

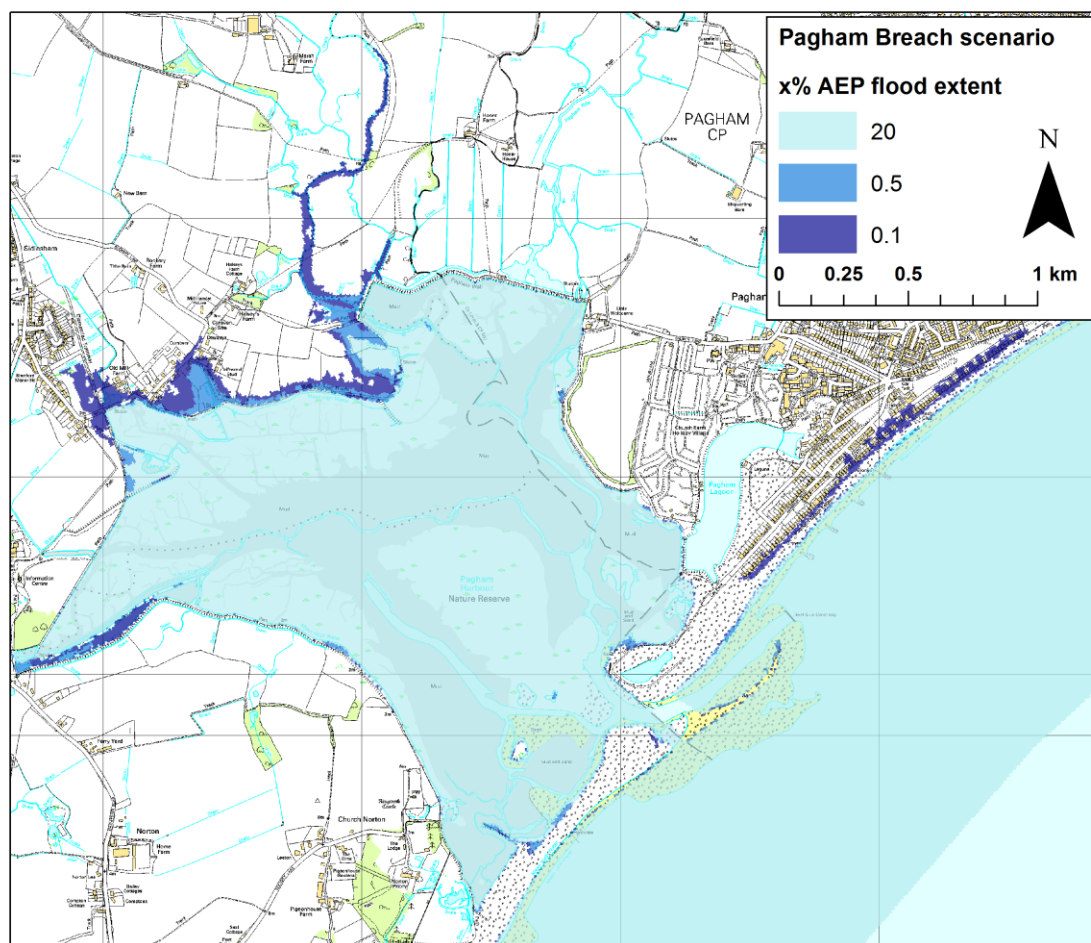
The breach at Felpham allowed water into the river channels of the Aldingbourne Rife and Lidsey Rife. Floodwater from the breach spreads several kilometres inland to the north-east and north-west within the river channels. Figure 7-7 shows the flood extents from the breach at Felpham for 20, 0.5, 0.1% AEP events.



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Figure 7-7: Flood extents from a breach at Felpham

The fourth breach was modelled at Pagham Harbour. A 40m breach was cut through the spit and the material was used to infill the existing channel to the east. The results from these simulations produced less flooding than the defended model simulations. This is in part due to the channel being blocked to the east and also due to the spit being removed from the harbour mouth to the end of the spit in the defended simulations, allowing a larger area for the water to flow through. The flood extents from the Pagham Harbour breach are shown in Figure 7-8.



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Figure 7-8: Flood extents from a breach at Pagham

7.4 Flooded properties

To provide an overview of the different model simulations, Table 7-1 below shows a comparison of the number of properties flooded during each defended and undefended simulation, including the 0.5% AEP events plus climate change for the years 2070 and 2115 based on both UKCP09 and NPPF guidance. These property counts were based on the National Receptors Database (NRD), which was edited to remove all properties which were listed in Appendix A of the 'Property Count Method - External Technical Note' as they were not required. There are clear differences between the defended and undefended simulations for all AEP events. For the 20% AEP defended event 222 properties are flooded compared with 2,565 during the undefended scenario. For the 0.5% AEP event, 968 properties flood in the defended simulation, most of which are on the River Arun and around Pagham Harbour. This count does however include some properties with Multi-Coloured Manual (MCM) code '999' and multiple points representing both ground floor and upper level flats. Thus the results are most appropriate for comparing the differences between different events and scenarios.

Table 7-1: Arun model flooded property count for all AEP events

Number of flooded properties			
AEP (%)	Flooded properties (Defended)	Flooded properties (Undefended)	Difference
20	222	2,565	2,343
5	378	3,011	2,633
3.33	415	3,092	2,677
1.33	584	3,314	2,730
1	640	3,397	2,757
0.5	968	3,575	2,607
0.2	1,562	3,880	2,318
0.1	2,199	4,144	1,945
0.5cc (2070 UKCP09)	3,006	4,711	1,705
0.5cc (2115 UKCP09)	5,115	5,972	857
0.5cc (2070NPPF)	3,537	5,077	1,540
0.5cc (2115 NPPF)	7,090	7,249	159

7.5 Onset and duration

Onset and duration of flooding grids were extracted from the 0.5% AEP model event simulation which detail the duration of inundation (duration grid) and the time of first inundation above a depth of 0.01m (onset grid).

7.6 Standard of protection

The SoP was calculated for all the coastal defences which overtopped during any of the model event simulations, excluding the climate change scenarios. Therefore, 32 SoP plots were created. The SoP was estimated based on various EurOtop wave overtopping tolerable limits. The tolerable discharge limits were obtained from the EurOtop Manual for various hazard types including trained staff, aware pedestrians, unaware pedestrians, fast/moderate moving vehicles and slow moving vehicles. Table 7-2 shows the SoP for the overtopped defences. For all overtopped defences, the SoP for slow moving vehicles is greater than 0.1% AEPs. Half of the defences also have a SoP for trained staff of more than 0.1% AEPs.

Wave overtopping profiles 38, 39 and 42 have a much lower SoP, with a 10% AEP standard of protection for 38 and 39 and less than 20% AEP SoP for trained staff at profile 42. These correspond to the areas that flooded during the 20% AEP event shown in Figure 13-1 at Bognor Regis pier and Aldwick. Wave overtopping profiles 24 and 46 have the highest SoP for overtopped defences in the region, with a 0.1% AEP SoP for all hazard types except fast moving vehicles, which reduces the SoP to 0.14% and 0.15% AEP respectively. All of the defences not included in Table 13-2 were not overtopped for the 20, 5, 3.33, 1.33, 1, 0.5, 0.2 or 0.1% AEP events and thus have a SoP greater than the 0.1% AEP event.

Table 7-2: Standard of protection for the 32 overtopped defences from Arun to East Head given as AEP (%)

WO profile	Threshold for fast moving vehicle 0.00001m ³ /s/m (SoP in AEP %)	Threshold for unaware pedestrian 0.00003m ³ /s/m (SoP in AEP %)	Threshold for aware pedestrian 0.0001m ³ /s/m (SoP in AEP %)	Threshold for trained staff 0.001m ³ /s/m (SoP in AEP %)	Threshold for slow moving vehicle 0.01m ³ /s/m (SoP in AEP %)
2	0.28	0.20	0.19	>0.1	>0.1
4	0.20	0.18	0.14	>0.1	>0.1
5	0.22	0.20	0.18	>0.1	>0.1
6	0.83	0.38	0.23	>0.1	>0.1
13	0.20	0.18	0.15	>0.1	>0.1
14	0.45	0.38	0.22	>0.1	>0.1

WO profile	Threshold for fast moving vehicle 0.00001m ³ /s/m (SoP in AEP %)	Threshold for unaware pedestrian 0.00003m ³ /s/m (SoP in AEP %)	Threshold for aware pedestrian 0.0001m ³ /s/m (SoP in AEP %)	Threshold for trained staff 0.001m ³ /s/m (SoP in AEP %)	Threshold for slow moving vehicle 0.01m ³ /s/m (SoP in AEP %)
15	0.48	0.45	0.38	0.12	>0.1
16	0.43	0.33	0.19	>0.1	>0.1
18	0.91	0.80	0.59	0.19	>0.1
19	0.91	0.80	0.59	0.19	>0.1
20	0.91	0.71	0.48	0.17	>0.1
21	0.91	0.71	0.48	0.17	>0.1
22	0.91	0.71	0.48	0.17	>0.1
23	0.20	0.19	0.17	>0.1	>0.1
24	0.14	>0.1	>0.1	>0.1	>0.1
25	0.71	0.50	0.43	0.15	>0.1
26	0.19	0.18	0.14	>0.1	>0.1
33	0.48	0.42	0.32	0.10	>0.1
34	1.18	0.91	0.77	0.23	>0.1
35	0.91	0.77	0.53	0.14	>0.1
36	0.91	0.77	0.53	0.17	>0.1
37	0.91	0.77	0.54	0.17	>0.1
38	<20	<20	<20	10.00	>0.1
39	<20	<20	<20	10.00	>0.1
42	<20	<20	<20	<20	>0.1
46	0.14	>0.1	>0.1	>0.1	>0.1
50	0.19	0.18	0.15	>0.1	>0.1
51	0.48	0.40	0.26	>0.1	>0.1
52	0.20	0.19	0.15	>0.1	>0.1
53	0.77	0.34	0.19	>0.1	>0.1
54	1.00	0.91	0.71	0.17	>0.1
55	3.03	2.50	1.43	0.40	>0.1

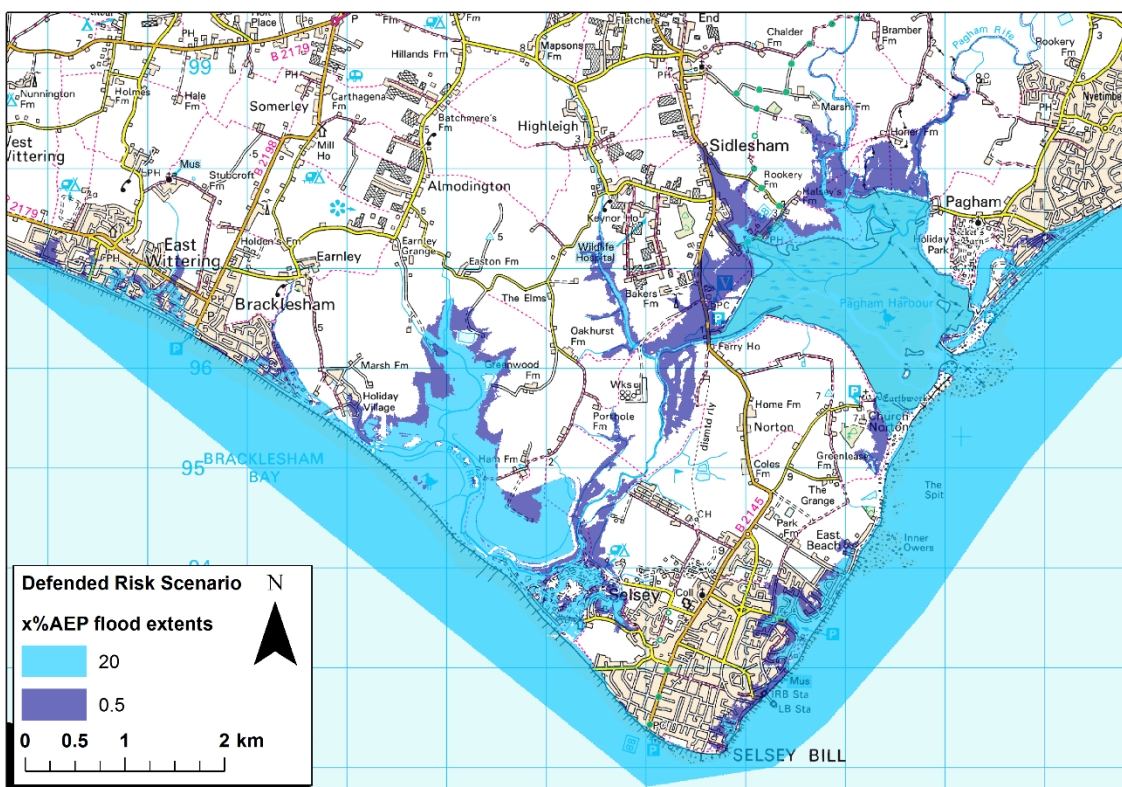
7.7 Risk model simulations

Wave overtopping calculations were completed for all joint probability scenarios for normal and risk profiles. The risk profiles were calculated for each coastal defence by analysing the CCO data for each area. The surveyed profile data was plotted and the worst case for each defence schematised in order to calculate the potential overtopping when the beach is in an eroded state. The model simulations were set up in exactly the same way as the defended models, but with the discharge rates from the risk profiles. Figure 7-9 and Figure 7-10 show the 20 and 0.5% AEP flood extents for the risk profile simulations at Bognor Regis, Littlehampton, Selsey and Wittering. When compared with the normal profile defended results for the 20 and 0.5% AEP flood extents, there is a distinctive increase in flooding, most notably around the river networks and coastal communities. There are significant increases around Bognor Regis, even during the 20% AEP event. Likewise, there is additional inundation of properties in the key communities of Selsey and Wittering during the 20% AEP event when using risk wave overtopping profiles.



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Figure 7-9: 20 and 0.5% AEP flood extents for Littlehampton and Bognor Regis using risk profiles



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Figure 7-10: 20 and 0.5% AEP flood extents for Selsey and Wittering using risk profiles

7.7.1 The impact of climate change

As with the defended and undefended scenarios, the risk profile simulations included assessing the impact of climate change, using both UKCP09 and NPPF guidance. Similarly to the lower AEP events, the risk profiles cause significant increases in flood extents compared with the defended climate change simulations. There is increased flooding at Wittering, Selsey, Bognor Regis, Felpham and Middleton-on-Sea. East Wittering in particular is almost entirely inundated during the 0.5% AEP plus climate change (2070 UKCP09) event, whereas almost no overtopping occurred during the defended equivalent.

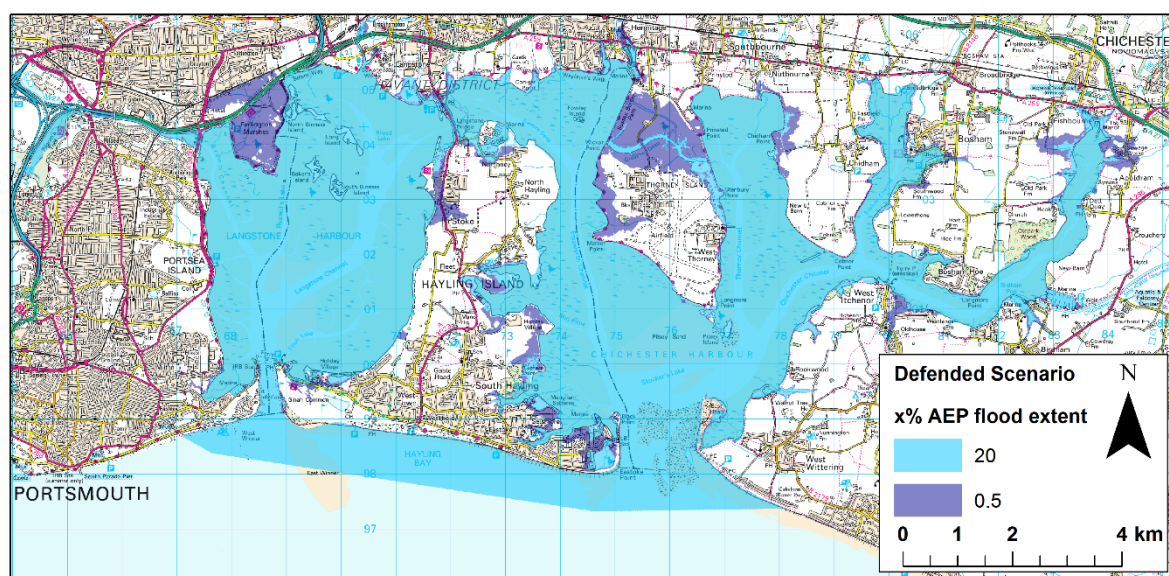
7.7.2 Risk profile flooded properties

For the risk profile scenarios, there is increased property inundation for all model simulations when compared against the defended results. During higher AEP events, more properties flood than during the undefended scenarios. With the undefended simulations, defences are removed, allowing water to flow back out to sea in some coastal communities and disperse on the floodplains.

7.8 Chichester Harbour model

This model extended from West Wittering to Eastney on Portsea Island. This incorporates the communities of Itchenor, Bosham, Emsworth and Hayling Island. Wave overtopping does not have a significant impact on this harbour area, with flooding mainly caused by still water flooding. Several areas were schematised to include wave overtopping, including West Wittering and Emsworth. The model was built using information from six existing models in Chichester Harbour, extended west to Portsea Island and included updated bathymetry and DTM data. As with the Arun to East Head model, defended and undefended models were set up for the 20, 5, 3.33, 1.33, 1, 0.5, 0.5 (2070 UKCPO9), 0.5 (2115 UKCP09), 0.5 (2070 NPPF), 0.5 (2115 NPPF), 0.2 and 0.1% AEP events. Risk profiles were not calculated for the area, as wave overtopping is limited in the harbour, with most flooding occurring as a result of still water inundation. The boundary conditions were updated and included new sea-level tidal graphs, with climate change increase calculated as +0.39m to 2070 and +0.78m to 2115 using UKCP09 guidance and +0.52m and +1.13m to 2070 and 2115 respectively using NPPF guidance methods.

Figure 7-11 illustrates the flood extents for the 20 and 0.5% AEP defended simulations in Chichester Harbour. In the harbour there is a noticeable increase in flooding during the 0.5% AEP event. The main differences are on Thorney Island and the land south of Fishbourne. Although there is increased flooding on Thorney Island, it does not extend as far as the urbanised areas, and instead mostly inundates fields.



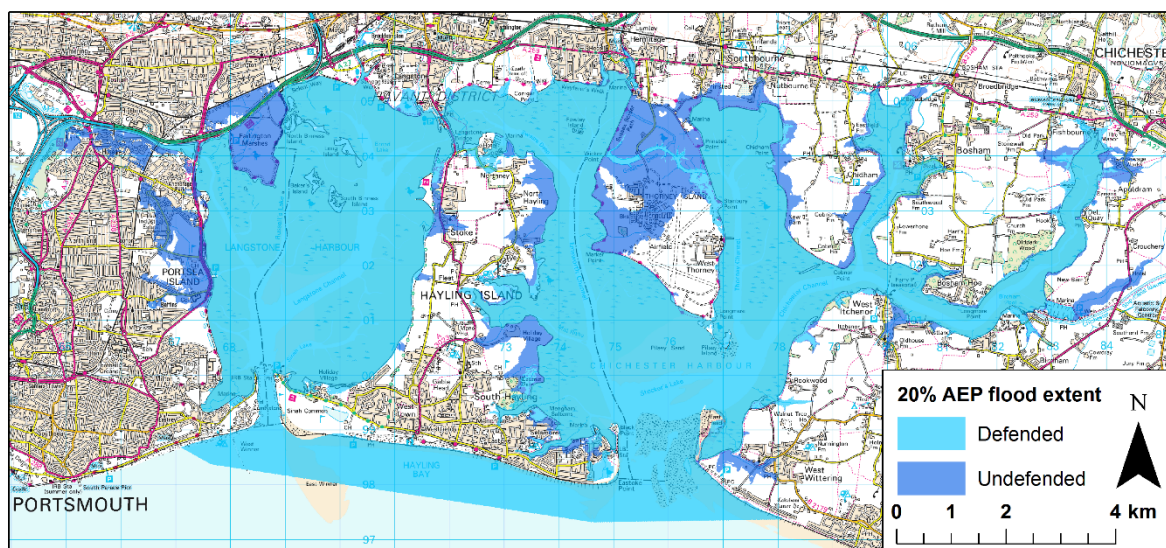
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Figure 7-11: Chichester Harbour flood extents for the 20 and 0.5% AEP defended scenarios

The coastal community of Bosham is affected during the 20% AEP defended scenario, particularly near Bosham Quay and the properties along Shore Road. The 0.2% AEP event causes significantly more flooding in Bosham, extending inland to Taylor's Lane and Canute Road. Thorney Island is flooded during the 0.2% AEP event, resulting in flooding at Baker Barracks and an electrical sub-station. In Emsworth, properties surrounding Slipper Mill Pond and the A529 Hermitage Road Bridge are at risk of flooding during a 20% AEP event. During the 1.33% AEP event properties on Marina Close and King Street are affected. With increasing AEP, the flooded properties in Emsworth increase, most notably during the 0.2% AEP event when Bridge Road is flooded, north of the A259. The 0.1% AEP event floods to a similar extent in Emsworth, extending approximately 20m further inland to the east along Lumley Road.

In the region of 100 properties are flooded during the 0.2% AEP event to the east of Emsworth, with the majority of them overlooking the Mill Pond and Hermitage Bridge. To the west of Emsworth, over 60 properties are flooded during the same event, with most of the inundated properties situated on Bath Road.

The undefended events show increased flooding for all AEP events. During the 0.1% AEP event all areas of Bosham along the Channel are flooded and Canute Road, Harbour Road and Southwood Farm are inundated. The 20% AEP undefended event resulted in increased flooding in Emsworth, both west and east of Mill Pond near Hermitage Bridge, affecting properties on Queen Street, King Street and Slipper Road. Figure 7-12 shows the difference in flooding between the 20% AEP defended and undefended simulations. The main differences are on Thorney Island and along the eastern side of Hayling Island. With each increasing AEP, further properties are flooded up to the 0.1% AEP event when the A259 is affected and additional properties are flooded on Lumney Road, Pagham Close, Bath Road, Bridge Road and Bridgefoot Path.



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Figure 7-12: 20% AEP defended and undefended flood extents for Chichester Harbour

Figure 7-13 shows the 0.1% AEP flood extents for both the defended and undefended simulations. There are fewer differences between these two than during the 20% AEP events, as more low lying areas are completely inundated. The most noticeable difference is to the east of Chichester Marina, which is still protected in the defended simulation. Towards the north of the model, Southbourne also continues to remain protected during the defended event but not for the undefended scenario. The extents at Emsworth are the same for both simulations.



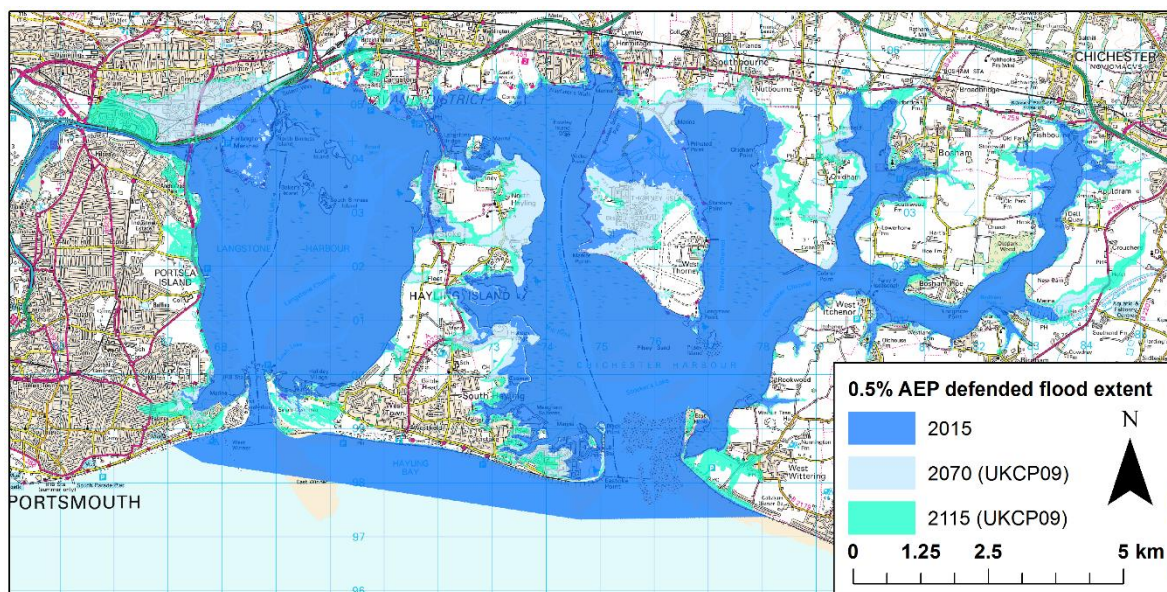
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Figure 7-13: 0.1% AEP defended and undefended flood extents for Chichester Harbour

The impact of climate change

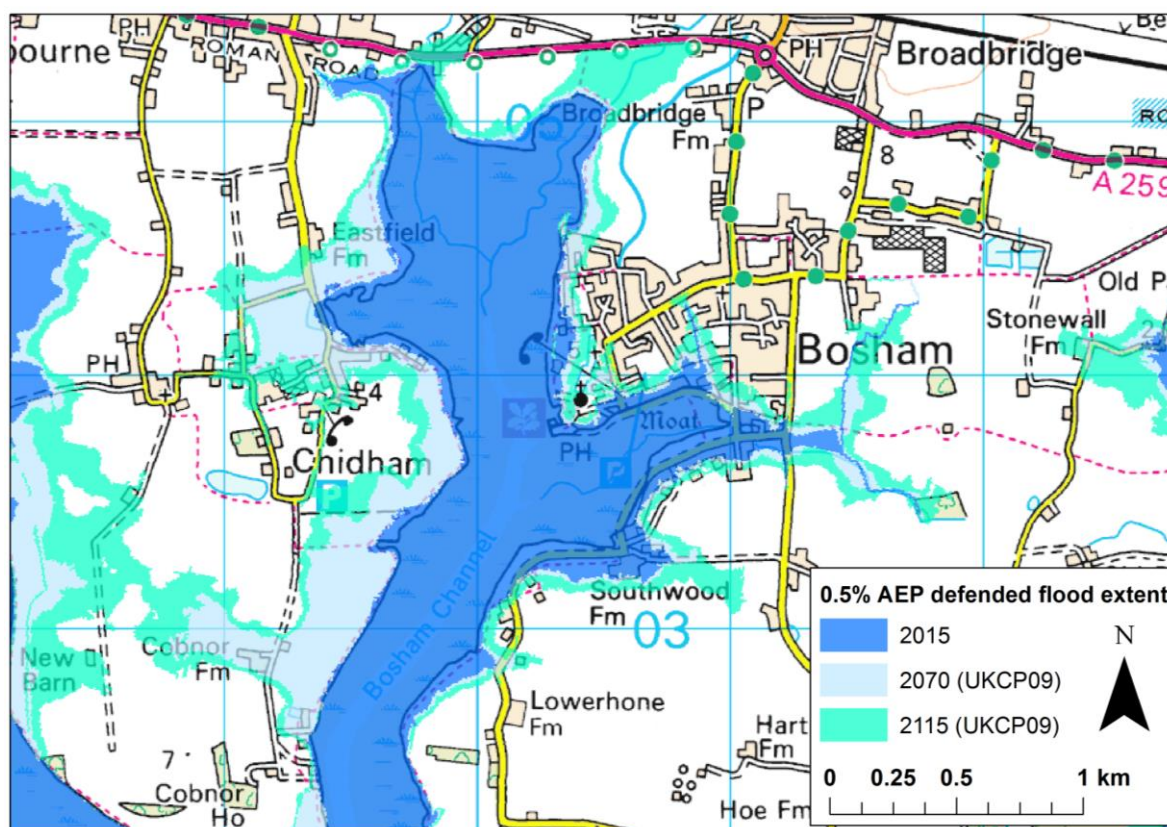
Figure 7-10 shows the flood extents in Chichester Harbour for the 0.5% AEP event and the 0.5% AEP events plus climate change to 2070 and 2115 based on the UKCP09 sea-level rise estimates. For both climate change simulations, there is increased flooding in Emsworth, Southbourne, Bosham, West Wittering and on Hayling and Portsea Islands. On Portsea Island, Eastney is affected by the 2115 climate change event, which extends 1km further inland to the west than the 0.5% AEP event.

In Emsworth there are fewer differences as a result of climate change, with additional flooding compared with the 0.5% AEP event mainly limited to the west, around Bridge Road. In Bosham, further properties are flooded during both climate change scenarios, although most of the additional flooding occurs only during the 2115 UKCP09 event. The additional flooding includes the area around the boat and car park, as well as Bosham Lane, Harbour Road and The Drive. Figure 7.14 illustrates the differences between the three events at Bosham. West Wittering remains defended during both the 0.5% and 0.5% AEP plus climate change to 2070 events. During the 0.5% AEP plus climate change to 2115 event, widespread flooding occurs affecting the Roman Landing area of West Wittering, including the church, National Trust site, school and properties around Rookwood Road. During the event, Rookwood Road has depths of up to 1.00m whilst the event flooded the nearby school to approximately 0.50m.



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Figure 7-14: 0.5% AEP defended and defended UKCP09 climate change comparison for the Chichester model



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Figure 7-15: 0.5% AEP defended and defended UKCP09 climate change comparison at Bosham

For both 2070 and 2115, climate change for the Chichester model was also calculated based on NPPF guidance. An increase of 0.52m and 1.13m was calculated for 2070 and 2115 respectively, the same increase as calculated for the Arun to East Head model. As would be expected, the increased still water level results in more widespread flooding based on NPPF guidance. Much of the coastline is affected, particularly during the 2115 NPPF event. During the 2070 NPPF event, flood extents are similar to the 2115 UKCP09 event. The 2115 NPPF event causes the largest amount of flooding. Emsworth and Bosham experience additional flooding, with Bosham the worst affected of the two, including depths of more than 0.60m on Bosham Lane.

Flooded properties

As with the Arun to East Head model, the flooded properties were calculated for the Chichester Harbour model to provide an overview of the different model simulations. Table 7-3 shows a comparison of the number of properties flooded during each defended and undefended simulation, including the 0.5% AEP events plus climate change for the years 2070 and 2115 based on both UKCP09 and NPPF guidance. These property counts were based on the same NRD as the Arun model, edited to remove all properties which were listed in Appendix A of the 'Property Count Method - External Technical Note'. There are clear differences between the defended and undefended simulations for all AEP events. For the 20% AEP defended event 375 properties are flooded compared with 2,195 during the undefended scenario. For the 0.5% AEP event, 1,581 properties flood in the defended simulation, most of which are around South Hayling, Emsworth and Bosham. The 0.2% AEP event causes 2,703 properties to flood in Chichester Harbour, which increases by 700 during the 0.1% AEP event to 3,438 properties. During the largest event, the 0.5% AEP event plus climate change (2115 NPPF), there is a smaller difference between the defended and undefended simulations, with only 2,045 more properties flooding during the undefended simulation. This count does however include some properties with MCM code '999' (84 properties in the 20% AEP extent). Thus the results are most appropriate for comparing the differences between different events and scenarios. When calculating the first, tenth and one hundredth properties to flood, which is discussed in the Chapter 8, this NRD was edited to remove such properties from the count.

Table 7-3: Chichester Harbour model flooded property count for all AEP events

Number of flooded properties			
AEP (%)	Flooded properties (Defended)	Flooded properties (Undefended)	Difference
20	375	2,195	1,820
5	894	3,323	2,429
3.33	1,001	3,620	2,619
1.33	1,331	4,390	3,059
1	1,415	4,582	3,167
0.5	1,581	5,116	3,535
0.2	2,703	5,823	3,120
0.1	3,438	6,478	3,040
0.5cc (2070 UKCP09)	4,823	8,345	3,522
0.5cc (2115 UKCP09)	9,190	12,647	3,457
0.5cc (2070NPPF)	6,636	9,800	3,164
0.5cc (2115 NPPF)	16,663	18,708	2,045

7.8.1 Onset and duration

Onset and duration of flooding grids were extracted from the 0.5% AEP model event simulation which detail the duration of inundation (duration grid) and the time of first inundation above a depth of 0.01m (onset grid) for Chichester Harbour.

7.8.2 Standard of protection

The SoP was to be calculated for all the coastal defences which overtopped during any of the model event simulations, excluding the climate change scenarios. Only four defences were schematised for this model, due to the sheltered nature of the harbour. Of the four defences, three

were at the eastern extent of the model near West Wittering and the other at Emsworth. All four defences were only overtopped during the climate change simulations and as such, SoP was not calculated. Therefore they all have a SoP greater than the 0.1% AEP event.

8 Flood warning updates

8.1 Update to existing Flood Alert and Flood Warnings Areas

New Flood Alert and Flood Warning areas were produced using the modelled flood extents. These were created for cell based areas and for individual community based areas.

8.1.1 Cell based Flood Alert and Flood Warning Areas

For the Arun model domain, the cell based Flood Alert and Flood Warning areas were based on the same six stretches of coastline that were covered in the existing Flood Warning areas. The six areas and their unique name codes are shown in Table 8-1. Similarly, for the Chichester Harbour model, three cell areas were used which are given in Table 8-2.

The Flood Alert Area was composed of the Flood Zone 2 outline. The Flood Warning Area A was composed of the 0.5% AEP defended flood extent and the Flood Warning Area B was composed of the area between the 0.5% AEP defended and Flood Zone 2 extents.

Table 8-1: Arun to East Head cell based Flood Alert codes and coverage

Flood Alert Code	Name
065WAF424	Lower Arun
065WAC405	Littlehampton Rope Walk
065WAC404	Climping
065WAC403	Selsey Bill to Elmer
065WAC402	Medmerry
065WAC401	Thorney Island to Bracklesham

Table 8-2: Chichester Harbour model cell based Flood Alert codes and coverage

Flood Alert Code	Name
065WAC401	Thorney Island to Bracklesham
065WAC155	Hayling Island
065WAC162	Langstone and Emsworth Harbour

8.1.2 Community based

Individual community based Flood Alert and Flood Warning areas were created to allow for more targeted Flood Alert and Flood Warnings along the coast. The format of these was the same as for the cell based output but clipped for specific communities rather than stretches of coastline. The communities that the targeted Flood Alert and Flood Warning areas were created for can be seen in Table 8-3 for the Arun model and Table 8-4 for the Chichester Harbour model. An additional Flood Warning area has also been recommended for East Wittering, which did not previously exist and therefore has no code. This is not in Table 8-3 as no code has been assigned.

Table 8-3: Arun to East Head community based Flood Alert and Flood Warning locations

Community	Flood Alert Area Code	Flood Warning, Area A Code	Flood Warning, Area B Code
Ford and Climping on the Arun	065FWF5006	065FWF5006A	065FWF5006B
Littlehampton Rope Walk	065FWC2601	065FWC2601A	065FWC2601B
Climping	065FWC2501	065FWC2501A	065FWC2501B
Elmer	065FWC2402	065FWC2402A	065FWC2402B
Bognor	065FWC2401	065FWC2401A	065FWC2401B
Pagham	065FWC2301	065FWC2301A	065FWC2301B
Sidlesham	065FWC2302	065FWC2302A	065FWC2302B
Selsey	065FWC2201	065FWC2201A	065FWC2201B
Medmerry	065FWC2101	065FWC2101A	065FWC2101B
Bracklesham	065FWC2002	n/a	065FWC2002B

Table 8-4: Chichester Harbour model community based Flood Alert and Flood Warning locations

Community	Flood Alert Area Code	Flood Warning, Area A Code	Flood Warning, Area B Code
West Wittering	065FWC2001	n/a	065FWC2001B
Bosham and West Itchenor	065FWC1901	065FWC1901A	065FWC1901B
Thorney Island, Southbourne and Nutbourne	065FWC1801	065FWC1801A	065FWC1801B
Eastoke Seafront and South Hayling	065FWC1602	065FWC1602A	065FWC1602B
Eastoke	065FWC1601	065FWC1601A	065FWC1601B
Northney to Selsmore, Hayling Island	065FWC1501	065FWC1501A	065FWC1501B
Langstone and Emsworth	065FWC1401	065FWC1401A	065FWC1401B

West Wittering did not have a Flood Warning Area A whilst Flood Warning Area B extends around Roman Landing and Rookwood Road. Where not necessary, small polygons were removed to create the final area A and B Flood Warnings. All polygons under 200m² were analysed to decide whether the area should be included in the warning areas based on location and the NRD.

8.2 Flooded properties

For the 0.5% AEP event, onset and duration grids were created and these were used to calculate the first, 10th and 100th property to flood. The first item of critical infrastructure to flood was also determined. The NRD was used to determine which properties flooded, together with the OS MasterMap data. Several modifications were made to the NRD. The first step was to reduce the size of the NRD by buffering the 0.1% AEP modelled flood extent and extracting the NRD points within it. This dataset was filtered to remove property types which were not required for analysis as recommended in Appendix A of the Environment Agency's 'Property Count Method - External Technical Note'. The filtered NRD was then compared against the OS MasterMap dataset and a series of manual edits were made to improve the way flooded properties would be calculated. This was completed separately for both models. The following sections discuss the methods and results for each model.

Arun model

The manual edits that were completed for the Arun model included:

- Removing upper level flats and accommodation from the dataset in areas where residential areas were above shops and other buildings.
- Editing areas on the River Arun. This included removing the Golf Club point from the flooded property count, leaving the Yacht Club. Both shared the same topographic ID in the NRD, but the Golf Club is a separate property, on the other side of the road and does not flood.
- Removing Bognor Regis Leisure Limited from the property count, which is the property on the pier. The onset grid suggested that this area was flooded after 5.5 hours from still water flooding, but this is without the pier being read into the model. Detailed analysis of the elevation in the area shows the road level to be 6.00mAOD, whereas the maximum SWL for the 0.5% AEP event was 4.04m. Wave overtopping was not present in the area until approximately 17 hours into the model simulation and even then, this remained on the road.
- Deleting some of the properties with an MCM code of '999', where the points were not individual dwellings and actually part of the same large property. For example, one particular property was listed as five buildings, one of which had an MCM code of '1' and the other four were listed as '999'. The adjacent building was listed as its own property, yet was a garage.

The first, 10th and 100th properties to flood during the 0.5% AEP event were all due to still water flooding on the River Arun. The first property to flood, based on the filtered NRD was the Arun Yacht Club on the west bank of the river on Rope Walk. The onset of flooding was at 5.88 hours resulting in a water level threshold of 3.69m. This threshold is based on the SWL at Littlehampton for the onset time of flooding. The tenth property to flood was also on Rope Walk; a semi-detached bungalow, 5 Riverside, postcode BN17 5DE. Further information about the flooded properties are provided in Table 8-5. The onset of flooding for the 10th property was after 6.30 hours, 25 minutes after the first property flooded. The 100th property to flood was in Littlehampton, again on Rope Walk. The property was a terraced house, 8 Tudor View, postcode BN17 5DE. This property flooded during the 0.5% AEP event after 15.41 hours, nine and a half hours after the first property.

Table 8-5: First, 10th and 100th property and first critical infrastructure to flood in the Arun model

Property number	Property information	Onset of flooding (hrs)	Toid	Water level threshold (mAOD)	WO volume threshold (m3/s/m)
First	Arun Yacht Club, Rope Walk, Littlehampton, BN17 5DL	5.88	osgb1000008159097	3.69	N/A
Tenth	5 Riverside, Rope Walk, Littlehampton, BN17 5DE	6.30	osgb1000008159484	3.83	N/A
One hundredth	8 Tudor View, Rope Walk, Littlehampton, BN17 5DE	15.41	osgb1000008159469	3.84	N/A
First critical infrastructure	Sewage pumping station, Rope Walk, Littlehampton, BN17 5DQ	6.70	osgb1000001824159274	3.84	N/A

8.2.1 Chichester model

The manual edits that were completed for the Chichester Harbour model included:

- Deleting all upper level flats and apartments.
- Removing of NRD points from Chichester, Emsworth and Langstone Channels, which had an MCM code of '526', labelled as harbours. These were flooded at all durations and would have an impact on the first, tenth and one hundredth property to flood. However, several buildings were also represented by the code '526' and these were included, as they were boatyards.
- Removing a boat from the property count in the yacht building yard on Hayling Island which was situated in the quay.
- Checking the first one hundred properties manually on Google Maps and deciding whether to include as a property. This included removing a shed from the NRD which was located at the quay near the yacht building yard.

Additional properties were examined, particularly those with an MCM code of '999' and removed where deemed necessary.

The first, 10th and 100th properties to flood during the 0.5% AEP event were all due to still water flooding in different parts of the harbour. The first property to flood, based on the filtered NRD, was a detached property on Harbour Way, Emsworth, with postcode PO10 7BE. The onset of flooding was at 5.52 hours resulting in a water level threshold of 2.69m. This threshold is based on the SWL at Wittering for the onset time of flooding. As the time of flooding was in-between the two model timesteps, the level was calculated by interpolating between the water levels at five and a half and five and three quarter hours. The 10th property to flood was also on Harbour Way, Emsworth, but a terraced house, with the same postcode PO10 7BE. The onset of flooding for the tenth property was after 5.79 hours with a water level threshold of 2.92m. The 100th property to flood was to the south of Bosham. The property was a detached house on Shore Road, Chichester, postcode PO18 8QL, with the property name Mermaid Cottage. This property flooded during the 0.5% AEP event after 6.18 hours with a water level threshold of 3.17m.

Table 8-6: First, tenth, one hundredth property and first critical infrastructure to flood in the Chichester model

Property number	Property information	Onset of flooding (hrs)	Toid	Water level threshold (mAOD)	WO volume threshold (m3/s/m)
First	14 Harbour Way, Emsworth, PO10 7BE	5.52	osgb1000002119006760	2.69	N/A
Tenth	10 Harbour Way, Emsworth, PO10 7BE	5.79	osgb1000002119007027	2.92	N/A
One hundredth	Mermaid Cotage, Shore Road, Chichester, PO11 0NQ	6.18	osgb1000002119074670	3.17	N/A
First critical infrastructure	Electricity sub-station, Hayling Island, PO11 0NQ	6.10	osgb5000000001290839	3.14	N/A

8.3 Critical infrastructure

8.3.1 Arun model

There were 10 critical infrastructure properties that flooded during the 0.5% AEP event. Critical infrastructure was extracted from the NRD based on the criteria for critical services in Table 6.1 of the 'EA Annexes for PFRA Guidance'. This included schools, hospitals, police stations, nursing homes, prisons, sewage treatment works and electricity installations.

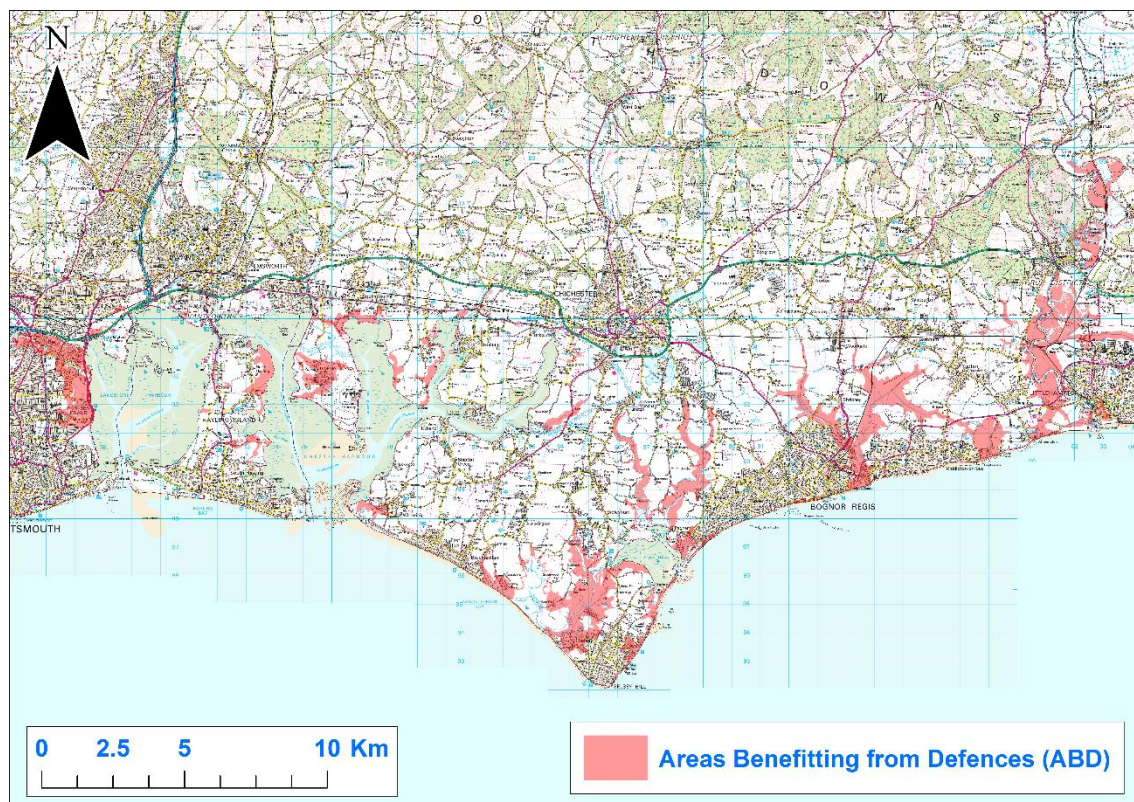
The critical infrastructure included six electricity sub-stations and four pumping stations. The sub-stations have an MCM code of '960' and the first sub-station to flood was the fourth critical infrastructure to flood, after the sewage pumping station and two additional pumping houses.

8.3.2 Chichester model

During the 0.5% AEP event in the Chichester model, much more critical infrastructure was affected, with 23 identified at flood risk. The first critical infrastructure to flood was an electricity sub-station on Hayling Island outside the Langstone Hotel, postcode PO11 0NQ. This sub-station was inundated after 6.10 hours, relating to a water level threshold of 3.14m at Wittering. Of the 23 critical services that were affected during the 0.5% AEP event, 19 of them were electricity sub-stations, two pumping stations, one education centre and a sewage treatment plant.

8.4 Areas benefitting from defences

ABDs were calculated by exporting the differences in area between the 0.5% AEP undefended and the 0.5% AEP defended modelled flood extents. In accordance with national guidance dry islands of less than 200m² were removed from the ABDs. In the Arun to East Head model domain the ABD totalled 27.19km², whilst the Chichester Harbour model ABD was 9.42km². To the east of the model domains, the main ABD is Climping and the nearby caravan park. Further west Elmer benefits from defences both on the coast and on the banks of Ryebank Rife. Central Bognor Regis also forms a significant area of the ABD, including Butlins Bognor Regis Resort, the University of Chichester and many properties either side of Aldingbourne Rife. Selsey benefits greatly from coastal defences, with the ABDs including much of East Selsey and both West Sands Caravan Park and Selsey Country Club. Sussex Beach Holiday Village also benefits from defences in the Arun model domain. The largest ABDs in the Chichester Harbour model are West Wittering, Thorney Island and East Hayling Island. Other areas benefitting from defences include the coastal frontages of Thornham, Southbourne and Nutbourne as well as small areas of West Itchenor and Bosham Hoe. Figure 8-1 shows a broad overview of both model domains with the areas benefitting from defences.



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Figure 8-1: ABDs in both Arun to East Head and Chichester Harbour model domains

9 Conclusions

9.1 Main findings

This project was commissioned by the Environment Agency to improve understanding of the area's exposure to coastal flood risk along the West Sussex coastline from Emsworth to Littlehampton's West Bank. The project focussed on the key communities of Littlehampton, Bognor Regis, Pagham, Selsey, Wittering, Bosham and Emsworth. The study used comprehensive extreme sea-level and wave information, improved quality topographic data and advanced inundation modelling techniques to produce revised tidal flood risk information, including Flood Zones 2 and 3. The revised Flood Zones were used to examine the potential impacts of climate change on flood risk, investigating flooding on a community based scale. Climate change simulations were completed using both NPPF and UKCP09 guidance, both to 2070 and 2115.

9.1.1 New flood map components

The new tidal Flood Zones derived for this study are similar to the previous Flood Zones, albeit slightly more extensive. The proposed Flood Warning thresholds are generally lower than the current Flood Alert and Warning thresholds, presumably due to the method of calculation using first property to flood rather than defence crest levels. In the Arun model, the proposed Flood Warning Area A includes significant inundation at Littlehampton West Bank from the River Arun as a result of still water flooding as well as coastal flooding at Bognor Regis and Pagham Harbour. Flood Warning Area B (the area between the 0.5% AEP defended flood extent and Flood Zone 2 extent) includes additional flooding at Climping, Elmer, Bognor Regis, Selsey and Bracklesham. Likewise in the Chichester Harbour model, the new Flood Zones are similar to the existing Flood Zones, with slight increases in extent for most regions. The most noticeable increases are at Birdham and on Thorney Island.

9.1.2 Impact of Climate Change

In addition to the present day flood simulations used to produce the revised Flood Zones for the study area, climate change simulations for the 0.5% AEP event were also carried out. These simulations indicate the expected increase in flood risk up to the year 2115 based on the latest UKCP09 and NPPF guidance on sea-level rise estimates. These simulations, run for the 0.5% AEP event, show that with the increases to still water level, the region and its current defence structures are vulnerable to flooding due to climate change. The defence network along the coast becomes heavily inundated as a result of increased wave overtopping of the current defences. In the Arun model, during the 0.5% AEP defended simulation, 968 properties were flooded, compared with 5,115 and 7,090 to 2115 based on UKCP09 and NPPF guidance respectively. Table 9-1 shows the number of flooded properties during climate change scenarios for both models compared against the 0.5% AEP property inundation.

Table 9-1: Property inundation for climate change simulations

Number of flooded properties		
AEP (%)	Flooded properties (Defended)	Model
0.5	968	Arun
0.5cc (2070 UKCP09)	3,006	Arun
0.5cc (2115 UKCP09)	5,115	Arun
0.5cc (2070NPPF)	3,537	Arun
0.5cc (2115 NPPF)	7,090	Arun
0.5	1,581	Chichester
0.5cc (2070 UKCP09)	4,823	Chichester
0.5cc (2115 UKCP09)	9,190	Chichester
0.5cc (2070NPPF)	6,636	Chichester
0.5cc (2115 NPPF)	16,663	Chichester

In the Chichester Harbour model 1,581 properties were flooded during the 0.5% AEP event, compared with 9,190 and 16,663 to 2115 based on UKCP09 and NPPF guidance respectively.

The climate change wave overtopping scenario suggests that the effects of climate change could make wave overtopping an increasing hazard, which threatens large areas of the coastal frontages around Bognor Regis, Selsey, Bracklesham and East Wittering in the Arun to East Head model and West Wittering, West Itchenor, Bosham, Emsworth, Thorney Island and Hayling Island in the Chichester Harbour model. Inland areas which are not affected by wave overtopping are shown to be at considerable risk of still water flooding when climate change sea-level rise is taken into account. The impacts of climate change on the West Sussex coastline is going to be an ever increasing hazard to both residential and commercial property and infrastructure.

9.1.3 Impact on critical infrastructure

As part of the study, the first critical infrastructure to flood for both Arun and Chichester models were identified. The first critical infrastructure to flood in the Arun to East Head model domain was a sewage pumping station, with a water level threshold of 3.84m relating to the water level at Littlehampton gauge. In the Chichester Harbour model, the first critical infrastructure to flood was also an electricity sub-station, on Hayling Island with postcode PO11 0NQ. The water level threshold for this sub-station was 3.14m which related to Wittering tidal curve.

9.1.4 Impact on coastal communities

In the Arun to East Head model domain, the major flooding during the defended scenarios occurs at Littlehampton West Bank, Felpham, Bognor Regis, Pagham and Selsey. Littlehampton West Bank was inundated by still water flooding from the 20% AEP defended event, whereas other coastal communities were generally not affected by overtopping until a 1% AEP event or greater.

Felpham coastal communities were inundated during the 1% AEP event, whilst a small area near Bognor Regis pier was flooded during the 5% AEP event. However, excluding this approximately 300m breach, Bognor Regis remains defended throughout all AEP events up to the 0.1% AEP scenario. Aldwick experienced minor flooding due to a breach of the sea wall at Dark Lane which is maintained by the Local Authority. Properties were affected by flooding around Pagham including Church Farm Holiday Village and the Mill Lane area to the west of the harbour. Excluding an area at Selsey Bill, Selsey coastal defence network mitigated the risk up to the 0.1% AEP event, when an area of East Selsey was inundated near the museum. Elsewhere to the west of the model, no communities were inundated with East Wittering and Bracklesham remaining defended.

The Chichester model differed from the Arun to East Head model in that inundation was mainly as a result of still water flooding, with only four wave overtopping discharges calculated for the whole domain. The main communities affected by flooding here were Bosham, West Itchenor, Emsworth, Hayling Island and Thorney Island. To the eastern extent of the model, West Wittering remained defended throughout all simulations from 100 to 0.1% AEP events. Properties in West Itchenor were largely defended until the 1% to 0.5% AEP events. Several properties were affected in Birdham during the 0.1% AEP event only. In the area surrounding Bosham Quay, localised coastal flooding occurred during the 3.33% AEP event, with more widespread flooding occurring further inland during the 0.2 and 0.1% AEP events. Emsworth was mainly inundated in the area surrounding Hermitage Bridge and Quay Mill. To the south of Emsworth, in front of the Oyster Beds, the defences mitigated the risk of flooding for all AEP events except to the east of King Street. Although Hayling Island was heavily flooded to the north and east near Northney and North Hayling, most of the large communities on the island remained protected. To the south, more communities were affected by flooding including Selmore, Mengham and Eastoke. From the 20% AEP event onwards, properties at Sandy Point became affected by flooding, whilst Selmore was flooded during the 5% AEP event. On Thorney Island, which was heavily inundated, the two most densely populated areas remained largely protected with flooding more restricted to the area around Baker Barracks, which flooded during the 0.2% AEP event.

9.2 Limitations and recommendations

The approaches taken in this study include the most appropriate methods currently available for flood inundation modelled on the scale of the study area. However, the results of a floodplain model are only as accurate as the input data that are used. Whilst all due care and diligence was taken to use appropriate data management and methods, the results should be viewed with a margin of caution given the inherent uncertainty in floodplain modelling and in particular in the estimation of wave overtopping.

A number of assumptions were made and there are elements of subjectivity throughout all stages of the modelling process. The joint probability approaches for coastal studies may be in line for review due to the methods being applied for the SotN study. For this study the joint probability is based on the Defra desk based approach. This simplified joint probability method, originally developed by HR Wallingford, creates contours of the extreme variables that have an equal likelihood of exceedence. Combinations of the variables that lie on a contour are used to provide the joint probability combinations of two dependent variables. The dependence factors used within this study were taken from the Technical report FD2308/TR1¹⁶ for the closest gauged location at Portsmouth and then applied across the modelled domain. There are limitations in that it can only be applied to calculate the joint probability between two variables and assumptions have to be made to calculate the associated conditions for the variables that are not included in the calculations. It is also well-known that this method contains a known error that results in an underestimation of overtopping rates (Hawkes et al 2002). This method has been best practice for a number of years but new approaches are now coming into use to calculate the joint probability across multiple variables using an application of the extreme value method developed by Heffernan and Tawn (2004) utilising a more robust full Monte-Carlo method.

Other assumptions include:

- The tidal graphs were created by aligning the peak of the surge profile with the low point in the trough prior to the peak tide.
- The overtopping discharges assume that the wind and wave conditions remain constant throughout the duration of the tidal event.
- Defence crest data used in both the overtopping calculations and the flood inundation models are based on topographic survey where available but where this data is not available the survey was supplemented with information from AIMS and point heights extracted from LIDAR data.
- It has just come to light that any LIDAR data flown since 2008 in the modelled area may not have been converted from a digital surface model (DSM) to a DTM. This means that the DTM used in the model may be from 2008 despite more recent surveys being available in DSM format.
- For the wave overtopping calculations the flood defence profiles, toe levels and crest heights remain the same throughout all of the modelled scenarios.
- The model grid size of 8m is relatively coarse when it comes to representing small flow paths and small drainage channels. Due to the limitations of present day computing this is a trade-off between model accuracy and manageable run times. All efforts have been made to minimise the impacts of this through modelling techniques such as the use of 1D structures to model flow through floodplain embankments taking account of the channel dimensions rather than stamping holes through the structures equal to the modelled grid resolution.
- The main river and drainage channel networks have been modelled through the use of gully lines which may not always represent the channel conveyance accurately.
- Infiltration losses into the beaches from wave overtopping have been assumed to equal 1.5L/s based on the results of the model calibration.
- Infiltration losses into the ground within the flood inundation model have not been considered.
- No account has been taken of the joint flood risk from tidal, fluvial, surface water and groundwater events, only coastal flooding from tides and waves have been modelled.
- The rates of sea-level rise used in the climate change calculations are based on the NPPF average figures for the south of England.
- The discharge rates for the Felpham pumping station are assumed to be constant throughout the defended model simulations but are not accounted for in the undefended scenarios due to instabilities from the large volumes of water reaching the station when the defences are removed.

¹⁶ EA Defra (2005). Joint Probability: Dependence Mapping and Best Practice R&D Technical Report FD2308/TR1. HR Wallingford
2014s0753_Emsworth to Littlehampton_Coastal final report_v2.docx

- No account of the operation control rules from structures such as the Ferry and Felpham pumping stations are included in the model. The most recent versions of TUFLOW now allow the incorporation of control rules in the 2D domains.

Overall, the work undertaken to update the Flood Map should provide users with a map that can be applied with greater confidence than previous versions. In light of the limitations highlighted above there are a number of recommendations for future work and updates which could be undertaken to improve confidence in the modelling.

It is recommend that the joint probability approach is reviewed once new practices come into use.

Following the winter storms of 2013/14 it is recommend that the CFB data are updated to account for the additional gauged data and the notable extremes that occurred.

The model should be updated to use the latest version of the TUFLOW software to allow incorporation of the operational control rules.

As many of the beaches are shingle beach defences it is recommend that an alternative method is used to calculate the wave overtopping, such as X-Beach-G, to take account of the dynamic response of the beach throughout the course of the event and compare these to the rates used within this study.

The results of this study should not be used for design purposes and should a flood risk assessment be required for a specific location within the modelled domain a separate investigation should be undertaken to investigate the specific risks and considerations for each site.

Appendices

A Joint probability conditions

Wave type (Swell/total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Total	20	100	3.35	5.81	8.76	225	19.16	225
Total	20	100	3.35	4.97	7.99	225	17.11	225
Total	20	100	3.35	3.84	6.95	225	14.34	225
Total	20	100	3.35	3.25	6.40	225	12.88	225
Total	20	50	3.43	2.65	5.86	225	11.43	225
Total	20	20	3.52	1.87	5.13	225	9.50	225
Total	20	100	3.35	4.94	7.27	180	21.67	180
Total	20	100	3.35	4.51	6.93	180	20.08	180
Total	20	100	3.35	3.69	6.28	180	17.03	180
Total	20	100	3.35	3.25	5.94	180	15.41	180
Total	20	50	3.43	2.82	5.59	180	13.79	180
Total	20	20	3.52	2.24	5.14	180	11.65	180
Total	20	100	3.35	2.76	5.30	135	14.60	135
Total	20	100	3.35	2.40	4.97	135	13.14	135
Total	20	100	3.35	1.76	4.37	135	10.52	135
Total	20	100	3.35	1.42	4.06	135	9.13	135
Total	20	50	3.43	1.07	3.75	135	7.74	135
Total	20	20	3.52	0.62	3.33	135	5.91	135
Total	5	100	3.35	7.10	9.94	225	22.32	225
Total	5	100	3.35	6.42	9.32	225	20.65	225
Total	5	100	3.35	5.35	8.34	225	18.03	225
Total	5	100	3.35	4.75	7.79	225	16.58	225
Total	5	50	3.43	4.16	7.24	225	15.12	225
Total	5	20	3.52	3.38	6.52	225	13.20	225
Total	5	5	3.67	2.19	5.43	225	10.29	225
Total	5	100	3.35	5.52	7.73	180	23.85	180
Total	5	100	3.35	5.42	7.65	180	23.48	180
Total	5	100	3.35	4.85	7.20	180	21.33	180
Total	5	100	3.35	4.48	6.90	180	19.96	180
Total	5	50	3.43	4.04	6.56	180	18.36	180
Total	5	20	3.52	3.47	6.11	180	16.22	180
Total	5	5	3.67	2.60	5.42	180	12.98	180
Total	5	100	3.35	3.30	5.80	135	16.79	135
Total	5	100	3.35	3.21	5.71	135	16.42	135
Total	5	100	3.35	2.68	5.23	135	14.29	135
Total	5	100	3.35	2.37	4.94	135	13.03	135
Total	5	50	3.43	2.04	4.63	135	11.65	135
Total	5	20	3.52	1.58	4.22	135	9.81	135
Total	5	5	3.67	0.90	3.59	135	7.04	135
Total	3.33	100	3.35	7.45	10.27	225	23.17	225
Total	3.33	100	3.35	6.78	9.65	225	21.53	225
Total	3.33	100	3.35	5.79	8.74	225	19.11	225
Total	3.33	100	3.35	5.20	8.20	225	17.66	225
Total	3.33	50	3.43	4.60	7.65	225	16.21	225
Total	3.33	20	3.52	3.82	6.93	225	14.28	225
Total	3.33	5	3.67	2.63	5.83	225	11.37	225
Total	3.33	3.33	3.71	2.28	5.52	225	10.52	225
Total	3.33	100	3.35	5.66	7.84	180	24.38	180
Total	3.33	100	3.35	5.64	7.82	180	24.29	180
Total	3.33	100	3.35	5.11	7.40	180	22.30	180
Total	3.33	100	3.35	4.78	7.14	180	21.09	180
Total	3.33	50	3.43	4.40	6.85	180	19.69	180
Total	3.33	20	3.52	3.83	6.39	180	17.55	180
Total	3.33	5	3.67	2.96	5.70	180	14.31	180
Total	3.33	3.33	3.71	2.70	5.50	180	13.36	180
Total	3.33	100	3.35	3.44	5.93	135	17.37	135
Total	3.33	100	3.35	3.42	5.91	135	17.27	135
Total	3.33	100	3.35	2.92	5.44	135	15.23	135

Wave type (Swell/total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Total	3.33	100	3.35	2.63	5.18	135	14.06	135
Total	3.33	50	3.43	2.32	4.89	135	12.79	135
Total	3.33	20	3.52	1.87	4.47	135	10.96	135
Total	3.33	5	3.67	1.18	3.85	135	8.18	135
Total	3.33	3.33	3.71	0.98	3.66	135	7.37	135
Total	1.33	100	3.35	8.13	10.90	225	24.85	225
Total	1.33	100	3.35	7.56	10.37	225	23.45	225
Total	1.33	100	3.35	6.67	9.55	225	21.27	225
Total	1.33	100	3.35	6.15	9.08	225	20.01	225
Total	1.33	50	3.43	5.60	8.57	225	18.65	225
Total	1.33	20	3.52	4.81	7.84	225	16.73	225
Total	1.33	5	3.67	3.63	6.75	225	13.82	225
Total	1.33	3.33	3.71	3.28	6.43	225	12.96	225
Total	1.33	2	3.77	2.84	6.03	225	11.89	225
Total	1.33	1.33	3.81	2.50	5.71	225	11.04	225
Total	1.33	100	3.35	5.95	8.06	180	25.42	180
Total	1.33	100	3.35	5.95	8.06	180	25.42	180
Total	1.33	100	3.35	5.63	7.81	180	24.24	180
Total	1.33	100	3.35	5.36	7.60	180	23.24	180
Total	1.33	50	3.43	5.06	7.37	180	22.15	180
Total	1.33	20	3.52	4.61	7.01	180	20.46	180
Total	1.33	5	3.67	3.77	6.34	180	17.32	180
Total	1.33	3.33	3.71	3.51	6.14	180	16.38	180
Total	1.33	2	3.77	3.19	5.89	180	15.18	180
Total	1.33	1.33	3.81	2.94	5.69	180	14.24	180
Total	1.33	100	3.35	3.74	6.20	135	18.57	135
Total	1.33	100	3.35	3.74	6.20	135	18.57	135
Total	1.33	100	3.35	3.41	5.90	135	17.23	135
Total	1.33	100	3.35	3.15	5.66	135	16.18	135
Total	1.33	50	3.43	2.88	5.41	135	15.08	135
Total	1.33	20	3.52	2.49	5.05	135	13.48	135
Total	1.33	5	3.67	1.82	4.43	135	10.76	135
Total	1.33	3.33	3.71	1.62	4.25	135	9.95	135
Total	1.33	2	3.77	1.37	4.02	135	8.93	135
Total	1.33	1.33	3.81	1.17	3.83	135	8.12	135
Total	1	100	3.35	8.33	11.08	225	25.34	225
Total	1	100	3.35	7.78	10.57	225	23.99	225
Total	1	100	3.35	6.92	9.78	225	21.88	225
Total	1	100	3.35	6.44	9.34	225	20.71	225
Total	1	50	3.43	5.90	8.84	225	19.38	225
Total	1	20	3.52	5.13	8.13	225	17.49	225
Total	1	5	3.67	3.94	7.04	225	14.58	225
Total	1	3.33	3.71	3.59	6.72	225	13.73	225
Total	1	2	3.77	3.16	6.32	225	12.66	225
Total	1	1.33	3.81	2.81	6.00	225	11.81	225
Total	1	1	3.84	2.56	5.77	225	11.20	225
Total	1	100	3.35	6.02	8.13	180	25.71	180
Total	1	100	3.35	6.02	8.13	180	25.71	180
Total	1	100	3.35	5.76	7.92	180	24.74	180
Total	1	100	3.35	5.53	7.73	180	23.87	180
Total	1	50	3.43	5.24	7.50	180	22.78	180
Total	1	20	3.52	4.83	7.18	180	21.26	180
Total	1	5	3.67	4.02	6.55	180	18.27	180
Total	1	3.33	3.71	3.77	6.34	180	17.32	180
Total	1	2	3.77	3.45	6.09	180	16.13	180
Total	1	1.33	3.81	3.19	5.89	180	15.18	180
Total	1	1	3.84	3.01	5.75	180	14.51	180
Total	1	100	3.35	3.83	6.28	135	18.93	135
Total	1	100	3.35	3.83	6.28	135	18.93	135
Total	1	100	3.35	3.54	6.02	135	17.78	135
Total	1	100	3.35	3.31	5.80	135	16.82	135
Total	1	50	3.43	3.04	5.55	135	15.72	135
Total	1	20	3.52	2.67	5.21	135	14.22	135
Total	1	5	3.67	2.02	4.61	135	11.58	135
Total	1	3.33	3.71	1.82	4.43	135	10.76	135
Total	1	2	3.77	1.57	4.20	135	9.74	135

Wave type (Swell/total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Total	1	1.33	3.81	1.37	4.02	135	8.93	135
Total	1	1	3.84	1.23	3.89	135	8.35	135
Total	0.5	100	3.35	8.70	11.42	225	26.25	225
Total	0.5	100	3.35	8.28	11.03	225	25.21	225
Total	0.5	100	3.35	7.51	10.33	225	23.34	225
Total	0.5	100	3.35	7.05	9.90	225	22.20	225
Total	0.5	50	3.43	6.57	9.46	225	21.03	225
Total	0.5	20	3.52	5.87	8.82	225	19.31	225
Total	0.5	5	3.67	4.69	7.73	225	16.43	225
Total	0.5	3.33	3.71	4.35	7.41	225	15.58	225
Total	0.5	2	3.77	3.91	7.01	225	14.51	225
Total	0.5	1.33	3.81	3.56	6.69	225	13.66	225
Total	0.5	1	3.84	3.32	6.47	225	13.05	225
Total	0.5	0.5	3.93	2.72	5.92	225	11.60	225
Total	0.5	100	3.35	6.19	8.26	180	26.34	180
Total	0.5	100	3.35	6.19	8.26	180	26.34	180
Total	0.5	100	3.35	6.04	8.14	180	25.78	180
Total	0.5	100	3.35	5.85	7.99	180	25.07	180
Total	0.5	50	3.43	5.63	7.81	180	24.24	180
Total	0.5	20	3.52	5.26	7.52	180	22.88	180
Total	0.5	5	3.67	4.61	7.01	180	20.45	180
Total	0.5	3.33	3.71	4.38	6.83	180	19.60	180
Total	0.5	2	3.77	4.06	6.58	180	18.41	180
Total	0.5	1.33	3.81	3.80	6.37	180	17.46	180
Total	0.5	1	3.84	3.62	6.23	180	16.79	180
Total	0.5	0.5	3.93	3.19	5.89	180	15.17	180
Total	0.5	100	3.35	4.02	6.46	135	19.72	135
Total	0.5	100	3.35	4.02	6.46	135	19.72	135
Total	0.5	100	3.35	3.85	6.30	135	19.01	135
Total	0.5	100	3.35	3.64	6.11	135	18.15	135
Total	0.5	50	3.43	3.41	5.89	135	17.22	135
Total	0.5	20	3.52	3.06	5.58	135	15.82	135
Total	0.5	5	3.67	2.48	5.05	135	13.47	135
Total	0.5	3.33	3.71	2.30	4.87	135	12.72	135
Total	0.5	2	3.77	2.05	4.64	135	11.70	135
Total	0.5	1.33	3.81	1.85	4.46	135	10.88	135
Total	0.5	1	3.84	1.71	4.33	135	10.31	135
Total	0.5	0.5	3.93	1.37	4.01	135	8.92	135
Total	0.2	100	3.35	9.12	11.81	225	27.29	225
Total	0.2	100	3.35	8.85	11.56	225	26.63	225
Total	0.2	100	3.35	8.19	10.95	225	25.00	225
Total	0.2	100	3.35	7.80	10.59	225	24.03	225
Total	0.2	50	3.43	7.37	10.20	225	22.99	225
Total	0.2	20	3.52	6.74	9.62	225	21.45	225
Total	0.2	5	3.67	5.69	8.65	225	18.88	225
Total	0.2	3.33	3.71	5.34	8.33	225	18.02	225
Total	0.2	2	3.77	4.91	7.93	225	16.95	225
Total	0.2	1.33	3.81	4.56	7.61	225	16.10	225
Total	0.2	1	3.84	4.31	7.38	225	15.50	225
Total	0.2	0.5	3.93	3.72	6.84	225	14.04	225
Total	0.2	0.2	4.04	2.93	6.12	225	12.12	225
Total	0.2	100	3.35	6.38	8.41	180	27.05	180
Total	0.2	100	3.35	6.38	8.41	180	27.05	180
Total	0.2	100	3.35	6.33	8.37	180	26.86	180
Total	0.2	100	3.35	6.19	8.26	180	26.32	180
Total	0.2	50	3.43	6.02	8.12	180	25.69	180
Total	0.2	20	3.52	5.75	7.91	180	24.69	180
Total	0.2	5	3.67	5.22	7.49	180	22.73	180
Total	0.2	3.33	3.71	5.05	7.36	180	22.09	180
Total	0.2	2	3.77	4.81	7.16	180	21.19	180
Total	0.2	1.33	3.81	4.59	6.99	180	20.38	180
Total	0.2	1	3.84	4.43	6.87	180	19.81	180
Total	0.2	0.5	3.93	4.00	6.53	180	18.19	180
Total	0.2	0.2	4.04	3.42	6.07	180	16.05	180
Total	0.2	100	3.35	4.26	6.68	135	20.68	135
Total	0.2	100	3.35	4.26	6.68	135	20.68	135

Wave type (Swell/total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Total	0.2	100	3.35	4.20	6.62	135	20.43	135
Total	0.2	100	3.35	4.02	6.46	135	19.70	135
Total	0.2	50	3.43	3.82	6.27	135	18.90	135
Total	0.2	20	3.52	3.53	6.01	135	17.73	135
Total	0.2	5	3.67	3.02	5.54	135	15.66	135
Total	0.2	3.33	3.71	2.86	5.40	135	15.02	135
Total	0.2	2	3.77	2.65	5.20	135	14.15	135
Total	0.2	1.33	3.81	2.47	5.03	135	13.42	135
Total	0.2	1	3.84	2.34	4.91	135	12.89	135
Total	0.2	0.5	3.93	2.00	4.60	135	11.50	135
Total	0.2	0.2	4.04	1.55	4.18	135	9.67	135
Total	0.1	100	3.35	9.41	12.08	225	28.00	225
Total	0.1	100	3.35	9.25	11.92	225	27.59	225
Total	0.1	100	3.35	8.64	11.37	225	26.11	225
Total	0.1	100	3.35	8.29	11.04	225	25.25	225
Total	0.1	50	3.43	7.91	10.69	225	24.30	225
Total	0.1	20	3.52	7.35	10.17	225	22.93	225
Total	0.1	5	3.67	6.39	9.29	225	20.58	225
Total	0.1	3.33	3.71	6.07	9.00	225	19.80	225
Total	0.1	2	3.77	5.66	8.62	225	18.80	225
Total	0.1	1.33	3.81	5.31	8.30	225	17.95	225
Total	0.1	1	3.84	5.07	8.08	225	17.35	225
Total	0.1	0.5	3.93	4.47	7.53	225	15.89	225
Total	0.1	0.2	4.04	3.69	6.81	225	13.97	225
Total	0.1	0.1	4.13	3.10	6.26	225	12.51	225
Total	0.1	100	3.35	6.51	8.51	180	27.51	180
Total	0.1	100	3.35	6.51	8.51	180	27.51	180
Total	0.1	100	3.35	6.51	8.51	180	27.51	180
Total	0.1	100	3.35	6.39	8.42	180	27.08	180
Total	0.1	50	3.43	6.25	8.30	180	26.55	180
Total	0.1	20	3.52	6.03	8.13	180	25.75	180
Total	0.1	5	3.67	5.61	7.80	180	24.19	180
Total	0.1	3.33	3.71	5.46	7.68	180	23.62	180
Total	0.1	2	3.77	5.25	7.51	180	22.82	180
Total	0.1	1.33	3.81	5.07	7.38	180	22.19	180
Total	0.1	1	3.84	4.95	7.28	180	21.73	180
Total	0.1	0.5	3.93	4.59	6.99	180	20.37	180
Total	0.1	0.2	4.04	4.04	6.56	180	18.33	180
Total	0.1	0.1	4.13	3.60	6.21	180	16.71	180
Total	0.1	100	3.35	4.42	6.83	135	21.34	135
Total	0.1	100	3.35	4.42	6.83	135	21.34	135
Total	0.1	100	3.35	4.42	6.83	135	21.34	135
Total	0.1	100	3.35	4.27	6.69	135	20.72	135
Total	0.1	50	3.43	4.09	6.52	135	20.00	135
Total	0.1	20	3.52	3.84	6.29	135	18.97	135
Total	0.1	5	3.67	3.39	5.88	135	17.17	135
Total	0.1	3.33	3.71	3.25	5.75	135	16.57	135
Total	0.1	2	3.77	3.05	5.56	135	15.76	135
Total	0.1	1.33	3.81	2.89	5.42	135	15.12	135
Total	0.1	1	3.84	2.78	5.31	135	14.66	135
Total	0.1	0.5	3.93	2.47	5.03	135	13.41	135
Total	0.1	0.2	4.04	2.03	4.63	135	11.62	135
Total	0.1	0.1	4.13	1.69	4.31	135	10.24	135
Swell	20	100	3.35	2.38	14.84	225	10.5	225
Swell	20	100	3.35	2.02	13.92	225	10.5	225
Swell	20	100	3.35	1.54	12.67	225	10.5	225
Swell	20	100	3.35	1.29	12.01	225	10.5	225
Swell	20	50	3.43	1.04	11.36	225	10.5	225
Swell	20	20	3.52	0.70	10.49	225	10.5	225
Swell	5	100	3.35	2.92	10.25	225	10.5	225
Swell	5	100	3.35	2.63	10.25	225	10.5	225
Swell	5	100	3.35	2.18	14.33	225	10.5	225
Swell	5	100	3.35	1.93	13.68	225	10.5	225
Swell	5	50	3.43	1.68	13.02	225	10.5	225
Swell	5	20	3.52	1.34	12.16	225	10.5	225
Swell	5	5	3.67	0.84	10.85	225	10.5	225

Wave type (Swell/total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Swell	3.33	100	3.35	3.07	10.25	225	10.5	225
Swell	3.33	100	3.35	2.79	10.25	225	10.5	225
Swell	3.33	100	3.35	2.37	14.81	225	10.5	225
Swell	3.33	100	3.35	2.12	14.16	225	10.5	225
Swell	3.33	50	3.43	1.86	13.51	225	10.5	225
Swell	3.33	20	3.52	1.53	12.64	225	10.5	225
Swell	3.33	5	3.67	1.03	11.33	225	10.5	225
Swell	3.33	3.33	3.71	0.88	10.95	225	10.5	225
Swell	1.33	100	3.35	3.35	10.25	225	10.5	225
Swell	1.33	100	3.35	3.11	10.25	225	10.5	225
Swell	1.33	100	3.35	2.74	10.25	225	10.5	225
Swell	1.33	100	3.35	2.52	10.25	225	10.5	225
Swell	1.33	50	3.43	2.29	14.61	225	10.5	225
Swell	1.33	20	3.52	1.95	13.74	225	10.5	225
Swell	1.33	5	3.67	1.45	12.43	225	10.5	225
Swell	1.33	3.33	3.71	1.30	12.05	225	10.5	225
Swell	1.33	0.5	3.93	1.12	11.57	225	10.5	225
Swell	1.33	1.33	3.81	0.97	11.19	225	10.5	225
Swell	1	100	3.35	3.44	10.25	225	10.5	225
Swell	1	100	3.35	3.21	10.25	225	10.5	225
Swell	1	100	3.35	2.85	10.25	225	10.5	225
Swell	1	100	3.35	2.64	10.25	225	10.5	225
Swell	1	50	3.43	2.41	14.94	225	10.5	225
Swell	1	20	3.52	2.09	14.09	225	10.5	225
Swell	1	5	3.67	1.58	12.78	225	10.5	225
Swell	1	3.33	3.71	1.44	12.40	225	10.5	225
Swell	1	0.5	3.93	1.25	11.91	225	10.5	225
Swell	1	1.33	3.81	1.10	11.53	225	10.5	225
Swell	1	1	3.84	1.00	11.26	225	10.5	225
Swell	0.5	100	3.35	3.59	10.25	225	10.5	225
Swell	0.5	100	3.35	3.41	10.25	225	10.5	225
Swell	0.5	100	3.35	3.09	10.25	225	10.5	225
Swell	0.5	100	3.35	2.90	10.25	225	10.5	225
Swell	0.5	50	3.43	2.70	10.25	225	10.5	225
Swell	0.5	20	3.52	2.40	14.91	225	10.5	225
Swell	0.5	5	3.67	1.90	13.61	225	10.5	225
Swell	0.5	3.33	3.71	1.76	13.23	225	10.5	225
Swell	0.5	0.5	3.93	1.57	12.75	225	10.5	225
Swell	0.5	1.33	3.81	1.42	12.36	225	10.5	225
Swell	0.5	1	3.84	1.32	12.09	225	10.5	225
Swell	0.5	0.5	3.93	1.07	11.44	225	10.5	225
Swell	0.2	100	3.35	3.76	10.25	225	10.5	225
Swell	0.2	100	3.35	3.65	10.25	225	10.5	225
Swell	0.2	100	3.35	3.38	10.25	225	10.5	225
Swell	0.2	100	3.35	3.21	10.25	225	10.5	225
Swell	0.2	50	3.43	3.03	10.25	225	10.5	225
Swell	0.2	20	3.52	2.77	10.25	225	10.5	225
Swell	0.2	5	3.67	2.33	14.71	225	10.5	225
Swell	0.2	3.33	3.71	2.18	14.33	225	10.5	225
Swell	0.2	0.5	3.93	1.99	13.84	225	10.5	225
Swell	0.2	1.33	3.81	1.85	13.46	225	10.5	225
Swell	0.2	1	3.84	1.74	13.19	225	10.5	225
Swell	0.2	0.5	3.93	1.49	12.54	225	10.5	225
Swell	0.2	0.2	4.04	1.16	11.67	225	10.5	225
Swell	0.1	100	3.35	3.88	10.25	225	10.5	225
Swell	0.1	100	3.35	3.82	10.25	225	10.5	225
Swell	0.1	100	3.35	3.57	10.25	225	10.5	225
Swell	0.1	100	3.35	3.42	10.25	225	10.5	225
Swell	0.1	50	3.43	3.26	10.25	225	10.5	225
Swell	0.1	20	3.52	3.02	10.25	225	10.5	225
Swell	0.1	5	3.67	2.62	10.25	225	10.5	225
Swell	0.1	3.33	3.71	2.49	15.12	225	10.5	225
Swell	0.1	0.5	3.93	2.31	14.68	225	10.5	225
Swell	0.1	1.33	3.81	2.17	14.29	225	10.5	225
Swell	0.1	1	3.84	2.06	14.02	225	10.5	225
Swell	0.1	0.5	3.93	1.81	13.37	225	10.5	225

Wave type (Swell/ total sea)	Joint exceedance probability (AEP %)	Water level (AEP %)	Water level at Littlehampton (mAOD)	Offshore wave height (m)	Offshore wave period (seconds)	Offshore wave direction (°)	Wind speed (m/s)	Wind direction (°)
Swell	0.1	0.2	4.04	1.48	12.50	225	10.5	225
Swell	0.1	0.1	4.13	1.22	11.85	225	10.5	225

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APPENDIX 3

CLIENT	Charles Glanville c/o Re-Format Limited		
SITE ADDRESS	Fowley Cottage, 46 Warblington Road, Emsworth, Hampshire PO10 7HD		
REPORT REFERENCE	GWPR1704		
ENGINEER	Joshua Laite, Ground and Water Limited		
INVESTIGATION LOCATIONS	Please see Figure 1 attached. Site works were undertaken on 20 th June 2016 and comprised the excavation of six trial pits (TP1-TP6) with soakaway testing in accordance with the principles of BRE365 in TP1-TP3 and TP5-TP6.		
GROUND CONDITIONS ENCOUNTERED	Summary of Strata Encountered (TP1-TP6)		
	Strata	Depth Encountered (m bgl)	Thickness (m)
	TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare to occasional, sub-angular to sub-rounded, fine to coarse flint.	GL	0.15 – 0.30
	MADE GROUND (TP6): Light brown silty sandy gravelly clay. Sand is fine to medium grained. Gravel is fine to abundant, fine to coarse, angular to sub-rounded flints, chalk and bricks.	0.20	0.60
	RIVER TERRACE DEPOSITS: Mottled light / mid brown / orange, silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare to occasional, fine to medium, sub-angular to sub-rounded flint.	0.15 – 0.30	0.90 – 1.55
	RIVER TERRACE DEPOSITS: Mottled light / mid brown / orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine to coarse, sub-rounded to sub-angular flints and chalk.	0.80 – 1.70	0.90 - 2.90
	RIVER TERRACE DEPOSITS (TP1 and TP4): Light brown / off white sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is abundant, fine to medium, sub-angular to sub-rounded, flint and chalk.	2.90 - 3.90	0.20 – 0.40
	LEWES NODULAR CHALK FORMATION (TP3): Structureless CHALK composed of cream gravelly sandy SILT. Gravel are moderately weak, high density, white and sub-angular. Locally white / light brown with a trace of light brown clay.	2.40	0.60
ROOTS	Roots were noted between 0.70 - 1.80m bgl.		
GROUNDWATER	Groundwater was not encountered during this investigation.		

INFILTRATION RATE

Soakaway tests, in accordance with the principles of BRE365, were undertaken at depths from 3.10m bgl – 4.30m bgl (TP1, TP3, TP5 and TP6) within the soils of the 1st River Terrace Deposits, comprising a silty sandy gravelly clay.

No infiltration was recorded and therefore soakaways constructed within the soils of the 1st River Terraced Deposits are **not** likely to perform to a satisfactory standard.

Soakaway Testing (TP1, TP2, TP5 and TP6)				
Trial Hole	Starting Depth (m bgl)	Final Depth (m bgl)	Time Elapsed (mins)	Infiltration Rate (m/sec)
TP1	2.50	2.49	125	0
TP2	2.03	2.01	156	0
TP5	1.82	1.80	154	0
TP6	2.10	2.20	190	0

A soakaway test, in accordance with the principles of BRE365, was undertaken at a depth of 3.00m bg in TP3 within the soils of the Lewes Nodular Chalk Formation, comprising a cream gravelly sandy SILT. No infiltration was noted and therefore the soils of the Lewes Nodular Chalk Formation are also **not** likely to perform to a satisfactory standard.

Soakaway Testing (TP3)				
Trial Hole	Starting Depth	Final Depth	Time Elapsed	Infiltration Rate
TP3	1.10m bgl	1.10m bgl	116 min	0 m/sec

The site was located within a **Secondary A Aquifer** relating to superficial deposits of the River Terrace Deposits, beneath a **Principal Aquifer** comprising the bedrock deposits of Lewes Nodular Chalk Formation is present.

Examination of the Environment Agency records showed that the site **was not** located within a **Groundwater Source Protection Zone** as classified in the Policy and Practice for the Protection of Groundwater.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

ANTICIPATED VOLUME CHANGE POTENTIAL

RIVER TERRACE DEPOSITS: Likely to have moderate to high volume change potential.

LEWES NODULAR CHALK FORMATION: Likely to have no volume change potential.

All in accordance with NHBC Standards Chapter 4.2 and BRE240. Subject to confirmation of results of geotechnical classification testing.

FOUNDATION RECOMMENDATIONS

At the time of reporting, June 2016, it is our understanding that the proposed development will incorporate the retention of the existing property and construction of 6No. detached properties with gardens in the surrounding grounds. Ancillary structures, such as site access, parking areas and private gardens will also be formed.

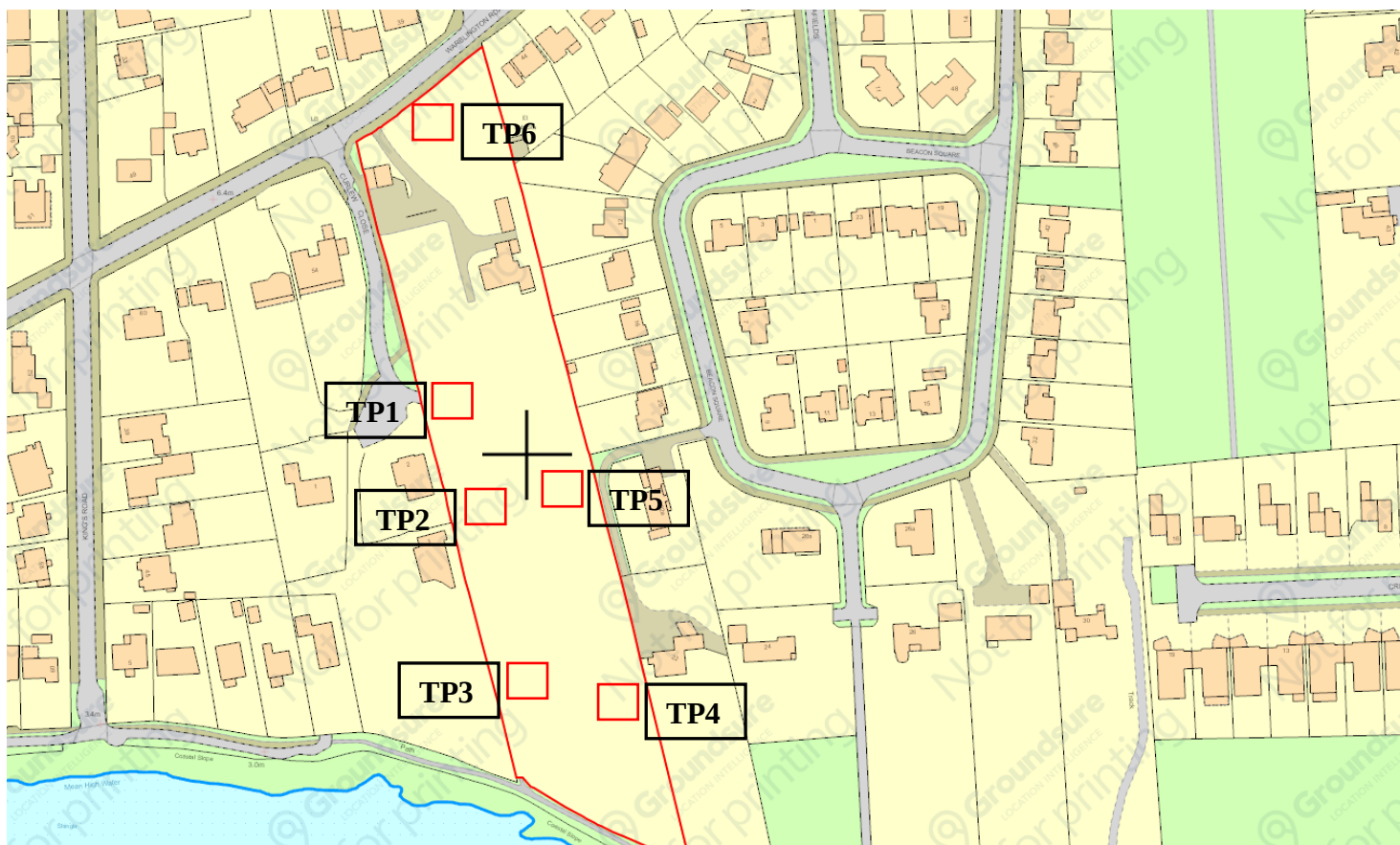
Foundations must not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account. The base of foundation excavations must extend at least 300mm into non-root penetrated soils. Should trees be removed from footprint of proposed development then a piled foundation should be considered.

Roots were generally noted ranging between 0.70 - 1.80m bgl, foundations minimum foundations depths rare likely to range from 1.00 - 2.10m bgl into the River Terrace Deposits.

Foundations constructed on the River Terrace Deposits at 1.00m bgl can be designed based on a presumed safe bearing capacity of 75kN/m², increasing to 100kN/m² at 2.10m bgl. This is based on trial hole records, inspection of samples recovered, geotechnical laboratory results, and referral to BS 8004:1986, Code of Practice for Foundations, the results of the insitu testing, and based on a 5m long by 1.0m wide foundation and a maximum settlement of ~25mm.

Given that the cohesive soils of the 1st River Terrace Deposits are likely to have a volume change potential in accordance with BRE Digest 240 and NHBC Chapter 4.2, a suspended slab should be considered. The volume change potential of the shallow surface soils must be taken into account in final design (underfloor void diameter/compressible material/void formers etc).

This preliminary information may be subject to amendment in the final report and no liability can be accepted for any actions based on this preliminary information.



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:

Fowley Cottage, 46 Warblington Road, Emsworth, Hampshire PO10 7HD

Client:

Charles Glanville c/o Re-Format Limited

Date:

July 2016

Trial Hole Location Plan

Ref:

GWPR1704

Figure 1

ground&water

Ground and Water Ltd							Trialpit No TP1 Sheet 1 of 1	
Project Name Fowley Cottage			Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016	
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD					Dimensions: -		Scale 1:25	
Client: Charles Glanville c/o Re-Format Ltd					Depth 4.30m		Logged By JL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
Depth (m)	Type	Results						
0.20	D		0.30			TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare to occasional, sub-angular to sub-rounded, fine to coarse flint.		
0.50	D					RIVER TERRACE DEPOSITS: Mottled light/mid brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare to occasional, fine to medium, sub-angular to sub-rounded flint.		
0.80	D							
1.20	D		1.30			RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine, sub-angular to sub-rounded flint and chalk fragments.		
1.50	D							
1.80	D							
2.20	D		2.00			RIVER TERRACE DEPOSITS: Mottled light brown/grey/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is abundant, fine, sub-angular to sub-rounded chalk fragments.		
2.50	D							
2.80	D							
3.00	D		3.90			RIVER TERRACE DEPOSITS: Light brown/off white sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is abundant, fine to medium, sub-angular to sub-rounded flint and chalk.		
3.40	D							
3.80	D							
4.30	D		4.30			Trialpit Complete at 4.30 m		
Remarks: Roots noted to 1.80m bgl.								
Groundwater: No groundwater encountered.								

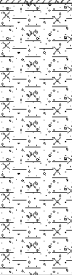
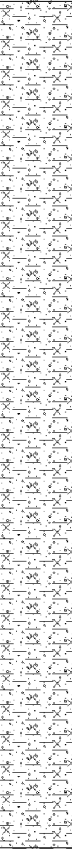
TRIALPIT LOG 3.1 (Rev 4.22.20) Standard Trialpit Log v2 (dated 27th Nov 03)

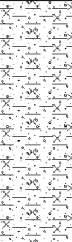
Ground and Water Ltd						Trialpit No TP2 Sheet 1 of 1	
Project Name Fowley Cottage			Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD					Dimensions: - Depth 3.40m		Scale 1:25
Client: Charles Glanville c/o Re-Format Ltd							Logged By JL
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.20	D		0.30			TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare, sub-angular to sub-rounded, fine to coarse flint.	1
0.50	D					RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare, fine to medium, sub-angular to sub-rounded flint.	
0.80	D						
1.20	D		1.30			RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine, sub-angular to sub-rounded flint and chalk.	2
1.50	D						
1.80	D						
2.20	D		2.10			RIVER TERRACE DEPOSITS: Light brown/orange/grey silty sandy gravelly CLAY. Sand is fine grained. Gravel is abundant, fine to medium, sub-angular to sub-rounded flint and chalk.	3
2.50	D						
2.80	D						
3.40	D		3.40			Trialpit Complete at 3.40 m	4
Remarks: Roots noted to 0.80m bgl							
Groundwater: No groundwater encountered.							



Ground and Water Ltd							Trialpit No TP3 Sheet 1 of 1		
Project Name Fowley Cottage			Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016		
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD					Dimensions: -		Scale 1:25		
Client: Charles Glanville c/o Re-Format Ltd					Depth 3.00m		Logged By JL		
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.10	D		0.15			TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare to occasional, fine to coarse, sub-angular to sub-rounded flint.			
0.30	D								RIVER TERRACE DEPOSITS: Light brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare, fine to medium, sub-angular to sub-rounded flint.
0.50	D								RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine, sub-angular to sub-rounded flint and chalk.
1.00	D		1.50		RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine, sub-angular to sub-rounded flint and chalk.				
1.40	D				2.10		RIVER TERRACE DEPOSITS: Light brown/orange/grey silty sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint and chalk.		
1.80	D						2.40		LEWES NODULAR CHALK FORMATION: Structureless CHALK composed of cream gravelly sandy SILT. Gravels are moderately weak, high density, white and sub-angular. Locally white/light brown with a trace of light brown clay.
2.50	D		3.00						
2.80	D								
Trialpit Complete at 3.00 m									
Remarks: Roots noted to 0.70m bgl.									
Groundwater: No groundwater encountered.									

Ground and Water Ltd							Trialpit No TP4 Sheet 1 of 1	
Project Name Fowley Cottage			Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016	
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD					Dimensions: -		Scale 1:25	
Client: Charles Glanville c/o Re-Format Ltd					Depth 3.10m		Logged By JL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
Depth (m)	Type	Results						
0.15	D		0.15			TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare, fine to coarse, sub-angular to sub-rounded flint.		
0.30	D					RIVER TERRACE DEPOSITS: Light brown/mid-brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare to occasional, fine to medium, sub-angular to sub-rounded flint.		
0.90	D							
1.20	D							
1.50	D							
1.80	D		1.70			RIVER TERRACE DEPOSITS: Light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine, sub-angular to sub-rounded flint and chalk.		
2.20	D		2.10			RIVER TERRACE DEPOSITS: Light brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is abundant, fine to coarse, flint and chalk.		
2.50	D							
3.00	D		2.90			RIVER TERRACE DEPOSITS: Light grey/off white sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is abundant, sub-angular to sub-rounded, fine to coarse flint and chalk.		
			3.10			Trialpit Complete at 3.10 m		
Remarks: Roots noted to 1.00m bgl.								
Groundwater: No groundwater encountered.								

Ground and Water Ltd							Trialpit No TP5 Sheet 1 of 1		
Project Name Fowley Cottage				Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016	
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD						Dimensions: -		Scale 1:25	
Client: Charles Glanville c/o Re-Format Ltd						Depth 3.90m		Logged By JL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
Depth (m)	Type	Results							
0.20	D		0.20			TOPSOIL: Mid brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare, fine to medium, sub-angular to sub-rounded flint.			
0.50	D					RIVER TERRACE DEPOSITS: Mid brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is rare, fine to medium, sub-angular to sub-rounded flint.			
0.80	D								
1.20	D		1.10			RIVER TERRACE DEPOSITS: Light brown/orange/grey silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint and chalk. Coarse chalk fragments noted from 2.40m bgl.			
1.50	D								
1.80	D								
2.20	D								
2.70	D								
3.40	D								
3.80	D		3.90			Trialpit Complete at 3.90 m			
Remarks: Roots to 1.30m bgl.									
Groundwater: No groundwater encountered.									

Ground and Water Ltd							Trialpit No TP6 Sheet 1 of 1	
Project Name Fowley Cottage			Project No. GWPR1704		Co-ords: - Level: -		Date 20/06/2016	
Location: 46 Warblington Road, Emsworth, Hampshire PO10 7HD					Dimensions: -		Scale 1:25	
Client: Charles Glanville c/o Re-Format Ltd					Depth 3.70m		Logged By JL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
Depth (m)	Type	Results						
0.20	D		0.20			TOPSOIL: Mid to dark brown silty sandy gravelly clay. Sand is fine grained. Gravel is rare, fine to coarse, sub-angular to sub-rounded flint.		
0.50	D					MADE GROUND: Light brown silty sandy gravelly clay. Sand is fine to medium grained. Gravel is fine to abundant, angular to sub-rounded, fine to coarse flint, chalk and brick.		
0.80	D		0.80			RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine to medium grained. Gravel is abundant, fine to medium, sub-angular to sub-rounded flint and chalk.		
1.20	D							
1.50	D							
1.80	D							
2.20	D							
2.70	D							
			2.90			RIVER TERRACE DEPOSITS: Mottled light brown/orange silty sandy gravelly CLAY. Sand is fine grained. Gravel is abundant, sub-angular to sub-rounded, fine to medium chalk and flint.		
3.20	D							
3.70	D		3.70			Trialpit Complete at 3.70 m		
Remarks: Roots noted to 1.80m bgl.								
Groundwater: No groundwater encountered.								