Floor Level:	Topographic levels at location of proposed built footprint range from 2.64mAOD to 1.96mAOD	No change
Level of Sleeping Accommodation:	N/A ¹	5.23mAOD and above as agreed with EA.
Impermeable Surface Area:	Brownfield Site. 100% Impervious	No change.
Surface Water Drainage:	N/A ¹	Surface Water Drainage Strategy recommended
Site Size:	N/A ²	No change
Risk to Development	Summary	Comment
EA Flood Zone:	3	
Flood Source:	Tidal	River Arun / English Channel
1 in 200yr flood level (2012):	3.73mAOD	River Arun to East Head model, completed in 2016 (Node 3) - undefended
1 in 200yr flood Level + Climate Change (2115):	4.93mAOD	
1 in 1000yr flood level (2012):	4.05mAOD	
Recorded Flood Events in Area:	Yes	
Recorded Flood Events at Site:	No	
SFRA Available:	Yes	Arun District SFRA (August 2016 Update)
Management Measures	Summary	Comment
Ground floor Finished Floor Levels above extreme flood levels:	N/A ¹	
Safe Access/Egress Route:	Warning & Evacuation Plan	Safe egress can be provided
Flood Resilient Design:	Yes	All sleeping accommodation located on the first floor and above. Internal stairwell to higher floors will be available
Site Drainage Plan:	N/A ¹	It is recommended that the developer attenuate runoff and net volume in accordance with the Supplementary Requirements for Surface Water Drainage Proposals of the Arun District Council
Flood Warning & Evacuation Plan:	Yes	EA Flood Warning Service and EA Flood Alert
OFFSITE IMPACTS	SUMMARY	COMMENT
Displacement of floodwater:	N/A ²	Site is area of tidal flood risk
Increase in surface runoff generation:	None	Attenuation following the NPPF guidance and the Supplementary Requirements for Surface Water Drainage Proposals of the Arun District Council
Impact on hydraulic performance of channels:	None	

Table 1: Summary of flood risks, impacts and proposed flood mitigation measures.

N/A¹ not required for this assessment; N/A² data not available.

2. Development Description and Site Area

Proposed Development and Location

- 2.1 The proposed development site is located at 46A to 47 Pier Road, Littlehampton, West Sussex, BN17 5LW (Figure 1).
- 2.2 It is understood that the development is for the demolition of the existing structure (a depot and associated hardstanding areas) on site and construction of a new structure to provide commercial use on the ground floor and 8 residential units above.

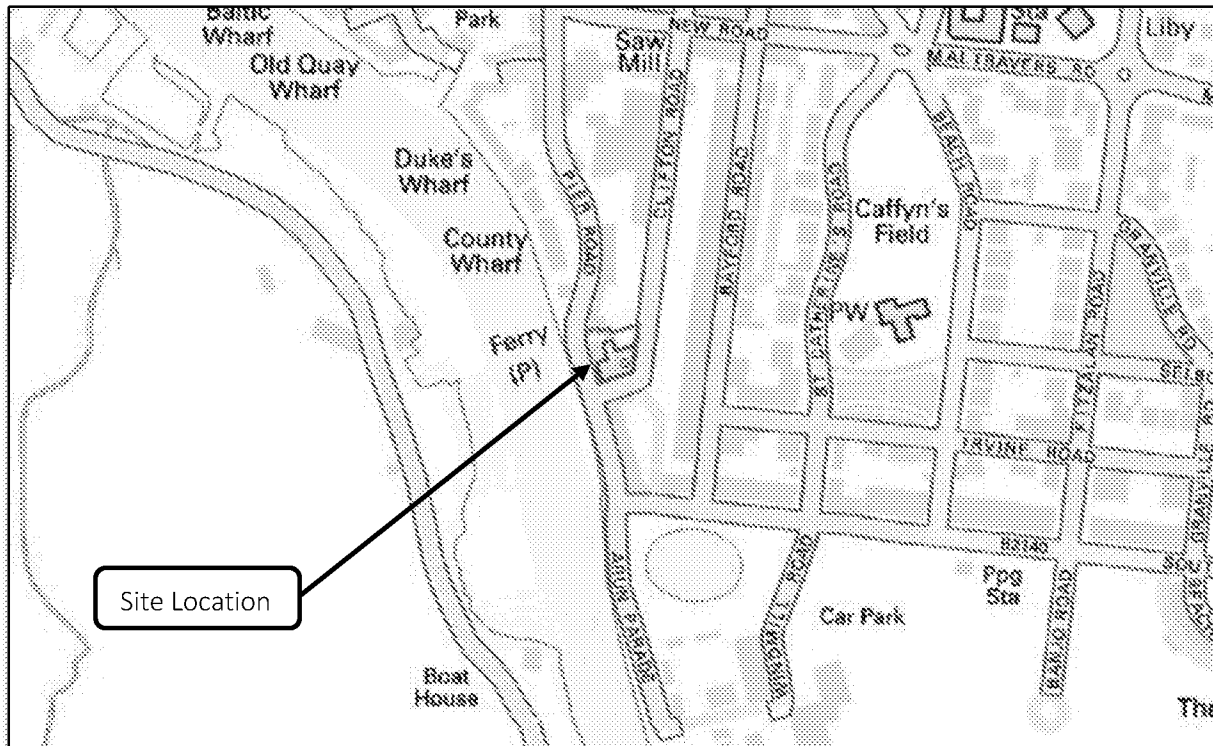


Figure 1 – Site Location Map, site boundary shown in red. (Source: OS StreetView).

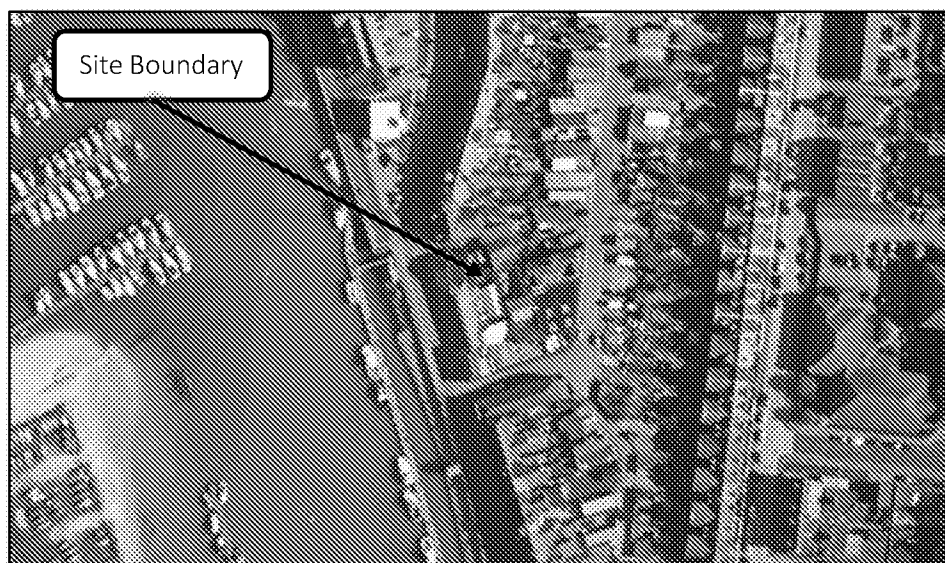


Figure 2 – Aerial View of Development Site (Source: ESRI).

ambiental

- 2.3 The topography of the site ranges from 2.64mAOD to 1.96mAOD. Hence it can be considered that the site slightly slope to the north-east (Clifton Road) with no likelihood of rapid runoff within the property development boundary. (Source: LiDAR, 2m resolution).
- 2.4 The nearest watercourse to the site is the River Arun, located approximately 25m to the west of the site. The River Arun has been classified as an EA main river. The site is also located approximately 400m north of the Mean High Water line of the English Channel.

Vulnerability classification

- 2.5 The existing development (vacant brownfield site) is “Less Vulnerable” under the NPPF and is located within Flood Zone 3 (Figure 3).
- 2.6 The proposed development- construction of mixed use commercial and residential development, is classified under the NPPF as “Less and More Vulnerable”.

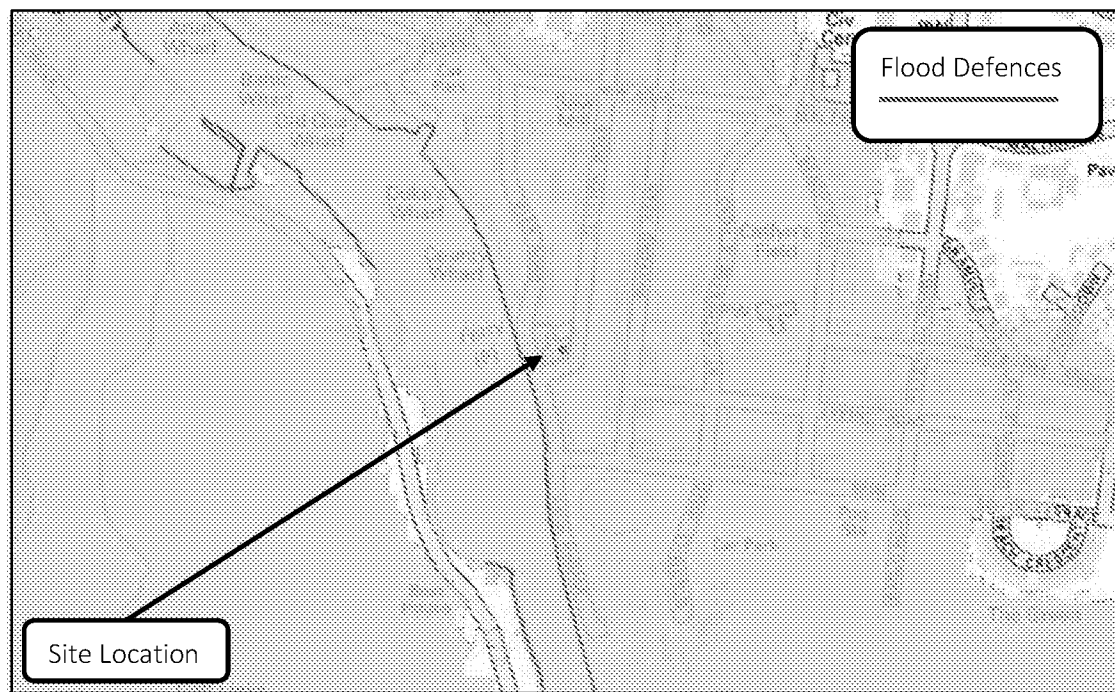


Figure 3: EA Flood Zone Map. Dark blue depicts Flood Zone 3 and lighter blue represents Flood Zone 2. Approximate site boundary shown in red. (Sources: EA, OS).

Geology

- 2.7 The British Geological Survey (BGS) Online Map indicates that the bedrock underlying the site is the *Lewes Nodular Chalk Formation*, *Seaford Chalk Formation*, *Newhaven Chalk Formation*, *Culver Chalk Formation*, formed in warm chalk seas with little sediment input from land.
- 2.8 The superficial deposits are ‘*Raised Beach Deposits, 1’* formed by Sand and Gravel up to 3 million years ago in the Quaternary Period. The local environment was previously dominated by shorelines with sediments deposited in beaches and barrier islands.
- 2.9 The Soil Parental Material in the area taken from the UK Soil Observatory (UKSO) website is classified as *Quaternary Marine/Estuarine Sand* while the Soil Texture is Sand to Sandy Loam.

3. Sequential Test/Exception Test

- 3.1 Under the NPPF, all new planning applications must undergo a *Sequential Test*. This test must be implemented by local planning authorities with a view to locating particularly vulnerable new developments (e.g. residential, hospitals, mobile homes etc.) outside of the floodplain.
- 3.2 The test refers to the EA Flood Zones shown in *Figure 3*. For reference, the NPPF *Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table* is reproduced below:

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
	Zone 3b <i>Functional Floodplain</i>	Exception Test Required	✓	✗	✗	✗

Table 2: The Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table as specified by NPPF. Shaded cells denote the proposed re-development. Please note: ✓ means development is appropriate; ✗ means the development should not be permitted.

- 3.3 Using the principles of the Sequential Test outlined above, the proposed development is "Less and More Vulnerable".
- 3.4 The site resides within Flood Zone 3 (as defined by the EA) and as such, under the NPPF, would normally be required to further implementation of the Exception Test.
- 3.5 As Table 2 demonstrates, the Exception Test would normally be required for this development. For the Exception Test to be passed, the proposed development would need to meet the following criteria:
- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh the flood risk, as informed by a Strategic Flood Risk Assessment;
 - a Flood Risk Assessment demonstrates that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

(Source: NPPF)

- 3.6 As such, and in order to address part two of the Exception Test requirements, the planning application submitted by the client is required to be accompanied by a FRA which shows that the development can be achieved in a sustainable manner, with an overall reduction of flood risk to the site and surrounding area.

- 3.7 To address part one of the Exception Test the development will improve the amenity of the local area by removal of an old commercial development and introduction of a new commercial/housing scheme. The proposed housing will go towards the local council meeting its housing targets. Additionally the development will reduce overall site runoff and provide SuDS rainfall runoff mitigation reducing surface water flood risk to others as a result of the development.

4. Site Flood Hazards

Sources of Flooding

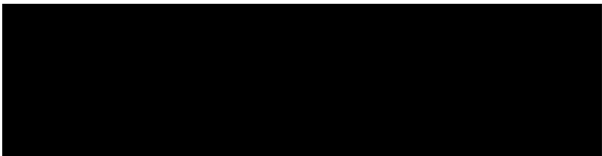
- 4.1 As outlined in *Figure 3*, the proposed development is located within Flood Zone 3 (high risk of flooding), and is considered to be “Less and More Vulnerable” under the NPPF. Communication with the Environment Agency (EA) and information provided in the Arun District Council Level 1 and 2 SFRA (2016) has identified the following potential sources of flooding to the site:

Source	Description
Fluvial	N/A
Tidal	River Arun / English Channel
Surface	On site
Groundwater	In Area
Sewer	N/A

Table 3: Summary of flood sources.

Mechanisms and History of Flooding

- 4.2 According to the low detail, national-scale flood mapping created on behalf of the EA the proposed development is located within Flood Zone 3 of the tidal flood plains of the River Arun and the English Channel.
- 4.3 The Flood Zones shown in *Figure 3* outlines only the potential floodplain; and the mitigating effects of flood defences currently in place are not considered. The site benefits from flood defences and the EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall has a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.



Tidal

- 4.4 The EA Flood Map for Planning (Figure 3) confirms that the site lies within Flood Zone 3 (High Risk), having a 1 in 200 or greater annual probability of flooding from the sea ($>0.5\%$).
- 4.5 The nearest watercourse to the site is the River Arun, located approximately 50m to the west of the site. The River Arun has been classified as an EA main river. The site is also located approximately 450m north of the Mean High Water line of the English Channel.
- 4.6 Figure 4 demonstrates the node points for flood plain modelled flood levels from the River Arun to East Head model, completed in 2016. The flood plain nodes provided have modelled flood level for annual exceedance probabilities (AEP). The AEP and flood levels are demonstrated in Table 4 below.
- 4.7 The analysis focuses on the defended 1:200 year (0.5%AEP) present day epoch, 1:200 year (0.5%AEP) 2115 epoch, 1:1000 year (0.1%AEP) flood levels. The EA has also provided data for the 1:20 year (5%AEP) present day epoch, however these have not been included in the final analysis as no flood depths were found at any node. Based on the EA data nodes the worst case scenario, highest flood level, has been used in the analysis.



Figure 4 – Node Location Map (Source: EA).

Modelled Flood Level for Annual Exceedance Probability (mAOD)				
Undefended				
Node	5% AEP (1:20yr)	0.5% AEP (1:200yr)	0.5% AEP (2115)	0.1% AEP (1:1000yr)
1	2.87	3.73	4.93	4.05
2	2.87	3.73	4.93	4.05
3	2.87	3.73	4.93	4.05

Table 4: Modelled Flood Plain Flood Levels (Source: EA).

- 4.8 The data provided demonstrates a flood level of 2.87mAOD for the 1 in 20 year event. The site benefits from flood defences and the EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall has a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD. It is therefore considered due to the presence of the defences that the site would not be flooded during a 1 in 20 year event.
- 4.9 The data provided shows a flood level of 3.73mAOD for the present day 1:200 year flood event, worst case (Node 1,2,3).
- 4.10 The data provided shows a flood level of 4.05mAOD for the present day 1:1000 year flood event, worst case (Node 1,2,3).
- 4.11 The data provided by the EA has also given a climate change flood level for the 2115 epoch 1:200 year flood event which is estimated to be 4.93mAOD (Nodes 1, 2 and 3).
- 4.12 Topographic levels across site vary between approximately 2.64mAOD and 1.96mAOD (Source: LIDAR, 2m resolution). Comparison of the topographic site levels with modelled flood levels confirms the site would be inundated if it were not for the presence of defences for all events. The defences provide a minimum crest height of 4.76mAOD. Thereofre based on the flood levels provided for the undefenced event as advised by the EA. The site would be protected up to the 1 in 200 year standard but could be overtopped for the 1 in 200 + CC event.
- 4.13 Possible maximum flood depth for the undefended events, based on the minimum topographic level on site (1.96mAOD), for the present day 1:200 year and 1:1000 year flood events has been shown to be 1.77m and 2.09m, respectively.
- 4.14 Comparison of the topographic site levels with modelled flood levels confirms the site fully resides within the 1:200 year flood event for the 2115 epoch (4.93mAOD). Possible maximum flood depths, based on the minimum topography on site, has been shown to be 2.97m. The site does benefit from defences with a crest height of 4.76mAOD to 4.80mAOD.
- 4.15 The Arun District Council SFRA (August 2016 Update) has shown that the site does benefit from the presence of defences in the form of a privately owned wall. The estimated design standard for the area is 1:75 for the defences along the River Arun and 1:200 along the beach to the south.
- 4.16 The EA have further provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with

concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence has a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.

- 4.17 Management of defences in the area is stated in the Beachy Head to Selsey Bill Shoreline Management Plan (2006), the management policy for Angmering-on-Sea to Littlehampton (Policy Unit: 4d18) is “Hold the Line” - maintain or upgrade the level of protection provided by defences. The management policy will continue to apply at present day and across the medium (2025 to 2055) to long term (2105). It can therefore be assumed the improvements in defences will be maintained and upgraded in the future.
- 4.18 The EA have provided details of historic flood incidents in the area of the site. Preceding 1985 flooding of properties, roads and industrial areas have been recorded in the vicinity of the site, caused by overtopping mainly through the harbour masters yard, where the water gates were reported to have been left open. Between 40 and 100 houses were affected by this incident. However, flood defences have been improved in the area which has subsequently reduced the risk of flooding in the vicinity of the site.
- 4.19 It is important to note that tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a ‘bulge’ of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 4.20 As such the risk of flooding is considered to be **moderate**.

Surface Water (Pluvial)

- 4.21 The EA’s Risk of Surface Water Flooding map (*Figure 6*) demonstrates that the majority of the site is at a “Very Low” risk of surface water flooding, while the east, south and north boundaries of the site is at a “Low”. Some of the surrounding road network and buildings to the north and east is deemed to be at a “High” risk.
- 4.22 There is a small area to the north of the existing property identified to be at ‘Medium’ risk of surface water flooding. Areas of ‘Medium’ risk have between 1 in 100 (1%) and 1 in 30 (3.3%) chance of surface water flooding annually.
- 4.23 The EA Surface Water Depth Map – High Chance of Occurring shows that the site and surrounding area would not be affected by any flood depths during this flood event (*Figure 7*).

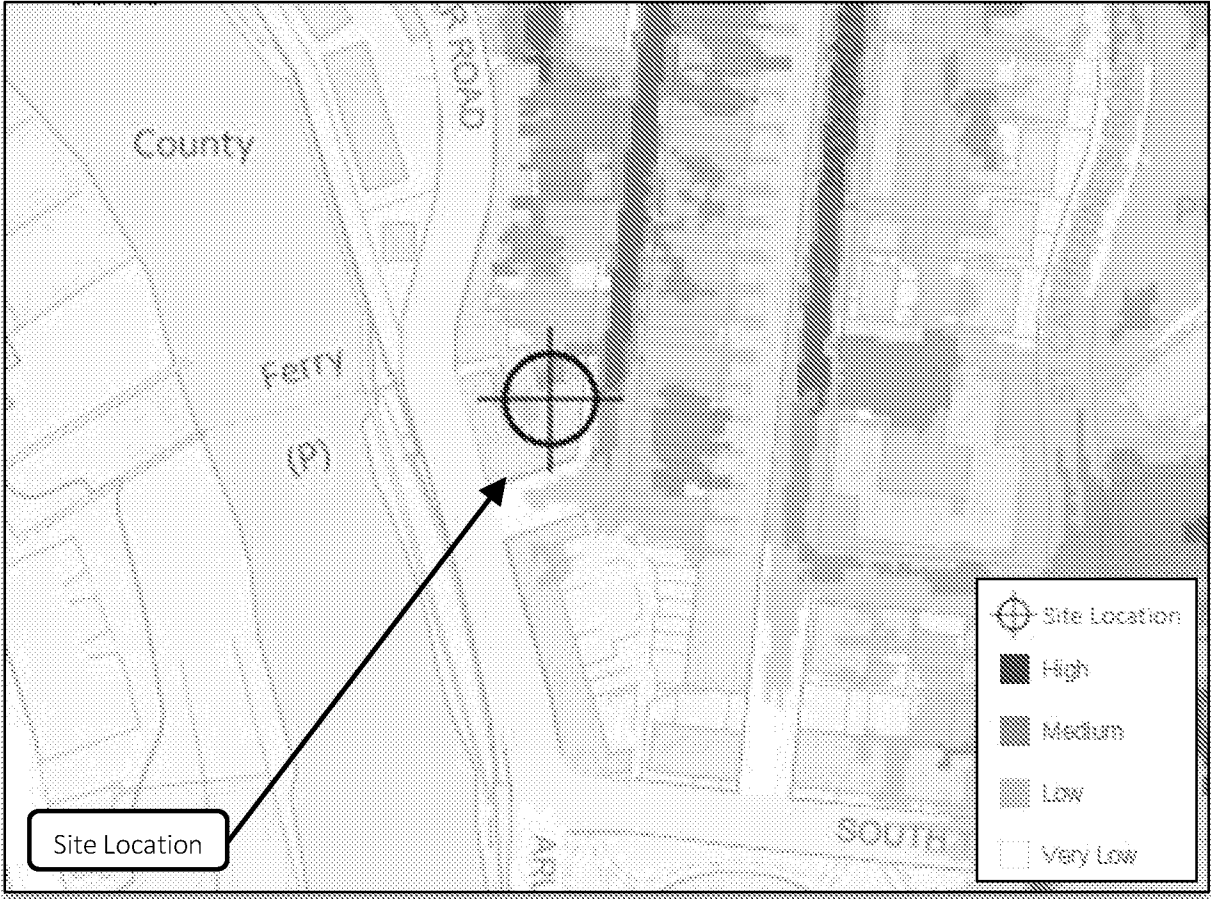


Figure 5 – EA Surface Water Flood Risk Map. (Source: EA Online)

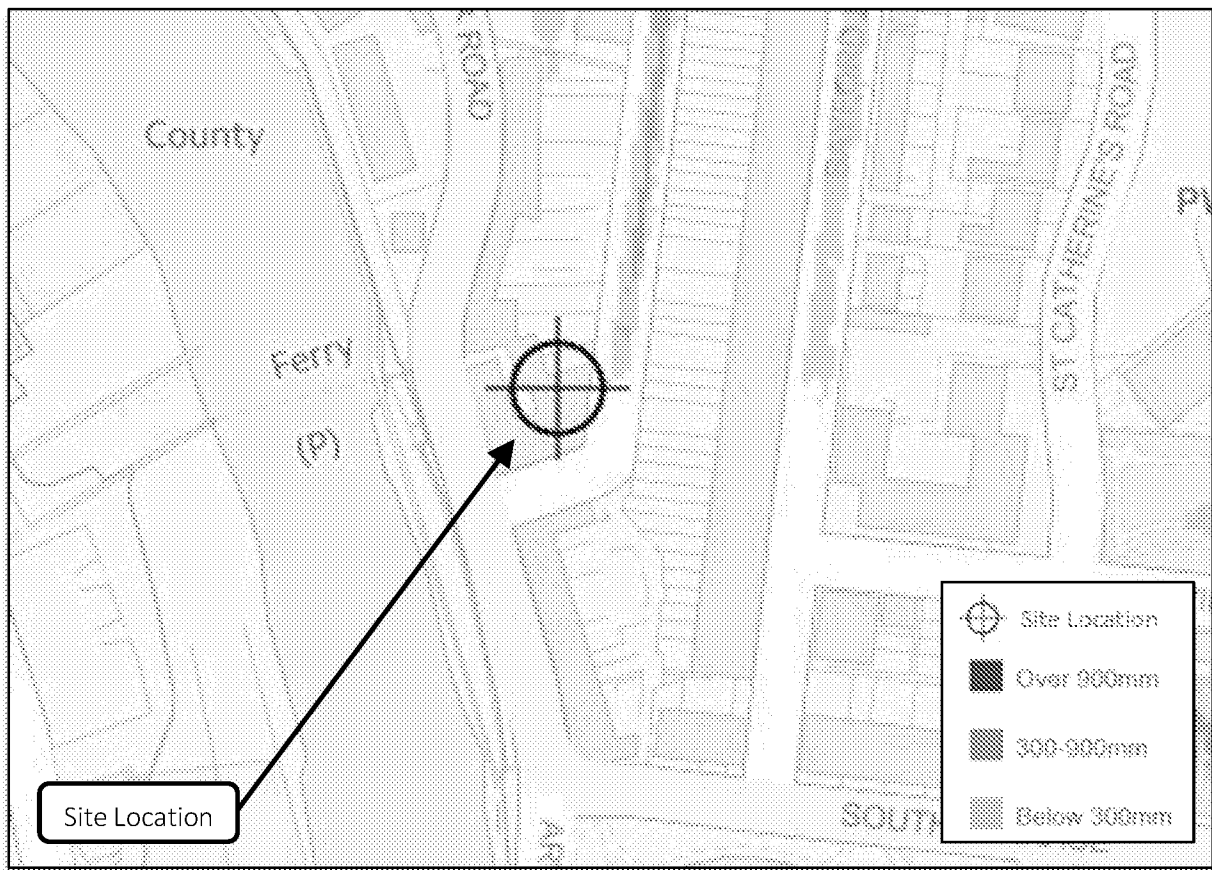


Figure 6 – Surface Water Depth – High Chance of Occurring (Source: EA Online).

4.24 A number of surface water flooding incidents have also been recorded in close proximity to the site along St Catherine's Road and on the junction of Irvine Road and Beach Road. No further information has been provided regarding these incidents, however the SFRA states that the primary source of surface water flooding was attributed to heavy rainfall overloading highway carriageways and paved areas, drains and gullies, as well as blockages and high water levels impeding free discharge from surface water drains and gullies.

4.25 As such the risk of flooding to the site from surface water is deemed to be **relatively low**.

Groundwater

4.26 The EA has shown the site to not be located within a groundwater source protection zone. The EA has however identified the site to be located over a major aquifer with high vulnerability.

4.27 The Arun District Council SFRA (August 2016 Update) Area Susceptible to Groundwater (Appendix C, Plan 2) shows the site to be located in an area susceptible to groundwater flooding classified as $\geq 75\%$.

4.28 The Arun District Council Strategic Flood Risk Assessment (2016 Update) has no records of historical groundwater flooding in the area have been found.

4.29 As such, the risk of flooding from this source can be considered to be **moderate**.

Sewer

- 4.30 The Arun District Council SFRA (2016 Update) Historic Incidents of Flooding from Sewers Map (Appendix C, Plan 4 and an extract of it on Figure 8 below) shows that the area surrounding the site has had six recorded historic sewer flooding incidents. However, there have been no recorded historic sewer flood events on site.

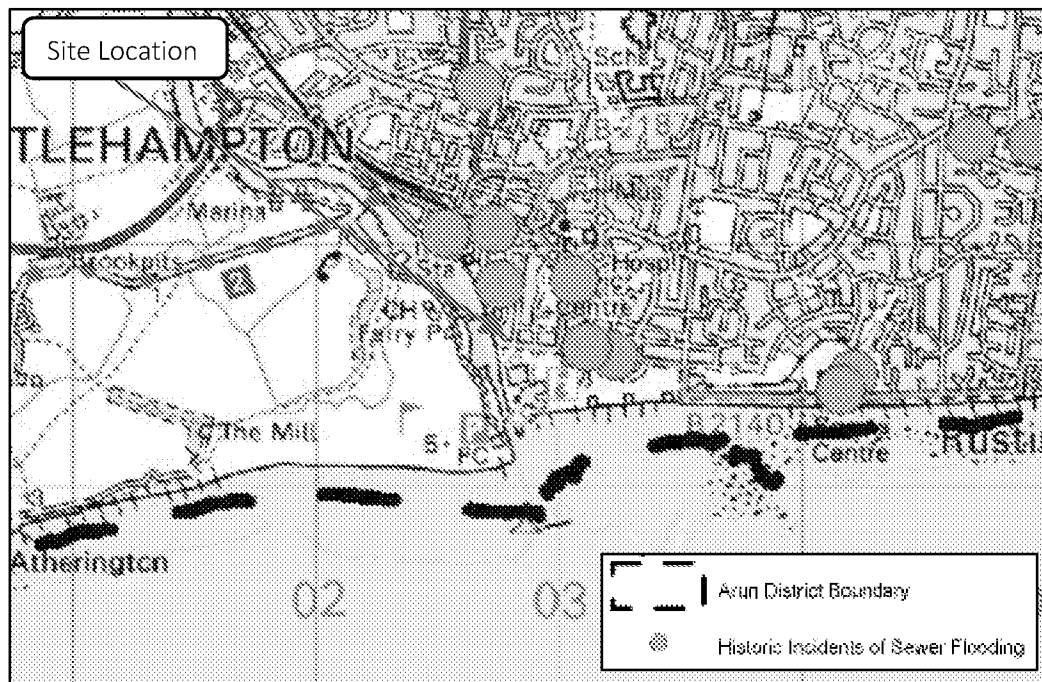


Figure 7 – Historic Incidents of Sewer Flooding Map (Source: Arun District Council SFRA).

- 4.31 The Arun District Council SFRA (August 2016 Update) does not provide any further information about when the incidents occurred, severity or cause.
- 4.32 Although at the time of writing there are no records of flooding from this source at the site, this does not mean that it has not flooded from this source. Equally, it may or may not flood from this source in the future.
- 4.33 As such, the risk to the site from sewer flood sources can be considered **relatively low**.

Surface Water Drainage Strategy

- 4.34 The site currently presumed to be 100% impermeable as existing, given that it is brownfield following demolition of previous structures.
- 4.35 Given that the proposed development is for the construction of a replacement structure to provide commercial space at the ground floor and 8 residential units above, it is considered a major development and it is recommended that the client undertake a Surface Water Drainage Strategy to implement sustainable drainage systems.

Records of Historical Flooding

- 4.36 The Arun District Council SFRA (August 2016 Update) Historic Flooding Records Map show one historic flood event approximately 100m south of the development site, however the source of flooding is unknown. One recorded flood outline has been identified to the north near to the site, along Pier Road (Appendix C, Plan 3 and an extract of it on the Figure 9 below).

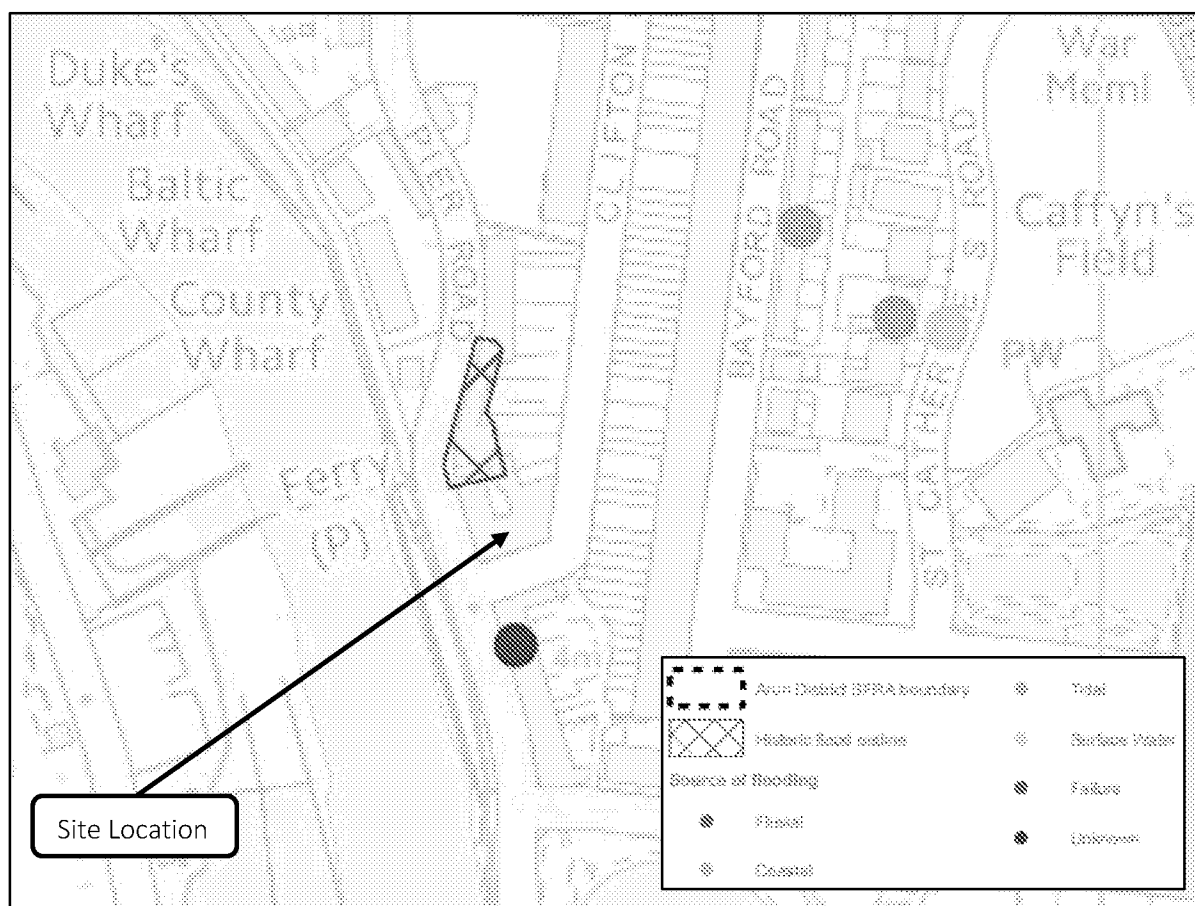


Figure 8 – Historic Flooding Records (Source: Arun District Council SFRA 2016 Update).

- 4.37 The EA have provided historic flood incidents in the area of the site. Preceding 1985, flooding of properties, roads and industrial areas have been recorded in the vicinity of the site, caused by overtopping mainly through the harbour masters yard where water gates were reported to be left open. Between 40 and 100 houses were affected by this incident. However, flood defences have been improved in the area which has subsequently reduced the risk of flooding in the vicinity of the site.
- 4.38 A number of surface water flooding incidents have also been recorded in close proximity to the site along St Catherine's Road and on the junction of Irvine Road and Beach Road. No further information has been provided regarding these incidents, however the SFRA states that the primary source of surface water flooding was attributed to heavy rainfall overloading highway carriageways and paved areas, drains and gullies, as well as blockages and high water levels impeding free discharge from surface water drains and gullies.

5. Probability of Flooding

- 5.1 According to the low detail, national-scale flood mapping created on behalf of the EA the site is located in Flood Zone 3, the probability of tidal flooding at the site is greater than 0.5% chance of annual tidal flooding.
- 5.2 Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 5.3 This information is supported by the EA Flood Map for Planning (Figure 3) which has been produced in part using JFLOW/HYDRO-F – a relatively coarse, national scale flood modelling strategy and in part using detailed flood models. These maps indicate the potential spatial extent of a tidal flood event which has a magnitude that is, on average, likely to occur once in every two hundred years (i.e. the 1:200 year tidal floodplain). It is important to note that only the *potential* floodplain is shown; ***the mitigating effects of any flood defences currently in place are not considered***. For reference, the definition of the NPPF flood risk zones is included in Table 5.

Zone	Description
1	Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
2	Medium Probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
3a	High Probability. This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).

Table 5 -- Definition of the NPPF Flood Zones. Shaded cells denote the proposed development. (Source: EA).

Climate Change on Site

- 5.4 Climate change is likely to increase the flow in rivers, raise sea levels and increase storm intensity.
- 5.5 The EA have recently updated the peak river flow allowances to use for different types of development. Communication with the EA, Flood and Coastal Risk Management Officer has confirmed that the changes are only focused to river flow and rainfall allowances. Tidal allowances are detailed in Table 3 of the new changes (<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>). As a result of this dialogue, it has been confirmed that the EA detailed data sets provided are relevant for the purposes of this assessment given that the dominant source of flooding is tidal.
- 5.6 The EA have also stated that the climate change will increase the peak rainfall intensity allowance in small and urban catchments.

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
South East	Upper end	25%	50%	105%
	Higher central	15%	30%	45%
	Central	10%	20%	35%

Table 6 – Peak river flow allowances by river basin district (Source EA).

6. Residual Risks

6.1 Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
- failure of a reservoir, or;
- a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with. At the time of writing, the EA has not provided tidal breach data.

6.2 The controlling residual flood risk mechanism on site is tidal. Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before a tidal flood event occurs. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.

6.3 Given the nature of the tidal cycle flood waters on site will likely recede as in-channel water levels fall.

Overtopping

6.4 At the time of writing, the EA and Arun District Council SFRA (August 2016 Update) has not provided data relating to overtopping of defences.

6.5 The Beachy Head to Selsey Bill Shoreline Management Plan (2006) states that the 'hold the line' strategy will cause no loss of property or land behind the existing defences, but properties may become more exposed and subject to overtopping and flood damage (See Table 7).

Location reference: Augmering-on-Sea to Littlehampton						
Policy 12a1 reference: 4275						
IMPLICATIONS OF THE PREFERRED PLAN FOR THIS LOCATION						
Time Period	Management Assumptions	Property, Built Assets & Land Use	Landscape	Nature Conservation	Historic Environment	Recreation & Recreational Use
2006 – 2025	Continue with current management practices.	No loss of property or land behind the existing defences.	No nature conservation gains or losses.	No loss or gains to landscape character or assets.	No loss of heritage sites landward of defences.	No loss of community or recreational facilities landward of defences. Narrow beach retained.
2025 – 2050	Increased engineering and beach management practices.	No loss of property or land behind the existing defences.	No nature conservation gains or losses.	Landscape character of beachfront may change due to greater defence works, with possible loss of beach habitat.	No loss of heritage sites landward of defences.	No loss of community or recreational facilities landward of defences. Some land may need to be sacrificed to establish new defence protection in beach.
2050 – 2106	Increased engineering and beach management practices. River replacement necessary. Embankment may need to be reduced on beach.	No loss of property or land behind the existing defences. Properties may become more exposed and subject to overtopping and flood damage.	No nature conservation gains or losses.	Landscape character of beachfront may change due to greater defence works.	No loss of heritage sites landward of defences. Some potential loss of conservation assets.	No loss of community or recreational facilities landward of defences. Wider flood status may be lost due to reduced beach width.

Table 7 – Implications of the Preferred Strategy for this Location (Source: Beachy Head to Selsey Bill SMP, 2006)

Defence Breach

- 6.6 The Arun District SFRA (August 2016 Update) has shown that the site does benefit from the presence of defences in the form of a privately owned wall. The estimated design standard for the area is 1:75 for the defences along the River Arun and 1:200 along the beach to the south.
- 6.7 The EA have further provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.
- 6.8 No further information has been provided by the EA or SFRA in regards to possible effects of a breach of the defences in the area.

7. Flood Risk Management Measures

- 7.1 The site is located in Flood Zone 3 (High Risk of flooding as defined in the NPPF) according to the EA Floodmap, as such the proposed development will require flood mitigation measures.
- 7.2 The controlling residual flood risk mechanism on site is tidal. Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 7.3 Given the nature of the tidal cycle and fluvial channel setting, flood waters on site will likely recede as the in-channel water levels fall.
- 7.4 The existing site is currently developed. It is understood that the proposed development is for the demolition of the existing structure on site and construction of a replacement structure to provide commercial space at the ground floor and 8 residential units above.
- 7.5 As such the following mitigation measures are proposed;
- bringing down electrical services from ceilings toward sockets, where possible;
 - residential element of the proposed will have a finished floor level of 5.23mAOD, as has been agreed with the EA.
 - Communal Internal stairwell on first floor level to higher floor level will be available
 - raised wiring and power outlets on ground floor level;
 - all plumbing insulation to be of closed-cell design;
 - use of MDF carpentry (i.e. skirting, architrave, built-in storage) to be avoided at ground floor level;
 - all sleeping accommodation to be located on the first floor and above;
 - raise ground levels/threshold levels 300mm above external ground levels to mitigate against extreme surface water flows, where possible, and;
 - sign up to the EA Flood Warning Service and ensure that this service is made available to all site users, future owners and residents, and;
 - formulate an evacuation plan to be implemented in the event of severe flood or weather warnings.

Safe Access/Egress

- 7.6 The site resides within Flood Zone 3 (tidal) and is located within an EA Flood Warning Service Area (Figure 10).
- 7.7 It is recommended the site owner and site staff sign up to the EA flood warning service if they have not done so already in order to provide betterment to the site. It is recommended that all new site owners and new site staff are made aware of the potential flood risk to the site and that they sign up to the EA flood warning service. It is recommended that all site users are also made aware of the potential flood risk posed to the site.

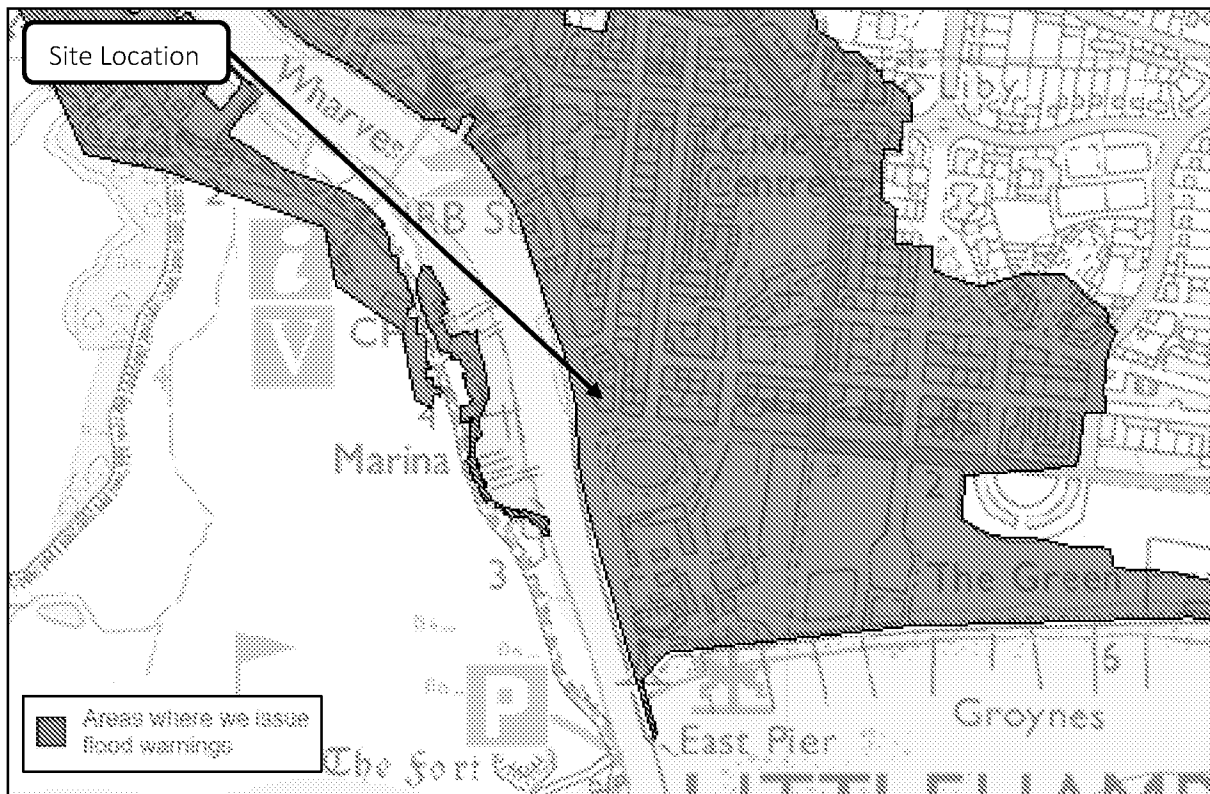


Figure 9 – EA Flood Warning Area (Source: EA Online).

- 7.8 The EA operates a 24-hour telephone service on 0345 988 1188 that provides frequently updated flood warnings and associated floodplain information. Further information can be found on www.environment-agency.gov.uk/floodline. Floodline Warnings Direct is a free service operated by the EA that provides flood warnings direct to occupants by telephone, mobile phone, fax or pager.

- On receipt of a **FLOOD ALERT**, the owners/occupiers of the property should:
 - monitor the situation via local media;
 - make themselves aware of forecast local weather conditions;
 - alert others resident in the property of the situation;
 - prepare to evacuate if necessary.

- On receipt of a **FLOOD WARNING**, the owners/occupiers of the property should:
 - follow advice to “go in, stay in, and tune in”;
 - be prepared to follow instruction from the Emergency Services.
- On receipt of a **SEVERE FLOOD WARNING**, the owners/occupiers of the properties should:
 - follow advice to “go in, stay in, and tune in”;
 - remain attentive to local media forecasts and news bulletins;
 - do not evacuate unless instructed to do so by the Emergency Services;
 - only when instructed to evacuate by the Emergency Services, leave the property and follow the agreed evacuation route – detailed previously.

- 7.9 Safe egress from the site can be achieved by migrating away from the source of flooding on receipt of a severe flood warning.
- 7.10 If flooding has already occurred prior to evacuation, it is advised to remain on the upper floors of the property and await instruction from the emergency services or until it is deemed safe to evacuate. Residents should move via internal stairwells to the upper floors of the property so as to be located within an area of safe refuge. No evacuation should be sought if flood depths exceed 25cm, evacuation should only be sought with the assistance of the emergency services in these circumstances.
- 7.11 It is the responsibility of the site owner(s) to keep the evacuation route known to all site users and visitors.
- 7.12 The maximum and minimum sea level (tidal peak and trough) are approximately 6 hours apart. As such, it is expected that tidal waters will drain away well within 6 hours. In practicality, the peak of the surge would last for a much shorter period of time and as such, it would be likely that water would recede much faster. However, due to the potential hazard of overtopping via wave-action, it is not recommended that occupants leave the building until low tide (or until the emergency services instruct them to do so).
- 7.13 Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a ‘bulge’ of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that early warning will be issued before such an event strikes.
- 7.14 **As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.**

8. Off Site Impacts

Impact to Flood Risk Elsewhere

- 8.1 The proposed development is for the construction of a new building providing a commercial space on the ground floor and 8 new residential units above.
- 8.2 The site is located in Flood Zone 3, (tidal, as defined by the EA) and under the NPPF:

“unless the development is located in an area which is subject to tidal flooding and which serves no conveyance function, land raising must be accompanied by compensatory provision of flood storage either on- or off-site”

as such there is no requirement for compensatory flood storage.

Generation of Runoff

- 8.3 It is understood that the development is for the demolition of the existing structure on site and construction of a replacement structure to provide commercial space at the ground floor and 8 residential units above.
- 8.4 The site currently presumed to be 100% impermeable as existing, given that it is brownfield following demolition of previous structures.
- 8.5 Given that the proposed development is for the construction of a commercial space on the ground floor and 8 residential units above, it is considered as a major development and it is recommended that the client undertake a Surface Water Drainage Strategy to implement sustainable drainage systems and reduce overall site runoff.
-

9. Conclusion

- 9.1 Ambiental Technical Solutions Limited has been appointed by Dowsett Mayhew Planning Partnership Ltd to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed development at 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW.
- 9.2 The proposed development is for the demolition of the existing structure on site and construction of a new structure to provide a commercial space on the ground floor and 8 residential units above, providing a mixed use scheme.
- 9.3 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the proposed development is located within Flood Zone 3 (high risk). Due to the proposed mixed use scheme, the proposed development is considered to be a “Less Vulnerable” and “More Vulnerable” development for the commercial and residential use respectively, under the NPPF.
- 9.4 Communication has been sought with the EA, who have confirmed that a residential finished floor level of 5.23mAOD is acceptable. Furthermore the EA have stipulated that despite there being defences in the area, the undefended flood levels should be used for analysis.
- 9.5 Ground levels across site vary between approximately 2.64mAOD and 1.96mAOD (Source: LiDAR, 2m resolution). Comparison of the site levels with modelled flood levels confirms the site partially resides within the extreme tidal flood extent for the undefended present day 1:200 year event (3.73mAOD) and the 1:1000 year flood event (4.05mAOD). Possible maximum flood depth, based on the minimum topographic level on site (1.96mAOD), for the undefended present day 1:200 year and 1:1000 year flood events has been shown to be 1.77m and 2.09m, respectively.
- 9.6 Comparison between the 1:200 year flood level for 2115 (4.93mAOD) and the minimum topographic levels at the location of the proposed built footprints (1.96mAOD) indicate a maximum potential flood depth of 2.97m for the 1:200 year (2115) scenario.
- 9.7 The EA have provided information regarding the flood defences in the area. **The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall has a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.**
- 9.8 As such and given that:
- The proposed development is for the demolition of the existing structure and the construction of a mixed use scheme to provide commercial uses on the ground floor and residential above;
 - All sleeping accommodation to be located on the first floor level (5.23mAOD) and above;
 - The site lies within an area of tidal flood risk and therefore is not required to provide flood compensatory storage;
 - Given the nature of tidal flooding, prior evacuation can be sought;

- e) In terms of flood vulnerability betterment can be achieved through the implementation of formal flood warnings/alerts and prior evacuation, an area of safe refuge can be provided via internal stairwells to the upper floors;

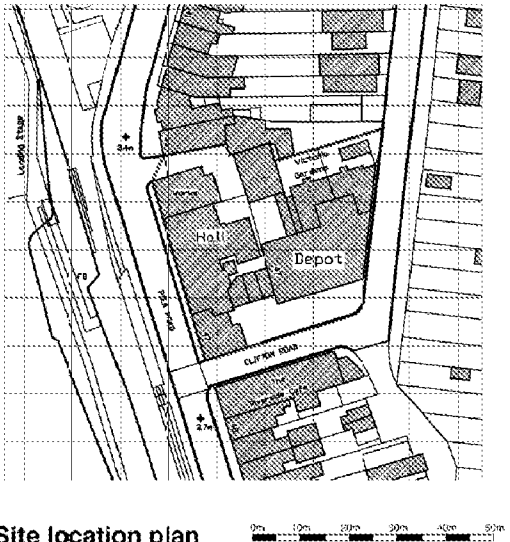
following the guidelines contained within the NPPF, the proposed development is considered **to be suitable** assuming appropriate mitigation (including adequate warning procedures) can be maintained for the temporary lifetime of the development.

Dr. J. B. Butler
B.Sc., M.Phil., PhD.
Ambiental Technical Solutions Ltd.

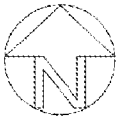
November 2017

Appendix A – Development Plans

- ❖ *Plan 1 -- Block & Site Location Plan*
- ❖ *Plan 2 -- Proposed Block Plan*
- ❖ *Plan 3 -- Elevation with FFL for residential element*



Site location plan
Scale 1:1250 @A3



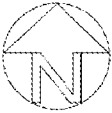
For info

rev.	date
These drawings should be approved by local authority. No dimensions to be scaled from this drawing. All dimensions to be checked on site. This drawing is copyright and should not be reproduced without the permission of the Architects.	
client	Max Pollock
project	46A - 47 Pier Road Littlehampton, BN17 5LW
drawing	Block & site location plans
scale	Shown @A3
date	July 2016
drawn	MOON/RS
11a Wilbury Avenue Hove, East Sussex BN1 6HY tel: 01273 203230 fax: 01273 321687 email: info@turnerassociates.co.uk	
Turner Associates Architects and Planning Consultants	
TA 948 /01	

Appendix A, Plan 1 – Block & Site Location Plan



Site location plan
Scale 1:1250 @A3



For info

rev.	date
These drawings should be approved by local Authority	
All dimensions to be copied from this drawing. All dimensions to be checked on site. This drawing is copyright and should not be reproduced without the permission of the architects.	
client	Max Pollock
project	46A - 47 Pier Road Littlehampton, BN17 5LW
drawing	Proposed block plan
archt	Shawn@TA
date	July 2016
drawn	Max Pollock
19a Wilbury Avenue Hove, East Sussex BN3 6JH	
tel: 01273 263236 fax: 01273 521087 email: info@haatchem.co.uk	
 Turner Associates Architects & Interiors	
TA 948 /09	

Appendix A, Plan 2 – Proposed Block Plan



Planning issue

- E 291017 Vehicle access revised
- D 241017 Floor levels raised
- C 201017 Minor amendments
- B 170517 Minor amendments
- A 030417 Minor amendments

rev.	date

Please drawings should be approved by local authority.
No dimensions to be added from this drawing. All dimensions to be checked on site. The drawing is copyright and should not be reproduced without the permission of the architect.

Client: Emerald Residential Limited

Project: 46A - 47 Pier Road
Littlehampton, BN17 5LW

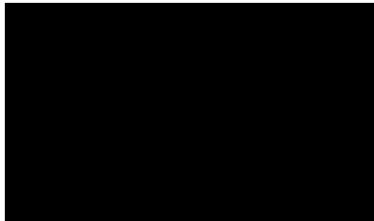
Drawing: Proposed front elevation

scale: 1:1000 A3	date: July 2016
drawn: MCKINCEY	

1/16 Wilbury Avenue
Hove, East Sussex
BN1 1BN
Tel: 01273 285234
Fax: 01273 521487
email: info@greenroberts.co.uk

Appendix A, Plan 3 – Proposed Elevation

Appendix B – Environment Agency Flood Data



Our ref: SSD/42232

Date: 29/03/2017

Provision of Product 4 for address: 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW

Thank you for your request on 23rd March 2017 to use Environment Agency data, Product 4. The information is attached.

The information on Flood Zones in the area relating to this address is as follows:

The property is in an area located within Flood Zone 3 shown on our Flood Map for Planning (Rivers and Sea).

Note - This information relates to the area that the above named property is in and is not specific to the property itself.

Please find attached a copy of the Flood Map for Planning (Rivers and Sea) for the area relating to your address.

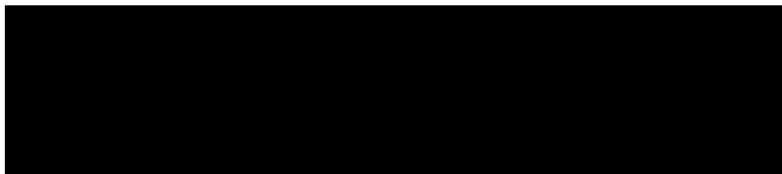
Further details about the Environment Agency information supplied can be found on the GOV.UK website:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

<https://www.gov.uk/planning-applications-assessing-flood-risk>

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>



Supporting Information

Flood Defences

Based on our records, Steel Pile Walls to the North-West of the site reduce the risk of flooding in this area to a standard of protection of a 1 in 75 year flood. There is also a flood wall to the West of the site with a concrete capping beam that offers a standard of protection of a 1 in 300 year flood.

Model Information

The flood outlines, depths and levels are taken from the Arun to Adur Flood Model, completed in 2012 by JBA Consulting.

Flood History

Our records show a previous flood event occurred near this area in 1983 due to overtopping of defences. I would suggest contacting Arun District Council for a more comprehensive flood history check.

Please note our records are not comprehensive and may not include all events, you can contact your Local Authority to check if they hold any relevant information regarding your application.

You are encouraged to use and re-use this information freely and flexibly, with only a few conditions. Details of which can be found here:

<http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us within 2 calendar months to ask for our decision to be reviewed.

If you have any queries or would like to discuss the content of this letter further please call us on 03708 506506.

Yours faithfully
Freddie Fielding
PSO West Sussex

Enc. Flood Map for Planning (Rivers and Sea) / Node point locations / Flood levels/depths / Modelled flood outlines / Flood Defence Locations

Use of Environment Agency Information for Flood Risk Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

You should refer to the Environment Agency's Flood Risk Standing Advice, Planning Practice Guidance, and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

<https://www.gov.uk/flood-risk-assessment-standing-advice>

<http://planningguidance.planningportal.gov.uk/>

<http://www.planningportal.gov.uk/planning/planningpolicyandlegislation/previousenglishpolicy/ppgpps/pps25>

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

Flood Defence Locations. Centred BN17 5LW. Created 29/03/2017.



Legend

Defences

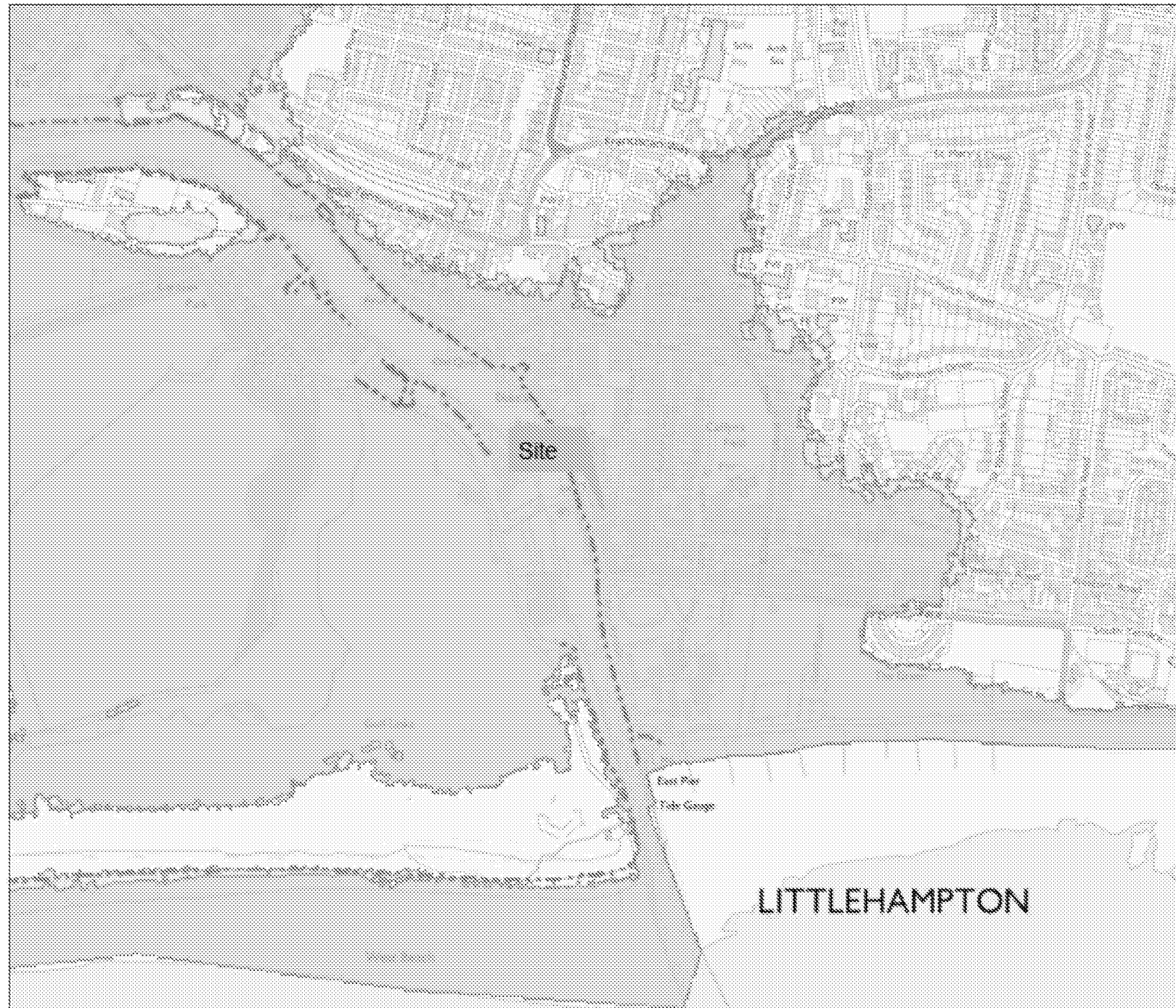
- Embankment
- Wall
- Flood Gate
- Demountable Defence
- Bridges Abutment
- High Ground
- Beach
- Barrier Beach
- Promenade
- Quay
- Cliff
- Dunes
- Culvert

0 100 200 300
Metres



© Crown Copyright and database rights 2017. Ordnance Survey 100024198.

Flood Map for Planning (Rivers and Sea). Centred BN17 5LW. Created 29/03/2017.



Scale 1: 10,000



Flood Map for Planning (Rivers & Sea)

- Defences
- Flood Storage Areas
- ▣ Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

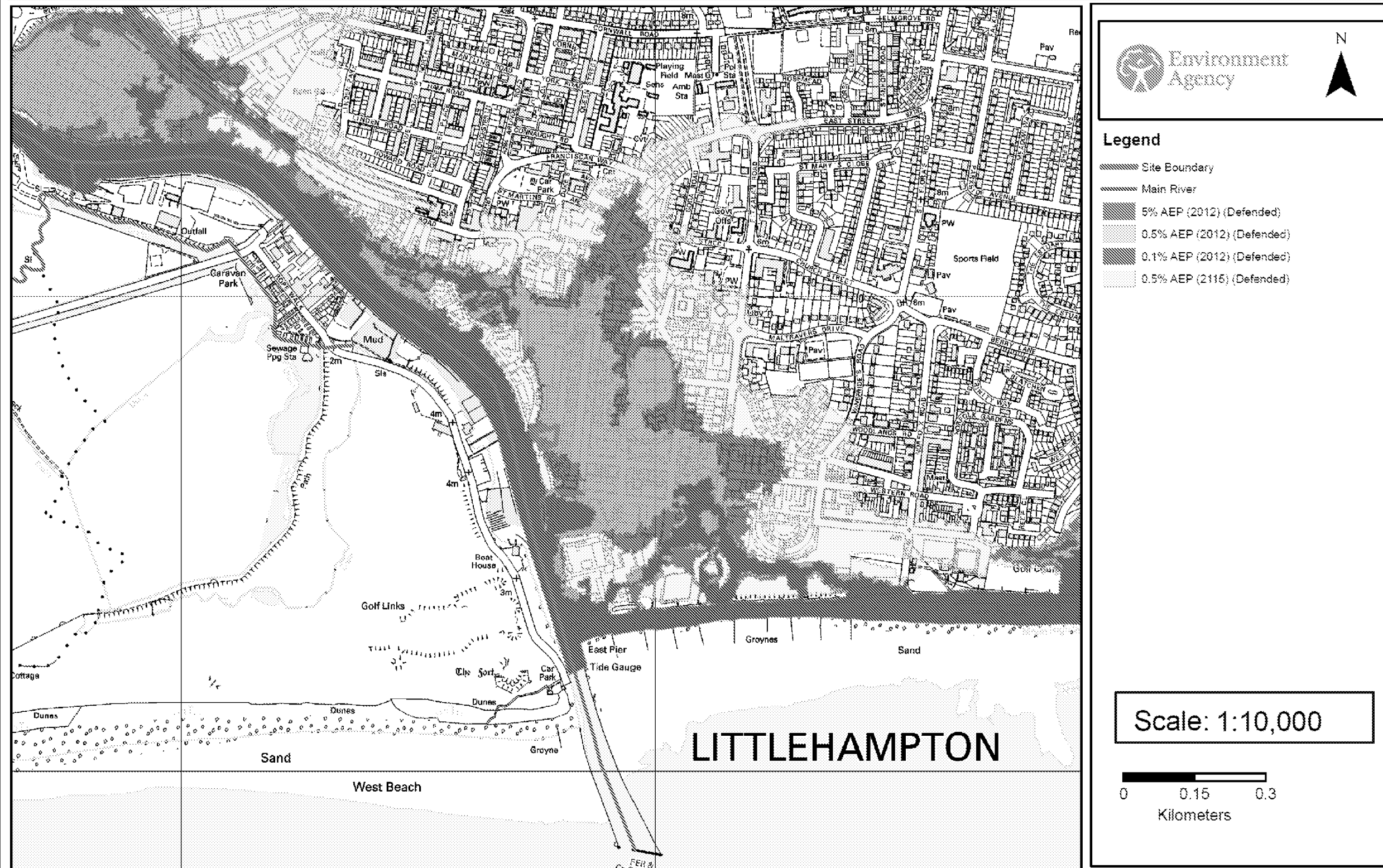
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

© Crown Copyright and database rights 2017. Ordnance Survey 100024186

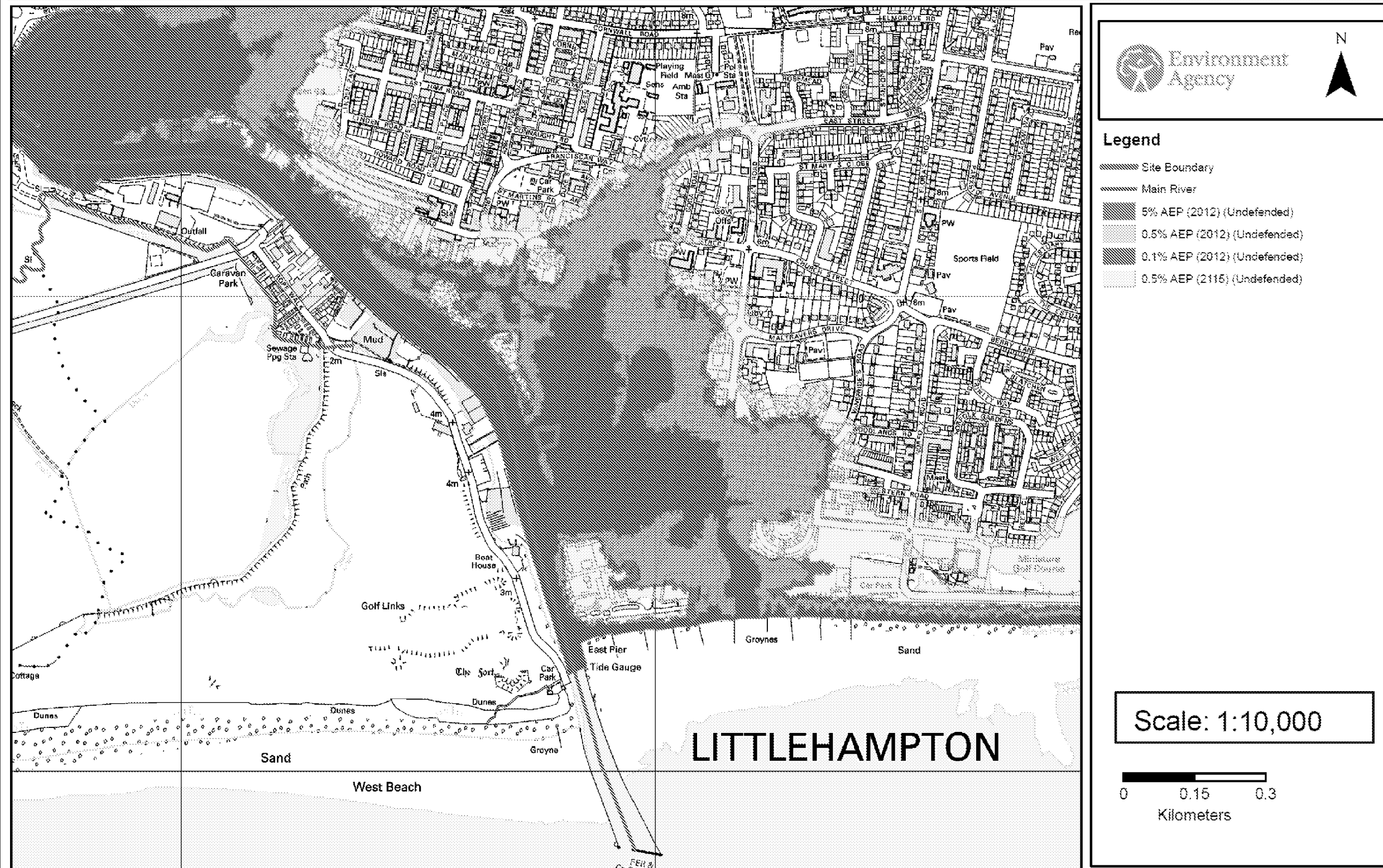
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-5). Email: enquiries@environment-agency.gov.uk

Modelled Flood Outlines (Defended Tidal). Centred BN17 5LW. Created 29/03/2017 (Ref: SSD/42232)



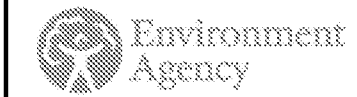
© Environment Agency Copyright and/or database rights 2017. All rights reserved. © Crown copyright and database rights 2017. All rights reserved. Ordnance Survey licence number 100026380.
Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email: enquiries@environment-agency.gov.uk

Modelled Flood Outlines (Undefended Tidal). Centred BN17 5LW. Created 29/03/2017 (Ref: SSD/42232)



© Environment Agency Copyright and/or database rights 2017. All rights reserved. © Crown copyright and database rights 2017. All rights reserved. Ordnance Survey licence number 100026380.
Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email: enquiries@environment-agency.gov.uk

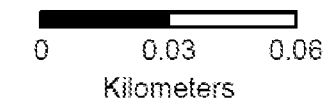
Modelled Site Node Points. Centred BN17 5LW. Created 29/03/2017 (Ref: SSD/42232)



Legend

- Site Nodes
- Site Boundary
- Main River

Scale: 1:2,000



© Environment Agency Copyright and/or database rights 2017. All rights reserved. © Crown copyright and database rights 2017. All rights reserved. Ordnance Survey licence number 100026380.
Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03706 506 506. Email: enquiries@environment-agency.gov.uk


Product 4 Flood Risk Data Requested by: Thea Powell
Site: 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW
Table 1: Water Levels: Tidal Undefended

Node Reference	NGR		Modelled Flood Levels in Metres			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	0.5%	0.5% (2115)	0.1%
1	502759	101712	2.87	3.73	4.93	4.05
2	502766	101687	2.66	3.73	4.93	4.05
3	502781	101707	2.55	3.73	4.93	4.05

Table 2: Water Levels: Tidal Defended

Node Reference	NGR		Modelled Flood Levels in Metres			
	Eastings	Northings	Defended Annual Exceedance Probability			
			5%	0.5%	0.5% (2115)	0.1%
1	502759	101712	-	-	4.88	2.94
2	502766	101687	-	-	4.88	2.94
3	502781	101707	-	2.37	4.88	2.94

Table 3: Water Depth: Tidal Undefended

Node Reference	NGR		Modelled Flood Depth in Metres			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	0.5%	0.5% (2115)	0.1%
1	502759	101712	0.41	1.27	2.47	1.58
2	502766	101687	0.24	1.31	2.52	1.63
3	502781	101707	0.49	1.67	2.87	1.99

Table 4: Water Depth: Tidal Defended

Node Reference	NGR		Modelled Flood Depth in Metres			
	Eastings	Northings	Defended Annual Exceedance Probability			
			5%	0.5%	0.5% (2115)	0.1%
1	502759	101712	-	-	2.42	0.47
2	502766	101687	-	-	2.47	0.52
3	502781	101707	-	0.33	2.84	0.90

All levels taken from: Arun to Adur Flood Model, completed in 2012 by JBA Consulting

There is no additional information or health warnings for these levels/depths or the model from which they have been produced.

Produced on 29/03/2017

Office Address: Guildbourne House, Chatsworth Road, Worthing BN11 1LD.
 Customer services line: 03708 506 506. Email: enquiries@environment-agency.gov.uk
www.gov.uk/government/organisations/environment-agency



ambiental

0420 211 7047 0959
Greenwood, Suz K <Suz.Greenwood@environment-agency.gov.uk>
RE: Pier Road - Littlehampton 146/2017/197001-140
To: David Cook
You forwarded this message on 02/11/2017 16:24.

Morning,

We have had a look at this we and we would be happy with the finished floor level of first floor accommodations being 5.23m AOD.

The 1 in 200 flood level (2115) for the undefended scenario is 4.93m AOD, and not 4.88m AOD (which is the flood level for the defended scenario)? in the FRA you should therefore refer to the undefended level and not the defended. The benefit of defences is something that should be identified and referred to in the FRA. However, the FRA must also address the residual risks of these defences failing or being overtopped. In this case the proposed finished floor level (5.23m AOD) will be 0.30m above 4.93m AOD, which is still acceptable.

I hope this helps, please be aware that we will not be able to issue a formal response until amended details have been submitted to the IPA and we have been formally consulted.

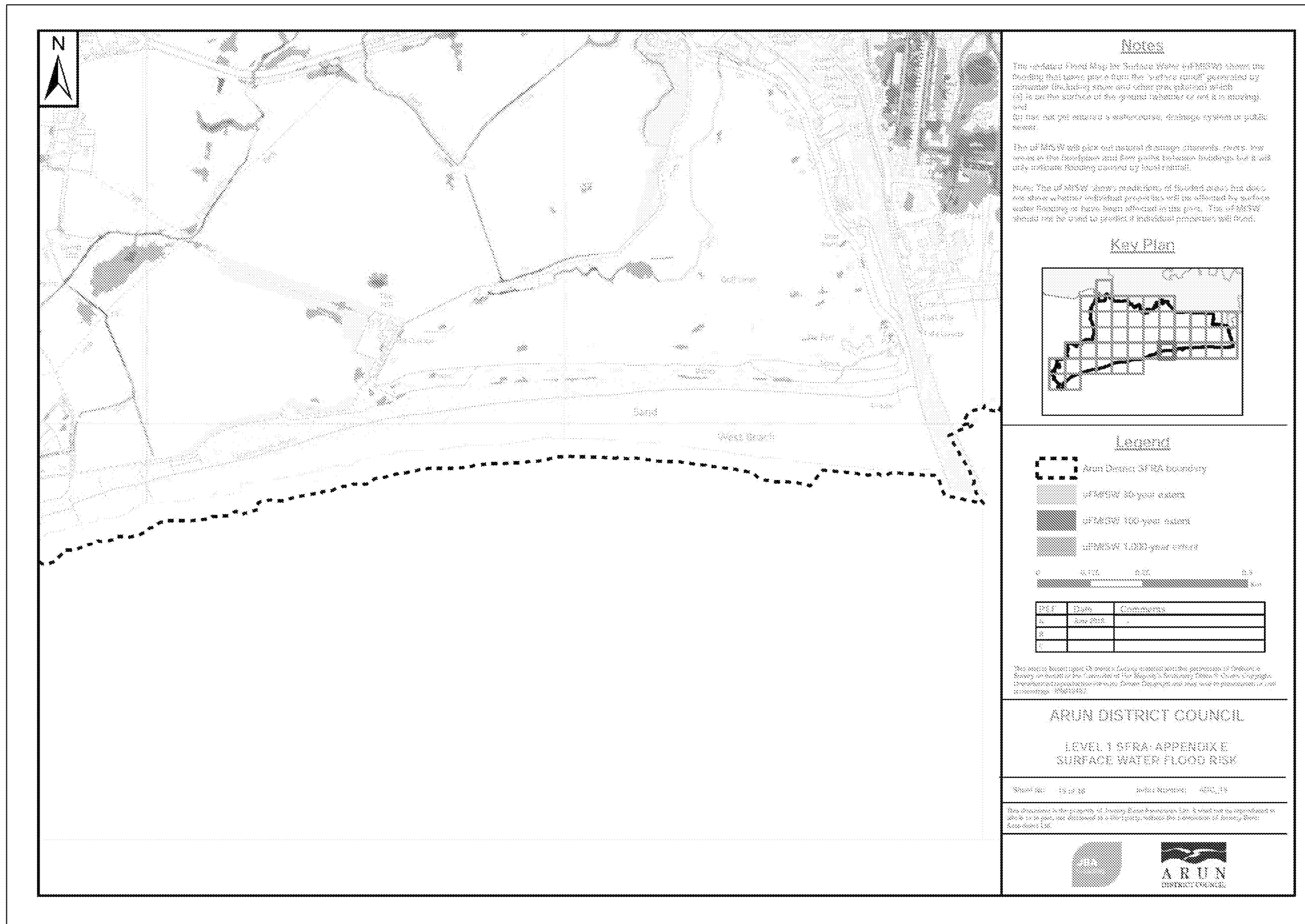
Thanks

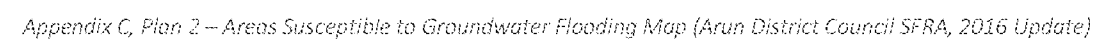
Suz

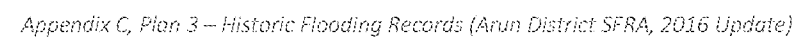
Suz Greenwood
Environment Agency – Solent and South Downs
Sustainable Places
02084743098
07748332838
Email to: Suz.Greenwood@environment-agency.gov.uk or PlanningSSD@environment-agency.gov.uk

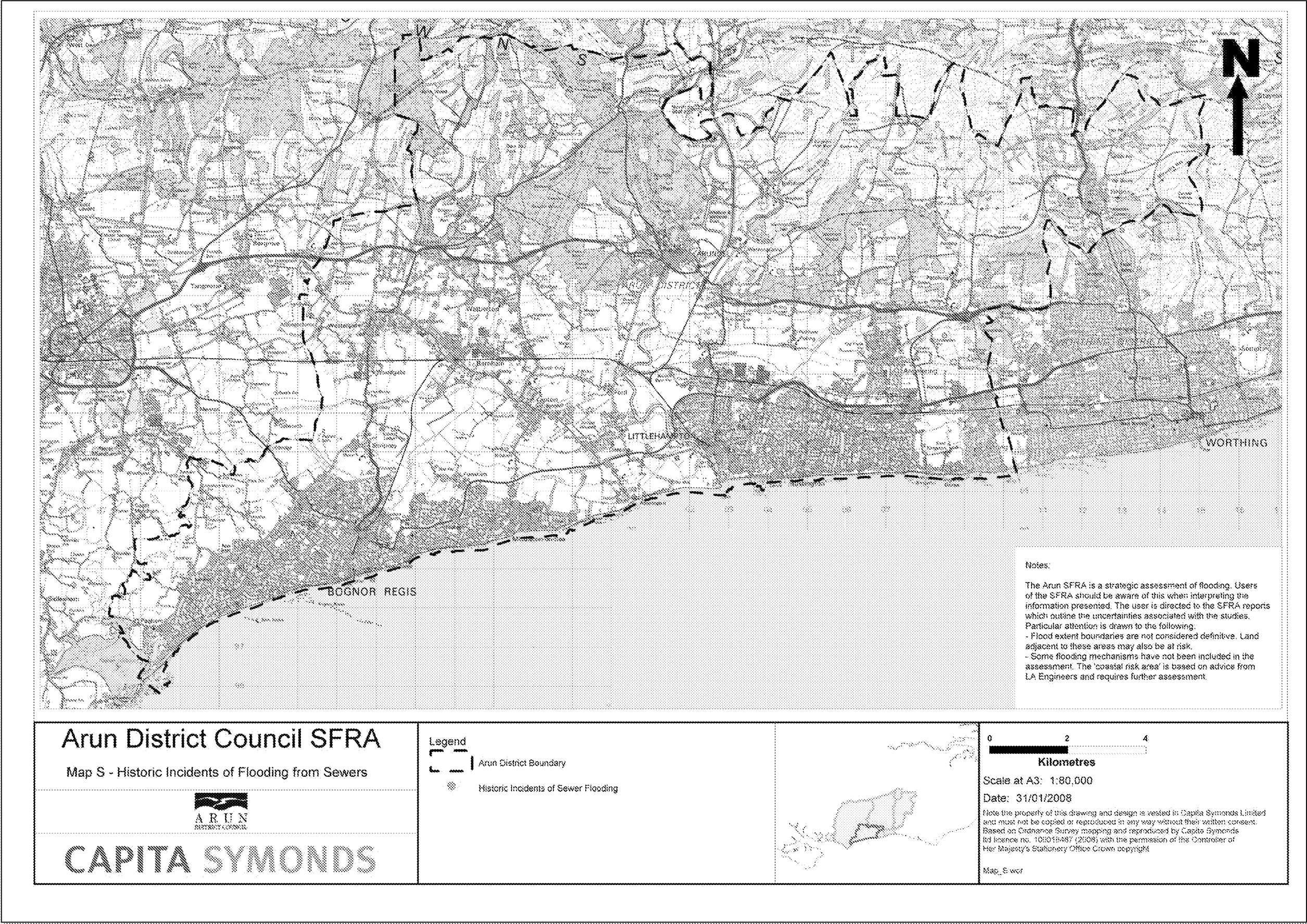
Appendix C — Arun District Council SFRA Data

ambiental

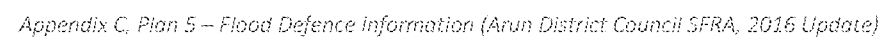








Appendix C, Plan 4 – Historic Incidents of Flooding from Sewers (Arun District Council SFRA, 2016 Update)



Appendix D – Information Relating To JFLOW

JFLOW and flood outlines (Source: EA)

Flood Zones have been produced using JFLOW, a nationally consistent model. JFLOW has been used to produce the 1% (1 in 100 year) and 0.1% (1 in 1000 year) flood outlines.

The flood outlines have been developed by applying flow and tide models to a 3D ground level map of England and Wales, known as a Digital Terrain Model (DTM). This is created by flying an aircraft over the whole of the country using radar to record and create a contoured model of the land. This DTM is used as the basis of a grid of cells which is used to estimate the extent of flooding in a flood of a given return period or probability.

The size of the flood event (1 in 100 or 1 in 1000 year) is determined by the inflows to the JFLOW model, which are calculated using statistical techniques from the Flood Estimation Handbook. The technique used is based upon catchment descriptors and data transfer, the details of these can be found in the Flood Estimation Handbook volume 3. The Flood Estimation Handbook provides a consistent technique for estimating inflows to the national model and its methods are widely accepted.

The methodology is a raster-based approach, driven by an underlying Digital Elevation Model (DEM).

- Each cell has a ground level and water depth
- Water can move to any of surrounding 8 cells where the water level is lower
- Water will pond in low spots until the water level is high enough to spill
- The velocity of movement depends on water surface slope and surface roughness

The above points describe the basic principles of the model. The two underlying principles are:

- Mass conservation within each cell
- Calculation of the fluxes between the cells

Each grid cell is treated as a small storage area. Mass conservation is applied to each grid cell. The flux between cells is calculated using a form of the generalised weir equation.

Efficient coding is achieved by keeping a list of all currently wet cells and a list of newly wet cells. This avoids having to search through each cell in the ground grid.

For whole catchment modelling, the hydrographs used as inflow boundary conditions represent the whole hydrograph at that inflow location and a simple conceptual method has been derived to account for the amount of flow within the channel banks. A simple solution was therefore sought which would approximately account for the proportion of flow contained within the channel without requiring further information about the channel.

The simple conceptual method used involves two assumptions:

1. That bankfull flow (Q_b) is equal to QMED as calculated by the Flood Estimation Handbook (FEH) methods. QMED has a return period of 2 years. This assumption derives from the concept of dominant discharge in fluvial geomorphology (Wolman and Leopold, 1957; Wolman and Miller, 1960) where the cross-section shape is assumed to be formed by a discharge with a recurrence interval of 1-2 years.
2. That the additional channel flow (Q_c) scales with both Q_b and depth above bankfull (d).

The basis of the current model is that each grid cell acts as a small flood cell and the links to each of the surrounding cells are automatically calculated. It is therefore capable of simulating the inundation extent at a level of detail equal to the underlying DEM. It is fundamentally volume conservative and so, in a given time period, will simulate the peak water levels across the floodplain depending on the volume of water that has entered the floodplain. This approach is a half-way house between the common 1D hydrodynamic models and a 2D hydrodynamic model.

Limitations

JFLOW was used to produce flood maps for the whole of England and Wales for all catchments greater than 3 sq-km in a consistent manner. The method is therefore very generalised and therefore cannot take account of information that may be very significant locally. This might include:

1. Effects of bridges and other structures including flood defences are not taken into account.
2. Errors in the DTM, caused by trees and buildings for example.
3. The effect of reservoirs and urban drainage and other man made influences on the flow regime can only be taken into account in a very general sense in JFLOW.
4. The channel is assumed to be able to take the 2 year flow. This may not be true especially in those modified by man.
5. Hydraulic roughness is assumed to be the same everywhere in JFLOW, but of course it is not.

For these and many other reasons, the flood outlines produced by JFLOW can only be taken as a rough guide, showing where more detailed flood risk assessments are essential. Flood risk assessments should also be undertaken near small watercourses whose catchments are too small to have been included in the JFLOW modelling.