EVANS

PROPOSED DWELLING BETWEEN 35 AND 43 VICTORIA DRIVE, GREAT WAKERING, SOUTHEND-ON-SEA, ESSEX

FLOOD RISK ASSESSMENT

APRIL 2014

REF: 1210/RE/11-13/01 REVISION A

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CONTRACT

Evans Rivers and Coastal Ltd has been commissioned by Lawrence and Browne Ltd to carry out a flood risk assessment for a proposed dwelling between 35 and 43 Victoria Drive, Great Wakering, Southend-on-Sea, Essex.

This revised assessment has been compiled to consider the Agency's comments provided in their letter dated 12th December 2013 (Appendix A) and the revised site proposals.

QUALITY ASSURANCE, ENVIRONMENT AND HEALTH AND SAFETY

Evans Rivers and Coastal Ltd operates a Quality Assurance, Environmental, and Health and Safety Policy.

This project comprises various stages including data collection; depth analysis; and reporting. Quality will be maintained throughout the project by producing specific methodologies for each work stage. Quality will also be maintained by providing specifications to third parties such as surveyors; initiating internal quality procedures including the validation of third party deliverables; creation of an audit trail to record any changes made; and document control using a database and correspondence log file system.

To adhere to the Environmental Policy, data will be obtained and issued in electronic format and alternatively by post. Paper use will also be minimised by communicating via email or telephone where possible. Documents and drawings will be transferred in electronic format where possible and all waste paper will be recycled. Meetings away from the office of Evans Rivers and Coastal Ltd will be minimised to prevent unnecessary travel, however for those meetings deemed essential, public transport will be used in preference to car journeys.

The project will follow the commitment and objectives outlined in the Health and Safety Policy operated by Evans Rivers and Coastal Ltd. All employees will be equipped with suitable personal protective equipment prior to any site visits and a risk assessment will be completed and checked before any site visit. Other factors which have been taken into consideration are the wider safety of the public whilst operating on site, and the importance of safety when working close to a water source and highway. Any designs resulting from this project and directly created by Evans Rivers and Coastal Ltd will also take into account safety measures within a "designers risk assessment".

Report carried out by:

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Rupert Evans, BSc (Hons), MSc, CEnv, C.WEM, MCIWEM, AIEMA

REGISTRATION OF AMENDMENTS

Revision and Date	Amendments	Revision Prepared By
A 07/04/2014	Changes to Appendix A.	Rupert Evans
A 07/04/2014	Appendix B added.	Rupert Evans
A 07/04/2014	Changes to paragraphs 1.1.1, 3.2, 4.4.7.	Rupert Evans
A 07/04/2014	Changes to Chapter 6 and 9.	Rupert Evans
A 07/04/2014	Section 5.4 added.	Rupert Evans
A 07/04/2014	Drawings VD/NAK/001 and VD/NAK/002 added.	Rupert Evans

DISCLAIMER

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1. INTRODUCTION

1.1 Project Scope

1.1.1 Evans Rivers and Coastal Ltd has been commissioned by Lawrence and Browne Ltd to carry out a flood risk assessment for a proposed dwelling between 35 and 43 Victoria Drive, Great Wakering, Southend-on-Sea, Essex. This revised assessment has been compiled to consider the Agency's comments provided in their letter dated 12th December 2013 (Appendix A) and the revised site proposals.

1.1.2 It is understood that this Flood Risk Assessment will be submitted to the Planning Authority and Environment Agency (Agency, hereafter) as part of a planning application. Specifically, this assessment intends to:

a) Consider the impacts of the 1 in 20 year, 1 in 200 year and 1 in 1000 year flood events (all inclusive of climate change), in accordance with NPPF and NPPF Technical Guidance;

b) Review any literature and guidance specific to this area such as the SFRA;

c) Determine the extents of the aforementioned NPPF and NPPF Technical Guidance Flood Zones across the site, together with depths of floodwater and hazard, using the topographical survey;

d) Assess the risks to people and property and propose mitigation measures accordingly;

e) Review existing evacuation and warning procedures for the area;

f) Develop a brief post-development management plan/drainage strategy for surface water across the site, which considers the use of SUDS and alternative methods of surface water disposal;

g) Carry out an appraisal of flood risk from any other sources such as groundwater as required by NPPF and NPPF Technical Guidance;

h) Report findings and recommendations.

1.1.3 This assessment is carried out in accordance with the requirements of the National Planning Policy Framework (NPPF) and associated Technical Guidance, both dated March 2012. Other documents which have been consulted include:

- DEFRA/EA document entitled *Framework and guidance for assessing and managing flood risk for new development Phase 2 (FD2320/TR2)*, 2005;
- Communities and Local Government 2007. *Improving the Flood Performance of New Buildings*. HMSO.
- DEFRA/EA document entitled *The flood risks to people methodology (FD2321/TR1)*, 2006;
- EA *Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose*, 2008;

2. DATA COLLECTION

2.1 To assist with this report, the data collected included:

- Ordnance Survey 1:10,000 street view map (Evans Rivers and Coastal Ltd OS licence number 100049458).
- Topographical Survey of the site carried out by BB Surveys Ltd (shown on Drawing Number VD/GW/001).
- 1:250,000 *Soil Map of Eastern England* (Sheet 4) published by Cranfield University and Soil Survey of England and Wales 1983.
- 1:625,000 *Hydrogeological Map of England and Wales*, published in 1977 by the Institute of Geological Sciences (now the British Geological Survey).
- Flood level data provided by the Agency in their response dated 1st August 2013 (Appendix A) and email dated 24th October 2013 (Appendix A).

2.2 All third party data used in this study has been checked and verified prior to use in accordance with Evans Rivers and Coastal Ltd Quality Assurance procedures.

3. SITE CHARACTERISTICS

3.1 Existing Site Characteristics and Location

3.1.1 The site is located across a vacant plot between numbers 35 and 43 Victoria Drive, Great Wakering, Southend-on-Sea, Essex. The approximate Ordnance Survey (OS) grid reference for the site is 595330 186810 and the location of the site is shown on Figure 1.

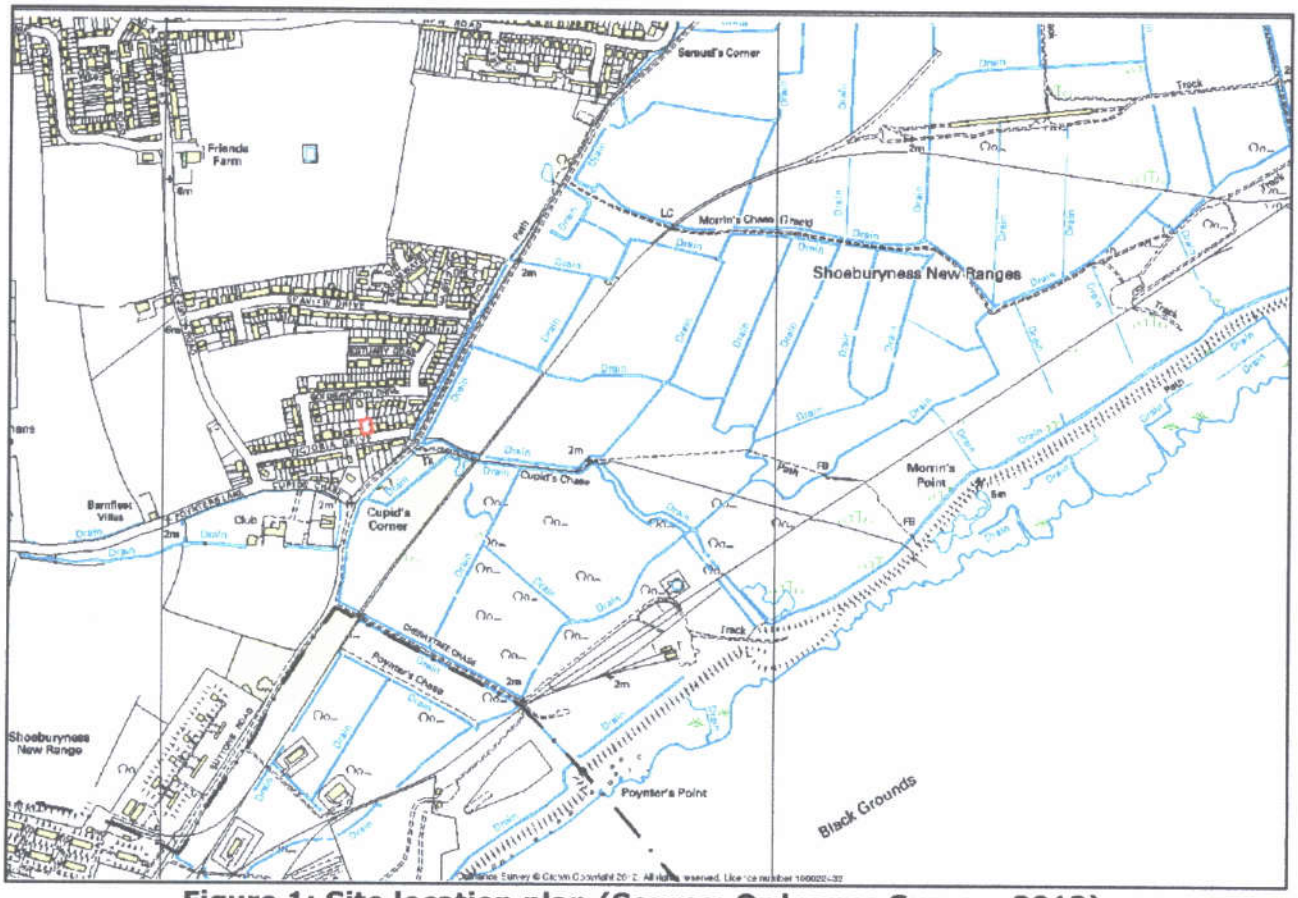


Figure 1: Site location plan (Source: Ordnance Survey, 2013)

3.1.2 The site is rectangular in shape and covers a total area of approximately 442 sq m. The site is currently vacant and occupied by long grass and vegetation. The site is surrounded by residential dwellings apart from its southern frontage which is bounded by Victoria Drive which runs in an east to west direction.

3.1.3 A topographical survey has been carried out by BB Surveys Ltd and can be seen on Drawing Number VD/GW/001. Ground levels are in metres above Ordnance Datum (m AOD). By reviewing the topographical survey, it can be seen that ground levels across the site fall in a south east direction from 3.40m AOD to 2.89m AOD.

3.1.4 Ground levels along Victoria Drive immediately adjacent to the site fall in a north east direction from 2.93m AOD to 2.80m AOD.

3.2 Site Proposals

3.2.1 It is the Client's intention to erect a new two-storey detached dwelling together with garden area and driveway. The dwelling will have non-habitable areas across the ground

floor including two car ports, storage areas, a gym and bathroom. Across the first floor there will be three bedrooms and living areas.

3.2.2 Access into the dwelling will be from Victoria Drive. The new dwelling will be located across the part of the site currently set at 3m AOD. It is understood that the finished ground floor level will be set at 3.30m AOD and the first floor level will be set above the climate change 1 in 1000 year flood level of 6m AOD. The proposals can be seen on Drawing Number VD/NAK/001 and VD/NAK/002.

4. BASELINE INFORMATION

4.1 Environment Agency Flood Zone Map

4.1.1 The Environment Agency's Flood Zone Map (Figure 2) shows that the site is located within the NPPF defined Flood Zone 3 associated with the North Sea and Havengore Creek (River Crouch estuary), located 747m south east of the site and 1.8 km north east of the site respectively.

4.1.2 The Flood Zone 3 is divided into two sub-categories, the Flood Zone 3a and Flood Zone 3b. The extent of the Flood Zone 3a 'High Probability' is defined as the 1 in 100 year return period fluvial event, or 1 in 200 year tidal event (or a combination of the two). As the river system and North Sea are tidal at this location, the extent of the Flood Zone 3a in this case is defined as the 1 in 200 year tidal surge event.

4.1.3 The maps do not show the extent of the functional floodplain (Flood Zone 3b). Flood Zone 3b functional floodplain is defined in Table 1 of the NPPF Technical Guidance as the area where water flows or is stored during flood events. The functional floodplain is generally defined by the limit of the 1 in 20 year flood envelope.

4.1.4 The extent of the flood zones do not take into account the presence of any formal flood defences, or other features which also act as informal flood defences. It should be noted that the Environment Agency website maps are "indicative only", and the disclaimer associated with the maps says: "*...maps only show the predicted likelihood of flooding from rivers or the sea for defined areas, and are not detailed enough to account for precise addresses...*".

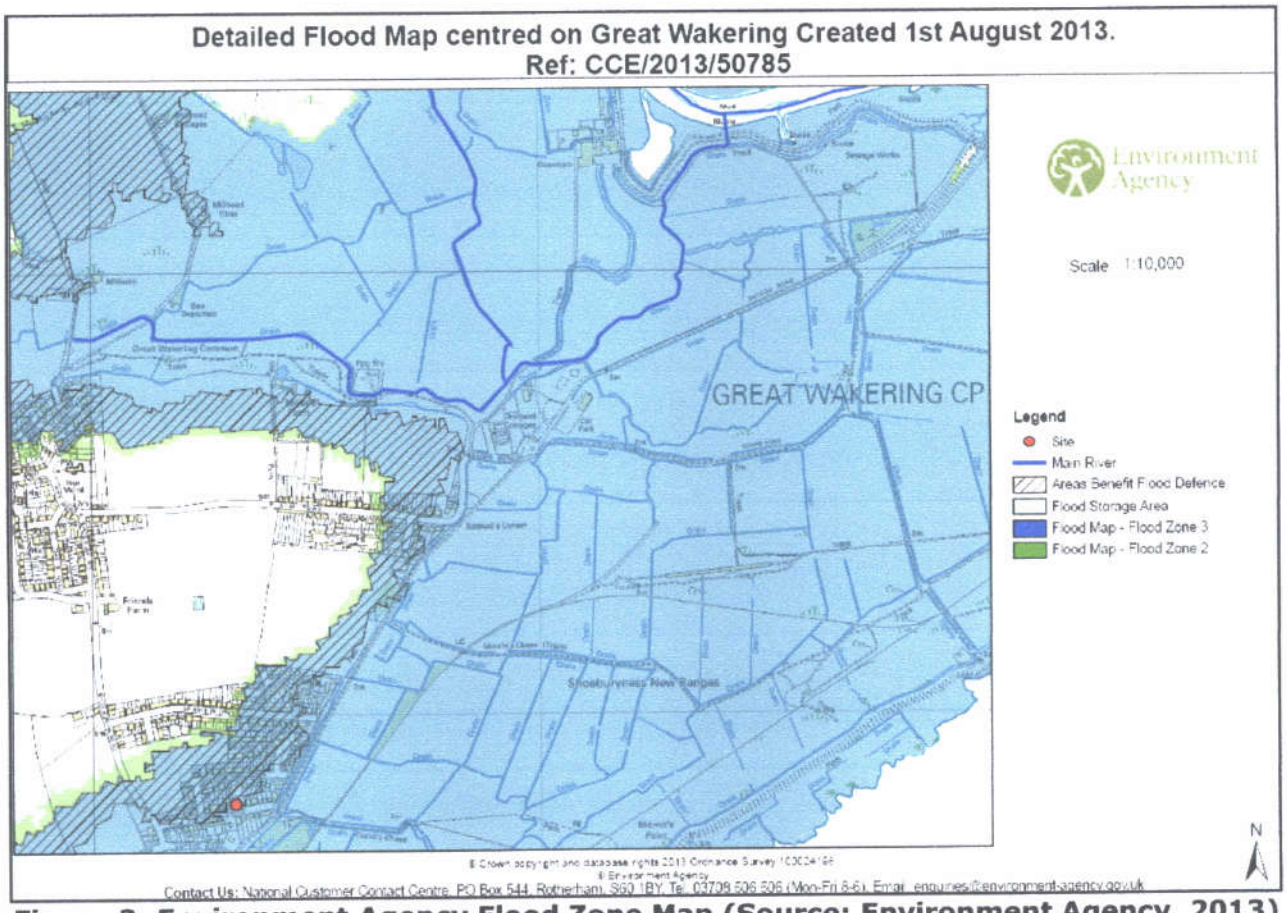


Figure 2: Environment Agency Flood Zone Map (Source: Environment Agency, 2013)

4.2 Flood Defences and Environment Agency Flood Levels

4.2.1 It is understood from the Agency's data included in Appendix A that the river defences located to the north east of the site and adjacent to Havengore Creek, comprise Environment Agency maintained clay seawalls set between 4.20m AOD and 4.64m AOD. These defences have a standard of protection of 1 in 200 years and are in Good to Fair condition.

4.2.2 The Agency has confirmed that the North Sea flood defences to the south east of the site are privately owned and comprise earth embankments. The OS map of the area indicates that the crest level of this defence is set at approximately 5m AOD.

4.2.3 The tidal flood levels for the Havengore Creek have been provided by the Agency as part of their response dated 1st August 2013 (Appendix A) and are summarised in Table 1.

Table 1: River system flood level data

Location	1 in 20 year (mAOD)	1 in 20 year plus climate change (mAOD)	1 in 200 year (mAOD)	1 in 200 year plus climate change (mAOD)	1 in 1000 year (mAOD)	1 in 1000 year plus climate change (mAOD)
Havengore Bridge undefended	3.82	5.02	4.33	5.50	4.68	5.83
Havengore Bridge defended	4.10	4.99	4.52	5.26	4.78	5.41

4.2.4 The tidal surge flood levels (without climate change) for the North Sea have been provided by the Agency as part of their response dated 1st August 2013 (Appendix A). It is understood that the data was produced in 2008.

Table 2: Tidal surge flood level data without climate change

Location	1 in 20 year (mAOD)	1 in 200 year (mAOD)	1 in 1000 year (mAOD)
North Sea at Node 2	4.07	4.54	4.90

4.2.5 Guidance within NPPF suggests that sea level rise is likely to increase depending on the pre-defined time period stated within Table 4 of the NPPF Technical Guidance. Table 3 shows this increase in sea level rise at the coast over 100 years from the date of this assessment.

Table 3: Expected increases in sea level rise over the next 100 years

Time period	Years within each time period (from 2013)	Increase per year at coast (mm)	Total increase at coast over period (mm)
1990-2025	12	4	48
2025-2055	30	8.5	255
2055-2085	30	12	360
2085-2115	28	15	420
Totals	**100**	-	**1083**

4.2.6 As climate change increments need to be considered from 2008 (the assessment date of the flood level), an additional 20mm (5 years x 4mm/year) needs to be applied (a total of 1103mm). Therefore the coastal flood levels as shown in Table 2 are expected to

increase by **1103mm** over the next 100 years, as a result of climate change and sea level rise. Table 4 shows the flood levels including an allowance for sea level rise.

Table 4: Tidal surge flood level data including sea level rise

Location	1 in 20 year plus climate change (mAOD)	1 in 200 year plus climate change (mAOD)	1 in 1000 year plus climate change (mAOD)
North Sea at Node 2	5.17	5.64	6.00

4.3 Historical Events

4.3.1 The Agency's historical flood map (Appendix A) shows that the site was not affected during the 1953 tidal surge event. However, low-lying marshland areas to the south east of the site were affected from overtopping and breaching of the flood defences.

4.4 Flood Warning and Emergency Planning

4.4.1 The site is located within an Environment Agency flood warning area. Tidal flood warning schemes use the information provided by the Met Office, DEFRA, Proudman Oceanic Laboratory (POL) and The Environment Monitoring and Response Centre (EMARC).

4.4.2 The Environment Agency can issue each level of warning when necessary at least 12 hours (model run which is reviewed every 6 hours) prior to the next high tide or critical estimated peak surge tide. It is understood that flood warnings can be issued to the media and local authorities/emergency services approximately 24 hours in advance of a high category flood warning, however in the interest of public safety warnings are only issued to residents 12 hours prior to a higher category flood warning.

4.4.3 Flood warnings can be issued to residents and businesses within flood risk areas by the Agency's *Floodline Warnings Direct* (FWD) service. This system is managed by the Environment Agency and dials out a message to the recipient when a particular category of flood warning is being advised. The message is conveyed by a constant ringing of the telephone or can alternatively be communicated to mobile phones and computers. The system functions at all times, issuing flood warnings and alerts in conjunction with announcements on radio and other media. Owners and occupiers of dwellings or businesses thought to be at risk can sign up to the scheme.

4.4.4 The service also takes advantage of more recent developments in technology and allows contact to be made through mobile phones and PC's. Information concerning the category of flood warning is also sent to the emergency services and local authorities who may need to mobilise and implement evacuation procedures.

4.4.5 A new Flood Forecasting Centre has been set up between the Agency and Met Office and is intended to improve the lead time and accuracy of flood warnings issued to emergency services and other important services to assist them with emergency planning decisions. The various flood warning codes can be seen on Figure 3.

	**Flooding is possible – Be prepared**
	**Flooding is expected – Immediate action required**
	**Severe flooding – Danger to life**

Figure 3: Flood warning codes (Source: Environment Agency, 2012)

4.4.6 It is understood from the Rochford District Council Strategic Flood Risk Assessment (SFRA, hereafter) carried out by Scott Wilson in 2011, that in the event of flooding, Rochford District Council will support the Agency and emergency services in providing a response to the public. Should a Flood Warning be issued then evacuation procedures for the area are organised by the Emergency Planning Officer. In the event of an emergency such as major flooding, the Essex Resilience Forum, which comprises a multi-agency group, is responsible for all evacuation and co-ordination/assistance to emergency services. Evacuation of people is towards allocated Council operated rest centres which consist of centres generally located outside of the floodplain and comprise village halls or sports centres. These centres provide shelter, first aid and refreshment. Transportation to rest centres may be provided by the local authorities upon the instruction of the emergency response team and priority is given to the elderly and other vulnerable groups, however the council have a Duty of Care to all people within the flood risk area.

4.4.7 It is understood from the Agency's email dated 2nd April 2014 (Appendix A) that the site lies in the Flood Warning Area "Paglesham, Rochford, the Wakerings and Potton Island". The Agency issues a *Flood Alert* when the surge tide at Clacton reaches 2.87m AOD and a *Flood Warning* when the surge tide reaches 3.77m AOD. A *Severe Flood Warning* is issued when the surge tide reaches 3.97m AOD.

5. TIDAL FLOOD RISK

5.1 Actual Flood Risk

5.1.1 The "defended" flood levels provided by the Agency in Table 1 reflect the flood level within the channel of the river system and assume that the defences are present. Therefore, in order to determine the "actual risk" from overtopping of the defences, these flood levels have been compared to the flood defence levels.

Table 5: River system overtopping potential for each flood return period

Location	1 in 20 year (mAOD)	1 in 20 year plus climate change (mAOD)	1 in 200 year (mAOD)	1 in 200 year plus climate change (mAOD)	1 in 1000 year (mAOD)	1 in 1000 year plus climate change (mAOD)
Havengore Bridge defended	4.10	4.99	4.52	5.26	4.78	5.41
Height of floodwater above minimum flood defence level of 4.20m AOD (m)	0	0.79	0.32	1.06	0.58	1.21

5.1.2 Table 5 shows that there is overtopping of the flood defences and into the floodplain areas behind the defences during all events apart from the present day 1 in 20 year event.

5.1.3 The North Sea flood levels provided in Tables 2 and 4 have also been compared to the height of the flood defences located towards the south east of the site.

Table 6: North Sea overtopping potential for each flood return period

Location	1 in 20 year (mAOD)	1 in 20 year plus climate change (mAOD)	1 in 200 year (mAOD)	1 in 200 year plus climate change (mAOD)	1 in 1000 year (mAOD)	1 in 1000 year plus climate change (mAOD)
North Sea at Node 2	4.07	5.17	4.54	5.64	4.90	6.00
Height of floodwater above minimum flood defence level of 5m AOD (m)	0	0.17	0	0.64	0	1.00

5.1.4 Table 6 shows that there is overtopping of the flood defences and into the floodplain areas behind the defences during climate change events only.

5.1.5 Figures B5 and B6 of the SFRA show the extent of the flooding from overtopping during the 1 in 200 year plus climate change event and 1 in 1000 year plus climate change event. Figures 4 and 5 show that the SFRA has determined a depth of floodwater at the site during both events of between 2m and 3m. Therefore the "actual risk" from overtopping is considered to be overall high.

5.1.6 Figures C5 and C6 of the SFRA show that the hazard to people at the site during both aforementioned flood events is *Dangerous for All.* The hazard to people has been classified by the SFRA in accordance with Table 13.1 of the DEFRA/EA R&D Document entitled *Framework and guidance for assessing and managing flood risk for new development Phase 2 (FD2320/TR2).*

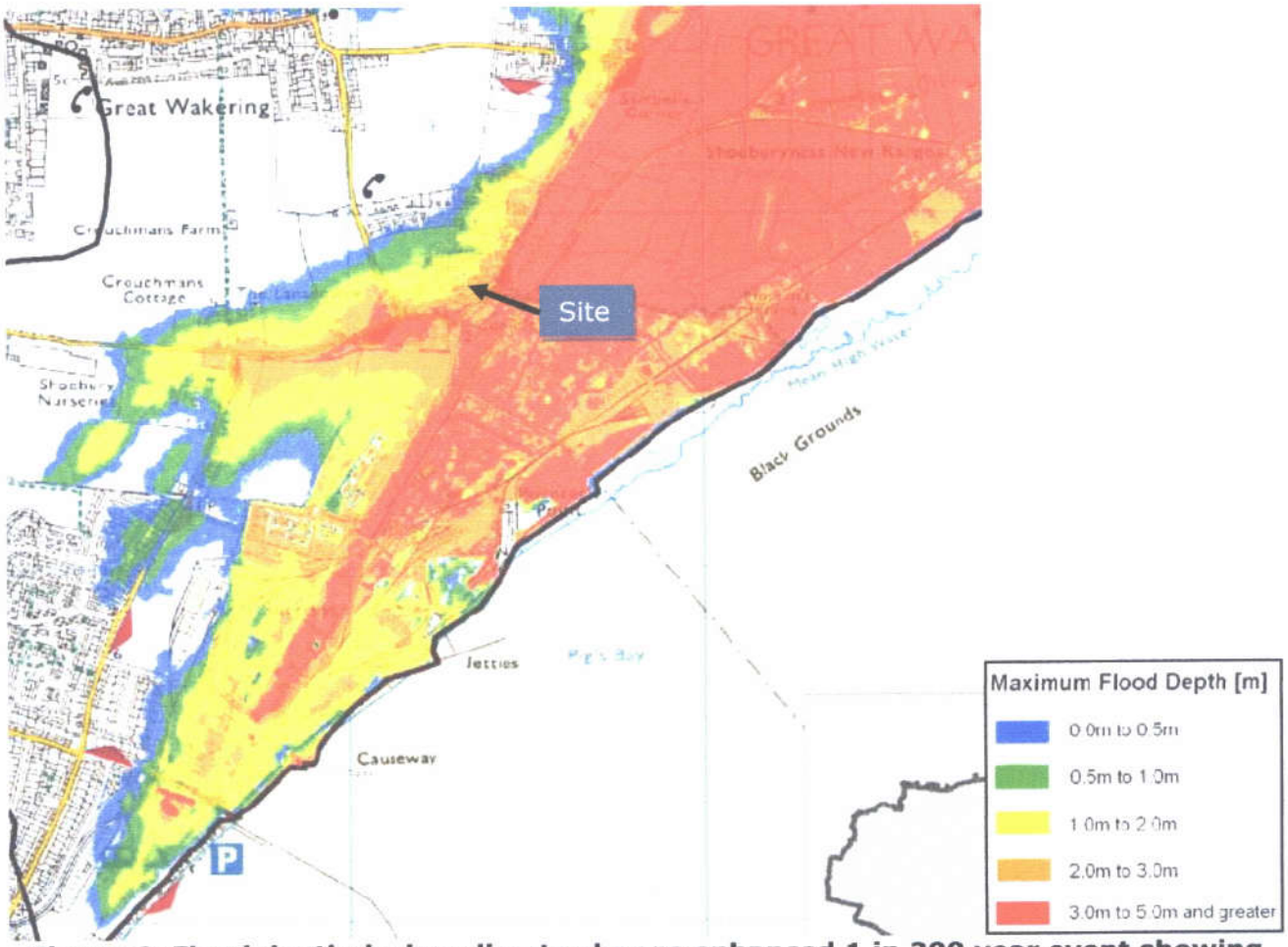


Figure 4: Flood depth during climate change enhanced 1 in 200 year event showing areas at risk of flooding from overtopping (Source: Figure B5, SFRA, 2011)

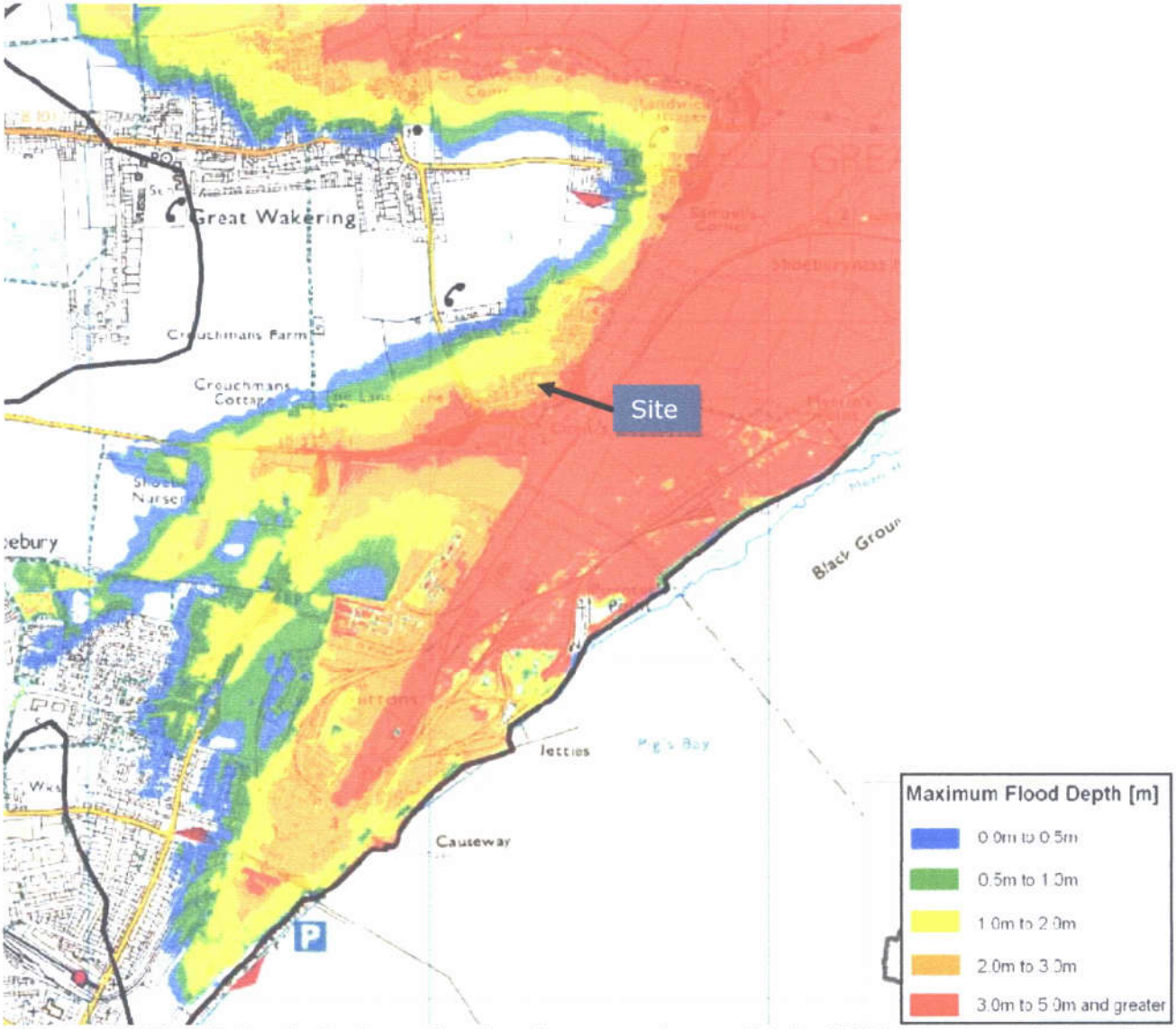


Figure 5: Flood depth during climate change enhanced 1 in 1000 year event showing areas at risk of flooding from overtopping (Source: Figure B6, SFRA, 2011)

5.2 Flood Zones

5.2.1 To determine flood zones, the "undefended" levels outlined in Table 1, together with the levels outlined in Tables 2 and 4 have been compared with the topographical survey.

5.2.2 The analysis indicates that assuming that no defences are present the whole site becomes inundated during all present day and future return period events and is located within the present day and future Flood Zone 3b.

5.2.3 According to NPPF the proposals comprise "more vulnerable" residential uses. NPPF states that "more vulnerable" development is not suitable in the Flood Zone 3b. The functional floodplain definition as stated in the NPPF Technical Guide is "...land where water has to flow or be stored in times of flood". The PPS 25 Practice Guide also states in paragraph 4.88 that "The functional floodplain includes water conveyance routes and flood storage areas".

5.2.4 As the floodplain is defended from flooding by flood defences which are set higher than the present day 1 in 20 year flood level, the area behind the defences (including the site) is not considered to act as functional floodplain and would not naturally be an area where floodwater is stored or conveyed. Therefore it is considered that the site is not located within the Flood Zone 3b.

5.2.5 The PPS 25 Practice Guide states in paragraph 4.90 that "The definition in PPS 25 [superseded by NPPF] allows flexibility to make allowance for local circumstances and should not be defined on rigid probability parameters".

5.2.6 It is therefore considered that a flexible approach is adopted for the site when considering the functional floodplain. The Flood Zone 3b should in this case be reclassified to Flood Zone 3a.

5.3 Residual Risk

5.3.1 The SFRA has investigated the risk of flooding from overtopping and a breach in the flood defences to the south east of the site and north east of the site. The return periods modelled included the present day and climate change enhanced 1 in 200 year event, and present day and climate change enhanced 1 in 1000 year event (Figures B1-B4 of the SFRA). It is understood from the SFRA that three breach locations were modelled (ref: ROC01, ROC02 and ROC03).

Present Day

5.3.2 Examination of the results from the SFRA indicates that during the present day 1 in 200 year event, floodwater at the site would reach a depth of between 0.5m to 1m. During the present day 1 in 1000 year event, floodwater at the site would reach a depth of between 1m to 2m.

5.3.3 The associated hazard across the site has been determined by the SFRA to be *Dangerous for Some* and *Dangerous for Most* respectively.

Climate Change

5.3.4 The SFRA indicates that during the climate change 1 in 200 year event (Figure 6), floodwater at the site would reach a depth of between 2m and 3m. During the climate change 1 in 1000 year event (Figure 7), floodwater at the site would reach a depth of between 2m and 3m.

5.3.5 The associated hazard across the site has been determined by the SFRA to be *Dangerous for All* during both events.

Time to Inundation

5.3.6 The SFRA also provides details of the time to inundation from the breach locations during the aforementioned return period events. Figure D1 of the SFRA shows that during the climate change 1 in 200 year and climate change 1 in 1000 year event, it would take less than one hour for the site to become affected by the floodwater from a breach in the south east and north east defences.

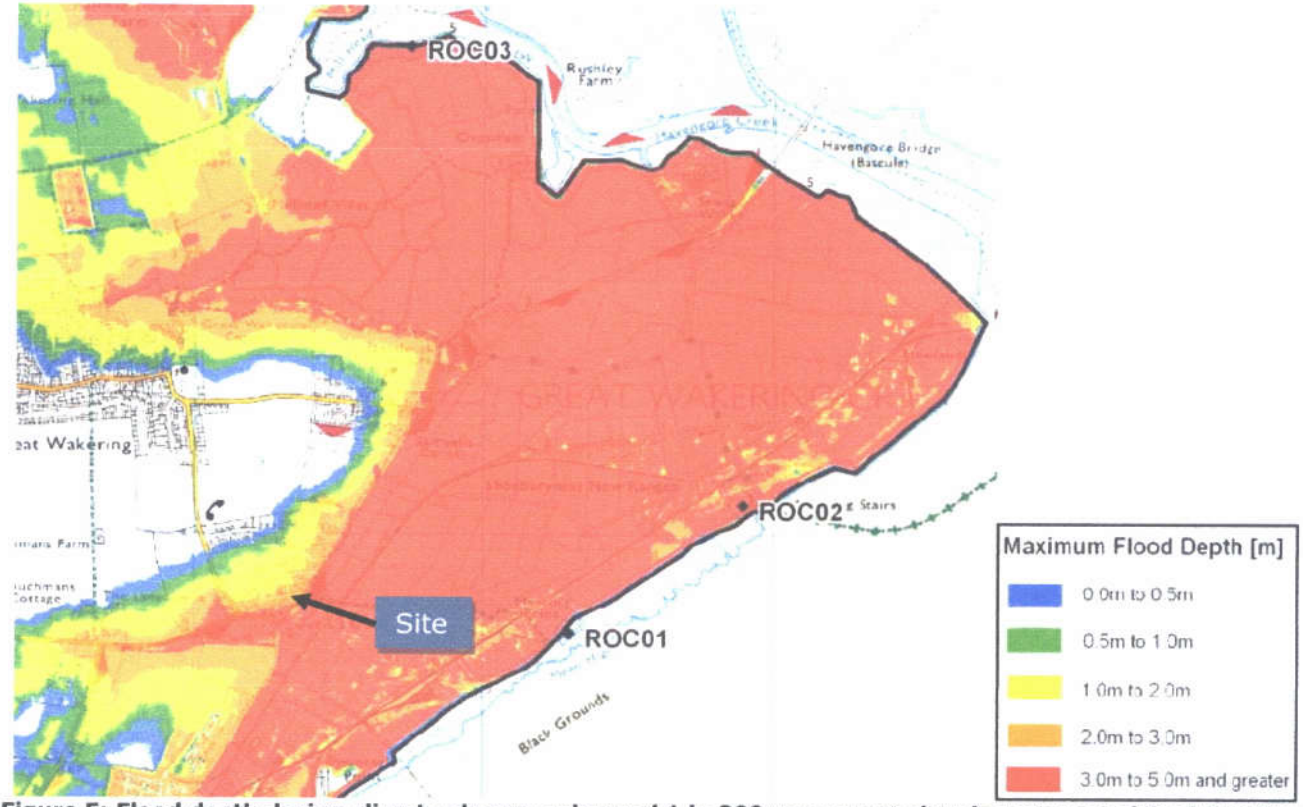


Figure 5: Flood depth during climate change enhanced 1 in 200 year event showing areas at risk of flooding from overtopping and breaching (Source: Figure B3, SFRA, 2011)

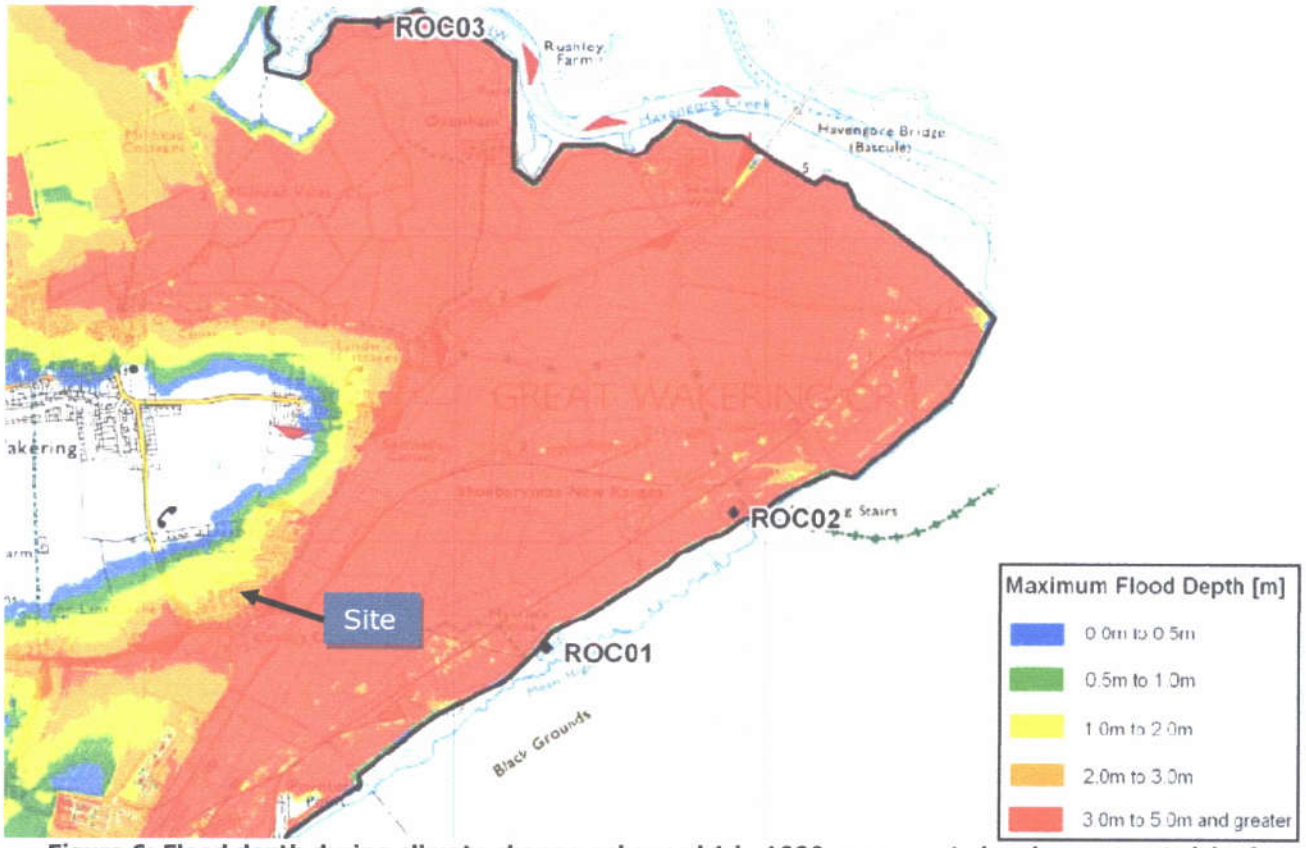


Figure 6: Flood depth during climate change enhanced 1 in 1000 year event showing areas at risk of flooding from overtopping and breaching (Source: Figure B4, SFRA, 2011)

5.4 Breach Analysis and Flood Warning

5.4.1 The Agency has suggested in their letter dated 12th December 2013 (Appendix A) that it would be useful for a breach of the defences to be modelled just below the *Flood Warning* threshold of 3.77m AOD. This will provide details of the risk to the site in an un-warned situation and if the defences were to fail prior to the issuing of a warning.

5.4.2 Table 4 shows that the coastal flood level appropriate to the site's location is 5.64m AOD during the climate change 1 in 200 year event. During the flood event, floodwater would overtop the defences, and flow through any breach openings. Inundation of the hinterland during the flood event would occur over consecutive tidal cycles. It is expected that overtopping and inflow through a breach of the defences would occur during periods when the surge tide is above the crest of the defences, or breach sill respectively.

5.4.3 The Agency's Tide 200 tidal curve spreadsheet has been used to calculate the tidal hydrograph, volume of inflow and backflow through the breach opening, together with the resultant maximum flood level within the flood compartment. As advised by the Agency, the breach sill level has been set lower than the *Flood Warning* threshold of 3.77m AOD (i.e. breach sill level set at 3.67m AOD). The breach has also been assumed to be open at the beginning of the tidal surge event.

5.4.4 By consulting the OS maps, SFRA and topographical survey, the floodplain compartment has been calculated to be approximately 2.42 sq km (Figure 7) and assumed to be set on average at 2m AOD. Assuming a breach of 50m in width occurs at the beginning of the surge event (i.e. at hour 0) and the breach has a sill level of 3.67m AOD, inflow through the breach will occur when the surge tide is above the breach sill. As the surge tide falls below the breach sill, a backflow of floodwater through the breach opening will occur. The results are shown on Figures 8 and 9 and in Appendix B.

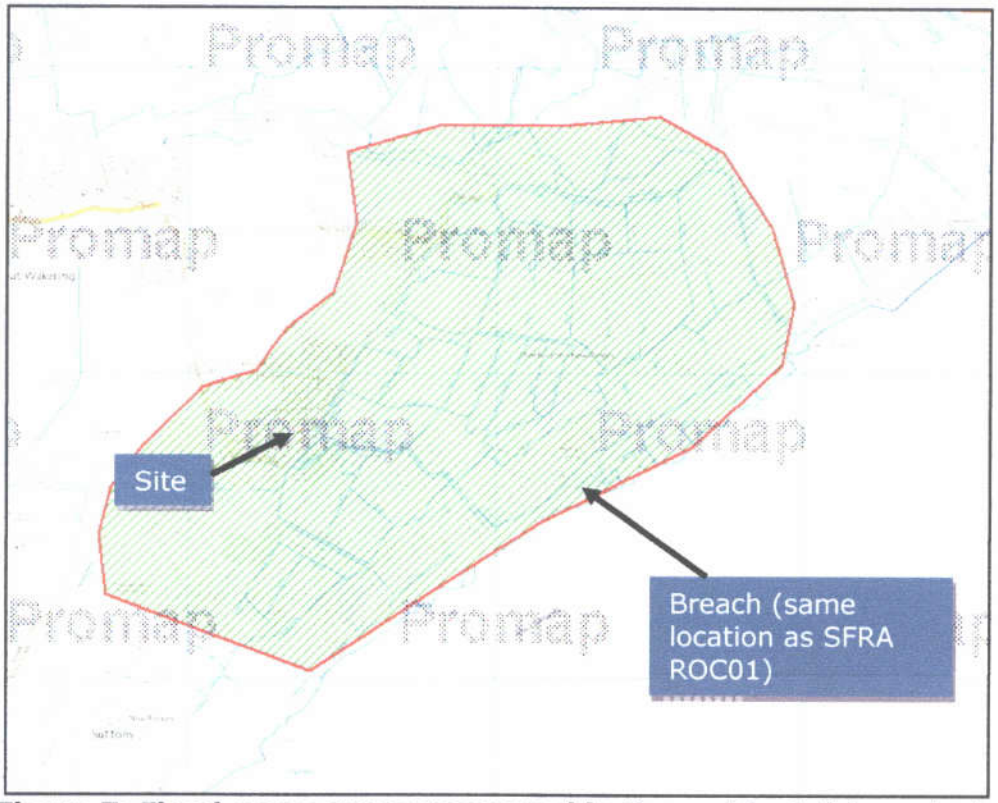


Figure 7: Flood compartment assumed in the residual risk analysis

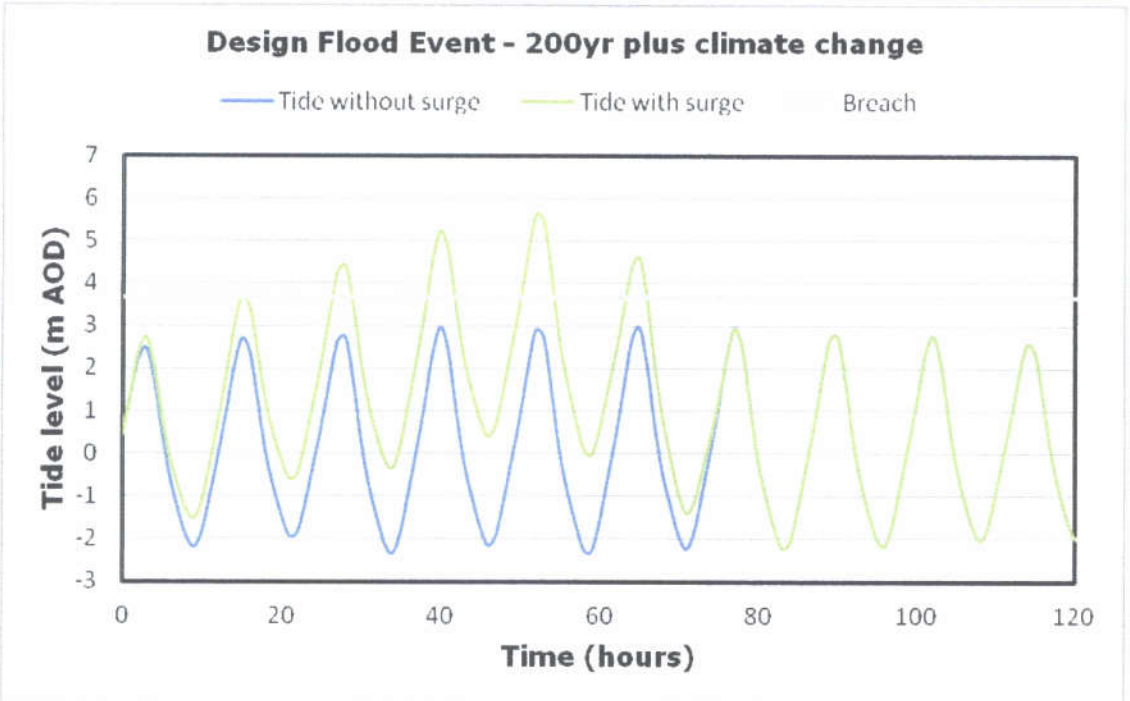


Figure 8: Tidal hydrograph showing 200yrCC surge event (Source: EA Tide 200)

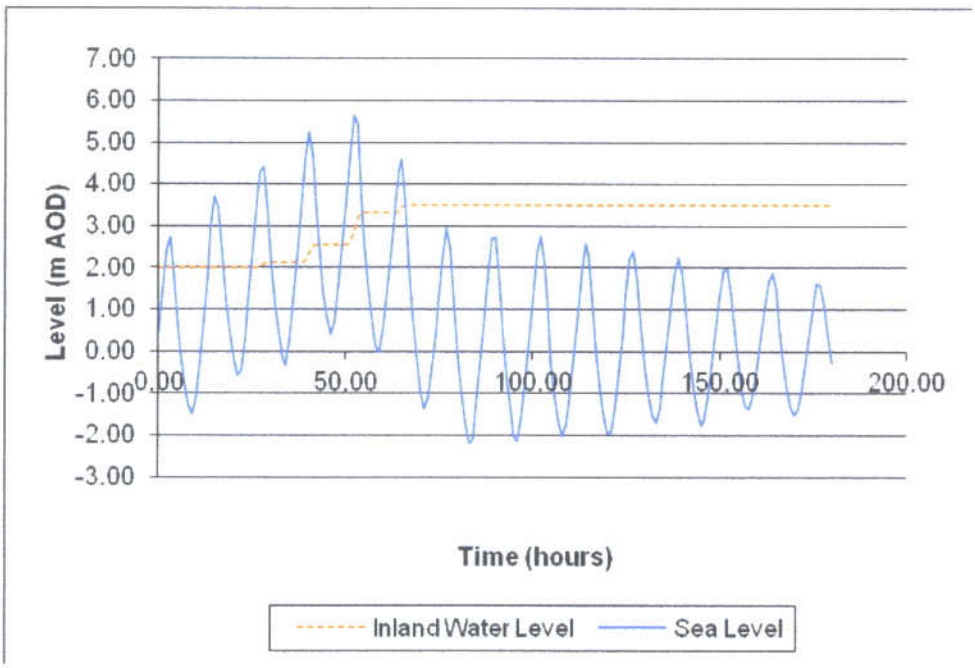


Figure 9: Flood compartment hydrograph during 200yrCC surge event (Source: EA Tide 200)

5.4.5 By consulting Figure 9 and Appendix B it can be seen that the maximum flood level within the flood compartment has been calculated at 3.49m AOD. The flood depth above the proposed ground floor level of 3.30m AOD would reach a maximum of 0.19m.

5.4.6 Assuming that the velocity of the floodwater propagating towards the site is 0.5 m/s (assuming that the floodwater slows down from the breach opening as a result of surface roughness), it would take 32 minutes and 52 seconds to travel 986m and reach the site.

5.4.7 The results in Appendix B also show that overtopping of the breach sill would occur after hour 14 and the ground floor of the dwelling would become affected by floodwater at hour 54.

5.4.8 The remaining flood level and flood depth across the ground floor after the event (i.e. after hour 65 when the surge tide is no longer able to rise above the sill level), will be 3.49m AOD and 0.19m respectively.

5.4.9 Table 7 shows that under the above conditions the hazard to people at the site remains *Very low hazard* during the entire event.

Table 7: Flood depth and hazard at the site assuming 50m breach of defences at the beginning of 200yr plus climate change tidal surge event in North Sea (data taken from Appendix B)

Time after surge event begins (hrs)	Flood depth (m) across proposed ground floor of 3.30m AOD.	Hazard to people (based on Table 13.1 of the DEFRA/EA R&D Document entitled *Framework and guidance for assessing and managing flood risk for new development Phase 2 (FD2320/TR2)*). Based on 0.5m/s velocity.
0-53	0	Very low hazard
54	0.02	Very low hazard
55-63	0.03	Very low hazard
64	0.05	Very low hazard
65	0.14	Very low hazard
66 onwards	0.19	Very low hazard

6. TIDAL FLOOD RISK MITIGATION AND EVACUATION

6.1 Reducing Exposure to the Hazard

6.1.1 In order to assess and reduce the exposure to the hazard and the vulnerability to the hazard after the site has been developed, the guidance outlined in the DCLG/DEFRA/EA document entitled *Flood Risk Assessment Guidance for New Development Phase 2*; *Flood Risks to People, Phase 2*; *Improving the Flood Performance of New Buildings* has been consulted.

6.1.2 Despite the breach analysis in section 5.4 showing a lower inland flood level, in order to represent a worst-case scenario and to develop mitigation measures, the information provided by the Agency has been adopted. The SFRA indicates that the flood depth at the site during the climate change 1 in 200 year and climate change 1 in 1000 year events is between 2m and 3m. Therefore, in order to represent a worst-case scenario when developing mitigation measures at the site, the largest of the flood levels outlined in Tables 1 and 4 has been adopted (i.e. a climate change 1 in 200 year flood level of 5.64m AOD and climate change 1 in 1000 year flood level of 6m AOD).

6.1.3 It is understood that the finished ground floor level of the dwelling will be set at 3.30m AOD. The internal depth of floodwater across the ground floor during the climate change 1 in 200 year event will therefore be 2.34m and 2.70m during the climate change 1 in 1000 year event.

6.1.4 The first floor level, which will comprise sleeping areas, will be set above the climate change 1 in 1000 year flood level of 6m AOD and therefore safe refuge during the flood event will be available at all times.

6.1.5 Research provided in paragraph 6.13 of the superseded 2009 DCLG document entitled *PPS 25 Development and Flood Risk Practice Guide* states that car parking areas should not be flooded to depths of more than 300mm. The expected flood depths across the driveway area to the front of the property will exceed this threshold and appropriate signage should be placed across the car parking area to warn of the flood risk. Vehicles should be moved to higher ground prior to the flood event in order to ensure that they do not become a hazard.

6.2 Differential Depth

6.2.1 During the climate change 1 in 200 year event, the depth of floodwater above the ground floor will be 2.34m. Assuming that floodwater is restricted somewhat from entering the building by external doors, the differential depth (i.e. the depth difference between the inside of the building and outside of the building) could therefore reach 2.34m.

6.2.2 During the climate change 1 in 1000 year event, the depth of floodwater above the ground floor will be 2.70m. The differential depth could therefore reach 2.70m if floodwater was restricted from entering the building.

6.2.3 The DEFRA/EA document entitled *Improving the Flood Performance of New Buildings*, dated 2007, suggests that where the depth of floodwater is higher than 0.5m above the floor level within a building, there will be damage to internal finishes.

6.2.4 It is also stated in the aforementioned DEFRA/EA document that there is some damage to buildings if the depth differential between the outside and inside water levels exceeds

0.6m. Severe damage can occur if this reaches 1m even if the buildings are flood proofed.

6.2.5 Therefore, in order to reduce this differential depth to safe limits, it is proposed that floodwater is allowed across the ground floor areas as part of a *Water Entry Strategy*.

6.3 Water Entry Strategy

6.3.1 In accordance with the ODPM guidance document *Preparing for Floods* and Figure 4.1 of the aforementioned DCLG/DEFRA/EA document, a *Water Entry Strategy* essentially permits the passage of floodwater through the building and prevents any displacement of floodwater during the event. A *Water Entry Strategy* in this case aims to allow floodwater to enter the building and flood resilience techniques are incorporated to reduce the consequences of flooding. It is proposed that the following mitigation measures are established up to the climate change 1 in 1000 year flood depth of 2.70m.

Floors

6.3.2 Ground supported floors will be preferable to reduce the hydrostatic pressures exerted on the walls below the flood level. A damp-proof membrane should also be included within the floor construction and suitable floor finished such as ceramic or concrete based floor tiles are recommended.

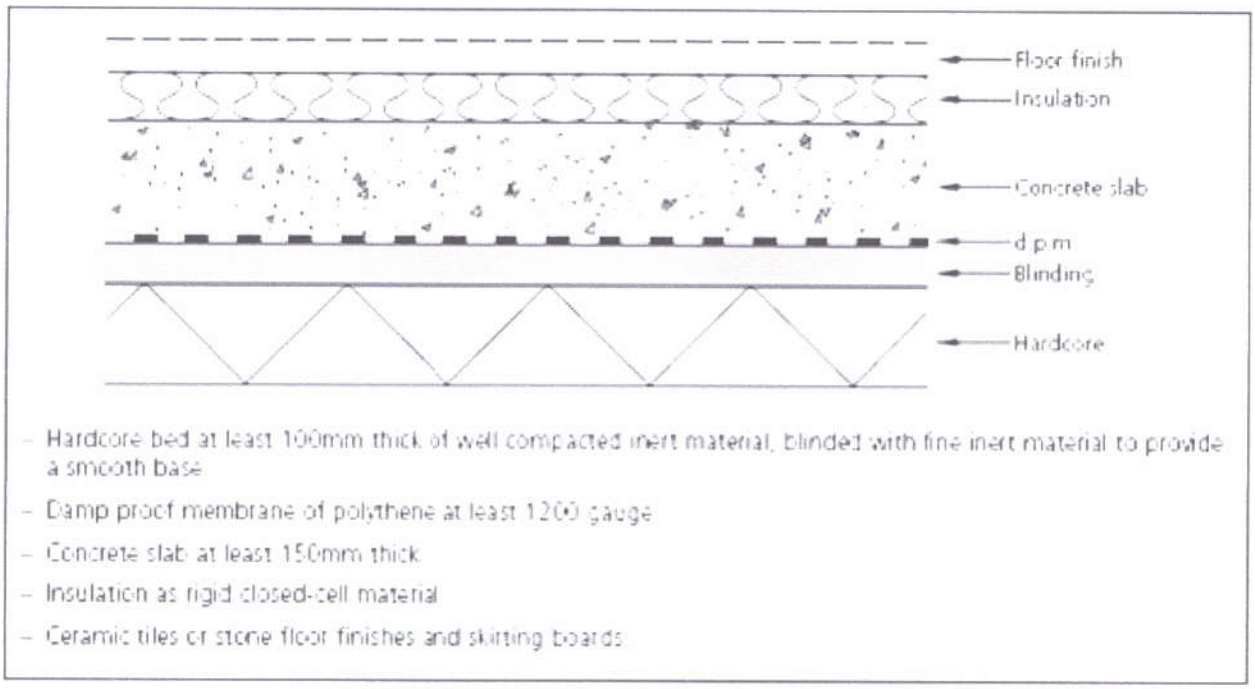


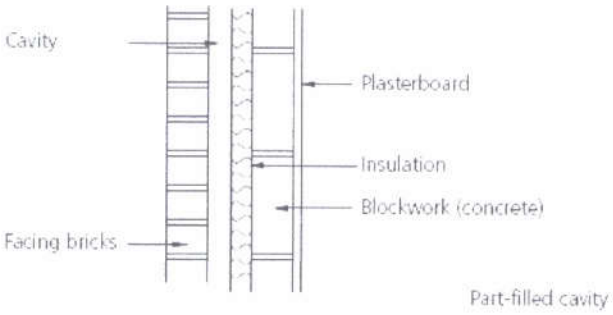
Figure 10: Ground-supported floor (Source: DCLG, 2007)

Walls

6.3.3 Suitable flood proofing measures will need to be incorporated within the walls up to the flood level. Concrete block walls dry quicker than other types such as Aircrete blocks.

6.3.4 Clear cavity walls (with no insulation) should be used as they also allow for quicker drying. Insulation can be fitted externally as it is easily replaced. If cavity insulation is preferred then rigid closed cell materials should be used as they have a low moisture take-up (Figure 11).

6.3.5 Internal cement renders should be avoided as they prevent effective drying. Standard gypsum plasterboard could be used as a sacrificial material and can be removed after the flood. Lime-based plaster and ceramic tiles are also known to offer some resilience.



Part-filled cavity

- External face consisting of engineering bricks up to required level for flood protection (up to d.p.c.). Other external facing materials can be used above this level, but ensure transition is watertight.
- Rigid insulation
- Internal cement based render, preferably with lime content. Composition depends on masonry; the following mix is effective:

  1 cement : 6 sand: 1 lime on concrete blocks.
- Stainless steel wall ties should be used to minimise corrosion and consequent staining.
- Sacrificial plasterboard can be used, but it needs to be removed between ground floor to flood level. The board should be laid horizontally to make removal easier.

Figure 11: Cavity External Walls (DCLG, 2007)

Fittings

6.3.6 Durable fittings which are not affected by floodwater could be used internally (e.g. plastic or stainless steel kitchen units). Wood fittings should be avoided; however sacrificial fittings can be installed which can then be replaced easily after the flood. There should be gaps behind the fittings to promote drainage and drying.

Services

6.3.7 It may not be practical to raise the electrical sockets above the extreme flood level. However, the mains supply of electric should be turned off in the event of a flood, and boiler units should be placed as high as possible. Wiring for communications should also be insulated to prevent damage. Non-return valves are recommended to prevent back-flow of foul water.

6.3.8 It is recommended that after the event, a structural survey is carried out in order to assess any damage due to prolonged periods of flood water exposure. The CIRIA guidance document (C623) entitled *Standards for the repair of buildings following flooding* outlines the various approaches.

6.4 Hydrodynamic Forces

6.4.1 A simple analysis of the likely hydrodynamic force associated with the design flood event has been carried out. The hydrodynamic force will be the force from the impact of the initial surge wave of floodwater arriving across the dry threshold. Assuming that the depth of approaching water is 300 mm and the velocity of approach is 0.5 m/sec, the appropriate calculation is:

Q = flowrate = approach flow per metre run of dwelling = 0.15 cu m/sec
Momentum Equation:
Force per metre run of building = F
F = water density x flowrate x change in velocity
Water density = 10 kN/cu m
Change in velocity = (initial velocity – final velocity) = (0.5 m/sec – nil) = 0.5 m/sec/sec
F = 10 x 0.15 x 0.5 = 0.75 kN/m

6.4.2 The hydrodynamic force resulting from the initial impact of water is 0.75 kN per metre run of the building. It is recommended that the walls of the dwelling are designed to withstand such a force, for example, by reinforcing the walls or providing a brick plinth around the walls. It is considered that this requirement could be conditioned as part of any planning approval.

6.4.3 By adopting a *Water Entry Strategy* this will remove the hydrostatic pressure as the differential depth will be equal.

6.5 Reducing Vulnerability to the Hazard

6.5.1 Although people will remain safe across upper floors during the design event and extreme event, people at the site are unlikely to have detailed knowledge of the dynamics of the flood event and the storminess of the event could result in people panicking or becoming anxious, particularly if they observe flooding across other areas of Great Wakering.

6.5.2 The Agency aims to provide up to 12 hours before the issue of a *Flood Warning* for tidal events. It is likely that the flood levels will be monitored by the Agency and the corresponding level of flood warning issued depending on the rising flood level. It is understood that the police and other emergency services will assist in the evacuation to rest centres operated by the Council. It is not mandatory for people to use these centres and personal evacuation arrangements can be just as effective. The Fire Service will assist in any rescuing of people and pets from the flooded area once this has occurred.

6.5.3 It is recommended that the occupants liaise with the Agency in order to register with the Agency's Flood Warnings Direct and ensure that they are aware of the flood risk so that they escape/evacuate upon receipt of a *Flood Warning*.

6.5.4 It should be noted that evacuation of people and vehicles well in advance of a predicted flood event is the recommended strategy as floodwater will reach the site very quickly, and there is likely to be floodwater surrounding the site for many days following the flood event.

6.5.5 The occupants should develop a *Family Flood Plan*. Further guidance is offered in the Environment Agency's guidance document entitled *What to do before, during and after a flood*. The *Family Flood Plan* should consider, for example, vital medical items needed and a *Flood Kit*.

6.5.6 A *Flood Kit* includes items such as key personal documents, torch and batteries, mobile phone, waterproofs and a first-aid kit. A *Flood Kit* is a useful precautionary measure especially if evacuation from the site is prolonged and many hours after the flood event.

The *Flood Kit* also includes items such as:

1. Important documents
2. Torch and batteries
3. Mobile phone (fully charged)
4. First-aid kit
5. Wind-up radio
6. Important telephone numbers
7. Bottled water
8. Non-perishable food provisions
9. Rubber Gloves and wellington boots
10. Medication
11. Blankets, warm clothes
12. Essential toiletries
13. Camera to record any damage
14. Emergency cash

6.5.7 Although there will be safe refuge across the site, it is not recommended that occupants remain within the building after the order for evacuation has been issued by the emergency services, unless the occupant is vulnerable (i.e. infirm) and the emergency services should be notified.

6.5.8 The DEFRA/EA document *Flood Risks to People* suggests that people who decide to reside within buildings during a flood event may become irrational and may attempt to inadvertently put themselves and others at risk. Other problems such as stress and risk of fire from damaged electrical points could also cause injury or death for such people. Therefore, it is recommended that people evacuate the site as early as possible or upon the instructions of the emergency services.

6.5.9 Assuming that people do not receive a flood warning, or if a breach occurs during the early stages of the surge event, they will remain protected across the upper floor of the dwelling. Table 8 includes additional information about what can be done in the event of a flood.

Table 8: Flood Event Action Plan

Environment Agency Flood Warning Code	What to do!	Evacuate?
Flood Alert (Flooding Possible. Be aware/prepared! Watch Out).  FLOOD ALERT	• Monitor flood risk through media and Floodline Warnings Direct. • Locate other family members and inform them of risk. If away from the site make assessment on risk if considering returning to site (i.e. how long it will take to return etc).	Not necessary although up to occupant's discretion. Drive carefully if evacuating as roads may be flooded or closed.
Flood Warning (Flooding of homes, businesses and main roads is expected. Act now!).	• Maintain communication through Floodline Warnings Direct and the media. • Begin to implement Flood Plan. • Gather Flood Kit and provisions in the event that evacuation is not possible.	Preferable. Advice from emergency services should be adopted. If evacuation is not possible, then people should reside across upper

 FLOOD WARNING	• Consider advice given from emergency services/Environment Agency. • Move valuables to safety. • Store electrical items as high as possible. • Turn off gas/electricity.	floor where safe refuge is available.
Severe Flood Warning (Severe flooding is expected. Imminent danger to life and property. Act now!).  SEVERE FLOOD WARNING	• Avoid electricity sources. • Co-operate with emergency services. • Avoid contact with floodwater. • Make way to first floor unless otherwise advised by the emergency services.	Evacuation should already have been carried out. People should remain across upper floor and maintain communication with the emergency services. Evacuate depending only on the advice provided by the emergency services.
Warnings no longer in force (No further flooding is expected in the area. Be careful).	• Return to site upon instruction from emergency services and assess any damage. • Contact insurance company depending on damage caused. • Beware of flood debris. • Do not touch sources of electricity.	Not applicable.

6.6 Vulnerable Groups

6.6.1 The occupants at the site may include vulnerable groups such as the elderly, those with sensory or physical disabilities, minority ethnic groups, or the infirm. Priority to these people will be needed during the flood event.

6.6.2 The research suggests that older people may have life experiences which inhibit appropriate action on receipt of a flood warning and warnings may not be heeded due to this strong sense of independence.

6.6.3 Minority ethnic groups may not be aware of warnings because these warnings are not conveyed on radio channels customarily heard by them. Also a poor command of English (verbally and written) may also inhibit their response to any flood warning and advice issued by the emergency services.

6.6.4 The infirm or disabled may also be vulnerable to flood risk. This may be in the form of anxiety or other ailments which are aggravated by flooding. Evacuation may also be a more extensive exercise for these groups than for other people at the site.

6.6.5 People with no prior experience of flooding tend to have a lack of awareness, preparedness and knowledge of flooding. These people often disbelieve that the flood water would reach their location and are not aware of how resilient their building is.

6.6.6 The research document entitled *Public Response to Flood Warning* published by the EA/DEFRA in 2007 suggests that warning messages issued face-to-face have been found to increase public response to hazard. Conversely, fear of looting can decrease the probability of response and therefore the necessary security measures will need to be implemented once evacuation has been ordered.

6.7 Safe Access/Egress

6.7.1 Safe refuge is available throughout the event, however, safe access and egress will not be achieved during the peak of the event. Section 5.3 indicates that floodwater could reach the site within 1 hour if overtopping and breaching of the flood defences occurred and that the flood hazard would be *Dangerous for All* during the peak of the climate change 1 in 200 year and climate change 1 in 1000 year events. During the peak of present day 1 in 200 year and 1 in 1000 year events the hazard would be *Dangerous for Some* and *Dangerous for Most* respectively.

6.7.2 By consulting the flood map and topographical survey, people will need to travel west along Victoria Drive and north along Shoeberry Road (Figure 12) in order to be outside of the floodplain (i.e. a total distance of 440m).

6.7.3 The SFRA shows that the hazard to people along the evacuation route during the peak of the climate change 1 in 200 year event will be *Dangerous for All* for 280m, *Dangerous for Most* for 85m, *Dangerous for Some* for 25m and *Caution* for the remaining 50m (Figure 13). The hazard characteristics are similar during the climate change 1 in 1000 year event.

6.7.4 The breach analysis in section 5.4 indicates, however, that if the breach sill level was set slightly below the *Flood Warning* threshold, the maximum flood depth across the ground floor of the dwelling would be a maximum of 0.19m. The hazard to people under these conditions would be *Very low hazard* across the ground floor of the dwelling, however, safe access/egress cannot be achieved as the hazard along Victoria Drive would be *Dangerous for Most.*

6.7.5 The Local Authority is encouraged to consider the case of the Wapshott Planning Inquiry, as discussed in the 2009 paper by Tunstall et al *(Journal of Flood Risk Management)*, in which the Inspector concluded that whilst it was a concern that a dry escape route was not available, long lead warning times, a flood evacuation plan and gradual rise of flood water, would allow residents to evacuate at an early stage. The Inspector also concluded that the absence of a dry escape route at all times during the event was not a sufficient reason to conclude that the residents would be put at excessive risk.

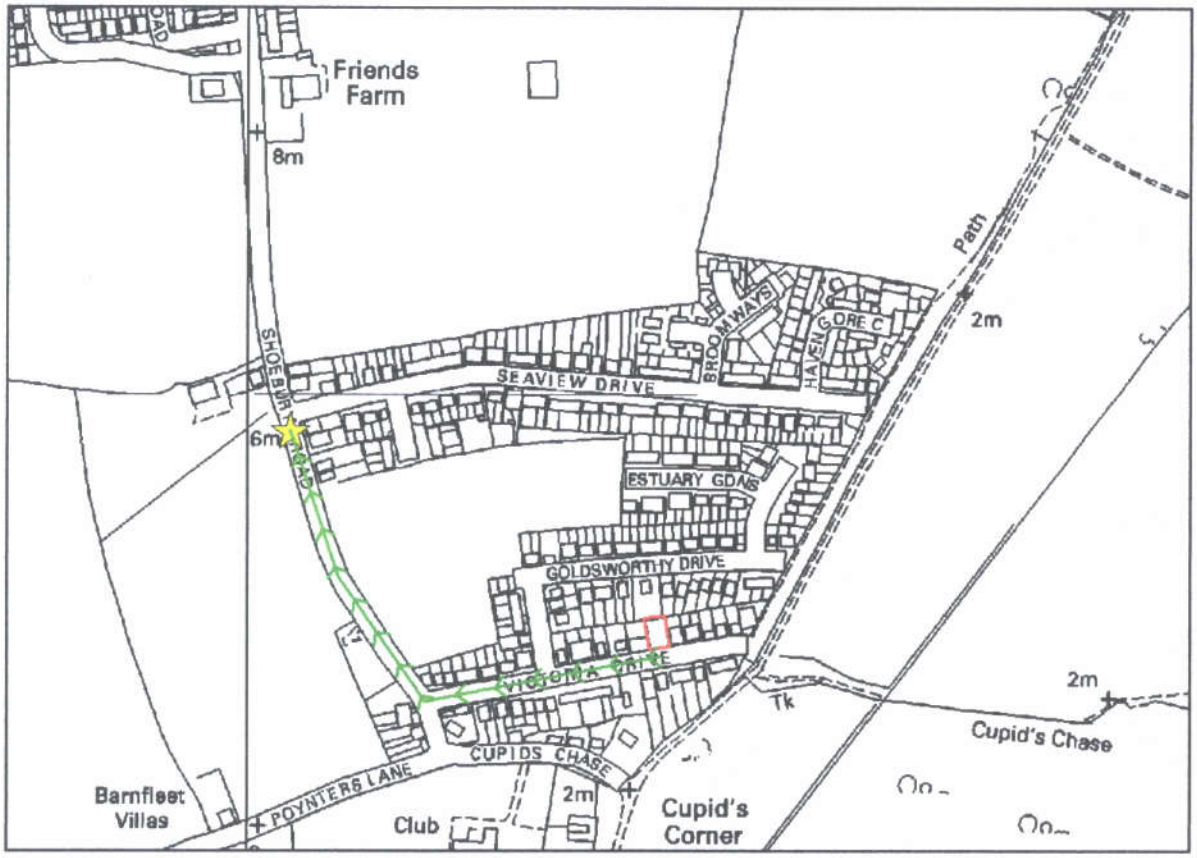


Figure 12: Evacuation Route

Figure 13: Flood hazard during climate change enhanced 1 in 200 year event showing hazard from overtopping and breaching (Source: Figure C3, SFRA, 2011)

6.8 Insurance

6.8.1 The Association of British Insurers (ABI) published a guidance document in 2012 entitled *Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England*.

6.8.2 The ABI guidance sets out the requirements of the insurance industry when considering flood risk and insurability of the property. The guidance suggests that properties should be protected for flood events up to the 1 in 100 year event in order to access insurance at a competitive price.

6.8.3 The guidance also states that insurers would of course prefer to cover properties which are not at risk of flooding, however, for those properties which are at risk of flooding insurers would prefer that the properties are raised above the flood level, over resistance measures which prevent floodwater from entering the building, or resilience measures which allows floodwater to enter the building.

6.8.4 It is not practical to raise the ground floor level above the flood level, however, flood resilience measures have been proposed up to the 1 in 1000 year plus climate change event. Therefore, the ABI's requirement of protection during a 1 in 100 year event will be exceeded and there will be a good chance of the property being insured at a competitive rate.

7. GROUNDWATER FLOODING

7.1 Mechanisms for Groundwater Flooding

7.1.1 In order to assess the potential for groundwater flooding during higher return period rainfall events, the Jacobs/DEFRA report entitled *Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study*, published in May 2004, was consulted, together with the guidance offered within the document entitled *Groundwater flooding records collation, monitoring and risk assessment (ref HA5)*, commissioned by DEFRA and carried out by Jacobs in 2006.

7.1.2 According to Cobby et al (2009), groundwater flooding can be defined as flooding caused by the emergence of water originating from subsurface permeable strata. The greatest risks of groundwater flooding are considered to be from either:

- a rise of groundwater in unconfined permeable strata, such as Chalk, after prolonged periods of extreme rainfall;
- a rise of groundwater in unconsolidated, permeable superficial deposits, which are in hydraulic continuity with local river water levels and where the hydraulic gradient of the water table is low.

7.1.3 As described above, it is widely accepted that groundwater flooding generally occurs from both permeable strata (e.g. Chalk) and superficial deposits (e.g. sands and gravels). In particular, unconfined water-bearing deposits (i.e. those with permeable soils above them) are susceptible to a rise in groundwater during prolonged, extreme rainfall and during periods of high recharge throughout autumn and winter. Antecedent conditions, such as, above average groundwater levels prior to the rainfall event, are also a contributing factor to a variation in the water table.

7.1.4 Groundwater flooding from Chalk aquifers, for example, mainly occurs when the surface of the Chalk is close to, or outcrops at the ground surface. The rise in the water table during prolonged and extreme rainfall can be significant, especially if the Chalk aquifer is unconfined and if the original water level in the aquifer is high. Flooding from such aquifers may occur within a few hours or days of the rainfall or up to a few weeks after.

7.1.5 Deposits comprising a mixture of permeable and impermeable soils can lead to a presence of perched water. Perched water tables are located above less permeable deposits such as clay and are located within water-bearing soils such as sand and gravel. If perched water is unconfined then the potential for recharge and groundwater flooding can be high. If the perched water is confined by less permeable clay deposits, then the clay deposits will have a buffering effect on percolating surface water and thus the recharge potential and rise in the water table is low.

7.2 Soil and Geology at the Site

7.2.1 It can be seen from the various soil and hydrogeological data, listed in Section 2, that the soils beneath the site comprise sand and gravel deposits overlying London Clay (clay, silt and sand).

7.2.2 Table 6 and equation 12 of the ADAS document entitled *Pipe Size Design for Field Drainage*, 1980, indicates that the soils in the area have a moderate Winter Rain Acceptance Potential (WRAP) and moderate Winter Runoff Potential.

7.3 Groundwater Flooding Potential at the Site

7.3.1 The mixture of permeable and less permeable soils will allow the recharge potential of the water table to be moderate as there will be a moderate buffering effect on infiltrating surface water.

7.3.2 There have been no recorded groundwater flood events across the area between 2000 and 2003, as indicated by the Jacobs study. The SFRA suggests that areas with low permeability prevents groundwater from rising and thus reduces the potential for groundwater flooding.

7.3.3 There could be perched groundwater situated within the more permeable deposits below the site, however, neighbouring borehole records obtained via the British Geological Survey indicate that the water table is at depth and between 6 and 9 feet below the ground surface. It is considered that the evidence suggests an overall low risk of groundwater flooding.

8. SURFACE WATER DRAINAGE AND SUDS

8.1 Planning policy recommends the maximum practical use of Sustainable Drainage Systems (SUDS) within proposals for new sites. There is a requirement that sustainable drainage systems (SUDS) be installed where appropriate, in order to limit the amount of surface water runoff entering drainage systems and to return surface water into the ground to follow its natural drainage path.

8.2 The soil types across the site are likely to be suitable for the effective use of infiltration devices such as permeable surfaces. Building roofs could then discharge onto these surfaces as described further in CIRIA 582 entitled *Source control using constructed pervious surfaces.*

8.3 Pervious surfaces act as an effective way to store or infiltrate surface water and have also been shown to act as a filter and retainer for pollutants, in particular oil. This has been investigated and documented within the Quarterly Journal of Engineering Geology and Hydrogeology, Volume 37, November 2004, in which this approach can also be implemented when considering the protection of groundwater. CIRIA have reported that approximately 70-90 percent of hydrocarbons can be removed by this technique. Also there are cost reductions available with this approach as there is no requirement to install pipes and gullies.

Note: According to the DCLG document entitled *Guidance on the permeable surfacing of front gardens* published in September 2008, from the 1st of October 2008 new driveways or parking areas (>5 sq m) which allow uncontrolled runoff of surface water (i.e. are not constructed using permeable surfaces or use other infiltration/disposal media) will require planning permission.

9. CONCLUSIONS

9.1 A review of the data provided by the Agency, topographical survey and information from the SFRA, has determined that:

- The site is located within the NPPF Flood Zone 3a from a tidal surge event within the river system and North Sea. The actual risk to the site from overtopping during all critical flood return period events is considered to be high particularly during climate change events.

- During the 1 in 200 year plus climate change event and 1 in 1000 year plus climate change event, floodwater would overtop the defences, and possibly flow through any breach openings. The SFRA has indicated a flood depth at the site of between 2m and 3m during both events.

- A *Water Entry Strategy* should be adopted across the ground floor area to reduce the differential depth to safe limits during the design and extreme event and to protect property.

- A warning and evacuation strategy has been developed within this assessment. It is proposed that the occupants register with the Agency's *Flood Warnings Direct* and prepare a *Family Flood Plan*. It is recommended that the occupants take advice from the emergency services and evacuate the site before the receipt of a *Flood Warning*.

- The SFRA has indicated that under breach and overtopping conditions, floodwater would reach the site within 1 hour and during the peak of the event the flood hazard to people would be *Dangerous for All.*

- A breach analysis undertaken as part of this FRA has suggested that if the breach sill was set slightly below the *Flood Warning* threshold, the maximum flood depth across the ground floor of the dwelling would be a maximum of 0.19m. The hazard to people under these conditions would be *Very low hazard* across the ground floor of the dwelling.

- Safe access/egress cannot be achieved during the peak of the event, however, it is recommended that the occupants evacuate the site during the early warning stages and when the hazard along the evacuation route is low. Safe refuge during all events including the climate change 1 in 1000 year event is available at all times.

- It is considered that there is a low risk of groundwater flooding at the site from underlying deposits.

- Surface water from hardstanding areas could be drained using SUDS measures consisting of permeable paving.

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APPENDIX A – CORRESPONDENCE

Woodhead, Susan [susan.woodhead@environment-agency.gov.uk]
02 April 2014 10:35
rupert.evans@evansriversandcoastal.co.uk
RE: CCE/2014/53001 - Reply to us by 4/4/14

Hello Mr Evans

Your enquiry below has just been forwarded to me.

I believe that the area that you require flood warning threshold levels for is for an area of land between **35 and 43 Victoria Drive, Great Wakering SS3 0AT**.
This area lies within the flood warning area known as 'Paglesham, Rochford, the Wakerings and Potton Island'.

The reference port that our thresholds are measured against for this flood warning area is for levels at Clacton in metres above ordnance datum Newlyn (mAODN).
The threshold levels that we use to issue our flood warnings for this area are as follows:

Flood Alert – 2.87 mAODN
Flood Warning – 3.77 mAODN
Severe Flood Warning - 3.97 mAODN

I hope that this is the information that you required.

Kind Regards

Sue Woodhead
Flood Resilience
susan.woodhead@environment-agency.gov.uk
Environment Agency, Iceni House, Cobham Road, Ipswich IP3 9JD

From: Rupert Evans [mailto:rupert.evans@evansriversandcoastal.co.uk]
Sent: 26 March 2014 13:44
To: Corporate Services
Cc: 'Graham Browne'
Subject: CCE/2013/50785 Great Wakering
Importance: High

Environment Agency

Mrs Claire Buckley
Rochford District Council
3-19 South Street
Rochford
Essex
SS4 1BW

AE/2013/116966/01-L01
*

12 December 2013

Dear Mrs Buckley

3 3

Thank you for your enquiry received on 27 November 2013. We have inspected the application, as submitted, and have the following comments to make on flood risk at this site:

A Flood Risk Assessment (FRA), prepared by Evans River and Coastal Ltd, referenced 1210/RE/11-13/01 and dated November 2013, has been submitted for the site.

The flood risk at this site is shown to be significant and we therefore have strong concerns regarding the placement of two 'more vulnerable' residential units at this location. If an application for planning permission is made in the future, we would advise you of the key flood risk issues at the site as follows:

- Significant flooding of the ground floor would be expected (over 2 metres within the building).
- There is no demonstration that the building could withstand hydrostatic and hydrodynamic pressures.
- Rapid inundation of flooding to the site.
- No access or egress during the flood event.
- Flood Insurance.
- Heavy reliance upon flood warning.

Floor levels are proposed at a level of 3.3mAOD. This level is below the 1 in 200 year and 1 in 1000 year climate change levels. According to the FRA, the ground floor would flood up to a depth of 2.34m in the 1 in 200 year climate change event, and 2.7m in the 1 in 1000 year climate change event. These depths have been calculated using the still North Sea tidal levels.

The FRA proposes a 'water entry strategy' to allow water to enter the building during a

flood, rather than displacing it elsewhere. Flood resilience measures are proposed up to a level of 2.7m (the expected internal flooding depth during the 1 in 1000 year climate change event) to reduce the impact of flooding internally. Whilst allowing water to enter the building is likely to reduce the pressures exerted on the building following flooding, further consideration should be given to the forces of the hydrostatic/hydrodynamic pressures that the building may experience during flooding, and whether the building is capable of remaining standing. If site users are not able to evacuate the site ahead of flooding, then refuge within the first floor will be required. It is therefore essential that the building is designed to remain standing during a flood event so that this essential refuge can be provided.

The FRA confirms that the site would be likely to flood within one hour of the defences breaching. This is not a long time to respond and means that if people have not received a flood warning, or have not already evacuated the area, they would be exposed to significant risk quickly.

The Strategic Flood Risk Assessment shows that access routes on and around the site would be flooded and, if early evacuation is not achieved, residents will have to take refuge within the building. During the present day 1 in 200 year event, flood depths at the site would be expected to reach 0.5m-1m. This increases to 2m-3m when considering climate change allowances over the lifetime of development. The site and surrounding area is therefore classified as a 'danger to most' based on present day flood levels, and a 'danger to all' based on future flood levels, according to the FD2320 Flood Risk Assessment Guidance for New Developments document.

The FRA recommends that site occupants evacuate the site upon receipt of a flood warning. A suitable site-specific flood plan may reduce the risk to the occupiers of the development, but would not remove it. Section 7.26 of the Planning Policy Statement 25 (PPS25) Practice Guide states that 'new development should not rely on flood warning alone as the only way of managing residual risk'. It should be noted that, even if a flood warning is successfully issued by us, there can be no guarantee that occupants will receive or heed the warning. In this case, failure to evacuate will result in additional persons becoming trapped or requiring rescue.

Taking into account the above comments, it would be useful for a breach of the defences to be modelled just below the flood warning threshold. This will provide a more accurate picture of flood risk to the site and enable the Local Planning Authority to better consider whether the mitigation measures proposed are sufficient to demonstrate that the risk can be managed. Identification of flood depths and velocities, following a breach of the defences just below the flood warning threshold level, will provide details of the risk to the site in an un-warned situation. Ideally, a flood warning will be received ahead of any flooding occurring. However, if the defences were to fail prior to the issue of a flood warning, it would be useful to know whether or not the flood risk would still be considered significant. This analysis would provide the worst case scenario for the site and will allow the Local Planning Authority to fully scrutinise the mitigation measures for the site. In order to obtain details of the flood warning thresholds, the applicant should contact our Corporate Services Team by emailing corporate.services@environment-agency.gov.uk.

Cont/d..

A guidance note has been issued by the Association of British Insurers (ABI) to complement the National Planning Policy Framework, which is available at: www.abi.org.uk/information/61595.pdf. It highlights the importance of adequately considering flood risk to ensure that insurance cover can be offered to properties. A 1 in 100 year plus climate change minimum standard is suggested, and a preference for flood avoidance (defences or raised floor levels) over flood resistance or resilience measures is stated.

Therefore, in making decisions regarding the safety of new dwellings, we would urge developers and planners to consider the potential insurance implications of a development. We strongly advise that the recommendations of the ABI are taken into account in the design of the development, in order that it may have a good chance of accessing flood cover at a competitive price. The ABI guidance note seems to indicate that the proposed properties may not receive insurance cover if they are only proposing to include flood resilience measures, and the building will still be at risk of flooding.

If it is practicable, we would therefore advise that the finished floor levels be set above the 1 in 200 year plus climate change flood level. If floor levels are not set above this flood level then it is not clear whether flood insurance would be able to be obtained. You should ensure that you are satisfied with the sustainability and long-term viability of the proposed development, which may include determining whether flood insurance would be able to be obtained.

The FRA shows that users of the site would be exposed to high hazards following a breach and overtopping of the existing defences. We would have very strong concerns over residential development at this site, which is reliant upon early evacuation to ensure that safety of site occupants.

We trust this advice is useful.

Yours sincerely

Direct dial 01473 706820
Direct e-mail lizzie.griffiths@environment-agency.gov.uk

End

PSOEssex [ESSEXPSO@environment-agency.gov.uk]
24 October 2013 12:35
rupert.evans@evansriversandcoastal.co.uk
50785DL rev01.pdf

CCE/ 2013/50785 Defence Line Query

Further to your telephone conversation with my colleague Julian Adams this morning please find attached an amended flood defence location map.

I understand you were looking for defence information for the coastal section to the east of your site. After examining our asset database I have been able to determine that there are in fact defences along this line of coast relevant to the site. However they were not previously included in our response as they are privately owned. We therefore do not hold in depth information such as crest levels and the standard of protection of these assets.

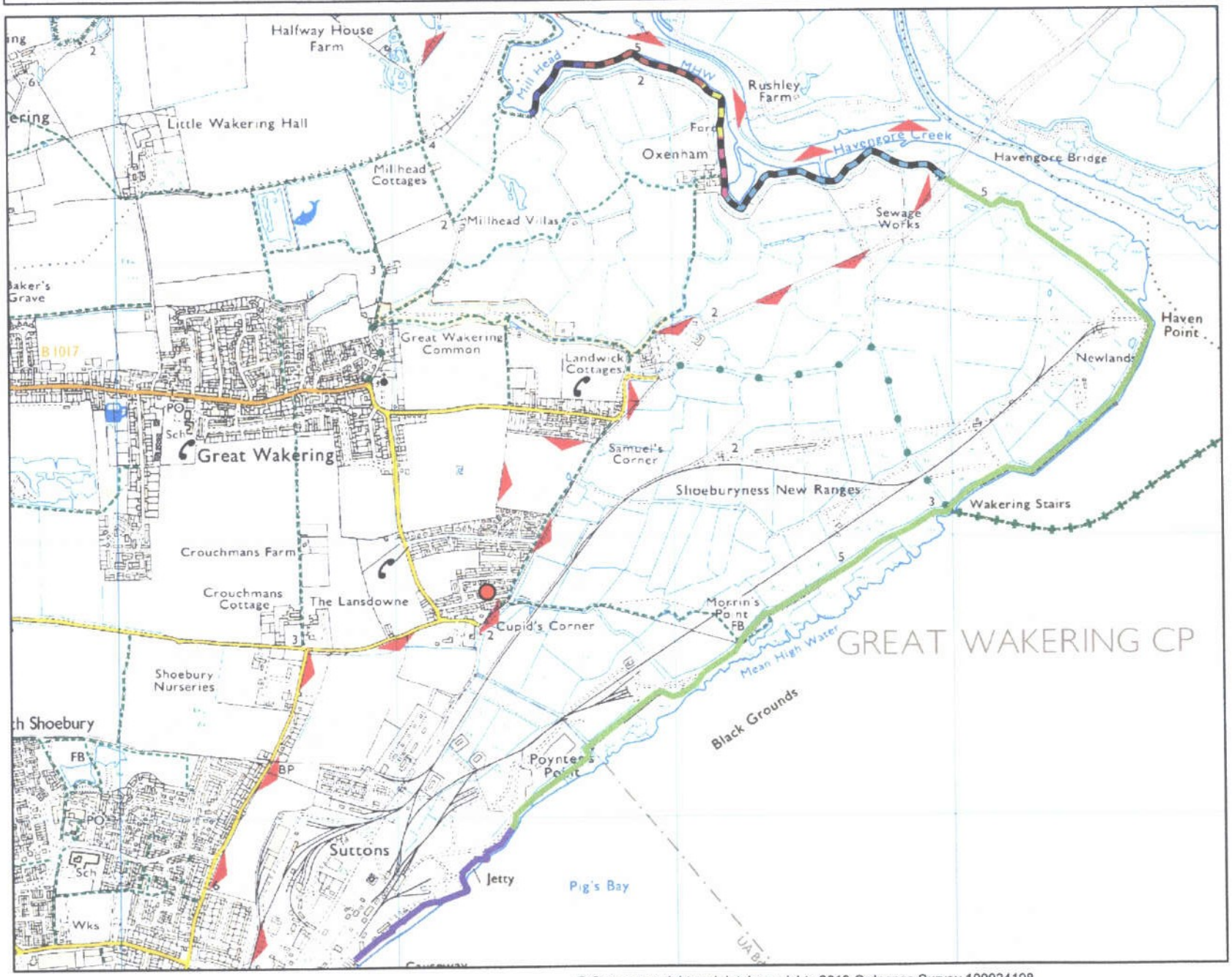
The map attached illustrates the designation of these defences in more detail which i hope is of use.

I hope this answers your question. Please do contact me if I can be of further assistance.

Regards

01 3 0
Email: essexpso@environment-agency.go.uk

Flood Defence Location Map centred on Great Wakering - Created 24th of October 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:20,000

Legend

- Site

EA Defence Line

ASSET_REF

- 051CDCROU6601C02
- 051CDCROU6601C03
- 051CDCROU6601C04
- 051CDCROU6601C05
- 051CDCROU6601C06

Private_Defence_Line

ASSET_TYPE

- embankment
- wall

N

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Environment Agency

Mr Tim Lawrence
aprilmagna@btinternet.com

Our ref CCE/2013/50785
Your ref
Date 01 August 2013

Dear Mr Lawrence

Land between 35 & 43 Victoria Drive, Great Wakering

Thank you for your enquiry which we received on 7 July 2013. Following internal consultations we are able to reply to your enquiry as below.

Product 4 & 5

Please see attached the following PDF documents:-

- Detailed Flood Map showing the Flood Zones (outlines) for the area of the site.
- Modelled Flood Levels and Defence Information.
- Modelled Flood Level Location Map's.
- Flood History Location Map.
- Flood Defence Location Map.
- Design Sea Levels Report.
- Design Swell Waves Report.
- Crouch Estuary Model Development Report 2011
- Crouch Estuary Summary Report 2011

This area falls within Flood Zone 3, Tidal.

Flood Zone 1, (i.e. a less than 0.1% annual probability of flooding).

The Flood Zone 2 outline shows a 1 in 1000 chance of flooding at a location in any one given year (i.e., a 0.1% annual probability of flooding).

The Flood Zone 3 fluvial outline shows a 1 in 100 chance of flooding at a location in any one given year (i.e., a 1% annual probability of flooding).

The Flood Zone 3 tidal outline shows a 1 in 200 chance of flooding at a location in any one given year (i.e., a 0.5% annual probability of flooding).

Eastern Area - Iceni House
Cobham Road, Ipswich, Suffolk, IP3 9JD
General Enquiries: 03708 506506 Fax: 01473 724205
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Email: enquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

The flood outlines show areas of potential flooding as a direct result of floodwater coming from a watercourse or sea. No direct effects of surface runoff or surface flooding are included. The Flood Maps show areas at risk of flooding, and not the risk to individual properties. This is because we do not hold data on individual properties.

Examinations of our records of historic flooding show that the general area of Great Wakering was flooded in 1953. Please note that these records show flooding to the land and do not necessarily indicate that properties within the historic flood events were flooded internally. It is also possible that the pattern of flooding in this area has changed and that this area would now flood under different circumstances.

For more information regarding the open coast modelled flood levels, please follow the link below and search for SC060064 in the keywords box.
http://publications.environment-agency.gov.uk/epages/eapublications.storefront?lang=_e

The purpose of the Flood Risk Assessment (FRA) is to demonstrate that any development will be safe and sustainable. The requirements and level of information required within a FRA depends on the development vulnerability and Flood Zone.

Further guidance on any development type within any of the Flood Zones can be found at the following website. Here you will find PDF documents detailing the information you will need to include in your Flood Risk Assessment. Just click on the relevant link for your proposal. http://www.environment-agency.gov.uk/research/planning/93498.aspx

If you would like to discuss the required content of the FRA in more detail, please email us at Corporate.Services@environment-agency.gov.uk.

Please see the attached notice for details of the permitted use of the information provided.

If you have any specific requirements because of dyslexia, visual or other physical impairment etc, we will be able to supply the data in an alternative format.

If we can be of any further assistance, please do contact our Partnership and Strategic Overview (PSO) Team on the number below.

Yours sincerely

N. Earrey

Nina Earrey
Flood and Coastal Risk Management Officer

PSO Team
Essex 01473 706844

Eastern Area - Iceni House
Cobham Road, Ipswich, Suffolk, IP3 9JD
General Enquiries: 03708 506506 Fax: 01473 724205
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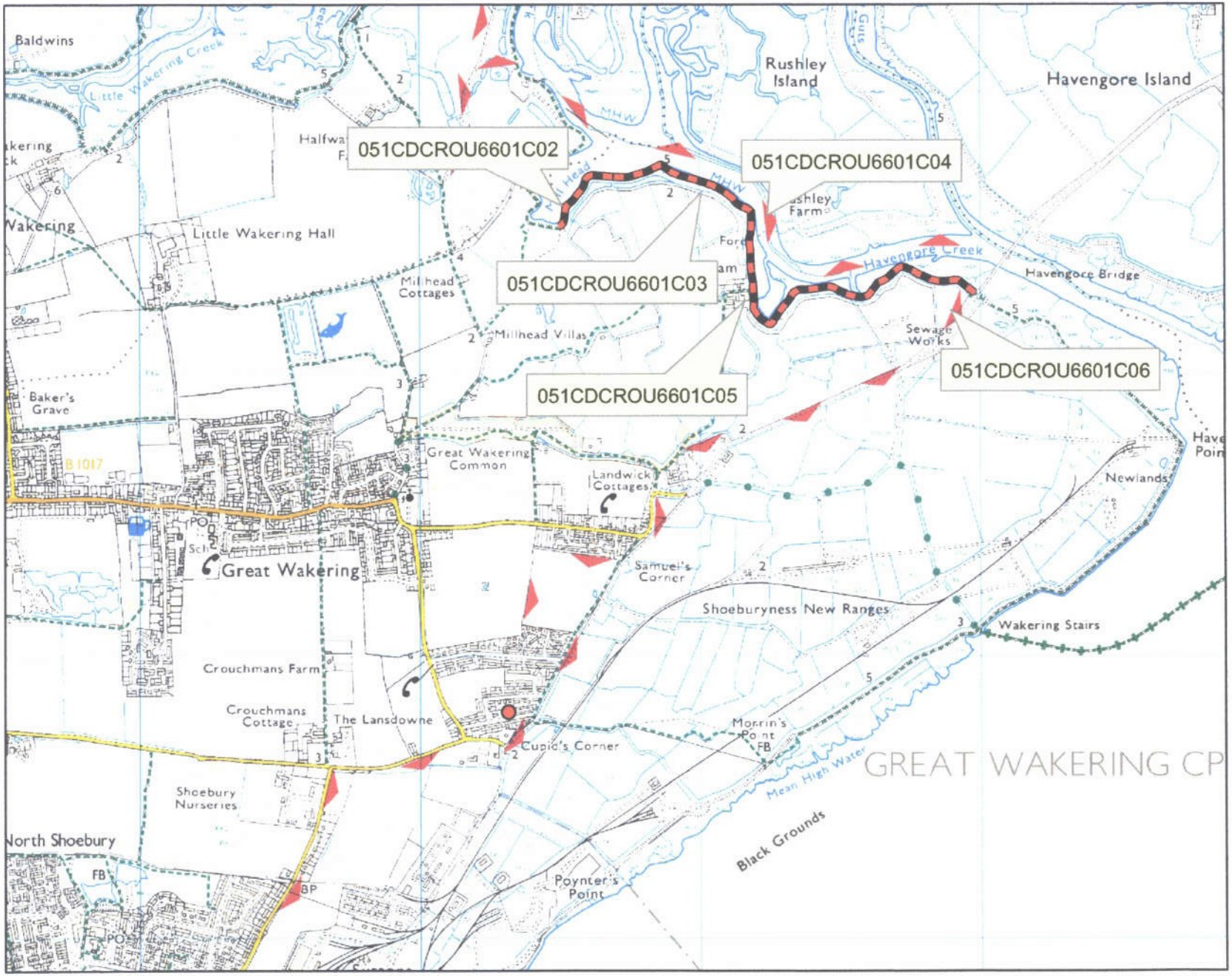
Email: enquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Flood Defence Location Map centred on Great Wakering Created 1st August 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:20,000

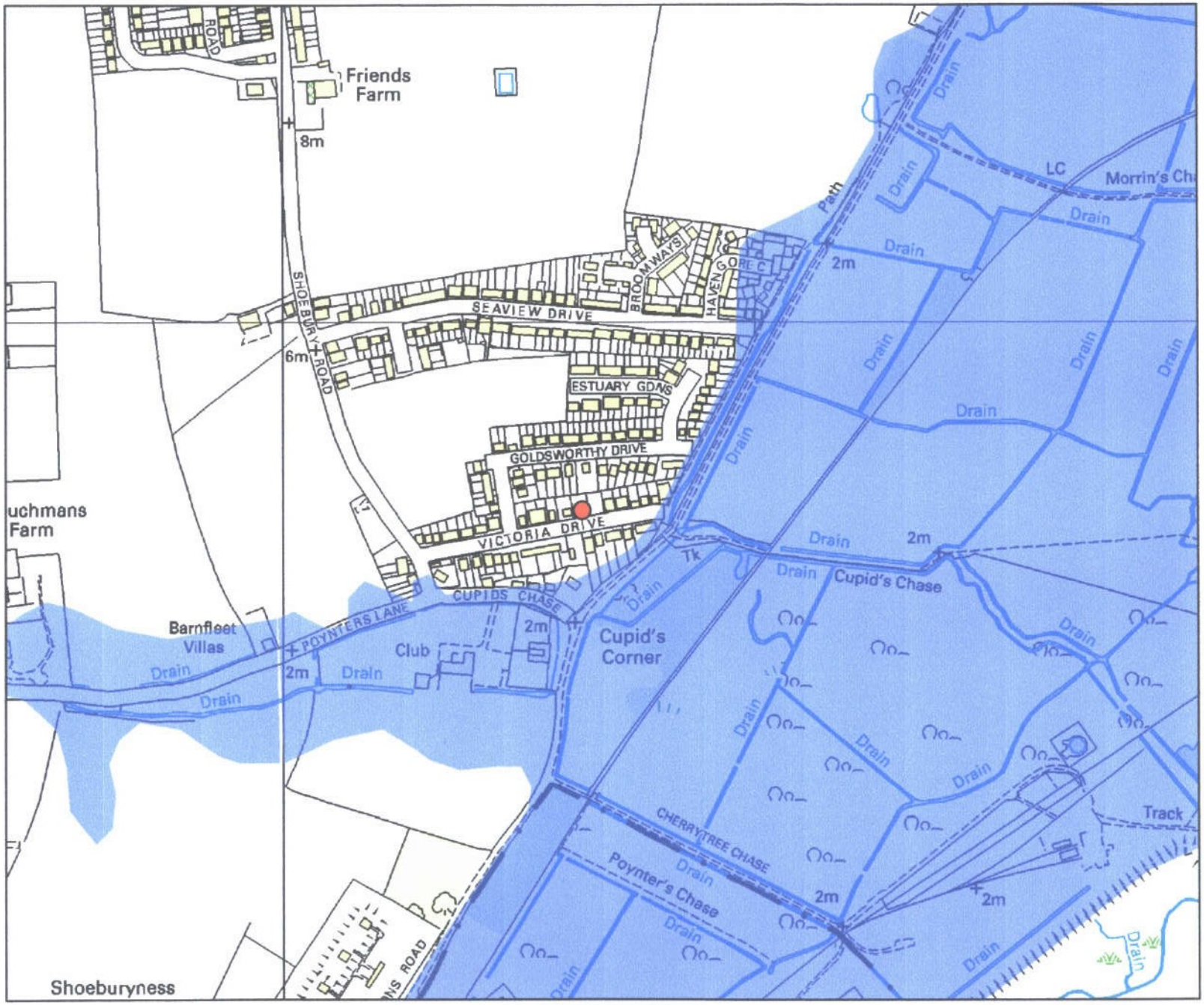
Legend

- Site
- Defence line

N

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Historic Flood Map centred on Great Wakering. Created 26th July 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:6,000

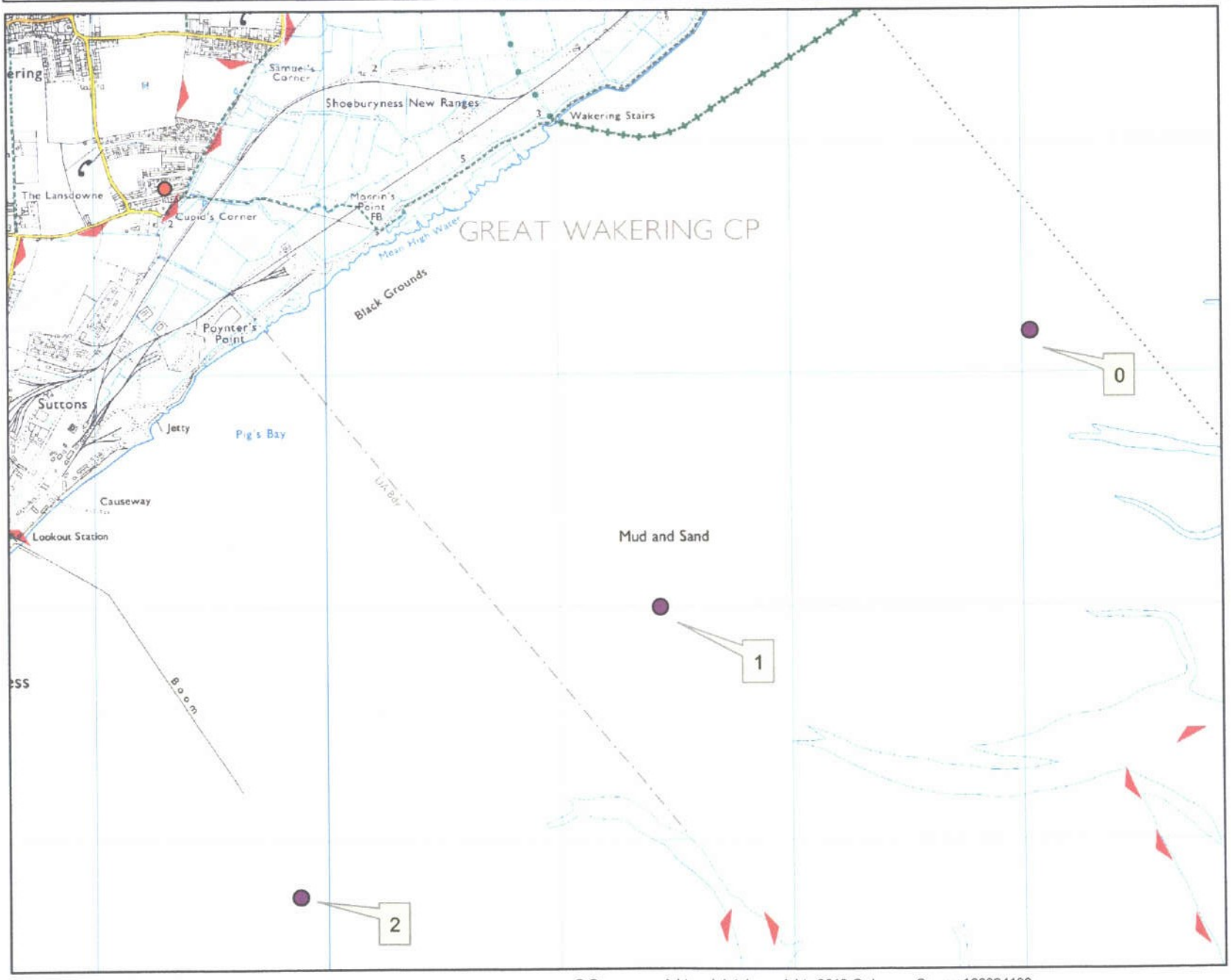
Legend

- 1953 Flood Outline
- Site

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

N

Modelled Level Location Map centred on Great Wakering Created 26th July 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:24,000

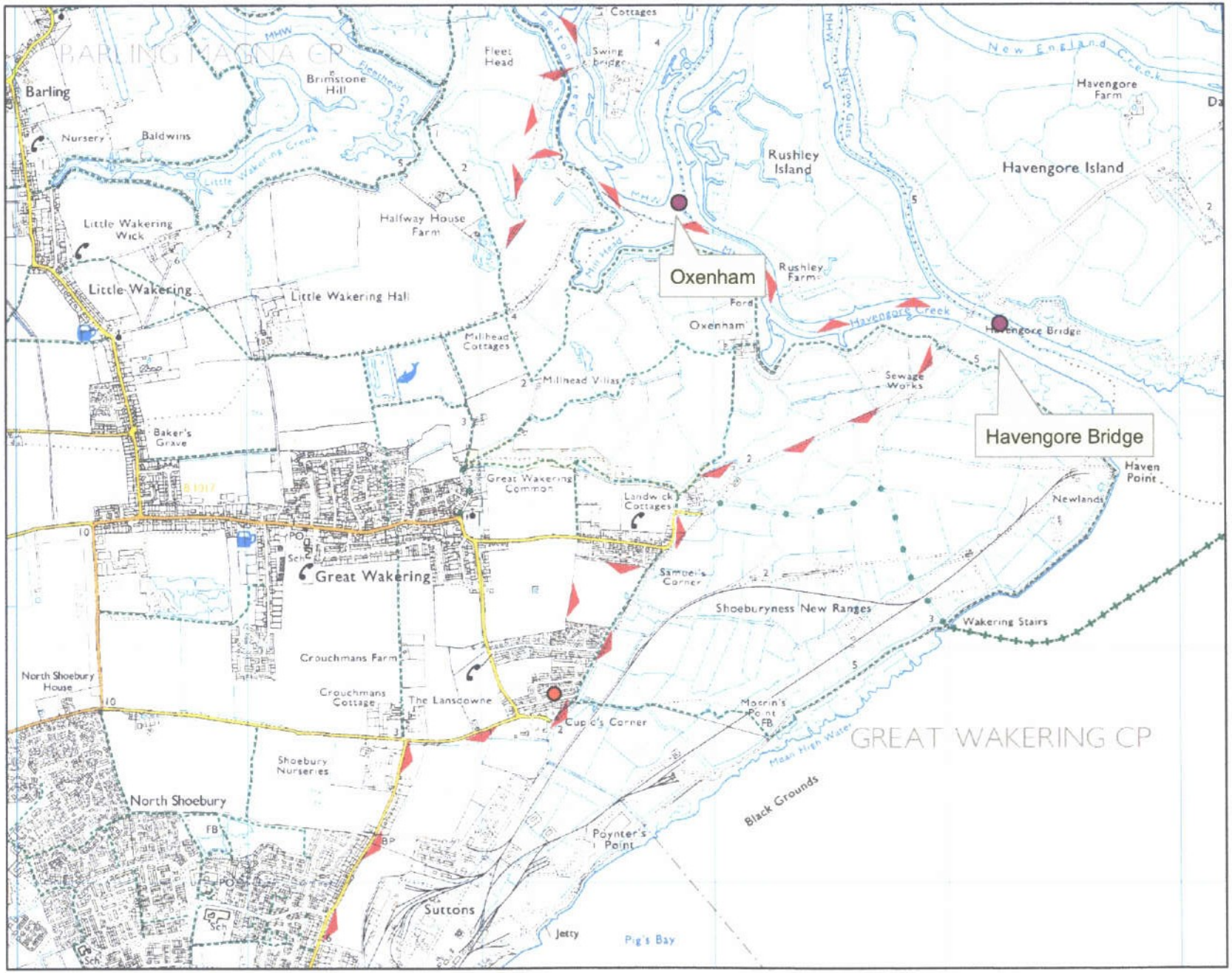
Legend

- Modelled Level node point
- Site

N

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Modelled Level Location Map centred on Great Wakering Created 1st August 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:24,000

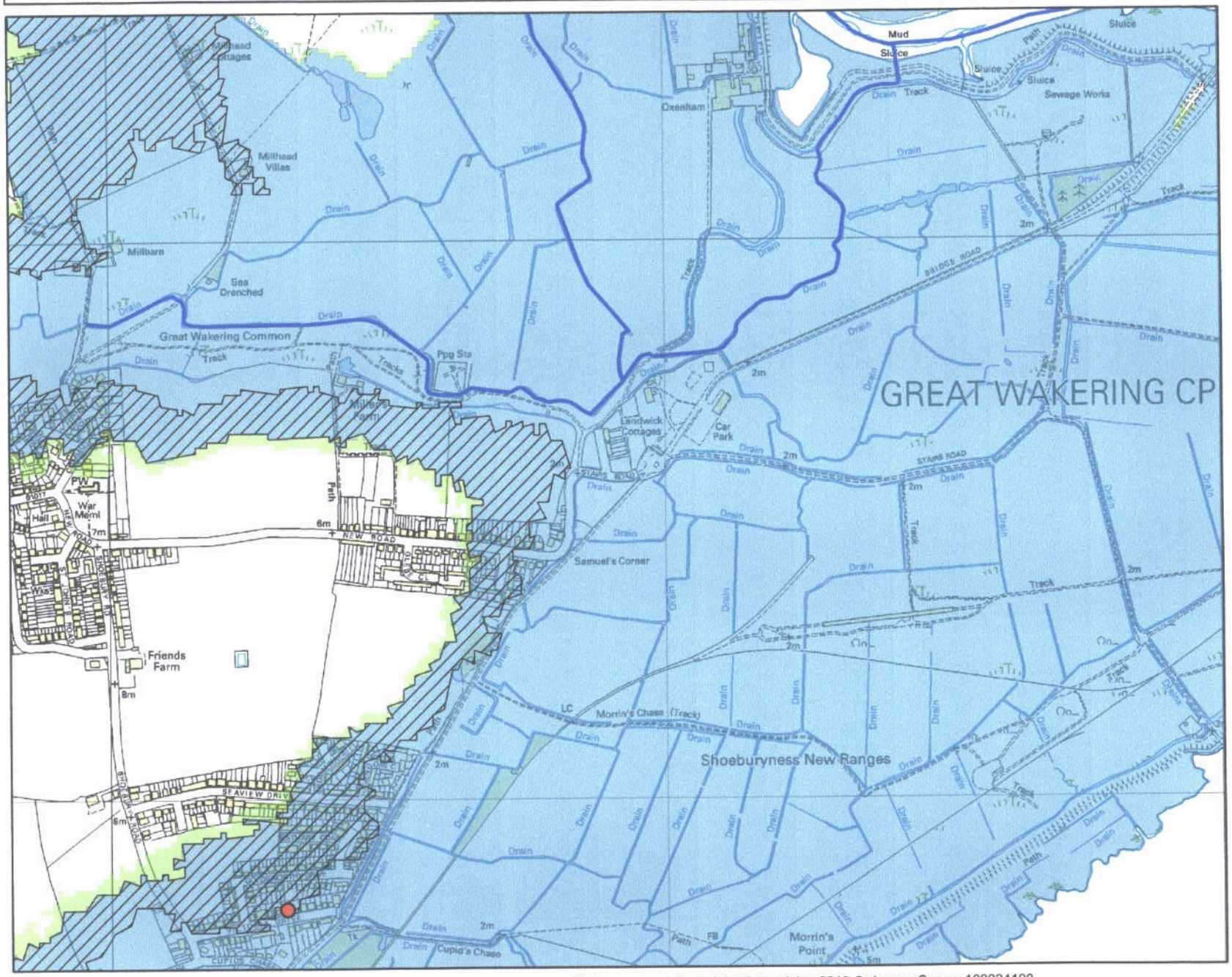
Legend

- Modelled Level node point (Crouch/Roach
- Site

N

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Detailed Flood Map centred on Great Wakering Created 1st August 2013.
Ref: CCE/2013/50785



Environment Agency

Scale 1:10,000

Legend

- Site
- Main River
- Areas Benefit Flood Defence
- Flood Storage Area
- Flood Map - Flood Zone 3
- Flood Map - Flood Zone 2

N

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Datasheet Reference CCE/2013/50785

Tidal flood levels (mAODN)

Node	100% (1:1)	50% (1:2)	20% (1:5)	10% (1:10)	5% (1:20)	4% (1:25)	2% (1:50)	1.3% (1:75)	1% (1:100)	0.66% (1:150)	0.5% (1:200)	0.4% (1:250)	0.33% (1:300)	0.2% (1:500)	0.1% (1:1000)	0.01% (1:10,000)
0	3.51	3.63	3.78	3.91	4.03	4.08	4.21	4.29	4.35	4.43	4.49	4.54	4.57	4.68	4.82	5.32
1	3.53	3.64	3.80	3.92	4.05	4.10	4.23	4.31	4.37	4.46	4.52	4.56	4.60	4.71	4.86	5.39
2	3.54	3.66	3.81	3.94	4.07	4.11	4.25	4.33	4.39	4.48	4.54	4.59	4.63	4.74	4.90	5.46

Source of information: Extreme Sea Levels (2008)

Tidal flood levels (mAODN)

Undefended

Node	50% (1:2)	20% (1:5)	10% (1:10)	5% (1:20)	5% (1:20) +CC	2% (1:50)	1.3% (1:75)	1% (1:100)	1% (1:100) +CC	0.66% (1:150)	0.5% (1:200)	0.5% (1:200) +CC	0.33% (1:300)	0.1% (1:1000)	0.1% (1:1000) +CC
Havengore Bridge	3.32	3.51	3.66	3.82	5.02	4.02	4.11	4.17	5.35	4.27	4.33	5.50	4.42	4.68	5.83
Oxenham	3.25	3.43	3.58	3.74	5.00	3.94	4.03	4.09	5.34	4.19	4.26	5.48	4.35	4.61	5.80

Defended

Node	50% (1:2)	20% (1:5)	10% (1:10)	5% (1:20)	5% (1:20) +CC	2% (1:50)	1.3% (1:75)	1% (1:100)	1% (1:100) +CC	0.66% (1:150)	0.5% (1:200)	0.5% (1:200) +CC	0.33% (1:300)	0.1% (1:1000)	0.1% (1:1000) +CC
Havengore Bridge	3.67	3.83	3.96	4.10	4.99	4.28	4.35	4.40	5.18	4.48	4.52	5.26	4.59	4.78	5.41
Oxenham	3.76	3.93	4.06	4.19	4.79	4.32	4.37	4.41	4.91	4.47	4.51	4.99	4.55	4.65	5.09

Source of information: Crouch Estuary Flood Risk Study (2011) by JBA Consultant for the Environment Agency

Defence Information

Asset Reference	Maintainer	Bank	Asset Type	Asset Description	Standard of Protection	Overall Condition Grade	Crest Level (m)
051CDCROU6601C05	Environment Agency	coastal	sea defence (man-made	SEAWALL - Essex Block Revetment + Steel Sheet Pile Parapet Wall CLAY	0.5% (1:200)	3	4.20
051CDCROU6601C06	Environment Agency	coastal	sea defence (man-made	SEAWALL - Essex Block Revetment. CLAY	0.5% (1:200)	2	4.42
051CDCROU6601C03	Environment Agency	coastal	sea defence (man-made	SEAWALL - Essex Block Revetment. CLAY	0.5% (1:200)	3	4.40
051CDCROU6601C04	Environment Agency	coastal	sea defence (man-made	SEAWALL - Ragstone Revetment.	0.5% (1:200)	3	4.62
051CDCROU6601C02	Environment Agency	coastal	sea defence (man-made	SEAWALL - Canewdon Slab Revetment.	0.5% (1:200)	3	4.64

Key to Overall Condition Grades

Grade	Rating	Description
1	Very Good	Cosmetic Defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation
5	Very Poor	Severe defects resulting in complete performance failure.

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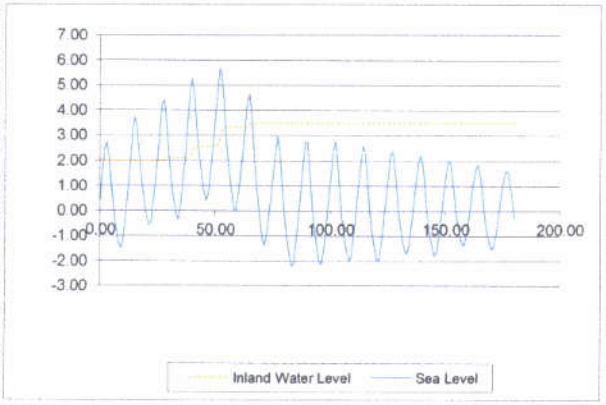
APPENDIX B – BREACH ANALYSIS

Time(hours)	Volume (cub. m)	Inland Water Level(m AOD)	Sea Level(m AOD)
0.00	0.00	2.00	0.46
1.00	0.00	2.00	1.48
2.00	0.00	2.00	2.44
3.00	0.00	2.00	2.74
4.00	0.00	2.00	2.08
5.00	0.00	2.00	0.92
6.00	0.00	2.00	-0.06
7.00	0.00	2.00	-0.75
8.00	0.00	2.00	-1.29
9.00	0.00	2.00	-1.51
10.00	0.00	2.00	-1.10
11.00	0.00	2.00	-0.23
12.00	0.00	2.00	0.75
13.00	0.00	2.00	1.80
14.00	0.00	2.00	2.96
15.00	65.45	2.00	3.71
16.00	174.10	2.00	3.44
17.00	174.10	2.00	2.35
18.00	174.10	2.00	1.23
19.00	174.10	2.00	0.46
20.00	174.10	2.00	-0.14
21.00	174.10	2.00	-0.58
22.00	174.10	2.00	-0.47
23.00	174.10	2.00	0.28
24.00	174.10	2.00	1.23
25.00	174.10	2.00	2.17
26.00	174.10	2.00	3.28
27.00	37544.94	2.02	4.29
28.00	211363.91	2.09	4.42
29.00	271154.24	2.11	3.44
30.00	271154.24	2.11	2.09
31.00	271154.24	2.11	1.10
32.00	271154.24	2.11	0.42
33.00	271154.24	2.11	-0.17
34.00	271154.24	2.11	-0.33
35.00	271154.24	2.11	0.24
36.00	271154.24	2.11	1.23
37.00	271154.24	2.11	2.24
38.00	271154.24	2.11	3.35
39.00	354121.82	2.15	4.59
40.00	790337.71	2.33	5.26
41.00	1249107.69	2.52	4.70
42.00	1346407.18	2.56	3.37
43.00	1346407.18	2.56	2.21
44.00	1346407.18	2.56	1.46
45.00	1346407.18	2.56	0.82
46.00	1346407.18	2.56	0.41
47.00	1346407.18	2.56	0.69
48.00	1346407.18	2.56	1.57
49.00	1346407.18	2.56	2.54
50.00	1346407.18	2.56	3.53
51.00	1463434.67	2.60	4.71
52.00	2038968.85	2.84	5.64
53.00	2822271.62	3.17	5.44
54.00	3200420.50	3.32	4.16
55.00	3213229.14	3.33	2.67
56.00	3213229.14	3.33	1.64
57.00	3213229.14	3.33	0.83
58.00	3213229.14	3.33	0.13
59.00	3213229.14	3.33	-0.03
60.00	3213229.14	3.33	0.56
61.00	3213229.14	3.33	1.44
62.00	3213229.14	3.33	2.31
63.00	3213229.14	3.33	3.32
64.00	3262699.05	3.35	4.37
65.00	3492848.52	3.44	4.62
66.00	3597723.85	3.49	3.62
67.00	3597723.85	3.49	2.05
68.00	3597723.85	3.49	0.81
69.00	3597723.85	3.49	-0.10
70.00	3597723.85	3.49	-0.93
71.00	3597723.85	3.49	-1.39
72.00	3597723.85	3.49	-1.11
73.00	3597723.85	3.49	-0.38
74.00	3597723.85	3.49	0.39
75.00	3597723.85	3.49	1.22
76.00	3597723.85	3.49	2.22
77.00	3597723.85	3.49	2.94
78.00	3597723.85	3.49	2.49
79.00	3597723.85	3.49	1.14
80.00	3597723.85	3.49	-0.16
81.00	3597723.85	3.49	-1.01
82.00	3597723.85	3.49	-1.70
83.00	3597723.85	3.49	-2.20
84.00	3597723.85	3.49	-2.08
85.00	3597723.85	3.49	-1.31
86.00	3597723.85	3.49	-0.36

3	3597723.85
	3.49



87.00	3597723.85	3.49	0.60
88.00	3597723.85	3.49	1.72
89.00	3597723.85	3.49	2.70
90.00	3597723.85	3.49	2.74
91.00	3597723.85	3.49	1.67
92.00	3597723.85	3.49	0.30
93.00	3597723.85	3.49	-0.70
94.00	3597723.85	3.49	-1.41
95.00	3597723.85	3.49	-2.00
96.00	3597723.85	3.49	-2.15
97.00	3597723.85	3.49	-1.60
98.00	3597723.85	3.49	-0.70
99.00	3597723.85	3.49	0.22
100.00	3597723.85	3.49	1.25
101.00	3597723.85	3.49	2.32
102.00	3597723.85	3.49	2.76
103.00	3597723.85	3.49	2.10
104.00	3597723.85	3.49	0.81
105.00	3597723.85	3.49	-0.31
106.00	3597723.85	3.49	-1.07
107.00	3597723.85	3.49	-1.69
108.00	3597723.85	3.49	-2.03
109.00	3597723.85	3.49	-1.75
110.00	3597723.85	3.49	-0.96
111.00	3597723.85	3.49	-0.07
112.00	3597723.85	3.49	0.86
113.00	3597723.85	3.49	1.89
114.00	3597723.85	3.49	2.58
115.00	3597723.85	3.49	2.33
116.00	3597723.85	3.49	1.24
117.00	3597723.85	3.49	0.04
118.00	3597723.85	3.49	-0.83
119.00	3597723.85	3.49	-1.49
120.00	3597723.85	3.49	-1.96
121.00	3597723.85	3.49	-1.93
122.00	3597723.85	3.49	-1.34
123.00	3597723.85	3.49	-0.50
124.00	3597723.85	3.49	0.39
125.00	3597723.85	3.49	1.36
126.00	3597723.85	3.49	2.21
127.00	3597723.85	3.49	2.39
128.00	3597723.85	3.49	1.68
129.00	3597723.85	3.49	0.57
130.00	3597723.85	3.49	-0.36
131.00	3597723.85	3.49	-1.03
132.00	3597723.85	3.49	-1.54
133.00	3597723.85	3.49	-1.72
134.00	3597723.85	3.49	-1.37
135.00	3597723.85	3.49	-0.66
136.00	3597723.85	3.49	0.14
137.00	3597723.85	3.49	0.99
138.00	3597723.85	3.49	1.83
139.00	3597723.85	3.49	2.25
140.00	3597723.85	3.49	1.87
141.00	3597723.85	3.49	0.90
142.00	3597723.85	3.49	-0.10
143.00	3597723.85	3.49	-0.87
144.00	3597723.85	3.49	-1.44
145.00	3597723.85	3.49	-1.77
146.00	3597723.85	3.49	-1.65
147.00	3597723.85	3.49	-1.08
148.00	3597723.85	3.49	-0.33
149.00	3597723.85	3.49	0.48
150.00	3597723.85	3.49	1.33
151.00	3597723.85	3.49	1.95
152.00	3597723.85	3.49	1.96
153.00	3597723.85	3.49	1.31
154.00	3597723.85	3.49	0.42
155.00	3597723.85	3.49	-0.35
156.00	3597723.85	3.49	-0.92
157.00	3597723.85	3.49	-1.31
158.00	3597723.85	3.49	-1.37
159.00	3597723.85	3.49	-1.01
160.00	3597723.85	3.49	-0.39
161.00	3597723.85	3.49	0.31
162.00	3597723.85	3.49	1.04
163.00	3597723.85	3.49	1.66
164.00	3597723.85	3.49	1.86
165.00	3597723.85	3.49	1.45
166.00	3597723.85	3.49	0.64
167.00	3597723.85	3.49	-0.18
168.00	3597723.85	3.49	-0.84
169.00	3597723.85	3.49	-1.31
170.00	3597723.85	3.49	-1.53
171.00	3597723.85	3.49	-1.37
172.00	3597723.85	3.49	-0.88
173.00	3597723.85	3.49	-0.22
174.00	3597723.85	3.49	0.49
175.00	3597723.85	3.49	1.18
176.00	3597723.85	3.49	1.62
177.00	3597723.85	3.49	1.58
178.00	3597723.85	3.49	1.07
179.00	3597723.85	3.49	0.37

180.00	3597723.85	3.49	-0.26
181.00	3597723.85	3.49	-0.74
182.00	3597723.85	3.49	-1.03
183.00	3597723.85	3.49	-1.05
184.00	3597723.85	3.49	-0.75
185.00	3597723.85	3.49	-0.24
186.00	3597723.85	3.49	0.35
187.00	3597723.85	3.49	0.94
188.00	3597723.85	3.49	1.40
189.00	3597723.85	3.49	1.50
190.00	3597723.85	3.49	1.16
191.00	3597723.85	3.49	0.51
192.00	3597723.85	3.49	-0.17
193.00	3597723.85	3.49	-0.74
194.00	3597723.85	3.49	-1.13
195.00	3597723.85	3.49	-1.29
196.00	3597723.85	3.49	-1.15
197.00	3597723.85	3.49	-0.74
198.00	3597723.85	3.49	-0.19
199.00	3597723.85	3.49	0.42
200.00	3597723.85	3.49	0.98
201.00	3597723.85	3.49	1.33
202.00	3597723.85	3.49	1.31
203.00	3597723.85	3.49	0.93
204.00	3597723.85	3.49	0.38
205.00	3597723.85	3.49	-0.14
206.00	3597723.85	3.49	-0.55
207.00	3597723.85	3.49	-0.79
208.00	3597723.85	3.49	-0.81
209.00	3597723.85	3.49	-0.58
210.00	3597723.85	3.49	-0.17
211.00	3597723.85	3.49	0.32
212.00	3597723.85	3.49	0.79
213.00	3597723.85	3.49	1.15
214.00	3597723.85	3.49	1.24
215.00	3597723.85	3.49	0.98
216.00	3597723.85	3.49	0.46
217.00	3597723.85	3.49	-0.11
218.00	3597723.85	3.49	-0.61
219.00	3597723.85	3.49	-0.96
220.00	3597723.85	3.49	-1.12
221.00	3597723.85	3.49	-1.02
222.00	3597723.85	3.49	-0.70
223.00	3597723.85	3.49	-0.22
224.00	3597723.85	3.49	0.31
225.00	3597723.85	3.49	0.80
226.00	3597723.85	3.49	1.14
227.00	3597723.85	3.49	1.18
228.00	3597723.85	3.49	0.91
229.00	3597723.85	3.49	0.47
230.00	3597723.85	3.49	0.01
231.00	3597723.85	3.49	-0.38
232.00	3597723.85	3.49	-0.63
233.00	3597723.85	3.49	-0.69
234.00	3597723.85	3.49	-0.54
235.00	3597723.85	3.49	-0.21
236.00	3597723.85	3.49	0.21
237.00	3597723.85	3.49	0.64
238.00	3597723.85	3.49	0.98
239.00	3597723.85	3.49	1.11


EVANS