

EXECUTIVE SUMMARY

BTP-Hyder were commissioned to carry out a Flood Risk Assessment in accordance with Planning Policy Statement 25 - Development and Flood Risk (December 2006), for a proposed residential redevelopment off Outram Road in Felpham. The site is shown to lie within Flood Zone 3 and at potential risk of flooding from the sea and the Aldingbourne Rife. Discussions have taken place with the Environment Agency to confirm the scope of this Flood Risk Assessment and applicable flood water levels.

The development proposals for the site include removing the existing two buildings on site and replacing them with two new buildings. The proposed development will maintain the total of 3 residential units on the site. The new buildings are proposed away from the concrete boundary (sea) wall, allowing generally more than 8m clearance. It is proposed to remove the existing concrete stairs from the raised foreshore onto the site, removing the existing floodgates and formally close the gaps through the concrete sea wall. The proposed development of the site will maintain the existing foul and surface water sewer connection to the off site sewer network. The design plan for the site show a decrease in the total hardstanding runoff areas on site and therefore a decrease in the surface water discharge from the site is expected.

The Environment Agency provided 1 in 100 year fluvial, 1 in 200 year tidal and 1 in 200 year tidal breach flood water levels applicable to the site. The topographic survey of the site showed that the site is suitably raised above the 1 in 100 year fluvial and 1 in 200 year tidal breach flood water levels and that the raised concrete foreshore and concrete wall on the sea facing boundary of the site protects against the 1 in 200 year tidal flood water level. The site is at risk of flooding as a result of wave overtopping during extreme storm events. The Environment Agency indicated that this occurs annually and requires flood gates to minimise the impact. As requested by the Environment Agency a wave overtopping assessment has been undertaken, using the modelling tools provided on the HR Wallingford website. Wave parameters and characteristics has been estimated / obtained from various sources, including the Channel Coastal Observatory's Annual Wave Report 2007 for Rustington Directional WaveRider Buoy. The assessment tested all the tools available and confirmed that wave overtopping does occur. The 1 in 200 year (2110) tidal sea level was used within the analysis to account for the effect of climate change. The assessment showed that wave overtopping will cause flooding of the site during extreme storm events as well as during the 1 in 200 year tidal event, if waves of significant size were to occur simultaneously. Wave overtopping is expected to worsen as a result of climate change due to the increase in sea water levels.

Dry pedestrian and vehicular escape will be maintained throughout the 1 in 200 year tidal and 1 in 100 year fluvial flood events. In the event of significant wave overtopping or a breach of the sea defences (at the site), safe access / escape from the site may require assistance from emergency services. However, as the proposed development will maintain the number of units on site, the proposals will not create an additional burden on emergency services. It is our opinion that although a PPS25 Sequential Test is not required, the development has been shown to be appropriate.

The report concludes that there will be no adverse social, environmental or economic effects to potential residents of the property, adjacent land owners or emergency services following development.

1 INTRODUCTION

General Information

- 1.1 The proposed development site is a seafront property off Outram Road in Felpham. The site is currently occupied by two residential buildings; a three storey block and a single storey building. It is proposed to replace the existing buildings with a single, four-storey, residential block.
- 1.2 The site lies wholly within 'Flood Zone 3' of the Environment Agency flood zone map and Amberley House Development Ltd. commissioned a Flood Risk Assessment (FRA) to be carried out for the proposed development.
- 1.3 The proposed development includes the replacement of the existing buildings by a dwelling on stilts (approximately 3m above the ground floor), and the creation of a parking.
- 1.4 The Environment Agency was consulted to obtain relevant flooding information. This included details of historic flood events and modelled floodwater levels in the vicinity of the site.
- 1.5 The proposed development lies within the Environment Agency Flood Zones 2 and 3 and therefore the Sequential and Exception Tests are considered.

Scope of Study

- 1.6 The main objectives of this study are:
 - Provide a flood risk assessment of the site, compliant with the guidelines set out in PPS25, to accompany the proposed development for planning permission.
 - Provide advice on the site layout and design that will ensure that safe operation of the site during extreme flood and storm events.

2 SITE DESCRIPTION

Location

- 2.1 As shown in Figure 1 and Drawing 1, the site is a seafront property off Outram Road in Felpham. The proximity of the Aldingbourne Rife and sea outfall to the site has also been indicated.

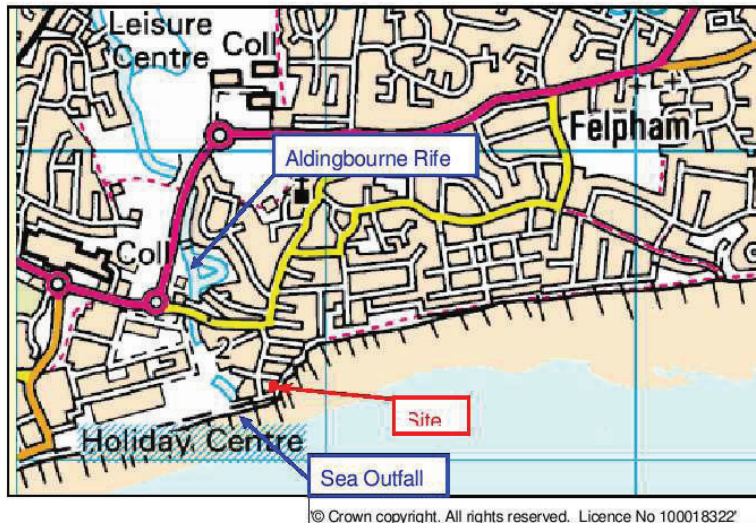


Figure 1 – Site location

- 2.2 The site covers an area of 0.078 hectares and is set low, behind a raised sea foreshore and concrete wall.

Sources of Potential Flooding

- 2.3 The site is at risk of flooding primarily due to wave overtopping during storm events which can be seen annually.
- 2.4 The most severe source of potential flooding on the site is tidal in nature from the English Channel, particularly if combined with a storm event and subsequent wave overtopping.
- 2.5 A secondary potential source of flooding on site is fluvial in nature from the Aldingbourne Rife that lies approximately 150 metres to the west of the site.
- 2.6 Surface water flooding from excess rainfall and has also been considered.

Existing Development

- 2.7 As shown in Drawing 1, the site is currently occupied by two residential buildings (a three-storey building and a single-storey building) and a detached single storey garage, as shown in Photograph 1.
- 2.8 There are three existing residential units on site, a three-storey residential block (Sea Lodge and Sea Bank) housing two residential units and the single-storey building (Sea Girt) housing the third residential unit.
- 2.9 The site lies behind an existing concrete sea wall and raised foreshore that runs along the full extent of the site. There is a low brick wall across the front of the three-storey building, dividing the front garden from the car access and parking area.
- 2.10 Access to the site is via an existing entrance off Outram Road, as shown in Photograph 1. There are existing concrete access stairs from the property up onto the promenade, through gated openings in the sea wall.

Topographic Survey

- 2.11 A topographic site survey was undertaken in July 2007 and has been included as Drawing 2.
- 2.12 The survey shows that site is predominantly flat with levels varying from 3.81m AOD to 4.24m AOD across the site. Outram Road falls from 4.09m AOD adjacent to the site entrance to 3.77m AOD six meters past the site boundary.
- 2.13 The brick wall across the front of the three-storey building is approximately 450mm high at its lowest point, while the top of the concrete sea wall is set at 6.55m AOD. The front promenade (sea wall) is set at between 5.45m AOD and 5.65m AOD across the front of the site.
- 2.14 The topographic survey suggests that the ground floor finished floor levels of the three-storey block are set at 4.35m AOD or above and the slab level of the single storey building is set at 5.16m AOD.
- 2.15 The site is approximately 775m², with the footprint of the buildings totalling 225m². The remaining site is made up of low walls, rough / planted / permeable areas (106m²) and concrete hardstanding surfaces (444m²).

Proposed Development

- 2.16 The development proposals for the site include, removing the three residential units on site (including all other buildings) and replacing them with three new residential units.
- 2.17 The proposed replacement residential units are to be developed as two buildings, with the larger building alongside Outram Road containing two units and a second smaller building containing the third unit.
- 2.18 The proposed site plan is shown in Drawing 1, floor plans in Drawing 3 and Drawing 4, and elevations in Drawing 5 and Drawing 6.
- 2.19 The proposed ground floor of all the units contain a front and rear entrance, single garage, games / boot / storage room and a cloak room.
- 2.20 The first floor level for each units contains three bedrooms; the second floor contains an open plan kitchen and dining room and a living room; and the third floor contains a sun room and roof terrace.
- 2.21 In accordance with the guidance provided by the Environment Agency, the proposed building has been set as far as possible away from the existing sea wall across the front of the site. As shown in Drawing 1 the building is at its closest point 6m away from the foot of the sea wall which increases to greater than 10m at the entrance to the site.
- 2.22 All hardstanding surfaces across the site are to be replaced, with only the access and parking areas potentially hardstanding. The remainder of the site will be covered with a suitable permeable ground cover.
- 2.23 The proposed new buildings are estimated to have an total footprint area of approximately 212m². The access, parking and other potentially hardstanding areas are estimated to cover an area of approximately 298m², leaving at least 342m² area to be permeable.
- 2.24 It is proposed to remove the existing concrete stairs from the raised foreshore onto the site, removing the existing floodgates and formally close the gaps through the concrete sea wall. As requested by the Environment Agency, a separate Engineers report has been prepared to investigate the removal of the concrete stairs.

3 FLOODING ON SITE

Flood Zone Maps

- 3.1 The Environment Agency's Flood Map for the area surrounding the site is shown in Figure 2.
- 3.2 The Flood Map shows the undefended floodplain for tidal and fluvial flooding, that is areas which would be at risk of flooding assuming that no flood defences or flood alleviation measures were in place. Areas coloured dark blue may be affected by the 1 in 100 year fluvial or 1 in 200 year tidal flooding event. This is categorised by the Environment Agency as Flood Zone 3. The light blue area shows the additional extent of an extreme flood (less than 0.1% probability in any one year) from rivers or the sea and is categorised as Flood Zone 2.

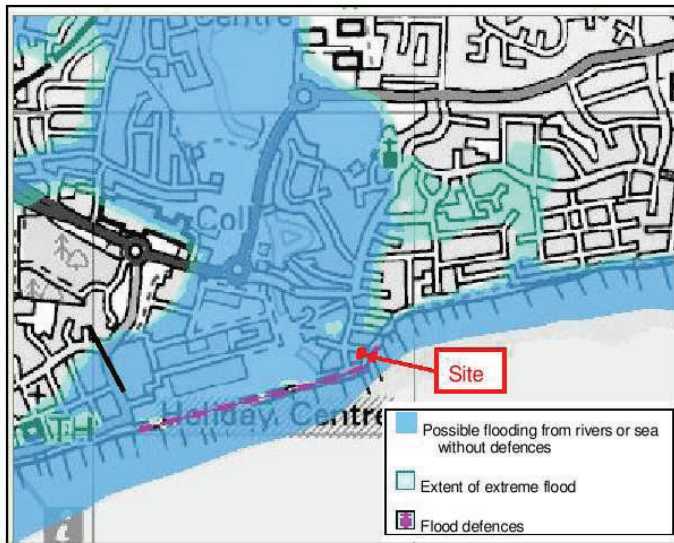


Figure 2 - Environment Agency's indicative floodplain map

- 3.3 The site is shown to lie in Flood Zone 3, potentially at risk of Tidal flooding during the 1 in 200 year event and/or fluvial flooding from the 1 in 100 year event.

Historic Information

- 3.4 The Environment Agency has not provided any records of the site having experienced any flooding during any recent historic flood events.

Existing Flood Alleviation Measures

- 3.5 The Environment Agency river and coastal defences are shown in Drawing 7.
- 3.6 The site is protected against tidal flooding by a raised foreshore and concrete wall, on the boundary of the site. The foreshore has a crest height minimum of approximately 5.40m AOD, while the concrete wall has a crest height of 6.55m AOD.
- 3.7 The site is protected against fluvial flooding by steel sheet piling along both sides of the Aldingbourne Rife within the vicinity of the site.
- 3.8 The Aldingbourne Rife outfall into the sea approximately 120m the west of the site. The Felpham Pumping Station (see Photograph 9) maintains the water levels in the watercourse when the outfall is affected by the tide.

Structures which may influence local hydraulics

- 3.9 The Felpham Pumping Station maintains water levels in the Aldingbourne Rife so that they are not affected by tides. Upstream of the site the Rife flows through a culvert and gated bridge.
- 3.10 There are several other hydraulic structures have been included in the Environment Agency's hydraulic model and as such their effects will be accounted for.

Floodwater Levels

- 3.11 The relevant tidal and fluvial modelled flood water levels were provided by the Environment Agency.
- 3.12 The 1 in 200 year tidal flood water levels was provided as 3.84m AOD for 1990, rising to 5.3m AOD, for 2115 (including the effects of climate change).
- 3.13 The fluvial modelling was undertaken on behalf of the Environment Agency by Mott-MacDonald using their in-house Hydro-1D Model. The 1 in 100 year flood water level including the effects of climate change results was given as 1.51m AOD, at the River Outlet alongside the automated Felpham Pumping Station.
- 3.14 The modelled 1 in 100 year fluvial floodplain has been included as Drawing 8.

Breach Modelling

- 3.15 Breach scenario modelling was undertaken on behalf of the Environment Agency by Capita Symonds using TUFLOW 2D modelling.
- 3.16 The Environment Agency provided the 1 in 200 year breach flood water level applicable to the site as 3.1m AOD, with a design horizon of 2060.
- 3.17 The extent of the modelled 1 in 200 year tidal breach floodplain is shown in Figure 3. A closer inspection of the modelled floodplain extent, with respect to the site, is shown in Drawing 9.

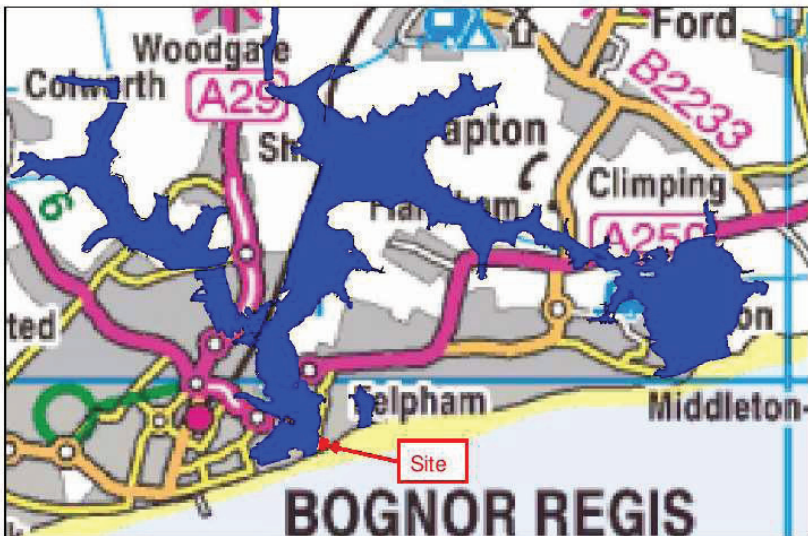


Figure 3 - Extent of EA modelled floodplain for a 1 in 200 year (2050) tidal breach event

- 3.18 The breach modelling undertaken on behalf of the Environment Agency did not consider a 100 year design horizon for climate change. In such an event the final modelled breach flood water will be higher, however considering the extent of the flooding a significant additional volume of water will be required to raise the level up to 4m AOD (the average site level).
- 3.19 In the extremely unlikely event that the concrete defences and raised walkway were breached at the site, the site and ground floor level of the proposed development would flood. In such an event, the water flowing past the site would likely be flowing at a significant velocity and as such residents would likely require assistance in evacuating safely. This extremely unlikely event is considered a residual risk.

- 3.20 All sleeping and living accommodation will be on the first floor and above. This level is above the 1 in 200 year (2110) tidal flood water level and therefore above any maximum breach flood water level.
- 3.21 The Environment Agency agreed that as the proposed development is for a replacement of the three units, with three new units, this Flood Risk Assessment does not have to undertake any revised breach modelling.
- 3.22 The EA stated that a broad estimate / discussion regarding the 2110 tidal breach scenario, as above, will be sufficient.

The modelled section in the Impacts of climate change

- 3.23 The tidal, breach and fluvial flood water levels provided by the Environment Agency all include the likely effects that climate change may have on rising sea water levels and increased flood flow rates.

Flooding at the site

- 3.24 The levels on site are significantly higher than the modelled 1 in 100 year fluvial flood water level or the modelled 1 in 200 year breach flood water level, thus the site is expected to remain above the floodwaters during these events.
- 3.25 While the existing coastal flood defences protect the site against the 1 in 200 year tidal flood water level, wave overtopping may be expected during such an event or during other severe storm events. A separate assessment of wave overtopping has been undertaken and discussed in Chapter 4.

Finished Floor Levels

- 3.26 The Environment Agency typically recommends that finished floor level be set at 300mm above the 1 in 100 year fluvial, the 1 in 200 year undefended tidal, or the 1 in 200 year breach flood water level.
- 3.27 The development proposals for the site require level access into the plots. However, the ground floor finished floor levels will be set at least 150mm above the surrounding ground levels (therefore at approximately 4.15m AOD) and ramping will be used to provide level access.

Cross sections of the proposed development

- 3.28 Architectural elevations of the proposed development have been included in Drawing 3 and Drawing 4. A notional cross-section of the

site relative to relevant floodwater levels has been prepared and is shown in Figure 4.

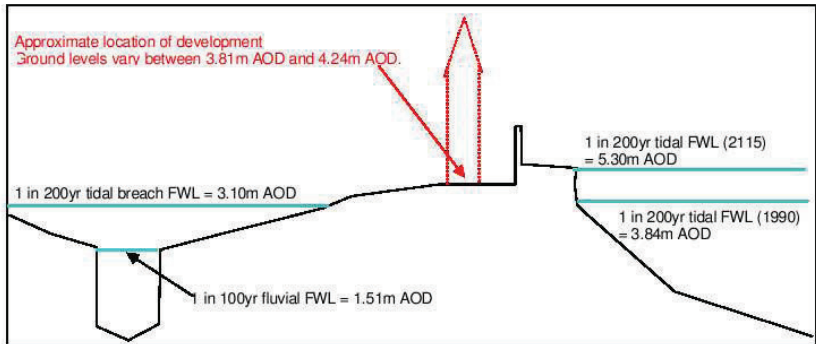


Figure 4 - Notional cross-section through the site

3.29 The notional cross-section shows that the site lies above the 1 in 200 year tidal (1990), 1 in 200 year tidal breach and 1 in 100 year fluvial flood water levels. The site lies approximately 1.3m below but defended against the 1 in 200 year tidal flood water level (including an allowance for climate change, 2115) by both the concrete wall and raised foreshore.

4 Wave Overtopping Modelling

- 4.1 The Environment Agency has indicated that the site is at risk of flooding primarily due to wave overtopping, which can be seen annually and requires flood gates to minimise the impact. The Environment Agency indicated that waves height which can be over 2m during a storm event
- 4.2 Wave overtopping may occur during high tidal flood event, extreme storm events or both. While it is difficult to quantify the overtopping that might occur over the concrete wall, the volume and flow across the site will depend on the combination of environmental factors.
- 4.3 The development proposals will include flood mitigation measure to protect the residential units from any flooding during overtopping events. The proposed mitigation measures are discussed further in Chapter 6.

Modelling

- 4.4 Attempts were made to assess the amount of wave overtopping of the flood defences using various wave overtopping software from HR Wallingford. The empirical method, PC-overtopping and neural network software have been investigated.
- 4.5 The wave parameters were obtained from the Channel Coastal Observatory for the nearest wave buoy at Rustington (OS coordinates: 506331N, 93784E) are shown in Table 1. The wave report¹ is shown in Appendix C.

Table 1 – Wave parameters from annual wave report for 2007

2007	Significant wave height H_s (m)	Significant wave period T_p (s)	Wave direction (°N)
Annual Average	0.83	6.48	195
Annual Maximum	4.32	10.5	--
Highest storm event (~1 in 20 year storm)	4.32	10.0	217
Most frequently occurring storm event	0.5	8	220

¹ Rustington Directional WaveRider Buoy – Annual Wave Report, Rustington 2007 Channel Coastal Observatory

Empirical Method

- 4.6 The empirical method was used and the sea defence type was selected as Slope Composite with Wall of the coastal dykes and embankment sea walls group. The general shape is shown in Figure 5.

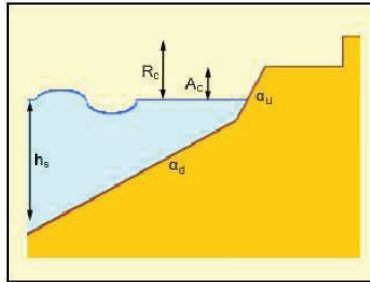


Figure 5 – Preset structural shape representation of flood defence

- 4.7 Input parameters are listed in Table 2.

Table 2 – Parameters entered for the empirical method

Parameter	Value
T (wave period)	$T_p = 8s$
H_{m0} (Wave Height at the Toe of the Structure)	3.4m
R_c (Freeboard - The height of the crest of the wall above still water level (m))	3m
α_d (Slope angle 1)	35°
α_u (Slope angle 2)	90°
γ (coefficient for reduction factors)	Asphalt (roughness factor = 1, worst case)

- 4.8 The results for this method are shown in Table 3.

Table 3 – Result for different values of T_p

Value of T_p	For breach type (default)	Result - Mean overtopping discharge rate per metre run of seawall (l/s/m)
8s	Breaking parameter < 7 and > 5	661
20s	Non-Breaking waves	1189

- 4.9 These values are very high and above the range of the model. To reduce the amount of wave overtopping, the water depth from the point at which the waves break should be used instead which is less than 3.4m used as there slope is very shallow and the waves will break further.
- 4.10 Unfortunately the online empirical method model provided by HR Wallingford is currently under maintenance and is not expected to be made available in the near future. We are therefore unable to test more appropriate wave parameters.

PC overtopping

- 4.11 The PC-overtopping software gave enough flexibility on the structural shape and wave parameters but was not overly dimensional.
- 4.12 A general section of the sea defence structure used in the modelling is shown in a schematic in Figure 6.

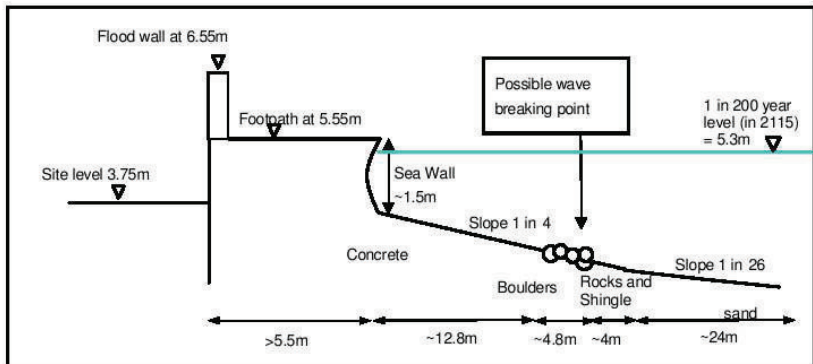


Figure 6 – Schematic of the structural section of flood defence

- 4.13 The modelled section in the PC-overtopping is shown in Figure 7, with the actual structure superimposed on the drawing to give an indication of how it is represented.

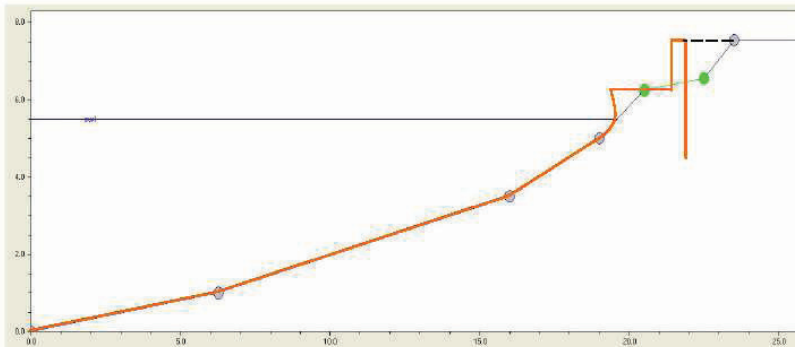


Figure 7 – Modelled section of flood defence

4.14 Four scenarios have been considered and the critical input parameters are tabulated in Table 4 below.

Table 4 – Wave parameters input into PC-overtopping model

2007	Significant wave height H_s (m)	Significant wave period T_p (s)	Wave direction (°N)	Water stand (m AOD)
Average waves	0.83	6.48	195	5.3
High average	1.5	7.0	200	5.3
Storm event	2	6.0	215	5.3

4.15 The wave parameters presented in the first two rows in Table 4 are taken from Channel Coastal Observatory's Annual Wave Report 2007² for Rustington Directional WaveRider Buoy (included in Appendix D).

4.16 The last row in Table 4 is an estimate based on the water depth limit assuming the water depth at breaking point is 4m by which, for such a high wave height, would have a shortened wave length and therefore period. A storm duration of 12 hours was used.

4.17 The effect of the 1 in 200 year tidal event, and climate change, has been included by using a water stand level of 5.3m AOD.

4.18 Results are summarised in Table 5.

² Rustington Directional WaveRider Buoy – Annual Wave Report, Rustington 2007 Channel Coastal Observatory

Table 5 – Results from PC-overtopping modelling

2007	Overtopping (l/s/m of wall)	Percentage Overtopping	2% wave runoff level (m)
Annual Average	0.249	6.72	2.47
High Average	16.07	40.69	4.28
Storm event	1.034	11.02	2.73

4.19 The results show that wave overtopping could be significant both for a 1 in 200 year tidal level and a for current storm events.

Neural Network

4.20 The Neural Network software from HR Wallingford³ allows for more detailed analysis and can better represent the structural configuration.

4.21 Table 6 shows the parameters used in the neural network analysis. The different combination of parameters used and results for each set of conditions is shown in Appendix C. Schematics of the structure and water levels used are also included in Appendix C.

Table 6 – Parameters for neural network

Parameter	Parameter Description	Typical Values
β	Angle of Wave attack (°)	75
h	Water depth in front of structure (m)	5.6-7.6
$H_{m, toe}$	Significant Wave Height at the toe of structure (m)	0.83-2.25
$T_{m, 1/10, toe}$	Wave period (s) $T_{m, 1/10, toe} = T_r/1.1$	5.4-6.4
h_t	Water depth at the toe of structure (m)	5.6-6.7
B_t	Width of toe (m)	0-9
γ	Roughness coefficient	0.5-1
$\cot \alpha_d$	Angle of down slope	4
$\cot \alpha_u$	Angle of upper slope	0
R_c	Crest Freeboard in relation to SWL	1.2-2.3
B	Berm Width (m)	0
h_b	Water depth at the berm of the structure (m)	0.2-1.3
$\tan \alpha_b$	Berm slope	0
A_c	Armour Freeboard in relation to SWL (m)	0.2-1.3
G_c	Armour Width (m)	6.0

4.22 The figures shown in Table 6 represent what is considered reasonable following an analysis of the structure and wave conditions in this stretch of coastline. The numbers in bold are wave dependant

³ CREST LEVEL ASSESSMENT OF COASTAL STRUCTURES BY FULL SCALE MONITORING, NEURAL NETWORK PREDICTION AND HAZARD ANALYSIS ON PERMISSIBLE WAVE OVERTOPPING. GENERIC PREDICTION METHOD. WLIDELFT HYDRAULICS

parameters and the numbers in italics are parameters which will be affected by water depth.

- 4.23 The results (shown in Appendix C) for the highest wave period, wave height and water depth with a realistic wave direction returns a overtopping rate of approximately 20 l/s/m.
- 4.24 The results for lower significant wave heights modelled with PC-overtopping model of 0.83 and 1.5 returned maximum overtopping rates of 0.18 and 3.27 l/s/m respectively.
- 4.25 The highest result is for the wave direction to be normal to the structure, however, it is thought that this is unrealistic as from the wave report⁴ all of the high (large) waves generally come from a direction of 215 degrees North, with is parallel to the shoreline.
- 4.26 From this analysis, the worst case modelled wave overtopping scenario in this case return a overtopping rate of approximately **20l/s/m**.

Discussion

- 4.27 The results were very similar for both PC-overtopping analysis and Neutral network given the relative complexity of the situation and uncertainties involved. Both methods calculated a overtopping rate of the order of 20 l/s/m (of wall).
- 4.28 The results show that overtopping should be a important consideration.
- 4.29 Given the general layout of the site, the structures are facing south-east direction and the general direction of waves are from the south-west. This is shown in Figure 7. Therefore, the waves are generally not expected to impact directly onto the wall and the force of impact on the flood defences should be minimal (i.e. wave direction is along the wall).
- 4.30 In addition, the site is protected by boulders extending southwards from the bay on the south west corner of the site (see Figure 7). This should protect the site from (the majority of) waves from the south west.
- 4.31 Waves can be reflected and refracted and the site is as a result not entirely protected from waves from the east. The wave report⁴ does however show that high waves are almost entirely from the southwest and the site is therefore considered more protected.
- 4.32 The Neutral Network was used to model the highest wave extracted from the wave report⁴ with its associated direction. The model returned an overtopping rate of 17 l/s/m.

⁴ Rustington Directional WaveRider Buoy – Annual Wave Report, Rustington 2007 Channel Coastal Observatory

4.33 In both current sever storm events and future storm and tidal flooding events, the wave overtopping of the flood defences is expected to result in flooding across the site.

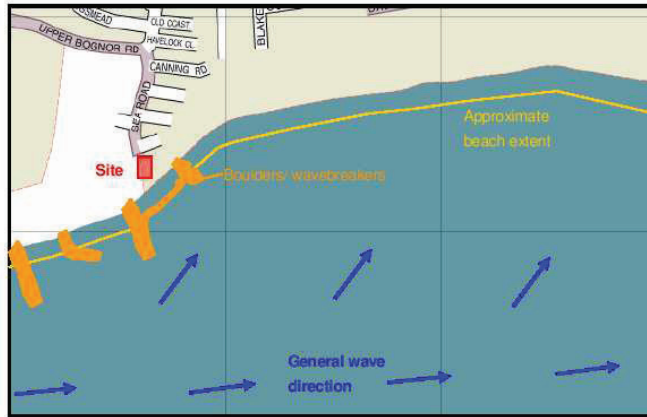


Figure 8 – Shoreline schematic

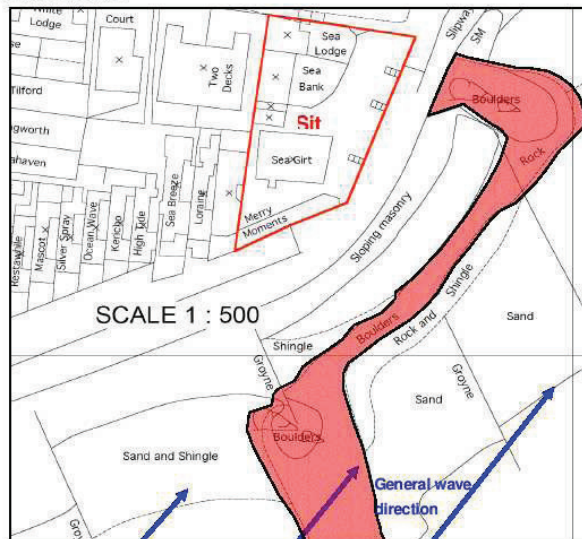


Figure 9 – Shoreline schematic

5 SITE DRAINAGE

Existing drains and sewers

- 5.1 The site is drained by existing public foul and surface water drainage system. The offsite and on site manholes, pipe sizes and flow directions have been picked up as part of the topographic survey, included as Drawing 2.
- 5.2 The concrete hardstanding area between the existing buildings and the concrete sea wall is drained by a surface water sewer, as shown in Photograph 8.
- 5.3 Excess surface water from the site not collected via the existing surface water drainage system would runoff into Outram Road and flow westwards ending up in the Aldingbourne Rife. Drawing 7 suggests that surface water runoff collected by the public sewers discharges into the Aldingbourne Rife.

Runoff generated from development of the site

- 5.4 The current development plans show that while there will be a net decrease in the total building footprint area as a result of the development, as well as a decrease in hardstanding surface areas. There should therefore be a net reduction in the total impermeable runoff areas on site. As a result of the decrease in impermeable runoff areas, it is expected that there will be a decrease in surface water runoff from the site.
- 5.5 The site has an existing foul water connection to the public foul sewer and as a result of the development matching the number of residential units on site; foul flows are not expected to increase significantly as a result of the proposed development.
- 5.6 Considering the existing buildings and the proposed layouts, it is expected that there will be an increase in the number of bathrooms and water closets and as a result an increase in the peak foul flow from the site.
- 5.7 Capacity checks with the public sewer authority will need to be undertaken as part of the proposed development.

Impact on fluvial morphology

- 5.8 Due to the small size of the site and the anticipated reduction in runoff generated on site, no adverse impact on the fluvial morphology of the Aldingbourne Rife is expected.

6 OTHER DESIGN CONSIDERATIONS

Flood Warning

- 6.1 As shown in Figure 10, the site is shown to lie within an Environment Agency Flood Warning Area, serviced by the Environment Agency 'Floodline' flood warning service.

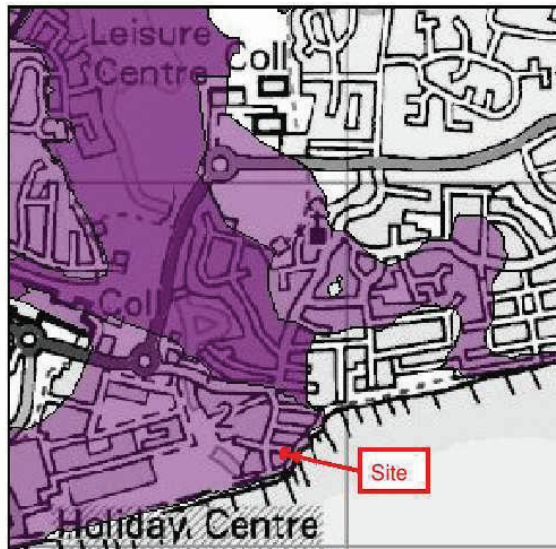


Figure 10 - Environment Agency Flood Warning Areas

- 6.2 The full Environment Agency 'Floodline' flood warning service comprises four staged warning codes, each indicating the severity of flooding and the level of danger. These are All Clear, Flood Watch, Flood Warning and Severe Flood Warning. The flood status of an area is updated at 15 minute intervals on the internet and is also available by telephone on a 24 hour floodline. Subscribers to the flood warning service receive automatic notification of a change in flood status for the area by telephone or facsimile.
- 6.3 Flood warnings can also be accessed through updates on local radio and local television (a list of the local stations and programmes which provide these updates can found on the Environment Agency website), on the Environment Agency website directly, and by calling the Floodline 0845 988 1188 service (this service allows one to listen to recorded flood warning information or speak to an operator for general information and advice 24 hours a day).

- 6.4 Future residents of the proposed site will be encouraged to subscribe the Environment Agency flood warning service for the area and evacuation procedures should be made known to future residents.

Site access in times of flood

- 6.5 The existing coastal flood defences are expected to protect the site and local area against 1 in 200 year tidal flood event, both currently and for the expected design life of the property. Dry pedestrian and vehicular access will be maintained throughout this event.
- 6.6 As shown in Figure 11 (Drawing 8), the modelled 1 in 100 year fluvial flood event is not expected to flood the surrounding road network. Dry pedestrian and vehicular access will be maintained throughout this event, along Outram Road then Sea Road.



Figure 11 - 1 in 100yr fluvial flood event floodplain

- 6.7 Dry pedestrian and vehicular access will be maintained throughout the 1 in 100 year fluvial event, along Outram Road then Sea Road.
- 6.8 In the event of a breach of the tidal defences during the 1 in 200 year tidal event the site is expected to remain dry, however as shown in Figure 12 (Drawing 9), Sea Road is expected to flood.



Figure 12 - 1 in 200yr tidal breach event floodplain

6.9 Although dry vehicular and pedestrian access / escape will not be available along sea road, the local topography is flat (as shown in Figure 12). Flooding along sea road would therefore likely be shallow and safe to wade or drive through depending on the velocity and turbidity of the water.

6.10 The combined impacts of depth and velocity on both people and buildings can be assessed with the risk table⁵ provided by DEFRA and the Environment Agency.

Table 13.1 Danger to people for different combinations of depth and velocity

Velocity (m/s)	Depth of flooding (m)											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00												
0.10												
0.25												
0.50												
1.00												
1.50												
2.00												
2.50												
3.00												
3.50												
4.00												
4.50												
5.00												

Key:
 Danger for some
 Danger for most
 Danger for all

Table 1– Combined impacts of depth and velocity (use FD2320 Report table 13.1)

⁵ Defra/Environment Agency – Flood and Coastal Defence R&D Programme: Flood Risks Assessment Guidance for New Developments, R&D Technical report FD2320, October 2005.

- 6.11 If required pedestrian access / escape should be required it may be possible to walk along the pedestrian foreshore (depending on the tide level and sea conditions) or emergency access thorough neighbouring properties between Outram Road, Clyde Road, Canning Road, etc.
- 6.12 In the event of wave overtopping during extreme storm event of during tidal flood events, dry access / escape from the site may not be possible or considered safe. In such an event residents should remain in doors on the upper floors and contact emergency services should they require evacuation.
- 6.13 As the development proposes to replace the existing three dwelling with three new (improved) dwellings, it is not considered that the proposed development will increase the burden on emergency services.

Flood mitigation

- 6.14 While the site is not expected to flood in any of the design flood events considered in accordance with PPS25, the proposed redevelopment of the site will include a number of flood mitigation measures to reduce risk of the new residential buildings flooding in the event of wave overtopping during extreme storm events.

Location and design

- 6.15 The development proposals pull back as far back as possible the new residential units from the existing defences.
- 6.16 The proposed ground floor finished floor levels will be set at least 150mm above the surrounding ground levels.

Landscaping

- 6.17 The site will landscaped such that the paved vehicular access and parking areas are lowered, collecting any water that overtops the defences and directing it safely offsite.
- 6.18 The collected water will flow onto Outram Road, towards and eventually into the Aldingbourne Rife, maintaining the existing flooding regime.

Flood Proofing

- 6.19 The proposed development will incorporate flood barriers across the front door and garage door or each residential unit. The demountable flood barrier can be stored in a garage under normal conditions and be installed by the resident if there is a risk of overtopping.
- 6.20 A 1.2m high wall is be constructed along the rear of the property, a 0.6m high wall connecting the two buildings and floodgates on either side of the entrances (the rear parking side and the road side) are to be constructed as shown in Figure 13 (Drawing 1). The flood gates

can be left open under normal conditions and only closed when there is a risk of overtopping.

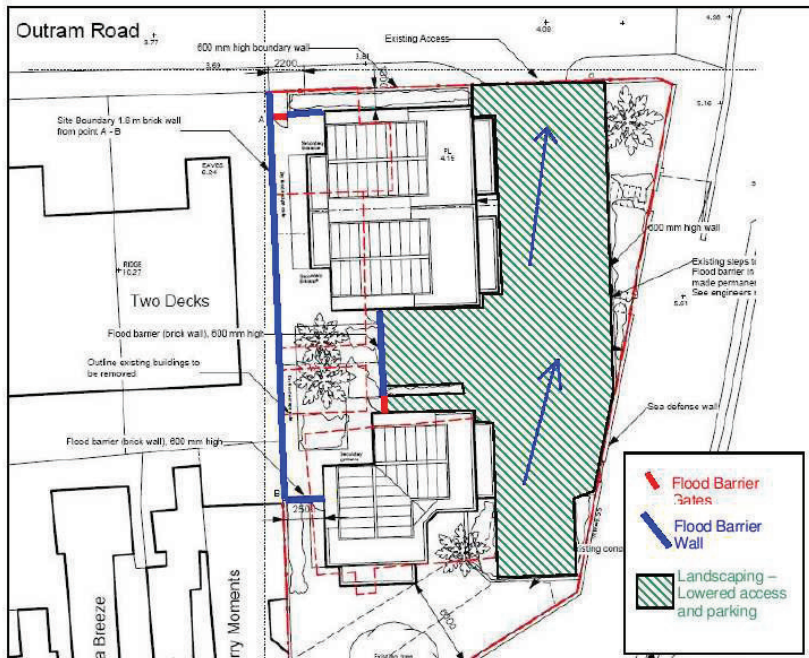


Figure 13 - Proposed flood proofing and landscaping

The Sequential Test

- 6.21 The proposed development is for a replacement of the existing number of residential units on site and as such should not require a Sequential Test to be undertaken. However, for completeness we have undertaken the test for references purposes only.
- 6.22 The site is located towards the extent of Flood Zone 3a (High probability).
- 6.23 Residential dwellings are classed as 'More Vulnerable' according to the Table D2 in appendix D of PPS25
- 6.24 PPS25 states that residential development within Flood Zone 3a is appropriate should it be shown that the Exception test is passed.

The Exception Test

- 6.25 The proposed residential development is on previously developed residential site and will not increase the number of residences.
- 6.26 The proposed development will reduce the impermeable area on site, resulting in a reduction in the surface water runoff from the site into the existing public sewers or onto the local road network.
- 6.27 The finished floor level will be set approximately 150mm above existing ground levels (at approximately 4.15m AOD), above both the 1 in 100 year fluvial flood and 1 in 200 year tidal breach event.
- 6.28 The proposed development will include temporary flood barriers and doors that residents will be encouraged to utilise during extreme storm events when wave overtopping may be expected.
- 6.29 Safe / dry pedestrian and vehicular access will be maintained throughout the 1 in 100 year fluvial and 1 in 200 year tidal flood events (unless significant overtopping occurs).
- 6.30 The proposed development is not expected to increase the flood risk elsewhere.
- 6.31 It is our opinion that the requirements set by the Exception Test (PPS25 Appendix D, paragraph D9) have been satisfied. Therefore satisfying the Sequential Test and showing the development to be appropriate within Flood Zone 3a.

7 Conclusions

- 7.1 The proposed development site is a seafront residential property located of Outram Road in Felpham. The site has two buildings, providing a total of three residential units. The topographic survey shows that the site is flat with levels roughly at 4.0m AOD.
- 7.2 The development proposals include removing all buildings on the site and replacing them with two new buildings, containing a total of three residential units.
- 7.3 The new building is proposed away from the concrete boundary (sea) wall, allowing generally more than 8m (6m at the closest point) clearance.
- 7.4 The site is shown to lie within Flood Zone 3 in the latest flood zone maps held by the Environment Agency and as a result a flood risk assessment is required. The site is potentially at risk of tidal flooding from the sea, fluvial flooding from the Aldingbourne Rife and wave overtopping during extreme storm events.
- 7.5 The Environment Agency provided the 1 in 100 year fluvial flood water level as 1.51m AOD; the 1 in 200 year tidal flood water level as 3.84m AOD (1990); the 1 in 200 year tidal flood water level, including an allowance for climate change, as 5.3m AOD (2115); and the 1 in 200 year tidal breach flood water level, including and allowance for climate change, as 3.1m AOD (2060).
- 7.6 The site is not at risk of fluvial flooding in the Aldingbourne Rife during the 1 in 100 year flood event.
- 7.7 The site is protected against tidal flooding by a raised wide concrete foreshore (with a crest height minimum of approximately 5.40m AOD), and a concrete sea wall along the site boundary (with a crest height of 6.55m AOD).
- 7.8 The site is not at risk of tidal flooding during the 1 in 200 year tidal flood event or the 1 in 200 year tidal breach event, with allowances for sea level rise as a result of climate change made in both cases.
- 7.9 An allowance of only 50 year climate change was included in the breach modelling, however the Environment Agency agreed that as the development was only a replacement of the existing three units a new breach assessment (to 2100) was not required.
- 7.10 Dry vehicular and pedestrian access will be maintained throughout the 1 in 100 year fluvial and 1 in 200 year tidal flood events, unless significant overtopping of the defences occur.
- 7.11 In the event of the 1 in 200 year tidal breach event modelled, dry vehicular and pedestrian access will not be possible along Sea Road. However considering the likely on the depth and velocity of the

floodwaters the route may be considered of 'Low' risk. Dry pedestrian access may be possible through neighbouring properties.

- 7.12 The site is considered to have a risk of flooding by wave overtopping during extreme storm events. The Environment Agency has indicated that the site is considered at risk of flooding primarily due to wave overtopping, which can be seen annually and requires flood gates to minimise the impact. Wave overtopping could be worsened if high waves occurred during tidal flood events.
- 7.13 An assessment of the volume and rate of overtopping during extreme storm and tidal events has been been modelled using hydraulic models provided on the HR Wallingford website. The results of the modelling confirm that overtopping will occur during extreme storm event and is expected to worsen with the effects of climate change and sea level rise.
- 7.14 The driveway and parking are will be lowered to store any water overtopping the defences and directing the water off the site (away from the building) and onto Outram Road (as the site currently does).
- 7.15 The ground floor finished floor level of the new building will be raised approximately 150mm above the surrounding ground levels.
- 7.16 Demountable flood barriers are proposed across each of the front entrance and garage doors, which can be erected by the residents when there is a risk of wave overtopping.
- 7.17 Low flood defence walls are proposed along the rear of the property and linking the two buildings. These walls when combined with floodgates and the rear access from the units will allow residents to leave their properties in the event of flooding in the sea facing area.
- 7.18 The proposed development of the site will maintain the existing foul and surface water sewer connection to the off site sewer network.
- 7.19 The development proposals for the site are shown to decrease the total hardstanding runoff areas on site and therefore a decrease in the surface water discharge from the site is expected.
- 7.20 The development is for the replacement of the three existing units with three new (better protected) units and as such the PPS25 Exception Test should not be required. The Sequential Test has however been considered and is considered passed.
- 7.21 There will be no increase in the risk of flooding on any third party land as a result of the development and there will be no adverse effects on the fluvial morphology of the Aldingbourne Rife.

8 APPENDIX A – PHOTOGRAPHS



Photograph 1 – Current site



Photograph 2 – Looking toward the sea (and the site) up Outram Road from Sea Road



Photograph 3 – View of the concrete wall in front of the site



Photograph 4 – Promenade area between the shore and the site



Photograph 5 – Flood defence wall and boulders in front of the site



Photograph 6 – Concrete foreshore and wave return structure to the front of the site



Photograph 7 – Existing floodgates through the concrete wall on the sea facing boundary



Photograph 8 – Existing surface water drainage on site to the rear of the concrete sea wall



Photograph 9 – Aldingbourne Rife double outfall into the sea and the Felpham Pumping Station to the right