APPENDIX B

EXTRACT FROM SFRA (APPENDIX A)

6 Appendix A Factors Affecting Flood Risk

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6.1 On the east coast of England high sea levels are generally caused by a combination of tidal conditions (caused by relative movements of the moon, earth and sun) and a surge (caused by the weather conditions, particularly the movement of low-pressure storm systems). As a result, unusually high sea levels tend to rise fairly rapidly, remain at their peak for one or two hours and then fall away equally rapidly. There will then be a further peak at the following high tide some 12½ hours later, which is generally lower than the first one but could be higher if the surge is particularly prolonged.

6.2 If the strip of low-lying land beside the coast (the coastal/tidal floodplain) is relatively narrow then there will normally be enough time for water from the sea to flood across it and rise to the same peak level that occurs just offshore. If the floodplain is broad, however, or if it lies towards the head of an estuary, then the flow of water from the sea to the area being flooded can be insufficient to fill it before the sea level begins to fall again. As a result the peak water level in the flooded area is less than the peak sea level. This effect is particularly marked in the tidal reaches of the rivers draining to the estuary, where the flooding of a large area of land can lower the water levels in the river as well.

6.3 Historically, the normal response to coastal flooding has been to build flood defences and the whole of the south bank of the Humber is protected in this way (apart from a few points where high land comes to the water's edge). These defences would be high enough to keep out all but the most extreme events if there were no waves. The weather conditions causing large surges, however, often cause waves as well. The spray from these can lead to local flooding nearby and, more importantly, could undermine the defences causing them to breach and allow the sea to flow through.

6.4 The defences can breach for a number of other reasons, including structural failure and accidental damage. A similar effect can be caused by the failure of a floodgate or barrier to close, either because of a mechanical or electrical fault or through operator error. Whatever the cause, if there is a gap in the defences the sea will flow through it and flood low-lying land behind. The extent of flooding will depend on the topography of the area and the volume of water flowing through the defences, which in turn will depend on the peak sea level and the size, number and timing of the breaches.

Fluvial flooding

6.5 When rainfall occurs over land some of the water will be absorbed into the vegetation or other materials on the surface and some will infiltrate into the underlying ground. Surplus water collects on the surface and flows downhill until it enters a ditch or other drainage system. In time some of the infiltration water will also enter the drainage system and from there the water will flow to a river and, eventually, to the sea. This takes time, however, so rain falling in the upper catchment of a large UK river can take several days to arrive at the lower reaches. Rainfall on the lower catchment will reach the same place more quickly, with the effect that the flow from two storms can converge giving results that are more serious than either one alone.

6.6 In most UK rivers, the bank-full capacity of the natural channel is about the mean annual flood (the flow that occurs, on average, once a year). When the flow is greater than this the river comes out of its banks and spreads across the surrounding land (the fluvial floodplain). This increases the area of flow, allowing more water to pass downstream, and provides storage for surplus water until conditions downstream have improved sufficiently for it to flow away. If the river channel is constricted at some point downstream the flow function is limited and the storage function becomes more important. The depth of water on the floodplain will depend on the severity of the flood and the conditions downstream.

6.7 Man's activity in the catchment, particularly urbanisation and agriculture, can affect both the proportion of rainfall entering the drainage system and the rate at which it does so. Urbanisation (the construction of buildings, roads, car parks and their drainage systems) tends to reduce the volume of water infiltrating into the ground (since the surfaces are normally impervious), reduce the volume of water stored on the surface (since puddles are not normally

acceptable) and increase the rate of discharge into the river (since water normally flows more rapidly through a designed drainage system than across natural ground). Agricultural practices, such as ploughing down rather than across a slope, can have similar effects. The result will generally be to increase the size and speed of flooding that occurs during small or medium rainfall events. The effect is normally less important during extreme events since prolonged heavy rainfall causes the ground to become sodden and fills the available surface storage, so any subsequent rain runs off into the rivers more rapidly.

6.8 Man's activity on the floodplain can affect both its ability to allow water to flow downstream and its storage capacity. A road across a valley or a wall across a field can obstruct the flow and cause water to pond upstream, raising flood levels. A building raised above the surrounding ground will reduce the volume available for storing floodwater. The water that would have been stored there has to go somewhere else, again raising flood levels.

6.9 Generally the most significant impacts on floodplain function are caused by flood defences. These, until they are overtopped, cut off the floodplain from its river so the water that would have been stored there has to pass further downstream, raising water levels and possibly causing referred flooding if the channel capacity is inadequate. Once the defences are overtopped any surplus water will flow into the floodplain and will be trapped there until the flood has passed. If the defences are breached, either accidentally, due to structural failure or because they are washed out, the flow into the floodplain will increase and is likely to lower the water levels in the river. The extent of flooding will depend on the volume of water stored in the river and the capacity of the channel downstream as well as the size and duration of the flood event. If the system is pumped the extent will also be controlled by the pump capacity and will be seriously affected if the pumps fail to operate.

Surface and groundwater flooding

6.10 During periods of very heavy rainfall (pluvial) the volume of the water flowing off the surface of the ground can exceed the capacity of the existing drainage system, either natural or man-made, to remove it. This can be because the channels, ditches or pipes are not large enough to carry all the flow, or because they have become blocked so their capacity is reduced.

6.11 When this happens the surface water will tend to flow overland where the ground is sloping towards a low point where it will collect. The velocity and depth of flow will depend on the slope of the ground and the volume of water that cannot enter the existing drainage system – the steeper the slope the faster and more dangerous the flow. The depth of water collecting in low points will depend on the local topography, the level will rise until the water can overflow and flood into an adjacent area. This is known as pluvial flooding (caused by high volumes of rainfall).

6.12 Maintenance of the drainage system can be an important factor in surface water flooding. If ditches and culverts are not kept clear they will not operate effectively, increasing the probability of a flood occurring. Not all blockages are due to poor maintenance, however, as a build-up of debris washed into the system during an event will have the same effect.

6.13 Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks, or aquifers. Water levels below the ground rise during wet winter months and fall again during the summer, when water flows out into rivers. During very wet periods the water level can rise above the level of the ground surface, causing flooding of areas that are normally dry. Groundwater flooding may take weeks or months to dissipate because water flows much more slowly through the ground than over the surface so high water levels take a long time to fall.

Future changes

6.14 The assessment of flood probability is based on a statistical analysis of past events, either in the same catchment (or at the same point on the shore for coastal flooding) or in similar catchments elsewhere. These records are generally quite short (possibly 30 or 40 years or less) which introduces some uncertainty when predicting events that may happen on average once every 100 or 200 years. This uncertainty is increasing, as the world's climate appears to be changing. As a result, the UK is expected to experience more frequent winter storms (and less rainfall in summer), which is likely to mean that high river flows, and hence fluvial flooding, will also occur more frequently. The incidence of coastal flooding is also likely to increase, partly because the increased storminess will increase the frequency of waves and surges but also because sea levels are expected to rise.

6.15 The effect of these changes is difficult to estimate but Government guidance currently suggests that sea levels off the East Coast could rise by to just over 1m over the next 100 years, flood flows in rivers could increase by perhaps 20% and peak rainfall intensities by 30%.