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Prepared for:	**BJW Architectural**
Reference #:	**2153**
Date:	**January 2015**

AMBIENTAL TECHNICAL SOLUTIONS LTD.

DOCUMENT ISSUE RECORD

PROJECT: PHASE 1 FLOOD RISK ASSESSMENT

LOCATION: TOWN QUAY, SHOREHAM

PREPARED FOR: BJW ARCHITECTURAL

PROPOSED CHANGE OF USE: OFFICE TO RESIDENTIAL

PAVILION FINANCIAL PLANNING
TOWN QUAY
SHOREHAM-BY-SEA
SUSSEX
BN43 5DS

PROJECT #: 2153

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SUMMARY

This report presents the findings of a Flood Risk Assessment (FRA) that has been carried out for the proposed development at Pavilion Financial Planning, 6 Town Quay, Shoreham-by-Sea, BN43 5DS. This FRA has been carried out using current best practices, and against the criteria set out in the National Planning Policy Framework (NPPF).

The proposed development is for the change of use of the existing office to a ground floor studio flat.

Modelled flood depths have been provided by the EA for the site and show the proposed development to be affected by 0.15m of flood water during the 1:200 year tidal flood event at the present day taking into account the flood defences. The site is modelled to be affected by a flood depth of 0.990m during a 1:200 year tidal flood event in 2115 taking into account the current flood defences.

The site has been confirmed as being within the area benefitting from the in progress Adur Tidal Walls Scheme which is due to provide a standard of protection to 1:300 year flood event with an allowance for 50 years of sea level rise. It is not possible to raise floor levels as part of the development as the proposal is for the change of use of the existing building.

The site is located in the EA defined Flood Zone 3, works done by Worthing and Adur Councils have found that the area of urban development on the banks of the River Adur at this point do not provide flood storage and as such the site is located in an area deemed to be Flood Zone 3a.

As such, safe access and egress will be provided by a formal flood warning and evacuation plan, which will be agreed with the emergency planners, and tied in to the existing emergency plans for the area.

As such, and given that:

a) the site lies within an existing developed area and is for the change of use of existing buildings;

b) a safe access and egress route will be provided by a formal flood warning and evacuation plan, which will be agreed with emergency planners, and tied in to the existing emergency plans for the area, and;

c) in terms of flood vulnerability, significant betterment can be achieved through the implementation of flood warning procedures;

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

DEVELOPMENT DESCRIPTION	EXISTING	PROPOSED
Development Type	Office	1x studio flat
(Number of Bedrooms)	None	1
EA Vulnerability Classification	Less vulnerable	More vulnerable
Ground Floor Level	Indicative ground levels approx. 3.6mAOD to 4mAOD	No change
Level of Sleeping Accommodation	N/A[1]	Ground floor
Impermeable Surface Area	N/A[1]	No change
Surface Water Drainage	N/A[1]	No change
Development Size	N/A[1]	No change

RISK TO DEVELOPMENT	SUMMARY	COMMENT
EA Flood Zone	3a	
Flood Source	Tidal	River Adur
Modelled 1:200 year tidal flood level	4.223mAOD	Based on Node Point 3 DEFENDED data
with climate change (2115)	5.069mAOD	
Modelled 1:1000 year flood level	4.484mAOD	
with climate change (2115)	N/A[2]	
Recorded Flood Events in Area	YES	1 event of unknown source
Recorded Flood Events at Site	None	
SFRA available	YES	Adur District Council and Worthing Borough Council SFRA (Jan 2012)

FLOOD RISK MANAGEMENT MEASURES	SUMMARY	COMMENT
Ground floor level above flood level?	NO	
Safe Access/Egress Route?	YES	Flood warning and evacuation plan
Flood Resilient Design?	YES	
Site Drainage Plan?	N/A[1]	
Flood Warning & Evacuation Plan?	YES	EA Flood Warning Service

OFFSITE IMPACTS	SUMMARY	COMMENT
Displacement of floodwater	None	Change of use of existing building
Impact on local geomorphology	None	
Increase in surface run-off generation	None	
Impact on hydraulic performance of channels	None	

Table S1: Summary of flood risks, impacts and proposed flood mitigation measures.
N/A[1] *not required for this assessment*
N/A[2] *data not available*

DEVELOPMENT DESCRIPTION AND LOCATION

PROPOSED DEVELOPMENT AND LOCATION

The proposed development site is located at Pavilion Financial Planning, 6 Town Quay, Shoreham-by-Sea, BN43 5DS (*Figure 1)* and is for the change of use of the existing office to 1 ground floor studio flat.

Indicative ground levels vary between approximately 3.6mAOD and 4mAOD across the site *(Source: 2m LiDAR)*.

VULNERABILITY CLASSIFICATION

The existing property is an office and therefore classified as "less vulnerable" throughout under the NPPF. The proposed development is a change of use to residential, which will be classified as "more vulnerable".

SEQUENTIAL TEST/ EXCEPTION TEST

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. The test refers to the EA Flood Zones described in Table 2. For reference, the NPPF *Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility'* 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 (functional floodplain)	Exception Test Required	✓	×	×	×

Table 1: The Sequential Test: *Flood Risk Vulnerability and Flood Zone 'Compatibility'* as specified by National Planning Policy Framework (NPPF). Shaded cells denote the proposed re-development. Please note: ✓ means development is appropriate; × means the development should not be permitted.
(Source: the NPPF)

Using the principles of the Sequential Test outlined above, the proposed development is 'more vulnerable' and is located partially within Flood Zone 3a (as defined by the EA).

Residential developments located within Flood Zone 3a are generally required to pass the Exception Test under the NPPF, however the NPPF states that applications for changes of use should not be subject to the Sequential or Exception Tests, but should still meet the requirements for site-specific flood risk assessments (*Source: the NPPF*).

As such, and in order to address these requirements, the planning application submitted by BJW Architectural 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.

DEFINITION OF FLOOD HAZARD

SOURCES OF FLOODING TO THE SITE

Communication with the EA has identified the following potential sources of flooding to the site:

Fluvial:	N/A
Tidal:	River Adur
Surface:	On site
Groundwater:	On site
Sewer:	Adjacent Road
Artificial sources:	N/A

MECHANISMS AND HISTORY OF FLOODING

FLUVIAL / TIDAL

According to the EA Floodmap, the development site lies within EA Flood Zone 3 (High Risk) of the River Adur.

The site is located in the EA defined Flood Zone 3, works done by Worthing and Adur Councils have found that the area of urban development on the banks of the River Adur at this point do not provide flood storage and as such the site is located in an area deemed to be Flood Zone 3a.

The EA have provided modelled flood depths for the development location of 0.150m for the 1:200 year defended tidal flood event and a flood depth for 0.990m for the 1:200 year (2115) defended tidal flood event.

The site is currently defended by a concrete retaining wall with a standard of protection to the 1:20 year tidal flood event. Work on the Adur Tidal Walls Scheme is due to start in 2016 and is due to have defences with a standard of protection to the 1:300 year taking into account 50 years of sea level rise. Construction is programmed to start in early 2016.

The defended flood depths modelled only take into consideration the current level of protection offered to the site.

There are no records of the area surrounding the site, or the site being affected by tidal flooding, from the EA historic flood extents or the Adur District Council and Worthing Borough Council SFRA, January 2012.

The SFRA historic flood events map (*Figure 5*) shows the area to have been affected by 1 point source of flooding of unknown source. This map shows all the extents of the known tidal flood events to occur in the Worthing and Adur Boroughs.

SURFACE

There are no records of surface water flooding occurring at the site.

According to the EA's Risk of Surface Water Flood Map the development site is located entirely in an area defined as being at 'Very Low' risk of surface water flooding, equating to less than 0.1% annual chance of flooding from this source.

GROUNDWATER

There are no records of groundwater flooding occurring at the site.

The SFRA states that the Worthing and Adur area's geology, comprising predominantly of chalk creates the potential for groundwater flooding throughout the area. Historic groundwater flood events have been well recorded for the area, however there are no recorded flood events from Groundwater occurring on the site. The SFRA's historic flood event map does show 1 occurrence of a flood event within the site's vicinity, however the source is unknown.

SEWER

The SFRA's historic flood event map does show 1 occurrence of a flood event within the site's vicinity, however the source is unknown.

SURFACE WATER DRAINAGE STRATEGY

Post development there will be no increase in impermeable surface coverage on site. As such, any change in surface water runoff generation will likely be negligible.

PROBABILITY OF FLOODING

FLOOD ZONE

Initial communication with the EA suggested that the proposed development site lies within the 1:200 year tidal floodplain of the River Adur (i.e. EA Flood Zone 3a).

This information is supported by the EA flood risk map (*Figure 3*) which has been produced in part using JFLOW – a relatively coarse, national scale flood modelling strategy. These maps indicate the potential spatial extent of a fluvial/tidal flood event which has a magnitude that is, on average, likely to occur once in every one/two hundred years (i.e. the 1:100/1:200 year fluvial/tidal floodplain respectively).

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 NPPF flood risk zones is included below in Table 2.

	Description
Zone 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%).
Zone 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.
Zone 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.
Zone 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 2: Definition of the NPPF Flood Zones. *(Source: EA)*

PROBABILITY OF THE SITE FLOODING

According to the EA Floodmap the site is located within Flood Zone 3a, with more than 0.5% annual probability of tidal flooding.

EXISTING RATES AND VOLUMES OF RUN-OFF GENERATED BY THE SITE

Post development there will be no increase in impermeable surface coverage on site. As such, any change in surface water runoff generation will likely be negligible.

CLIMATE CHANGE

HOW WILL THE SITE BE AFFECTED BY CLIMATE CHANGE?

According to the NPPF, climate change is likely to increase the flow in rivers by 20% and sea levels are predicted to rise. As such, the site may be more likely to be affected by flooding.

Furthermore, increases in rainfall would lead to an increased risk of surface water flooding.

Modelled data provided by the EA shows the site to be affected by 0.355m of flooding during the 1:200 year flood event in 2070 and 0.990m of flooding during the 1:200 year flood event in 2115 taking into account current defences.

DETAILED DEVELOPMENT PROPOSALS

DEVELOPMENT LAYOUT

The proposed development is for the change of use of the existing office to 1 residential studio flat on the ground floor.

FLOOD RISK MANAGEMENT MEASURES

PROTECTION MEASURES

Given that the proposed redevelopment site resides in Flood Zone 3a ('High Risk' of flooding) as defined under the NPPF, the proposed development may require flood mitigation measures. As the development is for the change of use of part of an existing building it is impossible to raise floor levels. The developer has however agreed to implement the following protection measures:

- To mitigate the impacts of an extreme tidal flood event, the developer has agreed to incorporate the following flood resilient design measures into the proposed change of use:
    - Bringing down electrical services from ceilings on the ground floor (where possible);
    - Using solid wood for built in features, i.e. kitchen cupboards etc;

  - Wiring, power outlets, switches, etc. installed above the maximum potential floodwater level (where possible);
  - Air brick protection;
  - Provide site occupiers with temporary (demountable) flood barriers which can be put into place in the event of an unexpected flood event.

- Post development, a **formal flood warning and evacuation plan will be implemented**. The site owner will be responsible for receiving and acting on any given warning. Upon receipt of an extreme flood warning, the site will be evacuated, and will not be reoccupied until the warning has been lifted. This will help to ensure that the site is unoccupied during a potential flood event.

The EA operates a 24-hour telephone service on 0845 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 individual property owners and occupiers should:
  - Monitor the situation via local media;
  - Make themselves aware of forecast local weather conditions;
  - Alert both current visitors, and those scheduled to arrive, of the situation;
  - Prepare to evacuate if necessary.
- On receipt of a **FLOOD WARNING**, the individual property owners and occupiers should:
  - Follow advice to "go in, stay in, and tune in";
  - Move all vehicles to an area outside of the potential flood extent, if safe to do so;
  - Alert scheduled visitors that they should seek alternative accommodation;
  - Be prepared to follow instruction from the Emergency Services.
- On receipt of a **SEVERE FLOOD WARNING**, the individual property owners and occupiers 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 plan.

It has been agreed that as an additional precautionary measure an evacuation route shall be communicated to all site users so as to enable evacuation from the site in the event of a flood.

The proposed dwelling is self-contained and has its own external access, and as such there is no way to provide internal access to the above floors to be used in the event of an unexpected flood event. As such temporary (demountable) flood barriers should be used on all access points to the property in the event of a severe flood warning.

ACCESS/EGRESS

In order for an access/egress route to be acceptable under the NPPF, the combination of flood depths, velocities and debris must be analysed. The methodology for calculating "Flood Hazard" is reproduced below according to the methodology stated within the "Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purposes – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1": and is reproduced below and overleaf:

This table is recommended for development planning and control use.

Table 4 – Hazard to People Classification using Hazard Rating *(HR= d x (v + 0.5) + DF)* for (Source Table 13.1 of FD2320/TR2 - Extended version)

HR	Depth of flooding - d (m)												
	DF = 0.5				DF = 1								
Velocity v (m/s)	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.0	0.03 + 0.5 = 0.53	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.13 + 0.5 = 0.63	0.15 + 1.0 = 1.15	0.20 + 1.0 = 1.20	0.25 + 1.0 = 1.25	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25
0.1	0.03 + 0.5 = 0.53	0.06 + 0.5 = 0.56	0.12 + 0.5 = 0.62	0.15 + 0.5 = 0.65	0.18 + 1.0 = 1.18	0.24 + 1.0 = 1.24	0.30 + 1.0 = 1.30	0.36 + 1.0 = 1.36	0.48 + 1.0 = 1.48	0.60 + 1.0 = 1.60	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50
0.3	0.04 + 0.5 = 0.54	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.19 + 0.5 = 0.69	0.23 + 1.0 = 1.23	0.30 + 1.0 = 1.30	0.38 + 1.0 = 1.38	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	1.13 + 1.0 = 2.13	1.50 + 1.0 = 2.50	1.88 + 1.0 = 2.88
0.5	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.25 + 0.5 = 0.75	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	2.50 + 1.0 = 3.50
1.0	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.30 + 0.5 = 0.80	0.38 + 0.5 = 0.88	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	2.25 + 1.0 = 3.25	3.00 + 1.0 = 4.00	3.75 + 1.0 = 4.75
1.5	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.50 + 0.5 = 1.00	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	2.00 + 1.0 = 3.00	3.00 + 1.0 = 4.00	4.00 + 1.0 = 5.00	5.00 + 1.0 = 6.00
2.0	0.13 + 0.5 = 0.63	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	0.63 + 0.5 = 1.13	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	3.50	4.75	6.00	7.25
2.5	0.15 + 0.5 = 0.65	0.30 + 0.5 = 0.80	0.60 + 0.5 = 1.10	0.75 + 0.5 = 1.25	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	1.80 + 1.0 = 2.80	3.40	4.00	5.50	7.00	8.50
3.0	0.18 + 0.5 = 0.68	0.35 + 0.5 = 0.85	0.70 + 0.5 = 1.20	0.88 + 0.5 = 1.38	1.05 + 1.0 = 2.05	1.40 + 1.0 = 2.40	1.75 + 1.0 = 2.75	3.10	3.80	4.50	6.25	8.00	9.75
3.5	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.80 + 0.5 = 1.30	1.00 + 0.5 = 1.50	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	3.00	3.40	4.20	5.00	7.00	9.00	11.00
4.0	0.23 + 0.5 = 0.73	0.45 + 0.5 = 0.95	0.90 + 0.5 = 1.40	1.13 + 0.5 = 1.63	1.35 + 1.0 = 2.35	1.80 + 1.0 = 2.80	3.25	3.70	4.60	5.50	7.75	10.00	12.25
4.5	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	1.00 + 0.5 = 1.50	1.25 + 0.5 = 1.75	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	3.50	4.00	5.00	6.00	8.50	11.00	13.50
5.0	0.28 + 0.5 = 0.78	0.60 + 0.5 = 1.10	1.10 + 0.5 = 1.60	1.38 + 0.5 = 1.88	1.65 + 1.0 = 2.65	3.20	3.75	4.30	5.40	6.50	9.25	12.00	14.75

Flood Hazard Rating (HR)	Colour Code	Hazard to People Classification
Less than 0.75		Very low hazard - Caution
0.75 to 1.25		Danger for some – includes children, the elderly and the infirm
1.25 to 2.0		Danger for most – includes the general public
More than 2.0		Danger for all – includes the emergency services

Flood Hazard Rating (HR) and thresholds

The revised 'hazard rating' expression based primarily, on consideration to the direct risks of people exposed to floodwaters.

HR = d x (v + n) + DF

where, HR = (flood) hazard rating;
d = depth of flooding (m);
v = velocity of floodwaters (m/sec); and
DF = debris factor (0, 0.5, 1 depending on probability that debris will lead to a hazard)
n = a constant of 0.5

This final revised Flood Hazard Rating formula from the Flood Risks to People project is presented on page 10 (section 3.5) of FD2321/TR1. The formula is identical in both FD2320 and FD2321 reports.

Extracts from the Supplementary Note to FD2320/TR2 and FD2321/TR1 describing the methodology for calculating 'Flood Hazard' under NPPF *(Source: EA)*

Further to the Flood Hazard Mapping tables from FD2320/21, it is clear that for an access/egress route to be considered 'safe' under the NPPF; the route must fall within the 'Low Degree of Flood Hazard' classification.

No estimates of the velocity of flood water has been provided. Modelled flood depths have been provided by the EA in the area surrounding the property. The proposed escape route is to exit the property and travel west along the front of the building onto Town Quay, then to travel north towards High Street (A259), once onto High Street, a travel distance of approximately 50m, site users will be within Flood Zone 1.

The modelled flood depth data provided by the EA is located along the proposed evacuation route, based on these modelled flood depths the evacuation route would appear to be deemed safe, or a very low hazard to people, during the 1:200 year present day flood event in the presence of defences and without defences.

The same evacuation route however is deemed a 'danger for most' during the 1:200 year defended flood event in 2115 and a 'danger for some' in 2070. However this is based on the current defence standard and not the proposed defence standard which should be achieved through the Adur Tidal Walls Scheme.

As such at present a dry or 'safe' escape route under the NPPF can be provided. Evacuees would be clear of floodwater almost immediately after joining Town Quay during a defended 1:200 year tidal flood event at the present day.

OFF SITE IMPACTS

IMPACT TO FLOOD RISK ELSEWHERE

The proposal is for the change of use of an existing building. As such there is no requirement for compensatory flood storage.

GENERATION OF RUN-OFF

The development is for the change of use of an existing property and as such will not increase the impermeable surface coverage on site. Any change in surface water runoff from the development will likely be negligible.

RESIDUAL RISKS

IDENTIFICATION OF RESIDUAL RISKS

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.

The site benefits from flood defences with a protection level of up to 1:20 years, the condition of these defences is unknown. As such there is a residual risk to the site of failure of the defences, both from overtopping and breach.

BREACH FAILURE

The EA has not provided any specific breach failure modelling to Ambiental associated with the development site. However flood depths have been provided for the site with no flood defences. These show a flood depth of 0.205m for the 1:200 year present day flood event and a depth of 1.322m during the 1:200 year 2115 flood event.

These flood depths do not take into consideration the velocity of flood waters or time to inundation associated with a breach failure.

OVERTOPPING

The EA has not provided any specific defence overtopping modelling.

CONCLUSIONS

The proposed development is located at Pavilion Financial Planning, 6 Town Quay, Shoreham-by-Sea, BN43 5DS, and is for the change of use of the existing office to a ground floor studio flat. This FRA has been carried out using current best practices, and against the criteria set out in the National Planning Policy Framework (NPPF).

The site is located in the EA defined Flood Zone 3, works done by Worthing and Adur Councils have found that the area of urban development on the banks of the River Adur at this point do not provide flood storage and as such the site is located in an area deemed to be Flood Zone 3a.

Modelled flood depths have been provided by the EA for the site and show the proposed development to be affected by 0.15m of flood water during the 1:200 year tidal flood event at the present day taking into account the flood defences. The site is modelled to be affected by a flood depth of 0.990m during a 1:200 year tidal flood event in 2115 taking into account the current flood defences.

The site has been confirmed as being within the area benefitting from the in progress Adur Tidal Walls Scheme which is due to provide a standard of protection to 1:300 year flood event with an allowance for 50 years of sea level rise.

As such, and following an analysis of EA flood risk maps, recorded / modelled river levels, topographic and anecdotal information, it can be concluded that the risk and impact of flooding is currently moderate and would remain so following redevelopment.

As such, and given that:

a) the site lies within an existing developed area and is for the change of use of an existing building;

b) a safe access and egress route will be provided by a formal flood warning and evacuation plan, which will be agreed with emergency planners, and tied in to the existing emergency plans for the area, and;

c) in terms of flood vulnerability, significant betterment can be achieved through the implementation of flood warning procedures;

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

The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

Dr. J. B. Butler

B.Sc., M.Phil., PhD.

Ambiental Technical Solutions Ltd. January 2015

APPENDIX A – SUPPORTING INFORMATION

- Figure 1: Wider Location Plan *(Source: Streetmap)*;
- Figure 2: Surface Water Flood Map *(Source: EA)*;
- Figure 3: Detailed EA Flood Risk Map *(Source: EA)*;
- Figure 4: Redefining Areas of Flood Zone 3a and 3b *(Source: Adur District Council and Worthing Borough Council SFRA)*;
- Figure 5: Historic Flooding *(Source: Adur District Council and Worthing Borough Council SFRA);*
- Figure 6: Actual Tidal Flood Risk (with defences) *(Source: Adur District Council and Worthing Borough Council SFRA);*
- Figure 7: Future Tidal Flood Risk (with defences) *(Source: Adur District Council and Worthing Borough Council SFRA);*
- Figure 8: Tidal Flood Risk – 5% AEP Wave Overtopping *(Source: Adur District Council and Worthing Borough Council SFRA);*
- Figure 9: Flood Defences *(Source: Adur District Council and Worthing Borough Council SFRA);*
- Pages 25 – 32: EA Product 4.

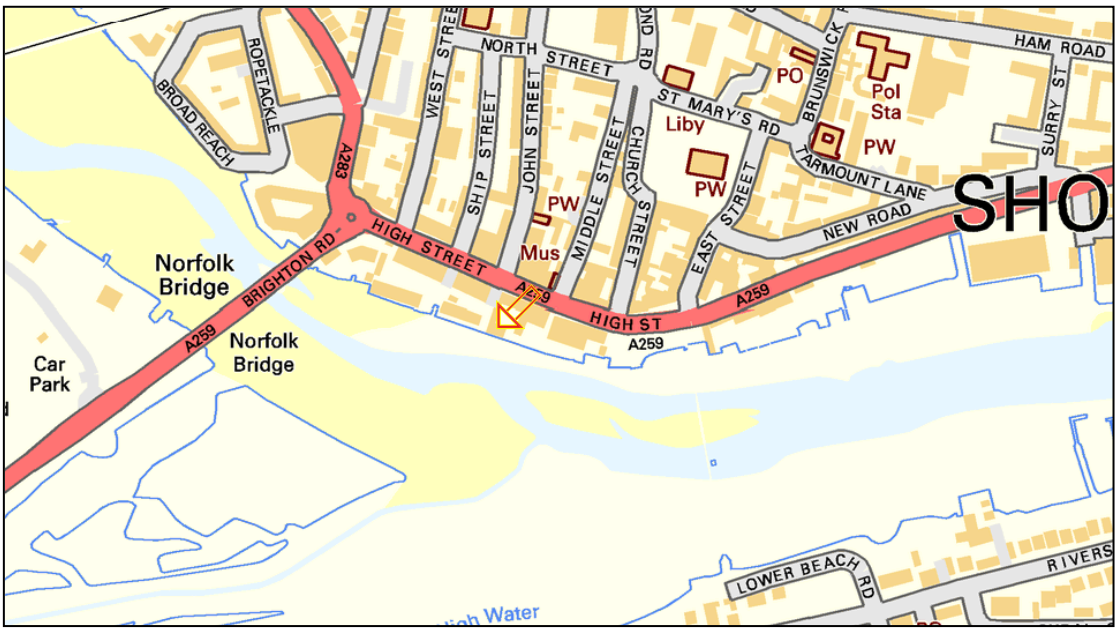


Figure 1: Wider Location Plan *(Source: Streetmap)*

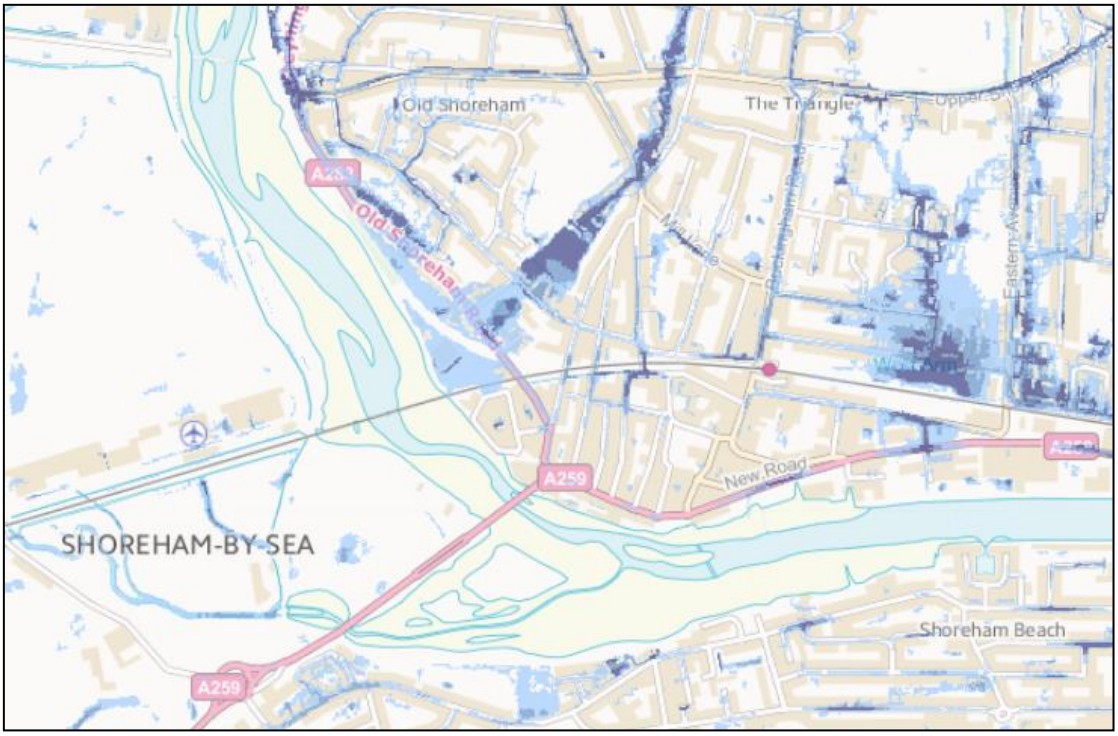


Figure 2: Surface Water Flood Risk Map *(Source: EA)*

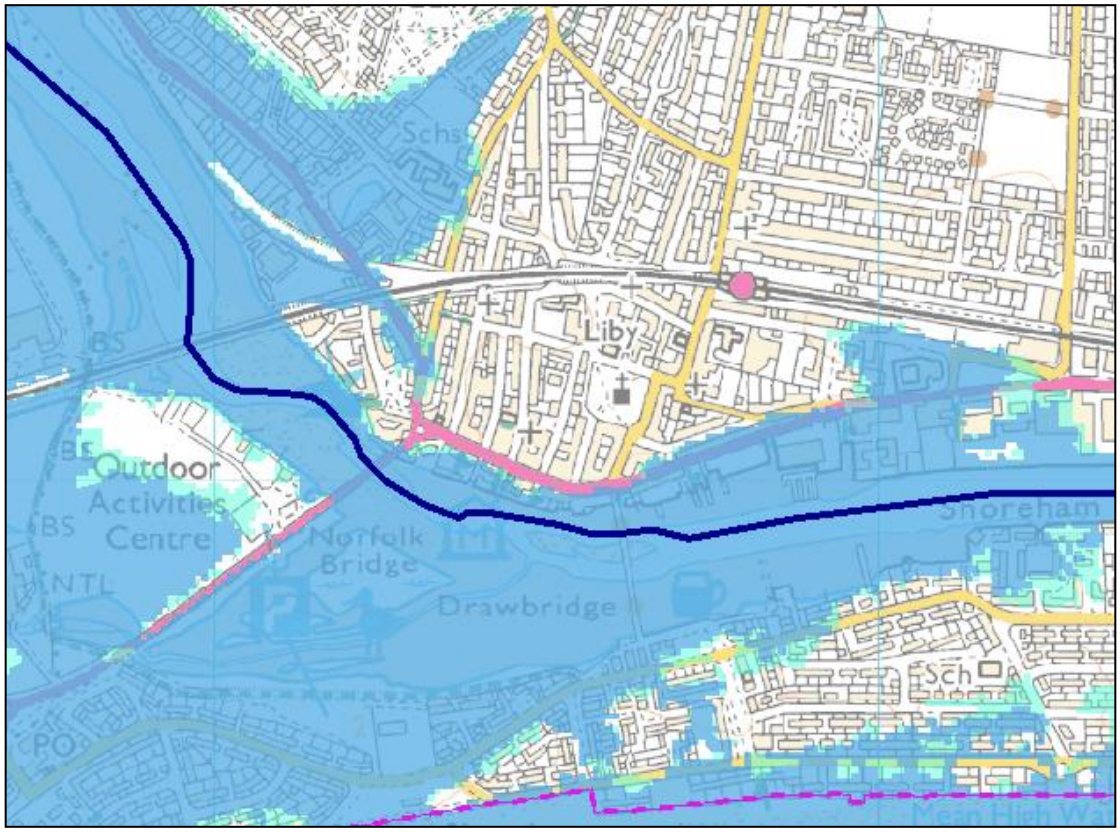


Figure 3: Flood Risk Map for Planning *(Source: EA)*

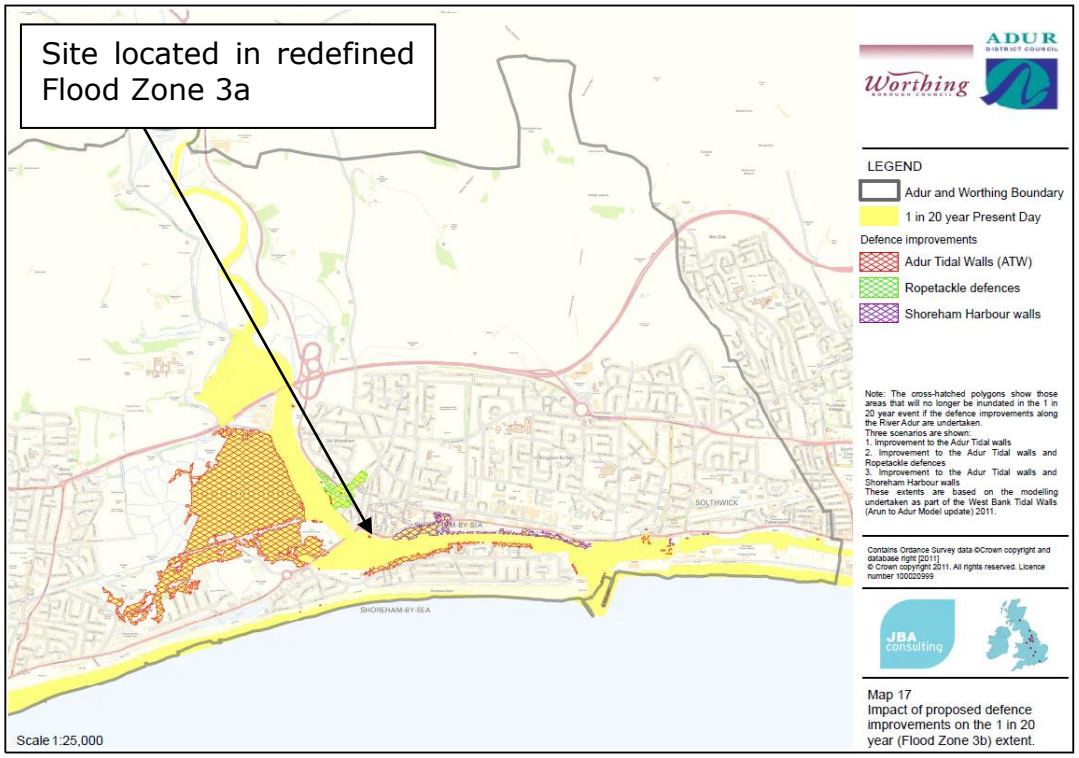
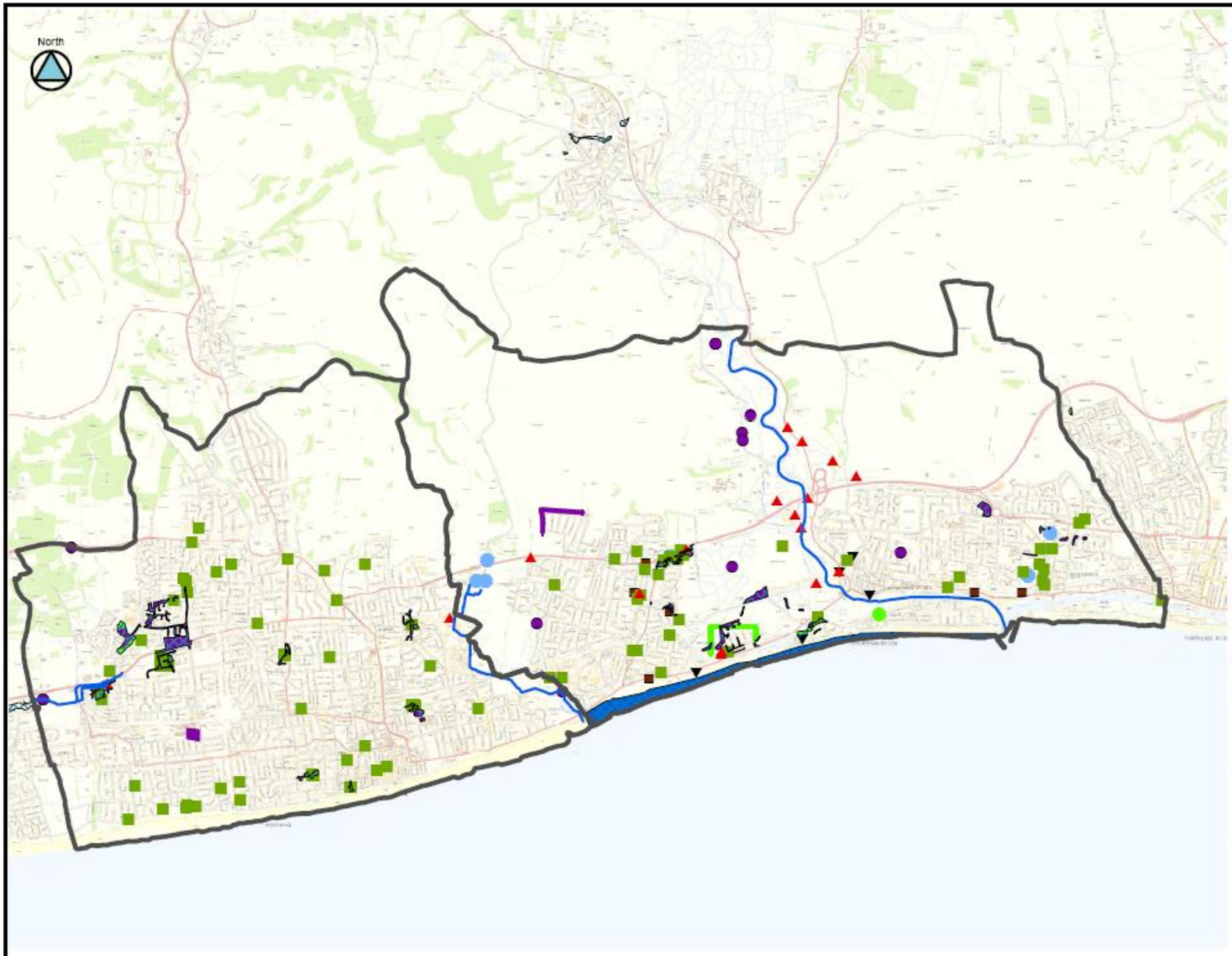


Figure 4: Redefining Areas of Flood Zone 3a and 3b *(Source: Adur District Council and Worthing Borough Council SFRA (Jan 2012))*



ADUR DISTRICT COUNCIL

Worthing BOROUGH COUNCIL

LEGEND

- Adur and Worthing Boundary
- Main River
- EA Historic Flood Map
- Fluvial Flooding
- Sewer Flooding
- Unknown Flooding
- Groundwater Flooding
- Coastal Flooding
- Surface Water Flooding
- Surface Water Flooding
- Surface Water Flooding
- Tidal Flooding
- Tidal Flooding
- Tidal Flooding
- Flooding from failure
- Flooding from failure

Note: Failure relates to a blockage or bank/structure failure and according to the SFRA 2008 this is usually related to flooding from rivers.

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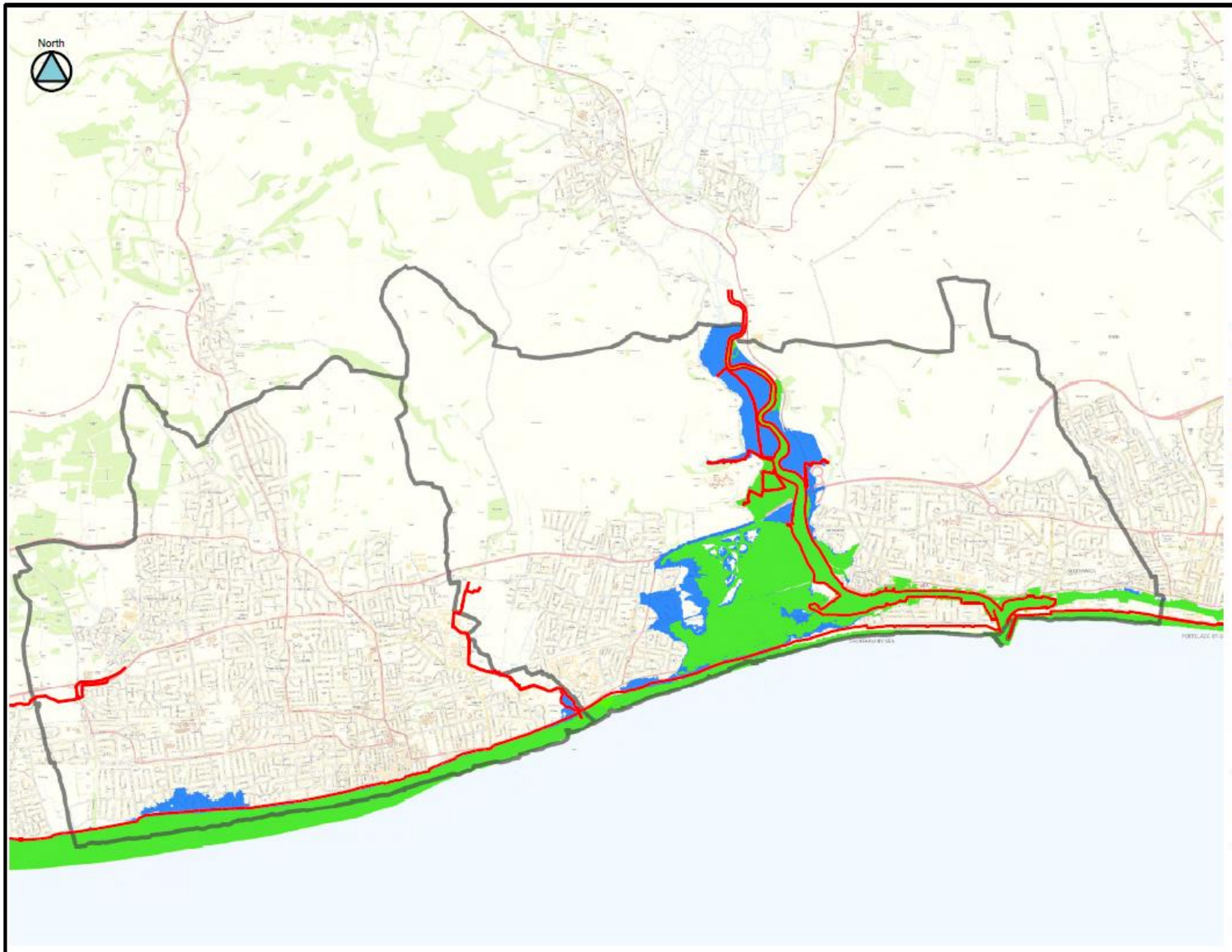
Map 3
Historical Flooding

Scale 1:55,000



Worthing Borough Council

ADUR District Council

LEGEND

Adur and Worthing Defences

Adur and Worthing Boundary

0.5% AEP Defended

Flood Zone 3a

Note: Flood zone delineation north of the A27 is from existing SFRA modelling. Elsewhere the delineation uses the results from the recent Environment Agency studies:
'Arun to Adur Flood Modelling' (2011); and
'Shoreham Harbour Regeneration: Design and Flood Risk Study' (2011).

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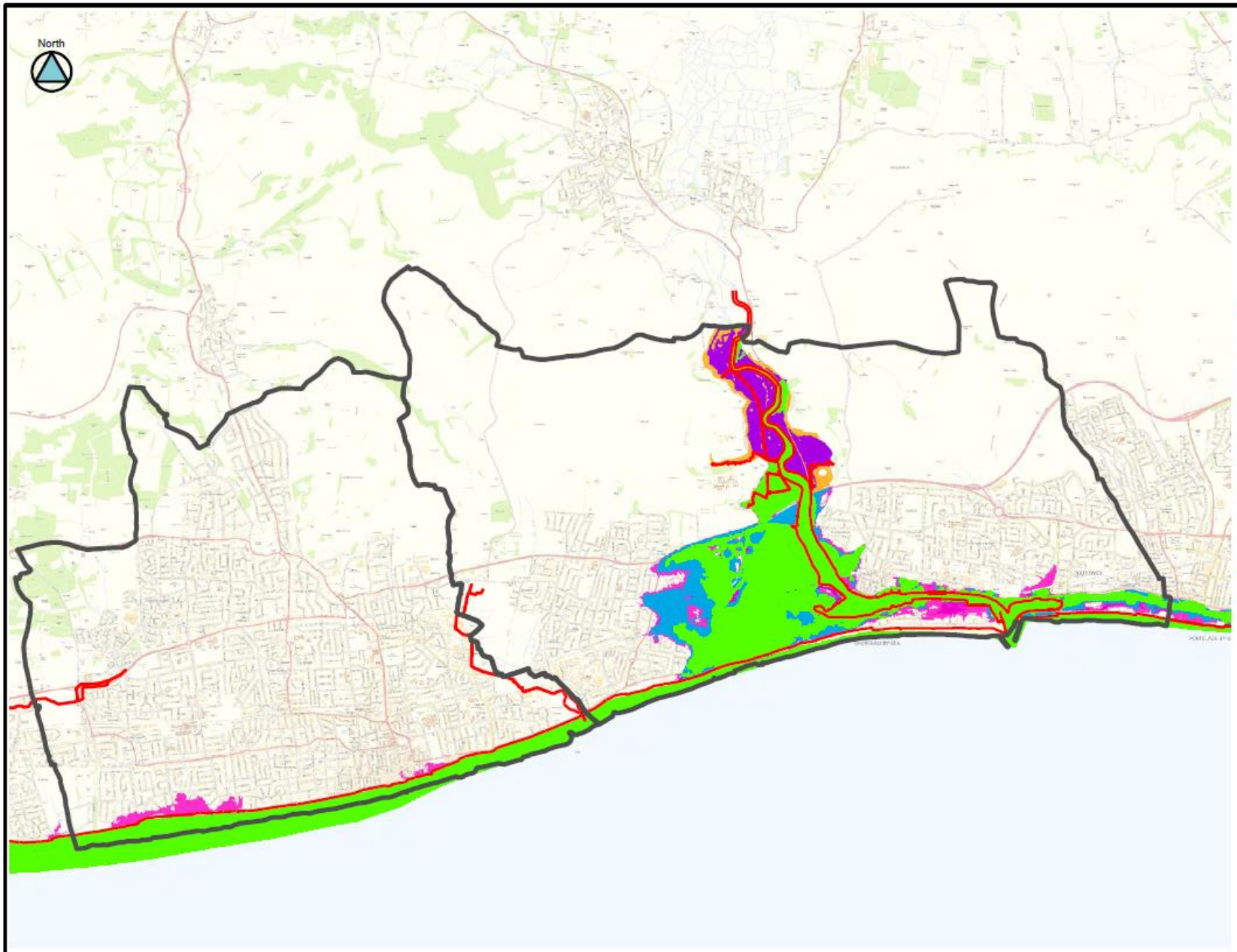
Map 8
Actual Tidal Flood Risk
(with defences)

Scale 1:55,000



Worthing Borough Council

Adur District Council

LEGEND

Adur and Worthing Boundary

Defences

0.5% AEP Defended

Present Day

Near Epoch 2056 or 2070

Future 2056

Future 2070

Far Epoch 2106 or 2115

Future 2106

Future 2115

Note: The future tidal flood outline north of the A27 is from existing SFRA modelling. This was modelled for the epochs 2056 and 2106.
Elsewhere the future tidal flood outline was modelled for epochs 2070 and 2115 and uses the results from the recent Environment Agency studies:
'Arun to Adur Flood Modelling' (2011); and

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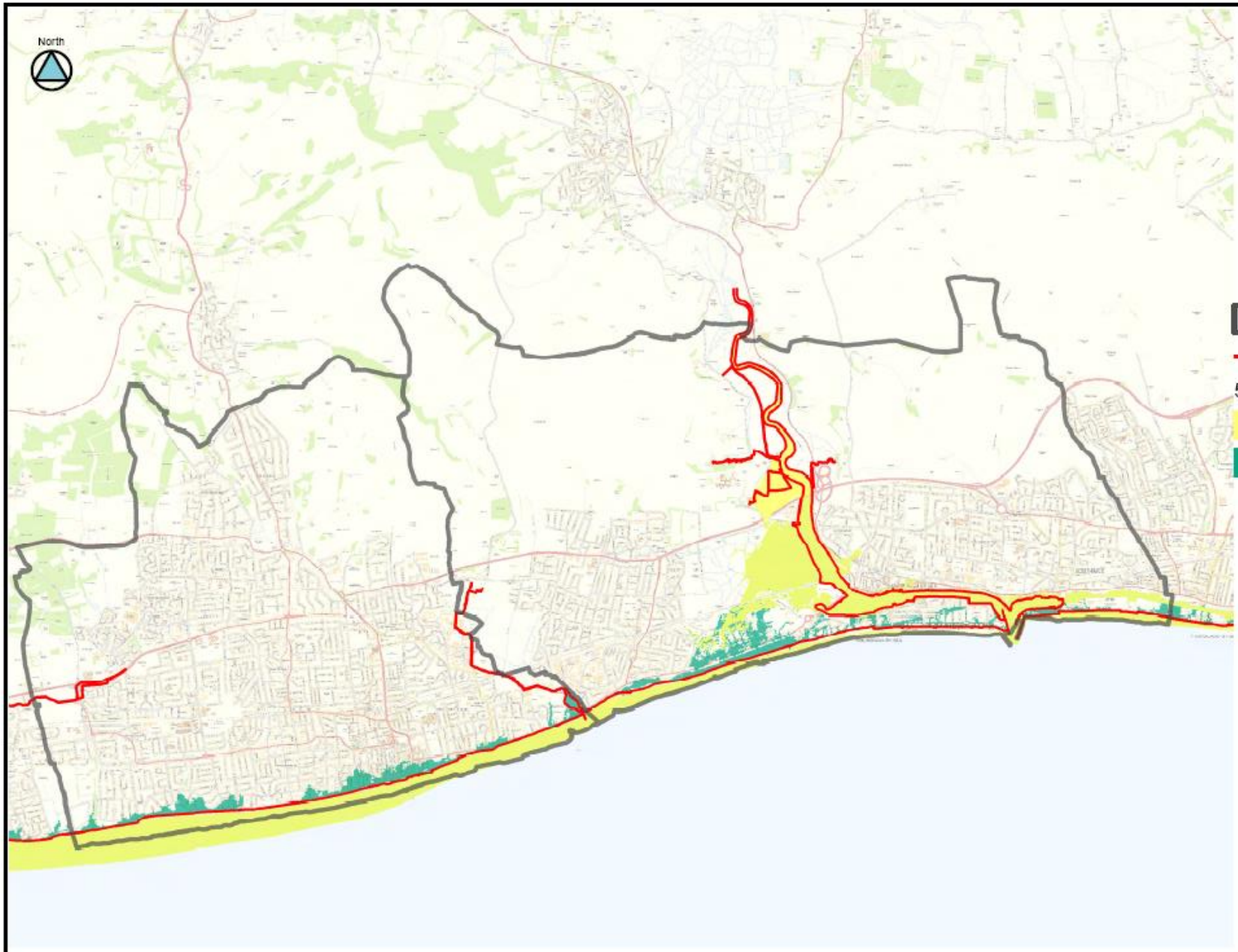
Map 9
Future Tidal Flood Risk
(with defences)

Scale 1:55,000



Worthing

ADUR DISTRICT COUNCIL

LEGEND

Adur and Worthing Boundary

Defences

5% AEP Defended present day

Still Water Level

with Wave Overtopping

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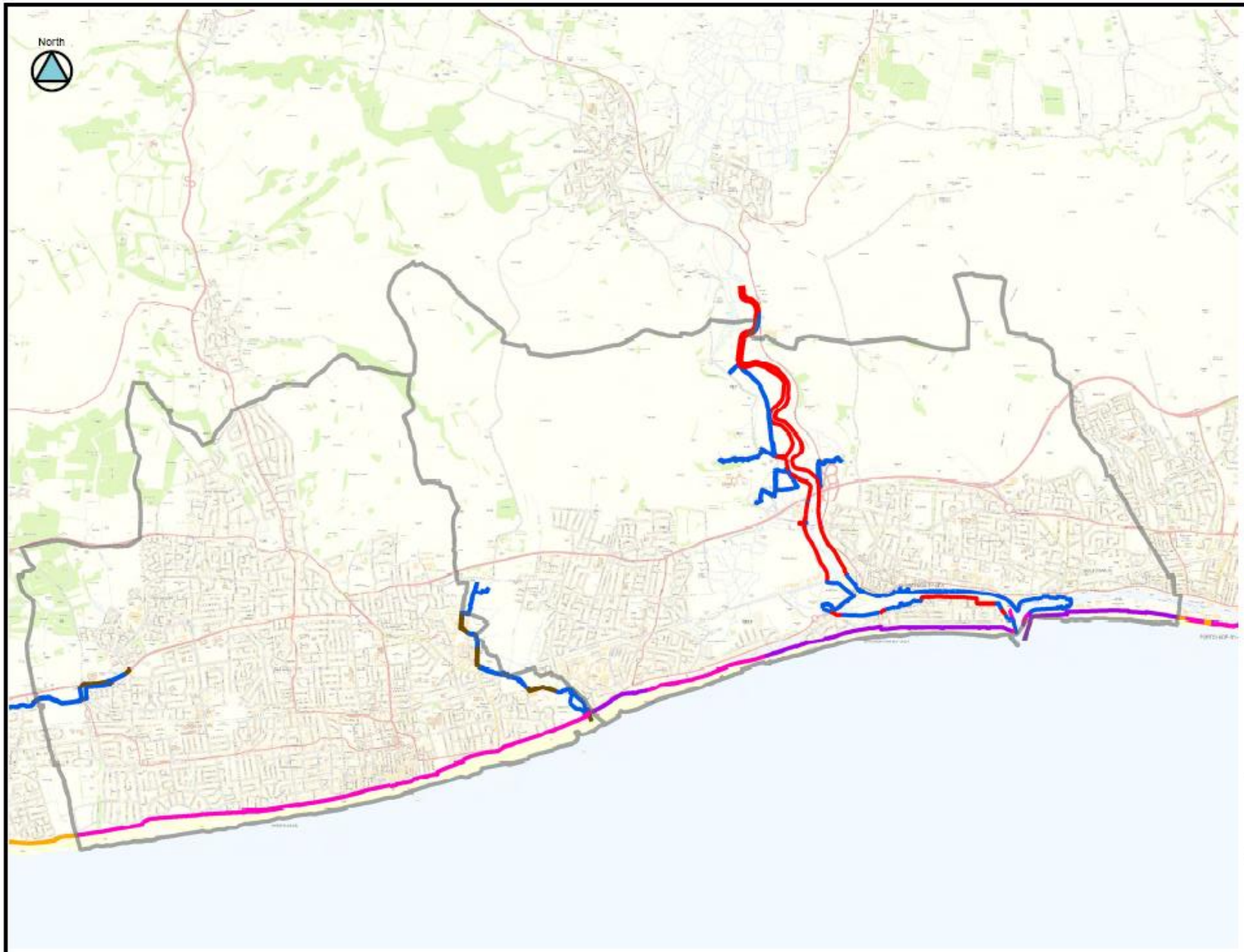
Map 10
Tidal Flood Risk – 5% AEP
Wave Overtopping

Scale 1:55,000



Worthing Borough Council

ADUR District Council

LEGEND

Adur and Worthing Boundary

Flood Defence Type

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

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Map 16
Flood Defences

Scale 1:55,000

Natalie James

Our ref: SSD/5574

Date: 23rd December 2014

Dear Natalie

Provision of Product 4 for the FRA for Town Quay, Shoreham-by-Sea, BN43 5DS

Thank you for your request to use Environment Agency data, product 4, in the development of the FRA for Town Quay, Shoreham-by-Sea, BN43 5DS. The information is attached.

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

Supporting Information

Our flood map shows the site at risk from tidal flooding from the River Adur. Please note flooding may come from other sources such as surface water, groundwater or drainage problems. You should contact the West Sussex County Council (LLFA), Adur District Council or Southern Water Services for further information.

		1:20 Def		1:200 Def		1:200 U		1:1000 U	
Point	Grid Reference	Depth	Height	Depth	Height	Depth	Height	Depth	Height
A	TQ2143705009	N/A	N/A	N/A	N/A	N/A	N/A	0.003	4.485
B	TQ2143204989	N/A	N/A	0.100	4.221	0.143	4.264	0.363	4.484
C	TQ2145304978	0.052	4.057	0.150	4.223	0.205	4.263	0.426	4.484
		1:200 2070 Def		1:200 2070 U		1:200 2115 Def		1:200 2115 U	
Point	Grid Reference	Depth	Height	Depth	Height	Depth	Height	Depth	Height
A	TQ2143705009	0.002	4.435	0.191	4.791	0.468	5.069	0.780	5.380
B	TQ2143204989	0.313	4.434	0.670	4.791	0.948	5.069	1.259	5.380
C	TQ2145304978	0.355	4.434	0.733	4.791	0.990	5.069	1.322	5.380

Depth = metres Height = mAOD Def = with defences U = without defences

The Environment Agency
Guildbourne House, Chatsworth Road, Worthing, BN11 1LD
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

The site is currently protected by a concrete retaining wall, which offers approximately a 1 in 20 year standard of protection (SoP).
We are in the process of the detailed design of the Adur Tidal Walls Scheme. When completed this will offer a consistent 1 in 300 SoP taking into account 50 years of sea level rise. Construction is programmed to start in early 2016.

We have no records of flooding in this area, however please be aware that not all incidents of flooding are reported to us.

The River Adur is classified as a 'main river'. Any works whatsoever in, under, over or within 15m of the river wall will require the prior consent of the Environment Agency under the Water Resources Act 1991 and the Southern Region Byelaws.

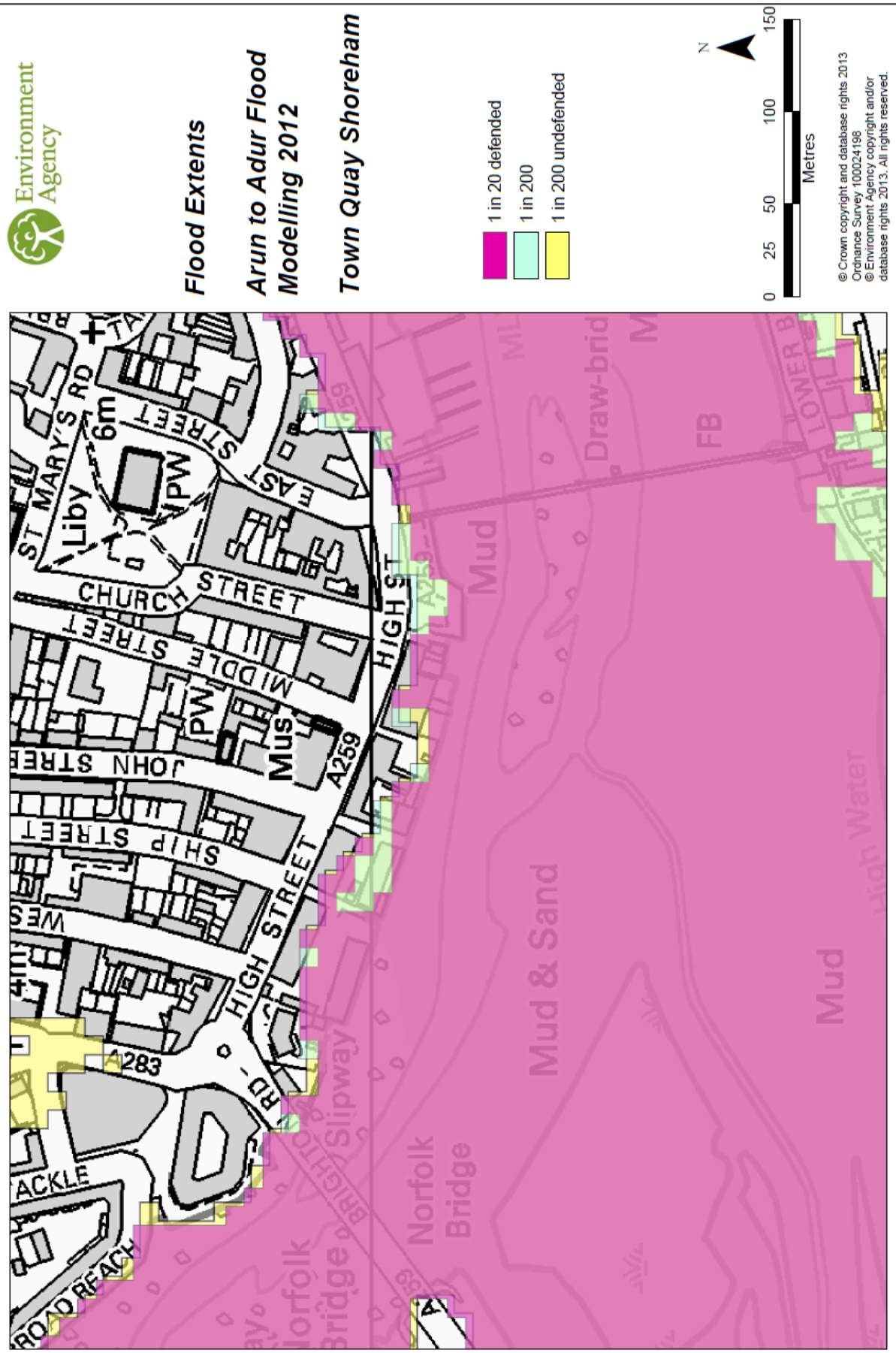
This information is provided subject to the enclosed notice, which you should read.

If you have any queries or would like to discuss the content of this letter further please contact me.

Yours faithfully

Keely Mowatt
FCRM Officer – West Sussex
keely.mowatt@environment-agency.gov.uk

Enc. Flood Map for Planning, Flood extents x4, Modelled level node locations.
Standard Notice (Commercial)


Environment Agency
Flood Extents
Arun to Adur Flood Modelling 2012
Town Quay Shoreham
1 in 20 defended
1 in 200
1 in 200 undefended
N
0 25 50 100 150
Metres
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ST MARY'S RD
EAST STREET
CHURCH STREET
MIDDLE STREET
JOHN STREET
SHIP STREET
HIGH STREET
HIGH ST
Liby
PW
Mus
A259
A283
Mud
Mud & Sand
Norfolk Bridge
Slipway
Draw-brid
FB
LOWER B
High Water
ROAD REACH

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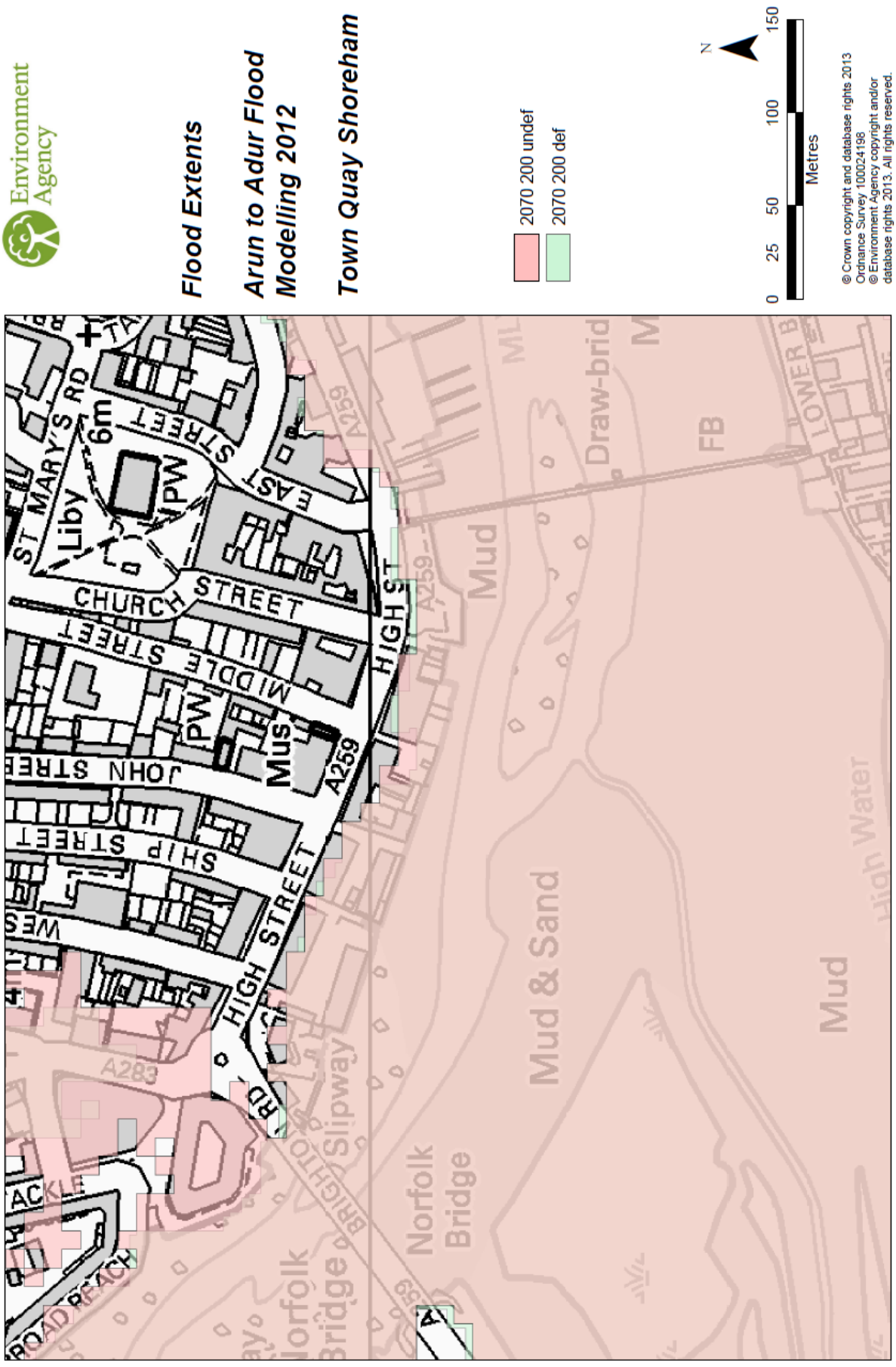

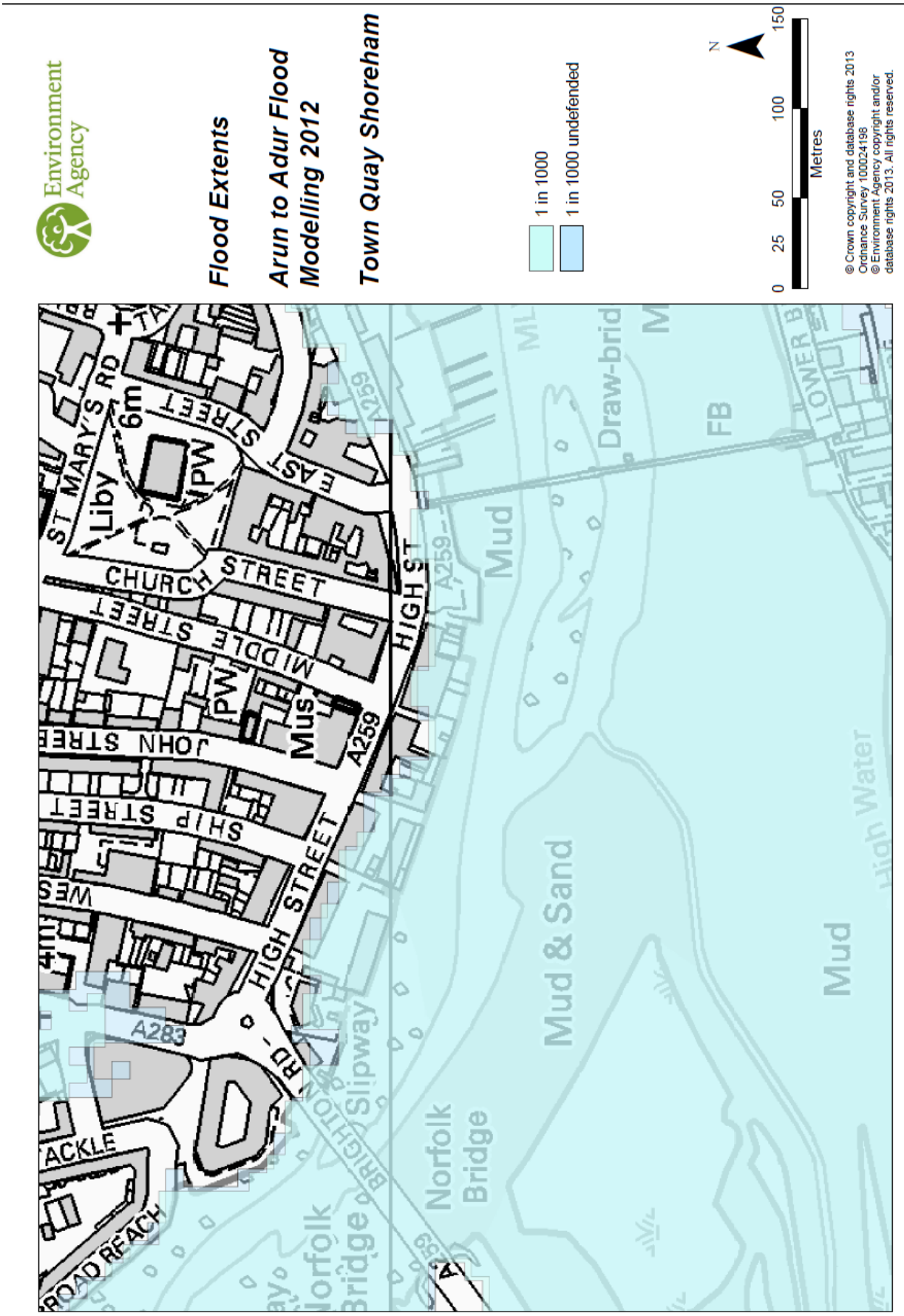
Environment Agency
Flood Extents
Arun to Adur Flood Modelling 2012
Town Quay Shoreham
1 in 1000
1 in 1000 undefended
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0 25 50 100 150
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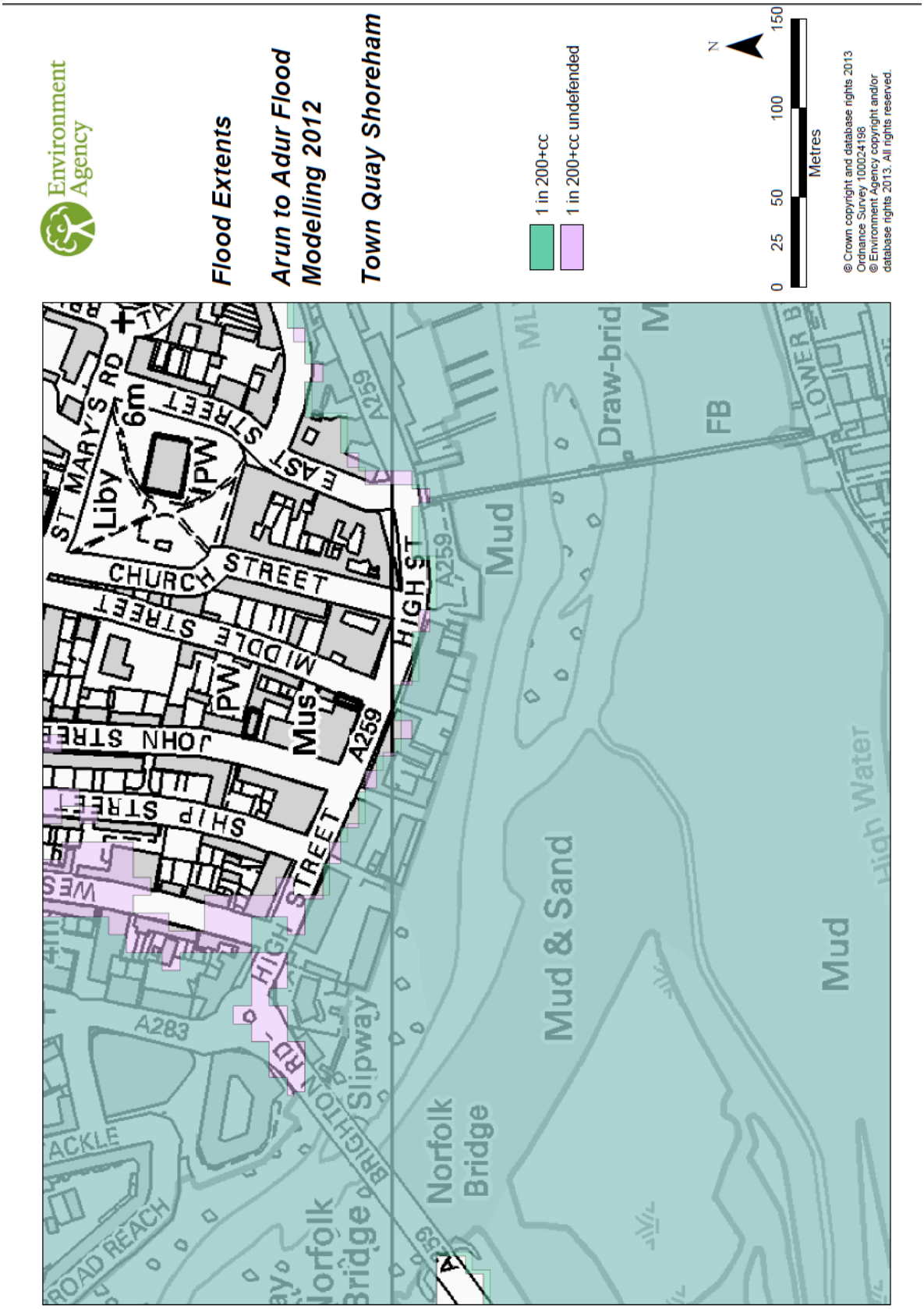
High Water
Norfolk Bridge
Slipway
Norfolk Bridge


Environment Agency
Flood Extents
Arun to Adur Flood Modelling 2012
Town Quay Shoreham
1 in 200+cc
1 in 200+cc undefended
N
0 25 50 100 150
Metres
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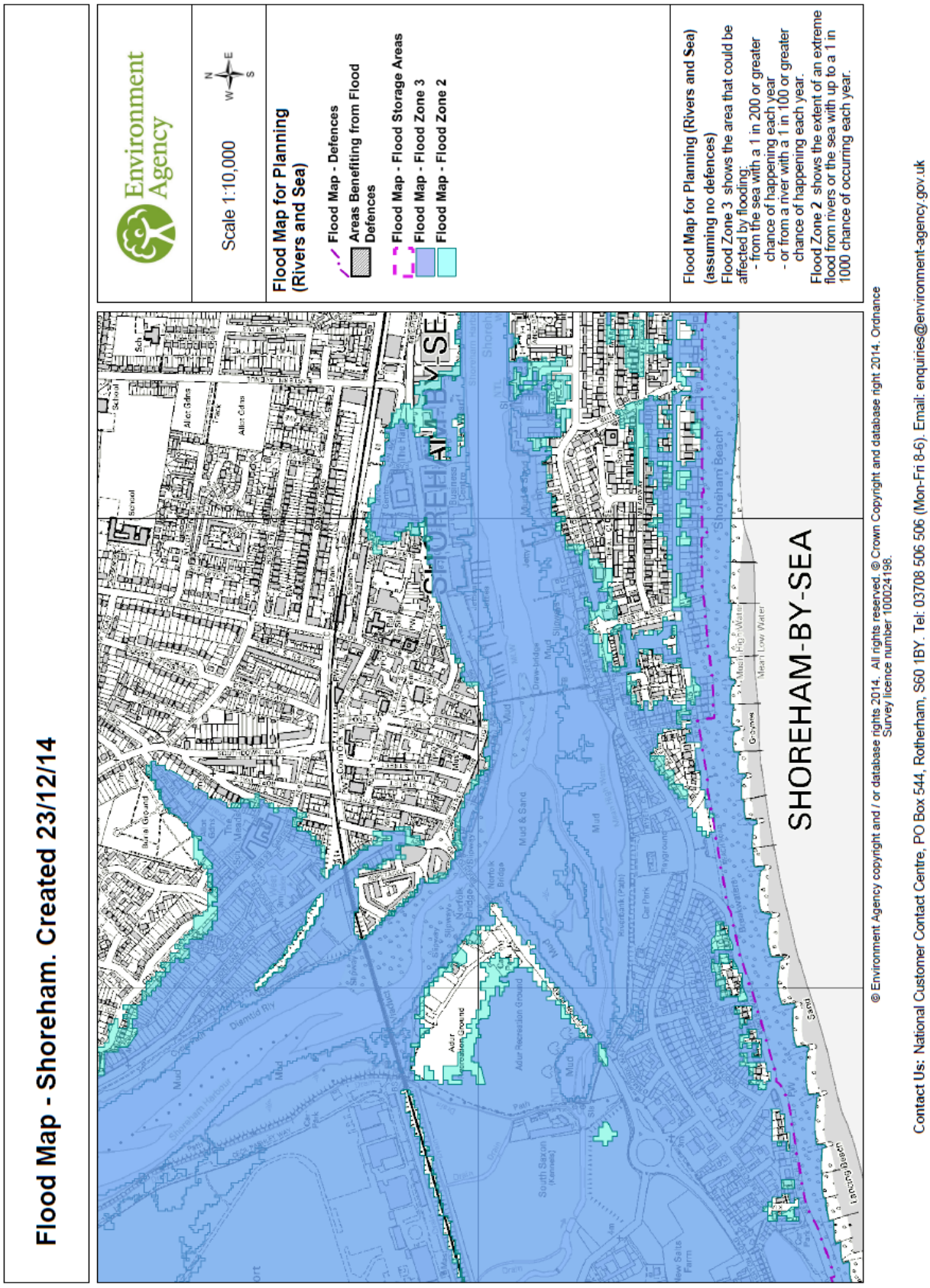
JOHN STREET
SHIP STREET
HIGH STREET
HIGH ST
Liby
PW
Mus
A259
A283
Mud
Draw-brid
FB
LOWER B
Mud & Sand
Mud
High Water
Slipway
Norfolk Bridge
BRIGHTON RD
ROAD REACH


Flood Map - Shoreham. Created 23/12/14
Environment Agency
Scale 1:10,000
Flood Map for Planning (Rivers and Sea)
Flood Map - Defences
Areas Benefitting from Flood Defences
Flood Map - Flood Storage Areas
Flood Map - Flood Zone 3
Flood Map - Flood Zone 2
Flood Map for Planning (Rivers and Sea) (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.
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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

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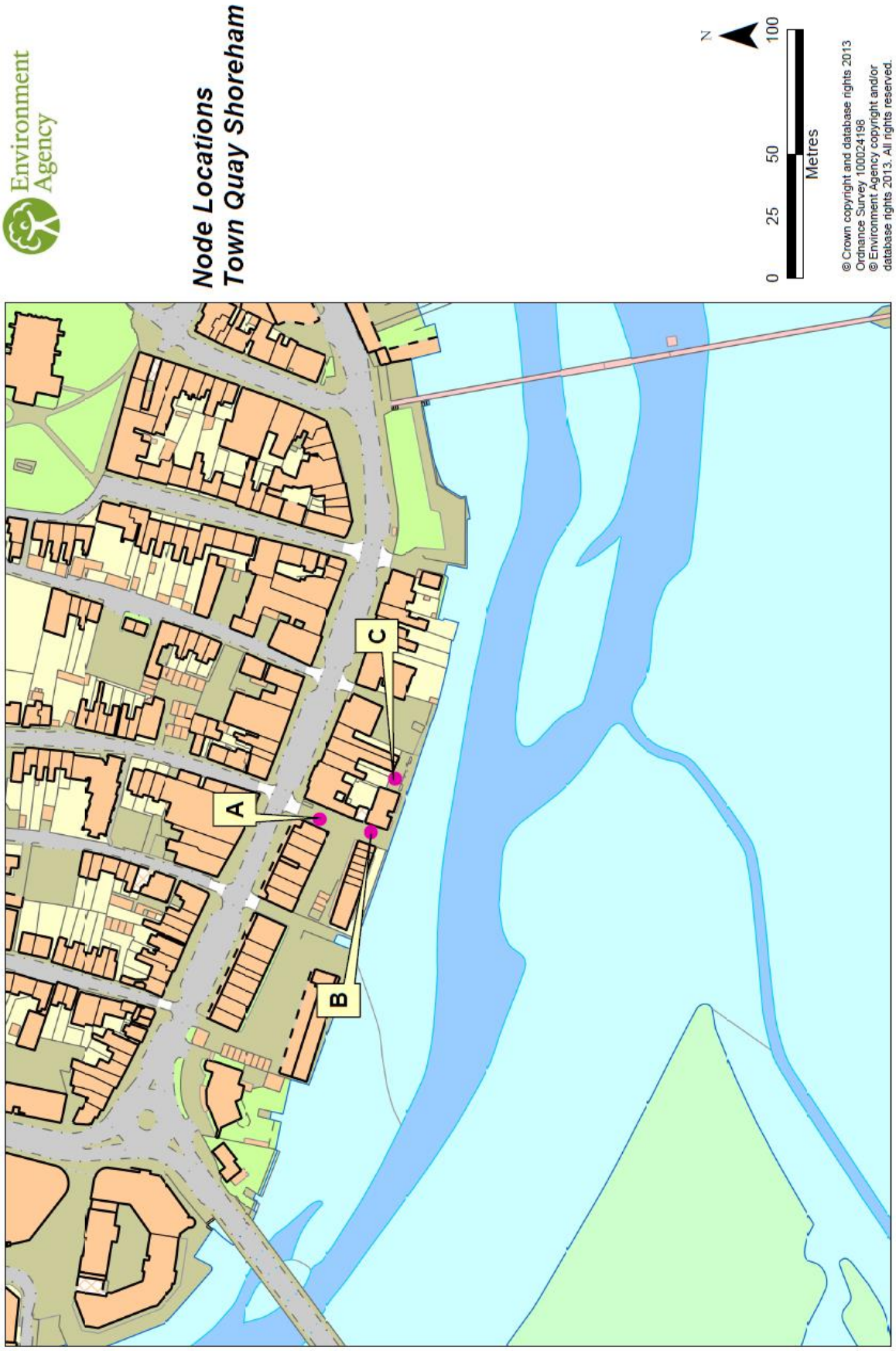

APPENDIX B – INFORMATION RELATING TO JFLOW

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 100 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 1-2years.

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

APPENDIX C – ADDITIONAL INFORMATION

Significance	Risk of flooding of proposed development following completion	Impact of proposed development on both local and catchment hydrology
Not significant	Proposed development is not located in a 1:100 year fluvial or 1:200 year tidal floodplain. Flooding as a result of the accumulation of surface runoff either on-site, or elsewhere in the catchment is highly unlikely.	Proposed development does not affect the quantity/quality of surface runoff and does not alter surface/groundwater flow locally or elsewhere within the catchment.
Low significance	Proposed development is located in a 1:100 year fluvial/1:200-year tidal floodplain, although no mitigation measures are required due to regional flood defences. Existing local drainage measures are sufficient to ensure that the accumulation of surface runoff does not result in flooding on-site or increase the risk of flooding elsewhere within the catchment.	Proposed development has a minor affect on the quantity/quality of surface runoff or surface/groundwater flow either locally or elsewhere within the catchment. Such changes may be sustainable without mitigation measures.
Moderately significant	Proposed development is located in a 1:100 year fluvial/1:200-year tidal floodplain and mitigation measures are required to reduce flood risk to an acceptable level. Surface runoff attenuation methods may be required to ensure that the accumulation of surface runoff does not result in flooding on-site or increase the risk of flooding elsewhere within the catchment.	Proposed development has a notable affect upon the quantity/quality of surface runoff and has a discernable impact upon surface/groundwater flow either locally or elsewhere within the catchment. Mitigation measures may be required in order for the development to be sustainable throughout the duration of its intended lifetime.
Moderate-high significance	Proposed development is located in a 1:100 year fluvial/1:200-year tidal floodplain and significant mitigation measures are required to reduce flood risk to an acceptable level. A range of surface runoff attenuation methods will be required to ensure that the accumulation of surface runoff does not result in flooding on-site or increase the risk of flooding elsewhere within the catchment.	Proposed development has a large affect on the quantity/quality of surface runoff and has a considerable impact upon surface/groundwater flow either locally or elsewhere within the catchment. A primary commitment to successful mitigation measures will be required in order for the development to be sustainable throughout the duration of its intended lifetime.
Highly significant	The proposed development is considered to be particularly susceptible to either tidal or fluvial flooding or a combination of both. Resultant changes in the rates of surface runoff as a result of the development will increase flood risk both on-site and elsewhere in the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable in terms of flood risk for the duration of its intended lifetime.	Proposed development has a major affect on the quantity/quality of surface runoff and has a severe impact upon surface/groundwater flow locally or elsewhere within the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable throughout the duration of its intended lifetime.

Table C1: Explanation of the levels of Significance used for the Flood Risk Assessment