

Foul & Surface Water Drainage Report and Flood Risk Assessment

Ford Road East, Littlehampton

For

HAWES CONSTRUCTION GROUP

Rev - P

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1 INTRODUCTION

- 1.1 The following report is a Phase 1 Flood Risk Assessment (FRA) for the proposals at Fort Road Garage, Fort Road East, Littlehampton, West Sussex, BN17 7QZ (see site location map, Figure 1).
- 1.2 This assessment has been requested to inform the planning permission sought for a demolition of the existing building and construction of new industrial unit. An FRA is required under the National Planning Policy Framework (NPPF) and the Arun District Council and West Sussex County Council (WSCC) given that the site is shown to be partially located within Flood Zone 2 and 3.
- 1.3 The purpose of this FRA is to inform the feasibility and appropriateness of the proposals given the location of the site being within Flood Zone 2 and 3 and to ensure development proposals incorporate flood resilient measures appropriate to its flood risk.

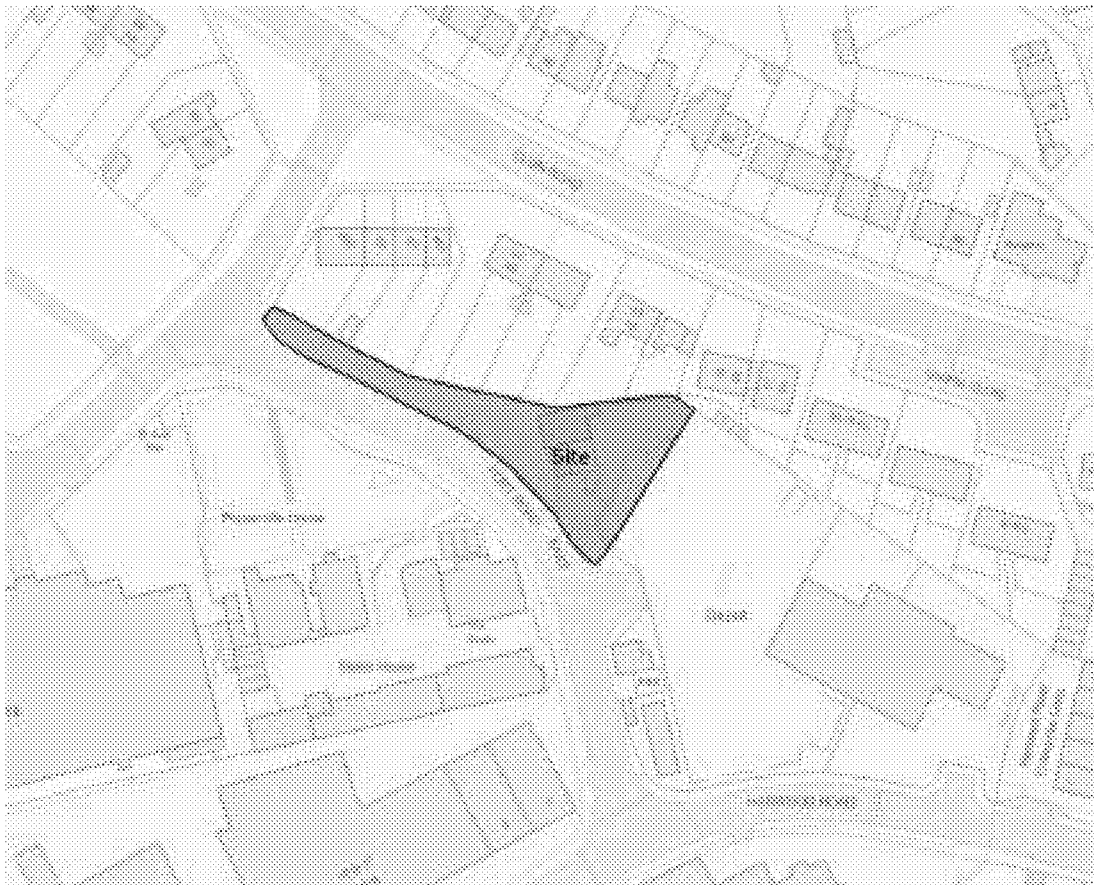


Figure 1 - Site Location Plan (site bordered red) - Source Magic Map

- 1.4 This FRA has been written in accordance with the National Planning Policy Framework (NPPF) and its Technical Guidance, Environment Agency (EA) Standing Advice and the WSCC guidance. This report has relied upon information presented within the WSCC (2012) Level 1 SFRA and the EA's Risk of Flooding from Surface Water (RoFSW) data sets.

DEVELOPMENT PROPOSALS

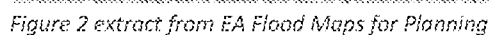
- 1.5 At present, it is understood that the development proposals are for the demolition of the existing commercial property and construction of the new industrial unit.
- 1.6 It is understood that a development of this nature has design life of 60 years (design epoch 2081) and is classified as a 'Minor Development' under the NPPF.

FLOOD RISK VULNERABILITY

- 1.7 This FRA has been undertaken with due regard to the statutory requirements of the NPPF and with reference to the Planning Practice Guidance (PPG) in relation to development and flood risk. This FRA aims to ensure that flood risk is considered and to avoid inappropriate development in areas potentially at risk of flooding.
- 1.8 Table 2: Flood Risk Vulnerability Classification of the PPG provides guidance on assigning development vulnerability. Based on the proposed commercial use it is considered that the proposals are 'Less Vulnerable'.
- 1.9 The existing sites classification is deemed to be 'Less Vulnerable' as commercial use, in accordance with the NPPF. The proposals will not change the existing use and therefore vulnerability will also remain as 'Less Vulnerable' post development.

SEQUENTIAL TEST/EXCEPTION TEST

- 1.10 The EA have designated different areas of the UK based on specific risk to assist and steer developments, these are:
- ⇒ Flood Zone 1 - land assessed as having a less than a 1 in 1,000 annual probability of river or sea flooding (<0.1%)
 - ⇒ Flood Zone 2 - land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year
 - ⇒ Flood Zone 3 - 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. Flood Zone 3b is land have greater than 1 in 20 annual probability of flooding.
- 1.11 According to NPPF footnote 20, a site-specific FRA should be prepared when the application site is:
- Situated in Flood Zone 2 and 3; for all proposals of new development (including minor development and change of use); or
 - Greater than 1 ha in size and located in Flood Zone 1; or
 - Located in Flood Zone 1 where there are critical drainage problems or within a designated Critical Drainage Area (CDA) as notified to the LPA by the Environment Agency; or
 - At risk of flooding from other sources of flooding, such as those identified in this SFRA; or
 - Where surface water flood risk exists, detailed surface water modelling may be required; or
 - Subject to a change of use to a higher vulnerability classification which may be subject to other sources of flooding.
- 1.12 Based on the EAs Flood Map for Planning (Figure 2 below), the WSCC SFRA, the site is partially located within Flood Zone 2 and 3 and therefore considered to be at medium to high risk of flooding from rivers and seas.



- Table 1 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; x means the development should not be permitted and should be subject to a full sequential test.*

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

- ARUN DISTRICT

2 LOCAL FEATURES

LOCALITY

- 2.1 The application site is located on the edge of a commercial area close to residential properties (which form its northern boundary). The site occupies a total area of 0.79 ha and is bounded on the South West by Fort Road East, and to the west existing commercial and industrial use.
- 2.2 The site context, two storey flats and houses are located to the north along Clun Road, a refuse vehicle depot to the south east and a community building to the south west.
- 2.3 The site lies within the administrative boundary of Arun District Council (WSCC) for planning purposes.

RIVERS AND WATERCOURSES

- 2.4 The nearest identified watercourse to the site appears to be the River Arun, located approximately 300m to the south (at its closest). There also appears to be a number some partially culverted watercourses that feed into the River Arun as part of the wider industrial use of the area. The site is located in the South East River Basin.
- 2.5 The South East river basin district covers over 10,200km² and extends from Hampshire in the west to Kent in the east. It includes East and West Sussex, the Isle of Wight and parts of Wiltshire and Surrey. In total over 3.5 million people live and work in the south east, which is densely populated and includes the major urban centres of Southampton, Portsmouth, Ashford, Brighton and Hove. The South East river basin district has a rich diversity of wildlife and habitats, supporting many species of global and national importance. These include migratory salmon rivers, native white clawed crayfish, and estuaries and coastal waters important for shellfish, wintering wildfowl, breeding gulls and terns. The management catchments that make up the river basin district include many interconnected rivers, lakes, groundwater, estuarine and coastal waters. These catchments range from chalk streams of the Test and Itchen catchments to the modified rivers of the Rother catchment

TOPOGRAPHY

- 2.6 Topographic survey provided by the client (see Appendix 1). The site's levels fall from the northern boundary (at approximately 4.90mAOD to the southern boundary with Fort Road East at approximately 3mAOD at the south eastern corner of the site. Wider site levels generally fall to the south and west towards the coast and the Arun River.

GEOLOGY & HYDROGEOLOGY

- 2.7 The BGS's online map shows the site's bedrock is ewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (undifferentiated) - Chalk. There are Raised Marine Deposits - Clay, Silt, Sand and Gravel superficial deposits recorded. The SoilScapes (England) data suggests the topsoil's in this location are freely draining. It is likely that this soil type will possess infiltration characteristics, at the time of writing it is unclear what the current groundwater levels and soil permeability are, and therefore should be investigated further.
- 2.8 An intrusive ground investigation has been conducted at the site by Your Environment (ref; YEX1978) dated 22 March 2021.
- 2.9 The ground investigation confirmed the proposed development site is underlain by Raised Marine Deposits and bedrock deposits recorded as the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation.
- 2.10 During the site investigation, three soakage tests in one trial pit were conducted.
- 2.11 A ground investigation summary showing where trial pits were undertaken and the findings is shown in Appendix 2

2.12 The following BRE 365 infiltration test results were recorded onsite;

Trial Pit Location	Infiltration Result
TP01	4.05×10^{-5} m/s
	3.60×10^{-5} m/s
	3.10×10^{-5} m/s

2.13 Groundwater was not encountered during the site investigation.

2.14 Based on the intrusive site investigation, the development site is underlain by Orange and mottled yellow Sand down to 1.7m BGL.

2.15 According to the EA's Magic Map, the aquifer typology in the Bedrock is Principle with Medium Vulnerability, but with risk of soluble rock. The site is not located in an Environment Agency designated Source Protection Zone. These designations relate to the sensitivity of the underlying aquifers to contamination from development. However, given that the development proposals will be generally low impact, it is unlikely (assuming proper construction precautions are followed) that there will be a negative impact on the underlying hydrogeology.

FLOOD DEFENCES

2.16 The Environment Agency releases a range of flood asset information as Open Data through their AIMS Defence (Spatial Flood Defences) GIS mapping. They are the only comprehensive and up-to-date group of datasets in England that show flood defences currently owned, managed or inspected by the EA.

2.17 Figure 3 provides an extract from EA AIMS Defence data (2021). This data shows that the River Arun at this location has defences along most of its length in the various forms. The standard of protection (SOP) these defences provide are up to the 1 in 300 year event, with defences in moderate condition and privately maintained.

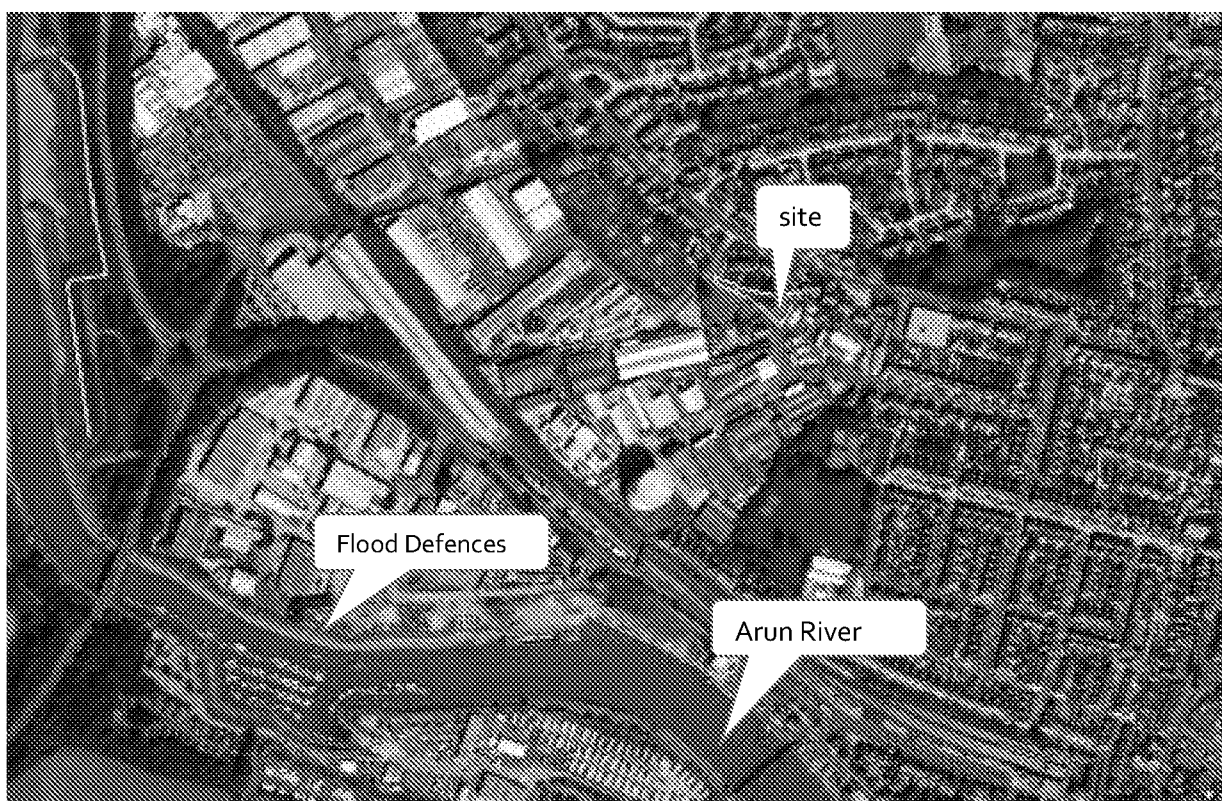


Figure 3 - Extract from EA AIMS Defence Dataset. Site edge yellow, defences shown in red.

2.18 The EA has provided a map and a detailed legend regarding the type of defences nearby the site, these are included in Appendix 1.

- 3.19 To remain conservative and to consider the worst case situation (i.e. defence failure), this FRA has also assessed flood risk assuming these defences are not present (i.e. assessed the undefended scenario).

3 SOURCES OF FLOOD RISK

- 3.1 In order to assist the implementation of the Government's NPPF, the EA and local councils have undertaken national scale flood risk mapping. This mapping considers a range of sources including flooding from rivers, sea/tidal, surface water and reservoir breach. Furthermore, each council produces a Strategic (county scale) Flood Risk Assessments (SFRA) that aim to specifically identify local flood risk issues (such as critical drainage areas and local groundwater flooding). This FRA has reviewed these sources to identify and (where possible) quantify the flood risk to the site.

- 3.2 The following section reviews both the EA data as well as information available from the local SFRA.

FLUVIAL AND TIDAL

- 3.3 The EA have undertaken fluvial and tidal modelling of the nation's main rivers in flood to support and ensure developments are steered away from flood prone areas or are designed to ensure risk to people is not increased as a result.
- 3.4 The EA's Flood Maps for Planning shows that the site is located within Flood Zone 2 and 3 (see Figure 2) and as such represents the site having a risk of flooding from river or sea > 0.5%. The EA data demonstrates that the primary source of flood risk at this location is from a tidal surge.
- 3.5 It should be noted that the EA's Flood Maps for Planning do not allow for the presence of defences and so illustrate a conservative representation of flood risk from rivers or seas.

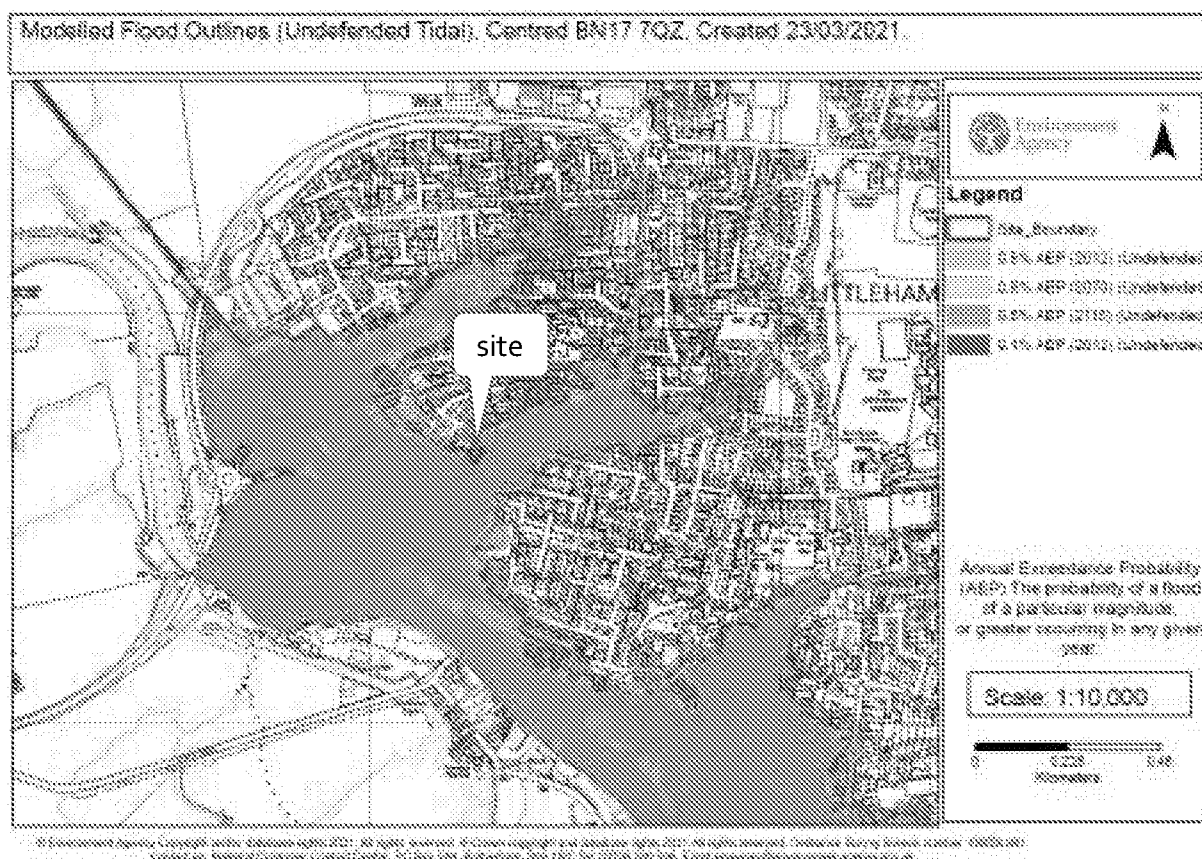


Figure 4 - Extract from EA Product 4 - Defended Scenario

- 3.6 The EA has provided extracts from its Arun to Adur Coastal Modelling which was completed by JBA Consulting in 2012. This model output presents the both the defended and undefended flood model scenarios for the area, with climate change impacts (based on 2012 estimates to 2115 design horizon).
- 3.7 Figure 4 presents the current undefended scenario and shows that the site could be marginally affected by the 1 in 200 (0.5% AEP) event, however, Figure 5 below shows that the site would be wholly defended in the same equivalent event.

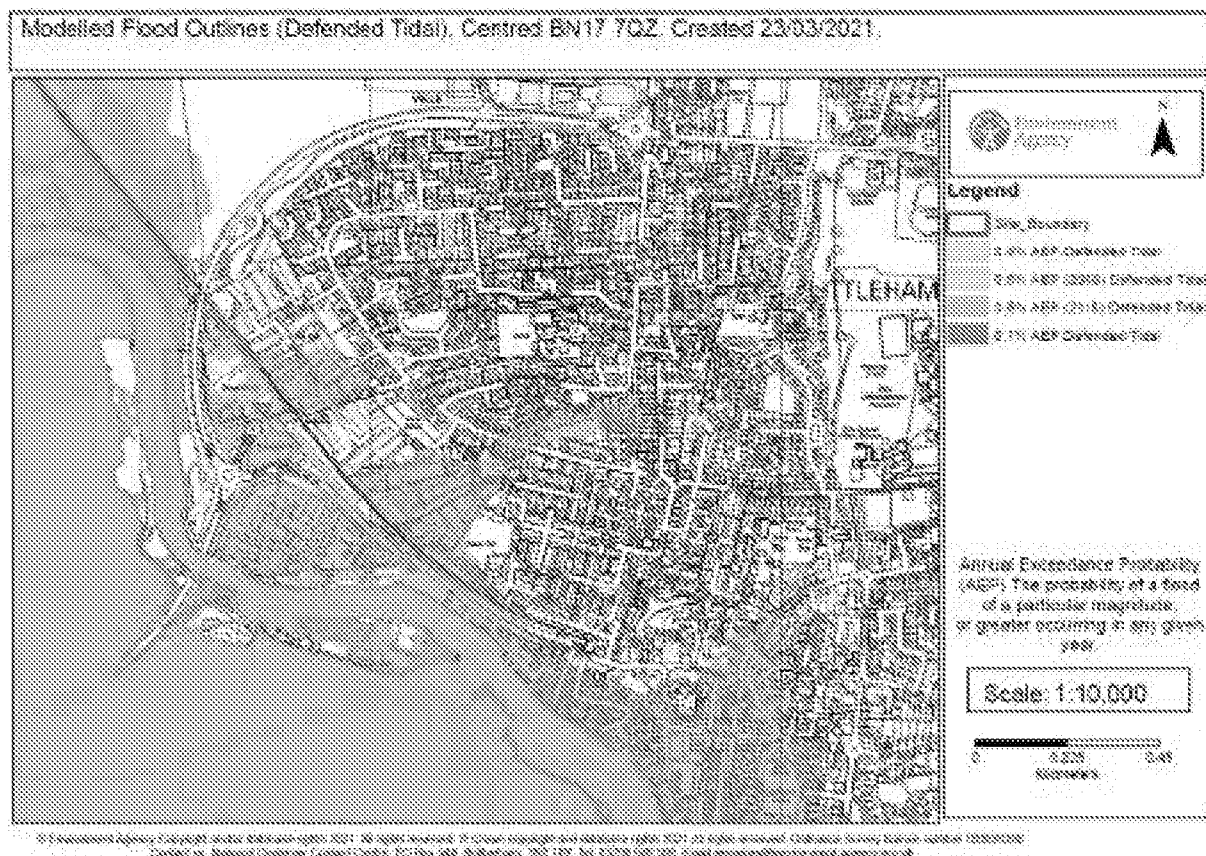


Figure 5 - Extract from EA Product 4 - Defended Scenario

- 3.8 Specifically, for the site, the EA has provided Node data to determine predicted flood depths across a number of event scenarios. Figure 6 below shows the node locations and corresponding depths taking from the EA model. This data shows, when compared to the site's topographic information the following:

- The site is defended for the present day and to the 2065 (climate change) design horizon for all modelled events (defended and undefended)
- In the event of defence failure, most of the site would remain above the modelled 2012 design event with only the south eastern corner of the site being affected.
- In the event of defence failure, much of the site would remain above the 2115 modelled water level being 4.88mAOD, with the existing building and much of the land along the northern boundary being situated at approximate 4.90mAOD and above. The primary areas affected being along the boundary with Fort Road East and the south eastern corner of the site.

Table 2: Water Levels Total DamagedTable 3. Water Deaths: Total UnsubstantiatedTable 4: Water Effects: Total Dissolved

Figure 6 - EA Product 4 Data Extract showing assessed node locations and corresponding depths and levels

Climate Change

- 3.9 A review of the current climate change impacts as detailed in the Governments *Flood risk assessments: climate change allowances*, state climate change impacts for tidally affected sites within the South East River Basin and for developments of a less vulnerable nature, to a design horizon of 2066 to 2095, is a cumulative sea level rise 0.81m. Adding this onto the worst case undefended 0.5% AEP event level of 3.72mAOD, gives a climate change based impact level of 4.53mAOD. Given that the majority of the sites levels are situated above 4.53mAOD, it is considered that even in the highly unlikely event of complete defence failure the site would remain largely unaffected by flooding for the design horizon, except for small areas along the boundary with Fort Road East and within the south eastern corner of the site which are topographically below 4.53mAOD.
- 3.10 Furthermore, from Littlehampton to Brighton, the Beachy Head to Selsey Bill Shoreline Management Plan (2006) covers the length of the coastline in the Adur and Worthing Local Plan areas in terms of what protection is offered and how it is maintained, which has a long term policy of 'Hold the Line' for the whole area. This means that the current standard of protection offered through tidally affected areas within the plan catchment will maintain their current level of protection (that is the 1 in 300 year event at this location), therefore current defences will be maintained for the life of the development offering a minimum 1 in 300 SoP.
- 3.11 Therefore, although the EA Flood Maps for Planning show the site is largely affected by Flood Zone 2 and 3, a closer review of the sites topographic levels and review of development specific design horizons, show that the majority of the site would remain unaffected by flooding in both the defended and undefended scenarios and also when considering climate change. However, it would be recommended that any new structures have a minimum finish floor level no lower than 4.53mAOD.

PLUVIAL (SURFACE WATER)

- 3.12 Surface water flooding is the term applied to flooding when intense rainfall overwhelms the ability of the land to infiltrate water, or in urban areas for the sewers and road drains to drain the water away, resulting in surface water runoff and consequent flooding. It is a particular problem in urban areas where the excess water will often travel along streets and paths, between and through buildings and across open space. It can result in indiscriminate flooding to properties when not controlled. The high profile flooding across the UK in the summer of 2007 was largely attributed to excess runoff where the capacity of the drains was exceeded by intense summer rain storms and led to the Government commissioning the independent Pitt Review in 2008.
- 3.13 These Maps use remotely sensed LiDAR data to determine large areas of topography. In all urban areas this LiDAR has been edited to remove the buildings. This editing process results in a slightly un-even surface profile, which can result in the production of small depressions that fill with water but in reality, are not at risk of surface water flooding. This should be taken into account where very localised areas of flooding are evident and are independent of wider surface water flood flows and routes.
- 3.14 The EA has produced national scale surface water flood risk mapping. This mapping shows 3 event scenarios for the 1 in 30 (3.3% chance of occurring in any one year) return period (high risk – Figure 7), 1 in 100 (1% chance of occurring in any one year) return period (medium risk – Figure 8) and 1 in 1000 (0.1% chance of occurring in any one year) return period (low risk – Figure 9).
- 3.15 The high risk scenario shows the site is unaffected by surface water flooding.

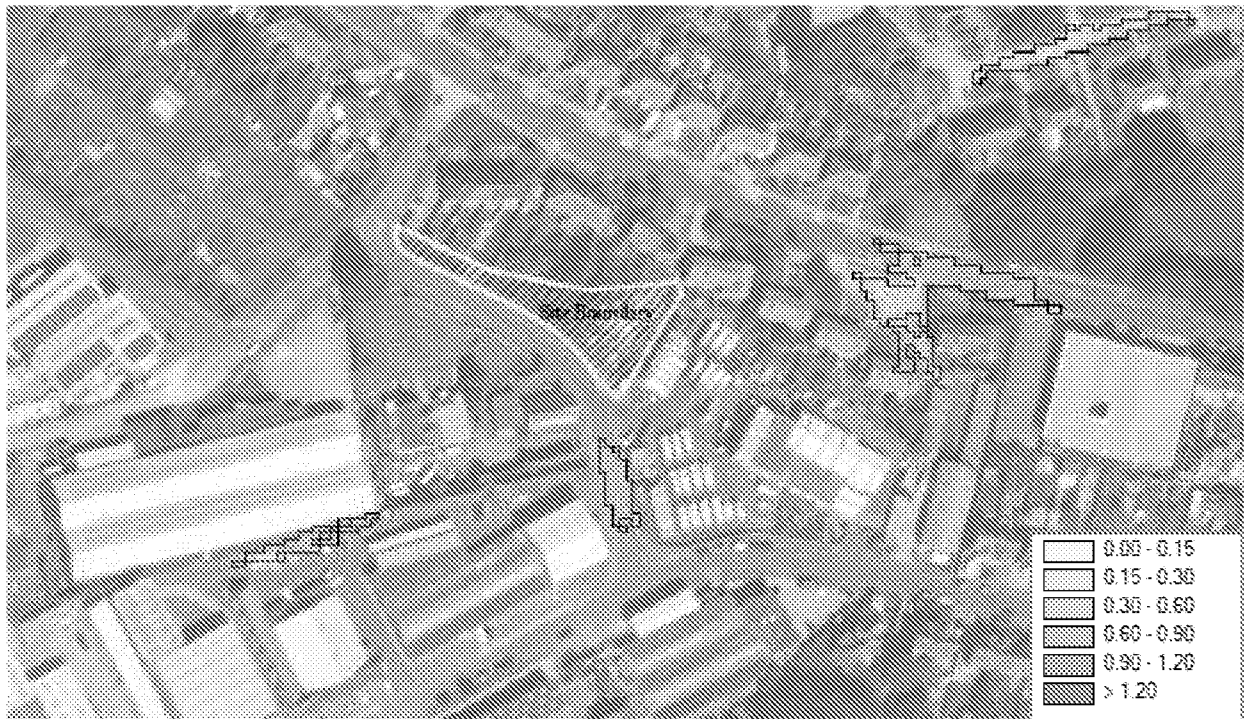


Figure 7 EA Long Term Flood Risk Maps (Extents) – High Risk of surface water flooding (source: Risk of Flooding from Surface Water (RoFSW))

- 3.16 The medium risk scenario (Figure 8), is similar in nature to the high risk scenario, with the site remaining wholly unaffected by surface water flooding.

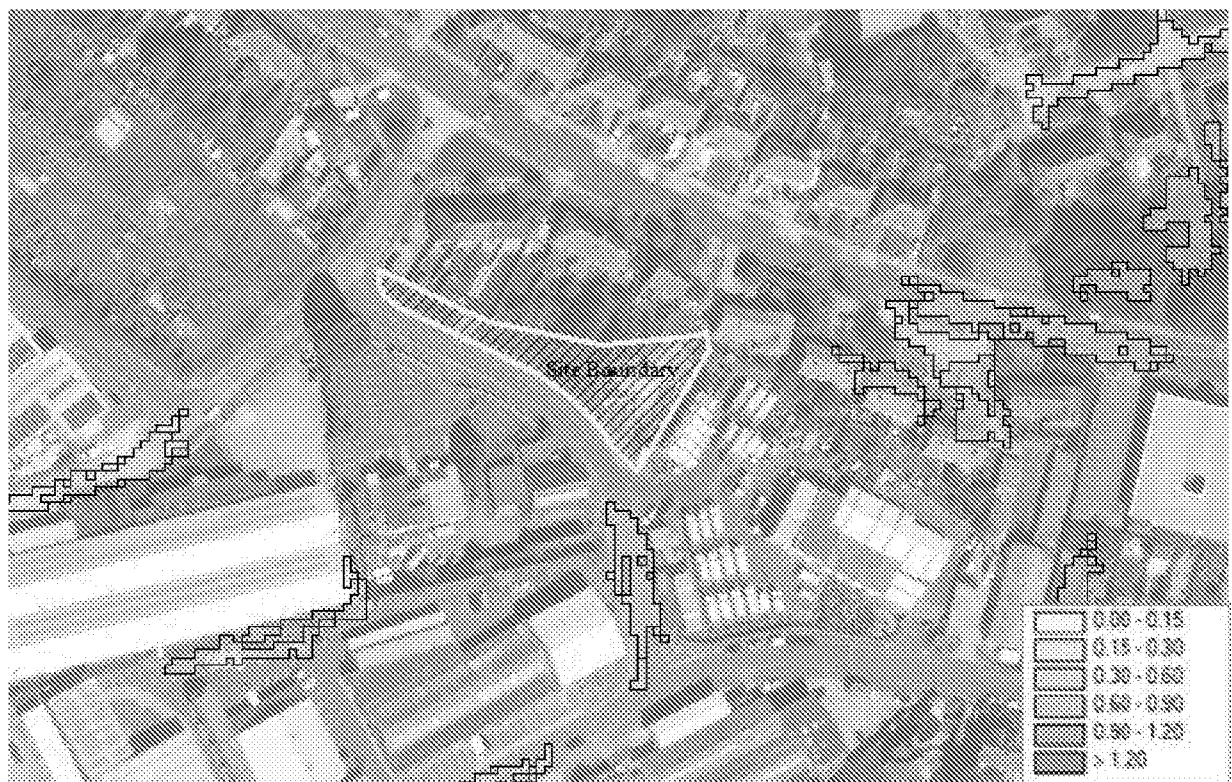


Figure 8 EA Long Term Flood Risk Maps – Medium Risk of surface water flooding (source: Risk of Flooding from Surface Water (RoFSW))

- 3.17 The low risk scenario (1 in 1000 year event) shows that the site remains unaffected by surface water flooding (see Figure 9). Although, overland flow paths are evident to the south of the site which are directed from the east to the west and into the Arun. However these overland flow paths do not directly affect the site.



Figure 9 EA Long Term Flood Risk Maps – Low risk of surface water flooding (source Risk of Flooding from Surface Water (RoFSW))

- 3.18 Therefore, the key recommendation relating to minimising the risk of surface water flooding to the site is to ensure that site access is positioned as far from the southern corner of the site to ensure flood free access remains possible from the site at all times.
- 3.19 The site access should be provided in the northern portion of the site where flood depths are typically less.

Impacts of Climate Change

- 3.20 With changes in climate profiles, it is expected that rainfall intensities and frequencies will increase, and as such the risk to property will increase with this. However, the risk of this is considered to be relatively low considering where the proposed dwellings are to be located above the modelled surface water flood extents.
- 3.21 It should be noted that the WSCC considers the implementation of SuDS as an essential element of reducing future flood risk to both the site and its surroundings. Indeed, reducing the rate of discharge from sites is one of the most effective ways of reducing and managing flood risk.

RESERVOIR FLOODING (BREACH)

- 3.22 The EA has undertaken failure scenarios of the UK reservoirs and summarised these extents through their Long Term Flood Risk Maps for Reservoir Flooding. Based on these maps, the site is not shown to be at risk of flooding from this source.

SEWERS AND DRAINAGE

- 3.23 A common source of flooding is a result of sewer or other drainage infrastructure becoming surcharged and flooding. Flood risk associated with the potential surcharging of the sewerage network is extremely hard to predict

and there are currently no datasets available that provide an indication of areas that may be at risk of flooding from the sewerage network. However, as most drainage systems are not designed for events greater than a 1 in 30 (3.33%) annual probability rainfall event (typically reducing to 1 in 5 (20%) for highway drainage systems and most likely less for older drainage systems) new development should always give consideration to likely overland flow paths should flooding from these systems occur.

- 3.24 As emergence from sewerage systems is likely to follow the ground's topography, it is recommended that consideration is given to the EA's Risk of Flooding from Surface Water map and other available topographic data as this will provide an indication of likely flow routes should surcharging of the sewerage system occur.
- 3.25 The WSCC SFRA present records relating to sewer flooding. Specifically, Map S from the SFRA highlights that there have been a number of sewer flooding incidences in the area, but none associated with the site specifically.

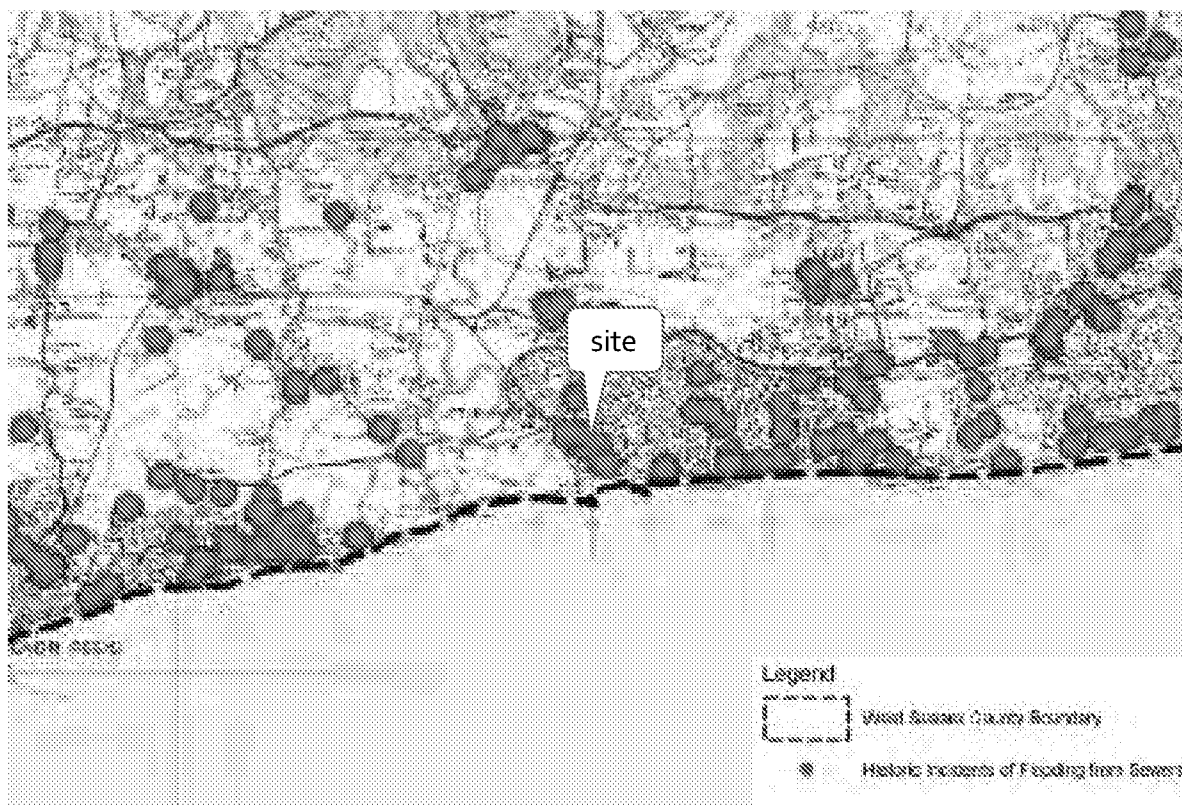


Figure 10 – extract from SFRA Map S – “Areas with Recorded Incidents of Sewer Flooding”

- 3.26 Therefore, it is considered the risk of sewer flooding to the site is low, assuming that any new development proposals include appropriate protective measures to manage runoff, and any additional runoff proposed to be directed offsite (either into the public sewer system or elsewhere) are approved by the local authority or body responsible for its management prior to discharge.

GROUNDWATER

- 3.27 Groundwater flooding is the emergence of groundwater at the ground surface or into subsurface voids arising as a result of:
- ⇒ abnormally high groundwater heads or flows;
 - ⇒ the introduction of an obstruction to groundwater flow; or
 - ⇒ the rebound of previously depressed groundwater levels.
- 3.28 Groundwater flooding usually occurs following a prolonged period of low intensity rainfall. As groundwater flow is much slower than surface flow, the flooding may not recede for long periods of time, typically weeks or even

months. It is important to recognise the risk of groundwater flooding is typically highly variable and heavily dependent upon local geology, topography and weather conditions, as well as local abstraction regimes. Groundwater flooding is hard to predict and challenging to mitigate.

- 3.29 Review of local geology can provide an indication of where groundwater flooding may occur. However, it is important to remember that once groundwater has reached the ground's surface, it is likely to flood overland and may therefore pose similar risks to those identified by the EA's Flood Risk from Surface Water map. It is therefore not necessarily those areas susceptible to groundwater emergence that are at risk, but the areas that are located downhill of those areas susceptible to groundwater emergence.
- 3.30 Records of groundwater flooding in Littlehampton are limited. However, this is likely to be because groundwater flooding is often perceived as surface water flooding as is therefore not accurately recorded, rather than groundwater flooding not being a potentially significant source of flood risk. However, the WSCC SFRA does provide some records of groundwater emergence in the county, Figure 11 shows that the site is located within a groundwater emergence zone, however there no specific records of groundwater flooding specifically impacting the site. As such flood risk from this source is considered low.

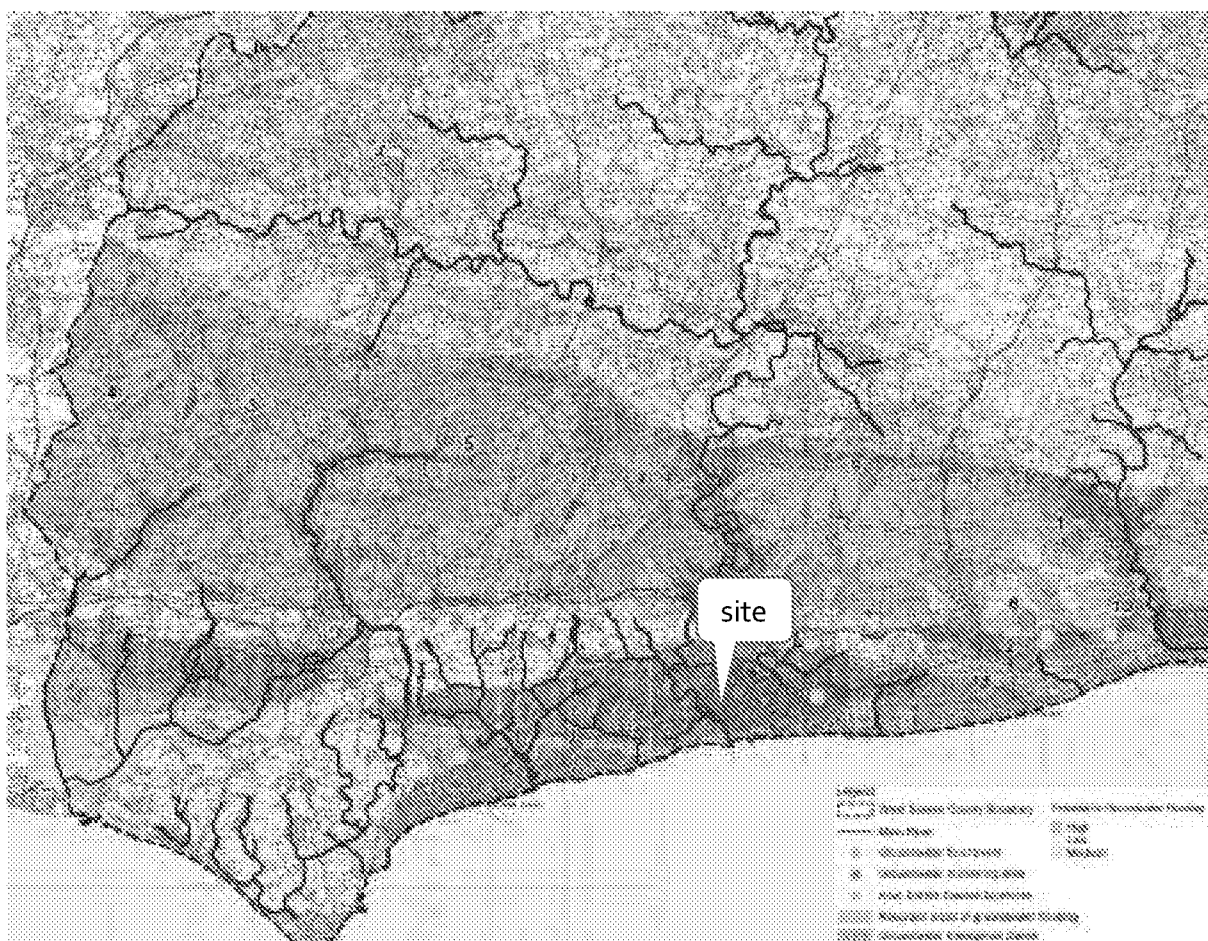


Figure 11 - Extract from WSCC SFRA Map G Areas More Prone to Groundwater Flooding (site marked with star)

Impacts of Climate Change

- 3.3.1 The potential effects of climate change on groundwater levels are uncertain. Greater seasonality in groundwater level fluctuation is a potential outcome under a pattern of higher winter rainfall and less summer rainfall. Broad predictions of the impacts of climate change on groundwater levels are difficult to make at the present time.

HISTORICAL SOURCES

- 3.32 The EA data suggests that the area no recorded instances of flooding, with from Fluvial, Pluvial or other sources. However, this does not mean that the site has not flooded in the past or may flood in the future.

RESIDUAL RISKS

- 3.33 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.
- 3.34 Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep-water flooding, with little or no warning if defences are overtopped or breached. Flood defences are present along the Arun near to the site, offering a standard of protection of 1 in 300 (0.5% AEP). The Fluvial and Tidal Flood Risk Section of this report has assessed a worst case undefended scenario and demonstrated that should flood defences completely fail in the area, the site will remain largely unaffected. As such there is limited risk to the site should failure of these defences occur.
- 3.35 Therefore, the primary residual risk to the site is considered to be from drainage failure or an event that exceed the 1 in 100 year surface water flood event. These risks are considered suitably low (assuming the onsite drainage is properly designed and maintained and buildings are situated in areas of lower flood risk).

SUMMARY OF RISKS

- 3.36 Based on the assessment of flood risk from a range of sources, the below is a summary of these risks:
- ⇒ **Fluvial** – Risk from this source is considered **low**.
 - ⇒ **Tidal** – Risk from this source is deemed **low to moderate**, as the site is remains unaffected in the defended scenario, with only small area in the southern corner and along the boundary with Fort Road East shown to be affected in the worst case scenario.
 - ⇒ **Surface Water** – Risk from this source is considered **low**, given that the site remains unaffected by surface water flooding in all modelled events.
 - ⇒ **Reservoir** – Risk from this source is considered **not applicable**.
 - ⇒ **Sewers and Drainage** – Risk from this source is considered **low** given no historical data points directly to the site having flooding from this source previously.
 - ⇒ **Groundwater** – Risk from this source is considered **low**. Although the site is located in an area at risk of groundwater emergence, site levels would direct any groundwater flows quickly away from the site to the south and as such is unlikely groundwater flooding would have any significant impact.
- 3.37 From analysis of the available information, it appears the primary source of flood risk is from tidal sources. However, the analysis shows that the site remains largely unaffected by all modelled tidal events and given that the site would be defended up to the 1 in 300 event. The analysis shows, further resilience can be provided by ensuring any valuable assets on the site or new buildings are set above 4.53mAOD. Therefore, Tidal flood risk is considered

relatively low (based on a 60 year design horizon) it is considered that flood risk from this source can be mitigated to a degree.

- 3.38 Risk from other identified sources (including Fluvial, Sewer and Drainage, Reservoir and Groundwater) are considered low.
- 3.39 A number of mitigation measures have been proposed below in Section 5 in order to minimise/mitigate flood risk from the above sources.

4 FLOOD MITIGATION MEASURES

- 4.1 The proposals allow the opportunity to improve flood resilience of the site by incorporating a number flood mitigation measures, both through the incorporation of flood resilient building materials, surface water drainage improvements and signing up to the EA Flood Warning/Alert System.
- 4.2 The client has yet to provide detailed site plans demonstrating the incorporation of the below.
- 4.3 Therefore, in order to meet the requirements of the WSCC SFRA and NPPF, it is recommended that the development proposals ensure:
- Buildings to incorporate flood resilient measures (in accordance with the Communities and Local Government (CLG) 2007 'Improving the Flood Performance of New Buildings' publication);
 - On site drainage should be designed in accordance with Building Regulations Part H and the SUDS Manual without flooding up to the 1 in 100 year plus climate change event;
 - Building should be constructed with a finish floor level set to a minimum 4.53mAOD (to provide protection against residual risks and tidal flood events greater);
 - Users sign up to the EA Flood Warning and Alert System and incorporate a flood evacuation plan;

BUILDING MATERIAL MITIGATIONS

- 4.4 The national government produced guidance for improving the flood resilience of building in the Communities and Local Government (CLG) 2007 'Improving the Flood Performance of New Buildings' publication. This publication provides recommendations on how to protect buildings in the case of a flood event, and propose two scenarios based on maximum expected flooded depths:

***Water exclusion strategy** – where emphasis is placed on minimising water entry whilst maintaining structural integrity, and on using materials and construction techniques to facilitate drying and cleaning. This strategy is favoured when low flood water depths are involved (not more than 0.3m). According to the definitions adopted in this Guidance, this strategy can be considered as a resistance measure but it is part of the aim to achieve overall building resilience*

***Water entry strategy** – where emphasis is placed on allowing water into the building, facilitating draining and consequent drying. Standard masonry buildings are at significant risk of structural damage if there is a water level difference between outside and inside of about 0.6m or more. This strategy is therefore favoured when high flood water depths are involved (greater than 0.6m) by utilising resilient materials, and construction methods.*

- 4.5 Given that the maximum depth of flooding is less than 0.3m, it is considered that a **Water Exclusion Strategy** should be adopted for any buildings located within the 1 in 1000 year surface water flood extents. Some recommendations include (but are not limited to):
- The route of all electrical services will run from ceilings at ground floor (where possible), down toward sockets;
 - All plumbing insulation to be of closed-cell design;

- Non-return valves to be fitted to all drain and sewer outlets;

4.6 Further detail can be found at <https://assets.publishing.service.gov.uk/>:

5 FLOOD EVACUATION PLAN

ANALYSIS TO DETERMINE IF SAFE ACCESS AND EGRESS IS AVAILABLE

- 5.1 In order to comply with the NPPF, all occupants should be able to make their way, unassisted by the Emergency Services, to dry land. This is known as ‘safe access to dry land’ and does not have to be dry, just not *hazardous* at the peak of the predicted critical 1% plus climate change storm.
- 5.2 Table 13.1 of FD2320 shows the maximum depths/velocity combinations that are safe for 3 categories of user (occupant). As it is possible for vulnerable people to be resident here (e.g. elderly, disabled) it is necessary to consider the lowest category, which is ‘danger to some’. 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” (Figure 12).
- 5.3 In order for an access/egress route to be acceptable under the NPPF, the combination of flood depths, velocities and debris must be analysed.

MR	Depth of Standing Water (m)												
	[m/s]												
velocity [m/s]	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.20	1.50	1.70
0.0	0.02+0.5	0.03+0.5	0.04+0.5	0.05+0.5	0.05+0.5	0.07+0.5	0.07+0.5	0.07+0.5	0.07+0.5	0.07+0.5	0.07+0.5	0.07+0.5	0.07+0.5
0.1	0.03	0.04	0.05	0.05	0.05	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
0.2	0.04	0.05	0.06	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
0.3	0.05	0.06	0.07	0.07	0.07	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
0.4	0.06	0.07	0.08	0.08	0.08	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
0.5	0.07	0.08	0.09	0.09	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
0.6	0.08	0.09	0.10	0.10	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
0.8	0.10	0.11	0.12	0.12	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
1.0	0.12	0.13	0.14	0.14	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
1.5	0.15	0.16	0.17	0.17	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
2.0	0.18	0.19	0.20	0.20	0.20	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
2.5	0.20	0.21	0.22	0.22	0.22	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
3.0	0.22	0.23	0.24	0.24	0.24	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
3.5	0.24	0.25	0.26	0.26	0.26	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
4.0	0.26	0.27	0.28	0.28	0.28	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
4.5	0.28	0.29	0.30	0.30	0.30	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
5.0	0.30	0.31	0.32	0.32	0.32	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
5.5	0.32	0.33	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
6.0	0.34	0.35	0.36	0.36	0.36	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
6.5	0.36	0.37	0.38	0.38	0.38	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
7.0	0.38	0.39	0.40	0.40	0.40	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
7.5	0.40	0.41	0.42	0.42	0.42	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
8.0	0.42	0.43	0.44	0.44	0.44	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
8.5	0.44	0.45	0.46	0.46	0.46	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
9.0	0.46	0.47	0.48	0.48	0.48	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
9.5	0.48	0.49	0.50	0.50	0.50	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
10.0	0.50	0.51	0.52	0.52	0.52	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54

Flood Hazard Rating (H/R)	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

Figure 12: Extracts from the Supplementary Note to FD2320/TR2 and FD2321/TR1 describing the methodology for calculating ‘Flood Hazard’ under the NPPF (Source: EA)

Figure 13 illustrates that flood hazard at the southern boundary could be considered danger for some (that’s is Flood Hazard shaded yellow with a value above 0.75). However, remainder of the southern boundary (where access

and egress can be provided) remains largely unaffected, and if possible site access should be provided through the in an area that does not direct users into an area shown to be a flood hazard.

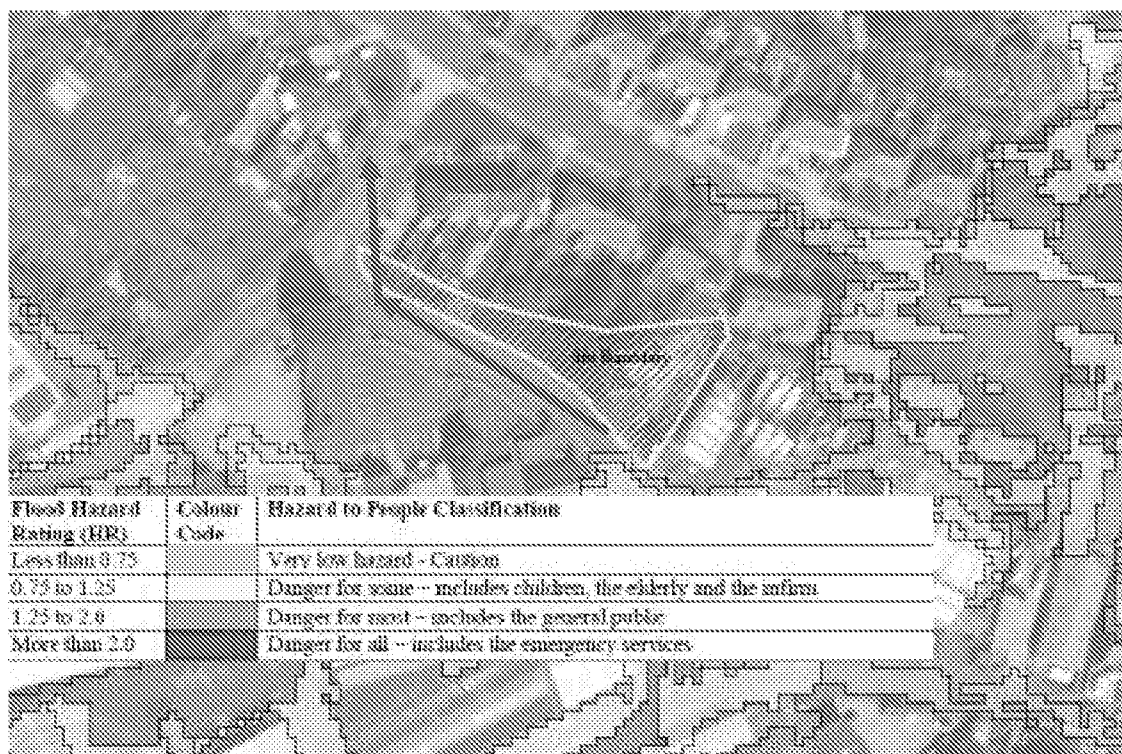


Figure 13 - EA RoFSW Hazard Mapping – Medium Risk of surface water flooding (source: Risk of Flooding from Surface Water (RoFSW)) - Red arrows designate suggested evacuation route.

- S.4 Nonetheless, it is recommended that the proposed development incorporates a Flood Emergency Management Plan. This should highlight the potential flood risks to the site and a proposed evacuation route. This route should direct people north and away from areas of higher flood risk.
- S.5 Further information can be found on www.environment-agency.gov.uk/floodline. It is advised that:

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;

- S.6 If flood waters along the proposed evacuation route have exceed 25cm, site users are advised to seek advice from emergency services.

6 PROPOSED DRAINAGE

SURFACE WATER STRATEGY

6.1 Part H of the Building Regulations (2010) recommends surface water run-off shall discharge to one of the following, listed in order of priority:

- An adequate soakaway or some other adequate infiltration system, or where that is not reasonably practicable,
- A watercourse, or, where that is not reasonably practicable,
- A sewer.

Each disposal option has been reviewed in the context of the site below;

6.2 Different SuDS Features have been assessed to determine if they are viable to use on site and can be seen in the following table:

SuDS Feature	Beneficial to Environment	Improves on Water quality	Suitable for low permeable soils (<10-6)	Ground Water recharge	Suitable for small sites	Site specific restrictions	Appropriate for site
Wetlands	Y	Y	Y	N	N	Site Constraints	No
Pond	Y	Y	Y	N	N	Site Constraints	No
Detention Basin	Y	Y	Y	N	N	Site Constraints	No
Infiltration Basin	Y	Y	N	Y	N	Site Constraints	No
Soakaway	N	Y	N	Y	Y	None	Yes
Attenuation Tank	N	N	Y	N	Y	None	Yes
Swale	Y	Y	Y	Y	N	Site Constraints	No
Filter Strip	Y	Y	Y	Y	N	Site Constraints	No
Rainwater Harvesting	N	Y	Y	Y	Y	Site Constraints	No
Permeable Paving	N	Y	Y	Y	Y	None	Yes
Green Roof	Y	Y	Y	N	Y	Site Constraints	No
Rain garden	Y	Y	Y	N	N	Site Constraints	No

- 6.3 Based on the intrusive ground investigation it has been confirmed that infiltration method for surface water runoff being viable.
- 6.4 A BRE365 infiltration test indicated infiltration rates varies between 3.1×10^{-5} m/s – 4.0×10^{-5} m/s.
- 6.5 It is proposed that surface water runoff will discharge to ground via infiltration. Surface water runoff from the proposed roof area will be collected and conveyed into the proposed cellular crate soakaway which has been designed based on the infiltration rate of 3.1×10^{-5} m/s which was the worst-case scenario infiltration rate.
- 6.6 All hard paved areas are proposed to discharge to ground via infiltration through permeable block paving.
- 6.7 Hydraulic calculations have been carried out which can be found at Appendix 2.

WATER QUALITY

- 6.8 A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution.
- 6.9 Frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals, and various organic and inorganic contaminants) therefore the first 5-10mm of rainfall should be adequately treated with SuDS.
- 6.10 The new SuDS Manual (Ciria C753, November 2015) introduces slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:
- The pollution hazard at a particular site (i.e., the pollution source)
 - The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels
 - The sensitivity of the receiving environment
- 6.11 The EA website indicates that the site does not lie within a Source Protection Zone.
- 6.12 The recommended approaches for water quality risk management are given in the SuDS Manual Table 26.1.

Fig 5. Approaches to Water Quality Risk Management

Table 26.1 Approaches to Water Quality Risk Management			
Design method	Hazard Characterisation	Risk Reduction	
		For Surface Water	For Groundwater
Simple Index Approach	Simple pollution hazard indices based on land use (Table 26.2)	Simple SuDS hazard mitigation indices (Table 26.3)	Simple SuDS hazard mitigation indices (Table 26.4)
Risk Screening	Factors characterising traffic density and extent of infiltration likely to occur (Table 26.5)	N/A	Factors characterising unsaturated soil depth and type, and predominant flow type through the soils (Table 26.5)
Detailed Risk Assessment	Site specific information used to define likely pollutants and their significance	More detailed, component specific performance information used to demonstrate that the proposed SuDS components reduce the hazard to acceptable levels	
Process-based treatment modelling	Time series rainfall used with generic pollution characteristics to determine statistical distributions of likely concentrations and loadings in the runoff	Models that represent the treatment processes in the proposed SuDS components give estimates of reductions in even mean discharge concentrations and total annual load reductions delivered by the system	

6.13 As per Table 26.1 Simple Index approach will be used as a design method for this site.

6.14 Table 26.2 will provide hazard classification of different land uses. The land uses for the surface water drainage for this site are.

- Industrial Roof
- Individual driveways and car parks
- Delivery Area

6.15 To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following must be achieved for the surface running off the site.

Total SuDS mitigation index $\geq$ pollution hazard index

6.16 Pollution Hazard Indices are given for different land uses in Table 26.2 of the SuDS manual;

Fig 6. Pollution Hazard Indices for Different Land Use Classifications

Land Use	Pollution Hazard Level	Total Suspended solids (TSS)	Metals	Hydro-Carbons
Residential roofs	Very Low	0.2	0.2	0.05
Other roofs (Typically commercial/industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (e.g., cul-de-sacs, homezones and general access roads) and non-residential car parking with infrequent change (e.g., schools, offices) i.e., < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g., hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g., haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways	High	0.8	0.8	0.9

6.17 From Table 26.2 the following information is tabulated in Table below;

Pollution hazard index and destination of runoff for the proposed site

Land Use	Destination of Runoff	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Industrial Roof	Ground Water	Low	0.3	0.2	0.05
Individual driveways, car parks and low traffic roads, delivery area	Ground water	Low	0.7	0.6	0.7

6.18 The SuDS mitigation index will be obtained from Table 26.4 (for groundwater) of the SuDS manual.

Figure 14 Indicative SuDS Mitigation Indices for discharges to ground waters.

6.19 SuDS mitigation index are tabulated in table below.

Table 26.4 Indicative SuDS mitigation indices for discharges to groundwater			
Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates	TSS	Metals	Hydrocarbons
A layer of dense vegetation underlain by a soil with good containment attenuation potential of at least 300mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, i.e., graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20mm gravel) underlain by a soil with good contaminant attenuation potential of at least 300mm in depth.	0.4	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area		

Table 2: SuDS mitigation index

Mitigation indices						
Runoff Source	Destination of Runoff	Mitigation Index Source	Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Individual driveways, residential car parks and low traffic roads	Ground water	Table 26.4 (for ground waters)	Permeable Pavement	0.7	0.6	0.7
Industrial Roof	Ground water	Table 26.4 (for ground waters)	Silt Traps/Catchpits and Soakaway	0.4	0.3	0.3

- 6.20 The above analysis demonstrates that the SuDS devices within the design will mitigate any pollution present within the surface water system.

FOUL DRAINAGE STRATEGY

- 6.21 It is proposed foul sewer runoff is discharged into the existing public foul sewer located to the north-east corner of the proposed development site.
- 6.22 The proposed new connection is subject to Section 106 Application with Southern Water.

7 CONCLUSION

- 7.1 The following report is a Phase 1 Flood Risk Assessment (FRA) for the proposals at Fort Road Garage, Fort Road East, Littlehampton, West Sussex, BN17 7QZ (see site location map, Figure 1).
- 7.2 This FRA has been written in accordance with the National Planning Policy Framework (NPPF) and its Technical Guidance, Environment Agency (EA) Standing Advice and the WSCC guidance. This report has relied upon information presented within the WSCC (2012) Level 1 SFRA and the EA's Risk of Flooding from Surface Water (RoFSW) data sets.
- 7.3 The existing sites classification is deemed to be 'Less Vulnerable' as commercial use, in accordance with the NPPF. The proposals will not change the existing use and therefore vulnerability will also remain as 'Less Vulnerable' post development.
- 7.4 The application site is located on the edge of a commercial area close to residential properties (which form its northern boundary). The site occupies a total area of 0.79 ha and is bounded on the South West by Fort Road East, and to the west existing commercial and industrial use.
- 7.5 The existing sites classification is deemed to be 'Less Vulnerable' as commercial use, in accordance with the NPPF. The proposals will not change the existing use and therefore vulnerability will also remain as 'Less Vulnerable' post development.
- 7.6 The nearest identified watercourse to the site appears to be the River Arun, located approximately 300m to the south (at its closest). There also appears to be a number of partially culverted watercourses that feed into the River Arun as part of the wider industrial use of the area. The site is located in the South East River Basin.
- 7.7 Figure 3 provides an extract from EA AIMS Defence data (2021). This data shows that the River Arun at this location has defences along most of its length in the various forms. The standard of protection (SOP) these defences provide are up to the 1 in 300 year event, with defences in moderate condition and privately maintained.
- 7.8 In order to assist the implementation of the Government's NPPF, the EA and local councils have undertaken national scale flood risk mapping. This mapping considers a range of sources including flooding from rivers, sea/tidal, surface water and reservoir breach. Furthermore, each council produces a Strategic (county scale) Flood Risk Assessments (SFRA) that aim to specifically identify local flood risk issues (such as critical drainage areas and local groundwater flooding). This FRA has reviewed these sources to identify and (where possible) quantify the flood risk to the site.
- 7.9 From analysis of the available information, it appears the primary source of flood risk is from tidal sources. However, the analysis shows that the site remains largely unaffected by all modelled tidal events and given that the site would be defended up to the 1 in 300 event. The analysis shows, further resilience can be provided by ensuring any valuable assets on the site or new buildings are set above 4.53mAOD. Therefore, Tidal flood risk is considered relatively low (based on a 60 year design horizon) it is considered that flood risk from this source can be mitigated to a degree.
- 7.10 Risk from other identified sources (including Fluvial, Sewer and Drainage, Reservoir and Groundwater) are considered low.

7.11 Therefore, in order to meet the requirements of the WSCC SFRA and NPPF, it is recommended that the development proposals ensure:

- Buildings to incorporate flood resilient measures (in accordance with the Communities and Local Government (CLG) 2007 'Improving the Flood Performance of New Buildings' publication);
- On site drainage should be designed in accordance with Building Regulations Part H and the SUDS Manual without flooding up to the 1 in 100 year plus climate change event;
- Building should be constructed with a finish floor level set to a minimum 4.53mAOD (to provide protection against residual risks and tidal flood events greater);
- Users sign up to the EA Flood Warning and Alert System and incorporate a flood evacuation plan;

7.12 As such, it is considered that a significant betterment, in terms of flood risk, a betterment can be provided by incorporating:

- ⇒ Users of the site sign up to the EA Flood Warning and Alert Service and have a Flood Evacuation and Management Plan in place;
- ⇒ Proposals follow the recommendations presented within this report;

7.13 Therefore, this FRA deems that the proposed development passes the exception test in accordance with the EA guidance, WSCC SFRA, and the NPPF for developments of a 'Less Vulnerable' nature. It is considered that as long as the development follows the advice presented in this report, that the development proposals can be considered appropriate at this location.

7.14 Surface water runoff will discharge to ground via infiltration based on measured infiltration rate of 3.1×10^{-5} m/s.

7.15 The foul water will discharge into the local foul water sewer.

7.16 The report has demonstrated that the proposed drainage measures ensure that suitable means of surface water and foul drainage can be achieved for the proposed development.