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Project: Phase 1 Flood Risk Assessment (FRA)

Prepared for: Parker Dann

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Date: December 2016

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ARUN DISTRICT COUNCIL CM/1/17/OUT

Document Issue Record

Project: Phase 1 Flood Risk Assessment

Prepared for: Parker Dann

Reference: 2323

Site Location: Land adjacent Church Lane, Clymping (also spelt Climping) BN17 5GG

Proposed Development: Construction of a new area of Clymping, to include residential development, commercial facilities, allotments as well as amenity spaces.

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Please Note:

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1. Summary

1.1 Ambiental Technical Solutions Limited has been appointed by Parker Dann to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the development on land adjacent to Church Lane, Clymping, West Sussex.

1.2 The existing site is currently undeveloped land currently used for agricultural use and is as such deemed to be Greenfield.

1.3 The proposed development is for the construction of a new area of Clymping to include residential development, community facilities, as well as amenity spaces. There will be a total of 300 residential dwellings created, 450m^2 of commercial space and a community building approximately 700m^2 in size at ground floor.

1.4 This study is based on the feasibility illustrative masterplan provided to Ambiental, dated June 2016, drawing number P14 4899 01 REV C.

1.5 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 site is located within Flood Zone 1 (Low Risk) and is considered to be predominantly a 'More Vulnerable' (residential) development under the NPPF.

1.6 The NPPF requires any planning application for new or re-development within a Flood Zone 1, over 1Ha in size to be accompanied by a FRA to demonstrate that the development can be achieved in a sustainable manner, with an overall reduction of flood risk to the site and surrounding area.

1.7 The present day impact to the development site from tidal and sewer flooding is deemed to be **relatively low**. The impact to the development from groundwater and surface water flooding is deemed to be **potentially moderate**.

1.8 The 2115 impact of tidal flooding to the development is deemed to be moderately high for those areas within the modelled 1:200 year with an allowance for climate change flood extent, however the developer has taken a sequential approach to the development and located as many units and structures outside of this flood extent. As such, based on the masterplan (drawing number P14 4899 01 REV C), a total of 4 structures are located within the modelled flood extent; 3 residential structures and 1 commercial structure.

1.9 A surface water drainage strategy report has been completed for the site based on the masterplan to provide an understanding of the natural surface water flow directions across the site, the volume of storage potentially required post development and the suitable SuDS components based on the development type and site location. A foul water strategy has also been undertaken separately.

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1.10 As such, and given that:

- The site is located within the present day Flood Zone 1, as of October 2016;
- A surface water drainage strategy assessment has been completed, and demonstrates the volume of water generated by development can be mitigated on-site (See Ambiental SWDS 2322);
- A foul water drainage scheme has been undertaken, and details of this are included within Ambiental Report 2495;
- Ground floor thresholds and internal finished floor levels shall be raised a minimum of 300mm above the general ground level for all structures on site to account for potential surface water flow in the future;
- The potential flood risk from tidal flooding in the future (2115) has been analysed and various flood management and mitigation methods have been proposed for those structures affected, and;
- A flood warning and evacuation plan has been set out based on the existing masterplan for those site users affected by the 1:200 year flood event 2115;

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

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Development Description	Existing	Proposed
Development Type:	Agricultural land	New area of Clymping, to include residential, community facilities, and amenity spaces
(Number of Bedrooms):	None	N/A[2]
EA Vulnerability Classification:	Less Vulnerable	More and Less Vulnerable
Ground Floor Level:	Ground levels vary between 4.28mAOD and 6.95mAOD	Finished floor levels a minimum of 300mm above ground level
Level of Sleeping Accommodation:	None	N/A[2]
Impermeable Surface Area:	None	N/A[2]
Surface Water Drainage:	N/A[1]	Surface water drainage strategy accompanies this report
Site Size:	21.5ha	No change
Risk to Development	**Summary**	**Comment**
EA Flood Zone:	1	
Flood Source:	Surface water & River Arun	River Arun is tidally controlled at this location
1 in 200yr flood level:	N/A[1]	Tidal levels taken from 2009 TUFLOW model (undefended) Church Lane at eastern boundary of site
1 in 200yr flood level + climate change (2115):	5.14mAOD	
1 in 1000yr flood Level	N/A[1]	
Recorded Flood Events in Area:	Yes	Surface water and sewer flood events
Recorded Flood Events at Site:	No	
SFRA Available:	Yes	Arun District Council Sept 2016
Management Measures	**Summary**	**Comment**
Ground floor level above 1:200yr with climate change flood levels:	Yes	Proposed finished floor levels 300mm above modelled flood level for those properties within the modelled flood extent
Safe Access/Egress Route:	Present day: N/A[1] 2115: Yes	Site is located in Flood Zone 1 at present day. Safe access/egress to those affected by tidal flooding to proposed village hall
Flood Resilient Design:	Yes	Various flood resilient measures proposed
Site Drainage Plan:	N/A[1]	Surface water drainage strategy accompanies this report
Flood Warning & Evacuation Plan:	Yes	EA Flood Warning Service
OFFSITE IMPACTS	**SUMMARY**	**COMMENT**
Displacement of floodwater:	N/A[1]	Site located within Flood Zone 1 and tidal flood extent
Increase in surface runoff generation:	N/A[1]	Surface water drainage strategy accompanies this report
Impact on hydraulic performance of channels:	None	Does not affect channel

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

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2. Development Description and Site Area

Proposed Development and Location

2.1 The site is approximately 21.5ha in size and located to the south of Clymping Village in West Sussex. The site is bounded to the south by Crookthorn Lane, to the east by Church Lane, to the west by Yapton Road (B2233) and to the north by existing residential development within Clymping Village itself and Horsemere Green Lane (*Figure 1*).

2.2 The existing site is currently undeveloped and is used for agricultural use.

2.3 The proposed development is to provide 300 residential dwellings, a commercial unit with 450m² floor space and a community building with a ground floor, floor space of 700m².

2.4 Topographic levels derived from remotely sensed LiDAR shows levels across the site vary between approximately 4.28mAOD to 6.95mAOD.

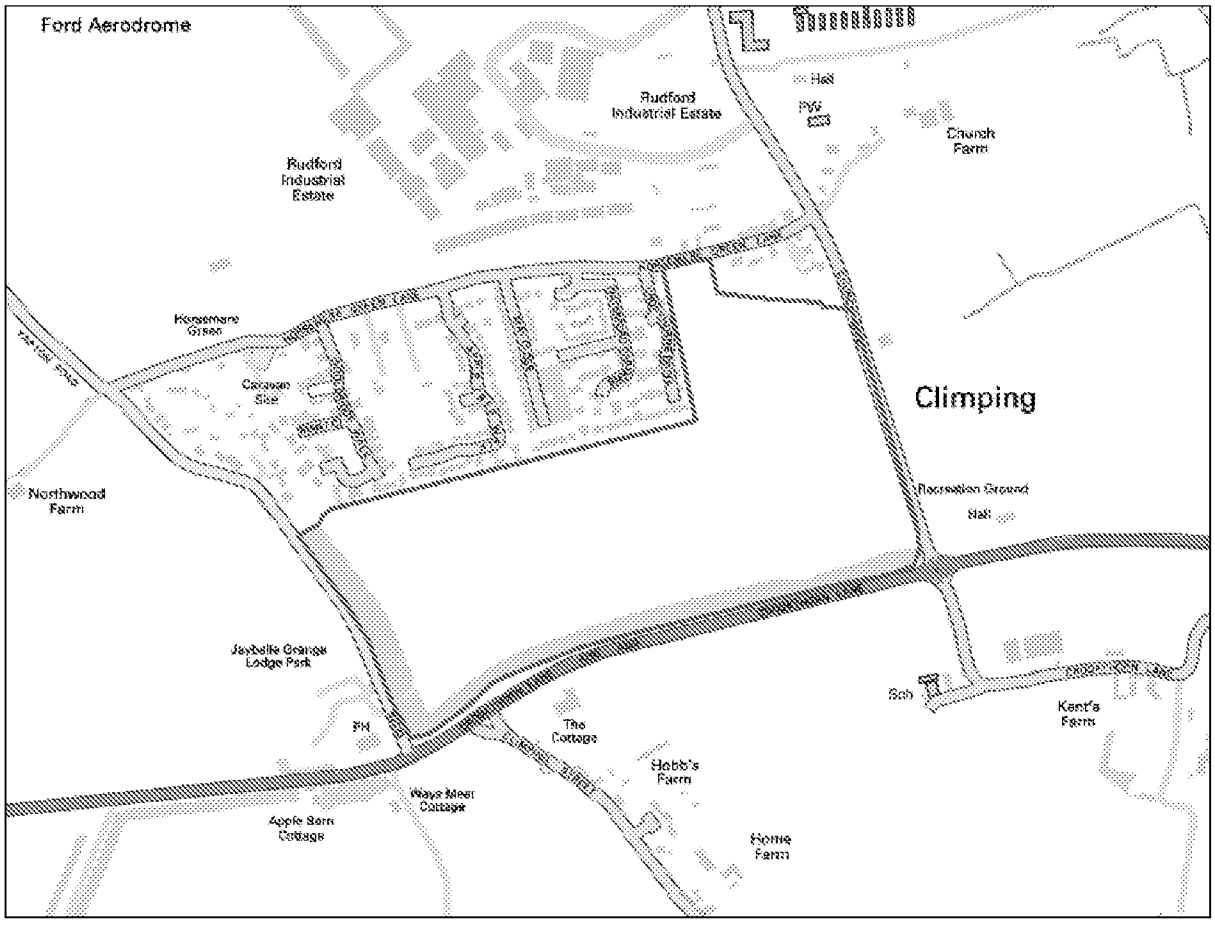


Figure 1: Wider Location Map. Proposed development area outlined in red. (Source: OS)

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Vulnerability classification

2.5 Under the NPPF, the existing agricultural site usage is considered to be "Less Vulnerable". The proposed development is for a mixed used development to include residential development, community facilities, as well as amenity spaces and as such classified as being both "More" and "Less" Vulnerable.

2.6 The development site is located within Flood Zone 1 as defined by the EA online Flood Map.

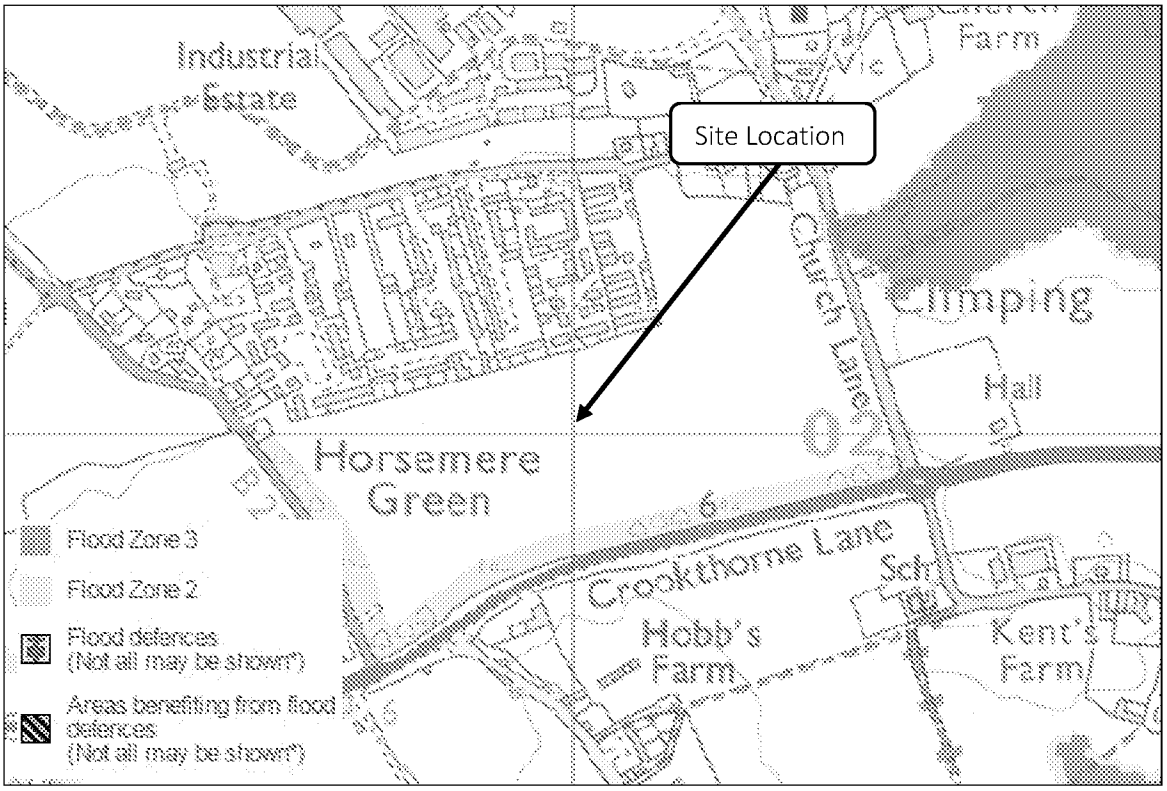


Figure 2: EA Flood Zone Map. (Source: EA Online, Oct 2016)

Geology

2.7 The British Geological Survey (BGS) Map indicates that the site geology is split into 2 distinct geologies.

2.8 The eastern half of the site has a bedrock geology of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation. With a superficial geology of raised beach deposits, formed of sand and gravel.

2.9 The western half of the site has a bedrock geology of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation. With a superficial geology of river terrace deposits, formed of sand, silt and clay.

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3. Sequential Test/Exception Test

3.1 Under the NPPF, the Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones as refined in the Strategic Flood Risk Assessment for the area provide the basis for applying the Test.

3.2 The test refers to the EA Flood Zones described in Table 4. 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 ***Functional Floodplain***	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 compatibility table above, the proposed development is both "More" and "Less" Vulnerable and located within Flood Zone 1 (as defined by the EA online Flood Map) and is therefore appropriate development for that zone. Development should be positioned sequentially wherever possible to the areas of lowest risk within each zone.

3.4 However, it is understood that the size is over 1Ha and as such the planning application submitted 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.

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4. Site Flood Hazards

Sources of Flooding

4.1 As outlined in Figure 2, the proposed development is located with Flood Zone 1 (Low Risk of flooding), and is considered to be both "More" and "Less" Vulnerable under the NPPF. Communication with the Environment Agency (EA) has identified the following potential sources of flooding to the site:

Source	Description
Fluvial/Tidal	Adjacent to site
Surface	On site
Groundwater	N/A
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 probability of fluvial or tidal flooding at the site is less than 0.1% annually (less than 1:1000). Figure 2 outlines only the potential floodplain; and the mitigating effects of flood defences currently in place are not considered.

River (Fluvial/Tidal)

4.3 The EA Flood Map for Planning (*Figure 2*) confirms that the site lies within Flood Zone 1 (Low Risk).

4.4 The nearest watercourses to the site are 2 unnamed drains, one located to the east of the site located some 140m at its closest proximity, and the other located to the north-west of the site located some 340m at its closest proximity.

4.5 The River Arun is located over 1km to the east of the site, and is tidal at this location.

4.6 A small area of Flood Zone 2 and 3 affects Church Lane which forms the eastern boundary of the site, due to the close proximity of the flood extents to the proposed development site specific EA data has been obtained and analysed.

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4.7 The data shows the site to be unaffected by flooding from the River Arun for the present day 1:200 year and 1:1000 year flood event.

4.8 Flood depths along Church Road to the east of the site have been shown to be between 0.04m and 0.18m during the present day 1:200 year flood event. No flood velocities have been made available to Ambiental at this time, however based on the flood depths only safe access / egress can be achieved from the development site along Church Road during the 1:200 year flood event.

4.9 There are no recorded flood events to have occurred in close proximity or at the site, based on EA data supplied.

4.10 The West Sussex SFRA produced in January 2010 does not provide any information with regards to historic flood event locations.

4.11 The Arun District Council SFRA updated in November 2016 however has produced a number of historic flood records maps, which provide locations of historic flood events. These maps are in a high resolution and as such it can be determined that there have been no incidents of tidal or fluvial flooding to have affected the site.

4.12 Following analysis of the available data it can be considered that the risk to the site at present day from fluvial/tidal flooding is **relatively low**.

Surface Water (Pluvial)

4.13 The EA's Flood Risk from Surface Water Map, now hosted on gov.uk, shows the majority of the site to be within a 'Very Low' risk of flooding from surface water area, with a less than 0.1% chance of flooding from this source annually.

4.14 There are small areas of 'Low' risk of flooding located within the site boundary, predominantly to the east of the site area; one located to the south-east corner and 2 small areas to the north-east corner, with an annual probability of flooding between 0.1% - 1% in these areas (*Figure 3*).

4.15 The EA's Flood Risk from Surface Water, High Risk (high chance of occurring) Event, Flood Depths Map shows no surface water flood depth across the site (*Figure 4*).

4.16 The West Sussex SFRA identifies the urban areas of Southwick, Shoreham, Worthing, Crawley, Horsham, Bognor Regis, Bosham, the Manhood Peninsula, Pulborough, Burgess Hill and Haywards Health to be at risk of surface water flooding within the county.

4.17 The Arun District Council SFRA's 'Surface Water Flood Risk' Map, Sheet 24 shows the site to be only affected by a 1:1000 year surface water flood event.

4.18 The SFRA's 'Historic Flooding Records' Map, Sheets 14 and 24 shows the site to have been unaffected by any surface water flood events, however there have been a number of incidents within the area surrounding the site *(SFRA Figure 5-6)*.

4.19 Taking into account the EA's Surface Water Flood Risk Map, the EA's Surface Water Depth (high chance of occurring) Map and the Arun District Council SFRA, the risk of surface water flooding to the site is deemed to be **relatively low**, with the risk of surface water flooding in the area immediately adjacent to the site deemed to be **moderate**.

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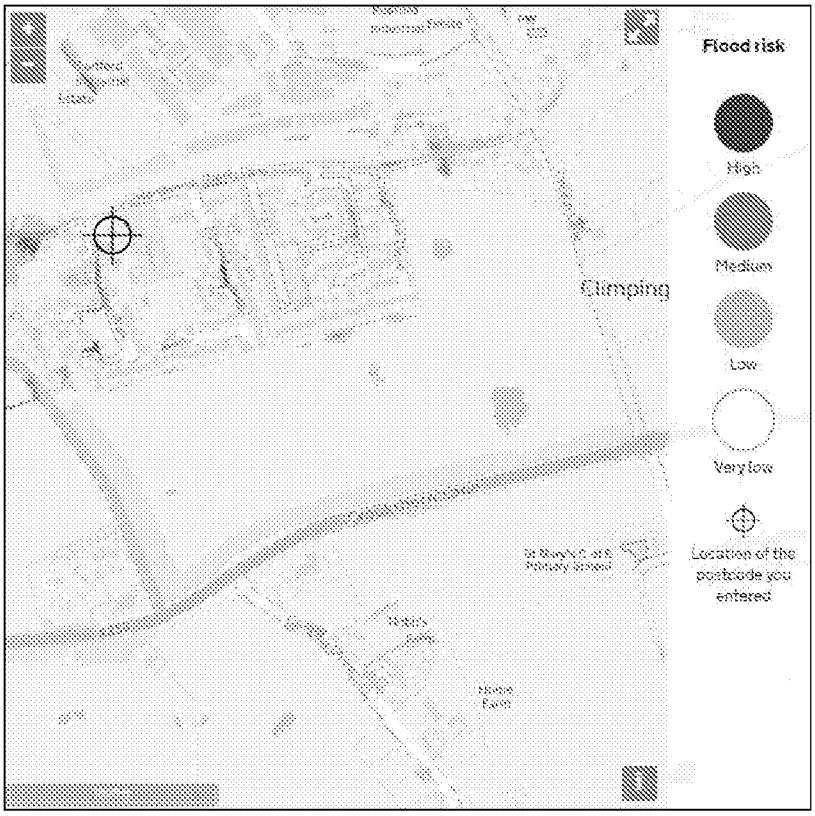


Figure 3: EA Flood Risk from Surface Water Map (Source: EA Online, Oct 2016)

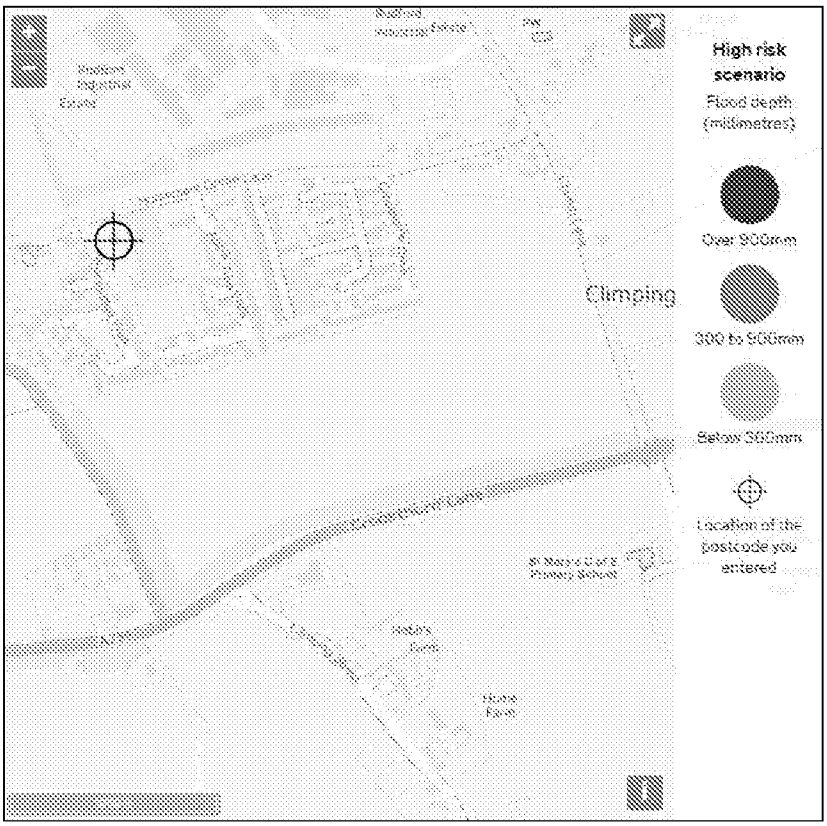


Figure 4: EA Flood Risk from Surface Water, High Risk (high chance) Depths Map (Source: EA Online, Oct 2016)

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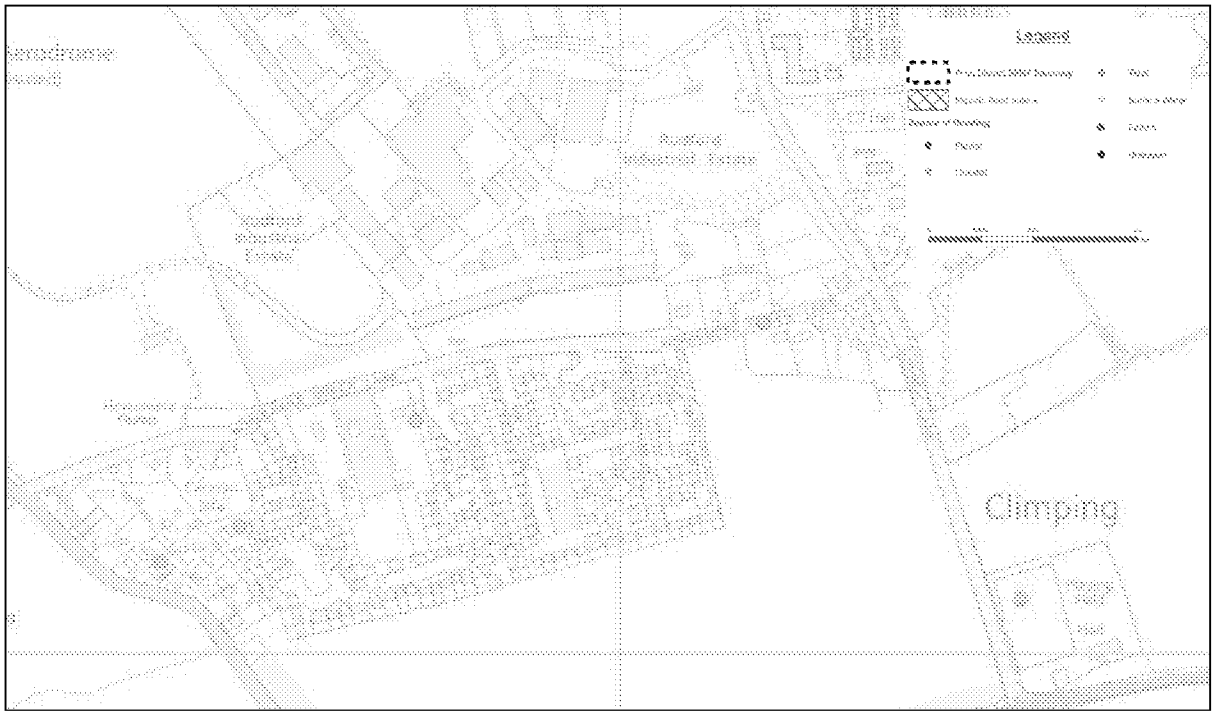


Figure 5: SFRA's 'Historic Flooding Records' Map, Sheet 24

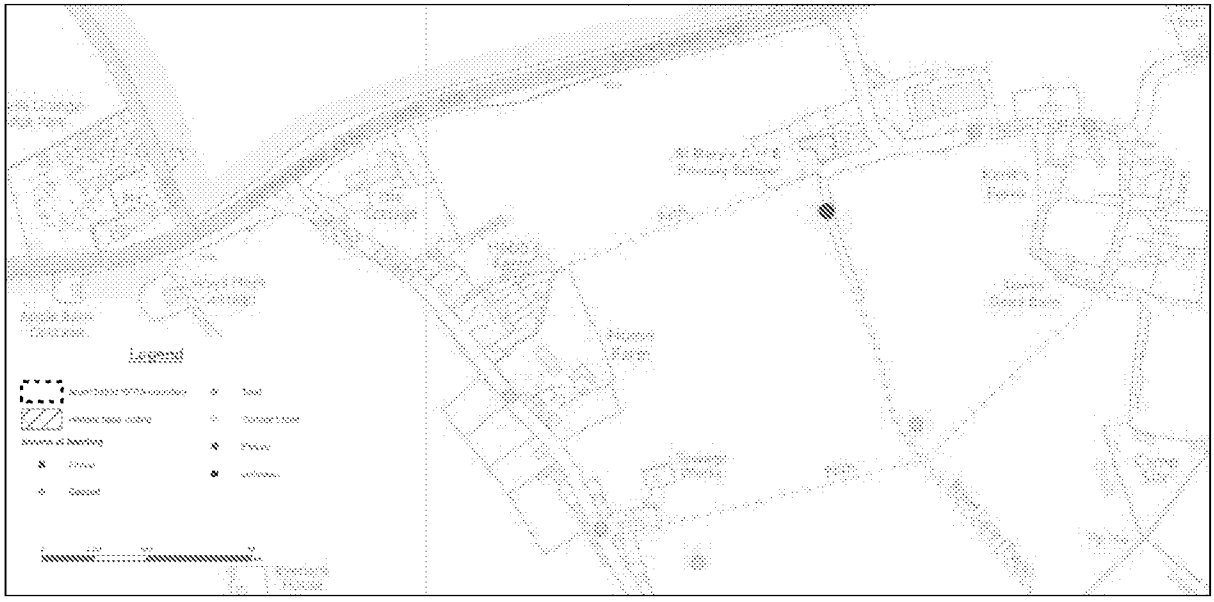


Figure 6: SFRA's 'Historic Flooding Records' Map, Sheet 14

Groundwater

4.20 The EA Groundwater Map shows that the site does not lie within a groundwater source protection zone.

4.21 The BGS Aquifer Map has classified the site's superficial geology as a 'Secondary A' aquifer defined as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers".

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4.22 The BGS Aquifer Map has classified the site's bedrock geology as a 'Principle' aquifer defined as "layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale".

4.23 The SFRA's Areas Susceptible to Groundwater' Map, Sheets 14 and 24 show the site to be located within an area of variable susceptibility to groundwater flooding. These maps are based on 1km^2 grid sections, with four of these grid squares intersecting within the site boundary.

4.24 The north east of the site is shown to have a <25% susceptibility to groundwater, with the north west shown as having >= 75% susceptibility. The southern half of the site is shown as having >=50% to <75% susceptibility to groundwater (Figure 7).



Figure 7: SFRA's 'Areas Susceptible to Groundwater' Map, Sheet 24

4.25 The earlier Arun District Council SFRA produced in 2008 states that "deep foundations, basements and underground infrastructure" will be most at risk from groundwater and that "the location of the emergence points cannot be accurately located".

4.26 The proposed development, based on the masterplan provided, does not appear to include any basements, or underground infrastructure and due to the small largely residential style of construction very deep foundations would appear to be unlikely to be required.

4.27 As such the proposed development would not appear to be at risk of groundwater except if a groundwater emergence point should become located within the site boundary.

4.28 As such the risk of flooding from this source to the development site is deemed **moderate.**

Sewer

4.29 The SFRA's 'Historic Flooding Records' Map, Sheets 14 and 24 do not specify sewer flooding sources, however it does specify a failure source and this could be linked to the failure of sewers *(SFRA Figure 5-6)*.

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4.30 No failure flood events have occurred within the proposed development boundary, however a single failure event has occurred within proximity to the southern boundary of the site, near St Mary's Primary School.

4.31 The proposed development is located on land currently used for agricultural use, as such it is unlikely any sewer connections exist for the site at present. It is deemed likely that the development will include additional sewer connections and as such communication with the local water authorities will be required as part of the planning application.

4.32 As such, given that there are no recorded sewer flood events to have occurred on site, that a relatively few incidents have occurred previously in the surrounding area and that communication will be sought with the local water companies regarding sewer outputs, the risk of sewer flooding to the site post development is deemed to be **relatively low**.

Surface Water Drainage Strategy

4.33 Under the NPPF, following development, surface water runoff rates should be equivalent to (or below) the existing site run-off rate for all events up to the 1 in 100 year storm event, with an allowance for climate change. The site is currently undeveloped agricultural land and as such this existing run-off rate will be the Greenfield run-off rate.

4.34 A Surface Water Drainage Strategy report has been undertaken based on the masterplan which has shown an increase of 150.21 litres/second runoff from the site post development for the 1:100 year 6 hour storm event with an allowance for climate change.

4.35 This increase in runoff rate from the site resulted in the development needing to provide a total of 3,143m^3 storage volume to limit the runoff rate from the site to the existing QBar Greenfield runoff rates as set out in the NPPF and Ciria SuDS Manual.

Foul Water Drainage Strategy

4.36 A foul water drainage scheme has been undertaken, and details of this are included within Ambiental Report 2495;

Records of Historical Flooding

4.37 Analysis of the EA's data shows no records of historical tidal or fluvial flooding to have affected the site or the surrounding area.

4.38 Analysis of the Arun District Council's SFRA shows records of both surface water and failure flooding within the immediate vicinity of the proposed development site.

4.39 No records of flooding from groundwater sources have been provided for the site or the surrounding area.

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5. Probability of Flooding

5.1 According to the low detail, national-scale flood mapping created on behalf of the EA the annual probability of fluvial flooding at the site is less than 0.1%.

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

Climate Change on Site

5.2 Climate change is likely to increase the flow in rivers, and raise sea levels and storm intensity.

5.3 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.

5.4 The EA have also stated that the climate change will increase the peak rainfall intensity allowance in small and urban catchments *(Table 5)*.

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Table 5: Peak Rainfall Intensity Allowance

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5.5 Given that the site is located in proximity to tidal flooding the existing flood levels and modelled extents have been deemed acceptable in relation to determining flood risk for the lifetime of the development.

5.6 Analysis of the site specific flood data provided by the EA has shown a small area of the site to be within the 'with climate change' 1:200 year (2115) flood extent.

5.7 Flood node points have been provided along Church Lane only, however analysis of the 1:200 year with climate change flood levels against the topographic levels within the area affected by the flood extent (4.30mAOD – 5.90mOD) has shown the flood depth on site to be between no depth and 0.84m.

5.8 The 2115 impact of tidal flooding to the development is deemed to be moderately high for those areas within the modelled 1:200 year with an allowance for climate change flood extent, however the developer has taken a sequential approach to the development and located as many units and structures outside of this flood extent. As such, based on the masterplan (drawing number P14 4899 01 REV C), a total of 4 structures are located within the modelled flood extent; 3 residential structures and 1 commercial structure. Given the flood extent is tidal in nature and providing floor levels are raised a minimum of 300mm above the predicted flood event (similar to adjacent properties) risk to the property can be mitigated. As the flood event is tidal in nature no flood plain mitigation is required as a result of this development.

5.9 Analysis of the available data has shown the remaining areas of the proposed development will remain located outside of all the modelled flood extents.

6. Residual Risks

Identification of 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.

6.2 The development is located within Flood Zone 1, in close proximity to Flood Zone 2 and 3. However the area does not benefit from flood defences and as such there is no residual risk of defence failure.

6.3 Analysis of the EA's Risk of Flooding from Reservoirs Map shows the site to be located outside of any maximum flood extents due to the failure of reservoirs.

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6.4 As such the only remaining residual risk to the site is that of drainage failure. A surface water drainage strategy (Ambiental SWDS 2322) has been undertaken as part of the planning process to allow surface water and the suitability of sustainable urban drainage systems to be analysed.

6.5 The indicative flow pathways across the site at present have been determined using remotely sensed LiDAR data to allow the developer to begin addressing the potential risks associated with drainage failure at this early stage.

6.6 The site is currently Greenfield and as such the residual risk of sewer failure will be addressed as part of the planning application in discussion with the local water companies as part of connection consent.

6.7 As such the residual risk from drainage failure to the site is deemed likely to be **not significant**.

7. Flood Risk Management Measures

7.1 The site is located within Flood Zone 1 (Low Risk) at present. The site will become partly located within the 1:200 year with an allowance for climate change (2115) in the future, based on the EA modelled flood data provided.

7.2 As such the part of the proposed development shown to be located within the 1:200 year flood with an allowance for climate change extent will be required to provide flood risk management measures. Due to the proposed development resulting in a net increase in impermeable area surface water runoff will also need to be addressed.

7.3 The controlling flooding mechanism within the sites location is tidal, from the River Arun.

7.4 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.

7.5 Given that part of the development is located within an area shown to be at risk of flooding during the 1:200 year flood event with an allowance for climate change (2115) flood mitigation measures may be required.

7.6 As such the developer/applicant is advised to implement the following measures should the current existing masterplan layout be maintained:

- Raise all external threshold on structures located outside of the 1:200 year with an allowance for climate change extent a minimum of 300mm above general ground level to protect against any potential surface water flows.
- Solid, i.e. concrete, floors on all ground floor levels to provide protection against groundwater flooding.
- For properties and structures location within the 1:200 year flood event with an allowance for climate change (2115) bring down electrical services from the ceiling at ground floor level.

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- For properties and structures location within the 1:200 year flood event with an allowance for climate change (2115) raise wiring and power outlets 600mm above floor level.
- For properties and structures location within the 1:200 year flood event with an allowance for climate change (2115) provide demountable flood barriers on all access points to provide protection to a minimum of 5.44mAOD (1:200 year +CC flood level plus 300mm freeboard allowance) OR raise the ground floor finish floor level to a minimum of 5.44mAOD to raise all habitable accommodation above the modelled flood level.
- For properties and structures location within the 1:200 year flood event with an allowance for climate change (2115) locate all sleeping accommodation at 1st floor or above.

Flood Warning and Evacuation Plan

7.7 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 property owners should:
  - Monitor the situation via local media;
  - Make themselves aware of forecast local weather conditions;
  - Alert others at the property of the situation;
  - Prepare to evacuate if necessary.
- On receipt of a **FLOOD WARNING**, the property owners should:
  - Follow advice to "go in, stay in, and tune in";
  - Be prepared to follow instruction form the Emergency Services.
- On receipt of a **SEVERE FLOOD WARNING**, the property owners 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.

7.8 Due to the primary flood risk to the site being tidal, it is likely, as discussed in more detail in point 7.4, that tidal flooding would not occur on site without several hours of notice.

7.9 On receipt of a severe flood warning residents and users of buildings located within the 1:200 year with an allowance for climate change flood extent are advised to locate any demountable flood barriers available to them and evacuate the area and travel across the site to the proposed new village hall which, based on the masterplan will be located well outside of the modelled flood extents and as such will provide a suitable location to remain until tidal flood levels recede (*Figure 8*).

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7.10 Should a flood event occur without prior warning, it is advised that site users or residents do not enter flood waters on site but to locate any demountable flood barriers possible and to egress to the upper floors of the properties, for safe refuge during an unexpected flood event.

7.11 The internal routes for each property for users to egress to upper floors should be maintained for the lifetime of the development. It is the responsibility of the site owner(s), and property owners to keep these routes known to all users.

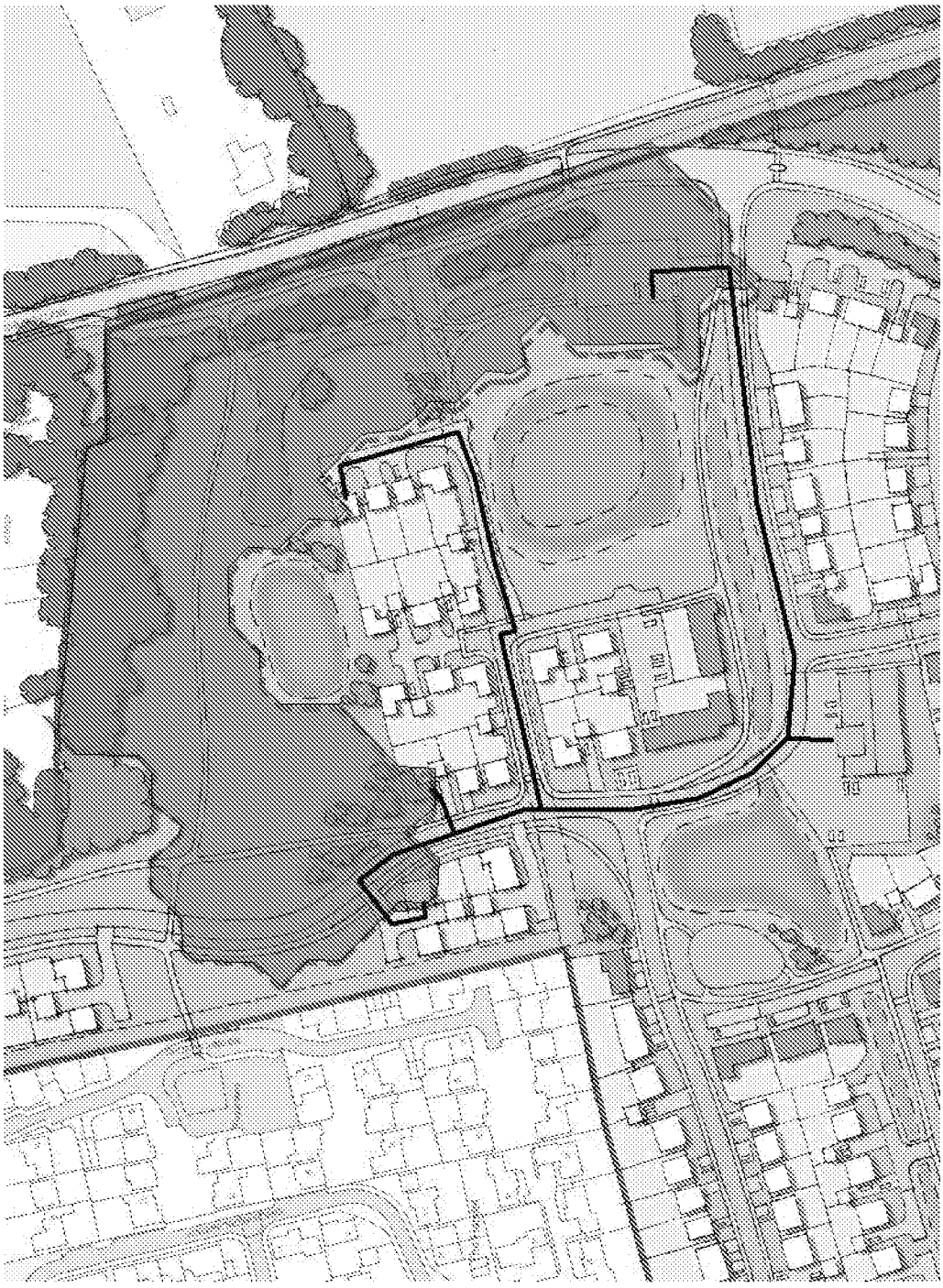


Figure 8: Proposed evacuation routes from properties affected by the 1:200 year flood event with an allowance for climate change (2115) shown with black line. Flood extent within site boundary shown in blue (Source: EA and jrp)

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8. Off Site Impacts

Impact to Flood Risk Elsewhere

8.1 Given that the site is located predominately within Flood Zone 1, and those areas located within the 1:200 year with an allowance for climate change are tidally controlled there is a no offsetting of flood storage, and thus; under the NPPF there is no requirement to provide compensatory flood storage.

8.2 As such, the proposed development will have no impact with regards to flood-plain storage capacity and on the hydraulics of local watercourses.

Generation of Runoff

8.3 Under the NPPF, following development, surface water runoff rates should be equivalent to (or below) the existing site run-off rate for all events up to the 1 in 100 year storm event, with an allowance for climate change. The site is currently undeveloped agricultural land and as such this existing run-off rate will be the QBar Greenfield run-off rate.

8.4 At an early stage in the development a Surface Water Drainage Strategy has been undertaken based on the masterplan which has shown an increase of 150.21 litres/second runoff from the site post development for the 1:100 year 6 hour storm event with an allowance for climate change.

8.5 This increase in runoff rate from the site resulted in the development needing to provide a total of 3,143m^3 storage volume to limit the runoff rate from the site to the existing QBar Greenfield runoff rates as set out in the NPPF and Ciria SuDS Manual.

8.6 Storage should ideally be provided outside the 1in200yr flood area extent if feasible.

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9. Conclusion

9.1 Ambiental Technical Solutions Limited has been appointed by Parker Dann to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the development on land adjacent to Church Lane, Clymping, West Sussex.

9.2 The existing site is currently undeveloped land currently used for agricultural use and is as such deemed to be Greenfield.

9.3 The proposed development is for the construction of a new area of Clymping to include residential development, community facilities, as well as amenity spaces. There will be a total of 300 residential dwellings created, 450m^2 of commercial space and a community building approximately 700m^2 in size at ground floor.

9.4 This study is based on the feasibility illustrative masterplan provided to Ambiental, dated June 2016, drawing number P14 4899 01 REV C.

9.5 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 site is located within Flood Zone 1 (Low Risk) and is considered to be predominantly a 'More Vulnerable' (residential) development under the NPPF.

9.6 The NPPF requires any planning application for new or re-development within a Flood Zone 1, over 1Ha in size to be accompanied by a FRA to demonstrate that the development can be achieved in a sustainable manner, with an overall reduction of flood risk to the site and surrounding area.

9.7 The present day impact to the development site from tidal and sewer flooding is deemed to be **relatively low**. The impact to the development from groundwater and surface water flooding is deemed to be **potentially moderate**.

9.8 The 2115 impact of tidal flooding to the development is deemed to be moderately high for those areas within the modelled 1:200 year with an allowance for climate change flood extent, however the developer has taken a sequential approach to the development and located as many units and structures outside of this flood extent. As such, based on the masterplan (drawing number P14 4899 01 REV C), a total of 4 structures are located within the modelled flood extent; 3 residential structures and 1 commercial structure.

9.9 A surface water drainage strategy report has been completed for the site based on the masterplan to provide an understanding of the natural surface water flow directions across the site, the volume of storage potentially required post development and the suitable SuDS components based on the development type and site location. See Ambiental SWDS report 2322.

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9.10 As such, and given that:

- The site is located within the present day Flood Zone 1, as of October 2016;
- A surface water drainage strategy assessment has been completed, and demonstrates the volume of water generated by development can be mitigated on-site (See Ambiental SWDS 2322);
- A foul water drainage scheme has been undertaken, and details of this are included within Ambiental Report 2495;
- Ground floor thresholds and internal finished floor levels shall be raised a minimum of 300mm above the general ground level for all structures on site to account for potential surface water flow in the future; and a minimum of 300mm above the predicted 1in200yr tidal flood event.
- The potential flood risk from tidal flooding in the future (2115) has been analysed and various flood management and mitigation methods have been proposed for those structures affected, and;
- A flood warning and evacuation plan has been set out based on the existing masterplan for those site users affected by the 1:200 year flood event 2115;

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

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.

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Appendix A – Supporting Information

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Appendix A, Figure 5: Arun District Council SFRA, 2016 - Surface Water Flood Risk Map, sheet 24 27

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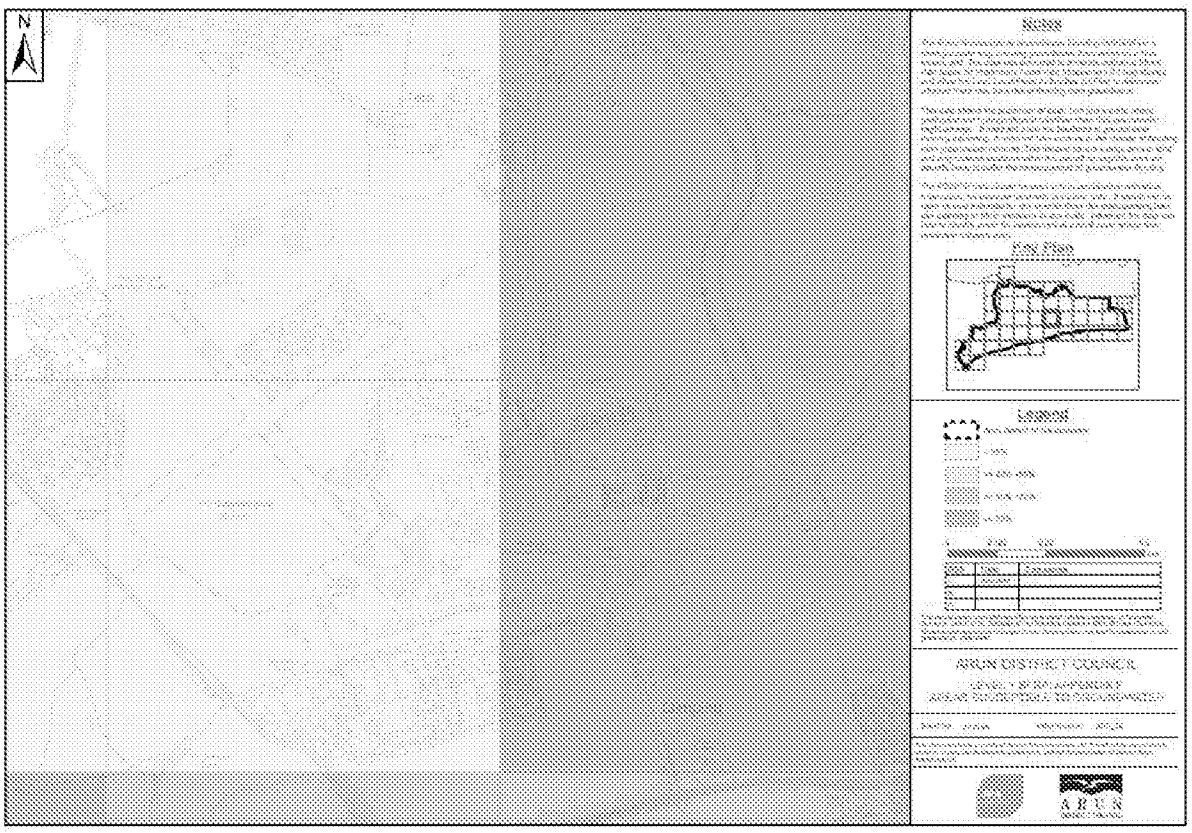
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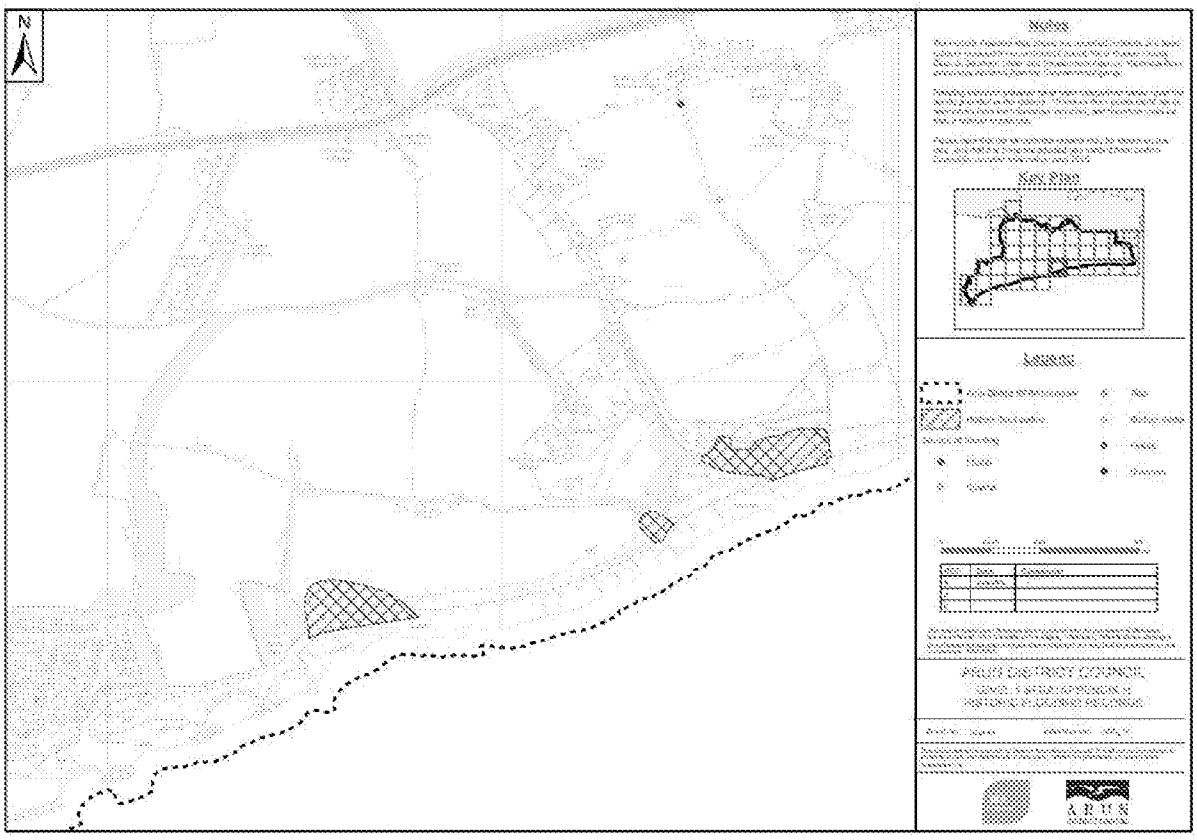
Appendix A, Figure 1: Proposed Site Masterplan (Source: jrp)

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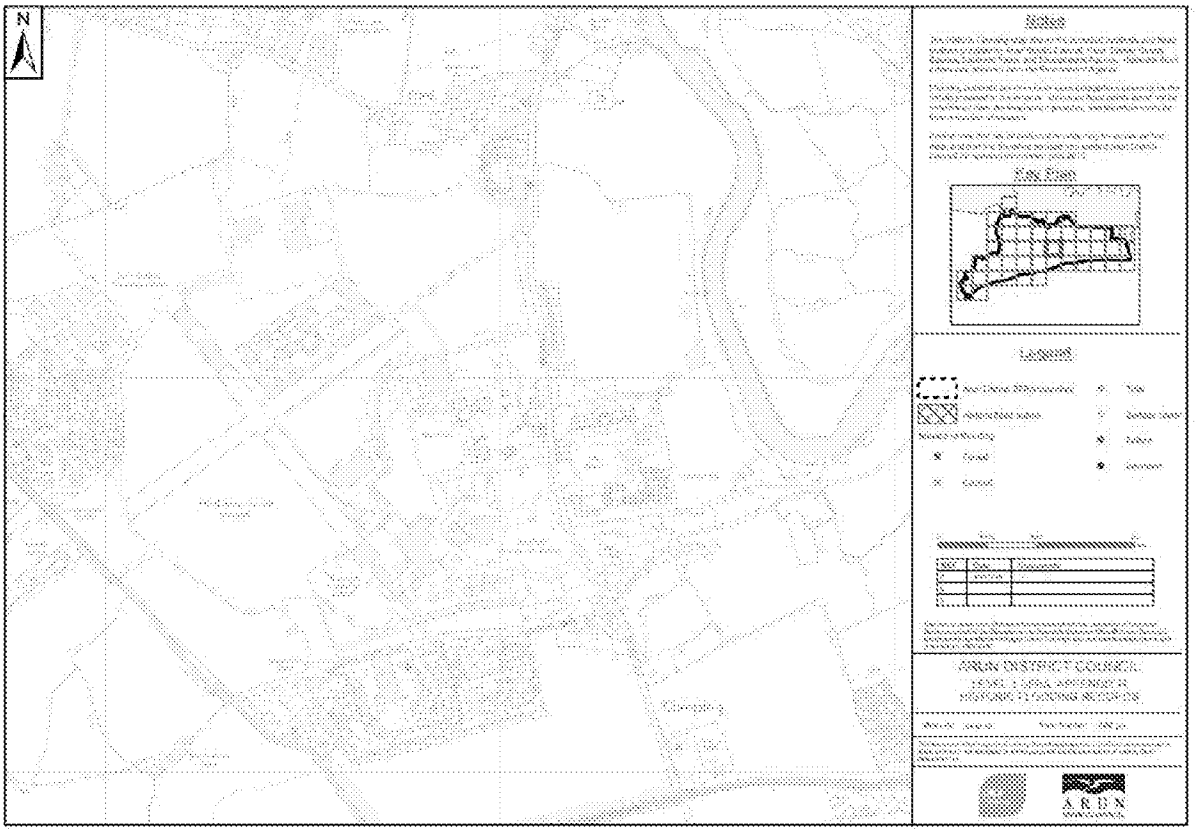
Appendix A, Figure 2: Arun District Council SFRA 2016 – Areas Susceptible to Groundwater, Sheet 24



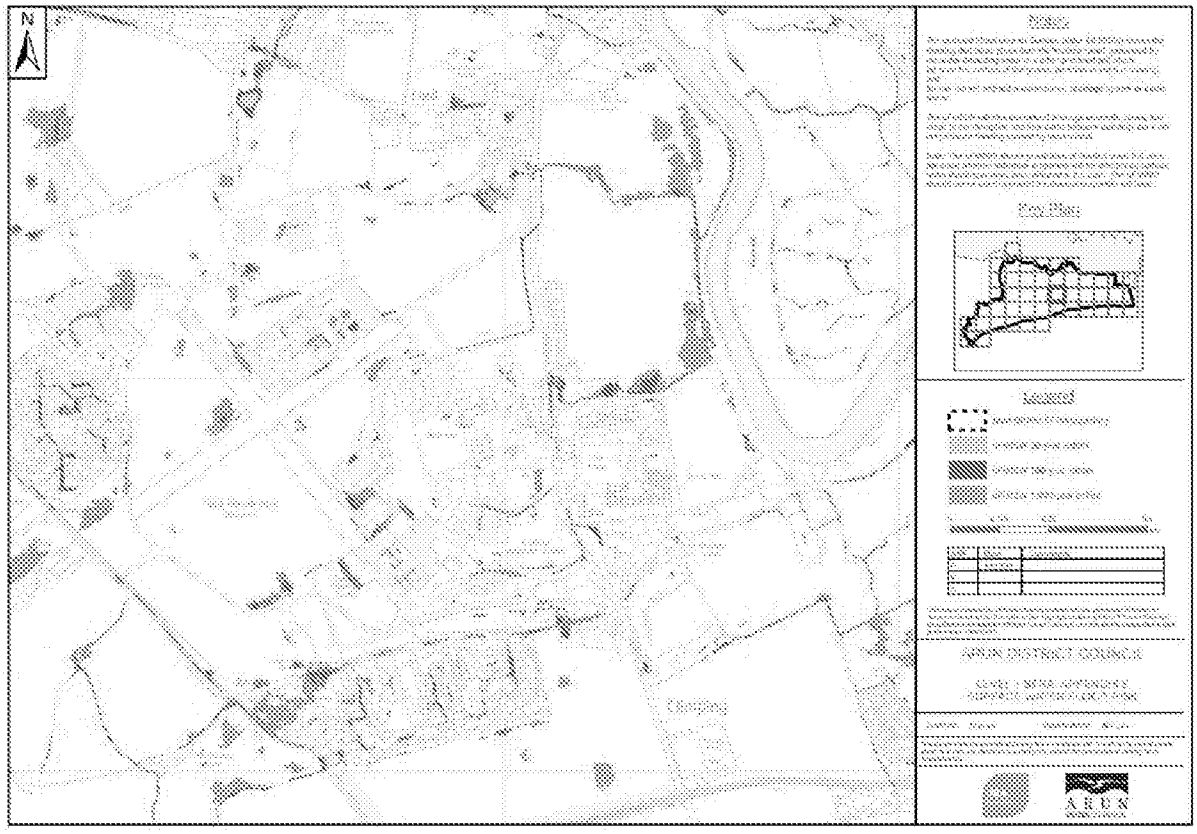
Appendix A, Figure 3: Arun District Council SFRA, 2016 - Historic Flooding Records, Sheet 14

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Appendix A, Figure 4: Arun District Council SFRA, 2016 - Historic Flooding Records, Sheet 24

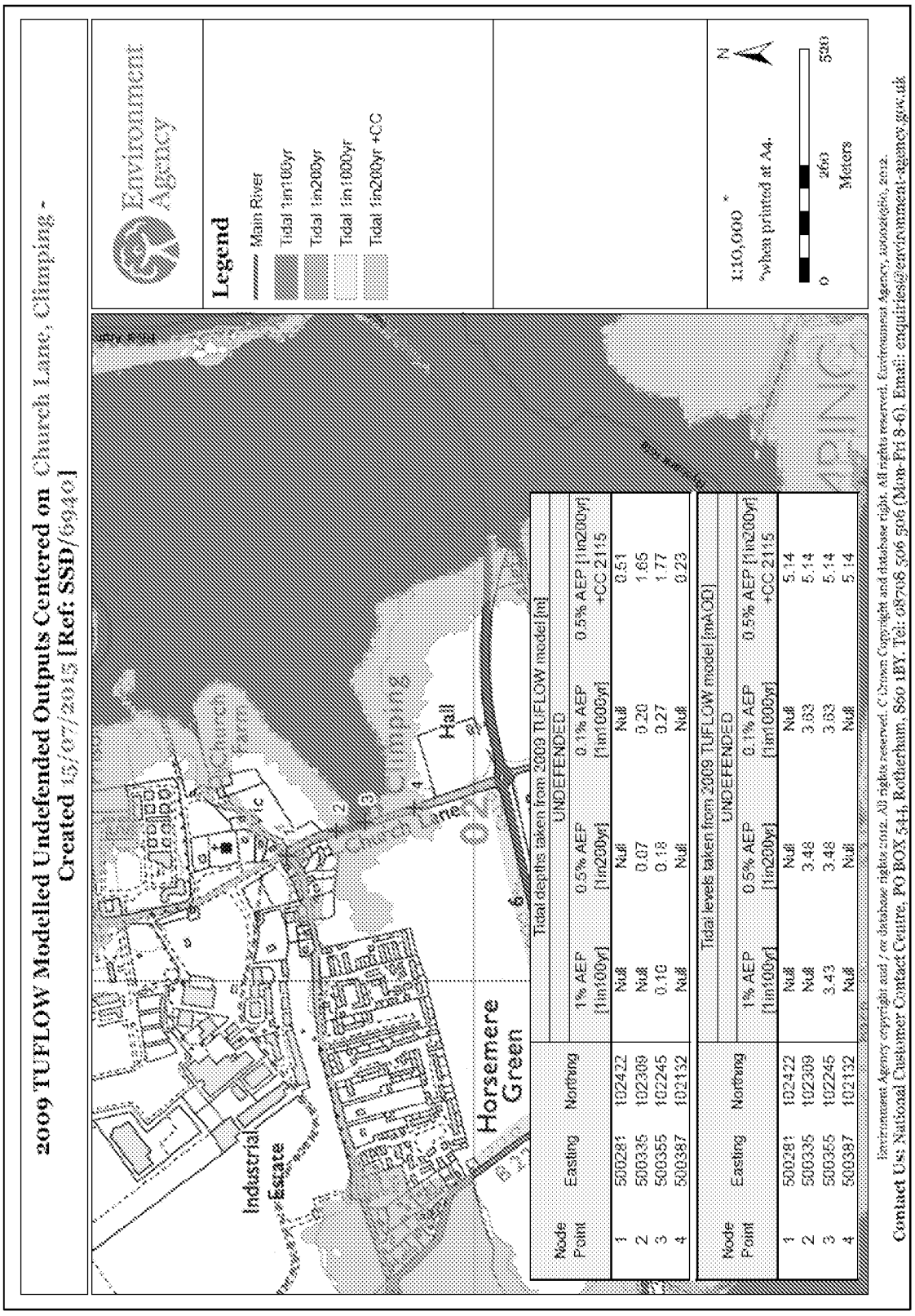


Appendix A, Figure 5: Arun District Council SFRA, 2016 - Surface Water Flood Risk Map, sheet 24

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Appendix B – EA Data



Appendix B; Figure 1: Modelled undefended outputs centred on Church Lane (Source: EA)

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Appendix C – 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

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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.

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